

ENVIRONMENT

Richborough Estates Limited and Mr & Mrs Adcock
Land East of Stoke Road and North of Normandy
Way (A47)
Hinckley
Flood Risk Assessment

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Birmingham
Livery Place, 35 Livery Street, Colmore Business District, Birmingham, B3 2PB
T: 0121 233 3322

Cambridge
14-16 High Street, Histon, Cambridge
CB24 9JD
T: 01223 235 173

Leeds
Whitehall Waterfront, 2 Riverside Way, Leeds
LS1 4EH
T: 0113 233 8000

London
11 Borough High Street
London, SE1 9SE
T: 0207 407 3879

Manchester
11 Portland Street, Manchester, M1 3HU
0161 233 4260

Market Harborough
12a Woodcock House, Compass Point Market Harborough, Leicestershire, LE16 9HW
T: 01858 455020

Nottingham
Waterfront House, Station Street, Nottingham NG2 3DQ
T: 0115 924 1100

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Author:	Lucy Reeves BSc (Hons)
Checked:	Max Brambani BSc (Hons) PgCert MCIWEM
Approved:	Alex Petrakis BSc (Hons)

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced on behalf of Richborough Estates Limited and Mr & Mrs Adcock in respect of a planning application for a proposed residential development at the Land East of Stoke Road and North of Normandy Way, Hinckley, Leicestershire (approximate grid reference: SP419956).

This report demonstrates that the proposed development is not at significant flood risk, subject to the recommended flood mitigation strategies being implemented.

The site is located entirely within Flood Zone 1 (low probability of fluvial flooding). The nearest EA Flood Zone Extents are located approximately 1.3km north west of the site and are attributed to the River Tweed. An Unnamed Ordinary Watercourse (UOW) is shown to flow adjacent to the eastern boundary of the site, ultimately discharging to the River Tweed approximately 2km downstream of the site. The UOW is not represented on the EA's Flood Map for Planning due to its small catchment. A series of ditches/highway drains have also been identified within the western part of the site, following a site visit. Two of the ditches are shown to flow parallel to either side of Stoke Road in a north westerly direction. A further ditch is shown to flow towards Stoke Road from Normandy Way and is assumed to outfall to the ditch that conveys flows immediately east of Stoke Road.

To provide a detailed understanding of flooding at the site, BWB Consulting Ltd have undertaken a hydraulic modelling study and associated hydrological assessment. The baseline modelling shows that the majority of the site is located outside of the 1 in 20-year, 1 in 100-year, 1 in 100-year +22% climate change (CC) and 1 in 1000-year events. During the 1 in 100-year return period and larger magnitude events, it is predicted that flood waters will overtop Normandy Way and be conveyed into the land parcel west of Stoke Road. During the 1 in 20-year event, this land parcel remains largely unaffected except for a small area of localised flooding that is predicted at the interaction between the end of Reach 4 (R4) and Stoke Road. It should be noted that no built development is currently proposed within this part of the site application boundary, as per the illustrative masterplan.

The proposed residential development, contained to the larger land parcel east of Stoke Road, is sequentially located outside of all modelled extents (including the 1 in 100-year +22%CC design event and 1 in 1000-year event).

As part of the development proposals, a roundabout is proposed off Stoke Road to access the site. To minimise the amount of culverting works that are to be required, it is proposed that the river corridor of the existing ditches that flow parallel to Stoke Road are diverted around the roundabout. A small section of culverting will be required within the site where the access road off the roundabout has entered the site. The proposed channel and culvert have been designed, in combination, to have sufficient capacity to contain the 1 in 100-year +22%CC flows, with the proposed development shown to be located outside of the proposed modelled flood extents for all events up to and including the 1 in 100-year + 22%CC event. As such, it is proposed that dwellings will have finished floor levels set no lower than 600mm above the peak flood level of the UOW during baseline conditions (in the east of the site) and the peak flood level of the ditches during the proposed development scenario (west of the site). It is also recommended that finished floor levels are generally raised a minimum of 150mm above

surrounding ground levels to help mitigate the residual risk of flooding. Ground levels should be profiled to encourage pluvial runoff and overland flows away from built development and towards the nearest drainage point.

The proposed development has been reviewed against other potential sources of flood risk including, canals, surface water, sewers, groundwater and reservoirs and large waterbodies. None of these flood sources have been found to represent a potential barrier to development.

To mitigate the development's impact on the current runoff regime, it is proposed to incorporate surface water attenuation and storage as part of the development proposals. It is proposed to drain foul water from the development separately to surface water. Further information regarding the management of surface water runoff and foul water is outlined in the Sustainable Drainage Statement (Ref: HIN-BWB-ZZ-XX-RP-CD-0001_SDS).

In compliance with the requirements of National Planning Policy Framework, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site.

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1. INTRODUCTION

- 1.1 This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. The FRA has been produced on behalf of Richborough Estates Limited and Mr & Mrs Adcock in respect of a planning application for a proposed residential development at the Land East of Stoke Road and North of Normandy Way, Hinckley, Leicestershire.
- 1.2 This FRA is intended to support an outline planning application and as such the level of detail included is commensurate and subject to the nature of the proposals. Summary information is included as **Table 1.1**.

Table 1.1: Site Summary

Site Name	Land East of Stoke Road and North of Normandy Way (A47)
Location	Hinckley
NGR (approx.)	SP419956
Application Site Area (ha)	25.4 (approx.)
Development Type	Residential
Flood Zone Classification	Flood Zone 1
NPPF Vulnerability	More Vulnerable
Environment Agency Office	East Midlands
Lead Local Flood Authority	Leicestershire County Council
Local Planning Authority	Hinckley & Bosworth Borough Council

Sources of Data

- i. Topographical Survey by Greenhatch Group, reference 42117_T
- ii. Environment Agency consultation
- iii. Leicestershire County Council Consultation
- iv. Environment Agency Surface Water Flood Risk Maps
- v. Hinckley and Bosworth Borough Council Level 1 Strategic Flood Risk Assessment
- vi. Hinckley and Bosworth Borough Council Level 2 Strategic Flood Risk Assessment
- vii. Leicestershire County Council Preliminary Flood Risk Assessment
- viii. Leicestershire County Council Local Flood Risk Management Strategy

- ix. Hinckley and Bosworth Borough Council Draft Local Plan
- x. Site visit undertaken by BWB Consulting Ltd, January 2022
- xi. Hydraulic modelling of the local watercourses and ditches undertaken by BWB Consulting, reference HIN-BWB-ZZ-XX-RP-YE-0002
- xii. Severn Trent Water Sewer Records and Consultation
- xiii. British Geological Survey Drift & Geology Maps

Existing Site

- 1.3 The site is located approximately 1.7km north of Hinckley town centre. The site is bound to the north by agricultural land, to the east by an Unnamed Ordinary Watercourse (UOW), to the south by Normandy Way (A47) and to the west by a pond and further greenfield land. Stoke Road is shown to pass through the site boundary. The site's location is illustrated within **Figure 1.1**.

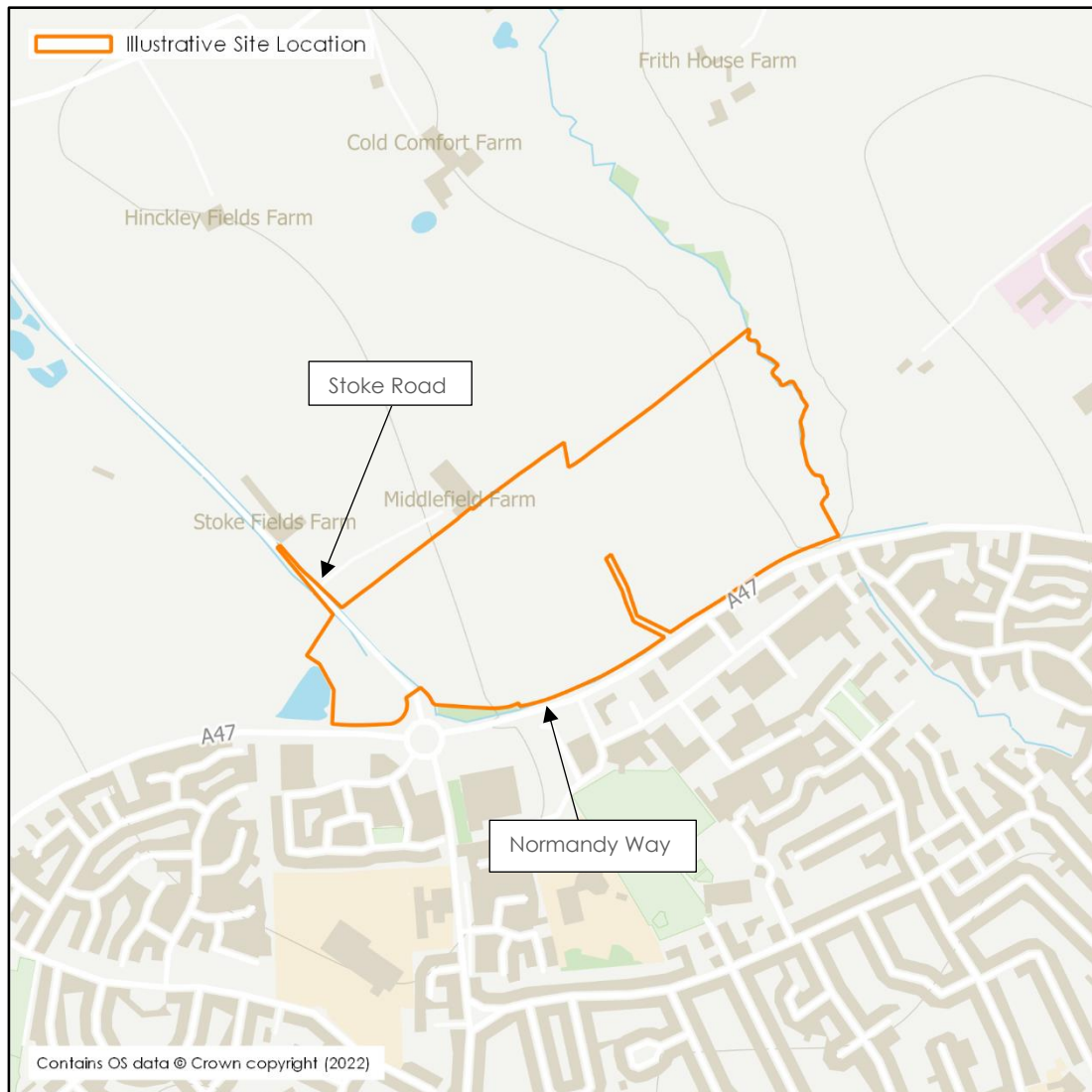


Figure 1.1: Site Location

- 1.4 A topographical survey has been undertaken and is included as **Appendix 1**. The land parcel to the west of Stoke Road is shown to generally fall in a northerly direction. Site levels are shown to range from approximately 106.1m Above Ordnance Datum (AOD) in the south to approximately 104.5m AOD in the north.
- 1.5 The primary land parcel has levels that rise away from Stoke Road to the west and the UOW to the east. The centre of the site subsequently forms a topographical high point, defining a split between two catchments. Site levels within the eastern catchment are shown to range from approximately 119.0m AOD in the centre of the site to approximately 106.5m AOD in the north east. Site levels within the western catchment are shown to range from approximately 119.0m AOD in the centre of the site to 104.8m AOD in the north west. The site contours are displayed in **Figure 1.2**.

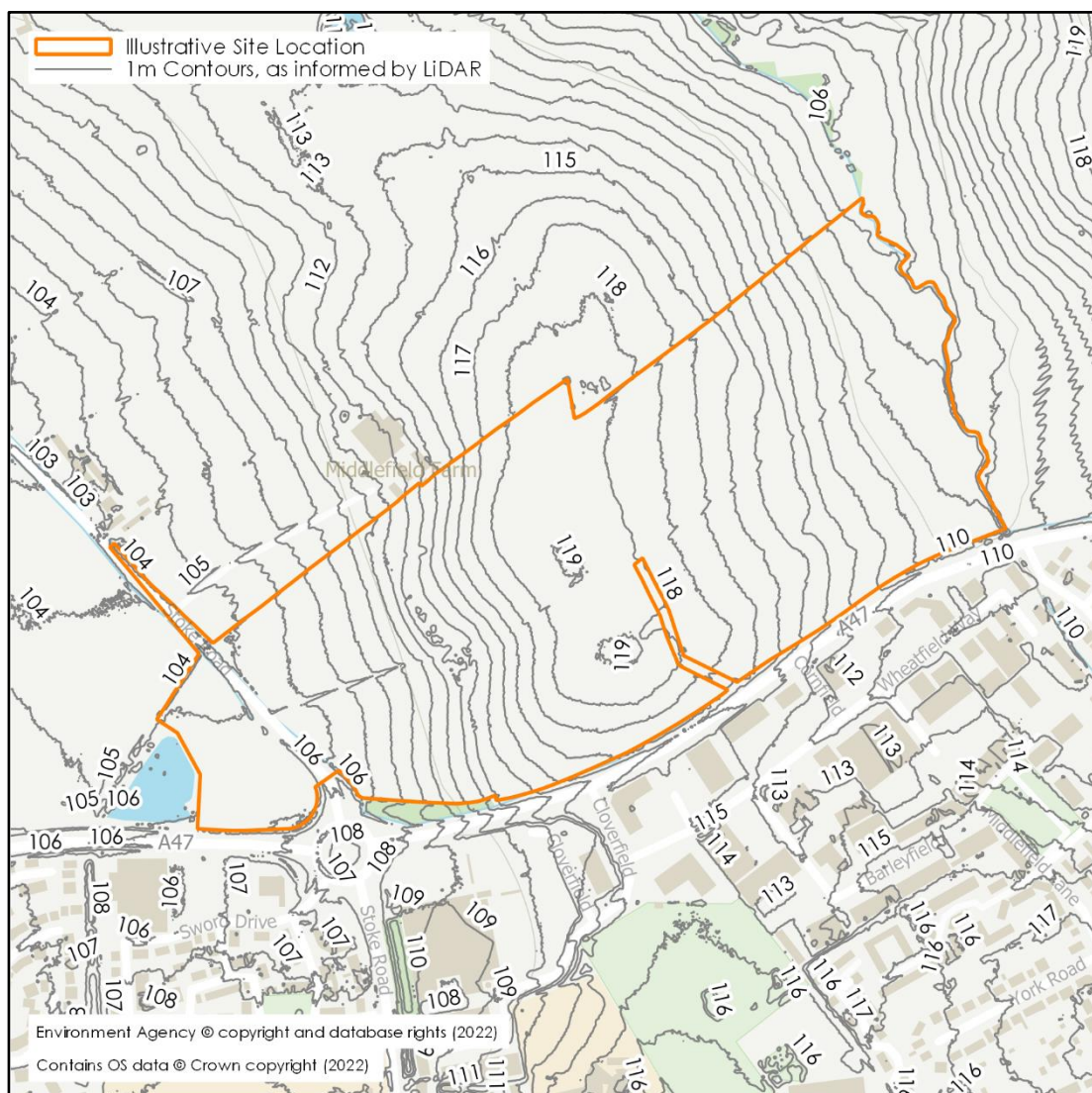


Figure 1.2: Site Topography

Local Watercourses

- 1.6 A UOW flows along the eastern boundary of the site in a northerly direction. The watercourse is a tributary of the River Tweed. The UOW flows from within an area of greenspace located approximately 500m south of Normandy Way. Flows are conveyed northwards into the site via twin 0.5m diameter circular culverts beneath Normandy Way. The UOW then forms the eastern boundary of the site as an open channel. Severn Trent Water sewer records demonstrate that two surface water sewers, that drain residential areas in the upper limits of the catchment, are understood to outfall to the watercourse immediately downstream of Normandy Way.
- 1.7 A series of ditches/highway drains have been identified, following a site visit, to be located within the vicinity of Stoke Road at the western portion of the site boundary. Two of the ditches (R2 & R3) are shown to flow adjacent to either side of Stoke Road in a north westerly direction. A further ditch (R4) is shown to flow towards Stoke Road from Normandy Way and is assumed to outfall to the ditch (R2) immediately east of Stoke Road. The local watercourse network is shown in **Figure 1.3**.

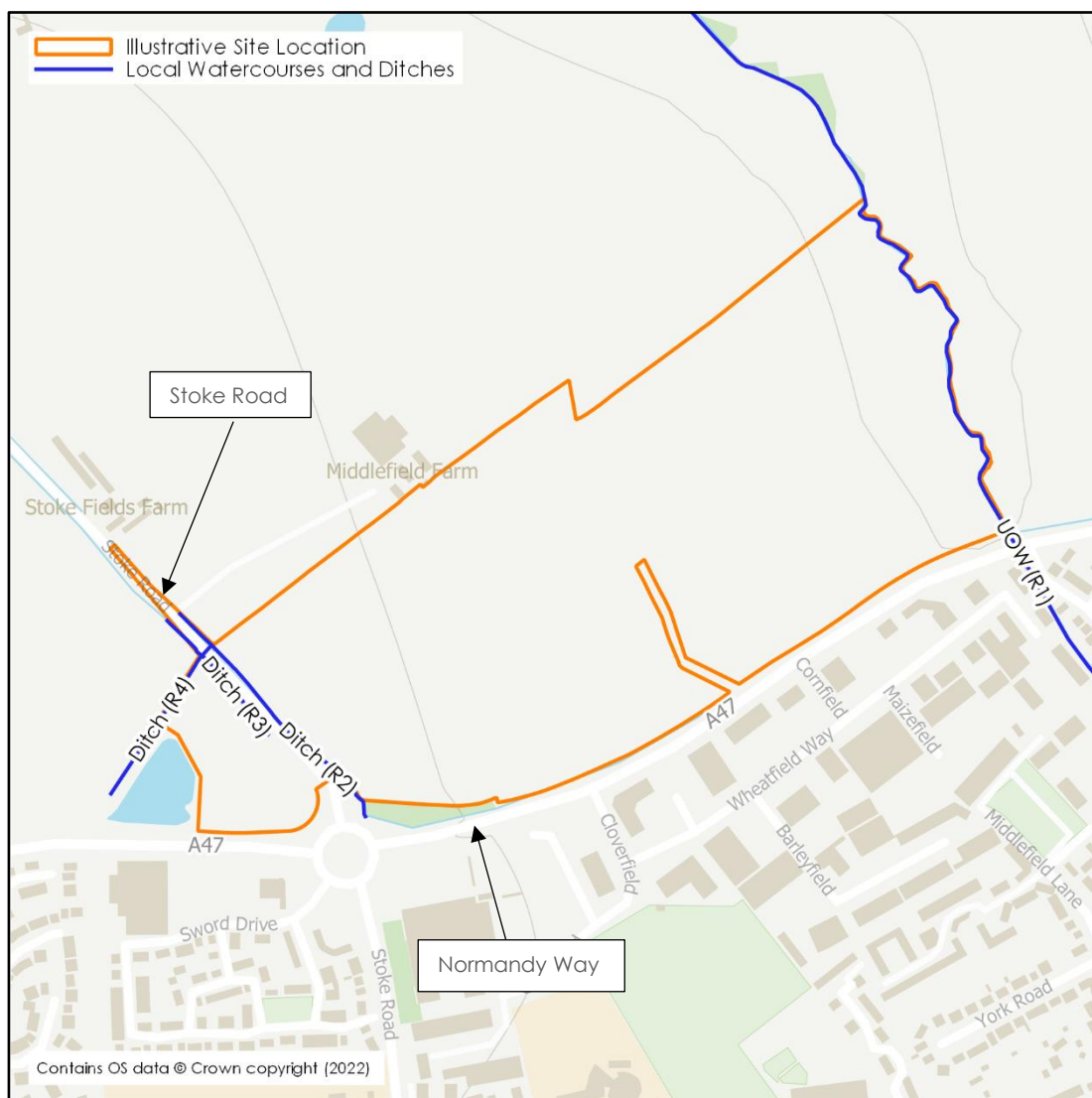


Figure 1.3: Local Watercourses

- 1.8 The ditches are understood to be fed by surface water sewers originating from within the urban development to the south of Normandy Way. As such, the associated flood risk is considered to be more representative of surface water flooding mechanisms.

Proposed Development

- 1.9 It is proposed that the site is to be developed to accommodate 'up to 475 dwellings, including public open space, land reserved for a primary school together with future expansion land (Use Class F1 (a)), landscaping, drainage and associated infrastructure'.
- 1.10 The residential-led development and associated infrastructure is contained to the larger land parcel east of Stoke Road, as per the proposed plans (refer to **Appendix 2**).

2. FLOOD RISK PLANNING POLICY

National Planning Policy Framework

- 2.1 The NPPF¹ sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. Planning Practice Guidance is also available online².
- 2.2 The Planning Practice Guidance sets out the vulnerability to flooding of different land uses. It encourages development to be located in areas of lower flood risk where possible and stresses the importance of preventing increases in flood risk off site to the wider catchment area.
- 2.3 The Planning Practice Guidance also states that alternative sources of flooding, other than fluvial (river flooding), should be considered when preparing an FRA.
- 2.4 The Planning Practice Guidance includes a series of tables that define Flood Zones (Table 1), the flood risk vulnerability classification of development land uses (Table 2) and 'compatibility' of development within the defined Flood Zones (Table 3).
- 2.5 This FRA is written in accordance with the NPPF and the Planning Practice Guidance.

Flood Map for Planning

- 2.6 With particular reference to planning and development, the Flood Map for Planning identifies Flood Zones in accordance with Table 1 of the Planning Practice Guidance. Further details on the Flood Zone classifications are outlined in **Table 2.1**.

Table 2.1: Flood Zone Classifications

Flood Zone	Description
Flood Zone 1 (Low Probability)	Land having less than a 1 in 1000 annual probability of river or sea flooding (<0.1% Annual Exceedance Probability).
Flood Zone 2 (Medium Probability)	Land having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1% AEP); or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1% AEP).
Flood Zone 3a (High Probability)	Land having a 1 in 100 or greater annual probability of river flooding (>1% AEP); or land having a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP). This is represented by "Flood Zone 3" on the Flood Map for Planning.
Flood Zone 3b (The Functional Floodplain)	Flood Zone 3b (The Functional Floodplain) is defined as land where water must flow or be stored in times of flood. This is not identified or separately distinguished from Zone 3a on the Flood Map for Planning.

¹ Revised National Planning Policy Framework, Ministry of Housing, Communities & Local Government, amended 2021

² Planning Practice Guidance: <https://www.gov.uk/government/collections/planning-practice-guidance>

2.7 The site is shown to be located entirely within Flood Zone 1, as shown in **Figure 2.1**.

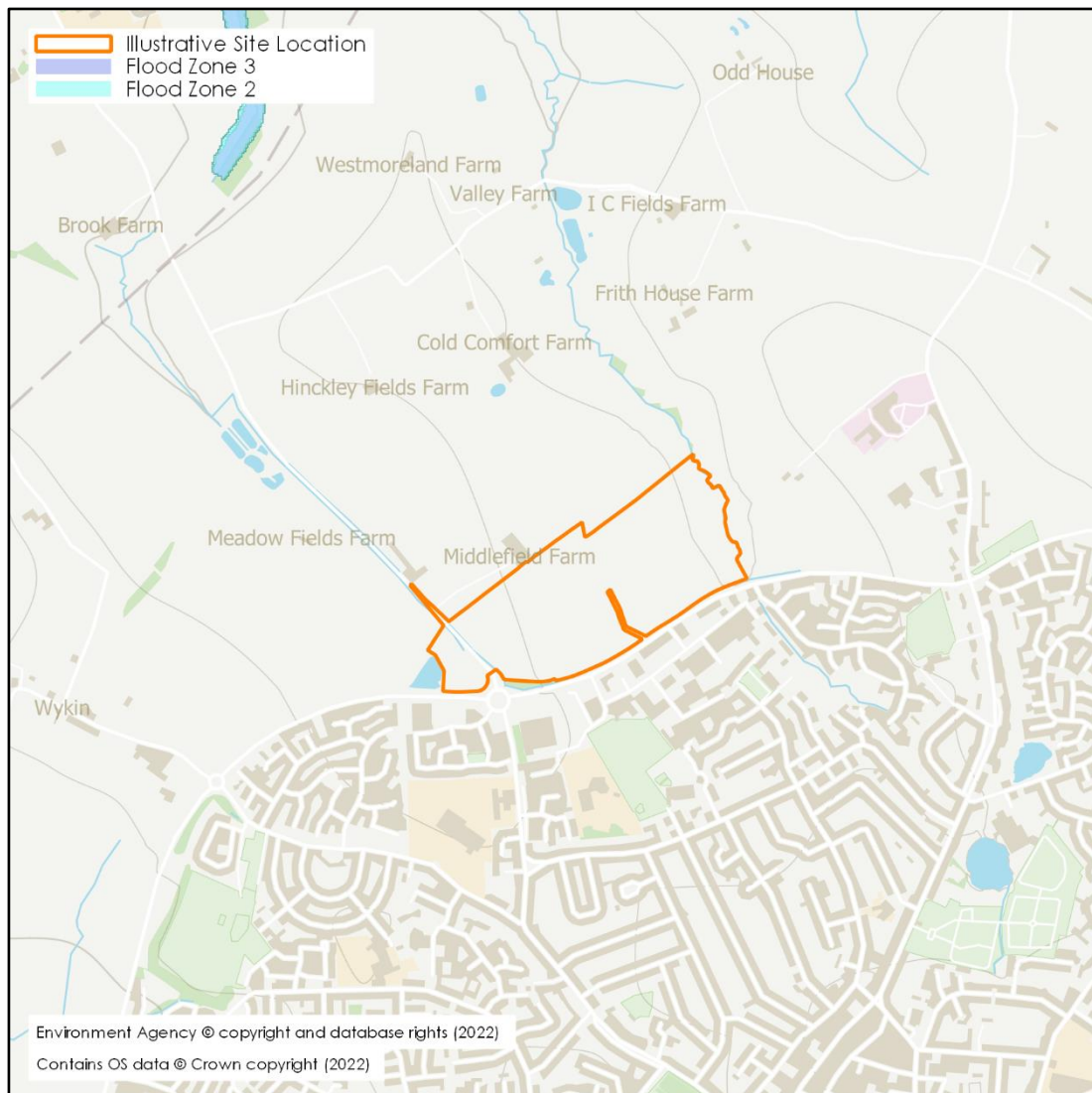


Figure 2.1: Flood Map for Planning

The Design Flood

- 2.8 The Planning Practice Guidance identifies that new developments should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.
- 2.9 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

- 2.10 Predicted future changes in peak river flows caused by climate change are provided by the Environment Agency (EA)³, with a range of projections applied to regionalised 'River Basin Districts', which are further subdivided into Management Catchments.
- 2.11 The site falls within the Tame Anker and Mease Management Catchment of the Humber River Basin District. **Table 2.2** identifies the relevant peak river flow allowances from this Management Catchment.

Table 2.2: Peak River Flow Allowance for the Tame Anker and Mease Management Catchment within the Humber River Basin District

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	24%	30%	51%
Higher Central	15%	17%	30%
Central	10%	11%	22%

- 2.12 When determining the appropriate allowance for use in a FRA, the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of the development should be considered. **Table 2.3** provides a matrix summarising the EA's guidance on determining the appropriate allowance(s).

Table 2.3: Application of the Appropriate Climate Change Allowance

Table 2.6: Application of the Appropriate Climate Change Allowance					
Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1	Use the central allowance where a location may fall within Flood Zone 2 or 3 in the future.				
2	Use the higher central allowance	Use the central allowance			
3a	Use the higher central allowance	Development should not be permitted	Use the central allowance		
3b	Use the higher central allowance	Development should not be permitted			Use the central allowance
If development is considered appropriate by the local authority when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the higher central allowance.					

³ Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

- 2.13 The site is located entirely within Flood Zone 1, the proposed development is classified as 'More Vulnerable' and has an anticipated lifespan of at least 100 years. Therefore, the Central allowance for the '2080s' epoch will be considered.
- 2.14 To ensure the development is designed adequately for its lifetime, a climate change (CC) allowance of 22% will be applied to the design flood and assessed as part of this FRA.

Strategic Flood Risk Assessment

- 2.15 A Strategic Flood Risk Assessment (SFRA) is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.
- 2.16 The Hinckley and Bosworth Borough Council Level 1 SFRA⁴ has been reviewed in the production of this FRA. The SFRA provides information specific to the site location in the form of fluvial, surface water and groundwater flood risk mapping, as well as records of historical flooding. Information from the Level 1 SFRA will be referenced within **Section 3**, where applicable.
- 2.17 The Hinckley and Bosworth Borough Council Level 2 SFRA⁵ was produced to facilitate the application of Sequential and Exception Tests to screen allocated development sites. The proposed application site is not referenced within the Level 2 SFRA. Information from the Level 2 SFRA will be referenced within **Section 3**,* where applicable.
- 2.18 The Leicestershire and Leicester City Level 1 SFRA⁶ has also been reviewed in the production of this SFRA as this document provides a comprehensive evidence base to support the production of the Strategic Growth Plan being prepared by the councils in Leicestershire.

Preliminary Flood Risk Assessment

- 2.19 A Preliminary Flood Risk Assessment (PFRA) is an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authorities.
- 2.20 The Leicestershire County Council PFRA⁷ considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. However, no historical instances of flooding at the site are referenced. Information from the PFRA will be referenced within this report where applicable.

⁴ Level 1 Strategic Flood Risk Assessment (JBA Consulting, July 2019)

⁵ Level 2 Strategic Flood Risk Assessment (JBA Consulting, May 2020)

⁶ Level 1 Strategic Flood Risk Assessment (JBA Consulting, October 2017)

⁷ Preliminary Flood Risk Assessment (Leicestershire County Council, June 2011)

Local Flood Risk Management Strategy

- 2.21 A Local Flood Risk Management Strategy (LFRMS) is prepared by a Lead Local Flood Authority to help understand and manage flood risk at a local level.
- 2.22 The LFRMS aims to ensure that the knowledge of local flood risk issues is communicated effectively so that they can be better managed. The LFRMS also aims to promote sustainable development and environmental protection.
- 2.23 The Leicestershire County Council LFRMS⁸ has been reviewed and will be referenced within this report, where applicable.

Local Plan

- 2.24 Hinckley and Bosworth Borough Council have produced a draft Local Plan⁹ which aims to set out the vision and objectives for the growth of the borough up to 2039.
- 2.25 The draft Local Plan includes Policy CC02 Flood Risk which notes:
- Where development is permitted within flood risk areas, it must demonstrate that, where required, it will reduce fluvial and surface water flood risk and manage residual risk, address the impacts of climate change through appropriate flood mitigation and adaption measures, including enhancements to existing defences.
 - All development proposals should, where possible, include measures to reduce and manage surface water through appropriate Sustainable Drainage Systems (SuDS) so as to minimise and manage flood risk and improve water quality.
- 2.26 The Strategic Housing and Economic Land Availability Assessment (SHELAA) Report¹⁰ provides an assessment of the land within the Borough. The purpose of the document is to support the delivery of sufficient land and potential development sites in suitable locations across the borough, in line with Government objectives and policy. The site is identified and referenced to within this report as Assessment Site 'AS1029 A Land North of A47 and East of Stoke Road, Hinckley'. The site is referenced as being suitable, available and achievable, with an overall assessment of "developable".

⁸ Local Flood Risk Management Strategy (Leicestershire County Council, August 2015)

⁹ Hinckley and Bosworth Local Plan 2020-2039. Consultation Draft Plan (Hinckley and Bosworth Borough Council, June 2021)

¹⁰ Strategic Housing and Economic Land Availability Assessment (SHELAA) Report (Hinckley and Bosworth Borough Council, 2020)

3. POTENTIAL SOURCES OF FLOOD RISK

- 3.1 Flooding can occur from a variety of sources, or a combination of sources, which may be natural or artificial. **Table 3.1** below identifies the potential sources of flood risk to the site in its current condition, and the impacts which the development could have in the wider catchment, prior to mitigation. These are discussed in greater detail in the forthcoming section. The mitigation measures proposed to address flood risk issues and ensure the development is appropriate for its location are discussed within **Section 4**.

Table 3.1: Pre-Mitigation Sources of Flood Risk

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Fluvial			X		According to the EA's Flood Map for Planning, the site is located entirely within Flood Zone 1.
			X		The baseline model results show that the proposed residential-led development is sequentially located at low risk of fluvial flooding for its lifetime. Flows are predicted to overtop Normandy Way and flow into the land parcel west of Stoke Road. However, flooding mechanisms in this area are considered more representative of pluvial risk.
Coastal				X	None of the watercourses in the vicinity of the site are tidally influenced.
Canals			X		The Ashby Canal is located approximately 1.9km west of the site. The site is removed from the canal network by distance and intervening topography.
Groundwater			X		The site is shown to fall within an area predicted to be at a low susceptibility to groundwater flooding.

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Reservoirs and waterbodies			X		The site is shown to fall outside of the area at risk of reservoir failure. There are two waterbodies located at the upper limit of the eastern catchment (Little Pit Fishery and a lake to the rear of the Asda superstore). The waterbodies are topographically higher than the site and could pose a risk, if breached. However, the probability of this occurring is considered low.
Pluvial runoff			X		The parcel of land to the east of Stoke Road, where the residential-led development is focused, is largely at a very low risk of surface water flooding. Two pluvial flow routes are present to the east and west of the parcel, attributed to the UOW and roadside ditch.
Sewers			X		Severn Trent Water sewer records do not identify any sewers within the site. In the event of exceedance of the upstream sewer network, water may flow into the western land parcel. Topographic levels in the eastern land parcel rise away from surrounding roads, therefore removing the proposed dwellings from any risk of sewer flooding.
Effect of Development on Wider Catchment	X				Flood water could be displaced as a result of the proposed roundabout, if left unmitigated.
	X				The development will increase the area of impermeable surfaces leading to a potential increase in runoff, if left unmitigated.

Fluvial Flood Risk

- 3.2 Flooding from watercourses occurs when flows exceed the capacity of the channel, or where a restrictive structure is encountered, which leads to water overtopping the banks into the floodplain. This process can be exacerbated when debris is mobilised by high flows and accumulates at structures.

- 3.3 The site is located entirely within Flood Zone 1, which is land defined as having a low probability of flooding from rivers or sea. The nearest EA Flood Extents are located approximately 1.3km north west of the site, attributed to the River Tweed.
- 3.4 An UOW is shown to flow adjacent to the eastern boundary of the site, and outfalls to the River Tweed approximately 2km downstream of the site. The UOW is not represented on the EA's Flood Map for Planning due to its small catchment.
- 3.5 A series of ditches/drains are shown to be located adjacent to and within the western part of the site. Two of the ditches are shown to flow adjacent to Stoke Road in a north westerly direction. A further ditch is shown to flow towards Stoke Road from Normandy Way and is assumed to outfall to the ditch immediately east of Stoke Road.
- 3.6 The ditches are understood to be fed by surface water sewers originating within the urban development to the south of Normandy Way.

Historical Flooding

- 3.7 The EA Historical Flood Map shows the nearest recorded flood outline to be located approximately 6.3km south west of the site attributed to the River Trent in 1992.
- 3.8 The Level 1 SFRA references no instances of fluvial flooding at the site.
- 3.9 Correspondence with Leicestershire County Council, included as **Appendix 4**, notes that there are no reports of flooding of the highway at the site boundary. There has been recorded flooding of the UOW to the north of the site, downstream of Rogues Lane, however it is noted that this would not concern the site.

Hydraulic Modelling

- 3.10 To provide a detailed understanding of fluvial flooding at the site, BWB Consulting Ltd completed a hydraulic modelling study and associated hydrological assessment in February – April 2022. The details of the hydraulic modelling exercise, along with detailed flood maps, are available in the Hydraulic Modelling Report (**Appendix 3**).
- 3.11 The baseline modelling shows that the majority of the site is located outside of the 1 in 20-year, 1 in 100-year, 1 in 100-year +22%CC and 1 in 1000-year events. The flood extents are displayed in **Figure 3.1** below and the associated mechanisms are summarised overleaf.

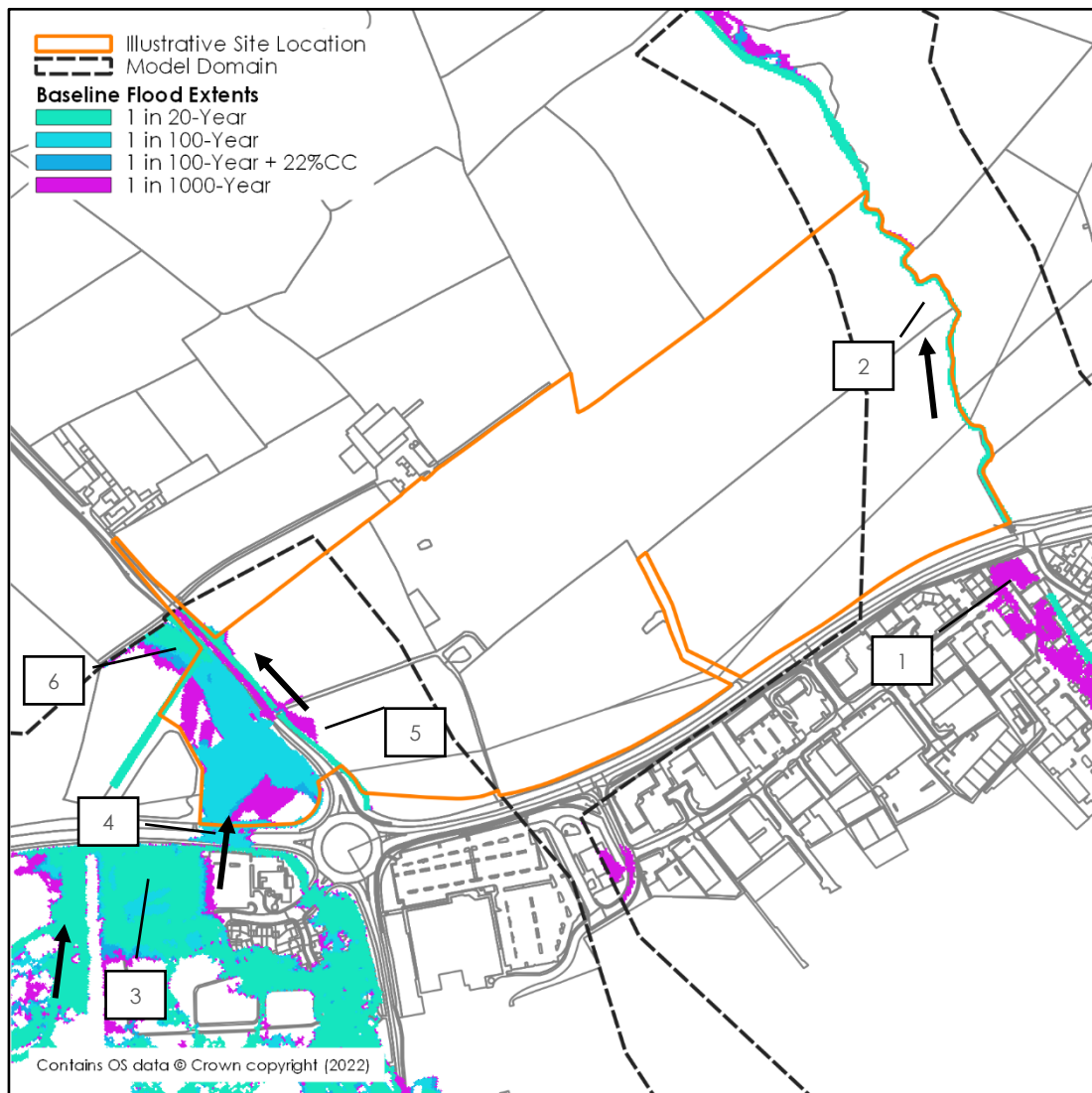


Figure 3.1: Baseline Modelled Flood Extents

1 – The UOW enters the site via twin 0.5m diameter circular piped culverts beneath Normandy Way. The structure is shown to have insufficient capacity to convey peak flows during the 1 in 1000-year event. Subsequently, the pipes become surcharged, resulting in localised flooding predicted immediately upstream.

2 – As the UOW flows adjacent to the site, maximum water levels remain in-channel. Subsequently, the proposed residential development is located outside of all modelled flood extents from this watercourse.

3 – Out of bank flooding is predicted upstream of Normandy Way for all modelled return periods including the 1 in 20-year event. This aligns with known capacity issues in this area that have been raised by Severn Trent Water at the time of consultation.

4 – As a consequence of flood waters accumulating upstream of Normandy Way, the model predicts that the A47 will be overtopped during the 1 in 100-year return period and larger magnitude events. It is subsequently predicted that flood waters will be conveyed into the land parcel west of Stoke Road.

5 – During the 1 in 1000-year event, out of bank flooding is predicted at low levels of the eastern land parcel immediately adjacent to R2. This occurs due to the 600mm diameter culvert having insufficient capacity to convey peak flows for the 1 in 1000-year event without the right bank being overtopped. Ground levels on this bank are lower due to an incoming hedgerow with an associated drainage ditch.

6 – During the 1 in 20-year event, a small area of localised flooding is predicted in the western parcel where R4 reaches Stoke Road. The extent of flooding is more significant during the 1 in 100-year return period and larger magnitude events given that flows overtop Normandy Way and enter the land parcel from the south. It should be noted, however, that no development is currently proposed within this area of risk.

- 3.12 A node location plan is displayed in **Figure 3.2**. Peak flood levels for the 1 in 20-year, 1 in 100-year, 1 in 100-year +22%CC and 1 in 1000-year events are reported at these 1D and 2D locations in **Table 3.2**.

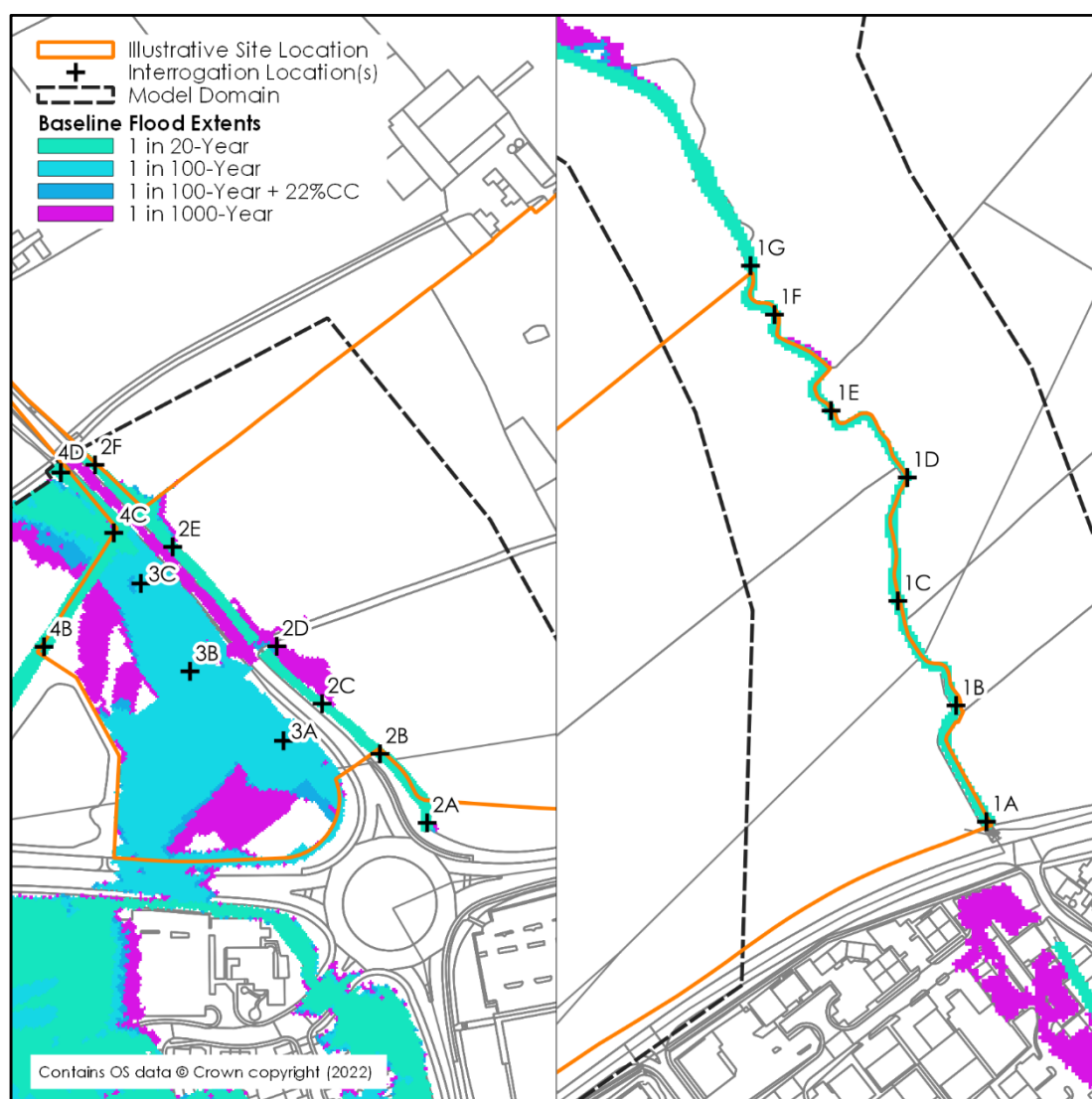


Figure 3.2: Baseline Modelled Flood Extents

Table 3.2: Baseline Peak Flood Levels (m AOD)

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year +22%CC	1 in 1000-Year
1A	108.12	108.20	108.26	108.43
1B	107.23	107.41	107.51	107.73
1C	107.08	107.25	107.34	107.55
1D	106.84	107.00	107.08	107.27
1E	106.51	106.66	106.73	106.91
1F	106.12	106.28	106.35	106.51
1G	105.97	106.10	106.15	106.27
2A	105.71	105.81	105.89	106.00
2B	105.48	105.65	105.78	105.88
2C	105.36	105.58	105.72	105.80
2D	-	-	-	105.74
2E	104.57	104.63	104.67	104.75
2F	104.01	104.02	104.03	104.04
3A	-	105.39	105.39	105.40
3B	-	105.11	105.12	105.13
3C	-	104.72	104.73	104.75
4A	104.57	104.62	104.66	104.75
4B	104.54	104.58	104.60	104.66
4C	104.54	104.57	104.59	104.64
4D	104.09	104.11	104.12	104.12

- 3.13 The proposed masterplan is displayed in **Figure 3.3** with 1m contours based off existing topography. All dwellings are shown to be removed from the modelled floodplain extents. The existing topographic levels also demonstrate that all built development will be located at least 1-2m above the closest 1 in 100-year +22%CC design flood extent. The modelled flood outlines therefore suggest that the site is at low risk of fluvial flooding. The proposed built development has been assessed as being topographically removed from the predicted modelled flood outlines. As such, the development could be considered safe for its lifetime.

