E138

High Speed Two Phase 2a (West Midlands - Crewe)

Background Information and Data

CA4: Whitmore Heath to Madeley

Hydraulic modelling report - Meece Brook (BID-WR-004-008)

July 2017

BID

E138

High Speed Two Phase 2a (West Midlands - Crewe)

Background Information and Data

CA4: Whitmore Heath to Madeley
Hydraulic modelling report - Meece Brook (BID-WR-004-008)

July 2017

BID

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

High Speed Two (HS2) Limited,
Two Snowhill
Snow Hill Queensway
Birmingham B4 6GA

Telephone: 08081 434 434

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.gov.uk/hs2

A report prepared for High Speed Two (HS2) Limited:

High Speed Two (HS2) Limited has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the HS2 website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard, please contact High Speed Two (HS2) Limited.

Printed in Great Britain on paper containing at least 75% recycled fibre.

Contents

List of figures

List of tables

Appendix A

1 Introduction

1.1 Background

1.1.1 This document presents the results of the hydraulic modelling carried out in the Stone and Swynnerton area (CA3) relevant to High Speed Rail (West Midlands - Crewe). This report is also relevant to the Whitmore Heath and Madeley area (CA4).

1.1.2 Hydraulic modelling report – Filly Brook (Background Information and Data 004: BID-WR-004-007) is also relevant to the Stone and Swynnerton area.

1.1.3 The following hydraulic modelling reports are also relevant to the Whitmore Heath and Madeley area:

- Hydraulic modelling report - River Lea (Volume 5: Background Information and Data 004, BID-WR-004-009); and
- Hydraulic modelling report - Checkley Brook (Volume 5: Background Information and Data 004, BID-WR-004-010).

1.1.4 The water resources and flood risk assessment is detailed in The High Speed Rail (West Midlands - Crewe) Environmental Statement (ES)[1]. Volumes 2, 3 and 4 discuss water resource and flood risk effects and Volume 5, Appendices sets out the following relevant to the Stone and Swynnerton area:

- a route-wide Water Framework Directive compliance assessment (Volume 5: Appendix WR-001-000);
- a water resources assessment (Volume 5: WR-002-003);
- a flood risk assessment (Volume 5: WR-003-003); and
- a route-wide draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-005-000).

1.2 Aims

1.2.1 The Proposed Scheme includes a number of locations where the route will cross watercourses and their floodplains. The Proposed Scheme crossing locations have the potential to increase flood risk where they restrict flood flows or change floodplain dynamics.

1.2.2 At the locations detailed in this report, the route will cross Meece Brook on the proposed Meece Brook viaduct and an unnamed watercourse via Swynnerton Footpath 10 accommodation underbridge.

1.2.3 A hydraulic model of Meece Brook was created to simulate the risk of flooding in this location for an approximate 2.3km stretch of the brook. This report

[1] HS2 Ltd (2017), *The High Speed Two (HS2) Phase 2a (West Midlands - Crewe) Environmental Statement (ES)*, www.gov.uk/hs2

documents the methods used and discusses the results, assumptions and limitations imposed by them.

1.2.4 Hydraulic models of the existing conditions and with the Proposed Scheme included have been evaluated to assess the impact of the Proposed Scheme on flood risk and to derive peak flood water levels relative to the proposed structures.

1.2.5 This report details the existing hydrological and hydraulic processes of the reaches modelled and how these will be affected by the Proposed Scheme.

1.3 Objectives

1.3.1 The objectives were to:

- conduct, where feasible, a site visit to inform understanding of existing conditions, including existing channel and floodplain characteristics, hydraulic structures and flow paths;
- estimate flow hydrographs at the Proposed Scheme crossing locations;
- develop a hydraulic model, commensurate with the level of detail required and available at this stage, to provide peak levels at key structures for the Proposed Scheme, based on the most suitable data available and flow hydrographs developed; and
- analyse the impact of the Proposed Scheme on flood risk levels obtained from the results of the following Annual Exceedance Probabilities (AEP): 50%, 20%, 5.0%, 1.33%, 1.0%, 1.0%+climate change (CC), 0.5% and 0.1%.

