M60/M62/M66 Simister Island Interchange

TR010064

ENVIRONMENTAL STATEMENT APPENDICES

APPENDIX 13.6 FLOOD RISK ASSESSMENT REPORT

APFP Regulation 5(2)(e)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

M60/M62/M66 Simister Island Interchange

Development Consent Order 202[ ]

ENVIRONMENTAL STATEMENT APPENDICES
APPENDIX 13.6 FLOOD RISK ASSESSMENT REPORT

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1 Introduction

1.1 Overview

Background

1.1.1 This document presents the Flood Risk Assessment (FRA) for the M60/M62/M66 Simister Island Interchange (the 'Scheme') in accordance with the National Policy Statement for National Networks (NPS NN) (Department of Transport, 2014). Consideration has also been made of the implications of the draft replacement of the NPS NN published in March 2023 (Department for Transport, 2023).

1.1.2 This document forms an appendix to the Chapter 13: Road Drainage and the Water Environment of the Environmental Statement (TR010064/APP/6.1).

Aims and objectives

1.1.3 This FRA has been produced in accordance with the National Planning Practice Guidance (NPPG) (Department for Levelling Up, Housing and Communities (DLUHC) and Ministry of Housing, Communities and Local Government (MHCLG), 2022) to the National Planning Policy Framework (NPPF) (DLUHC, 2023) and seeks to demonstrate compliance with the requirements of the NPS NN, specifically that the Scheme will:

- Remain operational and safe for users in times of flood; and
- Not increase flood risk elsewhere.

1.1.4 The FRA seeks to demonstrate the Scheme's compliance with the NPS NN by including:

- An assessment of flood risk to the Scheme from all sources
- An assessment of change in flood risk from all sources as a result of the Scheme
- Appropriate consideration of the impacts of climate change on flood risk using the latest UK Climate Projections available
- An initial assessment of mitigation measures to prevent adverse impact on flood risk
- Details of completion of the Sequential and Exception Tests.

1.1.5 The FRA is supported by the following Environmental Statement Figures (TR010064/APP/6.2):

- Figure 13.6: Flood Zones
- Figure 13.7: Areas at Risk from Surface Water Flooding

- Figure 13.8: Areas Susceptible to Groundwater Flooding
- Figure 13.9: Areas at Risk of Flooding from Reservoirs

1.1.6 The FRA is also supported by Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR010064/APP/6.3).

1.2 The Scheme

Context

1.2.1 The Scheme comprises improvements to the M60 Junction (J) 18 interchange (also known as Simister Island) and also widening of the M60 to five lanes between J17 and J18 to improve the traffic flow on the M60. Figure 2.2: Scheme Design of the Environmental Statement Figures (TR010064/APP/6.2) shows the location of the different elements of the Scheme that are described below (see Chapter 2: The Scheme of the Environmental Statement (TR010064/APP/6.1) for further details):

- Widening of the existing M60 northbound to M60 westbound link road from one lane to two lanes
- Construction of a new loop road (the 'Northern Loop') providing a free flow link from the M60 eastbound to M60 southbound
- Widening of the M66 southbound through J18 from two lanes to four lanes
- Realignment of the M66 southbound diverge slip road to M60 J18 to accommodate the Northern Loop structure including a new overbridge where the slip road crosses the Northern Loop and realignment of the left turn lane to the M62 eastbound
- Widening of the M60 carriageway between J17 and J18 from four lanes to five lanes in both directions and installation of a hard shoulder
- New alignment on the approach to the M60 eastbound to M66 northbound free flow link
- Realignment of the existing M62 westbound to M60 southbound free flow link
- New lane alignments on the M60 J18 roundabout.

Site description

Location

1.2.2 The location of the Scheme is shown in Figure 2.2: Scheme Design of the Environmental Statement Figures (TR010064/APP/6.2). The Scheme extent falls within the administrative boundary of Bury Metropolitan Borough Council (BMBC) and is close to Rochdale Borough Council, Salford City Council and Manchester City Council.

1.2.3 The Scheme is situated between several urban areas and settlements including Whitefield, Prestwich, Simister and Middleton. It is situated in an urban fringe landscape, with urban settlements to the west, north and south of the Scheme and predominantly low-lying Grade 3/4 agricultural land to the east. The majority of the Scheme falls within the Green Belt boundary.

Surface water features

1.2.4 The watercourses within the study area (defined as an area within 1km of the Order Limits) are classified into two categories:

- Main River: Defined under Water Resources Act 1991 as being regulated by the Environment Agency. These rivers are generally larger than ordinary watercourse and have bigger floodplains and greater potential impact on the local area. Construction work on or surrounding a main river is controlled by Section 109 of the Water Resources Act 1991 and the Environment Agency Anglian Regional by-laws.

- Ordinary watercourses: BMBC defines an ordinary watercourse as '*a stream, ditch, cut, sluice or non-public sewer which is not classified as a main river*' (BMBC, 2013). is responsible for regulating activities affecting an ordinary watercourse.

1.2.5 A detailed summary of the surface water features within the study area is presented in Section 13.7 of Chapter 13: Road Drainage and the Water Environment of the Environmental Statement (TR010064/APP/6.1).

Geology

1.2.6 A summary of the bedrock and superficial geology pertinent to the FRA is provided here to provide context to the groundwater and surface water interactions likely across the Order Limits. Full details of the geology and aquifers are presented in Chapter 9: Geology and Soils of the Environmental Statement (TR010064/APP/6.1) and Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3).

1.2.7 Extensive made ground deposits are present within most of the Order Limits, largely associated with the existing motorways and their junctions. The superficial geology is complex, and comprises glacial till, hummocky (moundy) glacial deposits, glaciofluvial/ice contact deposits, head, peat and small areas of glaciolacustrine clay and silt.

1.2.8 The bedrock geology underlying the Order Limits primarily includes the Coal Measures Group, along with the Permo-Triassic sandstone units such as the Chester Formation. The bedrock has generally undergone significant structural deformation, with multiple faults shown to be present cutting across the bedrock at depth beneath the Scheme.

1.3 Methodology

1.3.1 This FRA has been undertaken in accordance with the Design Manual for Roads and Bridges (DMRB) LA 113 Road drainage and the water environment (Highways England, 2020). The document provides an initial assessment method for determining and managing the effects of the Scheme on the water environment.

1.3.2 Where this FRA has identified potential flood risk impacts, flood mitigation measures (either embedded in design or essential) have been considered to minimise the overall impact on flood risk. At locations where the Scheme may have an impact, a range of measures have been explored with the aim of achieving no significant detrimental effect on overall flood risk.

Assessment of Flood Risk

1.3.3 The assessment of flood risk is used to steer development at the planning stage. The flood risk from main rivers and the sea is initially assessed using the Environment Agency Flood Map for Planning (FMfP) (Environment Agency, 2023a). This map has delineated three zones of flood risk: Flood Zones 1, 2 and 3a (defined in Table 1.1). In addition to main rivers, risk from all other sources of flooding have been considered in determining the whether the development would be in an appropriate location with regard to flood risk.

Table 1.1 Flood zones

Flood Zone	Definition
Flood Zone 1	'Low probability of flooding' – This zone comprises land assessed as having a less than 1 in 1,000 annual probabilities of river or sea flooding (<0.1%).
Flood Zone 2	'Medium probability of flooding' – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.
Flood Zone 3a	'High probability of flooding' – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
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 flood. This zone is not normally included within the national FMfP and is calculated where necessary using detailed hydraulic modelling. This flood zone is identified as being likely to flood with annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in extreme scenarios.

The Sequential Test

1.3.4 The NPPF (DLUHC, 2023) requires a risk-based sequential approach to determine the suitability of land for development in flood risk areas which should be applied at all stages of the planning process.

1.3.5 The Sequential Test should be applied to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development.

1.3.6 The published Flood Zones are the starting point for the Sequential Test and refer to the probability of sea and river flooding. They are defined on a 'worst case' basis, ignoring the presence of existing defences. The overall aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding.

