Hooklands Farmhouse Level Raising towards A24

Flood Risk Assessment & Surface Water Drainage Assessment

June 2023

www.jbaconsulting.com

Hooklands Farm
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Ashington
West Sussex
RH20 3AT

JBA Project Manager

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Revision History

Revision Ref/Date	Amendments	Issued to
12/06/2023		Andrew Softley

Contract

This report describes work commissioned by Mark Nunn, on behalf of Penfold Verrall Ltd. Dimitrios Goukos of JBA Consulting carried out this work.

Prepared by .... Dimitrios Goukos

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Reviewed by .... Howard Keeble

Technical Director

Approved by................................. Andrew Softley

Senior Planning Consultant

Purpose

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1 Introduction

1.1 Overview

This proportionate Flood Risk Assessment (FRA) and Surface Water Drainage Assessment (SWDA) has been prepared following instruction from Mark Nunn, on behalf of Penfold Verrall Ltd, by an email dated 17/04/2023. The development was for the Hooklands Farmhouse noise, air quality and light pollution mitigation scheme. They will provide support for the required land raising proposals that will allow the validation of the original 'Application for Planning Permission' prepared by Ashdown Planning Consultants.

This FRA and SWDA is based on a desktop review of the proposed development layout.

1.2 Scope

The proposed land raising scheme is located at Hooklands Farmhouse, shown on Figure 2-1. A planning application has already been submitted. However, this application has not been validated due to the request for further detailed information on issues relevant to flooding and drainage by West Sussex County Council (WSCC).

Penfold Verrall wish to secure a valid planning application, and so want to address these outstanding validation issues by commissioning this additional assessment.

2 Spatial Planning Considerations

2.1 Location

The proposed development is located in Hooklands Farm, London Road, Ashington, West Sussex, RH20 3AT (see Figure 2-1 and Table 2-1 below).

The site lies within the Lancing Brook catchment that joins River Adur near Knepp Castle, about 3.5 Km north of the development, while, to the south (around 1.2 Km) lies the large village of Ashington.

Table 2-1: Location of the Development Site

Reference	Value
OS X (Eastings)	513476
OS Y (Northings)	116910
Nearest Post Code	RH20 3AT
Lat (WGS84)	N50:56:26
Long (WGS84)	W0:23:11
Nat. Grid	TQ134169

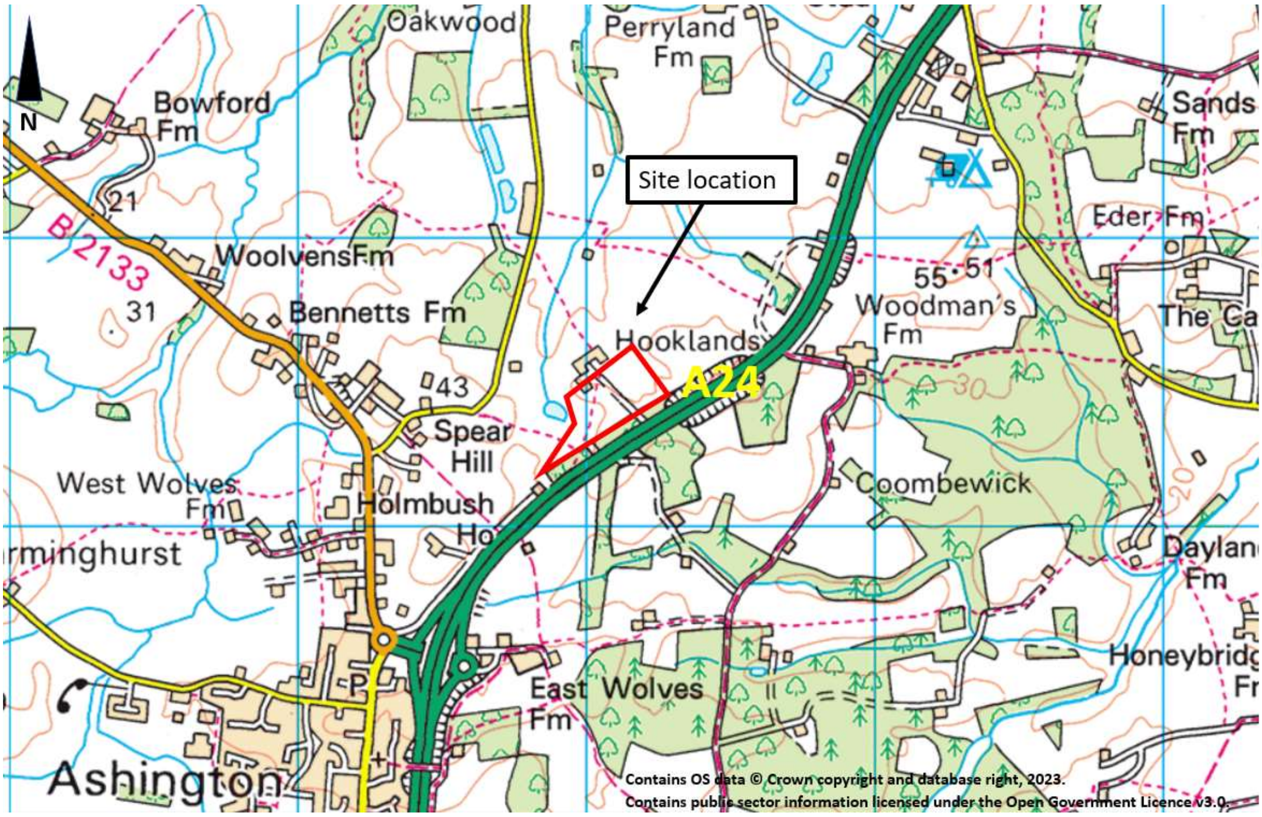

Figure 2-1: Wider Location Plan

2.2 Pre and Post Development Site Description

The development site covers approximately 4.5 hectares and consists predominately of grassland, a hardstanding access track, and surrounding deciduous woodland. The wider landscape is comprised of agricultural land and woodland parcels with hedgerows and treelines.

The development involves land raising towards the A24 in order to create two bunds that will mitigate noise, air quality and light pollution. A temporary haul road will provide access for the erection of these two bunds (Figure 2-2). A site compound and parking of vehicles for site operatives and visitors will also be established (Figure 2-3). It will contain a standalone 12ft welfare unit that provides facilities up to 7 site operatives.

The temporary haul road is proposed to pass through fields to the west of Hooklands Farm and link into the existing old A24 road next to No 2 Hooklands Lodge (Figure 2-2).

Also, a wheel cleaning facilities area will be established at the entrance to the site to ensure no debris is deposited onto the highway (Figure 2-3). All vehicles leaving the site will use this facility.

The aforementioned will all be removed upon completion of the works.

The existing and proposed site development layouts are presented in Figure 2-2 (red contours: existing terrain / blue contours: terrain after the intervention). Figure 2-2 indicates where the developer is proposing to construct the two, parallel with A24, bunds. The amounts proposed are a maximum of circa 110,000 cubic metres.

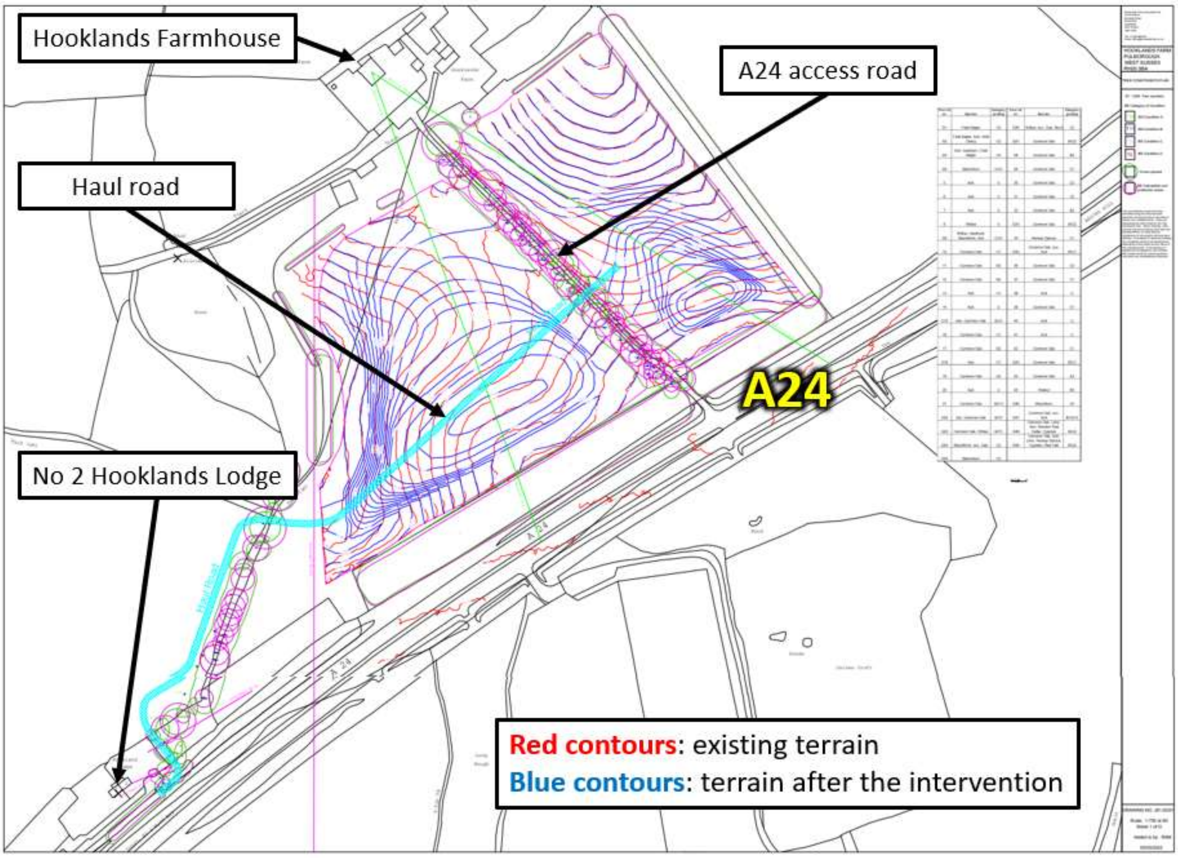

Figure 2-2: Existing and Proposed Site Layout (with temporary haul road)

