Longfield Solar Farm

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Appendix 9A: Flood Risk Assessment

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Longfield Solar Energy Farm Ltd

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Quality information

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1. Executive Summary

1.1.1 AECOM has been commissioned to undertake a Flood Risk Assessment (FRA) for Longfield Solar Farm, hereafter referred to as 'the Scheme' (centred on approximate National Grid Reference (NGR); TL 74179 14620 as an appendix to the Environmental Statement (ES)).

1.1.2 The Order limits cover an area of approximately 453 hectares, comprising arable fields interspersed with tree shelter belts (linear), small woodland and copse, agricultural fields, farm access tracks and farm buildings. The Order limits and the Scheme is described in further detail in ***Chapter 2: The Scheme*** in the ES **[EN010118.APP/6.1]**.

1.1.3 The Scheme includes:

a. Solar PV Arrays Works Area;

b. Battery Energy Storage System (BESS) Compound;

c. The Longfield Substation;

d. The Bulls Lodge Substation Extension; and

e. The Grid Connection Route.

1.1.4 This FRA has been prepared in accordance with the requirements of the Overarching National Policy Statement for Energy (EN-1) and the draft NPS-EN-1 2021, the National Policy Statement for Renewable Energy Infrastructure (EN-3) and the National Planning Policy Framework, 2019 (NPPF). The proposed use of the Scheme would be classed as 'Essential Infrastructure'.

1.1.5 The vast majority of the Order limits lies within Flood Zone 1. The River Ter Main River passes through part of the northern part of the Order limits and a tributary of the River Chelmer, the Boreham Brook Tributary crosses the Order limits in the south west corner. This river is partially a Main River and an Ordinary Watercourse upstream in the tributary.

1.1.6 The flood risk summary table below indicates the overall flood risk across the Scheme; the report assesses the Scheme in more detail relative to each flood risk area.

Flood Risk Summary

Table 1: Flood Risk Summary

Flood Risk Source	Pre-Scheme Risk	Post Scheme Risk	Comments
Fluvial	Low (Majority) Medium – high (North West side)	Low (Majority) Medium – high (North West side)	The vast majority of the Order limits is in Flood Zone 1, but certain areas lie in Flood Zone 2, 3a and 3b, adjacent to the River Ter and Boreham Brook. No development will occur in Flood Zone 3. Long term post Scheme flood risk remains the same, as pre -Scheme.
Tidal	Very Low	Very Low	Not in a tidal area (therefore scoped out of report herein). Long term post Scheme flood risk remains the same as pre-Scheme.
Pluvial (Surface Water)	Very Low	Very Low	Surface water risk varies throughout the Order limits, indicating patches of the Site which are susceptible to surface water flooding; these are primarily field ditches / small tributaries of the River Ter. However, flooding is very localised and generally shallow (very low risk). According to the Chelmsford Surface Water Management Plan (2014), the south western area of the Site that crosses the Boreham Brook, is not within a Critical Drainage Area. Long term post Scheme flood risk remains the same, as pre -Scheme.
Groundwater	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Generally, the Order limits is at low risk of groundwater flooding (<50% risk); a very small part of the Order limits extends near to an area at high risk, near the River Ter catchment in the east, with a risk >75% of groundwater flooding. Groundwater flood risk within the Order limits is considered to be low. Further ground investigation to confirm groundwater levels should be undertaken following receipt of the DCO to inform a detailed drainage strategy for the Order limits. Long term post Scheme flood risk remains the same, as pre -Scheme.

Flood Risk Source	Pre-Scheme Risk	Post Scheme Risk	Comments
Sewers	Low	Low	There are no noted significant public sewer networks in the Order limits. The Braintree Strategic Flood Risk Assessment (SFRA) indicated no cases of sewer flooding within the surrounding areas, such as Terling, Boreham and Hatfield Peverell. Long term post Scheme flood risk remains the same, as pre -Scheme.
Artificial Sources	Very Low	Very Low	There are no identified sources that pose a risk to the Order limits. Long term post Scheme flood risk remains the same, as pre-Scheme.

1.1.7 There appear to be no formal surface or foul water drainage networks present in the Order limits; geological and topographical conditions suggest that the surface water runoff runs off to the adjacent watercourses or ponds, as well as potentially utilising some infiltration to ground at natural low spots.

1.1.8 The outline drainage strategy for the Scheme will be secured under the DCO within section 4 of ***Appendix 9C: Longfield SuDS Strategy*** **[EN010118/APP/6.2]** and section 3 of ***Appendix 9D: Bulls Lodge Substation Extension: Drainage Strategy*** **[EN010118/APP/6.2]**.

1.1.9 The full drainage strategy will be designed to ensure there will be no increase in the risk of flooding within or outside of the Order limits. Surface water runoff from the Scheme will be captured by infiltration SuDS techniques: swales and basins to mimic existing drainage conditions and accommodate the 1 in 100-year return period storm event plus a 20% increase allowance for climate change.

1.1.10 When considered within the context of national, regional and local planning policy in respect of development and flood risk, the assessment concludes that the site of the Scheme remains safe from this perspective, does not increase flood risk elsewhere and fulfils the Government's wider criteria for sustainable development.

1.1.11 On this basis, it is concluded that flood risk considerations should not prevent the granting of development consent.

2. Introduction

6.1 Introduction

6.1.1 AECOM has been commissioned to undertake an FRA for Longfield Solar Farm, hereafter referred to as the 'Scheme' (approximate centre TL761135), approximate postcode: CM3 2RA.

6.1.2 The Order limits covers an area of approximately 453 hectares, comprising arable fields interspersed with tree shelter belts (linear), small woodland and copses, agricultural fields, and farm access tracks and farm buildings. The Order limits is described in more detail in ***Chapter 2: The Scheme*** of the ES **[EN010118/APP/6.1]**.

6.2 FRA Objectives

6.2.1 The minimum requirements for FRAs as outlined in the NPS EN-1 (paragraph 5.7.5) are to:

a. Be proportionate to the risk and appropriate to the scale, nature, and location of the project;

b. Consider the risk of flooding arising from the project in addition to the risk of flooding to the project;

c. Take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;

d. Be undertaken by competent people, as early as possible in the process of preparing the proposal;

e. Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure;

f. Consider the vulnerability of those using the site, including arrangements for safe access;

g. Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;

h. Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;

i. Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project;

j. Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;

k. Consider if there is a need to be safe and remain operational during a worst case flood event over the development's lifetime; and

l. Be supported by appropriate data and information, including historical information on previous events.

6.2.2 It should be noted that revised draft NPS EN-1 sets out an amended list of minimum requirements for FRAs. The draft NPS EN-1 has been considered within this report.

6.2.3 The principal objectives of the FRA taking into account the above are to:

a. Identify potential forms of flooding including rivers, watercourses, surface water flooding, groundwater flooding, flooding from sewer systems and other forms of flooding;

b. Establish the risk of flooding to the Scheme;

c. Determine the effects of the development on flooding elsewhere either through displacement of floodwaters or increased runoff; and

d. Suggest appropriate flood mitigation measures, including a strategy for disposal of surface water run-off following the principles of sustainable drainage systems (SuDS).

6.3 Scope of Work

6.3.1 In preparing this FRA, AECOM has:

a. Obtained relevant data and information from statutory and other authorities;

b. Considered the potential sources of flooding;

c. Assessed the risk of flooding to the Order limits;

d. Assessed the impact of off-site flooding (displaced water) on third parties;

e. Considered the impact of climate change; and

f. Considered likely mitigation requirements and any residual risk.

6.4 Site Description

6.4.1 The Order limits covers approximately 453ha and is approximately centred on National Grid Reference (NGR) TL 74179 14620 and located approximately 1.1km to the west of the village of Terling. The Order limits is located within the District Council administrative areas of Chelmsford and Braintree, in the county of Essex.

6.4.2 LiDAR and Ordnance Survey mapping have been interrogated to establish approximate ground levels across the Site.

6.4.3 The land immediately surrounding the Order limits comprises a number of villages, including:

a. Fuller Street approximately 300m to the north;

b. Gamble's Green and Terling, 500m and 1.1km to the east;

c. Boreham, 500m to the south-west;

d. Hatfield Peverel 1.5km to the south-east; and

e. Chelmsford 5.7km to the south-west. Boreham Road runs north to south along the western edge of the Site, with the A12 abutting and bounding the southern edge of the Site boundary.

6.4.4 The northern part of the Order limits and surrounding area consists of undulating and relatively elevated landform, as part of the River Ter valley. The landform rises steeply northwards from the river and Terling Spring, between 35m Above Ordnance Datum (AOD) to 50m AOD along parts of Braintree Road. It culminates at a ridgeline at 70m AOD at Rank's Green, in the northern part of the study area. To the south of the River Ter, the landform also rises steeply, across Sandy Wood, to a ridgeline at 55m AOD.

6.4.5 To the west of the Order limits, the landscape consists of a varied pattern of landform, reflecting past sand and gravel extraction and engineered flat terrain across Boreham airfield, which is situated at 55m AOD approximately 800m to the west of the Order limits. From the airfield, the landform falls very gradually eastwards to the River Ter, which flows southwards between Terling and the northern part of Hatfield Peverel, at approximately 20m AOD.

6.4.6 The River Chelmer flows across the southern part of the study area, at approximately 15m AOD. There are several large-scale reservoirs and lakes adjacent to the river. From the river, the landform rises consistently northwards, to form a ridgeline around 40m AOD at Boreham, and southwards, across Little Baddow, to an elevated ridgeline at 100m AOD, approximately 3km from the CP Site Boundary.

6.4.7 Neither the Order limits nor the immediate surrounding area is covered by any statutory landscape designations.

6.5 Site Extent

6.5.1 **Figure 1** overleaf presents the extents of the Order limits; it occupies approximately 453ha. Only the Flood Risk within the Order Limit extents is discussed within this FRA. The figure below has been extracted from ***Chapter 9: Water Environment*** and can be found in ***Figure 9-2b: Fluvial Flood Zones including indicative Concept Design*** **[EN010118/APP/6.3].**

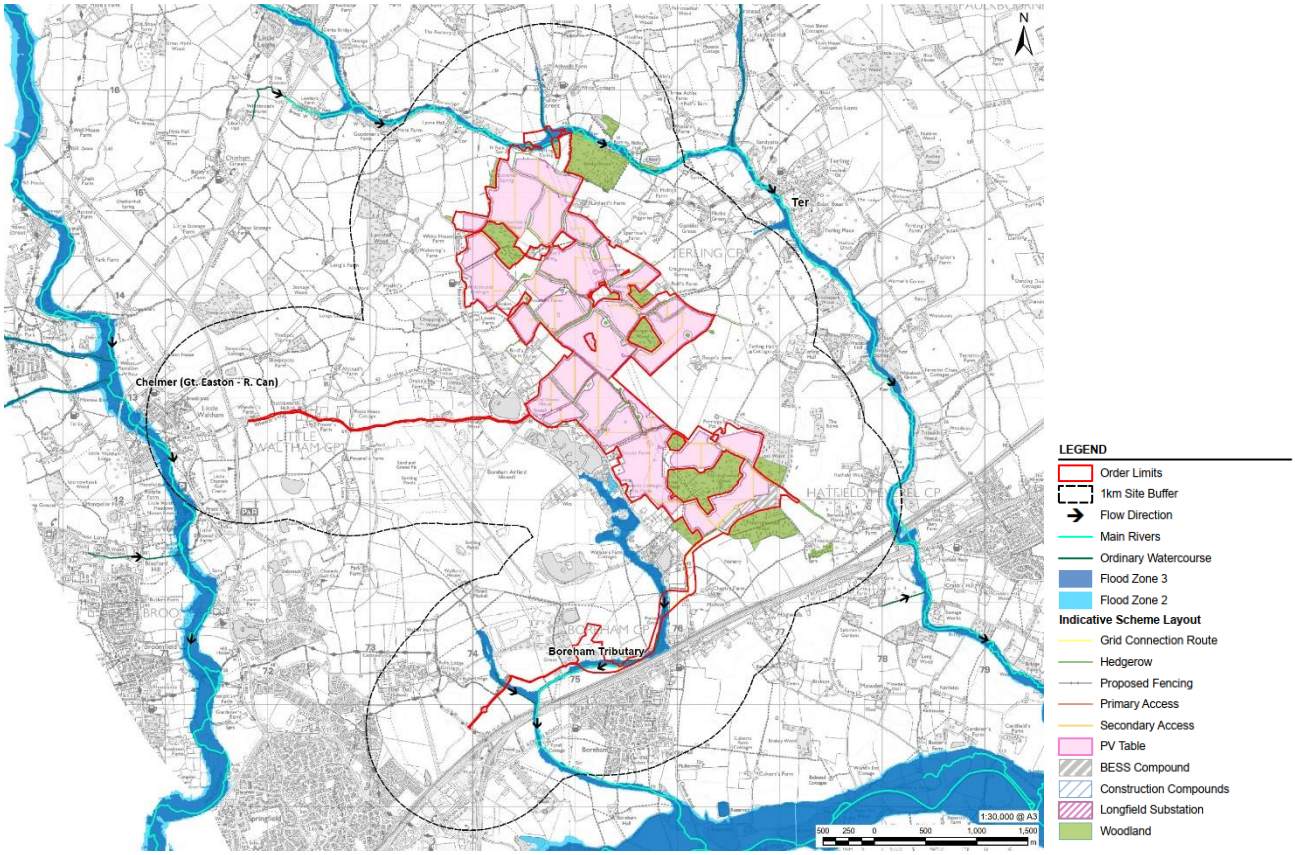


Figure 1: Fluvial Flood Zones including indicative concept design (*Figure 9-2b* [EN010118/APP/6.3])

6.6 Existing Land Use

6.6.1 The Order limits has been set to only occupy natural landscape, avoiding existing developments and buildings It is estimated to be less than 1% impermeable area); therefore, the site is considered 100% permeable].

6.6.2 The Order limits consist of agricultural fields with some small parcels of pasture, interspersed with individual trees, hedgerows, tree belts (linear), small woodland blocks and farm access tracks. The hedgerows within the Order limits range between lengths of dense tall vegetation (shrub and tree species) and thin lines of vegetation with sporadic trees present, although the former is a dominant feature. The arable fields are of small to moderate size, some of which are of irregular shape.

6.6.3 **Table 2** below provides the existing site permeable and impermeable areas:

Table 2: Contributing Areas

	Total Area (ha)	Permeable Area (ha)	Impermeable Area (ha)	Percentage Impermeable
Extent of Order limits	453	453	Considered 0 ha (<1%)	0%

6.7 Development Proposals

6.7.1 The Scheme comprises the installation of solar PV Panels and on-site energy storage facilities. It would allow for the storage of electricity to the National Grid as described within ***Chapter 2: The Scheme*** of this ES **[EN010118/APP/6.1]**. The Scheme is also described in ***Schedule 1*** to the DCO, where the "authorised development" is divided into works packages, which comprise:

f. Solar PV Array Works Area and The Solar Farm Site (Work No. 1): up to 279.5ha;

g. Battery Energy Storage System (BESS) Compound (Work No. 2): up to 5.2ha;

h. Longfield Substation (Work No. 3): up to 1.7ha;

i. Grid Connection Route (Work No. 4A): up to 30.4ha;

j. Bulls Lodge Substation Extension Site (Work No. 5): up to 4.4ha;

k. Ancillary Infrastructure which could be located across the Scheme (Work No. 6 and generally listed at the end of Schedule 1 of the draft DCO);

l. Temporary Construction Laydown Areas (Work No. 7A, up to 6.9ha) and the Bulls Lodge Substation Extension (Work No. 7B, up to 6.4ha);

m. Ancillary Building (Work No. 8): up to 0.6ha;

n. Site Access Works (Work No. 9, up to 6.5ha); and

o. Habitat Management Areas (Work No. 10): a minimum of 41.1ha.

During the construction phase, one or more temporary construction compound(s) will be required as well as temporary roadways to facilitate access to all land within the Order limits. These will not necessarily constitute the permanent access tracks, as these are yet to be agreed but will lie within the Order limits boundary.

6.7.2 Please refer to **Annex A** for the Scheme layout.

6.8 Consultees

6.8.1 The following stakeholders have been consulted. Comments from stakeholders has been incorporated within this report:

a. Lead Local Flood Authority – Chelmsford City Council and Braintree District Council; and

b. The Environment Agency.

3. Existing Legislation and Policy

National Policy

7.1 Overarching National Policy Statement (NPS) for Energy (EN-1), including overview of the Draft NPS (EN-1)

7.1.1 The Overarching National Policy Statement for Energy (NPS) (EN-1) sets out the Government's policy for the development of nationally significant infrastructure projects which must be authorised by a DCO.

7.1.2 Paragraph 6.2.1 states the objectives of this Flood Risk Assessment which are in line with paragraph 5.7.5 of NPS EN-1.

7.1.3 Paragraph 5.7.7 recommends that applicants should arrange pre-application discussions with the EA, and, where relevant, other bodies such as Internal Drainage Boards and sewerage undertakers to identify the likelihood and possible extent and nature of the flood risk, help scope the FRA, identify the information that will be required, and address concerns, where proposed development is affected by flood risk or is likely to increase flood risk elsewhere.

7.1.4 NPS EN-1 states at paragraph 5.7.12 that the Infrastructure Planning Commission (IPC) (now, for the purposes of this application, the appointed Examining Authority with the Secretary of State for Business Energy and Industrial Strategy being the decision-maker) should not recommend consent development in Flood Zone 2 in England unless it is satisfied that the Sequential Test requirements have been met and that it should not consent development in Flood Zone 3 unless it is satisfied that the Sequential and Exception Test requirements have been met. For the Sequential Test, it states at paragraph 5.7.13 the following:

> *Preference should be given to locating projects in Flood Zone 1 in England or Zone A in Wales. If there is no reasonably available site in Flood Zone 1 or Zone A, then projects can be located in Flood Zone 2 or Zone B. If there is no reasonably available site in Flood Zones 1 or 2 or Zones A and B, then nationally significant energy infrastructure projects can be located in Flood Zone 3 or Zone C subject to the Exception Test.*

7.1.5 The overarching objectives of the NPS are addressed within this FRA, however, with regard to the Exception Test, the NPS requires the following at paragraph 5.7.14 to 5.7.17:

If, following application of the sequential test, it is not possible, consistent with wider sustainability objectives, for the project to be located in zones of lower probability of flooding than Flood Zone 3 or Zone C, the Exception Test can be applied. The test

provides a method of managing flood risk while still allowing necessary development to occur.

The Exception Test is only appropriate for use where the sequential test alone cannot deliver an acceptable site, taking into account the need for energy infrastructure to remain operational during floods. It may also be appropriate to use it where, as a result of the alternative site(s) at lower risk of flooding being subject to national designations such as landscape, heritage and nature conservation designations, for example Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS) it would not be appropriate to require the development to be located on the alternative site(s).

All three elements of the test will have to be passed for development to be consented. For the Exception Test to be passed:

- *It must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk;*
- *The project should be on developable, previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs; and*
- *An FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere subject to the exception below and, where possible, will reduce flood risk overall.*

Exceptionally, where an increase in flood risk elsewhere cannot be avoided or wholly mitigated, the IPC [now Secretary of State] may grant consent if it is satisfied that the increase in present and future flood risk can be mitigated to an acceptable level and taking account of the benefits of, including the need for, nationally significant energy infrastructure as set out in Part 3 above. In any such case the IPC [now Secretary of State] should make clear how, in reaching its decision, it has weighed up the increased flood risk against the benefits of the project, taking account of the nature and degree of the risk, the future impacts on climate change, and advice provided by the EA and other relevant bodies.

7.1.6 Paragraph 5.7.23 of NPS EN-1 also requires a sequential approach to be applied to the layout and design of projects with more vulnerable uses being located on parts of the site at lower probability and residual risk of flooding by using Sustainable Urban Drainage Systems (SuDS).

7.1.7 Paragraph 5.7.24 and 5.7.25 require "*Essential energy infrastructure which has to be located in flood risk areas should be designed to remain operational when floods occur*" and that "*the receipt of and response to warnings of floods is an essential element in the management of the residual risk of flooding*".

7.1.8 Paragraph 5.7.19 explains the range of sustainable approaches to surface water drainage management and paragraph 5.7.21 requires "*surface water drainage arrangements for any project to be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior*

to the proposed project, unless specific off-site arrangements are made and result in the same net effect".

7.1.9 Paragraph 5.7.22 also states that it "*may be necessary to provide surface water storage and infiltration to limit and reduce both the peak rate of discharge from the site and the total volume discharged from the site. There may be circumstances where it is appropriate for infiltration facilities or attenuation storage to be provided outside the project site, if necessary, through the use of a planning obligation*".

7.2 National Policy Statement for Electricity Networks Infrastructure (EN-5)

7.2.1 National Policy Statement for Electricity Networks Infrastructure (EN-5) (NPS EN-5) principally concerns high voltage transmission systems and distribution systems in addition to associated infrastructure.

7.2.2 Paragraph 2.4.1 of NPS EN-5 explains that as climate change is likely to increase risks to the resilience of electrical infrastructure it requires applicants to "*set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it would be resilient to flooding, particularly for substations that are vital for the electricity transmission and distribution network*". Applicants should, in particular, set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it has been designed to be resilient to:

a. Flooding, particularly for substations that are vital to the network; and especially in light of changes to groundwater levels resulting from climate change;
b. The effects of wind and storms on overhead lines;
c. Higher average temperatures leading to increased transmission losses;
d. Earth movement or subsidence caused by flooding or drought (for underground cables); and
e. Coastal erosion – for the landfall of offshore transmission cables and their associated substations in the inshore and coastal locations respectively.

7.3 National Planning Policy Framework (NPPF)

7.3.1 The NPPF was first published in March 2012, superseding national planning policy statements and guidance. The NPPF was revised in July 2021 and this FRA complies with the revised version of the NPPF. Flood Risk and Coastal Change Planning Practice Guidance (PPG) was also published in 2014 to provide guidance to support the implementation of the NPPF policies.

7.3.2 Section 14 of the NPPF entitled Meeting the Challenge of Climate Change, Flooding and Coastal Change (paragraphs. 152-173) sets out the requirements to assess flood risk and climate change for developments. Paragraph 169 expects "*major developments to incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate."*

7.3.3 The assessment of flood risk is based on the definitions in **Table 3** below, extracted from the PPG:

Table 3: Flood Zones – Table 1 of the PPG 2014

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

7.3.4 Annex 3: Flood risk vulnerability classification of the NPPF, classifies the Flood Risk Vulnerability of various land uses in **Table 4** below. The More Vulnerable classification encompasses usages such as hospitals and buildings used for dwellings. Less Vulnerable applies to buildings used for general industry, storage and distribution.

Table 4: Flood Risk Vulnerability Classification – Table 2 of the PPG 2014

Development Type	Classifications
Essential infrastructure	a) Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines. Solar farms.

Development Type	Classifications
Highly vulnerable	Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”)
More vulnerable	Hospitals. Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. Non–residential uses for health services, nurseries and educational establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan
Less vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding. Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment works which do not need to remain operational during times of flood.

