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ROXHILL (JUNCTION 15) LIMITED
NORTHAMPTON GATEWAY
NORTHAMPTONSHIRE

FLOOD RISK ASSESSMENT

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ROXHILL (JUNCTION 15) LIMITED NORTHAMPTON GATEWAY NORTHAMPTONSHIRE

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					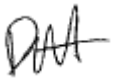
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					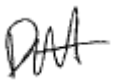

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All Environment Agency mapping data used under special license. Data is current as of March 2018 and is subject to change.

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

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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, the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced on behalf of Roxhill (Junction 15) Ltd in respect of a Development Consent Order for Northampton Gateway Strategic Rail Freight Interchange, adjacent to M1 Junction 15, Northamptonshire.

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

Proposals are based around a large rail served warehousing development (the Main Site) which is situated adjacent to Junction 15 of the M1 Motorway. In addition to the Main Site, works are proposed on highways in the vicinity ranging in size from a bypass around the village of Roade to localised carriageway widening.

Hydraulic models have been produced for two Ordinary Watercourses, the Courteenhall Brook (within the Main Site) and an unnamed watercourse referred to as Roade Brook for the purpose of this assessment, located near the proposed bypass. These models have been used to provide baseline fluvial flood outlines and proposals for mitigation where the proposed development encroaches into the floodplain. The remaining sites (referenced 3 – 9) have no fluvial flood risk associated with them.

Significant changes in level are proposed within the Main Site to form development plateaus and therefore existing pluvial flood routes will be removed. No routes enter the site from outside the boundary of the Main Site and as such the existing risk can be managed within the development.

Pluvial risk is considered to pose a medium risk to one site (Site 6 at Knock Lane/Stoke Road) and a suitable mitigation strategy has been proposed in the form of an adjacent balancing pond.

Other sources of flood risk have been assessed and can be considered to be low, with limited mitigation required to ensure this remains the case post development.

All the proposals provide an increase in impermeable area when compared to the existing situation and mitigation in the form of a suitable drainage strategy is proposed to ensure flood risk is not increased post development. Drainage strategy details are provided in a separate Sustainable Drainage Statement, reference NGW-BWB-EWE-XX-RP-CD_0007.

The Environment Agency were approached to provide pre-application advice and guidance on the development however as the Main Site is located within Flood Zone 1 they did not consider it necessary to engage. The Lead Local Flood Authority (Northamptonshire County Council) provided pre application advice and are the responsible body for Ordinary Watercourses. They have been involved in dialogue with the Applicant's team regarding a Statement of Common Ground in relation to flood risk and drainage.

In compliance with the requirements of the National Policy Statement for National Networks, and subject to the mitigation measures proposed the development would not be subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area as a result of suitable management of surface water runoff discharging from the site, and will deliver some betterment over the existing regime.

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FIGURES

APPENDICES

1.0 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 Roxhill (Junction 15) Limited in respect of a Development Consent Order for a strategic rail freight interchange adjacent to Junction 15 of the M1 Motorway and highway works in the wider surrounding area.

1.2 This FRA is intended to support an application for a Development Consent Order and as such the level of detail included is commensurate and subject to the nature of the proposals.

Table 1.1 - Site Summary

Site Name	Northampton Gateway
Location	South Northamptonshire
Development Type	Strategic Rail Freight Interchange Highway Works
EA Flood Zone Classification	Flood Zone 1
NPPF Vulnerability	Less Vulnerable (SRFI) Essential Infrastructure (Highway Works)
Environment Agency Office	Lincolnshire and Northamptonshire
Lead Local Flood Authority	Northamptonshire County Council

Sources of Data

1.3 The report is based on the following information

(i) Parameters Plan (document reference 2.10)
(ii) Illustrative Masterplan by php Architects, reference 4054-R000
(iii) Topographical Survey by Greenhatch, reference 19595 Rev 9
(iv) OS Explorer Series mapping
(v) Environment Agency consultation and model information
(vi) Local Authority Surface Water Flood Risk Maps
(vii) West Northamptonshire Strategic Flood Risk Assessment
(viii) Northamptonshire County Council Preliminary Flood Risk Assessment
(ix) Northamptonshire Local Flood Risk Management Strategy
(x) Hydraulic modelling of Courteenhall and Roade Brooks undertaken by BWB Consulting (ref NTH/2315/TN1/TN2)
(xi) Anglian Water Sewer Records
(xii) British Geological Survey Drift & Geology Maps

Existing Sites

1.4 The SRFI proposal is located to the west of the M1 Motorway, adjacent to Junction 15 and extends to some 291ha. To support the proposals and mitigate impact on the surrounding area there are a further eight areas of work to the existing highway which range from small areas of carriageway widening to the construction of a new bypass.

1.5 A site location plan which includes all of the developments sites is shown as **Figure 1.1** and the individual component sites are described in detail in the following section.

1.6 Some of the proposals outside of the main SRFI development site would not necessarily require a Flood Risk Assessment from a policy perspective but for the purposes of completeness and as they act to form a combined single application they have been assessed within this document.

1.7 Topographical surveys are available for each site however they have not been included within this report for brevity.

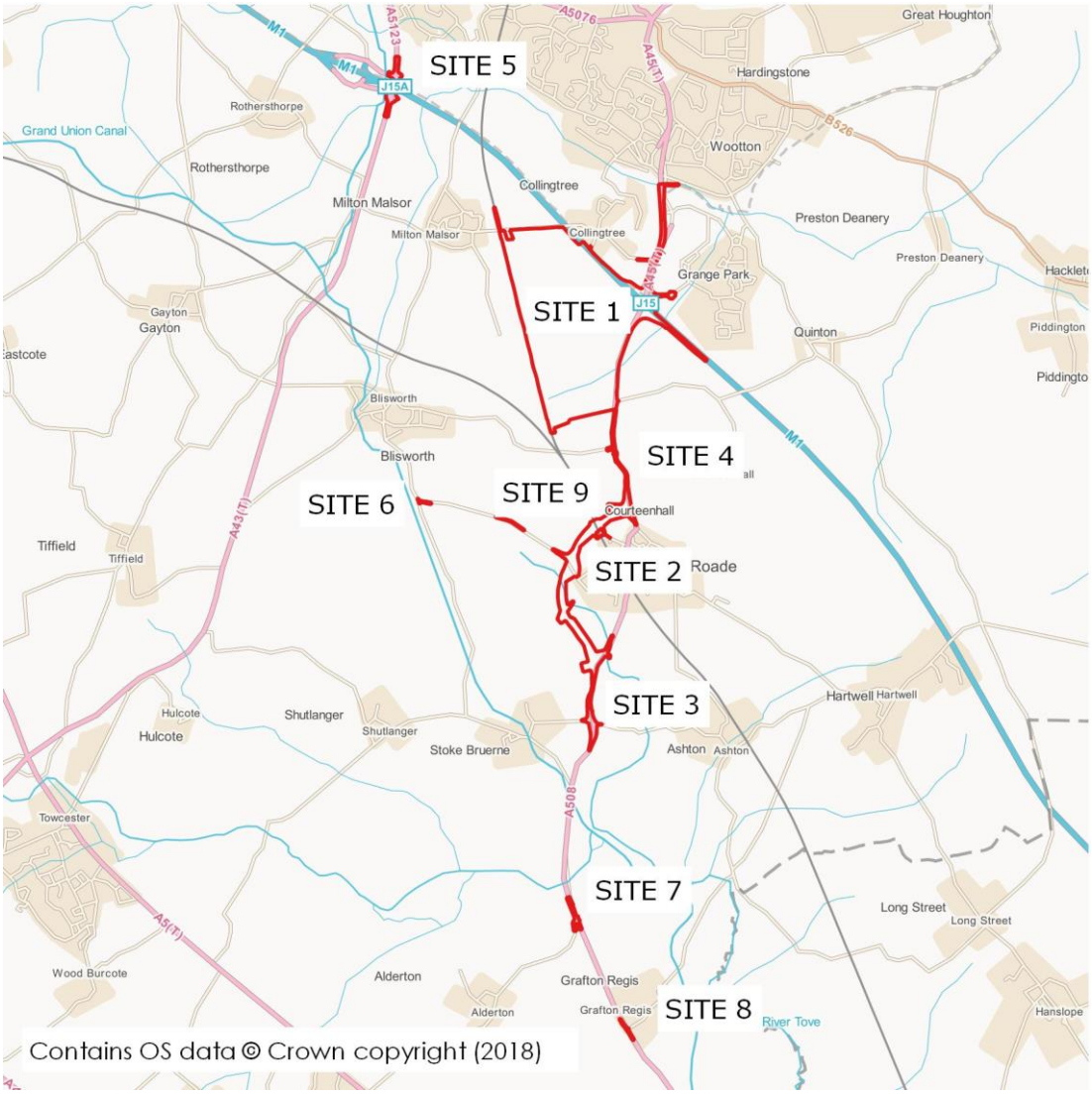


Figure 1.1 - Site Locations

Site 1 – Main Site

1.8 This is the proposed development site and is referred to as 'the Main Site' throughout this document. It is proposed to be accessed off a new roundabout located on the A508 Northampton Road. The remainder of land within the Site 1 boundary is generally for highway works to the M1, A45 and A508 and construction of a new foul water rising main. An Illustrative Masterplan is included for reference as **Appendix 1**.

1.9 A topographical survey for the Main Site shows levels to range from approximately 102mAOD to 80mAOD, with the site falling in all directions towards its boundaries which are Collingtree Road (north), M1 Motorway (northeast), A508 Northampton Road (east), farmland (south) and the Northampton Loop rail line (west).

1.10 A site location plan is included for reference as **Figure 1.2.**

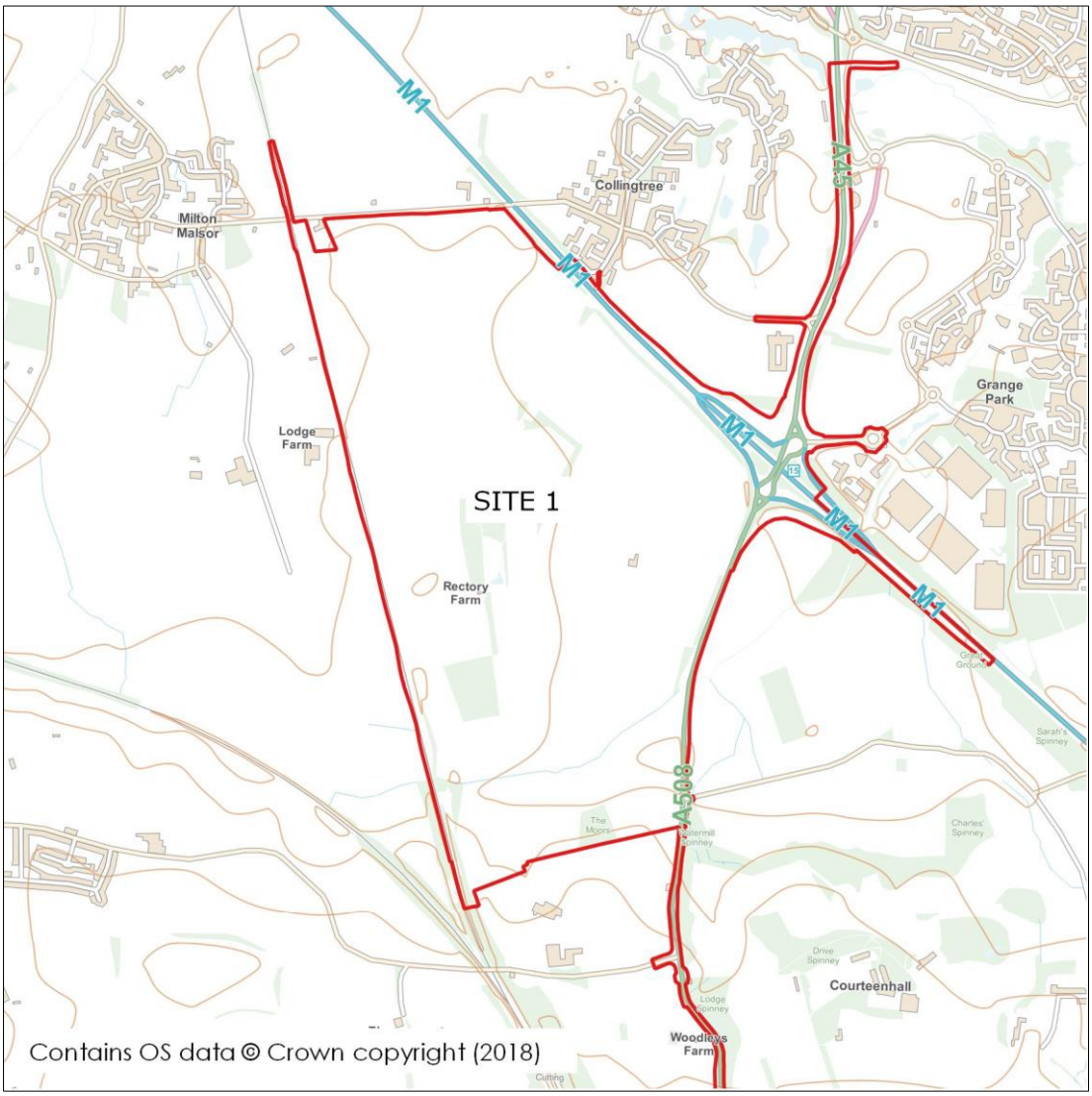


Figure 1.2 – Site 1 Location

1.11 The Main Site is currently used for agricultural pasture and arable fields and thus is considered to be greenfield in nature. The remaining land within the Site 1 area is

existing highway and will remain as such, with amendments to carriageway widths to accommodate the recommendations of transport assessment work.

1.12 Proposed layouts for the remaining sites are included within **Appendix 2** for reference.

Site 2 – A508 Roade Bypass

1.13 Site 2 is the route for a proposed bypass around the village of Roade. It is located west of the village and represents an alternative route for traffic around it. It is linear in nature and extends to some 2.3km in length.

1.14 A site location plan is included for reference as **Figure 1.3.**

Figure 1.3 – Site 2 Location

1.15 The site is currently used for agricultural pasture and arable fields and thus considered be greenfield in nature. It crosses the West Coast Mainline and Blisworth Road along its route, tying into the existing highway at either end.

1.16 A crossing of the Roade Brook is also proposed approximately midway along its length.

Site 3 - A508 Rookery Lane/Ashton Road

1.17 This is a road road junction where Rookery Lane and Ashton Road meet the A508 Northampton Road and is located south of Roade. The propsals are to realign a section of the A508 and amend the junctions accordingly.

1.18 A site location plan is included for reference as **Figure 1.4**.

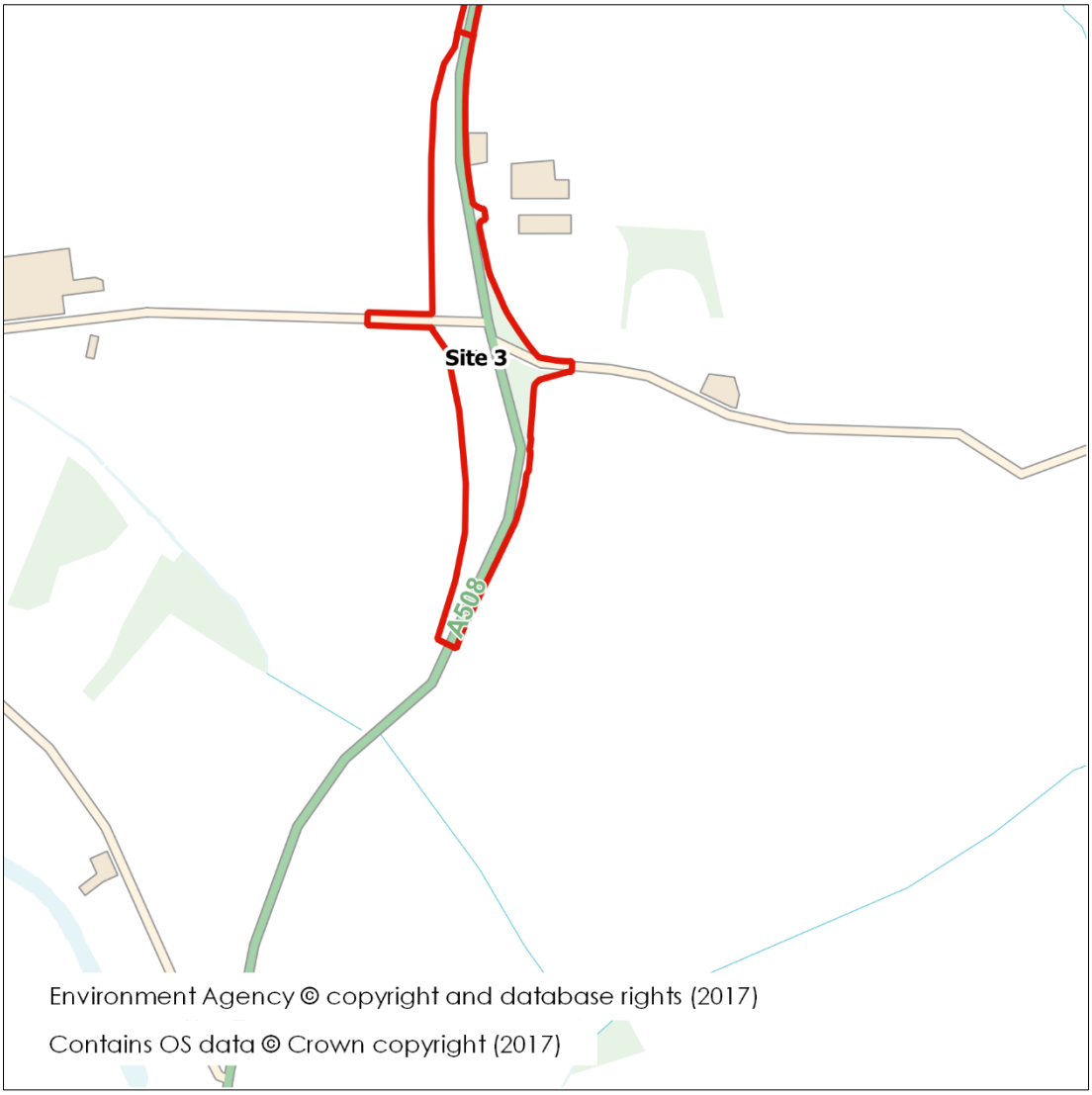


Figure 1.4 – Site 3 Location

1.19 The proposals include for a new section of carriageway to the west of the existing alignment over land that is predominantly undeveloped, including land within the highway verge and small areas of existing agricultural land.

Site 4 – A508 Courteenhall Road Junction

1.20 Site 4 is at the junction of Courteenhall Road and the A508 Northampton Road and is located north of Roade.

1.21 A site location plan is included for reference as **Figure 1.5.**

Figure 1.5 – Site 4 Location

1.22 The proposals are to widen the northbound carriageway of the A508 into land which is currently undeveloped (highway verge and field margins).

Site 5 – M1 J15A/A43

1.23 Site 5 is formed of junction 15A of the M1, extending north along the A43 and south along the A5123. It is located approximately 3.7km north of the Main Site, being the next junction along the M1.

1.24 A site location plan is included for reference as **Figure 1.6.**

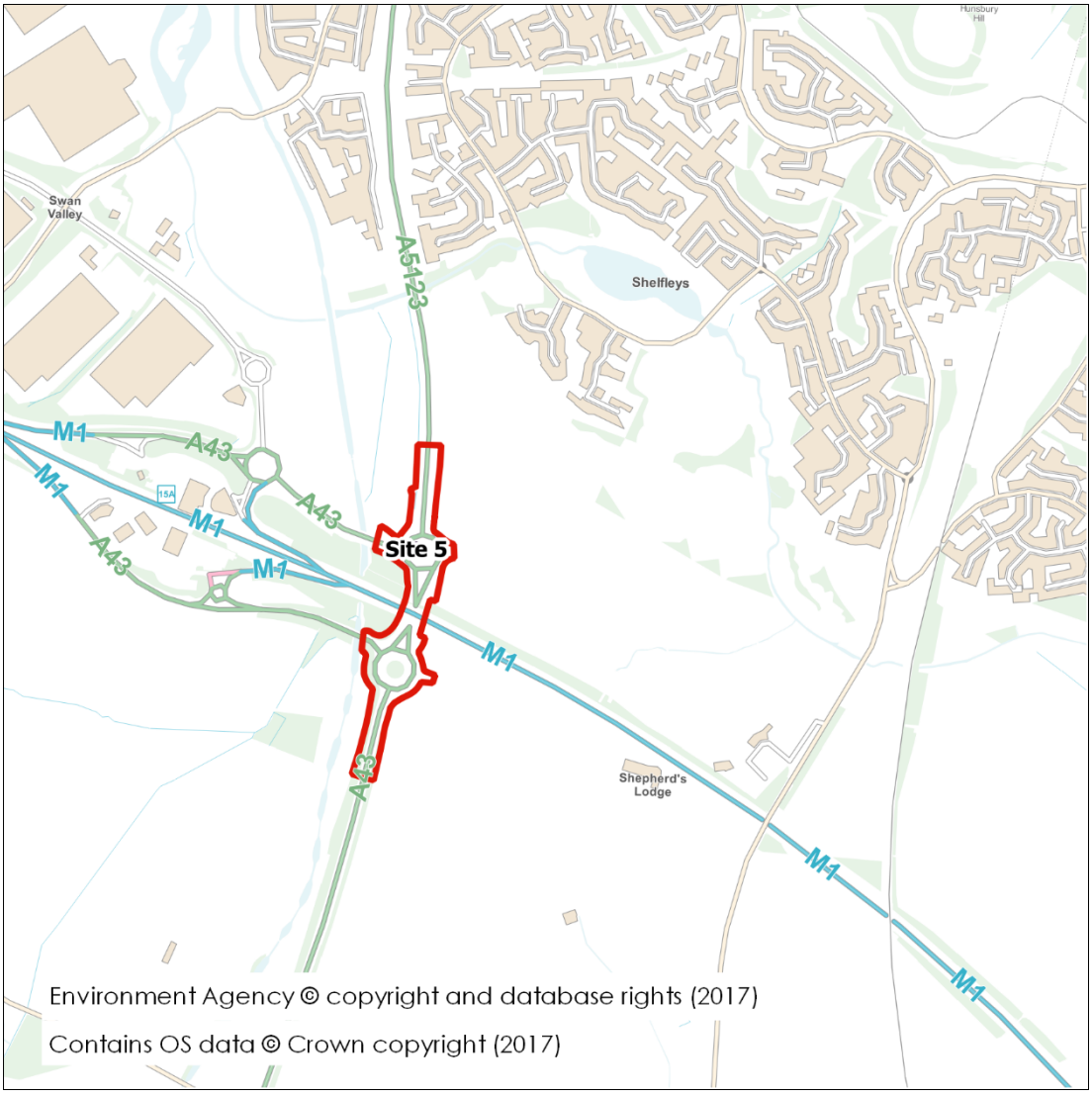


Figure 1.6 – Site 5 Location

1.25 The works are limited to widening of lanes around the two roundabouts, utilising land which is within the verge of the existing highway.

Site 6 – Knock Lane/Stoke Road

1.26 The site is formed by the junction of Stoke Road and Knock Lane, south of Blisworth and extends approximately 140m along Knock Lane. The site slopes steeply towards the Stoke Lane junction, with a fall from 120mAOD to 115mAOD.

1.27 A site location plan is included for reference as **Figure 1.7.**

Figure 1.7 – Site 6 Location

1.28 The proposals are to widen the westbound carriageway of Knock Lane and the junction radius at Stoke Lane into land which is currently undeveloped including highway verge and field margins.

Site 7 – Pury Road Junction

1.29 The site is formed by the junction of Pury Road and the A508 Northampton Road, approximately 1.5km north of Grafton Regis and extends approximately 270m along the A508. The site slopes northwards, with a fall from 85mAOD to 75mAOD.

1.30 A site location plan is included for reference as **Figure 1.8.**

Figure 1.8 - Site 7 Location

1.31 The proposals are to widen the southbound carriageway of the A508 into land which is currently undeveloped highway verge.

Site 8 – A508 Grafton Regis

1.32 Site 8 is located within Grafton Regis on the A508 Northampton Road adjacent the Church Road junction, extending for around 80m. Levels fall southwards from 100mAOD to 97mAOD.

1.33 A site location plan is included for reference as **Figure 1.9.**

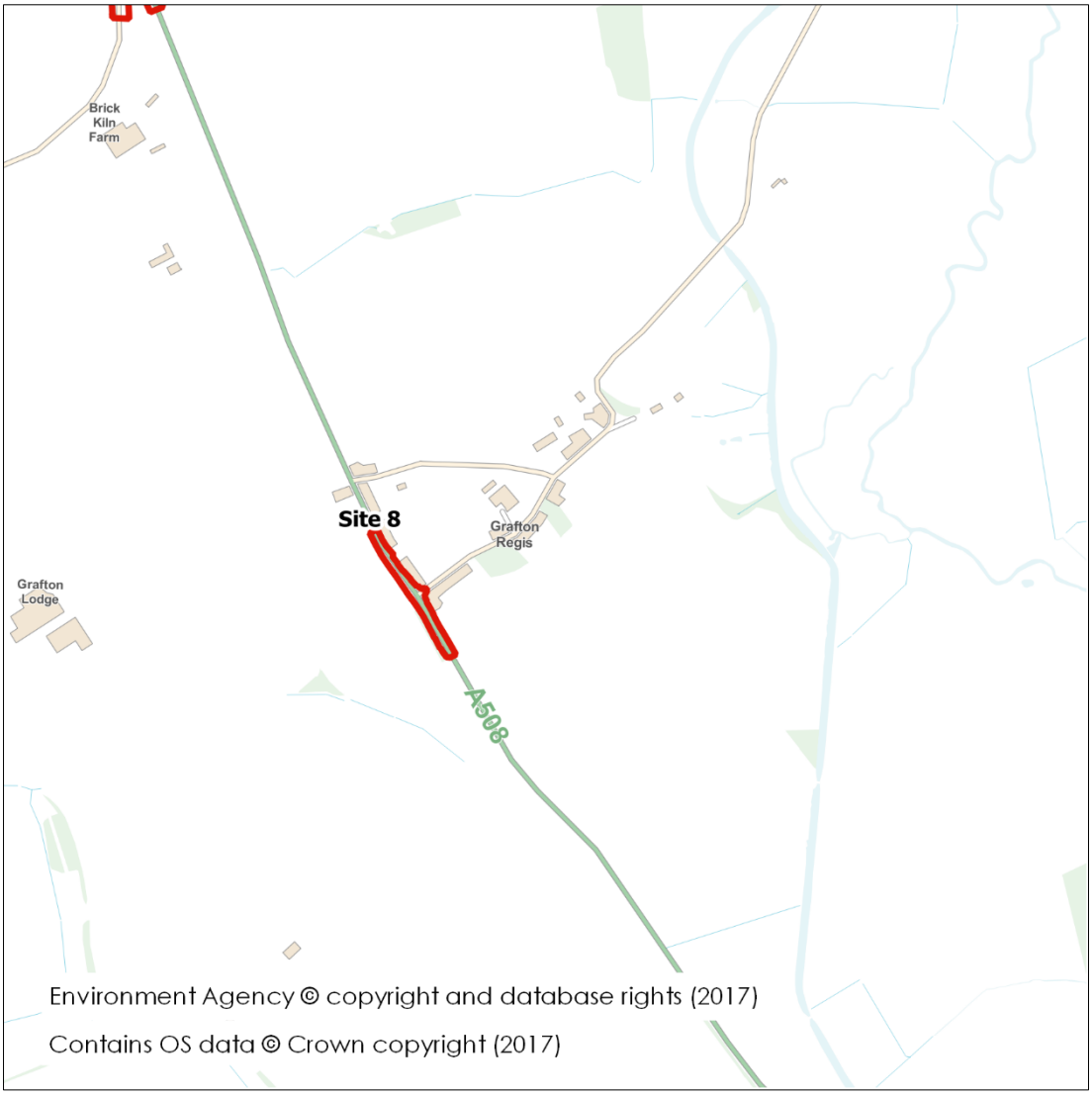


Figure 1.9 - Site 8 Location

1.34 The proposals are to widen the carriageway on the northbound side within the existing verge.

Site 9 – Knock Lane/Blisworth Rd

1.35 The site is located on the bend where Knock Lane and Blisworth Road meet. The proposals are limited to nominal widening of the bend.

1.36 A site location plan is included for reference as **Figure 1.10.**

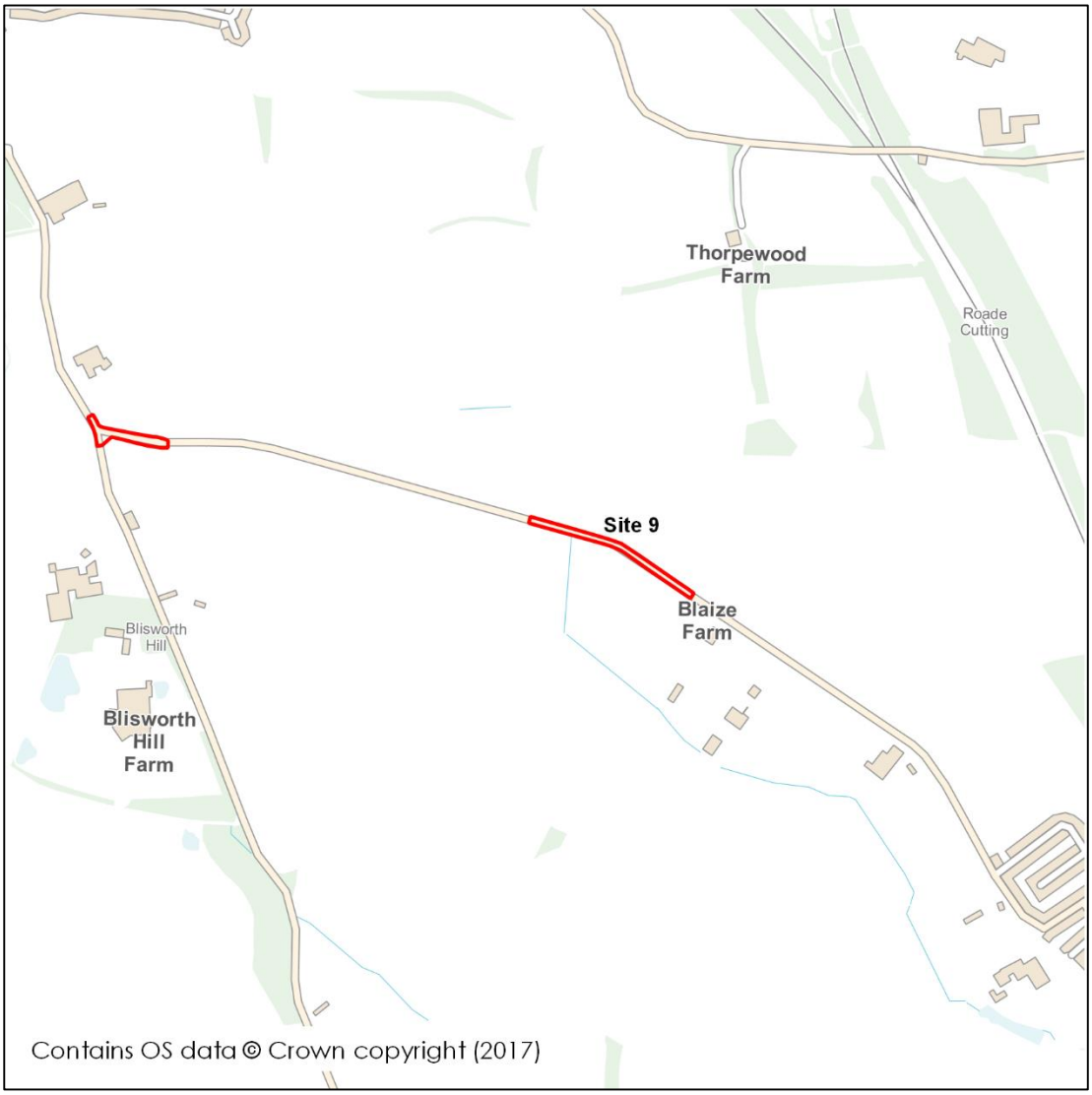


Figure 1.10 - Site 9 Location

Proposed Development

1.37 The Northampton Gateway Strategic Rail Freight Interchange (SRFI) scheme would, if consented, include the following;

- An intermodal freight terminal including container storage and HGV parking, rail sidings to serve individual warehouses, and the provision of an aggregates facility as part of the intermodal freight terminal, with the capability to also provide a 'rapid rail freight' facility;
- Up to 468,000 sq m (approximately 5 million sq ft) (gross internal area) of warehousing and ancillary buildings, with additional floorspace provided in the form of mezzanines;
- A secure, dedicated, HGV parking area of approximately 120 spaces including driver welfare facilities to meet the needs of HGVs visiting the site or intermodal terminal;
- New road infrastructure and works to the existing road network, including the provision of a new access and associated works to the A508, a new bypass to the village of Roade, improvements to Junction 15 and to J15A of the M1 motorway, the A45, other highway improvements at junctions on the local highway network and related traffic management measures;
- Strategic landscaping and tree planting, including diverted public rights of way;
- Earthworks and demolition of existing structures on the SRFI site.

1.38 Proposed site layouts, including an Illustrative Masterplan, are included within **Appendix 1 and 2**. The Main Site and Roade Bypass are the only significant areas of new development and the main focus of this Flood Risk Assessment is concentrated on these areas, with hydraulic models created of the main watercourses that pose a risk.

1.39 The remaining highway mitigation works are all small areas generally within Flood Zone 1, which would not necessitate a full FRA on their own. However, due consideration has been made proportionate to the apparent risk.

2.0 FLOOD RISK PLANNING POLICY

National Policy Statement for National Networks (NPSNN)

2.1 The NPSNN 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, and 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 a Flood Risk Assessment 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[1] sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. Planning Practice Guidance is also available online[2].

2.5 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 also be considered when preparing a Flood Risk Assessment.

2.7 The Planning Practice Guidance also 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 Flood Risk Assessment is written in accordance with the NPPF and the Planning Practice Guidance.

Flood Map for Planning

2.9 With particular reference to planning and development, the Flood Map for Planning produced by the Environment Agency identifies Flood Zones in accordance with Table 1 of the Planning Practice Guidance.

1 National Planning Policy Framework, CLG, March 2012
2 Planning Practice Guidance: https://www.gov.uk/government/collections/planning-practice-guidance

2.10 Flood Zone 1 (Low Probability) is defined as land having less than a 1 in 1000 annual probability of river or sea flooding (<0.1%).

2.11 Flood Zone 2 (Medium Probability) is defined as land having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%); or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%).

2.12 Flood Zone 3a (High Probability) is defined as land having a 1 in 100 or greater annual probability of river flooding (>1%); or land having a 1 in 200 or greater annual probability of flooding from the sea (>0.5%). This is represented by "Flood Zone 3" on the Flood Map for Planning.

2.13 Flood Zone 3b (The Functional Floodplain) is defined as land where water has to flow or be stored in times of flood. This is not identified or separately distinguished from Zone 3a on the Flood Map for Planning.

2.14 **Table 2.1** summarises the Flood Zone classifications for the nine sites which have been assessed.

Table 2.1 – Site Flood Zone Classification

Site	Flood Zone Classification
1	1(Most) 2,3(Partial)
2	1
3	1
4	1
5	1
6	1
7	1(Most) 2,3(Partial)
8	1
9	1

2.15 **Figures 2.1 – 2.9** graphically show the extent of Flood Zones for the nine sites which form part of this assessment.