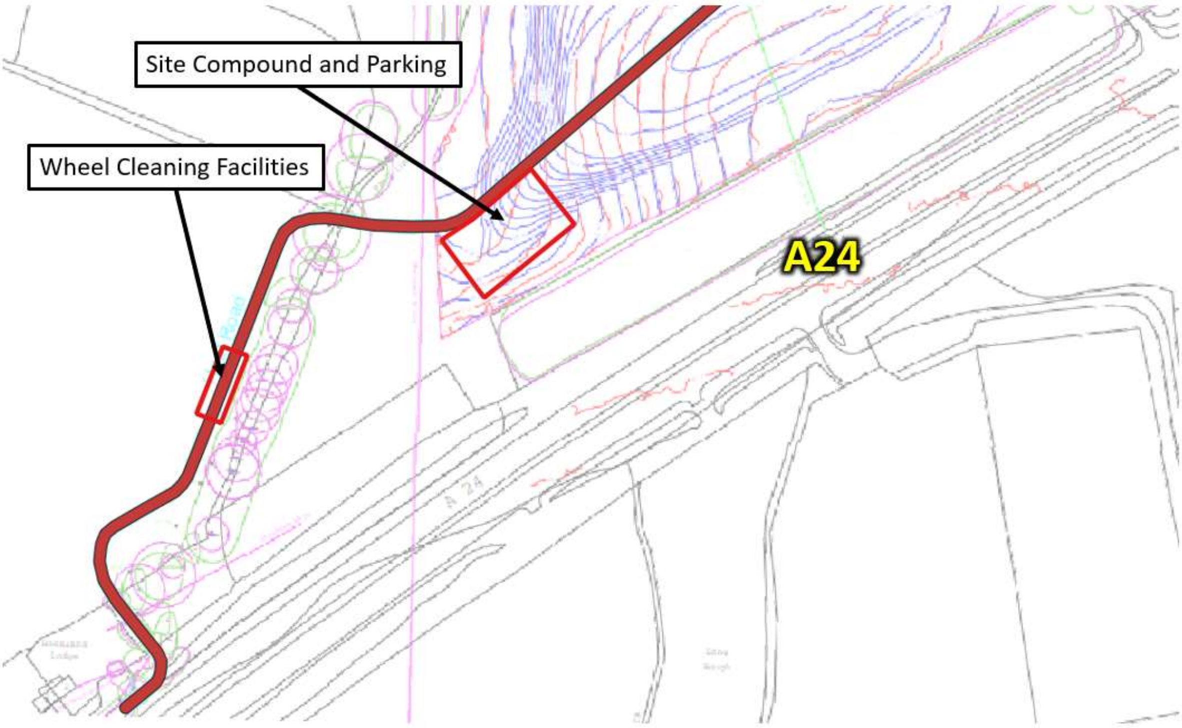

Figure 2-3: Site Compound, Parking and Wheel Cleaning Facilities Area

2.3 Topography – Local Hydrological Network

The existing ground elevations on site is shown in Figure 2-4 (yellow contours). It indicates that the site is split by the existing access road to a western side, sloping towards the north west of the site's boundary (see below Section 2.6.1), and specifically the existing pond, and an eastern side, sloping towards the north eastern corner of the site, where the parallel to the site's boundary drainage ditch (indicated by the characteristic folds alongside the eastern boundary) also ends up (see below Section 2.6.1). Ground levels vary between 45mAOD and 34mAOD.

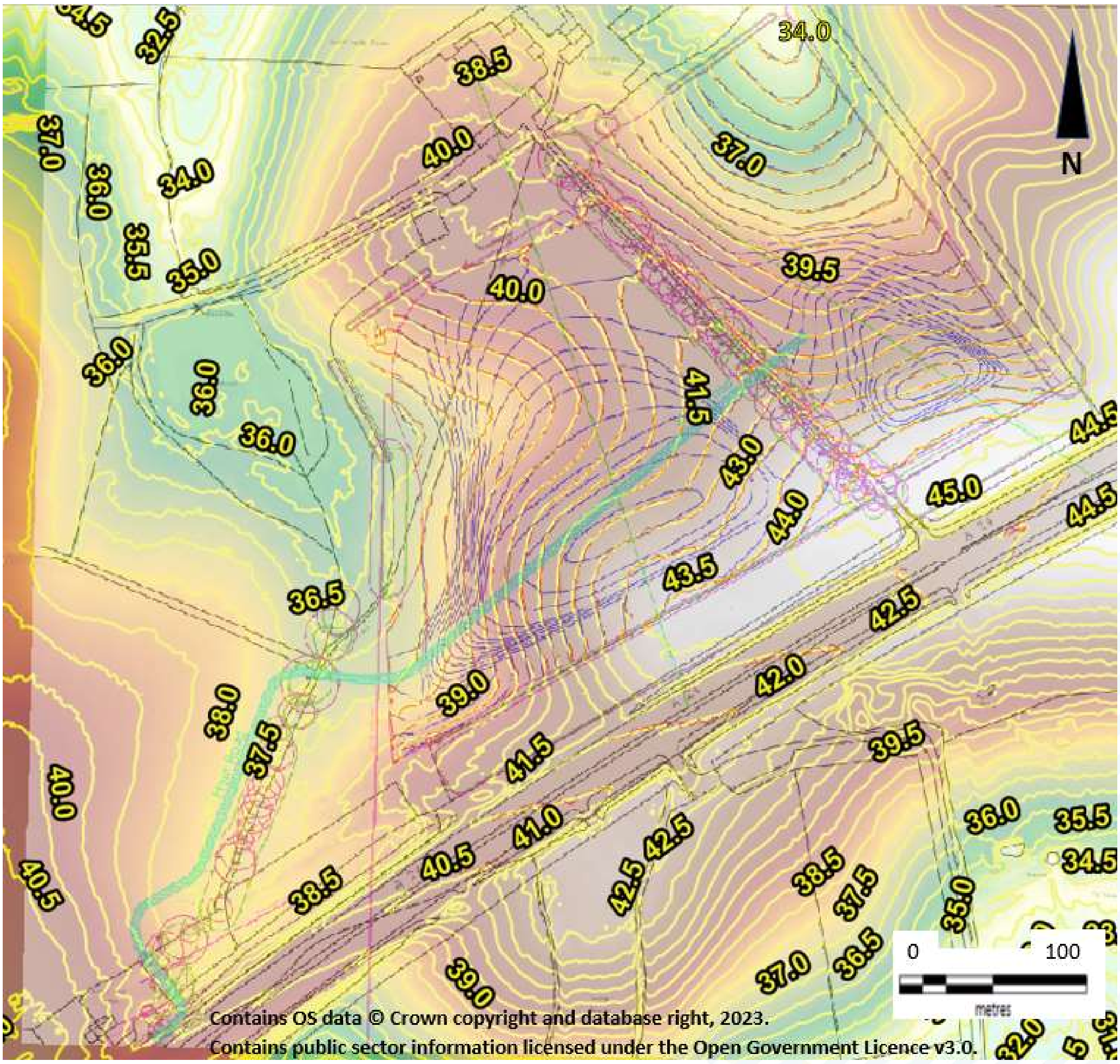

Figure 2-4: Pre-development topography (Yellow contours)

The post-development ground elevations on site is shown in Figure 2-5 (blue contours). It indicates that the topographical alteration will cause a respective modification in the hydromorphic characteristics of the site (see below Section 2.6.1).

Ground levels will vary between 48.5mAOD and 34mAOD.

Figure 2-5: Post-development topography (purple contours)

Figure 2-6 depicts the local hydrological network. We can see that both north west and north east corners of our site are the starting points of two brooks, merging downstream before they end up in Lancing Brook. The one in the west side flows out of the aforementioned pond.

These two local brooks are the receptors of the surface water runoff occurring from our site.

