M5 Junction 10 Improvements Scheme

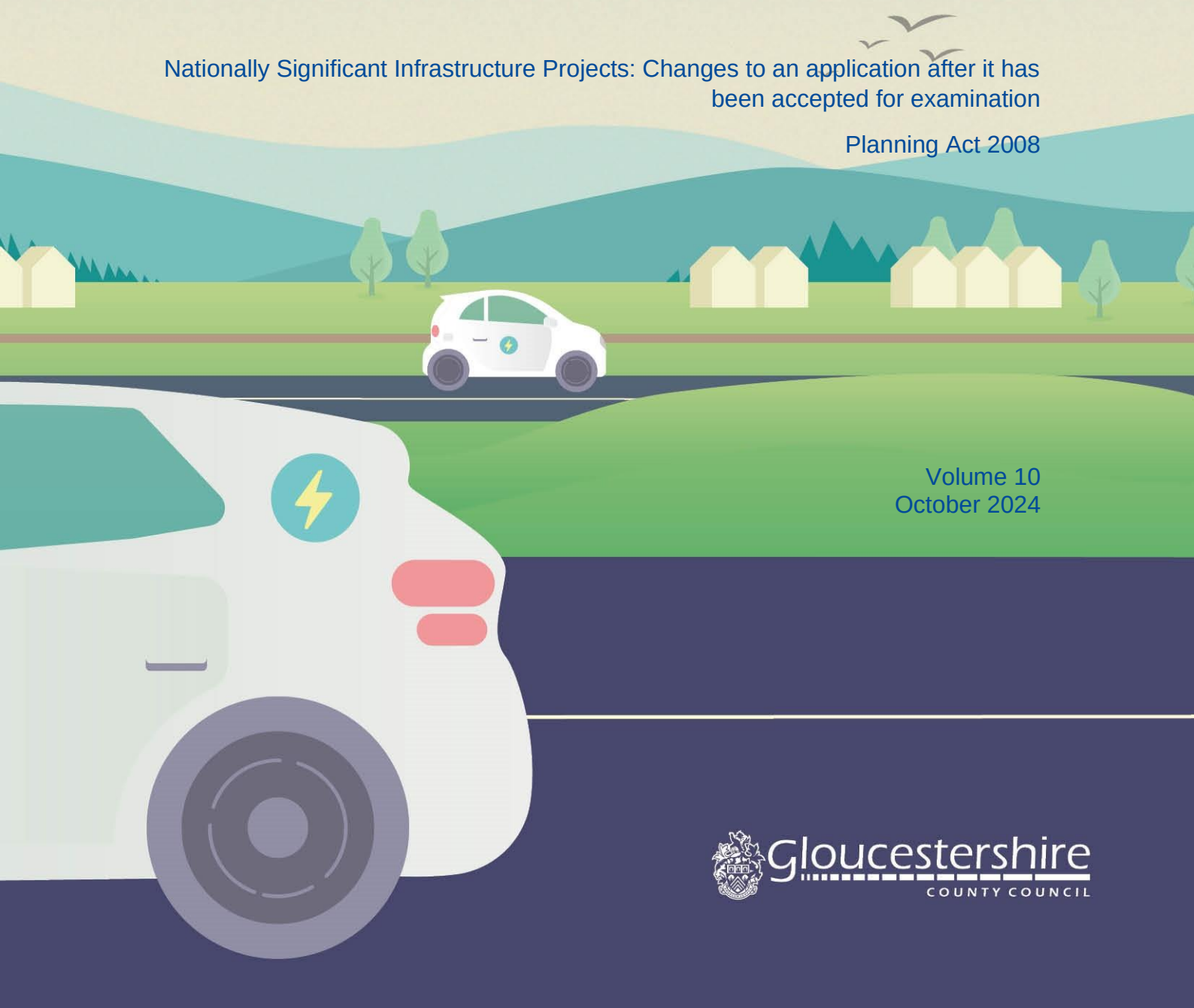
DCO Change Application 2

Flood Risk Assessment Addendum

TR010063 – APP 10.25

Nationally Significant Infrastructure Projects: Changes to an application after it has been accepted for examination

Planning Act 2008



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Nationally Significant Infrastructure Projects: Changes to an application after it has been accepted for examination

M5 Junction 10 Improvements Scheme

Development Consent Order 202[x]

Change Application 2

Flood Risk Assessment Addendum

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1. Introduction

1.1.1. This flood risk assessment (FRA) addendum relates to an application submitted by Gloucestershire County Council (the “Applicant”) to the Secretary of State for Transport (through the Planning Inspectorate) for a Development Consent Order (DCO) under the Planning Act 2008. The M5 Junction 10 Improvements Scheme (the Scheme) involves improvements to the M5 Junction 10, consisting of a new all-movements junction; the widening of the A4019 east of the M5 Junction 10 to the Gallagher Retail Park Junction; and a new West Cheltenham Link Road (from the A4019 to the B4634). To the west of Junction 10 the existing section of two-lane dual carriageway will be replaced with single lanes.

1.2. Site history

1.2.1. A DCO application for the Scheme was accepted for examination by the Planning Inspectorate on 16 January 2024. The Scheme is currently in examination which started on 4 June 2024 and is due to close on 4 December 2024.

1.2.2. Since the DCO application was made, the Applicant has continued to engage and refine designs to identify opportunities to further improve the Scheme. As a result of this, the Applicant is proposing seven design changes to the Scheme during the examination stage to implement improvements to the Scheme.

1.2.3. Notification of the intention to submit 8 non-material changes was made to the ExA (Examining Authority) on 12 August 2024 [AS-061]. The ExA issued a Rule 9 letter in respect of the proposed changes on 21 August 2024 [PD-014]. Since then, the Applicant has decided to split the proposed change application into two separate applications, to differentiate between those aspects of the proposed changes that relate exclusively to upgrades in the rights the Applicant is seeking and engage the Infrastructure Planning (Compulsory Acquisition) Regulations 2010 ("CA Regulations") (“Change Application 1”) [which includes Change 8 as set out in the Notification Letter] and those that relate to changes in the design of the Scheme (“Change Application 2”) [which includes Changes 1 to 7 as set out in the Notification Letter]. This is to ensure the necessary Statutory Consultation and examination of change can be accommodated in the time left in the examination.

1.3. Aims and objectives

1.3.1. The purpose of this addendum is as a supporting document to the Environmental Statement Addendum (ESA) [APP 10.23] setting out the evidence that underpins the flood risk conclusions presented in Chapter 8 on the Road Drainage and the Water Environment (RDWE) [REP1-014]. The addendum will present any changes to the findings or conclusions of the FRA submitted to support the DCO (Appendix 8.1 of the ES) [REP5-008] (referred to subsequently as the FRA) resulting from the seven design changes proposed in Change application 2.

1.3.2. This addendum only considers whether there are changes to the assessment outcomes provided in the FRA [REP5-008] submitted for the DCO application and as such is intended to be read alongside this document. If no change is listed in this addendum, then the conclusions are the same as those presented in the FRA [REP5-008].

2. Background

2.1.1. The M5 links the Midlands with the Southwest, running from Junction 8 of the M6 at West Bromwich near Birmingham to Exeter in Devon, and linking with the M4 north of Bristol. Junction 10 of the M5 is located 76 km to the south of Birmingham, 64 km to the north of Bristol, 8 km to the south of Tewkesbury, 6.5 km to the north-west of Cheltenham, and 8.7 km to the north-east of Gloucester.

2.1.2. The junction is in a strategically important location for the region, particularly as northern and western Cheltenham are the sites of a number of large retail parks and employment areas, and the location of planned future housing and nationally significant business development.

2.1.3. The location of M5 Junction 10 and Order limit is shown in Figure 2-1. Site location details are set out in Table 2-1.

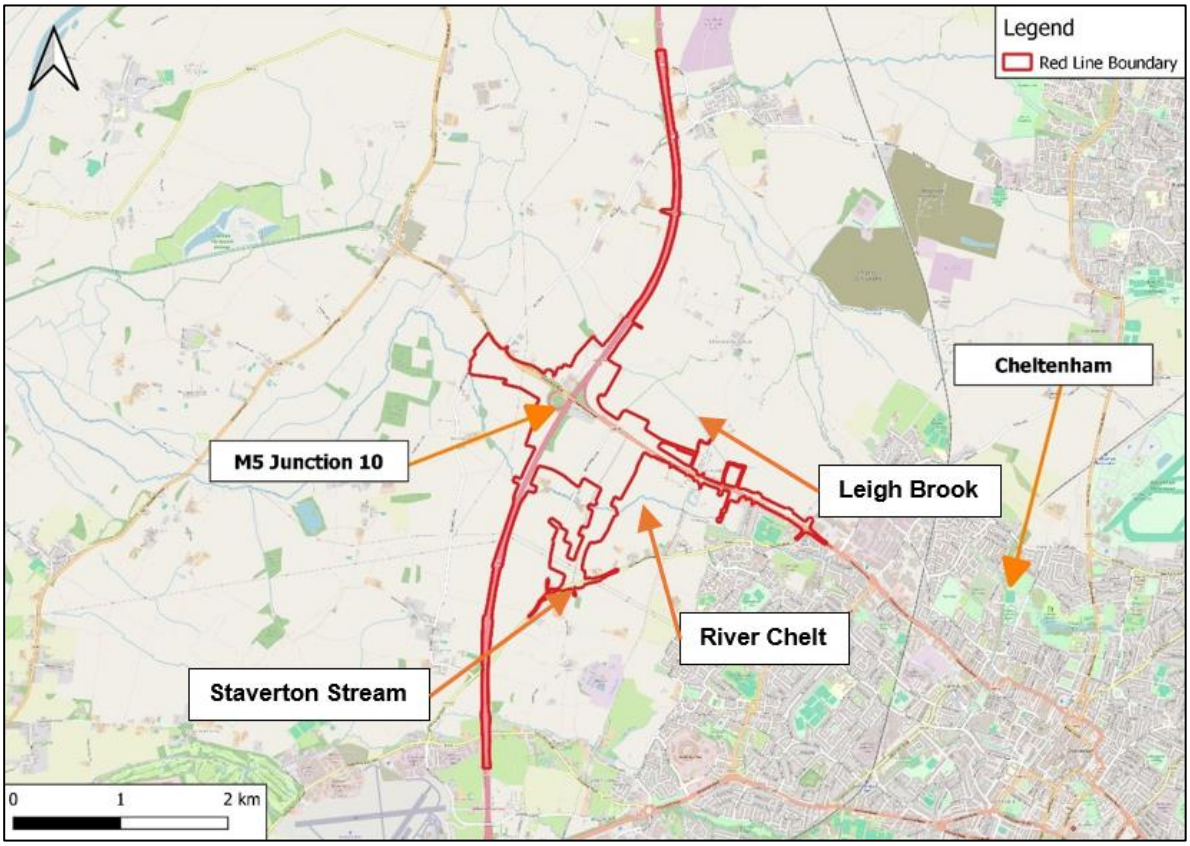


Figure 2-1 Site location

Table 2-1 Site location details

Subject	Information
Site centroid grid reference	393494, 232220
Maximum / minimum elevation	46.28 m AOD / 18.46 m AOD
Study area	7.96 km^2 model domain, 196 ha Scheme
Lead local flood authority	Gloucestershire County Council (GCC)
Borough council	Tewkesbury Borough Council (TBC)

Subject	Information
River Basin District	Severn
Management catchment	Severn Vale

2.2. Topography

2.2.1. There have been no changes to the topography set out in Chapter 4.2 of the FRA [REP5-008].

2.3. Historical flooding

2.3.1. There have been no changes to the flooding history set out in Chapter 3.1 of the FRA [REP5-008].

2.4. Proposed DCO application changes

2.4.1. This FRA addendum covers the seven changes forming part of Change Application 2, which are:

- Change 1 - Link Road replacement of swales with filter drains
- Change 2 - Link Road replacement of box culverts with bridges
- Change 3 - Link Road River Chelt bridge structural form
- Change 4 - Link Road alignment
- Change 5 - Relocation of existing NRTS TS
- Change 6 - FSA reconfiguration
- Change 7 - Infill of existing northbound on-slip loop

2.4.2. The design changes are described below are reflected in the design drawings included in Appendix A of the ESA [APP 10.23].

