MetroWest

Portishead Branch Line (MetroWest Phase 1)

TR040011

Applicant: North Somerset District Council
Response to the Planning Inspectorate's letter of advice under s 51 of the Planning Act 2008 and dated 24 January 2020
Planning Act 2008

Author: Jacobs
Date: March 2020

Jacobs

Memorandum

Portishead Branch Line (MetroWest Phase 1) DCO Scheme

Response to the Planning Inspectorate's letter of advice under s 51 of the Planning Act 2008 and dated 24 January 2020 ("s 51 Letter")

This document sets out North Somerset District Council's ("**the Applicant's**") response to the Planning Inspectorate's request for information contained in the s 51 Letter.

<table>
<tr><th>Planning Inspectorate's comment</th><th>The Applicant's response</th></tr>
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<td>
The Planning Inspectorate has undertaken an initial review of the Flood Risk Assessment ("FRA") submitted as part of the Portishead Branch Line (MetroWest Phase 1) Development Consent Order (DCO) application. See APP-076 to APP-092, duplicated in APP-173 to APP-189. Some concerns were identified during the acceptance stage relating to the FRA and the Inspectorate has raised the following issues and has requested a response from the Applicant:
Flood Risk Assessment Currency
The Inspectorate has identified apparent inconsistencies within the FRA relating to the climate change allowances used in modelled scenarios. The inconsistencies relate to allowances for rainfall intensity, peak river flow and sea level rise. Section 5 of the Applicant's FRA Report states that projected climate change allowances were derived following the NPPF 2013 guidance (which is based on DEFRA 2006 climate change guidance). The Inspectorate notes that the NPPF was updated in February 2019, and revised in line with UK Climate Projections 2018, prior to the DCO application being made in November 2019
The inconsistences are broadly as highlighted in the tables below.
<table>
<tr><th colspan="3">Rainfall intensity: Applicant's Assessment</th><th colspan="2">NPPF Guidance recommendatio</th></tr>
<tr><td>Year</td><td>2075</td><td>2115</td><td>2040 to 2069 (2050s)</td><td>2070 to 2115 (2080s</td></tr>
<tr><td>Allowance</td><td>20%</td><td>30%</td><td>UE = 20%
C = 10%</td><td>UE = 40%
C = 20%</td></tr>
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The guidance states that central and upper end allowances should be used in flood risk assessments to understand the range of impact.
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<tr><th colspan="3">Peak river flow (Severn): Applicant's Assessment</th><th colspan="2">NPPF Guidance recommendation</th></tr>
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<tr><td>Allowance</td><td>20%</td><td>20%</td><td>UE = 40%
HC = 25%
C = 20%</td><td>UE = 70%
HC = 35%
C = 25%</td></tr>
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The guidance states that upper end allowances should be used for essential infrastructure in flood zones 2 or 3a.
NPPF Guidance recommendation
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Section A
It is clear that the climate change allowances in the Inspectorate's tables have been taken from paragraph 5.1.5 of the FRA which states:
"The following climate change allowances have been applied in the modelling undertaken for this FRA:
• Extreme rainfall depths: +20% for 2075; +30% for 2115
• Extreme river flows: +20% for 2075 and 2115
• Sea level rise: +0.59 m between 1990 and 2075; +1.14 m between 1990 and 2115
• Extreme wind speed: +10%
• Extreme wave height: +10%. "

Whilst the Inspectorate has used the correct allowances in the tables provided in the s 51 letter, the Applicant wishes to explain that these were not the climate change allowances applied in the modelling for all the catchments and for all parts of the Proposed Development:

1. The allowances for rainfall intensity (or extreme rainfall depths) for small catchments (< 5km^2) fluvial models (Drove Rhyne and Easton-in-Gordano Stream) are 20% for 2075 and 30% for 2115 as referred to above. However, for Longmoor and Colliter's Brooks (catchment areas 8.6km^2 and 5.4km^2 respectively) a 25% allowance was applied for both 2075 and 2115. This is because the FRA uses Bristol City Council's (BCC) Central Area Flood Risk Assessment (CAFRA) model to assess fluvial flood risk in Longmoor and Colliter's Brooks (as well as River Avon tidal flood risk). The CAFRA model fluvial climate change allowances specified in the model boundary conditions were retained (+25%) as this was consistent with BCC's CAFRA modelling. Also, the climate change allowances applied in the drainage design for the permanent development sites at Portishead and Pill Station car parks, haul roads and compounds was 40% (see document APP 192 - 6.26 Surface Water Drainage Strategy for Portishead and Pill Stations, Haul Roads and Compounds) which is the Upper End for 2070 to 2115 in the updated NFFP guidance (December 2019 NPPF Guidance – see - https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances). Also, the Applicant's climate change allowance was 30% for the stations and platforms and 20% for the track (see section 8.3 FRA). This was because Network Rail's GRIP 3 design uses a 30% allowance for station buildings and platforms and 20% for track. However, the Applicant formally acknowledges that at detailed design at GRIP 5 it will need to consider a design capacity reflecting an allowance of 40% for climate change which may be enforced through Requirement 11 of the draft DCO.

