Land off Harp Hill

Battledown

Cheltenham

Robert Hitchins
The Complete Development Solution

Flood Risk Assessment

&

Drainage Strategy

March 2020

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Document Control:

Project Number:	476
Project:	Land off Harp Hill, Battledown, Cheltenham
Client:	Robert Hitchins Limited
Document Title:	Flood Risk Assessment & Drainage Strategy
Author:	Mark Headford
Revision:	A
Status:	For Planning
Control date:	03/03/2020

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
-	For Planning	M Headford	09/01/20	P Amies	09/01/20	P Amies	09/01/20
A	For Planning	M Headford	03/03/20	P Amies	03/03/20	P Amies	03/03/20

Contents

Appendices

1. EXECUTIVE SUMMARY

1.1. The Environment Agency online mapping reproduced in section 6.3.1 identifies the site as being entirely within Flood Zone 1 (low risk, less that 1:1,000 annual probability of flooding).

1.2. The Gloucestershire County Council Online Flood Map reproduced in section 6.3.2 shows that the proposed application site is located entirely within Flood Zone 1.

1.3. The Cheltenham Borough Council (CBC) Strategic Flood Risk Assessment Level 1 has assessed the risk of flooding from Fluvial (rivers), Tidal (sea), groundwater, surface water, sewers and impounded water bodies (reservoirs and canals). The extent of flooding has been reproduced on flood maps for the CBC SFRA study area. A review of the SFRA maps and report for the proposed development site area has been carried out and commensurate that shown on EA flood mapping, identifying that the proposed development site area is located entirely within Flood Zone 1. Refer to SFRA flood maps reproduced within section 6.3.3 and included within Appendix C.

1.4. Flood risk from all sources (sea, fluvial, pluvial, sewers, groundwater, and artificial) has been assessed and it has been demonstrated that the proposed development will not be at risk from flooding from these sources.

1.5. This site specific FRA has been produced in accordance with the requirements of the NPPF, Planning Practice Guidance, and EA advice notes, and demonstrates that the proposed development will be safe from flood risk and that it will not increase flood risk elsewhere.

1.6. A surface water drainage strategy has been developed that incorporates a Sustainable Drainage System (SuDS) and is shown on drawing No. 476-003 – Drainage Strategy contained within Appendix E. The proposed SuDS will ensure that flood risk resulting from pluvial events (rainfall) will be managed on-site and that flood risk will not be increased elsewhere as a result of the development.

1.7. To mitigate for the additional volume of surface water run-off resulting from the development the peak run-off rate will be restricted to the mean annual flood flow, Qbar (1 in 2.3 year event), for all events above the 1 year.

1.8. A 40% allowance in accordance with EA guidance for climate change has been included in the SuDS assessment to take in to account the predicted increase in rainfall intensity over the lifetime of the development.

1.9. Micro-drainage has been used for the preliminary design of the proposed attenuation pond and ditch system. The results of the modelling are contained within Appendix F and summarised in Table 1, section 7.3. The attenuation volumes and discharge rates shown will be subject to detailed design and will be submitted for approval at the RMA stage to discharge conditions attached to the outline consent.

1.10. Surface water flows will discharge from the attenuation pond to the existing 375mm diameter surface water drain running down the access track currently serving the former Oakley Farm, which replicates the existing natural drainage pattern for the site as the land drainage ditches collecting the natural greenfield run-off outfall into this existing surface water drain.

1.11. The proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual'.

1.12. Flood routes have been provided for exceedance events or for local failure of the drainage system and will ensure that flood flows are directed safely through the development to the downstream attenuation features or into existing watercourses.

The existing onsite and offsite overland flow routes are shown on drawing No.476-001 "Existing Hydrology" contained within Appendix B.

Drawing No. 476-003 "Drainage Strategy" contained within Appendix E shows indicative Strategic flood routes for the proposed development and how any flood water will be directed towards proposed SuDS features.

Please note, the surface water drainage system has been designed to cater for the 1 in 100 year plus 40% climate change without flooding occurring.

1.13. The proposed Sustainable Drainage System for the development will be managed and maintained to ensure that it will operate effectively for its lifetime and has been discussed in detail within section 8 of this report.

1.14. The foul drainage strategy is shown on drawing No. 476-003 "Drainage Strategy" contained within Appendix E. The foul drainage from the site has been designed to connect by gravity to the existing public foul sewer located in Pillowell Close owned and maintained by Severn Trent Water. However, there is an alternative connection point to the existing public sewer located within Priors Road to the west, if required. Details of this connection will need to be agreed with Severn Trent Water.

Any necessary network upgrades will be provided by the water authority, Severn Trent Water via the new infrastructure charging regime.

All private foul drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the foul sewers to Severn Trent Water for adoption under a Section 104 Agreement in accordance with The Water Industries Act 1991. All details will be subject to technical approval at the detailed design stage as part of the S104 process.

1.15. The Flood Risk Assessment and Drainage Strategy demonstrates that the proposed development meets with all the national and regional policy requirements, that being, CBC development plan policy CP.3 and Joint Core policy INF2 and satisfies all the criteria of the Environment Agency.

1.16. The Flood Risk Assessment concludes that the site can be safely developed without flood risk and without increasing flood risk elsewhere through the use of an appropriately designed Sustainable Drainage System.

2. INTRODUCTION

2.1. This Flood Risk Assessment (FRA) and Drainage Strategy has been prepared by Phoenix Design Partnership Limited on behalf of Robert Hitchins Limited and their successors in title to the land to support an outline planning application.

2.2. The outline planning application is for a residential development for up to 250 dwellings associated infrastructure, ancillary facilities, open space and landscaping with vehicular access from Harp Hill. Demolition of existing farm buildings on site.

2.3. This site specific Flood Risk Assessment (FRA) has been produced in accordance with the National Planning Policy Framework document, Section 14 'Meeting the challenge of climate change, flooding and coastal change' and Planning Practice Guidance document 'Flood Risk and Coastal Change' Framework together with Environment Agency FRA Guidance Notes.

2.4. The FRA demonstrates that the site is suitable for development without flood risk and without causing an increase in flood risk to others, including allowances for climate change. It also demonstrates how SuDS will be used to manage surface water from the development, and to ensure that water quality is not adversely affected.

3. POLICY & GUIDANCE

3.1. National Planning Policy Framework (NPPF): June 2019

As set out in paragraph 163 of the NPPF, local planning authorities should only consider development in flood risk areas appropriate where informed by a site specific flood risk assessment. Footnote 50 & 51 in the NPPF states that '*a site specific Flood Risk Assessment should be provided for all developments in Flood 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified within a strategic flood risk assessment as being at increased flood risk in the future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use. This includes householder development, small non-residential extensions (with a footprint of less than 250m2) and changes of use; except for changes of use to caravan, camping or chalet site, or to a mobile home or park site, where the sequential and exception tests should be applied as appropriate*'.

Section 14 'Meeting the challenge of climate change, flooding and coastal change' sets out the government policies on development and flood risk.

Paragraphs 157 to 165 set out the requirements for Sequential Tests and Exception Tests to direct development to areas of lowest flood risk and ensure that development will be safe from flooding and that it does not increase flood risk elsewhere, taking in to account climate change.

Section 15 'Conserving and enhancing the natural environment' sets out the government policies on water supply, wastewater and water quality and the requirements to contribute and enhance the natural environment and aim to minimise pollution and other adverse effects on the local and natural environment.

3.2. Planning Practice Guidance: Launched 2014

The Section 'Flood Risk & Coastal Change' advises on how planning can take account of the risks associated with flooding and coastal change in plan-making and the application process.

The section 'Climate Change' advises on how planning can identify suitable mitigation and adaptation measures in plan-making and the application process to address the potential impacts of climate change. Notably it does not provide any detailed guidance on climate change allowances for fluvial flows and rainfall intensity over the lifetime of development.

The Section 'Water Supply, Wastewater & Water Quality' advises on how planning can ensure water quality and the delivery of adequate water and wastewater infrastructure. The guidance sets out to implement the EU Water Framework Directive (WFD) through River Basin Management Plans, and draw attention to the National Policy Statement for Wastewater.

3.3. Flood & Water Management Act 2010 (FWMA)

The Flood and Water Management Act provides for better, more comprehensive management of flood risk for people, homes and businesses, helps safeguard community groups from unaffordable rises in surface water drainage charges, and protects water supplies to the consumer.

Serious flooding can happen at any time. Climate projections suggest that extreme weather will happen more frequently in the future. This act aims to reduce the flood risk associated with extreme weather.

Government announced in December 2014, that Sustainable Drainage Systems (SuDS) will be delivered for all major development through the planning system as of 6 April 2015.

3.4. Cheltenham Borough Council Development Plan Policies

3.4.1. **Policy CP.3 – Sustainable Environmental**

In achieving the above the following is relevant to the FRA:-

1. *Not give rise to harmful levels of pollution to land, air or water (surface or ground) and*
2. *Minimise the risk of flooding*
3. *The provision of water supply and the development's impact on groundwater, watercourses and any protected abstractions.*

3.5. Joint Core Strategy 2017

Policy INF2: Flood Risk Management

1. Development proposals must avoid areas at risk of flooding, in accordance with a risk- based sequential approach. Proposals must not increase the level of risk to the safety of occupiers of a site, the local community or the wider environment either on the site or elsewhere. For sites of strategic scale, the cumulative impact of the proposed development on flood risk in relation to existing settlements, communities or allocated sites must be assessed and effectively mitigated.

2. Minimising the risk of flooding and providing resilience to flooding, taking into account climate change, will be achieved by:

   i. Requiring new development to, where possible, contribute to a reduction in existing flood risk;

   ii. Applying a sequential test for assessment of applications for development giving priority to land in Flood Zone 1, and, if no suitable land can be found in Flood Zone 1, applying the exception test;

   iii. Requiring new development that could cause or exacerbate flooding to be subject to a flood risk assessment which conforms to national policy and incorporates the latest available updates to modelling and climate change data and historic data and information and guidance contained in the authorities'

Strategic Flood Risk Assessments and Supplementary Planning Documents, in order to demonstrate it will be safe, without increasing flood risk elsewhere;

iv. Requiring new development to incorporate suitable Sustainable Drainage Systems (SuDS) where appropriate in the view of the local authority to manage surface water drainage: to avoid any increase in discharge into the public sewer system; to ensure that flood risk is not increased on-site or elsewhere; and to protect the quality of the receiving watercourse and groundwater. Where possible, the authorities will promote the retrofitting of SuDS and encourage development proposals to reduce the overall flood risk through the design and layout of schemes which enhance natural forms of drainage. Developers will be required to fully fund such mitigation measures for the expected lifetime of the development including adequate provision for on-going maintenance.

v. Working with key partners, including the Environment Agency and Gloucestershire County Council, to ensure that any risk of flooding from development proposals is appropriately mitigated and the natural environment is protected in all new development.

3.6. Strategic Flood Risk Assessment (SFRA)

3.6.1. Cheltenham Borough Council Strategic Flood Risk Assessment, Level 1

In September 2008 Cheltenham Borough Council commissioned Halcrow Group to produce a Level 1 Strategic Flood Risk Assessment (SFRA). The purpose of this SFRA is to assess and map all forms of flood risk from Fluvial (rivers), Tidal (sea), groundwater, surface water, sewers and impounded water bodies (reservoirs and canals), both now and in the future taking into account future climate change predictions, to allow the councils to use this as an evidence base to locate future development primarily in low flood risk areas.

The SFRA will also be used for the preparation of the Local development Framework (LDF), in particular the core strategy. Furthermore, the SFRA provides useful information for Sustainability Appraisal (SA) and will assist in the development of flood risk policies.

Copies of the SFRA mapping are included in Appendix C

3.6.2. Gloucester, Cheltenham & Tewkesbury JCS Level 2 SFRA

A Level 2 Strategic Flood Risk Assessment was commissioned by the Joint Core Strategy authorities in April 2010 and published in October 2011. The study by Halcrow provides a more detailed assessment of areas identified as potential development locations and used the information from SFRA Level 1 to determine which areas required a further assessment of flood risk. A review of this SFRA has identified that the proposed application site/area is not included.

3.6.3. Gloucester, Cheltenham & Tewkesbury JCS Level 2 SFRA Additional Assessments

A further Level 2 Strategic Flood Risk Assessment was commissioned by the Joint Core Strategy authorities in 2012 and published in early 2013. This additional work by Capita covered other areas identified as potential development locations. A review of this SFRA has identified that the proposed application site/area is not included.

3.7. Ciria C753 'The SuDS Manual'

Ciria C753 'The SuDS Manual' published in 2015 provides comprehensive guidance on the planning, design, construction and maintenance of Sustainable Drainage Systems (SuDS) in the UK. C753 guidance should be used to help develop the strategy and design of the SuDS.

3.8. Ciria C635 'Designing for Exceedance'

Ciria C635 'Designing for Exceedance in Urban Drainage – Good Practice' published in 2006 provides guidance on the design and management of urban sewerage and drainage systems to reduce the impacts from drainage exceedance. C635 guidance should be used to help develop the strategy and design of the flood routes for the development.

3.9. Sewers for Adoption

'Sewers for Adoption' 7th Edition published by Water UK in August 2012 provides guidance on the design and construction of foul & surface water drainage systems for adoption by Water Companies.

At the time of writing, it is expected that Sewers for Adoption 8th Edition will be published in April 2020 therefore the sewer design and construction maybe in accordance with the 8th Edition. One of the primary changes expected will be that SuDS will now be adopted by the drainage authority.

3.10. EA/Defra Preliminary Rainfall Runoff Management for Developments

Preliminary Rainfall Runoff Management for Developments' (R&D Technical Report W5-074/A/TR/1, Revision E) jointly published in January 2012 for the Department for Environment Food and Rural Affairs (Defra) and the Environment Agency (EA) provides advice on the Management of Stormwater Drainage for developments at Planning stage and in particular the preliminary sizing of storage for the control and treatment of storm water runoff.

3.11. Building Regulations Part H 2015 'Drainage & Waste Disposal'

The above document should be used to assist in the design of the drainage and SuDS.

3.12. BS 8582:2013 Code of practice for surface water management for development sites

BS 8582:2013 "Code of practice for surface water management for development sites' published in November 2013 by BSI Standards Limited gives recommendations on the planning, design, construction and maintenance of surface water management systems for new developments and redevelopment sites.

3.13. Non Statutory Technical Standards For Sustainable Drainage Systems 2015

This document sets out the Non-Statutory Technical Standards for Sustainable Drainage Systems and should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

3.14. EA 'Flood Risk Assessments: Climate Change Allowances' 2019

The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and supporting planning practice guidance on Flood Risk and Coastal Change explain when and how flood risk assessments should be used. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account. Local planning authorities refer to this when preparing local plans and considering planning applications.

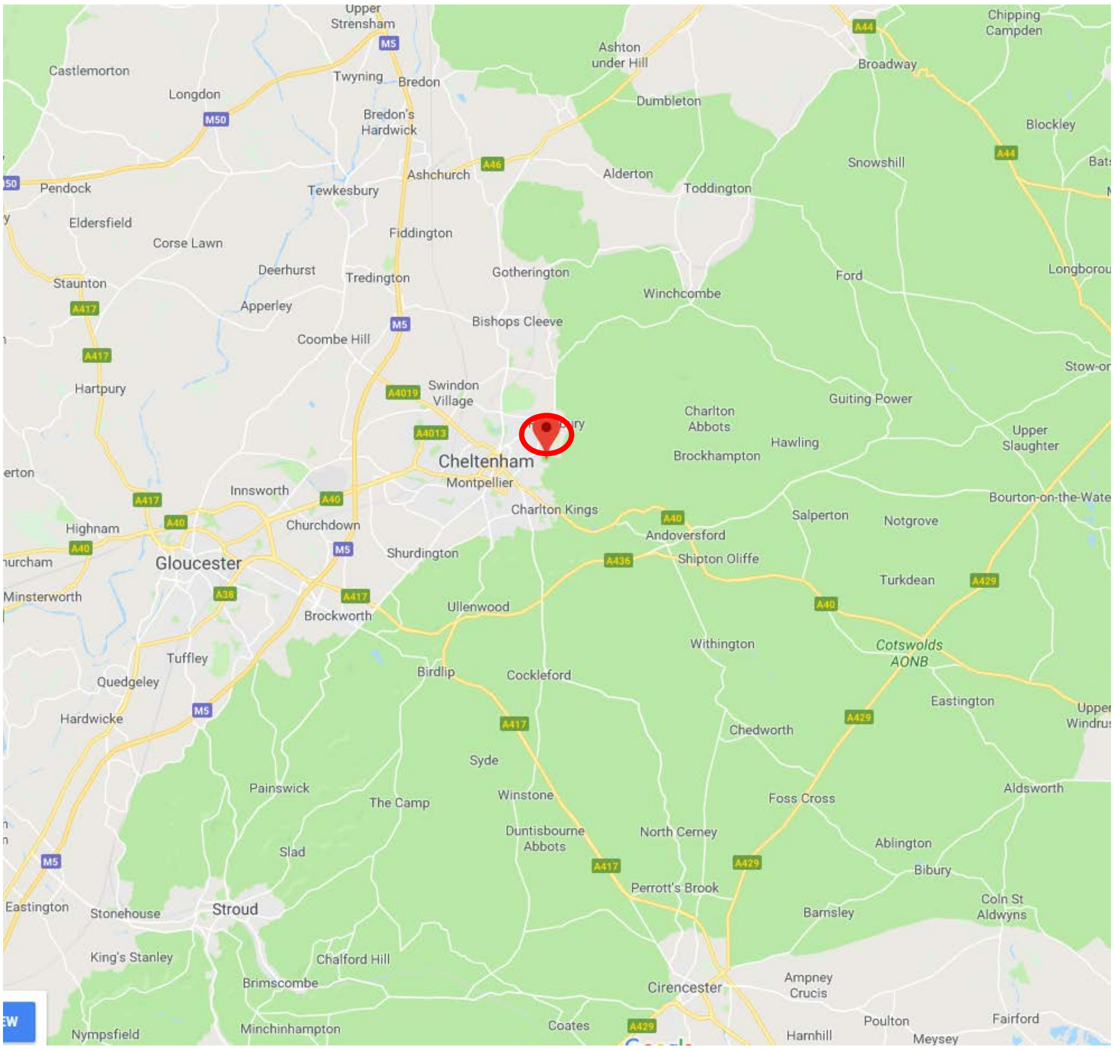
This advice updates previous climate change allowances to support NPPF. The Environment Agency (EA) has produced it as the government's expert on flood risk.

The 2019 update incorporated the following statement "This guidance is being revised in line with the UK Climate Projections 2018. Please contact the Environment Agency for interim guidance if you are preparing a flood risk assessment for a development or local plan affected by tidal flooding."