Change 1 - Link Road replacement of swales with filter drains

2.4.3. The Scheme submitted as part of the DCO application proposed three swales as the surface water collection method on the Link Road. The change is to replace these swales with filter drains.

2.4.4. Furthermore, the cross-section of the Link Road will be altered which allows the number of filter drain runs to be reduced from three to two. In combination with the optimisation of the two-way footway cycleway in Change 4, these changes result in a 4m reduction in the width of the Link Road. The top of the filter drain would be finished with a topsoil/seed mix.

Change 2 - Link Road replacement of box culverts with bridges

2.4.5. In the Scheme submitted as part of the DCO application, the flood alleviation structures on the Link Road consist of two sets of culverts constructed from pre-cast concrete. The change is to improve this arrangement by changing the structural form of this flood conveyance from two sets of culverts to two bridges.

Change 3 - Link Road River Chelt bridge structural form

2.4.6. In the Scheme submitted as part of the DCO application the River Chelt bridge is a skewed structure with reinforced earth wing walls and a skewed span of 26.38m. The Scheme also includes some reprofiling of the existing riverbank to reduce the risk of erosion and create more natural channel profiles. The change is to utilise the requirement for the reprofiling works to straighten the river under the Link Road River Chelt Bridge (to run perpendicular to the Link Road) thereby allowing the installation of a straight (rather than skewed) structure with abutments running perpendicular to the Link Road. To mitigate for the section of straightened channel, the River Chelt will be realigned to exaggerate the natural meandering upstream and downstream of the River Chelt bridge. The pools and riffles between meanders described in the ES will be retained. The Scheme mitigation, including enhancements to riparian vegetation, bank reprofiling to create more natural profiles and installation of in channel enhancements, will also be further developed within the Order limits which are extended 160m upstream and 100m downstream of the River Chelt Link Road bridge.

Change 4 - Link Road alignment

2.4.7. The Link Road is to be constructed on an embankment, consisting primarily of imported fill material. The vertical limit of deviation (LoD) set out in Article 8 of the draft DCO is a maximum of 0.5 m upwards or 1.0 m downwards, in the height of the Link Road. The Scheme submitted as part of the DCO application for the Link Road includes a 4 m wide two-way footway cycleway.

2.4.8. The change is to optimise the vertical alignment of the Link Road beyond the LoD, by reducing the height of the embankment by over 1m in localised areas. In addition, the Applicant proposes to reduce the width of the two-way footway cycleway from 4 m to 3 m to optimise the width of the Link Road. A review of the potential number of future cyclists identified that a 3 m wide cycleway would be more than sufficient for the number of users identified.

Change 5 - Relocation of existing NRTS TS

2.4.9. In the Scheme submitted as part of the DCO application the Uckington TS is located in very close proximity (4.9 m) to the construction works proposed for the Piffs Elm interchange. It is proposed that the TS is relocated, and a new, modular TS is constructed within the Order limits and highway boundary, approximately 2.6 km south of the current location. There will be very limited vegetation clearance required for this change, as the footprint of the TS will be smaller than the existing substation and will be located on existing hardstanding adjacent to the M5 southbound carriageway.

2.4.10. Once the TS is relocated, retaining walls will no longer be required for the Piffs Elm North bridge. As a result, the retaining walls on the north side of the east and west abutments would be replaced with planted embankments.

Change 6 - Flood storage area reconfiguration

2.4.11. In the Scheme submitted as part of the DCO application a FSA (c.82,000m^3 of below ground storage with c.200,000m^3 of total excavated material) is proposed to the south-east of the Piffs Elm Interchange, between the M5 Corridor, A4019 and Link Road. The Scheme would sever the existing hydraulic connectivity that conveys floodwater from south to north of the A4019. The M5 and A4019 road embankments would act as impoundment structures and the FSA would need to be registered as a large, raised reservoir under the Reservoirs Act 1975.

2.4.12. The change will amend the FSA design as follows:

- Provide two hydraulically separate basins to store approximately 23,500m^3 and 62,000m^3 each entirely below the current ground level which would require a total

excavation of c145,000m^3 of material, with conveyance channels to pass flood water under the M5 and the A4019 road embankments. The larger basin would be a reservoir under the Reservoirs Act 1975. Under the current legislation the smaller basin would not be a reservoir and would be designed as an operational wetland.

- The existing 750 mm pipes under the A4019 will be replaced with new culverts and a new conveyance channel to carry flows to Leigh brook, which then passes under the M5 through the existing Barn Farm culvert.
- Lower the invert level of Withybridge A4019 underpass to convey flood water under the A4019 during the design flood event.

2.4.13. This design change will be refined during future design stages. A technical note providing more details regarding the classification of Change 6 under the Reservoirs Act 1975 is presented in Appendix B.

Change 7 - Infill of existing northbound on-slip loop

2.4.14. In the Scheme submitted as part of the DCO application, the existing M5 junction 10 northbound on-slip loops onto the M5 carriageway. The change is to infill the loop with site won material to provide a new, raised platform to extend woodland planting from the retained vegetation at the outer bank of the existing slip road and provide strengthened screening of the Piffs Elm Interchange.

2.5. Flood Risk Scope and Context

2.5.1. Flood risk is a product of both the likelihood and consequences of flooding. Throughout this document, flood events are defined according to their likelihood of occurrence. Floods are described according to an ‘annual chance’, meaning the chance of a particular flood occurring in any one year. This is directly linked to the probability of a flood. For example, a flood with an annual chance of 1 in 100 (a 1 in 100 chance of occurring in any one year), has an Annual Exceedance Probability (AEP) of 1%.

2.5.2. An FRA should consider all types of flooding to satisfy the following three key objectives:

- To assess flood risk to the Scheme and to demonstrate that any residual risks to the development and its users would be acceptable.
- To assess the potential impact of the Scheme on flood risk elsewhere and to demonstrate that the development would not increase flood risk elsewhere.
- To satisfy the requirements of the NPS NN section of Flood Risk and the National Planning Policy Framework (NPPF).

2.5.3. Flood risk should be considered alongside other spatial planning issues such as transport, housing, economic growth, natural resources, regeneration, biodiversity, the historic environment and the management of other hazards.

3. Planning Policy Context

3.1. National policy

3.1.1. There has been no change to the national policy summarised in Chapters 2.1 to 2.3 of the FRA [REP5-008].

3.2. Local policy

3.2.1. There has been no change to the local policy summarised in Chapters 2.5 of the FRA [REP5-008].

3.3. Consultation with flood risk management Authorities

3.3.1. The DCO change application non-statutory consultation meetings with key stakeholders and affected parties were held between 9 July and 11 July 2024, with further consultation on 19 August, 27 August and 17 September 2024. The purpose of these consultation meetings was to seek views on the seven proposed design changes to the DCO application submitted to the Planning Inspectorate in December 2023.

3.3.2. Meetings were held to present the seven proposed design changes to the Joint Councils, Natural England, Environment Agency, National Highways and Lead Local Flood Authority (LLFA). The presentation included an overview of each proposed design change, the reason for the proposed design change and a summary of any changes to the potential environmental effects.

3.3.3. Feedback relating to the risk of flooding from the pertinent stakeholders of the Environment Agency and LLFA are provided in Chapter 4.3 of the ESA [APP 10.23].

3.4. The Sequential and Exception Test

3.4.1. There has been no change to the guidance on the Sequential and Exception tests set out in Chapter 2.2 of the FRA [REP5-008].

3.5. Flood zone classification

3.5.1. There has been no change to the guidance on the flood zone classification set out in Chapter 2.2 of the FRA [REP5-008].

3.6. Application of the Sequential and Exception Test

3.6.1. There have been no changes to the flood zones associated with the Scheme and no changes to the vulnerability classification of the site. There are therefore no changes to the Sequential Testing carried out as part of the FRA [REP5-008].

3.6.2. There have been no changes to the conclusions of the Exception Test presented in Chapter 4.3 of the FRA [REP5-008].

3.7. Requirement for an addendum to the FRA

3.7.1. The proposed scheme changes to the DCO have the potential to impact the findings of the FRA [REP5-008] and as such an addendum is required to assess these changes and support the ESA [APP 10.23].

4. Potential sources of flooding

4.1. Overview

4.1.1. In line with best practice, this section considers flood risk from the range of possible sources listed in Table 4-1 highlighting the key sources that warrant further assessment and mitigation.

4.1.2. It should be noted that the majority of these sources will not have changed from the FRA [REP5-008].

Table 4-1 Sources of flooding

Sources of flooding	Description
Flooding from rivers (fluvial)	Floodwater originating from a nearby watercourse when the amount of water exceeds the channel capacity of that watercourse.
Flooding from the sea (tidal)	Flooding originating from the sea or a connected waterbody when seawater overflows onto land through extreme tidal conditions, storm surge or breach.
Flooding from surface water (pluvial)	Flooding caused by intense rainfall exceeding the available infiltration and/or drainage capacity of the ground.
Flooding from groundwater	Flooding caused when groundwater levels rise above ground level following prolonged rainfall.
Flooding from sewers	Flooding originating from surface water, foul or combined drainage systems, typically caused by limited capacity or blockages.
Flooding from reservoirs, canals, and other artificial sources	Failure of infrastructure that retains or transmits water or controls its flow.