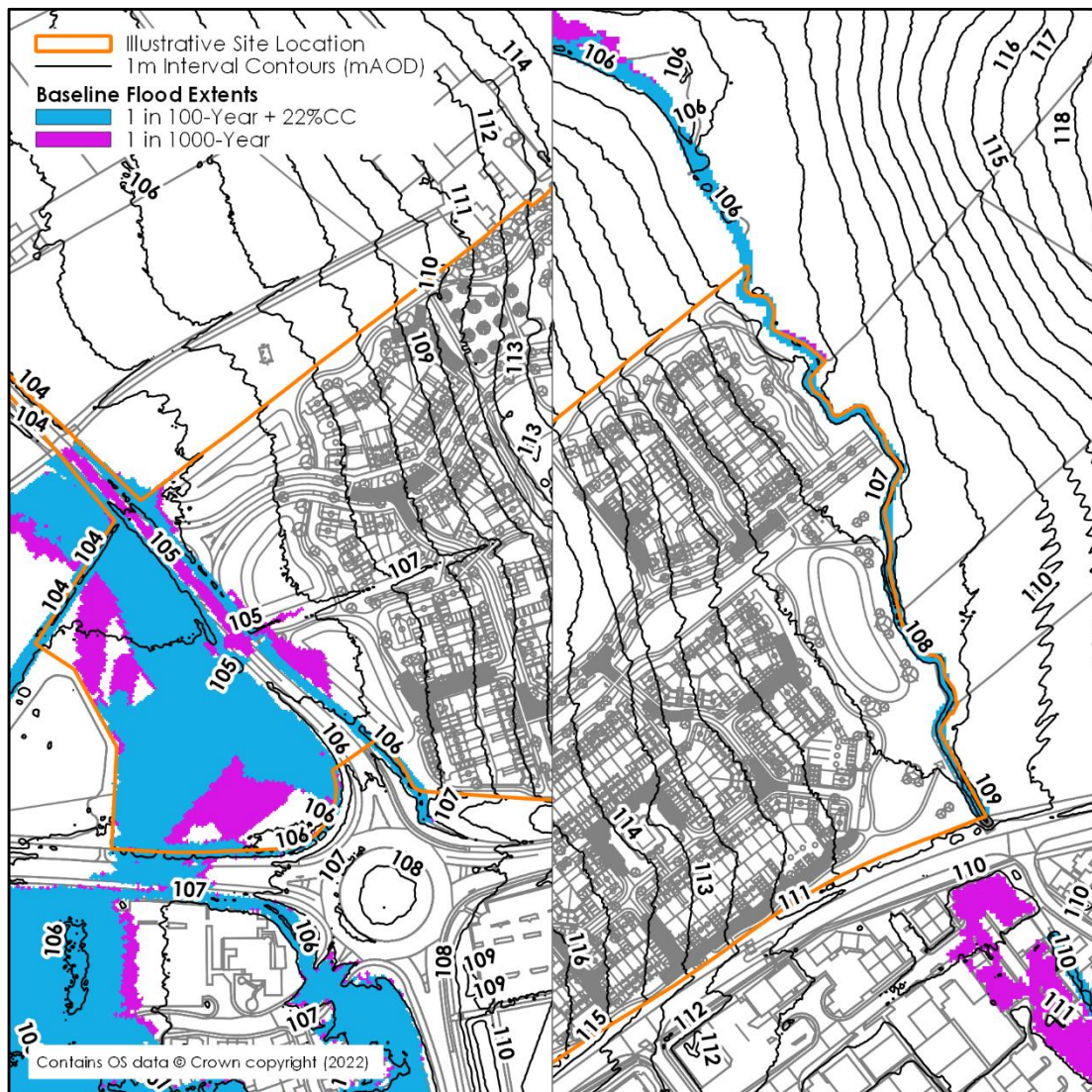


Figure 3.3: Baseline Modelled Flood Extents with 1m Contour Intervals

Flood Risk from Canals

- 3.14 The Canal and River Trust (CRT) generally maintains canal levels using reservoirs, feeders and boreholes and manages water levels by transferring it within the canal system.
- 3.15 Water in a canal is typically maintained at predetermined levels by control weirs. When rainfall or other water enters the canal, the water level rises and flows out over the weir. If the level continues rising it will reach the level of the storm weirs. The control weirs and storm weirs are normally designed to take the water that legally enters the canal under normal conditions. However, it is possible for unexpected water to enter the canal or for the weirs to become obstructed. In such instances the increased water levels could result in water overtopping the towpath and flowing onto the surrounding land.
- 3.16 Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.

- 3.17 The Ashby Canal is located approximately 1.9km west of the site and is set at approximately 90mAOD. The site is elevated a minimum of circa 15m above the canal network, therefore, the flood risk associated with canals is low.

Groundwater Flood Risk

- 3.18 Groundwater flooding occurs when the water table rises above ground elevations. It is most likely to happen in low lying areas underlain by permeable geology. This may be regional scale chalk or sandstone aquifers, or localised deposits of sands and gravels underlain by less permeable strata such as that in a river valley.
- 3.19 British Geological Survey (BGS) mapping shows the site to be underlain by Mercia Mudstone Group, which is designated by the EA as a Secondary B Aquifer. Secondary B Aquifers are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
- 3.20 Superficial deposits of Bosworth Clay Member (Clay and Silt), Wolston Sand And Gravel, Oadby Member (Diamicton) and Alluvium (Clay, Silt, Sand and Gravel) are expected to be present throughout the site, as shown in **Figure 3.4**.
- 3.21 The superficial deposits are designated as Secondary A Aquifers, Secondary (undifferentiated) Aquifers and Unproductive Strata. Secondary A Aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. Secondary (undifferentiated) Aquifers are assigned in cases where it has not been possible to attribute either category A or B to a rock type. Unproductive Strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
- 3.22 A BGS borehole log (reference: SP49NW25) is located to the south east of the site and is shown to be underlain by Mercia Mudstone Group with superficial deposits of Alluvium. Here, slight water seepage was noted at 1.5m below ground level (bgl).
- 3.23 The Hinckley and Bosworth Borough Council SFRA Groundwater Susceptibility mapping shows the site to be located within a 1km² grid tile, whereby less than 25% of the area is considered to be susceptible to groundwater flooding.
- 3.24 It should be noted that Groundwater Susceptibility mapping is based on strategic scale mapping that uses a 1km² grid. It identifies areas susceptible to flooding from groundwater at a broad scale on the basis of geological and hydrogeological conditions. Therefore, the classification could potentially be based on another area within the cell.

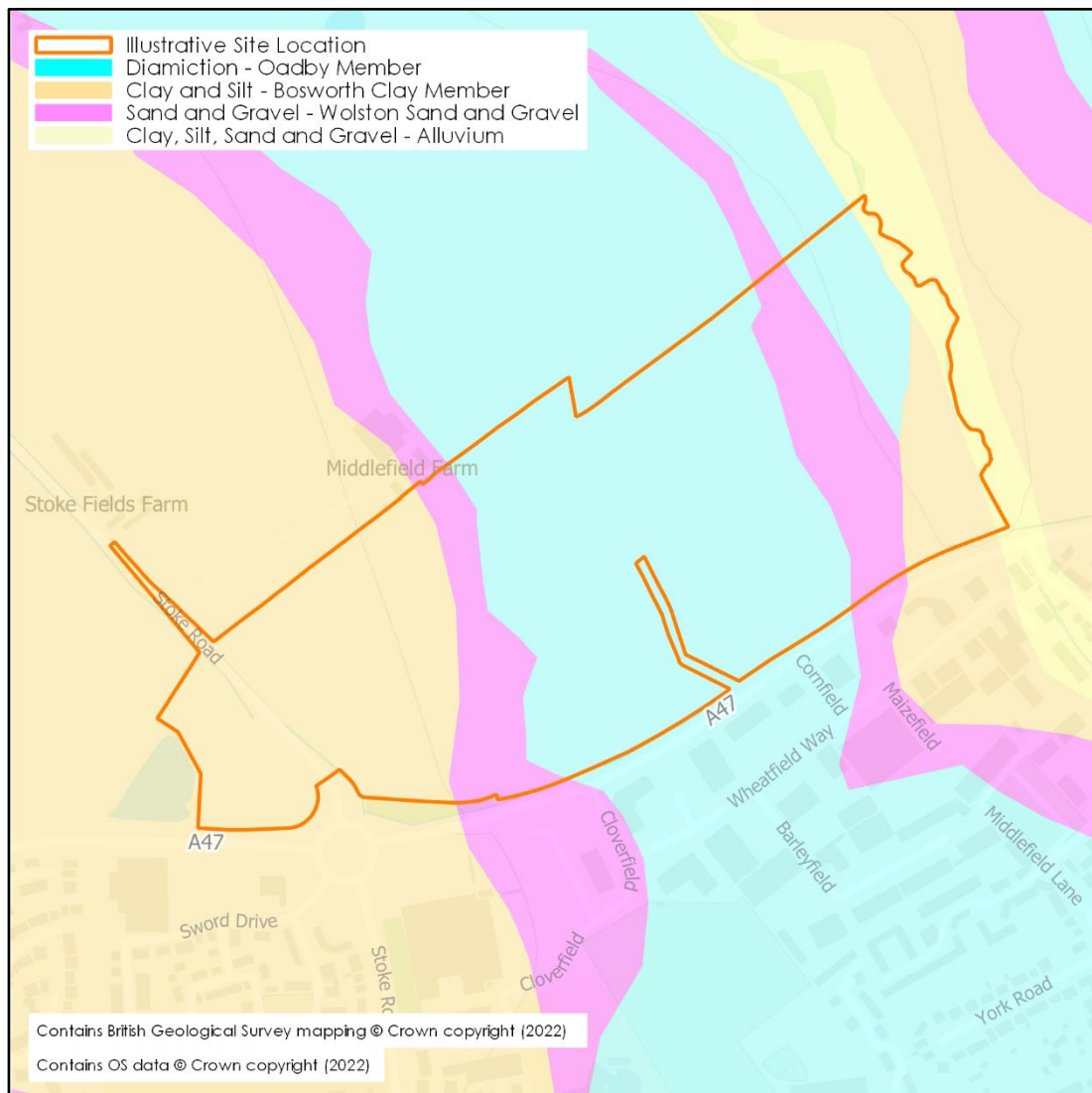


Figure 3.4: BGS Superficial Deposits

- 3.25 The site is shown to be located outside of all EA groundwater source protection zones.
- 3.26 The overall risk of groundwater flooding at the site is considered to be low.

Flood Risk from Reservoirs & Large Waterbodies

- 3.27 Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.
- 3.28 To help identify this risk, reservoir failure flood risk mapping has been prepared by the EA, this shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The map displays a worst case scenario and is only intended as a guide. An extract of the mapping is included as **Figure 3.5**

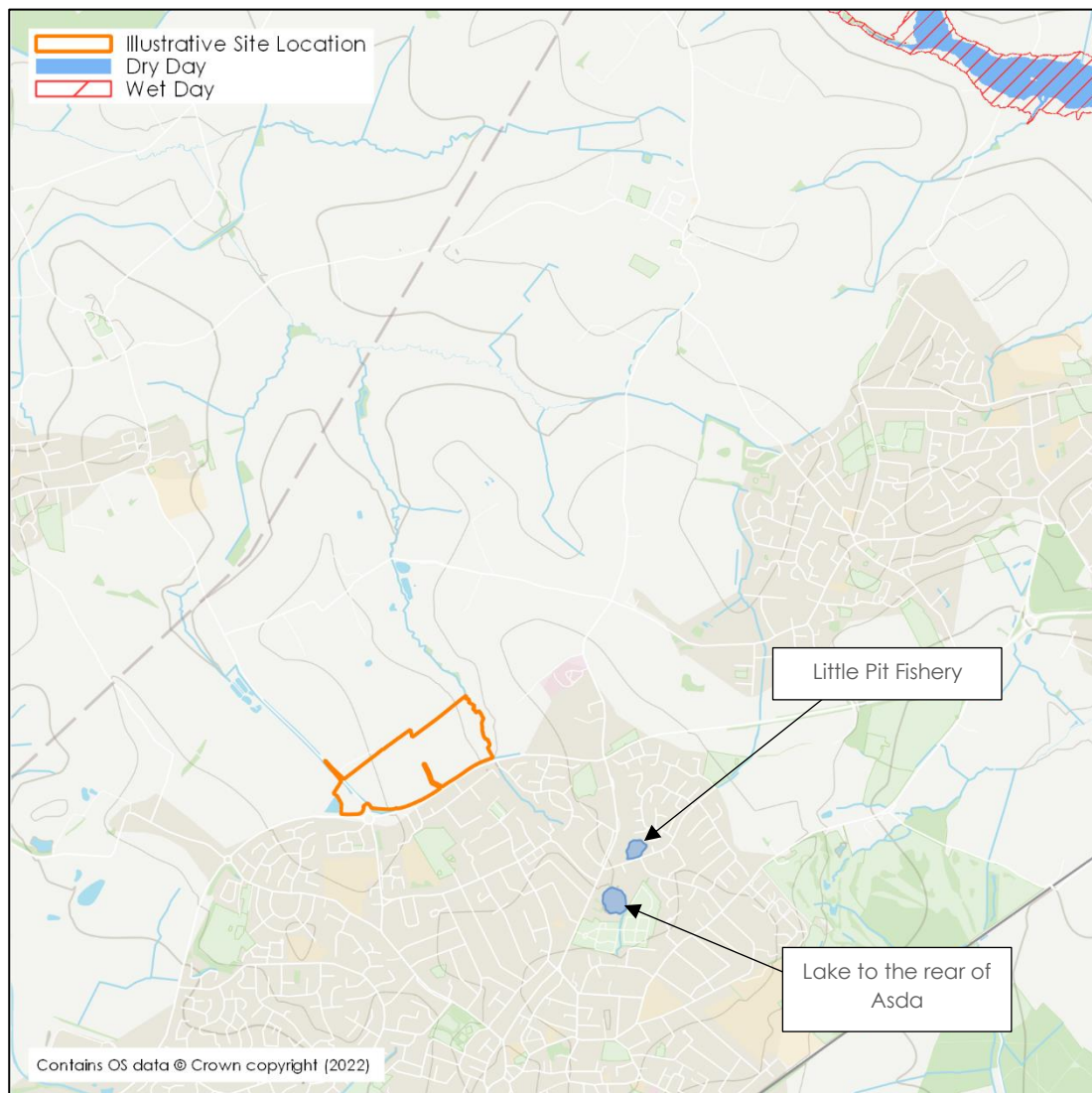


Figure 3.5: Reservoir Failure Flood Mapping

- 3.29 The nearest reservoir failure flood extent is shown to be located approximately 4.1km north east of the site, associated with Mallory Park Large Lake during a 'wet-day'. A 'wet-day' event is where reservoir flooding takes place alongside wider river flooding. The nearest 'dry-day' extent is located approximately 4.2km north east of the site and shows the extent of reservoir flooding with river levels at normal level.
- 3.30 The site is shown to be located outside of the flood extents of any reservoir failure.
- 3.31 A pond is shown to be located immediately west of the western parcel. It is assumed that the pond is utilised as a drainage feature. In the event of overtopping, water may flow into the western parcel, however intervening topography would prevent flows from reaching the main development area to the east of Stoke Road.
- 3.32 Two waterbodies have been identified in the upper limit of the eastern catchment, approximately 1km south of the site (as identified on **Figure 3.5**). These are the Little Pit Fishery and a lake at the rear of the Asda Superstore. The waterbodies are set topographically above the site (approximately 125mAOD). Therefore, there is a residual

risk of flooding to the site in the unlikely event that the lakes are breached. With that said, given the size of the lakes, the distance to the site and the intervening topography, exceedance flows are likely to dissipate as they approach the site and any impact would likely be negligible.

- 3.33 Due to the maintenance responsibilities associated with the ownership of waterbodies, the probability of such an event occurring is considered low. As such, this would not be considered a barrier to development.

Pluvial Flood Risk

- 3.34 Pluvial flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes.
- 3.35 Risk of flooding from surface water mapping has been prepared by the EA (**Figure 3.6**),

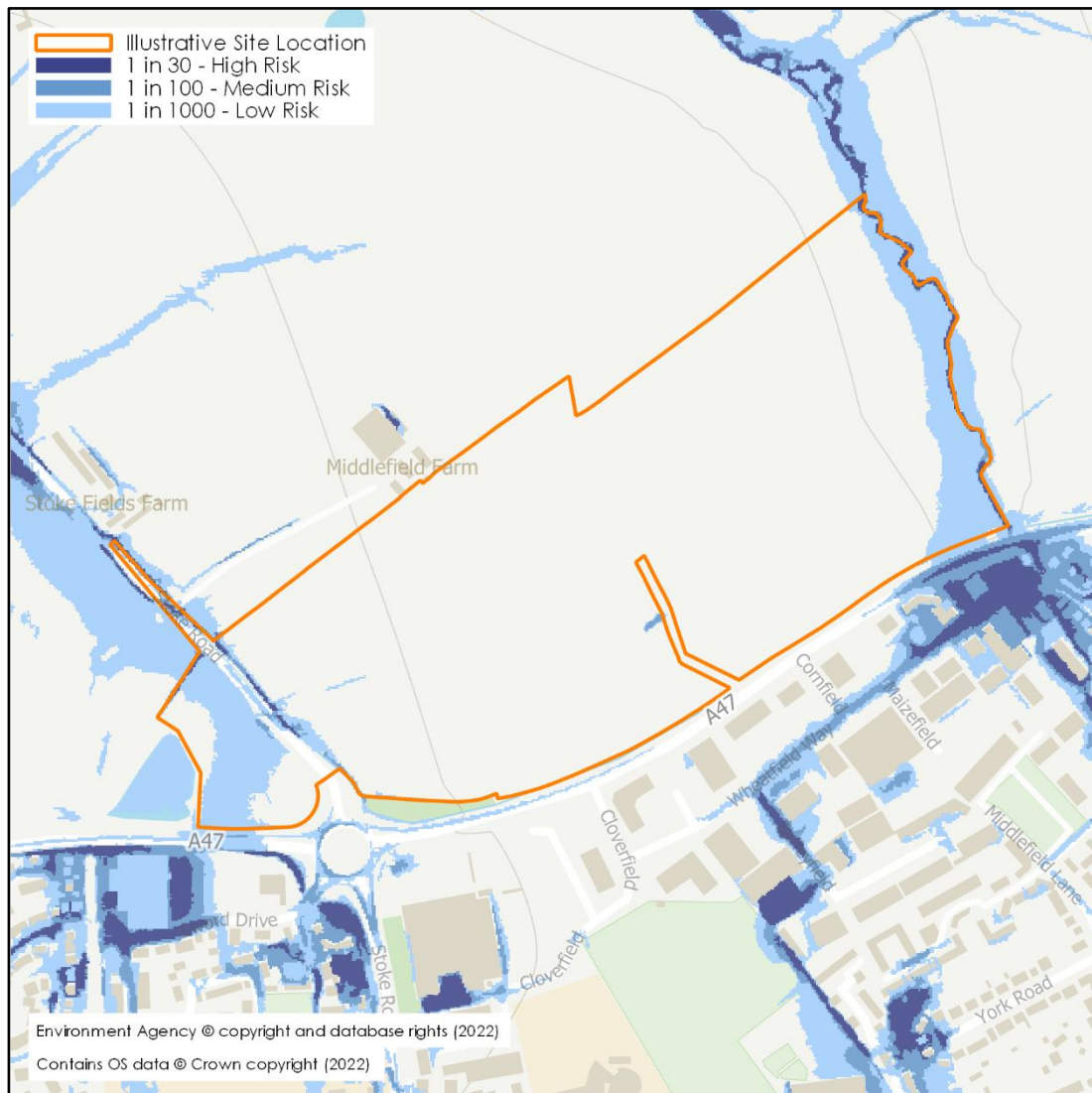


Figure 3.6: Surface Water Flood Risk Map

- 3.36 The EA surface water mapping shows the potential flooding which could occur 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.
- 3.37 The majority of the site is shown to be at a very low risk of surface water flooding. A pluvial flow route, presenting a low (1 in 1000-year) to high (1 in 30-year) risk is shown to be present along the eastern and western boundaries of the site, thought to be associated with the UOW and ditches. A small, isolated area of low to medium (1 in 100-year) surface water flood risk is shown to be present within the centre of the site, associated with a topographical depression.
- 3.38 The land parcel to the west of Stoke Road is shown to be at a low risk of surface water flooding. Surface water is predicted to overtop the A47 and into the site. Similar flooding mechanisms were confirmed as part of the hydraulic modelling exercise.
- 3.39 Site access and egress from Stoke Road is shown to be at a low risk of flooding, with the ditch presenting a low to high risk. Surface water depth mapping shows depths of below 150mm along Stoke Road during the 1 in 100-year event.
- 3.40 The Level 1 SFRA notes that a surface water overland flow route exists along Stoke Road and is associated with an unnamed drain adjacent to this road, however, there are no historic flooding incidents recorded at the site.
- 3.41 Overall, the site is considered to be at a low risk of flooding from pluvial sources.

Flood Risk from Sewers

- 3.42 Sewer flooding can occur when the capacity of the infrastructure is exceeded by excessive flows, or as a result of a reduction in capacity due to collapse or blockage, or if the downstream system becomes surcharged. This can lead to the sewers flooding onto the surrounding ground via manholes and gullies, which can generate overland flow paths.
- 3.43 The local sewerage undertaker is Severn Trent Water. A copy of their asset records is included as **Appendix 5**.
- 3.44 The nearest public sewer network is shown to be located south of Normandy Way. No sewer networks have been identified within the site or along Stoke Road or Normandy Way. Two public surface water sewers (750mm dia and 900mm dia) are shown to outfall to the UOW to the south east of the site. A 1050mm dia public surface water sewer is shown to outfall to the ditch to the south west of the western parcel.
- 3.45 The hydraulic modelling exercise includes a representation of the sewer networks upstream of the site to understand the capacity of the sewer network during a suite of return periods. The proposed development is shown to be unaffected in the event of sewer exceedance, however, the western land parcel is predicted to be affected from flooding mechanisms previously outlined in the fluvial and pluvial sections of this report (overtopping of the A47 / Normandy Way).

- 3.46 Correspondence with Severn Trent Water, included as **Appendix 6**, notes that there are capacity issues during heavy storm events. The details surrounding any issues regarding capacity are not known. This has been confirmed by the hydraulic modelling exercise.
- 3.47 Topographic levels at the eastern land parcel rise steeply away from the eastern, southern and western boundaries and subsequently, should any sewer system be exceeded, the risk to the proposed development could be considered low.
- 3.48 Overall, the site is considered to be at a medium risk of flooding from sewers due to predicted flooding at the western land parcel. The proposed development could be considered at a low risk.

Effect of Development on Wider Catchment

Displacement of Floodplain

- 3.49 The proposed development is largely shown to be located outside of the 1 in 100-year +22%CC floodplain. However, the proposed roundabout is shown to be located within the flood extents of the baseline 1 in 100-year +22%CC modelled extent. As a result of proposed earthworks, this could, in turn, result in a displacement of flood water and an increase in flood risk elsewhere, if left unmitigated.
- 3.50 Appropriate mitigation measures for addressing the risk of flooding to the site are outlined in **Section 4**. This therefore offers a means of managing flood water displacement.

Development Land Use/Drainage Considerations

- 3.51 The proposed development will increase the area of impermeable surfaces on the site. This will result in an increase in surface water runoff, which could increase flood risk downstream unless properly mitigated. Appropriate surface water management is discussed in **Section 4**.

4. FLOOD RISK MITIGATION

- 4.1 **Section 3** has identified the sources of flooding which could pose a risk to the site and the proposed development. This section sets out the mitigation measures which are to be incorporated to address and reduce the risk of flooding to within acceptable levels.

Sequential Arrangement

- 4.2 The proposed residential development is sequentially located outside of all modelled flood extents, including the 1 in 100-year +22%CC and 1 in 1000-year events.

Proposed Scheme

- 4.3 As part of the development proposals, a roundabout is proposed off Stoke Road to access the site. To mitigate against floodwater displacement and limit the extent of culverting, a watercourse diversion scheme is proposed, as illustrated within **Figure 4.1**.

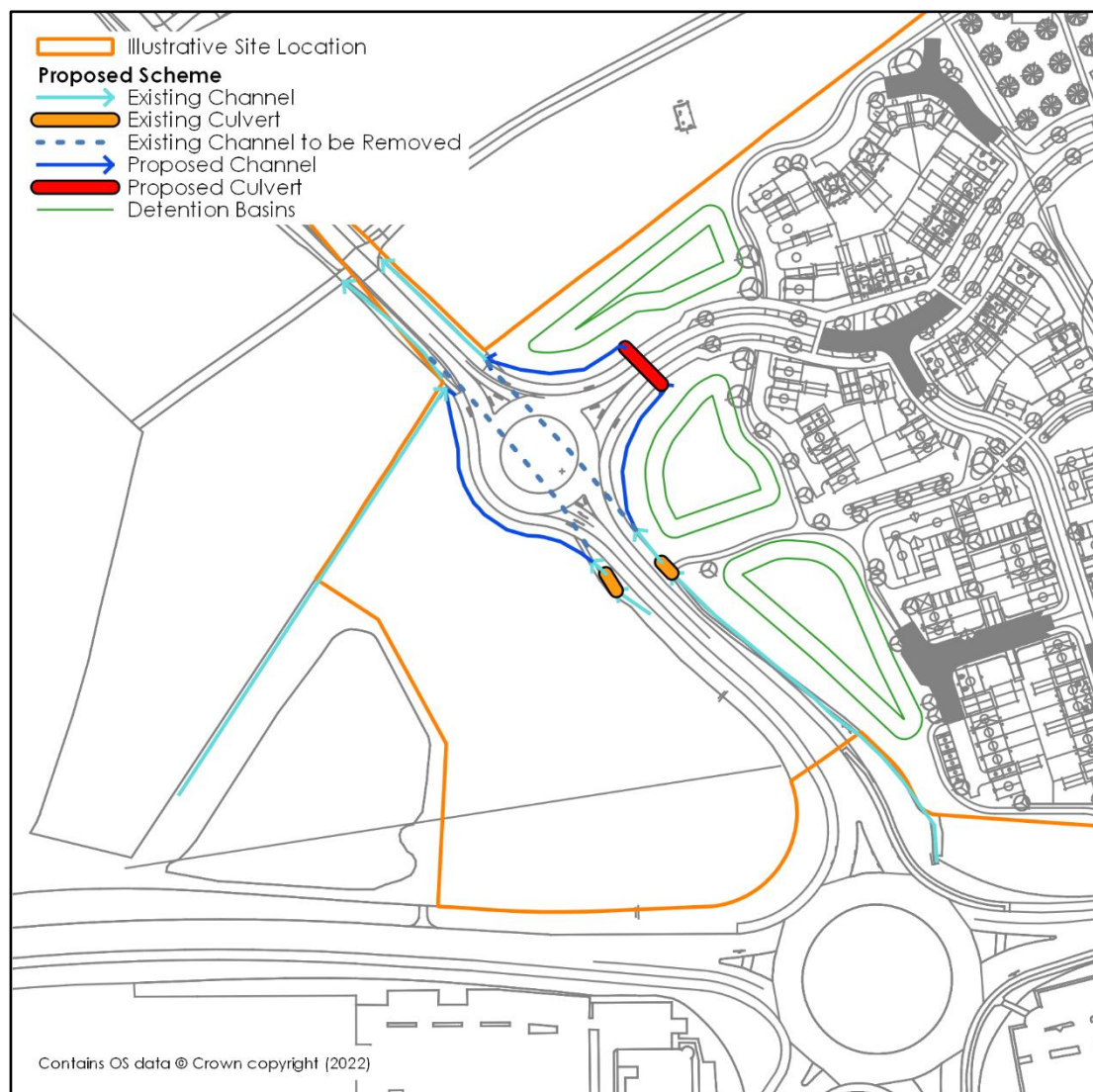


Figure 4.1: Proposed Watercourse Diversion Scheme

- 4.4 Whilst culverting will be limited as a result of the proposed diversion scheme, a small section of culverting will be required within the site where the access road off the roundabout has entered the site.
- 4.5 The proposed channel and culverts, in combination, have been designed to have sufficient capacity to contain the 1 in 100-year +22%CC flows. Therefore, the proposed development, including the proposed access road, is shown to be located outside of the flood extents for all events up to and including the 1 in 100-year + 22% climate change event. The proposed development model results are included in **Figure 4.2** and the modelled flood levels for the interrogation locations are summarised in **Table 4.1**.

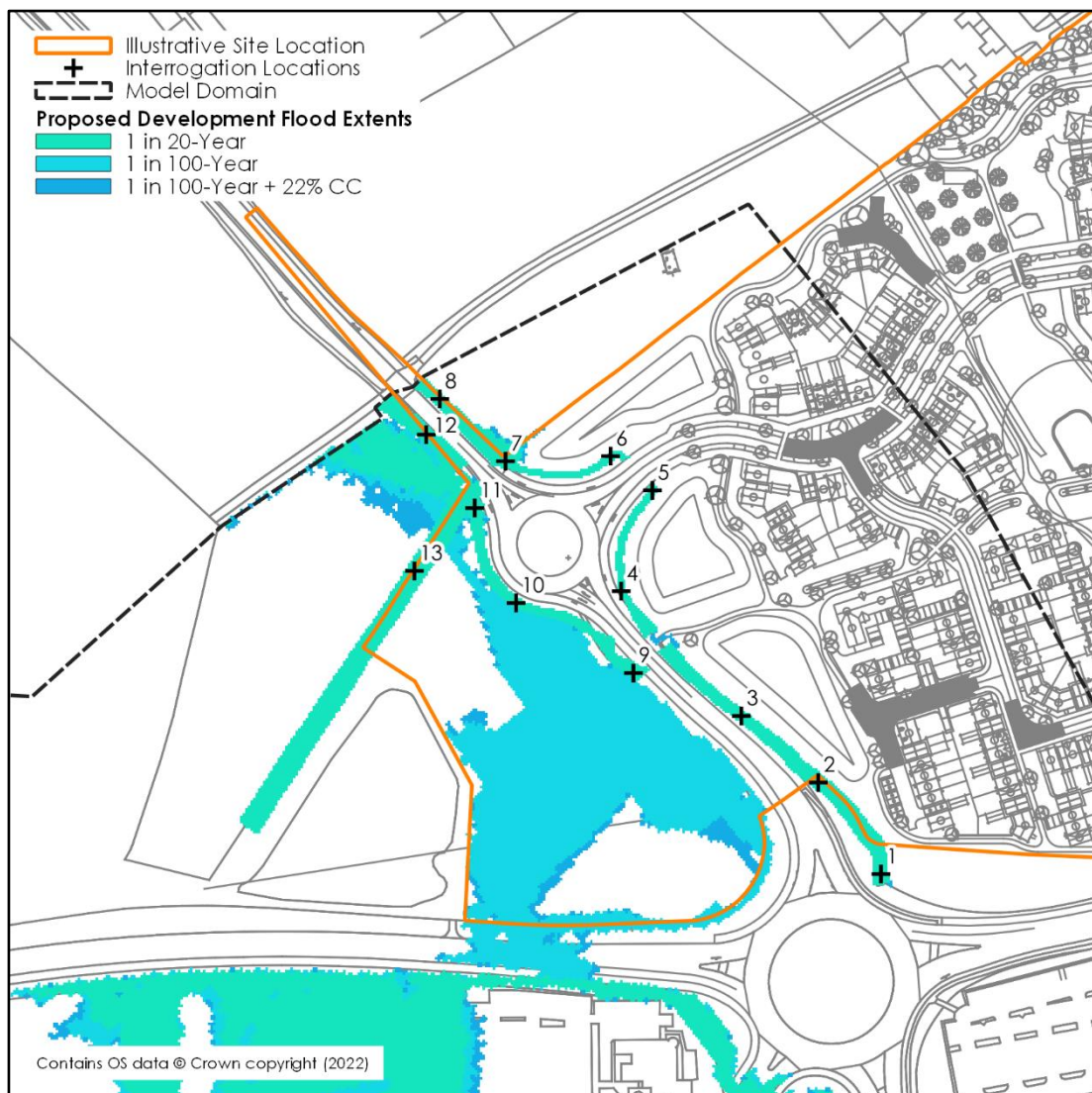


Figure 4.2: Proposed Development Floodplain Extents

Table 4.1: Proposed Development Peak Flood Levels (mAOD)

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year + 22%CC
1	105.71	105.81	105.89
2	105.48	105.65	105.78
3	105.36	105.58	105.72
4	104.78	104.92	105.04
5	104.67	104.86	104.99
6	104.56	104.63	104.67
7	104.49	104.54	104.57
8	104.01	104.02	104.03
9	104.52	104.57	104.61
10	104.52	104.57	104.59
11	104.52	104.57	104.59
12	104.28	104.31	104.32
13	104.52	104.57	104.59

Development Levels

- 4.6 Hinckley and Bosworth Borough Council Level 1 SFRA advises that minimum finished floor levels should be set 600mm above the 1 in 100-year plus climate change (+22%) peak flood level.
- 4.7 The proposed channel and culvert have been designed to have sufficient capacity to contain the 1 in 100-year + 22%CC flows. As such, it is proposed that dwellings are to have finished floor levels set no lower than 600mm above the peak flood level at the nearest upstream interrogation node. For dwellings in the east of the site, this will mean raising floor levels 600mm above the UOW flood levels during baseline conditions. Dwellings located at the west of the site are to be set 600mm above the peak design flood level of the ditches during the proposed development scenario.
- 4.8 To the eastern side of the development, the nearest dwelling to the UOW is located at 107.5m AOD which is raised approximately 1.2m above the nearest modelled flood level for the 1 in 100-year + 22%CC event. To the western side of the development, the nearest dwelling to the ditches is located at 107.0m AOD which is raised approximately 1.1m above the nearest modelled flood level. This is illustrated with contour mapping in **Figure 4.3**. The existing topography of the site rises away from the watercourse and ditches and therefore all dwellings are expected to be raised sufficiently above the top of banks of the ditches and watercourse.

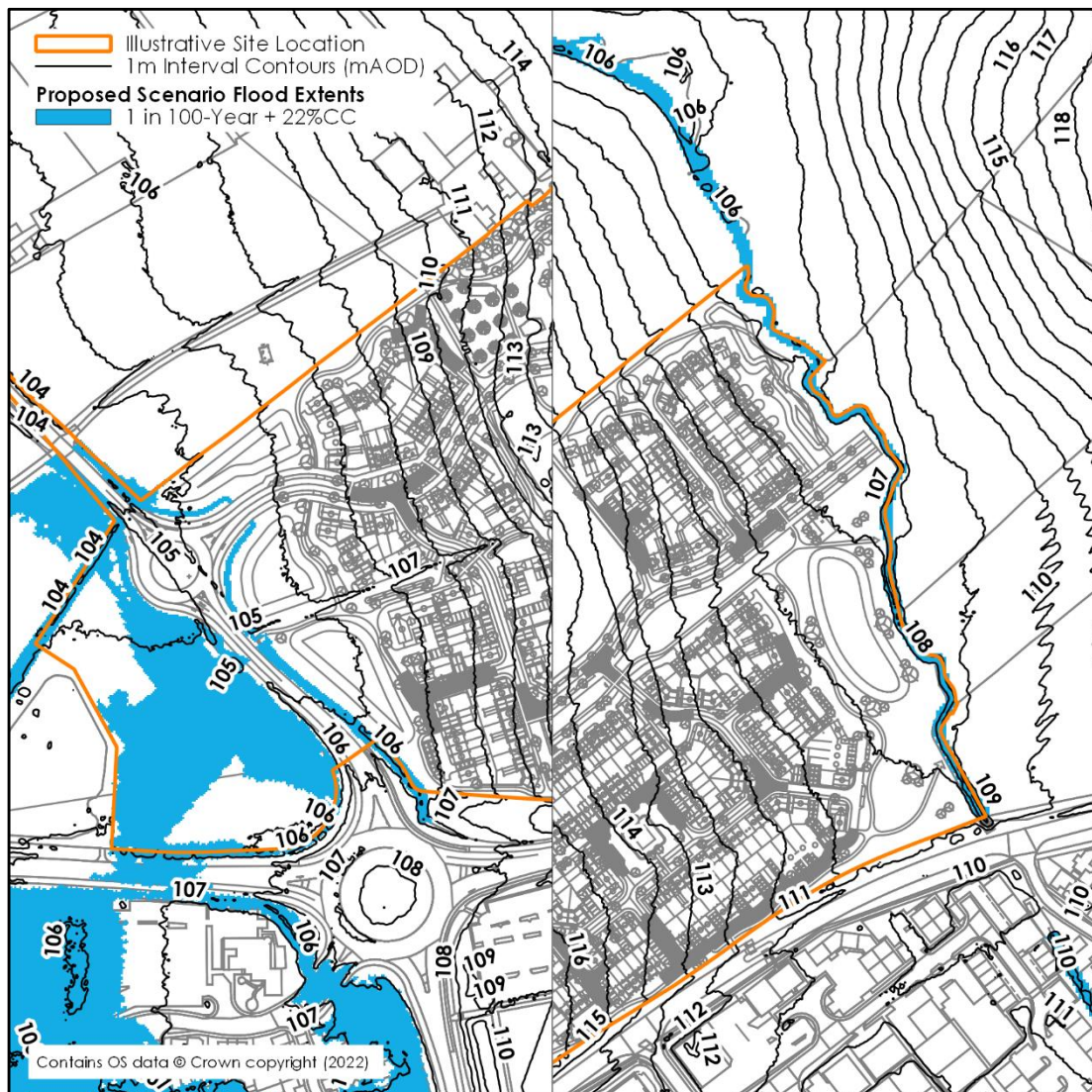


Figure 4.3: Proposed Scenario Modelled Flood Extents with 1m Contour Intervals

- 4.9 It is also recommended that finished floor levels are raised a minimum of 150mm above the surrounding ground levels to help mitigate against the residual risk of flooding from surface water runoff.
- 4.10 Ground levels should be profiled to encourage pluvial runoff and overland flows away from the built development and towards the nearest drainage point.

Safe Access and Egress

- 4.11 The proposed channel and culvert have been designed to have sufficient capacity, in combination, to contain the 1 in 100-year +22% CC flows. **Figure 4.4** shows the proposed roundabout and associated access to be outside of the modelled flood extents for the 1 in 100-year + 22% CC design event.
- 4.12 A 75% blockage scenario has been run on the proposed culvert for the design event, which shows the proposed roundabout and access road to be at a residual risk of flooding, however the flood hazard rating is shown to be 'Low'.

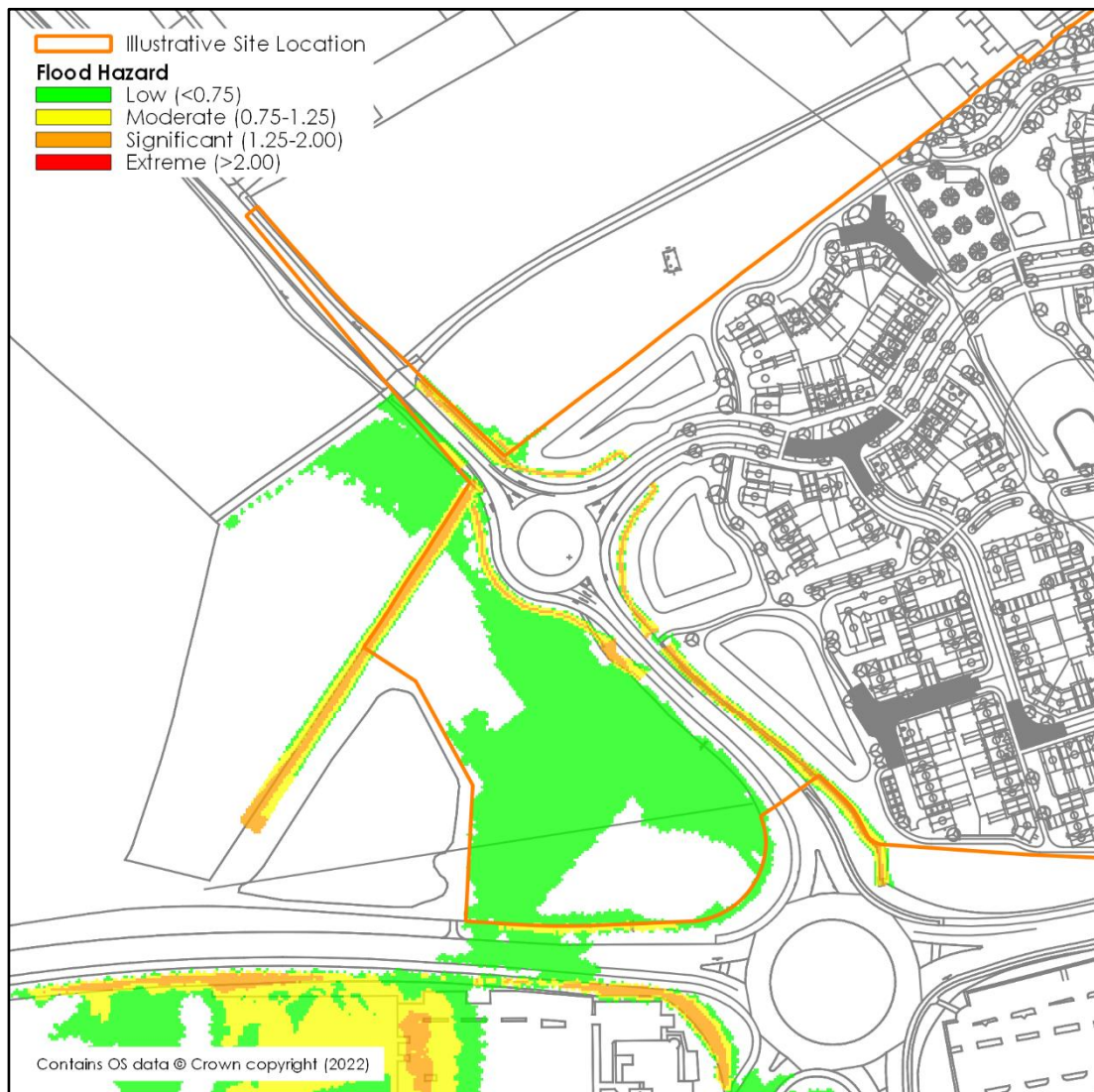


Figure 4.4: Flood Hazard in the Proposed Scenario - 1 in 100-Year + 22% CC

- 4.13 Site access and egress from Stoke Road is shown to be at a low risk of surface water flooding. Surface water depth mapping shows depths of below 150mm along Stoke Road, to the north of the proposed access, during the 1 in 100-year event.
- 4.14 Therefore, access and egress from Stoke Road can be safely achieved for the lifetime of the proposed development.

Requirement for Floodplain Compensation

- 4.15 The proposed channel and culvert will be designed to have sufficient capacity to contain the 1 in 100-year + 22%CC flows to ensure that no downstream detriment is caused by the proposed development and the construction of the roundabout. Therefore, floodplain compensation will not be required.

Surface Water Drainage

- 4.16 To mitigate the development's impact on the current runoff regime, it is proposed to incorporate surface water attenuation and storage as part of the development proposals.
- 4.17 Further information on the drainage approach is provided within the accompanying Sustainable Drainage Statement (reference: HIN-BWB-ZZ-XX-RP-CD-0001).
- 4.18 In brief, the development will discharge surface water at the greenfield QBAR rate. Attenuated surface water storage will be provided with capacity for the 1 in 100-year storm with an allowance for climate change.
- 4.19 The majority of on-site storage is to be provided in detention basins that are situated at the eastern and western boundaries of the primary development parcel. It is expected that any shortfall in calculated storage volume is to be provided within the freeboard of the basins, conveyance swales (displayed along the green corridor) and through distributed cellular storage within the fabric of the development. Such storage could be offered in areas of Public Open Space (POS) or beneath shared/private roads and parking areas. It is anticipated that attenuation volumes will reduce as the site progresses through the detailed design stage and further network modelling is undertaken.

Foul Water Drainage

- 4.20 It is proposed to drain foul water from the development separately to surface water.
- 4.21 Further information on the drainage approach is provided within the accompanying Sustainable Drainage Statement (reference: HIN-BWB-ZZ-XX-RP-CD-0001).

