Tritax Symmetry (Hinckley) Limited

HINCKLEY NATIONAL
RAIL FREIGHT INTERCHANGE

The Hinckley National Rail Freight Interchange Development Consent Order

Project reference TR050007

Flood Risk Assessment

Report Prepared by: BWB Consulting Ltd

Document reference: 6.2.14.1

Revision: P05

November 2022

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 5(2)(e)

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 Regulation 14

This document forms a part of the Environmental Statement for the Hinckley National Rail Freight Interchange project.

Tritax Symmetry (Hinckley) Limited (TSH) has applied to the Secretary of State for Transport for a Development Consent Order (DCO) for the Hinckley National Rail Freight Interchange (HNRFI).

To help inform the determination of the DCO application, TSH has undertaken an Environmental Impact Assessment (EIA) of its proposals. EIA is a process that aims to improve the environmental design of a development proposal, and to provide the decision maker with sufficient information about the environmental effects of the project to make a decision.

The findings of an EIA are described in a written report known as an Environmental Statement (ES). An ES provides environmental information about the scheme, including a description of the development, its predicted environmental effects and the measures proposed to ameliorate any adverse effects.

Further details about the proposed Hinckley National Rail Freight Interchange are available on the project website:

[redacted]

The DCO application and documents relating to the examination of the proposed development can be viewed on the Planning Inspectorate's National Infrastructure Planning website:

https://infrastructure.planninginspectorate.gov.uk/projects/east-midlands/hinckley-national-rail-freight-interchange/

DOCUMENT ISSUE RECORD

Author:	Robin Green BSc (Hons)
Checked:	Lucy Reeves BSc (Hons) Max Brambani BSc (Hons) PgCert MCIWEM
Approved:	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM Matthew Day BA (Hons) MSc FRGS MCIWEM C.WEM C.Sci C.Env

Rev	Date	Status	Comment	Author:	Checked:	Approved:
P01	21/10/21	S0	Preliminary Issue	RG	LR	CG
P02	10/11/21	S2	Updated to reflect latest boundary	RG	LR	CG
P03	13/12/21	S2	Updated to reflect the latest DCO Site boundary and terminology. Issued alongside the PEIR.	RG	LR	CG
P04	30/08/22	S2	Updated to reflect the latest DCO Site boundary, report layout amended to follow ES format.	RG	MB	MD
P05	16/11/22	S2	Minor formatting changes	RG	MB	MD

EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Policy Statement for National Networks (NPSNN). The FRA has been produced in respect of a Development Consent Order (DCO) for a Strategic Rail Freight Interchange (SRFI) on land adjacent to the north-west of Junction 2 of the M69.

The Flood Maps for Planning identify that the majority of the Main HNRFI Site, A47 Link Road, and M69 Junction 2 are located within Flood Zone 1, with just the new rail connection to the existing railway Main Line and the A47 Link Road between the M69 and the B4668 partially falling within Flood Zones 3 and 2.

A site-specific hydraulic model of the local watercourse network has been developed which has shown that the Main HNRFI Site, A47 Link Road, and M69 Junction 2 are generally located outside of the floodplain and at a low risk of fluvial flooding. There are a few localised areas upstream of the railway line within the Main HNRFI Site where flood water can pond, as well as an overland flow route at the A47 Link Road, that the development will need to consider.

The layout has been arranged to either fall outside of the floodplain on higher ground or in an area where it is afforded protection by the intervening topography, or in case of the A47 Link Road, M69, and railway line, to be located on elevated embankments raising them above flood levels so that they can remain operational.

The floodplain present within the Main HNRFI Site (alongside the railway line) is largely a product of rain falling within the Main HNRFI Site, the impeded drainage conditions of the underlying ground, and the limited capacity of the downstream culverts through the railway embankment. This flood risk will be addressed by the Proposed Scheme which will intercept and store rainwater within new drainage infrastructure and Sustainable Drainage Systems (SuDS)before releasing it slowly to the surrounding watercourse network.

The pluvial floodplain associated with the watercourse network at the Main HNRFI Site, A47 Link Road, and M69 Junction 2 closely mirrors the fluvial flooding mechanisms, and the flood risk posed by this will be addressed in the same manner. Away from the watercourses any remaining surface water flood risk will be addressed through the reprofiling of the Main HNRFI Site and the introduction of appropriate drainage infrastructure.

The Main HNRFI Site, A47 Link Road, and M69 Junction 2 have been identified to be at low risk of groundwater flooding due to the depth of groundwater and the low permeability of the underlaying strata. However, it is recommended that groundwater should be monitored during the construction phase, particularly during excavations. Where shallow groundwater is encountered appropriate dewatering should be employed if necessary.

All other potential sources of flood risk were assessed as posing a low risk.

Hydraulic modelling of the Proposed Scheme and a comparison against the baseline floodplain has shown that the Proposed Scheme will have no detrimental impact in the wider catchment. The assessment has also identified that the scheme could potentially offer marginal downstream betterment due to the attenuated storage of surface water.

The proposed A47 Link Road includes culverts to preserve watercourse connectivity beneath its elevated carriageway. An overland flow route located between two channels is to be preserved by a series of offline culverts located beneath the road. Flood water is predicted to build above existing levels on the upstream side of the road, but the increase does not affect any land outside of the DCO Site. Therefore, this increase is considered acceptable. Hydraulic modelling has identified that the A47 Link Road has no detrimental impacts on the downstream floodplain.

The Proposed Scheme will include surface water drainage infrastructure that will be designed to intercept and store storm water falling on the development, so that it can remain operational. The development will continue to discharge surface water to the local watercourses at the equivalent 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.

The Proposed Scheme includes a number of minor improvements to highways and the railway in the surrounding area. Generally, these are located in areas of low flood risk. However, some do fall within an area of high fluvial or surface water flood risk. However, the proposed works are minor, generally consisting of localised widening of the carriageway, a change in the junction type, improvements or closure of a footway, or the installation of a new crossing point, all of which would most likely be undertaken at grade so that there would be no significant interruption of flow routes or loss in floodplain storage. Additionally, the proposed works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any new impermeable surfaces.

In compliance with the requirements of NPSNN and NPPF, and subject to the mitigation measures proposed, the Proposed Scheme could proceed without being subject to significant flood risk. Moreover, the Proposed Scheme will not increase flood risk to the wider catchment area as a result of suitable management of surface water runoff.

CONTENTS

Figures

Tables

Appendices

1. INTRODUCTION

1.1. This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Policy Statement for National Networks (NPSNN). The FRA has been produced on behalf of Tritax Symmetry (Hinckley) Ltd in respect of a Development Consent Order (DCO) for a Strategic Rail Freight Interchange (SRFI) on land adjacent to the north-west of Junction 2 of the M69 and includes highway works in the wider surrounding area.

1.2. This FRA is intended to support an application for a DCO based upon parameter plans and an illustrative layout. The level of detail included in the assessment is commensurate and subject to the level of detail available at this stage. Summary information is included as **Table 1.1**.

Table 1.1: Summary Information

Site Name	Hinckley National Rail Freight Interchange
Location	Leicestershire
Development Type	• Primary Road & Rail Infrastructure • Rail Port, Warehouses & Ancillary Buildings, and associated infrastructure • Landscaping, SuDS, Ecology & Amenity Areas • Highway, Junction, and Railway Improvements
Environment Agency Office	East Midlands
Lead Local Flood Authority	Leicestershire County Council & Warwickshire County Council

Sources of Data

i. Topographical Survey of the Site (07700-HYD-A-00-M2-D-0006)

ii. Parameters Plan & Illustrative Layout (5905-252 & 2905-250)

iii. Ordnance Survey mapping

iv. Environment Agency consultation

v. Consultation with the Lead Local Flood Authority and the District Council.

vi. Leicestershire Strategic Flood Risk Assessment

vii. Leicestershire Preliminary Flood Risk Assessment

viii. Site visit undertaken by BWB Consulting

ix. A desk study of the potential flood risk at the location of the off-site highway, junction, and railway improvements (HNRFI-BWB-ZZ-XX-RP-YE-0008) – **Appendix 1**

x. Hydraulic modelling of the Thurlaston Brook tributary watercourses undertaken by BWB Consulting (HNRFI-BWB-ZZ-XX-RP-YE-0006) - **Appendix 2**

xi. Hydraulic modelling of the Soar Brook tributary undertaken by BWB Consulting (HNRFI-BWB-ZZ-XX-RP-YE-0007) - **Appendix 3**

xii. Preliminary ground Investigations undertaken by Hydrock (RFI-HYD-XX-XX-RP-GE-1002)

xiii. Geo-Environmental assessment of the site prepared by BWB Consulting (HNRFI-BWB-ZZ-XX-RP-YE-0001)

xiv. Severn Trent Water Sewer Records

xv. Anecdotal Reports of Flooding (anonymous sources)

xvi. British Geological Survey Drift & Geology Maps

xvii. Surface Water Drainage Strategy (HNRFI-BWB-ZZ-XX-RP-CD-0002) – document reference 6.2.14.2

The Site

1.3. The Main HNRFI Site lies 3 km to the north-east of Hinckley town centre to the north-west of Junction 2 of the M69. The Nuneaton to Felixstowe railway forms the north-western boundary, with the M69 motorway defining the south-eastern boundary. To the south-west are blocks of deciduous woodland (including Burbage Wood, Aston Firs and Freeholt Wood), and a traveller community site and a mobile home site. Beyond the north-eastern boundary lies the village of Elmesthorpe, a linear settlement on the B581 Station Road.

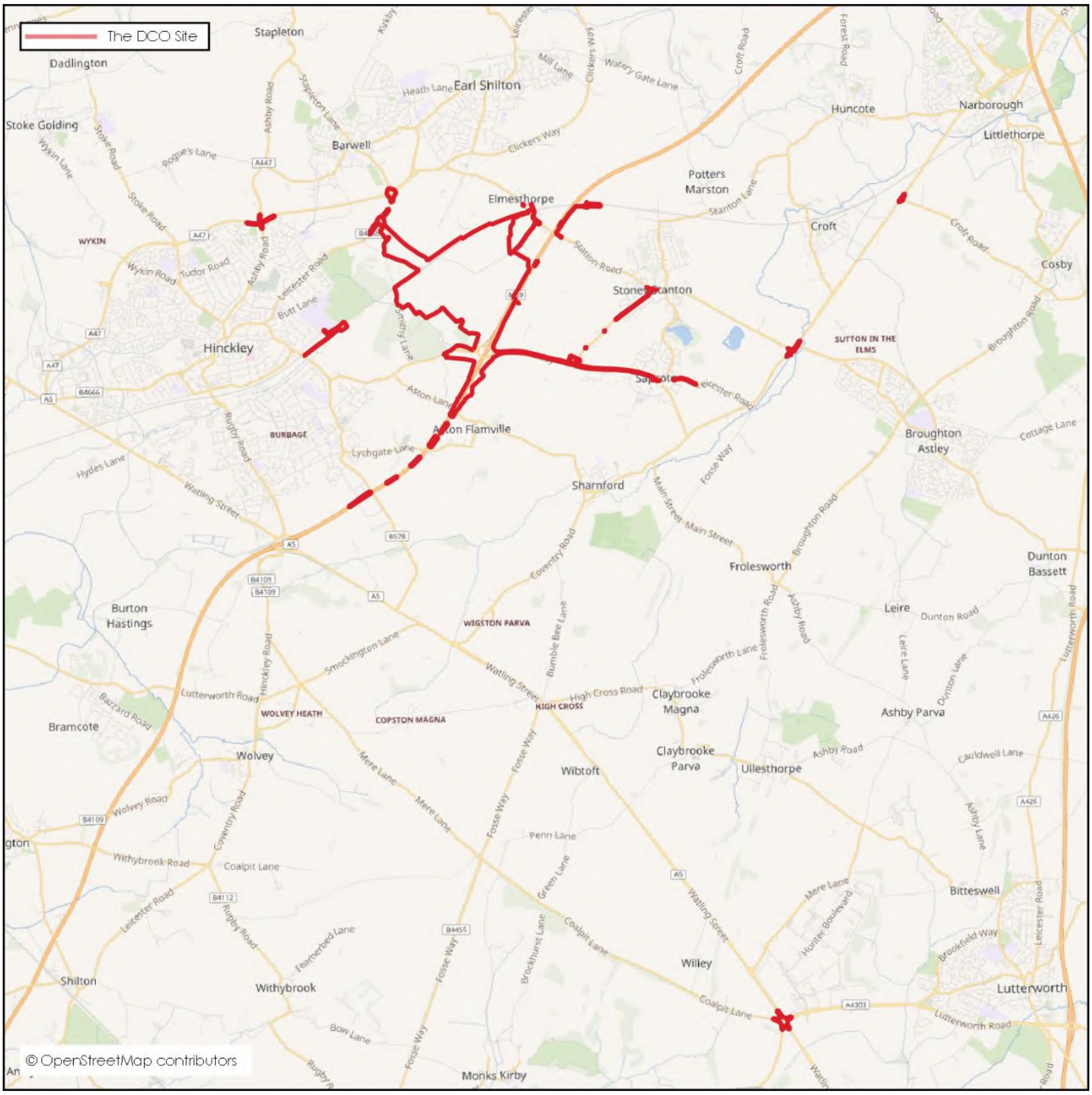
1.4. The Main HNRFI Site comprises the proposed SRFI, which includes but may not be limited to, the railway sidings and freight transfer area alongside the two-track railway between Hinckley and Leicester, land for the development of storage and logistics sheds, site hub building, energy centre, and associated lorry and car parking, infrastructure, and landscaping.

1.5. The Development Consent Order (DCO) Site extends beyond the Main HNRFI Site to include other elements including a new link road from M69 Junction 2 to the B4668 (Leicester Road) ('the A47 Link Road'), and alterations to M69 Junction 2 – this larger area is referred to as the Main Order Limits.

1.6. The DCO Site also extends beyond the Main Order Limits to include other minor highway, junction, and railway alterations.

1.7. A location plan illustrating the DCO boundary is illustrated within **Figure 1.1**.

Figure 1.1: The DCO Site Location



1.8. The watercourse network in and around the Main Order Limits, as shown on Ordnance Survey mapping and identified on a site-specific topographical survey, are shown in **Figure 1.2**.

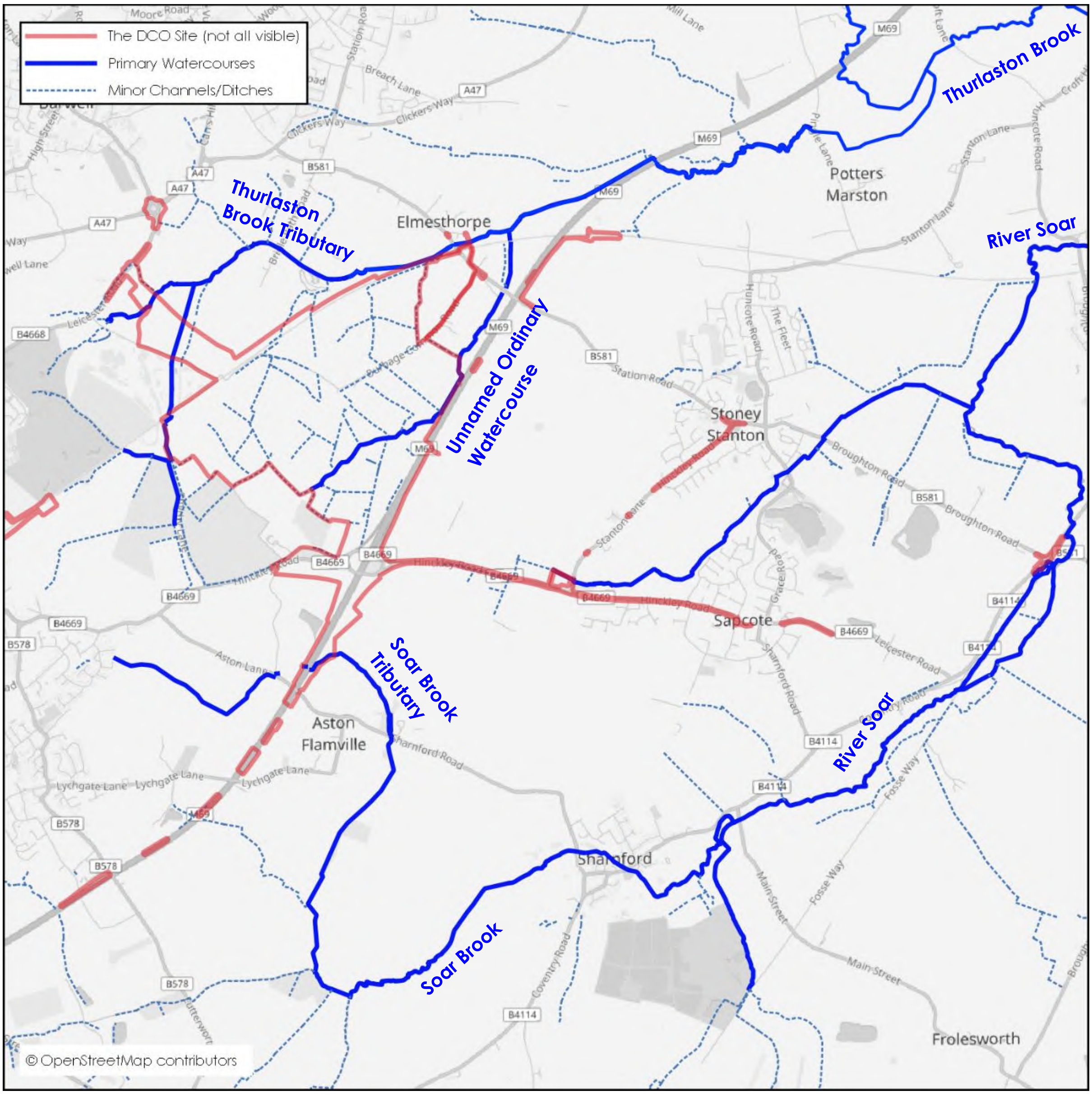
1.9. The Main Order Limits are located within the catchment of an unnamed tributary of the Thurlaston Brook. This watercourse issues from the eastern side of Hinckley and flows eastwards to the north of the railway line.

1.10. Five smaller tributary watercourses/ditches serving land to the south-west of the

Main Order Limits and land in the north of the Main HNRFI Site pass beneath the railway line and join the unnamed tributary of the Thurlaston Brook as it flows to the north of the Main HNRFI Site.

1.11. The unnamed tributary of the Thurlaston Brook continues to flow towards the northeast, through Elmesthorpe and the farmland beyond, before it is culverted beneath the M69.

Figure 1.2: Watercourse Network



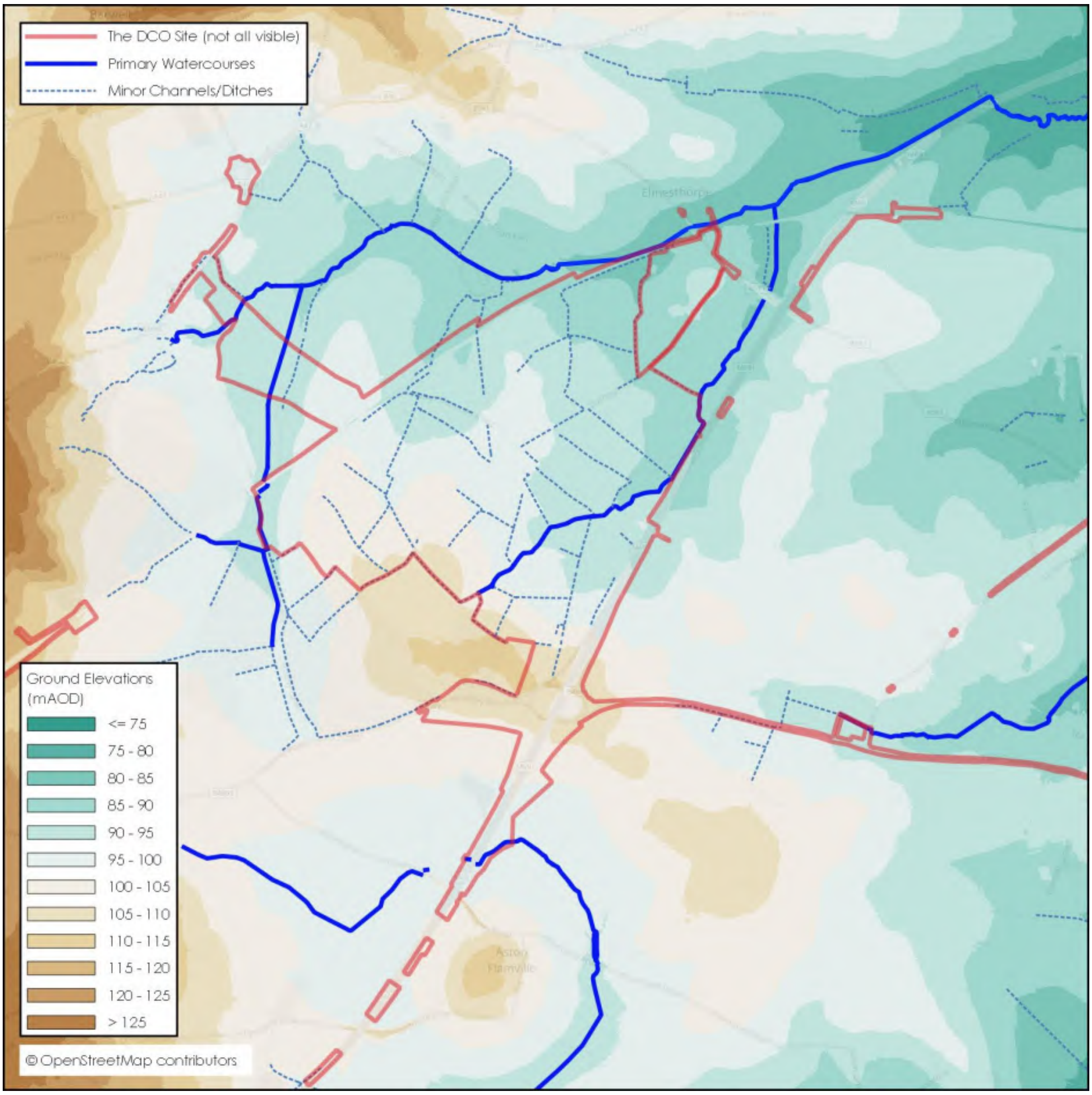
1.12. An Unnamed Ordinary Watercourse (UOW) flows north-eastward through the centre of the Main HNRFI Site before joining the tributary of the Thurlaston Brook just downstream of the railway line.

1.13. The catchment of this UOW is largely made up by land within the Main HNRFI Site, rather than being fed by a significant upstream catchment. Additionally, within the Main HNRFI Site, several field drainage ditches and small ponds also discharge into this watercourse.

1.14. The Soar Brook tributary issues from the south-eastern side of Hinckley. This flows beneath the M69, to the south west of Junction 2, and through the Order Limits for a short length, before turning south-east and flowing away from the DCO Site.

1.15. The topography of the local area is illustrated within **Figure 1.3** using a combination of LiDAR and Photogrammetry Digital Terrain Models (DTMs). This identifies that the watercourses generally follow the natural topography, and that the local area generally falls towards the watercourses.

Figure 1.3: Generalised Topography



1.16. The railway line runs to the north of the Main HNRFI Site. Due to the undulating topography of the local area, the railway line is in cut beneath the more elevated areas and is located upon an embankment above the lower lying areas - this includes the low-lying watercourse corridors. The watercourses are culverted beneath the railway line.

1.17. The M69 is located upon an embankment off the eastern boundary of the Main HNRFI Site, this transitions into being in cut at Junction 2, where the natural topography is more elevated.

1.18. Station Road is also located upon an embankment downstream of the Main HNRFI Site (to the east). It is elevated above the low-lying watercourses corridors, and the watercourses are culverted beneath it.

1.19. The elevated linear infrastructure around the Main Order Limits bisect the local floodplain, influencing flow routes and the flood risk of the local area.

Proposed Scheme

1.20. The development on the Main HNRFI Site includes:

- The demolition of Woodhouse Farm, Hobbs Hayes, Freehold Lodge and the existing bridge over the Leicester to Hinckley railway on Burbage Common Road;
- new rail infrastructure including points off the existing Leicester to Hinckley railway providing access to a series of parallel sidings at the HNRFI, in which trains would be unloaded, marshalled and loaded;
- an intermodal freight terminal or 'Railport', with hard-surfaced areas for container storage and HGV parking and cranes for the loading and unloading of shipping containers from trains and lorries;
- warehousing and ancillary buildings;
- an energy centre incorporating an electricity substation connected to the local electricity distribution network and a gas-fired combined heat and power plant;
- a lorry park with welfare facilities for drivers and HGV fuelling facilities;
- a site hub building providing office, meeting space and marketing suite for use in connection with the management of the HNRFI and ancillary car parking;
- terrain remodelling, hard and soft landscape works, amenity water features and planting;
- noise attenuation measures, including acoustic barriers up to six metres in height;
- habitat creation and enhancement, and the provision of publicly accessible

amenity open space at the south-western extremity of the HNRFI near Burbage Wood and to the south of the proposed A47 Link Road between the railway and the B4668/A47 Leicester Road;

- pedestrian, equestrian and cycle access routes and infrastructure, including a new dedicated route for pedestrians, cyclists and horse riders from a point south of Elmesthorpe to Burbage Common;
- utility compounds, plant and service infrastructure;
- security and safety provisions inside the HNRFI including fencing and lighting;

1.21. drainage works including surface water retention ponds, underground attenuation tanks and swales. Beyond the Main HNRFI Site, the Main Order Limits include:

- works to M69 Junction 2 comprising the reconfiguration of the existing roundabout and its approach and exit lanes, the addition of a southbound slip road for traffic joining the M69 motorway and the addition of a northbound slip road for traffic leaving the M69 motorway at Junction 2.
- a new road (‘the A47 Link Road’) from the modified M69 Junction 2 to the B4668 / A47 Leicester Road with a new bridge over the railway, providing vehicular access to the proposed HNRFI from the strategic highway network. The A47 Link Road will be intended for adoption as a public highway under the Highways Act 1980.

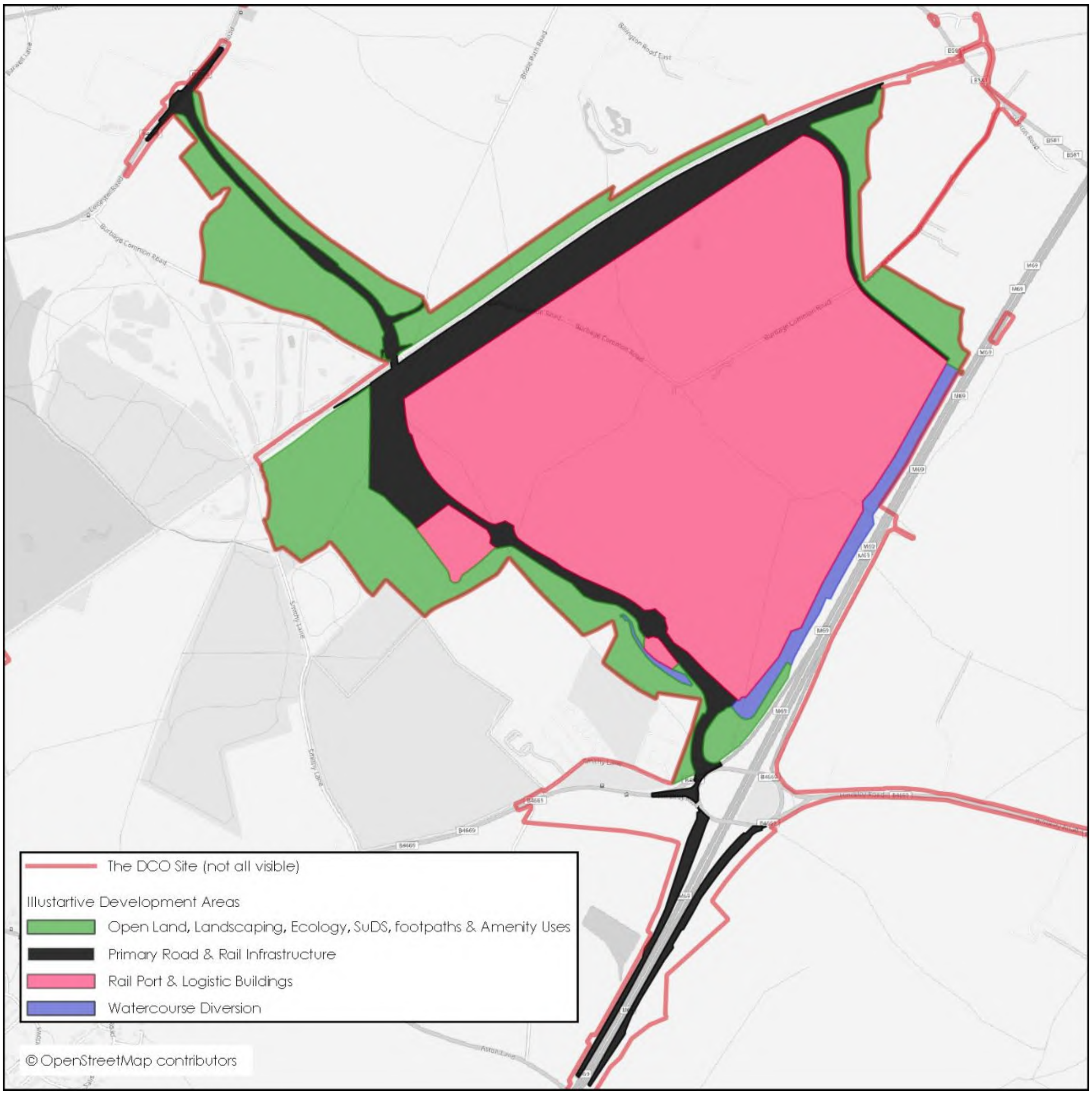
1.22. For the purpose of this FRA, the proposed land use areas from the parameters plan have been generalised and grouped into their respective vulnerability classifications – this is illustrated within **Figure 1.4**, and identified within **Table 1.2**. The FRA will be based around these subdivisions of the development proposals.

Table 1.2: Summary of Proposed Development Areas

Development Group	Description	NPPF Vulnerability	Flood Zone Classification
Primary Road & Rail Infrastructure	Includes works to the Main Line railway, the railway sidings and rail terminal, the link road between the M69 and the B4668 and the associated minor road diversions, and the new motorway slip roads (including widening of the M69 carriageway)	Essential Infrastructure	Flood Zone 1, 2 & 3

Development Group	Description	NPPF Vulnerability	Flood Zone Classification
Warehousing & ancillary buildings	Includes Rail corridor within development zones, warehousing, ancillary buildings, energy centre, site hub, with associated parking, access, and frontage to rail port.	Less Vulnerable	Flood Zone 1
Watercourse Diversion	Relocation of an existing UOW into a new corridor alongside the M69.	Water Compatible	Flood Zone 1
Open Land, Landscaping, Ecology, SuDS, Footpaths & Amenity Areas	Includes: open land, landscaping and acoustic barriers; landscaped amenity areas; SuDS; footpaths and bridleways and environmental zones for habitat creation.	Water Compatible	Flood Zone 1, 2 & 3

Figure 1.4: Illustrative Summary of Proposed Development Areas



1.23. Beyond the Main Order Limits, the DCO Site extends to include:

- modifications to several junctions and amendments to Traffic Regulation Orders on the local road network;
- works affecting existing pedestrian level crossings on the Leicester to Hinckley railway at Thorney Fields Farm north-west of Sapcote, at Elmesthorpe and at Outwoods between Burbage and Hinckley.

1.24. These more minor proposals are identified within **Figure 1.5** to **Figure 1.10**, with a summary description provided within **Table 1.3**.

Figure 1.5: Off-Site Highway/Railway Works Location 1

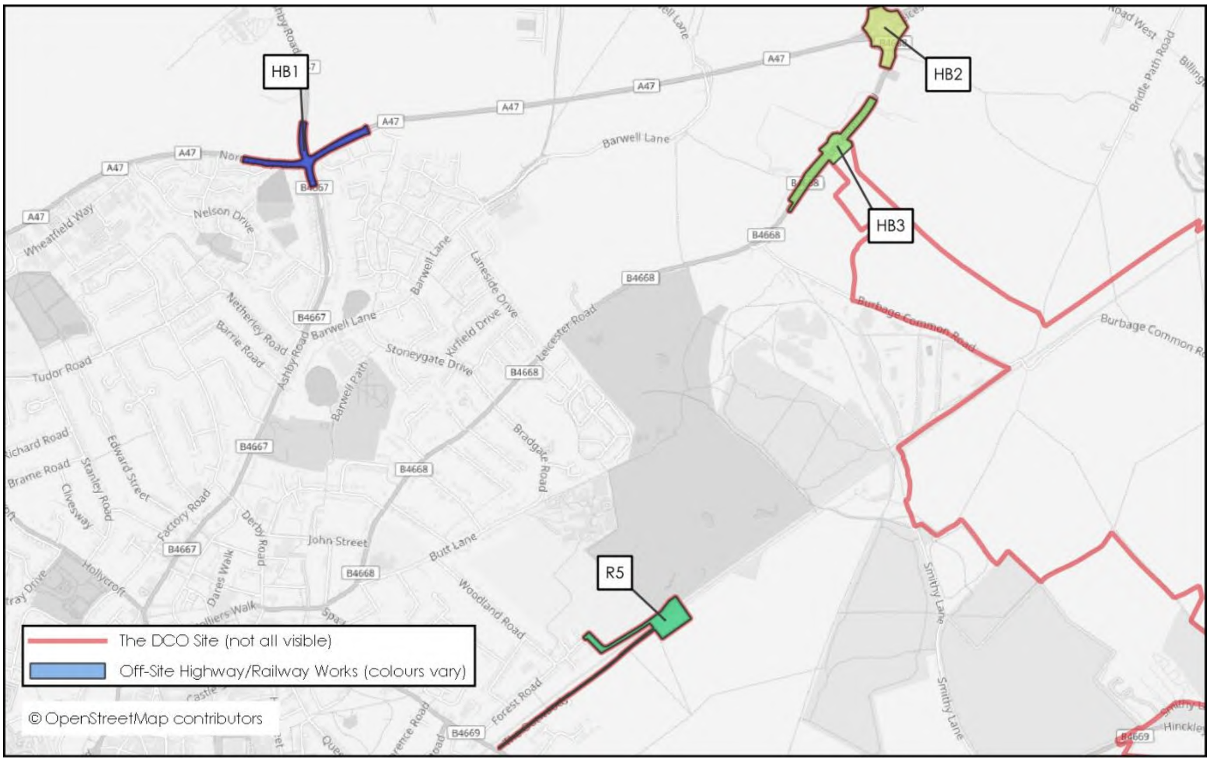


Figure 1.6: Off-Site Highway/Railway Works Location 2

Figure 1.7: Off-Site Highway/Railway Works Location 3

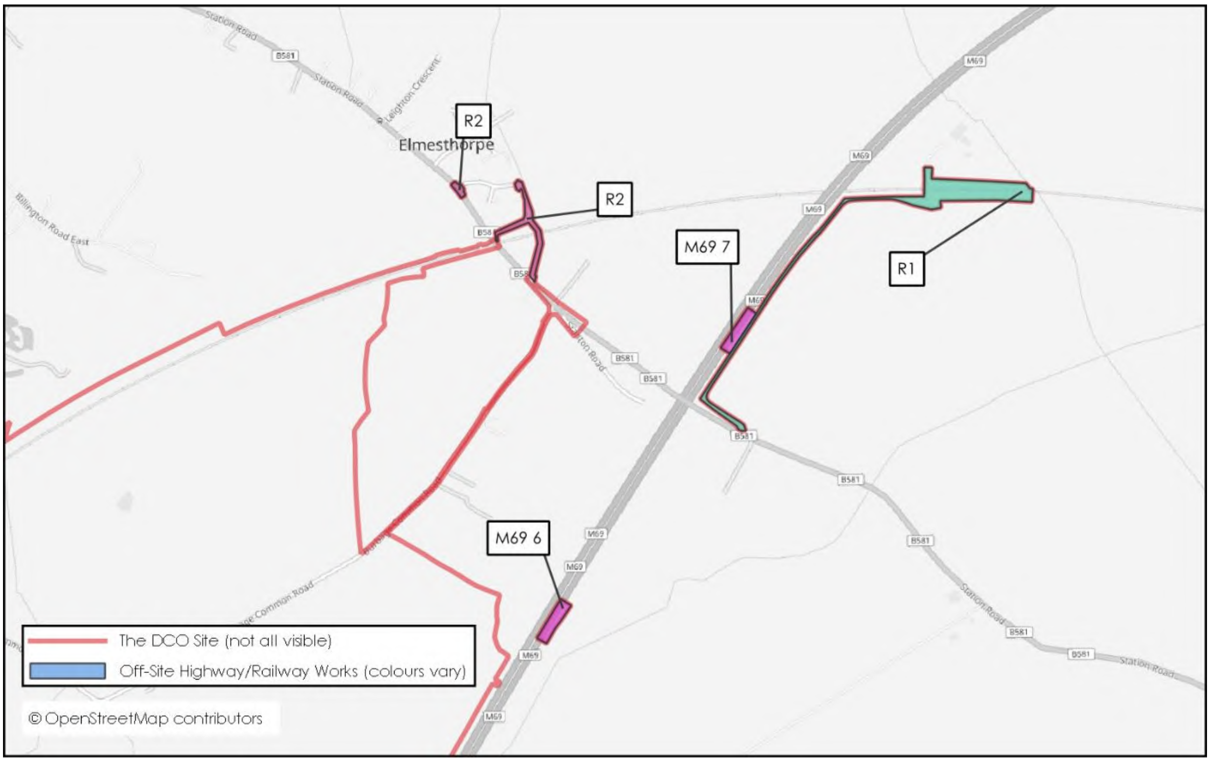


Figure 1.8: Off-Site Highway/Railway Works Location 4

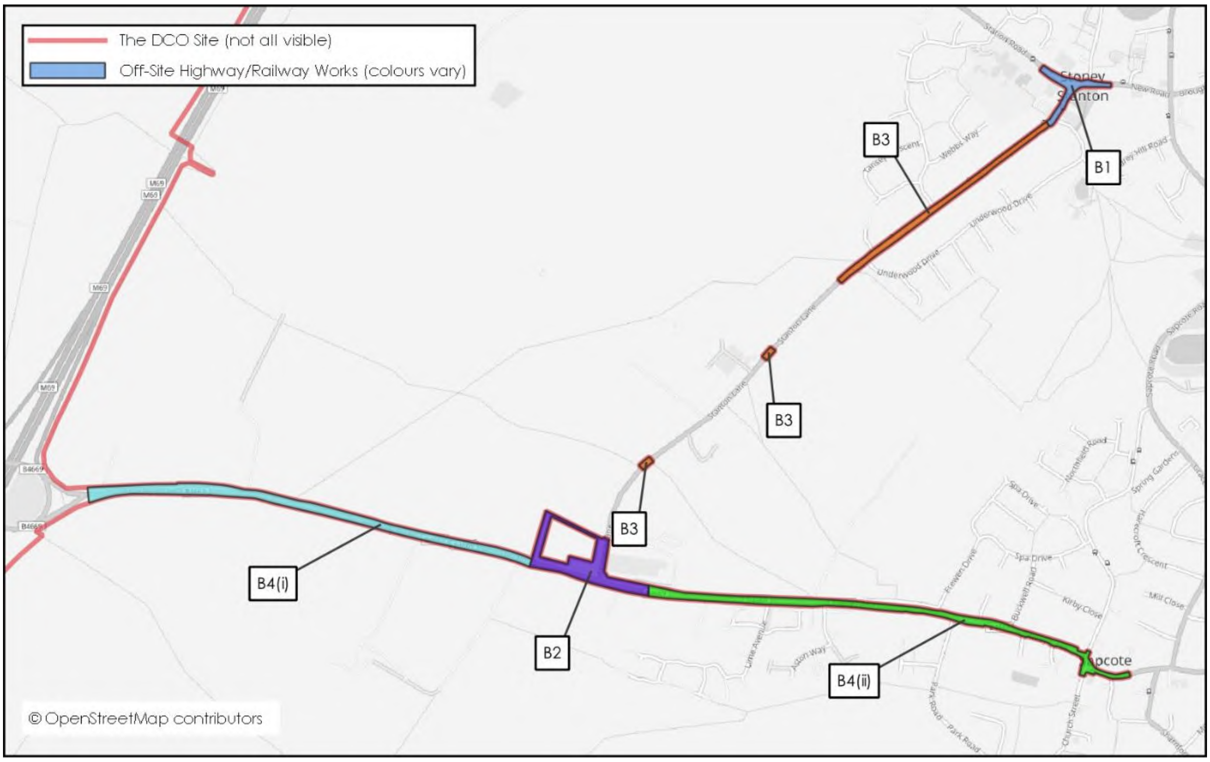


Figure 1.9: Off-Site Highway/Railway Works Location 5

Figure 1.10: Off-Site Highway/Railway Works Location 6

Table 1.3: Summary of Highway & Railway Works away from the Main HNRFI Site, the A47 Link Road, and the M69 Junction 2

ID	Location	Description of Proposed Works
B1	Junction of B581 Station Road / New Road and Hinckley Road, Stoney Stanton	The existing mini roundabout would be replaced by traffic lights with signalised crossings for pedestrians.
B2	Junction of B4669 Hinckley Road and Stanton Lane, west of Sapcote	Traffic lights would be introduced with a phase to allow pedestrians and cyclists to cross.
B3	Stanton Lane / Hinckley Road, south-west of Stoney Stanton	Reduction of the speed limit to 40mph from the national speed limit; traffic calming features and formalisation of on-carriageway parking.
B4 i B4 ii B4 iii	B4669 Hinckley Road/ Leicester Road, Sapcote	Traffic calming features, creation of cycle infrastructure and wider footways, public realm and junction improvements and a bus stop relocation at junction of Church Street and B4669. A new pedestrian crossing is included.
B5	Junction of B4114 Coventry Road and B581 Broughton Road at Soar Mill, south-east of Stoney Stanton	New traffic lights are already scheduled to be introduced as part of the Broughton Astley S278 works (Planning Ref: 19/00856/OUT). The Applicant proposes to widen the carriageway on the northbound approach to the B4114 Coventry Road and on the B581 Broughton Road to provide additional capacity for left-turning traffic on both arms. The left turn on Broughton Road would be provided as separately signalised phase to enable it to run at the same time as the right turn into Broughton Road from Coventry Road to improve the efficiency of the junction.
B6	Junction of B4114 Coventry Road and Croft Road, south-west of Narborough	Lane widening on junction approaches

ID	Location	Description of Proposed Works
HB1	Junction of A47 Normandy Way and A447 Ashby Road, Hinckley	It is proposed that the approach roads to this junction would all be widened to accommodate additional traffic. Indicative right turn and two lanes would be provided through the junction in a westbound direction.
HB2	Junction of A47 Normandy Way / Leicester Road, the B4668 Leicester Road and The Common, south-east of Barwell	Widening of the entry arm on the B4668 Leicester Road
HB3	Junction of B4668 and New A47 Link Road, northeast of the site access (Access Infrastructure)	Provision of a three-arm new roundabout access to the B4668 Leicester Road, including a segregated left turn lane southbound from the A47. (*Note: For the purpose of this FRA, due to its close proximity, this has been assessed as part of the A47 Link Road*).
H1	Cross in Hand roundabout at the junction of the A5 Watling Street, A4303 Coventry Road, B4428 Lutterworth Road and Coal Pit Lane, west of Lutterworth	Increased roundabout radius and widened lane entries, with two lanes marked for longer distances for traffic approaching the junction on the A5 Watling Street southbound, the B4027 and on Coal Pit Lane.
R1	B581 to footpath south of Thorney Fields Farm	The proposals in this area include the closure of a level crossing and the existing public right of way diverted with pedestrians rerouted to an existing bridge over the railway south of Thorney Fields Farm.

ID	Location	Description of Proposed Works
R2	Footpath between Bostock Close and the B581 Station Road, opposite the Wentworth Arms public house.	The proposals in this area include the permanent closure of a public right of way via a level crossing. Pedestrians would instead be able to cross the railway using the existing Station Road bridge, 75 metres to the south-west. A drop kerb at the junction of Bostock Close and the B581 is also included
R3	Located on the Leicester to Hinckley railway immediately to the north of the Main HNRFI Site	Closure of level crossings. (*Due to their location within/immediately next to the Main Order Limits, and the inconsequential nature of the proposals from a flood risk perspective, a standalone assessment of the flood risk at their locations is not required*).
R4		
R5	The Outwoods, between Burbage and Hinckley	The proposals in this area include the replacement of the level crossing with a pedestrian footbridge, with associated public rights of way diversions.
M69 1 to M69 7	The M69 on the approach to Junction 2	Changes to signage

1.25. To allow the FRA to present a concise and clear assessment of the Proposed Scheme at the Main HNRFI Site, the A47 Link Road, and Junction 2 of the M69, a separate technical note has been prepared to review the flood risk associated with the more minor highway and railway improvement works (ref: HNRFI-BWB-ZZ-XX-RP-YE-0008) which is available within **Appendix 1**. The findings and recommendations of this are summarised within this FRA.

2. FLOOD RISK PLANNING POLICY

National Policy Statement for National Networks

2.1. The NPSNN[1] provides planning policy guidance for the promoters of nationally significant infrastructure projects, including SRFIs. The NPSNN includes guidance about the generic and other impacts which should specifically be considered in assessing and designing projects. It also sets the context for the examination of proposals by the Planning Inspectorate (PINS).

2.2. Paragraph 5.90 of the NPSNN identifies the requirement for an FRA to accompany the application. This should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed taking climate change into account.

2.3. The NPSNN specifically refers to the National Planning Policy Framework for further, more detailed guidance on flood risk.

National Planning Policy Framework

2.4. The NPPF[2] sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk.

National Planning Practise Guidance

2.5. Planning Practice Guidance is available online[3]. 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.

2.6. The Planning Practice Guidance also states that alternative sources of flooding, other than fluvial (river flooding), should be considered when preparing an FRA.

2.7. 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).

2.8. This FRA is written in accordance with the NPSNN, the NPPF, and the Planning Practice Guidance.

---

[1] National Policy Statement for National Networks, Department for Transport, December 2014
[2] Revised National Planning Policy Framework, Ministry of Housing, Communities & Local Government, amended 2021
[3] Planning Practice Guidance: https://www.gov.uk/government/collections/planning-practice-guidance, last updated August 2022

Flood Map for Planning

2.9. 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.

2.10. The Flood Map for Planning at the DCO Site is illustrated within **Figure 2.1** and **Figure 2.2**. This shows that majority of the Main HNRFI Site, A47 Link Road, and the M69 Junction 2 are located within Flood Zone 1, with just the rail connection to the existing Main Line and a short stretch pf the A47 Link Road partially falling within Flood Zones 3 and 2. With reference to **Figure 1.4**, and Table 3 of the Planning Practice Guidance, **Table 2.2** has been prepared to identify the proposed land use within each Flood Zone.

Table 2.2: Development Flood Zone Classifications

Development Group	NPPF Vulnerability	Flood Zone Classification
Primary Road & Rail Infrastructure	Essential Infrastructure	Mostly within Flood Zone 1, but partially falls in Flood Zone 3 and 2.
Warehousing & ancillary buildings	Less Vulnerable	Located with Flood Zone 1
Watercourse Diversion	Water Compatible	Located with Flood Zone 1
Open Land, Landscaping, Ecology, SuDS, Footpaths & Amenity Areas	Water Compatible	Mostly within Flood Zone 1, but partially falls in Flood Zone 3 and 2.

2.11. The rail infrastructure's small encroachment into Flood Zone 3 in the north-east of the Main HNRFI Site is associated with connecting to the existing Main Line which is located in Flood Zone 3. Therefore, this cannot be avoided. In reality, and as this FRA will demonstrate, the existing Main Line is actually elevated above the floodplain. With the exception of this minor encroachment in Flood Zone 3, the new rail infrastructure is located in Flood Zone 1.

2.12. The proposed road infrastructure's small encroachment into Flood Zone 3 is associated with the A47 Link Road crossing a small UOW which flows between the railway line and the B4668. The proposed road needs to run between the B4668 and Junction 2 of the M69, therefore this crossing cannot be avoided.

2.13. Table 3 of the Planning Practice Guidance identifies that essential infrastructure within Flood Zone 3 should be designed and constructed to remain operational and safe in times of flood.

Figure 2.1: Flood Map for Planning (The Order Limits)

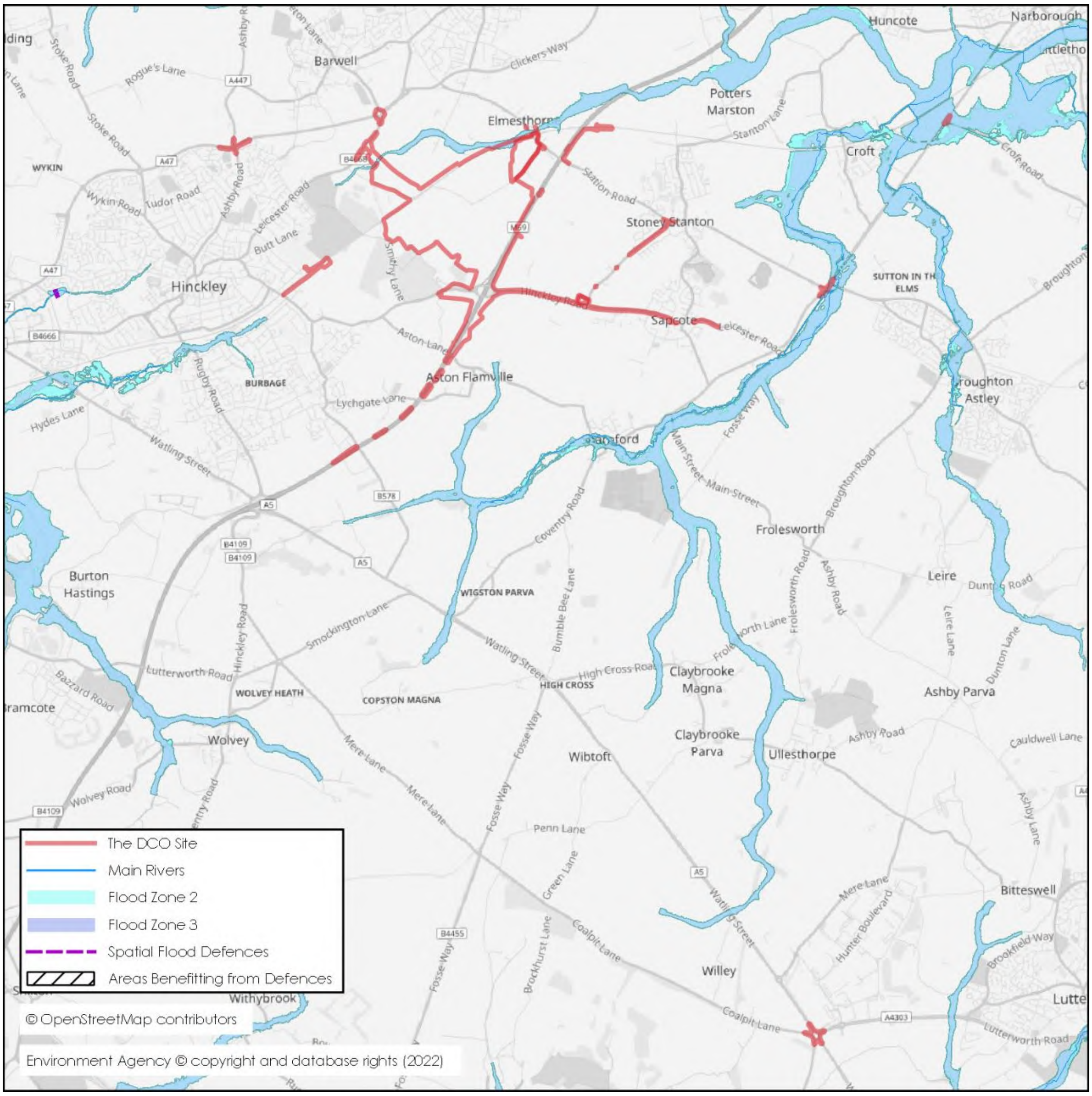
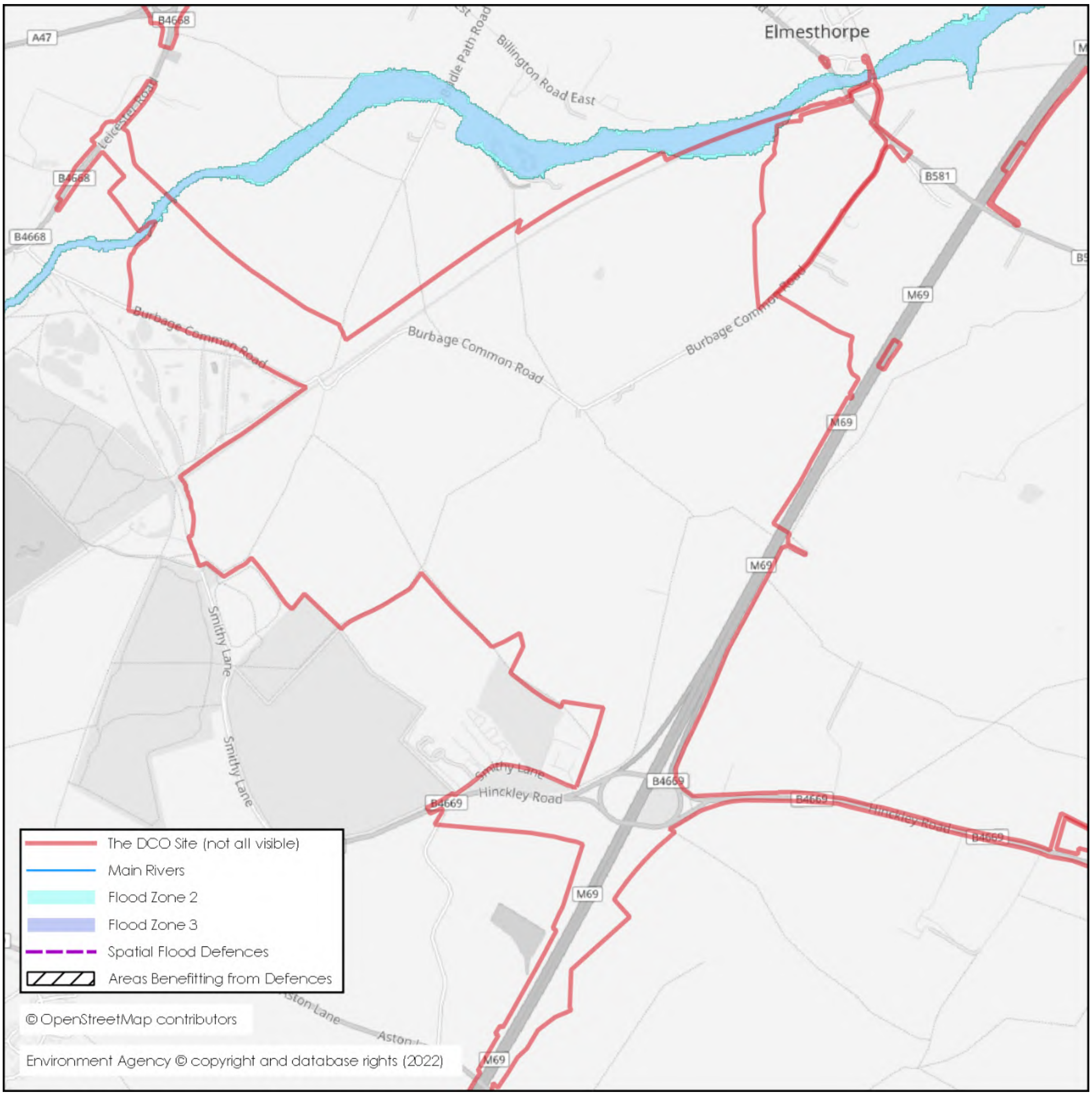


Figure 2.2: Flood Map for Planning 2 (The Main Order Limits)



The Exception Test

2.14. Table 3 of the Planning Practice Guidance identifies the flood risk vulnerability and Flood Zone compatibility, this identifies that essential infrastructure in Flood Zone 3 requires the application of the Exception Test.

2.15. The two parts to the Test require the Proposed Scheme to show that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall; and that the Proposed Scheme will provide wider sustainability benefits to the community that outweigh flood risk.

2.16. This FRA addresses the first part of the Test and demonstrates the Proposed Scheme will be safe for its lifetime, without increasing flood risk elsewhere (see

Sections 4 & 5). This FRA also confirms that the Proposed Scheme can remain operational and safe in time of flood.

2.17. The Proposed Scheme plays a key role in the Government's identified need for an expanded network of SRFI sites. The NPSNN confirms that the need for development of the national networks has been accepted by the Government.

2.18. The Proposed Scheme is intended to support economic growth and will employ thousands of workers. This is likely to have significant benefits to the economic productivity of the region and local area. There will also be indirect benefits to the supply chain, through the commission of sub-contractors and suppliers from the new economic activity. This is in line with economic objectives outlined in Blaby District Council's Sustainability Appraisal Report[4] prepared in support of the Local Plan.

2.19. The A47 Link Road provides a better connection to the strategic road network for settlements to the north of Hinckley, including Barwell, Earl Shilton and Hinckley itself. Journey times will be reduced, and it will alleviate existing pressure in the centre of Hinckley for traffic heading to or from the M69. Trips on the B581 crossing the M69 are also likely to shift to the A47 Link Road reducing pressure from this link into the centre of Stoney Stanton. Additionally, the new slip roads on Junction 2 will also bring better connectivity to the villages to the East of the M69. This is in line with economic objectives outlined in Blaby District Council's sustainability appraisal prepared in support of the Local Plan.

2.20. Relocating traffic off local roads and on to the strategic road network will return an improvement in air quality in the surrounding settlements, especially Hinckley. This is in line with air quality objectives outlined in Blaby District Council's sustainability appraisal prepared in support of the Local Plan.

2.21. These benefits are considered to outweigh the relatively minor and very isolated flood risk present on the Main HNRFI Site and A47 Link Road. Therefore, the requirements of the Exception Test are considered to be fulfilled.

The Design Flood

2.22. The Planning Practice Guidance identifies that new development should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.

2.23. 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

[4] Blaby District Local Plan: Delivery Development Plan Document, Blaby District Council (October 2017)

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

2.24. Predicted future change in peak river flows caused by climate change are provided by the Environment Agency (EA) within their online guidance[5], with a range of projections applied to a series of 'Management Catchments' within regionalised 'River Basin Districts'. The Main HNRFI Site, A47 Link Road, and M69 Junction 2 fall within the 'Soar' 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 Soar Management Catchment in 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	28%	35%	60%
Higher Central	18%	21%	37%
Central	14%	16%	28%

2.25. 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 2.4** provides a matrix summarising the EA's guidance on determining the appropriate allowance(s).

[5] Environment Agency, Flood risk assessments: climate change allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1, last updated May 2022

Table 2.4: Application of the Appropriate Climate Change Allowance for River Flows

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.					

2.26. The Proposed Scheme has an anticipated lifespan of over 60 years and the DCO Site includes a mix of land uses and Flood Zones that would require assessment of the Central and Higher Central allowances for the 2080's. Also, although the NPSNN does not specifically reference this requirement, it is generally advised that nationally significant infrastructure projects consider a high impact climate change scenario – such as the upper end allowance.

2.27. Therefore, to estimate the potential future design floodplain under a range of scenarios, the Central, Higher Central, and Upper End climate change allowance for the 2080s have been applied to the 1 in 100-year flood flows. During preliminary consultations, the EA recommended that the allowances are rounded up to the nearest 5%. Therefore, allowances of +30%, +40%, and +60% have been assessed.

2.28. When determining the potential off-site impacts of a proposed development its vulnerability is not critical, instead the land use in the wider floodplain needs to be considered. In their online guidance, the EA advise that generally it is appropriate to use the Central allowance. Therefore, the impact of the Proposed Scheme will be assessed at events up to the 1 in 100-year return period event including a 30%

allowance for climate change.

Strategic Flood Risk Assessment

2.29. 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.

2.30. The Joint Hinckley and Bosworth Borough, Blaby District, and Oadby and Wigston Borough Councils SFRA[6] has been reviewed in the production of this FRA. The SFRA provides information specific to the Main HNRFI Site, A47 Link Road, and M69 Junction 2 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.

2.31. The Leicestershire and Leicester City SFRA[7] also provides information specific to the Main HNRFI Site, A47 Link Road, and M69 Junction 2 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.

2.32. The Hinckley and Bosworth Borough Council SFRA[8] provides information specific to this district, which only includes a small proportion of the DCO Site, but the mapping overlaps into Blaby District providing an overview of flood data at the Main HNRFI Site, A47 Link Road, and M69 Junction 2. Information from the SFRA will be referenced within **Section 3** where applicable.

Preliminary Flood Risk Assessment

2.33. 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.

2.34. The Leicestershire County Council PFRA[9] considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. It also references local flood events that have occurred across the county. However, no historical instances of flooding at the DCO Site are referenced. Information from the PFRA will be

[6] Joint Strategic Flood Risk Assessment, Hinckley and Bosworth Borough, Blaby District, and Oadby and Wigston Borough Councils (2014)
[7] Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (Leicestershire Local Planning Authorities and Leicester City Council (2017)
[8] Strategic Flood Risk Assessment for Hinckley and Bosworth Borough Council: Final Report, Hinckley and Bosworth Council (July 2019)
[9] Preliminary Flood Risk Assessment, Leicestershire County Council (2011))

referenced within this report where applicable.

Local Flood Risk Management Strategy

2.35. 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.

2.36. 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.

2.37. The Leicestershire LFRMS[10] has been reviewed and will be referenced within this report where applicable.

2.38. The Blaby Local Plan (Core Strategy)[11] sets out the vision, objectives, strategy and core policies for the spatial planning of the District up to 2029. The key relevant policies from the Local Plan in relation to water resources and flood risk, comprise of CS21 (Climate Change) and CS22 (Flood Risk Management). Amongst other aims, these policies require proposed developments to:

- Minimise the risk of flooding to property, infrastructure and people.
- Minimise vulnerability and provide resilience to climate change and flooding by including adaptations such as appropriate shading and planting, green roofs, SUDS, rain water harvesting and storage, and grey water recycling.
- Be preferentially located in areas at lowest risk of flooding within the District.
- Manage surface water run-off to minimise the net increase in the amount of surface water discharged.

2.39. The Hinckley and Bosworth Local Plan 2006-2026 outlines HBBC's policies for development within the Borough. The Local Plan is made up of a series of documents, of which the Core Strategy Development Plan Document (DPD)[12] provides the vision and spatial strategy for the borough. The Core Strategy was adopted in December 2009 and sets out, that whilst flooding is not a major issue for the borough, flood mitigation measures, such as sustainable urban drainage, will need to be incorporated into new developments.

2.40. Another document, Site Allocations and Development Management Policies DPD[13], adopted in July 2016, includes Policy DM7 'Preventing Pollution and Flooding' sets

[10] Local Flood Risk Management Strategy, Leicestershire County Council (2015)
[11] Blaby District Local Plan: Local Plan (Core Strategy) Development Plan Document, Blaby District Council (February 2013)
[12] Local Plan 2006 – 2026 Adopted Core Strategy, Hinckley and Bosworth Borough Council (December 2009)
[13] Local Plan 2006 – 2026 Site Allocations and Development Management Policies DPD, Hinckley and Bosworth Borough Council (July 2016)

out that adverse impacts from pollution and flooding will be prevented by:

- Ensuring development proposals will not adversely impact the water quality, ecological value or drainage function of water bodies in the borough.
- Appropriate containment solutions for oils fuels and chemicals are provided.
- The development does not create or exacerbate flooding by being located away from areas of flood risk unless adequately mitigated against in line with National Policy.

3. POTENTIAL SOURCES OF FLOOD RISK

3.1. Flooding can occur from a variety of sources, or combination of sources, which may be natural or artificial. **Table 3.1** below identifies the potential sources of flood risk to the Main HNRFI Site, A47 Link Road, and M69 Junction 2 in their current condition, 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 Proposed Scheme is appropriate for its location are discussed within **Section 4**.

Table 3.1: Pre-Mitigation Sources of Flood Risk at the Main HNRFI Site, A47 Link Road, and M69 Junction 2

Flood Source	Potential Risk				Description
	High	Moderate	Low	None	
Fluvial		X			Most of the Main HNRFI Site, A47 Link Road, and the M69 Junction 2 is located outside of the floodplain and is at a low flood risk; however, there are a few localised areas upstream of the railway line where flood water can pond, as well as an overland flow route near Burbage Common, that the Proposed Scheme will need to consider.
Coastal				X	Due to the DCO Site's inland location, there is no risk of flooding from coastal sources and so this source does not need to be considered further.
Canals				X	The nearest canals are all substantially removed from the DCO Site and are located in downstream or entirely different catchments. Therefore, they pose no flood risk to the site.

Flood Source	Potential Risk				Description
	High	Moderate	Low	None	
Ground Water			X		The Main HNRFI Site, A47 Link Road, and the M69 Junction 2 are underlain by low permeability geology and groundwater was recorded at a level typically over 3m below ground level.
Reservoirs and waterbodies				X	The DCO Site is located a significant distance from any surrounding reservoirs and falls outside of flood risk extents resulting from a potential reservoir failure.
Pluvial runoff		X			Most of the Main HNRFI Site, A47 Link Road, and the M69 Junction 2 is at a low to very low risk of surface water flooding. However, there are a few localised areas upstream of the railway line where flood water can pond. There is also an overland flow route near Burbage Common, that the Proposed Scheme will need to consider.
Sewers			X		The Main HNRFI Site, A47 Link Road, and the M69 Junction 2 are generally well removed from the existing public sewer network and the minor combined sewer that is present in the very south poses a low flood risk.

Historical Flooding Incidents

3.2. A review of the EA recorded flood outlines dataset identified that the nearest mapped fluvial flooding incident is in the village of Croft, located approximately 3.8km downstream of the Main HNRFI Site. None of the flooding incidents included in the dataset were shown to have affected the DCO Site.

3.3. Furthermore, a review of the historical incidents collated and listed in the PFRA and

SFRAs also did not identify any which had affected the DCO Site.

3.4. However, it is understood that there is an anecdotal account of an observed, but unrecorded, flooding incident in the north-east of the Main HNRFI Site at the start of 2020. It is understood that this was a localised incident located in the proximity of the area currently falling within Flood Zone 3 and was likely associated with heavy rainfall and poor land drainage.

3.5. Further to this, throughout the consultation process a number of reports of the Main HNRFI Site becoming waterlogged and experiencing shallow surface water flooding were made. This is also likely associated with poor land drainage, and the poor permeability of the underlying soils and geology.

Fluvial Flood Risk

3.6. 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.

3.7. The Main HNRFI Site and A47 Link Road are crossed by a network of small UOWs feeding an unnamed tributary of the Thurlaston Brook, and a tributary of the Soar Brook passes beneath the M69 in close proximity to Junction 2. None of the watercourses are enmained and so fall under the responsibility of the Lead Local Flood Authority and the riparian landowners.

3.8. A review of the PFRA identified that Leicestershire has been subject to a number of flooding incidents from ordinary watercourses, none of which were deemed significant. Neither the Thurlaston Brook nor the Soar Brook are listed as being subject to historical flooding incidents.

Thurlaston Brook Catchment

3.9. A bespoke site-specific hydraulic model of the local watercourse network draining towards the Thurlaston Brook tributary was undertaken in consultation with the EA and is discussed in detailed under separate cover in **Appendix 2**.

3.10. The watercourses assessed are identified within **Figure 3.1**. As these are unnamed, the reaches have been numbered for ease of reference. The modelled floodplain extents are summarised within **Figure 3.2**.

Figure 3.1: Thurlaston Brook Tributary Modelled Reaches

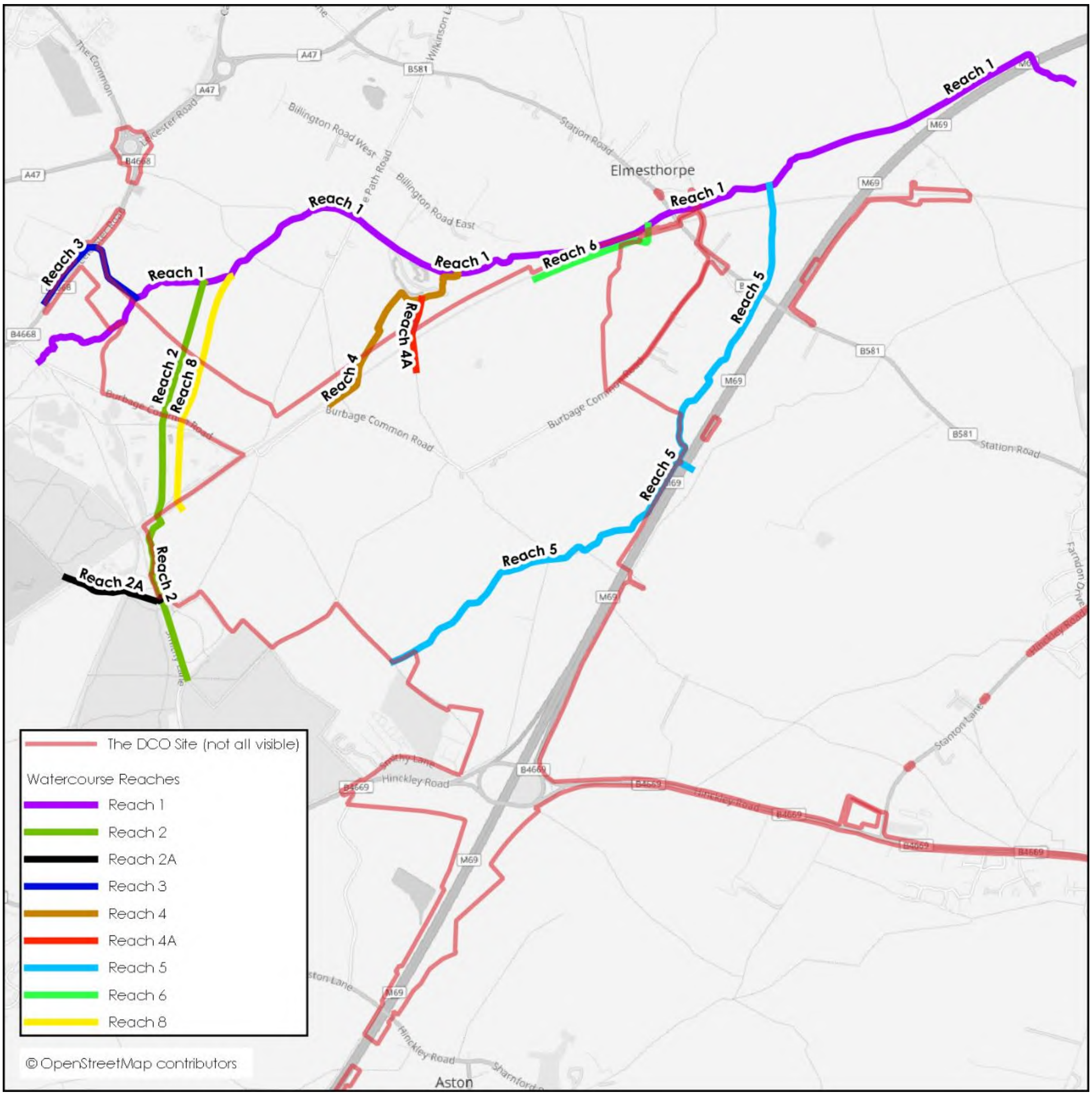
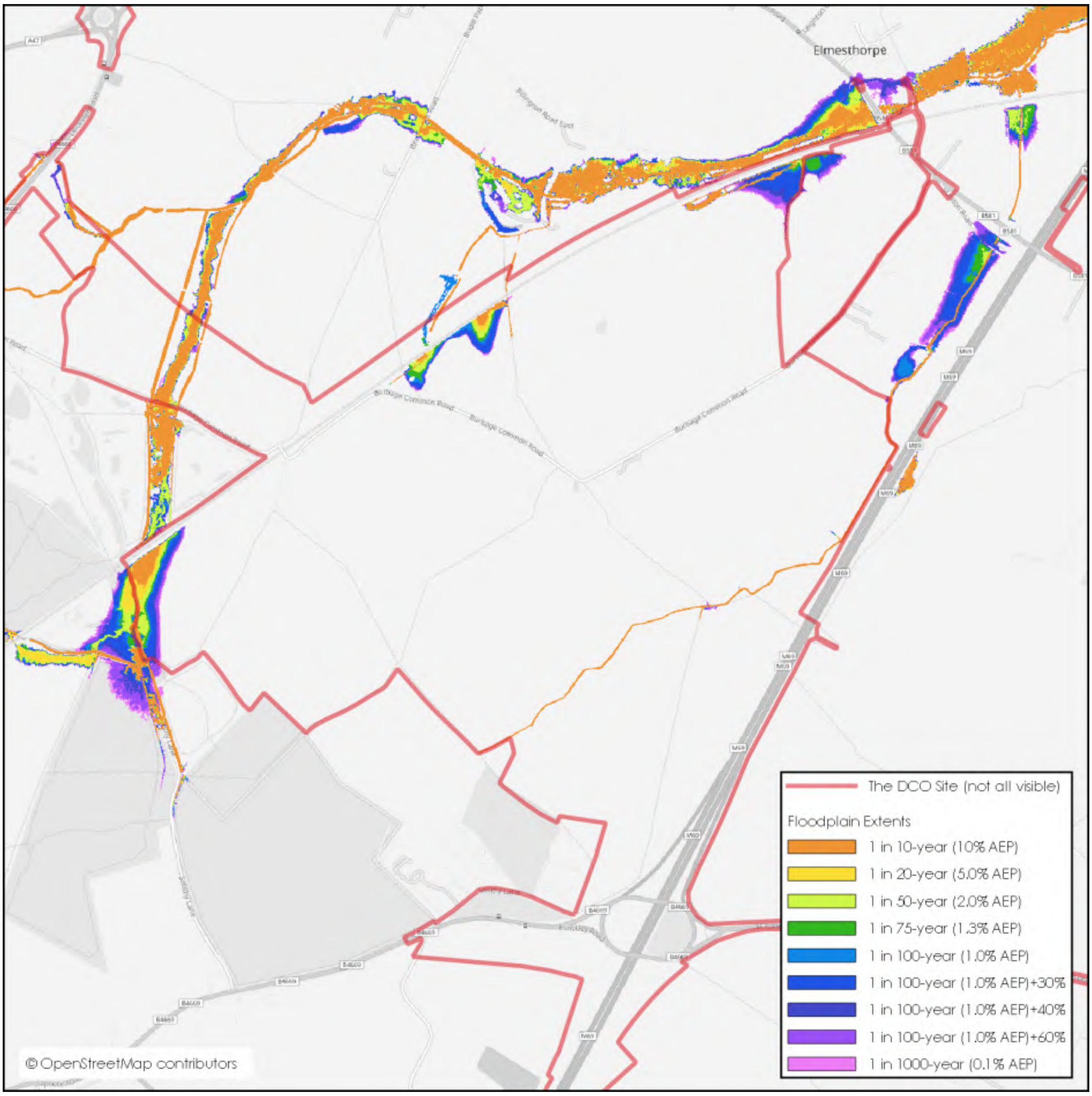


Figure 3.2: Thurlaston Brook Tributary Modelled Floodplain



3.11. The hydraulic modelling exercise identified that the flood risk from Reach 1 to the Main HNRFI Site and A47 Link Road is limited, with flows remaining within bank until the confluence with Reach 2 downstream of the Main HNRFI Site and A47 Link Road. The floodplain extents on Reach 1 increase downstream of the Main HNRFI Site and A47 Link Road as it is joined by Reach 3, 2, 8, 4, 4A and then 5.

3.12. The floodplain of Reach 2 and 2A interact and join to the west of the of Main HNRFI Site and A47 Link Road, where flood water builds upstream of the railway line due to restrictive culverts beneath the embankment. Downstream of the railway line an overland flow route forms in a topographical depression located between Reach 2 and 8. The overland flow route flows in parallel to Reach 2 and 8, through the A47 Link Road location, and outfalls into Reach 1 downstream of the Main HNRFI Site and A47 Link Road.

3.13. A relatively minor overland flow route forms on Reach 3 within the DCO Site downstream of Leicester Road. This re-joins the channel at the confluence within Reach 1.

3.14. Reach 4, 4A and 6 all generate a floodplain within the Main HNRFI Site immediately upstream of the railway line, due to flood flows being attenuated by restrictive culverts through the elevated embankment.

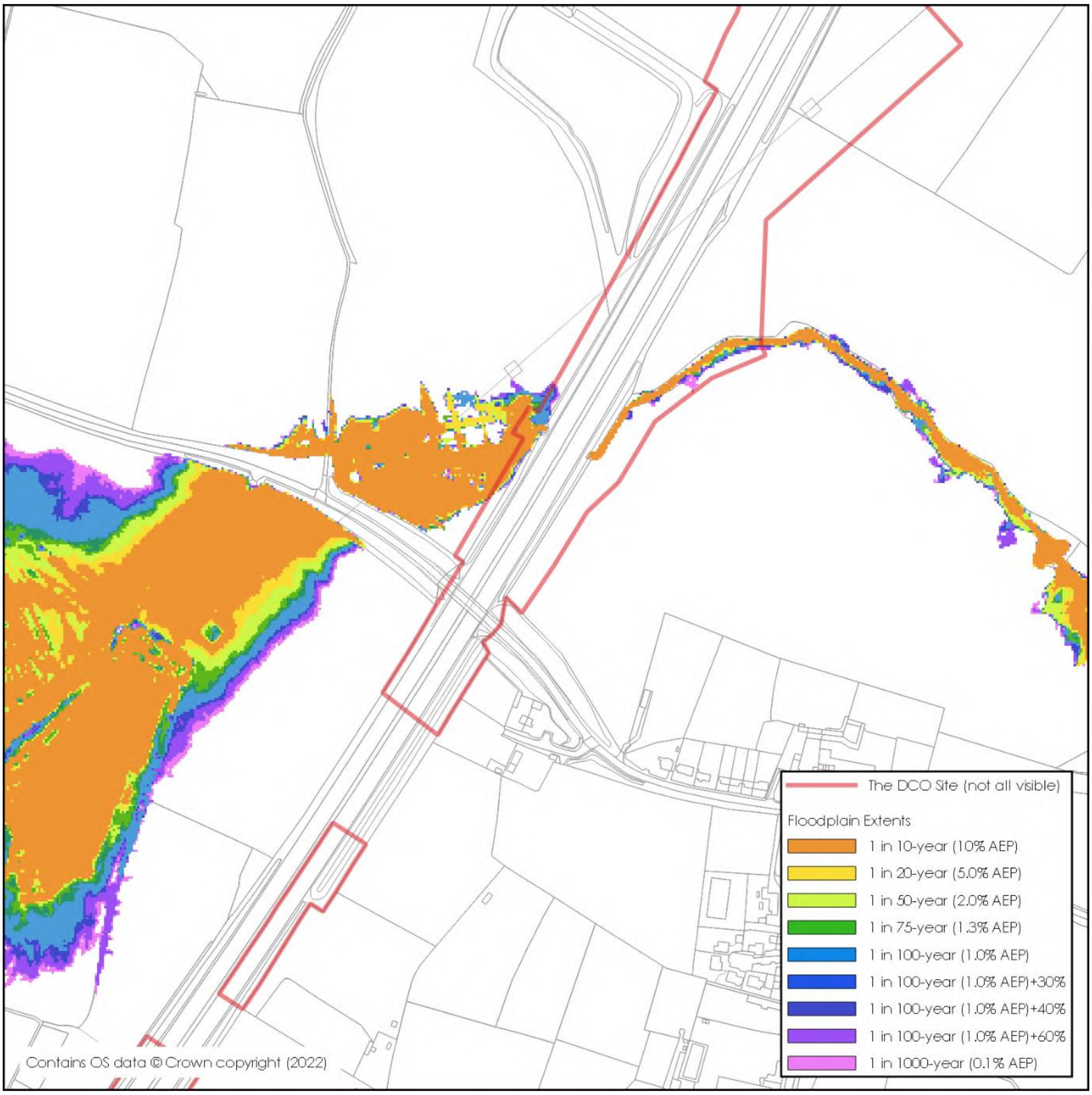
3.15. The flood risk from Reach 5 to the Main HNRFI Site is limited, as most flood flows are predicted to remain within bank. Downstream of the Main HNRFI Site, the floodplain is more extensive because flood water is attenuated by the culvert beneath Station Road.

3.16. The modelling has also identified that the existing railway Main Line located in Flood Zone 3 is actually elevated above the modelled flood levels, including the 1 in 1000-year flood level. Therefore, it is expected that the existing railway infrastructure could remain operational during a flood event.

Soar Brook Catchment

3.17. A second bespoke site-specific hydraulic model was developed for a tributary of the Soar Brook in the south of the DCO Site. The development of the model is discussed in detail under separate cover in **Appendix 3.** The modelled floodplain extents on the Soar Brook are illustrated within **Figure 3.3**.

Figure 3.3: Soar Brook Tributary Modelled Floodplain



3.18. The model results identify that flood water is attenuated upstream of Aston Road and the M69 due to their elevated positions. This leads to a relatively broad floodplain in these areas. Downstream of the M69 the floodplain is largely restricted to a well-defined corridor.

3.19. The M69 in this location is at an elevation of approximately 99.2mAOD, this is over 2m above the 1 in 100-year+60% and 1 in 1000-year modelled flood levels (97.07mAOD and 97.08 respectively). Therefore, the flood risk from this watercourse is low.

Summary

3.20. The Soar Brook poses a low flood risk to the M69, and no flood risk to the Main

HNFRI Site and A47 Link Road

3.21. Overall, there is considered to be a moderate fluvial flood risk to the Main HNRFI Site and A47 Link Road. Most of the Main HNRFI Site and A47 Link Road are located outside of the floodplain and are at a low risk, but there are a few localised areas upstream of the railway line where there is a risk of flood water ponding, and an overland flow route near Burbage Common is predicted that the Proposed Scheme will need to consider. The necessary flood mitigation measures are discussed in **Section 4**.

Coastal Flood Risk

3.22. Inundation of low-lying coastal areas by the sea may be caused by seasonal high tides, storm surges and storm driven wave action. Coastal flooding is most commonly a result of a combination of two or more of these mechanisms which can result in the overtopping or breaching of sea defences. River systems may also be subject to tidal influences.

3.23. Due to the DCO Site's inland location, there is no risk of flooding from coastal sources and so this source does not need to be considered further.

Flood Risk from Canals

3.24. 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.

3.25. 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.

3.26. Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.

3.27. The nearest canals to the DCO Site are as follows:

- The Ashby-de-la-Zouch Canal – located 4.5km to the west of the Main HNRFI Site
- The Grand Union Canal – located 9.1km to the east of the Main HNRFI Site
- The Oxford Canal – located 20km to the south of the Main HNRFI Site

3.28. These are all substantially removed from the DCO Site and are located in downstream or entirely different catchments. Therefore, they pose no flood risk to the DCO Site and so this potential source of flood risk does not need to be considered further.

Groundwater Flood Risk

3.29. 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.

3.30. The PFRA identifies that the majority of Leicestershire is underlain by non-permeable or low-permeability geology, so where groundwater exists it flows through strata very slowly and in limited quantities. It is reported that groundwater rebound following the cessation of industrial abstractions has not been a problem in the region. The PFRA identities one recorded incident of groundwater flooding in the entirety of the county, which occurred in Melton – which is significantly removed from the DCO Site.

3.31. British Geological Survey (BGS) data identifies that the Main HNRFI Site, A47 Link Road and M69 Junction 2 are underlain by Mercia Mudstone, overlain by a range of superficial deposits, which include:

- Bosworth Clay Member - sedimentary deposits which are glacigenic in origin.
- Thrussington & Oadby Member - glacial tills deposited by ice
- Wolston Sand and Gravel - outwash deposits formed from melting ice
- Alluvium - variable sediment of mud, sand and gravel

3.32. The EA classifies the Alluvium and the Wolston Sand and Gravel as Secondary A Aquifers. 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. However, it is reported that in preliminary ground investigations that the Wolston Sand and Gravels were not recorded on the site.

3.33. The Bosworth Clay Member is an unproductive stratum, defined as rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. This was recorded in preliminary site investigations.

3.34. The Thrussington Member is an undifferentiated Secondary Aquifer which has been assigned in cases where it has not been possible to attribute either a Secondary A or B category to a rock type. This was recorded in preliminary site investigations.

3.35. The Mercia Mudstone is categorised as a Secondary B Aquifer which are defined as predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

3.36. A number of borehole logs are available from the BGS along the line of the M69 to the south east of the Main HNRFI Site. These generally encountered between 0.2 – 0.3m of top soil with clayey silty superficial deposits and Mudstone bedrock beneath. Groundwater strikes were recorded at depths of between 16m below ground level (bgl) to 3.9m bgl. Groundwater was recorded either within granular bands/horizons, or above hard strata. Ingress rates were recorded as normal strikes and seepages.

3.37. Preliminary exploratory site investigations (RFI-HYD-XX-XX-RP-GE-1002) on the Main HNRFI Site reported that groundwater was encountered in the site in four exploratory positions during fieldwork between 3.10m bgl and 3.90m bgl.

3.38. These groundwater strikes are located beneath a band of cohesive geology that underlies the site. This cohesive geology layer impedes infiltration from shallower depths, and results in some localised shallow groundwater and surface water being present on the site. The cohesive geology underlying the site means that there is not a significant groundwater reservoir or flow pathway that could impact the Main HNRFI Site.

3.39. A Geo-Environmental desk study (ref: HNRFI-BWB-ZZ-XX-RP-YE-0001-Ph1) of the Main HNRFI Site identified that due to the depth of groundwater and the low permeability of the underlaying strata, the Main HNRFI Site is located within an area with a low risk of groundwater flooding.

Flood Risk from Reservoirs & Large Waterbodies

3.40. Reservoir flood risk mapping, prepared by the EA, identifies that the DCO Site is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents resulting from a potential reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

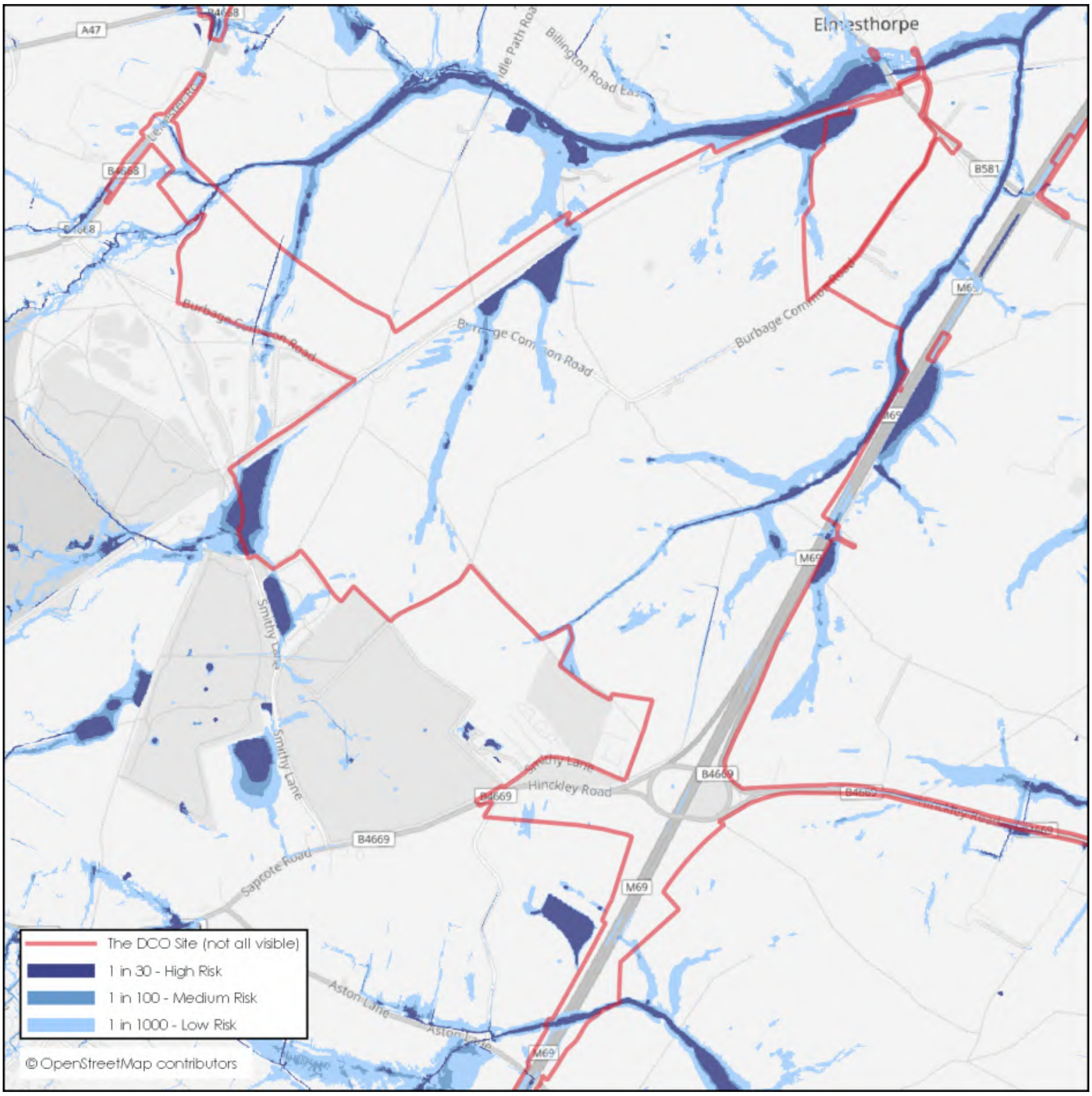
Pluvial Flood Risk

3.41. 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.

3.42. The PFRA identifies that Leicestershire has not been significantly affected by historical surface water flooding, with the exception of Loughborough in 1998. There are no records of surface water flooding incidents at the DCO Site.

3.43. Risk of flooding from surface water mapping has been collated and published by the EA, this 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. An extract from the mapping is included as **Figure 3.4**.

Figure 3.4: Risk of Flooding from Surface Water



3.44. The mapping identifies a high to medium flood risk along the watercourse corridors and in the areas at risk of accumulated fluvial floodplain upstream of the railway line and the M69, as previously identified in **Figure 3.2** and **Figure 3.3**. The Risk of Flooding from Surface Water data is of a strategic scale and will not include details of culverts and other hydraulic structures whereas the bespoke hydraulic models prepared to inform this FRA do include this detail. Therefore, the bespoke hydraulic models are considered the better dataset for assessing flood risk associated with the watercourse networks.

3.45. Away from the watercourses, the Risk of Flooding from Surface Water mapping identifies a few isolated areas of high and medium risk which are associated with localised topographical depressions and ponds. These isolated areas are not a significant flood risk as they can be easily addressed through reprofiling and through improved drainage.

3.46. There are also a number of low risk overland flow routes present in the Main HNRFI Site. These are associated with localised valley lines which direct overland flows towards the watercourse network. The flow routes originate within the Main HNRFI Site and, therefore, do not represent runoff from third party land. Additionally, during the consultation process, a number of reports of the Main HNRFI Site becoming waterlogged and experiencing shallow surface water flooding were made. This is likely associated with poor land drainage, and the poor permeability of the underlying soils and geology. These are not considered a significant flood risk as they can be easily addressed through reprofiling of the Main HNRFI Site and through improved drainage.

3.47. Overall, there is considered to be a moderate flood risk from Surface Water runoff. Most of the Main HNRFI Site, A47 Link Road and M69 Junction 2 is at a very low to low risk; however, there are a few localised areas upstream of the railway line where there is a risk of flood water ponding, and an overland flow route near Burbage Common that the Proposed Scheme will need to consider. The necessary flood mitigation measures are discussed in **Section 4**.

Flood Risk from Sewers

3.48. 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 flows.

3.49. The PFRA identities that Leicestershire has been subject to numerous instances of flooding related to sewers, the DCO Site and the local area are not mentioned in the flood record.

3.50. Severn Trent Water asset plans have been reviewed which has confirmed that the vast majority of the Main HNRFI Site, A47 Link Road and M69 Junction 2 are not currently served by the public sewer network. The only sewers on record include a combined sewer in the very south of the Main Order Limits on Smithy Lane, next to Junction 2 of the M69 and the Hinckley Road. This would appear to serve the adjacent travelling community site. The consequence of this asset being exceeded would not be detrimental to the Proposed Scheme, as any flood water would follow Smithy Lane and flow away from the Proposed Scheme.

3.51. The local watercourse network is located between the Proposed Scheme and the sewer networks associated with the surrounding settlements. Any exceedance flows from these networks that were directed towards the Proposed Scheme would be intercepted before reaching the Proposed Scheme. Therefore, the risk of sewer flooding is low.

Off-Site Highway & Railway Works

3.52. The conclusions of the off-site highway and footpath works flood risk review (**Appendix 1**) are summarised within **Table 3.2**.

Table 3.2: Summary of Pre-Mitigation Flood Risk at the Off-Site Highway, Junction and Railway Improvements Areas

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
B1	Low	No	Low	Low	Low	No	Low
B2	Low	No	Moderate	Low	Low	No	Low
B3	Low	No	Low	Low	Low	No	Low
B4 – i	Low	No	High	Low	Low	No	Low
B4 – ii	Low	No	High	Low	Low	No	Low
B4 – iii	Low	No	Low	Low	Low	No	Low
B5	Low	No	Low	Low	Low	No	Low
B6	High	No	Low	Moderate	Low	No	Low
HB1	Low	No	Low	Low	Low	No	Low
HB2	Low	No	High	Low	Low	No	Low
H1	Low	No	Low	Low	Low	No	Low
R1	Low	No	High	Low	Low	No	Low

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
R2	High	No	High	Low	Low	No	Low
R5	Low	No	High	Low	Low	No	Low
M69 1 to M69 7	Low	No	Low	Low	Low	No	Low

4. FLOOD RISK MITIGATION

4.1. **Section 3** has identified the sources of flooding which could potentially pose a risk to the Main HNRFI Site, A47 Link Road, and M69 Junction 2. This section of the FRA sets out the mitigation measures which are to be incorporated within the Proposed Scheme to address and reduce the risk of flooding to within acceptable levels.

Sequential Arrangement

4.2. The Proposed Scheme has been arranged so that all of the less vulnerable uses are located within Flood Zone 1.

4.3. The majority of the essential infrastructure is also located in Flood Zone 1. The only encroachment into Flood Zones 2 and 3 is associated with establishing a railway connection to the existing main line in the north-east of the Main HNRFI Site, and the A47 Link Road crossing over an unnamed watercourse (Reach 1).

Main HNRFI Site Flood Mitigation Strategy

4.4. The proposals include the reprofiling of the Main HNRFI Site to form two plateaus on which the Proposed Scheme will be located. To facilitate the reprofiling, the UOW (Reach 5) will be realigned to flow alongside the M69 within a new channel. The channel will be designed to convey the necessary flood flows.

4.5. Two culverts are necessary on the diverted reach. The first is beneath the A47 Link Road; the second is beneath a footpath which crosses the M69. At this preliminary stage, both culverts have been assessed as 1.05m diameter pipes. The final design of the culverts will be determined at the detailed design stage.

4.6. The Proposed Scheme will include surface water drainage infrastructure which will intercept, convey and store storm water falling on development. This will relocate the existing floodplain generated by runoff from within the Main HNRFI Site to within the drainage system, thereby addressing the floodplain currently present upstream of the railway line within the Main HNRFI Site. The existing culverts beneath the railway line on Reach 4 and 4a will effectively become outfall structures for the development drainage network.

4.7. It is proposed to continue to discharge surface water from the Proposed Scheme to the local watercourses. The discharge rate will be restricted to the equivalent greenfield QBAR rate. Therefore, the contributing peak flow runoff from the Proposed Scheme will be reduced from existing during equivalent flood events.

A47 Link Road Flood Mitigation Strategy

4.8. The A47 Link Road crosses a number of small watercourses (Reach 8, 2, 3, and 1). The road will be elevated upon an embankment above the floodplain so that it can remain operational during times of flood. Culverts will be provided beneath the road to preserve hydraulic connectivity and convey flood flows into the downstream channels. At this preliminary stage the following culverts have been assessed; the final design of the culverts will be determined at the detailed design stage:

- The existing 0.5m diameter culvert beneath Leicester Road on Reach 3 will be relocated
- A new 2.1 x 1m box culvert beneath the proposed link road on Reach 1
- A new 2.1 x 1m box culvert beneath the proposed link road on Reach 2
- A new 2.1 x 1m box culvert beneath the proposed link road on Reach 8
- A bank of six 1.05m diameter culverts beneath the link road on the floodplain in between Reach 2 and 8 where an overland flow route runs in between the two channels.

4.9. These proposed flood management measures are illustrated within **Figure 4.1**, **Figure 4.2**, **Figure 4.3**, and **Figure 4.4**.

Figure 4.1: Schematic of Proposed Flood Management Measures

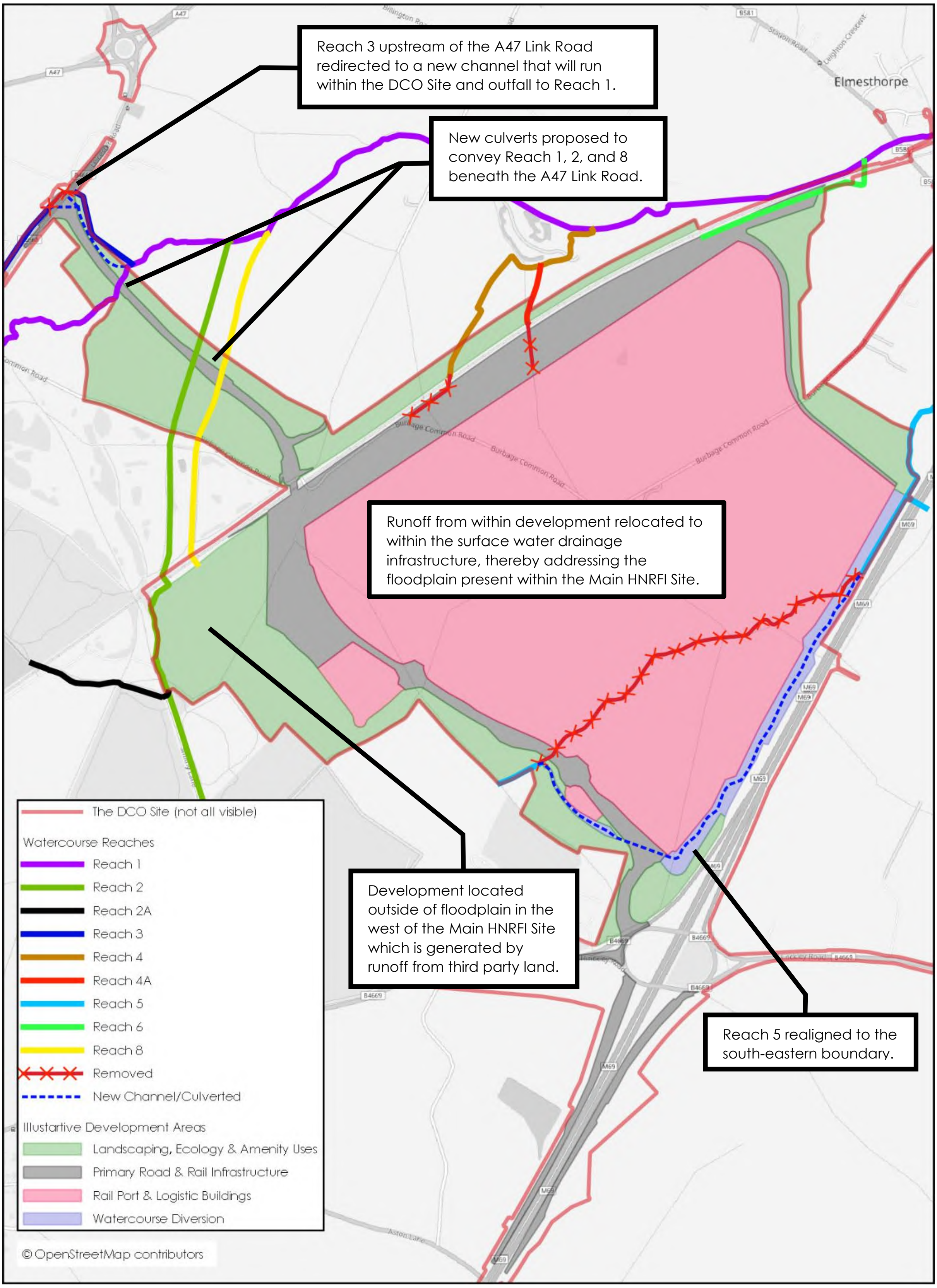


Figure 4.2: Proposed Alterations to Reach 3

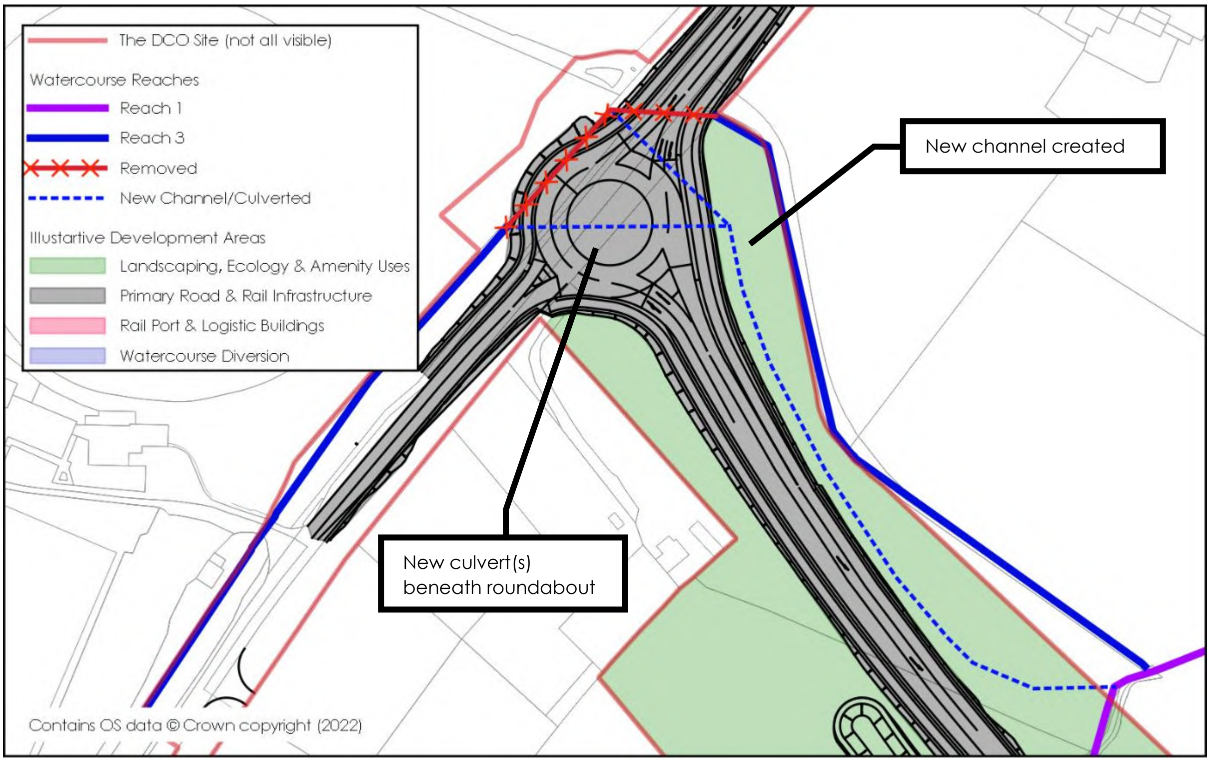


Figure 4.3: Proposed Alterations to Reach 5

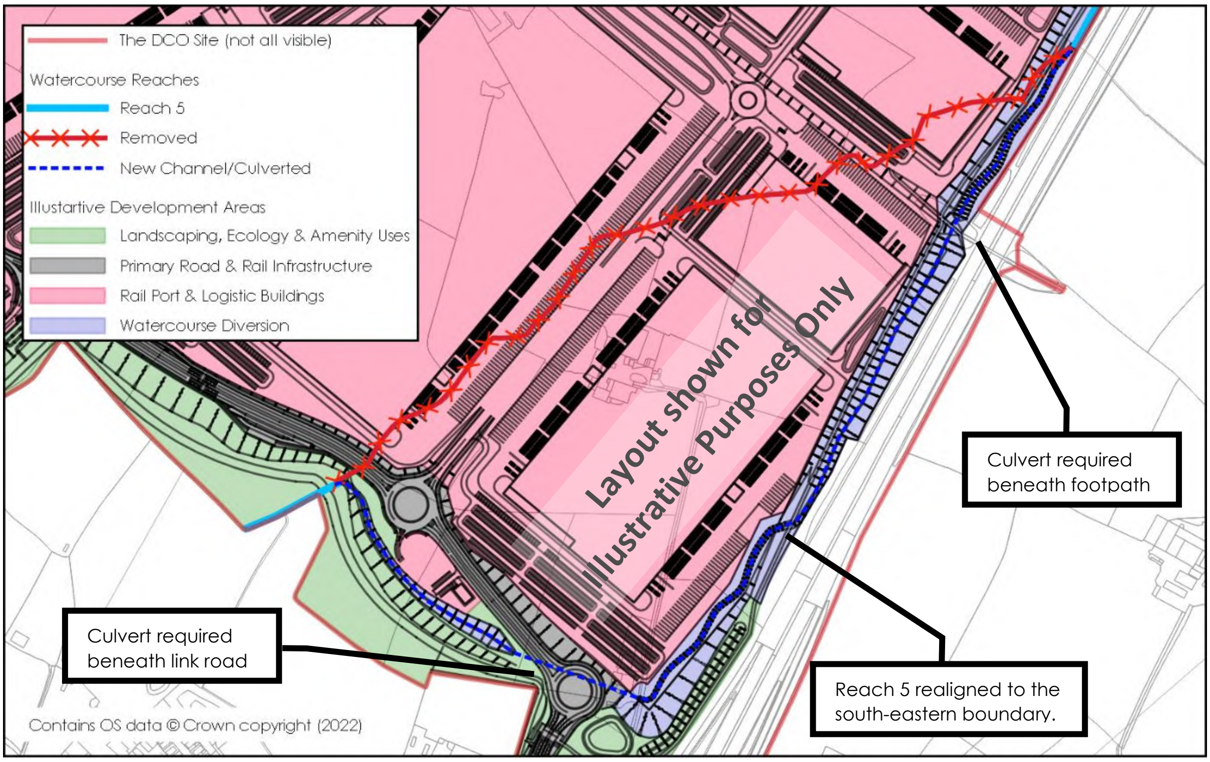
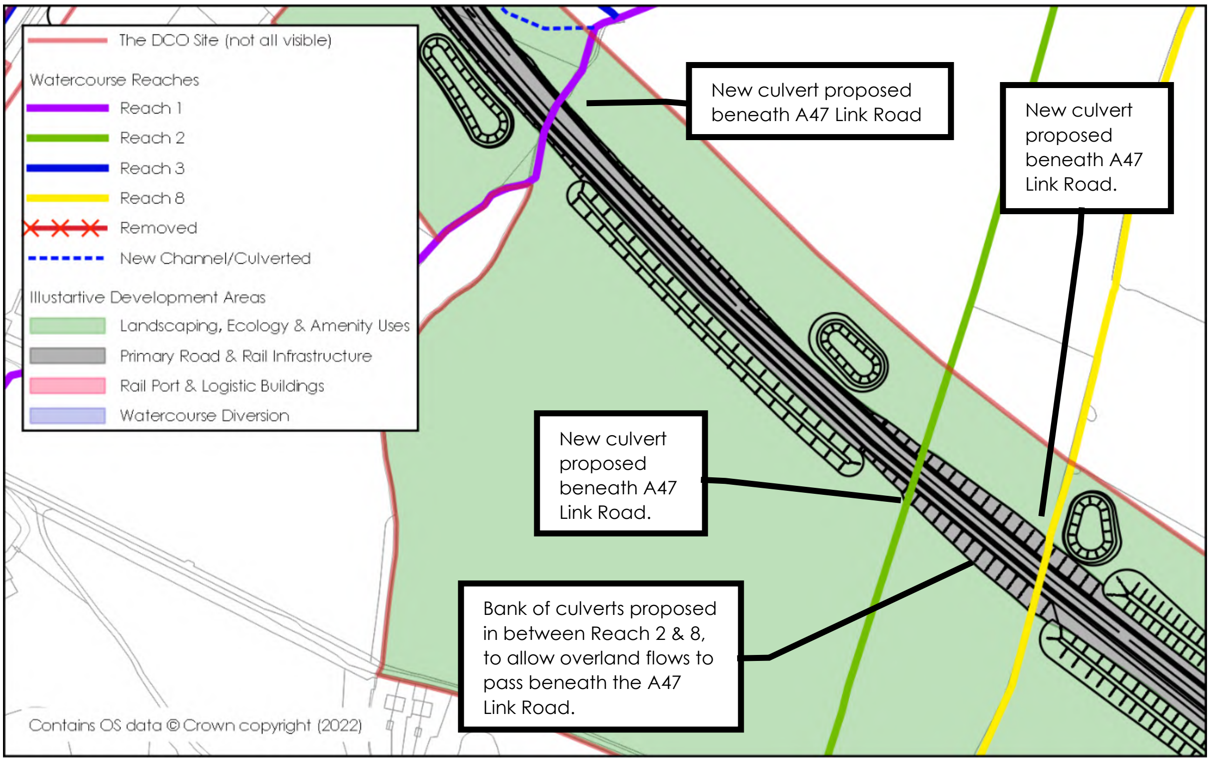


Figure 4.4: Proposed Alterations to Reach 1, 2 & 8



Hydraulic Modelling

4.10. The flood mitigation proposals were added to the site-specific hydraulic model and simulated at a range of flood events to confirm that they will address the flood risk to the Proposed Scheme. Full details are available in the accompanying hydraulic model report (**Appendix 2**). The results of the exercise are summarised within **Figure 4.5**, **Figure 4.6**, and **Figure 4.7** with peak flood levels at key locations provided in **Table 4.1.**

Figure 4.5: Illustrative Post-Development Floodplain – A47 Link Road & West of Main HNRFI Site

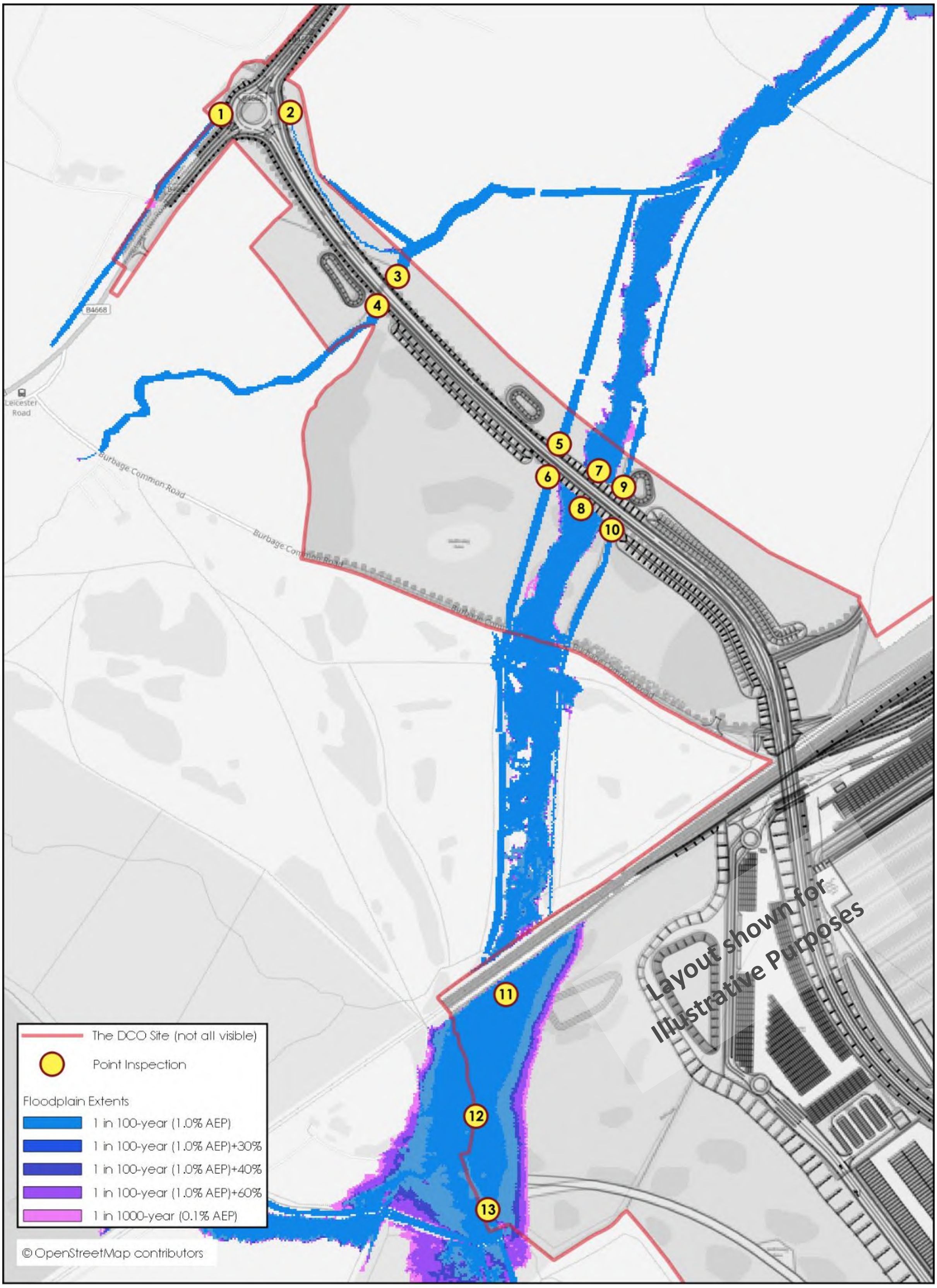


Figure 4.6: Illustrative Post-Development Floodplain – South East of Main HNRFI Site

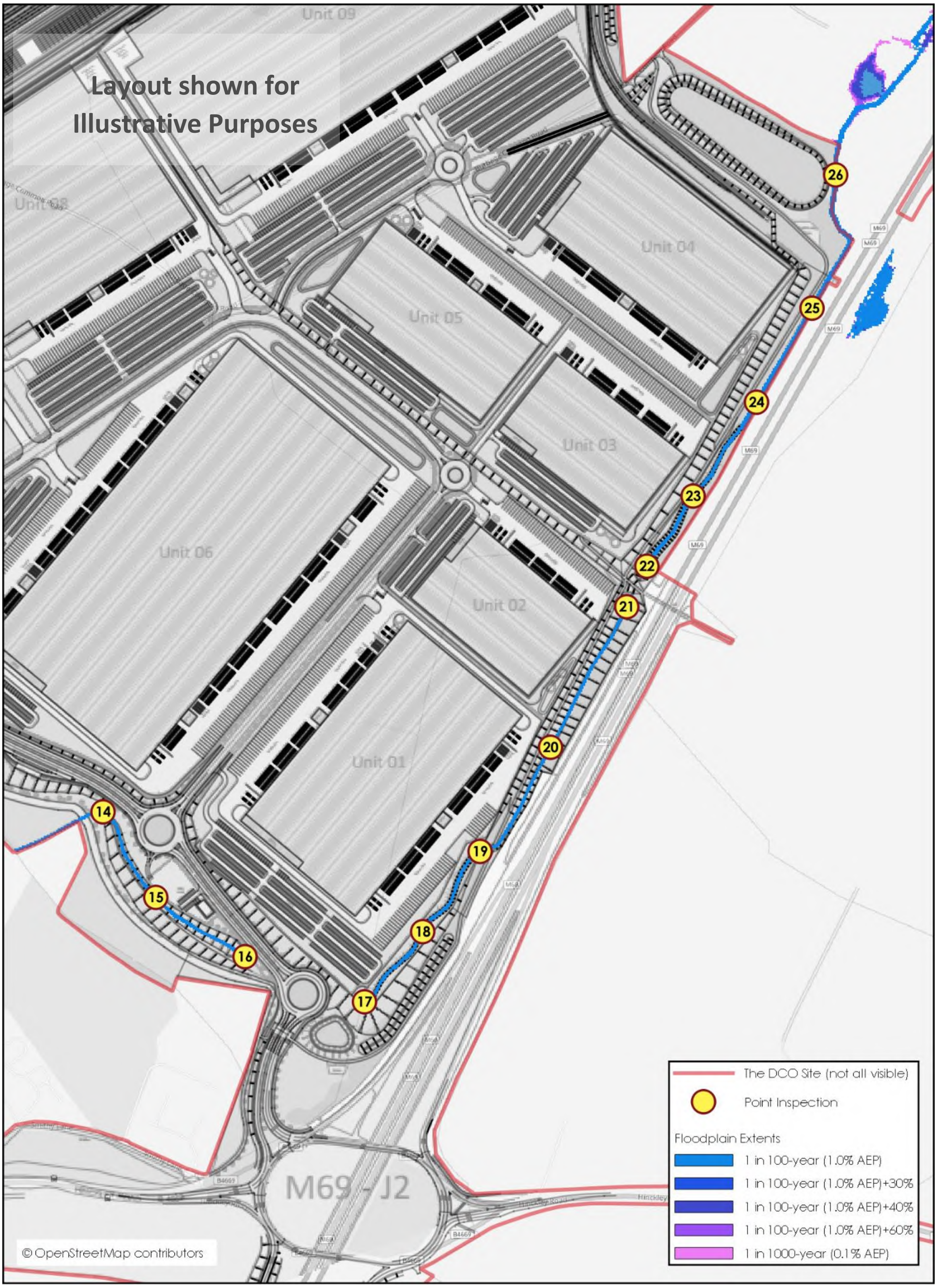


Figure 4.7: Illustrative Post-Development Floodplain – North East of Main HNRFI Site

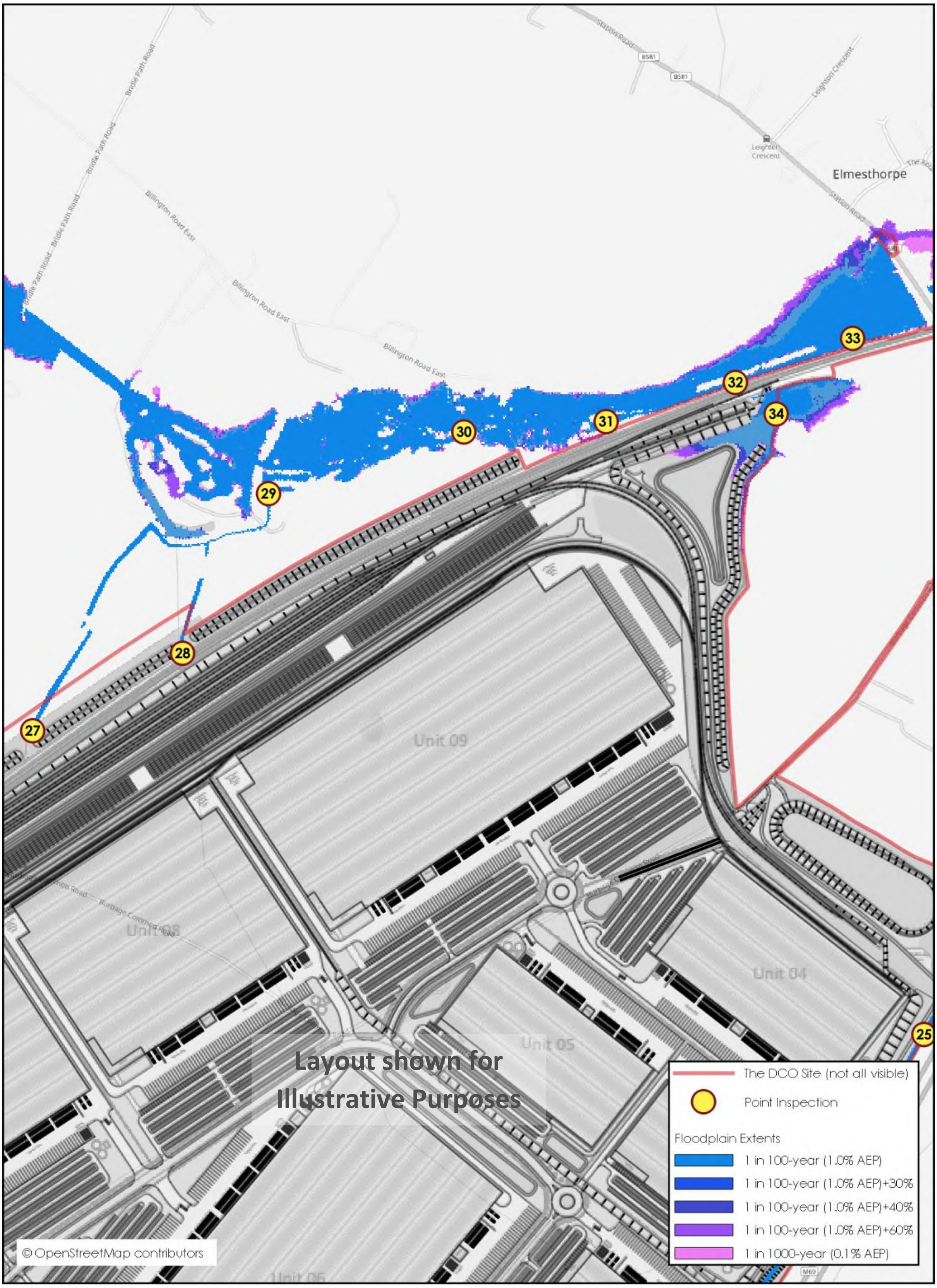


Table 4.1: Post-Development Peak Flood Levels

Point	Description	Peak Flood Level (m AOD)				
		1 in 100-Year	1 in 100-Year+30%	1 in 100-Year+40%	1 in 100-Year+60%	1 in 1000-Year
1	Downstream of A47 Link Road (Reach 3)	93.40	93.49	94.18	94.18	94.37
2		92.69	92.72	92.74	92.75	92.76
3	Downstream of A47 Link Road (Reach 1)	91.44	91.47	91.48	91.49	91.51
4	Upstream of A47 Link Road (Reach 1)	91.63	91.67	91.68	91.71	91.73
5	Downstream of A47 Link Road (Reach 2)	90.44	90.45	90.46	90.46	90.47
6	Upstream of A47 Link Road (Reach 2)	90.53	90.54	90.54	90.55	90.55
7	Downstream of A47 Link Road (floodplain)	90.74	90.76	90.76	90.77	90.77
8	Upstream of A47 Link Road (floodplain)	91.14	91.19	91.20	91.22	91.23
9	Downstream of A47 Link Road (Reach 8)	90.85	90.88	90.89	90.90	90.91
10	Upstream of A47 Link Road (Reach 8)	90.90	90.92	90.93	90.94	90.95
11	Floodplain to the	93.89	94.22	94.32	94.49	94.59

Point	Description	Peak Flood Level (m AOD)				
		1 in 100-Year	1 in 100-Year+30%	1 in 100-Year+40%	1 in 100-Year+60%	1 in 1000-Year
12	West of the Main HNRFI Site (Reach 2)	93.90	94.22	94.32	94.49	94.59
13		93.93	94.22	94.32	94.49	94.59
14	Diverted watercourse (Reach 5) upstream of A47 Link Road	99.83	99.84	99.84	99.85	99.85
15		98.12	98.15	98.16	98.17	98.19
16		97.84	97.87	97.88	97.90	97.91
17	Diverted watercourse (Reach 5) between 47 Link Road and M69 Footpath	95.85	95.88	95.89	95.91	95.92
18		95.48	95.51	95.52	95.54	95.55
19		95.07	95.09	95.10	95.11	95.12
20		93.74	93.76	93.77	93.78	93.79
21		92.22	92.26	92.26	92.29	92.30
22	Diverted watercourse (Reach 5) downstream of M69 Footpath	91.71	91.72	91.73	91.74	91.75
23		89.90	89.92	89.92	89.93	89.94
24		87.21	87.23	87.24	87.25	87.26
25		86.29	86.32	86.33	86.36	86.37
26		85.75	85.88	85.91	85.95	85.98

Point	Description	Peak Flood Level (m AOD)				
		1 in 100-Year	1 in 100-Year+30%	1 in 100-Year+40%	1 in 100-Year+60%	1 in 1000-Year
27	Downstream of Railway Line (Reach 4)	88.23	88.25	88.26	88.27	88.28
28	Downstream of Railway Line (Reach 4a)	88.64	88.65	88.65	88.65	88.66
29	Downstream of Railway Line (Reach 1)	85.93	85.96	85.97	85.98	86.00
30		85.24	85.29	85.30	85.32	85.34
31		84.50	84.55	84.56	84.60	84.63
32		84.22	84.30	84.34	84.42	84.46
33		83.81	84.11	84.19	84.35	84.40
34	North East of Main HNRFI Site (Reach 6)	83.83	84.13	84.22	84.38	84.43

Diverted Watercourse (Reach 5)

4.11. The modelling has confirmed that the proposed channel realignment (Reach 5) can convey the predicted flood flows around the Main HNRFI Site in all modelled events including the 1 in 100-year+30%, 1 in 100-year+40%, 1 in 100-year+60% and 1 in 1000-year flood events.

