RACE
RESIDENTIAL & COMMERCIAL ENGINEERING

Flood Risk Assessment and Drainage Strategy

Proposed Residential Development at Rebecca Road, Pershore

Written on behalf of Lioncourt Homes & Touch Developments Limited

Flood Risk

Transportation

Engineering

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REVISION STATUS

Document / Report Number	LCH – RRP – FRA3

Status	Revision	Date of Issue	Author	Checked
For Approval	1	May 2024	R. Holden	#
	2	July 2024	L. Everiss	#
	3	August 2024	J. Shaw	G. Jones

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1 EXECUTIVE SUMMARY

1.1.1 Residential and Commercial Engineering Ltd (**RACE**) have been requested to carry out a Flood Risk Assessment and Drainage Strategy (**FRA**) by Lioncourt Homes & Touch Developments Limited to support an outline application for the erection of up to 115 dwellings with all matters reserved with the exception of access, including open space, landscaping, drainage and associated works.

1.1.2 This report discusses the risk of flooding to the site and the potential consequences. It then assesses the development proposals and the impact of potential flooding based on these. Future ground levels and drainage proposals are also considered as part of the assessment.

1.1.3 Methodology - A comprehensive assessment including the review of the surface water drainage hierarchy was carried out in accordance with the requirements of the NPPF, Planning Practice Guidance, and EA advice notes, to ensure compliance with all these relevant guidance and that it results in a minimal risk of flooding, whilst providing a drainage strategy to inform any future detailed engineering designs. The general methodology of this report (including outflow rates & SuDS strategies) should be adhered to during any subsequent detailed engineering designs.

1.1.4 The report has been compiled with regard to all relevant national and local legislation, guidance and advice.

1.1.5 This report also considers the latest update to the 'National Planning Policy Framework' which was published in December 2023, along with South Worcestershire Development Plan policy SWDP29.

CONCLUSIONS

1.1.6 This assessment shows that the proposed development can be accommodated in its proposed location with low risk of flooding to the development site and no increase in risk of flooding to adjacent properties, whilst maintaining the existing Greenfield flow rates from the proposed site to the downstream network. This will result in significant reductions in flows for all storm events when measured against existing greenfield run-off, and will be a benefit of the development.

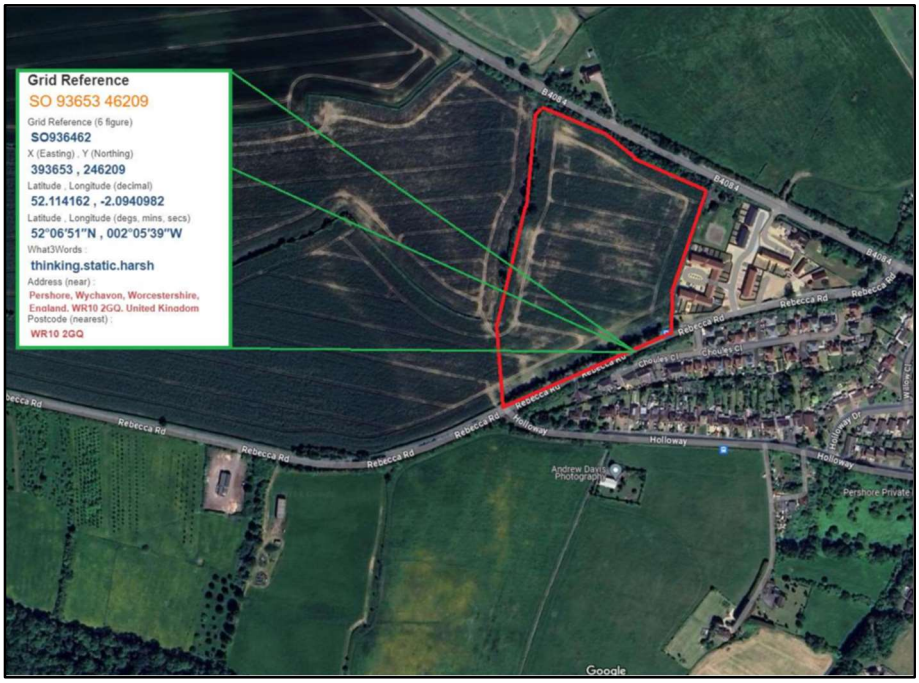
1.1.7 The proposed drainage strategy has taken into consideration the mitigation measures mentioned within this FRA, including the appropriate use of SuDS [and their long-term maintenance].

1.1.8 This report concludes that there will be no increase in flood risk due to the construction of the proposed development, and that it is in accordance with SWDP29 and there should be no reason to refuse the planning application on the grounds of flood risk.

2 EXISTING SITE

2.1.1 The existing site outline comprises of an agricultural field, which is approximately 4.96 Ha in area.

Figure 2.1 Site Location



2.1.2 Looking at the Topographical Survey in **Appendix A**, the site falls generally from the East to the Western boundary of the site from the highest level of around 55.3m AOD to the lowest level of 46.0m AOD.

2.1.3 A Site Location Plan is shown above and the relevant Lead Local Flood Authority (**LLFA**) is the Worcestershire County Council, the relevant local Environment Agency Office (**EA**) is Tewkesbury. The relevant Local Planning Authority (**LPA**) is the Wychavon District Council and the site is within the Severn Trent Water (**STW**) company area.

2.1.4 This existing site is bordered by the following;

- **North** – The North of the proposed development is bound by Allesborough Hill (B4084).
- **East** – The proposed development is bound by existing residential properties served off Rebecca Road.

- **South** – The proposed development is bound to the South by Rebecca Road.
- **West** – The proposed development is bound by hedgerow and an open agricultural field.

2.1.5 The nearest watercourse is the Bow Brook, approximately 830m to the west. The Brook is classified as Main River and is the responsibility of the Environment Agency. The hedgerows in and around the site have shallow ditches in places. The ditch running along the southern boundary link seems to indicate that it flows west to Bow Brook.

2.1.6 OS mapping of the vicinity of the site indicates that the general topography falls to the west of the site with any overland flows running towards the ditch running along the northern side of Rebecca Road.

Figure 2.2 General topography

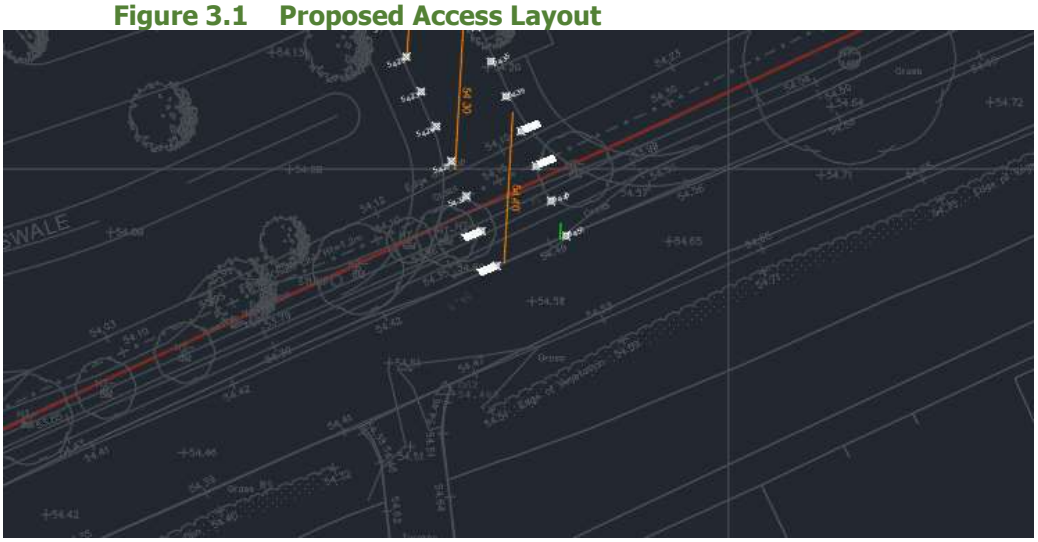
2.1.7 The Phase 1 Desk Study undertaken by Georisk Management in May 2024 identified the existing ground conditions that the site was located in as an area of the Charmouth Mudstone formation of the Lias Group (see Georisk Report section 6.1 in **Appendix B**). From the information available it was concluded that infiltration is not a suitable solution for the disposal of surface water run-off from the proposed site (see Georisk report section 8.6).

3 PROPOSED SITE

3.1.1 The proposed development is for the erection of up to 115 dwellings with all matters reserved with the exception of access, including open space, landscaping, drainage and associated works. See **Appendix C**.

