Flood Risk Assessment & Drainage Strategy

Hayes Lane, Slinfold

22-001-003 Rev A

June 2025

Charles & Associates

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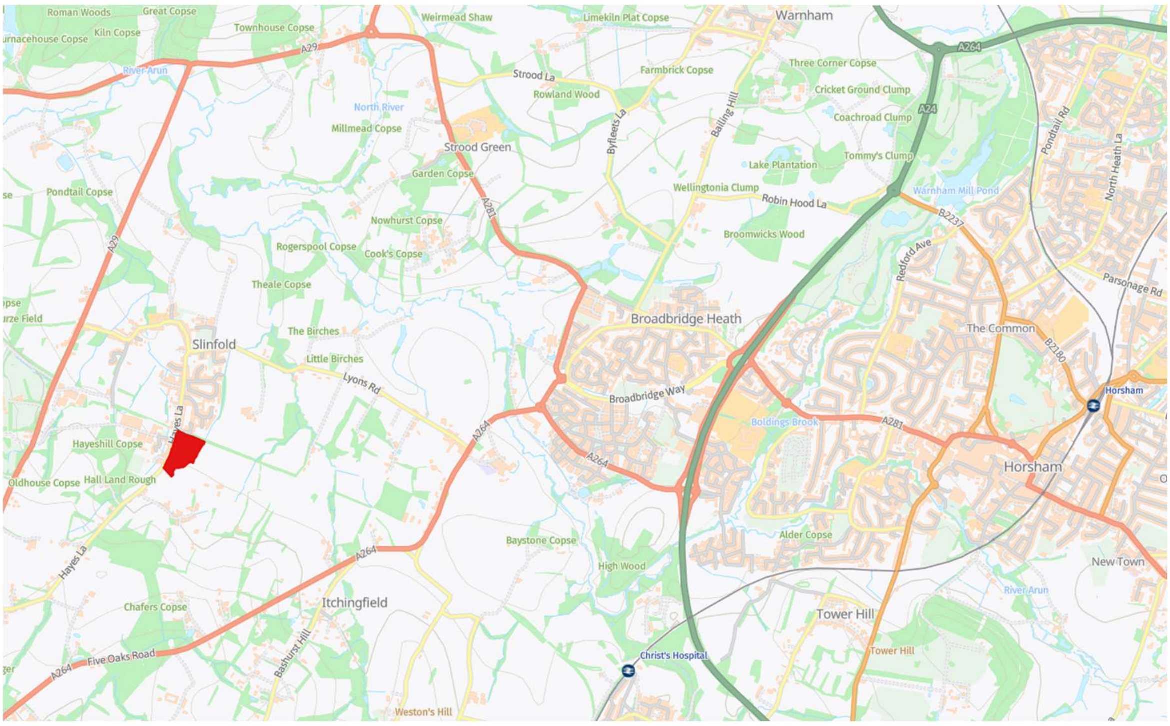
1 Introduction

1.1 Introduction

1.1.1 This Flood Risk Assessment and Drainage Strategy (FRA) has been prepared by Charles and Associates (C&A) on behalf of TIL Co in support of a detailed planning application at Hayes Lane, Slinfold. The development proposal comprises of the erection of 38 dwellings including access from Hayes Lane, parking, landscaping, open space and associated infrastructure and earthworks (See **Appendix D** for Site Layout).

1.1.2 The site is located as shown in **Figure 1.1** below. The local planning authority is Horsham District Council (HDC) and the Lead Local Flood Authority (LLFA) is West Sussex County Council (WSCC). The site's National Grid Reference is TQ 11801 30715.

Figure 1.1: Site Location



1.1.3 This site is part of an allocation for housing under Policy 7 – Slinfold Neighbourhood Plan 2014-31.

1.2 Purpose

1.2.1 This FRA has been prepared to demonstrate that flooding and drainage issues will not constrain the development of the site. It also confirms that the site will conform to the recently published national standards for sustainable drainage (SuDS) and the local requirements set out by WSCC as LLFA and also HDC.

1.2.2 In terms of surface water drainage and potential for flooding, it examines the sites suitability in planning policy terms and physical characteristics to allow suggested solutions to deal with drainage in the developed state, thus ensuring the site is drained in a sustainable manner while not affecting the surrounding area. The Sustainable Drainage Systems (SuDS scheme) has been designed to conform to non-statutory Technical Guidance for a detailed planning application and the CIRIA SuDS Manual

1.2.3 The provisions of the National Planning Policy Framework (NPPF, revised in Dec 2024) have been considered in preparing the Flood Risk Assessment, together with The Flood & Water Management Act 2010. In addition, attention has also been paid to the Planning Practice Guidance (PPG) and policies within the Local Plan. This FRA also follows the guidance provided by West Sussex County Council (WSCC) , as the lead local flood authority (LLFA) and Horsham District Council (HDC) as the local planning authority, on the preparation of the surface water drainage strategy.

1.3 Report Limitations

1.3.1 The findings, recommendations and conclusions of this report are based on information obtained from a variety of external sources which are understood to be reputable. However, C&A Consulting Engineers cannot guarantee the authenticity or reliability of any data and/or records provided by third parties.

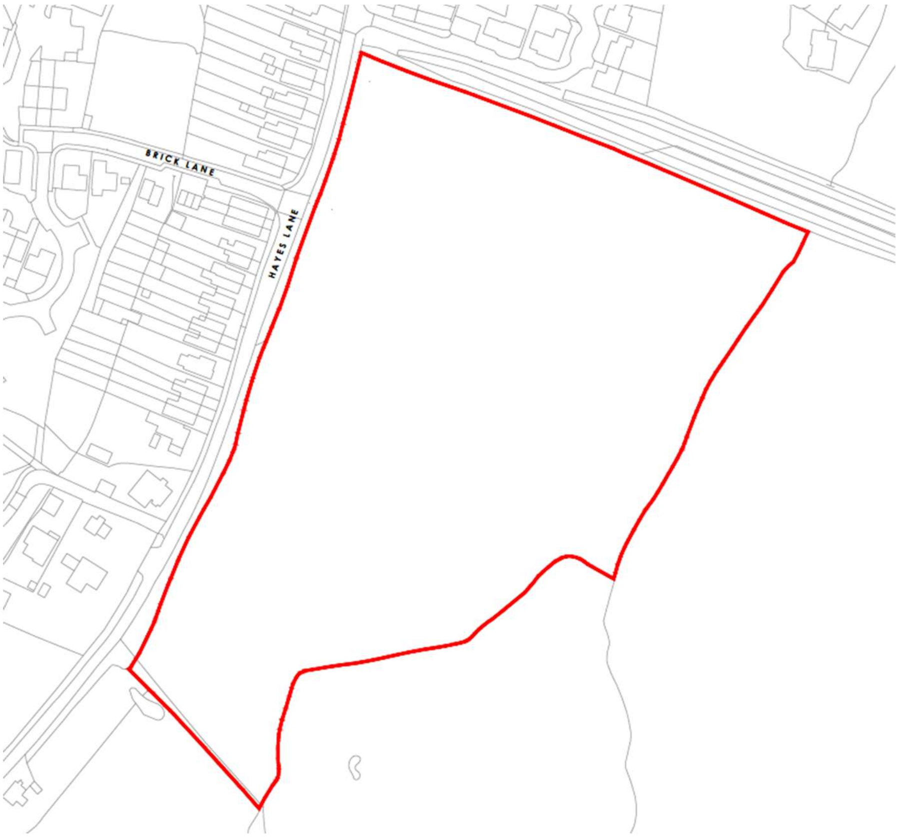
2 Existing Site

2.1 Site Location

2.1.1 The Site is located to the South of Slinfold and is within the catchment of Horsham District Council. The Site is bound by fields to the East and South. To the North it is bound by Downs Link Public Right of Way (PROW) with residential developments beyond. To the west it is bound by Hayes Lane along with residential properties.

2.1.2 The Site within the Red line boundary is 3.9ha. The Site is currently greenfield enclosed by dense hedgerow surrounding the Site. Refer to **Figure 2.1** below for a Site Location Plan.

Figure 2.1: Site Location



2.2 Topography and Existing Drainage

2.2.1 The topographic survey (**See Appendix B**) shows that the site slopes generally from south west to north east.

2.2.2 The highest point of the site is approximately 41.62m AOD fallling to approximately 35.17m in the north east corner of the eastern area of the site.

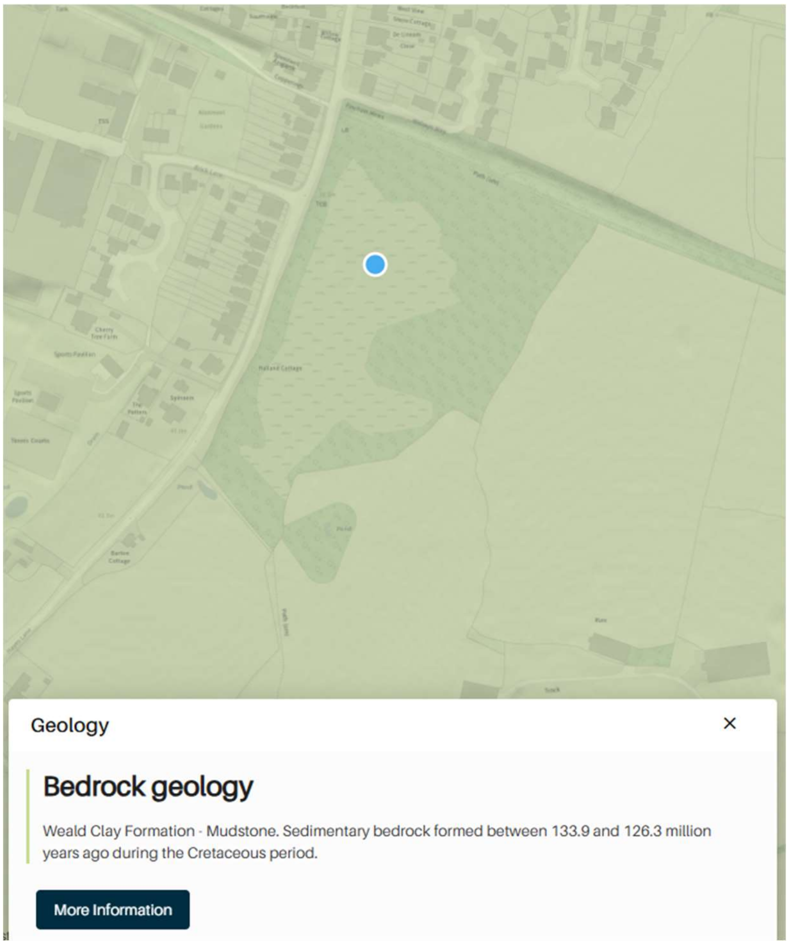
2.2.3 The site area is currently greenfield, having ‘natural’ drainage. There are no surface water sewers on or close to the site, the closest watercourse being a ditch that runs south to north to the east of the site. The ditch is culverted (675Ø) under the “Downs Link” PROW and eventually discharges to the River Arun aprroximately 1.44Km north of the site.

2.2.4 There are no existing foul water sewers located within the proposed site boundary. The nearest foul sewer is located in Hayes Lane towards to the east of the site. (See **Appendix C** for Southern water Sewer Records).

2.3 Geology

2.3.1 A review of the British Geological Society’s records confirms that the site is predominantly underlain by the Weald Clay formation, There is no record of superficial deposits, see Figure 2.2.

