Welsh Government

M4 Corridor around Newport

Environmental Statement Supplement
Volume 3: Appendix S16.2 Flood Consequences Assessment

M4CaN-DJV-HDG-ZG_GEN-RP-CD-0010

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Contents

References

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1 Report Supplements

1.1 Purpose of this Report

1.1.1 The Welsh Government's draft Orders and Environmental Statement for the M4 Corridor around Newport (M4CaN) were published in March 2016. Supplements and Modifications to the draft Orders have been developed by the Welsh Government to be published in September 2016 for the following reasons:

a) Amendments to the details of parties in the Schedules to the Compulsory Purchase Order following receipt of further information on title holders, lessees and interested parties.

b) Amendments to the project further to matters raised by responses received to the draft Orders.

Supplements to the Environmental Statement and Associated Reporting are also published to consider the changes as well as further information available since preparing the draft Orders, such as further ecological surveys.

1.1.2 The following design changes have been incorporated as part of this supplement:

1. Minor revisions to the NMU provision at Church Lane and Lighthouse Road.
2. Docks Way Junction: revised horizontal and vertical alignment to lower the slip and link roads, remove the secondary roundabout and change the form of structure of the mainline viaduct (SBR-0885 Docks Way Junction Viaduct). This also reduced the length and height of the retaining wall along Docks Link Road (SRW-0895 Docks Link Retaining Wall).
3. Docks Link Road: realignment of Maes Glas Pill Culvert and bridge extension SBR-0925A and retaining wall SRW-0910 added based on outcome of further survey and as-built information provided allowing further design to be undertaken.
4. Glan Llyn Junction: providing access from Glan Llyn Link Road to the TATA owned land to the east. In addition, providing a retaining wall along the mainline to minimise impact on the existing pylon (SWR-1520 Pylon SE001 Retaining Wall).
5. J23a to J23 Trunk Road: revised vertical alignment at the west tie-in to lower the trunk road, achieved by matching the headroom of the proposed extension to St Bride's Road Bridge to the headroom of the existing St Bride's Road Bridge.
6. Magor Interchange (Junction 23) Roundabout: revised vertical alignment to lower part of the roundabout, achieved by realigning Bencroft Lane, removing Bencroft Lane underpasses and providing an overbridge to the east over the M48 (SBR-2340 Windmill Hill Overbridge).
7. Magor Interchange (Junction 23) Westbound Free-flow Link: revised vertical alignment to lower the free-flow link and height of the associated retaining wall (SRW-2320 Magor Retaining Wall) by introducing a small retaining wall (SRW-2285 Rockfield Lane North Wall) between the link and the J23a to J23 trunk road.

8. Magor Interchange (Water Treatment Area 12B): Further site investigation work has concluded that Vurlong Reen would not be sufficient for discharge of this Water Treatment Area (WTA). An alternative discharge point has been identified, which runs alongside Old Court Farm access drive and from where it would tie into existing drainage arrangements.

1.1.3 The Key Stage 3 Flood Consequence Assessment Report provides details of how the new section of motorway could impact on flood consequences for the locality.

1.1.4 This supplementary report provides detail of changes to the flood consequences resulting from the above design amendments. This report also provides supplementary information on tidal flood risk.

1.2 Report Layout

1.2.1 This report presents supplementary information to the Flood Consequence Assessment Report using the same paragraph numbering as the original report.

4 Assessment Approach

4.7 Scheme Drainage

Carriageway Drainage

4.7.4 The preliminary drainage designs have been amended to reflect the changes to the proposed new section of motorway. A revised set of drawings are provided in Appendix A1.

6 Summary

6.1 Tidal Flood Risk

Existing situation as regards tidal defences

6.1.10 As noted in the Flood Consequence Assessment (FCA), the tidal flood defences along the Wentlooge and Caldicot Levels have a generally good Standard of Protection (SoP) of approximately 0.1% Annual Exceedance Probability (AEP). This is confirmed in the Severn Estuary Flood Risk Management Strategy (SEFRMS) (Environment Agency, 2014). At the time of the SEFRMS work, there were three localised sections of lower SoP tidal flood defences, that the SEFRMS recommended to be improved as Priority Schemes (Tabbs Gout, Stephenson Street and Portland Grounds). NRW have stated that Tabbs Gout priority scheme is now completed, and that the Portland Grounds priority scheme was completed in summer 2016.