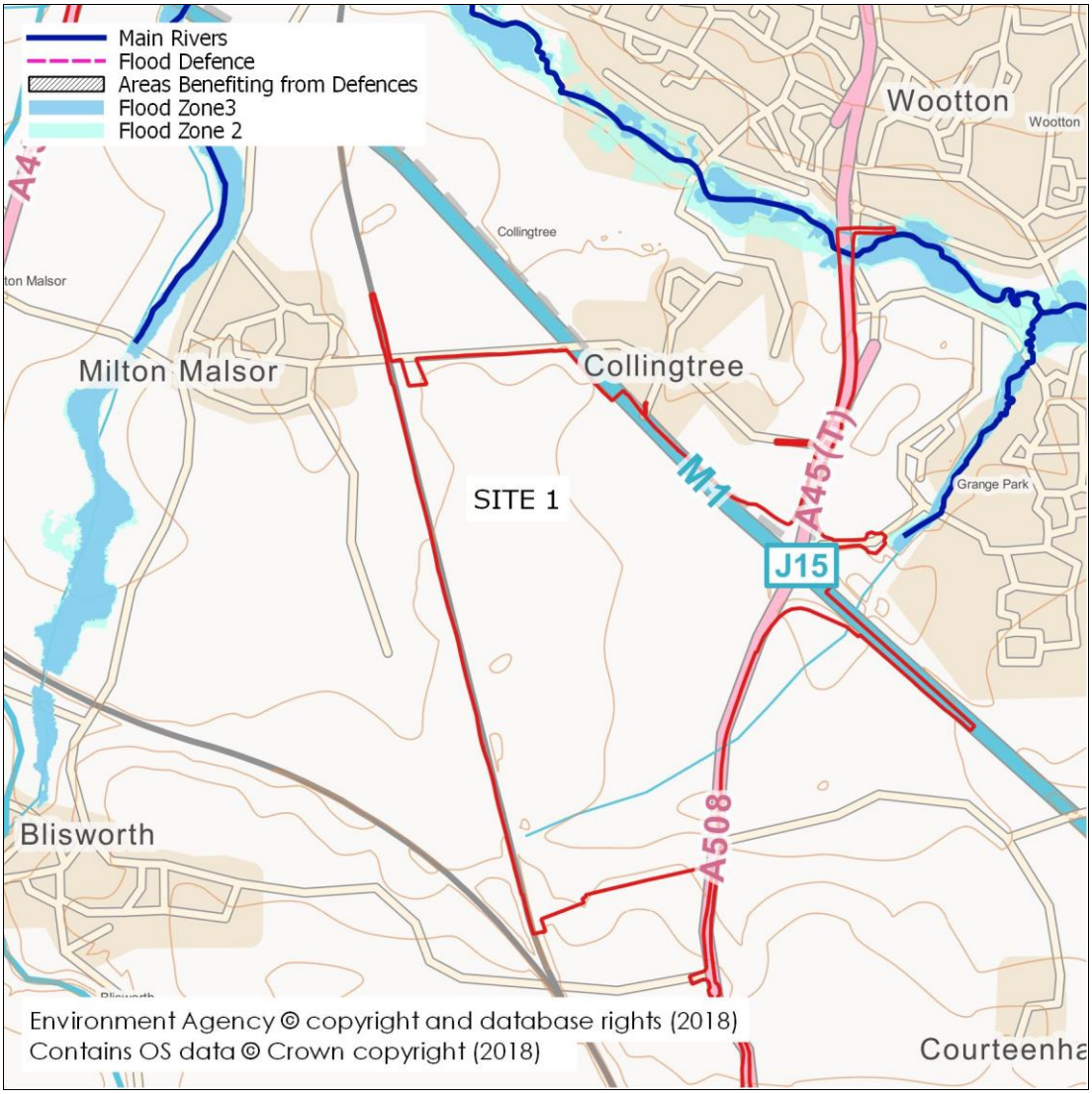


Figure 2.1 – Site 1 Environment Agency Flood Zone Map

Figure 2.2 - Site 2 Environment Agency Flood Zone Map

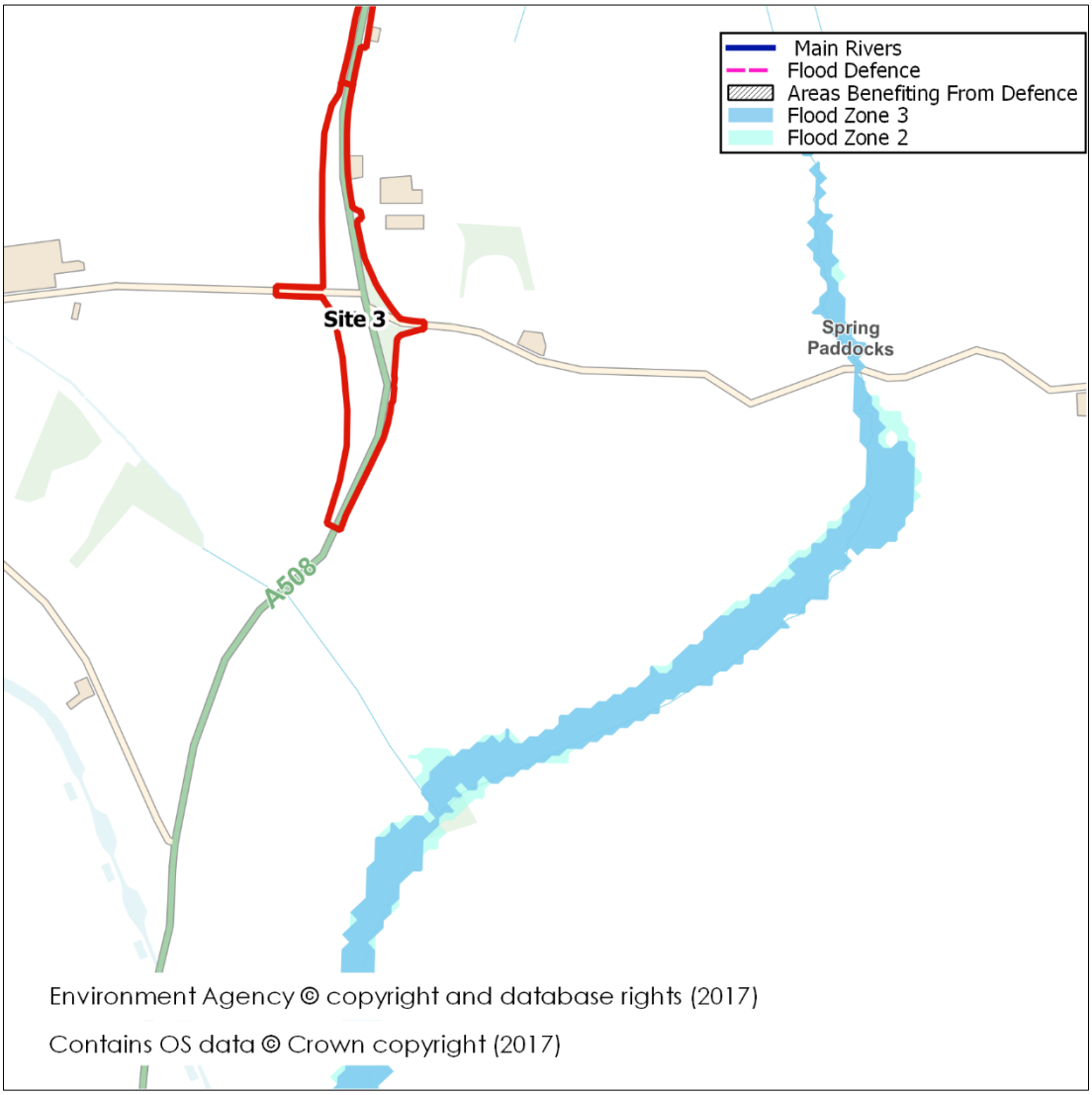


Figure 2.3 - Site 3 Environment Agency Flood Zone Map

Figure 2.4 - Site 4 Environment Agency Flood Zone Map

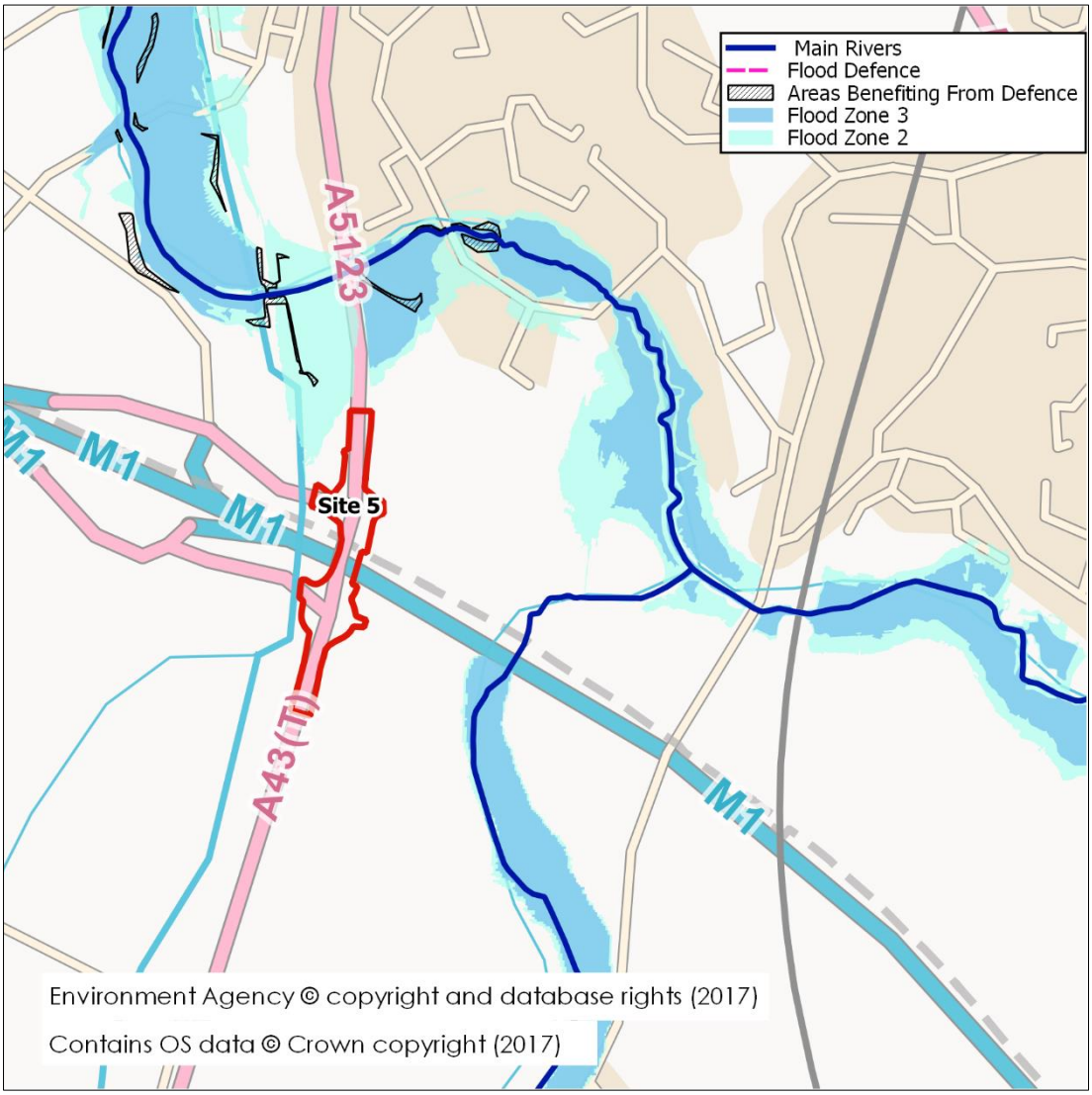


Figure 2.5 - Site 5 Environment Agency Flood Zone Map

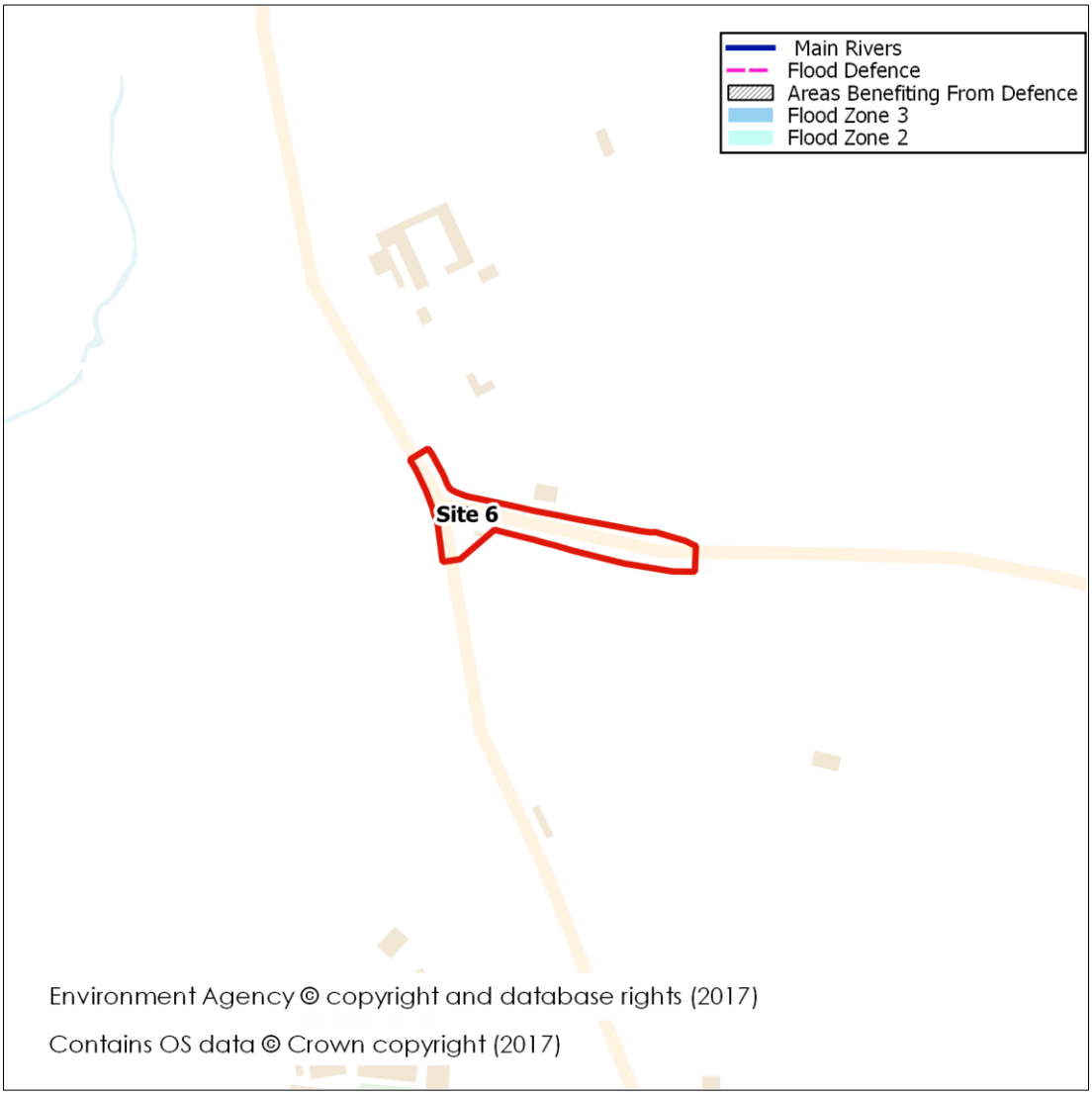


Figure 2.6 - Site 6 Environment Agency Flood Zone Map

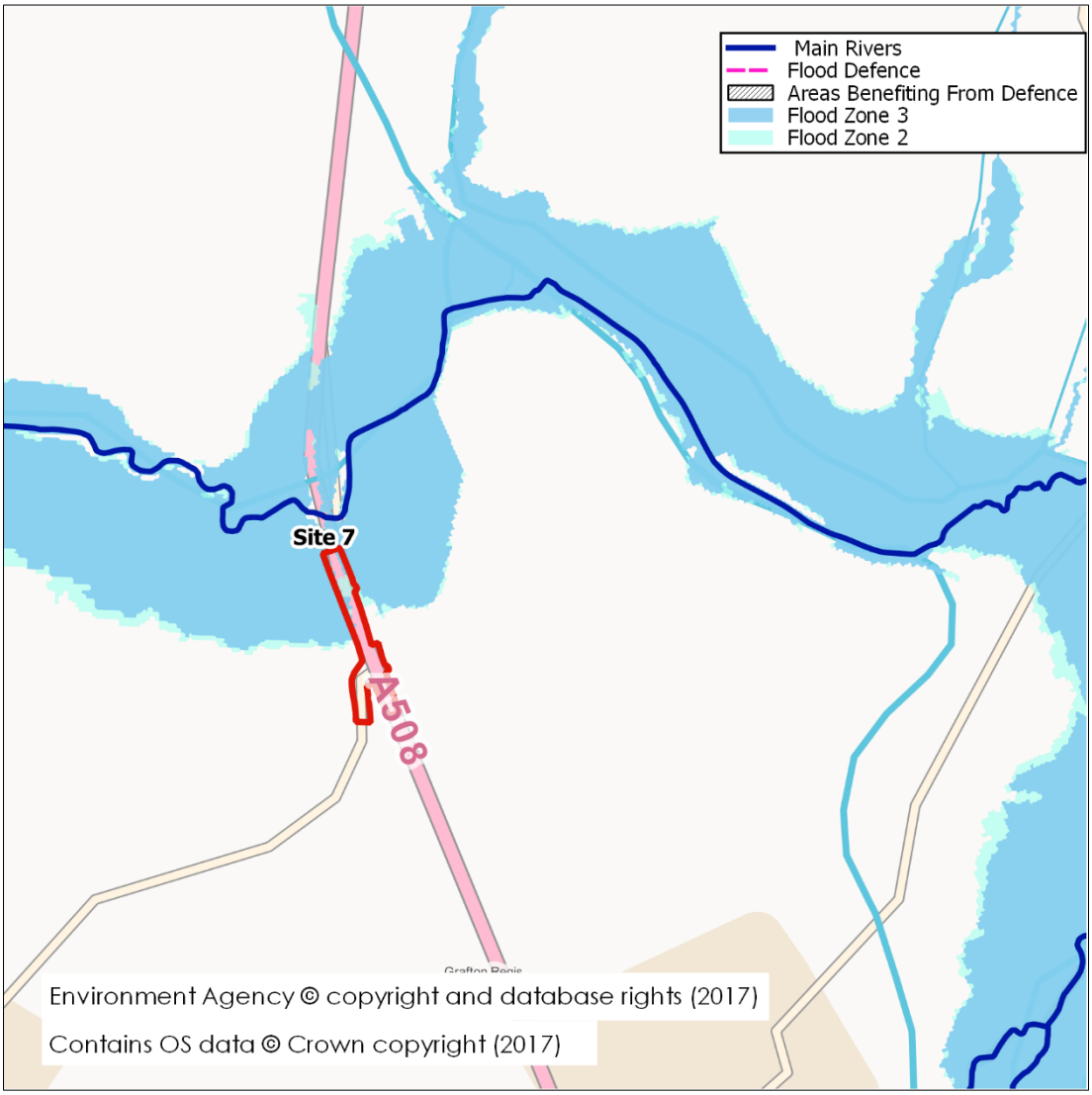


Figure 2.7 - Site 7 Environment Agency Flood Zone Map

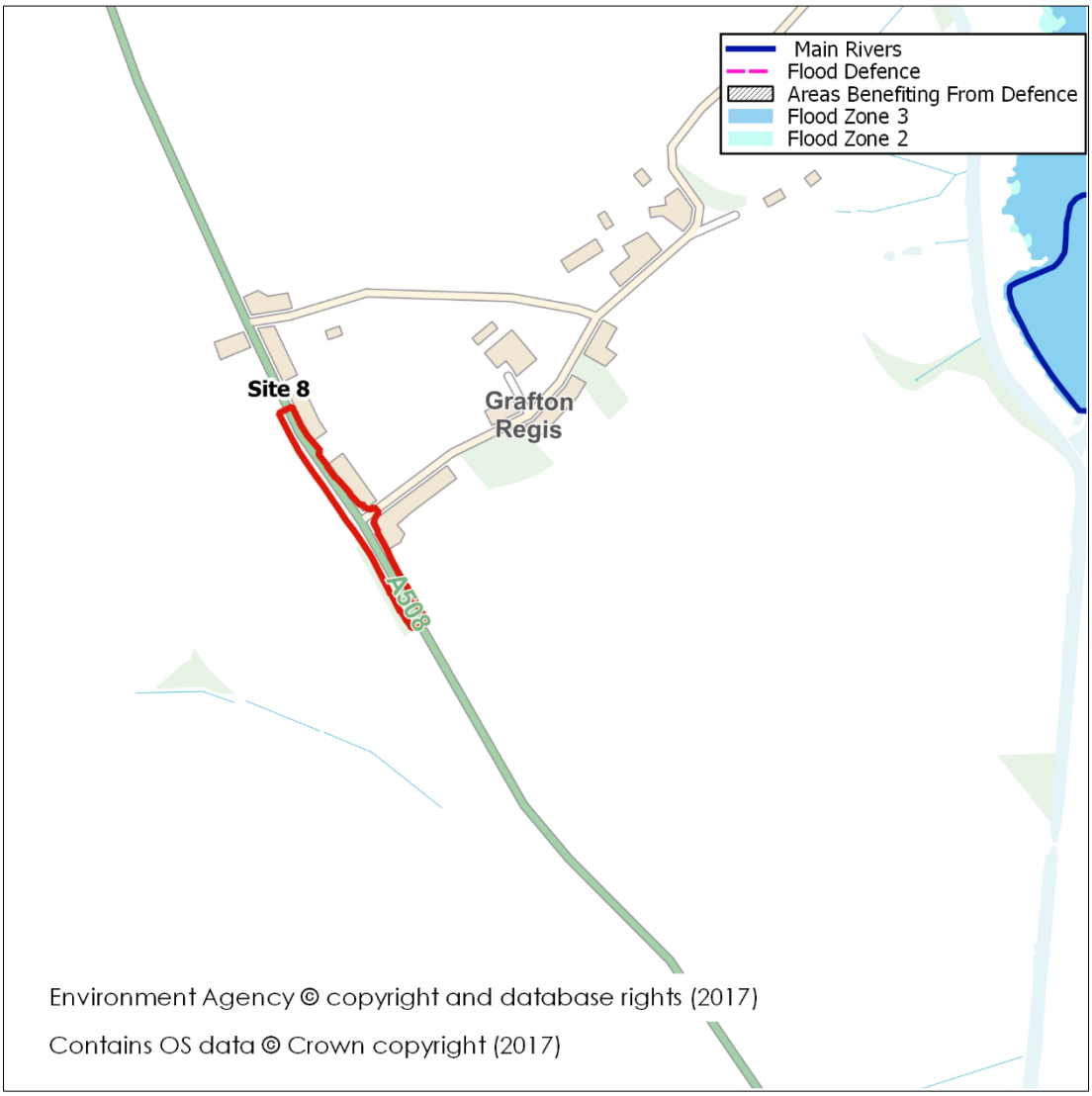


Figure 2.8 - Site 8 Environment Agency Flood Zone Map

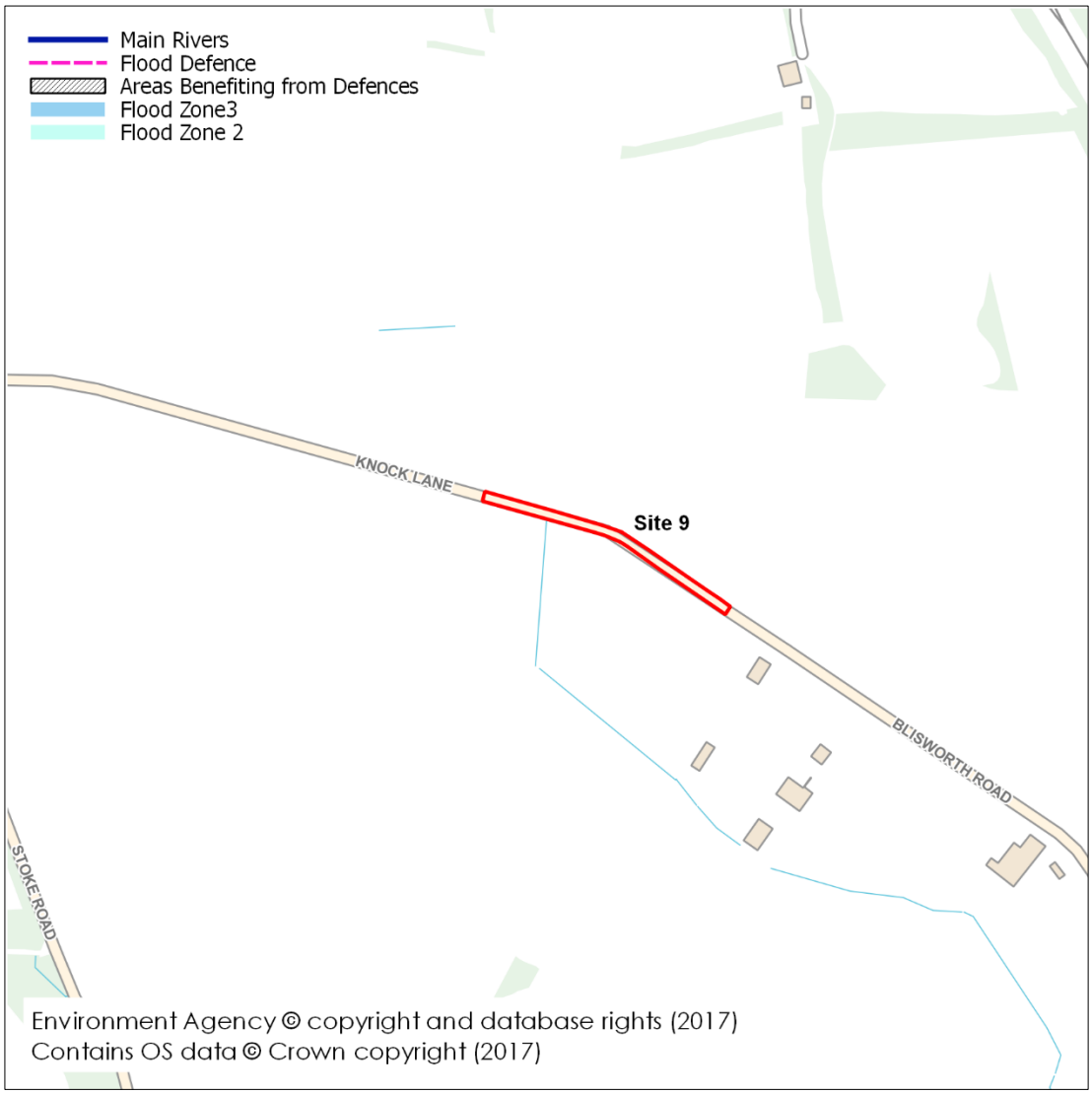


Figure 2.9 - Site 9 Environment Agency Flood Zone Map

The Design Flood

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

2.17 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

2.18 In February 2016, the predicted future change in peak river flows were updated by the Environment Agency[3]. This replaced the previous national 20% allowance, with a range of projections applied to regionalised 'river basin districts'.

2.19 The South Northamptonshire catchment falls within the Anglian river basin district. **Table 2.2** identifies the relevant peak river flow allowances from this river basin district.

Table 2.2 - Peak River Flow Allowance for the Anglian 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	25%	35%	65%
Higher Central	15%	20%	35%
Central	10%	15%	25%

2.20 When determining the appropriate allowance for use in a Flood Risk Assessment the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of the development should be considered. **Table 2.3** provides a matrix summarising the Environment Agency's guidance on determining the appropriate allowances.

Table 2.3 - Environment Agency Guidance on the Application of Climate Change Allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
2	Use the higher central and upper end to assess a range of allowances	Use the higher central and upper end to assess a range of allowances	Use the central and higher central to assess a range of allowances	Use the central allowance	Use none of the allowances
3a	Use the upper end allowance	Development should not be permitted	Use the higher central and upper end to assess a range of allowances	Use the central and higher central to assess a range of allowances	Use the central allowance
3b	Use the upper end allowance	Development should not be permitted	Development should not be permitted	Development should not be permitted	Use the central allowance
*If development is considered appropriate when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the upper end allowance.					

2.21 Most of the proposed development sites are located within Flood Zone 1 with the exception of Site 1 and Site 7 which have small extents of Flood Zone 2&3 within their boundaries.

[3] Environment Agency. 2016. Flood risk assessments: climate change allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1. [Accessed 24 February 16].

2.22 The areas of significant development are the Main Site and Roade Bypass. The Main Site falls within Site 1, and whilst the wider boundary is shown within Flood Zones 2/3 the Main Site is not shown to be at risk. Fluvial risk to the Main Site and Roade Bypass has been developed further in separate documents which will be referenced later in this report.

2.23 To ensure the proposed development on Site 1 is designed adequately for its lifetime an allowance of 35% (higher central) and 65% (upper end) should applied to the design flood, and will be considered within the assessment.

2.24 Site 7 is located partially within Flood Zone 2/3, and being a highway it is classified as 'Essential Infrastructure'. It has an anticipated lifespan of over 60 years. Therefore, the upper end & higher central allowances for the 2080 epoch should be considered. However the extent of works is limited and generally outside the floodplain. Further assessment is provided in **Section 3.0**.

Strategic Flood Risk Assessment

2.25 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.

2.26 The West Northamptonshire Level 1 SFRA[4] has been reviewed in the production of this FRA. The SFRA provides information specific to the sites which are all located in South Northamptonshire in the form of fluvial, surface water and groundwater flood risk mapping, as well as records of historic flooding. Information from the Level 1 SFRA will be referenced within **Section 3.0** where applicable.

2.27 The West Northamptonshire Level 2 SFRA[5] was produced to facilitate the application of Sequential and Exception Tests to screen allocated development sites. The proposed application site is not referenced within the Level 2 SFRA.

Preliminary Flood Risk Assessment

2.28 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 Lead Local Flood Authorities.

2.29 The Northamptonshire County Council PFRA[6] considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. It also references the historic river flooding which occurred in the local area in South Northamptonshire District. However, no historic instances of flooding at the site are referenced. Information from the PFRA will be referenced within this report where applicable.

[4] West Northamptonshire Level 1 Strategic Flood Risk Assessment (Scott Wilson, 2009)
[5] West Northamptonshire Level 2 Strategic Flood Risk Assessment (Scott Wilson, 2009)
[6] Northamptonshire County Council Preliminary Flood Risk Assessment (Northamptonshire County Council, 2007)

Local Flood Risk Management Strategy

2.30 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. 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.

2.31 The Northamptonshire LFRMS[7] has been reviewed and will be referenced within this report where applicable.

[7] Northamptonshire County Council Local Flood Risk Management Strategy (Northamptonshire County Council, 2012)

3.0 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 each site in its current condition (using the same site references discussed above), and the impacts which the development could have in the wider catchment, prior to mitigation. These are discussed in greater detail in the forthcoming section. The mitigation measures proposed to address flood risk issues and ensure the development is appropriate for its location are discussed within **Section 4.0**.

Table 3.1 - Pre-Mitigation Sources of Flood Risk

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Fluvial	1,7		2,3,4,5, 6,8,9		All sites in FZ1 except 1 & 7 which partially encroach into FZ2/3.
			1,2,3,4, 5,6,7,8, 9		Various unnamed watercourses and ditches in vicinity.
Canals			4,6	1,2,3, 5,7,8,9	Grand Union Canal passes near sites 4 & 6.
Groundwater			1,2,3,4, 5,6,7,8, 9		All sites shown to fall within an area predicted to be at a low susceptibility to groundwater flooding.
Reservoirs and waterbodies			7	1,2,3,4, 5,6,8,9	Site 7 is partially within an area at risk from reservoir flooding.
Pluvial runoff	4,5,7,9	1,2,6	3,8		Refer to site specific assessments for comment.
Sewers			1,2,3,4, 5,6,7,8, 9		No known sewer flooding.
Effect of Development on Wider Catchment	1	2	3,4,5,6, 7,8,9		Varying impacts due to scale of works. Refer to site specific assessments.
	1	2	3,4,5,6, 7,8,9		The development will increase the area of impermeable surfaces leading to a potential increase in runoff.

Fluvial Flood Risk

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

Main Rivers

3.3 Sites 1 and 5 are located within the Upper Nene catchment, draining towards Northampton. Both sites are in Flood Zone 1, with the exception of a small area at the northern extent of Site 1 which is partially within Flood Zones 2 & 3.

3.4 All remaining sites are in the catchment of the River Tove, which flows towards Milton Keynes. All sites are in Flood Zone 1 with the exception of the northern extent of Site 7 which is partially within Flood Zone 2.

3.5 **Table 3.2** summarises the overall risk posed to the sites once the risk has been assessed and any potential mitigation strategies have been implemented. The mitigation requirements (if any) for each Site are discussed in detail in the following section.

Table 3.2 – Main River Flood Risk Summary

Site	Overall Risk
1 – Main Site	Low
2 – A508 Roade Bypass	None
3 – A508 Rookery/Ashton Road	None
4 – A508 Courteenhall Road Junction	None
5 – M1 J15A/A43	None
6 – Knock Lane/Stoke Road	None
7 – Pury Road	Low
8 – A508 Grafton Regis	None
9 – Knock Lane/Blisworth Road	None

Site 1

3.6 The closest Main River is the Wootton Brook which is a tributary of the River Nene and flows in a north westerly direction towards Northampton, from the eastern side of the M1. It is approximately 500m from the Main Site at the point the Main River designation ends, which is immediately east of the M1.

3.7 There is an upstream tributary of the Wootton Brook within the Main Site which is classed as an Ordinary Watercourse. This is considered in further detail and discussed later in this document.

3.8 The extent of Flood Zones 2 & 3 is at the extreme northern point of the Site 1 boundary in an area identified as required to upsize Anglian Water foul drainage assets to larger diameter pipes, and therefore no development is proposed in this area.

3.9 Fluvial risk from the Wootton Brook Main River can therefore be considered low.

Site 2 – A508 Roade Bypass

River Tove

3.10 The closest Main River is the River Tove which lies approximately 1.8km south of the site and flows in a north easterly direction.

3.11 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Tove.

3.12 Therefore the site is not considered to be at risk from any Main River source.

Site 3 – A508 Rookery Lane/Ashton Road

River Tove

3.13 The closest Main River is the River Tove which lies approximately 1.15km south of the site.

3.14 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Tove.

3.15 Therefore the site is not considered to be at risk from any Main River source.

Site 4 – A508 Courteenhall Road Junction

Wootton Brook

3.16 The closest Main River is the Wootton Brook which lies approximately 2.9km north east of the site.

3.17 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Brook.

3.18 Therefore the site is not considered to be at risk from any Main River source.

Site 5 – M1 J15A/A43

Wootton Brook

3.19 The closest Main River is the Wootton Brook which lies approximately 0.4km north of the site and flows in a north westerly direction.

3.20 The distance from the river and the intervening topography means that is well removed from the flood extent of the Wootton Brook.

3.21 Therefore the site is not considered to be at risk from any Main River source.

Site 6 – Knock Lane/Stoke Road

River Tove

3.22 The closest Main River is the River Tove which lies 4.1km south of the site and flows in a north easterly direction.

3.23 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Tove.

3.24 Therefore the site is not considered to be at risk from any Main River source.

Site 7 – Pury Road Junction

River Tove

3.25 The closest Main River is the River Tove which lies 80m north of the site and flows in a north easterly direction. The A508 Northampton Road north of the Pury Rd junction lies partially within Flood Zone 2.

3.26 Proposals are limited to a small widening scheme on the southbound carriageway of the A508 which will increase the impermeable area by around 300m^2. The function of the road will not change and the proposals are purely to provide betterment to the functioning of the highway.

3.27 It will be necessary to mitigate the additional impermeable area by providing adequate extra capacity within the adjacent drainage network, a separate strategy has been prepared to address this.

3.28 The extent of the widening works is removed from the area within the floodplain and therefore the proposed works are effectively within Flood Zone 1.

3.29 A drainage mitigation scheme will ensure that the post development flood risk will not increase. Subject to a suitable strategy being implemented, flood risk will not increase and remain low.

Site 8 – A508 Grafton Regis

River Tove

3.30 The closest Main River is the River Tove which lies approximately 0.75km east of the site and flows in a south easterly direction.

3.31 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Tove.

3.32 Therefore the site is not considered to be at risk from any Main River source.

3.33 Site 9 – Knock Lane/Blisworth Road

Wootton Brook

3.34 The closest Main River is the Wootton Brook which lies approximately 3.2km north east of the site and flows in a north easterly direction.

3.35 The distance from the river and intervening topography means that the site is well removed from the flood extents of the Wootton Brook.

3.36 Therefore the site is not considered to be at risk from any Main River source.

Minor Watercourses

3.37 **Table 3.3** summarises the overall risk posed to the sites once the risk has been assessed and any potential mitigation strategies have been implemented. The mitigation requirements (if any) for each Site are discussed in detail in the following section.

Table 3.3 – Minor Watercourse Flood Risk Summary

Site	Overall Risk
1 – Main Site	High
2 – A508 Roade Bypass	Low
3 – A508 Rookery/Ashton Road	None
4 – A508 Courteenhall Road Junction	Low
5 – M1 J15A/A43	Low
6 – Knock Lane/Stoke Road	None
7 – Pury Road	Low
8 – A508 Grafton Regis	None
9 – Knock Lane/Blisworth Road	Low

Site 1 – Main Site

Courteenhall Brook

3.38 A minor watercourse flows through the southern part of the Main Site, forming an upstream tributary to the Wootton Brook. For the purpose of this assessment it is referred to as Courteenhall Brook

3.39 This watercourse has been surveyed and a hydraulic model constructed which provides mitigation options for the anticipated flooding. This modelling is summarised in a Technical Note (reference NGW-BWB-EWE-XX-RP-EN-0002_TN1) and is included as **Appendix 3**.

3.40 The mitigation measures as proposed within the Technical Note will ensure the proposed development remains at a low risk of fluvial flooding from the Courteenhall

Brook, and provides a degree of downstream betterment. Specific areas of the site are to be formed to act as floodplain compensation to offset the impact of the development.

3.41 Subject to the recommended flood mitigation strategies being implemented risk to the proposed development will be low.

Site 2 – A508 Roade Bypass

3.42 A minor watercourse flows near and under the proposed bypass route, forming an upstream tributary of the River Tove. For the purpose of this assessment it has been referred to as Roade Brook.

3.43 This watercourse has been surveyed and a hydraulic model constructed which provides mitigation options for the anticipated flooding. This modelling is summarised in a Technical Note (reference NGW-BWB-EWE-XX-RP-EN-0001_TN1) and is included as **Appendix 4**.

3.44 There is limited mitigation necessary based on the current proposals as the risk is generally low with flows constrained to the channel in the design event. Some realignment may be necessary but given the proposed raised level of the alignment in this location the overall risk is considered to be low.

Site 3 – A508 Rookery Lane/Ashton Road

3.45 The site is well removed from the vicinity of any minor watercourses. There are existing drainage ditches for the highway which do not pose any risk to the proposals being located lower than the carriageways.

3.46 The risk from this source is therefore considered to be low.

Site 4 – A508 Courteenhall Road Junction

3.47 The site is well removed from the vicinity of any minor watercourses. There are existing drainage ditches for the highway which do not pose any risk to the proposals being located lower than the carriageways.

3.48 The risk from this source is therefore considered to be low.

Site 5 – M1 J15A/A43

3.49 The closest minor watercourse flows under the Grand Union Canal to the west, however the Motorway junction is located significantly higher than the both the watercourse and the canal.

3.50 The junction is served by a network of existing drainage which includes ditches however the risk from these is not considered to be significant.

3.51 The risk from this source is therefore considered to be low.

Site 6 – Knock Lane/Stoke Road

3.52 The site is well removed from the vicinity of any minor watercourses. There are existing drainage ditches for the highway which do not pose any risk to the proposals as they are generally much lower than the carriageway levels.

3.53 The risk from this source is therefore considered to be low.

Site 7 – Pury Road Junction

3.54 An unnamed watercourse/ditch lies adjacent to the River Tove at the northern extent of the proposed works, however it is much lower than the carriageway and would not pose any additional risk than previously noted from the Tove, which would likely overcome this smaller channel.

3.55 Overall, the site sits well above the levels of the unnamed watercourse hence the risk of flooding from this source on its own is considered to be low.

Site 8 – A508 Grafton Regis

3.56 The site is well removed from the vicinity of any minor watercourses. There are existing drainage ditches for the highway which do not pose any risk to the proposals being located lower than the carriageways.

3.57 The risk from this source is therefore considered to be low.

Site 9 – Knock Lane/Blisworth Road

3.58 The site is well removed from the vicinity of any minor watercourses. There are existing drainage ditches for the highway and adjacent fields which do not pose any risk to the proposals being located lower than the carriageways.

3.59 The risk from this source is therefore considered to be low.

Flood Risk from Canals

3.60 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.

3.61 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.

3.62 Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails. **Table 3.4** summarises the risk posed to the individual sites from the canal source. Further discussion is provided beneath where appropriate.

Table 3.4 - Canals Flood Risk Summary

Site	Overall Risk
1 – Main Site	None
2 – A508 Roade Bypass	None
3 – A508 Rookery/Ashton Road	None
4 – A508 Courteenhall Road Junction	None
5 – M1 J15A/A43	None
6 – Knock Lane/Stoke Road	None
7 – Pury Road	None
8 – A508 Grafton Regis	None
9 – Knock Lane/Blisworth Road	None

Sites 1,2,3,4,7,8,9

3.63 These sites are located away from canals and therefore no risk is present.

Site 5 – M1 J15A/A43

3.64 The Grand Union Canal flows to the west of the Motorway junction but at significantly lower levels and it therefore does not present a risk.

Site 6 – Knock Lane/Stoke Road

3.65 The junction is adjacent to the route of the Grand Union Canal however it is within a tunnel at this point and therefore does not pose any risk.

Groundwater Flood Risk

3.66 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.

3.67 **Table 3.5** summarises the risk posed to the individual sites from the groundwater source with further discussion is provided beneath where appropriate.

Table 3.5 - Groundwater Flood Risk Summary

Site	Overall Risk
1 – Main Site	Low
2 – A508 Roade Bypass	Low
3 – A508 Rookery/Ashton Road	Low
4 – A508 Courteenhall Road Junction	Low
5 – M1 J15A/A43	Low
6 – Knock Lane/Stoke Road	Low
7 – Pury Road	Low
8 – A508 Grafton Regis	Low
9 – Knock Lane/Blisworth Road	Low

Site 1 – Main Site

3.68 The underlying geology is identified to be comprised of Whitby Mudstone Formation with superficial deposits of sand and gravel.

3.69 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a 25% to 50% susceptibility to groundwater flooding, as illustrated within **Figure 3.1.**

3.70 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

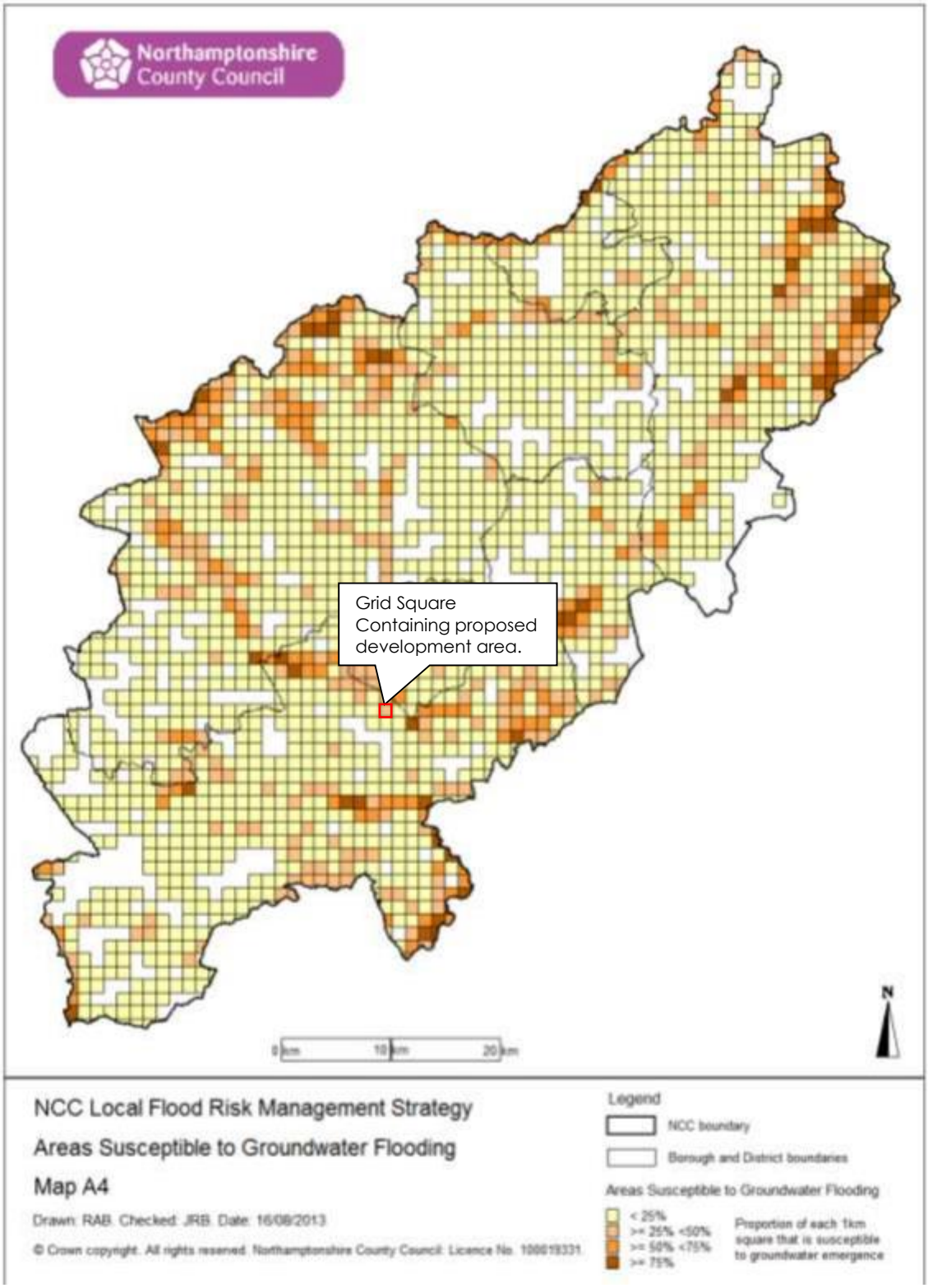


Figure 3.1 – Areas Susceptible to Groundwater Flooding Map (Site 1)
Source: Northamptonshire LFRMS – Figure A4

3.71 A thorough geotechnical investigation has been undertaken within the Main Site, and proposed levels have been compared to recorded groundwater levels. Significant

changes in finished ground levels are proposed however the vast majority of the site is to be paved in impermeable material which will not permit groundwater to flow through it.

