M25 junction 10/A3 Wisley interchange TR010030

5.5 Flood risk assessment

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M25 junction 10/A3 Wisley interchange

The M25 junction 10/A3 Wisley interchange Development Consent Order 202[x]

5.5 FLOOD RISK ASSESSMENT

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Executive Summary

This Flood Risk Assessment (FRA) forms part of the Development Consent Order (DCO) application for the M25 junction 10/A3 Wisley interchange (the Scheme) and has been prepared in accordance with the requirements of Regulation 5(2)(e) of The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009.

The Scheme comprises a series of road improvements proposed by Highways England to address congestion and journey reliability issues at junction 10/A3 of the M25 motorway in Surrey.

This FRA has been completed to provide a quantitative assessment of flood risk and demonstrate that proposed mitigation (where necessary) would achieve an acceptable level of flood risk and would not increase flood risk elsewhere. This FRA has also been completed in line with National Policy Statement for National Networks (NPS NN) and follows the current national planning policy in relation to development and flood risk, namely the National Planning Policy Framework (NPPF). The FRA and NPS NN addresses all sources of flood risk both under current conditions and taking climate change into account.

Environment Agency flood risk mapping and both the Elmbridge and Guildford Strategic Flood Risk Assessments (SFRAs) were used as the main sources of flood risk information to inform the understanding of flood risk within the study area, specifically within the Scheme DCO boundary. This information has been supplemented with detailed hydraulic modelling undertaken specifically for the DCO application both to provide a more robust understanding of flood risk and inform the Scheme design.

Fluvial flood risk arises when watercourses exceed capacity and significant areas at risk are shown by the Environment Agency Flood Zone mapping. This Flood Zone mapping identifies that the majority of the Scheme is within Flood Zone 1 and so not at risk of fluvial flooding. Several areas of the Scheme are however at within Flood Zone 2 and 3. There are also five locations where the M25 and A3 cross ordinary watercourses (those which are not designated main rivers), although the flood risk for these has not been defined by Flood Zone mapping. In the majority of the areas at risk from fluvial flooding there are no proposed works that would impact on flood risk, either through the displacement of flood water or as a result in a constriction of conveyance. The key location of works that could have an impact is in the southern extent of the Scheme where culvert works and a new bridge are proposed over Stratford Brook (main river). However, the proposed works in this area involves measures that prevent an increase in flood risk, as demonstrated through detailed modelling.

The other key source of flood risk requiring consideration is surface water runoff. The existing drainage system manages the current surface water flood risk to the road network and this will be upgraded and supplemented with additional drainage systems (where necessary) to accommodate the Scheme. The drainage system is described in detail within the Drainage Strategy Report (application reference TR010300/APP/6.5/) Appendix 8.1, but in summary will prevent onsite flooding and increased runoff from the site in line with current planning policy requirements. For example, it will prevent onsite flooding during the 1 in 30 (3.3%) rainfall event and more frequent, and prevent runoff from the site above greenfield rates up to the 1 in 100 (1%) annual probability rainfall event, with both scenarios including an allowance for climate change.

Flood risk from all other sources is considered low, although requirements will be included within the Construction Environmental Management Plan (CEMP) to ensure that this risk remains low. These items include consideration of groundwater ingress into excavations; understanding the water transmission infrastructure network in the area; and potential impacts on Bolder Mere.

To summarise, the proposed Scheme would be at an acceptable level of flood risk and would not increase flood risk elsewhere. This conclusion remains true, both now and over the lifetime of the Scheme taking climate change into consideration.

1. Introduction

1.1 Background

1.1.1 In December 2014 the Department for Transport (DfT) published its Road Investment Strategy (RIS) for 2015-2020. The RIS sets out the list of schemes that are to be delivered by Highways England over the period covered by the RIS (2015-2020). The RIS identified improvements to the M25 junction 10/A3 Wisley interchange as one of the key investments in the Strategic Road Network (SRN) for the London and south east region.

1.1.2 The Scheme provides increased capacity at the M25 roundabout by elongating the existing roundabout, providing additional lanes to provide more circulatory capacity and enabling more traffic to discharge the roundabout whilst providing dedicated free-flowing left turns. For a full description of the Scheme refer to Introduction to the Application (application document TR010300/APP/1.2).

1.1.3 The area of development for the alteration works will exceed the limit prescribed in Section 22 (4) (a) of the Planning Act 2008 (as amended) and the Scheme will be developed as two Nationally Significant Infrastructure Projects (NSIPs). This means that a Development Consent Order (DCO) application will need to be made to the Secretary of State under Section 37 of the Planning Act 2008 to seek authorisation to build the Scheme.

1.1.4 This Flood Risk Assessment (FRA) is required to demonstrate how the impacts of flood risk both to the Scheme and that can result from the Scheme, have been assessed and mitigated where necessary. This will allow the approval process for the DCO to be followed with a good knowledge as to the risks and potential impacts of the Scheme in relation to flooding.

1.2 Scope

1.2.1 This FRA has been completed in line with the National Policy Statement for National Networks (NPS NN) and follows the current planning policy in relation to development and flood risk, namely the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance. This FRA has also been completed in line with the Highways England's Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3 Part 10 Road Drainage and the Water Environment (Highways England et al 2009).

1.2.2 Complying with this planning policy and design manual promotes a Scheme that would be at an acceptable level of flood risk, whilst not increasing flood risk both on site and elsewhere, and where possible reducing flood risk overall. This is required for all sources of flood risk and over the life time of the development (i.e. taking into account climate change).

1.2.3 This FRA is a quantitative appraisal to demonstrate that the development complies with the above requirements. Therefore, this FRA:

- Defines flood risk to the site;
- Determines the impact of the development on flood risk;
- Outlines the proposed mitigation measures; and

- Provides evidence demonstrating that the development is at an acceptable risk of flooding, whilst ensuring the development will not increase flood risk elsewhere.

1.3 Location and Proposed Scheme

1.3.1 The M25 junction 10/A3 Wisley interchange lies in the south west quadrant of the M25 London Orbital Motorway. At junction 10, the A3, a key radial route from London to Portsmouth, which crosses the M25 motorway. Just to the north of junction 10 on the A3 is the Painshill junction with the A245. To the south of junction 10 on the A3 is the Ockham junction with the B2039 and B2215. The Scheme is located within the County of Surrey and within the Boroughs of Guildford and Elmbridge.

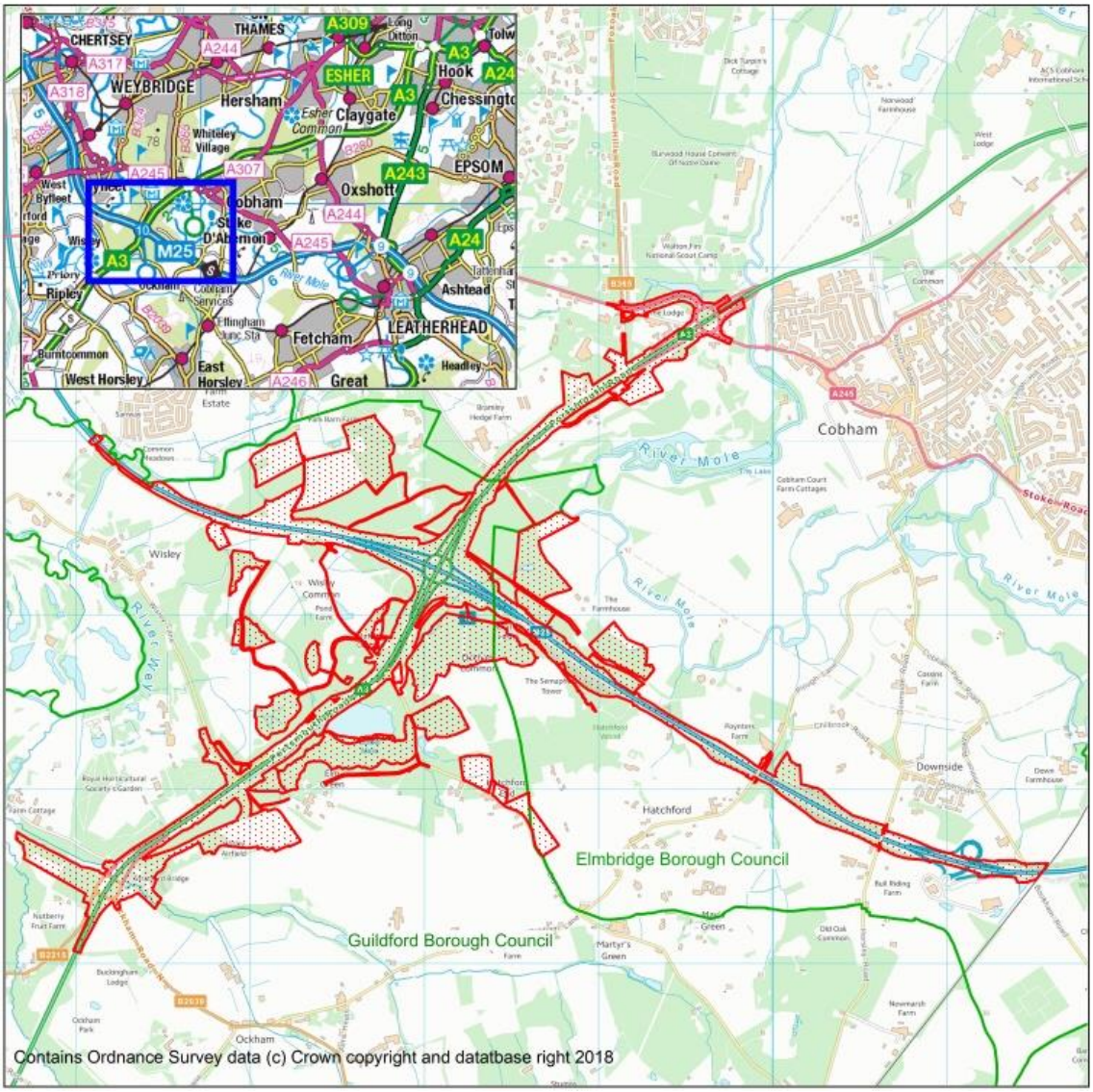
1.3.2 The location of the Scheme and the DCO boundary for the area of works is shown in Figure 1.1. Scheme Layout Plans (application document TR010300/APP/2.8) showing the proposed Scheme are provided within the DCO submission

1.3.3 The M25 junctions at this location, in the current configurations restrict traffic flow through the area and a package of measures is required to improve junction performance and safety.

1.3.4 The Scheme proposed provides increased capacity at the M25 roundabout by elongating the existing roundabout, providing additional lanes to provide more circulatory capacity and enabling more traffic to discharge the roundabout whilst providing dedicated free–flowing left turns. The elongated roundabout would use the existing bridges under the A3 and new bridges over the M25, with additional lanes and capacity between the traffic signals and dedicated left–turn filters at the traffic signals. Most of the existing roundabout and slip roads would be broken out and removed, with the existing structures over the M25 being demolished.

1.3.5 The Scheme includes widening the A3 from Ockham to M25 junction 10 and M25 junction 10 to Painshill from three lanes to four lanes in both directions to improve safety and capacity of the A3. There would also be widening of the A245 to three lanes between the Painshill junction and the B365 Seven Hills Road junction. As the A3 will be widened to four lanes the current access to it from side roads and private properties will need to be closed and alternative arrangements will be put in place to provide access to the road network for the properties affected. Alterations to signage and improvements to drainage are also included in the Scheme. Construction is expected to start in winter 2020.

Figure 1.1: Scheme location plan



1.4 Flood risk policy

1.4.1 The NPS NN, NPPF and associated guidance are the key planning policy guidance in relation to flood risk and development to ensure that flood risk is adequately considered as part of development design. The NPS NN is the policy specific for NSIPs and it references much of the policy and guidance from the NPPF.

1.4.2 The NPS NN requires a Sequential Test when determining the location of the new development to promote development away from areas at risk of flooding. The Highways England RIS for 2015-2020 identifies the significant need for capacity improvements at this junction and therefore works are required at this location. However, where possible a sequential approach has been taken within the study area for the road improvements, such as when locating balancing ponds and site compounds.

1.4.3 The NPPF categorises development type based on vulnerability to flooding. The proposed road scheme falls under these classifications as ‘Essential Infrastructure’. This means that the proposed development would be considered

acceptable for construction in Flood Zones 1 and 2, hence areas at risk from fluvial (river) flooding during the 1 in 1000 (0.1%) annual probability event and rarer. This type of development could be proposed within higher risk areas, i.e. Flood Zone 3 (both 3a and 3b) if a passed Exception Test is demonstrated.

1.4.4 A passed Exception Test demonstrates that:

1. The development is required for wider benefits that outweigh flood risk; and
2. That the development is safe from flooding without increasing flood risk elsewhere.

1.4.5 This FRA demonstrates point 2 above.

2. Assessment of Flood Risk

2.1 Overview

2.1.1 As outlined in the NPS NN and NPPF, flood risk from all sources must be addressed within the FRA to ensure that potential flood risk has been considered during the design of the Scheme. This section provides a list of the data sources used for this assessment and flood risk to and from the development from all sources. This section also outlines mitigation measures, as appropriate, to achieve this requirement.

2.2 Data sources

2.2.1 The assessment makes use of readily available information as follows:

- The Environment Agency Flood Zones, surface water mapping and historical flood extents, taken from the Environment Agency data catalogue[1];
- The Elmbridge Strategic Flood Risk Assessment (SFRA) (Elmbridge Borough Council, 2014);
- The Guildford SFRA (Guildford Borough Council, 2015);
- The Surrey County Council (Lead Local Flood Authority, LLFA) Preliminary Flood Risk Assessment (PFRA) (2011);
- The Surrey Local Flood Risk Management Strategy 2017-2032 (2017); and
- Elmbridge Section 19 Flood Investigation Report for the winter 2013/14 event (2015).

Based on the Surrey County Council website[2], it appears that a Surface Water Management Plan (SWMP) has not been completed either covering or in the vicinity of the Scheme DCO boundary.

This FRA has also been informed by detailed hydraulic modelling as discussed within the Hydraulic Modelling Report prepared to inform the drainage design and the Scheme Drainage Strategy (TR010030/APP/6.5) Appendix 8.1

2.3 Historic flooding

2.3.1 Areas that have flooded in the past often indicate areas that are vulnerable to flooding in the future. The Environment Agency publish mapping that indicates areas which have been inundated by water from main rivers in the past. In relation to the Scheme, this mapping shows that predominately the proposed works are outside areas that have experienced fluvial flood risk in the past.