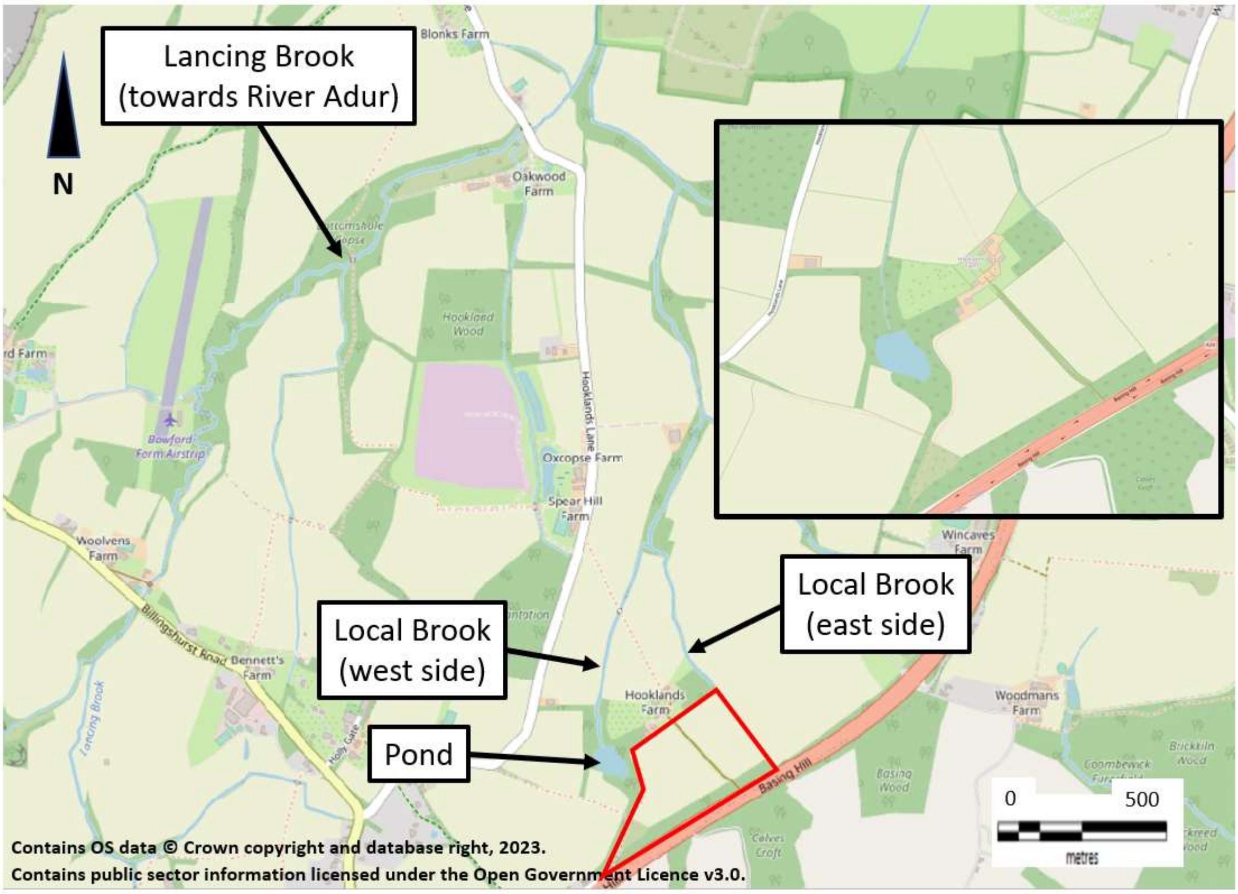

Figure 2-6: Local Hydrological Network

2.4 Soil conditions - Infiltration rate

Soilscapes mapping provided by Cranfield University on behalf of DEFRA (Figure 2-7) shows that the site of the proposed development falls on HOST soil class 18, which is defined as 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils'.

Information from the Soilscapes mapping suggests that the specific soils may be suitable for the use of SuDS methods, concerning surface water runoff handling, involving infiltration.

In dry soil, water infiltrates rapidly. This is called the initial infiltration rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady rate. This is called the basic infiltration rate.

Soilscapes refers the site's soil texture as 'loamy and clayey'. According to FAO's 'Irrigation Water Management: Irrigation methods' the basic infiltration rates, for this type of soil, vary between 5 and 10mm/h. We will accept, in the lack of field evidence (infiltration test) that an average value of 7.5mm/h is representative for the site.

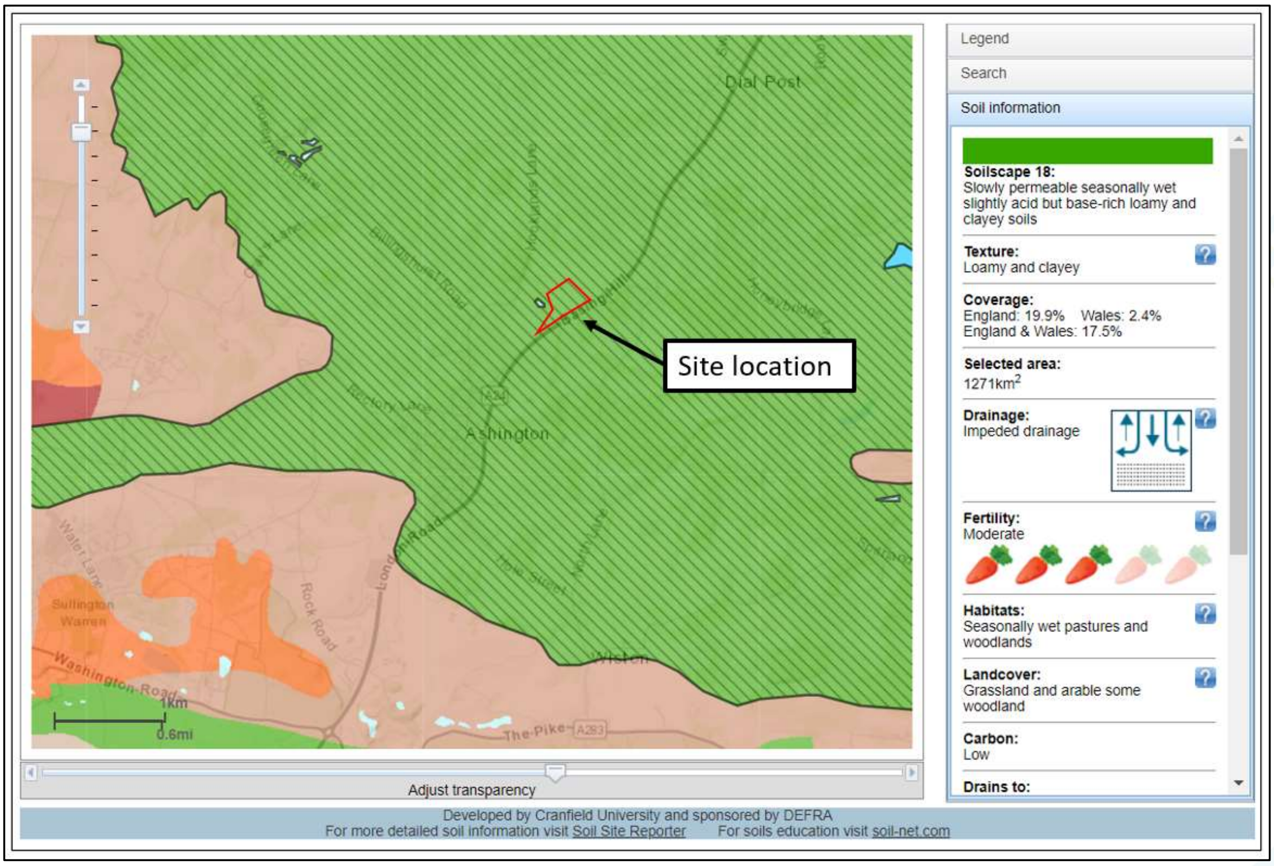

Figure 2-7: Cranfield University Soilscapes mapping

2.5 Runoff Coefficient

The runoff coefficient (Cv) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. Agricultural land's runoff coefficient, and specifically, grassland and pasture growing on a 'loamy and clayey' soil, according to the literature, varies between 0.1 and 0.4. We will accept that an average value of 0.25 is representative for the site.

2.6 Pre, during and post development drainage patterns

The determination of how the intervention will impact (increase) flooding risk (from surface water runoff) within its boundary or downstream, depends on the changes that will occur in the drainage patterns, and specifically:

- terrain alterations (changes in hydromorphic characteristics due to changes in topography)
- infiltration patterns changes

2.6.1 Topography related impact

The erection of the bund will redistribute surface water flowpaths as shown in Figure 2-8.

Initially surface water was flowing fairly uniformly towards the lower points of the two distinct drainage parts, as described in Section 2.3. The intervention will change the pattern of runoff as water will flow in a perimetric way around each bund (Figure 2-8).

This means that surface water will flow towards the existing access road from both 'eastern' and 'western' bund (Figure 2-8), while, before the intervention water could only move towards the aforementioned receptors.

