A614 / A6097 Major Road Network Improvement Project

Via East Midlands Ltd.

February 2022

Quality information

Prepared by	Checked by	Verified by	Approved by
Francesca Steeples Graduate Engineer	Anupriya Prabhuswamy Principal Engineer	Fay Bull Regional Director - Water	Katie Pearson Technical Director-Hydraulic Modelling
James Boddey Graduate Consultant			

Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	14-12-2021	Initial Issue		Katie Pearson	Technical Director
02	01-02-2022	Lowdham Addition Client comments addressed		Katie Pearson	Technical Director
03	22-02-2022	Further client comments addressed		Katie Pearson	Technical Director

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Prepared for:

VIA East Midlands Ltd.

Prepared by:

Katie Pearson
Technical Director – Hydraulic Modelling
T: 07826519304
E: katie.pearson@aecom.com

AECOM Infrastructure & Environment UK Limited
Royal Court, Basil Close
Chesterfield
Derbyshire S41 7SL
United Kingdom

T: +44 (1246) 209221
aecom.com

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1. Introduction

AECOM Infrastructure & Environment UK (AECOM) has been commissioned by VIA East Midlands Ltd to undertake a Flood Risk Assessment (FRA) for the proposed A614 / A6097 Major Road Network Improvements to support a planning application for the scheme.

This report provides an assessment of the present flood risk and the effect of the proposed scheme on flood risk at the six primary sites in the Major Road Network Improvement scheme. The assessment focuses on pre and post-development flood risk impacts of the proposed scheme.

The study area for the A614/A6097 Major Road Network Improvements can be seen below in Figure 1-1. The study area lies within the county of Nottinghamshire. The proposed extent of the A614 / A6097 Major Road Network Improvements stretches between Ollerton (SK655675) which is located north-east of Nottingham to the Kirk Hill junction on the A6097 south of the River Trent (SK689427). Figure 1-1 provided below shows the six scheme sites/ study areas. Of the six sites, two of the sites (Ollerton and Lowdham) required a more detailed assessment of flood risk.

Figure 1-1: Study Area for Proposed Highway Improvements

Source: © OpenStreetMap contributors https://www.openstreetmap.org/copyright

1.1 Background

Nottinghamshire County Council (NCC) and VIA East Midlands Ltd are promoting junction improvements at six key locations on the A614 – A6097 Major Road Network as a single scheme package. The A614 is a vital north-south route from Retford towards north Nottingham, with the A6097 providing a spur from the A614 to the A64 (a trunk road linking Leicester to Newark and Lincoln). This route was designated part of the Major Road Network in October 2018 and regularly acts as a diversion or alternative route during major accidents or incidents on the Strategic Road Network (SRN).

At its northern extent, the A614 serves several tourist attractions such as: Centre Parcs, Go Ape, Sherwood Forest Country Park and Rufford Abbey. As part of NCC's Visitor Economy Strategy[1] (2018-2029), the A614 is identified as being a Key Development Project to strengthen the sense of place for visitors along the A614 and to take advantage of investment along the growth corridor. As such, the A614 route serves a dual-economic function: facilitating regular commuter trips and local movements and being an important corridor for the tourist economy which is set to grow in the future.

The scheme seeks to continue the strategic development of the network to both accommodate and facilitate economic growth. The existing arrangement at Ollerton Roundabout is seen as a capacity restraint which has resulted in limits on nearby planning applications and thus the proposed developments plan to reduce journey time delays. The existing arrangement at the Lowdham Roundabout experiences significant levels of congestion during the peak hour periods and this capacity restraint has resulted in limits on nearby planning applications and thus the proposed improvements are intended to reduce journey time delays. The main issues at the White Post Roundabout, Warren Hill and Mickledale Lane junctions is the ability of minor-arm traffic to safely judge gaps when entering the A614 and to do so without undue delay and thus the proposed scheme aims to improve access from side roads, improving road safety. The scheme is also intended to facilitate trips from future land-use development which are likely to route along the network and enable economic growth. The improvements along the route will add resilience to the route which will help support the SRN during major works or incidents.

The main river catchments affected by the scheme proposals are the River Maun (Ollerton) and Cocker Beck (Lowdham).

[1] Nottinghamshire County Council (2018). 'The Visitor Economy Strategy'. [Online]

1.2 Scheme Locations & Development Proposals

This section provides a brief overview of the proposed Major Road Network Improvements along the A614 / A6097.

Table 1-1: Details of proposed improvement works along the A614 / A6097

Location	Description of proposed Major Road Network Improvement works
Ollerton Roundabout	Proposed improvements at this junction consists of an enlarged conventional roundabout with five arms, with the bus-only link road now realigned onto the A616 Ollerton Road arm. Two of the arms would have Toucan Crossing points.
Mickledale Lane	Proposed improvements consist of construction of a new three-arm roundabout on the A614 (south of the existing junction) with a new link road and mini roundabout connecting the A614 and Mickledale Lane passing through a field to the east of the existing junction. The new link road would tie into Mickledale Lane via a second three arm-roundabout. The existing Mickledale Lane junction with the A614 (near the four residential properties) would be closed off to vehicles and become a cul-de-sac accessed from the east, off the new link road. New road access would be provided off the new link road into Strawson's Ltd premises to the east.
White Post Roundabout	The proposed improvement to this roundabout is a road safety scheme involving anti-skid road surfacing and minor maintenance improvements. This will involve carriageway maintenance and repairs and could also include minor realignment and widening of entries and exits, the provision of high friction surfacing on carriageway entries, signing, lining and street lighting upgrades.
Warren Hill junction	At this junction geometric improvements replace the existing priority controlled gyratory where traffic on the A6097 gives way to traffic on the A614.
Kirk Hill Junction	Proposed improvements at this junction consists of: • localised widening of the A6097 junction approaches to provide separate right turn lanes into Kirk Hill and East Bridgford Road; • provision of two straight ahead lanes in both directions • traffic signal improvements to the existing junction; • a retaining structure on the northbound carriageway; and • localised widening on the Kirk Hill to facilitate easier negotiation of left turns into the side road.
Lowdham Roundabout	Construction of an enlarged four-arm elliptical roundabout to replace the existing roundabout. This would have a two-lane circulatory carriageway and include a third left turn filter lane on the A612 Nottingham Road (eastbound) approach to the junction. A new access road would be provided from the A612 Nottingham Road to access the four properties on the south side of the road, closest to the roundabout.

1.3 Methodology

An FRA is required to assess the risks from all sources of flooding to and from a proposed development. Section 14 of the National Planning Policy Framework (NPPF)[2] provides national policy in relation to development and flood risk. This is supported by the Planning Policy Guidance[3] (PPG) which accompanies the NPPF. The NPPF emphasises the need for a risk-based approach to be adopted through the application of the 'Source-Pathway-Receptor' model. In accordance, AECOM's approach to this FRA is based on the Source-Pathway-Receptor model.

The Source-Pathway-Receptor model firstly identifies the causes or 'sources' of flooding to and from a development based on a review of local conditions and consideration of the effects of climate change. The nature and likely extent of flooding arising from any one source is considered, e.g., whether such flooding is likely to be localised or widespread. The presence of a flood source does not always infer a risk. It is the exposure 'pathway' or the flooding mechanism that determines the risk to the receptor and the effective consequence of exposure. For example, sewer flooding does not necessarily increase the risk of flooding unless the sewer is local to the site and ground levels encourage surcharged water to accumulate. The varying effect of flooding on the 'receptors' depends largely on the sensitivity of the target. Receptors include any people or property within the range of the flood source, which are connected to the source of flooding by a pathway. For there to be a flood risk, all the elements of the model (i.e., a flood source, pathway and receptor) must be present. Furthermore, effective mitigation can be provided by removing one element of the model.

[2] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2021) 'National Planning Policy Framework' (Online)
[3] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (Last updated 2021) (Online)

AECOM's approach involves a desk-based review of available information in combination with hydraulic modelling, (where relevant) to establish the levels of flood risk. Once the flood risks have been established, mitigation measures are proposed (where necessary) and residual risks are addressed.

1.4 Aims and Objectives

The aim of this report is to provide VIA East Midlands Ltd with an FRA to inform of the risks of flooding posed to and by the proposed scheme in support of a planning application for the proposed scheme. The FRA has been prepared in accordance with the NPPF, its associated PPG and other relevant regional and local planning policy.

To achieve the above aim the following objectives were met:

- A site visit was undertaken to inform the assessment;
- Liaison with the Environment Agency (EA) to outline and agree requirements for the site-specific FRA and various flood related issues around the proposed scheme;
- Collection and review of existing site data including Environment Agency (EA) flood data, ground conditions (if available), scheme proposals and reference to relevant Nottinghamshire County Council policy including Strategic Flood Risk Assessment, Preliminary Flood Risk Assessment, Surface Water Management Plan and Local Flood Risk Management Strategy;
- Liaison with VIA East Midlands Ltd to obtain scheme drawings, proposed drainage scheme drawings etc.;
- Assessment and interpretation of available information to identify potential sources of flood risk with reference to historical flood events. This included fluvial, (River Maun), pluvial (surface water), groundwater, combined, foul or surface water sewers, surface water and infrastructure failure to include any history of burst water mains, blocked sewers etc. AECOM liaised with Severn Trent Water to obtain surface water sewer plans.
- A review of the surface water drainage design that has been prepared for the proposed highway improvement works, and incorporation of the design calculations into the FRA; and
- Discussion and recommendations for flood mitigation measures and fluvial compensatory storage and residual risk mitigation measures in line with the conclusions of the drainage strategy, where applicable.

1.5 Data Sources

Through a desk study and via consultation with the Environment Agency, the flood risks associated with the routes have been established. These flood risks have been utilised to inform the assessment made within this report with the appropriate data that has been collected during this assessment is described in Table 1-2.

Table 1-2: Sources of Data Reviewed

Purpose	Data Source	Comments
Identification of Hydrological Features	Ordnance Survey (OS) Open Map – Local	Identifies the location of the proposed scheme and local hydrological features
	Ordnance Survey (OS) Vector Map – District	
	Ordnance Survey (OS) Open Rivers	
	LIDAR Composite DTM 1m (Online)	
	Topographical Survey	
Identification of Existing Flood Risk	EA Indicative Flood Zone Map (online)	Identifies fluvial/ tidal inundation extents and historical flooding.
	EA Long Term Flood Risk Map (online)	Provides information on the risk of flooding from fluvial, surface water and reservoirs (artificial sources).
	Nottinghamshire County Council Preliminary Flood Risk Assessment 2011 (PFRA), Greater Nottingham Strategic Flood Risk Assessment Addendum 2017 (SFRA) and Nottinghamshire Local Flood Risk Management Strategy 2016 (LFRMS), Nottinghamshire County Council Section 19 Report Lowdham 2013.	Assesses flood risk across the county and borough boundary areas. Includes flood risk from fluvial/tidal, sewers, overland flow, and groundwater.

Purpose	Data Source	Comments
Identification of Historical Flooding	PFRA, SFRA and Nottinghamshire County Council Section 19 Report Lowdham 2013	Provides locations of historic flooding.
Details of the Scheme	A614 / A6097 Major Road Improvement Scheme Options Assessment Report	Provides an overview of the current issues facing our study area and the proposed scheme options to tackle these issues
	Proposed Scheme drawings of the six study areas	Provides the layout of the proposed Major Road Network Improvements at the six study sites
	3D ground model – Lowdham roundabout	Provides existing and proposed ground levels for Lowdham roundabout.
Surface Water Drainage	EA Flood Risk from Surface Water Map	Identifies existing surface water flood risk from the route options.
	DEFRA SuDS – Non-statutory technical standards	Provides information regarding drainage requirements for the study sites
2019 Baseline Fluvial Flood Model	Environment Agency Lowdham Hydraulic Model - Lowdham Strategic Outline Case (2019)	The Cocker Beck ISIS-TUFLOW model was created by AECOM in March 2016 to inform the Lowdham Initial Assessment. Originally the model was derived from the Environment Agency. The model was later updated by Jacobs to inform a Strategic outline case.
2021 Baseline Fluvial Flood Model	Environment Agency Lowdham Hydraulic Model – EA Flood Alleviation Scheme (2021)	The Cocker Beck Flood Modeller – TUFLOW was updated in 2021 by Arup in support of the Environment Agency Flood Alleviation Scheme in Lowdham. This was provided to AECOM on 22/12/2021.
Climate Change Guidelines	Data provided by the Environment Agency	The Environment agency provided AECOM with the up-to-date climate change allowances for the Humber River Basin District.

1.6 Environment Agency Flood Alleviation Scheme

As part of this report, a check of other Environment Agency schemes in the area was undertaken. One such scheme is the Lowdham Flood Alleviation Scheme (expected to be fully operational in spring 2024). This scheme aims to reduce flooding for 195 residential properties and several local businesses in Lowdham. This scheme consists of a single flood storage reservoir on the Cocker Beck, adjacent to Lambley Road near Lowdham Grange[4].

[4] Environment Agency (2022) 'Lowdham Information Page' [Online]

The layout of the flood storage reservoir proposed, as part of the Flood Alleviation Scheme can be seen below in Figure 1-2.

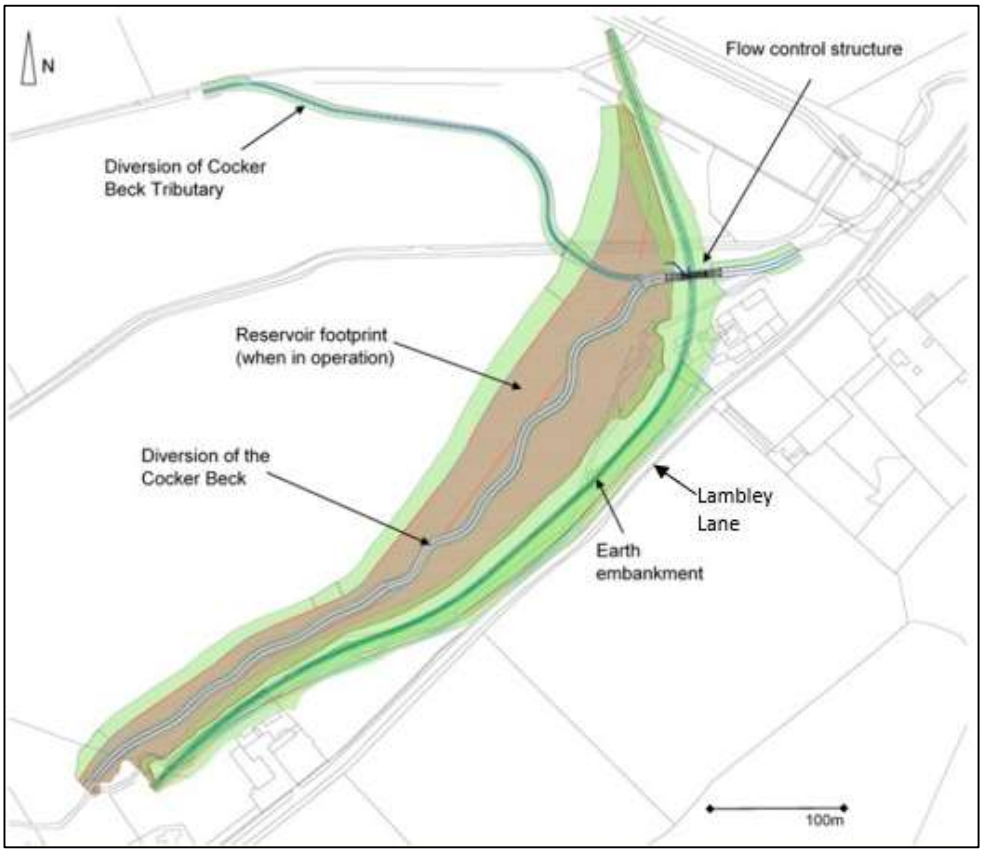


Figure 1-2: Environment Agency Flood Storage Reservoir Layout

Source: Environment Agency Lowdham Information Page https://consult.environment-agency.gov.uk/east-midlands/lowdham/

1.7 Report Structure

This report is structured in the following manner:

- Introduction – Background and description of the scheme, including methodology and data sources for the Flood Risk Assessment.
- Planning Policy and Guidance – National and Local policy and guidance which is relevant to all the junctions.
- Individual Junction Flood Risk Assessment – Each junction has been assessed individually, with baseline and post scheme impacts assessed in each section.
- Conclusions – Overall conclusion of the Flood Risk assessment for the scheme as a whole.

2. Planning Policy and Guidance

The following planning policies and guidance are relevant to the proposed scheme with regards to flood risk and surface water management.

2.1 National Planning Policy Context

The NPPF was published on 27 March 2012 and revised most recently on 20 July 2021. It sets out the government's planning policies for England and how these are expected to be applied. The principal aim of the NPPF with respect to flood risk is that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe without increasing flood risk elsewhere."

Section 14 of the 2021 updated NPPF and the 2021 Flood Risk and Coastal Change PPG, both advise how the planning process can consider the risks associated with flooding. The updated NPPF guidance states that flooding from all sources must be avoided where at all possible by applying a sequential approach to site selection, taking account of climate change and the vulnerability of future uses to flood risk. Therefore, as well as assessing fluvial and coastal flooding either through hydraulic modelling or the Flood Map for Planning (FMfP) it is also necessary to consider flood risk from all sources, including ordinary watercourses, surface water, groundwater, sewers, drainage infrastructure failure, reservoirs, and canals. Other reputable online sources will be consulted to determine the risk associated with the remaining flood risk sources.

2.1.1 NPPF Flood Zones

The Flood Zones referred to in the NPPF can be found in Table 1 of the PPG. The NPPF defines the four flood zones as:

- **Flood Zone 1 'low probability of flooding' –** This zone comprises land assessed as having a less than 1 in 1,000 chance of river or sea flooding in any year (<0.1% annual exceedance probability (AEP)).
- **Flood Zone 2 'medium probability of flooding' –** This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 chance of river flooding (1% - 0.1% AEP) in any year, or between a 1 in 200 and 1 in 1,000 chance of sea flooding in any year (0.5% - 0.1% AEP).
- **Flood Zone 3a 'high probability of flooding'** – This zone comprises land assessed as having a 1 in 100 year or greater chance of river flooding in any year (>1% AEP), or a 1 in 200 year or greater chance of flooding from the sea in any year (0.5% AEP).
- **Flood Zone 3b 'functional floodplain'** – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of a flood. This zone is not usually included within the FMfP and can be defined (where necessary) through detailed hydraulic modelling.

Ollerton is mainly located within Flood Zone 2 'Medium Risk', which is land assessed as having between a 1% AEP (1 in 100) and 0.1% AEP (1 in 1,000) chance of river flooding in any year. However, some parts of Ollerton are also located within Flood Zone 3 'high risk' which is land having a >1% AEP of flooding.

The Lowdham roundabout is shown as partially within Flood Zone 3 'High Risk' on the Environment Agency flood map for planning, that is land assessed as having a 1 in 100 year or greater chance of river flooding in any year. Part of the roundabout is within Flood Zone 2 'Medium Risk' and some within Flood Zone 1, with a 'Low Risk' of flooding. Figure 7-2 shows the extent of the Flood Zones in relation to the Lowdham roundabout. It is noted that the Environment Agency Flood Zones and flood map for planning do not take account of the presence of existing flood defence structures. More detailed modelling available from the Environment Agency (see section 0) shows that the actual level of flood risk is significantly lower than indicated by the Flood Zones when the presence of defences and the use of the most up to date data is considered.

The other sites in the proposed Major Road Network Improvement scheme are in Flood Zone 1 which means they have a very low risk (0.1% AEP) of flooding each year.

2.1.2 The Sequential and Exception Tests

The overall aim of the Sequential Test is to steer new development to areas designated as Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1 areas, Local Planning Authorities (LPAs) allocating land in Local Plans or determining planning applications for development at any location should consider the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 areas, applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zone 1 or 2 areas should the suitability of sites in Flood Zone 3 be considered, taking into consideration the flood risk vulnerability of land uses and applying the Exception Test if required.

For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared; and,
- A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted.

2.1.3 Development and Flood Risk Vulnerability

The NPPF considers the vulnerability of different forms of development to flooding and classifies proposed uses accordingly. Section 7, Paragraph 066 of the PPG illustrates a matrix which identifies which vulnerability classifications are appropriate within each flood zone. This is replicated below in Table 2-1.

Table 2-1: Flood Risk Vulnerability and Flood Zone Compatibility

Flood risk Vulnerability classification	*Essential Infrastructure*	*Water Compatible*	*Highly Vulnerable*	*More Vulnerable*	*Less Vulnerable*
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	×	Exception test required	✓
Zone 3b 'Functional Flood plain'	Exception test required	✓	×	×	×
Key *✓ Development is appropriate.* *× Development should not be permitted*					

The proposed scheme is considered 'Essential Infrastructure' under the heading "Essential transport infrastructure" (including mass evacuation routes) which must cross the area at risk. However, the proposed improvement scheme is a replacement to an existing road layout and therefore cannot be situated elsewhere. Mickledale Lane, White Post, Warren Hill and Kirk Hill junctions are all located in Flood Zone 1 and pass the Sequential test as long as flood risk to the area is not increased. Ollerton Roundabout is located in Flood Zones 2 and 3 and the Exception Test will therefore be required.

For the exception Test to be passed the development must demonstrate that:

a) It provides wider sustainability benefits to the community that outweigh flood risk.

b) It will be safe for the lifetime of the development and won't increase flood risk elsewhere.

2.2 Regional and Local Planning Policy

The following regional and local policies are relevant to the proposed developments and have been collated in Table 2-2.

