ABLEY LETCHFORD PARTNERSHIP
Consulting Engineers

LAND AT UPTHORPE ROAD, CAM

FLOOD RISK, DRAINAGE AND ENGINEERING REPORT

TERRA STRATEGIC

07 JULY 2021

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Executive Summary

A site walkover was conducted in order to establish the location of existing drainage apparatus within and surrounding the development.

The site drains predominantly by overland flow with no discernible onsite drainage features, although beyond the site boundaries lies the River Cam, which flows to the Gloucester and Sharpness Canal, a tributary to the River Severn.

The detailed flood map, for fluvial sources, provided by the Environment Agency show that the site development area is located wholly within Flood Zone 1. The Flood Zones 2 and 3 associated with the River Cam, which are within the sites boundaries, are in an area of heavy vegetation and not subject to development or change. There are no secondary flooding sources identified within the site.

In accordance with PPG ID: 7, the proposed development is classified as 'more vulnerable'. All development types are generally deemed acceptable in terms of flood risk in Flood Zone 1.

Based on the above, the site passes the Sequential Test with respect to NPPF and the Exception Test is not applicable.

The surface water management strategy for the proposed development will manage and reduce the flood risk posed by the surface water runoff from the site.

The impermeable area of the proposed development has been calculated, including an allowance for Urban Creep with all drainage controlled on site and discharged at existing greenfield run off rates into the River Cam.

The attenuation requirements for the site could be met by attenuation basins situated in the lower portions of the development. However, to comply with current best practice, further SuDS techniques, such as swales and permeable paving, can be introduced over the wider site, known as Micro SuDS.

Through the provision of a positive drainage network attributed to the Development, pluvial flooding to offsite receptors will be significantly reduced.

Exceedance flows can be safely accommodated within the Development.

Foul water drainage can be discharged into the local Severn Trent foul sewer network located in the west of the development.

Overall, the site should not be precluded on flood risk grounds as the Development will not be at risk from existing sources and will not result in an increase in flooding downstream.

The existing site does not preclude the use of standard construction techniques and foundations. There are minimal trees and the ground conditions do not indicate shrinkable clays. However, a full geotechnical site investigation will be sought at the appropriate time.

A balanced cut and fill reducing the need to export or import materials thus reducing construction traffic on the surrounding roads should be achieved and the masterplan will take into account the sites topography by limiting access roads traversing perpendicular to the site contours

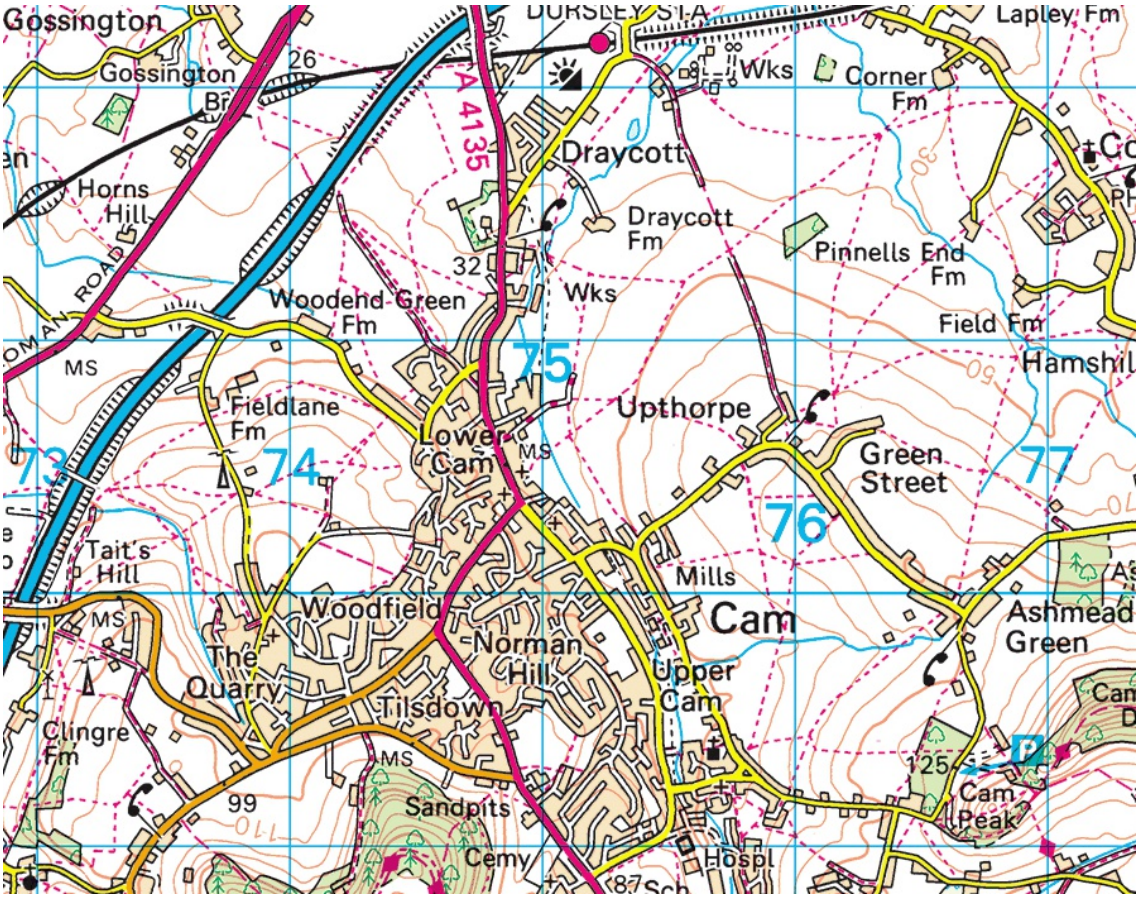
Accessibility for all is critical on new developments and current guidelines will be followed to ensure there are suitable accessible access throughout the development by foot and sustainable travel modes.