Development Type	Classifications
	Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). Car parks. Solar Farms
Water-compatible development	Flood control infrastructure. Water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel working. Docks, marinas and wharves. Navigation facilities. Ministry of Defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

7.3.5 The Scheme is classified as Essential Infrastructure. The overall aim is to steer new development to the lowest flood zone, i.e. Flood Zone 1 (Sequential Test). Where there are no reasonably available sites within Flood Zone 1, Flood Zones 2 and 3 may be considered, subject to passing the Exception Test, as required and set out in **Table 5** below.

7.4 The Sequential Test and Exception Test

7.4.1 The NPPF sets out the details of the Sequential Test, which is a risk-based test that should be applied at all stages of development. The aim of the test is to steer new development to areas with the lowest probability of flooding (Zone 1). This is applied by local authorities by means of a SFRA.

7.4.2 If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives), the NPPF requires the Exception Test to be applied to certain forms of new development. The Exception Test considers the vulnerability of the new

development to flood risk. The need for the Exception Test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in national planning guidance (paragraph 163 of the NPPF).

Table 5: Flood Risk Vulnerability and Flood Zone Compatibility - Table 3 of the PPG 20121

Flood Zone	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 functional floodplain	Exception Test Required	×	×	×	✓

✓	Development is appropriate
×	Development should not be permitted
	Flood Zones the Scheme Sits Within for the Vulnerability classification applied.

7.4.3 The NPPF states in paragraph 164 that for the Exception Test to be passed 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.

7.4.4 Both elements of the Exception Test should be satisfied for development to be allocated or permitted.

7.4.5 NPS EN-1 was published in July 2011, prior to the first release of the NPPF in 2012. With regard to the Exception Test the NPPF, which was subsequently updated in 2021, only requires two of the three requirements referred to in NPS EN-1. The requirement for projects to be located on developable or previously developed land should no alternative site on previously developed

land be available is not referred to in the NPPF. Whilst NPS EN-1 relates specifically to nationally significant energy infrastructure projects, planning policy relating to development and flood risk listed in NPPF provides more up to date government policy.

7.4.6 The draft NPS EN-1, published in September 2021 has been reviewed for this FRA, and does not change the approach to the assessment. It should be noted that the text of this draft is closely aligned to the NPPF (see paragraph 7.4.3 above) and requires the following two limbs to be passed:

a) the project provides wider sustainability benefits to the community that outweigh flood risk; and

b) the project reduces flood risk overall, where possible.

Local Planning Policy

7.4.7 The Order limits are located within the administrative areas of Chelmsford City Council (CCC) and Braintree District Council (BDC). The Lead Local Flood Authority is Essex County Council (ECC). ECC will consider the FRA (through consultation with the Environment Agency as necessary) as the Order limits is predominantly located in Flood Zone 1.

7.4.8 The following key planning documents and salient policies have been considered to inform this FRA:

7.4.9 ECC SuDS Guidance:

a) Sustainable Drainage Systems: Design Guide (2020); and

b) Preliminary Flood Risk Assessment (2011, Amended 2017)

7.4.10 Chelmsford City Council:

a) The Chelmsford Local Plan (2013-2036);

b) The Plan includes the follow planning policies which are relevant to flood risk, drainage and surface water:

    a. S2: Addressing Climate change and Flood Risk;

    b. DM18: Flooding/SuDS; and

    c. DM19: Renewable and Low Carbon energy.

c) Chelmsford Surface Water Management Plan (SWMP) (2014); and

d) Chelmsford City Strategic Flood Risk Assessment (SFRA) (2018)

7.4.11 Braintree District Council:

a) Braintree District Council SFRA, 2016

b) Mid Essex SFRA (Covering Braintree) (2007)

c) Braintree District Council Draft Local Plan (2017) – (Section 1 – Adopted February 2021) and Publication Draft Local Plan (2017):

    a. SP1: Presumption in Favour of Sustainable Development;

b. LPP 67: Natural Environment and Green Infrastructure;

c. LPP 70: Protection, Enhancement and Management of Biodiversity

d. LPP 73: Protecting and Enhancing Natural Resources, Minimising Pollution and Safeguarding from Hazards

e. LPP 76: Renewable Energy Schemes;

f. LPP 78: Flooding Risk and Surface Water Drainage;

g. LPP 79: Surface Water Management Plan; and

h. LPP 80: Sustainable Urban Drainage Systems.

7.4.12 Braintree and Witham Surface Water Management Plan (SWMP) (2016).

4. Supporting Information

8.1 Contributing Areas

8.1.1 Within hydrology, it is generally understood that permeable surfaces absorb rainfall whilst impermeable surfaces repel rainfall leading to surface water runoff. For a site, the total impermeable area is often referred to as the site's Contributing Area. The Contributing Area is used as part of the calculation to determine the volume of surface water runoff generated within the site. Developing greenfield sites (typically entirely permeable land) often increases the site's Contributing Area as natural permeable surfaces are sealed by impermeable surfaces. For the Scheme, some existing permeable surfaces will be replaced by proposed impermeable surfaces; these areas are located at the Bulls Lodge Substation Extension, the BESS Compound and the Ancillary Building. A comparison of the proposed and existing site has been undertaken to demonstrate how the Scheme would affect the Order limits Contributing Area.

8.1.2 **Table 6** below presents this comparison:

Table 6: Contributing Areas

	Total Area (ha)	Pre-Development Contributing Area (ha)	Post-Development Contributing Area (ha)	Pre-Development PIMP*	Post-Development PIMP
Order limits	**453**	0	2.4	0%	0.5%**

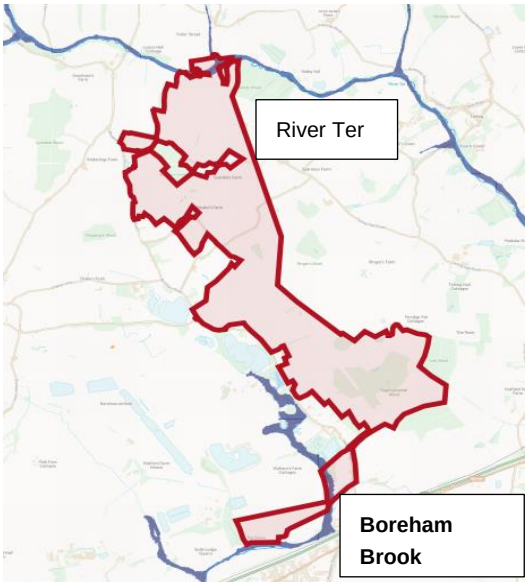
*- Percentage Impermeable Area (PIMP) – percentage of an area that is impermeable

**- Assumed Battery and Substation Areas 100% PIMP. Photovoltaic (PV) panel areas assumed to have 0% PIMP

8.2 Flood Risk Mapping

8.2.1 **Table 7** summarises the pre-Scheme flood risk across the Order limits (the Order limits has been marked indicatively in **Table 7** maps, purely to represent perspective of the site and surroundings to the SFRA mapping. Refer to ***Figure 2-1: Environmental Constraints*** **[EN010118/APP/6.3]** for the precise extent of the Order limits):

Table 7: Flood Risk Mapping

Flood Risk Source	Flood Risk Level	Comments
Fluvial	Low (Majority) Medium – high (North West side)	**Source: *EA Flood Zone Dataset*** The vast majority of the Order limits lies in Flood Zone 1. However, Flood Zones 3 are shown to encroach into the Order limits to the north, in proximity of the River Ter (Classified as Main River by the EA), and towards south-west, where a tributary of the River Chelmer, the Boreham Brook, flows, as a culverted watercourse, in a north-south direction (Classified as Main River by the EA when it flows as an open channel, south of Brick House Farm and the A12). **Source: *Online Flood Map for Planning, accessed 2021.*** SFRA mapping corroborates the EA mapping above. The Braintree SFRA Indicates climate change flood extents which, as modelling has not been undertaken to date, uses Flood Zone 2 as a proxy for Flood Zone 3a including climate change, i.e. 70% climate change (River Thames Basin). Refer to Figure 2 and 3 below for EA mapping and Braintree SFRA climate change flood risk mapping.  **Figure 2 : BDC 2016 Flood Zone Mapping Flood Zone 2 and 3a including Climate Change** The mapping within the Chelmsford City Council SFRA was not available for the Boreham Brook; however, assuming Flood Zone 2 as the climate change Flood Zone 3a extent, flood risk is still confined to within the watercourse boundary. The south west part of the site that crosses the Brook is proposed as a buried cable route, so there will be no change in flood risk in this

location, to or for the Scheme. Refer Figure 3 and Figure 4 below.

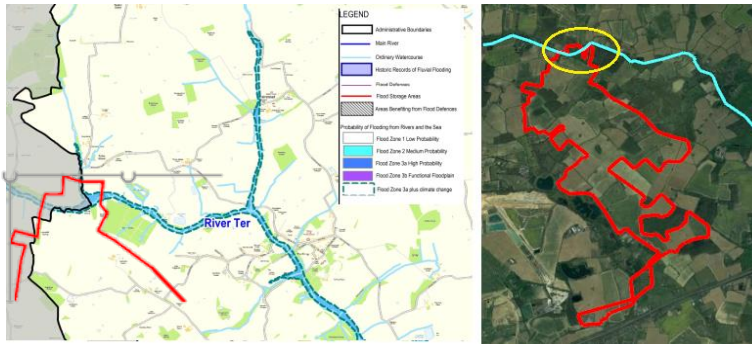


Figure 4 : BDC 2016 Flood Zone Mapping Flood Zone 2/3 and Flood Zone 3a including Climate Change

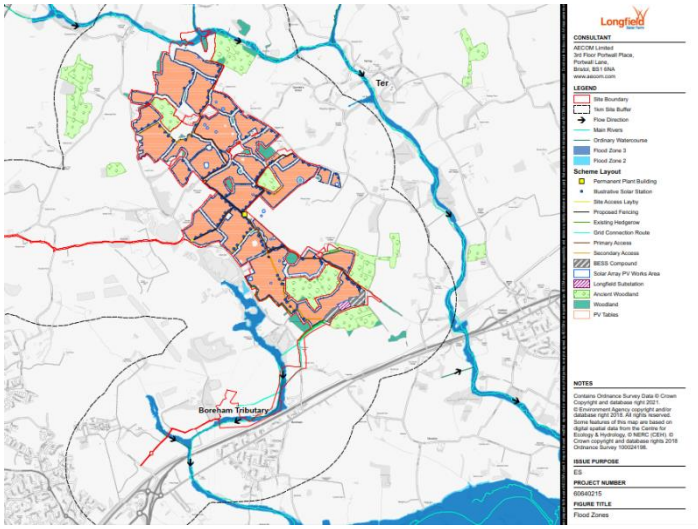


Figure 3 : SFRA Fluvial Flood Zone Mapping 65% Climate Change - Fluvial Modelling Report

Tidal	Very Low	Not in a Tidal area
Pluvial (Surface Water)	Very Low	**Source: *GOV.uk Flood Risk from Surface Water; Gov.uk Online mapping (23/01/2021), BDC SFRA and CCC SWMP*** All reference sources indicate that patches of the Order limits are susceptible to surface water flooding; however, flooding is generally very localised and generally shallow (low risk). Some larger patches are located within the north-eastern portion of the Order limits which are at a high risk. Several field ditches displayed within the Order limits are also shown to be susceptible to surface water flooding. However, the majority of the Order limits is at very low risk of surface water flooding. The Chelmsford SWMP confirms the Order limits does not fall within a Critical Drainage Area (CDA). All reference sources indicate that patches of the Order limits are susceptible to

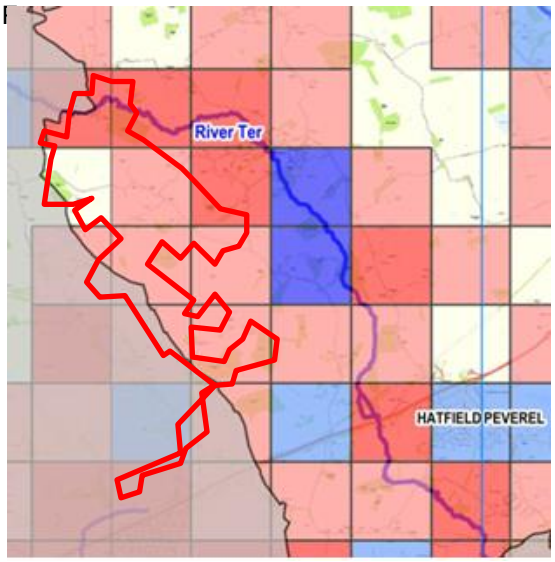
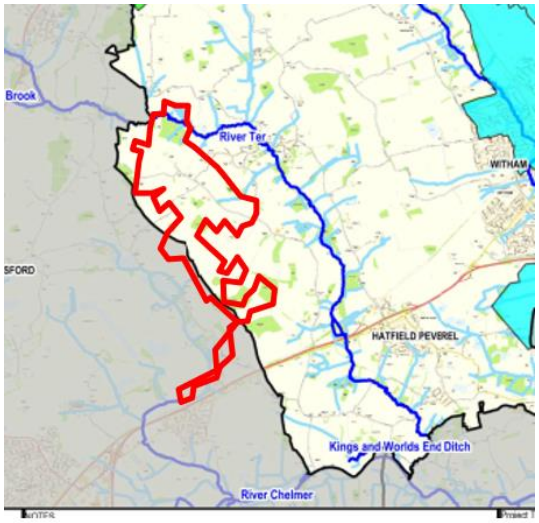
surface water flooding; however, flooding is generally very localised and generally shallow (low risk). Some larger patches are located within the north-eastern portion of the Order limits which are at a high risk. Several field ditches displayed within the Order limits are also shown to be susceptible to surface water flooding. However, the majority of the Order limits is at very low risk of surface water flooding.

The Chelmsford SWMP confirms the Order limits does not fall within a Critical Drainage Area (CDA).

Pluvial Modelling Undertaken in November 2021 (Refer to paragraphs 5.1.16 to 5.1.21 below for further detail.

The revised modelling provides predicted surface water depths and extents across the DCO Boundary and surrounding areas for the 1 in 100-year storm event + 20% climate change. The mapping output from the modelling offers an opportunity to assess the risk of flooding from surface water sources more accurately specifically for the Order limits and surrounding area and therefore supersedes the mapping available from the Local Council's SFRAs and Environment Agency's Online Flood Maps for Planning

The model results show a reduction over the estimated flood risk indicated in SFRA and online mapping. The post development scenario also maintains a low pluvial risk across the site and off site.

Groundwater	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Figure 6 of the BDC SFRA Update produced in 2016 shows areas susceptible to groundwater flooding, indicating the probability of flooding from groundwater per 1km square grid. The map covers the majority of the Order limits area, but also indicates in shaded squares, the risk outside of the borough boundary, which includes the Chelmsford City Council administrative area of the Order limits. The probability of flooding is shown as generally less than 25%, increasing to values between 25%-50% in proximity of the River Ter. A higher risk area of >75% lies encroaches into the east boundary of the Order limits as shown in Figure 5 below adjacent to Ringers F  **Figure 5: BDC SFRA Figure 6: Groundwater Flood Risk Map**
Sewers	Low	**Source: *BDC SFRA*** Figure 5.1 and 5.2 of the BDC SFRA Update from 2017 shows no external or internal sewer flood incidents recorded at this location. Refer to Figure 6 below.  **Figure 6: BDC Figure 5.1 and Figure 5.2 Sewer Flood History Map (no flooding recorded)**

Artificial Sources	Very Low (residual)	The Order limits is not within or near any registered reservoirs (assumed with volumes >10,000m^3) or other artificial sources. The Order limits is at very low risk of flooding from artificial sources.

8.3 Watercourse

8.3.1 Watercourses are designated as main rivers or ordinary watercourses, main rivers are identified on the Statutory Main river Map and are maintained by the Environment Agency whereas, ordinary Watercourses are maintained by the Lead Local Flood Authority.

8.3.2 The following watercourses lie within the Order limits:

Main River:

8.3.3 The River Ter runs across the very north of the Order limits flowing eastwards.

8.3.4 The Boreham Brook is designated as main river where it passes near Boreham in the far west of the Order limits, before it enters the River Chelmer further south.

Ordinary Watercourse:

8.3.5 The Boreham Brook is designated as an ordinary watercourse throughout all of the Order limits excluding in the above-mentioned section where it is designated as main river.

8.3.6 A series of field ditches, noted as ordinary watercourses, drain east to the River Ter.

8.4 Geology and Hydrogeology

8.4.1 A desk top assessment has been completed to determine bedrock and superficial geology within the Order limits Boundary. These maps indicate the Order limits is underlain by the London Clay Formation comprising clay, silt and sand, atop superficial deposits of Lowestoft Formation (diamicton), Brickearth (clay, silt and sand), glaciofluvial deposits (sand and gravel), alluvium (clay, silt, sand and gravel), and head deposits (clay, silt and sand).

8.4.2 The EA's Online Interactive Maps for Groundwater shows the entire Order limits to be at medium to low risk of groundwater pollution.

5. Assessment of Flood Risk

9.1 Flood Risk from all Sources

9.1.1 This section assesses the flood risk from the following sources against the Order limits parameter plans within Appendix A for the with-Scheme scenario:

a. Fluvial (Rivers and the Sea);

b. Surface Water;

c. Sewers;

d. Groundwater; and

e. Artificial waterbodies.

9.1.2 The methodology used to assess the flood risk is detailed below:

a. Low: where little risk is identified or any theoretical risk identified is classified as low within Local Authority SFRAs and/or EA flood risk mapping extents, with very low probability of flooding occurring;

b. Medium: where risk is identified within Local Authority SFRA and/or EA flood risk mapping extents indicating a medium probability, but manageable flood risk with little to no mitigation required; and

c. High: where modelled levels within Local Authority SFRA and/or EA flood risk mapping extents show risk to the Scheme as a high probability of flood risk and where mitigation needs to be considered and residual risks controlled.

9.1.3 Through the sequential process and design iterations, all Ancillary Buildings and BESS Compound will be located outside of Flood Zones 2 and 3 (River Ter flood risk area), i.e., in Flood Zone 1. The Boreham Brook will not alter in flood risk as the location will be used for cable routes/access with no above ground installations. Infrastructure shown to be at flood risk is to be mitigated as discussed below (Mitigation discussed in ***Appendix 9C: Longfield SuDS Strategy*** **[EN010118/APP/6.2]**).

9.1.4 Flood Risk mapping and EA flood risk guidance is presented in ***Annex B***: ***Flood Risk Mapping*** **[EN010118/APP/6.2]**.

Climate Change

9.1.5 As of July 2021, the climate change allowances have changed, and now propose peak river flow allowances based on Water Framework Directive catchment areas. The Environment Agency Website ‘Climate change allowances for peak river flow in England’ has been consulted to check and confirm the revised climate change allowances for the catchment areas that cover the Order limits.

9.1.6 Climate change allowance relate to predicted percentage increase in peak river flows that the Scheme design must be considerate of.

9.1.7 The current allowance for design purposes for the Order limits is now the Higher Central allowance of 38% (for Essential Infrastructure), instead of 65%. The Mid Essex and Chelmsford SFRA use Flood Zone 2 as a proxy for the 65% climate change event in lieu of detailed hydraulic modelling. The Order limits PV panel areas are located outside of the Flood Zone 2 boundary, i.e. the PV panels are within Flood Zone 1.

9.1.8 Previously the H++ Scenario would be applied to Infrastructure projects of this scale. The H++ scenario provides an estimate of sea level rise and river flood flow change beyond the likely range but within physical plausibility. It is useful for contingency planning to understand what might be required if climate change were to happen much more rapidly than expected.

9.1.9 H++ still applies to sea level rise, although no longer for river flows. This specific area of the UK is not considered to be impacted by coastal sea level rise, so H++ is not discussed further in this report. As the H++ Scenario no longer applies to river flows, the 38% value is the required design allowance.

9.1.10 ***Figure 7*** below is extracted from the EA online climate change allowance website:

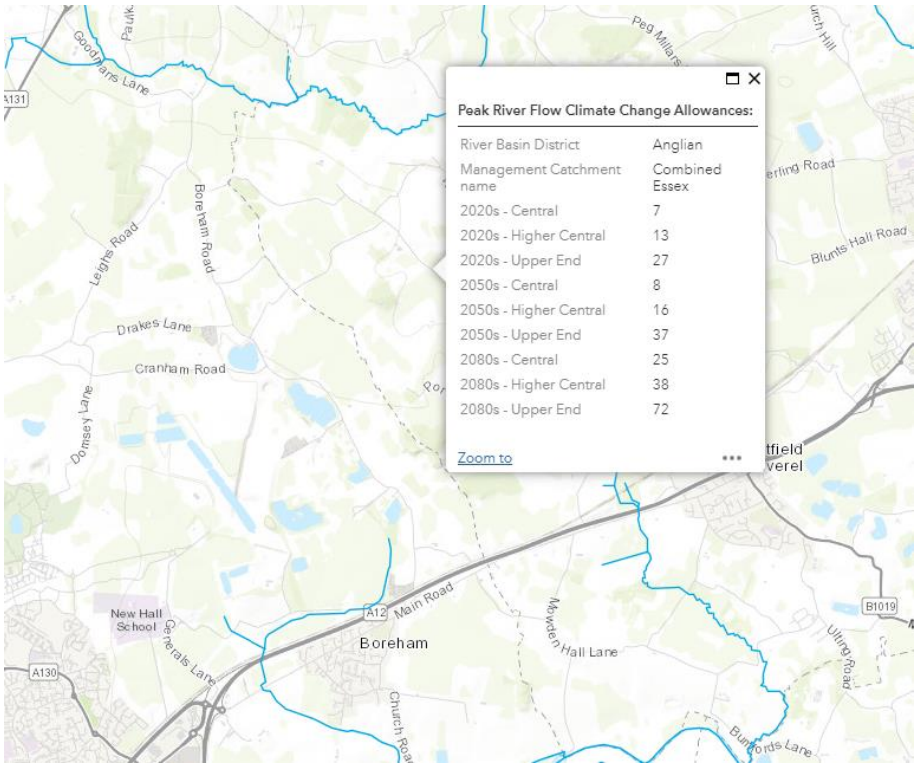


Figure 7: EA Online Climate Change Allowances – Reviewed October 2021 Anglian River Basin: Combined Essex Management Catchment

9.1.11 A ground level assessment was carried out, using available LiDAR data from Defra online, and overlaying of the EA long term fluvial flood risk maps on a 3D surface to determine the approximate level difference between both the Flood Zone 3 and Flood Zone 2 extents, where the Order limits is in proximity to Flood Zones 2 and 3.

9.1.12 Two areas were considered in this review that fit this criterion; all other areas of the Order limits are not in the vicinity of Flood Zones, except for the cable route, which is not considered to impact long term flood risk as the cables are fully buried below existing ground level. The two areas reviewed were:

Area 1: The north of the site adjacent to the River Ter, where the DCO boundary is within Flood Zone 2 and 3 (but not PV Panels) – Shown on ***Figure 8*** below.