2. For the peak river flow the allowance of 20% referred to in paragraph 5.1.5 of the FRA is not correct. As described in the FRA, the only element of the Applicant's modelling that applied river flow allowances was the fluvial simulations undertaken with CAFRA hydraulic model. This modelling applied a 25% allowance for both 2075 and 2115 (to be consistent with the CAFRA modelling). The Applicant has however explained the implications of using the December 2019 NPPF Guidance climate change allowances in Tables 1 and 2 in Appendix 1. The tables show that the Applicant has run further models using the December 2019 NPPF. Guidance for sea level rises (tidal River Avon flooding), and increased rainfall allowances (applied in the Longmoor and Colliter's Brooks and Easton-in-Gordan Stream fluvial models). Furthermore, notwithstanding the reference to the small size of the catchments (see table 1) the Applicant will also re-run the simulation with a 70% allowance for fluvial flooding as an "upper limit" sensitivity test.
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Planning Inspectorate's comment	The Applicant's response
Sea level (South west): **Applicant's Assessment** Year: 1990 to 2075	1990 to 2115	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative 2000 to 2125 (m) Allowance: 0.59m	1.14m	HC = 5.8 UE = 7	HC = 8.8 UE = 11.4	HC = 11.7 UE = 16	HC = 13.1 UE = 18.4	HC = 1.21 UE = 1.62 The Inspectorate understands that rainfall intensity and peak river flow allowances have not been amended in the NPPF guidance since February 2019, but notes that further guidance on their use was added in the December 2019 update. The Inspectorate also understands that updates to NPPF guidance for sea level were made in December 2019, after the DCO application was made.	3. **Rainfall intensity** and **peak river flow** have some but not a significant impact on flood risk (see implications in Tables 1 and 2 in Appendix 1). The most significant impact of future projected climate change on flood risk will be an increase in tidal (River Avon) flood risk due to the projected **sea level rise**. (see paragraph 2.4.12 of the FRA). For sea level rises, paragraph 5.1.5 of the FRA denotes the increases in sea levels to 2075 and 2115 due to climate change (0.59m and 1.14m) used in the CAFRA model. The December 2019 NPPF Guidance levels are generally higher but as the Inspectorate acknowledges, these figures were only updated in December 2019 after the DCO application was made. A copy of the sea level rise guidance adopted at the time of the study (pre-December 2019 guidance) is provided in Appendix 3. These were the sea level rise allowances that were current at the time of submitting the DCO application and it was therefore a pragmatic and reasonable approach to have taken. The Applicant also explains in paragraph 4.2.17 and table 4.4 of the FRA, the Environment Agency (**EA**) Coastal Flood Boundary (**CFB**) 2018 Extreme Water Levels (**EWL**) at Avonmouth was compared with those of the CFB 2011 dataset (applied in the CAFRA modelling). This comparison shows the revised CFB 2018 EWLs are lower than equivalent CFB 2011 EWLs, by 0.09 m for the 20 year return period EWL. This indicates that whilst the CAFRA modelling uses the climate change allowances derived from the NPPF 2013 guidance it overstates "present day" tidal flood risk compared to the more recent 2018 CFB EWLs. Also Section C together with Tables 3 and 4 in Appendix 1 below compares EWLs at Avonmouth applied in the Portishead Branch Line (MetroWest Phase 1) tidal River Avon modelling (as a downstream boundary condition) with those derived by applying the values of the current CFB 2018 EWLs adjusted to future years with the current sea level rise allowances for flood risk assessments (as updated in the December 2019 NPPF Guidance). In other words using the climate change allowances in the Inspectorate's table for sea level rises opposite. The Applicant however readily acknowledges that ideally the most recent climate change allowances should have been used throughout where possible. The reason for this omission is mainly due to the FRA having being conducted over a number of years prior to the February 2019 NPPF guidance. The Applicant's consultants also agreed with the EA use of the NPPF2013 allowances in September 2015. Subsequently the EA undertook several model reviews as referred to in section 6.2 of the FRA to July 2019 and at no stage were the climate change allowance discrepancies raised.
The Applicant's FRA Report suggests throughout that ongoing consultation and agreement has been sought with the Environment Agency regarding the approach and scope of the assessment, however no specific evidence of agreements reached has been provided.	Section B The Applicant has consulted with the EA throughout development of the FRA as detailed in Section 6 of the FRA. This has included several submissions of the draft FRA and hydraulic modelling for review. The EA is currently reviewing modelling undertaken to assess the proposed floodplain compensation at the Clanage Road compound site. The Applicant accepts that there has been no final agreement with the EA but is in dialogue and is aiming to progress with a Statement of Common Ground.
(i) Frequency of incidents of flooding	
At Bower Ashton - the simulation of impacts from River Avon tidal flooding indicates that this section of the operational NSIP would experience tidal flood events once every 5 to 10 years for the assessment year (taken to be 2015) and more than once a year on average in the future (scenarios 2075 and 2115) (taking into account climate change, including sea level rise, into consideration). In preparation for the examination the Inspectorate seeks to understand the extent to which the application of the revised climate change allowances may (or may not) affect the findings in this regard. In particular, whether such detail would result in anticipated flood events at more frequent intervals and at earlier points in the design life of the Proposed Development.	Section C To respond to the Inspectorate's specific query for Bower Ashton, the Applicant has prepared tables 3 and 4 in Appendix 1 which compares EWLs at Avonmouth applied in the Portishead Branch Line (MetroWest Phase 1) tidal River Avon modelling (as a downstream boundary condition) with those derived by applying the values of the current CFB2018 EWLs adjusted to future years with the current sea level rise allowances for flood risk assessments (as updated in the December 2019 NPPF Guidance.) The tables have been prepared for the whole of the Proposed Development but naturally includes Bower Ashton as the first part of the operational railway which may be susceptible to flooding due to its close proximity to the River Avon. The graph below compares EWLs applied in the MetroWest modelling with those derived applying the current CFB dataset (CFB2018) adjusted to future years with the current upper end sea level rise allowances for flood risk assessments, for the 10 year and 200 year return periods. This shows that up to approximately 2065 the EWLs applied in the MetroWest modelling are higher than those derived using the current CFB 2018 values and December 2019 NPPF Guidance climate change allowances -