Figure 2.2: Bedrock Geology

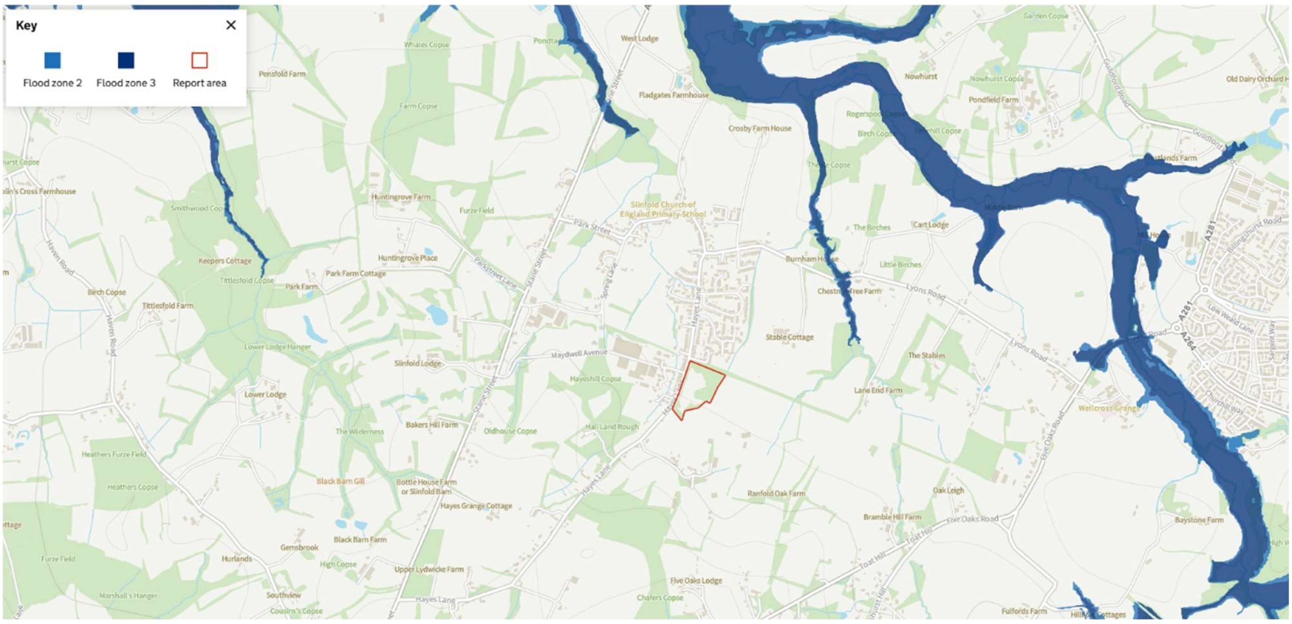


Reproduced with the permission of the British Geological Survey © UKRI 2025

2.4 Enviroment Agency Flood Data

2.4.1 The Enviroment Agency (EA) flood mapping website provides flood risk information in respect of River and Sea and Surface Water flooding to inform FRAs for planning applications[1]. In the case of this site the potential flood risks associated with each of these flood sources is shown on Figures 2.3 and 2.4 below.

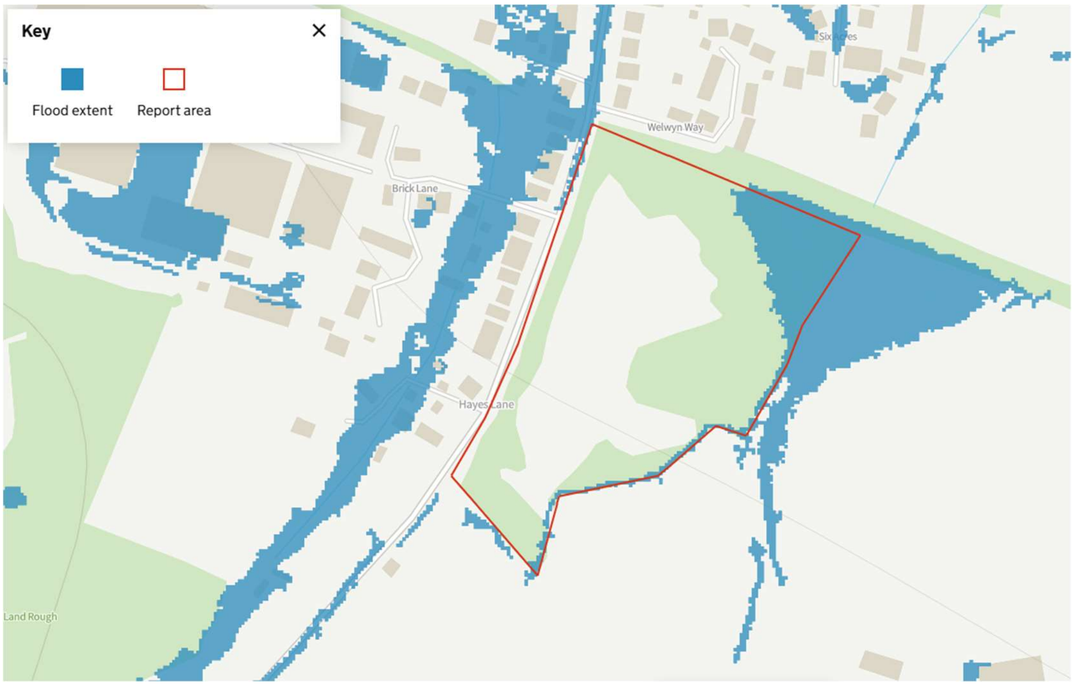
Figure 2.3: Flood Zone Map



2.4.2 This map shows the site is within flood zone 1 which is the lowest flood risk category for flooding from rivers and sea

[1] EA mapping reproduced in this report as public sector information licensed under the Open Government Licence v3.0

Figure 2.4: Surface Water Flooding



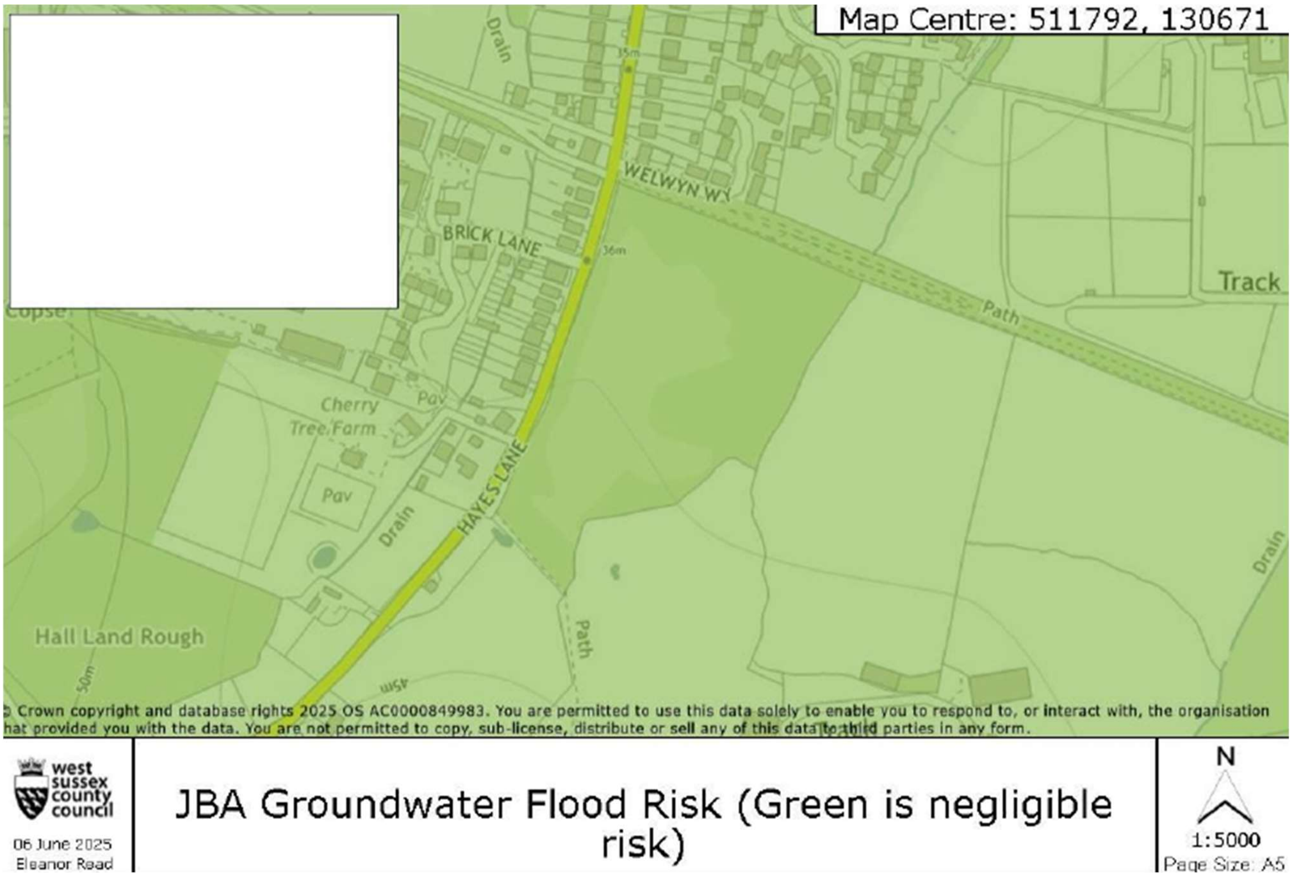
2.4.3 This map shows that the majority of the site is at very low risk of surface water flooding.

2.4.4 An area of surface water flooding (1 in 100 annual exceedance probability) is shown in the northeast of the site. This mapped flood extent represents surface water runoff that is unable to pass through the culvert beneath the PROW. It is assumed that this is either due to flows exceeding the capacity of the 675mm diameter culvert or to represent a blocked or partially blocked culverted pipe. The extent of the modelled surface water flooding is therefore considered to be robust for the purposes of this FRA. The flood extents have been reviewed and updated to suit onsite topographical survey which have been shown on the drainage strategy plan **Appendix F**, this area is within the open space of the proposals and will not have any built development within the extents.

2.4.5 The EA website also confirms that the site is at low risk of flooding from either groundwater or artifical sources such as reservoirs. WSCC map confirms low risk of groundwater flooding.

Figure 2.5: Reservoirs Map

Figure 2.6: Groundwater Flood Risk



3 Development Proposals

3.1.1 The detailed planning application is for the construction of up to 38 residential units including affordable dwellings with associated access, parking and landscaping areas at land east of Hayes Lane south of Slinfold in Horsham. A copy of the illustrative masterplan is enclosed at **Appendix D.**

3.1.2 The proposed development will be accessed via a simple priority junction off Hayes Lane.

3.1.3 The proposed levels of the dwellings roads and parking areas will be designed to generally match the existing ground levels.

3.1.4 The foul and surface water arrangements for the development are discussed in Section 7.0 of this report.

4 Planning Policy

4.1 National Planning Policy

4.1.1 NPPF sets out a robust approach to the Sequential Test and is intended to provide a rigorous understanding of flood risk. Its aim is to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1 and outside areas at risk from other forms of flooding).

4.1.2 The information related to Sequential test is included within section 172 of the National Planning Policy Framework (NPPF, revised in Dec 2024). This states;

All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

a) applying the sequential test and then, if necessary, the exception test as set out below;

b) safeguarding land from development that is required, or likely to be required, for current or future flood management;

c) using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and

d) where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

4.1.3 In addition, section 175 of the National Planning Policy Framework (NPPF, revised in Dec 2024) states that;

The sequential test should be used in areas known to be at risk now or in the future from any form of flooding, except in situations where a site-specific flood risk assessment demonstrates that no built development within the site boundary, including access or escape routes, land raising or other potentially vulnerable elements, would be located on an area that would be at risk of flooding from any source, now and in the future (having regard to potential changes in flood risk).

4.1.4 The NPPF is supported by Planning Practice Guidance (PPG), the latest PPG flood risk update being published in February 2024

4.1.5 This guidance provides further information on the requirements for flood risk assessments including sustainable drainage systems (SuDS) which should be included in FRAs. The PPG advises on flood risk vulnerability, flood zone compatibility and operation and maintenance of SuDS systems.

Sequential and Exception Tests

4.1.6 In relation to fluvial flood, the proposed development is located in Flood Zone 1 (little to no risk of flooding).

4.1.7 The proposed development is allocated in the Slinfold Neighbourhood Plan (2018) which is a 'made' plan and as such forms part of the adopted Development Plan for Horsham, therefore is deemed to haved passed the Sequential Test and application of the Exception Test is not necessary.

4.1.8 The proposed development is a residential scheme, and therefore, can be classified by NPPF as ''More Vulnerable' to risk of flooding. It is consistent with the appropriate uses for Flood Zone 1, as set out in Table 3 of Planning Practice Guidance.

Climate Change

4.1.9 Based on the most recent advice on climate change published by the Environment Agency (EA) peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future. It is recommended that considerations for future climate change are included in Flood Risk Assessments for Proposed Developments.

4.2 Regional Policy

4.2.1 As the Lead Local Flood Authority (LLFA), WSCC produced a Drainage and Planning Policy – West Sussex LLFA Policy for the Management of Surface Water in November 2018. The primary objective of this document is to contribute to the achievement of sustainable development and deliver the requirements of the NPPF and specific policies set out by the relevant Local Planning Authority. Key policies included within WSCC policy statement are summarised below.