1.3.7 Whilst the Scheme is located wholly within Flood Zone 1, a sequential approach has still been considered for both surface water and groundwater flood risks.

1.3.8 To locate the Scheme entirely outside of areas within groundwater and surface water flood risk extents would involve moving the Scheme into a new area. As the Scheme is upgrading existing road infrastructure, this would not be a viable option.

1.3.9 Elements within the Scheme, such as ponds, where the location is not dependent on the existing infrastructure, have been located in areas with lower risk of surface water flooding.

1.3.10 As the Scheme is in Flood Zone 1, and a sequential approach has been taken to avoiding locating infrastructure within areas at medium or high groundwater or surface water flood risk, the Scheme is considered to pass the Sequential Test.

Assessment of development vulnerability

1.3.11 The NPPF (DLUHC, 2023) defines what development is suitable for construction within each flood risk zone based upon the level of vulnerability of the development, as set out in Table 1.2.

1.3.12 This either identifies that development is suitable, should not be allowed, or is suitable subject to the Exception Test. The Exception Test is used to demonstrate and ensure that flood risk to people and property would be managed properly, while allowing the Scheme to go ahead in situations where suitable sites at lower risk of flooding are not available.

Table 1.2 Flood risk vulnerability and flood zone 'compatibility'

Flood Risk Vulnerability	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	X	Exception Test Required	✓
Zone 3b	Exception Test Required	✓	X	x	x

1.3.13 The Scheme has been assigned a Flood Risk Vulnerability Classification of 'Essential Infrastructure' in accordance with the NPPF (DLUHC, 2023). As the Scheme is wholly located in Flood Zone 1 it is deemed compliant with national planning policy and application of the Exception Test is not required.

Flood risk information sources

1.3.14 Flood risk has been assessed based on information from the following sources:

- British Geological Survey (BGS) Groundwater Flooding Susceptibility data (BGS, 2022)
- BGS mapping at 1:10,000 scale and 1:50,000 scale, historical borehole records and permeability index/aquifer properties datasets (where required) (BGS, 2023)
- Level 1 Strategic Flood Risk Assessment for Greater Manchester (JBA Consulting, 2019)
- Bury Preliminary Flood Risk Assessment (JBA Consulting, 2011)
- Bury Preliminary Flood Risk Assessment Addendum (Bury Council, 2017)
- Greater Manchester Surface Water Management Plan (JBA Consulting, 2012)
- Appendix 9.3: Ground Investigation Report of the Environmental Statement Appendices (TR010064/APP/6.3)
- The Coal Authority Interactive Map Viewer (Coal Authority, 2018)
- Ordnance Survey (OS) Open Rivers dataset (OS, 2023)
- Environment Agency Catchment Data Explorer (Environment Agency, 2020e)
- Environment Agency Flood Map for Planning (Environment Agency, 2023a)
- Environment Agency Long Term Flood Risk Information Mapping (Environment Agency, 2023b)
- Environment Agency Risk of Flooding from Surface Water Extent (Environment Agency, 2023c)
- Environment Agency Risk of Flooding from Reservoirs (Environment Agency, 2023d)
- Environment Agency Statutory Main River Map (Environment Agency, 2023e)
- Environment Agency Historic Flood Map (Environment Agency, 2023f)

- Bedrock and superficial aquifer designations from the Department of the Environment, Food and Rural Affairs (Defra)'s Multi-Agency Geographic Information for the Countryside (MAGIC) map application (Defra, 2023)
- Ordnance Survey mapping for identifying the locations of springs, sinks, sources, spreads, collects, issues, wells (OS, 2022)

Assessment assumptions and limitations

1.3.15 The FRA has been based on readily available web-based data sources and organisational experience. No detailed hydraulic modelling of flood risk has been undertaken.

1.3.16 The Environment Agency's long term flood risk mapping (Environment Agency, 2023b) is assumed to sufficiently represent the risk associated with Ordinary Watercourses. The mapping does not take climate change into account. Therefore, the 0.1% (1 in 1000) Annual Exceedance Probability (AEP) mapping has been assessed as a proxy for the 1% (1 in 100) AEP event plus an allowance for climate change.

1.4 Flood risk policy and guidance

National planning policy

1.4.1 Defra is responsible for all aspects of water policy in England. Key legislation and policies relating to flood risk are detailed in Table 1.3.

Table 1.3 Key national legislation and policy relating to the water environment

Legislation / Policy	Relevance to the Scheme
Reservoirs Act 1975	This legislation was enacted to protect against escapes of water from large reservoirs or from artificially created or enlarged lakes. It provides regulation for assessing the risk of escape of water and ensuring that reservoirs are regularly monitored, and their asset status (integrity) is regularly assessed. This is enforced by the Environment Agency in England.
Environmental Protection Act 1990	The Environmental Protection Act (1990) defines the structure and authority of waste management and control of emissions into the environment within England, Wales, and Scotland.
Water Resources Act 1991	The Water Resources Act (1991) regulates water resources, water quality, water pollution, flood defence, and provides for the general management of water resources, the standards expected for controlled waters, and prevention/mitigation through flood defence.
Land Drainage Act 1991	The Land Drainage Act 1991 outlines the responsibilities of various bodies that deal with local (land) drainage including local authorities, internal drainage boards and riparian owners. The Act requires that a watercourse be maintained by its owner in such a condition that the free flow of water is not impeded. The riparian owner must accept the natural flow from upstream but need not carry out work to cater for increased flows resulting from some types of works carried out upstream.

Legislation / Policy	Relevance to the Scheme
Environment Act 1995	The Environment Act (1995) created the standard for environmental management and made provision for the establishment of the Environment Agency.
Flood and Water Management Act 2010	The Flood and Water Management Act (2010) defines the responsibilities of various flood risk management authorities. The Act gives the Environment Agency strategic overview for national flood risk management in England and gives unitary and county council responsibility for local flood risk management.
Flood Risk (England and Wales) Regulations 2016	The Flood Risk Regulations transposed the European Union (EU) Floods Directive into law in England and Wales. The EU Floods Detective aims to provide a consistent approach to flood risk management across Europe.

National Policy Statement for National Networks

1.4.2 The NPS NN (Department for Transport, 2014) is a requirement of the Planning Act 2008. It sets out the need for, and Government's policies relating to the development of Nationally Significant Infrastructure Projects on the national road and rail networks in England. It provides planning guidance for promoters of Nationally Significant Infrastructure Projects on the road and rail networks, and the basis for the examination by the Examining Authority and decisions by the Secretary of State (SoS). NPS NN is used as the primary basis for making decisions on development consent applications for national networks Nationally Significant Infrastructure Projects in England.

1.4.3 Key policy from the NPS NN relevant to the assessment of flood risk is set out below (see also the NPS NN Accordance Tables (TR010064/APP/7.2) for an assessment of the Scheme's compliance with the NPS NN):

- Paragraphs 5.91 to 5.97 state that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk although essential transport infrastructure is permissible in areas of high flood risk subject to the Exception Test. But where development is necessary, it should be made safe without increasing flood risk elsewhere.
- Paragraph 5.93 states that the assessment of impact should take climate change into account.
- Paragraph 5.99 states that when determining an application, the SoS should be satisfied that flood risk would not be increased elsewhere, that the most vulnerable development is located in the areas of lowest risk, and that it is appropriately flood resilient and resistant.
- Paragraph 5.109 states that the Scheme should be designed and constructed to remain operational and safe for users in times of flood.

- Paragraph 5.230 states that projects are required to adhere to National Standards for Sustainable Drainage Systems (SuDS), which promotes the most sustainable approach but recognises feasibility, and use of conventional drainage systems as part of a sustainable solution for any given site given its constraints.