3.72 The remaining area within the boundary comprises existing hard paved carriageways which will not permit groundwater flow through them.

3.73 Groundwater is therefore a residual risk which should be managed during construction appropriately and considered in the design of external levels to ensure any theoretical flows are managed without posing a risk.

Site 2 – A508 Roade Bypass

3.74 The underlying geology is identified to be comprised of Blisworth Limestone Formation and Stamford Member, with superficial deposits of Tufa.

3.75 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a <25% susceptibility to groundwater flooding.

3.76 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.77 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 3 – A508 Rookery Lane/Ashton Road

3.78 The underlying geology is identified to be comprised of a combination of Whitby Mudstone Formation, with superficial deposits of sand and gravel.

3.79 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a <25% susceptibility to groundwater flooding.

3.80 There no records of groundwater flooding occurring in the South Northamptonshire District.

3.81 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 4 – A508 Courteenhall Road Junction

3.82 The underlying geology is identified to be comprised of a combination of Whitby Mudstone Formation, with superficial deposits of sand and gravel.

3.83 The Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a <25% susceptibility to groundwater flooding, as illustrated within **Figure 3.4.**

3.84 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.85 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 5 – M1 J15A/A43

3.86 The underlying geology is identified to be comprised of a combination of Whitby Mudstone Formation, with superficial deposits of Oadby Member.

3.87 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a 25% up to 50% susceptibility to groundwater flooding.

3.88 British Geological Survey Mapping has borehole records for the site (SP75NW244) and the record shows no groundwater to be found at depths up to 7.1m.

3.89 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.90 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 6 – Knock Lane/Stoke Road

3.91 The underlying geology is identified to be comprised of a combination of Blisworth Limestone Formation, with no superficial deposits.

3.92 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a 25% up to 50% susceptibility to groundwater flooding.

3.93 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.94 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 7 – Pury Road Junction

3.95 The underlying geology is identified to be comprised of a combination of Whitby Mudstone Formation, with superficial deposits of Alluvium.

3.96 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a 25% up to 50% susceptibility to groundwater flooding.

3.97 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.98 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 8 – A508 Grafton Regis

3.99 The underlying geology is identified to be comprised of a combination of Blisworth Limestone Formation, with no superficial deposits.

3.100 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a <25% susceptibility to groundwater flooding.

3.101 The West Northamptonshire SFRA confirms there are no records of groundwater flooding occurring in the South Northamptonshire District.

3.102 Based on the available information, the overall risk posed to the site by groundwater is low and any remaining risk is residual in nature.

Site 9 – Knock Lane/Blisworth Road

3.103 The underlying geology is identified to be comprised of a combination of Whitby Mudstone Formation, with superficial deposits of Oadby Member.

3.104 Northamptonshire LFMS groundwater susceptibility mapping shows the proposed site to be within an area at a 25% up to 50% susceptibility to groundwater flooding.

Flood Risk from Reservoirs & Large Waterbodies

3.105 Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.

3.106 **Table 3.6** summarises the overall risk posed to the sites based on reservoir flooding.

Table 3.6 – Reservoir/Large Waterbodies Flood Risk Summary

Site	Overall Risk
1 – Main Site	None
2 – A508 Roade Bypass	None
3 – A508 Rookery/Ashton Road	None
4 – A508 Courteenhall Road Junction	None
5 – M1 J15A/A43	None
6 – Knock Lane/Stoke Road	None
7 – Pury Road	Low
8 – A508 Grafton Regis	None
9 – Knock Lane/Blisworth Road	None

Sites 1,2,3,4,5,6,8,9

3.107 These sites are all well removed from areas at risk from reservoirs or large waterbodies.

Sites 7 – Pury Road

3.108 Environment Agency Mapping identifies that the reservoir breach extent from Towcester Flood Storage Reservoir extents into the north of the proposed works boundary.

3.109 In practice this would not occur due to the significant changes in levels noted on the topographical survey, and water would remain within the River Tove floodplain.

3.110 Therefore, the risk of flooding is considered to be low.

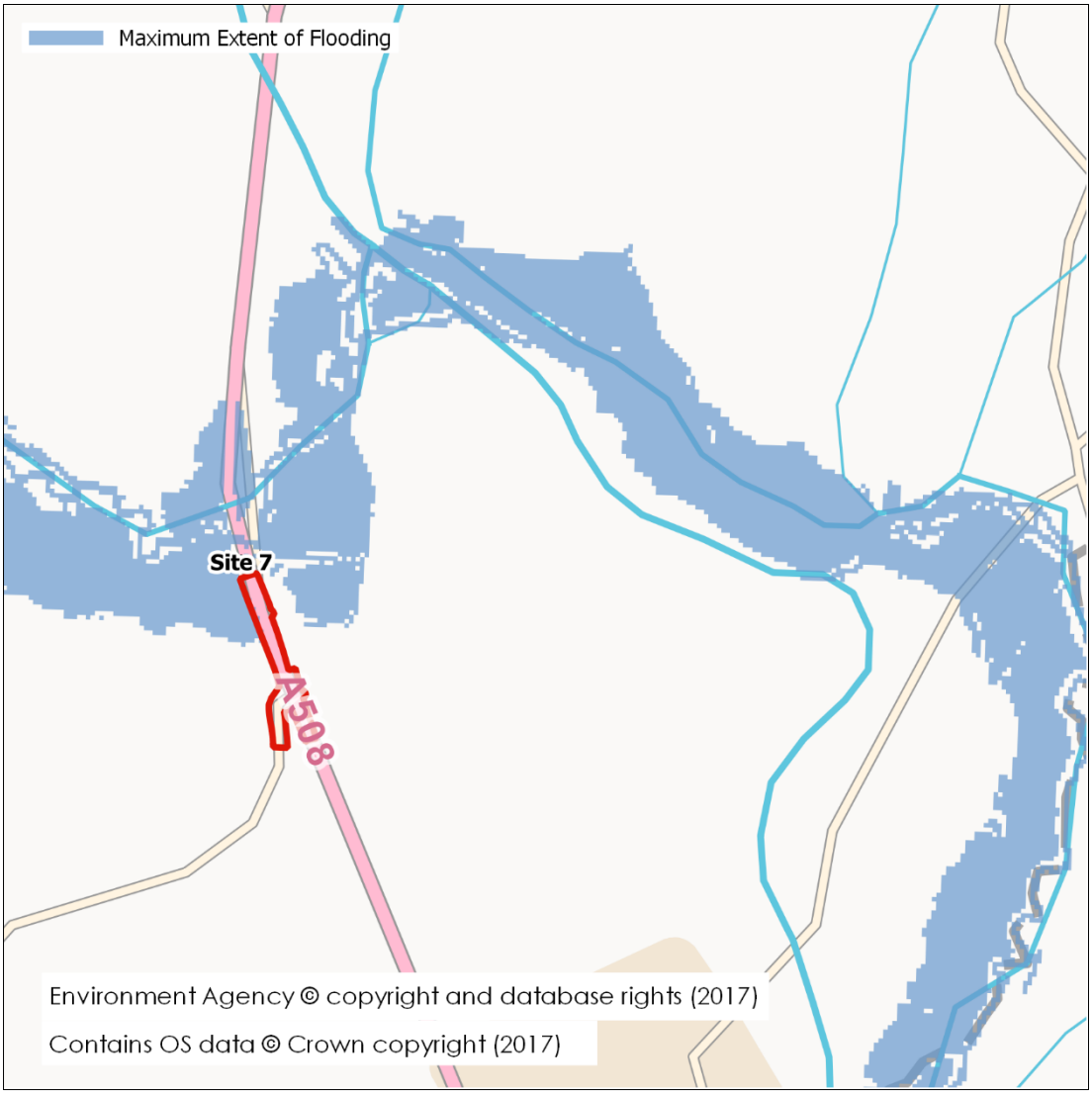


Figure 3.2 - Site 7 Reservoir Failure Flood Risk Map

Pluvial Flood Risk

3.111 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. **Table 3.7** provides a summary of risk to the sites from the pluvial source, with further analysis provided for each site as necessary.

Table 3.7 - Pluvial Flood Risk Summary

Site	Overall Risk
1 – Main Site	Low
2 – A508 Roade Bypass	Low
3 – A508 Rookery/Ashton Road	Low
4 – A508 Courteenhall Road Junction	Low
5 – M1 J15A/A43	Low
6 – Knock Lane/Stoke Road	Medium
7 – Pury Lane	Low
8 – A508 Grafton Regis	Low
9 – Knock Lane/Blisworth Road	High

Site 1 – Main Site

3.112 Pluvial risk within the Site 1 boundary is contained within the Main Site and related to existing watercourses, ditches and topographic low points (see **Figure 3.11**). The mapping does not make allowance for culverts or outfalls and therefore can be considered to over represent the extent of flooding in some instances. The proposed development will significantly change ground levels across the site.

3.113 As discussed in the fluvial risk section, a hydraulic model has been produced for Courteenhall Brook. This also includes a calculated allowance for runoff from the developed site such that fluvial and pluvial risk can be quantified together. Refer to **Appendix 3** for this report.

3.114 The increased impermeable area associated with the site will require a drainage strategy which restricts flows to pre development runoff rates. The inclusion of such a strategy will provide the mitigation necessary to ensure that the risk posed by the development is not increased and remains low.

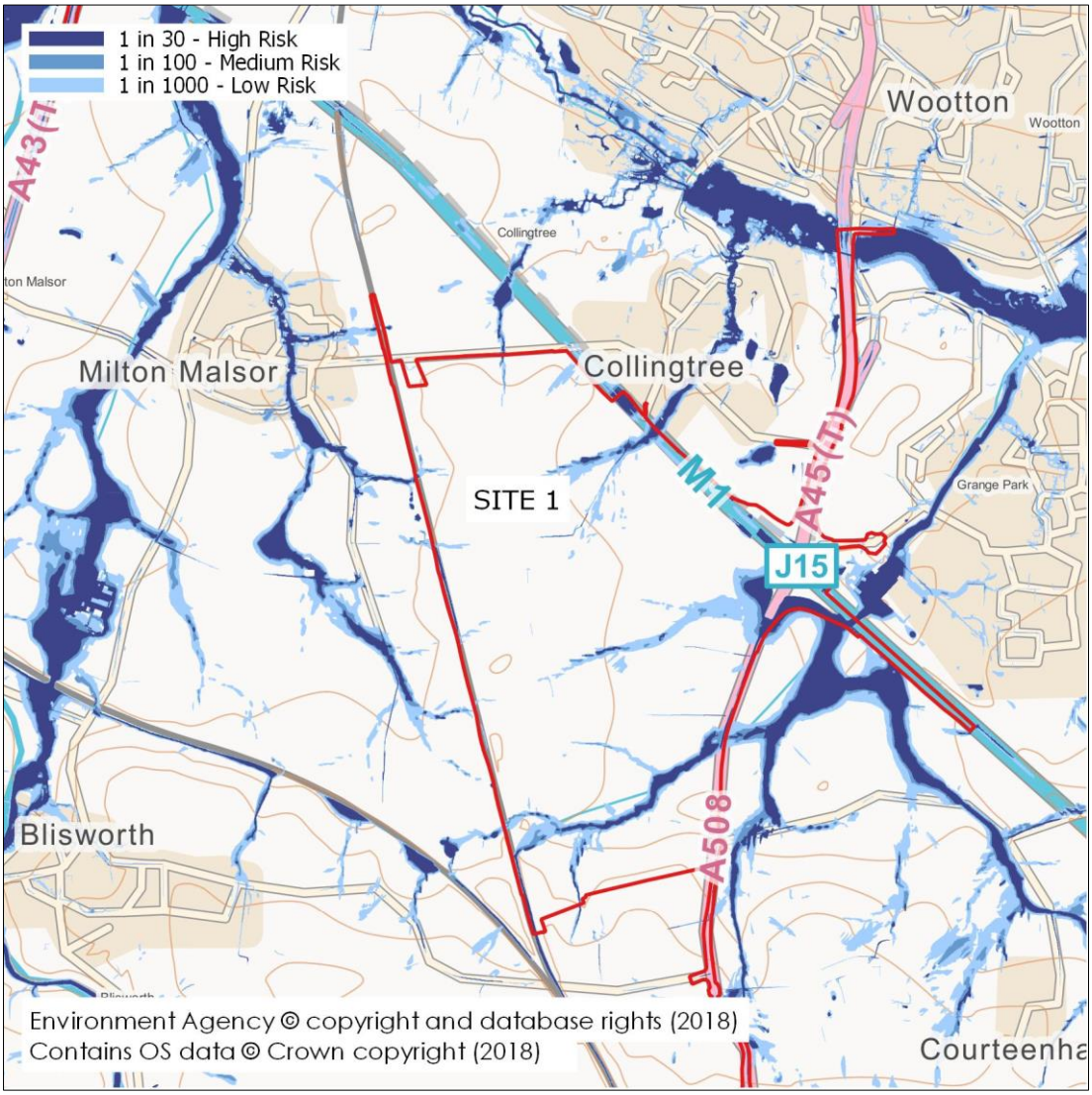


Figure 3.3 – Risk of Flooding from Surface Water Mapping (Site 1)

Site 2 – A508 Roade Bypass

3.115 Pluvial risk within the Site 2 boundary is predominantly due to the small watercourse (Roade Brook) which crosses the route to the west of the village.

3.116 As discussed in the fluvial risk section, a hydraulic model has been produced for Roade Brook (refer to **Appendix 4** for this report.). The fluvial risk from the watercourse (i.e the surface water risk shown in **Figure 3.12**) is low and therefore risk to the new bypass is also low.

3.117 A drainage strategy which restricts flows to pre development runoff rates will be necessary in order to ensure the risk posed by the bypass is not increased and remains low.

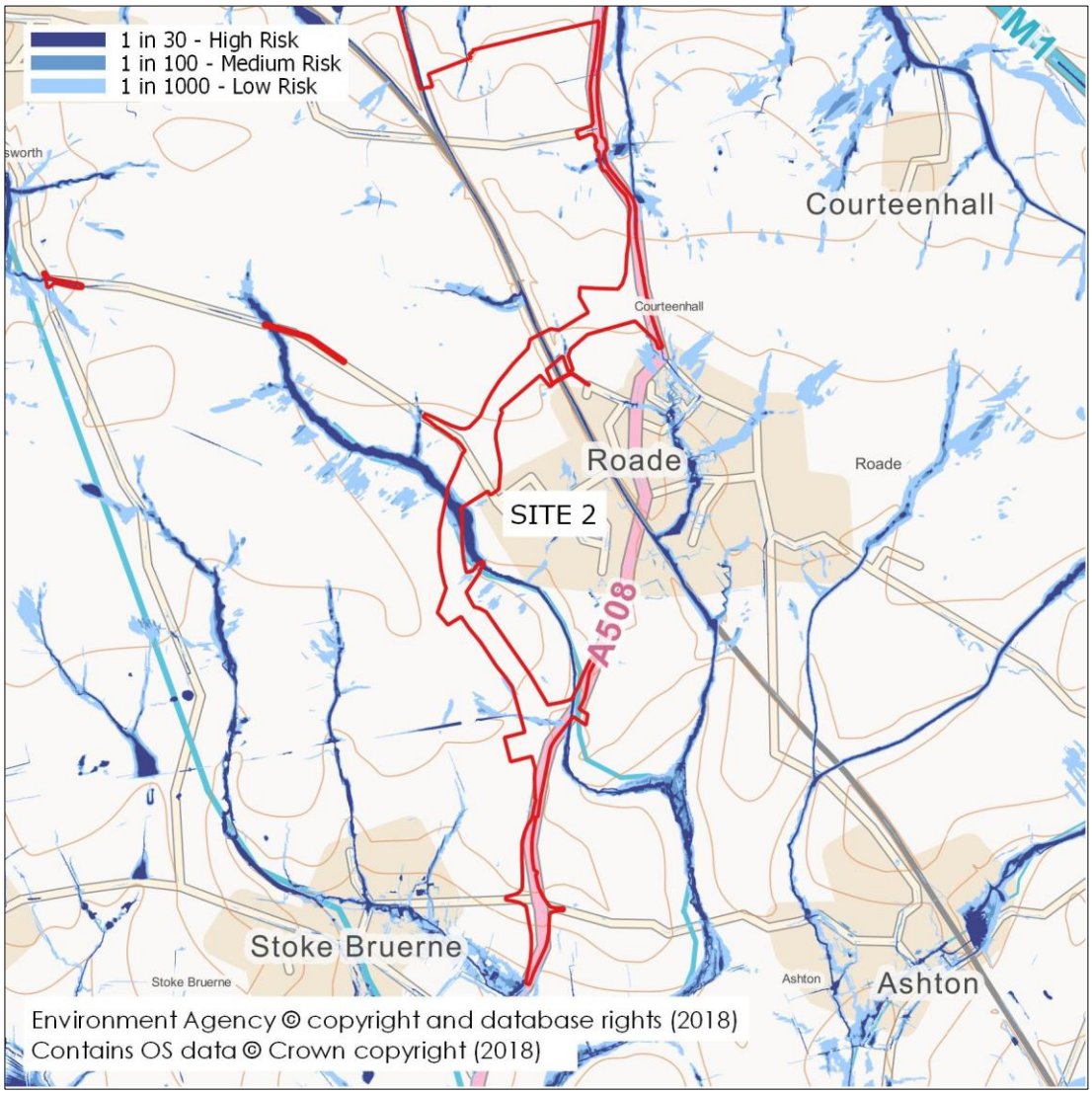


Figure 3.4 - Risk of Flooding from Surface Water Mapping (Site 2)

Site 3 – A508 Rookery Lane/Ashton Road

3.118 There is no pluvial risk indicated within the Site 3 boundary although there is some to the immediate south associated with low lying fields (see **Figure 3.13**). However the topography is such that this will not encroach towards the site.

3.119 The risk from this source can therefore be considered low.

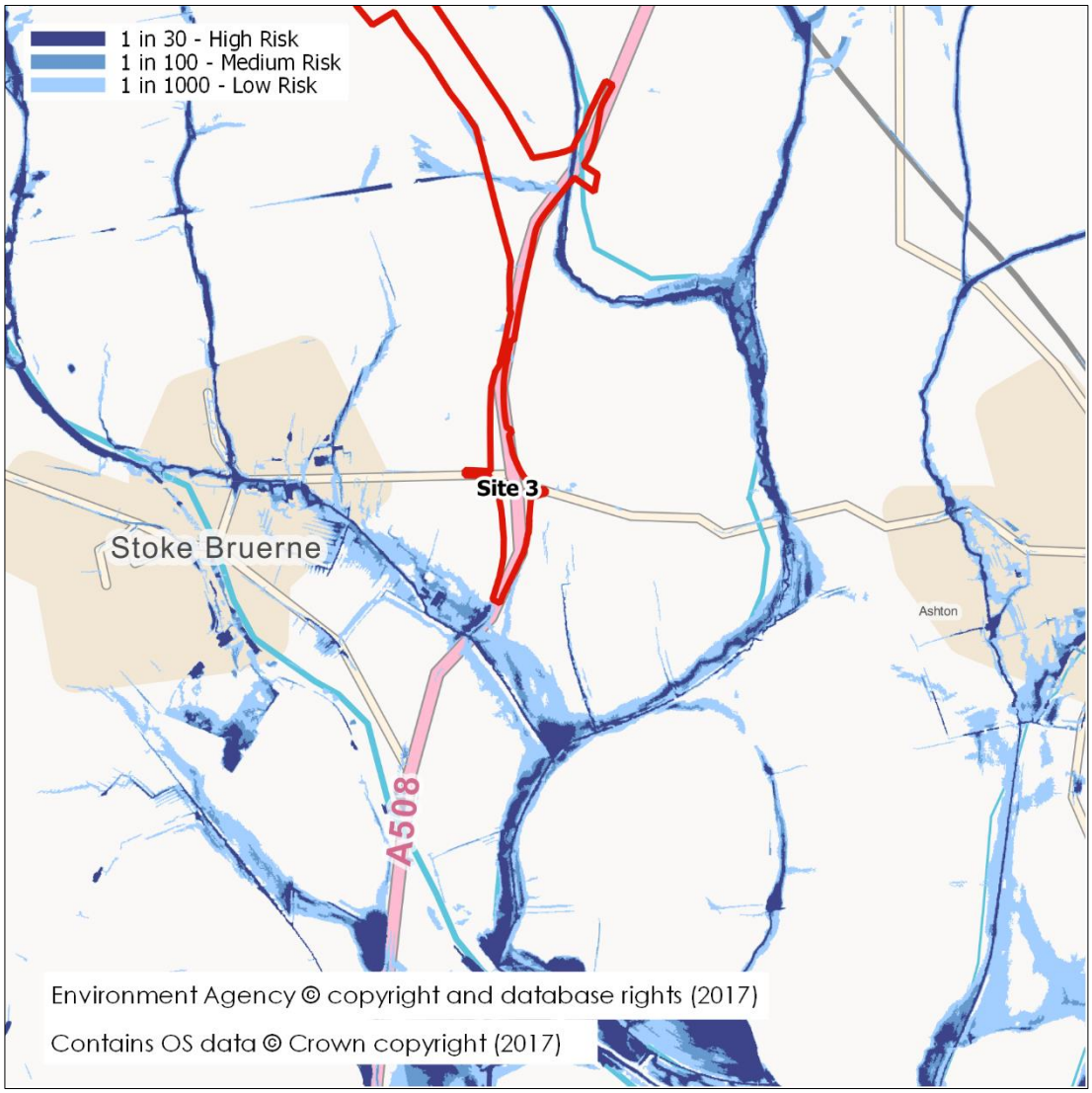


Figure 3.5 - Risk of Flooding from Surface Water Mapping (Site 3)

Site 4 – A508 Courtenhall Road Junction

3.120 Pluvial risk within the Site 4 boundary is limited to a flow route from adjacent fields crossing the carriageway at a localised low point, passing eastwards towards a local drainage ditch (see **Figure 3.14**).

3.121 The proposals in this area are to widen the existing northbound carriageway but levels will not be affected to a degree where the flow route would be compromised, and it will remain as existing.

3.122 The risk from this source can therefore be considered low.

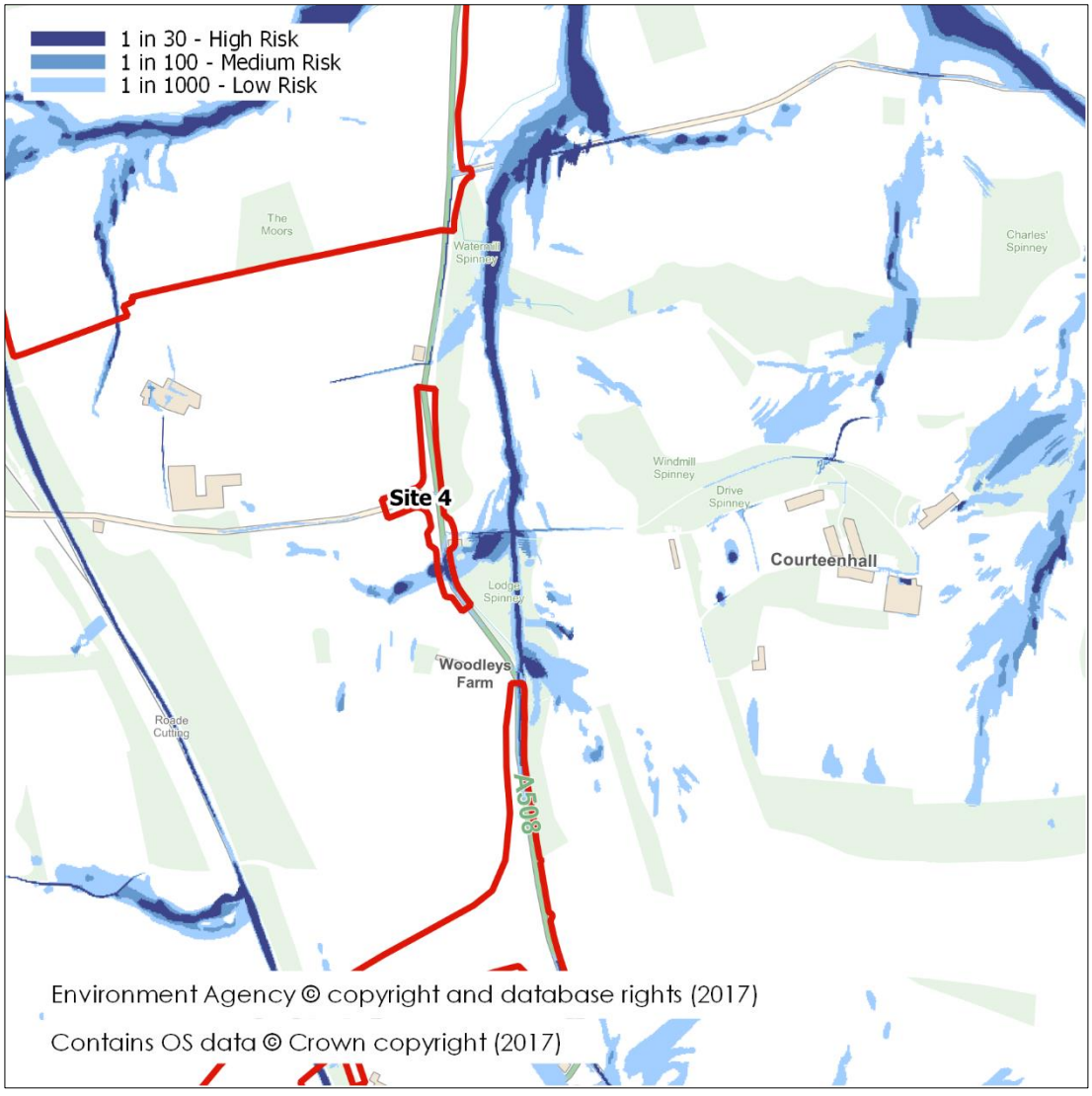


Figure 3.6 - Risk of Flooding from Surface Water Mapping (Site 4)

Site 5 – M1 J15A/A43

3.123 The risk shown to the existing carriageways is due to the topography of the junction, being largely in cut and therefore susceptible to flow from the adjacent land pooling on the carriageway (see **Figure 3.15**). In practice the existing drainage network which is not represented within the pluvial modelling would capture this flow.

3.124 The amendments to the carriageway are limited to widening works around the roundabouts and any additional impermeable area will require managing within a suitable drainage strategy, however the relative increase is nominal.

3.125 The risk from this source can therefore be considered low.

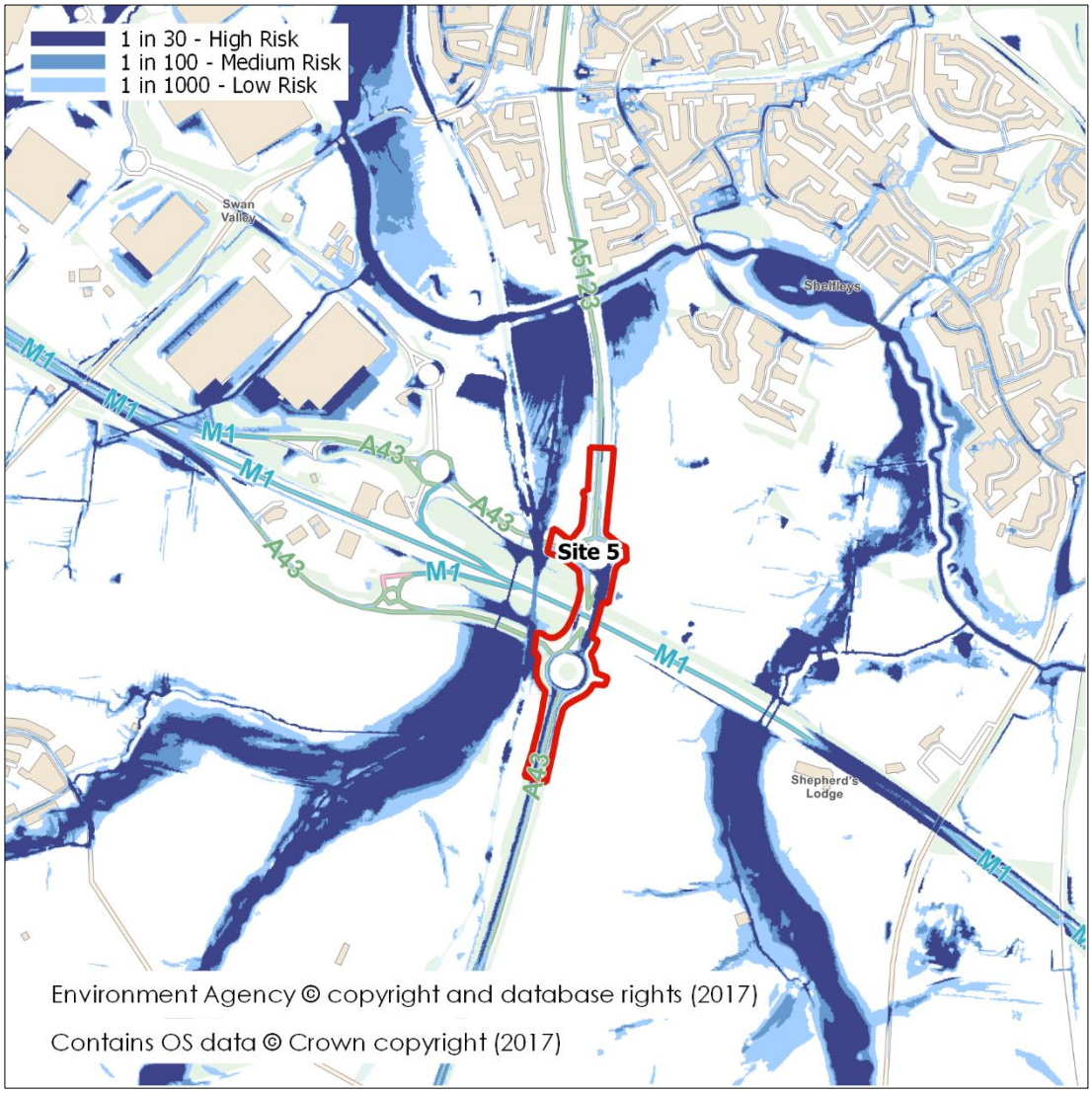


Figure 3.7 - Risk of Flooding from Surface Water Mapping (Site 5)

Site 6 – Knock Lane/Stoke Road

3.126 Pluvial flooding is known to present an issue at this location, due in part to the steep gradient of Knock Lane creating potential for flows to pool at the junction, and exacerbated by runoff from the south (see **Figure 3.16**).

3.127 Runoff will ultimately flow westwards across the adjacent fields into a network of existing ditches, however the widening of Knock Lane could increase the risk and suitable mitigation will be necessary to ensure the scheme remains safe.

3.128 Although the risk remains residual, suitable mitigation measures will be required to reduce the theoretical risk and offset the increase in impermeable area to an acceptable result to ensure the overall risk post development remains low.

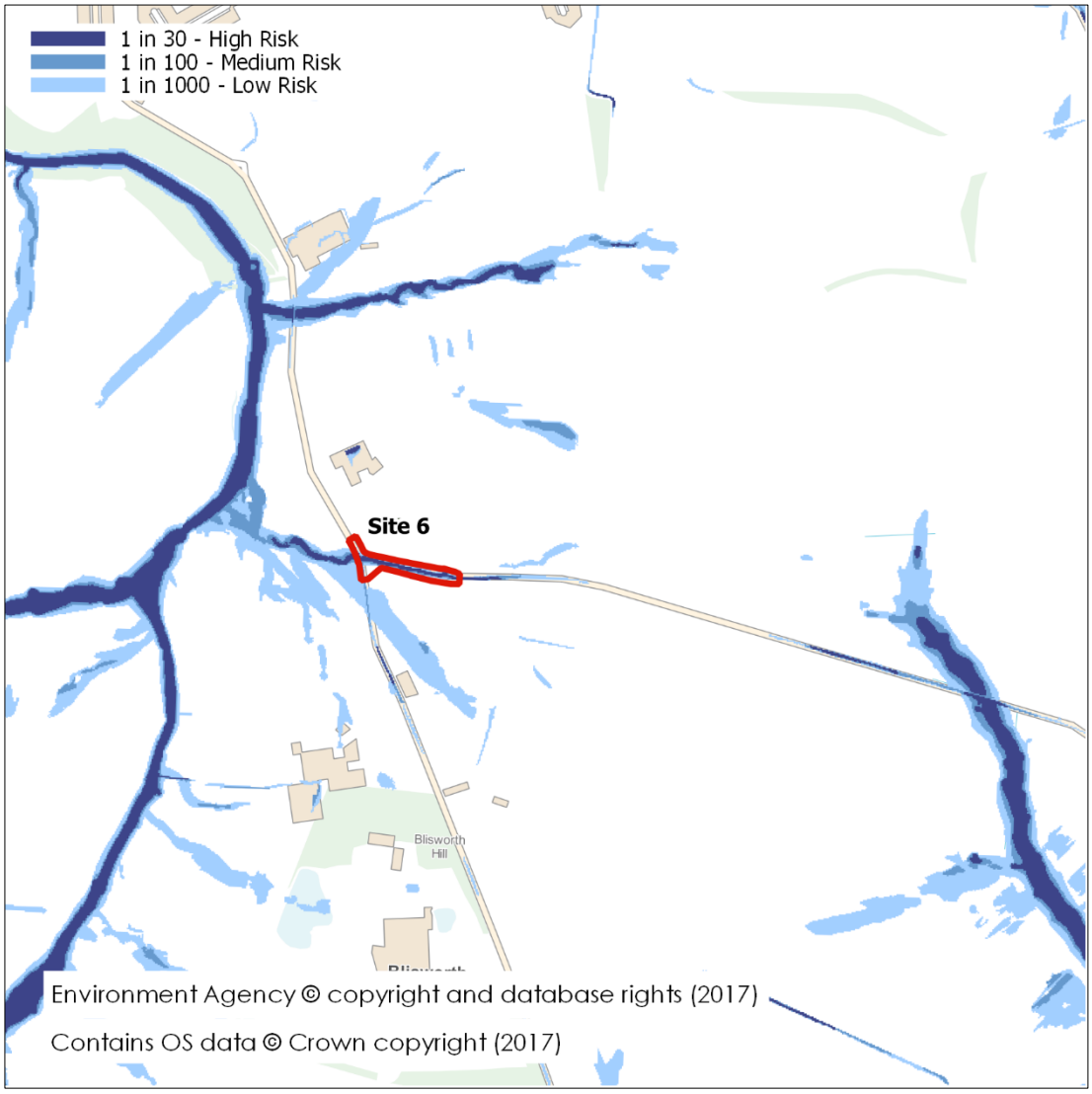


Figure 3.8 - Risk of Flooding from Surface Water Mapping (Site 6)

Site 7 – Pury Road Junction

3.129 Areas of High risk are indicated on mapping at the Pury Rd/A508 junction and to the north within the carriageway (see **Figure 3.17**). At Pury Rd, a low spot to the south of the carriageway is shown to collect runoff however this area is lower than the carriageway, being a part of the open ditch drainage network. There is also no allowance within the mapping for an outlet from this ditch which will allow flows to drain away.

3.130 The risk to the north is associated with a local topographic low point where flow would theoretically collect on the surface. A significant number of gullies are already present within the highway, but not included within the pluvial modelling which would collect runoff.

3.131 The proposed amendments are limited to widening the southbound carriageway. The increase in impermeable area will require consideration to ensure flood risk is not increased, however the potential risk remains low.

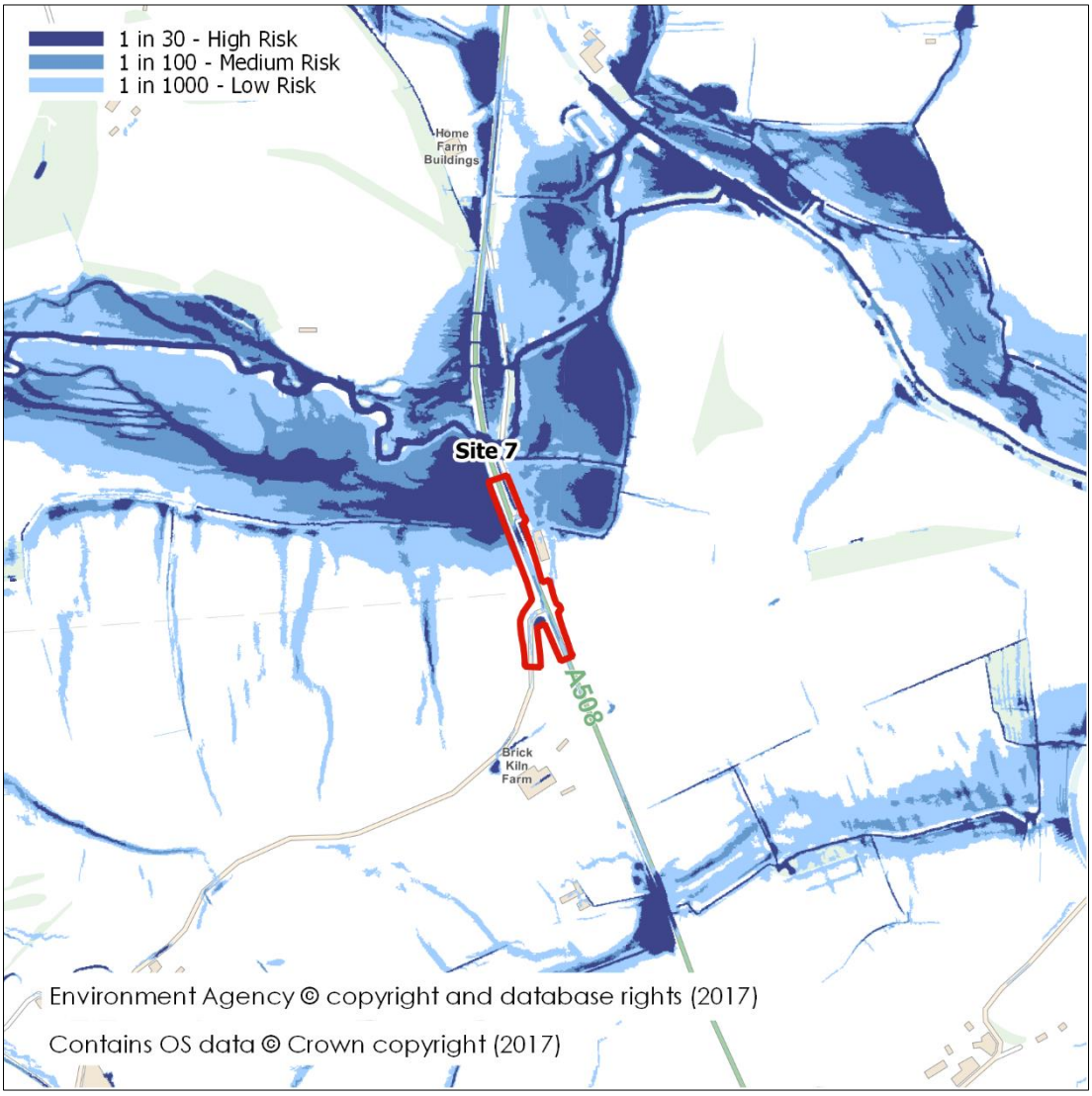


Figure 3.9 - Risk of Flooding from Surface Water Mapping (Site 7)

Site 8 – A508 Grafton Regis

3.132 No pluvial risk is shown within this site and the risk can therefore be considered low.

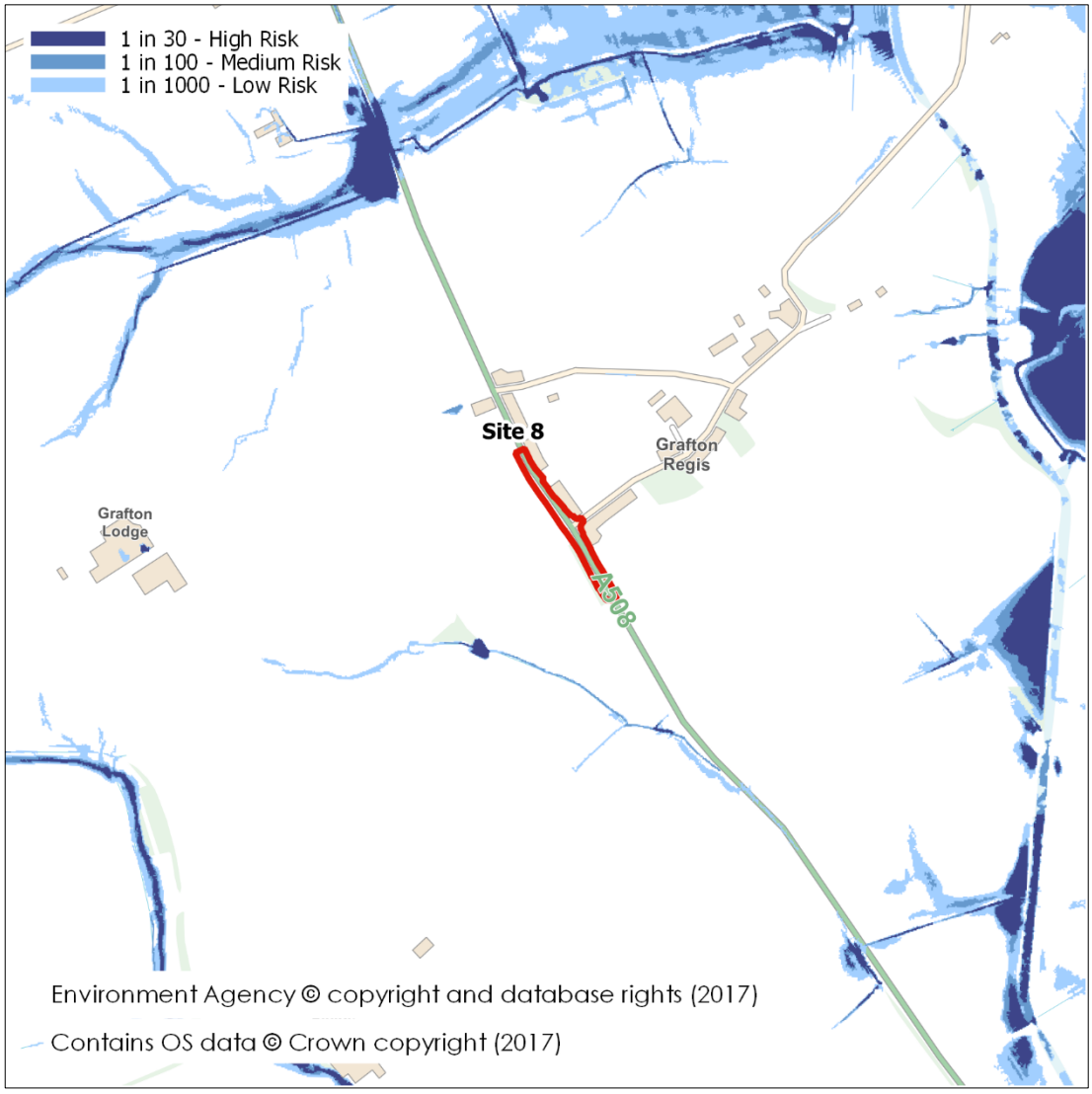


Figure 3.10 - Risk of Flooding from Surface Water Mapping (Site 8)

Site 9 – Knock Lane/Blisworth Road

3.133 A flow route is shown on the mapping to pass across the carriageway towards the south, broadly following the route of a localised low area in adjacent fields before entering an existing ditch (see **Figure 3.19**).