4.2. Flooding from rivers

Catchment overview

4.2.1. There have been no significant changes to the catchment since the production of the FRA [REP5-008]. The Scheme is set in the three catchments detailed in Table 4-2.

Table 4-2 Summary of catchment data

Water body ID	Water Body Name	Catchment Area (km2)	Hydromorphological Designation	Ecological Status
GB109054039770	Leigh Bk - source to conf R Chelt Water Body	11.143	Not designated artificial or heavily modified	Moderate
GB109054032810	Chelt - M5 to conf R Severn	11.999	Not designated artificial or heavily modified	Poor

Water body ID	Water Body Name	Catchment Area (km2)	Hydromorphological Designation	Ecological Status
GB109054032820	Chelt - source to M5	27.092	Heavily modified	Moderate

Existing flood defences

4.2.2. There have been no changes to the flood defences in the catchment since the production of the FRA [REP5-008].

Flood mapping

4.2.3. There have been no changes to the flood mapping in the vicinity of the site since the production of the FRA [REP5-008].

4.2.4. The proposed design changes have not impacted the overall location of the site and as such it is located in flood zones 1, 2 and 3. There is therefore no change to the findings of Chapter 3.2 of the FRA [REP5-008]; the site is at high risk of flooding, and flooding has been identified as a major consideration for the scheme.

4.3. Flooding from the sea

4.3.1. There has been no change to flooding from the sea set out in Chapter 3.4 of the FRA [REP5-008]. The site is located more than 9 km from the nearest tidal waterbody and is considered at low risk of tidal flooding.

4.4. Flooding from surface water

4.4.1. There has been no change to the online surface water mapping since the production of the FRA [REP5-008]. The proposed design changes have not impacted the location of parts of the Scheme in an area at high risk of surface water flooding, and surface water flooding will be a major consideration for the Scheme. Any changes to the surface water drainage strategy as part of the design amendments are set out in Chapter 7.

4.5. Flooding from groundwater

4.5.1. A groundwater assessment has been undertaken to consider likely effects of the Scheme on groundwater flood risk presented in the Groundwater Technical Note presented in the Statement of Common Ground Environment Agency [REP4-024]. This was used to support the FRA [REP5-008].

4.5.2. The area within the Order limits is underlain by discontinuous superficial deposits (Cheltenham Sand and Gravel, and Alluvium) comprising Secondary A aquifers; the bedrock geology comprises Secondary Undifferentiated (Charmouth Mudstone Formation) and Secondary A (Rugby Limestone Member) aquifers. The GCC Strategic Flood Risk Assessment Level 1 Executive Summary (2008) indicates no records of groundwater flooding to be present for Gloucester and Cheltenham Borough Councils.

4.5.3. The latest available groundwater level data was collected for six months including February 2022. In addition, new ground investigation is proposed which will provide further data, including groundwater levels during another winter period showing season high groundwater levels. The ground investigation will further define the extent of water bearing horizons. Shallow groundwater levels are anticipated consistent with the previously obtained data, and as such, no significant change is expected from previous conclusions.

4.5.4. Overall, there are no changes to the conclusions of Chapter 3.5 of the FRA [REP5-008] that the site is considered at medium risk from groundwater flooding.

4.6. Flooding from sewers

4.6.1. The FRA [REP5-008] used the National Highways Drainage Data Management System (HADDAMS) to assess flood events occurring on the motorway and trunk roads in the area of the M5 Junction 10. It was determined that the flood events severity at Junction 10 had an average value of 0-2, the lowest severity.

4.6.2. There have been no updates made to the CBC Strategic Flood Risk Assessment, referred to in the FRA [REP5-008]. The site was considered to have a low-level risk of flooding from sewers.

4.6.3. The GCC Level 1 Strategic Flood Risk Assessment assesses the TBC as having a medium to low flood risk from artificial drainage systems.

4.6.4. The site is considered at low risk of flooding from sewers.

4.7. Flooding from reservoirs, canals and other artificial sources

Flooding from reservoirs

4.7.1. As per the FRA [REP5-008], the site is at risk of flooding from reservoirs, specifically from the Dowdeswell reservoir, should the dam fail. Dowdeswell reservoir is located approximately 10 km south-east of M5 Junction 10, on the eastern side of Cheltenham. This artificial waterbody is regulated by the Reservoirs Act 1975, and as such the risk of breach (dam failure) is very low.

4.7.2. Change 6 has resulted in a change to the volume of water impounded by the A4019 embankment following the scheme. The implications of this are discussed in this FRA Addendum.

Flooding from canals

4.7.3. As per the FRA [REP5-008], there are no canals in the vicinity that may otherwise pose a flood risk to the site. The site is more than 2.5 km away from the disused canal at Coombe Hill and thus is not considered a risk.

4.7.4. The site is considered at very low risk of flooding from canals.

Flooding from other artificial sources

4.7.5. As stated in the FRA [REP5-008], there is a water distribution main running beside the A4019 in the study area. If this main was to fail, it would likely result in flooding of the highway. However, flood risk from water transmission infrastructure is considered to be low, due to Severn Trent Water managing the potential failure of their systems to an acceptable level.

4.7.6. However, if water transmission is located in this area, a construction method statement will propose an approach to ensure no impact on this existing infrastructure.

4.7.7. The site is considered to be at low risk of flooding from water transmission infrastructure.

5. Detailed assessment of flood risk

5.1. Baseline hydraulic modelling

5.1.1. To support the FRA [REP5-008] a baseline hydraulic model was developed and used to model the existing risk of flooding in the River Chelt and Leigh Brook catchments. This model was reviewed and signed off by the Environment Agency for the purposes of supporting the DCO process.

5.1.2. A comment from the Environment Agency on the Scheme noted that a newer version of the modelling software had been released. As such the baseline model simulations were re-run using the latest version of the modelling software and the model output approach was updated to match the guidance released with the latest version of the software.

5.1.3. A further hydraulic model was developed of the Staverton Stream and its tributary that cross the southern extent of the scheme at the B4634. None of the seven DCO design changes impact this area of the scheme and therefore the hydraulic modelling of this watercourse has not been updated.

5.1.4. The detailed assessment of the baseline risk of flooding from fluvial and surface water is unchanged from Chapter 4.5 of the FRA [REP5-008].

5.2. Scheme hydraulic modelling

5.2.1. The scheme model has been updated with the latest highways, landscape and drainage design development and the seven design changes proposed as part of the DCO. The design details used to inform the updated highways, landscape and drainage design are set out in Table 5-1 below. Design drawings for the seven DCO changes are provided in Appendix A of the ESA [APP 10.23].

Table 5-1 Design development model references

Design data	File name
Highways Surface Model	GCCM5J10-ARC-HML-ZZ-M3-CH-00003
Landscape Design	GCCM5J10-ARC-ELS-ZZ-M2-LS-00001
Drainage Data	GCCM5J10-ARC-HDG-ND-M2-CD-00009

5.2.2. A summary of how the model was updated to represent the seven DCO changes and how the changes would impact the fluvial flood risk to the scheme is provided below.

Change 1 - Link Road replacement of swales with filter drains

5.2.3. The proposed design change is not anticipated to change the assessment outcomes for flood risk, as the filter drains are set on top of the Link Road embankment. Therefore, the proposed filter drains have not been included within the hydraulic model. This proposed change would result in a reduction in built footprint in the floodplain which has been represented in the 3D model used to update the flood model.

Change 2 - Link Road replacement of box culverts with bridges

5.2.4. The Link Road highways model has been included within the hydraulic model. This includes gaps in its profile to represent the bridge structures. The losses associated with the bridge piers based on their size, geometry and spacing have been modelled based on a Technical Memo published by TUFLOW titled ‘Modelling Bridge Piers and Afflux in TUFLOW’.

5.2.5. There are two bridges proposed, each one is located over one of the two main overland flow routes that are considered part of the functional floodplain. This design change would reduce encroachment on Flood Zone 3b from that in the Scheme design, and also reduce overall built footprint within the floodplain.

Change 3 - Link Road River Chelt bridge structural form

5.2.6. The proposed realignment of the River Chelt to provide a crossing perpendicular to the Link Road was represented in the model by overwriting the existing 1D channel and cross section representation in the locations where the realignment is proposed to reflect the new design.

Change 4 - Link Road alignment

5.2.7. The highways alignment and profile for the Link Road and associated maintenance tracks were extracted from a highways 3D surface model and added to the flood model. The design change would result in a lower profile and narrower embankment for the Link Road and therefore a reduction in built footprint within the floodplain. This has been represented in the 3D model used to update the flood model.

Change 5 - Relocation of existing NRTS TS

5.2.8. The footprint of the proposed new NRTS transmission station is smaller than the existing footprint and is proposed to be located on existing partly surfaced verge and hardstanding area. The proposed new location of the transmission station does not lie within the floodplain and is not anticipated to impact the flood regime, therefore has not been included within the hydraulic model.

Change 6 - Flood storage area reconfiguration

5.2.9. The two proposed basins have been represented in the flood model based on a 3D surface model which was used to overwrite the existing ground elevations where appropriate. Invert levels are set no lower than those proposed in the FRA [REP5-008] and as such there are no changes to the findings of the previous assessment regarding the interactions of the basins with groundwater.

5.2.10. The proposed culverts and channels have also been represented in the model to convey flow away from the proposed basins. The culverts and Withybridge A4019 underpass proposed beneath the A4019 would reinstate a flow route from the River Chelt to the Leigh Brook found in the baseline model. Another new flow route is proposed that would allow the larger of the two basins to drain back to the River Chelt rather than through Piffs Elm culvert.

Change 7 - Infill of existing northbound on-slip loop

5.2.11. This design change lies outside of the fluvial floodplain, therefore is not anticipated to have an impact on the flood regime of the scheme. The design change has therefore not been included within the hydraulic model.

5.3. Results of Scheme modelling

Design flood event (1% AEP plus 53% climate change)

5.3.1. Hydraulic modelling was used to predict the with-Scheme and proposed design changes flood risk in the study area (and hence change from the baseline/present-day). The description below includes the flood risk during the design flood, being the 1% AEP event

(1 in 100-year return period) with +53% increase in peak flow to account for future climate change.

5.3.2. Figure 5-1 shows changes in flood depths between the baseline scenario and the Scheme with proposed design changes for the design event. There are large increases in flood depths in the flood storage basins in the range 1.00 m to 2.50 m, which is to be expected due to reductions in ground level. Flood depths also increase by up to 0.50 m in the new drainage ditches proposed in Change 6 for the same reason. All of these patterns are to be expected and there are no increases in flood depth outside the site boundary.

5.3.3. Figure 5-1 shows that there are reductions in flood depths along the River Chelt and the Leigh Brook, and around the Staverton Stream confluence with the Chelt.