2.3.2 The Elmbridge SFRA provides details of past flooding events, although river flooding has been taken from the Environment Agency dataset and therefore indicates the same coverage as above. This SFRA indicates that there have been no incidents of sewer or other flooding as recorded by Elmbridge Borough Council within the DCO boundary.

[1] http://environment.data.gov.uk/ds/catalogue/index.jsp#/catalogue
[2] https://www.surreycc.gov.uk/people-and-community/emergency-planning-and-community-safety/flooding-advice/more-about-flooding/surface-water-management-plans

2.3.3 The Guildford SFRA shows areas that have flooded in the past as identified by the Environment Agency, (including an event that occurred in 2003) and historic road flooding. None of these events have occurred within the DCO boundary.

2.3.4 Within the Elmbridge area a Section 19 Flood Investigation report was completed for the winter 2013/14 flood event (Section 19 Flood Investigation Report, Elmbridge, 2015). This identifies that areas within the Cobham area, at the northern extent of the Scheme suffered flood inundation resulting in a road closure (not affecting the M25 or A3) and internal property flooding. The flooding resulted from overtopping from the River Mole,

2.3.5 There are no other Section 19 Flood Investigation reports for areas in close proximity to the Scheme DCO boundary.

2.3.6 The Surrey Local Flood Risk Management Strategy identifies wetspots as areas used to describe locations of past flooding, which are prioritised for assessment and remedial works. There are no such wetspots along the M25 or A3 within the DCO boundary.

2.4 Fluvial flood risk

2.4.1 Fluvial flood risk occurs when the capacity of a watercourse is exceeded such that water overspills the watercourse channel.

Baseline flood risk

2.4.2 In the southern area of the site the Scheme will cross Stratford Brook which is a designated main river (under the permissive and regulatory powers of the Environment Agency) and which is a tributary of the River Wey. At the eastern end of the site the Scheme will cross another main river, albeit this appears to be an unnamed tributary of the River Mole. In addition to these locations where the Scheme will cross main rivers, the River Mole is located in close proximity to the northern extent of the Scheme and the River Wey in the west, both of which are main rivers.

2.4.3 In addition to crossing and close proximity to main rivers, within the DCO boundary the M25 also crosses three ordinary watercourses (those which are not main rivers and fall under the regulatory jurisdiction of the Lead Local Flood Authority Surrey County Council) to the east of junction 10. These ordinary watercourses are tributaries of the River Mole. Similarly, the A3 crosses an ordinary watercourse which appears to discharge from Bolder Mere.

2.4.4 The initial source of information used to determine fluvial flood risk to a proposed development is the Environment Agency Flood Zone mapping. The Flood Zones are defined as:

- Flood Zone 1 – Areas with a ‘Low Probability’ of flooding and where the annual probability of flooding is lower than 1 in 1000 (0.1%) for either fluvial or tidal flooding. The NPPF imposes no constraints upon the type of development within Flood Zone 1.
- Flood Zone 2 – Areas with a ‘Medium Probability’ of flooding and where the annual probability of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%) for fluvial flooding or between 1 in 1000 (0.1%) and 1 in 200 (0.5%) for tidal flooding. The NPPF recommends that Flood Zone 2 is suitable for most types of development with the exception of ‘Highly Vulnerable’ land uses.

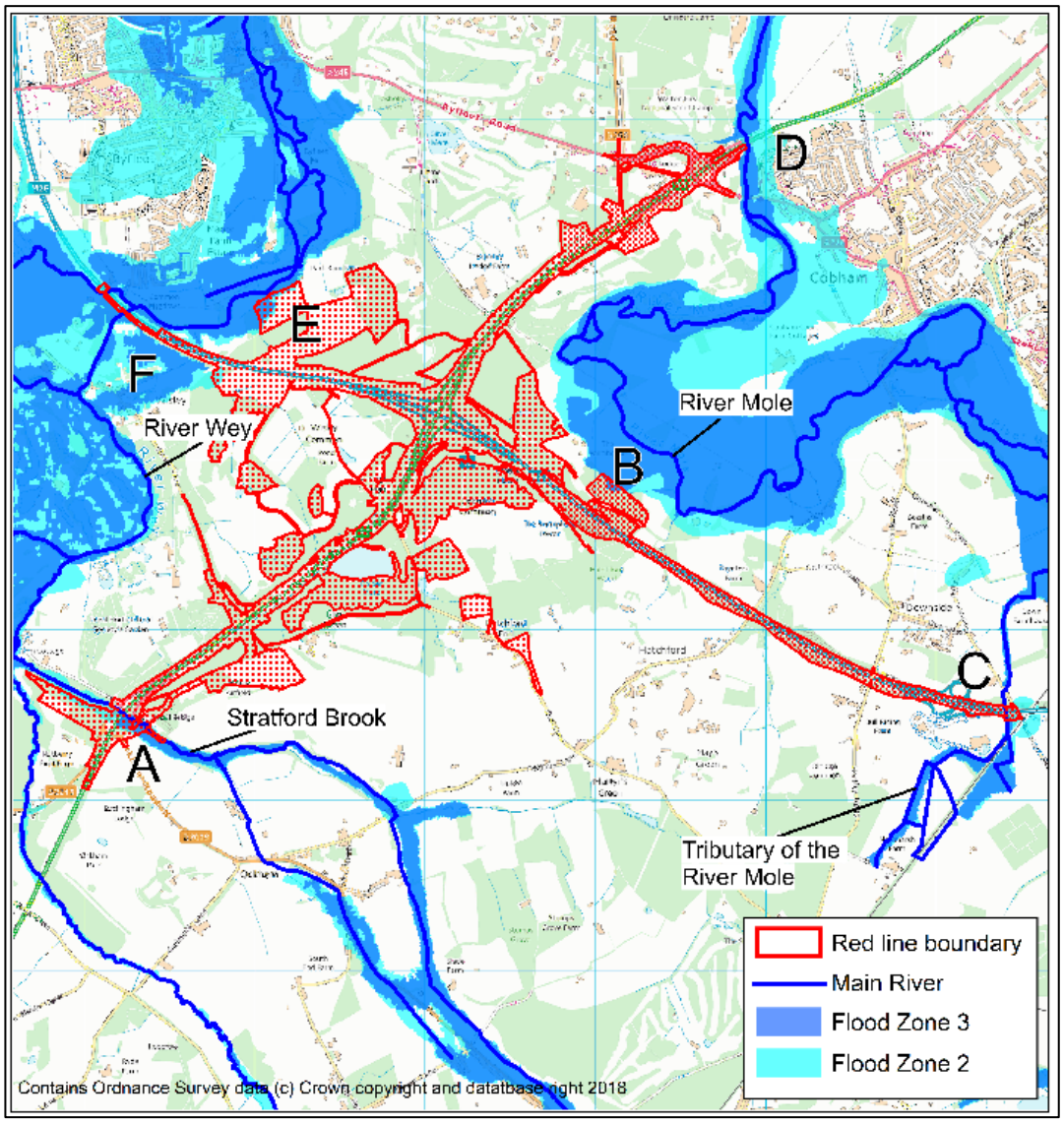
- Flood Zone 3 – Areas with a 'High Probability' of flooding and where the annual probability of flooding is 1 in 100 (1%) or greater for fluvial flooding or 1 in 200 (0.5%) or greater for tidal flooding. The NPPF recommends that appropriate development is based upon a further classification of Flood Zone 3 into 3a 'High Probability' and 3b 'Functional Floodplain' (where water has to flow or be stored in times of flood during the 1 in 20, 5%, event).

2.4.5 The Environment Agency mapping also indicates areas that benefit from flood defences and areas of floodplain storage, however neither are located within or adjacent to the Scheme.

2.4.6 Figure 2.1 shows that the Scheme DCO boundary overlaps with Flood Zone 2 and Flood Zone 3 at six locations, labelled A to F in Figure 2.1. These locations are:

- A: At the southern extent of the Scheme on the A3, at the location of the Stratford Brook crossing, the Scheme crosses both Flood Zones 2 and 3;
- B: The northern side of the M25 approximately 1 km east of J10;
- C: At the eastern extent of the Scheme on the M25, at the location of the crossing of the tributary to the River Mole, the Scheme crosses an area of Flood Zone 2 and extents into an area of Flood Zone 3;
- D: At the northern extent of the Scheme on the A3, a small proportion of the DCO boundary falls within the Flood Zone 2 and 3; and
- E: The northern side of the M25 approximately 1 km west of J10
- F: At the western extent of the Scheme, encroachment into the River Wey Flood Zones 2 and 3.

Figure 2.1: Environment Agency Flood Zone mapping and watercourse location plan



Post Scheme impacts

2.4.7 Any development that encroaches into Flood Zones 2 or 3 or works to watercourse crossings has the potential to increase fluvial flood risk. This can occur as a result of displacement of flood water when development is located in floodplain or owing to constriction of flood flows at the location of watercourse crossings. Where there is an impact on flood risk, appropriate mitigation is required.

2.4.8 The potential impact on flood risk arising from the Scheme must be considered over the life time of the Scheme taking into account climate change. The design standard for the Scheme is the Higher Central climate change allowance (a 35% increase in peak flow).

2.4.9 Whilst the Higher Central allowance is the design standard, the Upper End allowance must also be considered to confirm that there are no significant changes in flood risk impact that might warrant including further mitigation.

2.4.10 For some parts of the Scheme, Flood Zone 2 has been used as a proxy for the 1 in 100 +70 % flood event. These are locations where for example the works are to the existing carriageway that is set several metres above the adjacent Flood Zone, or where there are no proposals to alter ground levels.

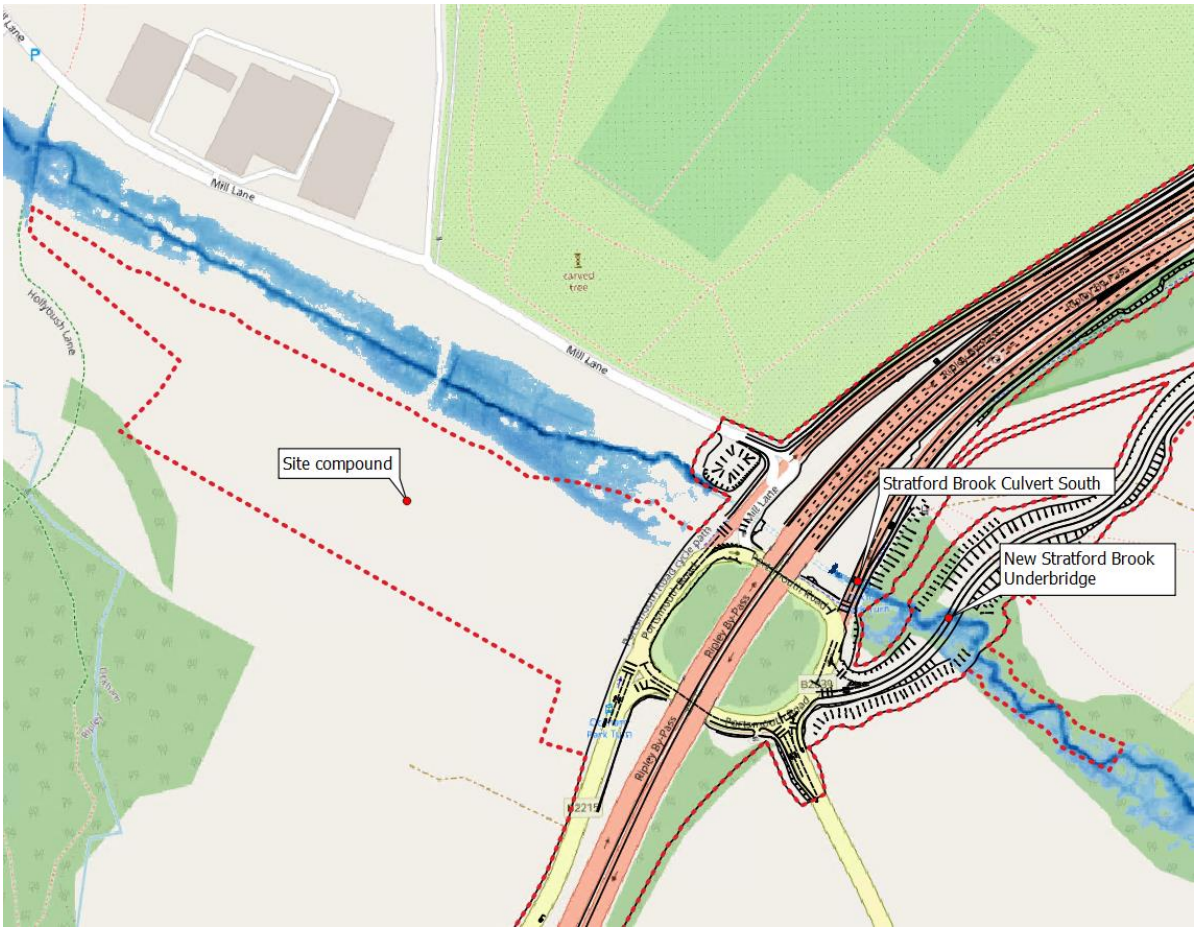
2.4.11 For locations where there is a potential impact on floodplain conveyance or storage, flood modelling has been used to define the flood extents for the 1 in 100 flood event for both the Higher Central and Upper End climate change scenarios. This is the case for the Stratford Brook (location A) and the M25 westbound slip road at the western extent of the DCO boundary on the M25 (location F).

2.4.12 Details of the flood risk associated with main rivers for each of the six locations outlined above are provided below.

Stratford Brook (Location A)

2.4.13 The Scheme near Stratford Brook is illustrated in Figure 2.2. Further detail of the Scheme is shown on sheet 1 of 31 of the Scheme Layout Plans.

Figure 2.2: Stratford Brook with modelled 1 in 100 +35% flood extent



2.4.14 At the southern extent of the Scheme, the A3 crosses Stratford Brook and is located within Flood Zone 2 and 3. The Scheme at this location does not involve works directly to the A3, but rather modifications to an existing slip road and the construction of a new link road (the Wisley Lane diversion).