3.134 In practice the flow from the north would be intercepted by the existing drainage ditch adjacent to the carriageway and conveyed into the network and culverted underneath the carriageway towards the south. This culvert is not represented within the pluvial modelling and therefore the likelihood of the degree of risk shown on the mapping being realised is low.

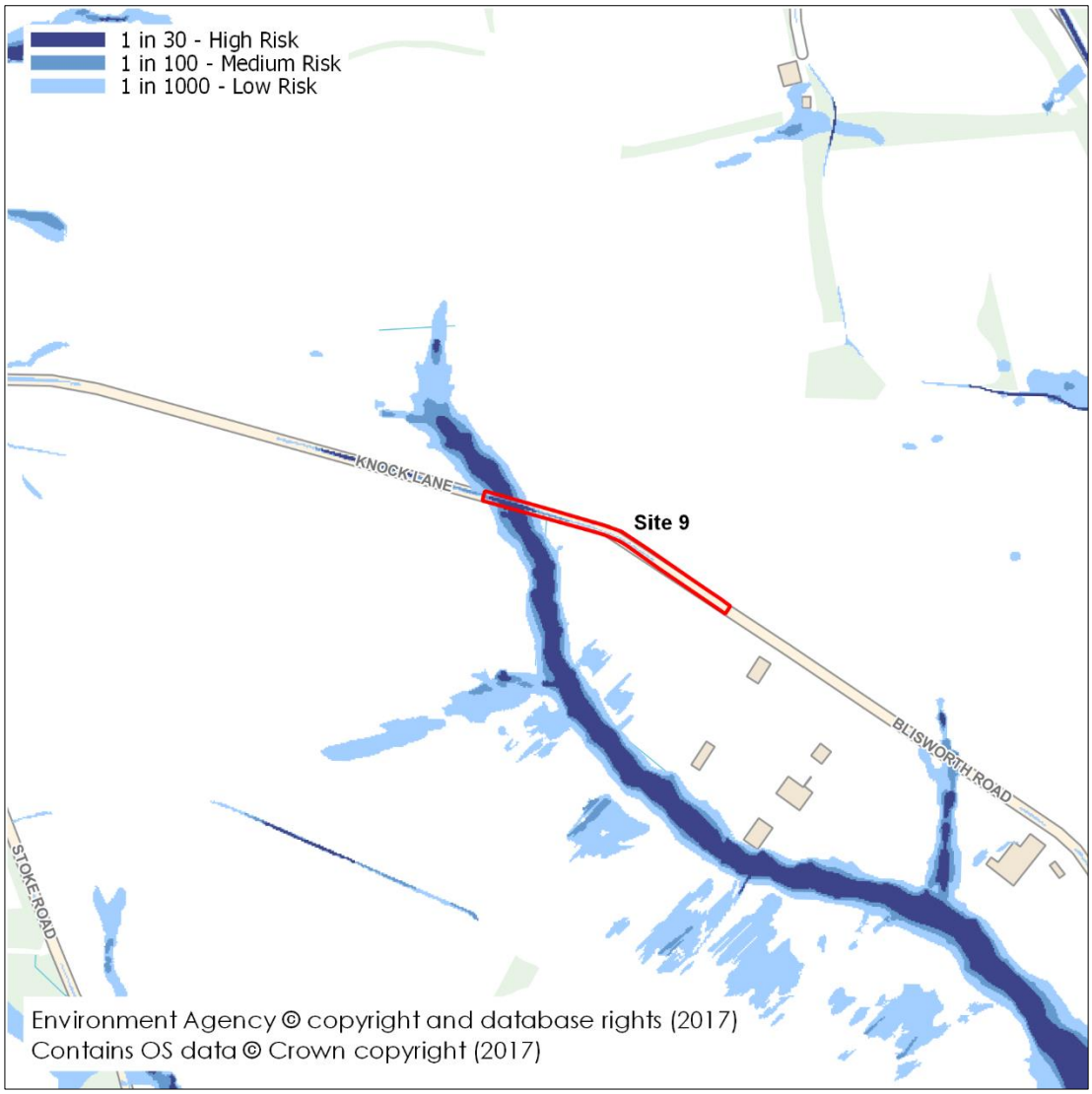


Figure 3.11 - Risk of Flooding from Surface Water Mapping (Site 9)

Flood Risk from Sewers

3.135 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.

3.136 **Table 3.8** provides a summary of the risk posed from sewer flooding at each site, with text below to provide additional information where required.

Table 3.8 - Sewer Flood Risk Summary

Site	Overall Risk
1 – Main Site	Low
2 – A508 Roade Bypass	Low
3 – A508 Rookery/Ashton Road	Low
4 – A508 Courteenhall Road Junction	Low
5 – M1 J15A/A43	Low
6 – Knock Lane/Stoke Road	Low
7 – A508 Rookery Lane/Ashton Road Junction	Low
8 – A508 Grafton Regis	Low
9 – Knock Lane/Blisworth Road	Low

Site 1 – Main Site

3.137 A review of Anglian Water sewer records reveals that there are no waste water assets within the Main Site but a network of sewers is present in the highways surrounding the development.

3.138 Where there are sewers present any exceedance would be captured within the existing drainage network and would not materially impact the operation of the highway. Additional impermeable area will require a suitable drainage strategy to ensure there is no increased risk.

3.139 Therefore the risk from existing sewers can be considered low.

Sites 2 – 9 - Highways

3.140 The remaining sites are entirely comprised of new or existing highway. There are no Anglian Water sewers within these sites, drainage being comprised of ditches or drains owned and maintained by the relevant Highway Authority.

3.141 Were the existing drainage features to exceed their capacity, this would not have a material impact on the functioning of the highway.

3.142 Where new impermeable area is proposed, a suitable drainage strategy will be required to mitigate the impact this could have on the receiving network.

3.143 Therefore the risk from existing sewers can be considered low.

Effect of Development on Wider Catchment

Displacement of Floodplain

3.144 Hydraulic modelling undertaken for the Main Site (included as **Appendix 3**) shows that the modelled flood extents of the Courteenhall Brook encroach into the proposed development area.

3.145 Without mitigation flood risk both on and off site could be increased.

3.146 Hydraulic modelling undertaken for Roade Bypass (included as **Appendix 4**) identifies that there is no out of bank flooding in the design event, and therefore mitigation is not required. The risk posed elsewhere by the proposed bypass is therefore very low.

3.147 The remaining sites (3 – 9) do not propose development within the floodplain.

Impedance of Flood Flows

3.148 Redevelopment of the Main Site has the potential to redirect flow due to the proposed amendments to external levels and access to existing culverts. Suitable mitigation will be necessary to ensure that any re-routing of flow does not increase flood risk elsewhere.

3.149 The Roade Brook is proposed to be culverted where it flows under the bypass alignment. It has been assumed that any culvert will not alter the cross sectional area of the channel but the final design should be checked to confirm that larger flows are not impeded.

3.150 The remaining sites (3 – 9) will not impede any flows.

3.151 Some mitigation will be necessary for the Main Site, but the flood flow routes are restricted to that caused predominantly by the development itself hence risk can be considered low.

Development Drainage

3.152 All sites will result in an increase in impermeable area and therefore potential runoff. A suitable drainage strategy will be required to ensure risk to the wider catchment can be mitigated.

4.0 FLOOD RISK MITIGATION

4.1 **Section 3.0** has identified the sources of flooding which could potentially pose a risk to the site and the proposed development. This section of the FRA sets out the mitigation measures which are to be incorporated within the proposed development to address and reduce the risk of flooding to within acceptable levels.

Sequential Arrangement

4.2 No buildings are proposed adjacent to the Courteenhall Brook, with the floodplain being separated on plan by attenuation ponds and buildings being elevated well above the watercourse.

Development Levels

Finished Levels

4.3 Modelled flood levels in the Courteenhall Brook vary along its length with the most extreme level approximately 89.0m at the upstream extent, falling to around 80.5m adjacent the M1 junction. Finished Floor Levels (FFLs) of the proposed building are defined with reference to a minimum level, with the details for each building required to fit within that and the other parameters defined. The minimum FFLs range from 90.0m to 81.5m AOD, however this is not a function of the relative flood risk which based on the Indicative Masterplan would not necessitate a minimum floor level.

4.4 The nature of large distribution warehouses and supporting infrastructure is that access requirements are fixed by design (dock levellers etc), however where practicable finished levels will fall away from buildings.

4.5 Ground levels will be profiled to encourage pluvial runoff and overland flows away from the built development and towards the nearest drainage point.

4.6 Highway levels will be designed to comply with the relevant approving authorities standards.

Safe Access and Egress

4.7 The proposed amendments to the Courteenhall Brook floodplain are sufficient to ensure that the development remains unaffected by flooding and that the critical highway access routes can be utilised by ensuring flow does not 'weir' from the site across the carriageways.

Floodplain Compensation

4.8 The principles of floodplain compensation for the Main Site are discussed within the technical note included as **Appendix 3**.

4.9 No further compensation arrangements are required.

Surface Water Drainage

4.10 To mitigate the developments impact on the current runoff regime it is proposed to incorporate surface water attenuation and storage as part of the development proposals.

4.11 The Main Site proposes attenuation basins located across the development to capture surface water runoff and all flows to be restricted to a greenfield runoff rate such that flood risk is not increased on site or downstream.

4.12 Roade Bypass is divided into five catchments which drain to attenuation basins located along its length and allow flows to be restricted to a greenfield runoff rate such that flood risk is not increased on site or downstream.

4.13 Allowance has been made within the application boundary for improvements to the existing drainage network on the south side of Knock Lane at its junction with Stoke Rd by providing space for a basin/pond to capture exceedance flows which could present an issue to road users. The intention is that this will present a betterment to the existing situation.

4.14 Further information on the surface water drainage solution is provided within the accompanying Sustainable Drainage Statement, reference NGW-BWB-EWE-XX-RP-CD-0007_SDS.

Foul Water Drainage

4.15 It is proposed to drain used water from the development separately to surface water. A strategy is put forward requiring a pumped solution from the Main Site to a connection point near the A45.

4.16 Further information on the foul drainage solution is provided within the accompanying Sustainable Drainage Statement, reference NGW-BWB-EWE-XX-RP-CD-0007_SDS

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Policy Statement for National Networks, the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced on behalf of Roxhill (Junction 15) Ltd in respect of a Development Consent Order for Northampton Gateway Strategic Rail Freight Interchange, adjacent to M1 Junction 15, Northamptonshire.

5.2 This report demonstrates that the proposed development is not at significant flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 5.1**:

Table 5.1 - Summary of Flood Risk Assessment

Flood Source	Risk & Proposed Mitigation Measures
Fluvial	Hydraulic modelling assessment has shown that mitigation is required to allow the Main Site layout to remain at low risk. This in the form of regraded land to the right bank of Courteenhall Brook. No further mitigation is required on any of the additional sites
Canals	All sites at low risk with no mitigation measures necessary
Groundwater	All sites at low risk with no mitigation measures necessary
Reservoirs and waterbodies	All sites at low risk with no mitigation measures necessary
Pluvial runoff	Finished ground levels will be designed to direct overland flows away from built development. Opportunity to reduce existing risk at highway junctions will be explored at detailed design stage.
Sewers	All sites at low risk with no mitigation measures necessary
Impact of the Development	Surface water runoff from the development will be controlled appropriately and discharged to local watercourses or sewers. The foul water from the development will be discharged to the public sewer at a location agreed with Anglian Water.
This summary should be read in conjunction with the full report.	

5.3 In compliance with the requirements of the National Policy Statement for National Networks, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. The development will not increase flood risk to the wider catchment area as a result of suitable management of surface water runoff discharging from the site. Moreover, the strategy will deliver betterment which helps reduce existing risks of flooding to some downstream communities.

5.4

APPENDIX 1

Illustrative Masterplan

GROSS INTERNAL AREAS

	Square ft	(Square m)
UNIT 1		
Warehouse	500,000 ft²	
Office	30,000 ft²	
TOTAL	530,000 ft²	(49,238 sqm)
UNIT 2		
Warehouse	515,000 ft²	
Office	30,000 ft²	
TOTAL	545,000 ft²	(50,632 sqm)
UNIT 3		
Warehouse	653,000 ft²	
Office	30,000 ft²	
TOTAL	683,000 ft²	(63,452 sqm)
UNIT 4		
Warehouse	790,000 ft²	
Office	40,000 ft²	
TOTAL	830,000 ft²	(77,109 sqm)
UNIT 5		
Warehouse	510,000 ft²	
Office	37,000 ft²	
TOTAL	547,000 ft²	(50,817 sqm)
UNIT 6		
Warehouse	660,000 ft²	
Office	35,000 ft²	
TOTAL	695,000 ft²	(64,567 sqm)
UNIT 7		
Warehouse	1,150,000 ft²	
Office	41,000 ft²	
TOTAL	1,191,000 ft²	(110,648 sqm)
FREIGHT TERMINAL		
Offices	20,000 ft²	(1858 sqm)
GRAND TOTAL	5,041,000 ft²	(468,324 sqm)

FOOTPATH KEY

- Footpath existing (public)
- Footpath existing (to be diverted) (public)
- Footpath Proposed (public)
- Footpath & Cycleway Proposed (public)
- Footpath & Cycleway Proposed (private)

LANDSCAPING KEY

- Existing Landscaping
- Proposed New Landscaping

N

0 50m 100m SCALE 1:2,500

Rev	Date	Details of issue / revision	Drw	Rev

ISSUES & REVISIONS

ROXHILL

NORTHAMPTON GATEWAY STRATEGIC RAIL FREIGHT INTERCHANGE

THE NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE ORDER 201X

Drawing Title
ILLUSTRATIVE MASTERPLAN

Scale	1:2,500	Drawn	RM
Size	A0	Reviewed	SH

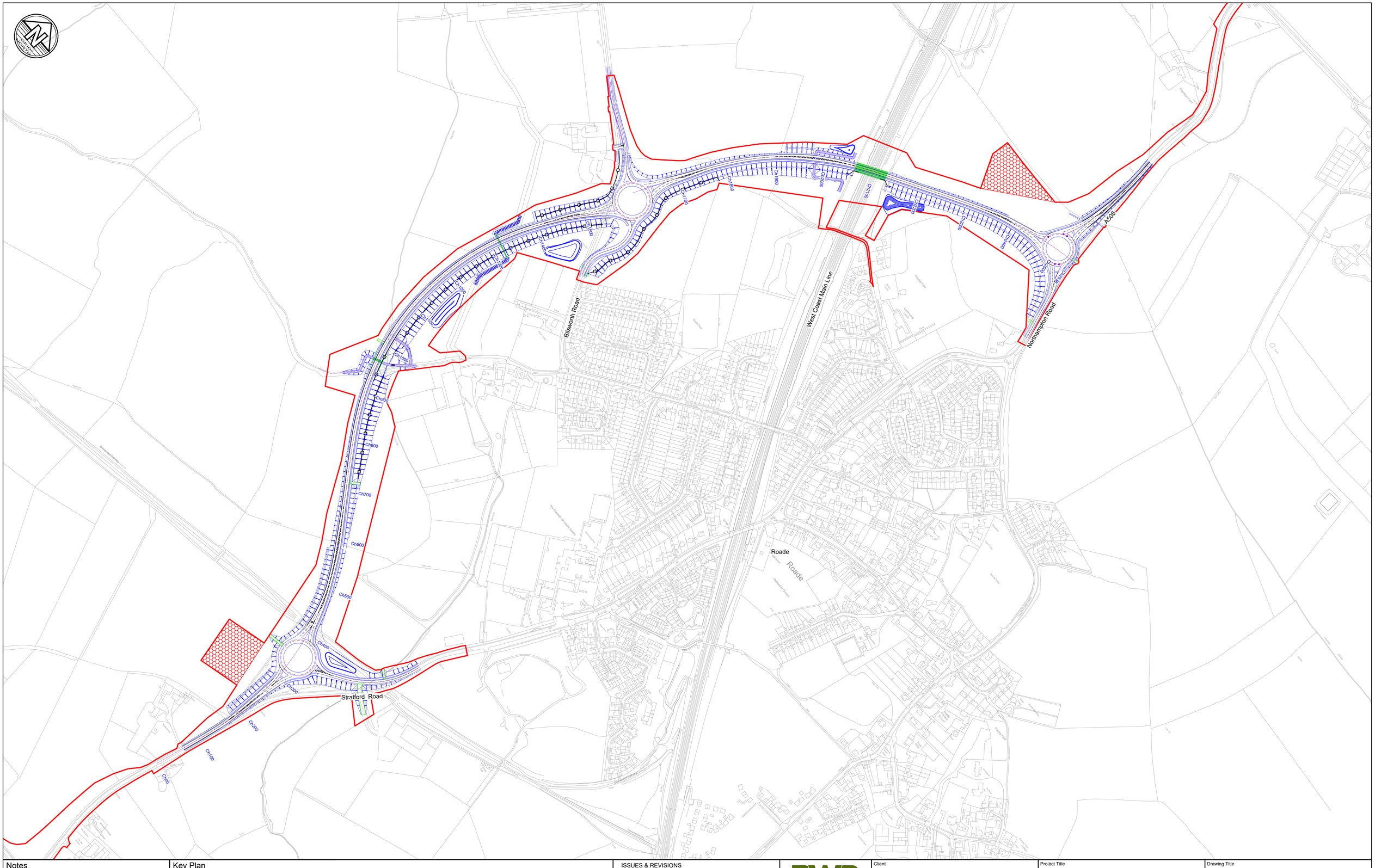
Regulation **Reg 5(2)(o)**
Document **2.11**

Drawing Status **PRELIMINARY**

Drawing No. **4054 - R001**
Revision **P61**

APPENDIX 2

Sites 2 – 9 Layout



Notes

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

Key Plan

Site Compound

ISSUES & REVISIONS

Rev	Date	Details of issue / revision	Drw	Rev
P1	02.08.17	PRELIMINARY ISSUE	PG	DM
P2	31.08.17	BYPASS ALIGNMENT REVISED	PG	SRH
P3	12.12.17	REFUGE ISLAND'S & BUNDS ADDED	PG	SRH
P4	20.12.17	BUNDS & PONDS REVISED	PG	SRH
P5	21.02.18	SITE COMPOUNDS ADDED	PG	SRH
P6	16.04.18	GENERAL UPDATES	PG	SRH

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Client: ROXHILL

Project Title: **NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE**

Drawing Title: **ROADE BYPASS GENERAL ARRANGEMENT**

Drawn:	P. Goodyear	Reviewed:	D. Mackrory		
BWB Ref:	NTH 2315	Date:	02.08.17	Scale: A1:	1:2500

Drawing Status: **PRELIMINARY**

Project - Originator - Zone - Level - Type - Role - Number: **NGW-BWB-GEN-XX-SK-C-S21**

Status: **S**

Rev: **P6**

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GRID NORTH

To Roade

105.6m

Stokegap Cottage

Stokehill Cottage

Barnhirst

The Old Granary

104.0m

Stokegap Lodge

Existing private accesses realigned and visibility improved

Uncontrolled crossings for pedestrians and cyclists

3m Footway (width is to permit future conversion to shared use footway cycleway)

Existing private access realigned and visibility improved

2m Footway on east side of A508

Single Lane Dualling Junction with Rookery Lane

3m Shared use footway cycleway

2m Footway on east side of A508

Existing A508 / Ashton Road alignment to be Stopped Up

3m Shared use footway cycleway

C26 Rookery Lane

To Stoke Bruerne

3m Shared use footway cycleway

Uncontrolled crossings for pedestrians and cyclists

3m Footway (width is to permit future conversion to shared use footway cycleway)

Ashton Road realigned

C26 Ashton Road

To Ashton

99.0m

ASHTON ROAD

Single Lane Dualling Junction with Ashton Road

Existing A508 alignment to be Stopped Up

3m Footway (width is to permit future conversion to shared use footway cycleway)

To Grafton Regis & Stony Stratford

Pond

FB

Tank

Rookery Farm

Issues

Pond

Sports Pavilion

Cricket Ground

Old

Filter Beds

Tanks

Sewage Works

Sludge Tank

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Legend

Order Limits

ISSUES & REVISIONS

Rev	Date	Details of issue / revision	Drw	Rev
P1	25.07.17	Preliminary Issue	SRH	SRH
P2	16.08.17	Order limits added	PG	PG
P3	20.10.17	Changed to single land dualling, NMU ings added	SRH	SRH
P4	26.01.18	Revised layout and extents of earthworks added	PG	SRH
P5	30.04.18	Updates following Stage 1 RSA	PG	SRH

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Client: ROXHILL

Project Title: NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE

Drawing Title: A50 ROOKERY LANE ASHTON ROAD JUNCTION GENERAL ARRANGEMENT

Drawn:	S. Hilditch	Reviewed:	S. Hilditch
BWB Ref:	NTH 2315	Date:	25.07.17

Scale: A1: 1:1250

Drawing Status: FOR COMMENT

Project - Originator - Zone - Level - Type - Role - Number: NGW-XX-W-GEN-XX-S-C-S-1

Status: S

Rev: P5

GRID NORTH

NORTHAMPTON ROAD

Ward Bdy

To Roade

Tollgate cottage access

75.2m

Def

Ward Bdy

Proposed refuge island

Carriageway widening to accommodate 3.65m wide through lanes and 3.5m wide turning lane (plus 1m hardstrips)

E□isting ghost island e□tended

E□isting access retained

E□isting refuge island retained

C85 Pury Road

A508 Northampton Road

To Grafton Regis & Stony Stratford

92.4m

GP

92.9m

95.4m

ETL

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5. Refer to Appendi□7/1 of the contract specification for details of proposed Pavement Types and restrictions.

Legend

Order Limits

ISSUES & REVISIONS

Rev	Date	Details of issue / revision	Drw	Rev
P1	20.07.17	Preliminary Issue	SRH	SRH
P2	16.08.17	Order limits shown	PG	PG
P3	26.01.18	Updated following topographical survey	PG	SRH

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Client: ROXHILL

Pro□ect Title: **NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE**

Drawing Title: **A50□PURY ROAD □UNCTION GENERAL ARRANGEMENT**

Drawn:	S. Hilditch	Reviewed:	S. Hilditch
BWB Ref:	NTH 2315	Date:	20.07.17

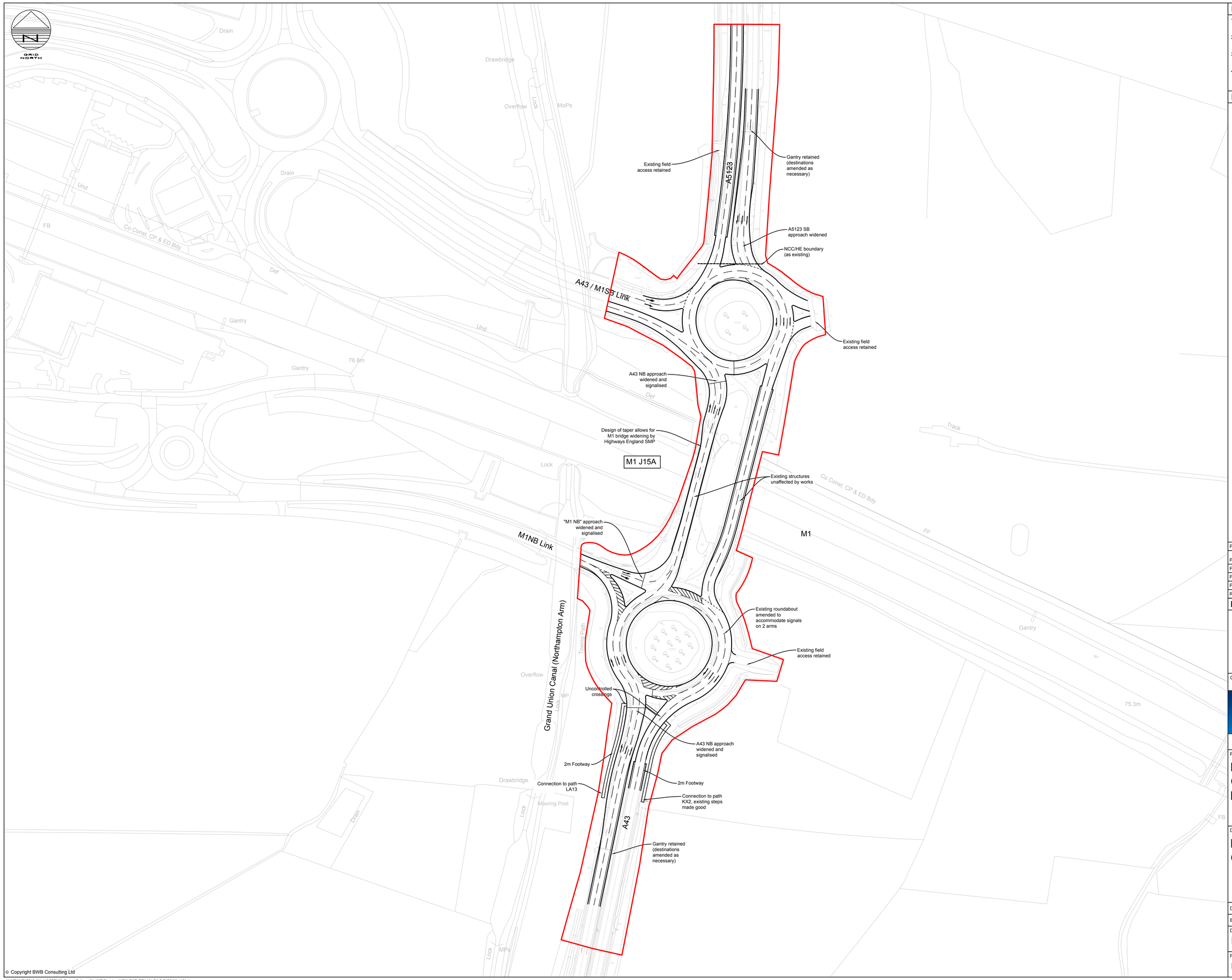
Scale□ A1: 1:1250

Drawing Status: **FOR COMMENT**

Pro□ect - Originator - Zone - Level - Type - Role - Number: **NGW-□W□-GEN-XX-S□-C-S□1□**

Status: **S□**

Rev: **P□**



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Order Limits

Rev	Date	Details of issue / revision	Drw	Rev
P5	30.04.18	Updated following RSA1 and HE review	PG	PG
P4	07.03.18	Southern roundabout geometry amended & footway and uncontrolled crossings added	PG	SRH
P3	21.12.17	Layout amended to reflect topographical survey	PG	SRH
P2	16.08.17	Order limits added	PG	PG
P1	26.07.17	Preliminary Issue	SRH	SRH

Issues & Revisions

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Project Title

NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE

Drawing Title

M1 J15A (A43/A5123) GENERAL ARRANGEMENT

Drawn:	S. Hilditch		Reviewed:	S. Hilditch	
BWB Ref:	NTH 2315	Date:	26.07.17	Scale@A1:	1:1250

Drawing Status

FOR COMMENT

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-GEN-XX-SK-C-SK20	S3	P5

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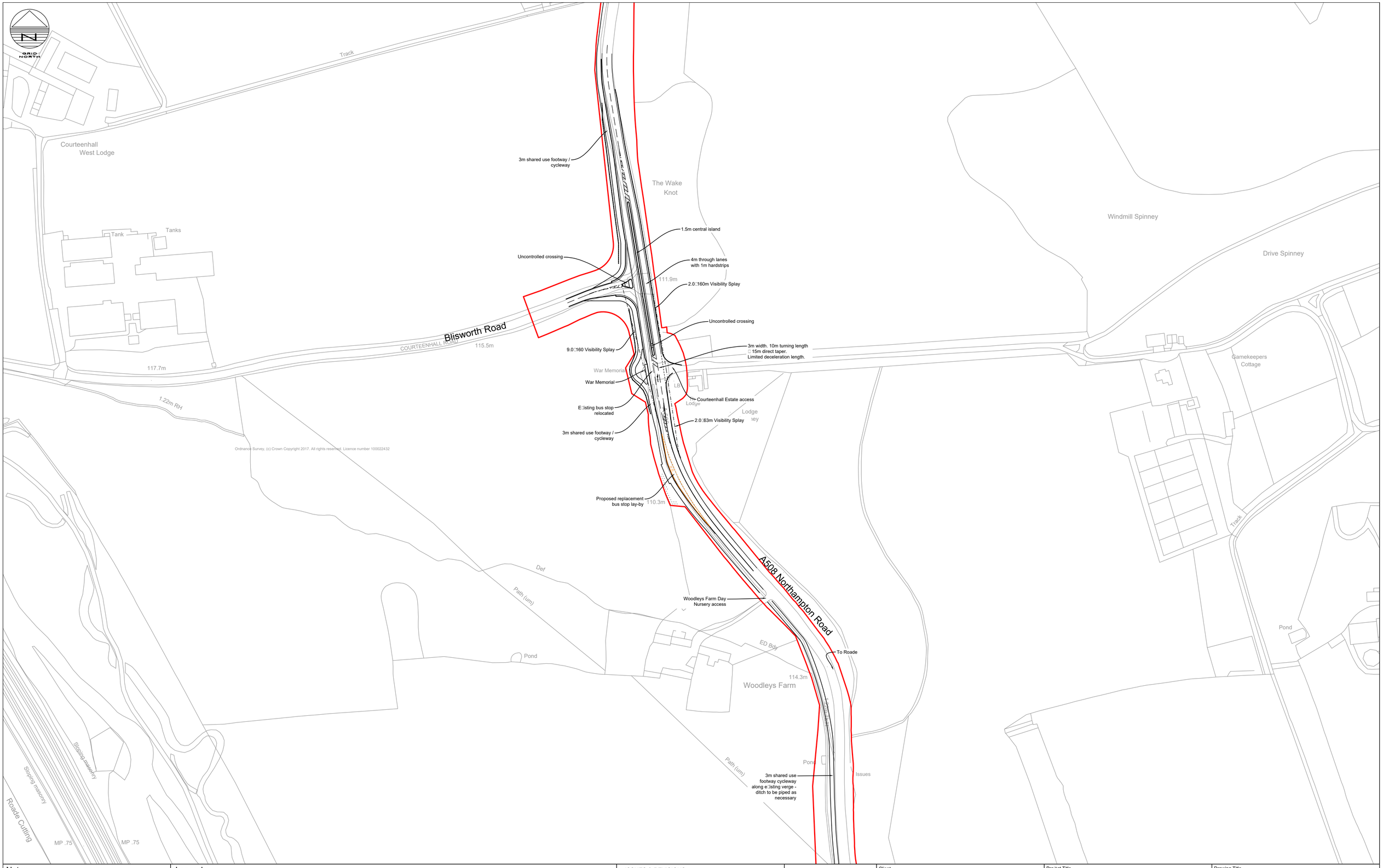

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Rev	Date	Details of issue / revision	Drw	Rev
P1	11.08.17	Preliminary Issue	PG	DM
P2	15.09.17	Bus stop added	PG	SRH
P3	20.10.17	Works to Woodleys Farm access shown	SRH	SRH
P4	07.11.17	Updated design geometry	SRH	SRH
P5	29.01.18	Footway e□tents and minor amendments	PG	SRH
P6	30.04.18	Updates following Stage 1 RSA	PG	SRH

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Pro□ect Title: **NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE**

Drawing Title: **A50□ □LISWORTH ROAD □UNCTION GENERAL ARRANGEMENT LEFT IN AND LEFT OUT**

Drawn:	P. Goodyear	Reviewed:	D. Mackrory
BWB Ref:	NTH 2315	Date:	11.08.17

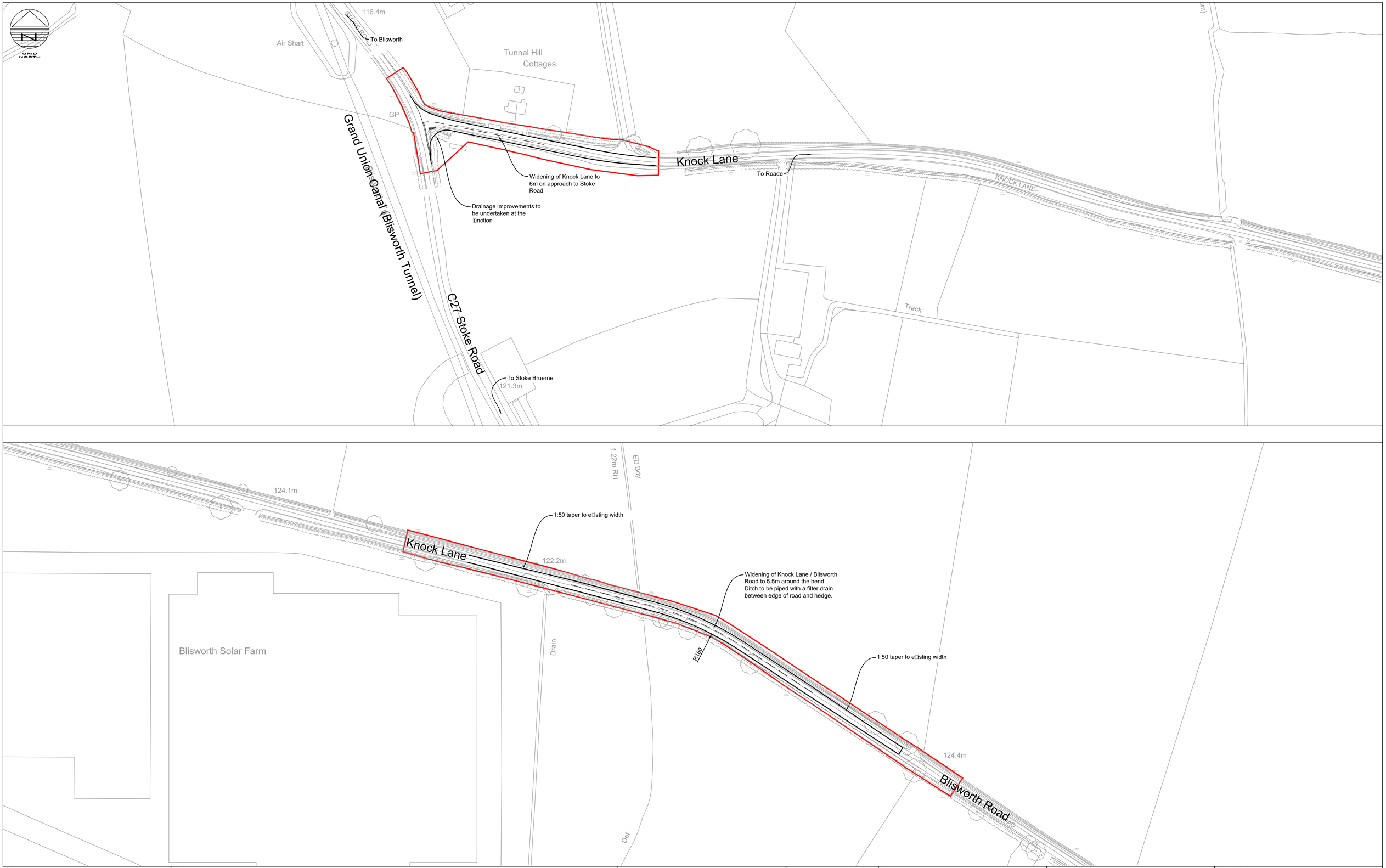
Scale□ A1: 1:1250

Drawing Status: **FOR COMMENT**

Pro□ect - Originator - Zone - Level - Type - Role - Number: **NGW-□W□-GEN-XX-S□-C-S□2□**

Status: **S□**

Rev: **P6**



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Rev	Date	Details of issue / revision	Drw	Rev
P1	23.08.17	Preliminary Issue	SRH	SRH
P2	25.08.17	Proposals updated	SRH	SRH
P3	06.11.17	Proposals updated	SRH	SRH
P4	26.01.18	Proposals updated following 3d design	PG	SRH

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Project Title: **NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE**

Drawing Title: **NOC LANE LISWORTH ROAD IMPROVEMENTS GENERAL ARRANGEMENT**

Drawn:	S. Hilditch	Reviewed:	S. Hilditch
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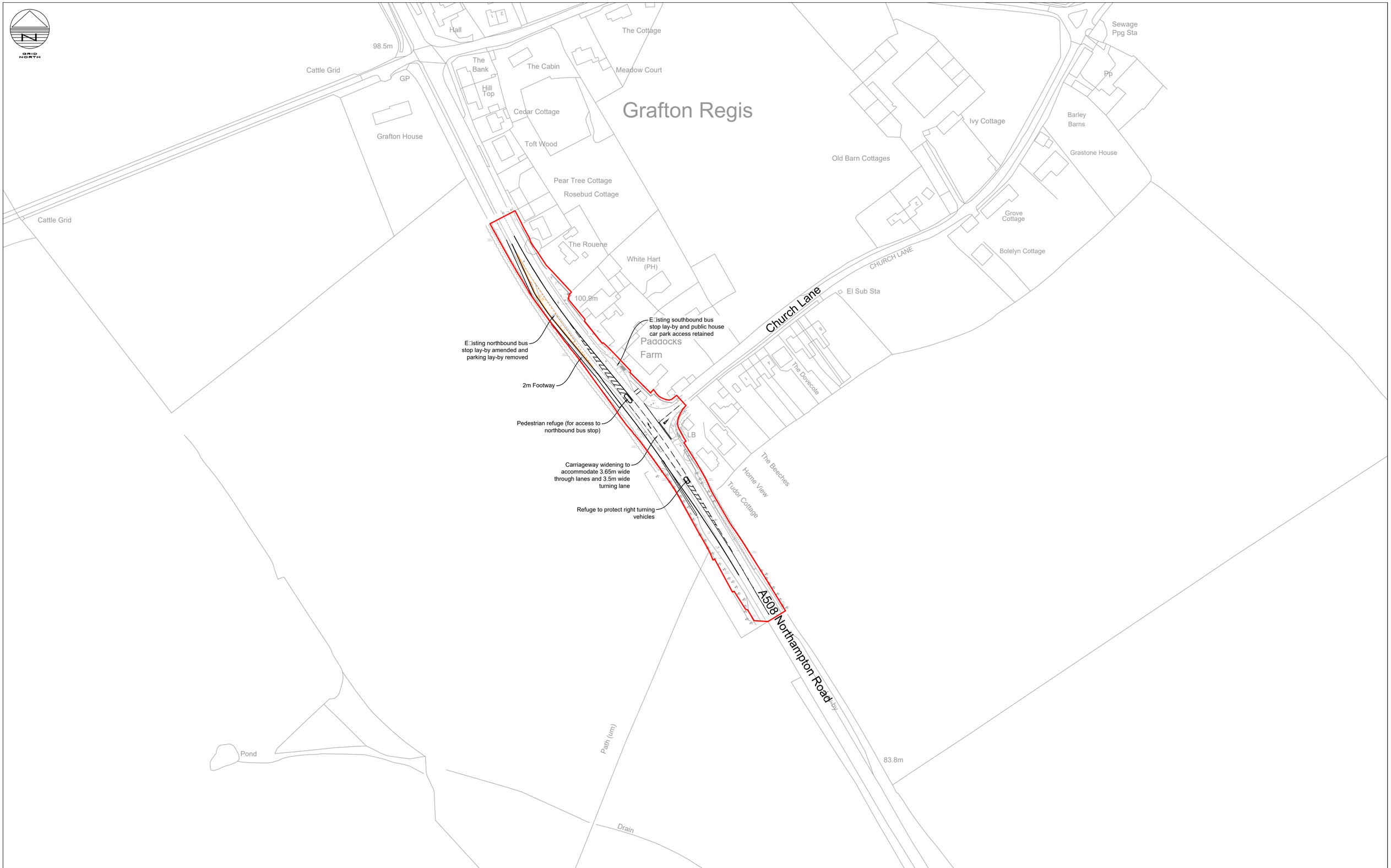
Scale: A1: 1:1000

Drawing Status: **FOR COMMENT**

Project - Originator - Zone - Level - Type - Role - Number: **NGW-W-GEN-XX-S-C-S2**

Status: **S**

Rev: **P4**



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Rev	Date	Details of issue / revision	Drw	Rev
P1	07.09.17	Preliminary Issue	SRH	SRH
P2	26.01.18	Updated following topographical survey	PG	SRH
P3	30.04.18	Updates following Stage 1 RSA	PG	SRH

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Client: ROXHILL

Project Title: **NORTHAMPTON GATEWAY RAIL FREIGHT INTERCHANGE**

Drawing Title: **A50 CHURCH LANE GRAFTON REGIS GENERAL ARRANGEMENT**

Drawn:	S. Hilditch	Reviewed:	S. Hilditch
BWB Ref:	NTH 2315	Date:	07.09.17

Scale: A1: 1:1000

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APPENDIX 3

Courteenhall Brook Technical Note

Project	Northampton Gateway - M1 Junction 15		
Document Number	NGW-BWB-EWE-XX-RP-EN-0002	**BWB Ref**	NTH2315
Author	Elijah Salami	**Status**	S2
Checked	Lauren Towle	**Revision**	P1
Approved	Robin Green	**Date**	08/12/17

1.0 INTRODUCTION

1.1 BWB Consulting Ltd has been commissioned by Roxhill Ltd to undertake a hydraulic modelling exercise of an Unnamed Ordinary Watercourse (UOW) located to the south of Northampton. The primary aim of the exercise is to identify the potential fluvial flood risk that the watercourse may pose to a proposed development site. The modelling exercise will be used to inform a Flood Risk Assessment (FRA) of the site, and develop a flood risk management strategy for the development.