1.4.4 The Government published a draft replacement of the NPS NN in March 2023 (DfT, 2023). The consultation closed in June 2023 and the draft NPS NN has not yet been designated. However, it is potentially capable of being an important and relevant consideration in the decision-making process. The Environmental Statement continues to reference the 2014 NPS NN though, as it remains the relevant Government policy. Notwithstanding that position, Table 1.4 summarises the policy requirements from the draft NPS NN for flood risk and how these have been addressed in the assessment. See also the Draft NPS NN Accordance Tables (TR010064/APP/7.3) for an assessment of the Scheme's compliance with the draft NPS NN.

Table 1.4 Draft NPS NN requirements for FRA (where different to existing)

Paragraph reference	Requirement	How this is addressed in the assessment
4.37	The applicant should also be able to demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario.	Climate change has been considered as part of the assessment, with the 0.1% (1 in 1000) AEP event flood extents from surface water flood mapping used as part of the assessment. It is considered likely that the 0.1% (1 in 1000) AEP flood extents give a reasonable approximation of potential future 1% (1 in 100) AEP extents in a credible maximum climate change scenario.
4.39	Any adaptation measures should be based on the latest set of UK Climate Projections, the government's latest UK Climate Change Risk Assessment, when available and in consultation with the Environment Agency's Climate Change Allowances for Flood Risk Assessments. Any adaptation measures must themselves also be assessed as part of any environmental assessment, which should set out how and where such measures are to be secured.	No adaptation measures have been identified.

Paragraph reference	Requirement	How this is addressed in the assessment
5.126	For local flood risk (surface water, groundwater and ordinary watercourse flooding), local flood risk management strategies and surface water management plans provide useful sources of information for consideration in Flood Risk Assessments. Surface water flood issues need to be understood and then account of these issues can be taken, for example, flow routes should be clearly identified and managed.	Surface water risk and flow routes have been identified in this FRA.

1.4.5 In addition to the national policy set out in the NPS NN, the Scheme must also have regard to other relevant national and local plans and policy.

National Planning Policy Framework

1.4.6 The NPPF (DLUHC, 2023) and associated NPPG (DLUHC and MHCLG, 2022) are the relevant guidance documents that local authorities use in reviewing proposals for development with respect to flood risk. If a site was to be developed, the NPPF sets out policies for planning authorities to:

- Ensure flood risk is properly considered at all stages of the planning process
- Prevent inappropriate development in areas at high risk of flooding
- Direct development away from areas at highest risk
- Ensure that new developments take climate change into account and do not increase flood risk elsewhere

1.4.7 The NPPF (DLUHC, 2023) provides guidance on the assessment of flood risk and how it may be addressed or mitigated. The guidance advises, among others, planning authorities in their planning decisions to use a risk-based approach to avoid flood risk wherever possible and manage flood risk elsewhere.

Sustainable Drainage Systems guidance

1.4.8 Defra's Non-Statutory Technical Standards for Sustainable Drainage Systems (Defra, 2015) includes the following guidance:

- 'The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30-year rainfall event'

- ‘The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100-year rainfall event are managed in exceedance routes that minimise the risks to people and property’

1.4.9 It should be noted that the Scheme has been designed to DMRB standards. As such, testing of the 1 in 30 year event has not been undertaken.

Local flood risk policy and guidance

1.4.10 The Scheme is located within an area administered by BMBC (as the Lead Local Flood Authority (LLFA)).

Local plans

1.4.11 Local plans are prepared by the Local Planning Authorities (LPAs) and provide guidance for future growth and development within the local area including Core Strategies and Development Policies. The key flood risk management policies and objectives identified relevant to the Scheme are summarised in Table 1.5.

Table 1.5 Local planning policies and objectives

Document	Flood Risk Policy / Objective	Key Requirements
Bury Unitary Development Plan (1997)	EN5: Flood Protection and Defence	The Council will not permit new development, including the raising of land and the intensification of development, where such development would be at risk from flooding, would be likely to increase the risk of flooding elsewhere, or would adversely affected river flood defences.
Manchester’s Local Development Framework (2012)	EN14: Flood Risk	Follow sequential approach contained within PPS25 New developments to minimise surface water runoff, including through SuDS
Greater Manchester Joint Development Plan Document (2022)	JP-S5: Flood Risk and the Water Environment	Locate and design developments to minimize the impacts of current and future flood risk. Development to manage surface water runoff through sustainable drainage system and as close to source as possible (unless demonstrably inappropriate) so as to not exceed greenfield run-off rates or alternative rates specified in district local plans, such as those identified for areas with critical drainage issues.
Bury Local Plan (2018)	Topic Paper 6: Flood Risk	Ensuring that new development complies with the flood risk management hierarchy and is not subject to unacceptable levels of risk, does not result in increased flood risk elsewhere and, where possible, achieves reductions in flood risk overall.

Document	Flood Risk Policy / Objective	Key Requirements
		In addition, it should seek to ensure that all new development proposals minimise the impact of development on surface water run-off, and where possible, seek to reduce it.

Bury Council Preliminary Flood Risk Assessment

1.4.12 A Preliminary Flood Risk Assessment (PFRA) provides a high-level overview of the flood risk from local sources and more specifically surface water, groundwater and ordinary watercourses. As BMBC is the LLFA for the Scheme area, the BMBC PFRA (JBA Consulting, 2011) has been consulted. The document identifies areas at high flood risk with potential consequences on the local population. The LLFA investigates the high-risk areas by producing Strategic Flood Risk Assessments (SFRAs) and Surface Water Management Plans (SWMPs). According to the BMBC PFRA the Scheme lies predominantly within an area of medium to low risk of surface water flooding.

1.4.13 The BMBC PFRA expands on the risk from the flood sources included in Section 1.4.6 that could have 'significant harmful' consequences. The Scheme does not cross any areas identified as having potential significant harmful consequences.

Strategic Flood Risk Assessment

1.4.14 A SFRA is a document produced by LPAs that helps various parties consider flood risk within planning decisions. It provides an overall understanding of the flood risk within its scope area, considering all potential sources. The SFRA of relevance to the Scheme is the Level 1 Strategic Flood Risk Assessment for Greater Manchester (JBA Consulting, 2010).

Surface Water Management Plan

1.4.15 A Surface Water Management Plan (SWMP) is produced by the LLFA and investigates the flood risk from local sources and determines a long-term plan of flood risk management. The flood sources commonly include surface water, groundwater, and ordinary watercourses. The Greater Manchester SWMP (JBA Consulting, 2012) is of relevance to the Scheme.

1.5 Climate change

1.5.1 The Environment Agency's latest available published guidance on climate change allowances (Environment Agency, 2022) has been incorporated into this assessment to demonstrate compliance with national planning policy.

1.5.2 The guidance provides allowances to be applied to incorporate the predicted impact of climate change into the assessment of flood risk for new developments. The allowance to be applied is dependent on the location, design life and vulnerability classification of the development (as detailed in Table 2 of the NPPG (DLUHC and MHCLG, 2022). In line with the guidance, the Scheme is considered to be 'essential infrastructure'.

Peak river flow

1.5.3 The allowance to be applied to assess the predicted impact of climate change on peak river flow is set out in Table 1.6. The guidance requires that the Higher Central allowances should be adopted for development classified as essential infrastructure for peak river flow.

Table 1.6 Climate change allowance for peak river flow for the River Irwell

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)
Irwell	Upper End	24%	43%	75%
	Higher Central	15%	26%	46%
	Central	12%	19%	35%

Peak rainfall intensity

1.5.4 The guidance also states that the potential increase in rainfall intensity due to climate change should be considered within an FRA for the central and upper end allowances. Assuming a 100-year design life for the Scheme a climate change allowance of 30% for rainfall intensity using the central allowance and 45% for rainfall intensity using the upper end allowance for sensitivity testing as per Table 1.7 have been adopted. Table 1.8 gives the equivalent values for a 3.3% (1 in 30) AEP event.