4.12. To provide flood resilience, and because the diverted watercourse will flow above the Main HNRFI Site plateaus in places, it is recommended that the top of bank of the realigned channel is set at least 300mm above the 1 in 100-year +30% flood level. The flood levels in **Table 4.1** show that this freeboard would be sufficient to contain all flood events.

A47 Link Road

4.13. The modelling has confirmed that the A47 Link Road can be elevated above all modelled flood events, thereby ensuring that it will remain operational during flood events, including the 1 in 100-year+60% and 1 in 1000-year events.

4.14. The proposed new culverts on the A47 Link Road on Reach 1, 2, and 8 are shown to not fully surcharge even during the 1 in 1000-year event, giving confidence that they can be designed to offer a soft bed and freeboard to flood levels at the appropriate design stage, if required.

4.15. While the final design of the A47 Link Road will be determined during the detailed design stage, providing a freeboard between peak flood levels and the culvert soffit, in addition to the level of cover required above the culverts, means that the road surface will be raised significantly above peak flood levels.

Floodplain to the West of the Main HNRFI Site

4.16. There is an existing ridge line located between the floodplain in the west of the Main HNRFI Site (points 11, 12 and 13, on Reach 2) and the Proposed Scheme. This intervening topography has a minimum ground level of 98.05mAOD providing a freeboard in excess of 3m to the 1 in 1000-year peak flood levels.

Floodplain to the North of the Main HNRFI Site

4.17. The existing railway main line upstream of Reach 4 has a ground level in the region of 93.2mAOD. This is over 5m above the adjacent peak flood level.

4.18. The existing railway main line upstream of Reach 4a has a ground level in the region of 91.7mAOD. This is over 3m above the adjacent peak 1 in 1000-year flood level.

4.19. The existing railway main line to the south of Reach 1 (at points 31, 32, and 33) has a ground level of between 88.0mAOD and 84.8mAOD. This is between 4m and 0.4m above the adjacent 1 in 1000-year peak flood level. Elsewhere the floodplain does not interact with the Main HNRFI Site due to the intervening topography.

4.20. In the north-eastern corner of the Main HNRFI Site, on Reach 6, flood water runoff from third party land continues to accumulate against the railway line. The railway connection to the existing Main Line is proposed in this location. To tie into the Main Line, the new rail line will need to be elevated to a level in the region of 86.0mAOD. This is in the order of 1.7m above the 1 in 100-year+40% flood level, and 1.5m above the 1 in 1000-year flood level. Therefore, the railway could remain operational during a flood event.

4.21. The existing topography rises up from the floodplain in the north eastern corner of the Main HNRFI Site to meet the Proposed Scheme. Minimum ground levels here are in the region of 85.0mAOD. This is approximately 0.8m above the 1 in 100-year+30% flood level, and 0.5m above the 1 in 1000-year flood level.

Summary

4.22. The Proposed Scheme has either been located outside of the floodplain on higher ground or in an area where it is afforded flood resilience by the intervening topography. In the case of the A47 Link Road and railway line, which need to pass over the floodplain, these have been located on elevated embankments raising them above the floodplain ensuring they can remain operational during a flood event. The flood risk to the Proposed Scheme has also been addressed by diverting a watercourse around the Main HNRFI Site. Therefore, post-construction, the flood risk to the Proposed Scheme is expected to be low.

M69 at Junction 2

4.23. The majority of the proposals at Junction 2 of the M69 are located away from the floodplain on land at low flood risk. However, where the M69 crosses over the Soar Brook tributary watercourse, widening on the carriageway is required.

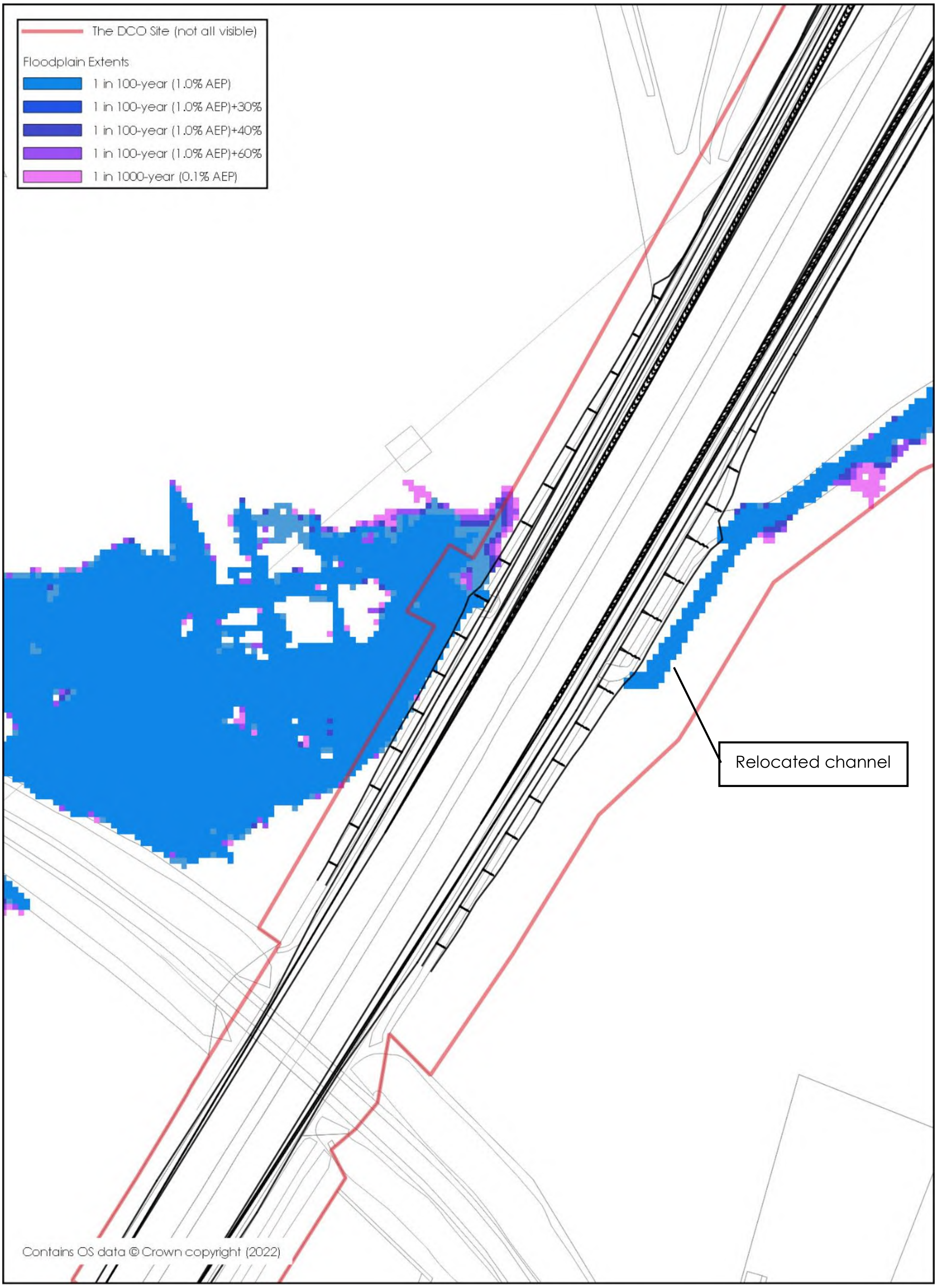
4.24. At this stage of the project, it is expected that the embankment on the northern side will need to be widened approximately 2 to 3m, and the inlet of the M69 culvert extended a similar distance upstream.

4.25. It is expected that the carriageway on the downstream side of the M69 will need to be widened by approximately 5m, which requires the channel which runs on the toe of the existing embankment to be relocated further south. The outlet of the M69 culvert will also need to be extended a similar distance downstream. As the floodplain is generally contained within the channel in this location, it is proposed to relocate the current channel geometry approximate 6m further south. This will preserve the current hydraulic regime minimising any impacts on flood risk in the wider area.

4.26. The proposals were added to the site-specific hydraulic model and simulated at a range of flood events. Full details are available in the accompanying hydraulic model report (**Appendix 3**). The results of the exercise are summarised within **Figure 4.8.**

4.27. The M69 in this location is elevated over 2m above peak flood levels. Therefore, the flood risk to the M69 will be unaffected by the proposed works.

Figure 4.8: Soar Brook Tributary Post-Development Model Predicted Floodplain Outlines



Safe Access and Egress

4.28. Post-construction, dry access/egress from the Main HNRFI Site will be available to the B4668 and Junction 2 of the M69 via the A47 Link Road.

4.29. Additionally, due to the elevated nature of the local rail network, the operation of the rail port and rail infrastructure should be unaffected during a flood event.

Surface Water Drainage

4.30. The Proposed Scheme will include surface water drainage infrastructure that will be designed to intercept and store storm water, ensuring that it can remain operational. Further details of the strategy are provided within the accompanying Sustainable Drainage Statement (HNRFI-BWB-ZZ-XX-RP-CD-0002) – document reference 6.2.14.2

4.31. In brief, the Proposed Scheme will continue to discharge surface water to the local watercourses at the equivalent greenfield QBAR rate. The existing drainage catchments will be retained wherever possible so that the distribution of surface water to the local watercourses is not significantly altered. Attenuated surface water storage will be provided with capacity for the 1 in 100-year storm with an allowance for climate change.

4.32. The Proposed Scheme will be designed with exceedance in mind. The road network will be used to convey excess overland flows towards the attenuation points, and overflows will be provided should the design standard of the drainage be exceeded.

Land Drainage Considerations

4.33. Groundwater will be monitored during the construction phase, particularly during the excavations. Where shallow groundwater is encountered appropriate dewatering will be employed where necessary.

Off-Site Highway & Railway Works

4.34. The flood risk to each of the wider minor highway/footpath works were generally assessed to be low, but there were exceptions where fluvial, surface water or groundwater could potentially pose a moderate or high risk.

4.35. However, these elements of the Proposed Scheme are associated with existing highway and railway infrastructure and addressing any existing flood risk issues at these locations does not form part of the Proposed Scheme.

5. THE EFFECT OF THE PROPOSED SCHEME IN THE WIDER AREA

The Main HNRFI Site & A47 Link Road

5.1. To assess the potential off-site impacts on flood risk, the post-development and baseline flood levels and floodplain extents have been compared at equivalent return period events. This has been undertaken at a selection of flood events between the 1 in 10-year and 1 in 100-year+30% return period events.

5.2. Full mapping is available within **Appendix 2**, and an example event (the 1 in 100-year+30% flood) is provided within **Figure 5.1**, **Figure 5.2,** and **Figure 5.3** for ease of reference, with a comparison of peak flood levels provided in **Table 5.1**.

Figure 5.1: 1 in 100-Year+30% Floodplain Comparison (A47 Link Road)

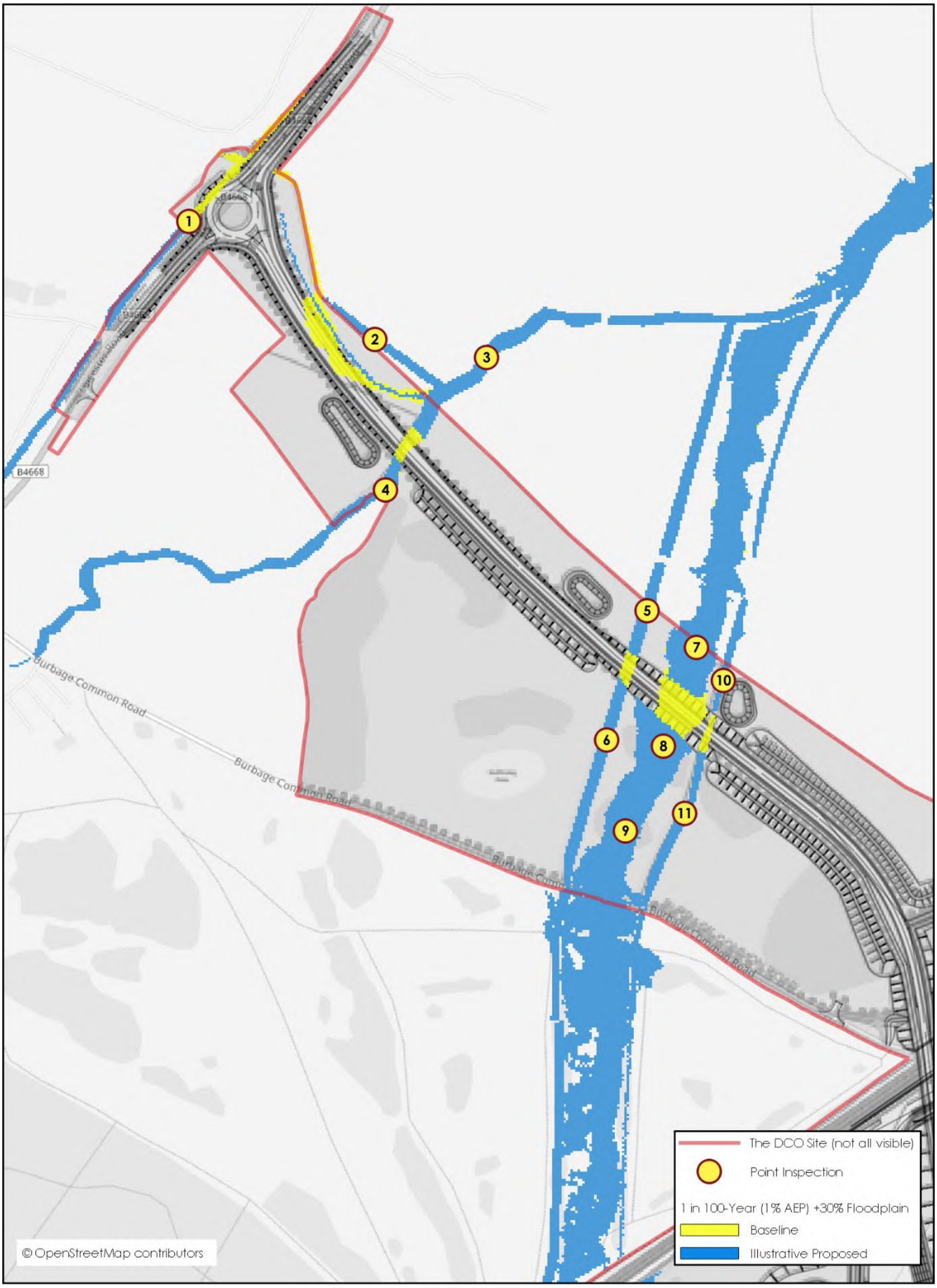


Figure 5.2: 1 in 100-Year+30% Floodplain Comparison (North of Main HNRFI Site)

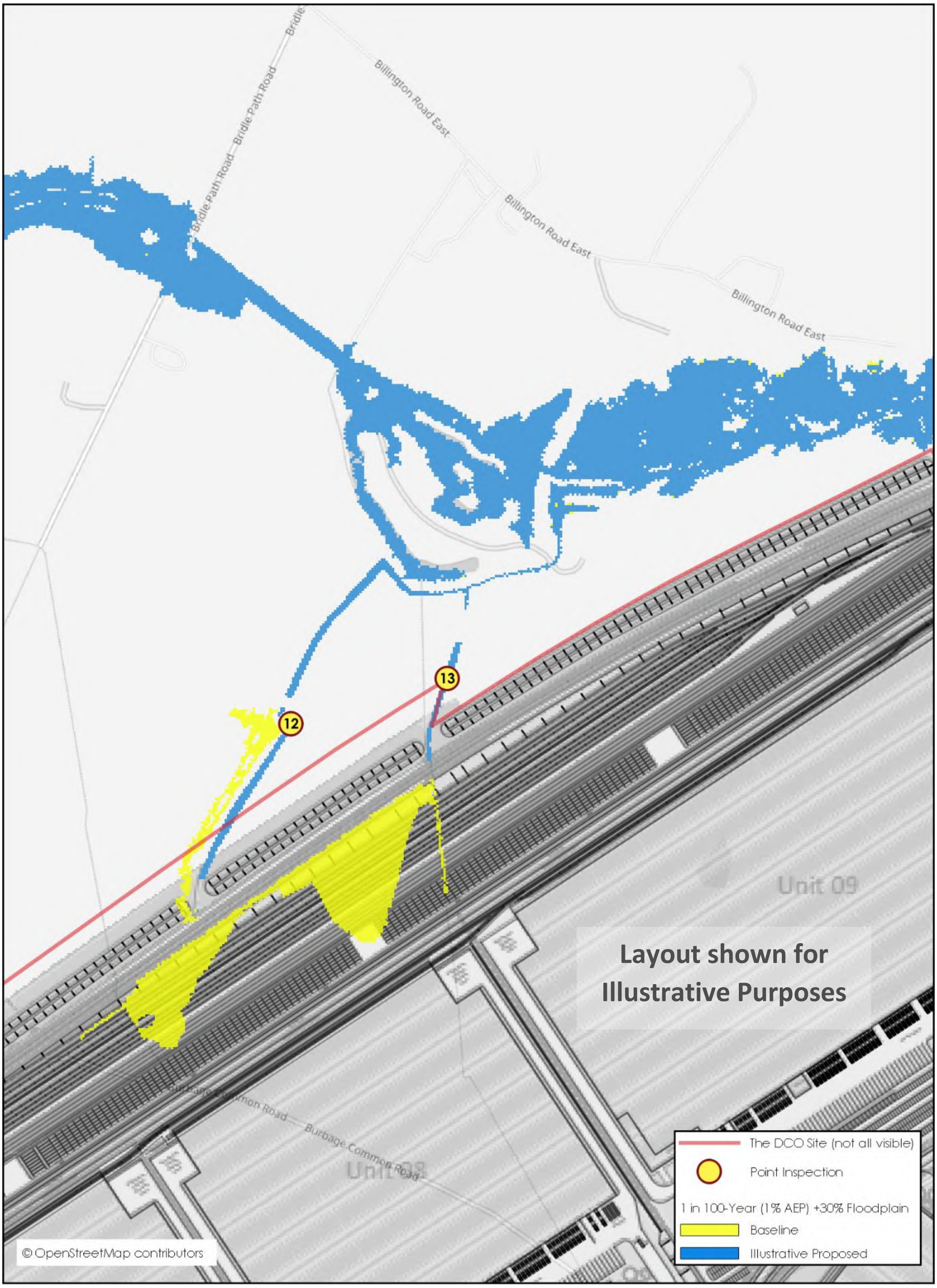


Figure 5.3: 1 in 100-Year+30% Floodplain Comparison (East of Main HNRFI Site)

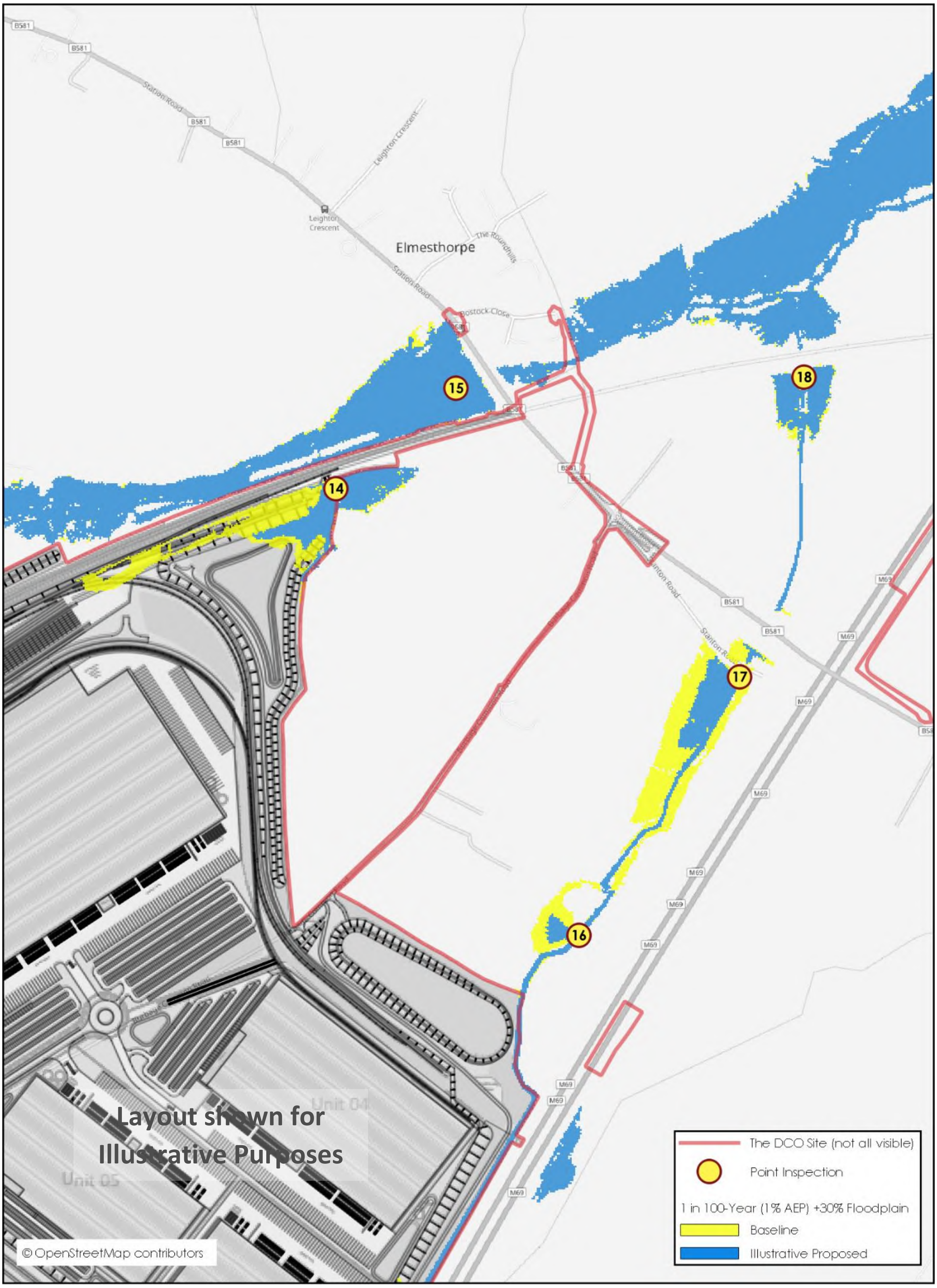


Table 5.1: Comparison of Peak Flood Levels

ID	Baseline Flood Levels (m AOD)			Proposed Conditions Flood Levels (m AOD)					
	1 in 20-year	1 in 100-year	1 in 100-year +30%	1 in 20-year	Change from Baseline (m)	1 in 100-year	Change from Baseline (m)	1 in 100-year +30%	Change from Baseline (m)
1	94.94	94.97	94.99	93.64	-1.29	93.73	-1.24	93.80	-1.19
2	91.99	91.99	92.00	91.77	-0.22	91.77	-0.22	91.78	-0.22
3	91.10	91.14	91.19	91.10	0.00	91.14	0.00	91.19	0.00
4	91.93	91.96	91.99	91.75	-0.18	91.78	-0.18	91.81	-0.17
5	90.50	90.51	90.52	90.41	-0.09	90.42	-0.09	90.43	-0.09
6	90.90	90.91	90.91	90.82	-0.08	90.83	-0.08	90.83	-0.08
7	90.57	90.61	90.63	90.57	0.00	90.61	0.00	90.63	0.00
8	91.01	91.04	91.05	91.06	0.05	91.15	0.11	91.19	0.14
9	91.36	91.39	91.41	91.36	0.00	91.39	0.00	91.41	0.00
10	90.81	90.84	90.87	90.79	-0.01	90.82	-0.02	90.85	-0.02
11	91.23	91.27	91.31	91.13	-0.09	91.15	-0.12	91.16	-0.14
12	87.37	87.43	87.45	87.31	-0.05	87.33	-0.09	87.36	-0.09
13	87.43	87.45	87.53	87.41	-0.02	87.42	-0.03	87.43	-0.10

ID	Baseline Flood Levels (m AOD)			Proposed Conditions Flood Levels (m AOD)					
	1 in 20-year	1 in 100-year	1 in 100-year +30%	1 in 20-year	Change from Baseline (m)	1 in 100-year	Change from Baseline (m)	1 in 100-year +30%	Change from Baseline (m)
14	83.52	83.88	84.19	83.50	-0.02	83.83	-0.05	84.13	-0.06
15	83.47	83.84	84.15	83.44	-0.02	83.81	-0.03	84.10	-0.05
16	85.50	85.82	85.94	85.41	-0.08	85.66	-0.17	85.81	-0.13
17	84.07	84.83	85.31	84.03	-0.04	84.38	-0.45	84.83	-0.47
18	82.15	82.26	82.34	82.13	-0.02	82.21	-0.05	82.28	-0.06

5.3. The comparative analysis shows that the proposed flood management and watercourse realignment strategy within the Main HNRFI Site results in no significant off-site detriment. The Proposed Scheme potentially offers marginal downstream betterment due to the attenuation of surface water runoff from. This is particularly evident on Reach 5, where flood levels are predicted to be reduced by almost 0.5m downstream of the Main HNRFI Site.

5.4. The proposed culverts beneath the A47 Link Road on Reach 1, 2, 3 and 8 are shown to provide reduced flood levels on the approach and exit channels. This is due to the increased efficiency of the culverts when compared to the vegetated channels they would replace.

5.5. Upstream of this betterment are isolated areas where modelled flood levels are shown to increase within the channel. The model results have been reviewed which has shown that the flows in these areas have not increased and that a backwater from the proposed culverts does not occur (flood levels between the areas of localised increase and the culverts are lower than the baseline conditions). Instead, the isolated increases in flood levels are a result of a change in the modelled hydraulic gradient. This would be expected following the increased data resolution in the model that can be attributed to the addition of the proposed culverts and associated river sections. Therefore, this is not considered to be a real-world impact.

5.6. The overland flow route between Reach 2 and 8 is conveyed under the A47 Link Road by a series of offline culverts in the floodplain. Flood water is predicted to build above existing levels on the upstream side of the road. The additional flood levels and floodplain do not affect any land outside of the DCO Site. Therefore, this increase is considered acceptable. This is viewed as an informal form of floodplain compensation. By allowing the floodplain to adjust itself within the natural topography, unnecessary excavations and engineering works to create a formal floodplain compensation area are avoided.

5.7. The comparison shows that the A47 Link Road has no significant detriment impacts on the downstream floodplain.

M69 Widening at Junction 2

5.8. To identity any potential detriment to the wider area as a result of the proposed amendments to the embankment and existing culvert, the modelled post-works hydraulic model results were compared to the modelled baseline conditions.

5.9. The analysis predicted that there will be a minor upstream betterment, due to the improved conveyance offered by replacing a short length of channel with the extended large diameter culvert. No significant upstream detrimental impact was predicted.

5.10. Additionally, no detrimental impact was predicted downstream of the M69 as flood flows are contained within the relocated channel. Further details are available within **Appendix 3**.

Off-Site Highway & Railway Works

5.11. It is understood that the minor widening or rearrangement of the carriageway and junctions, and the works to improve the footways and footpaths, will mostly likely be undertaken at grade, thereby minimising any potential changes to the existing topography and minimising any significant impact on any floodplain or flow routes that may be present. Additionally, it is expected that at the detailed design stage the existing highway drainage infrastructure will be reviewed and improved to accommodate any change in impermeable areas where capacity improvements are identified as necessary.

5.12. Therefore, the wider highway and footpath works are not expected to have any significant detrimental impacts on third party flood risk.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. This FRA has been prepared in accordance with the requirements set out in NPSNN. The FRA has been produced in respect of a DCO for a SRFI on land adjacent to the north-west of Junction 2 of the M69.

6.2. This FRA is intended to support an application for a DCO based upon parameter plans and an illustrative layout. The detail included is commensurate and subject to the level of detail available at this stage.

6.3. This report demonstrates that the Proposed Scheme is at an acceptable level of flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 6.1**:

Table 6.1: Summary of Flood Risk Assessment at the Main HNRFI Site, A47 Link Road & M69 Junction 2

Flood Source	Risk & Proposed Mitigation Measures
Fluvial	The majority of the Main HNRFI Site and A47 Link Road are located outside of the floodplain on land at a low flood risk; however, there are a few localised areas upstream of the railway line where flood water can pond, as well as an overland flow route near Burbage Common, that the Proposed Scheme has needed to consider. Junction 2 of the M69 is generally removed from the floodplain and is elevated above the Soar Brook tributary. The layout has either been arranged to fall outside of the floodplain on higher ground, in an area where it is afforded flood resilience from the watercourses by the intervening topography or, in case of the A47 Link Road, M69, and railway line, have been located on elevated embankments, raising them above the floodplain ensuring they can remain operational. The floodplain present within the Main HNRFI Site (alongside the railway line) is a product of runoff from within the Main HNRFI Site. Therefore, this will be addressed by a new drainage system which will intercept the rainwater before it reaches the railway line. The storm water will be stored within the development and released slowly to the surrounding watercourse network. An unnamed ordinary watercourse in the Main HNRFI Site will be diverted around the development area.

Flood Source	Risk & Proposed Mitigation Measures
Coastal/Tidal	The DCO Site does not fall within a coastal flood risk zone.
Canals	The DCO Site is significantly removed from any canals or artificial waterways
Groundwater	The Main HNRFI Site, A47 Link Road, and M69 Junction 2 have been identified to be at low risk of groundwater flooding due to the depth of groundwater and the low permeability of the underlaying strata. However, localised shallow groundwater may be present. Therefore, it is recommended that groundwater is monitored during the construction phase, particularly during the excavations. Where shallow groundwater is encountered appropriate dewatering should be employed as necessary.
Reservoirs and waterbodies	The DCO Site is significantly removed from any impounded reservoirs, and it does not fall within the inundation zone of a potential reservoir failure.
Pluvial runoff	The pluvial flood extents associated with the watercourse network in the Main HNRFI Site, A47 Link Road, and M69 Junction 2 closely mirrors the fluvial floodplain, and the flood risk posed by this will be addressed in the same manner. Away from the watercourses, any remaining flood risk from surface water runoff will be addressed through reprofiling the development and by the introduction of appropriate drainage infrastructure.
Sewers	The Main HNRFI Site, A47 Link Road, and M69 Junction 2 are generally well removed from the existing public sewer network, and the minor combined sewer that is present in the very south poses a low risk to the Proposed Scheme. The new drainage infrastructure constructed to serve the Proposed Scheme will be designed to modern standards, and to accommodate the 1 in 100-year storm event including an allowance for climate change.

Flood Source	Risk & Proposed Mitigation Measures
Impact of the Development	Hydraulic modelling of the Proposed Scheme and a comparison against the baseline floodplain has shown that the Proposed Scheme will have no detrimental impact in the wider catchment. The analysis also identifies that it potentially offers marginal downstream betterment due to the attenuation of surface water runoff from within the Main HNRFI Site. The A47 link Road includes culverts to preserve watercourse connectivity beneath the carriageway. An overland flow route located between two channels is to be conveyed under the A47 Link Road by a series of offline culverts in the floodplain. Flood water is predicted to build above existing levels on the upstream side of the road. The additional flood levels and floodplain do not affect any land outside of the DCO Site. Therefore, this increase is considered acceptable. This is viewed as an informal form of floodplain compensation. By allowing the floodplain to adjust itself within the natural topography, unnecessary excavations and engineering works to create a formal floodplain compensation area can be avoided. Hydraulic modelling has identified that the A47 Link Road has no detrimental impacts on the downstream floodplain. Surface water runoff from the development will be controlled appropriately and discharged to the local watercourse at the equivalent greenfield QBAR rate.
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.	

6.4. A number of highway and railway improvements outside of the Main HNRFI Site, A47 Link Road, and M69 Junction 2 are included within the DCO Site. A desktop review of each of the areas has been undertaken; this is summarised within **Table 6.2**.

Table 6.2: Summary of Flood Risk within the DCO Site away from the Main HNRFI Site, the A47 Link Road, and M69 Junction 2

Junction	Flood Risk						
	Fluvial	Coastal	Surface Water	Ground-water	Canal	Reservoirs	Sewers
B1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
B2	Located in Flood Zone 1 – Low Risk	No Risk	Moderate Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
B3	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
B4 – i	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
B4 – ii	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
B4 – iii	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
B5	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
B6	Located in Flood Zone 3 – High Risk. However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	No Risk	Low Risk	Moderate Risk However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
HB1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
HB2	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
H1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
R1	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk

Junction	Flood Risk						
	Fluvial	**Coastal**	**Surface Water**	**Ground-water**	**Canal**	**Reservoirs**	**Sewers**
R2	Located in Flood Zone 3 – High Risk. However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk
R5	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk
M69 1 to M69 7	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk

6.5. In compliance with the requirements of NPSNN, and subject to the mitigation measures proposed, the Proposed Scheme could proceed without being subject to significant flood risk. Moreover, the Proposed Scheme will not increase flood risk to the wider catchment area as a result of suitable management of surface water runoff.

APPENDICES

Appendix 1: Review of Off-Site Highway, Junction, and Railway Improvements

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange
Leicestershire
Desktop Flood Risk Review: Off-Site Highway, Junction, & Railway Works

November 2022

[redacted]

DOCUMENT ISSUE RECORD

Document Number:	HNRFI-BWB-ZZ-XX-RP-YE-0008
BWB Reference:	NTT-2814-0008

Author:	Craig Crowe BSc (Hons) MSc
Checked:	Robin Green BSc (Hons)
Approved:	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM

Rev	Date	Status	Comment	Author:	Checked:	Approved:
P01	03/09/21	S0	Draft Issue for Preliminary Review	CC	RG	CG
P02	10/11/21	S2	Updated to reflect the latest DCO site boundary and development proposals	RG	RD	CG
P03	13/12/21	S2	Updated to reflect the latest DCO site boundary and development proposals. Issued alongside the PEIR.	RG	RD	CG
P04	25/08/22	S2	Updated to reflect the latest DCO Site boundary and acronyms	JD	RG	RG
P05	16/11/22	S2	Minor formatting changes	JD	RG	RG

Notice

1. INTRODUCTION

1.1 Tritax Symmetry (Hinckley) Ltd is promoting proposals for a new Strategic Rail Freight Interchange (SRFI) on land east of Hinckley, in Blaby District in Leicestershire. A SRFI is a large multi-purpose freight interchange and distribution centre linked into both the rail and trunk road systems.

1.2 BWB Consulting Ltd has been commissioned by Tritax Symmetry (Hinckley) Ltd to undertake an assessment of surface water and flood risk. This includes identifying the baseline conditions and the potential impacts of the proposed development on these elements.

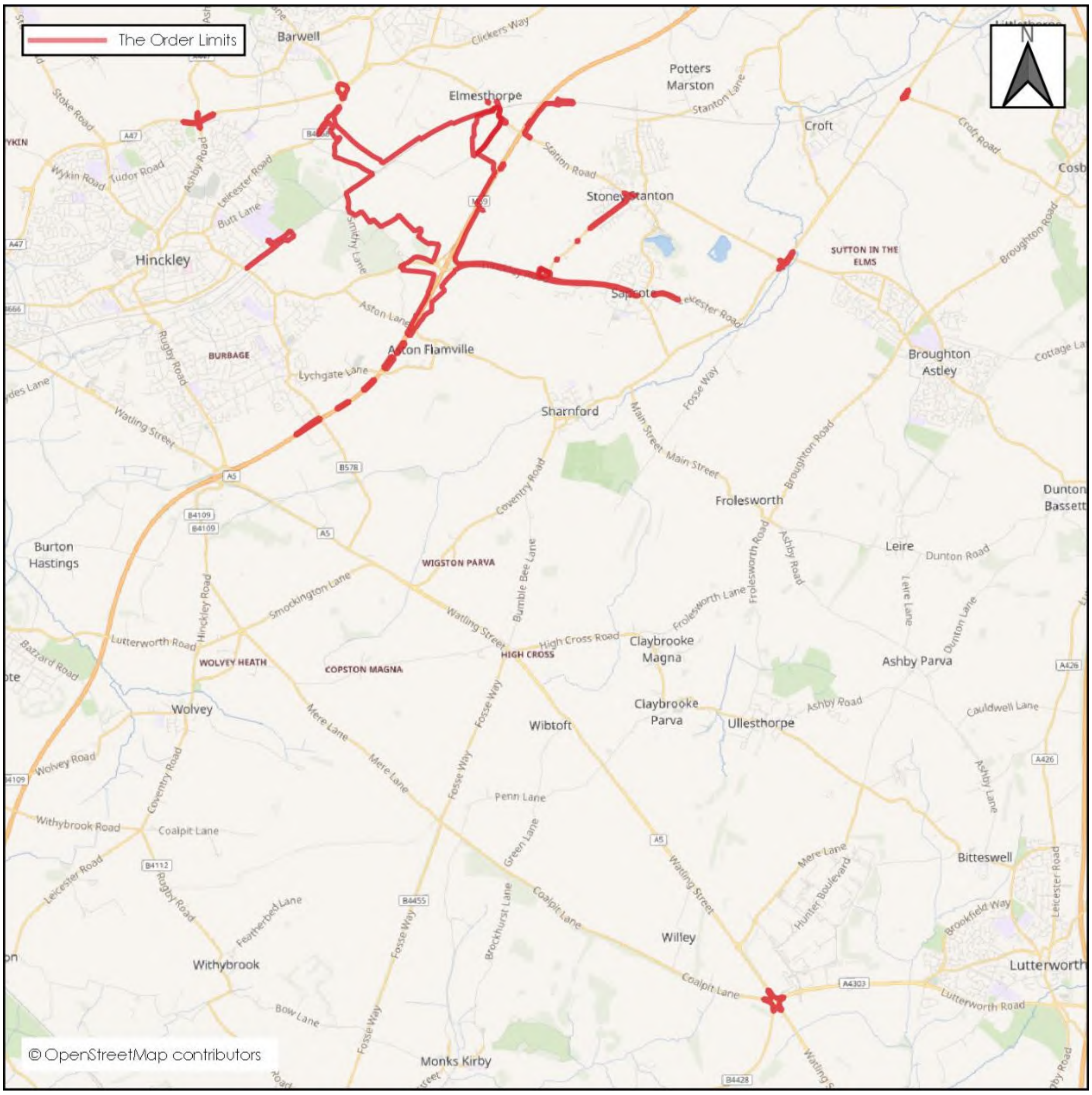


Figure 1.1: Site Location Plan

1.3 The Main HNRFI Site lies 3 km to the north-east of Hinckley town centre, to the north-west of M69 Junction 2. The Nuneaton to Felixstowe railway forms the north-western boundary, with the M69 motorway defining the south-eastern boundary. To the south-west are blocks of deciduous woodland (including Burbage Wood, Aston Firs and Freeholt Wood), a gypsy and traveller community site and a mobile home site. Beyond the north-eastern boundary lies the village of Elmesthorpe, a linear settlement on the B581 Station Road.

1.4 The Main HNRFI Site comprises the proposed SRFI, which includes but may not be limited to, the railway sidings and freight transfer area alongside the two-track railway between Hinckley and Leicester, land for the development of storage and logistics sheds, site hub building, energy centre, and associated lorry and car parking, infrastructure, and landscaping.

1.5 The Development Consent Order (DCO) Site extends beyond the Main HNRFI Site to include other elements including a new link road from M69 Junction 2 to the B4668 (Leicester Road) ('the A47 Link Road'), alterations to Junction 2 itself, and a section of the B4669 towards Sapcote – this larger area is referred to as the Main Order Limits.

1.6 The DCO Site also extends beyond the Main Order Limits to include other minor highway, junction, and railway alterations.

1.7 A location plan illustrating the Development Consent Order (DCO) boundary is illustrated within **Figure 1.1**.

1.8 To allow the Flood Risk Assessment (FRA) to present a concise and clear assessment of the Main HNRFI Site, the A47 Link Road, and Junction 2 of the M69, this technical note has been prepared to review the flood risk associated with the more minor highway, junction railway improvement works. The flood risk at the Main HNRFI Site, the A47 Link Road, and M69 Junction 2 are discussed within the covering FRA (ref: HNRFI-BWB-ZZ-XX-RP-YE-0010_FRA). Also, due to their close proximity to, or location within, the Main Order Limits, the 'HB3' roundabout and 'R3' and 'R4' level crossing closures are covered with the FRA.

1.9 The areas covered within this note are identified within **Figure 1.2** to **Figure 1.7**, with summary information provided within **Table 1.1**.

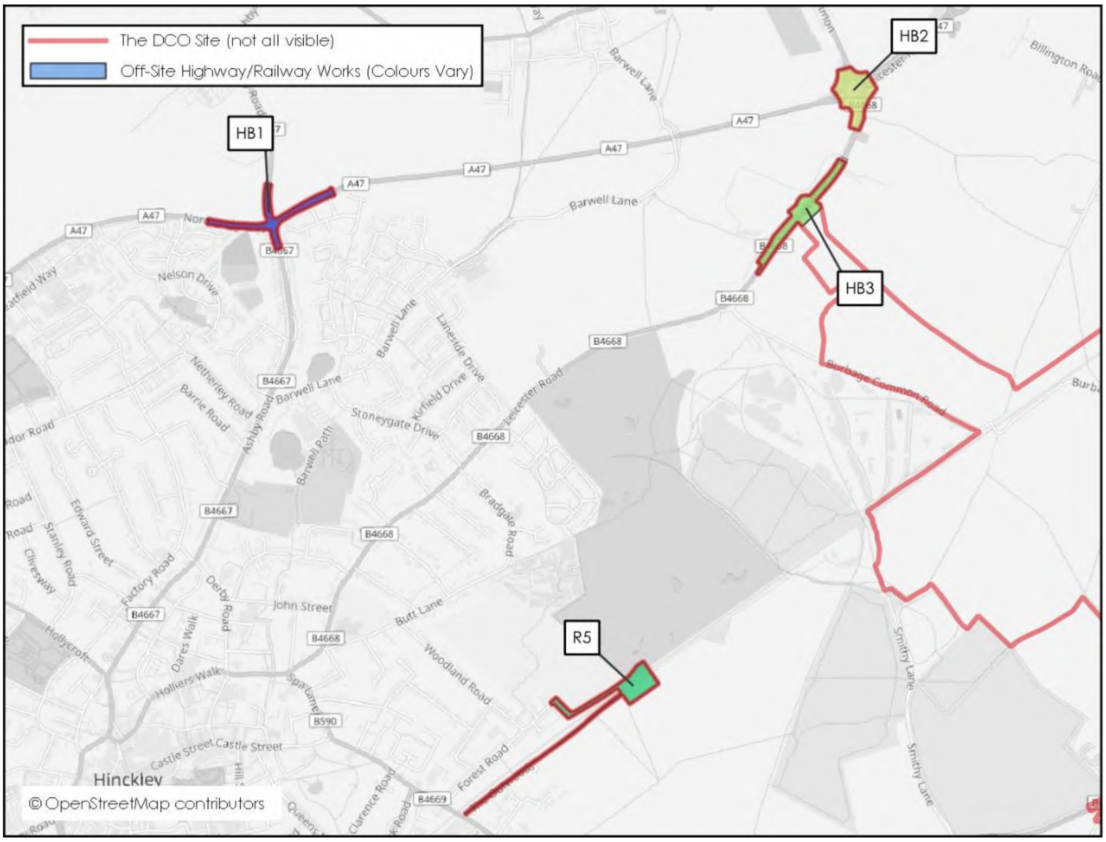


Figure 1.2 Off-Site Highway/Railway Works Location 1

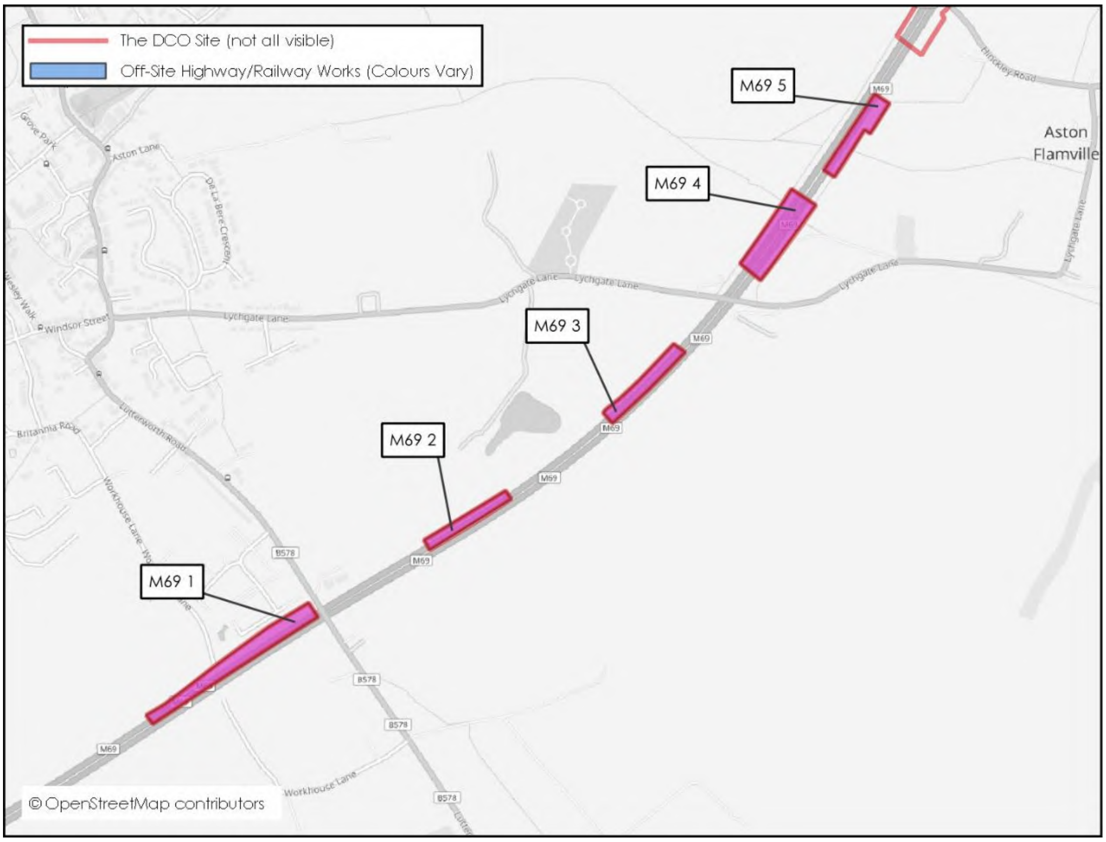


Figure 1.3: Off-Site Highway/Railway Works Location 2

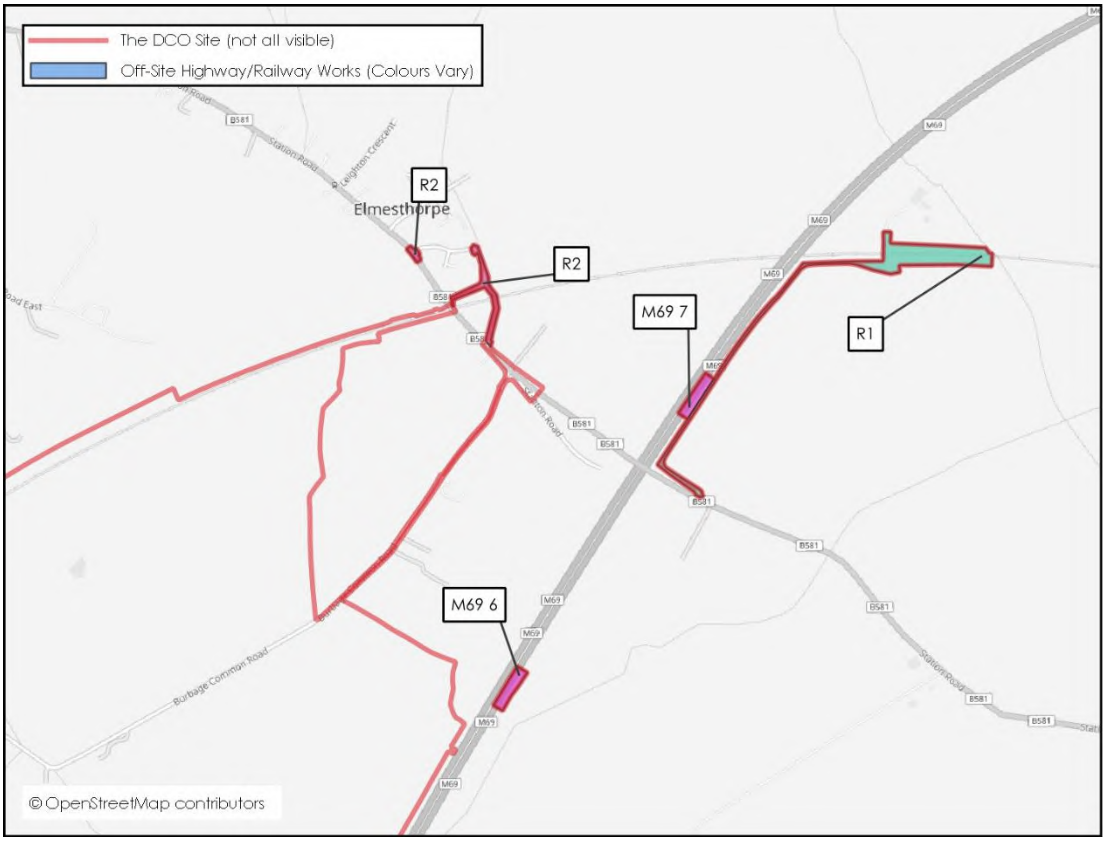


Figure 1.4: Off-Site Highway/Railway Works Location 3

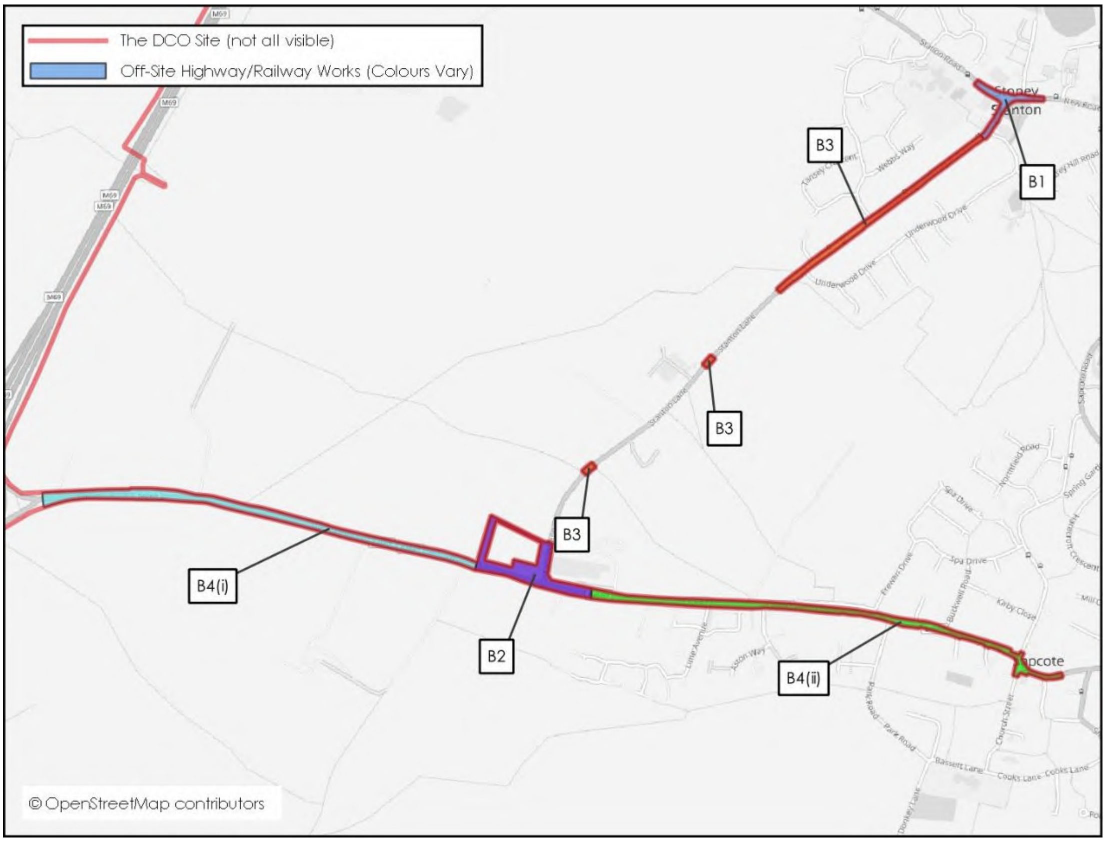


Figure 1.5: Off-Site Highway/Railway Works Location 4

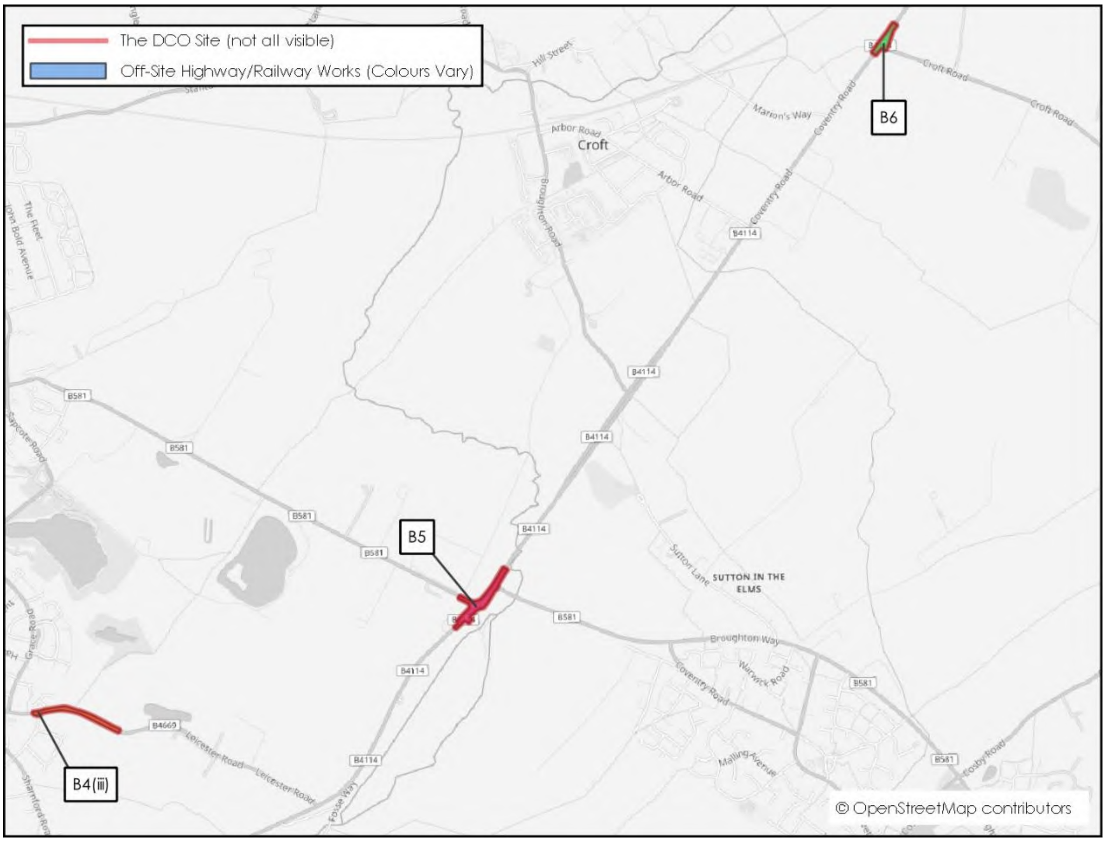


Figure 1.6: Off-Site Highway/Railway Works Location 5

Figure 1.7: Off-Site Highway/Railway Works Location 6

Table 1.1: Summary of Highway & Railway Works away from the Main HNRFI Site, the A47 Link Road, and the M69 Junction 2

ID	Location	Description of Proposed Works
B1	Junction of B581 Station Road / New Road and Hinckley Road, Stoney Stanton	The existing mini roundabout would be replaced by traffic lights with signalised crossings for pedestrians.
B2	Junction of B4669 Hinckley Road and Stanton Lane, west of Sapcote	Traffic lights would be introduced with a phase to allow pedestrians and cyclists to cross.
B3	Stanton Lane / Hinckley Road, south-west of Stoney Stanton	Reduction of the speed limit to 40mph from the national speed limit; traffic calming features and formalisation of on-carriageway parking.
B4 - i	B4669 Hinckley Road / Leicester Road, between M69 and Sapcote (M69 to B2)	Resurfacing of the footway
B4 - ii	B4669 Hinckley Road / Leicester Road, between M69 and Sapcote (B2 to Sapcote)	Improvements to the public realm, bus stop relocation, and traffic calming
B4 – iii	B4669 Hinckley Road / Leicester Road, between M69 and Sapcote (East of Sapcote).	Traffic calming measures
B5	Junction of B4114 Coventry Road and B581 Broughton Road at Soar Mill, south-east of Stoney Stanton	New traffic lights are already scheduled to be introduced as part of the Broughton Astley S278 works (Planning Ref: 19/00856/OUT). The Applicant proposes to widen the carriageway on the northbound approach to the B4114 Coventry Road and on the B581 Broughton Road to provide additional capacity for left-turning traffic on both arms. The left turn on Broughton Road would be provided as separately signalised phase to enable it to run at the same time as the right turn into Broughton Road from Coventry Road to improve the efficiency of the junction.
B6	Junction of B4114 Coventry Road and Croft Road, south-west of Narborough	Lane widening on junction approaches
HB1	Junction of A47 Normandy Way and A447 Ashby Road, Hinckley	It is proposed that the approach roads to this junction would all be widened to accommodate additional traffic. Indicative right turn and two lanes would be provided through the junction in a westbound direction.

ID	Location	Description of Proposed Works
HB2	Junction of A47 Normandy Way / Leicester Road, the B4668 Leicester Road and The Common, south-east of Barwell	Widening of the entry arm on the B4668 Leicester Road
HB3	Junction of B4668 and New A47 Link Road, northeast of the site access (Access Infrastructure)	Provision of a three-arm new roundabout access to the B4668 Leicester Road, including a segregated left turn lane southbound from the A47. *(Assessed within the overarching Flood Risk Assessment alongside the Main Order Limits)*
H1	Cross in Hand roundabout at the junction of the A5 Watling Street, A4303 Coventry Road, B4428 Lutterworth Road and Coal Pit Lane, west of Lutterworth	Increased roundabout radius and widened lane entries, with two lanes marked for longer distances for traffic approaching the junction on the A5 Watling Street southbound, the B4027 and on Coal Pit Lane.
R1	B581 to footpath south of Thorney Fields Farm	The proposals in this area include the closure of a level crossing and the existing public right of way diverted with pedestrians rerouted to an existing bridge over the railway south of Thorney Fields Farm.
R2	Footpath between Bostock Close and the B581 Station Road, opposite the Wentworth Arms public house.	The proposals in this area include the permanent closure of a public right of way via a level crossing. Pedestrians would instead be able to cross the railway using the existing Station Road bridge, 75 metres to the south-west. A drop kerb at the junction of Bostock Close and the B581 is also included
R3 R4	Located on the Leicester to Hinckley railway immediately to the north of the Main HNRFI Site	Closure of level crossings. *(Covered within the overarching Flood Risk Assessment alongside the Main Order Limits)*
R5	The Outwoods, between Burbage and Hinckley	The proposals in this area include the replacement of the level crossing with a pedestrian footbridge, with associated public rights of way diversions.
M69 1 to M69 7	The M69 on the approach to Junction 2	Changes to signage

1.10 A desktop review of the potential flood risk at each location is reviewed within the following sections using Ordnance Survey mapping, public sewer records, flood data from the Environment Agency (EA), and the Leicestershire Strategic Flood Risk Assessment (SFRA)[1] and Preliminary Flood Risk Assessment (PFRA)[2].

1.11 As the proposals are associated with improvements to existing infrastructure, the principle of a road, footway or new signage in each location does not need to be discussed. Instead, the review will identify the presence of a potential flood risk source and it will discuss the potential impact of the proposals on that flood risk source.

1.12 Where available, illustrative outlines of the proposed works are provided for context, although it should be noted that these are subject to change through design and development.

[1] Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (Leicestershire Local Planning Authorities and Leicester City Council (2017)
[2] Preliminary Flood Risk Assessment, Leicestershire County Council (2011))

2. B1: JUNCTION OF B581 STATION ROAD / NEW ROAD AND HINCKLEY ROAD, STONEY STANTON

Illustrative Junction Proposals

2.1 The existing mini-roundabout will be replaced by traffic lights with signalised crossings for pedestrians – this is illustrated within **Figure 2.1**. The proposed reconfiguration would predominantly fall within the existing highway land, but the potential flood risk at this location has been reviewed for completeness.

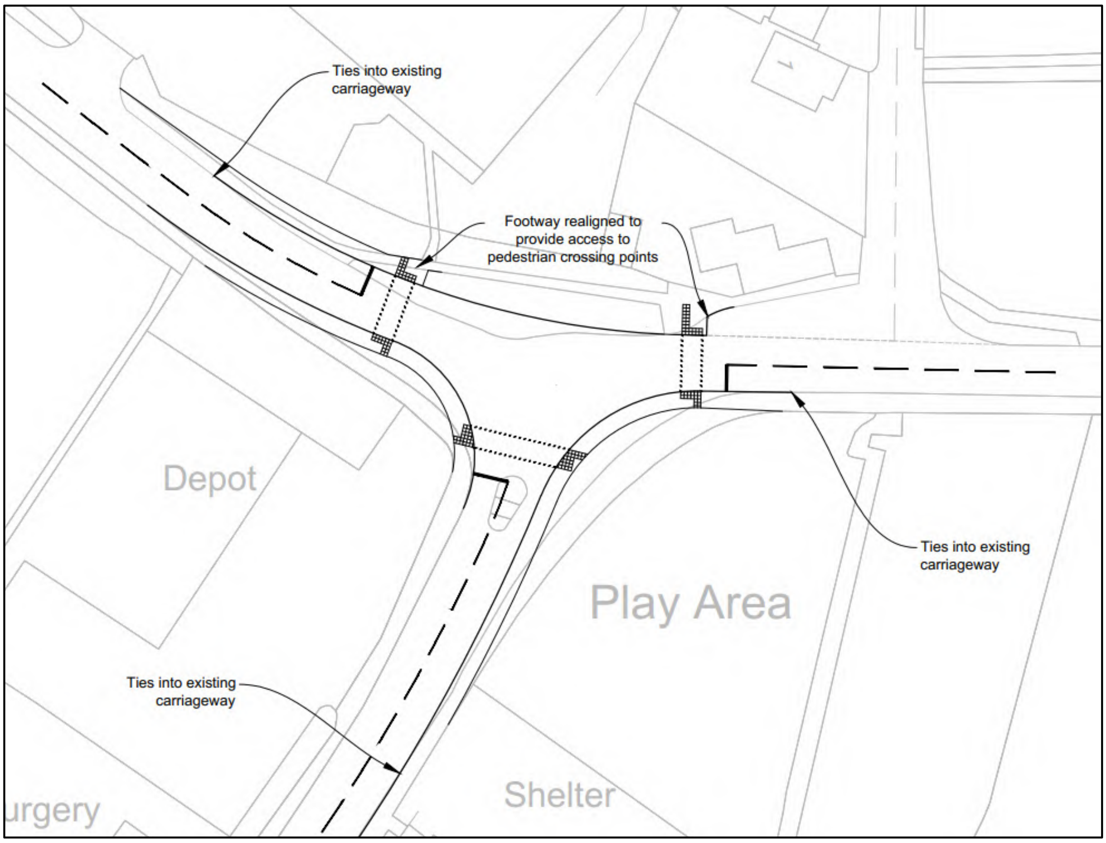


Figure 2.1: Illustrative Mitigation Proposals at B1

Historical Flooding Incidents

2.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

2.3 The junction sits entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 2.2**. Therefore, the proposed junction mitigation works could proceed without being affected or detrimentally affecting third party flood risk from this source.

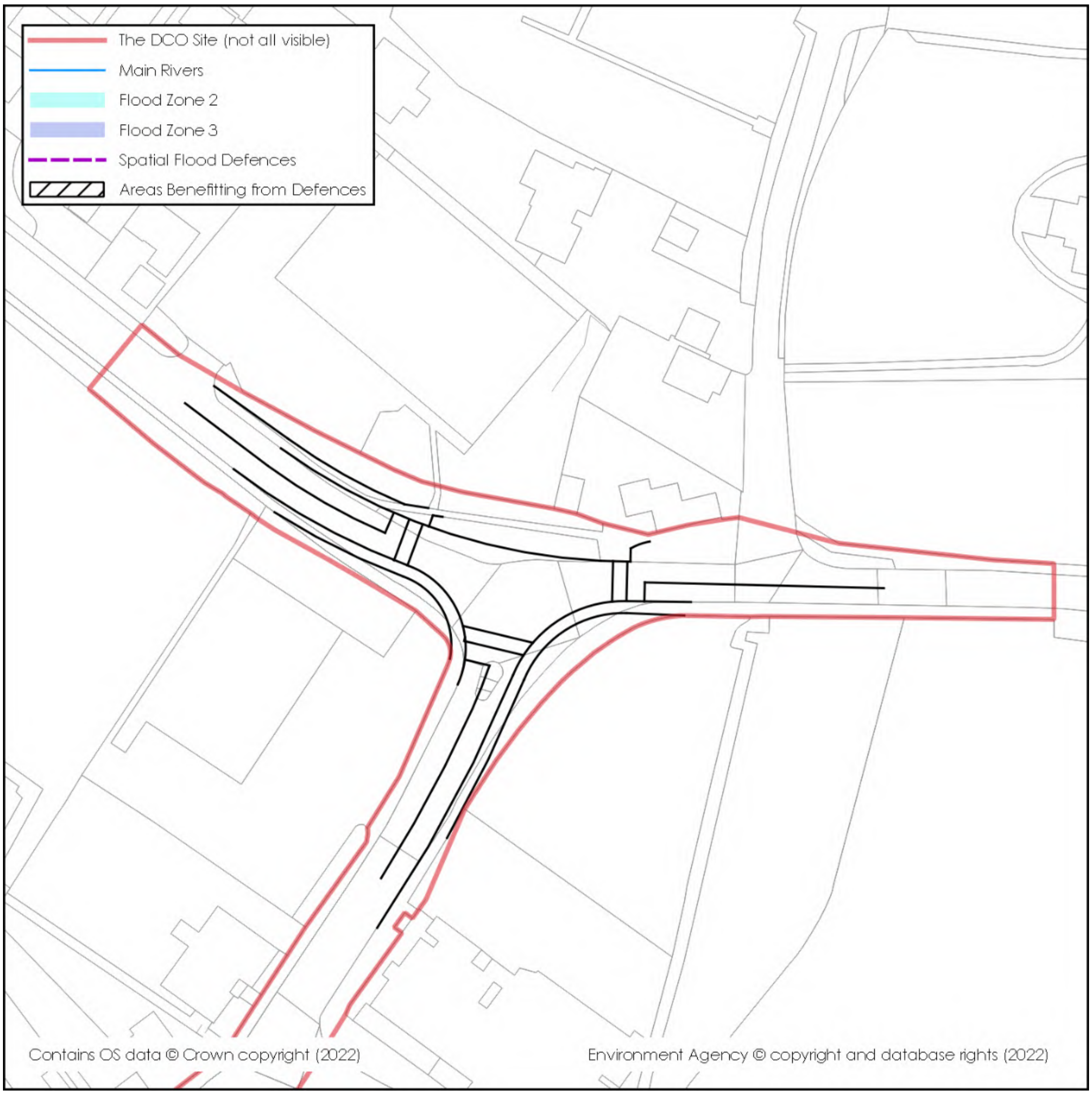


Figure 2.2 Fluvial Flood Risk Map, B1

Surface Water Flood Risk

2.4 The extent of the proposed works is shown to fall within an area of very low to low flood risk from surface water flooding, as shown in **Figure 2.3.** The extent of surface water flooding is generally restricted to the existing carriageway, the proposed works would not cross any significant overland flow routes.

2.5 Additionally, it is understood that the proposed works are likely to be undertaken at grade; therefore, the surface water floodplain and flood risk to third parties will not be significantly affected.

2.6 This minor flood risk is not a barrier to the proposed improvement works to the junction.

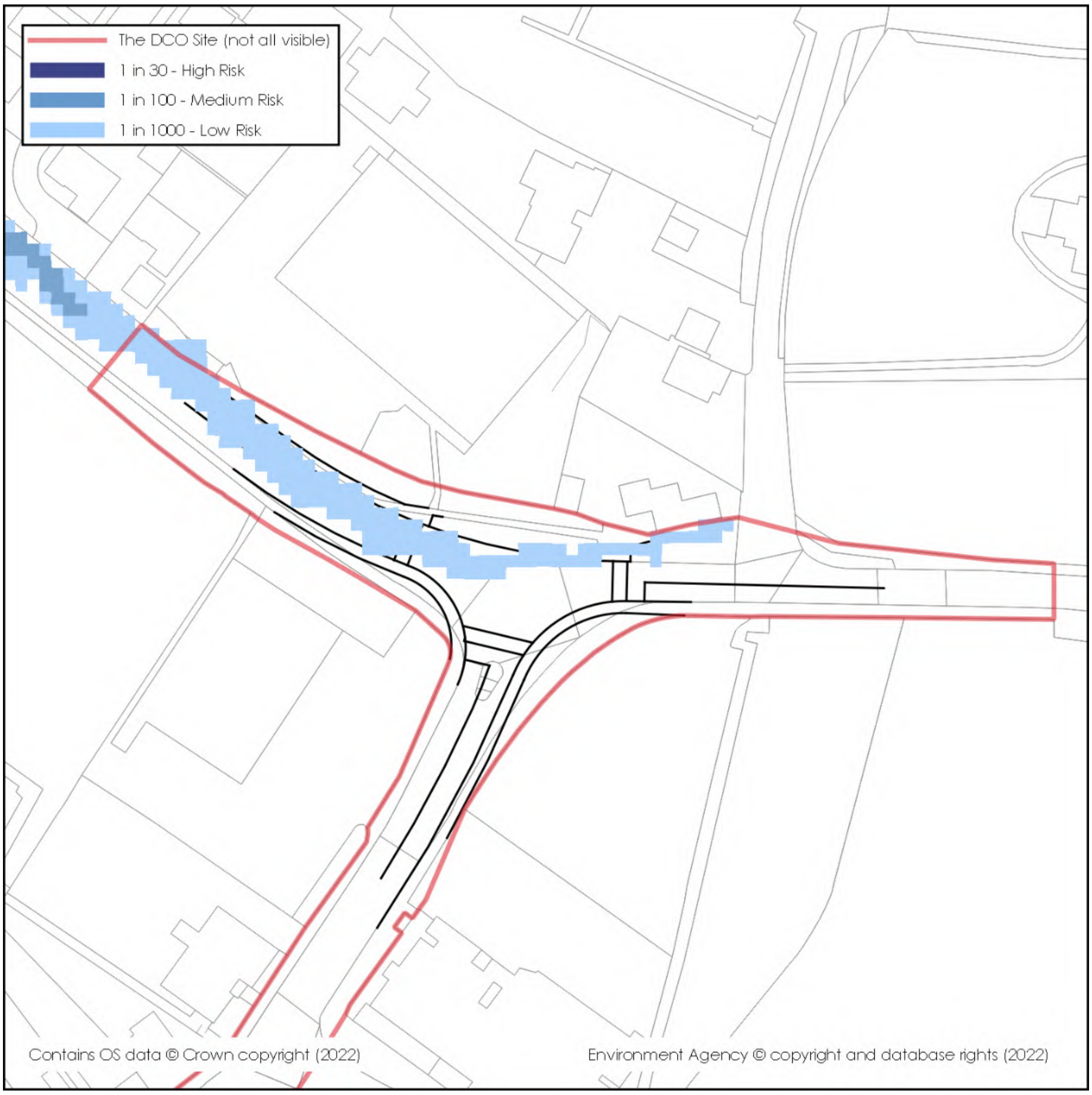


Figure 2.3 Surface Water Flood Risk, B1

Groundwater Flood Risk

2.7 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that <25% of the local area is potentially susceptible to groundwater flooding. Given the underlying geology, and that the junction is removed from watercourses and the floodplain, and it is not located in a topographical depression, the risk of groundwater flooding is considered to be low.

2.8 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

2.9 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

2.10 Reservoir flood risk mapping, prepared by the EA, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

2.11 Public sewer records identify a combined and surface water sewer present within the existing junction. These are likely to have a limited standard of design (1 in 20-year to 1 in 30-year). In the event of exceedance, surcharging flood water would likely be directed on to the highway. However, it is common for drainage infrastructure to fall within the highway and so this is considered an acceptable source of flood risk.

2.12 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

2.13 Overall, the risk of flooding from the reviewed sources at this junction are all considered to be at an acceptable level, therefore, they will not pose a barrier to the proposed works. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

3. B2: JUNCTION OF B4669 HINCKLEY ROAD AND STANTON LANE, WEST OF SAPCOTE

Illustrative Junction Proposals

3.1 A right turn lane will be introduced with traffic lights to allow pedestrians and cyclists to cross, this will require localised widening of the junction. This is illustrated within **Figure 3.1**.

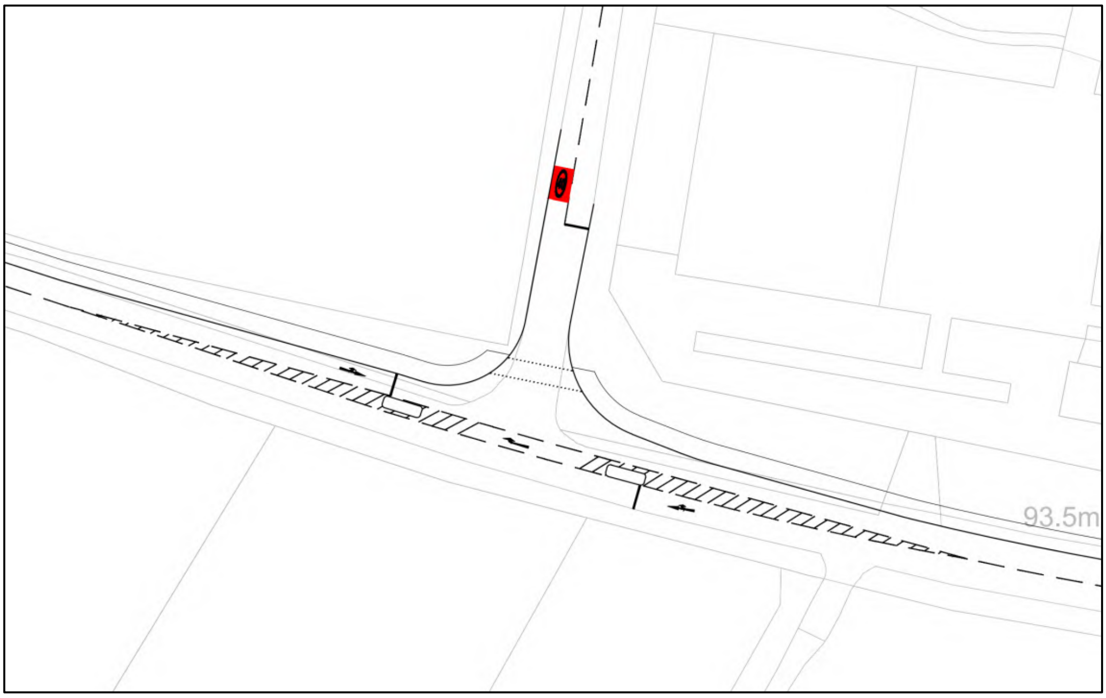


Figure 3.1: Illustrative Mitigation Proposals at B2

Historical Flooding Incidents

3.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

3.3 The junction sits entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 3.2**. Therefore, the proposed junction works could proceed without being affected or detrimentally affecting third party flood risk from this source.

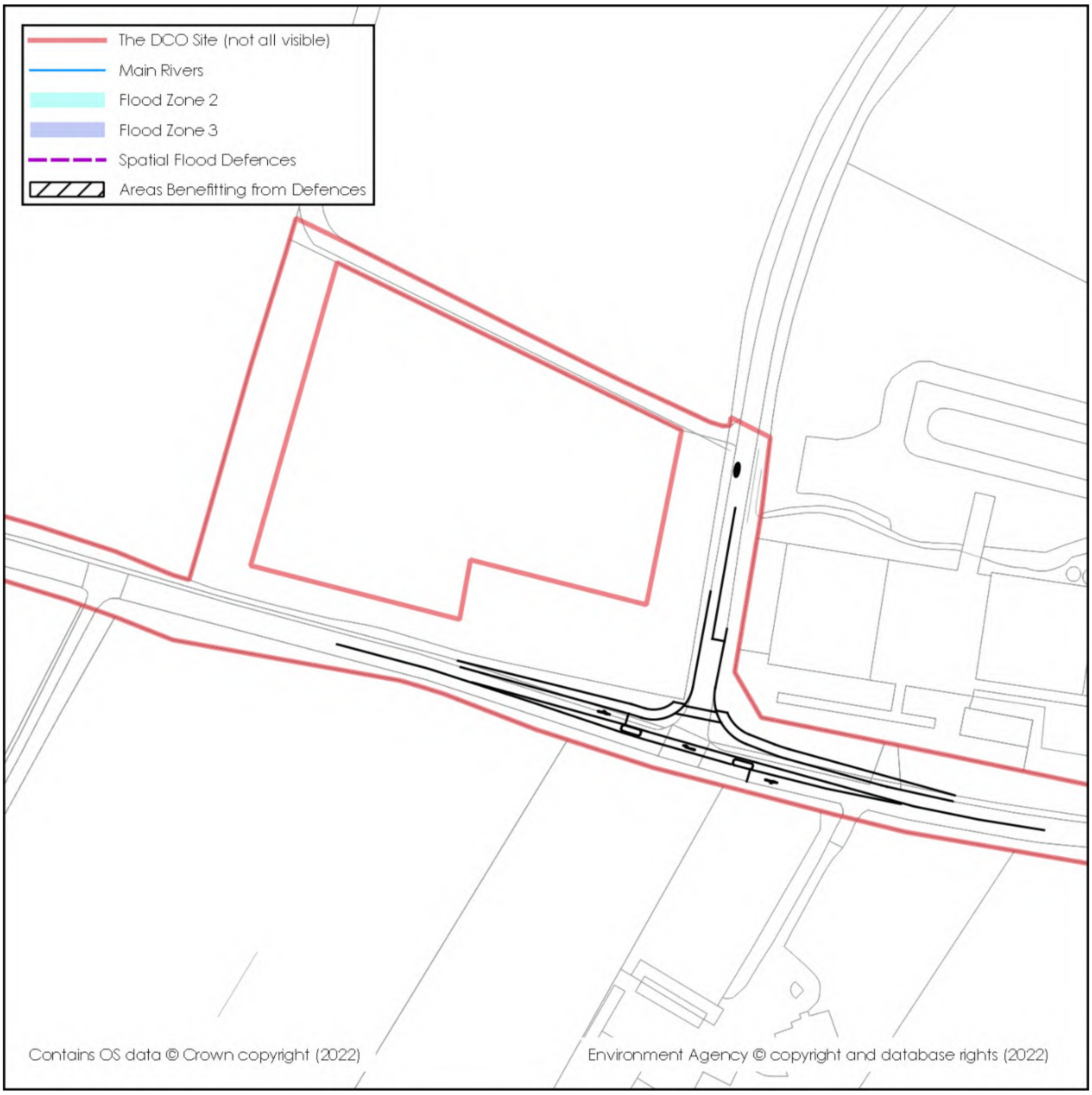


Figure 3.2 Fluvial Flood Risk Map, B2

Surface Water Flood Risk

3.4 The local site area falls within an area of high surface water flood risk associated with an ordinary watercourse located to the north. There is also an overland flow route passing over the road from south to north which introduces areas of moderate surface water flood risk to the local site, as shown in **Figure 3.3.** The SFRA suggests that this is also associated with an ordinary watercourse that is culverted beneath the road. The flood risk mapping does not appear to account for the presence of this culvert; therefore, the level of mapped flood risk is likely to be over-estimated.

3.5 The proposed junction reconfiguration (as shown in **Figure 3.1**) is located away from the ordinary watercourses and largely outside of the overland flow route, in an area of low to very low risk.

3.6 Additionally, it is understood that the proposed widening of the carriageway will largely be undertaken at grade, thereby minimising any potential changes to the existing topography and minimising any significant impact on existing flow routes. Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected.

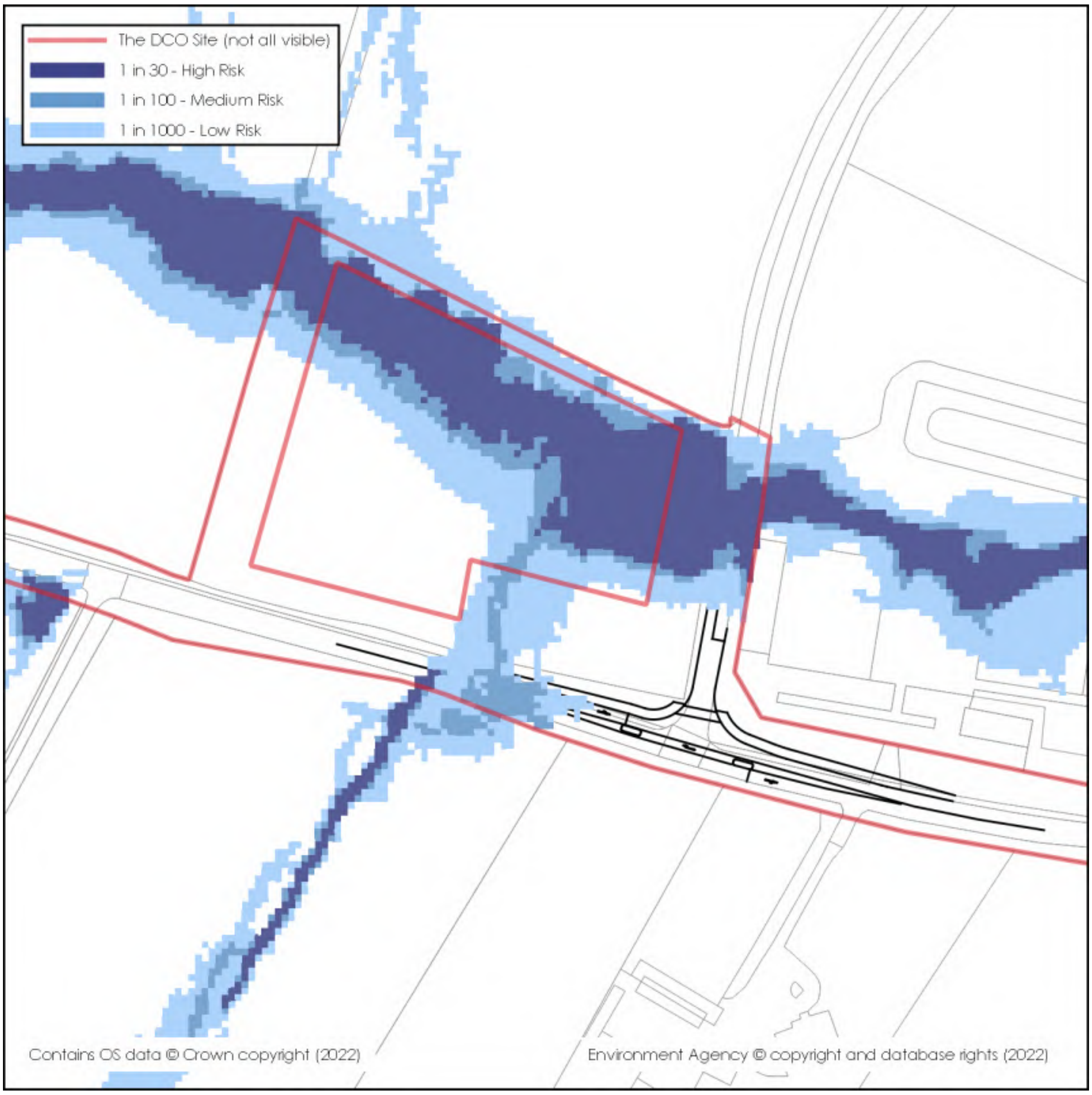


Figure 3.3 Surface Water Flood Risk, B2

Groundwater Flood Risk

3.7 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 50-75% of the local area is potentially susceptible to groundwater flooding. The potential susceptibility is likely to be due to the nearby ordinary watercourse and land drainage ditches.

3.8 Any groundwater emergence is likely to occur in the low-lying areas associated with the watercourse corridors rather than on the more elevated road network. Therefore, the risk of groundwater flooding is considered to be low.

3.9 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

3.10 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

3.11 Reservoir flood risk mapping, prepared by the EA, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

3.12 Public sewer records show no assets within the vicinity of the junction. However, the area is likely served by local highway drainage infrastructure.

3.13 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

3.14 Overall, the risk of flooding from the reviewed sources at this junction are all considered to be at an acceptable level, therefore, they will not pose a barrier to the proposed works. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

4. B3: STANTON LANE / HINCKLEY ROAD, SOUTH-WEST OF STONEY STANTON

Illustrative Proposals

4.1 The proposals to this stretch of highway, located between B1 and B2, include the reduction of the speed limit to 40mph from the national speed limit and traffic calming features within the existing highway. The length of works reviewed in this section are illustrated within **Figure 4.1**.

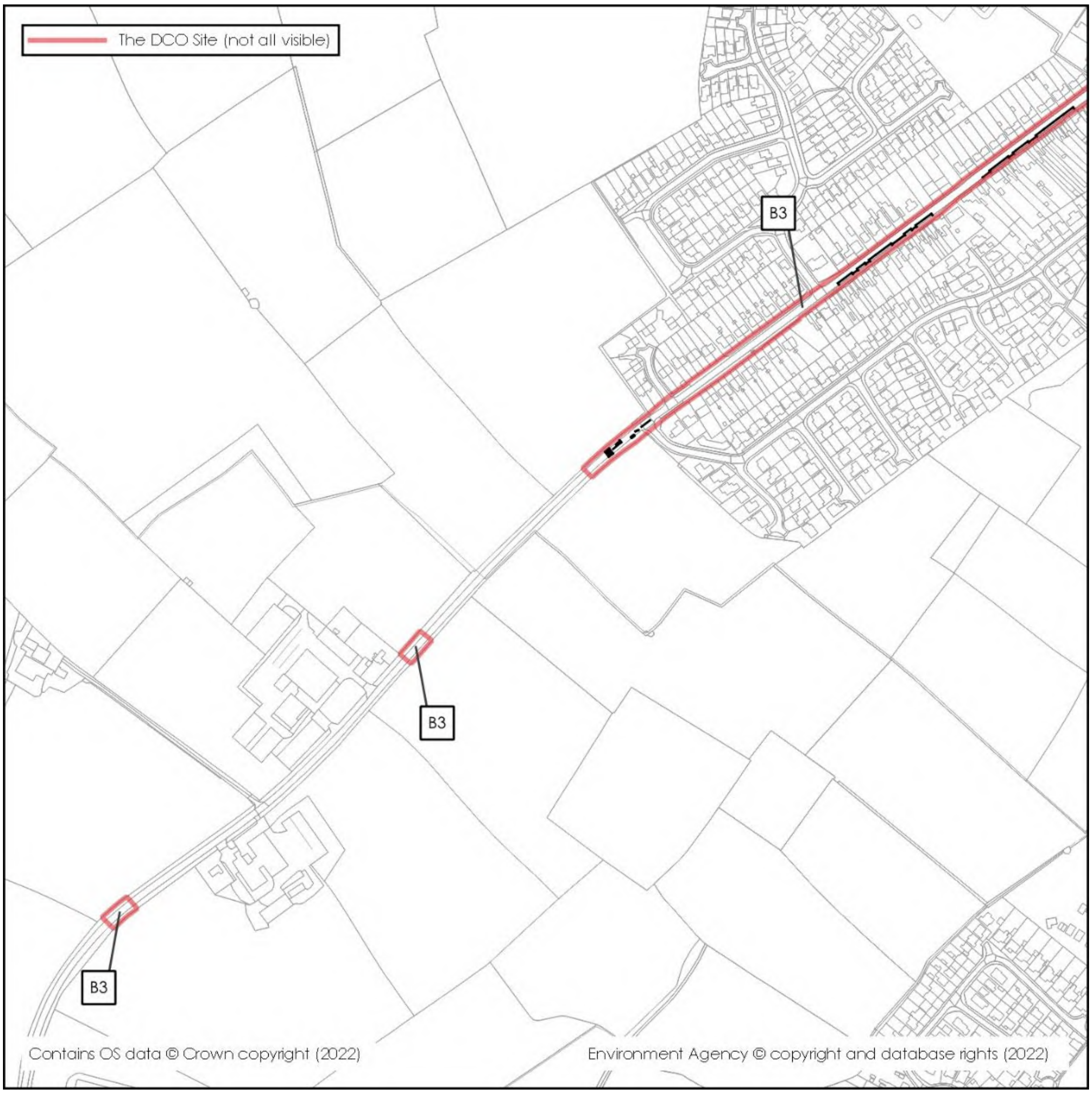


Figure 4.1: Illustrative Extent of Changes,B3

Historical Flooding Incidents

4.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected these areas. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected these areas.

Fluvial Flood Risk

4.3 These areas are located entirely within Flood Zone 1, land at a low probability of river flooding, as shown in **Figure 4.2.** Therefore, the proposed works could proceed without being affected or detrimentally affecting third party flood risk from this source.

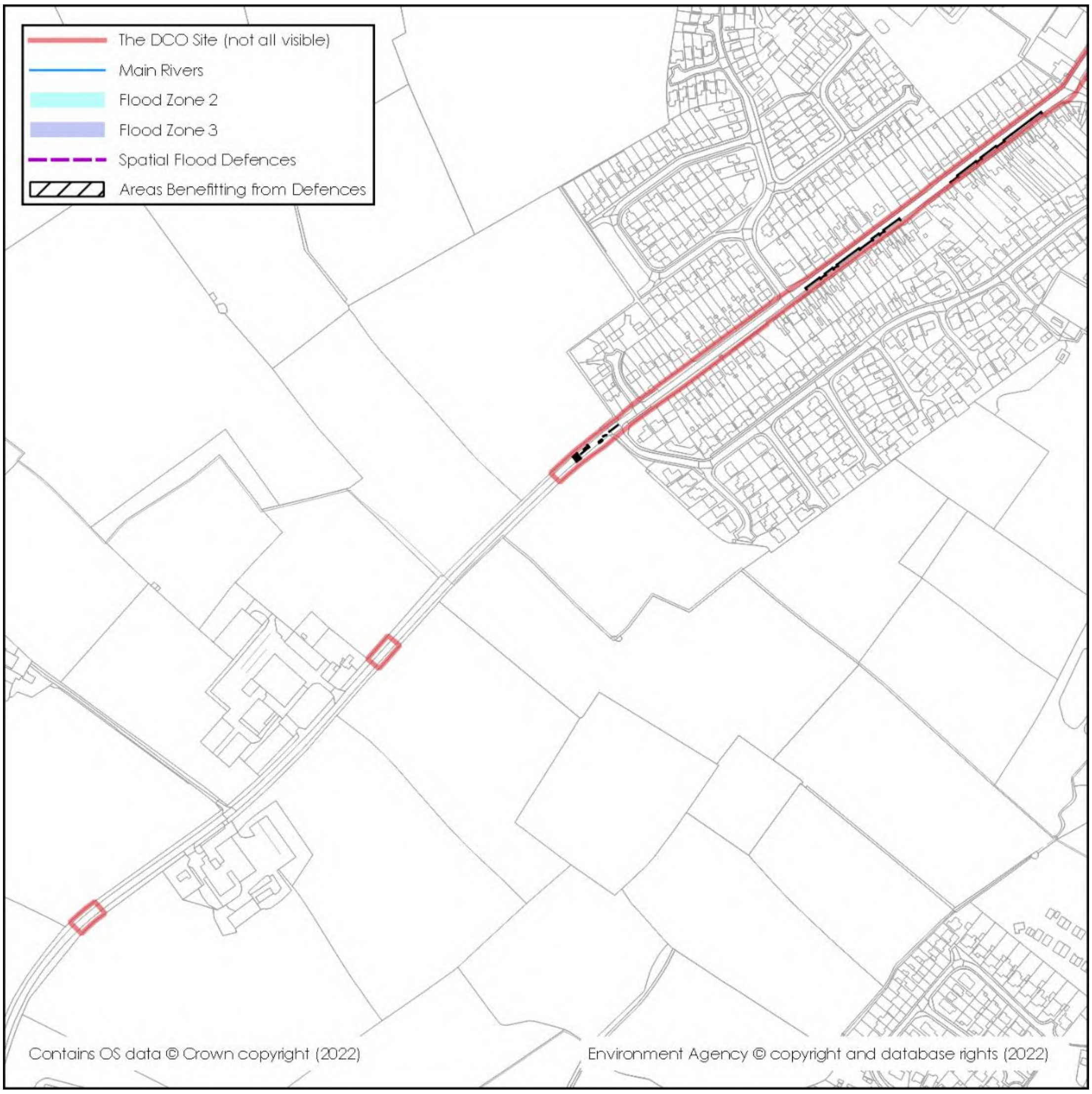


Figure 4.2 Fluvial Flood Risk, B3

Surface Water Flood Risk

4.4 These areas are at a low to very low risk of surface water flooding, as shown in **Figure 4.3.** Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected by the proposed minor works.

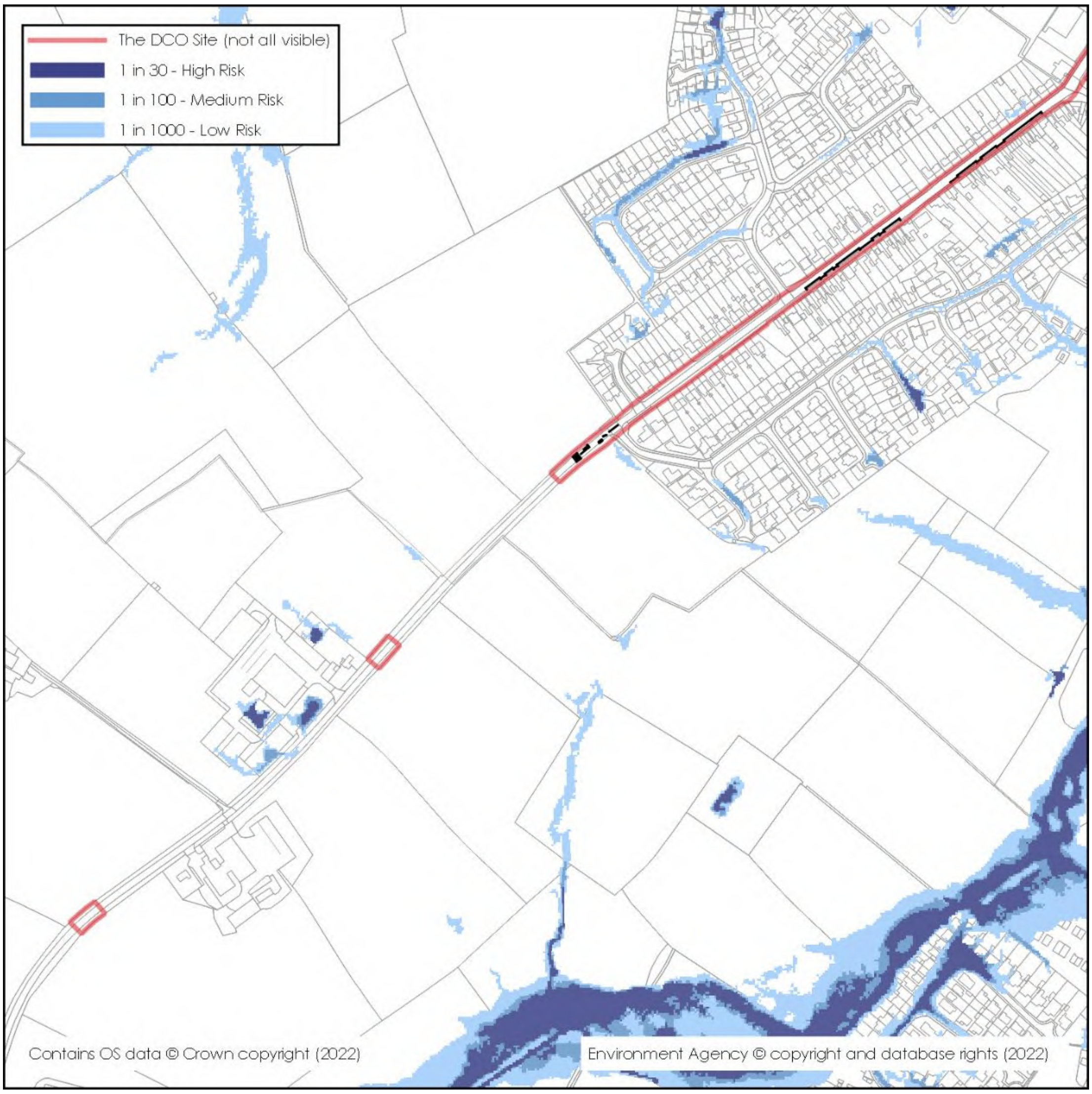


Figure 4.3 Surface Water Flood Risk, B3

Groundwater Flood Risk

4.5 British Geological Survey data identifies that the highway is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 25% of the local area is potentially susceptible to groundwater flooding.

4.6 Any groundwater emergence is likely to occur in the low-lying areas surrounding the road network. Therefore, the risk of groundwater flooding is considered to be low.

4.7 In any event, the relatively minor proposed works will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

4.8 There are no canals in a significant vicinity to this stretch of highway, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

4.9 Reservoir flood risk mapping, prepared by the EA, identifies that these areas are located a significant distance from any surrounding reservoirs and that they fall outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

4.10 Public records show that a combined sewer is present within this stretch of highway. This is likely to have a limited standard of design (1 in 20-year to 1 in 30-year). In the event of exceedance, surcharging flood water would likely be directed on to the highway. It is common for drainage infrastructure to fall within the highway and so this is considered an acceptable source of flood risk.

4.11 The traffic calming measures are not expected to introduce any new impermeable areas or affect the existing drainage infrastructure.

Summary

4.12 Overall, the risk of flooding from the reviewed sources on this highway are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

5. B4(i): B4669 HINCKLEY ROAD / LEICESTER ROAD, SAPCOTE (M69 TO B2)

Illustrative Proposals

5.1 The proposals to this stretch of highway include improvements to the to the existing footway. This are expected to be limited to resurfacing. The length of works reviewed in this section are illustrated within **Figure 5.1**.