2.4.15 The new link road will require a new crossing of Stratford Brook, and the proposed structure is a clear span bridge of the watercourse and the 1 in 100 (+35% climate change allowance) flood extent. As a result, the bridge will neither act as a constriction on flow nor would the embankments extend into the floodplain, and thus flood risk would not be altered. This has been confirmed through detailed hydraulic modelling of Stratford Brook.

2.4.16 The hydraulic modelling included model simulations of the Upper End climate change allowance (+70% increase on peak flow). The results of this simulation showed that there was no change in flood levels. Floodplain compensation is not required for this element of the Scheme. Furthermore, the bridge deck is more than 1.5 m above the flood level for all scenarios tested, resulting in safe and operational use of the road during periods of fluvial flooding along Stratford Brook.

2.4.17 The modelling work is described in Hydraulic Modelling Report. The modelling has been reviewed and accepted by the Environment Agency. The correspondence from the Environment Agency confirming this is provided in Appendix A of this document.

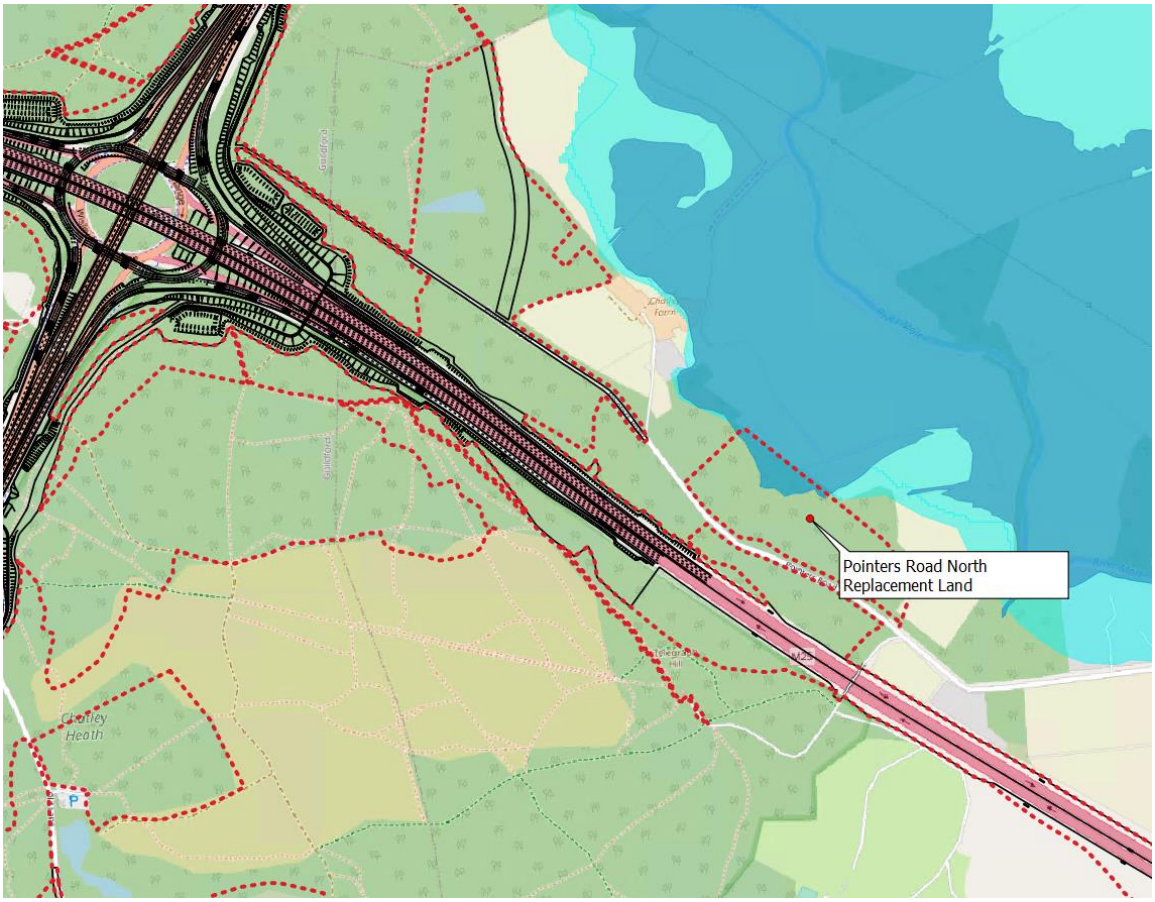
2.4.18 The proposed works to the slip road will involve upgrade works from one to two lanes to improve traffic flow. To accommodate this upgrade the existing culvert under the slip road conveying Stratford Brook (Stratford Brook Culvert South) will require strengthening. The modifications to strengthen the existing culvert under the slip road will have no impact on internal dimensions of the culvert and therefore it will have no impact on flood risk.

2.4.19 The flood modelling of the Stratford Brook will be reassessed as part of the detailed design process and the outputs will be submitted as supporting information to the Environment Agency as part of the Protective Provisions approvals process.

Eastern section of the Scheme on the M25 (Location B)

2.4.20 The section of the Scheme east of J10 is illustrated in Figure 2.3. Further detail of the Scheme is shown on sheet 14 of 31 of the Scheme Layout Plans.

Figure 2.3: River Mole Flood Zone 2 & 3



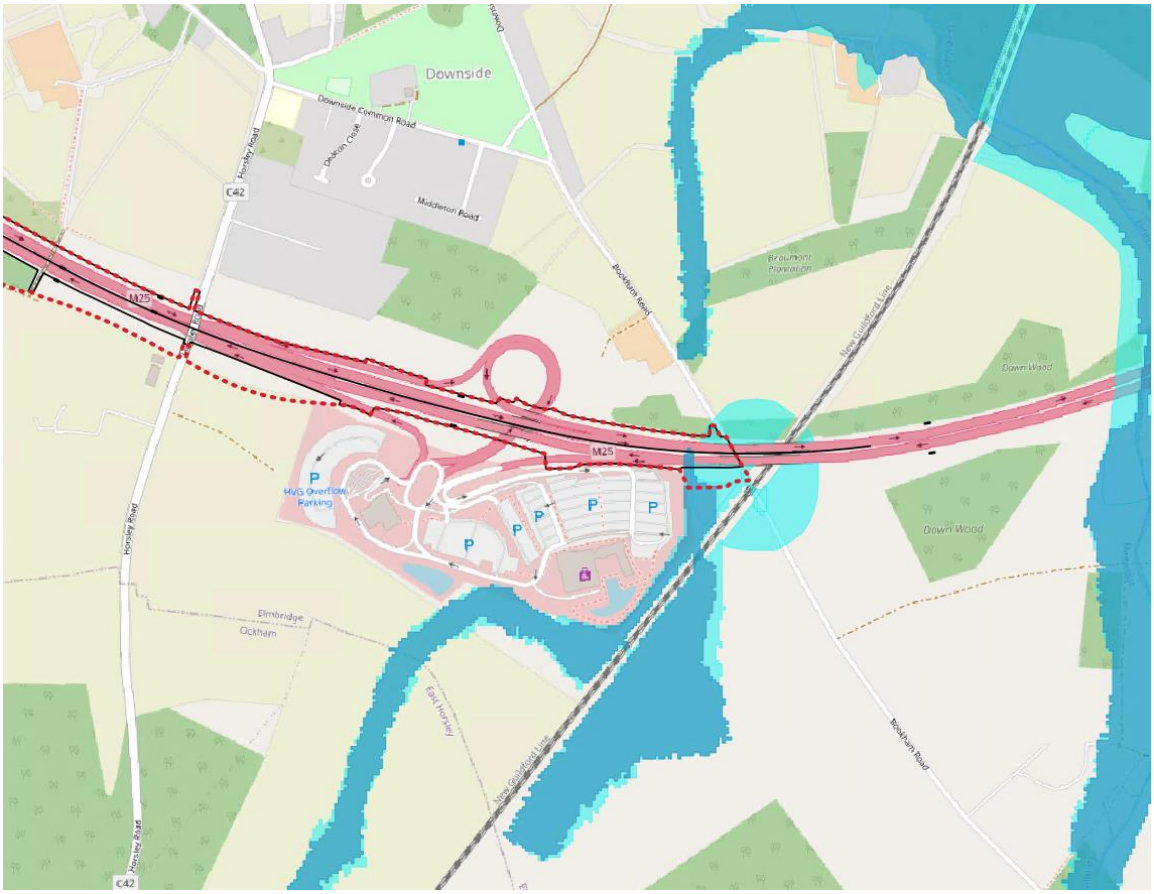
2.4.21 The Pointers Road North Replacement Land that is proposed for habitat replacement is partly within Flood Zone 3, however this will not involve any changes to ground levels and will not affect flood risk. The proposal is to plant native species trees and shrubs in this area, further details, including the planting regime, will be determined during the detailed design phase of the Scheme.

2.4.22 The ground levels rise steeply between the edge of Flood Zone 2 and the M25. The M25 is some 10 m higher than the flood levels estimated from the extents of Flood Zone 2 (by comparison of the lidar levels at the edge of the flood zone). The existing and proposed M25 will not therefore be at risk from fluvial flooding in the Upper End climate change scenario in this location.

Eastern section of the Scheme on the M25 (Location C)

2.4.23 The eastern most section of the Scheme on the M25 is illustrated in Figure 2.4. Further detail of the Scheme is shown on sheet 18 of 31 of the Scheme Layout Plans.

Figure 2.4: Eastern extent of the Scheme with Flood Zones 2 & 3



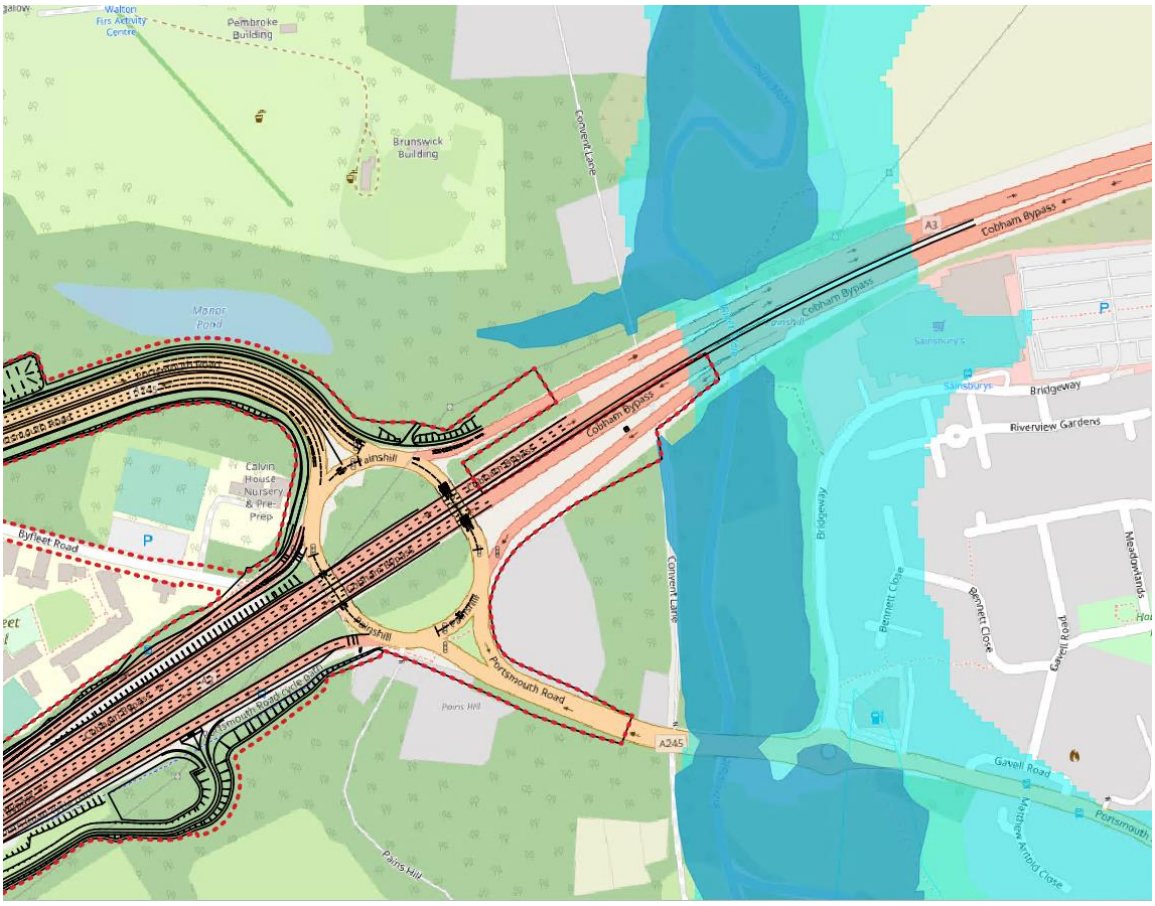
2.4.24 In the eastern area of the Scheme the M25 crosses a main river tributary of the River Mole. However, the works in this area are limited to gantries and signage within the confines of the existing highway. Therefore, the proposed works would be above the existing level of the road, which is approximately 8 m above the Flood Zone 2 level at this location (based on comparison between Lidar data and flood extents), and therefore would neither be at risk from flooding, nor impact on flood risk elsewhere.

2.4.25 Given the elevation of the road above the estimated Flood Zone 2 level, the Scheme would not be at risk from fluvial flooding in Upper End climate change scenario in this location.

Northern section of the Scheme on the A3 (Location D)

2.4.26 Figure 2.5 shows the works proposed for the Scheme and Flood Zone 2 & 3 in this location. Further detail of the Scheme is shown on sheet 8 of 31 of the Scheme Layout Plans.

Figure 2.5: Northern section of the Scheme on the A3 (Location D): Flood Zone 2 & 3



2.4.27 At the northern extent of the Scheme the DCO boundary extends into Flood Zones 2 and 3 associated with the River Mole. The Flood Zones at this location represent the floodplain in the absence of the A3. Interrogation of the lidar data in this area shows that the elevation of the A3 at road level is more than 5 m above the flood level (estimated based on the ground levels at the edge of the Flood Zone 2 extent). The works planned in this area are confined to the extents of the existing road. Therefore, the Scheme will not be at risk of fluvial flooding, nor would the Scheme increase fluvial flood risk elsewhere.