Table 2-2: Regional and Local Planning Policy

Planning Document Title	Comments
Nottinghamshire County Council Preliminary Flood Risk Assessment 2011 (PFRA)[5]	The NCC PFRA provides a high-level screening assessment of local flood risk across the County, including information on historic and potential flooding and the consequences. The PFRA concluded that Nottingham and surrounding urban area just falls below the national threshold set for national significance. The PFRA thus concluded that Nottinghamshire County Council and Nottingham City Council would jointly consider the flood risk through Local Flood Risk Management Strategies.
Greater Nottingham Strategic Flood Risk Assessment Addendum 2017[6]	The addendum recommends the increased use of sustainable drainage systems (SuDS) and Natural Flood Management techniques to provide more sustainable flood risk management schemes in respect of the latest climate change projections
Nottingham Level 1 Minerals Strategic Flood Risk Assessment 2018[7]	Most recently this assessment was produced to cover changes to the PPG in relation to the assessment of flood risk in the context of climate change and to cover the planning period between 2016 to 2036. The predominant risk of flooding within Nottinghamshire is fluvial flooding from the overtopping of surface watercourses including rivers, streams and drainage channels (i.e. flows exceeding their bank-full capacity). In relation to our study areas, the River Maun which runs through Ollerton was noted as not being defended by any formal flood defences.
Nottinghamshire Local Flood Risk Management Strategy 2016[8]	The main strategy outcomes from this report included a need to integrate local flood risk management into the planning process and support sustainable growth. As well as to consider the environmental impact of proposed flood risk management measures, maximise opportunities to contribute to the sustainable management of our cultural heritage and landscape and deliver environmental benefits
Community Resilience Flooding Plan 2014[9]	This document was created by Newark and Sherwood District Council to raise awareness about the responsibilities of agencies and contacts for Flash and Fluvial flood events. The document advises residents to be prepared for flood events by familiarising themselves with evacuation plans, keeping a store of sandbags and having a suitable level of insurance. Furthermore, the document advises against fly tipping as this can cause obstructions to the free flow of water which may make things worse. As well as informing residents that they have 'riparian rights' and thus are responsible for the free flow of water through their properties and as such should not create any obstructions/diversions to the flow of water.
Waterside Living in Newark and Sherwood District Council[10]	Further to the information above, Newark and Sherwood District Council has produced a document which provides further guidance about riparian rights. If you own land on either side or both sides of an ordinary watercourse then you are a riparian owner under common law. This therefore means residents have a duty under the Land Drainage Act 1991 to ensure water flows freely through any watercourse. The document also advises that, except for private unadopted roads, road gullies/grates should be maintained and keep cleared by Nottinghamshire County Council.
Nottinghamshire County Council, Flood Risk Management Update[11]	This document provided an update on the latest position in relation to the Council's duties and responsibilities under the Flood Risk Regulations 2009 and the Flood and Water Management Act 2010, including an update on current flood mitigation measures and progress on major flood protection schemes. At the time this document was written, an EA scheme in Lowdham had secured £1.5 million of local levy funding to progress the scheme and the EA had appointed consultants to develop the Outline Business Case (OBC) for a future Lowdham scheme.

[5] Nottinghamshire County Council (2011) 'Preliminary Flood Risk Assessment' [Online]
[6] Nottingham City Council (2017) 'Strategic Flood Risk Assessment Addendum [Online]
[7] Nottinghamshire County Council (2018) 'Minerals Strategic Flood Risk Assessment' [Online]
[8] Nottinghamshire County Council (2016) 'Nottinghamshire Local Flood Risk Management Strategy' [Online]
[9] Newark and Sherwood District Council (2014) 'Community Resilience Flooding Plan' [Online]
[10] Newark and Sherwood District Council 'Waterside Living in Newark and Sherwood' [Online]
[11] Nottinghamshire County Council (2018) 'Flood Risk Management Update' [Online]

2.3 Nottinghamshire County Council Section 19 Report – Lowdham July 23rd 2013

The Nottinghamshire County Council Section 19 Report – Lowdham (23rd July 2013) report[12] was commissioned in response to the flood event which occurred on the 23rd July 2013 which flooded up to 70 properties in the village of Lowdham. Section 19 Reports aim to investigate which Risk Management Authorities have relevant flood risk management functions and how these authorities plan to or have exercised these functions in response to a flood event. It was determined that the flooding experienced by residents came from three identified sources: The Cocker Beck, surface water from surrounding fields and roads and from public sewers exceeding operational capacity.

Whilst historically the main flooding cause and source for Lowdham is the Cocker Beck over topping its bank after prolonged periods of rainfall, the event in 2013 was different. Investigations have shown that the main source of flooding for this event was from rapid surface water run-off caused by an unprecedented amount of rainfall. 36mm of rain fell in under one hour in areas across Nottinghamshire and this intensity of rainfall significantly exceeded the capacity of any existing drainage provision in Lowdham. There were, additionally, a few isolated issues caused by the Cocker Beck overtopping bank levels.

In response to the flood, NCC and Severn Trent Water Ltd surveyed and cleansed highway drainage assets, culverted watercourses and the public sewer system. The report also noted that the Environment Agency were investigating the possibility of a Flood Alleviation Scheme for Lowdham.

2.4 Other Relevant Policy and Guidance

2.4.1 Sustainable Drainage Systems: Non-statutory technical standard for sustainable drainage systems

A Non-statutory Technical Standard for Sustainable Drainage Systems[13] guide was published by Defra in March 2015. To be used in conjunction with NPPF and PPG, it sets out non-statutory technical standards for sustainable drainage systems that cover the following areas:

- Flood risk outside the development;
- Peak flow control;
- Volume control;
- Flood risk within the development;
- Structural integrity;
- Designing for maintenance considerations; and
- Construction.

2.4.2 Building Standards Regulations Part H

The Building Standards Regulations 2000 Part H[14] requires that surface water runoff be preferentially discharged first to soakaway, then to surface watercourse and finally to sewer.

2.5 Consultation with Environment Agency & Lead Local Flood Authority

There has been close coordination with the Environment Agency and VIA East Midlands Ltd in the development of this scheme. The Environment Agency provided us with detailed flood risk assessment maps for the Ollerton site as well as model data. The Environment Agency also provided historic flood event information and the correct climate change allowances to be used in our study.

[12] Nottinghamshire County Council (2013) 'Section 19 Report Lowdham July 23rd July' [Online]
[13] Department for Environment, Food and Rural Affairs (2015) 'Sustainable drainage systems: non-statutory technical standards' [Online] Last Accessed: 03/12/21
[14] Ministry of Housing, Communities and Local Government (2010) 'Drainage and Waste disposal: Approved Document H' [Online] Last Accessed: 03/12/21

Flood modelling which has been undertaken to inform how flood risk would change under the proposed developments has been reviewed by the Environment Agency and their comments have been incorporated.

2.6 Climate Change

The EA published updated climate change guidance[15] in July 2021. The guidance indicates that climate change is likely to increase river flows, sea levels, rainfall intensity, and wave height and wind speed.

2.6.1 Peak River Flow Allowances by River Basin District

The peak river flow allowances show the anticipated changes to peak flow by river basin district.

The proposed road alignments are located within the Idle and Torne Management Catchment (Ollerton and Mickledale) and Lower Trent and Erewash (White Post, Warren Hill, Kirk Hill and Lowdham) Management Catchment. Table 2-3 shows the climate change allowances for the Idle and Torne Management Catchment. Table 2-4 shows the climate change allowances for the Lower Trent and Erewash Management Catchment. VIA EM indicated that the proposed scheme is likely to have a lifetime into the 2050s epoch and the Environment Agency guidance indicates that a Central and Higher allowance scenario should be considered when assessing fluvial flood risk for infrastructure development.

Table 2-3: Climate Change Allowance for the Idle and Torne Management Catchment

Allowance category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	27%	37%	69%
Higher	14%	19%	39%
Central	9%	12%	27%

Table 2-4: Climate Change Allowance for the Lower Trent and Erewash Management Catchment

Allowance category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	29%	38%	62%
Higher	18%	23%	39%
Central	13%	17%	29%

2.6.2 Peak Rainfall Intensity Allowance

Increased rainfall affects river levels and land and urban drainage systems. Table 2-5 shows anticipated changes in extreme rainfall intensity in small and urban catchments. For FRAs and SFRAs, both the central and upper end allowances need to be assessed to understand the range of impact.

[15] Environment Agency (2021) 'Flood Risk Assessments: Climate change allowances' [Online] Last Accessed: 03/12/21

Table 2-5: Peak Rainfall Intensity Allowance

Applies across all of England	*Total potential change anticipated for 2010 to 2039*	*Total potential change anticipated for 2040 to 2059*	*Total potential change anticipated for 2060 to 2115*
Upper End	10%	20%	40%
Central	5%	10%	20%

3. Ollerton Roundabout

Table 3-1: Overview of Proposed Improvements - Ollerton Roundabout

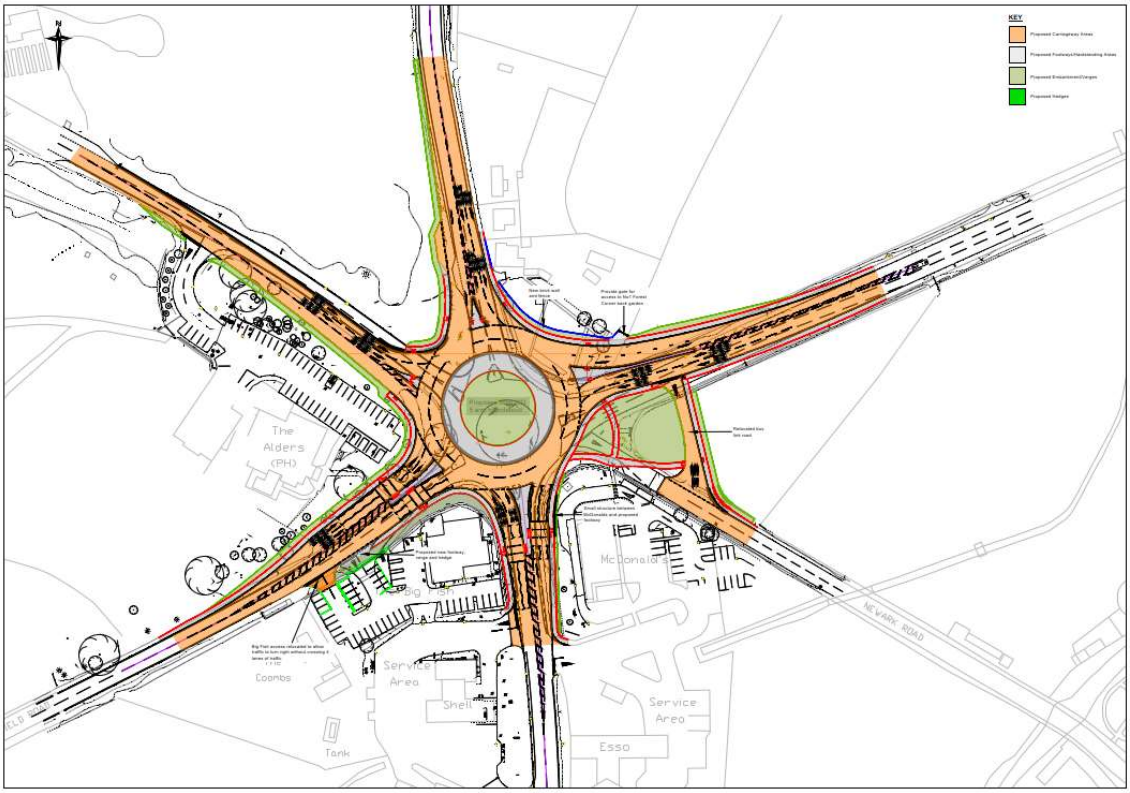


Figure 3-1: Ollerton Roundabout Proposed Drainage Plan

Currently Ollerton Roundabout is a six-arm standard roundabout, with one of the approach arms being made bus-only. A McDonalds restaurant and a fish restaurant (The Big Fish) have been built to the immediate south of the junction. A public house is situated to the west of the junction.

It is proposed that an enlarged, five arm conventional roundabout will be constructed with the bus-only link road realigned onto the A616 Ollerton Road arm. Two of the arms would have Toucan crossing points.

Permanent land take beyond the highway boundary will be required.

Table 3-2: Baseline Flood Risk Assessment - Ollerton Roundabout

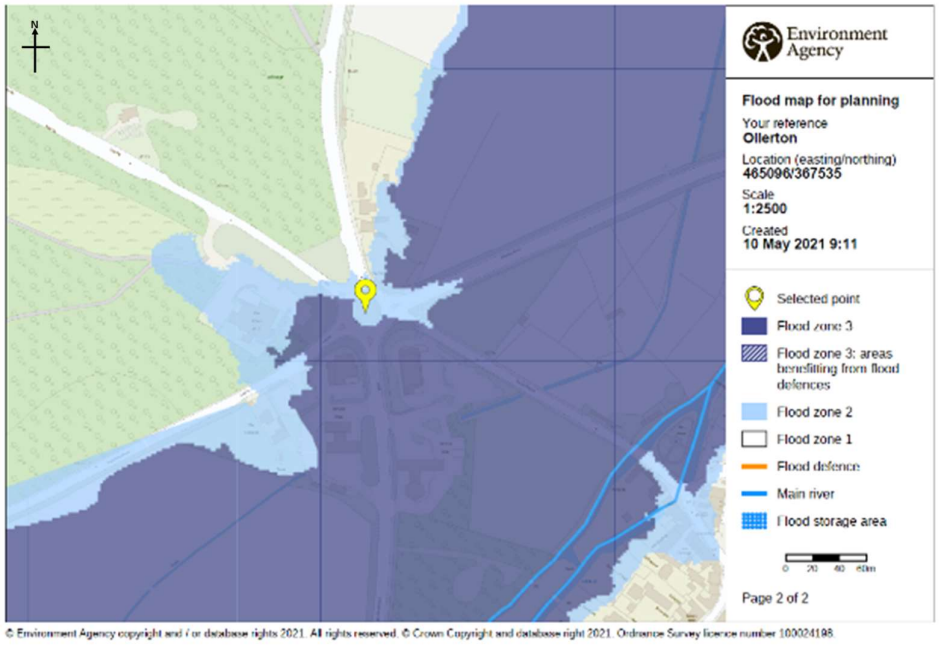
Source of flood risk	Baseline / existing flood risk
Fluvial	

Figure 3-2: Ollerton Roundabout Fluvial Flood Risk

The EA Flood Map for Planning shows the roundabout to be partially in Flood Zone 2 and Flood Zone 3 with some of the south and eastern approach roads shown to be Flood Zone 3, the western approach road in Flood Zone 2 and the northern approach roads in Flood Zone 1. Land and property in Flood Zone 3 are considered to have a high probability of flooding from rivers or the sea and land or property in Flood Zone 2 is considered to have a medium probability of flooding from rivers or the sea. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea.

The fluvial flood risk associated with these Flood Zones is from the River Maun, approximately 100m from the Scheme at its closest point, which flows in a south-west to north-east direction along the edge of the village of Ollerton. The stretch of the river passing through Ollerton has been heavily managed. At Newark Road the River Maun has been split into two separate channels, one channel flows under a bridge on Newark Road and the other channel is culverted under the road where it later opens. The River then joins back up just before passing under the A616 (Ollerton Road) and continuing its course towards Haughton.

The EA flood map does not show the Scheme to be in an area that benefits from flood defences.

The 2007 EA flood model of the River Maun was available for use in this assessment. Figure 3-3 provided below shows the flood extents for various storm events provided by the Environment Agency. Based on this map, most of the roundabout is at low risk of flooding except parts of the southern two arms which are at a high risk of flooding. The modelled flood extents show that the roundabout and approach roads are slightly higher than surrounding ground levels. The modelled flood levels from results provided by the EA were used to consider the level of fluvial risk to the Scheme area. The modelled flood levels for a 1% AEP design event, at nodes nearest to the roundabout are in the range of 41.09 – 42.57m AOD compared to elevations of the road and roundabout that are currently 40.464 – 46.676m AOD. The modelled levels for a 0.1% AEP design event are approximately 0.3m higher than the 1% AEP design event, in the range of 41.26 – 43.00m AOD. These results suggest there may be some flooding across parts of the junction in a 1% AEP design event, to depths of 0.626m but it is not expected that the whole roundabout would be inundated. The depths of flooding on the parts of the junction affected are low as the junction appears to be at the edge of the flood extent.

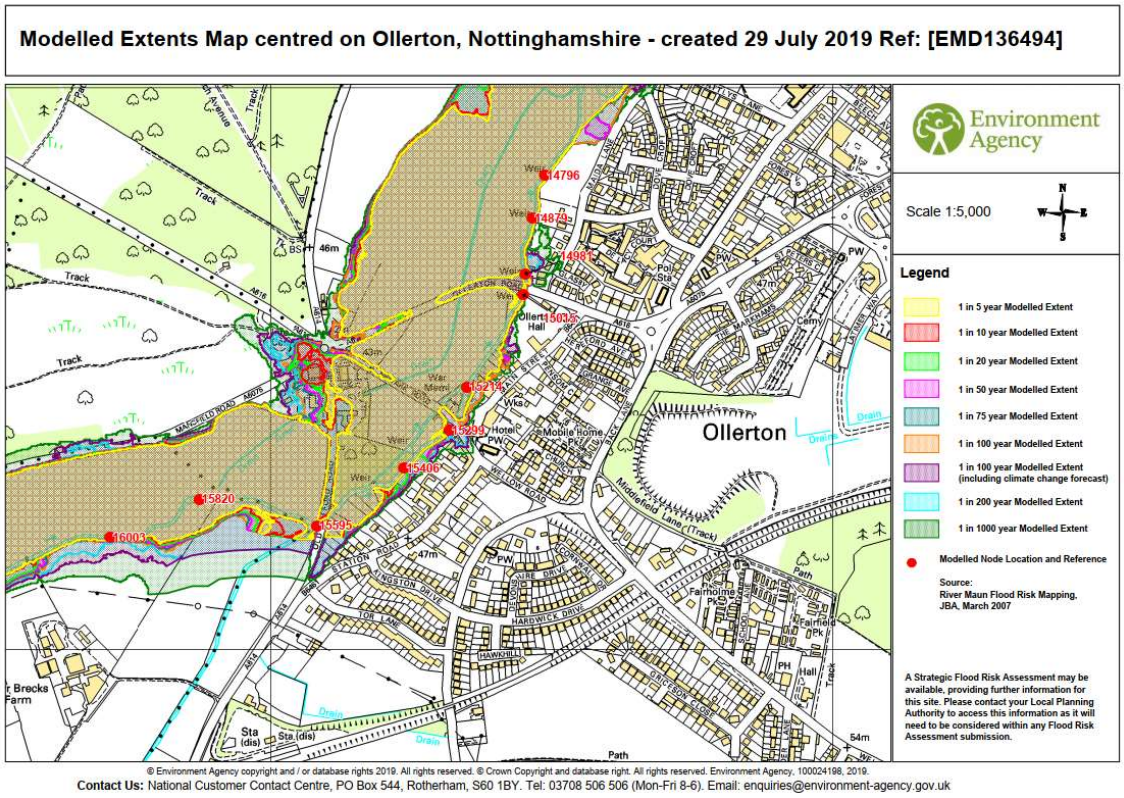


Figure 3-3 Environment Agency Modelled Flood Extents Map

Taking all the above into account, the risk of fluvial flooding to the junction is considered to be Medium-High. The roundabout is slightly elevated above surrounding ground levels and positioned at the edge of the flood extent.

Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

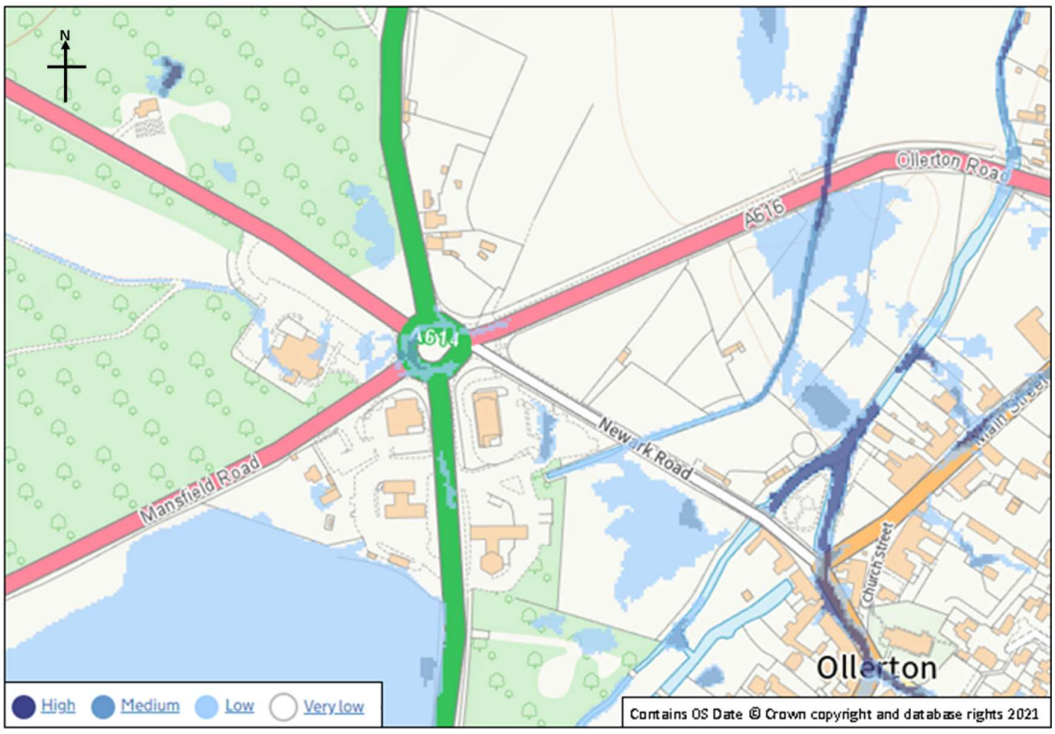


Figure 3-4: Ollerton Roundabout Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map indicates that the risk of surface water flooding at Ollerton Roundabout is generally classed as 'Very Low' to 'Low', as shown in Figure 3-4 above. The EA define a 'Low' risk' as each year the area has a chance of flooding from surface water of between 0.1% and 1%. A 'Very low' risk' means that each year the area has a chance of flooding of less than 0.1%.

Surface water runoff generated on the A616, A614 and Newark Road is drained via gullies and kerb outlets either directly back into the River Maun through a series of pipes or into a small heavily vegetated tributary which runs south of the A616.

On a site visit, it was made clear that the site is at risk of surface water flooding, the roundabout sits at the bottom of a depression with the surrounding roads feeding down into it which is likely to lead to a large collection of standing water at the base of the roundabout in the event of a flood. This was confirmed on a topographic map of Ollerton which shows the roundabout sits at 44m above sea level whereas the incoming roads sit around 3m higher on average.