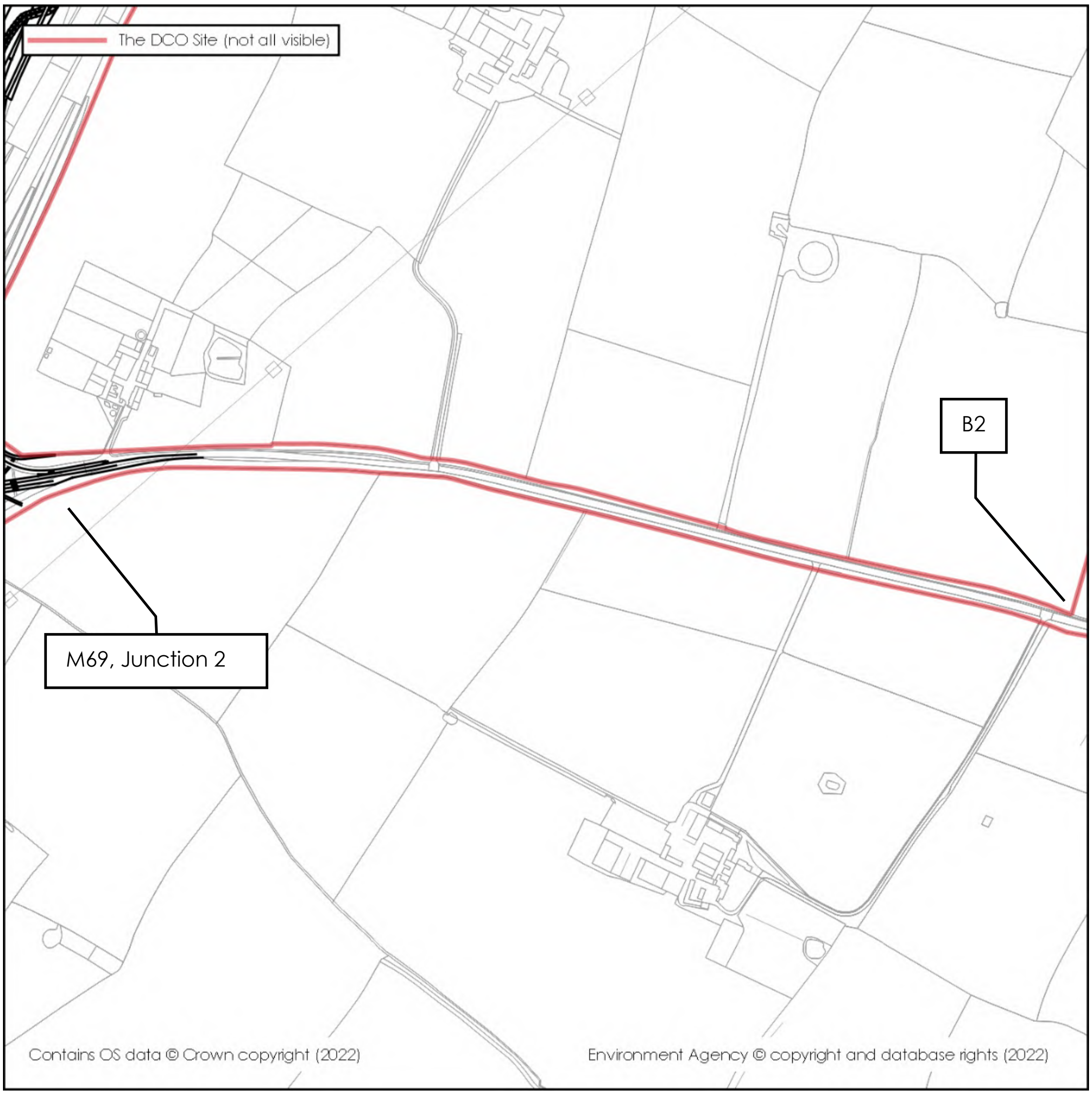


Figure 5.1: Illustrative Extent of Footpath Improvements at B4(i)

Historical Flooding Incidents

5.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this stretch of highway. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this stretch of highway.

Fluvial Flood Risk

5.3 This stretch of highway and footway are located entirely within Flood Zone 1, land at a low probability for river flooding, as shown in **Figure 5.2**. Therefore, the proposed footpath improvement works could proceed without being affected or detrimentally affecting third party flood risk from this source.

Figure 5.2 Fluvial Flood Risk, B4(i)

Surface Water Flood Risk

5.4 This stretch of the B4669 is generally at a low to very low risk of surface water flooding, as shown in **Figure 5.3.**

5.5 However, there is shown to be a localised area of high to medium risk, where surface water runoff is predicted to accumulate at a low point in the carriageway. The footway itself is unaffected by the accumulation of surface water in the carriageway. Therefore, the surface water floodplain is not expected to be significantly affected by the proposed improvements to the footway.

5.6 There is also shown to be on overland flow route which crosses this stretch of highway, which is associated with a minor watercourse or land drainage ditch. A site visit confirmed that this watercourse is culverted beneath the road here, which the surface water flood risk maps does not account for. Therefore, the mapped risk of flooding is likely to be over-estimated here.

5.7 Additionally, it is understood that the resurfacing will largely be undertaken at grade, thereby minimising any potential changes to the existing topography and minimising any significant impact on existing flow routes. Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected.

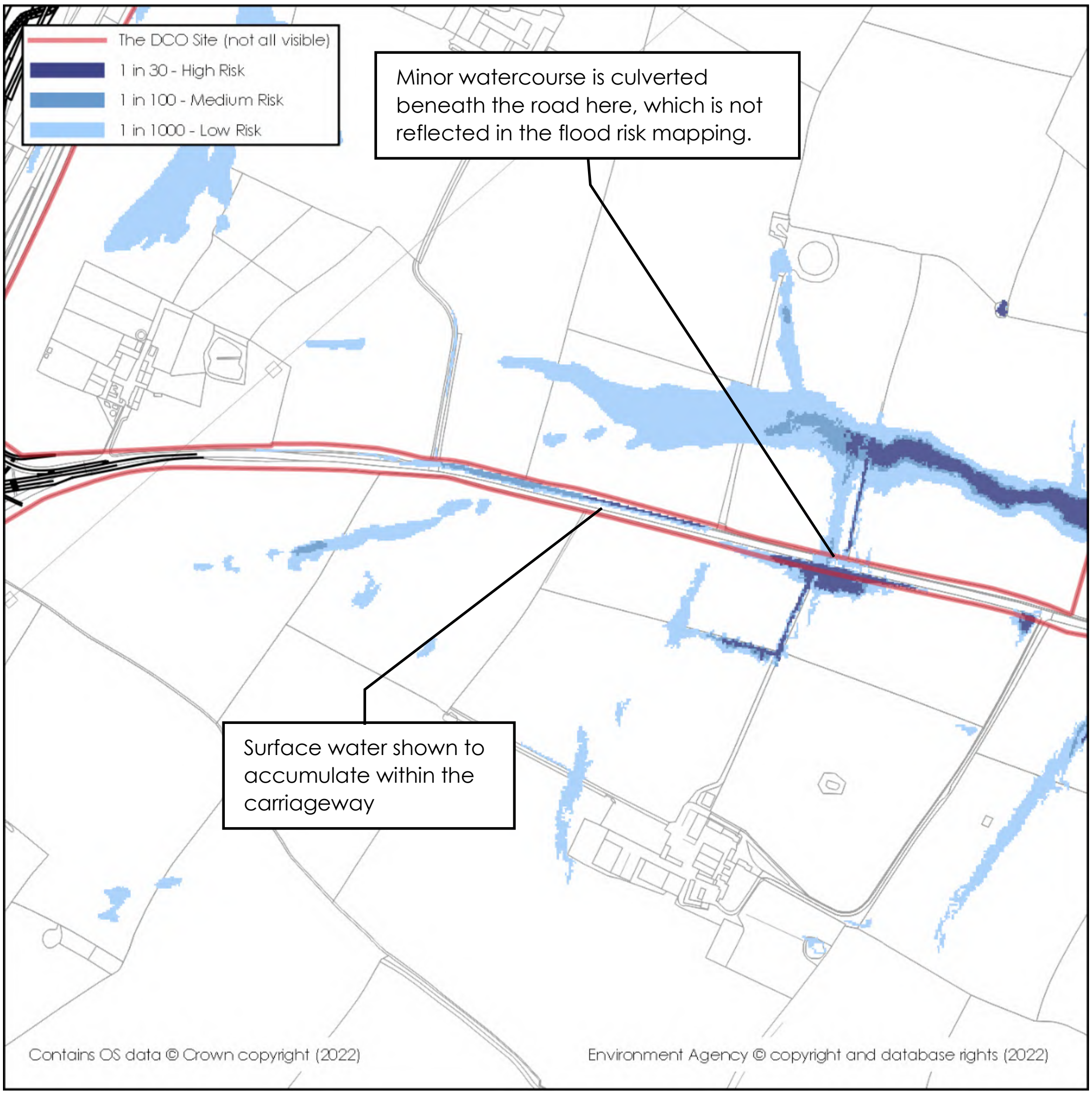


Figure 5.3 Surface Water Flood Risk, B4(i)

Groundwater Flood Risk

5.8 British Geological Survey data identifies that this stretch of highway is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 50-75% of the local area is potentially susceptible to groundwater flooding. The potential susceptibility is likely to be due to the nearby ordinary watercourse and land drainage ditches.

5.9 Any groundwater emergence is likely to occur in the low-lying areas associated with the watercourse corridors rather than on the more elevated road network. Therefore, the risk of groundwater flooding is considered to be low.

5.10 In any event, the relatively minor proposed works to the footway will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

5.11 There are no canals in a significant vicinity to this stretch of highway, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

5.12 Reservoir flood risk mapping, prepared by the EA, identifies that this stretch of highway is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

5.13 Public sewer records show no assets within the vicinity of this stretch of highway. However, the area is likely served by local highway drainage infrastructure.

5.14 The resurfacing is not expected to introduce any new impermeable areas or affect the existing drainage infrastructure.

Summary

5.15 Overall, the risk of flooding from the reviewed sources on this highway are all considered to be at an acceptable level. The proposed resurfacing is not expected to negatively affect any flood risk in the surrounding area.

6. B4–(II): B4669 HINCKLEY ROAD / LEICESTER ROAD, SAPCOTE (B2 TO SAPCOTE)

Proposals

6.1 The length of works reviewed in this section are illustrated within **Figure 6.1**.

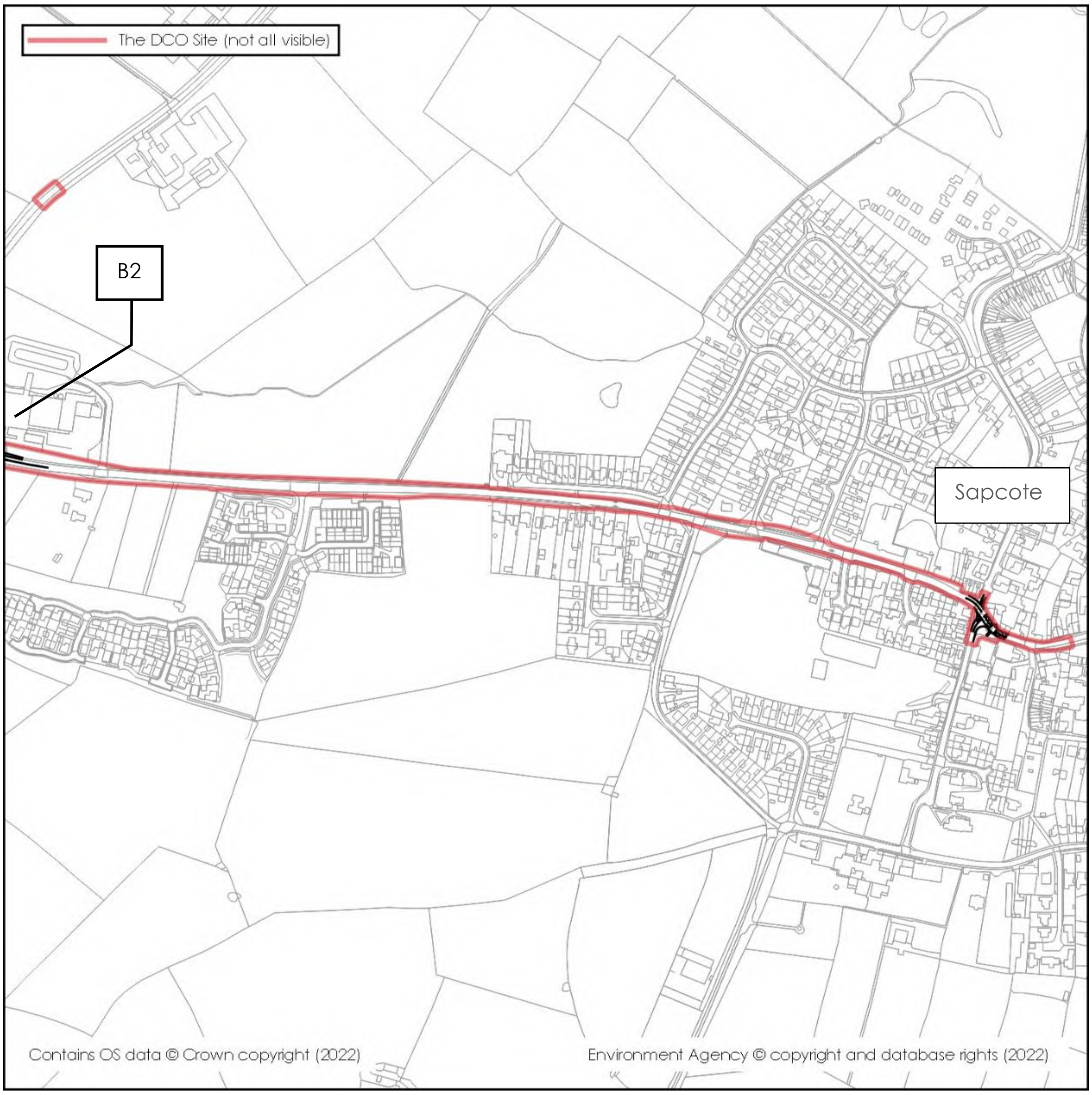


Figure 6.1: Illustrative Extent of Footpath Improvements at B4(ii)

6.2 While the Order Limits extend join with B2 to the west, much of the proposed works fall within Sapcote and include: a new pedestrian crossing; creation of cycle infrastructure and wider footways; public realm and junction improvements; and a bus stop relocation at junction of Church Street. This is illustrated within **Figure 6.2**.

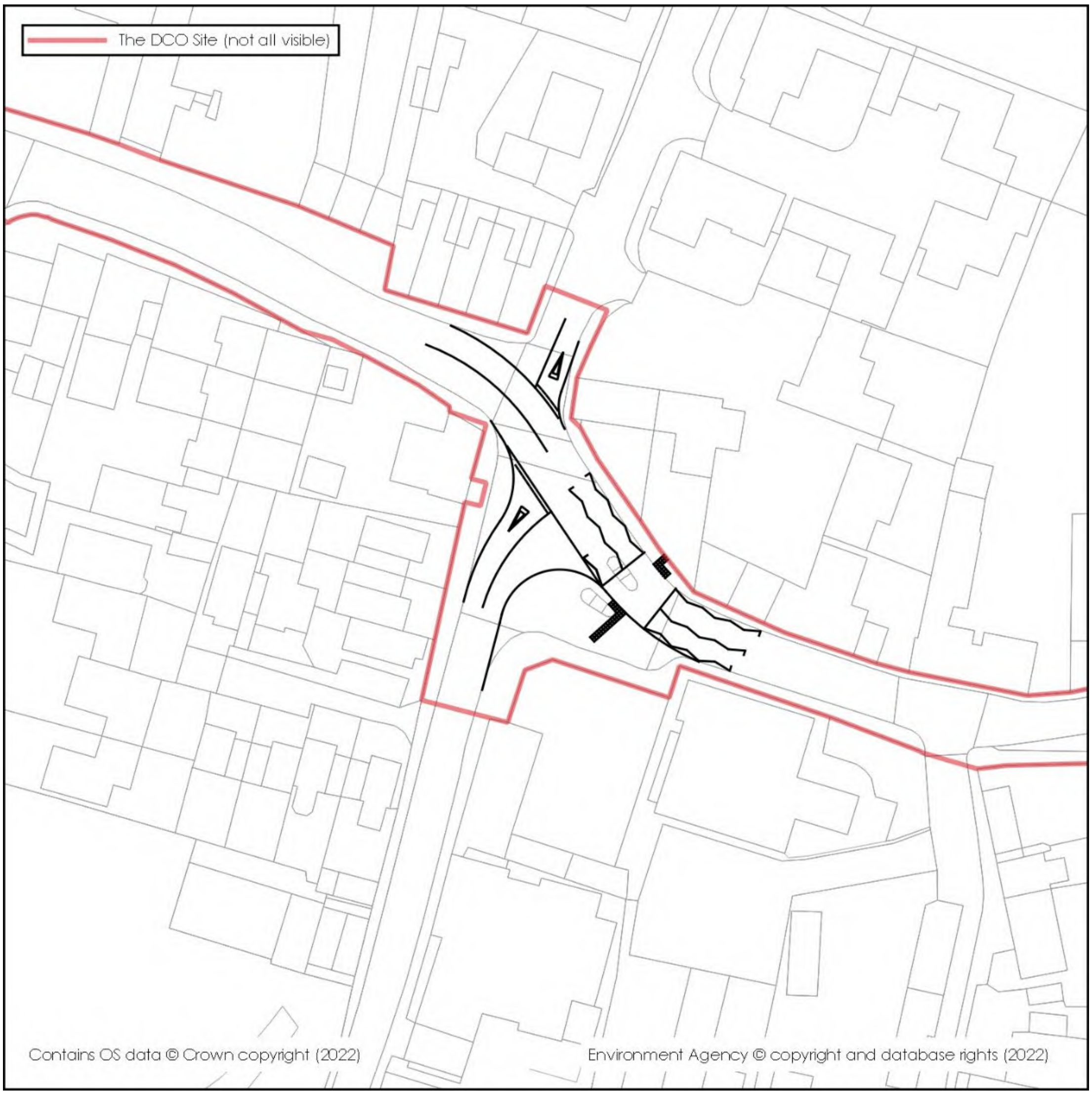


Figure 6.2: Proposed Improvements within Sapcote B4(ii)

Historical Flooding Incidents

6.3 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this stretch of highway. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this stretch of highway.

Fluvial Flood Risk

6.4 This stretch of highway is located entirely within Flood Zone 1, land at a low probability of river flooding, as shown in **Figure 6.3.** Therefore, the proposed improvements could proceed without being affected or detrimentally affecting third party flood risk from this source.

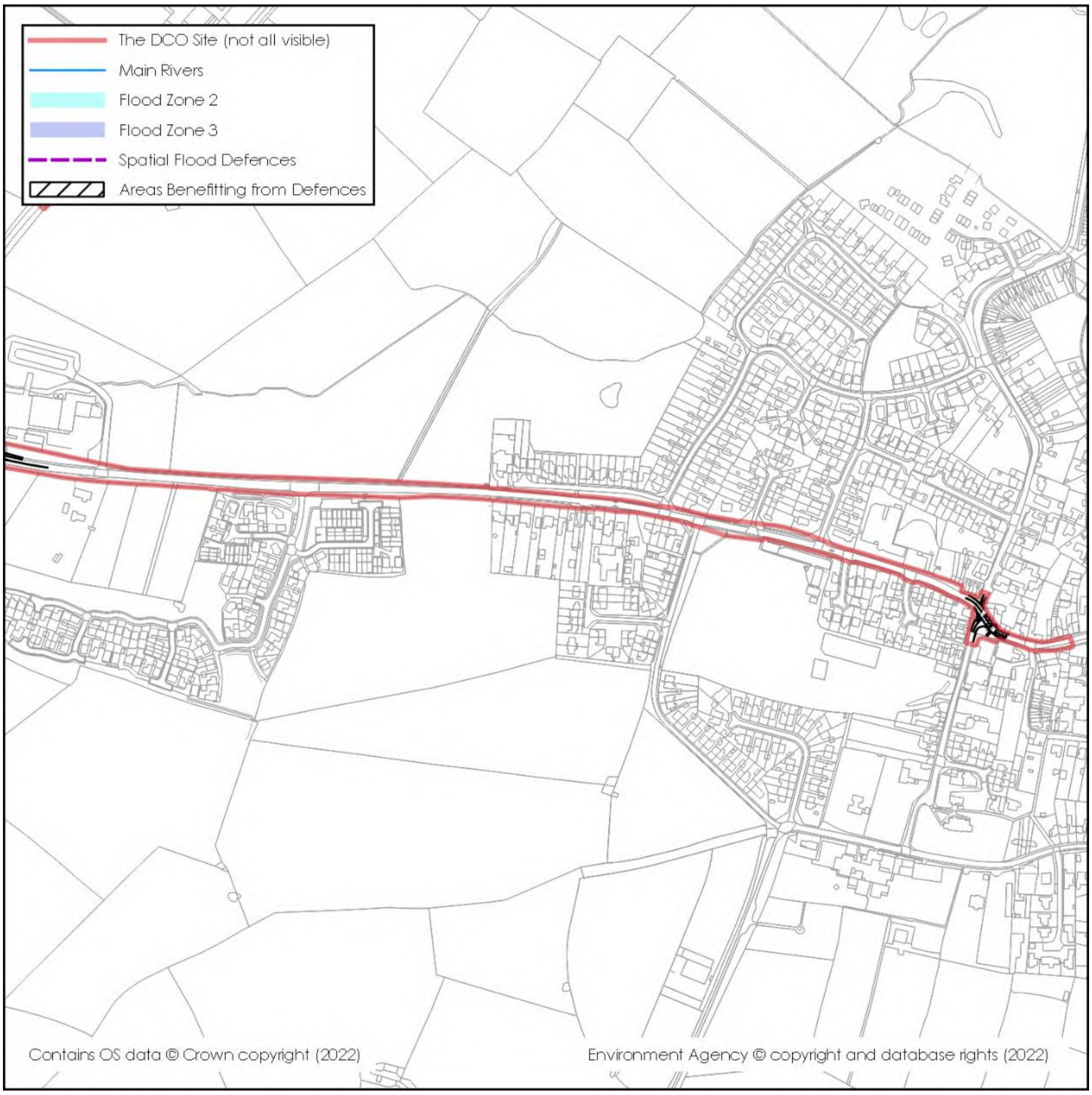


Figure 6.3 Fluvial Flood Risk, –B4(ii)

Surface Water Flood Risk

6.5 This stretch of the B4669 is generally at a low to very low risk of surface water flooding, as shown in **Figure 6.4.**

6.6 There is shown to be a localised area of high to medium risk, where surface water runoff is precited to accumulate in a low point on the carriageway and is contained by the footway. However, it is understood that no improvements are proposed in this area.

6.7 At the location of the proposed improvements in Sapcote, surface water flood risk is shown to be low to very low. This is shown within **Figure 6.5**. Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected by the proposals in this location.

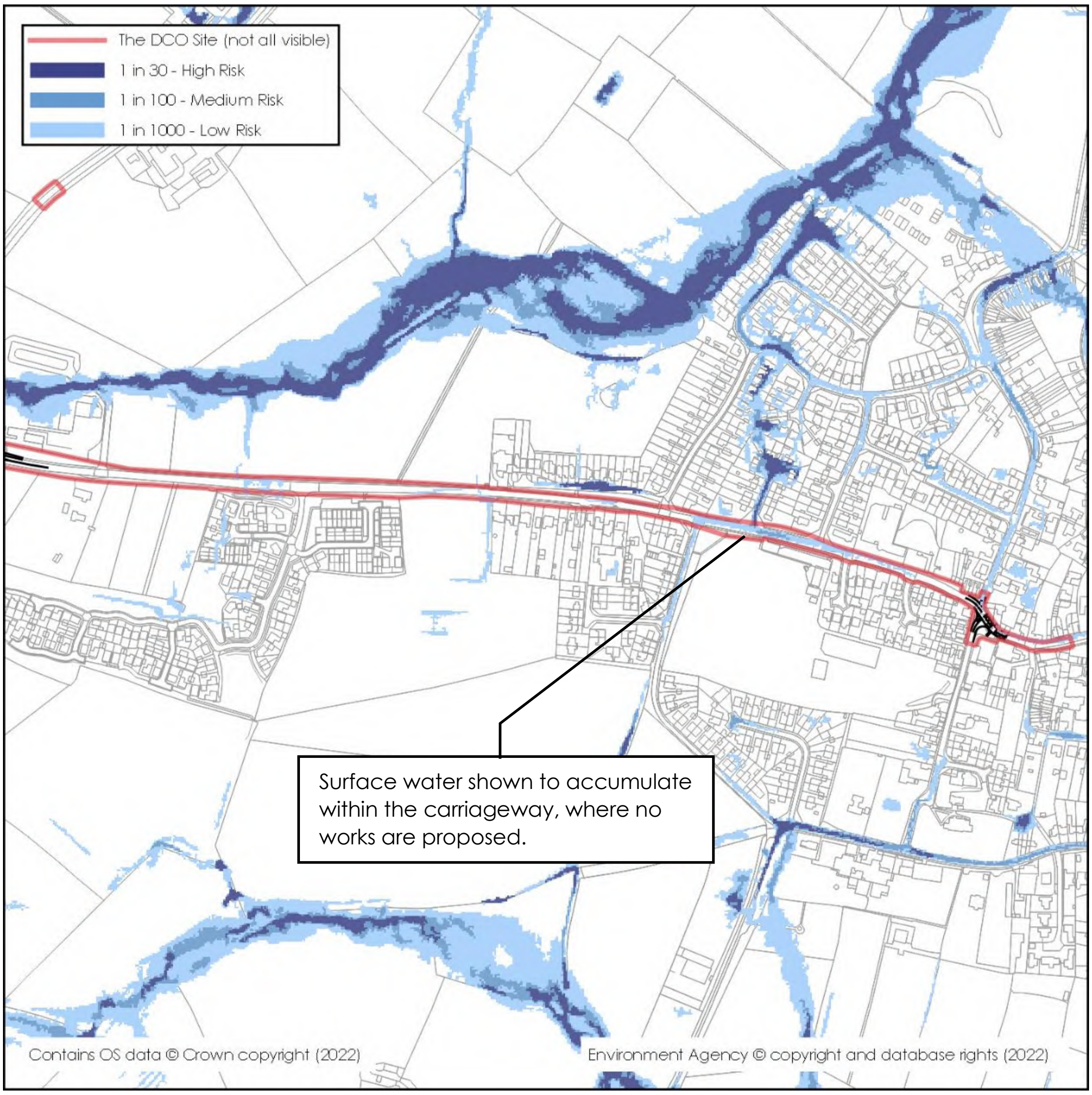


Figure 6.4 Surface Water Flood Risk, B4(ii)

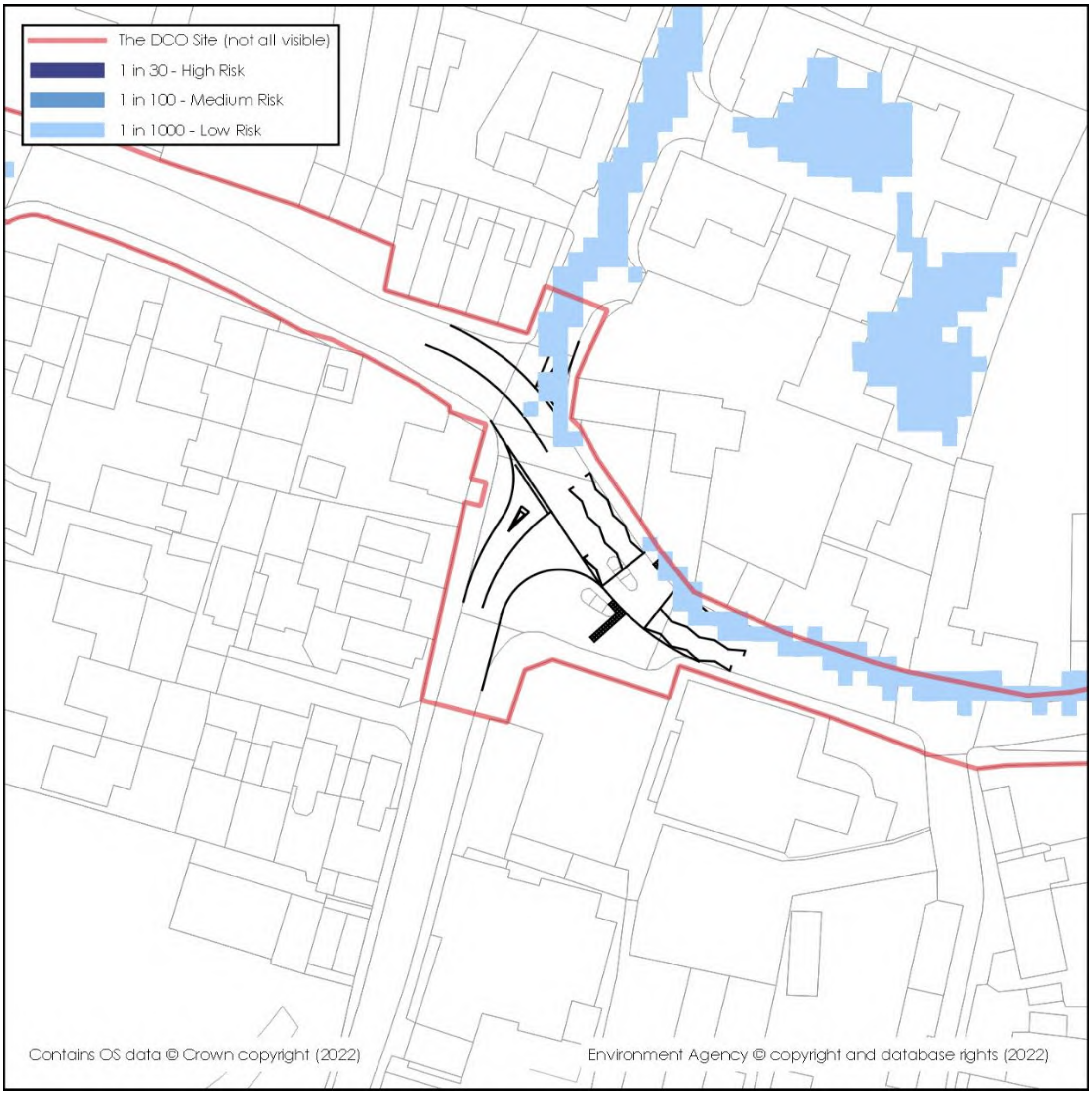


Figure 6.5: Surface Water Flood Risk, B4(ii) (view of Sapcote)

Groundwater Flood Risk

6.8 British Geological Survey data identifies that the highway is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 50-75% of the local area is potentially susceptible to groundwater flooding. The potential susceptibility is likely to be due to the nearby ordinary watercourse (located approximately 100m to the north).

6.9 Any groundwater emergence is likely to occur in the low-lying areas associated with the watercourse corridors rather than on the more elevated road network. Therefore, the risk of groundwater flooding is considered to be low.

6.10 In any event, the relatively minor proposed works to the existing highway will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

6.11 There are no canals in a significant vicinity to this stretch of highway, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

6.12 Reservoir flood risk mapping, prepared by the EA, identifies that this stretch of highway is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure Flood Risk

6.13 Public records show that a series of combined sewers are present within this stretch of highway. These are likely to have a limited standard of design (1 in 20-year to 1 in 30-year). In the event of exceedance, surcharging flood water would likely be directed on to the highway. It is common for drainage infrastructure to fall within the highway and so this is considered an acceptable source of flood risk.

6.14 The alterations to the highway may introduce additional impermeable areas that may need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

6.15 Overall, the risk of flooding from the reviewed sources on this highway are all considered to be at an acceptable level. The proposed improvements are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

7. B4(iii): B4669 HINCKLEY ROAD / LEICESTER ROAD, SAPCOTE (EAST OF SAPCOTE)

Illustrative Proposals

7.1 The proposals to this stretch of highway include traffic calming measures within the existing highway. The length of works reviewed in this section are illustrated within **Figure 7.1**.

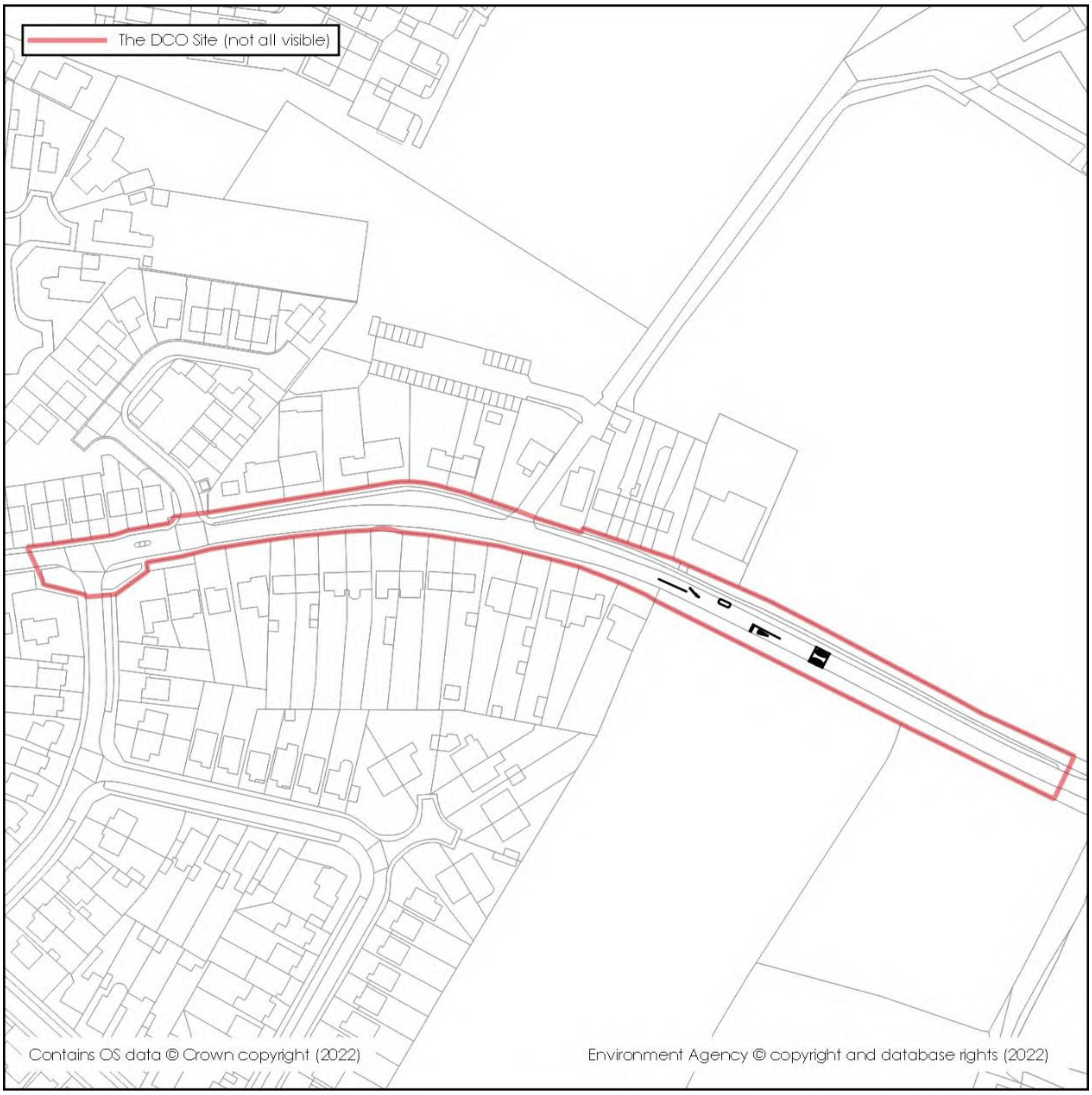


Figure 7.1: Illustrative Extent of Changes at –B4(iii)

Historical Flooding Incidents

7.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this stretch of highway. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this stretch of highway.

Fluvial Flood Risk

7.3 This stretch of highway is located entirely within Flood Zone 1, land at a low probability of river flooding, as shown in **Figure 7.2**. Therefore, the proposed works could proceed without being affected or detrimentally affecting third party flood risk from this source.

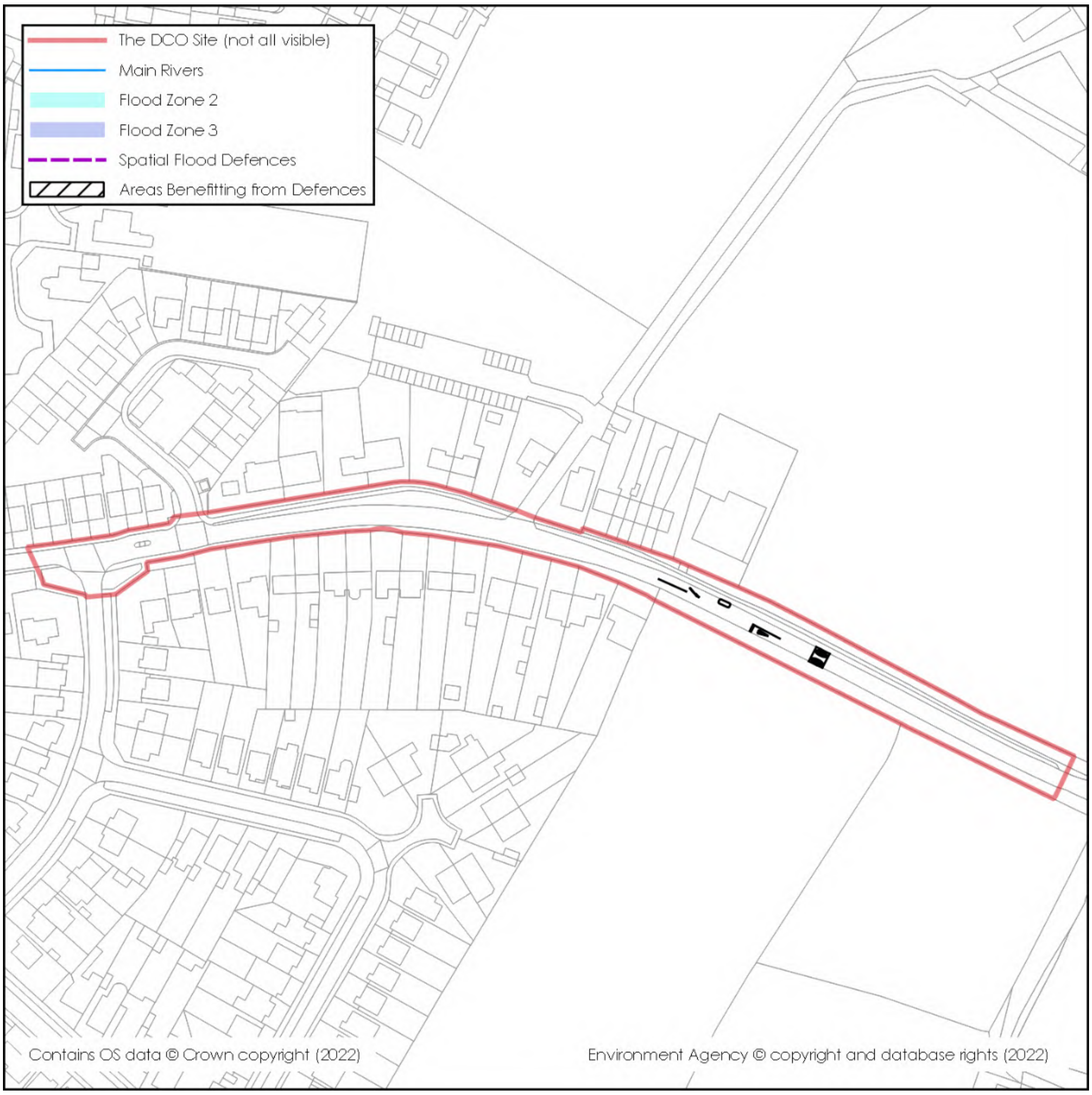


Figure 7.2 Fluvial Flood Risk, –B4(iii)

Surface Water Flood Risk

7.4 This stretch of the B4669 is generally at a low to very low risk of surface water flooding, as shown in **Figure 7.3**. Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected by the proposed minor works.

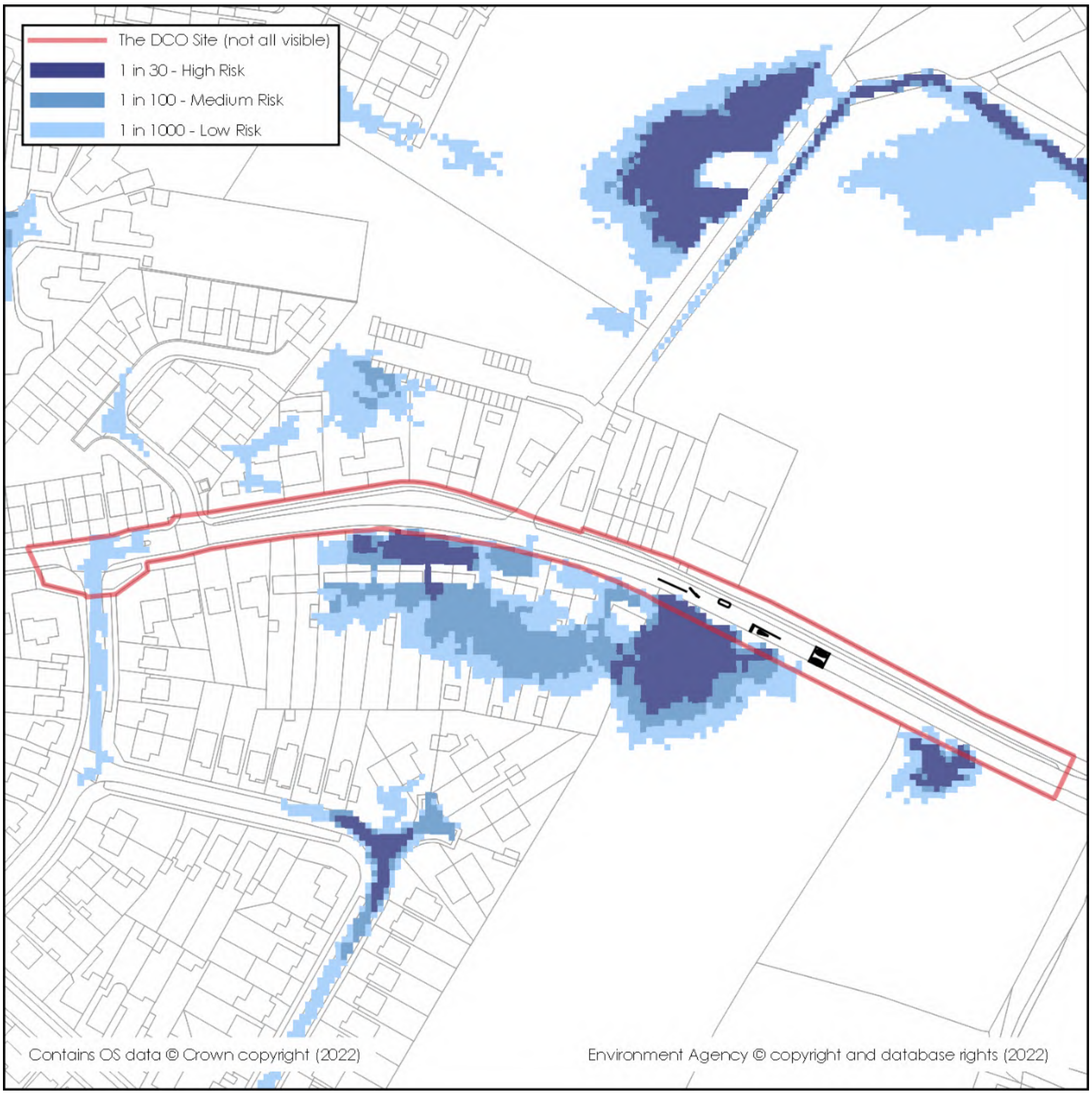


Figure 7.3 Surface Water Flood Risk, –B4(iii)

Groundwater Flood Risk

7.5 British Geological Survey data identifies that the highway is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 25% of the local area is potentially susceptible to groundwater flooding.

7.6 Any groundwater emergence is likely to occur in the low-lying areas surrounding the road network. Therefore, the risk of groundwater flooding is considered to be low.

7.7 In any event, the relatively minor proposed works will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

7.8 There are no canals in a significant vicinity to this stretch of highway, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

7.9 Reservoir flood risk mapping, prepared by the EA, identifies that this stretch of highway is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

7.10 Public records show that a combined sewer is present within this stretch of highway. This is likely to have a limited standard of design (1 in 20-year to 1 in 30-year). In the event of exceedance, surcharging flood water would likely be directed on to the highway. It is common for drainage infrastructure to fall within the highway and so this is considered an acceptable source of flood risk.

7.11 The traffic calming measures are not expected to introduce any new impermeable areas or affect the existing drainage infrastructure.

Summary

7.12 Overall, the risk of flooding from the reviewed sources on this highway are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

8. B5: JUNCTION OF B4114 COVENTRY ROAD AND B581 BROUGHTON ROAD AT SOAR MILL, SOUTH-EAST OF STONEY STANTON

Illustrative Junction Proposals

8.1 Wider improvement works to this junction (to the north east of the junction on the B4114) have already been agreed under a Section 278 as part of a sperate scheme. However, it is expected that some additional works will be required to accommodate the HNSRFI development. This includes widening of the carriageway on the northbound approach to the B4114 Coventry Road and on the B581 Broughton Road to provide additional capacity for left-turning traffic on both arms. The left turn on Broughton Road will be provided as separately signalised phase to enable it to run at the same time as the right turn into Broughton Road from Coventry Road to improve the efficiency of the junction. This is illustrated within **Figure 8.1**.

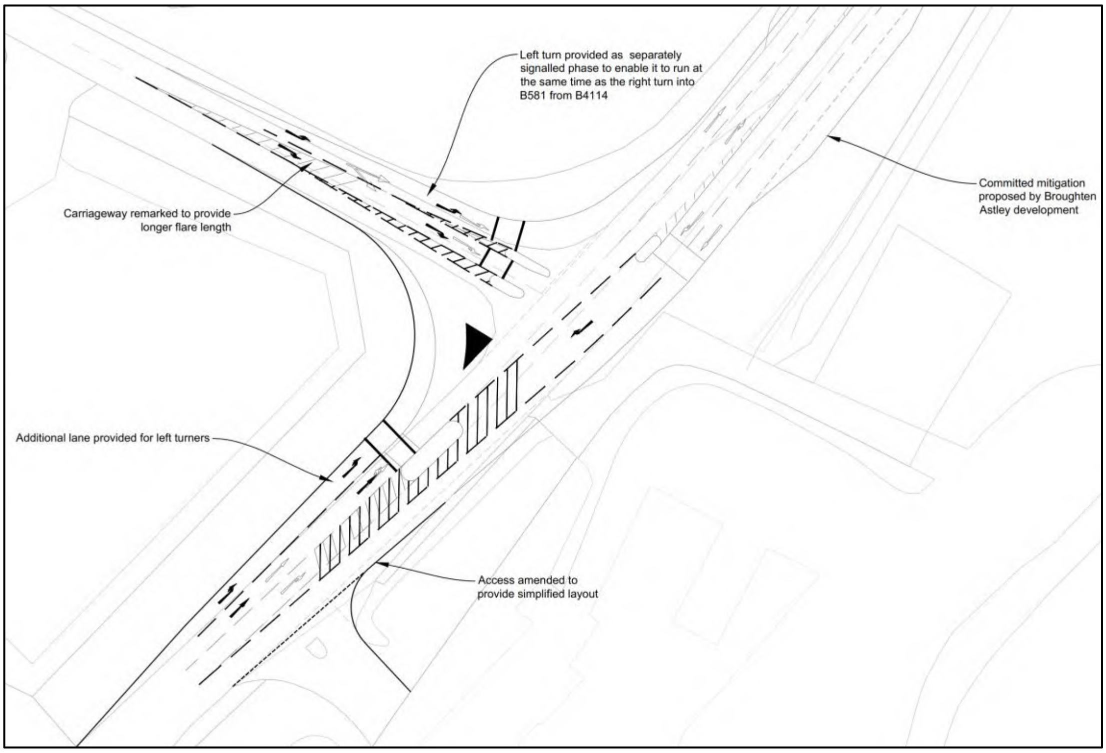


Figure 8.1: Illustrative Mitigation Proposals at B5

Historical Flooding Incidents

8.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

8.3 The local site is located next to the River Soar, and the Order Limits fall partially within Flood Zone 3 and Flood Zone 2 – land at a high and medium probability of fluvial flooding respectively. However, the proposed junction improvement works illustrated within **Figure 8.1** sit entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 8.2**. Therefore, the proposed junction works could proceed without being affected or detrimentally affecting third party flood risk from this source.

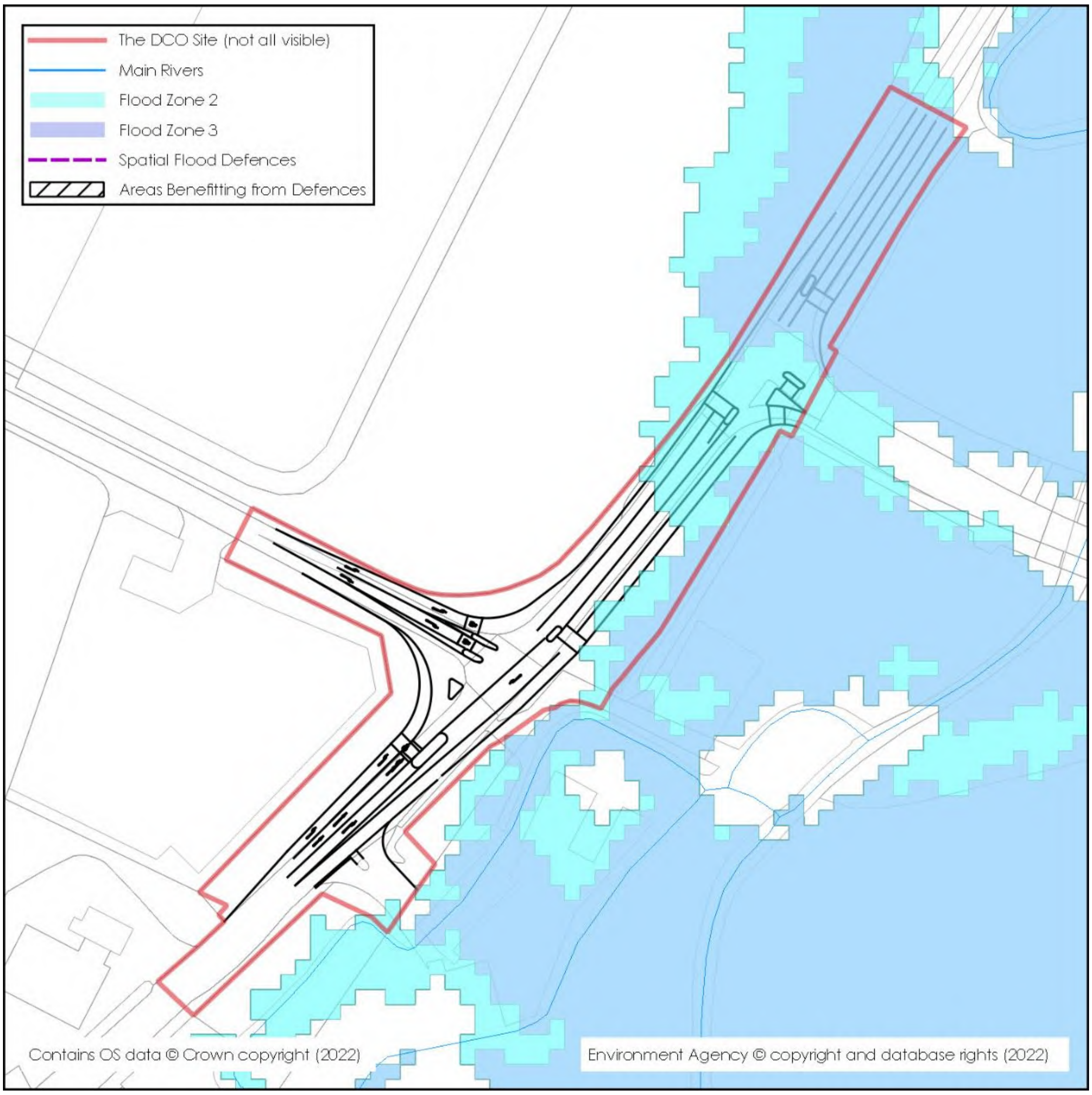


Figure 8.2 Fluvial Flood Risk Map, B5

Surface Water Flood Risk

8.4 The extent of the proposed works illustrated within **Figure 8.1** are shown to fall within an area at very low to low flood risk from surface water flooding. This is shown in **Figure 8.3.** The extent of surface water flooding is generally restricted to the existing carriageway and the proposed works would not cross any significant overland flow routes.

8.5 The proposed works are likely to be undertaken at grade; therefore, the surface water floodplain and flood risk to third parties will not be significantly affected.

8.6 This minor flood risk is not a barrier to the proposed improvement works to the junction.

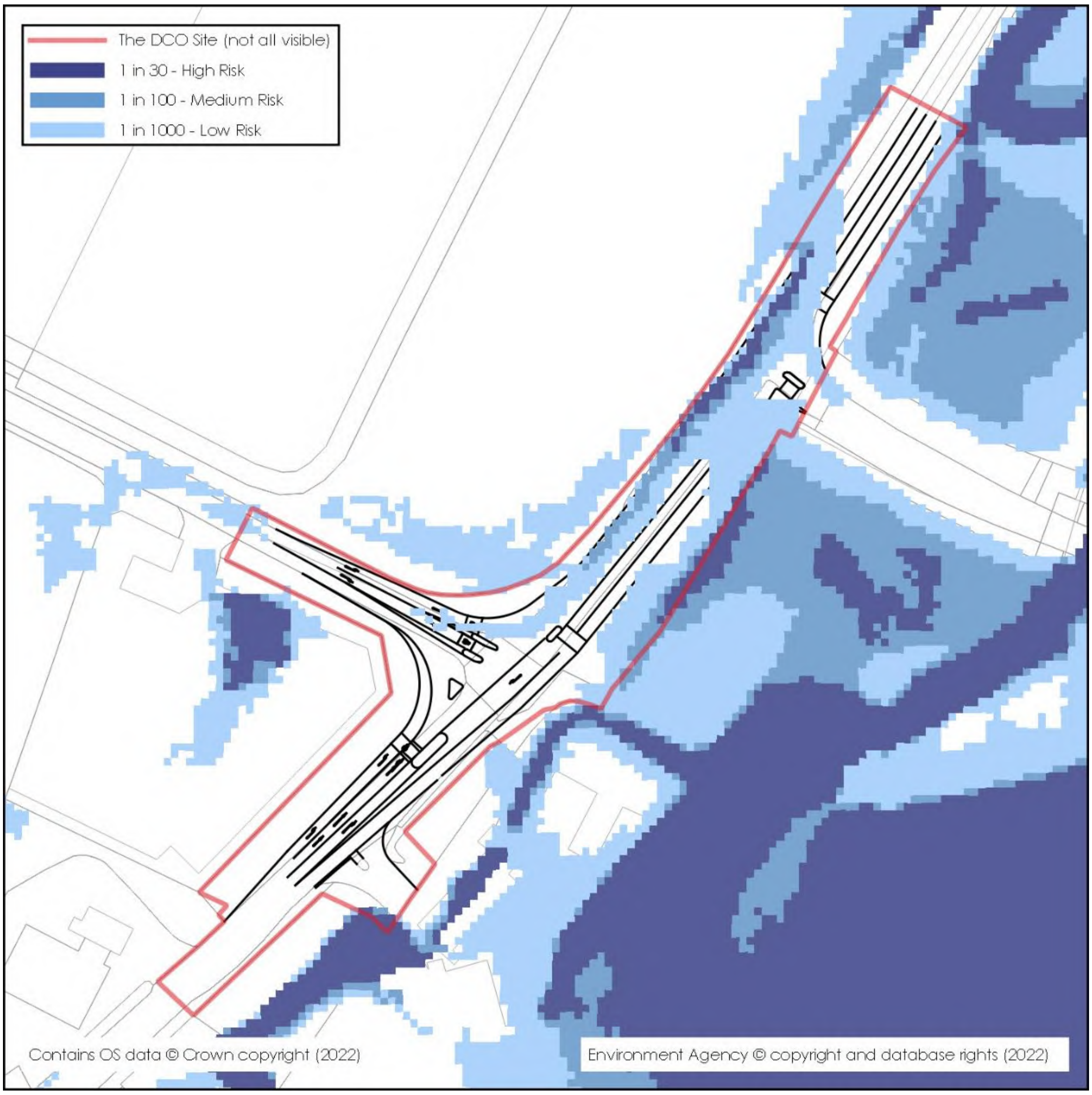


Figure 8.3 Surface Water Flood Risk, Junction 21a

Groundwater Flood Risk

8.7 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with river terrace superficial deposits. The SFRA identifies that 50-75% of the local area is potentially susceptible to groundwater flooding. The potential susceptibility is likely to be due to the nearby river floodplain.

8.8 Any groundwater emergence is likely to occur in the low-lying areas associated with the river floodplain, rather than on the more elevated road network. Therefore, the risk of groundwater flooding is considered to be low.

8.9 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

8.10 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

8.11 Reservoir flood risk mapping, prepared by the EA, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

8.12 Public sewer records show no assets within the vicinity of the junction. However, the area is likely served by local highway drainage infrastructure.

8.13 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

8.14 Overall, the risk of flooding from the reviewed sources at this junction are all considered to be at an acceptable level, therefore, they will not pose a barrier to the proposed works. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

9. B6: JUNCTION OF B4114 COVENTRY ROAD AND CROFT ROAD, SOUTHWEST OF NARBOROUGH

Illustrative Junction Proposals

9.1 Lane widening on the junction approaches are proposed. . This is illustrated within **Figure 9.1**.

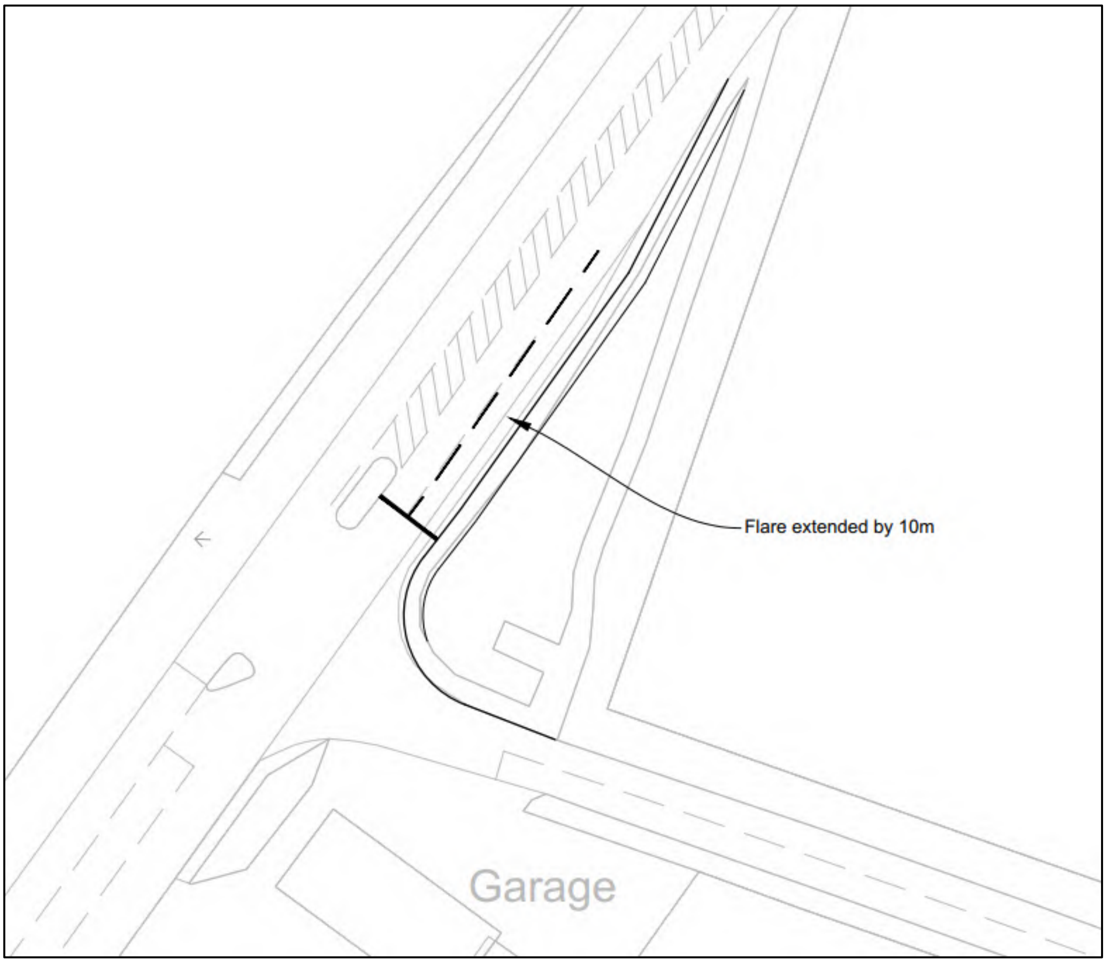


Figure 9.1: Illustrative Mitigation Proposals at B6

Historical Flooding Incidents

9.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

9.3 The junction is located entirely within Flood Zones 2 and 3, land at a moderate and high probability of flooding respectively, as shown in **Figure 9.2**. The Flood Zone classification is associated with the River Soar and the Broughton Astley Brook. The SFRA confirms that the junction does not fall within Flood Zone 3b (the functional floodplain).

9.4 While the flood risk on the junction is high, the proposed widening of the carriageway is relatively minor and it is expected that it will largely be undertaken at grade, thereby minimising any potential changes to the existing topography and minimising any significant impact on existing flow routes. Therefore, the fluvial floodplain and flood risk to third parties are not expected to be significantly affected.

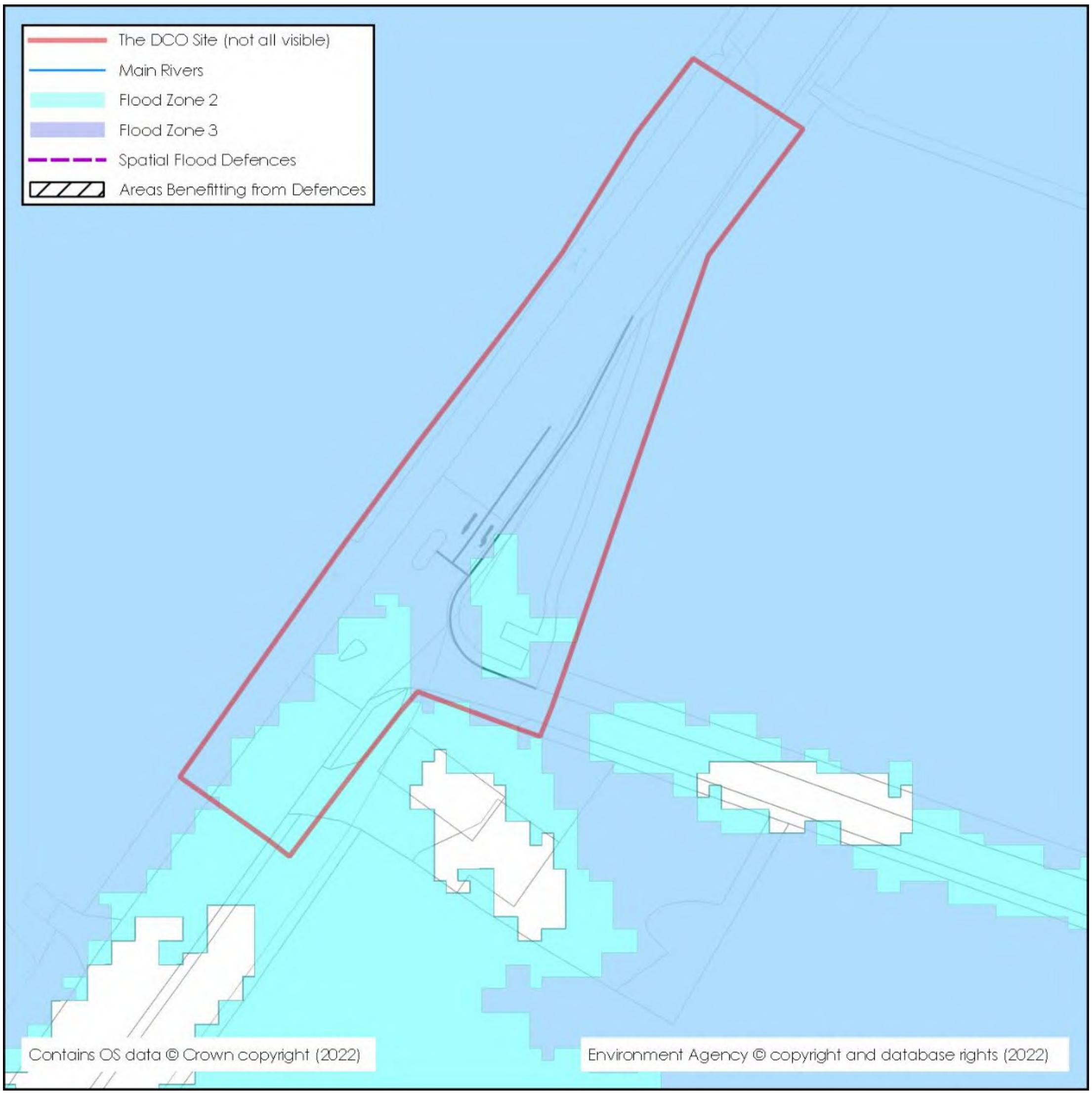


Figure 9.2 Fluvial Flood Risk, B6

Surface Water Flood Risk

9.5 The extent of the proposed works is shown to fall within an area at very low flood risk from surface water flooding; this is shown in **Figure 9.3.** Therefore, this source of flood risk is not a barrier to the proposed improvement works to the junction.

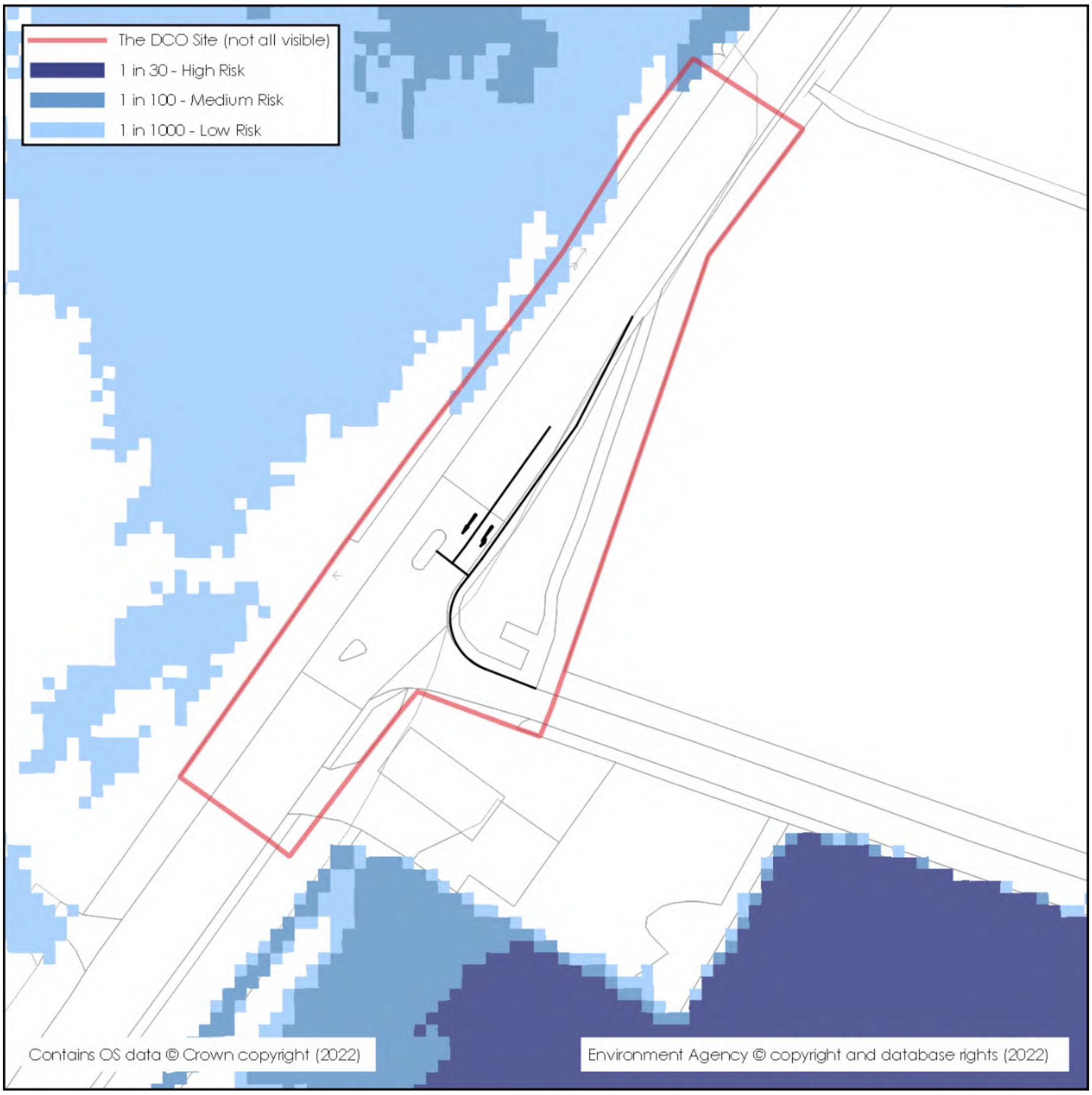


Figure 9.3 Surface Water Flood Risk, B6

Groundwater Flood Risk

9.6 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with alluvium superficial deposits. The SFRA identifies that >75% of the local area is potentially susceptible to groundwater flooding. Given the underlying geology, and the junctions position in the floodplain, the risk of groundwater flooding is considered to be moderate.

9.7 However, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

9.8 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

9.9 Reservoir flood risk mapping prepared by the EA identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

9.10 Public sewer records show no assets within the vicinity of the junction. However, the area is likely served by local highway drainage infrastructure.

9.11 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

9.12 The junction falls within the high-risk floodplain of the River Soar and Broughton Astley Brook. However, the proposed improvement works are very minor and could be undertaken at grade so that there is no interruption of flow route or loss in floodplain storage. Other sources of flooding have been identified to pose a low risk. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

10. HB1: JUNCTION OF A47 NORMANDY WAY AND A447 ASHBY ROAD, HINCKLEY

Illustrative Junction Proposals

10.1 It is proposed that the approach roads to this junction will all be widened to accommodate additional traffic. Indicative right turn and two lanes would be provided through the junction in a westbound direction. Formal signal-controlled pedestrian crossing points will be introduced. This is illustrated within **Figure 10.1**.

10.2 The proposed reconfiguration would predominantly fall within the existing highway land, but the potential flood risk at this location has been reviewed for completeness.

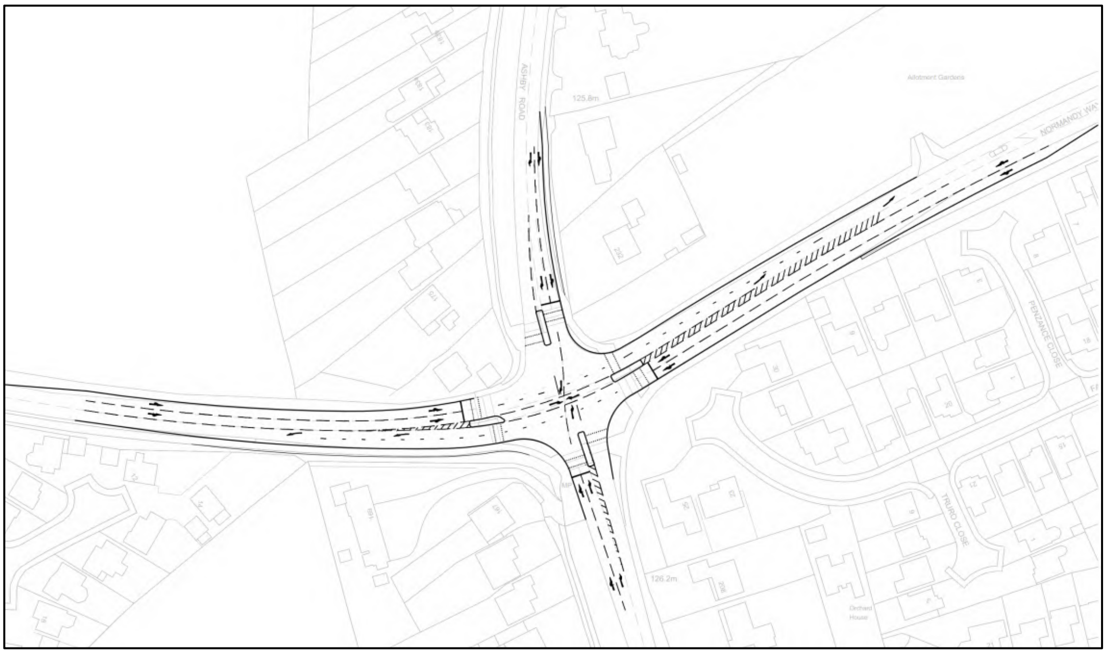


Figure 10.1: Illustrative Mitigation Proposals at HB1

Historical Flooding Incidents

10.3 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

10.4 The junction sits entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 10.2**. Therefore, the proposed mitigation works could proceed without detrimentally affecting third party flood risk from this source.

Figure 10.2 Fluvial Flood Risk Map, HB1

Surface Water Flood Risk

10.5 The extent of the proposed works is shown to fall within an area of very low to low flood risk from surface water flooding, as shown in **Figure 10.3**. The extent of surface water flooding is restricted to the existing carriageway, the proposed works do not cross any significant overland flow routes.

10.6 The proposed works are likely to be undertaken at grade; therefore, the surface water floodplain and flood risk to third parties will not be significantly affected. Therefore, this low source of flood risk is not a barrier to the proposed improvement works to the junction.

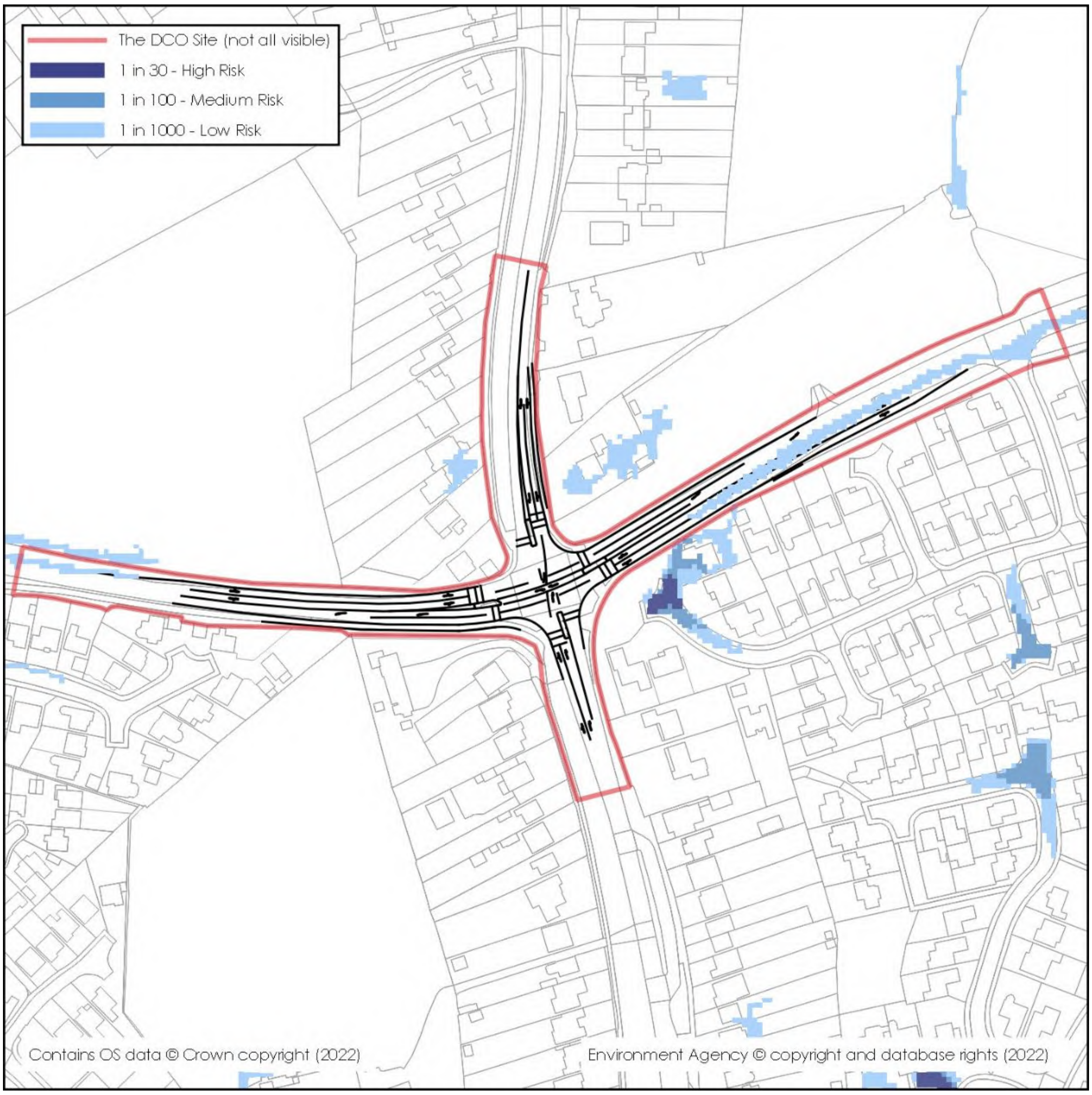


Figure 10.3 Surface Water Flood Risk, HB1

Groundwater Flood Risk

10.7 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that <25% of the local area is potentially susceptible to groundwater flooding. Given the underlying geology, and that the junction is removed from watercourses and the floodplain, and it is not located in a topographical depression, the risk of groundwater flooding is considered to be low.

10.8 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

10.9 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

10.10 Reservoir flood risk mapping, prepared by the EA, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

10.11 Public sewer records identify a foul water sewer in the vicinity of the junction. It is common for drainage infrastructure to fall within the highway and so this is considered an acceptable source of flood risk. The works would not increase any flow loadings on the foul sewer network and so any potential flood risk to third party from the public sewer network would be unaffected.

10.12 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

10.13 Overall, the risk of flooding from the reviewed sources at this junction are all considered to be at an acceptable level, therefore, they will not pose a barrier to the proposed works. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure where capacity improvements are necessary to accommodate any additional impermeable surfaces.

11. HB2: JUNCTION OF A47 NORMANDY WAY / LEICESTER ROAD, THE B4668 LEICESTER ROAD AND THE COMMON, SOUTH-EAST OF BARWELL

Illustrative Junction Proposals

11.1 Widening of the entry arm on the B4668 Leicester Road are proposed. This is illustrated within **Figure 11.1**.

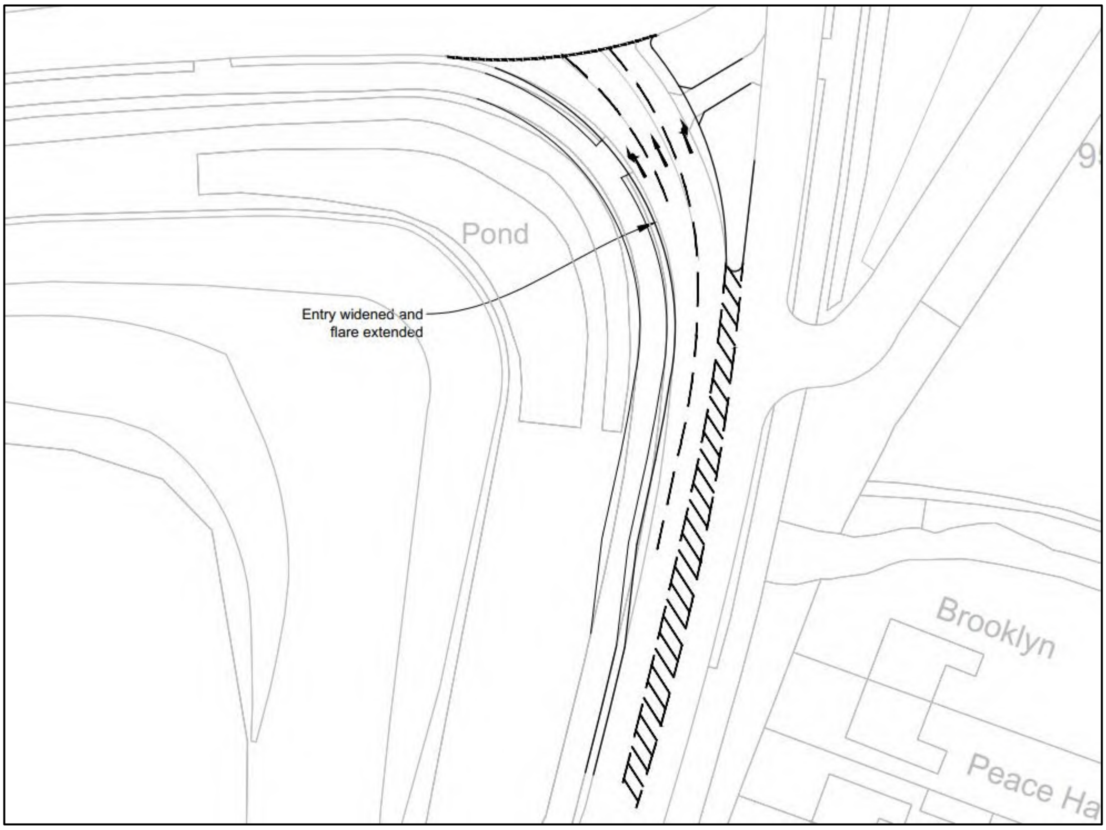


Figure 11.1: Illustrative Mitigation Proposals at HB2

Historical Flooding Incidents

11.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the junction. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

11.3 The junction sits entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 11.2**. Therefore, the proposed junction mitigation works could proceed without being affected or detrimentally affecting third party flood risk from this source.

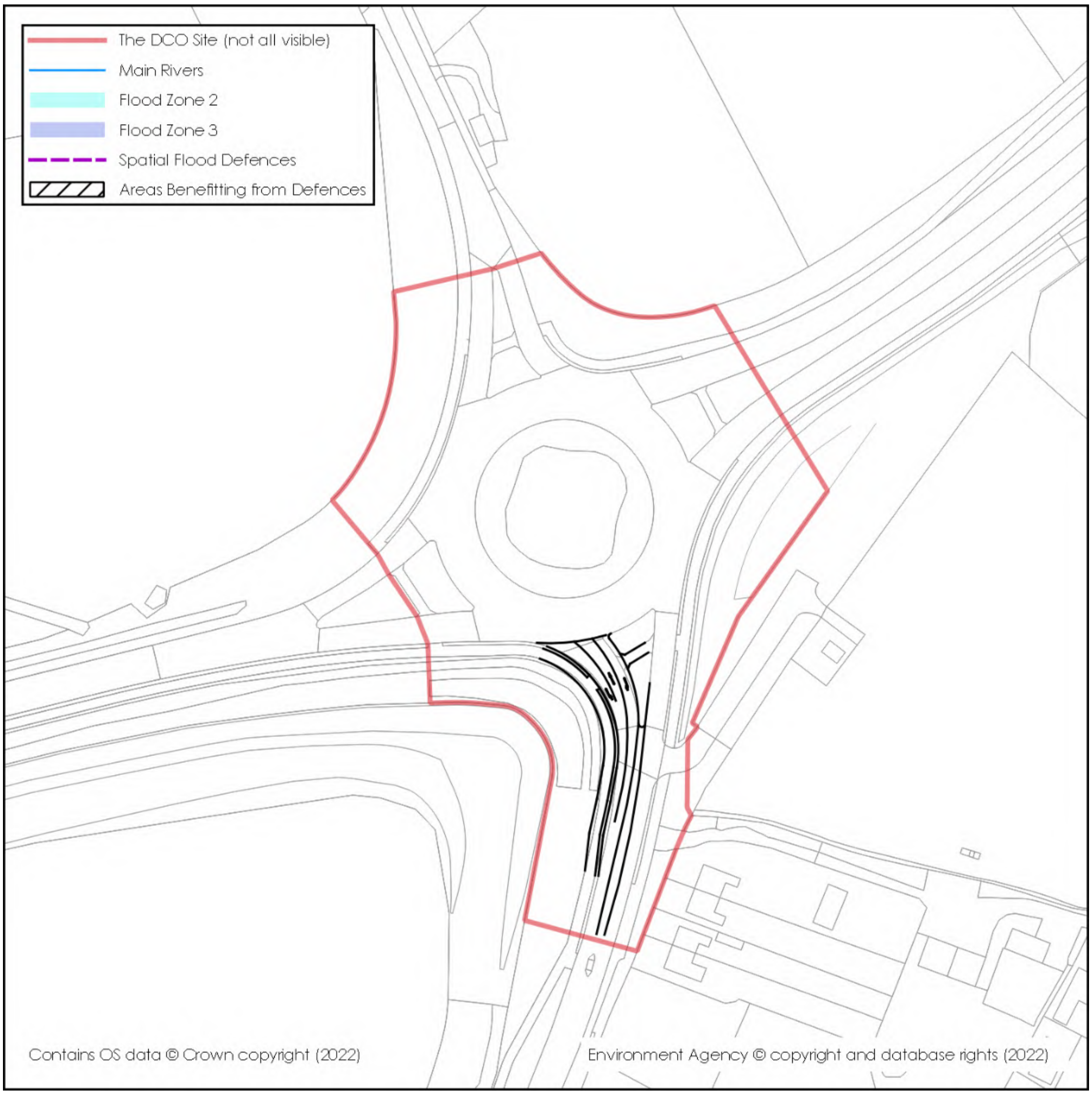


Figure 11.2 Fluvial Flood Risk Map, HB2

Surface Water Flood Risk

11.4 The extent of the proposed works is shown to fall within an area at a high flood risk from surface water flooding. This is shown in **Figure 11.3**. The extent of surface water flooding is associated with an overland flow route which spills over the A47 carriageway into a pond, located in a woodland area to the west of the junction, before flowing over the B4668 and the southern extent of the junction improvement area.

11.5 It is expected that the pond forms part of the highway's drainage infrastructure. A watercourse is located on the downstream side of the B4668, and it is believed that there would be a culverted connection between the pond and the downstream watercourse that would convey the surface water runoff beneath the road. Therefore, the level of mapped flood risk is likely to be overestimated.

11.6 Additionally, it is understood that the proposed widening of the carriageway will largely be undertaken at grade, thereby minimising any potential changes to the existing topography and minimising any significant impact on existing flow routes. Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected.

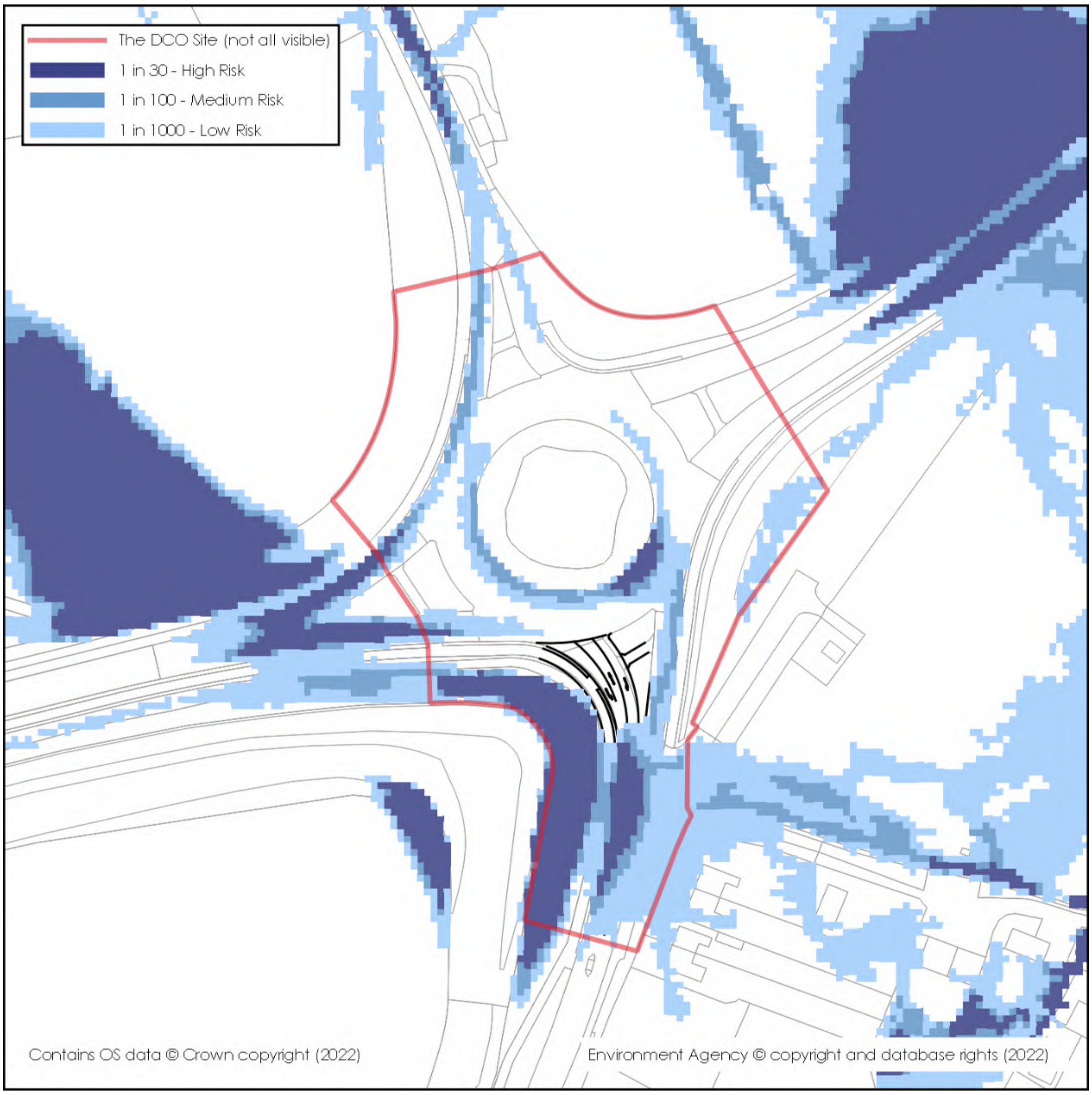


Figure 11.3 Surface Water Flood Risk, HB2

Groundwater Flood Risk

11.7 British Geological Survey data identifies that the junction is underlain by Mercia Mudstone, with glacial till and alluvium superficial deposits. The SFRA identifies that <25% of the local area is potentially susceptible to groundwater flooding. The underlying geology and proximity of a watercourse suggests that there is a risk of elevated groundwater levels, but the risk of these exceeding road levels is considered to be low.

11.8 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

11.9 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

11.10 Reservoir flood risk mapping, prepared by the EA, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

11.11 Public sewer records show a combined sewer within the vicinity of the junction, but the proposed works are not located over this infrastructure.

11.12 A public surface water sewer is also shown in the local area; the records appear to be incomplete, but they suggest that the sewer either outfalls to the pond to the west of the junction, or to the expected culvert between the pond and the downstream watercourse. The proposed works to the junction are not expected to affect the public sewer network.

11.13 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

11.14 Generally, the risk of flooding from the reviewed sources at this junction are considered to be low. Surface water risk is shown to be high but, based on the available data, this is considered to be overestimated. In any event, the proposed junction improvement works are not expected to significantly alter ground levels, therefore any existing surface water floodplain and overland flows routes should not be significantly affected. The proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

12. H1: CROSS IN HAND ROUNDABOUT AT THE JUNCTION OF THE A5 WATLING STREET, A4303 COVENTRY ROAD, B4428 LUTTERWORTH ROAD AND COAL PIT LANE, WEST OF LUTTERWORTH

Illustrative Junction Proposals

12.1 In addition to improvements already committed under a Section 278 agreement for a seperate scheme, it is proposed to increase the roundabout radius and widen lane entries, with two lanes marked for longer distances for traffic approaching the junction on the A5 Watling Street southbound, and on Coal Pit Lane and B4428 Lutterworth Road. This is illustrated within **Figure 12.1**.

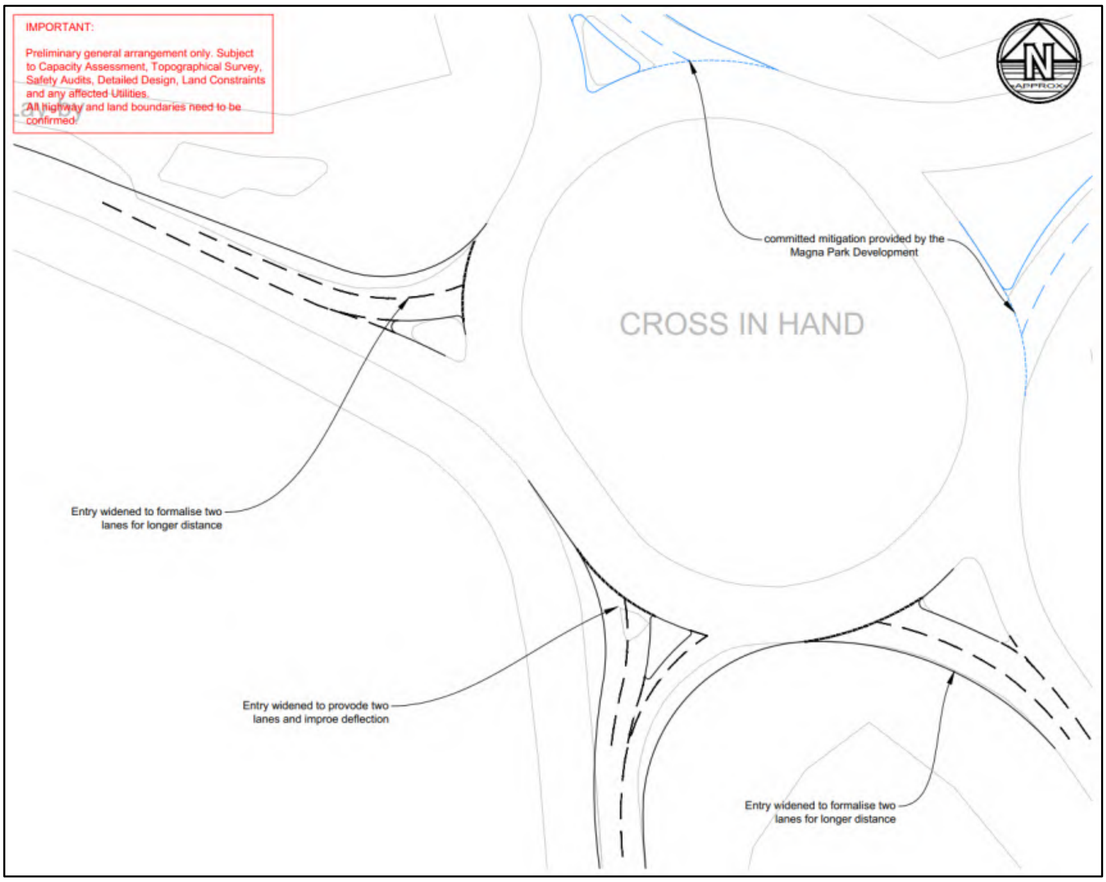


Figure 12.1: Illustrative Mitigation Proposals at H1

Historical Flooding Incidents

12.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected the site. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the junction.

Fluvial Flood Risk

12.3 The junction sits entirely within Flood Zone 1, land at a low probability of river flooding. This is shown in **Figure 12.2**. Therefore, the proposed junction mitigation works could proceed without being affected or detrimentally affecting third party flood risk from this source.

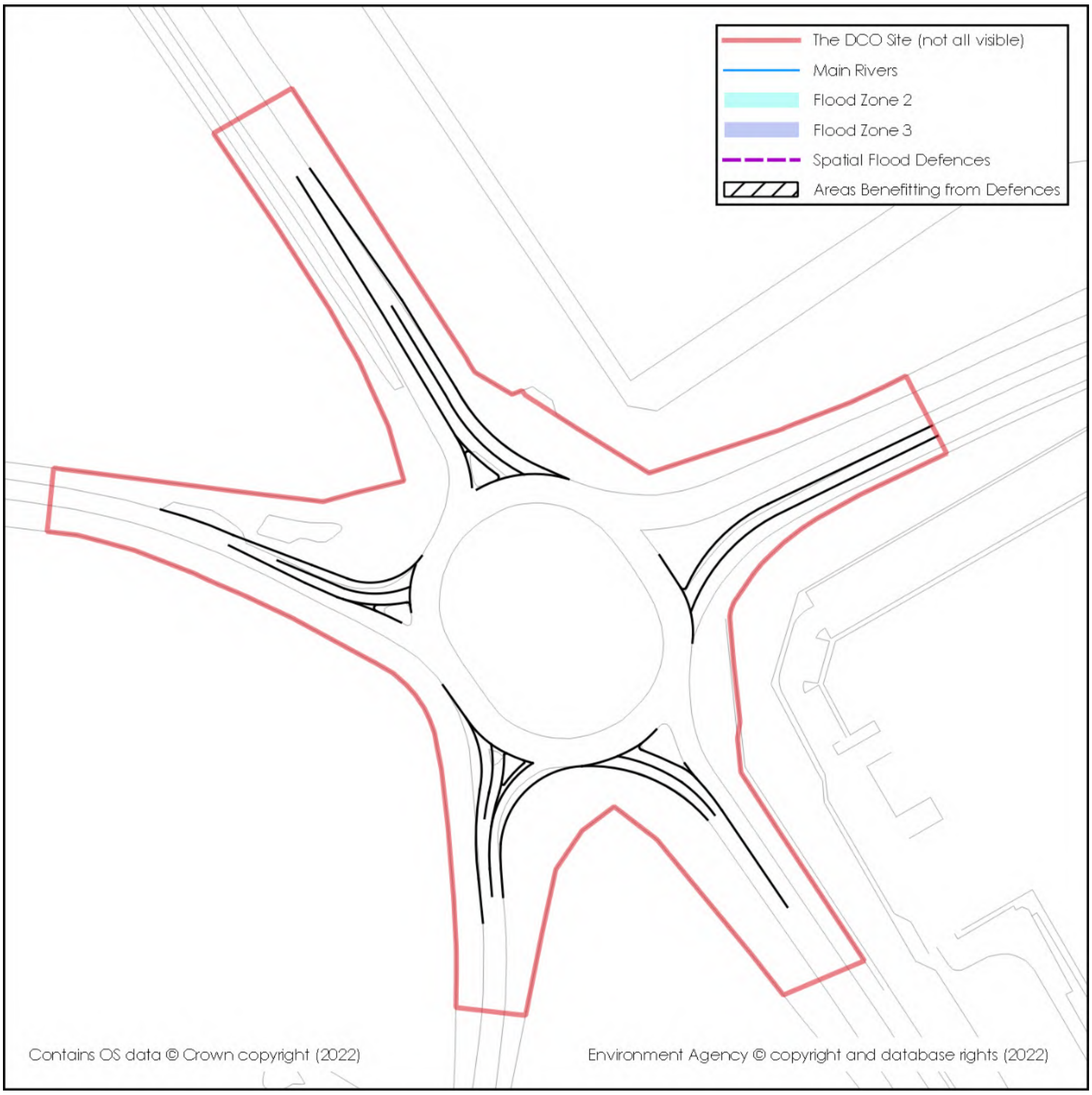


Figure 12.2 Fluvial Flood Risk Map, H1

Groundwater Flood Risk

12.4 British Geological Survey data identifies that the junction is underlain by Blue Lias Formation (Mudstones and Limestone), with glacial till superficial deposits. The SFRA identifies that <25% of the local area is potentially susceptible to groundwater flooding. Given the underlying geology, and as the junction is removed from local watercourses and the floodplain, and is not located in a topographical depression, the risk of groundwater flooding is considered to be low.

12.5 In any event, the relatively minor proposed works to the junction will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Surface Water Flood Risk

12.6 The extent of the proposed works is shown to fall within an area at a very low to low flood risk from surface water flooding; this is shown in **Figure 12.3.** The extent of surface water flooding is generally restricted to the existing carriageway, the proposed works would not cross any significant overland flow routes.

12.7 The proposed works are likely to be undertaken at grade; therefore, the surface water floodplain and flood risk to third parties will not be significantly affected.

12.8 This minor flood risk is not a barrier to the proposed improvement works to the junction.

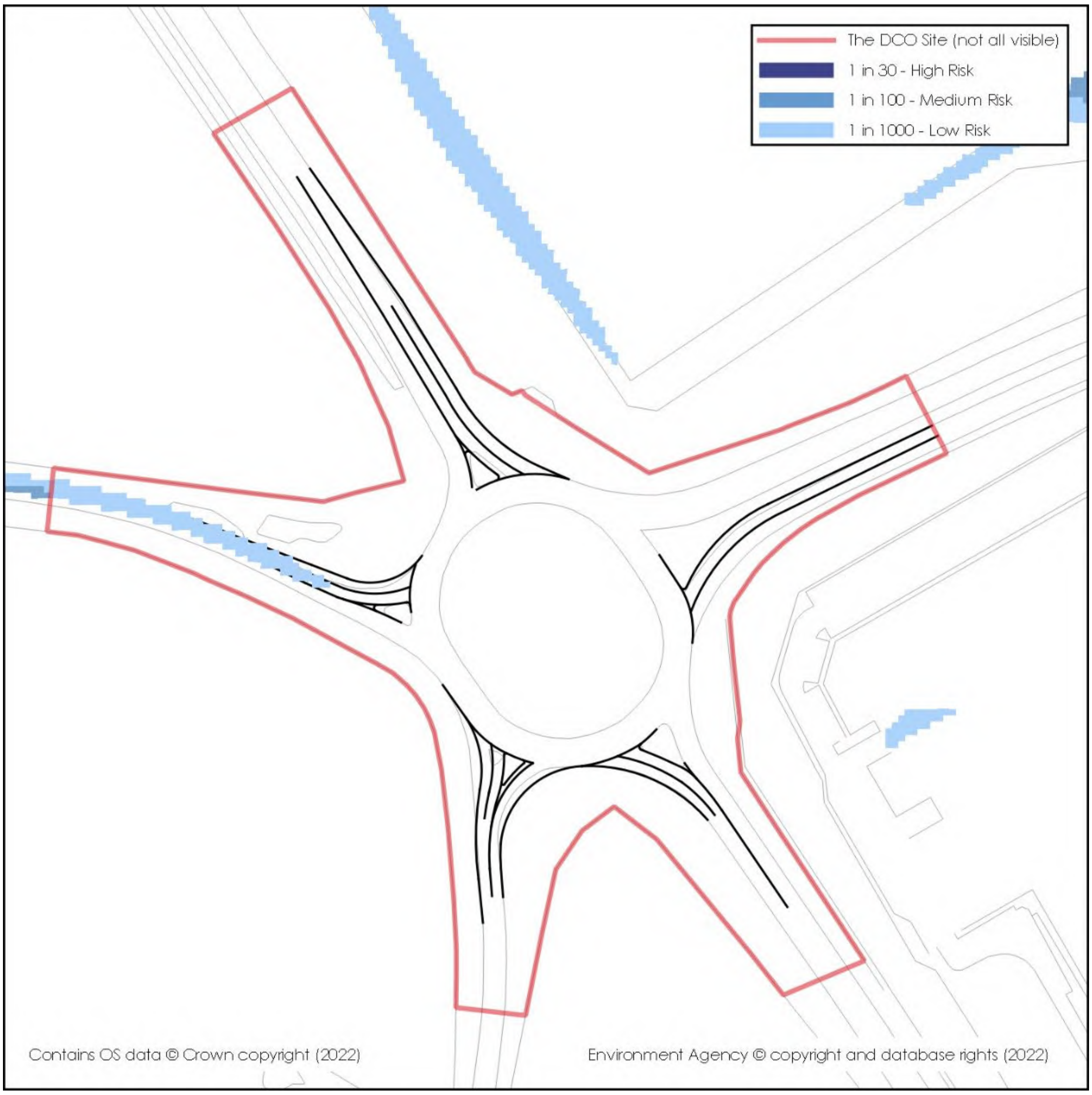


Figure 12.3 Surface Water Flood Risk, H1

Flood Risk from Canals

12.9 There are no canals in a significant vicinity to the junction, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

12.10 Reservoir flood risk mapping, prepared by the Environment Agency, identifies that the junction is located a significant distance from any surrounding reservoirs and that it falls outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure Flood Risk

12.11 Public sewer records show no assets within the vicinity of the junction. However, the area is likely served by local highway drainage infrastructure.

12.12 The alterations to the junction may introduce additional impermeable areas that would need to be accommodated within the local highway drainage infrastructure. If this is the case, then the available capacity in the existing highway drainage will need to be reviewed at the detailed design stage and improved where there is shown to be a shortfall. The improvements to the highway drainage would be undertaken to ensure that flood risk to third parties is not detrimentally affected by the works.

Summary

12.13 Overall, the risk of flooding from the reviewed sources at this junction are all considered to of an acceptable level and, therefore, they will not pose a barrier to the proposed works. Additionally, the proposed junction works are not expected to negatively affect any flood risk in the surrounding area, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are necessary to accommodate any additional impermeable surfaces.

13. R1: – B581 TO FOOTPATH SOUTH OF THORNEY FIELDS FARM

Illustrative Proposals

13.1 The proposals in this area include the closure of a level crossing and the existing public right of way diverted with pedestrians rerouted to an existing bridge over the railway south of Thorney Fields Farm. The length of works reviewed in this section are illustrated within **Figure 13.1**.

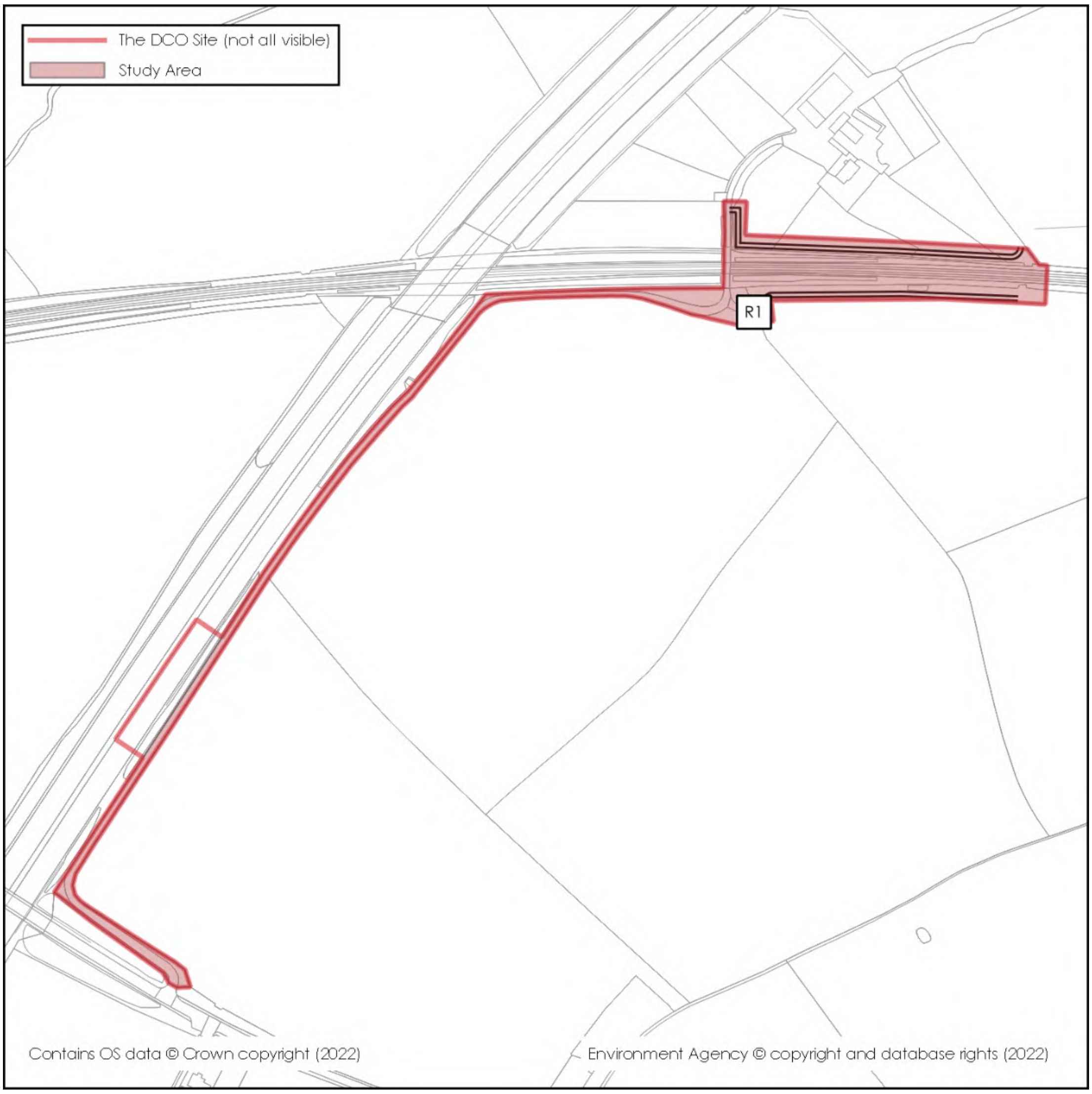


Figure 13.1: Illustrative Extent of Changes at R1

Historical Flooding Incidents

13.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this area. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this area.

Fluvial Flood Risk

13.3 This area is located entirely within Flood Zone 1, land at a low probability of river flooding, as shown in **Figure 13.2**. Therefore, the proposed works could proceed without being affected or detrimentally affecting third party flood risk from this source.

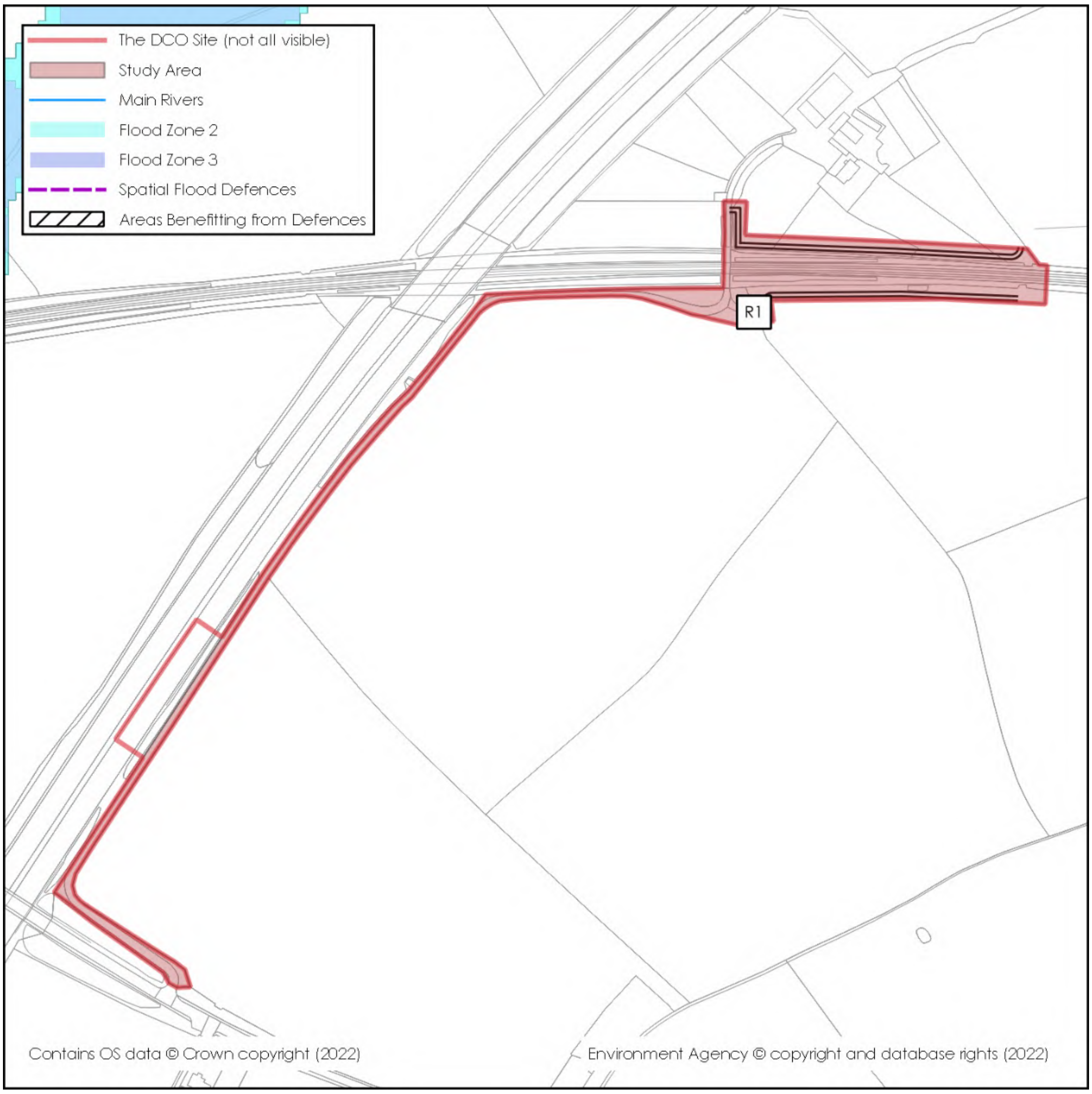


Figure 13.2 Fluvial Flood Risk, at R1

Surface Water Flood Risk

13.4 The proposed footpath diversion in the north of this site, passes through an area at a low to very low risk of surface water flooding. In the south of this site, is a localised area of high to medium flood risk; however, no works are proposed in this location. This is shown within **Figure 13.3**. Therefore, the surface water floodplain and flood risk to third parties are not expected to be affected by the proposed works.