Table 1.7 Climate change allowance for peak rainfall intensity (1% AEP event) in Irwell Management Catchment

End	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2070s' (2061 to 2125)
Upper End	40%	45%
Central	25%	30%

Table 1.8 Climate change allowance for peak rainfall intensity (3.3% AEP event) in Irwell Management Catchment

End	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2070s' (2061 and 2125)
Upper End	30%	40%
Central	25%	35%

2 Assessment of flood risk to the Scheme

2.1 Introduction

2.1.1 This section includes the assessment of all potential sources of flood risk to the Scheme.

2.1.2 This FRA considers flood risk from all sources:

- Tidal and coastal – flooding from the sea
- Fluvial – flooding from watercourses including Main Rivers, Ordinary Watercourses and land drainage
- Surface water – flooding from runoff and overland flow as a result of rainfall events
- Groundwater – flooding due to the rising of the water table below ground
- Failure of artificial drainage systems and infrastructure – flooding that occurs as a direct result of infrastructure failure or overflow; including canals and reservoirs
- Water supply and wastewater infrastructure failure
- Failure of flood risk management assets.

2.2 Assessment criteria

2.2.1 Table 2.1 describes these sources of potential flooding and outlines the methodology used to assess flood risk for this FRA. If the risk is considered moderate or high, then mitigation measures may be required.

Table 2.1 Sources of flood risk considered and assessment methodology for this FRA

Flood source	Flood source detail	Assessment methodology
Coastal/Tidal	Coastal/tidal flooding is flooding originating from the sea where water levels exceed the normal tidal range and flood onto the low-lying areas that define the coastline. Coastal/tidal flooding results in the inundation of low-lying areas and areas where sea defences have been breached or overtopped and is generally caused by seasonal high tides and where stormy weather conditions results in strong wave action that increase water levels above the norm. The Scheme does not traverse areas considered to be at risk of coastal flooding and would not increase the risk of coastal flooding. Therefore, this FRA has not considered this source of flooding further.	N/A
Fluvial (main rivers)	Fluvial flooding occurs when rivers (main rivers or ordinary watercourses) are unable to cope with the volume of water draining from the surrounding land as a result of sustained or intense rainfall. The increase in water causes the rivers to rise above its banks and/or retaining structures and flow across land.	Environment Agency Flood Map for Planning (FMfP) (Environment Agency, 2023a) will be reviewed to understand risk from fluvial flooding associated with main rivers within the Order Limits. Where FMfP cannot provide data for smaller main rivers, the Environment Agency Statutory Main River Mapping (Environment Agency, 2020) can be used to cross reference smaller, unmapped main rivers, and compared to flood risk within RoFSW mapping, which can be used to identify risks from smaller rivers.
Fluvial (ordinary watercourses)		Environment Agency Risk of Flooding from Surface Water (RoFSW) (Environment Agency, 2023c) mapping will be reviewed to identify ordinary watercourses. However, the RoFSW mapping may not include all these watercourses or ditches or include all structures on them.

Flood source	Flood source detail	Assessment methodology
Surface water	Surface water (pluvial) flooding results from rainfall-generated overland flow before the runoff enters any watercourse, drainage system or sewer or when the infiltration capacity of the ground surface is exceeded during extreme rainfall events. Excessive surface water runoff can pose a flood hazard especially if flowing at high velocity. Localised depressions in the ground topography can result in the ponding of water, sometimes to a significant depth. The antecedent conditions, permeability of the soil type or geology can affect the volume of runoff, whilst the capacity and condition of the drainage network can affect how much water remains on the surface. The topography of the land and location of urban features such as road networks also influence surface water flood risk.	Environment Agency RoFSW (Environment Agency, 2023c) mapping will be reviewed to determine areas of high, medium, and low surface water flood risk within the Order Limits.
Groundwater	Groundwater flooding occurs when groundwater levels rise above the ground surface. In some instances, groundwater can emerge at surface level following heavy or prolonged rainfall events and contribute to existing flooding from other sources. A greater risk can be presented if construction works or long term, large developments, such as road schemes, intersect areas with shallow groundwater levels, or create pathways for deeper confined artesian groundwater to be released at ground level causing widespread flooding. The presence of linear below ground structures can also increase the risk of flooding as they can impede groundwater flow leading to a rise in the water table up hydraulic gradient of the structures.	Local PFRA (JBA Consulting, 2011), SFRA (JBA Consulting, 2010) and SWMP (JBA Consulting, 2012) will be reviewed for groundwater flood risk information pertinent to the Order Limits. BGS (2022) groundwater flooding susceptibility data will be reviewed to determine areas of high, medium, and low likelihood of groundwater emergence.

Flood source	Flood source detail	Assessment methodology
		Groundwater levels reported during the various ground investigations which have taken place between 2021 and 2023 (see Appendix 9.3: Ground Investigation Report of the Environmental Statement Appendices (TR010064/APP/6.3)), bedrock and superficial aquifer properties information, and potential indicators of shallow groundwater emergence (such as springs) (BGS, 2023) will be reviewed. This will be compared with the BGS (2022) groundwater flooding susceptibility data, alongside design considerations for the Scheme, to identify areas of potential high, medium, and low groundwater flood risk within the Order Limits.
Failure of water retaining infrastructure	Flooding due to the collapse and/or failure of man-made water retaining features such hydropower-dams, water supply reservoirs, canals, flood defences structures, underground conduits, and water treatment tanks or pumping stations. Reservoir flooding can occur as a result of the failure of artificially created ponds/lakes and is detailed in the NPPG to be residual risk. The Reservoir Act 1975 defines a 'large, raised reservoir' as 'a reservoir that is capable of holding more than 25,000 m3 of water above the topographical level of any adjoining land'. The failure of a reservoir can result in a large volume of water escaping, potentially at high velocity and flooding land within its flow path. This can lead to significant consequences in the surrounding area. Flooding due to the failure and or collapse of flood defence infrastructures is considered to be a residual risk. Failure could potentially result in a release of large volumes of water at high velocity.	The assessment will be based on the Environment Agency (2023b) Long Term Flood Risk mapping that indicates areas at risk of flooding from reservoirs structures within the Order Limits. Local SFRA (JBA Consulting, 2010) will also be also reviewed to understand the condition and nature of any water retaining structures.

Flood source	Flood source detail	Assessment methodology
Failure of sewers and water mains infrastructure	Sewer or water supply infrastructure flooding occurs when there is a failure, collapse, or blockage of the network. The probability of sewer or water supply infrastructure flooding is dependent on the combined effect of several factors such as infrastructure condition, existing maintenance regimes and other outside influences. However, failure could potentially result in a release of a large volume of water.	Local SFRA (JBA Consulting, 2010) will be reviewed regarding the sewer and water main infrastructure flood risk.
Land drainage and artificial drainage	Failure of land drainage infrastructure such as drains, channels and outflow pipes, which is most commonly the result of obstructions, poor maintenance and/or blockages.	N/A. For the Scheme, a like for like replacement would be undertaken where this infrastructure is affected. Therefore, the risk of flooding is unlikely to change and consequently this FRA has not considered this source of flooding further.

2.3 Tidal/coastal flood risk

2.3.1 Due to its inland location with ground levels ranging between 82 – 102m Above Ordnance Datum (AOD), flooding from the sea is not considered to be a risk to the Scheme and has therefore been scoped out.

2.4 Fluvial flood risk from Main Rivers

2.4.1 Based on the FMfP (Environment Agency, 2023a) (reproduced as Figure 13.6: Flood Zones of the Environmental Statement Figures (TR010064/APP/6.2)), the Scheme is located wholly within Flood Zone 1. The nearest mapped areas of Flood Zones 2 and 3, are associated with the Parr Brook, approximately 1.3km north-west of the Order Limits. The overall flood risk from Main Rivers to the Scheme is considered to be **Low**.