Fishing lakes are located downstream of the Scheme, approximately 375m to the north-east. The ponds are adjacent to the River Maun and appear to be artificially constructed (possibly former gravel pits).

Small pond features are indicated on current mapping within Sherwood Heath LNR, which is located immediately west and north-west of the existing roundabout.

The risk of flooding at Ollerton from surface water is considered Low to Medium.

Groundwater

The British Geological Survey Map shows that the underlying geology in the area around Ollerton comprises of superficial deposits comprising of alluvium overlying the Chester Sandstone Formation. The alluvium deposit is made up of Clay, Silt, Sand and Gravel.

The superficial deposits (Alluvium and glacio-fluvial deposits) are classified as Secondary A Aquifers. The bedrock geology (Chester Formation) is classified as a Principal Aquifer.

Groundwater vulnerability is classed as high in relation to the superficial and bedrock geology. High vulnerability is defined as 'areas able to easily transmit pollution to groundwater'. They are characterised by high-leaching soils and the absence of low-permeability superficial deposits.

The soils within the study area are largely described as freely draining, slightly acid sandy soils. Soils associated with the River Maun, to the east of the existing roundabout, are described as naturally wet, very acid, sandy, and loamy soils.

A ground investigation has recently been undertaken by Nichols Colton Group for VIA East Midlands. As part of the ground investigation groundwater seepage noted in borehole WS09 at 6m below ground level (bgl) at National Grid Reference 465157, 367534, 40m east of the current circulatory of the roundabout. As a result, a piezometer was installed with a response zone of 1 – 10 m bgl. Subsequent monitoring from 15th June to 10th September 2021 has monitored groundwater levels of 5.29m to 5.4m bgl within the borehole. The borehole was formed at 41.2m AOD, which gives a groundwater level of approximately 35.8 m AOD.

The risk of flooding at Ollerton from groundwater is considered Low.

Sewers

As the risk of flooding from surface water is considered to be low to medium, it can also be inferred that that risk of flooding from surface water sewers is likely to be Low to Medium.

Artificial sources

The EA's Risk of Flooding from Reservoir map, Figure **3-5** indicates that the proposed Scheme at Ollerton lies on the edge of an area considered to be at risk from reservoir flooding. The area shown to be at risk of reservoir flooding is along the River Maun corridor and covers a similar extent to the fluvial Flood Zones. The maximum flood depth likely from the reservoir has been assessed as low (<0.3m) and medium (0.3 – 3m).

The risk of flooding to the Scheme at Ollerton from artificial sources is considered Low to Medium.

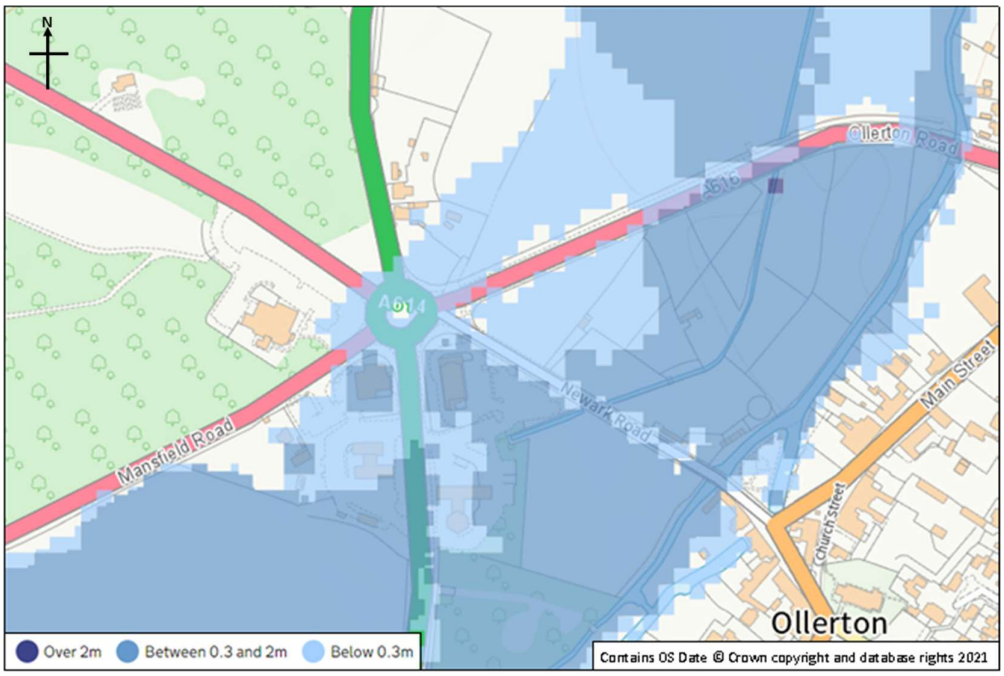


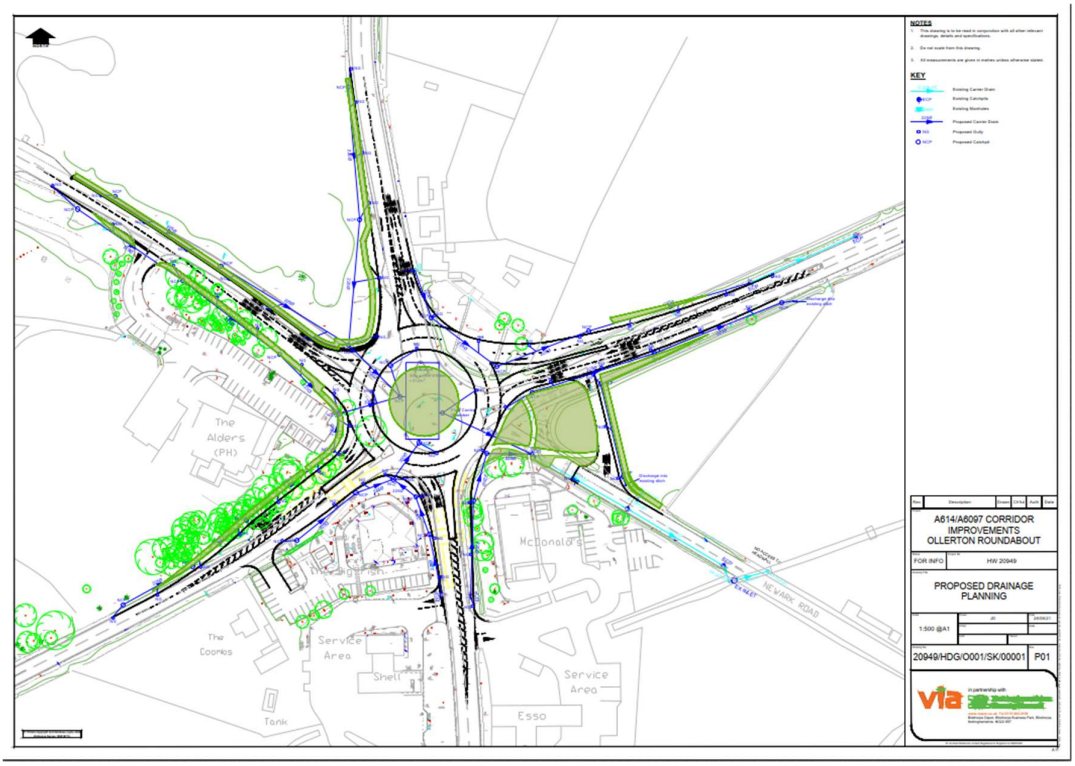
Figure 3-5: Ollerton Roundabout Reservoir Flood Risk: Flood Water Depth

Other

Within the Nottinghamshire Local Flood Risk Management Strategy[7] flooding events are noted within the Ollerton area for 2007, 2013, 2014-early 2015. These flood events were noted as being mainly surface water and ordinary watercourse events. Additionally, in 2012 there was a flood event which caused problems in Ollerton where the A616 Worksop Road shut both ways at the junction with the A614 Blyth Road, as a result of heavy rainfall.[16]

[16] BBC (2012) Flooding disrupts travel in Nottinghamshire and Lincolnshire [Online] Last Accessed 30-11-21

Table 3-3: Scheme Flood Risk Assessment Summary - Ollerton Roundabout

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	There are some minor changes in road / roundabout elevations as part of the junction improvement design but there is not a significant, consistent, or wholesale raising (or lowering) of the junction and therefore no significant impact on fluvial flood risk. Located at the edge of the flood zone, there is no scope within the highway improvements design to significantly reduce the risk of flooding at the roundabout. Parts of the junction will be at risk of flooding in a fluvial flood event, but the level of risk is unchanged from the baseline situation. With the location at the edge of the flood extent and no significant changes in ground levels proposed, the highway improvements work will not significantly affect fluvial flood risk to third parties. The main area at risk of inundation is the fields between the River Maun and Ollerton Road and the risk here would not be changed by the proposed works. The residential properties on the edge of Ollerton are raised above the River Maun floodplain and would not be affected by these changes.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location. The proposed scheme does not change the risk of tidal or coastal flooding.
Surface water	 **Figure 3-6: Ollerton Roundabout Proposed Drainage** Surface water drainage systems at Ollerton will be installed or diverted to accommodate the existing and new impermeable surface. Where possible the flows will be collected in gullies and discharged into existing drainage outfalls. The existing junction is split into five catchments. Following the proposed works four out of five catchments will see no change to the impermeable area. Within catchment 5, refer to Figure 3-7, the impermeable area will increase from 3549m^2 to 5202m^2, an increase of 1653m^2. All runoff from this catchment (5202m^2) will be captured and attenuated (see Table 3-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year +40% CC event. This will result in a significant betterment to the existing surface water discharge. The storage will be maintained as part of the highway network, as the responsibility of Nottinghamshire County Council. Flows from the Southern and eastern portions of the junction are not attenuated but are to be collected in new underground drainage which is to connect to the existing network. All the flows are to discharge into existing drainage ditches. There may be small changes in road / roundabout level because of the proposed improvement works but there is not a significant, consistent, or wholesale raising (or lowering) of the road / roundabout. Therefore, there may be some localised impacts on surface water flow routes, but these are not expected to be significant or to affect third parties and can be managed further through the detailed design process. The proposed highway drainage design will better manage runoff generated on the road surface than

	the existing arrangement, reducing this risk of flooding (see Section 3.2 below).. Surface water flooding/ponding evident on the western portion of the gyratory may be caused by a flow route from the adjacent building and carpark. Raising the ground level in this area may result in the surface water ponding outside the extent of the scheme. Considering these points, the post-development risk may be considered medium, which is reduced to Low with the described mitigation.
Groundwater	The proposed scheme is not anticipated to include deep excavations or significant changes to the existing ground levels. Where surface levels do change, the proposed surface is above the existing ground level. The increased size of the junction will result in it being closer to the boundary of the high groundwater vulnerability. The flood risk of groundwater because of the scheme is not expected to increase from the existing risk. The risk of groundwater flooding is considered Low.
Sewers	The proposed scheme does not amend or change the existing sewer network. As the risk of flooding from surface water is shown to be predominantly low with small areas at higher risk, it can also be inferred that that risk of flooding from sewers is likely to be Low.
Artificial sources	The proposed junction increases in size, expanding towards the north and west. The additional area of the junction is on the border of the area at risk of flooding from artificial sources. The maximum flood depth likely from the reservoir has been assessed to remain as low (<0.3m) for the majority of the roundabout with areas of medium (0.3 – 3m) to the south. The risk of flooding as a result of the Scheme at Ollerton from artificial sources is considered to be unchanged and remains Low to Medium.
Other	No risk from other sources identified or introduced as a result of the proposed scheme.

3.1 Summary assessment – Ollerton Roundabout

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Medium	Medium	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Low to medium	Low	Yes – See Surface Water Drainage Strategy below
Groundwater Flooding	Low	Low	No
Sewer Flooding	Low	Low	No
Artificial Sources Flooding	Low to medium	Low to medium	No
Other Flooding			

3.2 Surface Water Drainage Strategy

3.2.1 Existing Surface Water Drainage

The existing surface water drainage system at Ollerton Roundabout is split into 4 catchments. The surface water from the A614 to the north of the roundabout, the A616 Worksop Road and the A616 Ollerton Road exit arm is collected in gullies connected with carrier pipes which discharge into a drain on the northern side of the A616 Ollerton Road. The surface water from the A614 to the south of the roundabout, Mansfield Road, and the southern side of Newark Road drains into gullies connected with carrier pipes which discharge into a drain on the southern side of Newark Road. The A616 Ollerton Road approach arm has gullies which collect the surface water and discharge into a ditch. The northern side of Newark Road has the surface water collected and discharged into a ditch on the Northern side of Newark Road.

3.2.2 Proposed Surface Water Discharge

As per CIRIA report C753, the established discharge hierarchy for surface water is as follows:

- Infiltration to the ground;
- Discharge to surface waters;
- Discharge to a surface water, highway drain or another drainage system;
- Discharge to a combined sewer.

Infiltration has been deemed unviable due to the geology although this will be confirmed at detailed design stage through infiltration testing.

The surface water collected from all roads will be collected by either gullies or kerb drains connected with carrier pipes and will discharge into the existing system which will in turn discharge into existing drains and ditches. Attenuation systems will be used to ensure that the proposed drainage does not increase the risk of flooding downstream.

3.2.3 Proposed Site Discharge Rates

The design requirements for the proposed redevelopment under various storm events according to the DEFRA 'Non-statutory technical standards for sustainable drainage systems' are as follows:

- 1 in 1 year – No surcharge of the drainage system (with exception of storage features)
- 1 in 30 years – No flooding from the drainage system
- 1 in 100 years – No flood risk to buildings or people and all flows contained on site

In accordance with the DEFRA Non-statutory technical standards for sustainable drainage systems, for sites which were previously developed such as this, the peak runoff rate from the development should be as close as reasonably practical to the greenfield runoff rate for the same return period. In order to avoid complex flow controls and long-term storage, it is proposed to discharge runoff at a single maximum allowable discharge rate based on Q_{BAR} for all events up to and including the 1 in 100 year return period with an allowance for climate change. Due to existing impermeable area currently freely discharging the proposed approach with restricted discharge will provide an improvement to downstream flood risk.

In accordance with SC030219 produced by the Environment Agency and DEFRA, "A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low rate while keeping the risk of blockage to an acceptable level. It is suggested that this is 5 litres per second. Therefore, where Q_{BAR} results in a proposed discharge rate of less than 5l/s, to prevent risks of excessive blockages and maintenance issues a practical minimum of 5l/s shall be taken.

3.2.4 Proposed Surface Water Catchments

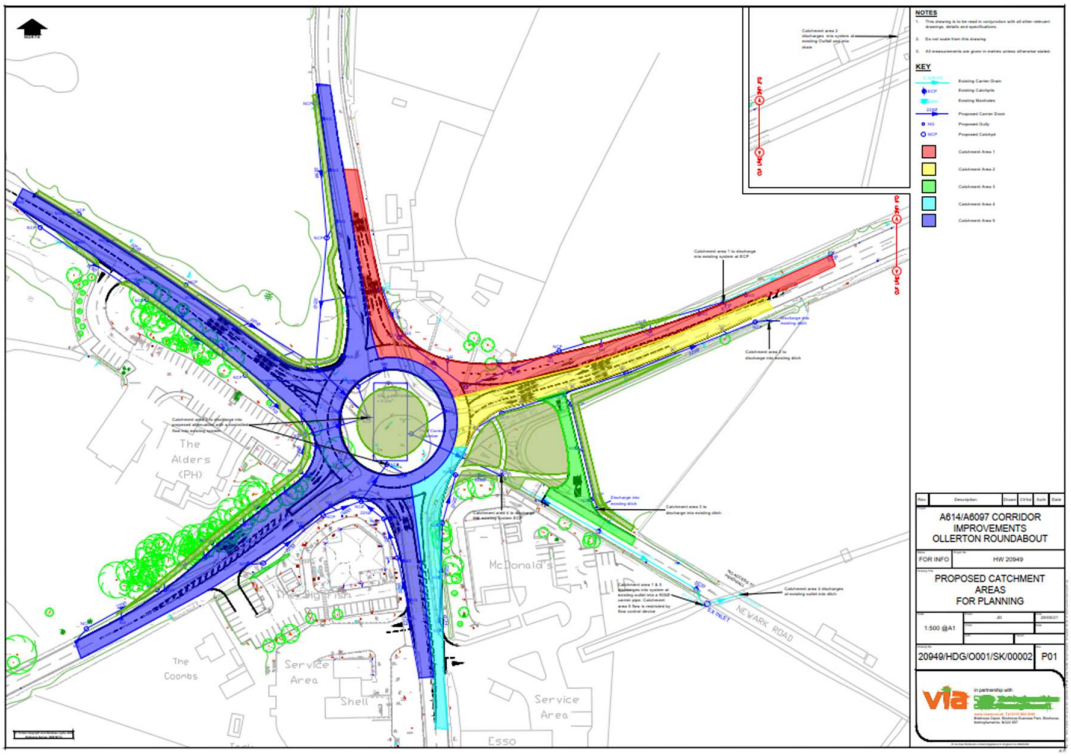


Figure 3-7: Ollerton Roundabout Proposed Drainage

As shown in Figure 3-7, the drainage plan for the Ollerton roundabout consists of dividing the junction into five catchment areas. The proposed surface water arrangements are as follows:

Catchment 1: On the A614 southbound approach arm and A616 Ollerton Road eastbound arm gullies will collect surface water that will discharge into the existing drainage system east of the roundabout which in turn discharges into an existing drain.

Catchment 2: On the A616 Ollerton Road approach arm surface water will be collected by gullies that will discharge via carrier pipes into an existing ditch to the east of the roundabout.

Catchment 3: The bus lane will have gullies that collect the surface water and convey into carriers drains that will discharge at a new outlet point into an existing ditch,

Catchment 4: The A614 southbound exit arm will have gullies connected with carrier pipes that will collect surface water and discharge into the existing highway drainage system which in turn discharges using an existing outlet into a ditch.

Catchment 5: The A614 northbound approach and exit arm, Mansfield Road and the A614 Worksop Road will have gullies connected with carrier pipes that will discharge surface water into an attenuation tank in the centre of the roundabout. The attenuation tank will then attenuate the surface water, releasing surface water via a flow control chamber into the existing system along Newark Road which then discharges into an existing drain.

For the A614 northbound exit arm and the A616 Worksop Road, there are additional areas north of the proposed catchments which currently drain towards the roundabout. These additional areas have not been included in the proposed catchment areas and no allowance has been made in the proposed attenuation. It is acknowledged that surface water from outside the identified catchments will flow towards the roundabout and may be intercepted by the proposed attenuation. The arrangement for these areas will be agreed at the detailed design stage.

Of the 5 catchments discussed above, catchments 1 to 4 have no increase in impermeable area, only catchment 5 has an increase of impermeable area from 3549m^2 to 5202m^2, an increase of 1653m^2. Therefore, attenuation is only proposed for catchment 5 and has been calculated for the 1 in 100 year return period with a 40% climate change allowance. The results can be seen in Table 3-4.

Table 3-4: Contributing areas, Discharge rates and Attenuation Volumes

Catchment	Contributing area (ha)	Proposed Allowable Discharge Rate (l/s)	Attenuation volume (1 in 100 year + 40%) (m^3)
1	0.1622	5	-
2	0.0986	5	-
3	0.0405	5	-
4	0.0741	5	-
5	0.5202	5	312

Estimates for the attenuation requirements for catchment 5 have been calculated using MicroDrainage Quick Storage estimates. The storage will be maintained by Nottinghamshire County Council as part of the highway maintenance regime.

3.3 Residual Risks

There would be a risk of fluvial flooding at the junction in a high probability flood event (e.g., 1% AEP or greater), but this risk is not increased from the baseline situation. The junction is at the edge of the fluvial flood extents so flooding would not be significant and there would be two (or more) dry routes away from the roundabout to the north.