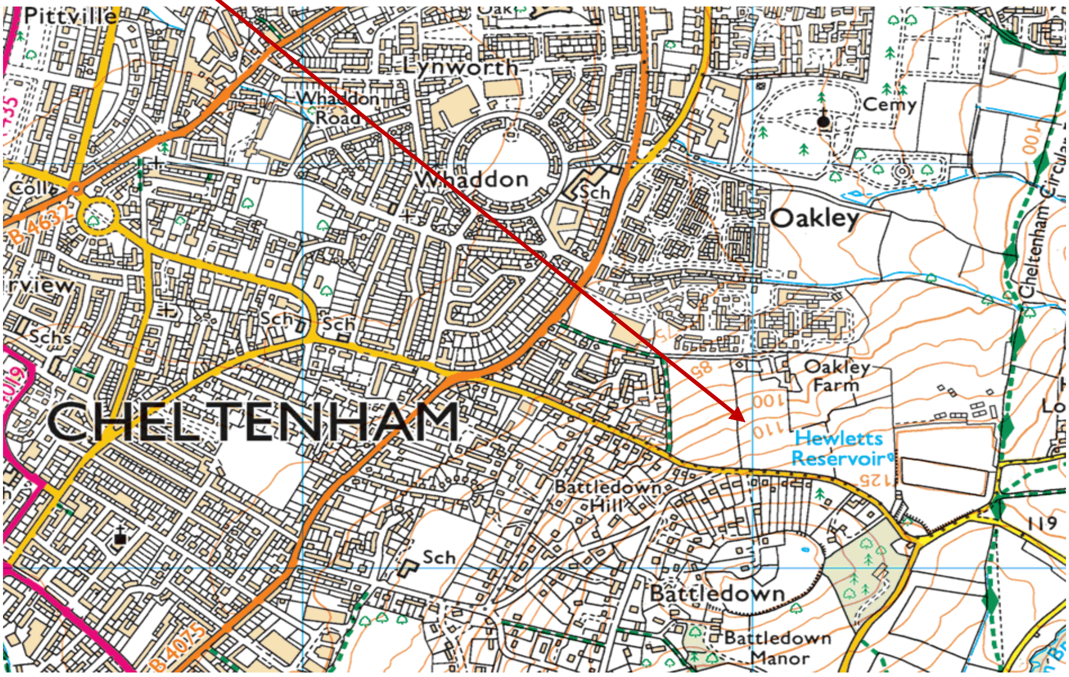
4. EXISTING SITE DETAILS

4.1. Site Location & Description

Item	Brief Description
Site address	Land Off Harp Hill, Battledown, Cheltenham, GL52 6PT
Council Area	Cheltenham Borough Council
Ordnance Survey Grid Reference	396971, 222405



Site Location



Site Location

The application site is located approximately 2.2Km east of Cheltenham town centre. The site comprises circa 14.76 hectare broadly rectangular in shape plot of land located on the northerly facing slope of Harp Hill comprising several grass covered fields with derelict farm buildings associated with Oakley Farm located in the central northern part of the site. The site is bounded to the south by Harp Hill road and residential housing, to the west by residential housing and to the north / northeast by recently constructed residential development. The site is bounded to the east by Hewletts reservoir's (buried reservoir's) which is maintained by Severn Trent Water.

4.2. Topography

A topographical survey of the site was undertaken by Ruxton Surveys in November 2018. The survey shows that the site falls from Harp Hill road in the South towards Pillowell Close and Brockweir Road to the north. The site has an approximate elevation of 126mAOD in the south adjacent to Harp Hill road and 77mAOD near Pillowell Close in the north.

The survey shows an existing ditch running along part of the northern boundary parallel to Pillowell Close. The survey also shows 2 No. land drainage ditches within the site.

Following on site drainage investigation it has been established that both internal ditch systems eventually outfall into an open brick chamber with a metal grill over located adjacent to Pillowell Close. The 375mm outlet from this chamber connects to the existing surface drainage system located on the B4075 (Priors Road) to the west.

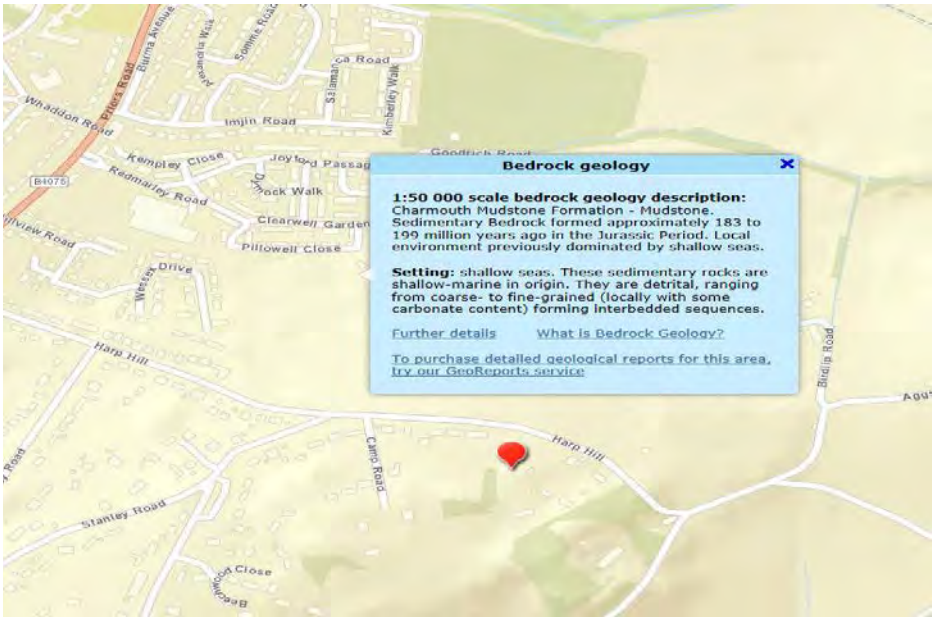
The 750mm surface water drain running parallel to Brockweir Road has been traced and confirmed to outfall into Wyman's Brook to the north.

The site survey and existing hydrology is shown on drawing No. 476-001 "Existing Hydrology" contained within Appendix B.

4.3. Hydrogeology

4.3.1. The British Geological Survey (BGS)

The 1:50,000 geological map indicates the site to be entirely underlain by bedrock of Charmouth Mudstone Formation of the Jurassic age, which usually comprise firm to stiff, grey brown, plastic clay, which grades at depth to dark blue, fissured shaly mudstone. Superficial deposits have not been recorded for this site.



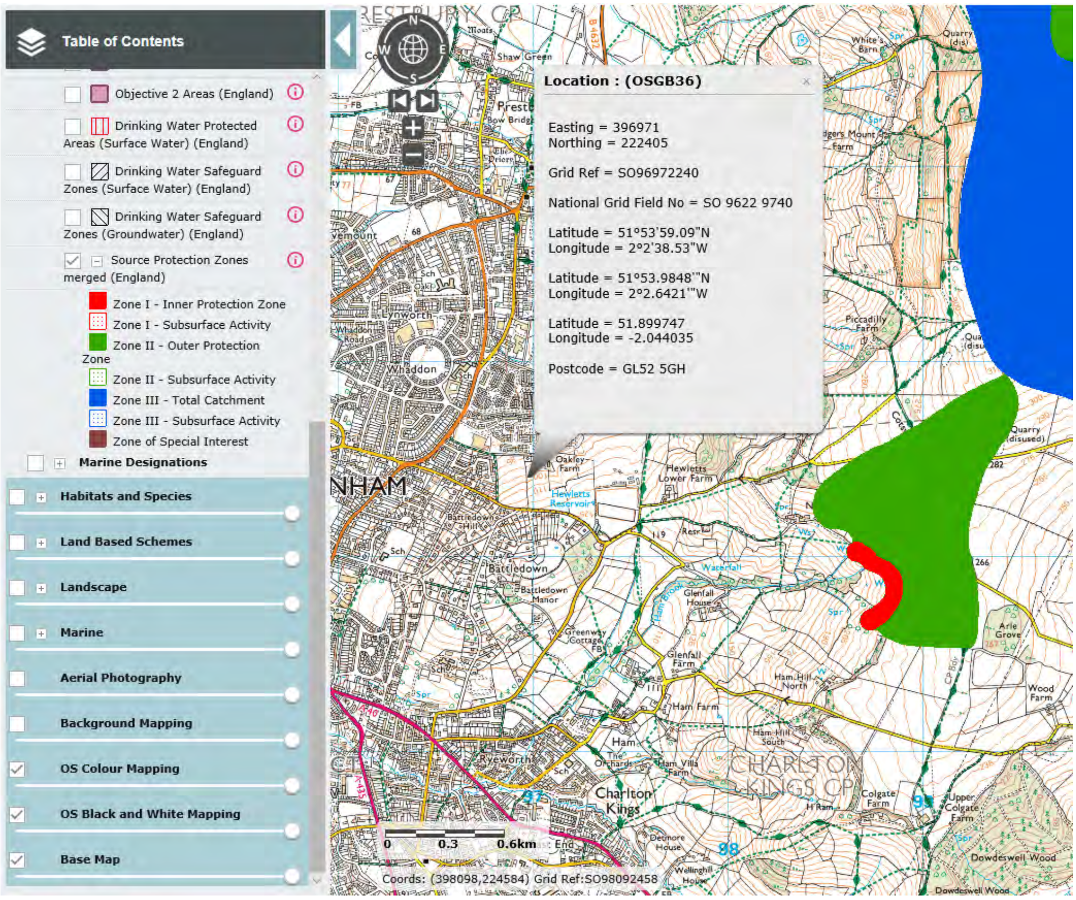
The distribution and movement of groundwater within the soil and rock for application site has been discussed within Section 4.2.2.

4.3.2. Environment Agency Information

Groundwater Source Protection Zone Map

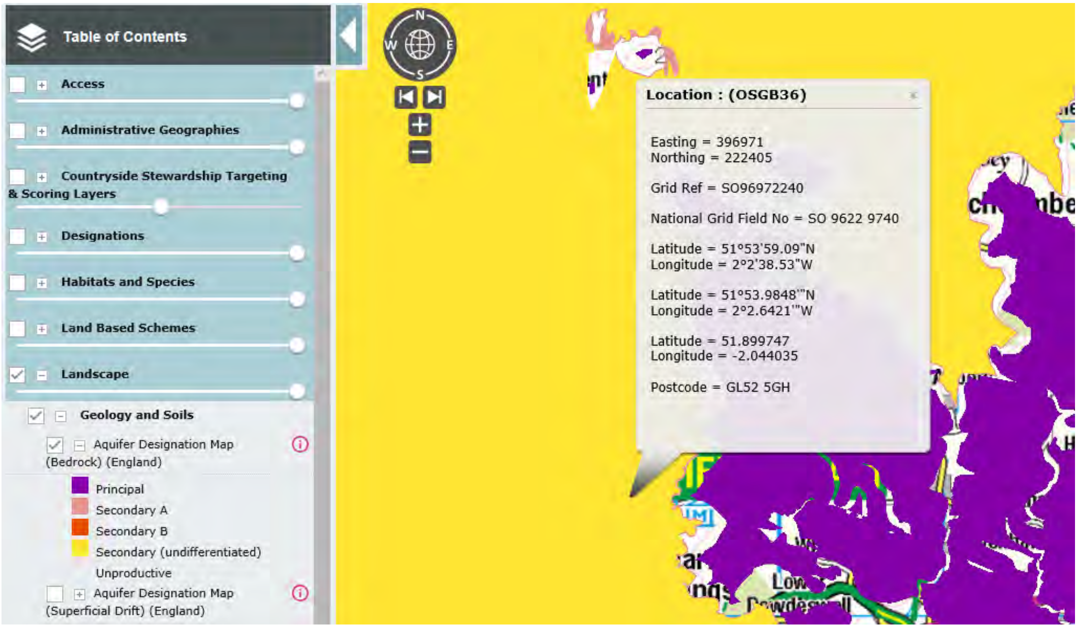
Groundwater provides a third of our drinking water in England, and it also maintains the flow in many of our rivers. In some areas of Southern England, groundwater supplies up to 80% of the drinking water that you get through your taps. It is crucial that we look after these sources and ensure that your water is completely safe to drink.

The Source Protection map below confirms that the site is not located within a Groundwater Source Protection Zones (SPZ).



Aquifer Designation

The Environment Agency Aquifer Designation map below classifies the Charmouth Mudstone formation (bedrock) as a Secondary Undifferented Aquifer. Secondary aquifer terminology was previously called Minor - Unproductive Strata: these are geological strata with low permeability that have negligible significance for water supply or river base flow.

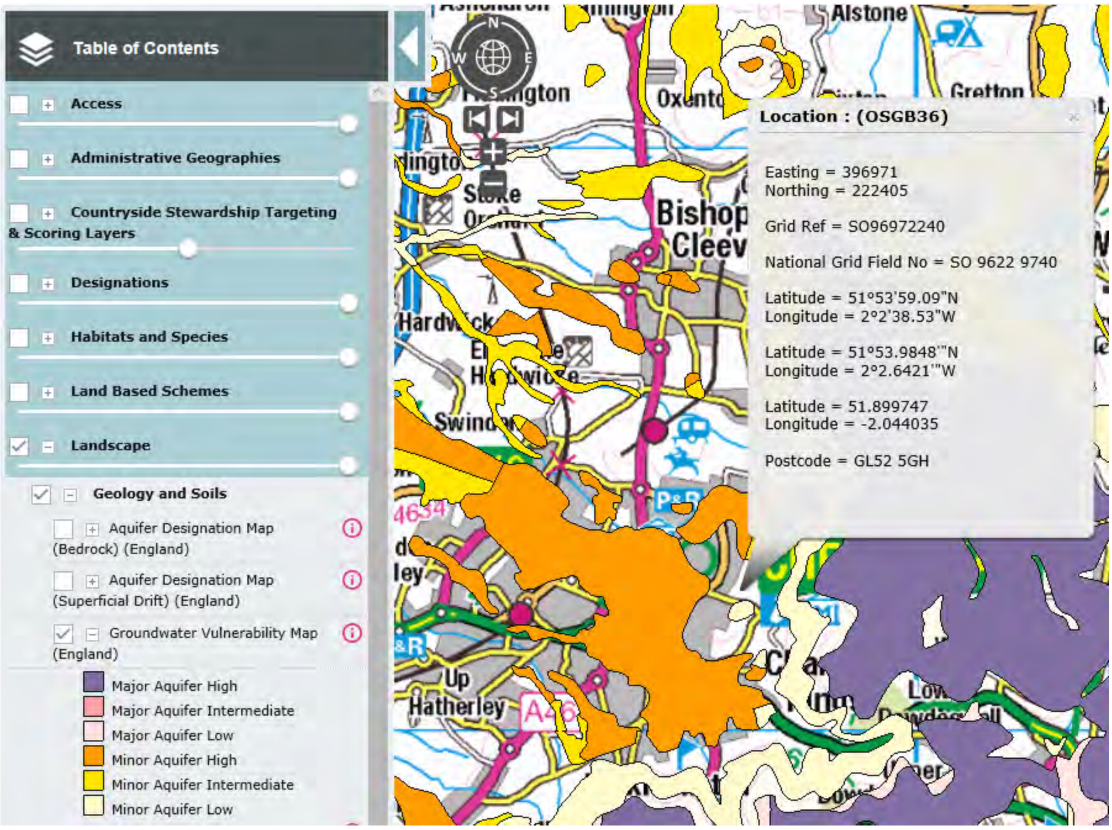


Groundwater Vulnerability Zone Map

The EA groundwater vulnerability map shows the vulnerability of groundwater to a pollutant discharged at ground level based on hydrology, geology, hydrogeology and soil properties within a single square kilometre. The potential impact of groundwater pollution is considered using the aquifer designation status which provides an indication of the scale and importance of groundwater for potable water supply and/or in supporting baseflow to rivers, lakes and wetlands.

The map has five risk categories (High, Medium-High, Medium, Medium-Low and Low) based on the likelihood of a pollutant reaching the groundwater (i.e. vulnerability) and the impact this would have on the type of aquifer present and the potential impact.

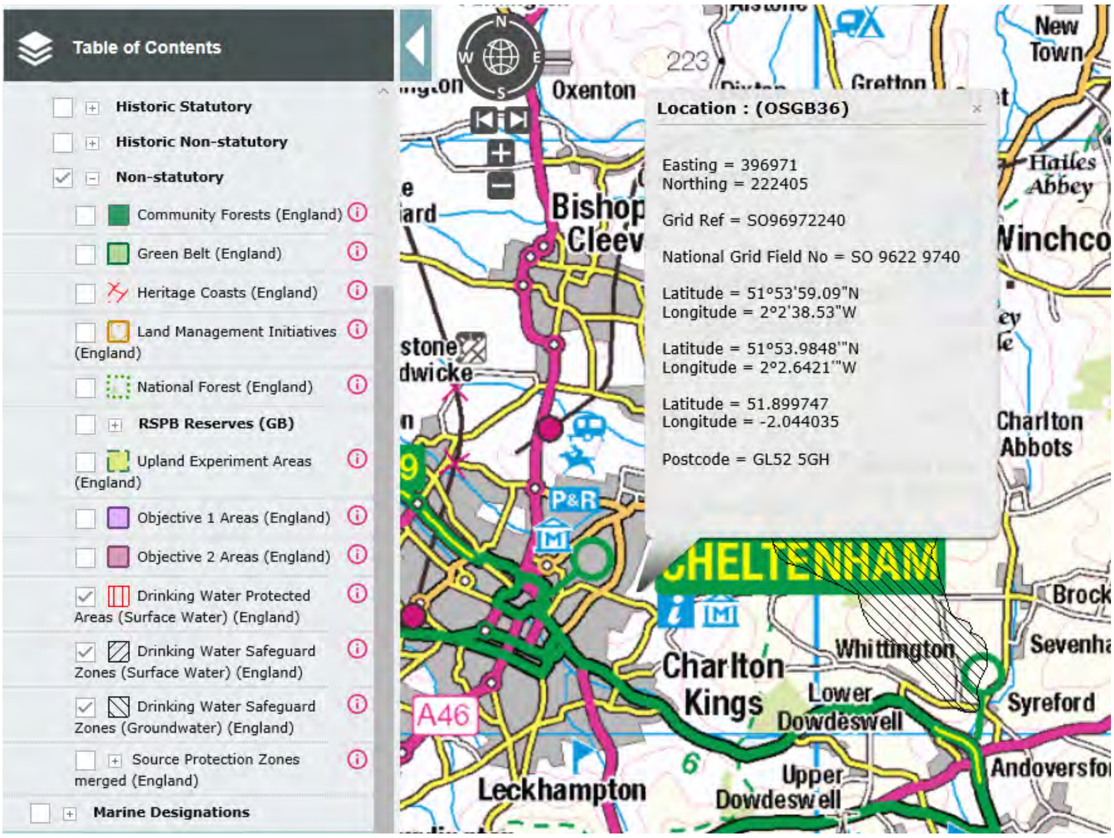
The ground water vulnerability map below shows that the application site to be located on the border of a low category risk area.