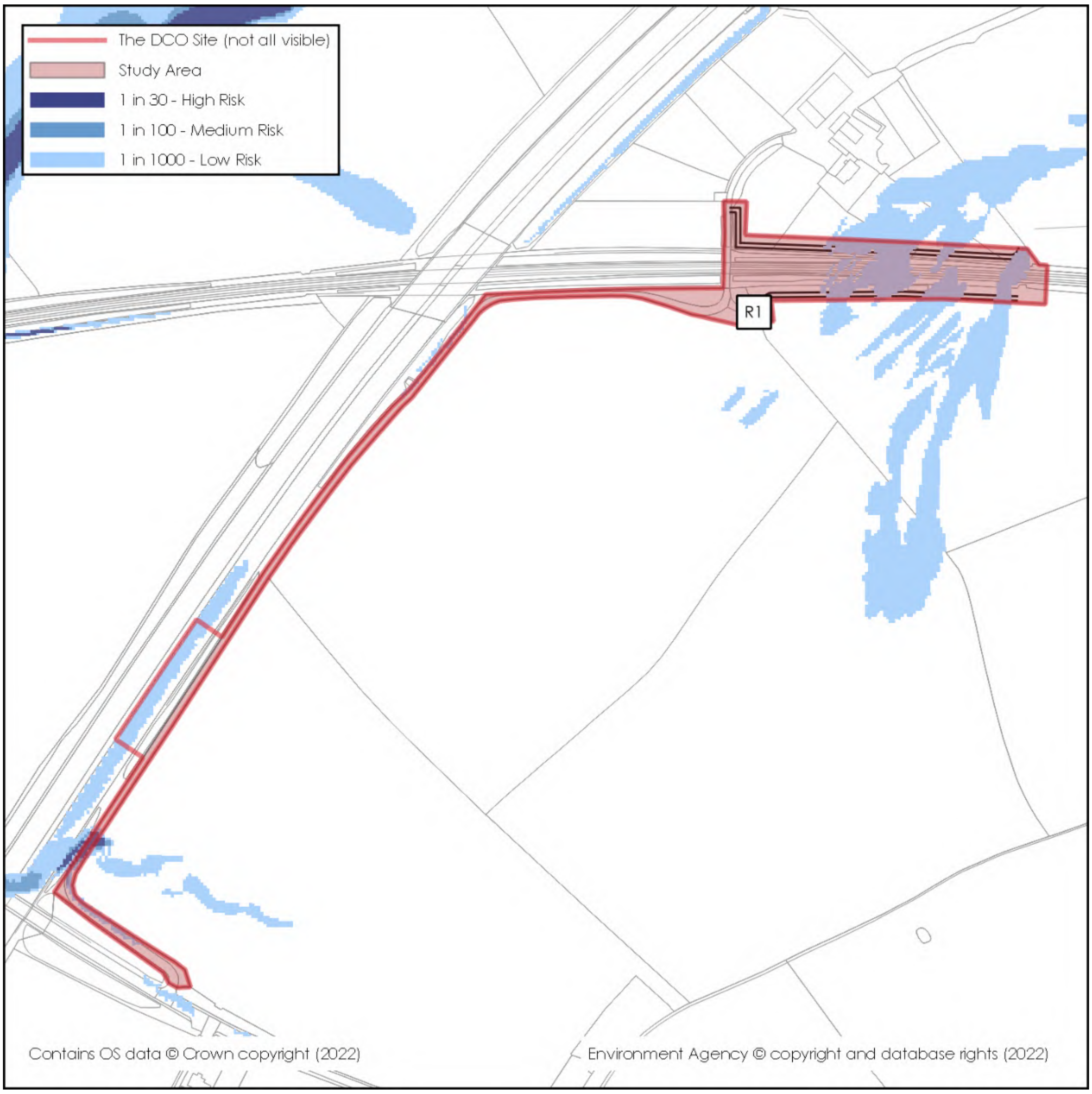


Figure 13.3 Surface Water Flood Risk, at R1

Groundwater Flood Risk

13.5 British Geological Survey data identifies that this area is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 25% of the local area is potentially susceptible to groundwater flooding. Therefore, the risk of groundwater flooding is considered to be low.

13.6 In any event, the relatively minor proposed works will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

13.7 There are no canals in a significant vicinity of this site, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

13.8 Reservoir flood risk mapping, prepared by the EA, identifies that this area is located a significant distance from any surrounding reservoirs and that it falls outside of the flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

13.9 Public records show that there is no infrastructure within the vicinity of this site. The closure of the level crossing and the footpath diversion are not expected to introduce any new significant impermeable areas.

Summary

13.10 Overall, the risk of flooding from the reviewed sources are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

14. R2: ELMESTHORPE

Illustrative Proposals

14.1 The proposals in this area include the permanent closure of a public right of way via a level crossing. Pedestrians would instead be able to cross the railway using the existing Station Road bridge, 75 metres to the south-west. A drop kerb at the junction of Bostock Close and the B581 is also included. The length of works reviewed in this section are illustrated within **Figure 14.1.**

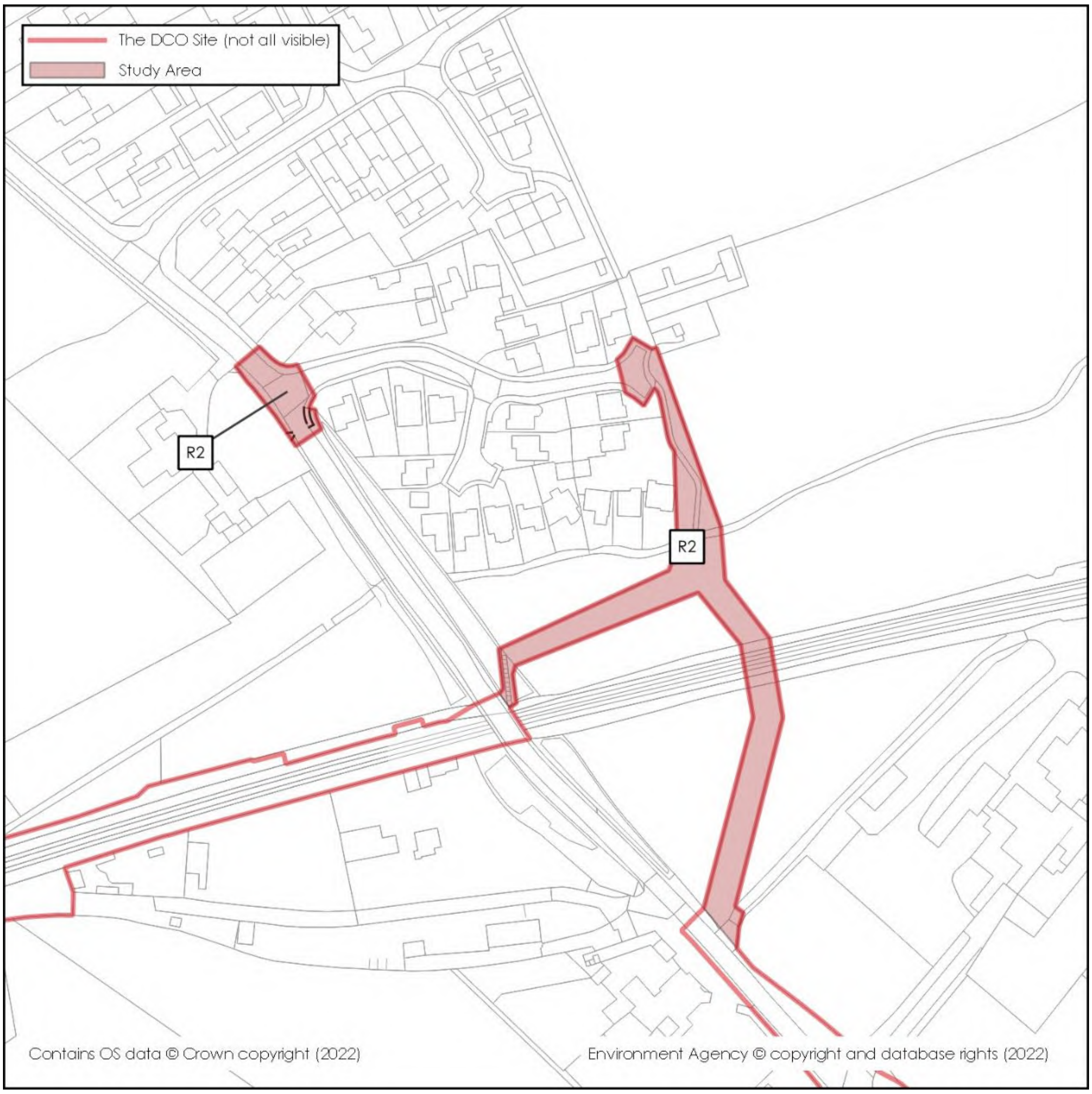


Figure 14.1: Illustrative Extent of Changes at Footpath 2

Historical Flooding Incidents

14.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this area. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this area.

Fluvial Flood Risk

14.3 This area is located across Flood Zones 3, 2 and 1, land at a high, medium, and low probability of river flooding respectively, as shown in **Figure 14.2**. This floodplain is associated with an ordinary watercourse (an unnamed tributary of the Thurlsaton Brook).

14.4 While there is a high risk of fluvial flooding, the proposals in this area are not sensitive to flood risk. Furthermore, the proposals will not affect flood risk in the wider area.

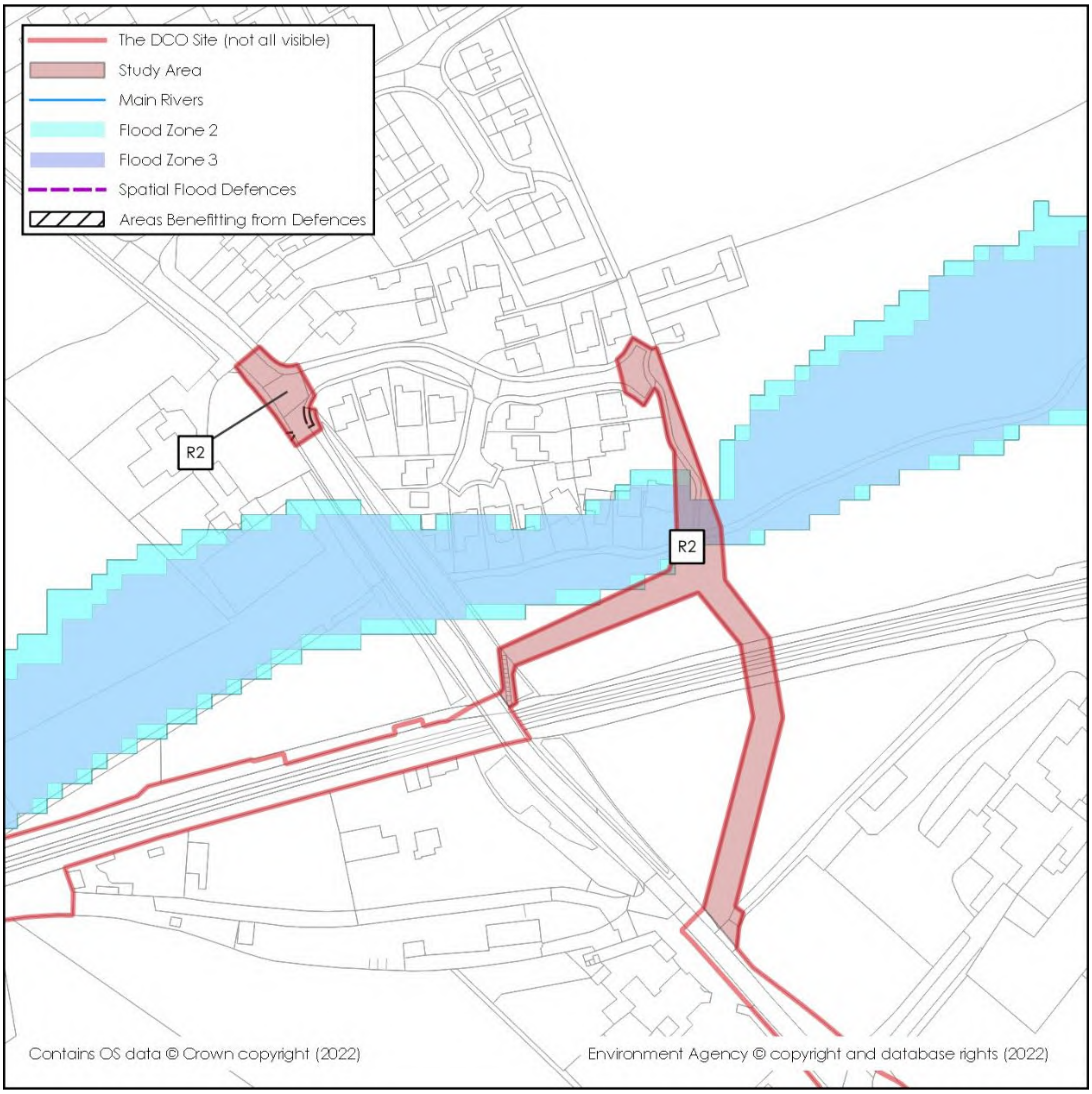


Figure 14.2 Fluvial Flood Risk, at Footpath 2

Surface Water Flood Risk

14.5 This area is also shown to fall in an area of high surface water flood risk, which is associated with the ordinary watercourse. Away from the watercourse, the surface water flood risk is low to very low. This is shown within **Figure 14.3**.

14.6 While there is a high risk of pluvial flooding, the proposals in this area are not sensitive to flood risk. Furthermore, the proposals will not affect flood risk in the wider area.

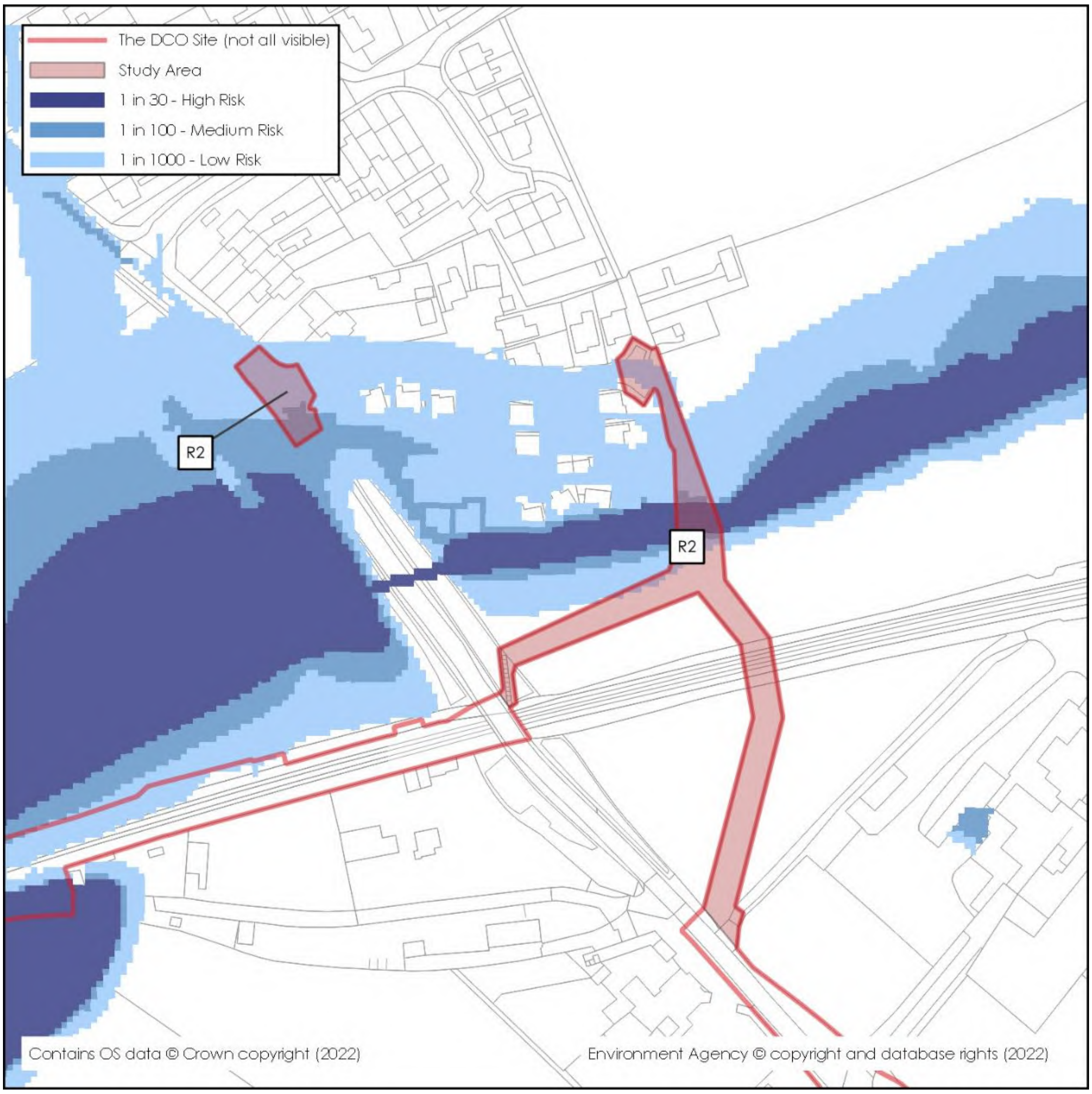


Figure 14.3 Surface Water Flood Risk, at Footpath 2

Groundwater Flood Risk

14.7 British Geological Survey data identifies that this area is underlain by Mercia Mudstone, with glacial till and alluvium superficial deposits. The SFRA identifies that between 50% to 25% of the local area is potentially susceptible to groundwater flooding. Therefore, the risk of groundwater flooding is considered to be moderate.

14.8 However, the minor proposed works are not sensitive to flood risk, and they would not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

14.9 There are no canals in a significant vicinity of this site, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

14.10 Reservoir flood risk mapping, prepared by the EA, identifies that this area is located a significant distance from any surrounding reservoirs and that it falls outside of the flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

14.11 Public records show that there are public surface water and foul sewers located in this area. However, the minor proposed works are not sensitive to flood risk, and they would not detrimentally affect the local public sewer or drainage infrastructure in the surrounding area.

Summary

14.12 Overall, the risk of flooding from the reviewed sources are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

15. R5: THE OUTWOODS, BETWEEN BURBAGE AND HINCKLEY

Illustrative Proposals

15.1 The proposals in this area include the replacement of the level crossing with a pedestrian footbridge, with associated public rights of way diversions. The length of works reviewed in this section are illustrated within **Figure 15.1**.

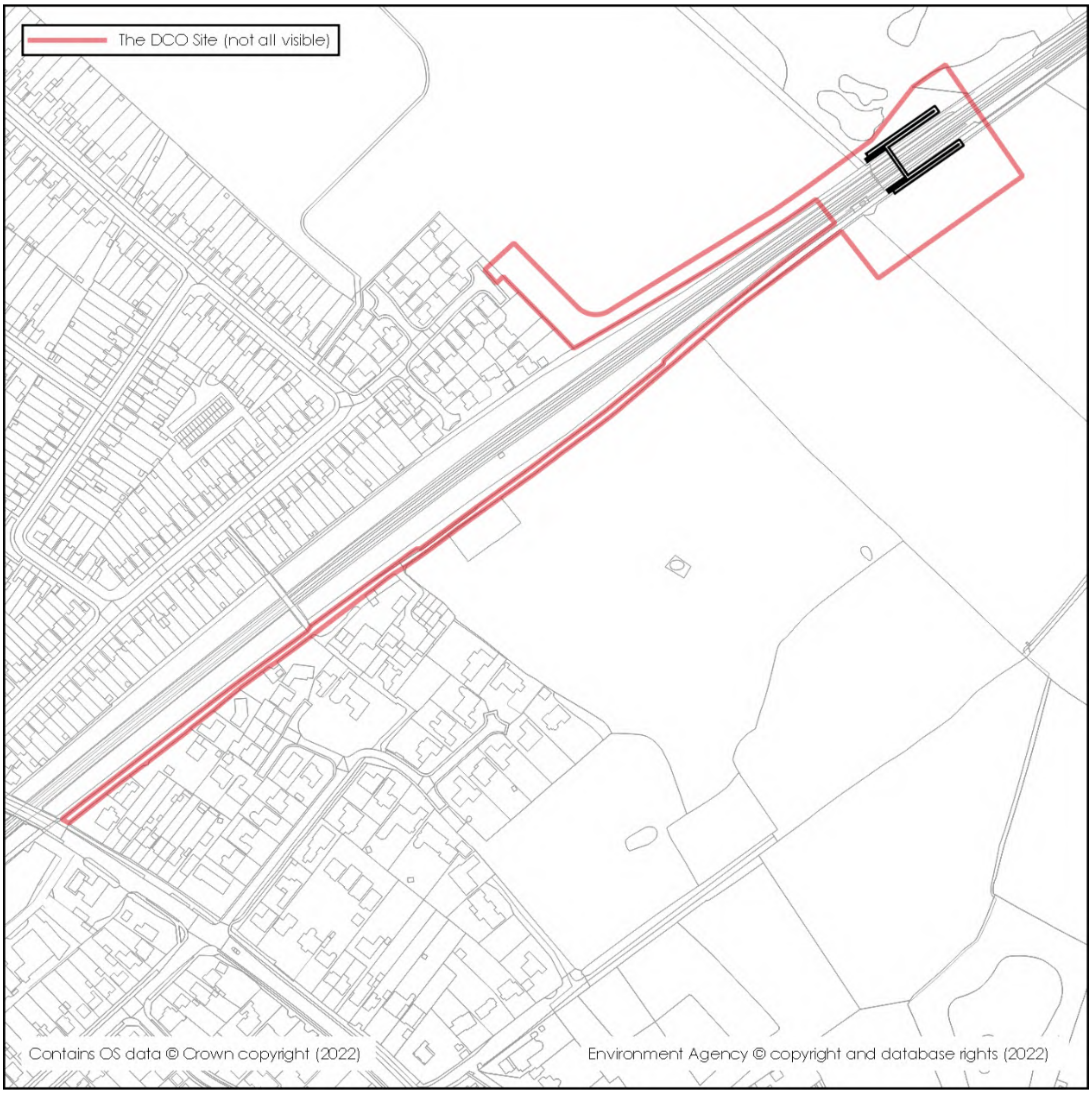


Figure 15.1: Illustrative Extent of Changes at R5

Historical Flooding Incidents

15.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected this area. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected this area.

Fluvial Flood Risk

15.3 This area is located entirely within Flood Zone 1, land at a low probability of river flooding, as shown in **Figure 15.2**. Therefore, the proposed works could proceed without being affected or detrimentally affecting third party flood risk from this source.

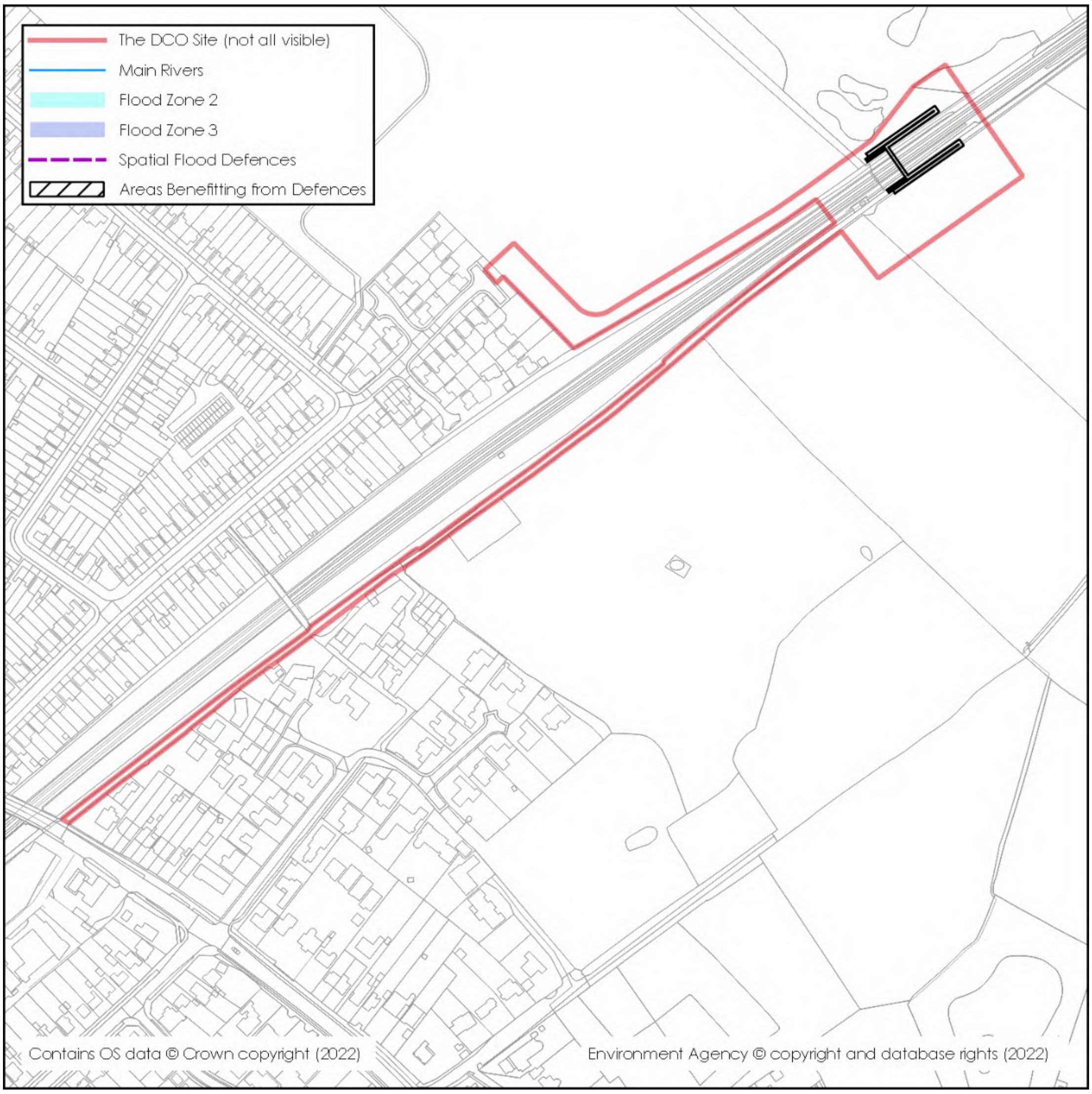


Figure 15.2 Fluvial Flood Risk, at R5

Surface Water Flood Risk

15.4 The railway line as it passes through this site is at a medium to high risk of surface water flooding. This is because the line is located within a cutting in this location. The proposed bridge footings and the extent of works are located either side of the railway line on land at a low to very low risk of surface water flooding. This is shown within **Figure 15.3**.

15.5 Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected by the proposed works.

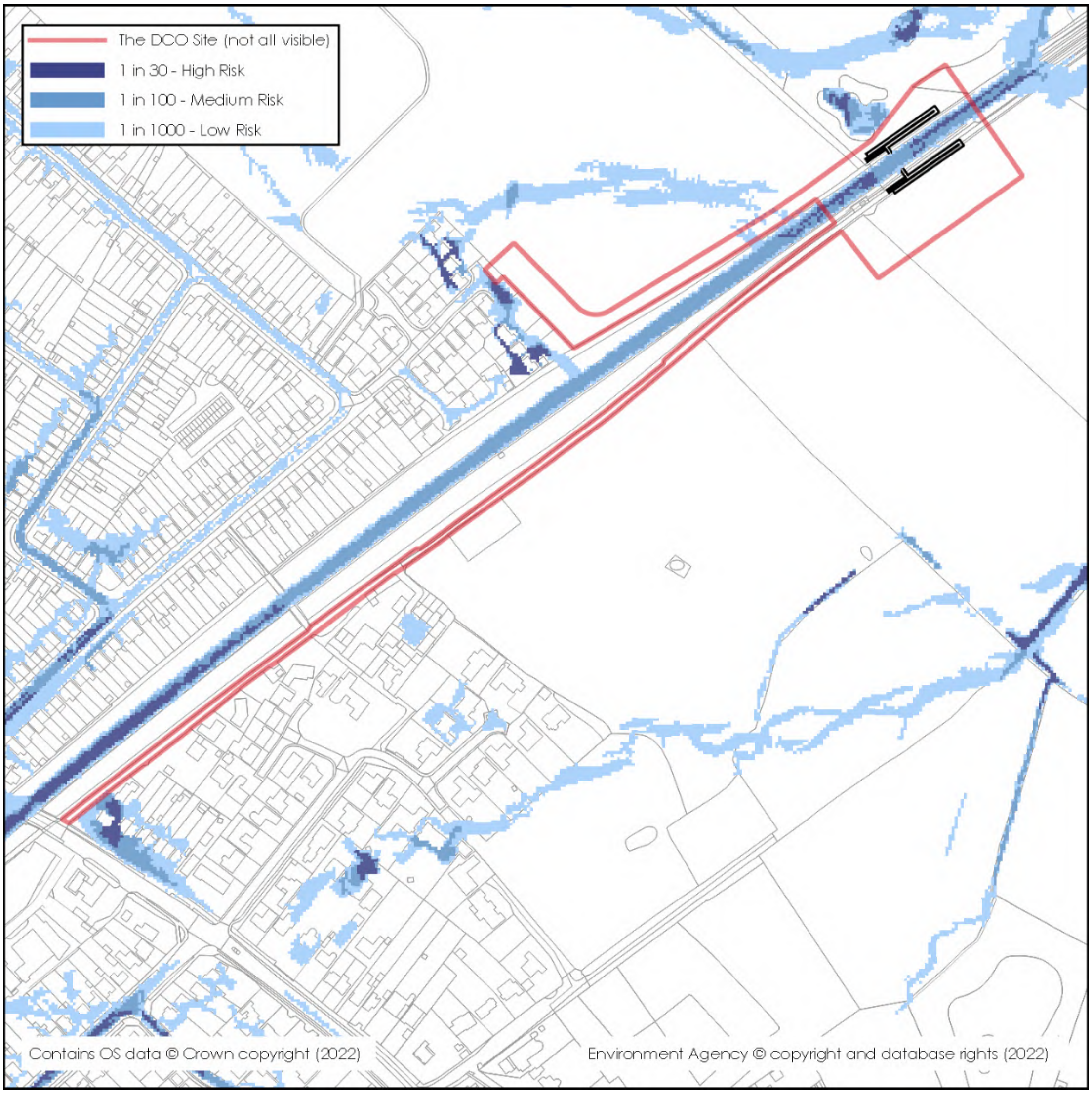


Figure 15.3 Surface Water Flood Risk, at R5

Groundwater Flood Risk

15.6 British Geological Survey data identifies that this area is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 25% of the local area is potentially susceptible to groundwater flooding.

15.7 Any groundwater emergence is likely to occur in the low-lying areas in the railway line cutting away from the proposed footbridge. Therefore, the risk of groundwater flooding is considered to be low.

15.8 In any event, the relatively minor proposed works will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

15.9 There are no canals in a significant vicinity to this area, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

15.10 Reservoir flood risk mapping, prepared by the EA, identifies that this area is located a significant distance from any surrounding reservoirs and that it falls outside of the flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

15.11 Public records show that a surface water sewer runs beneath this site on the northern side of the railway line. This outfalls to a watercourse present within the adjacent golf course. This is likely to have a limited standard of design (1 in 20-year to 1 in 30-year). In the event of exceedance, surcharging flood water would likely be directed to the downstream watercourse.

15.12 The closure of the level crossing and the creation of a new footbridge are not expected to introduce any significant new impermeable areas or affect the existing drainage infrastructure.

Summary

15.13 Overall, the risk of flooding from the reviewed sources are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

16. M69-1 TO M69-7 – THE M69 ON THE APPROACH TO JUNCTION 2

Proposals

16.1 The proposals on the M69 include signage changes on the approach to Junction 2. The areas included within the Order Limits are shown within **Figure 16.1** and **Figure 16.2**.

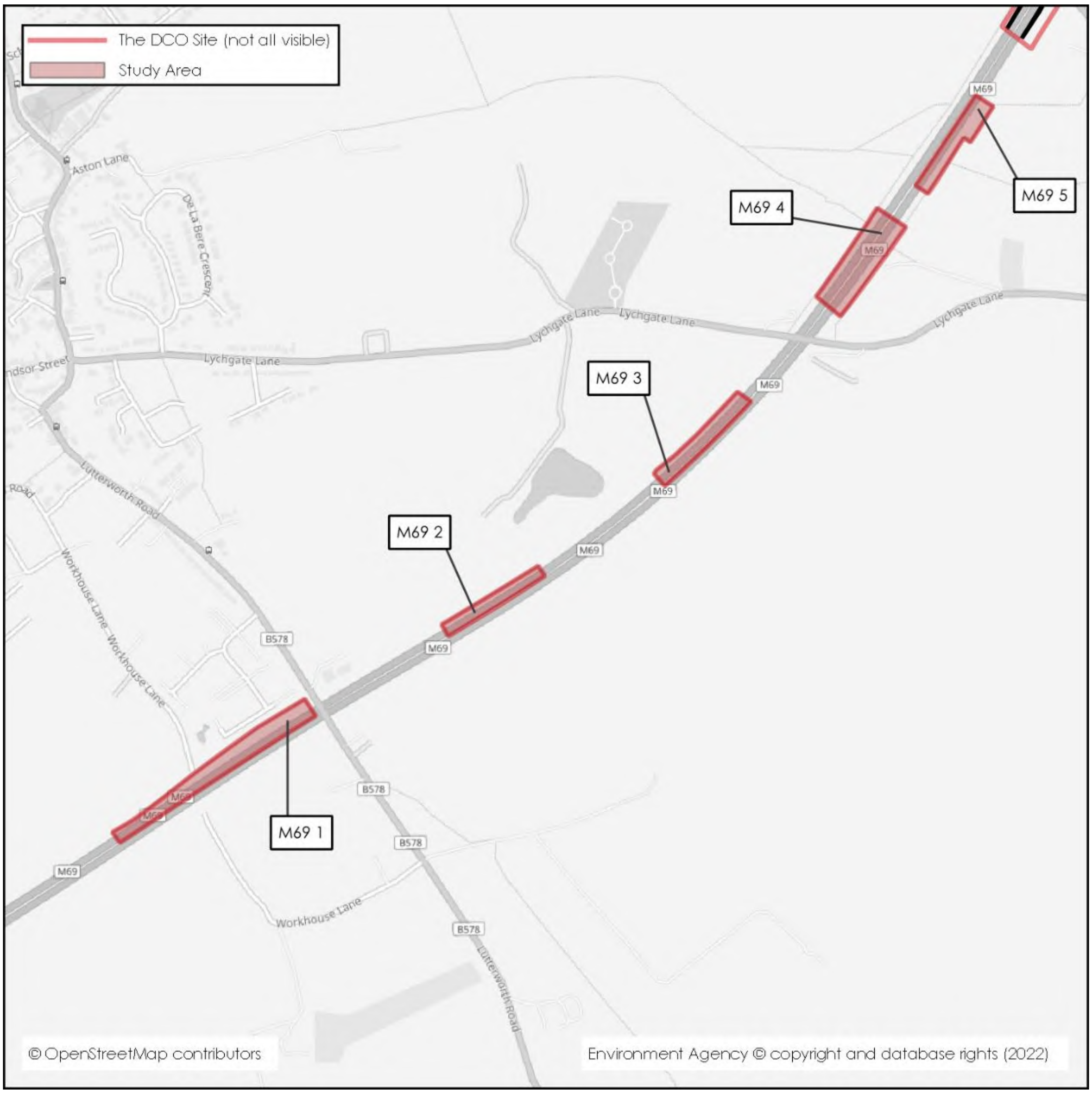


Figure 16.1: Illustrative Extent of Signage alterations, on the M69 - South

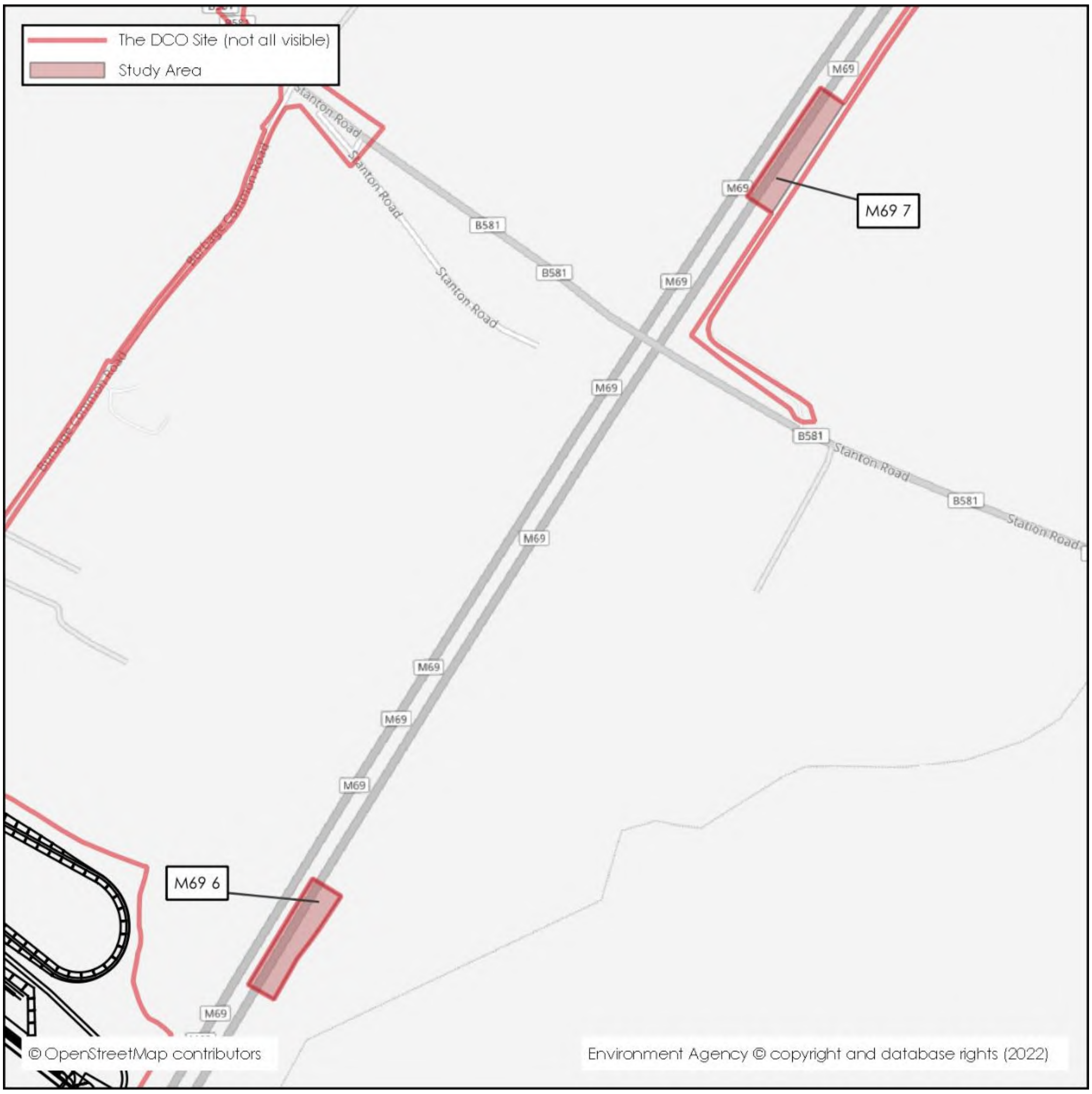


Figure 16.2: Illustrative Extent of Signage alterations, on the M69 - North

Historical Flooding Incidents

16.2 A review of the EA recorded flood outlines dataset did not identify any historical incidents that have affected these areas. Furthermore, a review of historical incidents collated and listed in the PFRA and SFRAs also did not identify any which had affected the areas.

Fluvial Flood Risk

16.3 These areas are located entirely within Flood Zone 1, land at a low probability of fluvial flooding, as shown in **Figure 16.3** and **Figure 16.4**. Therefore, the proposed works could proceed without being affected by, or detrimentally affecting third party, flood risk from this source.

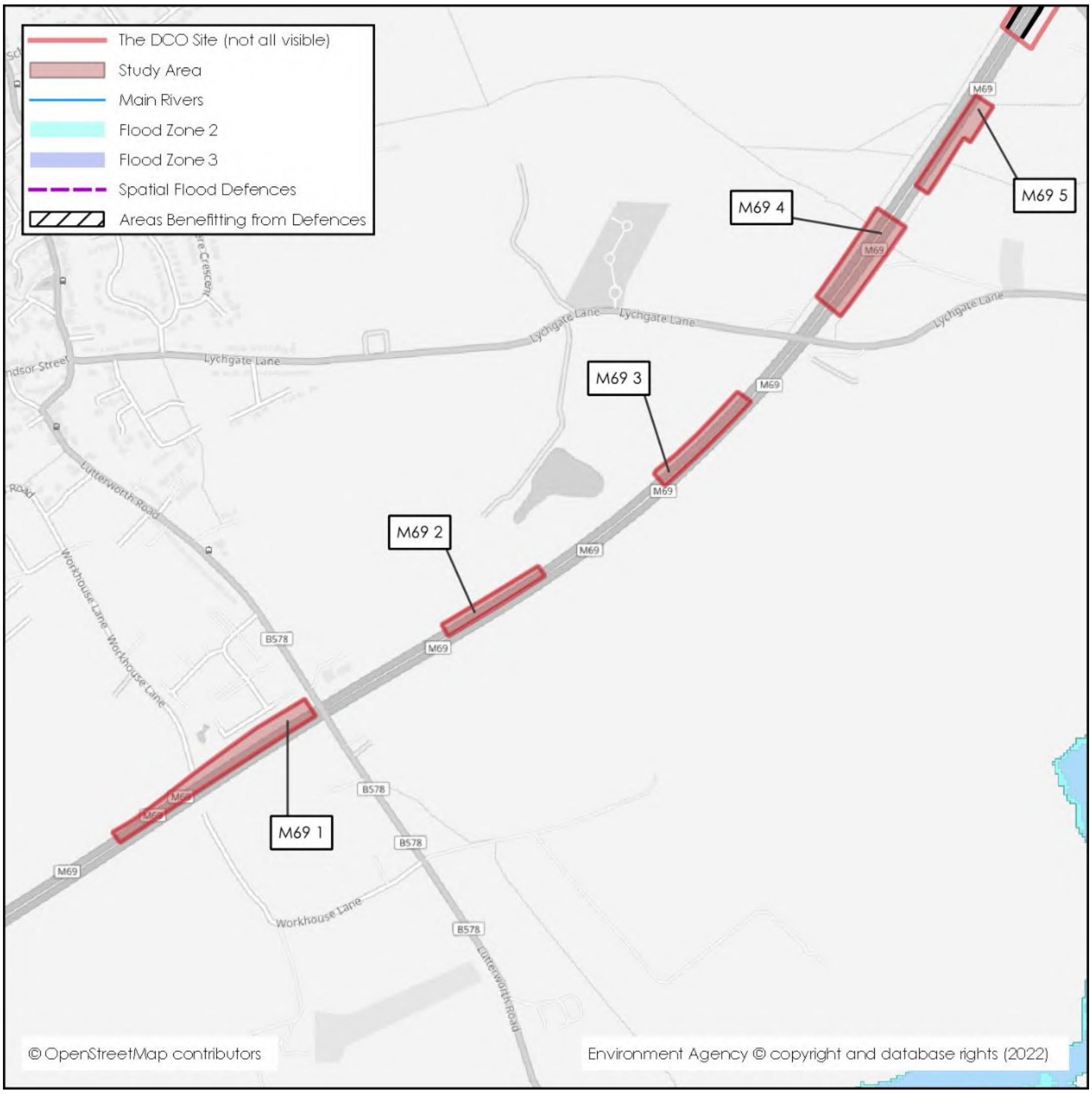


Figure 16.3 Fluvial Flood Risk, M69 South

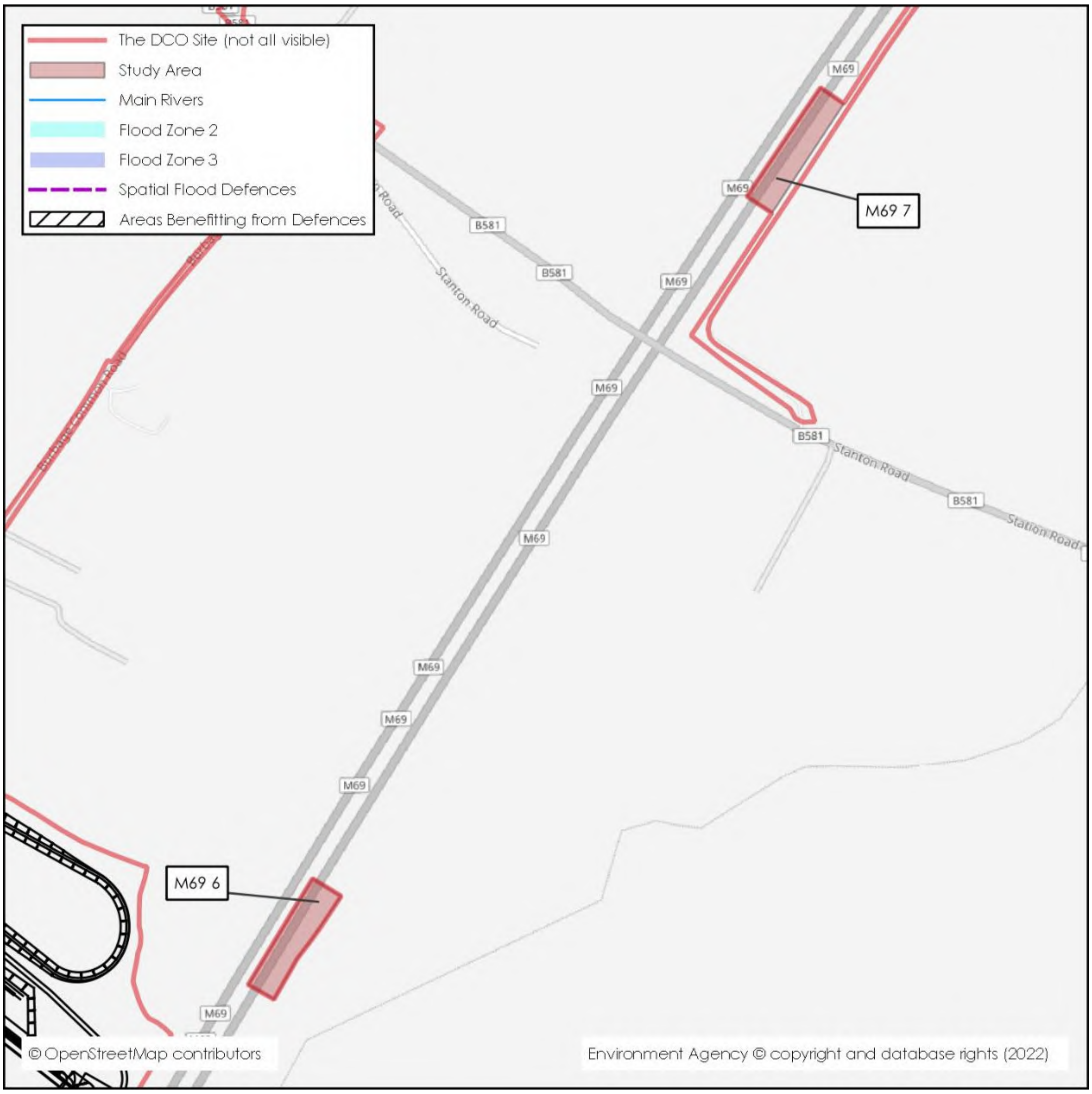


Figure 16.4 Fluvial Flood Risk, M69 North

Surface Water Flood Risk

16.4 These areas are identified to be at a low to very low risk of surface water flooding, as shown in **Figure 16.5** and **Figure 16.6.** Therefore, the surface water floodplain and flood risk to third parties are not expected to be significantly affected by these proposed minor works.

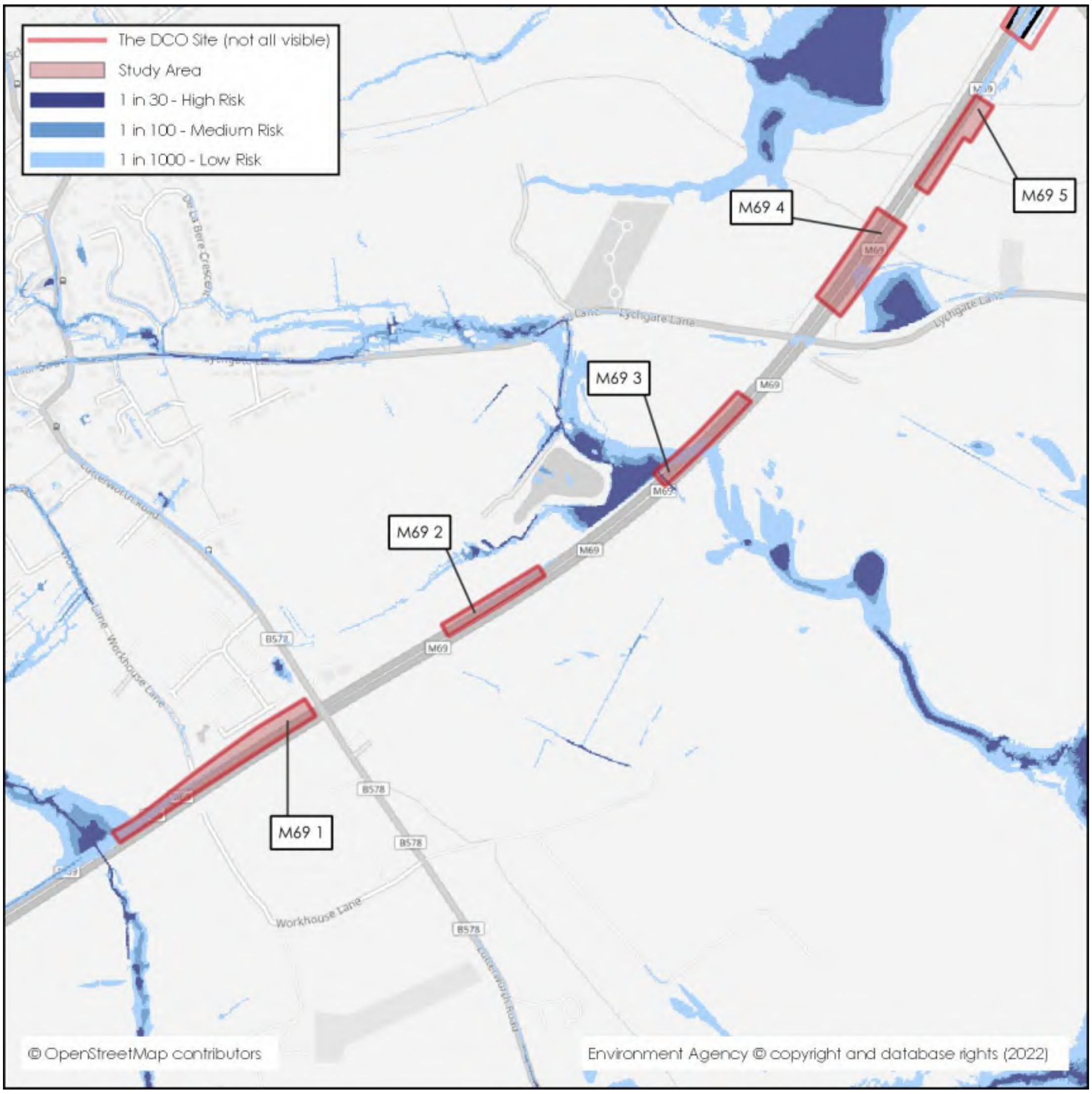


Figure 16.5 Surface Water Flood Risk, M69 South

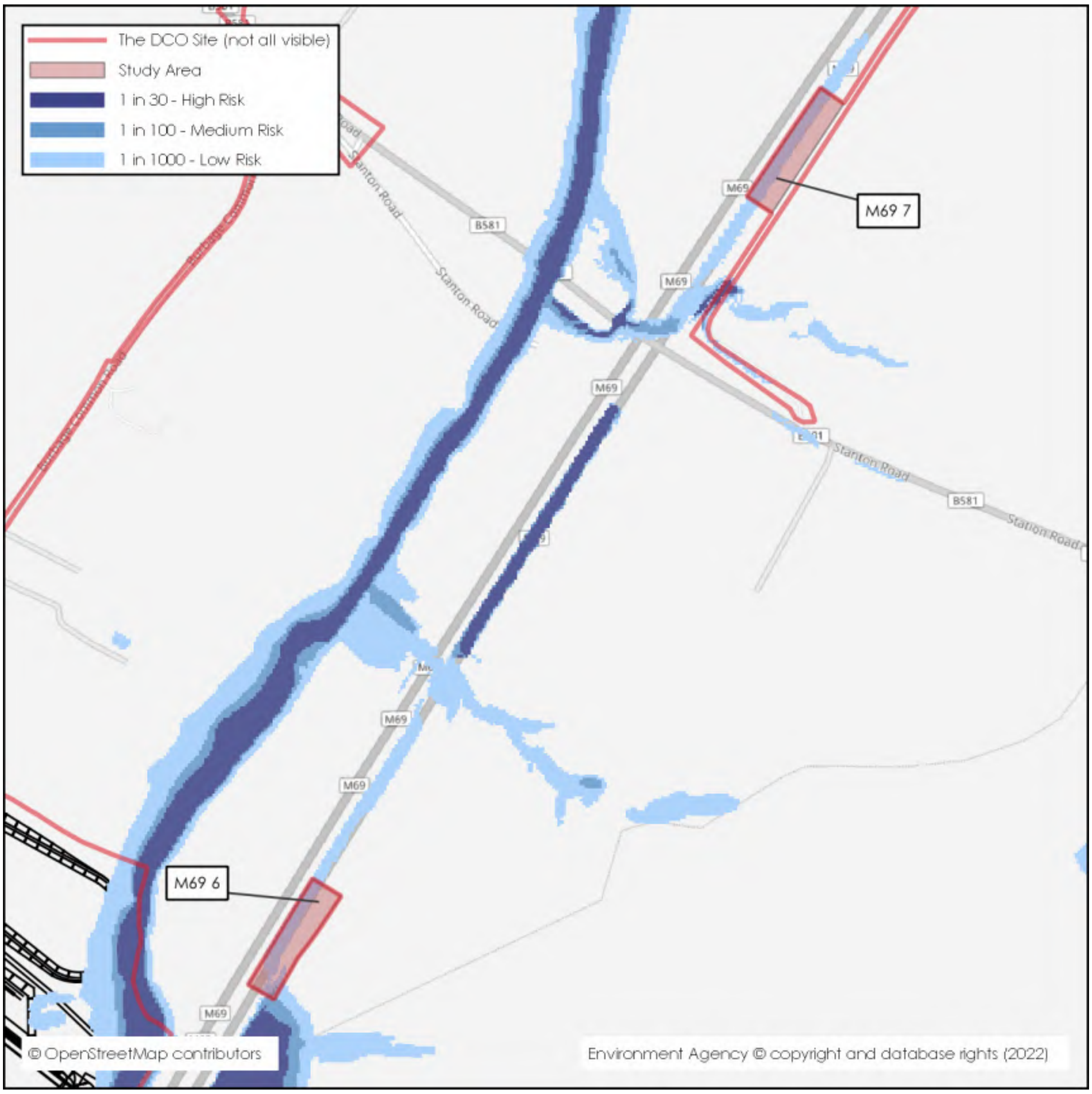


Figure 16.6 Surface Water Flood Risk, M69 North

Groundwater Flood Risk

16.5 British Geological Survey data identifies that the highway is underlain by Mercia Mudstone, with glacial till superficial deposits. The SFRA identifies that 25% to 50% of the local area is potentially susceptible to groundwater flooding.

16.6 Any groundwater emergence is likely to occur in the low-lying areas surrounding the road network. Therefore, the risk of groundwater flooding is considered to be low.

16.7 In any event, the relatively minor proposed works will not detrimentally affect the risk of groundwater flooding in the surrounding area.

Flood Risk from Canals

16.8 There are no canals in a significant vicinity to this stretch of highway, so this potential source of flood risk does not need to be considered further.

Reservoir and Large Water Body Flood Risk

16.9 Reservoir flood risk mapping, prepared by the EA, identifies that these areas are located at a significant distance from any surrounding reservoirs and that they fall outside of flood risk extents as a result of reservoir failure. Therefore, this potential source of flood risk does not need to be considered further.

Sewer & Drainage Infrastructure

16.10 Public sewer records show no assets within the vicinity of these areas.

16.11 The changes to signage on the motorway are not expected to introduce any new impermeable areas or affect the existing drainage infrastructure.

Summary

16.12 Overall, the risk of flooding from the reviewed sources on this highway are all considered to be at an acceptable level. The proposed works are not expected to negatively affect any flood risk in the surrounding area.

17. SUMMARY

17.1 The Hinckley National Rail Freight Interchange DCO Site boundary extends beyond the Main HNRFI Site to include a new link road from M69 Junction 2 to the B4668 (Leicester Road). It also extends to include other highway, junction, and footpath improvements.

17.2 To allow the Flood Risk Assessment (FRA) to present a concise and clear assessment of the Main HNRFI Site, the A47 Link Road, and the M69 Junction 2, this technical note has been prepared to review the flood risk associated with the more minor highway and footpath improvement works. The flood risk at the Main HNRFI Site, the A47 Link Road, and the M69 Junction 2are discussed within the covering FRA (ref: HNRFI-BWB-ZZ-XX-RP-YE-0010_FRA).

17.3 The results of the desktop review are summarised within **Table 17.1**. Given the proposed works are anticipated to have a negligible impact on flood risk, it is not considered necessary to undertake a more detailed assessment of flood risk at each location.

Table 17.1 - Summary of Flood Risk away from the Main HNRFI Site, the A47 Link Road, and M69 Junction 2

Location	Flood Risk Source						
	Fluvial	Coastal	Surface Water	Ground-water	Canal	Reservoirs	Sewers & Drainage
B1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
B2	Located in Flood Zone 1 – Low Risk	No Risk	Moderate Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
B3	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk

Location	Flood Risk Source						
	Fluvial	Coastal	Surface Water	Ground-water	Canal	Reservoirs	Sewers & Drainage
B4 - i	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
B4 - ii	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
B4 – iii	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary
B5	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.

Location	Flood Risk Source						
	Fluvial	Coastal	Surface Water	Ground-water	Canal	Reservoirs	Sewers & Drainage
B6	Located in Flood Zone 3 – High Risk. However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	No Risk	Low Risk	Moderate Risk However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
HB1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
HB2	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, level of risk may be overestimated. Additionally, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.
HB3	*(Assessed within the overarching Flood Risk Assessment alongside the Main Order Limits)*						
H1	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk, subject to improvements being made to the local highway drainage infrastructure, where capacity improvements are identified as necessary.

Location	Flood Risk Source						
	Fluvial	Coastal	Surface Water	Ground-water	Canal	Reservoirs	Sewers & Drainage
R1	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk
R2	Located in Flood Zone 3 – High Risk. However, the proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk
R3	*(Covered within the overarching Flood Risk Assessment alongside the Main Order Limits)*						
R4							
R5	Located in Flood Zone 1 – Low Risk	No Risk	High Risk – however, proposed works are not expected to result in any loss of floodplain storage or interruption of overland flow routes.	Low Risk	Low Risk	No Risk	Low Risk
M69 1 to M69 7	Located in Flood Zone 1 – Low Risk	No Risk	Low Risk	Low Risk	Low Risk	No Risk	Low Risk

BWB

A CAF GROUP COMPANY

[redacted]

APPENDICES

Appendix 2: Thurlaston Brook Tributary Hydraulic Model Report

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange
Leicestershire
Thurlaston Brook Tributary Hydraulic Model Report

[redacted]

BWB

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange
Leicestershire
Thurlaston Brook Tributary 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

August 2022

DOCUMENT ISSUE RECORD

Document Number:	HNRFI-BWB-ZZ-XX-RP-YE-0006_HMR
BWB Reference:	NTT-2814-HMR1

Author:	Robin Green BSc (Hons)
Checked:	Max Brambani BSc (Hons)
Approved:	Matthew Day BA (Hons) MSc FRGS MCIWEM C.WEM C.Sci C.Env

Rev	Date	Status	Comment	Author:	Checked:	Approved:
P01	16/07/21	S0	Draft Issue for Preliminary Review	RG	MB	MD
P02	22/10/21	S0	Updated with latest flow estimates and climate change allowances, and following an Environment Agency review	RG	MB	MD
P03	10/11/21	S2	Updated to reflect the latest DCO Site boundary and development proposals	RG	MB	MD
P04	10/12/21	S2	Updated to reflect the latest DCO Site boundary and terminology. Issued alongside the PEIR.	RG	MB	MD
P05	22/08/22	S2	Updated to reflect the latest DCO boundary	CC	RG	RG

Notice

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after: -

(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 August 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.

CONTENTS

FIGURES

TABLES

APPENDICES

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.

HPC – Heavily Parallelised Compute.

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

m AOD – metres above Ordnance Datum

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

QBAR – annual average runoff rate.

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).

SuDS – Sustainable Drainage Systems

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 river bank, 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 Tritax Symmetry (Hinckley) Ltd is promoting proposals for a new Strategic Rail Freight Interchange on land east of Hinckley, in Blaby District in Leicestershire. A Strategic Rail Freight Interchange (SRFI) is a large multi-purpose freight interchange and distribution centre linked into both the rail and trunk road systems.

1.2 BWB Consulting Ltd has been commissioned by Tritax Symmetry (Hinckley) Ltd to undertake an assessment of surface water and flood risk. This includes identifying the baseline conditions and the potential impacts of the proposed development of these elements.

1.3 To facilitate the assessment of flood risk, site-specific hydraulic modelling has been undertaken. The modelling assessment(s) will be used to inform an FRA of the site and develop a flood risk management strategy for the proposed development.

1.4 The subject of this report is an assessment of an unnamed tributary of the Thurlaston Brook, and an UOW present within the Main Order Limits.

1.5 A preliminary review of the model was undertaken by the EA in September 2021, and following some relatively minor amendments the model was approved as fit for purpose by the EA in March 2022 (ref: ENVPAC/1/EMD/00121).

Site Description

1.6 The Main HNRFI Site lies 3 km to the north-east of Hinckley town centre, to the north-west of M69 Junction 2. The Nuneaton to Felixstowe railway forms the north-western boundary, with the M69 motorway defining the south-eastern boundary. To the south-west are blocks of deciduous woodland (including Burbage Wood, Aston Firs and Freeholt Wood), a gypsy and traveller community site and a mobile home site. Beyond the north-eastern boundary lies the village of Elmesthorpe, a linear settlement on the B581 Station Road.

1.7 The Main HNRFI Site comprises of the proposed SRFI, which includes but may not be limited to; the railway sidings and freight transfer area alongside the two-track railway between Hinckley and Leicester, land for the development of storage and logistics sheds, site hub building, energy centre, and associated lorry and car parking, infrastructure, and landscaping.

1.8 The Development Consent Order (DCO) Site extends beyond the Main HNRFI Site to include other elements including a new link road from M69 Junction 2 to the B4668 (Leicester Road) ('the A47 Link Road'), alterations to Junction 2 itself, and a section of the B4669 towards Sapcote – this larger area is referred to as the Main Order Limits. The DCO site also extends beyond the Main Order Limits to include other minor highway, junction, and railway improvements.

1.9 A location plan illustrating the Order Limits is illustrated within **Figure 1.1**.

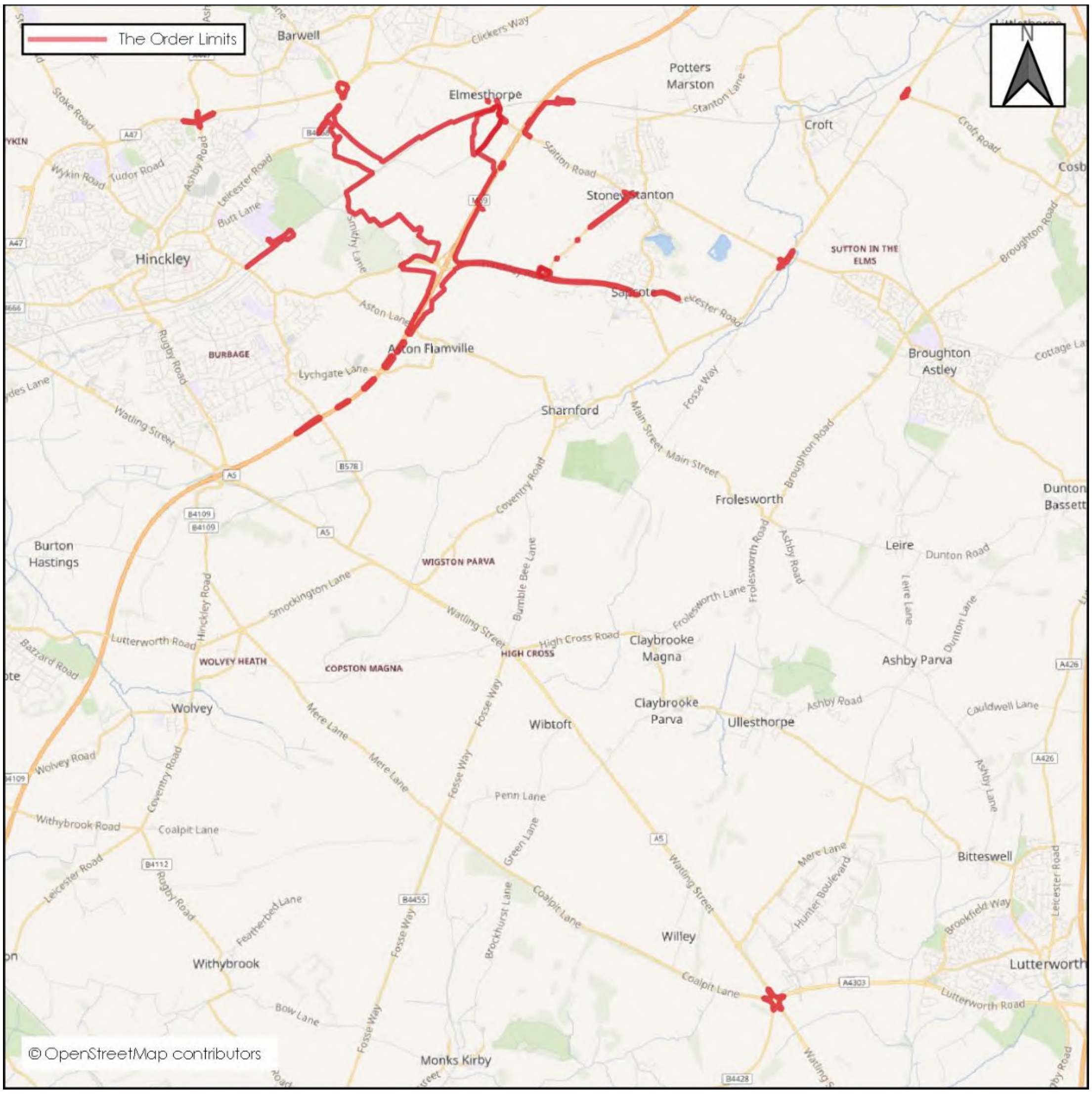


Figure 1.1: Site Location Plan

Watercourse Network

1.10 The watercourse network in and around the Main Order Limits, as shown on OS mapping and identified on a site specific topographical survey, are shown in **Figure 1.2**.

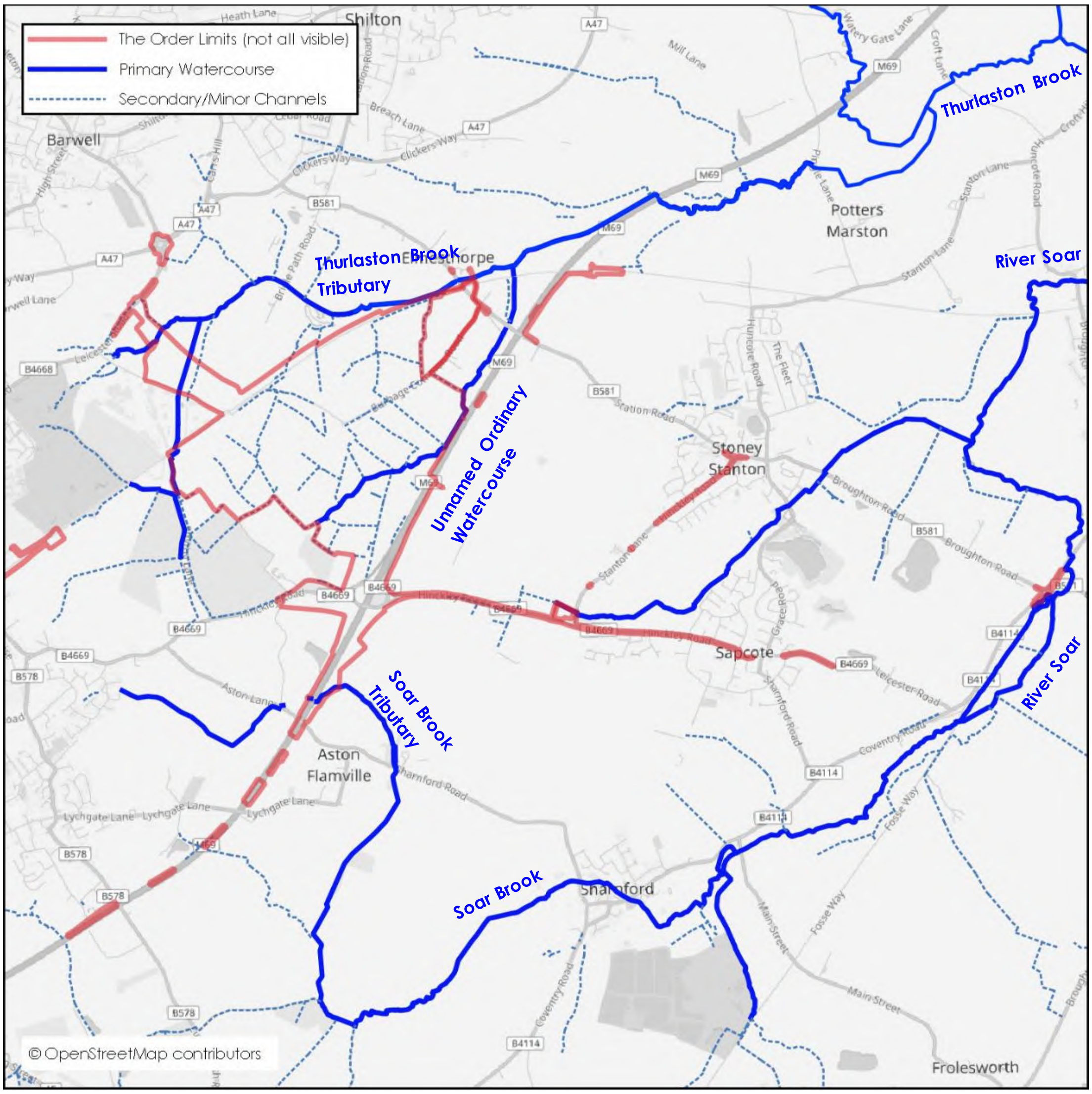


Figure 1.2: Watercourse Network

1.11 The Main Order Limits are predominantly located within the catchment of an unnamed tributary of the Thurlaston Brook. This watercourse issues from the eastern side of Hinckley and flows eastwards across the route of the proposed link road and immediately beyond the railway line to the north of the Main HNRFI Site.

1.12 Five smaller tributary watercourses/ditches serving land to south-west of the Main Order Limits and also land in the north of the Main HNRFI Site pass beneath the railway line and join the unnamed tributary of the Thurlaston Brook as it flows to the north of the Main HNRFI Site.

1.13 An UOW flows north-eastwards through the south-eastern portion of the Main HNRFI Site before joining the tributary of the Thurlaston Brook just downstream of the railway line.

1.14 This UOW issues within the Main HNRFI Site, rather than being fed by a significant upstream catchment. Additionally, within the Main HNRFI Site, several field drainage ditches and small ponds also discharge into this watercourse.

1.15 Downstream of the Main HNRFI Site, the Thurlaston Brook tributary continues to flow north eastwards. It passes beneath the M69 and joins the Thurlaston Brook approximately 3.5km downstream of the Main HNRFI Site.

1.16 The Soar Brook tributary issues from the south-eastern side of Hinckley. This flows beneath the M69, to the south west of Junction 2, and through the Order Limits for a short length, before turning south-east and flowing away from the DCO Site.

1.17 This report discusses the hydraulic assessment of the unnamed Thurlaston Brook tributary and UOW within the vicinity Main Order Limits. The watercourses assessed are identified within **Figure 1.3**. As these are unnamed, the reaches have been numbered for the purpose of this report for ease of reference.

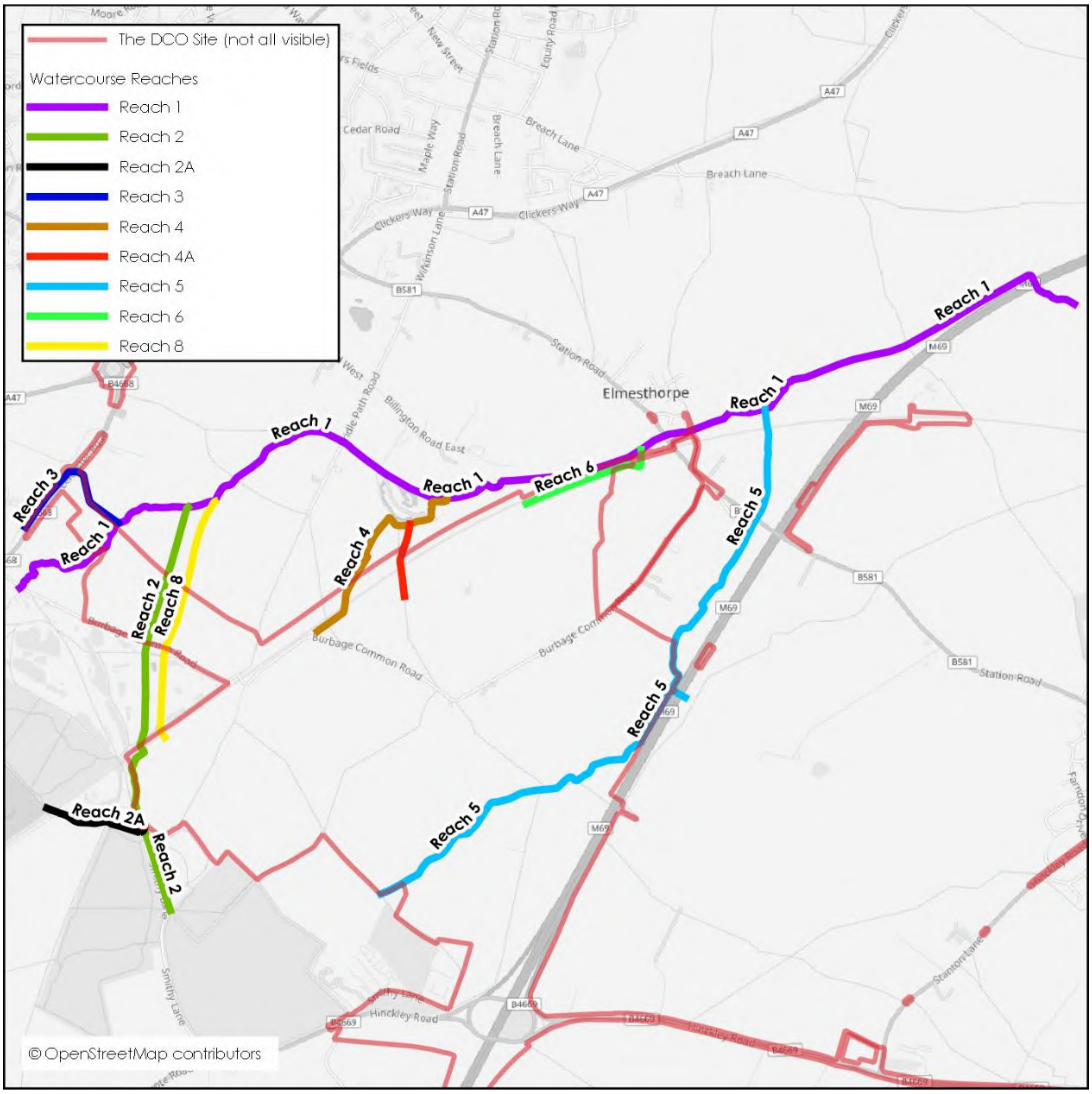


Figure 1.3: Modelled Reaches

1.18 The smaller channels present within the area have been omitted as they either just serve runoff from within the Main HNRFI Site itself or are not considered to pose a significant hydraulic influence on flood risk. Instead, these will be represented in the 2D floodplain model domain. However, their contributing catchments will be fully included in the applied flood flows.

Topography

1.19 The topography of the local area is illustrated within **Figure 1.4** using a combination of LiDAR and Photogrammetry DTMs. This identifies that the watercourses generally follow the natural topography.

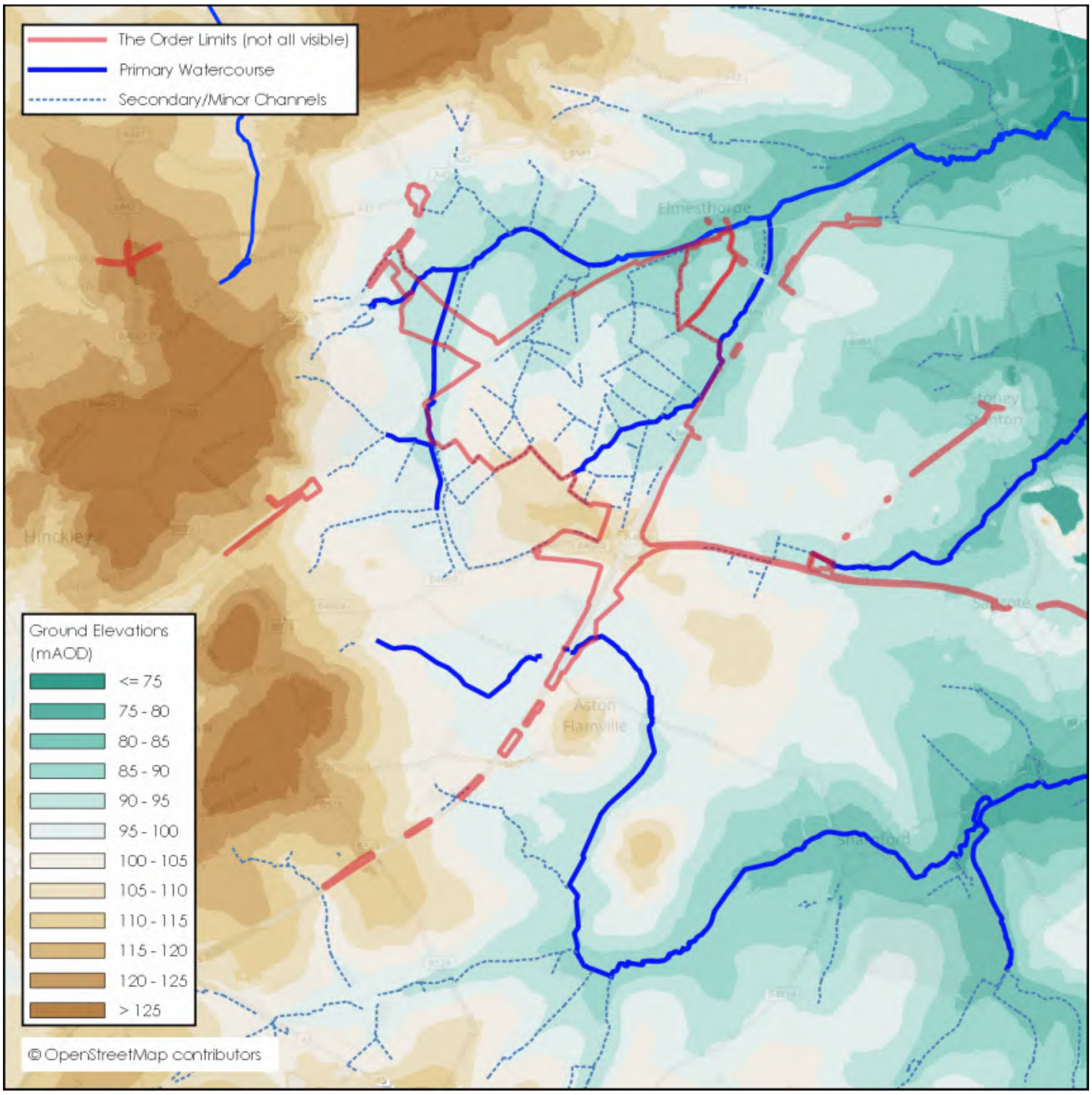


Figure 1.4: Catchment Topography

2. PREVIOUS STUDIES & AVAILABLE DATA

Flood Map for Planning

2.1 With particular reference to planning and development, the Flood Map for Planning produced by the EA identifies Flood Zones in accordance with Table 1 of the Planning Practice Guidance (PPG). The mapping is based upon generalised strategic scale models of 'main rivers' and of catchments greater than 3km^2. An extract of the mapping is provided within **Figure 2.1**.

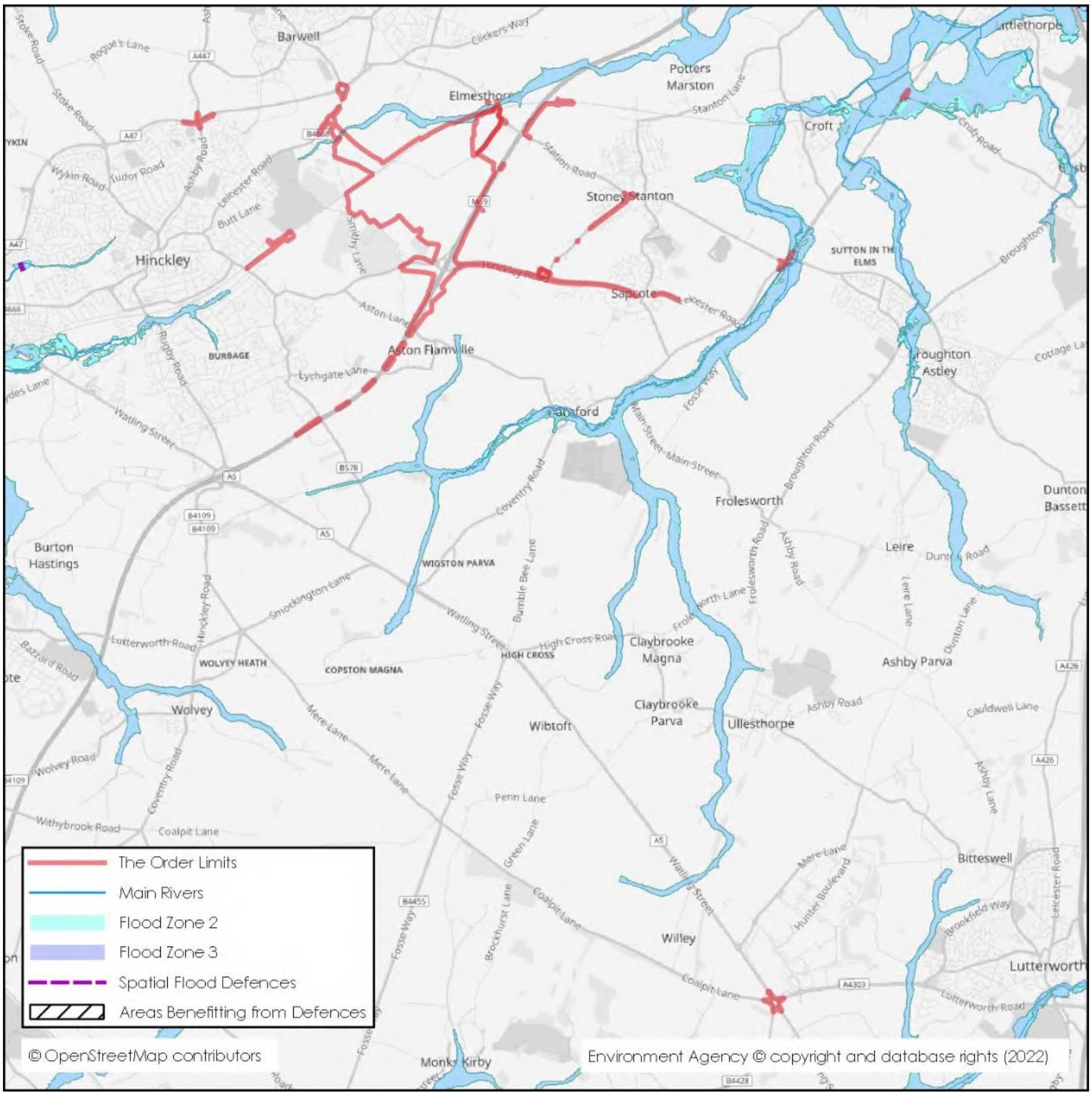


Figure 2.1: Flood Map for Planning

2.2 The mapping clearly omits most of the watercourses within the vicinity of the Main Order limits, and so is not a reliable data source.

2.3 Also, the mapped floodplain does not consider the projected impacts of climate change, and is based upon strategic level modelling where culverts and other hydraulic structures are either crudely represented or not represented at all.

Flood Risk from Surface Water Map

2.4 Risk of flooding from surface water mapping has been collated and published by the EA. This 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. While not strictly a fluvial source, this data can provide an indication of the potential floodplain of smaller watercourses not included within the Flood Map for Planning.

2.5 An extract of the Flood Risk from Surface Water maps is provided within **Figure 2.2** and **Figure 2.3**. These show that there is the potential for a floodplain to form on the various watercourses present in the Main Order limits.

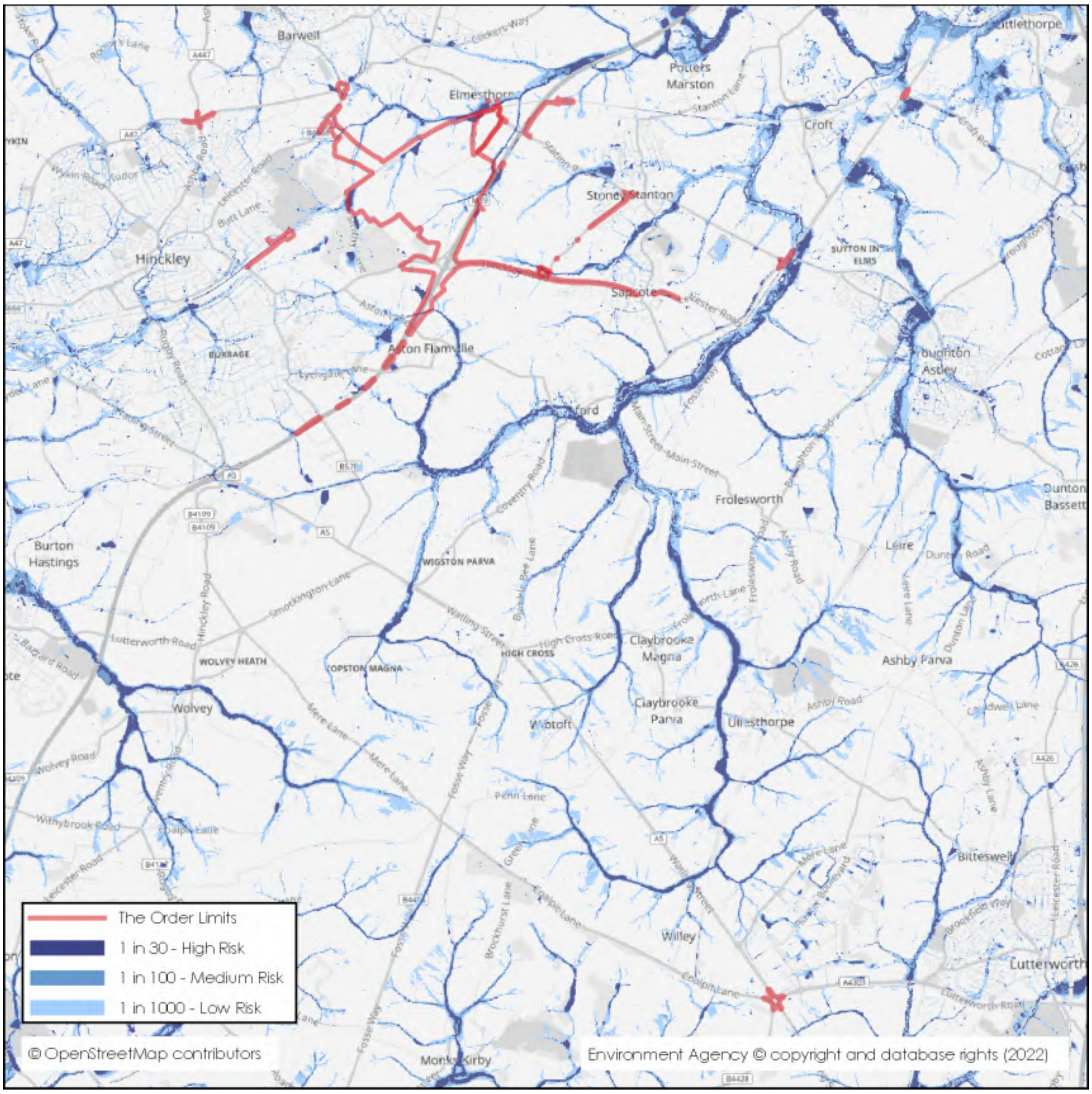


Figure 2.2: Flood Risk from Surface Water 1

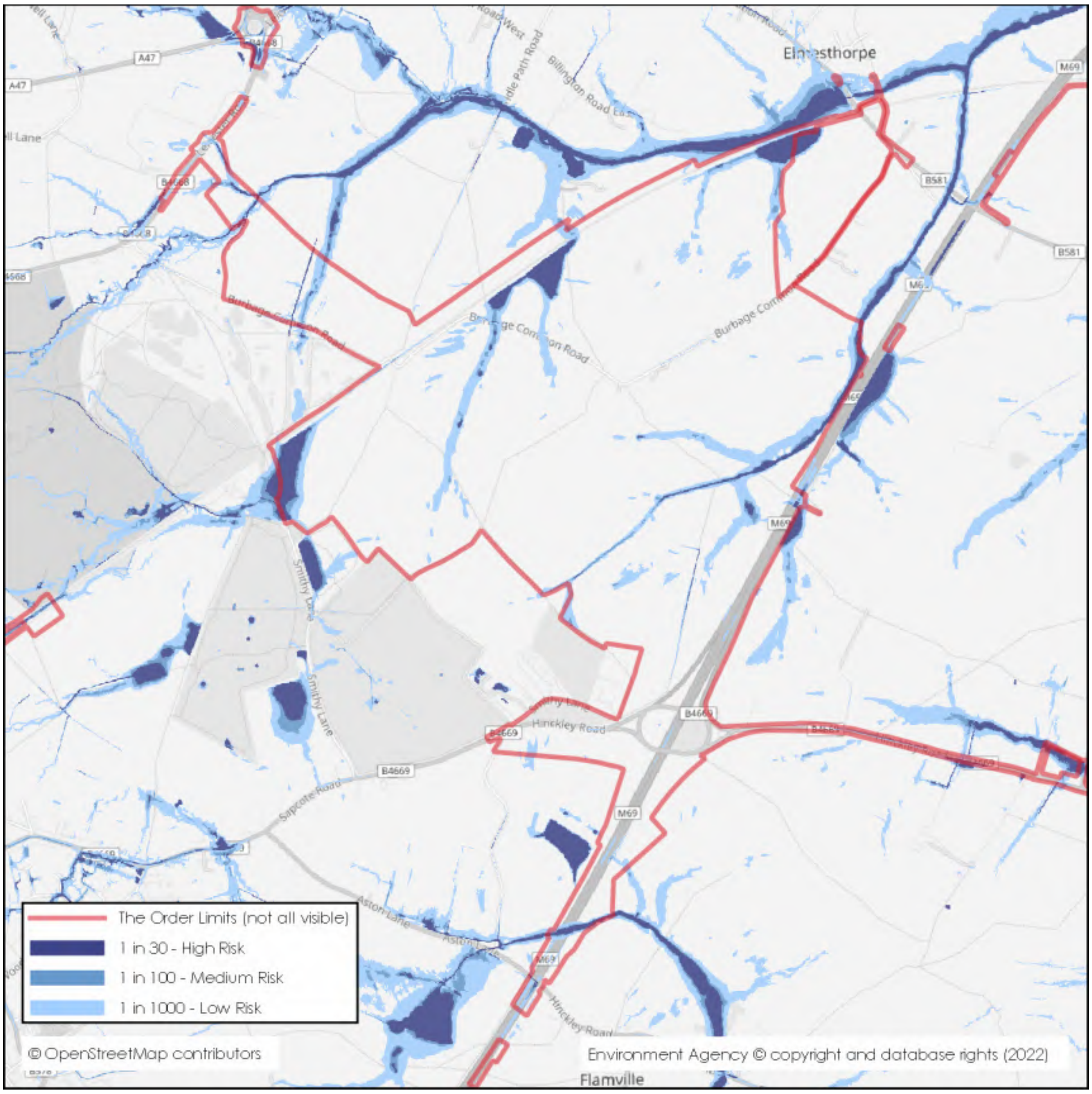


Figure 2.3: Flood Risk from Surface Water 2

2.6 While this data is considered to be more representative than the Flood Map for Planning, it is still of a strategic scale and is unsuitable for a site-specific assessment.

2.7 Additionally, in previous correspondence the EA identified their preference for a hydraulic assessment of the floodplain to be derived from FEH flow estimation methods, rather than the direct rainfall approach as used in the Flood Risk from Surface Water maps.

Preceding Hydraulic Studies

2.8 The EA and LLFA have confirmed that their hydraulic models do not provide coverage of the site.

2.9 Hydrock Engineering started to prepare a bespoke hydraulic model in support of the site. However, this was not completed, and it only covered a short reach of the UOW (Reach 5) within the Main HNRFI Site. Therefore, this is not suitable for an assessment of flood risk across the full site.

LiDAR & Topographical Surveys

2.10 Composite LiDAR coverage (2019) from the EA is illustrated in green within **Figure 2.4**. This is composed of data captured across 2008 and 2011 at the Main Order Limits. Resolutions of 1m and 2m are available for the area, 2m was used in this study as it provided a greater coverage.

2.11 The available topographical survey coverage (ref: 24975) of the Main HNRFI Site is shown in grey in **Figure 2.4**. This was captured between March and June 2018.

2.12 A topographical survey of the railway line between Burbage Common and the M69 was also available (ref: 25547). This was captured in June 2018 and confirms the elevation of the railway line where it is on embankment or in cut passed the Main HNRFI Site.

2.13 While the topographical survey provides a good coverage of the Main HNRFI Site, this does not extend beyond the development area. The available LiDAR coverage from the EA is also limited, with the floodplain downstream of the DCO Site being omitted. The area to the east of the M69 is also omitted from the LiDAR coverage. This area is of interest as a proportion of the area drains beneath the M69 and into the Main HNRFI Site.

2.14 LiDAR is the preferred dataset to model floodplains. The data is put through a filtering process to remove buildings and vegetation to provide a 'bare earth' surface, suitable for floodplain modelling. LiDAR is widely used in the national EA hydraulic model catalogue. The dataset has a typical resolution of 1-2metres, a vertical accuracy of 5-15cm +/- RMSE, and a horizontal accuracy of 40cm +/- RMSE.

2.15 Therefore, the preferred approach would be to extend the LiDAR coverage to include the area that currently falls outside of the of the existing LiDAR coverage and the topographical survey.

2.16 A bespoke aerial LiDAR survey was completed in June 2021 which infilled most of the area omitted by the EA LiDAR and topographical site survey. This is shown in yellow in **Figure 2.4**.

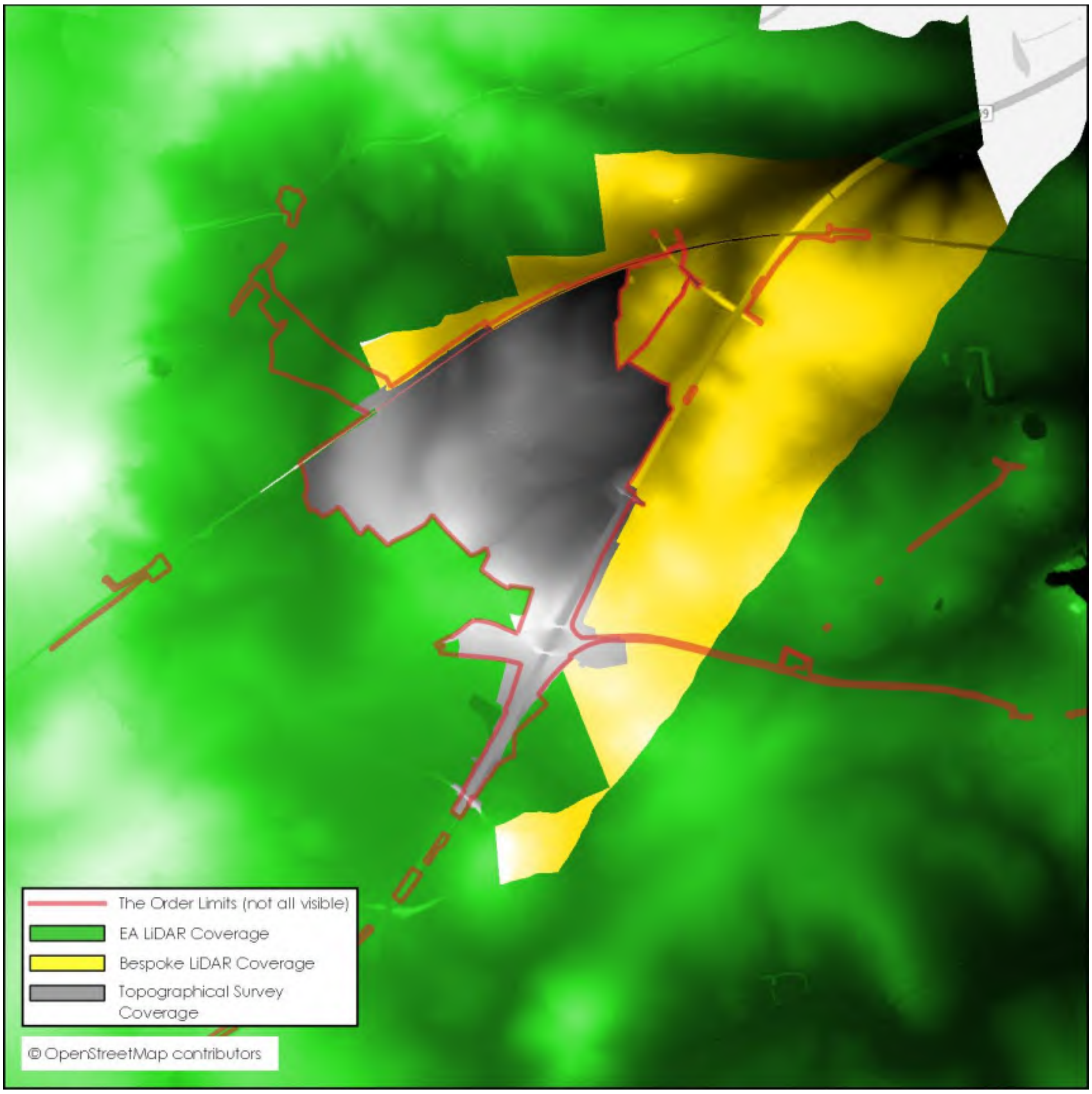


Figure 2.4: LiDAR and Topographical Survey Coverage

2.17 Any remaining areas outside of the LiDAR and survey coverage were considered sufficiently far removed from the study site to not require supplementary surveys. Therefore, the ground levels in these areas were informed by 5m DTM photogrammetric data (captured by Bluesky in April 2020).

Watercourse Survey

2.18 The topographical survey includes detail of the channel and hydraulic structures present in the Main HNRFI Site. To inform the hydraulic model outside of this, a topographical survey of the watercourse channels was commissioned. This involved surveying cross-sections through the channel at regular intervals. The survey also captured details of hydraulic structures.

2.19 The watercourse survey was undertaken between May and June 2021. Sections were surveyed through the channel and adjacent floodplain in targeted locations which captured the general condition and shape of the open watercourses. Additional sections were taken on the upstream and downstream face of hydraulic structures.

2.20 During the survey, the resolution of the section spacing was affected by dense vegetation, and certain reaches were inaccessible either because landowner permission was not granted, or because the channel was heavily vegetated. As those reaches are outside of the DCO Site, vegetation clearance could not be undertaken.

2.21 Where reaches were inaccessible, they were instead modelled within the 2D domain. The key hydraulic structures on these reaches were still modelled in the 1D domain using supplemental information from asset records available from Network Rail, Leicestershire Highways, Highways England, or observations, and hand measurements made during the site visits. The application of the available sources through the study area is illustrated within **Figure 2.5**.

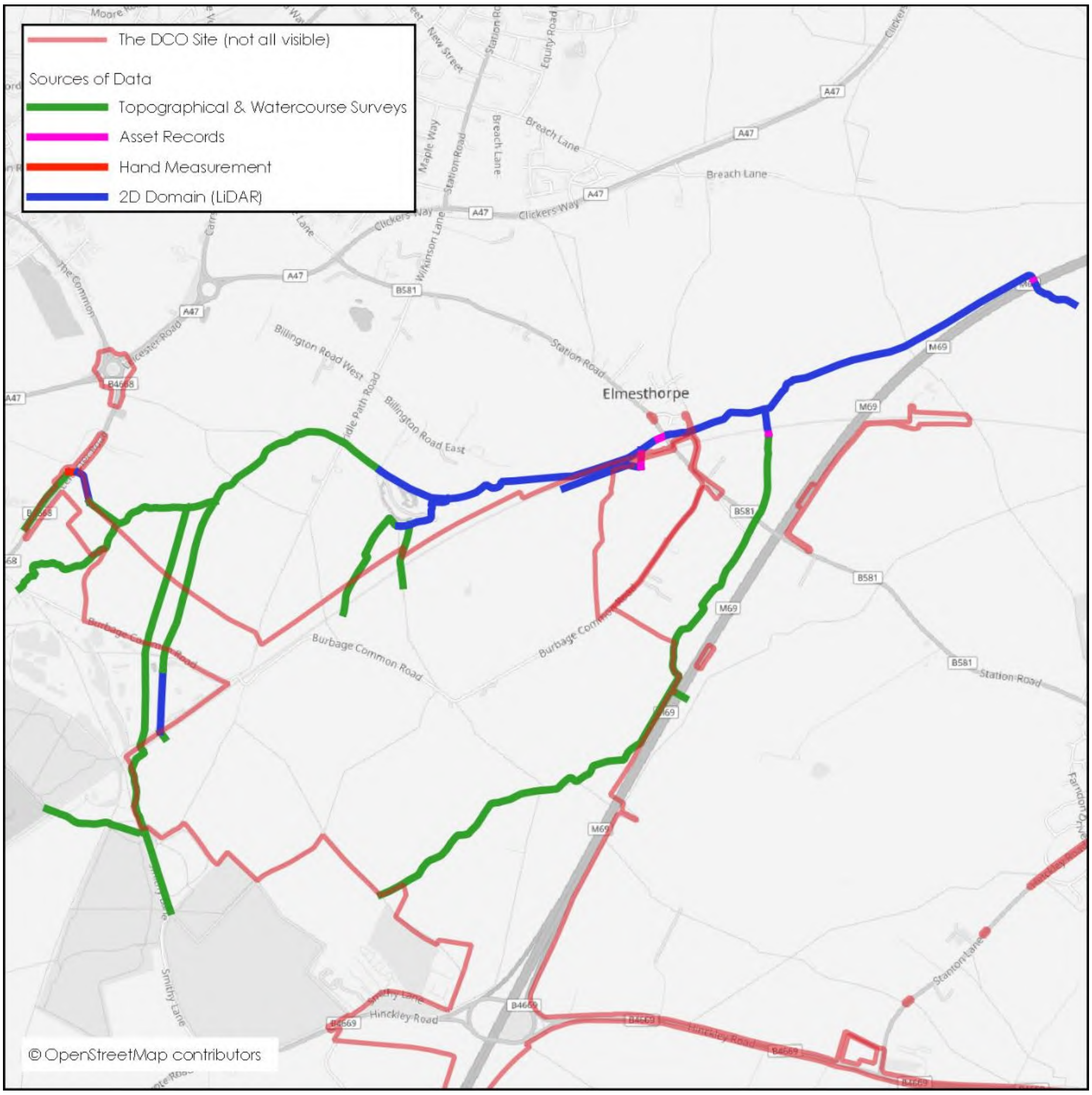


Figure 2.5: Watercourse & Hydraulic Structure Sources of Data

2.22 While the coverage of the available survey data is a limitation of the study, the inaccessible reaches are outside of the Main Order Limits, so the flood risk within the area of interest can still be assessed sufficiently. Also, the modelling approach will still allow for a like-for-like comparison between the baseline and proposed conditions, which will allow the development's potential impact on the downstream flood risk to still be assessed.

Other Sources of Data

2.23 The following additional datasets were used within the hydraulic modelling exercise:

- OS mapping
- Photographs and observations from site visits undertaken between January and June 2021 by BWB Consulting
- A hydrological assessment of Flood Flows undertaken by BWB Consulting (included as Appendix 1).
- Public Sewer Records
- NRFA Peak Flow Dataset (version 9)
- Leicestershire Highways Asset records
- Highways England Asset records
- Network Rail Asset records

3. AIMS AND OBJECTIVES

3.1 The primary aim of this modelling exercise was to establish a good hydraulic representation of the watercourse network associated with the Thurlaston Brook tributary within the Main Order Limits. The model will be used to identify the current level of fluvial flood risk to these site areas, as well as assist in the design of a flood management strategy for the development.

3.2 To achieve this aim, the following objectives were identified:

i. Create a 1D hydraulic model of the hydraulic structures and watercourse channels where access could be achieved, or asset data was available.

ii. Create a 2D representation of the site and surrounding floodplain. Create a 2D representation of the channels where access for survey could not be achieved.

iii. Undertake a hydrological assessment of the catchment to estimate peak flood flows and generate flood hydrograph profiles.

iv. Simulate flood events within the combined 1D-2D model to establish a set of baseline conditions.

v. Simulate sensitivity tests and residual risks within the model, which would include roughness coefficients, blockage scenarios, downstream boundary gradient, storm duration, variations in flows, and climate change.

vi. Develop an outline flood management strategy within the model to remove the proposed development areas from the design floodplain.

vii. Compare existing and proposed conditions to ensure that the development will not have a negative effect on flood risk in the wider catchment.

4. HYDROLOGY REVIEW

Flood Flow Estimation

4.1 A hydrological review of the Thurlaston Brook tributary upstream of the M69 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 guidance. This assessment is documented within **Appendix 1**.

4.2 In summary, there was no hydrometric data available in the study catchment to inform the hydrological analysis. The nearest gauged data was at Littlethorpe on the River Soar downstream of the study catchment. Observed flows from this gauge were considered in a statistical analysis.

4.3 The industry standard FEH statistical method and ReFH2.3 rainfall-runoff model were both reviewed, and the ReFH2 method was determined to be the most suitable for a site-specific hydraulic model as it produced the more conservative flow estimates.

4.4 While conservative estimates are not necessarily the 'correct' estimates, given the exercise will be supporting an assessment of flood risk, and given the lack of site-specific flow information, a precautionary approach was considered appropriate.

4.5 The flow estimates were made at the downstream extent of the site, and therefore represent runoff generated upstream and from within the site.

4.6 The catchment area was updated using a watershed analysis to improve its accuracy. The catchment was compared against public sewer records which showed that no cross-catchment transfers are present – the sewer networks generally follow the topographical catchment.

4.7 ReFH2 was also used to derive the hydrograph shape for the flood events, and a recommended storm duration: 9.0-hours. However, storm duration sensitivity testing in the hydraulic model (see **Section 7**) identified that a 13.5-hour storm produced slightly more conservative peak water levels in the study area. Therefore, the 13.5-hour event was adopted in the model. The peak flows are compared within **Table 4.1**.

Table 4.1: ReFH2 Derived Peak Flood Flows for the Study Catchment

Return Period Event (Yrs)	Annual Exceedance Probability (AEP)	Peak Flow (m^3/s)	
		9.0-hour Duration	13.5-hour Duration
1 in 5	20%	3.7	3.7
1 in 10	10%	4.3	4.3
1 in 20	5.0%	5.0	5.0
1 in 50	2.0%	6.2	6.2
1 in 75	1.3%	6.9	6.8

Return Period Event (Yrs)	Annual Exceedance Probability (AEP)	Peak Flow (m^3/s)	
		9.0-hour Duration	13.5-hour Duration
1 in 100	1.0%	7.4	7.3
1 in 1000	0.1%	13.1	12.8

Flow Distribution

4.8 The estimated flood flows were distributed across the model on an area weighted basis, as shown in the accompanying hydrology report. The sub-catchments were derived from a watershed analysis based on the combined LiDAR, and photogrammetry DTMs. Sub-catchments were delineated at large tributary inflows, and at locations where the floodplain is bisected by significant embankments (such as Station Road, the railway line, and the M69).

The Design Flood

4.9 The PPG identifies that new development should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.

4.10 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) flooding likely to occur with a 1.0% AEP (a 1 in 100 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

4.11 Predicted future change in peak river flows caused by climate change are provided by the EA within their online guidance[1], with a range of projections applied to a series of 'Management Catchments' within regionalised 'River Basin Districts'. The Thurlaston Brook falls within the 'Soar' Management Catchment of the 'Humber' River Basin District. **Table 4.2** identifies the relevant peak river flow allowances.

Table 4.2: Peak River Flow Allowance for the Soar Management Catchment, located 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	28%	35%	60%
Higher Central	18%	21%	37%
Central	14%	16%	28%

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

4.12 The development has an anticipated lifespan of over 60 years and the site includes a mix of land uses and Flood Zones that would require assessment of the Central and Higher Central allowances for the 2080's. Also, although the guidance does not specifically reference this requirement, it is generally advised that nationally significant infrastructure projects consider a high impact climate change scenario – such as the upper end allowance.