1.2 For the purposes of this report the UOW will be referred to as the CourteenHall Brook.

Study Site Description

1.3 The study site is located to the south of the M1 carriageway, off Junction 15, by Northampton - centred at National Grid coordinates 474879, 254462. The approximate location of the study site is shown in **Figure 1.1**. It should be noted that this represents the approximate planning application boundary, and does not reflect the extent of proposed development.

1.4 The study site is currently used for agricultural pasture and arable fields. The Courteen Hall Brook flows through the southern proportion of the site, from south-west to north-east. The channel network of the watercourse is identified within **Figure 1.1**.

The Courteen Hall Brook

1.5 The Courteen Hall Brook is a tributary of the Wootton Brook, which is located 1.5km downstream of the study site. The Courteen Hall Brook has a total catchment area of approximately 7.1km^2. For comparison, the Wootton Brook's catchment is in the region of 40km^2 at their confluence.

1.6 The Courteen Hall Brook can be sub-divided into two main sub-catchments. The 'western sub-catchment' rises to the south-west of the study site, on the far side of a railway line embankment. The watercourse flows in a north-easterly direction through the southern proportion of the study site. It is culverted under the A508 (Northampton Road) on the site's eastern boundary. Downstream of the A508 it is joined by a small tributary which drains land south-east of the study site. The channel is joined by a second tributary just upstream of the M1 embankment, this drains land falling mainly within the study site. The watercourse is culverted under the M1.

1.7 The 'southern sub-catchment' rises to the south east of the study catchment, and flows in a north-westerly direction. This is also culverted under the M1.

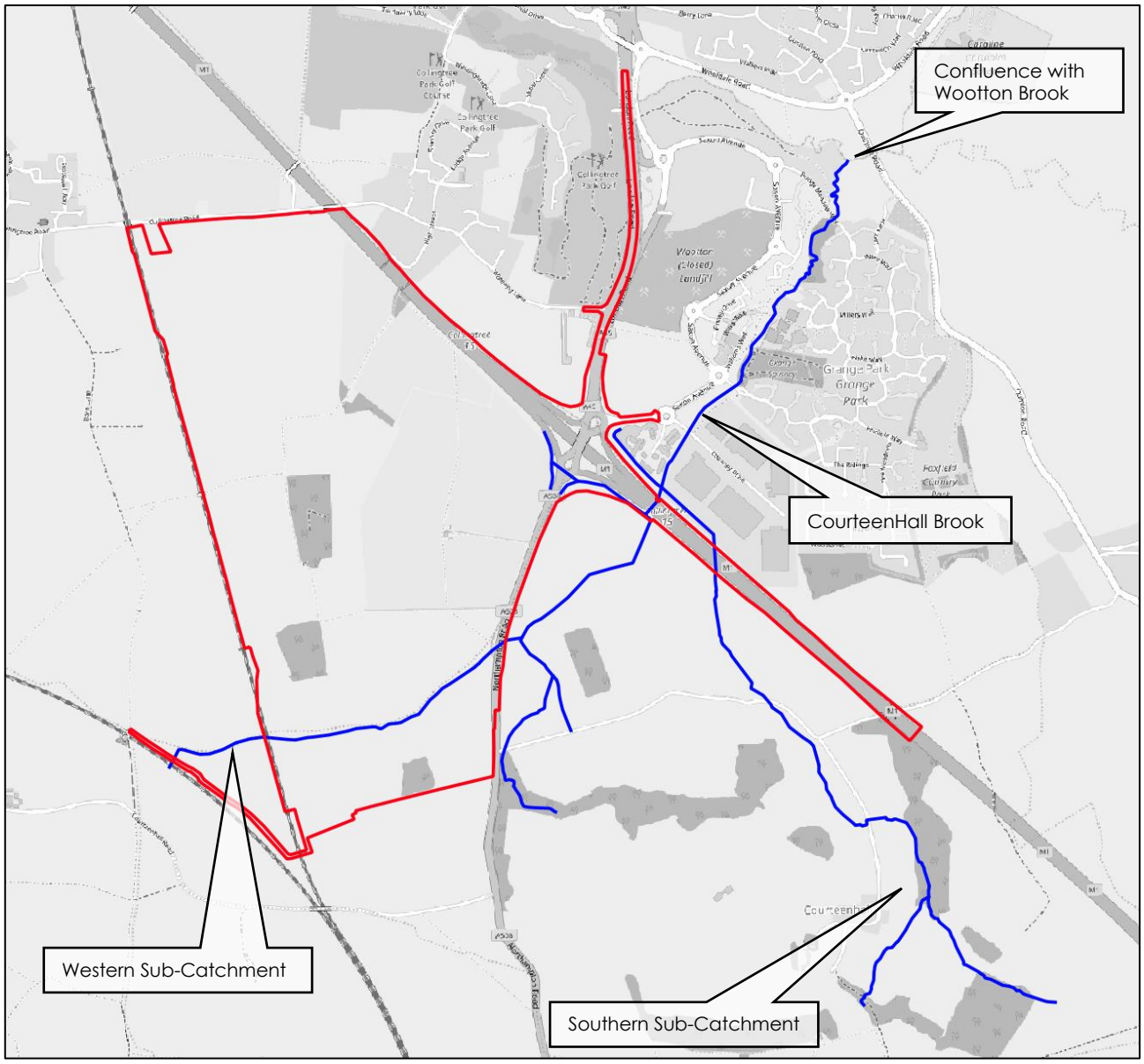


Figure 1.1 - Site Location Plan

1.8 Downstream of the M1 the two sub-catchments combine and the watercourse continues to flow towards the north-east. It flows within what appears to be an engineered floodplain corridor through an industrial and residential estates of Grange Park, where it is re-classified as 'main river' before outfalling to the Wootton Brook.

1.9 The catchment upstream of the M1 is largely rural, comprised of arable fields and pasture with some areas of woodland. Some minor development associated with Courteenhall is present within the catchment.

1.10 The catchment downstream of the M1 is largely urbanised with industrial/commercial development, and residential housing estates.

Previous Studies & Available Data

1.11 The Environment Agency (EA) Flood Maps for Planning identify that the study site is located within Flood Zones 1 - as illustrated within **Figure 1.2**. Floodplain associated with the reach of main river has been generated, but the upstream ordinary watercourse has been omitted. The catchment upstream of the M1 is understood to be too small to have been included in the national scale Flood Mapping.

The Flood Zone Maps for Planning are therefore not considered suitable to confirm flood risk at a site level.

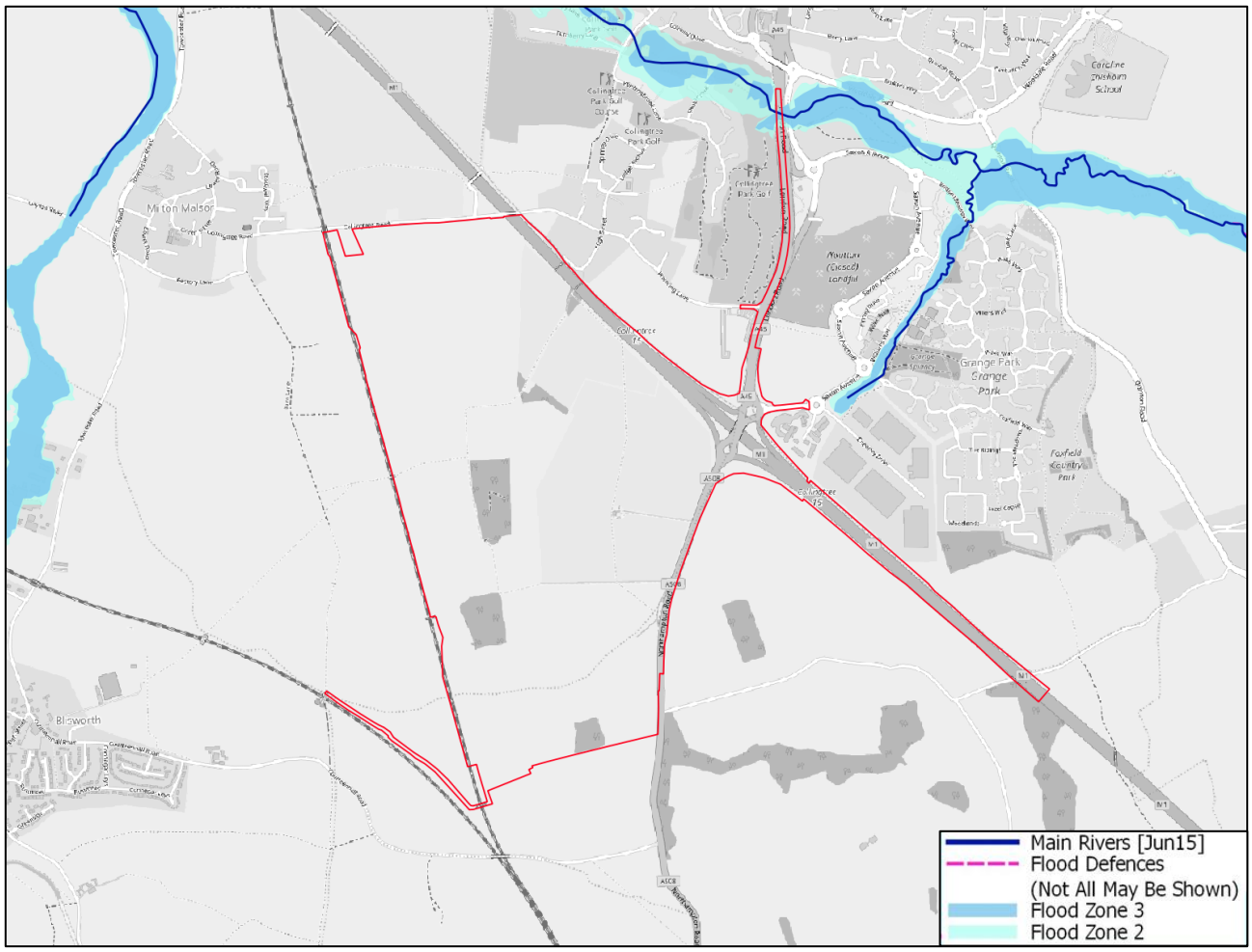


Figure 1.2 - Environment Agency Flood Map for Planning (Rivers and Sea)

1.12 It is understood that the EA and Lead Local Flood Authority (LLFA) do not hold detailed modelled flood data of the watercourse.

1.13 The Environment Agency do hold a hydraulic river model of the Wootton Brook, and a copy of the model has been obtained for use in this exercise. This takes the form of a one-dimensional (1D) hydraulic model built within Flood Modeller (formerly known as ISIS). The model does not include any geometry for the Courteen Hall Brook, but it does include a point inflow representing the contributing flood flows from the watercourse.

1.14 EA surface water flood risk maps identify the potential areas at risk of flooding if rain water does not enter the drainage system or infiltrate into the ground. While not strictly a fluvial source, this mapping can provide an indication of the potential flood risk associated with minor watercourses where detailed modelling has not been undertaken. An extract of the Surface Water Flood Risk maps is illustrated within **Figure 1.3**.

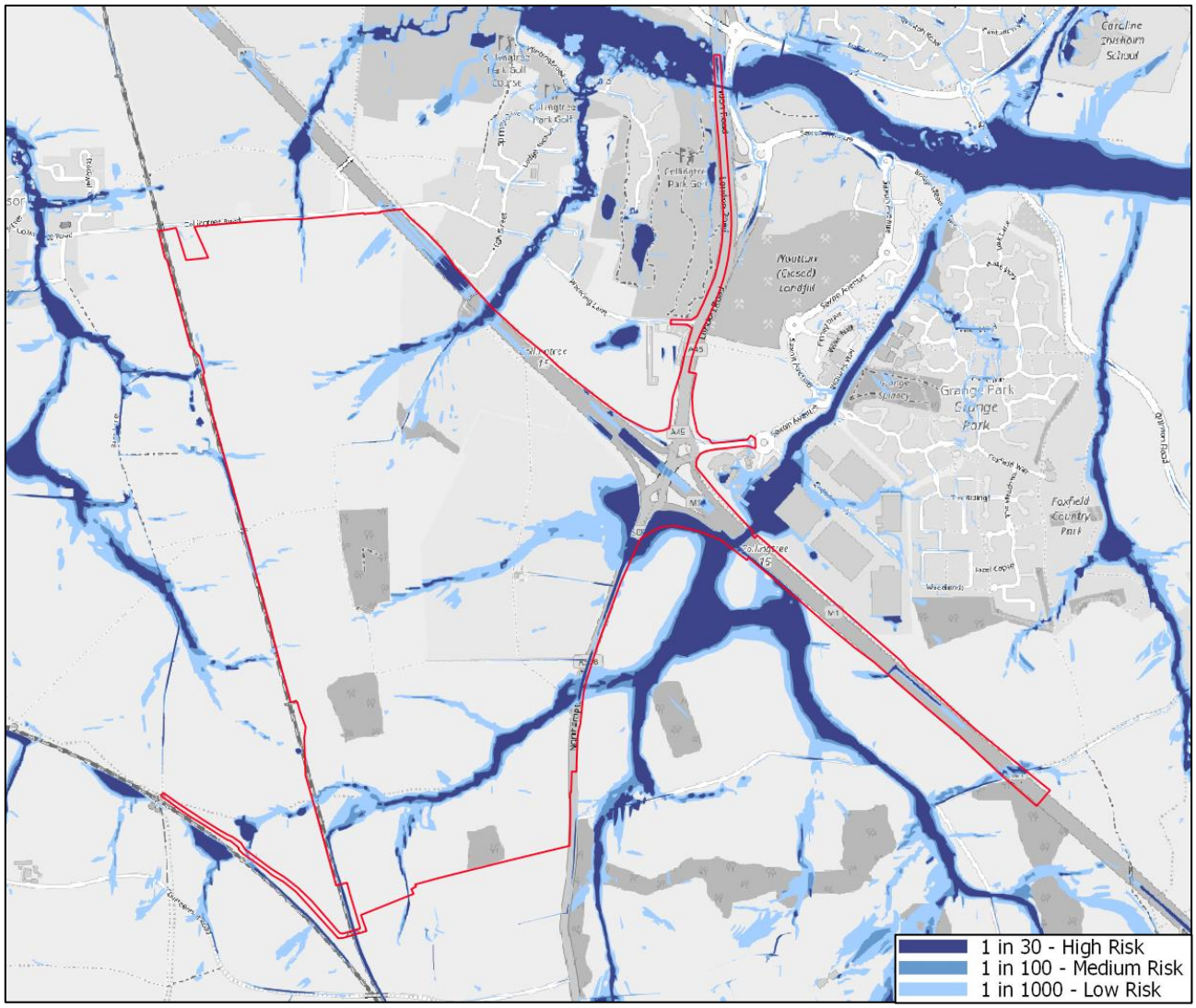


Figure 1.3 - Environment Agency Risk of Flooding from Surface Water Maps

1.15 The surface water maps illustrate the potential floodplain extents upstream of the M1. However, it appears that the mapping does not account for all the known culverted connections through embankments, and therefore the mapped extent of floodplain upstream of the A508, M1 and railway lines may be unrealistic.

1.16 The EA do not have any records of flooding within the area of the study site, and no historic flooding incidents are reported within SFRA or PFRA.

1.17 A review of the available the LiDAR (Light Detection and Ranging) coverage has revealed that EA 2m and 1m Digital Terrain Model (DTM) is available for most of the Courteen Hall Brook catchment. This has undergone a filtering process to remove vegetation and buildings, to create a bare earth surface.

Other Sources of Data

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

- A Topographic survey of the study site, undertaken in May 2017
- A cross-sectional survey of the watercourse channel and structures, undertaken in May 2017 – **Annex 2**
- Ordnance Survey 1:1,250 scale mapping
- Ordnance Survey 1:50,000 scale mapping
- Flood Estimation Handbook catchment descriptors
- Hi-Flows Database (version 4.1)

Aim & Objectives

1.19 The primary aim of this modelling exercise is to establish a good hydrological and hydraulic representation of the Courteen Hall Brook within the study site. The model will be used to identify the current level of fluvial flood risk to the site, and be used to design a flood management strategy for the development in a future Flood Risk Assessment.

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

i. Create a one-dimensional (1D) hydraulic model of the reach of the Courteen Hall Brook which could influence the site.

ii. Create a two-dimensional (2D) floodplain representation of the site and surrounding floodplain.

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

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

v. Option test development layout(s) and flood management schemes to identify potential flood mitigation measures.

vi. Simulate sensitivity tests and residual risks within the model, whichinclude roughness coefficients, blockage scenarios and climate change.

2.0 HYDROLOGICAL ASSESSMENT

Method Statement

2.1 Flood flows estimates are required to support a hydraulic modelling exercise of the Courteen Hall Brook. The hydraulic model will be used to identify floodplain extents and peak flood levels through the site of the proposed development. The exercise will be used to inform a site specific Flood Risk Assessment and to inform the flood management strategy of the proposed development.

2.2 The hydraulic assessment will model unsteady flood flows, therefore hydrographs as well as peak flood levels are required.

2.3 To inform the Flood Risk Assessment the following return period events are required: 1 in 20, 1 in 100, and 1 in 1000-year.

2.4 The Courteen Hall Brook is un-gauged therefore there are no hydrometric records of river flows or levels on which a hydrological assessment of flood flows can be made.

2.5 This hydrological analysis is therefore based around the industry standard methodologies which utilise the Flood Estimation Handbook (FEH) catchment descriptors: the FEH Statistical Analysis; and the ReFH (Revitalised Flood Hydrograph) rainfall-runoff model.

2.6 Other methodologies such as IH124, and the Modified Rational method were dismissed due to the size and rural nature of the catchment. The FEH rainfall-runoff hydrological model was not utilised as this has been superseded by the ReFH.

2.7 The catchment as delimited at the downstream extent of the study site (the confluence of the two main sub-catchments on the downstream side of the M1) was assessed in this analysis; a catchment area of 6.10km^2. This approach means that only flows generated upstream or within the site will be applied to the hydraulic model.

2.8 Flow estimates from the catchment will be distributed along the modelled reach, at the location of tributary inflows.

2.9 As the flow estimates will be supporting a Flood Risk Assessment a conservative approach to the decision making will be made where applicable.

Review of the Catchment

2.10 A review of the Courteen Hall Brook watershed was undertaken against EA 2m LiDAR DTM, this is illustrated within **Figure 2.1**. Generally, there was found to be a fair correlation between the LiDAR derived watershed and the FEH catchment. However, the FEH catchment excluded land to the west of the railway line, and omitted some land within the study site. The catchment with the LiDAR catchment equalling 6.37km^2 compared to the FEH 6.10km^2. The catchment descriptors were updated to reflect this slightly larger area.

2.11 British Geological Society (BGS) geological mapping indicates that the brook flows through a variety of geologies as it flows towards the Wootton Brook. The headwaters rise within Blisworth Limestone Formation overlain with Oadby Member Diamicton superficial deposits. At Courteen Hall and the railway line the bed geology transitions through Rutland Formation Mudstone, Wellingborough Limestone Member, Stamford Member Sandstone, and Whitby Mudstone Formation over the course of just 200m. The Whitby Mudstone Formation remains the predominate bedrock for the remainder of its course to the Wootton Brook, but the superficial deposits transition from Oadby Member Diamicton to Glaciofluvial Deposits and Alluvium downstream of the M1.

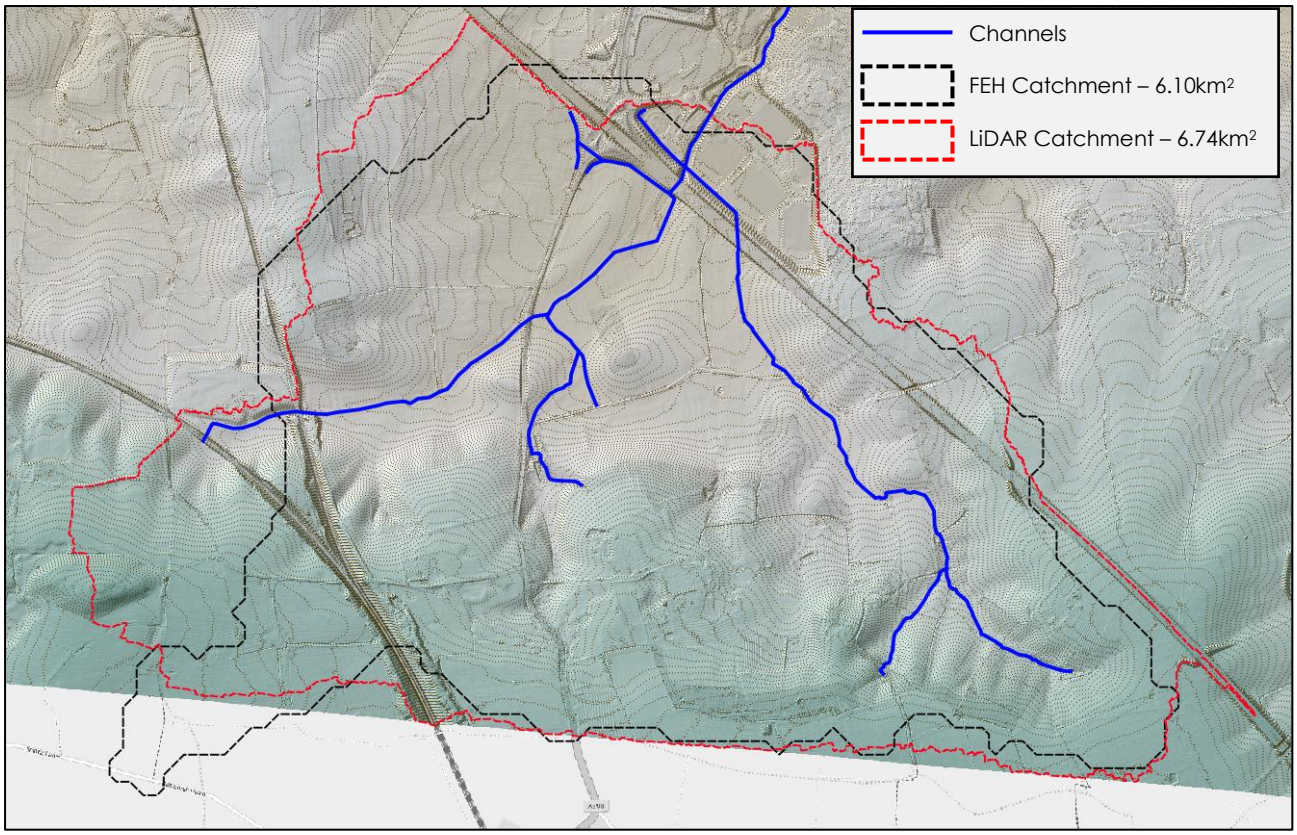


Figure 2.1 - FEH compared to LiDAR Catchment

2.12 This underlying geology suggests that the BFI_{HOST} and SPR_{HOST} values from the FEH descriptors are reasonable (as shown in **Table 2.1**).

2.13 The BFI_{HOST} and SPR_{HOST} values identify that the catchment is not classified as permeable. These values do not necessitate any special measures in the FEH procedures, nor do they prohibit the use of either the ReFH or FEH Statistical Approach.

2.14 URBEXT values are very low indicating a predominantly rural catchment, these values do not necessitate any special measures in the application of the FEH procedures, nor do they prohibit the use of either the ReFH or FEH Statistical Approach.

2.15 Given that the catchment as a whole is essentially rural, it was not considered necessary to redefine the remaining catchment descriptors as a result of the relatively minor change in area and watershed. Key catchment descriptors are summarised within **Table 2.1**.

Table 2.1 - Key Catchment Descriptors

Descriptor	
AREA (km²)	6.74
BFI_{HOST} – Base Flow Index	0.426
FARL – Flood attenuation from reservoirs & lakes	1.000
FPEXT – Floodplain extent	0.0592
PROPWET – Proportion of time that soils are wet	0.3
SAAR – Standard Average Annual Rainfall	616
SPR_{HOST} – Standard Percentage Runoff (Host soils classification)	40.79
$URBEXT_{1990}$ – Fraction of Urban Extent	0.0098
$URBEXT_{2000}$ – Fraction of Urban Extent	0.0000

FEH-Statistical Analysis

2.16 WINFAP version 3 was utilised to undertake a statistical analysis of the adjusted catchment using a hydrometric record of gauged catchments with similar catchment descriptors. Version 4.1 (May 2016) of the Hi-Flow dataset was used to provide a hydrometric record. **Annex 1** contains extracts from WINFAP procedure illustrating the methodology and detailing the composition of the pooling group.

2.17 A group of hydrologically similar gauged sites was generated by the software from the 'OK for Pooling' dataset. The group was identified as 'strongly heterogeneous' - this does not mean that it is inappropriate, just that it should be reviewed.

2.18 The 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.

2.19 Three stations within the pooling group were identified as highly permeable catchments (BFIHOST>0.80, SPRHOST<20%): Brompton Beck (27073), Gypsey Race (26802), and South Winterbourne (44008). Given their permeability is considerably different from the study catchment they were removed from the pooling group, and replaced with three other sites to meet the minimum record length target.

2.20 All other stations in the pooling group were considered to be acceptable: they were all identified as having sufficient record length, and to be of sufficient hydrological similarity for the purpose of this study (i.e.: no other sites within the Hi-Flows dataset are believed to be more representative). The sites were of a rural nature, had similar flood seasonality, and were not of a highly permeable nature. It is believed that the heterogeneous nature of the pooling groups is a result of the limited number of small gauged sites which are available in the record.

2.21 The resultant record length for the pooling group totalled 506 years, which meets the recommended guidelines on required record length.

2.22 In line with the generally accepted approach, the 'generalised logistic' distribution (regarded as the best fit for most UK catchments) was selected to derive a growth curve from the pooling group. No other distribution was identified to give an acceptable fit.

2.23 The $URBEXT_{2000}$ value was updated from 0.0000 to an estimate of the 2017 coverage using the national average model of urban growth: 0.0000.

2.24 The updated catchment descriptors from **Table 2.1** were initially used to estimate the rural QMED of the study site ($QMED_{CDS}$) using the revised equation from Science Report SC050050[1]. $QMED_{CDS}$ was estimated at 1.151m^3/s.

2.25 The Hi-Flows dataset was used to generate a list of potential donor sites from the "OK for QMED & Pooling" dataset. It is the recommended procedure to use a 'Donor Station' to validate $QMED_{CDS}$. In this instance station 32029 (Flore at Experimental Catchment) was identified as being the most appropriate station to act as a donor. This increased the rural QMED value to 1.415 ($QMED_{ADJ}$).

2.26 Given the catchment has no urban influence it was not necessary to apply an Urban Adjustment Factor (UAF).

2.27 The $QMED_{ADJ}$ was applied to the pooled growth curve to derive a flood frequency curve. The peak flood flow estimates are detailed in **Table 2.2**.

Revitalised Flood Hydrograph Analysis

2.28 The ReFH 2 Revitalised Flood Hydrograph Modelling tool (version 2.2) was utilised to undertake an estimation of the peak flows from the catchment. This makes use of the latest changes to the rainfall-

[1] Kjeldsen, T.R., Jones, D. A. and Bayliss, A.C. (2008) Improving the FEH statistical procedures for flood frequency estimation. Science Report SC050050, Environment Agency.

runoff model to incorporate the FEH13 Depth Duration Frequency rainfall model, and urban/rural catchment sub-divisions[2].

2.29 A critical duration of 5.5hrs was identified at a 0.5hr timestep, and due to the rural nature of the catchment a winter storm profile was adopted; all other parameters were left as default.

2.30 The resultant peak flood flow estimates are detailed in **Table 2.2**.

Discussion

2.31 The peak flows from both methods are summarised in **Table 2.2.** This table also includes the Courteen Hall Brook inflows from the Environment Agency's Wootton Brook hydraulic model for comparison.

Table 2.2 - Summary of Peak Flows

Return Period (Yrs.)	Annual Probability (AP)	Peak Flows (m^3/s)		
		FEH Statistical Analysis	ReFH2	Wootton Brook Model Inflows (WO5319IF)
2	50.0%	1.42	1.99	1.41
10	10.0%	2.25	3.42	2.56
20	5.0%	2.62	4.07	3.05
50	2.0%	3.16	5.04	3.79
75	1.3%	3.43	5.54	4.13
100	1.0%	3.63	5.91	4.30
200	0.5%	4.17	6.94	4.73
1000	0.1%	5.69	9.95	6.19

2.32 The FEH Statistical Analysis flow predictions bare a close relation to those adopted in the EA's Wootton Brook model. However, to promote a conservative assessment the worst-case flows predicted by ReFH2 were adopted within this hydraulic model.

2.33 The ReFH2 derived a 100-year pooled growth factor of 2.97, this falls with the typical range of 2.1 to 4.0 and so seems reasonable.

2.34 The ReFH2 flow estimates equate to a QMED runoff rate of 2.1 l/s/ha, and a 100-year runoff rate 8.8l/s/ha.

Climate Change

2.35 In February 2016 the predicted future change in peak river flows were updated by the Environment Agency[3]. This replaced the previous national 20% allowance with a range of projections applied to regionalised 'river basin districts'.

2.36 The Courteen Hall Brook catchment falls within the Anglian river basin district. **Table 2.3** identifies the relevant peak river flow allowances.

Table 2.3 - Peak River Flow Allowance for the Anglian River Basin District

Allowance Category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 69)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper End	25%	35%	65%
Higher Central	15%	20%	35%
Central	10%	15%	25%

[2] Kjeldsen, T.R., Miller, J.D. and Packman, J.C., (2013). Modelling design flood hydrographs in catchments with mixed urban and rural land cover. Hydrology Research, 44 (6), pp. 1040-1057.
[3] Environment Agency. 2016. Flood risk assessments: climate change allowances. [ONLINE] Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1. [Accessed 24 February 16].

2.37 When determining the appropriate allowance for use in a Flood Risk Assessment the Flood Zone classification, the flood risk vulnerability, and the anticipated lifespan of the development should be considered. **Table 2.4** provides a matrix summarising the Environment Agency's guidance on determining the appropriate allowances.

Table 2.4 – Environment Agency Guidance on the Application of Climate Change Allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
2	use the higher central and upper end to assess a range of allowances	use the higher central and upper end to assess a range of allowances	use the central and higher central to assess a range of allowances	use the central allowance	use none of the allowances
3a	use the upper end allowance	development should not be permitted	use the higher central and upper end to assess a range of allowances	use the central and higher central to assess a range of allowances	use the central allowance
3b	use the upper end allowance	development should not be permitted	development should not be permitted	development should not be permitted	development should not be permitted
*If development is considered appropriate when not in accordance with flood zone vulnerability categories, then it would be appropriate to use the upper end allowance.					

2.38 The proposed development is for commercial/distribution use (less vulnerable) with an anticipated lifespan of over 60 years, therefore the total potential change for the '2080s' will be adopted. The study site currently falls entirely within Flood Zone 1. However, given the proximity of the watercourses to the site, and the uncertainties associated with estimating flows on ungauged catchments, it is considered prudent to follow a precautionary approach. Therefore, for the purposes of this hydraulic modelling exercise it is proposed to view the site as if it were within Flood Zone 3a. Therefore, the higher central (35%) and the upper end (65%) allowances will be considered.

The Design Flood

2.39 New developments should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime. The design event for fluvial flooding is generally taken as the 1 in 100-year event (1% AEP)[4].

2.40 To allow the development's flood risk management strategy to be adequately designed for its lifetime the climate change the allowances discussed previously will be applied to the baseline (present day) 1 in 100-year hydrograph.

Flow Distribution

2.41 To minimise the flood volumes being unrealistically attenuated in the upstream floodplain, and to assign the appropriate proportion of the total flow to the sub-catchments, the ReFH2 flood flows were distributed on an area basis at key topographical locations, as illustrated within **Figure 2.2** and **Table 2.5**.

[4] Planning Practice Guidance. http://planningguidance.planningportal.gov.uk/. Paragraph: 054 & 055

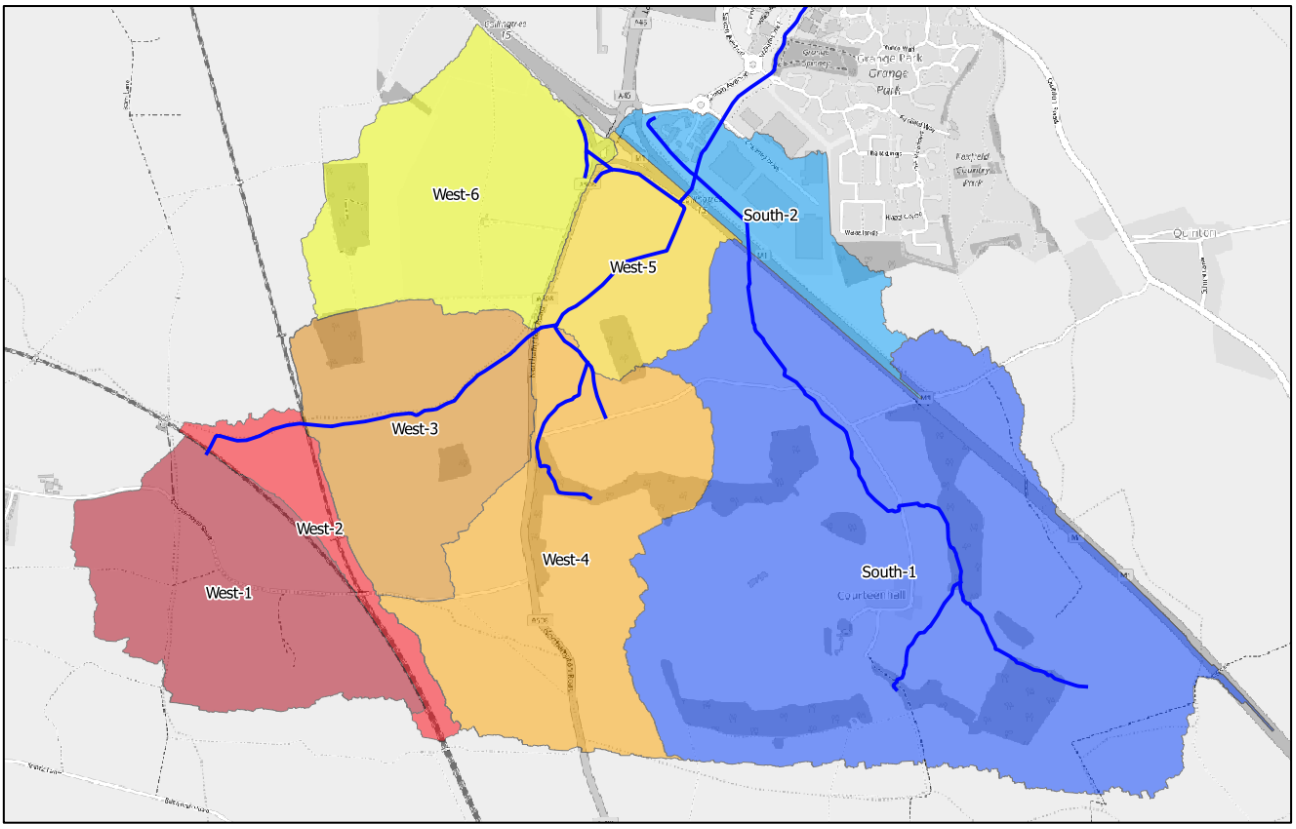


Figure 2.2 - Courteen Hall Brook Sub-Catchments

Table 2.5 - Sub-Catchment Areas

Sub-Catchment	Area (km2)	Percentage of Whole Catchment
South-1	2.625	38.9
South-2	0.348	5.2
West-1	0.758	11.2
West-2	0.194	2.9
West-3	0.693	10.3
West-4	0.998	14.8
West-5	0.370	5.5
West-6	0.757	11.2

3.0 THE HYDRAULIC MODEL

3.1 A dynamically linked 1D-2D modelling approach was adopted to represent the Courteen Hall Brook: the open channel and hydraulic structures were modelled within a one-dimensional (1D) ESTRY domain; and the out of bank floodplain was modelled within a two-dimensional (2D) TUFLOW domain.

3.2 Both ESTRY and TUFLOW are standard hydraulic modelling packages widely used in the UK and have been benchmarked by the Environment Agency.

3.3 In a similar manner to the hydrological assessment, a conservative approach to the modelling was adopted where necessary.

ESTRY: The 1D Model Domain

3.4 A cross-sectional survey of the western sub-catchment watercourse network within the vicinity of the study site was completed in May 2016. The survey extended from the railway line (NGR: 474135, 253609), 400m upstream of the site, to Cheaney Drive (NGR: 475992, 254796), 650m downstream of the site.

3.5 Channel cross-sections were surveyed at regular intervals of between 50m to 100m in locations which captured the general condition and shape of the open watercourses.

3.6 Additional sections were taken on the upstream and downstream face of hydraulic structures. The watercourse survey is included as **Annex 2** for reference.

3.7 Access to the culvert beneath a second railway line embankment (between sub-catchments 'West-2' and 'West-3') could not be achieved due to restrictions. Therefore, the upstream surveyed reach was omitted from the final model. This is considered to provide a conservative representation, as the potential attenuation and flood storage provided by the culvert are omitted.

3.8 Due to its distance from the study site, detailed representation of the southern sub-catchment channel was not necessary. The upstream reach was represented in the 2D domain, while the channel and structures between the M1 and its confluence with the main watercourse downstream of the M1 were represented within the 1D domain.

3.9 The surveyed channel was found to be relatively narrow, and the channel width could fall as low as 3m between banks. Truncating the 1D domain to top-of-bank would have necessitated an overly high resolution within the 2D domain, which would have increased simulation times needlessly. Therefore, the full surveyed cross-section width was retained, this extended 5 to 8m into the floodplain beyond top-of-bank.

3.10 The in-channel conditions were generally observed to be moderately vegetated with some coarse bed sediments. Bank top vegetation was fairly dense; however, flows were observed to be relatively free flowing. A Manning's 'n' roughness value of 0.04 was adopted to represent these conditions.

