Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section

Volume 6

Proposed Ribble Crossing

Chapter 8: Flood Risk

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8. Flood Risk

8.1 Introduction

1) This chapter presents a provisional assessment of flood risk posed to or by the Proposed Ribble Crossing due to rivers, rainfall, failure of a water retaining structure and groundwater. It has been agreed in consultation with Ribble Valley Borough Council and the Environment Agency that a further, supplemental report, detailing the outcome of fluvial flood risk modelling based on empirical watercourse data, shall be submitted in due course in support of the Proposed Marl Hill Section planning application.

2) The legislation and planning policies relevant to flood risk are considered in Volume 2 Section 8.3 of the Proposed Marl Hill Section ES and are not repeated here. Within this chapter, the assessment area and methodology for the assessment are outlined in Section 8.2. The nature, value and sensitivity of the existing, baseline environment is then described before an assessment is made of the potential effects of the Proposed Ribble Crossing on flood risk. Embedded mitigation and good practice measures relevant to flood risk are summarised in Section 8.4 and have been considered in the assessment in Section 8.6.

3) A provisional Flood Risk Assessment (FRA) has been produced in accordance with the requirements of the National Planning Policy Framework (NPPF). This is included within Appendix 8.1. The findings of the FRA are summarised in this chapter. This provisional FRA does not include any analysis of hydraulic modelling, which is being undertaken at the time of writing. The FRA will be updated once the results of this modelling are available.

4) The FRA identifies that the Proposed Ribble Crossing as part of the wider Programme of Works would comprise water transmission infrastructure which is classified as water-compatible development. As such it would be acceptable within areas of high flood risk if it can be demonstrated that it would be safe from flooding and not increase flood risk elsewhere.

8.2 Scoping and consultations

8.2.1 Scoping

5) A formal EIA Scoping Addendum was submitted to the relevant planning authorities in February 2021 which included details of FRA approaches for the Proposed Ribble Crossing as shown in Table 8.1.

Table 8.1: Scoping Assessment Summary

Flood Source / Assessment Element Ribble Crossing	Assessment Summary	Conclusion
Assessment Area The assessment area of the Proposed Ribble Crossing defines the area used to identify sources of flood risk and the potential spatial extents of impacts.	The assessment area is generally based on the planning application boundary (as shown on Figure 1 of the FRA) but also extends along the River Ribble approximately 1 km upstream and approximately 500 m downstream of the B6478 bridge over the Ribble.	Assessment area extended to identify potential areas of impact.
Coastal Flood Risk Flooding originating from the sea where water levels exceed the normal tidal range and flood onto the low-lying areas that define the coastline.	The Proposed Ribble Crossing is approximately 40 km from the River Ribble Estuary at an elevation of more than 50 m above Ordnance Datum (AOD). Therefore, no risk from this source has been identified and no further assessment is necessary.	Scoped out

Flood Source / Assessment Element Ribble Crossing	Assessment Summary	Conclusion
Fluvial Flood Risk (Main Rivers) Flooding originating from Main Rivers, including the River Ribble.	Environment Agency flood zone definitions are set out in the National Planning Policy Guidance (2014) and as set out in Table 8.3 of this chapter these range from 1 to 3, with Flood Zone 1 having the lowest flood risk. The Proposed Ribble Crossing would be located within Flood Zone 2 and 3 across the River Ribble. Construction phase discharges into the catchments of the River Ribble have the potential to increase flow and increase risk downstream.	Scoped in
Fluvial Flood Risk (Ordinary Watercourses) Flooding originating from minor watercourses, with localised flood risk issues.	The Proposed Ribble Crossing would also cross over three Ordinary Watercourses. Other design features including construction laydown areas, top-soil storage, welfare and generator locations would be located near to these Ordinary Watercourses.	Scoped in
Surface Water (Pluvial) Flooding resulting from high intensity rainfall, with runoff travelling overland and ponding in local topographic depressions before the runoff enters any watercourse, drainage systems or sewer.	Temporary access tracks and construction compounds would be constructed near or over surface water flow paths. These features also have the potential to increase runoff and flood risk downstream if not managed appropriately.	Scoped in
Groundwater Flooding due to a significant rise in the water table, normally as a result of prolonged and heavy rainfall over a sustained period.	There is potential for excavations to encounter groundwater and for the emergence of groundwater at the surface.	Scoped in
Failure of Water Retaining Infrastructure Flooding due to the collapse and/or failure of man-made water retaining features such as hydro-dams, water supply reservoirs, canals, flood defences structures, underground conduits, and water treatment tanks or pumping stations.	Environment Agency mapping indicates that flooding from West Bradford Reservoir would flow in the direction the Proposed Ribble Crossing. No canals or flood defences have been identified within the vicinity of the Proposed Ribble Crossing.	Scoped in
Sewer and Water Mains Flooding due to surcharging of man-made drainage systems.	United Utilities has not identified any areas of sewer flood risk in close proximity to the Proposed Ribble Crossing and no discharges to the public sewer network are proposed. Failure of water mains are a potential source of flooding but are unlikely to impact this type of development. Therefore, no further assessment of these sources is required.	Scoped out
Land Drainage and Artificial Drainage	No data is available on the location of local land drainage assets. Where these features are identified on site and	Scoped out