1.0 Introduction

Site Context

1.1. This report has been prepared by Abley Letchford Partnership Ltd, on behalf of Terra Strategic, in relation to a proposed residential development on land located at Upthorpe Road, Cam. The location of the site in its local geographical context is shown below.

Site Location Plan



Development Proposals

1.2. At this stage an initial concept masterplan for the site has been progressed and it is anticipated the site could accommodate residential development alongside other uses such as open space, play, etc.

Report Structure

1.3. This report addresses the requirements of NPPF and considers the following aspects:

- Section 2: Policy and Sources of Information – a review of policy relevant to the assessment and sources of information.

- Section 3: Baseline Environmental Conditions – a description of the site location, its topography, geology and hydrology.
- Section 4: Flood Risk – the effect of flooding within the existing site layout from all sources.
- Section 5: Drainage Strategy – offer appropriate mitigation measures to protect the site in the post development scenarios for surface and foul water drainage strategies.
- Section 6: Engineering – an appraisal of the sites topography and potential engineering constraints and opportunities.

2.0 Policy and Sources of Information

Introduction

2.1. This chapter provides a review of policy relevant to the assessment and sources of information

National Planning Policy

2.2. National Planning Policy in relation to Flood Risk is set out in Section 14 of the National Planning Policy Framework (NPPF) and Planning Practice Guidance ID:7 for Flood Risk and Coastal Change (PPG). Flood Risk is discussed in Paragraphs 155-165 of the NPPF.

2.3. Paragraphs 157-162 discuss the Sequential approach. Paragraph 158 refers to a Strategic Flood Risk Assessment (SFRA) that would form the basis of applying the Sequential Test for local authorities to allocate development, whilst Paragraphs 159-162 relates to the Exemption Tests.

2.4. Paragraph 163 discusses the determination of planning applications stating:

When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood risk assessment. Development should only be allowed in areas at risk of flooding where, in light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b) the development is appropriately flood resilient and resilient;

c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) any residual risk can be safely managed; and

e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

2.5. The development would be classed as Major Development providing more than 10 homes and the site is greater than 0.5 hectares. Paragraph 165 states:

Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

a) Take account of advice from the lead local flood authority (LLFA);

b) Have appropriate proposed minimum operational standards;

c) *Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*

d) *Where possible, provide multifunctional benefits.*

The Sequential Test, Exception Test and Sequential Approach

2.6. The sequential test is an approach used to enable new developments to be designed in areas at lower risk of flooding in preference to sites at higher risk. All opportunities to direct development to reasonably available areas with little or no flood risk should be explored prior to deciding to build in higher flood risk areas. For strategic sites, this is applied by the Local Planning Authority by means of a Strategic Flood Risk Assessment (SFRA).