2.4.28 Given the elevation of the road above the estimated Flood Zone 2 level, the Scheme would not be at risk from fluvial flooding in Upper End climate change scenario in this location.

Western section of the Scheme on the M25 (Location E & F)

2.4.29 Figure 2.6 shows the works proposed for the Scheme and the flood extents in this location. Further detail of the Scheme is shown on sheet 10 of 31 of the Scheme Layout Plans.

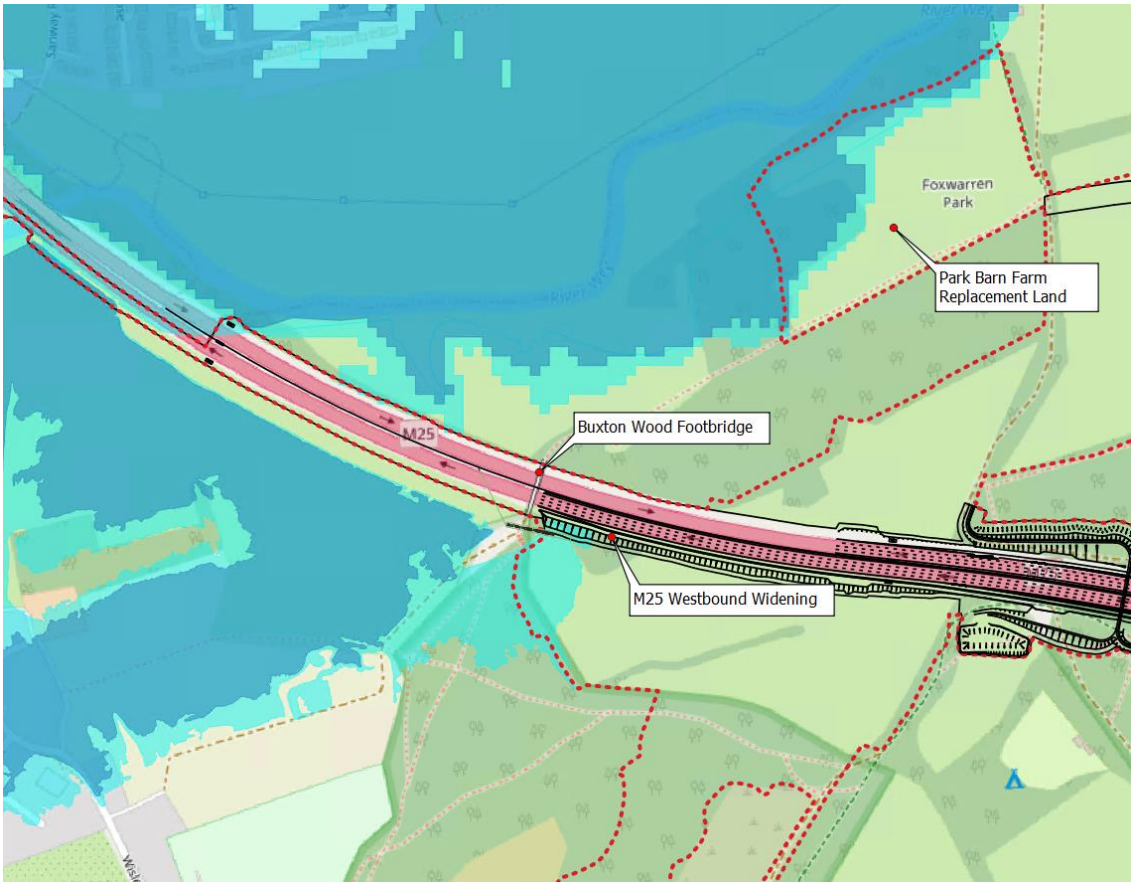
2.4.30 Upstream of the M25 the flood extents are defined by outputs from the Lower Wey flood model. The 1 in 100 flood event from the 1D Lower Wey flood model has been rerun with a 35% and a 70% uplift of peak flows to simulate the Higher Central and the Upper End climate change allowances. No other changes were made to the model except this change of the inflow hydrographs.

2.4.31 The upstream extent of the Lower Wey model is approximately 10 km upstream of the M25. The attenuating effects of the whole River Wey catchment on the climate change uplifts, will not therefore be represented within this model. Therefore the peak flood levels associated with the climate change events is likely to be overestimated.

2.4.32 In Figure 2.6 upstream of the M25 the dark blue flooding is the 1 in 100 +35% flood extent and the light blue flooding is the 1 in 100 +70% flood extent.

2.4.33 Downstream of the M25 the flood extents are Flood Zone 2 & 3.

Figure 2.6: Western section of the Scheme on the M25 (Location E & F): Flood extents



2.4.34 The 1 in 100 +35% flood extent does not extend as far as Buxton Wood Footbridge and the widening of the M25 to the east of the footbridge does not impact the floodplain.

2.4.35 The 1 in 100 +70% flood extent does extend east of Buxton Wood footbridge and the widening of the M25 is within this flood extent. The depths of flooding here are low and the loss of floodplain volume is similarly low, estimated to be less than 100 m^3.

2.4.36 The flood extent estimates for the 1 in 100 +70% climate change are expected to be an overestimate given the modelling approach adopted, so it is similarly expected that the loss of floodplain is also overestimated.

2.4.37 The loss of a small volume of floodplain storage within the wide floodplain of the River Wey in the Upper End climate change scenario does not represent a significant step change in the potential impact of the Scheme in comparison to

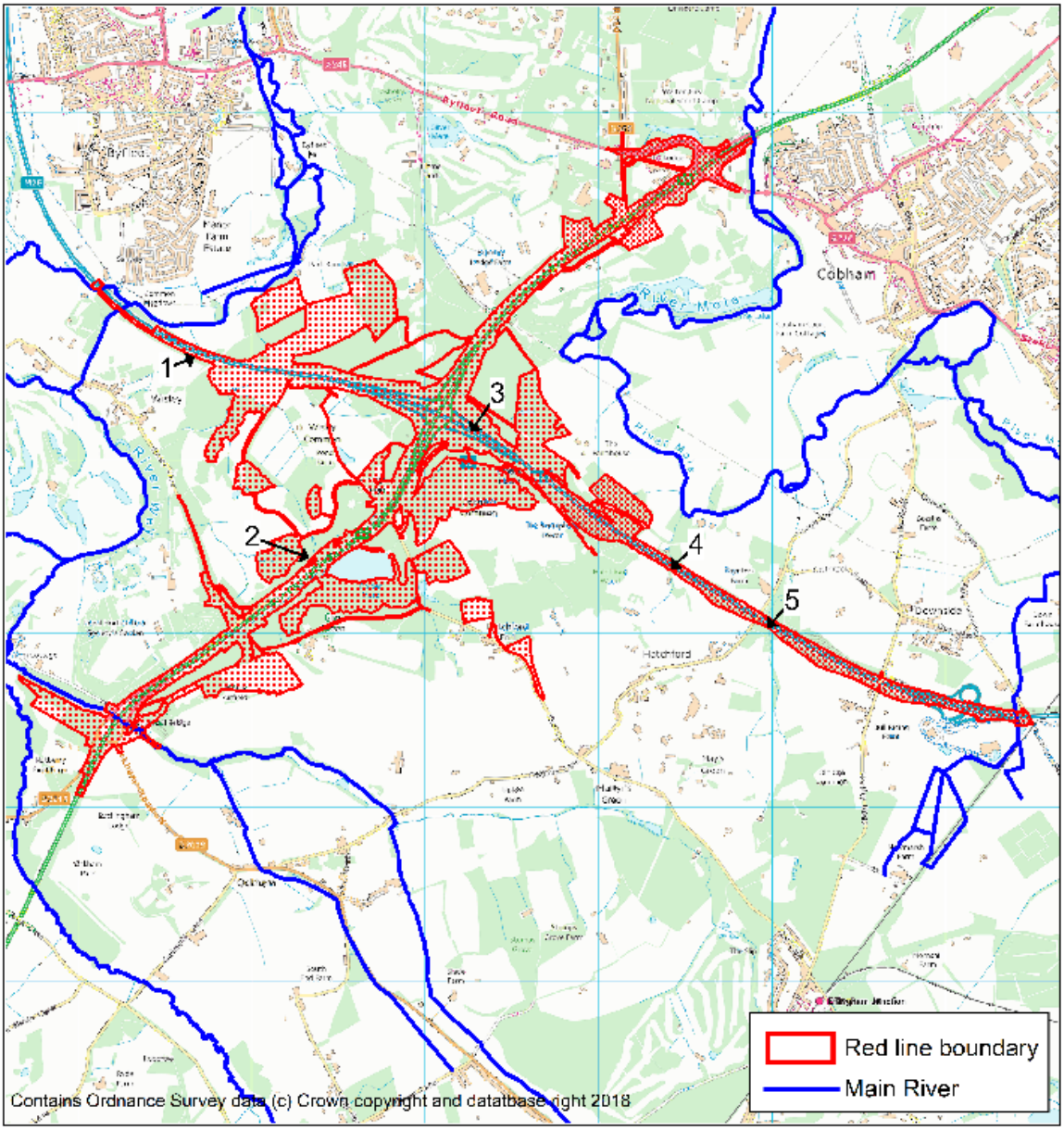
the Higher Central climate change scenario. Therefore, no mitigation is proposed.

2.4.38 The flood modelling of the River Wey will be reassessed as part of the detailed design process. This will confirm if there is a flood risk impact that warrants being addressed within the design (either by designing out the source of the impact, or by providing appropriate mitigation). The outputs of the assessment will be submitted as supporting information to the Environment Agency as part of the Protective Provisions approvals process.

Ordinary watercourses

2.4.39 The Scheme crosses a number of ordinary watercourses for which Flood Zones have not been defined. The five ordinary watercourses are identified in Figure 2.7.

Figure 2.7: Ordinary watercourses



2.4.40 There are five locations are described below.

1. There is an ordinary watercourse that passes under the M25 just west of Buxton Wood footbridge. There are no works proposed that would impact on this ordinary watercourse, nor the River Wey further west i.e. there is no change to these crossing structures
2. Works are required at the road section adjacent at Bolder Mere (designated as a reservoir). The works at this location require an extension to the existing Bolder Mere culvert. Therefore, this culvert will be designed to ensure that there is no impact on flood risk.
3. Immediately to the east of junction 10 the M25 crosses an ordinary watercourse which may provide hydraulic linkage to a pond. The works in this area includes strengthening embankments and if there is a culvert at this location it may require extending. It is proposed that the culvert will have the same dimensions. Given the flood risk at this location and the absence of vulnerable receptors (residential, commercial or industrial properties or critical infrastructure), the proposed Scheme at this location would have no significant impact on flood risk.
4. East of the above location, and immediately east of Hatchford Wood, again the M25 crosses an ordinary watercourse. The proposed works in this area are to the gantry only, i.e. above the existing road. Therefore, there will be no impact to this existing culvert and therefore flood risk will remain unchanged.
5. To the east of Hatchford, the M25 crosses a slightly larger tributary of the River Mole. As above, the proposed works in this area are to the gantry only, i.e. above the existing road. Therefore, there will be no impact to this existing culvert and flood risk will remain unchanged.

Construction impacts

2.4.41 As shown in Figure 2.2, there is a small extent of the DCO boundary, within Flood Zone 3 of the Stratford Brook. The DCO boundary here is associated with a construction compound. The DCO boundary is set simply as an offset from the river and the compound will be outside the Flood Zone 3.

2.4.42 Therefore, the proposed fluvial flood risk associated with the construction phase of the Scheme is considered minimal and floodplain compensation is not required (compensation would only be required if ground raising was proposed in Flood Zone 3, which is not proposed).

2.4.43 The temporary works are shown in the Temporary Works Plans. If any of these works are proposed within Flood Zone 2 and/or within 8 m of main river banks, the works details and associated method statements will be issued as part of the Protective Provisions applications.

2.4.44 Any fencing required for the Scheme will be determined during the detailed design phase and agreed with the adjacent land owner. However, it is proposed that any fencing within Flood Zone 2 or 3 will be suitably permeable to prevent displacement or rerouting flood water.

2.4.45 To ensure that both the Scheme and construction staff are at an acceptable level of flood risk, and to ensure the construction activities do not impact on fluvial flood risk, the below recommendations will be included in the CEMP by the Principal Contractor. The CEMP is secured by Requirement 3 of the DCO. The recommended actions are:

- The Environment Agency flood warning system will be adopted. A suitable plan should be put in place to ensure effective and safe evacuation of personnel (and plant if safe to do so) from the areas at risk on receipt of a flood warning.
- Site compounds will be located outside Flood Zone 3 and preferably in Flood Zone 1 if possible. Site compounds will also be at least 8 m from the river banks.
- No plant or materials will be stored within Flood Zone 3.

2.5 Surface water flood risk

2.5.1 Surface water flooding occurs when rainfall intensities exceed the infiltration capacity such that water collects on the ground surface. Therefore, there is a greater risk of flooding from this source within urbanised areas where there is a higher proportion of impermeable surfacing.

Baseline flood risk

2.5.2 The Environment Agency publish mapping showing areas at risk from surface water flooding. This data set is based on broad scale mapping, often identifying areas of low lying land which would be vulnerable to surface water accumulation. Figure 2.8 shows the predicted extents of surface water flooding during three event categories:

- High risk – At risk during the 1 in 30 (3.3) annual probability event and more frequent.
- Medium risk – At risk during events between the 1 in 30 (3.3) and 1 in 100 (1%) annual probability events.
- Low risk – At risk during events between the 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability events.