Flood Source / Assessment Element Ribble Crossing	Assessment Summary	Conclusion
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.	affected, they would be replaced if necessary, with assets that have the same performance. Therefore, the risk of flooding is unlikely to change, and no further assessment is required.	
Climate Change Climate change and the impacts associated with wetter winters and more intense storm events have the potential to increase flood risks.	The lifetime of the Proposed Ribble Crossing would be approximately six years starting in 2023 as part of the enabling and construction phase of the main HARP. The effects of climate change would not be discernible over this period.	Scoped out

8.2.2 Consultation

6) As Risk Management Authorities (RMAs), both the Environment Agency and United Utilities were consulted to obtain relevant historical and predictive flood risk datasets along with details and assets owned and operated that may influence flood risk. United Utilities responded to a data request to confirm that there are no public sewers within the assessment area or any sewer flooding incidents on record.

7) Consultation with Lancashire County Council as the Lead Local Flood Authority (LLFA) comprised formal responses to scoping and virtual workshops providing details of the proposals due to Covid-19 restrictions. Consultation to inform the planning and Environmental Permitting processes is ongoing.

8.3 Limitations and Assumptions

8) This assessment has been undertaken with the following limitations and assumptions:

- The assessment was based on the design details that were available at the time of writing, a qualitative review of national datasets and publicly available data only
- No site-specific ground investigation data within the assessment area including historical borehole logs were available at the time of writing
- A hydraulic river modelling and quantitative hydrological assessment is ongoing and the results will be submitted following the initial planning application. Therefore, the assessment of risk and potential scheme impacts at this stage have been determined based on a conceptual understanding of changes to flooding mechanisms, which will be updated at a later stage. Where there was uncertainty, a precautionary approach has been taken
- The Proposed Ribble Crossing would be designed using appropriate flood design standards and good practice to help mitigate the flood risks and potential scheme impacts. The Construction Code of Practice (CCoP) has been produced to provide an overview of appropriate flood design principles, standards and good practice to be considered at later stages of the design process.

8.3.1 Embedded mitigation and good practice

9) Embedded mitigation is inherent to the design, and good practice measures are standard industry methods and approaches used to manage commonly occurring environmental effects. The assessments presented in Section 8.6 of this chapter are made considering embedded mitigation and the implementation of good practice measures.

10) The need for any additional topic-specific essential mitigation (generally for effects likely to be significant in the context of the EIA Regulations) identified as a result of the assessment in Section 8.6 is then set out separately in Section 8.7.

Embedded Mitigation

11) Embedded mitigation measures were also considered when determining potential impacts on flood risk. Measures of relevance to flood risk is are set out below:

- A three-span structure that crosses the floodplain of the River Ribble on slender piers
- A flood relief culvert built into the embankment within the left-hand floodplain
- Clear span crossings of ordinary watercourses
- Soffit levels for all crossings set 600 mm above the 1 % AEP peak flood level
- The road surface constructed at grade across areas of floodplain
- Drainage systems based on SuDS to manage runoff from laydown areas and roads.