Low Risk: Areas that provide the greatest protection to groundwater from pollution. They are likely to be characterised by low leaching soils and /or the presence of low-permeability superficial deposits

Drinking Water Safeguard Zones Map

The Drinking Water Safeguard map below shows that the site is not located within a safeguard zone.



Based upon the Environment Agency information the site is located within an area of low sensitivity in terms of Hydrogeology and groundwater resources.

However, the proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual' and ensures that water quality is not adversely affected.

4.4. Hydrology

The nearest main river to the application site is Wyman's Brook located approximately 0.2km to the north of the site and is a tributary of the River Swilgate. The River Swilgate is a tributary of the River Avon which outfalls into the River Severn at near Mitton in Tewkesbury, Glos. Ham Brook and the River Chelt are located approximately 1.4Km to the south of the site.

The topographical survey shows 2 No. existing ditches running along part of the northern boundary, one being located to the east near Brockweir road and the other running parallel to Pillowell Close. The survey also shows 2 No. internal land drainage ditches within the site and a land / collector drain running across the northern eastern part of the site.

Following on site drainage investigation it has been established that both internal ditch systems and existing land drains eventually outfall into an open brick chamber with a metal grill over located in the access track to Oakley Farm, adjacent to Pillowell Close. The 375mm outlet from this chamber follows the Oakley Farm access track and connects to the existing surface drainage system located on the B4075 (Piors Road) to the west.

The 750mm surface water drain running parallel to Brockweir Road has been traced and confirmed to outfall into Wyman's Brook to the north.

There is an existing underground / covered reservoir (Hewletts Reservoir) located immediately to the east of the site operated by Severn Trent Water.

The site survey and existing hydrology is shown on drawing No. 476-001 "Existing Hydrology" contained within Appendix B.

Water Framework Directive River Basin Management Plan (WFD)

Environment Agency online data shows that the site is located in the Avon – Midlands West Operational catchment area which is part of the River Severn River Basin District shown below.

Avon – Midlands West Operational catchment shown below drains to the River Swilgate. The aim / goal of the Water Framework Directive objective is for all watercourses to achieve good status by 2027.

Swilgate - source to conf R Avon

Download Water Body as CSV / GeoJSON

Overall classification for 2016
Moderate

Overview

Id	GB109054039780
Type	River
Hydromorphological designation	not designated artificial or heavily modified
NGR	SO9305824942
Catchment area	4949.43 ha
Length	21.295 km
Surveillance Water Body	No
Catchment area	49.494 km2

The EA information below currently shows that the River Swilgate has an overall classification of Moderate for 2016.

Classifications

Cycle 2 classifications

Download as CSV

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Poor	Moderate	Moderate
Ecological	Moderate	Poor	Moderate	Moderate
Chemical	Good	Good	Good	Good

Cycle 1 classifications Hide

Download as CSV

Classification Item	2009	2010	2011	2012	2013	2014
Overall Water Body	Poor	Poor	Poor	Poor	Moderate	Poor
Ecological	Poor	Poor	Poor	Poor	Moderate	Poor
Chemical	Good	Good	Good	Does not require assessment	Does not require assessment	Does not require assessment

The reasons why the River Swilgate is not currently achieving good status is shown below:-

Swilgate - source to conf R Avon

Issues preventing waters reaching good status and the sectors identified as contributing to them (the numbers in the table are counts of the reasons for not achieving good status in water bodies.)

	Agriculture and rural land management	Domestic General Public	Industry	Local and Central Government	Mining and quarrying	Navigation	Recreation	Urban and transport	Waste treatment and disposal	Water Industry	Other	No sector responsible	Sector under investigation	Total
Changes to the natural flow and levels of water	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Pollution from rural areas	3	-	-	-	-	-	-	-	-	-	-	-	-	3
Pollution from abandoned mines	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Pollution from waste water	-	-	-	-	-	-	-	-	-	3	-	-	-	3
Physical modifications	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Pollution from towns, cities and transport	-	1	-	-	-	-	-	3	-	-	-	-	-	4
Non-native invasive species	-	-	-	-	-	-	-	-	-	-	-	-	-	0

The Objectives set for the River Swilgate are shown below:-

Objectives

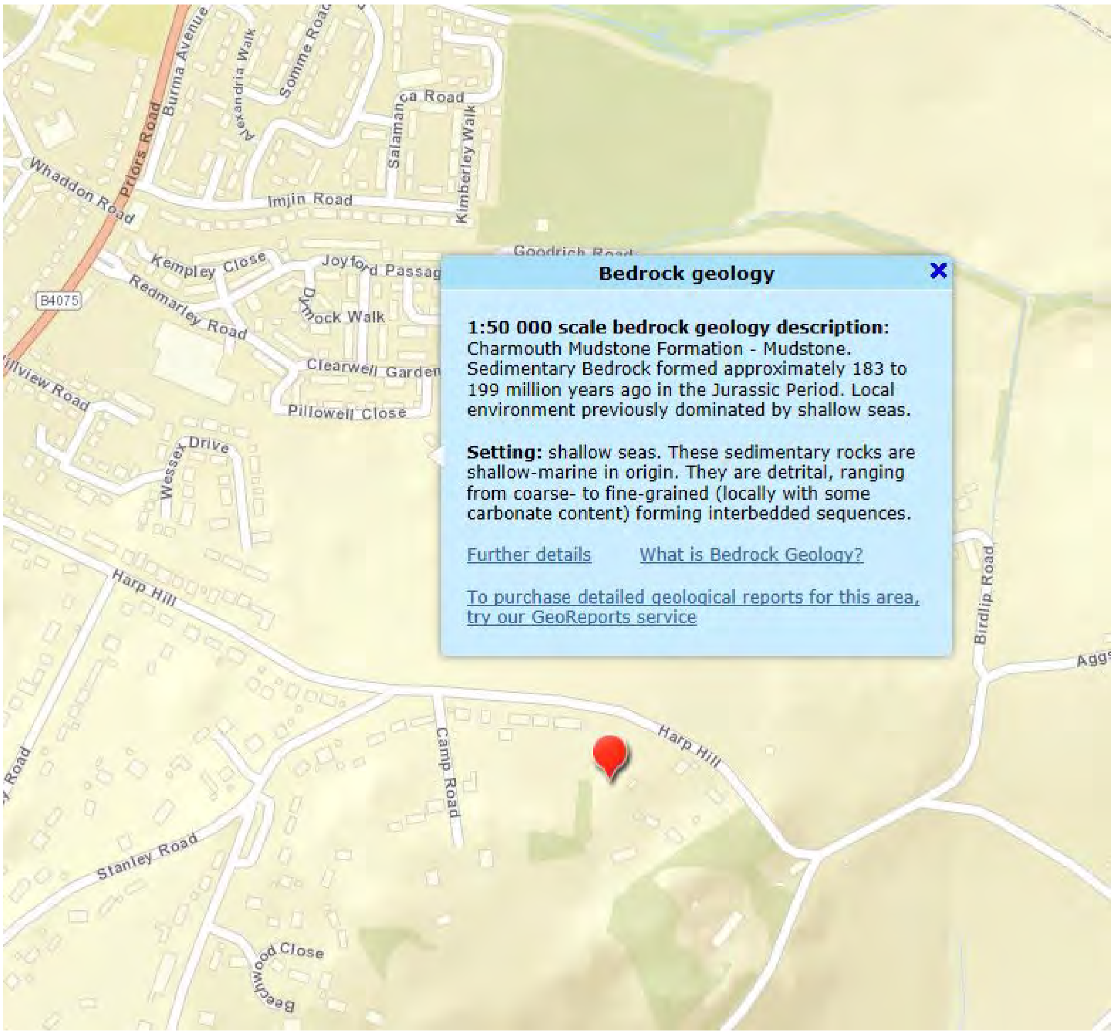
Download as CSV

Classification Item	Status	Year	Reasons
Overall Water Body	Good	2027	Ecological recovery time
Ecological	Good	2027	Ecological recovery time
Supporting elements (Surface Water)	Not assessed	2015	
Biological quality elements	Good	2027	Ecological recovery time
Macrophytes and Phytobenthos Combined	Good	2027	Ecological recovery time
Fish	Good	2015	
Invertebrates	Good	2027	Ecological recovery time
Hydromorphological Supporting Elements	Supports Good	2015	
Hydrological Regime	Supports Good	2015	
Physico-chemical quality elements	Good	2021	
Ammonia (Phys-Chem)	Good	2015	
Dissolved oxygen	Good	2015	
pH	Good	2015	
Phosphate	Good	2021	
Temperature	Good	2015	
Specific pollutants	High	2015	
Triclosan	High	2015	
Copper	High	2015	
Chemical	Good	2015	
Priority substances	Does not require assessment	2015	
Other Pollutants	Does not require assessment	2015	
Priority hazardous substances	Does not require assessment	2015	

The proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual' and will ensure that the WFD objectives are not adversely affected.

4.5. Geology

The 1:50,000 geological map indicates the site to be entirely underlain by bedrock of Charmouth Mudstone Formation of the Jurassic age, which usually comprise firm to stiff, grey brown, plastic clay, which grades at depth to dark blue, fissured shaly mudstone. Superficial deposits have not been recorded for this site.



4.6. Ground Investigation

A Phase 1 Geo-Environmental Desk Study Report was undertaken in June 2018 by Wilson Associates Consulting Engineering Geologists & Geo-Environmental Engineers. The desk study report concentrated on identifying and evaluating the former site usage, environmental setting and its likely contamination status. In summary this study established that the site has remained undeveloped farmland with no history of industrial or other former usage and therefore the risk on site contamination is low.

A phase 2 intrusive ground investigation was undertaken in July 2018 by Wilson Associates Consulting Engineering Geologists & Geo-Environmental Engineers.

The intrusive investigation was carried using windowless sampling (WS) small diameter boreholes. A total of eleven WS boreholes were drilled to depths of up to 4.45m (WS1 – WS11). The WS borehole locations are shown on drawing no. 4360/2/2 contained within Appendix G. The intrusive investigation has shown the natural ground conditions to commensurate with geological mapping with all WS boreholes finding undisturbed clay representing the recorded Charmouth Mudstone Formation, overlain by a veneer of topsoil. A summary of the observed strata is shown below:-

Stratum	Base Depth (m)	Notes
TOPSOIL: generally encountered as probable firm, dark brown, organic CLAY with many roots from overlying grass	0.15 - 0.4	Encountered in all boreholes except WS4
MADE GROUND: probable medium dense, sandy GRAVEL with many roots. Gravel is brick and concrete	0.4	Encountered in borehole WS4 only
MADE GROUND: probable stiff, desiccated, light brown, slightly gravelly CLAY. Gravel is typically charcoal, brick and/or glass	0.35 – 0.5	Encountered in WS1 and WS5 only
CLAY: probable initially firm, mottled light brown and light grey desiccated CLAY. Possible relict shear surfaces identified between 0.65m and 0.85m depth in boreholes WS1-3 and WS5. Below 0.9-1.4m depth appearing normally hydrated. With increasing depth becoming stiff, dark grey, with fossil and shell fragments, localised pockets of gypsum and showing relict mudstone structure. See specific logs for details *(Charmouth Mudstone Formation)*	>4.45	Encountered to terminal depth in all boreholes
Perched/Groundwater	All boreholes	Depth to Water (m) dry

In-situ percolation testing was undertaken during the works to establish the infiltration potential of the natural ground utilising falling head percolation test in accordance with BRE 365 guidance. This was carried out in WS1 & WS6, with results shown below:-

Borehole No.	Test Zone Depth (m)	Approximate Soil Infiltration Rate (m/sec)	Approximate time to drain to 50% storage (hours)
WS1	0.34-4.45	N/A	>24
WS6	0.24-4.45	N/A	>24

Due to negligible recorded drainage outflow it was not possible to calculate soil infiltration rate or undertake repeat tests within either test locations. The ground investigation report has therefore concluded that's SuDS in the form of soakaways is not feasible for this site and has recommended that alternative drainage options are sought.

Ground water monitoring was undertaken on 17th August, 24th August and 18th September 2019. This showed ground water levels to vary between 1m and 3.76m below ground level.

The relevant sections of the ground investigation report are enclosed within Appendix G for reference.

4.7. Existing Greenfield Run-off Rates

From the topographical survey, the natural drainage regime (surface water run-off) from the site drains to the existing ditch systems (ordinary watercourses) within the site and ditch system located along part of the northern boundary of the site.

The greenfield run-off rate for the site has been calculated using Micro-Drainage ICP SuDS method assuming:-

SAAR (Standard Average Annual Rainfall) = 800mm (from Wallingford Map)
SOIL (soil Index) = 0.45 (Taken from the 'Winter Rain Acceptance Potential' WRAP map)
Region = 4 (FSR Region)

The Micro Drainage calculations are contained with within Appendix D with results summarised for 1ha site are:-

Q1	(1 year existing green-field run-off)	=	4.3 l/s/ha
Q30	(30 year existing green-field run-off)	=	10.1 l/s/ha
Q100	(100 year existing green-field run-off)	=	13.2 l/s/ha
Qbar	**(mean annual green-field run-off, 2.3 years)**	**=**	**5.1 l/s/ha**

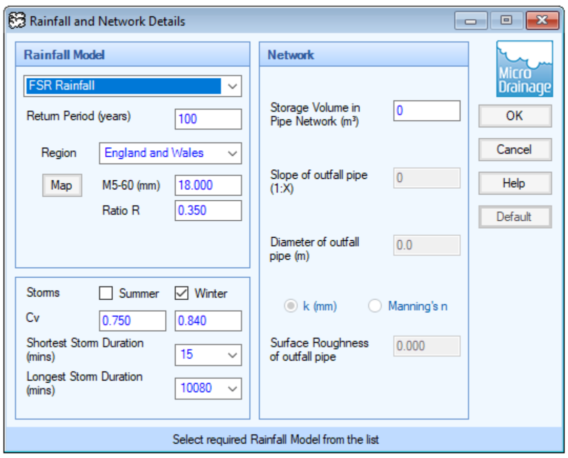
4.8. Existing Greenfield Run-off Volume

Ciria C753 & the EA/DEFRA guide 'Preliminary Rainfall Runoff Management for Developments' recommend that the basis for considering the run-off volume is the difference pre- and post-development for the 100 year 6 hour event.

Ciria C753 (Section 24.10)

Green-field Run-off Volume = 10*RD*A*(SPR or PR)

RD: 100 year 6 hour rainfall (6 hours @ 10.027mm/hr, from Micro Drainage) = 60.162mm (see Micro Drainage images below and included within Appendix H)
A: Site Area (Ha) = 14.76 ha
SPR: Soil Type Standard Percentage Run-off (Soil Type 4 from WRAP Map) = 0.45



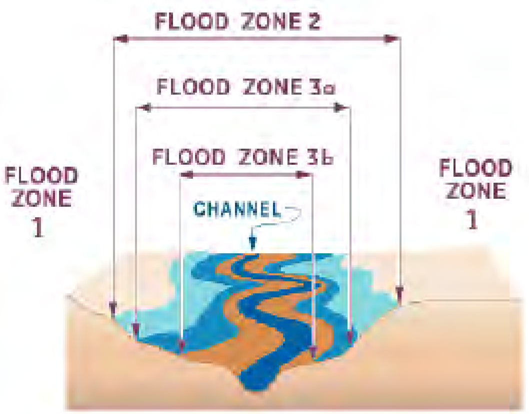
Storm Event	Rain (mm/hr)
15 min Winter	83.892
30 min Winter	56.436
60 min Winter	36.294
120 min Winter	22.586
180 min Winter	16.884
240 min Winter	13.646
360 min Winter	10.027
480 min Winter	8.062
600 min Winter	6.801

Existing 100 Year Green-field Run-off Volume: 10 x 60.16x 14.76 x 0.45 = **3995m³**

5. FLOOD RISK ASSESSMENT

5.1. Flood Zones

Table 1 of the NPPF Technical Guidance defines different flood zones according to the probability of river and sea flooding, ignoring the presence of any defences (although areas benefiting from formal defences are identified).



Flood Zone 1 - Low Probability

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)

Flood Zone 2 - Medium Probability

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Flood Zone 3a - High Probability

This zone comprises land assessed as having between a 1 in 100 or greater annual probability of river flooding (>1%) or 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Flood Zone 3b - The Functional Floodplain

This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, including conveyance routes).

It should be noted that flooding from surface water, groundwater, sewers and impounded water bodies can occur in any flood zone, even in Flood Zone 1.

Flood risk from all potential sources (sea, fluvial, pluvial, sewers, groundwater, and artificial) has been assessed and discussed in detail within Section 6.3.

5.2. Flood Risk Vulnerability Classification & Flood Zone Compatibility

Flood risk vulnerability classifications are shown in Table 2 of the Planning Practice Guidance 'Flood Risk & Coastal Change'.

The proposed development will comprise of residential development and open space, landscaping, and supporting infrastructure and utilities; and the creation of a new vehicular access from the Harp Hill road. In accordance with Table 2 the proposed development is classified as:

More Vulnerable – Building used for dwelling houses
Water Compatible – Amenity Open Space.

Flood Risk Vulnerability and Flood Zone 'Compatibility' is shown in Table 3 of the Planning Practice Guidance 'Flood Risk & Coastal Change' below:-

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 *	✗	✗	✗	✓*

The proposed application site is located entirely within Flood Zone 1, refer to Section 5.3.1.