4.2.2 SuDS Policy 1: Follow the drainage hierarchy

1. Surface runoff not collected for use must be discharged according to the following discharge hierarchy:

- *to ground,*
- *to a surface water body,*

• to a surface water sewer, highway drain, or another drainage system, or

• to a combined sewer where there are absolutely no other options, and only where agreed in advance with the relevant sewerage undertaker.

2. The selection of a discharge point should be clearly demonstrated and evidenced.

4.2.3 SuDS Policy 2: Manage Flood Risk Through Design

1. The drainage scheme proposed is to:

a. protect people and property on the development site from flooding; and,

b. avoid creating any additional flood risk outside of the development in any part of the catchment, either upstream or downstream.

2. Any drainage scheme must manage all sources of surface water, including exceedance flows and surface flows from offsite, provide for emergency ingress and egress and ensure adequate connectivity.

3. For large sites where development is to be phased, there will need to be a strategic site surface water management system that allows different parts of the site to be developed at different times while ensuring that each of the design criteria can be met.

4.2.4 SuDS Policy 3: Mimic Natural Flows and Drainage Flow Paths

1. Drainage schemes should be designed to match greenfield discharge rates and follow natural drainage routes as far as possible; pumps should therefore not form part of drainage schemes.

2. Greenfield runoff should be calculated from FEH or a similar approved method. SAAR and any other rainfall data used in run-off storage calculations should be based upon FEH rainfall values.

4.2.5 SuDS Policy 4: Seek to Reduce Existing Flood Risk

1. New development should be designed to take full account of any existing flood risk, irrespective of the source of flooding.

2. Where a site or its immediate surroundings have been identified to be at flood risk, all opportunities to reduce the identified risk should be investigated at an early stage and subsequently incorporated at the detailed design stage.

4.2.6 SuDS Policy 5: Maximise Resilience

1. The design of the drainage system must account for the likely impacts of climate change and changes in impermeable area over the design life of the development. Appropriate allowances should be applied in each case.

2. A sustainable drainage approach which considers control of surface runoff at the surface and at source is preferred and should be explored prior to other design solutions.

3. Culverting an existing watercourse should only be considered if there is no feasible alternative.

4.2.7 SuDS Policy 6: Design to be Maintainable

1. No building is to be occupied until a Verification Report pertaining to the surface water drainage system, carried out by a Chartered Engineer, has been submitted to the Local Planning Authority which demonstrates the suitable operation of the drainage system such that flood risk is appropriately managed, as approved by the Lead Local Flood Authority. The Report shall contain information and evidence (including photographs) of earthworks; details and locations of inlets, outlets and control structures; extent of planting; details of materials utilised in construction including subsoil, topsoil, aggregate and membrane liners; full as built drawings; and topographical survey of 'as constructed' features.

2. The Verification Report should also include an indication of the adopting or maintaining authority or organisation and may require inclusion within a register of drainage features.

4.2.8 SuDS Policy 7: Safeguard Water Quality

1. When designing a surface water management scheme, full consideration should be given to the system's capacity to remove pollutants and to the cleanliness of the water being discharged from the site, irrespective of the receiving system.

2. Interception of small rainfall events should be incorporated into the design of the drainage system.

4.2.9 SuDS Policy 8: Design for Amenity and Multi-Functionality

Drainage design should from the outset consider opportunities for inclusion of amenity and biodiversity objectives and thus provide multi-functional use of open space with appropriate design for drainage measures within the public realm.

4.2.10 SuDS Policy 9: Enhance Biodiversity

Drainage design should from the outset consider opportunities for biodiversity enhancement, through optimising the scope for surface systems, consideration of connectivity to adjacent water bodies or natural habitats, and appropriate planting specification.

4.2.11 SuDS Policy 10: Link to Wider Landscape Objectives

Drainage design should from the outset consider opportunities to contribute to the wider landscape and ensure proposals are coherent with the surrounding landscape character area.

4.3 Local Plan Policy

Horsham District Council Local Plan

4.3.1 The Horsham District Local Plan "(Horsham District Planning Framework) was adopted in November 2015 and sets out the development strategy for Horsham until 2031. The key policy with regard to flooding and drainage is Policy 38, summarised below.

4.3.2 Strategic Policy 38: Flooding

1. Development proposals will follow a sequential approach to flood risk management, giving priority to development sites with the lowest risk of flooding and making required development safe without increasing flood risk elsewhere. Development proposals will;

a. take a sequential approach to ensure most vulnerable uses are placed in the lowest risk areas.

b. avoid the functional floodplain (Flood zone 3b) except for water-compatible uses and essential infrastructure.

c. only be acceptable in Flood Zone 2 and 3 following completion of a sequential test and exceptions test if necessary.

d. require a site-specific Flood Risk Assessments for all developments over 1 hectare in Flood Zone 1 and all proposals in Flood Zone 2 and 3.

2. Comply with the tests and recommendations set out in the Horsham District Strategic Flood Risk Assessment (SFRA).

3. Where there is the potential to increase flood risk, proposals must incorporate the use of sustainable drainage systems (SuDS) where technically feasible, or incorporate water management measures which reduce the risk of flooding and ensure flood risk is not increased elsewhere.

4. Consider the vulnerability and importance of local ecological resources such as water quality and biodiversity when determining the suitability of SuDS. New development should undertake more detailed assessments to consider the most appropriate SuDS methods for each site. Consideration should also be given to amenity value and green infrastructure.

5. Utilise drainage techniques that mimic natural drainage patterns and manage surface water as close to its source as possible will be required where technically feasible.

6. Be in accordance with the objective of the Water Framework Directive, and accord with the findings of the Gatwick Sub Region Water Cycle Study in order to maintain water quality and water availability in rivers and wetlands and wastewater treatment requirements.

Horsham Distrcit Council Surface Water Drainage Statement

4.3.3 In order to provide the required information on surface water drainage from the proposed development, the Surface Water Drainage Statement pro-forma must be completed in full and submitted with any planning application which seeks permission for major development.

4.3.4 Surface Water Drainage Statement form included in **Appendix J**

Horsham District Strategic Flood Risk Assessment

4.3.5 A Strategic Flood Risk Assessment (SFRA) for Horsham District Council was published in April 2010 . The primary objective of the SFRA is to identify the areas within a development plan area that are at risk from all forms of flooding now and in the future taking into account the effects of climate change. This enables the Local Planning Authority (LPA) to select and allocate sustainable development away from flood risk areas.

4.3.6 With regards to future development within HDC, flood risk management guidance and FRA requirements for developers are included within Chapter 6.2 of the SFRA and state;

1. Flood Risk Assessments (FRAs) should be undertaken for all developments within Flood Zones 2 and 3 and sites with identified flooding sources (according to PPS25 Annex E) to assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area;

2. FRAs are required for all major developments in Flood Zone 1 (according to PPS25 Annex E). These are residential developments consisting of sites greater than 0.5 ha or greater than 10 dwellings and commercial developments that are greater than 1 ha or have a floor area greater than 1000 m2 .

3. Flood Risk to development should be assessed for all forms of flooding;

4. Surface water flooding should be investigated in detail as part of site specific FRAs for future developments and early liaison with the Environment Agency and Horsham DC is recommended for appropriate management techniques.

5. Groundwater flooding should be investigated in more detail as part of site specific FRAs for developments located to the south of the District where a potential for groundwater flooding exists (see Level 1 GIS layers and mapping) or where a site is located within a defined groundwater emergence zone.

6. Where floodplain storage is removed, the development should provide compensatory storage on a level for level and volume for volume basis to ensure that there is no loss in flood storage capacity;

7. When re-developing existing buildings in flood risk areas, the use of flood resilient measures should be promoted at the individual property level.

4.3.7 Sustainable Drainage Systems & Surface Water Management Policy:

1. Sustainable Drainage Systems should be included in new developments unless it is demonstrably not possible to manage surface water using these techniques;
2. PPS25 requires the use of SuDS as an opportunity of managing flood risk, improving water quality and increasing amenity and biodiversity;
3. FRAs are required for all major developments in Flood Zone 1 (according to PPS25 Annex E). These are residential developments consisting of sites greater than 0.5 ha or greater than 10 dwellings and commercial developments that are greater than 1 ha or have a floor area greater than 1000 m2 ;
4. Runoff rates from new developments on Greenfield sites should not exceed Greenfield runoff rates pre-development and should allow for climate change;
5. Runoff rates from previously developed developable land should not exceed existingrates of runoff and should seek betterment. In addition, an allowance should be made for climate change;
6. Runoff and/or discharge rates should be restricted to Greenfield runoff rates in areas known to have a history of sewer and/or surface water flooding;
7. Potential overland flow paths should be considered to ensure that buildings do not obstruct flows;
8. Where basements are proposed the risk of surface water flooding should be considered, with possible mitigation options including raised thresholds and inclusion of storage for surface water in such developments;
9. Opportunities should be sought to reduce the risk of flooding from the sewer network through consultation with Southern Water to determine key areas for maintenance and flood alleviation schemes;
10. At the site specific FRA level, the suitability of Sustainable Drainage Systems should be investigated for each development. Areas to north of the District (the High and Low Weald areas) may be more suited to attenuation systems;
11. The vulnerability and importance of local ecological resources, such as water quality and biodiversity, should also be considered when determining the suitability of SuDS.

5 Probability of Flooding

5.1 Definition of the Flood Hazard

5.1.1 Flood Zones are defined in Table 1 of the PPG. The Flood Zones refer to the probability of flooding from rivers, the sea and tidal sources and ignore the presence of existing defences, as these can be breached, overtopped and may not be in existence for the lifetime of the development.

5.2 Sources of Flooding

5.2.1 NPPF identifies six potential sources of flooding that require investigation:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from land;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources.

5.3 Flooding from Rivers or Fluvial Flooding

5.3.1 The closest main river to the site is the River Arun, approximately 1.44km to the north west. During times of severe storm events, water levels within the watercourses can rise to cause fluvial flooding.

5.3.2 Figure 2.3 shows that the site is in Flood Zone 1 which is defined as land having less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year. This is considered to be the lowest flood risk and therefore the site is at little or no risk from fluvial flooding and is deemed to be suitable for all forms of development.

5.4 Flooding from Sea or Tidal Flooding

5.4.1 The site is in flood zone 1 and is remote from the coast and at an elevation of between 42.0m AOD and 35.0m AOD and is therefore not at risk from sea or tidal flooding.

5.5 Flooding from Land (Surface Water Flooding)

5.5.1 Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. Increased run-off from developed areas consisting of impermeable surfaces can increase overland flows. If the flow paths of these overland flows are not carefully considered during the detail design and planning of the drainage design, flooding from overland flows could occur.

5.5.2 Figure 2.4 shows that an area of the Northern part of the proposed development site has been identified as being at high risk of surface water flooding during extreme rainfall events.

5.5.3 An area of surface water flooding (1 in 100 annual exceedance probability) is shown in the northeast of the site. This mapped flood extent represents surface water runoff that is unable to pass through the culvert beneath the PROW. It is assumed that this is either due to flows exceeding the capacity of the 675mm diameter culvert or to represent a blocked or partially blocked culverted pipe. The extent of the modelled surface water flooding is therefore considered to be robust for the purposes of this FRA. The flood extents have been reviewed and updated to suit onsite topographical survey which have been shown on the drainage strategy plan **Appendix F**, this area is within the open space of the proposals and will not have any built development within the extents.

5.6 Flooding from Sewers

5.6.1 Every drainage system has a design capacity which at some point can be exceeded. Sewer and surface water flooding generally results in localised short-term flooding caused by intense rainfall events which overload the capacity of local sewers or run off adjacent land as sheet flow. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

5.6.2 Southern Water are responsible for the managing the sewer network in and around the proposed development area. There are no public sewers located within the proposed development boundary. The site is therefore not considered to be at risk from sewer flooding.

5.7 Flooding from Groundwater

5.7.1 Groundwater flooding in general can occur when water levels in the ground rise above surface elevations. Severe storm events could cause groundwater levels to rise above ground level. Underlying geology is the principal factor that effects groundwater flooding. Groundwater flooding most commonly occurs in low lying areas which are underlain by permeable rocks or aquifers.

5.7.2 The EA website notes that “flooding from groundwater is unlikely in this area”. This assessment is supported by the low permeability soil (Weald Clay) and topography of the site.

5.8 Flooding from Reservoirs or other artificial sources

5.8.1 There are no artificial sources of water (i.e. reservoirs, dams etc.) or flood defences in the vicinity or upstream of the site. There is therefore no flood risk to the development from these sources.