3.1.2 The proposed site will gain access from Rebecca Road on the Southern boundary of the development. This can be seen in the below figure;

Figure 3.1 Proposed Access Layout



4 POLICY FRAMEWORK

4.1 NATIONAL PLANNING POLICY FRAMEWORK

4.1.1 The National Planning Policy Framework (**NPPF**), published in December 2023, provides an assessment and management of flood risk for proposed developments within England. This is not specific to just residential developments however is used when completing new development as a guide. Within the NPPF there is associated Planning Practice Guidance which should also be considered when developing any new development.

4.1.2 Within the NPPF there is a section specific to "Planning and flood risk" which identifies the below;

PLANNING AND FLOOD RISK

165. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

166. Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.

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

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

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

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

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

168. The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.

169. If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable 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 Annex 3.

170. 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. To pass the exception test it should be demonstrated that:

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

171. Both elements of the exception test should be satisfied for development to be allocated or permitted.

172. Where planning applications come forward on sites allocated in the development plan through the sequential test, applicants need not apply the sequential test again. However, the exception test may need to be reapplied if relevant aspects of the proposal had not been considered when the test was applied at the plan-making stage, or if more recent information about existing or potential flood risk should be taken into account.

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

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

b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

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

d) any residual risk can be safely managed; and

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

174. Applications for some minor development and changes of use60 should not be subject to the sequential or exception tests but should still meet the requirements for site-specific flood risk assessments set out in footnote 59.

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

a) take account of advice from the lead local flood authority;

b) have appropriate proposed minimum operational standards;

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

d) where possible, provide multifunctional benefits.

4.1.3 The NPPF has been reviewed and considered when completing this FRA and drainage strategy.

4.2 PLANNING PRACTICE GUIDANCE: 2014 (UPDATED 2022)

4.2.1 The Section 'Site-Specific Flood Risk Assessment' (August 2022): The National Planning Policy Framework sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed. The main steps to be followed are set out in the guidance which, in summary, are designed to ensure that if there are better sites in terms of flood risk, or a proposed development cannot be made safe, it should not be permitted.

4.2.2 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. Detailed guidance on climate change allowances for fluvial flows and rainfall intensity over the lifetime of development is included in the document 'Flood Risk Assessments: Climate Change Allowances' issued by the Environment Agency.

4.3 WYCHAVON DC FLOOD & WATER MANAGEMENT SPD

4.3.1 This Supplementary Planning Document (SPD) for South Worcestershire, which includes Wychavon, was completed in July 2018 and aims too 'to provide guidance on the approach that should be taken to manage flood risk and the water management as part of new development proposals.'

4.3.2 The SPD outlines key legislation, both national and local, that needs to be considered as well as detailing local stakeholders (Such as EA, LLFA, IDB, Sewage Undertakers etc.).

4.3.3 The SPD describes the requirements of the FRA, the most salient being as follows:

Ensure only appropriate new development is located in areas at risk of flooding through:

- *Ensuring that Site Specific FRA's are undertaken where required with relevant incorporation of Climate Change.'*
- *Requiring provision of floodplain compensation where necessary.*
- *Ensuring 'vulnerable uses' are not permitted in inappropriate areas.*

Prevent flood exacerbation for all development proposals through:

- *The inclusion of Sustainable Drainage Systems (SuDS) including permeable paving, planted roofs, filter drains, swales, basins and ponds wherever appropriate.*
- *The provision of on-site storage capacity for surface water attenuation for storm events up to the 1 in 100 years (1%) probability event including an appropriate allowance for climate change.*
- *The use of porous materials to reduce surface water run-off in new developments and applications for changes of use.*
- *The provision of Green Infrastructure, where necessary, to reduce surface water run-off within developments.*
- *Requiring, as a minimum, for Greenfield and Brownfield sites, that the post-development surface water run-off rate will not increase.*

Promote effective water management through:

- *The installation of water efficiency devices in new developments including water harvesting, saving and recycling in any new built scheme wherever practical/ viable.*

Maintain water quality through:

- *Appropriate water management techniques to, at the very least, maintain existing hydrological conditions and prevent adverse effects on the natural water cycle caused by surface water pollution and discharges into watercourses and groundwater.*
- *Reducing negative impacts on, and maximising biodiversity gain and amenity interest*

Reduce negative impacts on and maximise biodiversity gain and amenity interest through:

- *Establishing coherent ecological networks.*
- *Requiring developers to demonstrate that SUDs schemes will benefit water habitat and biodiversity.*

4.3.4 The drainage strategy will need to demonstrate that run off is restricted for events from the 1:1 year up to the 1:100 year with a suitable allowance for climate change with attenuation provided in 'Surface SuDS Elements' wherever possible, such as a Pond, Basin or Swale.

4.4 CIRIA C753 – THE SUDS MANUAL.

4.4.1 Ciria C753 'The SuDS Manual' published in 2015 (latest v6 2019) provides comprehensive guidance on the implementation of Sustainable Drainage Systems (SuDS) in the UK. C753 guidance should be used to help develop the strategy and design of the SuDS.

4.4.2 SuDS techniques are believed to be critical for the future delivery of managed runoff from new and re-developed sites.

5 CURRENT FLOOD RISK

5.1 FLOOD MAP FOR PLANNING

5.1.1 According to the EA's indicative Flood maps for planning, (which are a guide to the extent of the existing significant flood plains), the site lies within flood zone 1, which is an area with a low probability of Flooding. All the proposed properties within the site will be located within this flood Zone 1.

5.1.2 All of the EA Flood Plain maps are shown in **Appendix D**.

5.2 FLOODING FROM MAIN RIVERS & SEA

5.2.1 There are four categories of flood risk from Main Rivers & Seas:-

- ***Very low risk*** *means that each year this area has a chance of flooding of less than 0.1%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail.*
- ***Low risk*** *means that each year this area has a chance of flooding of between 0.1% and 1%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail.*
- ***Medium risk*** *means that each year this area has a chance of flooding of between 1% and 3.3%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail.*
- ***High risk*** *means that each year this area has a chance of flooding of greater than 3.3%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail.*

5.2.2 According to the EA's indicative Flood Plain maps for Long Term Flood Risk, the site lies within a **very low risk** area, falling within the EA category of 0.1% (1 in 1,000) or less. It should be noted that the proposed development is outside any flood extents generated by either rivers or the sea.

5.3 FLOODING FROM SURFACE WATER

5.3.1 The mapping for surface water by the Environment Agency is created by dropping a volume of rainfall on the land for three different storm events (0.1%, 1% & 3.3%) and modelling where it flows , and also the depth and velocity of the flow. This modelling doesn't include for smaller bridges, culverts etc. and is only intended to provide guidance on areas where flood risk from surface water needs to be considered in more detail.

5.3.2 The EA's Flood Map for Surface Water shows that the proposed development is showed to have a Low Risk (between 0.1% and 1%, or 1:1,000 to 1:100) of being affected by surface water flooding, with only a very minor amount of flooding at the central point along the western boundary with the flooding running west away from the site.

5.3.3 In addition the mapping reveal that the depth of this flooding is less than 300mm, with a high flow velocity running away from the site. Taking into account its location within the site this flooding is likely to be eliminated once the development has been constructed, as any overland surface water flows will be directed into the new sewer system for the site, thus ensuring that the development is not at risk from surface water

5.3.4 Based on the above it is considered that the risk of flooding from surface water flooding is considered to be **low**.

5.4 FLOODING FROM RESERVOIRS AND CANALS

5.4.1 The site is not affected by reservoir flooding, with the nearest flooding being in excess of 800m to the west associated with Bow Brook.

5.4.2 Based on this the risk from reservoir & canals flooding is considered to be **low**.

5.5 GROUNDWATER FLOODING

5.5.1 Groundwater flooding occurs where water levels build up and rise above the ground level in low areas, resulting in flooding.

5.5.2 The Georisk report concluded that the soils on this site are generally impermeable clays with limited capacity for groundwater movement.

5.5.3 There is no records of any incidents of groundwater flooding within the vicinity of the site.

5.5.4 The resultant risk of flooding from groundwater is **Low**.

5.6 SEWER FLOODING

5.6.1 STW records identify that there are several sewers in the vicinity of the site;

- There is a 150mm diameter Sever Trent Water foul sewer within Choules Close [on the opposite side of Rebecca Road to the site]. The capacity of the sewer is greater than the likely peak flows so flood risk from it is low.
- There is also a Surface water sewer in Choules Close [pipe size unknown].
- There are foul and surface water sewers in the adjacent development to the east. The sewers and development levels will be designed to ensure that there is no risk of flooding to its development or the surrounding area.

5.6.2 Flood risk from the sewers in Choules Close, and those within the adjacent development to the east are very low, and there are no formal records of previous flooding from sewers.