2.5.3 Figure 2.8 identifies the areas at risk of surface water flooding throughout the Scheme area as noted below. However, the majority of these high-risk areas are associated with watercourses and are considered as fluvial flood risk, as described in the sub section above. The other areas shown to be at risk are either likely to be associated with isolated depressions in topography and areas along the A3 and M25 which are at a slightly lower elevation that other sections of the road. The notable areas at risk from surface water flooding that are not associated with watercourses are:

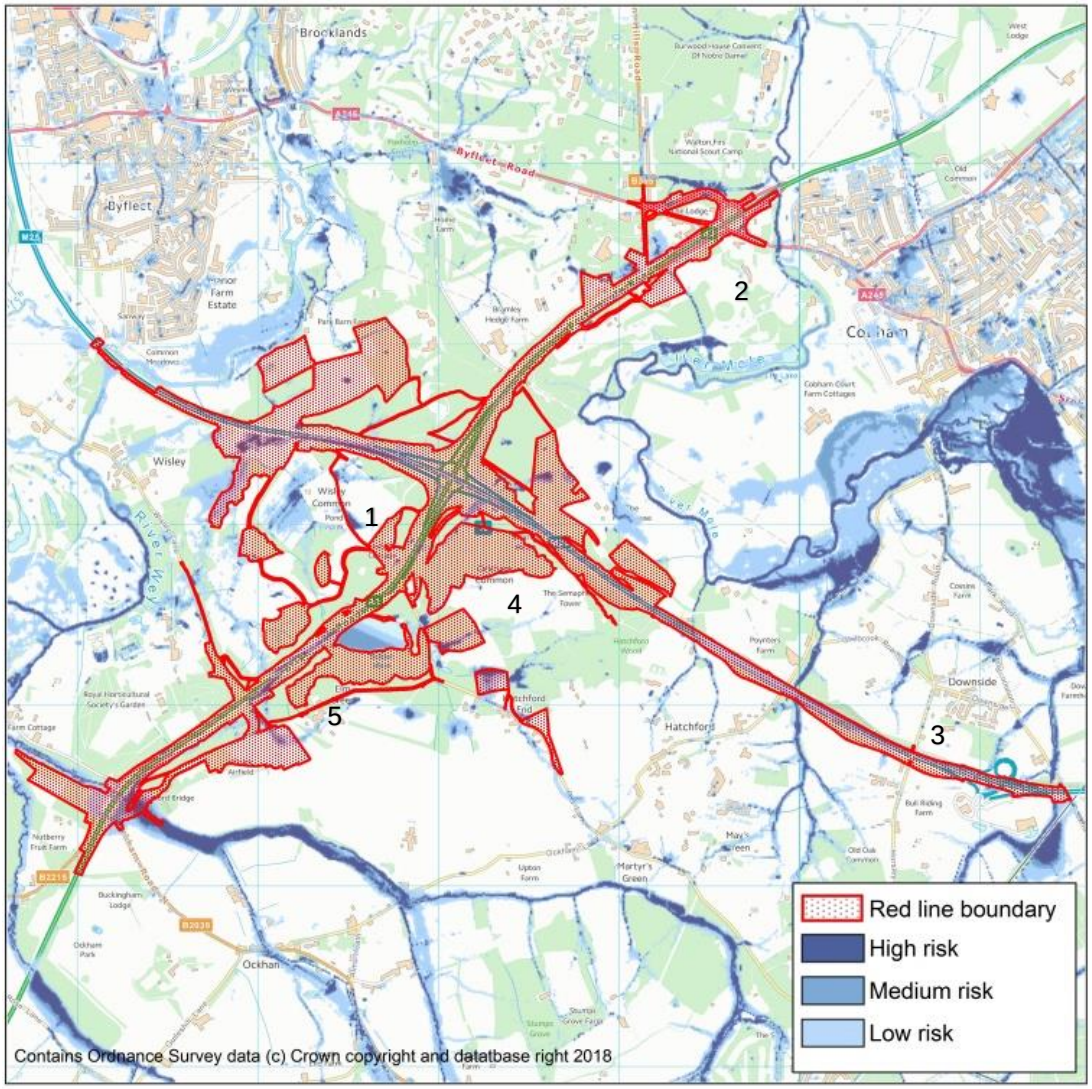
1. Surrounding Wisley Common. At this location there appears to be hydraulic connectivity between areas at risk from surface water flooding (ranging from high to low), including a 800 m length of the M25.
2. Northern extent of the Scheme. At this location there are various isolated areas shown to be at risk and these areas are likely to be associated with localised depressions in topography. There also appears to be a flow route to a series of lakes associated with the River Mole. Baseline surface water flood risk is low risk to vulnerable receptors.

3. South of Downside. At this location there are various areas at low risk from surface water flooding, and the location of this suggest a potential overland flow route which is blocked by the existing M25 that may cause backing up. However, there are no properties at risk here. Also at this location a 1 km length of the M25 is identified to be at high risk from surface water flooding, although it is assumed from the lack of flooding incidents on this section that the existing drainage of the road network adequately addresses this risk.
4. Ockham Common. At this location there are several interconnecting areas at risk (ranging from low to high) of surface water flooding at and around Ockham Common. These appear to be flow routes to Bolder Mere. There are no properties within this area.
5. A3 adjacent to Bolder Mere. There is a 500 m length of the A3 at this location identified to be at high risk from surface water flooding, although it is assumed that the existing drainage of the road network adequately addressed this risk. This area appears to also be connected with surface water flow paths in the area. There are no properties at risk of flooding in this area.

2.5.4 The flood risk in these latter areas are currently managed by the existing road surface water drainage.

2.5.5 Although the surface water flood risk within the DCO boundary is considered high, the existing drainage system reduces this risk to an acceptable level along the road network and there are no vulnerable receptors (residential, commercial or industrial properties) identified to be at risk.

Figure 2.8: Environment Agency surface water mapping



Post Scheme impacts

2.5.6 Any new development has the potential to impact on ground permeability and therefore surface water flood risk. This is of primary importance where development will increase the impermeable ground coverage within a site, and therefore will require mitigation.

2.5.7 The Scheme involves additional roads, access tracks and road widening which will involve an increase in impermeable surfacing.

2.5.8 To ensure that the proposed works will not cause an increase in surface water flooding, the surface water drainage system will be upgraded where appropriate and a new system installed for areas of new road/access. The drainage system will be designed in line with current Highways England standards (DMRB) to ensure that runoff from the site does not exceed the greenfield rate up to the 1 in 100 (1%) annual probability event taking into account climate change (the climate change allowance is 20%). The proposed drainage system involves a variety of drainage ditches and attenuation basins. Further details associated with the drainage design are included within the Drainage Strategy Report.

2.5.9 Therefore, the proposed drainage design will ensure that the Scheme is at an acceptable risk from surface water flooding and will not increase flood risk elsewhere. This will be true for present day scenarios and over the lifetime of the development taking climate change into account.

Construction impacts

2.5.10 Based on the risk identified in the subsection 2.5.1 to 2.5.9 above, it is considered that the risk during the construction phase is low. However, as plant moves around within the DCO boundary, in areas that are currently permeable, there is a risk that the ground will be compacted and the infiltration potential temporarily reduced. Similarly, site compounds have the potential to temporarily increase surface water runoff.

2.5.11 Given the nature of the works, these risks are likely to be short term and not extensive. Nevertheless, the CEMP will identify this risk and put in place necessary mitigation to prevent a temporary increase in surface water flood risk on site and elsewhere.

2.6 Groundwater flood risk

2.6.1 Groundwater flooding normally occurs where the water table meets the ground surface in low lying areas which are underlain by permeable rock known as aquifers. Groundwater flooding tends to follow long periods of sustained rainfall but can also be caused by local obstructions to groundwater flow (e.g. following the placement of engineering structures or buildings with foundations) or by the rebound of groundwater levels after a decrease in abstraction or dewatering.

Baseline flood risk

2.6.2 The Elmbridge SFRA (Elmbridge Borough Council, 2014) identifies areas that are susceptible and at risk of groundwater flooding. This mapping indicates that the areas within the DCO boundary that fall within Elmbridge Borough (north and eastern extents of the Scheme) are at low or very low risk from this source of flooding.

2.6.3 The Guildford SFRA (Guildford Borough Council, 2015) covers the western and southern extents of the Scheme and identifies the same level of risk as outlined for the eastern and northern extents of the Scheme above.

2.6.4 Based on the groundwater flood risk mapping provided within the SFRAs, which is based on geology for the area, the overall risk of groundwater flooding within the DCO boundary is considered low. This is primarily associated with the risk at and above the existing ground level.

Post Scheme impacts

2.6.5 The baseline assessment of groundwater flooding has identified a low risk within the DCO boundary at existing ground level. The road itself and the upgrade works are all above ground level and therefore would be at low risk.

2.6.6 However, the new drainage network, specifically the drainage ditches and attenuation features are below ground level. The proposed drainage ditches will be to an approximate depth of 1 m below existing ground levels. Similarly, the attenuation features are unlikely to be at significant depths (details provided in

the drainage strategy). Although the potential for water ingress into these features will need consideration as part of the design, the overall impact/risk of groundwater flooding to the Scheme is considered low.

2.6.7 Other development below ground level, such as foundations and sheet piling, has the potential to interrupt groundwater movements that can cause an increased flood risk.

Construction impact

2.6.8 As outlined above, development below existing ground levels would be at a slightly higher risk from flooding. Therefore, there is potential that any excavations required for enabling works for the Scheme would be at risk of groundwater ingress. The greater the depth of excavation the more likely for water ingress.

2.6.9 This potential for this will be considered, and associated mitigation proposed, as part of the CEMP.

2.7 Other sources of flooding

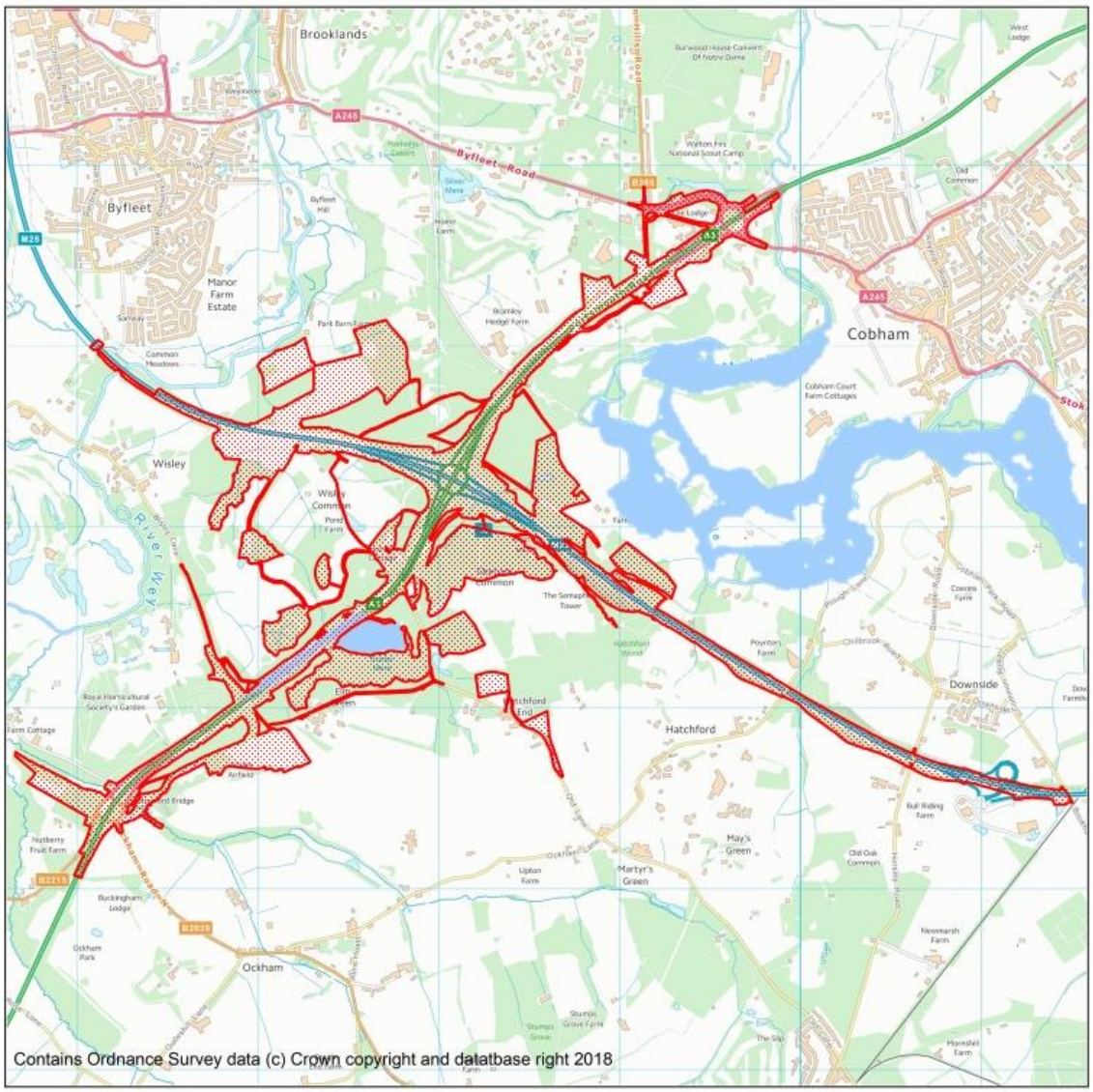
Reservoir flooding

2.7.1 The Environment Agency produce flood risk mapping indicating areas at risk of inundation should a designated reservoir fail, see Figure 2.9. This mapping shows that in the vicinity of the Scheme, reservoir flooding would occur along the floodplain of the River Mole. The only location where this extent is in close proximity to the DCO boundary is the most easterly extent of the site. However, works in this area do not extend into the area at risk.

2.7.2 A small section of the A3 (south of Bolder Mere) is also considered to be at risk of inundation from Bolder Mere. Bolder Mere is classified as a category D reservoir. A category D reservoir is one where no loss of life can be foreseen as a result of a breach and very limited additional flood damage would be caused. Although this risk should be considered for any works in this area, the risk is considered low.

2.7.3 However, based on the DMRB guidance, the importance of flood risk is also related to the receptors at risk of flooding. The importance of this source of risk is categorised as low as there are no properties at risk.

Figure 2.9: Environment Agency reservoir inundation mapping



Canal flooding

2.7.4 There are no canals located either within the DCO boundary or in adjacent areas. Therefore, it is considered that there is no risk from this source of flooding within the DCO boundary.

Water transmission infrastructure

2.7.5 There is an inherent risk of flooding from water transmission infrastructure, both potable and sewerage, owing to burst or leaking pipes. The risk will be dependent on the location and age of the network in this area. The Elmbridge and Guildford SFRAs indicate that there have been no incidents of sewer flooding within the DCO boundary up to 2015.

2.7.6 Therefore, the existing risk, particularly of significant flooding that would cause disruption, is considered low.

2.7.7 There is potential that proposed works could impact on risk from this source during the construction phase. However, the location of the network will be

established as part of the design phase, and associated requirements to prevent impact on this infrastructure proposed as part of the CEMP.