In addition, surface water will be conveyed southerly from the south-sloping sides of each bund, towards the areas neighbouring A24 (Figure 2-8) where it may create pool(s) of stagnant water.

This redistribution will need to be mitigated (see below Section 4.2) in order to avoid erosion phenomena both to the access road and the toe of the bunds themselves.

In conclusion, there will be an increase in flood risk, during and post the intervention, because of the obvious terrain alteration, which will respectively cause changes in the hydromorphic characteristics. As a mitigation we will propose in Section 4.2 a drainage arrangement capable of it.

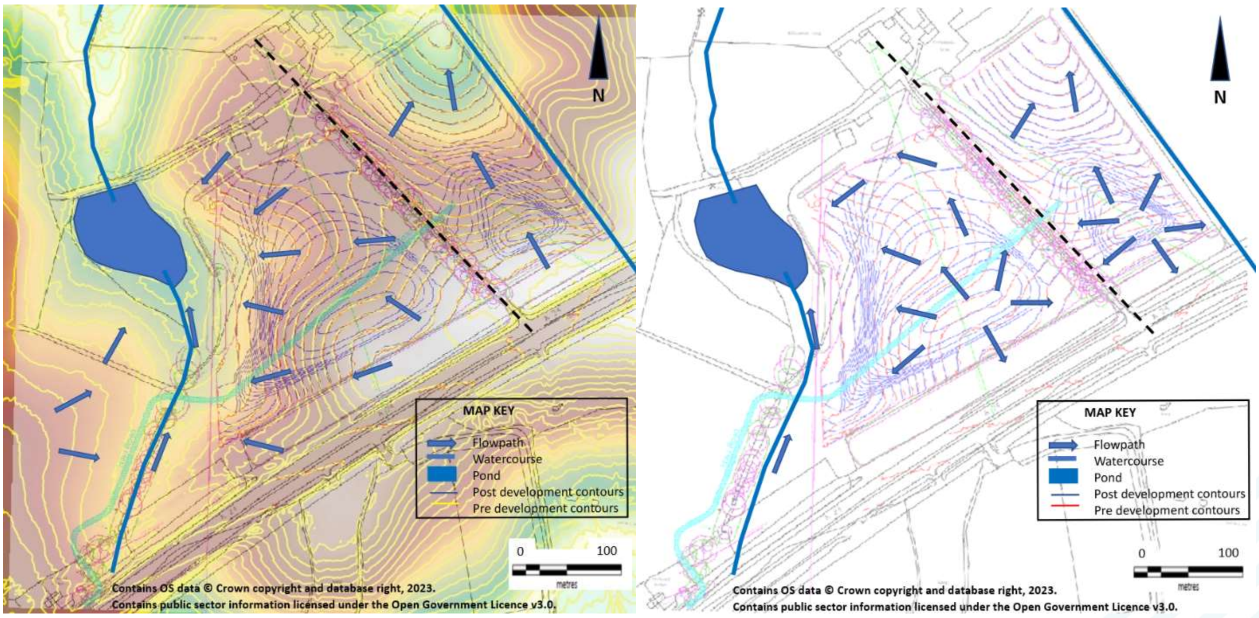

Figure 2-8: Pre and post development flowpaths

2.6.2 Infiltration patterns related impact

The erection of the two bunds, the temporary haul road, the site compound (and parking) and the wheel cleaning facilities area will not change the infiltration patterns of the site. According to the 'Construction Management Plan' by Penfold Verrall, submitted with the original 'Application for Planning Permission':

- The material to be deposited at the site will be clean naturally occurring soil and mineral material and will be imported according to a Materials Management Plan (MMP) under the Definition of Waste: Code of Practice (DoWCoP / CL:AIRE) which regulates/enables the direct transfer and reuse of clean naturally occurring soil materials between sites.
- The temporary haul road will consist of a stoned track built to specifications to match the lorry weights required to minimise ground compaction. It will be constructed from recycled stone and enabling lorries to access the working area safely. The track would be 4 metres wide with passing bays incorporated to allow safe passing of on-site traffic and will be located outside of any tree root protection areas. The existing topsoil would be stripped and stored separately to a height of 2.0m and also outside the tree root protection areas. The track will be removed once the site operations have been completed prior to re-spreading the topsoil. Vehicular movements during the construction period shall be limited

to areas of existing and new temporary hard standing or newly protected ground only.

- The site compound and parking will be established by laying a geotextile membrane to the existing ground and laying a recycled stone upon this and consolidating.
- The wheel cleaning facilities area will occupy part of the temporary haul road. Any washwater is in the responsibility of the contractor to manage.

It is considered that there will be no increase in flood risk during and post the intervention due to infiltration patterns' alteration as, according to the above, they will not change.

It is for the contractor that will erect the bunds to handle any washwater in order to avoid contamination issues.

3 Flood Risk

The site, as will be shown below, is at very low flood risk from fluvial, pluvial, sewer and artificial flood sources (reservoirs).

No tidal and groundwater assessment has been performed as they were regarded improbable eventualities.

3.1 Fluvial Flooding

The site is within 'Flood Zone 1', defined as areas having less than 1 in 1,000 annual exceedance probability of river flooding (Figure 3-1), therefore it is at very low fluvial flood risk.

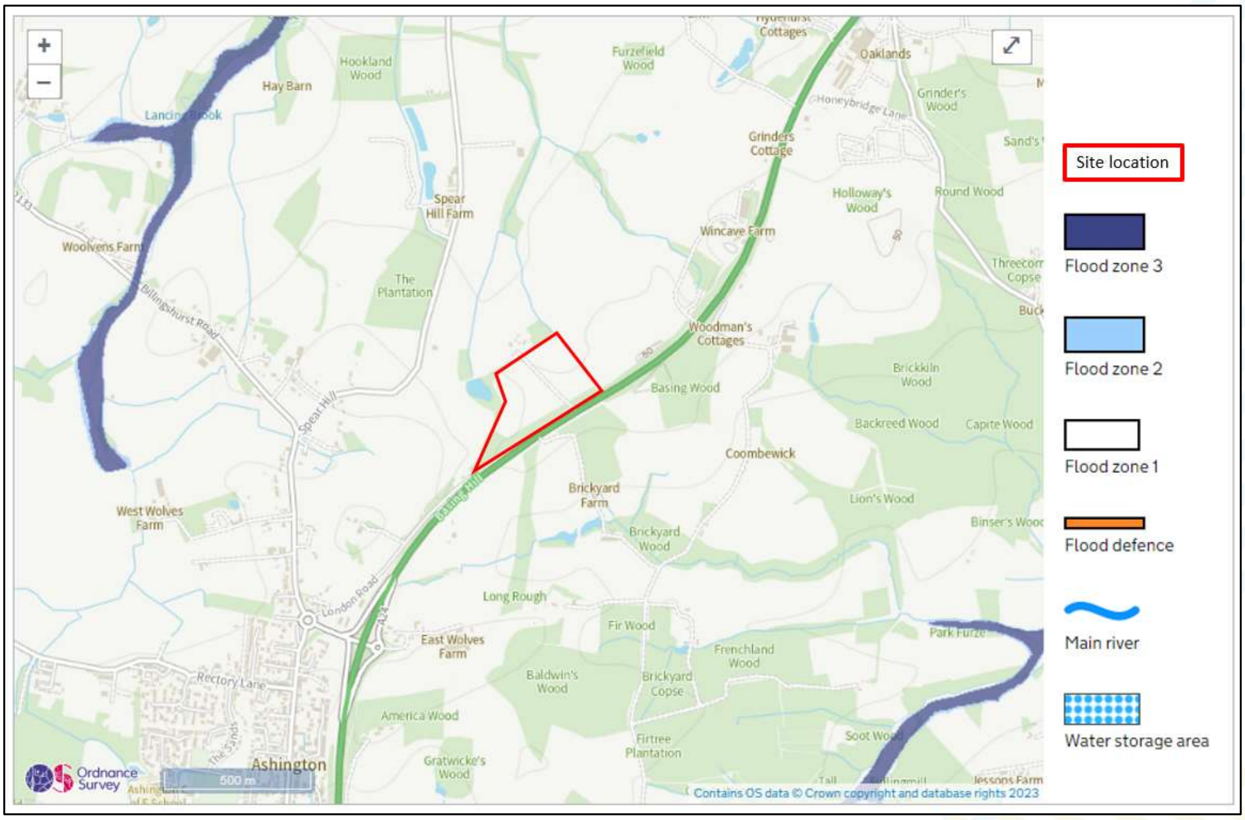

Figure 3-1: Flood Zones (Source: EA Flood Map for Planning)

3.2 Sequential Test/Exception Test - NPPF Vulnerability

No Sequential Test/Exception Test will be required as the site lies in Flood Zone 1.

You need to do a sequential test if both of the following apply:

- The site is in flood zone 2 or 3
- A sequential test hasn't already been done for a development of the type you an plan to carry out on your proposed site

An exception test is required when the sequential test has been passed.

