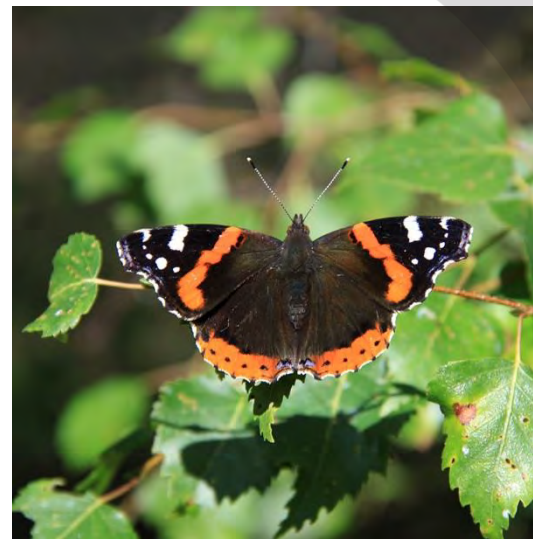




Bloor Homes, Barwood Land & Jelson Limited

Earl Shilton Sustainable Urban Extension

Flood Risk Assessment



Report for

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Jelson Ltd; and
Barwood Strategic Land LLP

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Document revisions

No.	Details	Date
1	First Draft	November 2021
2	Final	December 2021

Executive summary

Purpose of this report

Wood Group UK Ltd. (Wood) (previously Amec Environment & Infrastructure UK Ltd) has been commissioned by Bloor Homes, Barwood Land, and Jelson Limited to undertake a Flood Risk Assessment (FRA) to accompany an outline planning application for a residential led mixed-use development on land to the east and south-east of Earl Shilton, Leicestershire hereafter referred to as 'the Site'.

The Site is 65.37 ha in area. In accordance with the National Planning Policy Framework, an FRA is therefore required because the Site is over 1 ha in area. The entire Site is located in Flood Zone 1 according to the Environment Agency flood map for planning. However, within the Site a small tributary of the Thurlaston Brook, named the Earl Shilton Brook, rises on the Site and flows east, dividing the Site in two. The Earl Shilton Brook is too small to have been included on the Environment Agency's flood map so a HEC-RAS hydraulic model has been developed to assess the extent of the fluvial flood risk zones alongside the watercourse.

The results of the flood modelling show a limited strip of land alongside the watercourse that lies within the extents of the 1% and 0.1% AEP flood extents (see Figure 3.2). However, owing to the steep valley topography in this area of the Site, the area of fluvial flood risk is confined to the area immediately adjacent to the watercourse, and the majority of the development areas are all located in Flood Zone 1. In order to achieve a practical development platform some minor land raising and compensatory land lowering is proposed. Whilst this affects an area of Flood Zone 2, it has been demonstrated in this report that there is sufficient scope for land lowering of adjacent land with hydraulic connection to the Earl Shilton Brook in order to provide full level for level compensation. This ensures that there is no net loss of flood storage within the Site and therefore no increase in flood risk to downstream receptors. Furthermore, all the proposed access routes to the Site (from the A47 road and Earl Shilton town) lie within Flood Zone 1.

All potential risks of flooding to the Site have been assessed and relevant flood management and mitigation measures have been recommended where necessary. Overall there is limited flood risk to the Site, the most significant source being fluvial flood risk along the Earl Shilton Brook. However, as these locations are within the Earl Shilton Brook corridor, away from the main development area, the risk to the development is small. The masterplan shows that this area will be left as a green corridor.

The Site divides naturally into seven land parcels as shown in Annex B of Appendix G. A surface water management strategy has been developed which recommends various attenuation based Sustainable Drainage System (SuDS) techniques to control discharge rates from the seven land parcels to greenfield runoff rates (for the 1% annual exceedance probability design event with 40% climate change) with a total requirement of approximately 25,266 m³ of attenuation storage being required (this figure will need to be refined as the design is finalised for construction). The attenuation storage would discharge into the Earl Shilton Brook.

The following further recommendations are made:

- All SuDS basins should be situated outside of Flood Zone 2 – i.e. as defined by the 0.1% AEP event;
- All Finished Floor Levels in the vicinity of the Earl Shilton Brook should be set at least 600 mm above the modelled flood level for the 0.1% AEP event or 300 mm above local ground levels. Elsewhere on the Site Finished Floor Levels should be at least 150 mm above final ground levels;

- Ground profiling should be carried out in such a way that any overland flow in excess of the capacity of the drainage system is controlled to divert it away from built development and to prevent surface ponding;
- Corridors should be left along the watercourses (as shown on the illustrative masterplan in Appendix A) to enable future maintenance access; and
- Redundant structures should be removed from the Earl Shilton Brook. Any new watercourse crossings should be designed so as not to increase flood risk, and to ensure hydromorphology (the physical/natural quality of the watercourse channel) is not impacted.

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Appendix G	Outline Drainage Strategy

1. Introduction

1.1 Context

Wood Group UK Ltd. (Wood) (previously Amec Environment & Infrastructure UK Ltd) has been commissioned by Bloor Homes, Barwood Land, and Jelson Homes to undertake a Flood Risk Assessment (FRA) to accompany an outline planning application for a residential led mixed-use development on land to the east and south-east of Earl Shilton, Leicestershire hereafter referred to as 'the Site'.

This report has been prepared by Wood Group UK Ltd (Wood) to reflect the current masterplan (Appendix A) for the Site and current planning guidance. The Site is currently greenfield and is approximately 65.37 hectares in area. The Environment Agency (EA) Flood Map for Planning¹ currently classifies the Site as Flood Zone 1, defined as having a less than 0.1% Annual Exceedance Probability (AEP) of fluvial or tidal flooding. However, the Earl Shilton Brook, (a small tributary of the Thurlaston Brook) which bisects the main Site, is too small to have been included in the EA modelling. The FRA therefore includes hydraulic modelling of this watercourse.

This FRA has been prepared in accordance with the *National Planning Policy Framework* (NPPF; 2021). The NPPF states (paragraph 167) that a Site-specific FRA is required for development proposals of 1 hectare or greater in Flood Zone 1, all proposals for new development located in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

The main purpose of the FRA, as detailed in the NPPF, is to demonstrate how flood risk to the Proposed Development and any increased flood risk to third parties due to the Proposed Development, will be managed over the lifetime of the Proposed Development, taking climate change into account.

1.2 Structure of this Report

The report is structured as follows:

- **Section 2: Site Description:** development proposals and planning context;
- **Section 3: Flood Risk Appraisal:** this provides an initial assessment and a summary of the various sources of flood risk to the Site;
- **Section 4: Surface Water Management Strategy:** this section details the surface water drainage strategy and provides details of any mitigation required to limit surface water runoff;
- **Section 5: Flood Risk Management and Mitigation:** this section details the measures to be taken to manage and mitigate flood risk; and
- **Section 6: Conclusions and Recommendations:** this Section summarises the report findings and presents the conclusions and recommendations.

¹ Ordnance Survey (2021). Flood map for planning. (Online) Available at: <https://flood-map-for-planning.service.gov.uk/> (accessed 17 September 2021)

The figures are embedded within the main body of the report while various supporting documents are presented at the end of the report in the form of appendices. In total there are seven appendices, as follows:

- **Appendix A** provides the Illustrative Site masterplan;
- **Appendix B** contains the topographic survey;
- **Appendix C** contains photographs taken on the site visit;
- **Appendix D** provides evidence of the consultation process (including consultation with the Environment Agency, Severn Trent Water Limited, Leicestershire County Council and Hinckley and Bosworth Borough Council);
- **Appendix E** contains the Site services plan;
- **Appendix F** contains details of Hydraulic Modelling Report; and
- **Appendix G** contains the outline Drainage Strategy.

1.3 Sources of Data & Information

- Environment Agency, Flood risk assessments climate change guidance² (2021);
- National Planning Policy Framework (2021)³;
- National Planning Policy Framework – Accompanying Flood Risk Guidance (2021)⁴;
- Defra, Magic Map website (2021)⁵;
- CIRIA, C753, The SUDS Manual, (2015)⁶;
- Hinckley and Bosworth Borough Council. Earl Shilton & Barwell Area Action Plan (2014)⁷;
- Hinckley and Bosworth Borough Council. Core Strategy (2009)⁸;
- Hinckley and Bosworth Borough Council. Green Infrastructure Strategy (2008)⁹;
- Hinckley and Bosworth Borough Council. Strategic Flood Risk Assessment, (2019)¹⁰; and

² Environment Agency (2021). Flood risk assessments: climate change allowances. (Online) Available at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances> (Accessed 17 September 2021).

³ Ministry of Housing, Communities & Local Government (2021). National Planning Policy Framework. (Online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf (Accessed 17 September 2021).

⁴ Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2021). Flood risk and coastal change. (Online) Available at: <https://www.gov.uk/guidance/flood-risk-and-coastal-change> (Accessed 17 September 2021).

⁵ Defra (2021). Magic Map website. (Online) Available at: <https://magic.defra.gov.uk/MagicMap.aspx> (Accessed 17 September 2021).

⁶ Woods Ballard, B, Wilson, S, Udale-Clarke, H, Illman, S, Scott, T, Ashley, R, Kellagher, R. (2015). The SuDS Manual C753. CIRIA; London, UK.

⁷ Hinckley & Bosworth Borough Council (2014). Earl Shilton and Barwell area action plan. (Online) Available at: https://www.hinckley-bosworth.gov.uk/info/856/local_plan_2006_to_2026/439/earl_shilton_and_barwell_area_action_plan (Accessed 17 September 2021).

⁸ Hinckley & Bosworth Borough Council (2009). Core Strategy adopted document. (Online) Available at: https://www.hinckley-bosworth.gov.uk/downloads/file/487/core_strategy_adopted_document (Accessed 17 September 2021).