4. Mickledale Lane Junction

Table 4-1: Overview of Proposed Improvements - Mickledale Lane Junction

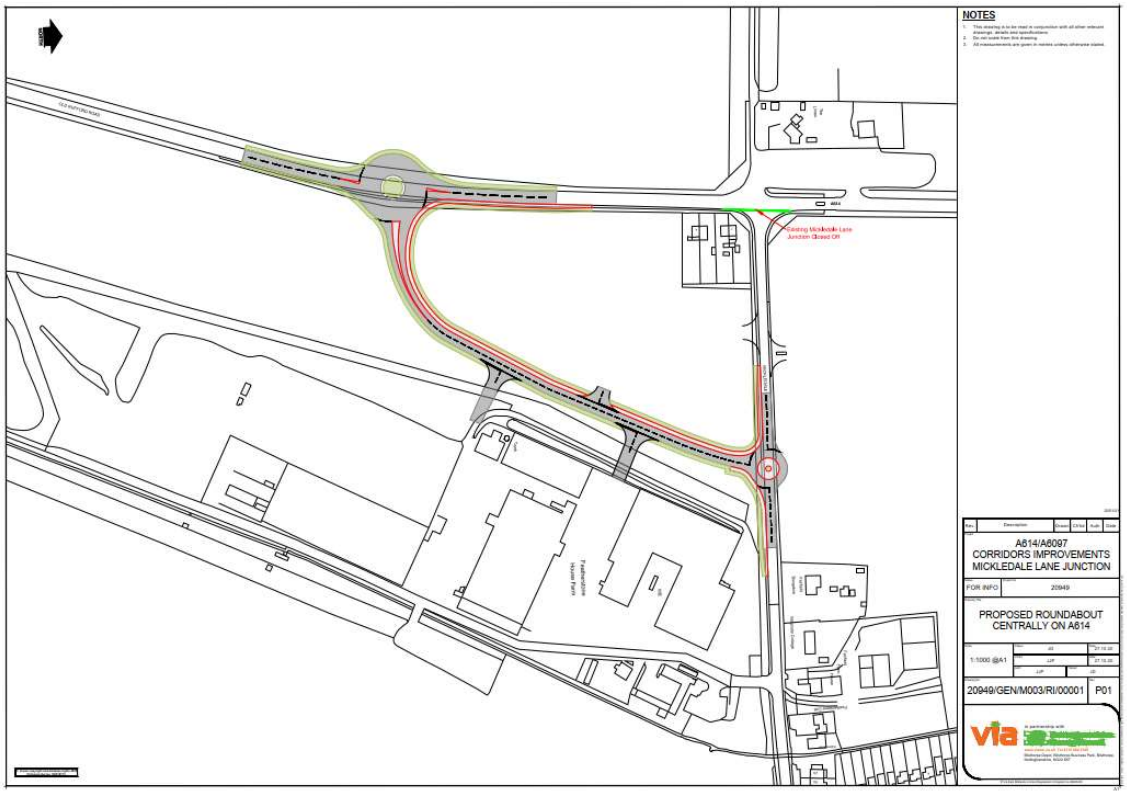
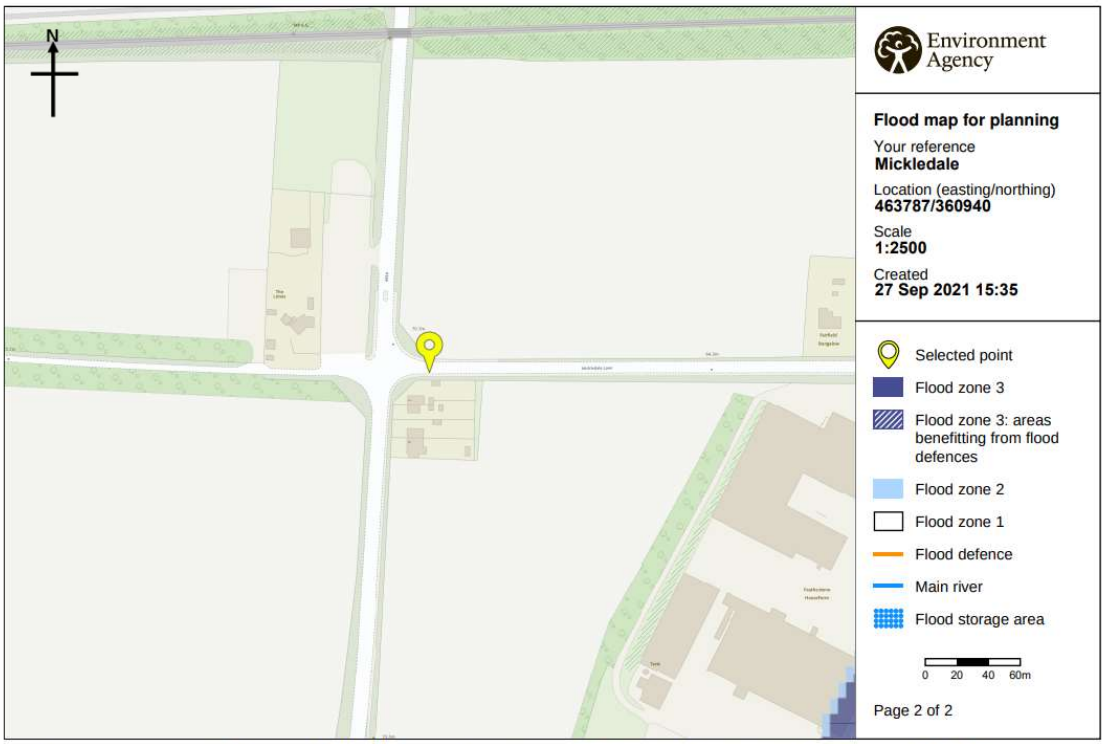


Figure 4-1: Mickledale Lane Junction

Currently this is a priority crossroads with right-turn harbourages provided into each of the minor arms. Four houses occupy the south-east corner of the junction, and a transport café is in the north-west quadrant.

The proposed works include construction of a new three-arm roundabout on the A614 (south of the existing junction) with a new link road connecting the A614 and Mickledale Lane passing through a field to the south-east of the existing junction. The new link road would tie into Mickledale Lane via a second three arm-roundabout. The existing Mickledale Lane junction with the A614 (near the four houses) would be closed off to vehicles and become a cul-de-sac accessed from the east, off the new link road. New road access would be provided off the new link road into Strawson's Ltd premises to the east. This will require permanent use of part of the land to the east of the A614.

Table 4-2: Baseline Flood Risk Assessment - Mickledale Lane Junction

Source of flood risk	Baseline / existing flood risk
Fluvial	 **Figure 4-2: Mickledale Lane Junction Fluvial Flood Risk** The Scheme is shown as being within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 4-2 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. Rainworth Water flows through the study area passing eastwards under the A614, approximately 100m south of the scheme. There is a small corridor of land nearby, approximately 500m from the Scheme, shown in Flood Zone 3 (a high probability of flooding from rivers or the sea) associated with Rainworth Water as it crosses through Bilsthorpe, but this does not impact the junction. Based on the information provided above, the risk to the Scheme from fluvial flooding is considered to be Low.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

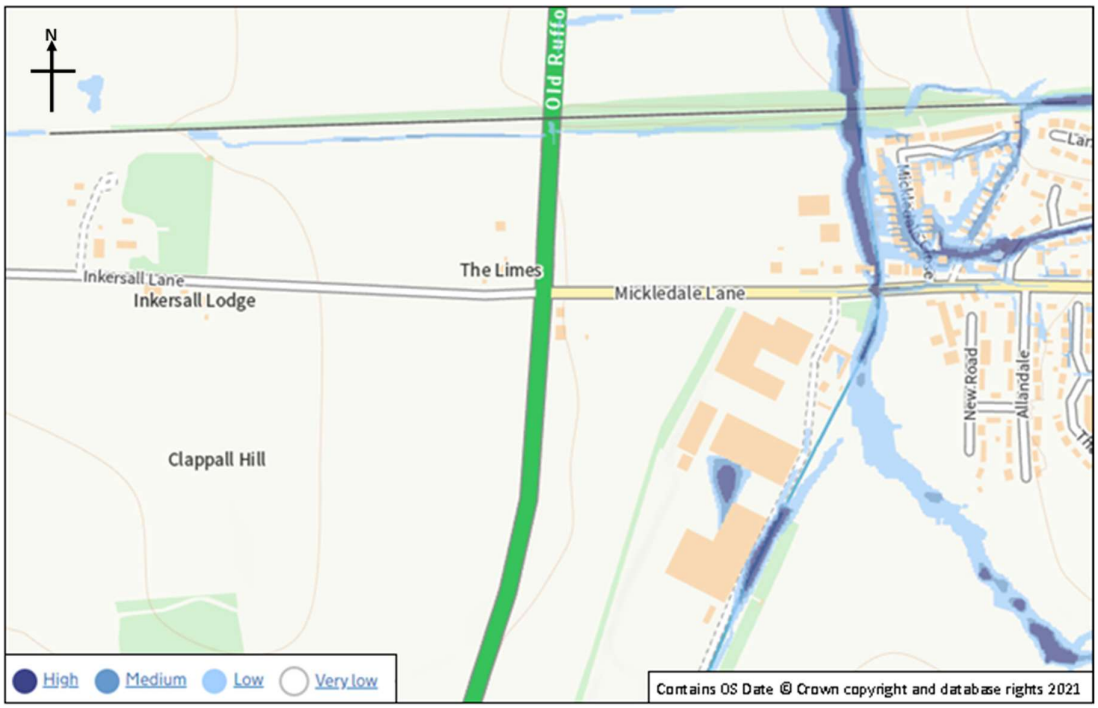


Figure 4-3: Mickledale Lane Junction Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map indicates that the risk of surface water flooding at Mickledale Lane Junction is generally classed as 'Very Low' to 'Low', as shown in Figure 4-3 above. The EA define a 'Low' risk' as each year the area has a chance of flooding from surface water of between 0.1% and 1%. A 'Very low' risk' means that each year the area has a chance of flooding of less than 0.1%.

Two ponds are located adjacent to Rainworth Water, to the south and south-west of the Scheme.

A small pond is in the study area, to the north-east of the Scheme.

Based on the above information, the risk of surface water flooding to the Scheme is considered to be Very Low.

Groundwater

The British Geological Survey (BGS) Map identifies the underlying bedrock geology within the Scheme and surrounding study area as the Sherwood Sandstone Group, Chester Formation.

Mickledale Lane Junction is located within an area designated as a principal aquifer. The BGS mapping suggests there is a limited potential for groundwater flooding to occur. There is potential groundwater flooding of property situated below ground level in the area of Rainworth water west and north of the scheme but not within the scheme area.

No superficial deposits are mapped within the Scheme area. Deposits of Alluvium are shown within the study area, to the east and south of the Scheme, following a surface watercourse. These deposits comprise clay, silt, sand, and gravel.

The Alluvium, to the east and south of the Scheme, is classified as a Secondary A Aquifer. The bedrock geology (Chester Formation) underlying the Scheme is classified as a Principal Aquifer.

Groundwater vulnerability is classed as high with areas of medium risk in relation to the limited superficial deposits within the study area (Alluvium).

The soils within the study area are largely described as freely draining, slightly acid sandy soils. Soils associated with Rainworth Water, at the eastern and southern extents of the study area are described as naturally wet, very acid, sandy, and loamy soils.

Based on the information above, the risk of flooding from groundwater emergence at this site is considered to be low.

Sewers

As the risk of flooding from surface water is considered to be low, it can also be inferred that that risk of flooding from surface water sewers is likely to be Low.

Artificial sources

The EA's Risk of Flooding from Reservoir map, Figure 4-4, indicates that the Scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity.

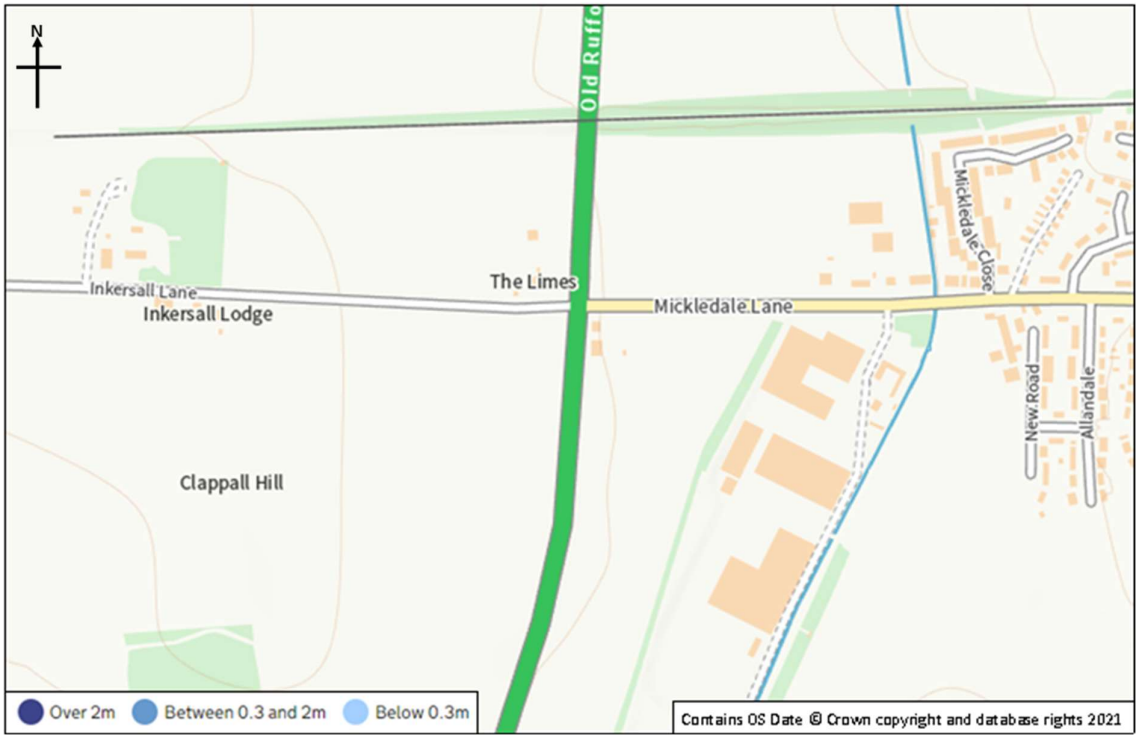


Figure 4-4: Mickledale Lane Junction Reservoir Flood Risk: Flood Water Depth

Table 4-3: Scheme Flood Risk Assessment Summary - Mickledale Lane Junction

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	The new highway and junction on Mickledale Lane result in the scheme being closer to the Rainworth Waters than the existing A614 Junction. However, the scheme remains within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 4-2 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. The proposed scheme does not change the risk of Fluvial flooding. The risk to the Scheme from fluvial flooding is considered to be Low.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location. The proposed scheme does not change the risk of tidal or coastal flooding.

Surface water

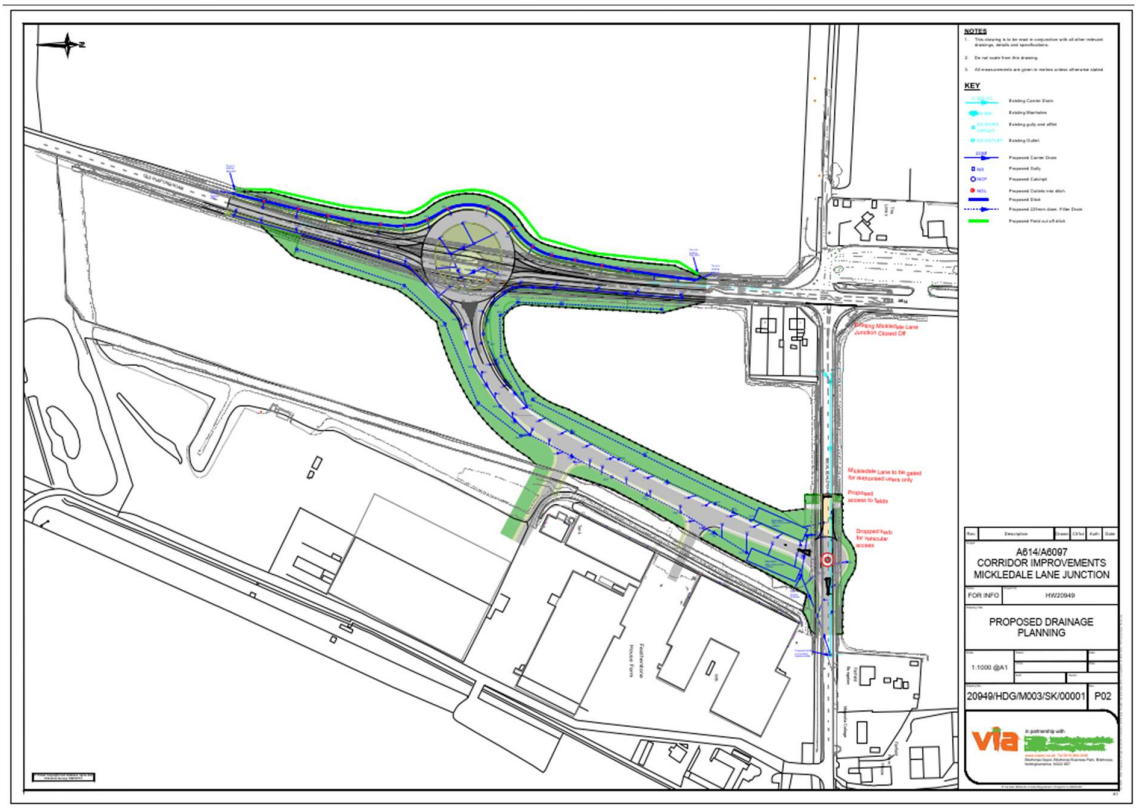


Figure 4-5: Mickledale Lane Roundabout Proposed Drainage

The development at Mickledale Junction introduces a new section of highway on the adjacent field with new roundabouts on the A614 and Mickledale Lane.

The existing drainage ditch on the Western edge of A614 is to be diverted around the new roundabout, with surface water discharging directly into the drainage ditch. The proposed junction and link road is split into 4 catchments, following the proposed works catchments 1 and 3 will see no change or a reduction in impermeable area. Within catchment 2a, refer to Figure 4-6, the impermeable area will increase from 623m^2 to 2568m^2, an increase of 1945m^2. All runoff from this catchment (2568m^2) will be captured and attenuated (see Table 4-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year + 40% CC event. This will result in a significant betterment to the existing surface water discharge. Within catchment 2b, refer to Figure 4-6, the impermeable area will increase from 623m^2 to 4501m^2, an increase of 3878m^2. All runoff from this catchment (4501m^2) will be captured and attenuated (see Table 4-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year + 40% CC event. This will result in a significant betterment to the existing surface water discharge. The storage will be maintained as part of the highway network, under the responsibility of Nottinghamshire County Council.

The roundabout on Mickledale Lane is to discharge into the existing drainage network. There is a slight increase in impermeable area which is flowing directly into the existing drainage network.

With the increased impermeable area and the proposed attenuation and flow control chambers the risk of flooding from surface water has been mitigated to Low.

Groundwater

The new section of highways is to be constructed within an area of high groundwater vulnerability. However, the scheme is not anticipated to include deep excavations or significant lowering of the existing ground level.

The risk of groundwater flooding is considered to not change as a result of the proposed scheme and remains Low.

Sewers

The proposed scheme does not amend or change the existing sewer network. As the risk of flooding from surface water is shown to be predominantly low with small areas at higher risk, it can also be inferred that that risk of flooding from sewers is likely to be Low.

Artificial sources	The scheme proposal is adjacent to the current junction. The EA Risk of Flooding from Reservoir map indicated that the scheme is not within an area at risk of flooding from reservoirs , and there are no other artificial sources of flooding in the vicinity. The proposed scheme does not change the risk of flooding from artificial sources.
Other	No risk from other sources identified or introduced as a result of the proposed scheme.

4.1 Summary assessment – Mickledale Lane Junction

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Low	Low	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Very Low	Low	No
Groundwater Flooding	Low	Low	No
Sewer Flooding	Low	Low	No
Artificial Sources Flooding	Low	Low	No

Other Flooding

4.2 Surface Water Drainage Strategy

4.2.1 Existing Surface Water Drainage

The existing surface water drainage system is split into 2 catchments, 1 along the western half of the A614 south of the junction with Mickledale Lane which collects the surface water in kerb outlets which discharge into a ditch along the side of the road. The second catchment includes the eastern part of the A614 south of the junction with Mickledale Lane and east of the junction with the A614. The surface water along Mickledale Lane is collected with gullies and connected with carrier pipes, as part of the Severn Trent Water sewer network.

4.2.2 Proposed Surface Water Discharge

As per CIRIA report C753, the established discharge hierarchy for surface water is as follows:

- Infiltration to the ground;
- Discharge to surface waters;
- Discharge to surface water, highway drain or another drainage systems;
- Discharge to a combined sewer

Infiltration has been deemed to be unviable due to the geology although this will be confirmed at detailed design stage through infiltration testing.

The surface water from the western half of the A614 south of the junction with Mickledale Lane is proposed to discharge into a ditch. The surface water across the rest of the site is collected and discharged into the existing highway drainage network.

4.2.3 Proposed Site Discharge Rates

The design requirements for the proposed redevelopment under various storm events according to the DEFRA Non-statutory technical standards for sustainable drainage systems are as follows:

- 1 in 1 year – No surcharge of the drainage system (with exception of storage features)
- 1 in 30 years – No flooding from the drainage system
- 1 in 100 years – No flood risk to buildings or people and all flows contained on site

In accordance with the DEFRA Non-statutory technical standards for sustainable drainage systems, for sites which were previously developed such as this, the peak runoff rate from the development should be as close as reasonably practical to the greenfield runoff rate for the same return period. In order to avoid complex flow controls and long-term storage, it is proposed to discharge runoff at a single maximum allowable discharge rate based on Q_{BAR} for all events up to and including the 1 in 100 year return period with an allowance for climate change. Due to existing impermeable area currently freely discharging the proposed approach with restricted discharge will provide an improvement to downstream flood risk.

In accordance with SC030219 produced by the Environment Agency and DEFRA, “A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low rate while keeping the risk of blockage to an acceptable level. It is suggested that this is 5 litres per second. Therefore, where Q_{BAR} results in a proposed discharge rate of less than 5l/s, to prevent risks of excessive blockages and maintenance issues a practical minimum of 5l/s shall be taken.

4.2.4 Proposed Surface Water Catchments

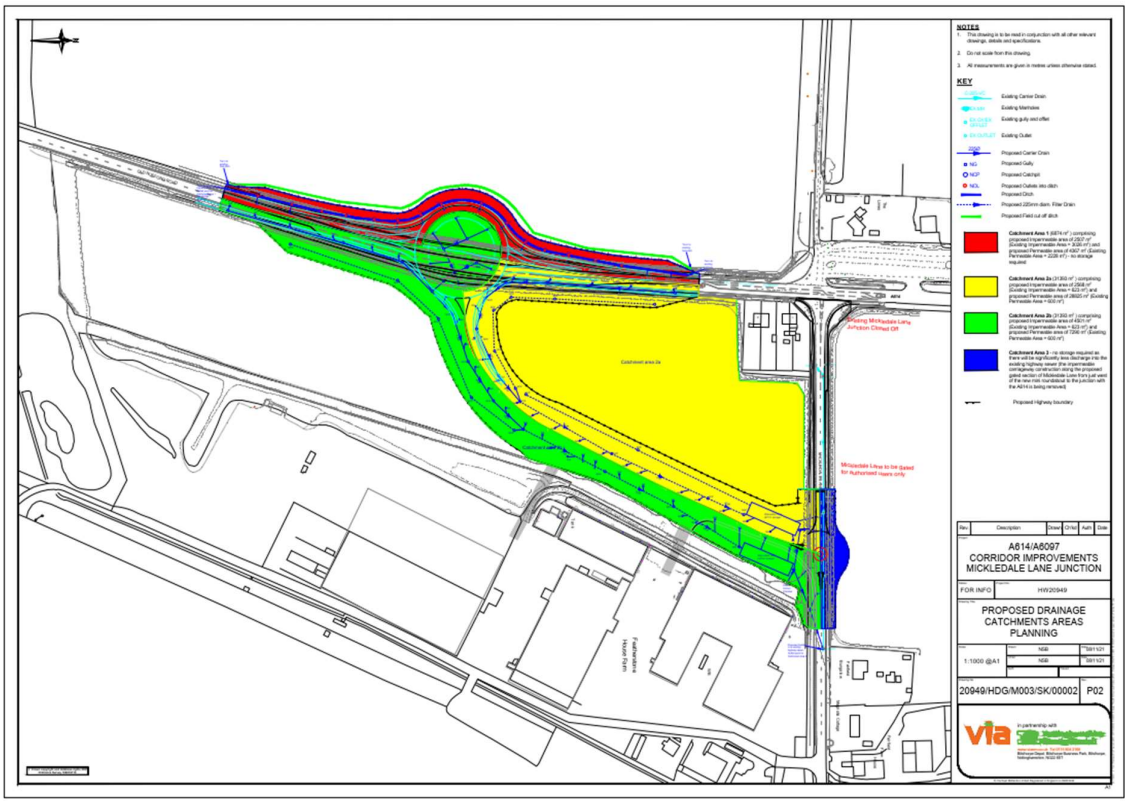


Figure 4-6: Mickledale Lane Junction Proposed Drainage

As shown in Figure 4-6, the proposed drainage plan consists of four catchments covering the junction and highway improvements. The proposed surface water arrangements are as follows:

Catchment 1: On the western half of the A614 and Western portion of the proposed roundabout kerb offlets will collect the surface water and will discharge directly into the existing ditch running along the western portion of the road. This ditch will be diverted to follow the proposed road layout.