6.1.11 Since the publication of the FCA, further information on the Stephenson Street Scheme was received from Natural Resources Wales, in August 2016 (NRW, in

draft, 2016). This confirmed that the scheme is currently at the project appraisal stage. Further items that were confirmed consist of:

- The existing SoP was confirmed as less than 3.3%AEP (noting that tidal flooding over the embankment occurred in January 2014, deemed to be approximately a 10%AEP event), with an NRW embankment inspection in 2015 classing the embankment as failing, were it to have been an asset within their responsibility.
- Concerns included evidence of subsidence, structural failure and an undulating and narrow crest. The SEFRMS estimated that the existing SoP was approximately 20%AEP, noting that more detailed topographic survey was required to confirm the detailed SoP of this section of tidal flood defence. Overall, the more detailed and up to date analysis in the Stephenson Street Scheme appraisal stage confirms that the existing SoP is approximately between 10%AEP and 3.3%AEP.
- The economic justification for the scheme was also confirmed to remain robust, with further analysis within the appraisal stage estimating that the Benefit Cost Ratio (BCR) was 24.8. The SEFRMS estimated the BCR as 66. The differences between the BCRs used in the two studies can be mostly attributed to the more detailed scheme level analysis, and the scheme level choice of the improvements being a combination of sheet-piled wall, reinforced concrete wall and embankment, which are more costly than the assumptions in the SEFRMS.
- The planned design crest level of the scheme was confirmed at the appraisal stage as 9.03mAOD. This ensures provision of a 0.5%AEP SoP, accounting for sea level rise through to 2064. For clarity, it is noted that whilst the appraisal stage report states that the SEFRMS recommends a 0.5%AEP SoP, this refers to the simplified, non-technical documentation. The more detailed, technical information in the Strategy Appraisal Report (StAR) and its appendices (Environment Agency, 2014; the StAR sets out the business case for the SEFRMS, and the more detailed engineering, economic and environmental recommendations) states that a 0.1%AEP SoP is recommended. Regardless of this, a 0.5%AEP SoP through to 2064 is closely equivalent to a 0.1%AEP SoP through to 2030; and also NRW confirmed in their letter of 4th May 2016 that if the Stephenson Street Scheme were to be constructed, then a 0.1%AEP SoP through to 2030 would be provided.

Summary of previous studies and datasets

6.1.12 The tidal flood risk that would occur into the future, and particularly the year 2122 and for the 0.1%AEP event, is approximated by a number of previous studies. These include the SESMP2, SEFRMS, KS2 (Arup, 2014) and Stephenson Street Scheme appraisal stage report (in draft, NRW, 2016).

6.1.13 The SESMP2 and SEFRMS studies assessed the tidal flood risks based on the existing tidal flood defences as at 2010. These specifically did not include any improvement works at Tabbs Gout, Portland Grounds and Stephenson Street. However, there is still useful information on the wider SoP of the overall tidal flood defence system along the Wentlooge and Caldicot Levels, and how the SoP would reduce over time due to predicted climate change, if no improvements were undertaken.

6.1.14 The draft Stephenson Street Scheme appraisal stage assessed the tidal flood risks caused by the locally lower SoP tidal defence. This therefore provides more detail on the localised flood risks that would occur with or without the scheme.

6.1.15 These documents provide a useful indication of the baseline flood risk management position on the Wentlooge and Caldicot levels.

6.1.16 The KS2 study assessed the tidal flood risks based on the Tabbs Gout and Portland Grounds schemes having been completed, but with the Stephenson Street scheme not having occurred now or into the future. This provides useful information on the overall SoP and tidal inundation processes that would occur now and into the future including an allowance for climate change, assuming the tidal flood defences stay as they are currently, when works on the M4CaN commence.