⁹ Hinckley & Bosworth Borough Council (2008). Green Infrastructure Strategy. HBB; Hinckley, UK

¹⁰ Hinckley & Bosworth Borough Council (2019). Strategic Flood Risk Assessment (SFRA) 2019. (Online) Available at: https://www.hinckley-bosworth.gov.uk/downloads/download/1641/strategic_flood_risk_assessment_sfra_2019 (Accessed 17 September 2021).

- Leicestershire County Council. Preliminary Flood Risk Assessment (2011)¹¹.

1.4 Terminology

Annual Exceedance Probability (AEP)

In this report, the probability of a flood occurring is expressed in terms of Annual Exceedance Probability (AEP), which is the inverse of the annual maximum return period. For example, the 100-year flood can be expressed as the 1% AEP flood, which has a 1% probability of being exceeded in any year.

Table 1.1 is provided to clarify the use of the AEP terminology as well a description of the Flood Zone definitions as set out in the NPPF Flood risk and coastal change guidance⁴.

Table 1.1 Flood Zone definitions and associated annual exceedance probability

Flood Zones	Probability of flooding	AEP	Definition
Flood Zone 1	Low Probability	<0.1% AEP of river or sea flooding	Land with less than 1 in 1,000 probability of flooding from rivers or the sea, in any given year
Flood Zone 2	Medium Probability	1% - 0.1% AEP of river flooding 0.5% – 0.1% AEP of sea flooding	Land with between a 1 in 100 and 1 in 1,000 of river flooding; or land having between a 1 in 200 and 1 in 1,000 probability of sea flooding
Flood Zone 3a	High Probability	>1% AEP of river flooding >0.5% AEP of sea flooding	Land having a 1 in 100 or greater probability of river flooding in any year; or Land having a 1 in 200 probability or greater of sea flooding in any year.
Flood Zone 3b	Functional Floodplain	>5% AEP of river or sea flooding; or a designated area designed to flood	Land having a 1 in 20 or greater probability of river or sea flooding in any year.

¹¹ Leicestershire County Council (2011). Preliminary Flood Risk Assessment. (Online) Available at: https://www.leicestershire.gov.uk/sites/default/files/field/pdf/2016/9/19/prelim_flood_risk_assessment.pdf (Accessed 17 September 2021).

2. Site Description, Development Proposal and Planning Context

2.1 Site Description

The Site

The Site is centred at Grid Reference SP 47313 97320 just west of the A47 at Earl Shilton, Leicestershire. The Site is surrounded by existing residential properties at the northwest and western edges, with some recreational playing fields located in the central northern part of the Site. The Site is bounded in the north-east by Thurlaston Lane and a Severn Trent Water Ltd (STWL) Wastewater Treatment Works (WwTW). The Site is bounded along the southern and eastern edges by the A47. The area of the Site to the south of Mill Lane is bisected by Earl Shilton Brook. The Site is entirely greenfield and mostly consists of agricultural land with some playing fields. Figure 2.1 shows the Site location and situation.

Five vehicular access points will be created in total. Two accesses direct from the A47 Clickers Way and three connections to Earl Shilton at Mill Lane, Astley Road and Breach Lane. Once the development is completed all the accesses, except for Breach Lane, will be connected internally within the Site to create a permeable and flexible movement network. The final masterplan layout will be designed to incorporate a wide range of additional pedestrian and cycle connections to Earl Shilton and the wider rights of way network.

The proposed access routes to the Site are not located in a fluvial flood risk area and the adjacent areas of Earl Shilton and the A47 are within Flood Zone 1, so safe access and egress can be maintained at all times.

Topography

Ground elevations across the Site taken from topographic survey (Appendix B) range from 105.0mAOD in the south west and 102.5mAOD in the northeast down to 90.0mAOD along the Earl Shilton Brook corridor. The main part of the Site, to the south of Mill Lane, forms a gentle valley sloping down from both the north and the south towards the Earl Shilton Brook in the centre of the Site. A smaller northern portion of the Site slopes northwards towards the Thurlaston Brook.

Hydrology, Drainage, Hydrogeology and Soils

Hydrology and Drainage

The Thurlaston Brook is the nearest Environment Agency Main River to the Site, located approximately 1.3km downstream (east) of the Site. This watercourse drains to the River Soar. A minor watercourse – the Earl Shilton Brook (tributary to the Thurlaston Brook) – issues on-site and flows east through the middle of the Site, under the A47 and down to the Thurlaston Brook. This watercourse falls from around 93mAOD in its upper reaches within the Site, to 88mAOD halfway upstream of where it joins the Thurlaston Brook. The Earl Shilton Brook has a catchment area of approximately 1.68 km² at the A47 road crossing of the watercourse and drains the south-eastern areas of Earl Shilton. In terms of piped drainage, the older parts of Earl Shilton and Barwell are drained by a combined sewer network (i.e. a single pipe which takes both foul and surface water), which will rapidly convey some storm water towards the adjacent STWL WwTW, and depending on the available storage capacity, directly into the Earl Shilton Brook (via a Combined Sewer Overflow (CSO)). The more modern areas of development in the parts of Earl Shilton that abut the Site drain via separate foul and surface water drains. Three of the surface water drains serving these areas discharge into the Earl Shilton

Brook. Flows in excess of the system's capacity (likely around the 10% AEP event at best) will drain overland towards the receiving watercourses within their natural topographical catchments. As well as CSOs from the STWL WwTW, treated effluent is discharged into the Earl Shilton Brook. On the day of the Site visit by a Wood hydrologist (10 March 2012) these flows made up around 75% of the dry weather flow in the watercourse (observe plates 8 to 14 in Appendix C). While the flood risk site visit occurred in 2012, a March 2021 site visit conducted by a Wood consultant confirmed that the baseline situation of the site remained the same. A smaller northern portion of the Site drains northwards directly towards the main Thurlaston Brook. The local hydrological features are shown on Figure 2.2.

In summary, draining to the Earl Shilton Brook on-site, there is:

- a) a natural catchment (topographically defined) draining directly to the watercourse; and
- b) a combined sewer serving a larger area and routing these flows via pipes to the WwTW. It should however be noted that:
 - i. The rate at which flows from these sewers can reach the watercourse will be determined by the pipe capacity and arrangements within the WwTW; and
 - ii. Exceedance flows for areas outside of the on-site watercourse's topographic catchment (but served by the combined sewer) will follow local drainage routes in these respective catchments, and drain to other watercourses.

STWL has provided details of the discharge rates from the WwTW. Along the course of the tributary there are a series of small culverts at bridge crossings. Details of their dimensions can be found on the topographic survey (Appendix A) and photographs in Appendix C.

The Flood Estimation Handbook web service¹² (FEH), indicates a catchment area of 1.68 km² at the downstream edge of the Site. The Standard Average Annual Rainfall (SAAR) is given as 623 mm for the Site.

Geology, Hydrogeology and Soils

BGS mapping¹³ shows the bedrock formation under at the Site to be Edwalton Member, made up of mudstone. The superficial geology is made up of alluvium in the area surrounding the Earl Shilton Brook in the centre of the Site, with bands where no superficial deposits are recorded to the north and south of the Brook. In the north and south of the Site superficial deposits of the Oadby Member (Diamicton) are recorded and in the south west of the Site there is an area of the Wigston member (Sand and Gravel).

At the Site the bedrock is designated as a 'Secondary B' aquifer. The Environment Agency website¹⁴ defines this as *"predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering"*. The superficial alluvium, sand and gravel are classified as a 'Secondary A' aquifer. The Environment Agency website defines these as *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers"*. The LANDIS Soilscales¹⁵ database indicates that the soils

¹² Centre for Ecology and Hydrology (2020), Flood Estimation Handbook Web Service. (Online) Available at: <https://fehweb.ceh.ac.uk/> (Accessed 14 September 2021)

¹³ British Geological Survey (2021). Geology of Britain Viewer (classic). (Online) Available at: <https://mapapps.bgs.ac.uk/geologyofbritain/home.html> (Accessed 14 September 2021)

¹⁴ Environment Agency (2014). Aquifer Designation data (online). Available at: <https://www.bgs.ac.uk/datasets/aquifer-designation-data/> (Accessed 14 September 2021)

¹⁵ Cranfield University (2021). Soilscales. (Online) Available at: <http://www.landis.org.uk/soilscales/> (Accessed 14 September 2021).

present on the Site are a mixture of: *“‘Freely draining slightly acid loamy soils’ in the north and south and ‘Slightly acid loamy and clayey soils with impeded drainage’ in a band around the Earl Shilton Brook.”*

The FEH gives an SPRHOST value of 30.3 for the Site. This indicates moderate soil permeability, and greenfield run-off rates. The BFIHOST value from the FEH is 0.682 which confirms the Site is moderately permeable. This value indicates that the catchment groundwater sources comprise approximately 68% of the total annual discharge (for the catchment to the Site).

The FEH for the year 2000 gives the percentage urban catchment coverage (URBEXT2000) for the catchment as 0.3367. An urban expansion factor was applied to the URBEXT2000 parameter to reflect potential increases in impermeable area, between 2000 and 2020, as advised by the EA¹⁶. This resulted in an increase in the URBEXT2000 parameter from 0.3367 to 0.4035. This indicates that the catchment is heavily urbanised (on account of the upstream area of Earl Shilton that drains to the Site).

2.2 Development Proposal

The Illustrative Site Masterplan is included within Appendix A. The following elements are proposed:

- up to 1,500 dwellings (class C3), the envisaged nature of which is set out below;
- up to 5.3 ha of employment uses comprising a mix of office and light industry uses (class B2, B8, and E);
- a two-form entry primary school (class F.1);
- A community hub comprising a retail centre (up to 2,000 m² comprising a mix of class E and F.2) to meet everyday convenience needs;
- up to 16.7 ha of public open space including areas of new planting, landscaping, and 3.26ha of SuDS; and
- new services such as gas, electricity, water, telecommunications, and drainage.