2.5 Fluvial flood risk from Ordinary Watercourses

2.5.1 Review of the RoFSW (Environment Agency, 2023c) map indicates a risk of flooding from smaller watercourses interacting with the Scheme, as presented in Figure 13.7: Areas At Risk From Surface Water Flooding of the Environmental Statement Figures (TR010064/APP/6.2). A number of these surface water flood extents can be attributed to fluvial flooding from watercourses with catchments less than 3km^2 not mapped on the FMfP (Environment Agency, 2023a). However, due to the way in which the RoFSW map is produced, areas identified as being at RoFSW often overlap with areas identified as being at risk of fluvial flooding. Thus, in locations where no fluvial flood risk mapping exists, the RoFSW map may provide an additional indication of potential fluvial flood risk associated with smaller watercourses. Table 2.2 details these risks.

Table 2.2 Summary of Ordinary Watercourse flood risk to the Scheme

Watercourse	Description of flood risk
Ordinary Watercourse 1 (Tributary of Parr Brook)	This watercourse rises to the north of the M60 in Whitefield and flows northwards through Thatch Leach Lane Park to join the Parr Brook. There is no surface water flow path evident from the RoFSW (Environment Agency, 2023c) mapping in the vicinity of the Scheme attributable to this watercourse.
Ordinary Watercourse 2 (Tributary of Castle Brook)	This watercourse rises to the north of M60 J18 and flows eastwards away from the M66 to join Ordinary Watercourse 2 and then the Parr Brook approximately 450m east of the motorway.
Ordinary Watercourse 3 (Tributary of Castle Brook)	This watercourse rises south of the M62 and flows northwards crossing the motorway approximately 530m north-east of the M60 J18 and flows north-westwards parallel to the M66 to join ordinary watercourse 2 and then the Parr Brook approximately 450m east of the M66. Flood extents based on the RoFSW (Environment Agency, 2023c) are within the river channel except for an area south of Egypt Lane, although that is outside the Order Limits.

Watercourse	Description of flood risk
Ordinary Watercourse 4 (Tributary of Castle Brook)	This watercourse rises approximately 330m north-west of the M62 and flows south-westwards to join Castle Brook at the same point as Ordinary Watercourses 2 and 3. It flows parallel and approximately 40m north-west of Egypt Lane. Based on the RoFSW (Environment Agency, 2023c) flooding is retained in the river channel except for an area at the head of the watercourses approximately 1km north-east of M60 J18 and outside the Order Limits.
Ordinary Watercourses 5, 6 & 7 (Tributaries of the River Irk)	These three ordinary watercourses rise within the study area to the east of the M60 south-east of M60 J18 and join to flow through farmland south-eastwards away from the Scheme to their confluence with the River Irk approximately 500m east of M60 J19. Based on the RoFSW (Environment Agency, 2023c) there are areas of flood risk attributed to these watercourses but not that intersect the Order Limits.
Ordinary Watercourse 8 (tributary of the Bradley Brook)	This watercourse rises to the north of the M60 in Whitefield Golf Club at the western end of the Scheme. It flows southwards crossing under the motorway approximately 700m to the west of M60 J17. Continuing southwards it joins the Bradley Brook approximately 250m south-east of the M60. The RoFSW (Environment Agency, 2023c) indicates areas of flood risk to the north of the M60. In the golf course, outside the Order Limits and areas of low risk across the carriageway south of Philips Park Road associated from a flow path to from the east rather than the watercourse itself from the M60 carriageway.
Ordinary Watercourse 9 (tributary of the Bradley Brook)	This watercourse rises to the north of the M60 in Philips Park. It flows southwards crossing under the motorway approximately 1.5km to the west of M60 J17. Continuing southwards it joins the Bradley Brook approximately 600m south-east of the M60.
Tributary of Bradley Brook	The main channel flows under the M60 and flows through the residential area and flows in a south-westerly direction to join the River Irwell approximately 1.3km downstream of Outfall 6. Based on the RoFSW (Environment Agency, 2023c) there are few areas of flood risk attributed to this watercourse beyond the river corridor and none within the study area.

2.5.2 A tributary of Castle Brook, located north-east, next to the Northern Loop, is located within the low risk (1 in 1000 (0.1%) AEP event) extent. The Northern Loop is above ground level, and therefore would not be impacted by the Ordinary Watercourse flooding. The Parr Brook directly crosses the M62, however, this is culverted under the motorway and the flood extents do not suggest risk of flooding to the road.

2.5.3 The overall flood risk from Ordinary Watercourses to the Scheme is considered to be **Low** due to the areas of surface water flood risk shown on RoFSW (Environment Agency, 2023c) map.

2.6 Surface water flood risk

2.6.1 The RoFSW (Environment Agency, 2023c) map indicates areas where incident rainfall intensities exceed the grounds infiltration capacity such that water collects on the ground surface. Therefore, there is a greater risk of flooding from this source within urbanised areas, where there is a higher proportion of impermeable surfacing.

2.6.2 The main areas of high risk of surface water flooding within the Order Limits include several carriageway areas of the Scheme, around M60 J18. Sections of M60 J18, and particularly the M66 through the junction, are within the high surface water flood risk extent. A section of the Northern Loop, close to the M66 southbound diverge slip road, is covered by high (1 in 30 (3.3%) AEP), medium (1 in 100 (1%) AEP) and low (1 in 1000 (0.1%) AEP) surface water flood extent. It is anticipated that the risk of this flooding would be addressed by the road drainage. As the road is on embankment in these locations, it is not anticipated that the road would be at high risk of surface water flooding. There are large areas of the Scheme covered by the low surface water flood risk extent; these areas are primarily on the existing motorway carriageways and as such, some mitigation would be anticipated to be provided by road drainage.

2.6.3 The risk of flooding due to surface water would be anticipated to increase due to climate change. Modelled surface water flood extents with an allowance for climate change are unavailable and therefore 0.1% (1 in 1000) AEP flood extents have been considered to represent potential risk as a result of climate change.

2.6.4 Other areas of surface water flood risk are located mainly within localised topographic depressions or against existing road embankments. It should be noted that the high-level models often used for large-scale surface water mapping may not take full account of the influence of existing drainage and culverts and may therefore overestimate flood risk in some areas.

2.6.5 The overall flood risk from surface water is considered to be **Moderate**.

2.7 Groundwater flood risk

2.7.1 The PFRA (JBA Consulting, 2011), SFRA (JBA Consulting, 2010) and SWMP (JBA Consulting, 2012) were reviewed in relation to groundwater flood risk. There were no reports of historical groundwater flooding within the study area.

2.7.2 Details on the groundwater and aquifer characteristics within the study area can be found in Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3). The following information from the baseline has been refined to focus on potential groundwater flooding risks.

2.7.3 BGS groundwater flooding susceptibility data (BGS, 2022) shows that there are two main areas within the Order Limits with potential for groundwater flooding to occur at surface level, or to property or infrastructure situated below ground level (see Figure 13.8: Areas Susceptible to Groundwater Flooding of the Environmental Statement Figures (TR010064/APP/6.2)):

- Most of the area in and around M60 J18, extending north to Unsworth and Pike Fold Golf Club along the M66
- Between M60 J17 and J18 around Besses o' th' Barn, north of Thatch Leach Lane

2.7.4 The remainder of the area within the Order Limits is considered to have limited potential for groundwater flooding to occur. However, it should be noted that the BGS susceptibility to groundwater flooding dataset does not provide coverage for areas underlain by peat, which is mapped in localised deposits across the centre of the scheme.

2.7.5 A review of groundwater level information from the ground investigation (GI) (see Appendix 9.3: Ground Investigation Report of the Environmental Statement Appendices (TR010064/APP/6.3)) and subsequent monitoring has been undertaken to determine groundwater levels across the Scheme. A full summary of information on groundwater from the GI is presented in Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3), with a brief summary provided here to inform the FRA. The locations of the boreholes referenced below is shown in Annex A of Appendix 9.1: Chemical Results Screening Table of the Environmental Statement Appendices (TR010064/APP/6.3)).