2.7. Dependent upon the type of development under consideration, there may be a subsequent requirement to carry out the Exception Test as depicted within Figure 1 below. The Exception Test ensures that any new developments implemented within areas of flood risk will only occur where flood risk is clearly outweighed by other sustainability drivers and it will ensure that the development can be made safe from flooding and not increase the flood risk elsewhere. The test considers the vulnerability of the new development to flood risk and in order to 'pass', must demonstrate that:

- The development provides wider sustainability benefits to the community that outweigh the flood risk;
- The development is sited on previously developed land, or if this is not the case, there are no other reasonable alternative sites; and
- The development is safe, does not increase flood risk elsewhere and where possible will reduce flood risk overall.

Figure 1 – Flood Risk Vulnerability Classification Table 3 PPG ID 7

Flood Risk Vulnerability classification (see Table 1 PPG ID: 7)	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1 Low Probability	Yes	Yes	Yes	Yes	Yes
Zone 2 Medium Probability	Yes	Exception test required	Yes	Yes	Yes
Zone 3a High Probability	Exception test required	No	Exception test required	Yes	Yes
Zone 3b Functional Floodplain	Exception test required	No	No	No	Yes

Key: Yes: Development is appropriate, No: Development should not be permitted.

Climate Change

2.8. National Planning Policy (NPPF and PPG) make it a requirement to account for climate change within any proposed development proposal. Research has shown that expected climate change will increase the peak rainfall intensity and river flow, which could result in more frequent and severe flood events.

2.9. PPG ID:7 for Flood Risk and Coastal Change Table 2 sets out anticipated changes in peak rainfall intensity in small catchments (less than 5km^2), or urbanised drainage catchment (as found within towns and cities. This is depicted below as Figure 2.

Figure 2 – Peak rainfall intensity allowance in small catchments or urban drainage

(Table 2 PPG ID 7)

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

2.10. Underlying text supporting Table 2 states that Upper End climate change allowances should be used within the drainage design of all development types.

Environment Agency / GOV.UK

2.11. The Flood and Water Management Act 2010 provides the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is a statutory consultee with regards to flood risk and planning dependent upon criteria.

2.12. Environment Agency Standing Advice has been consulted and reviewed within this assessment.

2.13. The GOV.UK Flood Map for Planning, Long Term Flood Risk and Catchment Data Explorer websites have been interrogated in respect to flood risk extents and sources.

Local Authorities

2.14. The Site lies within the administrative area of Gloucestershire County Council and Stroud District Council.

2.15. Gloucestershire County Council (GCC) became a Lead Local Flood Authority (LLFA) under the Flood and Water Management Act 2010 and provide guidance to assess, manage and inform flood risk.

2.16. Planning guidance published by GCC regarding flood risk was consulted to assess the mitigation policies in place. This includes the Level 1 and 2 Strategic Flood Risk Assessments (SFRA) which, alongside GCC's Local Flood Risk Management Strategy (LFRMS), and their standing advice documents and guidance, sets out the drainage strategies and surface water management provisions by which applications for development will be assessed. Furthermore, the documents provide links to wider special strategy and flood risk documents, and these have been consulted in preparation of this assessment.

2.17. The Stroud Development Plan for Stroud District consists of a series of documents which are used to determine planning applications setting out the spatial vision, objectives and sustainable strategy for delivering the needed growth of the District.

Severn Trent

2.18. Severn Trent is responsible for the disposal of waste water within the local area, and for the supply of clean water.

2.19. Information with regards to sewer and water main flooding contained within the SFRA has been consulted as part of this assessment. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

Other Sources of Information

2.20. A desktop study of the Site was carried out using the following websites to ascertain local features, hydrology and soil characteristics:

- DEFRA's MAGIC portal,
- British Geological Survey (BGS) and
- Cranfield University Soilscapes portal.

2.21. A Site walkover conducted in 2021 allowed observation of existing topography, watercourses, and infrastructure.

2.22. Guidance with respect to Sustainable Drainage Systems (SuDS) is contained within DEFRA document Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems March 2015, as well as CIRIA C753 The SuDS Manual, BS8582:2013 – Code of Practice for Surface Water Management for Development Sites and Approved Document H of the Building Regulations.