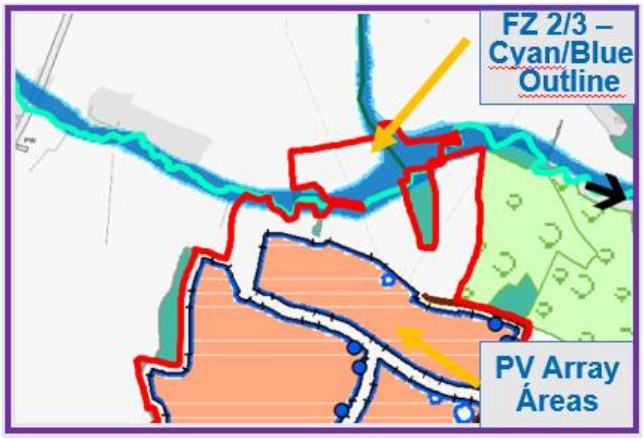


Figure 8: Flood Zones 2 and 3 – River Ter

Area 2: The mid-west of the Site near to the Flood Zone 2 boundary. Shown on ***Figure 9*** below.

Figure 9: Flood Zones 2 and 3 – Boreham Brook

9.1.13 For Area 1, the Flood Zone 2 boundary, at its highest point in the Order limits is approximately 34.00m AOD. The nearest point of the Potential Developable Areas (PDAs) is approximately 38.00m AOD; a level difference of 4m. Due to the catchment characteristics and free flow downstream, it is highly unlikely that fluvial flood risk will rise by 4m in this location.

9.1.14 The distance from the Scheme at Area 1 to the Flood Zone 2 extent (at is shortest distance) is approximately 61m, representing a ground slope of 1 in 15.

9.1.15 For Area 2, the Flood Zone 2 Boundary, at its highest point in the Order limits is shown to be approximately 45.00m AOD. The nearest point of the PV Panel area is approximately 46.50m AOD. A level difference of 1.5m. The level difference is relatively small; however, the topography indicates the Flood Zone 2 extent would not increase in depth as it is located in small "valley". Flood Zone 2 extents in proximity to the Boreham Brook are approximately 43.00m AOD. It is considered the mapping for the "spur" of Flood Zone 2 in Figure 9 presents an unrealistic spike in flood level here of 45.00m AOD, and fluvial levels would reasonably be in the region of 43.00m AOD, a level difference of 3.5m.

9.1.16 The distance from the Scheme at Area 2 to the Flood Zone 2 extent (at is shortest distance) is approximately 47m, representing a ground slope of 1 in 13.

9.1.17 The online and SFRA mapping reviewed has not been provided using detail hydraulic modelling. However, with the assessment above, it is considered that fluvial modelling of both the River Ter and Boreham Brook is not required for the Order limits, as it is reasonable to assume fluvial flood levels would not reflect an increase in flood level, in the order of magnitude that the PV Panels sit above the estimated Flood Zone 2 levels. Additionally both the SFRAs indicate Flood Zone 2 as a proxy for the 65% climate change extent, with the revised climate change allowances now only requiring 38% for design purposes; the fluvial design extent level would be less, providing a greater depth difference to the PV Panels.

Surface Water Modelling

9.1.18 Surface water modelling undertaken by ARCUS, November 2021 appended to this FRA assessment in **Annex D**, supports and is considered to supersede the local authority and the Environment Agency broadscale mapping available online. Refer to Appendix D for Arcus Pluvial Modelling report and associated revised mapping.

9.1.19 The modelling provides predicted surface water depths and extents across the Order limits and surrounding areas for the 1 in 100-year storm event + 20% climate change. The mapping output from the modelling offers an opportunity to assess the risk of flooding from surface water sources more accurately specifically for the Order limits and surrounding area and therefore supersedes the mapping available from the Local Council's SFRAs and Environment Agency's Online Flood Maps for Planning.

9.1.20 The modelling was undertaken through an iterative process using the "worst-case scenario" rainfall data for three modelling scenarios: "Baseline, "Refined Baseline" and "Operational Phase". The "Refined Baseline Scenario" is a revised output of the "Baseline Scenario" modelling which identifies the existing surface water flow characteristics across the Order limits and any

areas of potential surface water flood risk at or emanating from the Order limits by using additional data for the catchment (refer to ARCUS Surface Water Modelling Technical Note for further details on the modelling methodology). The Operational Phase Scenario identifies the potential surface water impact of the proposed infrastructure associated with the Scheme and quantifies the potential betterment of mitigation measures proposed within the report.

9.1.21 The surface water modelling results for each of the scenarios are as follows:

9.1.22 The “Baseline Scenario” modelling indicates the existing maximum surface water flood depths are located in an isolated area within the Order limits with a depth of approximately 0.9m. However, significant areas of the model extent have less than 0.1m depth of surface water flood levels. There are also areas within the Order limits associated with existing surface water features (i.e. ponds, open land drains) demonstrating depths significantly greater than 0.9 m, however this is due to the depression in topography associated with these types of features.

9.1.23 The “Refined Baseline Scenario” modelling indicates the maximum surface water flood depths within the Order limits decreased from the “Baseline Scenario” to approximately 0.88 m.

9.1.24 The “Operational Phase Scenario” modelled the maximum surface water flooding depth as approximately 0.6m.

9.1.25 A comparison of the scenarios modelled indicates that post-construction, with the proposed surface water management measures (refer to ***Appendix 9C: Longfield SuDS Strategy*** **[EN010118/APP/6.2]** and ***Appendix 9D: Bulls Lodge Substation Extension: Drainage Strategy*** **[EN010118/APP/6.2]**. the risk of surface water flooding on or off the Order limits.

9.1.26 The residual risk of flooding from surface water therefore remains low.

9.2.1 **Table 8** below summarises the flood risk as a result of the Scheme.

Table 8: Flood Risk Assessment

Flood Risk Source	Flood Risk Level	Comments
Fluvial	Low (Majority) Medium – High (Proximity to the River Ter / Boreham Brook)	The Scheme is predominantly in Flood Zone 1 with very small areas at the northern boundary (River Ter) and the south-west corner of the Order limits (at the Boreham Brook). In areas of flood risk (Flood Zone 2 and 3) The Scheme layout in Appendix A indicates no development, PV panels or associated infrastructure will be located within flood risk areas; flood risk is not increased by the Scheme or elsewhere. Climate change has been assessed in sections 5.1.5 to 5.1.15 for the Order limits, in particular to the areas of PV panels in proximity to Flood Zones 2 and 3. For this stage of the design, it is not considered necessary to undertake hydraulic modelling as the built development areas are outside of the SFRA mapped extents and EA long term flood risk extents and are considered to be sufficiently above the predicted flood extents. It is considered fluvial flood risk will not increase as a result of development.
Tidal	Very Low	Not in a Tidal area
Pluvial (Surface Water)	Very Low	Solar Farm Site: The PV Panels will not increase peak surface water runoff. Swales will be implemented to reduce peak rates exiting the Order limits during storm events. BESS Compound: Surface water runoff will be attenuated, and the outfall flows restricted to limit peak surface water flows exiting the facility to the existing greenfield rate for up to and including the 1 in 100 year (+20%) event. Fire water runoff will be stored in an additional 4000m3 attenuation tank, which can be isolated to ensure no pollution discharges to the hydrological network. Pollution risk from site compound areas will be managed within the Construction Environmental Management Plan (CEMP), included in the ES. Ancillary Building: A filter drain is proposed to intercept and store surface water runoff, allowing it to slowly percolate into the underlying strata as per the existing conditions. Bulls Lodge Substation Extension: A hybrid system utilising infiltration and attenuation will limit peak surface water flows exiting the Extension to the existing greenfield rate for tup to and including the 1 in 100 year (+20%) event. The risk of surface water flooding will not increase as a result of the Scheme.
Groundwater	Low (East side) -	The overall probability of flooding is shown as generally less than 25%, increasing to values between 25%-50% in proximity of the River Ter. A higher risk area of >75% lies encroaches into the east boundary of the Order limits as shown in **Figure 4** adjacent to Ringers Farm

Flood Risk Source	Flood Risk Level	Comments
	Medium (North West side)	Shallow Infiltration SuDS are currently proposed for the development, subject to further ground investigation, groundwater monitoring and infiltration testing. SuDS will be designed to ensure no increase in flood risk to the site or elsewhere.
	High (far eastern boundary adjacent to Ringers Farm)	The risk will not increase as a result of the Scheme.
Sewers	Low	It is not envisaged that the construction of the PV Panels and infrastructure will increase the risk existing sewers flooding risk. An Ancillary Building will be constructed as part of the Scheme. Wastewater emanating from this facility the BESS Compound will be contained within cesspits (or similar self-contained arrangement) to be emptied at regular intervals. The Bulls Lodge Substation Extension proposes to utilise the existing welfare facilities onsite. The risk will not increase as a result of the Scheme, it will remain Low
Artificial Sources	Very Low (residual)	It is not envisaged this risk will increase to the existing with the construction of the Solar PV Arrays. The risk will not increase as a result of the Scheme, it will remain Very Low.

Flood Risk Summary

9.2.2 The following Flood Risk conclusions are presented in **Table 9** below.

Table 9: Flood Risk Summary

Flood Risk Source	Pre-Scheme Risk	Post Scheme Risk	Comments
Fluvial	Low (majority) Medium – High in proximity to watercourse	Low (majority), Medium – High in proximity to watercourse	The majority of the Order limits is in Flood Zone 1, but certain areas lie in Flood Zone 2, 3a, 3b. No built development or ground level raising will occur in Flood Zone 3a or 3b. It is considered fluvial flood risk will not increase as a result of development.
Tidal	Very Low	Very Low	Not in a tidal area
Pluvial (Surface Water)	Very Low	Very Low	Surface water risk varies throughout the Order limits indicating patches of the Order limits which are susceptible to surface water flooding. However, flooding is localised and generally shallow (very low risk).

Groundwater	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Groundwater flood risk varies across the Order limits. Shallow Infiltration SuDS are currently proposed for the development, subject to further ground investigation, groundwater monitoring and infiltration testing. Infiltration techniques must ensure mitigation measures are put in effect to protect groundwater interaction where a risk is identified following ground investigation.
Sewers	Low	Low	The risk of sewer flooding in the vicinity of the Order limits is deemed to remain low.
Artificial Sources	Very Low (residual)	Very Low (residual)	Statutory Reservoirs (large, raised reservoirs with volumes above ground of 25,000m^3 or over) are regularly inspected and maintained as set out in the Reservoirs Act 1975. On that basis they are deemed to pose a low (residual) risk. Other artificial sources such as canals and waterways are considered to be regularly maintained and therefore only deemed to pose a low (residual) risk to the proposed development

The Sequential Test

9.2.3 The Scheme satisfies the requirements and purpose of the Sequential and Exception Tests as set out by both NPS EN-1 and the NPPF.

9.2.4 Paragraph 5.7.13 of NPS EN-1 states a preference should be given to locating projects in Flood Zone 1. If there is no reasonably available site in Flood Zone 1, then projects can be located in Flood Zone 2. If there is no reasonably available site in Flood Zones 1 or 2, then energy NSIPs can be located in Flood Zone 3, subject to the Exception Test.

9.2.5 Similarly, within the NPPF the overall aim of the Sequential Test is to steer new development to the lowest flood zone, i.e. Flood Zone 1. Flood Zones 2 and 3 may be considered, subject to passing the Exception Test depending on the type of development proposed. The development type for the Solar Farm infrastructure, the Grid Connection Route and the Bulls Lodge Substation Extension is 'Essential Infrastructure', which is defined in Annex 3 of the NPPF. The biodiversity enhancement areas that form part of the Scheme, including that adjacent to the River Ter is classified by NPPF Annex 3 as 'Water-Compatible' development ('nature conservation and biodiversity'). In accordance with national planning policy, the Secretary of State will need to be satisfied that the Scheme passes the Sequential Test and Exception Test, as small areas of the Scheme, comprising parts of the Order limits to be used for biodiversity enhancement and for the Grid Connection Route, are in Flood Zones 2 and 3.

9.2.6 In terms of the solar farm infrastructure, principally comprising the Solar PV Panels, BESS Compound and Longfield Substation, all of this is located within Flood Zone 1, and, therefore, in compliance with the Sequential Test.

9.2.7 The Grid Connection Route is required to link the Longfield Substation within the Solar Farm Site to the Bulls Lodge Substation Site. The Boreham Tributary and its associated flood plain is located between these two locations. There is no practical alternative to the Grid Connection Route crossing the Boreham Tributary (i.e. Flood Zones 2 and 3). The Grid Connection Route therefore passes the Sequential Test.

9.2.8 Regarding water compatible development; the biodiversity enhancement areas adjacent to the River Ter is partly within Flood Zone 2 and 3. This is defined as a water compatible use; therefore, in compliance with the requirements of the Sequential Test.

9.2.9 Overall, each of the component areas of the Scheme is in accordance with the purpose and requirements of the Sequential Test, taking account of the flood risk vulnerability classification.

The Exception Test

9.2.10 The requirements of the Exception Test are set out in paragraph 7.4.3 above; the two elements to be passed are reproduced below:

9.2.11 The development would provide wider sustainability benefits to the community that outweigh the flood risk; and

9.2.12 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.

9.2.13 NPS EN-1, which was published in 2011 (with a draft consultation revision in 2021) also includes the requirement that 'the project should be on developable, previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs'. It has been considered there are no suitable alternative sites located on pre-developed land, that offer the size and nature of the topography to facilitate a scheme of this size.

9.2.14 The majority of the Order limits lie within Flood Zone 1 and so do not require the Exception Test to be passed. The Exception Test is therefore applied because parts of the Grid Connection Route and a part of the Order limits to be used for biodiversity enhancement lie within Flood Zone 3a.

9.2.15 The national need and benefits for the Scheme is set out in the ***Statement of Need*** **[EN010118/APP/7.1**] and the ***Planning Statement*** **[EN010118/APP/7.2]** which accompany the DCO Application. These documents explain why the large scale nature of the Scheme is urgently needed nationally and the wider sustainability benefits of renewable energy production. The Planning Statement also explains the local benefits provided by the Scheme which include the delivery of significant biodiversity net gain and increased public local access.

9.2.16 The biodiversity net gain that will be provided within flood risk areas, will exceed the minimum 10% net gain required on the Scheme (as discussed within ***Chapter 8: Ecology*** of the ES **[EN010118/APP/6.1]**); therefore, providing greater environmental benefits to the area. The proposals do not increase flood risk to the Scheme or elsewhere as there will be no ground raising involved with these proposals, or increased pathways for surface water runoff to enter the watercourse.

9.2.17 Overall, the Scheme's wider sustainability benefits outweigh the low flood risk which is identified by this FRA to and from the Scheme. Measures set out in section 7 will ensure the Scheme is safe for its lifetime and that there will be no increases in flooding elsewhere

9.2.18 With regard to meeting the Exception Test requirements of the NPPF, and the first and third requirements of the Exception Test set out in NPS EN-1, the assessment of the flood risk from the Scheme presented in section 5.1 demonstrates that there is no increase in flooding elsewhere once the Scheme is operational and during its construction stage

9.2.19 All above ground, built development has been relocated outside of Flood Zones 2 and 3 (including climate change allowance) through embedded design mitigation, with biodiversity and ecological enhancement areas located within Flood Zone 2 and 3 extents. Cable routes passing through Flood Zones 2 and 3 will be buried and have no long term flood risk impact, with no flood risk increased elsewhere as a result.

9.2.20 Additionally, surface water drainage will reduce flood risk elsewhere from the Scheme, reducing peak runoff rates into watercourses

9.2.21 The Scheme is considered to be in compliance with the Exception Test.

9.3 Finished Floor Levels

9.3.1 The main development areas of the Order limits are all within Flood Zone 1. All access points, floor levels and electrical/switchgear apparatus will be set a minimum of 300mm above existing ground level, as per the online Environment Agency Standing Advice, to provide flood resilience.

10. Drainage Strategy Assessment

10.1 Arcus SuDS Strategy

10.1.1 The following section provides a summary of the Outline Drainage Strategy for The Scheme prepared by ARCUS in ***Appendix 9C: Longfield SuDS Strategy*** **[EN010118/APP/6.2]**.

10.1.2 The ***Appendix 9c: Longfield SuDs Strategy*** assesses the "the Scheme infrastructure" in separate sections; "Solar Farm (the Solar Development)", "Ancillary Building" and "Battery Energy Storage System (BESS) Compound".

Existing Surface Water Drainage

10.1.3 The Order limits is within the Anglian River Basin District, Essex Combined Management Catchment and the Chelmer Operational Catchment and within the Boreham and Ter tributaries. The Order limits is not shown to be located within the operational boundary of an Internal Drainage Board (IDB). There are various undesignated waterbodies within the Order limits which comprise drainage channels and ponds, some of which are connected to the wider hydrological network associated with the River Ter and Boreham Tributary.

10.1.4 There are various ponds across the Order limits located within low lying areas and these are assessed to provide storage capacity through the flow of surface water flow towards low lying areas.

10.1.5 There is a collection of former gravel quarry pits approximately 250 m immediately west of the Order limits adjacent to Witham Road.

10.1.6 An irrigation reservoir is located approximately 650m north east of the Order limits north of the River Ter.

10.1.7 The Cranfield Soil and Agrifood Institute Soilscapes map indicates soils at the Order limits are categorised as 'freely draining slightly acid sandy soils', 'Slightly acid loamy and clayey soils with impeded drainage' and 'Lime-rich loamy and clayey soils with impeded drainage'. Infiltration Testing was undertaken by Rogers Geotechnical Services in July 2021 at the proposed BESS Compound area. The report from this testing determined that the underlying strata is not suitable for soakaways.

Existing Foul Water Drainage

10.1.8 It is currently believed that there is no formal foul drainage network across the Order limits. Asset records have not yet been obtained from utility provides (Anglian Water) to confirm there are no sewer routes across the fields between local settlements.

10.2 Proposed Surface Water Drainage Strategy for areas of the Scheme proposed to have PV Arrays installed

10.2.1 An Outline Drainage Strategy has been prepared for the Scheme (excluding the Bulls Lodge Substation Extension site area) within ***Appendix 9C:***

Longfield SuDS Strategy **[EN010118/APP/6.2]** as part of the DCO application, in compliance with national and local planning policy and guidance.

10.2.2 The SuDS measures outlined in the report have been designed to ensure that greenfield runoff rates are maintained during the construction and operational phases of the Scheme.

10.2.3 Installation of the PV arrays does not involve the introduction of hardstanding at ground level meaning there is not expected to be a decrease in permeable area across the Solar Development as a result of the Scheme.

10.2.4 The PV Arrays are to be installed with regular rainwater gaps to prevent water being concentrated along a single drip line, in addition to this Rural Sustainable Drainage System measures are proposed to limit possible channelisation from surface water runoff from the PV panels by promoting interception and infiltration in the areas surrounding and between the PV Arrays throughout the Solar Development.

10.2.5 To intercept extreme surface water runoff, swales are proposed within low lying areas and parallel to the Order limit's contours. With the negligible increase in surface water runoff associated with the Solar Development, the proposed swales will provide additional surface water storage capacity relative to the pre-Scheme scenario and do not form part of the formal SuDS network.

10.2.6 To limit the potential flows of surface water within the proposed swales check dams will be implemented within the swales throughout the operational phase of the Scheme, limiting the potential of surface water to settle in low lying extents of the swales.

10.3 Proposed Surface Water Drainage Strategy for the Ancillary Building

10.3.1 An Ancillary Building is located within the Order limits which measures 540 m² and will comprise a warehouse building, office, kitchen and toilets.

10.3.2 Surface water runoff associated with this part of the Scheme is proposed to be intercepted by a shallow filter drain located between the building and proposed Primary Access Track.

10.3.3 Due to the limited infiltration capacity on the Site, surface water will not disperse into soils at a significant rate. As such the implemented feature will be designed with no calculated outflow or discharge and will slowly percolate to the underlying strata as per the natural percolation of the soils with no overtopping during the 1:100 year (+20%) event, preventing any increase in surface water runoff as a result of this part of the Scheme.

10.3.4 In such an eventuality there would be significant surface water depths at the surrounding Ancillary Building site and catchment. Surface water emanating from the filter drain would disperse as per existing flow routes within the wider Site and would flow away from the Ancillary Building.

10.4 Proposed Surface Water Drainage Strategy for BESS Compound

10.4.1 The area designated for the BESS Compound (6.86 ha) will have an increase in impermeable area, of 1.94ha as a result of the Scheme.

10.4.2 The increased surface water runoff associated with the BESS Compound is proposed to be “attenuated within the unbound free-draining subbase beneath the aggregate chippings and an attenuation pond which will discharge to the existing open land drain to the east through an excavated surface water pipe.”

10.4.3 The subbase will be served by a network of drains which will migrate surface water to two outfalls located at topographic low points within the BESS Compound. The two outfalls are located at the location of existing surface water flow routes which will lead to the attenuation pond to the east.

10.4.4 Surface water flows will be limited to the 1:1-year rate of 2.4 l/s up to and including the 1:100-year (+20% CC) through the use of a flow restriction evice placed on the outfall of the pipes from the subbase and attenuation pond receiving land drain.

10.4.5 To provide additional ecological benefits the attenuation pond will incorporate embankments with native planting to be implemented on the wider banks of the pond.

10.4.6 During an exceedance event, surface water flow routes will disperse as per the current pre-Scheme sicario within the Order limits.

10.5 Fire Water Control / Discharge for BESS Compound

10.5.1 As part of the operation of the Order limits, the risk of fire within the battery storage containers must be considered. Consultations with ECC Fire and Rescue (F&R) department have outlined that the BESS Compound has a fire risk which must be assessed in relation to the potential contaminants within any fire suppressing water runoff.

10.5.2 The BESS units will be underlain by a concrete base and any immediate runoff from the infrastructure during a fire event which would require direct firefighting would then runoff the concrete base and be intercepted by the drainage system. The limited infiltration capacity of the underlying grounds confirmed via localised infiltration testing would prevent any potentially contaminated water from percolating into the underlying ground.

10.5.3 During a fire event whereby, fires are to be managed onsite, 4,000 kilolitres of suppressant water will be released as per agreement with ECC F&R. Due to the potential contaminants within any firewater runoff, a separation and storage mechanism will be required within the drainage system.

10.5.4 A sub-surface attenuation tank with 4,000m^3 of storage is proposed to capture the 4,000 kilolitres of fire suppressant water during a large fire event, enabling contaminated water to be isolated from entering the surrounding hydrological network before it is tested and disposed of offsite.

10.5.5 To enable any contaminants to be extracted from the system it is proposed that the drains will have the ability to be bunged and a penstock to be implemented at the downstream extremity of pipe 1.013 to isolate the network. The penstock will then enable potential contaminated suppression waters to be isolated and stored within a sub-surface attenuation tank prior to extraction in order to be suitably tested and disposed of offsite without entering the surrounding hydrological network.

10.5.6 The bung and penstock system is designed to intercept and isolate potentially contaminated runoff from the wider SuDS system for all fire events and thus prevent contaminated runoff entering the wider hydrological network.