3.11 Approximately 2.5km of channel was modelled within the 1D domain. This included 36 open channel cross-sections and six hydraulic structures. A further nine 1D hydraulic structures, remote from the main channel, were embedded within the wider 2D domain. A summary of the hydraulic structures is provided within **Table 3.1**.

Table 3.1 - Summary of Hydraulic Structures

Model Ref.	NGR	Type	Dimensions	Roughness (Manning's 'n)	Comments
N/A	474424, 253685	Unknown Culvert	Unknown	-	Culvert beneath upstream railway embankment. Omitted as access could not be made.
WB_13-C2	474629, 253692	Circular Pipe	1.00m diameter	0.02	Concrete pipe under access track/footpath
WB_24-C3	475295, 254006	Circular Pipe	0.50m diameter	0.02	Concrete pipe beneath Northampton Road. Inlet surveyed as 0.5m diameter, outlet is surveyed as 1.0m diameter.
N/A	475342, 254047	Weir	-	-	Weir immediately downstream of Northampton Road culvert outlet omitted from model for stability purposes. Represents a nominal change in bed level, and flows controlled by upstream culvert, therefore omission will not affect aim of the exercise.
WB_30-C	475551, 254189	Circular Pipe	1.00m diameter	0.02	Concrete pipe under access track/footpath.
WB_39-C5	475857, 254453	Circular Pipe	0.60m diameter	0.02	Concrete pipe under access track/footpath.
WB_44-C6	475852, 254503	Rectangular	3.75m x 1.72m	0.02	Concrete box culvert beneath the M1. Modelled with reduced height and 2% blockage due to represent silted bed and slumped banks.
WB_50-C	475983, 254768	Circular Pipe with overflow	0.60m diameter	0.02	Concrete pipe under access track/footpath. Flows over the culvert modelled within the 1D domain using a weir.
WBT_A3-C8330	476095, 254290	Irregular: box culvert base, with trapezoidal top	3.17m x 1.823m	0.020	Southern Sub-catchment: Concrete irregular culvert beneath the M1. Inlet could not be accessed, so dimensions taken from outfall structure. Upstream invert interpreted from LiDAR data.
WB-C90	475501, 254690	Irregular: box culvert base, with trapezoidal top	2.725m x 1.565m	0.020	Concrete culvert beneath Junction 15 roundabout, between study site and downstream watercourse.
Ditch 1	474815, 254147	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 2	475121, 254154	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 3	475329, 254156	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 4	475340, 254148	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.

Model Ref.	NGR	Type	Dimensions	Roughness (Manning's 'n)	Comments
Ditch 5	475410, 254387	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 6	475430, 254384	Circular Pipe	0.30m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 7	475434, 254398	Circular Pipe	0.55m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.
Ditch 8	475467, 254492	Circular Pipe	0.60m diameter	0.015	Concrete culvert beneath footpath/access track. Associated with a ditch network within the study site.

TUFLOW: The 2D Floodplain Model Domain

3.12 Environment Agency 2.0m resolution LiDAR DTM (Digital Terrain Model) 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.

3.13 A 4m resolution grid was adopted for the TUFLOW model; this is considered to be more than sufficient given the rural nature of the floodplain.

3.14 Although the 4m cell size will pick up most of the significant topographic features, the southern sub-catchment channel upstream of the M1, as well as a ditch network present within the study site, were reinforced using a 'gully Z-line'.

3.15 The 2D domain was deactivated between 1D cross-sections to avoid double counting floodplain conveyance and storage.

3.16 In most instances, the ground over a structure was modelled with the 2D domain. To reinforce these ground levels a 'z-shape' was used to triangulate between adjacent banks.

3.17 Ordnance survey 1:1250 scale mapping was used to digitise land use areas within the floodplain and apply suitable Manning's 'n' roughness values.

3.18 Buildings, walls, and other structures were modelled at ground level with an elevated roughness value, in line with best practise.

Boundary Conditions

Inflows

3.19 All the flood flow hydrographs described in **Section 2.0** were applied to either the 1D ESTRY or 2D TUFLOW domain as flow-time (QT) boundaries.

Downstream Boundary

3.20 A head-time (HT) boundary was used at the downstream extent of the 1D domain. A fixed level of 76.0mAOD was adopted, which is roughly equivalent to the water level at the time of survey.

3.21 For comparison, the modelled 1 in 1000-year flood level in the downstream Wootton Brook (node ref: WO56319d) is 73.62mAOD.

1D-2D Interface

3.22 The ESTRY-TUFLOW interface was digitised between the 1D and 2D domain (at the end of each cross-section). A 'HX' (External Head) boundary was adopted as the interface type in line with best practise.

Model Schematic

3.23 An illustrative schematic of the model is presented within **Figure 3.1.**

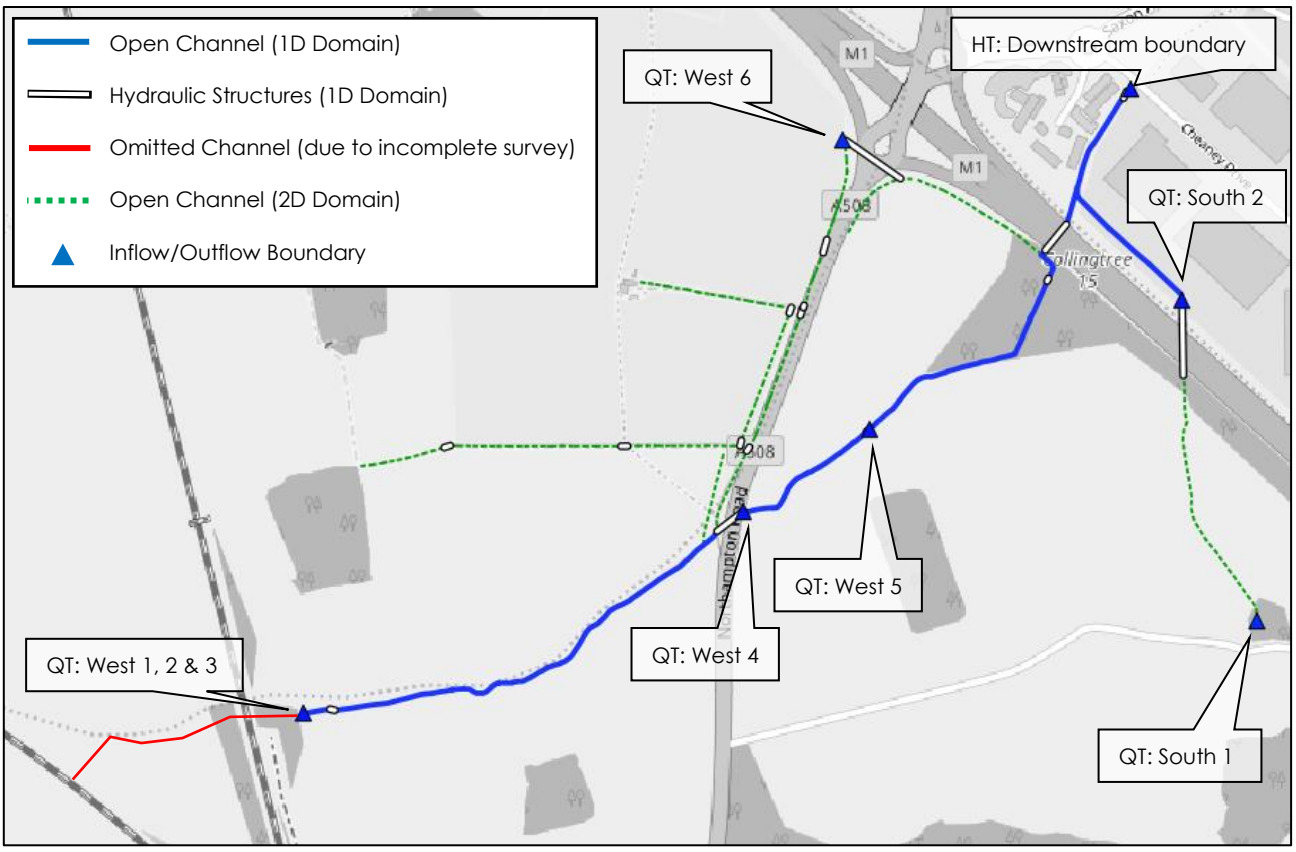


Figure 3.1 - Model Schematic

Model Calibration

3.24 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.

3.25 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.

Model Parameters and Stability

Simulation Parameters

3.26 TUFLOW version 2016-AE-iDP-w64 was used in all the simulations. All parameters were retained as default.

3.27 A time step of 0.5 second was adopted for the ESTRY domain and 1.0 second TUFLOW domain.

Results Parameters

3.28 TUFLOW maximum results were output for water levels, depths, and UK Hazard Rating. UK Hazard rating was derived from the following equation[5]:

$$Hazard\ Rating = D * (V+0.5) + DF$$

Where:
D = depth
V = velocity
DF = Debris Factor

3.29 **Table 3.2** identifies the recommended debris factors from FD2321/TR1. The debris factor has been set at 'Conservative', to be consistent with the conservative approach to the hydraulic assessment.

Table 3.2 - Guidance Debris Factors (Ref: FD2321/TR1)

Depths	Pasture/Arable	Woodland	Urban	Conservative*
0 to 0.25 m	0	0	0	0.5
0.25 to 0.75 m	0	0.5	1	1
d>0.75 m and/or v>2	0.5	1	1	1

**an additional category in TUFLOW*

3.30 **Table 3.3** identifies the thresholds of the flood hazard categories as identified within DEFRA guidance document FD2320 and the "*Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose*" (DEFRA, 2008) which have been adopted within this exercise.

Table 3.3 - Hazard to People[6]

Threshold for Flood Hazard Rating	Degree of Flood Hazard	Description
< 0.75	Low	**Caution** - "Flood zone with shallow flowing water or deep standing water"
0.75 - 1.25	Moderate	**Danger for some (i.e.: children)** - "Danger: Flood Zone with deep or fast flowing water"
1.25 - 2.0	Significant	**Danger for most people** - "Danger: Flood Zone with deep fast flowing water"
2.0 >	Extreme	**Danger for all** - "Extreme Danger: Flood Zone with deep fast flowing water"

Model Stability

3.31 No negative depths were reported throughout the different model simulations, and the model flux (flow in and out) did not show any significant evidence of an unstable/fluctuating ESTRY-TUFLOW interface.

3.32 The ESTRY-TUFLOW mass error remains within 1 to 3% for all the simulations, which is within the acceptable range.

Limitations

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

3.34 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.

3.35 The model includes a good coverage of river sections throughout the modelled reach. It was not possible to survey the railway line culvert immediately upstream due to access restrictions, but its

[5] DEFRA R&D Outputs: Flood Risks to People Phase Two Draft FD2321/TR1 and TR2
[6] 2008, DEFRA. Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purposes.

omission should produce a conservative result within the study site (flows are likely to be over-estimated).

3.36 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.

3.37 The 4.0m resolution of the model may negate any small scale topographic features, although all the significant features are believed to have been captured.

3.38 The baseline floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.15m). However, this is considered to be sufficient for the purpose of this exercise.

3.39 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.

3.40 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.

4.0 BASELINE RESULTS

4.1 The baseline hydraulic model was simulated against the key return period events. Floodplain extents, depths and flood hazards for these events are mapped within **Annex 3**. Flooding mechanisms are discussed below, with reference points illustrated within **Figure 4.1**.

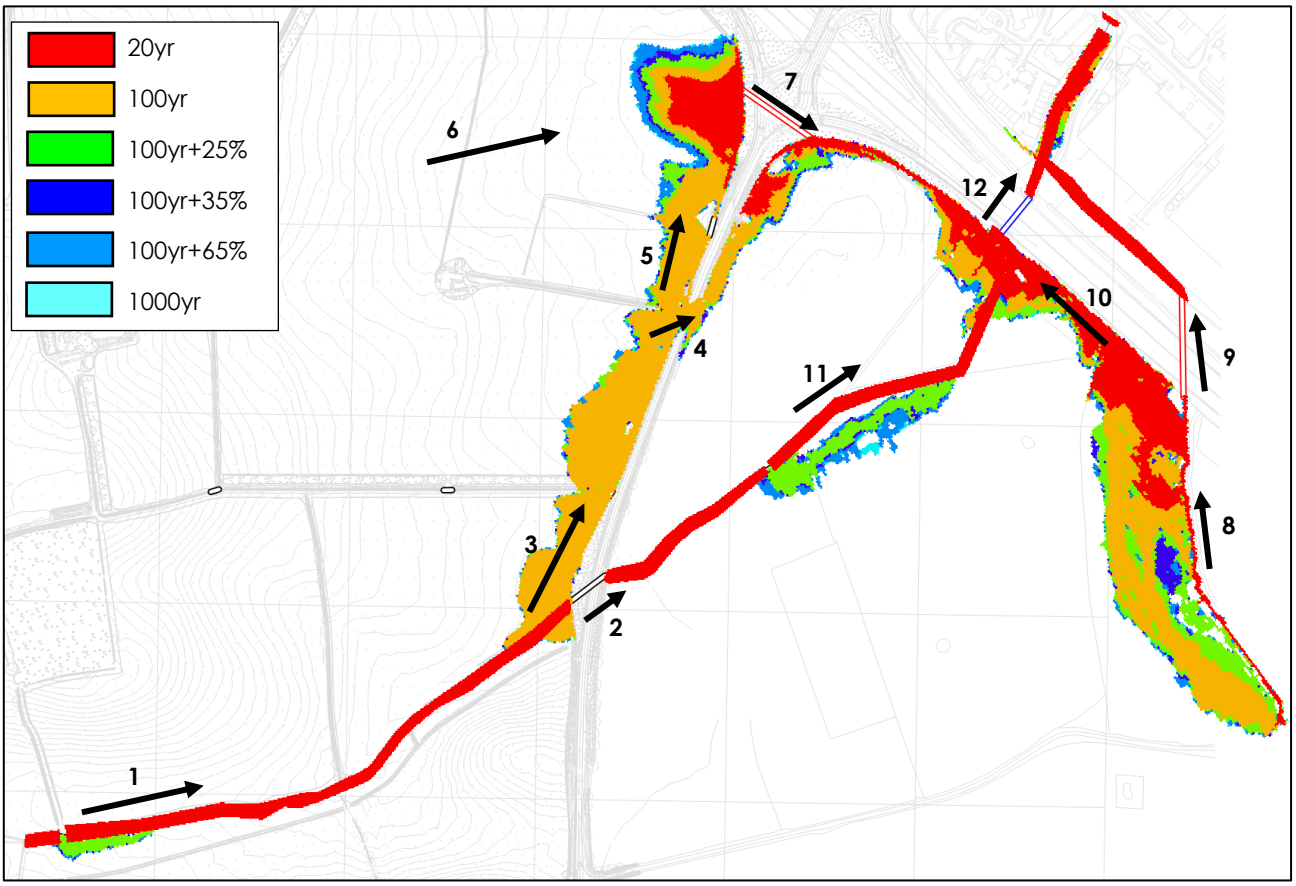


Figure 4.1 - Flooding Mechanisms

1) The Courteen Hall Brook flows from the southwest towards the northeast. Modelled flows remain within the channel/within the close proximity floodplain (within 5-10m of top of bank). A culvert under access track is exceeded in the 1 in 100-year+25% event leading to some minor flooding.

2) At the Northampton Road the watercourse passes through a restrictive culvert. This has capacity for only a small amount of flow (~0.4m³/s).

3) Flows in excess of the Northampton Road culvert capacity are directed over left bank towards the north (above a 1 in 20-year event). The overland flows exceed the capacity of the minor ditch network and connecting culverts on the eastern boundary of the site.

4) At a site access road, another restrictive culvert directs a proportion of the overland flows over the Northampton Road and into the fields to the east of the site (up to ~0.4m³/s).

5) The remainder of the flows continue north towards Junction 15 (up to ~1.5m³/s).

6) Contributing runoff from the site (West-6) is directed towards junction 15 (up to ~1.0m³/s).

7) A culvert is present beneath Junction 15 which conveys flows to the south-eastern fields. Due to the limited gradient and partially surcharged outfall, flood depths of around 1.25m are present at the upstream inlet.

8) Floodplain extents of the southern sub-catchment channel are shown to be relatively extensive, but this is likely to be a product of the 2D modelling approach in this location.

9) The south-eastern culvert is shown to convey up to 1.2m^3/s under the M1, with capacity to spare.

10) This is because a proportion of the flows are directed to the north-west before they reach the culvert.

11) Flows downstream of the Northampton Road remain largely within bank, or within the floodplain immediately next to the channel (within 5-10m of top of bank). A culvert under access track is exceeded in the 1 in 100-year+25% event leading to some minor flooding.

12) The Courteen Hall Brook continues towards the M1 where it is joined by flows exiting the Junction 15 culvert (7) and flows from the south-eastern tributary (10), before it is culverted beneath the western M1 culvert. This culvert Is shown to convey flows up to 7.0m^3/s.

5.0 ILLUSTRATIVE DEVELOPMENT MODELLING

Hydrological Changes

5.1 It is proposed to restrict runoff from the development to 4.0l/s/ha. This will attenuate the contributing runoff from sub-catchment 'West-6' to a maximum discharge rate of 141.1l/s, and the contributing site area to the north of the watercourse within sub-catchment 'West-3' to 186.9l/s.

5.2 The attenuated surface water will be designed up to the 1 in 200-year event including an allowance for climate change.

5.3 To reflect the attenuated catchments within the hydraulic model, the inflow hydrograph from West-6 was reduced to a peak of 141.1l/s. The 100l/s peak was extended for the full length of the simulation to reflect the extended hydrograph from the on-site surface water storage. This is illustrated within **Figure 5.1**.

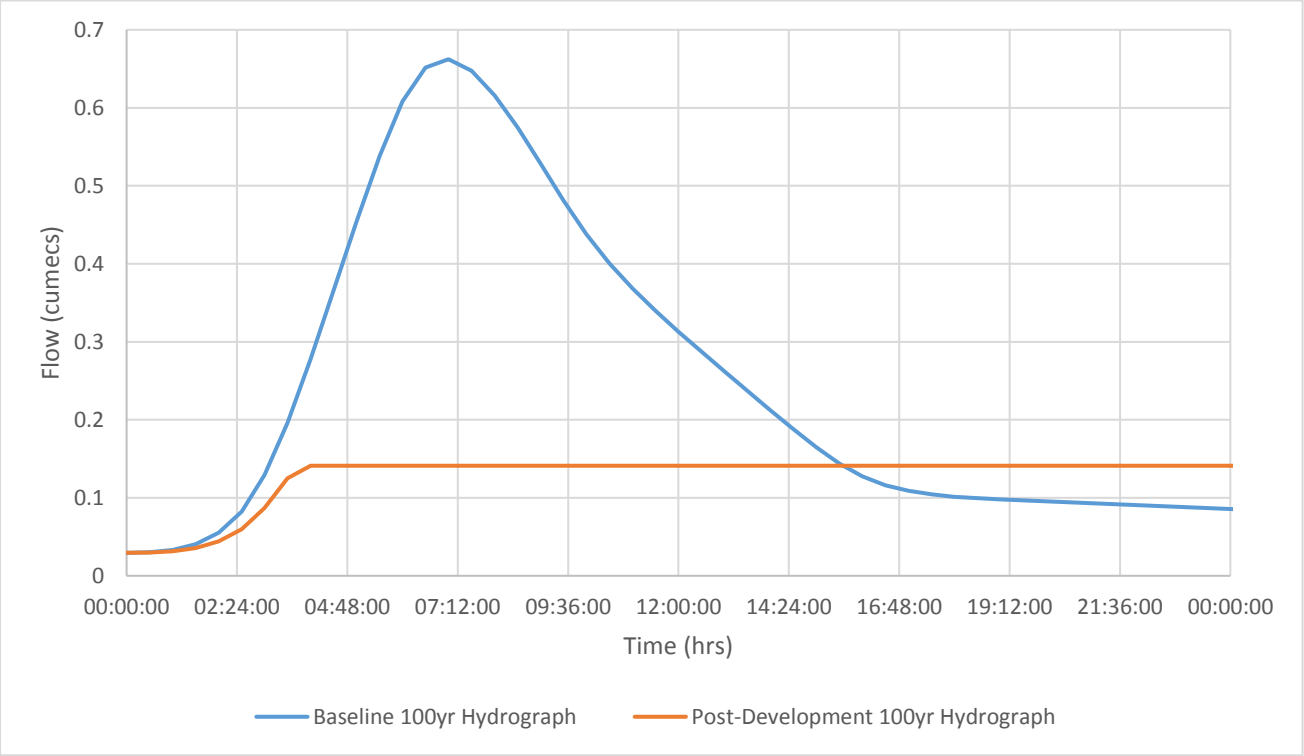


Figure 5.1 - Hydrological Changes within Sub-Catchment 'West 6'

5.4 The inflow from the combined 'West 1 2 3' inflow was prorated to leave the 1.375km^2 (86%) outside of the development area unchanged, and the 0.279km^2 (16%) within the development site restricted to 186.9l/s. The 186.9l/s component of the hydrograph was extended in the same manner as West-6. This is illustrated within **Figure 5.2**.

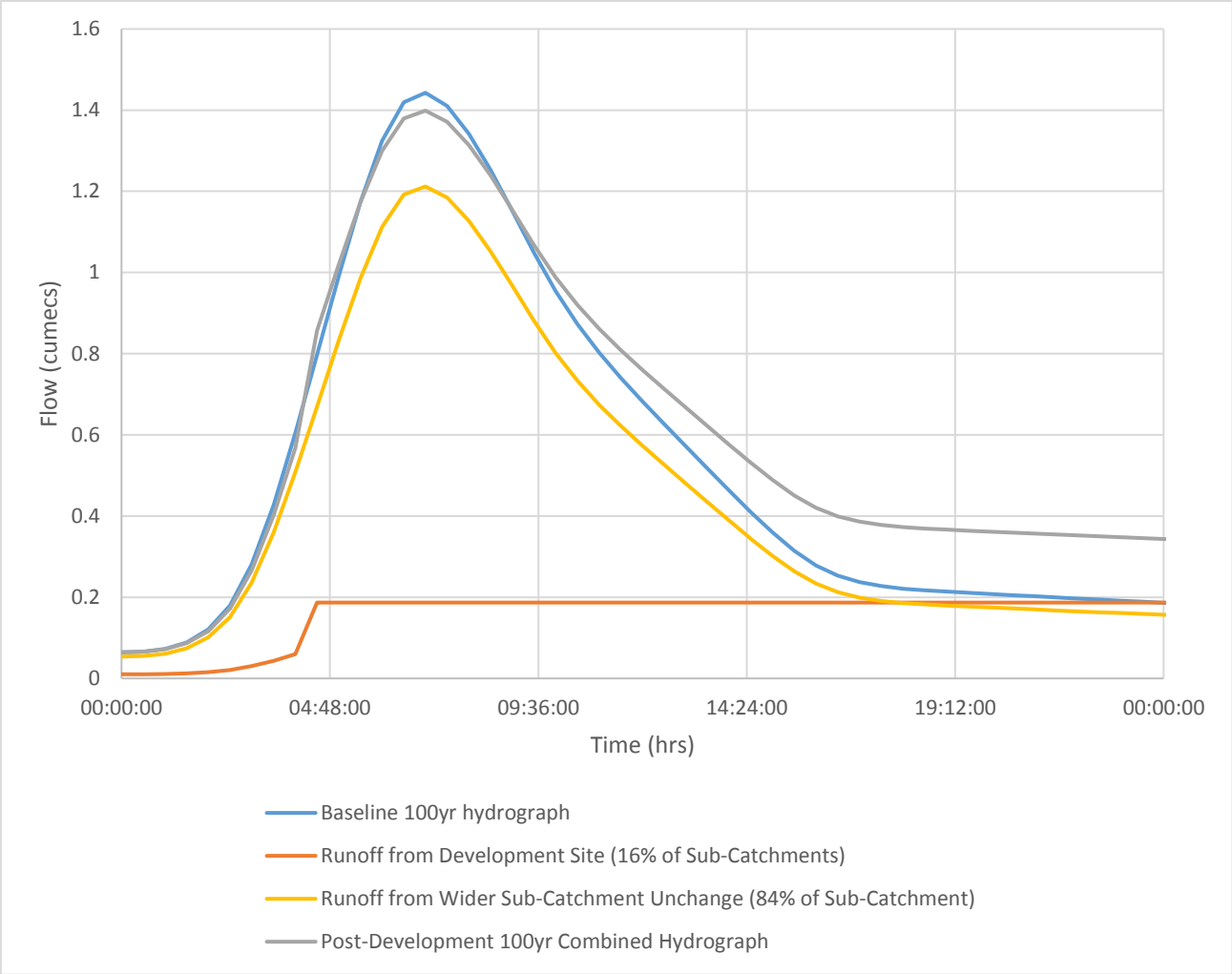


Figure 5.2 – Hydrological Changes within Sub-Catchment 'West 1 2 3'

Hydraulic Model Changes

5.5 A partial DTM of the proposed development was used to update the model topography within the vicinity of the floodplain. This includes for:

- land re-reprofiling alongside the Northampton Road to create a series of surface water attenuation ponds and development plateaus,
- the re-sectioning on the Northampton Road to create a new roundabout and site entrance.

5.6 A z-shape was used to create an illustrative flood corridor upstream of Northampton Road, for the purpose of offering additional flood storage. This would involve the excavation of the right bank floodplain between the main watercourse and a parallel ditch. The extent of additional flood storage has not yet been optimised, and is currently included to illustrate the principal of its operation.

5.7 A z-shape was also used to create an elevated landform/bund on the upstream side of Northampton Road to prevent flood water from spilling on to the highway. Alternatively, the highway could be elevated above flood levels.

5.8 To avoid overly increasing floodplain extents on the downstream side of Northampton Road, the existing culvert was retained to act as a throttle.

5.9 A schematic of the illustrative flood management measures in included as **Figure 5.3**.

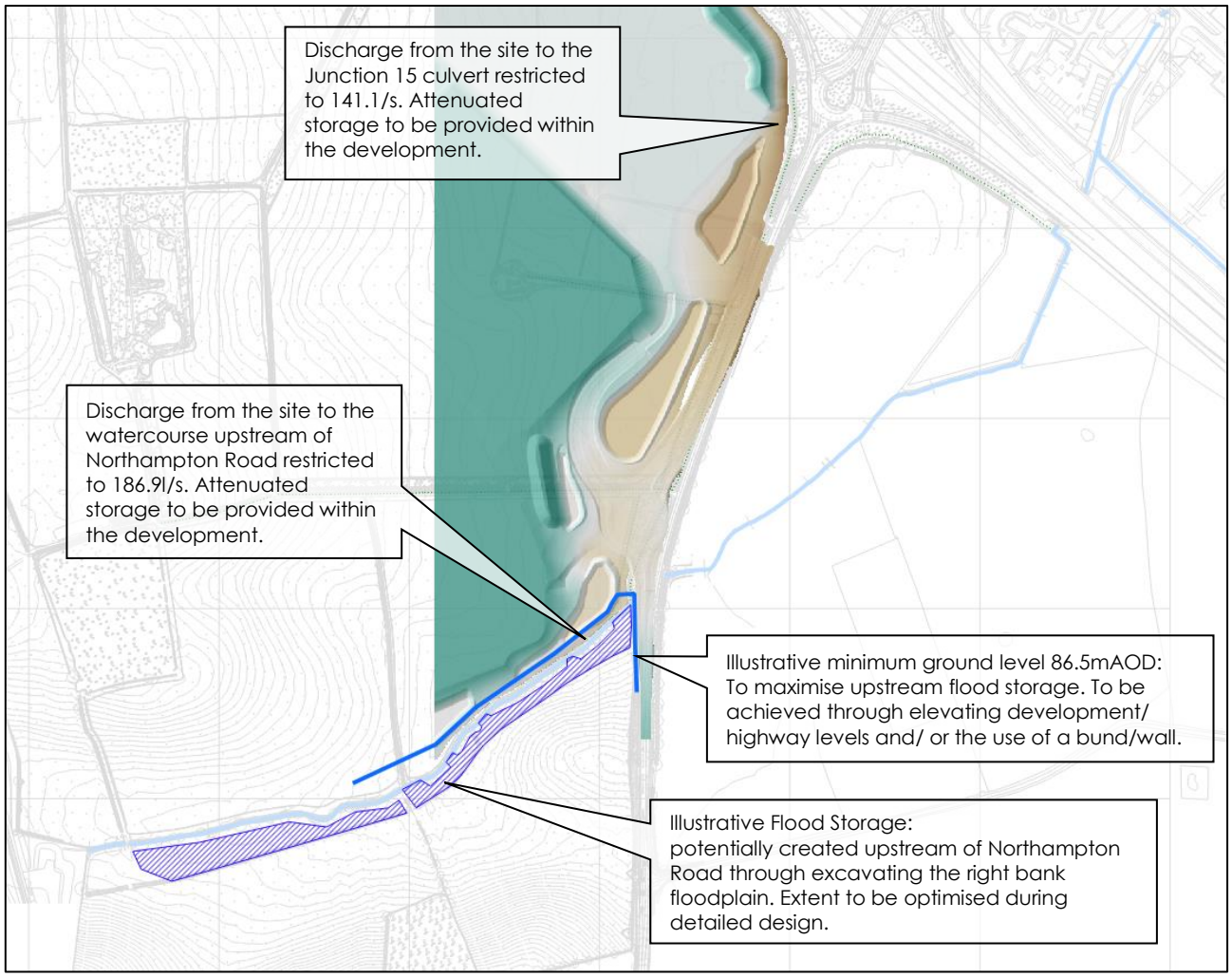


Figure 5.3 - Schematic of the illustrative flood management measures

Results

5.10 The floodplain extents following the implementation of the proposed flood management measures are illustrated within **Figure 5.4**.

5.11 This shows that Northampton Road and the proposed development site are removed from the fluvial floodplain.

5.12 It also shows that the illustrative flood storage areas are not fully utilised, demonstrating that there is room for optimisation of these elements during the detailed design stage.

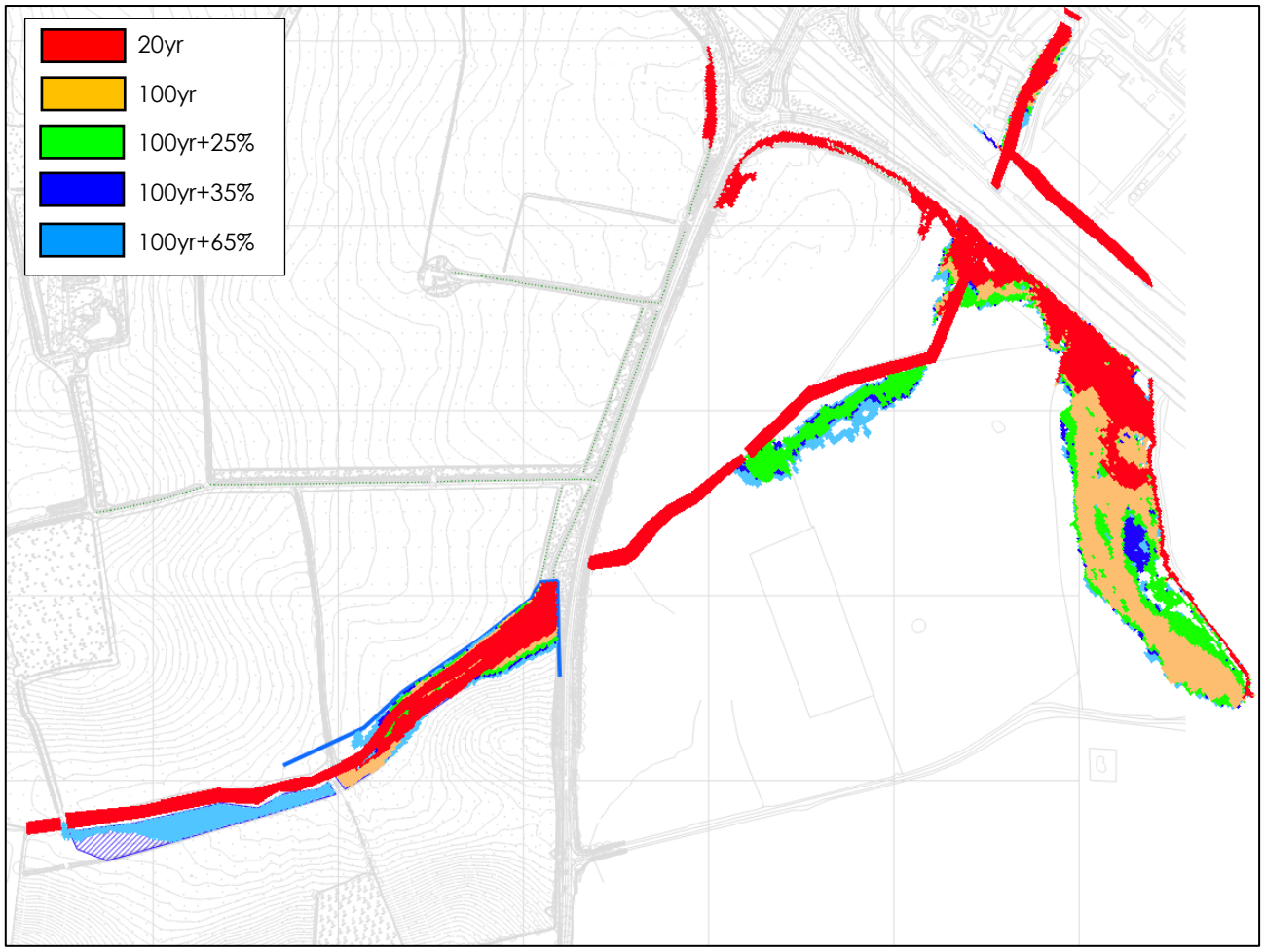


Figure 5.4 - Illustrative Post-Development Floodplain

Comparative Analysis

5.13 The mapping in **Annex 4** illustrates a comparative analysis between the post-development flood levels and the baseline flood levels. This was undertaken at a range of flood events between a 1 in 10-year (10% AEP) and the 1 in 100-year (1.0% AEP) flood event included a 65% allowance for climate change.

5.14 This shows that flood levels upstream of Northampton Road will increase as a result of the proposed flood management measures. This will result in a marginal increase in floodplain extents. This is an expected result of the proposals, and the increases are contained within land within the wider land ownership.

5.15 Immediately downstream of Northampton Road there are predicted to be nominal increases in peak flood levels, of up to 26mm. However, any increases occur for only a short reach and soon dissipate, consequently there is no significant increase in floodplain extent.

5.16 At Junction 15 and downstream of the M1, there is shown to be a general reduction in flood levels of up to 231mm. This is a result of the reduced contributing runoff from within the development site. As peak flows are being reduced, this will continue to offer betterment downstream of the modelled domain.

Sensitivity Tests

5.17 To account for the seasonal variations in vegetation, uncertainties in the downstream boundary, and the residual risk of blockages at hydraulic structures, a series of sensitivity tests were conducted using the 1 in 100-year (1.0% AEP) flows.

5.18 These were undertaken against the post-development model geometry, to test the robustness of the proposed flood management strategy.

5.19 The difference in peak waters between the tests and the design 1 in 100-year event are mapped within **Annex 5**.

Roughness

5.20 The modelling has shown that a 20% reduction in channel and floodplain roughness (representative of winter seasonal conditions, or following a period of maintenance) results in a general decrease of in-channel flood levels, of between 10 to 138mm. This has no significant impact on flood risk within the vicinity of the development.

5.21 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 of in-channel flood levels of between 10 to 170mm. However, the increase is shown to be accommodated by the specified minimum ground level of the flood management measures, therefore no flooding of the development or Northampton Road is predicted.

Downstream Boundary

5.22 The downstream boundary of the model is located on the upstream side of the large box culvert (2.9m x 2.9m) beneath Cheaney Drive. The adopted downstream boundary water level of 76mAOD is the surveyed water level. The modelled 1 in 1000-year flood level in the downstream Wootton Brook (node ref: WO56319d) is 73.62mAOD. A blockage of such a large culvert is considered unlikely, especially as it is downstream of smaller culverts, but to understand the potential impact on flood risk within the development this was investigated as part of the sensitivity tests.

5.23 The watercourse survey shows that ground levels over the Cheaney Drive culvert are in the region of 79.12mAOD. For the purpose of the sensitivity test, the downstream water level was increased to 79.5mAOD to represent a complete blockage of the culvert and a flow depth of approximately 0.4m over Cheaney Drive.

5.24 The increase in downstream water levels increases flood levels by up to 1.482m downstream of the M1, which greatly increases floodplain extents.

5.25 Flood levels upstream of the M1 are shown to increase by up to 1.4m. However, any increase dissipates before it reaches the development site.

Blockage Scenarios

5.26 Blockage scenarios were undertaken on four culverts which could have the potential to affect flood risk within the development, these are located within **Figure 5.5**. A 75% blockage of each structure was assessed individually.

5.27 A blockage of the downstream Cheaney Drive culvert was assessed as part of the downstream boundary sensitivity test. The other hydraulic structures within the model could be easily bypassed and so were omitted from the analysis.

5.28 A 75% blockage of the Northampton Road culvert was shown to increase upstream flood levels by 727mm. However, the increase is shown to be accommodated by the specified minimum ground level, therefore no flooding of the development or Northampton Road is predicted.

5.29 A 75% blockage of the southern M1 culvert is shown to divert flood water towards the northern M1 culvert. This leads to marginal increases in flood levels, in the region of 22mm. Any detriment dissipates before reaching the development site.

5.30 A 75% blockage of the northern M1 culvert is shown to result in a localised increase in flood levels of up to 800mm. This impact does not affect flood levels within the vicinity of the development site.

5.31 A 75% blockage of the Junction 15 culvert is predicted to result in a marginal localised increase in flood levels of up to 45mm within the development site.

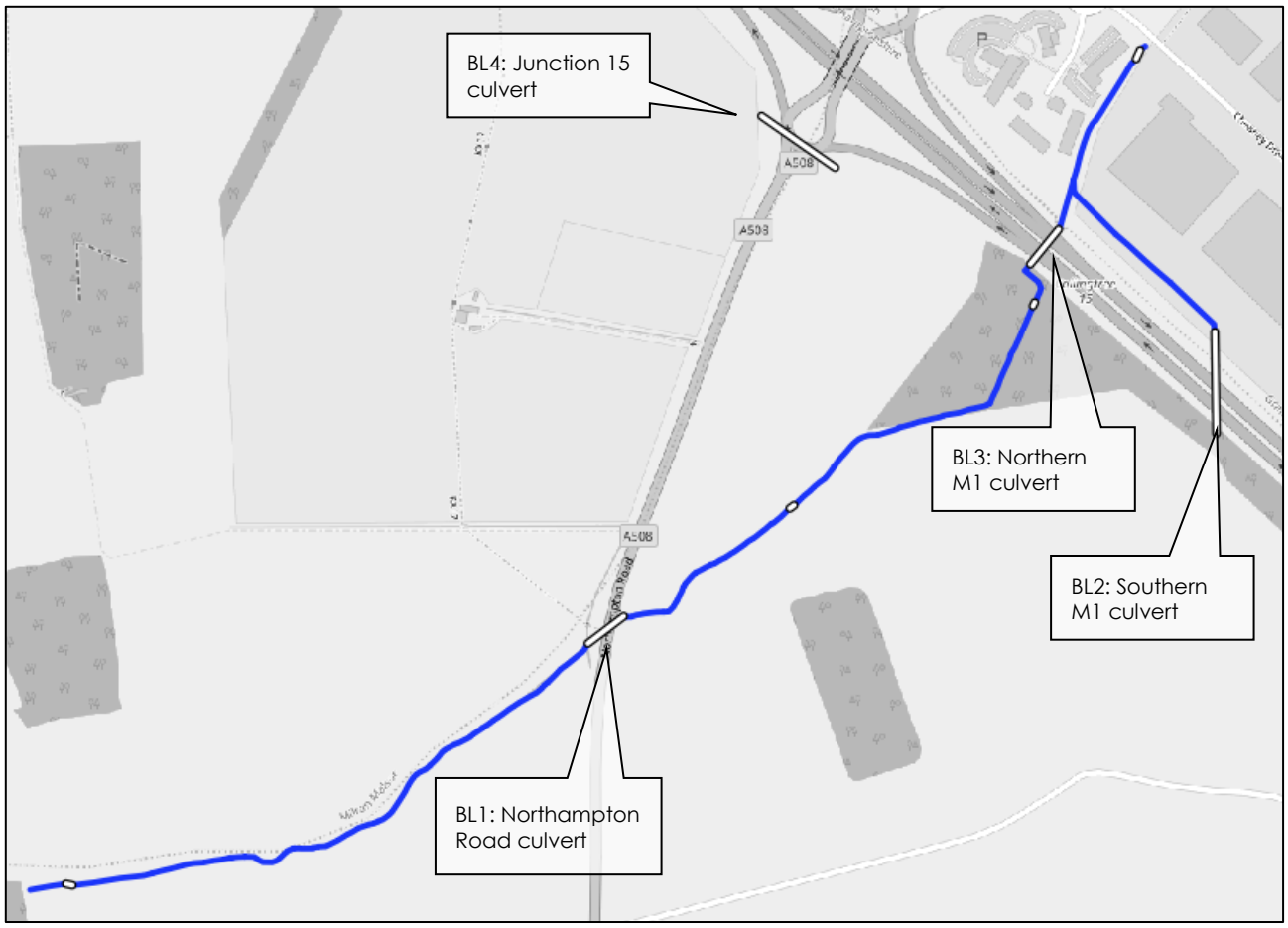


Figure 5.5 - Blockage Scenario Locations

Tabulated Results

5.32 Peak water levels from selected points through the site are detailed within **Table 5.1**. Interrogation locations are identified within **Figure 5.6**.