2.23. Additional guidance on development and flood risk is contained within CIRIA C624 Development and Flood Risk – Guidance for the Construction Industry which identifies several key aims for a development to ensure it is sustainable in flood risk terms.

3.0 Baseline Environmental Conditions

Introduction

3.1. This chapter provides for a description of the site location, its topography, geology and hydrology.

Site Location

3.2. The site lies to the east of Lower Cam on land to the north west of Upthorpe Road. The site is square in shape and bound along its western side by dense vegetation and the River Cam. Open fields lie to the north west and north east.

3.3. Adjacent to the far River Cam to the west of the site lies Rackleaze nature reserve, an area created to enhance and preserve ecological and biodiversity improvements to the area.

3.4. The site lies within the administrative area of Stroud District Council.

Existing Site

3.5. Overall the site is predominantly open fields for farming uses split into smaller field parcels by hedgerows, some being prominent. A Public Right of Way (PROW) runs on its north western edge connecting the site to the town centre.

3.6. The topography of the site is predominantly north east to south west with the lowest point being close to the River Cam in the south west. Levels range from approximately 72m AOD in the far north east to approximately 35m AOD at its lowest point at an average gradient of approximately 1 in 15 although the gradient varies slightly across the site.

Existing Drainage

3.7. The site currently drains by overland flow with some infiltration and evapotranspiration, with osmosis through the trees.

3.8. There are no surface water sewers, ditches or watercourses within the site itself save for a few informal low points and depressions. There is a visible low point of the site, which potentially takes any overland flow to the River Cam. However, as the whole site flows towards the River Cam it is likely there are no formal connections and the site drains as a whole, by overland flow, in the most convenient route.

3.9. There is a Severn Trent 525mm foul water sewer located along the sites south western boundary adjacent to the existing tree line flowing north west, which crosses the River Cam near to the sites informal low point before carrying on to the wider infrastructure to the north. There are further foul water sewers within Upthorpe Road to the south east of the site.

Geology and Hydrogeology

3.10. British Geological Survey mapping indicates the site is underlain by the bedrock geology of Blue Lias Formation And Charmouth Mudstone Formation.

3.11. The Cranfield University Soilscapes maps indicates the soil to be loamy and clayey soils.

3.12. Infiltration testing has not been carried out to date. Due to the underlying Bedrock, it is expected infiltration techniques may not be viable. However, given the lack of surface water sewers in the area and the lack of formal ditches and water courses some infiltration may be feasible. This should be confirmed at a later date by onsite infiltration testing to BRE365.

3.13. Aquifer designations reflect the importance of aquifers in terms of groundwater as a resource and in their role in supporting surface water flows and wetland ecosystems.

3.14. Aquifer maps are split into two different types of aquifer designations namely; Superficial (Drift), which are permeable unconsolidated deposits e.g. sands, gravels, etc, and Bedrock, which are solid permeable formations e.g. Sandstone, chalk, etc.

3.15. Environment Agency (EA) mapping indicates the site lies within Secondary aquifer designation for Bedrock and Unproductive for Superficial Drift.

3.16. Mapping confirms that the site does not lies within a Groundwater Source Protection Zone (SPZ).

Hydrology

3.17. The site lies in the catchment of the River Cam, located just to the west of the site, which flows to the Gloucester and Sharpness Canal, a tributary to the River Severn.

4.0 Flood Risk

Introduction

4.1. This chapter assesses flood risk at the site from all sources including appropriate allowance for climate change required by relevant National and Local planning policy.