5.6.3 The risk of flooding from Sewers is therefore **Low**.

5.7 SUMMARY TABLE

Table 5.1 Risk of Flooding

Fluvial Flooding (Rivers and Sea)	**Flood Risk Rating**	**Very Low**
The Environment Agency (EA) Fluvial Flood Map shows the site is within Flood Zone 1. Zone 1 indicates an Annual Exceedance Probability (AEP) of not greater than 0.1% (Probability 1 in 1,000 year) flood risk – Low Probability. Residential developments are classified as "more vulnerable" developments in the current National Planning Policy Framework (NPPF). Developments of this "more vulnerable" nature are considered appropriate in Flood Zone 1. As the access is situated within EA Flood Zone 1 and there is no history of flooding at the site, it is considered all access and egress routes to the site are safe.		
Groundwater Flooding	**Flood Risk Rating**	**Low**
The SFRA or Georisk report didn't highlight any groundwater flooding concerns. Based on the above it is considered that the risk of flooding from groundwater is low.		
Pluvial Flooding (Surface Water)	**Flood Risk Rating**	**Low**
EA Updated Flood Map for Surface Water (1,000-year event) only shows some areas of shallow surface water flooding associated with the low point on the western boundary of the site. Based on these being kept within the drainage strategy for overland flows it considered this is a low risk for the site. Based on the above it is considered that the risk of flooding from surface water is low.		
Sewer Flooding	**Flood Risk Rating**	**Low**
At the stage of completing this report there were no records available to suggest the site would be affected by sewer flooding. Based on the above it is considered that the potential risk of flooding from existing and proposed sewers is low.		
Flooding from Other Sources	**Flood Risk Rating**	**Low**
Based on a review of the EA Reservoir Inundation maps and the Ordnance Survey mapping of the area around the site it is considered that the site is not at significant risk of flooding from artificial sources such as reservoirs and canals. Based on the above it is considered the risk of flooding from other sources is low.		

6 MITIGATING FUTURE FLOOD RISK

6.1 RISK FROM SITE SEWERAGE SYSTEMS & FLOODING FROM OTHER SOURCES

6.1.1 Site sewerage will be designed so as not to cause flooding on the site itself or to increase the risk of flooding to adjacent properties. In addition, the site sewerage will be designed to Greenfield run off rates and incorporate an allowance for climate control and any necessary urban creep.

6.1.2 In addition, the following mitigation measures highlighted within this FRA should be noted and adhered to;

- *Safe dry access/egress will be provided to all dwellings.*
- *The external ground levels adjacent to the dwellings will be generally set 150mm below the finished floor levels in order to reduce the risk of overland flows entering the property. Where flush thresholds are required, these must be ramped up to the finished floor level to maintain the required level difference.*
- *Wherever possible, the external ground profile around buildings will ensure that surface water is directed away from the building.*
- *An increase of **10%** should be applied to any impermeable area to allow for future development/extensions etc [urban creep]. Dependant on the final density of the development this value could be reduced.*

6.1.3 Based on current guidance the allowance for climate change is calculated based on river catchment. The site is located within the River Avon Warwickshire Management Catchment. The allowance to use is the upper value for a development life of 2080's. Table 6.1 below shows that an allowance of **59%** should be applied when the design of the surface water attention is undertaken.

Table 6.1 Allowance for Climate Change

Avon Warwickshire Management Catchment peak river flow allowances

	Central	Higher	Upper
2020s	7%	12%	22%
2050s	8%	14%	31%
2080s	21%	32%	59%

This map contains information generated by UK Centre for Ecology and Hydrology using UK Climate projections.

6.1.4 It is considered that the measures described above provide adequate protection against flooding.

6.1.5 Table 6.2 below identifies the future vulnerability to flood risk for the development.

Table 6.2 Flood Risk Vulnerability of the Development

Sources of Flooding	Potential			Comments
	High	Medium	Low	
Fluvial (Rivers)			✓	The built development is located within Flood Zone 1 (Low probability).
Tidal / Coastal			✓	The site is located within flood zone 1 based on the rivers and sea's EA flood maps.
Pluvial (Drainage Systems)			✓	Low probability as the drainage will be designed to accommodate 100year storm event + 59% for climate change without flooding.
Surface Run-off			✓	The site has some SW flooding however this will be mitigated through positively draining the site at an agreed restricted rate.
Ponding			✓	Proposed site levels will prevent and avoid any potential ponding issues
Groundwater			✓	No apparent groundwater flood risk. No existing/proposed basements
Infrastructure			✓	Reservoir flooding does not affect site.

6.1.6 The proposed development, taking into account the assessment of both existing and future mitigated flood risk, indicates that this site has a low risk of flooding.

7 PLANNING

7.1 GENERAL

7.1.1 Under the NPPF it is a requirement to locate development proposals in an area of lowest risk. Within the guidelines, various types of development have been classified as to their vulnerability, and annex of the NPPF sets out the type of development that is acceptable within each of the risk zones. Due care is however to be given to ensure that the proposals do not result in an increase in flood risk to surrounding properties.

7.1.2 NPPF (Paras. 165 – 175) guidelines use the sequential test and the risk-based approach to flood risk and development.

7.2 SEQUENTIAL TEST

7.2.1 Paragraph 168 of the NPPF states that:

The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.

7.2.2 The application site is located almost entirely in Flood Zone 1. All dwellings will be located in Flood Zone 1; the proposals are therefore considered to be in accordance with the NPPF sequential approach to locate development in areas of lowest flood risk, thus no further action is required as the Sequential test is passed.

7.3 FLOOD RISK VULNERABILITY CLASSIFICATION

7.3.1 Under NPPF Annex 3: Flood Risk Vulnerability Classification the proposed development is identified as 'More Vulnerable' as its prime purpose is to provide *Buildings used for dwelling houses…*

7.3.2 Table 7.1 below indicates the Flood Risk vulnerability and flood zone 'incompatibility' of a development. It shows, based on which flood zone a proposed development is located, as to whether it can be permitted, requires an exception test, or can be permitted without a test.

Table 7.1 Risk of Flooding

Table 2: Flood Risk Vulnerability and flood zone 'incompatibility'					
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	×	×	×	✓
✓ Development is appropriate × Development should not be permitted					

7.3.3 As the proposed development is only situated within the area of Flood Zone 1, this is what has been used against the selection criteria.

7.4 EXCEPTION TEST

7.4.1 Paragraph 169 of the NPPF states that:

169. If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable 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 Annex 3.

7.4.2 Paragraph 170 of the NPPF states that:

170. 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. To pass the exception test it should be demonstrated that:

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

7.4.3 Using the Flood Risk Vulnerability classification of 'More Vulnerable' and Flood Zone 'Compatibility' Table 3 within 7.3 (with the whole development being in Flood Zone 1) it clearly indicates that the proposed development is appropriate, compatible and therefore an exception test is not required.

8 CONSULTATIONS WITH AUTHORITIES

8.1 THE ENVIRONMENT AGENCY

8.1.1 The Environment Agency is a statutory consultee for all major planning applications and will provide comments and recommendations to planning authorities for any development over 1 Ha or within their mapped floodplain.

8.1.2 According to the EA's indicative Flood Plain maps, (which are a guide to the extent of the existing significant flood plains), the site lies within a very low risk area, falling within the EA category of 0.1% (1 in 1,000) or less.

8.2 WORCESTERSHIRE CC LLFA

8.2.1 Worcestershire County Council, acting as Local Lead Flood Authority (LLFA) are a statutory consultee for all major planning applications within their area and will provide comments and recommendations to planning authorities for any development.

8.2.2 The Council's validation checklist requires a Water Management Statement to be submitted with the planning application. This requires the following:

The level of information required will depend upon the development proposed. However, the Statement should demonstrate that site drainage and runoff will be managed in a sustainable and co-ordinated way that mimics natural drainage network. Also information should be provided on how drainage system will protect water quality and secure long term maintenance of drainage schemes (see SWDP policy SWDP29).

8.2.3 This FRA, along with the Drainage Strategy plan, forms the Water Management Statement.

8.3 SEVERN TRENT WATER

8.3.1 Severn Trent Water (STW) are also a statutory consultee for all major planning applications within their area and will provide comments and recommendations to planning authorities for any development.

8.3.2 A copy of the STW's developer Enquiry response can be found in **Appendix E**.

8.3.3 A summary of the STW's response is that they have no objection to the proposed development and have indicated potential foul and surface water outfalls. There is also no indication that there are any current capacity or flooding problems within their sewer network.

9 DRAINAGE HIERARCHY

9.1.1 Generally, the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

- Into the ground (infiltration);
- To a surface water body (e.g. ditch, watercourse, river);
- To a surface water sewer, highway drain, or another drainage system;

9.1.2 Following the hierarchy, using infiltration as a method of surface water disposal should be investigated. As discussed in the Georisk report, it was concluded that infiltration would not be viable due to the site strata.

9.1.3 Based on this not being viable then the next method of discharge should be investigated which is via a surface water body.