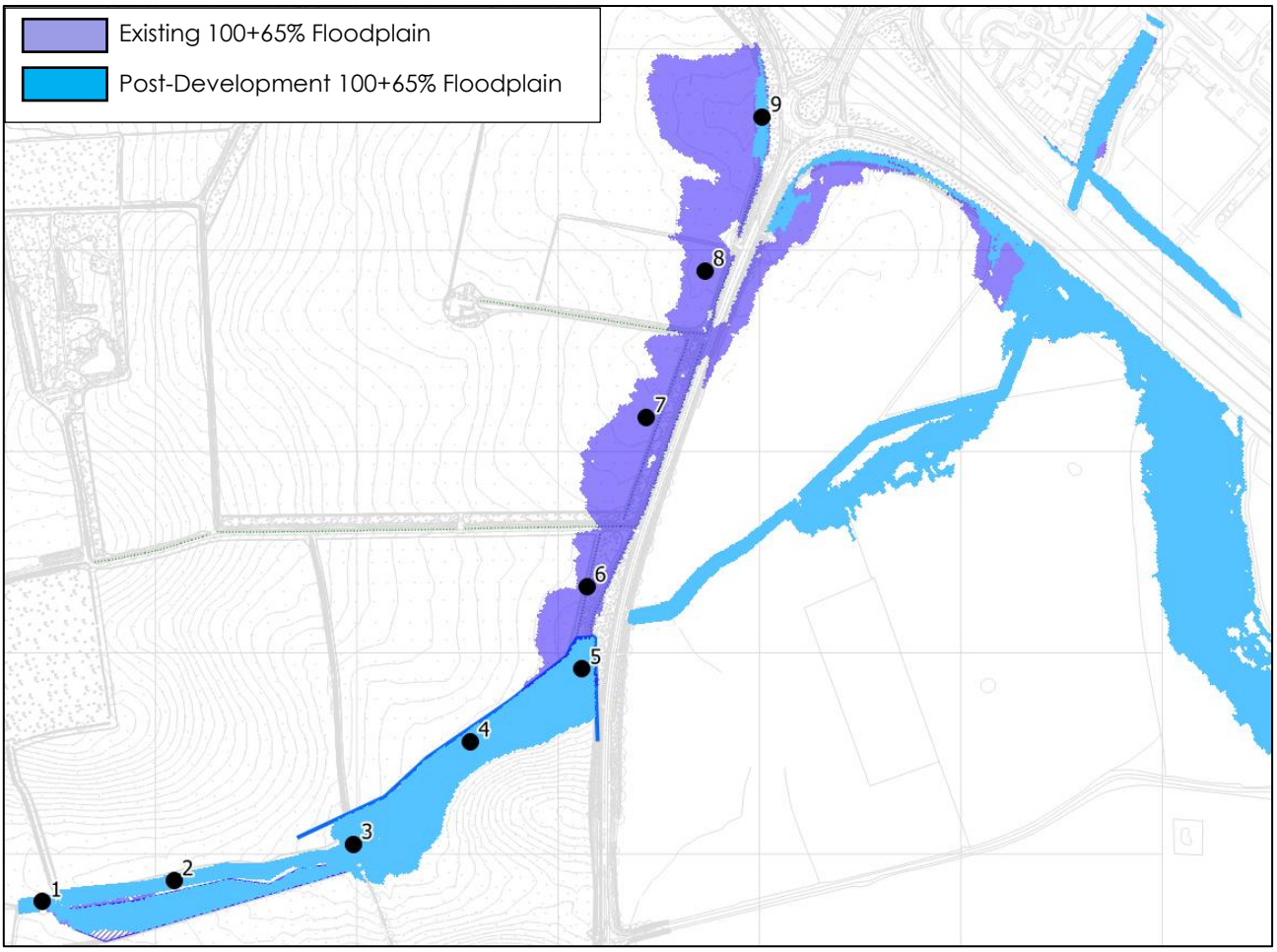


Figure 5.6 - Flood Level Interrogation Locations

Table 5.1 - Peak Modelled Flood Levels (mAOD)

	Flood Events	1	2	3	4	5	6	7	8	9
Baseline	1 in 20	88.73	86.90	84.82	83.98	83.95	83.95	82.21	80.95	80.37
	1 in 100	88.95	87.02	84.95	84.04	83.97	83.97	82.22	80.98	80.50
	1 in 100 + 25%	89.11	87.10	85.04	84.07	83.98	83.98	82.23	81.00	80.59
	1 in 100 + 35%	89.13	87.12	85.07	84.09	83.99	83.99	82.23	81.00	80.63
	1 in 100 + 65%	89.18	87.20	85.16	84.13	84.00	84.00	82.23	81.02	80.75
	1 in 1000	89.18	87.21	85.16	84.14	84.01	84.00	82.23	81.02	80.76
Post Development	1 in 20	88.74	86.91	85.07	84.93	84.93	-	-	-	80.24
	1 in 100	88.93	87.01	85.51	85.47	85.46	-	-	-	80.24
	1 in 100 + 25%	89.09	87.06	85.83	85.83	85.83	-	-	-	80.24
	1 in 100 + 35%	89.11	87.07	85.95	85.95	85.95	-	-	-	80.24
	1 in 100 + 65%	89.16	87.10	86.28	86.28	86.28	-	-	-	80.24
Sensitivity Tests	Roughness + 20%	88.95	87.07	85.62	85.60	85.60	-	-	-	80.25
	Roughness - 20%	88.90	86.94	85.34	85.29	85.29	-	-	-	80.24
	D/S Boundary	88.93	87.01	85.51	85.47	85.46	-	-	-	80.24
	Blockage Scenario BL1	88.93	87.01	86.19	86.18	86.18	-	-	-	80.24
	Blockage Scenario BL2	88.93	87.01	85.51	85.47	85.46	-	-	-	80.24
	Blockage Scenario BL3	88.93	87.01	85.51	85.47	85.46	-	-	-	80.24
	Blockage Scenario BL4	88.93	87.01	85.51	85.47	85.46	-	-	-	80.29

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 The primary aim of this exercise was to establish a good hydrological and hydraulic representation of the Couteenhall Brook to identify the fluvial flood risk to the proposed development, and to outline potential flood management measures.

6.2 The modelling has shown that the eastern edge of the development site is currently subject to a shallow overland flow route, which is initiated by a restrictive culvert under the Northampton Road.

6.3 This flood route can be prevented through the elevation of ground levels around the Courteenhall Brook upstream of the road. While this will increase upstream flood levels, analysis has shown that any detriment is contained within the wider land ownership and therefore deemed acceptable.

6.4 Any downstream impacts are mitigated through the attenuation and on-site storage of the contributing runoff from the development site to 4l/s/ha. This has the potential to offer betterment to downstream flood levels.

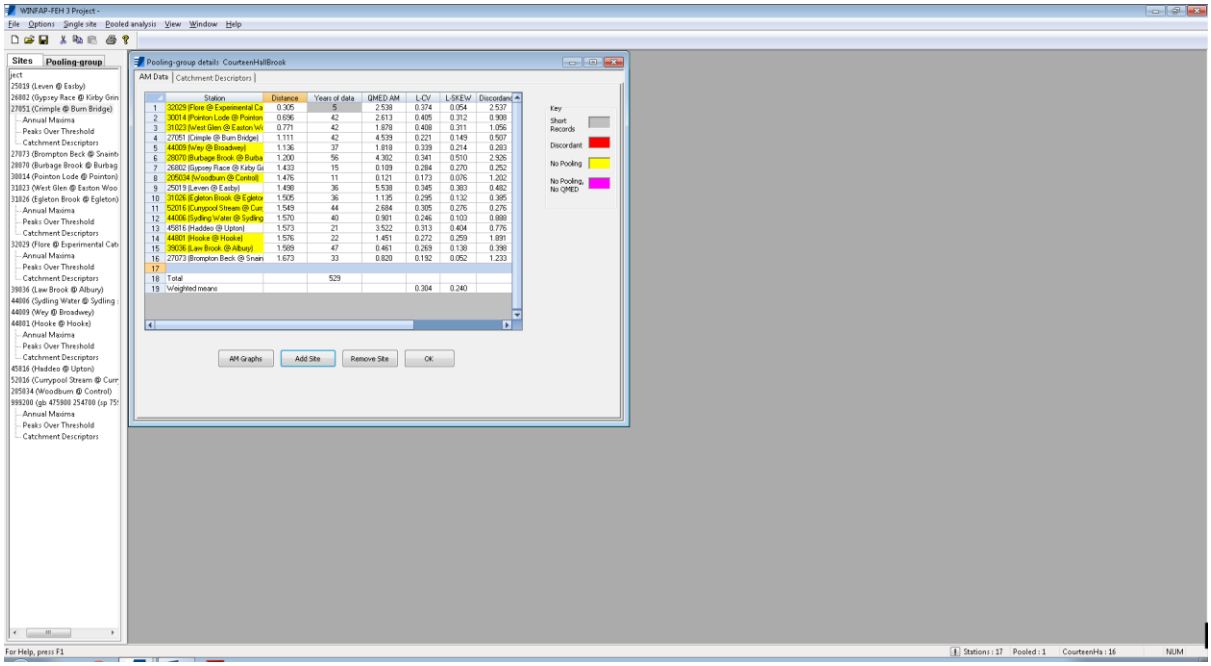
6.5 Analysis has shown that the watercourse is sensitive to increases in roughness, and to a potential blockage of the Northampton Road culvert and the Junction 15 culvert. However, any residual risk that these could pose to the development can be mitigated through setting development levels appropriately.

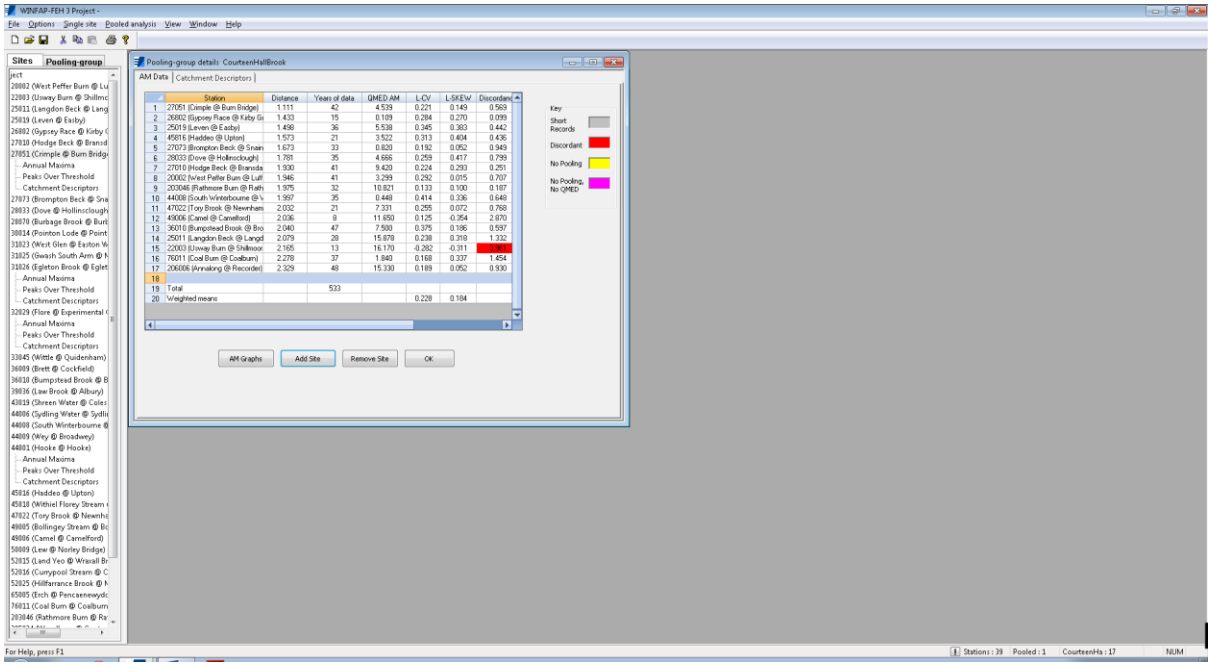
6.6 If possible in future assessments, survey of railway line culvert would allow the model to be extended to include for the floodplain storage available upstream.

6.7 The proposed flood management solution has been modelled to illustrate the principle of the scheme. There is the potential for the recommended works to be refined/ optimised as part of the design and development stage.

ANNEX 1

WINFAP Audit Trail & Pooling Group Composition


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance Years of data QMED AM L-CV L-SKEW Discordanc
1 32029 (Flore @ Experimental Ca 0.305 5 2.538 0.374 0.054 2.537
2 30014 (Pointon Lode @ Pointon 0.606 42 2.613 0.405 0.312 0.908
3 31023 (West Glen @ Easton Wo 0.771 42 1.878 0.408 0.311 1.056
4 27051 (Crimple @ Burn Bridge) 1.111 42 4.539 0.221 0.149 0.507
5 44009 (Wey @ Broadwey) 1.136 37 1.818 0.339 0.214 0.283
6 28070 (Burbage Brook @ Burba 1.200 56 4.302 0.341 0.510 2.326
7 26802 (Gypsey Race @ Kirby Gr 1.433 15 0.109 0.284 0.270 0.252
8 205034 (Woodburn @ Control) 1.476 11 0.121 0.173 0.076 1.202
9 25019 (Leven @ Easby) 1.498 36 5.538 0.345 0.393 0.492
10 31026 (Egleton Brook @ Egleton 1.505 36 1.135 0.295 0.132 0.395
11 52016 (Currypool Stream @ Cur 1.549 44 2.684 0.305 0.276 0.276
12 44006 (Sydling Water @ Sydling 1.570 40 0.901 0.246 0.103 0.888
13 45816 (Haddeo @ Upton) 1.573 21 3.522 0.313 0.404 0.776
14 44001 (Hooke @ Hooke) 1.576 22 1.451 0.272 0.259 1.891
15 39036 (Law Brook @ Albury) 1.589 47 0.461 0.269 0.138 0.398
16 27073 (Brompton Beck @ Snain 1.673 33 0.820 0.192 0.052 1.233
17
18 Total 529
19 Weighted means 0.304 0.240
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
AM Graphs Add Site Remove Site OK
For Help, press F1
Stations : 17 Pooled : 1 CourteenHa : 16
NUM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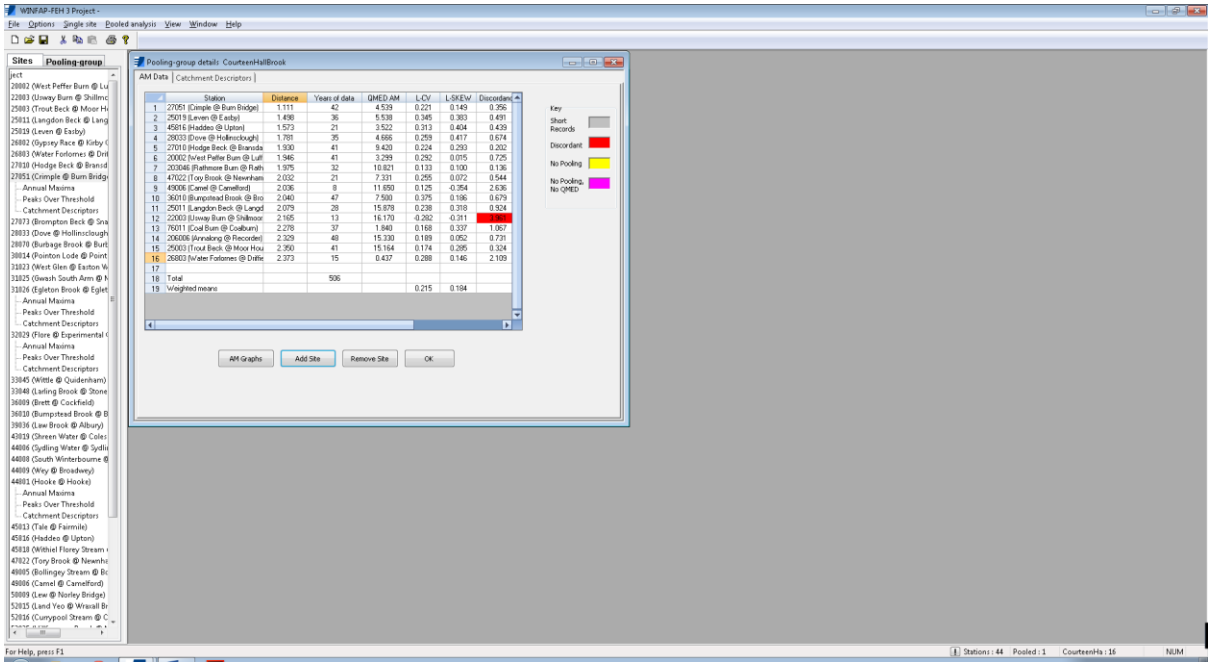
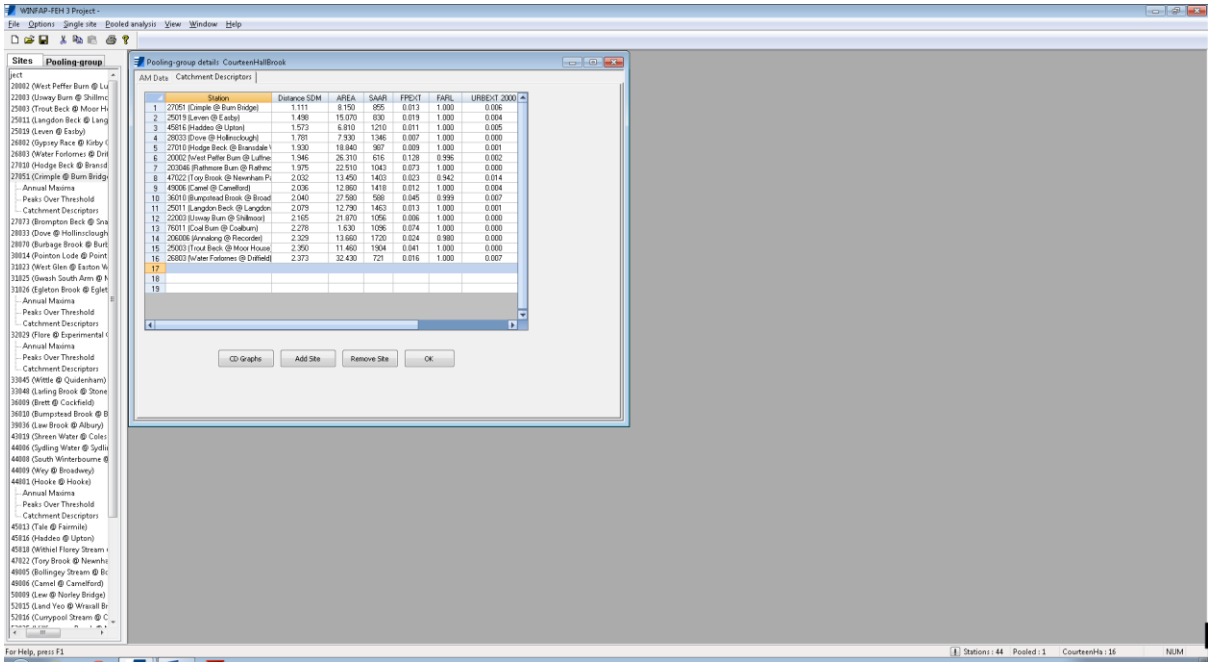
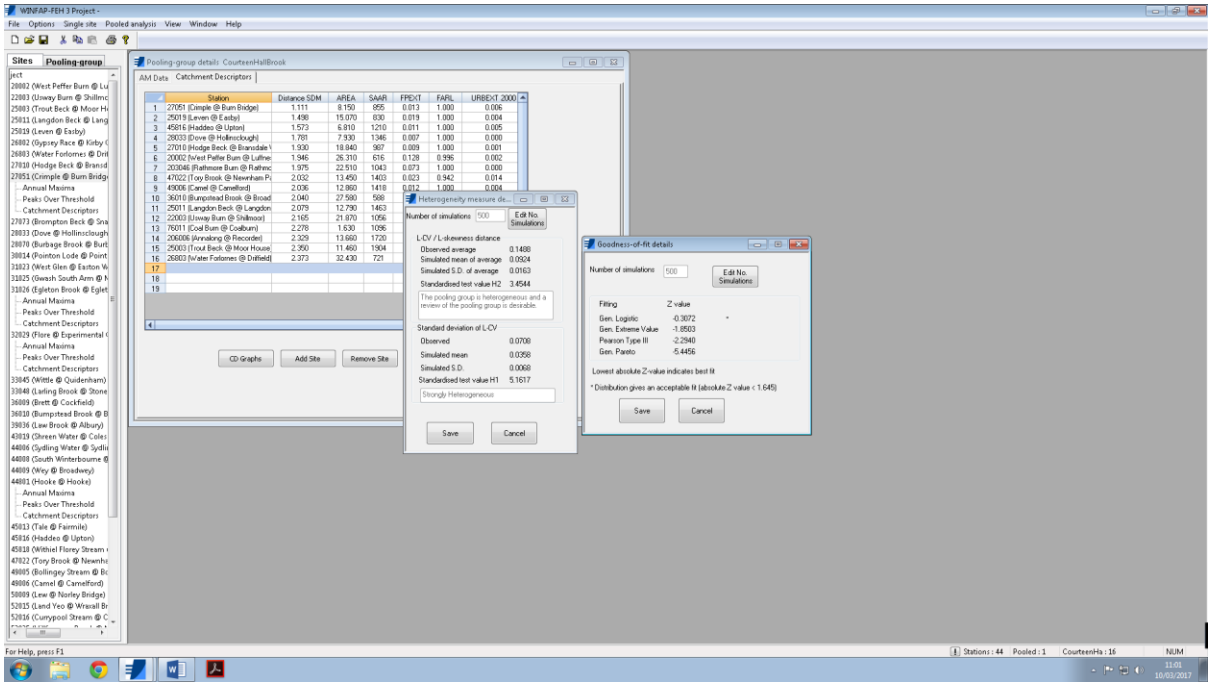
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance Years of data QMED AM L-CV L-SKEW Discordanc
1 27051 (Crimple @ Burn Bridge) 1.111 42 4.539 0.221 0.149 0.569
2 26802 (Gypsey Race @ Kirby Gr 1.433 15 0.109 0.284 0.270 0.099
3 25019 (Leven @ Easby) 1.498 36 5.538 0.345 0.393 0.442
4 45816 (Haddeo @ Upton) 1.573 21 3.522 0.313 0.404 0.436
5 27073 (Brompton Beck @ Snain 1.673 33 0.820 0.192 0.052 0.949
6 28033 (Dove @ Hollinsclough) 1.781 35 4.665 0.259 0.417 0.799
7 27010 (Hodge Beck @ Bransda 1.930 41 9.420 0.224 0.293 0.251
8 20002 (West Peffer Burn @ Luff 1.946 41 3.299 0.292 0.015 0.707
9 203046 (Rathmore Burn @ Rath 1.975 32 10.821 0.133 0.100 0.187
10 44008 (South Winterbourne @ \ 1.997 35 0.448 0.414 0.336 0.648
11 47022 (Tony Brook @ Newenham 2.032 21 7.331 0.295 0.072 0.768
12 49006 (Camel @ Camelford) 2.036 8 11.650 0.125 -0.354 2.870
13 36010 (Bumpstead Brook @ Bro 2.040 47 7.500 0.375 0.186 0.597
14 25011 (Langdon Beck @ Langd 2.079 28 15.870 0.238 0.318 1.332
15 22003 (Uway Burn @ Shillmoor 2.165 13 16.170 -0.282 -0.311 1.854
16 76011 (Coal Burn @ Coalburn) 2.278 37 1.840 0.168 0.337 1.454
17 206006 (Annalong @ Recorder) 2.329 48 15.330 0.189 0.052 0.930
18
19 Total 533
20 Weighted means 0.228 0.184
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
AM Graphs Add Site Remove Site OK
For Help, press F1
Stations : 39 Pooled : 1 CourteenHa : 17
NUM


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance Years of data QMED AM L-CV L-SKEW Discordan
1 27051 (Cimple @ Burn Bridge) 1.111 42 4.539 0.221 0.149 0.356
2 25019 (Leven @ Easby) 1.498 36 5.538 0.345 0.393 0.491
3 45816 (Haddea @ Upton) 1.573 21 3.522 0.313 0.404 0.439
4 28033 (Dove @ Hollinsclough) 1.781 35 4.665 0.259 0.417 0.674
5 27010 (Hodge Beck @ Bransda 1.930 41 9.420 0.224 0.293 0.202
6 20002 (West Peffer Burn @ Luff 1.946 41 3.299 0.292 0.015 0.725
7 203046 (Rathmore Burn @ Rath 1.975 32 10.821 0.133 0.100 0.136
8 47022 (Tory Brook @ Newnham 2.032 21 7.331 0.295 0.072 0.544
9 49006 (Camel @ Camelford) 2.036 8 11.650 0.125 -0.354 2.636
10 36010 (Bumpstead Brook @ Bro 2.040 47 7.500 0.375 0.196 0.679
11 25011 (Langdon Beck @ Langd 2.079 28 15.878 0.238 0.318 0.924
12 22003 (Uxway Burn @ Shillmoor 2.165 13 16.170 -0.282 -0.311 3.067
13 76011 (Coal Burn @ Coalburn) 2.278 37 1.840 0.168 0.337 1.067
14 206006 (Annalong @ Recorder) 2.329 48 15.330 0.189 0.052 0.731
15 25003 (Trout Beck @ Moor Hou 2.350 41 15.164 0.174 0.285 0.324
16 26803 (Water Fotomes @ Drifte 2.373 15 0.437 0.288 0.146 2.109
17
18 Total 506
19 Weighted means 0.215 0.184
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
AM Graphs Add Site Remove Site OK
For Help, press F1
Stations : 44 Pooled : 1 CourteenHa : 16
NUM


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance SDM AREA SAAR FPEXT FARL URBEXT 2000
1 27051 (Cimple @ Burn Bridge) 1.111 8.150 955 0.013 1.000 0.006
2 25019 (Leven @ Easby) 1.498 15.070 830 0.019 1.000 0.004
3 45816 (Haddea @ Upton) 1.573 6.910 1210 0.011 1.000 0.005
4 28033 (Dove @ Hollinsclough) 1.781 7.930 1346 0.007 1.000 0.000
5 27010 (Hodge Beck @ Bransdale 1.930 18.840 907 0.009 1.000 0.001
6 20002 (West Peffer Burn @ Luffnes 1.946 26.310 616 0.128 0.996 0.002
7 203046 (Rathmore Burn @ Rathmo 1.975 22.510 1043 0.073 1.000 0.000
8 47022 (Tory Brook @ Newnham Pa 2.032 13.450 1403 0.023 0.942 0.014
9 49006 (Camel @ Camelford) 2.036 12.860 1418 0.012 1.000 0.004
10 36010 (Bumpstead Brook @ Broad 2.040 27.580 588 0.045 0.999 0.007
11 25011 (Langdon Beck @ Langdon 2.079 12.790 1463 0.013 1.000 0.001
12 22003 (Uxway Burn @ Shillmoor) 2.165 21.870 1056 0.006 1.000 0.000
13 76011 (Coal Burn @ Coalburn) 2.278 1.630 1096 0.074 1.000 0.000
14 206006 (Annalong @ Recorder) 2.329 13.660 1720 0.024 0.980 0.000
15 25003 (Trout Beck @ Moor House 2.350 11.460 1904 0.041 1.000 0.000
16 26803 (Water Fotomes @ Driffield) 2.373 32.430 721 0.016 1.000 0.007
17
18
19
CD Graphs Add Site Remove Site OK
For Help, press F1
Stations : 44 Pooled : 1 CourteenHa : 16
NUM


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance SDM AREA SAAR FPEXT FARL URBEXT 2000
1 27051 (Crimple @ Burn Bridge) 1.111 8.150 855 0.013 1.000 0.006
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3 45816 (Haddes @ Upton) 1.573 6.810 1210 0.011 1.000 0.005
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7 203046 (Rathmore Burn @ Rathmc) 1.975 22.510 1043 0.073 1.000 0.000
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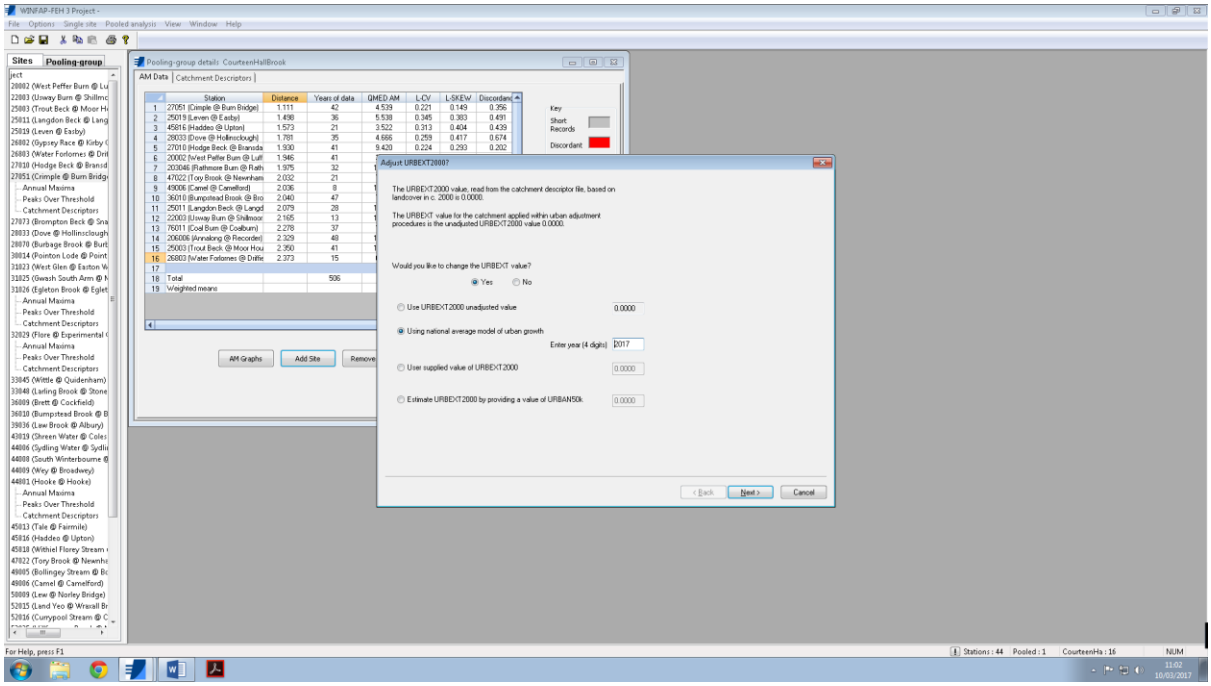
9 49006 (Camel @ Camelford) 2.036 12.860 1418 0.012 1.000 0.004
10 36010 (Bumpstead Brook @ Broad) 2.040 27.580 588 0.000 1.000 0.000
11 25011 (Langdon Beck @ Langdon) 2.079 12.790 1463 0.000 1.000 0.000
12 22003 (Upway Burn @ Shillmoor) 2.165 21.870 1056 0.000 1.000 0.000
13 76011 (Coal Burn @ Coalburn) 2.278 1.630 1096 0.000 1.000 0.000
14 206006 (Annalong @ Recorder) 2.329 13.660 1720 0.000 1.000 0.000
15 25003 (Trout Beck @ Moor House) 2.350 11.460 1904 0.000 1.000 0.000
16 26803 (Water Fortornes @ Driffield) 2.373 32.430 721 0.000 1.000 0.000
17
18
19
CD Graphs Add Site Remove Site
Heterogeneity measure de...
Number of simulations 500 Edit No. Simulations
L-CV / L-skewness distance
Observed average 0.1488
Simulated mean of average 0.0924
Simulated S.D. of average 0.0163
Standardised test value H2 3.4544
The pooling group is heterogeneous and a review of the pooling group is desirable.
Standard deviation of L-CV
Observed 0.0708
Simulated mean 0.0358
Simulated S.D. 0.0068
Standardised test value H1 5.1617
Strongly Heterogeneous
Save Cancel
Goodness-of-fit details
Number of simulations 500 Edit No. Simulations
Fitting Z value
Gen. Logistic -0.3072 *
Gen. Extreme Value -1.8503
Pearson Type III -2.2940
Gen. Pareto -5.4456
Lowest absolute Z-value indicates best fit
* Distribution gives an acceptable fit (absolute Z value < 1.645)
Save Cancel
For Help, press F1
Stations : 44 Pooled : 1 CourteenHa : 16 NUM
11:01 10/03/2017


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance Years of data QMED AM L-CV L-SKEW Discordan
1 27051 (Crimple @ Burn Bridge) 1.111 42 4.539 0.221 0.149 0.356
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4 28033 (Dove @ Hollinsclough) 1.781 35 4.666 0.259 0.417 0.674
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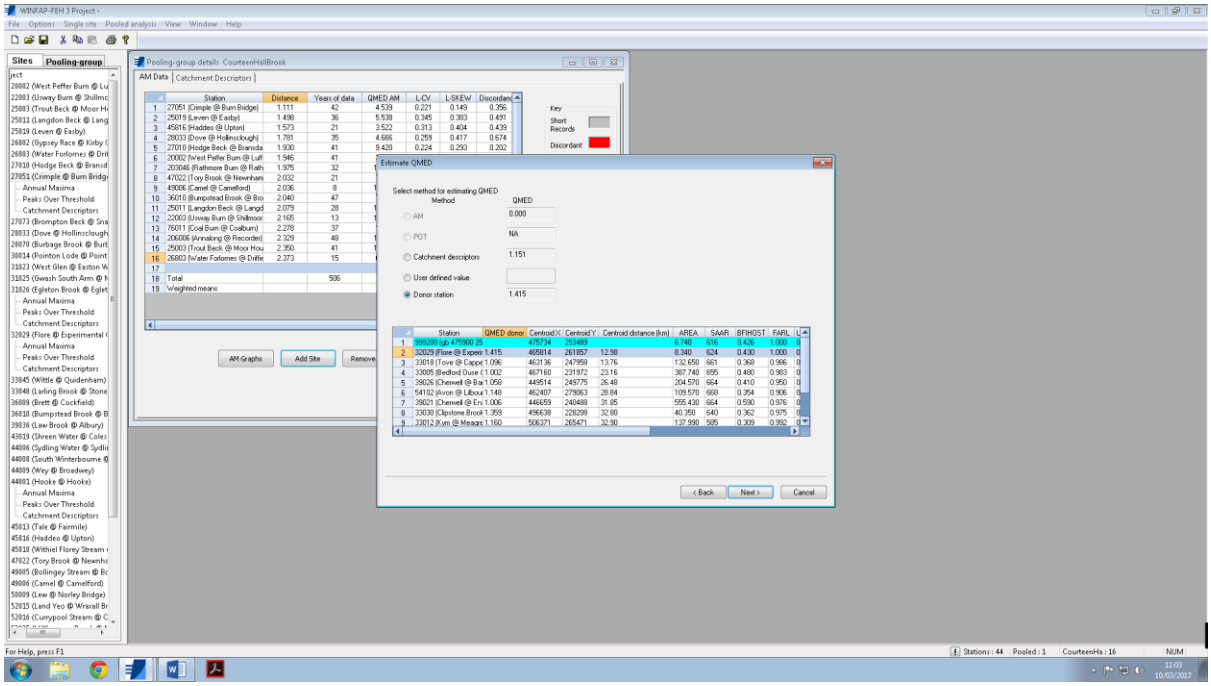
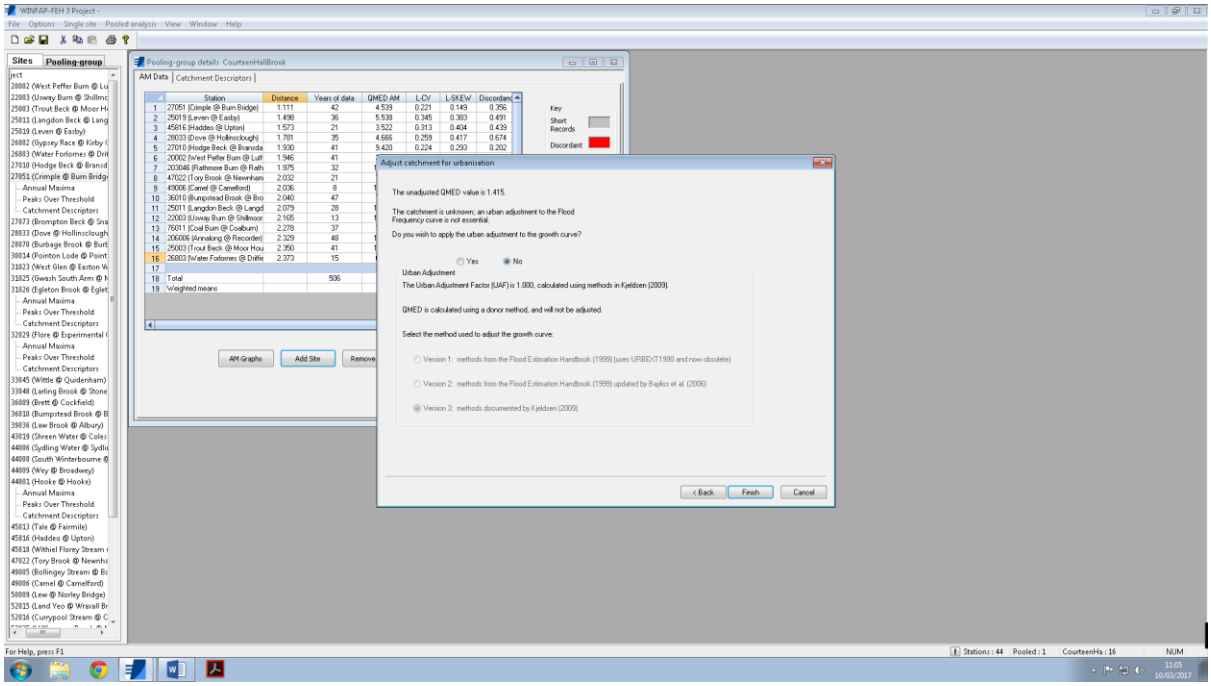
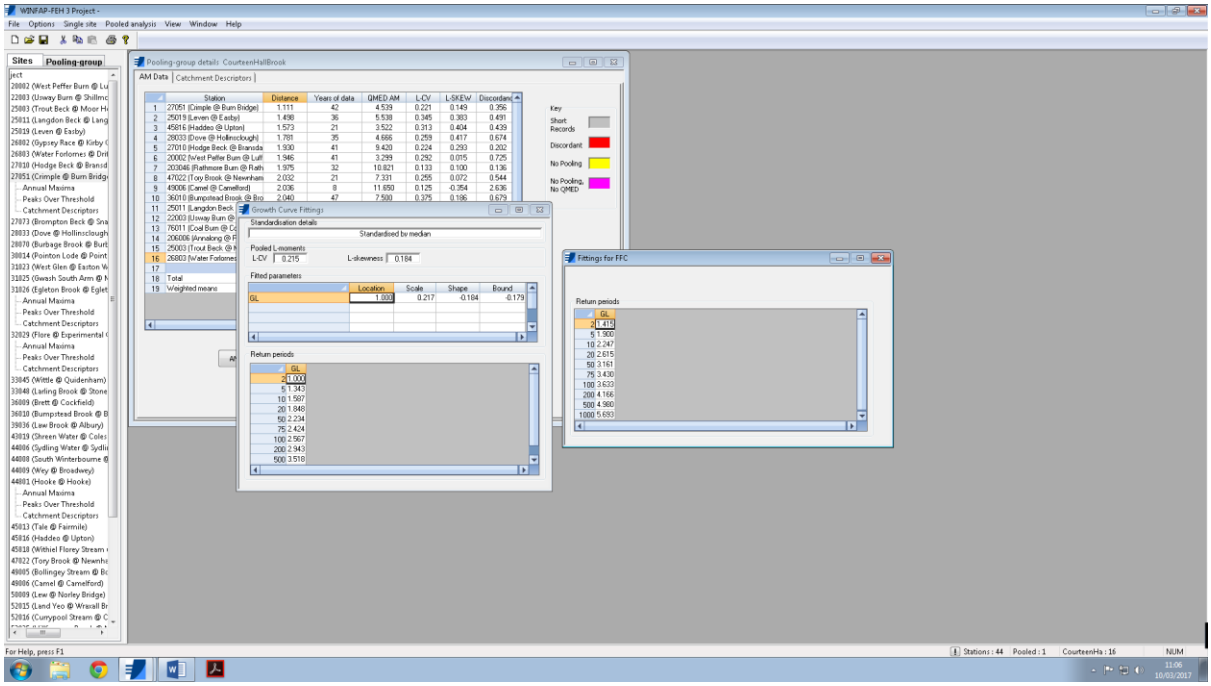
7 203046 (Rathmore Burn @ Rath 1.975 32
8 47022 (Tory Brook @ Newnham 2.032 21
9 49006 (Camel @ Camelford) 2.036 8
10 36010 (Bumpstead Brook @ Bro 2.040 47
11 25011 (Langdon Beck @ Langd 2.079 28
12 22003 (Upway Burn @ Shillmoor 2.165 13
13 76011 (Coal Burn @ Coalburn) 2.278 37
14 206006 (Annalong @ Recorder) 2.329 48
15 25003 (Trout Beck @ Moor Hou 2.350 41
16 26803 (Water Fortornes @ Drifte 2.373 15
17
18 Total 506
19 Weighted means
Key
Short Records
Discordant
AM Graphs Add Site Remove
Adjust URBEXT2000?
The URBEXT2000 value, read from the catchment descriptor file, based on landcover in c. 2000 is 0.0000.
The URBEXT value for the catchment applied within urban adjustment procedures is the unadjusted URBEXT2000 value 0.0000.
Would you like to change the URBEXT value?
Yes No
Use URBEXT2000 unadjusted value 0.0000
Using national average model of urban growth
Enter year (4 digits) 2017
User supplied value of URBEXT2000 0.0000
Estimate URBEXT2000 by providing a value of URBAN50k 0.0000
< Back Next > Cancel
For Help, press F1
Stations : 44 Pooled : 1 CourteenHa : 16 NUM
11:02 10/03/2017