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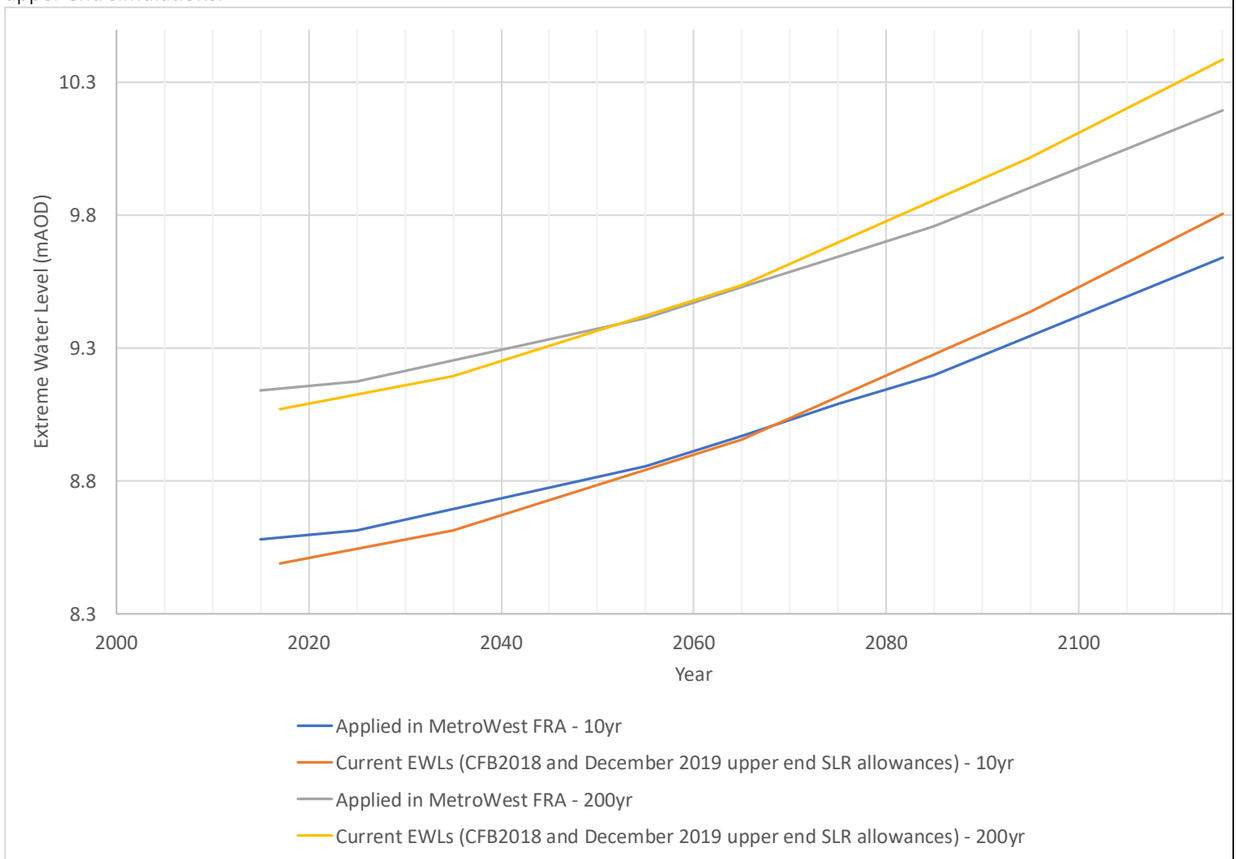
	i.e. until approximately 2065 the MetroWest tidal River Avon flood simulations would give higher flood levels than current upper end simulations.  **Present day** Based on the MetroWest simulations undertaken, the FRA concludes that the MetroWest railway floods at Bower Ashton approximately once every 5 to 10 years on average for the present day. Table 3 in Appendix 1 shows the updated (i.e. December 2019 NPPF Guidance) tidal boundary conditions for the CFB 2018 dataset base year of 2017 are lower than the 2015 values applied in the MetroWest FRA by 0.03m to 0.09m. Therefore the MetroWest FRA present day simulations overstate flood risk compared to the updated CFB2018 EWLs i.e. the FRA values are slightly more precautionary. **2075 (DCO scheme design life year)** The current December 2019 NPPPF Guidance* states: "For flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact." The 2075 EWLs applied in the MetroWest FRA modelling are between the updated CFB2018 values with higher central and upper end allowances applied, and closer to the values with the upper end allowance applied (See Table 3 in Appendix 1).