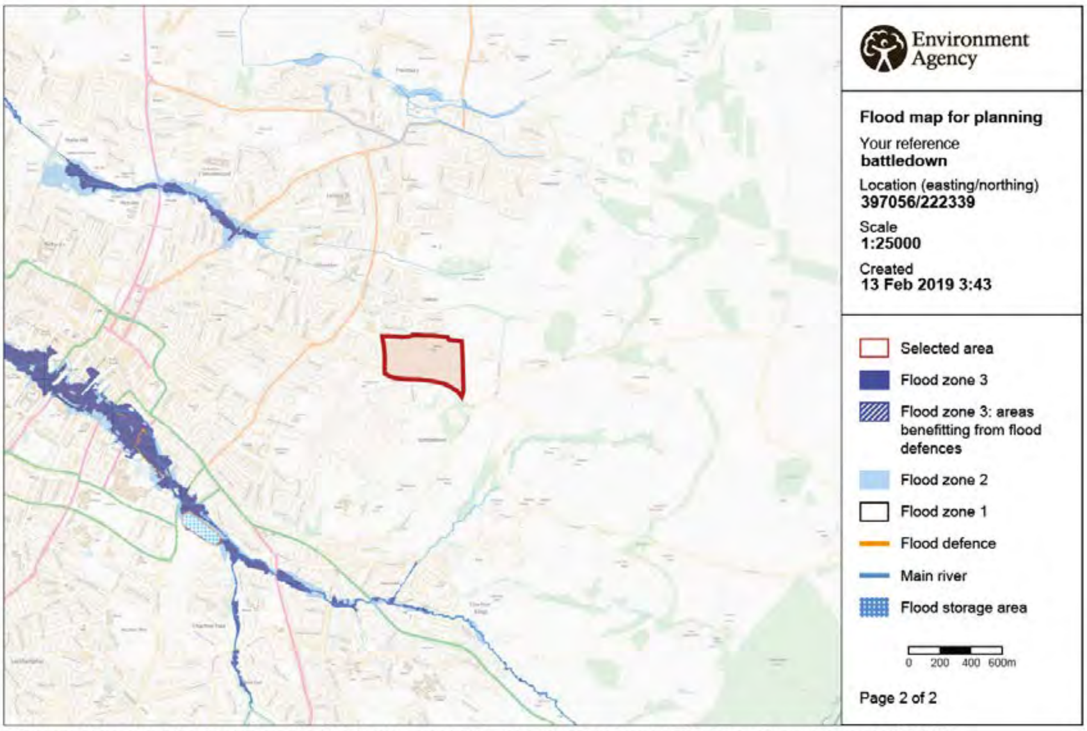
In accordance with Table 3 all types of development are compatible with Flood Zone 1.

5.3. Flooding Hazards

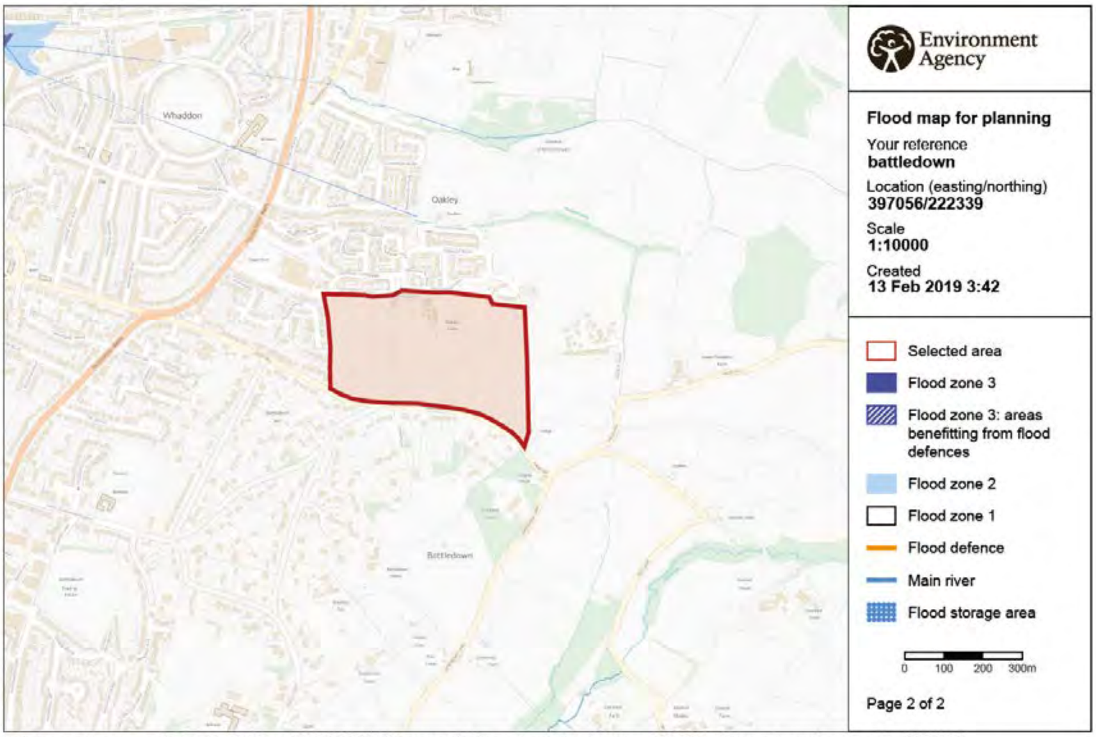
5.3.1. Fluvial & Tidal Flooding

The nearest main river to the application site is Wyman's Brook located approximately 0.2km to the north of the site. Ham Brook and the River Chelt are located approximately 1.4Km to the south of the site

The Environment Agency flood maps for planning shown below demonstrates that the proposed application site is located outside of the flood level extents from all rivers and the site is located entirely within Flood Zone 1 (low probability of flooding having less than 1 in 1,000 annual probability of fluvial or tidal flooding).



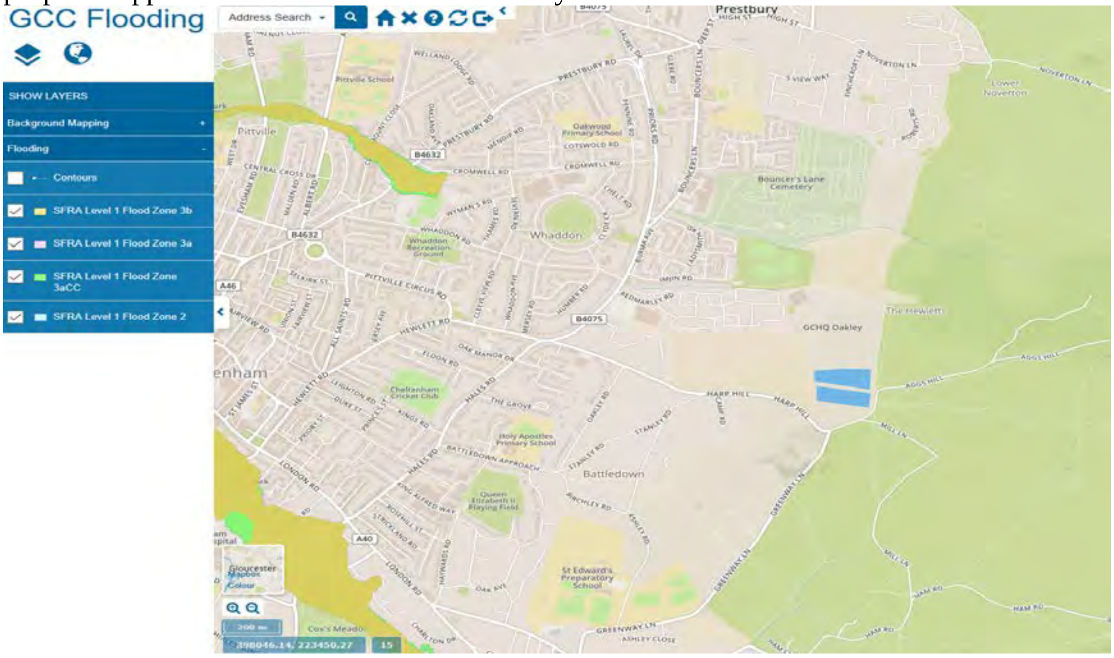
Environment Agency Flood Map for Planning – Scale 1:25000



Environment Agency Flood Map for Planning – Scale 1:10000

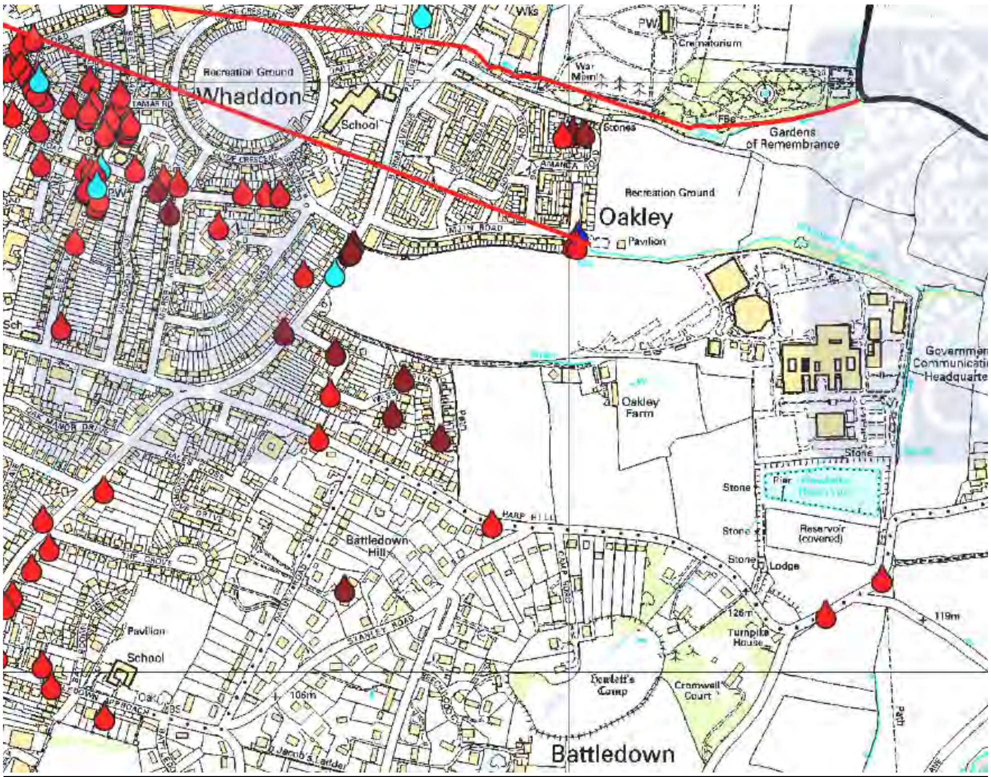
5.3.2. Gloucester County Council Flood Mapping

The below Gloucestershire County Council Online Flood Map shows that the proposed application site area is located entirely within Flood Zone 1.



5.3.3. Strategic Flood Risk Assessment

The Strategic Flood Risk Assessment flood map below (extract) commensurate that shown on Environment Agency flood mapping, identifying that the proposed application site area is located entirely within Flood Zone 1.



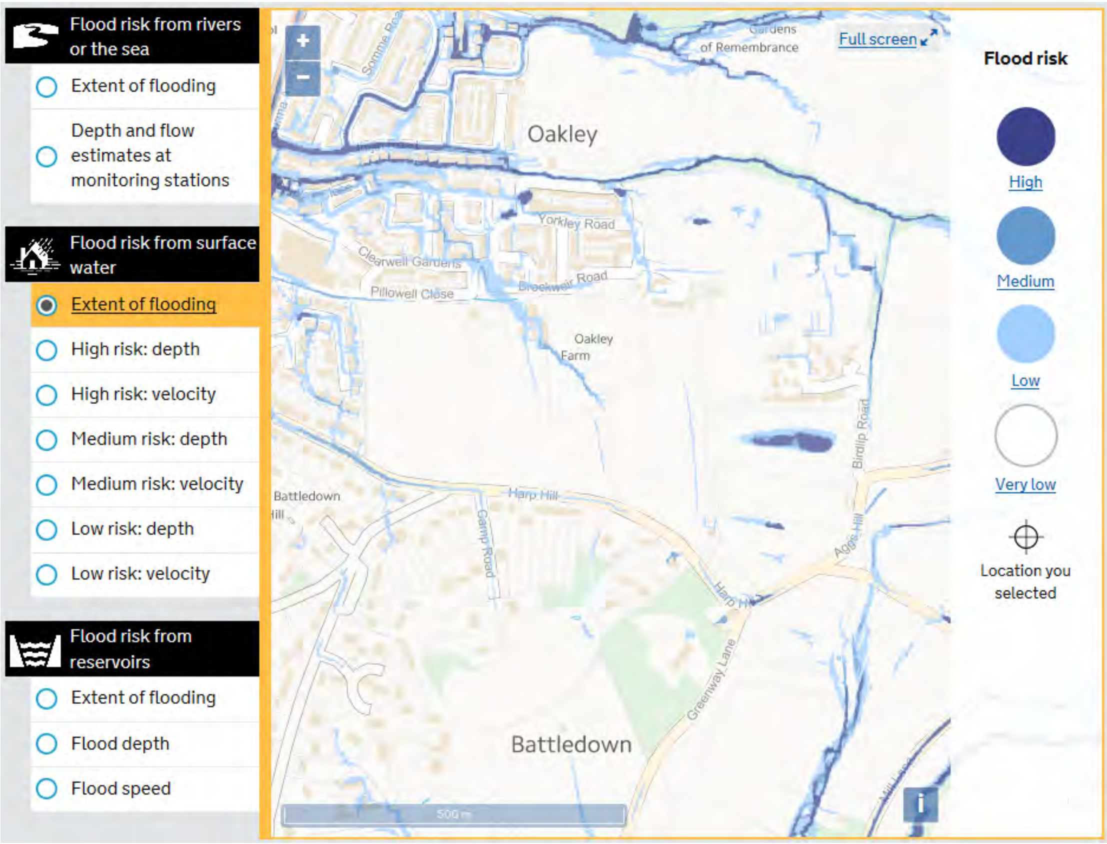
The full SFRA map is enclosed within Appendix C for reference

5.3.4. Flood Risk from Land (Surface Water Overland Flow)

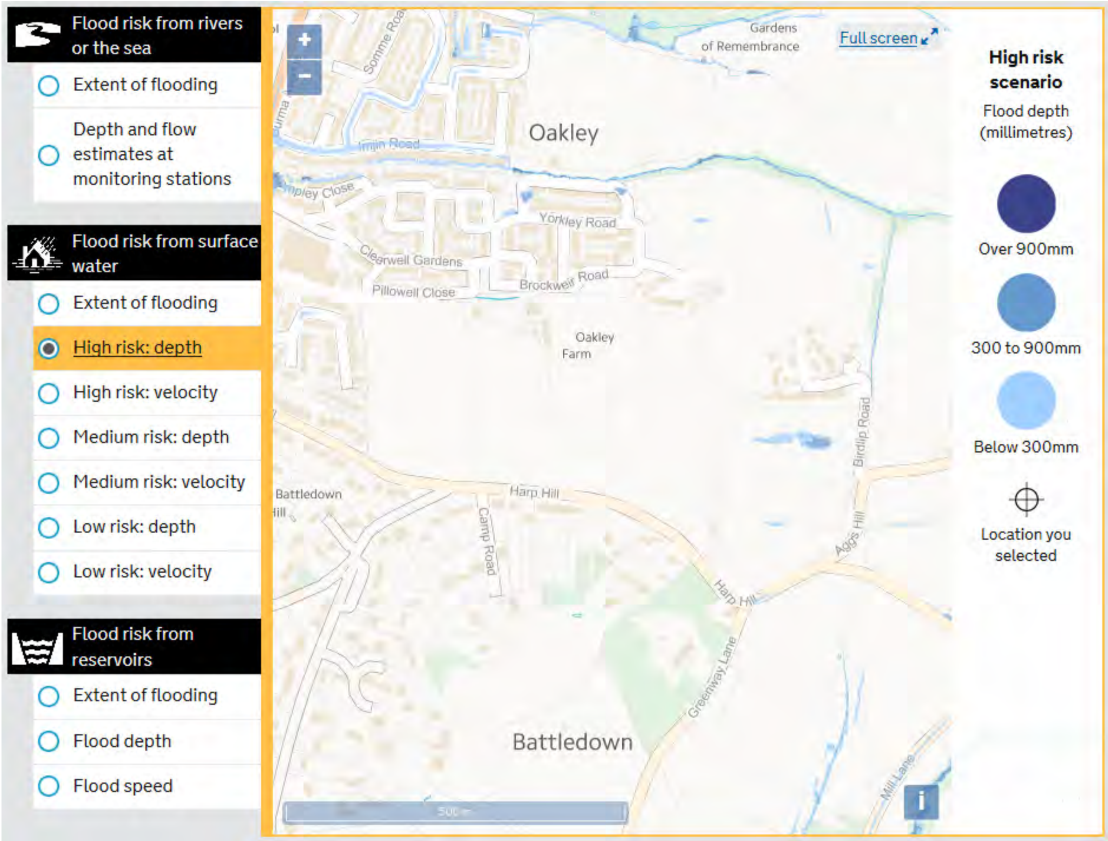
Intense periods of rainfall over a short duration can often lead to overland flow as rainwater is unable to infiltrate into the ground or enter drainage systems. It is made worse when soils are saturated so that they cannot accept any more water. Surface water run-off is currently collected by on site watercourses (ditches).

The Environment Agency online surface water flood maps have been generated by simulating rainfall events over the site to determine where surface flows and collects based on Lidar survey information. The rainfall events chosen for modelling were the 1 in 30, 1 in 100 and 1 in 1000 year storm return periods. These events were modelled for the 1 hour, 3 hour and 6 hour storm durations.