2.7.6 During the ground investigations groundwater was encountered in 49 out of 144 GI locations during drilling, with some locations having multiple strikes at different depths. Where encountered, groundwater was primarily struck within 6m of ground level in glacial deposits. Some groundwater strikes were recorded in made ground.

2.7.7 In five locations groundwater was encountered at less than 1m below ground level (bgl) during drilling, i.e., at a relatively shallow depth. Additionally, during subsequent groundwater level monitoring (using a manual dip meter), 15 out of 46 boreholes had groundwater recorded at a depth of less than 1mbgl, with one location (WS-N02B) presenting artesian conditions throughout the monitoring period. These areas of shallow groundwater (less than 1mbgl) indicates areas where groundwater flooding could occur. A summary of these locations and their positions in relation to the Scheme are presented in Table 2.3.

Table 2.3 Summary of high groundwater levels within the Order Limits

Borehole ID	Relation to the Scheme	Number of manual dip readings	Groundwater Level Information (mbgl)
BH-N09	Located at loop road, north of Egypt Lane	14	0.83-3.66 between 11/08/2021 and 02/05/2023
BH-N10	Located at loop road, northwest of Egypt Lane. Adjacent to M66 southbound carriageway	8	0.24-2.95 between 12/01/2022 and 02/05/2023. One day noted dry conditions.

Borehole ID	Relation to the Scheme	Number of manual dip readings	Groundwater Level Information (mbgl)
BH-N21	Located at loop road, northwest of Egypt Lane. Adjacent to M66 southbound carriageway	19	0.89-3.8 between 07/10/2021 and 02/05/2023. One day noted dry conditions.
BH-P03	Located south of M60 J18, south of the M60 carriageway. At attenuation pond (Pond 5)	17	0.11-1.37 between 12/01/2022 and 02/05/2023
WS-N02B	Located north of M60 J18, west of Simister Island at loop road embankment	11	-0.23-0 between 14/01/2022 and 02/05/2023. Artesian conditions encountered on every monitoring visit.
WS-N04	Located at loop road, north of Egypt Lane	18	0.56-1.84 between 12/08/2021 and 02/05/2023
WS-N04A	Located at loop road, north of Egypt Lane	10	0.96-3.3 between 11/08/2021 and 02/05/2023. One day noted dry conditions.
WS-N06A	Located at loop road, north of Egypt Lane	10	0.74-1.69 between 11/08/2021 and 02/05/2023. The adjacent borehole BH-P06 encountered groundwater at 0.8mbgl during drilling.
WS-N09	Located at loop road, north of Egypt Lane	20	0.18-0.97 between 11/08/2021 and 02/05/2023
WS-N13	Located north of M60 J18, west of Simister island at loop road embankment	13	0.1-1.06 between 14/01/2022 and 06/04/2022
WS-P01	Located northeast of loop road, north of Egypt Lane	18	0.3-1 between 07/09/2021 and 02/05/2023
WS-P02A	Located north of M60 J18, west of Simister Island north of loop road embankment at attenuation pond (Pond 7)	5	0.64-2.97 between 14/01/2022 and 02/05/2023. Three day noted dry conditions.
WS-P06	Located south of M60 J18 at westbound slip road from M66 at attenuation pond (Pond 4)	15	0.39-1.43 between 14/01/2022 and 02/05/2023. This borehole encountered groundwater at 0.5mbgl during drilling.

Borehole ID	Relation to the Scheme	Number of manual dip readings	Groundwater Level Information (mbgl)
WS-P12B	Located north of M60 J18, west of Simister Island north of loop road embankment at attenuation pond (Pond 7)	11	0.53 to 0.96 between 14/01/2022 and 02/05/2023. This borehole encountered groundwater at 0.6mbgl during drilling, additionally, the adjacent boreholes WS-P12 AND WS-P12A encountered groundwater at 0.25mbgl during drilling.
WS-S05	Located south of M60 J18, south of the M60 carriageway, north of Simister Lane	14	0.44 to 1.14 between 12/01/2022 and 06/04/2022

2.7.8 Most of the locations in Table 2.3 have response zones within glacial till, with some locations having response zones in the glaciofluvial ice contact and glaciolacustrine deposits. These deposits are all classified as either secondary B or secondary undifferentiated aquifers. Groundwater within these units is likely contained to the more permeable layer, and because of their heterogeneous nature, within the formations and likely have a limited lateral extent.

2.7.9 The GI locations with shallow groundwater broadly correlate with areas that the BGS groundwater flooding susceptibility data map shows as having potential for groundwater flooding to occur at surface and property situated below ground level. The exception are three areas to the south where shallow groundwater has been encountered in areas mapped as having limited potential for groundwater flooding. Additionally, areas to the north of Egypt Lane, which are not covered by BGS mapping, have been identified as having shallow groundwater levels, and therefore may be susceptibility for groundwater flooding.

2.7.10 During the GI, groundwater was struck in bedrock in two locations along the M66 to the north of the Scheme. Strikes were encountered in sandstone and mudstone units associated with the Pennine Coal Measures. No rise was noted after the initial strikes suggesting that groundwater within the bedrock may not be confined in these locations.

2.7.11 By assessing recorded groundwater levels along the Scheme, a screening assessment was carried out to identify those areas at greatest risk of groundwater flooding, potential Scheme impacts and to identify where potential mitigation may be required. This included a detailed review of all parts of the Scheme that would involve excavations below existing ground level, for cuttings and drainage assets. Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3) presents a dewatering assessment, and the outcome has been used to identify any new potential groundwater flooding issues of relevance generated by the earthworks.

2.7.12 Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3) identified that three cuttings/widenings, all ponds, and five catchments in the drainage networks are likely to intercept groundwater during the construction phase. In these instances, mitigation measures will be implemented to mitigate for flooding within the excavation areas identified to be at risk of intercepting groundwater (commitment W17 in the Register of Environmental Actions and Commitments (REAC), contained within the First Iteration Environmental Management Plan (EMP) (TR010064/APP/6.5)). None of the areas of excavation have monitored groundwater to be artesian, with the shallowest groundwater level recorded at 0.28mbgl in BH-N10 which is in drainage catchment 1.

2.7.13 Groundwater intercepted and pumped out of the aquifers during construction will be discharged to ground, adjacent surface waterbodies or existing drainage network in accordance with Appendix H: Outline Surface and Ground Water Management Plan of the First Iteration EMP (TR010064/APP/6.5). However, if contaminated groundwater is intercepted this would need to be collected and treated before being released back into the environment. This could consist of either on site or offsite methods.

2.7.14 Based on the information presented above, with shallow groundwater recorded across the centre of the Scheme within the superficial deposits, the Scheme is considered to be at **Moderate** risk of groundwater flooding.

2.8 Reservoir flood risk

2.8.1 The Environment Agency's Risk of Flooding from Reservoirs mapping (Environment Agency, 2023d) indicates that areas withing the Scheme are at risk of flooding from reservoirs, both when river levels are normal and when there is also flooding from rivers.

2.8.2 M60 J18 and the northern and southern slip roads are within the areas at risk of flooding. The potential extent of reservoir flooding also reaches residential areas in Prestwich and Whitefield to the west of M60 J18. The source of the risk is not stated but it may be Heaton Park Reservoir to the south-west of M60 J18; the flow path flows north-eastwards and then follows the course of the Castle Brook.

2.8.3 Heaton Park Reservoir lies approximately 750m directly south of M60 J18 and covers an area of some 33 hectares (ha). The reservoir is not hydrologically connected to the watercourses within the Order Limits.

2.8.4 All large reservoirs, as defined by the Reservoirs Act 1975, are regularly inspected and maintenance is supervised by reservoir engineers. Therefore, the likelihood of failure is considered to be very low due to their monitoring and inspection.

2.8.5 Therefore, the likelihood of reservoir failure and risk to the Scheme is considered to be 'Very Low' however the consequences could be severe with a potential risk to life, therefore the risk is considered to be **Low**.