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	The higher central and upper end allowances are both precautionary. As the MetroWest simulated 2075 River Avon tidal EWLs are consistently higher than the equivalent updated CFB2018 values with higher central allowance applied, and only 0.03m to 0.05m below the upper end allowances (for the 2 year to 200 year return periods), the associated FRA conclusions are considered robust. Table 4 in Appendix 1 details an assessment of the calculated future frequency of flooding to the proposed railway. The calculated frequency of future flooding of the proposed railway is approximately: - 1 to 2 times per year in 2075 applying the higher central sea level rise allowances, - 2 to 3 times per year in 2075 applying the upper end sea level rise allowances. - Once every 1 to 2 years in 2060 applying the higher central sea level rise allowances, - Once per year in 2060 applying the upper end sea level rise allowances These estimates are considered precautionary as the sea level rise allowances are precautionary. The Applicant has also applied the impact of frequency of future flooding on the proposed train service timetable for 2075 at Appendix 2. As is demonstrated the impact of flooding on the operation of the proposed train service is negligible. **2115 (longer climate change horizon simulated as sensitivity test)** The 2115 FRA simulations were undertaken as a sensitivity test (the scheme design life is represented by the 2075 simulations). The 2115 EWLs applied in the MetroWest FRA tidal River Avon modelling are between the current CFB 2018 values with higher central and upper end allowances applied, and closer to the values with the higher central allowance applied. As the higher central and upper end allowances are both precautionary, and the MetroWest simulated 2115 River Avon tidal EWLs are consistently higher than the equivalent CFB 2018 values with higher central allowance applied, the 2115 sensitivity test simulations and associated FRA conclusions are considered robust. The calculated frequency of future (2115) flooding of the proposed railway was calculated in the same way as for 2075 (described above). The calculated frequency of future (2115) flooding is approximately 5 to 6 times per year applying the higher central sea level rise allowances, and approximately 8 times per year applying the upper end sea level rise allowances. However, these estimates are considered precautionary as the sea level rise allowances are precautionary. Before Bristol urban areas were exposed to this frequency of flooding, it is likely there would be a strategic intervention to reduce flood risk to Bristol. Therefore taking into account updated climate change allowances, including sea level rises, into consideration there is a small but not significant increase in anticipated tidal River Avon flood events at more frequent intervals (see Table 4 in Appendix 1) but not, as demonstrated in the above graph, at earlier points in the design life of the Proposed Development until after 2065. Appendix 2 also shows the impact of frequency of future flooding on the proposed train service timetable for 2115,

Planning Inspectorate's comment	The Applicant's response
(ii) Potential need for compensation	
The Clanage Road maintenance and access compound will include access ramps to the main road and to the railway. These ramps displace existing floodplain storage. The Applicant proposes compensation to address this displacement by lowering ground levels within the compound site. In preparation for the examination the Inspectorate seeks to understand the extent to which the application of the revised climate change allowances may (or may not) affect the findings in this regard. In particular whether such detail would result in a need for increased levels of flood compensation to address greater levels of floodplain storage being displaced.	Section D The Applicant has now undertaken further modelling to assess whether the proposed floodplain compensation at Bower Ashton (lowering ground levels within the Clanage Road compound site) provides the required compensation – applying the current tidal boundary conditions in the model (i.e. applying the current CFB 2018 dataset and the current climate change allowances as updated in December 2019 NPPF Guidance. This modelling demonstrates the proposed floodplain compensation at Bower Ashton does fully compensate for the ramps to the main road and railway with no simulated increase in offsite flood risk up to the 200 year tidal River Avon flood in 2075 and 2115, applying the December 2019 NPPF Guidance Upper end sea level rise allowances. In any event, as the design life of the proposed development is 2075, the mitigation proposed and the tide levels used to undertake an assessment are greater than those which are required. An assessment has been completed using 2115 tidal predictions which are in excess of those required for an equivalent assessment of a 2075 design life (both Higher Central and Upper End) and is therefore considered to be conservative. The EA is currently considering the Applicant's further modelling. In the meantime therefore, the FRA conclusions are considered robust in this regard.
The Applicant also proposes to increase the footprint of the railway embankment within the Easton-in-Gordano Stream floodplain which would result in displacement of potential floodplain storage, south of the railway. The Applicant therefore proposes floodplain storage compensation. In preparation for the examination the Inspectorate seeks to understand the extent to which the application of the revised climate change allowances may (or may not) affect the findings in this regard. In particular whether such detail would result in a need for increased levels of flood compensation to address greater levels of floodplain storage being displaced.	Section E The December 2019 NPPF Guidance on climate change guidance specifies for small catchments such as the Easton-in-Gordano Stream catchment (<5km^2) rainfall climate change allowances should be applied rather than river flow allowances. Assessment of the central and upper end rainfall allowances is required (20% and 40% respectively for both the 2075 and 2115 simulated future years). As mentioned above, the MetroWest Phase 1 FRA modelling of Easton-in-Gordano Stream applies a 20% climate change allowance for 2075 and 30% allowance for 2115. We have now undertaken simulations applying the December 2019 NPPF Guidance upper end climate change allowance (applying 40% uplift for both the 2075 and 2115 simulated future years). Results of these simulations show that the proposed floodplain storage compensation within the Easton-in-Gordano Stream floodplain does provide mitigation when applying the current upper end climate change allowance of 40%. The proposed floodplain storage compensation provides compensation for fluvial flood events up to a peak level of 8.3mAOD. The simulated 100 year return period fluvial flood peak level with 40% climate change allowance is 8.28 mAOD in 2075 and 8.29 mAOD in 2115 i.e. no additional floodplain compensation is required beyond what is proposed in the DCO application.
More generally the Inspectorate is keen to understand the extent to which the application of revised climate change allowances may influence the findings of the assessment and/or the design of the Proposed Development, including any potential consequential needs for lands, rights or powers to deliver mitigation	Section F The significance on the findings of the FRA modelling of applying the climate change allowances in the December 2019 NPPF Guidance (and where relevant, the current Coastal Flood Boundary 2018 dataset) is summarised in Tables 1 to 6 of Appendix 1. Applying the December 2019 NPPF Guidance climate change allowances and current CFB 2018 dataset does not result in a requirement to change the alignment or elevation of the proposed railway and associated development. The significance in terms of floodplain compensation requirements is summarised in Sections D and E above for two critical areas raised by the Inspectorate; Clanage Road compound and Easton in Gordano railway embankment. The floodplain compensation areas proposed in the FRA are sufficient for these two areas and the proposed development generally i.e. no additional lands, rights or powers are required above what is proposed in the DCO application. The December 2019 NPPF Guidance climate change allowances will be applied in the drainage design during the "GRIP 5" detailed design stage. The Applicant's principal consultant team have also given initial thought to whether it is likely the additional percentage specification at GRIP 5 stage might: (a) lead to either the need for additional land outside of the existing Order land; (b) lead to additional material works being required; and/or (c) give rise to significant environmental effects beyond those contemplated in the Applicant's ES. The conclusions were that no additional land or material new works are required. No additional significant environmental effects are contemplated.