Under the NPPF, the vulnerability classification of dwelling houses and educational establishments is ‘More Vulnerable’ (see Table 2 in NPPF Technical Guidance⁴).

2.3 Planning Context

Hinckley and Bosworth Strategic Flood Risk Assessment and Core Strategy

The Hinckley and Bosworth Borough Council Strategic Flood Risk Assessment (SFRA) was adopted in 2007 and updated in 2019. Earl Shilton is highlighted as one of the Urban Centres in Hinckley and Bosworth. The SFRA generally provides some basic guidance on requirements for a FRA, but largely refers to national guidance on flood risk (i.e. PPS25 – now replaced by the NPPF). It does contain a broad scale assessment of the risk to existing development in Earl Shilton (Appendix E of the SFRA), in which it states that there were historic flood events in 2014 and 2018, with potential risks associated with surface water and groundwater flooding. It also states that development of this greenfield Site would need to attenuate its runoff through the use of SuDS.

The Hinckley and Bosworth Borough Council Core Strategy was adopted in December 2009. The Core Strategy (CS) reiterates what is stated in the SFRA, and suggests flooding is not a major issue for the

¹⁶ Joint Defra/EA Flood and Coastal Erosion Risk Management R&D Programme (2006). URBEXT₂₀₀₀ - A new FEH catchment descriptor Calculation, dissemination and application. (Online) Available at: http://sciencesearch.defra.gov.uk/Document.aspx?Document=FD1919_5228_TRP.pdf%20 (Accessed 07 September 2021)

borough. The CS states flood mitigation measures, such as SuDS, will need to be incorporated into new developments to ensure that the issue of improved resource management is suitably addressed. Within the CS only one policy is relevant to flood risk and Site drainage, this is Policy 20 (Green Infrastructure). This Policy is accompanied by a Green Infrastructure Strategy which highlights that green infrastructure can provide opportunities to reduce urban run-off and risk of flooding, reducing the impacts of climate change through flood mitigation. Three policies have been retained from the 2001 Local Plan which includes statements to ensure that flood risk is managed appropriately and not increased by any development.

2.4 Consultation

As part of the production of this FRA, there has been consultation with the Environment Agency, Leicestershire County Council as Lead Local Flood Authority (LLFA), Severn Trent Water and Hinckley and Bosworth Borough Council. This correspondence is included within Appendix D.

The LLFA responded on 11/02/21, their key points were that:

- They have no records of any flood incidents within close proximity to the site;
- The sequential approach should be taken with regards to masterplan development;
- For any development in proximity to Flood Zone 2 or medium and high risk of surface water the Finished Floor Levels (FFLs) should be set to 300mm above the general ground level or 600 mm above the Flood Zone 2 water level;
- SuDS should be included within the development and suitably managed as per best CIRIA C753 best practice;
- At the outline stage, infiltration testing is only required should the site propose infiltration techniques. If not proposed then infiltration testing may be conditioned to demonstrate that is not viable to use them;
- Discharge from the site should be no greater than the QBar greenfield value up to the peak return periods plus a 40% allowance for climate change;
- A 10% allowance for urban creep should be incorporated into the SuDS design; and
- A clear margin of 4.5m along the banks of watercourses which are wider than 2 m should be left to allow maintenance. For watercourses less than 2m in width a margin of 3 m should be left.

Consultation with STWL has indicated that the nearest recorded foul sewers are situated within the residential area to the northwest of the Site (plans included in Appendix E). A 70 m length of pumped rising foul sewer is also present in the far north of the Site, running from a pumping station situated on Thurlaston Lane to the WwTW. In order to serve the Site, provision and construction of connecting sewers will need to be agreed with STWL. Further detail is given in the accompanying Utilities Assessment document. STWL has also provided details of the discharge rates from the WwTW.

The Environment Agency stated that they are not aware of any groundwater flooding events within the area.

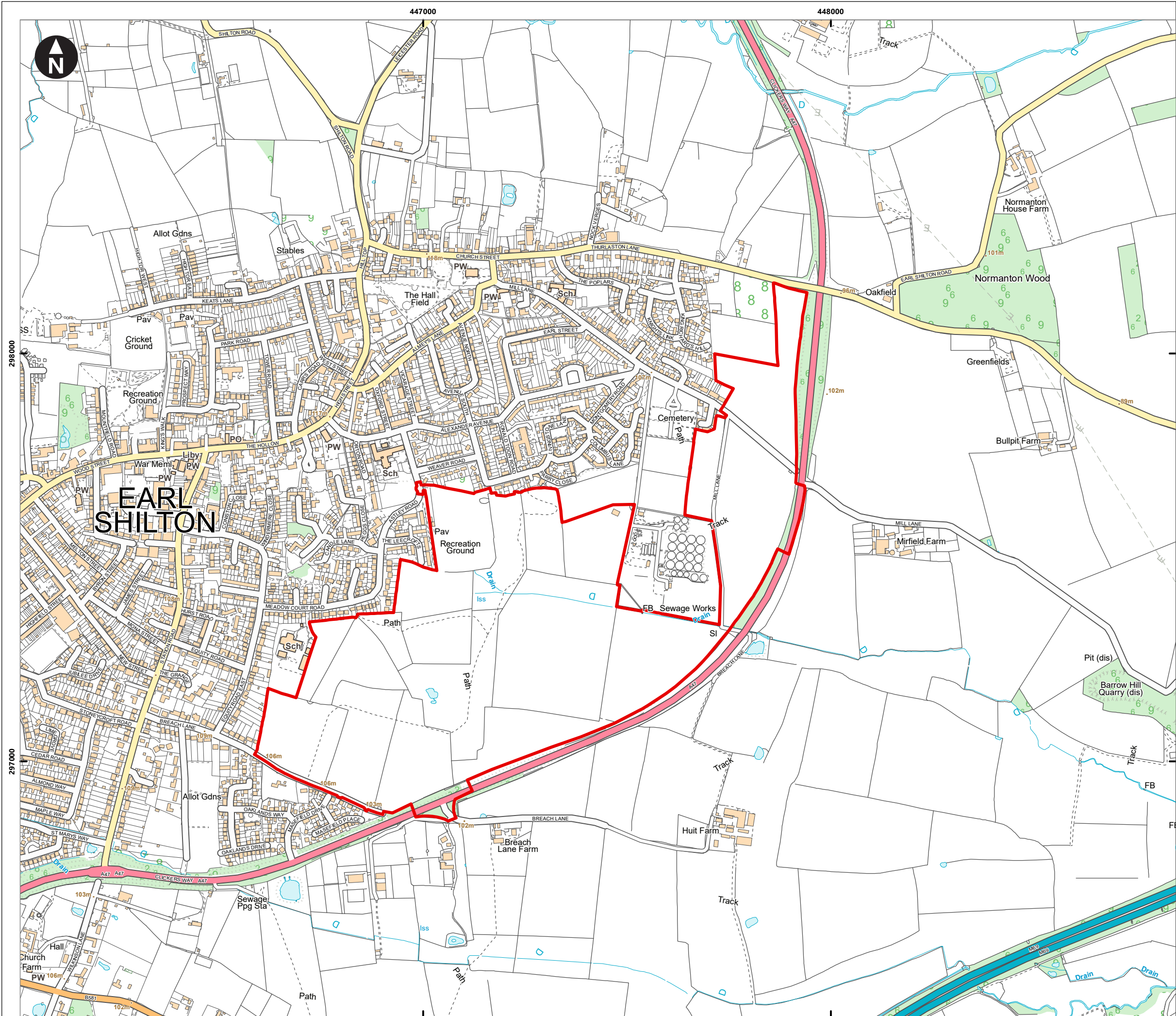
2.5 Sequential Test and Exception Test

Sequential Test

The NPPF and the accompanying Technical Guidance document describe the principles of the Sequential Test, which aims to steer new development to areas with the lowest probability of flooding. The Sequential Test is a decision-making tool designed to ensure that Sites at little or no risk of flooding are developed in preference to areas at higher risk. As the majority of the Site and all of the proposed development is located within Flood Zone 1, the Sequential Test is considered to have been passed. All new building development and site accesses will be in Flood Zone 1.

Exception Test

Table 3 in the Technical Guidance for NPPF⁴ identifies that, for a 'more vulnerable' development within Zone 1, the Exception Test does not need to be applied. For this reason, the type of development proposed is considered to be appropriate for this Site, and therefore the Exception Test has not been considered further in this FRA.



Key
Site boundary

0 100 200 300 400 500 m

Scale at A3: 1:9,000
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Earl Shilton
Flood Risk Assessment