9.1.4 The nearest surface water body is Bow Brook, approximately 800m west of the site. Although this is a significant distance the general topography does indicate that overland flows would travel to this outfall. In addition, initial investigations seem to identify that there are land drainage ditches running alongside both Rebecca Road and Allesborough Hill (B4084), with both potentially outfalling into Bow Brook.

9.1.5 Taking the above into account, and subject to relative levels of the site and its outfalls, it is proposed to outfall the surface run-off from the proposed development into the land drainage ditch that runs along Rebecca Road, thus there is a viable option to drain to an open watercourse. This option also mimics the current overland flows, across the western field, with those discharging into the land drainage system and eventually outfalling into Bow Brook.

9.1.6 Finally, when there is no option to discharge via infiltration or via watercourses then a connection to an existing sewer should be investigated. As discussed in the above section there is a viable option for outfalling via means of a watercourse, be it via a secondary land drainage ditch downstream, connection to a sewer doesn't need to be considered.

9.1.7 Therefore it is proposed that the surface water from the proposed site will discharge into the existing watercourse Bow Brook, via the ditch located next to Rebecca Road to the South of the development.

10 STORM WATER DRAINAGE

10.1 RUN-OFF RATE FROM EXISTING SITE

10.1.1 In **Appendix A** there is a copy of the existing Topographical information for the development site and the Site Layout can be found in **Appendix B** The overall developable site red line boundary area is 4.96 Ha, which is Greenfield.

10.1.2 Using the IH124 approach, based on the existing greenfield run-off for the site has been calculated as **7.66 l/s** (Q_{BAR}). This has been calculated using only the proposed impermeable area for the site. This calculation can be found in **Appendix F** with a summary of the results in Figure 10.1 below.

Figure 10.1 Summary of Greenfield Rates

Qbar (l/s)	7.66	7.66
Greenfield runoff rates		
1 in 1 year (l/s)	6.36	6.36
1 in 30 years (l/s)	15.33	15.33
1 in 100 years (l/s)	19.7	19.7
1 in 200 years (l/s)	23.3	23.3

10.1.3 In accordance with Worcestershire CC (WCC) Standing Advice and Development Guidance the peak flow from any new greenfield development, for storms up to and including 100-year (+ an allowance for climate change), should not exceed the peak greenfield run-off rate for the same event.

10.1.4 Based on Figure 10.1 above the greenfield run-off rates for 1-year; 30-year; 100-yea;r & 200-year storm events are 6.36 l/s; 15.33 l/s; 19.70/s & 23.30 l/s. It is proposed that for all storm events (up to 100-year + CC%) the flows from the development will actually be restricted to **7.66 l/s** (Q_{BAR}).

10.1.5 Using the value of Q_{BAR} as the maximum flow for all storm events actually will provide a significant benefits compared to current flows from the site. Table 10.2 below shows the percentage betterment for each storm event.

Table 10.2 Existing/Proposed Flow Comparison.

Storm Event	Current Greenfield Flows (l/s)	Proposed Discharge (l/s)	Betterment
30-year	15.33	7.66	50.0 %
100-year	19.70	7.66	61.2 %
100-year +59%	31.32	7.66	75.6 %

10.1.6 The above drainage strategy used within the drainage design, of restricting all flows to a maximum of Q_{BAR}.

10.1.7 As discussed, the above-agreed methodology used within this report and has been used within the attached drainage strategy.

10.2 PROPOSED DRAINAGE STRATEGY

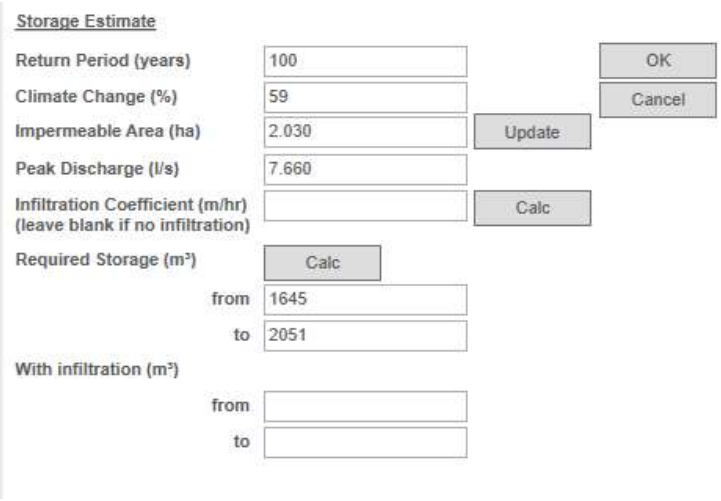
10.2.1 As outlined above and detailed in **Drainage Strategy Plan** (Dwg. **RRP-P_ENG_001** – see **Appendix G**) the surface water drainage strategy is to restrict the flows from the development to **7.66 l/s** (Q_{BAR}) for all storm events up to and including the **100-year + 59%**. The flow will be restricted using a Vortex control device (Hydro-brake or similar approved), located downstream of the attenuation and at the point that surface water flows leave the site.

10.2.2 The attenuated flows will be stored within both the surface water sewer system as well as within the proposed pond. This attenuation pond is as detailed in Section 12 below. Surface water flows will discharge into the ponds via precast concrete headwalls (designed to adoptable standards).

10.2.3 It is proposed that the surface water sewer system will be adopted under a Section 104 Agreement by either Severn Trent Water, or other approved water/sewerage company.

10.2.4 Based on quick storage estimate calculations (using FLOW), the total volume of attenuation required for storm events up to and including 100-year + 59% is approximately (1645 +2051)/2 = 1,848 m^3. See figure 10.3 below.

Figure 10.3 Flow Quick Storage Calculation



10.2.5 The surface water design for the site should ensure that the discharge does not exceed the approved 7.66 l/s for any storm events up to and including the 100-year + 59% (percentage allowance for climate change for the relevant catchment). Any open pond design should be based on the maximum attenuation depth is 1.0m and the freeboard is never less than 300mm and provides up to 1,848m^3 of storage including that of which the adoptable sewerage and manholes will provide.

11 SUSTAINABLE DRAINAGE

11.1 SUDS FEATURES

11.1.1 The use of Sustainable drainage systems is a requirement on all major development. Sustainable drainage systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. They provide opportunities to:

- Reduce the causes and impacts of flooding;
- Remove pollutants from urban run-off at source;
- Utilise water management within green spaces with benefits for amenity, recreation and wildlife.

11.1.2 The site wide drainage strategy incorporates SuDs for the development. It is proposed to utilise the following SuDS features:

- A detention pond
- Swales

11.1.3 Both the swales and the pond has been designed to provide treatment to the surface water run-off from the development and remove pollutants prior to discharge to the downstream receiving watercourses.

11.1.4 The on-site pond has been designed with bank slopes of 1 in 3 for safety purposes and in accordance with the SuDS Manual. The ponds will have a shallow zone (aquatic bench) along the edge of the permanent pool to support wetland planting which will act as a biological filter. The pond will also have a low flow channel with associated aquatic planting to act as a biological filter. This pond will provide ecology, amenity and biodiversity benefits.

11.1.5 The swales will also act as a biological filet whilst also conveying flows across the site and into the pond.

11.2 WATER QUALITY

11.2.1 As consideration of any type of SuDS within a development, one of the main functions is to ensure that water quality is maintained. Any SuDS feature incorporated into a design will need to sufficient mitigation as to offset any increase in potential pollutant hazards as a result of the development.

11.2.2 A detailed water quality assessment, in accordance with the principles set out in C753 The SuDS Manual, will inform the SuDS principles to be utilised during the detailed drainage design which forms part of the reserved matters application.

11.2.3 Based on the current layout and the SuDS features proposed, A Simple Index approach to assess whether the proposed SuDS features provide the necessary mitigation for the potential hazard levels generated from this type of site.

11.2.4 Table 4.3 from C753 The SuDS Manual classifies the land use of the site in terms of Pollution Hazard Level as '**very low**' for residential roofs and '**low**' for external paved areas. This hazard level requires that the Simple Index approach be followed to formulate the appropriate drainage solution for the site, as indicated in **Table 26.2** below:

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]

11.2.5 The pollution hazard indices relevant to the site are therefore **0.2, 0.2 & 0.05** for roof areas and **0.5, 0.4 & 0.4** for external paved areas. This gives combined indices of **0.7, 0.6 & 0.45** for pollution hazards.

11.2.6 It is therefore necessary to select SuDS which provides a mitigation index at least equal to those indicated above. Typical mitigation indices are provided in **Table 26.3** of C753 (The SuDS Manual)

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

Type of SuDS component	Mitigation indices[1] 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.		