5. CONCLUSIONS AND RECOMMENDATIONS

- 5.1 This FRA has been prepared in accordance with requirements set out in the NPPF and the associated Planning Practice Guidance. The FRA has been produced on behalf of Richborough Estates Limited and Mr & Mrs Adcock in respect of a planning application for a proposed residential development at the Land East of Stoke Road and North of Normandy Way, Hinckley, Leicestershire.
- 5.2 This FRA is intended to support an outline planning application and as such the level of detail included is commensurate and subject to the nature of the proposals.
- 5.3 This report demonstrates that the proposed development is not at significant flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 5.1**:

Table 5.1: Summary of Flood Risk Assessment

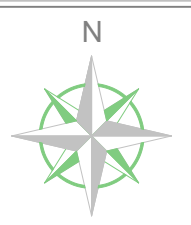
Flood Source	Risk & Proposed Mitigation Measures
Fluvial	The site is shown to be located entirely within Flood Zone 1. A hydraulic modelling exercise has been undertaken to assess the risk of flooding to the site from the UOW and ditches. The modelling has confirmed that the development parcel is at low risk of flooding and located outside of the 1 in 100-year +22%CC design extent during both baseline and post development scenarios. To ensure the development is safe for its lifetime, it is recommended that finished floor levels are raised a minimum of 600mm above the peak flood level of the UOW during baseline conditions (east of the site) and the peak flood level of the ditches during the proposed development scenario (west of the site). As a minimum, floor levels should also be set 150mm above surrounding ground levels to help mitigate the residual risk of flooding.
Pluvial Runoff and Sewers	EA surface water mapping demonstrates that the proposed development is at low risk of surface water flooding. Whilst no existing sewer records have been identified at the site, Severn Trent Water have confirmed that the sewer network upstream (south of Normandy Way) has known capacity issues. This has been confirmed in the hydraulic modelling exercise by representing the sewer network. The model demonstrates built development is not at risk of sewer exceedance due to the rise in topographic levels away from the surrounding roads. Ground levels should be profiled to encourage runoff and overland flows away from the built development and towards the nearest drainage point. It is also recommended that finished floor levels are raised a minimum of 150mm above surrounding ground levels.
Impact of the Development	The residential development has been sequentially located so as to not encroach or displace any modelled floodplain. A roundabout is proposed as part of the development. To mitigate against the risk of flood water displacement, a watercourse diversion scheme is proposed. This scheme will limit the extent of culverting, which will be designed to have sufficient capacity to contain the 1 in 100-year +22%CC flows.

	Surface water runoff from the development will be discharged at the greenfield QBAR rate. Attenuated surface water storage will be provided with capacity for the 1 in 100-year storm with an allowance for climate change. It is expected that any shortfall in calculated storage volume is to be provided within the freeboard of the proposed basins, conveyance swales (displayed along the green corridor) and through distributed cellular storage within the fabric of the development. It is proposed to drain foul water from the development separately to surface water.
This summary should be read in conjunction with BWB's full report. It reflects an assessment of the Site based on information received by BWB at the time of production.	

- 5.4 In compliance with the requirements of the NPPF, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site.

APPENDICES

Appendix 1: Topographical Survey



Station	Easting (m)	Northing (m)	Level (m)
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OS Note:

This survey has been orientated to the Ordnance Survey (O.S.) National Grid OSGB36(15) via Global Navigation Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.
Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

+ 123.66
levels shown at margins are taken from Ordnance Survey
lidar data. Access to 3rd party land unauthorised

[illegible]

Rev	Date	Description	Drawn	Q. Rev
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- Topographical Surveys
- Site Engineering
- Utility / CCTV Surveys
- Measured Building Survey
- 3D Laser Scanning
- Revit & BIM Models

Rowan House
Duffield Road
Little Eaton
Derby
DE21 5DR

Tel (01332) 830044 Fax (01332) 830055
admin@greenhatch-group.co.uk
www.greenhatch-group.co.uk

St Albans Unit B, The Courtyard Alban Park St Albans Hertfordshire AL4 0LA t. (01727) 854481	Newcastle 24 Riverside Studios Armathyst Road Newcastle Bus, Park Newcastle-U-Tyne NE4 7YL t. (01912) 736391	London 27, Cornwall Terrace M Regents Park London NW1 5LL t. (02072) 24180
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CLIENT
Richborough Estates Ltd

Hinckley North
LE10 3EA

Topographical Survey

SCALE A1@ 1: 2500	DATE Nov 2021
DRAWN ALS	QUALITY REF GH12172

Level datum	See note
Grid orientation	See note

Job number	42117
Drawing No.	42117_T
Rev.	0

Comments

This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

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

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

Notes:

Appendix 2: Illustrative Masterplan



- KEY**
- SITE LOCATION
25.39 HECTARES / 62.74 ACRES
 - PROPOSED RESIDENTIAL DEVELOPMENT
 - PROPOSED 1 HECTARE FOR 1 FORM ENTRY SCHOOL + 1 HECTARE SAFE GUARDED LAND
 - PUBLIC OPEN SPACE (INCLUDING SuDS) - 8.08 HA / 19.97 ACRES
 - RETAINED EXISTING LANDSCAPE
 - ADDITIONAL/ REINSTATED VEGETATION
 - PRIMARY STREET / AVENUE
 - KEY FOCAL JUNCTION
 - SECONDARY STREET
 - SIDE STREET / SHARED SURFACE
 - PRIVATE LANES
 - RETAINED PUBLIC OF RIGHT OF WAY
 - KEY PEDESTRIAN MOVEMENT WITHIN SITE
 - SUSTAINABLE URBAN DRAINAGE
 - NEIGHBOURHOOD EQUIPPED AREA OF PLAY
 - LOCALLY EQUIPPED AREA OF PLAY
 - LOCAL AREA OF PLAY/ NATURAL PLAY SPACE
 - KEY VISUAL CORRIDORS

- KEY PRINCIPLES**
1. PROPOSED NEW ACCESS VIA HIGHWAYS IMPROVEMENTS TO STOKE ROAD;
 2. PRIMARY STREET PROVIDING VEHICULAR, PEDESTRIAN AND CYCLE MOVEMENT;
 3. SECONDARY MOVEMENT ROUTES PROVIDING A LOOPED INFRASTRUCTURE TO PRIMARY MOVEMENT ROUTES;
 4. SHARED SURFACE ROUTES SERVING CLUSTERS OF DEVELOPMENT;
 5. PRIVATE LANES SERVING OUTWARD FACING DEVELOPMENT PROVIDING PASSIVE SURVEILLANCE OVER NEWLY CREATED OPEN SPACE;
 6. HIGHWAYS IMPROVEMENTS ALONG NORMANDY ROAD PROVIDING DEDICATED CROSSING POINTS TO EXISTING DEVELOPMENT;
 7. RETAINED PUBLIC RIGHT OF WAY RUNNING NORTH-SOUTH THROUGH DEVELOPMENT, PICKING UP KEY EAST-WEST MOVEMENT ROUTES;
 8. KEY PEDESTRIAN MOVEMENT ROUTES RUNNING IN A NORTH-SOUTH AND EAST-WEST MOVEMENT ROUTES OFFERING FULL PEDESTRIAN PERMEABILITY;
 9. KEY MEETING POINT AT HIGHEST POINT OF DEVELOPMENT PROVIDING KEY VISUAL CORRIDORS TO SURROUNDING CONTEXT;
 10. KEY PLAY SPACES ALONG PEDESTRIAN MOVEMENT ROUTES SERVING MAXIMUM RESIDENTS
 11. MAXIMUM RETENTION OF EXISTING FIELD BOUNDARIES AND WOODED AREAS;
 12. CREATION OF COMMUNITY SPACES IN THE FORM OF COMMUNITY ORCHARDS AND INFORMAL KICK ABOUT AREAS;
 13. CREATION OF A SERIES OF GREENWAYS PROVIDING A KEY WILDLIFE NETWORK THROUGHOUT DEVELOPMENT;
 14. PROPOSED ADDITIONAL PLANTING TO THE NORTHERN EDGE TO AID BIO-DIVERSITY AND WILDLIFE OPPORTUNITIES;
 15. POTENTIAL SCHOOL SITE WITH SAFE GUARDED LAND FOR FUTURE SCHOOL EXPANSION;
 16. KEY (PEDESTRIAN MEETING POINTS PROVIDING RESIDENTS OPPORTUNITIES WITH SOCIAL INCLUSION;
 17. SITE LOW POINTS UTILISED FOR SUSTAINABLE URBAN DRAINAGE AIDING WETLAND HABITATS ALONG EXISTING WATERCOURSES;
 18. MAXIMUM CONTINUOUS FRONTAGE ALONG DEVELOPMENT ABUTTING NORMANDY WAY TO REDUCE IMPACT OF ACOUSTIC INTERFERENCE TO REAR GARDEN SPACES;
 19. STREETS AND DEVELOPMENT ORIENTATED TO RUN WITH CONTOURS REDUCING IMPACT OF RETAINING STRUCTURES ON STREET SCENE;
 20. 2M HIGH PLANTED BUND TO REDUCE ANY POTENTIAL ACOUSTIC DISTURBANCE; AND
 21. POTENTIAL ACCESS POINT FOR FUTURE DEVELOPMENT.

Appendix 3: Hydraulic Modelling Report

ENVIRONMENT

Richborough Estates Limited and Mr & Mrs Adcock
Land East of Stoke Road and North of
Normandy Way (A47)
Hinckley
Hydraulic Model Report

ENVIRONMENT

Richborough Estates Limited and Mr & Mrs Adcock
Land East of Stoke Road and North of Normandy Way (A47)
Hinckley
Hydraulic Model Report

Birmingham
Livery Place, 35 Livery Street, Colmore Business District, Birmingham, B3 2PB
T: 0121 233 3322

Cambridge
14-16 High Street, Histon, Cambridge
CB24 9JD
T: 01223 235 173

Leeds
Whitehall Waterfront, 2 Riverside Way, Leeds
LS1 4EH
T: 0113 233 8000

London
11 Borough High Street
London, SE1 9SE
T: 0207 407 3879

Manchester
11 Portland Street, Manchester, M1 3HU
0161 233 4260

Market Harborough
12a Woodcock House, Compass Point Market Harborough, Leicestershire, LE16 9HW
T: 01858 455020

Nottingham
Waterfront House, Station Street, Nottingham NG2 3DQ
T: 0115 924 1100

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GLOSSARY & NOTATION

1D – one-dimensional hydraulic model, good for representing the hydraulics of a definitive channel or flow pathway and hydraulic structure.

2D – two-dimensional hydraulic model, good for representing complex flow routing present within the floodplain.

Annual Exceedance Probability (AEP) - the probability (%) of a flood event occurring in any year.

Catchment - the land area that drains (normally naturally) to a given point on a river, drainage system or body of water.

Design flood event - magnitude of the flood adopted for the design of the whole or part of a development, usually defined in relation to the severity of the flood in terms of its return period. Typically, the 1 in 100-year return period event including an allowance for future climate change for fluvial flood events.

DTM – Digital Terrain Model

EA – Environment Agency

ESTRY - a 1D hydraulic modelling software package published by BMT.

Flood Estimation Handbook (FEH) – industry standard guidance on rainfall and river flood frequency estimation across the UK.

Floodplain - any area of land over which water flows or is stored during a flood event.

FRA – Flood Risk Assessment

Freeboard - the height of the top of a bank, floodwall or other flood defence structure, above the design water level. Freeboard can be seen as a safety margin that makes allowance for uncertainty associated with the potentially damaging effects of flood rise or wave action.

Hydraulic Model - a mathematical (generally computer based) model of a water/sewer/storm system which is used to analyse the system's hydraulic behaviour.

LiDAR – Light Detection and Ranging aerial survey data

LLFA – Lead Local Flood Authority

mAOD – metres above Ordnance Datum

m BGL – metres below ground level

Main River - a statutory type of watercourse in England and Wales, usually larger streams and rivers. The EA can carry out maintenance, improvement or construction work on main rivers to manage flood risk as part of its duties and powers.

NRFA – National River Flow Archive

OS – Ordnance Survey

Preliminary Flood Risk Assessment (PFRA) - an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authority.

ReFH – Revitalised Flood Hydrograph rainfall-runoff hydrological model

Return period - a statistical term defining the probability of occurrence of a flood event. Thus a 1 in 50-year flood is one likely to be equalled or exceeded on average only once in a 50-year period: a flood with a 2.0% annual probability exceedance (AEP).

Strategic Flood Risk Assessment (SFRA) - a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.

TUFLOW – a 2D fixed grid hydraulic modelling software package published by BMT.

UOW – Unnamed Ordinary Watercourse

Watercourse – a natural or man-made open channel for the conveyance of water.

Z-line – a break line layer in TUFLOW which can be used to reinforce linear features in the 2D model domain such as a riverbank, flood defence, or channel bed.

Z-Shape – a layer in TUFLOW which can be used to manipulate the 2D model geometry.

1. INTRODUCTION

- 1.1 BWB Consulting Ltd has been commissioned by Richborough Estates Limited and Mr & Mrs Adcock to undertake a site-specific hydraulic modelling exercise of an Unnamed Ordinary Watercourse (UOW) and a series of ditches to support a proposed residential development at the Land East of Stoke Road and North of Normandy Way, Hinckley (NGR: SP419956).

Aims and Objectives.

- 1.2 This modelling exercise will be used to establish a good hydrological and hydraulic representation of the flooding mechanisms to the site and within the wider vicinity. Modelled floodplain extents and flood levels will be used to support a Flood Risk Assessment (FRA). The following objectives have been identified:
- i. Undertake a hydrological review of the Unnamed Ordinary Watercourse and ditches within the vicinity of the site to estimate peak flows and general flood hydrograph profiles.
 - ii. Construct a one-dimensional (1D) representation of the in-channel environment, where topographical survey is available, including structures using ESTRY software.
 - iii. Construct a two-dimensional (2D) representation of the floodplain using TUFLOW software.
 - iv. Combine and link the 1D and 2D model domains.
 - v. Undertake simulations of key flood return period events to understand the floodplain extents and peak flood levels within and adjacent to the site.
 - vi. Undertake simulations to account for climate change flows within the model.
 - vii. Undertake sensitivity analysis of baseline conditions.

Approach

- 1.3 In order to achieve the objectives identified above, a new 1D/2D ESTRY-TUFLOW model was constructed, based on a watercourse survey completed by BWB Consulting Ltd in February 2022 (Reference: HIN-BWB-ZZ-M2-G-0060, see **Appendix 1**).
- 1.4 The model has been simulated for a series of design storm events. These modelled events include the 1 in 20-year, 1 in 100-year and 1 in 1000-year events that are typically used by the Environment Agency (EA) for planning purposes to define Flood Zones 3b, 3a and 2 respectively.
- 1.5 Simulations have been run to account for the impacts of climate change in accordance with the allowances released by the EA in July 2021. This is necessary so that the FRA can assess the risk of flooding to the proposed development over the length of the anticipated lifetime.
- 1.6 Sensitivity testing has also been undertaken to understand what impacts changes to roughness and downstream boundary has upon the model outputs and to increase confidence in the outputs of the hydraulic modelling.

- 1.7 The modelled flood extents and peak water levels from this study have been assessed in the associated FRA (reference: HIN-BWB-ZZ-XX-RP-YE-0003). Following an assessment of the development proposals, appropriate development levels and mitigation measures have been recommended as part of the FRA.

Site Description

- 1.8 The site is located approximately 1.7km north of Hinckley town centre. The site is bound to the north by agricultural land, to the east by an Unnamed Ordinary Watercourse (UOW) to the south by Normandy Way (A47) and to the west by a pond and further greenfield land. Stoke Road is shown to pass through the site boundary.
- 1.9 The site location is shown in **Figure 1.1**.

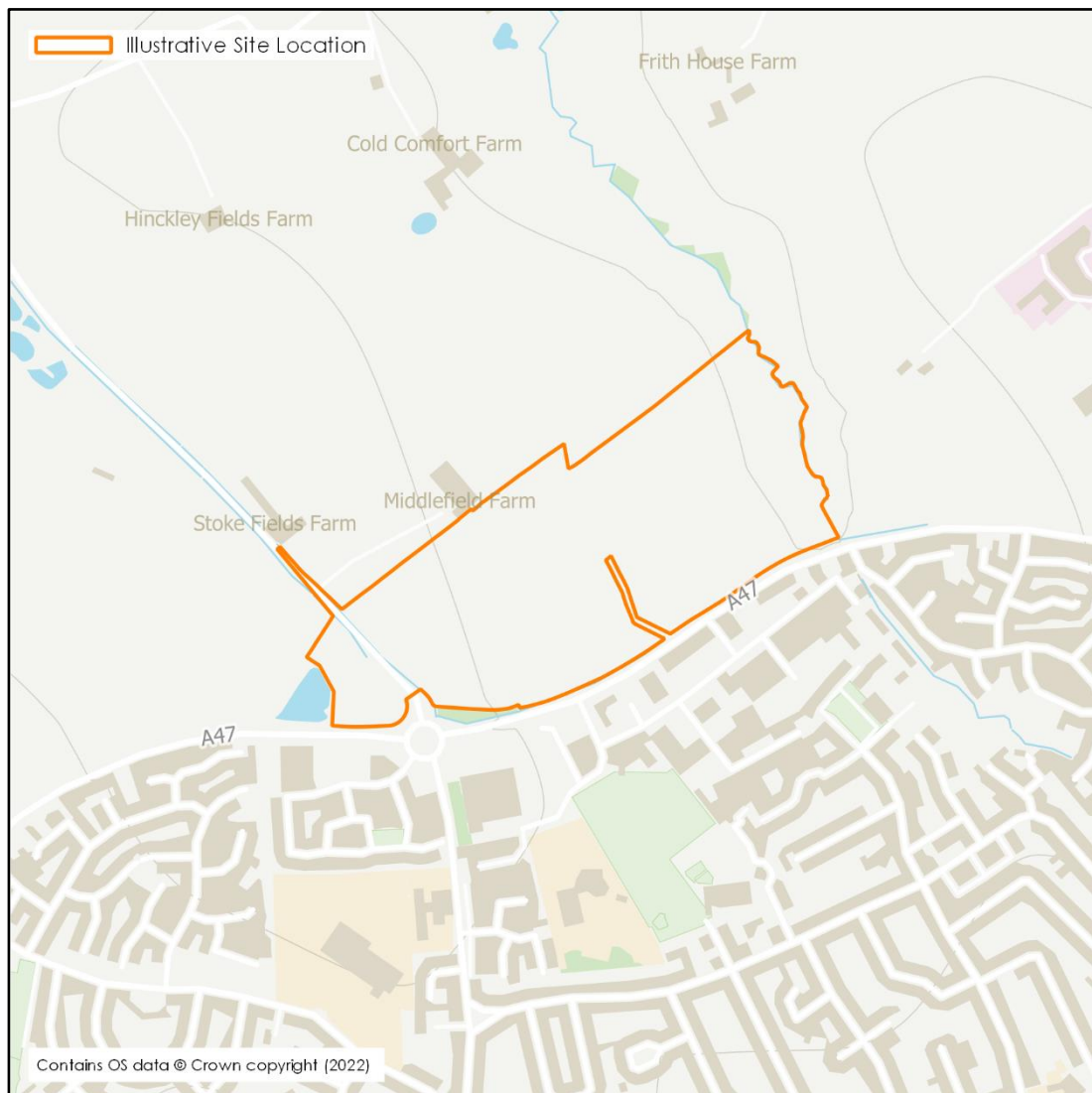


Figure 1.1: Site location

- 1.10 A topographical survey has been undertaken to inform the study. The land parcel to the west of Stoke Road is shown to generally fall in a northerly direction. Site levels are shown

to range from approximately 106.1 metres Above Ordnance Datum (mAOD) in the south to approximately 104.5mAOD in the north.

- 1.11 Ground levels across the main land parcel rise away from Stoke Road to the west and the UOW to the east. The centre of the site subsequently forms a topographical high point, defining a split between two catchments. Site levels within the eastern catchment are shown to range from approximately 119.0mAOD at the centre of the site to approximately 106.5mAOD in the north east. Site levels within the western catchment are shown to range from approximately 119.0mAOD to 104.8mAOD in the north west. The site contours are displayed in **Figure 1.2**.

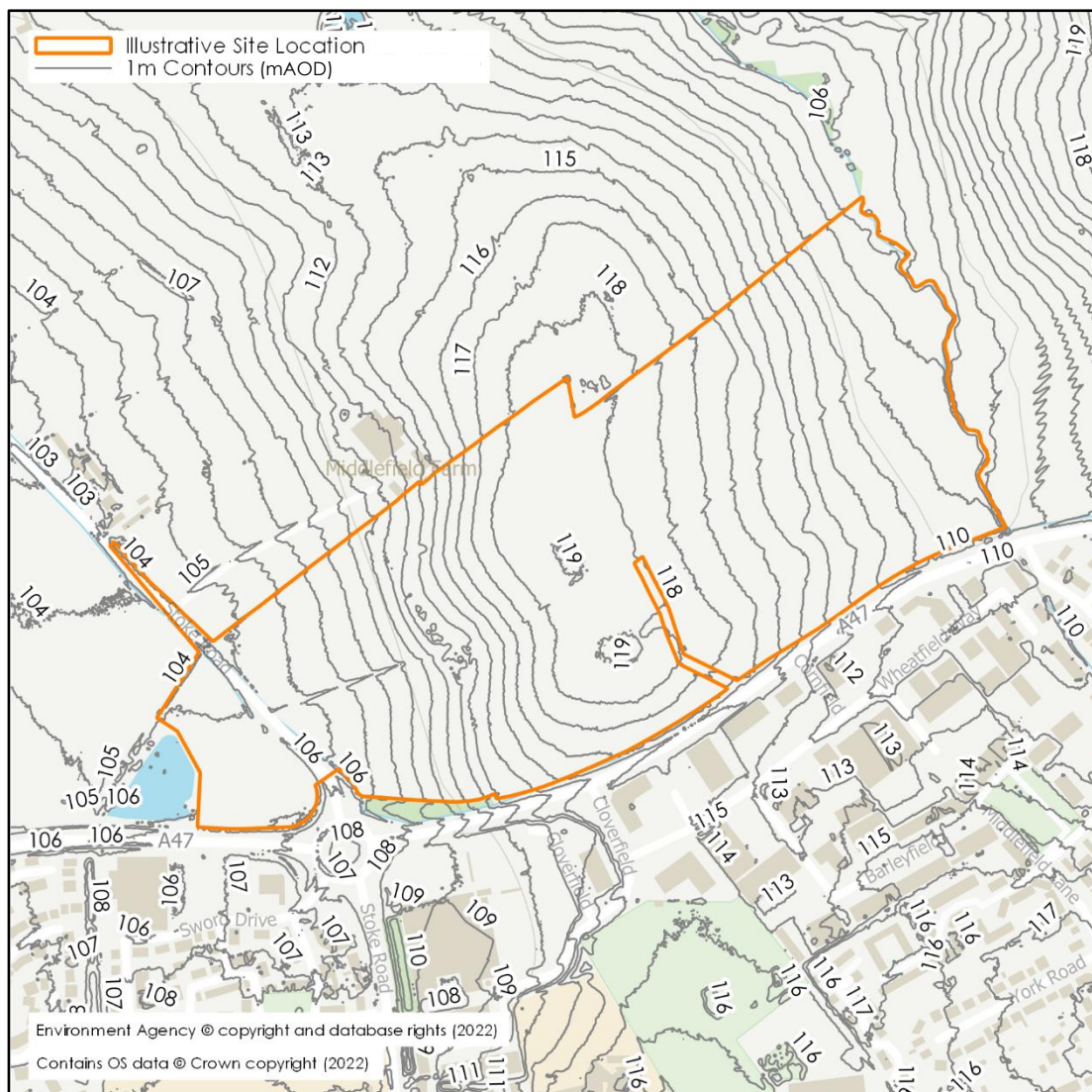


Figure 1.2: Site Topography

Local Watercourses

- 1.12 An Unnamed Ordinary Watercourse (UOW) flows along the eastern boundary of the site in a northerly direction. The watercourse is a tributary of the River Tweed. The UOW flows from within the urban development to the south of the site via twin 0.5m diameter circular culverts beneath Normandy Way. The UOW then flows adjacent to the

perimeter of the site as an open channel. Severn Trent Water sewer records demonstrate that two surface water sewers, that drain residential areas in the upper limits of the catchment, outfall to the river immediately downstream of Normandy Way.

- 1.13 A series of ditches/highway drains are shown to be located within the vicinity of Stoke Road at the western portion of the site boundary. Two of the ditches (R2 & R3) are shown to flow adjacent to either side of Stoke Road in a north westerly direction. A further ditch (R4) is shown to flow towards Stoke Road from Normandy Way and is assumed to outfall to the ditch (R2) immediately east of Stoke Road.
- 1.14 The ditches are understood to be fed by surface water sewers originating within the urban development to the south of Normandy Way and are therefore considered to be more representative of surface water flooding mechanisms.
- 1.15 **Figure 1.3** shows the local watercourse network. The watercourse labels shown will be referenced throughout this report with R2, R3 and R4, as a collective, referred to as the 'western ditches'.

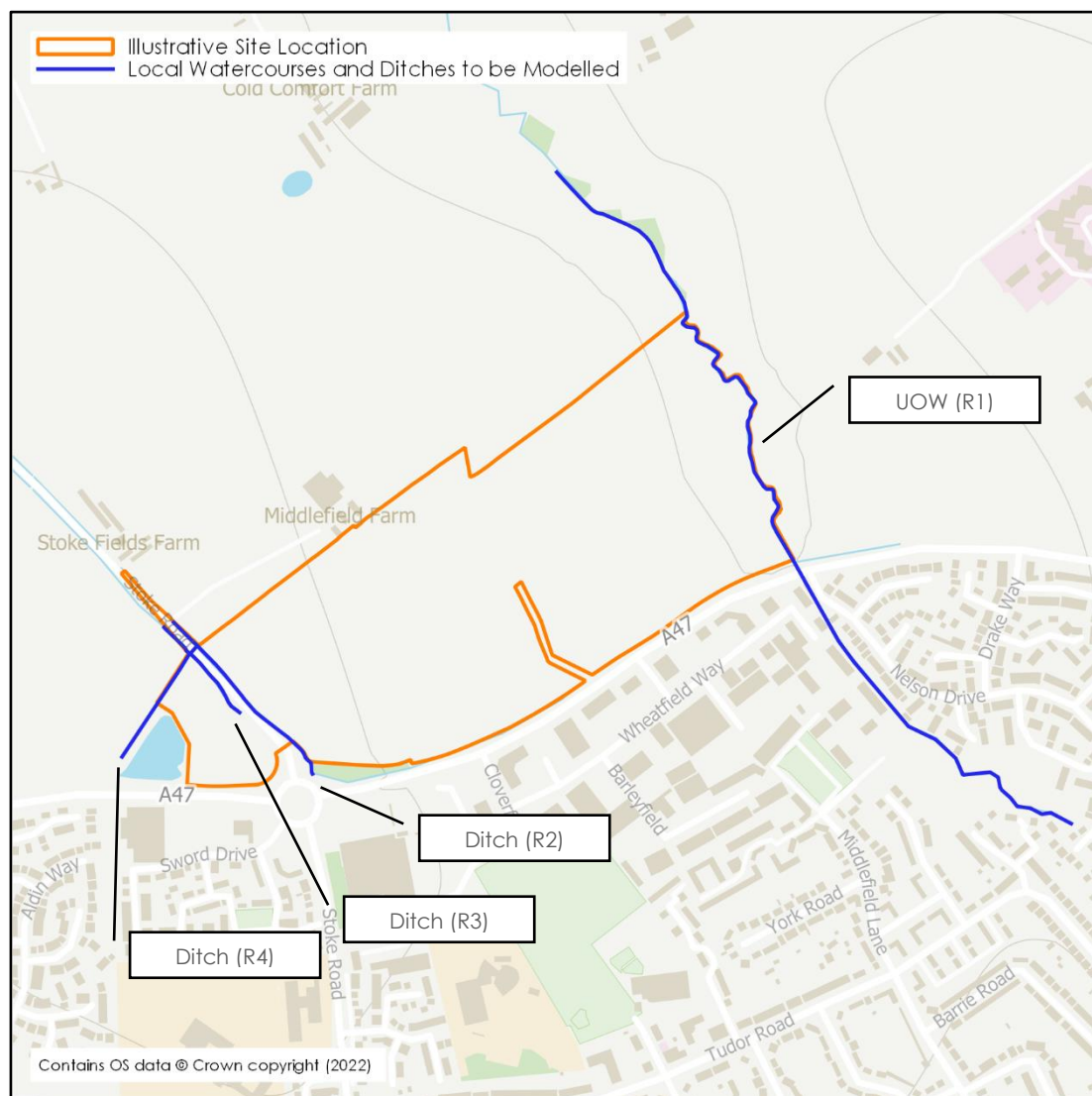


Figure 1.3: Watercourse Network

- 1.16 The UOW (R1) has a total catchment area of approximately 2.1km², R2 and R3 have a catchment area of 0.7km² and R4 has a catchment area of 0.3km². The watercourses and ditches are fed by surface water sewers, which outfall to the waterbodies downstream of Normandy Way. The modelled catchments are displayed in **Figure 1.4**.

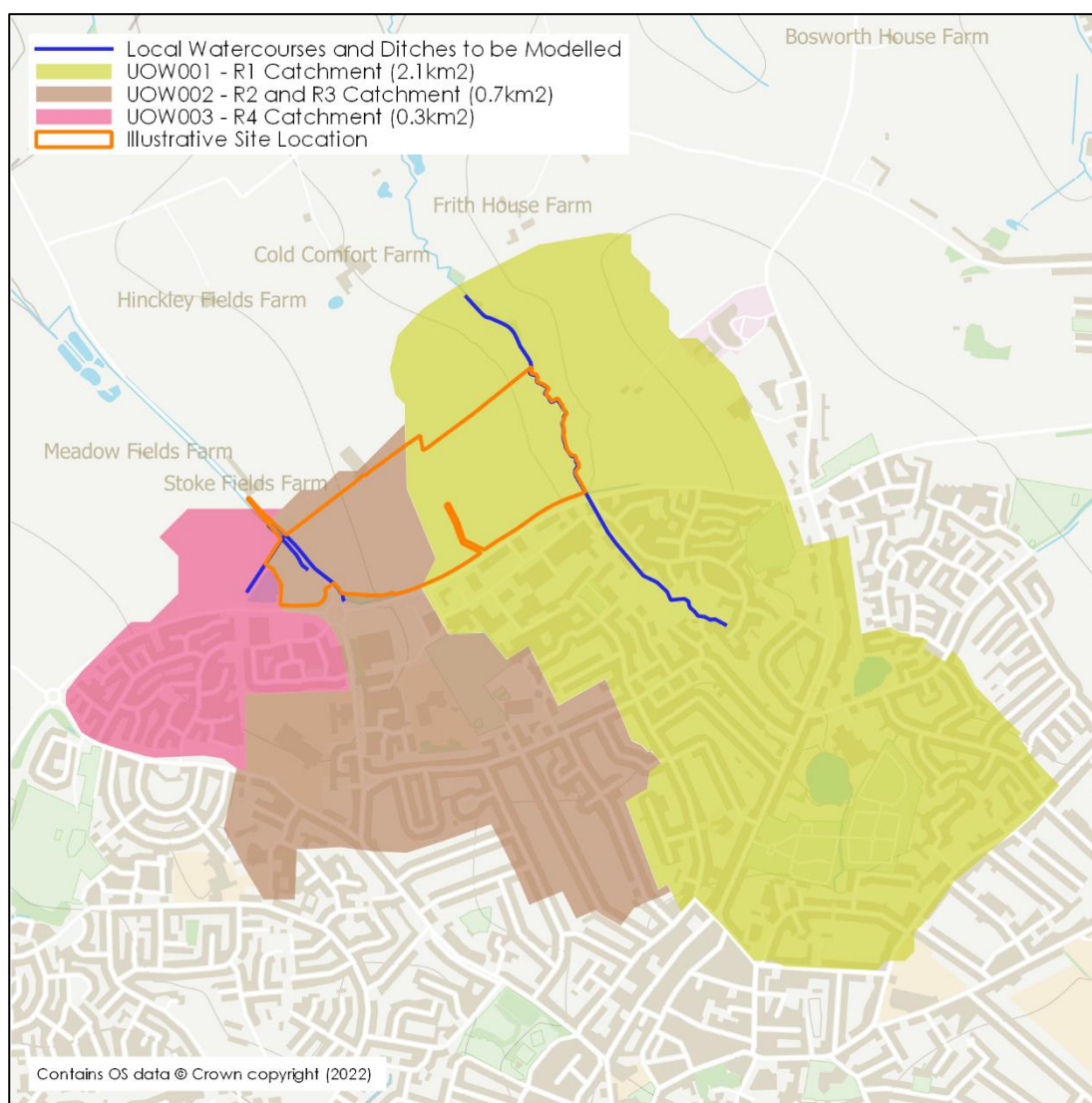


Figure 1.4: Modelled Catchment Areas

Previous Studies & Available Data

Historic Flood Events

- 1.17 A flood history review for the catchment has been undertaken using EA recorded flood outlines, Hinckley and Bosworth Borough Council Level 1 Strategic Flood Risk Assessment (SFRA)¹, Hinckley and Bosworth Borough Council Level 2 SFRA², Leicestershire County Council Preliminary Flood Risk Assessment (PFRA)³, Leicestershire

¹ Level 1 Strategic Flood Risk Assessment (JBA Consulting, July 2019)

² Level 2 Strategic Flood Risk Assessment (JBA Consulting, May 2020)

³ Preliminary Flood Risk Assessment (Leicestershire County Council, June 2011)

County Council Local Flood Risk Management Strategy (LFRMS)⁴, the British Chronology of Hydrological Events and online newspaper records.

- 1.18 The Level 1 SFRA notes that a surface water overland flow route exists along Stoke Road and is associated with an unnamed drain adjacent to this road, however there are no historic flooding incidents recorded. It is unknown whether this surface water flow route affects the development site.
- 1.19 The Environment Agency (EA) recorded flood outline information does not include any historical records within proximity of the site. Given the greenfield nature of the site and lack of receptors, this does not necessarily mean that the site has never flooded.
- 1.20 Following consultation with Severn Trent Water, it was confirmed that no information is held on ditches R2, R3 and R4. It was stated, however, that whilst no locations of flooding have been identified, they are aware of capacity issues regarding the surface water sewer network within this area.

BWB Site Visit (January 2022)

- 1.21 A site visit was undertaken by BWB during January 2022 to walk the local watercourse reaches and observe any key features that either needed surveying or needed to be considered during the hydraulic modelling process. The key considerations have been summarised below:
- The UOW (R1) to the east of the site flows in a northerly direction. A brick arch structure was observed looking upstream towards the culvert beneath Normandy Way. Adjacent to the site, the watercourse follows the site boundary as open channel with some small structures along this reach.
 - The ditch located immediately east of Stoke Road (R2) is shown to be culverted at the head of the reach. It was not possible to trace back to an open reach of the watercourse within the town of Hinckley, with manholes notable at the Morrisons car park on the southern side of Normandy Way.
 - A detention basin is located adjacent to R4. No outfall from the detention basin could be identified due to access restrictions within this part of the site. It is assumed that the basin likely discharges into R4, the adjacent ditch.
 - The upstream limit of R3 appeared dry at the time of the site visit.

Environment Agency Flood Maps

- 1.22 The EA Flood Map for Planning confirms the site as being located entirely within Flood Zone 1. This is likely to be due to the smaller catchments associated with the UOW and ditches which means they have been excluded from the national scale mapping. Subsequently, no existing detailed model information is held by the EA at the site.
- 1.23 The closest Flood Zones to the site are located approximately 1.3km downstream. The Flood Map is displayed in **Figure 1.5**.

⁴Local Flood Risk Management Strategy (Leicestershire County Council, August 2015)



Figure 1.5: EA Flood Map

Environment Agency Surface Water Maps

- 1.24 The EA Risk of Flooding from Surface Water mapping provides an indication of the floodplain associated with ordinary watercourses that are not included in the Flood Map for Planning. The surface water mapping is included within **Figure 1.6**.
- 1.25 The mapping shows that pluvial flow routes overtop Normandy Way (A47) both upstream of the UOW (R1) and the western ditches. The surface water extent along R2 is relatively contained to the capacity of the channel with some out of bank flooding predicted at lower ground levels immediately adjacent to the site and downstream of the site. Isolated areas of surface water flooding are seen in the site which are attributed to existing hedgerows (with drainage ditches) and a pond/topographical depression in the centre of the site. The field between the existing detention basin and Stoke Road is predicted to convey overtopping surface water from Normandy Way into R3 and R4.

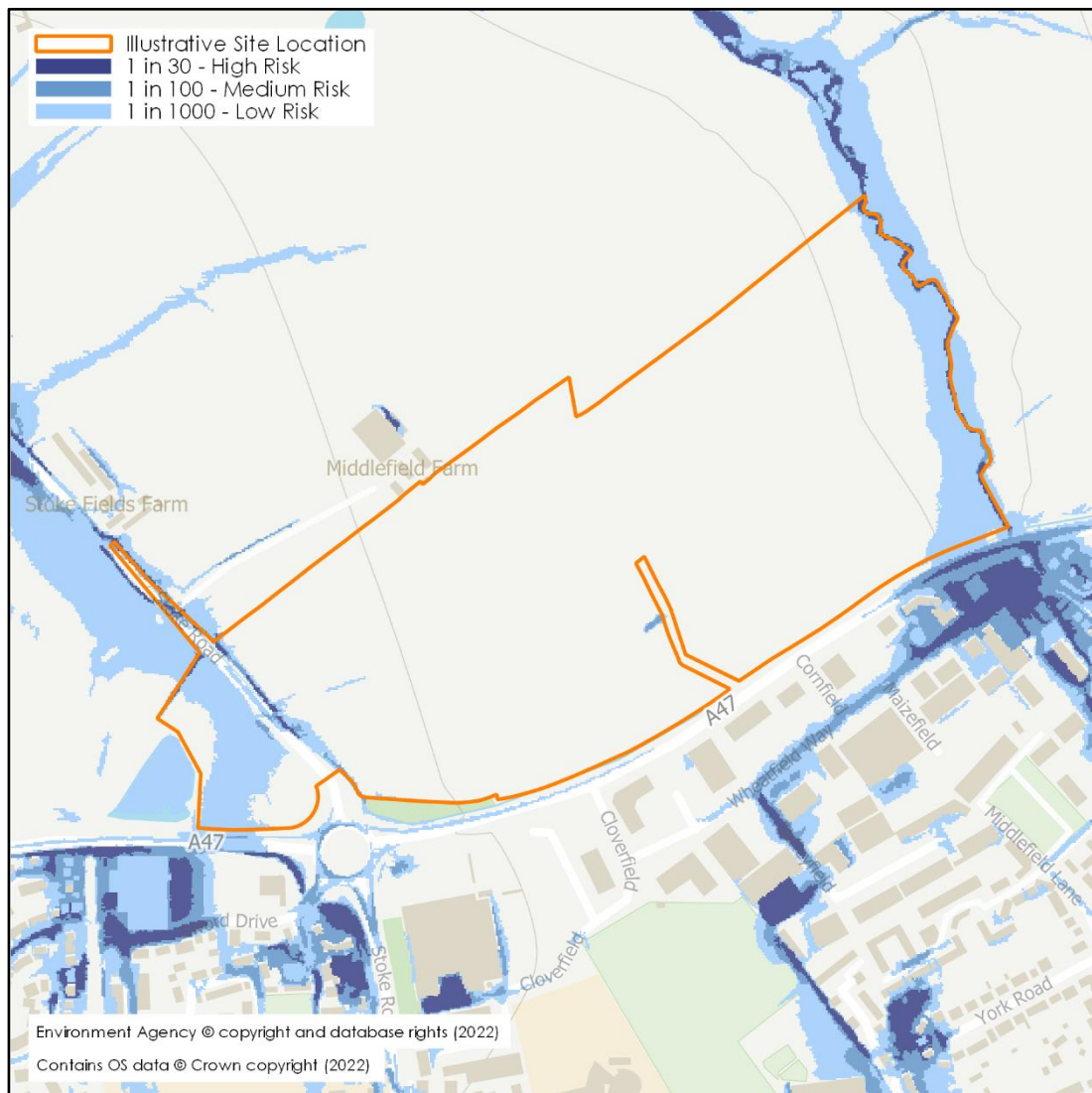


Figure 1.6: EA Risk of Flooding from Surface Water

- 1.26 Given that surface water flooding is also predicted to overtop Normandy Way at the UOW (R1), out of bank flooding is also predicted within the site at the eastern boundary for the larger magnitude (1 in 1000-year) storm event. Notable surface water flooding is predicted within urban areas of Hinckley upstream of both the UOW (R1) and the western ditches, which aligns with the capacity issues of the existing sewer network (as identified by Severn Trent Water). However, the surface water mapping does not explicitly represent culverts and structures and therefore is expected to provide a conservative representation of surface water flood risk at the site.

Other Sources of Data

- 1.27 The following additional datasets were used within the hydraulic modelling exercise:
- EA Light Detection and Ranging (LiDAR) 2020 1m Digital Terrain Model (DTM).
 - Topographical survey (reference: 42117_T_REV0), undertaken in November 2021.
 - Cross-sectional Watercourse Survey, undertaken in February 2022 (**Appendix 1**).

- Photographs and observations from the site visit undertaken in January 2022 by BWB Consulting.
- A hydrological assessment of flood flows undertaken by BWB Consulting (**Appendix 2**).

Assumptions and Limitations

1.28 Several assumptions were made during the study which may lead to implications on the modelled results. However, the study has been based on the data available at the time of writing. The key assumptions and limitations are as follows:

- The modelling exercise has made use of the available data at the time of construction and simulation. The model represents the floodplain and channel conditions at the time of survey.
- The model contains no formal representation of the conveyance within minor watercourses or ditches other than that captured by the model grid and within the 1D model domain.
- The 2m resolution of the model may negate any small-scale topographic features, although all the significant features are believed to have been captured.
- Some of the floodplain levels are derived from LiDAR which has limited accuracy ($\pm 0.15\text{m}$). however, this is considered to be sufficient for the purpose of this study.
- The bare earth DTM does not include for the presence of walls, buildings or other structures. Buildings have been modelled at ground level with an elevated roughness in line with best practice.
- The modelling exercise has been undertaken to produce a good representation of flood risk mechanisms in and around the study site. It has not been designed to accurately map flooding in the wider catchment.
- An assessment of OS mapping, LiDAR and sewer records was undertaken to determine the extent of the upstream catchment areas that drain to the watercourse and ditches that have been assessed as part of this study.
- The culvert at the end of R4 has been assumed to discharge beneath Stoke Road into R2 so that levels maintain a constant gradient. A CCTV survey will be required to confirm the exact culvert outlet location.
- Sewer manhole cover levels have been based off Severn Trent Water sewer records in the catchment upstream of the UOW (R1). An alternative approach has been adopted in the catchment upstream of the ditches, whereby cover levels are determined off the respective ground level informed by the 1m LiDAR data at this location. This was to overcome off-site model instabilities.
- It is assumed that Severn Trent Water sewer records can be relied upon to represent the network surrounding the site and no CCTV survey has been undertaken at this time to verify the outputs.
- All manholes are assumed to have a diameter of 0.5m with the diameter of any pipes taken from Severn Trent Water Sewer records.
- It is assumed that all sewers are clear from any blockages/sedimentation.
- Only the primary trunk sewer runs have been represented within the model. No secondary networks or private drainage have been included which may alter the timing and distribution of flows.

- The existing topographical survey has been used to derive the proposed access road level in the absence of design levels.

2. HYDROLOGY

Flood Flow Estimation

- 2.1 A hydrological review of the catchment was undertaken using Flood Estimation Handbook (FEH) methodologies to estimate peak flood flows and derive an appropriate hydrograph shape. This was undertaken in relation to the EA's latest guidance⁵. This assessment is documented within **Appendix 2**. For the purpose of the hydrological assessment, all features have been given a UOW site code prefix as detailed within **Table 2.1**.

Table 2.1: Naming Convention

Modelling Naming Convention	Hydrology Naming Convention
UOW (R1)	UOW001
Ditch (R2)	UOW002
Ditch (R4)	UOW003

- 2.2 In summary, there was no hydrometric data available in the area to inform the hydrological analysis. Therefore, the industry standard FEH statistical method and Revitalised Flood Hydrograph (ReFH2.3) rainfall-runoff model were both reviewed, and a comparative analysis undertaken.
- 2.3 The final choice of peak flows for input into the model for the UOW was the FEH Statistical Method as it benefits from an up-to-date flood peak dataset, using growth curves from hydrologically similar catchments to derive a growth curve. The Statistical Method also benefits by avoiding the need to make assumptions about factors such as rainfall duration, time of concentration and the nature of the design flood, unlike the ReFH2 method.
- 2.4 ReFH2 was used to provide a hydrograph shape for the model inflows for the UOW (R1), scaled to the Statistical peak.
- 2.5 The final choice of peak flows for input into the model for the ditches is the ReFH2 Method, due to the influence of sewers at the upstream extent of the watercourses.
- 2.6 A full record of the hydrological analysis can be found in **Appendix 2**.
- 2.7 The final inflows incorporated into the model are summarised within **Table 2.2**. **Figure 2.1** demonstrates how the flows will be applied to the model. For UOW001, the model extent was located further upstream than the flow estimation location and therefore the flows detailed in **Table 2.2** were pro-rated to cover a catchment that would drain to the extent of the watercourse that has been modelled.