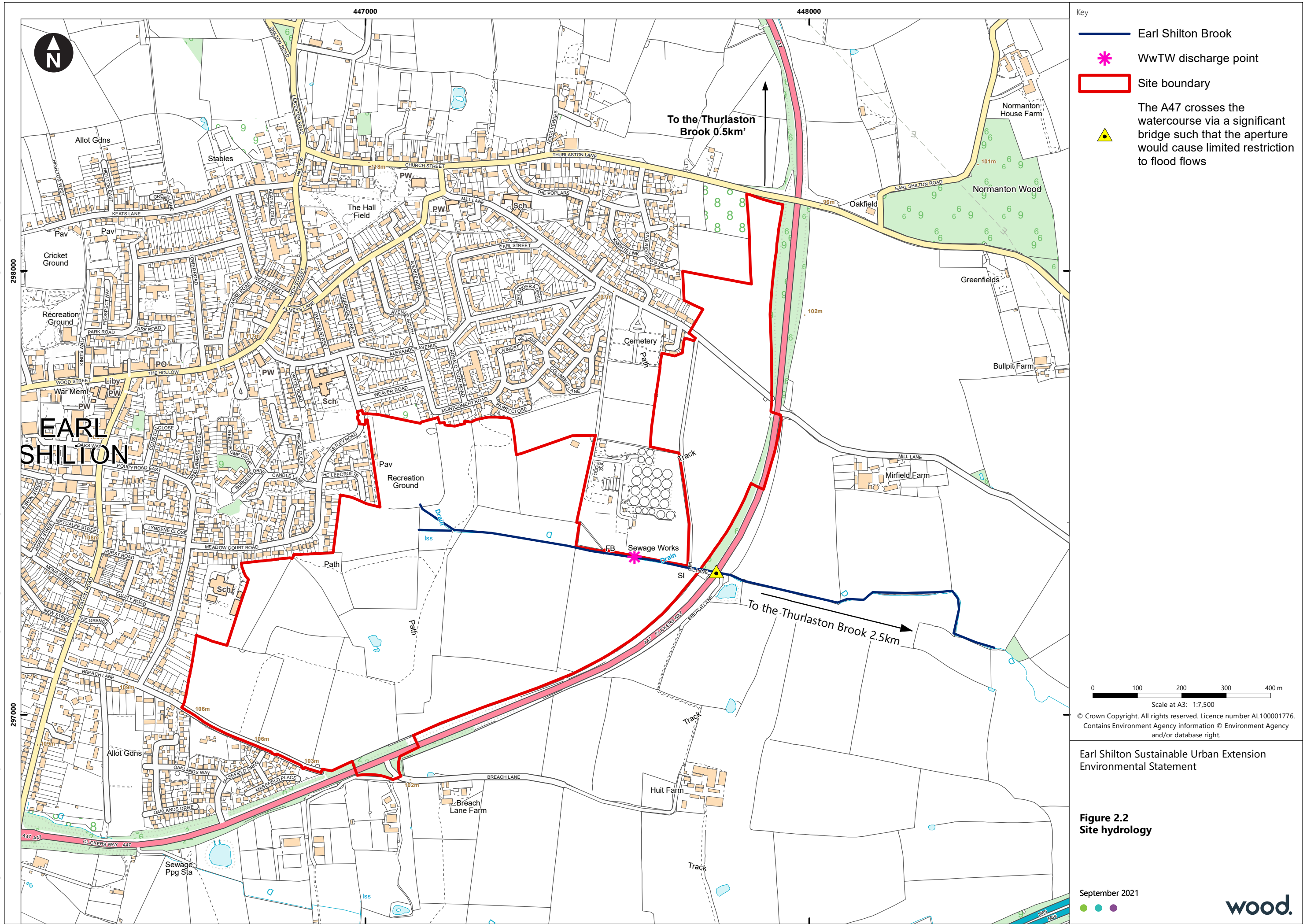
Figure 2.1
Site plan

September 2021

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3. Flood Risk Appraisal

3.1 Summary of Potential Sources

An extract from the Environment Agency's flood map for planning is shown in Figure 3.1. It can be seen that the Site lies entirely in Flood Zone 1, the Earl Shilton Brook which bisects the Site is not large enough to be included in the EA Flood Map (as it has a catchment area <3 km²). Table 3.1 summarises the flood risk across the Site from various potential sources of flooding - these are then discussed in the following sections.

Table 3.1 Summary of Potential Flood Risk Sources

Source of Flooding	Risk Posed	Notes
Fluvial	Limited Risk	The Site is located in Flood Zone 1 on the Environment Agency flood map for planning (Figure 3.1). There is one small watercourse present (Earl Shilton Brook) which rises within the Site, and flows south-east to join the Thurlaston Brook, hydraulic modelling of this watercourse has been undertaken. Section 3.3, Figure 3.2 and 3.3 provide further detail.
Tidal	No Risk	As the Site is situated at elevations of 90mAOD and above, there is no risk of tidal flooding to the Site.
Groundwater	Low	The Leicestershire PFRA shows the area to be <25% susceptible to groundwater flooding.
Surface runoff/ run on and surface water drainage	Medium	The Environment Agency Surface Water flood risk mapping (Figure 3.3) shows areas at risk. The mapping only shows a limited flood extent across the Site, the flood extent generally follows the corridor of the Earl Shilton Brook on Site. The proposed area of impermeable surfaces on Site will increase as a result of the development. A surface water management strategy is being developed to ensure this is managed and attenuated so as not to increase downstream flood risk.
Sewer	Low	STWL have no recorded sewer flooding incidents in the area.
Artificial	No risk	There are no artificial waterbodies, or flood defences that pose a risk of flooding to the Site.

3.2 Historic Flooding

The Environment Agency has no records of flooding on or immediately adjacent to the Site. Hinckley and Bosworth Borough Council (HBBC) and STWL were also contacted to request any information on historic flooding in the area. HBBC stated that they had no record of any flooding incidents in the area, but thought that was likely to be a consequence of the Site always having been agricultural land.

The Level 1 SFRA states that there have been historic flood events in Earl Shilton in 2014 and 2018. These affected a number of properties on Wood Street, which is approximately 430 m to the north west of the Site. The SFRA does not state that there have been any historic flooding events affecting the Site, but given the residential focus of the document, were any events to have occurred, these may not have been reported or included.

The Leicestershire County Council 'Preliminary Flood Risk Assessment' (PFRA) presents a record of the major historical river flood events in the area; however there are no records of flooding in Earl Shilton. In addition, a review of the SFRA and consultation with the Environment Agency yielded no evidence of pluvial or groundwater flooding in the area.

3.3 Fluvial Flooding

The Earl Shilton Brook rises on Site and is shown on Figure 2.2. This watercourse has a catchment area of around 1.68km² at the downstream edge of the Site. The Site visit indicated that this was a relatively small watercourse, initially rising from a surface water drain outfall, and passing through an area of rough grassland, before being joined by another minor surface water outfall. The watercourse then passes alongside arable fields, within these reaches limited vegetation is present along the banks of the watercourse. Just upstream of the WwTW, the bankside vegetation becomes particularly dense, with overgrown hawthorn shrubs partially blocking the channel, as the channel reaches the WwTW, the channel again becomes more open and free running, and two outfalls from the WwTW join the watercourse. The watercourse then passes through a concrete lined channel inset within a larger open span bridge beneath the A47, to flow through further open farmland downstream of the Site. Several culverts are present along the route of the watercourse, with a number of these structures in a poor state of repair.

Hydraulic Modelling

While the EA Flood Map for Planning (Figure 3.1) shows that the entire Site is within Flood Zone 1, this is because the Earl Shilton Brook is not included within the EA's modelling, due to its small catchment size. In order to confirm the extent of flood risk along the Earl Shilton Brook, a computer hydraulic model of the watercourse has been developed using the HEC-RAS software package (v4.1). Full detail is provided in the Hydraulic Modelling Report (Appendix F) with a summary of the modelling process and results included here.

A 1D-2D modelling approach has been utilised using HEC-RAS (Hydraulic Engineering Centre – River Analysis System) version 5.0.7, to provide design flood extents upstream of the A47 embankment. The model represents the watercourse from its source within the Site to a point 964 m downstream (approximately 220 m downstream of the A47). The model is 1D only downstream of the A47 road embankment since the region is outside of the EA LiDAR coverage, and has not been covered by the topographical survey undertaken in 2012. The 2012 topographic survey was specifically commissioned to support development of the site, and includes full detail (cross-sections, structures etc) to inform the flood modelling undertaken. The survey is thus still considered suitable to inform the current application, given the detail included originally, and the limited likelihood of change since the survey. The 2D model upstream of the embankment makes use of the EA 2m LiDAR data where available and is supplemented by the topographical survey collected for the project by SV Surveying Ltd in 2012 (Appendix B) where there is no coverage.

The input fluvial hydrology to the Earl Shilton Flood model was produced using the second iteration of the Revitalised Flood Hydrograph (ReFH2) model. This is an industry standard rainfall-runoff approach, approved by the Environment Agency and LLFAs, for generating design event flood hydrographs. In addition to this the inputs from the WwTW and CSO were included with the values supplied by STWL (Appendix D).

Model scenarios were run of the 5%, 1%, 1% plus 50% Climate Change and 0.1% AEP fluvial flood events¹⁷. Flood levels for nodes along the channel for these events are provided in Table 4.1 of Appendix F. The modelled flood extents are shown on Figure 3.2. It can be seen the while the area affected by flooding is slightly more extensive than that shown on the surface water flood map (Figure 3.3) it remains constrained close to the channel of the Earl Shilton Brook and does not spread extensively across the site. There is very little difference in extent between the scenarios due to the well-defined channel topography of the Earl

¹⁷ This modelling was undertaken using NPPF 2019 climate change uplifts. Since the modelling was completed, the NPPF 2021 climate change uplifts have come into force. For a 'highly vulnerable' development, NPPF now states that the central allowance should be used, which is 28% for this location. As such the models have not been re-run with the updated climate change allowances as the current modelling represents a conservative approach. However, as the development could be considered to be a significant urban extension, the upper end allowance for peak river flow is recommended to be assessed as part of assessing credible maximum scenarios. In this instance the 60% climate change uplift would need to be applied. However as the 0.1% river flows are greater than the 1% plus 60% climate change flows, and the masterplan and subsequent floodplain compensation have been based on ensuring no development within the 0.1% extent it can be seen that a flood event above the credible maximum has been assessed.

Shilton Brook, with its steep banks. The modelled 0.1% AEP event is the most extensive flood event and represents the outline of Flood Zone 2. All residential development will be outside of this area and have FFLs set 600 mm above the level.

3.4 Groundwater Flooding

The Leicestershire County Council Preliminary Flood Risk Assessment (PFRA) concluded that groundwater flooding was not a significant risk due to the underlying geology being classified as a non-aquifer / low permeability aquifer. The PFRA mapped the susceptibility to groundwater flooding across the region using the EA Areas Susceptible to Groundwater Flooding (ASStGWF) dataset. From this dataset the area of the Site falls within an area thought to be <25% susceptible to groundwater flooding.