The development will be classed as 'Water-compatible development' under the NPPF vulnerability classification (Table 3-1). The flood risk vulnerability and flood zone compatibility are displayed in Table 3-2.

Table 3-1: Flood Risk Vulnerability Classification (Source: NPPF Technical Guide)

Water-compatible development
Flood control infrastructure.
Water transmission infrastructure and pumping stations.
Sewage transmission infrastructure and pumping stations.
Sand and gravel working.
Docks, marinas and wharves.
Navigation facilities.
Ministry of Defence installations.
Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
Water-based recreation (excluding sleeping accommodation).
Lifeguard and coastguard stations.
Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 3-2: Flood Risk Vulnerability and flood zone compatibility (Source: NPPF Technical Guide)

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate

✗ Development should not be permitted.

As the development's closest category is 'Sand and gravel working' (Water-compatible) and it is located in Flood Zone 1 the development is acceptable; it is appropriate to proceed with it.

3.3 Flood Compensation Storage

No flood compensation storage will be required as the site is lacated in Flood Zone 1.

3.4 Flooding from Artificial Sources

Based on the Environment Agency's Flood Risk mapping (Figure 3-2), the proposed development is located entirely outside reservoir flood extents.

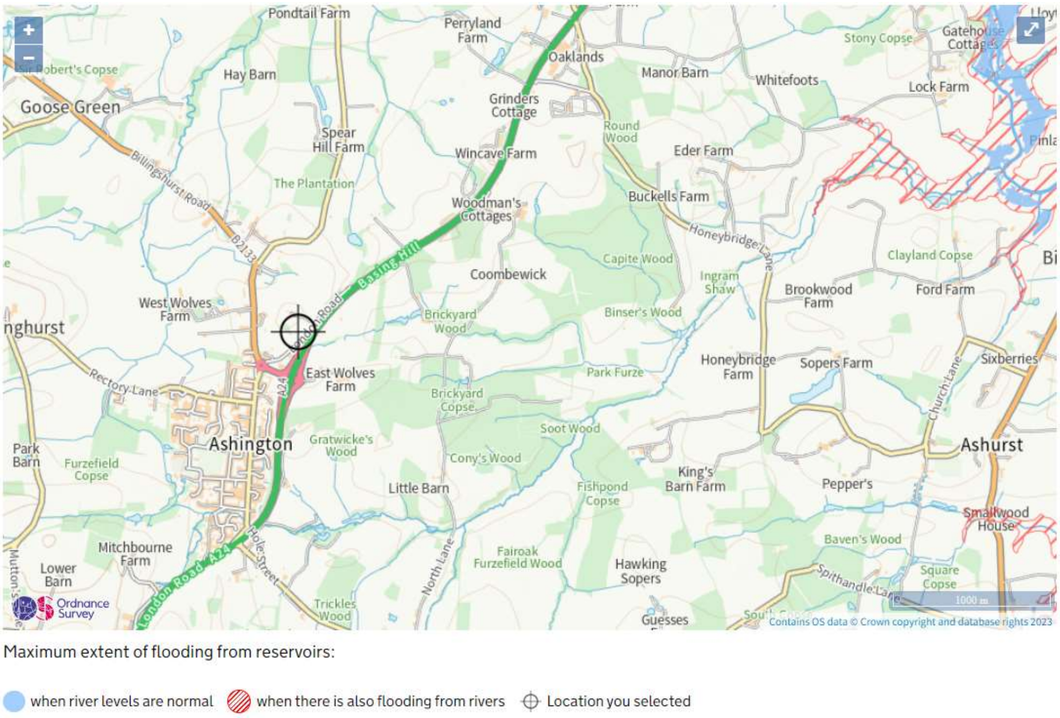

Figure 3-2: Flood Extent from Reservoirs

3.5 Surface Water Flooding

The Environment Agency Risk of Flooding from Surface Water (RoFSW) map is presented in Figure 3-3. The site is shown to be at very low risk of surface water flooding. Very low risk means that each year this area has a chance of flooding of less than 0.1%.

Surface water flood risk at the site appears to vary in a very small proportion of the total area while the vast majority remains at very low risk. These isolated areas shown to be at high risk likely are due to local depressions in topography.

It is important to stress that no overlay occurs between the none of the two bunds, the temporary haul road, the site compound (and parking) and the wheel cleaning facilities area, and the areas of surface water flood risk.

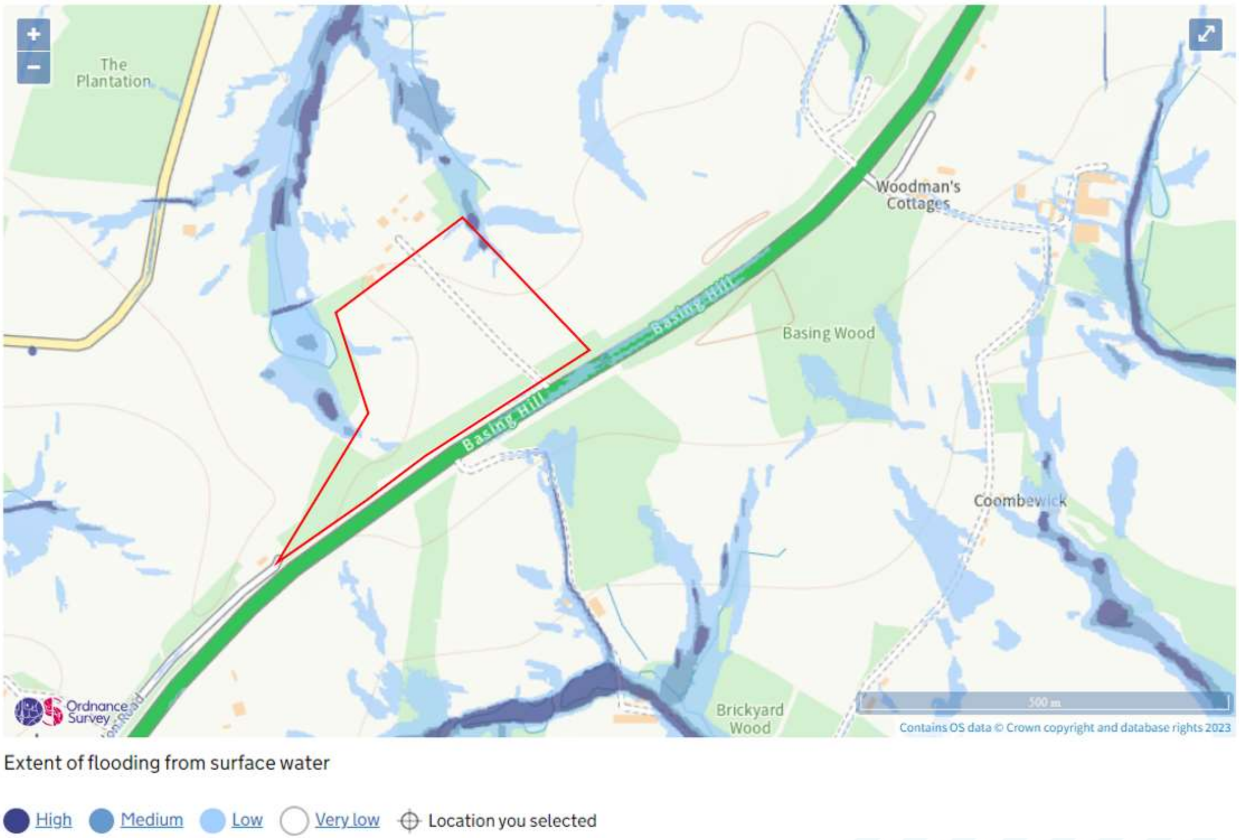

Figure 3-3: Surface Water Flood Map

3.6 Flooding from Sewers

There are no existing sewers in the vicinity of the site.

4 Surface water drainage strategy

4.1 Overview of drainage strategy

The Surface Water Drainage Strategy (SWDS) includes the provision of SuDS, in order to manage the new hydromorphic situation created by the intervention, concerning runoff in the development site. As detailed in Section 2.4 infiltration is feasible at this site.

The idea behind the proposed drainage strategy is to dispose, utilising infiltration, the redistributed by the intervention, quantities of surface water, while allowing those that remain intact to follow their usual path to either of the two drainage routes shown in Figure 2-6.

After further investigation, it was considered that the most suitable option for managing surface water runoff would be the construction of perimetric swales around the bunds. Swales that will be capable of storing initially the surface water runoff quantities before they allow them to infiltrate.

The design event that was considered was the 100 year rainfall event plus 20% climate change allowance.

The climate change allowance was set to 20% after consulting the relevant Department for Environment Food & Rural Affairs Climate Change Allowances site ('Adur and Ouse Management Catchment peak rainfall allowances').

4.2 Positioning and sizing of the swales

The SWDS will rely on the targeted attenuation (storage) of the unfavourably redistributed runoff and its disposal through infiltration (Section 2.6.1). Figure 4-1 shows the areas requiring drainage and the respective positioning of the proposed swales. Swale East 1, Swale East 2, Swale West 1 and Swale West 2 are the areas requiring drainage. No alteration in the drainage patterns have been regarded for the rest of the site's areas.