11.2.7 The use of swales and a pond will provide a two-stage treatment train to all areas of the site. This will provide adequate mitigation as follows:

Total SuDS mitigation Index = mitigation index$_1$ + 0.5 x (mitigation index$_2$)

For roads and parking areas: mitigation index =	Swale [1.0] + Pond [0.5] =	0.50 0.70 **0.85**	0.60 0.70 **0.95**	0.60 0.50 **0.75**
Pollution combined index =		0.70	0.60	0.45

11.2.8 The combined mitigation indices exceed the potential hazard indices and therefore will provide a satisfactory solution to pollution control.

11.2.9 As the combined mitigation indices for swales & a pond [**0.85, 0.95 & 0.75**] exceed the combined potential hazard indices referred to in 9.2.4 above [**0.7, 0.6 & 0.45**] the use of swales and a pond will provide sufficient treatment to offset the potential hazards, therefore water quality is maintained.

11.2.10 In addition to the above trapped gullies will also be used for all access roads, drives and parking areas which will remove sediments and debris, prior to it entering the surface water drainage system.

11.2.11 During construction there is an increased risk of pollution, particularly in the form of silt and sediment. Temporary pre-treatment to remove silt, and other pollutants, may be required in accordance with current guidance and good practice.

11.2.12 Higher concentrations of pollutants occur in the early stages of a storm event known as the 'first flush' and are 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 pollutants and improve water quality Ciria C753 'The SuDS Manual' recommends that a Treatment Volume is provided in suitable SuDS features such as ponds, filter trenches, permeable paving, etc. The treatment volume is calculated using the fixed rainfall depth method. Ciria C753 recommends that the first flush is retained for treatment (5-10mm for at source filtration, >10mm if treatment is in a pond).

11.2.13 Assuming a 10mm fixed rainfall depth over the impermeable area of 2.03 Ha, the minimum treatment volume required would be approximately 203m^3. For 5mm rainfall depth the volume required would be 101.5m^3.

11.2.14 The treatment volume will be provided within the attenuation pond in the form of a permanent pool with a water depth of 0.50m. The treatment volume available in the pond is approx. 168m^3, the equivalent of 8.2mm of rainfall.

11.3 LANDSCAPING

11.3.1 The landscaping and aquatic planting for the on-site pond will be designed by the Landscape Architect to ensure the provision of a diversity of planting species to provide a variety of wildlife habitats, thus enhancing the visual interest and potentially biodiversity. Due to the depth of the pond the landscaping should also barrier planting to discourage public access into the pond.

11.4 POND ACCESS

11.4.1 Access to the pond will be made via the proposed roads within the new development, allowing inspections and routine maintenance to be undertaken.

12 FOUL SEWAGE

12.1.1 This FRA identified that there was an existing 150mm diameter adopted foul sewer within Choules Close [on the opposite side of Rebecca Road to the site, approximately 50m from the proposed site entrance]. There is also an existing 150mm foul sewer within Worcester Road, which is approximately 350m from the north-east corner of the site. The sewer records do indicate a new sewer at the junction of Worcester Road and Rebecca Road, but this is subject to a S104 Agreement and therefore cannot be utilised until it has been adopted by STW.

12.1.2 In accordance with current guidance for this development of 115 plots would have a peak discharge of **5.32l/s.**

12.1.3 Based on the STW developer response, there is little capacity in the sewer within Choules Close and any discharge from the site will need to be restricted to **1.7l/s**. Therefore may be more viable connect to the sewer in Worcester Road via a pumped rising main at a rate of **3.8l/s**. As no clear level data is available for either outfall, along with the flow restrictions identified by STW [which are subject to further modelling], it is assumed that an adoptable pumping station and rising main would be required for either outfall option.

12.1.4 Either outfall option will require additional attenuation on the site to contain flows whilst the discharge is reduced from 5.32 l/s to either 3.8 or 1.7 l/s. Based on current guidance, the storage required on site [either within the on-site sewer network upstream of the pumping station, or an adjacent storage structure] equates to 1**8.40m³** [or 160 litres per property].

12.1.5 Therefore in designing a compliant drainage strategy, an adoptable foul water pumping station and ring main, in association with suitable emergency storage of 18.40m^3, will need to be provided.

13 WHOLE LIFE MAINTENANCE

13.1 MAINTENANCE

13.1.1 The future management of any SuDS feature needs to be considered, as to whether they will be adopted by the Water Authority (STW), the Local Authority or maintained privately by a suitably employed management company. Based on the current design, it is proposed that most of the elements will be offered initially to Severn Trent Water. If adoption by STW is not possible, it is proposed that a private management company would maintain those elements that they do not. Adequate access for maintenance will be provided according to the requirements of the future maintainer, currently via the proposed estate roads and a grassed verge around the pond area.

13.1.2 The engineering design will be submitted to and approved by WCC land drainage team (as Lead Local Flood Authority), to ensure the proposals are in accordance with this, and the previously approved Flood Risk Assessment, via the reserved matters planning application.

13.1.3 It is proposed that any maintenance is in accordance with the standards detailed within CIRIA C753 'The SuDS Manual'. For ponds the operational and maintenance requirements are summarised in Table 13.1, swales in table 13.2 (see below):

Table 13.1 Operation and Maintenance requirements for Ponds

Maintenance Schedule	Required Action	Typical frequency
Regular Maintenance	Remove Litter and debris	Monthly (or as required)
	Cut 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 to October)
	Inspect silt accumulation rates in any forebay and in main body of 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, e.g. penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1m above pond base; include max 25% of pond surface)	Annually

Table 13.1 (Cont.)

Maintenance Schedule	Required Action	Typical frequency
Regular Maintenance	Remove 25% of bank vegetation from water's edge to minimum of 1.0m 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 to 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 water volume is reduced by 20%	With effective pre-treatment (via trapped gullies) this will only be required rarely, e.g. every 25 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 inlet, outlets and overflows	As required

Table 13.2 Operation and Maintenance requirements for Swales

Maintenance Schedule	Required Action	Typical frequency
Regular Maintenance	Remove Litter and debris	Monthly (or as required)
	Cut grass – to retain grass height within specified ranges	Monthly (during growing season)
	Manage other vegetation and remove nuisance plants	Monthly (or as required)
	Inspect inlets, outlets, and overflows for evidence of blockage and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48hours	Monthly (or as required)
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then Half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if base soil is exposed over 105 or more of swale treatment area.
Remedial Actions	Repair erosion or other damage by re-turfing or re-seeding	As required
	Re-level uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of soil surface.	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices.	As required

14 CONSTRUCTION

14.1 POLLUTION PREVENTION DURING CONSTRUCTION WORKS

14.1.1 Advice is available from CIRIA "Guidance on the Construction of SuDS C768" on the control of soils, silt and erosion during construction works. "The SuDS Manual C753" also has advice on pollution prevention in Chapter 31.

14.1.2 The EA's Pollution Prevention Guidelines give advice for avoiding pollution issues from constructions sites. They are currently under review but the old guidance PPG6 and PPG5 (withdrawn in 2015) can be found through these links:

https://www.gov.uk/government/publications/construction-and-demolition-sites-ppg6-prevent-pollution

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/485199/pmho1107bnkg-e-e.pdf

14.2 BEFORE & DURING CONSTRUCTION

14.2.1 When starting and completing construction works it is important to ensure that adequate build orders are followed in order to prevent flooding the proposed development or anything downstream. Based on the current drainage strategy it is stated that the attenuation basin should be constructed first along with a wrapped land drain along the Western boundary which would direct water into the pond. Temporary debris screens should also be installed to ensure water quality into the received ditch along Rebecca Road.

14.2.2 By constructing the attenuation basin and wrapped land drains, this would ensure that the development doesn't increase the risk of flooding during the site build process.

14.2.3 It is recommended during construction that the attenuation basin and debris screens are monitored and cleaned/cleared when required to avoid build-ups of silts.

14.3 SUDS SPECIFIC ADVICE

14.3.1 More detailed advice is available from "The SuDS Manual C753" and also the document "Guidance on the Construction of SuDS C768" both published by CIRIA on the construction of specific types of SuDS.

15 CONCLUSIONS

15.1 ASSESSMENT OF DEVELOPMENT SITE

15.1.1 During the planning process an assessment of why the proposed site should be developed is required, to support the planning application. Therefore, the following items assisted in supporting the proposed development and consequently provided the reasoning to pursue the development of the proposed site:-

- The proposed building area of the site will only be located in Flood Zone 1, therefore should not be constrained for any attached issues.
- Flows from the proposed site will be controlled to the site-specific calculated rate for Qbar, based on the proposed impermeable area, for all storm events up to and including 100-year plus a percentage allowance for climate change [which for this river catchment is 59%]. This provides a betterment against the equivalent Greenfield runoff rate for each mean annual event, providing significant downstream betterment of up to 75.6%.
- SuDS are included as part of the overall scheme providing sufficient water quality mitigation for this type of development.
- It is proposed that the drainage system on this site will be offered for adoption to STW, or a NAV; however, if the on-site system remains private the maintenance will be transferred to a management company. The operation and maintenance will be in accordance with CIRIA C753 "The SuDS Manual" and the "Design and Construction Guidance for foul and surface water sewers …" [version 2.0].