Flood Risk to the Site from Tidal Sources

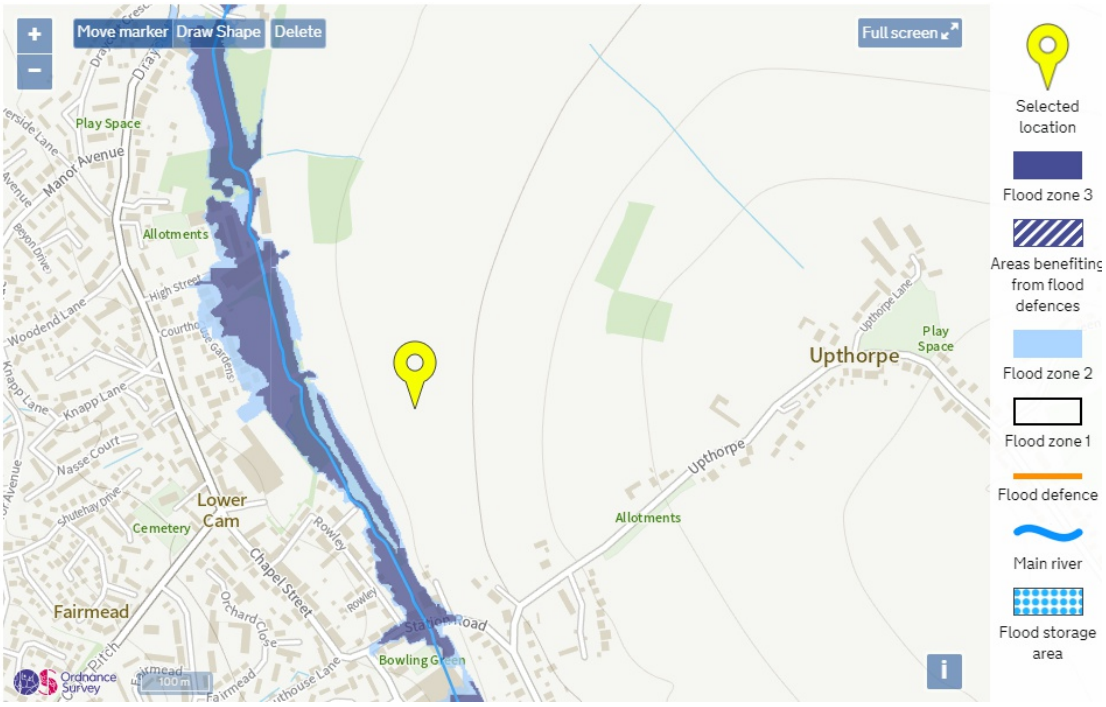
4.2. The site is at a low risk from tidal flooding due to its inland elevated location.

Flood Risk to the Site from Fluvial Flooding Sources

4.3. A review of the EA's Flood Map for Planning maps show the site, subject to any development, to be located entirely within Flood Zone 1. This zone comprises land where flooding from rivers and the sea (fluvial) is very unlikely. There is less than a 0.1% (1 in 1000) chance of flooding occurring each year. The site is at a low risk of flooding from fluvial sources.

4.4. The Flood Zones 2 and 3 associated with the River Cam, which are within the sites boundaries, are in an area of heavy vegetation and not subject to development or change.

Environment Agency's Flood Zone Map



Flood Risk to the Site from Pluvial Flooding Sources

4.5. The SFRA, EA and GOV.uk websites and local available documents indicate there is no history of flooding at the site from heavy rainfall events or overland flood routes. However, the EA flood maps indicate a low to medium risk of surface water flooding on the site.

4.6. This is wholly due to rainfall falling on the site and flowing downhill before being discharged into the River Cam.

4.7. The proposed development will provide positive improvements to overland flow with surface water being intercepted, stored in attenuation areas and discharged at controlled rates or into the ground.

4.8. The remaining Greenfield areas will be managed with grass and vegetation providing a surface treatment more conducive to reductions in overland flow.

4.9. Not only will these measures assist in management of surface water on site, but also contribute to a reduction in flood risk downstream, as the discharge rate off site is controlled, restricted and attenuated on site. However, cognisance will be taken to ensure downstream receptors are suitably recharged.

4.10. Therefore, overall, the site is at a very low risk of flooding from pluvial sources.

Environment Agency's Surface Water Map

Extent of flooding from surface water

High Medium Low Very low Location you selected

Flood Risk to the Site from Groundwater

4.11. Groundwater flooding has the potential to occur after prolonged periods of unusually high rainfall. During such periods, more water than usual infiltrates through the ground, raising the water table above its normal depth below the surface. Where the water table is at shallow depth in any case, the water table can reach the surface. This can cause ground water to merge with rainfall and cause localised flooding.

4.12. Groundwater flooding tends to occur sporadically in both location and time. Surface groundwater flooding has not been a risk on the site and there is no reason to believe it would present a problem and the test confirm this.

Flood Risk to the Site from Other Sources

4.13. The SFRA, EA and GOV.uk websites and local available documents indicate there is no existing flood risk from: reservoirs, sewers, canals or other artificial sources.