Planning Inspectorate's comment	The Applicant's response
(iii) Update on view of the Environment Agency	
The Inspectorate recommends the Applicant responds to the specific points addressed above and in doing so explains if/how climate change allowances applied in the FRA, are robust and sufficient, taking into account any departure from the allowances proposed in existing guidance. The Applicant should provide confidence with regard to the robustness of the FRA and ideally demonstrate agreement with the Environment Agency on the scope of the assessment.	Section G Responses to the specific points above are presented in this document. Tables 1 to 6 provide further detail of the significance to the FRA of the differences between the climate change allowances applied in the FRA and those in the December 2019 NPPF Guidance. Further to the FRA modelling, additional model simulations have been undertaken to inform responses to the specific points above, applying current climate change allowances. Whilst there has not yet been final agreement with the EA, we are in dialogue and are aiming to progress with a Statement of Common Ground.

APPENDICES

Appendix 1

Table 1: Peak river flow climate change allowances

Peak river flow (Severn)			
Epoch	*17 December 2019 guidance	Allowances applied in MetroWest Phase 1 FRA	Significance of differences
'2080s' (2070 to 2115)	December 2019 NPPF Guidance specifies the Upper end allowance should be applied for Essential Infrastructure projects in Flood Zones 2, 3a or 3b. +70% (Upper end allowance)	2075: +25%** 2115: +25%** ** The MetroWest Phase 1 FRA uses Bristol City Council's (BCC) Central Area Flood Risk Assessment (CAFRA) model to assess fluvial flood risk in Longmoor and Colliter's Brooks (as well as River Avon tidal flood risk). The CAFRA model fluvial climate change allowances specified in the model boundary conditions were retained (+25%) as this was consistent with BCC's CAFRA modelling. In the River Avon flood risk in the vicinity of the MetroWest Phase 1 project is tidally dominated and so determined by the tidal (rather than fluvial) simulated events. Simulated River Avon tide conditions are considered in Tables 3 and 4.	For small catchments (< 5km2), the climate change allowances specified for rainfall intensity are considered more appropriate than those specified for river flows*. As the Longmoor and Colliter's Brooks catchment areas are only slightly larger (Flood Estimation Handbook catchment areas 8.6km2 and 5.4km2 respectively) the peak rainfall allowances are considered more representative for these watercourses than the peak river flow allowances, which are considered representative of larger catchments. Longmoor and Colliter's Brooks climate change allowances are therefore considered in Table 2, under peak rainfall allowances.
'2050s' (2040 to 2069)	+40% (Upper end allowance)	Epoch not included in assessment	Epoch not included in assessment

** 17 December 2019 guidance taken from* https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 2: Peak rainfall climate change allowances

Peak rainfall intensity			
Epoch	***December 2019 NPPF Guidance**	**Allowances applied in MetroWest Phase 1 FRA**	**Significance of differences**
'2080s' (2070 to 2115)	Guidance* specifies: "For flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact." +20% (Central allowance) +40% (Upper end allowance)	For small catchments (< 5km2) fluvial models (Drove Rhyne and Easton-in-Gordano Stream): 2075: +20% 2115: +30% For Longmoor and Colliter's Brooks (catchment areas 8.6km2 and 5.4km2 respectively): 2075: +25%** 2115: +25%** ** The MetroWest Phase 1 FRA uses Bristol City Council's (BCC) Central Area Flood Risk Assessment (CAFRA) model to assess fluvial flood risk in Longmoor and Colliter's Brooks (as well as River Avon tidal flood risk). The CAFRA model fluvial climate change allowances specified in the model boundary conditions were retained (+25%) as this was consistent with BCC's CAFRA modelling.	**Drove Rhyne and Easton-in-Gordano Stream:** The December 2019 NPPF Guidance specifies the central and upper end allowances (20% and 40% for both the 2075 and 2115 simulated future years). The MetroWest Phase 1 modelling of Drove Rhyne and Easton-in-Gordano Stream applies a 20% climate change allowance for 2075 and 30% allowance for 2115. **Drove Rhyne** At the railway crossing of Drove Rhyne locations, simulated 1000 year return period peak flood levels (with a 30% climate change allowance) are more than 0.4m below the railway level. The differences between simulated 1000 year peak flood levels with a 20% allowance and 30% allowance are only approximately 0.01m at the railway crossing. Increasing the climate change allowance to 40% is therefore not expected to significantly increase simulated peak flood levels, and therefore is not expected to impact the railway (and as there is no proposed change to the railway footprint below the flood level the railway would not affect flood risk elsewhere). The conclusions of the FRA would therefore be unlikely to change if a 40% allowance were applied in the Drove Rhyne modelling. The FRA conclusions are therefore considered robust in this regard. **Easton-in-Gordano Stream** At the railway crossing of Easton-in-Gordano Stream, the simulated 1000 year return period peak flood level (with a 30% climate change allowance) is more than 0.2m below the railway level. The difference between simulated 1000 year peak flood levels with a 20% allowance and 30% allowance is only approximately 0.02m at the railway crossing. Increasing the climate change allowance to 40% is therefore not expected to significantly increase simulated peak flood levels, and therefore is not expected to impact the railway. The MetroWest phase 1 FRA details proposed floodplain compensation on land to the south of (i.e. upstream of) the railway crossing of Easton-in-Gordano Stream, to mitigate a proposed slight increase in railway footprint in the Easton-in-Gordano Stream fluvial floodplain. Table 8.1 in the FRA lists the displaced floodplain storage volumes within 0.1 m level ranges, and the compensation volumes provided up to 8.3 mAOD. Table 8.1 in the FRA shows that the proposed floodplain compensation provides more than the enough compensation for flood levels up to 8.3 mAOD. We have now simulated the 100 year return period Easton-in-Gordano Stream fluvial flood event in 2075 and 2115, applying the December 2019 NPPF Guidance climate change allowance (+40% for both the 2075 and 2115 simulations) and with increased tidal boundaries according to the current climate change guidance. This gives peak 100 year fluvial flood levels in the floodplain directly south of the railway of 8.28mAOD for 2075 and 8.29mAOD for 2115. The proposed flood compensation area is therefore shown to be sufficient when applying the December 2019 NPPF Guidance climate change allowances. The FRA conclusions are therefore considered robust in this regard. **Longmoor and Colliter's Brooks** The December 2019 NPPF Guidance specifies the central and upper end allowances (20% and 40% for both the 2075 and 2115 simulated future years). The MetroWest Phase 1 modelling of Longmoor and Colliter's Brooks applies a 25% climate change allowance for both 2075 and 2115. We have now simulated flooding in the Longmoor and Colliter's Brooks applying the December 2019 NPPF Guidance climate change allowances (40% uplift in model inflows and current sea level rise allowances applied). Applying these climate change and sea level rise allowances has not resulted in a change in the simulated future frequency of closure of the railway at Longmoor and Colliter's Brooks in 2075 and 2115. This remains at once every 50 to 75 years (i.e. as assessed in the FRA). The FRA conclusions are therefore considered robust in this regard.
'2050s' (2040 to 2069)	+10% (Central allowance) +20% (Upper end allowance)	Epoch not included in assessment	Epoch not included in assessment