1.4 Justification of approach

1.4.1 The hydraulic model has been constructed to provide an awareness of existing flood risk to inform the Proposed Scheme design. The detail included identifies potential impacts of the Proposed Scheme on surrounding land and to ensure that 0.6m freeboard to soffit is provided in a 1.0% +CC AEP event and 1.0m freeboard to track level is provided in a 0.1%AEP event.

1.4.2 A 2D hydraulic model was selected for this study as detailed 1D channel information was not available at the time of study and the Light Detection and Ranging (LiDAR) survey adequately portrayed the existing channels and features. Using a 2D approach allows for structures to be represented using the ESTRY solver within Two-dimensional Unsteady FLOW (TUFLOW).

1.4.3 Due to the Proposed Scheme crossing the floodplain on a viaduct and thus causing a high level of risk for the design of the project and its impact on the environment, it was proposed that hydrological calculations be undertaken to a full level of detail. This considered Flood Estimation Handbook (FEH) Statistical, Revitalised Flood Hydrograph 2 (ReFH2) and the hybrid methods. This is particularly relevant in this location where both abutments are driven by flood risk.

1.5 Scope

1.5.1 The scope of the study was to undertake hydraulic modelling to enable an assessment to be made of the impact of the Proposed Scheme on the local environment. The models should be detailed enough to allow future assessment of different options associated with each crossing location, to allow the management of flood risk and correct sizing of crossing openings.

1.5.2 The report focuses upon:

- discussion of all relevant datasets, quality and gaps;
- hydrological analysis undertaken, approach used and calculation steps;
- integration of the hydrological analysis with the hydraulic modelling;
- hydraulic modelling methodology chosen, with clear identification of general methodologies and justification; and
- hydraulic modelling parameters, assumptions, limitations and uncertainty.

2 Site characteristics

2.1 Description of the study area

Model reach

2.1.1 The section of Meece Brook being modelled is located near the hamlet of Baldwin's Gate. Figure 1 shows the modelled extent, with the model upstream boundary situated approximately 40m south of the A53 Newcastle Road and the downstream boundary located approximately 175m north of the A51 London Road. Approximately 2.3km of Meece Brook has been modelled.

2.1.2 Within the study area, there are several major receptors. Meece Brook passes alongside and underneath the West Coast Main Line (WCML). The unnamed watercourse to the north-east flows underneath Bent Lane which is being re-routed slightly to form the Bent Lane (North) diversion and Bent Lane (South) realignment due to the Stableford North embankment.

2.1.3 The watercourse passes several bodies of water. For the majority of the modelled section of Meece Brook, before it meets the confluence with the unnamed drain, it passes several well-vegetated ponds. At the downstream extent, there is another group of ponds that Meece Brook weaves between.

Hydrological description

2.1.4 Meece Brook originates in the hills to the north of Whitmore.

2.1.5 The catchment area contributing to the downstream boundary of proposed hydraulic model is 7.1km² and is predominantly rural.

2.1.6 The unnamed watercourse originates south of the village of Acton.

2.1.7 The catchment area contributing to the downstream boundary of proposed hydraulic model is 1.5km² and is predominantly rural.

2.1.8 There are no gauging stations present within the Meece Brook catchment and the unnamed watercourse.

2.1.9 Standard Annual Average Rainfall for the catchment at the downstream boundary is 785mm.

Railway alignment

2.1.10 The route of the Proposed Scheme crosses the study area in a north-west direction along the Stableford South embankment before crossing Swynnerton Footpath 10 accommodation underbridge and the unnamed watercourse. The alignment then continues along the Stableford North embankment before crossing Meece Brook on the proposed Meece Brook viaduct further north. After the proposed Meece Brook viaduct the route continues along the Meece embankment in a north-west direction. Further detail on the Proposed Scheme can be found in the design as shown in Map CT-06-229 in the Volume 2 Map Book.

Flood mechanisms

2.1.11 Meece Brook has significant storage upstream of the Proposed Scheme, flooding the cricket ground. Downstream of the Proposed Scheme there is a network of swales and ponds within the floodplain which convey flood water between them. In extreme flood events there is overtopping of the WCML upstream of where the brook is crossed by a footpath.