4.14. The site is deemed of low risk of flooding from these sources.

The Sequential Test

4.15. In the context of PPG Flood Risk and Coastal Change ID: 7 (Table 2) the proposed development has been identified as 'residential' development and therefore is classified as 'More Vulnerable'.

4.16. The proposed development is situated wholly within Flood Zone 1.

4.17. By applying the Flood Risk Vulnerability compatibility matrix under PPG Flood Risk Coastal Change ID:7 (Table 3), all development types are deemed to be accepted in Flood Zone 1 as depicted.

Flood Risk Vulnerability Classification Table 3 PPG ID 7

Flood Risk Vulnerability classification (see Table 1 PPG ID: 7)	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	Yes	Yes	Yes	Yes	Yes
Zone 2	Yes	Yes	Exception test required	Yes	Yes
Zone 3a	Exception test required	Yes	No	Exception test required	Yes
Zone 3b 'Functional Floodplain'	Exception test required	Yes	No	No	No

Key: Yes: Development is appropriate, No: Development should not be permitted.

4.18. It is therefore considered that, within the context of Flood Risk, the Site passes the Sequential Test with respect to NPPF and is suitable for the type of development proposed.

Flood Risk Summary

4.19. An overall summary of the risk of flooding from all sources is provided below.

Flood Risk Summary

Source of Flooding	High	Medium	Low	Comments
Tidal			✓	The Site is elevated and inland.
Fluvial			✓	The Site is located wholly within Flood Zone 1.
Pluvial			✓	There is minor pluvial flood risk associated with the slopes of the site. The proposed development and mitigation will reduce any perceived flood risk.
Groundwater			✓	EA/GOV.UK mapping and onsite groundwater monitoring does not indicate the Site to be at risk.
Sewers			✓	The Site has no exposure to existing sewer assets, except the aforementioned foul water rising main, with no evidence of flooding.
Reservoirs, canals and other artificial sources			✓	EA/GOV.UK mapping does not indicate the Site to be at risk.

4.20. Based upon the above information, the Site is deemed to be at **LOW RISK OF FLOODING**. The Proposed Site is therefore in full accordance with National and Local planning policy concerning Flood Risk and as such is suitable for residential development.

5.0 Surface Water Strategy

Introduction

5.1. This chapter provides details on an indicative surface water drainage strategy and measures to drain the Development.

Overall Strategy

5.2. The proposed drainage strategy will be designed to exceed the requirements of the NPPF by providing a comprehensive drainage system which embraces the Sustainable Drainage Systems (SuDS) philosophy and key principles. The utilisation of SuDS not only provides the benefit of controlling waters at source and online treatment of collected surface water but also allows enhanced aesthetics through improved landscaping, biodiversity, and ecological opportunities.

5.3. These features offer a holistic treatment train and management system to the benefit of new residents, members of the wider community, downstream receptors and the environment.

5.4. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. Changes to land uses can have significant downstream impacts where existing drainage systems may not have sufficient capacity for any additional surface water flow.

5.5. A surface water management strategy is therefore required to manage and reduce the flood risk posed by the surface water runoff from the site. The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates to the pre-development scenario, unless specific off-site arrangements are made and result in the same net effect.

5.6. Sustainable water management measures (SuDS) should be introduced to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from the surface water runoff.

5.7. The Construction Industry Research and Information Association, CIRIA's C690 states the following:

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing surfaces)
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting)
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one or several soakaways for the entire site)
- **Regional Control** – management of runoff from several sites, typically in a detention basin or wetland.

5.8. The SuDS Manual 2015 (C753) provides best practice guidance on the planning, design, construction, operation and maintenance of SuDS. This document provides guidance to ensure that SuDS are planned and designed to maximise the opportunities and benefits of surface water management.

5.9. The four main categories of benefits that can be achieved by SuDS, referred to as the four pillars of SuDS design, are:

- **Water quantity** – control the quantity of runoff to support the management of flood risk, and maintain and protect the natural water cycle;
- **Water quality** – manage the quality of the runoff to prevent pollution
- **Amenity** – create and sustain better places for people
- **Biodiversity** – create and sustain better places for nature.

5.10. Supplemental to CIRIA guidance, Document H of the Building Regulations 2015 sets out three possible options to discharge surface water runoff. Rainwater shall discharge to one of the following, listed in order of priority:

- An adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,
- A watercourse; or where that is not reasonably practicable
- A sewer.