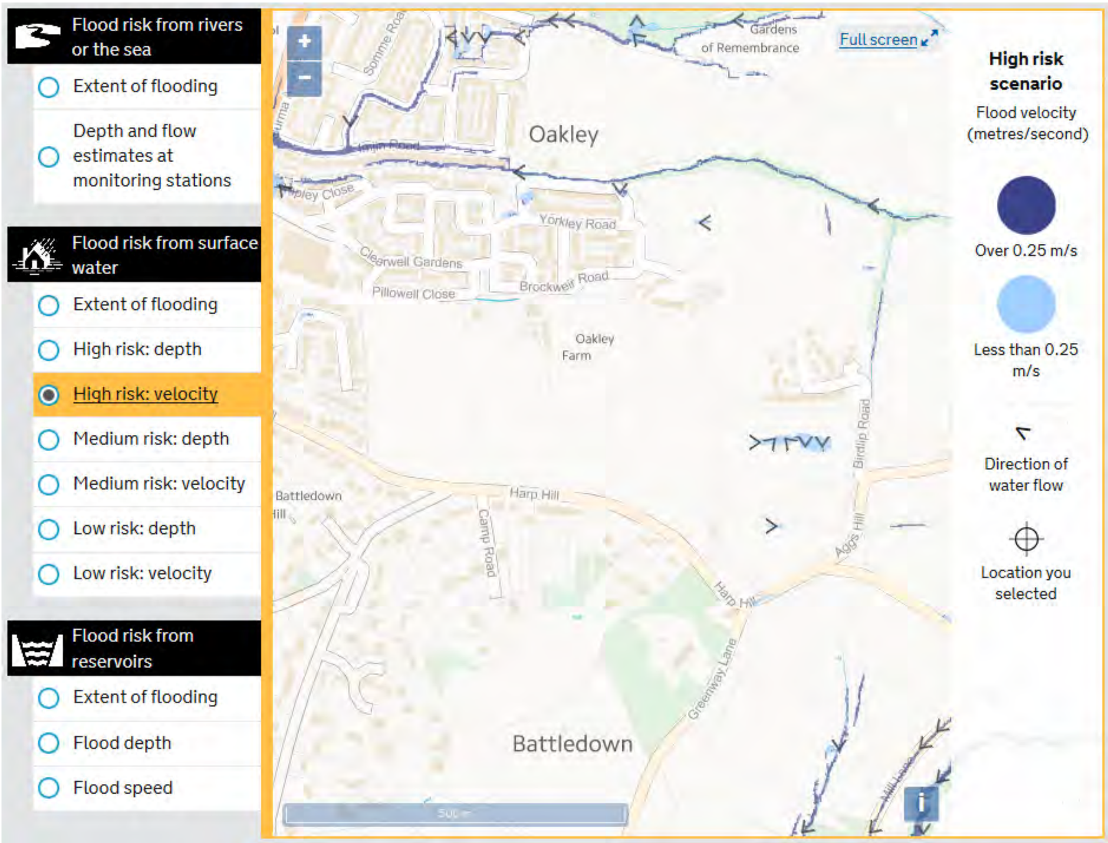
High – Site area that has a chance of flooding of greater than 1 in 30 (3.3%) in every year
Medium - Site area that has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%) in every year
Low - Site area that has a chance of flooding of between 1 in 1,000 (0.1%) and 1 in 100 (1%) in every year
Very Low – Site area that has a chance of flooding of less than 1 in 1,000 (0.1%) in every year



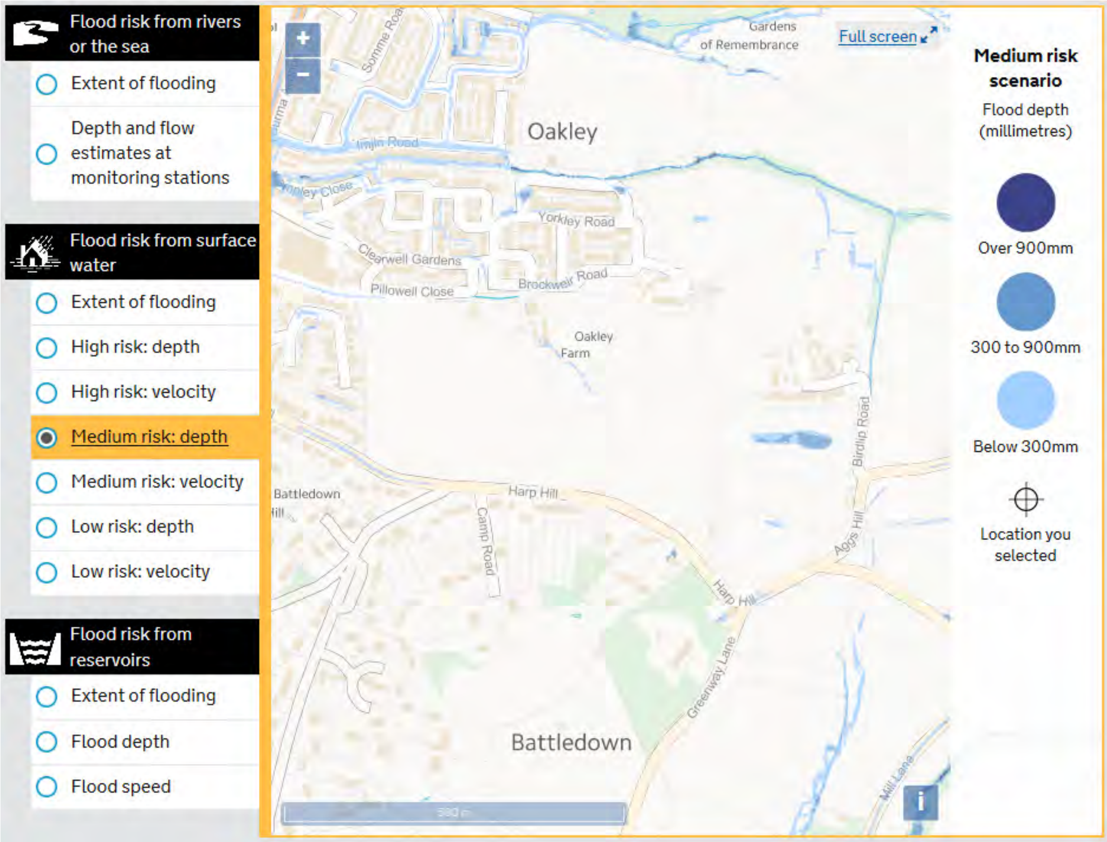
Environment Agency Flood Risk from Surface Water - Extent of Flooding



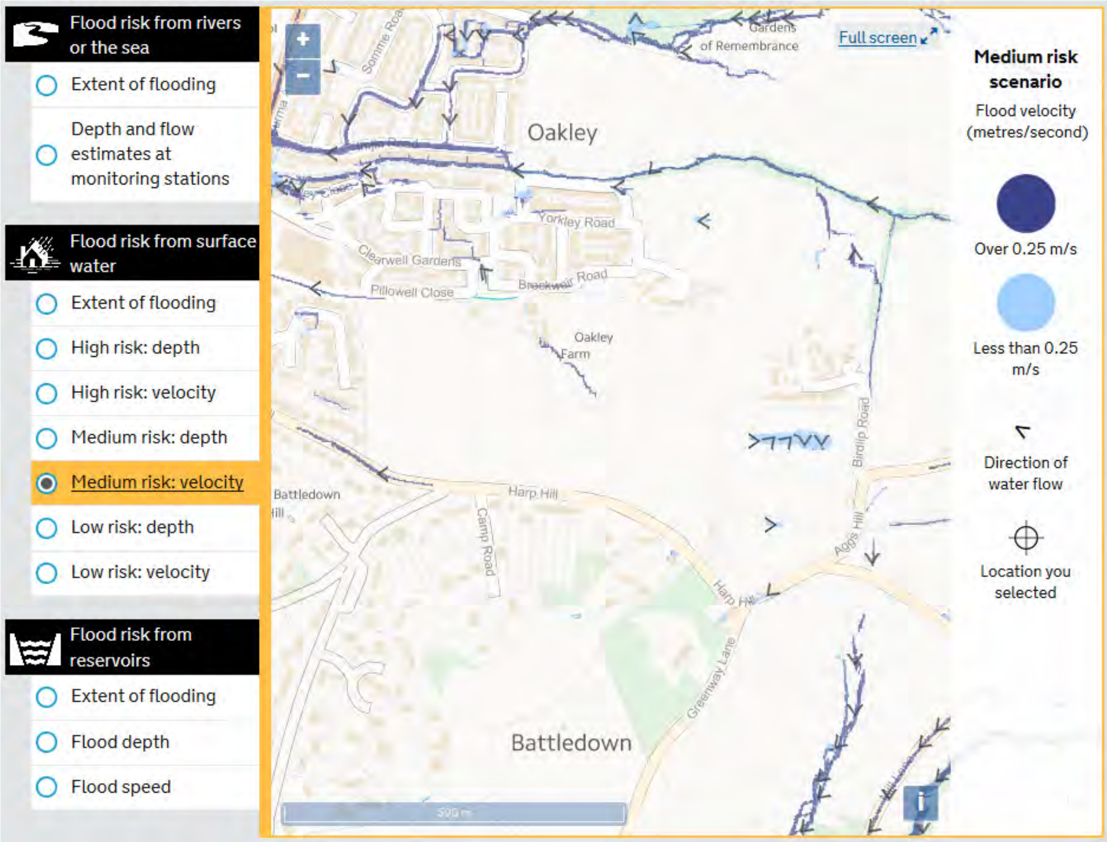
Environment Agency Flood Risk from Surface Water – High Risk Depth



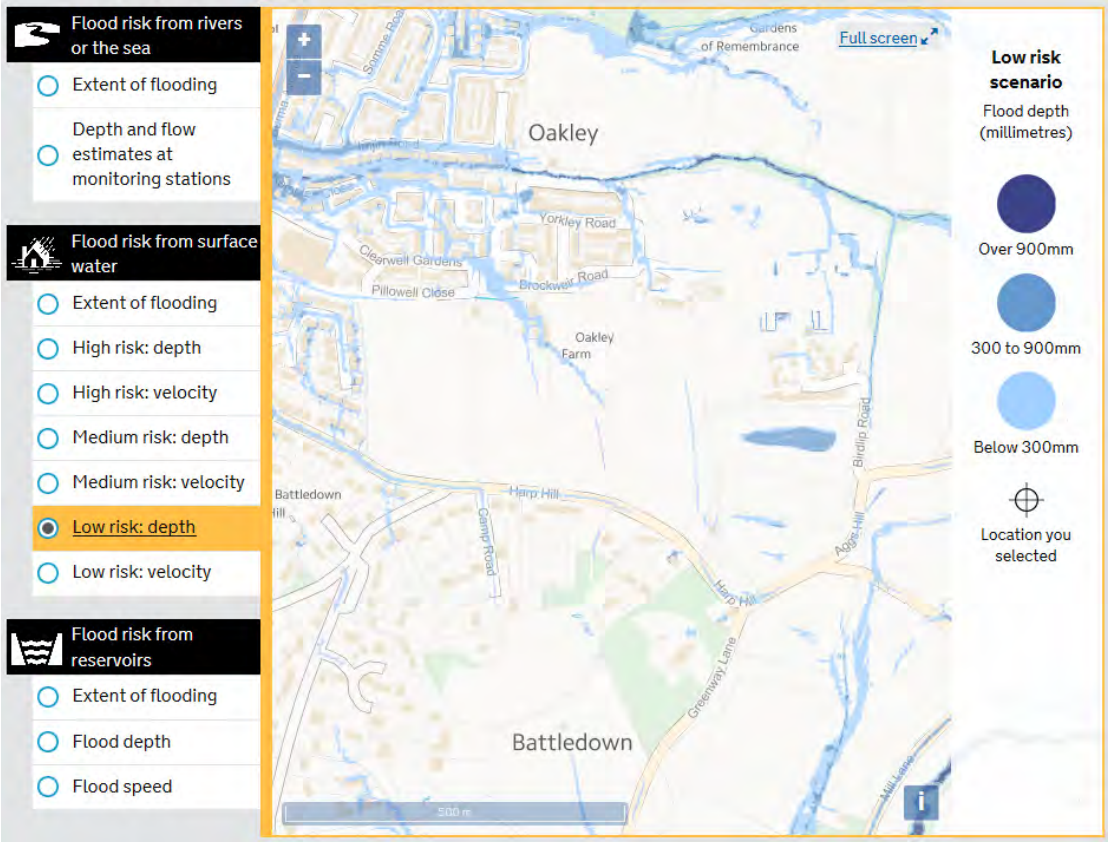
Environment Agency Flood Risk from Surface Water – High Risk Velocity



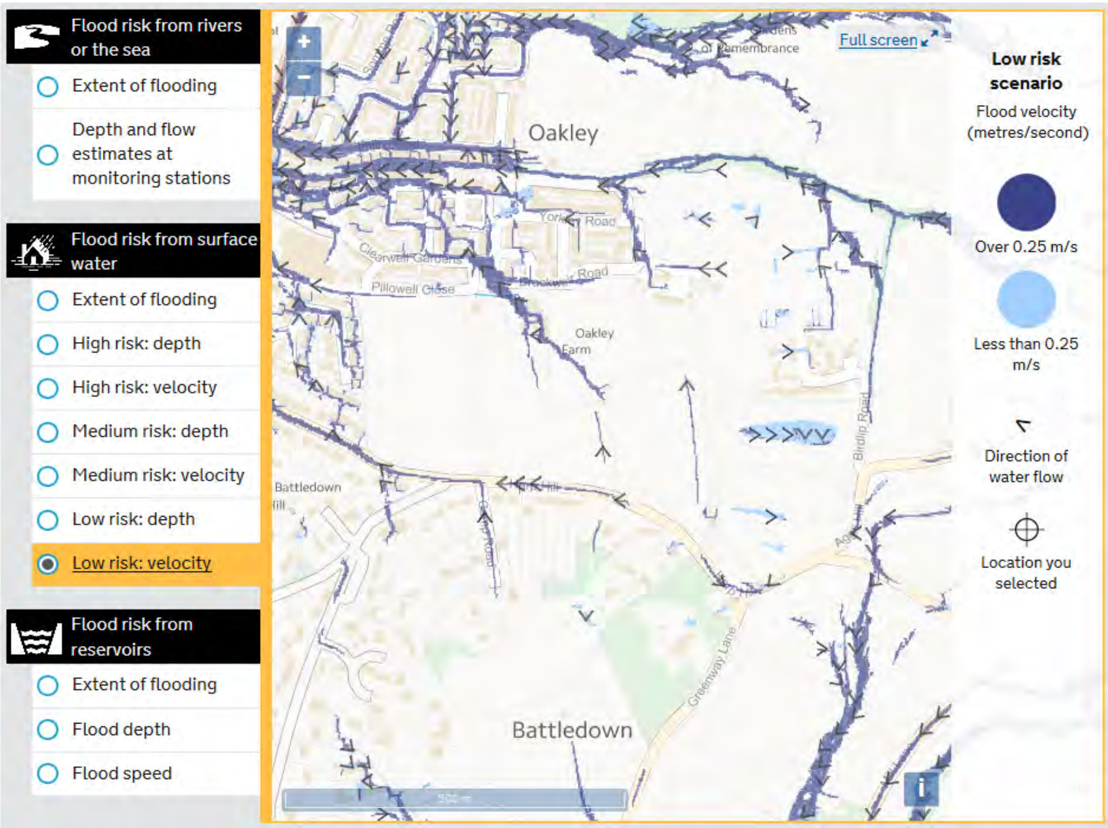
Environment Agency Flood Risk from Surface Water – Medium Risk Depth



Environment Agency Flood Risk from Surface Water – Medium Risk Velocity



Environment Agency Flood Risk from Surface Water – Low Risk Depth



Environment Agency Flood Risk from Surface Water – Low Risk Velocity

The surface water mapping shows that the application site is not located in a high risk depth area. The mapping confirms that rainwater is collected by the internal land drainage ditches (low points within the site) and adequately conveyed downstream. The mapping indicates that the rainfall depth within the existing ditches is less than 300mm deep and therefore all rainfall will be retained in bank (within the existing ditch profile). Although the mapping shows some minor flooding near the old farm buildings where the ditch abuts the access track on the low risk flood depth map, surface water flood maps do not take into account existing culverts, weirs or other structures. The ditch at this location has a 300mm diameter outfall (culvert) and therefore the surface water flood map in this instance does not provide a true representation of the pluvial run-off from the site as the existing culverts and other drainage systems are not explicitly modelled or represented.

Due to the topography of the site rainwater will also naturally collect within the existing land drainage ditches running along part of the northern boundary near Brockweir Road and Pillowell Close and the existing land /collector drains running across the northeastern part of the site.

The surface water run-off from the proposed development will be collected and managed through the use of Sustainable Drainage System. Interception / cut off drains have also been incorporated within the SuDS for the site to capture any potential overland flow and safely convey surface water back to downstram ditch systems to mimic the natural drainage pattern for the site, refer to drawing No. 476-003 “Drainage Strategy” contained within Appendix E.

The existing overland flood routes are shown on drawing No. 476-001 “Existing Hydrology” contained within Appendix B.

5.3.5. Groundwater Flooding

Groundwater flooding occurs when the sub-surface water levels in the ground rise above surface elevations, which is most likely to occur in low lying areas underlain by permeable rocks (aquifers).

Ground water monitoring was undertaken on 17th August, 24th August and 18th September 2019. This showed ground water levels to vary between 1m and 3.76m below existing ground level.

The underlying soils for the site are clays which are impermeable and do not allow the free passage of groundwater and therefore the risk of flooding from ground water is considered negligible for this site. However, in the unlikely event that the ground water table rises above existing ground levels, the proposed development will be designed to ensure flood routes are provided and interception / cut off drains incorporated to either convey or channel groundwater away from site and towards the existing watercourses, mimicking the existing drainage regime for the site.

5.3.6. Flooding from Sewers

Sewer flooding occurs when sewers are overwhelmed by heavy rainfall or when they become blocked. The likelihood of flooding depends on the capacity of the local sewerage system.

There are no existing public sewers within the application site. The nearest public foul and surface water sewers are located within Brockweir Road and Pillowell Close. These roads at located at a lower level than the proposed application site and therefore if flooding did occur, flood water would follow the road levels which fall northwards away from the application site negating any flood risk.

There are a number of private foul and surface water drains associated with the now derelict Oakley farm buildings, however the farm buildings and associated drainage will be removed as part of the proposed development. Existing highway drainage exists within Harp Hill Road to the south of the site. Any potential flooding from this source will be channeled within the existing highway and flow away from the proposed application site. Harp Hill roads falls from east to west at an average gradient of 1 in 28.

On site drainage investigations have found additional private surface water drainage crossing the site. This drainage will be maintained and incorporated within the development. This drainage is located at the low end of the site and therefore any potential flooding from these sources are considered to be low as flood water follow the existing ground contours and flow away from the site.

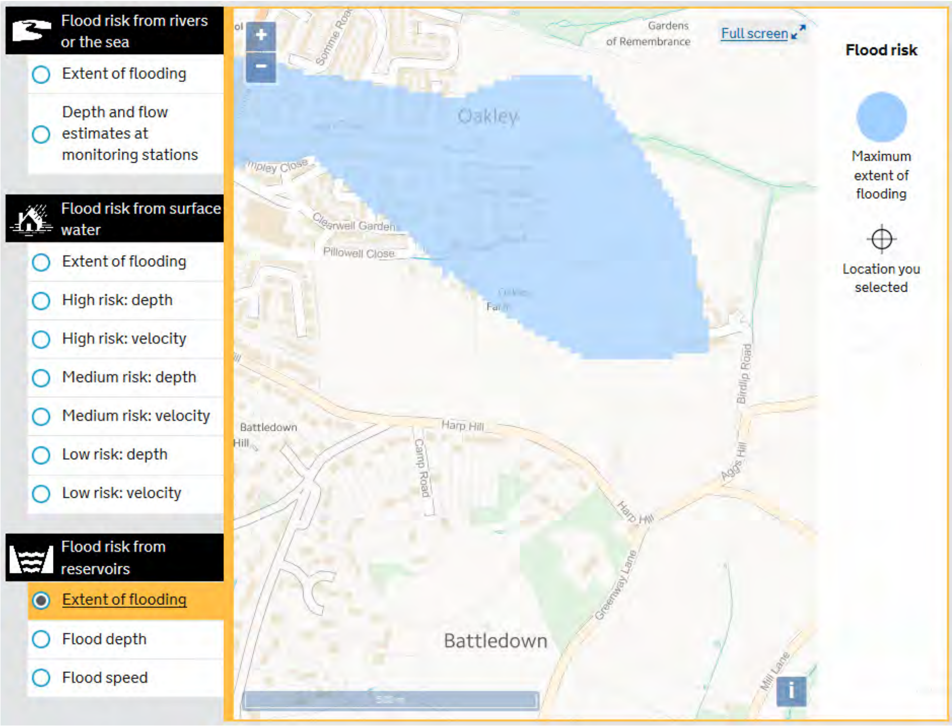
The surface water run-off from the proposed development will be collected and managed through the use of Sustainable Drainage Syetem. This system will be designed to cater for the 1 in 100 year plus 40% climate change without flooding occuring. In the unlikly event that a sewer becomes blocked, or fails or the capacity exceeded the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties.