4.13 Therefore, to estimate the potential future design floodplain under a range of scenarios, the Central, Higher Central and Upper End climate change allowance for the 2080s have been applied to the 1 in 100-year flood flows. The EA recommended in preliminary consultations that the allowances are rounded up to the nearest 5%. Therefore, allowances of +30%, +40%, and +60% will be assessed.

4.14 When determining the potential off-site impacts of a proposed development its vulnerability is not critical, instead the land use in the wider floodplain needs to be considered. In their online guidance, the EA advise that generally it is appropriate to use the Central allowance. Therefore, the impact of the proposed development will be assessed at events up to the 1.0% AEP + 30%.

5. THE HYDRAULIC MODEL

Modelling Approach

5.1 A dynamically linked 1D-2D modelling approach was adopted: the in-channel conditions and hydraulic structures were modelled within a one-dimensional (1D) ESTRY domain; and the out of bank flow routing and floodplain was modelled within a two-dimensional (2D) TUFLOW domain.

5.2 Both ESTRY and TUFLOW are standard hydraulic modelling packages widely used in the UK, and have been benchmarked by the EA.

5.3 TUFLOW & ESTRY version 2020-10-AB-iDP-w64 (HPC) were used in the hydraulic model study.

The 1D Model Domain

5.4 The watercourse survey included 113 sections through the channel and immediate floodplain. These were supplemented with an additional 21 river sections on Reach 5 which were extracted from the site topographical survey.

5.5 The model includes 53 hydraulic structures derived from the topographical, and watercourse surveys, as well as from data provided within Network Rail, Leicestershire Highways and Highways England records, and hand measurements made during a site visit. The details of the hydraulic structures are described within **Appendix 2**.

5.6 Generally, the spill over hydraulic structures were modelled in the 2D domain, but at very short structures the deck was too small to be picked up correctly. In such instances, the spill was added to the 1D domain as a weir over the top of the structure.

5.7 The channel sections were generally truncated at top-of-bank, at what would be the interface with the 2D model domain. However, in some instances the section, and interface with the 2D domain, was extended into the floodplain to avoid overly narrow reaches. A minimum channel width of approximately 4m was achieved.

5.8 Roughness values were derived from observations made during the survey and site visits, based on appropriate Manning's 'n' value from Chow (1959)[2]. Examples are provided within **Appendix 3**.

The 2D Model Domain

5.9 EA 2.0m resolution LiDAR DTM data was used as a base for the 2D floodplain; this has undergone a filtering process to remove buildings and vegetation to provide a 'bare earth' ground model. The 2.0m DTM was used in preference to the 1.0m DTM as it provided greater coverage and mirrored the proposed model grid resolution. This was

[2] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill Book Co., 680 p

supplemented with the bespoke LiDAR data captured for the purpose of this assessment.

5.10 The site topographical survey, and railway line survey were applied on top of the LiDAR data as DTMs.

5.11 A 2.0m x 2.0m resolution was adopted for the TUFLOW model grid; this is considered to be more than sufficient given the rural nature of the floodplain, but necessary due to the narrow 1D channel width in certain locations.

5.12 Although the 2.0m cell size will pick up most of the significant topographic features, river bank levels from the watercourse survey, in combination with supplementary data from the LiDAR and topographical survey, were used to reinforce the river bank through the use of a 'Z-line' layer.

5.13 Additionally, the channels represented in the 2D domain were reinforced using a z-shape layer, as informed by the available survey and LiDAR.

5.14 Floodplain roughness was represented in the model through incorporation of an appropriate Manning's 'n' value. These values were determined from an assessment of the land use types included in the OS digital data GIS files. The data contains different layers of land use type in the form of lines and polygons, which can be transferred to a material layer. Each type of land use was assigned an ID which was then linked to the Manning's 'n' values in the material files. The list of Manning's 'n' values used in the model is presented in **Table 5.1**.

Table 5.1: Floodplain Roughness Values

Roughness Code	Description	Manning's n'
11	General Surface	0.035
1	Buildings	0.300
6	Water	0.040
2	Roads tracks and paths	0.015
3	Hardstanding	0.020
8	Woodlands	0.060
5	Gardens (to account for fences and hedges)	0.100

5.15 Buildings, walls, and other structures were modelled at ground level in line with best practice. Buildings were given an elevated roughness value so that the structures resistance to flow is partially represented. There are no buildings present within the floodplain in the site, so this approach is considered appropriate.

5.16 The 2D model domain was digitised to meet higher ground levels on either side of the floodplain and extended to mirror the upstream extents of the 1D domain. The 2D domain was extended beyond the 1D domain, to the downstream side of M69 culvert to provide a sufficient offset from the study area.

5.17 The results downstream of the surveyed area should be treated with caution, as they are predominantly based upon LiDAR. However, the model provides sufficient detail within the study area, and the inclusion of the downstream reaches continues to allow for a like-for-like analysis of potential off-site impacts that could occur as a result of the proposed development. Therefore, this limitation does not diminish the aims of the exercise.

5.18 The surveyed watercourse channel(s) were deactivated within the 2D domain, so that they were only represented by the 1D domain. This included land over hydraulic structures where the spill was also modelled in the 1D domain.

Boundary Conditions

1D-2D Interface

5.19 The ESTRY-TUFLOW interface was digitised on top of the bank lines; a HX (External Head) boundary was adopted as the interface type in line with best practice.

Inflows

5.20 The flood flow hydrographs described in **Section 3** were applied to the 1D ESTRY domain as flow-time (QT) boundaries.

Downstream Boundary

5.21 An automated Head-Flow (HQ) boundary was adopted as the downstream boundary. This was applied at the downstream extent of the 2D domain, on the downstream side of the M69. The boundary was drawn perpendicular to the general direction of flow, and the gradient was measured from the LiDAR data.

Initial Conditions

5.22 An approximate ‘baseflow’ event was created by using the starting flow value form the flood hydrographs (at t=0). This was applied as a constant flow through the model until flow in equalled flow out. A restart file was generated from this event to act as the initial conditions for the flood event simulations.

Calibration

5.23 As there was no hydrometric data, historic flood mapping, or representative strategic flood maps available, the model could not be directly calibrated against existing data.

5.24 However, it is believed that the conservative approach to the model build should offer a sufficiently robust model for the purposes of assessing flood risk at the site.

Simulation Parameters

5.25 A timestep of 1.0 second was adopted for the 2D TUFLOW domain, this is representative of ½ of the adopted grid size and is therefore within the typical range.

5.26 A timestep of 0.5 seconds was adopted for the 1D ESTRY domain, this is an equal interval of the 2D timestep, and is therefore in line with best practice.

5.27 All TUFLOW and ESTRY parameters were retained as default.

5.28 Initial simulations were undertaken at single precision. This identified that the 1D domain was subject to an initial peak in mass error in the region of +/-3.0%, before falling back to a more acceptable range within +/-1.0%. This is thought to be due to the relatively low flows present in the model. To overcome this initial spike of mass error, double precision was enabled which reduced mass error for the entire simulation to within +/-0.5%.

5.29 Flood events were simulated for 24-hours, to allow the flood flows generated by the 13.5-hour critical storm event to flow through the site and start to recede.

Stability

5.30 During all simulated events there were no recorded 1D or 2D negative depths.

5.31 The cumulative mass error stayed below +/- 1.0% for all simulations, and so was within the accepted tolerance levels. This is illustrated for within **Figure 5.1**, as an example.

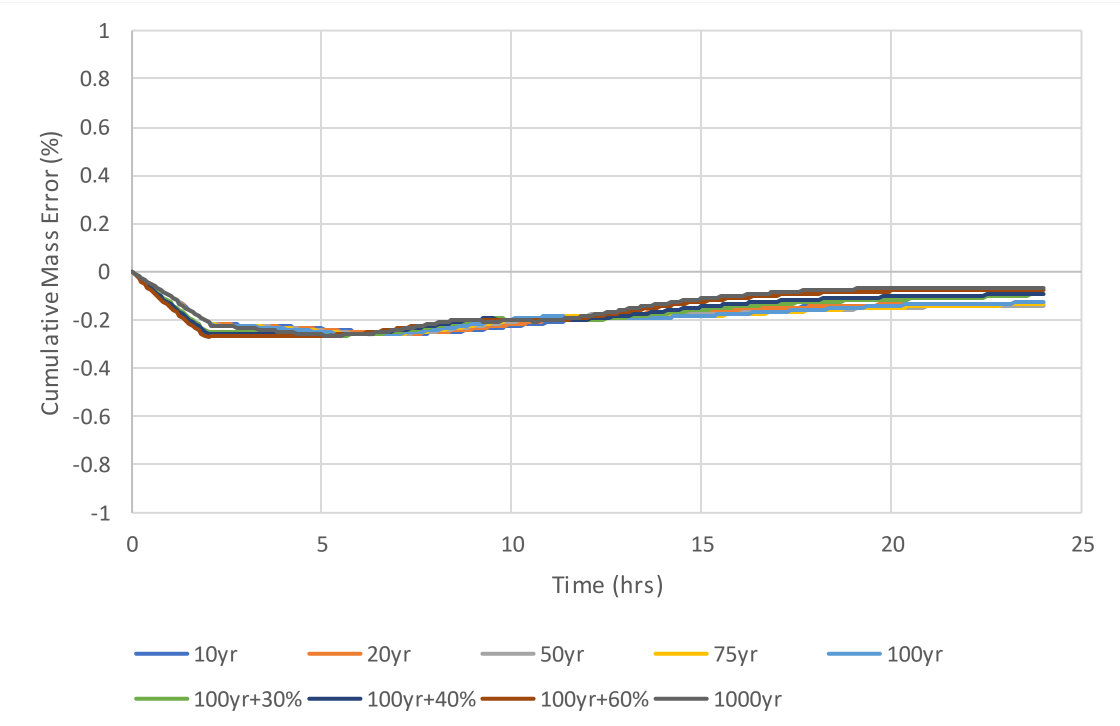


Figure 5.1: Cumulative Mass Error Time Series

6. BASELINE RESULTS

6.1 The results from the existing conditions model are mapped within **Appendix 5**, and are also summarised within **Figure 6.1** for ease of reference.

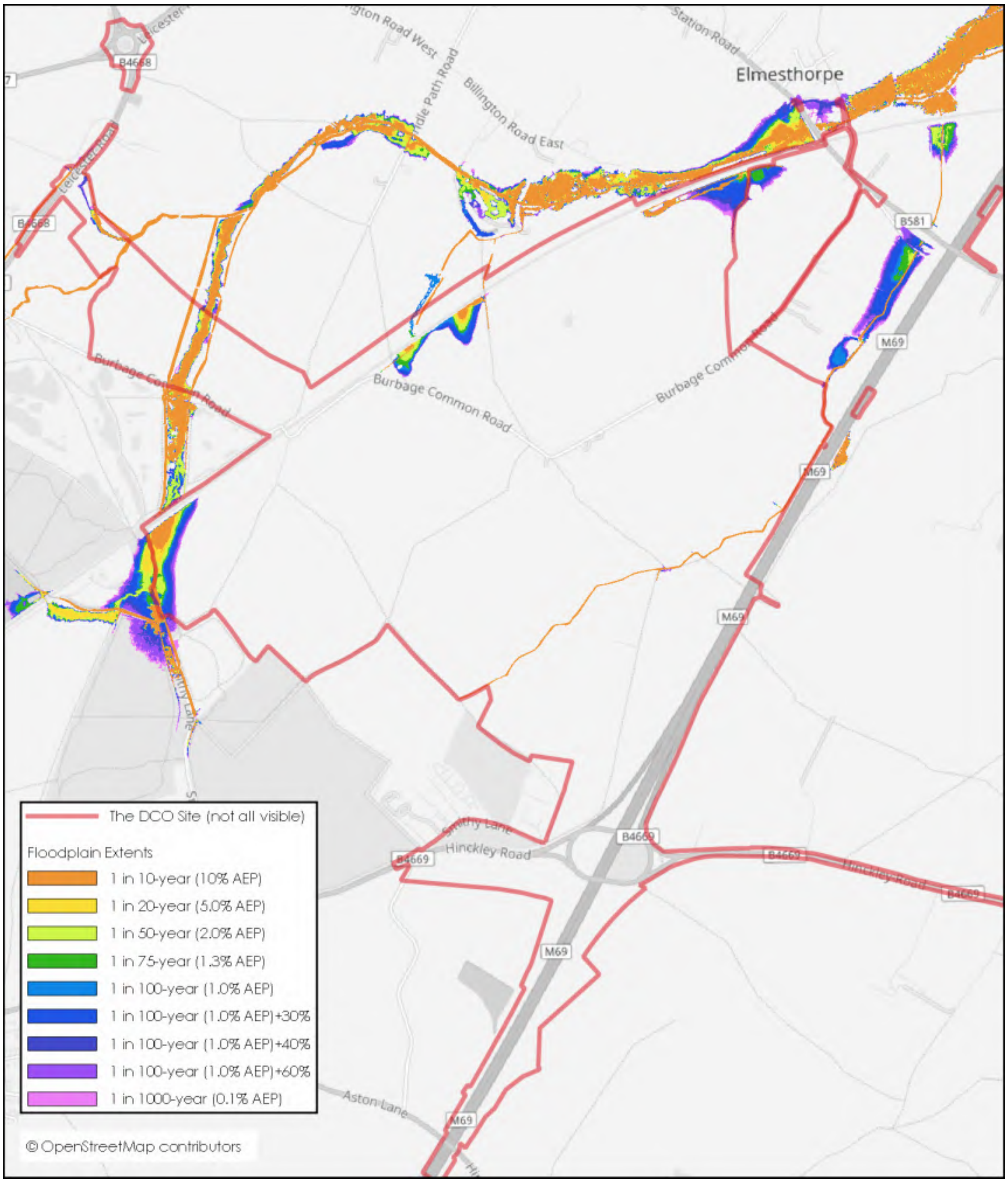


Figure 6.1: Baseline Floodplain Extents

6.2 The baseline results suggest that the flood risk from Reach 1 to the study area is limited, with flows remaining within bank until the confluence with Reach 2 downstream of the Main Order Limits. The floodplain extents on Reach 1 increase downstream of the Main Order Limits as it is joined by Reach 3, 2, 8, 4, 4A and then 5. However, downstream of Reach 4 and 5 the channel capacity may be underestimated due to the 2D modelling approach. Therefore, the floodplain extents may be overestimated.

6.3 The floodplain of Reach 2 and 2A interact and join to the west of the of Main Order Limits, where flood water builds upstream of the railway line due to the restrictive culverts beneath the embankment. Downstream of the railway line, a significant overland flow route forms in a topographical depression located between Reach 2 and 8. The overland flow route flows in parallel to Reach 2 and 8, through the Main Order Limits, and outfalls into Reach 1 downstream of the Main Order Limits.

6.4 A relatively minor overland flow route forms on Reach 3 within the Main Order Limits downstream of Leicester Road. This re-joins the channel at the confluence within Reach 1.

6.5 Reach 4, 4A and 6 all generate a floodplain within the Main HNRFI Site immediately upstream of the railway line, due to flood flows being attenuated by restrictive culverts through the elevated embankment.

6.6 The flood risk from Reach 5 is limited, as most flood flows are predicted to remain within bank through the Main HNRFI Site. Downstream of the Main HNRFI Site, the floodplain is more extensive because flood water is attenuated by the culvert beneath Station Road.

7. SENSITIVITY TESTING

7.1 To account for seasonal variations in vegetation, uncertainty of key hydraulic parameters, and the residual risk of blockages at hydraulic structures, a series of sensitivity tests were conducted using the 1 in 100-year flood return period event. The difference in peak water levels and floodplain extent between the tests and the original 1 in 100-year event are mapped within **Appendix 6**.

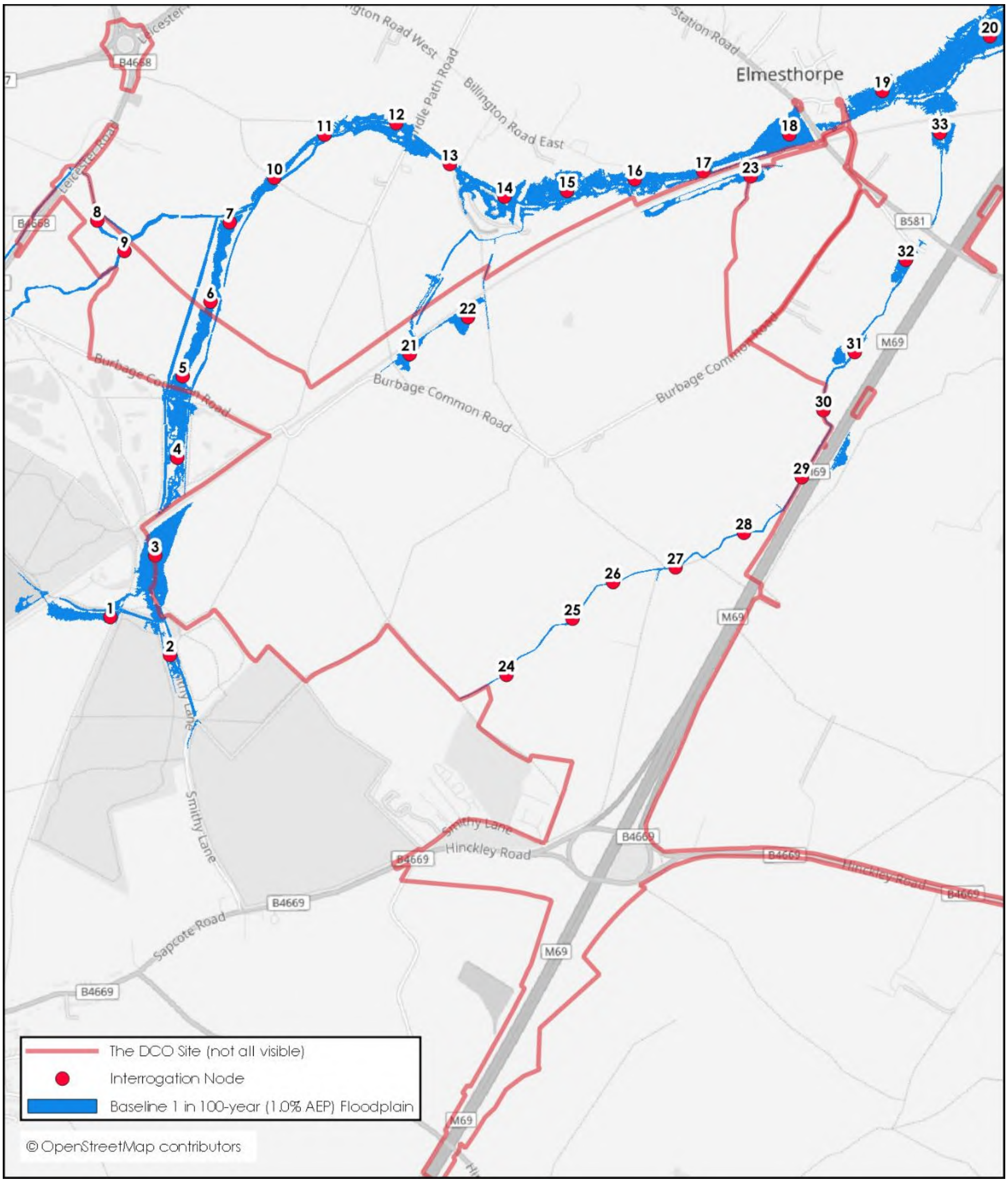


Figure 7.1: Interrogation Node Locations

7.2 To provide information on the confidence limits of the model, peak flood levels at key locations (as shown in **Figure 7.1**) were compared against the original 1 in 100-year peak flood levels. This was undertaken for flow estimate, storm duration, and roughness sensitivity tests. It was not undertaken for the downstream boundary sensitivity tests, as there was essentially no precited change. It was not undertaken for blockage scenarios as these theoretical tests are specific to the residual flood risk associated with a particular structure.

Flow Estimates

7.3 As a full range of climate change allowances have been assessed, an additional sensitivity test on the estimated flood flows would not normally by undertaken. However, this has been specifically requested by the EA for this project.

7.4 The 1 in 100-year flows were increased and decreased by 20% and compared against the baseline 1 in 100-year event to identify the extent of changes. Peak flood levels are compared in **Table 7.1**.

Table 7.1: Flow Sensitivity Tests

Node	Baseline (m AOD)	Flow-20%		Flow+20%	
		Peak Level (m AOD)	Difference (m)	Peak Level (m AOD)	Difference (m)
1	94.90	94.88	-0.02	94.92	0.02
2	94.20	94.18	-0.02	94.22	0.02
3*	93.89	93.70	-0.19	94.11	0.22
4	92.32	92.28	-0.04	92.34	0.02
5	91.49	91.47	-0.02	91.50	0.01
6	90.46	90.44	-0.02	90.47	0.02
7	89.61	89.59	-0.02	89.62	0.01
8	92.59	92.58	0.00	92.59	0.01
9	91.60	91.58	-0.03	91.63	0.02
10	88.97	88.94	-0.03	88.99	0.02
11	88.27	88.26	-0.01	88.27	0.00
12	87.42	87.39	-0.04	87.45	0.02
13	86.87	86.78	-0.09	86.90	0.03
14	86.20	86.13	-0.06	86.25	0.05
15	85.72	85.68	-0.04	85.74	0.03
16	84.88	84.84	-0.04	84.90	0.02
17	84.38	84.33	-0.05	84.42	0.04
18*	83.85	83.60	-0.24	84.05	0.21

Node	Baseline (m AOD)	Flow-20%		Flow+20%	
		Peak Level (m AOD)	Difference (m)	Peak Level (m AOD)	Difference (m)
19	82.67	82.63	-0.04	82.69	0.02
20	81.03	81.01	-0.02	81.04	0.02
21*	90.91	90.62	-0.29	90.99	0.08
22*	89.71	89.54	-0.18	90.02	0.31
23*	83.88	-	-	84.10	0.21
24	99.13	99.12	-0.02	99.15	0.01
25	93.89	93.87	-0.02	93.92	0.02
26	91.67	91.64	-0.03	91.70	0.03
27	89.75	89.71	-0.03	89.78	0.03
28	88.17	88.13	-0.04	88.21	0.03
29	86.82	86.77	-0.05	86.86	0.04
30*	85.92	85.78	-0.14	86.00	0.08
31*	85.81	85.65	-0.16	85.88	0.07
32	84.84	-	-	85.18	0.34
33	82.28	-	-	82.33	0.05

Located upstream of a significant hydraulic structure

7.5 A comparison of peak flood levels against the original 1 in 100-year results confirms that a lower flood flow will return lower peak flood levels in the site and surrounding area, and a higher flow will return higher peak flood levels.

7.6 The change in peak flood level is greater immediately upstream of the elevated embankments in the catchment (such as the railway line), as the flooding is artificially influenced by the attenuating effects of the hydraulic structures. Away from these hydraulic structures, the average change in peak water level is +/-0.03m. Therefore, the model results can be generally considered to be robust to changes in flow, increasing model confidence in the design runs.

Storm Duration

7.7 The ReFH2 recommended storm duration (9.0-hours) was derived from the total study catchment area. However, ReFH2.3 recommends a storm duration of 4.5-hours for the sub-catchments upstream of the railway line on Reach 2, 4 and 5 (which all appear on the FEH webservice).

7.8 Therefore, as a sensitivity test, a 4.5-hour storm duration 1 in 100-year event was simulated. A longer duration 13.5-hour storm was also simulated. The results were compared against the 9.0-hour 1 in 100-year flood event to identify the extent of changes in water levels.

7.9 The comparison identified that the shorter 4.5-hour duration storm results in substantially lower peak flood levels within the Main Order Limits and surrounding area. The longer duration 13.5-hour storm produced generally higher flood levels, suggesting this is more representative of the critical duration. Therefore, the 13.5-hour storm was retained for the design events.

7.10 As a further analysis, a 15.0-hour storm duration 1 in 100-year event was simulated. A comparison against the 13.5-hour storm identified slightly lower flood levels. This increases confidence that the correct storm duration has been adopted.

7.11 A comparison of peak flood levels between the different durations is provided within **Table 7.2**.

Table 7.2: Storm Duration Sensitivity Tests

Node	13.5hr Duration (m AOD)	4.5hr Duration		9hr Duration		15hr Duration	
		Peak Level (m AOD)	Dif (m)	Peak Level (m AOD)	Dif (m)	Peak Level (m AOD)	Dif (m)
1	94.90	94.89	-0.01	94.90	0.00	94.90	0.00
2	94.20	94.19	-0.01	94.20	0.00	94.20	0.00
3*	93.89	93.74	-0.16	93.87	-0.02	93.89	-0.01
4	92.32	92.29	-0.02	92.31	0.00	92.32	0.00
5	91.49	91.48	-0.01	91.49	0.00	91.49	0.00
6	90.46	90.44	-0.02	90.46	0.00	90.46	0.00
7	89.61	89.60	-0.01	89.60	0.00	89.61	0.00
8	92.59	92.59	0.00	92.59	0.00	92.59	0.00
9	91.60	91.59	-0.02	91.60	0.00	91.60	0.00
10	88.97	88.95	-0.02	88.97	0.00	88.97	0.00
11	88.27	88.27	0.00	88.27	0.00	88.27	0.00
12	87.42	87.40	-0.02	87.42	0.00	87.42	0.00
13	86.87	86.80	-0.06	86.87	0.00	86.87	0.00
14	86.20	86.15	-0.05	86.19	0.00	86.19	0.00
15	85.72	85.69	-0.03	85.71	0.00	85.72	0.00

Node	13.5hr Duration (m AOD)	4.5hr Duration		9hr Duration		15hr Duration	
		Peak Level (m AOD)	Dif (m)	Peak Level (m AOD)	Dif (m)	Peak Level (m AOD)	Dif (m)
16	84.88	84.85	-0.03	84.88	0.00	84.88	0.00
17	84.38	84.35	-0.04	84.38	0.00	84.38	0.00
18*	83.85	83.65	-0.19	83.82	-0.03	83.84	-0.01
19	82.67	82.64	-0.03	82.66	0.00	82.67	0.00
20	81.03	81.01	-0.02	81.03	0.00	81.03	0.00
21*	90.91	90.70	-0.22	90.89	-0.02	90.90	-0.01
22*	89.71	89.54	-0.17	89.67	-0.04	89.69	-0.02
23*	83.88	-	-	-	-	83.87	-0.01
24	99.13	99.12	-0.01	99.13	0.00	99.13	0.00
25	93.89	93.88	-0.01	93.90	0.00	93.90	0.00
26	91.67	91.65	-0.02	91.67	0.00	91.67	0.00
27	89.75	89.73	-0.02	89.75	0.00	89.75	0.00
28	88.17	88.15	-0.02	88.17	0.00	88.17	0.00
29	86.82	86.79	-0.03	86.82	0.00	86.82	0.00
30*	85.92	85.85	-0.06	85.92	0.00	85.92	0.00
31*	85.81	85.75	-0.06	85.81	0.00	85.81	0.00
32	84.84	-	-	84.81	-0.03	84.83	-0.01
33	82.28	82.24	-0.04	82.27	0.00	82.28	0.00

**Located upstream of a significant hydraulic structure*

7.12 The change in peak flood level is greater immediately upstream of the elevated embankments in the catchment (such as the railway line), as the flooding is artificially influenced by the attenuating effects of the hydraulic structures. Away from these hydraulic structures, the average change in peak water level between the different storm durations is less than -0.02m Therefore, the model results can be generally considered to be robust to changes in storm duration, increasing model confidence in the design runs.

Roughness

7.13 The modelling has shown that a 20% reduction in channel and floodplain roughness (representative of winter seasonal conditions or channel conditions following maintenance) results in a general decrease in flood levels. This is as expected, as the reduced roughness will increase the conveyance of the channels and culverts.

7.14 This exception to this is on Reach 1 at the downstream extent of the model and on Reach 4 downstream railway line, where the increase in upstream conveyance leads to more flow reaching these locations.

7.15 Conversely, a 20% increase in Manning's 'n' (representative of summer seasonal conditions, and a period without maintenance) is shown to result in a general increase in flood levels. This is to be expected given that an increase in roughness values across the floodplain would be associated with greater frictional forces against the flow of water as it looks to drain back into the channel. 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 flow conveyance.

7.16 The exception to this is on Reach 1 at the downstream extent of the model and on Reach 4 downstream of the railway line, where the decrease in upstream conveyance leads to less flow reaching these locations.

7.17 A comparison of peak flood levels under the different roughness conditions is provided within **Table 7.4**.

Table 7.3: Roughness Sensitivity Tests

Node	Baseline (mAOD)	Roguhness-20%		Roguhness+20%	
		Peak Level (mAOD)	Dif (m)	Peak Level (mAOD)	Dif (m)
1	94.90	94.90	-0.01	94.91	0.00
2	94.20	94.19	-0.01	94.21	0.01
3*	93.89	93.82	-0.07	93.96	0.07
4	92.32	92.30	-0.02	92.33	0.01
5	91.49	91.48	-0.01	91.50	0.01
6	90.46	90.44	-0.02	90.47	0.01
7	89.61	89.60	-0.01	89.61	0.01
8	92.59	92.59	0.00	92.59	0.01
9	91.60	91.58	-0.02	91.62	0.02
10	88.97	88.97	0.00	88.98	0.01
11	88.27	88.27	0.00	88.27	0.00
12	87.42	87.41	-0.01	87.44	0.02

Node	Baseline (mAOD)	Roguhness-20%		Roguhness+20%	
		Peak Level (mAOD)	Dif (m)	Peak Level (mAOD)	Dif (m)
13	86.87	86.83	-0.04	86.88	0.01
14	86.20	86.16	-0.03	86.23	0.03
15	85.72	85.70	-0.02	85.73	0.02
16	84.88	84.85	-0.03	84.90	0.02
17	84.38	84.36	-0.02	84.41	0.02
18*	83.85	83.78	-0.06	83.91	0.06
19	82.67	82.66	-0.01	82.68	0.01
20	81.03	81.01	-0.01	81.04	0.01
21*	90.91	90.78	-0.13	90.96	0.05
22*	89.71	89.65	-0.06	89.86	0.15
23*	83.88	-	-	83.96	0.08
24	99.13	99.12	-0.01	99.15	0.02
25	93.89	93.89	-0.01	93.92	0.02
26	91.67	91.64	-0.03	91.72	0.05
27	89.75	89.71	-0.03	89.78	0.03
28	88.17	88.13	-0.04	88.21	0.03
29	86.82	86.77	-0.05	86.86	0.04
30*	85.92	85.88	-0.04	85.97	0.05
31*	85.81	85.80	-0.01	85.83	0.02
32	84.84	84.68	-0.15	84.98	0.15
33	82.28	82.26	-0.02	82.29	0.01

Located upstream of a significant hydraulic structure

7.18 The change in peak flood level is greater immediately upstream of the elevated embankments in the catchment (such as the railway line), as the flooding is artificially influenced by the attenuating effects of the hydraulic structures. Away from these hydraulic structures, the average change in peak water level between the different storm durations is less than +/-0.02m. Therefore, the model results can be generally considered to be robust to changes in roughness, increasing model confidence in the design runs.

Downstream Boundary

7.19 The downstream boundary is located on the downstream side of the M69. As access to this reach could not be achieved it is modelled solely within the 2D domain. The downstream boundary is an automated head-flow (HQ) type, with the gradient derived from a terrain profile measured over the downstream 100m.

7.20 Variations in the downstream boundary can be used to assess if the boundary is in a suitable location as to not influence the results at the DCO Site. The downstream gradient was increased (slackened) and decreased (steepened) by 20% and compared against the baseline 1 in 100-year event to identify the extent of changes in water levels.

7.21 The comparison identified that both alterations had a minimal impact on flood levels downstream of the M69, and virtually no impact upstream of the M69. Therefore, the model results can be generally considered to be robust to changes in downstream boundary, increasing model confidence in the design runs.

Blockage Scenarios

7.22 Blockage scenarios were undertaken at key culverts located downstream of the study site; these are identified within **Figure 7.2**. Other structures in the domain are readily bypassed and sufficiently removed from the site to not warrant a blockage test.

7.23 Smaller culverts are more at risk of a significant blockage due to their limited capacity to convey flows and debris. Whereas large culverts are less at risk. Therefore, the magnitude of each blockage was determined by the size of the culvert, as shown within **Table 7.4**.

Table 7.4: Sensitivity Test Blockage Percentages

Culvert Diameter(m)	Blockage Applied
< 0.5	100%
0.5 – 1.0	75%
1.0 – 1.5	50%
1.5 >	25%

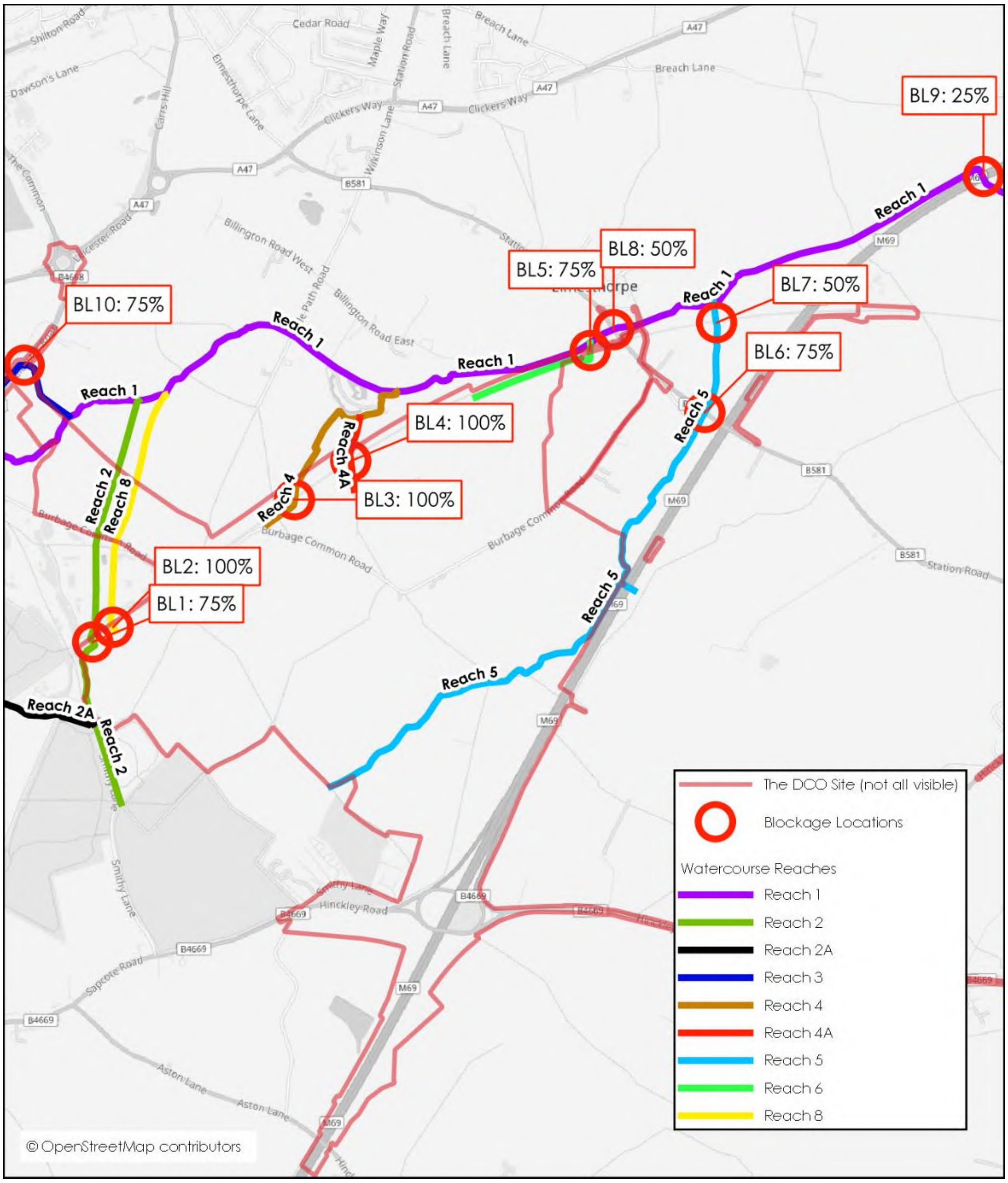


Figure 7.2: Blockage Scenario Test Locations

7.24 Blockage 1 (BL1) was undertaken on the 0.9m diameter culvert through the railway line embankment on Reach 2. A 75% blockage of this structure resulted in a 0.85m increase in upstream flood levels, and a 0.05m increase in downstream flood levels as more flood water was routed through the adjacent Reach 8 culvert.

7.25 Blockage 2 (BL2) was undertaken on the 0.375m diameter culvert through the railway line embankment on Reach 8. A 100% blockage of this structure resulted in 0.13m increase in upstream flood levels, and a 0.02m increase in downstream flood levels as more flood water was routed through the adjacent Reach 2 culvert.

7.26 Blockage 3 (BL3) was undertaken on the 0.375m diameter culvert through the railway line embankment on Reach 4. A 100% blockage of this structure resulted in up to 0.45m increase in upstream flood levels, and a 0.24m increase in downstream flood levels as more flood water was routed through the adjacent Reach 4A culvert. The increased flow on Reach 4a nominally affects water levels on Reach 1 (<0.01m), but this was sufficient to alter the backwater through the Reach 6 culvert leading to a 0.01m increase upstream of the railway line.

7.27 Blockage 4 (BL4) was undertaken on the 0.375m diameter culvert through the railway line embankment on Reach 4A. A 100% blockage of this structure resulted in a 0.41m increase in upstream flood levels. The attenuated flood water is unable to flow through an adjacent culvert, so there are no detrimental downstream impacts.

7.28 Blockage 5 (BL5) was undertaken on the 0.9m diameter culvert through the railway line embankment on Reach 6. A 75% blockage of this structure resulted in a 0.30m increase in upstream flood levels. The attenuated flood water is unable to flow through an adjacent culvert, so there are no detrimental downstream impacts.

7.29 Blockage 6 (BL6) was undertaken on the 0.8m diameter culvert beneath Station Road on Reach 5. A 75% blockage of this structure resulted in a 1.54m increase in upstream flood levels. The attenuated flood water is unable to flow through an adjacent culvert, so there are no detrimental downstream impacts.

7.30 Blockage 7 (BL7) was undertaken on the 1.3m x 1.0m arch culvert through the railway line embankment on Reach 5. A 50% blockage of this structure resulted in a 0.45m increase in upstream flood levels. The attenuated flood water is unable to flow through an adjacent culvert, so there are no detrimental downstream impacts.

7.31 Blockage 8 (BL8) was undertaken on the twin 1.2m diameter culverts beneath Station Road on Reach 1. A 50% blockage of both these structures resulted in up to a 0.61m increase in upstream flood levels, which includes an impact on Reach 6. Flood risk is also detrimentally affected downstream as flood water overflows Station Road via a residential area.

7.32 Blockage 9 (BL9) was undertaken on the 4.2m x 1.5m box culvert beneath the M69 on Reach 1. A 25% blockage of this structures resulted in a 0.19m increase in upstream flood levels. The attenuated flood water is unable to flow through an adjacent culvert, so there are no detrimental downstream impacts.

7.33 Blockage 10 (BL10) was undertaken on the 0.5m diameter culvert beneath Leicester Road on Reach 3. A 75% blockage of this structure resulted in up to a 0.86m increase in upstream flood levels. Flood risk is also detrimentally affected downstream as flood water overflows Leicester Road.

8. DEVELOPMENT PROPOSALS

8.1 The following section describes the changes that were made to the baseline model to reflect the proposed development.

Philosophy

8.2 The Main HNRFI Site development occupies an area between the M69 and the railway line. The proposals include the reprofiling of this area to form two plateaus on which the development will be located. To facilitate the reprofiling, the Reach 5 watercourse will be realigned to flow along the south-eastern boundary within a new channel. The channel will be designed to convey the necessary flood flows, thus addressing the flood risk this could otherwise represent.

8.3 The development will include surface water drainage infrastructure which will restrict runoff from the development to the equivalent greenfield QBAR rate. Therefore, the post-development runoff from the development area will be reduced from existing rates during flood events.

8.4 The excess storm water runoff from the development will be stored in the development parcel(s) within their drainage infrastructure, where it will be released slowly at the QBAR rate. This will effectively relocate the existing floodplain generated by runoff from within the development area to within the attenuated storage infrastructure.

8.5 Elsewhere, where the Main HNRFI Site is subject to a floodplain generated by upstream third-party runoff, the development has been arranged in a manner to not detrimentally displace any floodplain.

8.6 The A47 Link Road present in more extensive Main Order Limits crosses Reach 8, 2, and 1. The road will be elevated above the flood levels to remain operation during a flood event. Culverts will be provided beneath the road to preserve hydraulic connectivity and convey flood flows into the downstream channels, as existing.

8.7 The A47 Link Road's junction with the Leicester Road requires a new roundabout that will be built over a stretch of Reach 3. To preserve hydraulic connectivity, a new culvert beneath the road will be required. The culvert will outfall into a new channel that will be created between the link road and the current Reach 3 watercourse. In turn, this new channel will outfall to Reach 1 downstream of the link road.

8.8 These proposed flood management measures are illustrated within **Figure 8.1**, with further detail provided within **Figure 8.2**, **Figure 8.3**, and **Figure 8.4**.

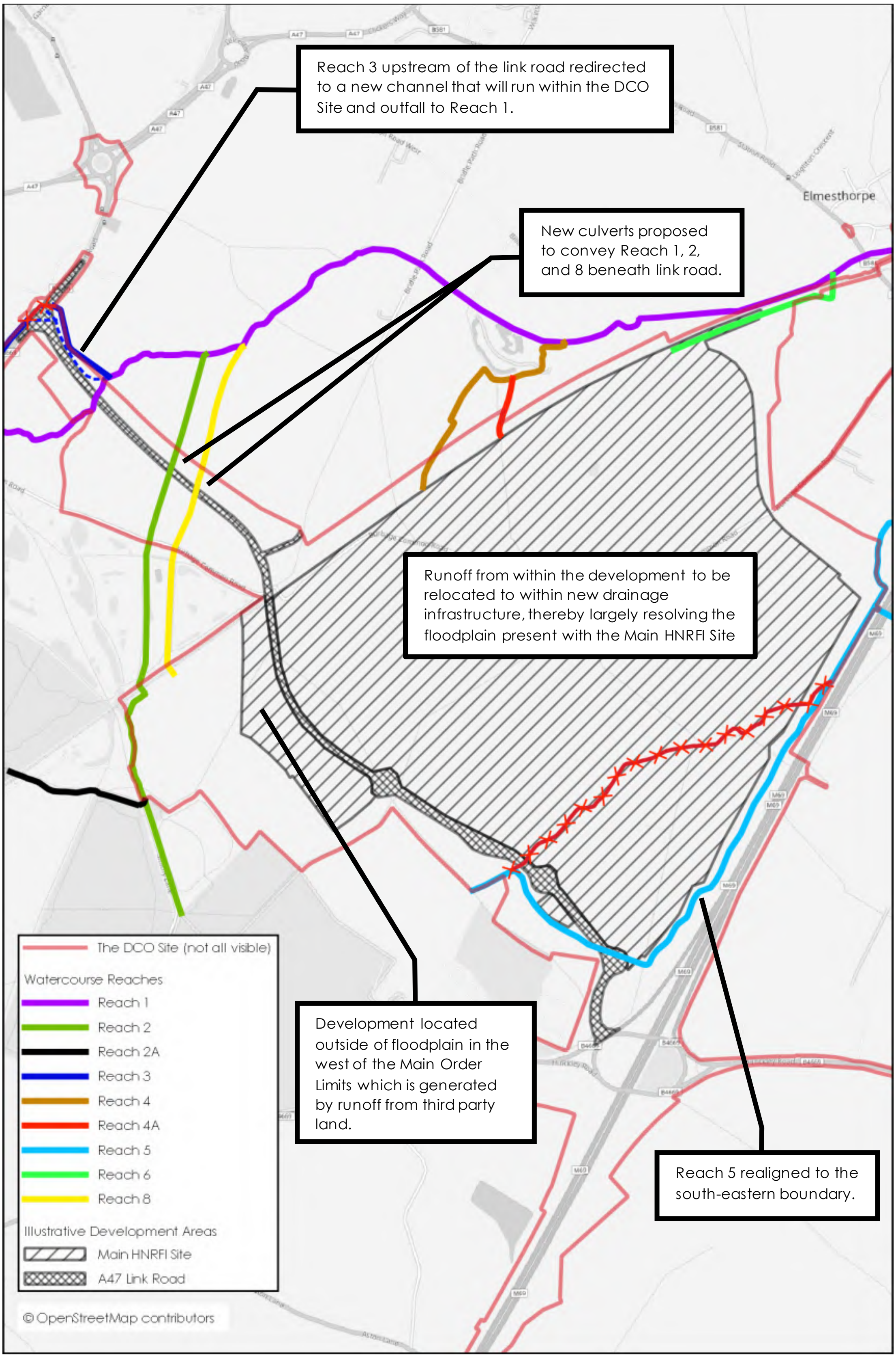


Figure 8.1: Schematic of Proposed Flood Management Measures

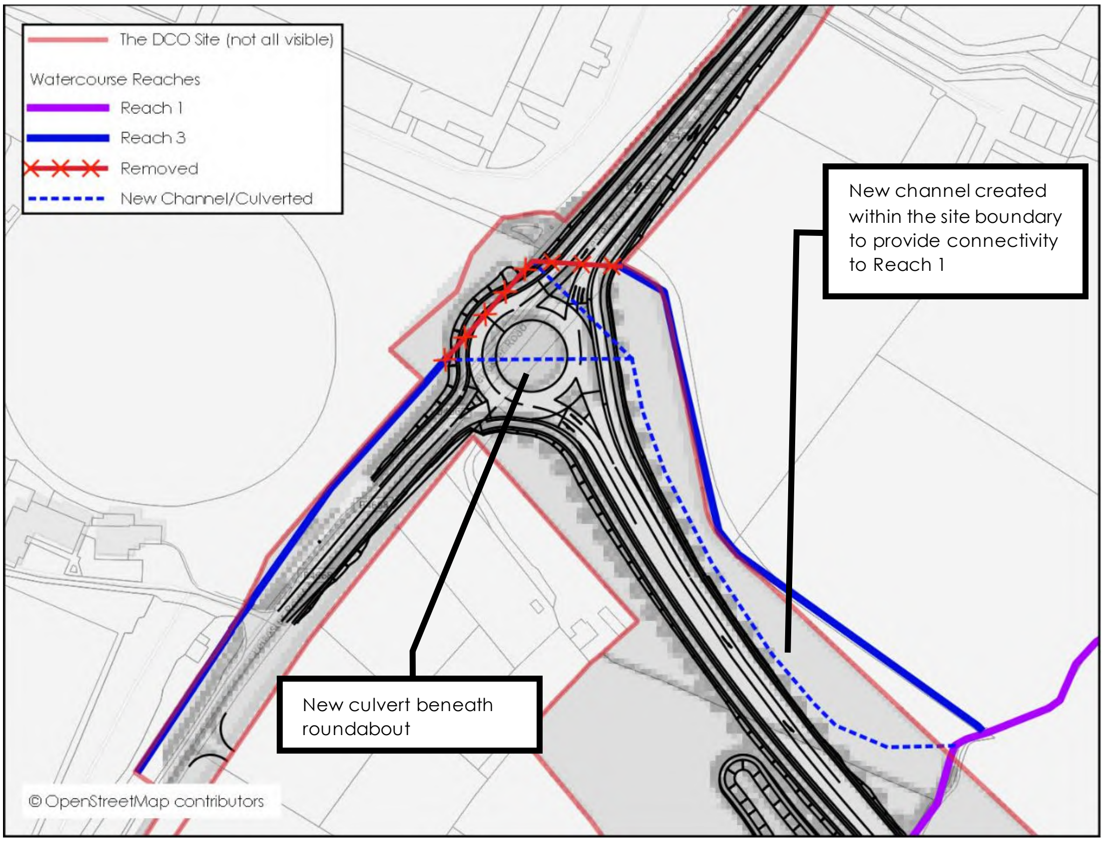


Figure 8.2: Proposed Alterations to Reach 3

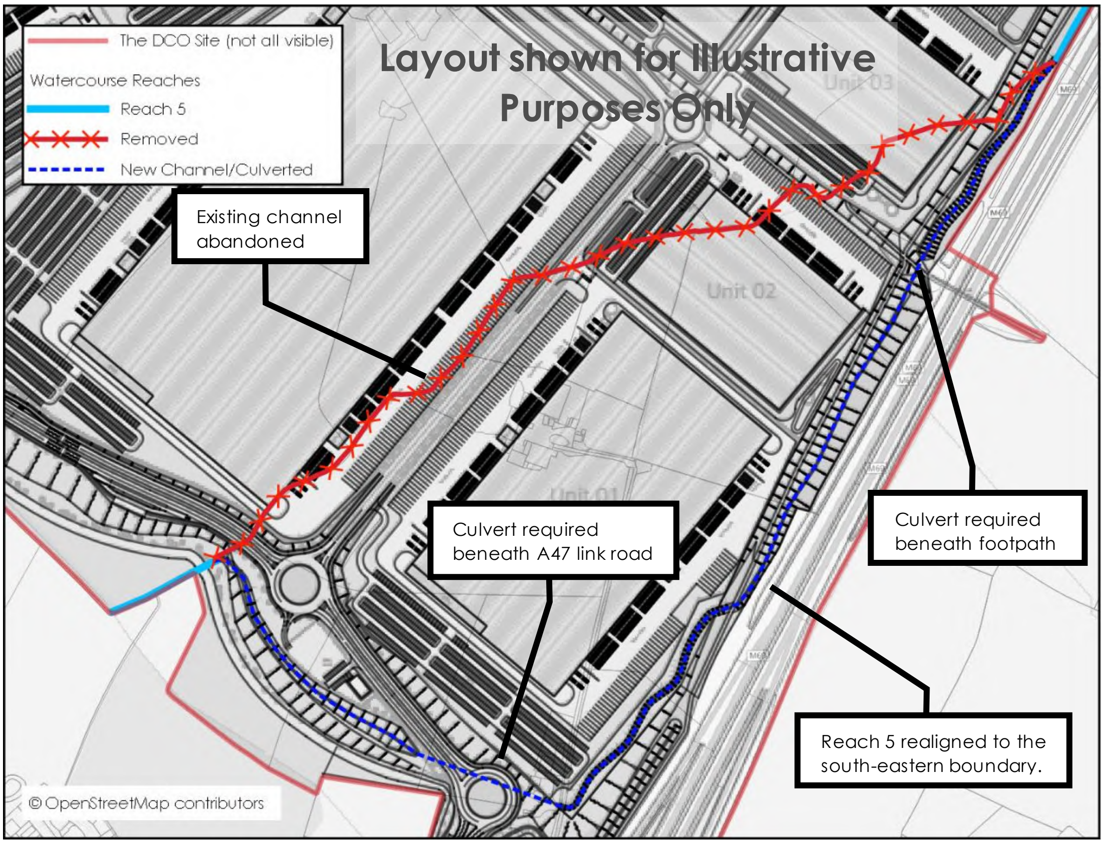


Figure 8.3: Proposed Alterations to Reach 5

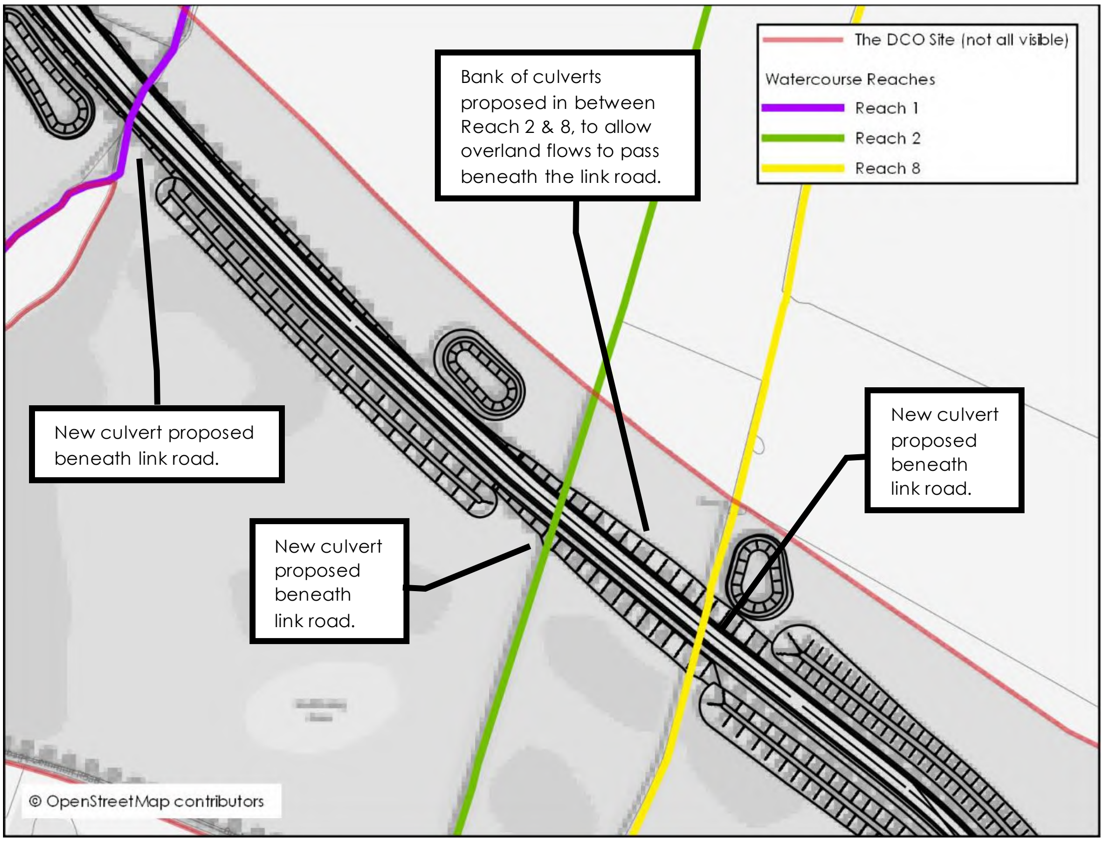


Figure 8.4: Proposed Alterations to Reach 1, 2 & 8

Hydrological Representation

8.9 The proposed development in the Main HNRFI Site will include a surface water management strategy which will seek to restrict the contributing runoff from within the development at the present day greenfield annual average runoff rate (QBAR) – 4.1l/s/ha.

8.10 The illustrative development layout of the Main HNRFI Site has been used to identify an area that will be intercepted by the development's drainage infrastructure: 1.49km^2. This represents 13.8% of the total 10.8km^2 catchment assessed within this study.

8.11 To represent the development and its drainage solution within the model, it is necessary to remove the existing contributing flows from within the development area and replace them with the proposed surface water outfalls.

8.12 The proposed 11 outfalls from the development were added to the model as new QT boundaries, which were applied to the 1D or 2D domain as required. Each inflow was set to the corresponding proposed discharge rate and was applied as a constant flow, starting 1hour into the simulation (to account for the time of concentration).

8.13 The inflows from the 'natural' sub-catchments (as identified within **Appendix 1**) were then reduced (factored on an area basis) where they fell within the main development boundary. This is detailed within **Table 8.1** and **Appendix 4**.

Table 8.1: Thurlaston Brook Tributary Sub-Catchments

Sub-Catchment	Baseline Conditions		Post-Development Conditions	
	Area (km²)	Percentage of Study Catchment	Area (km²)	Percentage of Study Catchment
Main HNRFI Site Development Area	-	-	1.49	13.8%
Reach 1 Upstream Catchment	0.34	3.1%	0.34	3.1%
Reach 1 Lateral Catchment 2	1.43	13.2%	1.43	13.2%
Reach 1 Lateral Catchment 3	0.55	5.1%	0.55	5.1%
Reach 1 Lateral Catchment 4	0.40	3.7%	0.40	3.7%
Reach 1 Lateral Catchment 5	0.49	4.5%	0.49	4.5%
Reach 2 Upstream Catchment	0.42	3.9%	0.42	3.9%
Reach 2 Lateral Catchment 2	0.28	2.6%	0.27	2.5%
Reach 2 (& 8) Lateral Catchment 1	0.46	4.2%	0.45	4.2%
Reach 2A Upstream Catchment	1.23	11.3%	1.23	11.4%
Reach 2A Downstream Catchment	1.07	9.9%	1.07	9.9%
Reach 3 Upstream Catchment	0.34	3.1%	0.34	3.1%
Reach 3 (& 1) Lateral Catchment 1	0.47	4.3%	0.47	4.3%
Reach 4 Upstream Catchment	0.43	4.0%	0.07	0.6%
Reach 4A Upstream Catchment	0.11	1.0%	0.00	0.0%
Reach 4 & 4A Lateral Catchment	0.26	2.4%	0.25	2.3%
Reach 5 Upstream Catchment	0.10	0.9%	0.10	0.9%

Sub-Catchment	Baseline Conditions		Post-Development Conditions	
	Area (km^2)	Percentage of Study Catchment	Area (km^2)	Percentage of Study Catchment
Reach 5 Eastern Catchment	0.60	5.5%	0.60	5.5%
Reach 5 Lateral Catchment (site)	0.87	8.0%	0.16	1.5%
Reach 5 Lateral Catchment (downstream of site)	0.50	4.6%	0.50	4.6%
Reach 6 Catchment	0.49	4.5%	0.22	2.0%

8.14 The link road in the wider Main Order Limits will also include a similar drainage strategy that will also attenuate and store runoff. However, as this represents a much smaller proportion of the study catchment, its effects and any downstream betterment will be less significant. Therefore, no hydrological alterations have been made to account for this.

8.15 As the culverts beneath the railway line on Reach 4 and 4A in the Main HNRFI Site will effectively become two of the downstream piped outfalls from the development drainage network, the relevant hydrological boundaries were applied directly to them (i.e.: the upstream channels will no longer exist).

Hydraulic Model Representation

8.16 An illustrative ground model of the proposed development and watercourse realignment was prepared by BWB Consulting - Ref: HRF-BWB-HGT-MS-M3-CH-00600 and HRF-BWB-HGT-MS-M3-CH-00610.

8.17 River sections from the proposed diversion of Reach 5 were extracted from the ground model and added to the hydraulic model within the 1D domain. It is expected that the diverted channel will be seeded/planted to encourage a diverse mix of native species, but to also be relatively free flowing – an in-channel Manning's 'n' roughness value of 0.050 was adopted to represent these conditions.

8.18 Two culverts are necessary on the diverted reach, and these were added to the 1D domain. The first is beneath the access road from Junction 2 of the M69 into the site. The second is beneath a footpath which crosses the M69. At this preliminary stage both culverts were added as 1.05m diameter pipes.

8.19 A new roundabout on the Leicester Road necessitates new culverts on Reach 3. Reach 3 is currently culverted under the road within a 0.5m diameter pipe. For the purpose of this preliminary assessment, this pipe size was retained to avoid increasing pass-on flow. A Manning's 'n' roughness value of 0.015 was adopted to represent a concrete construction. To achieve sufficient depth for the new culvert to pass beneath the road, the upstream reach was re-sectioned, lowering the bed level at the culvert inlet by 640mm. The downstream stretch of Reach 3 falls outside of the site and is at a higher level than the new culvert outlet. Therefore, a new channel will be required to connect the new culvert back into Reach 1. For the purpose of this initial assessment, this new channel was modelled within the 2D domain as a simple z-shape line set approximately 1m below existing ground levels.

8.20 A new 2.1 x 1m box culvert was added to Reach 1 beneath the proposed link road. A Manning's 'n' roughness value of 0.025 was adopted to represent a concrete construction with a soft bed. Two new cross-sections were added on either side of the link road to facilitate the structure's addition to the model. The section and culvert were based upon a linear gradient between the two surveyed sections (R1.020A and R1.020). The sections were based upon a simple trapezoidal profile for this assessment, which assumes that the channel will be re-sectioned as part of the culvert installation.

8.21 A new 2.1 x 1m box culvert was added to Reach 2 beneath the proposed link road. A Manning's 'n' roughness value of 0.025 was adopted to represent a concrete construction with a soft bed. Two new cross-sections were added on either side of the link road to facilitate the structure's addition to the model. The sections and culvert were based upon a linear gradient between the two surveyed sections (R2.005 and R2.004). The sections were based upon a simple trapezoidal profile for this assessment, which assumes that the channel will be re-sectioned as part of the culvert installation.

8.22 A new 2.1 x 1m box culvert was added to Reach 8 beneath the proposed link road. A Manning's 'n' roughness value of 0.025 was adopted to represent a concrete construction with a soft bed. A new cross-section was added upstream of the link road to facilitate the structure's addition to the model. The section and culvert were based upon a linear gradient between the two surveyed sections (R8.009 and R8.007). The section was based upon a simple trapezoidal profile for this preliminary assessment, which assumes that the channel will be re-sectioned as part of the culvert installation.

8.23 A bank of 6 culverts were added beneath the link road, in between Reach 2 and 8, where an overland flow route runs in between the two channels. At this stage the culverts were added as 1.05m diameter pipes. A Manning's 'n' roughness value of 0.015 was adopted to represent a concrete construction.

8.24 The associated TUFLOW layers (1D network, bank lines, channel code, 1D-2D interface, etc.) were updated to reflect the new channel alignments.

8.25 The proposed ground model was exported as a DTM and added to the 2D TUFLOW domain to represent the proposed finished levels within the development area. As the elements of the development are to be raised out of the floodplain it was not necessary to amend the Manning's n' roughness layers in the 2D domain.

8.26 The link roads elevation was too low in the preliminary development ground model. This was corrected by applying a z-shape to bring the road level above flood levels.

8.27 The developments north-eastern surface water attenuation basin/pond was also set too low in the initial development ground model. This was corrected by applying a z-shape to bring the basin/pond above flood levels.

Results

8.28 A selection of events between the 1 in 10-year to the 1 in 1000-year, including the 1 in 100-year +30%, +40% and +60% were simulated to demonstrate that the described measures will manage flood risk to the development at a range of events.

8.29 The results from the post development model are mapped within **Appendix 7** and are summarised within **Figure 8.5.**

8.30 The modelling has shown that the proposed channel realignments and culverts convey the predicted flood flows around the development as intended. This is predicted to occur during all modelled simulations, including the 1 in 100-year+60% and 1 in 1000-year flood events.

8.31 The proposed new culverts on Reach 5 are shown to not surcharge even during the 1 in 1000-year event, giving confidence that they can be designed to offer a soft bed and freeboard to flood levels at the appropriate design stage, if required.

8.32 The proposed new culverts on the link road on Reach 1, 2, and 8 are also shown to not surcharge even during the 1 in 1000-year event, giving confidence that they can also be designed to offer a soft bed and freeboard to flood levels at the appropriate design stage, if required.

8.33 The proposed water rearrange on Reach 3 is shown to operate as intended, preserving hydraulic connectivity without putting the road at flood risk.

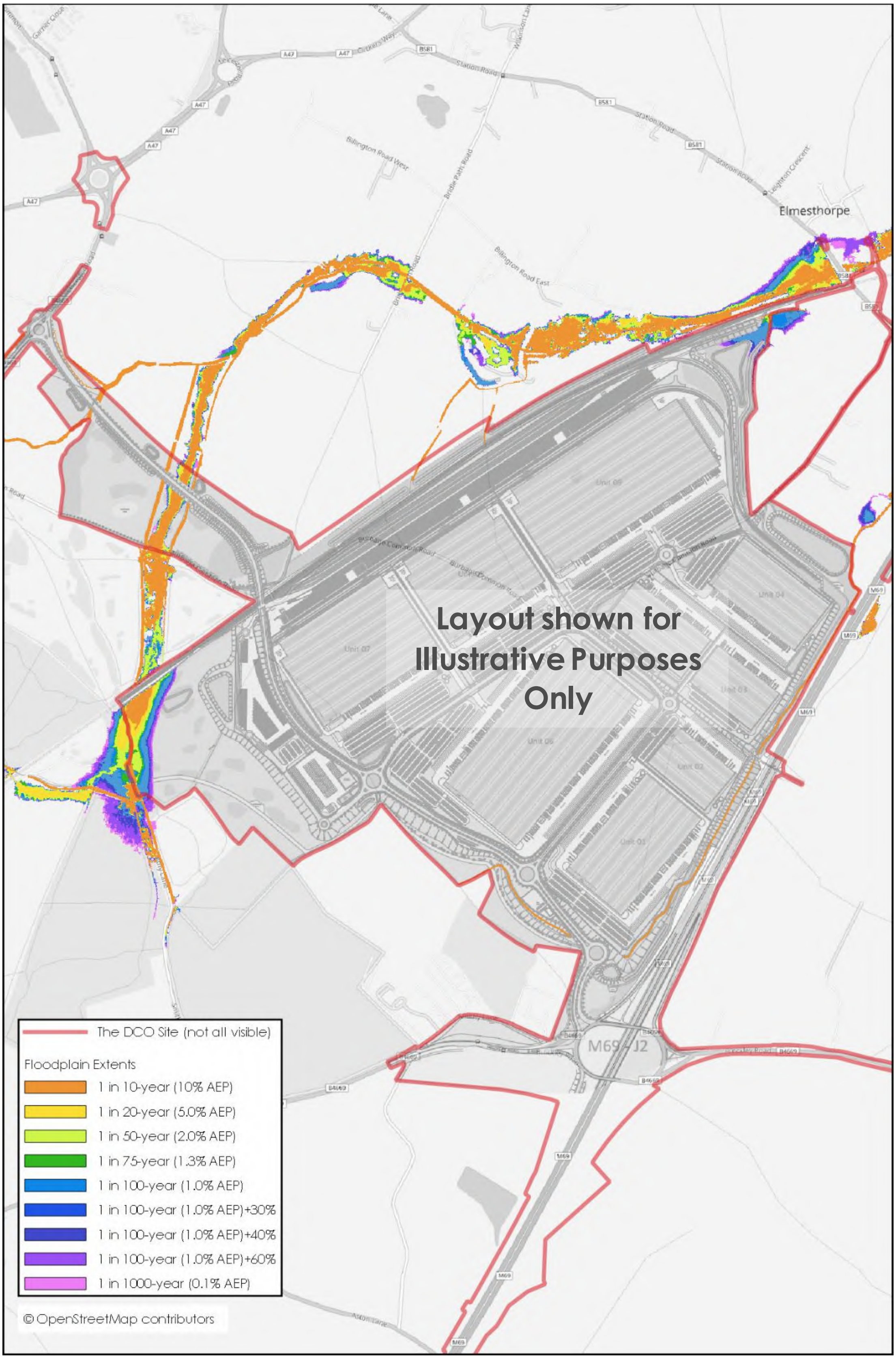


Figure 8.5: Illustrative Post-Development Floodplain

Comparative Analysis

8.34 The floodplain mapping in **Appendix 8** includes comparative analysis between the post-development flood levels and the baseline flood levels at the equivalent return period event. This has been undertaken for all events up to the 1 in 100-year+30% flood.

8.35 The mapping shows that the proposed flood management and watercourse realignment strategy within the Main Order Limits results in no detriment, and potentially offers marginal betterment, around Elmesthorpe due to the attenuation of surface water runoff from within the proposed development area.

8.36 The proposed culverts on Reach 1, 2, 3 and 8 are shown to provide reduced flood levels on their respective approach and exit channels. This is due to the increased efficiency of the culverts when compared to the vegetated channels they would replace.

8.37 Upstream of this betterment, and immediately downstream on Reach 1, are located isolated areas where in-channel flood levels are shown to increase – land outside of the channel is unaffected. These areas are identified within **Figure 8.6**. The results have been reviewed which has shown that the flows in these areas have not increased, and that a backwater from the proposed culverts does not occur (flood levels between the areas of localised increase and the culverts are lower than the baseline conditions). Instead, the isolated increase in flood levels is likely to be a result of a change in the modelled hydraulic gradient. This would be expected following the increased data resolution in the model that can be attributed to the addition of the proposed culverts and associated river sections. Therefore, this is not considered to be a real-world impact.

8.38 The overland flow route between Reach 2 and 8 is conveyed under the link road by a series of offline culverts in the floodplain. Despite this, flood water is still predicted to build above existing levels on the upstream side of the road. The additional flood levels and floodplain do not affect any land outside of the DCO Site. Therefore, this increase is considered acceptable. This is viewed as an informal form of floodplain compensation. By allowing the floodplain to adjust itself within the natural topography, unnecessary excavations and engineering works to create a formal floodplain compensation area can be avoided.

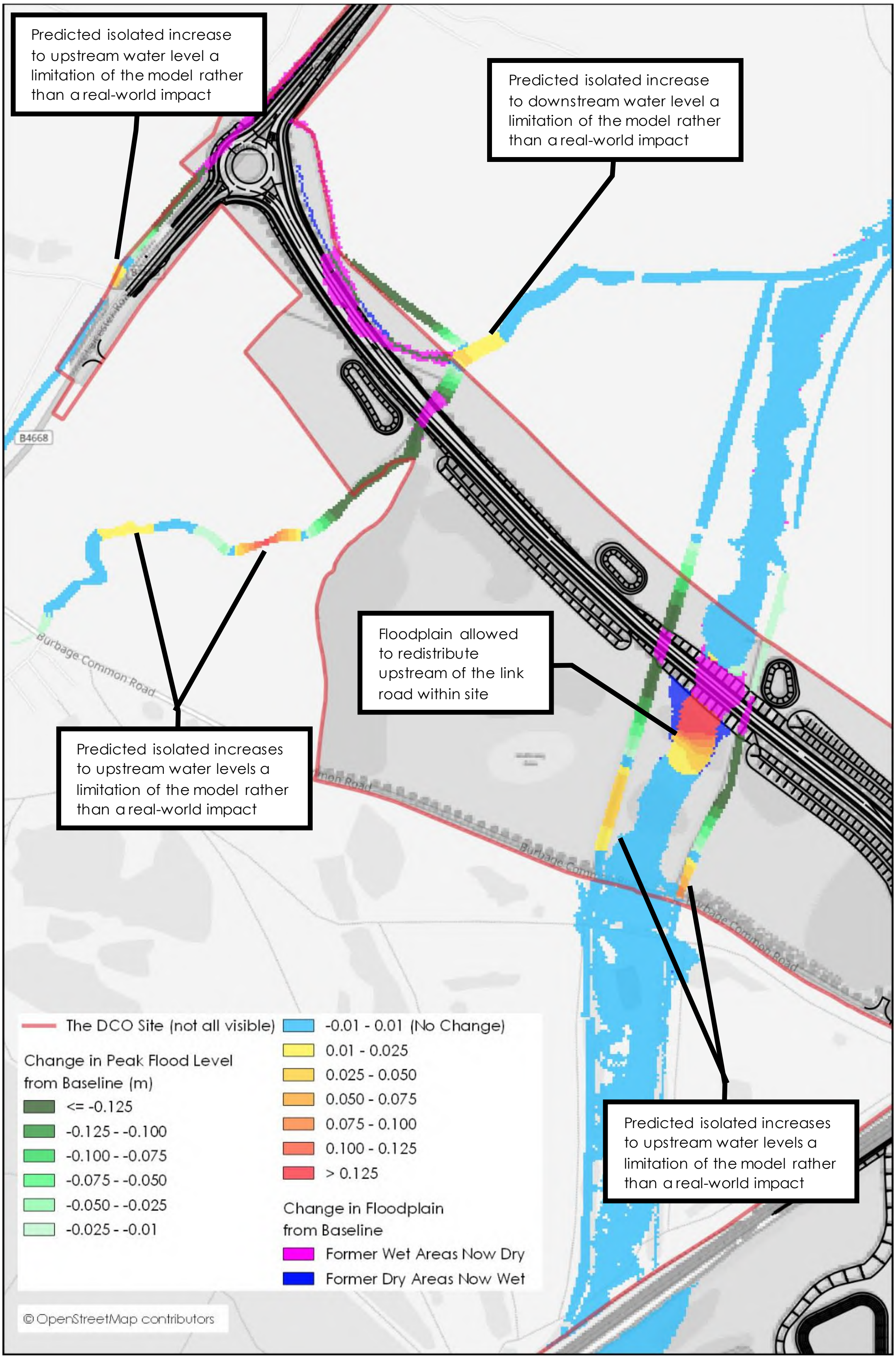


Figure 8.6: Predicted Change in Peak Water Levels on Reach 1, 2, 3 & 8 (1 in 100-Year+30% Flood Event)

9. SUMMARY, RECOMMENDATIONS & LIMITATIONS

9.1 The primary aim of this exercise was to establish a good hydrological and hydraulic representation of the watercourses within the Thurlaston Brook tributary catchment within vicinity of the Main Order Limits of the Hinckley National Rail Freight Interchange. This was achieved through the creation of a site specific 1D-2D hydraulic model.

9.2 The model includes an unnamed tributary of the Thurlaston Brook, an UOW present with the Main HNRFI Site, and a number of smaller tributary channels.

9.3 The hydraulic assessment was informed by a hydrology assessment of the likely flood flows. This was undertaken using the industry standard FEH methodologies, as there was no gauged data available within the study area. However, the assessment did make use of gauged data available in the wider catchment.

9.4 The model was approved as fit for purpose by the EA in March 2022 (ref: ENVPAC/1/EMD/00121).

9.5 The baseline modelling has shown that the Main HNRFI Site is potentially at risk from flood water as it is attenuated on the upstream side of the railway line embankment due to a number of restrictive culverts. The UOW present within the Main HNRFI Site does not pose a significant flood risk until it reaches Station Road, which is downstream of the site.

9.6 The baseline model has identified that the proposed link road crosses 4 channels and 1 overland flow route which will need to be considered in its design.

9.7 An illustrative representation of the proposed development and the A47 Link Road has been tested in the hydraulic model. The results show that the proposals will be located outside of the floodplain and that the link road will be set above flood levels. The model outputs also confirm that there will be no detrimental impact on flood risk outside of the DCO Site boundary. This can be attributed to the preservation of flow routes within the added culverts, as well as the attenuation of surface water runoff from the development at the equivalent greenfield QBAR rate.

Limitations

9.8 The model represents the floodplain and channel conditions at the time of survey.

9.9 The modelling exercise has made use of the available data at the time of construction and simulation.

9.10 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 ESTRY model domain.

9.11 Permission to access to all of the reaches downstream of the site was not possible as they fall within private ownership. As they could not be surveyed, these reaches were modelled within the 2D domain, based upon LiDAR data. Key hydraulic structures on these reaches were informed by asset data records from Network Rail, Leicestershire Highways and Highways England.

9.12 The results downstream of the surveyed area should be treated with caution, as they are predominantly based upon LiDAR. However, the model provides sufficient detail within the study area, and the inclusion of the downstream reaches allows for a like-for-like analysis of the development potential off site impacts. Additionally, the channel capacity on these 2D reaches is likely to be underestimated by the LiDAR, a precautionary outcome for assessing upstream flood risk at the study site. Therefore, this limitation does not diminish the aims of the exercise.

9.13 A number of blockage scenarios have been undertaken at key structures. Blockages of downstream structures on Station Road and the Leicester Road have a significant local impact, but little to no impact on flood risk on the proposed development area. This gives reassurances that the assumption made downstream of the site will not affect the assessment of flood risk in the study site.

9.14 The desired resolution of surveyed cross sections could not be achieved due to overgrown vegetation outside of the site, which could not be cut back.

9.15 As no hydrometric data or recorded flood levels were available, the model has not been verified or calibrated. However, a conservative approach to the model build has been adopted where appropriate, and a range of sensitivity tests have been undertaken to help to compensate for this limitation.

9.16 The 2.0m resolution of the model may negate any small scale topographic features, although all the significant features are believed to have been captured.

9.17 The baseline floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.05 - 0.15m). However, this is considered to be sufficient for the purpose of this exercise, it has also been supplemented with topographical surveys where coverage allows.

9.18 The bare earth DTM does not include for the presence of minor walls or other structures. Buildings have been modelled at ground level with an elevated roughness level.

9.19 This 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.

9.20 A number of sensitivity tests have been undertaken within the model on key assumptions. These tests have identified that the model results for the watercourses are generally not significantly sensitive to changes in roughness, flow, and storm duration where an average change of +/-0.02m is predicted. The exception to this is immediately upstream of the elevated embankments in the catchment (such as the railway line), where the flooding is artificially influenced by the attenuating effects of the hydraulic structures, and flood levels are more sensitive to change.

9.21 The sensitivity tests confirmed that the most appropriate storm duration has been adopted.

APPENDICES

Appendix 1: Hydrological Assessment

BWB

A CAF GROUP COMPANY

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd

Hinckley National Rail Freight Interchange

Leicestershire

Flow Estimation Record – Thurlaston Brook Tributary

[redacted]

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange Leicestershire
Flow Estimation Record – Thurlaston Brook Tributary

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

October 2021

BWB

DOCUMENT ISSUE RECORD

Document Number:	HNRFI-BWB-ZZ-XX-RP-YE-0005_FER
BWB Reference:	NTT-2814-FER

Revision	Date of Issue	Status	Author:	Checked:	Approved:
1	16/07/2021	S2	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM	Robin Green BSc (Hons)	Max Brambani BSc (Hons) PgCert MCIWEM
2	22/10/2021	S2	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM	Robin Green BSc (Hons)	Max Brambani BSc (Hons) PgCert MCIWEM

Notice

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after: -

(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 October 2021 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.

CONTENTS

APPENDICES

1. METHOD STATEMENT

Overview of requirements

1.1 Flow estimates are required for input into a hydraulic model of a tributary of the Thurlaston Brook to support development of the Hinckley National Rail Freight Interchange.

1.2 The location of the site of interest and the watercourses to be modelled are provided in **Figure 1.1.** The Thurlaston Brook Tributary is a tributary of the Thurlaston Brook which, in turn, is a tributary fo the River Soar. The Thurlason Brook Tribuary is fed by two channels which converge downstream of Burbage Common Road. A tributary (Unnamed Ordinary Watercourse) joins the Thurlaston Brook Tributary just downstream of the B581. A number of smaller watercourses and drains are also to be modelled.

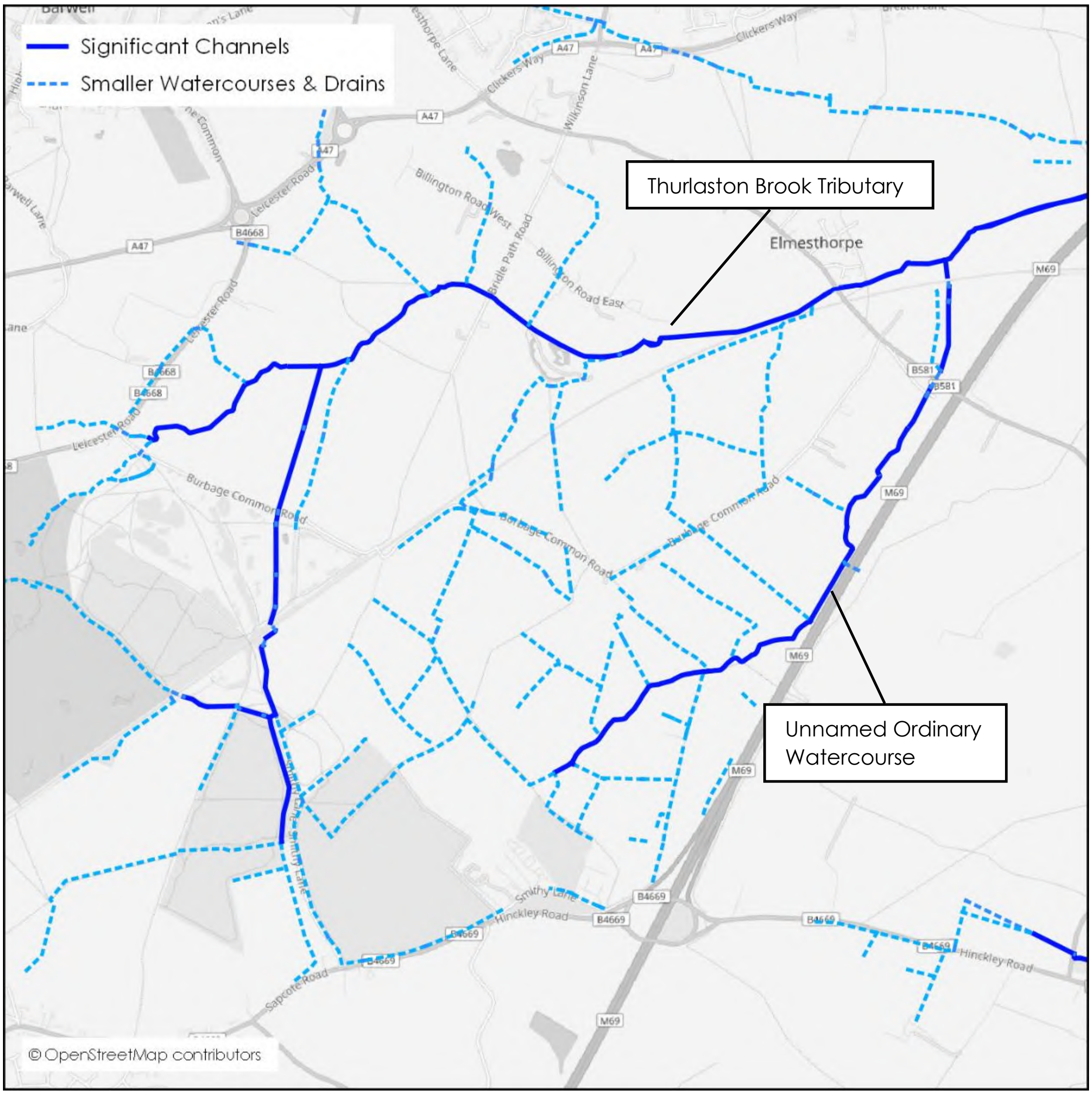


Figure 1.1: Site Location Plan

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 July 2021.

Available hydrometric data

1.5 There are no hydrometric gauges within the study catchment. 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.

1.6 During consultation with the Environment Agency, a gauge on the River Soar at Littlethorpe, was suggested as a possible source of local data that could be used within the assessment.

1.7 The Littlethorpe gauge is located on a different watercourse to the study watercourse. As such, whilst the gauge can be used as part of the Statistical analysis for donor adjustment of QMED, its use for calibration and verification is limited.

1.8 **Table 1.1** and **Table 1.2** provide details on the Littlethorpe gauge. A detailed review of the data quality at the Littlethorpe gauge, beyond a review of the information on the NRFA website, was outside the scope of this assessment.

Table 1.1: Hydrometric gauges within the Study Catchment

Watercourse	Station Name	NRFA number	Grid Reference	Catchment Area (km^2)	Type	Period of Record
River Soar	Littlethorpe	28082	SP542973	183.9	Cross-correlation	08/1971 - present

Table 1.2: Gauging Station Data Availability and Quality

Station Name	Period of data in Peak Flow dataset	Suitable for QMED?	Suitable for Pooling?	Comments on station and data quality
Littlethorpe	1981 - 2019	Yes	Yes	Flood relief channel joins on the right bank just upstream. Bypassed at high flows above 2.4 mASD. During electromagnetic gauged data record, a rating was used to derive flows above 2.3m when instrumentation underestimated. Prone to weed growth.

1.9 The National River Flow Archive (NRFA) Peak Flow Dataset Version 9 will also be utilised in this assessment for the purposes of identifying any potential donor stations and for the development of pooling groups. This is the latest version of the dataset at the time of assessment.

Initial choice of approach

Table 1.3: Method statement

Is FEH appropriate?	Yes. The study catchment is greater than 0.5km^2, is not considered to be highly permeable (BFIHOST is less than 0.75), and there is no significant reservoir attenuation (FARL>0.9). Catchment is considered to be moderately urbanised (URBEXT2000>0.06).
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 before choosing the final method.
Software to be used	WINFAP v4 and ReFH2 version 2.3

2. LOCATIONS WHERE FLOOD ESTIMATES ARE REQUIRED

Location of Flow Estimates

2.1 The study catchment is complex with numerous smaller watercourses and ditches to be modelled, besides the Thurlaston Brook Tributary and the Unnamed Ordinary Watercourse. The majority of the smaller watercourses are not included in the FEH Web Service. Given the relatively small size of the study catchment at the downstream model extent, rather than introducing uncertainty by manually deriving catchment descriptors for each of the smaller watercourses, flow estimates will be undertaken at the downstream model extent. The resulting flows will then be applied to the model by pro-rating the final hydrographs using the individual catchment areas. This is discussed in more detail in **Section 5.2**.

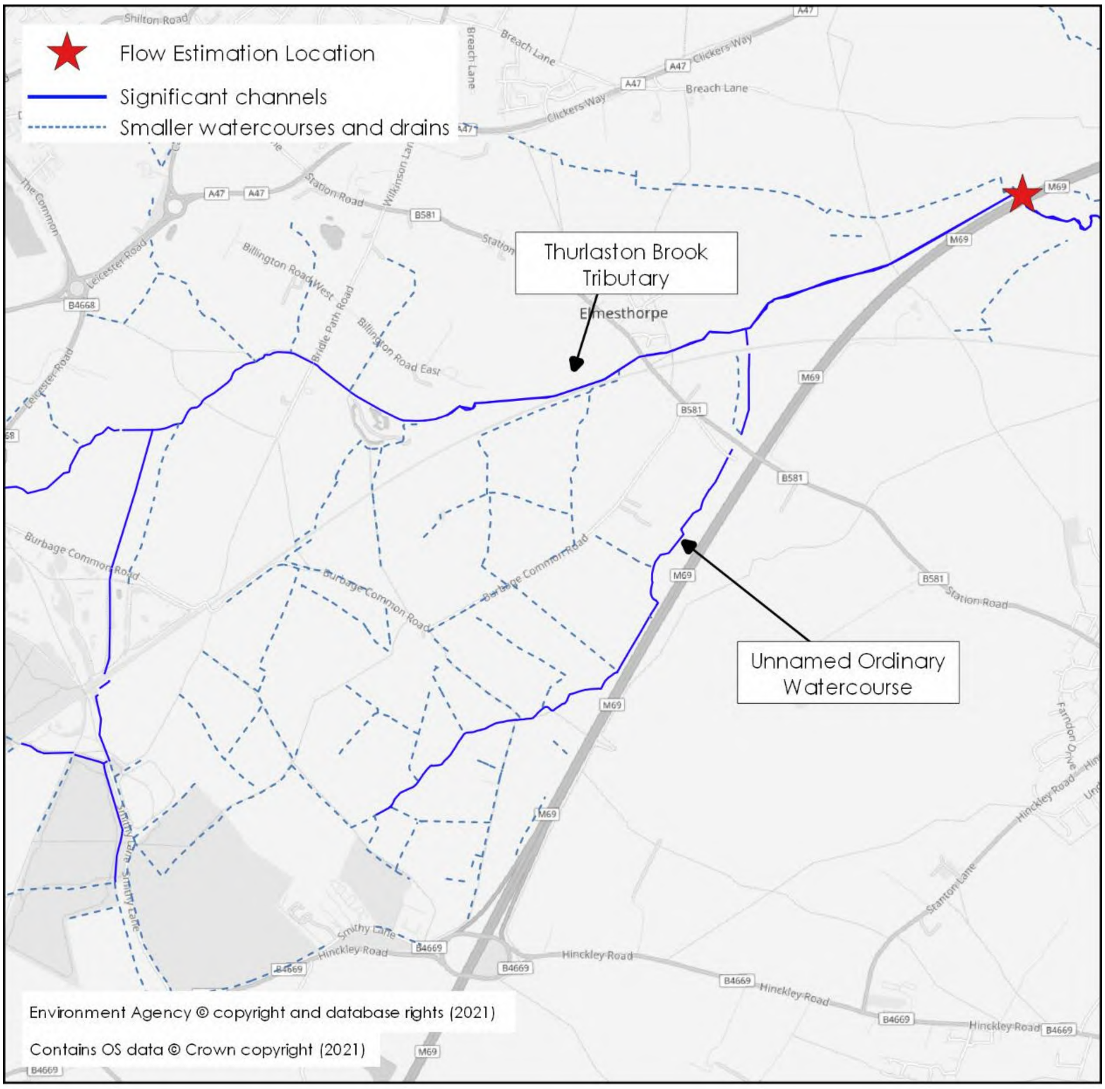


Figure 2.1: Flow Estimation Locations

Table 2.1: Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Area on FEH Web Service (km²)	Revised area (if altered) (km²)
Thurlaston	Thurlaston Brook Tributary	M69 crossing	448250	296450	11.4	10.8

2.2 The two channels that feed the Thurlaston Brook and the Unnamed Ordinary Watercourse are included in the FEH Web Service. Catchment descriptors were extracted to assess the benefit of utilising these for some of the smaller watercourses. However, following comparison, there were mostly only small differences in the catchment descriptors for these tributaries and the wider downstream catchment **(Table 2.2)**. Given the additional complexity and uncertainty using these very small catchments would introduce, including the need to derive flows for lateral catchments, a single flow estimation point at the downstream model extent was considered suitable for the purpose and scope of this assessment.

Table 2.2: Catchment Descriptor Comparison

Catchment	Area	BFIHOST19	DPLBAR	FARL	FPEXT	SAAR	SPRHOST	URBEXT 2000
Thurlaston	10.8	0.372	3.69	0.998	0.1154	635	42.64	0.0643
FEH subcatchment	2.2	0.427	1.5	1	0.1382	645	42.34	0.1894
FEH subcatchment	0.6	0.353	0.83	1	0.1034	363636	42.05	0
FEH subcatchment	1.5	0.357	1.03	1	0.0522	635	41.39	0

Checking Catchment Descriptors

Table 2.3: Catchment Descriptor Checks

Record how catchment boundary was checked and describe any changes.	The catchment boundary for the flow estimation point was identified by the FEH Web Service. The boundary was reviewed using EA LIDAR. A watershed analysis was undertaken using the LIDAR and the results compared to the FEH boundary. Results were also compared to sewers records; the sewer catchment generally follows the topographical catchment and no significant cross-catchment transfer is expected. Surface water sewers in Barwell generally fall towards ordinary watercourses to the north and north west. Elmsthorpe fall towards a tributary of the Thurlaston Brook Tributary, which confluences downstream of the subject catchment. Earls Shilton also falls towards a tributary of the Thurlaston Brook Tributary, confluencing downstream of the M69.

	Following a review of the watershed analysis, the catchment boundary was updated to reflect the results, The original and amended catchment boundary is shown in **Figure 2.2**.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	British Geological Survey (BGS) mapping[1] indicates that the catchment is predominately underlain by the Mercia Mudstone Group, with superficial deposits largely consisting of Bosworth Clay Member – clay and silt and Thrussington Member – diamicton. According to the Soilscapes website[2], the catchment is predominantly underlain by slowly permeable, seasonally wet clayey soils or loamy and clayey soilds with impeded drainage. The underlying geology and soils suggest the BFIHOST and SPRHOST values of the FEH catchment descriptors are appropriate for the catchments. DPLBAR has been updated using the standard equation for DPLBAR, given in the FEH Volume 5. Given the relatively small change in catchment area and following a review of the urban coverage of the catchment, no changes to URBEXT were made beyond updating it for the present day.
Source of URBEXT	$URBEXT_{2000}$
Method for updating of URBEXT to present day.	CPRE formula from 2006 CEH report on $URBEXT_{2000}$

Table 2.4: Important catchment descriptors (changes made are highlighted in red)

Site Code	FARL	PROPWET	BFIHOST	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR	SPRHOST	URBEXT 2000 *	FPEXT
Thurlaston	0.998	0.3	0.372	0.372	3.69	24.0	635	42.64	0.0643	0.1154

* $URBEXT_{2000}$ updated to 2021

[redacted]

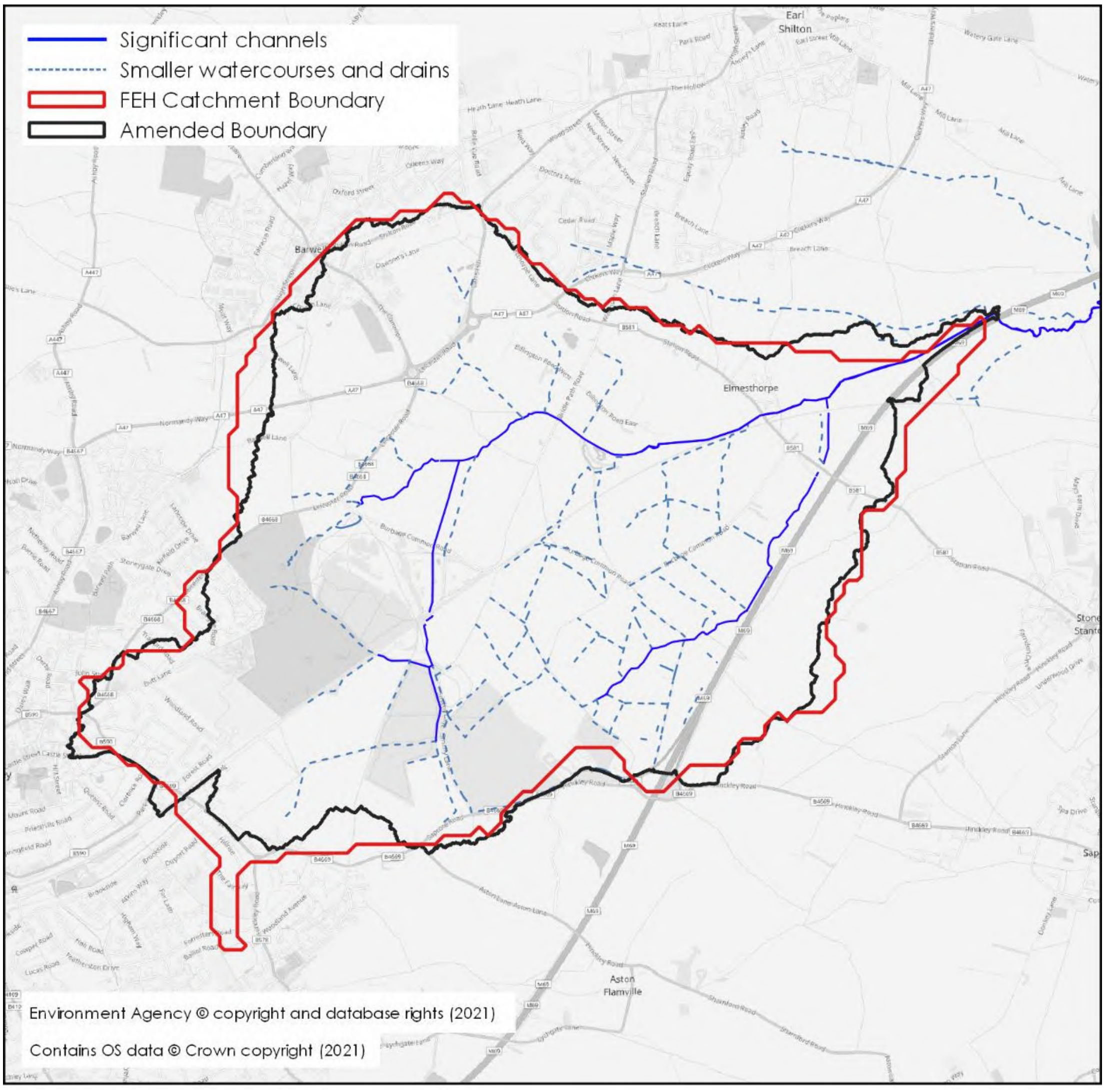


Figure 2.2: Original and Amended Catchment Boundaries

3. STATISTICAL METHOD

3.1 WINFAP version 4 was utilised to undertake a statistical analysis of the catchment using a hydrometric record of gauged catchments with similar characteristics. The latest version of the NRFA Peak Flow dataset (v9) was used to provide an up-to-date hydrometric record.

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 The research underlying the revised data transfer method (SC050050) found that the identification of potential donor catchments should be based on geographical closeness rather than on hydrological similarity, as defined by catchment descriptors. More recent research on small catchments (SC090031) has supported the findings of SC050050, again recommending that donors are selected purely based on proximity. The EA FEH Guidelines advises similarity in catchment descriptors is not essential for donors. However, in view of the sometimes-uncertain relationship between BFIHOST and runoff, similarity in geology or soil type may be relevant. The guidelines also advise considering more than one donor.

3.4 With the guidance in mind, a search was undertaken within WINFAP 4 for suitable donor stations for QMED data transfer. Whilst the FEH recommends avoiding urbanised donors, the Littlethorpe gauge is approximately 8km from the site and only just over the 0.03 threshold for $URBEXT_{2000}$. 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 The six nearest donors were reviewed based on similarity in BFIHOST to the subject site and data quality. Of the recommended donors, station 54111, was rejected due to concerns over data quality, particularly with early flow estimates.

3.6 None of the stations have a record of less than 14 years; therefore adjustment for climatic variation is not required.

3.7 Details for the donor stations are provided in **Table 3.1.**

Table 3.1: Donor Station Details

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28082	15.472*	19.528	0.792
54019	27.319*	34.588	0.790

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28086	21.807*	18.886	1.155
54102	12.313	13.242	0.930
31005	37.240	43.461	0.857

* As URBEXT2000 is greater than 0.03, QMED from observed data has been deurbanised.

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 (m^3/s) (URBAN)
			Donor site NRFA no	Distance between centroids d_j (km)	Weight	Final Adjustment Factor	
Thurlaston	Data Transfer	2.0	28082	3.70	0.519	0.911	2.1
			54019	18.62	0.317		
			28086	19.36	0.312		
			54102	23.32	0.288		
			31005	32.26	0.241		

Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?	There are no gauges with which to check QMED estimates; however, QMED is consistent with the size and characteristics of a small, moderately urbanised catchment.
Which version of the urban adjustment was used for QMED?	Urban adjustment was applied using Kjeldsen (2010), as applied in WINFAP4.

Derivation of Pooling Groups

3.8 A pooled group of hydrologically similar gauged sites was generated by the WINFAP software for the subject sites using the 'OK for Pooling' dataset.

3.9 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.

3.10 The growth curve derived from the pooling group was also adjusted to reflect the urban influence using the methods adopted in WINFAP[3] which is based on those published by Kjeldsen 2010[4].

[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

3.11 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)
Thurlaston_PG	Thurlaston	No	**Stations Removed:** 49005 - low kurtosis compared to rest of the sites within the pooling group, dissimilar seasonality and just 9-years' worth of data. 44008 – highly permeable catchment with non-flood years accounting for >15% of the record. **Stations Added:** 25011 – added to give 500 years of data **Comments:** Final 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: 0.263 L-Skew: 0.239

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
Thurlaston	Pooled	Thurlaston_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for most UK catchments	Urban adjustment using methods adopted in WINFAP which is based on those published by Kjeldsen 2010 Permeable adjustment using WHS Permeable Adjustment Worksheet Beta v1.1	3.17

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
Thurlaston	2.1	2.9	3.6	4.3	5.5	6.1	6.6	7.8	11.8

4. REVITALISED FLOOD HYDROGRAPH (REFH) METHOD

4.1 The ReFH2 Revitalised Flood Hydrograph Modelling Tool (Version 2.3), using FEH 2013 rainfall frequency statistics, 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
Thurlaston	CD	5.81	300.76	39.24	1.08
Description of flood event analysis carried out			No flood event analysis was undertaken due to a lack of gauging station in the study catchment.		

Table 4.2: Critical storm durations

Site code	Season of design event	Storm duration	Selected interval
Thurlaston	Winter	9 hrs	1 hr
Comments	The recommended storm duration for the Thurlaston Brook tributary is 9 hours. As such the model will be run with 9 hour storm duration using a winter storm profile. However, sensitvitiy analysis will also be undertaken using 4.5 hr and 17 hr storm durations to assess the sensitivity of the model to differing storm durations.		

Table 4.3: Flood estimates from the ReFH method

Site Code	Flood peak (m^3/s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Thurlaston	2.8	3.7	4.3	5.0	6.2	6.9	7.4	8.9	13.1

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 flood frequency curves for both methods are shown in **Figure 5.1**.

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
Thurlaston	2.1	2.8	1.33	6.6	7.4	1.12

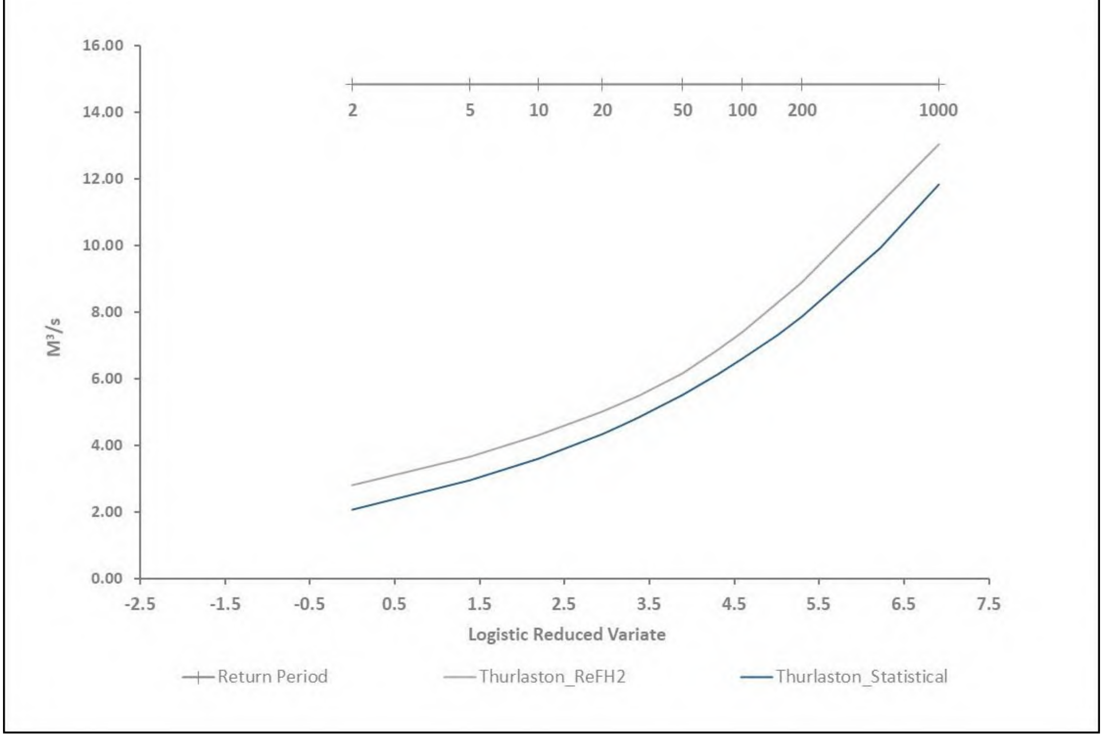


Figure 5.1: Comparison of Statistical method and ReFH Flood Frequency Curves

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 the catchments, the final choice of peak flows for input into the model is the ReFH2 method. Although the Statistical method incorporates local data from the Littlethorpe gauge, the Littlethorpe gauge is located on the River Soar not the Thurlaston Brook Tributary and so is not truly representative of the subject site. (The Thurlaston Brook Tributary flows into the Thurlaston Brook which, in turn flows into the River Soar). Additionally, there is uncertainty regarding flow estimates for the smaller watercourses and drains as they are not included within the FEH Web Service and are very small. As such, due to the uncertainty regarding the flows, and the lack of gauged data on the Thurlaston Brook tributary itself, with which to verify flows, the more conservative ReFH2 flows will be applied to the hydraulic model. This more precautionary approach is considered appropriate for the purposes of an flood risk assessment to support development.

Table 5.3: Final Peak Flows 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
Thurlaston	2.8	3.7	4.3	5.0	6.2	6.9	7.4	8.9	13.1

Table 5.4: Assumptions, limitations and uncertainty

List the main assumptions made	• The pooling group is representative of the catchment. • The River Soar at Littlethorpe gauge is suitable for use as a donor for QMED. • The ReFH2 hydrograph shape is representative of catchment response. • Tp and storm duration is representative of the catchment response. • The hydrograph at the downstream extent of the model is suitable to apply to the sub-catchments within the study area by pro-rata based on catchment area. • The characteristics of the catchment do not change significantly between the upper reaches and the downstream extent of the model.
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 small gauged sites in the UK. As such the representation in the pooling is not ideal given the relatively small size of the study catchment.

	• There is no observed flow data within the catchment with which to calibrate or verify the flow estimates. • The majority of the catchments that require flow estimates are not included within the FEH Web Service.
Give what information you can on uncertainty in the results	According to Table 4 of the EA FEH Guidelines, confidence intervals for the 1 in 100 year for a moderarately urbanised site when calculated from catchment descriptors are quoted as 0.33-3.01 (for the 95% confidence interval). Confidence is considered to be improved when using observed data from a donor site. When six donors are used in the assessment, the confidence intervals changes to 0.34-2.94 (for the 95% confidence interval). It is more difficult to quantity uncertainty in design flows estimated from the ReFH rainfall-runoff model. However, evidence[5] 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. The nature of the catchment and watercourses to be modelled (small catchments, short reaches, split catchments due to embankments) means there is a greater degree in uncertainty in the results as there is a shortage of such sites in the NRFA dataset used to derive the regression quations for ungauged sites and to select pooling groups and donor catchments. Given the uncertainty, the more precautionary, ReFH2 peak flows are preferred for the pruposes of the modelling study.
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 planning decisions for a site near Hinckley. 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 5.5: Checks

Are the results consistent?	Peak flows are consistent with the size and characteristics of the catchment.
What do the results imply regarding the return periods of floods during the period of record?	It is not possible to imply return periods of floods due to the lack of gauged data within the study catchment.
What is the 1 in 100-year growth factor? (the guidance	• Statistical Method: 3.17 • ReFH2 Method: 2.64

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

suggests a typical range or 2.1 to 4.0)	These all 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: 1.80 • ReFH2 Method: 1.77
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred	There are no previous detailed studies on the Thurlaston Brook tributary with which to make a comparison.
Are the results consistent with the longer-term flood history?	It is not possible to compare the results with the longer-term flood history due to the lack of gauged data within the study catchment.
Describe any other checks on the results	Sensibility checks of modelled outlines will be undertaken at the modelling stage.

Application of flows to model

5.2 Flows will be applied to the model in the following way:

i. Watershed analysis has been used to derive the catchment area draining to each of the watercourses to be modelled. Sub-catchments were delineated at large tributary inflows, and at locations where the floodplain is bisected by significant embankments (such as Station Road, the railway line, and the M69).

ii. The ReFH hydrograph has been pro-rated based on the catchment areas derived from the watershed analysis.

iii. The initial hydrograph has been generated using catchment descriptors, a 9 hour storm duration with a winter storm pofile. Sensitivity testing will be carried out at the modelling stage and is documented within the hydraulic modelling report.

iv. Hydrographs can be found in the hydraulic model boundary condition files.

5.3 **Appendix 1** demonstrates the breakdown of the catchments and **Table 5.6** provides an explanation of the breakdown.

Table 5.6: Sub-catchment breakdown

Sub-Catchment	Area (km^2)	Percentage of Study Catchment (rounded to 1 d.p)	Description
Reach 1 Upstream Catchment	0.34	3.1%	Catchment upstream of 1D model domain. Applied as a point inflow to the 1D model at the top of Reach 1.
Reach 1 Lateral Catchment 2	1.43	13.2%	Well defined tributary watercourse catchment. Applied as a distributed inflow

Sub-Catchment	Area (km^2)	Percentage of Study Catchment (rounded to 1 d.p)	Description
			to the 1D nodes within the catchment area.
Reach 1 Lateral Catchment 3	0.55	5.1%	Intervening area between 'Reach 1 Lateral Catchment 2' and 'Reach 4'. Covers the downstream extent of the 1D domain. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 1 Lateral Catchment 4	0.40	3.7%	Intervening area between 'Reach 4' and B581 Station Road. Applied as a distributed inflow to the 2D domain within the catchment area using the stream line approach.
Reach 1 Lateral Catchment 5	0.49	4.5%	Intervening area between B581 Station Road and the M69. Applied as a distributed inflow to the 2D domain within the catchment area using the stream line approach.
Reach 2 Upstream Catchment	0.42	3.9%	Catchment upstream of 1D model domain. Applied as a point inflow to the 1D model at the top of Reach 2.
Reach 2 Lateral Catchment 2	0.28	2.6%	Intervening area between 'Reach 2 Upstream Catchment' and the railway line. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 2 (& 8) Lateral Catchment 1	0.46	4.2%	Intervening area between the railway line and 'Reach 1'. Also includes a parallel channel (Reach 8). Applied as a distributed inflow to the 1D nodes within the catchment area (Reach 2 and Reach 8).
Reach 2A Upstream Catchment	1.23	11.3%	Catchment upstream of 1D model domain. Applied as a point inflow to the 1D model at the top of Reach 2A.
Reach 2A Downstream Catchment	1.07	9.9%	Intervening area between 'Reach 2A Upstream Catchment' and 'Reach 2'. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 3 Upstream Catchment	0.34	3.1%	Catchment upstream of B4668 Leicester Road. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 3 (& 1) Lateral Catchment 1	0.47	4.3%	Intervening area between B4668 Leicester Road and 'Reach 1' (includes part of Reach 1). Applied as a distributed inflow to the 1D nodes within the catchment area.

Sub-Catchment	Area (km^2)	Percentage of Study Catchment (rounded to 1 d.p)	Description
Reach 4 Upstream Catchment	0.43	4.0%	Catchment upstream of railway line. Applied as a point inflow to the 2D model at the top of Reach 4.
Reach 4A Upstream Catchment	0.11	1.0%	Catchment upstream of railway line. Applied as a point inflow to the 2D model at the top of Reach 4A
Reach 4 & 4A Lateral Catchment	0.26	2.4%	Intervening area between the railway line and 'Reach 1' (includes part of Reach 4 and 4A). Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 5 Upstream Catchment	0.10	0.9%	Catchment upstream of 1D model domain. Applied as a point inflow to the 1D domain at the top of Reach 5.
Reach 5 Eastern Catchment	0.60	5.5%	Catchment to the east of the M69 draining to Reach 5. Applied as a point inflow to the 2D domain upstream of the M69 culvert.
Reach 5 Lateral Catchment (site)	0.87	8.0%	Intervening area between 'Reach 5 Upstream Catchment', 'Reach 5 Eastern Catchment' and the downstream site boundary. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 5 Lateral Catchment (downstream of site)	0.50	4.6%	Intervening area between the downstream site boundary and Reach 1. Applied as a distributed inflow to the 1D nodes within the catchment area.
Reach 6 Catchment	0.49	4.5%	Catchment upstream of railway line. Applied as a point inflow to the 2D model at the top of Reach 6

6. SUPPORTING INFORMATION

Flood history

6.1 A flood history review for the area has been undertaken using Environment Agency recorded flood outlines, Strategic Flood Risk Assessments[6,7,8,9], Leicestershire County Council Flood Investigation Reports, the British Chronology of Hydrological Events and online newspaper reports. No record of flooding to the proposed development site has been found during the search of these sources.

6.2 In a response to the Hinckley National Rail Freight Interchange Scoping Opinion[10], Burbage Parish Council note that the site is known to be frequently waterlogged and has very poor natural drainage, particularly alongside the railway where sustained flooding / standing water is commonplace. However, no detail on specific occurrences and sources of the flooding are provided.