6 Effect of Climate Change

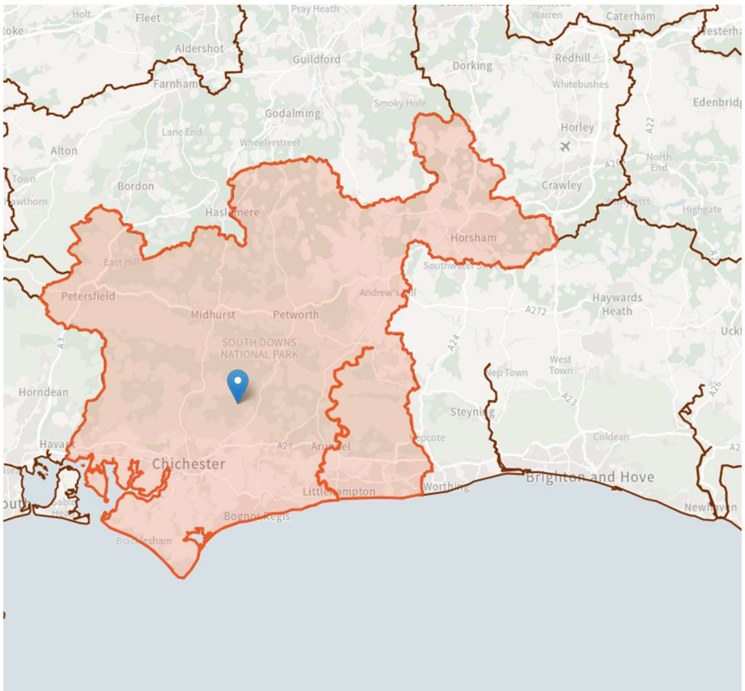
6.1 Climate Change

6.1.1 Based on the most recent advice on climate change reported in PPG, peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future. It is recommended that considerations for future climate change are included in Flood Risk Assessments for proposed developments.

6.1.2 In May 2022, the Environment Agency published their latest guidance on how to use climate change allowances in Flood Risk Assessments and Drainage Strategies. The Department for Environment and Rural Affairs has produced a Climate Change Allowance map for the country. The map provides information on the peak rainfall allowance depending on the Management Catchment in which the site is located.

6.1.3 Having reviewed the Climate Change Allowance map the site lies within Stour Management Catchment. **Figure 6.1** below summarises climate change allowances within this catchment.

Figure 6.1: Climate Change Allowances



Arun and Western Streams Management Catchment peak rainfall allowances

3.3% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	35%
2070s	25%	40%

1% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	45%
2070s	25%	45%

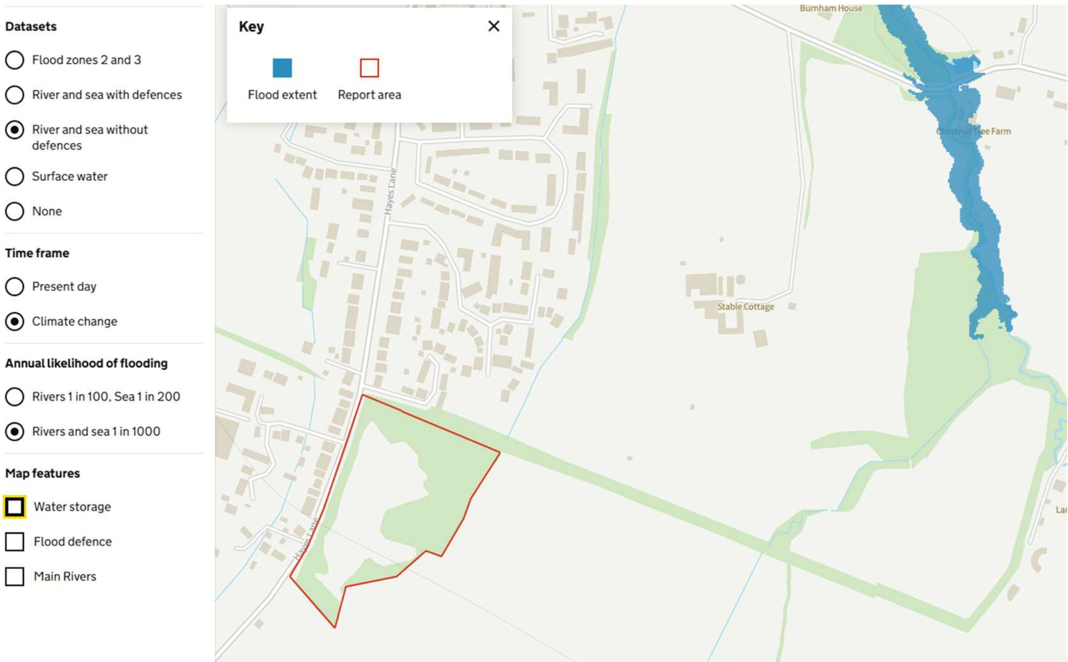
*Use '2050s' for development with a lifetime up 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.

This map contains information generated by Met Office Hadley Centre (2019): UKCP Local Projections on a 5km grid over the UK for 1980-2080. Centre for Environmental Data Analysis, 2022

6.1.4 The proposed surface water drainage strategy will be designed to cater for the upper allowance for the 2070s epoch, thus providing a suitable surface water drainage solution for the lifetime of the development. All events up to and including the 100 year + 45% climate change event will be catered for within the proposed system. See **Section 7** below for details of the proposed surface water drainage strategy.

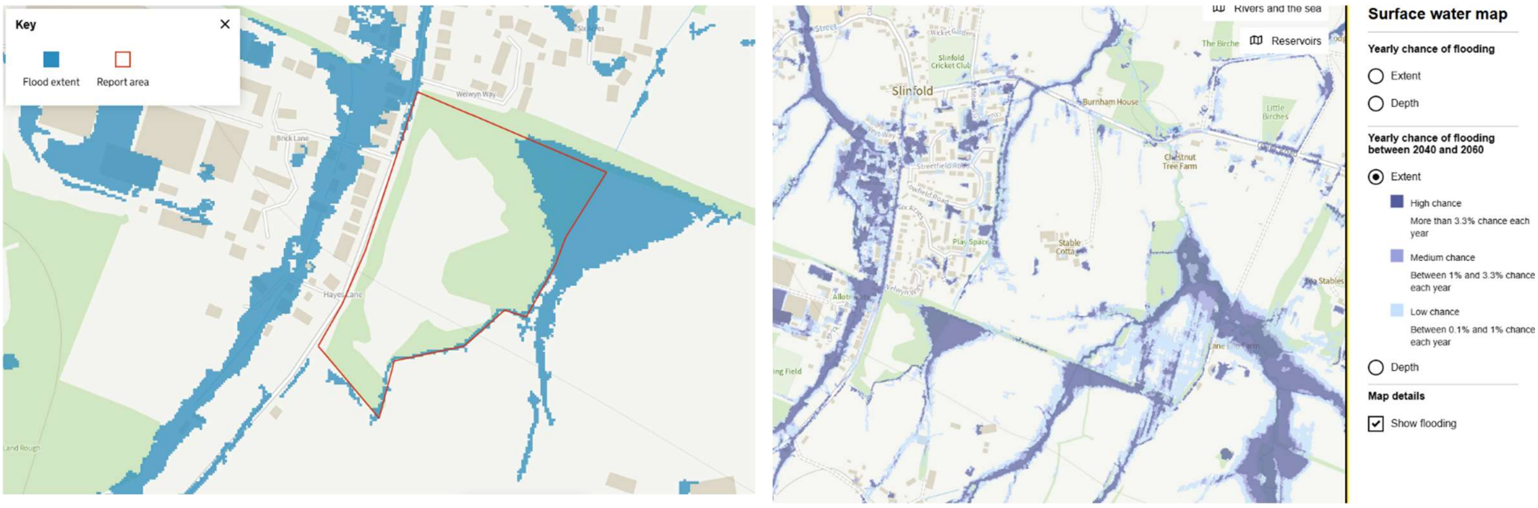
6.1.5 When climate change is applied to the current EA flood mapping the Site is shown to not be at a 0.1% (1 in 1000) risk of flooding from rivers for the period 2070 to 2125 and from tidal flooding by the year 2125, see Figure 6.2 below

Figure 6.2: Climate Change Flood Risk from Rivers and Sea



6.1.6 A comparison of the surface water flood map for planning and the long term flood risk maps (see Figure 6.3 below) shows that the 1 in 100 climate change surface water flood extent is approximately the same as, or slightly reduced from, the 1 in 100 extent shown on the flood map for planning.

Figure 6.3: Comparison of (1:100 extents vs 1:100 Climate Change mapping)



7 Surface Water and Foul Drainage Proposals

7.1 Existing Surface Water Run Off

7.1.1 The existing site is currently undeveloped and can be considered to exhibit greenfield run-off rates. The development area of the site has a total area of approximately 3.9ha. This has been used to calculate the existing greenfield run off from the site.

7.1.2 Greenfield run off rate calculations have been carried out in accordance with FEH methodology, which is a built-in feature of the Site3D software.

7.1.3 The greenfield run-off rates for varying return periods for the total site area are shown in Table 7.1 below: Greenfield runoff calculations are included within **Appendix E**

Table 7.1 Existing Greenfield Run-off Rates

Return Period (Years)	Total Calculated Existing Greenfield Site Discharge rate (l/s)
Q_{BAR}	23.01
1 in 1 year	19.56
1 in 30 year	52.93
1 in 100 year	72.41
1 in 200 year	86.07

7.2 Surface Water Drainage Proposals

7.2.1 A comprehensive sustainable drainage system will be implemented to prevent runoff from the development increasing flood risk to other areas. This will be fully detailed at the detail drainage design stage of the proposed development, although a preliminary drainage strategy demonstrating that SuDS can be delivered is described below.

7.2.2 The proposed development will be designed to current best practice for both piped drainage (Part H of the Building Regulations) and Sustainable Drainage (CIRIA C753 – The SuDS Manual).

7.2.3 The Planning Policy Document sets out in SuDS Policy 1, the hierarchy below which should be adopted when selecting surface water discharge options for development run off.

- to ground,
- to a surface water body,
- a surface water sewer, highway drain, or another drainage system, or

- to a combined sewer where there are absolutely no other options, and only where agreed in advance with the relevant sewage undertaker.

7.2.4 The site is underlain by the Weald Clay Formation which is considered unsuitable to support infiltration techniques as a means of disposal of surface water run off.

7.2.5 Surface water runoff will therefore be attenuated and discharged to the existing watercourse at the eastern site boundary. Discharge rates will be restricted to suit the area of impermeable development (**Figure 7.3**).