10.5.7 The bung equipment required to manage suppression water is to be covered further in an Emergency Response Plan and ancillary emergency equipment will be kept onsite (e.g. drain bungs, extra fire hose). The Emergency Response Plan will outline the emergency measures in place and the procedures implemented to mitigate potential impacts of the infrastructure on surrounding receptors during emergency situations. The Emergency Response Plan will be produced in accordance with principles agreed with ECC F&R with engagement and communication ongoing from an early stage in the concept stage and through to the design and construction phase.

10.5.8 Following a fire event, the drainage network will undergo an assessment to confirm the absence of any contaminants prior to the penstock being released. The designated Development operator will be responsible for conducting a controlled flushing of the drainage network prior to the release of the penstock and bung tools.

10.6 Proposed Foul Water Drainage Strategy

10.6.1 During the construction of the Scheme, it is proposed that foul water will be disposed of via ‘Port-a-loo’ type facilities and disposed of via a licenced waste carrier.

10.6.2 During the operational phase of the Scheme, the Battery Energy Storage System (BESS) Compound and the Ancillary Building will contain welfare facilities for the staff when in use. It is proposed that foul water will be collected in cesspits within the confines of these areas and will be managed, inspected and drained by a licensed courier who will also dispose of the waste off site.

10.6.3 The Ancillary Building and BESS Compound are located approximately 550 m and 750 m from the nearest potential foul sewer, assumed to be on Waltham Road. Therefore connection to a foul sewer will not be feasible for either proposal.

10.7 Bulls Lodge Substation Extension Drainage Strategy

10.7.1 The following section provides a summary of the Proposed Surface Water Strategy Prepared by Mott MacDonald in ***Appendix 9D: Bulls Lodge Substation Extension: Drainage Strategy*** **[EN010118/APP/6.2]**.

10.7.2 ***Appendix 9D: Bulls Lodge Substation Extension: Drainage Strategy*** **[EN010118/APP/6.2]** summarises the proposed drainage strategy and outlines measures taken to reduce the impact of the Bulls Lodge Substation Extension by utilising sustainable drainage systems.

10.7.3 The proposed substation expansion is to be constructed on a currently undeveloped greenfield site (1.525 ha) adjacent to the existing Bulls Lodge Substation. The construction of Ancillary Buildings, Primary Access Tracks and associated parking areas delivers 0.360 ha of impermeable area post-development across the site (23.6%).

Existing and Proposed Surface Water Strategy

10.7.4 The strategy proposes to compensate for the increase in impermeable area constructed on the site through the use of a hybrid attenuation and infiltration SuDS system; limiting the surface water discharge rate to the 1 in 1 year greenfield runoff rate (1.9l/s) for surface water run off events up to and including the 1 in 100 year + 20% climate change event.

10.7.5 The strategy proposes to limit the surface water discharge rate using 1160m^3 of attenuation volume provided in the subbase of the gravel Access Tracks.

10.7.6 The strategy also accounts for proposed ground level changes across the site through the use of land drains located on the north and western boundary of the site. The rate/volume of flow from the land drainage are to be determined during detailed hydraulic modelling.

10.7.7 The controlled site runoff and land drains are proposed discharge via a gravity pipe network, south to Boreham Brook and outfall at a new headwall structure.

Proposed Foul Water Drainage Strategy

10.7.8 There are no proposed foul water drainage plans for the Bulls Lodge Substation Extension as the development proposal does not include plans for welfare facilities as it will not be a manned facility. Personnel visiting the site will use the existing welfare facilities in the existing Bulls Lodge Substation.

11. Residual Risks and Mitigation

11.1 Residual Risks to Site

11.1.1 By passing the Exception Test, any residual risks relating to fluvial flooding around the PV sites have been demonstrated to be sufficiently mitigated. Residual risks are considered to be very low.

11.1.2 The residual risk for fire water entering groundwater or watercourses remains. However, the fire management plan measures that are captured with the Drainage Strategy Report (***Appendix 9C: Longfield SuDS Strategy*** **[EN010118/APP/6.2]**) ensure the risk is mitigated as far as reasonably practicable.

11.2 Resilience and Resistance Measures

11.2.1 The proposed Solar Stations have all been located in Flood Zone 1. However, to account for residual extreme surface water flooding events, finished floor levels, and electrical components should be set 300mm above existing ground levels.

11.3 Safe Access

11.3.1 Through the sequential process and design iterations there are no buildings located within the floodplain. All compounds for site staff and battery storage units have been located out of Flood Zones 2 and 3, i.e. within Flood Zone 1, and it is envisaged access to the PV Panels would not be sought during flooding conditions.

11.3.2 Safe access and escape for flood risk during construction will be addressed within the Construction Environment Management Plan, ensuring access to and from the site is safely maintained in areas at risk of flooding.

12. Conclusions and Recommendations

12.1.1 This Flood Risk Assessment has been prepared to support the Application.

12.1.2 The following conclusions from the FRA are presented in **Table 10** below:

Table 10: Flood Risk Summary

Flood Risk Source	Pre-Scheme Risk	Post Scheme Risk	Comments
Fluvial	Low (majority), Medium – High in proximity to watercourse	Low (majority), Medium – High in proximity to watercourse	The majority of the Order limits is in Flood Zone 1, but certain areas lie in Flood Zone 2, 3a, 3b. No development will occur in Flood Zone 3b.
Tidal	Very Low	Very Low	Not in a tidal area
Pluvial (Surface Water)	Very Low	Very Low	Surface water risk varies throughout the Order limits indicating patches of the Site which are susceptible to surface water flooding. However, flooding is localised and generally shallow (low risk).
Groundwater	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Low (East side) - Medium (North West side) High (far eastern boundary adjacent to Ringers Farm)	Groundwater flood risk is low across the Order limits, less than 50% probability. Shallow Infiltration SuDS are currently proposed for the development, subject to further ground investigation, groundwater monitoring and infiltration testing. Infiltration techniques must ensure mitigation measures are put in effect to protect groundwater interaction where a risk is identified following ground investigation.
Sewers	Low	Low	There is no history of sewer flooding within or around the Order limits. Operational use of the Order limits is not considered to increase the risk of sewer flooding.
Artificial Sources	Very Low (residual)	Very Low (residual)	Statutory Reservoirs (large raised reservoirs with volumes above ground of 25,000m^3 or over) are regularly inspected and maintained as set out in the Reservoirs Act 1975. On that basis they are deemed to pose a low (residual) risk.

12.2.3 The Scheme is classed as ‘Essential Infrastructure’ and therefore not suitable within Flood Zone 3a and 3b without passing the Exception Test. All new built development is set within Flood Zone 1, incorporating the estimated climate change fluvial flood extents (based on the SFRA maps). The Order limits

passes the Sequential Test in terms of flood risk. Consequently, the Exception Test is not considered necessary.

12.1.4 The Outline Drainage strategy (***Appendix 9C: Longfield SuDS Strategy* [EN010118/APP/6.2]**) proposes to use RSuDS techniques and perimeter swales to mimic existing drainage conditions and accommodate the 1 in 100-year return period storm event plus a 20% increase allowance for climate change. Additional surface water runoff volume generated from impermeable areas of the Scheme will be attenuated and discharged from at controlled rates, ensuring there is no increase in flood risk off site.

12.1.5 Exceedance flows from the Order limits will not increase the existing flood risk on or off site as a result of the Scheme.

13. Annexes

Annex A - Development Parameter Plans

Revision: 0 Drawn: BM Checked: BB Approved: PD Date: 2022-02-01

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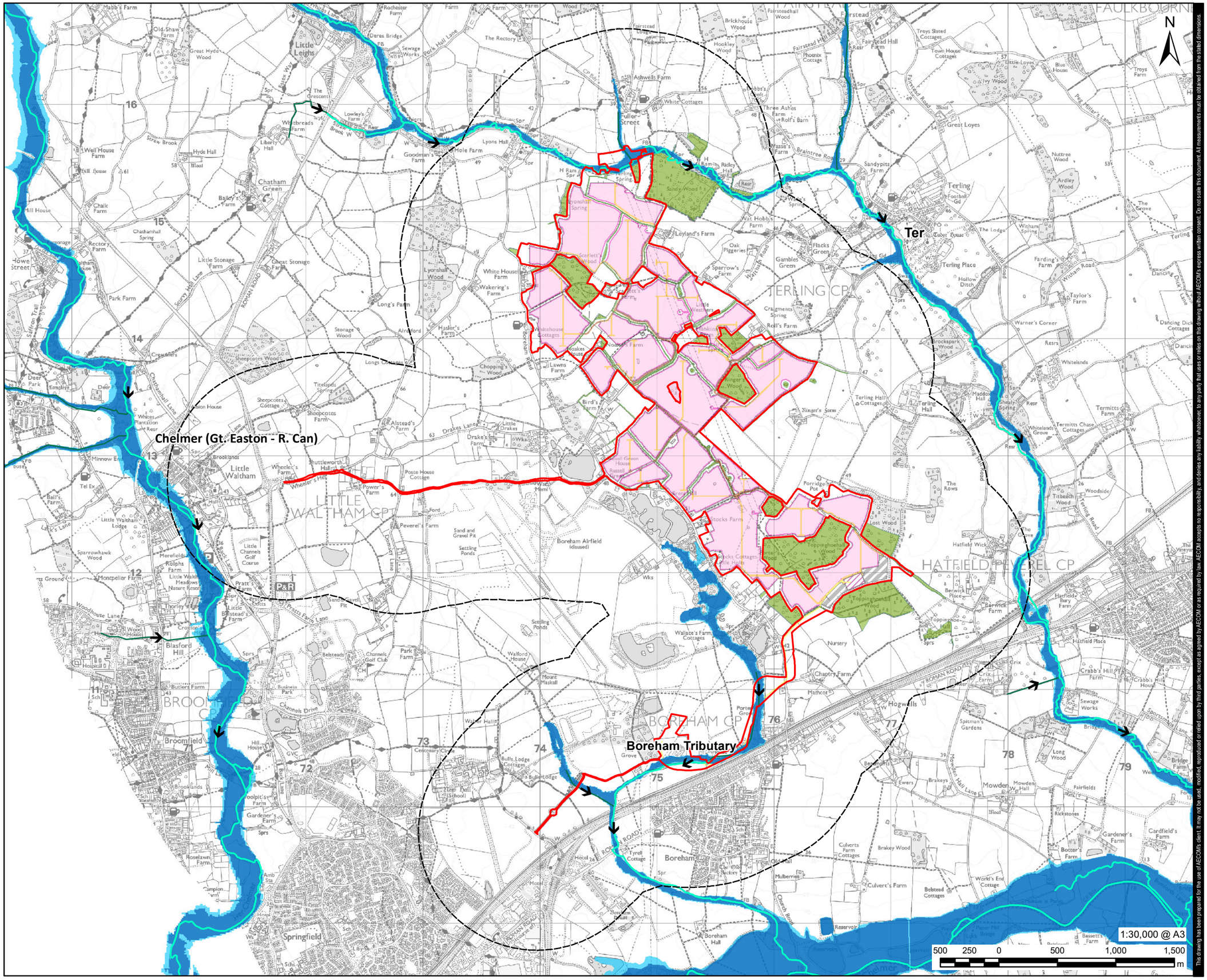

AECOM

PROJECT

60640215 - LONGFIELD SOLAR FARM

CLIENT

Longfield Solar Farm

CONSULTANT

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LEGEND

- Order Limits
- 1km Site Buffer
- Flow Direction
- Main Rivers
- Ordinary Watercourse
- Flood Zone 3
- Flood Zone 2

Indicative Scheme Layout

- Grid Connection Route
- Hedgerow
- Proposed Fencing
- Primary Access
- Secondary Access
- PV Table
- BESS Compound
- Construction Compounds
- Longfield Substation
- Woodland

NOTES

ISSUE PURPOSE

Environmental Statement
APFP Regulation: 5(2)(a)

PINS REFERENCE NUMBER

EN010118

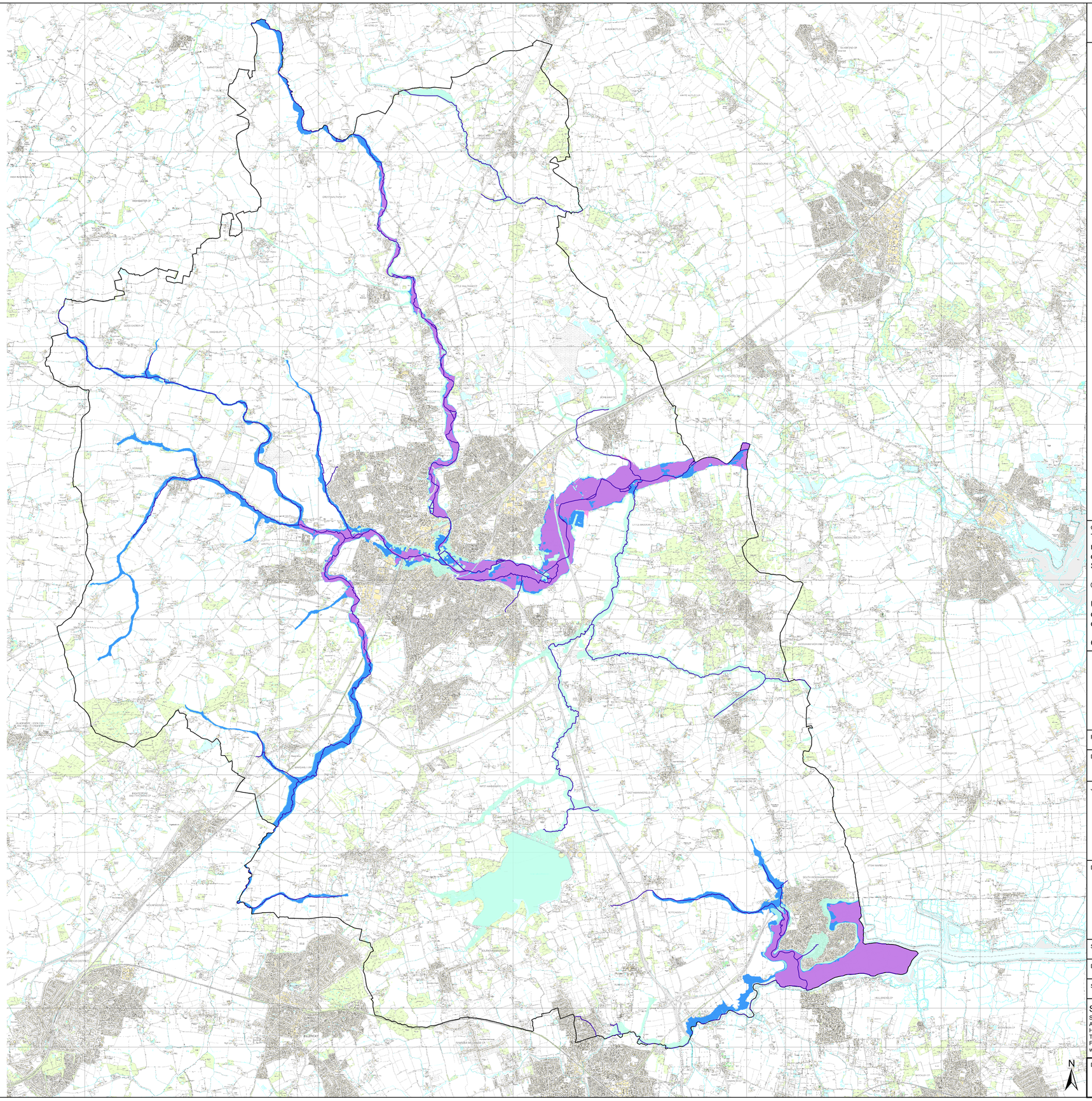
FIGURE TITLE

Fluvial Flood Zones including indicative concept design

FIGURE NUMBER

Figure 9-2b

Annex B – Flood Risk Mapping



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LEGEND

- River Centrelines
- Chelmsford District Boundary

Present Day Flood Zones (2007)

- Functional Floodplain
- Flood Zone 3
- Flood Zone 2

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: MID ESSEX SFRA
Chelmsford Borough Council

Drawing Title: Present Day Flood Zones

Scale at A1: 1:50,000

Drawn	Approved		
AJG			
Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE B39** Rev

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Date: 12th March 2008
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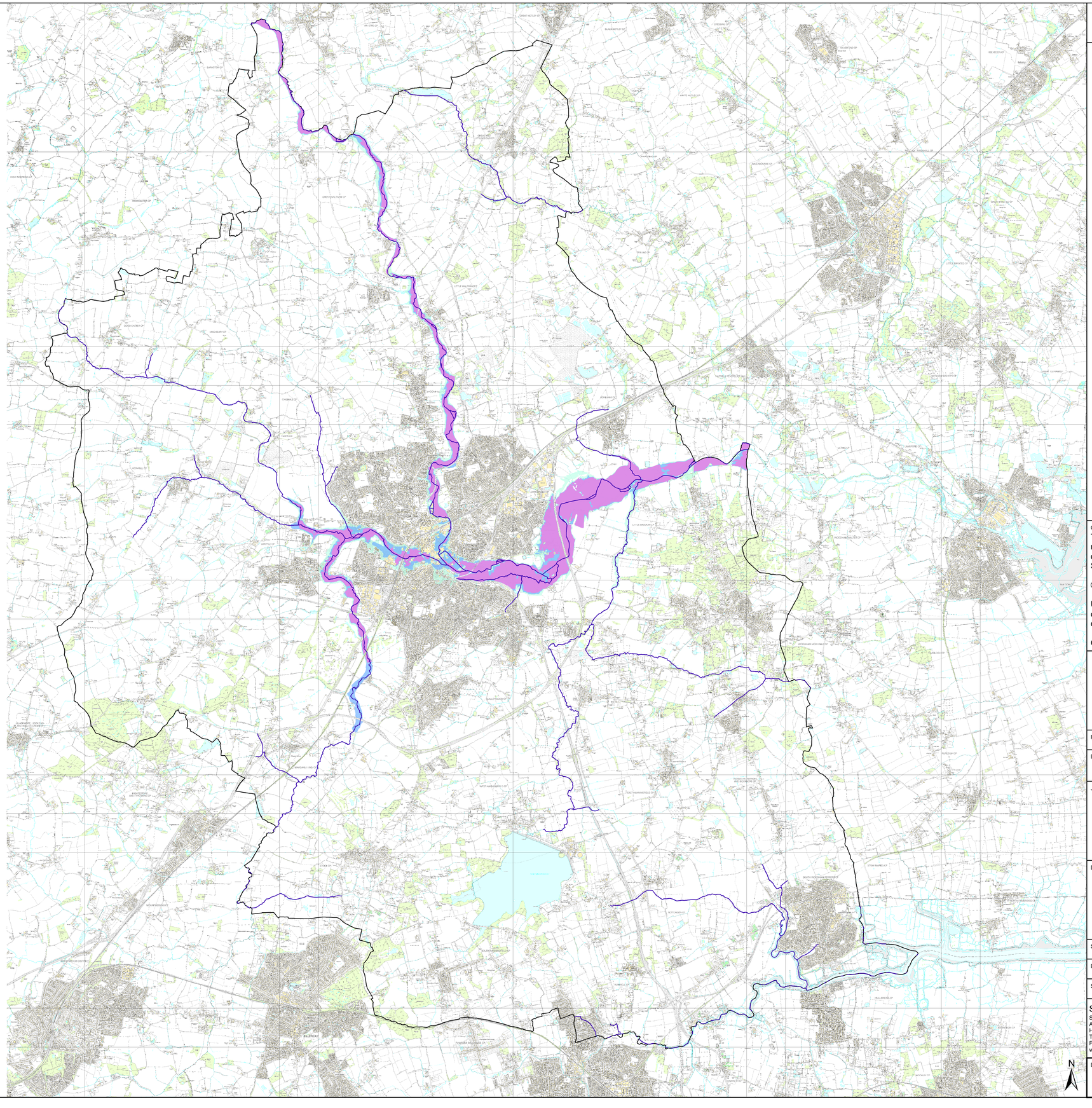

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LEGEND

- River Centrelines
- Chelmsford District Boundary

Climate Change Flood Zones

- Functional Floodplain
- Flood Zone 3
- Flood Zone 2

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: MID ESSEX SFRA
Chelmsford Borough Council

Drawing Title: Climate Change Flood Zones

Scale at A1: 1:50,000

Drawn	Approved		
AJG			
Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE B40** Rev

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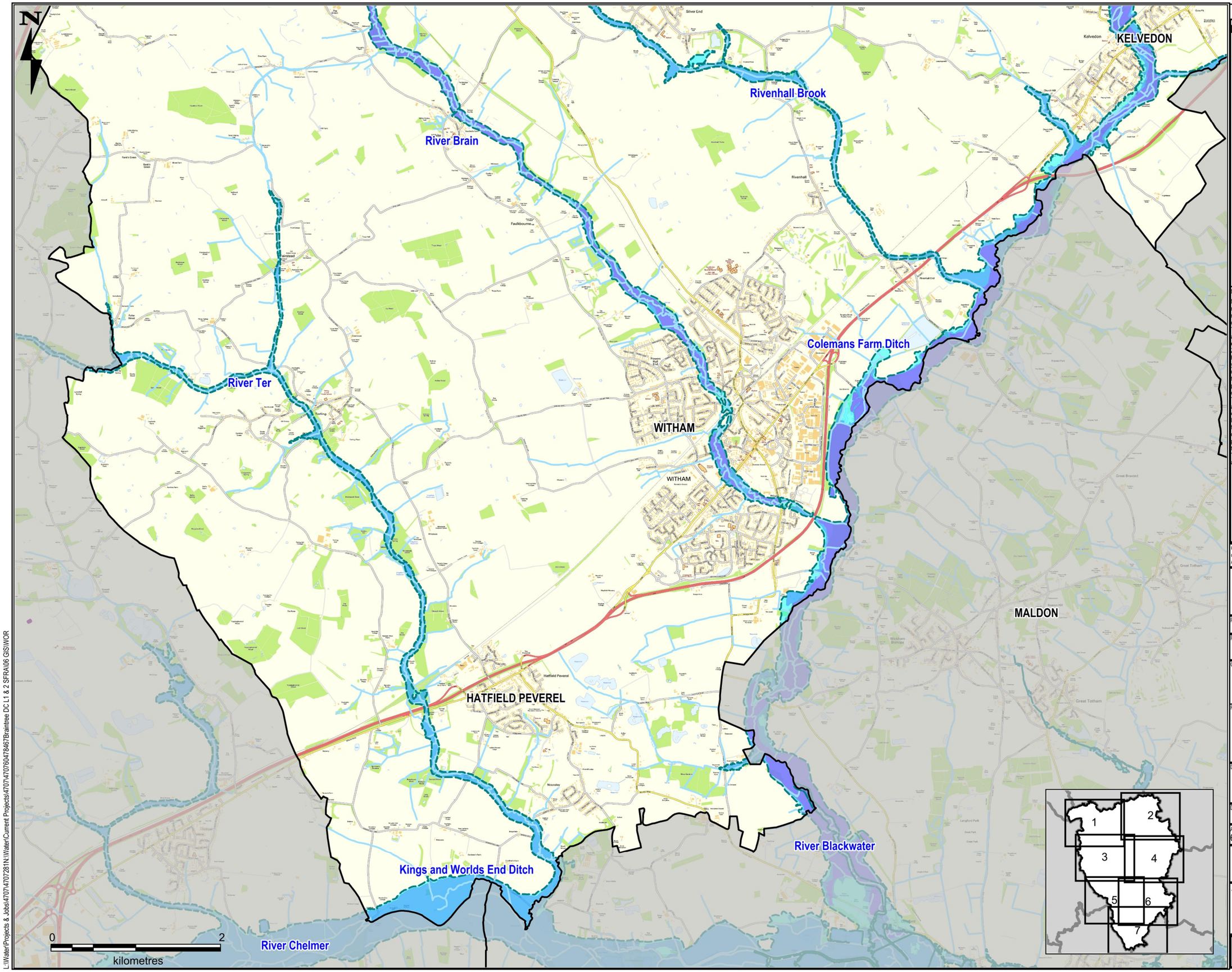

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse
- Historic Records of Fluvial Flooding
- Flood Defences
- Flood Storage Areas
- Areas Benefiting from Flood Defences

Probability of Flooding from Rivers and the Sea

- Flood Zone 1 Low Probability
- Flood Zone 2 Medium Probability
- Flood Zone 3a High Probability
- Flood Zone 3b Functional Floodplain
- Flood Zone 3a plus climate change

Notes

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner.