Other sources of flood risk summary

2.7.8 The flood risk from reservoirs, canals and water transmission infrastructure is low. Consideration of these risks, specifically reservoir and water transmission infrastructure will need to be considered as part of the design but following standard construction principles these risks will remain low during the construction and operational phases of the Scheme. Furthermore, this risk is anticipated to remain low over the life time of the development, taking climate change into account.

2.7.9 There are no other known sources of flooding that would pose a risk to the Scheme or would be impacted as a result of the works. This remains true for the current situation and over the life time of the development taking climate change into account.

2.8 Flood risk summary

2.8.1 A summary of all known sources of flood risk to the Scheme and that could arise from the works is provided in Table 2.1. This table is based on the DMRB categorisations of importance, impact magnitude and significance, which are defined in Chapter 4 of the Environmental Statement (application document TR010030/APP/6.3).

Table 2.1: Flood risk summary based on DMRB categorisation

Source of flood risk	Importance	Impact magnitude taking into account mitigation	Mitigation details	Significance of effect
Fluvial	Low to High	Negligible	Clear span bridge over Stratford Brook therefore no floodplain compensation required. Stratford Brook culvert under the slip road widening element of the Scheme will be altered although there will be no change in flood risk, therefore no floodplain compensation required. Construction actions to mitigate flood risk during the construction phase.	Neutral
Surface water	Low to High	Negligible	As outlined within the drainage strategy.	Neutral
Groundwater	Low	Negligible	Risks to and mitigation for the impact on the drainage system are outlined within the drainage strategy. Consider the potential for water ingress into excavations during the construction phase.	Neutral

Source of flood risk	Importance	Impact magnitude taking into account mitigation	Mitigation details	Significance of effect
Reservoir	Low	Negligible	None	Neutral
Canal	Low	Negligible	None	Neutral
Water transmission infrastructure	Low	Negligible	Standard construction principals.	Neutral

3. Conclusions and recommendations

3.1 Conclusions

3.1.1 The conclusions that have been reached from this Flood Risk Assessment are:

- The proposed Scheme is considered as essential infrastructure and based on the principles of current national planning policy (NPS NN and NPPF) would be acceptable for flood risk if a passed Exception Test can be demonstrated.
- This FRA provides evidence for the second part of the Exception Test, whereby the development would remain safe and not increase flood risk elsewhere, over the life time of the development taking into account climate change.
- Fluvial flood risk mapping indicates that the greater majority of the Scheme DCO boundary is within Flood Zone 1 i.e. at low risk from fluvial flooding. The northern, eastern and western extents of the Scheme, and areas for land compensation or replacement fall within Flood Zone 2 or 3, but no works that would impact on flood risk are proposed within these areas and flood risk mitigation is not required.
- The southern extent of the Scheme crosses Stratford Brook and works in this area has the potential to impact on flood risk. Mitigation has been proposed, including a clear span bridge of both the watercourse and the 1 in 100 (+35% climate change allowance) flood extent, to ensure that there is no constriction on flow or displacement of water. This has been confirmed through detailed hydraulic modelling. The culvert conveying Stratford Brook under the slip road will be strengthened, although there will be no impact on internal culvert dimensions and hence on flow conveyance. Therefore, there will be no impact on flood risk associated with Stratford Brook as a result of the Scheme, both under present day conditions and over the lifetime of the Scheme.
- The road network within the DCO boundary crosses five ordinary watercourses for which Flood Zones have not been defined:
  - The works at three of these locations are for signage only and would not impact on flood risk.
  - At the M25 crossing noted, the flood risk is minor and there are no vulnerable receptors (properties) and therefore the flood risk impact of a potential culvert alteration is considered insignificant.
  - At the A3 crossing there is a potential flood risk impact associated with Bolder Mere, but the design has mitigated this risk.
- The Scheme, in all locations, does not cause an increase in fluvial flood risk to the existing road, and in locations of new road the construction the road level is above the flood level associated with Flood Zone 2 (and hence an approximation for the 1 in 100 annual probability flood with a 35% allowance for climate change). Therefore, the Scheme would not alter the operation or safety of the road in respect to fluvial flooding.

- Current surface water flood risk mapping shows a high proportion of the area within the DCO boundary as being at risk from surface water flooding. However, the vast majority of this risk is due to watercourses (which is assessed as fluvial flood risk), in localised isolated depressions in topography and along the road network (already managed by the existing drainage network).
- The detailed drainage design will be completed in line with current planning policy requirements and will ensure that the new and upgraded drainage systems will serve to prevent unacceptable surface water flood risk to the Scheme. The drainage design will also present a system that would prevent an unacceptable increase in runoff from the site.
- There are no other sources significant flood risk to the Scheme, however a considerations of groundwater ingress, the impact of water transmission infrastructure and the impact on Bolder Mere will be considered in the CEMP.

3.1.2 In summary, it is concluded that based on current flood risk understanding and the incorporation of flood risk mitigation/considerations (as detailed above) the proposed Scheme at all locations would be at an acceptable level of flood risk (from all sources) and would not increase flood risk elsewhere. This conclusion remains true, both now and over the lifetime of the Scheme taking climate change into consideration.

3.2 Recommendations

3.2.1 It is recommended that the proposed Scheme, with the incorporation of flood risk mitigation/considerations (as above) is considered acceptable from a flood risk perspective.

3.2.2 The flood risk analysis should be reviewed and updated through the detailed design process and the updated data should be provided as supporting information to the Protective Provision applications where appropriate.

4. References

Elmbridge Borough Council. (2014). *Elmbridge Strategic Flood Risk Assessment. Completed by URS on behalf of Elmbridge Borough Council.*

Guildford Borough Council. (2015). *Guildford Strategic Flood Risk Assessment. Completed by Capita on behalf of Guildford Borough Council. .*

Appendices

Appendix A. Environment Agency model review correspondence

Hydraulic MODEL REVIEW

Project	M25 J10- Stratford Brook Hydraulic model review- Follow up	**Job Number**	WA/2017/123763/05

Model Type	1D-only	**Software**	ISIS
Revision	1	**Date**	27/09/18
Area Client	Jack Moeran	**Reviewer**	Nick Holder

REVIEW SUMMARY/CONCLUSION

Is the model suitable for intended use	This is the follow up review following responses from Atkins on the 25th September 2018. The model updates, reporting updates and additional simulations undertaken by the consultants since the last review have served to address and resolve and issues previously raised. This review finds that the modelling work completed to date is sufficient to support the conclusions of the report and provide an appropriate level of risk assessment for the proposed works.

MODEL REVIEW PROCESS

Hydraulic MODEL REVIEW

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Hydraulic Model reviews are an essential component of the Hydraulic Modelling Quality Assurance (QA) process that provides confidence in a model's suitability for its intended purpose. Evidence that the model has undergone QA may be requested by external parties and hence all reviews should be written with an expectation that they could be read externally.

Should any issue(s) be raised during the review process, which require attention, the reviewer should detail the action(s) required in sufficient detail to allow the modeller to complete the changes as appropriate. Completion of this Model Review document does not automatically constitute model approval. Once the suggested changes have been completed, the reviewer may require that the model be resubmitted for further review to establish whether the actions have been completed satisfactorily. Only once all the amendments have been completed satisfactorily, will the model be approved and the quality assured by the reviewer.

It is recommended that the reviewer makes good use of the fluvial design guide chapter 7
http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter_7_Background.aspx
and the user manual/help guides for the appropriate modelling software.

On completion of the review the reviewer may choose to use the following colour coding system to alert the modeller to the priority of the actions required (if any).

Colour coding used:

Green – Good practice – not strictly necessary in this case but good practice for future studies.
Amber – Useful – please follow recommendation if time allows.
Red – Must do.

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PROJECT BACKGROUND AND APPROACH

PROJECT DESCRIPTION & REQUIREMENTS

Hydraulic modelling of the Stratford Brook has been undertaken by Atkins to evaluate the potential flood risk of a proposed road bridge, forming part of the A3 Ockham Park Junction. The results of the modelling are to inform any mitigation that may be required.

This review forms part of the Environment Agency's Pre Application advice, with a full FRA due to be submitted at a later date.

A full Hydraulic modeller review and associated Hydrology review are to be undertaken to ensure the model developed is suitable for this study.

This review has made use of the following data:

- M25_J10_Stratford Brook modelling.zip
- Modelling files

Technical Note M25 Junction 10 Hydraulic model, Atkins, 18/07/18

MODEL APPROACH & SUMMARY

Item Checked	Comments	Actions	Atkins Response	M+F Response
What model approach has been adopted? Is it appropriate? *(e.g. new 1D/2D build, existing model truncation, 1d only?).*	1D only schematisation has been used- appropriate for most but some issues in the upper reach of the model- See cross section plots	Braided channels or out of bank flow paths require separate cross sections or alternative schematisation.	The model is appropriate as schematised. The purpose of the model is to define the impact of the proposed new bridge. The model needs to reliably estimate the water levels within the reach potentially affected by the structure. It is not the intent for the model to deliver accurate flood levels for the full modelled reach. The upstream reach is included to ensure we estimate the backwater effect of the proposed new bridge. The	On further review of the model results- this would be acceptable for the key locations within the model to access the impact of the bridge.

			results show that there is no impact of the proposed structure, and therefore no backwater effect upstream. The accuracy of the flood levels in this upper reach is therefore not relevant to the assessment. Actions as suggested are not required.	
Software used, including versions?	Flood Modeller VER= 4.2.0.192 Single precision, 64-bit version has been used for all simulations	n/a	n/a	n/a
Node Summary and river length?	- 69 cross sections - 5 bridges - 3 culverts - 1 short twin culvert model as two parallel orifices Combined length of approximately 2.8km	n/a	n/a	n/a
Model Version Reviewed	Flood Modeller VER= 4.2.0.192 Single precision, 64-bit version has been used for all simulations	n/a	n/a	n/a
Are all model files provided?	Not all results, including convergence plots, have been included in the data provided	Provide all remaining data including .bmp images of convergence plots.	To be provided	Now Provided
Does the model run?	Yes. The with scheme 100yr+CC has been re-run with no issues once file paths were changed.	n/a	n/a	n/a

EVENTS & SCENARIOS				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
What events have been simulated (Q5, Q100, Q100CC, Q1000)?	Q25, Q75, Q100 and Q100+35%. A higher climate change allowance should be	Additional simulations to cover the “Upper End” estimate of climate	35% was used as the change factor to inform the design of	This is a good approach as now both results are

Are they sufficient to meet the project requirements?	used as this development should be considered “Essential Infrastructure” under NPPF. The guidance states the 70% allowance should be used for the “2080s” epoch.	change (+70%) should be undertaken.	the structure. The upper end change factor should have been run as well as a sensitivity test to confirm no issue under this scenario. A sensitivity test has now been run to simulate this scenario and is detailed in the report.	available- any concern over the design life or the schemes definition as essential infrastructure would not be impacted
Is a development being modelled? If so are appropriate scenarios modelled to assess the impact?	The development (bridge) has been modelled using a standard USBPR bridge unit and associated spill unit.	n/a	n/a	n/a
Flood Mapping scenarios? *Defended, undefended, climate change*	n/a	n/a	n/a	n/a

1D MODEL

1D NETWORK				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Model overview: Node Summary 1d length	- 69 cross sections - 5 bridges - 3 culverts - 1 short twin culvert model as two parallel orifices Combined length of approximately 2.8km	n/a	n/a	n/a
Have appropriate distances between sections and/or nodes been used (dx)?	Yes- largest at node 1.031 is 198m	n/a	n/a	n/a
Are out of bank flows represented in 1d? If so, how has it been done and is it appropriate? *extended channel sections, storage areas; or secondary channel sections*	Extended sections have been used- in a number of instances section data is not well suited to this application- in many sections upstream of the bridge the channel appears to be braided-	Schematisation of channel in the upstream reach needs addressing to reflect correct flow paths. Check the rest of model to ensure it is also appropriate. Out of bank flow paths may	See response to first comment. Actions as suggested are not necessary.	Agreed- comment addressed

	or feature defences that are not represented by the current schematisation- this is particularly prevalent between nodes 1.066-1.047. See Figures 1 and 2 below.	need separate channel with spills or similar schematisation.		
Is the model geo-referenced (gxy/ixy file available?)	Yes	n/a	n/a	n/a
Do the cross sections and bed profiles look reasonable? *When compared with survey data where possible and if not OS mapping or photographs Review of random sample required if large number of sections.*	There is a lot of variance in the cross section profiles in the upstream reaches which impacts conveyance as detailed below. The provenance of the section data is questionable given that it is reported to be from 2005 survey merged with LiDAR. This cannot be checked as the survey has not been supplied. The use of extended sections in many of the modelled areas is also questionable if the sections are representative of the topography as they appear to show significant banks and/or defences which are bypassed by the simple 1D schematisation used.	Review cross section data and report the provenance of the data more thoroughly- especially the method of merging the survey and LiDAR. In cross sections where significant out of bank flows exist (see Figure 3 for example) the section should be separated to reflect the true nature of the two channels as this would have a significant impact on water levels.	The survey data used is as provided by the EA. We can send the survey back to you if necessary. See response to first comment in relation to the schematisation of the channels. For the critical reach of the model, the maximum flood level stays within the surveyed cross section extent, so the merging of the channel survey and lidar is largely irrelevant. Sensitivity test has been carried out to assess the sensitivity of the conclusions to changes in channel geometry.	On further review of the model results- this would be acceptable for the key locations within the model to access the impact of the bridge.
Chainage – compared to surveyed sections *the reviewer should check the distance between sections in the model against the survey*	Chainage of sections cannot be checked against survey as it has not been supplied.	Supply survey to check chainages against	The survey data used is as provided by the EA. We can send the survey back to	n/a