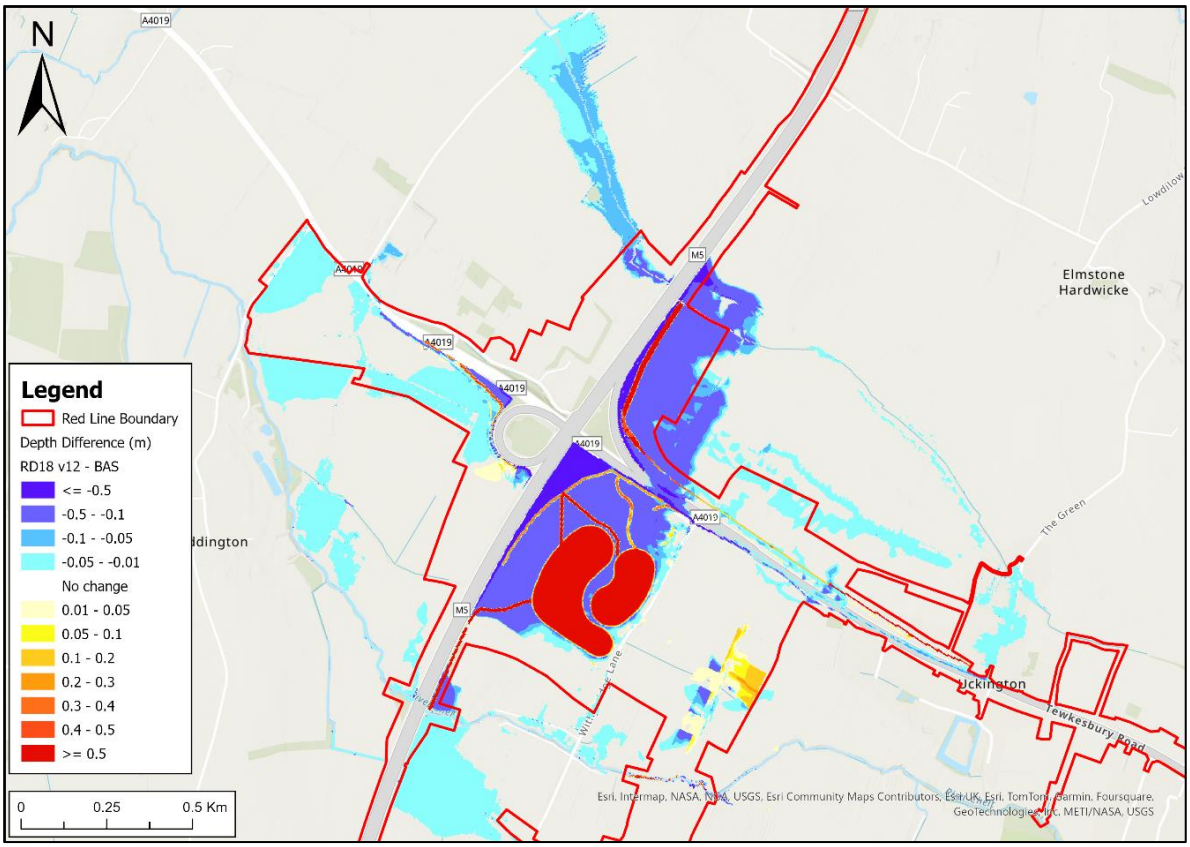


Figure 5-1 Flood depth differences for the 1% AEP plus 53% climate change allowance event

5.3.4. Table 5-2 and Table 5-3 show peak flows and flood depths for the 1% AEP plus 53% climate change allowance event in both the baseline and with-Scheme and proposed design changes scenarios. The reporting locations in Table 5-2 and Table 5-3 are shown below in Figure 5-2.

Figure 5-2 Results reporting locations

5.3.5. The results in Table 5-2 show that there is a reduction in flow passing through the Barn Farm culvert in the with-Scheme and proposed design changes scenario, since floodwater no longer overtops the A4019. There is also a reduction in peak flow through the Piffs Elm culvert in the with-Scheme and proposed design changes scenario compared to the baseline, since more floodwater is retained south of the A4019 (in the flood storage basins) compared to the baseline. Flows through the River Chelt bridge, Withybridge Lane bridge, and Piffs Elm Road bridge are similar for the baseline and Scheme with proposed design changes, with marginal reductions in the Scheme with proposed design changes scenario.

5.3.6. The results in Table 5-3 show that there are large increases in flood depths adjacent to Withybridge Gardens and on the Leigh Brook floodplain near the existing slip road for the Scheme with design changes scenario. Flood depths are greater at these locations due to the presence of the excavation associated with the new drainage ditches proposed as part of Change 6. There is an overall reduction in flood level in these locations. There is a reduction in flood depths at Barn Farm culvert which is consistent with the reduction in flow at this location.

Table 5-2 1% AEP plus 53% climate change allowance event peak flows

Location	Baseline peak flow (m^3/s)	Scheme peak flow (m^3/s)	Change in peak flow (m^3/s)
Barn Farm culvert	4.70	3.32	-1.38
Piffs Elm culvert	3.68	2.84	-0.84
River Chelt bridge	21.21	20.79	-0.42
A4019 culvert	1.62	5.38*	3.76

Location	Baseline peak flow (m^3/s)	Scheme peak flow (m^3/s)	Change in peak flow (m^3/s)
A4019 overtopping	11.53	0.00	-11.53
Withybridge Lane bridge	15.03	14.62	-0.41
Upstream of Piffs Elm Road bridge	23.32	23.21	-0.11

**combined flood through NC and BU under the A4019*

Table 5-3 1% AEP plus 53% climate change allowance event maximum flood depths

Location	Baseline maximum depth (m)	Scheme maximum depth (m)	Change in maximum depth (m)
Leigh Brook at Barn Farm culvert	2.86	2.43	-0.43
Leigh Brook floodplain near existing slip road	0.81	1.35	0.54
Leigh Brook floodplain near A4019	0.03	0.00	-0.03
Withybridge Gardens	0.81	1.03	0.22
Eastern end of River Chelt floodplain	0.17	0.17	0.00
River Chelt at Piffs Elm Road	2.53	2.53	0.00

5.3.7. The results provide sufficient confidence that the Scheme with proposed design changes can sufficiently maintain the hydraulic connectivity, floodplain conveyance and volumetric storage compared to the existing conditions in the 1% AEP event.

1% AEP event

5.3.8. The effect of the Scheme with proposed design changes on the baseline conditions for the present day 1% AEP event (1 in 100-year return period) are detailed below.

5.3.9. Figure 5-3 shows changes in flood depths between the baseline and Scheme with design change scenarios. The results are broadly similar to those shown in Figure 5-1 for the 1% AEP event plus 53% climate change allowance event. The main differences are increases in flood depths across the floodplain of the Leigh Brook downstream of the M5. These are generally less than 0.05m with isolated topographic low spots having flood depths just over 0.05m. Average depths in this area are well below 0.05m. An assessment of the impact this increase would have on overall flood risk is presented in Chapter 5.4.

5.3.10. These increases are associated with the interactions between the overflow channel conveying flow from the smaller basin and the surface water drainage system to the North of the A4019. These will be mitigated during the design development of the FSA reconfiguration which will consider these interactions in more detail.

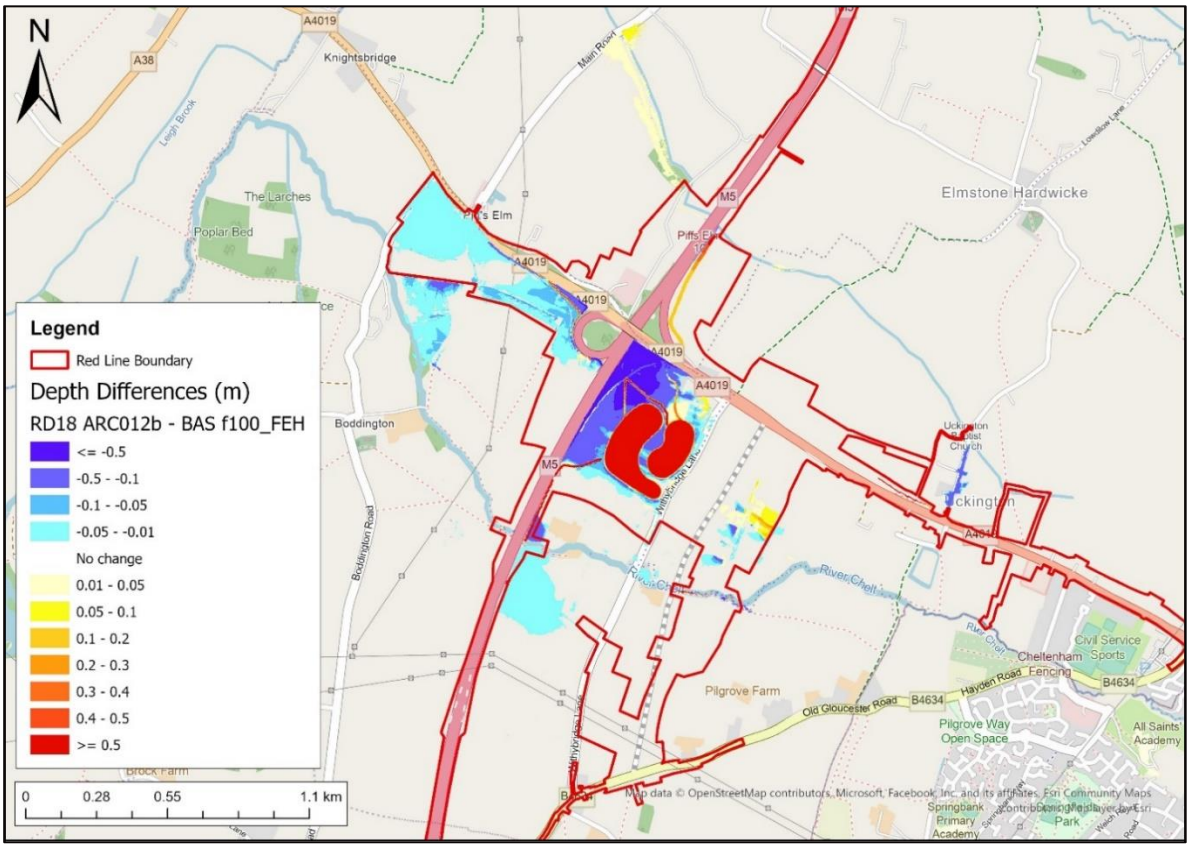


Figure 5-3 Flood depth differences for the 1% AEP event

5.3.11. Table 5-4 and Table 5-5 show peak flows and flood depths for the 1% AEP event in both the baseline and Scheme with proposed design changes scenarios. The reporting locations in Table 5-4 and Table 5-5 are shown in Figure 5-2.