Figure 7.1: Network 1 Discharge Flow Rate

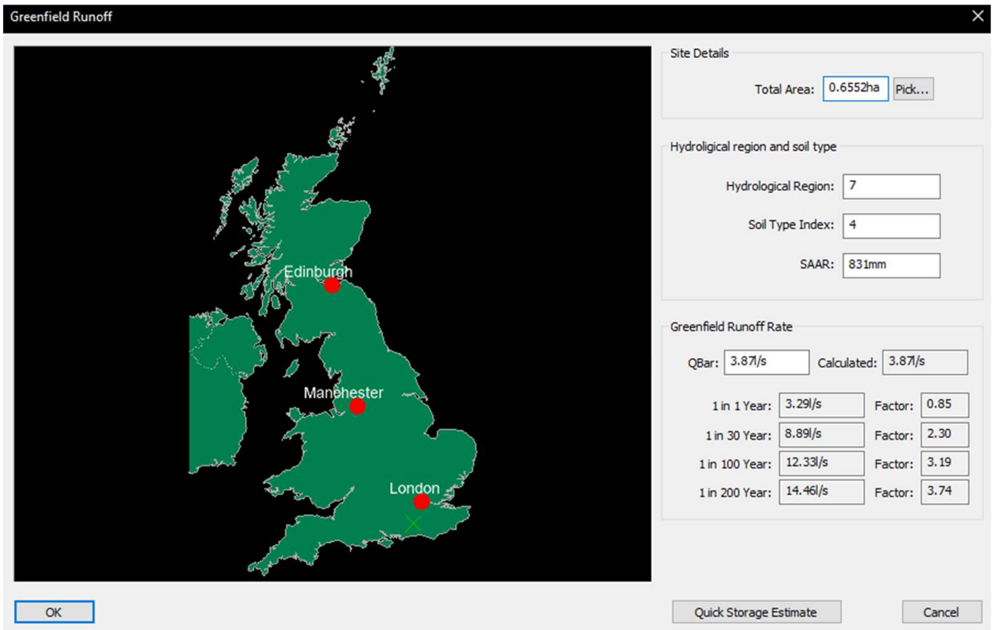


Figure 7.2: Network 2 Discharge Flow Rate

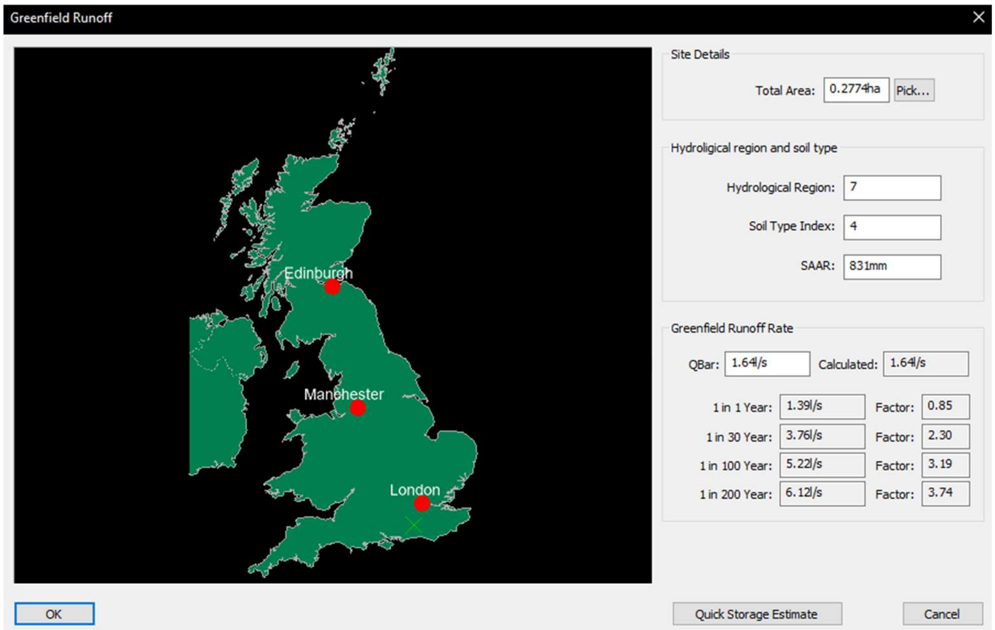
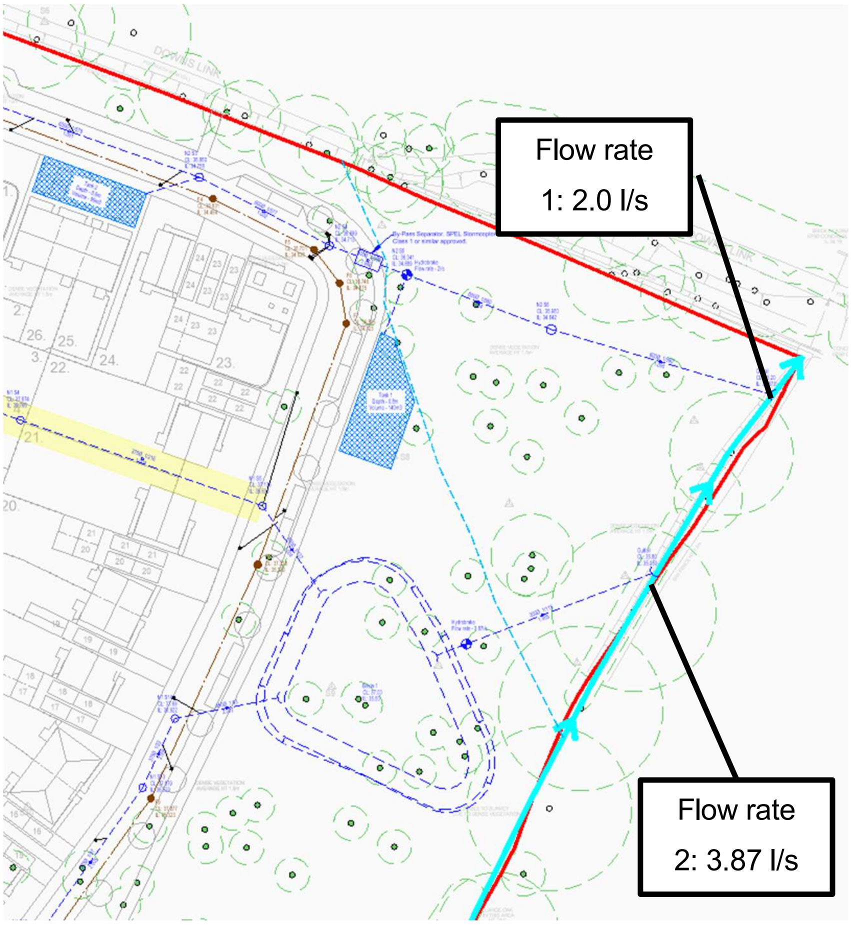


Figure 7.3: Restricted Discharge Flow Rates



7.3 Design Approach

7.3.1 The surface water drainage strategy has been developed in line with the National Planning Policy Framework (NPPF), EA standing advice, WSCC's Drainage Policies and the SuDS Manual CIRIA C753.

7.3.2 This drainage strategy has been developed in reference to the response received from the LLFA noted earlier.

7.3.3 The site has been split into 2 drainage catchment/network areas, one to the north draining direct to the western ditch and a southern catchment to an attenuation basin then to the western ditch. Each catchment will discharge to the existing ditch at QBar rates.

7.3.4 A minimum FFL will be set at 36.8m AOD to provide protection from residual risk of surface water flooding.

7.4 Sustainable Drainage Systems

7.4.1 Planning Practice Guidance advises that sustainable drainage systems (or SuDS) should be designed to control surface water runoff close to where it falls combining a mixture of built and nature based techniques to mimic natural drainage as closely as possible and accounting for the predicted impacts of climate change. They provide benefits for water quality, biodiversity and amenity. Sustainable drainage systems provide opportunities to;

- reduce the causes and impacts of flooding,
- remove pollutants from the urban runoff at source,
- combine water management and green space with benefits for amenity, recreation and wildlife.

7.5 Surface Water Drainage Strategy

7.5.1 In view of the requirements of the NPPF, PPG, and the LLFA and design parameters and constraints associated with redeveloping this site, a surface water drainage strategy has been devised and hydraulically modelled to demonstrate that a scheme can be suitably implemented in compliance with current standards and practice without increasing the level of flood risk, when the surface water drainage systems experience run off generated by rainfall equivalent to the 1:100 year rainfall event, including a climate change allowance.

7.5.2 The surface water drainage scheme has been designed to ensure:

- Post development run off for peak storm events does not exceed predevelopment discharge rates
- Sustainable Drainage systems are wholly incorporated within the scheme,
- Consideration is given for the improvement of water quality within the design,
- The designed drainage scheme can satisfactorily retain a critical 1 in 100 year storm event with a 45% climate change allowance and 10% Urban creep.

7.5.3 Two principal surface water run off drainage networks have been established across for the development, see drawing 22-011-007/008 in **Appendix F**. Each of these networks collects run off from development land parcels and main infrastructure and transports it via a piped network and SuDS features to an existing ditch.

7.5.4 Geocellular tanks will be used within the northern catchment to provide adequate storage with the network to achieve a outflow rate at QBar utilising Hydrobrake flow control systems.

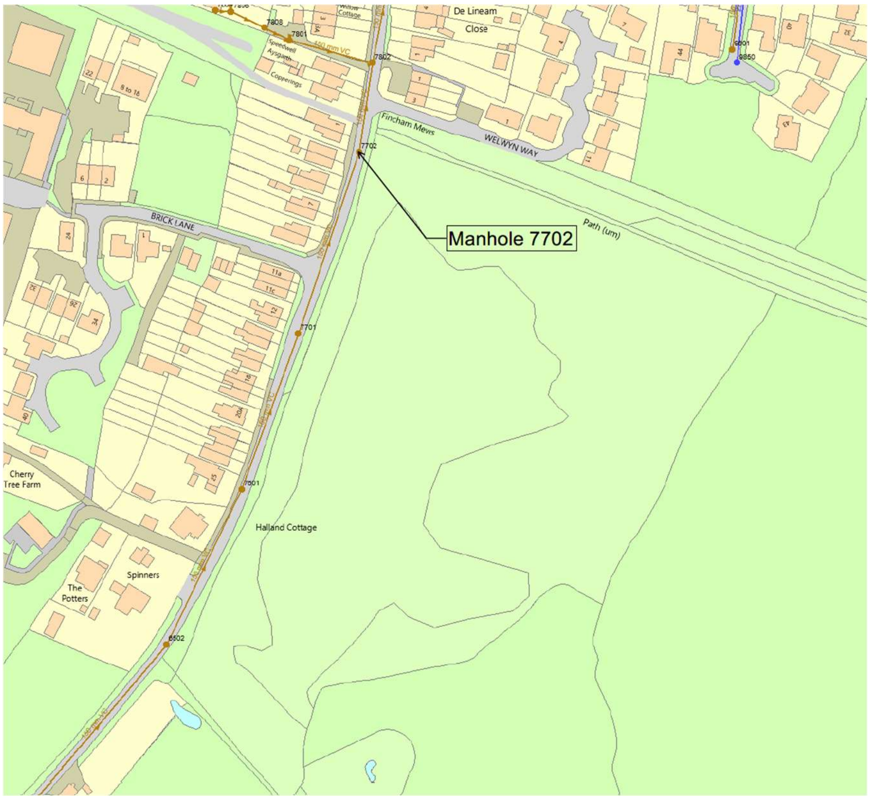
7.5.5 The attenuation basin will be maximum 1.5m deep with side slopes no greater than 1 in 3.

7.5.6 A preliminary surface water drainage strategy has been prepared and is shown on drawing 22-011-007/008 included in **Appendix F** of this report.

7.6 Foul Water Drainage Proposals

7.6.1 The closest foul water sewer to the development is a manhole, number 7702, in Hayes Lane towards the west of the site, see Figure 7.4 below.

Figure 7.4: Foul Sewer Connection Point



7.6.2 A pre-application capacity enquiry was submitted in June 2025 to determine the available capacity within the Southern Water (SW) local sewer system.

7.6.3 This capacity check by Southern Water, received on 16/06/2025, see **Appendix G** identified that the existing downstream foul network currently has sufficient capacity to serve all of the proposed development.

7.6.4 An indicative foul drainage layout has been designed and is shown on drawing 22-011-007/008 included in **Appendix F**.

8 Surface Water Management Measures

8.1 Flood Risk Management Measures

8.1.1 PPG requires that the safety of people and the proposed development be considered against each source of flooding identified in Section 5.

8.1.2 All residential dwellings will be located within Flood Zone 1 and therefore, even with the potential for climate change, properties will not be at risk of fluvial flooding.

8.1.3 All residential dwellings will be located outside of the 1in100 surface water flood extent and FFLs will be set >300mm above flood level, therefore properties will not be at risk of surface water flooding.

8.1.4 A preliminary drainage strategy incorporating SuDS has been developed which demonstrates that any increase in run-off from the site over the lifetime of the development will not place properties at risk of surface water flooding.

8.1.5 The SuDS system will also be maintained by a suitably qualified Management Company for the lifetime of the development, such that it will not place properties either on the site or elsewhere at an increased risk of surface water flooding. This complies with NPPF guidance and HDC/WSCC SuDS guidance & policies.

8.1.6 The flood risk to the proposed development and surrounding area, as a consequence of the development is therefore considered to be very low and no specific flood risk management measures will be required.

8.2 Water Quality

8.2.1 It is important to address issues with regards to water quality when considering surface water management.

8.2.2 Chapter 26 of the SuDS Manual (2015) provides guidance on methods which should be used to design SuDS to meet water quality design criteria and good practice design standards.

8.2.3 Chapter 4 of the SuDS Manual summarises factors, which influence pollution levels in urban run-off. This summary is presented in Table 8.1 below.

Table 8.1 Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices)i.e.. Less than 300 vehicle movements/day	Low	0.5	0.4	0.4

8.2.4 The indicative SuDS mitigation indices for discharge to surface water for the features proposed are summarised in Table 8.2 below (reproduced from appropriate extracts from tables 26.3 of the SuDS Manual C753) and from manufacturer information on the by-pass separator.