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: Thurlaston_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
26016 (Gypsey Race @ Kirby Grindalythe)	1.14	22	0.1	0.321	0.266	0.266
25019 (Leven @ Easby)	1.276	41	5.09	0.342	0.386	0.825
27051 (Crimple @ Burn Bridge)	1.334	47	4.524	0.218	0.156	0.336
27073 (Brompton Beck @ Snainton Ings)	1.444	39	0.812	0.215	0.035	1.444
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	1.51	9	5.777	0.271	0.151	3.256
36010 (Bumpstead Brook @ Broad Green)	1.535	52	7.395	0.382	0.181	2.033
27010 (Hodge Beck @ Bransdale Weir)	1.647	41	9.42	0.224	0.293	0.484
44008 (South Winterbourne @ Winterbourne Steepleton)	1.677	40	0.434	0.411	0.337	1.531
45816 (Haddeo @ Upton)	1.814	26	3.456	0.3	0.406	1.001
41020 (Bevern Stream @ Clappers Bridge)	1.832	50	13.575	0.207	0.182	0.815
72014 (Conder @ Galgate)	1.863	51	16.646	0.231	0.16	0.312
47022 (Tory Brook @ Newnham Park)	1.891	25	6.176	0.257	0.191	0.49
73015 (Keer @ High Keer Weir)	1.893	28	12.375	0.204	0.26	0.554
26014 (Water Forlornes @ Driffield)	1.911	21	0.424	0.306	0.147	0.502
28033 (Dove @ Hollinsclough)	1.925	44	4.177	0.228	0.371	1.149

[6] Joint Strategic Flood Risk Assessment, Hinckley and Bosworth Borough, Blaby District, and Oadby and Wigston Borough Councils (2014)
[7] Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (Leicestershire Local Planning Authorities and Leicester City Council (2017)
[8] Strategic Flood Risk Assessment for Hinckley and Bosworth Borough Council: Final Report, Hinckley and Bosworth Council (July 2019)
[9] Hinckley and Bosworth Borough Council Level 2 Strategic Flood Risk Assessment: Final Report, Hinckley and Bosworth Borough Council (May 2020)
[10] Scoping Opinion: Proposed Hinckley National Rail Freight Interchange. Case Reference: TR50007, The Planning Inspectorate ((December 2020)

Total		536				
Weighted Means				0.275	0.237	
H2 value	2.7193					
Goodness of Fit	**Generalised Logistic**			**General Extreme Value**		
	1.598			-0.0468		

Table 6.2: Final pooling group (before permeable adjustment): Thurlaston_PG

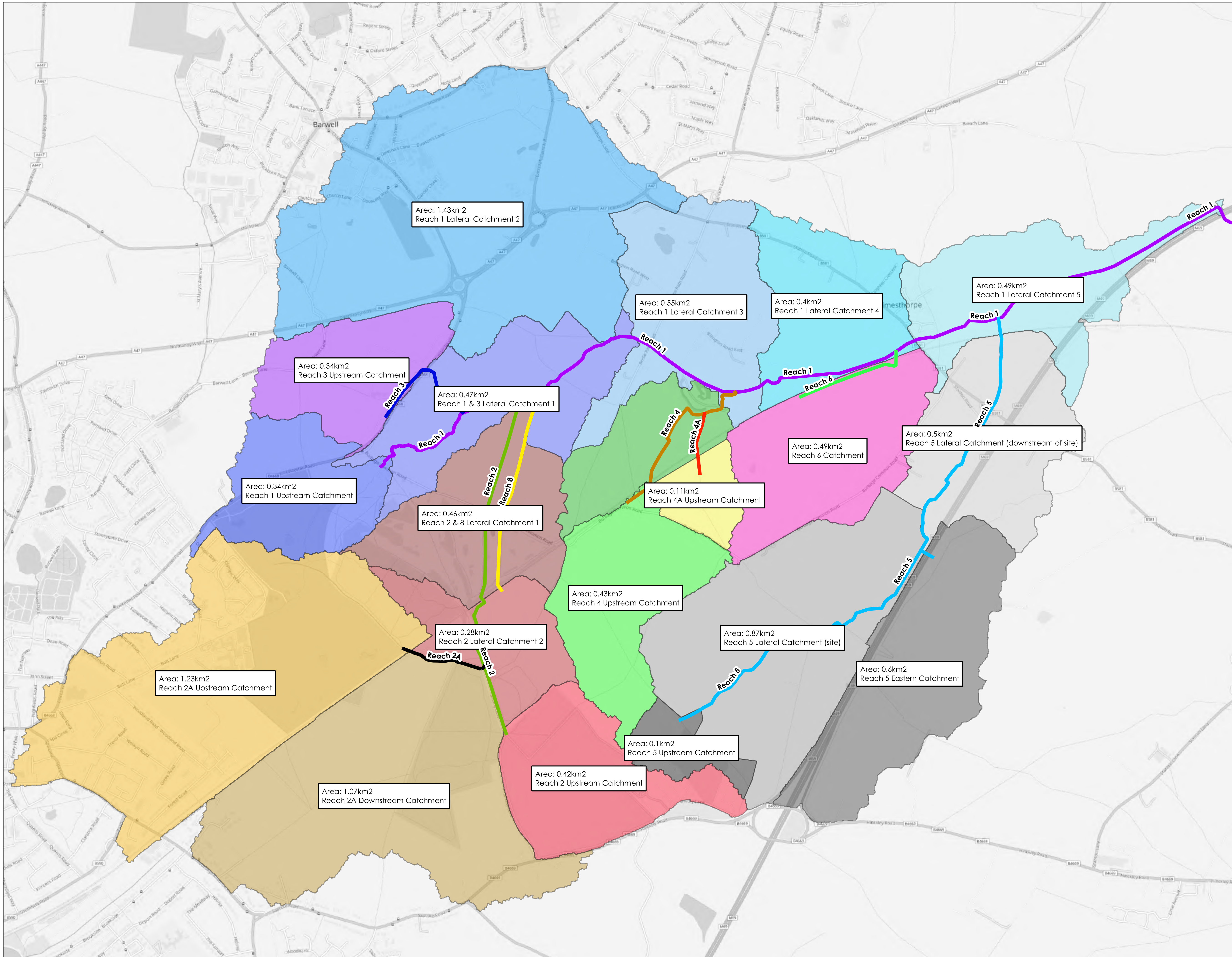
Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
26016 (Gypsey Race @ Kirby Grindalythe)	1.14	22	0.1	0.321	0.266	0.443
25019 (Leven @ Easby)	1.276	41	5.09	0.342	0.386	1.124
27051 (Crimple @ Burn Bridge)	1.334	47	4.524	0.218	0.156	0.377
27073 (Brompton Beck @ Snainton Ings)	1.444	39	0.812	0.215	0.035	1.375
36010 (Bumpstead Brook @ Broad Green)	1.535	52	7.395	0.382	0.181	2.293
27010 (Hodge Beck @ Bransdale Weir)	1.647	41	9.42	0.224	0.293	0.405
45816 (Haddeo @ Upton)	1.814	26	3.456	0.3	0.406	0.92
41020 (Bevern Stream @ Clappers Bridge)	1.832	50	13.575	0.207	0.182	1.105
72014 (Conder @ Galgate)	1.863	51	16.646	0.231	0.16	0.282
47022 (Tory Brook @ Newnham Park)	1.891	25	6.176	0.257	0.191	1.342
73015 (Keer @ High Keer Weir)	1.893	28	12.375	0.204	0.26	0.472
26014 (Water Forlornes @ Driffield)	1.911	21	0.424	0.306	0.147	1.032
28033 (Dove @ Hollinsclough)	1.925	44	4.177	0.228	0.371	1.17
25011 (Langdon Beck @ Langdon)	1.981	33	15.647	0.232	0.328	1.658
Total		520				
Weighted Means				0.263	0.239	
H2 value	2.4866					
Goodness of Fit	**Generalised Logistic**			**General Extreme Value**		
	1.4759			-0.2249		

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

Station	Adjusted L-CV	Adjusted L-Skew
26016 (Gypsey Race @ Kirby Grindalythe)	0.293	0.313
27073 (Brompton Beck @ Snainton Ings)	0.200	0.072
26014 (Water Forlornes @ Driffield)	0.296	0.124

APPENDICES

APPENDIX 1: Application of Flows to Model



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

Modelled Reaches

- Reach 1
- Reach 2
- Reach 2A
- Reach 3
- Reach 4
- Reach 4A
- Reach 5
- Reach 6
- Reach 8

Rev	Date	Details of issues/ revision	Drw	Rev
P02	04.11.21	GENERAL UPDATE	RG	CG
P01	30.06.21	PRELIMINARY ISSUE	RG	CG

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Tributary Sub-Catchments

Drawn:	R Green		Reviewed:	C Gardner
BWB Ref:	NTT 2814	Date: 30/06/21	Scale@A3:	1:15,000

Drawing Status

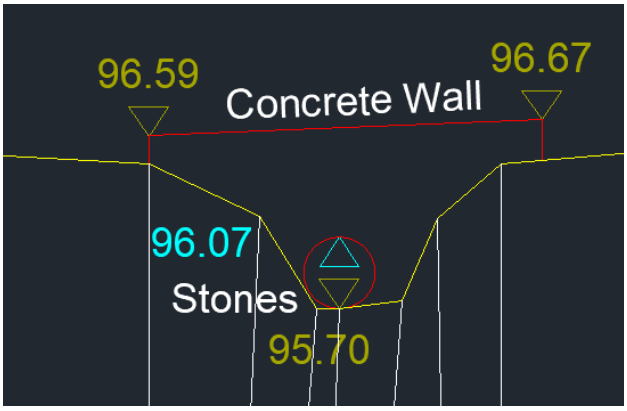
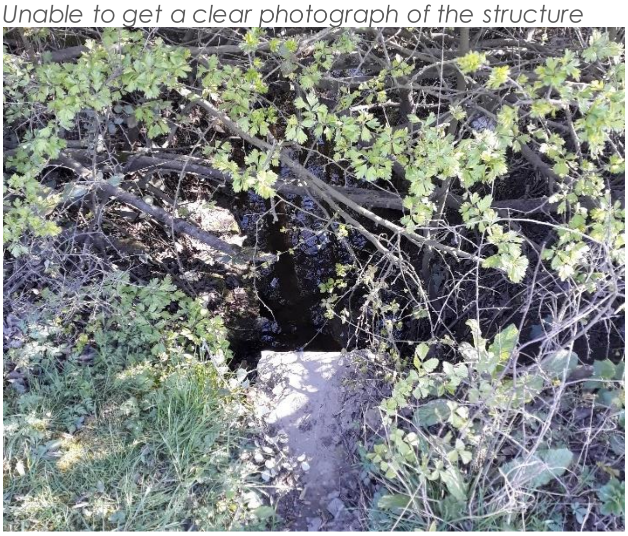
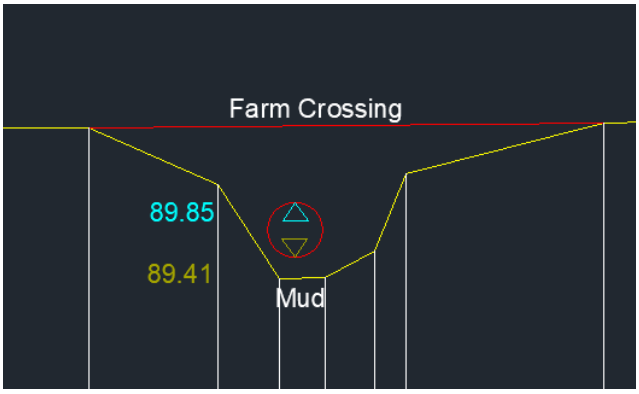
PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0016	S2	P02

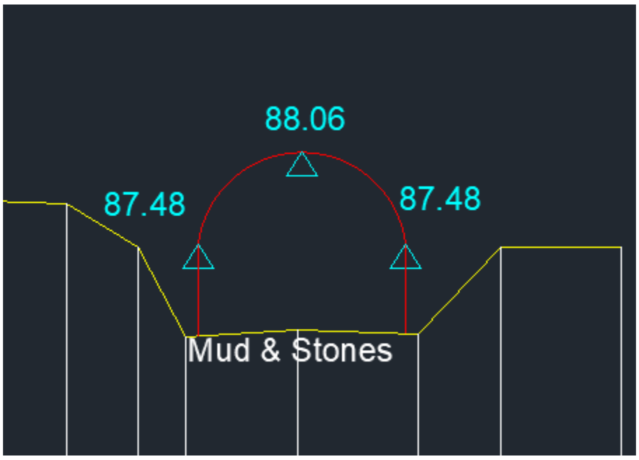
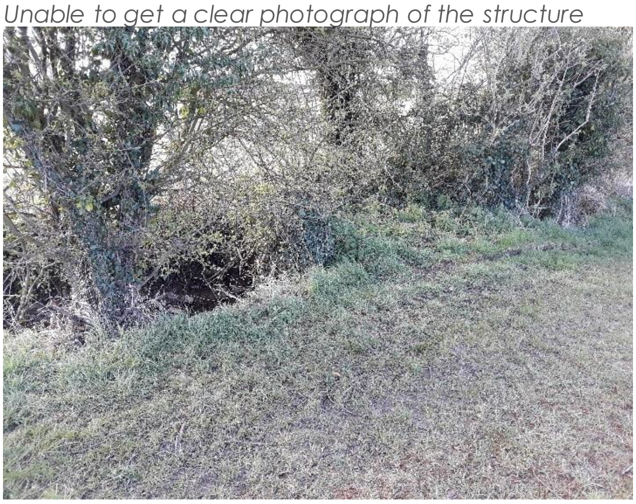
BWB

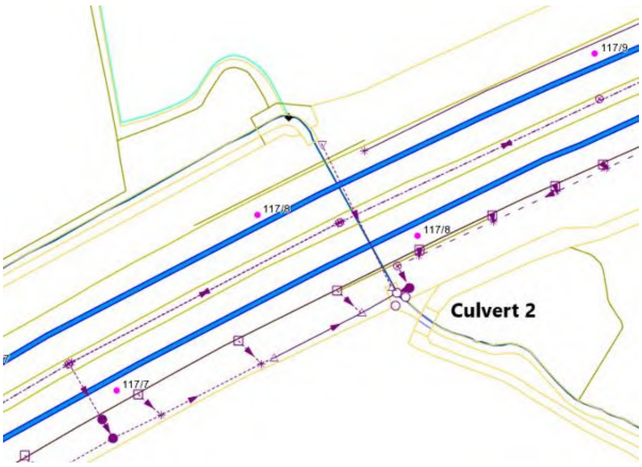
A CAF GROUP COMPANY

Appendix 2: Table of Hydraulic Structures

Model ID	Model Details	Photograph
Reach 1 1.024c	**Description:** Culvert Beneath Burbage Common Road **NGR:** 444685, 295366 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.367m internal diameter **Upstream Invert Level:** 95.70mAOD **Downstream Invert Level:** 95.70mAOD **Length**: 5.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	 *Unable to get a clear photograph of the structure* 
Reach 1 1.018c	**Description:** Culvert Beneath Farm Access Track **NGR:** 445177, 295657 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.406m internal diameter **Upstream Invert Level:** 89.71mAOD **Downstream Invert Level:** 89.41mAOD **Length**: 6.6m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	 *Unable to get a clear photograph of the structure*

Model ID	Model Details	Photograph
		
Reach 1 1.014b	**Description:** Farm Access Track Bridge **NGR:** 445374, 295677 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 1.9m span, 1.1m above bed **Upstream Invert Level:** 87.86mAOD **Downstream Invert Level:** 87.78mAOD **Length**: 4.9m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 1 1.011c	**Description:** Culvert Beneath Farm Access Track **NGR:** 445459, 295753 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.872m internal diameter **Upstream Invert Level:** 87.67mAOD (U/S Invert raised to match d/s to overcome instability). **Downstream Invert Level:** 87.70mAOD **Length**: 3.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	

Model ID	Model Details	Photograph
Reach 1 1.007c	**Description:** Culvert Beneath Farm Access Track **NGR:** 445683, 295919 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Irregular Conduit (Arch) **Dimensions:** 1.33m span, soffit 1.1m above bed (HW table) **Upstream Invert Level:** 86.88mAOD **Downstream Invert Level:** 86.89mAOD **Length**: 4.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	 *Unable to get a clear photograph of the structure* 
Reach 1 1.003c	**Description:** Culvert Beneath Private Road **NGR:** 445852, 295892 **Data Source:** Watercourse Survey. Upstream inaccessible for survey. Downstream dimensions and invert adopted. **Domain:** 1D ESTRY **Unit Type**: Irregular Conduit (Arch) **Dimensions:** 1.74m span, soffit 0.94m above bed (HW table) **Upstream Invert Level:** 86.14mAOD **Downstream Invert Level:** 86.14mAOD **Length**: 4.5m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	

Model ID	Model Details	Photograph
Reach 1 1.002c	**Description:** Twin Culverts Beneath Private Road **NGR:** 445984, 295791 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.56m internal diameter x 2 **Upstream Invert Level:** 85.31mAOD (Upstream invert raised nominally) to 85.32mAOD to overcome instability brought about by negative gradient). **Downstream Invert Level:** 85.32mAOD **Length**: 2.9m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 1 B581	**Description:** Twin Culverts Beneath B581 (Station Road) **NGR:** 447009, 295912 **Data Source:** No Access for Survey. Leicestershire Highways asset data used as next best alternative. Inverts approximated from available DTMs. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 1.2m internal diameter x 2 **Upstream Invert Level:** 81.67mAOD **Downstream Invert Level:** 81.67mAOD **Length**: 25.7m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	 *Photograph provided by Leiscestershire Highways*
Reach 1 M69	**Description:** Culvert Beneath M69 **NGR:** 448349, 296466 **Data Source:** No Access for Survey. Highways England asset data used as next best alternative. **Domain:** 1D ESTRY **Unit Type**: Rectangular Conduit **Dimensions:** 4.2m x 1.5m **Upstream Invert Level:** 77.49mAOD **Downstream Invert Level:** 77.10mAOD **Length**: 45.9m **Manning's N:** 0.015	

<table>
<tr><th>Model ID</th><th>Model Details</th><th>Photograph</th></tr>
<tr><td></td><td>Spill/Bypass: Modelled in 2D as part of the floodplain</td><td>Extract from Highways England Asset Database</td></tr>
<tr><td>Reach 2
2.030c</td><td>Description: Culvert Beneath Footpath
NGR: 445225, 294204
Data Source: Watercourse Survey
Domain: 1D ESTRY
Unit Type: Circular Conduit
Dimensions: 0.5m internal diameter
Upstream Invert Level: 95.07mAOD
Downstream Invert Level: 94.85mAOD
Length: 12.1m
Manning's N: 0.015
Spill/Bypass: Modelled in 2D as part of the floodplain</td><td></td></tr>
<tr><td>Reach 2
2.027c</td><td>Description: Culvert Beneath Footpath
NGR: 445178, 294349
Data Source: Watercourse Survey
Domain: 1D ESTRY
Unit Type: Circular Conduit
Dimensions: 0.387m internal diameter
Upstream Invert Level: 94.24mAOD (raised to 94.36mAOD to match d/s and overcome instability)
Downstream Invert Level: 94.36mAOD
Length: 12.1m
Manning's N: 0.015
Spill/Bypass: Modelled in 2D as part of the floodplain</td><td></td></tr>
</table>

Model ID	Model Details	Photograph
Reach 2 2.025b	**Description:** Footbridge **NGR:** 445135, 294486 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 2.7m span, soffit between 0.61 and 0.37m above bed **Upstream Invert Level:** 93.35mAOD **Downstream Invert Level:** 93.31mAOD **Length**: 0.8m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 2 2.022b	**Description:** Footbridge **NGR:** 445118, 294529 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 4.6m span, soffit between 0.68m above bed **Upstream Invert Level:** 93.04mAOD **Downstream Invert Level:** 93.08mAOD **Length**: 0.8m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 2 2.019c	**Description:** Culvert through field **NGR:** 445096, 294735 **Data Source:** Watercourse Survey & Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.675m internal diameter **Upstream Invert Level:** 92.40mAOD **Downstream Invert Level:** 92.36mAOD **Length**: 27.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

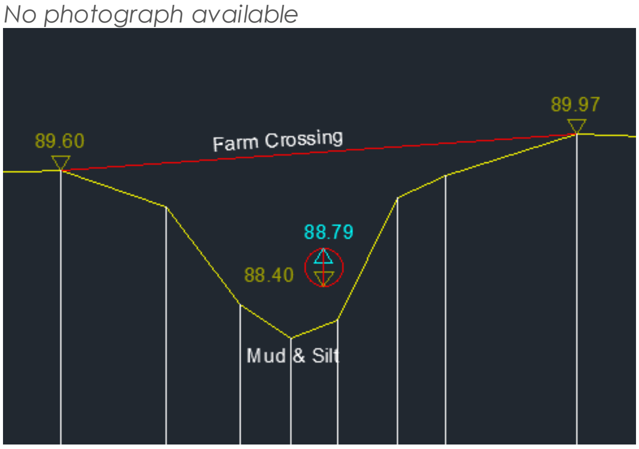
Model ID	Model Details	Photograph
Reach 2 2.017c	**Description:** Culvert Beneath Railway **NGR:** 445125, 294782 **Data Source:** Watercourse Survey & Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.90m internal diameter **Upstream Invert Level:** 91.72mAOD **Downstream Invert Level:** 91.72mAOD **Length**: 26.1m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 2 2.015c	**Description:** Culvert Beneath Footpath/Track **NGR:** 445119, 294803 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 1.0m internal diameter **Upstream Invert Level:** 92.07mAOD (invert raised nominal to meet upstream channel invert and to overcome instability 92.12mAOD) **Downstream Invert Level:** 92.08mAOD **Length**: 4.5m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 2 2.012c	**Description:** Culvert Beneath Footpath **NGR:** 445136, 295053 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.915m internal diameter **Upstream Invert Level:** 91.50mAOD **Downstream Invert Level:** 91.49mAOD **Length**: 1.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	

Model ID	Model Details	Photograph
Reach 2 2.010c	**Description:** Culvert Beneath Footpath/Track **NGR:** 445136, 295128 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.80m internal diameter **Upstream Invert Level:** 91.49mAOD **Downstream Invert Level:** 91.48mAOD **Length**: 5.3m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 2 2.008c	**Description:** Culvert Beneath Burbage Common Road **NGR:** 445143, 295168 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.675m internal diameter **Upstream Invert Level:** 91.19mAOD **Downstream Invert Level:** 91.19mAOD **Length**: 6.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 2 2.004c	**Description:** Culvert Beneath Farm Track **NGR:** 445229, 295450 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 1.05m internal diameter **Upstream Invert Level:** 89.71mAOD **Downstream Invert Level:** 89.64mAOD **Length**: 6.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 2A 2A.013c	**Description:** Culvert Beneath Railway **NGR:** 444806, 294559 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.687m internal diameter **Upstream Invert Level:** 95.26mAOD **Downstream Invert Level:** 95.14mAOD **Length**: 26.7m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 2A 2A.011c	**Description:** Culvert Beneath Footpath/Track **NGR:** 444825, 294551 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.50m internal diameter **Upstream Invert Level:** 95.04mAOD **Downstream Invert Level:** 94.82mAOD **Length**: 35.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 2A 2A.008b	**Description:** Footbridge **NGR:** 445002, 294520 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 2.1m span, soffit 0.4m above bed **Upstream Invert Level:** 93.59mAOD **Downstream Invert Level:** 93.53mAOD **Length**: 0.9m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 1D as a weir over the structure	

Model ID	Model Details	Photograph
Reach 2A 2A.006b	**Description:** Footbridge **NGR:** 445011, 294514 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 2.1m span, soffit 0.4m above bed **Upstream Invert Level:** 93.64mAOD **Downstream Invert Level:** 93.62mAOD **Length**: 1.3m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 2A 2A.004c	**Description:** Culvert Beneath Footpath **NGR:** 445118, 294481 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.532m internal diameter **Upstream Invert Level:** 93.23mAOD **Downstream Invert Level:** 93.23mAOD **Length**: 2.1m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	
Reach 2A 2A.002c	**Description:** Culvert Beneath Track **NGR:** 445129, 294486 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Narrow arch (0.56m) in wide box culvert (2.69m). Modelled using most restrictive dimensions (arch) **Dimensions:** 0.56m span, soffit 0.58m above bed (HW table) **Upstream Invert Level:** 93.11mAOD **Downstream Invert Level:** 93.15mAOD **Length**: 15.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 3 3.007c	**Description:** Culvert Beneath Access Road **NGR:** 444744, 295645 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.363m internal diameter **Upstream Invert Level:** 96.19mAOD **Downstream Invert Level:** 95.98mAOD **Length**: 13.6m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 3 3.004c	**Description:** Culvert Beneath Leicester Road **NGR:** 444878, 295784 **Data Source:** Too overgrown to survey, and on the Leicestershire highways asset database. Hand Measurement and LiDAR Data used as the next best alternative. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.50m internal diameter **Upstream Invert Level:** 94.00mAOD (from LiDAR) **Downstream Invert Level:** 93.77mAOD (from LiDAR) **Length**: 30.7m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 3 3.003c	**Description:** Culvert Beneath Farm Access **NGR:** 444941, 295670 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.247m internal diameter **Upstream Invert Level:** 92.33mAOD **Downstream Invert Level:** 92.33mAOD **Length**: 2.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 4 Rail_Cul4	**Description:** Culvert Beneath Railway **NGR:** 444941, 295670 **Data Source:** Watercourse Survey & Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.375m internal diameter **Upstream Invert Level:** 89.32mAOD **Downstream Invert Level:** 89.01mAOD **Length**: 27.3m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 4 4.011c	**Description:** Culvert Beneath Farm Track **NGR:** 445860, 295330 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.393m internal diameter **Upstream Invert Level:** 89.19mAOD **Downstream Invert Level:** 88.40mAOD **Length**: 26.5m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	*No photograph available* 
Reach 4 4.008b	**Description:** Farm Track Bridge **NGR:** 445934, 295483 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Bridge **Dimensions:** 1.3m span, soffit 0.5m above bed. **Upstream Invert Level:** 87.08mAOD **Downstream Invert Level:** 86.77mAOD **Length**: 7.8m **Manning's N:** 0.040 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 4 4.011c	**Description:** Culvert Beneath Farm Track **NGR:** 445935, 295497 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.55m internal diameter **Upstream Invert Level:** 86.80mAOD **Downstream Invert Level:** 86.44mAOD **Length**: 8.8m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 4A Cul4a	**Description:** Culvert Beneath Farm Track **NGR:** 446063, 2954013 **Data Source:** Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.166m internal diameter **Upstream Invert Level:** 89.56mAOD **Downstream Invert Level:** 89.40mAOD **Length**: 6.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 4A Rail_Cul5	**Description:** Culvert Beneath Railway Line **NGR:** 446060, 295438 **Data Source:** Watercourse Survey & Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.375m internal diameter **Upstream Invert Level:** 88.69mAOD **Downstream Invert Level:** 88.47mAOD **Length**: 17.7m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 5 Topo1.10c	**Description:** Culvert Beneath Farm Track **NGR:** 446579, 294636 **Data Source:** Topographical Site Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.3m internal diameter **Upstream Invert Level:** 89.80mAOD **Downstream Invert Level:** 89.78mAOD **Length**: 3.4m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 1D as a weir over the structure	No Photograph Available – see Topographical Survey
Reach 5 Cul5_M69	**Description:** Culvert Beneath M69 **NGR:** 447065, 294982 **Data Source:** Topographical Site Survey. Culvert inlet not accessible for survey therefore invert taken from available DTM **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.975m internal diameter **Upstream Invert Level:** 86.16mAOD **Downstream Invert Level:** 85.75mAOD **Length**: 52.7m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	No Photograph Available – see Topographical Survey
Reach 5 5.010_c1	**Description:** Culvert Beneath Access Track **NGR:** 447154, 295296 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.575m internal diameter **Upstream Invert Level:** 84.39mAOD **Downstream Invert Level:** 84.38mAOD **Length**: 4.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 5 5.010_c2	**Description:** Culvert Beneath Access Track **NGR:** 447154, 295296 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.25m internal diameter **Upstream Invert Level:** 84.67mAOD **Downstream Invert Level:** 84.67mAOD **Length**: 4.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 5 5.008_c1	**Description:** Culvert Beneath Private Road **NGR:** 447316, 295564 **Data Source:** Watercourse Survey. Inlet inaccessible for survey, surveyed outlet invert and channel dimensions adopted as next best available data source. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.885m internal diameter **Upstream Invert Level:** 83.11mAOD **Downstream Invert Level:** 83.11mAOD **Length**: 54.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 5 5.008_c2	**Description:** Culvert Beneath Station Road **NGR:** 447340, 295609 **Data Source:** Watercourse Survey. Inlet inaccessible for survey, adjacent upstream section adopted as invert and channel dimensions. Outlet as surveyed. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.8m internal diameter **Upstream Invert Level:** 83.11mAOD **Downstream Invert Level:** 83.11mAOD **Length**: 54.0m **Manning's N:** 0.015	

Model ID	Model Details	Photograph
	Spill/Bypass: Modelled in 2D as part of the floodplain	
Reach 5 5.006c	**Description:** Culvert Beneath Station Road **NGR:** 447357, 295637 **Data Source:** Watercourse Survey. Culvert entirely submerged. Dimensions of upstream structure adopted in the absence of any data. Adjacent 3 structures on reach are all circular culverts at or over 0.8m in diameter. Inverts as surveyed. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.8m internal diameter **Upstream Invert Level:** 82.23mAOD **Downstream Invert Level:** 82.07mAOD **Length**: 4.1m **Manning's N**: 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 5 5.006c	**Description:** Culvert Beneath Farm Access **NGR:** 447385, 295873 **Data Source:** Watercourse Survey. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.9m internal diameter **Upstream Invert Level:** 81.38mAOD **Downstream Invert Level:** 81.24mAOD **Length**: 4.6m **Manning's N**: 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Reach 5 5.006c	**Description:** Culvert Beneath Railway Line **NGR:** 447385, 295935 **Data Source:** Watercourse Survey. Outline not accessible for survey. Inlet invert adopted in the absence of more reliable data. **Domain:** 1D ESTRY **Unit Type**: Irregular Conduit (Arch) **Dimensions:** 1.3m span, soffit 1.0m above the bed (HW Table) **Upstream Invert Level:** 81.10mAOD **Downstream Invert Level:** 81.10mAOD **Length**: 24.2m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 6 Rail_Cul6	**Description:** Culvert Beneath Scrap Yard & Railway Line **NGR:** 446925, 295814 **Data Source:** Dimensions from Network Rail asset data, inverts from available DTMs **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.9m internal diameter **Upstream Invert Level:** 82.76mAOD **Downstream Invert Level:** 82.76mAOD **Length**: 46.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 8 Rail_Cul3	**Description:** Culvert Beneath Railway Line **NGR:** 445198, 294835 **Data Source:** Topographical Site Survey. Outlet not accessible for survey. Inlet invert adopted. **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.375m internal diameter **Upstream Invert Level:** 92.44mAOD **Downstream Invert Level:** 92.44mAOD **Length**: 27.9m **Manning's N:** 0.015	No Photograph Available – see Topographical Survey

Model ID	Model Details	Photograph
	Spill/Bypass: Modelled in 2D as part of the floodplain	
Reach 8 8.013c	**Description:** Culvert Beneath Footpath/ Track **NGR:** 445203, 295114 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.26m internal diameter **Upstream Invert Level:** 91.53mAOD (invert raised to 91.55mAOD to level off and overcome instability) **Downstream Invert Level:** 91.55mAOD **Length**: 5.9m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Reach 8 8.011c	**Description:** Culvert Beneath Burbage Common Road **NGR:** 445209, 295149 **Data Source:** Watercourse Survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.20m internal diameter **Upstream Invert Level:** 91.60mAOD **Downstream Invert Level:** 91.50mAOD **Length**: 5.0m **Manning's N:** 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

<table>
<tr><th>Model ID</th><th>Model Details</th><th>Photograph</th></tr>
<tr><td>Reach 8
8.008c</td><td>Description: Culvert Beneath Footpath/ Track
NGR: 445270, 295317
Data Source: Watercourse Survey
Domain: 1D ESTRY
Unit Type: Circular Conduit
Dimensions: 0.365m internal diameter
Upstream Invert Level: 90.65mAOD
Downstream Invert Level: 90.62mAOD
Length: 4.4m
Manning's N: 0.015
Spill/Bypass: Modelled in 2D as part of the floodplain</td><td></td></tr>
<tr><td>Reach 8
8.005c</td><td>Description: Culvert Beneath Footpath/ Track
NGR: 445300,295435
Data Source: Watercourse Survey
Domain: 1D ESTRY
Unit Type: Circular Conduit
Dimensions: 0.28m internal diameter
Upstream Invert Level: 90.22mAOD
Downstream Invert Level: 89.98mAOD
Length: 37.1m
Manning's N: 0.015
Spill/Bypass: Modelled in 2D as part of the floodplain</td><td></td></tr>
</table>

Appendix 3: Example 1D Roughness Coefficients

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
Reach 1	R1.023		0.06 Scattered brush, heavy weeds	0.06 Sluggish, heavy weeds	0.06 Scattered brush, heavy weeds
	R1.021		0.05 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.05 Scattered brush, heavy weeds
	R1.018		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R1.012		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R1.006		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R1.003		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R2.029		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
Reach 2	R2.020		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R2.015		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R2.009		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R2.005		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
Reach 2A	R2A.014		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.04 Scattered brush, heavy weeds
	R2A.011		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.04 Scattered brush, heavy weeds
	R2A.006		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.04 Scattered brush, heavy weeds

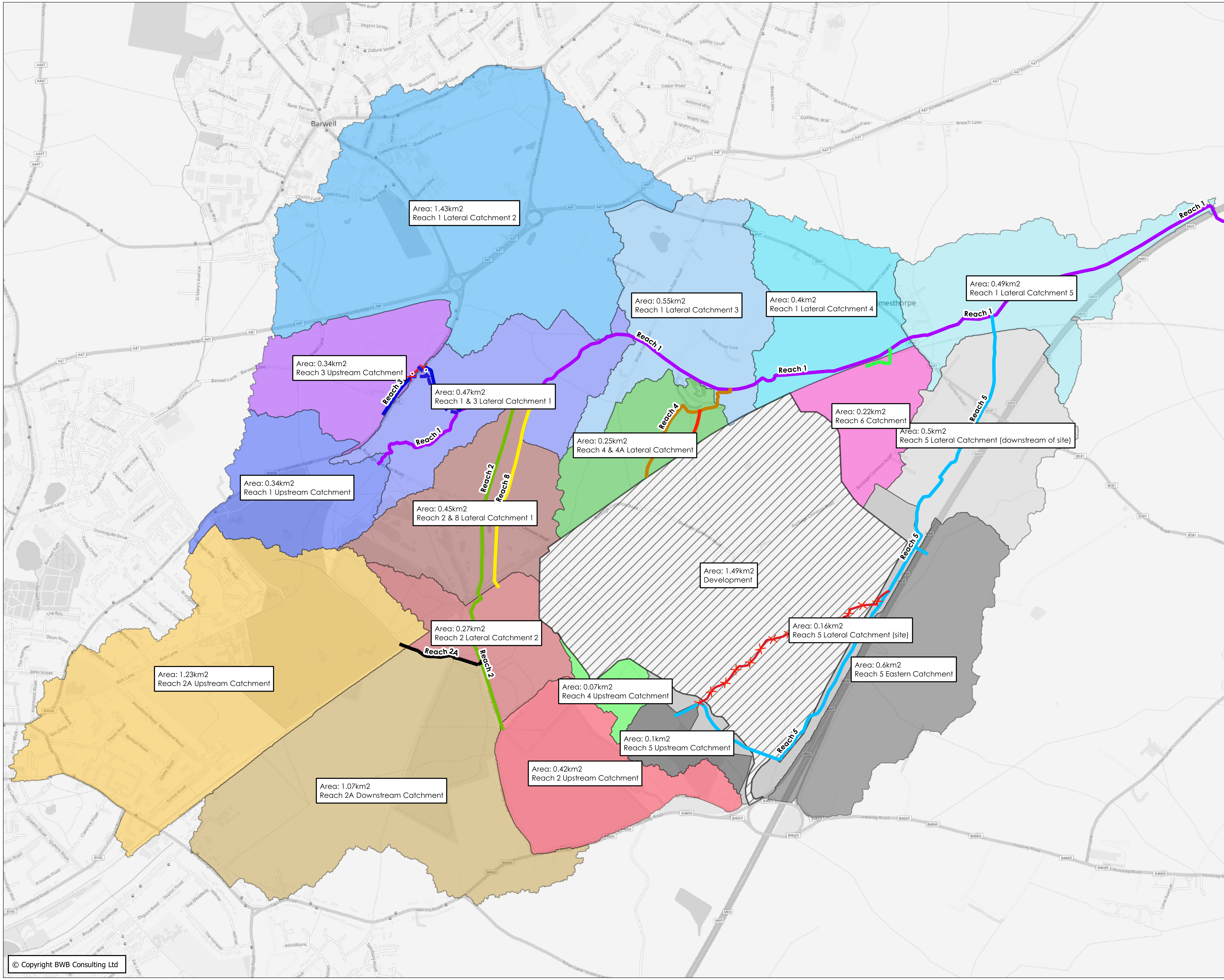
Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R2A.003		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.04 Scattered brush, heavy weeds
Reach 3	R3.007		0.05 medium scrub	0.05 Winding some pools and shoals with weeds.	0.05 medium scrub
	R3.004		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R3.001		0.06 Scattered brush, heavy weeds	0.06 Sluggish, heavy weeds	0.06 Scattered brush, heavy weeds
Reach 4	R4.008		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R4.005		0.05 medium scrub	0.04 Winding some pools and shoals with minor weeds.	0.05 medium scrub
	R4.002		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
Reach 4A	R4A.002		0.06 Scattered brush, heavy weeds	0.05 Sluggish with minor weeds.	0.06 Scattered brush, heavy weeds
	R4A.001		0.06 Scattered brush, heavy weeds	0.06 Sluggish, heavy weeds	0.06 Scattered brush, heavy weeds
Reach 5	R5.010		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R5.007		0.06 Scattered brush, heavy weeds	0.055 Larger rocks present on bed.	0.07 Scattered brush, heavy weeds, rocky

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R5.004		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R5.002		0.06 Scattered brush, heavy weeds	0.06 Sluggish, heavy weeds	0.06 Scattered brush, heavy weeds
Reach 8	R8.014		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R8.008		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds

Reach	Cross-Section	Photo	Left Bank Roughness	In-Channel Roughness	Right Bank Roughness
	R8.005		0.040 Short grass, light scrub	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds
	R8.002		0.06 Scattered brush, heavy weeds	0.04 Winding some pools and shoals with minor weeds.	0.06 Scattered brush, heavy weeds

Appendix 4: Sub-Catchment Plans



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

Modelled Reaches

- Reach 1
- Reach 2
- Reach 2A
- Reach 3
- Reach 4
- Reach 4A
- Reach 5
- Reach 6
- Reach 8
- Channel/Culverts to be Abandoned
- New Channel/Culverts

Rev	Date	Details of issues/ revision	Drw	Rev
P02	04.11.21	GENERAL UPDATE	RG	CG
P01	30.06.21	PRELIMINARY ISSUE	RG	CG

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Tributary Sub-Catchments, Post-Development

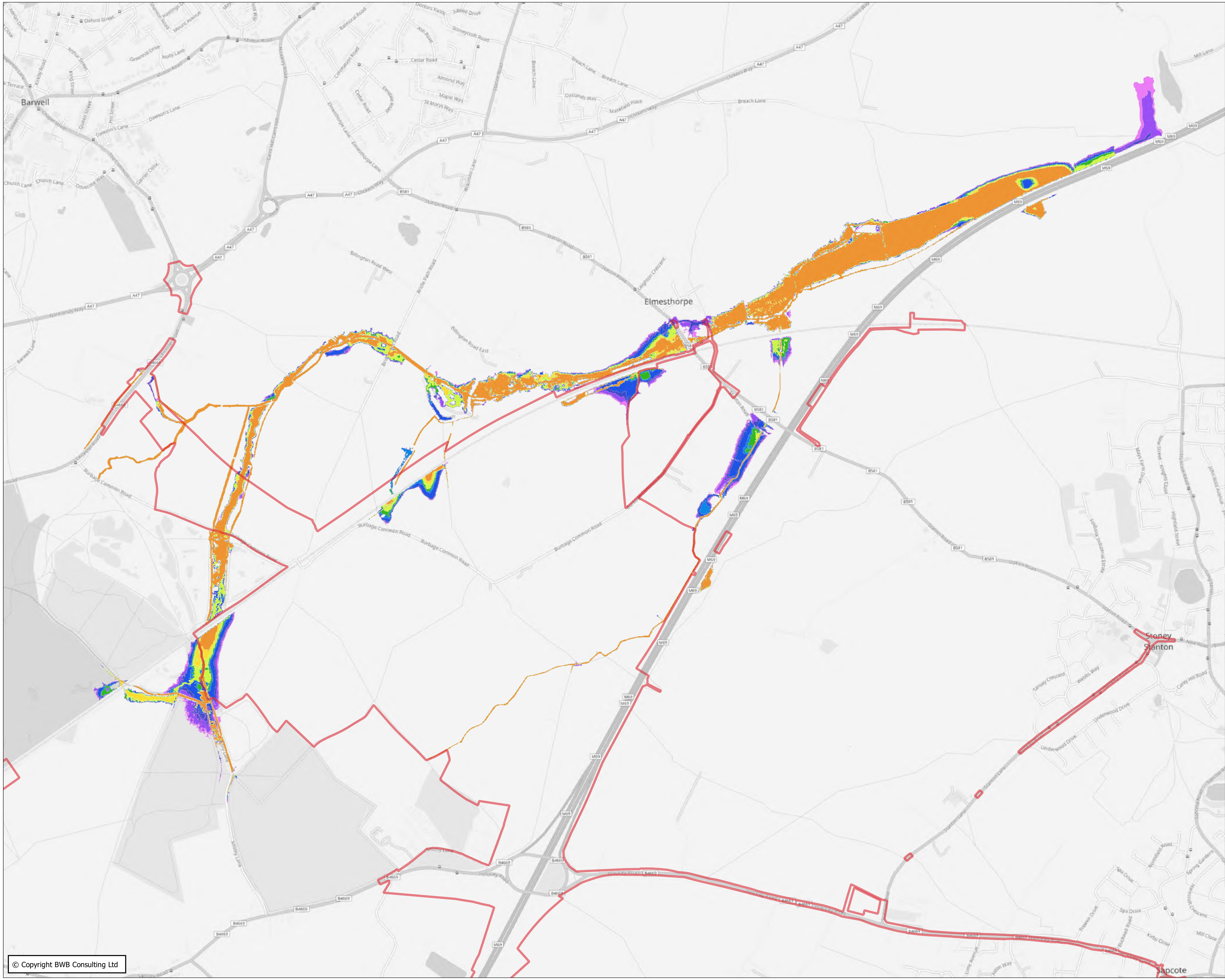
Drawn:	R Green	Reviewed:	C Gardner
BWB Ref: NTT 2814	Date: 30/06/21	Scale@A3:	1:15,000

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0017	S2	P02

Appendix 5: Baseline Floodplain Maps



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Floodplain Extents

- 1 in 10-year (10% AEP)
- 1 in 20-year (5.0% AEP)
- 1 in 50-year (2.0% AEP)
- 1 in 75-year (1.3% AEP)
- 1 in 100-year (1.0% AEP)
- 1 in 100-year (1.0% AEP)+30%
- 1 in 100-year (1.0% AEP)+40%
- 1 in 100-year (1.0% AEP)+60%
- 1 in 1000-year (0.1% AEP)

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Boundary	RG	CD
P04	10.12.21	Update to DCO Boundary	RG	CD
P03	16.11.21	Update to DCO Boundary	RG	CD
P02	04.10.21	General Update following EA model review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

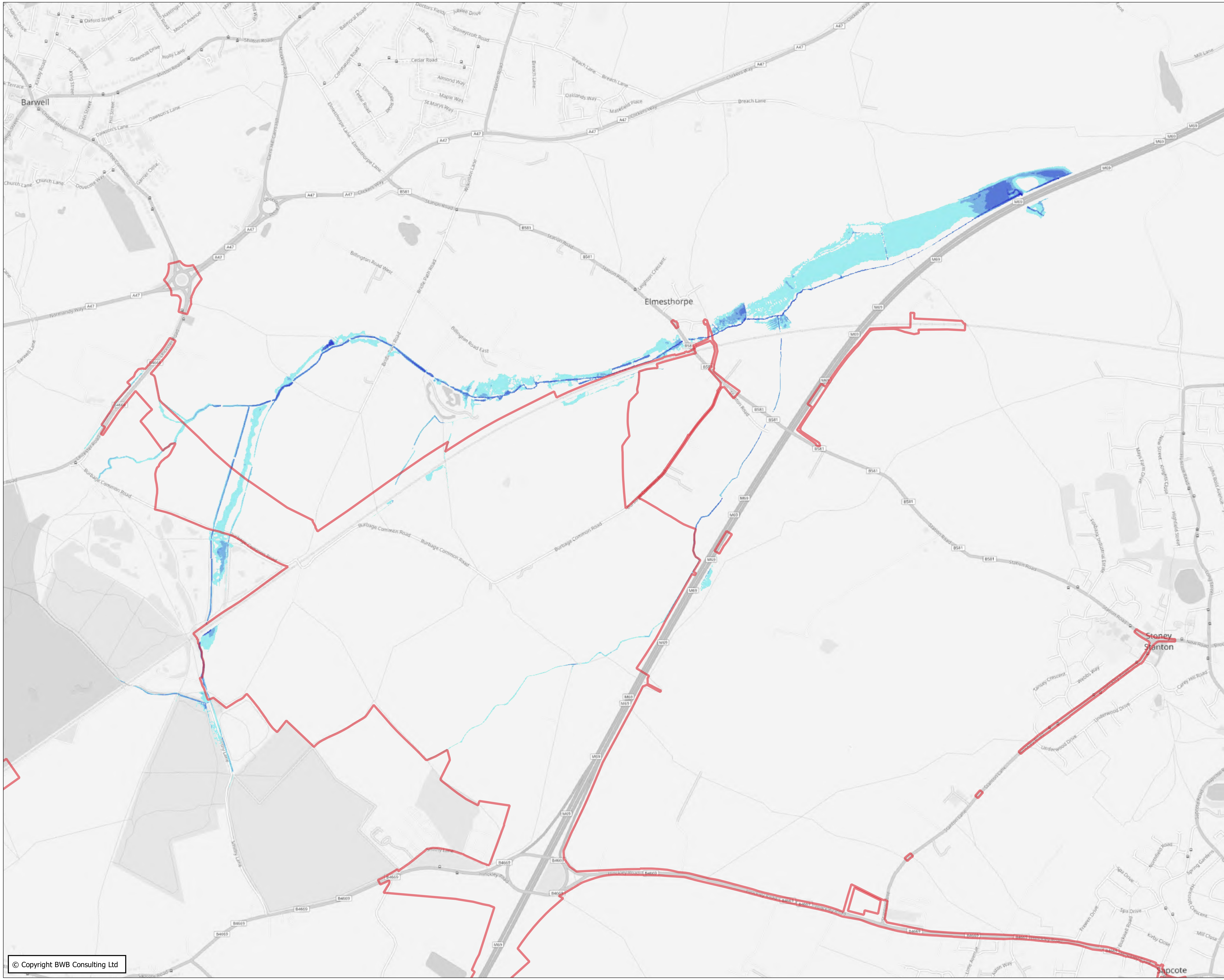
Thurlaston Brook Floodplain Extents

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0029	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

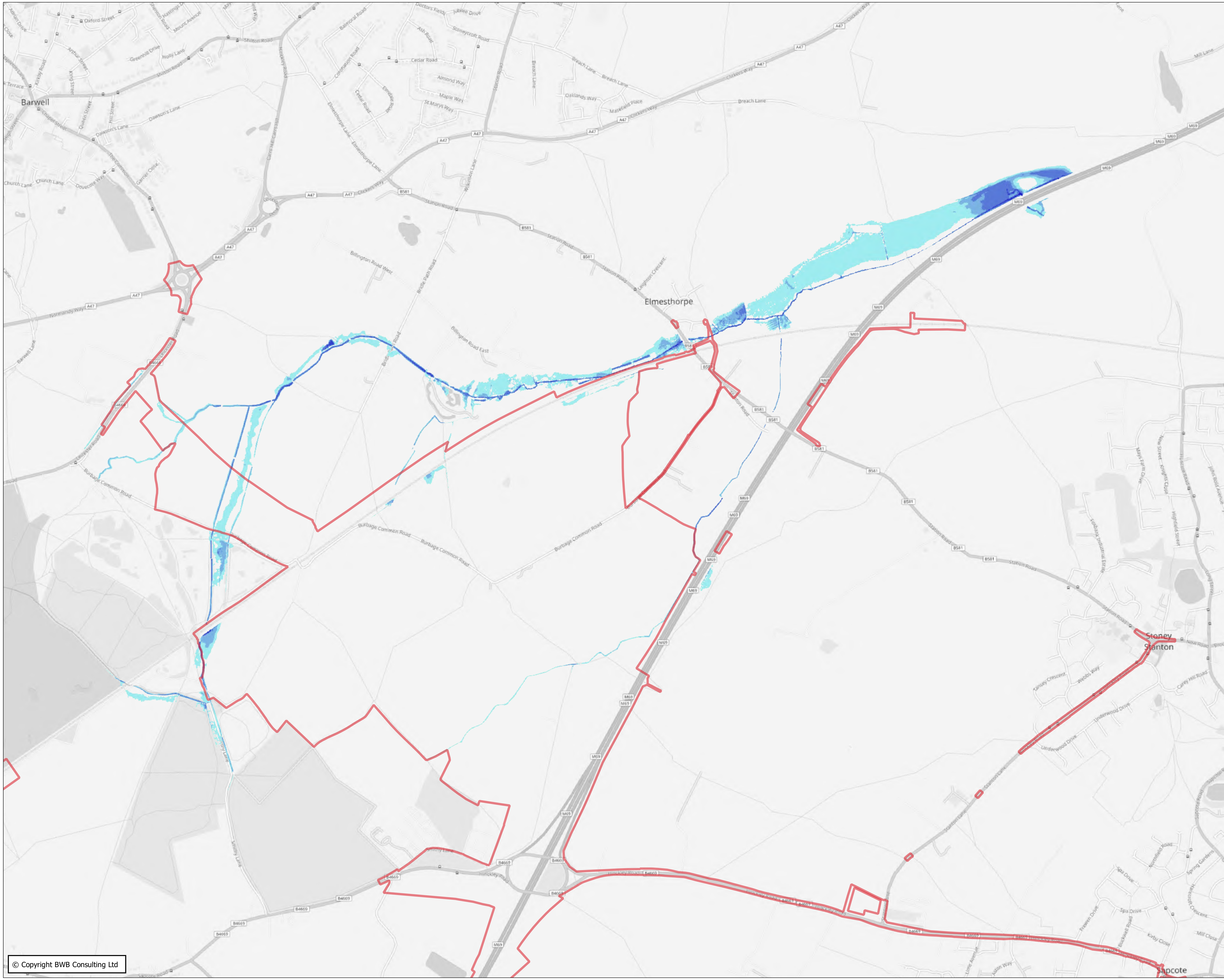
Thurlaston Brook Flood Depths: 1 in 10-Year (10% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0019	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

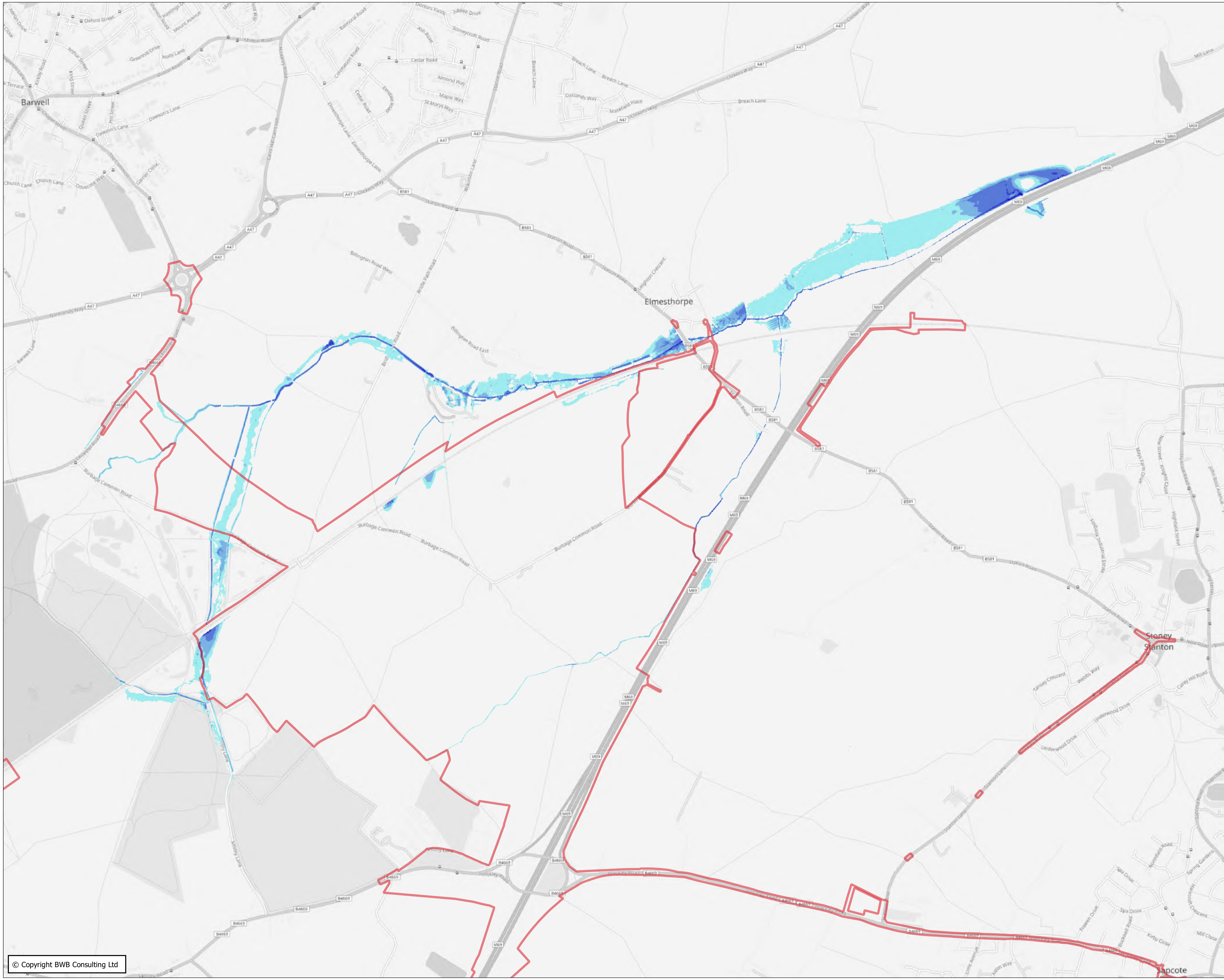
Thurlaston Brook Flood Depths: 1 in 20-Year (5.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0020	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- □ Leeds | 0113 233 8000
- □ London | 0207 407 2879
- □ Manchester | 0161 233 4260
- □ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

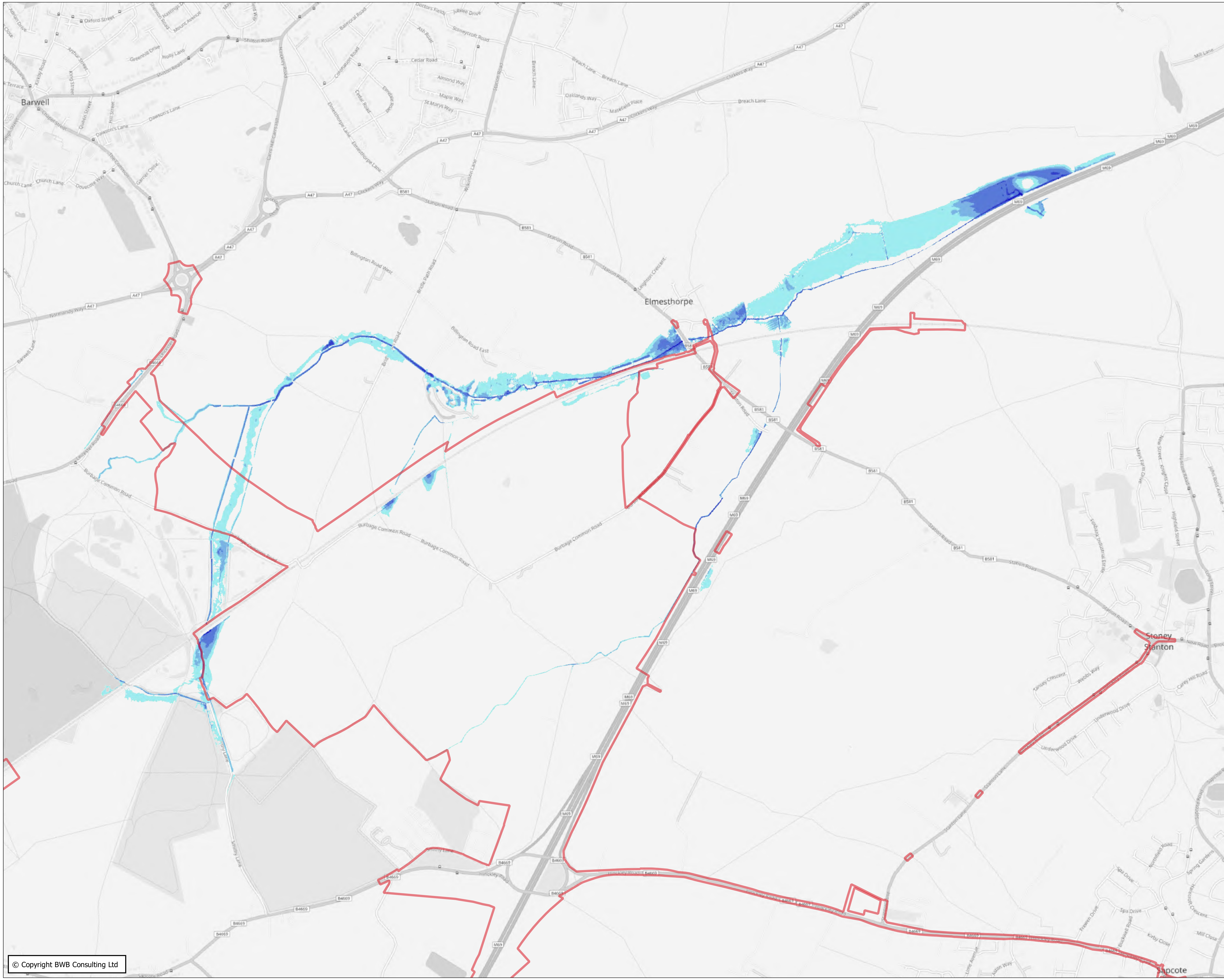
Thurlaston Brook Flood Depths: 1 in 50-Year (2.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0021	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

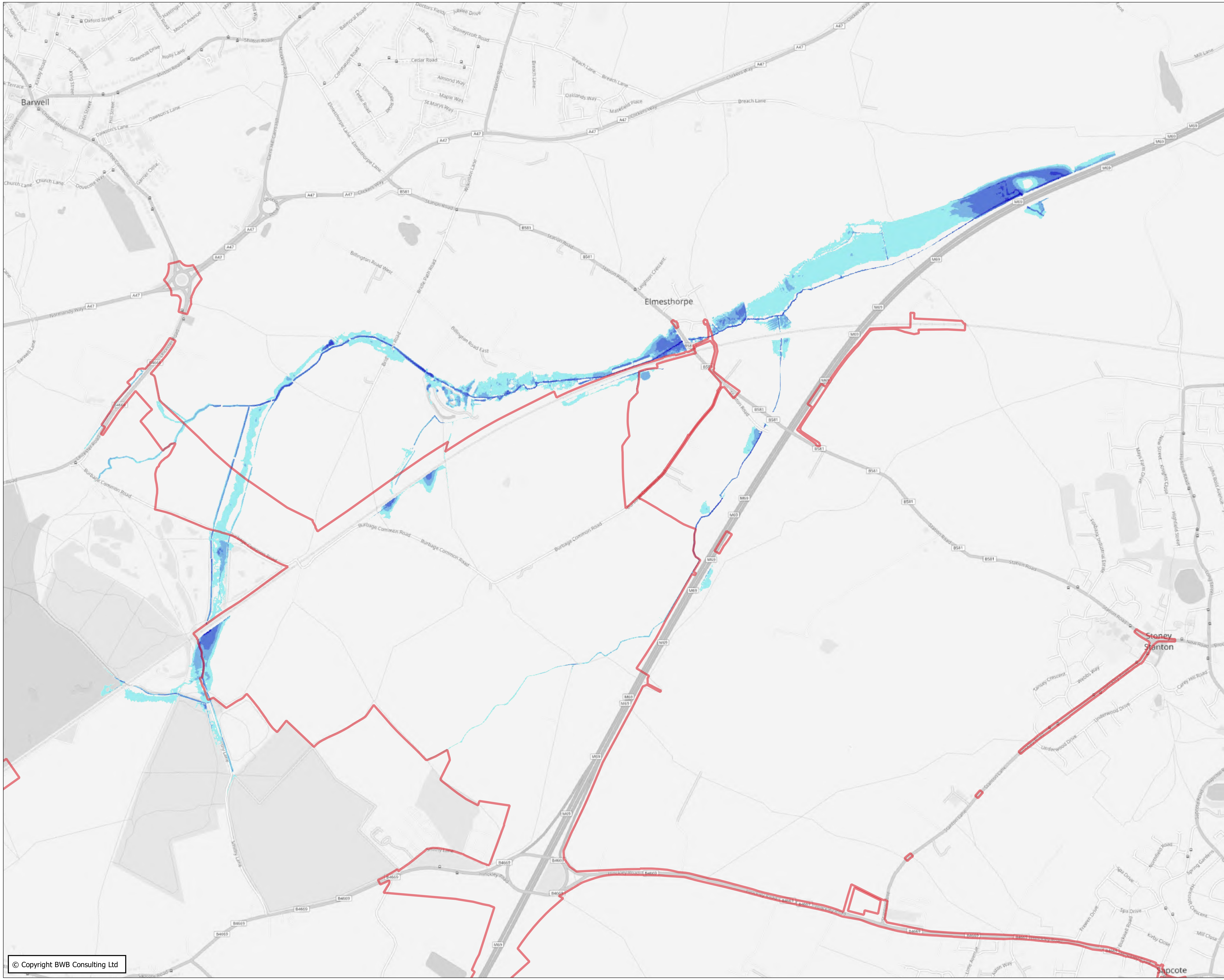
Thurlaston Brook Flood Depths: 1 in 75-Year (1.3% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0022	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

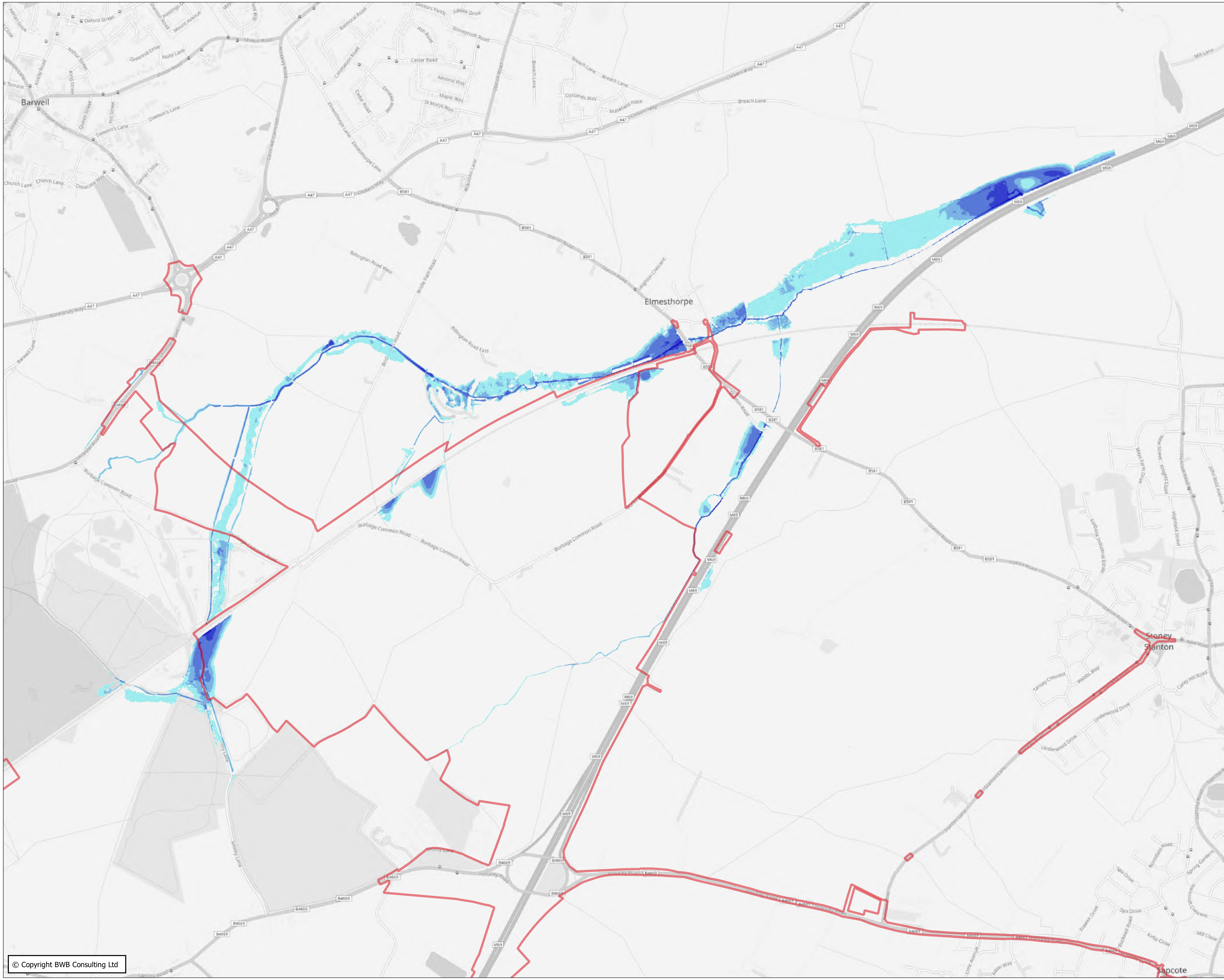
Thurlaston Brook Flood Depths: 1 in 100-Year (1.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0023	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client
Tritax Symmetry (Hinckley) Ltd

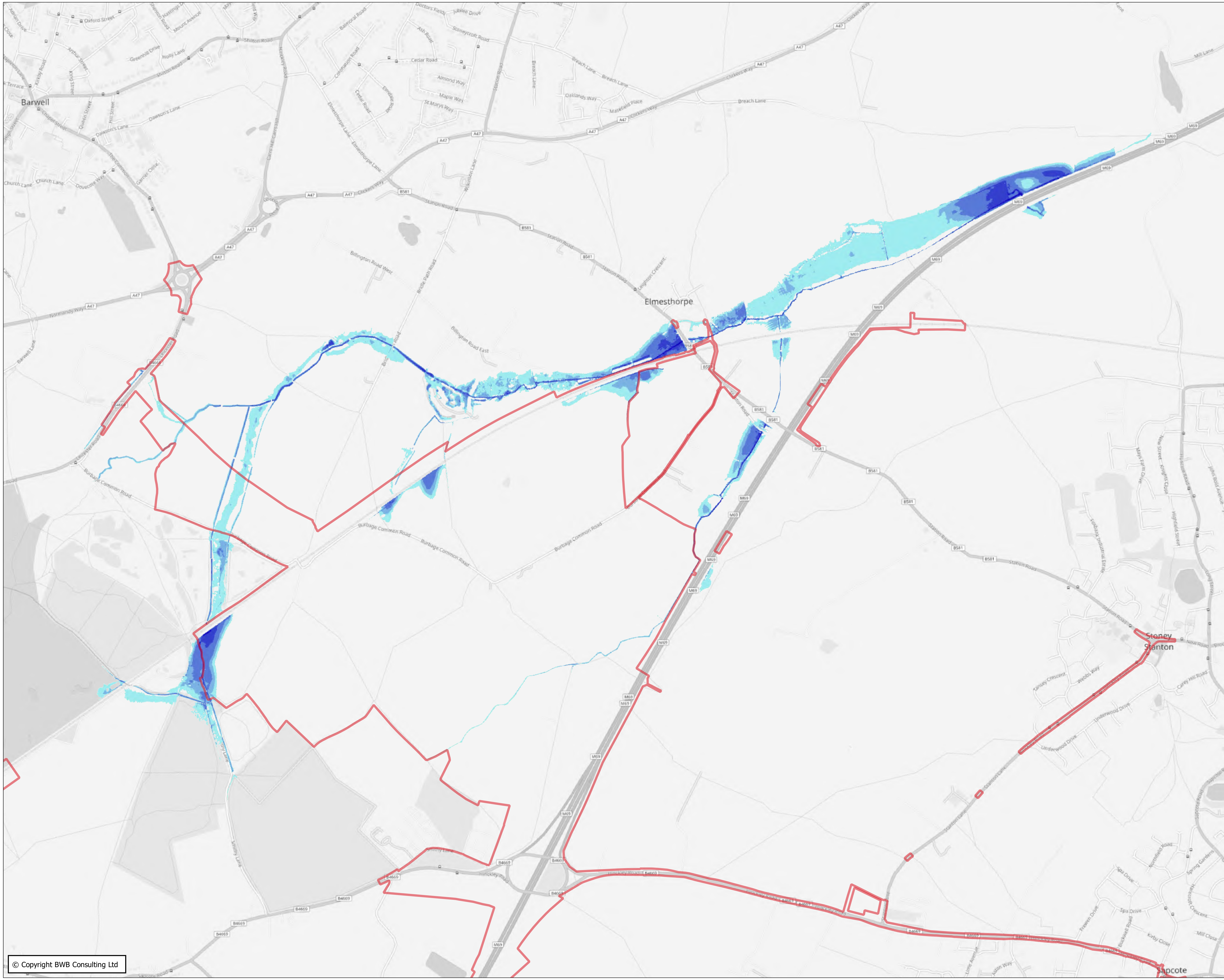
Project Title
Hinckley National Rail Freight Interchang

Drawing Title
**Thurlaston Brook Flood Depths:
1 in 100-Year (1.0% AEP) +30% Climate Change**

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 05/07/21	Scale@A3: NTS

Drawing Status
PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0025	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100
- [redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

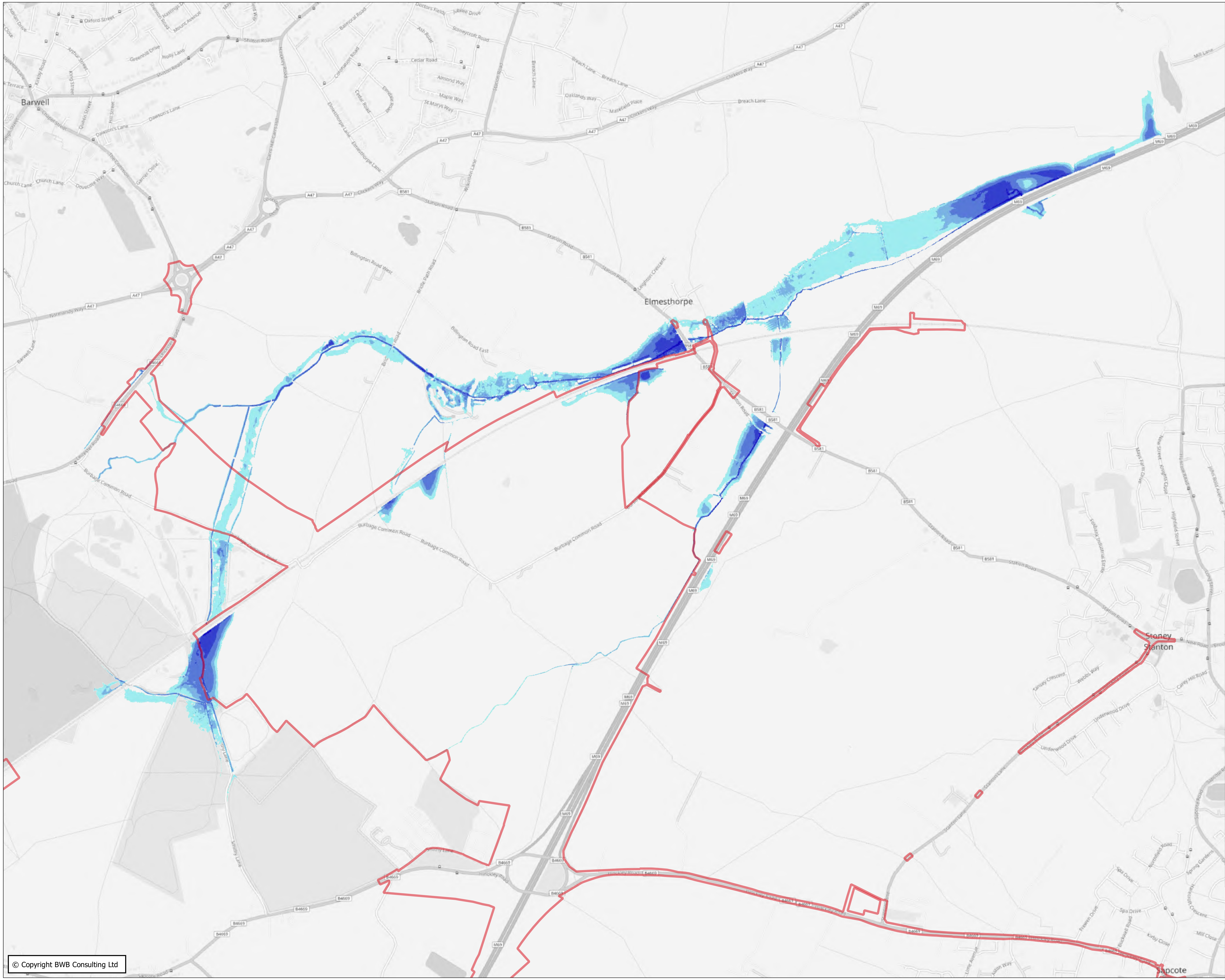
Thurlaston Brook Flood Depths: 1 in 100-Year (1.0% AEP) +40% Climate Change

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0026	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

**Thurlaston Brook Flood Depths:
1 in 100-Year (1.0% AEP)
+60% Climate Change**

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 05/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0027	S2	P05

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1
- 1 - 1.5
- > 1.5

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to DCO Site Boundary	RG	CD
P04	10.12.21	Update to DCO Site Boundary	RG	CD
P03	16.11.21	Update to DCO Site Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- □ Leeds | 0113 233 8000
- □ London | 0207 407 2879
- □ Manchester | 0161 233 4260
- □ Nottingham | 0115 924 1100
- [redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchang

Drawing Title

Thurlaston Brook Flood Depths: 1 in 1000-Year (0.1% AEP)

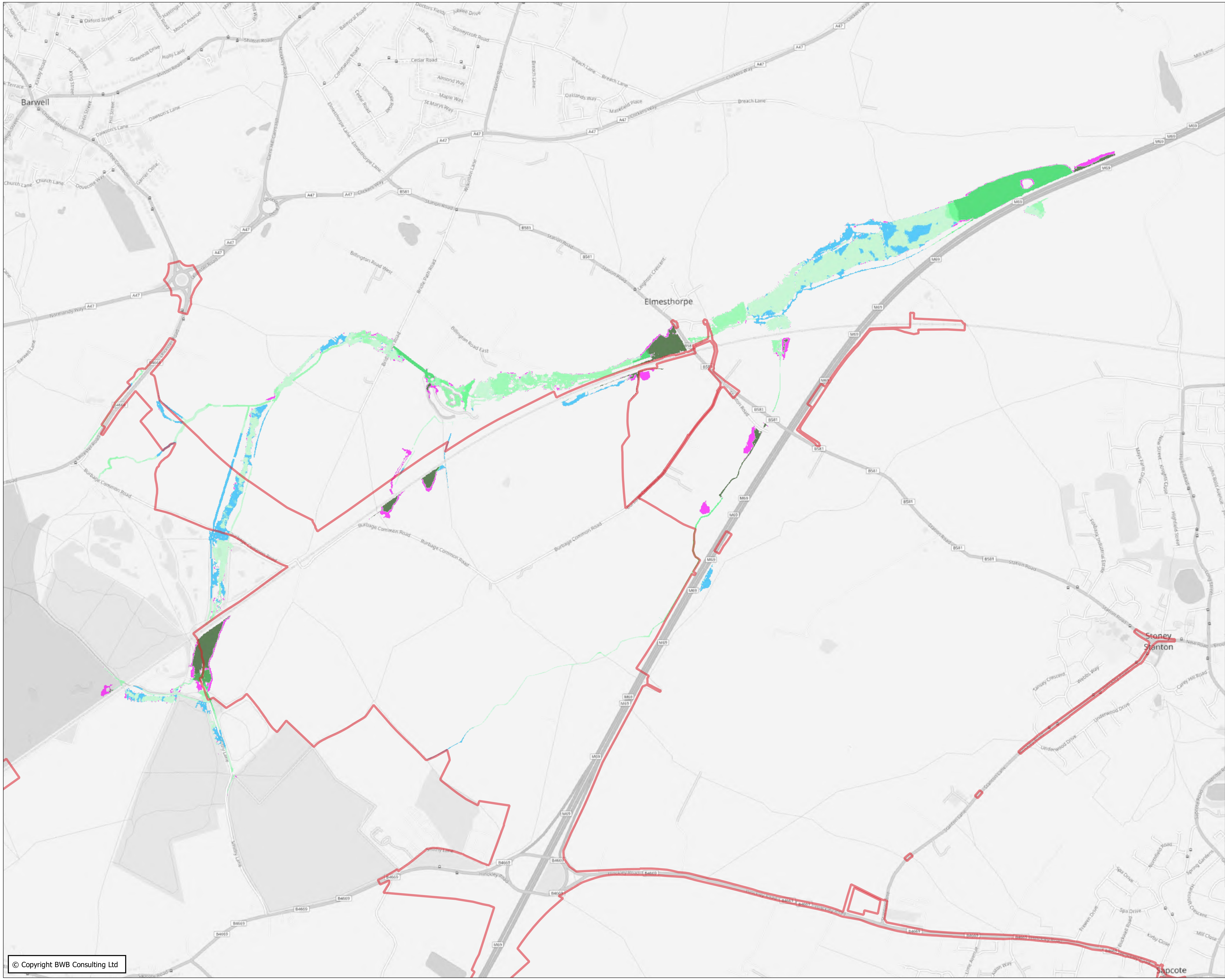
Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0028	S2	P05

Appendix 6: Sensitivity Test Floodplain Maps



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

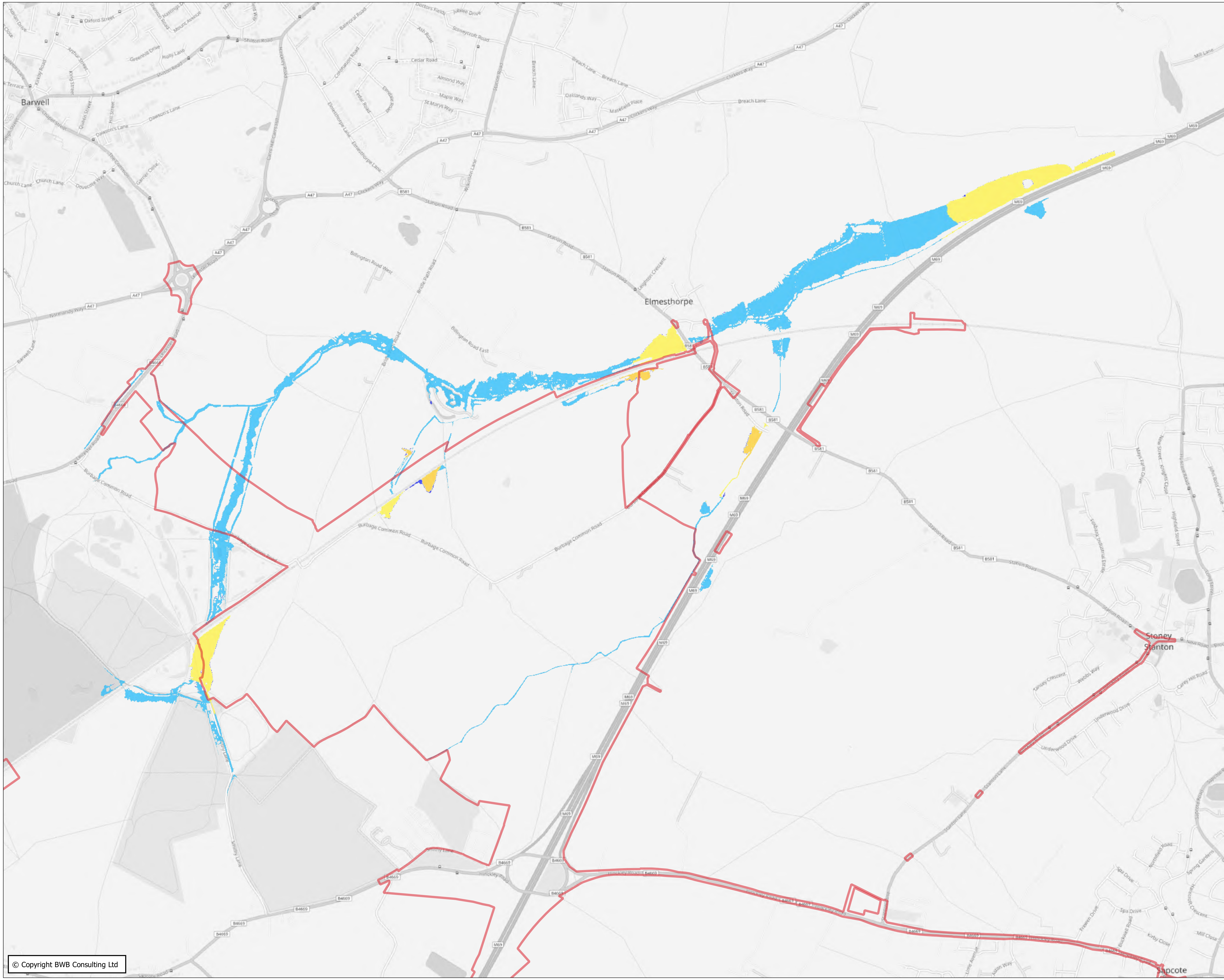
Sensitivity Tests: 1 in 100-Year (1.0% AEP) 4.5hr Storm Compared to 9.0hr

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0030	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Sensitivity Tests: 1 in 100-Year (1.0% AEP) 13.5hr Storm Compared to 9.0hr

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0031	S2	P05

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

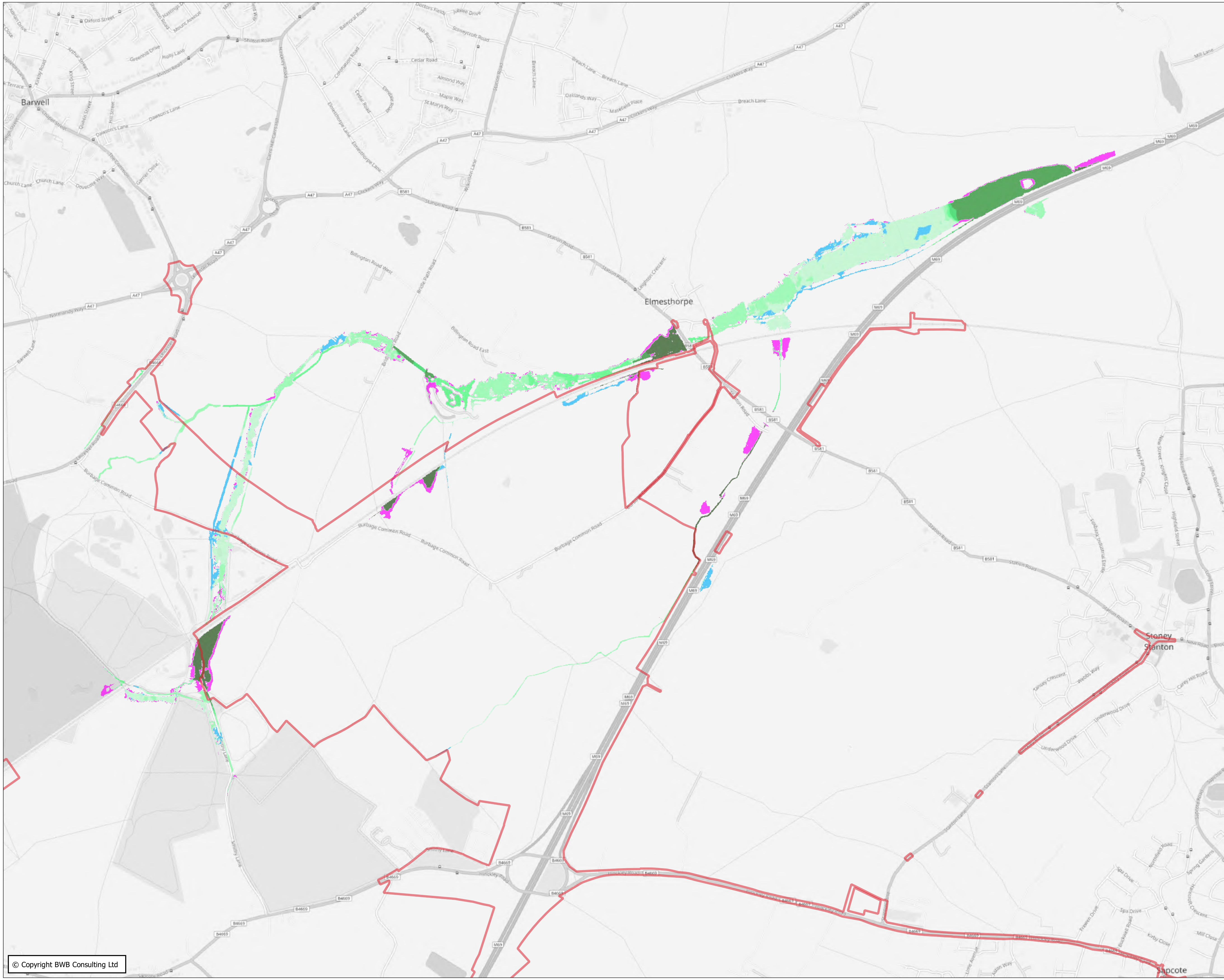
Sensitivity Tests: 1 in 100-Year (1.0% AEP) 13.0hr Storm Compared to 13.5hr Storm

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0060	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
□ Leeds | 0113 233 8000
□ London | 0207 407 2879
□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Sensitivity Tests: 1 in 100-Year (1.0% AEP) 20% Reduction in Flow

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0032	S2	P05

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Sensitivity Tests:
1 in 100-Year (1.0% AEP)
20% Increase in Flow

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 05/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0033	S2	P05

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

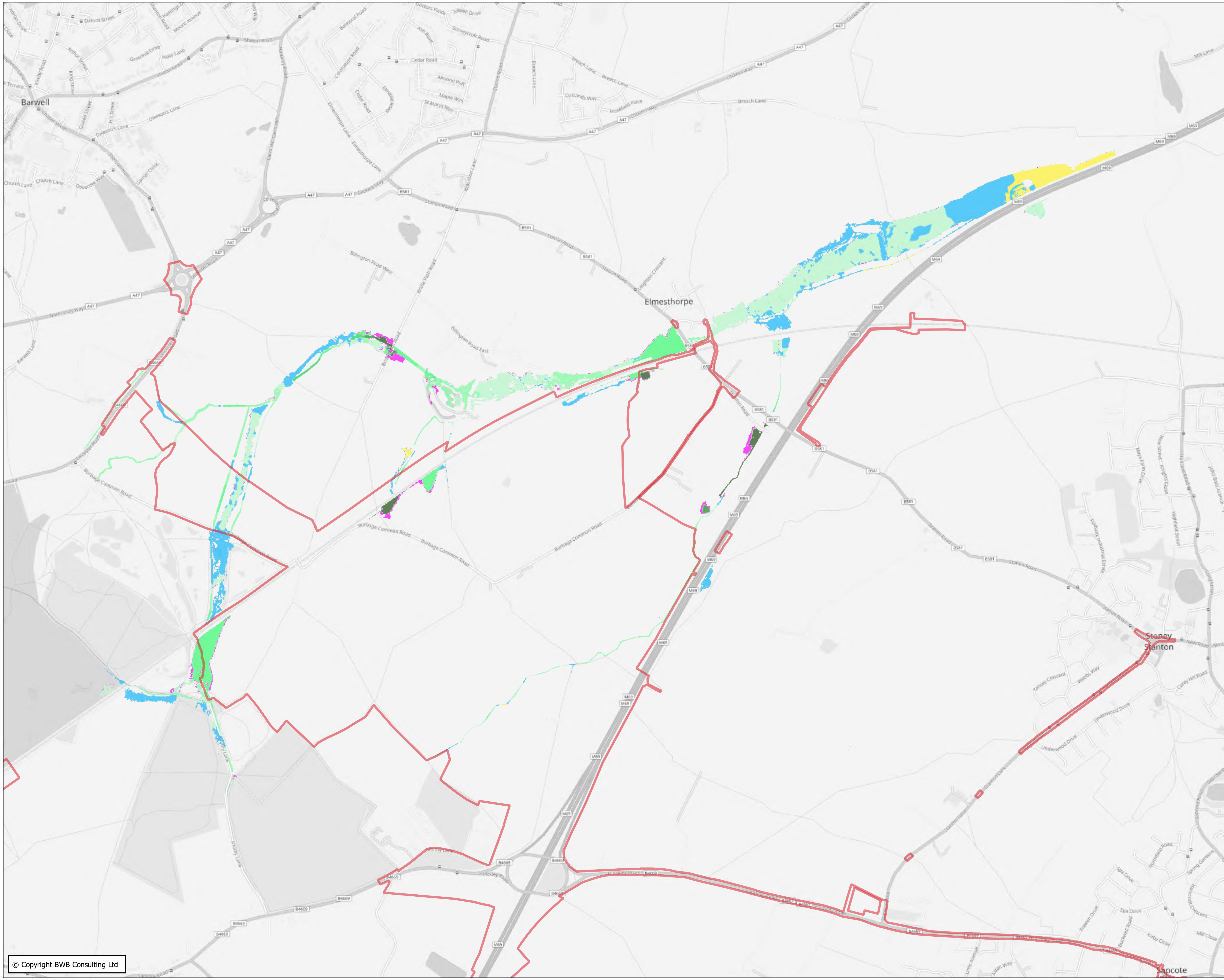
Sensitivity Tests:
1 in 100-Year (1.0% AEP)
20% Increase in Roughness

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0034	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

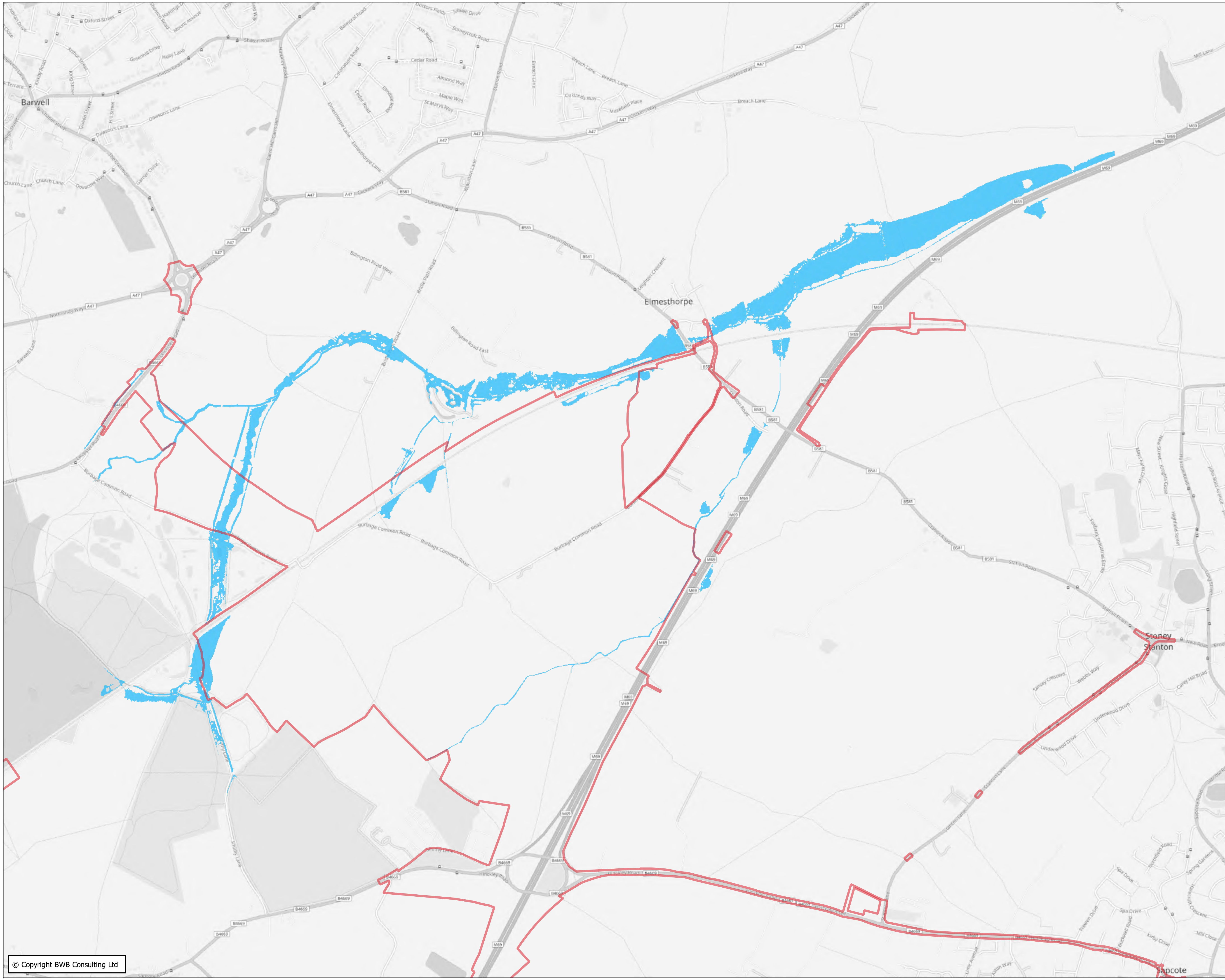
**Sensitivity Tests:
1 in 100-Year (1.0% AEP)
20% Reduction in Roughness**

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date:	05/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0035	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

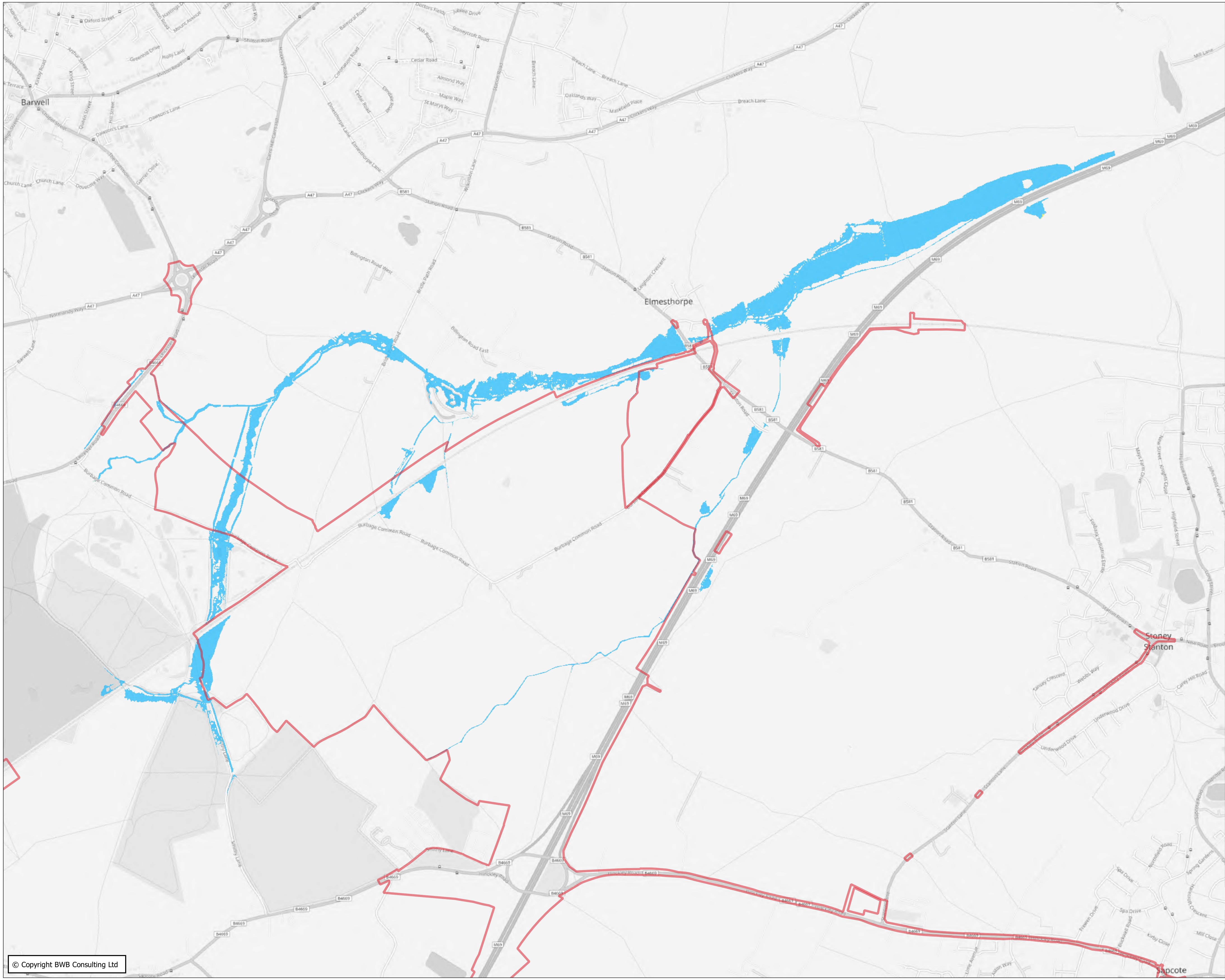
Sensitivity Tests:
1 in 100-Year (1.0% AEP)
20% Increase in the Downstream Boundary

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0036	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

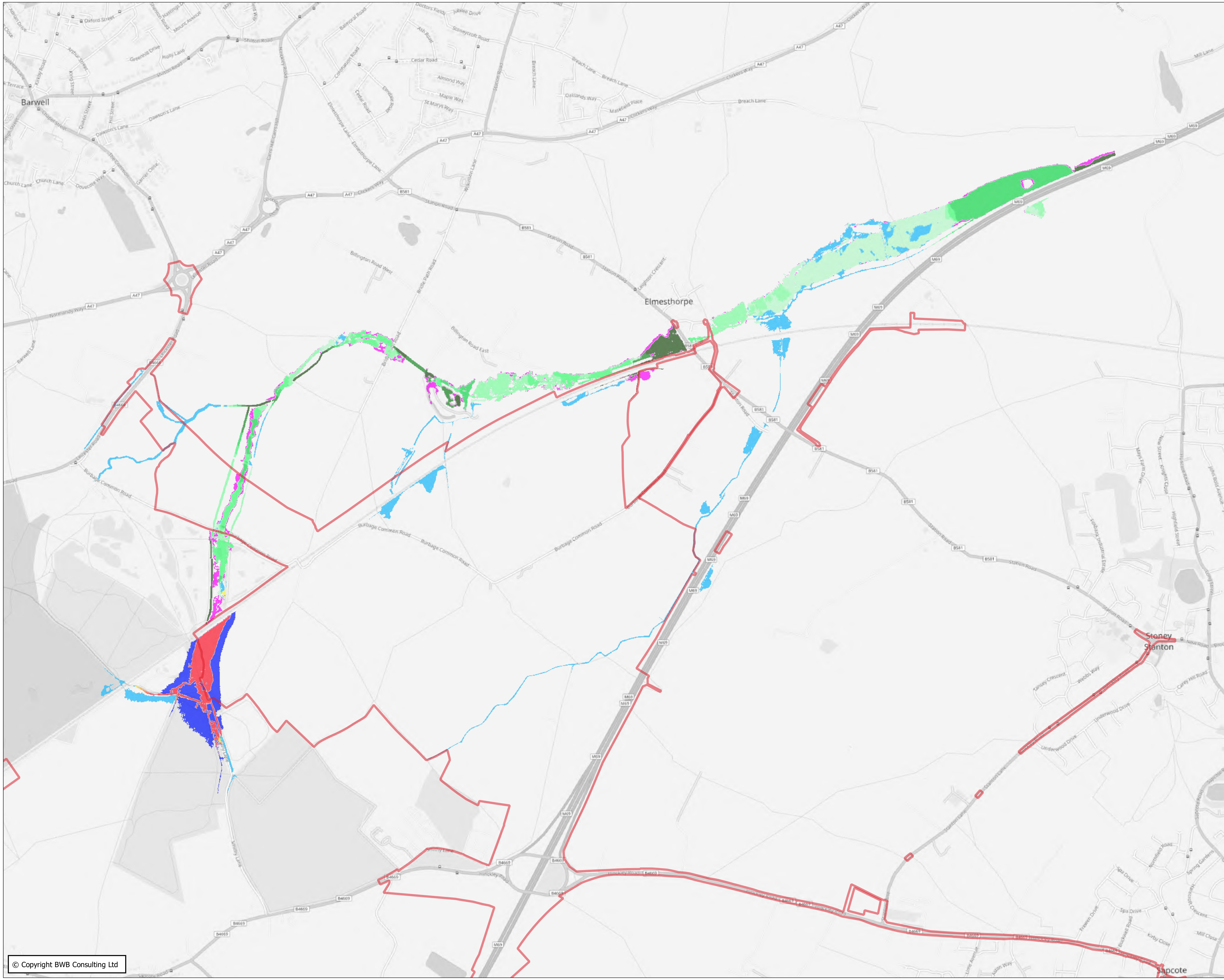
Sensitivity Tests:
1 in 100-Year (1.0% AEP)
20% Decrease in the Downstream Boundary

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0037	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

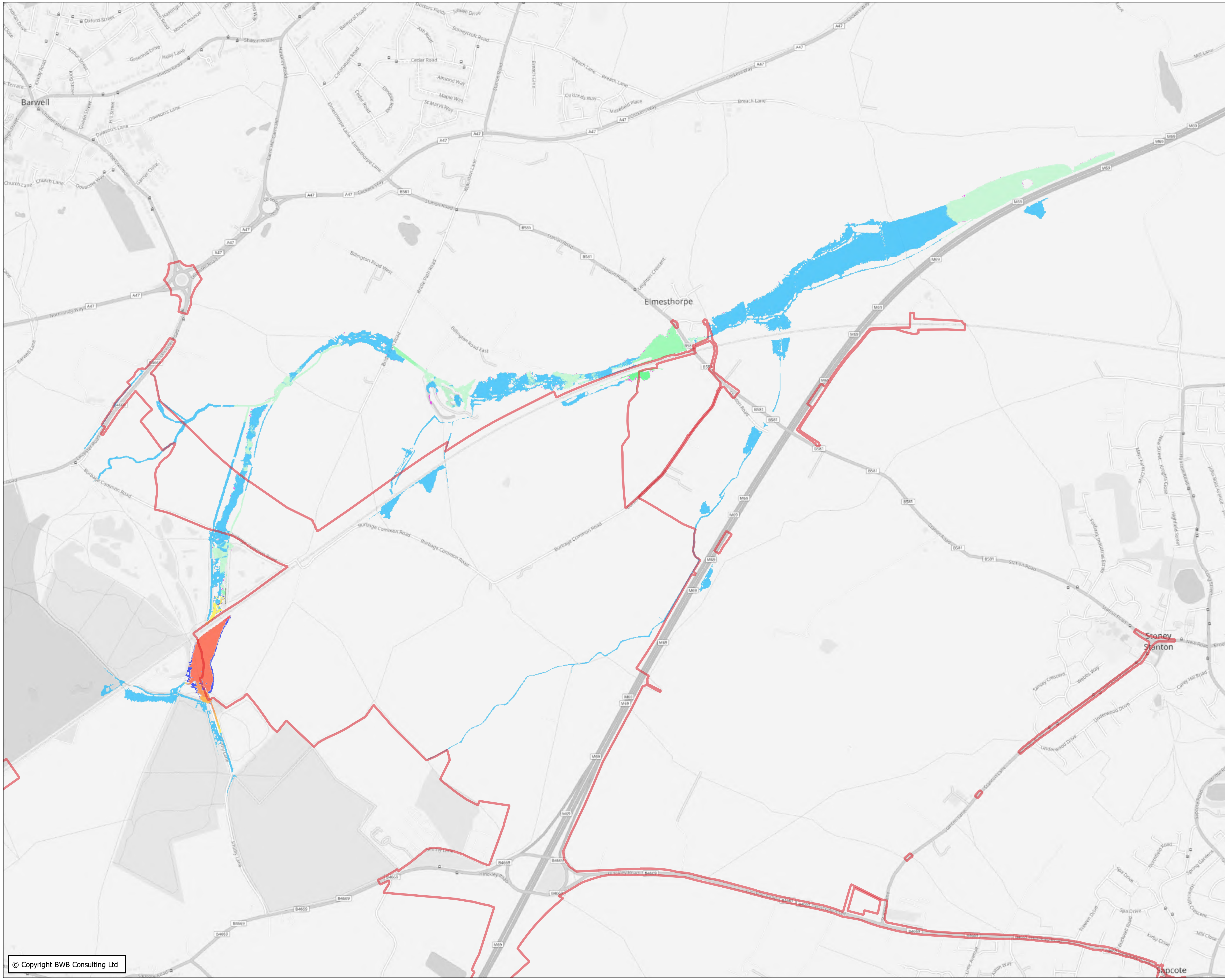
Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 1

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0038	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
□ Leeds | 0113 233 8000
□ London | 0207 407 2879
□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

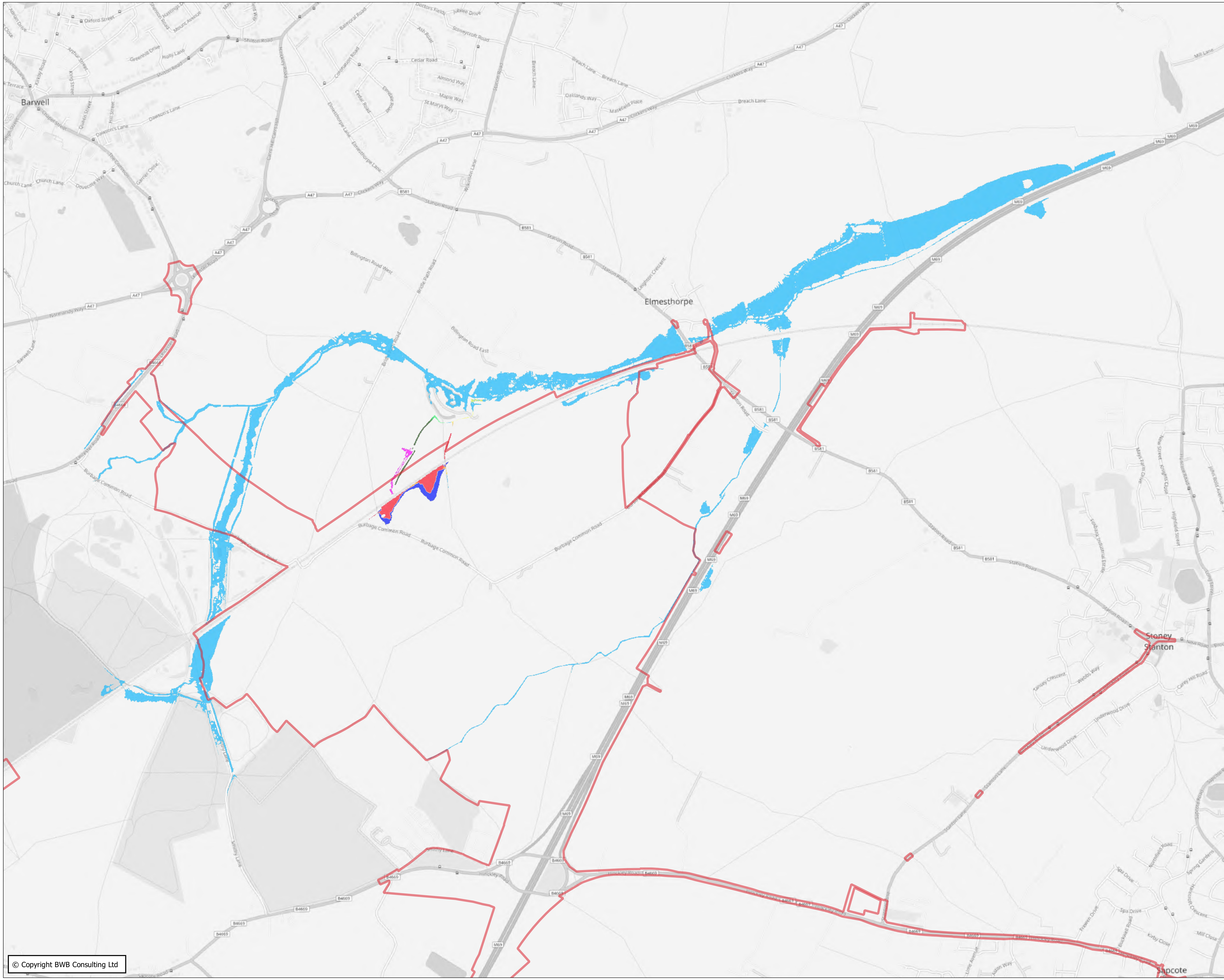
Sensitivity Tests:
1 in 100-Year (1.0% AEP)
Blockage Scenario 2

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0039	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

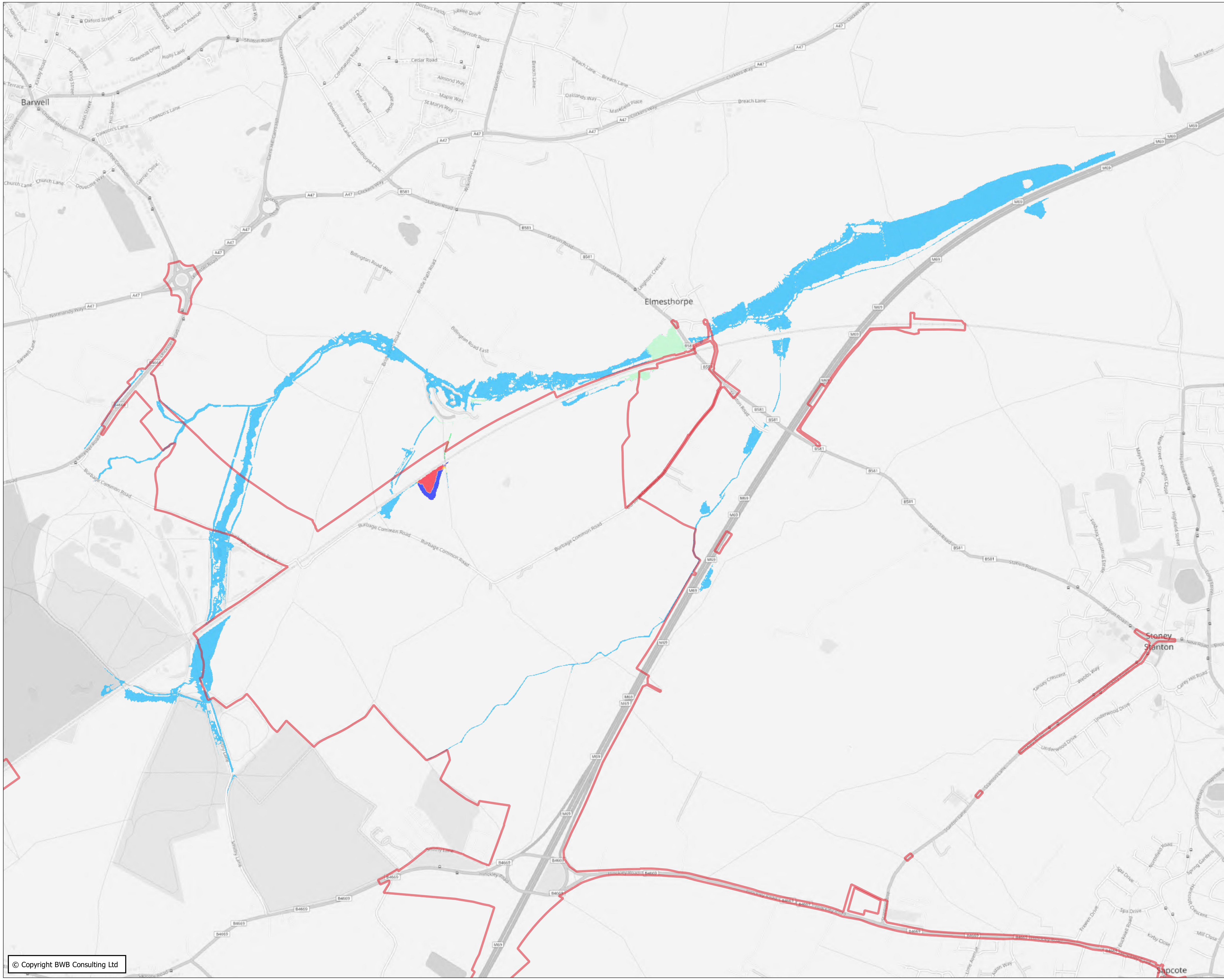
**Sensitivity Tests:
1 in 100-Year (1.0% AEP)
Blockage Scenario 3**