5.3.12. The results in Table 5-4 show that there is a slight increase in flows passing through the Barn Farm culvert in the Scheme with proposed design changes scenario. This is driven by 0.24m³/s passing through the new culverts under the A4019, which convey flow from the flood storage basins to the Leigh Brook. There is a reduction in flow through the Piffs Elm culvert in the Scheme with proposed design changes scenario compared to the baseline since more floodwater is retained in the flood storage basins. Flows through the River Chelt bridge, Withybridge Lane bridge, and Piffs Elm Road bridge are similar for the baseline and Scheme with proposed design changes, with marginal reductions in the Scheme with proposed design changes scenario.

5.3.13. The results in Table 5-5 show that there are now flood depths of 0.11m on the Leigh Brook floodplain near the existing slip road and 0.01m at the Barn Farm culvert associated with the excavations for the proposed drainage ditch in Change 6. There is no longer flooding at Withybridge Gardens in the Scheme with proposed design changes scenario. This is due to the presence of the new ditches which form part of the FSA reconfiguration in Change 6. There are negligible changes in flood depths at the other locations shown in Table 5-5.

Table 5-4 1% AEP event peak flows

Location	Baseline peak flow (m^3/s)	Scheme peak flow (m^3/s)	Change in peak flow (m^3/s)
Barn Farm culvert	1.13	1.24	0.11
Piffs Elm culvert	3.04	1.85	-1.19
River Chelt bridge	17.82	17.37	-0.45
A4019 culvert*	0.00	0.24	0.24
A4019 overtopping	0.00	0.00	0.00
Withybridge Lane bridge	14.58	14.29	-0.29
Piffs Elm Road bridge	21.74	21.31	-0.43

**combined flood through two new culverts under the A4019*

Table 5-5 1% AEP event maximum flood depths

Location	Baseline maximum depth (m)	Scheme maximum depth (m)	Change in maximum depth (m)
Leigh Brook at Barn Farm culvert	0.81	0.82	0.01
Leigh Brook floodplain near existing slip road	0.00	0.11	0.11
Leigh Brook floodplain near A4019	0.00	0.02	0.02
Withybridge Gardens	0.20	0.00	-0.20
Eastern end of River Chelt floodplain	0.10	0.11	0.01
River Chelt at Piffs Elm Road	2.48	2.47	-0.01

5.3.14. The results provide sufficient confidence that the Scheme with the proposed changes can sufficiently maintain the hydraulic connectivity, floodplain conveyance and volumetric storage compared to the existing conditions in the 1% AEP event. As part of the Register of Environmental Actions and Commitments (REAC) [REP4-018], the Environment Agency (EA) are a consultee on the detailed design for minimising impacts on flood risk (WE17) and will be consulted throughout design development.

5.4. Summary of impacts on flood risk

5.4.1. The only change to the impacts on flood risk outside of Act limits presented in the FRA [REP5-008] is the increase in flood depth downstream of Barn Farm in the 1% AEP event. As set out in Chapter 5.3, the increases in flood depths are predominantly between 0.01m and 0.05m with an isolated low spot where flood depths are slightly higher than 0.05m. Flood depth increases over the entire floodplain are on average well below 0.05m and as such the assessment of impacts will consider them in the range 0.01m to 0.05m.

5.4.2. There is also a minor increase in flood depth on the floodplain of the River Chelt west of the Link Road in a 4% AEP event. This impact results from the location of the interpolates and cross-sections in the baseline model. The impact of the river realignment on model conveyance is shown a significant distance from the area proposed for realignment. This is a function of the model representation in this location rather than a result of the design change and these impacts will not be shown in the detailed design flood model which will be submitted to the EA to satisfy the REAC [REP4-018] commitment (WE17). For completeness, both impacts have been included in the impacts assessment presented in Table 5-6.

Table 5-6 Impact of flood risk

Location	Probability of Flooding	Consequence of flood risk	Change in flood risk
Upstream of Link Road on River Chelt floodplain – 4% AEP event	No change - area is flooded in the 4% AEP event.	Increase in flood depth of 0.01m to 0.02m drives a small increase in flood extent. Scale of changes are a non-material consequence	Non-material increase
Downstream of Barn Farm – 1% AEP event only	No change – area is flooded in the baseline 1% AEP event.	The minor increase in flood depth would result in an indiscernible increase in flood extent on the fields. Scale of changes are a non-material consequence	Non-material increase

5.4.3. Table 5-6 concludes that the adverse effects not mitigated by embedded mitigation do not change the flood risk to those areas and the increases in flood depth can be considered a non-significant impact. As such, according to the methodology used for the assessment of impacts for the Scheme, the effects should not be considered material.

5.4.4. Design development will seek to address the increases in flood depth. As part of the Register of Environmental Actions and Commitments (REAC) [REP4-018], the Environment Agency (EA) are a consultee on the detailed design for minimising impacts on flood risk (WE17) and will be consulted throughout design development.

6. Residual risk

6.1.1. The following sections identify the assessment of residual risks that have changed since the FRA [REP5-008] and presents and updated assessment of these risks. In keeping with the FRA [REP5-008] residual risks are flood events larger than the design flood and breach events.

6.2. Extreme flood event

6.2.1. As per the FRA [REP5-008], the 0.1% AEP event has been chosen as the extreme event to assess the Scheme with proposed design changes, and flood depths are presented in Figure 6-1. There are no changes to the findings presented in Chapter 6.1, that the new proposed highways would not be at risk of fluvial flooding in the 0.1% AEP event.

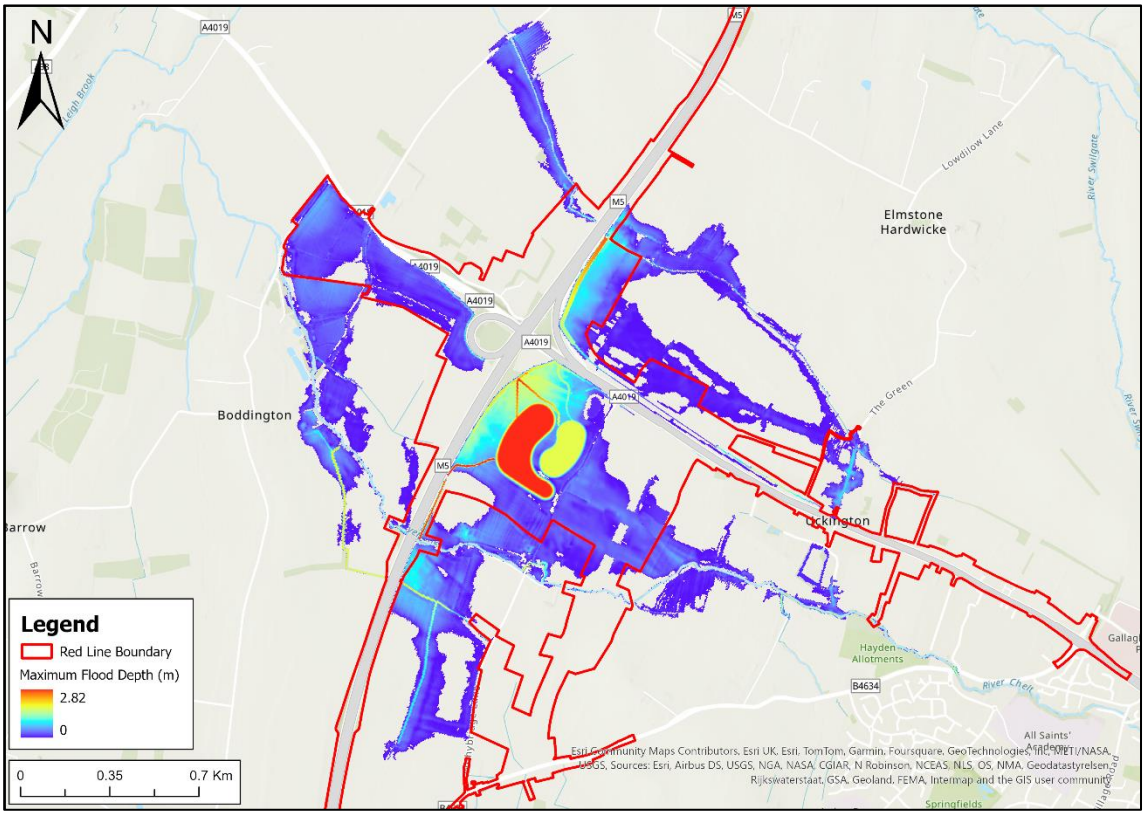


Figure 6-1 Flood depths in a 0.1% AEP event

6.2.2. It is anticipated that the drainage systems would not have been designed to cope with the rainfall predicted in this flood event and could result in flooding.

6.3. Upper end climate change event

6.3.1. To ensure that the Scheme with proposed design changes is resilient to the worst potential impacts of climate change, the 94% climate change event has been tested in the 1% AEP event. Flood depths are presented in Figure 6-2. There are no changes to the findings presented in Chapter 6.2, that the highways would remain operational under the worst potential impacts of climate change.

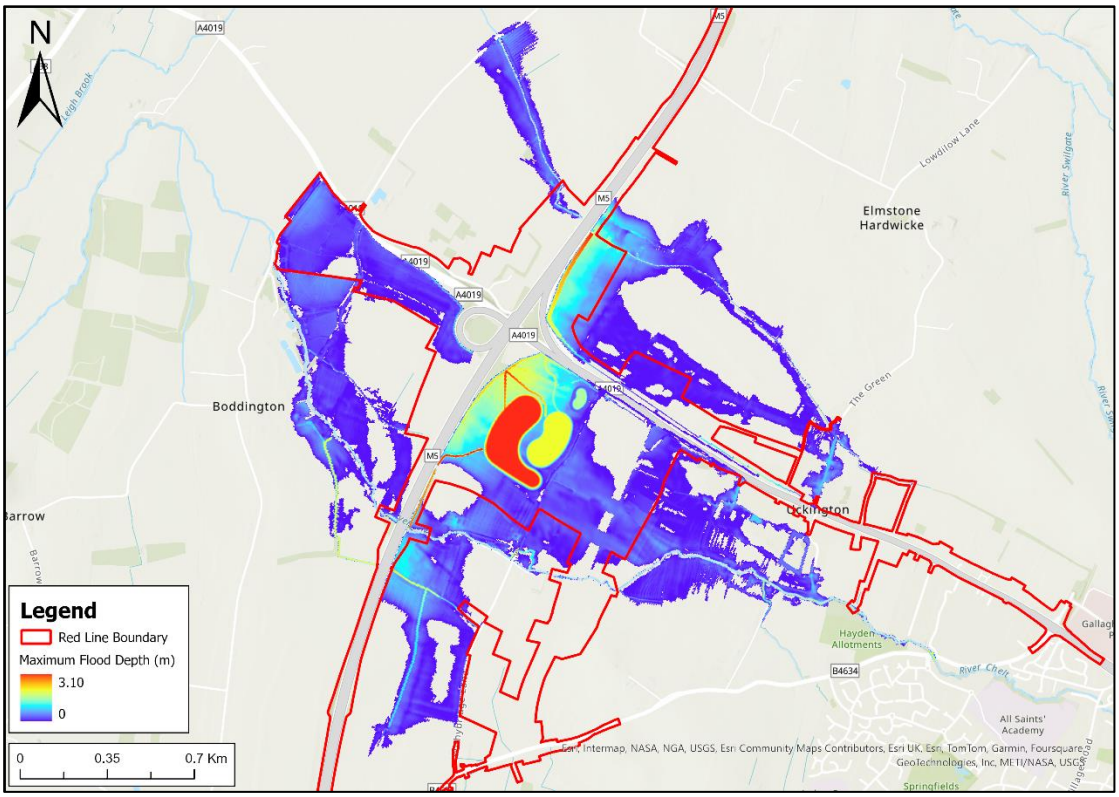


Figure 6-2 Flood depths in a 1% AEP event plus a 94% allowance for climate change

6.4. Risk of breach

Flood defence breach

6.4.1. There have been no changes to the raised defences since the FRA [REP5-008] was produced and therefore no changes to low risk of breach from any raised defences in the study area.