15.2 SUMMARY AND RECOMMENDATIONS

15.2.1 As the proposed residential proposals lie within flood zone 1, the site is no constrained by flood risk.

15.2.2 Finished floor levels should be raised a minimum 150mm above existing ground levels during the detailed design when a fixed layout is provided.

15.2.3 Wherever possible, levels around buildings will be designed so that water flows away from the building.

15.2.4 All run-off from drives, parking areas and roads will pass through trapped gullies before draining into the surface water sewer system.

15.2.5 The proposed drainage strategy should include the use of a new pond on the site, along with swales and all surface water flows from the site will then pass through these before exiting the site and connecting to the wider land drainage network, and subsequently discharge into Bow Brook. This strategy mimics the current natural drainage network.

15.2.6 Runoff rates will be restricted to that of the agreed rates of 7.66 l/s for all storm event up to and including the 100-year + 59% (allowance for climate change).

15.2.7 The foul flows from the site of 115 plots will discharge at a specified restricted rate via an adoptable foul pumping station into the existing STW sewer either in Choules Close, or Worcester Road. Suitable emergency storage will be provided in accordance with current guidance.

15.2.8 Based on the discussions within this report, the proposals would ensure that the site itself will not flood and there will be no impact on the surrounding area and are also in accordance with South Worcestershire Development Plan policy SWDP29.