Good Practice Measures

12) Good practice measures are contained in Appendix 3.2: Construction Code of Practice (CCoP). These include:

- The development of flood response plans including subscription to flood warning services where available, the monitoring of water levels and plans to move equipment and staff to safety in the event of a flood
- Good materials management such as adding breaks into stockpiles to minimise disruption of flow.

8.4 Baseline Conditions

13) This section details the Flood Risk baseline for the assessment area and identifies receptors where there is potential for significant effects to arise. Baseline data were collated from a variety of sources in compiling this assessment, including:

- A desk-based assessment of publicly available data as detailed in Table 8.2
- Field Surveys undertaken by Jacobs staff between December 2019 and November 2020.

8.4.1 Information Sources

14) The assessment was undertaken with reference to the sources detailed in Table 8.2.

Table 8.2: Key Information Sources

Data Source	Reference
Environment Agency Flood Map for Planning (FMfP)	https://flood-map-for-planning.service.gov.uk/
Environment Agency Risk of flooding from Surface Water mapping	https://assets.publishing.service.gov.uk/What-is-the-Risk-of-Flooding-from-Surface-Water-Map.pdf
Risk of Flooding from Reservoirs mapping	https://data.gov.uk/dataset/44b9df6e-c1d4-40e9-98eb-bb3698ecb076/risk-of-flooding-from-reservoirs-maximum-flood-extent-web-mapping-service
Recorded Flood Outlines	https://data.gov.uk/dataset/16e32c53-35a6-4d54-a111-ca09031eaaaf/recorded-flood-outlines
British Geological Survey Mapping	https://mapapps2.bgs.ac.uk/geoindex/home.html
Ribble Valley Strategic Flood Risk Assessment	https://www.ribblevalley.gov.uk/download/downloads/id/7085/strategic_flood_risk_assessment.pdf
United Utilities Asset data	Consultation

15) The baseline sensitivity is assessed in Table 8.3. The features identified below are shown on Figures 2 to 4 in the FRA.

Table 8.3: Baseline summary

Feature	Value	Justification
Fluvial Flood Risk – River Ribble, West Bradford Brook and Waddington Brook (Main River)	Very High	The baseline assessment indicated that these Main Rivers pose a high risk of flooding. The floodplain of the rivers is classified as Flood Zone 3 indicating a high probability of flooding. Receptors identified include residential property in West Bradford, Clitheroe Road and agricultural land.
Fluvial Flood Risk - Tributaries (Ordinary Watercourses) of the River Ribble including Coplow Brook, Greg Sike, Unnamed watercourse 2097 and Unnamed watercourse 2099	High	The proposed crossings of these watercourses would be located within Flood Zone 3, or the probability of flooding inferred from the Risk of Flooding from Surface Water mapping would be 3.3 % AEP. Receptors identified include pastoral farmland.
Surface Water Flood Risk	Low to High	The probability of surface water flood risk across the assessment area was found to be generally low, with a probability of flooding less than 0.1 % AEP. However, surface water flow paths are present where the likelihood of flooding is 3.3 % AEP or greater. Receptors identified include pastoral farmland.
Reservoir Flooding from West Bradford Reservoir	Low	The failure of West Bradford Reservoir would pose a risk to land within the River Ribble floodplain that the Proposed Ribble Crossing passes through. However, the probability of failure would be low.
Groundwater Flood Risk from Superficial Deposits (Glacial Till and River Terrace Deposits)	Medium	Groundwater levels are likely to be in continuity with water levels in the River Ribble and there is potential that groundwater levels may be shallow.
Groundwater Flood Risk from Bedrock (Clitheroe Limestone Formation and Hodder Mudstone)	Medium	Groundwater levels are likely to be in continuity with water levels in the River Ribble and there is potential that groundwater levels may be shallow.

8.5 Assessment of likely significant effects

16) The following section describes the effects of the Proposed Marl Hill Section on Flood Risk during the construction and operational phases.