2.9 Flood risk from sewers and artificial drainage systems

2.9.1 The Scheme is within the area serviced by United Utilities. The Scheme would pass over areas where there is public foul and surface water sewage infrastructure. It is anticipated that protection measures would be required to potable and wastewater United Utilities assets to allow the construction of temporary access tracks that are suitable for plant trafficking at from Simister Lane. It is likely that protection measures or a diversion would be required to ensure that the works can be undertaken safely. Diversion and protection requirements would be confirmed during the detailed design stage of the Scheme. Therefore, the risk is considered to be **Low**.

2.10 Risk of flood defence failure

2.10.1 According to the FMfP (Environment Agency, 2023a) there are no flood defences within the study area of the Scheme, with the nearest flood defence being over 3km from the Scheme.

2.11 Other sources of flooding

2.11.1 The Scheme is not near to any other artificial sources of flood risk such as canals, with the nearest canal being over 5km from the Scheme. As such, the Scheme is considered not to be at risk from any other artificial sources of flood risk.

2.11.2 A review of the local SWMP (JBA Consulting, 2012) was undertaken to provide information regarding the sewer flood risk. The information states that the data is not sufficient to determine the magnitude of sewer flood risk but is considered to be **Low**.

2.12 Historic flooding

2.12.1 The Environment Agency's Historic Flood Map (Environment Agency, 2023f) identifies the maximum extent of recorded flood outlines from the rivers, sea, and groundwater springs. A review of the map indicates there are no recorded incidents of fluvial flooding identified within 1km of the Scheme.

2.12.2 Due to the steep topography of Bury, the borough has narrow and shallow surface water flow paths. This has the potential to lead to rapid inundation with higher velocities and hazards.

2.12.3 A request was made to BMBC as LLFA to identify any recorded flood incidents related to surface water flooding. BMBC responded detailing that the valley either side of the M60 between J17 and J18 are steep sided and have regularly caused surface water flooding to the motorway, particularly to the south.

2.12.4 Surface water flooding hotspots were identified in the BMBC Local Plan (BMBC, 2018): an area within the boundary of the Scheme, Kenilworth Avenue, has been identified as an area consistently impacted by surface water flooding.

3 Flood risk from the Scheme

3.1 Introduction

3.1.1 This section assesses the potential impact that the Scheme may have on the risk of flooding elsewhere.

3.2 Fluvial flood risk (from Main Rivers)

3.2.1 The Scheme is entirely located within Flood Zone 1, therefore the Scheme does not impact on river or floodplain storage and fluvial flood risk elsewhere remains unchanged.

3.3 Fluvial flood risk (from Ordinary Watercourses)

3.3.1 There is potential for the Scheme to have an adverse impact on flood risk associated with Ordinary Watercourses. For example, encroachment into the floodplain associated with Ordinary Watercourses could increase water levels upstream or downstream of the Scheme, reduce floodplain storage volume or pass additional flood flow downstream, increasing the risk of flooding.

3.3.2 There is a flood plain of Ordinary Watercourse 2 present in the embankment in the south-west of the Scheme. The nearby ditches will be designed to deal with the displaced water and prevent increase in flooding elsewhere (commitment W7 in the REAC, contained within the First Iteration EMP (TR010064/APP/6.5)).

3.3.3 There are also areas which show surface water flood extents for where in the incident rainfall intensities exceed the grounds infiltration capacity such that water collects on the ground surface.

3.3.4 It is considered that the maintenance of flood flow conveyance and drainage storage and flow attenuation embedded in the design of the Scheme will not have an adverse impact on flood risk from the Scheme, and the overall risk is considered to be **Low**.

3.4 Surface water drainage flood risk

3.4.1 Drainage of highway runoff will follow existing arrangements and will only be adjusted to suit the new pavement locations. The surface water drainage strategy includes storage and attenuation of additional runoff to ensure no increase in flood risk to receiving watercourses, including an allowance for climate change of 30%, in all events up to the 1% (1 in 100) AEP event. The risk of increase in surface water flooding is therefore **Low**.

3.4.2 Mitigation to reduce the risk of surface water flooding includes the use of ponds, oversized pipes, underground geocellular storage units, filter trenches, or swales, as appropriate to the location. Further detail is set out in the Drainage Strategy Report (Appendix 13.7 of the Environmental Statement Appendices (TR010064/APP/6.3)).

3.5 Groundwater flood risk

3.5.1 Groundwater flooding can also occur where linear below ground structures, such as sheet piling, could act as a barrier to groundwater flow and increase the risk of groundwater flooding upgradient of the structure. On the down-hydraulic gradient side, the structure could cause a lowering of groundwater levels which would reduce the risk of groundwater flooding in this localised area.

3.5.2 Sheet pile retaining walls would be implemented in three locations across the Scheme (Table 3.1). All sheet piles would be contained to the superficial deposits and will not intercept bedrock. At this current stage, the estimated depths and lengths of the sheet pile retaining walls are indicative due to the design not yet being finalised (and would be refined later, during detailed design). However, at the current design depths there is potential for all the sheet piles to intercept groundwater perpendicular to groundwater flow paths. A summary of the sheet pile characteristics, groundwater levels and likelihood of sheet piles causing groundwater impedance is summarised in Table 3.1.

3.5.3 Whilst short-term impacts might be expected, the sheet piles are unlikely to form watershed-scale barriers to groundwater flow. Groundwater would be expected to naturally find alternative paths of least resistance through the ground at tie-in points, interlocks connecting the sheet piles or behind the sheet piles. Therefore, the sheet piles, are unlikely to disturb the mass balance of the groundwater flow system and cause groundwater flooding.

Table 3.1 Summary of sheet pile locations in the Order Limits

Stretch/Relation to the Scheme	Approximate length (m)	Estimated depth to toe (mbgl)	Groundwater Level along wall (mbgl)	Position of retaining wall in relation to groundwater flow direction	Likelihood of retaining wall causing groundwater impedance and flooding
M60 eastbound, east of the Haweswater Aqueduct (west of Simister Island)	200	12-15	6.04-6.1	Perpendicular	Given the position of the walls in relation to groundwater flow direction and the estimated depth to toe, there might be short-term impedance of groundwater flow. However, given that the retaining wall is unlikely to encounter bedrock, is unlikely to form watershed-scale barriers to groundwater flow and groundwater levels in the longer-term will equilibrate with the structure, the sheet piles, are unlikely to disturb the mass balance of the groundwater flow system and cause groundwater flooding. However, localised impediment of flow cannot be ruled out and mitigation for this scenario is required.
M60 eastbound, west of the Haweswater Aqueduct (west of Simister Island)	200	12-15	Strike at 9m (rose to 8.3m)*	Perpendicular	
M66 northbound (north of Simister Island)	20 to 30	6 to 10	Strike at 3m (rose to 2.2m)*	Perpendicular	

*No groundwater monitoring information in vicinity of the sheet pile location, therefore only strike data available.

3.5.4 Whilst bored piled foundations would be required for the construction of bridges, they are of limited extent compared to the size of the aquifers, and therefore are unlikely to impede groundwater flow and cause groundwater flooding.

3.5.5 No ongoing dewatering for cuttings/widenings is predicted in the operational phase. Following construction groundwater levels would likely equilibrate back to pre-construction levels, with any excess groundwater during operation dealt with via passive drainage through the drainage system. Appendix 13.4: Groundwater Assessment Report of the Environmental Statement Appendices (TR010064/APP/6.3) provides the results of a dewatering assessment to assess dewatering requirements for all excavations including cuttings and drainage assets.

3.5.6 The construction depths for the Scheme are not expected to perforate or significantly reduce the thickness of the underlying bedrock formations. Therefore, no deep bedrock artesian conditions, if present, are expected to be released as a result of the Scheme.