However, they do note that localised floodplain sands and gravels could give rise to groundwater flooding. There are two strips of these types of superficial deposits running through the Site, and they have been classified as Secondary A aquifers. These areas could potentially give rise to localized flooding. There have been no reported incidents of groundwater flooding in the vicinity of the Site; however, the Site has historically been agricultural land with little developed areas. Although, given the small extent of these areas and their shallow nature, notable egress of groundwater is considered unlikely.

The following precautions should be taken against groundwater flooding, and be incorporated within the surface water management strategy:

- In the areas of the Site away from the Earl Shilton Brook, Finished Floor Levels should be maintained a minimum of 150mm above surrounding ground; and
- The creation of low points within the Site where rising groundwater might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings.

3.5 Surface Water Flooding

The Environment Agency's Surface Water Flood Mapping shows only limited flooding on the Site, generally along the course of the Earl Shilton Brook which bisects the Site (see Figure 3.3). The flowpath extends upstream to the urban area of Earl Shilton, so any surface water exceeding the capacity of the combined sewer system is likely to flow downstream through the Site along this flowpath. However, the area upslope of where the Earl Shilton Brook issues is at present open ground used as football pitches, and this will remain the case in future, so very occasional surface water flooding should not be an issue here. Situated to the west of the WwTW, a minor surface water flowpath is shown draining from the north towards the Earl Shilton Brook. In the illustrative masterplan for the Proposed Development, the area this surface water drains through has been set aside as a green corridor/swale.

The areas of the Site to be developed are above the valley bottom where surface water would be expected to concentrate, with development being set away from the floodplain of the Earl Shilton Brook.

The increase in impermeable surfaces as a result of the development will also increase the surface water flood risk; therefore a surface water management strategy is required, this is summarised in Section 4 and presented in full in Appendix G. This outlines measures to restrict runoff from the Site to greenfield rates.

In addition, the following precautions should be taken against surface water flooding on-site, and are incorporated within the surface water management strategy:

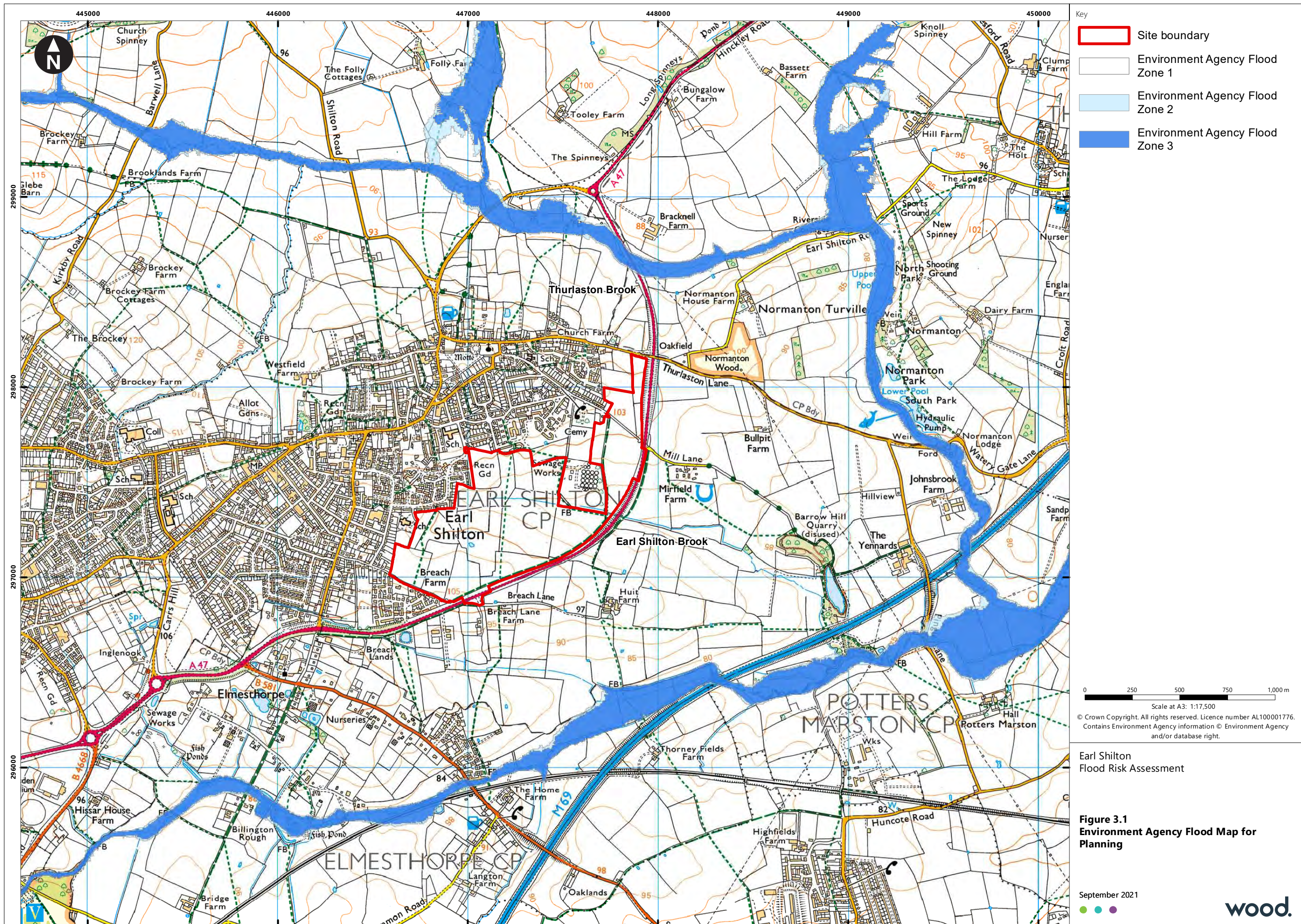
- Finished Floor Levels should be maintained a minimum of 150 mm above surrounding ground;
- The creation of low points within the Site where water might pond should be avoided by careful profiling of the ground to allow overland drainage away from the buildings; and
- The existing surface water flowpaths should be maintained.

3.6 Sewer Flooding

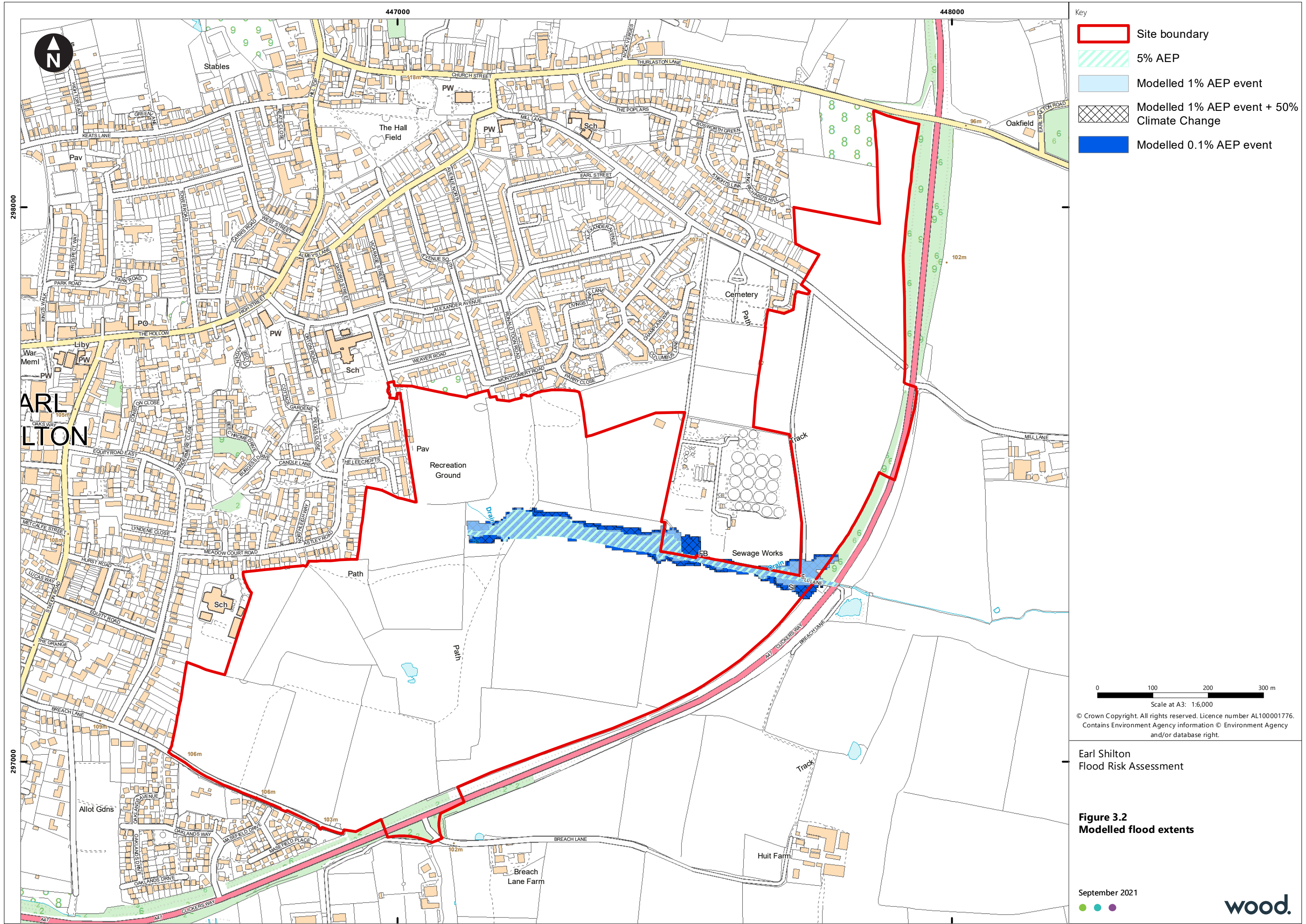
There is currently a combined sewer running beneath the Site, which connects the sewer network through Earl Shilton to the WwTW north of the Site. A 70 m length of pumped rising foul sewer is also present in the far north of the Site, running from a pumping station situated on Thurlaston Lane to the WwTW. However, it is considered that there is limited current risk from sewer flooding, since the illustrative masterplan for the Proposed Development avoids building over these routes, and if a pipe failure did occur, wastewater would drain downslope and be intercepted by roads/watercourses. Given that the sewers will be subject to a regular maintenance program, failure/blockage is considered unlikely.