2.1.12 Downstream of the WCML there are further networks of swales and ponds which also convey flood water.

2.1.13 A number of culverts on both Meece Brook and the unnamed watercourse locally influence flood mechanisms but do not have a wider impact.

2.2 Existing understanding of flood risk

Sources of information

2.2.1 Sources of Environment Agency data were assessed as below:

- Flood Map for Planning (Rivers and Sea)[2]; and
- updated Flood Map for Surface Water (uFMfSW)[3]

2.2.2 The proposed Meece Brook viaduct spans Flood Zone 2 (0.1%AEP) and 3 (1.0%) of the Environment Agency Flood Map for Planning as shown in Figure 1.

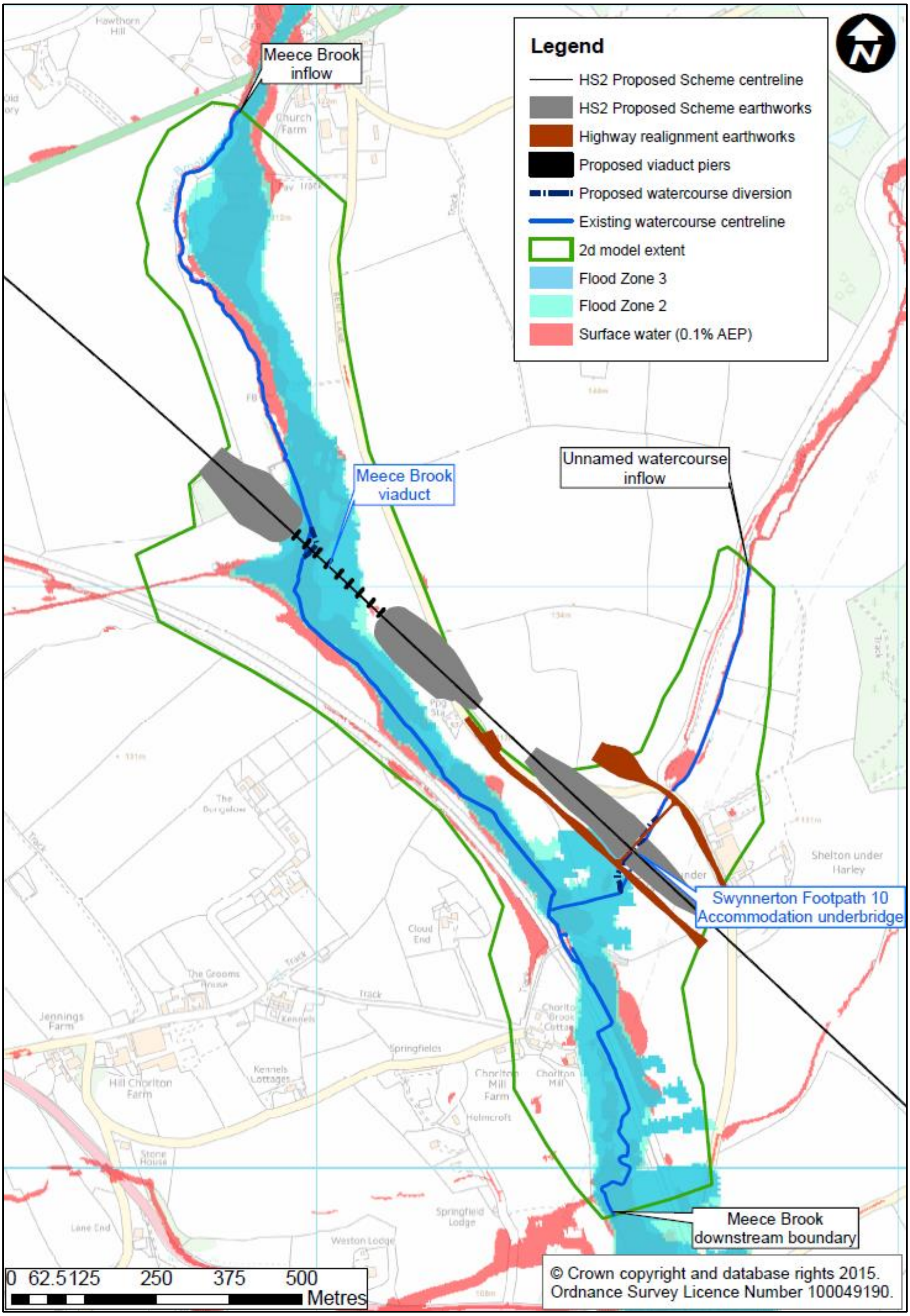
2.2.3 The uFMfSW shows that a flow path joins Meece Brook before it passes beneath the WCML.