3.5.7 There are no soakaway discharges to ground as part of the Scheme.

Mitigation measures

3.5.8 It is considered that several mitigation measures can be incorporated into the design development and prevent long-term groundwater flooding issues from arising. These are provided in Table 3.2 and follow the overarching principle that all aspects of the design, in particular the detailed drainage strategy, would be developed in cognisance of groundwater conditions. With these in place, both the risk of groundwater flooding affecting the Scheme and the risk of the Scheme affecting regional groundwater levels and flow paths is likely to be **Low**. These mitigation measures are detailed in the REAC, contained within the First Iteration Environmental Management Plan (TR010064/APP/6.5).

Table 3.2 Groundwater flood risk embedded mitigation measures

Groundwater flood risk mitigation measures in the REAC, contained within the First Iteration EMP (TR010064/APP/6.5))	Description
Commitment W7 – Long-term drainage of cuttings	To protect flood sensitive receptors (including the new road) from groundwater flooding during the operational phase, groundwater seepage would be collected by the road drainage system.
Commitment W7 – Long-term drainage for embankments and sheet piles	To prevent flooding at the surface around embankment and sheet piles where pre-existing groundwater conditions are known to be shallow, drainage systems would be installed to limit the build-up of water.

3.5.9 It is considered that mitigation as part of the Scheme would be sufficient to manage any groundwater flooding issues identified above and ensure the Scheme is safe for users, without increasing flood risk elsewhere.

3.6 Impact on flood risk from reservoirs

3.6.1 The Scheme would not involve works that would impact on the risk of flooding from reservoirs, and it is unlikely that the Scheme would have an impact on the flooding that would occur if a reservoir were to flood, therefore the risk is considered to be **Low**.

3.7 Impact on flood risk from sewers and artificial drainage systems

3.7.1 The Scheme would result in an increase in impermeable area to be drained by the drainage system. Without mitigation this would increase the rate of surface water runoff and could exacerbate downstream flood risk. Embedded mitigation through the storage and attenuation of additional runoff would ensure there would be no increased risk on receiving drainage networks and no additional mitigation is required (commitment W7 in the REAC, contained within the First Iteration EMP (TR010064/APP/6.5)).

3.7.2 The local SWMP (JBA Consulting, 2012) provides information regarding the sewer flood risk. The information states that the data is not sufficient to determine the magnitude of sewer flood risk but is considered to be **Low**. This would be investigated further at the detailed design stage.

3.8 Residual risks

3.8.1 The residual risks for the Scheme would include:

- Flood risk associated with reservoir flooding
- Severe flood events which exceed the designed capacity of the culverts or drainage system

4 Summary and conclusion

4.1 Summary of flood risk

4.1.1 Table 4.1 summaries the flood risk from each of the sources described in Sections 2 and 3.

Table 4.1 Summary of flood risk

Source of Flooding	Existing Risk to the Scheme	Flood Risk from the Scheme
Fluvial (Main River)	**Low:** The Scheme is not located within any functional floodplains of Main Rivers.	**Low:** Scheme will not impact flood storage as is located in Flood Zone 1.
Fluvial (Ordinary Watercourse)	**Low:** Ordinary Watercourses within the Scheme do not make direct contact with the Scheme infrastructure.	**Low:** Drainage strategy has been designed to deal with displaced water from Ordinary Watercourses.
Surface water	**Moderate:** Areas within the Scheme are at high and low risk according to RoFSW (Environment Agency, 2023c).	**Low:** Drainage of highway runoff will follow existing arrangements and will only be adjusted to suit the new pavement locations. The surface water drainage strategy (see Appendix 13.7: Drainage Strategy Report of the Environmental Statement Appendices (TR010064/APP/6.3)) has been designed to incorporate storage and attenuation of additional runoff to ensure no increase in flood risk.
Groundwater	**Moderate:** Areas within the Scheme have the potential for groundwater flooding to occur at the surface with shallow groundwater levels recorded across the centre of the Scheme. However, historically, there are no reports of groundwater flooding in the study area.	**Low:** After implementation of mitigation measures, which include embedding groundwater conditions into the detailed design development and ensuring adequate drainage strategies are in place, the Scheme is considered to be generally at a low risk of groundwater flooding.
Water-retaining infrastructure	**Low:** Areas within the Scheme are in areas at risk of flooding from reservoirs. But the risk of reservoir failing is very low.	**Low:** The Scheme would not involve works that would impact on the risk of flooding from reservoirs.

Source of Flooding	Existing Risk to the Scheme	Flood Risk from the Scheme
Sewers and artificial drainage systems	**Low:** Protection measures or a diversion would be required to ensure that the Scheme can be undertaken safely.	**Low:** Embedded mitigation ensures there would be no increased risk on receiving drainage networks.

4.2 Conclusion

4.2.1 This FRA has been carried out in accordance with the NPS NN (Department of Transport, 2014) and has had regard to the Draft NPS NN (Department for Transport, 2023).

4.2.2 This FRA provides information on potential flood risk to, and caused by, the Scheme. The main findings are:

- The flood risk from Main Rivers is considered to be Low, as the Scheme is located within Flood Zone 1
- The flood risk from Ordinary Watercourses to the Scheme is considered to be Moderate, due to the areas of surface water flood risk shown on the RoFSW (Environment Agency, 2023c) map that could be due to Ordinary Watercourse flooding
- The flood risk from surface water flooding is considered to be Moderate
- The flood risk from groundwater flooding is considered to be Low. There are areas within the Scheme, around the Northern Loop, that have potential for groundwater flooding to occur at the surface. However, after implementation of the mitigation measures set out in paragraph 3.1.16 of this report, groundwater flood risk is considered to be Low
- The risk of flooding from water-retaining infrastructure is considered to be Low
- The risk of flooding from sewers and artificial drainage systems to the Scheme is considered to be Low.

Compliance with the Sequential Test

4.2.3 The Scheme is located within Flood Zone 1. To locate the Scheme entirely outside of areas within groundwater and surface water flood risk extents would involve moving the Scheme into a new area. As the Scheme is upgrading existing road infrastructure, this would not be a viable option.

4.2.4 Elements within the Scheme, such as ponds, where the location is not dependent on the existing infrastructure, have been located in areas with lower risk of surface water flooding.

4.2.5 As the Scheme is in Flood Zone 1, and a sequential approach has been taken to avoiding locating infrastructure within areas at medium or high groundwater or surface water flood risk, the Scheme is considered to pass the Sequential Test.

Compliance with the Exception Test

4.2.6 As the Scheme is wholly located in Flood Zone 1 it is deemed compliant with national planning policy and application of the Exception Test is not required.

Acronyms and initialisms

Acronym or initialism	Term
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
bgl	below ground level
BGS	British Geological Survey
BMBC	Buy Metropolitan Borough Council
Defra	Department of the Environment, Food and Rural Affairs
DLUHC	Department for Levelling Up, Housing and Communities
DMRB	Design Manual for Roads and Bridges
EMP	Environmental Management Plan
EU	European Union
FMfP	Flood Map for Planning (Environment Agency, 2023a)
FRA	Flood Risk Assessment
GI	Ground Investigation
ha	Hectare
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MAGIC	Multi-Agency Geographic Information for the Countryside
MHCLG	Ministry of Housing, Communities and Local Government
NGR	National Grid Reference
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS NN	National Policy Statement for National Networks
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
REAC	Register of Environmental Actions and Commitments
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
SoS	Secretary of State

Acronym or initialism	Term
SuDS	Sustainable Urban Drainage System
SWMP	Surface Water Management Plan
UU	United Utilities

Glossary

Term	Definition
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard)
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
Greenfield	Undeveloped parcel of land
Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management. The duties of LLFAs are set out in the Floods and Water Management Act
LiDAR	Light Detection and Ranging
Local Planning Authority	The local authority or Council that is empowered by law to exercise planning functions for a particular area. This is typically the local study area or study area Council
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
Ordinary Watercourse	All watercourses that are not designated main river. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SuDS	Sustainable Drainage Systems – Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques

Term	Definition
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding
Surface water runoff	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.

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