The Environment Agency Flood Map for Planning (Rivers and Sea) is available on the Environment Agency website (www.gov.uk/environment-agency) and displays the risk of flooding based on probability. Flood Zone 1: Land assessed, ignoring the presence of flood defences, as having a less than 0.1% annual probability of fluvial or tidal flooding in any year. Flood Zone 2: Land assessed, ignoring the presence of flood defences, as having between a 1% and 0.1% annual probability of fluvial flooding in any year. Flood Zone 3: Land assessed, ignoring the presence of flood defences, as having a 1% or greater annual probability of fluvial flooding in any year.

The Flood Map displays the location of linear raised flood defences such as embankments and walls. Flood storage areas, land designated and operated to store flood water are displayed in a separate polygon layer. Land that may benefit from the presence of flood defences during a 1% fluvial or 0.5% tidal flood event. These are areas that would flood if the defence were not present, but may not flood because the defence is present. Areas benefitting from flood storage areas may be remote from the flood defence structure.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

In February 2016, the Environment Agency published revised guidance on climate change allowances. In the absence of model outputs for the updated climate change allowances, this Level 1 SFRA has adopted a conservative approach to assessing climate change for the purpose of the Sequential Test by using the existing Flood Zone 2 extent (1 in 1000 annual probability of river flooding) as a proxy for the Flood Zone 3a plus climate change. This represents the 'higher central' allowance. Developers should note that for all subsequent site specific FRAs, confirmation is required from the Environment Agency on the appropriate climate change assessment approach for each site.

Revision Details			Suffix

Purpose of Issue: FINAL

Client: Braintree District Council

Project Title: Braintree Level 1 Strategic Flood Risk Assessment

Drawing Title: Flood Zone Maps

Drawn	Checked	Approved	Date
SB	JB	JR	Nov 2016

AECOM Internal Project No.: 60478467

Scale at A3: 1:40,000

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Drawing Number: FIGURE 2.7

Rev: 03

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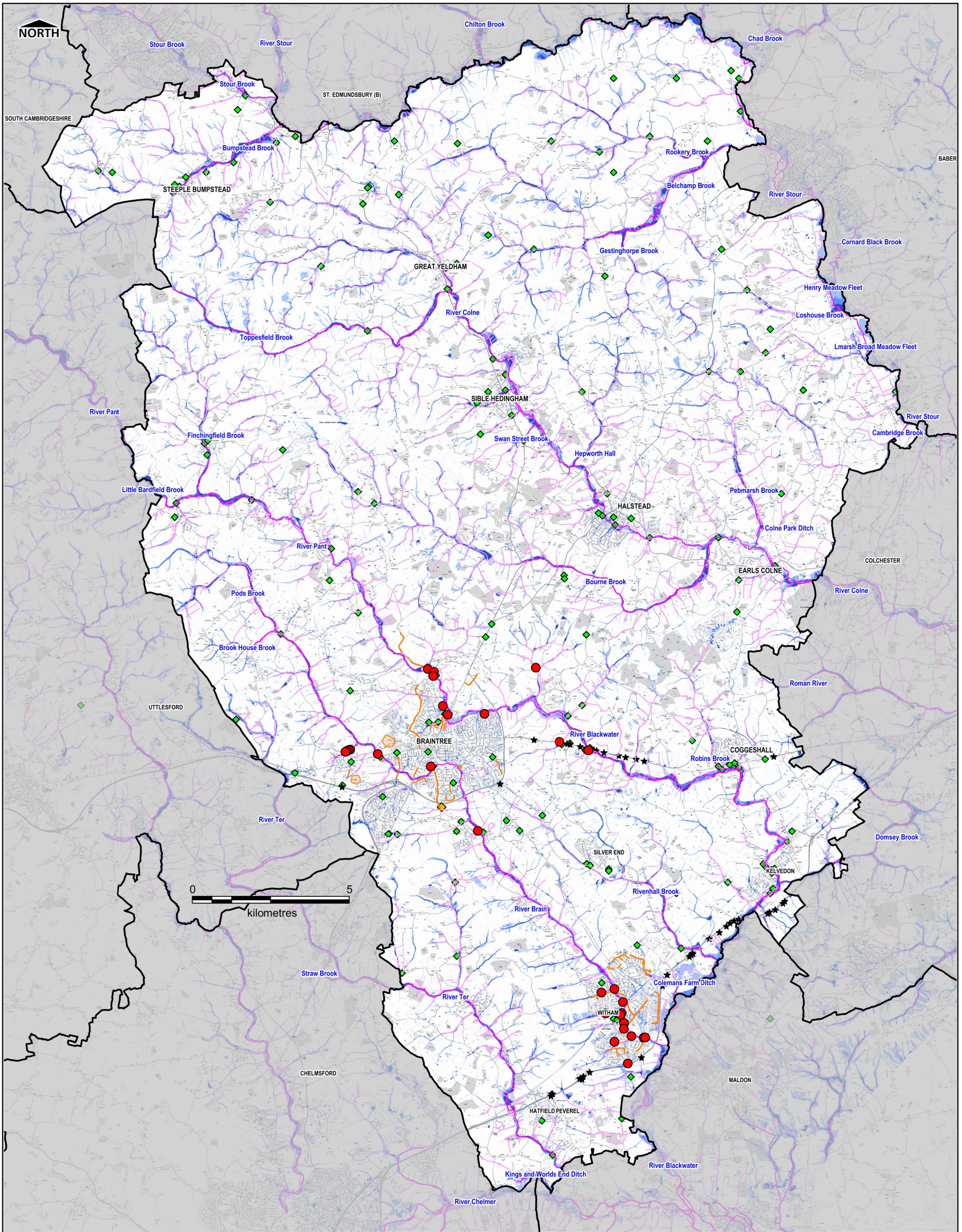

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LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse
- BDC Flood Summaries
- ECC Flood Incident Records
- Highways England Flood Records
- Known Flood Hotspots (EA & ECC)

Probability of Flooding from Surface Water

- High (>3.3% AEP)
- Medium (1% - 3.3% AEP)
- Low (0.1% - 1% AEP)
- Very Low (<0.1% AEP)

NOTES

This map shows the predicted likelihood of surface water flooding based on the Environment Agency's Risk of Flooding from Surface Water (RoFSW) data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/environment-agency).

The Risk from Surface Water Flooding is divided into categories: High: each year, the chance of flooding is greater than 1 in 30 (3.3%). Medium: each year, the chance of flooding is greater than 1 in 100 (1%) and 1 in 30 (3.3%). Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%). Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%). The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm. This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Braintree District Council provided flood risk summaries for the towns and villages of Braintree as assessed by the local community, which is idenfited by the "BDC Flood Summaries".

Essex County Council have provided information on surface water flooding from the 18th June 2015 throughout Braintree and Witham.

Project Title

Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title

Risk of Flooding from Surface Water

Client: Braintree District Council

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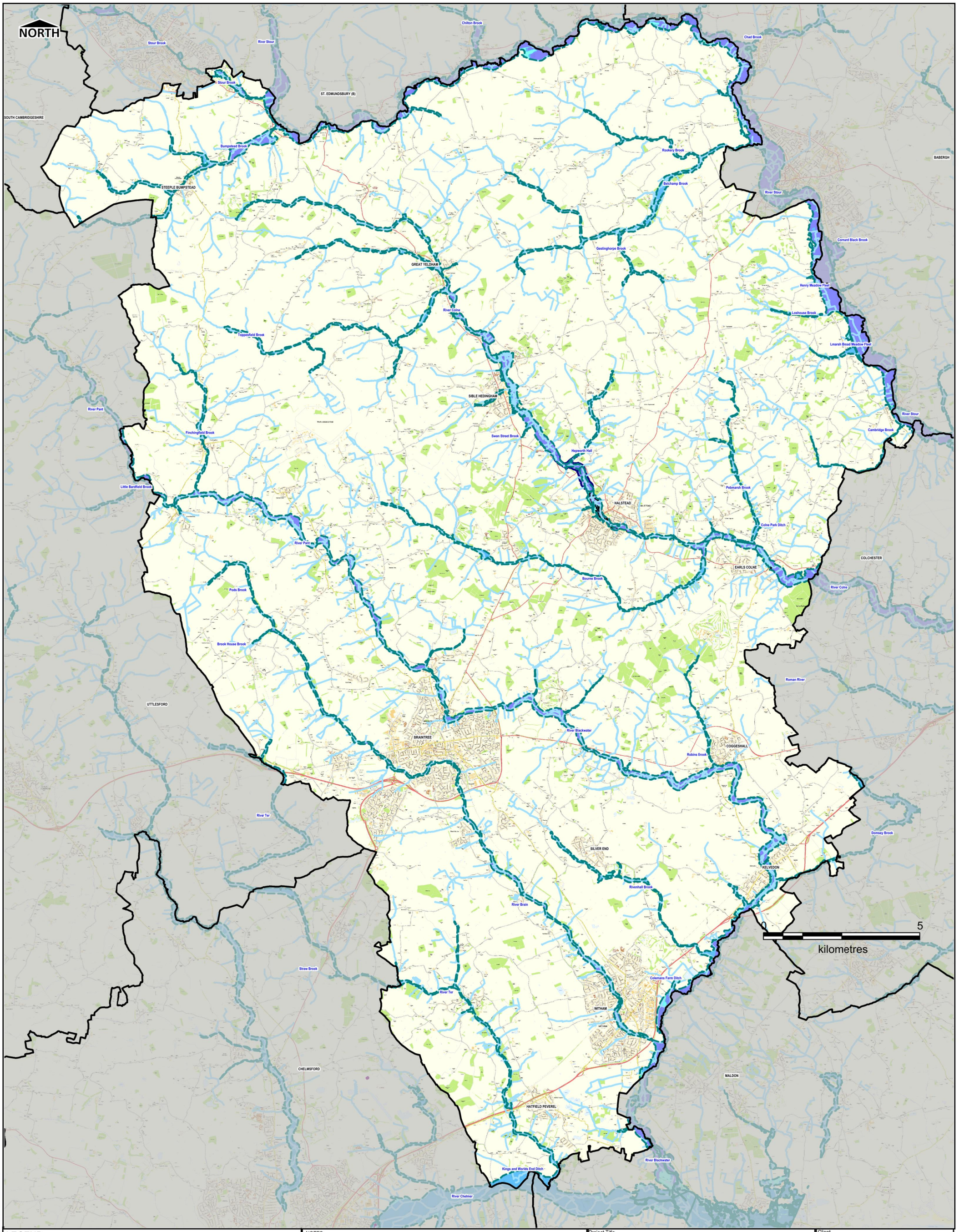
Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Drawing Number: FIGURE 3

Rev: 02



LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse
- Historic Records of Fluvial Flooding
- Flood Defences
- Flood Storage Areas
- Areas Benefiting from Flood Defences

Probability of Flooding from Rivers and the Sea

- Flood Zone 1 Low Probability
- Flood Zone 2 Medium Probability
- Flood Zone 3a High Probability
- Flood Zone 3b Functional Floodplain
- Flood Zone 3a plus climate change

NOTES

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner. An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991. The Environment Agency Flood Map for Planning (Rivers and Sea) is available on the Environment Agency website (www.gov.uk/environment-agency) and displays the risk of flooding based on probability. Flood Zone 1: Land assessed, ignoring the presence of flood defences, as having a less than 0.1% annual probability of fluvial or tidal flooding in any year. Flood Zone 2: Land assessed, ignoring the presence of flood defences, as having between a 1% nd 0.1% annual probability of fluvial flooding in any year. Flood Zone 3: Land assessed, ignoring the presence of flood defences, as having a 1% or greater annual probability of fluvial flooding in any year. Land that may benefit from the presence of flood defences during a 1% fluvial or 0.5% tidal flood event. These are areas that would flood if the defence were not present, but may not flood because the defence is present. This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

In February 2016, the Environment Agency published revised guidance on climate change allowances. In the absence of model outputs for the updated climate change allowances, this Level 1 SFRA has adopted a conservative approach to assessing climate change for the purpose of the Sequential Test by using the existing Flood Zone 2 extent (1 in 1000 annual probability of river flooding) as a proxy for the Flood Zone 3a plus climate change. This represents the 'higher central' allowance. Developers should note that for all subsequent site specific FRAs, confirmation is required from the Environment Agency on the appropriate climate change assessment approach for each site.

Project Title

Braintree District Council
Strategic Flood Risk Assessment update

Drawing Title

Flood Zone Map

Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Client

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Drawing Number: FIGURE 2

Rev: 03

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BDC/049/4/5

NORTH

Chilton Brook
Chad Brook
Stour Brook
River Stour
Stour Brook
ST. EDMUNDSBURY (B)
SOUTH CAMBRIDGESHIRE
Bumpstead Brook
Rookery Brook
BABER
STEEPLE BUMPSTEAD
Belchamp Brook
River Stour
Cornard Black Brook
Gestinghorpe Brook
GREAT YELDHAM
Henry Meadow Fleet
River Colne
Loshouse Brook
Toppesfield Brook
Lmarsh Broad Meadow Fleet
SIBLE HEDINGHAM
River Pant
River Stour
Finchingfield Brook
Swan Street Brook
Cambridge Brook
Hepworth Hall
Little Bardfield Brook
Pebmarsh Brook
HALSTEAD
Colne Park Ditch
River Pant
COLCHESTER
EARLS COLNE
Bourne Brook
Pods Brook
River Colne
Brook House Brook
Roman River
UTTLESFORD
River Blackwater
BRAINTREE
COGGESHALL
Robins Brook
River Ter
Domsey Brook
SILVER END
KELVEDON
Rivenhall Brook
River Brain
Straw Brook
Colemans Farm Ditch
River Ter
WITHAM
CHELMSFORD
MALDON
HATFIELD PEVEREL
River Blackwater
Kings and Worlds End Ditch
River Chelmer

0 5
kilometres

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LEGEND

Administrative Boundaries
Main River
Ordinary Watercourse

Probability of Flooding from Ground Water

>= 75%
>= 50% <75%
>= 25% <50%
<25%

NOTES
Areas Susceptible to Groundwater Flooding (AStGWF) is a strategic scale map showing groundwater flood areas on a 1km square grid. It was developed specifically by the Environmental Agency for use by Lead Local Flood Authorities (LLFAs) for use in Preliminary Flood Risk Assessment (PFRA) as required under the Flood Risk Regulartions. The was produced to annotate indicative Flood Risk Areas for PFRA with information to allow LLFAs to determins whether there may be a risk of flooding from groundwater.
The data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map and thus covers consolidated aquifers (chalk, sandstone etc., termed 'cleanwater' in the data attributes) and superficial deposits.It does not take account of the chance of flooding from groundwater rebound. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that ground water might emerge. The susceptible areas are represented by one of four area catergories (listed above) showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwarer flooding occuring.

In common with the majority of datasets showing areas which may experience groundwater emergence, this dataset covers a large area of land, and only isolated locations within the overallsusceptible area are actuall/ likley to suffer the consequences of groundwater flooding.

Project Title
Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title
AREAS SUSCEPTIBLE TO GROUNDWATER FLOODING

Client
Braintree District Council

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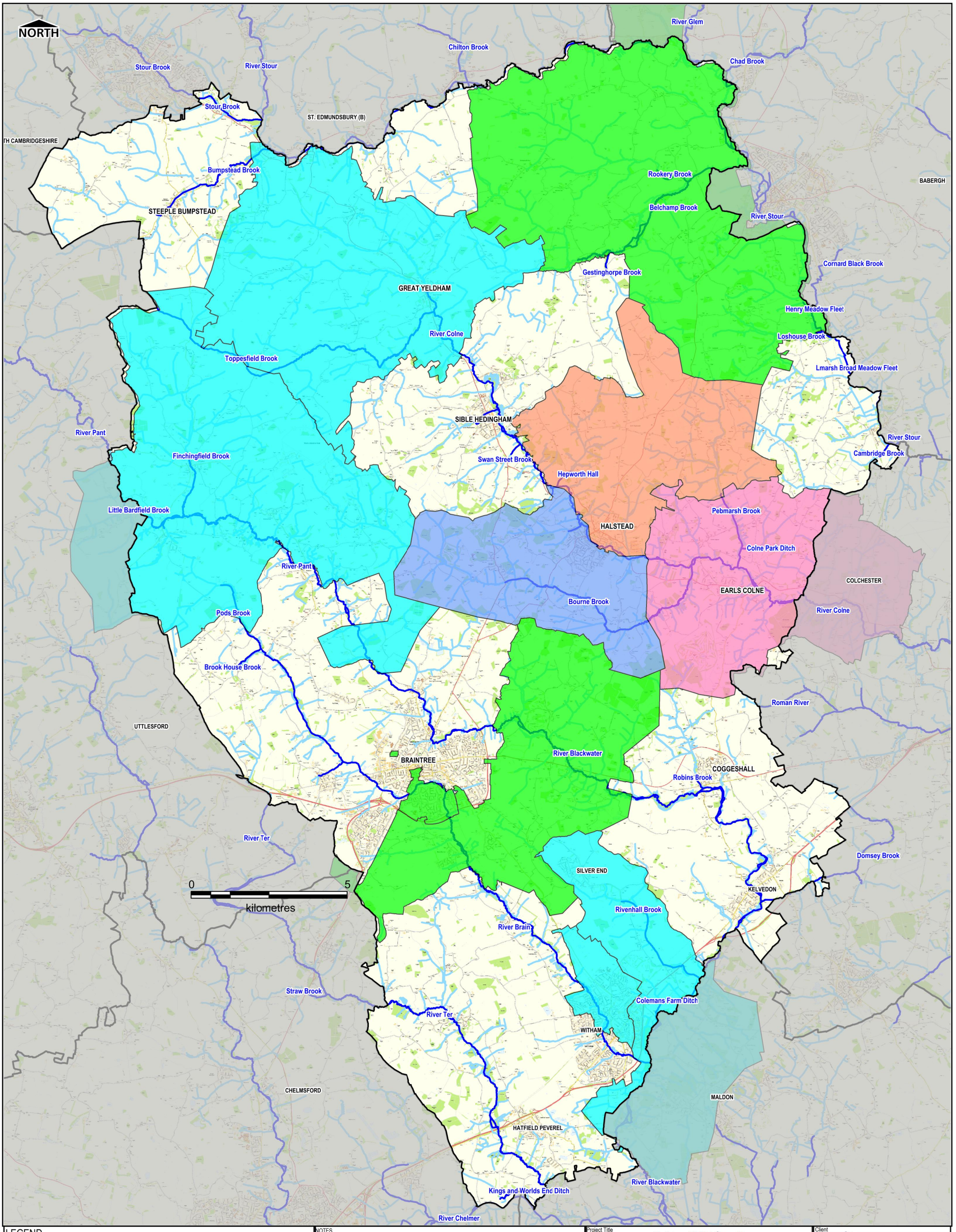
Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Drawing Number: FIGURE 4
Rev: 02



LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse

External Sewer Flood Incidents

- 1
- 2
- 3
- 5
- 6

Purpose: FINAL

NOTES

Anglian Water Services has provided an extract from their DG5 Flood Register for the study area. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

It should be noted that records only appear on the DG5 register where they have been reported to AWS, and as such they may not include all instances of sewer flooding.

Furthermore given that AWS target these areas for maintenance and improvements, areas that experienced flooding in the past may not longer be at greatest risk of flooing in the future.

This map is intended to provide a strategic overview of sewer flood risk and should not be used to assess flood risk individual properties.

Project Title: Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title: External Sewer Flood Incidents

Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Client: Braintree District Council

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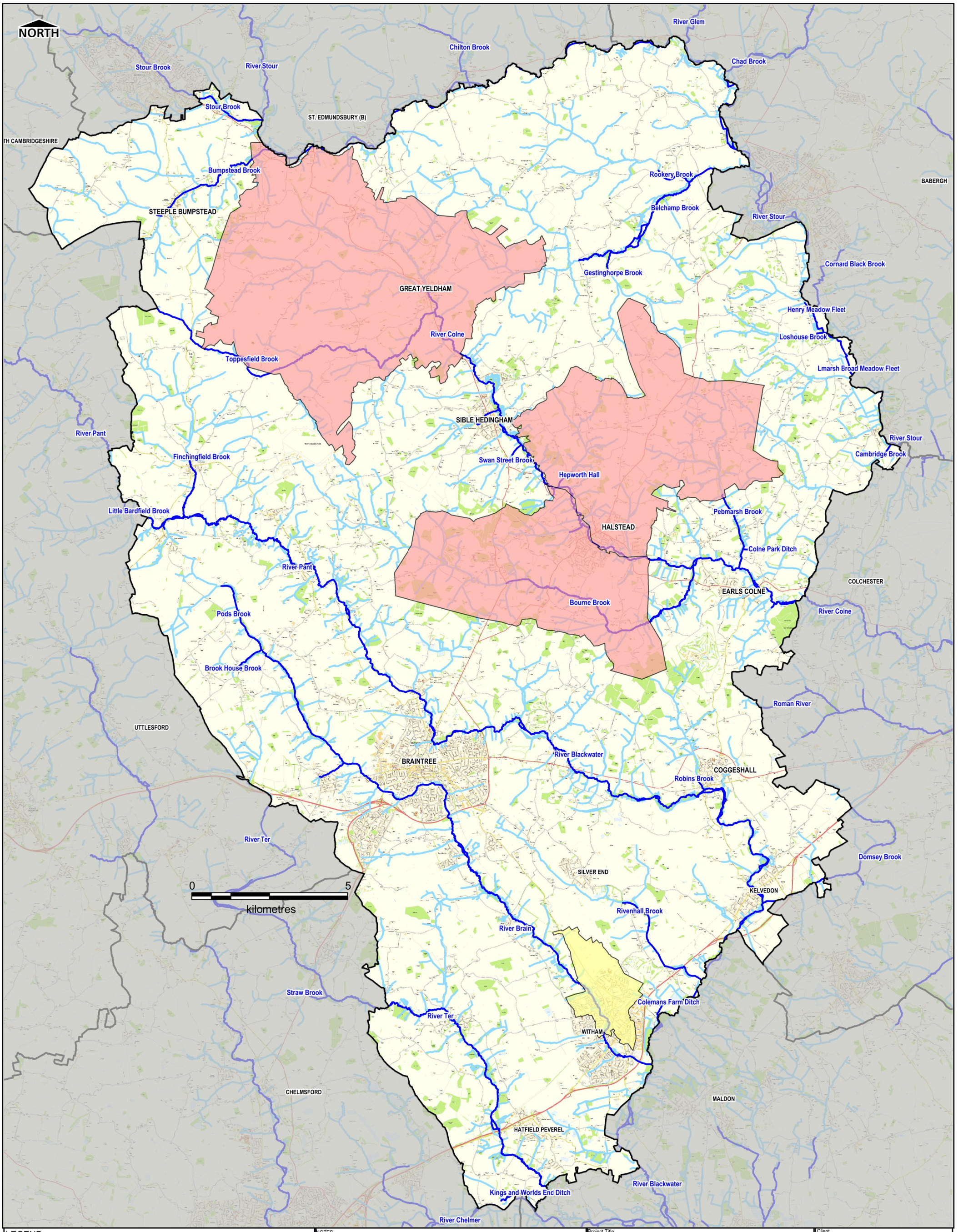
Drawing Number: FIGURE 5.1
Rev: 02

N:\Water\Current Projects\47071\60478467 Braintree DC L1 & 2 SFRA\06 GIS



LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse

Internal Sewer Flood Incidents

1	(3)
2	(1)

Purpose: FINAL

NOTES

Anglian Water Services has provided an extract from their DG5 Flood Register for the study area. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

It should be noted that records only appear on the DG5 register where they have been reported to AWS, and as such they may not include all instances of sewer flooding.