Reservoir breach

6.4.2. Change 6 has been designed to prevent the floodplain of the River Chelt to the South of the A4019 from being designated a 'large-raised reservoir' to avoid assets belonging to National Highways forming part of a statutory reservoir. Further details can be found in Appendix B.

6.4.3. The current threshold in England for defining a large, raised reservoir under the Reservoirs Act 1975 is 25,000m^3. The larger of the two basins has a retained volume (62,000m^3 below ground level) greater than this threshold and as such would be considered a reservoir under the Reservoirs Act 1975, and the Enforcement Authority will decide whether the reservoir is high risk or not high risk. The smaller basin is below the current threshold at 23,500m^3 stored below the lowest ground level.

6.4.4. The reservoir would be formed by removing material below the current ground level. To enable the reservoir to drain and provide storage for subsequent flood events, the reservoir would include a high-level conveyance channel, and a low-level outlet pipe connected to a conveyance channel. Both conveyance channels would also be constructed by excavating material below the current ground level. The outlets would potentially give breach locations.

6.4.5. In line with the methodology applied by the FRA [REP5-008] the detail of potential overtopping and breach locations and mechanisms as well as the consequences of such a breach will be assessed at the next stage of design for the FSAs.

6.4.6. It is anticipated that the reservoir would be considered a Category B (where a breach could endanger lives not in a community or result in extensive damage) or Category C (where a breach would pose negligible risk to life and cause limited damage) reservoir. Further analysis of the risk of breach from this reservoir will be undertaken during the design development of this structure.

7. Drainage proposals

7.1.1. The impact that each change would have on the drainage design has been set out in this chapter. It should be noted that these are minor changes and there are no changes to the overall catchments or peak flows discharged from the networks from each design change.

Change 1 - Link Road replacement of swales with filter drains

7.1.2. The change would not result in a reduction in the capacity of the surface water drainage system and there would be no change in eventual outfall rates from the proposed attenuation ponds.

Change 2 - Link Road replacement of box culverts with bridges

7.1.3. The replacement of the Link Road culverts with bridges would not result in any material changes to the drainage strategy.

Change 3 - Link Road River Chelt bridge structural form

7.1.4. The structural form of the River Chelt bridge and associated river realignment would not result in any material changes to the drainage strategy.

Change 4 - Link Road alignment

7.1.5. The amendments to the alignment of the Link Road would not result in any material changes to the drainage strategy.

Change 5 - Relocation of existing NRTS TS

7.1.6. The footprint of the proposed new NRTS transmission station is smaller than the existing footprint and is proposed to be located on an existing hardstanding area. As such there would be no change to the paved area as for consideration in the drainage strategy.

Change 6 - Flood storage area reconfiguration

7.1.7. The interaction between the Scheme drainage ditches and the conveyance channels associated with Change 6 have not been detailed as part of the design used in this assessment. This will be undertaken during the design development of the FSA reconfiguration and detailed design of the drainage system. It is not anticipated that this would result in material changes to the findings of either assessment.

Change 7 - Infill of existing northbound on-slip loop

7.1.8. The change includes realignment of an existing ditch designed to convey the excess flows from the grassed embankment. As a result of the reprofiling, this ditch is no longer required. There will be no change to the overall drainage strategy.

8. Conclusions

8.1.1. This FRA addendum has been produced to set out any amendments to the assessments in the FRA [REP5-008], resulting from the seven proposed design changes in Change Application 2. The changes to the Scheme are as follows:

- Change 1 - Link Road replacement of swales with filter drain
- Change 2 - Link Road replacement of culverts with bridges
- Change 3 - Link Road River Chelt bridge structural form
- Change 4 - Link Road alignment
- Change 5 - Relocation of existing NRTS transmission station
- Change 6 - Flood storage area reconfiguration
- Change 7 - Infill of existing northbound on-slip loop

8.1.2. There have been no changes to the risk of flooding to the Scheme from all sources as a result of the proposed design changes.

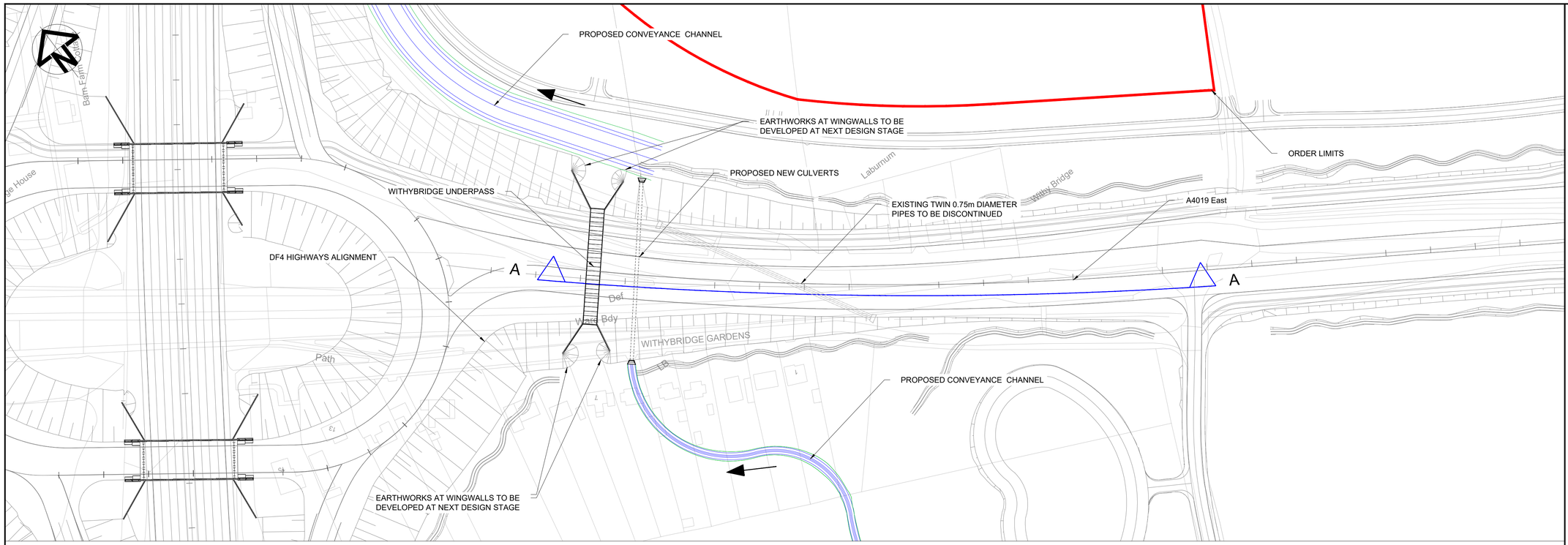
8.1.3. In the design 1% AEP plus 53% climate change fluvial flood event there have been no changes to overall impacts on the risk of fluvial flooding from the Scheme as a result of the design changes. In lower order events there are small increases in flood depth predicted on the River Chelt floodplain upstream of the M5 (4% AEP event) and Leigh Brook floodplain downstream of the M5 (1% AEP event). The impacts of these increases in flood depth have been assessed and are considered non-significant effects and as such should not be considered material. Both impacts will be removed through design development and reflected in the flood model to be submitted to the EA to satisfy the REAC [REP4-018] commitment (WE17).

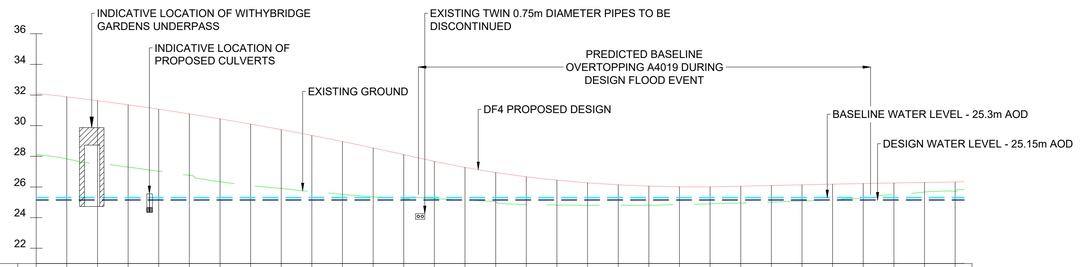
8.1.4. The FSA reconfiguration in Change 6 would reduce the maintenance responsibilities (when compared to the Scheme) by removing the requirement to use either the M5 or the A4019 road embankments as a means of impounding a reservoir.

8.1.5. The proposed scheme remains compliant with local and national policy and there are no flood risk grounds for objection to the scheme.