END OF REPORT

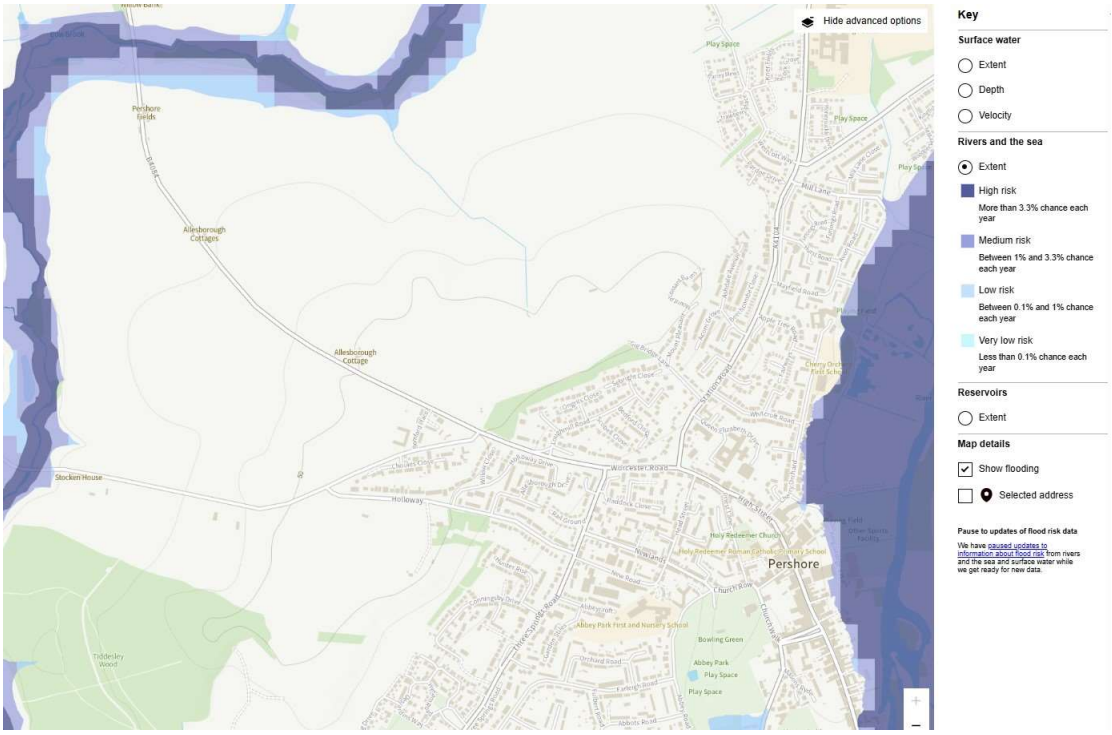
APPENDIX A – Topographical Survey

APPENDIX B – Georisk Report

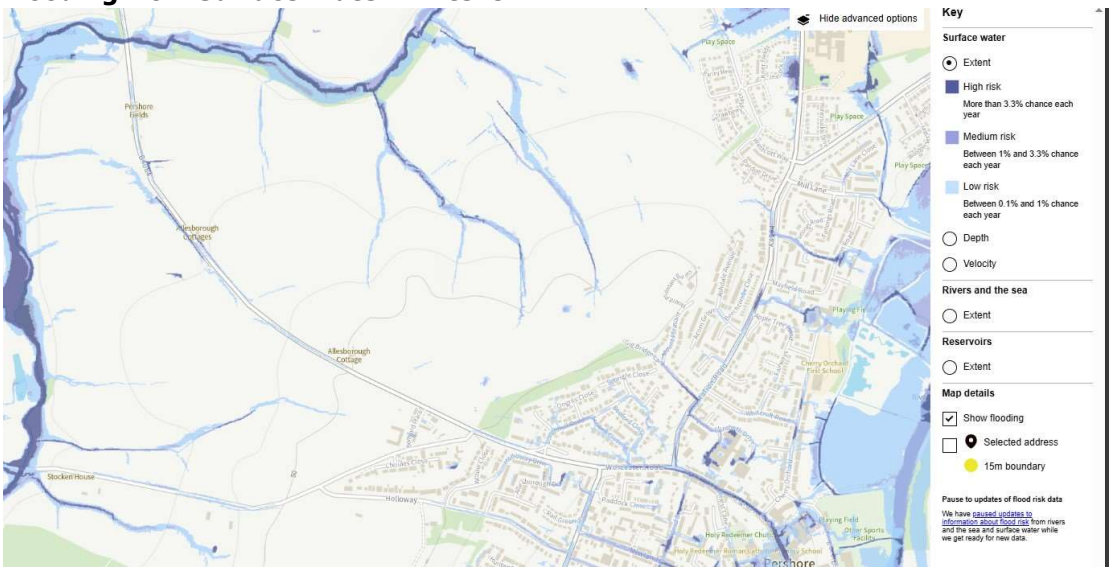
APPENDIX C – Illustrative Site Layout

APPENDIX D – EA Flood Mapping Information

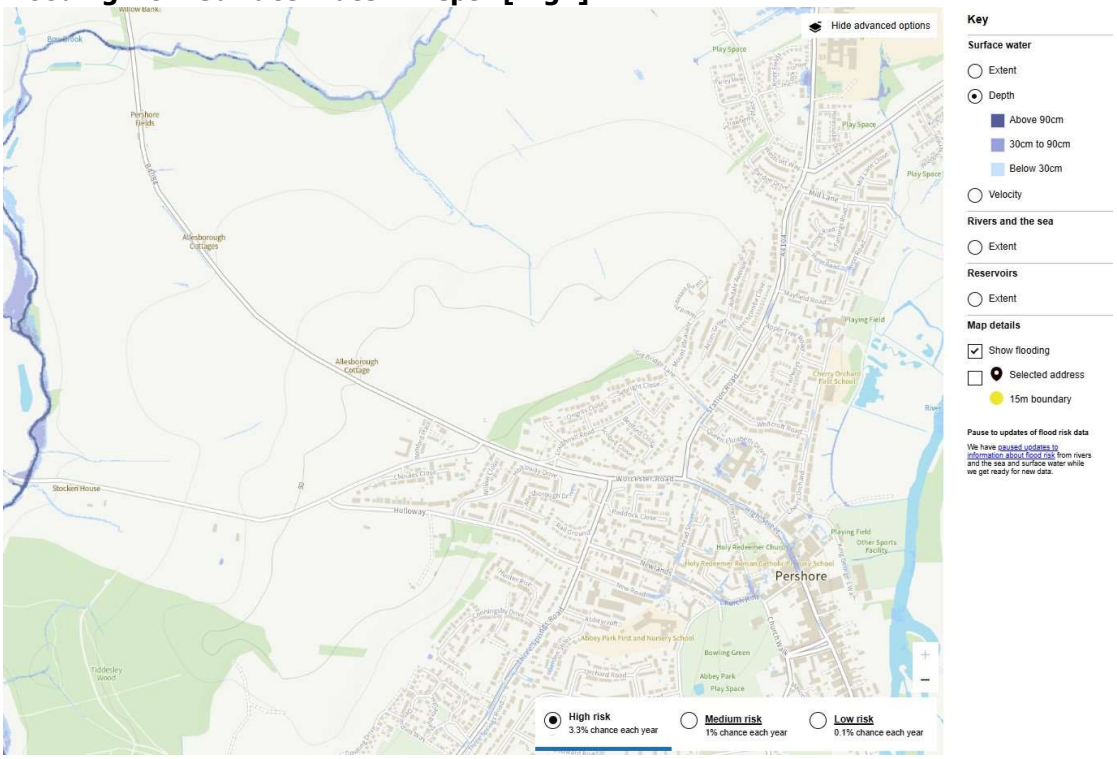
Flooding from Rivers & Seas



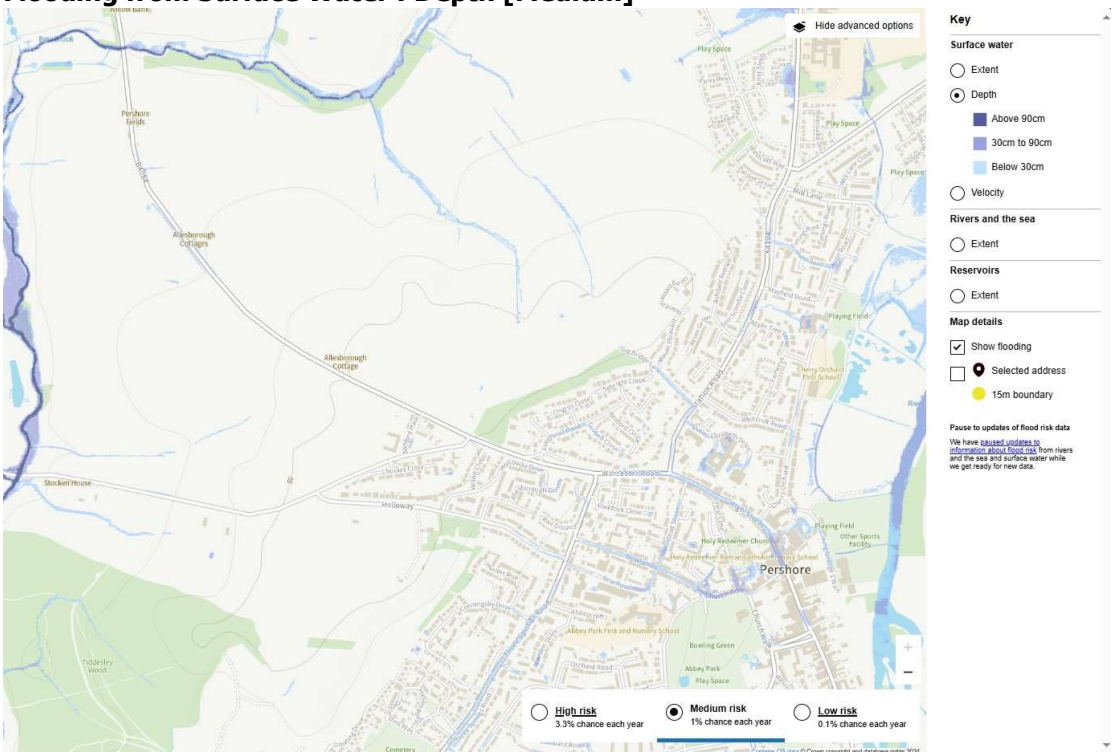
Flooding from Surface Water : Extent



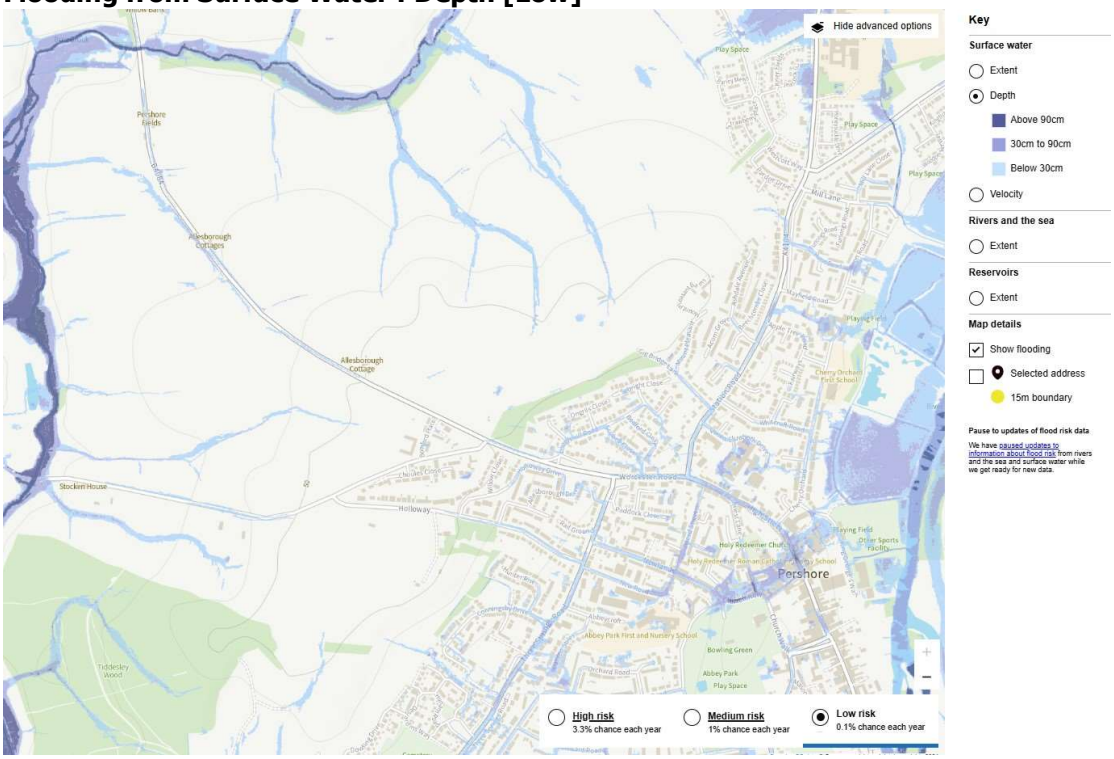
Flooding from Surface Water : Depth [High]



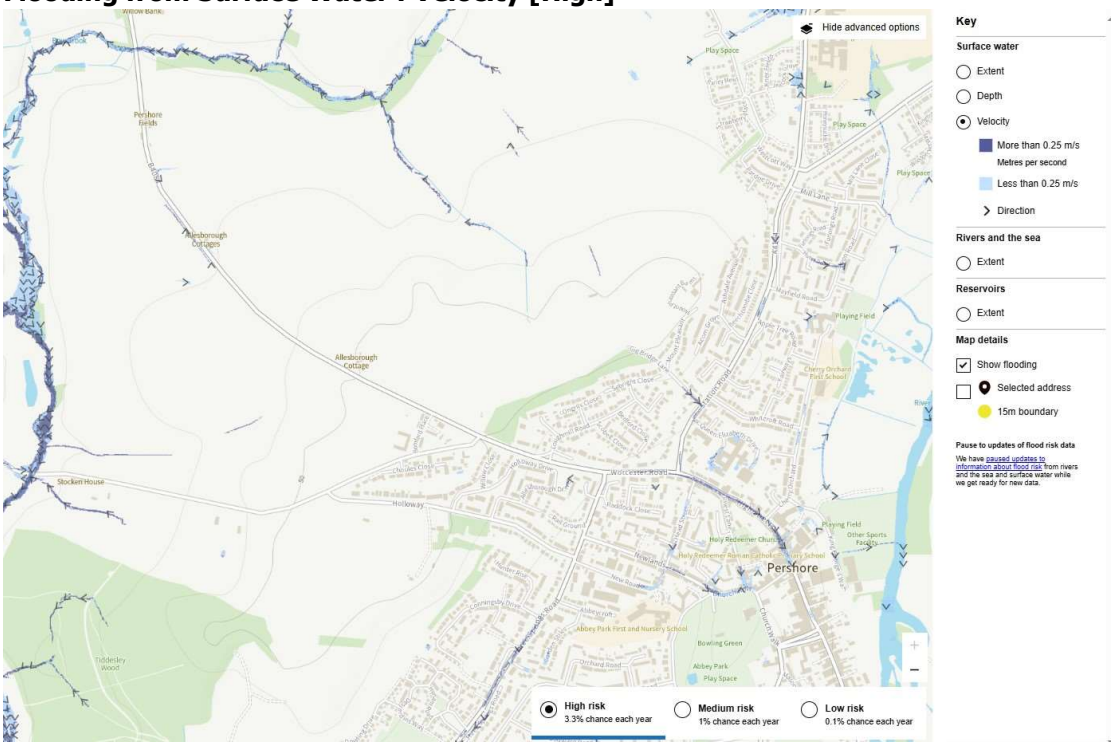
Flooding from Surface Water : Depth [Medium]