Furthermore given that AWS target these areas for maintenance and improvements, areas that experienced flooding in the past may not longer be at greatest risk of flooing in the future.

This map is intended to provide a strategic overview of sewer flood risk and should not be used to assess flood risk individual properties.

Project Title: Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title: Internal Sewer Flood Incidents

Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Client: Braintree District Council

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Drawing Number: FIGURE 5.2
Rev: 02

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NORTH

Chilton Brook
River Glem
Chad Brook
Stour Brook
River Stour
Stour Brook
ST. EDMUNDSBURY (B)
SOUTH CAMBRIDGESHIRE
Bumpstead Brook
STEEPLE BUMPSTEAD
Rookery Brook
Belchamp Brook
River Stour
BABERG
Cornard Black Brook
Gestinghorpe Brook
GREAT YELDHAM
Henry Meadow Fleet
River Colne
Loshouse Brook
Toppesfield Brook
Lmarsh Broad Meadow Fleet
SIBLE HEDINGHAM
River Pant
River Stour
Finchingfield Brook
Cambridge Brook
Swan Street Brook
Hepworth Hall
Little Bardfield Brook
Pebmarsh Brook
HALSTEAD
Colne Park Ditch
River Pant
COLCHESTER
EARLS COLNE
Bourne Brook
Pods Brook
River Colne
Brook House Brook
Roman River
UTTLESFORD
River Blackwater
BRAINTREE
COGGESHALL
Robins Brook
River Ter
Domsey Brook
SILVER END
KELVEDON
Rivenhall Brook
River Brain
Straw Brook
Colemans Farm Ditch
River Ter
WITHAM
ISFORD
MALDON
HATFIELD PEVEREL
River Blackwater
Kings and Worlds End Ditch
River Chelmer

0 5
kilometres

LEGEND

Adminstrative Region

BDC Emergency Rest Centres

Main River

Ordinary Watercourse

Flood Warning Areas

Blackwater North Bank	(1)
Blackwater South Bank from Maldon to Maylandsea	(1)
Maldon Town waterfront and the Hythe	(1)
River Blackwater from Braintree to Langford, including Coggeshall and Kelvedon	(1)
River Brain from Black Notley to Witham, inclusive	(1)
River Chelmer from Great Dunmow to Rivermead campus and Industrial Estate in Cho	(1)
River Chelmer from the A138 at Chelmsford to Maldon	(1)
River Colne from Castle Hedingham to upstream of Halstead	(1)
River Colne from Halstead to Lexden	(1)
River Pant, from Great Bardfield to Braintree, inclusive	(1)
River Stour from downstream of Kedington to Sudbury	(1)
River Stour from Sudbury to Boxted, inclusive	(3)
Stour Brook at Haverhill & Sturmer and the Bumpstead Brook from Steeple Bumpstea	(2)

NOTES
The Environment Agency provide a free flood warning service for many areas at risk of flooding from rivers and the sea. In some parts of England the Envircnment Agency may be able to provide warnings when flood from groundwarer is possible. The Environment Agency free flood warning service can provide advance notice of flooding and can provide time to prepare.
The Environment Agency issue flood warnigs to homes and businesses when flooding is expected. Upon receipt of a flood warning, occupants should take immediate action.
The Enviroment Agency issue flood alerts when flooding is possible. Flood alerts cover larger areas than flood warnings and are issued more frequently. Upon receipt of a flood warning, occupants should be prepared for flooding and to take action.
If a flood alert for groundwater if available this does not mean that your property is definitely at risk. it is very difficult to predict the exact location of flooding from groundwater as it is oftern related to local geology. To help people, the Environment Agency provde flood alerts for large areas that could be affected if groundwater levels were high.

Project Title
Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title
Flood Warning Areas and
Emergency Rest Centres

Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Client
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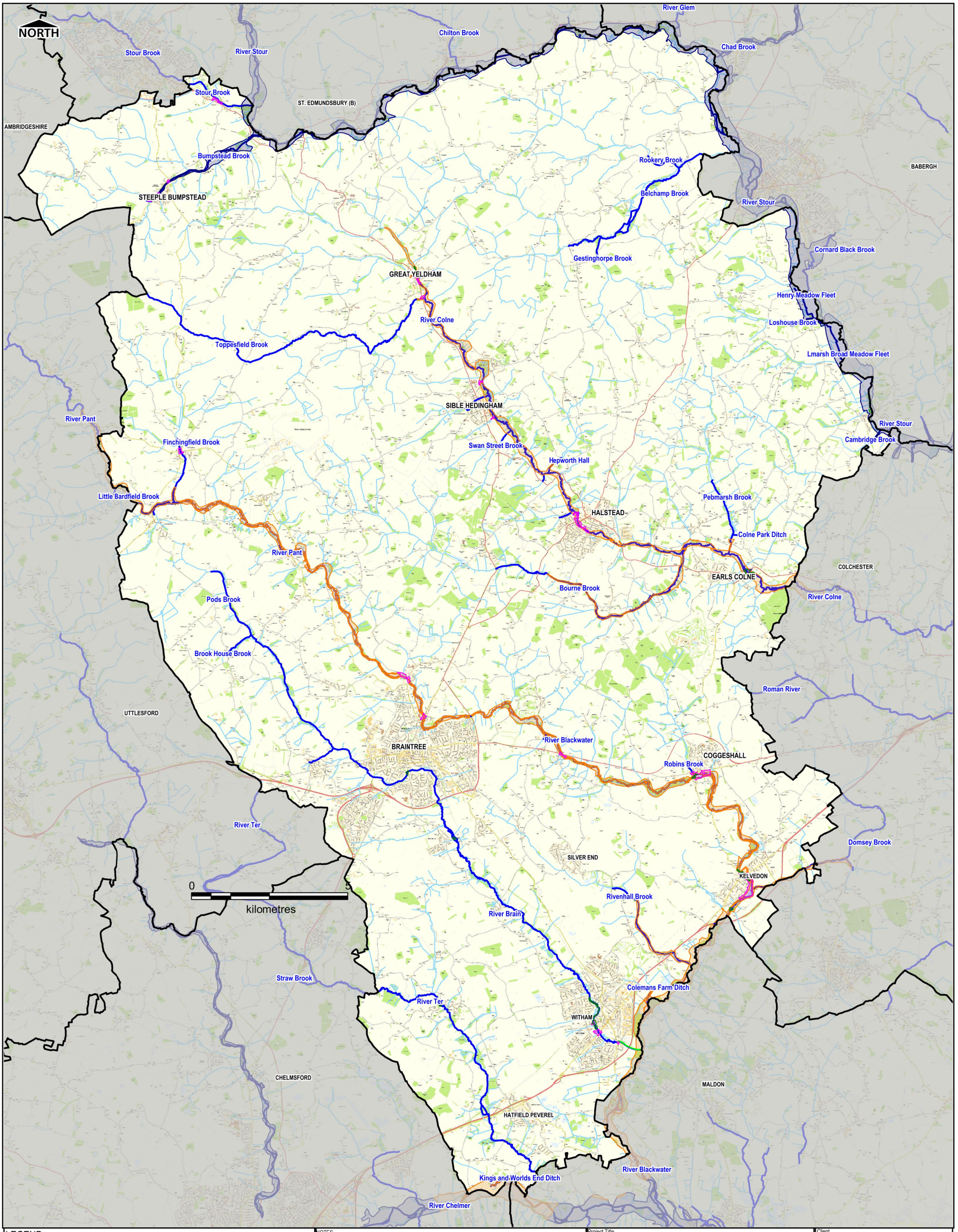
AECOM

Drawing Number
FIGURE 6

Rev
02

N:\Water\Current Projects\47016\0478467 Braintree DC L1 & 2 SFRA\06 GIS



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LEGEND

- Administrative Boundaries
- Main River
- Ordinary Watercourse

Historic Flood Outlines

- Historic Flood Record
- 1947 Flood Outline
- 1970 Flood Outline
- 2001 Flood Outline
- 2009 Flood Outline

NOTES

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However overall responsibility for maintenance lies with the riparian owner.

An Ordinary Watercourse is a watercourse that does not form part of a Main River. This includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows according to the Land Drainage Act 1991.

Purpose: FINAL

Project Title: Braintree District Council
Strategic Flood Risk Assessment Update

Drawing Title: Environment Agency
Historic Flood Outlines

Client: Braintree District Council

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Drawn	SB	Version	2
Checked	JB	Date	November 2016
Approved	JR	Scale at A3	1:110,000

Drawing Number: FIGURE 7
Rev: 02

Annex C – Additional Mapping

Flood map for planning

Your reference	Location (easting/northing)	Created
Longfield	**575399/213026**	**16 Mar 2021 9:19**

Your selected location is in flood zone 3, an area with a high probability of flooding.

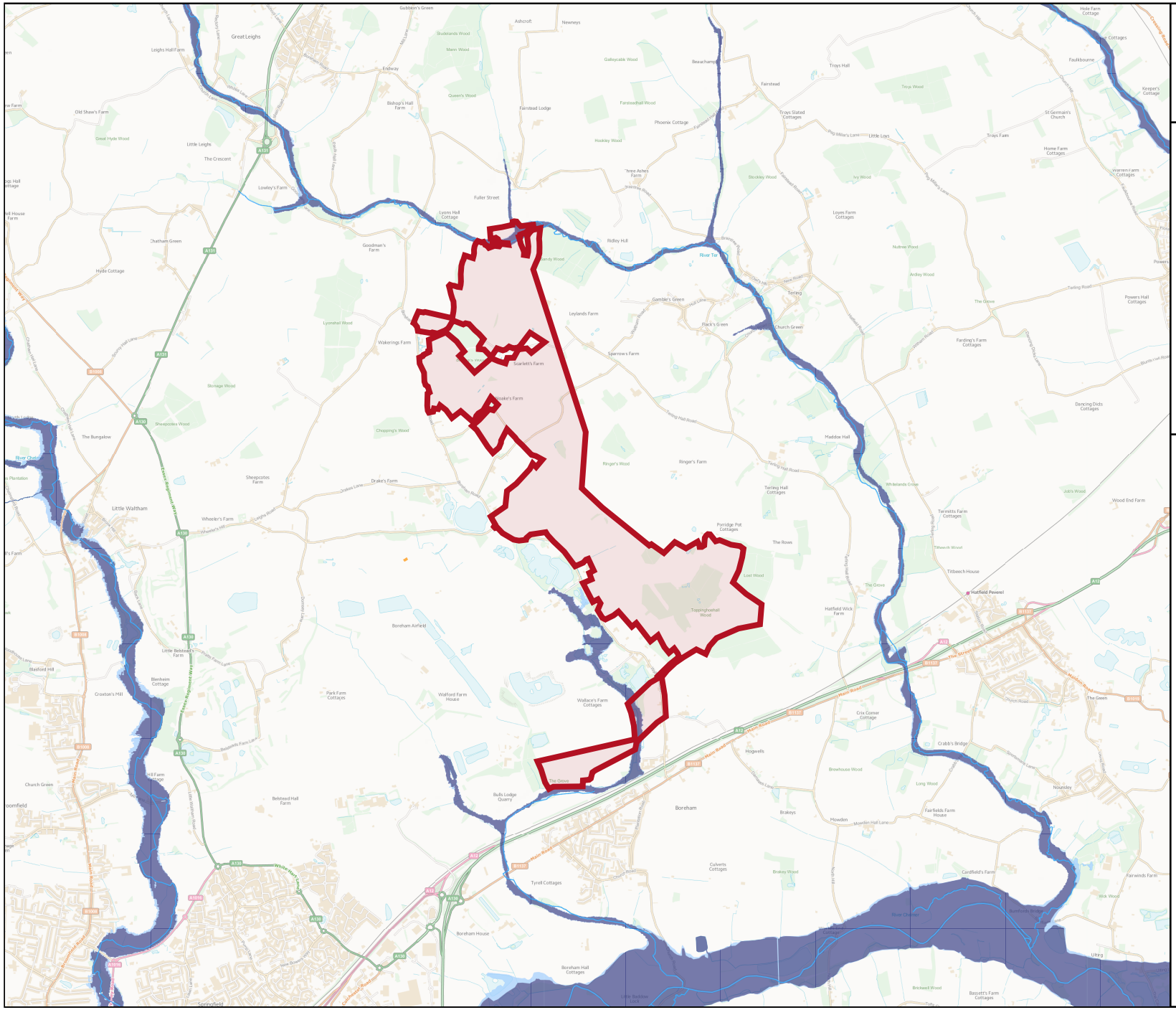
This means:

- you must complete a flood risk assessment for development in this area
- you should follow the Environment Agency's standing advice for carrying out a flood risk assessment (see www.gov.uk/guidance/flood-risk-assessment-standing-advice)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
Longfield

Location (easting/northing)
575399/213026

Scale
1:50000

Created
16 Mar 2021 9:19

- Selected area
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

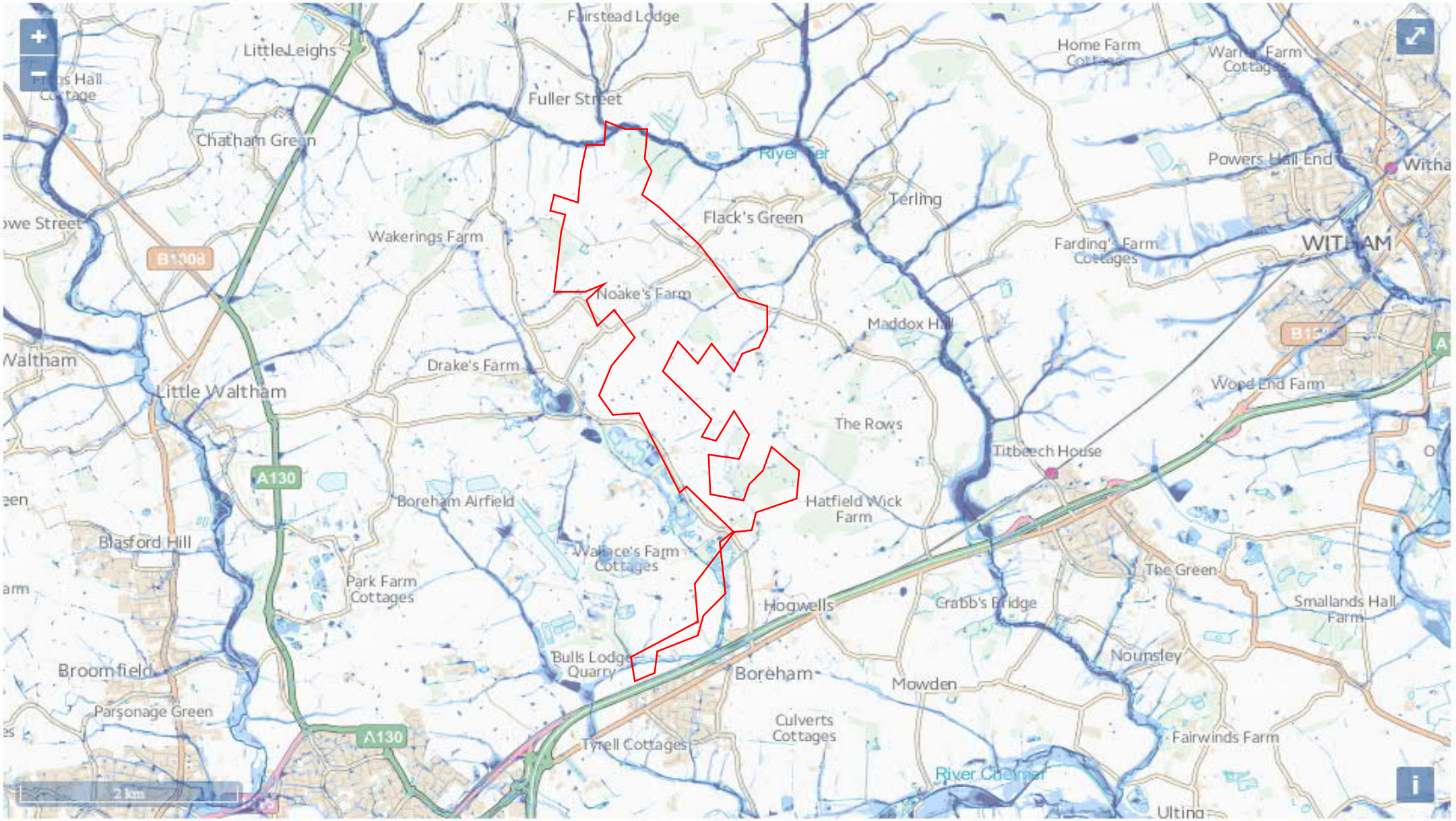
0 500 1000 1500m

Flood risk

Extent of flooding

Location

BOREHAM, ESSEX



Extent of flooding from surface water

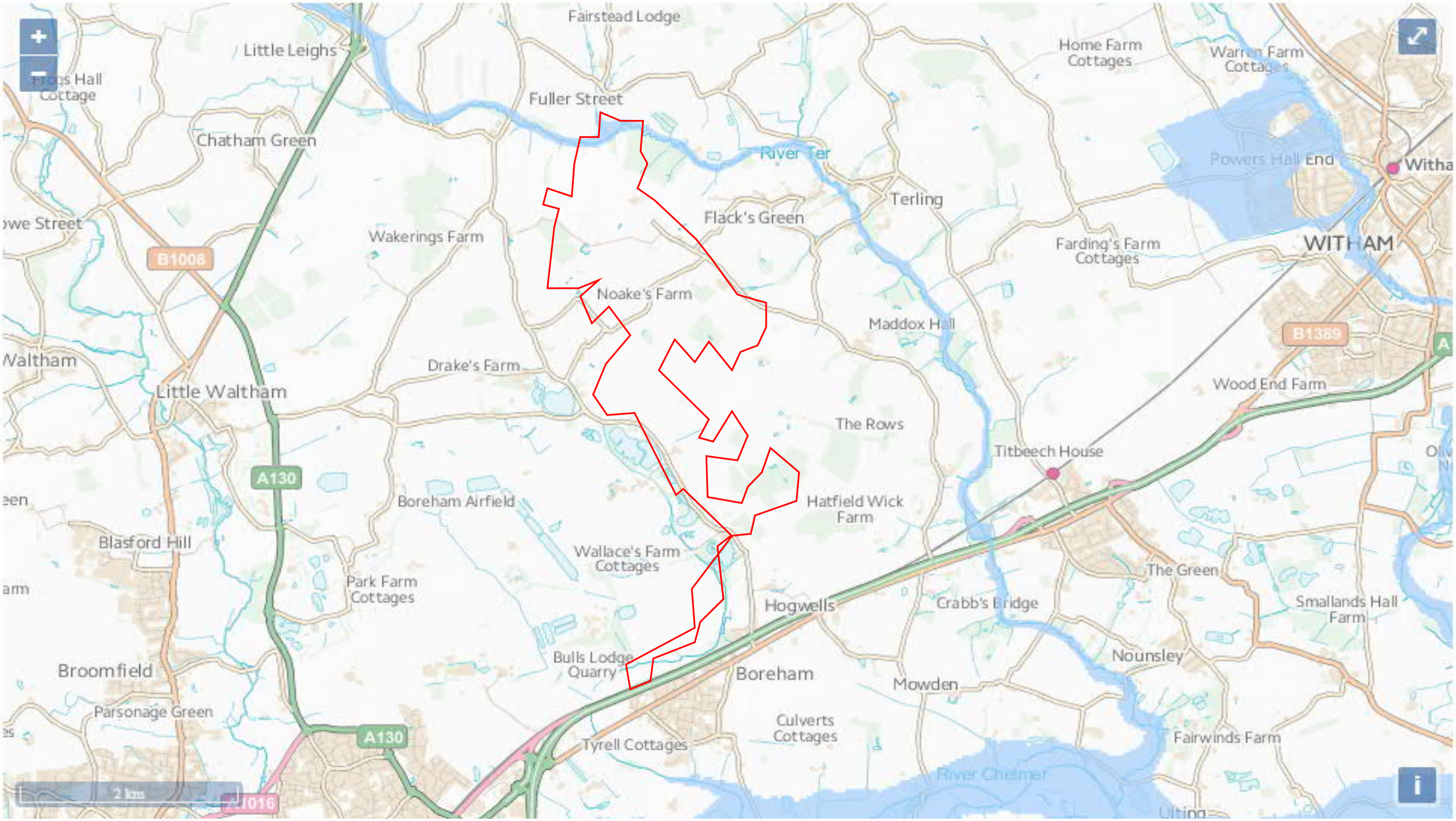
High Medium Low Very low Location you selected

Flood risk

Extent of flooding

Location

BOREHAM, ESSEX



Extent of flooding from reservoirs

Maximum extent of flooding Location you selected

Annex D - Pluvial Modelling Report

SURFACE WATER MODELLING TECHNICAL NOTE

LONGFIELD SOLAR FARM

LONGFIELD SOLAR ENERGY FARM LTD

FEBRUARY 2022

1 INTRODUCTION

1.1 Project Background

Arcus Consultancy Services Ltd (Arcus) has been instructed by Longfield Solar Energy Farm Ltd to produce a surface water model at the location of the proposed Longfield Solar Farm (the Development) located north of Boreham village, Chelmsford at National Grid Reference E 576665, N 212070 (the DCO Site).