6.1.17 The draft Stephenson Street Scheme appraisal stage assessed the tidal flood risks caused by the locally lower SoP tidal defence. This therefore provides more detail on the localised flood risks that would occur with or without the scheme.

6.1.18 This document provides an assessment of the likely extent of the flood impacts of the scheme, in the event that the Stephenson Street scheme does not go ahead.

6.1.19 Combined consideration of the above studies, and interpretation of their findings, can be used to estimate the overall SoP of the tidal flood defence system as it would be if all three of the Tabbs Gout, Portland Grounds and Stephenson Street schemes were present along the Wentlooge and Caldicot Levels, and how the overall SoP would reduce over time if the subsequent SEFRMS recommended programme of improvement through 2030-2110 did not occur. It is noted that this interpretation is necessarily semi-qualitative.

6.1.20 Of particular note is that various sets of extreme water level (EWLs) and climate change scenarios have been applied across the above studies, due to their specific purpose and timing of when they were undertaken. Table 6.1 and 6.2 provides a summary of the EWLs and climate change scenarios applied for the different studies (with and without confidence intervals). It is further noted that the SEFRMS undertook an analysis of extreme wave heights and their joint probability analysis with EWLs. Our understanding is that these two analyses remain the only study on extreme wave heights, and the Joint Probability Analysis between extreme wave heights and EWLs.

6.1.21 Furthermore, it is noted that the SEFRMS undertook its analyses for the medium 95%ile emissions scenario, and it also undertook sensitivity analyses for the low 50%ile, upper end (similar to Defra 2006/WAG 2007) and upper end plus surge emissions scenarios; and also for the SEFRMS EWLs and also the EA (2011) EWLs. Under all these scenarios the SEFRMS recommendations remained robust for provision of a 0.1%AEP SoP now and through to 2110.

6.1.22 The following sections describe the tidal flood risk that would occur with or without the recommended programme of improvements from the SESMP2 and SEFRMS. As the various studies have used different EWLs and climate change scenarios, the following sections interpret all the studies to a common basis of the EA (2011) EWLs and WAG (2007) climate change guidance, so as to form an assessment in accordance with TAN15 requirements. This primarily requires reference to future years to be amended, and the actual amount of sea level rise (SLR) to one decimal place is added in brackets to provide a clear reference.

Table 6.1. Application of EWLs in Previous Studies.

Location and reference			0.1%AEP EWL dataset in 2010		
Approximate location	EA (2011) chainage reference	SEFRMS reference	SEFRMS	EA (2011) without CI	EA (2011) with CI (0.6m)
River Rhymney	408	JPA2	9.0	8.5	9.1
Peterstone Gout	402	JPA3	8.9	8.6	9.2
River Usk	396	JPA4	9.0	8.8	9.4
Goldcliff	392	JPA5	9.1	8.9	9.5
Magor Pill	384	JPA6	9.5	9.2	9.8
Studies using EWL datasets			SEFRMS	SEFRMS, Arup (2014), NRW (2016)	

Table 6.2. Application of Climate Change Guidance in Previous Studies.

Year	Sea level rise from base date of 2010				
	WAG (2007)	Scenarios from EA (2011)			
		Low 50%ile from UKCP09	Medium 95%ile from UKCP09	Upper end	Upper end plus surge
2030	0.09	0.06	0.11	0.10	0.30
2060	0.35	0.17	0.31	0.35	0.70
2110	1.00	0.39	0.72	1.02	1.72
Studies using climate change guidance	SEFRMS, Arup (2014)	SEFRMS	SEFRMS, NRW (2016)	SEFRMS	SEFRMS

Note: values are given to 2 decimal places solely to clarify differences between guidance and scenarios.

Tidal Flood Risk without the SESMP2 and SEFRMS Recommended Programme of Improvements (2030 to 2110)

6.1.23 NRW (2016) indicates that in 2016 without the Stephenson Street Scheme present, tidal flooding to the immediate east of the River Usk (Caldicot Levels) would begin to occur in the 10%AEP event (from actual observed flooding in January 2014); this was confirmed by the modelling in Arup (2014).