8.5.1 Enabling Works Phase

17) Enabling works would include:

- Clearance of hedgerows, trees and vegetation at the access points with West Bradford Road towards Waddington and towards Clitheroe
- Vegetation clearance at other locations along construction easement (noting that construction easement will be wider than the final sealed surface)

- Installation of stock-proof fencing and crossing points along the road corridor and around compounds
- As noted above stock proof fencing would be required, but Heras fencing would be used in compounds for security. Minor reprofiling and stone laying to laydown areas and compounds. Installation of site cabins
- Temporary bridge construction access and bridge access track construction. Dry stone wall removal
- Formation of bridge construction working areas, including crane platform
- Establish crossing points for Public Rights of Way bisected by construction easement.

18) The impacts of these enabling phase activities would be limited to short term, negligible changes in surface water runoff rates and patterns. These would be mitigated by embedded mitigation, including the installation of temporary drainage which would be installed as part of the construction phase which would follow immediately after the enabling phase.

19) The summary of enabling works effects are shown in Table 8.4.

Table 8.4: Summary of Enabling Works Effects

Environmental / Community Asset	Value / Sensitivity	Effect	Duration	Magnitude	Significance of Effect (Pre-Mitigation)
Surface water flood risk	Low to High	Increase in surface water runoff rates from the creation of low permeability surfaces including compounds and tracks.	Temporary, enabling phase only	Negligible	Neutral – Not Significant

8.5.2 Construction Phase

20) Construction phase works would include:

- Installation of pollution control techniques e.g. sediment control in watercourses, surface run-off and sediment control around designated soil stockpile areas
- Topsoil stripping along the haulage route corridor
- Topsoil storage mound formation, taking account of use of soil stockpiles for visual mitigation from properties, school etc. – only if specified in Environmental Masterplan
- Construction of the road base and tarmac wearing course, including drainage and fencing. Access off highway at southern extent would require earthworks and culvert to allow floodwater to pass through
- Construction of bridges for smaller watercourse crossings
- Construction of the Bailey bridge – 72 m main span of the River Ribble and two shorter 34 m spans to span the flood plain. Total bridge span of approximately 140 m
  - Piling and construction of concrete abutments and columns
  - Installation of modular bridge sections by crane
- Includes parapets, pedestrian footway and solid deck to ensure no risk of falling debris to users of the Public Rights of Way (PRoW) below
- Reinstatement of laydown areas, compounds and other disturbed areas and return to agricultural use where possible.

21) During the outline design stage of the Proposed Ribble Crossing, several crossing locations were considered, taking into account a range of design and environmental considerations including flood risk. The location of the proposed access road and temporary bridge crossing has been confirmed, as it is believed to be the best location due to the stable straight channel, the relatively narrow floodplain, and its proximity to the existing road network.

22) Embedded mitigation measures detailed in Section 8.3.1 would reduce the magnitude of predicted effects. As identified within Section 8.1, hydraulic modelling has not been undertaken at the time of writing. However, the predicted impacts are summarised below.