A new section of trunk sewer would be required to serve the Site. This would be constructed to the required standards (i.e. as specified in Ofwat's Code for adoption agreements for water and sewerage companies operating wholly or mainly in England, and agreed with STWL), and would run directly to the adjacent WwTW.

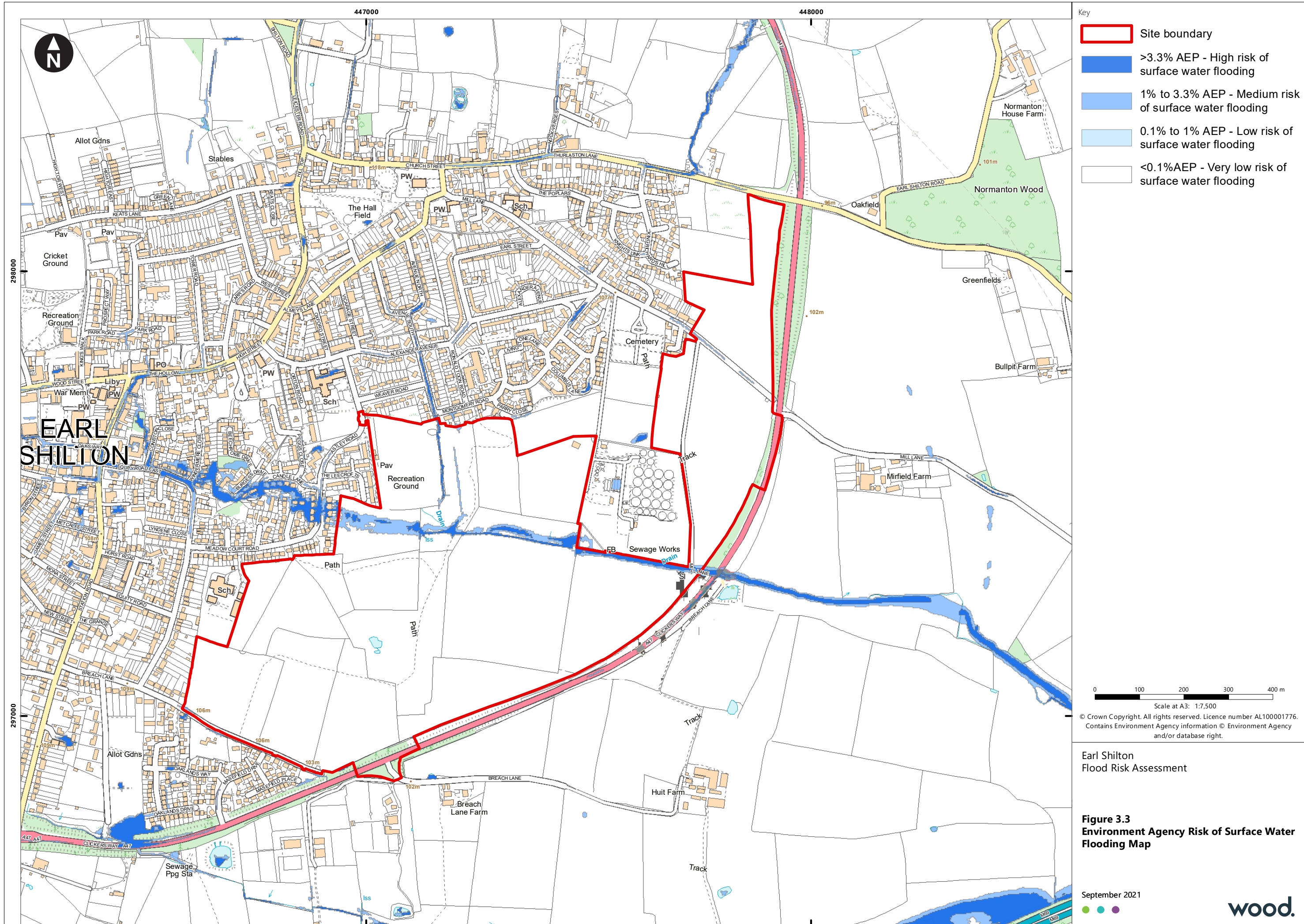
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4. Surface Water Management Strategy

This section discusses the outline strategy for managing runoff from the developed Site in a sustainable manner, in accordance with the NPPF guidelines and EA requirements. The Outline Drainage Strategy is included within Appendix G, with overall requirements for attenuation storage are provided. It should be noted that, as outline planning permission is being sought at this stage, this assessment does not constitute a detailed drainage design. Detailed drainage design will be undertaken post submission, either as part of the process of discharging planning conditions, or as part of a further application for detailed planning permission and should be carried out in consultation with HBBC, STWL and the EA.

4.1 Development of the Outline Drainage Strategy

National Planning Policy Framework

The NPPF requires that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development (unless specific off-site arrangements are made and result in the same net effect). Wherever possible, rainfall should be retained on site and allowed to infiltrate into the ground. Typically, run-off volumes generated during a storm will have to be stored for the duration of the storm and released slowly afterwards to meet the required discharge rate.

The NPPF further advises that planning authorities should promote the use of Sustainable Drainage System (SuDS) principles in the management of surface-water run-off from new developments. There is a presumption for the use of SuDS within any development, except in rare instances that it can be demonstrated that SuDS principles cannot feasibly be incorporated within a development, as agreed with the planning authority.

4.2 Outline Drainage Strategy

The Outline Drainage Strategy and its basis is set out in Appendix G. A summary of the key design criteria and requirements are provided here.

Site layout and design

A sequential approach to the development area layout and design has been taken to minimise the risk to the development from the sources of flood risk detailed in Section 3. This primarily comprises avoiding the areas at risk of fluvial and surface water flooding within the development area. SuDS features have been situated in Flood Zone 1, as shown on the Site masterplan (Appendix A). SuDS, sized according to the scale of new impermeable will be provided within each drainage catchment on Site. This will ensure that surface water runoff is managed close to source for both quantity and quality, and ensure no increase in downstream flood risk.

Existing drainage arrangements

As the Site is currently a greenfield Site there are minimal existing surface water arrangements and rainfall either accumulates at low points, soaks into the ground, or drains across the surface to the existing ditch/watercourse sections.

Requirements of the Drainage System

Based on the requirements of the LLFA, the drainage system is required to limit the peak discharge rate from the Site to greenfield for all events up to the 1% AEP rainfall event, including a 40% allowance for climate change. In order to achieve this flow restriction it is necessary to include attention in the system. In addition, any piped drainage system provided as part of the development will need to be designed to cope with the 3.33% AEP storm event (1 in 30 year event) without surcharging. Whilst in more extreme events the drainage system may surcharge, Site levels and gradients should be designed in such a way that overland flow generated from the Site does not cause flooding of on-Site properties or increase the risk of flooding outside the Site for any event up to the 1% AEP with 40% climate change event, including for 10% urban creep. The Site should be profiled in such a way that all overland flows are contained on-site and directed to the attenuation storage facilities. To meet the requirements set out in Ofwat's *Code for adoption agreements for water and sewerage companies operating wholly or mainly in England*¹⁸, the risk of surcharging should be assessed to establish if any overland flow routes could cause temporary surface water flooding. If the system does surcharge in the more intense storm events, then floor levels of the properties need to be raised to ensure that the water levels do not cause any major issues.

The drainage strategy for managing surface water needs to be based on the Management Train as outlined in *The SuDS Manual* (CIRIA C753)¹⁹. This ensures that surface water is managed at source and as the water is conveyed through the Site, each sequential technique is designed to reduce the intensity of flow and to enhance the quality of flow by removing pollutants. The most suitable techniques for use across the Site can be ascertained by undertaking a SuDS Assessment. An appraisal has been made by considering the SuDS hierarchy and choosing suitable techniques in line with the main objectives of Quantity (Flood Reduction), Quality (Pollution Reduction) and Amenity/Biodiversity (Landscape and Wildlife Benefit).

The SuDS Hierarchy

The SuDS Hierarchy is illustrated in Figure 4.1. This table rates each type of technique in terms of its overall sustainability.

¹⁸ Ofwat (2020). Code for adoption agreements for water and sewerage companies operating wholly or mainly in England. Ofwat, March 2020. (Online) Available at: <https://www.ofwat.gov.uk/wp-content/uploads/2018/08/March-2020-Code-for-adoption-agreements-for-water-and-sewerage-companies-operating-wholly-or-mainly-in-England.pdf> (Accessed 17 September 2021)

¹⁹ CIRIA (2015). C753: The SuDS Manual, (online). Available at: https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx (Accessed 17 September 2021).

Figure 4.1 SuDS Hierarchy

Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
	Tanked systems - over-sized pipes/tanks - storms cells	✓		
Least Sustainable				

Source: SuDS: A Practical Guide, Environment Agency Development Control Thames Region, 2006.

Techniques such as permeable surfaces are typically located within urban areas and although they offer source control by managing flow intensity entering the system, they do not promote any wildlife benefit. Tanked systems are typically located underground and as such they offer no landscape, wildlife or pollution control benefit. Therefore, these systems are only to be used once all other sustainable techniques have been assessed and considered unsuitable. For this Site geocellular storage is only proposed in the north of the site in the area designated for business use, all other SuDS features would be above ground. Swales would be situated downstream of any geocellular storage to ensure that the SuDS overall acts to provide suitable additional stages of water quality treatment to provide a full SuDS management train before discharge to the receiving watercourse.