6.1.24 NRW (2016) indicates that currently without the Stephenson Street Scheme present, tidal flooding to the immediate east of the River Usk (Caldicot Levels) would begin to occur in the 10%AEP event (from actual observed flooding in January 2014); this was confirmed by the modelling in Arup (2014). NRW (2016) notes that in the event of a breach in the 0.5%AEP event in 2014, to the immediate east of the River Usk some 192 residential and 620 non-residential properties are predicted to be inundated, as well as regionally-significant industrial areas, leisure amenities and key infrastructure such as the A48, Newport International Sports Village, Newport Stadium and Dragon Park. By 2030 (0.1m SLR) in the 0.1%AEP event this increases to 1,117 residential and 1,016 non-residential properties.

6.1.25 The Arup (2014) flood extent for the 0.1%AEP event in 2013 (with no breaches due to excessive wave or tidal overtopping) broadly corroborates the NRW (2016) modelling work in that the flood extent without a breach is less extensive but still exists.

6.1.26 The Arup (2014) work states that there would be up to 260 properties at risk of flooding. Inspection of the flood extent from NRW (2016) (which includes a 50m breach) indicates that flooding could extend further east of the River Usk, which would indicate that, with the M4CaN in place, there could be some further betterment and detriment to properties (likely not negligible) in and around the flood extent of the NRW (2016) work.

6.1.27 Overall, the above discussion identifies that without the Stephenson Street scheme in place there would be significant flooding of over 2,000 properties and regionally significant infrastructure, to the immediate east of the River Usk by 2030 in the 0.1%AEP event. This would occur with or without the M4CaN in place. The NRW (2016) work confirms that there is a compelling case for the Stephenson Street scheme to occur. Furthermore, Arup (2014) confirms that there would be no tidal flooding of the Wentlooge Levels in 2013 in the 0.1%AEP event.

6.1.28 The SEFRMS (EA, 2014) sets out how the wider SoP of the Wentlooge and Caldicot Levels would reduce over time in response to climate change beyond 2030, assuming that the existing tidal flood defence system is maintained as it is. This identifies that:

- By 2060 (0.3m SLR), the majority of the Wentlooge and Caldicot Levels tidal defences would still provide a SoP against breach (due to excessive wave or tidal overtopping) at or greater than 0.1%AEP; however, there are localised sections that would provide a SoP against breach of between 10-0.5%AEP. These sections would be where extensive flooding would initiate for events greater than 10%AEP.
- By 2110 (1.0m), the majority of the Wentlooge and Caldicot Levels tidal defences would not provide a SoP against breach of 0.1%AEP. The SoP against breach across the tidal flood defence system would vary between 100-1%AEP. There would be sections where extensive flooding would initiate for events greater than 100%AEP (i.e. annual flooding). Arup (2014) estimates that by 2113 (assuming the Stephenson Street scheme is not constructed, and no breaches occur due to excessive tidal overtopping), that extensive flooding of the Wentlooge and Caldicot Levels would result in up to 4,575 (Wentlooge Levels) and 22,926 (Caldicot Levels) properties, and nationally significant infrastructure, being at flood risk in the 0.1%AEP event.

6.1.29 The above regular and extensive flooding of the vast majority of the Wentlooge and Caldicot Levels, and the properties and infrastructure present in the floodplain, would occur with or without the M4CaN in place.

6.1.30 With the M4CaN in place, Arup (2014) indicates that in the 0.1%AEP event in 2113 (assuming no breaches due to excessive wave and tidal overtopping), up to 4,638 (Wentlooge Levels, an increase of 63) and 22,977 (Caldicot Levels, an increase of 49) properties would be at flood risk. This translates to:

- In the Wentlooge Levels, betterment for 2,045 (0-0.2m reduced flood depth) properties; and detriment for 551 (0-0.2m increased flood depth), 60 (0.2-0.4m increased flood depth), and 2 (0.4-0.6m increased flood depth) properties.
- In the Caldicot Levels, betterment for 38 (0.2-0.4m reduced flood depth) and 4,560 (0-0.2m reduced flood depth) properties; and detriment for 755 (0-0.2m increased flood depth), 266 (0.2-0.4m increased flood depth), and 6 (0.4-0.6m increased flood depth) properties.
- However, Arup (2014) states that without the M4CaN the flood depths would be up to 1.2m (Wentlooge Levels) and exceed 3m on average (Caldicot Levels), rendering the above impacts (betterments and detriments) relatively small in context.