Table 8.2 Mitigation Indices

TABLE 26.3 Extract			
Component	**Total Suspended Solids (TSS}**	**Metals**	**Hydrocarbons**
Detention Basin	0.5	0.5	0.6
Permeable Paving	0.7	0.6	0.7

Proprietary Treatment Systems			
Component	**Total Suspended Solids (TSS}**	**Metals**	**Hydrocarbons**
SPEL Stormceptor Class 1 by-pass separator	0.8	0.6	0.9

8.2.5 The majority of run off from this development will be from roof run off, low traffic roads, residential driveways, parking areas etc. and will therefore come within the Low/Very Low hazard classification as noted in Table 8.2 above.

8.2.6 The proposed drainage strategy incorporates a SuDS treatment train for these areas which includes trapped road gullies, catchpit manholes on all roads, diffuser units on all permeable paving and Geocelluar systems and detention basins. By-pass interceptors will be used where the network does not pass through the detention basin.

8.2.7 From the above Tables it can be seen that mitigation indices for the SuDS features, will be greater than the respective hazard indices.

8.2.8 In the majority of cases the run off will pass through more than one component, eg. road gully, by-pass interceptor, catchpit manhole, detention basin prior to outfall into the existing ditch. This will provide enhanced mitigation.

8.3 Exceedance Flows

8.3.1 Whilst the drainage system has been designed to a very high standard (1 in 100 year storm event plus 45% climate change allowance), it is possible that should more extreme events occur then the design standard for the system may be exceeded.

8.3.2 It is best practice therefore to design the system to allow for excess water to discharge overland, primarily into landscaped areas away from built development, thus reducing the risk of flooding these areas during such extreme events.

8.3.3 Exceedance flow paths are shown on drawing 22-011-011 in **Appendix H**

8.4 Operation and Maintenance

8.4.1 The PPG sets out the requirement for developers to consider the operation, management and maintenance of all SuDS features. The on-Site drainage networks will be offered for adoption under a standard Section 104 Agreement and SuDS will be privately managed and maintained for the lifetime of the development, ensuring that they remain fit for purpose and function satisfactorily.

8.4.2 The on-site management team for the development will be responsible for the maintenance of the SuDS included within the Scheme. Maintenance and repairs of SuDS features will be undertaken in line with guidance from the CIRIA SuDS Manual.

8.4.3 Maintenance schedule included in **Appendix I**

9 Residual Risks

9.1 Residual Flood Risk

9.1.1 As the residential properties will be built in Flood Zone 1 they will not be at significant risk of flooding, even with allowance for climate change.

9.1.2 As the residential properties will be built outside and have set FFLs above the 1:100 level of the surface water flooding they will not be at significant risk of residual surface water flooding.

9.1.3 Extreme rainfall events are generally predictable, but by their nature predictions are based on probability and thus subject to uncertainty. Therefore, an unquantifiable residual risk remains that events exceeding those predicted may occur, notably surcharging or blockage of sewers or gullies.

9.1.4 If the drainage system is overwhelmed, either by a storm event with a magnitude greater than that designed for or due to a blockage, the finished site levels will be designed to ensure that there is no risk of floodwaters ponding to a significant depth. In addition, the overland flow path for any such exceedance storm event will be designed to take overland flow to open space areas.

9.2 Long Term Management

9.2.1 The traditional piped networks within the proposed development will be offered for adoption to Southern Water Ltd under a standard Section 104 agreement of the Water Industry Act, (1991). For any additional SuDS elements of the scheme, WSCC, as the Lead Local Flood Authority, will approve the systems in detail. A management Company will be employed to maintain the SuDS elements of the system.

10 Conclusions and Recommendations

10.1 Background

10.1.1 This report has been commissioned to assess the risk to, and the impact of, a proposed development of the land east of Hayes Lane, Slinfold in West Sussex. It is proposed to provide 38 residential dwellings with associated access, parking and landscaping.

10.1.2 The entire site lies in Flood Zone 1 which is a 'Low Probability' flood area as defined by Table 1 of PPG. The proposed development is identified as 'More Vulnerable' to flooding in Table 2 of PPG. It is consistent with the appropriate uses for Flood Zone 1, as outlined in Table 3 of Planning Practice Guidance.

10.2 Sequential and Exception Tests

10.2.1 The proposed development is allocated within the Horsham District Local Plan and the Slinfold Neighbourhood Plan, therefore is deemed to haved passed the Sequential Test and application of the Exception Test is not necessary.

10.3 Probability of Flooding

10.3.1 Following the application of the Sequential Approach on site, All potential sources of flood risk to the proposed built development, as identified in NPPF have been assessed, as low. In assessing these flood risks, the impacts of climate change have been considered for the lifetime of the proposed development and considered acceptable.

10.4 Proposed Drainage Strategy

10.4.1 A comprehensive sustainable drainage strategy will be implemented as part of the development. Surface water run off will be discharged to an existing watercourse in accordance with the hierachy of discharge. Sustainable drainage systems (SuDS) will be used and will include, attenuation basins, geocelluar tanks and permeable paving.

10.4.2 The drainage proposals include measures to manage and protect water quality in accordance with the recommendations of the SuDS Manual (CIRIA 753).

Appendix A LLFA Scoping Response

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Flood Risk Management Team, Planning Services
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www.westsussex.gov.uk

Ground Floor,
Northleigh,
County Hall,
Chichester,
PO19 1RH

Tom Butler
C & A Consulting Engineers Ltd
Landmark House
Station Road
Hook
Hampshire
RG27 9HA

Dear Tom,

WSCC-714986018 – Hayes Lane, Slinfold, West Sussex, RH13 0SN

WSCC Flood Risk Management Team Level 1 Pre-Application Advice has been sought for an approximately 3.9ha site in Horsham district. It is expected that 35 dwellings will be built.

Flood Risk for Hayes Lane:
The proposed site does not lie within Flood Zones 2 or 3, however it is over 1ha therefore a Flood Risk Assessment in line with guidance from the Environment Agency (Flood risk assessments: applying for planning permission), NPPF and PPG Flood risk and coastal change (August 2022 version; this includes a Site-specific flood risk assessment checklist) will be required. Within the FRA all sources of flooding should be assessed, including flood risk from surface water, ordinary watercourses including ditches, groundwater, artificial sources such as reservoirs and existing drainage infrastructure. The site is not currently located in EA flood warning or alert areas.

The proposed site has areas of low to high surface water flood risk along the southern boundary of the site, as well as a large are of high surface water flood risk in the north-east of the site as identified by the Environment Agency Flood Map for Planning. According to our records there are no ordinary watercourses within the site, although there is one to the north of the site. It is noted that the topographical survey shows there is a ditch along the southern and eastern boundaries of the site. In the FRA/Drainage Strategy it will need to be demonstrated how the watercourse is connected to the wider network. If there are any features outside the red line boundary which could restrict flow, for example a culvert, this must be considered when designing the surface water drainage for the site, to ensure flood risk is not increased within the site or elsewhere. If it is proposed that surface water attenuation features are located within areas of surface water flood risk, compensation will be required to ensure there is enough attenuation on site. Safe access and escape routes for a design flood, considering the impacts of climate change for the lifetime of the development.

According to BGS data the bedrock for the site is Weald Clay Formation. It is noted that winter groundwater monitoring and infiltration testing results have not been provided for our review. Groundwater flood risk details can be found in Appendix A.

Slinfold is not identified as a wetspot in West Sussex Local Flood Risk Management Strategy 2013-2018. Please note the LFRMS is currently being updated, with adoption expected in summer 2025. WSCC have no reports of surface water or groundwater flooding within the red line boundary, although we have had reports of highway flooding along Hayes Lane, along the western boundary of the site. Please note, this does not guarantee that no flooding has occurred within the site boundary or immediate vicinity as flood events might not have been reported to the Flood Risk Management Team.

SuDS Guidance:

While an attenuation basin is mentioned in the scoping report, it is unclear where this will be located in the site layout. Depending on the location of the basin, on-site level for level compensatory storage may be required. This is to ensure there is adequate storage for draining the development, whilst ensuring the pre-existing flood risk on the site does not increase flood risk elsewhere.

The use of Sustainable Drainage Systems (SuDS) should be considered at an early stage in the design process, to integrate SuDS with road networks and other infrastructure. The drainage system should consider the four pillars of SuDS (water quantity, water quality, amenity, and biodiversity) and follow the surface water discharge hierarchy. We expect that investigation into infiltration potential is undertaken using methods in accordance with BRE365. If infiltration testing and groundwater monitoring results are unfavourable for draining the site using infiltration SuDS, any existing runoff rates/volumes must be controlled to a pre-development greenfield runoff rate (Qbar). We would expect that above ground SuDS are used as much as possible to maximise controlling surface water runoff where if falls (e.g. water reuse, green roofs, bioretention areas, ponds, basins, swales etc.).

The FRA/Drainage Strategy should demonstrate there will be sufficient surface water quality treatment by implementing an appropriate amount of water quality treatment stages through the use of SuDS. Chapter 26 of the CIRIA SuDS Manual has lots of guidance for managing surface water quality, including tables for suitability of different SuDS components and the Simple Index Approach. Interception storage should be used in the beginning of the treatment train to ensure the drainage system manages pollutants as close to the source as possible and remove sediment upstream in the system rather than closer to the discharge location.

We would expect that any proposed surface water drainage scheme takes all opportunities to improve any existing risk of flooding to the surrounding road networks. Opportunities should also be considered on how the development may improve flood risk overall by assessing if any additional flood mitigation can be integrated into the scheme, such as storage areas in blue green corridors.

Any phasing of the development must be shown to be able to be developed with a dedicated drainage infrastructure that does not rely on any other phase to be developed. A drainage phasing timeline will be required to show how each element of the drainage system will be implemented prior to completion of the building phase. Details of the required maintenance of any SuDS features and structures and who will be adopting these features for the lifetime of the development must be provided in accordance with the NPPF.

We require the applicant to submit information and drawings which clearly shows the proposed drainage strategy and exceedance flood flow routes for all areas of development. These plans should include the finished floor levels of all buildings, the proposed finished floor levels and potential exceedance flow route.

Details of the construction phase temporary drainage arrangements are required by the LLFA to ensure there will be no increase in flood risk due to the construction works of the development either onsite or elsewhere. A high-level assessment is required at an initial planning stage. Furthermore, the applicant will also need to submit the proposed construction phasing plans for the development to demonstrate that prior to completing the site there will be no increase in flood risk due to the interim development phases either onsite or elsewhere.

It is unclear what the WSCC Drainage and Planning Policy document is.

When submitting the application to the Local Planning Authority, please submit the SuDS proforma and validation checklist to assist us in reviewing the application and expedite the process. These can be found here: Flood Risk Management: Pre-application advice .