Appendices

Appendix A. Long section plots





DATUM: 21.000m

CHAINAGE (m)	0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	240.000	250.000	260.000	270.000	280.000	290.000	300.000
DF4 PROPOSED LEVELS (m)	32.114	31.882	31.632	31.363	31.075	30.770	30.445	30.102	29.741	29.361	28.962	28.545	28.110	27.670	27.279	26.945	26.666	26.442	26.271	26.143	26.056	26.011	26.008	26.045	26.094	26.140	26.182	26.222	26.259	26.293	26.324
EXISTING LEVELS (m)	28.120	27.829	27.536	27.296	27.021	26.758	26.341	26.093	25.897	25.696	25.515	25.352	25.235	25.234	25.134	25.041	24.856	24.818	24.802	24.799	24.803	24.851	24.899	24.950	25.013	25.084	25.181	25.279	25.546	25.664	25.711
LEVEL DIFFERENCE (m)	-3.994m	-4.053m	-4.096m	-4.067m	-4.054m	-4.012m	-4.104m	-4.009m	-3.844m	-3.665m	-3.447m	-3.194m	-2.875m	-2.436m	-2.146m	-1.904m	-1.809m	-1.624m	-1.469m	-1.344m	-1.254m	-1.161m	-1.109m	-1.095m	-1.081m	-1.055m	-1.001m	-0.943m	-0.712m	-0.629m	-0.613m

A4019 East LONGSECTION (A - A)

SCALE: H = 1:1000 V = 1:200

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. DESIGN FLOOD EVENT IS 100YR+53%CC.
3. WITHYBRIDGE UNDERPASS TO BE LOWERED TO PROVIDE FLOW CONNECTIVITY FROM SOUTH TO NORTH OF A4019.
4. ALL CULVERT SIZES AND LOCATIONS ARE SUBJECT TO DETAILED DESIGN AND ASSOCIATED HYDRAULIC MODELLING.
5. EXISTING TWIN 750mm DIA PIPES UNDER A4019 TO BE DISCONTINUED AND REPLACED WITH NEW CULVERTS. NEW CULVERTS TO INCLUDE 0.3m DEPTH OF GRAVEL BED.
6. THE CONCEPT HAS ONLY BEEN ASSESSED FROM FLOOD RISK / HYDRAULICS PERSPECTIVE AND NEXT STAGE WILL BE REVIEWED AND ASSESSED BY OTHER DISCIPLINES.
7. LOCATIONS AND DIMENSIONS OF ALL CHANNELS WILL BE FURTHER DEVELOPED AT THE NEXT DESIGN STAGE.
8. THE FLOOD MITIGATION ALTERNATIVE CONCEPT DESIGN HAS BEEN DEVELOPED USING AVAILABLE TOPOGRAPHIC DATA AND LIDAR DATASETS.

Rev	Date	Description	Prod.	Chk.	Rev.	App.
P01	19/08/24	FIRST ISSUE	RO	PE	IG	DM
P02	04/10/24	UPDATED FOR BOX CULVERTS	SB	MJ	DS	NH

Gloucestershire COUNTY COUNCIL

Project:

M5 Junction 10
Improvement Scheme

Site

Client

Gloucestershire County Council

Shire Hall, Westgate St, Gloucester
GL1 2TG
www.gloucestershire.gov.uk

ARCADIS GallifordTry

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London
EC3M 4BY

Coordinating office:
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London
EC3M 4BY
Tel: 44 (0)20 7812 2000

www.arcadis.com

Drawing Title:

M5J10
FLOOD MITIGATION ALTERNATIVE CONCEPT DESIGN
A4019 EAST LONG SECTION

Designed: S.Begum	Signed: Digitally Signed	Date: 04/10/24
Produced: S.Begum	Signed: Digitally Signed	Date: 04/10/24
Checked: M.Jack	Signed: Digitally Signed	Date: 04/10/24
Reviewed: D.Stone	Signed: Digitally Signed	Date: 04/10/24
Approved: N.Henderson	Signed: Digitally Signed	Date: 04/10/24
Design Stage: Preliminary Design		
Original Size: N/A	Grid: OS	Datum: AOD
Suitability Code: S4	Scale: 1:1000	Project Number: GCCM5J10

Suitability Description:
Suitable for Review and Authorization

Security Classification:

Drawing Number: GCCM5J10 - ARC - HGN - ZZ - SK - CH - 00068

Revision: P02

0 10 20 30 40 50
METRES

SCALE 1:500 (A1)
SCALE 1:1000 (A3)

Print Date: 2024-10-04 12:51:05

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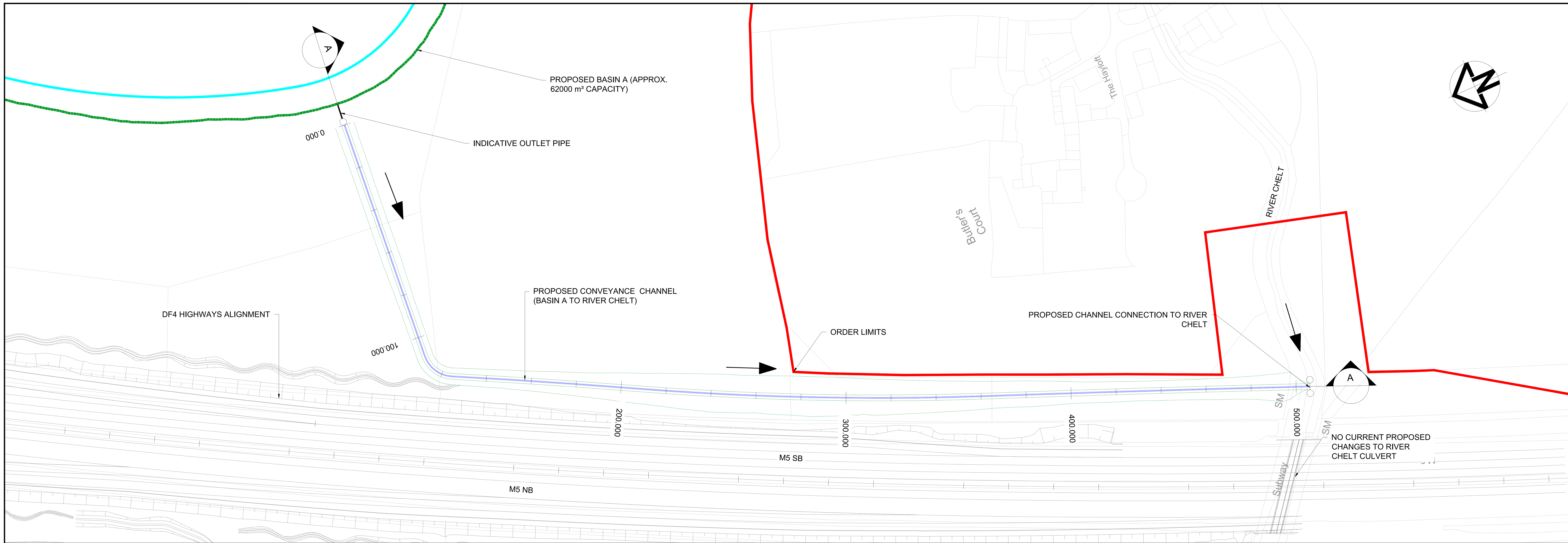


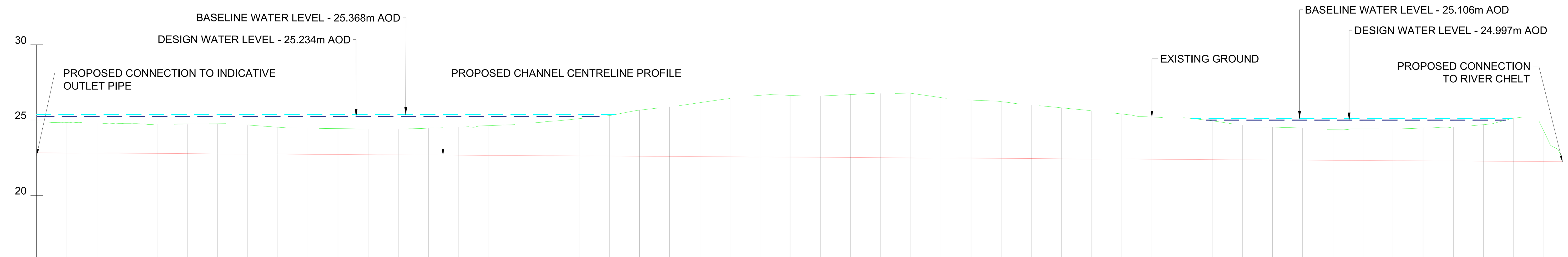
NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. PLEASE REFER TO DRAWING GCCM5J10-ARC-GEN-ZZ-SK-CH-00004 FOR DETAILS OF THE FLOOD MITIGATION ALTERNATIVE CONCEPT DESIGN.
3. DESIGN FLOOD EVENT IS 100YR+53%CC.
4. LOCATIONS AND DIMENSIONS OF CHANNELS WILL BE FURTHER DEVELOPED AT THE NEXT DESIGN STAGE.
5. THE FLOOD MITIGATION ALTERNATIVE CONCEPT DESIGN HAS BEEN DEVELOPED USING AVAILABLE TOPOGRAPHIC DATA AND LIDAR DATASETS.
6. THE CONCEPT HAS ONLY BEEN ASSESSED FROM FLOOD RISK / HYDRAULICS PERSPECTIVE AND THE NEXT STAGE OF DESIGN WILL INCLUDE REVIEW AND ASSESSMENT BY OTHER DISCIPLINES.
7. THE CHANNEL CONVEYING FLOW FROM BASIN A TO THE RIVER CHELT WILL INCLUDE A NON-RETURN VALVE TO PREVENT FLOODWATER FROM THE RIVER CHELT FLOWING UP THE CHANNEL AND INTO THE BASIN. THE LOCATION AND DETAILS OF THE NON-RETURN VALVE WILL BE UNDERTAKEN AT THE NEXT STAGE OF THE DESIGN PROCESS.
8. THE PROPOSED BASIN A AND BASIN B (REFER TO GCCM5J10-ARC-GEN-ZZ-SK-CH-00004 AND GCCM5J10-ARC-HGN-ZZ-SK-CH-00072) WILL BE DESIGNED SUCH THAT THEY OPERATE INDEPENDENTLY AND WILL NOT BE CONSIDERED AS A CASCADE.
9. BOTH BASIN A AND BASIN B WILL CONTAIN A LOW AND A HIGH LEVEL OUTLET. THE LOW LEVEL OUTLET WOULD COMPRISE A PIPE LEADING TO A TRAPEZOIDAL CHANNEL. THE HIGH LEVEL OUTLET WILL CONSIST OF A TRAPEZOIDAL NOTCH IN THE TOP OF THE BASIN.
10. ALL SIZES ARE SUBJECT TO DETAILED DESIGN AND ASSOCIATED HYDRAULIC MODELLING.
11. THE PROPOSED BASIN A WILL BE A RESERVOIR UNDER THE RESERVOIRS ACT 1975. THE RESERVOIR CLASSIFICATION AND RISK DESIGNATION ARE TO BE DISCUSSED AND AGREED WITH THE ENFORCEMENT AUTHORITY.
12. DRAINAGE CONNECTION TO PROPOSED CONVEYANCE CHANNEL AND CAPACITIES TO BE ASSESSED AT THE NEXT STAGE OF THE DESIGN PROCESS.