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 05/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0040	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- □ Leeds | 0113 233 8000
- □ London | 0207 407 2879
- □ Manchester | 0161 233 4260
- □ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

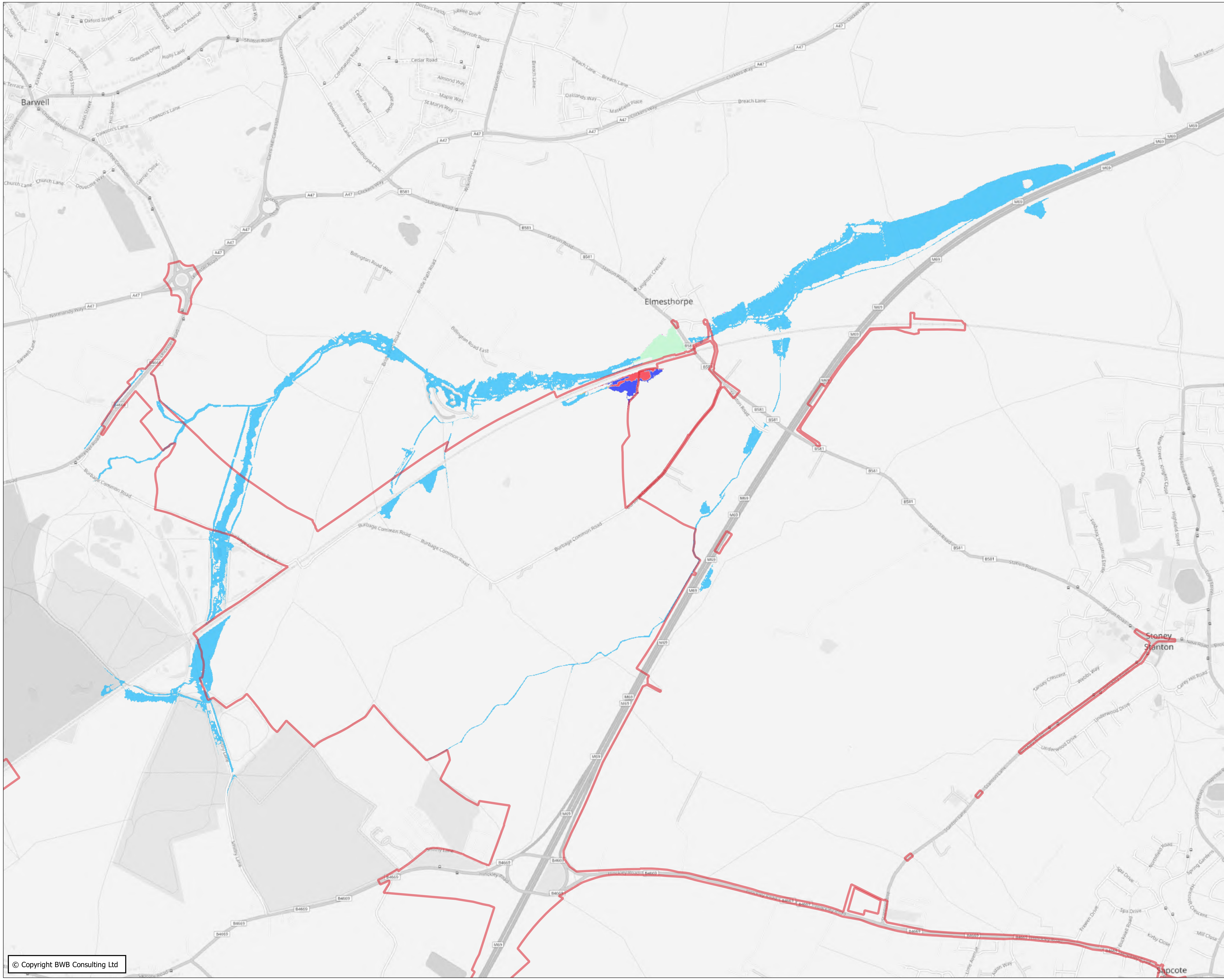
Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 4

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0041	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

- The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

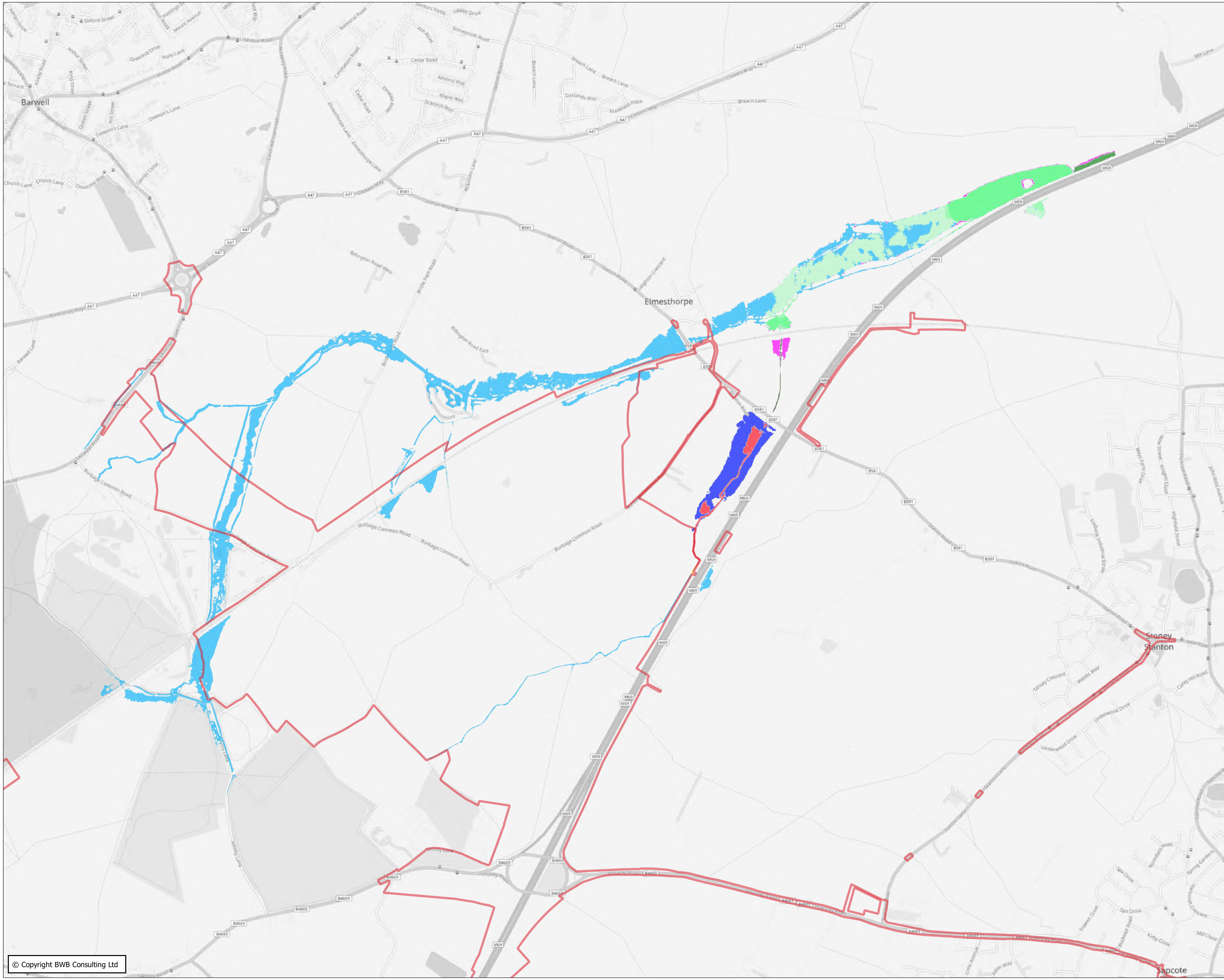
Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 5

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0042	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

- The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Sensitivity Tests:
1 in 100-Year (1.0% AEP)
Blockage Scenario 6

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0043	S2	P05

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- □ Leeds | 0113 233 8000
- □ London | 0207 407 2879
- □ Manchester | 0161 233 4260
- □ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

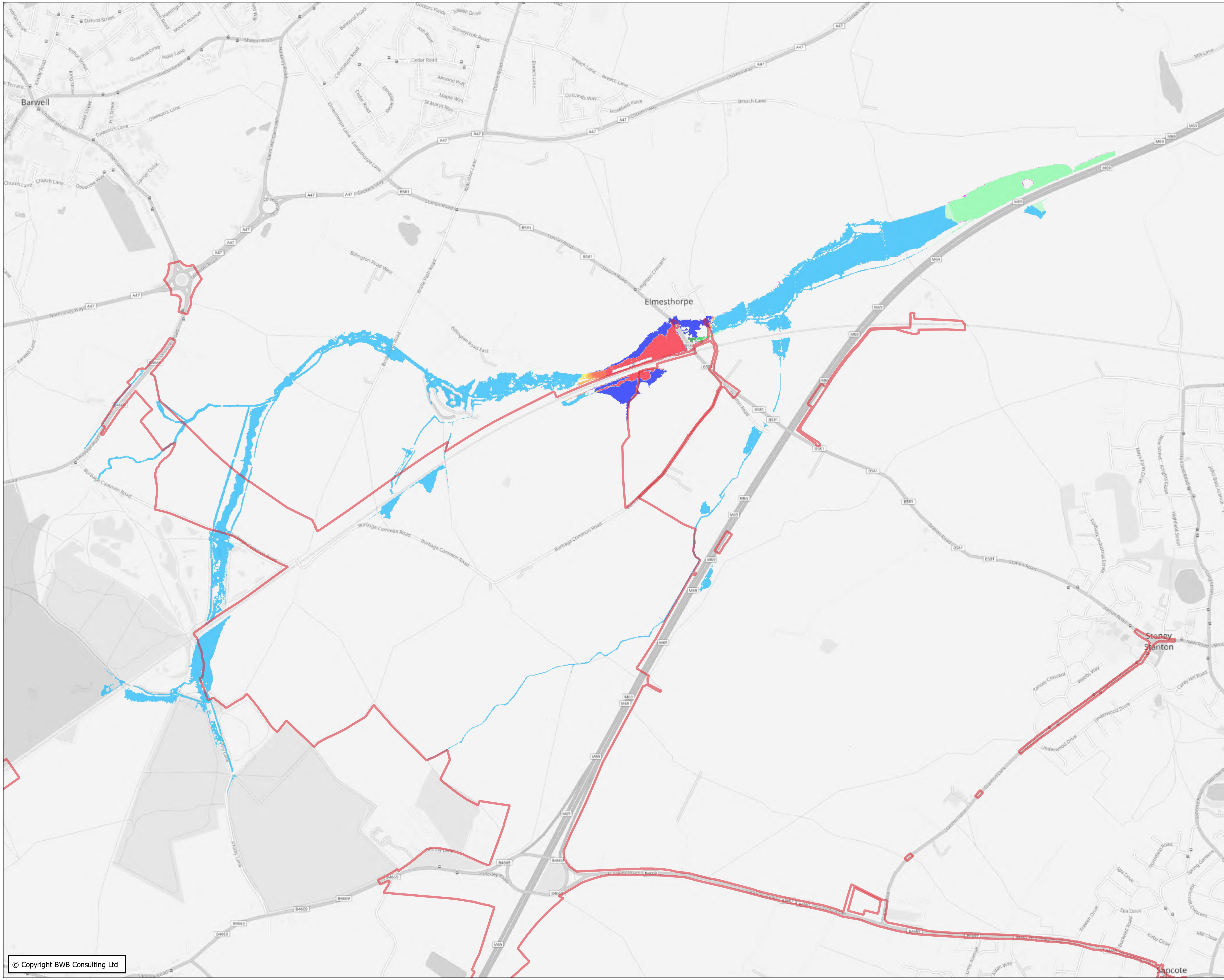
Sensitivity Tests:
1 in 100-Year (1.0% AEP)
Blockage Scenario 7

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0044	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

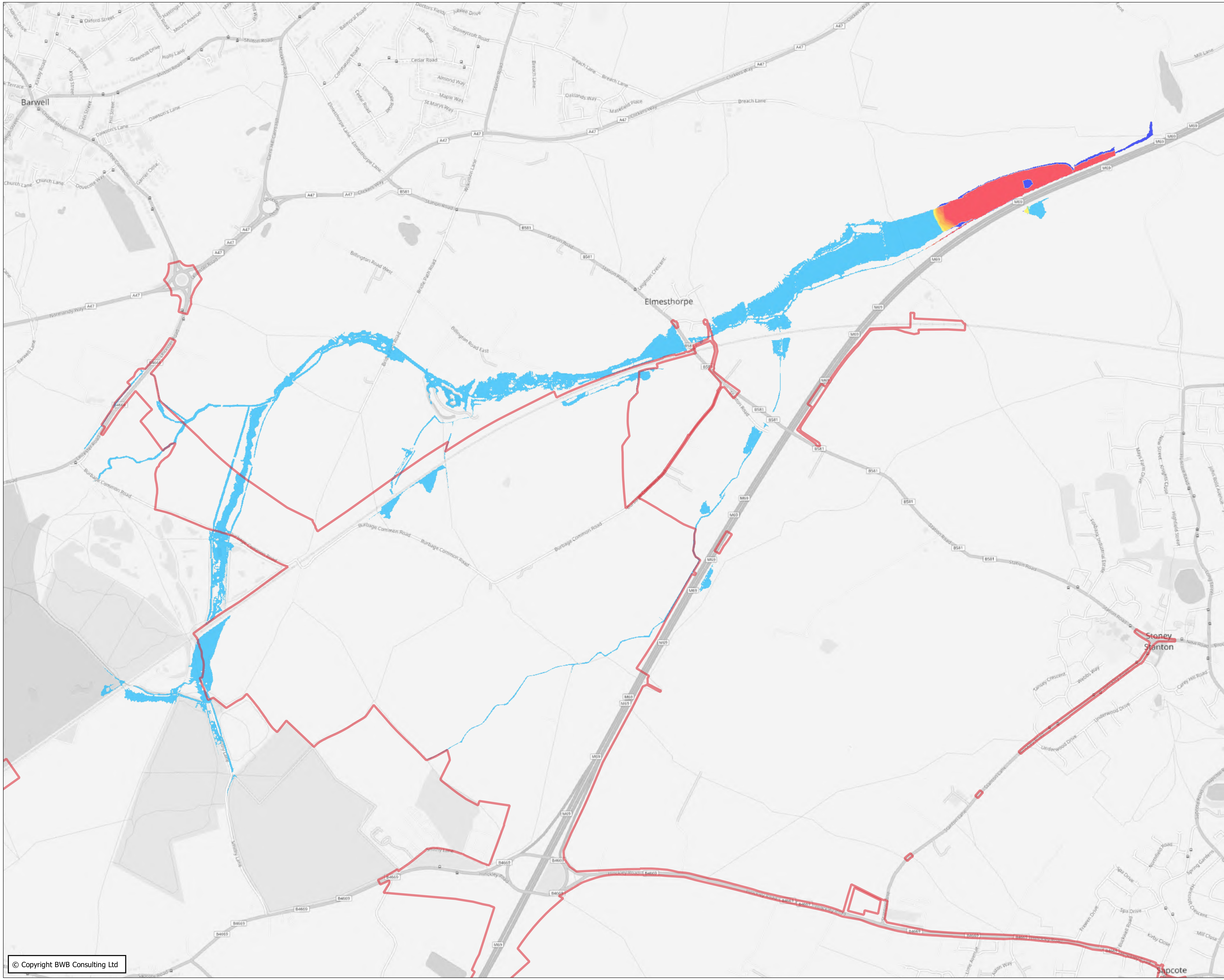
Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 8

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0045	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
□ Leeds | 0113 233 8000
□ London | 0207 407 2879
□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

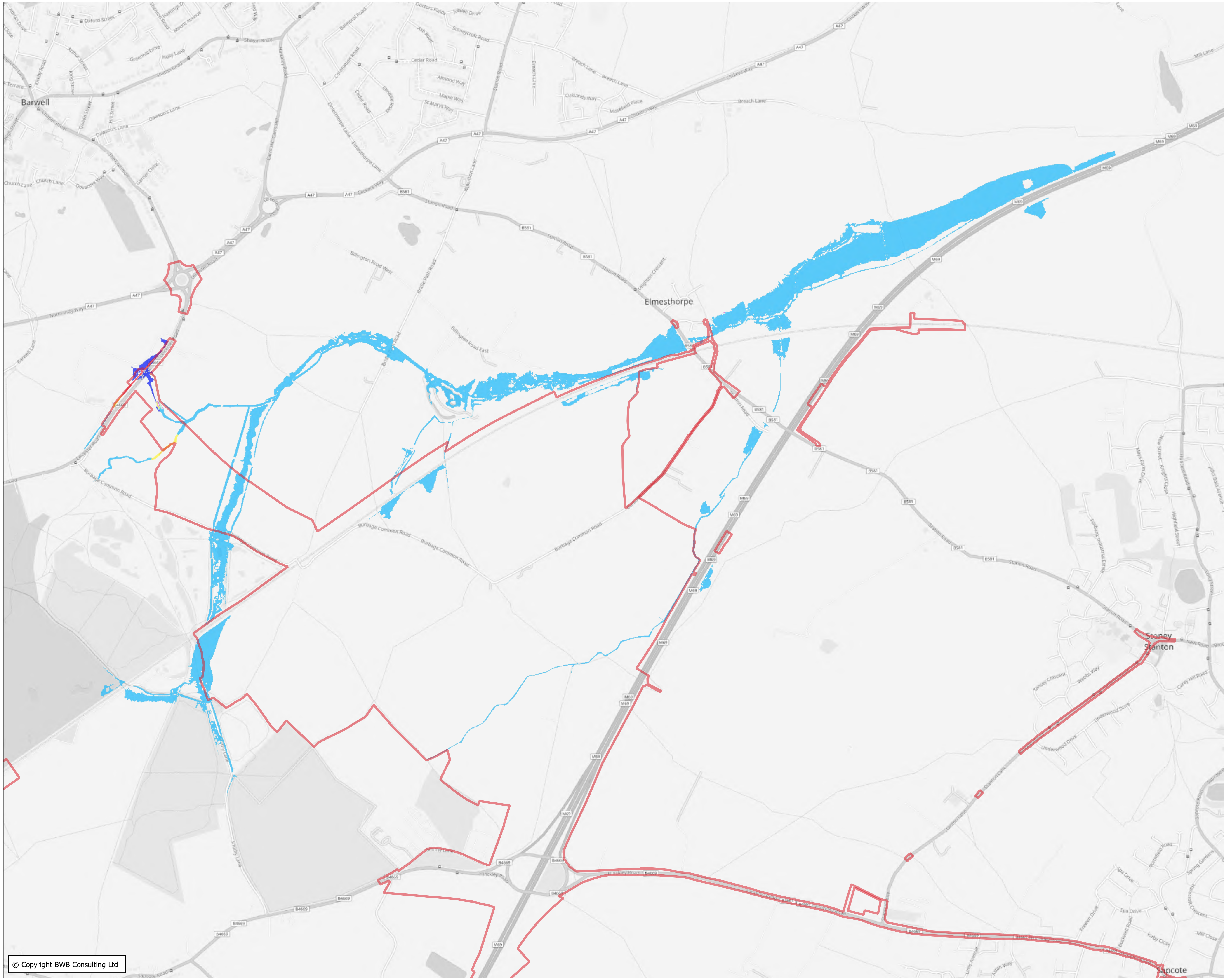
Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 9

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0046	S2	P05



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P05	22.08.22	Update to the DCO Boundary	RG	CD
P04	10.12.21	Update to the DCO Boundary	RG	CD
P03	16.11.21	Update to the DCO Boundary	RG	CD
P02	04.10.21	General update following EA review	RG	CD
P01	05.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Sensitivity Tests: 1 in 100-Year (1.0% AEP) Blockage Scenario 10

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref: NTT 2814	Date: 05/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0047	S2	P05

Appendix 7: Post Development Floodplain Maps

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Floodplain Extents

- 1 in 10-year (10% AEP)
- 1 in 20-year (5.0% AEP)
- 1 in 50-year (2.0% AEP)
- 1 in 75-year (1.3% AEP)
- 1 in 100-year (1.0% AEP)
- 1 in 100-year (1.0% AEP)+30%
- 1 in 100-year (1.0% AEP)+40%
- 1 in 100-year (1.0% AEP)+60%
- 1 in 1000-year (0.1% AEP)

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Floodplain Extents

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0048	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 10-Year (10% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0053	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
□ Leeds | 0113 233 8000
□ London | 0207 407 2879
□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 20-Year (5.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0054	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
□ Leeds | 0113 233 8000
□ London | 0207 407 2879
□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 50-Year (2.0% AEP)

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0061	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 75-Year (1.3% AEP)

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0062	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 100-Year (1.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 07/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0055	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 100-Year (1.0% AEP) +30%

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0056	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 100-Year (1.0% AEP) +40%

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0057	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 100-Year (1.0% AEP) +60%

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0058	S2	P04

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. Background cartography used with permission of © OpenStreetMap contributors.

Key

- The DCO Site

Peak Flood Depths (m)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- > 1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.08.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Thurlaston Brook Illustrative Post-Development Flood Depths: 1 in 1000-Year (0.1% AEP)

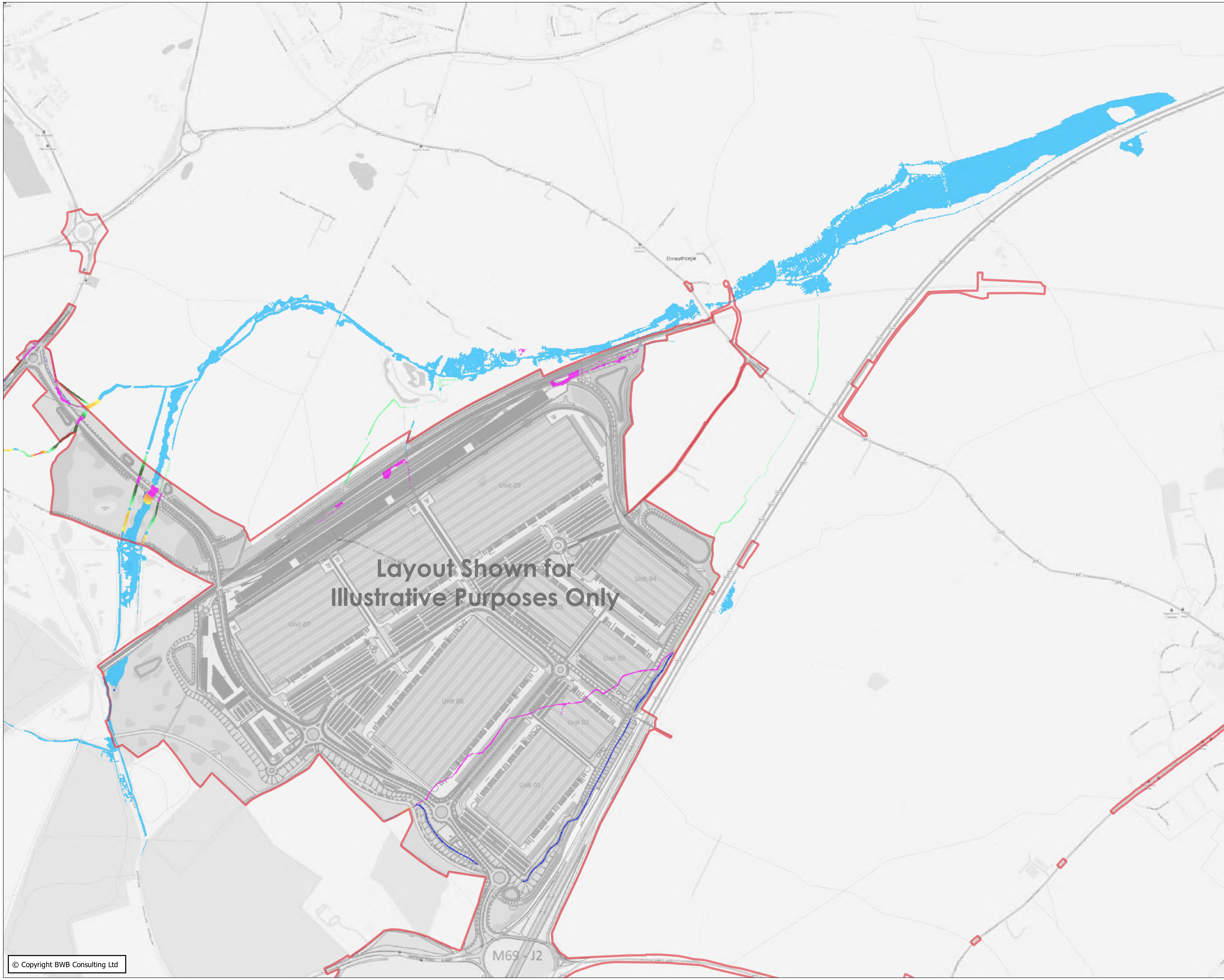
Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21
		Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0059	S2	P04

Appendix 8: Proposed Development Impact Analysis



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

■ Birmingham | 0121 233 3322
☐ Leeds | 0113 233 8000
☐ London | 0207 407 2879
☐ Manchester | 0161 233 4260
☐ Nottingham | 0115 924 1100
[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

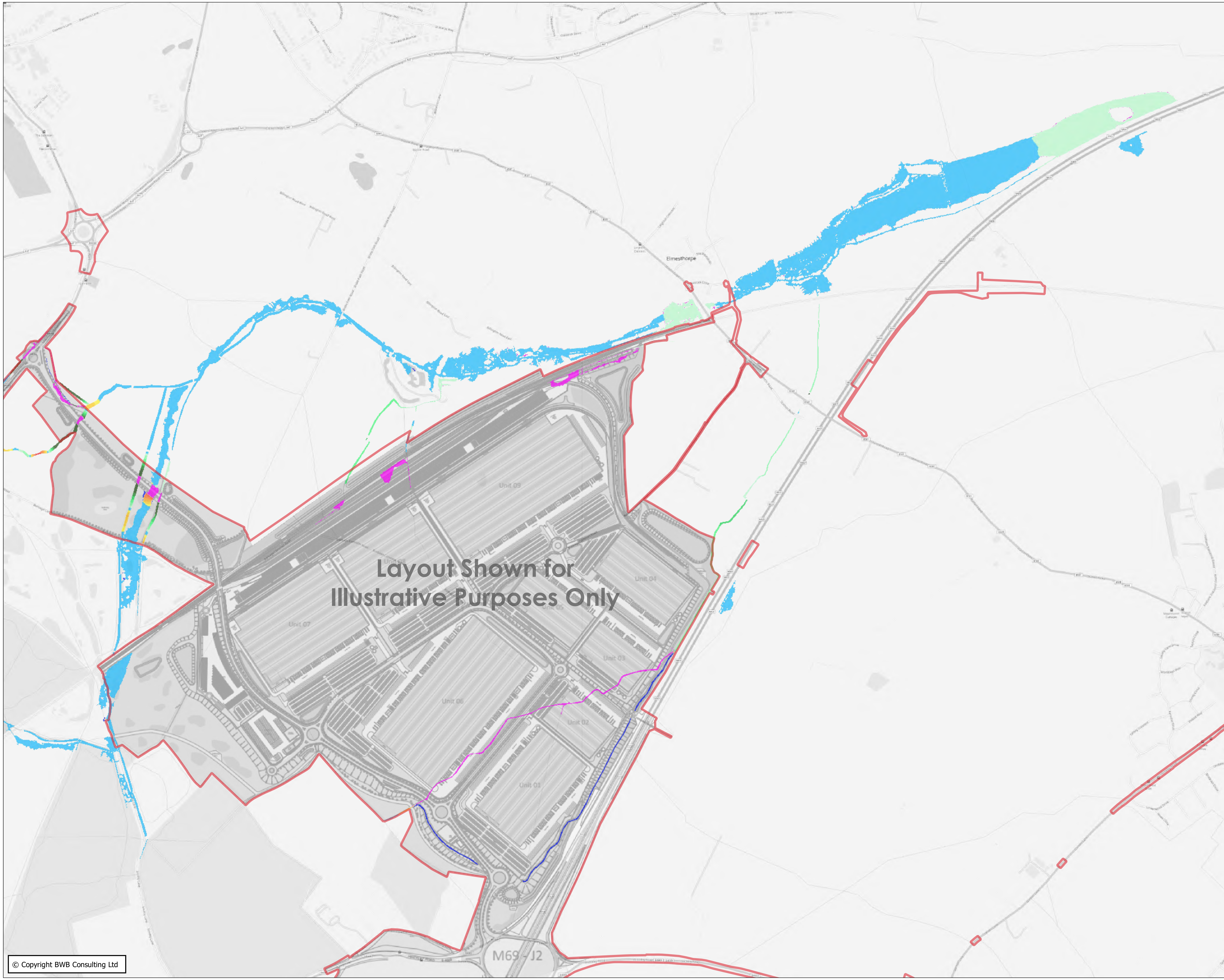
Change in Flood Levels & Floodplain Extent due to Development: 1 in 10-Yr (10% AEP)

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0049	S2	P04



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

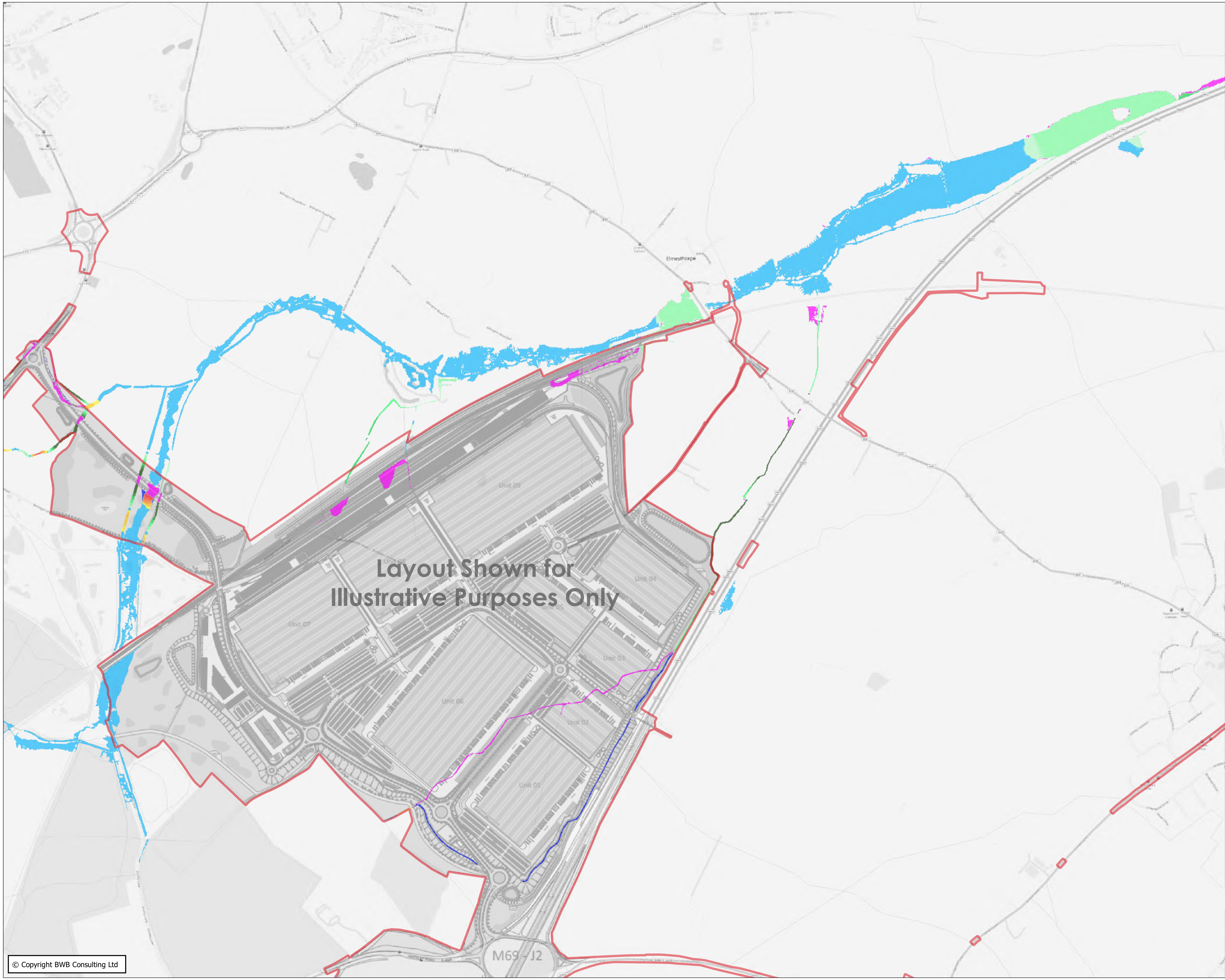
Change in Flood Levels & Floodplain Extent due to Development: 1 in 20-Yr (5.0% AEP)

Drawn:	R Green		Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0050	S2	P04



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

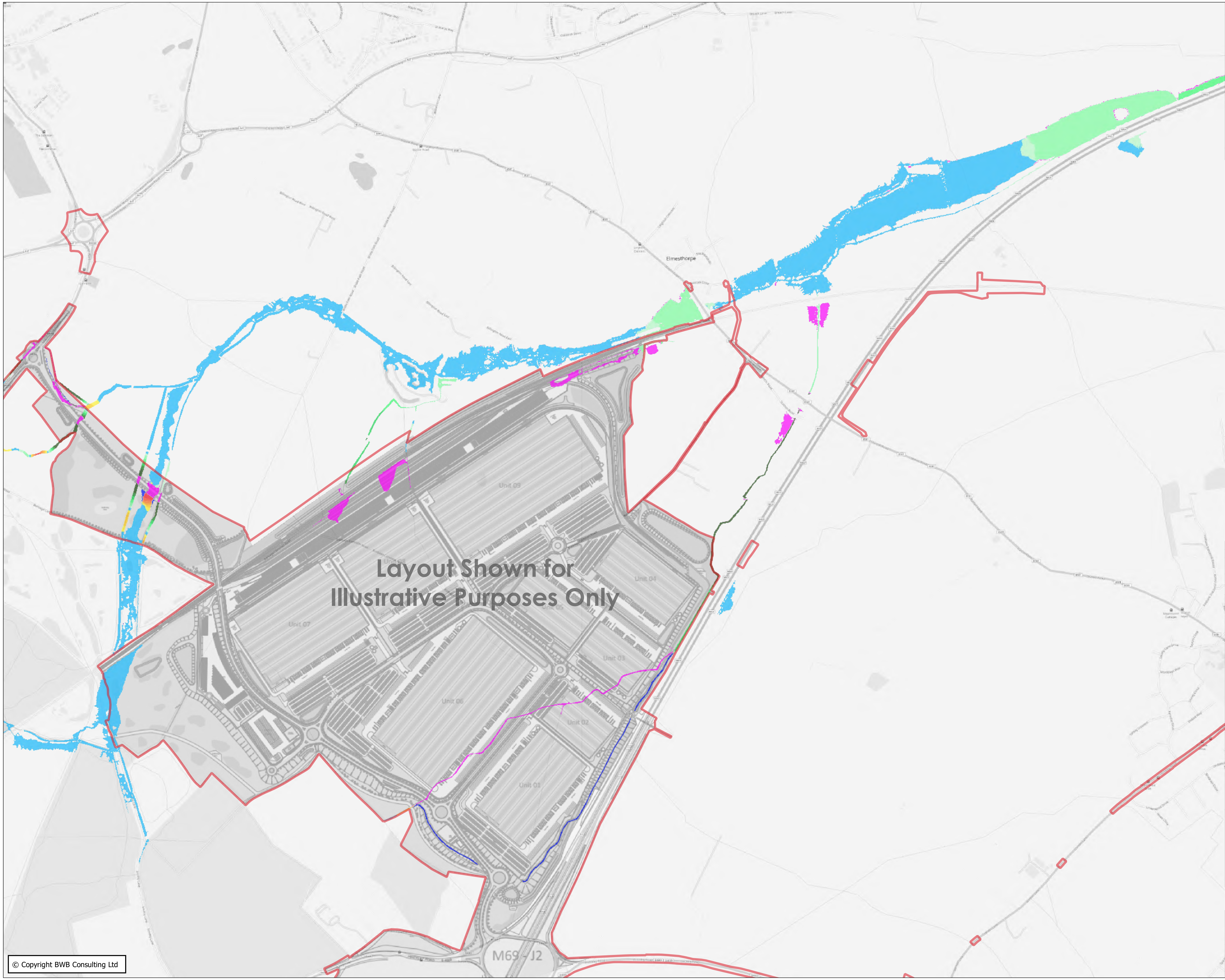
Change in Flood Levels & Floodplain Extent due to Development: 1 in 50-Yr (2.0% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date: 07/07/21	Scale@A3: NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0063	S2	P04



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

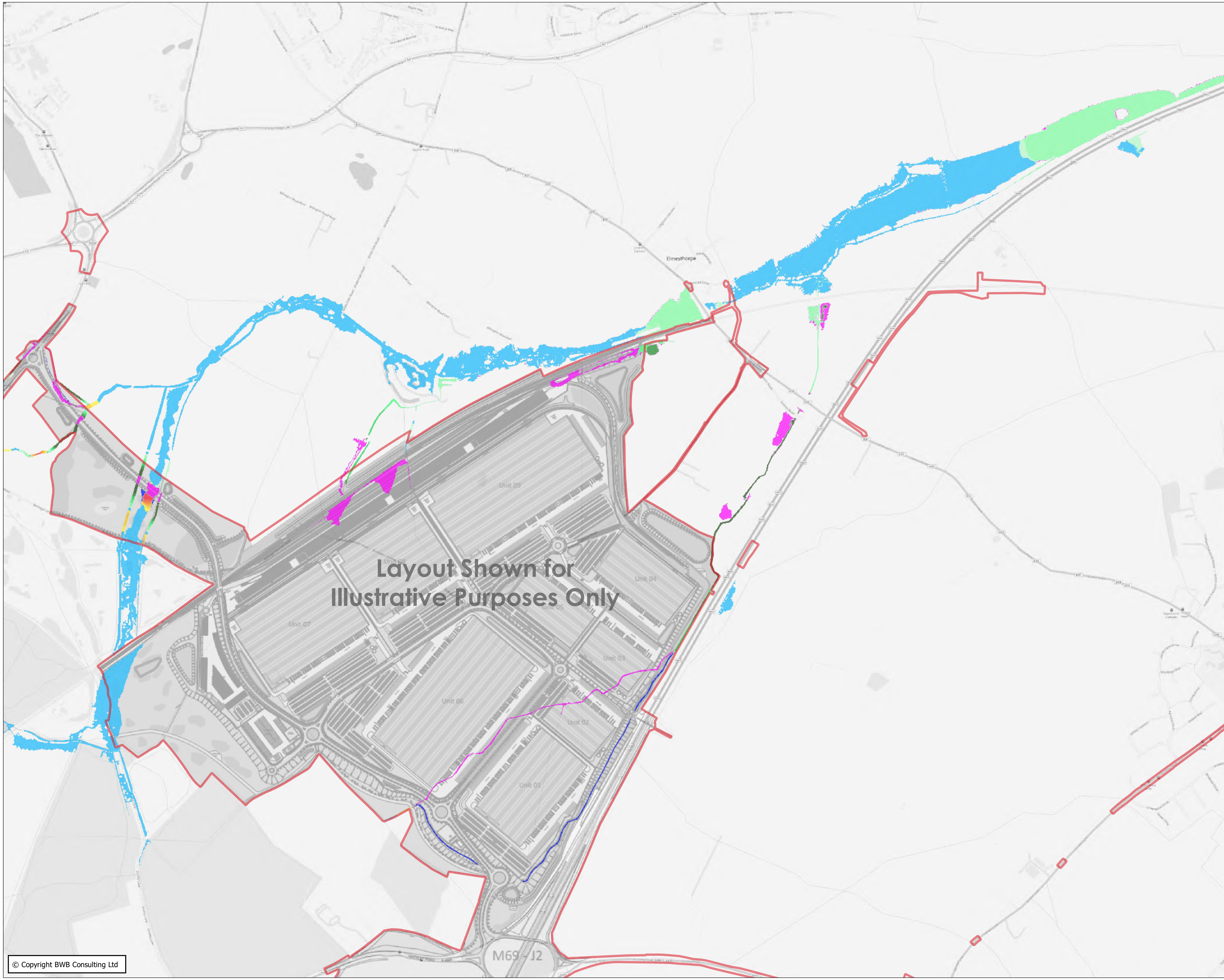
Change in Flood Levels & Floodplain Extent due to Development: 1 in 75-Yr (1.3% AEP)

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTT 2814	Date:	07/07/21
Scale@A3:	NTS		

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0064	S2	P04



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

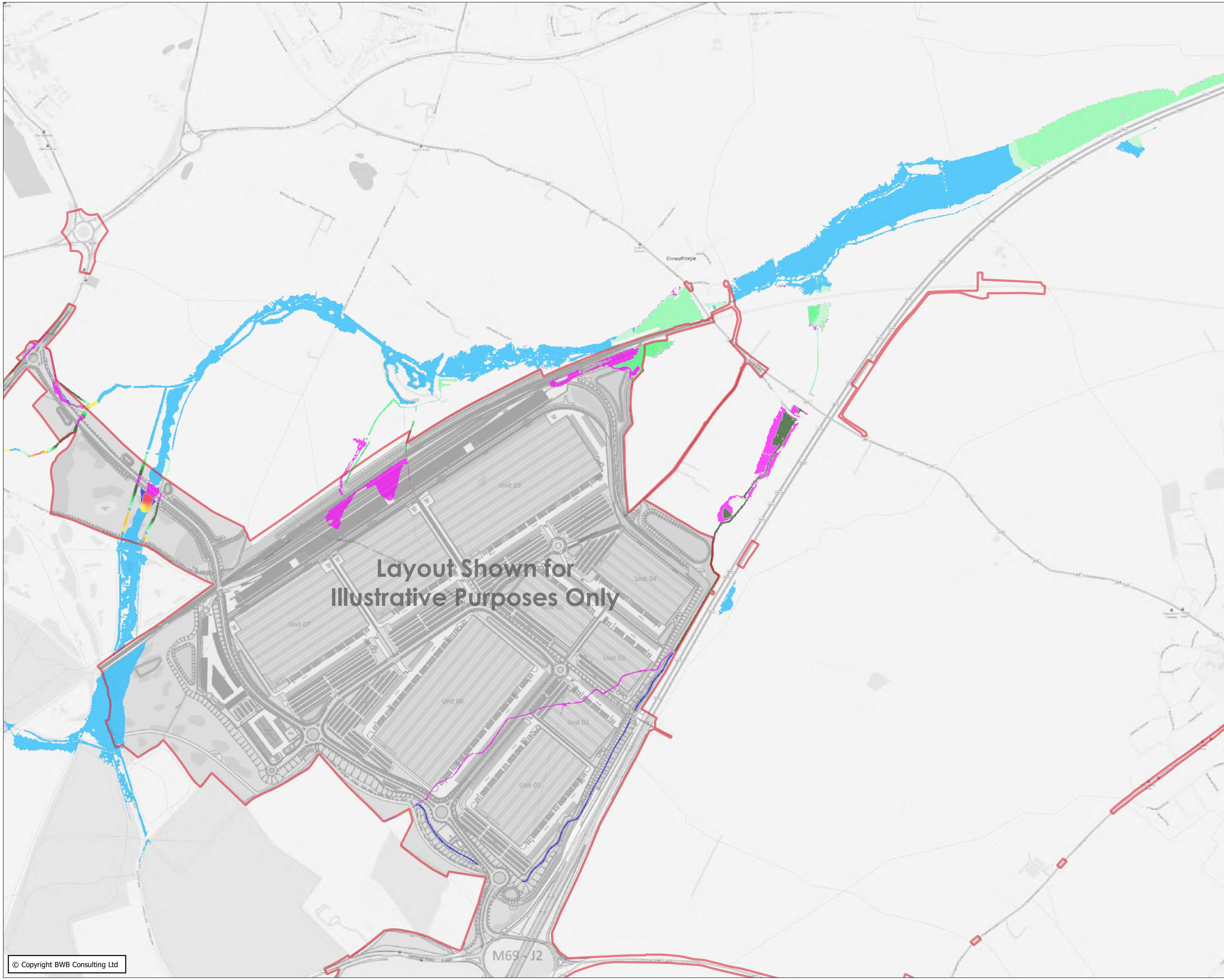
Change in Flood Levels & Floodplain Extent due to Development: 1 in 100-Yr (1.0% AEP)

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0051	S2	P04



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. Background cartography used with permission of © OpenStreetMap contributors.

Key

The DCO Site

Change in 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

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P04	22.0.22	Update to DCO Boundary	RG	CD
P03	10.12.21	Update to DCO Boundary	RG	CD
P02	16.11.21	General Update Following EA Review	RG	CD
P01	07.07.21	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

- ■ Birmingham | 0121 233 3322
- ☐ Leeds | 0113 233 8000
- ☐ London | 0207 407 2879
- ☐ Manchester | 0161 233 4260
- ☐ Nottingham | 0115 924 1100

[redacted]

Client

Tritax Symmetry (Hinckley) Ltd

Project Title

Hinckley National Rail Freight Interchange

Drawing Title

Change in Flood Levels & Floodplain Extent due to Development: 1 in 100-Yr (1.0% AEP) +30%

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTT 2814	Date:	07/07/21	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
HRF-BWB-ZZ-XX-SK-YE-0052	S2	P04

BWB

A CAF GROUP COMPANY

APPENDICES

Appendix 3: Soar Brook Tributary Hydraulic Model Report

BWB
A CAF GROUP COMPANY

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd

Hinckley National Rail Freight Interchange

Leicestershire

Soar Brook Tributary Hydraulic Model Report

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange
Leicestershire
Soar Brook Tributary 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

August 2022

DOCUMENT ISSUE RECORD

Document Number:	HNRFI-BWB-ZZ-XX-RP-YE-0007_HMR
BWB Reference:	NTT-2814-HMR2

Author:	Robin Green BSc (Hons)
Checked:	Max Brambani BSc (Hons) PgCert MCIWEM
Approved:	Matthew Day BA (Hons) MSc FRGS MCIWEM C.WEM C.Sci C.Env

Rev	Date	Status	Comment	Author:	Checked:	Approved:
P01	16/08/21	S0	Draft Issue for Preliminary Review	RG	MB	MD
P02	11/11/21	S2	Updated to reflect the latest DCO Site boundary and development proposals	RG	MB	MD
P03	10/12/21	S2	Updated to reflect the latest DCO Site boundary and terminology. Issued alongside the PEIR.	RG	MB	MD
P04	25/08/22	S2	Updated to reflect the latest DCO Site boundary and terminology.	AE	RG	RG

CONTENTS

FIGURES

TABLES

APPENDICES

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.

HPC – Heavily Parallelised Compute.

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

m AOD – metres Above Ordnance Datum

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

QBAR – Annual average runoff rate.

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).

SuDS – Sustainable Drainage Systems

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 river bank, 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 Tritax Symmetry (Hinckley) Ltd is promoting proposals for a new Strategic Rail Freight Interchange on land east of Hinckley, in Blaby District in Leicestershire. A Strategic Rail Freight Interchange (SRFI) is a large multi-purpose freight interchange and distribution centre linked into both the rail and trunk road systems.

1.2 BWB Consulting Ltd has been commissioned by Tritax Symmetry (Hinckley) Ltd to undertake an assessment of surface water and flood risk. This includes identifying the baseline conditions and the potential impacts of the proposed development on these elements.

1.3 To facilitate the assessment of flood risk, site-specific hydraulic modelling has been undertaken. The modelling assessment(s) will be used to inform an FRA of the site and develop a flood risk management strategy for the proposed development.

1.4 The subject of this report is an assessment of a tributary of the Soar Brook as it passes beneath the M69.

1.5 The majority of the development proposals are significantly removed from the Soar Brook tributary. However, to accommodate new slip roads at Junction 2 of the M69 it is necessary to widen the carriageway over the watercourse. At this stage, it is expected that the embankment on the northern side is to be widened by approximately 3m. The carriageway on the downstream side of the M69 will be widened by approximately 5m, this will require the watercourse, which runs along the toe of the existing embankment, to be relocated further south. The impact of these relatively minor proposals is assessed within this report.

Site Description

1.6 The Main HNRFI Site lies 3 km to the north-east of Hinckley town centre, to the north-west of M69 Junction 2. The Nuneaton to Felixstowe railway forms the north-western boundary, with the M69 motorway defining the south-eastern boundary. To the south-west are blocks of deciduous woodland (including Burbage Wood, Aston Firs and Freeholt Wood), a gypsy and traveller community site, and a mobile home site. Beyond the north-eastern boundary lies the village of Elmesthorpe, a linear settlement on the B581 Station Road.

1.7 The Main HNRFI Site comprises the proposed SRFI, which includes but may not be limited to the railway sidings and freight transfer area alongside the two-track railway between Hinckley and Leicester, land for the development of storage and logistics sheds, site hub building, energy centre, and associated lorry and car parking, infrastructure, and landscaping.

1.8 The Development Consent Order (DCO) Site extends beyond the Main HNRFI Site to include other elements including a new link road from M69 Junction 2 to the B4668 (Leicester Road) ('the A47 Link Road'), alterations to Junction 2 itself, and a section of the B4669 towards Sapcote – this larger area is referred to as the Main Order Limits. The

DCO Site extends beyond the Main Order Limits to include other highway, junction, and railway improvements.

1.9 A location plan illustrating the Order Limits is illustrated within **Figure 1.1**.

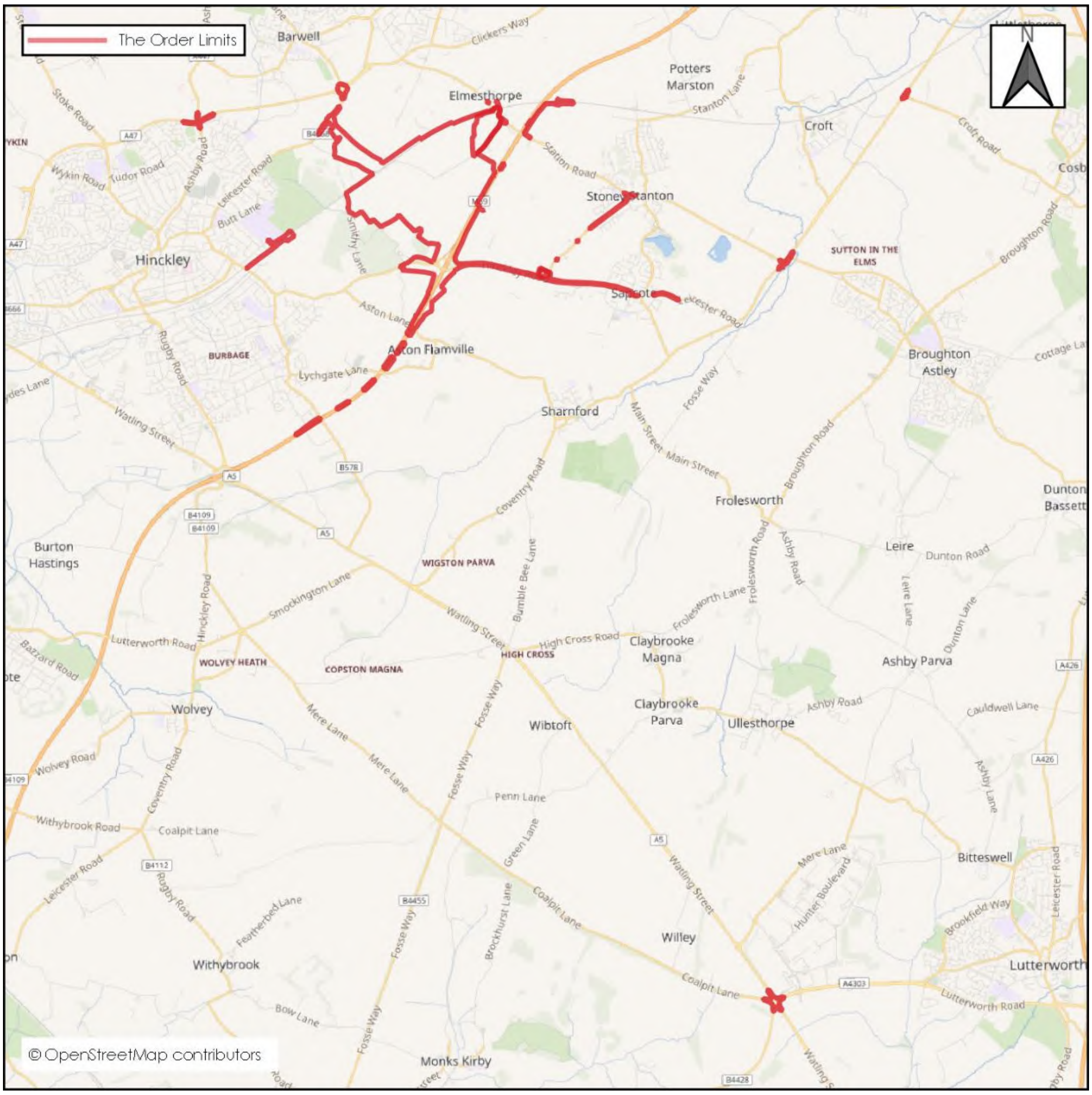


Figure 1.1: Site Location Plan

Watercourse Network

1.10 The watercourse network in and around the Main Order Limits, as shown on OS mapping and identified on a site-specific topographical survey, are shown in **Figure 1.2**.

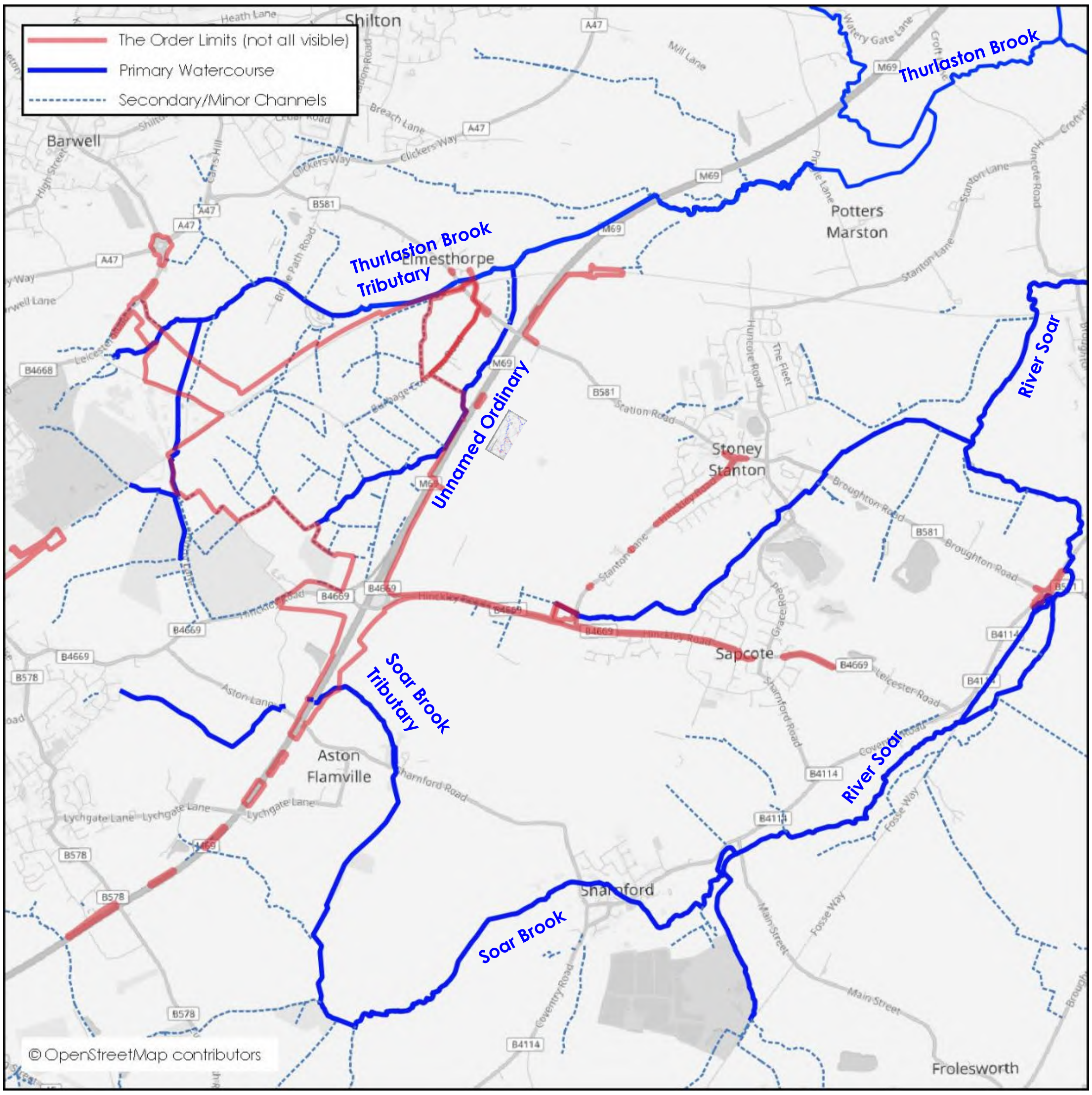


Figure 1.2: Watercourse Network

1.11 The Main Order Limits are predominantly located within the catchment of an unnamed tributary of the Thurlaston Brook. This watercourse issues from the eastern side of Hinckley and flows eastwards across the route of the proposed link road and immediately beyond the railway line to the north of the Main HNRFI Site.

1.12 Five smaller tributary watercourses/ditches serving land to south-west of the Main Order Limits and also land in the north of the Main HNRFI Site, pass beneath the railway line and join the unnamed tributary of the Thurlaston Brook as it flows to the north of the Main HNRFI Site.

1.13 An UOW flows north-eastwards through the south-eastern portion of the Main HNRFI Site before joining the tributary of the Thurlaston Brook just downstream of the railway line.

1.14 This UOW issues within the Main HNRFI Site, rather than being fed by a significant upstream catchment. Additionally, within the Main HNRFI Site, several field drainage ditches and small ponds also discharge into this watercourse.

1.15 Downstream of the Main HNRFI Site, the Thurlaston Brook tributary continues to flow north eastwards. It passes beneath the M69 and joins the Thurlaston Brook approximately 3.5km downstream of the Main HNRFI Site.

1.16 The Soar Brook tributary issues from the south-eastern side of Hinckley. This flows beneath the M69, to the south west of Junction 2, and through the Order Limits for a short length, before turning south-east and flowing away from the DCO Site.

1.17 This report discusses the hydraulic assessment of the Soar Brook tributary as it flows next to the proposed development, as identified within **Figure 1.3**.

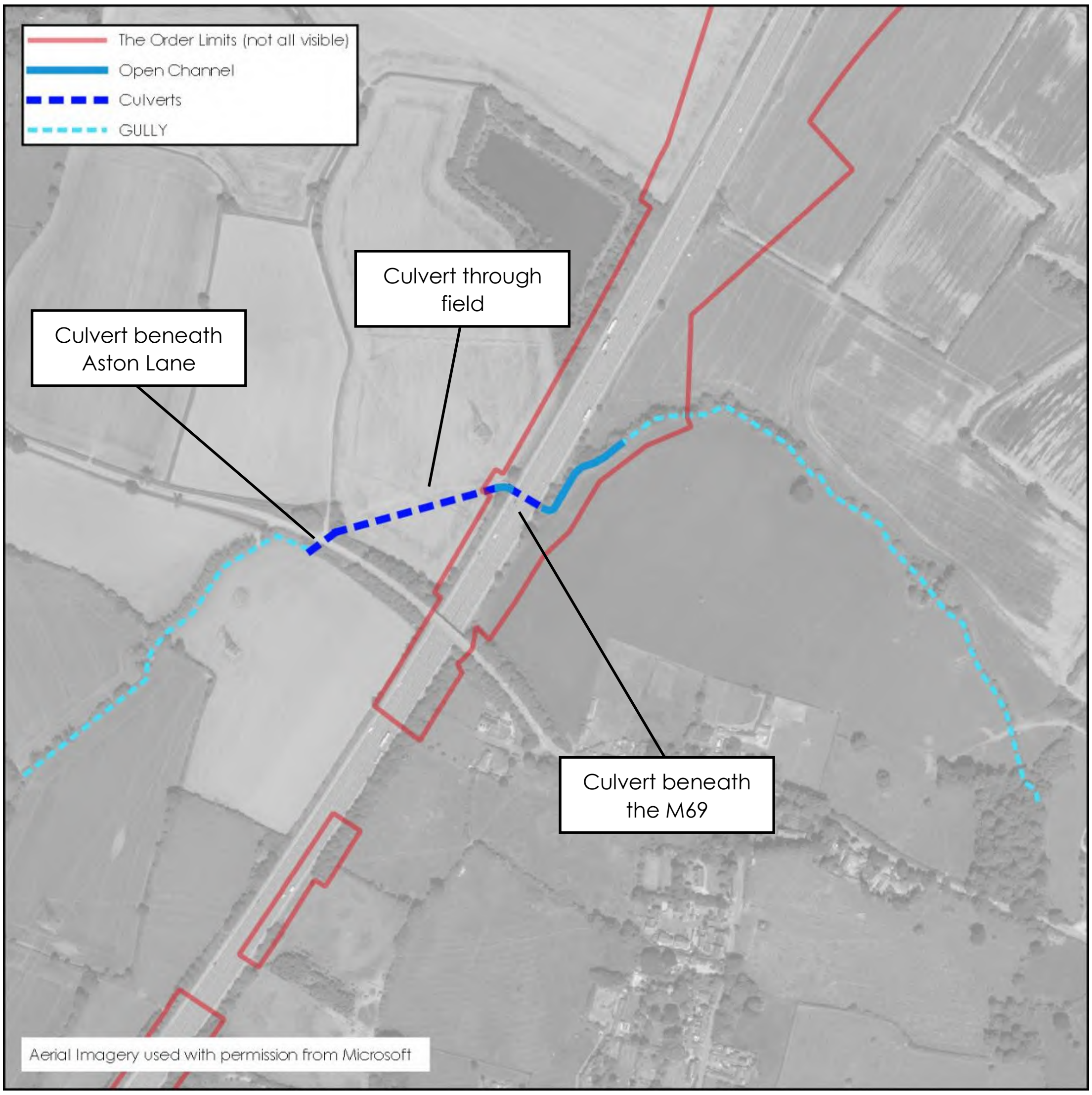


Figure 1.3: Modelled Reaches

Topography

1.18 The topography of the local area is illustrated within **Figure 1.4** using a combination of LiDAR and Photogrammetry DTMs. This identifies that the watercourses generally follow the natural topography.

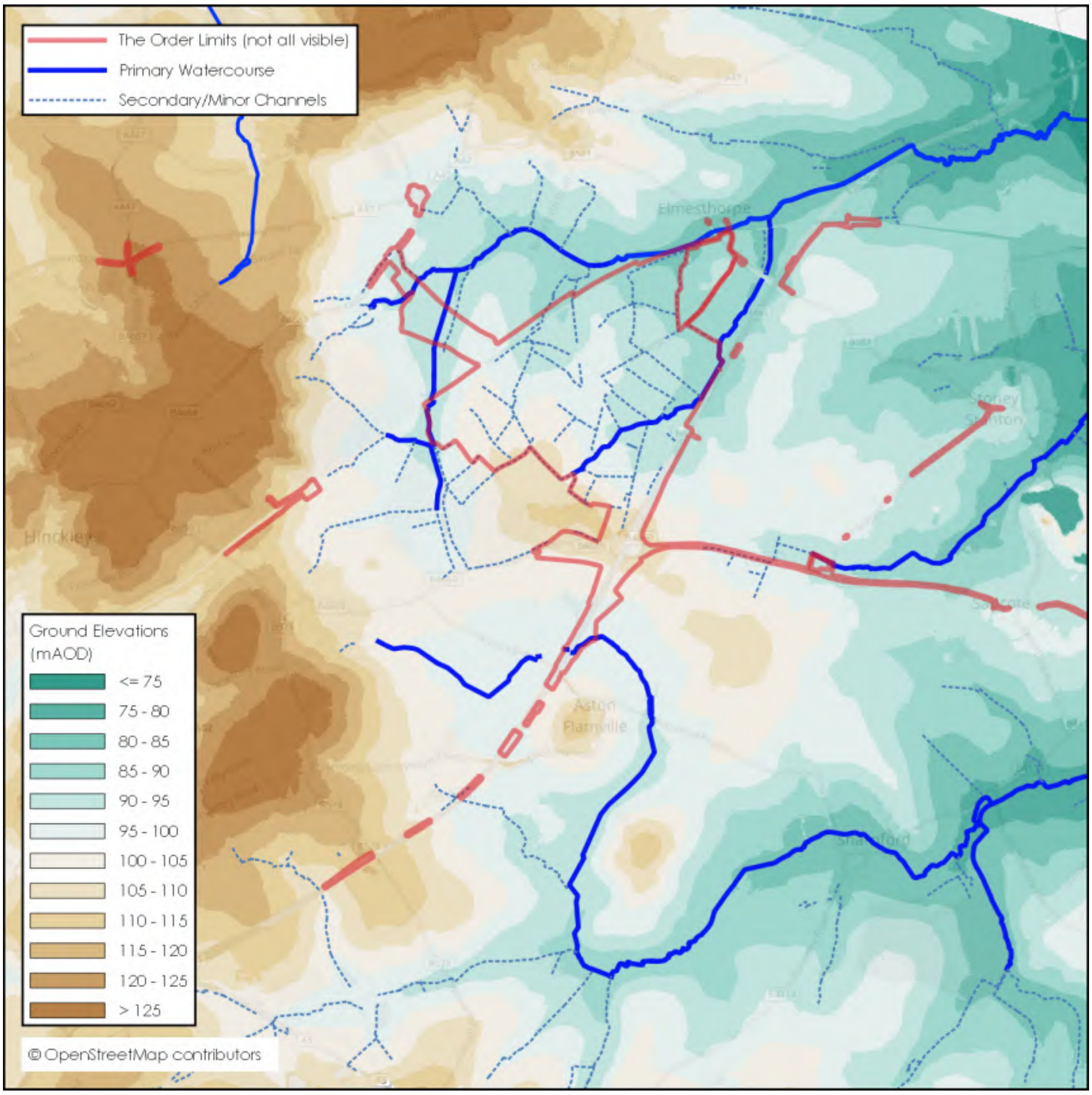


Figure 1.4: Catchment Topography

2. PREVIOUS STUDIES & AVAILABLE DATA

Flood Map for Planning

2.1 With particular reference to planning and development, the Flood Map for Planning, produced by the EA, identifies Flood Zones in accordance with Table 1 of the Planning Practice Guidance. The mapping is based upon generalised strategic scale models of 'main rivers' and of catchments greater than 3km². An extract of the mapping is provided within **Figure 2.1**.

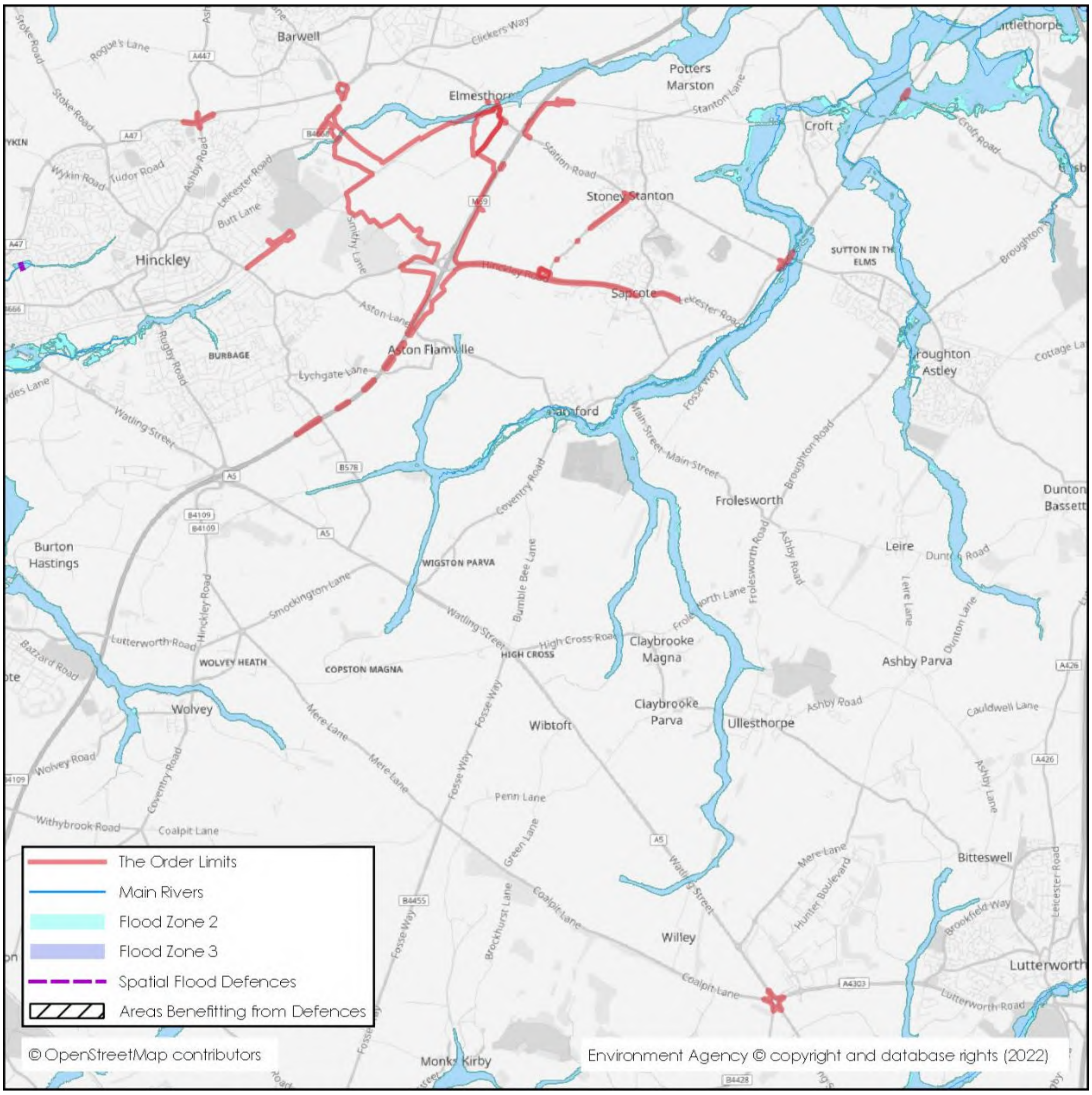


Figure 2.1: Flood Map for Planning

2.2 The mapping clearly omits the Soar Brook tributary at the M69, and so is not a reliable data source.

Flood Risk from Surface Water Map

2.3 Risk of flooding from surface water mapping has been collated and published by the EA. This 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. While not strictly a fluvial source, this data can provide an indication of the potential floodplain of smaller watercourses not included within the Flood Map for Planning.

2.4 An extract of the Flood Risk from Surface Water map is provided within **Figure 2.2** and **Figure 2.3**. These show that there is the potential for a floodplain to form on the various watercourses present in the Main Order limits. The Soar Brook tributary is shown to potentially flood over a relatively wide area upstream of Aston Lane, but to be relatively constrained on the downstream side.

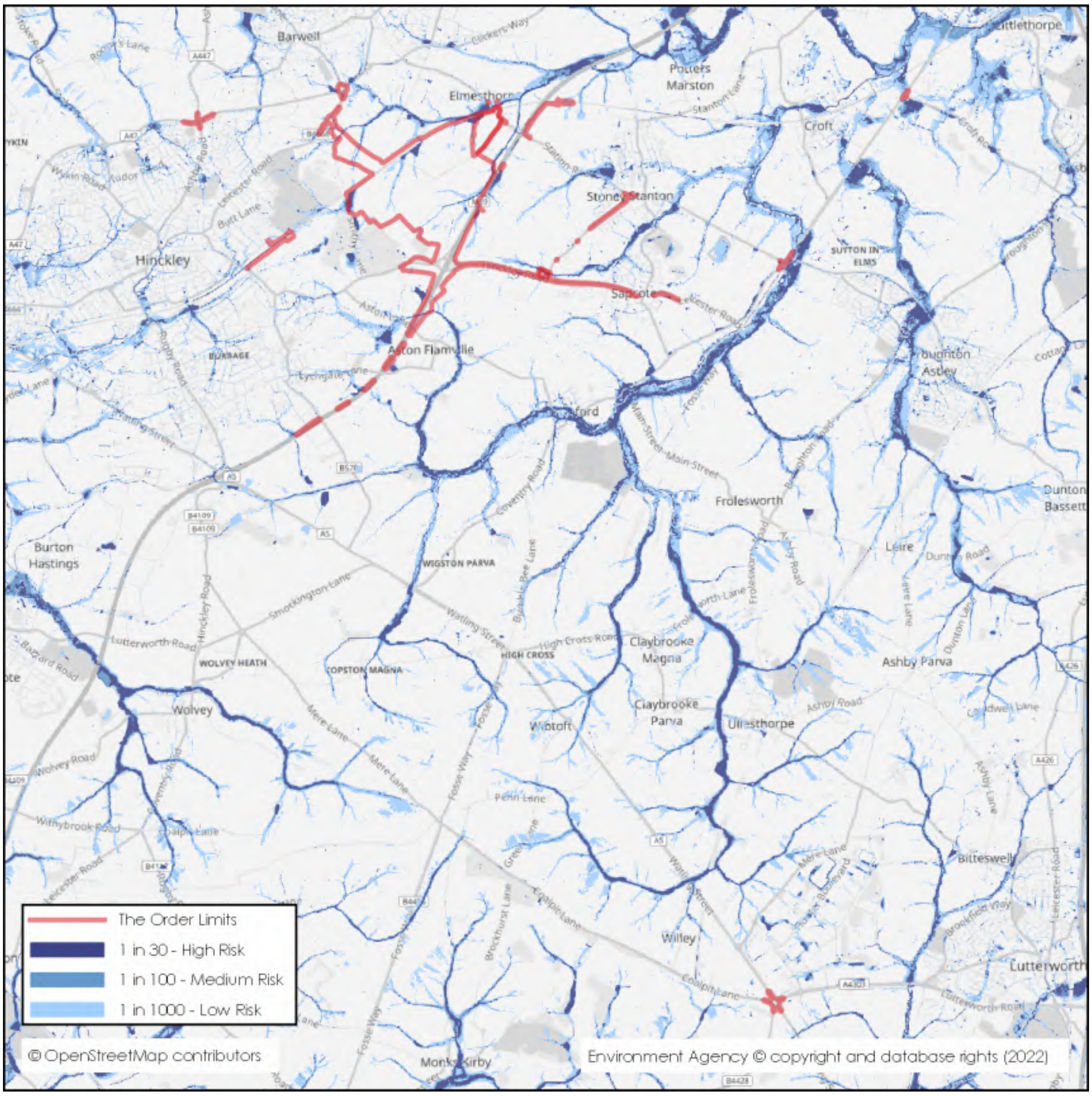


Figure 2.2: Flood Risk from Surface Water 1

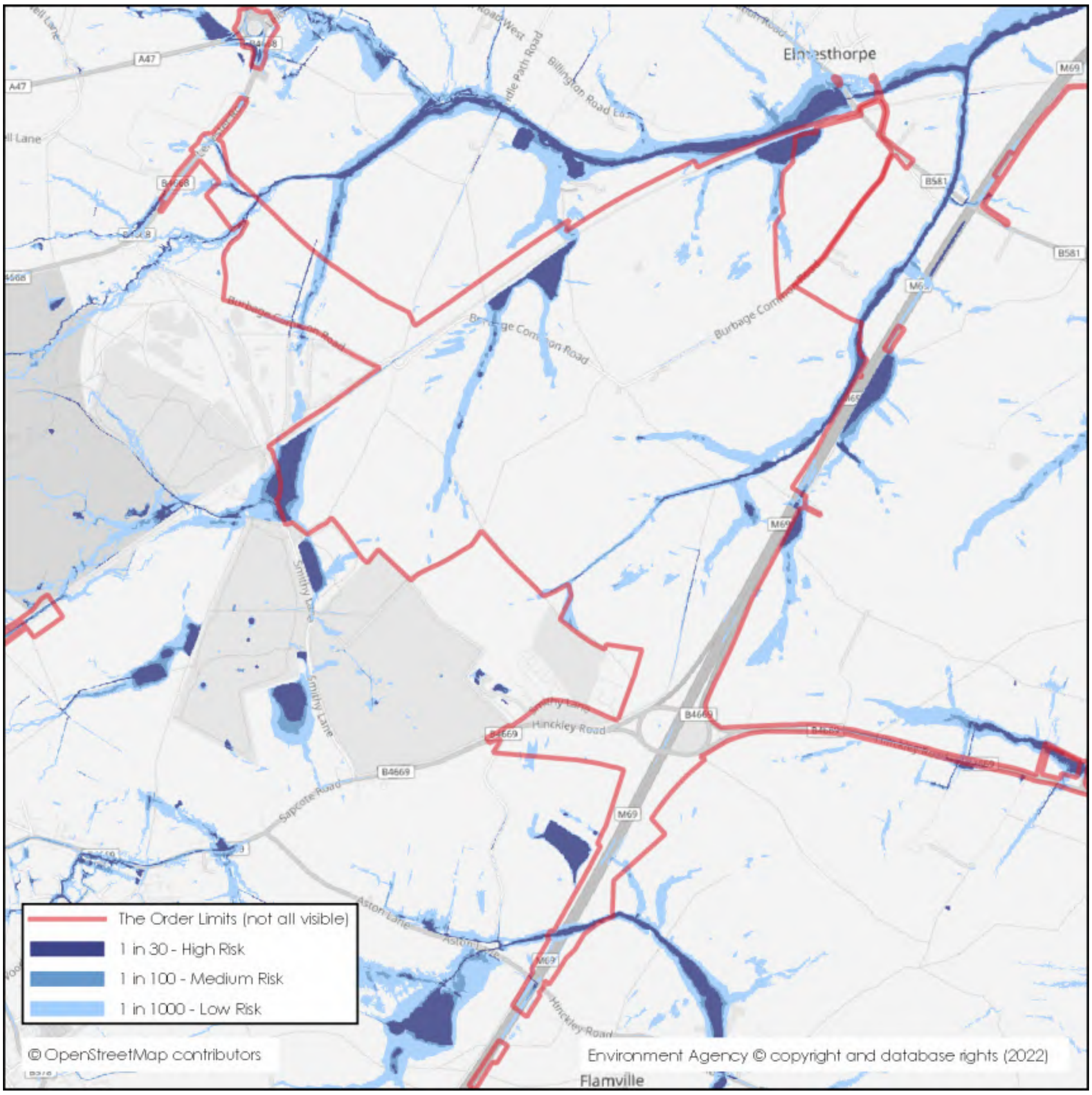


Figure 2.3: Flood Risk from Surface Water 2

2.5 While this data is considered to be more representative than the Flood Map for Planning, it is still of a strategic scale and is unsuitable for a site-specific assessment.

2.6 Additionally, in previous correspondence, the EA identified their preference for a hydraulic assessment of the floodplain to be derived from FEH flow estimation methods, rather than the direct rainfall approach as used in the Flood Risk from Surface Water map.

Preceding Hydraulic Studies

2.7 The EA and LLFA have confirmed that their hydraulic models do not provide coverage of the site.

LiDAR & Topographical Surveys

2.8 Composite LiDAR coverage (2019) from the EA is illustrated in green within **Figure 2.4**. This is composed of data captured across 2008 & 2011 at the Main Order Limits.

Resolutions of 1.0m and 2.0m are available for the area. The 2.0m dataset was used in this study as it provided greater coverage.

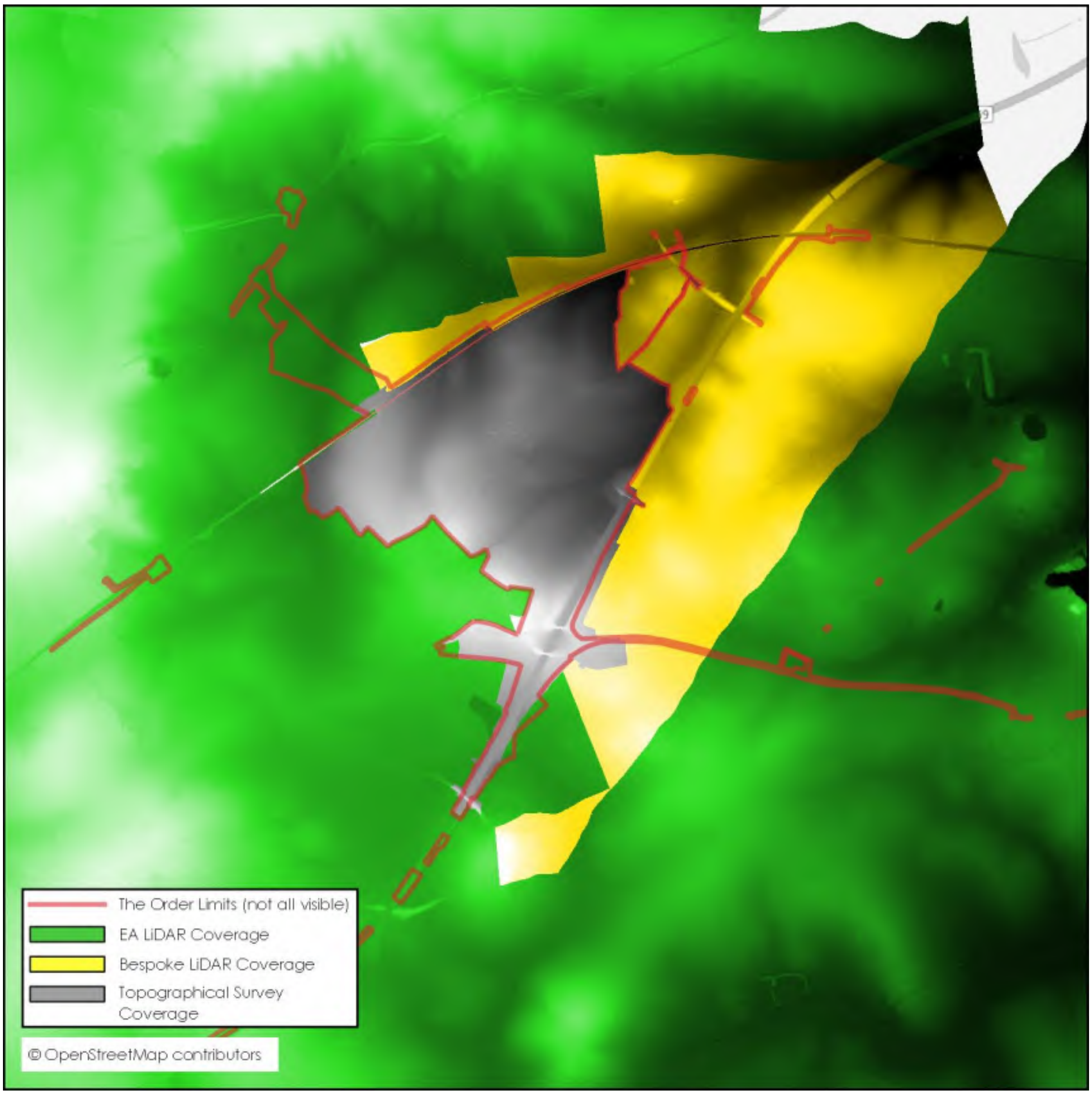


Figure 2.4: LiDAR and Topographical Survey Coverage

2.9 The available topographical survey coverage (ref: 24975) of the Main HNRFI Site is shown in grey in **Figure 2.4**. This was captured between March and June 2018. This also provides some coverage of the Soar Brook tributary immediately adjacent to the M69.

2.10 The available LiDAR coverage from the EA is limited, with the floodplain downstream of the Main Order Limits being omitted. The area to the east of the M69 is also omitted from the LiDAR coverage.

2.11 LiDAR is the preferred dataset to model floodplains. The data is put through a filtering process to remove buildings and vegetation to provide a 'bare earth' surface, suitable for floodplain modelling. LiDAR is widely used in the national EA hydraulic model catalogue. The dataset has a typical resolution of 1-2metres, a vertical accuracy of 5-15cm +/- RMSE, and a horizontal accuracy of 40cm +/- RMSE.

2.12 Therefore, the preferred approach would be to extend the LiDAR coverage to include the area that currently falls outside of the of the existing LiDAR coverage and the site topographical survey.

2.13 A bespoke aerial LiDAR survey was completed in June 2021 which infilled most of the area omitted by the EA LiDAR and topographical site survey. This is shown in yellow in **Figure 2.4**.

Watercourse Survey

2.14 The Soar Brook tributary flows through private land on both sides of the M69. Access to survey the watercourses' channel form and hydraulic structures was refused by the landowner in 2021. However, the topographical site survey, which was captured at an earlier date, includes a short reach of the brook immediately upstream and downstream of the M69 where it falls within the DCO Site.

2.15 The survey team were also able to measure the size of the two upstream culverts from the public highway.

2.16 Away from the study area the hydraulic model is based upon the available LiDAR data.

2.17 The application of the available sources through the study area is illustrated within **Figure 1.3**.

Other Sources of Data

2.18 The following additional datasets were used within the hydraulic modelling exercise:

- OS mapping
- Photographs and observations from site visits undertaken between January and June 2021 by BWB Consulting
- A hydrological assessment of Flood Flows undertaken by BWB Consulting (included as **Appendix 1**)
- Public Sewer Records
- Topographical site survey

3. AIMS AND OBJECTIVES

3.1 The primary aim of this modelling exercise was to establish a good hydraulic representation of the Soar Brook tributary watercourse to demonstrate that it would not pose a flood risk to the proposed development, and that the proposed development would not cause a detrimental impact on flood risk outside of the DCO Site.

3.2 To achieve this aim, the following objectives were identified:

i. Create a 1D representation of the channel hydraulic structures using the available topographical survey and hand measurements taken on a site visit.

ii. Create a 2D representation of the remaining channel and surrounding floodplain using the available LiDAR data.

iii. Undertake a hydrological assessment of the catchment to estimate peak flood flows and generate flood hydrograph profiles.

iv. Simulate flood events within the combined 1D-2D model to establish a set of baseline conditions

v. Simulate sensitivity tests and residual risks within the model, which would include roughness coefficients, blockage scenarios, downstream boundary gradient, storm duration, variations in flows, and climate change.

vi. Update the model with the development proposals and generate a predicted floodplain for the post-development conditions.

vii. Compare the post-development and baseline floodplain and identify any detrimental impacts.

4. HYDROLOGY REVIEW

Flood Flow Estimation

4.1 A hydrological review of the Soar Brook tributary at the study site 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 guidance. This assessment is documented within **Appendix 1**.

4.2 In summary, there was no hydrometric data available in the study catchment to inform the hydrological analysis. The nearest gauged data was at Littlethorpe on the River Soar downstream of the study catchment. Observed flows from this gauge were considered in a statistical analysis at the request of the EA.

4.3 The industry standard FEH statistical method and ReFH2.3 rainfall-runoff model were both reviewed, and the ReFH2 method was determined to be the most suitable for a site-specific hydraulic model as it produced the more conservative flow estimates.

4.4 While conservative, estimates are not necessarily the 'correct' estimates. Given that the exercise will be supporting an assessment of flood risk, and given the lack of site-specific flow information, a precautionary approach was considered appropriate.

4.5 The flow estimates were made at the downstream extent of the study area, and therefore represent runoff generated upstream and from within the site.

4.6 The FEH catchment area was updated using a watershed analysis to improve its accuracy. The catchment was compared against public sewer records which showed that no cross-catchment transfers are present – the sewer networks generally follow the topographical catchment.

4.7 Flood flow estimates were derived for a range of return period events, the adopted peak flow estimates are provided within **Table 4.1**.

Table 4.1: Adopted Peak Flood Flows for the Study Catchment

Return Period Event (Yrs)	Annual Exceedance Probability (AEP)	Peak Flow (m^3/s)
1 in 2	50%	0.9
1 in 5	20%	1.3
1 in 10	10%	1.5
1 in 20	5.0%	1.7
1 in 50	2.0%	2.2
1 in 75	1.3%	2.4
1 in 100	1.0%	2.6

Return Period Event (Yrs)	Annual Exceedance Probability (AEP)	Peak Flow (m^3/s)
1 in 200	0.5%	3.1
1 in 1000	0.1%	4.6

4.8 ReFH2 also provided the hydrograph shape for the flood events, this was based upon the software's recommended duration: 6.5-hours.

Flow Distribution

4.9 The estimated flood flows were distributed across the model on an area weighted basis as shown within **Figure 4.1**. The sub-catchments were derived from a watershed analysis based on the combined LiDAR and photogrammetry DTMs. Two sub-catchments were delineated: one upstream of the M69; and one downstream, as the M69 represents a barrier to floodplain flows.

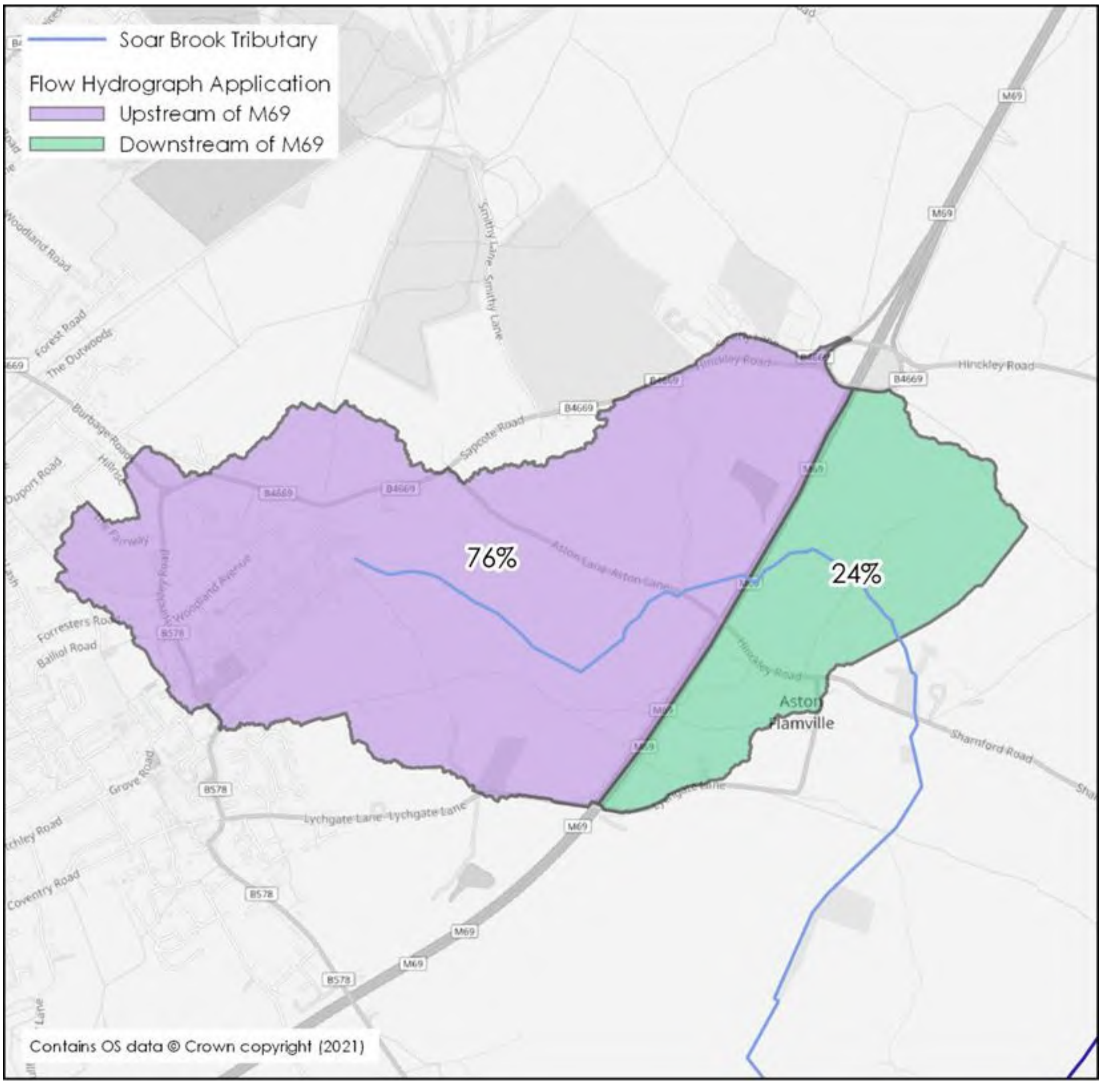


Figure 4.1: Flow Distribution

The Design Flood

4.10 The Planning Practice Guidance identifies that new development should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.

4.11 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) flooding likely to occur with a 1.0% AEP (a 1 in 100 probability of occurrence each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

4.12 Predicted future change in peak river flows caused by climate change are provided by the EA within their online guidance[1], with a range of projections applied to a series of 'Management Catchments' within regionalised 'River Basin Districts'. The Soar Brook tributary falls within the 'Soar' Management Catchment of the 'Humber' River Basin District. **Table 4.2** identifies the relevant peak river flow allowances.

Table 4.2: Peak River Flow Allowance for the Soar Management Catchment, located 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	28%	35%	60%
Higher Central	18%	21%	37%
Central	14%	16%	28%

4.13 The development has an anticipated lifespan of over 60 years and the site includes a mix of land uses and Flood Zones that would require assessment of the Central and Higher Central allowances for the 2080's. Also, although the EA guidance does not specifically reference this requirement, it is generally advised that nationally significant infrastructure projects consider a high impact climate change scenario – such as the upper end allowance.

4.14 Therefore, to estimate the potential future design floodplain under a range of scenarios, the Central, Higher Central and Upper End climate change allowance for the 2080s have been applied to the 1 in 100-year flood flows. The EA recommended in preliminary consultations that the allowances are rounded up to the nearest 5%. Therefore, allowances of +30%, +40%, and +60% will be assessed.

4.15 When determining the potential off-site impacts of a proposed development its vulnerability is not critical, instead the land use in the wider floodplain needs to be considered. In their online guidance, the EA advise that generally it is appropriate to

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

use the Central allowance. Therefore, the impact of the proposed development will be assessed at events up to the 1.0% AEP + 30%.

5. THE HYDRAULIC MODEL

Modelling Approach

5.1 A dynamically linked 1D-2D modelling approach was adopted: the in-channel conditions and hydraulic structures were modelled within a one-dimensional (1D) ESTRY domain; and the out of bank flow routing and floodplain was modelled within a two-dimensional (2D) TUFLOW domain.

5.2 Both ESTRY and TUFLOW are standard hydraulic modelling packages widely used in the UK and have been benchmarked by the EA.

5.3 TUFLOW & ESTRY version 2020-10-AB-iSP-w64 (HPC) were used in the hydraulic model study.

The 1D Model Domain

5.4 While access to the full length of watercourse for survey was denied by the landowner, a short reach of channel immediately upstream and downstream of the M69 was captured in the topographical survey.

5.5 This allowed the short reach upstream of the M69 (between the two culverts) to be fully represented using two river sections extracted from the survey. A 100m reach of channel was represented downstream of the M69 using five river sections extracted from the survey.

5.6 While this provided 1D coverage within the study site, it was necessary to transition into a 2D representation of the channel further afield.

5.7 The channel sections were truncated at top-of-bank, at what would be the interface with the 2D model domain. A minimum channel width of approximately 5m was achieved.

5.8 Three key culverts were included in the model. The M69 was the most crucial of these due to the significant barrier to flows that the M69 represents. The details of this culvert were available on the topographical survey.

5.9 Upstream of the M69, a field culvert and a highway culvert are present. These were informed partially from the topographical survey and were supplemented with hand measurements taken on site and elevation data taken from the LiDAR.

5.10 Further information on these structures and their interpretation is provided within **Table 5.1**.

Table 5.1: Hydraulic Structures

Model ID	Model Details	Photograph
Culvert Beneath Aston Lane (Cul2)	**Description:** Culvert beneath Aston Lane **NGR:** 445824, 293057 **Data Source:** Hand measurements & LiDAR **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 1.0m internal diameter **Upstream Invert Level:** 96.16mAOD **Downstream Invert Level:** 96.16mAOD **Length**: 32m **Manning's N**: 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	
Culvert through field (Cul1)	**Description:** Culvert through field **NGR:** 445931, 293097 **Data Source:** topographical survey & LiDAR **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 0.6m internal diameter **Upstream Invert Level:** 96.16mAOD (from LiDAR) **Downstream Invert Level:** 95.59mAOD (from survey) **Length**: 181m **Manning's N**: 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

Model ID	Model Details	Photograph
Culvert beneath M69 (M69)	**Description:** Culvert beneath M69 **NGR:** 446046, 293109 **Data Source:** Topographical survey **Domain:** 1D ESTRY **Unit Type**: Circular Conduit **Dimensions:** 1.7m internal diameter **Upstream Invert Level:** 95.51mAOD **Downstream Invert Level:** 95.51mAOD **Length**: 181m **Manning's N**: 0.015 **Spill/Bypass:** Modelled in 2D as part of the floodplain	

5.11 Roughness values were derived from observations made during the site visits, based on appropriate Manning's 'n' value from Chow (1959)[2].

The 2D Model Domain

5.12 EA 2.0m resolution LiDAR DTM data was used as a base for the 2D floodplain; this has undergone a filtering process to remove buildings and vegetation to provide a 'bare earth' ground model. The 2.0m DTM was used in preference to the 1.0m DTM as it provided greater coverage and mirrored the proposed model grid resolution. This was supplemented at the site by a topographical survey which was applied on top of the LiDAR data as a DTM.

5.13 A 2.0m x 2.0m resolution was adopted for the TUFLOW model grid; this is considered to be more than sufficient given the rural nature of the floodplain, but necessary to try and capture some detail of the channel.

5.14 Although the 2.0m cell size will pick up most of the significant topographic features, river bank levels from the topographical survey, were used to reinforce the river bank through the use of a 'Z-Shape' layer.

5.15 Additionally, the channels represented in the 2D domain were reinforced using a 'Z-Shape' layer, as informed by the available survey and LiDAR.

5.16 The surveyed watercourse channel(s) were deactivated within the 2D domain, so that they were only represented by the 1D domain.

5.17 Floodplain roughness was represented in the model through the incorporation of an appropriate Manning's 'n' value. These values were determined from an assessment of the land use types included in the OS digital data GIS files. The data contains

[2] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill Book Co., 680 p

different layers of land use types, in the form of lines and polygons, which can be transferred to a material layer. Each type of land use was assigned an ID which was then linked to the Manning's 'n' values in the material files. The list of Manning's 'n' values used in the model is presented in **Table 5.2**.

Table 5.2: Floodplain Roughness Values.

Roughness Code	Description	Manning's n'
11	General Surface	0.035
1	Buildings	0.500
6	Water	0.040
2	Roads tracks and paths	0.015
3	Hardstanding	0.020
8	Woodlands	0.060
5	Gardens (to account for fences and hedges)	0.100

5.18 Buildings, walls, and other structures were modelled at ground level in line with best practice. Buildings were given an elevated roughness value so that the structures resistance to flow are partially represented. There are no buildings present within the floodplain at the site.

5.19 The 2D model domain was digitised to meet higher ground levels on either side of the floodplain and extended approximately 450m upstream and downstream of the M69 to provide an offset from the area of interest.

Boundary Conditions

<u>1D-2D Interface</u>

5.20 The ESTRY-TUFLOW interface between channel and floodplain was digitised on top of the bank lines; a HX (External Head) boundary was adopted as the interface type in line with best practice.

5.21 The ESTRY-TUFLOW interface between structure and floodplain was digitised on the upstream and downstream side of the culverted reaches to allow the free flow of water in and out of the culverts; a SX (External Source) boundary was adopted as the interface type in line with best practice.

<u>Inflows</u>

5.22 The flood flow hydrographs described in **Section 4** were applied to the model as flow-time (QT) boundaries.

Downstream Boundary

5.23 An automated Head-Flow (HQ) boundary was adopted as the downstream boundary in the 2D domain. The boundary was drawn perpendicular to the general direction of flow, and the applied gradient was measured from the LiDAR data.

Calibration

5.24 As there was no hydrometric data, historical flood mapping, or representative strategic flood maps available, the model could not be directly calibrated against existing data.

5.25 However, it is believed that the conservative approach to the model build should offer a sufficiently robust model for the purposes of assessing flood risk at the site. In addition, a series of sensitivity tests have been undertaken on the baseline model to test key model parameters to increase confidence in the model results.

Simulation Parameters

5.26 A timestep of 1.0 second was adopted for the 2D TUFLOW domain, this is representative of ½ of the adopted grid size and is therefore within the typical range.

5.27 A timestep of 1.0 seconds was adopted for the 1D ESTRY domain, this is an equal interval of the 2D timestep and is therefore in line with best practice.

5.28 All TUFLOW and ESTRY parameters were retained as default.

5.29 Flood events were simulated for 17-hours, to allow the flood flows generated by the 6.5-hour storm event to flow through the site and start to recede.

Stability

5.30 During all simulated events there were no recorded 1D or 2D negative depths.

5.31 The cumulative mass error stayed below +/- 1.0% for all simulations, and so was within the accepted tolerance levels. This is illustrated for within **Figure 5.1**.

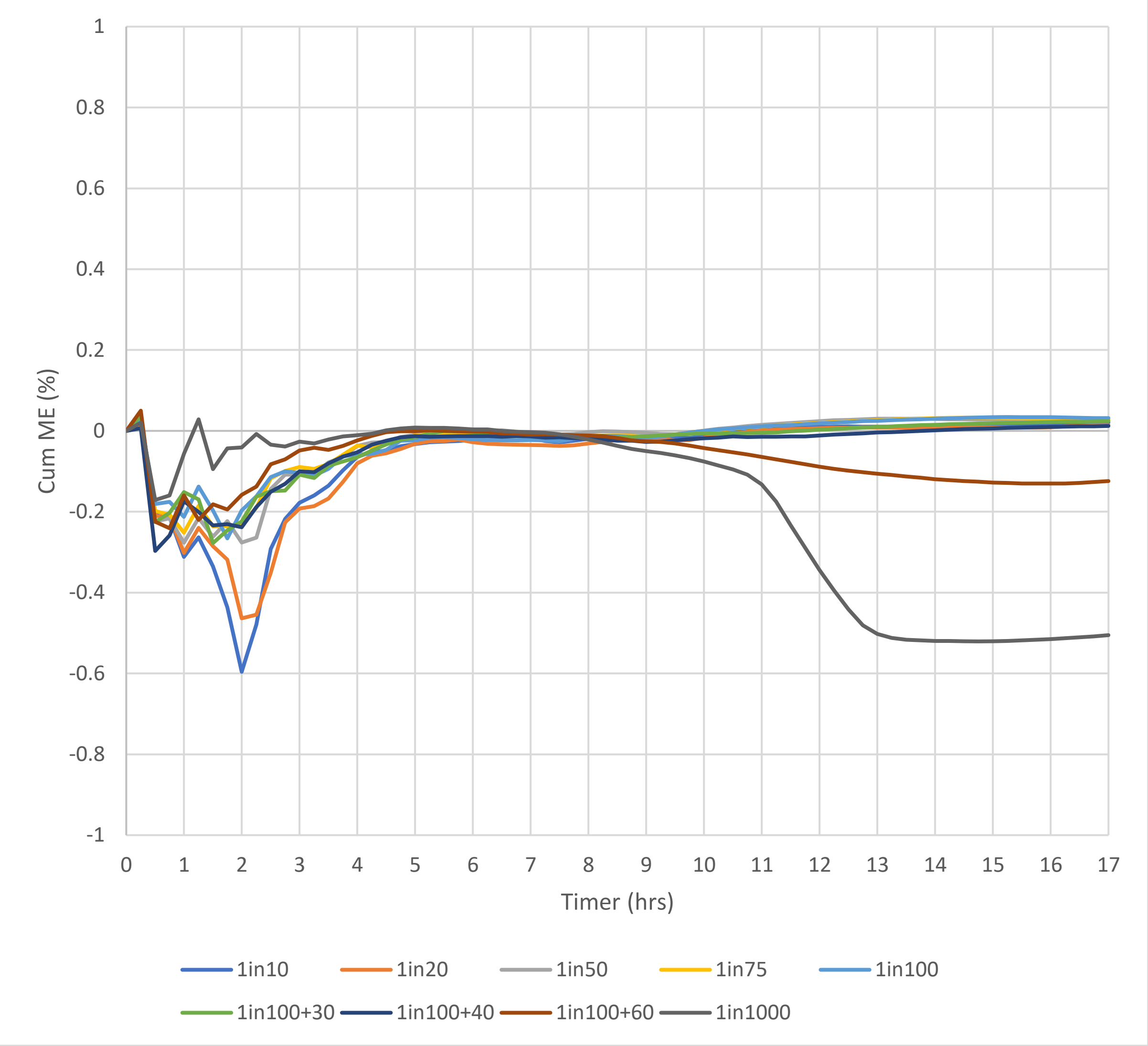


Figure 5.1: Cumulative Mass Error Time Series

6. BASELINE RESULTS

6.1 The results from the existing conditions model are mapped within **Figure 6.1** and **Figure 6.2**.

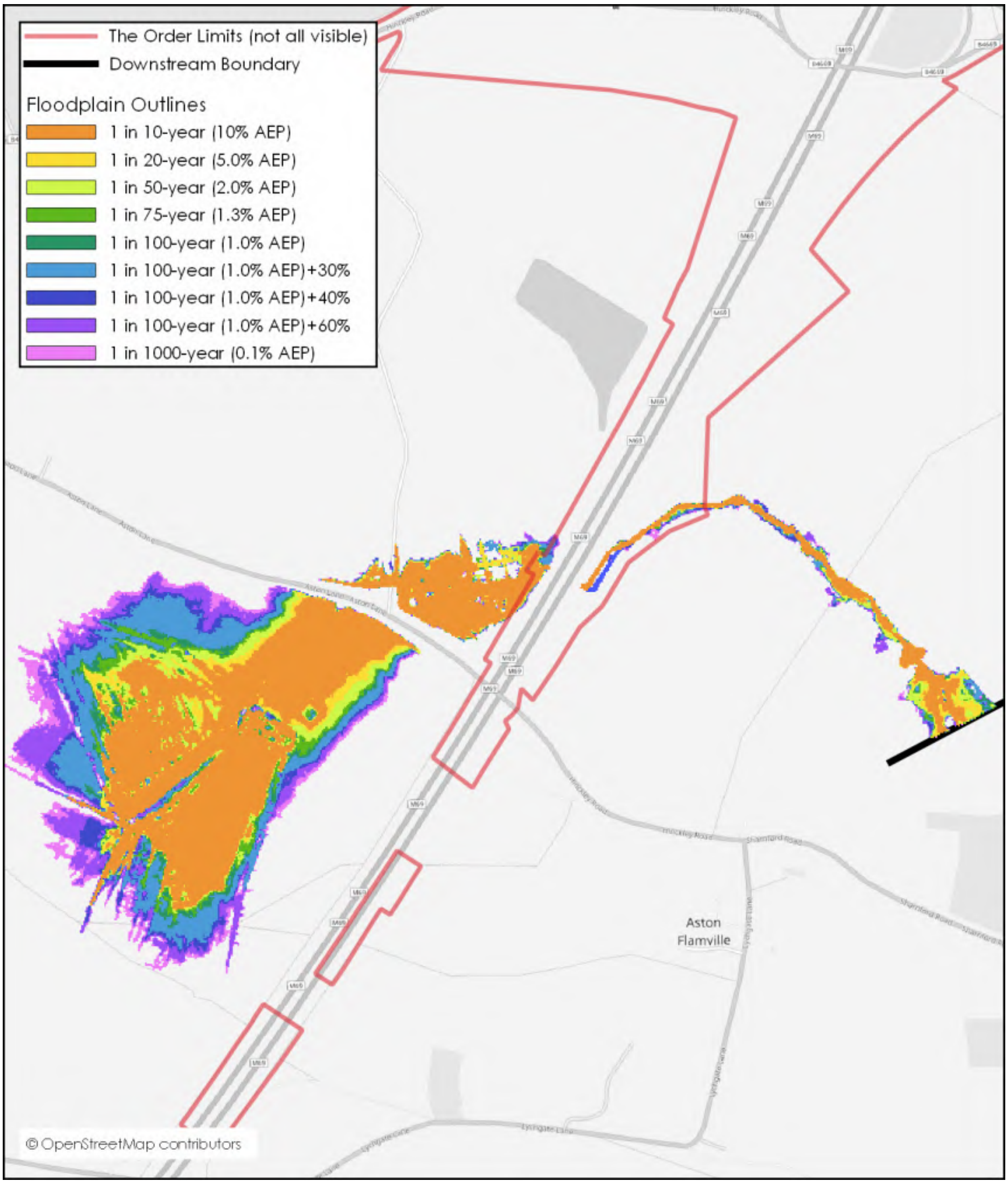


Figure 6.1: Baseline Floodplain Modelled Extent

6.2 The model results identify that flood water is attenuated upstream of Aston Lane and the M69 due to their elevated positions. This leads to relatively broad floodplains in these areas.

6.3 Downstream of the M69, the floodplain is largely restricted to the channel until the watercourse leaves the site, then a floodplain starts to form again.