Modelling of the surface water runoff to the design parameters was carried out using the Source Control of Micro Drainage, an industry leading software which allows design and analysis of SuDS features. Original model results are displayed in Appendix A: MicroDrainage-Source Control Results. The following conservative assumptions and design parameters have been set within the Hydraulic model:

- Swale East 1, Swale East 2, Swale West 1 and Swale West 2 equal 0.323ha, 0.313ha, 1.418 and 0.399;
- Time take for runoff to reach the detention basin respectively has been set at 4 minutes (this takes into account the fact that impermeable surfaces are lying in a wide range of distance from the swale);
- Rainfall intensity was obtained using the FEH rainfall runoff methods and specifically the ReFH2 methodology (ReFH2 Tool), and increased by 20%, the central end allowance for climate change over the 30 years design life of the proposed site, in line with the requirements of the NPPF;
- No runoff loses have been assumed in the modelling, therefore all the design rainfall landing on the impermeable surfaces is expected to reach the swales;
- The dimensions of the detention basin are displayed in Appendix A: MicroDrainage-Source Control Results;
- As per the conclusions in Section 3.3, the soil has been modelled with an infiltration rate of 7.5 mm/hr;
- Runoff Coefficient was set to a value of 0.25.

Table 3 below includes a summary of the swales specifications, designed to collect and manage the rainfall runoff from the 1 in 100 year event plus climate change allowance. The SWDS plan showing the indicative layout of the swales and inflowing drainage areas, is displayed in Figure 4-1.

Table 4-1, below, includes a summary of swales' drainage areas, dimensions and performances for the 100 year rainfall event (plus 20% Climate Change Allowance).

Table 4-1: Swales' drainage areas, dimensions and performance

Swale	Drained Area (m2)	Total Length (m)	Depth (m)	Base Width (m)	Side Slope (1/X)	u/s ground Level (mAOD)	d/s ground Level (mAOD)	S/W Volume to be accomodated (m3)	Critical Storm Event Duration (min) - Season	Half Drain Time (min)	Max Depth (mm)
1	3,230	90	0.9	1.0	1/3	44.00	43.00	75	2160 Winter	2,861	800
2	3,130	98	1.3	1.0	1/3	44.50	40.75	79	2880 Winter	4,345	1,298
3	14,180	270	1.2	1.0	1/3	43.50	38.00	354	2880 Winter	4,126	1,184
4	3,990	115	1.1	1.0	1/3	44.00	41.75	98	2880 Winter	3,789	1,096

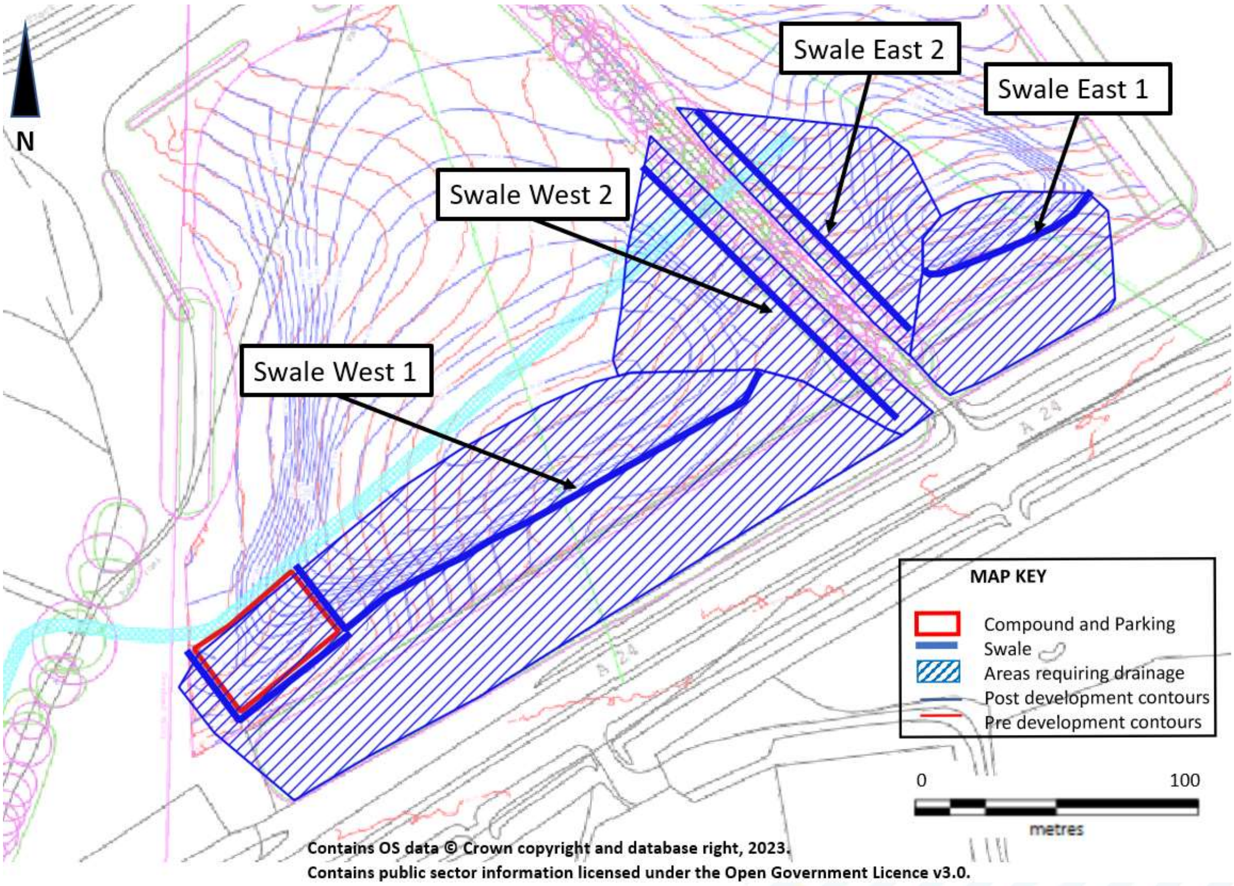

Figure 4-1: Surface water drainage strategy layout

5 Conclusions

- The proposed development site is located in Hooklands Farm, London Road, Ashington, West Sussex, RH20 3AT (OS X (Eastings) 513476 / OS Y (Northings) 116910);
- The development involves the erection of two bunds towards A24 that will mitigate noise, air quality and light pollution.;
- This FRA is based on a desktop review of the proposed development layout;
- The proposed development site sits within Flood Zone 1. It is at very low flood risk from fluvial, pluvial, sewer and artificial flood sources (reservoirs);
- The development is considered as 'Water Compatible' according to the NPPF 'Flood Risk Vulnerability Classification';
- According to NPPF 'Flood Risk Vulnerability and Flood Zone Compatibility' there is no need of sequential and exception test, to determine whether the development is acceptable; it is appropriate to proceed with it;
- It is important to stress that no overlay occurs between the two bunds, the temporary haul road, the site compound (and parking) and the wheel cleaning facilities area, and the areas of fluvial or surface water flood risk;
- There will be an increase in flood risk, during and post the intervention, because of the obvious terrain alteration, which will respectively cause changes in the hydromorphic characteristics. A drainage arrangement (surface water drainage strategy) capable of mitigating these issues is proposed;
- The surface water drainage strategy comprises swales to dispose, utilising infiltration, the redistributed by the intervention, quantities of surface water, while allowing those that remain intact to follow their usual path to either of the two final receptors. Four swales will be required;
- The bunds, the temporary haul road, the site compound (and parking) and the wheel cleaning facilities area will not alter the hydromorphic characteristics of the site as they will be permeable structures;
- It is for the contractor that will erect the bunds to handle any washwater in order to avoid contamination issues.