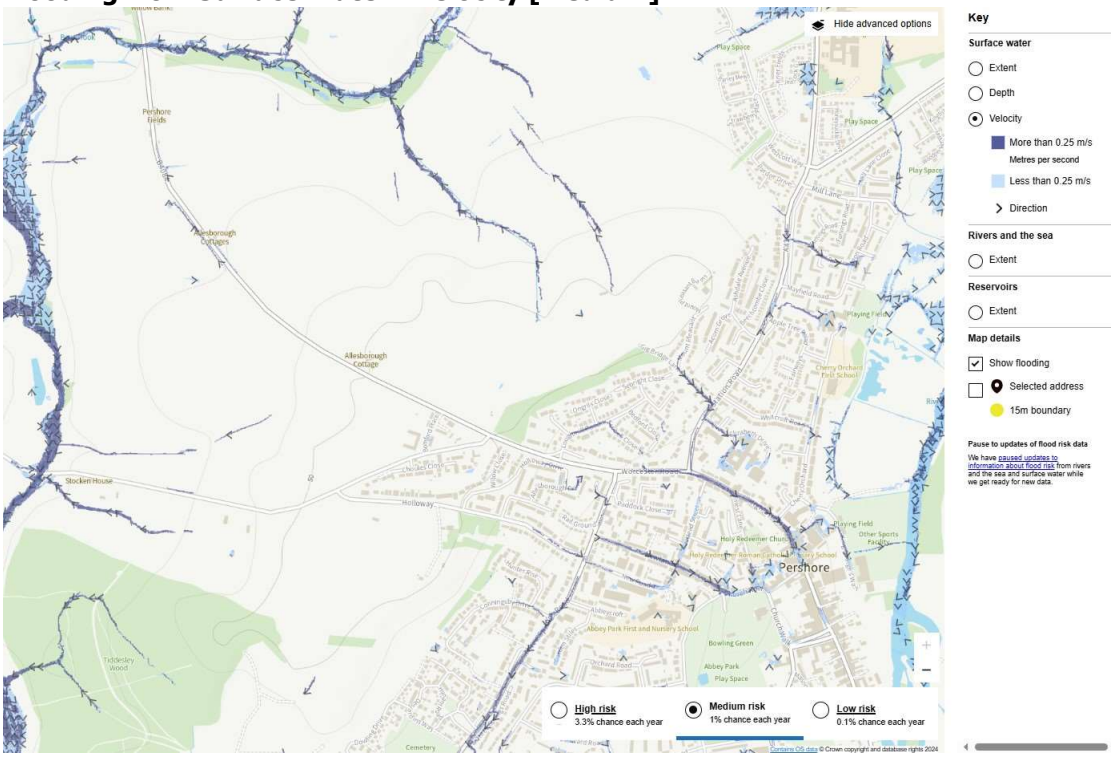
Flooding from Surface Water : Depth [Low]



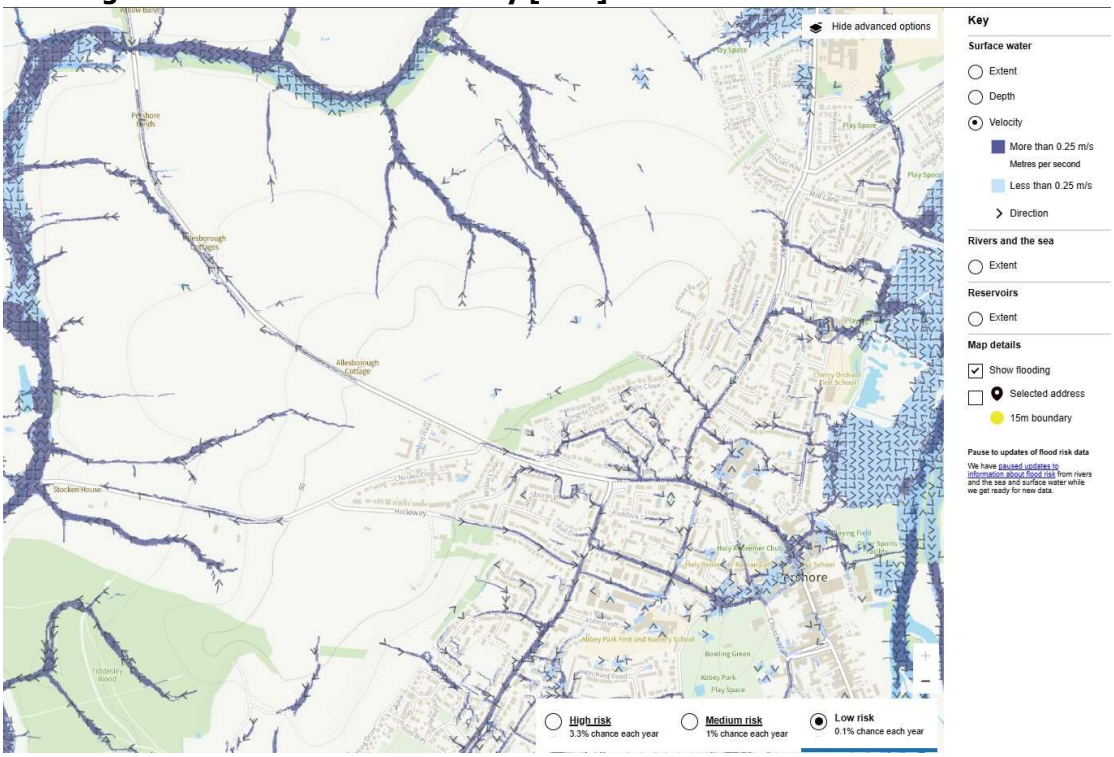
Flooding from Surface Water : Velocity [High]



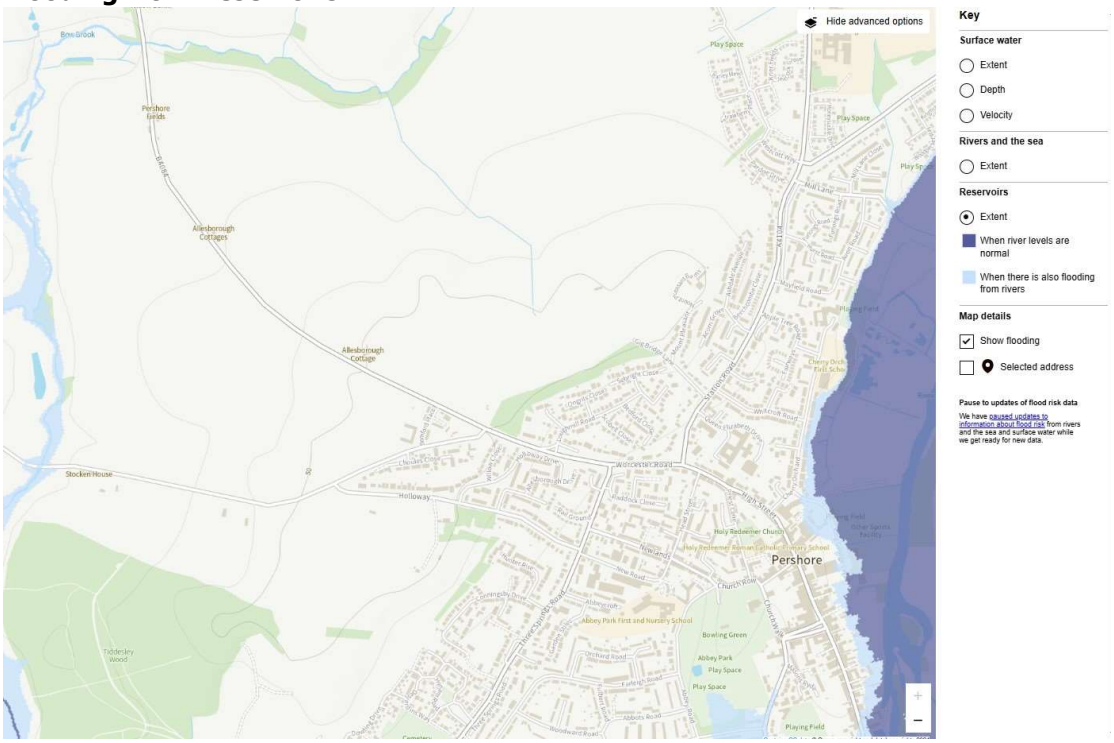
Flooding from Surface Water : Velocity [Medium]



Flooding from Surface Water : Velocity [Low]



Flooding from Reservoirs



APPENDIX E – Sewer Records

APPENDIX F – Greenfield Run-off Calculations

APPENDIX G – Drainage Strategy Plan