Hydraulic MODEL REVIEW

			you if necessary.	
Does conveyance look appropriate? *Do channel conveyance values vary outside the ratios of 0.7 and 1.4 between adjacent river sections? (Are panel markers needed or in the correct place)*	There are massive variances in channel conveyance- the first 7 sections have conveyance values of 18,000, 400, 210, 12,000, 18,000, 35,000 and 240,000m^3/s. These represent ratios of 0.022, 0.525, 57, 1.5, 1.94 and 6.8 respectively.	Review and amend cross section data to reflect true size of channel.	Values quoted are for conveyance at the maximum cross section elevation which differs significantly between cross sections and therefore comparison of these values is inappropriate. The conveyance at the same relative level within adjacent sections is generally within the usual variation. No updates to the model have been made.	Agreed- however this is not good practise
Bank Markers. Are they used and if so, are they suitably located?	Yes	n/a	n/a	n/a
What approach to channel roughness has been used? *Uniform approach or varying bed and banks?*	0.035 for the channel, 0.060 for the floodplain and 0.017 for the culvert conduits and brick walls, based on photography and Chow, 1959	Would expect to see sensitivity testing on the roughness especially given the lack of information pertaining to it in this model from survey etc.	A range of sensitivity tests have been simulated and are reported in the updated document.	Agreed- this co0mment has now been met
What manning's n value(s) have been used for the channel? If it is 1d only what values and how have they been applied in the flood plain?	0.035 for the channel, 0.060 for the floodplain and 0.017 for the culvert conduits and brick walls, based on photography and Chow, 1959	See above	See above	n/a
What method has been used to estimate roughness (USGS, Chow, etc. based on survey, photographs)? Are they appropriate	0.035 for the channel, 0.060 for the floodplain and 0.017 for the culvert conduits and brick walls, based on photography and Chow, 1959	See above	See above	n/a

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BOUNDARY CONDITIONS				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
1d boundary model domain; is there glass walling anywhere in the modelled reaches?	No glass walling has been identified as most sections are massive in comparison to the channel size.	n/a	n/a	n/a
How have the boundaries been applied? *Flow time boundary, FEH units..etc*.	Single REFH boundary has been applied to the upstream extent of the model- defined by .IED file.	n/a	n/a	n/a
How is the downstream boundary(s) applied? *Is it a rating curve (Q/H), Head/time? etc. Is the choice appropriate for the type of outflow?*	Downstream boundary is defined in .DAT file as is a single HT boundary set at a constant water level extracted from the EA Wey Lower Model.	n/a	n/a	n/a
Have appropriate locations been chosen for the downstream model extents? *Is it sufficient distance from site to have minimal impact (L = 0.7xdepth/gradient)?*	The report eludes to sensitivity testing that shows the downstream boundary to be sufficient. It appears to be sufficiently far down stream to have negligible impacts at the development site.	This should be more thoroughly reported.	Clarification has been added to the report that the A3 crossing is 900m upstream of ds boundary (in comparison to the 400m influence of the ds boundary change).	Agreed- clarifications added to 2.4.2 in the report

STRUCTURES				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Are all structures represented? If not have explanations for structures not modelled been given in the Log/report? *If more than 10 structures, check of 10 most critical structures required only.*	All existing structures appear to have been modelled appropriately. There is some confusion over the level of the soffit and the alignment of the proposed bridge. The modelled soffit level is shown as 23.24mAOD however the drawing (see Figure 4) shows a level of 23.5mAOD, which is defined as 1300mm above the 1:100yr+CC level given	Clarify level of proposed bridge soffit. Check against surveyed channel profile at bridge as the drawing and the model data differ greatly, the drawing suggests a secondary channel within the span of the bridge which is not modelled but could be significant.	The report (section 2.3) states that the level defined on the drawing has been superseded. The channel cross section on the drawing is indicative and should not be interpreted as anything other than that.	Noted- as this bridge soffit would not affect the 1:100yr +35% this should not be an issue.

	as 22.2mAOD which does not correspond itself to modelled levels extracted from the results. The alignment of the bridge and the channel profile at the bridge should are not well defined between the model data and drawings.		It is not a secondary channel. As labelled on the drawing it is the lateral location of the same channel at the downstream end of the proposed bridge. No changes to the model have been made.	
Are invert levels correct compared to survey data? *Check of all critical structures required.*	No survey has been provided to check against.	Supply survey to check structures against	The survey data used is as provided by the EA. We can send the survey back to you if necessary.	Noted
Do bridges surcharge? If so has orifice flow been enabled?	Orifice flow is not enabled however the bridges are modelled appropriately with spill units to take surcharging flows.	n/a	n/a	n/a
Are there spills around the structure or over the top represented appropriately? – *these could be in 1d or 2D, if a linked model.*	No reporting or comments detail the nature of the spill data.	For Bridges where spills are active for the 1:100yr+CC event- report what the spill unit defines or add comment to model.	Report updated to define the use of spill units.	Text added to 2.4.3
If there are any movable structures have they been modelled correctly? *E.g. have control rules been agreed with the Agency*	n/a	n/a	n/a	n/a
Have appropriate roughness and loss coefficient values been used?	Yes	n/a	n/a	n/a

INITIAL CONDITIONS & OTHER RUN PARAMETERS				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
What time step has been used for the 1D model? Is it appropriate?	2 Second- this is fine given the short duration	n/a	n/a	n/a

	of the event and model runs times.			
What initial conditions have been used? Steady state, hotstart file?	Initial conditions are defined by a .zzs file (Steady State model results) these are different for each simulation and appear to be appropriate given the lack of model stability issues at the state of the runs.	n/a	n/a	n/a
Have any of the parameters and advanced parameters been changed from the default. If so, has it been justified?	No- all appear to be default settings	n/a	n/a	n/a

STABILITY, CALIBRATION & SENSTIVITY TESTING

RESULTS & STABILITY				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Mass Balance	Mass balance reported in the .ZZD file shows MB is 0.81% of peak system volume, and 0.08% of the boundary inflow volume. These values are fine.	n/a	n/a	n/a
Convergence *Check zzd file and bitmaps*	Convergence plots look fine (See Figure 5 below)	n/a	n/a	n/a

CALIBRATION / VERIFICATION				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Have calibration runs been completed? Is data for calibration available? Gauge data, extents, anecdotal etc.	No Calibration runs have been completed, and no details of any calibration data have been provided in the modelling technical note.	Details of any calibration data should be reported and calibration runs should be undertaken as part of a model proving exercise. Try checking against historic flood extents, previous	The brook is ungauged. There are no historical flood outlines. The current EA flood zones are the national scale mapping output and	Noted- Can you please add a chapter to the report to make this clear? Justifying it though the more thorough sensitivity

		modelling or EA flood Zones mapping.	therefore not suitable for comparison. The Lower Wey model did not include this tributary hydrodynamically and the hydrology was set up for the catchment scale hydrology for the Wey, so no valid comparisons could be made. Sensitivity tests are now reported to demonstrate the conclusions of the assessment remain valid when key model parameters are changed.	testing now conducted.
Are the simulated hydrograph peaks reasonably similar to the recorded peaks? *Within 250mm is recommended in the fluvial design guide*	n/a	See above	See above	n/a
Is the shape of the simulated hydrograph and therefore the volume suitably similar? *Scope guidance often suggests the mean error plus one standard deviation of the error should be within 150mm.*	n/a	See above	See above	n/a
Are simulated floodplain extents similar to recorded extents? Are flow routes similar?	n/a	See above	See above	n/a
Has suitable effort been made to attempt and improve calibration. Have attempted changes been documented with a quantification of impact? Roughness changes, structure coefficient changes, antecedent conditions	n/a	See above	See above	n/a

If no historic data is available, are the simulated flood outputs similar or very different from past modelling in the area? If there is a large difference, does it seem sensible?	n/a	See above	See above	n/a

SENSITIVITY TESTING & UNCERTAINTY				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Have appropriate model parameters been chosen for sensitivity testing? Typical tests include: □ ± 20% Mannings n (1D and 2D) □ Design Flow (upper and lower confidence intervals - 95%, or 68% if 95% is deemed too wide) □ Downstream boundary □ Key structure blockage(s)	No sensitivity testing has been undertaken or reported at this stage. Would expect sensitivity testing to cover model roughness (+/- 20%, downstream boundary water level +/-20%, structure blockages etc.	Undertake appropriate sensitivity testing to prove the operation of the model and determine how sensitive to key model parameters the results are. This is key given the lack of model calibration and/ or validation.	Sensitivity tests are now reported to demonstrate the conclusions of the assessment remain valid when key model parameters are changed.	Agreed- appropriate sensitivity testing has now been completed
Do the results of the tests show the models to be particularly sensitive to certain parameters?	n/a	See above	See above	n/a
Have confidence limits for model results (+/- mm) been presented? How were they derived and does this seem sensible?	n/a	See above	See above	n/a

AUDIT TRAIL				
Item Checked	**Comments**	**Actions**	**Atkins Response**	**M+F Response**
Was a model run log provided?	Yes- a simple log was including detailing the run files associated with each simulation.	n/a	n/a	n/a
Was a suitable file naming, structure & management system used?	Yes	n/a	n/a	n/a
Were check files provided?	n/a	n/a	n/a	n/a

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Were comments provided within the model? *Explanations of units or bridge names for example*	No	Comments detailing the data used in Spills, Bridges and other key structures would be very useful in terms of model reviewing and audit trail	See response above that comments made in the report	
Was there good version control? Is the model history detailed where applicable?	n/a- only single versions of each simulation were provided- this is a newly developed model with no significant history	n/a	n/a	n/a
Were Errors / comments / warnings made available?	n/a	n/a	n/a	n/a
Was a technical overview of the model and its background provided *(usually covered in the model report)*	Only a brief introduction to the modelling was provided in the modelling technical note	More thorough reporting of the modelling is required to cover all the issues raised above and to cover the scheme more generally.	Updates to the report have been made to address the comments where necessary.	More report detail has been added which covers all issues previously raised
Were notes on how the model operates under different flow conditions provided?	No	Whilst the model is very simple- some form of operation manual would be useful	A model log has been generated and supplied outlining model naming and their contents. This is consistent with the complexity (or lack of) of the model.	Agreed- comment resolved
Was an explicit statement of any concerns about the accuracy of the model or its ability to represent reality provided?	No	Given the lack of sensitivity testing, calibration or validation, the accuracy of the model would definitely be questioned at his stage- the above actions would help to address this.	Sensitivity tests are now reported to demonstrate the conclusions of the assessment remain valid when key model parameters are changed.	Agreed- issue now resolved
Is there anything else missing or are there suggestions for additional information or clarification?	Survey is missing, as are any details of sensitivity testing or calibration	Actions to undertake	See previous responses	Completed