Appendix A: MicroDrainage-Source Control Results

Swale East 1

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Micro Drainage	Source Control 2020.1.3	

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

Half Drain Time : 2861 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.510	0.510	0.1	23.7	O K
30 min Summer	0.572	0.572	0.2	31.5	O K
60 min Summer	0.627	0.627	0.2	39.9	Flood Risk
120 min Summer	0.676	0.676	0.2	48.4	Flood Risk
180 min Summer	0.702	0.702	0.2	53.2	Flood Risk
240 min Summer	0.718	0.718	0.2	56.5	Flood Risk
360 min Summer	0.741	0.741	0.2	61.2	Flood Risk
480 min Summer	0.756	0.756	0.2	64.5	Flood Risk
600 min Summer	0.766	0.766	0.2	66.9	Flood Risk
720 min Summer	0.774	0.774	0.3	68.7	Flood Risk
960 min Summer	0.785	0.785	0.3	71.2	Flood Risk
1440 min Summer	0.795	0.795	0.3	73.6	Flood Risk
2160 min Summer	0.797	0.797	0.3	74.2	Flood Risk
2880 min Summer	0.797	0.797	0.3	74.1	Flood Risk
4320 min Summer	0.793	0.793	0.3	73.2	Flood Risk
5760 min Summer	0.787	0.787	0.3	71.6	Flood Risk
7200 min Summer	0.779	0.779	0.3	69.8	Flood Risk
8640 min Summer	0.771	0.771	0.3	68.0	Flood Risk
10080 min Summer	0.762	0.762	0.2	66.1	Flood Risk
15 min Winter	0.510	0.510	0.1	23.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	117.607	0.0	19
30 min Summer	78.466	0.0	34
60 min Summer	49.857	0.0	64
120 min Summer	30.521	0.0	124
180 min Summer	22.540	0.0	184
240 min Summer	18.079	0.0	244
360 min Summer	13.261	0.0	364
480 min Summer	10.625	0.0	482
600 min Summer	8.940	0.0	602
720 min Summer	7.759	0.0	722
960 min Summer	6.200	0.0	962
1440 min Summer	4.511	0.0	1440
2160 min Summer	3.275	0.0	1968
2880 min Summer	2.606	0.0	2308
4320 min Summer	1.886	0.0	3068
5760 min Summer	1.497	0.0	3912
7200 min Summer	1.252	0.0	4688
8640 min Summer	1.082	0.0	5536
10080 min Summer	0.957	0.0	6360
15 min Winter	117.607	0.0	19

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Micro Drainage	Source Control 2020.1.3	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.572	0.572	0.2	31.5	O K
60 min Winter	0.627	0.627	0.2	39.9	Flood Risk
120 min Winter	0.676	0.676	0.2	48.4	Flood Risk
180 min Winter	0.702	0.702	0.2	53.2	Flood Risk
240 min Winter	0.718	0.718	0.2	56.5	Flood Risk
360 min Winter	0.741	0.741	0.2	61.3	Flood Risk
480 min Winter	0.756	0.756	0.2	64.6	Flood Risk
600 min Winter	0.767	0.767	0.2	67.0	Flood Risk
720 min Winter	0.775	0.775	0.3	68.8	Flood Risk
960 min Winter	0.785	0.785	0.3	71.4	Flood Risk
1440 min Winter	0.796	0.796	0.3	74.0	Flood Risk
2160 min Winter	0.800	0.800	0.3	74.8	Flood Risk
2880 min Winter	0.797	0.797	0.3	74.1	Flood Risk
4320 min Winter	0.791	0.791	0.3	72.7	Flood Risk
5760 min Winter	0.781	0.781	0.3	70.4	Flood Risk
7200 min Winter	0.770	0.770	0.3	67.7	Flood Risk
8640 min Winter	0.758	0.758	0.2	65.1	Flood Risk
10080 min Winter	0.746	0.746	0.2	62.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	78.466	0.0	34
60 min Winter	49.857	0.0	64
120 min Winter	30.521	0.0	122
180 min Winter	22.540	0.0	182
240 min Winter	18.079	0.0	240
360 min Winter	13.261	0.0	358
480 min Winter	10.625	0.0	476
600 min Winter	8.940	0.0	594
720 min Winter	7.759	0.0	708
960 min Winter	6.200	0.0	942
1440 min Winter	4.511	0.0	1396
2160 min Winter	3.275	0.0	2036
2880 min Winter	2.606	0.0	2364
4320 min Winter	1.886	0.0	3244
5760 min Winter	1.497	0.0	4160
7200 min Winter	1.252	0.0	5048
8640 min Winter	1.082	0.0	5960
10080 min Winter	0.957	0.0	6848

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Micro Drainage	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.250
Region	England and Wales	Cv (Winter)	0.250
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.363	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.323

Time From:	(mins) To:	Area (ha)
0	4	0.323

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Model Details

Storage is Online Cover Level (m) 0.900

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00750	Length (m)	90.0
Infiltration Coefficient Side (m/hr)	0.00750	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	90.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Swale East 2

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Micro Drainage	Source Control 2020.1.3	

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

Half Drain Time : 4345 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.817	0.817	0.1	23.0	O K
30 min Summer	0.911	0.911	0.1	30.6	O K
60 min Summer	0.996	0.996	0.1	38.8	O K
120 min Summer	1.072	1.072	0.1	47.2	Flood Risk
180 min Summer	1.112	1.112	0.1	52.0	Flood Risk
240 min Summer	1.138	1.138	0.1	55.3	Flood Risk
360 min Summer	1.174	1.174	0.2	60.3	Flood Risk
480 min Summer	1.199	1.199	0.2	63.8	Flood Risk
600 min Summer	1.217	1.217	0.2	66.4	Flood Risk
720 min Summer	1.232	1.232	0.2	68.5	Flood Risk
960 min Summer	1.252	1.252	0.2	71.7	Flood Risk
1440 min Summer	1.276	1.276	0.2	75.4	Flood Risk
2160 min Summer	1.291	1.291	0.2	77.9	Flood Risk
2880 min Summer	1.294	1.294	0.2	78.4	Flood Risk
4320 min Summer	1.292	1.292	0.2	78.1	Flood Risk
5760 min Summer	1.289	1.289	0.2	77.5	Flood Risk
7200 min Summer	1.283	1.283	0.2	76.6	Flood Risk
8640 min Summer	1.277	1.277	0.2	75.6	Flood Risk
10080 min Summer	1.270	1.270	0.2	74.4	Flood Risk
15 min Winter	0.817	0.817	0.1	23.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	117.607	0.0	19
30 min Summer	78.466	0.0	34
60 min Summer	49.857	0.0	64
120 min Summer	30.521	0.0	124
180 min Summer	22.540	0.0	184
240 min Summer	18.079	0.0	244
360 min Summer	13.261	0.0	364
480 min Summer	10.625	0.0	484
600 min Summer	8.940	0.0	602
720 min Summer	7.759	0.0	722
960 min Summer	6.200	0.0	962
1440 min Summer	4.511	0.0	1442
2160 min Summer	3.275	0.0	2160
2880 min Summer	2.606	0.0	2852
4320 min Summer	1.886	0.0	3460
5760 min Summer	1.497	0.0	4208
7200 min Summer	1.252	0.0	5040
8640 min Summer	1.082	0.0	5872
10080 min Summer	0.957	0.0	6656
15 min Winter	117.607	0.0	19

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Micro Drainage	Source Control 2020.1.3	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.911	0.911	0.1	30.6	O K
60 min Winter	0.996	0.996	0.1	38.8	O K
120 min Winter	1.072	1.072	0.1	47.2	Flood Risk
180 min Winter	1.112	1.112	0.1	52.0	Flood Risk
240 min Winter	1.138	1.138	0.1	55.4	Flood Risk
360 min Winter	1.175	1.175	0.2	60.3	Flood Risk
480 min Winter	1.199	1.199	0.2	63.8	Flood Risk
600 min Winter	1.218	1.218	0.2	66.5	Flood Risk
720 min Winter	1.232	1.232	0.2	68.6	Flood Risk
960 min Winter	1.253	1.253	0.2	71.8	Flood Risk
1440 min Winter	1.277	1.277	0.2	75.6	Flood Risk
2160 min Winter	1.293	1.293	0.2	78.2	Flood Risk
2880 min Winter	1.298	1.298	0.2	79.0	Flood Risk
4320 min Winter	1.293	1.293	0.2	78.2	Flood Risk
5760 min Winter	1.287	1.287	0.2	77.3	Flood Risk
7200 min Winter	1.279	1.279	0.2	75.9	Flood Risk
8640 min Winter	1.269	1.269	0.2	74.3	Flood Risk
10080 min Winter	1.258	1.258	0.2	72.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	78.466	0.0	34
60 min Winter	49.857	0.0	64
120 min Winter	30.521	0.0	122
180 min Winter	22.540	0.0	182
240 min Winter	18.079	0.0	242
360 min Winter	13.261	0.0	360
480 min Winter	10.625	0.0	478
600 min Winter	8.940	0.0	596
720 min Winter	7.759	0.0	714
960 min Winter	6.200	0.0	946
1440 min Winter	4.511	0.0	1412
2160 min Winter	3.275	0.0	2096
2880 min Winter	2.606	0.0	2740
4320 min Winter	1.886	0.0	3548
5760 min Winter	1.497	0.0	4432
7200 min Winter	1.252	0.0	5336
8640 min Winter	1.082	0.0	6232
10080 min Winter	0.957	0.0	7160

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Micro Drainage	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.250
Region	England and Wales	Cv (Winter)	0.250
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.363	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.313

Time (mins) From:	To:	Area (ha)
0	4	0.313

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Model Details

Storage is Online Cover Level (m) 1.300

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00750	Length (m)	98.0
Infiltration Coefficient Side (m/hr)	0.00750	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	26.1
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Swale West 1

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Micro Drainage	Source Control 2020.1.3	