The risk of flooding from existing and proposed future sewers is therefore considered to be negligible.

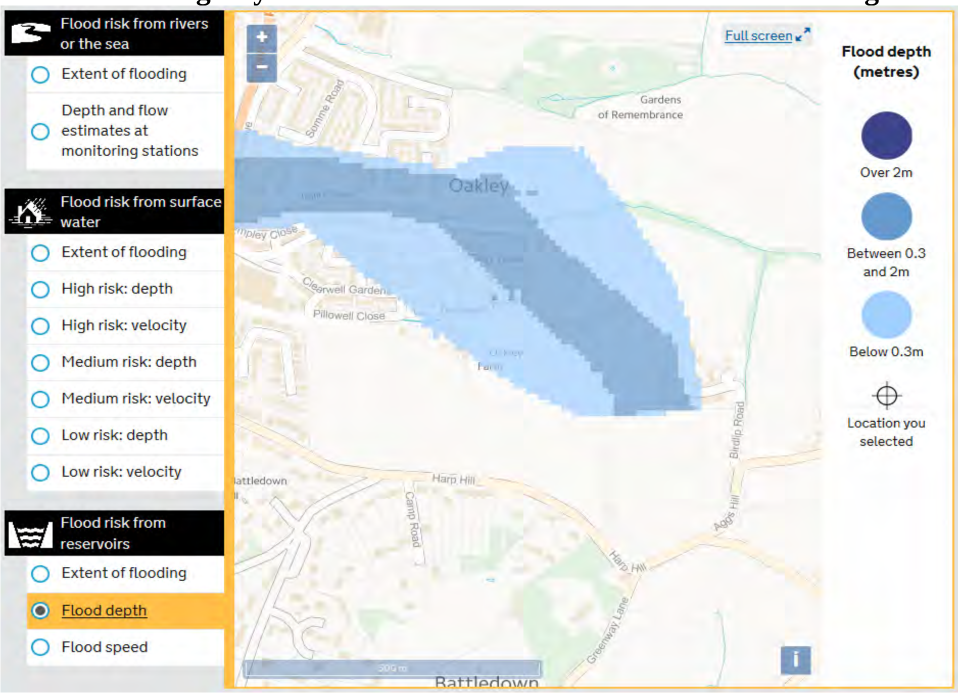
5.3.7. Artificial Sources

Artificial sources of flooding include reservoirs, dams, canals, attenuation ponds and lakes upstream of the site.

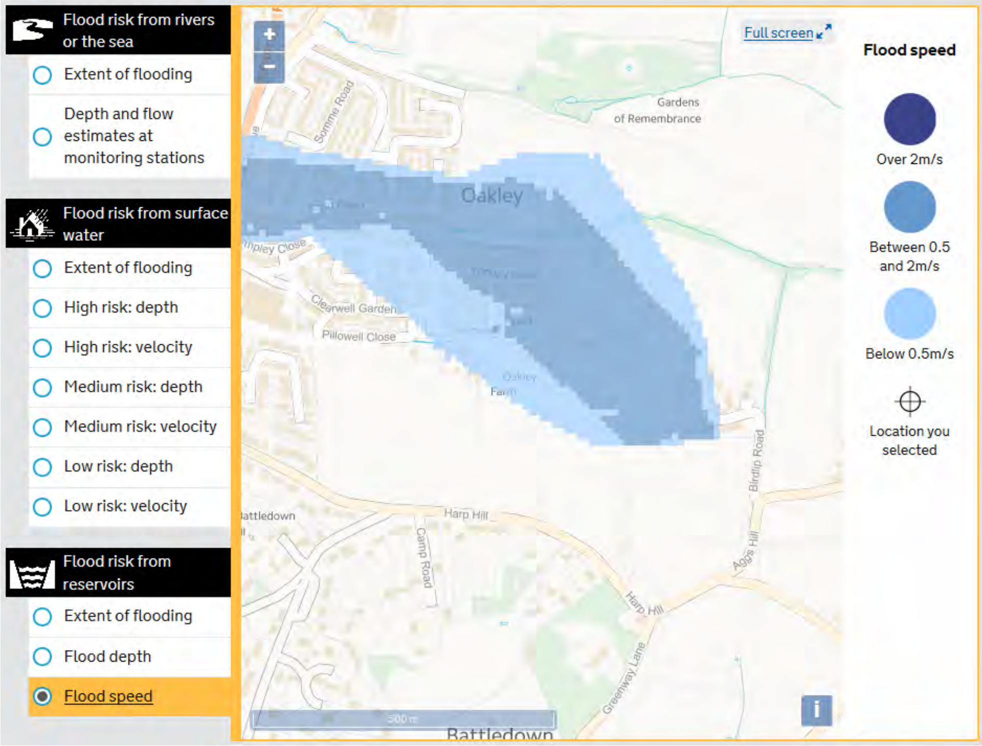
The Environment Agency online mapping below shows that part of the site is located within the flood extents for Hewletts Reservoir's located immediately to the east. Hewletts reservoir's is owned and maintained by Severn Trent Water.



Environment Agency Flood Risk from Reservoirs - Extent of Flooding



Environment Agency Flood Risk from Reservoirs – Flood Depth



Environment Agency Flood Risk from Reservoirs – Flood Speed

It has been reported following consultation with an on-site Severn Trent Water operative that the northernmost reservoir is now empty and has been infilled. The southernmost reservoir is a covered structure and is still operational supplying water by gravity to local residential housing.

Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensure that reservoirs are inspected regularly and essential safety work is carried out. In the unlikely event that the reservoir did flood, flood water would naturally drain towards and be collected by the existing internal land drainage ditches and therefore by safely conveyed through the site.

Therefore the risk of flooding from Hewletts reservoir is considered to be negligible and this has been supported by the approval of the adjoining residential developments to the north, which are equally impacted on the EA maps above.

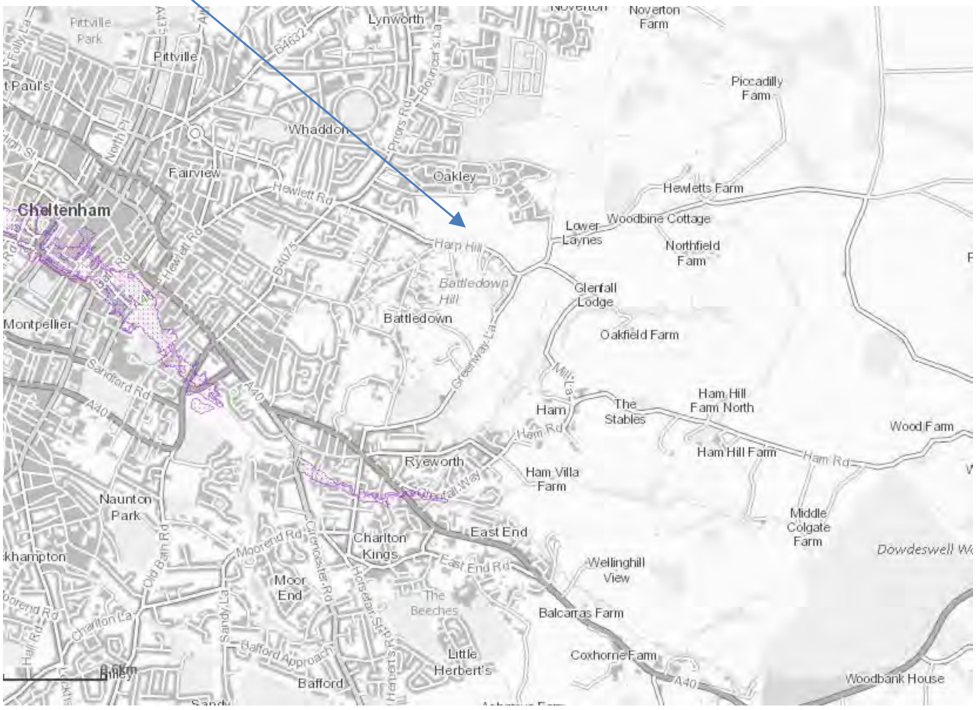
There are no other artificial sources that that could result in flood risk to the application site.

5.3.8. **Flood Warning & Flood Alert Areas**

The Environment Agency maps show details of Flood Warning and Flood Alert Areas.

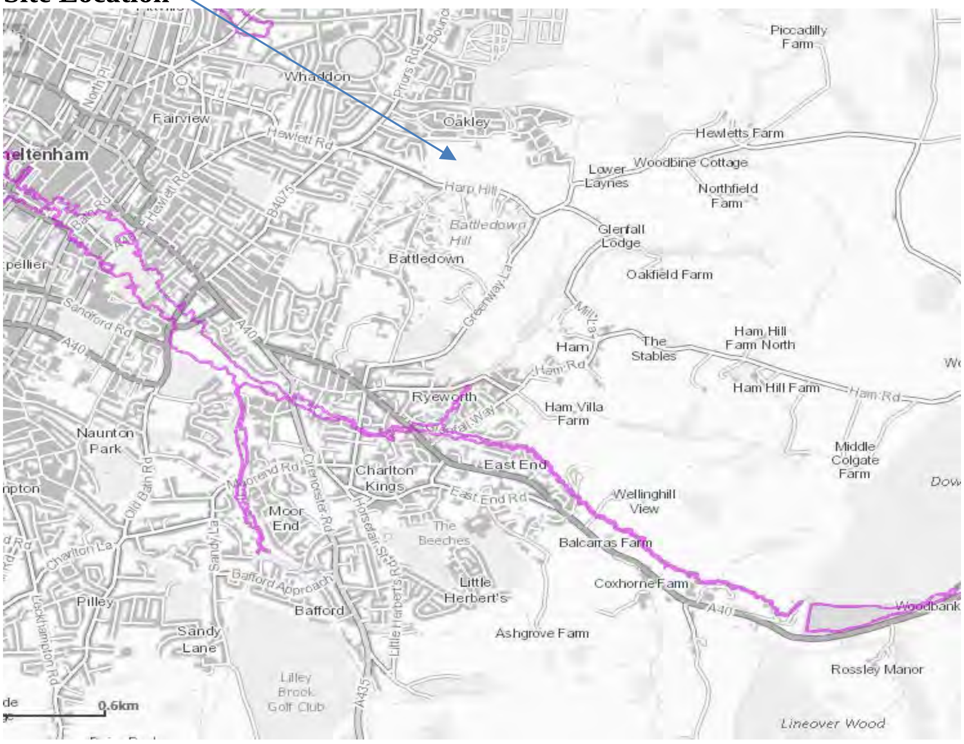
The proposed development site is outside of the flood warning and flood alert areas.

Site Location



Environment Agency Flood Warning Area Map

Site Location



Environment Agency Flood Alert Area Map

5.3.9. Historic Flooding

Recent years have seen a number of large scale flood events throughout the UK including Easter and October 1998, autumn 2000, February 2002, February 2004 and summer of 2007.

The below SFRA map is an extract of an Historic Flood Map for the area. This shows that there has been no historic flooding for the application site.

Site Location

The full SFRA map is enclosed within Appendix C for reference

5.4. Sequential Test

Paragraph 158 of the NPPF states that:

The aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk now or in the future from any form of flooding'.

The application site is located entirely in Flood Zone 1, the proposals are therefore is in accordance with the NPPF sequential approach to locate development in areas of lowest flood risk.

5.5. Exception Test

Paragraph 159 of the NPPF states that:

If it is not possible for the development to be located in zones with a lower risk of flooding (taking into account wider sustainability development objectives), the exception Test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in National Planning Guidance.

Paragraph 160 of the NPPF states that:

The application of the exception test should be informed by a strategic or site specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. For the exception test to be passed it should be demonstrated that:-

- *the development provides wider sustainability benefits to the community that outweigh flood risk, and*
- *the development will be safe for its lifetime taking into account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

The Flood Risk Vulnerability and Flood Zone 'Compatibility' Table 3 within Section 5.3 shows that the proposed development is appropriate and compatible and therefore an exception test is not required.

5.6. Probability of Flood Risk

The EA and SFRA flood mapping has identified that the application site is located entirely within Flood Zone 1 (low probability of flooding having a less than 1 in 1,000 annual probability of fluvial or tidal flooding).

The surface water run-off from the proposed development will be collected and managed through the use of a Sustainable Drainage System. This system will be designed to cater for the 1 in 100 year plus 40% climate change without flooding occuring. In the unlikly event that a sewer becomes blocked the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties.

All flood hazards appropriate for this site have been evaluated within section 5.4. It has been concluded that the application site is not at risk of flooding from all the hazards identified and therefore the probability and consequences of flooding from all sources is considered to be negligible and the risk of flooding low.

6. DEVELOPMENT PROPOSALS

6.1. Development

The outline planning application is for a residential development for up to 250 dwellings associated including infrastructure, ancillary facilities, open space and landscaping with vehicular access from Harp Hill. Demolition of existing farm buildings on site.

6.2. Foul Drainage Strategy

The foul drainage strategy is shown on drawing No. 476-003 “Drainage Strategy” contained within Appendix E. The foul drainage from the site has been designed to connect by gravity to the existing public foul sewer located in Pillowell Close owned and maintained by Severn Trent Water. However, there is an alternative connection point to the existing public sewer located within Priors Road to the west, if required.

Details of this connection will need to be agreed with Severn Trent Water.

Any necessary network upgrades will be provided by the water authority, Severn Trent Water via the new infrastructure charging regime.

All private foul drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the foul sewers to Severn Trent Water for adoption under a Section 104 Agreement in accordance with The Water Industries Act 1991. All details will be subject to technical approval at the detailed design stage as part of the S104 process.

The future management and maintenance of the foul drainage system is discussed in detail within section 8 of this report.

Severn Trent Water Sewer Records
(Full maps are contained within Appendix K)

6.3. Surface Water Drainage Strategy

6.3.1. Sustainable Drainage System (SuDS)

SuDS will be used to manage surface water run-off from the proposed development. The SuDS will be designed to ensure that the existing run-off regime is maintained as closely as possible and that there is no increase in flood risk as a result of the development of the site.

6.3.2. Development Run-off Volume

Guidance recommends that the run-off volume for the 100 year 6 hour event is used to compare existing and proposed volumes. Existing run-off from the development area has been calculated at 3995m3. The developed run-off has been calculated using formulae from Ciria C753 as shown below.

Developed Run-off Volume:

10.RD.A[((PIMP/100)α0.8) + ((1-(PIMP/100))βSPR)] (From Paragraph 24.4)

RD = Rainfall Depth (mm)
A = Catchment Area
α = Proportion of impermeable draining to system at 80% (0.8) run-off (roofs, parking, roads, etc). Can be increased to 100 % for more conservative assessment (will depend on materials, drainage...).
β = Proportion of pervious areas draining to system, 0-1.0 (gardens, open space, etc).

RD: 100 year 6 hour rainfall (6 hours @ 14.373mm/hr, from Micro Drainage) = 86.23mm

A: Site Area (Ha) = 14.76 ha

PIMP: 55%
SPR: Soil Type Standard Percentage Run-off (Soil Type 4 from WRAP Map) = 0.45

Existing 100 Year 6 Hour Volume = 3995m3

Developed 100 Year + 40% 6 Hour Volume = **6886 m3**

The full set of calculations can be seen in Appendix H along with extracts from Micro Drainage showing results.

The calculations show that that there is an increase in the volume of runoff from the development. As the underlying soils are impermeable and are not suitable for infiltration it will be necessary to follow alternative guidance to mitigate for the increase in run-off volume resulting from the development.

To mitigate for the additional run-off volume EA/Defra and Ciria guidance together with BS8582 recommend that Extended Attenuation Storage is provided and that run-off is restricted to the Mean Annual Flood Flow (Qbar) green-field rate for all events above the 1:1 year and up to the 1:100 year with an allowance for climate change.

6.3.3. Surface Water Parameters

An outline surface water drainage strategy has been developed that incorporates a Sustainable Drainage System and is shown on drawing Drg. No. 476-003 “Drainage Strategy” contained within Appendix E. The strategy is intended to provide guidance to inform the detailed design; full details of the SuDS will be submitted as a reserved matters planning application or to discharge a planning condition attached to the outline permission. Detailed designs should be based on the principles established in this FRA and Drainage Strategy.

The surface water drainage and SuDS will be designed in accordance with the following:

- Building Regulations Part H: Drainage & Waste Disposal
- Sewers for Adoption and the requirements of Severn Trent
- Ciria C753: The SuDS Manual.
- BS8582: Code of Practice for Surface Water Management for Development Sites
- Non Statutory Technical Standards For Sustainable Drainage Systems

The hierarchy for the disposal of surface water (Part H of Building regulations) is that rainwater shall discharge to one of the following, listed in order of priority:

a) an adequate soakaway, or some other adequate infiltration system; or, where that is not reasonably practicable,
b) a watercourse; or, where that is not reasonably practicable,
c) a sewer.

6.3.4. Proposed Strategy

The British Geological Survey (BGS) and site specific ground investigation have identified underlying strata to be clay soils representing the Charmouth Mudstone formation. Percolation tests to ascertain soil infiltration rates were carried out in window sampling boreholes WS1 & WS6 in order to determine soil infiltration rates. Due to negligible recorded drainage outflow it was not possible to calculate soil infiltration rate or undertake repeat tests within either test locations. The ground investigation report has therefore concluded that’s SuDS in the form of soakaways is not feasible for this site and has recommended that alternative drainage options are sought.

Outfall into the existing land drainage ditch running along the north western boundary has been discounted as the ditch is very shallow in places and only catered for part of natural run-off from the greenfield site.

The site has therefore been designed to drain to a proposed attenuation pond located within the northwest corner of the site with an outfall to the existing 375mm diameter surface water drain running down the access track to Oakley Farm, which replicates the existing natural drainage pattern for the site as the land drainage ditches collecting the natural greenfield run-off outfall into this existing surface water drain.

The development catchment area draining to the attenuation pond is shown on drawing No. 476-002 “Catchment Areas” contained within Appendix I and equates to 6.85 hectares with an impermeable area of 3.767 hectares.

The attenuation pond has been designed as an online feature to provide storage and treatment to the surface water run-off from the proposed residential development prior to discharging into the existing 375mm diameter surface water drain running down the access track to Oakley Farm. Refer to note below on future adoption of this existing 375mm drain.