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Figures

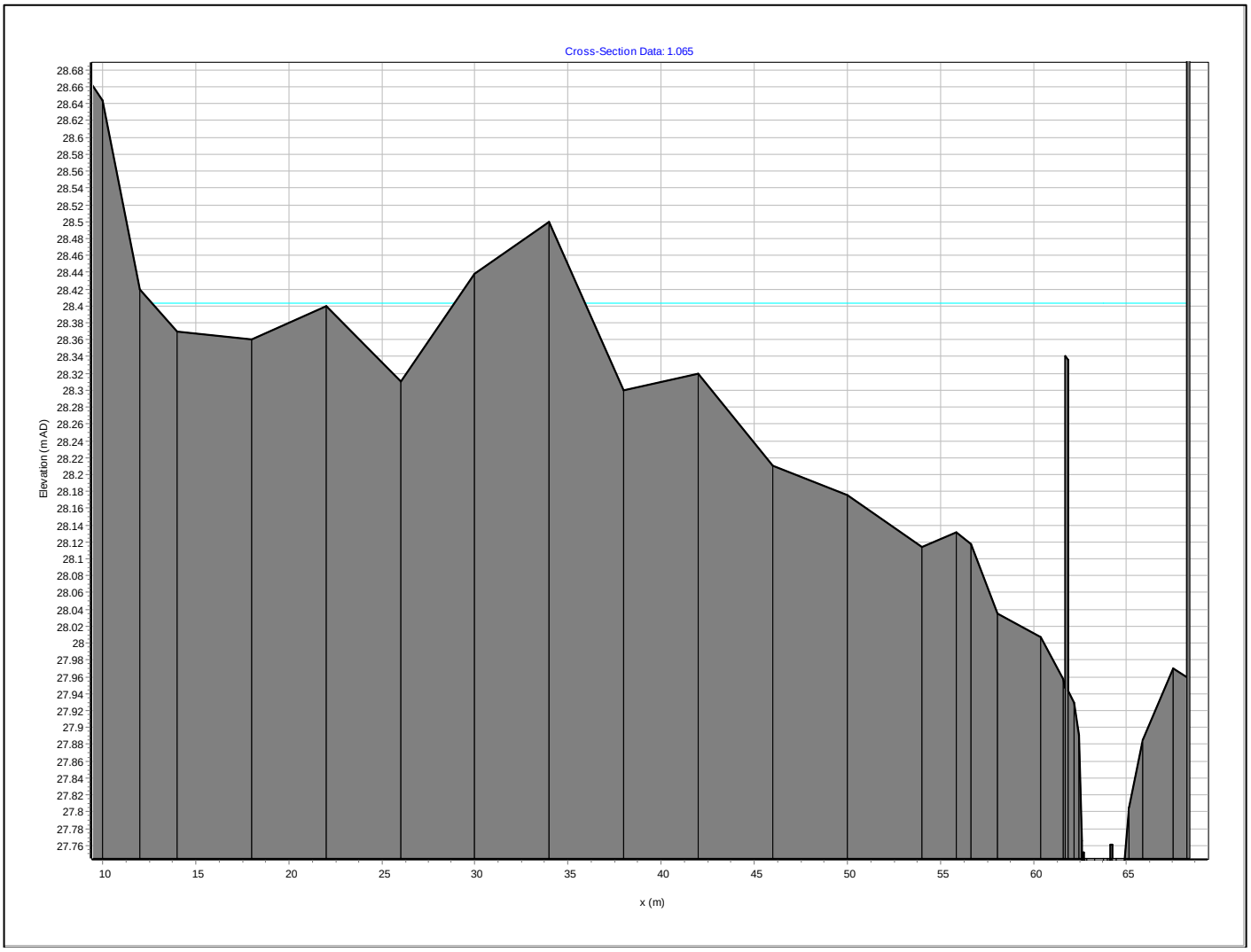

Figure 1: Cross section data

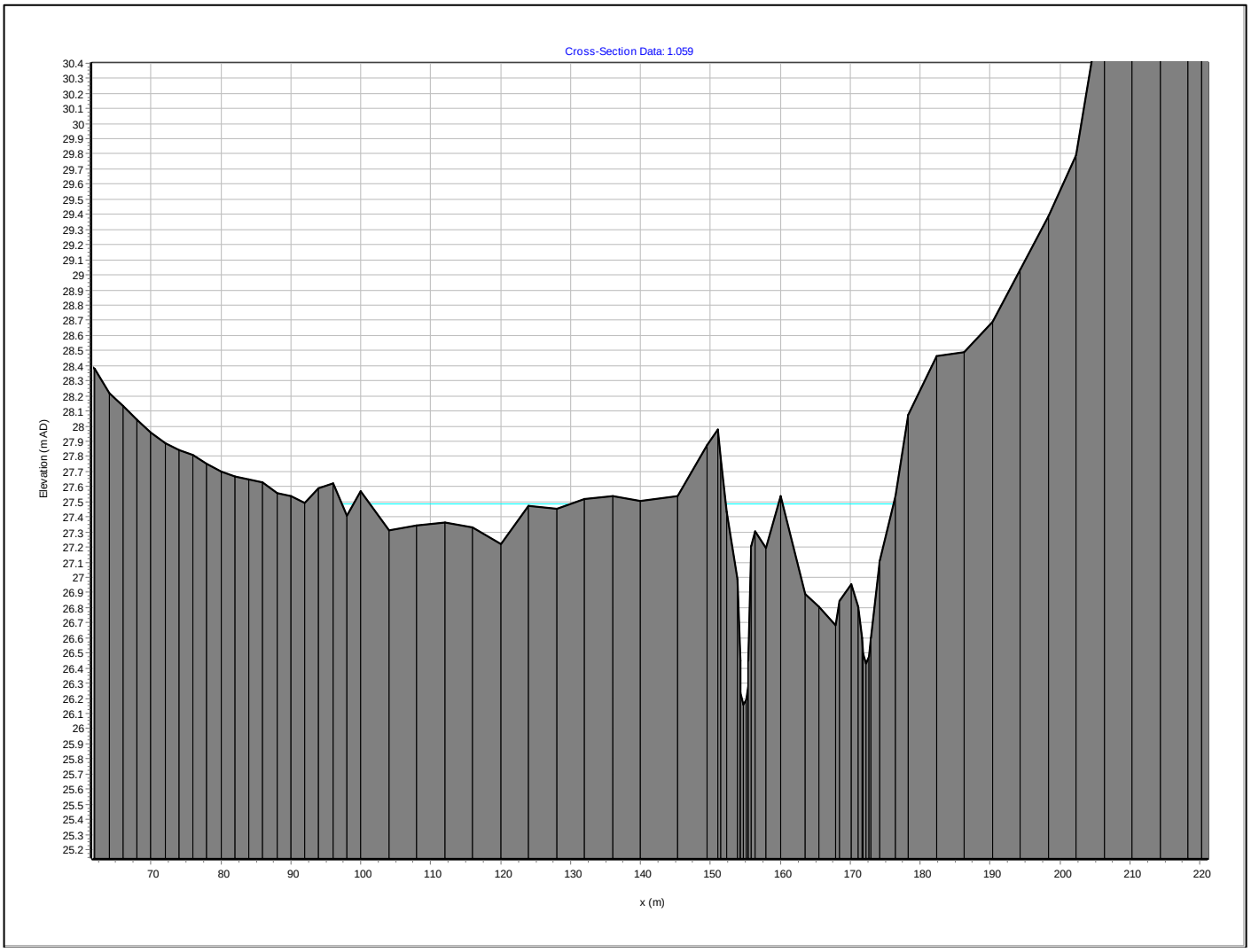

Figure 2: Cross Section data

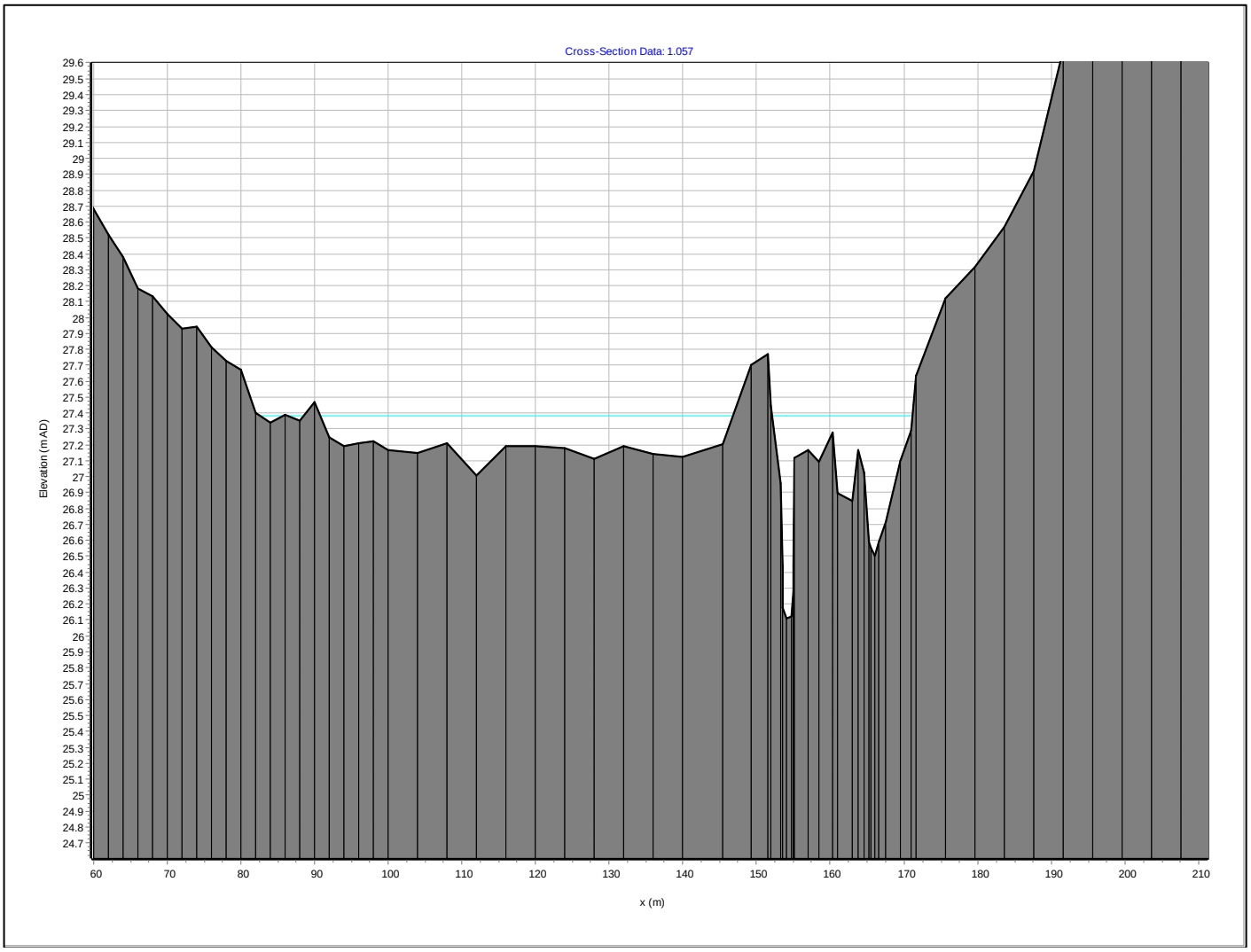

Figure 3: Cross section data showing out of bank flows

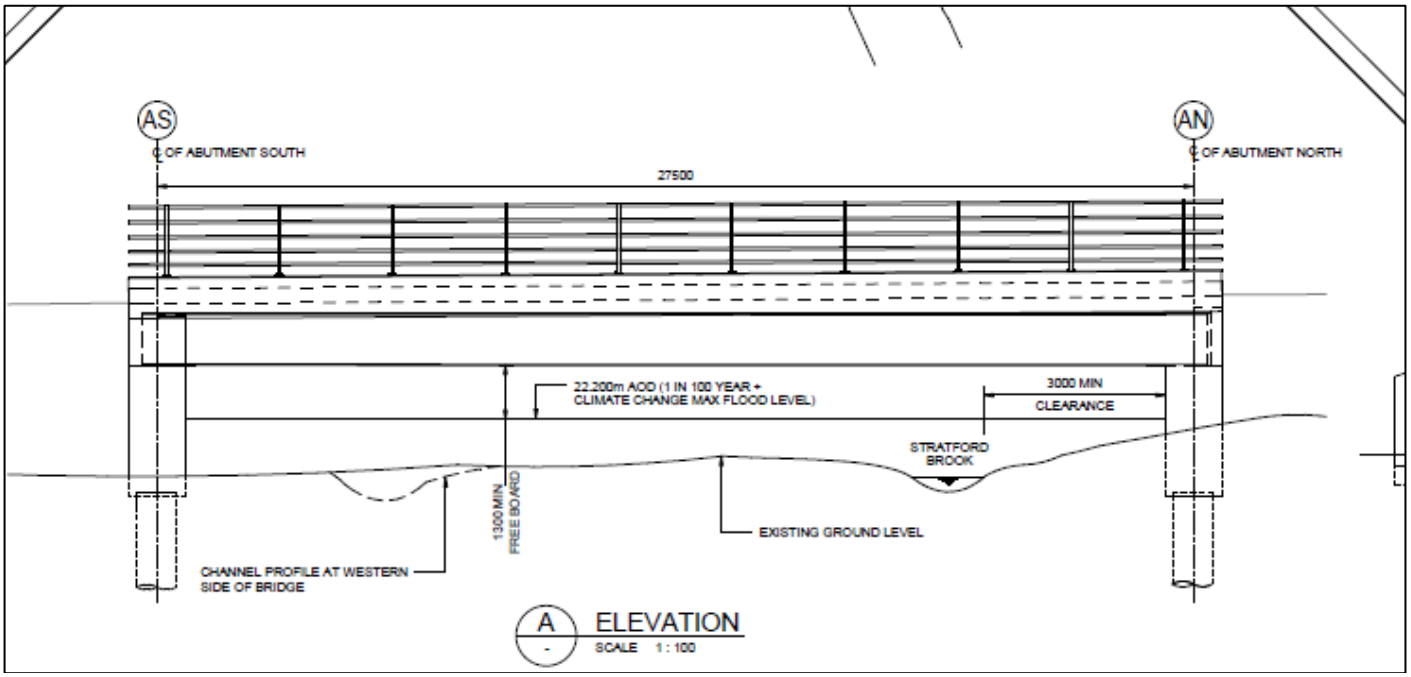

Figure 4: Extract from Bridge drawing

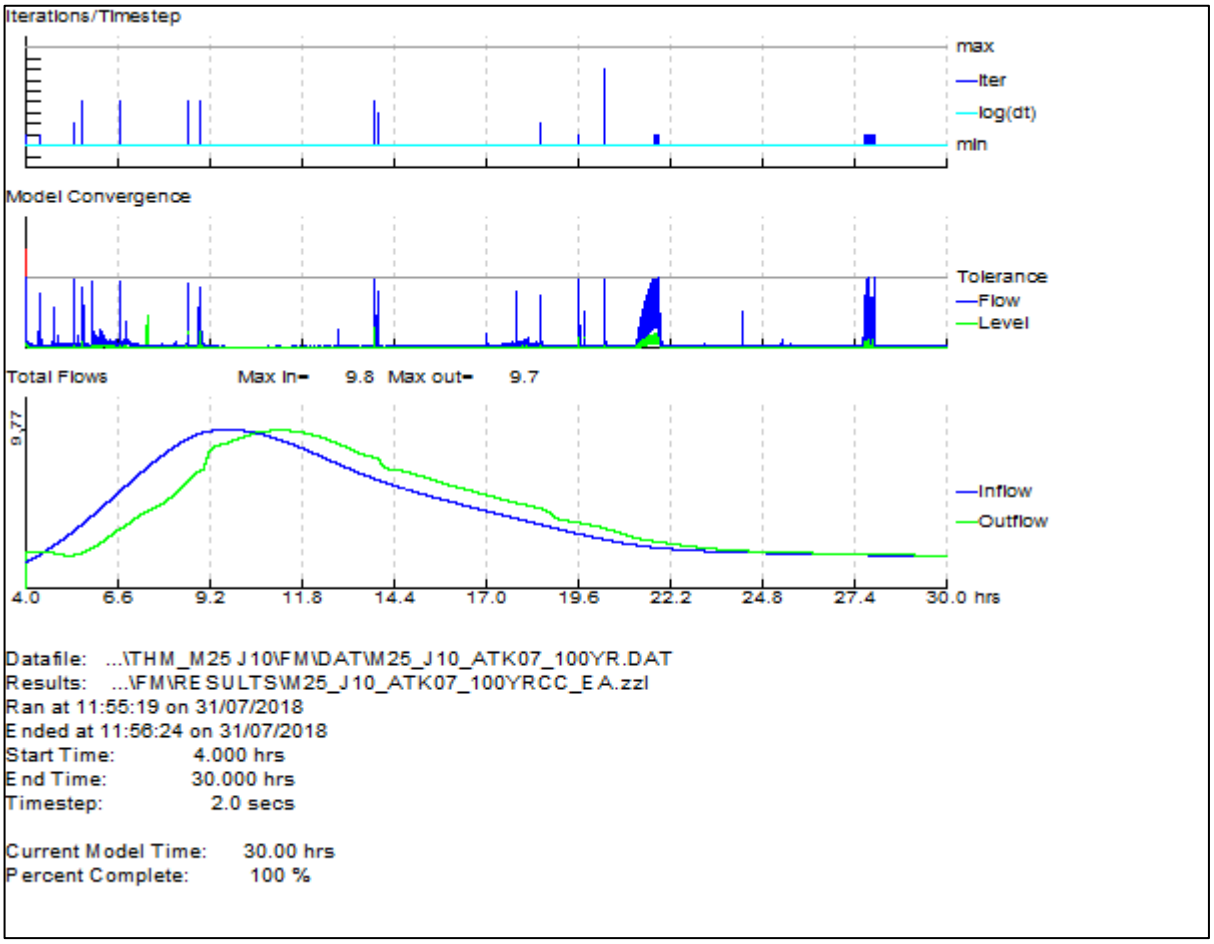

Figure 5: Convergence plot from re-run of the 1:100yr+CC simulation

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