Catchment 2a: On the eastern half of the A614 north of the roundabout, the western side of the proposed link road and the southern side of Mickledale lane west of the proposed junction with the link road will collect the surface water in gullies which will be connected by a combination of filter drains and carrier pipes which will discharge into an attenuation tank on the western side of the link road. The attenuation tank will then attenuate the surface water, releasing the surface water via a flow control chamber into the existing sewer network.

Catchment 2b: On the eastern half of the A614 south of the roundabout, the roundabout, and the eastern side of the proposed link road will collect surface water by gullies connected by a combination of filter drains and carrier pipes which will discharge into an attenuation tank on the eastern side of the link road. The attenuation tank will then attenuate the surface water, releasing the surface water via a flow control chamber into the existing sewer

network. The southern side of Mickledale Lane east of the proposed junction with the link road will have the surface water collected by gullies connected with carrier pipes and will discharge directly into the existing sewer network.

Catchment 3: On the northern side of Mickledale Lane surface water will discharge into the existing sewer network.

Of the 4 catchments discussed above, catchments 1 and 3 have no increase in impermeable area, however, catchments 2a and 2b have an increase of impermeable area of 1945m^2 and 3878m^2 respectively. Therefore, attenuation is only proposed for catchments 2a and 2b and has been calculated for the 1 in 100 year return periods with a 40% climate change allowance. The results can be seen in table 4-4.

Table 4-4: Contributing areas, Discharge rates and Attenuation volumes

Catchment	**Contributing area** (ha)	**Proposed Allowable Discharge Rate** (l/s)	**Attenuation volume** (1 in 100 year + 40%) **(m^3)**
1	0.6874	5	-
2a	3.1393	5	677
2b	3.1393	5	447
3		5	-

Estimates for the attenuation requirements for catchments 2a and 2b have been calculated using MicroDrainage Quick Storage estimates. The storage will be maintained by Nottinghamshire County Council as part of the highway maintenance regime.

5. White Post Roundabout

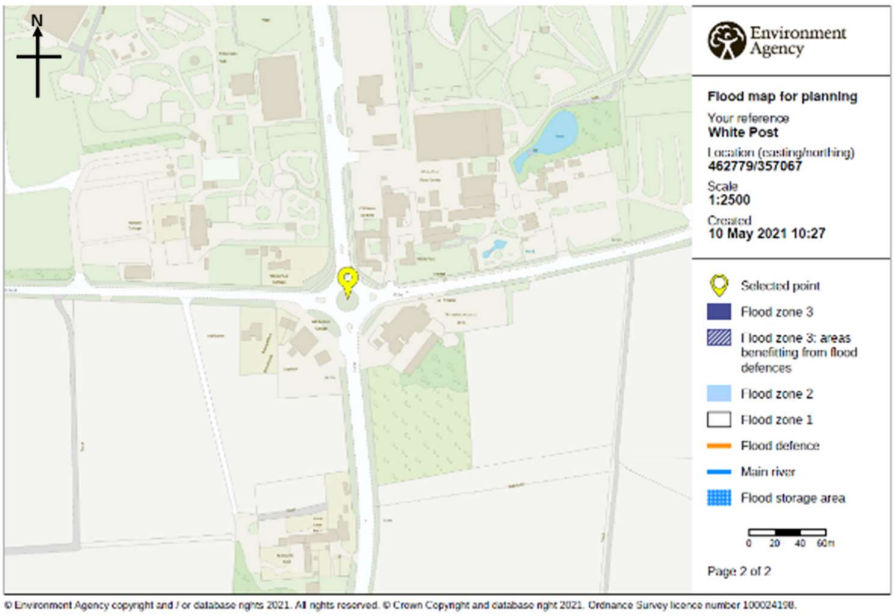
Table 5-1: Overview of Scheme - White Post Roundabout

This is a four-arm standard roundabout, with businesses located in close proximity to the junction on all sides.

The proposed improvement to this roundabout is a road safety scheme involving anti-skid road surfacing and minor maintenance improvements will be undertaken. This will involve carriageway maintenance and repairs and could also include minor realignment and widening of entries and exits, the provision of high friction surfacing on carriageway entries, signing, lining and street lighting upgrades. There are no proposed changes to the existing drainage scheme or gully locations.

No land take beyond the highway boundary is required.

Table 5-2: Baseline Flood Risk Assessment - White Post Roundabout

Source of flood risk	Baseline / existing flood risk
Fluvial	 **Figure 5-1: White Post Roundabout Fluvial Flood Risk** The Scheme is shown as being located entirely within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 5-1 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. There are no watercourses within 1km of the Scheme. Based on the information provided above, the risk to the Scheme from fluvial flooding is Low.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

Figure 5-2: White Post Roundabout Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map shows the surface water flood risk at White Post Roundabout is predominantly 'Low', with small areas of 'Medium' and 'High' within this, as shown in Figure 5-2 above.

The EA define 'Medium' risk as each year this area has a chance of flooding of between 1% and 3.3%. A 'High' risk means that each year this area has a chance of flooding of greater than 3.3%

The land slopes towards the roundabout from all directions. The land is approximately 73m AOD on Mansfield Road to the west, and 66m AOD to the east. The A614 starts at approximately 96m AOD to the north of the junction, lowering to 73m AOD just north of the junction. To the south, the A614 rises to approximately 89m AOD.

The closest surface water feature to the Scheme is a pond within White Post Farm, to the north-east.

There are also soakaways, however the assets that drain into them get silted up quite quickly.

Based on the above information, the risk of surface water flooding to the Site is considered to be Medium.

Groundwater

The British Geological Survey (BGS) Map identifies the underlying bedrock geology within the Scheme and the surrounding study area as Sherwood Sandstone Group, Chester Formation. No superficial deposits are mapped within the study area. The bedrock geology (Chester Formation) is designated as a Principal Aquifer.

The soils within the study area are largely described as freely draining, slightly acid sandy soils.

There were no BGS borehole logs available within the vicinity of the Scheme.

Based on the information above, the risk of groundwater flooding to the Scheme is considered to be Low.

Sewers

As the risk of flooding from surface water is shown to be predominantly low with small areas at higher risk, it can also be inferred that that risk of flooding from surface water sewers is likely to be low to medium. In addition, VIA East Midlands Ltd have not reported any known history of sewer flooding to the Scheme.

Artificial sources

The EA's Risk of Flooding from Reservoir map indicates that the Scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity.

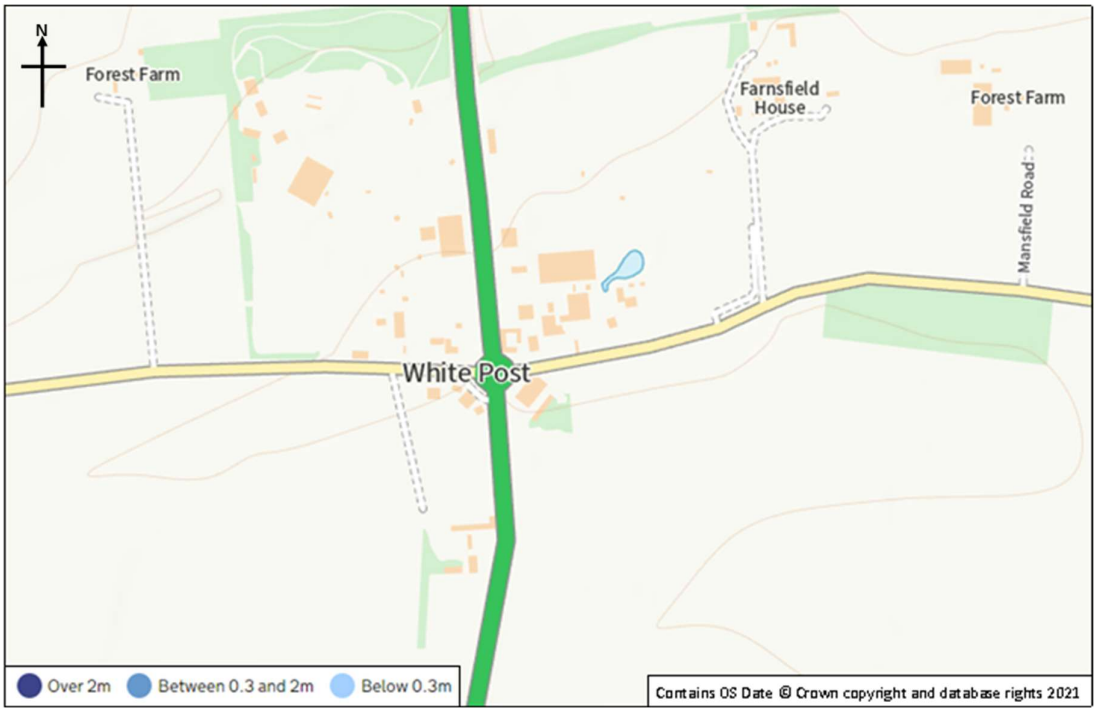


Figure 5-3: White Post Roundabout Reservoir Flood Risk: Flood Water Depth

Other

There has been historic flooding at White Post Roundabout due to the roundabout being in a low spot and water from all approaches hits it. There are soakaways but the assets that drain into them get silted up quite quickly. Flooding arises either when the assets on the approaches are silted and/or when there are excessive spells of rain.

Table 5-3: Scheme Flood Risk Assessment Summary - White Post Roundabout

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	The existing junction is located entirely within the Flood Zone 1 on the EA Flood Map for Planning. The proposed scheme is within the highway boundary at the junction. The proposed scheme does not enter any other Flood Zone designations. The junction remains at least 1km from the nearest watercourse. Based on the information provided above, the risk from the proposed Scheme from fluvial flooding is considered to be 'low'
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location. The proposed scheme does not change the risk of tidal or coastal flooding.
Surface water	In a similar capacity to the fluvial flood risk, the changes to surface water flood risk are minimal. There is no increase in impermeable area at White Post Roundabout. The proposed development does not alter the existing surface water drainage. The EA Risk of Flooding from Surface Water map shows the surface water flood risk at White Post Roundabout is predominantly 'Low', with small areas of 'Medium' and 'High' within this. The land within and around the junction is to remain the same level as the existing situation. It is not expected that existing flow routes indicated by the Flooding from Surface Water Map will be affected by the proposed works. Based on the above information, the risk of surface water flooding to the Site is considered to remain Medium.

Groundwater	The proposed scheme does not include excavation or changes to existing ground levels. The existing ground levels and types are to be retained. The scheme is not anticipated to change the risk of flooding from groundwater. The risk of groundwater is considered to be Low.
Sewers	The proposed scheme does not include for altering or amending the existing sewer network. As the risk of flooding from surface water is shown to be predominantly low with small areas at higher risk, it can also be inferred that that risk of flooding from sewers is likely to be low.
Artificial sources	The scheme proposal is within the current junction boundary. The EA Risk of Flooding from Reservoir map indicated that the scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity. The proposed scheme does not change the risk of flooding from artificial sources.
Other	No risk from other sources identified or introduced as a result of the proposed scheme.

5.1 Summary assessment – White Post Roundabout

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Low	Low	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Medium	Low	No
Groundwater Flooding	Low	Low	No
Sewer Flooding	Low to Medium	Low	No
Artificial Sources Flooding	Low	Low	No
Other Flooding			

6. Warren Hill Junction

Table 6-1: Warren Hill Junction

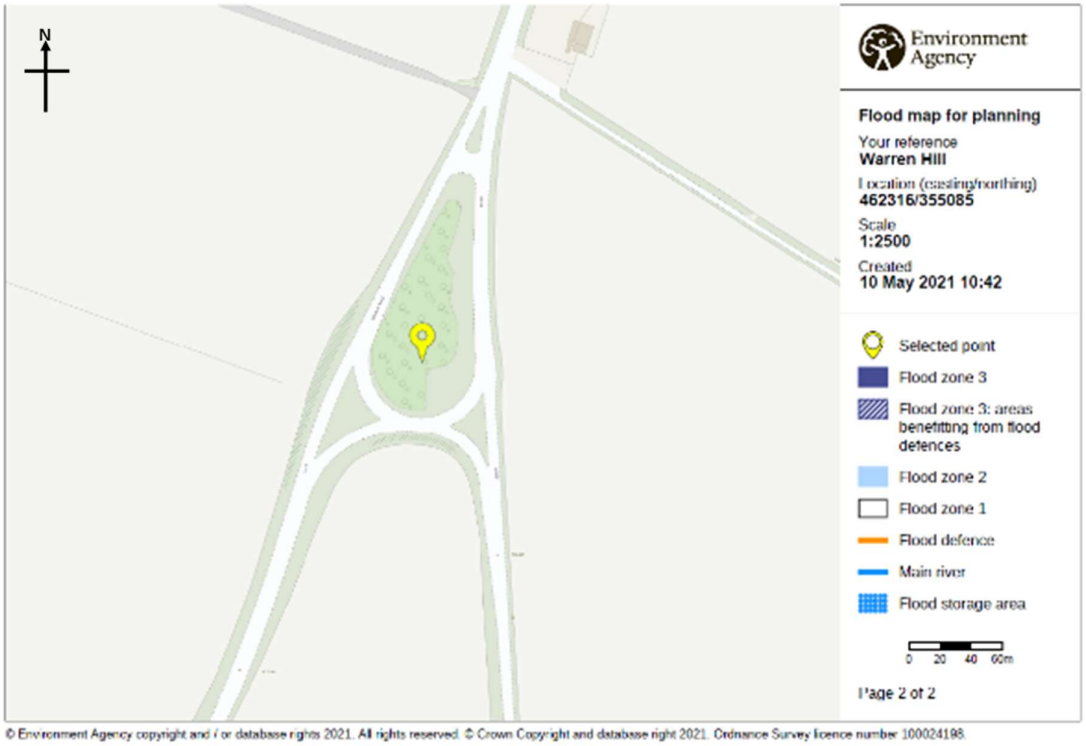
Figure 6-1: Warren Hill Junction

This is a priority controlled gyratory junction where traffic on the A6097 gives way to traffic travelling north/ south on the A614. The junction layout is unusual in that traffic from the A6097 (routeing north) merging onto the A614 does so by entering the mainstream on the passenger side (rather than the normal driver's side).

At this junction geometric improvements will be undertaken, the existing gyratory (where the A6097 gives way to traffic on the A614) will be simplified with an extended merge lane to reducing conflicting movements.

No land take beyond the highway boundary is required.

Table 6-2: Baseline Flood Risk Assessment - Warren Hill Junction

Source of flood risk	Baseline / existing flood risk
Fluvial	 **Figure 6-2: Warren Hill Junction Fluvial Flood Risk** The Scheme is shown as being located entirely within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 6-2 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. The closest watercourse is Dover Beck located approximately 350 m to the south-east of the existing junction. Based on the information provided above, the risk to the Scheme from fluvial flooding is considered to be ‘low’.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

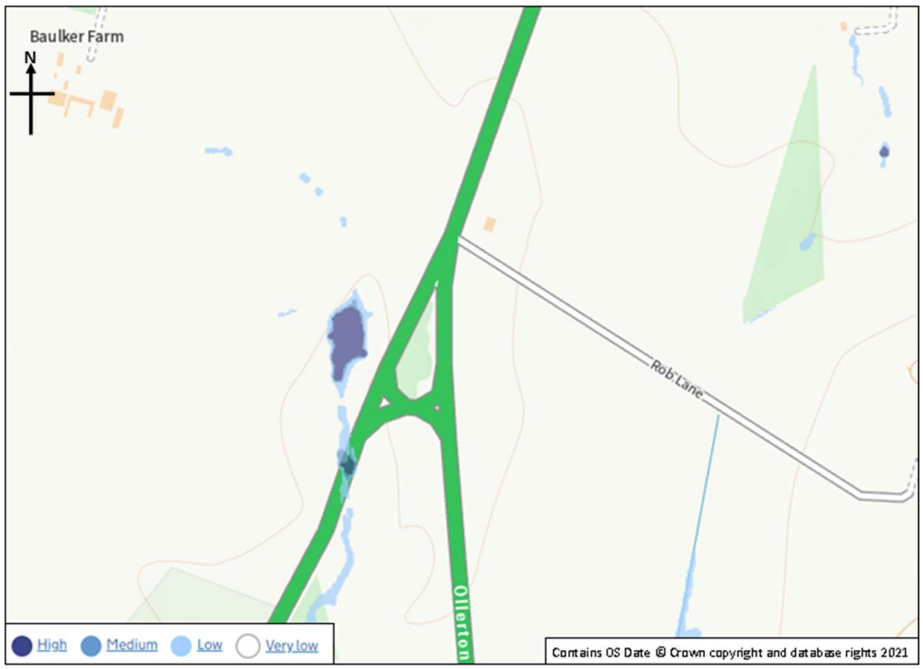


Figure 6-3: Warren Hill Junction Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map shows the surface water flood risk in the area of the Scheme is predominantly 'Low', with small areas of 'Medium' and 'High' to the west and south of the gyratory, as shown in Figure 6-3 above.

The EA define 'Medium' risk as each year this area has a chance of flooding of between 1% and 3.3%. A 'High' risk means that each year this area has a chance of flooding of greater than 3.3%.

Based on the above information, the risk of surface water flooding to the Site is considered to be 'Low'.

Groundwater

The British Geological Survey (BGS) Map identifies the underlying bedrock geology within the Scheme and most of the surrounding study area as Sherwood Sandstone Group, Chester Formation. The Tarporley Siltstone Formation underlies the south-eastern edge of the study area. No superficial deposits are mapped within the study area.

The Chester Formation, which underlies the Scheme, is classified as a Principal Aquifer. The Tarporley Siltstone Formation, at the south-eastern edge of the study area, is classified as a Secondary B Aquifer.

There were no BGS borehole logs available within the vicinity of the Scheme.

Based on the information above, the risk of groundwater flooding to the Scheme is considered to be Low.

Sewers

As the risk of flooding from surface water is shown to be predominantly low with small areas at higher risk, it can also be inferred that that risk of flooding from surface water sewers is likely to be low. In addition, VIA East Midlands Ltd have not reported any known history of sewer flooding to the Scheme.

Artificial sources

The EA's Risk of Flooding from Reservoir map indicates that the Scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity.

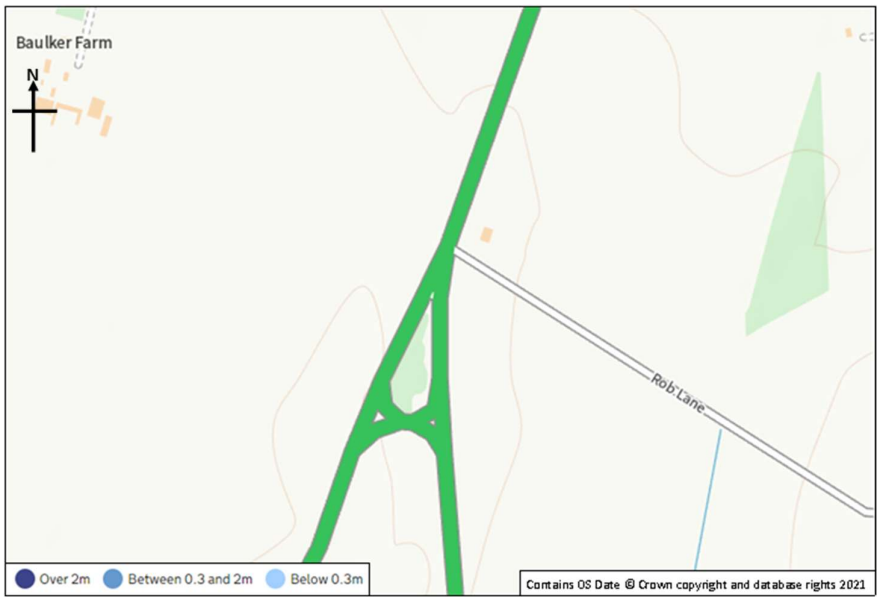


Figure 6-4: Warren Hill Junction Reservoir Flood Risk

Table 6-3: Scheme Flood Risk Assessment Summary - Warren Hill Junction

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	The proposed scheme is still within the Flood Zone 1. The proposed scheme remains within the highway boundary. The distance to the near watercourse, Dover Beck approximately 350m to the East, remains unchanged. The risk from the scheme of Fluvial Flooding remains Low.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.
Surface water	In a similar capacity to the fluvial flood risk, the changes to surface water flood risk are minimal. There is no increase in impermeable area at Warren Hill junction. The proposed development does not alter the existing surface water drainage. The EA Risk of Flooding from Surface Water map shows the surface water flood risk in the area of the Scheme is predominantly 'Low', with small areas of 'Medium' and 'High' to the west and south of the gyratory. The land within and around the junction is to remain the same level as the existing situation. Based on the above information, the risk of surface water flooding to the Site is considered to remain Low.
Groundwater	The proposed scheme does not include excavation or changes to existing ground levels. The existing ground levels and types are to be retained. The scheme is not anticipated to change the risk of flooding from groundwater. The risk of groundwater is considered to be Low.
Sewers	No changes to the sewers are proposed as part of the works. The proposed scheme is not anticipated to impact the existing sewer network or change the level of flood risk. The risk of flooding as a result of the scheme is considered Low.
Artificial sources	The scheme proposal is within the current junction. The EA Risk of Flooding from Reservoir map indicated that the scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity. The proposed scheme does not change the risk of flooding from artificial sources.