- The above property numbers would be expected to reduce if quantitative modelling was undertaken with the Stephenson Street scheme in place, since the SoP would be improved. A qualitative assessment of the situation with the Stephenson Street scheme in place is set out below, given the reasonable likelihood that the scheme progresses. However, the Arup (2014) work can be considered to be a precautionary worst case assessment.

6.1.31 Whilst inspection of the WAG (2007) climate change guidance indicates that between 2110 and 2122 a further approximately 0.2m of sea level rise would occur, the above discussion would still provide a reasonable description of the baseline flood risks, assuming the Stephenson Street scheme were not to proceed.

Tidal Flood Risk with the SESMP2 and SEFRMS Recommended Programme of Improvements (2030 to 2110)

6.1.32 With the recommended SESMP2 and SEFRMS programme of improvements, the tidal flood defence system would provide a 0.1%AEP SoP against breach through to 2110. The recommended programme of improvements are independent of the M4CaN and would be recommended whether the M4CaN was present or not.

6.1.33 Implementation of the improvements programme would result in only localised and temporary flooding occurring due to wave overtopping, and limited tidal overtopping that would not cause breach. Under these conditions the M4CaN would not be expected to cause any betterment or detriment to properties within the Wentlooge and Caldicot Levels.

6.1.34 Whilst inspection of the WAG (2007) climate change guidance indicates that between 2110 and 2122 a further approximately 0.2m of sea level rise would occur, interpretation of the SESMP2 and SEFRMS recommendations indicates that the above discussion would still provide a reasonable description of the expected programme of improvement works.

6.1.35 The reasonable likelihood is that the Stephenson Street scheme will proceed, and the above description of flood risks is reasonable. However, on a precautionary basis the flood risks without the Stephenson Street scheme are set out above, notwithstanding that that is not the likely scenario.

6.3 Fluvial Flooding (St Brides Brook/Mill Reen)

6.3.6 The impact of the changes to the vertical alignment at St Brides Road Bridge has slightly reduced the footprint of the proposed embankment on the flood plain of the St Brides Brook.

6.3.7 This will slightly reduce the adverse impacts associated with the loss of flood plain storage to the north of the new section of motorway.

6.3.8 The preferred solution to accept that there will be a slight increase in flood risk to the north and enter into a ‘right to flood’ agreement with the landowner or alternatively exercising CPO rights still holds.

6.4 Fluvial Flood Risk (River Usk and River Ebbw Crossings)

6.4.4 NRW's Newport hydraulic model (ESTRY TUFLOW) was used to investigate whether the bridge supports for the River Usk and River Ebbw crossings will impact on the flood risk within the lower reaches of the Rivers Usk and Ebbw.

6.4.5 NRW supplied surge tide data and the median flood (50% (1 in 2) AEP) for this purpose. Model simulations were tested for 50% (1 in 2) AEP flood routed against the 0.1% (1 in 1000) AEP tide, (9.56mAOD). Climate change (100 years) was added to both the fluvial and tidal boundary conditions.

6.4.6 Although NRW are currently looking at schemes to improve tidal flood risk within the lower reaches of the River Usk, (SEFRM priority scheme: Stephenson St), the model previously included the current level of the defences, (i.e. no scheme in place).

6.4.7 In order to assess whether the bridge supports would impact on flood risk following completion of the tidal flood defence scheme, a second test was made whereby levels were raised along the east bank of the river to protect against the 0.1% (1 in 1000) AEP tide.