⁵ Flood Estimation Guidelines 197_08 (Environment Agency, June 2020)

Table 2.2: Adopted Peak Flood Flows

Return Period Event (Yrs)	Annual Exceedance Probability (AEP)	Catchment Peak Flow – UOW001 (m ³ /s)	Catchment Peak Flow – UOW002 (m ³ /s)	Catchment Peak Flow – UOW003(m ³ /s)
1 in 2	50%	0.6	0.3	0.2
1 in 5	20%	0.8	0.5	0.2
1 in 10	10%	1.0	0.6	0.3
1 in 20	3.3%	1.2	0.7	0.3
1 in 50	2.0%	1.5	0.8	0.4
1 in 75	1.3%	1.7	0.9	0.5
1 in 100	1.0%	1.8	1.0	0.5
1 in 200	0.5%	2.2	1.3	0.6
1 in 1000	0.1%	3.5	2.0	1.0

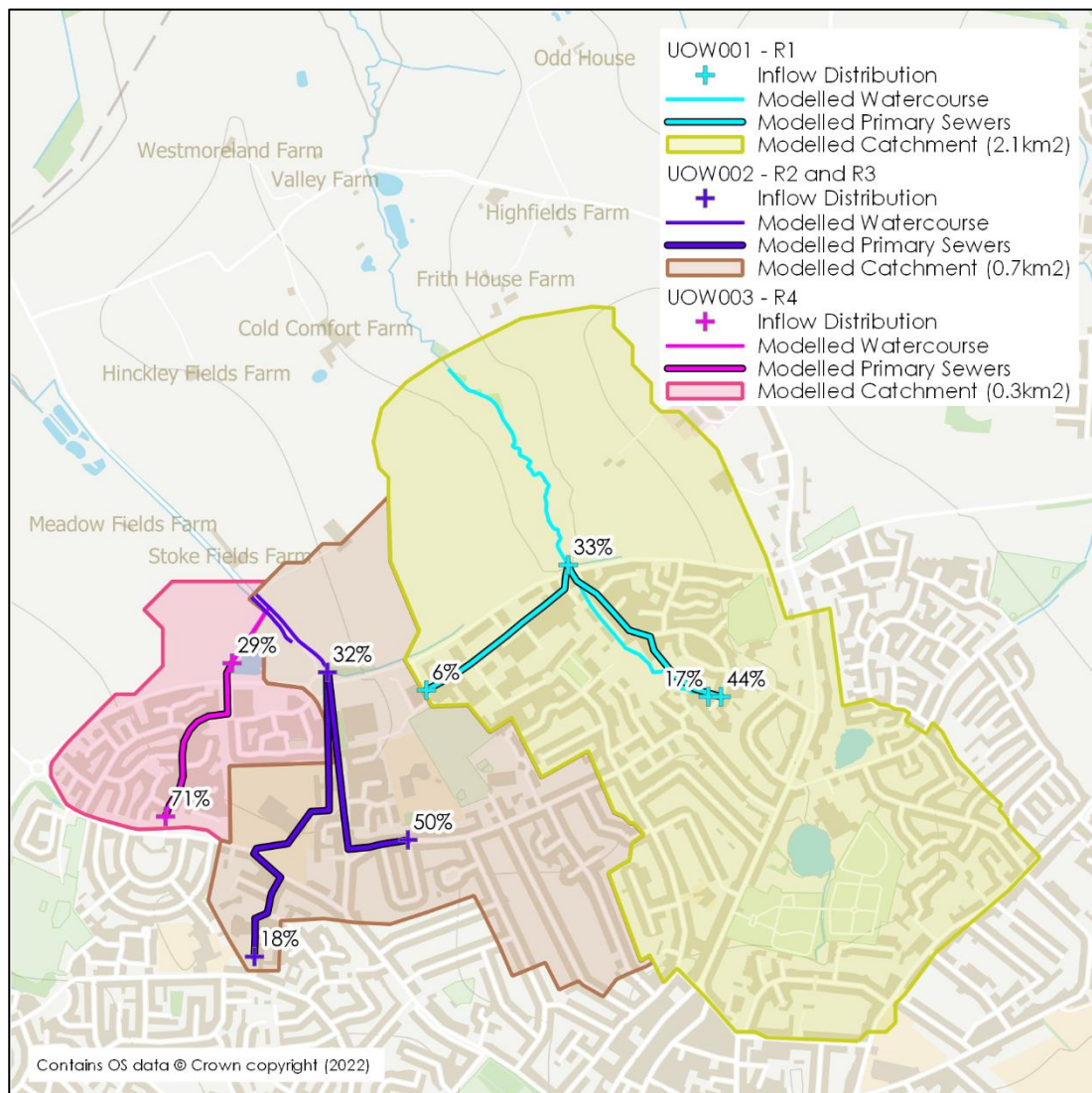


Figure 2.1: Distribution of Model Inflows

Climate Change

- 2.8 Predicted future change in peak river flows caused by climate change are provided by the EA within their online guidance⁶, with a range of projections applied to regionalised 'River Basin Districts'. These districts are further split into 'Management Catchments'.
- 2.9 The study area falls within the Tame Anker and Mease Management Catchment of the Humber River Basin District. **Table 2.3** identifies the relevant peak river flow allowances.

Table 2.3: Peak River Flow Allowance for the Tame Anker and Mease Management Catchment

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Upper End	24%	30%	51%
Higher Central	15%	17%	30%
Central	10%	11%	22%

- 2.10 To estimate the potential future design floodplain under a range of scenarios, the Central climate change allowance for the 2080s will be applied to the 1 in 100-year flood flows. The design event is subsequently the 1 in 100-year +22% climate change (CC) event.

⁶ Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

3. THE HYDRAULIC MODEL

Software and Solver

- 3.1 A combination of TUFLOW version 2020-10-AC-iDP and 2020-10-AB-iDP was used for all model runs. TUFLOW's Classic solver was used.
- 3.2 TUFLOW's built in 1D component, ESTRY, was used to model the 1D domain/channel.

The 1D Domain

Extent

- 3.3 The 1D domain for the western ditches begins from within the site boundary. The ditches are represented within the 1D domain until the downstream boundary. A Model Schematic is included as **Appendix 4**.
- 3.4 The 1D domain for the UOW (R1) begins upstream of the site, to the rear of the dwellings located along Nelson Drive. The majority of the channel is represented within the 1D domain, however the first 400m of watercourse is modelled within the 2D domain.
- 3.5 The public sewers, as shown on Severn Trent Water sewer records, have been identified as discharging to the eastern UOW and western ditches. Accordingly, relevant areas of the public sewer network were represented within the 1D domain. Only the trunk sewers that drain towards to the watercourses/ditches were incorporated within the model. No private sewer networks or secondary networks have been included within the model.
- 3.6 The inclusion of the main sewer runs in the model provides a representation of how the flows are routed through the drainage system before outfalling to the watercourse and ditches. In addition, this allows for an assessment of constraints introduced by the insufficient capacity of the sewer network upstream of the site.
- 3.7 In order to represent the interaction between the subsurface sewer network and the surface, manhole locations (as identified by Severn Trent Water sewer asset records) were represented in the model using a "1d_pits" layer.
- 3.8 Each manhole was provided an assumed diameter of 0.5m. The surface levels in the sewer network associated with the UOW (R1) were defined by cover levels provided by Severn Trent. For the sewer network upstream of the western ditches, 1m LiDAR data was used to inform the manhole surface levels. This different approach was considered necessary to overcome off-site model instabilities that were caused by a disagreement between the Severn Trent cover levels and 2D ZC levels of surrounding cells, as defined by the 1m LiDAR.
- 3.9 The model domain is shown in **Figure 3.1** and as a Model Schematic included as **Appendix 4**.

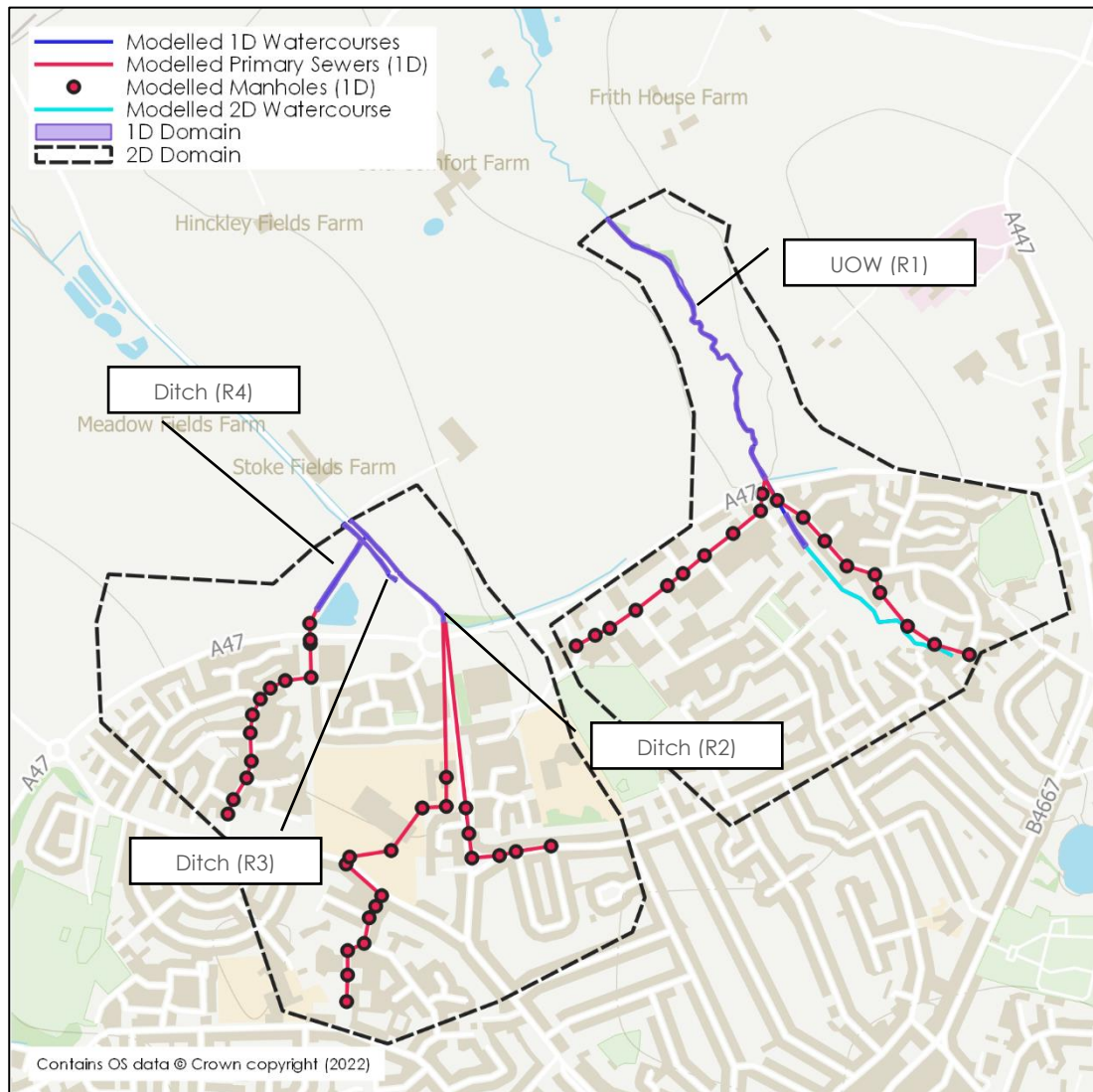


Figure 3.1: Modelled Watercourses, Sewers and Domain Extents

Channel Geometry

- 3.10 The river channel geometry is based on a new watercourse survey carried out by BWB Consulting in February 2022. The survey also captured hydraulic structures that were present such as bridges and culverts.
- 3.11 The maximum distance between cross sections is 125m. However, sections are more generally spaced 45m-80m apart. The river channel survey is available as **Appendix 1**.
- 3.12 The channel sections were truncated at top-of-bank from survey data, at what would be the interface with the 2D domain.

Hydraulic Roughness

- 3.13 Hydraulic roughness has been represented using the Manning's n coefficient. The values applied are based on those stipulated in the literature, using Chow (1959)⁷. This study documents appropriate values based on channel bed material, sinuosity and presence of vegetation.
- 3.14 The guideline values are chosen using engineering judgement, based on photographs of the channel condition taken at the time of survey. Each cross section has a Manning's roughness value applied in the same way as the channel geometry and is read into TUFLOW within a CSV file.
- 3.15 The bed of the eastern UOW and ditches were generally clean and winding with pools and riffles and light bank vegetation. The bank vegetation varied across the sections, however predominately areas were considered to be either highly vegetated around hedgerows with lower roughness values assigned where grass was present. Some examples are highlighted in **Table 3.1** below.

Table 3.1: Manning's n examples

Model ID	Values chosen and description	Photograph
UOW001_00769	0.04 Main Channels Clean, but winding with pools and riffles, light bank vegetation	

⁷ http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm

Model ID	Values chosen and description	Photograph
R4_00023	0.03 Floodplains Grass, short	
R2_00077	0.06 Floodplains Trees – medium density with sprouts	

Hydraulic Structures

- 3.16 A number of hydraulic structures were represented in the 1D domain, the data for which was collected during the watercourse survey.
- 3.17 In total, 6 circular culverts and 2 irregular culverts were included in the model, the details of which are included as **Appendix 3**.

Boundary Conditions

- 3.18 Boundary conditions were applied to the 1D domain to both allow flow in and out of the model.
- 3.19 QT (flow vs time) boundaries were used to represent the fluvial inflows (**Section 2**) as hydrographs. These consisted of point inflows at the upstream extents of the watercourses and sewers and at the downstream extent of any intervening

topography (i.e. Normandy Way). **Figure 2.1** shows where these boundaries were applied.

- 3.20 A HT (water level vs time) boundary was applied at the downstream limit of the 1D domain. This was set to 104.77mAOD for the UOW (R1) which is the surveyed top of bank at the downstream cross section (UOW001_00702), 103.85mAOD for R2 which is the surveyed water level at the downstream cross section (R2_00000) and 104.05m AOD for R3 which is between the top of bank and bed level of the downstream cross section (R3_00000).

1D/2D Links

- 3.21 The 1D channel was linked to the floodplain using "HX" links. These transfer the calculated water level from the 1D cross sections into the 2D floodplain, providing that the water level is above the level of the cell that the HX link is located in. Therefore, HX links should be digitised along the top of bank of the watercourse visible in LiDAR data or along the crest of any embankments if present.
- 3.22 In order to represent the interaction between the subsurface sewer network and the 2D domain, manholes were represented in the model using a "1d_pits" layer. A "SXZ" command is utilised in the 1d_pits layer to allow water to spill from the manhole into the 2D domain and vice versa.
- 3.23 The average modelled width of the channel was approximately 6-8m.

The 2D Model Domain

Extent and Active Area

- 3.24 The main influence on the 2D domain extent is generally the expected width of the floodplain, meaning that it should be large enough to allow for flows to be routed through the floodplain, where necessary, and so that no "glass walling" occurs within the boundary of the model domain.
- 3.25 The river channel was deactivated to ensure that it was modelled in the 1D domain. This deactivated area may appear fragmented in places where the deck of a structure is modelled in the 2D domain. The active area is displayed in **Figure 3.1** and is shown in the Model Schematic included as **Appendix 4**.

Grid Size and Orientation

- 3.26 The grid cell size should be chosen in order to sufficiently represent the average width of the modelled channel and its ability to capture key floodplain topographic features.
- 3.27 The selected grid size of 2m provides a high enough resolution to capture the capacity of the channel (6m width = 3 number of 2m cells) as well as provide the representation of key floodplain features to an appropriate level of detail.

- 3.28 The orientation of the grid is important for flow routing as flow cannot pass to the neighbouring cell via its corner, only via the cell sides. Therefore, the location line (2d_loc) was drawn to orientate the grid in the predominant direction of flow (southeast to northwest).

Floodplain Roughness

- 3.29 Floodplain roughness is defined by the Manning's n coefficient, as per the 1D domain. However, the method in which it is applied differs.
- 3.30 A global roughness value is set based on the predominant land use (long grass) in the catchment. This is then supplemented by a series of polygons, based on spatial variation in land use, which applies values, where appropriate, from a variety of sources such as OS MasterMap data and aerial imagery. These are linked to a coefficient listed in a TUFLOW Materials File (TMF).
- 3.31 The values applied for different land use types are listed in **Table 3.2**.

Table 3.2: Floodplain Roughness Values

Land Use Type	Manning's n Coefficient
Long grass	0.035
Short grass	0.030
Roads	0.015
Woodland	0.060
Buildings	0.500

Floodplain Topography and Amendments

- 3.32 The general floodplain topography is based on the latest available LiDAR data (flown in 2020), which was downloaded from the DEFRA Open Survey website at a 1m resolution.
- 3.33 The following amendments to the base topography were made:
- River bank levels were reinforced through the use of a 'THICK' z-line. Bank elevations were provided at intervals along the z-line. The levels were informed by surveyed cross section data, topographical survey and LiDAR data (where survey data was unavailable).
 - Stoke Road was reinforced through the use of a z-shape. Road elevations were provided at intervals along the z-shape. The levels were informed by topographical survey and LiDAR (where survey was unavailable).
 - Approximately 400m of the eastern UOW was reinforced upstream of Nelson Drive through using a z-shape, with a width of 3, given that no watercourse survey data was available. The bed level of the UOW was reinforced from LiDAR at intervals

along the z-shape. Spot checks were then undertaken on the model grid to ensure a constant positive gradient towards the 1D domain.

Floodplain Structures

- 3.34 There were no floodplain structures within the model. All hydraulic structures were in line with the channel and hence modelled in the 1D domain.

Boundary Conditions

- 3.35 Boundary conditions within the 2D domain are often used to prevent “glass walling” at the downstream end of the model through use of a “HQ” boundary. This is a flow vs stage relationship automatically defined in TUFLOW when the user inputs a slope value, to allow water to flow out of the model.
- 3.36 A “HQ” boundary was applied to the downstream extent of the model and adjacent to any sewers located near to the 2D domain. The slope in the “HQ” boundary was calculated by assessing the fall in floodplain ground levels over a set distance. The fall in ground levels was then divided by the distance measured to determine a slope value.

Initial Water Levels

- 3.37 Initial water levels are often applied to features such as lakes, ponds or canals to represent them containing water of a nominal depth at the start of the model run.
- 3.38 An initial water level was applied at each cross section. The value was taken from the surveyed water level.

Calibration/Verification

- 3.39 A lack of detailed flow or level data for the catchment meant that there was limited opportunity to calibrate the model.
- 3.40 Due to the lack of documentation on previous historical instances of flooding, the model cannot be verified against historic events. A conservative approach adopted to the model build mitigates this.

Stability, Warnings and Messages

- 3.41 TUFLOW has a number of indicators available to assess the stability of a model. These differ slightly between the Classic and HPC solver (the Classic solver was used for this model). The following indicators were checked to ensure the model was performing as expected:
- **Stage and flow time series** – A number of spot checks should be completed to ensure that conveyance through the channel is as expected and that both the stage and flow time series are reasonably smooth, particularly around the study area.

- **1D negative depths** – Significant negative depths indicate that instabilities are present.
- **Cumulative Mass Error** – A value of +/-1% is considered acceptable.
- **Velocities** – Unusually high velocities or circulating vectors are usually a sign of instabilities.

3.42 The time series graphs were reviewed along the modelled reaches and no significant issues were present that could compromise results at the site. The river channel water levels were shown to peak at approximately 6 hours into the event along the eastern UOW, 5 hours into the event along Reach 2 and 3.5hrs into the event along Reach 4.

3.43 No 1D or 2D negative depths were reported.

3.44 The baseline simulations reported a peak mass error within +/- 1% except for the very high magnitude events for the western ditches. The maximum peak mass error found within the model simulations was -1.05% for the 1 in 100-year +51%CC event. This occurs approximately 3-5 hours after the peak of the flood event and the mass error drops back into the accepted range within 15 mins of reaching this peak value. It should be noted that in both design events (1 in 100-year +22%CC) the mass error peaked within +/- 1%. Therefore, although not ideal, this mass error can be considered insignificant.

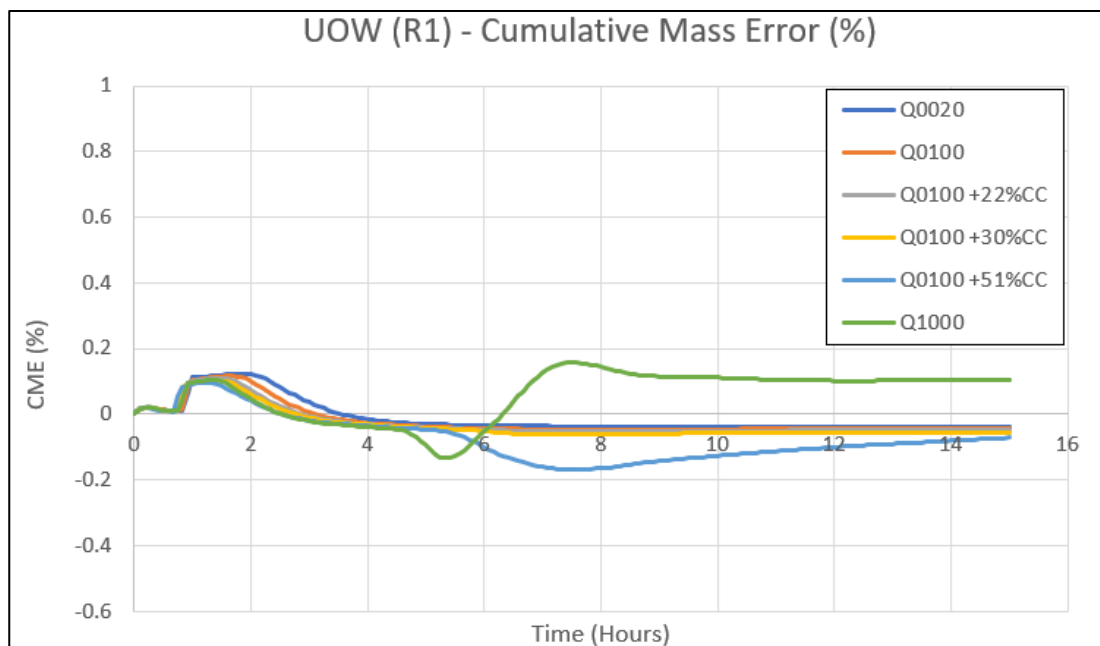


Figure 3.2: UOW (R1) Cumulative Mass Error Plots (Baseline)

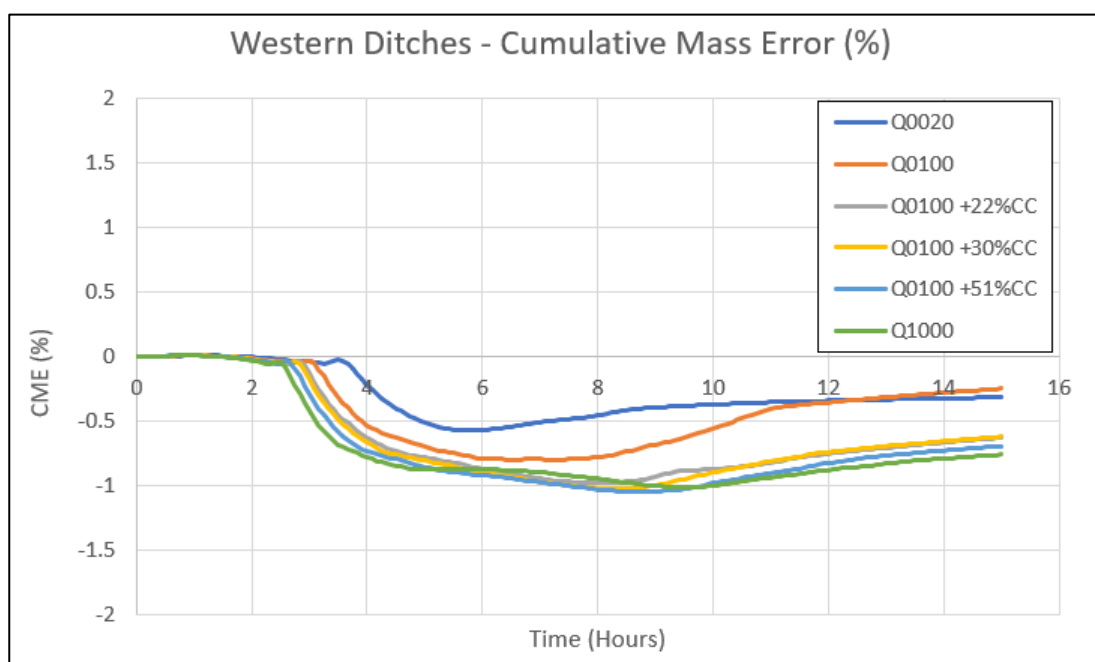


Figure 3.3: Western Ditches Cumulative Mass Error Plots (Baseline)

3.45 There were no warnings recorded during the simulation.

Model Runs

3.46 In order to achieve the study objectives, the simulations summarised in **Table 3.3** were completed.

Table 3.3: Model Runs

Model Scenario	Return Periods	Comments
Baseline Runs		
Baseline	1 in 20-Year 1 in 100-Year 1 in 1000-Year 1 in 100-Year +22%CC 1 in 100-Year +30%CC 1 in 100-Year +51%CC	Representative of 'as surveyed' conditions
Roughness +20%	1 in 100-Year	Floodplain, channel and structure roughness increased by 20%
Roughness -20%	1 in 100-Year	Floodplain, channel and structure roughness decreased by 20%
Downstream Boundary +	1 in 100-Year	Downstream boundary water level decreased by 100mm and 20% increase of gradient at HQ boundaries

Model Scenario	Return Periods	Comments
Downstream Boundary -	1 in 100-Year	Downstream boundary water level increased by 100mm and 20% decrease of gradient at HQ boundaries
Proposed Runs		
Proposed Design	1 in 20-Year 1 in 100-Year 1 in 100-Year +22%CC	Representative of 'post-development' conditions including the proposed watercourse diversion scheme
Blockage 1 (UOW001_01475)	1 in 100-Year	75% blockage of each opening
Blockage 2 (Representation of sewer network at locations 1B, 2B and 3D)	1 in 100-Year	75% blockage of three trunk sewers
Blockage 3 (R2_00071_PRO)	1 in 100-Year	75% blockage of proposed culvert
Blockage 4 (R4_00000)	1 in 100-Year	75% blockage

4. BASELINE RESULTS

- 4.1 The baseline floodplain extents are provided in **Appendix 5** and are summarised below.

UOW (R1)

- 4.2 The floodplain extents and levels at selected locations for the UOW (R1) are illustrated in **Figure 4.1** and **Table 4.1**.

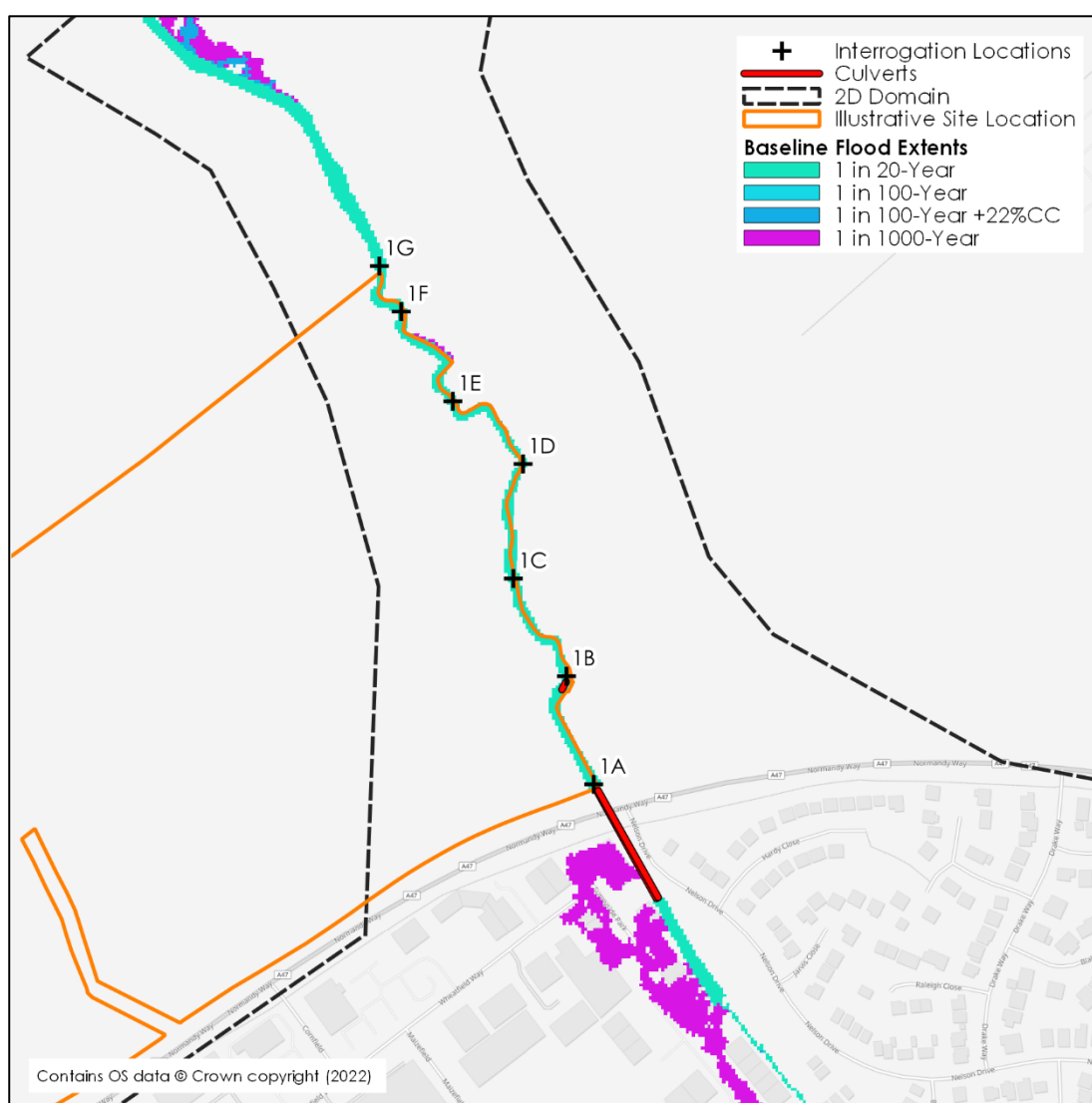


Figure 4.1: UOW (R1) Flood Extents

Table 4.1: UOW (R1) Peak Flood Levels (mAOD)

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year + 22%CC	1 in 1000-Year
1A	108.12	108.20	108.26	108.43

1B	107.23	107.41	107.51	107.73
1C	107.08	107.25	107.34	107.55
1D	106.84	107.00	107.08	107.27
1E	106.51	106.66	106.73	106.91
1F	106.12	106.28	106.35	106.51
1G	105.97	106.10	106.15	106.27

Flood Mechanisms

- 4.3 The flood mechanisms for the UOW (R1) are shown in **Figure 4.2** and are summarised below.

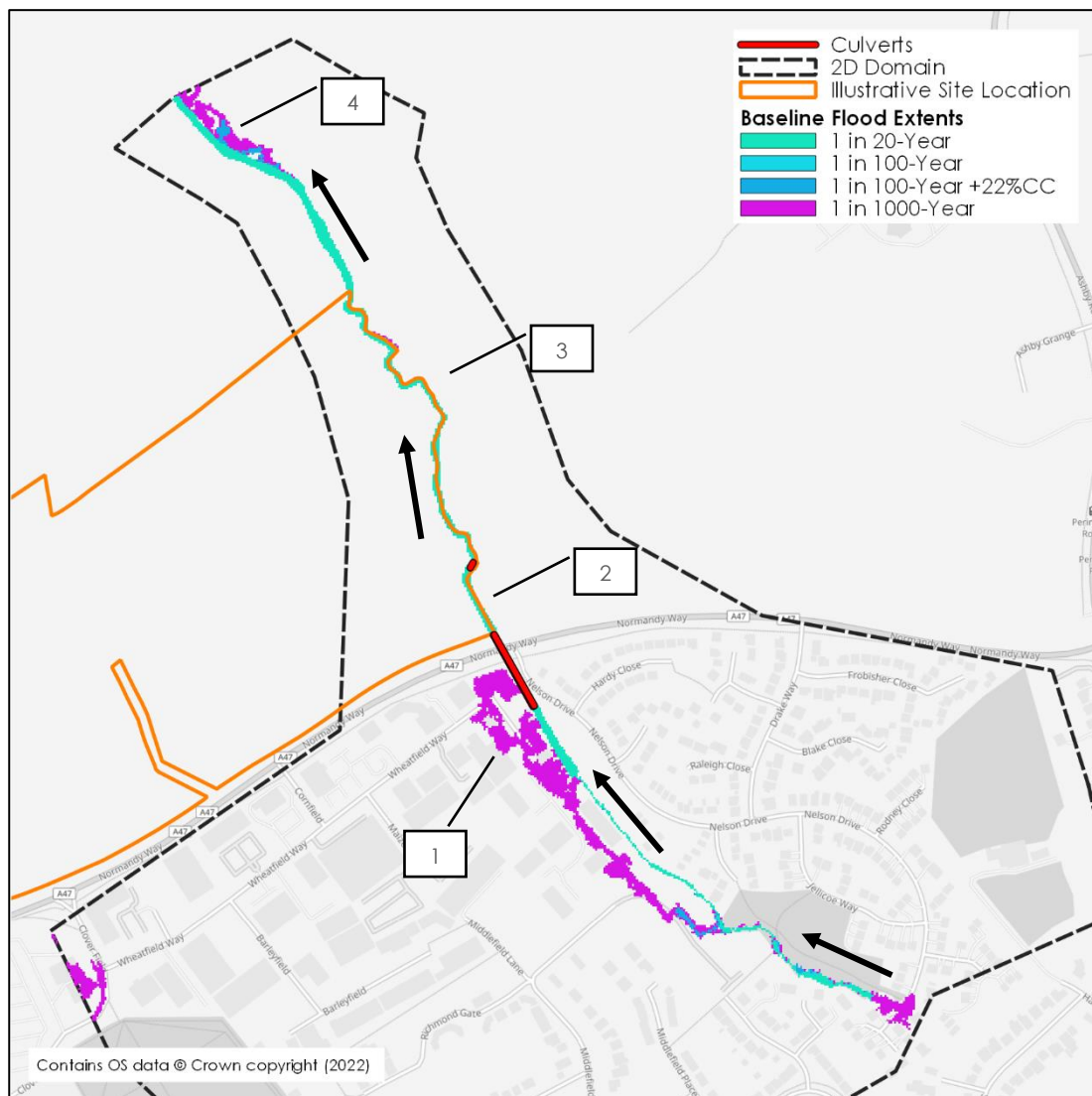


Figure 4.2: UOW (R1) Flood Mechanisms

1 – The UOW enters the site via twin 0.5m diameter culverts beneath Normandy Way. The structure is shown to have insufficient capacity to convey peak flows during the 1 in 1000-year event. Subsequently, the pipe becomes surcharged, resulting in localised flooding predicted immediately upstream.

2 – There are notable differences between the modelled 1 in 1000-year flood extent and the 1 in 1000-year surface water (low risk scenario) extent (see **Figure 1.6**). The surface water mapping does not explicitly represent culverts and structures and therefore is expected to provide a conservative representation of surface water flood risk at the site. The hydraulic model has represented the culvert (2 x 0.5m diameter pipes) beneath Normandy Way which has sufficient capacity to convey flows through the site for events up to the 1 in 1000-year. Subsequently, there is a reduction in flood extent when compared to the surface water mapping.

3 – As the UOW flows adjacent to the site, maximum water levels remain in-channel. Subsequently, the proposed residential development is located outside of all modelled flood extents from this watercourse.

4 – Downstream of the site, flood events in excess of the 1 in 100-year event are predicted to exceed the channel capacity, with evidence of overtopping along the right bank.

Western Ditches (R2, R3 and R4)

- 4.4 The floodplain extents and levels at selected locations for the western ditches (R2, R3 and R4) are illustrated in **Figure 4.3** and **Table 4.2**.

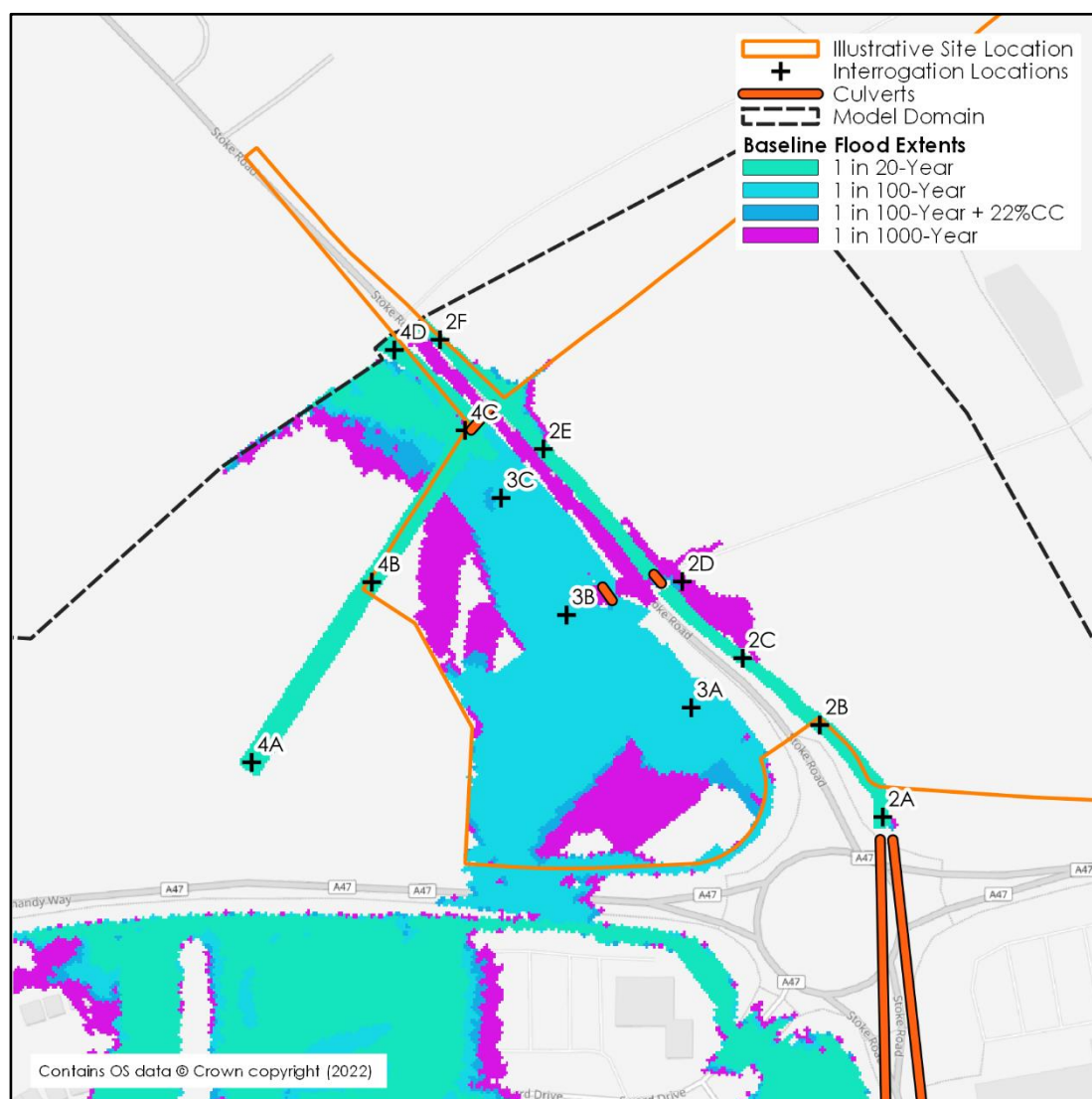


Figure 4.3: Western Ditches (R2, R3 and R4) Flood Extents

Table 4.2: Western Ditches (R2, R3 and R4) Peak Flood Levels (mAOD)

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year + 22%CC	1 in 1000-Year
2A	105.71	105.81	105.89	106.00
2B	105.48	105.65	105.78	105.88
2C	105.36	105.58	105.72	105.80
2D	-	-	-	105.74
2E	104.57	104.63	104.67	104.75
2F	104.01	104.02	104.03	104.04
3A	-	105.39	105.39	105.40

3B	-	105.11	105.12	105.13
3C	-	104.72	104.73	104.75
4A	104.57	104.62	104.66	104.75
4B	104.54	104.58	104.60	104.66
4C	104.54	104.57	104.59	104.64
4D	104.09	104.11	104.12	104.12

The flood mechanisms for the western ditches (R2, R3 and R4) are shown in **Figure 4.4** and are summarised below.

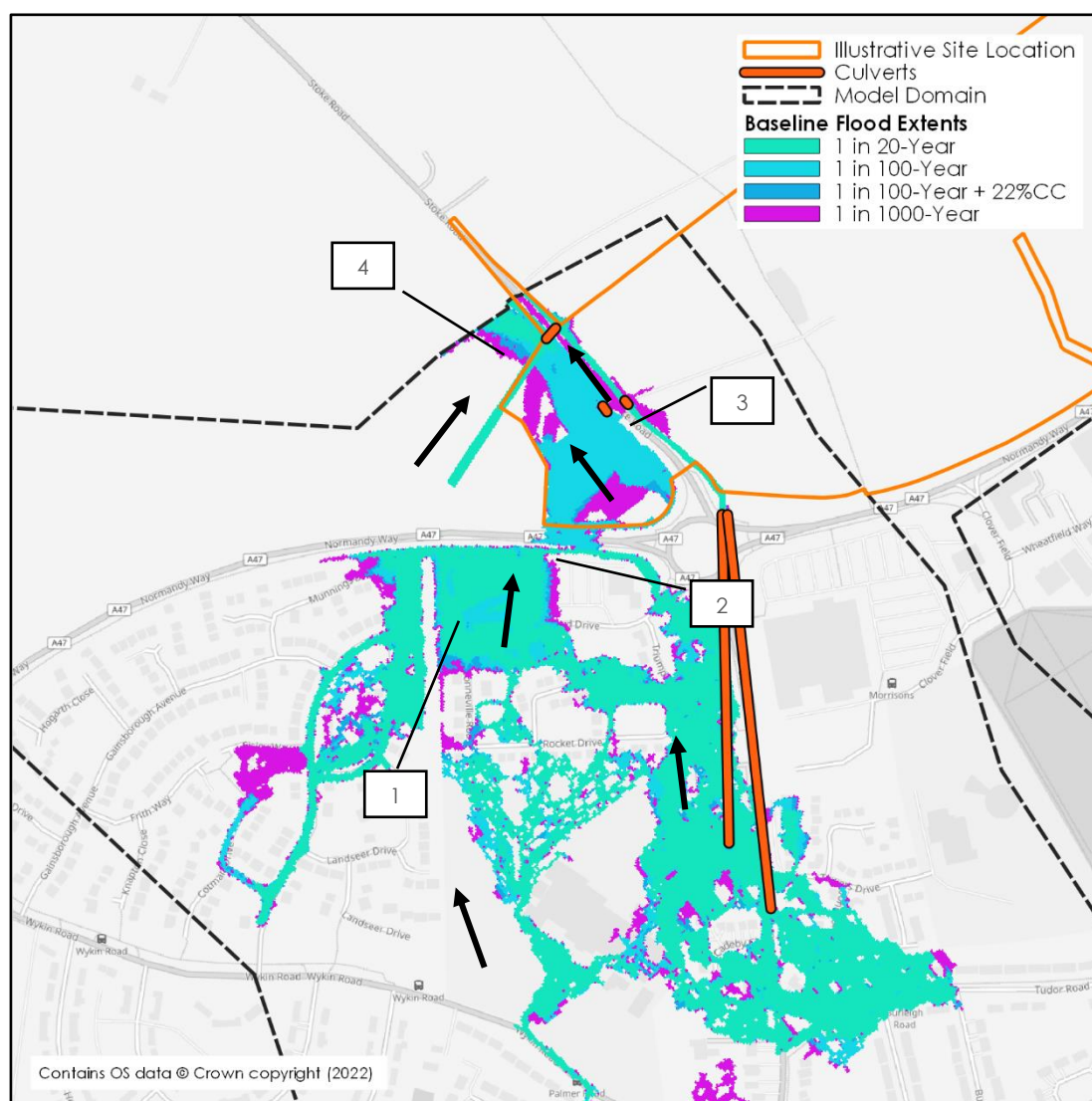


Figure 4.4: Western Ditches (R2, R3, R4) Flood Mechanisms

1 – The manholes represented within the upstream Severn Trent sewer network are predicted to surcharge during all events including the 1 in 20-year event. This subsequently results in out of bank flooding predicted upstream of Normandy Way for all modelled return periods. This aligns with known capacity issues in this area that have been raised by Severn Trent Water at the time of consultation.

2 – As a consequence of flood waters accumulating upstream of Normandy Way, the model predicts that the A47 will be overtopped during the 1 in 100-year return period and larger magnitude events. It is subsequently predicted that flood waters will be conveyed into the land parcel west of Stoke Road.

3 – During the 1 in 1000-year event, out of bank flooding is predicted at low levels of the eastern land parcel immediately adjacent to R2. This occurs due to the 600mm diameter culvert having insufficient capacity to convey peak flows for the 1 in 1000-year event without the right bank being overtopped. Ground levels on this bank are lower due to an incoming hedgerow with an associated drainage ditch.

4 - Flows also exceed channel capacity where R4 is assumed to converge with R2. This is understood to be associated with a restrictive irregular culvert and a topographical depression adjacent to the road between R3 and R4, which overland flows subsequently pool within.

5. PROPOSED DEVELOPMENT MODELLING

Philosophy

- 5.1 A new roundabout is proposed along Stoke Road in order to provide access to the proposed development. The proposed roundabout and associated access road into the site is shown to cross existing ditches that convey flows adjacent to Stoke Road.
- 5.2 As such, it is proposed to divert and culvert R2 around the roundabout and underneath the proposed access road within the site. It is proposed that R3 will also be diverted around the proposed roundabout and will discharge into R4.
- 5.3 This diversion scheme has been proposed to limit the extent of culverting beneath the proposed roundabout and to promote the daylighting of the watercourse.
- 5.4 No changes were made to the UOW (R1), which forms the eastern boundary of the proposed development.
- 5.5 A model schematic is included as **Appendix 6**.

Representation in Hydraulic Model

- 5.6 The baseline model was updated as follows:
 - R2 was diverted around the proposed roundabout within the site. The cross sections were amended to be 3m wide in total with a 0.8m width bed, 1:1 bank slopes and a gradient of 1:350.
 - A proposed box culvert (0.8m x 0.5m) was added to R2, allowing flows to pass beneath the proposed access road. The soffit level of the opening was set to 104.55mAOD, allowing for 0.95m of cover from the deck of the proposed access road. At this outline stage, the proposed road level of 105.50mAOD has been derived from the existing topographical survey in the absence of design levels. This is considered a conservative approach as it is anticipated that ground levels will be raised in the construction of the new access road and a larger culvert could be used. However, this initial representation of the culvert structure allows for an assessment of flood risk from the proposed design concept within the hydraulic model and to identify potential impacts to third party land. A schematic showing the proposed culvert is presented in **Figure 5.1**.
 - R3 was diverted around the southwestern perimeter of the proposed roundabout and outfalls into R4. The cross sections were also amended to be 3m wide in total with a 0.8m width bed, 1:1 bank slopes and a gradient of 1:350. Due to the proposed levels and contributing catchment, it was deemed acceptable to outfall the diverted R3 into R4.