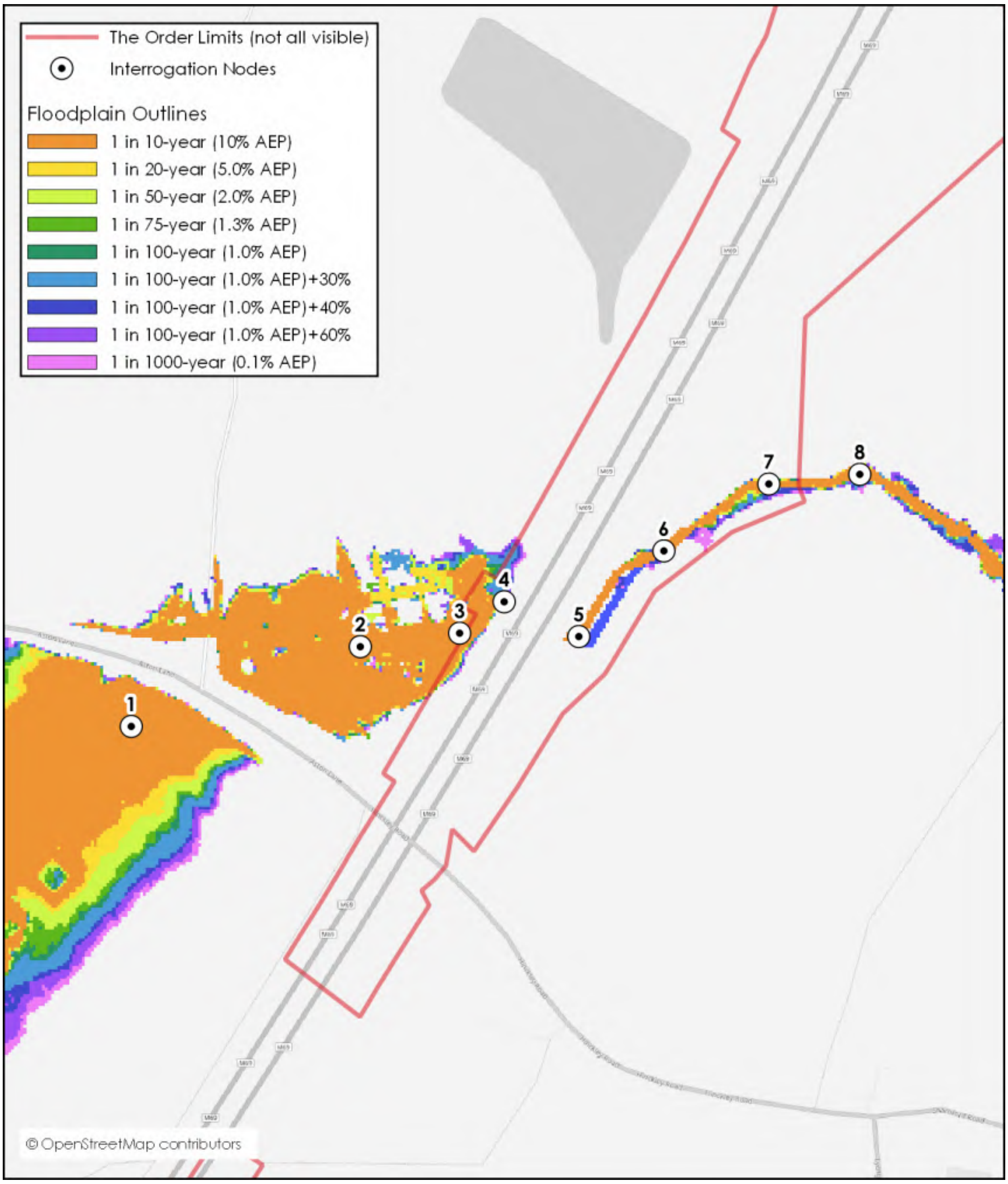


Figure 6.2: Baseline Floodplain - Development Overview

6.4 Peak flood levels from the locations illustrated in **Figure 6.2** are presented within **Table 6.1**.

Table 6.1: Modelled Peak Flood Levels

Return Period (Yrs)	Flood Levels (m AOD) at Interrogation Point							
	1	2	3	4	5	6	7	8
1 in 10	97.37	97.18	96.99	96.51	96.40	96.35	96.22	96.10
1 in 20	97.43	97.19	97.01	96.57	96.46	96.40	96.27	96.14
1 in 50	97.51	97.20	97.02	96.64	96.52	96.46	96.32	96.18
1 in 75	97.54	97.20	97.02	96.66	96.55	96.49	96.34	96.20
1 in 100	97.57	97.20	97.03	96.68	96.57	96.50	96.36	96.22
1 in 100+30	97.67	97.21	97.05	96.75	96.63	96.57	96.41	96.28
1 in 100+40	97.70	97.22	97.06	96.78	96.67	96.61	96.45	96.33
1 in 100+60	97.75	97.22	97.07	96.81	96.70	96.63	96.47	96.35
1 in 1000	97.80	97.22	97.08	96.83	96.72	96.65	96.49	96.37

7. SENSITIVITY TESTING

7.1 To account for seasonal variations in vegetation, uncertainty of key hydraulic parameters, and the residual risk of blockages at hydraulic structures, a series of sensitivity tests were conducted using the 1 in 100-year flood return period event.

7.2 The difference in peak water levels and floodplain extents between the tests and the original 1 in 100-year event are compared within the following section. The change in peak flood level for each location shown in **Figure 6.2** is provided within **Table 7.1**.

Table 7.1: Sensitivity Test Flood Level Comparison (1 in 100-Year Return Period Event)

Scenario		Flood Levels (m AOD) at Interrogation Point							
		1	2	3	4	5	6	7	8
Baseline 1 in 100-year	Peak Flood Level (m AOD)	97.57	97.20	97.03	96.68	96.57	96.50	96.36	96.22
Flow -20%	Peak Flood Level (m AOD)	97.50	97.20	97.02	96.63	96.52	96.46	96.31	96.18
	Difference (m)	-0.07	-0.01	-0.01	-0.06	-0.05	-0.05	-0.05	-0.04
Flow +20%	Peak Flood Level (m AOD)	97.64	97.21	97.04	96.72	96.61	96.54	96.40	96.26
	Difference (m)	0.07	0.01	0.01	0.04	0.04	0.04	0.04	0.05
2.5hr Storm Duration	Peak Flood Level (m AOD)	97.45	97.19	97.01	96.60	96.49	96.44	96.28	96.15
	Difference (m)	-0.12	-0.01	-0.02	-0.08	-0.07	-0.06	-0.08	-0.07
10.5hr Storm Duration	Peak Flood Level (m AOD)	97.59	97.21	97.03	96.69	96.57	96.51	96.37	96.23
	Difference (m)	0.02	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Roughness +20%	Peak Flood Level (m AOD)	97.59	97.21	97.04	96.72	96.60	96.53	96.38	96.25
	Difference (m)	0.02	0.01	0.02	0.03	0.03	0.02	0.02	0.03

Scenario		Flood Levels (m AOD) at Interrogation Point							
		1	2	3	4	5	6	7	8
Roughness - 20%	Peak Flood Level (m AOD)	97.54	97.20	97.02	96.64	96.53	96.48	96.33	96.19
	Difference (m)	-0.03	-0.01	-0.01	-0.04	-0.04	-0.03	-0.03	-0.03
Downstream Boundary +20%	Peak Flood Level (m AOD)	97.57	97.20	97.03	96.68	96.57	96.50	96.36	96.22
	Difference (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Downstream Boundary - 20%	Peak Flood Level (m AOD)	97.57	97.20	97.03	96.68	96.57	96.50	96.36	96.22
	Difference (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M69 Culvert Blockage	Peak Flood Level (m AOD)	97.57	97.21	97.03	96.74	96.57	96.50	96.36	96.22
	Difference (m)	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00

Flow Estimates

7.3 The 1 in 100-year flows were increased and decreased by 20% and compared against the baseline 1 in 100-year event to identify the extent of changes.

7.4 A comparison of peak flood levels against the original 1 in 100-year results confirms that a larger flood flow will return greater peak flood levels in the site and surrounding area (see **Figure 7.1**). Upstream of Aston Lane flood levels are increased by up to 0.07m, upstream of the M69 flood levels are increased by up to 0.04m, and downstream of the M69 flood levels are increased by up to 0.05m.

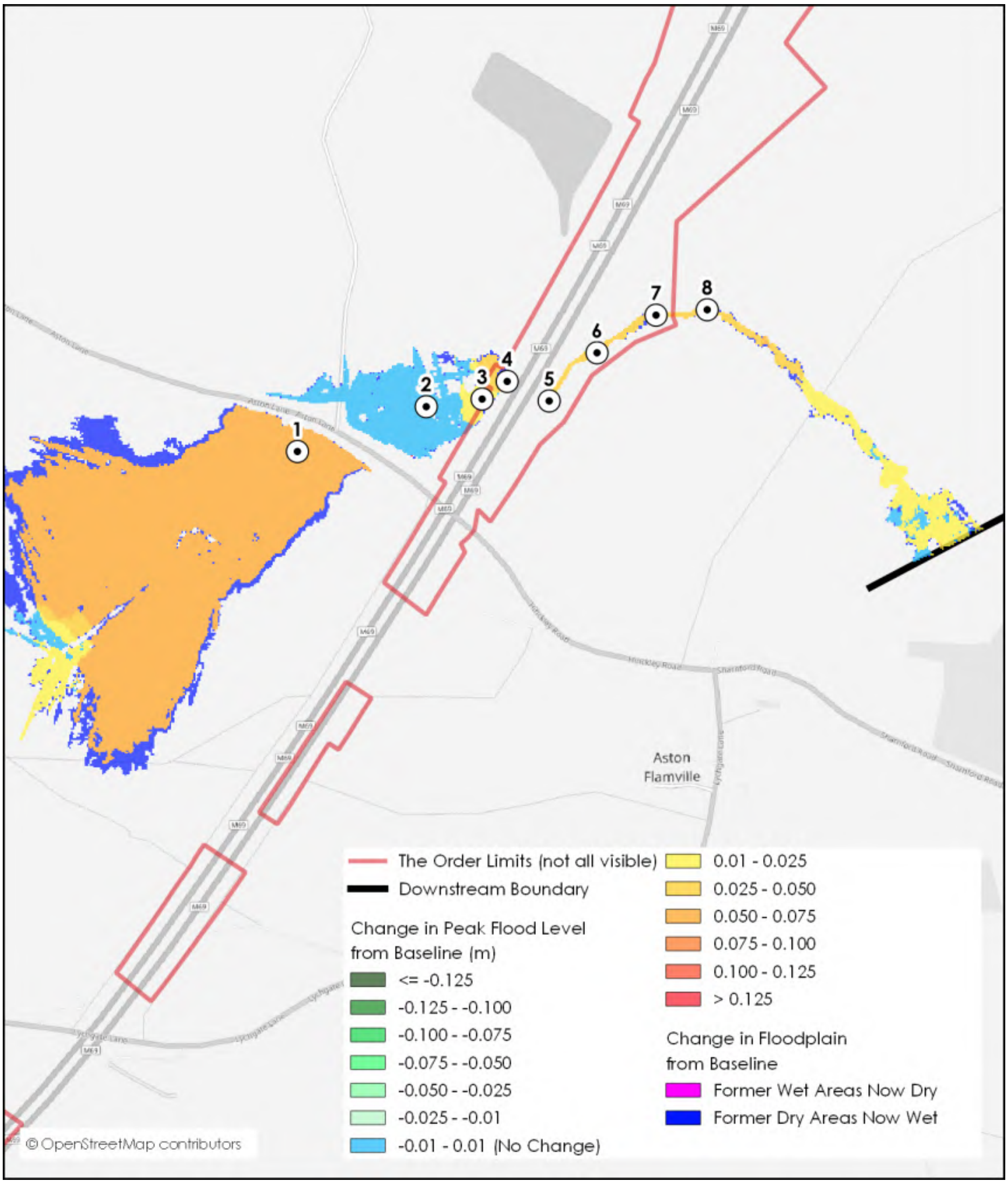


Figure 7.1: Sensitivity Test - Flow +20%

7.5 A comparison of peak flood levels against the original 1 in 100-year results confirms that a lower flood flow will return lower peak flood levels in the site and surrounding area (see **Figure 7.2**). Upstream of Aston Lane flood levels are reduced by up to 0.07m, upstream of the M69 flood levels are reduced by up to 0.06m, and downstream of the M69 flood levels are reduced by up to 0.05m.

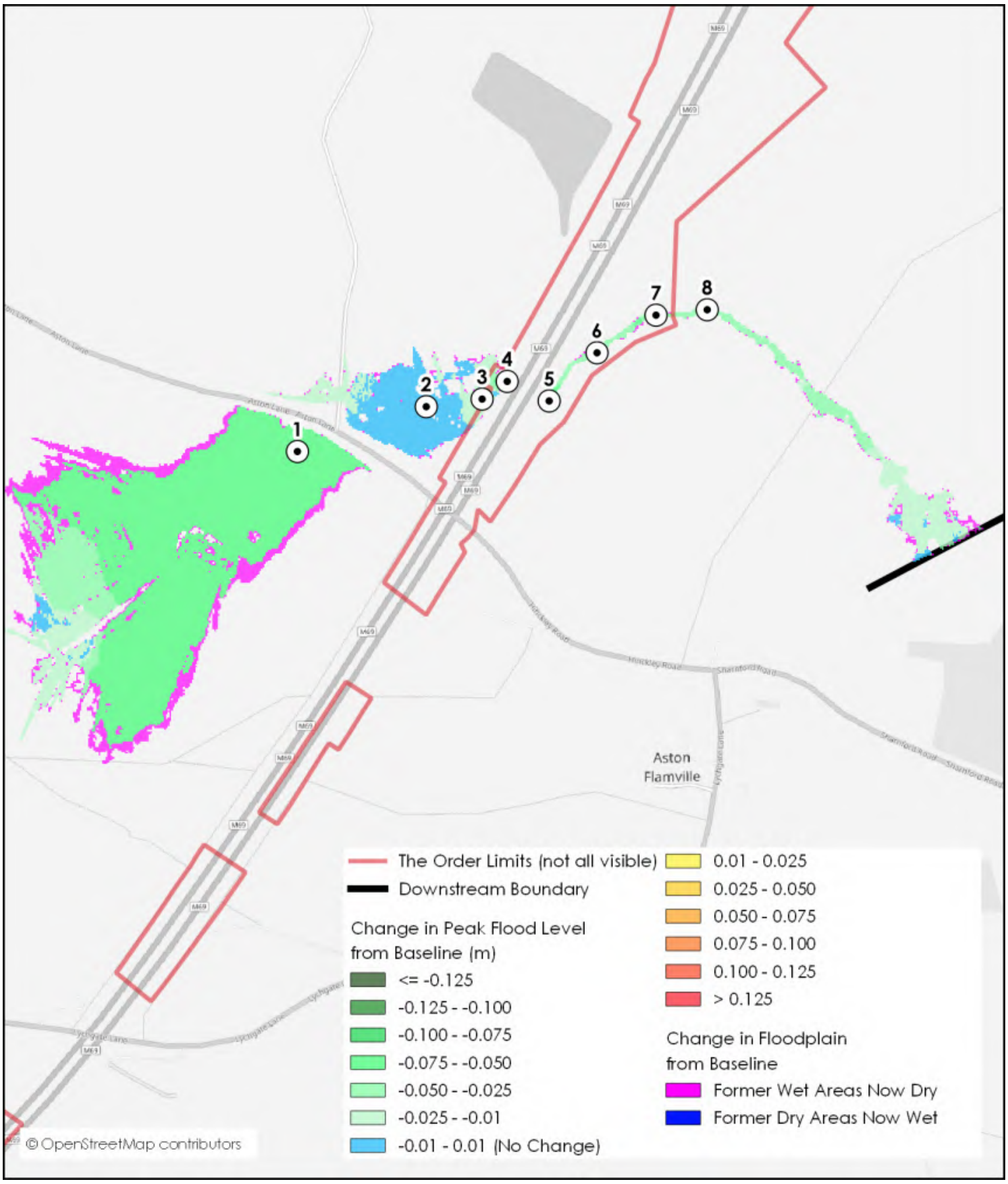


Figure 7.2: Sensitivity Test - Flow -20%

Storm Duration

7.6 The adopted storm duration (6.5-hours) was altered to understand the floodplains sensitivity to shorter (2.5-hour) and longer (10.5-hour) duration events.

7.7 The comparison in **Figure 7.3** identifies that a shorter 2.5-hour duration storm results in lower peak flood levels within the site and surrounding area. Upstream of Aston Lane flood levels are reduced by up to 0.12m, upstream of the M69 flood levels are reduced by up to 0.08m, and downstream of the M69 flood levels are reduced by up to 0.08m. These reductions are brought about by the lower flows and volumes generated by the shorter duration storm.

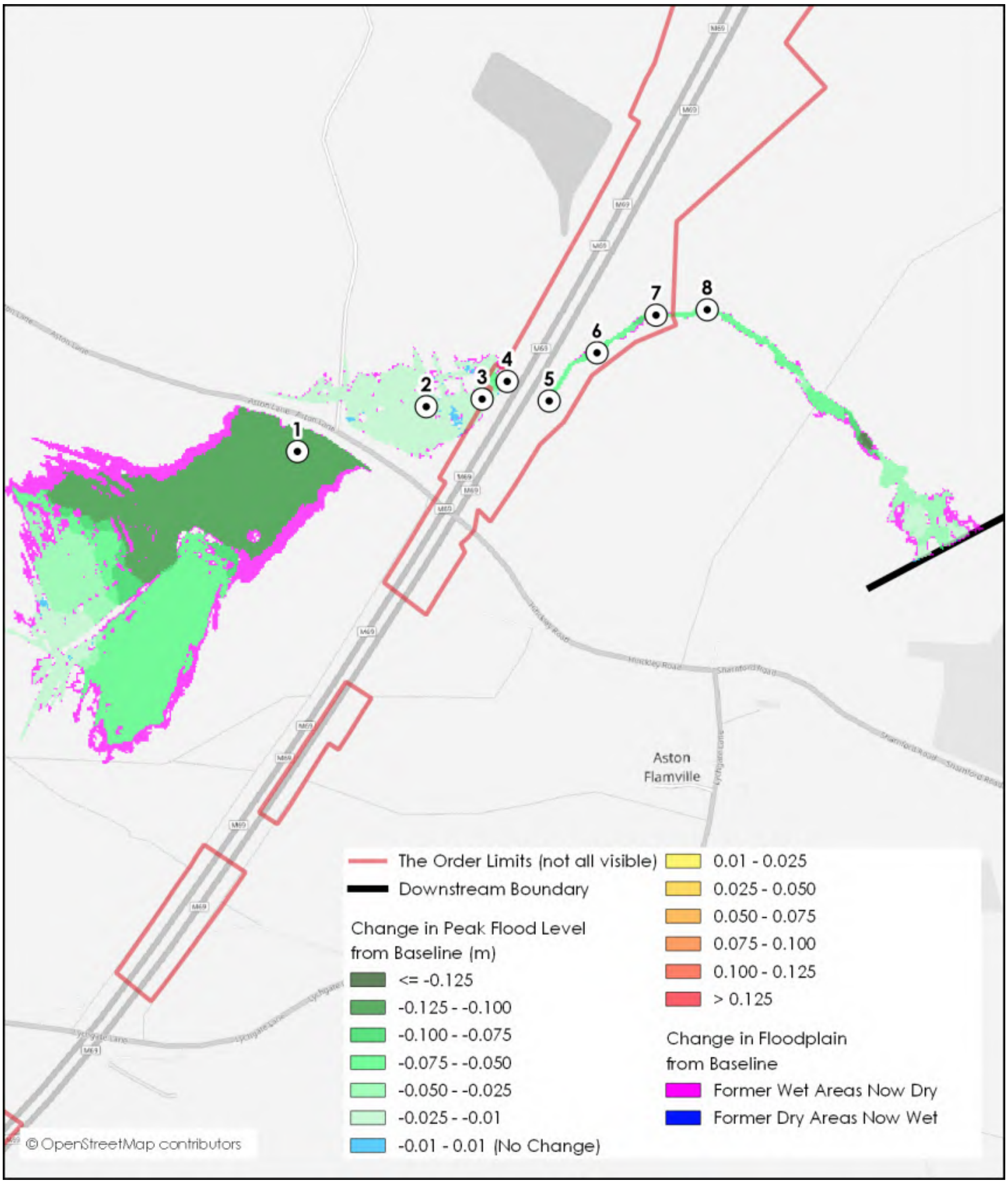


Figure 7.3: Sensitivity Test – Shorter Storm Duration (2.5hr)

7.8 The comparison in **Figure 7.4** identifies that a longer 10.5-hour duration storm results in slightly greater flood levels in the surrounding area, but that there is no significant change at the area of interest. Upstream of Aston Lane flood levels are increased by up to 0.02m, this is due to the increased volume of runoff of the longer duration event. Next to the M69 flood levels are increased nominally by up to 0.01m, this shows that these areas are less influenced by changes in flood volume.

7.9 These findings provide confidence to the adopted 6.5-hour duration event being appropriate for the study.

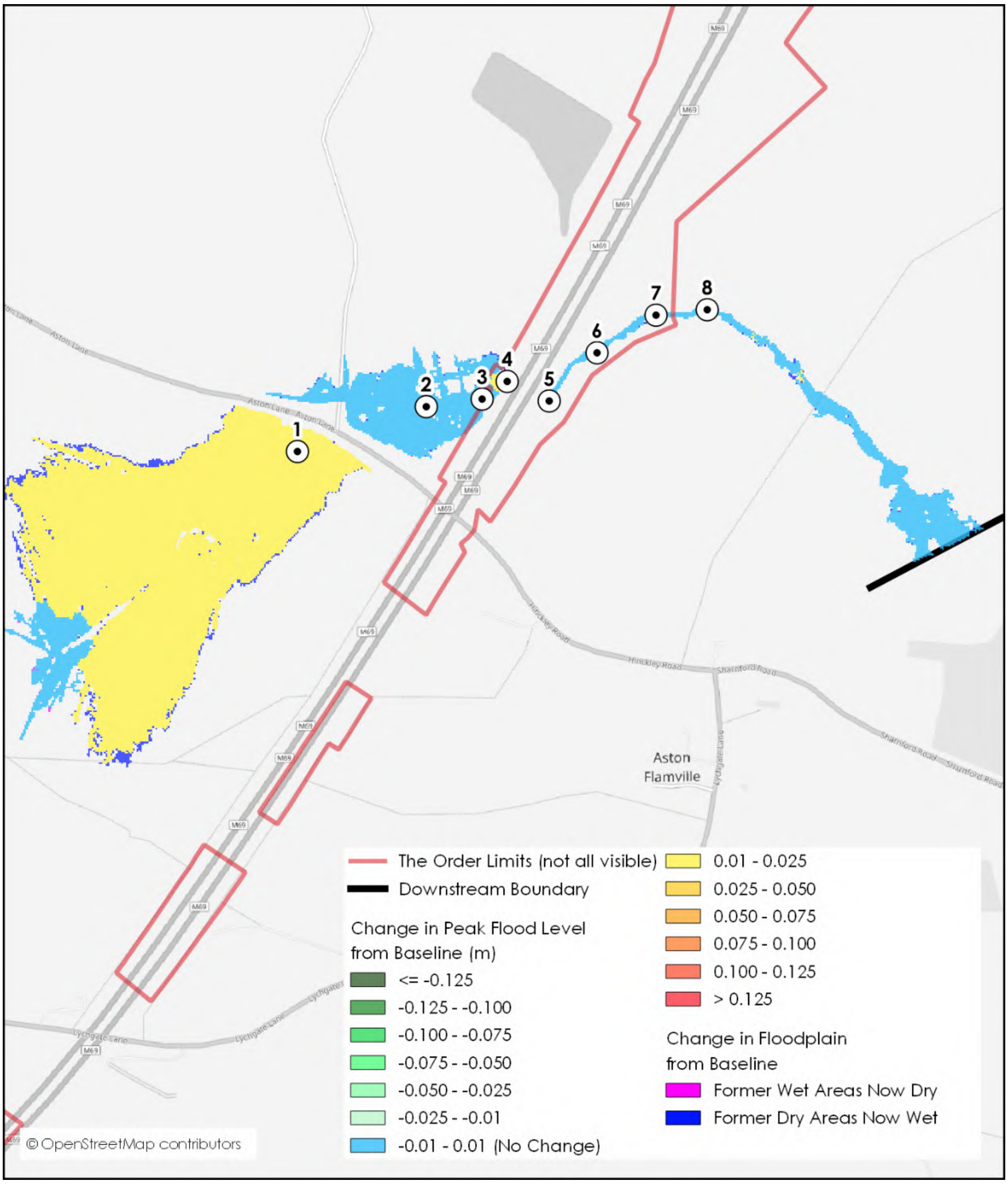


Figure 7.4: Sensitivity Test – Longer Storm Duration (10.5hr)

Roughness

7.10 The modelling has shown that a 20% reduction in channel and floodplain roughness (representative of winter seasonal conditions or channel conditions following maintenance) results in a general decrease in flood levels. Upstream of Aston Lane flood levels are reduced by up to 0.03m, upstream of the M69 flood levels are reduced by up to 0.04m, and downstream of the M69 flood levels are reduced by up to 0.04m – this is illustrated within **Figure 7.5**.

7.11 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.

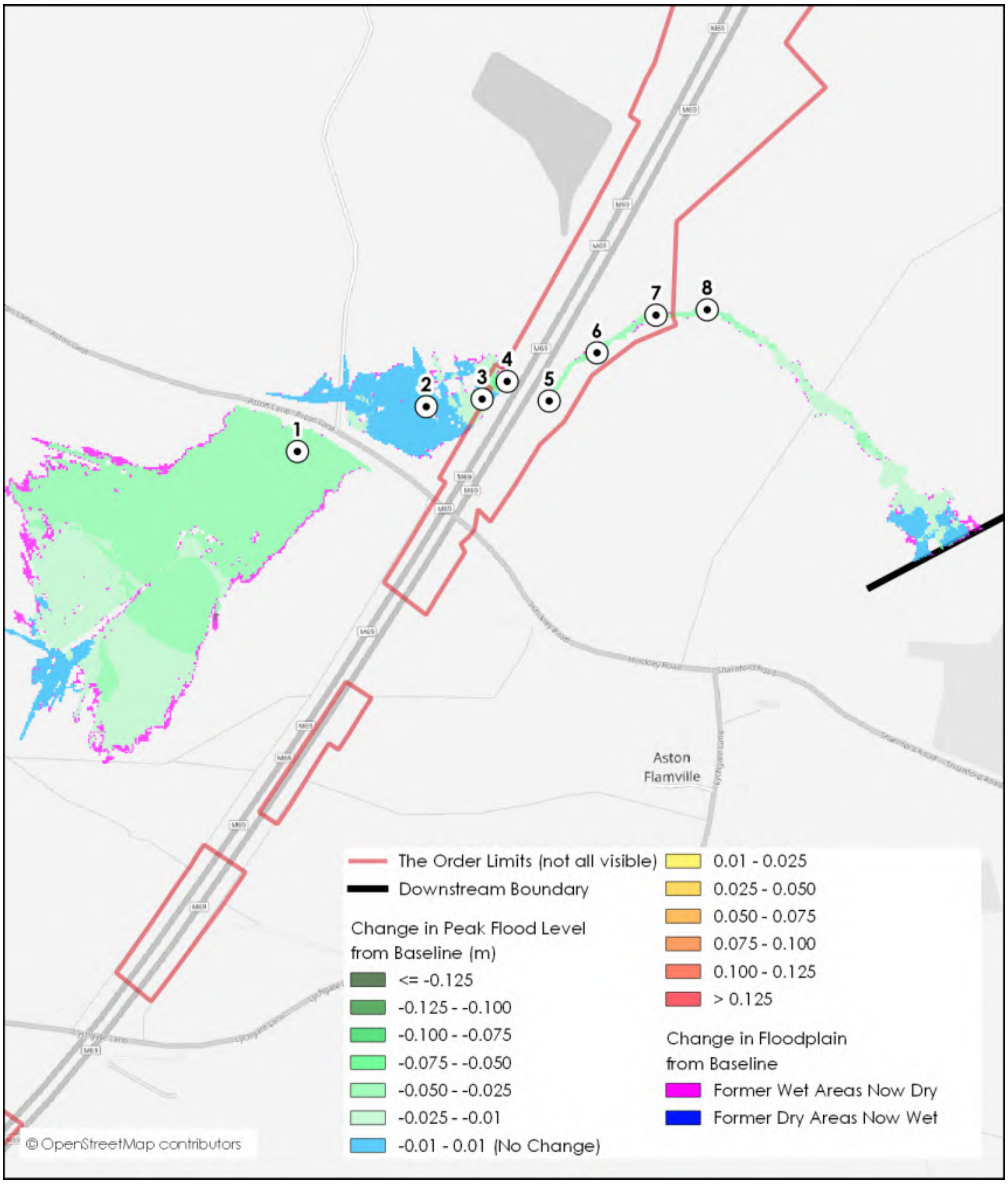


Figure 7.5: Sensitivity Test - Roughness -20%

7.12 Conversely, a 20% increase in Manning's 'n' (representative of summer seasonal conditions, and a period without maintenance) is shown to result in a general increase in flood levels. Upstream of Aston Lane flood levels are increased by up to 0.02m, upstream of the M69 flood levels are increased by up to 0.03m, and downstream of the M69 flood levels are increased by up to 0.03m – this is illustrated within **Figure 7.6**.

7.13 This is to be expected given that an increase in roughness values across the floodplain would 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 'n' values would be expected to increase water levels as a rougher channel would detrimentally impact flow conveyance.

7.14 The change in flood levels brought about by variations in roughness are relatively minor (+/-0.04m). This therefore suggests that the model results can be generally considered to be robust, increasing model confidence in the design runs.

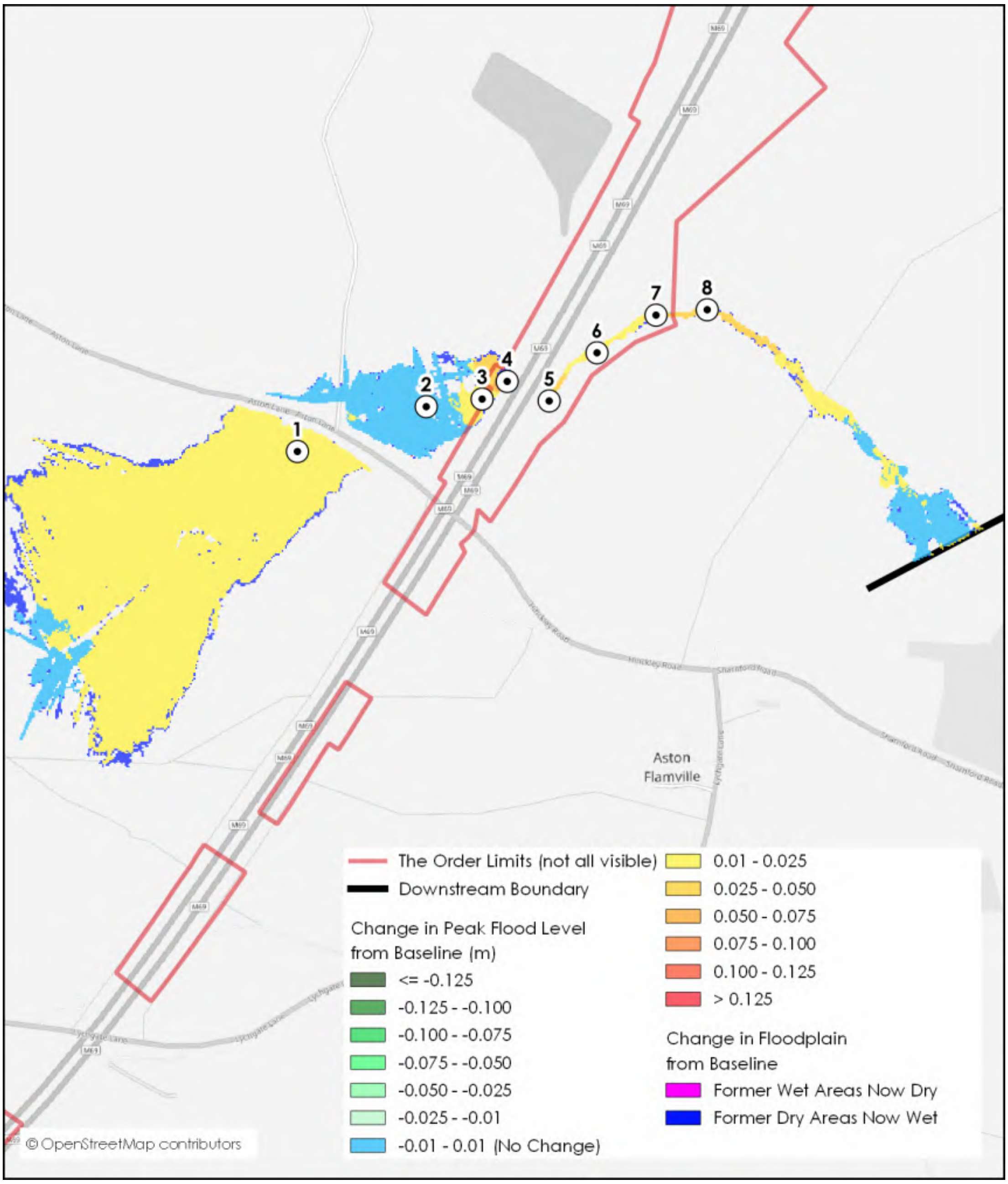


Figure 7.6: Sensitivity Test - Roughness +20%

Downstream Boundary

7.15 Variations in the downstream boundary can be used to assess if the boundary is in a suitable location as to not influence the results at the site. The downstream gradient was increased (slackened) and decreased (steepened) by 20% and compared against the baseline 1 in 100-year event to identify the extent of changes in water levels.

7.16 The comparison (see **Figure 7.7** and **Figure 7.8**) identified that both alterations had a minimal impact on flood levels. This confirms that the downstream boundary is in an appropriate location. Therefore, the model results can be generally considered to be robust to changes in downstream boundary, increasing model confidence in the design runs.

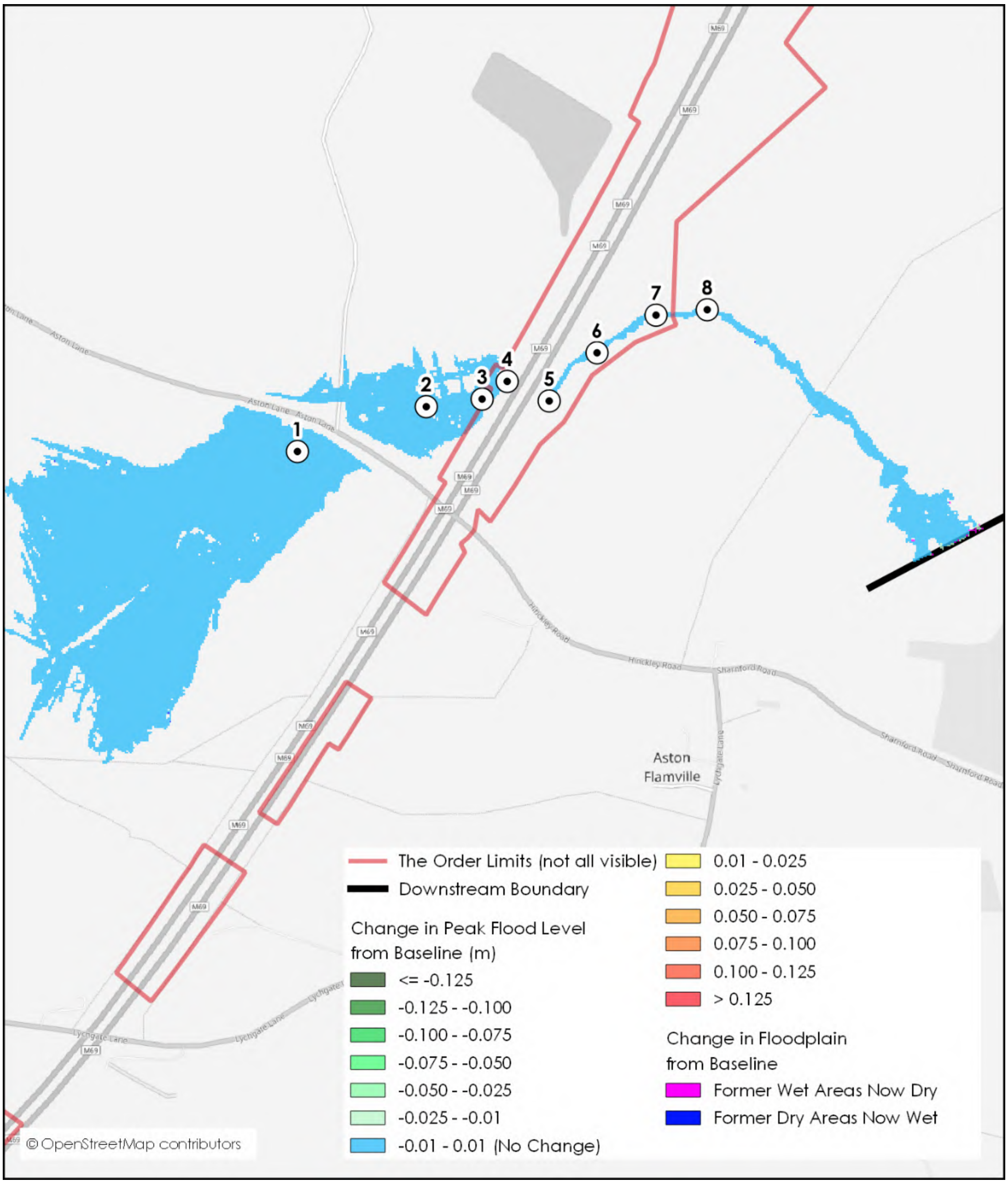


Figure 7.7: Sensitivity Test - Downstream Boundary +20%

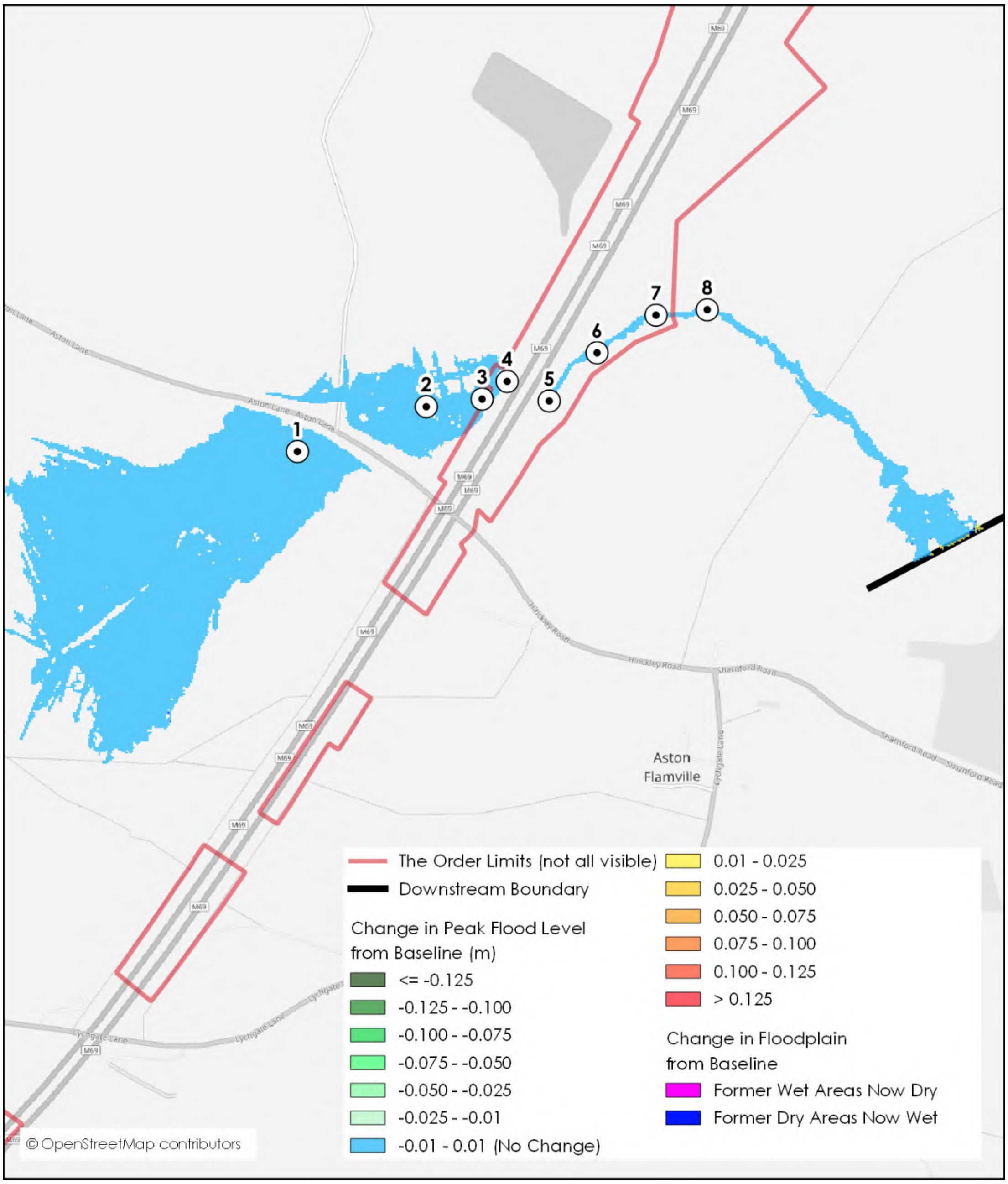


Figure 7.8: Sensitivity Test - Downstream Boundary -20%

Blockage Scenarios

7.17 Blockage scenarios should generally be undertaken at hydraulic structures where the potential loss in capacity could pose a residual flood risk to the site. The impact of a potential blockage can be especially detrimental where a structure passes beneath an elevated linear feature, such as Aston Lane and the M69. However, a blockage of these structures would only attenuate flood water upstream of the site. To demonstrate this, a single blockage scenario was undertaken on the M69 culvert.

7.18 The M69 culvert was estimated as a 1.7m diameter culvert; and 50% blockage was applied. This resulted in a 0.06m increase in flood levels upstream of the M69. Flood levels elsewhere were unaffected – this is illustrated within **Figure 7.9**.

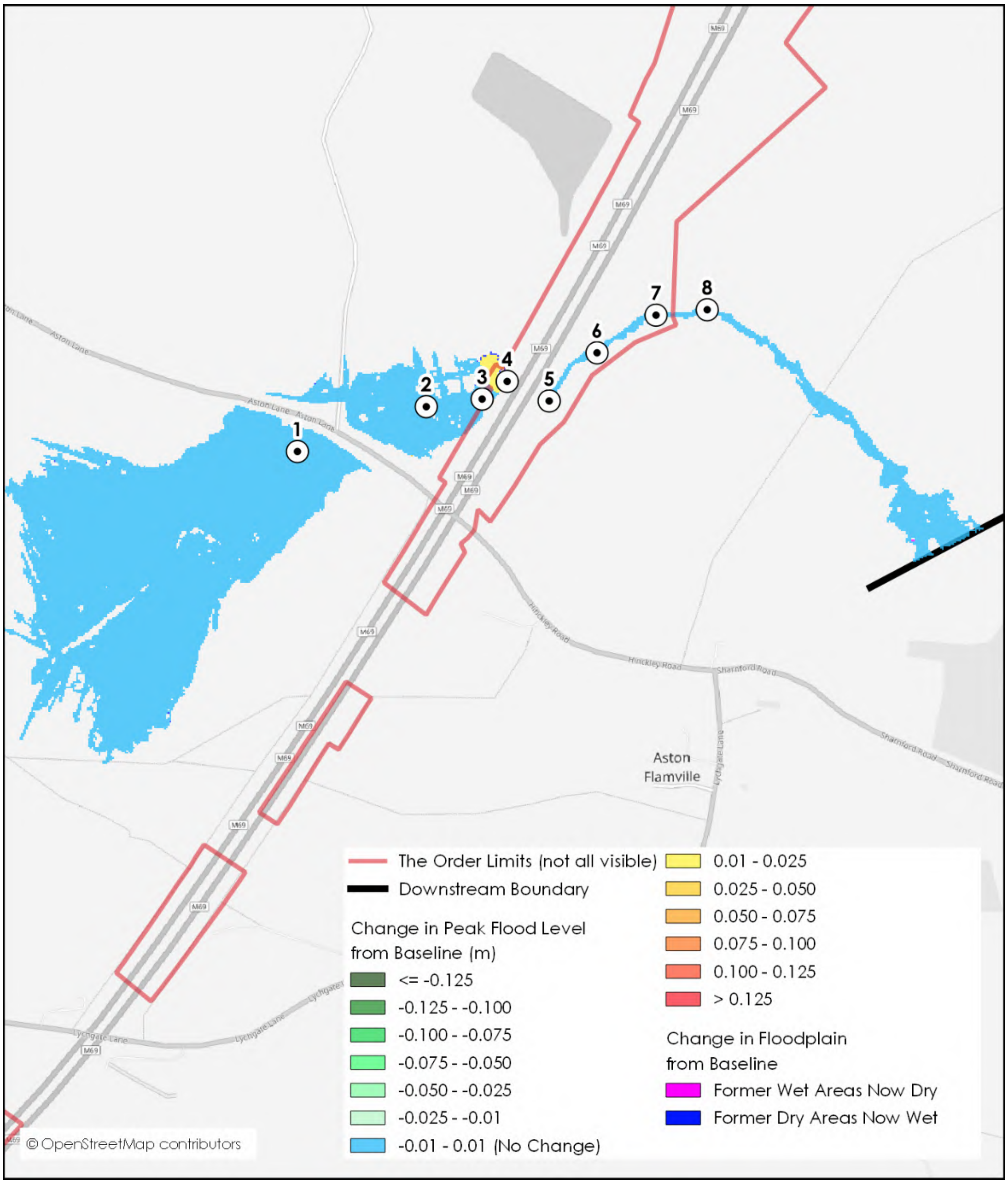


Figure 7.9: M69 Blockage Scenario

7.19 Given these findings, it was not considered necessary to undertake any further blockage scenarios.

8. DEVELOPMENT PROPOSALS

8.1 The following section describes the changes that were made to the baseline model to reflect the proposed development. It is envisaged that the proposals will be updated as the design progresses.

Philosophy

8.2 The majority of the development proposals are significantly removed from the Soar Brook. However, to accommodate the new slip roads at Junction 2 of the M69, it is necessary to widen the carriageway over watercourse.

8.3 At this stage of the project, it is expected that the embankment on the northern side will need to be widened by approximately 2 to 3m, and the inlet of the M69 culvert extended a similar distance upstream.

8.4 It is expected that the carriageway on the downstream side of the M69 will need to be widened by approximately 5m, which requires the channel which runs on the toe of the existing embankment to be relocated further south. The outlet of the M69 culvert will also need to be extended a similar distance downstream. As the floodplain is generally contained within the channel in this location, it is proposed to relocate the current channel geometry approximately 6m further south. This will preserve the current hydraulic regime minimising any impacts on flood risk in the wider area.

Hydrological Representation

8.5 No changes to the model hydrology were necessary.

Hydraulic Model Representation

8.6 A 'Z-Shape' following the outline of the widened carriageway was added to the model, this raised ground levels to the height of the current carriageway. This is a worst-case representation as it ignores the batter that would be present on the embankment.

8.7 The existing channel to the south of the M69 was relocated to fall outside of the new embankment's positions, and the M69 culvert was extended to meet its new location.

8.8 The upstream channel was also shortened, and the M69 culvert extended here to accommodate the wider embankment.

Results

8.9 A selection of events between the 1 in 10-year to the 1 in 1000-year, including the 1 in 100-year +30%, +40%, +60%, and the 1 in 1000-year floodplain were simulated to demonstrate that the widened carriageway would be at a low risk of flooding from the Soar Brook.

8.10 The results from the post development model are summarised within **Figure 8.1**.

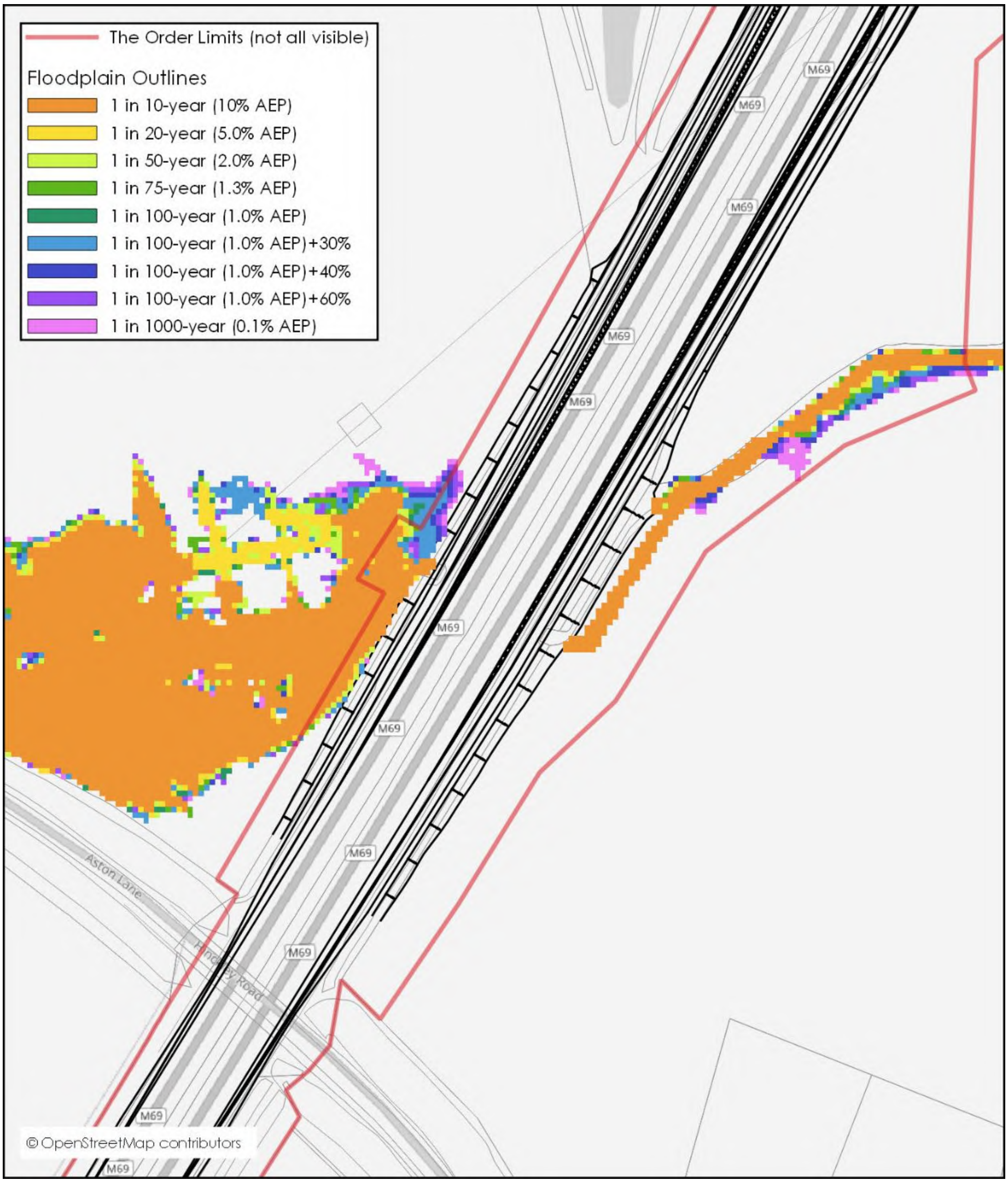


Figure 8.1: Post-Development Model Predicted Floodplain Outlines

Comparative Analysis

8.11 The post-development flood levels and the baseline flood levels at the equivalent return period event were compared to identify potential impacts on flood risk. The mapped analysis is included in **Figure 8.2** to **Figure 8.7**.

8.12 The analysis predicts that there will be a minor upstream betterment, due to the improved conveyance offered by replacing a short length of channel with the extended culvert. No significant upstream detrimental impact was predicted. Additionally, no detrimental impact was predicted downstream of the M69, as flood flows are contained within the relocated channel.

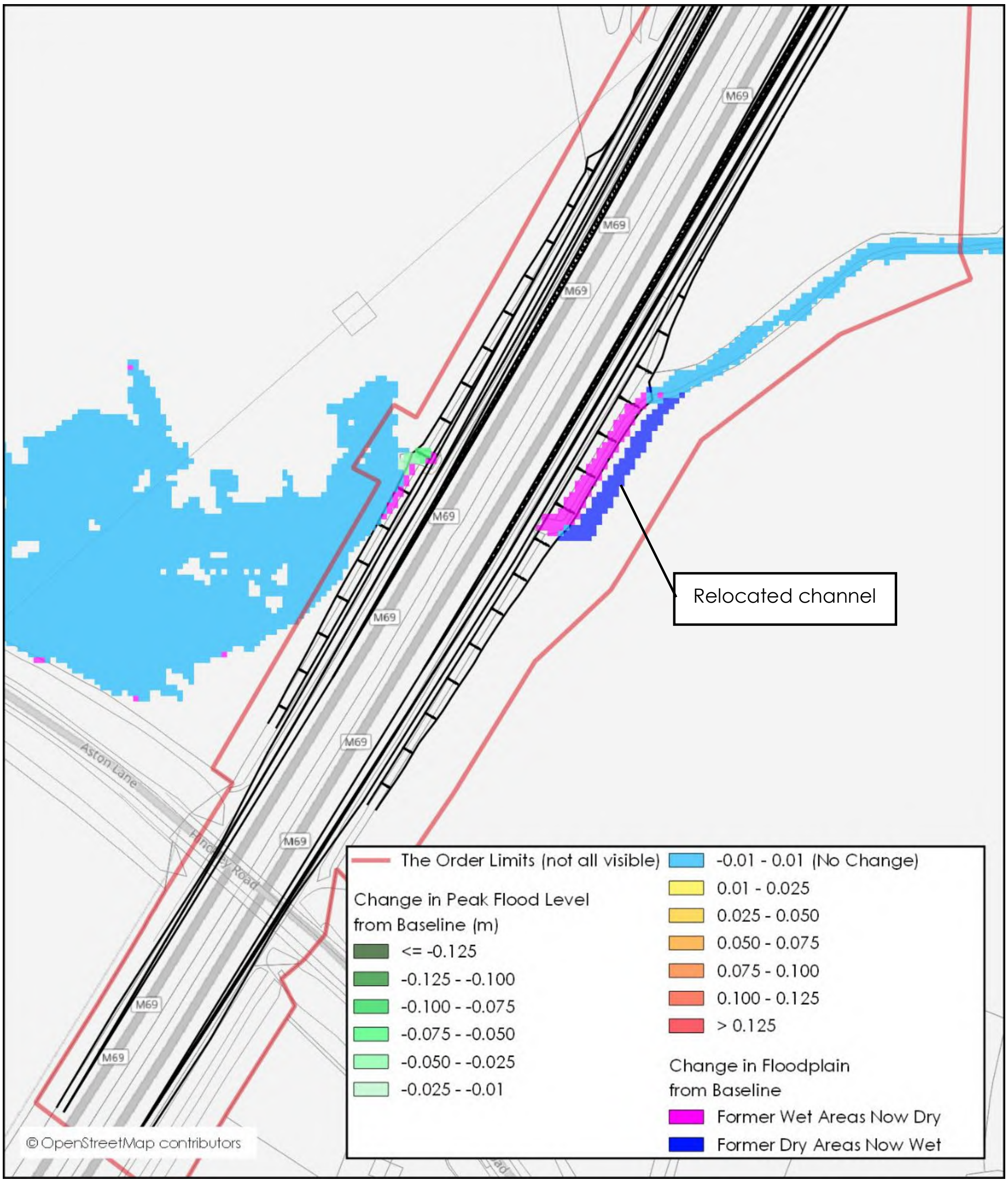


Figure 8.2: Impact of the Development on the Floodplain - 1 in 10-year (10% AEP)

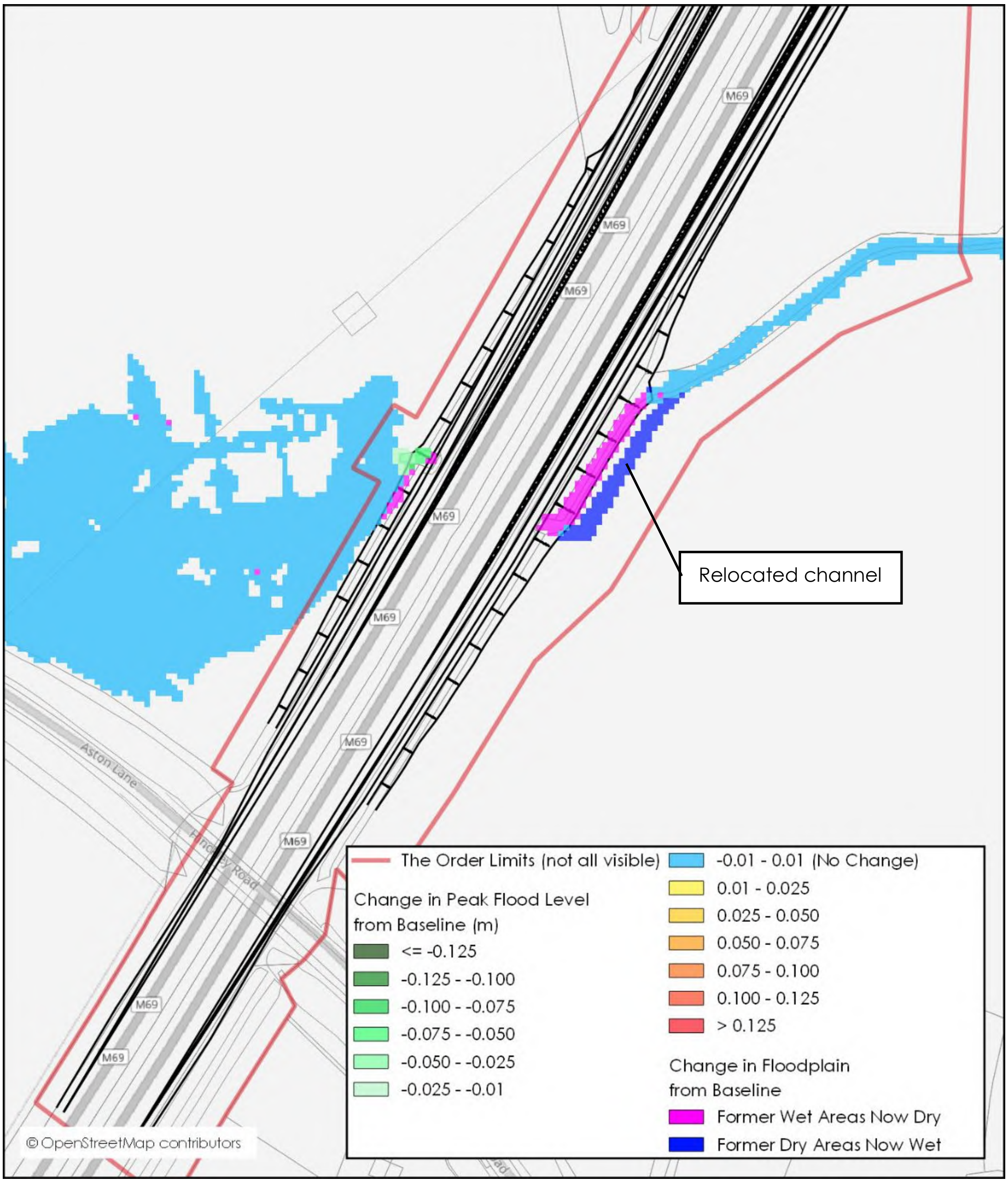


Figure 8.3: Impact of the Development on the Floodplain - 1 in 20-year (5.0% AEP)

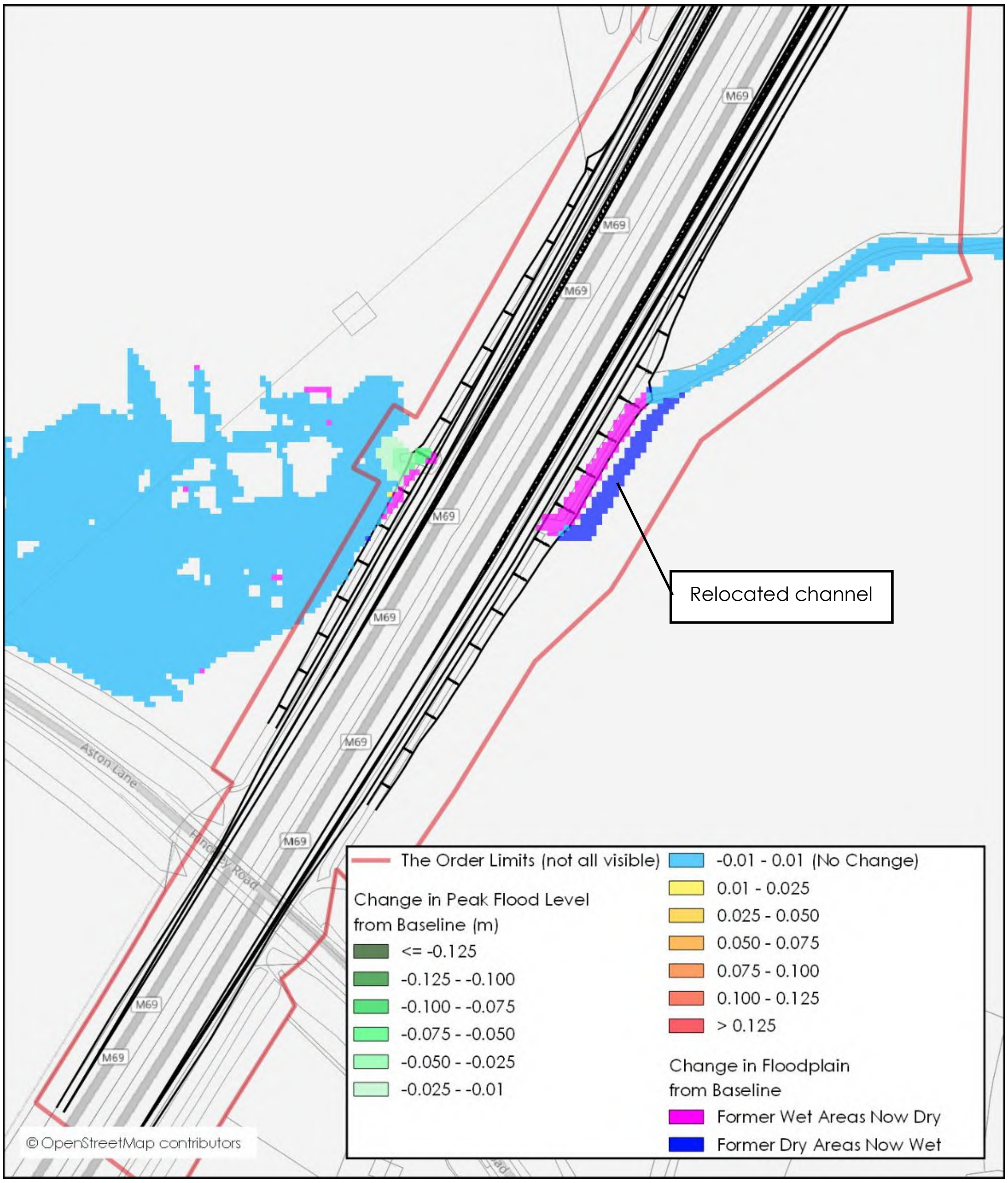


Figure 8.4: Impact of the Development on the Floodplain - 1 in 50-year (2.0% AEP)

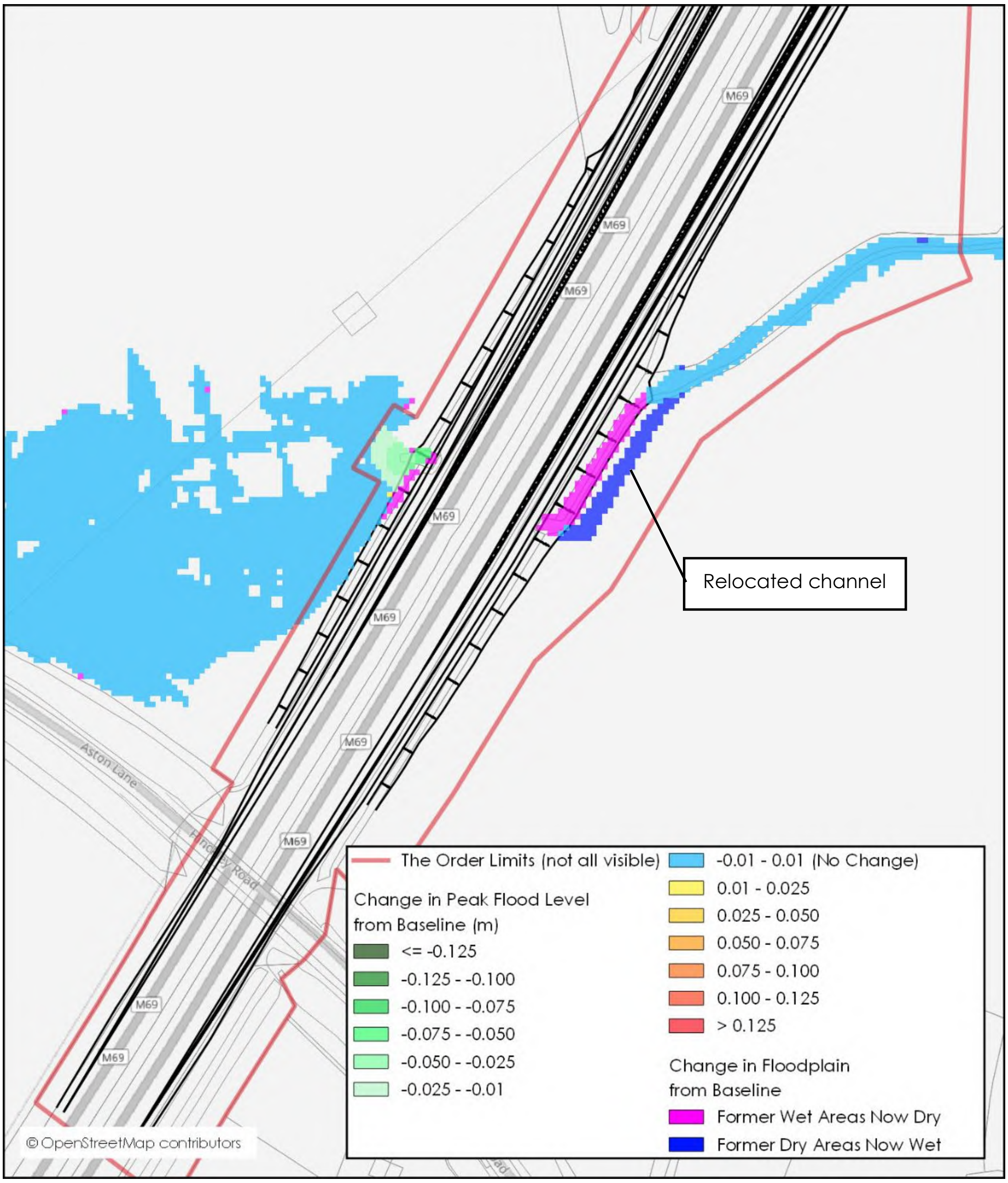


Figure 8.5: Impact of the Development on the Floodplain - 1 in 75-year (1.3% AEP)

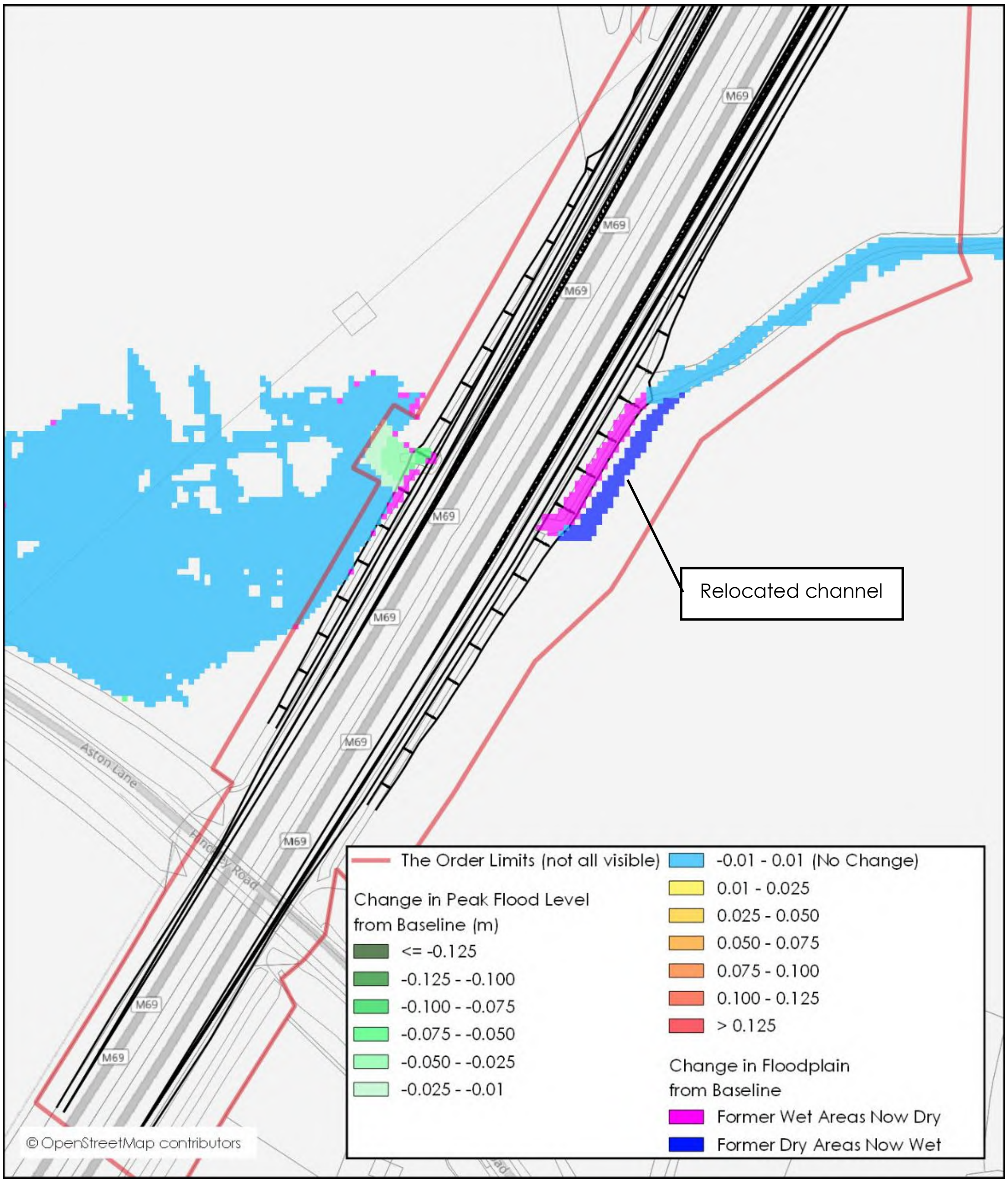


Figure 8.6: Impact of the Development on the Floodplain - 1 in 100-year (1.0% AEP)

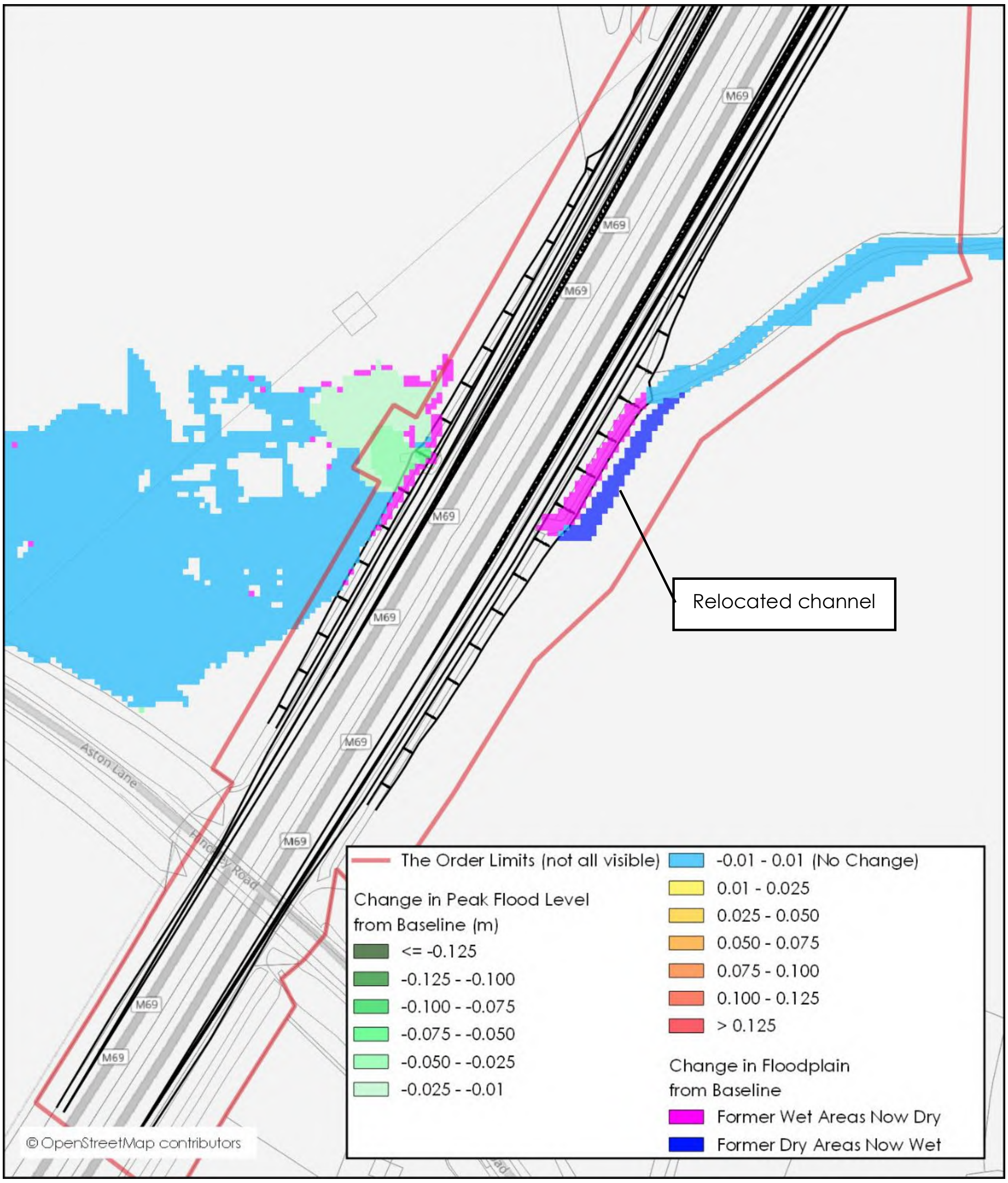


Figure 8.7: Impact of the Development on the Floodplain - 1 in 100-year (1.0% AEP) +30%

9. SUMMARY, RECOMMENDATIONS & LIMITATIONS

9.1 The primary aim of this modelling exercise was to establish a good hydraulic representation of the Soar Brook to demonstrate that it would not pose a flood risk to the Proposed Scheme, and that the Proposed Scheme would not cause a detrimental impact on flood risk outside of the site.

9.2 The hydraulic assessment was informed by a hydrological assessment of the likely flood flows. This was undertaken using the industry standard FEH methodologies, as there was no gauged data available within the study area.

9.3 The modelling has shown flood water can accumulate upstream of Aston Lane and the M69 where flows are restricted by culverts beneath the elevated roads. Due to the attenuation of flood water upstream of the M69, the floodplain downstream of the M69 largely remains with channel through the site.

9.4 A number of sensitivity tests have been undertaken within the model on key assumptions. These tests have identified that the model results are not very sensitive to changes in roughness, flow, and blockages of key structures, increasing confidence in the modelling undertaken. The sensitivity tests confirmed that an appropriate storm duration has been adopted.

9.5 The proposed carriageway widening of the M69, and the Soar Brook channel relocation on the downstream side of the M69, have been tested in the model. This has confirmed that the widened carriageway would be at a low risk of flooding from the Soar Brook.

9.6 A comparison against baseline floodplain conditions has shown that proposed works would have no significant detrimental impact on flood risk within the DCO Site or in the wider area.

Limitations

9.7 Access to all of the watercourse was denied by the landowner, so the model has adopted a largely 2D approach outside of the site. However, key structures and the channel within the site were modelled using topographical survey and hand measurements taken during a site visit.

9.8 The modelling exercise has made use of the available data at the time of construction and simulation.

9.9 The model contains no formal representation of the conveyance within watercourses or ditches other than that captured by the model grid.

9.10 As no hydrometric data or recorded flood levels were available, the model has not been verified or calibrated. However, a conservative approach to the model build has been adopted where appropriate, and a range of sensitivity tests have been undertaken to help to compensate for this limitation.

9.11 The 2.0m resolution of the model may negate any small scale topographic features, although all the significant features are believed to have been captured.

9.12 The baseline floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.05 - 0.15m). However, this is considered to be sufficient for the purpose of this exercise, it has also been supplemented with topographical surveys where coverage allows.

9.13 The bare earth DTM does not include for the presence of minor walls or other structures. Buildings have been modelled at ground level with an elevated roughness level.

9.14 This 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.

APPENDICES

Appendix 1: Hydrological Assessment

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd

Hinckley National Rail Freight Interchange

Leicestershire

Flow Estimation Record – Soar Brook

[redacted]

BWB

ENVIRONMENT

Tritax Symmetry (Hinckley) Ltd
Hinckley National Rail Freight Interchange Leicestershire
Flow Estimation Record – Soar Brook

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

October 2021

DOCUMENT ISSUE RECORD

Document Number:	HNRFI-BWB-ZZ-XX-RP-YE-0009_FER
BWB Reference:	NTT-2814-FER

Revision	Date of Issue	Status	Author:	Checked:	Approved:
1	22/10/2021	S2	Claire Gardner BSc (Hons) MSc MCIWEM C.WEM	Robin Green BSc (Hons)	Max Brambani BSc (Hons) PgCert MCIWEM

Notice

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after: -

(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 October 2021 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.

CONTENTS

1. METHOD STATEMENT

Overview of requirements

1.1 Flow estimates are required for input into a hydraulic model of a tributary of the Soar Brook to support development of the Hinckley National Rail Freight Interchange. The model is required to assess flood risk at Junction 2 of the M69, where junction improvements are proposed.

1.2 The location of the site of interest and the watercourse to be modelled are provided in **Figure 1.1.** The Soar Brook Tributary is a tributary of the Soar Brook which, in turn, is a tributary of the River Soar.

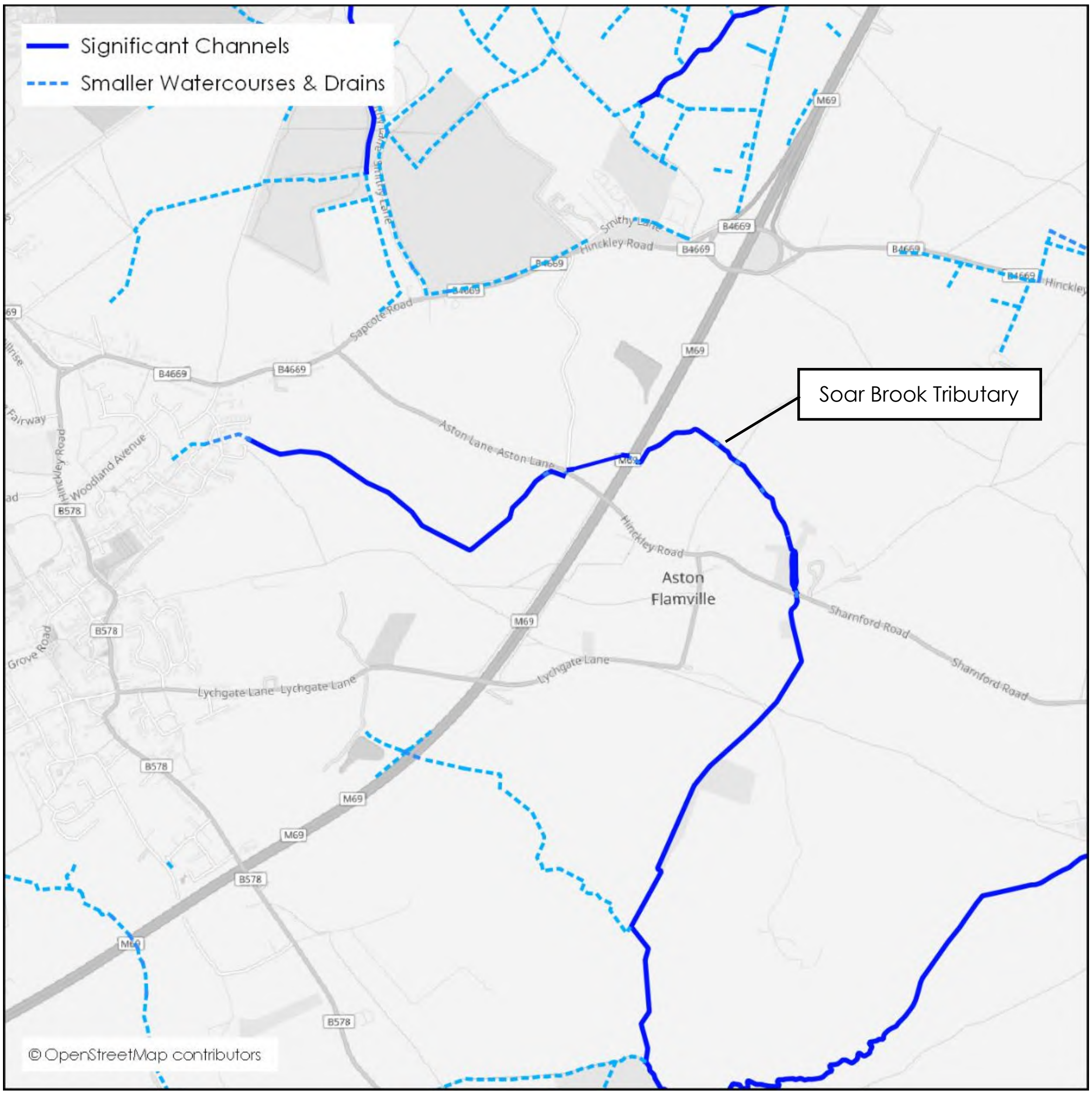


Figure 1.1: Site Location Plan

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 July 2021.

Available hydrometric data

1.5 There are no hydrometric gauges within the study catchment. 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.

1.6 During consultation with the Environment Agency, a gauge on the River Soar at Littlethorpe, was suggested as a possible source of local data that could be used within the assessment.

1.7 The Littlethorpe gauge is located on a different watercourse to the study watercourse. As such, whilst the gauge can be used as part of the Statistical analysis for donor adjustment of QMED, its use for calibration and verification is limited.

1.8 **Table 1.1** and **Table 1.2** provide details on the Littlethorpe gauge. A detailed review of the data quality at the Littlethorpe gauge, beyond a review of the information on the NRFA website, was outside the scope of this assessment.

Table 1.1: Hydrometric gauges within the Study Catchment

Watercourse	Station Name	NRFA number	Grid Reference	Catchment Area (km²)	Type	Period of Record
River Soar	Littlethorpe	28082	SP542973	183.9	Cross-correlation	08/1971 - present

Table 1.2: Gauging Station Data Availability and Quality

Station Name	Period of data in Peak Flow dataset	Suitable for QMED?	Suitable for Pooling?	Comments on station and data quality
Littlethorpe	1981 - 2019	Yes	Yes	Flood relief channel joins on the right bank just upstream. Bypassed at high flows above 2.4 m above gauge datum. During electromagnetic gauged data record, a rating was used to derive flows above 2.3m when instrumentation underestimated. Prone to weed growth.

1.9 The National River Flow Archive (NRFA) Peak Flow Dataset Version 9 will also be utilised in this assessment for the purposes of identifying any potential donor stations and for the development of pooling groups. This is the latest version of the dataset at the time of assessment.

Initial choice of approach

Table 1.3: Method statement

Is FEH appropriate?	Yes. The study catchment is greater than 0.5km^2, is not considered to be highly permeable (BFIHOST is less than 0.75), and there is no significant reservoir attenuation (FARL>0.9). Catchment is considered to be moderately urbanised (URBEXT2000<0.15).
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 before choosing the final method.
Software to be used	WINFAP v4 and ReFH2 version 2.3

2. LOCATIONS WHERE FLOOD ESTIMATES ARE REQUIRED

Location of Flow Estimates

2.1 A flow estimation point has been taken at the downstream extent of the model and the resulting flows will be applied to the model by pro-rating the hydrograph based on catchment area upstream and downstream of the M69, which forms a break within the catchment. This is considered appropriate given the small size of the study catchment and short reach of the watercourse to be modelled. It also avoids the need to derive intervening catchments which would otherwise introduce additional uncertainty to the assessment.

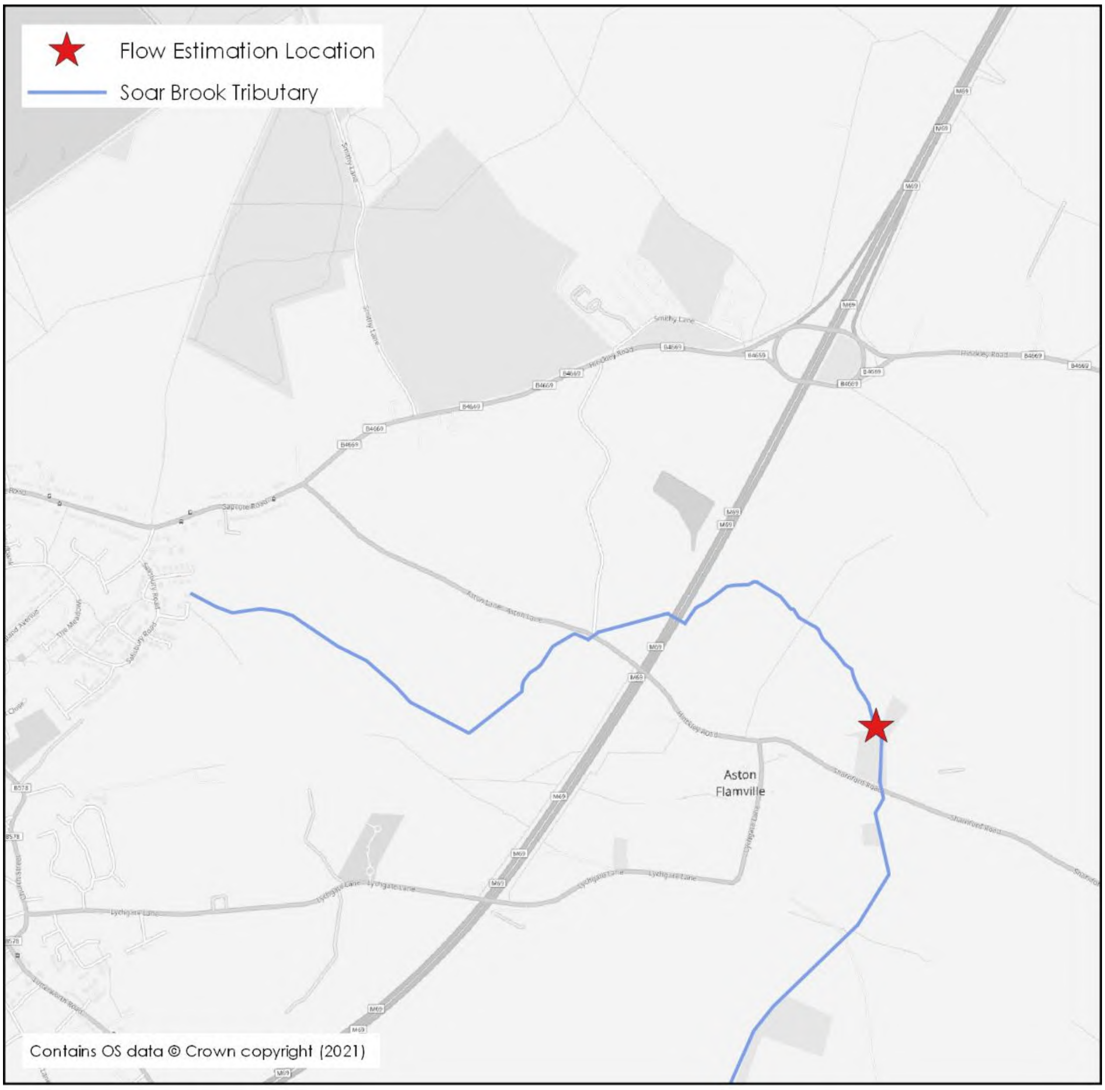


Figure 2.1: Flow Estimation Locations

Table 2.1: Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Area on FEH Web Service (km²)	Revised area (if altered) (km²)
SBTrib	Soar Brook Tributary	Upstream of Sharnford Road	446550	292850	3.1	2.9

Checking Catchment Descriptors

Table 2.2: Catchment Descriptor Checks

Record how catchment boundary was checked and describe any changes.	The catchment boundary for the flow estimation point was identified by the FEH Web Service. The boundary was reviewed using EA LIDAR and photogrammetry DTM data. A watershed analysis was undertaken using the DTM data and the results compared to the FEH boundary. Results were also compared to sewer records; the sewer catchment generally follows the topographical catchment and no significant cross-catchment transfer is expected. Surface water sewers in Burbage typically fall away to the west and south west. Following a review of the watershed analysis, the catchment boundary was updated to reflect the results. The original and amended catchment boundary is shown in **Figure 2.2**.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	British Geological Survey (BGS) mapping[1] indicates that the catchment is underlain by the Mercia Mudstone Group, with superficial deposits largely consisting of Bosworth Clay Member – clay and silt, Wolston Sand and Gravel and Oadby Member – diamicton. According to the Soilscapes website[2], the catchment is predominantly underlain by slowly permeable, seasonally wet clayey soils or loamy and clayey soilds with impeded drainage. The underlying geology and soils suggest the BFIHOST and SPRHOST values of the FEH catchment descriptors are appropriate for the catchments. DPLBAR has been updated using the standard equation for DPLBAR, given in the FEH Volume 5. Given the relatively small change in catchment area, and following a review of the urban coverage of the catchment, no changes to URBEXT were made beyond updating it for the present day.
Source of URBEXT	$URBEXT_{2000}$
Method for updating of URBEXT to present day.	CPRE formula from 2006 CEH report on $URBEXT_{2000}$

[redacted]

Table 2.3: Important catchment descriptors (changes made are highlighted in red)

Site Code	FARL	PROPWET	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR	SPRHOST	URBEXT 2000 *	FPEXT
SBTrib	0.980	0.3	0.395	1.81	21.8	641	43.52	0.1437	0.1167

* $URBEXT_{2000}$ updated to 2021

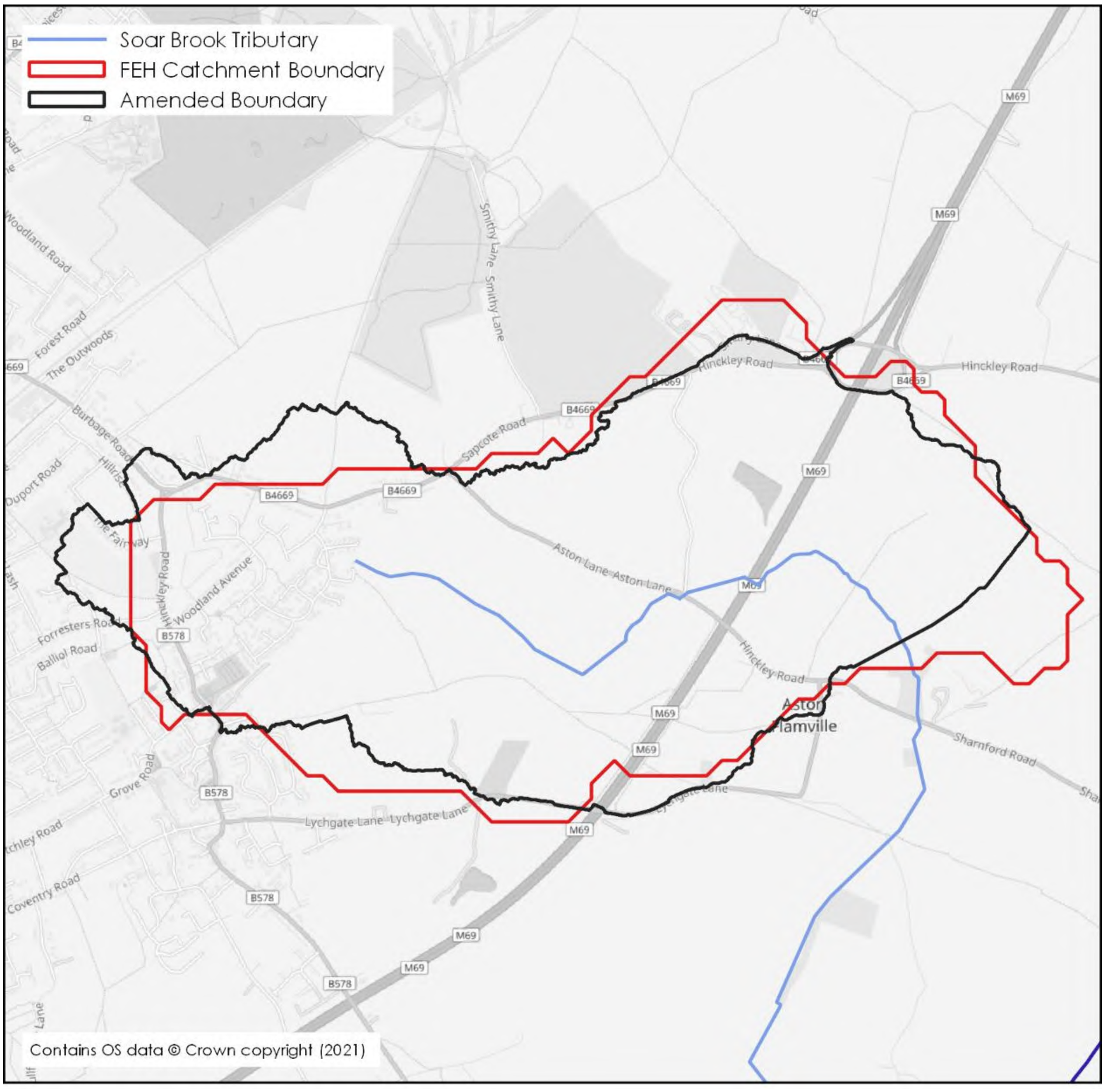


Figure 2.2: Original and Amended Catchment Boundaries

3. STATISTICAL METHOD

3.1 WINFAP version 4 was utilised to undertake a statistical analysis of the catchment using a hydrometric record of gauged catchments with similar characteristics. At the time of writing, the latest version of the NRFA Peak Flow dataset (v9) was used to provide an up-to-date hydrometric record.

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 The research underlying the revised data transfer method (SC050050) found that identification of potential donor catchments should be based on geographical closeness rather than on hydrological similarity, as defined by catchment descriptors. More recent research on small catchments (SC090031) has supported the findings of SC050050, again recommending that donors are selected purely based on proximity. The EA FEH Guidelines advises similarity in catchment descriptors is not essential for donors. However, in view of the sometimes-uncertain relationship between BFIHOST and runoff, similarity in geology or soil type may be relevant. The guidelines also advise considering more than one donor.

3.4 With the guidance in mind, a search was undertaken within WINFAP 4 for suitable donor stations for QMED data transfer. Whilst the FEH recommends avoiding urbanised donors, the Littlethorpe gauge is approximately 8km from the site and only just over the 0.03 threshold for $URBEXT_{2000}$. 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 The six nearest donors were reviewed based on similarity in BFIHOST to the subject site and data quality. Of the recommended donors, station 54111, was rejected due to concerns over data quality, particularly with early flow estimates.

3.6 None of the stations have a record of less than 14 years; therefore adjustment for climatic variation is not required.

3.7 Details for the donor stations are provided in **Table 3.1.**

Table 3.1: Donor Station Details

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28082	15.472*	19.528	0.792
54019	27.319*	34.588	0.790

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28086	21.807*	18.886	1.155
54102	12.313	13.242	0.930
31005	37.240	43.461	0.857

* As URBEXT2000 is greater than 0.03, QMED from observed data has been deurbanised.

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 (m^3/s) (URBAN)
			Donor site NRFA no	Distance between centroids d_j (km)	Weight	Final Adjustment Factor	
SBTrib	Data Transfer	0.6	28082	3.62	0.523	0.908	0.7
			54019	16.80	0.329		
			28086	19.58	0.311		
			54102	21.94	0.297		
			31005	32.18	0.242		

Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?	There are no gauges with which to check QMED estimates; however, QMED is consistent with the size and characteristics of a small, moderately urbanised catchment.
Which version of the urban adjustment was used for QMED?	Urban adjustment was applied using Kjeldsen (2010), as applied in WINFAP4.

Derivation of Pooling Groups

3.8 A pooled group of hydrologically similar gauged sites was generated by the WINFAP software for the subject sites using the 'OK for Pooling' dataset.

3.9 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.

3.10 The growth curve derived from the pooling group was also adjusted to reflect the urban influence using the methods adopted in WINFAP4 which is based on those published by Kjeldsen 2010[3].

3.11 Further detail on pooling group composition is provided in **Section 6.**

[3] 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 3.3: 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)
SBTrib_PG	SBTrib	No	**Stations Removed:** 49005 - low kurtosis compared to rest of the sites within the group, dissimilar seasonality and just 9-years' worth of data. 106002 – located on Isle of Harris and therefore likely to be subject to differing flood generating characteristics to the subject site. 44008 – highly permeable catchment with non-flood years accounting for >15% of the record. **Stations Added:** 91802 and 54022 – added to give 500 years of data **Comments:** Final pooling group is acceptably homogeneous and a review of the pooling group is not required.	L-CV: 0.227 L-Skew: 0.269

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
SBTrib	Pooled	SBTrib_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for most UK catchments	Urban adjustment using methods adopted in WINFAP which is based on those published by Kjeldsen 2010 Permeable adjustment using WHS Permeable Adjustment Worksheet Beta v1.1	2.94

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
SBTrib	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.4	3.7

4. REVITALISED FLOOD HYDROGRAPH (REFH) METHOD

4.1 The ReFH2 Revitalised Flood Hydrograph Modelling Tool (Version 2.3), using FEH 2013 rainfall frequency statistics, 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
SBTrib	CD	3.99	319.27	34.84	1.57
Description of flood event analysis carried out			No flood event analysis was undertaken due to a lack of gauging station in the study catchment.		

Table 4.2: Critical storm durations

Site code	Season of design event	Storm duration	Selected interval
SBTrib	Winter	6.5 hrs	0.5 hrs
Comments	The recommended storm duration for the Soar Brook Tributary is 6.5 hrs. As such the model will be run with a 6.5 hr storm duration using a winter storm profile. However, sensitvitiy analysis will also be undertaken using 2.5 hr and 10.5 hr storm durations to assess the sensitivity of the model to differing storm durations.		

Table 4.3: Flood estimates from the ReFH method

Site Code	Flood peak (m^3/s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
SBTrib	0.9	1.3	1.5	1.7	2.2	2.4	2.6	3.1	4.6

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 flood frequency curves for both methods are shown in **Figure 5.1**.

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
SBTrib	0.7	0.9	1.29	2.0	2.6	1.30

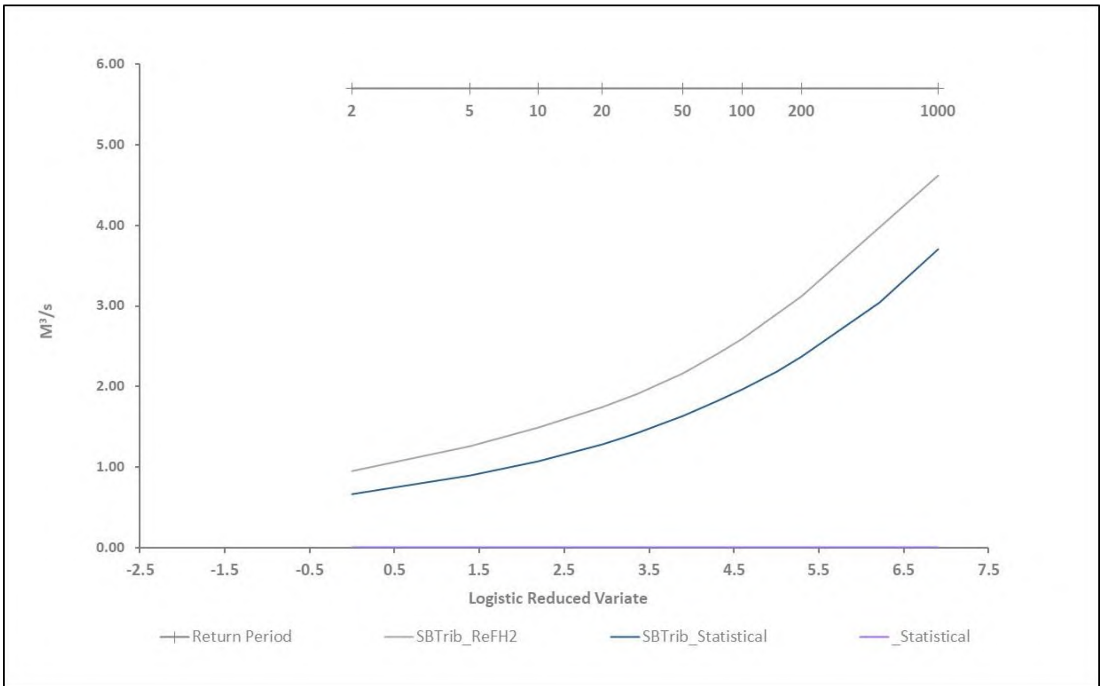


Figure 5.1: Comparison of Statistical method and ReFH Flood Frequency Curves

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 the catchment, the final choice of peak flows for input into the model is the ReFH2 method. Although the Statistical method incorporates local data from the Littlethorpe gauge, the Littlethorpe gauge is located on the River Soar not the Soar Brook Tributary so is not truly representative of the subject site. (The Soar Brook Tributary flows into the Soar Brook which, in turn, flows into the River Soar). The Littlethorpe gauge encompasses a much larger catchment, with a number of

	tributaries joining the River Soar between the Soar Brook and the gauge. As such, due to the lack of gauged data on the Soar Brook tributary itself with which to verify flows, the more conservative ReFH2 flows will be applied to the hydraulic model. This more precautionary approach is considered appropriate for the purposes of a flood risk assessment to support development.

Table 5.3: Final Peak Flows 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
SBTrib	0.9	1.3	1.5	1.7	2.2	2.4	2.6	3.1	4.6

Table 5.4: Assumptions, limitations and uncertainty

List the main assumptions made	• The pooling group is representative of the catchment. • The River Soar at Littlethorpe gauge is suitable for use as a donor for QMED. • The ReFH2 hydrograph shape is representative of catchment response. • Tp and storm duration is representative of the catchment response. • The hydrograph at the downstream extent of the model is suitable to apply to the sub-catchments within the study area by pro-rata based on catchment area.
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 small gauged sites in the UK. As such the representation in the pooling is not ideal given the relatively small size of the study catchment. • There is no observed flow data within the catchment with which to calibrate or verify the flow estimates.
Give what information you can on uncertainty in the results	According to Table 4 of the EA FEH Guidelines, confidence intervals for the 1 in 100 year for a moderately urbanised site when calculated from catchment descriptors are quoted as 0.33-3.01 (for the 95% confidence interval). Confidence is considered to be improved when using observed data from a donor site. When six donors are used in the assessment, the confidence intervals changes to 0.34-2.94 (for the 95% confidence interval). It is more difficult to quantity uncertainty in design flows estimated from the ReFH rainfall-runoff model. However, evidence[4] suggests the factorial standard errors from ReFH2

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

	are comparable to those observed for the FEH pooled Statistical method when the catchment is treated as ungauged. The nature of the catchment and watercourse to be modelled (small catchment, short reaches, split catchment due to embankment) means there is a greater degree in uncertainty in the results as there is a shortage of such sites in the NRFA dataset used to derive the regression quations for ungauged sites and to select pooling groups and donor catchments. Given the uncertainty, the more precautionary, ReFH2 peak flows are preferred for the purposes of the modelling study.
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 planning decisions. 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 5.5: Checks

Are the results consistent?	Peak flows are consistent with the size and characteristics of the catchment.
What do the results imply regarding the return periods of floods during the period of record?	It is not possible to imply return periods of floods due to the lack of gauged data within the study catchment.
What is the 1 in 100-year growth factor? (the guidance suggests a typical range or 2.1 to 4.0)	• Statistical Method: 2.94 • ReFH2 Method: 2.74 These all 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: 1.89 • ReFH2 Method: 1.78
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred	There are no previous detailed studies on the Soar Brook Tributary with which to make a comparison.
Are the results consistent with the longer-term flood history?	It is not possible to compare the results with the longer-term flood history due to the lack of gauged data within the study catchment.
Describe any other checks on the results	Sensibility checks of modelled outlines will be undertaken at the modelling stage.

Application of flows to model

5.2 Flows will be applied to the model in the following way:

i. The catchment has been divided based upon the areas upstream and downstream of the M69.

ii. The ReFH hydrograph has been pro-rated based on the catchment areas for the two areas.

iii. The initial hydrograph has been generated using catchment descriptors, a 6.5 hour storm duration with a winter storm pofile. Sensitivity testing will be carried out at the modelling stage and is documented within the hydraulic modelling report.

iv. Hydrographs can be found in the hydraulic model boundary condition files.

5.3 **Figure 5.2** demonstrates the breakdown of the catchment.

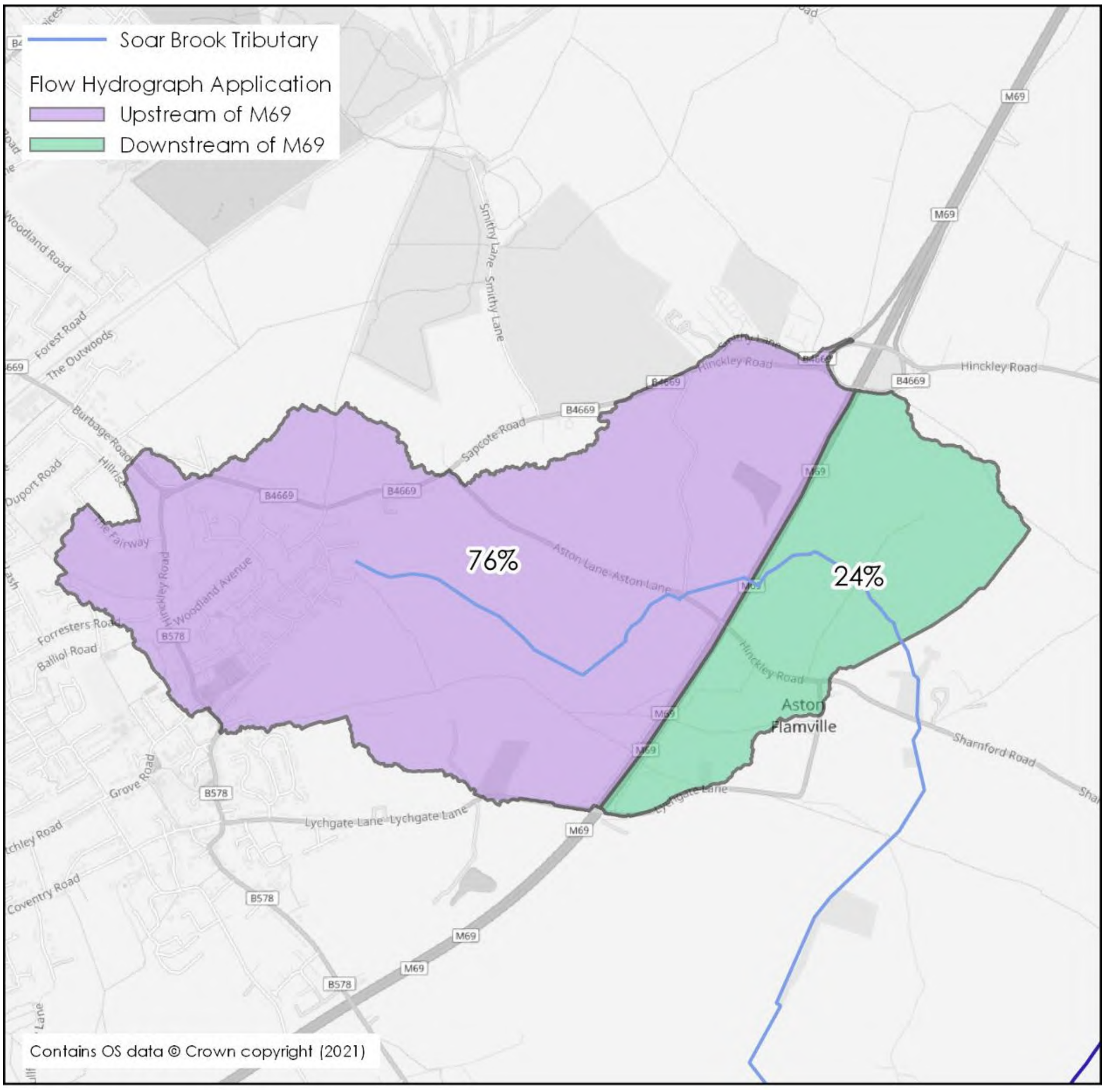


Figure 5.2: Application of Flows to Model

6. SUPPORTING INFORMATION

Flood history

6.1 A flood history review for the area has been undertaken using Environment Agency recorded flood outlines, Strategic Flood Risk Assessments[5,6,7,8], Leicestershire County Council Flood Investigation Reports, the British Chronology of Hydrological Events and online newspaper reports. No record of flooding to the proposed development site has been found during the search of these sources.

6.2 There is no record of flooding from the Soar Brook Tributary.

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: SBTrib_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
76011 (Coal Burn @ Coalburn)	1.407	42	1.84	0.163	0.301	0.683
27051 (Crimple @ Burn Bridge)	1.922	47	4.524	0.218	0.156	0.396
27073 (Brompton Beck @ Snainton Ings)	1.967	39	0.812	0.215	0.035	2.202
45816 (Haddeo @ Upton)	2.063	26	3.456	0.3	0.406	0.656
28033 (Dove @ Hollinsclough)	2.331	44	4.177	0.228	0.371	0.563
26016 (Gypsey Race @ Kirby Grindalythe)	2.567	22	0.1	0.321	0.266	0.797
25019 (Leven @ Easby)	2.582	41	5.09	0.342	0.386	0.812
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.759	9	5.777	0.271	0.151	3.095
47022 (Tory Brook @ Newnham Park)	2.81	25	6.176	0.257	0.191	0.471
25011 (Langdon Beck @ Langdon)	2.843	33	15.647	0.232	0.328	1.03
25003 (Trout Beck @ Moor House)	2.942	46	15.142	0.168	0.29	0.559
71003 (Croasdale Beck @ Croasdale Flume)	2.963	37	10.9	0.212	0.323	0.284
27010 (Hodge Beck @ Bransdale Weir)	2.978	41	9.42	0.224	0.293	0.124
44008 (South Winterbourne @ Winterbourne Steepleton)	3.052	40	0.434	0.411	0.337	1.841
106002 (Laxdale @ Laxdale)	3.059	12	17.449	0.103	0.132	1.488
Total		536				
Weighted Means				0.275	0.237	
H2 value	2.7193					

[5] Joint Strategic Flood Risk Assessment, Hinckley and Bosworth Borough, Blaby District, and Oadby and Wigston Borough Councils (2014)
[6] Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (Leicestershire Local Planning Authorities and Leicester City Council (2017)
[7] Strategic Flood Risk Assessment for Hinckley and Bosworth Borough Council: Final Report, Hinckley and Bosworth Council (July 2019)
[8] Hinckley and Bosworth Borough Council Level 2 Strategic Flood Risk Assessment: Final Report, Hinckley and Bosworth Borough Council (May 2020)

Goodness of Fit	Generalised Logistic	General Extreme Value
	1.598	-0.0468

Table 6.2: Final pooling group (before permeable adjustment): SBTrib_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
76011 (Coal Burn @ Coalburn)	1.407	42	1.84	0.163	0.301	0.711
27051 (Crimple @ Burn Bridge)	1.922	47	4.524	0.218	0.156	0.513
27073 (Brompton Beck @ Snainton Ings)	1.967	39	0.812	0.215	0.035	2.082
45816 (Haddeo @ Upton)	2.063	26	3.456	0.3	0.406	0.865
28033 (Dove @ Hollinsclough)	2.331	44	4.177	0.228	0.371	0.609
26016 (Gypsey Race @ Kirby Grindalythe)	2.567	22	0.1	0.321	0.266	1.265
25019 (Leven @ Easby)	2.582	41	5.09	0.342	0.386	1.514
47022 (Tory Brook @ Newnham Park)	2.81	25	6.176	0.257	0.191	1.492
25011 (Langdon Beck @ Langdon)	2.843	33	15.647	0.232	0.328	1.498
25003 (Trout Beck @ Moor House)	2.942	46	15.142	0.168	0.29	0.543
71003 (Croasdale Beck @ Croasdale Flume)	2.963	37	10.9	0.212	0.323	0.2
27010 (Hodge Beck @ Bransdale Weir)	2.978	41	9.42	0.224	0.293	0.066
91802 (Allt Leachdach @ Intake)	3.138	34	6.35	0.153	0.257	0.82
54022 (Severn @ Plynlimon Flume)	3.234	38	14.988	0.156	0.171	1.821
Total		515				
Weighted Means				0.227	0.269	
H2 value	0.7472					
Goodness of Fit	Generalised Logistic			General Extreme Value		
	0.1862			-1.1299		

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

Station	Adjusted L-CV	Adjusted L-Skew
27073 (Brompton Beck @ Snainton Ings)	0.200	0.072
26016 (Gypsey Race @ Kirby Grindalythe)	0.293	0.314

BWB

A CAF GROUP COMPANY