Further guidance on surface water drainage requirements for planning applications within Horsham District Council can be found here: Surface Water Drainage Statement | Horsham District Council

Yours sincerely,

Eleanor Read

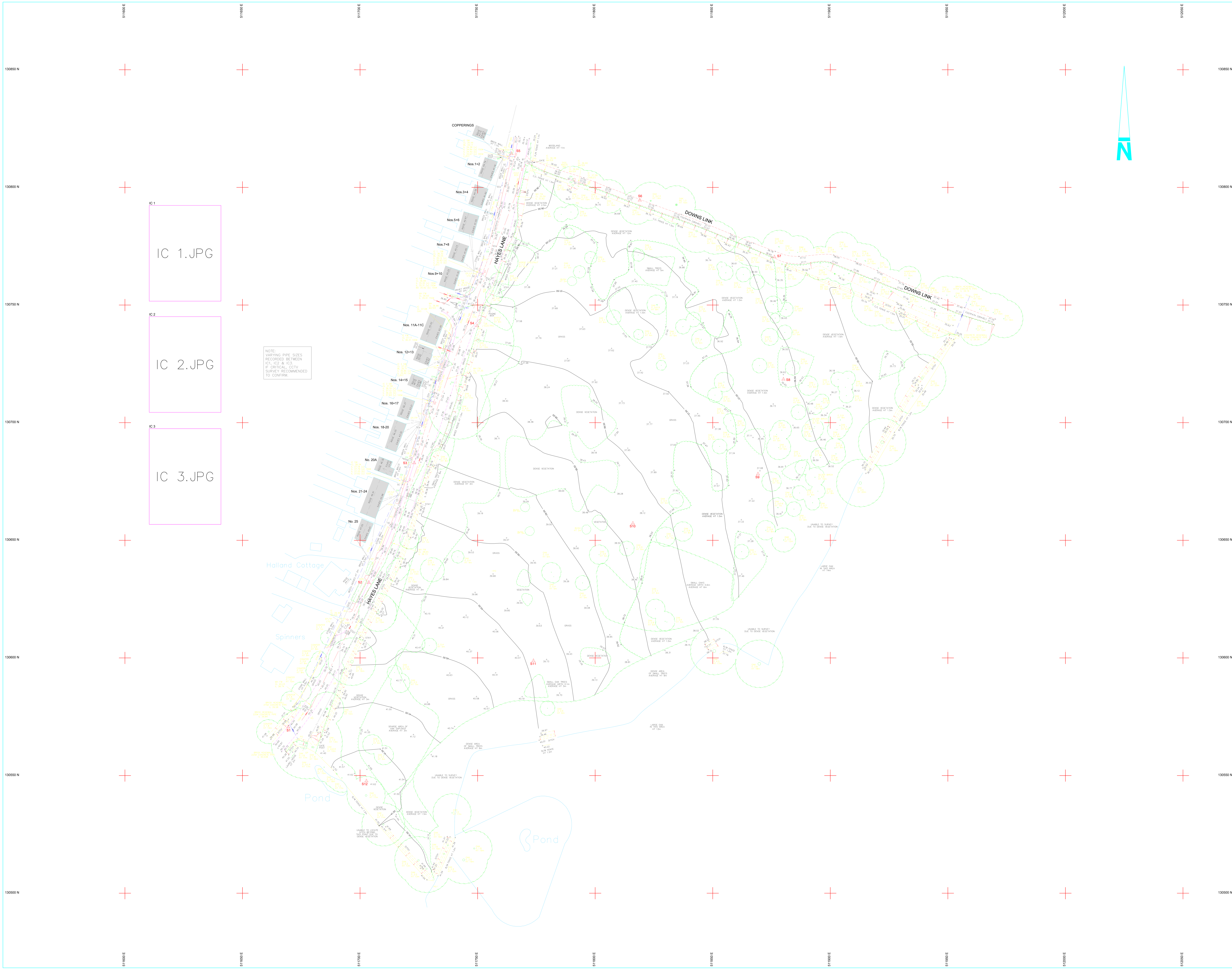
Eleanor.read@westsussex.gov.uk

Flood Risk Management Team

Appendix A

west sussex county council 06 June 2025 Eleanor Read	JBA Groundwater Flood Risk (Green is negligible risk)	N 1:5000 Page Size: A5

Appendix B Topographical Survey



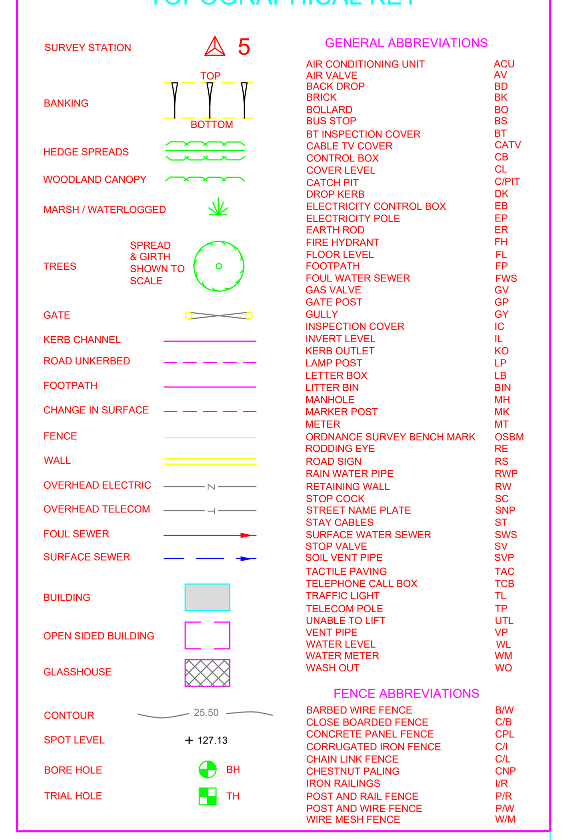
Notes :

1. GRID AND LEVELS BASED ON ORDNANCE DATUM, DERIVED FROM THE NATIONAL GPS NETWORK. LOCAL SCALE FACTOR USED IN ALL CALCULATIONS.
2. DRAINAGE INFORMATION HAS BEEN DETERMINED WITHOUT MAN ENTRY INTO CHAMBERS AND WHILST EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY THIS INFORMATION, IT SHOULD ALWAYS BE CHECKED IN AREAS THAT ARE CRITICAL TO THE FUTURE PROPOSAL.
3. ALL SEWERS ARE PRESUMED TO BE STRAIGHT BETWEEN CHAMBERS.
4. TREE AND HEDGE SPECIES HAVE BEEN IDENTIFIED AS ACCURATELY AS POSSIBLE BUT SHOULD BE CROSS CHECKED IN CRITICAL AREAS.
5. BACKGROUND INFORMATION TAKEN FROM ORDNANCE SURVEY DIGITAL DATA.
CROWN COPYRIGHT. ALL RIGHTS RESERVED. LICENCE No. 100022432.

Coordinate Table

Station	Description	Easting	Northing	Level
S1	ROAD NAIL	511669.465	130570.596	40.437
S2	ROAD NAIL	511703.681	130632.046	39.149
S3	ROAD NAIL	511723.028	130682.897	38.112
S4	ROAD NAIL	511749.808	130741.174	36.799
S5	ROAD NAIL	511764.439	130814.335	35.377
S6	ROAD NAIL	511818.982	130794.547	37.173
S7	ROAD NAIL	511876.229	130770.419	36.685
S8	PEG	511880.072	130718.445	36.829
S9	PEG	511869.236	130678.163	37.339
S10	PEG	511816.041	130657.226	38.551
S11	PEG	511773.744	130598.829	40.112
S12	PEG	511702.710	130547.708	41.959

TOPOGRAPHICAL KEY



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www.surveys4bim.co.uk

Taylor Wimpey

Hayes Lane
Slinfold
Horsham
West Sussex

Topographical Survey

Scale	Sheet Size:	Sheet Number:	Date:
1:500	A0	1	September 2014

Project Number:	Rev:	Surveyed By:	Approved By:
20109	-	RG	NS

Appendix C Southern Water Sewer Records

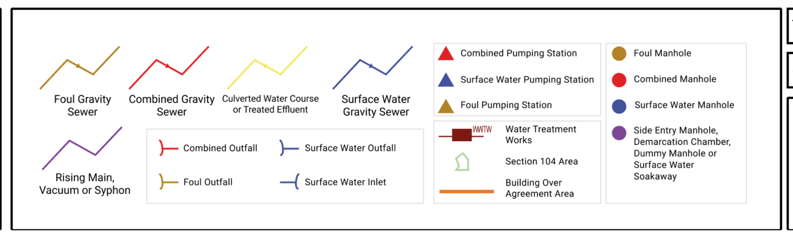
(c) Crown copyright and database rights 2025 Ordnance Survey AC0000808122	Date: 15/05/25	Scale: 1:1250	Map Centre: 511779,130692	Data updated: 20/03/25	Our Ref: 1770934 - 1

Wastewater Plan A1
Powered by digdat

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. This plan is produced by Southern Water Services Ltd (c) Crown copyright and database rights 2025 Ordnance Survey AC0000808122 .This map is to be used for the purposes of viewing the location of Southern Water plant only. Any other uses of the map data or further copies is not permitted.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement.

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



tbutler@c-a.uk.com

Slinfold

WATER for LIFE from Southern Water.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3001	F	39.04	37.36	
3901	F	39.12	37.68	
5401	F	43.77	42.02	
5402	F	43.32	41.54	
6501	F	42.09	40.60	
6502	F	40.26	38.77	
7001	F	33.44	32.07	
7601	F	38.69	36.80	
7701	F	37.37	35.86	
7702	F	35.62	33.84	
7801	F	35.46	34.23	
7802	F	35.12	33.48	
7803	F	34.56	33.09	
7804	F	0.00	0.00	
7805	F	0.00	0.00	
7806	F	0.00	0.00	
7807	F	0.00	0.00	
7808	F	0.00	0.00	
7901	F	33.76	32.23	
8002	F	34.12	30.93	
8901	F	34.84	31.51	
8902	F	34.56	31.29	
8903	F	34.37	31.17	
9801	F	35.33	32.84	
9802	F	35.19	32.52	
9901	F	34.08	32.21	
9902	F	34.63	31.96	
9903	F	35.27	31.86	
9904	F	34.99	31.63	
0950	S	33.73	31.92	
8950	S	34.60	33.04	
8951	S	34.78	32.91	
9850	S	35.40	33.49	
9950	S	34.97	32.80	
9951	S	35.13	32.40	
9952	S	34.55	32.37	
9953	S	34.02	32.26	
9954	S	33.74	32.01	

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix D Development Proposals

0 10 20 30 40 50 metres

N

- Site Boundary: **3.93ha**
- Proposed access point
- Visibility splays
- Primary street
- Secondary street (shared surface)
- Footways
- Lanes/private drives
- Allocated parking
- Unallocated parking
- Replacement unallocated parking
- Existing vegetation and RPAs
- Tree planting
- SuDS basin
- Public footpaths
- Public bridleways
- Net Developable Area: **1.62ha (4 acres)**
- Affordable units
- Sheds (affordable only)
- Garden fences
- Garden walls
- Bin collection points

Rev	Date	By	Description
B	19.08.25	RC	Minor layout amendments
A	14.08.25	RC	Minor layout amendments

CSA environmental

Dixies Barns, High Street,
Ashwell, Hertfordshire SG7 5NT

t 01462 743647
e ashwell@csaenvironmental.co.uk
w csaenvironmental.co.uk

Project	Land east of Hayes Lane, **SLINFOLD**
Title	Planning Layout
Client	The Incidental Land Company

Scale	1:1000 @ A3	Drawn	RC
Date	June 2025	Checked	RR
Drawing No.	CSA/5675/111	Rev	B

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Appendix E Drainage Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	999.9		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.024	5.00	38.868	1350	511751.557	130680.942	1.779
2	0.110	5.00	37.861	1350	511770.937	130732.369	1.500
3	0.014	5.00	37.710	1350	511773.795	130740.125	1.765
5	0.119	5.00	37.133	1350	511857.331	130710.493	1.500
4			37.674	1350	511814.990	130725.512	1.908
6	0.088	5.00	39.425	1350	511740.876	130652.728	1.350
7	0.019	5.00	39.194	1350	511745.410	130664.154	1.450
8			39.216	1350	511778.303	130651.842	1.823
9	0.048	5.00	39.158	1350	511784.710	130648.597	1.837
10	0.072	5.00	39.028	1350	511799.371	130616.423	1.915
11	0.063	5.00	38.776	1350	511808.242	130625.116	1.787
12	0.011	5.00	38.513	1350	511817.895	130634.577	1.659
13	0.067	5.00	37.879	1350	511836.142	130660.478	1.350
14	0.027	5.00	37.690	1350	511841.762	130672.596	1.768
Basin 1			37.000		511876.903	130679.602	1.500
Outfall			35.800		511925.202	130697.965	0.661

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	54.958	0.600	37.089	36.361	0.728	75.5	225	5.61	166.7
1.001	2	3	8.370	0.600	36.361	36.095	0.266	31.5	225	5.67	166.1
1.002	3	4	43.710	0.600	35.945	35.766	0.179	244.2	375	6.30	160.0
1.004	5	Basin 1	36.569	0.600	35.633	35.500	0.133	275.0	450	7.41	151.7
2.007	14	Basin 1	35.833	0.600	35.922	35.500	0.422	84.9	450	6.64	156.8
2.000	6	7	12.292	0.600	38.075	37.744	0.331	37.1	225	5.10	171.8
2.001	7	8	35.121	0.600	37.744	37.393	0.351	100.1	300	5.47	168.1

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.506	59.9	14.5	1.554	1.275	0.024	0.0	75	1.246
1.001	2.340	93.1	80.4	1.275	1.390	0.134	0.0	162	2.623
1.002	1.155	127.5	85.6	1.390	1.533	0.148	0.0	225	1.235
1.004	1.221	194.2	146.4	1.050	1.050	0.267	0.0	293	1.336
2.007	2.207	351.0	223.9	1.318	1.050	0.395	0.0	261	2.333
2.000	2.153	85.6	54.7	1.125	1.225	0.088	0.0	131	2.277
2.001	1.571	111.1	65.0	1.150	1.523	0.107	0.0	165	1.630