The purpose of the surface water modelling is to confirm the existing surface water depths and flow routes at the Site and surrounding land in order to incorporate surface water betterment measures as part of the biodiversity measures proposed as part of the Development.

2 METHODOLOGY

2.1 Initial Design Parameters

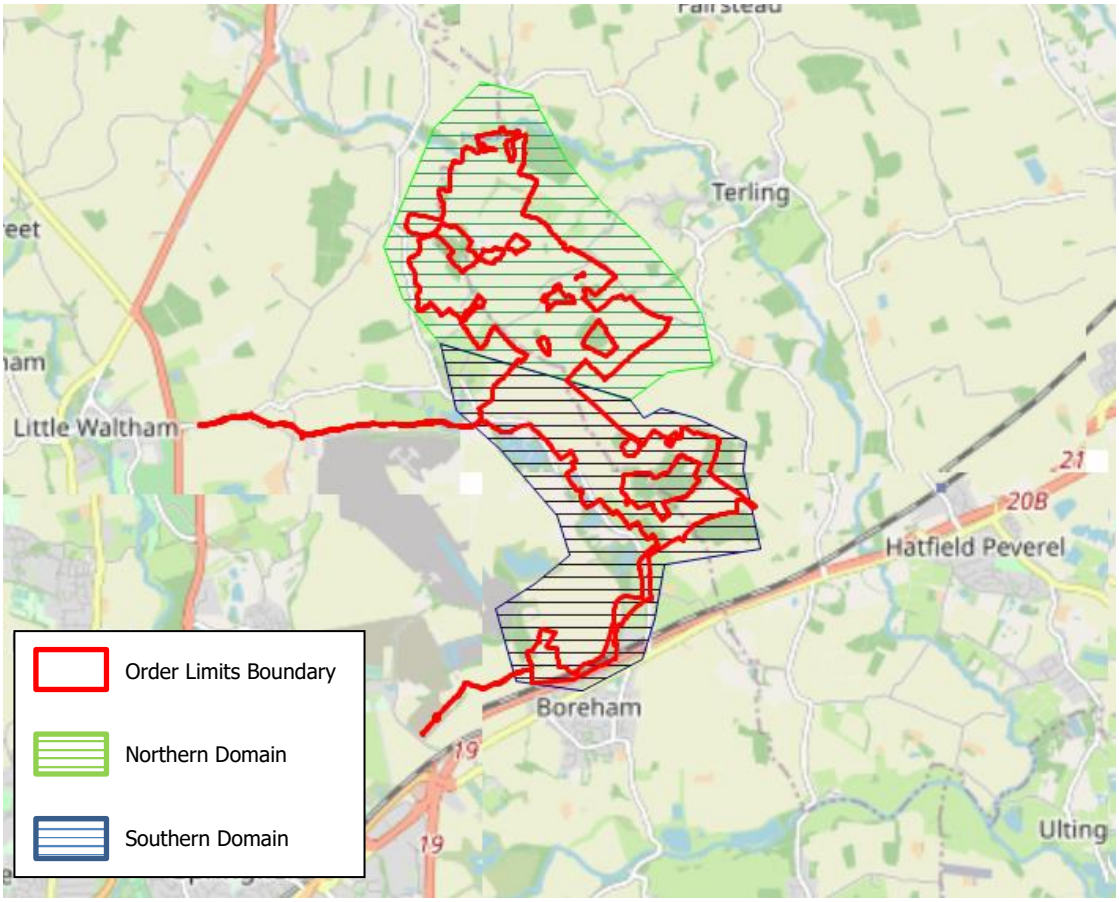
The surface water characteristics of the Site has been modelled in a 2D simulation utilising Flood Modeller 5.0 software and Alternating Direction Implicit (ADI) solver.

The topography at the Site and surrounding catchment is represented in the model by 2019 LiDAR data to 1 metre (m) resolution (TL71 and TL70).

All model runs are set to a timestep of 2 seconds and grid sizing of 4 m. To enable the model to run at such a grid size the Site was split into a northern and southern domain, as shown in Plate 1, to incorporate the Site and surrounding catchment.

The northern and southern domains are approximately 5.7 square kilometres (km²) and 5.2 km² in area respectively.

Plate 1 – 2D Model Domain (Taken from Flood Modeller)

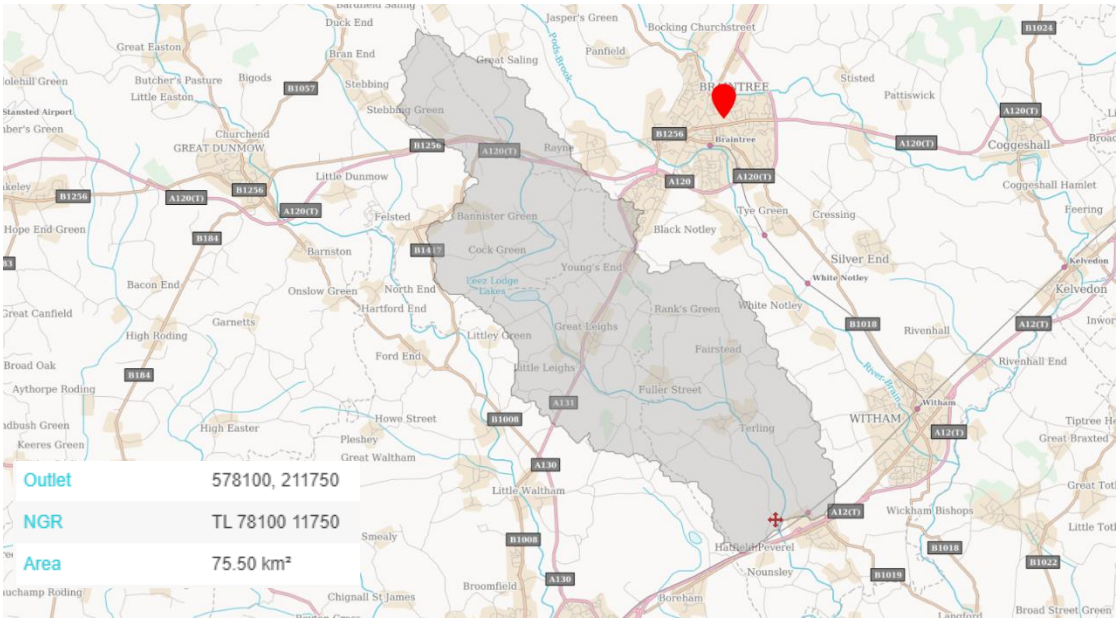


2.2 Hydrology Data

To develop hyetographs, catchment descriptors have been imported from the UK Centre for Ecology and Hydrology (CEH) Flood Estimation Handbook (FEH) web map[1] for a number of return periods as a 100 % rural model from a catchment of 75.5 km² as shown in Plate 2.

[1] UK Centre for Ecology and Hydrology, Flood Estimation Handbook. [Online]. Available at: https://fehweb.ceh.ac.uk/GB/map

Plate 2 – FEH Catchment



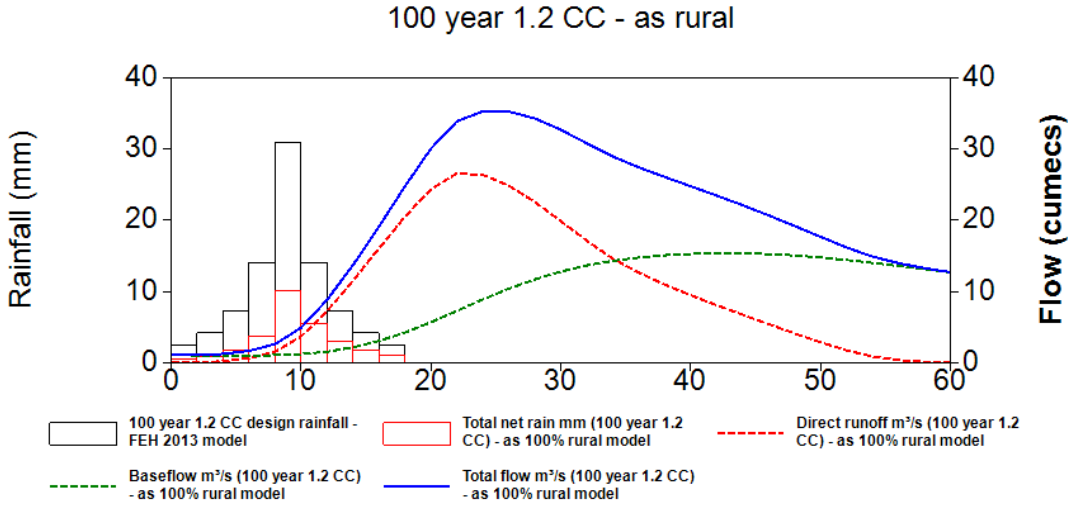
To account for the percolation capacity of the catchment the net loss rainfall data has been utilised within the Revitalised Flood Estimation Handbook 2 (ReFH2) software to generate a hyetograph which represents rainfall loses within the catchment. The summer profile shows the greatest rainfall intensities and has been utilised to demonstrate a 'worst-case scenario'.

The 1:100-year return period is the appropriate return period for the Development and has been utilised.

The Development has an operational lifetime of less than 50 years. In accordance with Environment Agency (EA) climate change allowances[2] a 20 % uplift has been applied to the 1:100-year hyetograph to account for increases in rainfall intensities associated with climate change up to 2069 with a hyetograph shown in Plate 3.

Outputs from the REFH2 hyetograph are shown in Appendix A.

Plate 3 – 1 in 100-Year (+20%) REFH2 Hyetograph



[2] Environment Agency, Flood Risk Assessment: Climate Change Allowances (2021). [Online]. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

2.3 Iterative Design

To measure the potential impact of the Development on surface water flood depths and flows the modelling process has been conducted through an iterative process. This process has been conducted in three key modelling phases; the baseline scenario, the refined baseline scenario and the operational phase scenario. The design details of each phase are detailed in the following sections.

2.3.1 Baseline Scenario

The baseline scenario model has been developed to identify the existing surface water flow characteristics at the Site and any areas of potential surface water flood risk at or emanating from the Site.

Ordnance Survey (OS) buildings data has been incorporated into the baseline scenario model with existing buildings within the model domains raised above topography.

OS roads data has been incorporated into the baseline scenario with existing roads within the model domains depressed 0.1 m below existing topography.

A universal Manning's N roughness value of 0.03 has been incorporated into the model to represent short grass pasture grounds in accordance with Chow 1959[3].

2.3.2 Refined Baseline Scenario

The refined baseline scenario has been developed to add further characteristics of the catchment into the baseline scenario to identify the surrounding surface water characteristics.

Consultations with surrounding landowners were conducted in September 2021 by Pershing Consultants where the baseline scenario methodology and outputs were reviewed. Consultations identified the presence of a 1 m high embankment located to the east of Stocks Farm which diverted surface water flow routes away from the property and within the Site. The embankments have therefore been incorporated into the model and raised 1 m above existing topography. The location of the embankment is show in Plate 3.

[3] Chow, Manning's N Values for Channels, closed Conduits Flow Partially Full and Corrugated Metal Pipes (1959). [Online]. Available at: http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm

Plate 3 – Embankments at Stocks Farm

Aerial imagery and photographs obtained from an Arcus hydrology site walkover in July 2021 have been assessed to identify existing ground conditions and land use at the Site and surrounding areas. The Manning's N roughness value has been amended from the universal value for any areas identified as woodland, roads and tracks as detailed in Plate 4 and Table 1 with values derived from Chow 1959.

Plate 4 – Manning's N Roughness Values (Taken from Flood Modeller)

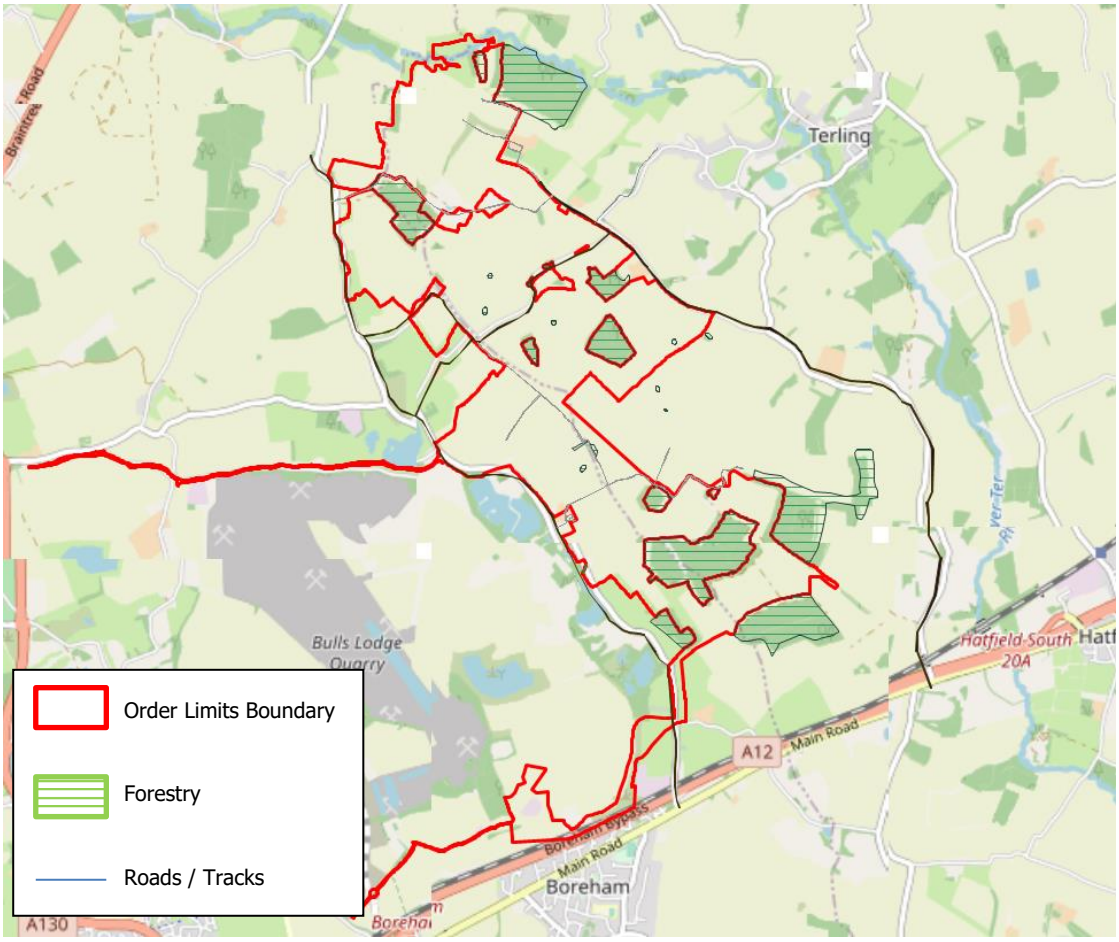


Table 1: Manning's N Roughness Values

Ground Condition Type	Manning's N Value Applied	Chow 1959 Definition
Woodland	0.15	Trees – dense willows, summer, straight
Tracks	0.025	Earth – no vegetation
Roads	0.02	Concrete – on good excavated rock

Aerial imagery and photographs have been assessed to identify existing roads and tracks not incorporated within the OS roads data. These have been depressed by 0.1 m below existing topography.

2.3.3 Operational Phase Scenario

The operational phase scenario has been developed to identify the potential surface water impact of infrastructure associated with the Development and to quantify the potential betterment of mitigation measures proposed.

The existing flow routes and surface water flood depths have been assessed form the refined baseline scenario to confirm proposed betterment measures alongside outcomes of local consultations. The proposed mitigation measures are detailed further in Section 2.4 and have been incorporated into the operational phase scenario.

The PV array tables will be driven into the ground via narrow legs and therefore will not contribute to impermeable areas. Impermeable areas associated with the Development are

therefore limited to the Battery Energy Storage System (BESS), Bull's Lodge Substation, inverters, transformers and an onsite plant and welfare facility. If string inverters are utilised then inverter units will not result in an increase in impermeable areas. As the type of inverter is yet to be confirmed the inverts are assumed to be 'on field' inverters to represent a 'worst case scenario' related to surface water runoff. Sustainable Drainage Strategies (SuDS) for the BESS, onsite plant and welfare facility and Bull's Lodge Substation have been designed by Arcus[4] and Mott MacDonald[5] respectively, with such strategies designed to manage any potential increase in surface water runoff rates.

The impermeable areas of the Development are therefore further limited to invert units which have been incorporated into the model and raised above existing topography.

An attenuation pond has been incorporated into the model to the east of Stocks Farm to intercept existing surface water. The proposed pond will not be designed to drain a defined impermeable or infrastructure but to intercept surface water along existing flow routes and thus increase the potential for attenuation of surface water within the Order Limits Boundary.

This has been modelled by depressing a feature of the total area, length and depth of the pond into existing height data. The pond structure has been designed using the Source Control feature within Micro Drainage software to incorporate 1 in 4 slopes. The pond structure will not serve a defined extent of impermeable areas but instead intercept surface water across existing flow routes and has not been designed to a defined rainfall return period. The design details of the pond are as follows:

- Depth 1 m;
- Slope 1 in 4;
- Base area 50 m²; and
- Total area 200.5 m².

To intercept surface water flows leading to Waltham Road and Stocks Farm, a swale has been incorporated to the model to the east of Stocks Farm by depressing a feature of the area, length and depth of the swale into existing height data. The design details of the swale are as follows:

- Length 70 m;
- Depth 1 m;
- Slope 1 in 4;
- Base width 0.5 m²; and
- Total area 6.9 m².

The locations of the proposed pond and swale are shown in Plate 5.

[4] Arcus, Longfield Solar Farm, SuDS Strategy (2021).
[5] Motts MacDonald, Drainage Strategy (2021).

Plate 5 – Stocks Farm Pond and Swale Location (Taken from Flood Modeller)

To provide additional surface water attenuation capacity and limit the potential surface water runoff associated with the Development, shallow filter drains along existing flow routes identified within the refined baseline scenario are proposed. The locations of the proposed filter drains are shown in Appendix C.

The filter drains have been incorporated into the model by depressing a feature of the area, length and depth of the drains into existing topography. The lengths of the filter drains vary relative to their location with depths of 1 m and widths of 0.5 m.

3 MITIGATION AND BETTERMENT MEASURES

As mentioned in Section 2.3.3, shallow filter drains are proposed along existing surface water flow routes in accordance with topographic contours. The filter drain features will not incorporate an active outfall but intercept surface water and allow it to infiltrate (as per the baseline scenario) along existing flow routes and provide additional attenuation of surface water throughout the operation of the Development.

The filter drain units will be gravel filled and will be approximately 1 m in depth and 0.5 m in width, with an example filter drain unit shown in Plate 6.

Plate 9: Shallow Filter Drains[6]

Following consultation with surrounding landowners, a pond and swale feature will be implemented to the east of Stocks Farm to intercept and attenuate surface water. This will limit potential surface water flood depths at the surrounding properties and on Waltham Road.

The design parameters of the pond and swale are detailed in Section 2.3.3.

The swale structure will be located at a topographic low point along existing contours in order to intercept surface water without flows dispersing horizontally across the feature and thus leading to overtopping at a low point. An example of a swale structure is shown in Plate 10.

[6] Malmaynes Solar Farm – Arcus As-built drainage review

Plate 10: Example Perimeter Swale at a Solar Farm Site[7]

4 RESULTS

4.1 Model Stability

To assess model stability the Manning's N Roughness value has been universally increased and decreased by 20 %. Modelling outputs identify a negligible maximal differentiation in surface water depths, thus demonstrating low sensitivity to modelled assumptions. As such, there is confidence that the model is producing credible results.

The maximum total mass error is 8 % with mass error decreasing throughout the iterative modelling process as shown in Table 2.

Table 2: 2D Model Total Mass Error

Simulation	Northern Domain Total Mass Error	Southern Domain Total Mass Error
Baseline	-7 %	8 %
Refined Baseline	-4 %	-4 %
Operational Phase	-4.3 %	-3.7 %

4.2 Baseline Scenario

The 1:100-year (+20 %) modelled outputs for the baseline scenario show maximum surface water flood depths of approximately 0.9 m in isolated area within the Order Limits Boundary, with significant areas of the model extent limited to surface water flood depths of less than 0.1 m.

[7] Bent Spur Solar Farm - Arcus As-built drainage review

Maximum depths within the Order Limits Boundary are shown at NGR E 576712, N 212576.

Areas within the Order Limits Boundary associated with existing surface water features (i.e. ponds, open land drains) demonstrate depths significantly greater than those upon the surrounding surface due to the depression in topography associated with the features.

The maximum surface water flood depths at the residential properties to the west of the DCO Site are approximately 0.8 m to 1 m. Areas within the vicinity of the Site are shown to have depths exceeding 1 m but are associated with existing surface water bodies.

There are areas on the wider extents of the model active area which are unrepresentative of surface water depths due to water reaching the extent of the model domains and glass-walling (i.e. water cannot exit the model extent).

4.3 Refined Baseline Scenario

To demonstrate the difference in surface water depths during the iterative modelling process, the depths at the maximum point within the Order Limits Boundary and outwith of the Order Limits Boundary for the baseline scenario have been assessed alongside the refined baseline scenario.

There are no significant benefits at the location of the maximal depths during the refined baseline scenario due to the location being a topographic low point, with depths within this areas not impacted by model variances.

The addition of the existing banks adjacent to Stocks Farm into the model is shown to redirect surface water flow routes, which correlates with anecdotal evidence from local landowner consultations.

The baseline and refined baseline scenarios at Stocks Farm are shown in Plates 11 and 12. The insertion of the bank results in additional surface water attenuation within the DCO Site and a reduction in offsite surface water depths.

The 1:100-year (+20 %) surface water depths for the refined baseline scenario are shown in Appendix B.