5.11. As infiltration may not be a viable method of disposal, the surface water drainage proposals will be designed to attenuate runoff with discharge into the River Cam.

5.12. Implementation of SuDS will ensure that flood risk downstream is not increased due to the proposed development. These features will also provide positive improvements to the quality of surface water runoff.

5.13. The following SuDS components are deemed applicable to the Site:

- Pervious surfacing systems – structural surfaces that allow water to penetrate into a granular layer thus providing storage and treatment, e.g. pervious paving.
- Conveyance systems – components that convey flows to downstream storage systems, e.g. swales and filter drains.
- Storage systems – components that control flow, and possibly volumes, by storing water and releasing it slowly, e.g. geocellular units, attenuation basins and wetlands.
- Treatment systems – components that remove or facilitate the degradation of contaminants present in runoff, e.g. filter strips and proprietary treatment systems.

Pre and Post Development Rates / Areas

5.14. To quantify any potential increase in surface water runoff, the existing Greenfield/Pre-Development runoff rate from the Site must be determined. The rates of runoff have been determined using the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS. The recommended methodology for sites up to 50 hectares in area is the ICP SuDS method.

5.15. An assessment of existing surface water runoff has been undertaken, to determine the potential surface water options and attenuation requirements for the site.

5.16. Greenfield run off calculations for the existing site provided in the appendix show the following discharge rates.

Pre-Development Runoff Rates/Volumes

Annual Probability	Greenfield/Pre-Development Runoff Rate per Hectare (l/s/ha)
1 in 1 year event	2.64
QBar	3.18
1 in 30 year event	6.36
1 in 100 year event	9.67

5.17. The existing site is predominantly Greenfield. Therefore, any development will increase the impermeable area and surface water run off.

5.18. Urban Creep is the conversion of permeable surfaces to impermeable over time through individual dwellings adding items such as extra parking spaces, extensions, conservatories, etc. In accordance with The SuDS Manual (CIRIA 753) this can be up to 10% dependent on density applied to impermeable area within the property curtilage only. As a general rule by applying 5% to the total site impermeable area is far greater than just applying 10% to individual properties. Therefore, the inclusion of an additional 5% to the overall impermeable area in all calculations provides for all future Urban Creep. As the design develops this will be turned into a more accurate figure by applying Urban Creep to individual properties but, as this will be far less than the overall 5% provided, a robust assessment of rates and areas is provided at this time.

5.19. In order to comply with best practice as stipulated in EA Report SC030219 'Rainfall Runoff Management for Developments', proposed discharge rates should be restricted to one of two methods for all storms up to and including the 1 in a 100 year storm event plus a 40% upper end allowance for climate change.

5.20. This is either the Variable Greenfield discharge rates, with Long Term Storage method or restricting all rates to the estimated mean greenfield runoff rate (QBar).

5.21. However, in the first instance, all discharge rates will be controlled to QBar as we know this provides the most robust analysis.

Surface Water Proposals

5.22. A surface water management strategy for the proposed development has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. The drainage system for the proposed development will manage and reduce the flood risk posed by the surface water runoff from the site.

5.23. It is proposed to provide a network of trapped gullies, pipes and Sustainable Drainage (SuDS) features to collect the surface water runoff from impermeable areas such as roads, roofs and driveways. The traditional system will work in combination with such features as permeable paving and attenuation features in tandem with underground storage to provide attenuation storage and high-quality water benefits.

5.24. The banks of SuDS basins will be designed in accordance with the SuDS Manual C753 in respect to having a maximum gradient of 1 in 4 and an appropriate freeboard above the maximum water level. This allows landscaping of both wetland and wildflower mixes to provide an appropriate landscape context in the vicinity of the features through the provision of an aquatic shelf.

5.25. The main SuDs for the site could be contained within a green corridor adjacent to the existing Rackleaze Nature Reserve, providing opportunity to enhance the ecological and biodiversity opportunities within the area.

5.26. The development parcels could utilise further Source Control techniques (such as permeable paving, swales and granular strips) to assist with the reduction of larger attenuation storage features, should space allow as the design develops. This is encouraged to promote Micro SuDS, which is numerous SuDS within parcels and throughout the development as opposed to one large feature at the bottom.

5.27. Open SuDS features will be designed so as not to compromise the safety of residents, visitors and their property. Generally open boundaries will be provided, and perimeter planting could be utilised to define the extents of the features.