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.002	8	9	7.182	0.600	37.393	37.321	0.072	99.8	300	5.54	167.4
2.003	9	11	33.243	0.600	37.321	36.989	0.332	100.1	300	5.90	163.8
3.000	10	11	12.420	0.600	37.113	36.989	0.124	100.2	225	5.16	171.2
2.004	11	12	13.516	0.600	36.989	36.854	0.135	100.1	375	6.02	162.6
2.005	12	13	31.683	0.600	36.854	36.529	0.325	97.5	375	6.31	159.9
2.006	13	14	13.358	0.600	36.529	35.922	0.607	22.0	375	6.37	159.4
1.005	Basin 1	Outfall	51.672	0.600	35.500	35.139	0.361	143.1	300	8.06	141.9
1.003	4	5	44.926	0.600	35.841	35.633	0.208	216.0	375	6.91	154.3

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
2.002	1.574	111.3	64.7	1.523	1.537	0.107	0.0	164	1.631
2.003	1.571	111.0	91.8	1.537	1.487	0.155	0.0	209	1.748
3.000	1.306	51.9	44.6	1.690	1.562	0.072	0.0	161	1.463
2.004	1.810	200.0	170.4	1.412	1.284	0.290	0.0	268	2.023
2.005	1.835	202.7	173.9	1.284	0.975	0.301	0.0	269	2.052
2.006	3.876	428.1	211.9	0.975	1.393	0.368	0.0	186	3.867
1.005	1.312	92.7	339.5	1.200	0.361	0.662	0.0	300	1.329
1.003	1.229	135.7	82.5	1.458	1.125	0.148	0.0	211	1.286

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	54.958	75.5	225	Circular	38.868	37.089	1.554	37.861	36.361	1.275
1.001	8.370	31.5	225	Circular	37.861	36.361	1.275	37.710	36.095	1.390
1.002	43.710	244.2	375	Circular	37.710	35.945	1.390	37.674	35.766	1.533
1.004	36.569	275.0	450	Circular	37.133	35.633	1.050	37.000	35.500	1.050
2.007	35.833	84.9	450	Circular	37.690	35.922	1.318	37.000	35.500	1.050
2.000	12.292	37.1	225	Circular	39.425	38.075	1.125	39.194	37.744	1.225
2.001	35.121	100.1	300	Circular	39.194	37.744	1.150	39.216	37.393	1.523
2.002	7.182	99.8	300	Circular	39.216	37.393	1.523	39.158	37.321	1.537
2.003	33.243	100.1	300	Circular	39.158	37.321	1.537	38.776	36.989	1.487
3.000	12.420	100.2	225	Circular	39.028	37.113	1.690	38.776	36.989	1.562
2.004	13.516	100.1	375	Circular	38.776	36.989	1.412	38.513	36.854	1.284
2.005	31.683	97.5	375	Circular	38.513	36.854	1.284	37.879	36.529	0.975

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1350	Manhole	Adoptable	2	1350	Manhole	Adoptable
1.001	2	1350	Manhole	Adoptable	3	1350	Manhole	Adoptable
1.002	3	1350	Manhole	Adoptable	4	1350	Manhole	Adoptable
1.004	5	1350	Manhole	Adoptable	Basin 1		Junction	
2.007	14	1350	Manhole	Adoptable	Basin 1		Junction	
2.000	6	1350	Manhole	Adoptable	7	1350	Manhole	Adoptable
2.001	7	1350	Manhole	Adoptable	8	1350	Manhole	Adoptable
2.002	8	1350	Manhole	Adoptable	9	1350	Manhole	Adoptable
2.003	9	1350	Manhole	Adoptable	11	1350	Manhole	Adoptable
3.000	10	1350	Manhole	Adoptable	11	1350	Manhole	Adoptable
2.004	11	1350	Manhole	Adoptable	12	1350	Manhole	Adoptable
2.005	12	1350	Manhole	Adoptable	13	1350	Manhole	Adoptable

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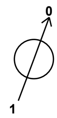
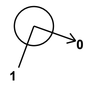
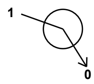
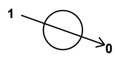
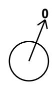
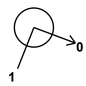
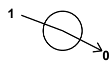
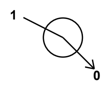
Pipeline Schedule

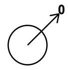
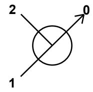
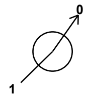
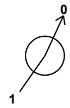
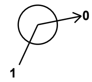
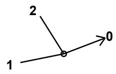
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
2.006	13.358	22.0	375	Circular	37.879	36.529	0.975	37.690	35.922	1.393
1.005	51.672	143.1	300	Circular	37.000	35.500	1.200	35.800	35.139	0.361
1.003	44.926	216.0	375	Circular	37.674	35.841	1.458	37.133	35.633	1.125

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
2.006	13	1350	Manhole	Adoptable	14	1350	Manhole	Adoptable
1.005	Basin 1		Junction		Outfall		Junction	
1.003	4	1350	Manhole	Adoptable	5	1350	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
1	511751.557	130680.942	38.868	1.779	1350					
							0	1.000	37.089	225
2	511770.937	130732.369	37.861	1.500	1350		1	1.000	36.361	225
							0	1.001	36.361	225
3	511773.795	130740.125	37.710	1.765	1350		1	1.001	36.095	225
							0	1.002	35.945	375
5	511857.331	130710.493	37.133	1.500	1350		1	1.003	35.633	375
							0	1.004	35.633	450
4	511814.990	130725.512	37.674	1.908	1350		1	1.002	35.766	375
							0	1.003	35.841	375
6	511740.876	130652.728	39.425	1.350	1350					
							0	2.000	38.075	225
7	511745.410	130664.154	39.194	1.450	1350		1	2.000	37.744	225
							0	2.001	37.744	300
8	511778.303	130651.842	39.216	1.823	1350		1	2.001	37.393	300
							0	2.002	37.393	300
9	511784.710	130648.597	39.158	1.837	1350		1	2.002	37.321	300
							0	2.003	37.321	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
10	511799.371	130616.423	39.028	1.915	1350		0	3.000	37.113	225
11	511808.242	130625.116	38.776	1.787	1350		1	3.000	36.989	225
							2	2.003	36.989	300
							0	2.004	36.989	375
12	511817.895	130634.577	38.513	1.659	1350		1	2.004	36.854	375
							0	2.005	36.854	375
13	511836.142	130660.478	37.879	1.350	1350		1	2.005	36.529	375
							0	2.006	36.529	375
14	511841.762	130672.596	37.690	1.768	1350		1	2.006	35.922	375
							0	2.007	35.922	450
Basin 1	511876.903	130679.602	37.000	1.500			1	2.007	35.500	450
							2	1.004	35.500	450
							0	1.005	35.500	300
Outfall	511925.202	130697.965	35.800	0.661			1	1.005	35.139	300

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	10080	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
30	40	0	0
100	0	0	0
100	45	0	0

Node Basin 1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.005	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0091-3900-1200-3900
Invert Level (m)	35.500	Min Outlet Diameter (m)	0.150
Design Depth (m)	1.200	Min Node Diameter (mm)	1200
Design Flow (l/s)	3.9		

Node Basin 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	35.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	1305

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	401.0	0.0	1.500	834.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	11	37.122	0.033	2.9	0.0474	0.0000	OK
15 minute summer	2	10	36.429	0.068	16.0	0.0967	0.0000	OK
15 minute summer	3	11	36.037	0.092	17.3	0.1317	0.0000	OK
15 minute summer	5	11	35.755	0.122	30.0	0.1748	0.0000	OK
15 minute summer	4	12	35.928	0.162	17.3	0.2323	0.0000	OK
15 minute summer	6	10	38.128	0.053	10.6	0.0764	0.0000	OK
15 minute summer	7	10	37.813	0.069	12.8	0.0983	0.0000	OK
15 minute summer	8	11	37.468	0.075	12.7	0.1076	0.0000	OK
15 minute summer	9	11	37.403	0.082	18.2	0.1168	0.0000	OK
15 minute summer	10	10	37.175	0.062	8.7	0.0882	0.0000	OK
15 minute summer	11	11	37.102	0.113	33.9	0.1610	0.0000	OK
15 minute summer	12	11	36.967	0.113	35.4	0.1615	0.0000	OK
15 minute summer	13	11	36.608	0.079	43.1	0.1137	0.0000	OK
15 minute summer	14	11	36.046	0.124	46.2	0.1774	0.0000	OK
480 minute summer	Basin 1	336	35.708	0.208	19.3	89.6677	0.0000	OK
15 minute summer	Outfall	1	35.139	0.000	2.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	2.8	0.429	0.047	0.3734	
15 minute summer	2	1.001	3	15.6	1.658	0.168	0.0792	
15 minute summer	3	1.002	4	17.3	0.536	0.136	1.4487	
15 minute summer	5	1.004	Basin 1	29.4	1.640	0.151	0.7548	
15 minute summer	4	1.003	5	16.6	0.671	0.122	1.1293	
15 minute summer	6	2.000	7	10.5	1.212	0.123	0.1071	
15 minute summer	7	2.001	8	12.7	0.989	0.114	0.4518	
15 minute summer	8	2.002	9	12.7	0.870	0.114	0.1051	
15 minute summer	9	2.003	11	18.3	0.928	0.165	0.6581	
15 minute summer	10	3.000	11	8.6	0.634	0.166	0.1767	
15 minute summer	11	2.004	12	34.1	1.225	0.170	0.3760	
15 minute summer	12	2.005	13	35.4	1.590	0.175	0.7109	
15 minute summer	13	2.006	14	43.1	1.787	0.101	0.3256	
15 minute summer	14	2.007	Basin 1	46.4	2.636	0.132	0.7288	
480 minute summer	Basin 1	Hydro-Brake®	Outfall	3.7				145.6

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.96%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	37.155	0.066	11.7	0.0950	0.0000	OK
15 minute summer	2	10	36.526	0.165	65.2	0.2364	0.0000	OK
15 minute summer	3	10	36.149	0.204	71.0	0.2918	0.0000	OK
480 minute winter	5	464	36.087	0.454	13.6	0.6491	0.0000	SURCHARGED
480 minute winter	4	464	36.087	0.321	7.5	0.4587	0.0000	OK
15 minute summer	6	10	38.197	0.122	43.0	0.1749	0.0000	OK
15 minute summer	7	10	37.892	0.148	52.1	0.2124	0.0000	OK
15 minute summer	8	11	37.572	0.179	51.6	0.2558	0.0000	OK
15 minute summer	9	11	37.506	0.185	74.2	0.2643	0.0000	OK
15 minute summer	10	11	37.330	0.217	35.2	0.3104	0.0000	OK
15 minute summer	11	11	37.260	0.271	137.9	0.3877	0.0000	OK
15 minute summer	12	11	37.107	0.253	143.8	0.3623	0.0000	OK
15 minute summer	13	11	36.717	0.188	175.9	0.2688	0.0000	OK
15 minute summer	14	11	36.167	0.245	189.0	0.3511	0.0000	OK
480 minute winter	Basin 1	464	36.087	0.587	32.9	284.8766	0.0000	SURCHARGED
15 minute summer	Outfall	1	35.139	0.000	3.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	11.5	0.560	0.191	1.1269	
15 minute summer	2	1.001	3	64.2	2.272	0.690	0.2360	
15 minute summer	3	1.002	4	71.0	0.973	0.557	3.2000	
480 minute winter	5	1.004	Basin 1	12.6	0.663	0.065	5.7934	
480 minute winter	4	1.003	5	7.5	0.489	0.055	4.1952	
15 minute summer	6	2.000	7	42.8	1.716	0.500	0.3061	
15 minute summer	7	2.001	8	51.6	1.316	0.464	1.3755	
15 minute summer	8	2.002	9	51.5	1.153	0.463	0.3206	
15 minute summer	9	2.003	11	74.5	1.298	0.671	1.8693	
15 minute summer	10	3.000	11	34.0	0.856	0.655	0.4910	
15 minute summer	11	2.004	12	138.7	1.687	0.694	1.1111	
15 minute summer	12	2.005	13	144.7	2.148	0.714	2.1284	
15 minute summer	13	2.006	14	176.4	2.676	0.412	0.8790	
15 minute summer	14	2.007	Basin 1	190.1	3.288	0.541	2.5930	
480 minute winter	Basin 1	Hydro-Brake®	Outfall	3.9				386.7