** 17 December 2019 guidance taken from* https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 3: Comparison of EWLs applied in MetroWest Phase 1 tidal River Avon modelling with EWLs applying the current CFB2018 dataset and December 2019 NPPF climate change guidance*

	*CFB 2018 EWLs adjusted for future year (mAOD)					EWLs applied in MetroWest Phase 1 tidal River Avon modelling (mAOD)			Differences: EWLs applied in MetroWest tidal River Avon modelling minus CFB2018 EWLs adjusted with December 2019 NPPF climate change climate change allowances (m)			
Return period (years)	Base year 2017	adjusted to 2075 UKCP18 Higher central	adjusted to 2075 UKCP18 Upper end	adjusted to 2115 UKCP18 Higher central	adjusted to 2115 UKCP18 Upper end	2015	2075	2115	2075: MetroWest EWLs – CFB2018 EWLs with Higher central adjustment	2075: MetroWest EWLs – CFB2018 EWLs with Upper end adjustment	2115: MetroWest EWLs – CFB2018 EWLs with Higher central adjustment	2115: MetroWest EWLs – CFB2018 EWLs with Upper end adjustment
2	8.22	8.71	8.85	9.20	9.54	8.30	8.81	9.36	0.10	-0.04	0.15	-0.18
5	8.37	8.86	9.00	9.35	9.69	8.46	8.97	9.52	0.11	-0.03	0.16	-0.17
10	8.49	8.98	9.12	9.47	9.81	8.58	9.09	9.64	0.11	-0.03	0.16	-0.17
20	8.61	9.10	9.24	9.59	9.93	8.70	9.21	9.76	0.11	-0.03	0.16	-0.17
50	8.79	9.28	9.42	9.77	10.11	8.88	9.39	9.94	0.11	-0.03	0.16	-0.17
200	9.07	9.56	9.70	10.05	10.39	9.14	9.65	10.20	0.09	-0.05	0.14	-0.19
1000	9.43	9.92	10.06	10.41	10.75	9.46	9.97	10.52	0.05	-0.09	0.10	-0.23

** Sea Level Rise allowances have been applied using the December 2019 NPPF Guidance) to adjust CFB2018 EWLs (base year 2017) at Avonmouth to future years*

Table 4: Interpretation of comparison of tidal River Avon EWLs presented in Table 3