Other No risk from other sources identified or introduced as a result of the proposed scheme.

6.1 Summary assessment – Warren Hill Junction

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Low	Low	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Low	Low	No
Groundwater Flooding	Low	Low	No
Sewer Flooding	Low	Low	No
Artificial Sources Flooding	Low	Low	No

Other Flooding

7. Lowdham

7.1 Proposed Development

Lowdham is a four-arm standard roundabout. The A6097 entering the junction from the north and south are both of dual-carriageway standards.

It is proposed that an enlarged four arm elliptical roundabout will be constructed with a two-lane circulatory carriageway with a third left turn filter lane incorporated on the A612 east bound approach to the junction, see Figure 7-1.

This will require permanent land take associated with the west-bound arm of the A612 and a new access road off the A612 for houses at the roundabout.

Figure 7-1: Lowdham Roundabout Junction Location

7.2 Baseline Flood Risk

Table 7-1: Baseline Flood Risk Assessment Lowdham Roundabout

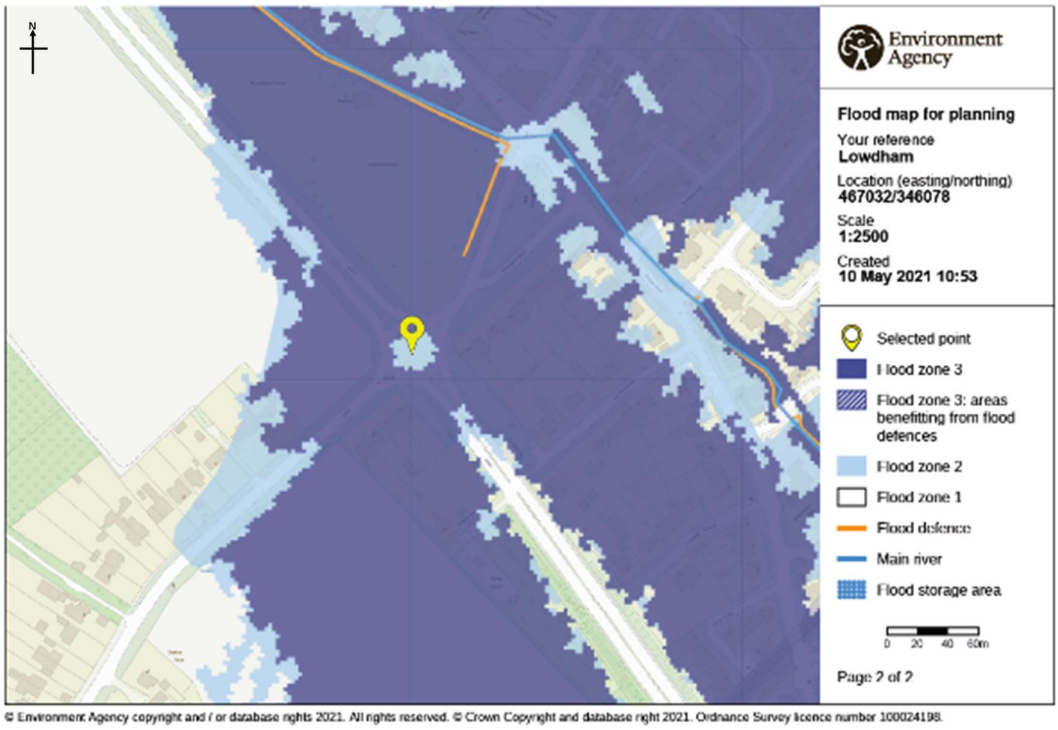
Source of flood risk	Baseline / existing flood risk
Fluvial	

Figure 7-2: Lowdham Roundabout Junction - Environment Agency Flood Zones

The Environment Agency Flood Map for Planning shows that the Lowdham Scheme is located within Flood Zone 2 and Flood Zone 3, see Figure 7-2 above. Land and property in Flood Zone 3 is considered to have a high probability of flooding from rivers or the sea and land or property in Flood Zone 2 is considered to have a medium probability of flooding from rivers or the sea. This assessment of flood risk is made without considering any benefit provided by flood defences.

At Lowdham, the source of this flood risk is the Cocker Beck, a main river located 160m east of the junction, which flows north-south through the village with areas of Flood Zone on both sides of the watercourse. The Cocker Beck is a tributary of the River Trent and downstream of the roundabout has a confluence with the River Trent at Gunthorpe, near East Bridgford. Here there is a wide expanse of floodplain associated with the River Trent and some Environment Agency flood defences.

The Environment Agency Flood Map for planning shows the presence of some flood defences along the right and left banks of Cocker Beck as it flows through Lowdham, but the impact of these defences is not taken into account in the Flood Zone mapping. The Flood Map shows the area at high probability of flooding (Flood Zone 3) includes the roundabout and approach roads, from all directions, as well as the cricket pitch and recreation ground and many properties in the Station Road area. The Flood Zones shown in the Environment Agency Flood Map are likely from the 2019 modelling of Cocker Beck.

There is updated and more detailed flood risk information available for the Cocker Beck in Lowdham and the Environment Agency have provided a 2021 flood model for use in this flood risk assessment and planning (see Table 1-2). This 2021 modelling is considered the best available flood risk data for this area and will be used in this assessment. This modelling takes account of the presence of existing flood defences. This modelling has been undertaken by the Environment Agency as part of the Lowdham Flood Risk Alleviation scheme design, a capital works project currently underway. The Flood Alleviation Scheme is being delivered by the Environment Agency's Collaborative Delivery Framework suppliers for this region, Arup.

The updated 'baseline' model from the Environment Agency includes existing defences near to the roundabout. This consists of a defence spanning part of the Cocker Beck and around the field, as seen below in Figure 7-3. The more detailed flood risk modelling, including representation of these defences, shown in Figure 7-3 shows a lower level of risk to the Lowdham scheme than indicated by the Environment Agency Flood Zones. Baseline results from the updated model for a 1% AEP design event including a + 39% climate change allowance can be seen in Figure 7-4.

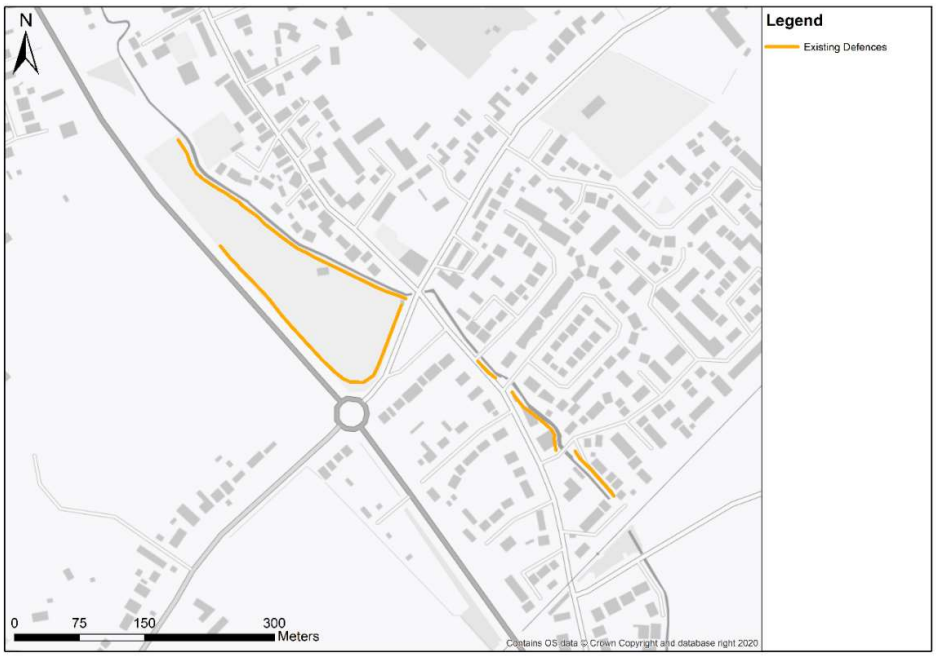


Figure 7-3: Existing defence elements prior to 2021/22 works.

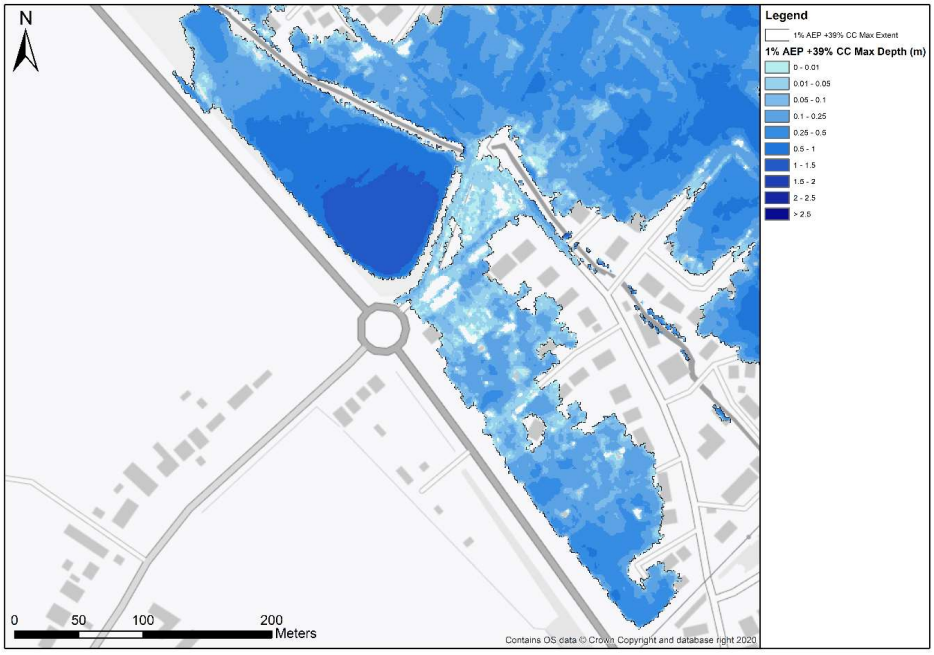


Figure 7-4: 1% AEP +39% Climate Change Baseline Max Flood Depth

Figure 7-4 shows the maximum flood extent and depths from the modelled 1% AEP design event, including a +39% climate change allowance. The figure shows that the modelled flood extent is confined to the north and east of the roundabout and the model results do not show inundation of the roundabout or of the main approach roads from the north, west and south. The inclusion of flood defences on the right bank of the Cocker Beck and around the cricket pitch

in the updated modelling shows that these defence features would contain flooding in the cricket pitch area north-east of the roundabout. There are flow routes into residential areas to the south and east of the roundabout with some flooding on Southwell Road (east of the roundabout) but no inundation of the A6097 south of the roundabout.

The updated Environment Agency modelling therefore shows the Lowdham scheme to be at a significantly lower baseline level of flood risk than indicated by the Flood Zone maps, when the presence of existing defences are considered.

For completeness, the flood risk to the Lowdham scheme has also been considered for a future baseline case when the Environment Agency Flood Alleviation Scheme has been completed and is operational (the capital project is expected to be completed by Spring 2024). The proposed Flood Alleviation Scheme consists of a single flood storage reservoir on the Cocker Beck, near Lowdham Grange, approximately 2km upstream of the roundabout which is expected to further reduce fluvial flood risk from Cocker Beck in Lowdham. Results of Environment Agency modelling of the scheme have been reviewed and show no change in flood risk at the roundabout location compared to the current baseline. Therefore, there is a low risk of fluvial flooding to the scheme in the current baseline and in the situation when the Environment Agency Flood Alleviation Scheme has been completed.

The delivery programmes for the Environment Agency Flood Alleviation Scheme and for the Via East Midlands Major Road Network Improvements Scheme are different. It is intended that the Environment Agency Flood Alleviation Scheme will be constructed and complete before the works at Lowdham Roundabout but there is no dependency between the two schemes, i.e. the proposed roundabout improvements could go ahead before or after the Environment Agency Flood Alleviation Scheme is completed and there would be no change in this assessment of flood risk.

To conclude, fluvial flood risk to the area of interest, based on hydraulic modelling, is considered low. The Lowdham roundabout and major approach roads (from the north, west and south) are not predicted to be impacted by flooding in a 1% AEP design event, with a +39% allowance for climate change. The proposed Environment Agency Flood Alleviation Scheme in the catchment will not change this assessment of low fluvial flood risk.

Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

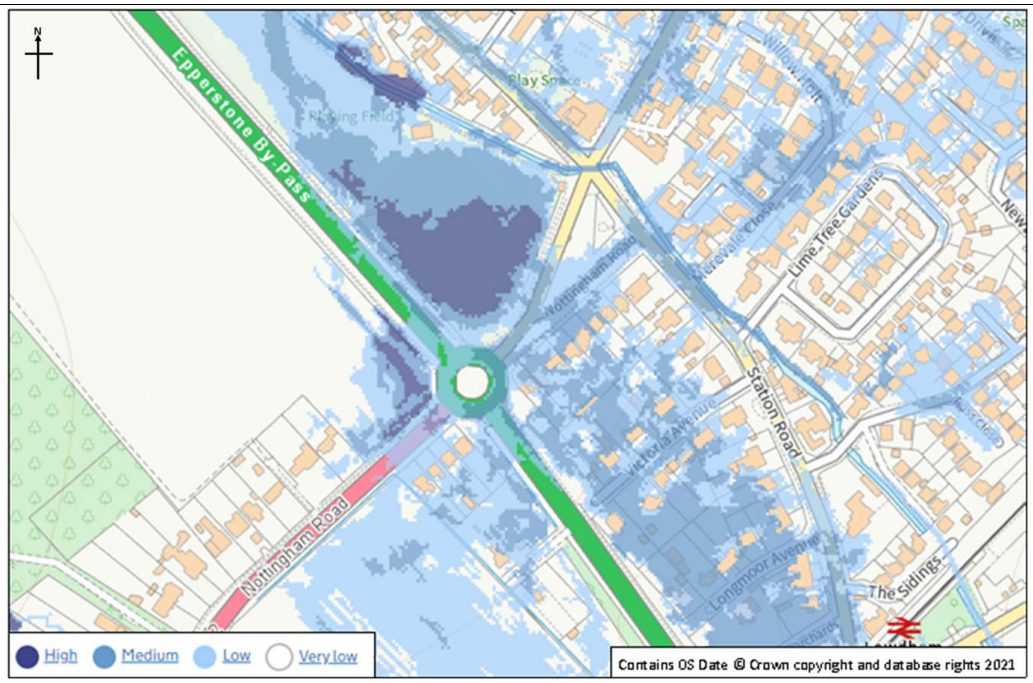


Figure 7-5: Lowdham Roundabout Junction Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map indicates that the risk of surface water flooding at Lowdham Roundabout is generally classed as 'Medium' to 'Low', as shown in Figure 7-5. The EA define a 'Low' risk' as each year the area has a chance of flooding from surface water of between 0.1% and 1%. A 'Very low' risk' means that each year the area has a chance of flooding of less than 0.1%.

	The area of the junction is characterised by a relatively flat area of land at approximately 20m AOD. Land to the east and south is fairly flat, with the ground sloping upwards to the west (up to 60m AOD within 1km) and to the north (50m AOD at Barker Hill situated north of Lowdham). Dover Beck is located approximately 1km to the north-east of the Scheme, flowing south-east to the River Trent, and several land drains are located on agricultural land lying between Cocker Beck and Dover Beck. Surface water runoff generated on the A6097 is drained via gullies and kerb outlets into ditches on either side of the road. During a site visit, it was observed that many of the existing ditches were overgrown, silted up and covered with litter. There is a pipe flowing into the Cocker Beck which is connected to a gully on the cricket pitch to allow standing water from the floodplain back into the channel. Gullies and kerb outlets also directed water into ditches on Nottingham Road and Southwell Road but again these were poorly maintained. There are several ponds located within the study area. Based on the above information, the risk of surface water flooding to the Scheme is considered to be 'Medium'.
Groundwater	The British Geological Survey (BGS) Map identifies the underlying bedrock geology within most of the study area as the Sidmouth Mudstone Formation, Radcliffe Member. The Sidmouth Mudstone Formation, Gunthorpe Member underlies the western edge of the Scheme and the study area lying to the west of the Scheme. The BGS geological mapping identifies Alluvium across the whole Scheme area. This is described as clay, silt, sand and gravel. Head deposits are located in the western and eastern parts of the study area. These deposits are described as clay, silt, sand and gravel. Deposits of Holme Pierrepont Sand and Gravel Member are locally present in the south-eastern part of the study area. These deposits comprise sand and gravel. The Alluvium is classified as a Secondary A Aquifer and the Head deposits are classified as a Secondary Aquifer (undifferentiated). The Radcliffe Member and Gunthorpe Member are classified as Secondary B Aquifers. The soils within the study area are described as loamy and clayey floodplain soils with naturally high groundwater. The EA's 'Areas Susceptible to Groundwater Flooding' (AStGWF) maps show that the Scheme is located in a 1km grid square with a >= 50% <75% susceptibility to groundwater flooding. The risk of flooding from ground water at Lowdham is Medium.
Sewers	As the risk of flooding from surface water is considered to be medium to low and sewers in the area are generally only draining the immediate highways / land. It is considered that the risk of flooding from sewers is likely to be Low.

Artificial sources

The EA's Risk of Flooding from Reservoir map indicates that the Scheme is not within an area at risk of flooding from reservoirs and there are no other artificial sources of flooding in the vicinity.

There is a series of fishing lakes approximately 1.5km to the east of Lowdham, near the River Trent, away from the scheme location. The scheme location is upstream of these waterbodies and they would not pose a flood risk to the Scheme.

The risk of flooding from artificial sources to the scheme at Lowdham is Low.

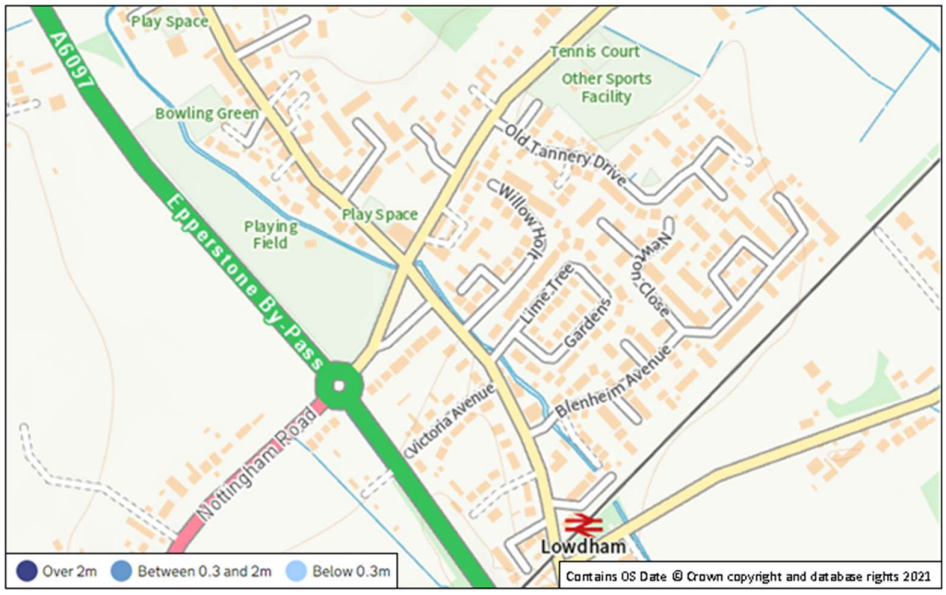


Figure 7-6: Lowdham Roundabout Junction Reservoir Flood Risk: Flood Water Depth

Other

Photos in Figure 7-7 and Figure 7-8 show significant flooding in Lowdham in 2007 and 2012. The 2007 floods in Lowdham were relatively localised and of short duration, however the flooding affected around 300 homes and some residents had to be evacuated to emergency shelters.

More recently in 2013 up to 70 houses were flooded, triggering the need for a Section 19 Report (see Section 2.3 of this document) into the causes and management of this flood event. According to the Section 19 Report into the events that led up to the 2013 flooding event, the floods were likely exacerbated by poor maintenance, of channels and drainage systems, (as observed on the site visit in November 2021), which are designed to convey large volumes of water from extreme rainfall events.

The village of Lowdham is currently the focus of an Environment Agency Flood Alleviation Scheme which will address the flood risk issues previously seen and noted here. There is no inter-dependency between the Environment Agency Flood Alleviation Scheme and this Major Road Network Improvements scheme.

Figure 7-7: The Cricket Pitch and the Cocker Beck during the 2007 flood event in Lowdham

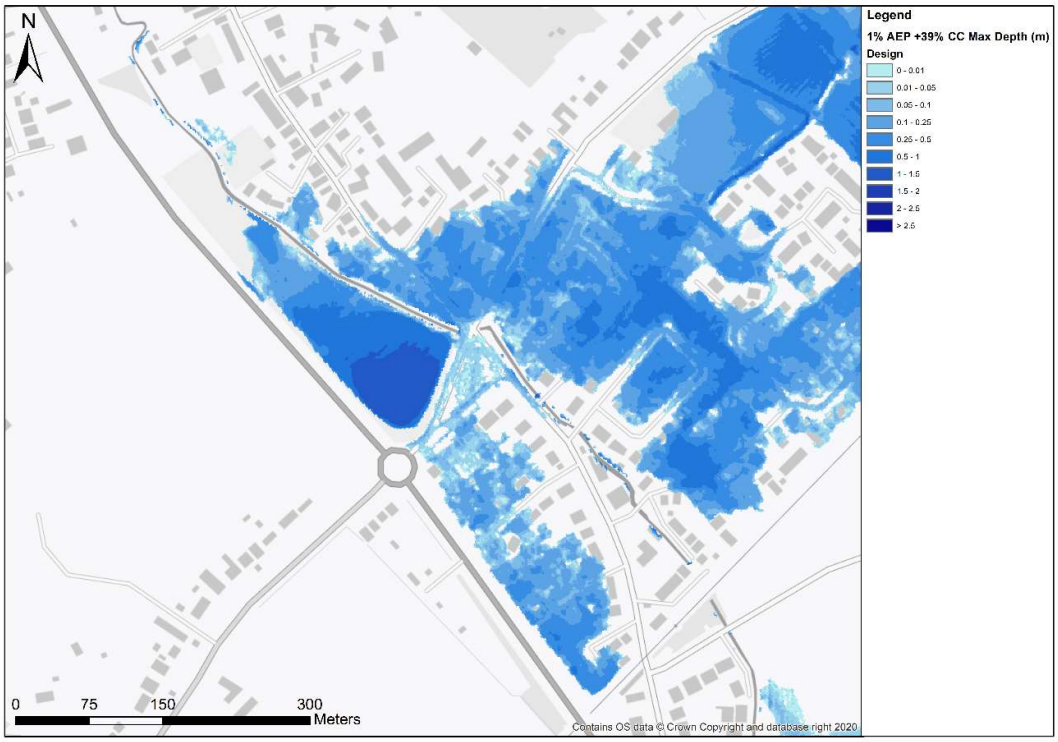
Photo taken from Station Road looking North West towards Cricket pitch and junction of Main Street and Southwell Road.