- Loss of Floodplain Storage – Due to the width of the floodplain in this location, it would not be practical to cross this in a single span and avoid any impacts. However, embedded mitigation measures detailed in Section 8.3.1 would minimise the loss of floodplain storage. The volume of storage that would be lost has not been quantified[1] but is likely to be negligible compared to the floodplain volume within Flood Zone 3 as inferred from the Environment Agency's Flood Map for Planning. A precautionary approach has been taken and it is assumed that the loss of floodplain storage would have a minor magnitude of impact on flood risk within the assessment area, due to the placement of the bridge piers and embankment in the floodplain
- Constriction of fluvial flood flows along the River Ribble – Structures within the floodplain of the River Ribble including piers and bridge embankments would act as a barrier to floodplain flow. Embedded mitigation measures including slender piers and a soffit level set at 600 mm above the 1 % AEP flood level would minimise this effect, but it is likely that flood waters would back up behind the structures within the floodplain. A conceptual assessment undertaken within the FRA has identified the following potential impacts:
  - The onset of flooding would not change. The existing Clitheroe Road bridge located immediately upstream of the Proposed Ribble Crossing has a smaller capacity than the proposed bridge. Therefore, floodwater would back up behind the existing bridge before overtopping into the downstream floodplain. This mechanism would not be changed by the proposed bridge which has no structures within the channel of the River Ribble
  - The extent of flooding is predicted to increase, but the magnitude of the impact would be negligible. The topography rises relatively steeply on either side of the floodplain and therefore, whilst depths may increase, the impact of this on flood extents would be negligible and no new receptors are predicted to be exposed to flooding
  - The depth of flooding is predicted to increase. Hydraulic modelling is being undertaken at the time of writing to quantify this impact and details will be provided in a supplemental report. Although it is not possible to quantify the increase in flood depth without hydraulic modelling, it is predicted that the magnitude of the impact on flood depth within pastoral farmland that currently forms the existing floodplain would be moderate. With the existing Clitheroe Road bridge forming a hydraulic break, it is predicted that the magnitude of the effect on flood depth at Clitheroe Road and upstream of this point would be negligible
  - The risk of blockage would not increase. The existing West Bradford Road bridge has a smaller capacity then the proposed River Ribble Crossing and includes piers within the channel. Any debris from upstream would be blocked by this existing bridge and so would be less likely to block the proposed bridge
- Constriction of reservoir flood flows – Whilst the Proposed Ribble Crossing would have the potential to restrict flow from a reservoir flood event, the likelihood of such an event occurring during the construction phase of the temporary haul route is extremely low and the magnitude of impact is considered to be negligible
- Constriction of flows along Ordinary Watercourses – The design of the three Ordinary Watercourse crossings with a clear span and a soffit level set 600 mm above the 1 % AEP peak flood level would

[1] The volume of lost storage will be calculated and presented in the supplemental FRA report.

minimise the risk of flow being constricted for this design flood event. Existing culvert crossings have been identified upstream of each of the proposed crossings which already constrict flow. Therefore, the magnitude of impact on the onset, extent and depth of flooding due to the proposed ordinary watercourse crossings would be negligible

- Impacts on surface water runoff – The proposed access road and the proposed construction compounds are located on existing greenfield sites currently comprising agricultural land. The compaction of soil and the creation of impermeable surfaces associated with the proposed construction compounds have the potential to increase the rate of surface water runoff which could have impacts on local surface water flood risk and/or fluvial flood risk within the receiving watercourse. However, the management of surface water runoff using the proposed surface water drainage system would limit runoff to greenfield rates and the magnitude of impact on surface water or fluvial flood risk would be negligible
- Dewatering of excavations – This has the potential to reduce groundwater levels locally whilst the use of soakaway drainage has the potential to result in localised increases in groundwater levels. Management of groundwater in line with good practice measures outlined within the CCoP would result in the magnitude of any impacts on groundwater flood risk being negligible
- Potential impacts associated with the construction compounds – These would apply during the construction phase only whilst the impacts associated with the bridges and road and would apply during the construction and operational phase.

23) Based on assumptions outlined in Section 8.3 it is anticipated that the magnitude of impact on flood risk for the construction phase works would generally be negligible, resulting in a Neutral significance of effect.

24) The constriction of the River Ribble Crossing would have a moderate magnitude of impact and Large significance of effect. The loss of floodplain storage would result in an effect of minor magnitude and Moderate significance. Therefore, additional mitigation would be required. This is detailed in Section 8.7.

25) The summary of construction effects is shown in Table 8.5.

Table 8.5: Summary of Construction Phase Effects

Environmental / Community Asset	Value / Sensitivity	Effect	Nature of Effect	Magnitude	Significance of Effect (Pre-Mitigation)
Fluvial Flood Risk – The River Ribble (Main River)	Very High	Constriction of floodplain flood flows increasing in flood levels upstream	Temporary, Construction and Operational phases only	Moderate	Large – Significant
Fluvial Flood Risk – The River Ribble (Main River)	Very High	Loss of floodplain storge increasing flood depths	Temporary, Construction and Operational phases only	Minor	Moderate – Significant
Fluvial Flood Risk – Tributaries (Ordinary Watercourses) of The River Ribble	High	Constriction of fluvial flows by new bridge crossings	Temporary, Construction and Operational phases only	Negligible	Neutral – Not Significant
Fluvial Flood Risk –	High to Very High	Increase in surface water runoff rates	Temporary, Construction	Negligible	Neutral – Not Significant