Simulation	Comparison	Significance
Present day	MetroWest simulated 2015 River Avon tidal EWLs are consistently higher than the CFB2018 values (with base year 2017)	Based on the MetroWest simulations undertaken, the FRA concludes that the MetroWest railway floods at Bower Ashton approximately once every 5 to 10 years on average for the present day. The MetroWest FRA present day simulations overstate flood risk compared to the current CFB2018 EWLs i.e. the FRA values are slightly more precautionary than the current guidance. The FRA conclusions are therefore considered robust in this regard.
2075 (DCO scheme design life year)	**Higher central allowance:** MetroWest simulated 2075 River Avon tidal EWLs are consistently higher than the CFB2018 values adjusted to 2075 applying the higher central allowance* by 0.09m to 0.11m (2 year to 200 year return periods) and by 0.05m (1000 year return period). **Upper end allowance:** MetroWest simulated 2075 River Avon tidal EWLs are consistently lower than the CFB2018 values adjusted to 2075 applying the upper end allowance* by 0.03m to 0.05m (2 year to 200 year return periods) and by 0.09m (1000 year return period).	The December 2019 NPPF Guidance* states: "For flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact." The 2075 EWLs applied in the MetroWest FRA modelling are between the current CFB2018 values with higher central and upper end allowances applied, and closer to the values with the upper end allowance applied. The higher central and upper end allowances are both precautionary. As the MetroWest simulated 2075 River Avon tidal EWLs are consistently higher than the equivalent CFB2018 values with higher central allowance applied, and only 0.03m to 0.05m below the upper end allowances (for the 2 year to 200 year return periods), the associated FRA conclusions are considered robust. Since the completion of the FRA, the Applicant has undertaken an assessment of the anticipated frequency of flooding of the proposed railway at Bower Ashton in 2075 as follows: - Downloaded quality controlled Avonmouth tidal gauge monthly extremes from the British Oceanographic Data centre (https://www.bodc.ac.uk/data/hosted_data_systems/sea_level/uk_tide_gauge_network/processed/) - From this dataset, derived tide levels that are exceeded on average 1, 2, 3, 4, 5, 6, 8 and 10 times per year. This was based on data for the period 2003 to 2011 and so is considered to represent a base year of 2007. - Adjusted these calculated 2007 tidal levels to future years (including 2075) by applying the current specified FRA sea level allowances - The MetroWest FRA modelling indicates there would be flooding of the proposed railway when Avonmouth tide levels reach approximately 8.46mAOD to 8.58mAOD (these are the 5 year and 10 year tide levels in 2015 applied in the MetroWest FRA tidal River Avon modelling, for which the 5 year simulation does not result in flooding to the proposed railway whilst the 10 year simulation does). - The approximate future (2075) frequency of flooding of the railway at Bower Ashton is taken to be the same as the calculated frequency of tide levels exceeding this approximate range in 2075. The calculated frequency of future flooding of the proposed railway is approximately: - 1 to 2 times per year in 2075 applying the higher central sea level rise allowances, - 2 to 3 times per year in 2075 applying the upper end sea level rise allowances. - Once per year in 2060 applying the higher central sea level rise allowances, - Once every 1 to 2 years in 2060 applying the upper end sea level rise allowances These estimates are considered precautionary as the sea level rise allowances are precautionary.
2115 (longer climate change horizon simulated as sensitivity test)	**Higher central allowance:** MetroWest simulated 2115 River Avon tidal EWLs are consistently higher than the CFB2018 values adjusted to 2115 applying the higher central allowance* by 0.14m to 0.16m (2 year to 200 year return periods) and 0.10m (1000 year return period). **Upper end allowance:** MetroWest simulated 2075 River Avon tidal EWLs are consistently lower than the CFB2018 values adjusted to 2075 applying the upper end allowance from the December 2019 NPPF Guidance by 0.17m to 0.19m (2 year to 200 year return periods) and by 0.23m (1000 year return period).	The 2115 FRA simulations were undertaken as a sensitivity test (the scheme design life is represented by the 2075 simulations). The 2115 EWLs applied in the MetroWest FRA tidal River Avon modelling are between the current CFB2018 values with higher central and upper end allowances applied, and closer to the values with the higher central allowance applied. As the higher central and upper end allowances are both precautionary, and the MetroWest simulated 2115 River Avon tidal EWLs are consistently higher than the equivalent CFB2018 values with higher central allowance applied, the 2115 sensitivity test simulations and associated FRA conclusions are considered robust.

Simulation	Comparison	Significance
		The calculated frequency of future (2115) flooding of the proposed railway was calculated in the same way as for 2075 (described above). The calculated frequency of future (2115) flooding is approximately 5 to 6 times per year applying the higher central sea level rise allowances, and approximately 8 times per year applying the upper end sea level rise allowances. However, these estimates are considered precautionary as the sea level rise allowances are precautionary.
Floodplain compensation within the Clanage Road compound at Bower Ashton to mitigate displacement of floodplain storage by access ramp at Clanage Road		The Applicant has now undertaken further modelling to assess whether the proposed floodplain compensation at Bower Ashton (lowering ground levels within the Clanage Road compound site) provides the required compensation – applying the current tidal boundary conditions in the model (i.e. applying the current EA CFB 2018 dataset and the December 2019 NPPF Guidance climate change allowances. This modelling demonstrates the proposed floodplain compensation at Bower Ashton does fully compensate for the ramps to the main road and railway with no simulated increase in offsite flood risk up to the 200 year tidal River Avon flood in 2075 and 2115, applying the current Upper end sea level rise allowances. The FRA conclusions are therefore considered robust in this regard.

Table 5: Comparison of EWLs applied in MetroWest Phase 1 coastal modelling with EWLs applying the current CFB2018 dataset and December 2019 NPPF climate change guidance*

	*CFB 2018 EWLs (mAOD)					EWLs applied in MetroWest coastal model at Avonmouth (mAOD)			Differences: EWLs applied in MetroWest coastal modelling minus CFB2018 EWLs adjusted with December 2019 NPPF climate change allowances (m)			
Return period (years)	Base year 2017	adjusted to 2075 UKCP18 Higher central	adjusted to 2075 UKCP18 Upper end	adjusted to 2115 UKCP18 Higher central	adjusted to 2115 UKCP18 Upper end	2015	2075	2115	2075: MetroWest EWLs – CFB2018 EWLs with Higher central adjustment	2075: MetroWest EWLs – CFB2018 EWLs with Upper end adjustment	2115: MetroWest EWLs – CFB2018 EWLs with Higher central adjustment	2115: MetroWest EWLs – CFB2018 EWLs with Upper end adjustment
25	8.65	9.14	9.28	9.63	9.97			9.87			0.24	-0.09
50	8.79	9.28	9.42	9.77	10.11			10.00			0.23	-0.10
100	8.92	9.41	9.55	9.90	10.24			10.13			0.23	-0.10
200	9.07	9.56	9.70	10.05	10.39		9.71	10.26	0.16	0.01	0.21	-0.12
1000	9.43	9.92	10.06	10.41	10.75	9.44		10.58			0.17	-0.16

** Sea Level Rise allowances have been applied using the December 2019 NPPF Guidance to adjust CFB2018 EWLs (base year 2017) at Avonmouth to future years*