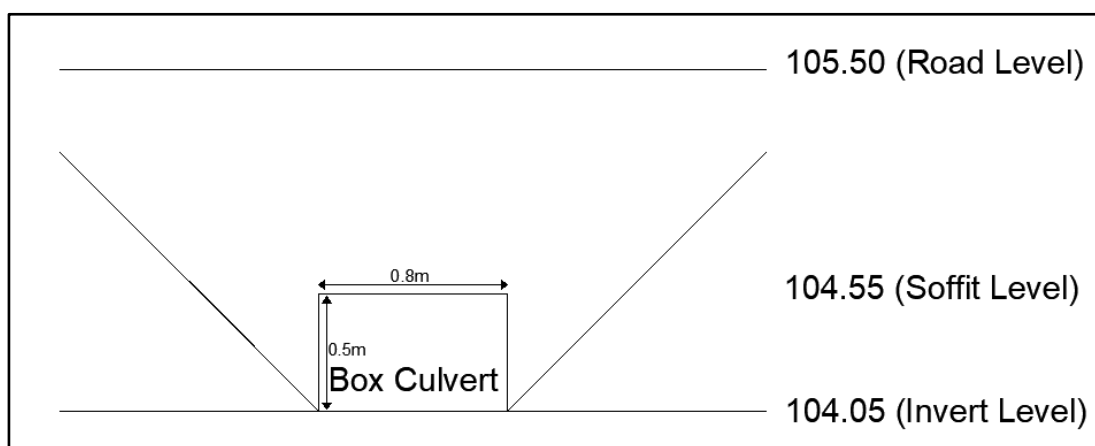


Figure 5.1: Modelled Schematic of Culvert Beneath Proposed Access Road

- 5.7 The model was simulated for the 20-year, 100-year and 100-year + 22% climate change events.

Model Results

- 5.8 The proposed development model results are included in **Figure 5.2** and **Appendix 7**.
- 5.9 The modelled flood levels are summarised in **Table 5.1**.

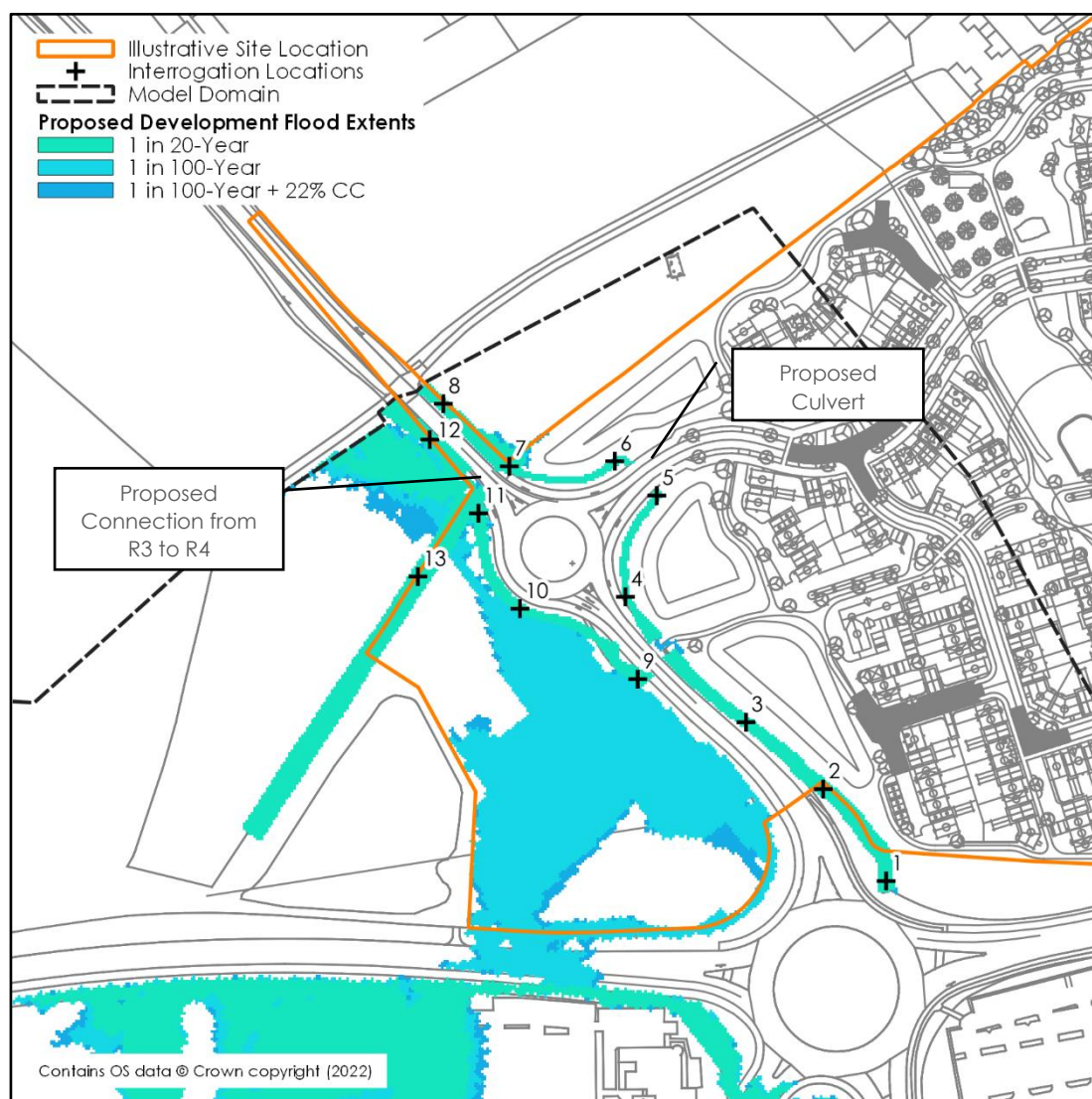


Figure 5.2: Proposed Development Floodplain Extents

Table 5.1: Proposed Development Peak Flood Levels (mAOD)

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year + 22%CC
1	105.71	105.81	105.89
2	105.48	105.65	105.78
3	105.36	105.58	105.72
4	104.78	104.92	105.04
5	104.67	104.86	104.99
6	104.56	104.63	104.67
7	104.49	104.54	104.57
8	104.01	104.02	104.03

ID	1 in 20-Year	1 in 100-Year	1 in 100-Year + 22%CC
9	104.52	104.57	104.61
10	104.52	104.57	104.59
11	104.52	104.57	104.59
12	104.28	104.31	104.32
13	104.52	104.57	104.59

Impact Analysis

- 5.10 The proposed development modelled peak flood levels have been compared to the equivalent baseline peak flood levels to establish off site impacts.
- 5.11 Based on the latest EA guidance, this has been assessed for events up to the 1 in 100-year + 22% climate change allowance event.
- 5.12 Impact analysis mapping is included in **Appendix 7**.
- 5.13 In the proposed modelling scenario, water is routed through the diverted channels. The proposed culvert underneath the access road and the proposed channel is shown to have sufficient capacity to convey flows for all events up and including to the 1 in 100-year + 22% climate change event. The roundabout is shown to be unaffected during all events up to and including the 1 in 100-year + 22% climate change event.
- 5.14 There is a minor decrease in peak flood levels to the east of R2, adjacent to the proposed development. For the majority of this reach there are no changes to peak flood levels as a result of the proposed diversion scheme.
- 5.15 The diversion of R3 is largely shown to result in no changes to peak flood levels, however, there is a decrease in flood levels where there have been topographic changes to divert the channel. As a direct consequence of this, there is subsequently a minor increase in flood levels adjacent to the channel, however these are confined to the immediate vicinity of the channel.

6. SENSITIVITY TESTING

- 6.1 To account for seasonal variations in vegetation and to ensure the robustness of boundary conditions, a series of sensitivity tests were conducted using the 1 in 100-year flood return period event. The difference in peak water level and floodplain extent between the sensitivity test scenarios and the 1 in 100-year baseline event are mapped in **Appendix 8**.
- 6.2 Robust sensitivity analysis also provides improved confidence in the model outputs, particularly in absence of calibration data.

Downstream Boundary

- 6.3 The modelled 1D downstream boundary is a HT boundary set in accordance with the top of bank or water level at the time of survey. The boundary was adjusted by 100mm within the sensitivity tests. The 2D HQ boundary slopes were also updated by 20%. These sensitivity tests were applied to the Baseline Scenario.
- 6.4 A 100mm increase in the HT boundary level and an increase in the slope gradient (20%) at the HQ boundaries leads to a decrease in peak flood level towards the downstream boundary of the UOW (R1). There is no change in peak flood levels or flood extents adjacent to the site. There are localised changes in peak flood level along the western ditches and a small, localised increase in modelled flood extent. The depths within the site boundary are shown to increase by 60mm in this area, as shown in **Appendix 8**.
- 6.5 A 100mm decrease in the HT boundary level and a reduction in the slope gradient (20%) at the HQ boundaries leads to an increase in peak flood level towards the downstream boundary of the UOW (R1). There is no change in peak flood levels or flood extents adjacent to the site. There are localised changes in peak flood level along the western ditches and a small, localised decrease in modelled flood extent. The depths within the site boundary are shown to decrease by 90mm in this area, as shown in **Appendix 8**.
- 6.6 Although there are differences in peak levels towards the downstream boundary, these effects do not propagate a significant distance upstream towards the site. This therefore indicates that the model results are not sensitive to changes to the downstream boundary.

Roughness Coefficients

- 6.7 The modelled roughness coefficients were determined from aerial imagery and site photographs. Increasing and decreasing the roughness values in the channel and structures as well as on the floodplain will test how seasonal variation and maintenance regimes may affect the flood risk posed to the development. These sensitivity tests were applied to the Baseline Scenario.
- 6.8 A 20% increase in Manning's n roughness coefficient, representative of a period without maintenance, leads to increased peak flood levels and floodplain extents

across the model domain. Adjacent to the site, peak flood levels are expected to increase by up to 90mm when compared to the baseline results.

- 6.9 This is to be expected given that an increase in roughness values across the floodplain will be associated with greater frictional forces against the flow of water. Subsequently, more flood water would likely be retained on the floodplain during these conditions, therefore resulting in a general increase in flood levels. Similarly, greater in-channel Manning's values would be expected to increase water levels as a rougher channel would detrimentally impact flows.
- 6.10 A 20% decrease in Manning's n roughness coefficient, representative of a period with maintenance, leads to reduced peak flood levels and floodplain extents across the model domain. Adjacent to the site, peak flood levels are shown to decrease by up to 100mm when compared to the baseline results.
- 6.11 This is to be expected, as the reduced roughness will increase the conveyance of the floodplain and culverts, allowing water to flow more freely through the system.

Blockage Scenarios

- 6.12 Blockage testing was applied at four locations. For each blockage scenario, a 75% blockage was applied. All simulations were run for the proposed scenario given the need to understand the impacts of blocking key proposed structures as part of the watercourse diversion scheme. The locations of the blockages are annotated on the respective mapping, provided in **Appendix 8**.

UOW (R1)

- 6.13 A blockage scenario was tested within the hydraulic model on the twin culverts underneath Normandy Way on the UOW (R1). Each opening is approximately 0.5m in width and therefore a 75% blockage was applied to each of the openings, which is considered appropriate due to their size. The flood levels around the culverts and upstream of the culverts are predicted to increase by up to 1.2m which results in a localised increase in flood extents adjacent to the culverts. Flood levels downstream of the culvert, adjacent to the site are shown to decrease by up to 0.03m.

Western Ditches (R2, R3 and R4)

- 6.14 The sewer network upstream of the western ditches is shown to be a key flood mechanism, as flows exceed the capacity of the sewer network, overtop Normandy Way and flow into the site. Therefore, a blockage scenario was also tested on the sewer network. A 75% blockage was applied to three trunk sewers at locations where flows are shown to exceed the network. There are localised increases to peak flood levels by up to 0.03m in close proximity to the sewer network with minor increases in flood extents. Flood levels within R2 are shown to decrease. The majority of the model domain shows no change to peak flood levels.
- 6.15 A blockage scenario was also tested on the proposed culvert underneath the proposed access road. A 75% blockage was applied to the cross-sectional area, which

is considered appropriate due to the size of the culvert. The flood levels around the culvert and upstream of the culvert are predicted to increase by up to 0.68m which results in an increase in flood extents. Water is shown to overtop the proposed roundabout and access road which results in a localised increase in peak flood levels adjacent to R3. Minor decreases in flood levels downstream of the culvert (approx. 0.02m) are predicted in this scenario.

- 6.16 A final blockage scenario was tested on the existing culvert underneath Stoke Road which connects R4 to R2. A 75% blockage was applied to the opening, which is considered appropriate due to the site of the culvert. The flood levels around and upstream of the culvert are predicted to increase by up to 0.02m which results in an increase in flood extents. Minor decreases in flood levels downstream of the culvert (approx. 0.06m) are predicted in this scenario.
- 6.17 While the blockage scenarios are shown to result in localised increases in peak flood levels near the site, this does not result in increased flood risk to the residential development. As the proposed roundabout and access road are shown to be affected by the blockage of the proposed culvert, hazard mapping has been produced for this scenario and is included as **Appendix 8**. The hazard mapping shows that the proposed access road and roundabout is at a 'Low' hazard rating (<0.75).

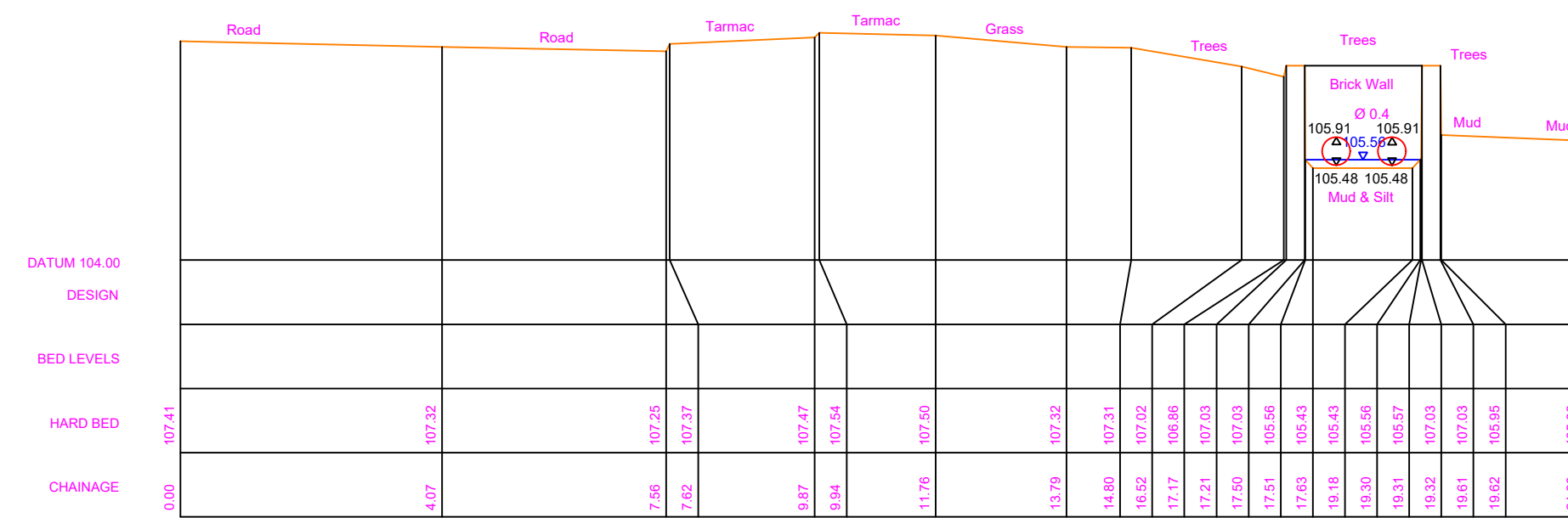
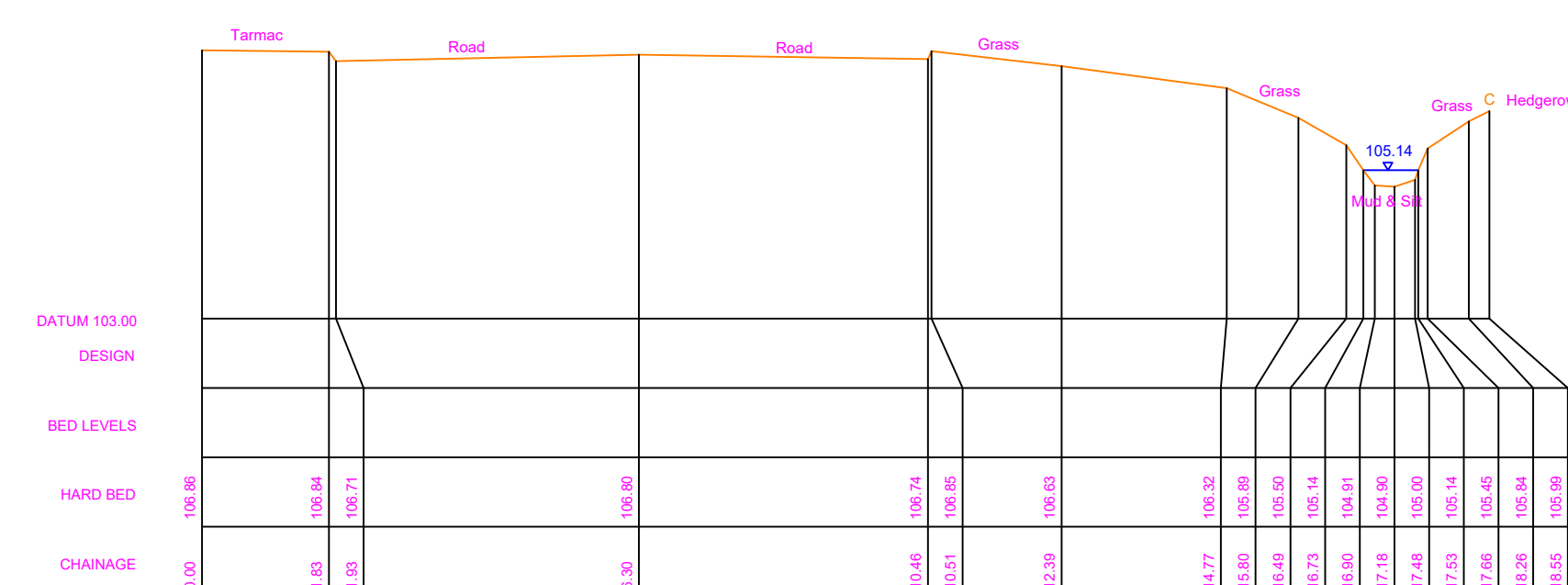
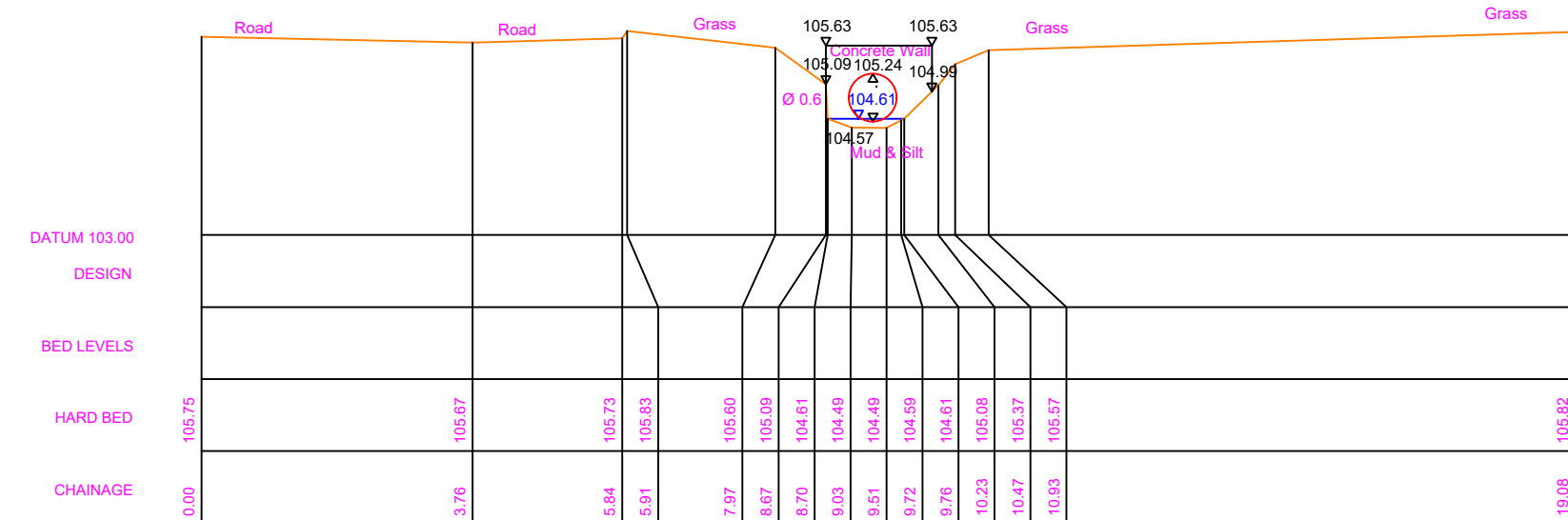
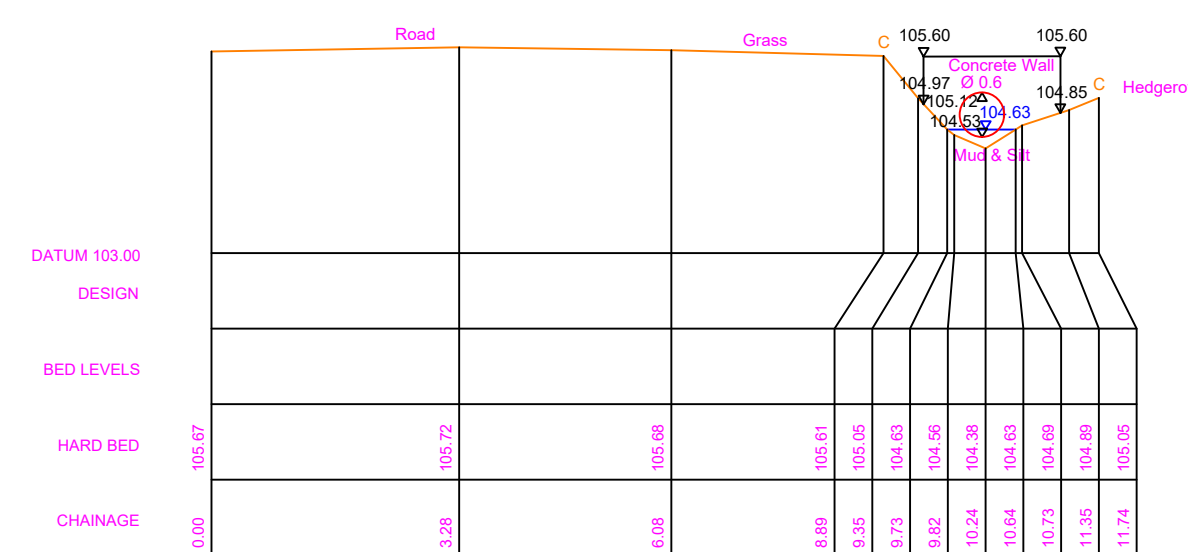
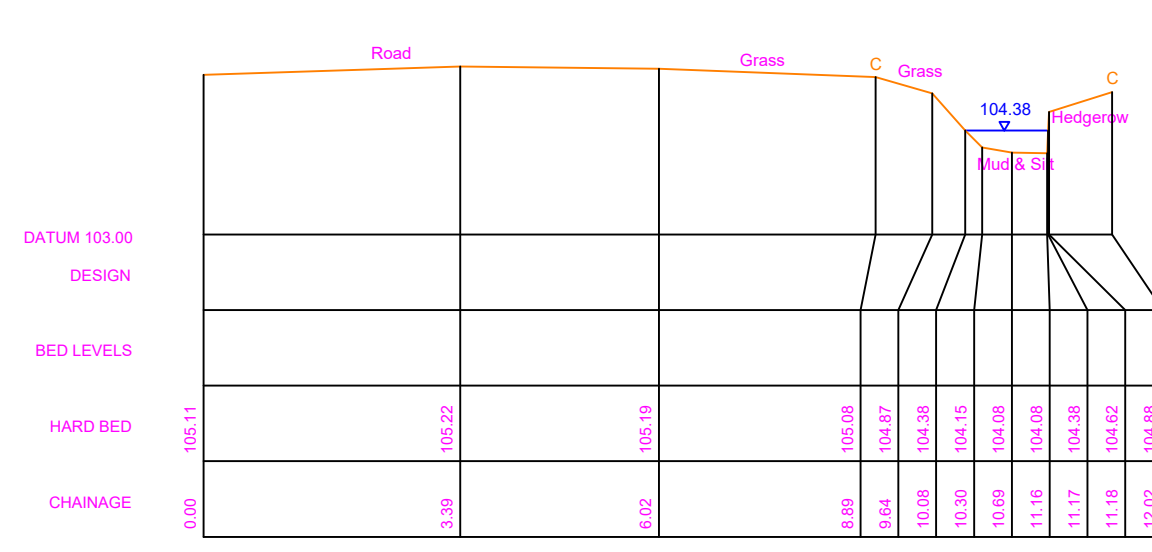
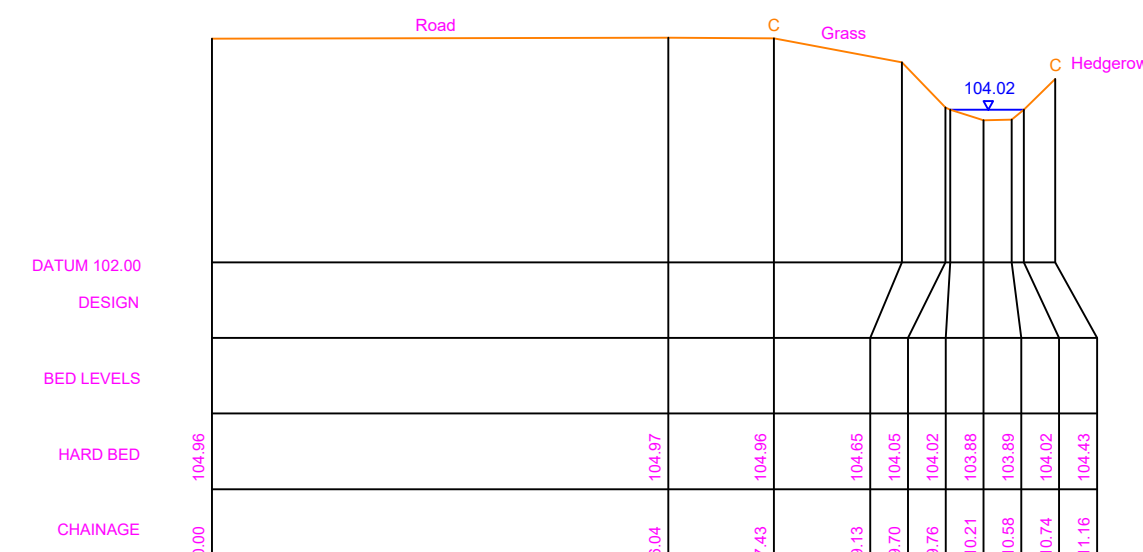
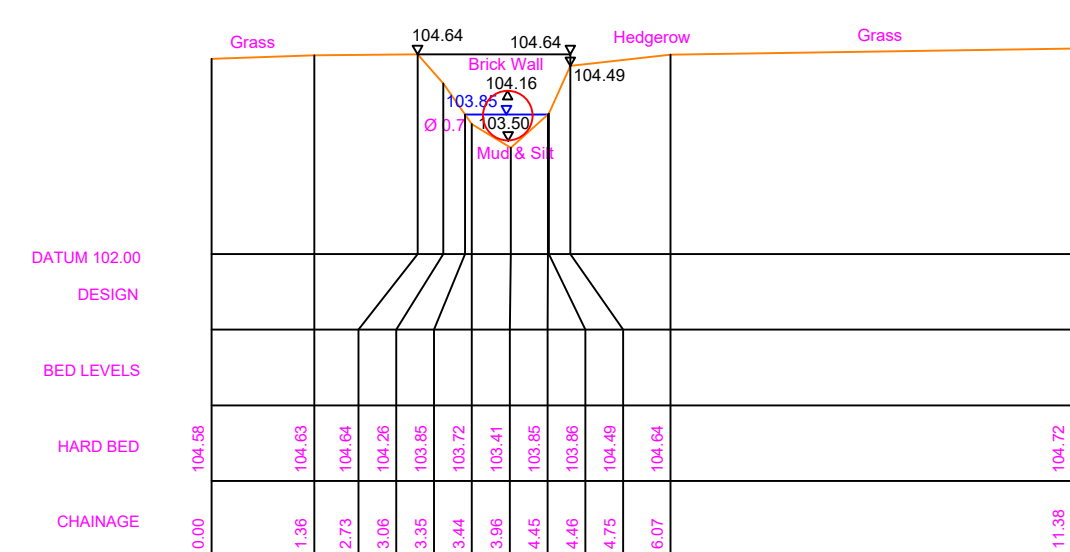
7. SUMMARY & RECOMMENDATIONS

- 7.1 Please note that this conclusion should be read in conjunction with the study limitations and assumptions in **Section 1**.
- 7.2 BWB Consulting Ltd has been commissioned by Richborough Estates Limited and Mr & Mrs Adcock to undertake a site-specific hydraulic modelling exercise of an Unnamed Ordinary Watercourse (UOW) and a series of ditches to support a residential development to the North of Hinckley.
- 7.3 The modelled flood flows have been informed by a hydrological review of the catchment associated with the UOW (R1) and western ditches within the vicinity of the site. The latest climate change allowances have been incorporated into the hydrological assessment.
- 7.4 The baseline model results provide a representation of surface water sewers within the hydraulic model. By representing the capacity of the sewer network, greater confidence in flooding mechanisms can be taken from the outputs of the hydraulic modelling study than what is otherwise provided by existing datasets (such as the EA surface water mapping). The baseline results show the UOW (R1) to remain in channel for all events adjacent to the site.
- 7.5 Flows are predicted to exceed the capacity of the Severn Trent Water trunk sewers within the residential development south of the site, leading to the manholes surcharging and overland flow being directed to the west of the site. Within the western ditches, R2 is shown to overtop both banks adjacent to the access track on the eastern side of Stoke Road, this is due to a restrictive 600mm diameter culvert. Water also marginally overtops where R4 is assumed to converge with R2, which is associated with a restrictive irregular culvert and a topographical depression adjacent to the road which water pools within.
- 7.6 A new roundabout is proposed along Stoke Road in order to provide access to the proposed development. As such, it is proposed to divert and culvert R2 around the roundabout and underneath the proposed access road within the site. It is proposed that R3 will also be diverted around the proposed roundabout and will discharge into R4. The proposed culvert underneath the access road and the proposed channel is shown to have sufficient capacity to convey flows for all events up to and including the 1 in 100-year + 22% climate change event. The roundabout is shown to be unaffected during all events up to and including the 1 in 100-year + 22% climate change event.
- 7.7 Sensitivity testing demonstrates that a 20% increase and decrease in Manning's n roughness coefficient leads to increased and decreased peak flood level and floodplain extents respectively.
- 7.8 Blockages of culverts result in increased flood levels and increases in flood extents within the site and within the vicinity of the site. However, the increased flood levels and extents do not increase risk to the residential development as it remains outside of the floodplain in these scenarios.

- 7.9 Additional testing shows the model results are sensitive to changes in downstream boundary in the immediate vicinity of the boundaries. However, further upstream from this, at the site, there is no change in peak flood levels.
- 7.10 The sensitivity tests do not have implications for flood risk to the residential development, which has been raised above peak flood levels. The proposed roundabout and access road is at residual risk of flooding in a blockage scenario, however this results in a 'Low' hazard rating. Subsequently, it is considered that safe access and egress from the site can be maintained.

APPENDICES

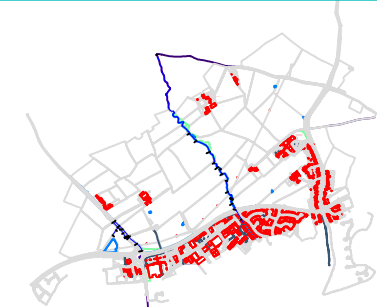
Appendix 1: River Channel Survey



- ### Note

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. No scale factor has been applied to this survey, therefore the co ordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via GPRS (not internet).
7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
8. OS licence number: 100022432

Key Plan



Legend

- | | | | |
|--|--------------------|--|--|
| | OS Buildings | | Contour Lines |
| | Surveyed Buildings | | Inspection Chamber |
| | Buried | | Flow direction and
pipe diameter |
| | Wall | | Station and Name |
| | Kerb Channel Line | | Monitoring Borehole |
| | Top Earth | | Trees / Bush / Seeping |
| | Edge of Surface | | Area of Vegetation/
Extent of Tree Canopy |
| | Top of Bank | | Hedge |
| | Bottom of Bank | | Body of Water |
| | Canopy / Overhang | | Body of Water from O
Spoon Level |
| | Line Cancellation | | Assumed Surface |
| | Centre Line | | Water Drainage Line |
| | Watercourse | | Surface Water Drainage |
| | Centre Line | | |
| | Barrier | | |
| | Fence | | |
| | Overhead Powerline | | |
| | Overhead Utilities | | |

- | | | | | | |
|-----|--------------------|----------------------|----------------------|-----|-------------------|
| AG | Ancher Plot | FBW | Fence Barbbed Wire | LB | Litter Bin |
| BP | Back Gully | FCB | Fence Closed Board | LP | Lamp Post |
| BO | Bollard | FCL | Fence Chain Link | MR | Manhole |
| BS | Bus Stop | FEL | Fence Electric | MZ | Service Marker |
| BT | Buttress Telecom | FM | Fence Metal Panel | MB | Mail Box |
| C | Curb | FMR | Fence Metal Railing | PT | Post |
| CL | Cover Level | FOB | Fence Open Board | RE | Reeding Eye |
| CMP | Cache Marker | FWF | Fence Post & Wire | SP | Sign Post |
| CS | CS/Security Camera | FSP | Fence Steel Post | ST | Stop Sign |
| CTV | CTV Camera | FPM | Fence Plastic Mesh | SV | Stove |
| CTV | CTV Camera | FPL | Finished Floor Level | TGB | Telephone |
| CD | Drainage | FP | Flagpole | CB | Cell Box |
| CH | Channel | Gas | Gas | THL | Threshold Level |
| DK | Down Pipe | GL | Gully | TL | Traffic Light |
| DP | Down Pipe | GU | Gully | TP | Telegraph Post |
| Ele | Electric | H | Height | TS | Traffic Signal |
| EP | Electricity Post | IC | Interception Chamber | UTS | Unsure to Survive |
| FI | Fire Hydrant | IFL | In Floor Level | W | Water |
| FL | Fire Hydrant | IL | Invert Level | WM | Water Meter |
| FL | Floodlight | (as a reduced level) | | WO | Wash Out |

P1	09/02/22	First Issue	IR	DS
Rev	Date	Details of issue / revision	Drawn	Revised

Issues & Revision



Client

RICHBOROUGH ESTATES LTD

Project Title

HINCKLEY NORTH

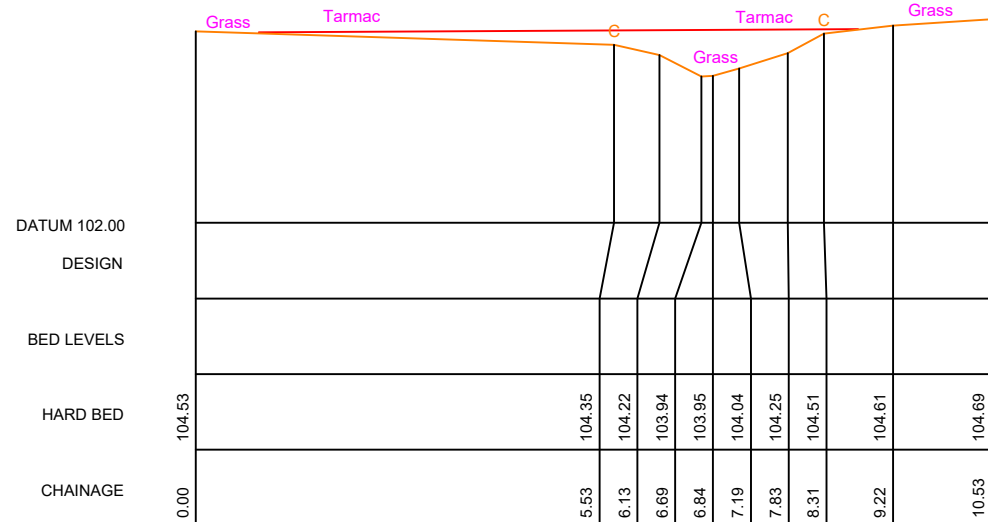
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**WATERCOURSE SURVEY
REACH 2
SHEET 2 OF 6**

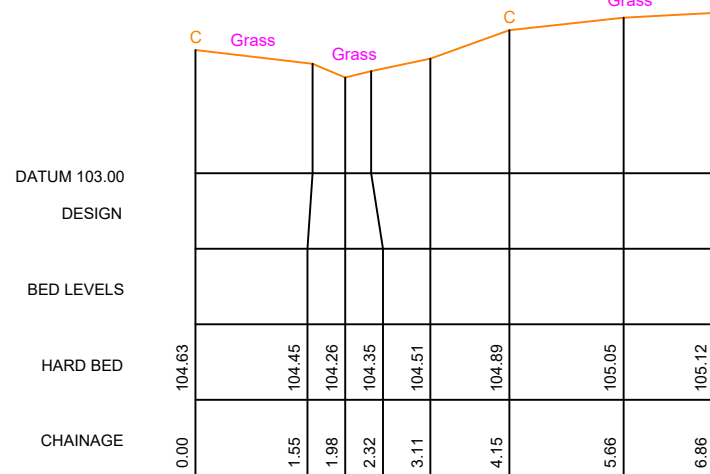
Drawn:	I.Riley	Reviewed:	D.Smith

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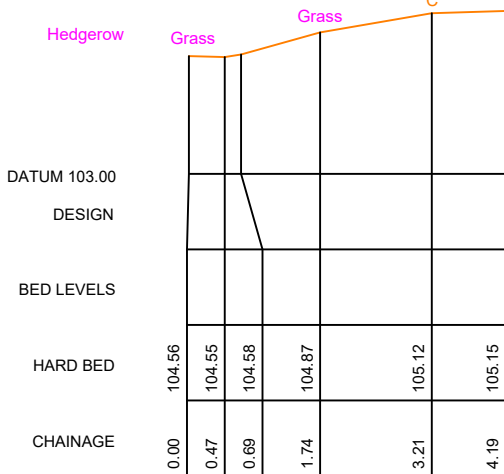
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HIN-BWB-02-ZZ-M2-G-0060	S2	P1



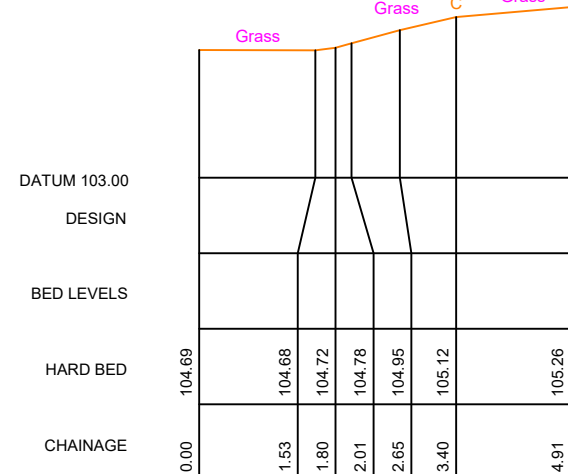
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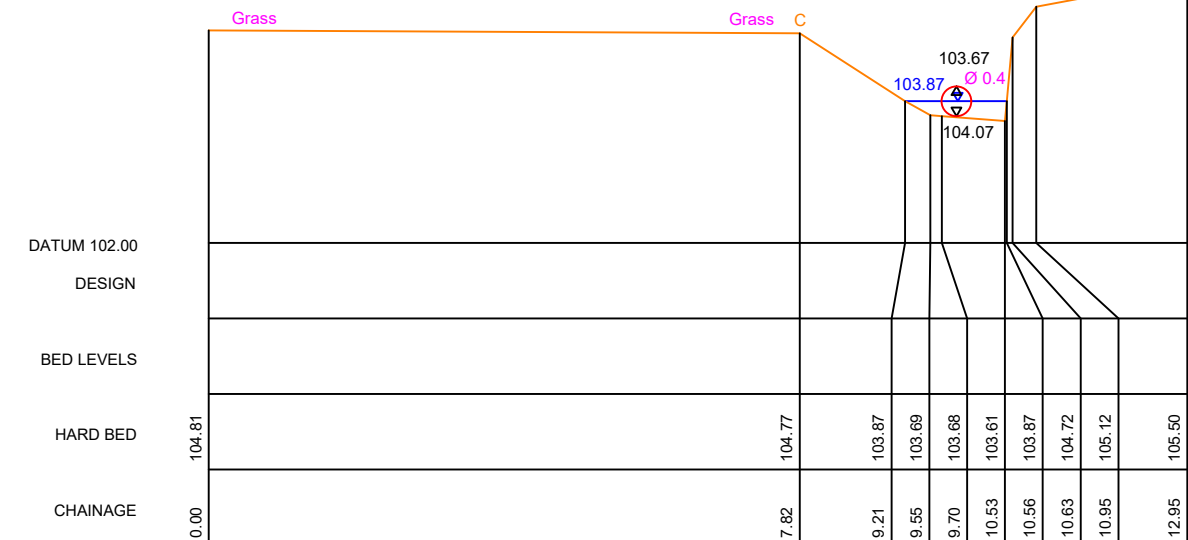
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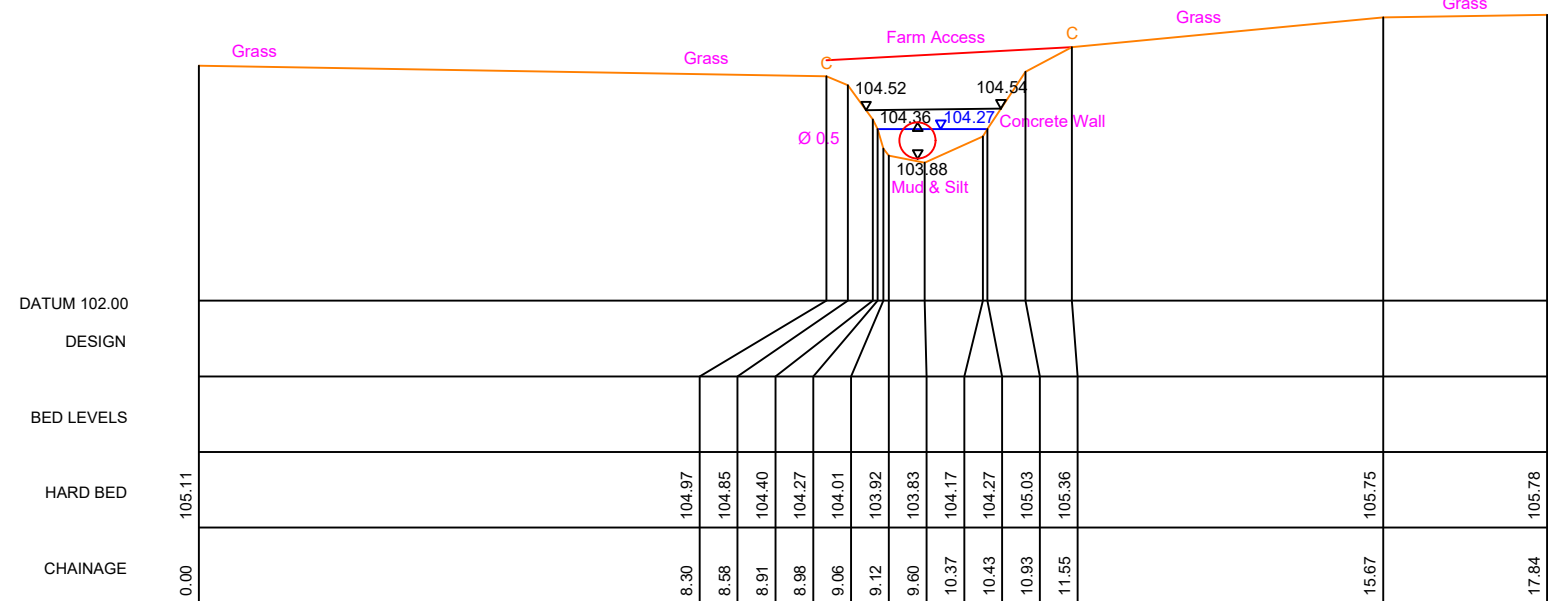
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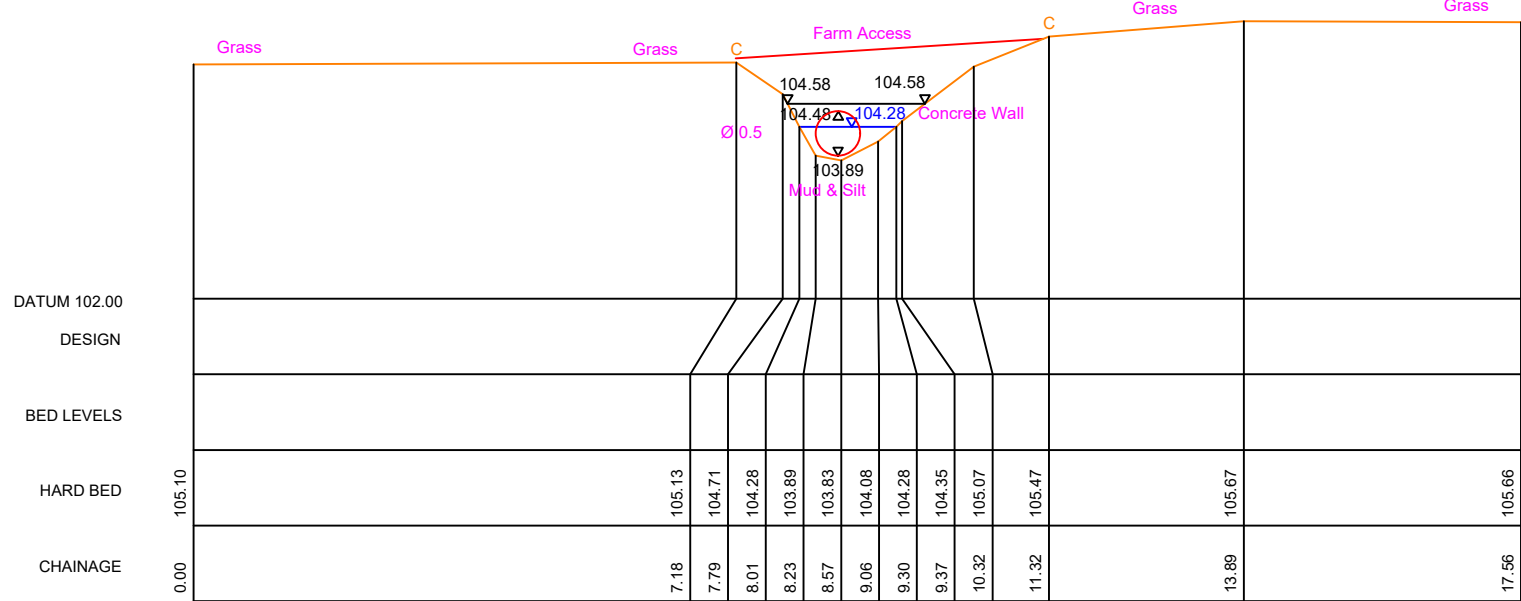
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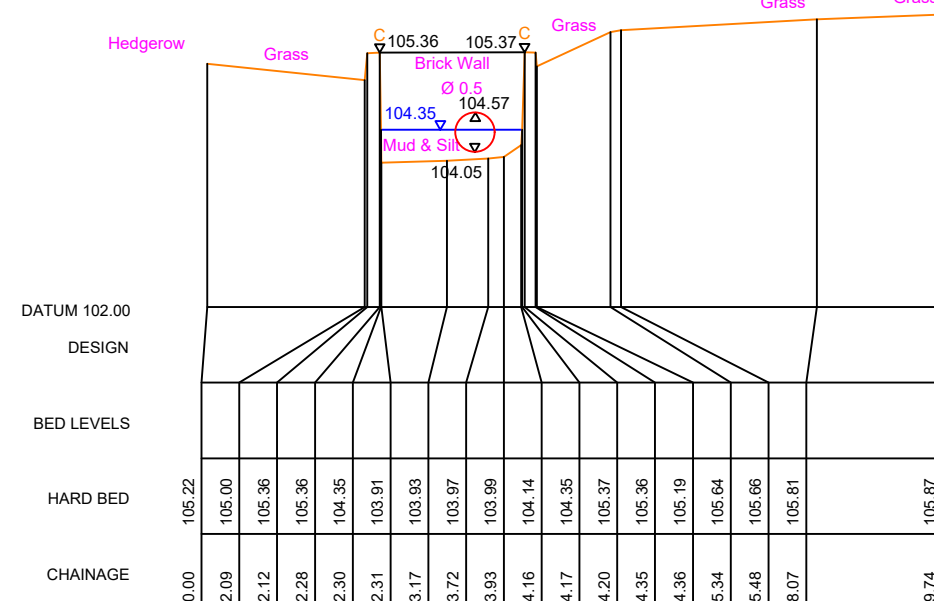
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Culvert