WINFAP-FEH 3 Project -
Pooling-group details: CourteenHallBrook
AM Data
Catchment Descriptors
Estimate QMED
Select method for estimating QMED
Method
QMED
AM
0.000
POT
NA
Catchment descriptors
1.151
User defined value
Donor station
1.415
< Back
Next >
Cancel
AM Graphs
Add Site
Remove
For Help, press F1
Stations : 44
Pooled : 1
CourteenHa : 16
NUM


WINFAP-FEH 3 Project -
Pooling-group details: CourteenHallBrook
AM Data
Catchment Descriptors
Adjust catchment for urbanisation
The unadjusted QMED value is 1.415.
The catchment is unknown; an urban adjustment to the Flood Frequency curve is not essential.
Do you wish to apply the urban adjustment to the growth curve?
Yes
No
Urban Adjustment
The Urban Adjustment Factor (UAF) is 1.000, calculated using methods in Kjeldsen (2009).
QMED is calculated using a donor method, and will not be adjusted.
Select the method used to adjust the growth curve:
Version 1: methods from the Flood Estimation Handbook (1999) [uses URBEXT1990 and now obsolete]
Version 2: methods from the Flood Estimation Handbook (1999) updated by Bayliss et al. (2006)
Version 3: methods documented by Kjeldsen (2009)
< Back
Finish
Cancel
AM Graphs
Add Site
Remove
For Help, press F1
Stations : 44
Pooled : 1
CourteenHa : 16
NUM


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Pooling-group details: CourteenHallBrook
AM Data Catchment Descriptors
Station Distance Years of data QMED AM L-CV L-SKEW Discordan
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10 36010 (Bumpstead Brook @ Bro 2.040 47 7.500 0.375 0.196 0.679
11 25011 (Langdon Beck
12 22003 (Usway Burn @
13 76011 (Coal Burn @ Co
14 206006 (Annalong @ R
15 25003 (Trout Beck @ M
16 26803 (Water Fortonme
17
18 Total
19 Weighted means
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
Growth Curve Fittings
Standardisation details
Standardised by median
Pooled L-moments
L-CV 0.215
L-skewness 0.184
Fitted parameters
Location Scale Shape Bound
GL 1.803 0.217 -0.184 -0.179
Return periods
GL
2 1.000
5 1.343
10 1.597
20 1.848
50 2.234
75 2.424
100 2.567
200 2.943
500 3.518
Fittings for FFC
Return periods
GL
2 1.415
5 1.900
10 2.247
20 2.615
50 3.161
75 3.430
100 3.633
200 4.166
500 4.980
1000 5.693
For Help, press F1
Stations : 44 Pooled : 1 CourteenHa : 16
NUM
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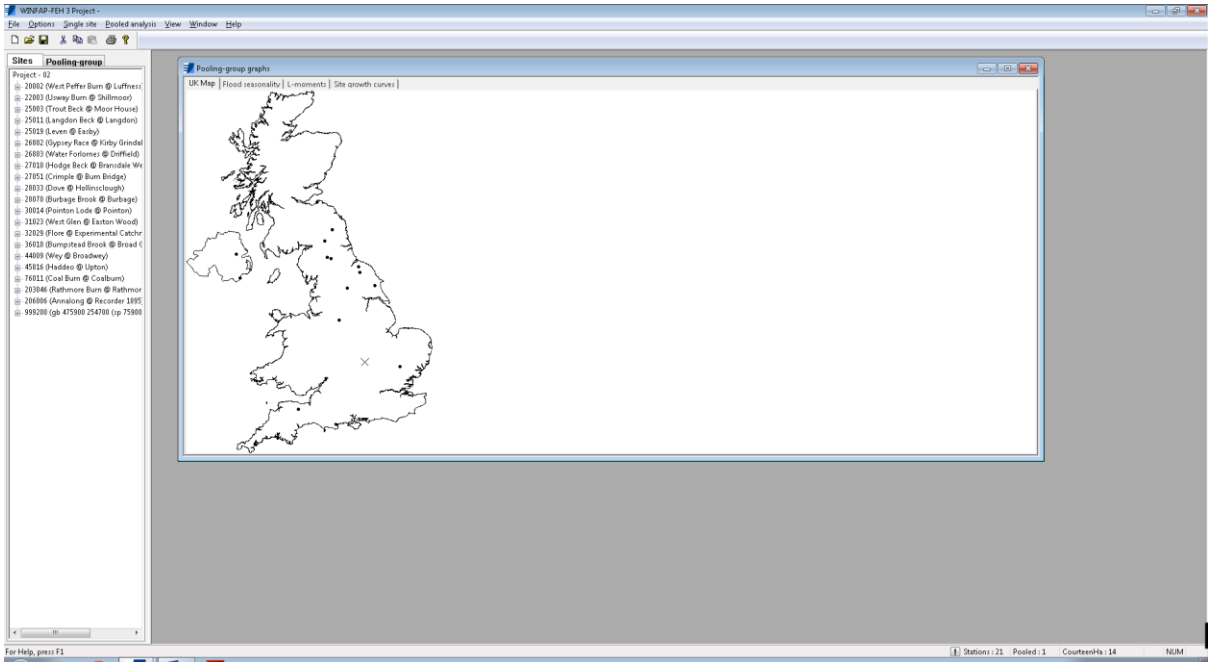
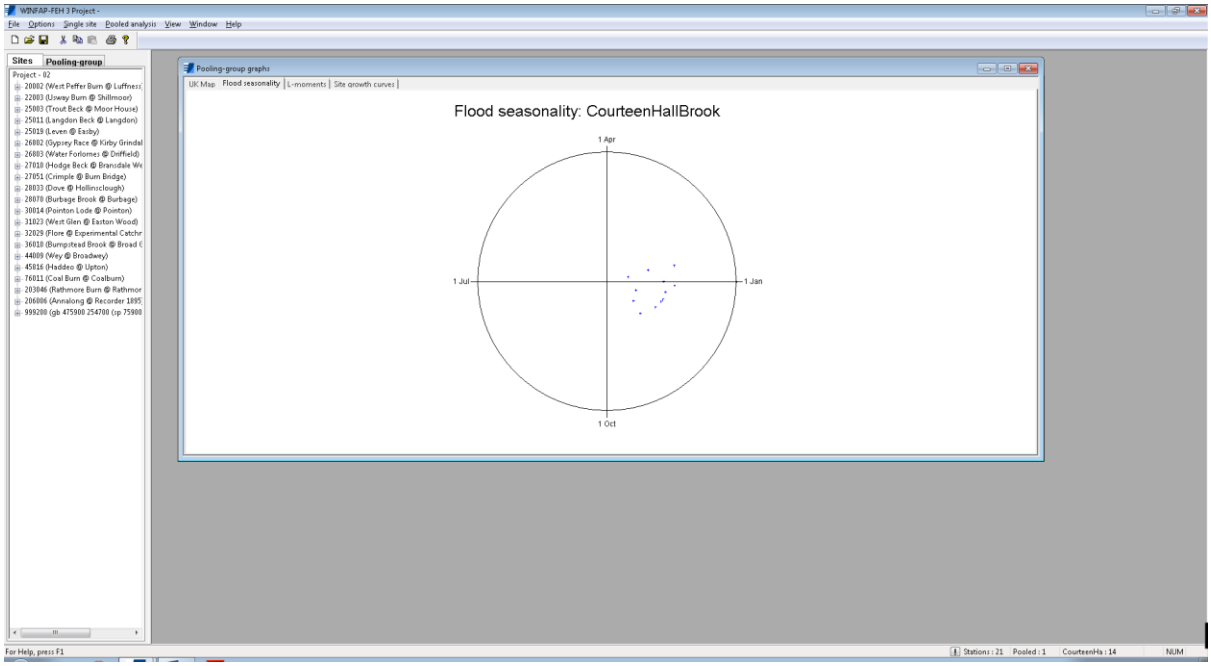
10/03/2017


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Project - 82
20002 (West Peffer Burn @ Luffness
22003 (Usway Burn @ Shillmoor)
25003 (Trout Beck @ Moor House)
25011 (Langdon Beck @ Langdon)
25019 (Leven @ Easby)
26802 (Gypsey Race @ Kirby Grindal
26803 (Water Forlornes @ Driffield)
27010 (Hodge Beck @ Brandsdale We
27051 (Crimple @ Burn Bridge)
28033 (Dove @ Hollinsclough)
28070 (Burbage Brook @ Burbage)
30014 (Pointon Lode @ Pointon)
31023 (West Glen @ Easton Wood)
32029 (Flore @ Experimental Catchr
36010 (Bumpstead Brook @ Broad (
44009 (Wey @ Broadwey)
45816 (Haddeo @ Upton)
76011 (Coal Burn @ Coalburn)
203046 (Rathmore Burn @ Rathmor
206006 (Annalong @ Recorder 1895
999200 (gb 475900 254700 (sp 75900
Pooling-group graphs
UK Map Flood seasonality L-moments Site growth curves
For Help, press F1
Stations : 21 Pooled : 1 CourteenHa : 14
NUM


WINFAP-FEH 3 Project -
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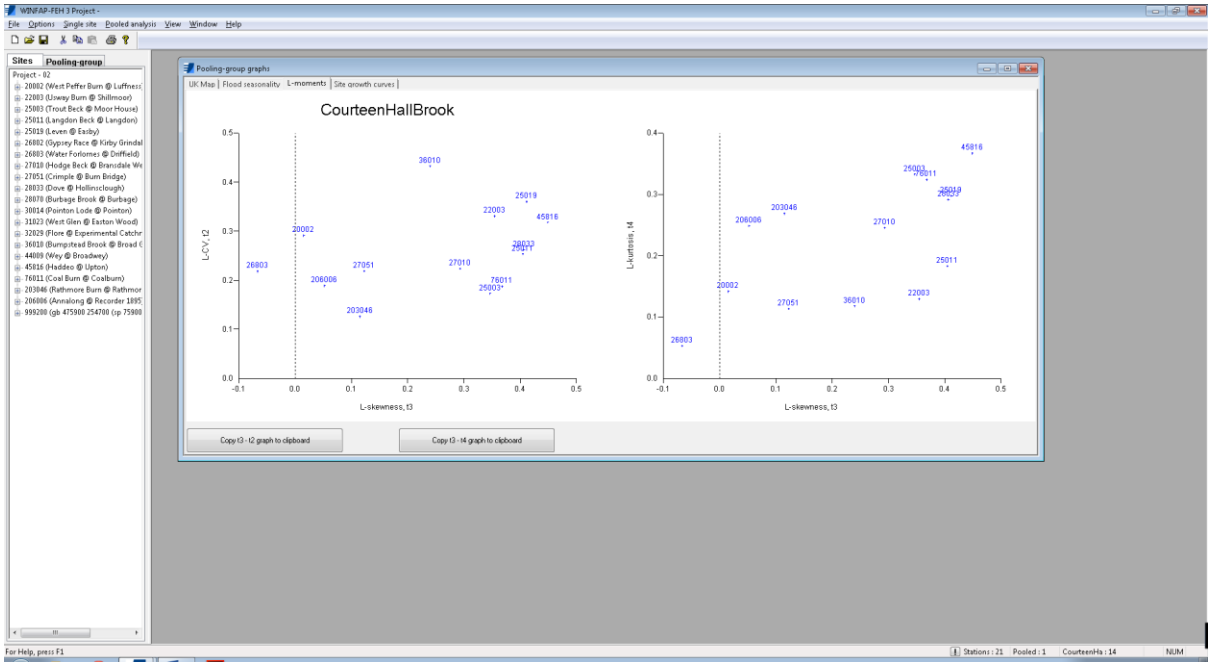
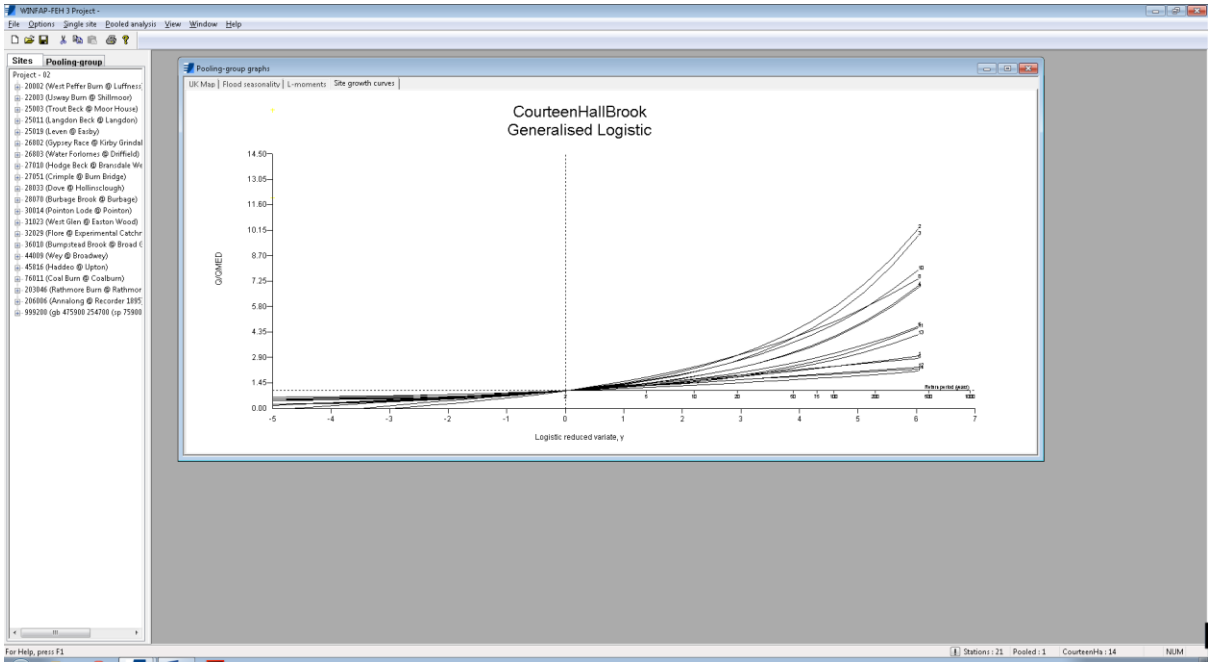
Sites Pooling-group
Project - 02
20002 (West Peffer Burn @ Luffness
22003 (Usway Burn @ Shillmoor)
25003 (Trout Beck @ Moor House)
25011 (Langdon Beck @ Langdon)
25019 (Leven @ Easby)
26002 (Gypsey Race @ Kirby Grindal
26003 (Water Forlornes @ Driffield)
27010 (Hodge Beck @ Brandsdale We
27051 (Crimple @ Burn Bridge)
28033 (Dove @ Hollinsclough)
28070 (Burbage Brook @ Burbage)
30014 (Pointon Lode @ Pointon)
31023 (West Glen @ Easton Wood)
32029 (Flore @ Experimental Catchr
36018 (Bumpstead Brook @ Broad (
44009 (Wey @ Broadwey)
45816 (Haddeo @ Upton)
76011 (Coal Burn @ Coalburn)
203046 (Rathmore Burn @ Rathmor
206006 (Annalong @ Recorder 1895
999200 (gb 475900 254700 (sp 75900
Pooling-group graphs
UK Map Flood seasonality L-moments Site growth curves
Flood seasonality: CourteenHallBrook
1 Apr
1 Jul
1 Jan
1 Oct
For Help, press F1
Stations : 21 Pooled : 1 CourteenHa : 14
NUM


WINFAP-FEH 3 Project -
File Options Single site Pooled analysis View Window Help
Sites Pooling-group
Project - 02
Pooling-group graphs
UK Map Flood seasonality L-moments Site growth curves
CourteenHallBrook
L-CV, t2
L-skewness, t3
L-kurtosis, t4
L-skewness, t3
Copy t3 - t2 graph to clipboard
Copy t3 - t4 graph to clipboard
For Help, press F1
Stations : 21 Pooled : 1 CourteenHa : 14
NUM


WINFAP-FEH 3 Project -
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Sites
Pooling-group
Project - 82
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206006 (Annalong @ Recorder 1895
999200 (gb 475900 254700 (sp 75900
Pooling-group graphs
UK Map
Flood seasonality
L-moments
Site growth curves
CourteenHallBrook
Generalised Logistic
Q/QMED
14.50
13.05
11.60
10.15
8.70
7.25
5.80
4.35
2.90
1.45
0.00
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
Logistic reduced variate, y
For Help, press F1
Stations : 21
Pooled : 1
CourteenHa : 14
NUM

ANNEX 2

Watercourse Survey

Collingtree

N

Legend:

Rev	Date	Description	Drawn	Ch. Ref
9	21.11.17	Additional areas added	BG	GH1964
8	08.11.17	Additional roads added	BG	GH1863
7	31.10.17	Knock Lane added	BG	GH1829
6	01.09.17	Roade Rail Cutting added	GJH	E1193
5	12.06.17	Sections & OS Added	BG	GH0953
4	31.05.17	Areas Complete + Rail Ve	BG	GH0953
3	25.01.17	Additional Survey	BG	GH0261
2	09.05.16	LiDar data added	CS	E0919
1	08.09.14	Sections	FB	E0919

greenhatch group

- Topographical Surveys
- Site Engineering
- Utility / CCTV Surveys
- Measured Building Surveys
- 3D Laser Scanning
- Revit & BIM Models

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Little Eaton
Derby
DE21 5DR
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admin@greenhatch-group.co.uk
www.greenhatch-group.co.uk

St Albans: Unit B, The Courtyard, Alban Park, St Albans, Hertfordshire, AL4 0LA, t. (01727) 854481

Newcastle: 24 Riverside Studios, Amethyst Road, Newcastle Bus. Park, Newcastle upon Tyne, NE4 7YL, t. (01912) 736391

Poland: ul. Panewnicka 91, 40-760 Katowice, Poland, t. 0048 32 202 2292, www.greenhatch.pl

CLIENT
Roxhill Management Ltd

PROJECT
Northampton Gateway

TITLE
Topographical Survey

SCALE	DATE
A0@ 1: 2500	Aug 14
DRAWN	QUALITY REF
FB	E0916

Level datum	See note
Grid orientation	See note
Job number	19595
Drawing No.	Rev.
19595_T	9

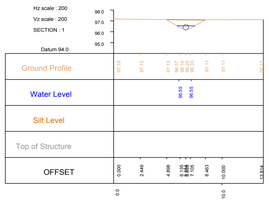
Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

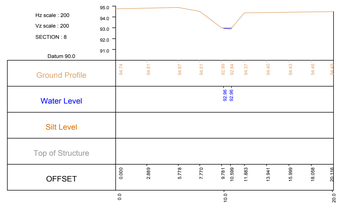
All dimensions should be checked on site prior to design and construction.

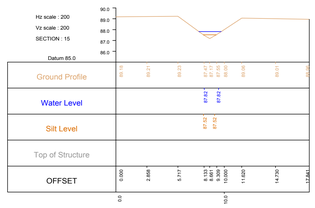
Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

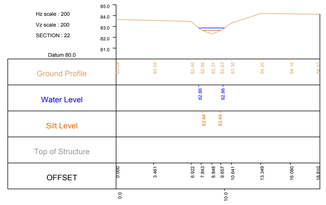
Notes:

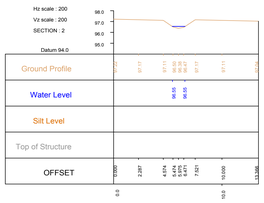
MAIN SITE SECTIONS 1 - 28

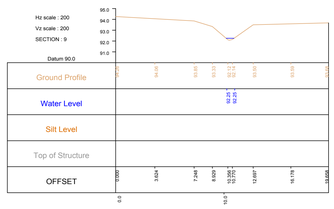


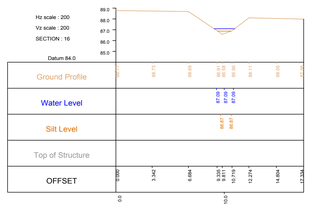


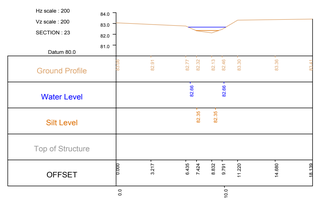


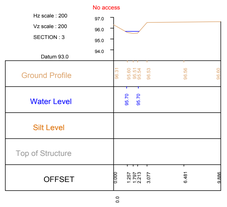


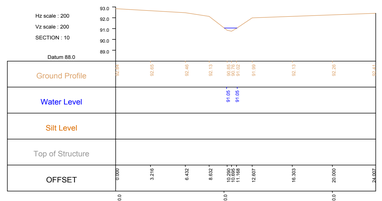


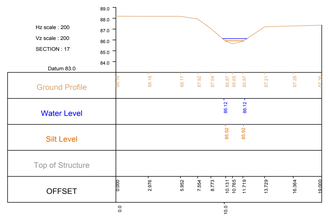


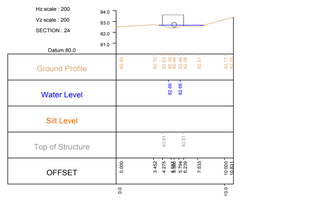


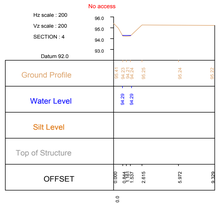


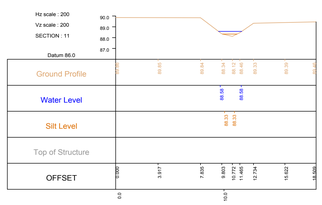


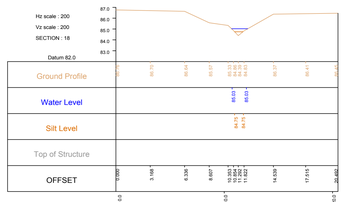


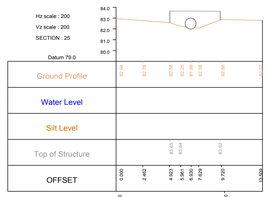


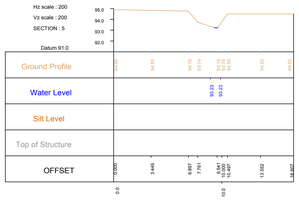


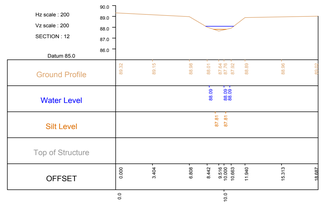


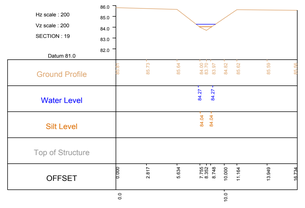


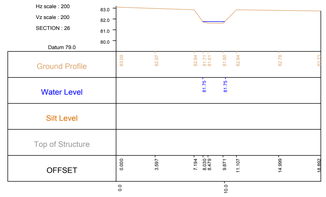


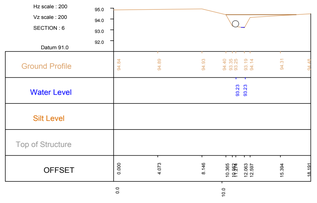


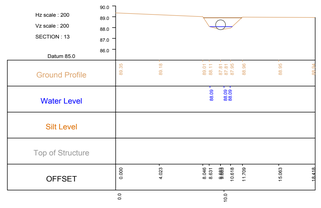


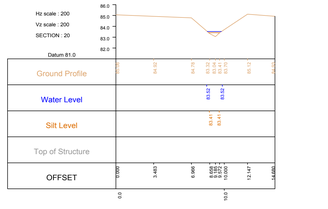


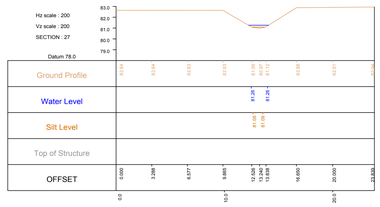


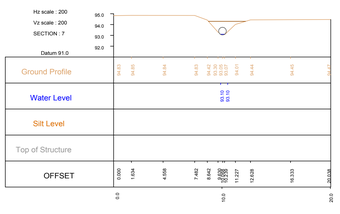


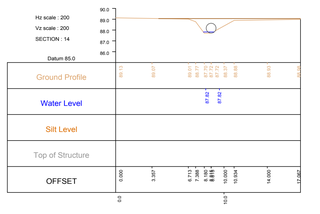


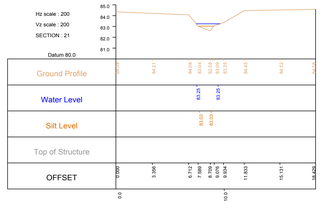


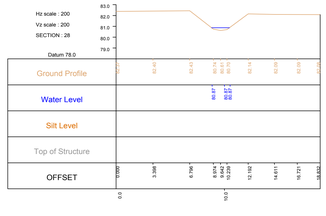












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Legend:

Buildings, Wall, Kerb line, Low Hatching, Drop kerb, Centre line, Overhead Cable, Concrete edge, Tarmac edge, Grass verge, Canopy/Overhang, Verge

Station and Name, Station Level, Tree / Bush / Sapling, Area of Underground, Woodland, Ridge Level, Eaves Level, Flat Roof Level, Gate

Fence Types: Hedge, Interwoven, Iron Railings, Wire Mesh, Post & Rail, Post & Wire, Chain Link, Wooden Panels, Concrete Panels, Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	Il	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Gl	Ground light
Pipe	Pipe above ground	Llox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sby	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	ThrL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Traphole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
Sb	Stop tap	Ctrox	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
IOU	Unidentified inspection	IC	Inspection chamber
Wo	Wash out	RWall	Retaining wall
Ra	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G	Girth
Mkr	Marker post	MG	Multi grim
GMkr	Gas marker post	SHrp	Tree Stump
So	Soffit	CLL	Cover level
		IL	Invert level

Rev.	Date	Description	Drawn	Q. Rev

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□ Utility / CCTV Surveys □ Revit & BIM Models

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CLIENT
Roxhill Management Ltd

PROJECT
Northampton M1 J15

TITLE
Section Survey

SCALE	DATE
A0@ 1: 200	20.01.17
DRAWN: BG	QUALITY REF
Level datum	See note
Grid orientation	See note
Job number	19595
Drawing No.	Rev.
Main Site Sections	0

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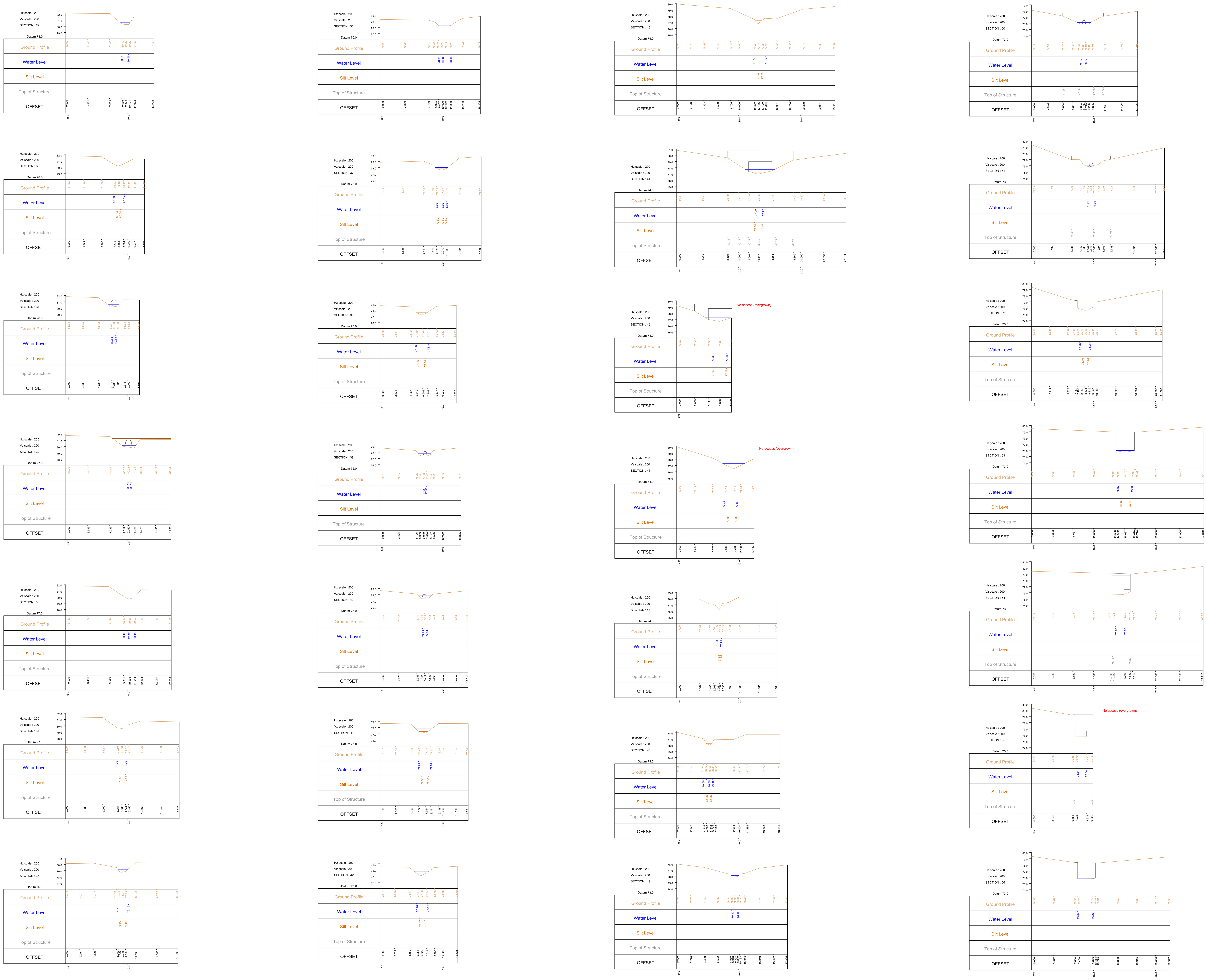
Notes:

MAIN SITE SECTIONS 29 - 56



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Legend:

Buildings, Wall, Kerb line, Line marking, Drop kerb, Centre line, Overhead Cable, Concrete edge, Tarmac edge, Grass verge, Canopy/Overhang, Verge

1 / 100.000 — Station and Name / Station Level

Tree / Bush / Sapling

P\W Post & Wire; C\L Chain Link; W\P Wooden Panels; C\P Concrete Panels; S\P Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref

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Topographical Surveys, Site Engineering, Utility / CCTV Surveys, Measured Building Surveys, 3D Laser Scanning, Revit & BIM Models

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Poland: ul. Panewnicka 91, 40-761 Katowice, Poland, t. 0048 32 202 2292, www.greenhatch.pl

CLIENT: **Roxhill Management Ltd**

PROJECT: **Northampton M1 J15**

TITLE: **Section Survey**

SCALE	DATE
A0@ 1: 200	20.01.17
DRAWN: BG	QUALITY REF:

Level datum	See note
Grid orientation	See note
Job number	19595
Drawing No.	Main Site Sections
Rev.	0

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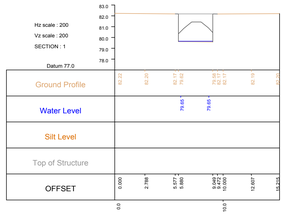
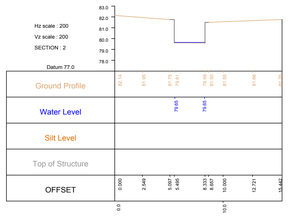
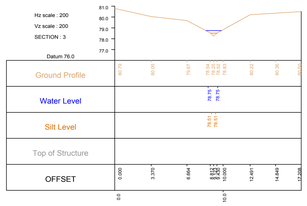
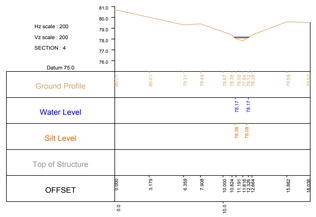
Notes:

TRIBUTRARY 1 - 4









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Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Overhead Cable
Concrete edge
Tarmac edge
Glass edge
Canopy/Overhang
Verge
100.000
Station and Name
Station Level
Tree / Bush / Sapling
Area of Undergrowth
Woodland
Ridge Level
Eaves Level
Flat Roof Level
Gate

Fence types:
SW Interwoven
IRN Iron Railings
WM Wire Mesh
PR Post & Rail
PW Post & Wire
CL Chain Link
WP Wooden Panels
CP Concrete Panels
SP Steel Palisade

IC	Inspection chamber	Bo	Bollard		
PInv	Pipe invert	Bl	Illuminated bollard		
Gy	Gully	Bin	Rubbish bin		
Rg	Rack gully	Vp	Vent pipe		
Dp	Down pipe	Gl	Ground light		
Pipe	Pipe above ground	Lbox	Letter box		
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Tl	Traffic light	BH	Borehole		
Bus	Bus stop	ELC	Electric		
Sv	Stop valve	BT	British Telecom		
St	Stop tap	Ctbx	Control box		
Er	Earth rod	TT	Tactile		
Wm	Water meter	BP	Brick paved		
Gas	Gas valve	CPS	Concrete paving slabs		
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Gmkr	Gas marker post	Stmp	Tree Stump		
So	Soffit	Ch..	Crane level		
		S..	Invert level		

Rev	Date	Description	Drawn	Q. Ref

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CLIENT

Roxhill Management Ltd

PROJECT

Northampton M1 J15

TITLE

Section Survey

SCALE	*DATE*
A0@ 1: 200	**20.01.17**
DRAWN	*QUALITY REF*
BG	

Level datum	*See note*
Grid orientation	*See note*
Job number	*19595*

Drawing No. *Rev.*

Main Site Sections *0*

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Notes:

ANNEX 3

Baseline Floodplain Maps

Notes

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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.

Key

Watercourse/Ditch

Culverts

Floodplain Extent

10% AEP (1 in 10-year)

5.0% AEP (1 in 20-year)

2.0% AEP (1 in 50-year)

1.3% AEP (1 in 75-year)

1.0% AEP (1 in 100-year)

0.1% AEP (1 in 1000-year)

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

BWB CONSULTANCY | ENVIRONMENT INFRASTRUCTURE | BUILDINGS

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Leeds | 0113 233 8000
London | 0207 407 2879
Manchester | 0161 233 4260
Nottingham | 0115 924 1100
www.bwbconsulting.com

Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Extents

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0109	S2	P1

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Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issue/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 10% AEP

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0100	S2	P1

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Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 5.0% AEP

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0101	S2	P1

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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 2.0% AEP

Drawn:	R Green	Reviewed:	C Dodd		
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0102	S2	P1

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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev.	Date	Details of issues/ revision	Drw	Rev.
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 1.3% AEP

Drawn:	R Green	Reviewed:	C Dodd		
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0103	S2	P1

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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

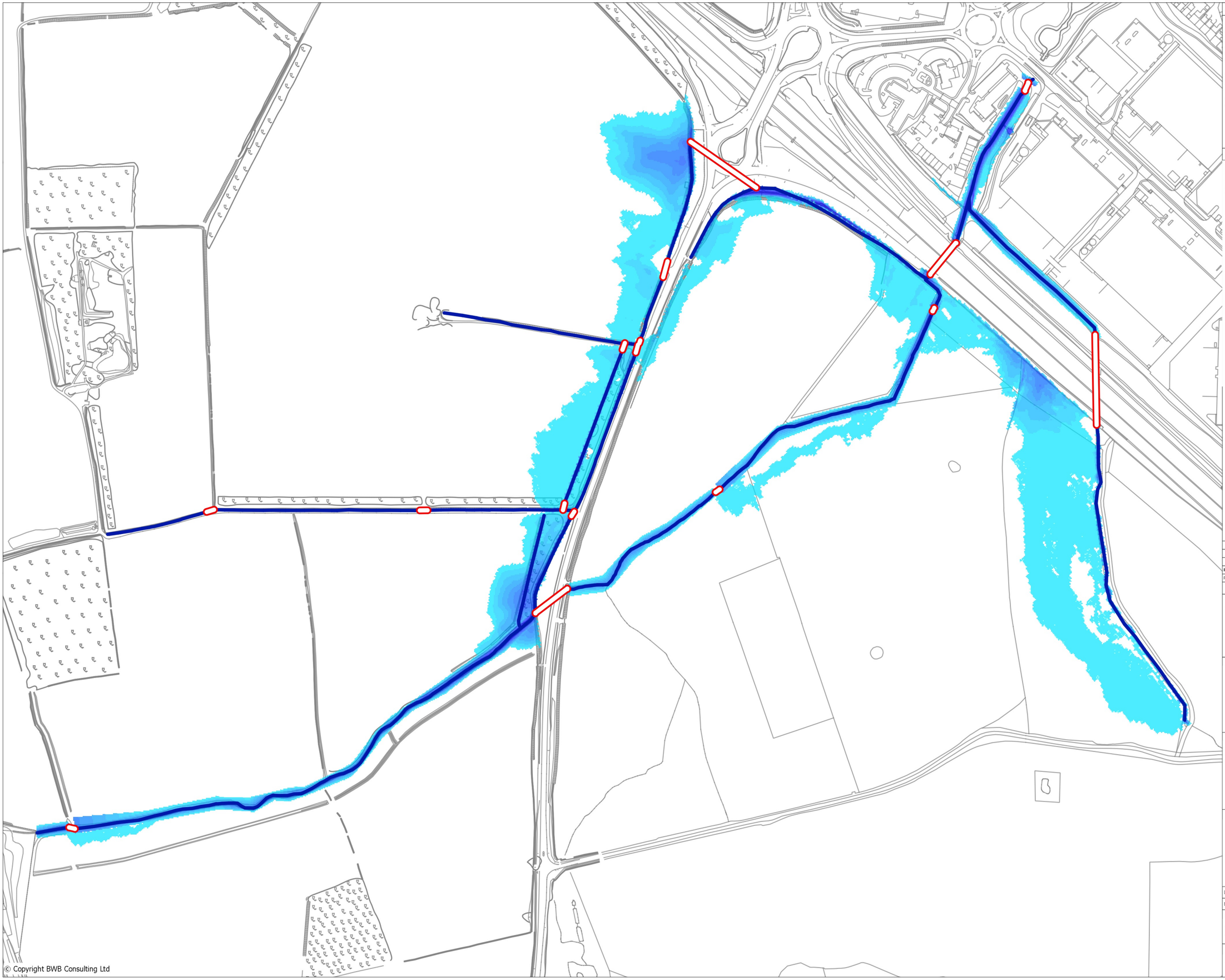
Courteenhall Brook Floodplain Mapping: 1.0% AEP

Drawn:	R Green	Reviewed:	C Dodd		
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0104	S2	P1



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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 1.0% AEP + 25%

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0105	S2	P1

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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 1.0% AEP + 35%

Drawn:	R Green	Reviewed:	C Dodd
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0106	S2	P1

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.

Key

Watercourse/Ditch

Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 1.0% AEP + 65%

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0107	S2	P1

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.

Key

- Watercourse/Ditch
- Culverts

Flood Depth (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	20.11.17	PRELIMINARY ISSUE	RG	CD

Issues & Revisions

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www.bwbconsulting.com

Client

Roxhill

Project Title

Northampton Gateway Rail Freight Interchange

Drawing Title

Courteenhall Brook Floodplain Mapping: 0.1% AEP

Drawn:	R Green		Reviewed:	C Dodd	
BWB Ref:	NTH 2315	Date:	20/11/17	Scale@A3:	NTS

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
NGW-BWB-EWE-XX-DR-YE-0108	S2	P1