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

Half Drain Time : 4126 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.746	0.746	0.4	104.0	O K
30 min Summer	0.833	0.833	0.5	138.5	O K
60 min Summer	0.911	0.911	0.6	175.5	Flood Risk
120 min Summer	0.981	0.981	0.6	213.7	Flood Risk
180 min Summer	1.017	1.017	0.7	235.4	Flood Risk
240 min Summer	1.041	1.041	0.7	250.4	Flood Risk
360 min Summer	1.074	1.074	0.7	272.6	Flood Risk
480 min Summer	1.097	1.097	0.8	288.3	Flood Risk
600 min Summer	1.114	1.114	0.8	300.2	Flood Risk
720 min Summer	1.126	1.126	0.8	309.6	Flood Risk
960 min Summer	1.145	1.145	0.8	323.4	Flood Risk
1440 min Summer	1.166	1.166	0.9	339.6	Flood Risk
2160 min Summer	1.178	1.178	0.9	349.5	Flood Risk
2880 min Summer	1.180	1.180	0.9	351.0	Flood Risk
4320 min Summer	1.179	1.179	0.9	349.8	Flood Risk
5760 min Summer	1.175	1.175	0.9	346.5	Flood Risk
7200 min Summer	1.169	1.169	0.9	342.1	Flood Risk
8640 min Summer	1.162	1.162	0.9	337.0	Flood Risk
10080 min Summer	1.155	1.155	0.8	331.2	Flood Risk
15 min Winter	0.746	0.746	0.4	104.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	117.607	0.0	19
30 min Summer	78.466	0.0	34
60 min Summer	49.857	0.0	64
120 min Summer	30.521	0.0	124
180 min Summer	22.540	0.0	184
240 min Summer	18.079	0.0	244
360 min Summer	13.261	0.0	364
480 min Summer	10.625	0.0	484
600 min Summer	8.940	0.0	602
720 min Summer	7.759	0.0	722
960 min Summer	6.200	0.0	962
1440 min Summer	4.511	0.0	1442
2160 min Summer	3.275	0.0	2160
2880 min Summer	2.606	0.0	2740
4320 min Summer	1.886	0.0	3416
5760 min Summer	1.497	0.0	4152
7200 min Summer	1.252	0.0	4968
8640 min Summer	1.082	0.0	5792
10080 min Summer	0.957	0.0	6648
15 min Winter	117.607	0.0	19

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Micro Drainage	Source Control 2020.1.3	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.833	0.833	0.5	138.5	O K
60 min Winter	0.911	0.911	0.6	175.5	Flood Risk
120 min Winter	0.981	0.981	0.6	213.7	Flood Risk
180 min Winter	1.017	1.017	0.7	235.5	Flood Risk
240 min Winter	1.041	1.041	0.7	250.5	Flood Risk
360 min Winter	1.075	1.075	0.7	272.7	Flood Risk
480 min Winter	1.097	1.097	0.8	288.5	Flood Risk
600 min Winter	1.114	1.114	0.8	300.4	Flood Risk
720 min Winter	1.127	1.127	0.8	309.8	Flood Risk
960 min Winter	1.145	1.145	0.8	323.8	Flood Risk
1440 min Winter	1.167	1.167	0.9	340.5	Flood Risk
2160 min Winter	1.181	1.181	0.9	351.3	Flood Risk
2880 min Winter	1.184	1.184	0.9	354.0	Flood Risk
4320 min Winter	1.179	1.179	0.9	349.8	Flood Risk
5760 min Winter	1.173	1.173	0.9	345.0	Flood Risk
7200 min Winter	1.164	1.164	0.9	338.0	Flood Risk
8640 min Winter	1.154	1.154	0.8	330.2	Flood Risk
10080 min Winter	1.143	1.143	0.8	321.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	78.466	0.0	34
60 min Winter	49.857	0.0	64
120 min Winter	30.521	0.0	122
180 min Winter	22.540	0.0	182
240 min Winter	18.079	0.0	242
360 min Winter	13.261	0.0	360
480 min Winter	10.625	0.0	478
600 min Winter	8.940	0.0	596
720 min Winter	7.759	0.0	714
960 min Winter	6.200	0.0	944
1440 min Winter	4.511	0.0	1412
2160 min Winter	3.275	0.0	2080
2880 min Winter	2.606	0.0	2736
4320 min Winter	1.886	0.0	3460
5760 min Winter	1.497	0.0	4384
7200 min Winter	1.252	0.0	5328
8640 min Winter	1.082	0.0	6224
10080 min Winter	0.957	0.0	7152

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.250
Region	England and Wales	Cv (Winter)	0.250
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.363	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.418

Time From:	(mins) To:	Area (ha)
0	4	1.418

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Model Details

Storage is Online Cover Level (m) 1.200

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00750	Length (m)	270.0
Infiltration Coefficient Side (m/hr)	0.00750	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	150.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Swale West 2

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

Half Drain Time : 3789 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.693	0.693	0.1	29.3	O K
30 min Summer	0.774	0.774	0.1	39.0	O K
60 min Summer	0.847	0.847	0.2	49.4	Flood Risk
120 min Summer	0.912	0.912	0.2	60.1	Flood Risk
180 min Summer	0.946	0.946	0.2	66.1	Flood Risk
240 min Summer	0.968	0.968	0.2	70.3	Flood Risk
360 min Summer	0.999	0.999	0.2	76.5	Flood Risk
480 min Summer	1.020	1.020	0.2	80.8	Flood Risk
600 min Summer	1.035	1.035	0.2	84.1	Flood Risk
720 min Summer	1.047	1.047	0.2	86.7	Flood Risk
960 min Summer	1.064	1.064	0.3	90.4	Flood Risk
1440 min Summer	1.082	1.082	0.3	94.6	Flood Risk
2160 min Summer	1.092	1.092	0.3	96.9	Flood Risk
2880 min Summer	1.092	1.092	0.3	97.1	Flood Risk
4320 min Summer	1.090	1.090	0.3	96.6	Flood Risk
5760 min Summer	1.086	1.086	0.3	95.5	Flood Risk
7200 min Summer	1.079	1.079	0.3	94.1	Flood Risk
8640 min Summer	1.072	1.072	0.3	92.4	Flood Risk
10080 min Summer	1.065	1.065	0.3	90.6	Flood Risk
15 min Winter	0.693	0.693	0.1	29.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	117.607	0.0	19
30 min Summer	78.466	0.0	34
60 min Summer	49.857	0.0	64
120 min Summer	30.521	0.0	124
180 min Summer	22.540	0.0	184
240 min Summer	18.079	0.0	244
360 min Summer	13.261	0.0	364
480 min Summer	10.625	0.0	484
600 min Summer	8.940	0.0	602
720 min Summer	7.759	0.0	722
960 min Summer	6.200	0.0	962
1440 min Summer	4.511	0.0	1442
2160 min Summer	3.275	0.0	2160
2880 min Summer	2.606	0.0	2624
4320 min Summer	1.886	0.0	3328
5760 min Summer	1.497	0.0	4088
7200 min Summer	1.252	0.0	4904
8640 min Summer	1.082	0.0	5712
10080 min Summer	0.957	0.0	6552
15 min Winter	117.607	0.0	19

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.774	0.774	0.1	39.0	O K
60 min Winter	0.847	0.847	0.2	49.4	Flood Risk
120 min Winter	0.912	0.912	0.2	60.1	Flood Risk
180 min Winter	0.946	0.946	0.2	66.2	Flood Risk
240 min Winter	0.968	0.968	0.2	70.3	Flood Risk
360 min Winter	0.999	0.999	0.2	76.5	Flood Risk
480 min Winter	1.020	1.020	0.2	80.9	Flood Risk
600 min Winter	1.036	1.036	0.2	84.2	Flood Risk
720 min Winter	1.047	1.047	0.2	86.7	Flood Risk
960 min Winter	1.064	1.064	0.3	90.5	Flood Risk
1440 min Winter	1.083	1.083	0.3	94.9	Flood Risk
2160 min Winter	1.094	1.094	0.3	97.5	Flood Risk
2880 min Winter	1.096	1.096	0.3	97.9	Flood Risk
4320 min Winter	1.090	1.090	0.3	96.5	Flood Risk
5760 min Winter	1.083	1.083	0.3	94.9	Flood Risk
7200 min Winter	1.073	1.073	0.3	92.6	Flood Risk
8640 min Winter	1.063	1.063	0.3	90.2	Flood Risk
10080 min Winter	1.051	1.051	0.2	87.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	78.466	0.0	34
60 min Winter	49.857	0.0	64
120 min Winter	30.521	0.0	122
180 min Winter	22.540	0.0	182
240 min Winter	18.079	0.0	242
360 min Winter	13.261	0.0	360
480 min Winter	10.625	0.0	478
600 min Winter	8.940	0.0	596
720 min Winter	7.759	0.0	714
960 min Winter	6.200	0.0	944
1440 min Winter	4.511	0.0	1402
2160 min Winter	3.275	0.0	2076
2880 min Winter	2.606	0.0	2712
4320 min Winter	1.886	0.0	3412
5760 min Winter	1.497	0.0	4328
7200 min Winter	1.252	0.0	5256
8640 min Winter	1.082	0.0	6144
10080 min Winter	0.957	0.0	7056

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Micro Drainage	Source Control 2020.1.3	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.250
Region	England and Wales	Cv (Winter)	0.250
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.363	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.399

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.399

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Micro Drainage	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 1.100

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00750	Length (m)	115.0
Infiltration Coefficient Side (m/hr)	0.00750	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	51.1
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

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