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Culvert



R3_00153
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Culvert

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- All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
- OS license number: 100022432

Key Plan



Legend

- OS Buildings
- Surveyed Buildings
- Building
- Wall
- Kerb Channel Line
- Edge of Kerb
- Top of Surface
- Bottom of Bank
- Canopy / Overhang
- Line Marking
- Centre Line
- Watercourse
- Centre Line
- Barrier
- Fence
- Gate
- Overhead Powerline
- Overhead Utilities
- Contour Lines
- Inspection Chamber
- Flow direction and pipe diameter
- Station and Name
- Monitoring Borehole
- Tree / Bush / Sapping
- Area of Vegetation/ Extant of Tree Canopy
- Hedge
- Body of Water
- Body of Water from OS
- Spot Level
- Assumed Surface
- Water Drainage Line
- Surface Water Drainage Line

- AP Anchor Point
- BO Back Gully
- BO Boltard
- BS Bus Stop
- BT British Telecom
- C Crest
- CL Cover Level
- CMP Cable Marker
- CCTV/Security Camera
- CIV Cable TV
- DC Drainage
- DK Drain Kerb
- DP Down Pipe
- Elec Electric
- EP Electricity Post
- ER Earth Road
- FH Fire Hydrant
- FL Floodlight
- FBW Fence Barbed Wire
- FOB Fence Closed Board
- FCL Fence Chain Link
- FEL Fence Electric
- FMP Fence Metal Panel
- FMR Fence Metal Rolling
- FOB Fence Open Board
- FPW Fence Post & Wire
- FSP Fence Steel Pipeline
- FWM Fence Wire Mesh
- FYP Finished Floor Level
- Gas Gas
- OV Gas Valve
- GUY Gully
- HT Height
- IC Inspection Chamber
- FCL Internal Floor Level
- IL Invert Level
- LB Litter Bin
- LP Lamp Post
- MH Manhole
- MV Service Marker
- PS Post Box
- PT Post
- RE Roadside Eye
- SP Sign Post
- ST Stop Sign
- SV Stop Valve
- TGB Telephone
- Call Box
- THL Threshold Level
- TL Traffic Light
- TP Telegraph Post
- TS Traffic Signal
- UTS Unable to Survey
- VL Water Level
- WM Water Meter
- WO Wash Out

P1	09.02.22	First Issue	IR	DS
Rev	Date	Details of issue / revision	Dw	Rev

Issues & Revisions

- Birmingham | 0121 233 3322
- Leeds | 0113 233 8000
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- Manchester | 0161 233 4260
- Nottingham | 0115 924 1100
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Client
RICHBOROUGH ESTATES LTD

Project Title
HINCKLEY NORTH

Drawing Title
**WATERCOURSE SURVEY
REACH 3
SHEET 3 OF 6**

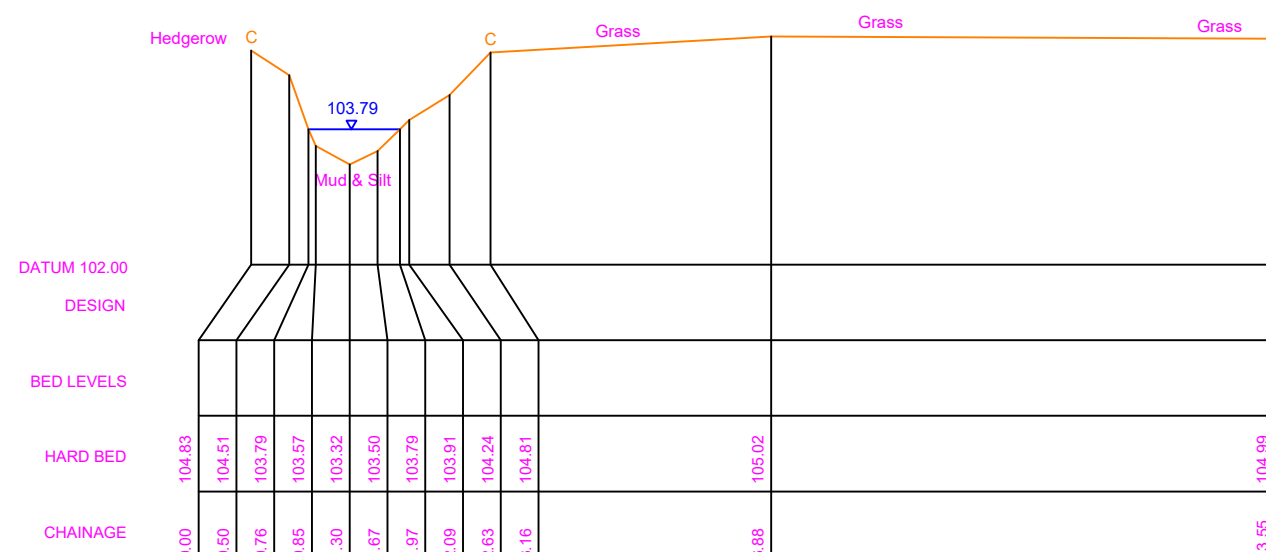
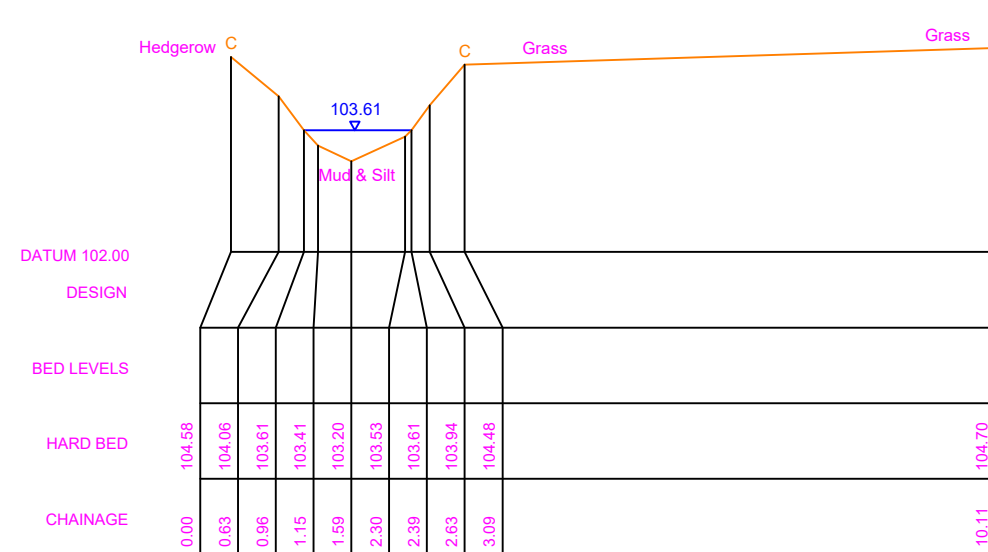
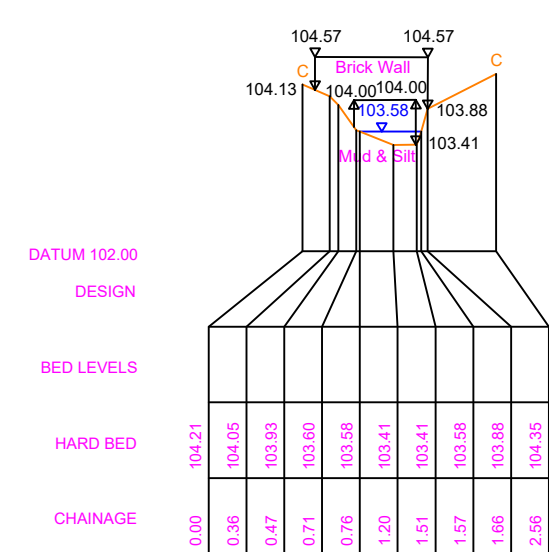
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BWB Ref: 210683
Date: 09.02.22
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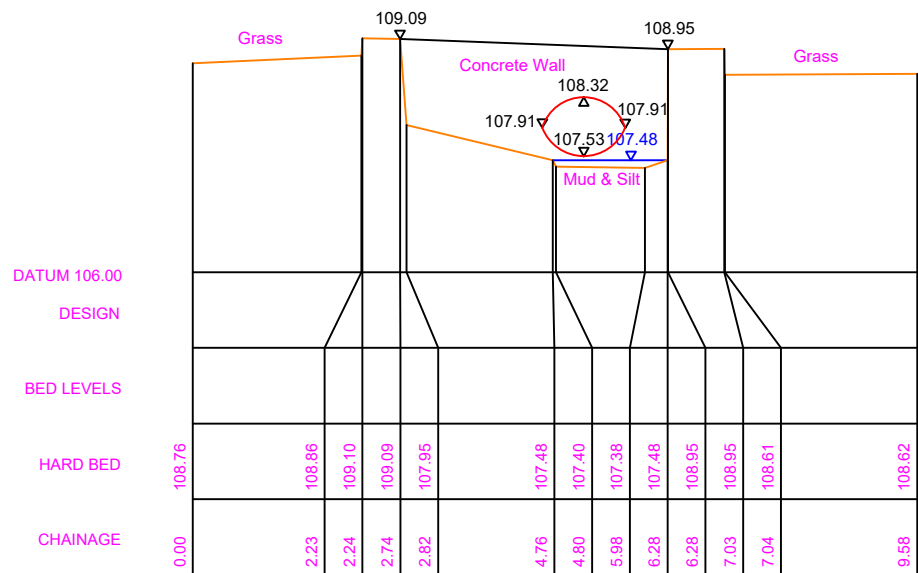
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Project - Originator - Zone - Level - Type - Role - Number
HIN-BWB-03-ZZ-M2-G-0060

Status
S2

Rev
P1



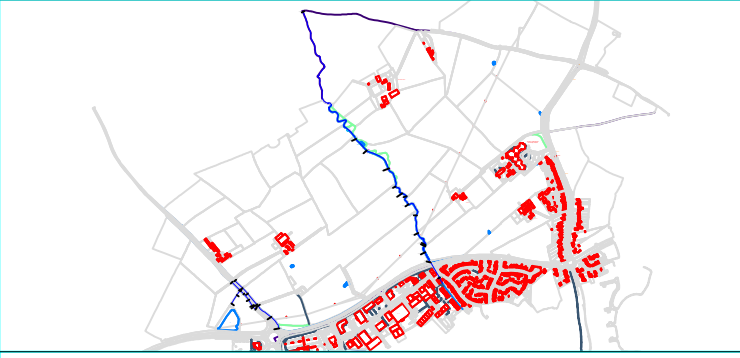


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Notes

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8. OS license number: 100022432

Key Plan



Legend

	OS Buildings		Contour Lines
	Surveyed Buildings		Inspection Chamber
	Building		Flow direction and pipe diameter
	Wall		Station and Name
	Kerb Channel Line		Monitoring Borehole
	Top of Kerb		Tree / Bush / Sapling
	Edge of Surface		Area of Vegetation/ Extent of Tree Canopy
	Top of Bank		Hedge
	Bottom of Bank		Body of Water
	Canopy / Overhang		Body of Water from OS
	Line Marking		Spot Level
	Centre Line		Assumed Surface
	Watercourse		Water Drainage Line
	Centre Line		Surface Water Drainage Line
	Barrier		
	Fence		
	Gate		
	Overhead Powerline		
	Overhead Utilities		

AP	Anchor Point	FBW	Fence Barbed Wire	LB	Litter Bin
BO	Back Gully	FOB	Fence Chain Board	LP	Lamp Post
BO	Bollard	FCL	Fence Chain Link	MH	Manhole
BS	Bus Stop	FEL	Fence Electric	MV	Service Marker
BT	British Telecom	FMP	Fence Metal Panel	PS	Post Box
C	Crest	FMR	Fence Metal Rolling	PT	Post
CL	Cover Level	FOB	Fence Open Board	RE	Rodding Eye
CMP	Cable Marker	FPW	Fence Post & Wire	SP	Sign Post
Post	Post	FSP	Fence Steel Pile/ stake	ST	Stop Tap
CCTV/Security Camera	FWM	Fence Wire Mesh	SV	Stop Valve	
CTV	Cable TV	FFL	Finished Floor Level	TGB	Telephone Call Box
DC	Drainage	FP	Flagpole	THL	Threshold Level
DK	Drop Kerb	OV	Gas Valve	TL	Traffic Light
DP	Down Pipe	GY	Gully	TP	Telegraph Post
Ele	Electric	HS	Height	TS	Traffic Signal
EP	Electricity Post	IC	Inspection Chamber	UTS	Unable to Survey
ER	Earth Road	IFL	Internal Floor Level	WL	Water Level
FH	Fire Hydrant	IL	Invert Level	WM	Water Meter
FL	Floodlight		(as a reduced level)	WO	Wash Out

P1	09.02.22	First Issue	IR	DS
Rev	Date	Details of issue / revision	Dw	Rev

Issues & Revisions

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Client

RICHBOROUGH ESTATES LTD

Project Title

HINCKLEY NORTH

Drawing Title

**WATERCOURSE SURVEY
REACH 5
SHEET 5 OF 6**

Drawn:	I.Riley	Reviewed:	D.Smith
BWB Ref:	210683	Date:	09.02.22
Scale@A0:	1:100		

Information

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-05-ZZ-M2-G-0060	S2	P1

Appendix 2: Hydrological Assessment

ENVIRONMENT

Richborough Estates Limited and Mr & Mrs
Adcock
Land East of Stoke Road and North of Normandy
Way (A47)
Hinckley
Flow Estimation Record

ENVIRONMENT

Richborough Estates Limited and Mr & Mrs Adcock
Land East of Stoke Road and North of Normandy Way (A47)
Hinckley
Flow Estimation Record

Birmingham
Livery Place, 35 Livery Street, Colmore Business District
Birmingham, B3 2PB
T: 0121 233 3322

Leeds
Whitehall Waterfront, 2 Riverside Way
Leeds, LS1 4EH
T: 0113 233 8000

London
11 Borough High Street
London, SE1 9SE
T: 0207 407 3879

Manchester
11 Portland Street
Manchester, M1 3HU
T: 0161 233 4260

Nottingham
5th Floor, Waterfront House, Station Street
Nottingham, NG2 3DQ
T: 0115 924 1100

March 2022

DOCUMENT ISSUE RECORD

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Checked:	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM
Approved:	Max Brambani BSc (Hons) PgCert MCIWEM

Rev	Date	Status	Comment	Author:	Checked:	Approved:
P01	25/03/22	S2	Preliminary Issue	LR	CG	MB

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- (i) The date on which this assessment was undertaken, and
- (ii) The date on which the final report is delivered

BWB Consulting makes no representation whatsoever concerning the legal significance of its findings or the legal matters referred to in the following report.

All Environment Agency mapping data used under special license. Data is current as of March 2022 and is subject to change.

The information presented, and conclusions drawn, are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

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1. METHOD STATEMENT

Overview of Requirements

- 1.1 Flow estimates are required for input into a hydraulic model of an Unnamed Ordinary Watercourse (UOW) and ditches within the vicinity of the site to quantify the flood risk posed to the development site. The UOW is located to the east of the site and forms a single eastern catchment. The ditches are located to and within the west of the site and form two western catchments. For the purposes of this assessment all features have been given a UOW site code prefix.
- 1.2 The location of the site of interest and the watercourses to be modelled are provided in **Figure 1.1**.

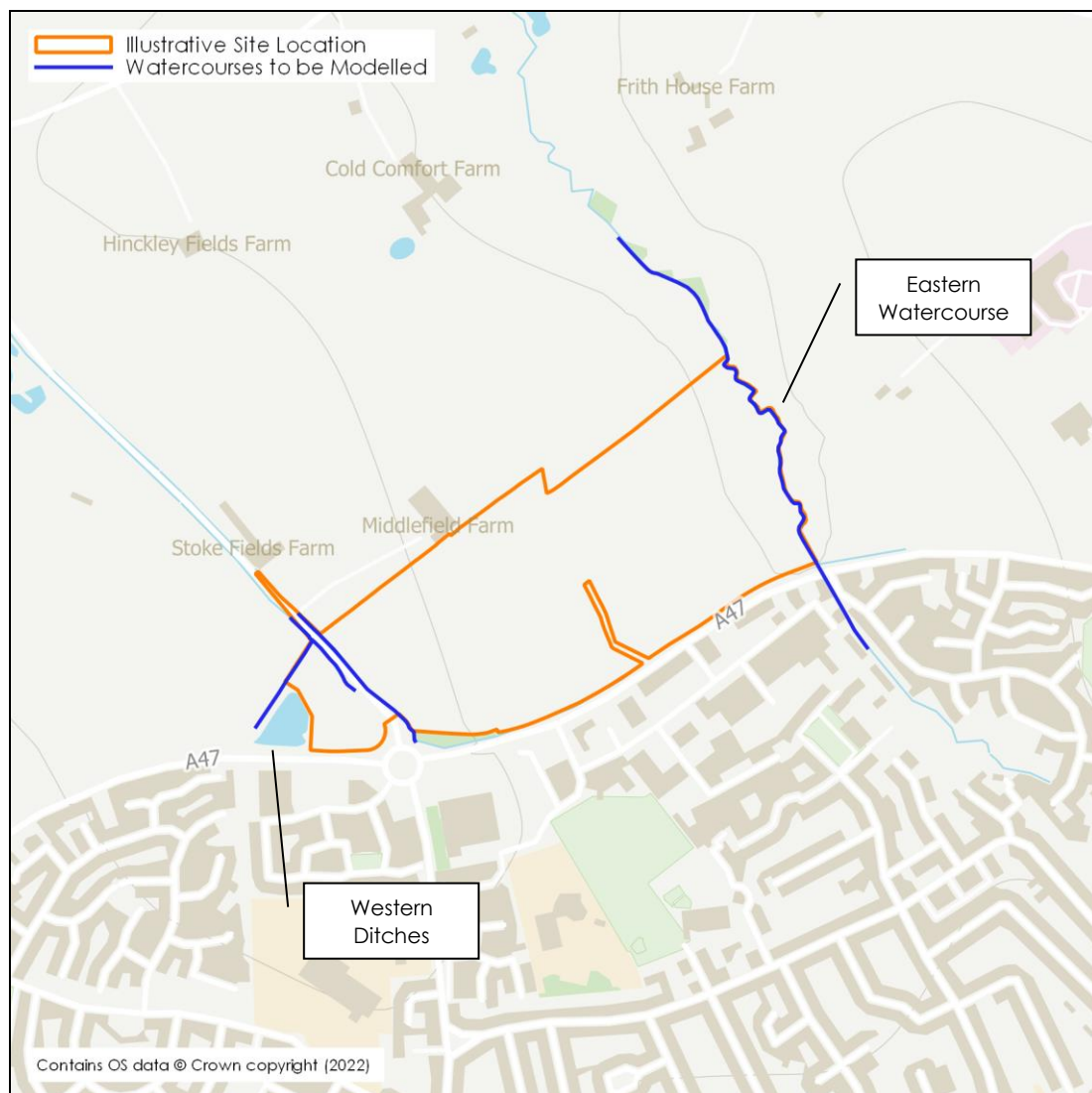


Figure 1.1: Site Location Plan

- 1.3 Return periods to be assessed include: 5, 10, 20, 50, 75, 100, 200 and 1000-years. To inform the design event and potential future floodplain, the 1 in 100-year event with a

range of climate change allowances applied will also be simulated. Hydrographs are required as well as peak flows.

- 1.4 The hydrological assessment was undertaken in February 2022. Version 5 of the Environment Agency (EA) Flood Estimation Guidelines¹ was referred to throughout the hydrological analysis.

Climate Change

- 1.5 Predicted future change in peak river flows caused by climate change are provided by the EA, with a range of projections applied to regionalised 'River Basin Districts', which are further sub-divided into 'Management Catchments'.
- 1.6 The catchments fall within the Tame Anker and Mease Management Catchment of the Humber River Basin District. **Table 1.1** identifies the relevant peak river flow allowances from this Management Catchment.

Table 1.1: Peak River Flow Allowance for the Tame Anker and Mease Management Catchment within the Humber River Basin District

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Upper End	24%	30%	51%
Higher Central	15%	17%	30%
Central	10%	11%	22%

- 1.7 When determining the appropriate allowance, the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of a future development should be considered. **Table 1.2** provides a matrix summarising the EA's guidance on determining the appropriate allowances.

Table 1.2: Application of the Appropriate Climate Change Allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1	Use the central allowance where a location may fall within Flood Zone 2 or 3 in the future.				
2	Use the higher central allowance	Use the central allowance			
3a	Use the higher central allowance	Development should not be permitted	Use the central allowance		

¹ Technical Guidance 197_08 Flood Estimation Guidelines, Environment Agency (June 2020)

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
3b	Use the higher central allowance	Development should not be permitted			Use the central allowance
*If development is considered appropriate when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the upper end allowance.					

Available Hydrometric Data

- 1.8 There are no hydrometric gauges within the catchments. Therefore, there are no current hydrometric records of river flows or levels for the watercourse on which a hydrological assessment of flood flows can be made.
- 1.9 The National River Flow Archive (NRFA) Peak Flow Dataset Version 10 (released 27 August 2021) will also be utilised in this assessment for the purposes of identifying any potential donor stations and for the development of pooling groups.

Initial Choice of Approach

Table 1.3: Method Statement

Is FEH appropriate?	Yes. Although the catchments are very small and the upper reaches are heavily urbanised, FEH methods are now the preferred methods for small catchments as well as being suitable for heavily urbanised catchments.
Initial choice of method(s) and reason	Both the FEH Statistical and the ReFH2 methods will be used. Both methods are suitable for the catchments and using both will enable comparison between the two flow estimation methods.
Software to be used	WINFAP v5 and ReFH2 version 2.3

2. LOCATIONS WHERE FLOOD ESTIMATES ARE REQUIRED

Location of Flow Estimates

- 2.1 The eastern watercourse was well-represented within the FEH web service. Therefore, the flow estimation point for this catchment was taken at the downstream extent of the hydraulic model.
- 2.2 The western ditches are not well-represented within the FEH web service. The ditches to be modelled are not shown in the FEH. However, the FEH does show a watercourse starting at a pond just north of the A47. Although this watercourse is misaligned with the ditches to be modelled, it does cover part of the catchments of interest and, therefore, was considered suitable for providing initial catchment descriptors for deriving inflows for the western hydraulic models (catchment descriptors were reviewed and amended accordingly, see **Table 2.2**).
- 2.3 It was decided to calculate flows at the downstream extent of the watercourses only due to the relatively small difference in catchment areas between the upstream and downstream extents of the models.

Table 2.1: Summary of Subject Sites

Site code	Watercourse	Site	Easting	Northing	Area on FEH Webservice	Revised area (if altered)
Eastern Watercourse						
UOW001	Unnamed Ordinary Watercourse	Rogue's Lane	441950	296750	2.3	2.1
Western Ditches						
UOW002	Unnamed Ordinary Watercourse	Farm Track adjacent to Stoke Road	441450	295550	1.0	0.7
UOW003	Unnamed Ordinary Watercourse	Farm Track adjacent to Stoke Road	441450	295550	1.0	0.3

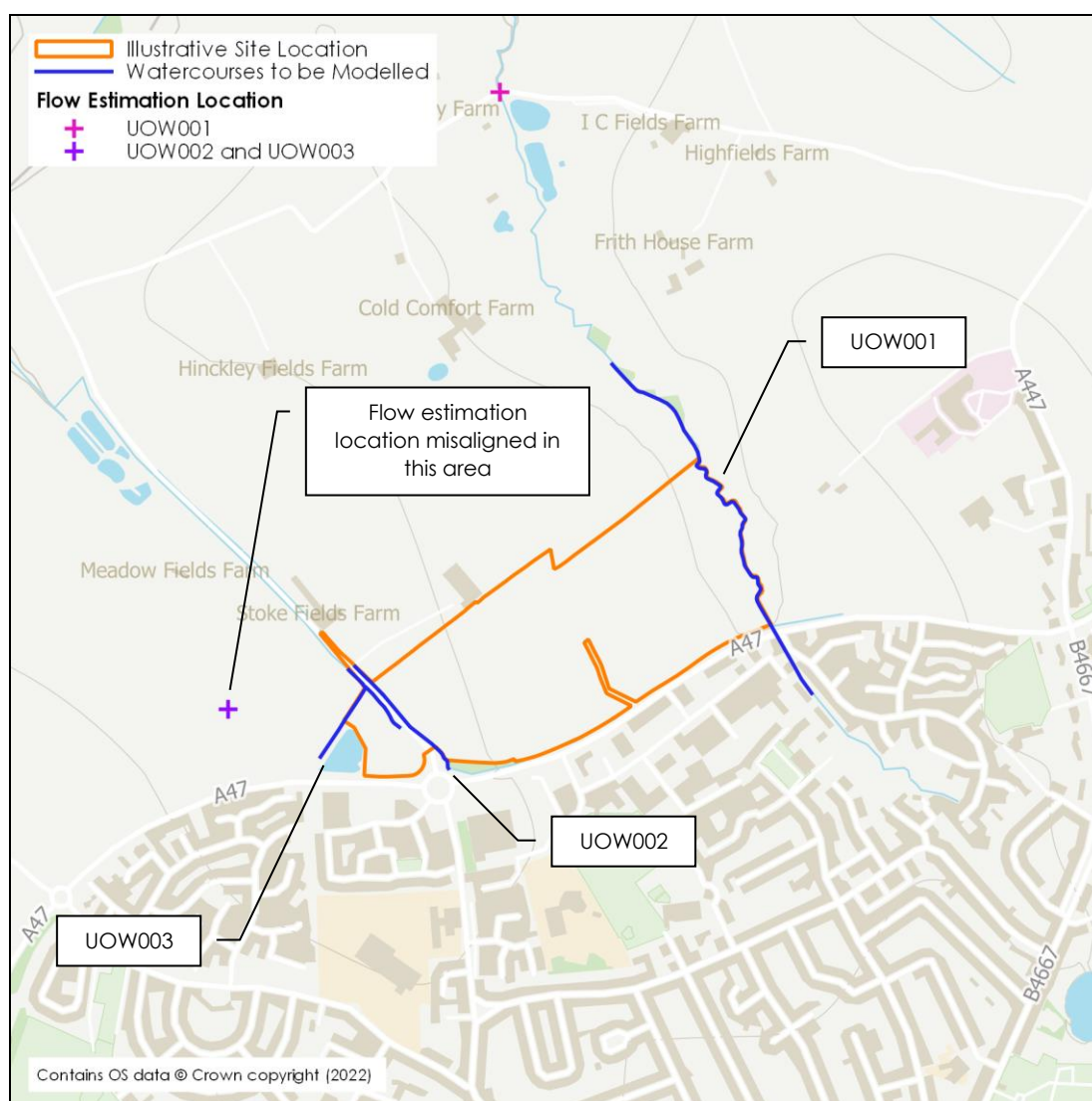


Figure 2.1: Flow Estimation Locations

Checking Catchment Descriptors

Table 2.2: Catchment Descriptor Checks

Record how catchment boundary was checked and describe any changes.	The catchment boundaries for the flow estimation points were identified by the Flood Estimation Handbook (FEH) web service. The boundaries were reviewed and updated using a combination of Ordnance Survey mapping, EA LiDAR and sewer records, where available. Adjustments were required, as demonstrated in Figure 2.2 , Figure 2.3 and Figure 2.4 .
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	The British Geological Survey (BGS) mapping indicates that the watersheds are predominately underlain by the Mercia Mudstone Group. Superficial deposits of Alluvium (Clay, Silt, Sand and Gravel), Bosworth Clay Member (Clay and Silt), Wolston Sand and Gravel and Oadby Member (Diamicton) are also expected to be present throughout the catchments.

	The underlying geology and soils suggest the BFIHOST and SPRHOST values of the FEH catchment descriptors are appropriate for the catchments. The FARL value was checked against OS mapping and was considered representative of the surface water features in the catchments. URBEXT₂₀₀₀ was updated following the changes to the catchment boundaries. DPLBAR has been updated using the standard equation for DPLBAR, given in the FEH Volume 5.
Source of URBEXT	The URBAN50k method has been used to calculate URBEXT₂₀₀₀ for the revised catchment boundaries. FARL was adjusted using the FEH procedure outlined in Volume 5 of the FEH Handbook.
Method for updating of URBEXT to present day.	An update to the current year is not required as the URBAN50k method has been used to calculate URBEXT₂₀₀₀. As such the current urban extent will be implicitly accounted for in the latest mapping.

Table 2.3: Important Catchment Descriptors at Each Subject Site (changes made are highlighted in red)

Site Code	FARL	PROPWET	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR	SPRHOST	URBEXT 2000 *	FPEXT
Eastern Watercourse									
UOW001	0.951	0.3	0.427	1.52	28	654	44.67	0.2910	0.048
Western Ditches									
UOW002	1	0.3	0.395	0.85	20.3	652	43.8	0.3910	0.1667
UOW003	1	0.3	0.395	0.52	20.3	652	43.8	0.3732	0.1667

* URBEXT₂₀₀₀ updated to 2022

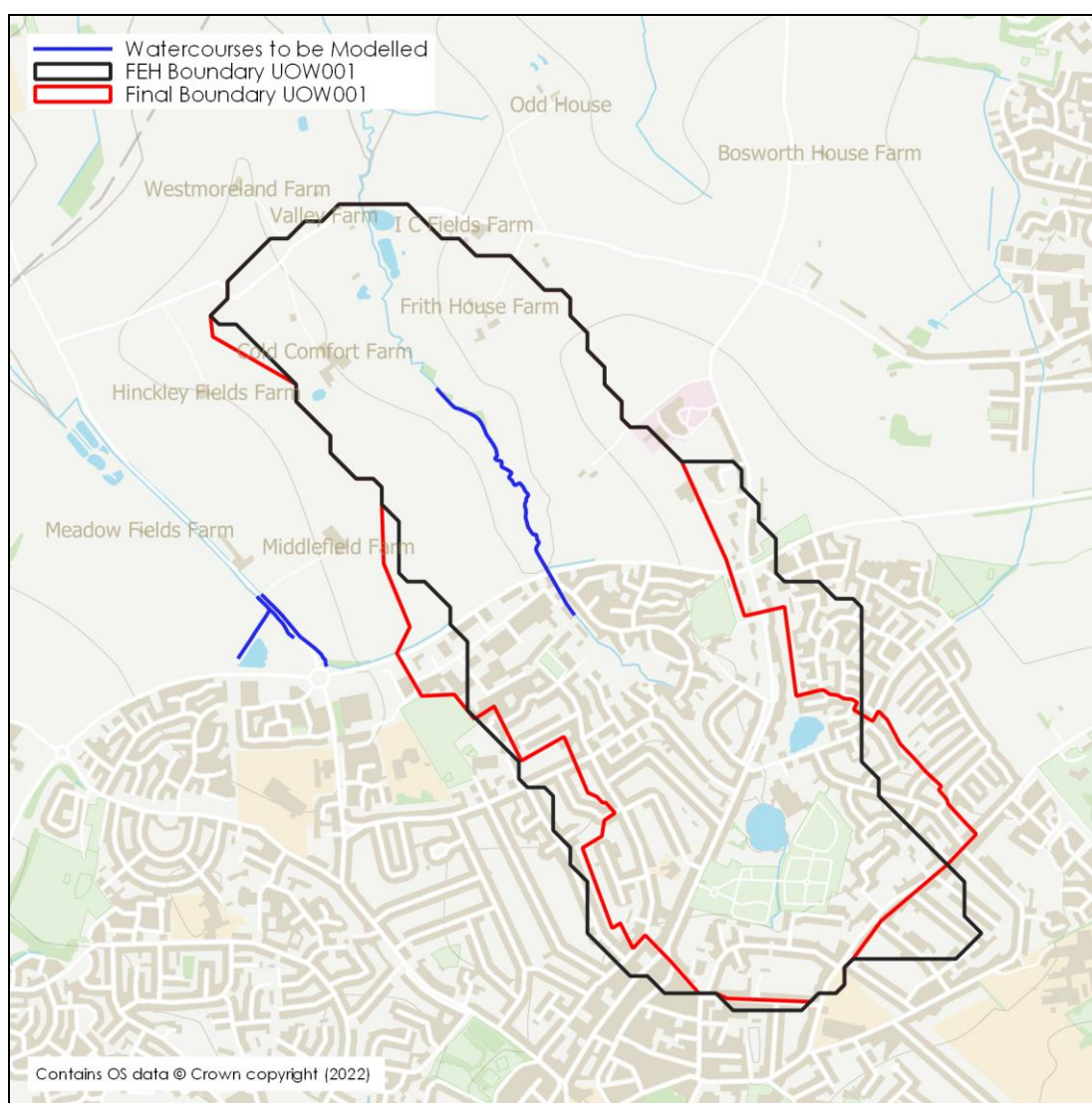


Figure 2.2: Original and Amended Catchment Boundaries – UOW001

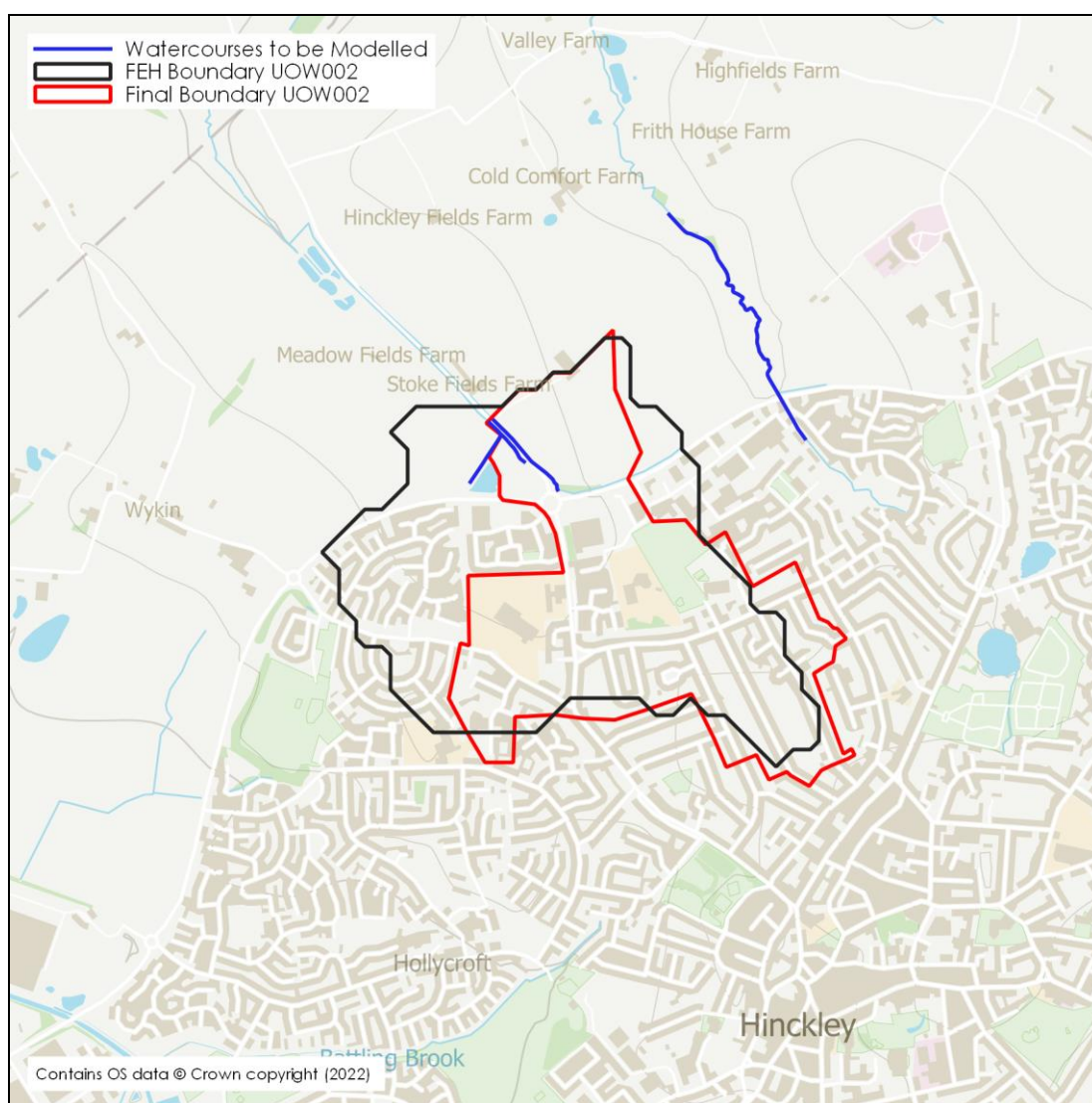


Figure 2.3: Original and Amended Catchment Boundaries – UOW002

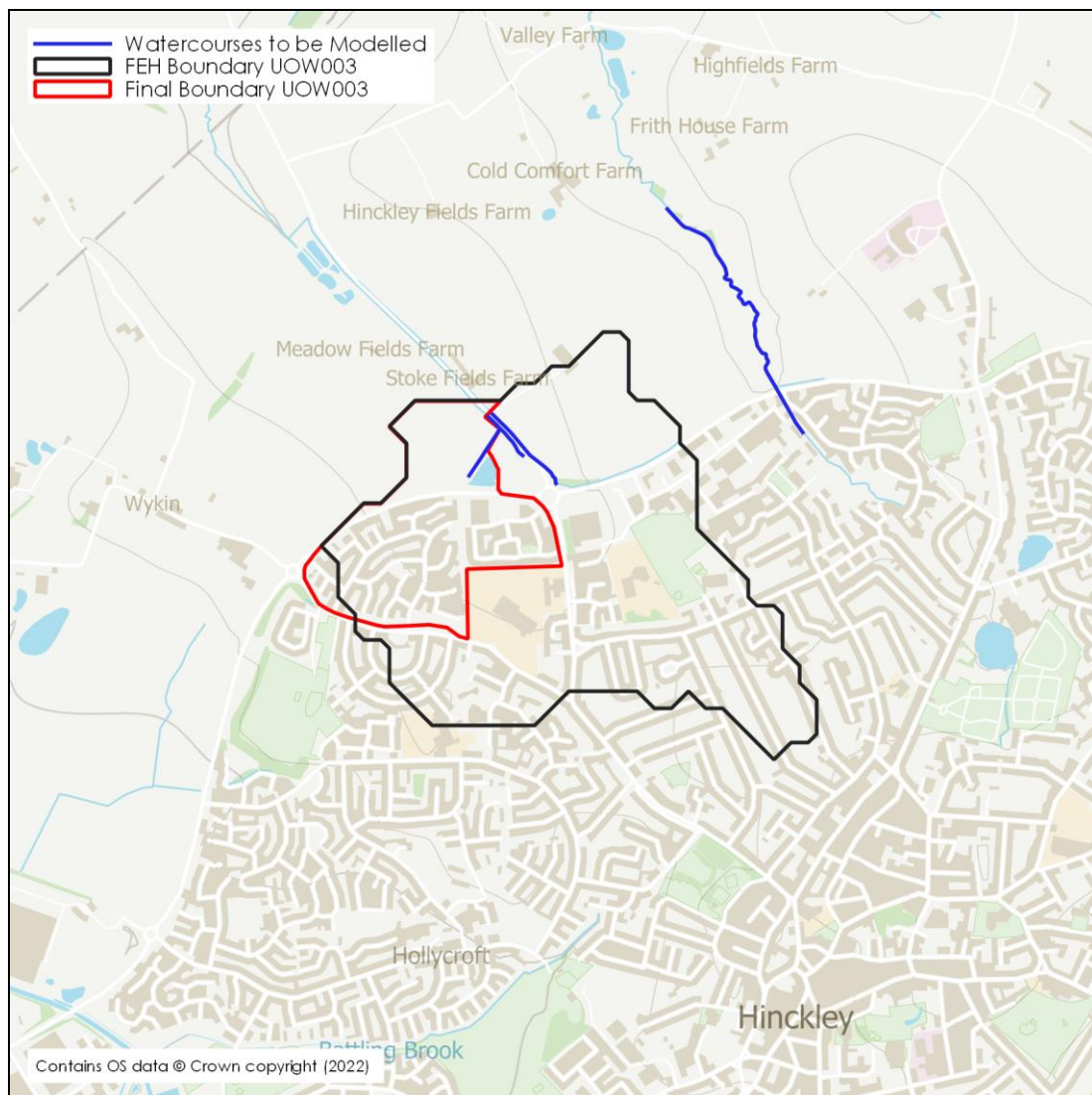


Figure 2.4: Original and Amended Catchment Boundaries – UOW003

3. STATISTICAL METHOD

- 3.1 WINFAP was utilised to undertake a statistical analysis of the catchments using a hydrometric record of gauged catchments with similar characteristics.

QMED Development

- 3.2 Catchment descriptors were originally used to estimate the rural QMED of the study site using the revised equation from Science Report (SC050050). The FEH states that flood frequency is best estimated by gauged data and estimation of key variables from catchment descriptors alone should be a method of last resort. As such, a search was undertaken to identify any potential donor sites that could be used to adjust QMED.
- 3.3 Phase 2 of Science Report SC090031² recommends using a single donor, chosen on the basis of proximity, to adjust QMED for 'small catchments' (defined as catchments with an area of less than 25km²). This method can also be applied to catchments less than 40km².
- 3.4 Whilst the FEH recommends avoiding urbanised donors, the Littlethorpe gauge (NRFA reference: 28082) is approximately 12km from the site and only just over the 0.03 threshold for URBEXT₂₀₀₀. WINFAP allows the use of urban donors, applying the urban adjustment factor in reverse to attempt to remove the urban influence. As such, the search for donors was extended to donors with URBEXT > 0.046 to allow WINFAP to include Littlethorpe as a donor.
- 3.5 With the guidance in mind, a search was undertaken within WINFAP to identify the closest station to the flow estimation point(s). The data quality of potential donor(s) was also reviewed. Of the recommended donors, the following were rejected:
- 28026 – flow bypasses on the left bank, variable drowning due to weed growth and substantial modification owing to Public Water Supply (PWS) imports.
- 3.6 Details for the donor station(s) used to adjust QMED, and which flow estimation point(s) they have been applied to, are provided in **Table 3.1**. Details of the donor adjustment(s) and final QMED estimation are provided in **Table 3.2**.