Table 6: Interpretation of comparison of coastal EWLs presented in Table 5

Simulation	Comparison	Significance
Present day	The MetroWest simulated 1000 year return period coastal EWL in 2015 is 0.01m higher than the CFB2018 value (base year 2017).	For this coastal flood event the DCO scheme is outside of the MetroWest FRA simulated flood extent. As the EWL applied in the FRA is higher than the equivalent CFB2018 EWL, the FRA conclusions are considered robust in this regard.
2075 (DCO scheme design year)	The MetroWest simulated 200 year return period coastal EWL in 2015 is 0.16m and 0.01m higher than the CFB2018 value with higher central and upper end allowances applied respectively.	For the 200 year return period coastal flood event in 2075, the DCO scheme is outside of the MetroWest FRA simulated flood extent. As the EWL applied in the FRA is higher than the equivalent CFB2018 EWL applying both the higher central and upper end allowances, the FRA conclusions are considered robust in this regard.
2115 (longer climate change horizon simulated as sensitivity test)	Higher central allowance: MetroWest simulated 2115 coastal EWLs are consistently higher than the CFB2018 values adjusted to 2115 applying the higher central allowance* by 0.21m to 0.24m (25 year to 200 year return periods) and 0.17m (1000 year return period). Upper end allowance: MetroWest simulated 2075 coastal EWLs are consistently lower than the CFB2018 values adjusted to 2115 applying the upper end allowance* by 0.09m to 0.12m (2 year to 200 year return periods) and by 0.16m (1000 year return period).	The 2115 FRA simulations were undertaken as a sensitivity test (the scheme design life is represented by the 2075 simulations). The 2115 EWLs applied in the MetroWest FRA coastal modelling are between the current CFB2018 values with higher central and upper end allowances applied, and closer to the values with the upper end allowance applied. As the higher central and upper end allowances are both precautionary, and the MetroWest simulated 2115 coastal EWLs are consistently higher than the equivalent CFB2018 values with higher central allowance applied, the 2115 sensitivity test simulations and associated FRA conclusions are considered robust. Applying CFB2018 values adjusted to 2115 applying the upper end allowance would change the assessed frequency of coastal flooding of the proposed MetroWest railway in 2115 from approximately once every 100 to 200 years to approximately once every 50 to 100 years, and may slightly increase the frequency of inundation of Portishead station, car parks and the crossing of Portbury ditch from approximately once every 1000 years on average to e.g. once every 200 years on average (estimated).

Appendix 2

	Frequency of flooding	Flooding frequency annualised equivalent (occurrences per year)	Number of high tides for each occurrence [1]	Aggregate flooding occurrences per year	Assumed duration of disruption to passenger train service [2]	Aggregate hours of flooding per year	Total hours of passenger train operation (Portishead Line) per year [3]	Percentage of train operating hours lost per year due to flooding [4]
Present Day	1 occurrence every 5 to 10 years on average	0.1 to 0.2	2	0.2 to 0.4	12 hours	2.4 to 4.8	6082	0.04% to 0.08%
2075 (DCO Scheme design life year)	1 to 2 occurrences in 2075 with higher central sea level rise allowances	1 to 2	2	2 to 4	12 hours	24 to 48	6082	0.39% to 0.79%
	2 to 3 occurrences in 2075 with upper end sea level rise allowances	2 to 3	2	4 to 6	12 hours	48 to 72	6082	0.79% to 1.18%
	1 occurrence every 1 to 2 years in 2060 with higher central sea level rise allowances	0.5 to 1	2	1 to 2	12 hours	12 to 24	6082	0.20% to 0.39%
	1 occurrence per year in 2060 with upper end sea level rise allowance	1	2	2	12 hours	24	6082	0.39%
2115 (Longer climate change horizon simulated sensitivity test)	5 to 6 occurrences in 2115 with the higher central sea level rise allowances	5 to 6	2	10 to 12	12 hours	120 to 144	6082	1.97% to 2.37%
	8 occurrences in 2115 with the upper end sea level rise allowances	8	2	16	12 hours	192	6082	3.16%

[1] The frequency of flooding was calculated based on historic monthly tidal extremes data rather than a sub-daily time series dataset, which results in a slight bias towards underestimating frequency of flooding. To compensate for this, the number of high tides has been adjusted (i.e. doubled). This is likely to over-compensate and hence the calculated "Percentage of train operating hours lost per year due to flooding" values are likely to be overestimates.
[2] 12 hours comprising of 2 hours either side of high tide and 8 hours for Network Rail to inspect the section line affected and remove any debris.
[3] Total hours of passenger train operation (Portishead Line) per year, was calculated as table below:
[4] Percentage of train operating hours lost per year due to flooding is overstated because the calculation assumes that flooding always coincides with when trains operate, however trains will operate a maximum of 18 hours in a 24 hour day.

	Level of service	Hours of operation per day	Hours of operation per week	Total hours of operation per year (less Christmas Day, Boxing Day and New Years day)
Mondays to Saturdays	Monday to Saturday first train 06XX, then hourly to 23XX	18	108	5562
Sundays	Sunday first train 10XX, then hourly to 18XX	10	10	520
Total				6082

Appendix 3

Sea level rise allowances that were current at the time of submitting the DCO application – copied from the February 2019 version of the FRA climate change allowances guidance: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (note the website now only includes the current allowances updated in December 2019). For the MetroWest Phase 1 FRA modelling, the South West allowances were applied.

Table 3 sea level allowance for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets (use 1990 baseline)

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
East, east midlands, London, south east	4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m
South West	3.5 (122.5 mm)	8 (240 mm)	11.5 (345 mm)	14.5 (435 mm)	1.14 m
North west, north east	2.5 (87.5 mm)	7 (210 mm)	10 (300 mm)	13 (390 mm)	0.99 m