Figure 7-8: Southwell Road during the 2012 Flood Event in Lowdham

Photo taken from entrance of Cricket pitch looking out towards Southwell Road.

7.3 Scheme Flood Risk

Table 7-2: Scheme Flood Risk Assessment Summary- Lowdham

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	As the proposed roundabout improvement works are outside the area at risk of flooding from Cocker Beck in Lowdham the proposed scheme is not expected to affect fluvial flood risk. To validate this assumption, the proposed scheme design has been tested in the Environment Agency flood model. A ground model of the proposed roundabout improvement scheme has been developed by Via East Midlands Ltd and was added to the Environment Agency hydraulic model to represent geometry changes associated with the works. The impact was tested in a 1% AEP design event with a +39% climate change allowance and the results showed no difference from the baseline flood modelling, refer to Figure 7-9.  **Figure 7-9: 1% AEP +39% Climate Change Proposed Scheme Max Flood Depth** Figure 7-9 shows that there is no change in flood model results compared to the baseline as a result of the minor ground level changes which are part of the proposed highway improvements scheme. Therefore, it is concluded that the proposed scheme will not have an impact on flood risk.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

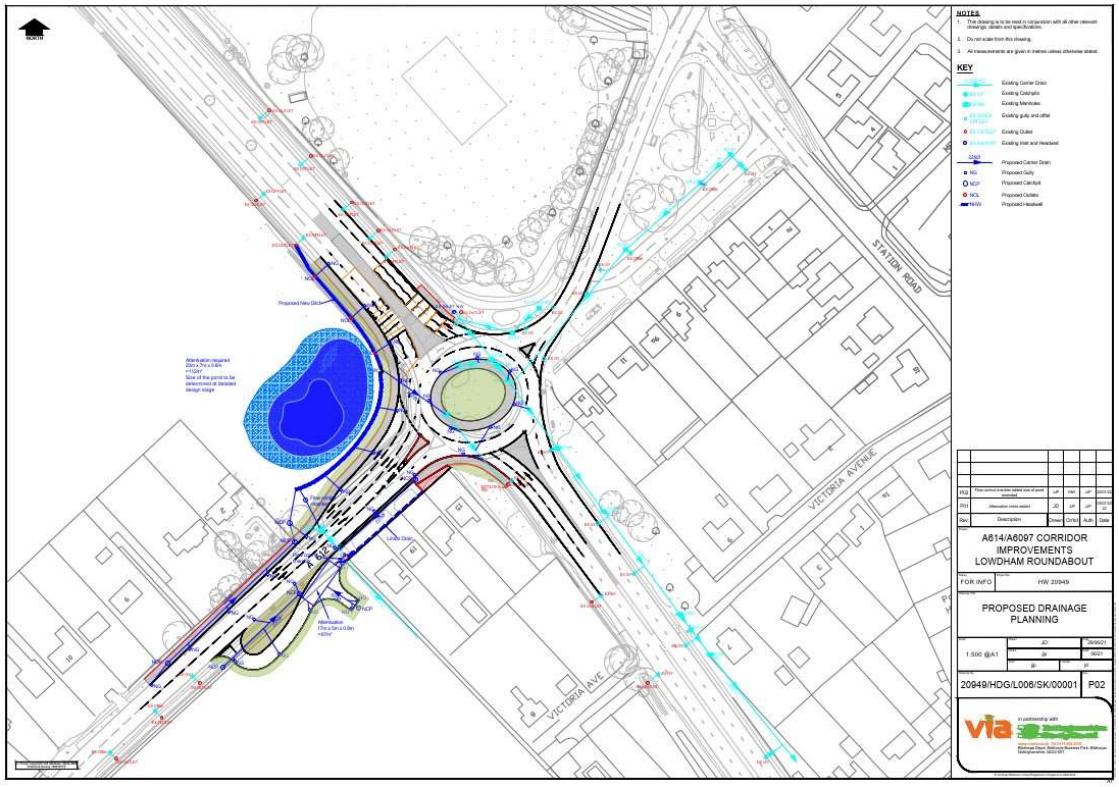


Figure 7-10: Lowdham Roundabout Proposed Drainage

Surface water drainage systems at Lowdham will be installed or diverted to accommodate the existing and new impermeable surface. Where possible the flows will be collected in gullies and discharged into existing drainage outfalls.

The proposed junction is split into three catchments. Following the works two out of three catchments will see no change to the impermeable area. Within catchment three, refer to Figure 7-10, the impermeable contributing area will increase from 1533m^2 to 2974m^2, an increase of 1441m^2. All runoff from this catchment will be captured and attenuated with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year +40% CC event. This will result in a significant **betterment** to the existing surface water discharge. The storage will be maintained as part of the highway network, as the responsibility of Nottinghamshire County Council.

The eastern side of the roundabout utilises the existing drainage network to transfer the surface water away from the junction. No mitigation or control measures are proposed to be added to the existing drainage network.

Based on the above information and the proposed mitigation, the risk of surface water flooding to the site is considered to remain Low.

Groundwater

The scheme is located in an area susceptible to ground water flooding. The 3D surface model indicates portions of the junction is proposed to be lowered. The area of maximum lowering is located along the A6097 Epperstone Bypass connecting to the roundabout from the north-west and is proposed to be lowered by approximately 300mm. The soils within the study area are characteristic with high water tables. The lowering of the junction is minor and is not expected to result in any worsening of flood risk from groundwater in these areas.

A new section of drainage ditch is proposed as part of the surface water drainage works, however this is anticipated to be at a similar level to the existing drainage ditch and will not worsen the ground water flood risk.

The risk of flooding from groundwater following the scheme is Medium.

Sewers

The risk of flooding from sewers is considered to be the same as risk of flooding from surface water. With the proposed mitigation, the risk of sewer flooding to the site is considered to remain Low.

Artificial sources	The EA Risk of Flooding from Reservoir map indicated that the scheme is not within an area at risk of flooding from reservoirs. The fishing ponds located to the East of the junction are downstream of the junction. The proposal does not change levels sufficiently enough to change the risk of flooding from the fishing pond. The proposed scheme does not change the risk of flooding from artificial sources.
Other	No risk from other sources identified or introduced as a result of the proposed scheme.

7.4 Summary assessment

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Low	Low	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Medium	Low	Yes- Refer to Section 7.5.
Groundwater Flooding	Medium	Medium	No
Sewer Flooding	Low	Low	No
Artificial Sources Flooding	Low	Low	No

7.5 Surface Water Drainage Strategy

7.5.1 Existing Surface Water Drainage

The existing surface water drainage system is split into three catchments. Catchment 1 consisting of the A6097 southbound approach and exit arm, Southwell Road and Nottingham Road to the north-east of the roundabout collects surface water in gullies and kerb inlets. The A6097 southbound approach arm collects the surface water in kerb inlets which discharge directly into an existing ditch. The rest of catchment 1 collects the surface water from gullies and kerb inlets into carrier drains and is assumed to discharge into the Cocker Beck 100m south of the junction of Station Road and A6097 southbound exit arm. Catchment 2, consisting of the A6097 northbound approach and exit arm collects surface water in gullies and kerb inlets which discharge directly into an existing ditch except around the roundabout where the gullies discharge first into a carrier pipe and then into the existing ditch. Catchment 3 consists of Nottingham Road to the south-west of the roundabout. South-west of 21 Nottingham Road, water is collected into gullies, which discharge directly into an existing ditch and north-east of 21 Nottingham Road the gullies are connected into carrier pipes which in turn discharge into Cocker Beck.

7.5.2 Proposed Surface Water Discharge

As per National Planning Policy Framework and The SuDS Manual CIRIA C753, the established discharge hierarchy for surface water is as follows:

- Infiltration to the ground;
- Discharge to surface waters;
- Discharge to a surface water, highway drain or another drainage system;
- Discharge to a combined sewer.

Infiltration has been deemed unviable due to the geology although this will be confirmed at detailed design stage through infiltration testing.

The surface water collected from all roads will be collected by either gullies or kerb drains connected with carrier pipes and will discharge into the existing system which will in turn discharge into existing drains and ditches. Attenuation systems will be used to ensure that the proposed drainage does not increase the risk of flooding downstream.

7.5.3 Proposed Site Discharge Rates

The design requirements for the proposed redevelopment under various storm events according to the DEFRA 'Non-statutory technical standards for sustainable drainage systems' are as follows:

- 1 in 1 year – No surcharge of the drainage system (with exception of storage features)
- 1 in 30 years – No flooding from the drainage system
- 1 in 100 years – No flood risk to buildings or people and all flows contained on site

In accordance with the DEFRA Non-statutory technical standards for sustainable drainage systems, for sites which were previously developed such as this, the peak runoff rate from the development should be as close as reasonably practical to the greenfield runoff rate for the same return period. In order to avoid complex flow controls and long-term storage, it is proposed to discharge runoff at a single maximum allowable discharge rate based on QBAR for all events up to and including the 1 in 100 year return period with an allowance for climate change. Due to existing impermeable area currently freely discharging the proposed approach with restricted discharge will provide a significant improvement to downstream flood risk.

In accordance with SC030219 produced by the Environment Agency and DEFRA, "A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low rate while keeping the risk of blockage to an acceptable level. It is suggested that this is 5 litres per second. Therefore, where QBAR results in a proposed discharge rate of less than 5l/s, to prevent risks of excessive blockages and maintenance issues a practical minimum of 5l/s shall be taken.

7.5.4 Proposed Surface Water Catchments

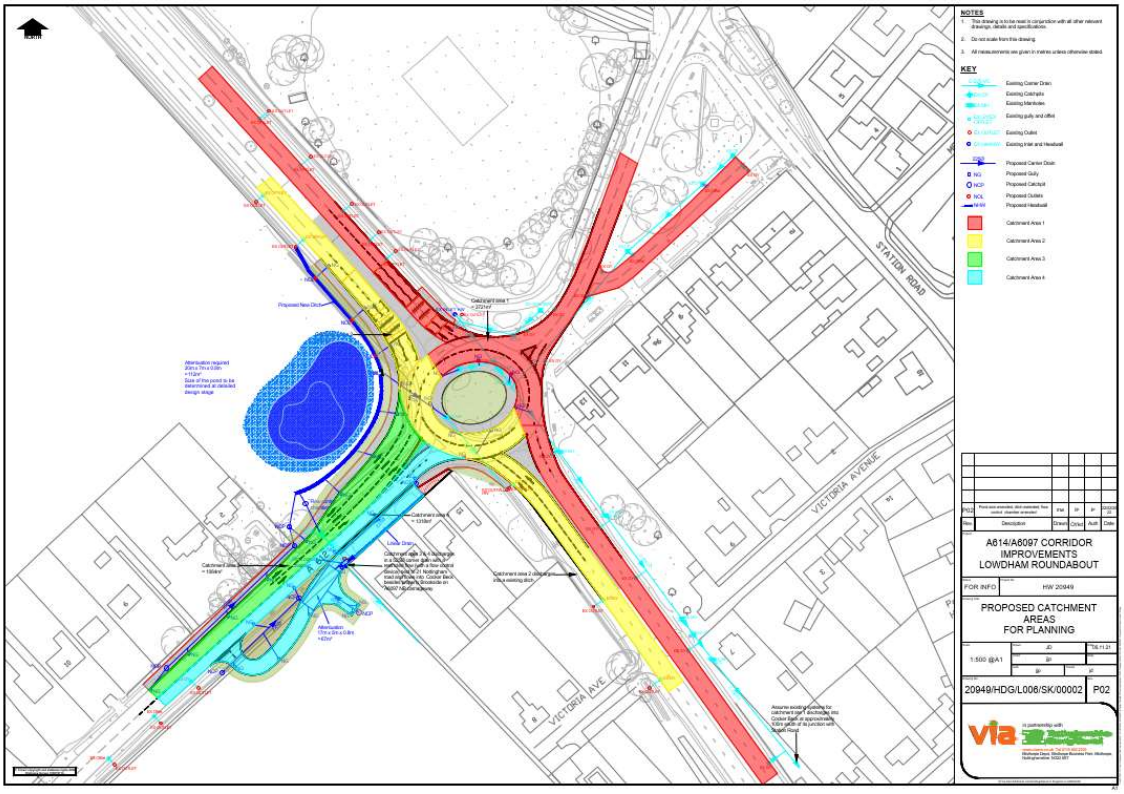


Figure 7-11: Lowdham Roundabout Proposed Drainage Catchments

The site plan, refer to Figure 7-11, shows that the area is to be split up into three catchments. Within catchment 3 there are two separate surface water networks with separate flow controls and storage, so for clarity the separate networks will be referred to as Catchment 3a and Catchment 3b.

The proposed surface water arrangements are as follows:

Catchment 1: On the A6097 Southbound approach and exit arm, Southwell Road and Nottingham Road to the north east of the roundabout the surface water drainage arrangement will remain the same as the existing arrangement with 4 additional gullies around the roundabout being connected into the carrier drain.

Catchment 2: On the A6097 northbound approach and exit arm the surface water will be collected by a combination of kerb inlets and gullies. Along the A6097 northbound approach arm the gullies discharge directly into an existing ditch, on the northbound exit arm the gullies and inlets discharge into a proposed ditch. On the roundabout the gullies are connected into carrier pipes which in turn discharge into the existing ditch adjacent to the A6097 northbound approach arm.

Catchment 3a: The A612 approach arm to the south-west of the roundabout will have the surface water collected by gullies, south-west of 21 Nottingham Road these gullies will be connected with carrier pipes which will discharge into a pond between the A612 and A6097 northbound exit arm. North-east of 21 Nottingham Road the gullies will discharge directly into the pond. The pond will then attenuate the surface water, releasing surface water via a flow control chamber into an outfall pipe which will discharge into the Cocker Beck.

Catchment 3b: The A612 exit arm to the south-west of the roundabout and the new side access road will have surface water collected by gullies. The entire A612 exit arm and the new side access road south-west of 21 Nottingham Road will have gullies connected via carrier pipes discharging into an attenuation tank underneath the new side access road. The new side access road north-east of 21 Nottingham Road will have a linear drain which will prevent any surface water entering the properties on the south-west of the junction which will discharge into the Cocker Beck.

One of the three drainage catchments has an increase in impermeable area, compared to the existing situation. Therefore, attenuation is proposed for this catchment and has been calculated for the 1 in 100 year return period with a 40% climate change allowance. The results can be found in Table 7-3.

Table 7-3: Discharge rates and Attenuation volumes

Catchment	Proposed Allowable Discharge Rate (l/s)	Attenuation volume (1 in 100 year + 40%) (m^3)
1	5	-
2	5	-
3	5	179

The attenuation volume provided for catchment 3 will be split, with catchment 3a having a pond with an attenuation volume of 112m^3 and catchment 3b having a storage tank with an attenuation volume of 67m^3. Estimates for the attenuation requirements for all catchments have been calculated using MicroDrainage Quick Storage estimates. The storage will be maintained by Nottinghamshire County Council as part of the highway maintenance regime.

8. Kirk Hill Junction

Table 8-1: Overview of Proposed Improvements - Kirk Hill Junction

Figure 8-1: Kirk Hill Junction Location

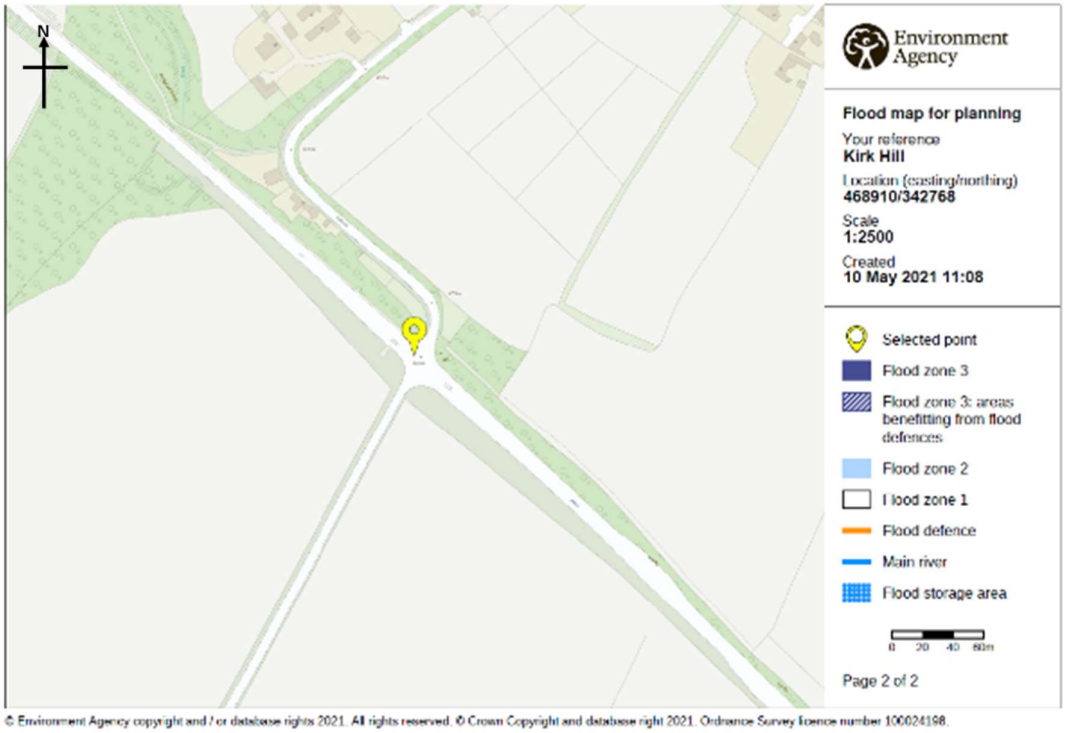
This is a four-arm traffic signalled junction: the A6097 Bridgford Street runs north-west to south-east; Kirk Hill joins the A6097 from the north, providing access to East Bridgford village, and East Bridgford Road and Newton village from the south. Both A6097 approaches are characterised by two lanes, one of which is dedicated right turn lane, with the other used for ahead and left movements. Both Kirk Hill and East Bridgford Road are single lane approaches.

Proposed improvements at this junction consists of:

- localised widening of the A6097 junction approaches to provide separate right turn lanes into Kirk Hill and East Bridgford Road;
- widening works on the northbound A6097 carriageway to provide two straight ahead lanes in both directions;
- traffic signal improvements to the existing junction;
- a retaining structure on the northbound carriageway; and
- localised widening on the Kirk Hill to facilitate easier negotiation of left turns into the side road.

This will require an area of permanent land use to the north-east of the Scheme.

Table 8-2: Baseline Flood Risk Assessment Summary - Kirk Hill Junction

Source of flood risk	Baseline / existing flood risk
Fluvial	 **Figure 8-2: Kirk Hill Junction Fluvial Flood Risk** The Scheme is shown as being located entirely within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 8-2 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. The River Trent, an EA Main River, lies 890m north of the Scheme. The EA flood map does not show the Scheme to be located in an area that benefits from flood defences. Based on the information provided above, the risk to the Scheme from fluvial flooding is considered to be Low.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

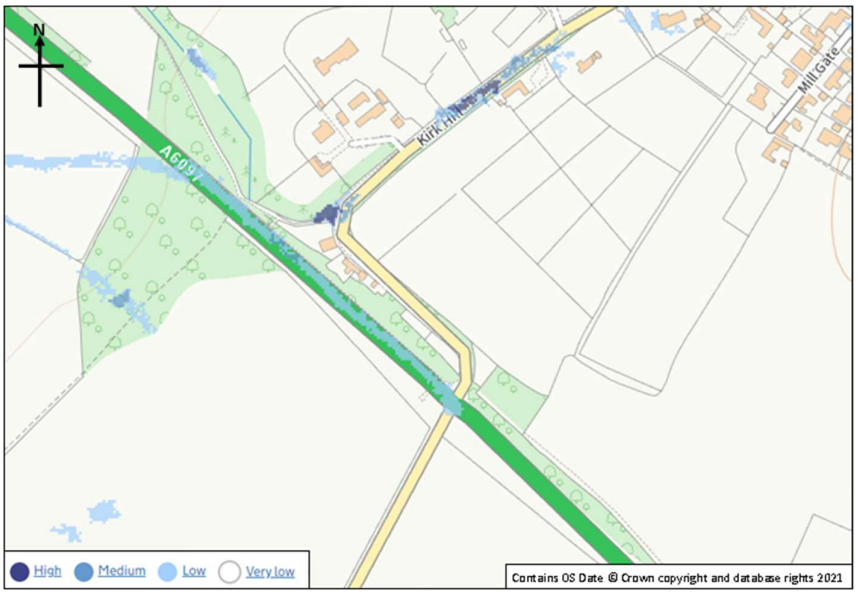


Figure 8-3: Kirk Hill Junction Extent of Flooding from Surface Water

The EA Risk of Flooding from Surface Water map shows that the Scheme is generally classed as 'Very Low' to 'Low' risk of surface water flooding, as shown in Figure 8-3 above. The EA define 'Low' risk' as an area having a chance of flooding from surface water of between 0.1% and 1% each year. A 'Very low' risk' means that each year the area has a chance of flooding of less than 1 in 1000 (0.1%).