² Science Report SC090031/R0: Estimating flood peaks and hydrographs for small catchments (Phase 2), Environment Agency (2019).

Table 3.1: Donor Station Details

Station Number	QMED from Observed Data (A)* (m ³ /s)	QMED from Catchment Descriptors (B)** (m ³ /s)	Adjustment Ratio (A/B)	Flow estimation point(s) donor is applied to
28082	15.58	18.593	0.84	UOW001 UOW002 UOW003

* The default, deurbanised observed data was used

** The default, rural, QMED from catchment descriptors was used

Table 3.2: Overview of Estimation of QMED at Each Subject Site

Site Code	Method	Initial Estimate of QMED (M ³ /s) (Rural)	Data Transfer				Final estimate of QMED (URBAN)
			Donor site NRFA no	Distance between centroids d _j (km)	Power term, a	Moderated QMED adjustment factor (A/B) ^a	
Eastern Watercourse							
UOW001	Donor Transfer	0.43	28082	25.71	0.275	1	0.57
Western Ditches							
UOW002	Donor Transfer	0.22	28082	26.11	0.273	1	0.32
UOW003	Donor Transfer	0.10	28082	26.11	0.273	1	0.15
Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?				QMED is consistent with the size and characteristics of the catchments.			
Which version of the urban adjustment was used for QMED?				Urban adjustment was applied using Kjeldsen (2010), as applied in WINFAP.			

Derivation of Pooling Groups

- 3.7 A pooled group of hydrologically similar gauged sites was generated by the WINFAP software for the subject sites using the 'OK for Pooling' dataset. WINFAP uses the deurbanised pooling group L-moments as default.
- 3.8 Similarly to QMED estimations, the 'small catchment' method was adopted within WINFAP, in which the pooling group is selected using a similarity measure that only considered AREA and SAAR, as recommended by SC090031.
- 3.9 The catchments for all flow estimation locations were similar in size and characteristics and, therefore, the same pooling group was used.

- 3.10 The pooling group was reviewed to identify sites which may be inappropriate due to being significantly hydrologically dissimilar to the study site, or if they have any inaccuracies, uncertainties, or limitations in their data record.
- 3.11 As the final pooling group contained some permeable catchments (SPRHOST<20%), permeable adjustment was undertaken using WHS Permeable Adjustment Worksheet Beta v1.2.
- 3.12 The growth curve derived from the pooling group was also adjusted to reflect the urban influence using the methods adopted in WINFAP³ which is based on those published by Kjeldsen 20104.
- 3.13 Further detail on pooling group composition is provided in **Section 6**.

Table 3.3: Derivation of Pooling Groups

Name of group	Site code from whose descriptors the group was derived	Subject site treated as gauged? (enhanced single site analysis)	Change made to default pooling group with reasons, including any sites investigated but retaining in the group	Weighted average L-moments L-CV and L-skew (before urban and permeable adjustment)
HIN_PG	UOW001	No	Stations Removed: 7011 – short record (<8 years of data) 44008 – non-flood years account for >15% of the record Stations Added: N/A Comments: The pooling group is heterogeneous and a review of the pooling group is desirable. It is not considered possible to improve the pooling group any further.	L-CV: 0.266 L-Skew: 0.249

³ Wallingford HydroSolutions (2016), WINFAP 4 Urban adjustment procedures, Wallingford HydroSolutions Ltd 2016.

⁴ Kjeldsen, T.K., 2010. Modelling the impact of urbanization on flood frequency relationships in the UK. Hydrology Research, volume 41, issue 5, pp391-405

Table 3.4: Derivation of Flood Growth Curves at Subject Sites

Site code	Method (SS, P, ESS)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban or permeable adjustment	Growth factor for 1% AEP event
Eastern Watercourse					
UOW001	P	HIN_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for UK catchments and is the distribution used in the WHS Permeable Adjustment Worksheet Beta v1.2	Urban adjustment using methods adopted in WINFAP which is based on those published by Kjeldsen 2010 Permeable adjustment using WHS Permeable Adjustment Worksheet Beta v1.2	3.12
Western Ditches					
UOW002	P	HIN_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for UK catchments and is the distribution used in the WHS Permeable Adjustment Worksheet Beta v1.2	Urban adjustment using methods adopted in WINFAP which is based on those published by Kjeldsen 2010	3.06
UOW003	P	HIN_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for UK catchments and is the distribution used in the WHS Permeable Adjustment Worksheet Beta v1.2	Permeable adjustment using WHS Permeable Adjustment Worksheet Beta v1.2	3.07

Table 3.5: Flood Estimates from the Statistical Method

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Eastern Watercourse									
UOW001	0.6	0.8	1.0	1.2	1.5	1.7	1.8	2.2	3.5
Western Ditches									
UOW002	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.9
UOW003	0.2	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.9

4. REVITALISED FLOOD HYDROGRAPH (ReFH) METHOD

- 4.1 The ReFH2 Revitalised Flood Hydrograph Modelling Tool (Version 2.3) was used to undertake an estimation of the peak flows for the subject sites.

Table 4.1: Overview of Parameters for ReFH2 Method

Site code	Method OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer	Tp (hours) Time to peak	C _{max} (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
ALL	Parameters calculated using catchment descriptors.				
Description of flood event analysis carried out			No flood event analysis was possible due to a lack of gauged data for the catchments.		

Table 4.2: ReFH2 Recommended Storm Durations

Site code	Season of design event	Storm duration	Selected interval
Eastern Watercourse			
UOW001	Winter	5.5hrs	0.5hr
Western Ditches			
UOW002	Summer	4.5hrs	0.5hrs
UOW003	Summer	3.25hrs	0.25hrs
Comments	The ReFH2 recommended storm duration and seasons will be taken forward with the modelling and will be used to derive model inflow hydrographs for the watercourse and ditches. As the modelled reach is short, with only a relatively small change in catchment areas between the upstream and downstream model extents, it was not considered necessary to test sensitivity to storm duration.		

Table 4.3: Flood Estimates from the ReFH Method (based on recommended duration for individual catchments)

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Eastern Watercourse									
UOW001	0.6	0.8	1.0	1.2	1.4	1.6	1.7	2.1	3.1
Western Ditches									
UOW002	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.3	2.0
UOW003	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	1.0

5. DISCUSSION AND SUMMARY OF RESULTS

Comparison of Method

- 5.1 A comparison of the peak flow results for the different estimation methods for the 1 in 2-year and 1 in 100-year events is provided in **Table 5.1**. Comparisons of the growth curves for both methods are shown in **Figure 5.1**, **Figure 5.2** and **Figure 5.3**.

Table 5.1: Comparison of Results

Site code	1 in 2-year peak flows			1 in 100-year peak flows		
	Statistical	ReFH	Ratio	Statistical	ReFH	Ratio
Eastern Watercourse						
UOW001	0.6	0.6	1.0	1.8	1.7	0.9
Western Ditches						
UOW002	0.3	0.3	1.0	1.0	1.0	1.0
UOW003	0.2	0.2	1.0	0.5	0.5	1.0

- 5.2 The Statistical Method provides a steeper growth curve when compared to the ReFH2 Method for UOW001. The Statistical Method provides greater flows for the greater return periods, however for the smaller return periods, flow remain similar.
- 5.3 The Statistical Method and ReFH2 Method provide similar growth curves for UOW002. The ReFH2 Method and Statistical Method provide similar flows.
- 5.4 The ReFH2 Method provides a steeper growth curve when compared to the Statistical Method for UOW001. The ReFH2 Method and Statistical Method provide similar flows.

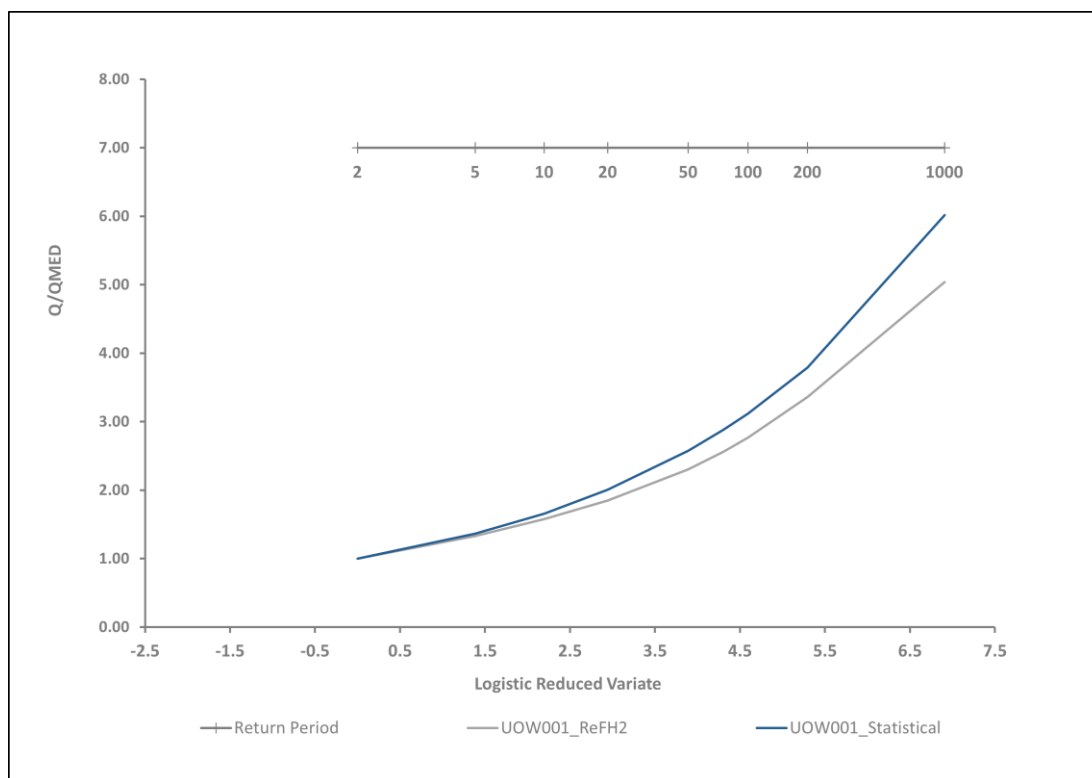


Figure 5.1: Comparison of Statistical Method and ReFH Growth Curves - UOW001

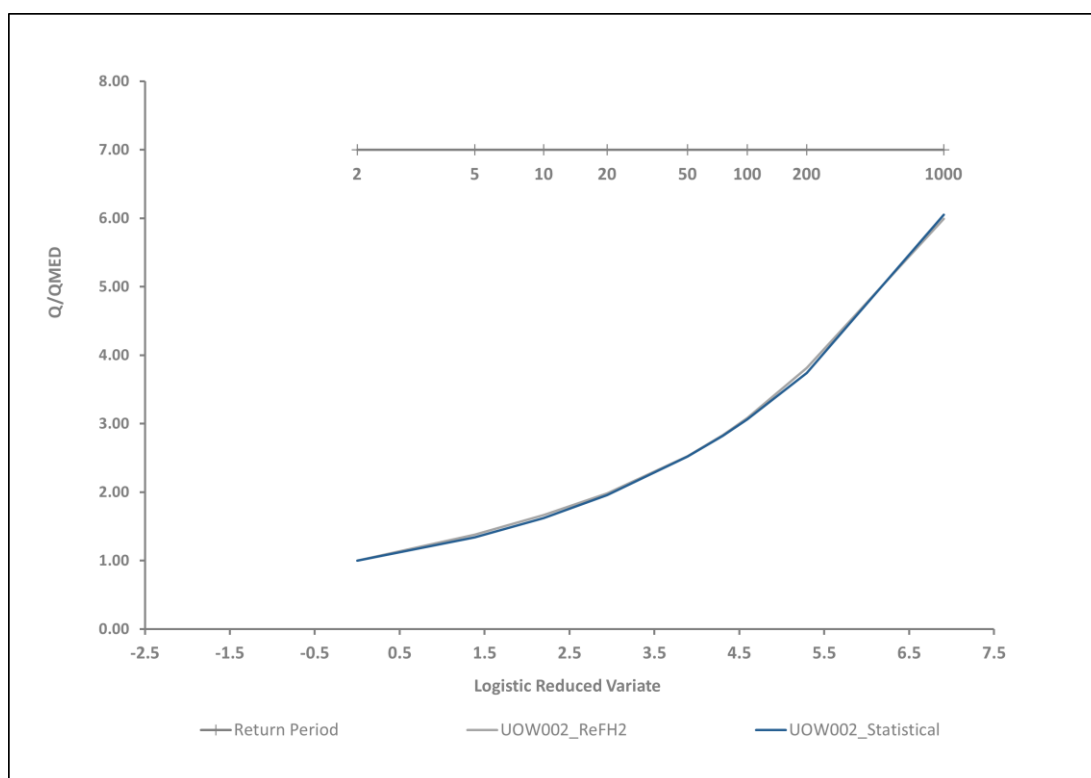


Figure 5.2: Comparison of Statistical Method and ReFH Growth Curves - UOW002

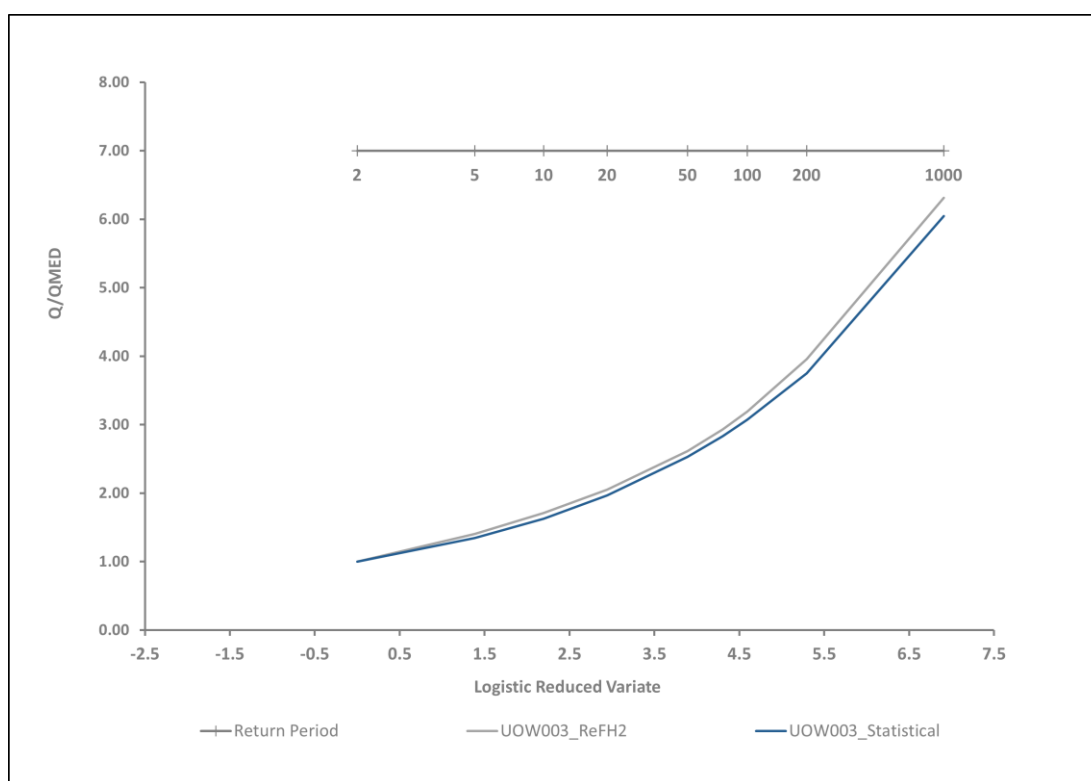


Figure 5.3: Comparison of Statistical Method and ReFH Growth Curves - UOW003

Final Method and Flows

Table 5.2: Final Choice of Method

Choice of method and justification	Whilst both Statistical and ReFH2 methods are considered suitable for UOW001, the final choice of peak flows for input into the model is the Statistical Method, in line with EA FEH Guidelines recommendation. The Statistical Method benefits from an up-to-date flood peak dataset, using growth curves from hydrologically similar catchments to derive a growth curve. The Statistical Method also benefits by avoiding the need to make assumptions about factors such as rainfall duration, time of concentration and the nature of the design flood, unlike the ReFH2 Method. ReFH2 will be used to provide a hydrograph shape for the UOW001 model inflows, scaled to the Statistical peak. Whilst both Statistical and ReFH2 methods are considered suitable for UOW001, the final choice of peak flows for input into the model is the ReFH2 Method. Whilst the Statistical method is generally the preferred method set out in the EA Guidelines, for the ditches, the flow estimates being calculated for are not real topographic catchments, with their upper reaches defined by sewer catchments. As such, the FEH Statistical method is not strictly applicable and ReFH 2 was preferred due to the influence of sewers at the upstream extent of the ditches.
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Table 5.3: Final Peak Flows for the Eastern Watercourse from Chosen Method (Statistical)

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
UOW001	0.6	0.8	1.0	1.2	1.5	1.7	1.8	2.2	3.5

Table 5.4: Final Peak Flows for the Western Ditches from Chosen Method (ReFH)

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
UOW002	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.3	2.0
UOW003	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	1.0

Table 5.5: Assumptions, Limitations and Uncertainty

List the main assumptions made	- The pooling groups are representative of the catchments. - The ReFH2 hydrograph shape is representative of the catchment responses. - Tp and storm duration is representative of the catchment responses. - The flow estimate derived at the downstream extent of the watercourses is applicable to the upstream catchments. - It is assumed that the misaligned FEH catchment is representative of the catchments associated with the western ditches. - It is assumed that FEH methods are suitable for the western ditches, although they are not strictly 'real' catchments.
Discuss any limitations e.g. applying methods outside the range of catchment types or return periods for which they were developed	- The FEH Statistical and ReFH2 methods are believed to be suitable up to the 1 in 200-year event. Estimates of flow beyond these events are extrapolations and, therefore, have a higher level of uncertainty. - There are only a small number of gauged sites in the UK. As such the representation in the pooling is not ideal given the small size of some of the study catchments. - There is no observed flow data within the catchments with which to verify the flow estimates.
Give what information you can on uncertainty in the results	Section 5.4 sets out confidence intervals for the Statistical method at ungauged sites. However, confidence intervals for heavily urbanised sites are not provided because there are not enough suitable catchments with flood peak data to provide reliable results.

	Donor transfer has been undertaken using data from a nearby gauge. Use of a donor station is considered to provide more reliable estimates compared to those calculated from catchment descriptors alone. It is more difficult to quantify uncertainty in design flows estimated from the ReFH rainfall-runoff model. However, evidence⁵ suggests the factorial standard errors from ReFH2 are comparable to those observed for the FEH pooled Statistical method when the catchment is treated as ungauged.
Comment on the suitability of the results for future studies	The design flow estimates have been derived for the purpose of providing flow hydrographs into a hydraulic model to support an understanding of flood risk at the development site. Users for different studies should, as a minimum, review results to assess suitability for the purpose of the study.
Give any other comments on the study	While the installation of temporary flow gauges would provide local data with which to better inform the design peak flows, this would not align with the timescales of this project.

Table 5.6: Checks

Are the results consistent?	Peak flows are consistent with the size and characteristics of the catchments.
What do the results imply regarding the return periods of floods during the period of record?	A flood history review for the area has been undertaken (Section 6). The Level 1 SFRA notes that a surface water overland flow route exists along Stoke Road and is associated with an unnamed drain adjacent to this road; however there are no historical flooding incidents recorded. There is no detailed information available for this event and no hydrometric data available for the catchments.
What is the 1 in 100-year growth factor? (the guidance suggests a typical range or 2.1 to 4.0)	- The 1 in 100-year growth factor for the Statistical Method is 3.12 for UOW001, 3.06 for UOW002 and 3.07 for UOW003. - The 1 in 100-year growth factor for the ReFH2 Method is 2.77 for UOW001, 3.08 for UOW002 and 3.19 for UOW003. These fall within the typical range.
If 1 in 1000-year flows have been derived, what is the range of ratios for 1 in 1000-year flow over 1 in 100-year flow?	- Statistical Method: ratio for UOW001 is 1.93, for UOW002 is 1.98 and for UOW003 is 1.97. - ReFH2 Method: ratio for UOW001 is 1.82, for UOW002 is 1.94 and for UOW003 is 1.98.

⁵ Wallingford Hydrosolutions (2019) ReFH2 Science Report: Evaluation of the Rural Design Event Model.

How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred	There are no previous studies with which to compare results.
Are the results consistent with the longer-term flood history?	A flood history review has been undertaken and the Level 1 SFRA notes that a surface water overland flow route exists along Stoke Road and is associated with an unnamed drain adjacent to this road, however there are no historic flooding incidents recorded. It is unknown whether this surface water flow route affects the development site. No specific details on the flows are recorded and there is no hydrometric data within the catchments with which to compare.
Describe any other checks on the results	Sensibility checks of modelled outlines will be undertaken at the modelling stage.

Application of Flows to Model

5.5 Flows will be applied to the model in the following way.

UOW001

- i. To derive hydrographs for UOW001, the ReFH2 hydrographs were scaled to meet the Statistical Method peak flows.
- ii. The model extent was located further upstream than the flow estimation location and, therefore, the flows were pro-rated to cover a catchment that would drain to the extent of the watercourse modelled.
- iii. Normandy Way, located to the south of the site, represents a catchment division. Therefore, the inflows have been prorated between the upstream and downstream catchment of Normandy Way.
- iv. Two surface water sewers are understood to outfall to the UOW adjacent to Normandy Way; therefore an inflow was applied to each of the sewers at the head of the run. The inflows were prorated between each of the sewers and the UOW.

5.6 **Figure 5.4** demonstrates how the flows will be applied to the model for UOW001.

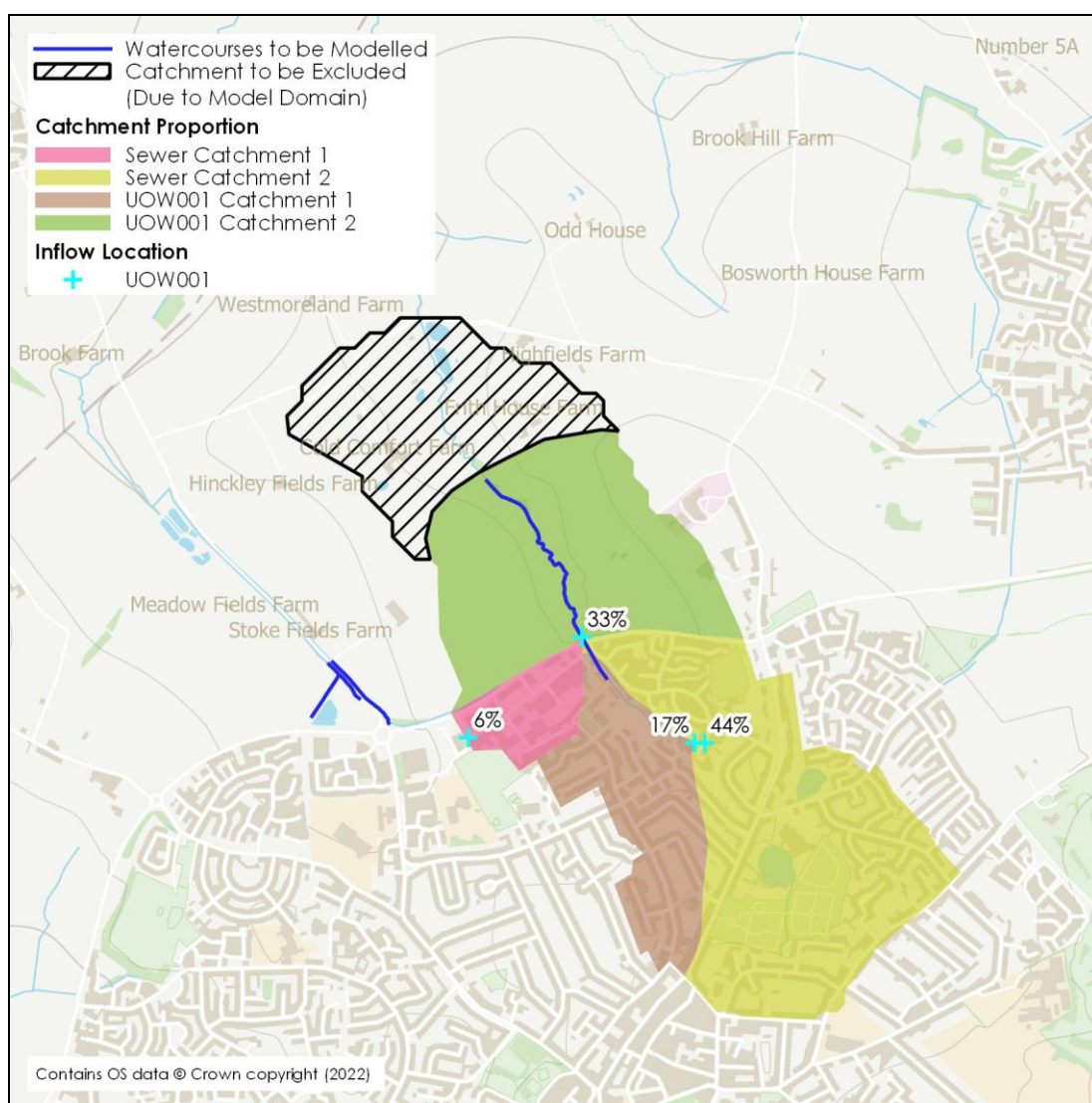


Figure 5.4: Application of Inflows into Model – UOW001

UOW002

- i. ReFH2 hydrographs were used and applied to the model.
- ii. Normandy Way, located to the south of the site, represents a catchment division. Therefore, the inflows have been prorated between the upstream and downstream catchment of Normandy Way.
- iii. Two surface water sewers are understood to outfall to the UOW adjacent to Normandy Way, therefore an inflow was applied to each of the sewers at the head of the run. The inflows were prorated between each of the sewers and the UOW.

5.7 **Figure 5.5** demonstrates how the flows will be applied to the model for UOW002.

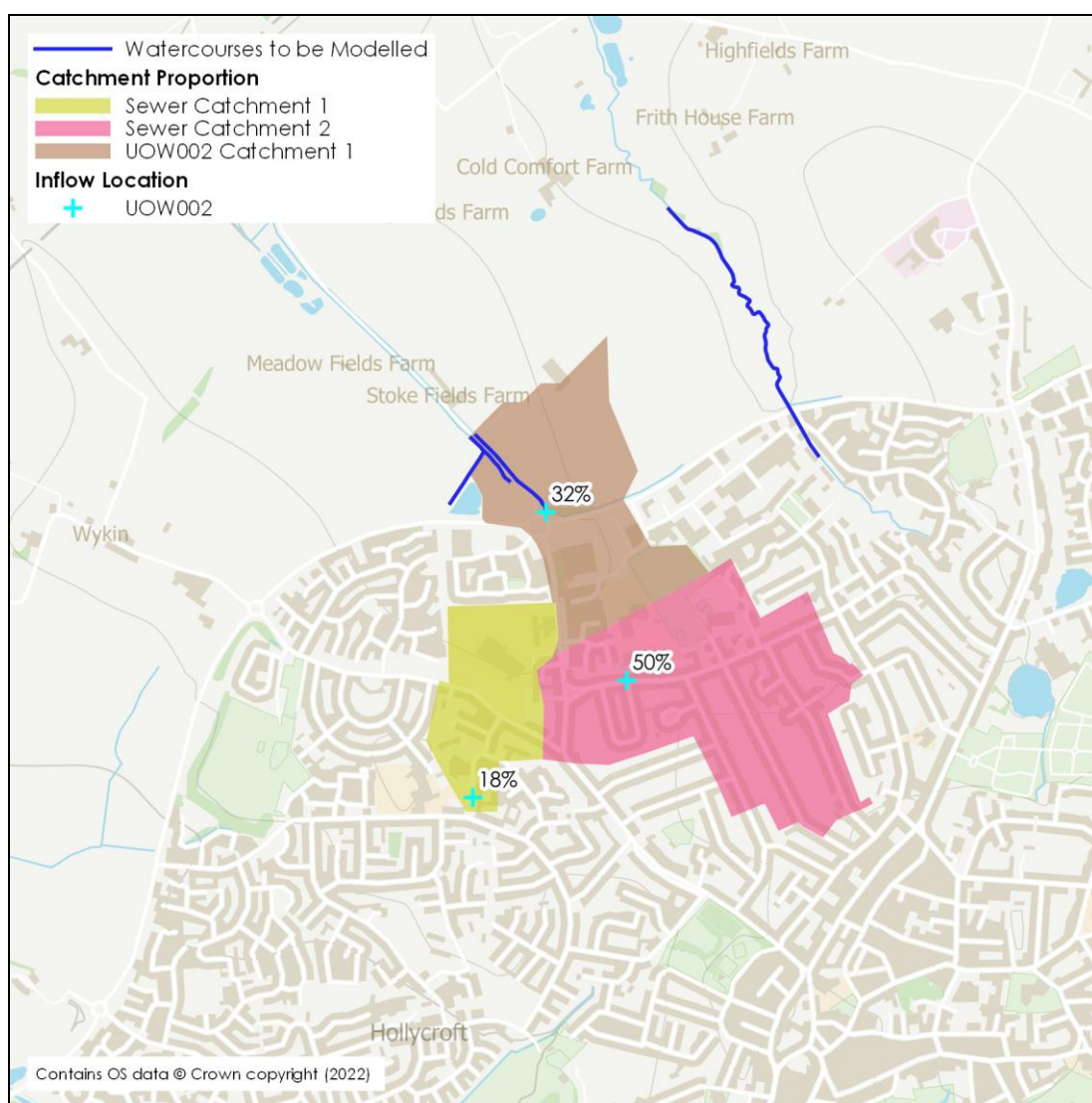


Figure 5.5: Application of Inflows into Model – UOW002

UOW003

- i. ReFH2 hydrographs were used and applied to the model.
- ii. Normandy Way, located to the south of the site, represents a catchment division. Therefore, the inflows have been prorated between the upstream and downstream catchment of Normandy Way.
- iii. One surface water sewer is understood to outfall to the UOW adjacent to Normandy Way, therefore an inflow was applied to the sewers at the head of the run. The inflows were prorated between each of the sewers and the UOW.

5.8 **Figure 5.6** demonstrates how the flows will be applied to the model for UOW003.

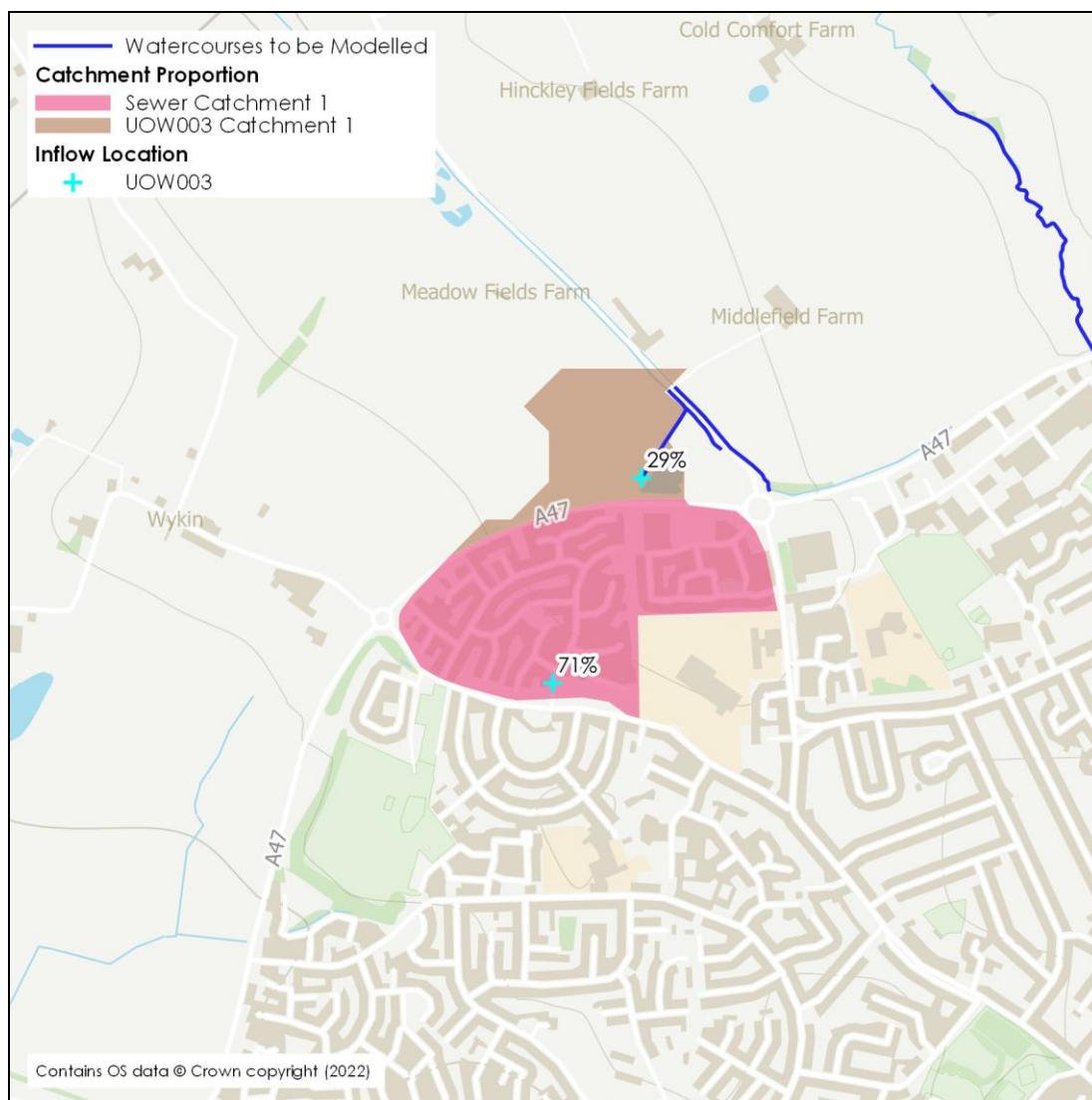


Figure 5.6: Application of Inflows into Model – UOW003

6. SUPPORTING INFORMATION

Flood History

- 6.1 A flood history review for the catchments has been undertaken using EA recorded flood outlines, Hinckley and Bosworth Borough Council Level 1 Strategic Flood Risk Assessment (SFRA)⁶, Hinckley and Bosworth Borough Council Level 2 SFRA⁷, Leicestershire County Council Preliminary Flood Risk Assessment (PFRA)⁸, Leicestershire County Council Local Flood Risk Management Strategy (LFRMS)⁹, the British Chronology of Hydrological Events and online newspaper records.
- 6.2 The Level 1 SFRA notes that a surface water overland flow route exists along Stoke Road and is associated with an unnamed drain adjacent to this road, however there are no historic flooding incidents recorded. It is unknown whether this surface water flow route affects the development site.

Detailed Pooling Group Information

- 6.3 The default pooling group generated by WINFAP is provided in **Table 6.1** and the final pooling group following review is provided in **Table 6.2**. Permeable adjusted L-CV and L-Skew are provided in **Table 6.3**.

Table 6.1: Default Pooling Group: HIN_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
27073 (Brompton Beck @ Snainton Ings)	1.086	40	0.816	0.215	0.019	1.186
27051 (Crimple @ Burn Bridge)	1.309	48	4.544	0.22	0.145	0.367
76011 (Coal Burn @ Coalburn)	1.495	43	1.84	0.167	0.303	1.112
26016 (Gypsey Race @ Kirby Grindalythe)	1.639	23	0.101	0.312	0.258	0.149
25019 (Leven @ Easby)	1.689	42	5.384	0.339	0.385	0.231
45816 (Haddeo @ Upton)	1.986	27	3.456	0.299	0.416	0.747
36010 (Bumpstead Brook @ Broad Green)	2.045	53	7.5	0.379	0.172	1.654
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.084	10	5.972	0.257	0.135	2.898
27010 (Hodge Beck @ Bransdale Weir)	2.085	41	9.42	0.224	0.293	0.356
26014 (Water Forlornes @ Driffield)	2.168	22	0.431	0.299	0.119	0.656
44008 (South Winterbourne @ Winterbourne Steepleton)	2.172	41	0.448	0.408	0.318	0.572

⁶ Level 1 Strategic Flood Risk Assessment (JBA Consulting, July 2019)

⁷ Level 2 Strategic Flood Risk Assessment (JBA Consulting, May 2020)

⁸ Preliminary Flood Risk Assessment (Leicestershire County Council, June 2011)

⁹ Local Flood Risk Management Strategy (Leicestershire County Council, August 2015)

28033 (Dove @ Hollinsclough)	2.313	45	4.15	0.225	0.373	0.864
7011 (Black Burn @ Pluscarden Abbey)	2.322	7	5.205	0.544	0.571	2.59
41020 (Bevern Stream @ Clappers Bridge)	2.386	51	13.66	0.205	0.171	0.725
39033 (Winterbourne Stream @ Bagnor)	2.43	58	0.401	0.342	0.382	0.893
Total		551				
Weighted Means				0.288	0.263	
H2 value	2.6958					
Goodness of Fit	Generalised Logistic			General Extreme Value		
	0.1471			-1.1661		

Table 6.2: Final Pooling Group (before permeable adjustment): HIN_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
27073 (Brompton Beck @ Snainton Ings)	1.086	40	0.816	0.215	0.019	1.383
27051 (Crimple @ Burn Bridge)	1.309	48	4.544	0.22	0.145	0.363
76011 (Coal Burn @ Coalburn)	1.495	43	1.84	0.167	0.303	1.187
26016 (Gypsey Race @ Kirby Grindalythe)	1.639	23	0.101	0.312	0.258	0.22
25019 (Leven @ Easby)	1.689	42	5.384	0.339	0.385	0.799
45816 (Haddeo @ Upton)	1.986	27	3.456	0.299	0.416	1.048
36010 (Bumpstead Brook @ Broad Green)	2.045	53	7.5	0.379	0.172	1.761
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.084	10	5.972	0.257	0.135	2.629
27010 (Hodge Beck @ Bransdale Weir)	2.085	41	9.42	0.224	0.293	0.277
26014 (Water Forlornes @ Driffield)	2.168	22	0.431	0.299	0.119	0.629
28033 (Dove @ Hollinsclough)	2.313	45	4.15	0.225	0.373	0.712
41020 (Bevern Stream @ Clappers Bridge)	2.386	51	13.66	0.205	0.171	0.915
39033 (Winterbourne Stream @ Bagnor)	2.43	58	0.401	0.342	0.382	1.076
Total		503				
Weighted Means				0.266	0.249	
H2 value	2.3818					
Goodness of Fit	Generalised Logistic			General Extreme Value		
	-0.1544			-1.3816		

Table 6.3: Permeable Adjusted L-CV and L-Skew

Station	Adjusted L-CV	Adjusted L-Skew
27073 (Brompton Beck @ Snainton Ings)	0.199	0.055

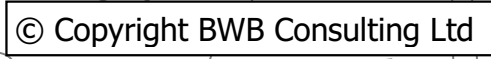
Station	Adjusted L-CV	Adjusted L-Skew
26016 (Gypsy Race @ Kirby Grindalythe)	0.283	0.313
26014 (Water Forlomes @ Driffield)	0.287	0.099

Appendix 3: Table of Hydraulic Structures

Network ID, Cross Section ID	Model Details	Photograph/Survey Section
UOW001_01475	Description: Normandy Way Culvert NGR: 442537, 295644 Domain: 1D ESTRY Unit Type: Circular Conduit (Double) Dimensions: 2 x 0.5m dia Upstream Invert Level: 108.71m AOD and 108.72m AOD Downstream Invert Level: Not surveyed Length: 81m Manning's N: 0.015 Blockage: 0% Spill/Bypass: Modelled in 2D domain	
UOW001_01321	Description: Access Bridge NGR: 442464, 295789 Domain: 1D ESTRY Unit Type: Irregular Culvert Upstream Invert Level: 106.88m AOD Downstream Invert Level: 106.67m AOD Length: 6m Manning's N: 0.020 Blockage: 0% Spill/Bypass: Modelled in 2D domain	
R2_00278	Description: Normandy Way Culvert NGR: 441843, 295428 Domain: 1D ESTRY Unit Type: Circular Culvert (Double) Dimensions: 2 x 0.45m dia Upstream Invert Level: Not surveyed Downstream Invert Level: 105.48 AOD Length: 306m Manning's N: 0.015 Blockage: 0% Spill/Bypass: Modelled in 2D domain	

Network ID, Cross Section ID	Model Details	Photograph/Survey Section
R2_00145	Description: Access Track Culvert NGR: 441766, 295522 Domain: 1D ESTRY Unit Type: Circular Culvert Dimensions: 0.6m dia Upstream Invert Level: 104.57m AOD Downstream Invert Level: 104.53m AOD Length: 7m Manning's N: 0.015 Blockage: 0% Spill/Bypass: Modelled in 2D domain	
R3_00139	Description: Access Track Culvert NGR: 441747, 295516 Domain: 1D ESTRY Unit Type: Circular Culvert Dimensions: 0.5m dia Upstream Invert Level: 103.89m AOD Downstream Invert Level: 103.88m AOD Length: 7m Manning's N: 0.015 Blockage: 0% Spill/Bypass: Modelled in 2D domain	
R4_00000	Description: Stoke Road Culvert NGR: 441697, 295593 Domain: 1D ESTRY Unit Type: Irregular Culvert Upstream Invert Level: 103.41m AOD Downstream Invert Level: Not surveyed Length: 19m (assumed) Manning's N: 0.020 Blockage: 0% Spill/Bypass: Modelled in 2D domain	

Appendix 4: Model Schematic



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5. Model not yet peer reviewed.
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- 1D Domain
- 1D Flow / Time (QT) Inflows
- 1D Head / Time (HT) Boundary
- 1D Sewer Manholes
- 1D Pipes / Culverts
- 1D Open Watercourse
- 2D Domain
- 2D Head / Flow (HQ) Boundary
- 2D Watercourse Channel
- Illustrative Site Boundary

P01	24.03.22	Preliminary Issue	MB	AP
Rev	Date	Details of issue / revision	Drw	Rev

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Project Title

Land East of Stoke Road and North of Normandy Way (A47), Hinckley

Drawing Title

Baseline Hydraulic Model Schematic

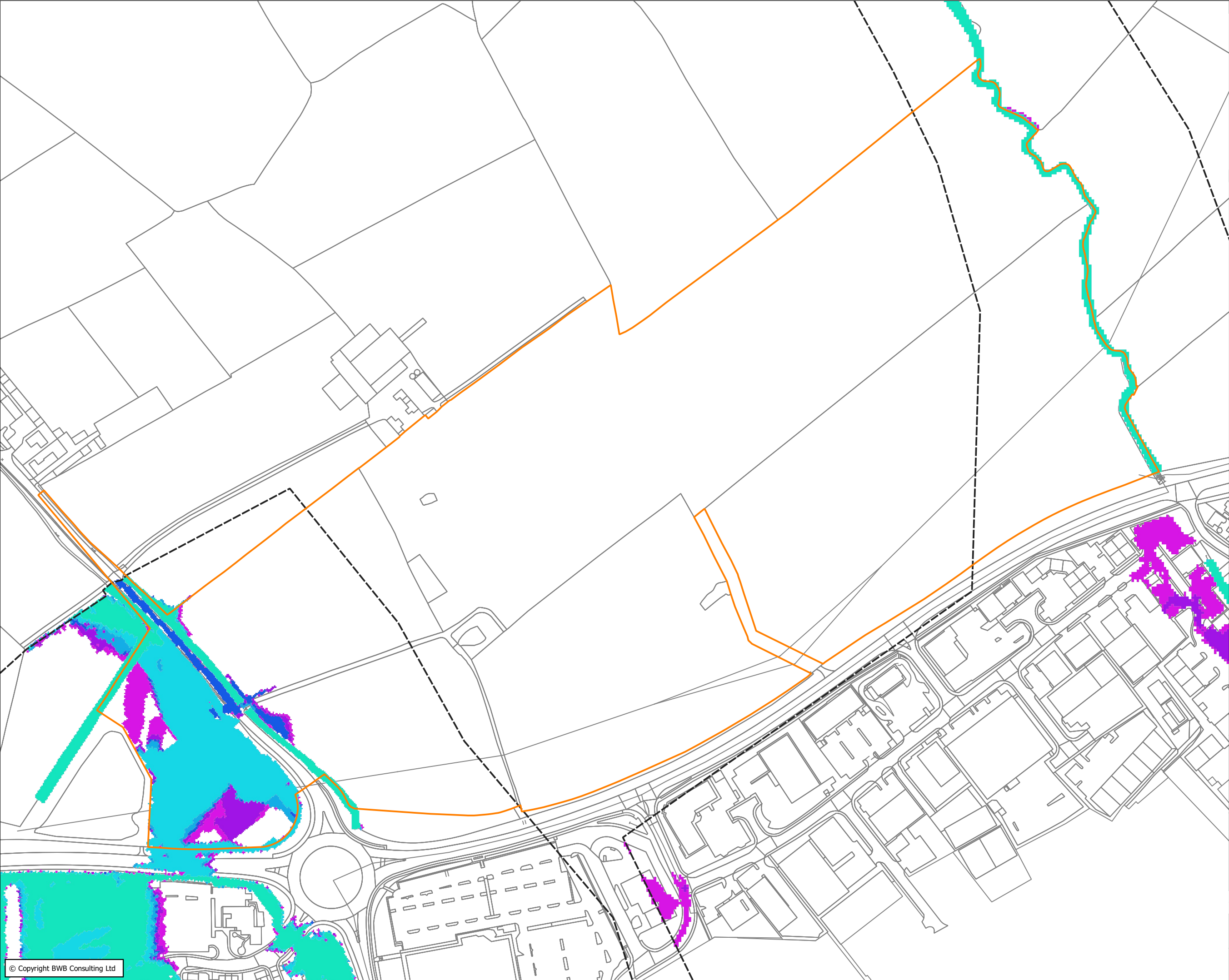
Drawn:	M. Brambani		Reviewed:	A. Petrakis	
BWB Ref:	210683	Date:	24.03.22	Scale@A1:	1:3000

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0008	S2	P01

Appendix 5: Baseline Flood Maps



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Key

Illustrative Site Location

Model Domain

Baseline Flood Extents

- 1 in 20-Year
- 1 in 100-Year
- 1 in 100-Year + 22%
- 1 in 100-year + 30%
- 1 in 100-Year + 51%
- 1 in 1000-Year

Rev	Date	Details of issues/ revision	Drw	Rev
P02	20.04.22	MINOR AMENDMENTS	LR	MB
P01	23.03.22	PRELIMINARY ISSUE	LR	MB

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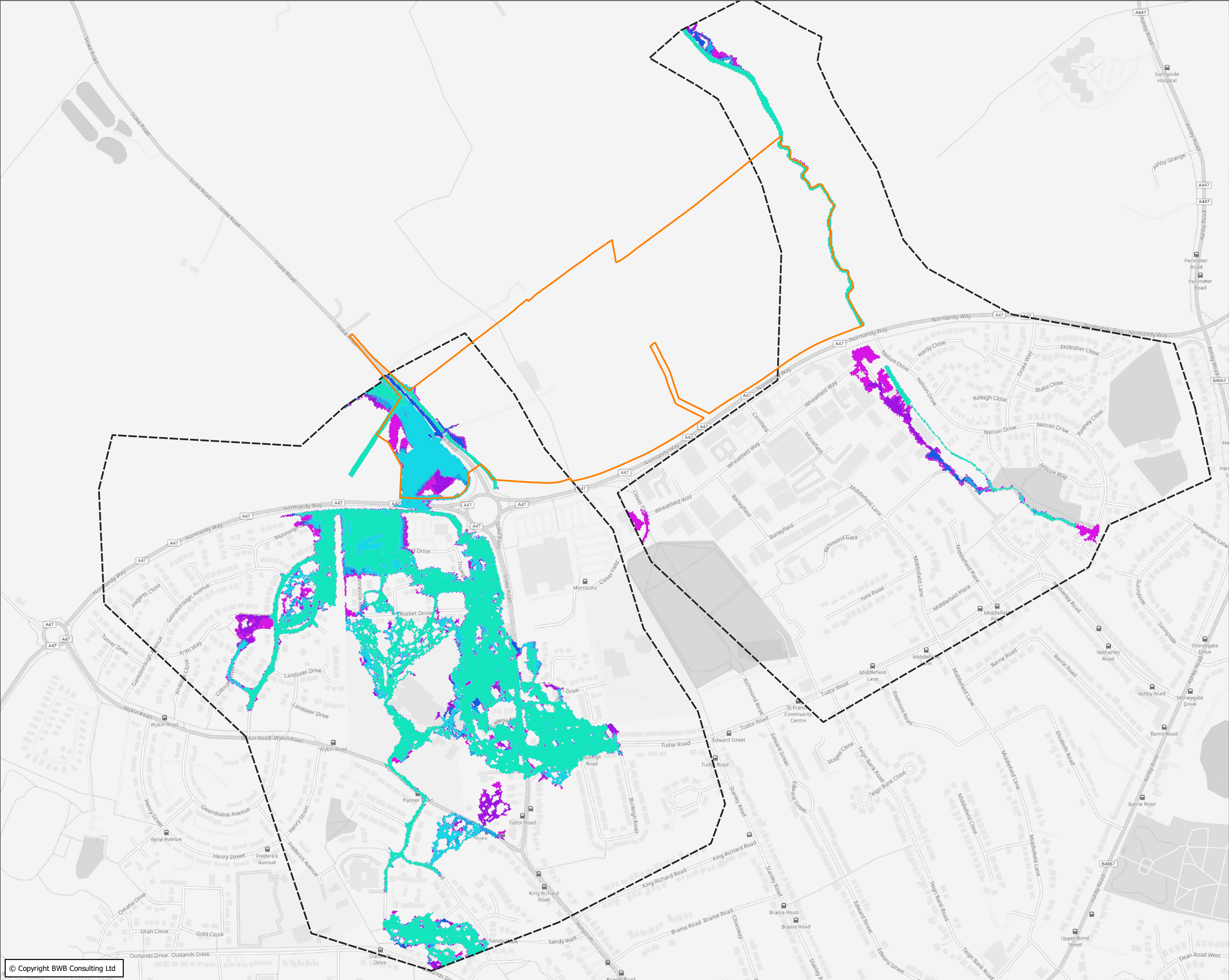
Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Baseline Model Flood
Extents**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	23.03.22
Scale@A3:	1:2750		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			Status Rev
HIN-BWB-ZZ-XX-DR-YE-0001			S2 P02



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 6. OpenStreetMap data has been reproduced under the terms of the Open Data Commons Open Database License. © OpenStreetMap contributors.