SuDS techniques that promote infiltration of surface water are preferred over those which promote attenuation before discharge to a watercourse. As identified in the Geology, Hydrogeology and Soils Section, the Site is underlain by mudstone with some superficial layers of Alluvium, Sand, Gravel and Diamicton. Overall, the geology at the Site is not particularly permeable due to the presence of mudstone and has been classified by the Environment Agency as a Secondary B aquifer. Therefore, SuDS techniques which primarily utilise infiltration are unlikely to be suitable at this Site. As infiltration based SuDS are not proposed, the LLFA do not require infiltration testing to be undertaken at the outline planning stage. Instead an attenuation based SuDS is being progressed, with all attenuation features restricting flows to the greenfield discharge rate before discharging into the Earl Shilton Brook.

4.3 Modelling of Surface Runoff

Introduction

Outline modelling has been carried out to estimate the likely requirements for surface water attenuation within the development Site. This has been carried out by first calculating the target greenfield runoff rate for the Site, then by simulating a simple conceptual drainage system, which enables attenuation storage volumes to be sized in order to limit post development runoff rates to the target greenfield rates.

Greenfield Run-off Rates

The calculated greenfield runoff rates in the unit rates of l/s/ha for the existing site were undertaken using MicroDrainage version 2018 and are shown in Table 4.1.

Table 4.1 Existing Site Greenfield runoff rates

Annual Exceedance Probability (%)	Return Period (1 in.....)	Unit GF Runoff (l/s/ha)
100	1	9.9
3.33	30	7.5
1	100	3.2
Q _{BAR}	-	3.8

Based on the Site topography, the Site divides naturally into seven land parcels; these are shown in Annex B of Appendix G. Within each land parcel the impermeable area has been calculated from the Masterplan, and a 10% allowance for urban creep applied. The results are shown in Table 4.2.

Table 4.2 Development Total and Impermeable Areas

Site	Total Area (ha)	Impermeable Area (ha)	10% Urban Creep (ha)	Final Impermeable Area (ha)	Contributing Greenfield Area (ha)
Land Parcel 1	4.8	2.3	0.2	2.5	NA
Land Parcel 2	5.8	3.3	0.3	3.6	NA
Land Parcel 3	2.3	0.9	0.1	1.0	NA
Land Parcel 4	7.9	2.8	0.3	3.1	0.9
Land Parcel 5	17.5	7.8	0.8	8.6	2.5
Land Parcel 6	11.6	2.8	0.3	3.1	6.0
Land Parcel 7	14.3	6.3	0.6	7.0	1.1
New access junctions*	1.2	N/A	N/A	N/A	N/A
Total	65.37	26.2	2.6	28.8	10.6

**the new access junctions will re-use the existing highways drainage and as such are not accounted for in this outline drainage design. At the detailed design stage, a full survey of existing assets and the final impermeable area will be used to size any supplementary storage required.*

Storage within the Site has been designed to ensure that there will be no flooding within the Site for rainfall events up to and including the 1% AEP event. This includes a 40% increase in rainfall intensity to account for the effects of climate change (as specified by NPPF). When undertaking the detailed drainage design care should be taken to ensure that existing discharge rates and proposed discharge rates are matched for the range of return periods.

A conceptual model of the proposed system has been run with a range of durations from 15 minutes up to 10,080 minutes, or 7 days. This is checked to ensure that the critical duration event is included within the analysis. Analysis resulted in a half drain down in excess of 24hrs and additional checks were therefore undertaken to test against a subsequent storm. The proposed storage volume was tested against a critical 1% AEP event (plus 40% climate change), followed by 24hrs drain down and then followed by a critical 10% AEP 1440 minute duration event. In the event that the proposed volume was insufficient for this scenario then additional volume was considered.

The outline planning land parcels have been assessed on an individual basis. The summary of the results is shown in Table 4.3. The full modelling outputs are included in Annex A of Appendix G and supporting drawings are included in Annex B of Appendix G.

Table 4.3 Attenuation Volumes for Earl Shilton

Development Land Parcel	Runoff. Area (ha)	GF Q _{BAR} Rate (l/s)	Attenuation Vol. (m ³)	Attenuation Method	Landtake (ha)
Land Parcel 1	2.3	9.5	1,900	1m deep SuDS Basin Slope 1 in 4	0.253
Land Parcel 2	3.3	13.8	2,800	Geocellular storage	0.308
Land Parcel 3	0.9	3.9	800	1m deep SuDS Basin Slope 1 in 4	0.118
Land Parcel 4	2.1	12.4	1,850	1m deep SuDS Basin Slope 1 in 4	0.248
Land Parcel 5	7.3	40.4	7,850	1m deep SuDS Basin Slope 1 in 4	0.946
Land Parcel 6	5.8	43.5	5,900	1m deep SuDS Basin Slope 1 in 4	0.722
Land Parcel 7	4.7	20.0	4,600	1m deep SuDS Basin Slope 1 in 4	0.570
25,700 m ³					3.166 ha

In order to attenuate the 1% event plus 40% climate change at the greenfield rate a total required attenuation volume of approximately 25,700 m³ will be required. This will need to be finalised to suit the final design details (impermeable area) before construction.

It should be noted these are only initial estimates of attenuation volume and there is some flexibility to sub-divide these volumes across the catchment within a number of storage structures, with a preference for

attenuation basins (wet or dry) and some swales. The volume requirements will need to be finalised as part of the detailed design to suit the exact impermeable areas associated with the final development proposals. At this point the precise methodology and detailed design of the SuDS can be agreed with the SuDS Approval Body (SAB).

The illustrative masterplan has been designed alongside the SuDS system to ensure that space has been made available for the required attenuation basins. By considering the SuDS design at an early stage within the design process it results in a system that not only manages surface water but also provides amenity and ecological benefit to the entire development.

In order to provide a positive source control solution it is recommended that runoff from parking areas and private is routed via low flow channels, filter beds and similar features. This technique reduces the intensity of rainfall entering the drainage system and also helps to clean the runoff water by removing some pollutants such as suspended solids and engine oils. Storage within these areas utilising these methods may slightly reduce the amount of attenuation required in the attenuation basins. The exact division between permeable and impermeable surfaces will be confirmed at the detailed design stage so that the final attenuation basins sizes can be confirmed.

Piped drainage system will be used for the majority of the drainage network around individual houses and streets. Then, where feasible, surface water from each residential area's drainage catchment will be conveyed by dry swales to an attenuation basin. These swales are to be located alongside roads and within public open spaces to provide natural green corridors and a means of flow control. Where they are positioned adjacent to roads, there is the potential for removing standard highway kerbs so that unrestricted surface water sheet flow can enter the swales without the need for gullies and headwalls.

It is recommended that attenuation basins are included for within each of the catchments so that flows entering the receiving watercourses are restricted to greenfield runoff rates. For the southern catchment in particular, it may be more effective to provide the required attenuation volume using several basins in accordance with CIRIA C753 SuDS guidance. This method also has the advantage that surface water discharges from the SuDS will be able to supplement flows in the Earl Shilton Brook, supporting the ecology/amenity value.

Where commercial and industrial units are proposed, it is recommended that underground geocellular storage tanks are incorporated underneath suitable areas so that each tank is owned and maintained by each unit owner. There is then the option of using the water stored in the tank for non-potable water applications within the buildings (i.e. grey water recycling). The outlet to the drainage system of each tank would need to be designed to control the flows to greenfield runoff rates to ensure that flows generated from each building catchment are controlled and managed before entering subsequent stages of the SuDS system. There is also an opportunity to include swales or filter trenches in the car parking areas surrounding the units, which would provide the benefit of pollutant removal and amenity value.

Outfall options

The proposed surface water outfalls from the attenuation basins would consist of a flow control device such as a weir, orifice or vortex control. Restricted flows would enter the watercourse through a pipe and headwall, although the final layout of the ponds and details of the flow control will need to be confirmed at detailed design stage.

Before construction commences, it is recommended that some basic maintenance work is carried out along the Earl Shilton Brook in order to remove any debris blockages (large dead trees, old fencing and other debris) that could significantly block the watercourse. This would ensure that the brook is able to accept discharge from the Site's SuDS, without the risk of any blockages along the watercourse.

5. Flood Risk Management and Mitigation

5.1 Floodplain compensation

While the entire Site is classed as being within Flood Zone 1, the results of the hydraulic modelling indicate that some small areas of residential development shown on the illustrative masterplan are within the 0.1% AEP flood extent. In order to raise these effected areas out of the level of the 0.1% AEP flood, level for level floodplain compensation will need to be provided. The compensatory level for level storage will be in the form of hydraulically connected areas of ground which will be lowered in order to accommodate the floodwater which would have otherwise been displaced so as to ensure that downstream flood risk is not increased.

Within the Site there are suitable locations along the banks of the Earl Shilton Brook which are able to be lowered in this manner to provide the level for level floodplain compensation. Full design calculations will be completed at the detailed design stage, but high level calculations have been undertaken here to demonstrate that this approach is feasible within the Site.

Due to the slope of the flood zone along the Earl Shilton Brook, for these initial calculations the locations where it is proposed to raise land and lower land in compensation have been split into sections. This ensures that lowering would be applied as locally as possible to the areas of raising. Figure 5.1 shows the locations of land to be raised so as to suit the development platform in orange, the areas of land which are available to be lowered in blue and the extent of the modelled 0.1% AEP flood event as a yellow outline. In the areas immediately adjacent to the Earl Shilton Brook, a suitable crossing will be constructed, and as such these areas have not been included as areas for compensation.

Figure 5.1 Floodplain Compensation locations



Orange areas 1, 2, 3 4 and 5 are where ground raising would occur. Blue areas 1, 2 and 3 are available areas in the masterplan where potential compensatory lowering could occur. Given the area and levels of land under the blue areas, overall more land than needed (Table 5.2) is potentially available for lowering than needed (Table 5.1),

Table 5.1 shows the volume of floodplain displacement that will need to be compensated for. Table 5.2 shows the volumes of land available to be lowered in compensation. The areas lowered to compensate need to be located at a similar elevations as the areas being raised, so as to ensure that the floodplain storage is compensated on a level for level basis. The volumes were calculated using EA LiDAR, by considering the overall area of each parcel, and the existing/proposed elevations. The calculations include for a suitably sized batter along the edges of the areas to ensure the calculations correctly approximate the respective volumes. In each case the value presented for lowering does not include material above the flood level and only material that could be used on a level-for level basis.