Environmental / Community Asset	Value / Sensitivity	Effect	Nature of Effect	Magnitude	Significance of Effect (Pre-Mitigation)
Tributaries (Ordinary Watercourses) of the River Ribble		into receiving watercourses from the creation of low permeability surfaces including compounds and tracks	and Operational phases only		
Surface Water Flood Risk	Low to High	Increase in surface water runoff rates from the creation of low permeability surfaces including compounds	Temporary, Construction phases only	Negligible	Neutral – Not Significant
Surface Water Flood Risk	Low	Increase in surface water runoff rates from the creation of low permeability road surfaces	Temporary, Construction and Operational phases only	Negligible	Neutral – Not Significant
Groundwater Flood Risk	Medium	Change in groundwater levels due to dewatering of excavations and soakaway drainage	Temporary, Construction phases only	Negligible	Neutral – Not Significant
Reservoir Flood Risk	Low	Constriction of flood flows and displacement of floodwater increasing in flood levels upstream	Temporary, Construction and Operational phases only	Negligible	Neutral – Not Significant

8.5.3 Operational Phase

26) Works associated with the operational phase including:

- Construction traffic for the Proposed Marl Hill Section using the haulage route serving the compounds
- Security presence at either end of route to control access onto the haul route.

27) The decommissioning of the construction compounds and laydown areas and their restoration to agricultural land would ensure that the effects on flood risk associated with these features would end at the end of the construction phase.

28) However, impacts associated with the road and bridges would continue during the seven-year operational phase. There would be no new impacts associated with these features and the magnitude of the impacts would remain unchanged during the construction phase. Mitigation measures for the significant effects associated with the constriction of fluvial flows and the loss of floodplain storage would also be the same as that detailed for the construction phase. This is detailed in Section 8.6.

8.5.4 Decommissioning Phase

29) During the decommissioning of the Proposed Ribble Crossing, the adverse impacts associated with the bridge structures and road would end with the bridges and road dismantled.

30) With all the structures removed and the land reinstated to its pre-construction state, there would be no constriction of floodplain flows or loss of floodplain. However, the establishment of compounds and laydown areas to enable the decommissioning would have the potential to result in a temporary increase in surface water runoff during the decommissioning phase. Embedded mitigation applied during the decommissioning phase would be similar to that used during the construction phase with temporary drainage managing runoff. This would reduce to potential impact on flood risk to a negligible magnitude resulting in a significance of Neutral.

31) The summary of operation effects is shown in Table 8.7.

Table 8.7: Summary of Decommissioning Phase Effects

Environmental / Community Asset	Value / Sensitivity	Effect	Nature of Effect	Magnitude	Significance of Effect (Pre-Mitigation)
Fluvial Flood Risk – Tributaries (Ordinary Watercourses) of the River Ribble	High to Very High	Increase in surface water runoff rates into receiving watercourses from the creation of low permeability surfaces including compounds and tracks.	Temporary, decommissioning phase only.	Negligible	Neutral – Not Significant
Surface Water Flood Risk	Low	Increase in surface water runoff rates from the creation of low permeability surfaces including compounds.	Temporary, decommissioning phase only.	Negligible	Neutral – Not Significant
Surface Water Flood Risk	Low	Increase in surface water runoff rates from the creation of low permeability road surfaces.	Temporary, decommissioning phase only.	Negligible	Neutral – Not Significant
Groundwater Flood Risk	Medium	Change in groundwater levels due to dewatering of excavations and soakaway drainage.	Temporary, decommissioning phase only.	Negligible	Neutral – Not Significant

8.6 Mitigation and Residual Effects

32) As explained in Section 8.4.4, the assessment of effects in Section 8.6 considers the application of both embedded mitigation and good practice measures. This section identifies additional essential mitigation identified through the assessment process, and then sets out the residual effects taking all three categories (embedded, good practice and essential) into account.