Key

Illustrative Site Location

Model Domain

Baseline Flood Extents

- 1 in 20-Year
- 1 in 100-Year
- 1 in 100-Year + 22%
- 1 in 100-Year + 30%
- 1 in 100-Year + 51%
- 1 in 1000-Year

Rev	Date	Details of issues/ revision	Drw	Rev
P02	20.04.22	MINOR AMENDMENTS	LR	MB
P01	23.03.22	PRELIMINARY ISSUE	LR	MB

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Project Title

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Drawing Title

**Baseline Model Flood
Extents**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	23.03.22
		Scale@A3:	1:2750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0013	S2	P02



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Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

<= 0.25

0.25 - 0.50

0.50 - 0.75

0.75 - 1.00

1.00 - 1.25

> 1.25

Rev	Date	Details of issues/ revision	Drw	Rev
P02	20.04.22	MINOR AMENDMENTS	LR	MB
P01	23.03.22	PRELIMINARY ISSUE	LR	MB

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**Land East of Stoke Road and
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Drawing Title

**Baseline Modelled Flood
Depths: 1 in 20-Year**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	23.03.22
Scale:	A3: 1:2750		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			
Status			
Rev			
HIN-BWB-ZZ-XX-DR-YE-0002			
S2 P02			



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Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

Rev	Date	Details of issues/ revision	Drw	Rev
P02	20.04.22	MINOR AMENDMENTS	LR	MB
P01	23.03.22	PRELIMINARY ISSUE	LR	MB

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Drawing Title

**Baseline Modelled Flood
Depths: 1 in 100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	23.03.22
Scale@A3:	1:2750		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			
HIN-BWB-ZZ-XX-DR-YE-0003			
Status	S2	Rev	P02



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 5. Model not yet peer reviewed.
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Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	23.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Drawing Title

**Baseline Modelled Flood
Depths: 1 in 100-Year + 22%
Climate Change**

Drawn:	L. Reeves	Reviewed:	M. Bramani		
BWB Ref:	210683	Date:	23.03.22	Scale@A3:	1:2750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0004	S2	P02



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Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

<= 0.25

0.25 - 0.50

0.50 - 0.75

0.75 - 1.00

1.00 - 1.25

> 1.25

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	23.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Project Title

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Drawing Title

**Baseline Modelled Flood
Depths: 1 in 100-Year + 30%
Climate Change**

Drawn:	L. Reeves	Reviewed:	M. Brambani		
BWB Ref:	210683	Date:	23.03.22	Scale@A3:	1:2750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0005	S2	P02



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Key

 Illustrative Site Location

 Model Domain

Modelled Flood Depths (m)

 <= 0.25

 0.25 - 0.50

 0.50 - 0.75

 0.75 - 1.00

 1.00 - 1.25

 > 1.25

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	23.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Drawing Title

**Baseline Modelled Flood
Depths: 1 in 100-Year + 51%
Climate Change**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	23.03.22
Scale@A3:	1:2750		

Drawing Status

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Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
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Key

 Model Domain

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	23.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Project Title

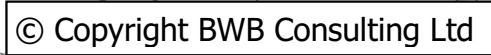
**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Baseline Modelled Flood
Depths: 1 in 1000-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	23.03.22
Scale@A3:	1:2750		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			Status Rev
HIN-BWB-ZZ-XX-DR-YE-0007			S2 P02

Appendix 6: Proposed Model Schematic



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Model not yet peer reviewed.

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- 1D Domain
- 1D Flow / Time (QT) Inflows
- 1D Head / Time (HT) Boundary
- 1D Sewer Manholes
- 1D Pipes / Culverts
- 1D Open Watercourse
- 2D Domain
- 2D Head / Flow (HQ) Boundary
- 2D Watercourse Channel
- 2D Proposed Ground Levels - 105.50m AOD
- Illustrative Site Boundary

01	21.04.22	Preliminary Issue	MB	LR
Rev	Date	Details of issue / revision	Drw	Rev

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Project Title

Land East of Stoke Road and North of Normandy Way (A47), Hinckley

Proposed Hydraulic Model Schematic

Drawn:	M. Brambani		Reviewed:	L. Reeves	
WB Ref:	210683	Date:	21.04.22	Scale@A1:	1:3000

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WIN-BWB-ZZ-XX-DR-YE-0026	S2	P01

Appendix 7: Proposed Flood Maps



- Notes
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 5. Model not yet peer reviewed.
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 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Proposed Flood Extents

1 in 20-Year

1 in 100-Year

1 in 100-Year + 22%

P01	26.04.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

Issues & Revisions

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Project Title

**Land East of Stoke Road and
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Drawing Title

**Proposed Model Flood
Extents**

Drawn: L. Reeves

Reviewed: M. Bramani

BWB Ref: 210683

Date: 26.04.22

Scale@A3: 1:2750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number

Status

Rev

HIN-BWB-ZZ-XX-DR-YE-0016

S2

P01



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 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

- ≤ 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

P01	26.04.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

Issues & Revisions

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Client

**Richborough Estates Limited
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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Proposed Modelled Flood
Depths: 1 in 20-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	26.04.22
Scale:	A3: 1:2750		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			
HIN-BWB-ZZ-XX-DR-YE-0017			
Status	S2	Rev	P01



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 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

P01	26.04.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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**Richborough Estates Limited
and Mr & Mrs Adcock**

Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Proposed Modelled Flood
Depths: 1 in 100-Year**

Drawn:	L. Reeves		Reviewed:	M. Bramani	
BWB Ref:	210683	Date:	26.04.22	Scale@A3:	1:2750
Drawing Status					
PRELIMINARY					
Project - Originator - Zone - Level - Type - Role - Number				Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0018				S2	P01



- Notes
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 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Modelled Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

P02	26.04.22	MINOR AMENDMENTS	LR	MB	
P01	08.04.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Client

**Richborough Estates Limited
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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

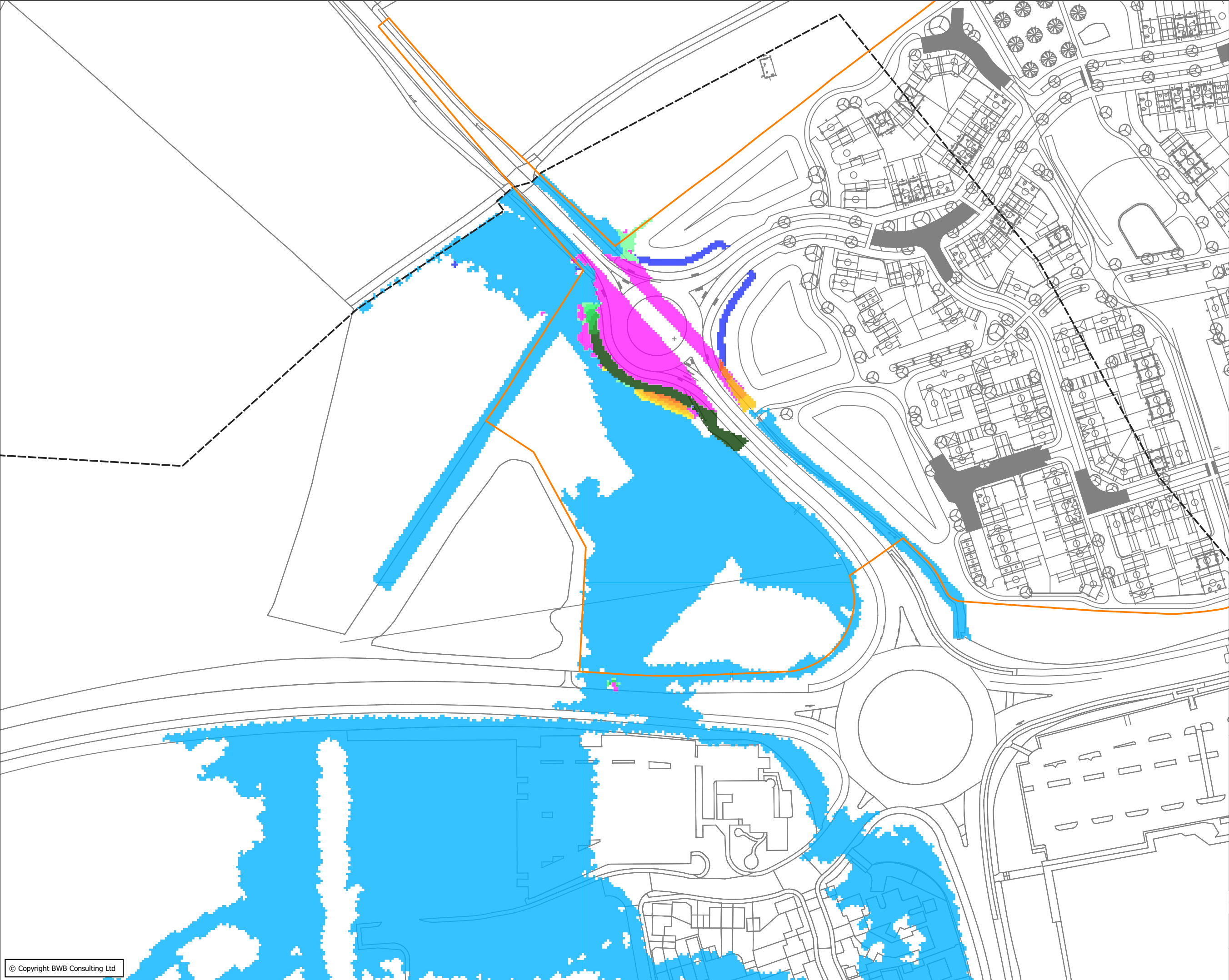
**Proposed Modelled Flood
Depths: 1 in 100-Year + 22%
Climate Change**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	08.04.22
		Scale@A3:	1:2750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0015	S2	P02



- Notes**
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 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P02	26.04.22	MINOR AMENDMENTS	LR	MB
P01	08.04.22	PRELIMINARY ISSUE	LR	MB
Rev	Date	Details of issues/ revision	Drw	Rev

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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Baseline and Post-
Development Comparative
Analysis: 1 in 100-Year +
22% Climate Change**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	08.04.22
Scale@A3:	1:500		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0014	S2	P02

Appendix 8: Sensitivity Tests



Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.

2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

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4. Any discrepancies noted on site are to be reported to the engineer immediately.

5. Model not yet peer reviewed.

6. OS Mapping has been reproduced under the licence number 100022432.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	28.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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**Richborough Estates Limited
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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Baseline Sensitivity:
Increased Downstream
Boundary (20%) 1 in 100-
Year**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	28.03.22
Scale@A3:	1:3750		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0009	S2	P02



Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.

2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.

4. Any discrepancies noted on site are to be reported to the engineer immediately.

5. Model not yet peer reviewed.

6. OS Mapping has been reproduced under the licence number 100022432.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	28.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Client

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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Baseline Sensitivity:
Decreased Downstream
Boundary (20%) 1 in 100-
Year**

Drawn:	L. Reeves	Reviewed:	M. Brambani
BWB Ref:	210683	Date:	28.03.22
Scale@A3:	1:3750		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0010	S2	P02



- Notes**
1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P02	20.04.22	MINOR AMENDMENTS	LR	MB	
P01	28.03.22	PRELIMINARY ISSUE	LR	MB	
Rev	Date	Details of issues/ revision	Drw	Rev	

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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

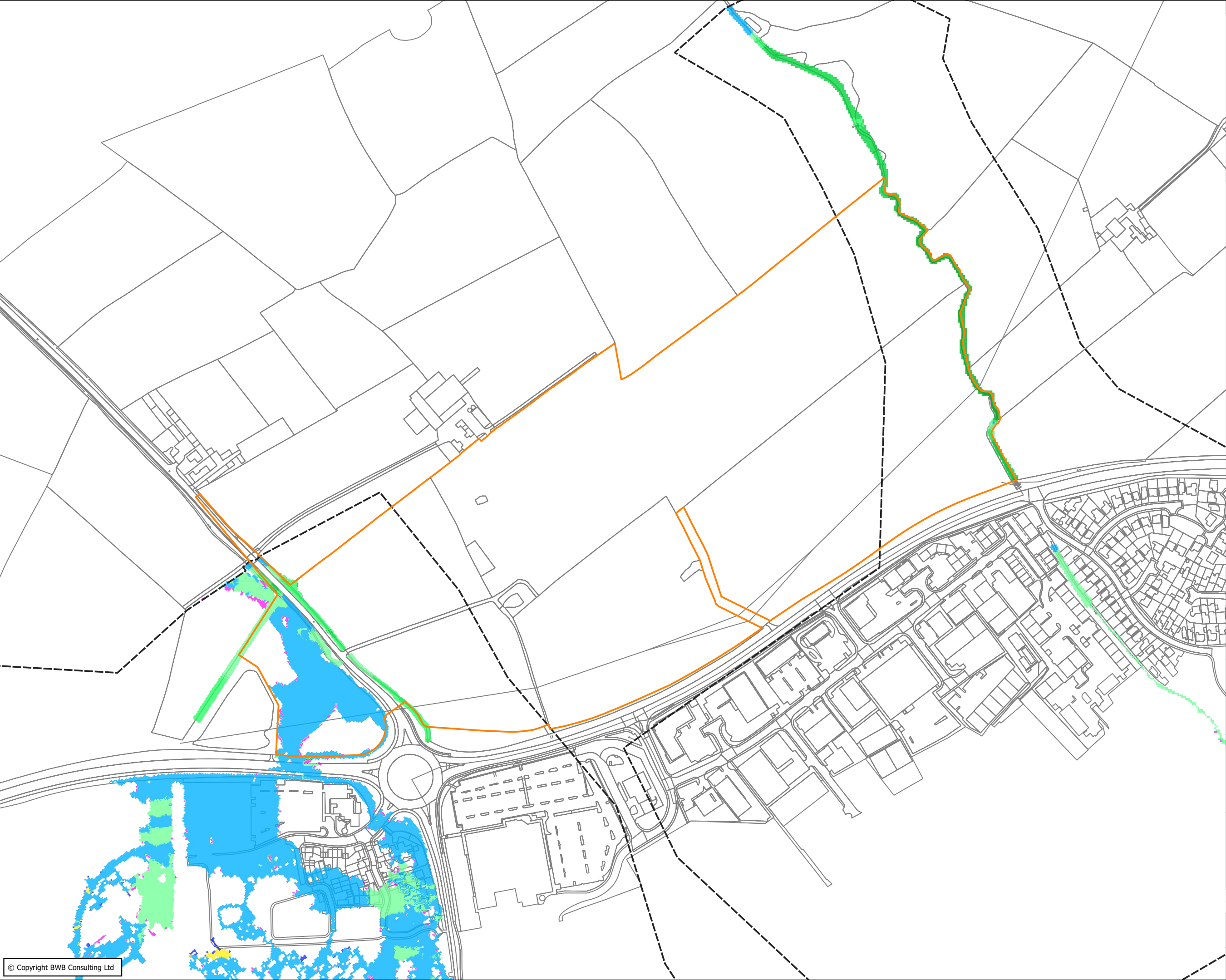
**Baseline Sensitivity:
Increased Roughness (20%)
1 in 100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	28.03.22
Scale@A3:	1:3750		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0011	S2	P02



Notes

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3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.

4. Any discrepancies noted on site are to be reported to the engineer immediately.

5. Model not yet peer reviewed.

6. OS Mapping has been reproduced under the licence number 100022432.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P02	20.04.22	MINOR AMENDMENTS		LR	MB
P01	28.03.22	PRELIMINARY ISSUE		LR	MB
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

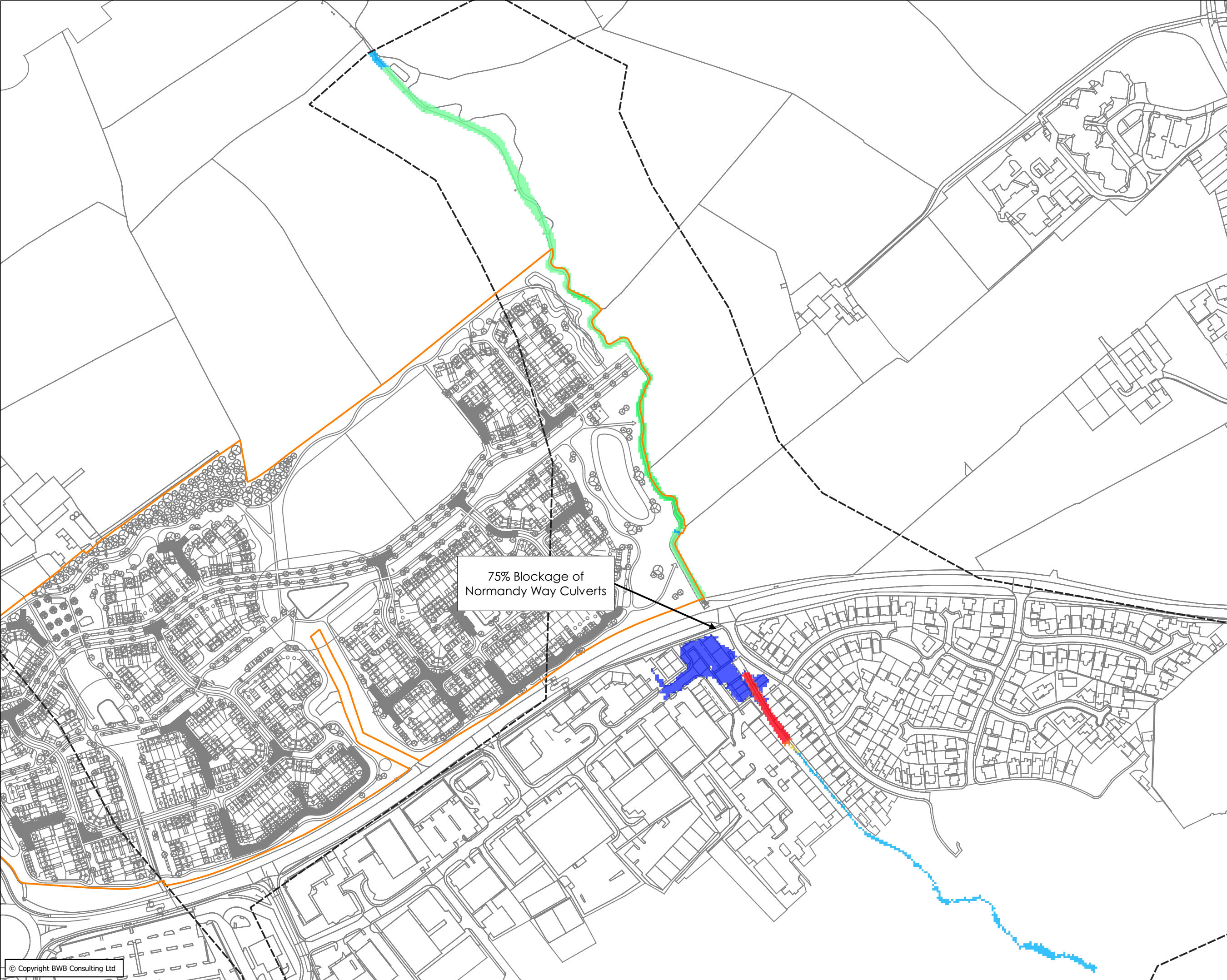
**Baseline Sensitivity:
Decreased Roughness (20%)
1 in 100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	28.03.22
		Scale@A3:	1:3750

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0012	S2	P02



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 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

- Key**
- Illustrative Site Location
 - Model Domain
 - Change in Floodplain Extent**
 - Former Wet Areas Now Dry
 - Former Dry Areas Now Wet
 - Change in Peak Flood Level (m)**
 - ≤ -0.125
 - 0.125 - -0.100
 - 0.100 - -0.075
 - 0.075 - -0.050
 - 0.050 - -0.025
 - 0.025 - -0.01
 - 0.01 - 0.01 (No Change)
 - 0.01 - 0.025
 - 0.025 - 0.050
 - 0.050 - 0.075
 - 0.075 - 0.100
 - 0.100 - 0.125
 - > 0.125

P01	26.04.22	PRELIMINARY ISSUE		LR	MB
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

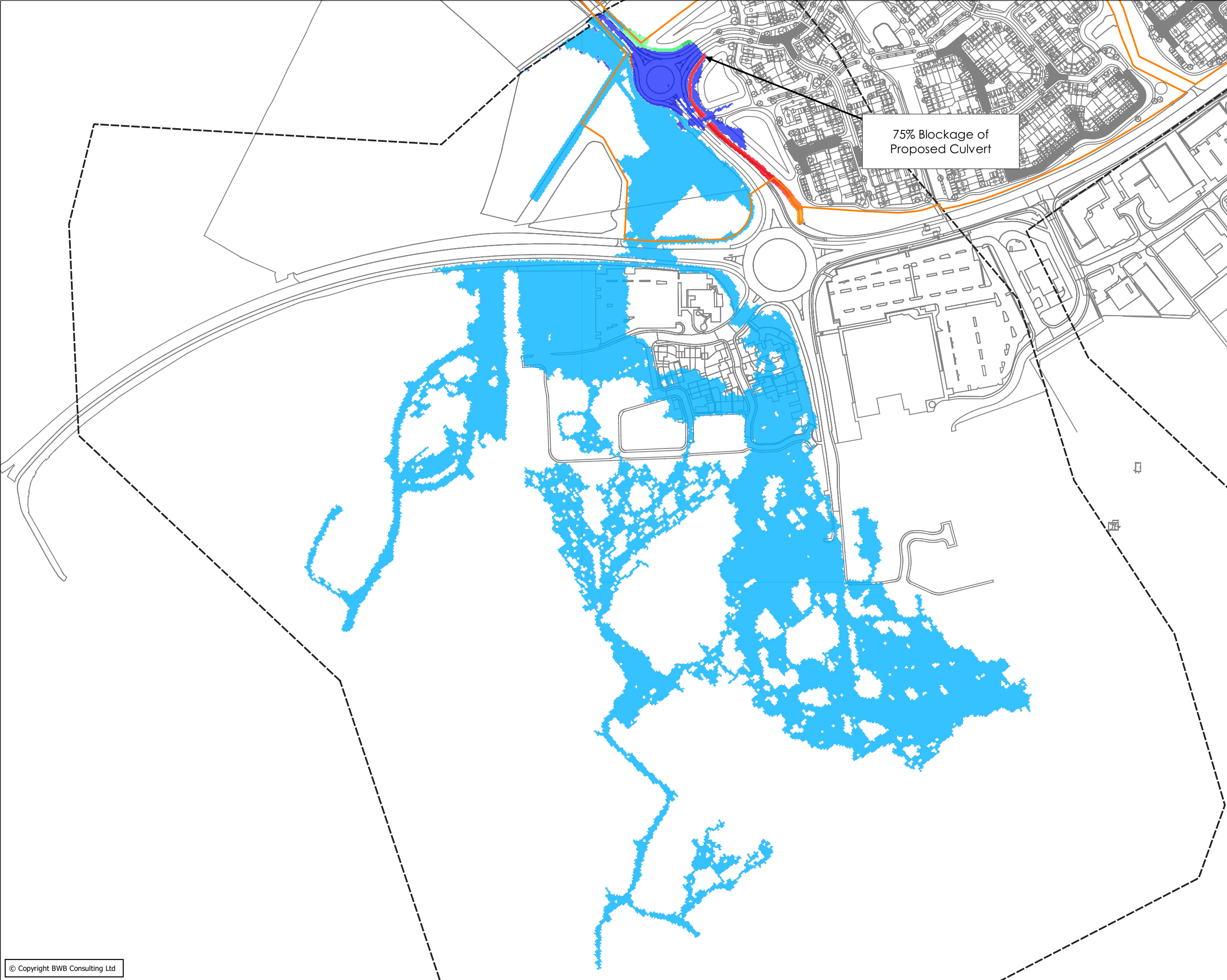
**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Post-Development
Sensitivity: Normandy Way
Blockage (75% Blockage of
Each Opening) 1 in 100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	26.04.22
		Scale@A3:	1:3250

Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev	
HIN-BWB-ZZ-XX-DR-YE-0019	S2	P01	



- Notes
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 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P01	26.04.22	PRELIMINARY ISSUE		LR	MB
Rev	Date	Details of issues/ revision		Drw	Rev

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**Richborough Estates Limited
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Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

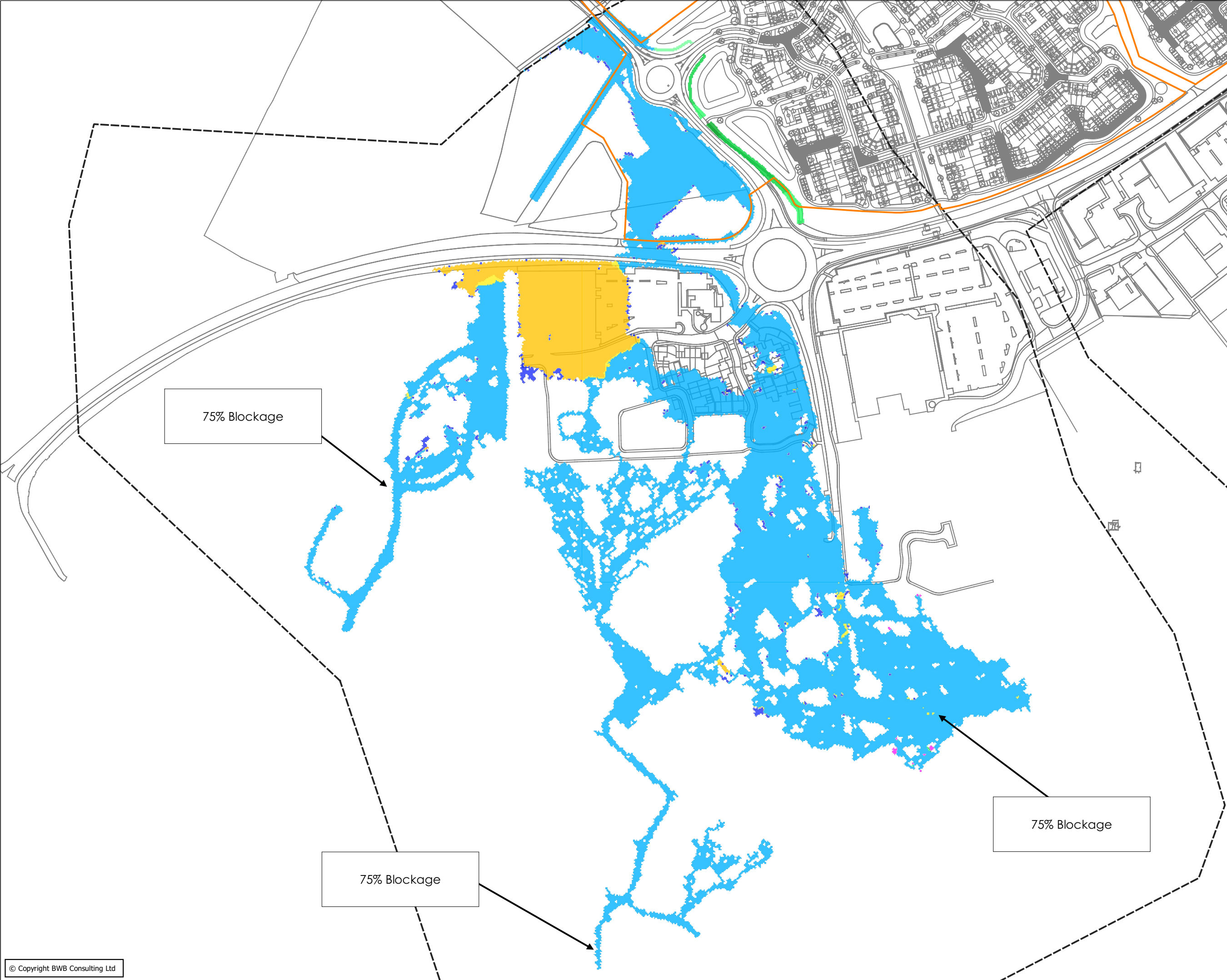
**Post-Development
Sensitivity: Proposed
Culvert (75% Blockage) 1 in
100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	26.04.22
		Scale@A3:	1:3250

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0021	S2	P01



- Notes**
1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P01	26.04.22	PRELIMINARY ISSUE		LR	MB
Rev	Date	Details of issues/ revision		Drw	Rev

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Client

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Project Title

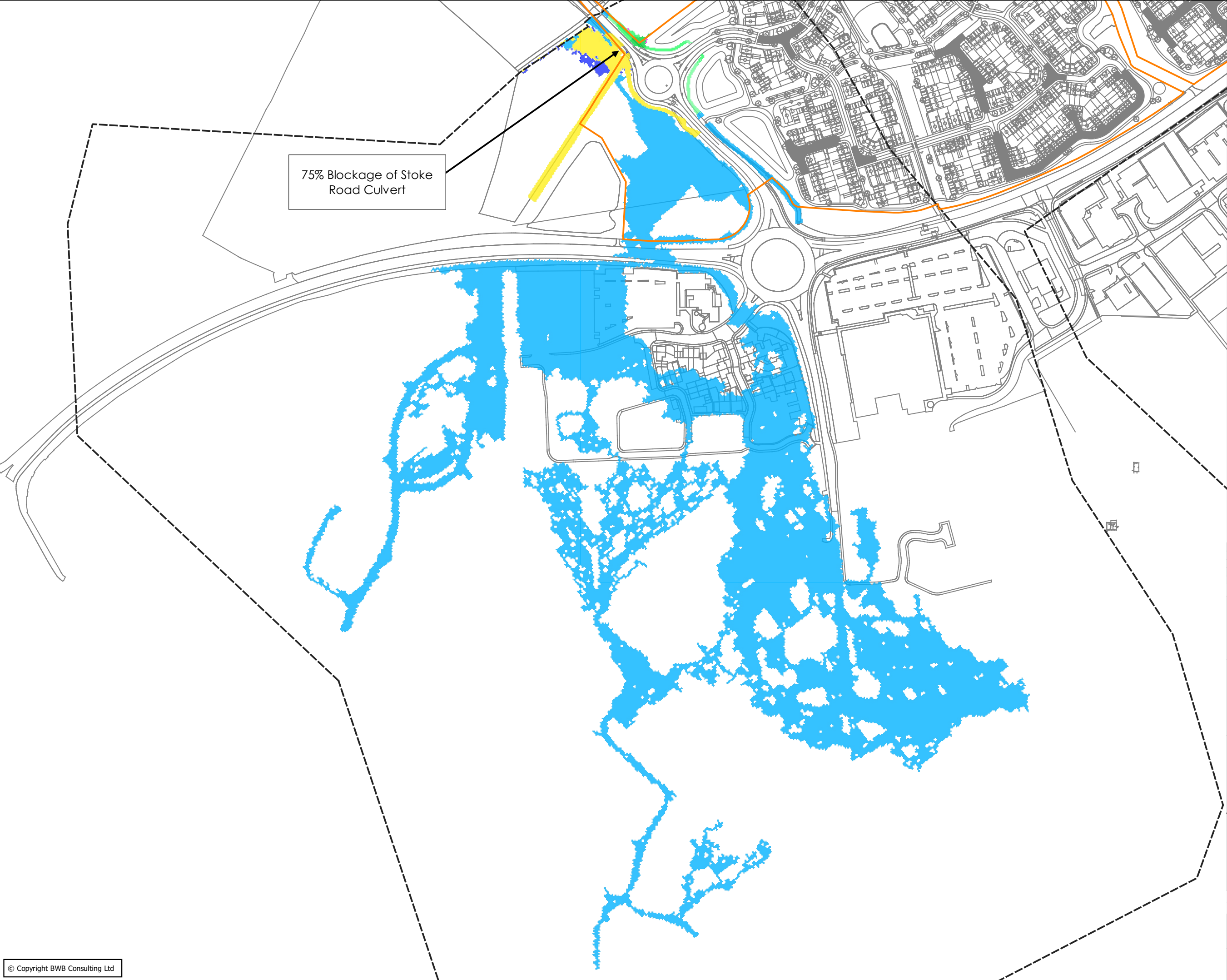
**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Post-Development
Sensitivity: Sewer Network
(75% Blockage of Multiple
Pipes) 1 in 100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	26.04.22
		Scale@A3:	1:3250

Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev	
HIN-BWB-ZZ-XX-DR-YE-0020	S2	P01	



75% Blockage of Stoke Road Culvert

- Notes**
1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. Model not yet peer reviewed.
 6. OS Mapping has been reproduced under the licence number 100022432.
 7. Proposed plans taken from drawing reference: P18-1531-009-1F.

Key

Illustrative Site Location

Model Domain

Change in Floodplain Extent

Former Wet Areas Now Dry

Former Dry Areas Now Wet

Change in Peak Flood Level (m)

<= -0.125

-0.125 - -0.100

-0.100 - -0.075

-0.075 - -0.050

-0.050 - -0.025

-0.025 - -0.01

-0.01 - 0.01 (No Change)

0.01 - 0.025

0.025 - 0.050

0.050 - 0.075

0.075 - 0.100

0.100 - 0.125

> 0.125

P01	26.04.22	PRELIMINARY ISSUE		LR	MB
Rev	Date	Details of issues/ revision		Drw	Rev

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Client

**Richborough Estates Limited
and Mr & Mrs Adcock**

Project Title

**Land East of Stoke Road and
North of Normandy Way
(A47), Hinckley**

Drawing Title

**Post-Development
Sensitivity: Stoke Road
Culvert (75% Blockage) 1 in
100-Year**

Drawn:	L. Reeves	Reviewed:	M. Bramani
BWB Ref:	210683	Date:	26.04.22
		Scale@A3:	1:3250

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HIN-BWB-ZZ-XX-DR-YE-0022	S2	P01



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Appendix 4: Leicestershire County Council Correspondence

Lucy Reeves

From: Jack Harriman <[REDACTED]>
Sent: 10 January 2022 15:47
To: Alex Petrakis
Subject: RE: Hinckley North

This email originated from outside of our organisation. Please exercise caution with content, links and attachments.

Hi Alex,

Thanks for your email. Both these are ordinary watercourses that are tributaries of the Sence Brook to the north. Our GIS shows this site to be at the top of the catchment for these tributaries with the catchment boundary roughly intersecting through the top of Hinckley town.

Having looked at the highway records for Normandy Way I cannot find any flooding reports of the highway at the site boundary. There was flooding from the eastern watercourse to the north downstream on Rogues Lane in 2014 however this wouldn't concern this site. People will obviously only report flooding that affects the highway so if fields flood from these watercourses then it will probably not be reported.

Also if you want information like this in future for Leicestershire the best email is flooding@leics.gov.uk and me or someone else will pick it up. Or you can ring me directly.

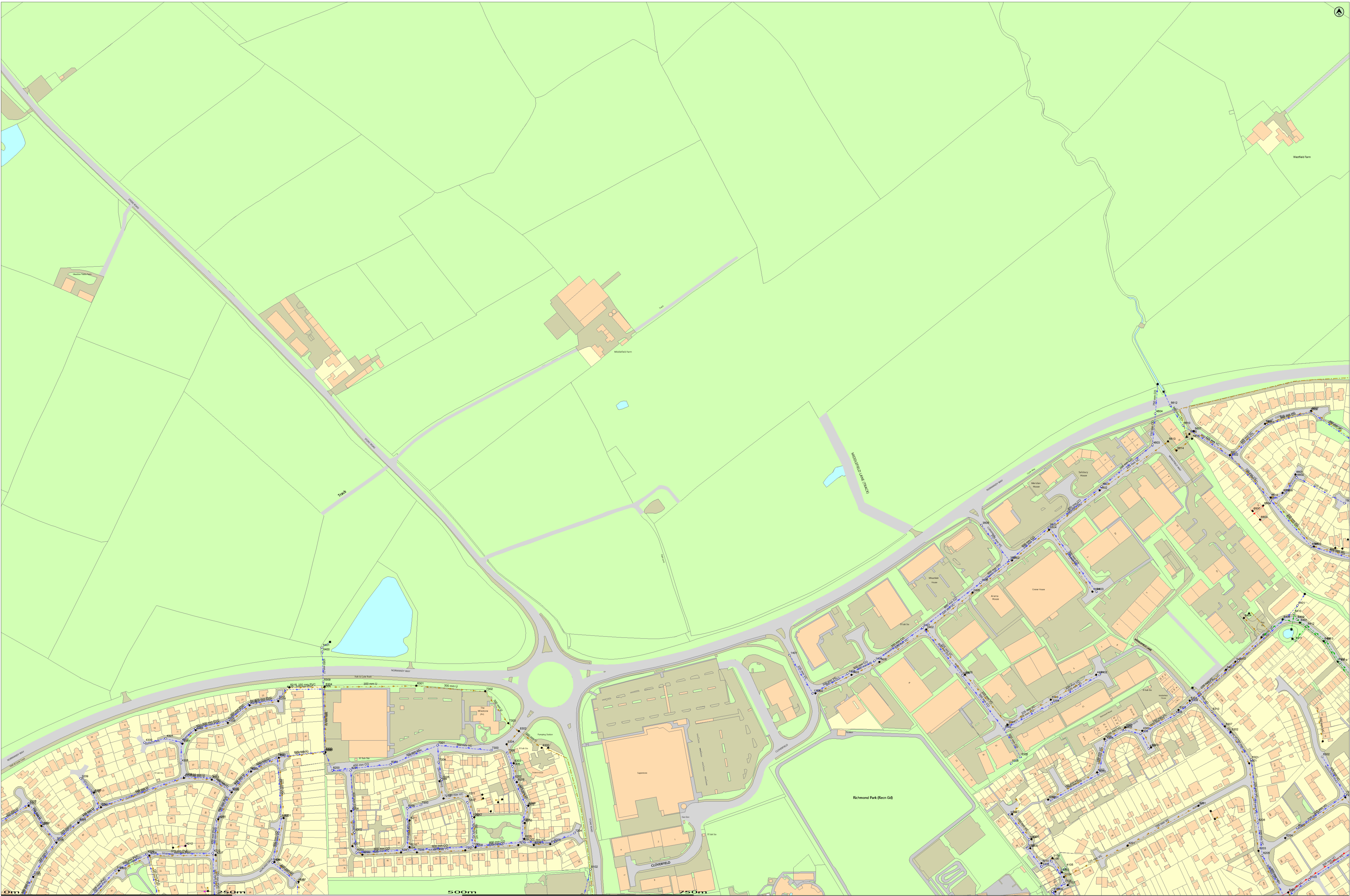
All the best

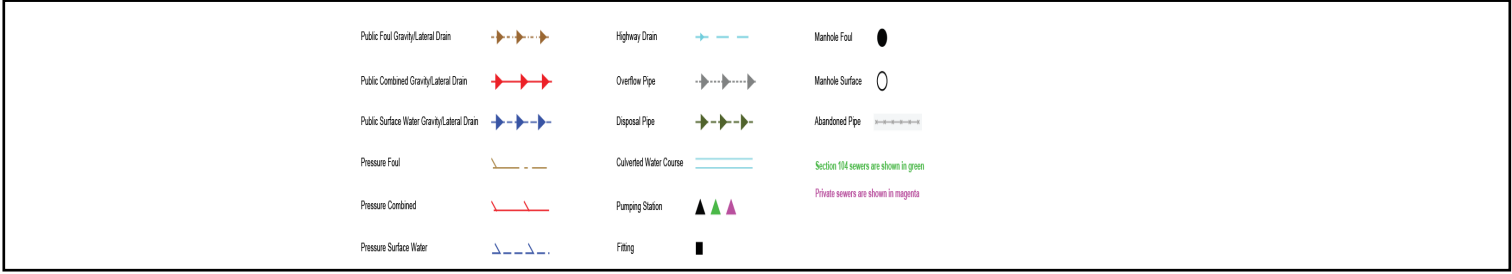
Jack Harriman
Technician (Flood Risk Management)
Unison Workplace Rep
Environment & Transport Department
Leicestershire County Council
Tel: [REDACTED]

[www.flooding@leics.gov.uk](mailto:flooding@leics.gov.uk)

www.leicestershire.gov.uk/planning-and-environment/flooding-and-drainage

Appendix 5: Severn Trent Water Sewer Records





GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on: **0800 753 4444 (24 hours)**

- a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt), mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.
- b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.
- c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.
- d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.
- e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).
- f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,
14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Appendix 6: Severn Trent Water Correspondence

Lucy Reeves

From: Alex Petrakis
Sent: 20 January 2022 14:48
To: Max Brambani
Subject: FW: Hinckley North

From: Asset.Protection <Asset.Protection@severntrent.co.uk>
Sent: 20 January 2022 14:47
To: Alex Petrakis <Alex.Petrakis@bwbconsulting.com>
Subject: RE: Hinckley North

This email originated from outside of our organisation. Please exercise caution with content, links and attachments.

ST Classification: OFFICIAL PERSONAL

Hello Alex

Thank you for your email below.

We wouldn't hold any information on the watercourse as these are not our assets.

With regards to the surface water sewers that discharge to the watercourses, I cannot see any locations of flooding instances but it does look like there are capacity issues on heavy storm events.

Hope this helps.

Kind regards

Asif Mussa

Senior Evaluation Technician
Asset Protection
Asset Strategy & Planning
Chief Engineer, Severn Trent Water

WONDERFUL ON TAP