KEY:

TOP OF BASIN SLOPE

BOTTOM OF BASIN SLOPE



DATUM: 15.000m

CHAINAGE (m)	EXISTING LEVELS (m)	PROPOSED CONVEYANCE CHANNEL LEVELS (m)	LEVEL DIFFERENCE (m)
0.00	24.860	22.830	-2.030m
10.00	24.832	22.818	-2.014m
20.00	24.823	22.807	-2.017m
30.00	24.761	22.795	-1.966m
40.00	24.717	22.783	-1.934m
50.00	24.734	22.772	-1.962m
60.00	24.756	22.760	-1.996m
70.00	24.671	22.748	-1.923m
80.00	24.526	22.737	-1.789m
90.00	24.454	22.725	-1.729m
100.00	24.432	22.713	-1.718m
110.00	24.411	22.702	-1.710m
120.00	24.407	22.690	-1.717m
130.00	24.463	22.678	-1.785m
140.00	24.527	22.667	-1.860m
150.00	24.631	22.655	-1.976m
160.00	24.728	22.643	-2.084m
170.00	24.911	22.632	-2.279m
180.00	25.095	22.620	-2.475m
190.00	25.297	22.609	-2.689m
200.00	25.657	22.597	-3.060m
210.00	25.883	22.585	-3.298m
220.00	26.154	22.574	-3.581m
230.00	26.433	22.562	-3.871m
240.00	26.638	22.550	-4.088m
250.00	26.636	22.539	-4.097m
260.00	26.591	22.527	-4.064m
270.00	26.696	22.515	-4.180m
280.00	26.761	22.504	-4.258m
290.00	26.777	22.492	-4.285m
300.00	26.489	22.480	-4.009m
310.00	26.330	22.469	-3.861m
320.00	26.222	22.457	-3.765m
330.00	25.995	22.445	-3.549m
340.00	25.812	22.434	-3.378m
350.00	25.619	22.422	-3.197m
360.00	25.402	22.410	-2.992m
370.00	25.201	22.399	-2.802m
380.00	25.153	22.387	-2.766m
390.00	24.946	22.375	-2.571m
400.00	24.653	22.364	-2.289m
410.00	24.532	22.352	-2.179m
420.00	24.474	22.340	-2.134m
430.00	24.361	22.329	-2.032m
440.00	24.399	22.317	-2.082m
450.00	24.402	22.305	-2.096m
460.00	24.468	22.294	-2.175m
470.00	24.522	22.282	-2.239m
480.00	24.699	22.270	-2.429m
490.00	25.120	22.259	-2.861m
500.00	24.269	22.247	-2.022m
506.16	22.483	22.240	-0.243m

VERTICAL GEOMETRY (m): G = -0.117%, L = 506.164m

PROPOSED CONVEYANCE CHANNEL (BASIN A TO RIVER CHELT) LONGSECTION (A-A)

SCALE H 1:1000 V 1:200

Rev	Date	Description	Prod.	Chk.	Rev.	App.
P01	04/10/24	FIRST ISSUE	SB	MJ	DS	NH
P02	10/10/24	Notes and Annotations Update.	RO	AP	DS	NH

Gloucestershire COUNTY COUNCIL

Project:

M5 Junction 10 Improvement Scheme

Site

Client

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Drawing Title:

M5J10 FLOOD MITIGATION ALTERNATIVE CONCEPT DESIGN BASIN A TO RIVER CHELT LONG SECTION

	Signed	Date
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Appendix B. Independent review of reservoir proposal by All Reservoirs Panel Engineer

1. Independent review brief

Fairhurst was appointed by Arcadis (UK) Limited (Arcadis) in September 2024 to provide an independent review by an All Reservoirs Panel Engineer of flood storage area proposals for the M5 J10 project. The purpose of the review is to provide advice on the likely requirements for regulation of the flood storage areas under the Reservoirs Act 1975 (the 1975 Act).

The M5 J10 project is intended to provide four-way access from the M5 to the A4019. The proposals under review form part of an alternative design prepared by Arcadis. The original proposal has not been seen by Fairhurst and does not form part of this review. The alternative proposals are currently at concept design stage and subject to further development.

The review has been undertaken by Kenneth Barr, a Technical Director of Fairhurst and a member of the All Reservoirs (England & Wales) and All Reservoirs (Scotland) Panels.

2. Documents reviewed

The following documents were provided by Arcadis for review:

Memo:

GCCM5J10-ARC-EWE-ZZ-TN-LE-00017 –Alternative Flood Storage Area Concept Design, 7 August 2024

Report:

GCCM5J10-ARC-EWE-ZZ-TN-LE-00018 - Hydraulic Modelling Report, 9 August 2024

Drawings:

GCCM5J10 ARC-GEN-ZZ SK CH 00004 Rev. P05.2 - Concept Design - General Arrangement

GCCM5J10 ARC-GEN-ZZ SK CH 00068 Rev. P01.2 - Concept Design - A4019 East Long Section

GCCM5J10 ARC-GEN-ZZ SK CH 00072 Rev. P01.1 - Concept Design - M5 Mainline to Basin B - Cross Section

In providing this review, Fairhurst relies on these documents as being representative of conditions, and the scope of this review excludes any check of or liabilities for the accuracy of these documents.

Reference has been made to the Reservoirs Act 1975 (as amended) and associated regulations, and to *A Guide to the Reservoirs Act 1975, Second Edition, ICE, 2014*.

3. Regulatory context

The Reservoirs Act 1975 regulates reservoirs in England. The Act applies to large raised reservoirs, which are defined as reservoirs capable of storing a volume exceeding 25,000 cubic metres of water above the natural level of any part of the surrounding land. The Act was modified by the Floods & Water Management Act 2010, including an amendment to reduce the volume limit to 10,000 cubic metres. This provision has not yet been brought into effect by secondary legislation, but is likely to apply from some future date.

Road and railway crossings are commonly constructed across floodplains. Where crossings of the floodplain are conveyed on embankments for reasons of economy this may incidentally displace floodwater storage and divert overland flood routes. The 1975 Act as originally drafted did not explicitly exclude road or railway embankments. The Act has been amended by Regulation 3(d) of SI 2013 No. 1896 to clarify this issue. The regulation states that a road or railway embankment is not to be treated as a large raised reservoir except where drains through the embankment are artificially blocked to store water, or are constructed to store water above natural ground level.

4. Existing conditions

The M5 motorway passes to the west of Cheltenham in a roughly north-south direction. The A4019 crosses above the M5 in a roughly east-west direction to the north-west of Cheltenham. Junction 10 currently provides access to and from the M5 to the north to the A4019 to the east.

The M5 locally to Junction 10 is set slightly above the level of the surrounding land. There are two watercourses crossing the M5 in the vicinity. The River Chelt crosses east to west about 900m to the south of the junction. The Leigh Brook crosses east to west about 500m to the north. In addition, there is a drainage culvert known as the Piff's Elm Culvert crossing the M5 immediately to the south of the junction. There is a twin culvert crossing the A4019 in a south-north direction immediately to the east of the junction. The culverts under the A4019 are for road/run-off drainage rather than for fluvial flows.

The modelling output provided to Fairhurst indicates that in flood conditions, flood water leaves the channel of the River Chelt and enters the floodplain in the quadrant to the east of the M5 and south of the A4019. Floodwater ponds to a shallow depth against the M5 in the 100 year plus climate change design event and a proportion drains through the Piff's Elm Culvert. Floodwater also passes through the A4019 culvert into the quadrant to the north, eventually exceeding the culvert capacity and passing over the road at shallow depth. This floodwater follows an overland flood route north to the Leigh Brook.

In the existing condition, floodwater ponding on the floodplain against the road embankments does not constitute a large raised reservoir and is not registered as such, in accordance with Regulation 3(d).

5. Alternative proposal

The alternative proposal provides a grade separated interchange between the M5 and the A4019 with an elevated roundabout above the motorway. The slip roads and roundabout are elevated on embankments. The vertical alignment of the A4019 as it approaches the junctions is raised to accommodate the roundabout. A new underpass is provided under the A4019 to the east of the junction for local access.

It is proposed that the Piff's Elm Culvert is extended at each end with a slightly increased diameter. The existing twin culverts under the A4019 are to be discontinued and replaced with a new culvert or culverts.

Construction of the roundabout, slip roads and raised A4019 will displace floodwater and affect overland flow routes. This could increase flood risk at sensitive receptors, which would be unacceptable. The alternative proposals include compensatory flood storage areas in the form of two basins to be excavated below existing ground level in the floodplain of the south-east quadrant. The invert level of the new underpass is set to maintain the overland flood route to the north.

Proposed Basin A has an approximate capacity of 62,000 cubic metres. Proposed Basin B has an approximate capacity of 23,500 cubic metres. The basins would have control structures with low level outlets and high level overflows. Basin A would be connected to the River Chelt and to the extended Piff's Elm culvert by proposed open conveyance channels. Basin B would be connected to Piff's Elm culvert and the new A4019 culvert by similar conveyance channels.

The modelling output provided to Fairhurst indicates that in the design flood event, water levels within the floodplain would be slightly reduced (250mm reduction in current model) compared to the existing conditions.

6. Opinion of All Reservoirs Panel Engineer

Any storage volume held below the natural level of the surrounding land is not normally considered to form part of a raised reservoir. However, in this instance it is proposed to alter the level of the land surrounding the proposed basins by construction of open conveyance channels. The volumes of water retained in the two basins could escape via the channels in the event of a failure of the control structures. This appears to come within the intention of the 1975 Act to regulate reservoirs where the water contained is escapable.

It is recommended that Basin A is progressed on the assumption that it will constitute a large raised reservoir under the 1975 Act. The procedures of the Act in respect of appointment of a Construction Engineer and preparation of certificates are followed unless a clear precedent is identified. Basin B has a volume less than the current statutory limit. But may come under regulation at a later date.

Following completion, the reservoir or reservoirs may be designated by the Environment Agency as "not high risk" based on its assessment of the consequences of failure. This cannot be guaranteed but would give rise to a minimal ongoing regime of regulation.

Once the stored water level in the basins is exceeded, floodwater will be stored on the floodplain and will drain through the culverts and watercourses. In Fairhurst's opinion, water stored above overflow level or on the surrounding floodplain does not form part of the reservoir capacity as defined by the Act.

It is predicted by concept modelling provided to Fairhurst that floodwater will impound against the M5 and A4019 embankments, but to a lesser depth than in existing conditions. This should be demonstrated for a range of flood events.

On this basis, the road embankments of the M5 and A4019 as proposed do not intentionally impound floodwater and in Fairhurst's opinion do not constitute structures (dams, reservoir walls or embankments) as defined by the Act and associated regulations. They should not be considered as part of the large raised reservoir or reservoirs.

Prepared by:

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