To mitigate for the additional surface water run-off volume resulting from the proposed development the Environment Agency/Defra and Ciria guidance together with BS8582 recommends that Extended Attenuation Storage is provided and that run-off is restricted to the existing 1:1 green-field rate for the 1:1 event and the Mean Annual Flood Flow (Qbar, 1:2.3 event) green-field rate for all events above the 1:1 and up to the 1:100 with allowance for climate change. This approach ensures that sufficient run-off is retained on site for extreme events to protect the receiving water course in times of flooding.

In order to restrict the surface water flows a suitable flow control device (e.g. Hydro-brake vortex control) will be used and all flows attenuated within the pond.
The total impermeable area has been calculated based on illustrative masterplan enclosed within Appendix A and equates to be 3.767ha.

Micro-Drainage has been used for the preliminary design of the proposed attenuation pond with results of the modelling are contained within Appendix F and summarised Table 1 below:-

Table 1

Storm Return Period (years)	Stored Volume (m3)	Water Level (mAOD)	Depth of Water (mm)	Existing Greenfield Flow Rate (l/s)	Proposed Flow Rate (l/s)	Freeboard (mm)
1	357	78.880	380	29.45	33.9	1620
30	1007	79.457	957	69.18	34.4	1043
100	1425	79.774	1274	90.42	34.4	726
100+40%CC	2137	80.250	1750	-	35.0	250

Attenuation volumes and discharge rates will be subject to detailed design and will be submitted for approval at the RMA stage to discharge conditions attached to the outline consent.

The proposed surface water sewers to serve the new development will be designed to meet the hydraulic design and construction requirements within “Sewers for Adoption”.

Approval for works to the existing ditches (ordinary watercourses) and proposed outfalls to the existing watercourses may need to be obtained from the LLFA/CBC via an Ordinary Watercourse Consent (land drainage consent) application.

All private surface water drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the new surface water sewers to Severn Trent Water for adoption under a Section 104 Agreement in accordance with The Water Industries Act 1991. All details will be subject to technical approval at the detailed design stage as part of the S104 process.

It is also intended to offer the existing 375mm surface water drain to Severn Trent Water for adoption under a Section 102 Agreement in accordance with The Water Industries Act 1991.

6.3.5. Climate Change

In accordance with the February 2019 EA guidance 'Flood risk assessments: climate change allowances' the SuDS design will consider 20% (central) and 40% (upper end) allowances for the predicted increase in rainfall intensity over the lifetime of the residential development (100 year design life to 2070 to 2115).

Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems.

When to use the peak rainfall intensity allowance

Table 2 shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact.

Table 2 peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

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%

For simplicity and to meet the design criteria above the SuDS will be designed with 40% climate change to allow for the predicted increase in rainfall intensity over the 100-year lifetime of the residential development.

Scientific evidence suggests that 10% of the possible scenarios fall below this upper end value.

6.4. Overland Flows/ Flood Exceedance Routing

The existing onsite and offsite overland flow routes are shown on drawing No.476-001 “Existing Hydrology” contained within Appendix B. The current onsite flow routes will follow the ground contours of the site and fall towards the existing ditch running along part of the northern boundary parallel to Pillowell Close and the 2 No. land drainage ditches located within the site. Interception / cut off drains has been provided to capture any potential run-off from the higher level of public open space located within the application site and direct any flows to the existing land drainage ditch located on the northern boundary of the site mimicking the existing drainage pattern of the site.

The residential development beyond the northern boundary of the site (Pillowell Close / Brockweir Road) and to the west fall away from the application site and therefore does not pose any risk to the proposed development.

The land to the east (Hewletts Reservoir) and residential development could potentially flow on the application site. An interception / cut off drain has been provided along the eastern boundary with outfall to the existing land drainage ditch to provide a high level of protection to the application site in the unlikely event of overland flow occurring or flooding from Hewletts reservoir.

The land and residential housing immediately to the south of the site falls towards the application site. However, overland run-off from this area will be intercepted and captured by Harp Hill road and be channel within the kerbs lines away from the proposed development site.

The surface water drainage system has been designed to cater for the 1 in 100 year plus 40% climate change without flooding occurring. In the unlikely event that a sewer becomes blocked, or fails or the capacity exceeded the proposed development will be designed to ensure flood routes are provided to convey and direct flows through the development without causing flood risk to existing or new properties. Drawing No. 476-003 “Drainage Strategy” contained within Appendix E shows indicative Strategic flood routes and how any flood water will be directed towards proposed SuDS features. A suitably worded condition can be used to secure this surface water construction stage management if necessary.

It is important to note that the proposed flood routes would only come in to use in extreme and exceptionally rare storm events.

6.5. Water Quality

Surface water run-off from the site currently discharges into the existing ordinary watercourse (ditches) along the northern boundary of the site with eventual outfall into the Wyman's Brook located approximately 0.2km to the north of the site.

The Water Framework Directive objective is to achieve good status for all watercourses by 2027. SuDS will be used to ensure that the proposed development will not result in deterioration in the status of the watercourses or compromise the WFD objectives.

The proposed development will include roads, hard standings, roofs and landscaped areas. Run-off from roofs is unlikely to contain significant pollution. Run-off from roads and hard standings will pick up fuel, oil, heavy metals, rubbish and other pollutants. Run-off from landscaped areas could include pesticides and fertilisers.

Higher concentration of pollutants occurs in the early stages of a storm event known as the 'first flush' and is due to higher initial rainfall intensities, greater erosion potential and to greater solids and pollutants that have built up on urban surfaces during preceding dry weather. To remove pollution guidance recommends that the run-off from small frequent events and the initial run-off (first flush) from larger and rarer events is captured and treated using SuDS.

The main techniques used to remove pollutants are filtration and detention. Improvements to water quality can be achieved by filtering the run-off (particularly for small frequent events) using a variety of media such as gravels (permeable paving and filter trenches), grass/vegetation (swales, ditches, basins and ponds). Storing run-off with controlled discharges allows sedimentation to take place which also contributes to water quality improvements.

The following SuDS techniques could be used within the proposed development to help remove pollution:

Trapped Gullies (Access Roads, Drives and Parking Areas) – Sedimentation.
Permeable/Porous Surfaces (Drives and Parking Areas) – Filtration through gravel bases.
Filter Trenches (Roofs, Drives & Parking Areas) – Filtration.
Ditch – Filtration & sedimentation
Ponds – Filtration through aquatic planting & sedimentation.

To remove pollutants, it is generally recommended that the first 5-10mm of rainfall 'first flush' is captured and treated. The total treatment volume provided within the attenuation pond permanent pool equates to 392m3, this is the equivalent of 10mm rainfall over 3.67ha total site impermeable area and therefore meets this requirement. Further treatment can be provided in permeable paved driveways etc, which will provide even further betterment over and above the minimum standard.

During construction there is also an increased risk of pollution particularly from silt and sediment. Temporary pre-treatment might be needed prior to discharge to the main drainage system. Areas of permeable or porous construction will also need to be protected from silt during construction. The contractor will comply with current guidance and good construction practice to ensure that the risk of pollution is managed, details will be agreed with the appropriate approving body. Where required additional measures such as silt screens/fences, silt removal devices such as 'Siltbuster' settlement units can be used to provide further protection.

Prior to completion and handover of the SuDS features to the management body or purchaser excess silt resulting from construction will be removed and any remedial works required carried out to ensure that the features will operate effectively.

Ciria C753, Chapter 26 provides guidance on Water Quality Management: Design Methods. The SuDS pollution mitigation index should equal or exceed the pollution hazard index. Tables 26.2 and 26.3 below provide details of the indices.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

The table below summarizes the Indices for the proposed development.

Pollution Hazard Indices for the Site

Land Use	Total Suspended Solids	Metals	Hydrocarbons
Pollution Index (Residential Roofs)	0.2	0.2	0.05
Pollution Index (Driveways, Residential Roads)	0.5	0.4	0.4

SuDS Mitigation Indices Provided

Type of SuDS Component	Total Suspended Solids	Metals	Hydrocarbons
Attenuation Pond (Permanent Pool)	0.7	0.7	0.5

All surface water run-off from the site will pass through an attenuation pond and therefore this SuDS component alone provides adequate pollution mitigation for the whole of the site. Additional treatment in the form of permeable paving could be provided in car parking areas/private drives to offer further benefits and betterment. Other suitable SuDS techniques are discussed in more detail in Section 6.5. Full details of the SuDS will be provided at detail design stage and will be submitted as part of a reserved matters planning application or to discharge any outline planning conditions relating to surface water drainage and SuDS.

6.6. SuDS Details

Table 7.1 of C753 'The SuDS Manual' provides a summary of the various SuDS components that could be used:

TABLE 7.1 SuDS component delivery of design criteria

Component type	Description	Collection mechanism	Design criteria: Water quantity (Chapter 3): Peak runoff rate	Design criteria: Water quantity (Chapter 3): Runoff volumes: Small events (interceptions)	Design criteria: Water quantity (Chapter 3): Runoff volumes: Large events	Design criteria: Water quality (Chapter 4)	Design criteria: Amenity (Chapter 5)	Design criteria: Biodiversity (Chapter 6)	Further information (Chapter ref)
Rainwater harvesting systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●		11
Green roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●	12
Infiltration systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●	13
Proprietary treatment systems	Subsurface structures designed to provide treatment of runoff	P				●			14
Filter strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○	15
Filter drains	Shallow stone-filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○	16
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●	17
Bioretention systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●	18
Trees	Trees within soil-filled tree pits, tree planters or structural soils used to collect, store and treat runoff	P	●	●		●	●	●	19
Pervious pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○	20
Attenuation storage tanks	Large, below-ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	P	●						21
Detention basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●	22
Ponds and wetlands	Permanent pools of water used to facilitate treatment of runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●	23

Key
P – Point, L – Lateral, S – Surface, ● – Likely valuable contribution to delivery of design criterion, ○ – Some potential contribution to delivery of design criterion, if specifically included in the design

The components identified below are considered to be appropriate for the development:

6.6.1. Water Butts

Water butts could be used for individual dwellings to collect water for reuse externally for irrigation. Any dwelling required to comply with the now withdrawn Code for Sustainable Homes with private gardens will include a water butt for external water use (150l capacity for 1-2 bed & 200l capacity for 3+ bed). Although it is recognised that the treatment benefits are negligible, water butts do have the benefit of reducing potable water demand.

6.6.2. Permeable/Porous Surfaces

Permeable and porous surfaces could be used externally on private driveways and shared parking courts to help reduce run-off and remove urban pollutants. Any pollution will be filtered out by the granular construction and geotextile. Research has also shown that 5mm of rainfall will be retained within the granular construction and that run-off is only likely to take place for rainfall events where the rainfall depth exceeds this figure.

Construction of permeable and porous surfaces will be in accordance with supplier/manufacturer details. Adjacent impermeable surfaces will, where possible, be designed to shed water on to the permeable surfaces. Where practicable permeable/porous surfaces will be used for shared private driveways, private drives and private parking courts.

Because of the impermeable clay soils the permeable surfaces will need to be designed to discharge to the main sewer system and will therefore need to be lined in accordance with the requirements of Severn Trent Water to ensure there is no groundwater ingress in to the sewer system (details will be agreed with Severn Trent Water).

Further guidance on pervious pavements is provided in Chapter 20 of Ciria C753 'The SuDS Manual'. Suitable types of permeable/porous surface include:

a. Permeable Clay & Concrete Block Paving;
b. Porous Asphalt;
c. Porous Bonded & Stabilised Gravels

6.6.3. Filter Trenches

Filter trenches could be used to convey flows, filter flows and provide subsurface storage. Because of the impermeable clay soils the filter trenches will need to be designed to discharge to the main sewer system and will therefore need to be lined in accordance with the requirements of Severn Trent Water to ensure there is no groundwater ingress in to the sewers system (details will be agreed with Severn Trent Water). Further guidance on trenches is provided in Chapter 16 of Ciria C753 'The SuDS Manual'.

6.6.4. Attenuation Pond

A pond will be used to provide surface water attenuation and treatment. Further guidance on ponds is provided in Chapter 23 of Ciria C753 'The SuDS Manual'. Refer to section 8 of this report for further details.

7. ATTENUATION POND DETAILS

7.1. Attenuation Pond Layout

The attenuation pond layouts are shown on drawing 476-003 ‘Drainage Strategy’ contained within Appendix E. A plan and section of the attenuation pond is shown on drawing 476-004 ‘Pond Details & Section’ contained within Appendix J.

7.2. Attenuation Pond Design

The pond has been designed to provide storage and treatment to the surface water run-off from the proposed development.

Hydraulic modelling of the pond has been carried out using micro-drainage with results enclosed within Appendix E for reference and tabulated within Section 7.3. The calculations show that all surface water run-off is restricted to the existing Mean Annual Flood Flow (Qbar, 1:2.3 event) green-field rate for all events above the 1:1 and up to the 1:100 with allowance for climate change in accordance with Ciria C753 ‘The SuDS Manual’. The pond has been designed to have circa 250mm freeboard allowance and a maximum water depth of 1.75m in the 1 in 100 year return period plus 40% climate change allowance.

To provide treatment to the surface water run-off from the development and remove pollutants prior to discharge to the downstream receiving waters, the pond has a permanent pool. The combination of the permanent pool and the use of at source SuDS means that the proposed water quality treatment is in accordance with the recommendations in C753 ‘The SuDS Manual’; refer to Section 6.5 for further details.

7.3. Pond Edge Geometry

The pond has been designed with slopes of 1 in 3 below permanent water level for safety purposes with a shallow zone (aquatic bench) along the edge of the permanent pool to support wetland planting which will act as a biological filter and safety margin. The pond slope above the permanent water level has been designed with 1 in 3 slopes for maintenance purposes. The pond will provide ecology, amenity and biodiversity benefits and will add to the aesthetics of the open space. Ciria C753 recommends max 1 in 3 bank slopes and therefore the proposed pond meets with the requirements of current guidance.

7.4. Landscaping

The landscaping and aquatic planting for the ponds will be designed by the Landscape Architect to provide a diversity of plant species to enhance visual interest and provide a variety of wildlife habitats. Details of the planting will be agreed with the Local Planning Authority and adopting body at the detailed engineering stage and can be secured via a suitably worded condition if necessary.

7.5. Management & Maintenance

For the pond to operate efficiently it will need to be correctly managed and maintained. Please refer to Section 8.7 for further details.

7.6. Pond Access

Vehicle access to the pond will be via the new development roads. A 3m wide grassed maintenance strip will be provided around the pond to allow routine maintenance activities and inspections to be carried out.

7.7. Operation and Maintenance Schedule

Regular inspection and maintenance is important for the effective operation of the pond. Table 23.1 from C753 below can be used as a guide to the routine maintenance and inspections requirements for the pond.

TABLE 23.1 Operation and maintenance requirements for ponds and wetlands

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (during growing season)
	Cut the meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices, eg penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1 m above water level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay.	Every 1–5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays.	Every 5 years, or as required
Occasional maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, eg every 25–50 years
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair / rehabilitate inlets, outlets and overflows.	As required

7.8. Health and Safety

The attenuation pond has been designed as an online hydraulic feature for water quality purposes and is not intended for recreational usage. The pond is located within an area of public open space. Fencing would isolate the pond and reduce its amenity benefit. Barrier planting and landscaping will therefore be used to discourage public access to the open areas of water.

The aquatic bench, although provided primarily for ecological purposes will act as a safety margin helping prevent access to the deeper areas of water in the centre of the pond.

If required safety signage and information boards can be provided around the perimeter of the pond to improve awareness, discourage unauthorised access and inform the public of the potential danger. Fencing or guarding will be provided around any structures such as headwalls where there is a vertical drop of 600mm or more.

The maximum depth of water for the 1 in 100 year + 40% CC for the attenuation pond has been designed to be 1.7m. The half drain down time for this storm return period is 14.8 hours.

The UK Flood Hazard for the attenuation pond has been calculated using the following equation from Defra's Flood Risk to People – Phase 2 document (FD2321/TR2) 2006.

Hazard = d x (v + 0.5) + DF

Where d = depth (m) = 1750mm

V = Velocity (m/s) = Calculated as 0.030m/s

DF = Debris Factor = Zero – No debris expected in pond

1.75 x (0.030 + 0.5) + 0 = **0.927**

Based on the value of the hazard calculated, a Hazard Classification is then assigned. The Flood Hazard classification are divided into four classes of risk:

Flood Hazard Rating & Associated Category

Flood Hazard Rating	Category
0.0 – 0.75	Low
0.75 – 1.5	Moderate
1.5 – 2.5	Significant
>2.5	Extreme

These classes of risk then translate into the following Flood Hazard classification:-

- Class 1: Danger for some – Flood zone with a deep or fast flowing water that presents a hazard for some people (i.e. children).
- Class 2: Danger for most - Flood zone with a deep or fast flowing water that presents a hazard for most people.
- Class 3: Danger for all - Flood zone with a deep or fast flowing water that presents a hazard for all people.

Flood Hazard Classification

Less than 0.75	Very Low Hazard - Caution
0.75 to 1.5	Danger for Some up to 1.5 (Class 1)
1.5 to 2.5	Danger for Most – 1.5 – 2.5 (Class 2)
Greater than 2.5	Danger for All >2.5 (Class 3)

Based upon the hazard value calculated the attenuation pond has a moderate risk category and a Danger for Some flood hazard classification.

A designer risk assessment for the attenuation pond will be undertaken with full safety details considered prior to construction and will be agreed with the Local Planning Authority and adopting body at the detailed design stage.

7.9. Adoption

Details for the adoption and maintenance of the pond will be agreed with the local planning authority prior to construction under the Flood & Water Management Act 2010 (FWMA)

It is anticipated that the pond and SuDS in public/shared ownership will be adopted/owned by:

a. The Local Planning Authority (Cheltenham Borough Council) as part of the open space; or

b. Private Management Company with appropriate experience; or

c. Adopted by Severn Trent Water under a S104 agreement in accordance with Sewers For Adoption 8.

8. MANAGEMENT & MAINTENANCE

8.1. The surface water and foul sewers will be offered to Severn Trent Water for adoption under Section 104 of the water Industry Act 1991. STW will be responsible for the management and maintenance of all public sewers, once vested / adopted.

8.2. Highway drains and gullies will be offered to Gloucester County Council for adoption under Section 38 of the Highway Act 1980. Gloucester County Council will be responsible for the management and maintenance of the highways, including any highway drainage.

8.3. Details for the management and maintenance of any SuDS within shared areas and open space such as the pond will be agreed with Cheltenham Borough Council (CBC) prior to construction but are likely to be managed and maintained by a suitably experienced management company.