Plate 11: Baseline Model Stocks Farm Output

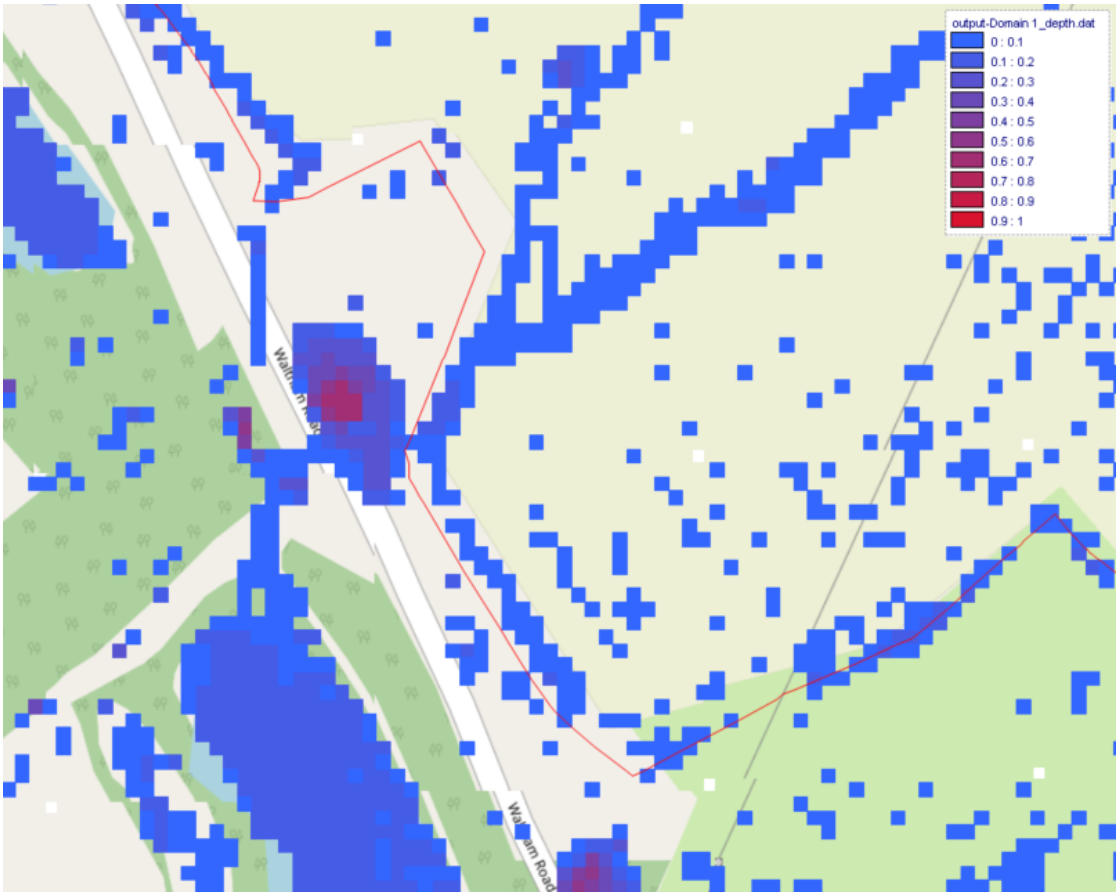
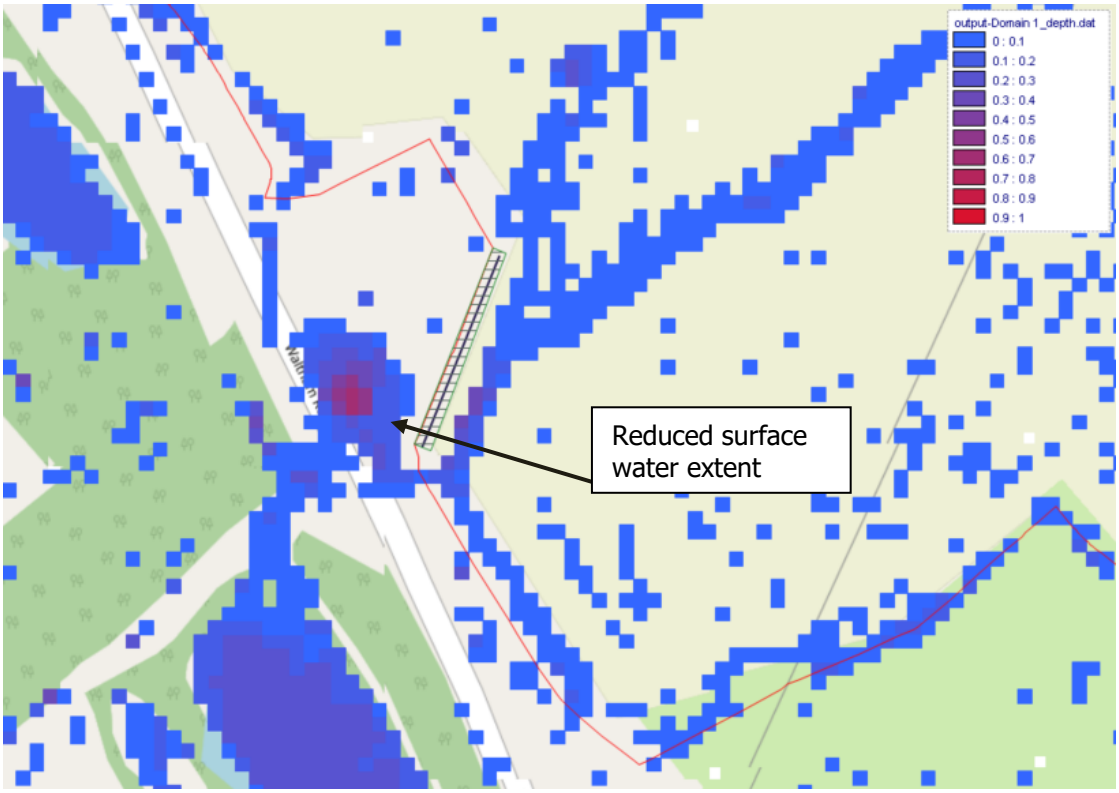


Plate 12: Refined Baseline Model Stocks Farm Output



4.4 Operational Phase Scenario

To demonstrate the difference in depths during the iterative modelling process the depths at the maximum point within the Order Limits Boundary and outwith of the Order Limits Boundary for the baseline scenario have been assessed alongside the refined baseline scenario.

The location of the maximum surface water depths within the Order Limits Boundary shows no significant reduction. The area with the maximal depths is a topographic low point and is therefore unlikely to have benefited from the benefit measures incorporated within the iterative modelling process.

The filter drains incorporated within the DCO Site are shown to vary in attenuation potential, with the attenuation capacity of the proposed features varying between 50 to 90 %.

Areas to the north west of the Site near Lawn Farm and Noakes House are shown to have benefitted from the insertion of filter drains along identified surface water flow routes as shown in Plate 13 and 14.

Plate 13: Refined Baseline Scenario Northern Flood Depths

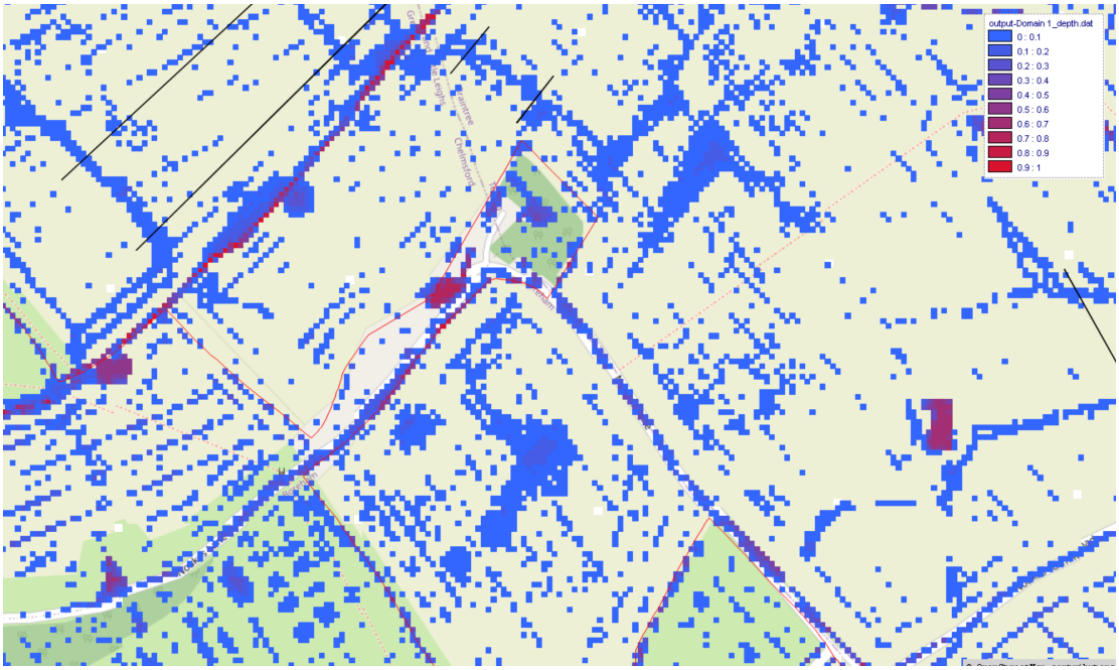
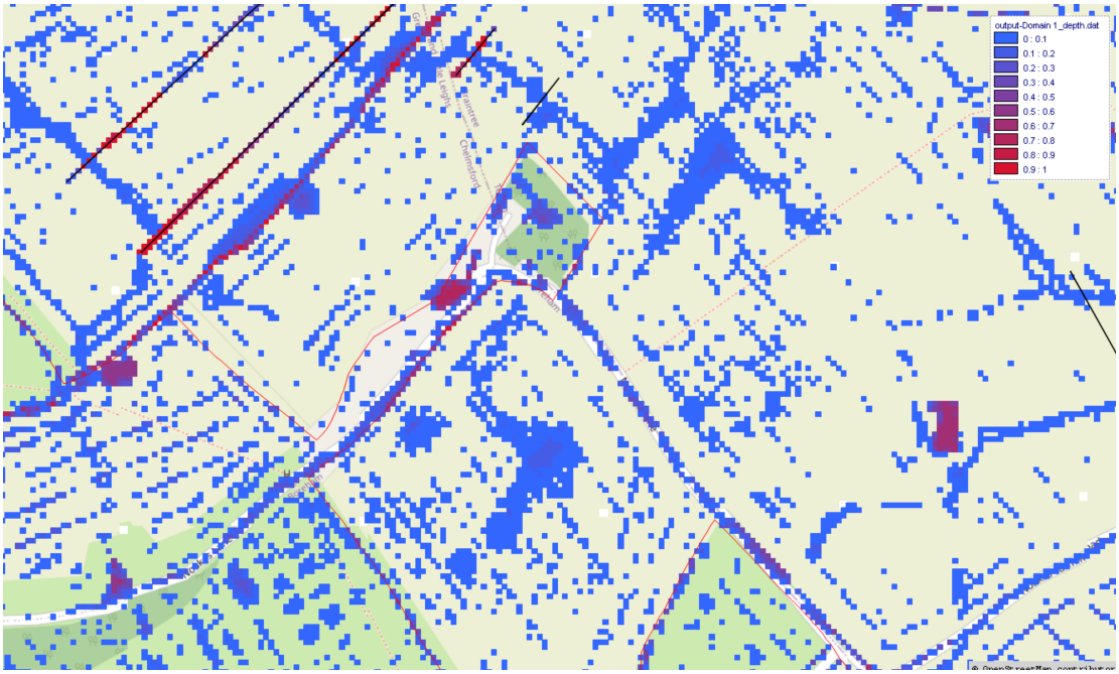


Plate 14: Operational Phase Scenario Northern Flood Depths



The pond and swale units implemented to the east of Stocks Farm are shown to attenuate and intercept surface water along existing flow routes. The maximum depths for the pond and swale during the 1:100-year (+20 %) 2D scenario are shown in Table 3.

Table 3: 2D Model Depth Reductions

Unit	Surface Water Depths
Pond	0.9 m
Swale	0.38 m

Surface water depths at the DCO Site and surrounding areas are shown to reduce at varying locations as detailed in Table 4, demonstrating the benefit of the proposed betterment measures in the interception and attenuation of surface water.

Table 4: 2D Model Depth Reductions

Location	NGR	Baseline Scenario 1:100 (+20%) Depths	Operational Phase Scenario 1:100 (+20%) Depths	Reduction in Depths
Noakes Lane	E 573970, N 213772	0.53 m	0.37 m	0.16 m
Waltham Road	E 573967, N 213 798	0.06 m	0.01 m	0.05 m
Stocks Farm	E 575492, N 212060	0.11 m	0.1 m	0.1 m
Wallace's Lane	E 575822, N 211580	0.82 m	0.7 m	0.12 m
Within OLB	E 576194, N 211921	0.26 m	0.03 m	0.23 m

The 1:100-year (+20%) surface water depths for the operational phase scenario are shown in Appendix C.

5 CONCLUSION

Arcus have produced a 2D hydraulic model utilising Flood Modeller software to demonstrate the surface water flows and depths of the DCO Site and surrounding areas during the 1:100-year+20 % scenario.

To demonstrate the current surface water characteristics of the DCO Site and surrounding areas an iterative process has been applied to enable comparisons of potential betterment measures.

The betterment measures incorporated into the 2D modelling include incremental filter drains, swales and an attenuation pond.

The 2D iterative modelling process demonstrates the benefit of incorporating surface water management measures within the Longfield Solar Farm Development i.e. a reduction in depth and extent of surface water.

The proposed surface water management measures are shown to provide betterment to the surrounding areas and the DCO Site.

APPENDIX A – REFH2 OUTPUT

UK Design Flood Estimation

Generated on 25 August 2021 09:02:37 by reagand
Printed from the ReFH2 Flood Modelling software package, version 3.2.7650.24314

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: C1D5-8D6A

Site name: FEH_Catchment_Descriptors_578100_211750_REFH2.3

Easting: 578100

Northing: 211750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 75.5

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year 1.2 CC

Summary of results

Rainfall - FEH 2013 model (mm):	93.12	Total runoff (ML):	2191.47
Total Rainfall (mm):	87.05	Total flow (ML):	6572.36
Peak Rainfall (mm):	30.85	Peak flow (m³/s):	35.52

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	18:00:00	No
Timestep (hh:mm:ss)	02:00:00	No
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	0.94	No
Seasonality	Summer [Winter]	Yes
Climate change factor	1.20	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	75.57	No
Cmax (mm)	360.11	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	12.37	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.1	No
BL (hr)	56.33	No
BR	2.02	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	1.11	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No
Exporting drained area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	2.572	0.000	0.557	0.000	1.092	1.092
02:00:00	4.210	0.000	0.951	0.051	1.056	1.107
04:00:00	7.264	0.000	1.757	0.239	1.029	1.268
06:00:00	14.053	0.000	3.814	0.674	1.024	1.698
08:00:00	30.851	0.000	10.287	1.615	1.066	2.681
10:00:00	14.053	0.000	5.559	3.835	1.215	5.050
12:00:00	7.264	0.000	3.087	7.485	1.559	9.045
14:00:00	4.210	0.000	1.856	11.854	2.167	14.021
16:00:00	2.572	0.000	1.158	16.460	3.063	19.523
18:00:00	0.000	0.000	0.000	20.957	4.243	25.200
20:00:00	0.000	0.000	0.000	24.791	5.674	30.465
22:00:00	0.000	0.000	0.000	26.923	7.269	34.192
24:00:00	0.000	0.000	0.000	26.647	8.878	35.525
26:00:00	0.000	0.000	0.000	25.029	10.370	35.399
28:00:00	0.000	0.000	0.000	22.694	11.676	34.370
30:00:00	0.000	0.000	0.000	19.983	12.762	32.745
32:00:00	0.000	0.000	0.000	17.185	13.619	30.803
34:00:00	0.000	0.000	0.000	14.668	14.260	28.928
36:00:00	0.000	0.000	0.000	12.660	14.722	27.382
38:00:00	0.000	0.000	0.000	10.962	15.040	26.002
40:00:00	0.000	0.000	0.000	9.438	15.235	24.674
42:00:00	0.000	0.000	0.000	8.025	15.322	23.347
44:00:00	0.000	0.000	0.000	6.683	15.310	21.993
46:00:00	0.000	0.000	0.000	5.365	15.204	20.569
48:00:00	0.000	0.000	0.000	4.082	15.010	19.092
50:00:00	0.000	0.000	0.000	2.856	14.734	17.589
52:00:00	0.000	0.000	0.000	1.736	14.383	16.119
54:00:00	0.000	0.000	0.000	0.871	13.974	14.845
56:00:00	0.000	0.000	0.000	0.402	13.532	13.934
58:00:00	0.000	0.000	0.000	0.158	13.080	13.238
60:00:00	0.000	0.000	0.000	0.041	12.631	12.672
62:00:00	0.000	0.000	0.000	0.002	12.192	12.193
64:00:00	0.000	0.000	0.000	0.000	11.767	11.767
66:00:00	0.000	0.000	0.000	0.000	11.356	11.356
68:00:00	0.000	0.000	0.000	0.000	10.960	10.960

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
70:00:00	0.000	0.000	0.000	0.000	10.578	10.578
72:00:00	0.000	0.000	0.000	0.000	10.209	10.209
74:00:00	0.000	0.000	0.000	0.000	9.853	9.853
76:00:00	0.000	0.000	0.000	0.000	9.509	9.509
78:00:00	0.000	0.000	0.000	0.000	9.177	9.177
80:00:00	0.000	0.000	0.000	0.000	8.857	8.857
82:00:00	0.000	0.000	0.000	0.000	8.548	8.548
84:00:00	0.000	0.000	0.000	0.000	8.250	8.250
86:00:00	0.000	0.000	0.000	0.000	7.962	7.962
88:00:00	0.000	0.000	0.000	0.000	7.684	7.684
90:00:00	0.000	0.000	0.000	0.000	7.416	7.416
92:00:00	0.000	0.000	0.000	0.000	7.158	7.158
94:00:00	0.000	0.000	0.000	0.000	6.908	6.908
96:00:00	0.000	0.000	0.000	0.000	6.667	6.667
98:00:00	0.000	0.000	0.000	0.000	6.434	6.434
100:00:00	0.000	0.000	0.000	0.000	6.210	6.210
102:00:00	0.000	0.000	0.000	0.000	5.993	5.993
104:00:00	0.000	0.000	0.000	0.000	5.784	5.784
106:00:00	0.000	0.000	0.000	0.000	5.583	5.583
108:00:00	0.000	0.000	0.000	0.000	5.388	5.388
110:00:00	0.000	0.000	0.000	0.000	5.200	5.200
112:00:00	0.000	0.000	0.000	0.000	5.019	5.019
114:00:00	0.000	0.000	0.000	0.000	4.843	4.843
116:00:00	0.000	0.000	0.000	0.000	4.674	4.674
118:00:00	0.000	0.000	0.000	0.000	4.511	4.511
120:00:00	0.000	0.000	0.000	0.000	4.354	4.354
122:00:00	0.000	0.000	0.000	0.000	4.202	4.202
124:00:00	0.000	0.000	0.000	0.000	4.056	4.056
126:00:00	0.000	0.000	0.000	0.000	3.914	3.914
128:00:00	0.000	0.000	0.000	0.000	3.778	3.778
130:00:00	0.000	0.000	0.000	0.000	3.646	3.646
132:00:00	0.000	0.000	0.000	0.000	3.519	3.519
134:00:00	0.000	0.000	0.000	0.000	3.396	3.396
136:00:00	0.000	0.000	0.000	0.000	3.277	3.277
138:00:00	0.000	0.000	0.000	0.000	3.163	3.163
140:00:00	0.000	0.000	0.000	0.000	3.053	3.053

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
142:00:00	0.000	0.000	0.000	0.000	2.946	2.946
144:00:00	0.000	0.000	0.000	0.000	2.844	2.844
146:00:00	0.000	0.000	0.000	0.000	2.744	2.744
148:00:00	0.000	0.000	0.000	0.000	2.649	2.649
150:00:00	0.000	0.000	0.000	0.000	2.556	2.556
152:00:00	0.000	0.000	0.000	0.000	2.467	2.467
154:00:00	0.000	0.000	0.000	0.000	2.381	2.381
156:00:00	0.000	0.000	0.000	0.000	2.298	2.298
158:00:00	0.000	0.000	0.000	0.000	2.218	2.218
160:00:00	0.000	0.000	0.000	0.000	2.140	2.140
162:00:00	0.000	0.000	0.000	0.000	2.066	2.066
164:00:00	0.000	0.000	0.000	0.000	1.994	1.994
166:00:00	0.000	0.000	0.000	0.000	1.924	1.924
168:00:00	0.000	0.000	0.000	0.000	1.857	1.857
170:00:00	0.000	0.000	0.000	0.000	1.792	1.792
172:00:00	0.000	0.000	0.000	0.000	1.730	1.730
174:00:00	0.000	0.000	0.000	0.000	1.669	1.669
176:00:00	0.000	0.000	0.000	0.000	1.611	1.611
178:00:00	0.000	0.000	0.000	0.000	1.555	1.555
180:00:00	0.000	0.000	0.000	0.000	1.501	1.501
182:00:00	0.000	0.000	0.000	0.000	1.448	1.448
184:00:00	0.000	0.000	0.000	0.000	1.398	1.398
186:00:00	0.000	0.000	0.000	0.000	1.349	1.349
188:00:00	0.000	0.000	0.000	0.000	1.302	1.302
190:00:00	0.000	0.000	0.000	0.000	1.257	1.257
192:00:00	0.000	0.000	0.000	0.000	1.213	1.213
194:00:00	0.000	0.000	0.000	0.000	1.170	1.170
196:00:00	0.000	0.000	0.000	0.000	1.130	1.130

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	75.5	No
ALTBAR	60	No
ASPBAR	151	No
ASPVAR	0.22	No
BFIHOST	0.46	No
BFIHOST19	0.44	No
DPLBAR (km)	12.68	No
DPSBAR (mkm^{-1})	18.3	No
FARL	0.99	No
LDP	27.82	No
PROPWET (mm)	0.31	No
RMED1H	11.5	No
RMED1D	28.8	No
RMED2D	36.9	No
SAAR (mm)	570	No
SAAR4170 (mm)	592	No
SPRHOST	41.84	No
Urbext2000	0.01	No
Urbext1990	0.01	No
URBCONC	0.73	No
URBLOC	1.22	No
DDF parameter C	-0.02	No
DDF parameter D1	0.27	No
DDF parameter D2	0.27	No
DDF parameter D3	0.25	No
DDF parameter E	0.31	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.26	No
DDF parameter D2 (1km grid value)	0.29	No
DDF parameter D3 (1km grid value)	0.26	No
DDF parameter E (1km grid value)	0.32	No
DDF parameter F (1km grid value)	2.53	No

APPENDIX B – REFINED BASELINE SCENARIO 1 IN 100-YEAR +20% SURFACE WATER DEPTHS

Longfield Solar Farm

ARCUS

Order Limits Boundary

1 in 100-Year (+20%) Surface Water Depths (m)

- 0.10
- 0.15
- 0.20
- 0.25
- 0.30
- 0.35
- 0.40
- 0.45
- 0.50

1:22,000 Scale @ A3

0 400 800 Meters

NORTH

Produced By: CH	Ref: 4077-PUB-050
Checked By: RD	Date: 28/10/2021

Baseline Full Model
Figure No. 50

Longfield Solar Farm

N:\GIS\Hydrology\Projects\4077 Longfield\4077 Longfield.aprx\4077-PUB-050 Baseline Full Model

APPENDIX C – OPERATIONAL PHASE SCENARIO 1 IN 100-YEAR +20% SURFACE WATER DEPTHS

Longfield Solar Farm

ARCUS

- Order Limits Boundary
- Filter Drains

1 in 100-Year (+20%) Surface Water Depths (m)

- 0.10
- 0.15
- 0.20
- 0.25
- 0.3
- 0.35
- 0.4
- 0.45
- 0.5

1:22,000 Scale @ A3

0 400 800 Meters

NORTH

Produced By: CH	Ref: 4077-PUB-051
Checked By: RD	Date: 28/10/2021

Iteration 3 Full Model
Figure No. 51

Longfield Solar Farm

N:\GIS\Hydrology\Projects\4077 Longfield\4077 Longfield.aprx\4077-PUB-051 Iteration 3 Full Model