5.28. All conveyance systems will be designed to cater for the 1 in 30 year storm event, in accordance with industry standard, with all attenuation and SuDS features designed to allow for the 1 in 100 year storm event plus 40% climate change allowance.

5.29. The proposals draw reference to the DEFRA document Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems March 2015, as well as CIRIA C753 The SuDS Manual.

5.30. This proposal identifies the principal components of the surface water strategy and is subject to further detailed localised investigations as part of any subsequent planning applications. These assumptions are subject to evolution as the design develops.

5.31. Calculations for the proposed attenuation volume provided in the appendix show the following results:

Zone	Site Area (ha)	Development Area (ha)	Impermeable Area 60% (ha)	Discharge Rate (l/s) (QBar)	Attenuation Volume (m^3)
1	14.71	5.02	3.014	16.0	3,000

Exceedance Flood Routing

5.32. Flows in excess of the above design storms, which may flood from the network, will be kept within the internal road network, until such time as they can be directed into adjacent landscaping areas. This ensures that onsite or offsite residential units are afforded an increased level of protection from flood waters until such time as the rain events become significant.

Foul Water Drainage Strategy

5.33. The topography of the site and location of the proposed foul sewer point of connection, results in wastewater from the site draining wholly by gravity to the receiving public sewer.

5.34. The nearest current point of connection is likely to be into the existing foul water sewer to the west of the site.

5.35. Discussions will commence with Severn Trent regarding the extent of additional off-site sewers or improvements to existing sewers that will be required to provide sufficient capacity to service the development.

5.36. Notwithstanding this, the delivery of the proposed on-site foul water sewers will be designed in collaboration with Severn Trent as approving body in accordance with the new Sewerage Sector Guidance (SSG) and will be offered to Severn Trent for adoption under S104 Agreement of the Water Industry Act. The connection to the existing public sewer system will be made via a S106 Agreement of the Water Industry Act with Severn Trent as part of the overall adoption process.

Adoption and Ownership

5.37. The drainage system is designed to the appropriate standards including the new Sewerage Sector Guidance (SSG), the Building Regulations and the requirement of the National Planning Policy Framework

5.38. The intention of adoption and ownership of drainage and SuDS is as follows:

- Surface and Foul water sewers within development parcels to be offered for adoption to Severn Trent under the Section 104 process of the Water Industry Act.
- Surface water highway drains, gullies and leads within adopted roads to be maintained by the Highway Authority.
- Above ground attenuation (i.e. swales and basins) within development parcels to be offered for adoption to either the Local Authority or ownership under a management company.
- SuDS features serving single properties, for example, permeable paved driveways to single dwellings, will be owned and maintained by the owner of that property.

5.39. Suitable adoption and maintenance regimes for SuDS should be submitted in support of any planning application.

6.0 Engineering

Introduction

6.1. This chapter provides an appraisal of the sites topography and potential engineering constraints and opportunities.

Engineering Strategy

6.2. The site is quite steep overall. However, development is confined to the lower parts of the site that are less steep than the upper reaches.

6.3. The site topography and online information does not preclude the use of standard construction techniques and foundations. There are minimal trees and the ground conditions do not indicate shrinkable clays. However, a full geotechnical site investigation will be sought at the appropriate time.

6.4. In the first instance roads will be set approximately 300mm above existing ground levels with dwellings set 450mm above existing ground levels. This normally results in a balanced cut and fill reducing the need to export or import materials thus reducing construction traffic on the surrounding roads.

6.5. The masterplan will take into account the sites topography by limiting access roads traversing perpendicular to the site contours and, where this is not possible, ensure suitable parallel roads to catch back levels. This will assist in the balanced cut and fill aims.

6.6. The site could be platformed into various building segments to reduce retaining walls, or alternatively numerous smaller retaining walls could be used to remove large level differences.

6.7. The housing strategy and layout should minimise long terraces and linked housing units where perpendicular to the contours, with care taken to garage, parking and rear garden access points.

6.8. Accessibility for all is critical on new developments and current guidelines will be followed to ensure there are suitable accessible access throughout the development by foot and sustainable travel modes.

Appendices

Appendix 1 – Drawings

Preliminary Drainage Strategy

Appendix 2 – Calculations

QBar Calculation

Attenuation Volume Calculations