8.4. Private on-curtilage foul and surface water drainage, including SuDS, will be the responsibility of the property owner and will be managed and maintained either by the owners or by suitably experienced management company.

8.5. To ensure that any private shared ownership SuDS will operate effectively for its lifetime a management plan for the operation and maintenance of the SuDS will be produced prior to construction and agreed with CBC, based on Chapter 32 of Ciria C753:

TABLE 32.1 Typical key SuDS components operation and maintenance activities (for full specifications, see Chapters 11–23)

Operation and maintenance activity	SuDS component												
	Pond	Wetland	Detention basin	Infiltration basin	Soakaway	Infiltration trench	Filter drain	Modular storage	Pervious pavement	Swale/bioretention/ trees	Filter strip	Green roofs	Proprietary treatment systems
Regular maintenance													
Inspection	■	■	■	■	■	■	■	■	■	■	■	■	■
Litter and debris removal	■	■	■	■	□	■	■	□	■	■	■		□
Grass cutting	■	■	■	■	□	■	■	□	□	■	■		
Weed and invasive plant control	□	□	□	□		□	□		□		□	■	
Shrub management (including pruning)	□	□	□	□					□	□	□		
Shoreline vegetation management	■	■	□										
Aquatic vegetation management	■	■	□										
Occasional maintenance													
Sediment management[1]	■	■	■	■	■	■	■	■	■	■	■		■
Vegetation replacement	□	□	□	□						□	□	■	
Vacuum sweeping and brushing									■				
Remedial maintenance													
Structure rehabilitation /repair	□	□	□	□	□	□	□	□	□	□	□	□	
Infiltration surface reconditioning				□	□	□	□		□	□	□		

Key
■ will be required
□ may be required

9. CONCLUSIONS

9.1. The Environment Agency online mapping reproduced in section 6.3.1 identifies the site as being entirely within Flood Zone 1 (low risk, less that 1:1,000 annual probability of flooding).

9.2. The Gloucestershire County Council Online Flood Map reproduced in section 6.3.2 shows that the proposed application site is located entirely within Flood Zone 1.

9.3. The Cheltenham Borough Council (CBC) Strategic Flood Risk Assessment Level 1 has assessed the risk of flooding from Fluvial (rivers), Tidal (sea), groundwater, surface water, sewers and impounded water bodies (reservoirs and canals). The extent of flooding has been reproduced on flood maps for the CBC SFRA study area. A review of the SFRA maps and report for the proposed development site area has been carried out and commensurate that shown on EA flood mapping, identifying that the proposed development site area is located entirely within Flood Zone 1. Refer to SFRA flood maps reproduced within section 6.3.3 and included within Appendix C.

9.4. Flood risk from all sources (sea, fluvial, pluvial, sewers, groundwater, and artificial) has been assessed and it has been demonstrated that the proposed development will not be at risk from flooding from these sources.

9.5. This site specific FRA has been produced in accordance with the requirements of the NPPF, Planning Practice Guidance, and EA advice notes, and demonstrates that the proposed development will be safe from flood risk and that it will not increase flood risk elsewhere.

9.6. A surface water drainage strategy has been developed that incorporates a Sustainable Drainage System (SuDS) and is shown on drawing No. 476-003 – Drainage Strategy contained within Appendix E. The proposed SuDS will ensure that flood risk resulting from pluvial events (rainfall) will be managed on-site and that flood risk will not be increased elsewhere as a result of the development.

9.7. To mitigate for the additional volume of surface water run-off resulting from the development the peak run-off rate will be restricted to the mean annual flood flow, Qbar (1 in 2.3 year event), for all events above the 1 year.

9.8. A 40% allowance in accordance with EA guidance for climate change has been included in the SuDS assessment to take in to account the predicted increase in rainfall intensity over the lifetime of the development.

9.9. Micro-drainage has been used for the preliminary design of the proposed attenuation pond and ditch system. The results of the modelling are contained within Appendix F and summarised in Table 1, section 7.3. The attenuation volumes and discharge rates shown will be subject to detailed design and will be submitted for approval at the RMA stage to discharge conditions attached to the outline consent.

9.10. Surface water flows will discharge from the attenuation pond to the existing 375mm diameter surface water drain running down the access track currently serving the former Oakley Farm, which replicates the existing natural drainage pattern for the site as the land drainage ditches collecting the natural greenfield run-off outfall into this existing surface water drain.

9.11. The proposed SuDS will provide treatment to the surface water run-off from the development and follows the guidance provided in Ciria C753, 'The SuDS Manual'.

9.12. Flood routes have been provided for exceedance events or for local failure of the drainage system and will ensure that flood flows are directed safely through the development to the downstream attenuation features or into existing watercourses.

The existing onsite and offsite overland flow routes are shown on drawing No.476-001 "Existing Hydrology" contained within Appendix B.

Drawing No. 476-003 "Drainage Strategy" contained within Appendix E shows indicative Strategic flood routes for the proposed development and how any flood water will be directed towards proposed SuDS features.

Please note, the surface water drainage system has been designed to cater for the 1 in 100 year plus 40% climate change without flooding occurring.

9.13. The proposed Sustainable Drainage System for the development will be managed and maintained to ensure that it will operate effectively for its lifetime and has been discussed in detail within section 8 of this report.

9.14. The foul drainage strategy is shown on drawing No. 476-003 "Drainage Strategy" contained within Appendix E. The foul drainage from the site has been designed to connect by gravity to the existing public foul sewer located in Pillowell Close owned and maintained by Severn Trent Water. However, there is an alternative connection point to the existing public sewer located within Priors Road to the west, if required. Details of this connection will need to be agreed with Severn Trent Water.

Any necessary network upgrades will be provided by the water authority, Severn Trent Water via the new infrastructure charging regime.

All private foul drainage for the development will be designed in accordance with the Building Regulations Part H 2015.

It is intended to offer the foul sewers to Severn Trent Water for adoption under a Section 104 Agreement in accordance with The Water Industries Act 1991. All details will be subject to technical approval at the detailed design stage as part of the S104 process.

9.15. The Flood Risk Assessment and Drainage Strategy demonstrates that the proposed development meets with all the national and regional policy requirements, that being, CBC development plan policy CP.3 and Joint Core policy INF2 and satisfies all the criteria of the Environment Agency.

9.16. The Flood Risk Assessment concludes that the site can be safely developed without flood risk and without increasing flood risk elsewhere through the use of an appropriately designed Sustainable Drainage System.

Appendix A

Drawing:

Illustrative Masterplan

Inset

Site Name:	Drawing Number:		Revision:
Land at Oakley Farm	333.P.3.9		A
Drawing Title:	**Drawn By:**	**Date:**	**Scale:**
Illustrative Masterplan	POK	01.08.2019	1:2000@A3

RobertHitchins
The Complete Development Solution

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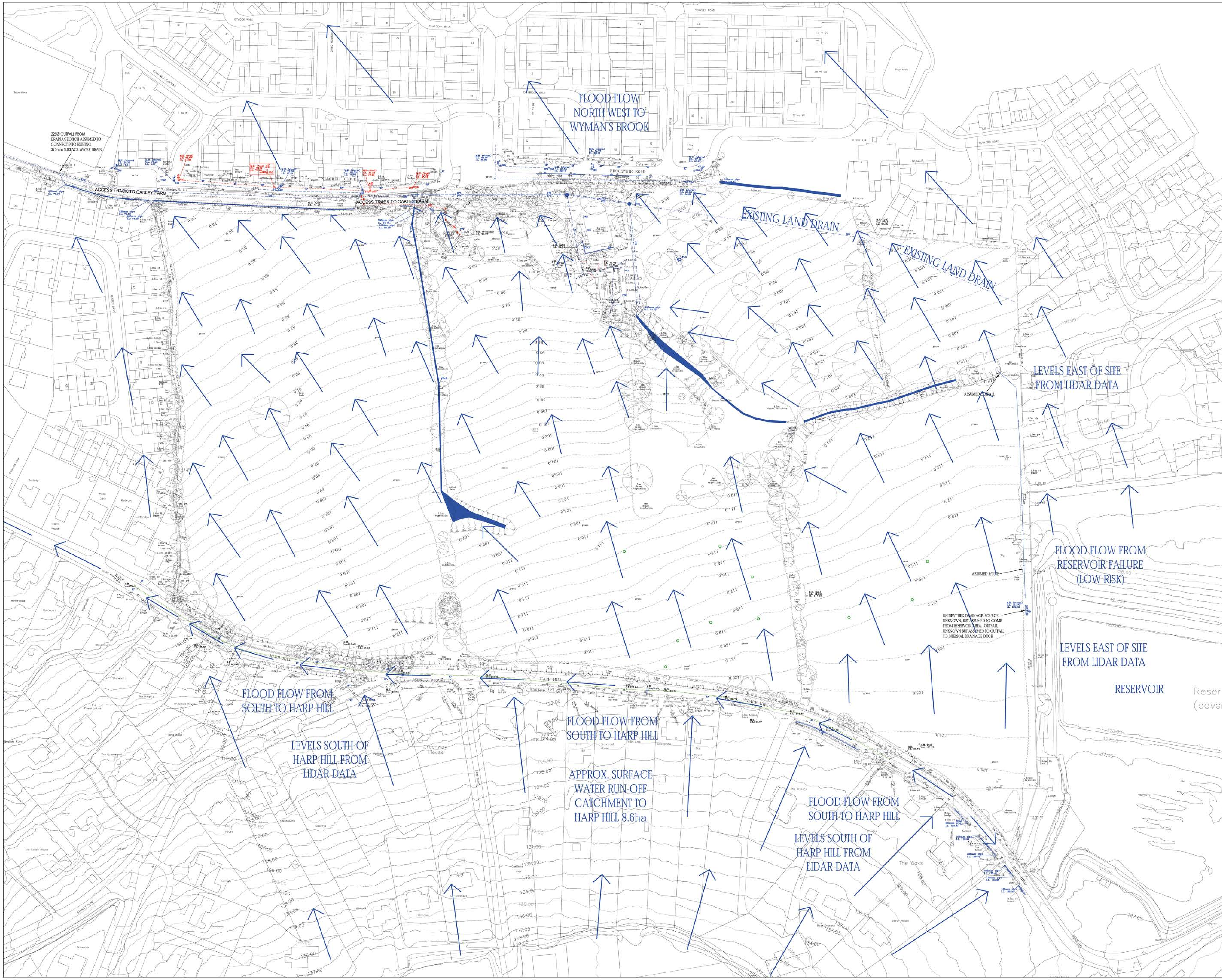
Appendix B

Drawing:

476-001 - Existing Hydrology



LEGEND:

- SURFACE WATER RUN-OFF FLOW DIRECTION
- EXISTING DITCHES/WATERCOURSES
- EXISTING SURFACE WATER DRAINS / SEWERS
- EXISTING LAND DRAINS
- EXISTING FOUL SEWER

Revisions

Project: Oakley Farm, Battledown Cheltenham

Client: Robert Hitchins — The Complete Development Solution

Drawing: Existing Hydrology

Scale: 1:1,000 @ A1 | Date: 13/04/2019 | Drawn by: P.A.

Drawing No: 476-001 | Rev: -

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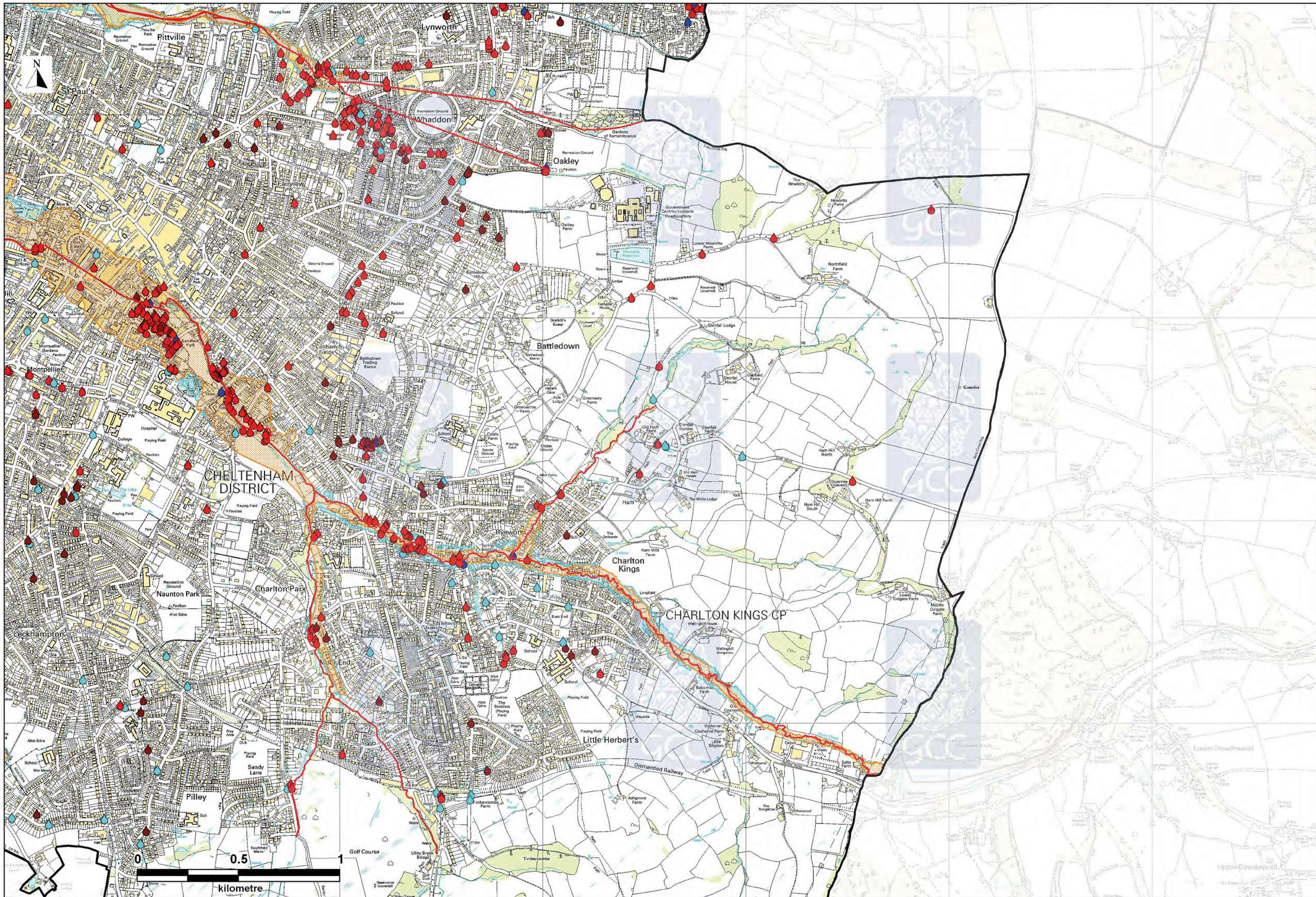
Drg.Status: PRELIMINARY

Appendix C

SFRA Flood Maps



PPS25: Flood Zones Definition

Zone 1 Low Probability

Definition
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Appropriate uses
All uses of land are appropriate in this zone.

FRA requirements
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

Policy aims
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Zone 2 Medium Probability

Definition
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Appropriate uses
The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.
Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.9) is passed.

FRA requirements
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Zone 3a High Probability

Definition
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Appropriate uses
The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone.
The highly vulnerable uses in Table D.2 should not be permitted in this zone.
The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

FRA requirements
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims
In this zone, developers and local authorities should seek opportunities to:
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;
ii. relocate existing development to land in zones with a lower probability of flooding; and
iii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Zone 3b The Functional Floodplain

Definition
This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

Appropriate uses
Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:
- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows; and
- not increase flood risk elsewhere.
Essential infrastructure in this zone should pass the Exception Test.

FRA requirements
All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims
In this zone, developers and local authorities should seek opportunities to:
i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and
ii. relocate existing development to land with a lower probability of flooding.

PPS25: Flood Risk Vulnerability and Flood Zone "Compatibility"

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✓
	Zone 3b "functional floodplain"	Exception Test Required	✓	✗	✗	✗

✓ : Development is appropriate

✗ : Development should not be permitted

PPS25: Flood Risk Vulnerability Classification

Essential Infrastructure	- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	- Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. - Emergency dispersal points. - Basement dwellings. - Caravans, mobile homes and park homes intended for permanent residential use. - Installations requiring hazardous substances consent 19.
More Vulnerable	- Hospitals. - Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. - Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. - Non-residential uses for health services, nurseries and educational establishments. - Landfill and sites used for waste management facilities for hazardous waste 20. - Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	- Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. - Land and buildings used for agriculture and forestry. - Waste treatment (except landfill and hazardous waste facilities). - Minerals working and processing (except for sand and gravel working). - Water treatment plants. - Sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	- Flood control infrastructure. - Water transmission infrastructure and pumping stations. - Sewage transmission infrastructure and pumping stations. - Sand and gravel workings. - Docks, marinas and wharves. - Navigation facilities. - MOD 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.

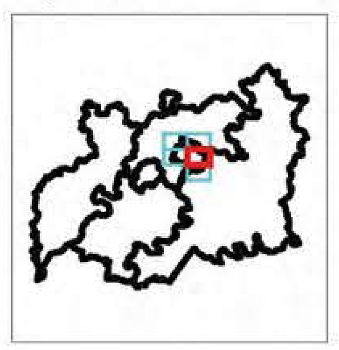
Project:- GLOUCESTERSHIRE STRATEGIC FLOOD RISK ASSESSMENT

Tile B4:- STRATEGIC FLOOD RISK MAP SHOWING FLOODING FROM ALL SOURCES
CHELTENHAM BOROUGH COUNCIL

Rev.	By	Date	Description
A	MJ Grogan	12/08/08	Canal embankments and associated residual risk added

Drawn By	:- A J Bryan	Revision	Drawing Scale :- 1:10,000	Drawing No.	:- WB/GLOS/DRAWING - 038
Checked By	:- B L Dunn	-	Sheet No. :- 4 of 5	Date	:- 26 March 2008
Approved By	:- J R Parkin	Status DRAFT	Plot Scale :- 1:1 @ A1	Issuing Office	:- Birmingham

Key Plan:



NB. The Environment Agency has not produced Flood Zones for catchments with an area less than 3km2. In such instances fluvial flood risk is present but is not illustrated.

Legend:-

- Council Boundary
- Main River Centreline
- Flood Zone 2 (Medium Probability)
- Flood Zone 3a (High Probability)
- Flood Zone 3b (Functional Floodplain) *(Flood Zone 3b is shown to equal Flood Zone 3a where no data exists to differentiate.)*
- Recorded Flooding - Impounded Water Bodies
- Recorded Flooding - Artificial Drainage
- Recorded Flooding - Surface Water
- Recorded Flooding - Fluvial
- Recorded Flooding - Unknown
- Canal Embankments
- Residual Risk

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