33) Essential mitigation has been identified for potential significant effects on fluvial flood risk in the River Ribble due to constriction of floodplain flows and loss of floodplain storage. These impacts would be temporary and would apply to the construction and operational phase but due to their significance, essential mitigation is identified in this section to address them.

34) Mitigation measures associated with the potential impacts would be informed by a detailed FRA informed by hydraulic modelling that is being undertaken at the time of writing this assessment (**Mitigation item FR-RC1**). The focus of mitigation measures would be to optimise the design of the Proposed Ribble Crossing to reduce the impacts to a negligible magnitude of impact. If this is not possible then a short-list of additional mitigation measures would be considered including floodplain compensation storage and agreement with landowners for any financial losses resulting from the impacts of the bridge.

35) With this mitigation in place, it is predicted that the magnitude of residual impact would be negligible with a Neutral significance of effect. Details of these further assessments and any additional mitigation requirements would be confirmed and presented as part of an FRA addendum report.

36) The summary of mitigation and residual effects is shown in Table 8.8.

Table 8.8: Summary of Mitigation and Residual Effects

Scheme Component	Mitigation Item ID	Mitigation	Magnitude (With Mitigation)	Residual Effect and Significance
Bridges across the River Ribble	**FR-RC1**	Detailed assessment of impacts and optimisation of the design with further additional mitigation if necessary.	Negligible	Neutral – Not Significant

8.7 Cumulative Effects

37) The following section provides an overview of the potential cumulative effects from different proposed developments and land allocations, in combination with the Proposed Ribble Crossing (i.e. inter-project cumulative assessment). Data on proposed third party developments and land allocations contained in development plan documents were obtained from various sources, including local planning authority websites, online searches, and consultations with planning officers. Proposed development data were then reviewed with a view to identifying schemes or land allocations whose nature, scale and scope could potentially give rise to significant flood risk effects when considered in combination with the flood risks associated with the Proposed Ribble Crossing.

38) Intra-project cumulative impacts, i.e. two or more types of impact acting in combination on a given environmental receptor, property or community resource, are considered in Chapter 14: Communities and Health.

39) The over-arching cumulative effects of the Proposed Programme of Works i.e. the five proposed replacement tunnel sections in combination, are considered in Chapter 19: Cumulative Effects. In addition, Chapter 19 examines the cumulative effects associated with the outcomes from Volume 2 (delivery and operation of the main construction compounds, tunnel, and construction traffic routes), Volume 5 (proposed off-site highways works and satellite compounds), and Volume 6 (Proposed Ribble Crossing).

40) Based on professional judgement, it was concluded that there are no proposed third party developments or land allocations in local development plan documents which could potentially give rise to likely

significant cumulative effects. No cumulative assessment was therefore undertaken in connection with flood risk.

8.8 Conclusion

41) Following a scoping assessment, four sources of risk were identified as requiring flood risk assessment: fluvial flooding, surface water, groundwater, and reservoirs.

42) The Proposed Ribble Crossing would be designed using appropriate flood design standards and good practice to mitigate the flood risks and potential scheme impacts. The CCoP has been produced to provide an overview of appropriate flood design principles, standards and best practice to be considered at later stages of the design process. With embedded mitigation and commitments to apply good practice it is assumed that the Proposed Ribble Crossing would remain safe from flooding and would not impact flood risk elsewhere.

43) Significant potential effects have been identified relating to the constriction of floodplain flows and the loss of floodplain storage and additional mitigation would be required relating to these impacts. Mitigation measures would be informed by a detailed FRA and with this additional essential mitigation effectively applied, the Proposed Ribble Crossing would have a neutral overall effect on flood risk. This detailed FRA is underway at the time of writing and is scheduled for completion in Summer 2021.

44) In conclusion, with additional essential mitigation implemented, the Proposed Ribble Crossing is predicted to be safe from flooding throughout its operational life and would not increase the risk of flooding elsewhere. Therefore, it would comply with the requirements of the NPPF and with the requirements of local planning policies and guidance.

8.9 Glossary and Key Terms

45) Key phrases and terms used within this technical chapter relating to Flood Risk are defined within Volume 4 Appendix 1.2: Glossary and Key Terms.