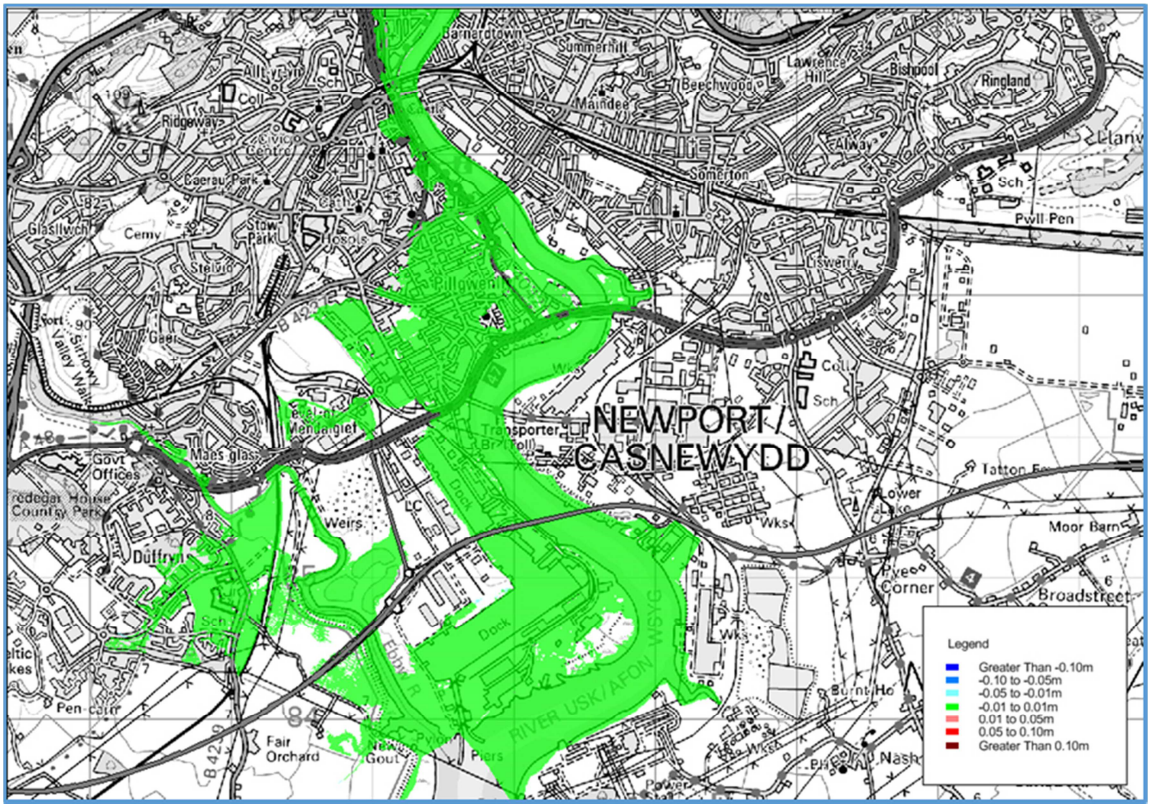
6.4.8 Simulations were run with and without the supports for the new bridge.

6.4.9 Figure 6.1 shows the level difference grid derived from the pre and post project simulations.

6.4.10 The results indicate that following completion of the Stephenson Street Scheme the supports for the new bridge will not impact on flood risk in the lower reaches of the Rivers Usk and Ebbw.

6.4.11

Figure 6.1 Difference Grid for Pre and Post Project Simulations for the 50% (1 in 2 year) +cc AEP flood routed against the 0.1% (1 in 1000 year) AEP tide (9.56mAOD) and raised tidal defences.



6.6 Scheme Drainage

6.6.6 The design changes undertaken within KS4 have not resulted in any changes to the impermeable surfaces for the proposed section of new motorway. The design of the Water Treatment Areas developed during KS3 is unchanged.

6.6.7 The surface water drainage infrastructure for the proposed new section of motorway will ensure satisfactory consequences with respect to highway drainage.

6.7 Conclusion

6.7.2 It is concluded that the Scheme can still be developed with satisfactory consequences with respect to flood risk.

7 Appendices

A1 Preliminary Drainage Drawings