A land drain is located adjacent to the Scheme, to the north-west. The drain flows approximately south-east to north-west between Bridgford Road and a water reclamation works to the north-west. The drain is indicated to be a tributary of the River Trent, which is located north of the Scheme. A small pond is located within the south-eastern section of the drain and a larger pond is located at the north-western end of the drain, at the water reclamation works.

Several land drains and small pond features are located within the agricultural land to the south and west of the Scheme. Based on the above information, the risk of surface water flooding to the Scheme is considered to be Low.

Groundwater

The British Geological Survey (BGS) Map identifies the underlying bedrock geology in the area around the Scheme as mostly comprising Sidmouth Mudstone Formation, Edwalton Member. There are no superficial deposits mapped in the area of the Scheme, however, the mapping identifies glacial till at the south-eastern edge of the study area.

The glacial till, which underlies the south-eastern part of the study area, is classed as a Secondary Aquifer (undifferentiated).The Edwalton Member (mudstone) and Gunthorpe Member are Secondary B Aquifers, while the Edwalton Member (siltstone) and the Cotgrave Sandstone Member are Secondary A Aquifers. The site also lies within an area of high groundwater vulnerability.

The soils within the study area are described as slightly acid loamy and clayey soils with impeded drainage.

There were no BGS borehole logs available within the vicinity of the Scheme.

Groundwater vulnerability is classed as high in relation to the bedrock geology. High vulnerability is defined as 'areas able to easily transmit pollution to groundwater'. They are characterised by high-leaching soils and the absence of low-permeability superficial deposits.

The EA's 'Areas Susceptible to Groundwater Flooding' (AStGWF) maps show that the Scheme is located in a 1 km grid square with a < 25% susceptibility to groundwater flooding.

Based on the information above, the risk of groundwater flooding to the Scheme is considered to be Low.

Sewers

As the risk of flooding from surface water is considered to be low, it can also be inferred that that risk of flooding from surface water sewers is likely to be Low.

Artificial sources

The EA's Risk of Flooding from Reservoir map indicates that the Scheme is not within an area at risk of flooding from reservoirs, and there are no other artificial sources of flooding in the vicinity.

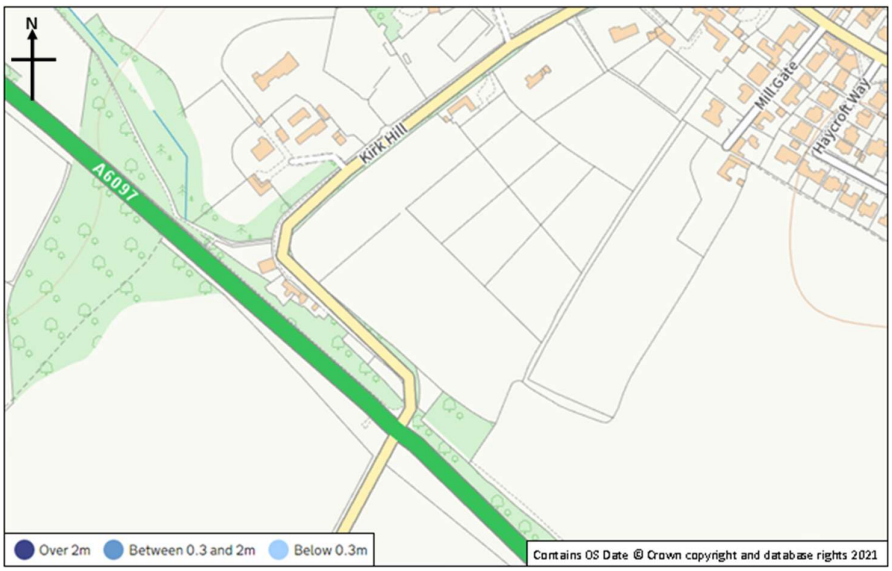


Figure 8-4: Kirk Hill Junction Reservoir Flood Risk: Flood Water Depth

Other	The Scheme includes proposed grass verges and retaining walls at the junction.

Table 8-3: Scheme Flood Risk Assessment Summary - Kirk Hill Junction

Source of flood risk	Flood risk to the scheme / impacts of the scheme on flood risk
Fluvial	The Scheme is shown as being located entirely within Flood Zone 1 on the EA Flood Map for Planning, as shown in Figure 8-2 above. Land and property in Flood Zone 1 are considered to have a low probability of flooding from rivers or the sea. The EA define Flood Zone 1 as land assessed as having less than 1 in 1000 (< 0.1%) annual probability of fluvial flooding in any given year. The proposed development at the junction does not change the Flood Zone level from the baseline. Based on the above details the fluvial flood risk from the scheme is considered 'Low'.
Tidal / Coastal	There is no risk of tidal or coastal flooding at this location.

Surface water

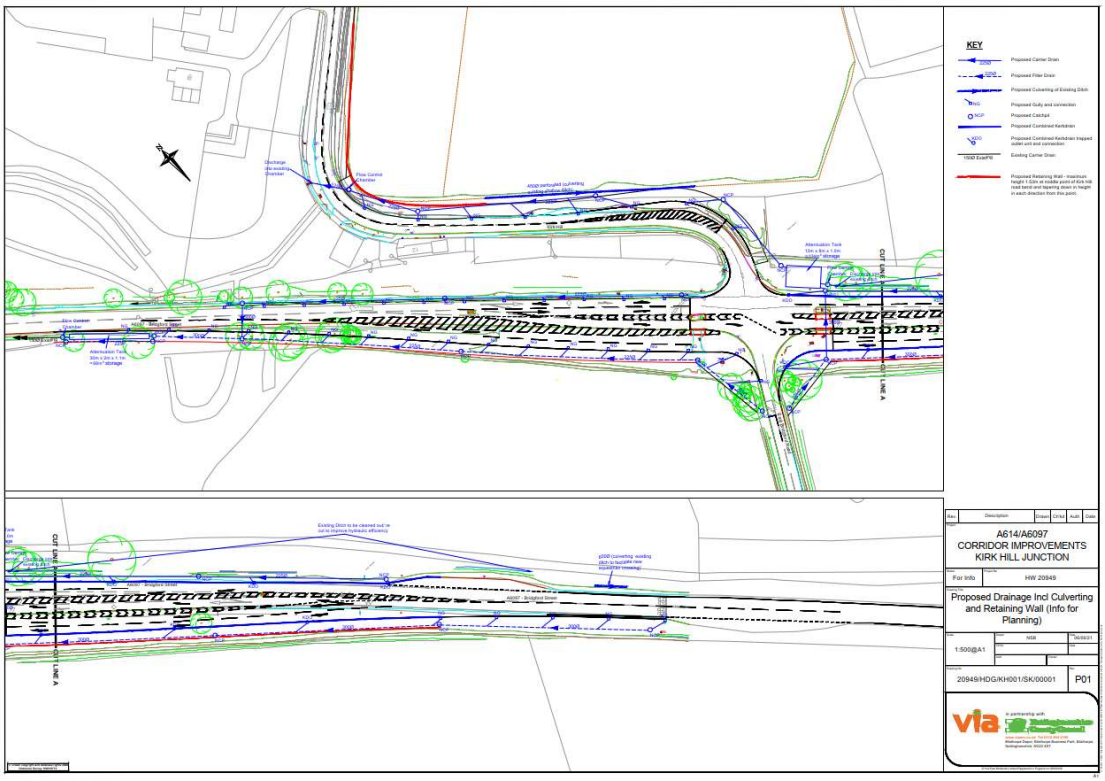


Figure 8-5: Kirk Hill Junction Proposed Drainage

The Kirk Hill junction is split into three drainage catchments, as shown in Figure 8-6. Following the proposed works all three catchments will see an increase in impermeable area:

- Within catchment 1a, the impermeable area will increase from 1391m^2 to 2260m^2, an increase of 869m^2. All runoff from this catchment (2260m^2) will be captured and attenuated (see Table 8-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year + 40% CC event. This will result in a significant betterment to the existing surface water discharge.
- Within catchment 1b, the impermeable area will increase from 1935m^2 to 2298m^2, an increase of 363m^2. All runoff from this catchment (363m^2) will be captured and attenuated (see Table 8-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year + 40% CC event. This will result in a significant betterment to the existing surface water discharge.
- Within catchment 2, the impermeable area will increase from 3269m^2 to 4212m^2, an increase of 943m^2. All runoff from this catchment (943m^2) will be captured and attenuated (see Table 8-4 for capacity) with the outlet of the attenuation limited to a flow of 5l/s, for all events up to the 1 in 100 year + 40% CC event. This will result in a significant betterment to the existing surface water discharge.
- The storage will be maintained as part of the highway network, as the responsibility of Nottinghamshire County Council.

An existing field ditch on the north edge of Kirk Hill is to be culverted where the highway realigned further north. The current proposal is for a 450mm diameter perforated pipe to culvert the shallow ditch section. However, the sizing and further design of the culvert shall be undertaken at the detailed design stage.

The current proposal is for a 600mm diameter pipe to be used to culvert a short section of existing ditch on the north side of the A6097 to facilitate new equestrian crossing. However, the sizing and further design of the culvert shall be undertaken at the detailed design stage. To mitigate the risk of flooding due to the installation of the culvert, the adjacent existing ditch is to be cleaned out and re-cut.

The Surface water flood map (Figure 8-3) indicates an existing flood flow route from the junction along the A6097 towards the north. The increase in impermeable area at the junction, if not collected within the proposed drainage would worsen the flooding along this section.

	The risk of surface water flooding of the proposed scheme and drainage is considered Low, however routine inspection and/or maintenance of new culverts is recommended.
Groundwater	The proposed scheme is not anticipated to include deep excavations or significant changes to the existing ground levels. The increased size of the junction will result in it being closer to the boundary of the high groundwater vulnerability. The flood risk of groundwater as a result of the scheme is not expected to increase from the existing risk. The risk of groundwater flooding is considered Low.
Sewers	No changes to the sewers are proposed as part of the works. The proposed scheme is not anticipated to impact the existing sewer network or change the level of flood risk. The risk of flooding as a result of the scheme is considered Low.
Artificial sources	The EA Risk of Flooding from Reservoir map indicated that the scheme is not within an area at risk of flooding from reservoirs. The proposed developments do not introduce any artificial sources of flooding.
Other	No risk from other sources identified or introduced as a result of the proposed scheme.

8.1 Summary assessment – Kirk Hill Junction

Flood Source	Flood Risk	Post Scheme Flood Risk	Mitigation currently required?
Fluvial Flooding	Low	Low	No
Tidal / Coastal Flooding	Low	Low	No
Surface Water Flooding	Low	Low	No
Groundwater Flooding	Low	Low	No
Sewer Flooding	Low	Low	No
Artificial Sources Flooding	Low	Low	No

Other Flooding

8.2 Surface Water Drainage Strategy

8.2.1 Existing Surface Water Drainage

The existing surface water drainage system is split into 3 catchments. The first catchment includes the A6097 southeast of Kirk Hill junction, the southeast side of East Bridgford Road and the eastern portion of the Kirk Hill Road up to the end of the bend. The second catchment includes the A6097 northwest of Kirk Hill junction, the northwest side of East Bridgford Road and the western portion of Kirk Hill Road up to the end of the bend. The third catchment covers the rest of Kirk Hill Road.

8.2.2 Proposed Surface Water Discharge

As per CIRIA report C753, the established discharge hierarchy for surface water is as follows:

- Infiltration to the ground;
- Discharge to surface waters;
- Discharge to a surface water, highway drain or another drainage system;
- Discharge to a combined sewer.

Infiltration has been deemed to be unviable due to the geology although this will be confirmed at detailed design stage through infiltration testing.

The surface water from the A6097 southeast of Kirk Hill junction, the southeast half of East Bridgford road, the eastern half of Kirk Hill Road up to the end of the bend and both sides of Kirk Hill Road north of the bend and will be collected and discharged into a combination of carrier pipes and filter drains which will discharge into 2 attenuation tanks which in turn will outfall into an existing ditch. The rest of the surface water will be collected and attenuated in a storage tank before being discharged into the existing Severn Trent Water mains network.

8.2.3 Proposed Surface Water Discharge Rates

- The design requirements for the proposed redevelopment under various storm events according to the DEFRA Non-statutory technical standards for sustainable drainage systems are as follows:1 in 1 year – No surcharge of the drainage system (with exception of storage features)
- 1 in 30 years – No flooding from the drainage system
- 1 in 100 years – No flood risk to buildings or people and all flows contained on site.

In accordance with the DEFRA Non-statutory technical standards for sustainable drainage systems, for sites which were previously developed such as this, the peak runoff rate from the development should be as close as reasonably practical to the greenfield runoff rate for the same return period. In order to avoid complex flow controls and long-term storage, it is proposed to discharge runoff at a single maximum allowable discharge rate based on Q_{BAR} for all events up to and including the 1 in 100 year return period with an allowance for climate change. Due to existing impermeable area currently freely discharging the proposed approach with restricted discharge will provide an improvement to downstream flood risk.

In accordance with SC030219 produced by the Environment Agency and DEFRA, “A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low rate while keeping the risk of blockage to an acceptable level. It is suggested that this is 5 litres per second. Therefore, where Q_{BAR} results in a proposed discharge rate of less than 5l/s, to prevent risks of excessive blockages and maintenance issues a practical minimum of 5l/s shall be taken.

8.2.4 Proposed Surface Water Catchments

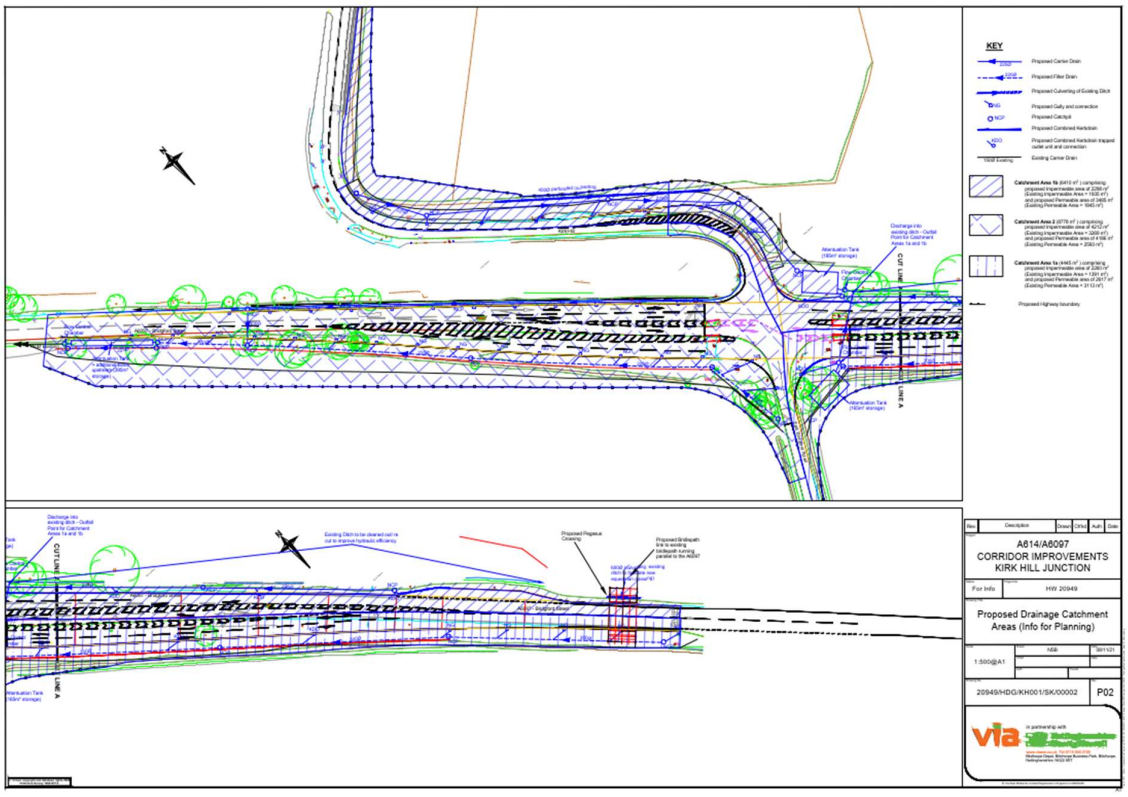


Figure 8-6: Kirk Hill Junction Proposed Layout

The site masterplan refer to Figure 8-6, shows that the area is to be split up into 3 catchments. The proposed surface water arrangements are as follows:

Catchment 1a: On the western half of the A6097 southeast of the junction and the southwest side of East Bridgford Road the surface water will be collected using gullies and kerb drains, connected with filter drains which will discharge into an attenuation tank located between the A6097 and East Bridgford Road. The attenuation tank will

then attenuate the surface water, releasing surface water via a flow control chamber into an existing ditch which runs along the eastern side of the A6097 southeast of the junction.

Catchment 1b: On the eastern half of the A6097 southeast of the junction, the eastern portion of Kirk Hill Road up to the end of the bend and the whole of Kirk Hill Road north of the bend will have the surface water collected by a combination of kerb drains and gullies connected with carrier pipes which will discharge into an attenuation tank located between the A6097 and Kirk Hill Road. The attenuation tank will then attenuate the surface water, releasing the surface water via a flow control chamber and outfall at the same point as Catchment 1a. It is also proposed to culvert an existing ditch which flows along the eastern side of Kirk Hill Road within this catchment.

Catchment 2:The surface water from the A6097 northwest of the junction, the northwest side of East Bridgford Road and the western portion of Kirk Hill Road up to the end of the bend will have the surface water collected using gullies. On the eastern portion of the A6097 and East Bridgford Road these will be connected with carrier pipes, on the western side of the A6097 and East Bridgford Road these will be connected with a filter drain. The carrier pipes and filter drains will discharge into an attenuation tank on the western side of the A6097. The attenuation tank will attenuate the surface water, releasing surface water via a flow control chamber into the existing Severn Trent Water mains network.

Of the 3 catchments discussed above, all catchments have an increase in impermeable area. Therefore, attenuation is proposed for all catchments and has been calculated for the 1 in 100 year return period with a 40% climate change allowance. The results can be found in table 7-4.

Table 8-4: Contributing areas, Discharge rates and Attenuation volumes

Catchment	Contributing area (ha)	Proposed Allowable Discharge Rate (l/s)	Attenuation volume (1 in 100 year + 40%) (m^3)
1a	0.4445	5	165
1b	0.6410	5	185
2	0.8778	5	395

Estimates for the attenuation requirements for all catchments have been calculated using MicroDrainage Quick Storage estimates. The storage will be maintained

9. Conclusions

This FRA has been prepared by AECOM to inform of the impact of the proposal to upgrade the existing junctions along the A614/A6097 Major Road Network. The junctions considered in this report are:

- Ollerton Roundabout
- Mickledale Lane Junction
- White Post Roundabout
- Warren Hill Junction
- Kirk Hill Junction
- Lowdham Roundabout

The proposed developments are located mostly in Flood Zone 1, meaning that fluvial flood risk is generally very low. However, Ollerton Roundabout lies in an area designated as Flood Zone 2 and 3, which are areas at medium and high fluvial risk, respectively. Ollerton roundabout is at the edge of the flood zones (flood extent) and the modelled flood levels available from the Environment Agency suggest some, but not complete, inundation of the roundabout in a design flood event, with shallow depths. Other parts of the roundabout are located within Flood Zone 1 and at least two dry routes are maintained according to the EA flood maps. The proposed highway improvement works do not include any significant changes to elevations and therefore will not affect fluvial flood risk to the road junction or to third parties. There is no scope within the works proposed to significantly reduce the level of risk here, given the location of the junction at the edge of the flood zone. Given there are no significant impacts predicted, there is no need for mitigation in relation to fluvial flood risk. There would remain a residual risk of fluvial flooding at Ollerton Roundabout for high probability flood events, but this risk will not have been increased from the baseline situation, and flooding would not be significant as the scheme is located on the edge of the flood extents.

The proposed development at Lowdham Roundabout also lies in areas designated as Flood Zone 2 and 3, based on the Environment Agency Flood Map for Planning. The Flood Zone mapping does not take account of the presence of existing flood defences which offer some protection for fluvial flooding from Cocker Beck. Updated and more detailed flood risk modelling from the Environment Agency, accounting for the presence of existing flood defences, shows that the proposed roundabout improvements are not at risk of fluvial flooding. This is the case in the present baseline conditions and considering the situation when the proposed Environment Agency Flood Alleviation Scheme is completed (Spring 2024). There is no dependency between the Environment Agency scheme and the Via East Midlands Ltd proposed roundabouts improvements, i.e. the proposed roundabout improvements could go ahead before or after the Environment Agency Flood Alleviation Scheme is completed and there would be no change in this assessment of flood risk. However, the proposed Environment Agency Flood Alleviation Scheme is planned for delivery in advance of the proposed highway improvements at Lowdham Roundabout.

For completeness, the flood model has been used to assess any potential impacts of the proposed roundabout improvement works in a 1% AEP design event, with an allowance for climate change. As the location of the improvement works is outside the area at risk of flooding the flood modelling confirmed there would be no impacts on flood risk from Cocker Beck through implementation of the proposed improvement works.

Pluvial flood risk is likely to increase due to proposals. A number of the junctions increase the amount of impermeable area within the study zone. To compensate this, an effective surface water drainage system is to be proposed at each junction where there is an increase.

Surface water drainage strategies have been developed for those sites where there is a proposed increase in impermeable surface: Ollerton, Mickledale, Kirk Hill and Lowdham. The aim of the surface water drainage strategy is to ensure that the scheme does not increase the risk of surface water flooding and attenuation is provided where required. Where attenuation is needed as a result of increasing impermeable area within a catchment, the storage requirements have been calculated based on attenuating the flow from the entire catchment, therefore bettering the existing surface water scenario.

For Lowdham the groundwater flood risk posed to the scheme before the proposed works is medium and remains so after the proposed works have taken. For all other forms of flood risk, the risk posed to each scheme before the proposed works is low and remains so after the proposed works have taken place. Therefore, there is no need to provide any form of mitigation in relation to these.