Table 5.1 Floodplain compensation location volumes of land to be raised

Location	Volume of land to be raised (m ³)
1	90.76
2	165.63
3	231.22
4	77.09
5	5.22
Total	569.24

Table 5.2 Floodplain compensation location volumes of land available to be lowered

Location	Volume of land available to be lowered (m ³)
1	239.23
2	189.23
3	1856.96
Total	2285.43

It can be seen that the proposed development has sufficient available land, at suitable elevations in hydraulic connectivity with the Earl Shilton Brook that can be lowered to successfully compensate for the land which will need to be raised out of the 0.1% AEP flood zone extent. As such it can be concluded that level for level floodplain compensation is possible at this site, with the exact design being undertaken at the detailed design stage.

5.2 Vulnerability

The vulnerability of the development proposed at this Site has been defined as 'more vulnerable' according to the categories set out in the NPPF. However, as the proposed development area within the Site is entirely located in Flood Zone 1 the Sequential Test is satisfied, and it is not a requirement of the FRA to apply the Exception Test. The development is deemed appropriate for the location, in accordance with the NPPF.

5.3 Flood Risks and Mitigation

The development areas and the access routes are not located in a fluvial flood risk area and therefore safe access and egress will be maintained at times when watercourses are in flood.

Flood risk has been considered from all sources. The proposed development is not at risk of tidal flooding or flooding from main rivers. The Earl Shilton Brook is present on Site but this has been assessed as not posing a flood risk as development has been placed outside of areas at risk of flooding, together with a recommended freeboard of 600mm above the 0.1% flood level. The watercourse will be retained, and attenuated SuDS flows released to it.

Groundwater flood risk is not considered to be a significant risk to the proposed development. Finally, the potential for surface water to run-on from upslope areas was considered. The Site was found to be on a ridge plateau, such that any flows generated up-slope would run towards the Earl Shilton Brook, located in the centre of the Site. This is therefore not considered to be a significant risk.

The impact of the developed Site on runoff has been assessed, and recommendations provided for SuDS that will prevent any increase in downstream flood risk.

Should the proposals include basements to buildings then a Site-specific investigation should be undertaken to assess the risk of groundwater ingress and if deemed necessary the development should be made resilient to groundwater.

5.4 Access and Egress

During a flood event safe access and egress must be available. In this case the primary source of flood risk to the Site comes from fluvial or surface water flooding along the Earl Shilton Brook corridor which bisects the Site. Hydraulic modelling has shown that the area that would be affected during a flood event forms a narrow corridor along the Earl Shilton Brook (Figure 3.3). While this would mean that no access or egress across the Earl Shilton Brook would be possible during a flood event, the main pedestrian and vehicular access onto the Site to the North and South would not be affected.

- For parts of the site to the north of the Earl Shilton Brook safe egress would be possible onto the A47 in the east or Astley Road in the west; and
- For parts of the Site to the south of the Earl Shilton Brook safe egress would be possible onto Mill Lane or the A47.

As such, safe access and egress onto both the north and south of the Site will be able to be maintained during a flood event.

While the new proposed bridge in the east of the Site will cross the Earl Shilton Brook, it will be designed so as to be open span and with a road level above the modelled 0.1% AEP flood event. This will mean that it is designed to be suitably elevated above predicted flood levels so that safe access across the Earl Shilton brook can be maintained during flood events. Full design details will be competed at the detailed design stage, but these design principals will ensure that the bridge is elevated above predicted flood events and will not cause a flow constriction that could exacerbate flood levels.

SuDS

The Outline Drainage Strategy in Appendix G and summarised in Section 4 has recommended potential options which could be implemented to ensure that surface water runoff generated as a result of the development is managed and controlled to greenfield discharge rates for the 1% AEP (with 40% climate change allowance and a 10% allowance for urban creep).

The proposed SuDS would prevent the development increasing flood risk elsewhere and facilitate appropriate management of the risk of surface water flooding to the development itself.

The outline SuDS detailed in Appendix G will be developed further as the development design progresses. Agreement on detailed design will be made with the adopting authority. Under the *Flood and Water Management Act* (FWMA), 2010 this would typically be the Lead Local Flood Authority (LLFA), in this case Leicestershire County Council. Under the Act, the LLFA is termed the 'SuDS Approving Body' (SAB) and should be consulted as the final designs are developed to ensure a final design suitable for implementation and adoption is constructed.

Finished floor levels and ground profiling

The Finished Floor Levels (FFLs) and surrounding ground within the development would be profiled in such a way to allow safe conveyance of overland flows in excess of the capacity of the drainage system and to avoid flooding the proposed properties or causing increased flood risk outside the Site boundary. These flows may arise from seasonally high groundwater or from extreme storm events or blockages of the new drainage system. In particular:

- Adjacent to the Earl Shilton Brook FFLs would be at least 600 mm above the modelled flood level for the 0.1% AEP event, or 300 mm above local ground levels. Elsewhere on the Site FFLs would be maintained a minimum of 150 mm above surrounding ground to protect against the residual risk of flooding from pluvial flooding or groundwater emergence.
- Low points within the Site where water might pond would be avoided by careful profiling of the ground to allow overland drainage away from the buildings and safe discharge to SuDS storage features without causing increased flood risk elsewhere. This may require some raised shallow bunds to convey water to the storage feature and prevent the water leaving the Site in an uncontrolled manner.

6. Conclusions and Recommendations

6.1 Conclusions

The following conclusions can be drawn:

- The Sequential Test has been passed and the Exception Test does not need to be applied in the case of this development; and
- All potential risks of flooding to the Site have been assessed and relevant management options have been presented where necessary.

6.2 Recommendations

- Some reprofiling of the Site should be carried out to remove local low points and ensure all runoff from the Site is directed away from buildings into the proposed SuDS drainage system and does not pond along overland flowpaths.
- All Finished Floor Levels should be set at least 600 mm above the modelled flood level for the 0.1% AEP event, or 300 mm above local ground levels in the vicinity of the flood extent. Elsewhere on the Site Finished Floor Levels should be set at least 150 mm above the local ground level at each development plot.
- Development will be located in Flood Zone 1, with the area of Flood Zones 2 and 3 associated with the Earl Shilton Brook set aside as a green corridor.
- In order to produce the desired development platform, some level for level floodplain compensation will be required along the Earl Shilton Brook Corridor. Initial calculations have demonstrated that sufficient land is available for this, but further calculations will be required at the detailed design stage. These will need to be informed by a bespoke topographic survey.
- The design of the proposed crossing over the Earl Shilton Brook will be confirmed at the detailed design stage. However, by utilising the design principals that it will be a clear span opening with the road level set to ensure that it is elevated above the 0.1% AEP modelled flood level it will ensure that the crossing will continue to enable safe access between both parts of the site during a flood event. In addition, the access routes in the north and south of the Site will ensure safe egress from within the site during all predicted flood events.
- The proposed development would result in impermeable surfaces covering an area of 26.2 ha. Based on preliminary estimates about 25,266 m³ of surface water storage would be required to attenuate run-off flows from this area up to the 1% AEP with 40% climate change event. It is recommended that multiple attenuation basins are developed to manage this water and release attenuated flows at greenfield rates to the receiving watercourses. This estimate will need to be refined as part of more detailed design.
- A Site-specific investigation may be required to be undertaken at the detailed design phase to determine the infiltration rate and whether infiltration SuDS options are appropriate for this Site. While it is not considered likely that infiltration based SuDS components would be able to solely manage the site's surface water runoff, infiltration may be able to provide some benefit. The attenuation based SuDS have been sized on the basis that they would be the only element of the Site's SuDS. If infiltration is shown to be feasible, and for example source control

measures such as filter beds, strips and low flow channels are used in parts of the Site, it may be possible to reduce the volume of attenuation storage as part of the final design.

- Attenuated surface water should be discharged to the Earl Shilton Brook. Based on the size of the Site, and its topography, it appears that a range of attenuation basins and associated outfalls will be required. The proposed attenuation basins locations are shown in Annex B of Appendix G.
- Should the proposals be changed to include basements for the buildings, a Site-specific investigation should be undertaken to assess the risk of groundwater ingress and if deemed necessary the development should be made resilient to groundwater.

Appendix A

Illustrative Masterplan



Key

Site boundary (65.37ha)

0 m300 m

Scale 1:5000 @ A3

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Earl Shilton

Illustrative masterplan

September 2021



Appendix B

Topographic Survey



File : 20200927-111111-1- EAGLE SW-IL (Cover) - 204 21 000
 Subject : East station
 Content : Content using USB VLSN V2
 Content : Content on 202.25.124.1120
 Content : Data of survey are content



This survey has been computerized / graphically fitted to the Coordinate Survey (O.S.) digital file. This is to show the survey in context with its surroundings. Although O.S. Coordinates are shown on this plan the grid is to be treated as arbitrary. No scale factor has been applied to the survey therefore the coordinates shown are not true O.S. Coordinates. Please refer to Survey Station Coordinate Table above to ensure correct establishment of the on-site grid used.

COMMENTS

His plan said only he used for its original purpose, S&P Surveys Ltd accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions / levels should be checked on site prior to design and construction.

Any additional information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Any information (where applicable) has been surveyed from ground level and therefore should be treated as approximate only.

Legend:

[illegible]

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**TOPOGRAPHIC
SITE SURVEY**

Scales	Drawn/Paper Size
N/A	MA/A0

Survey Date	Drawing No
2011/2012	11131/12/01

DO NOT SCALE