2.2.4 Available information does not indicate the presence of any flood defences within the model extent.

2.2.5 The Environment Agency flood maps are believed to be derived by National Generalised Modelling.

[2] Gov.uk, *Flood map for planning*, https://flood-map-for-planning.service.gov.uk
[3] Gov.uk, *Long term flood risk information*, https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=SurfaceWater

Figure 1: Environment Agency Flood Zones 2 and 3 and uFMfSW (0.1%AEP) at Meece Brook



2.3 Availability of existing hydraulic models

2.3.1 There were no existing models for Meece Brook identified for this study.

2.4 Site visit

2.4.1 A site visit was undertaken in October 2016 to determine the dimensions of the channel and any existing infrastructure.

2.4.2 Several structures were visited along Meece Brook however not all could be visited due to site access restrictions and general accessibility issues. For the structures that were visited, images were taken to ascertain dimensions and roughness.

2.4.3 Meece Brook appeared to be approximately 2m wide throughout, with a depth varying greatly from approximately 0.5-2m across the watercourse.

2.4.4 The structures shown in Figure 2 and Figure 3 represent the culverts on the unnamed watercourse passing under Bent Lane. Upon analysis of the culvert in the channel, it became apparent that there was another culvert alongside it at an elevated height of 0.3m in comparison to the inlet of the main culvert. Figure 2 shows the inlet to the pipe partially covered by a tree which has been represented by an increase in the culvert roughness.

Figure 2: Inlet to culverts under Bent Lane

Figure 3: Outlet to culverts under Bent Lane

3 Model approach and justification

3.1 Model conceptualisation

3.1.1 Model extents were carefully selected to ensure that the model boundaries did not have any impact on the flood extent in the area of interest.

3.1.2 Utilising a 2D approach is appropriate for this area as there was no survey data available for the watercourse extent. Using 2D allows more confidence in the flood extent under the proposed Meece Brook viaduct which is important in this area as it defines the abutment positions and viaduct width.

3.2 Software

3.2.1 TUFLOW (2016-AA) has been used. This methodology is in line with standard practice to use the latest available build at the time modelling commenced, while TUFLOW is industry standard software.

3.3 Topographic survey

3.3.1 No additional topographic survey was commissioned for this study.

3.4 Input data

3.4.1 The elevation data for the domain was produced using 200mm LiDAR flown specifically for HS2 Ltd and covers 500m either side of the route centreline.

4 Technical method and implementation

4.1 Hydrological assessment

4.1.1 The estimation of design peak flows and hydrographs was based on the application of the methodologies pre-approved by HS2 Ltd. These are standard in the UK Flood Risk Management Industry.

4.1.2 The FEH methodologies were followed, in particular the Statistical Method. No suitable gauging station was available in the study area, so the FEH Pooling Group methodology was adopted. This uses recorded river flows in hydrologically similar catchments to estimate flows at the subject location. The calculations were based on the most up to date national database available at the time of undertaking the calculations. The data was obtained from the National River Flow Archive and/or HiFlowsUK.

4.1.3 In addition, the FEH Revitalised Rainfall Runoff Method, version 2 (part of ReFH2) was used to produce an alternative set of design peak flows and event probability. ReFH2 uses the recently updated FEH13 rainfall database and parameters. The calculations are based on relevant catchment descriptors of each catchment, which were obtained from the FEH Web Service database.

4.1.4 The two sets of design peak flows (from FEH Statistical Method and ReFH2) were analysed and compared, selecting the methodology that produced the most conservative river flows. The ReFH2 produced the highest flows and thus it was the method adopted.

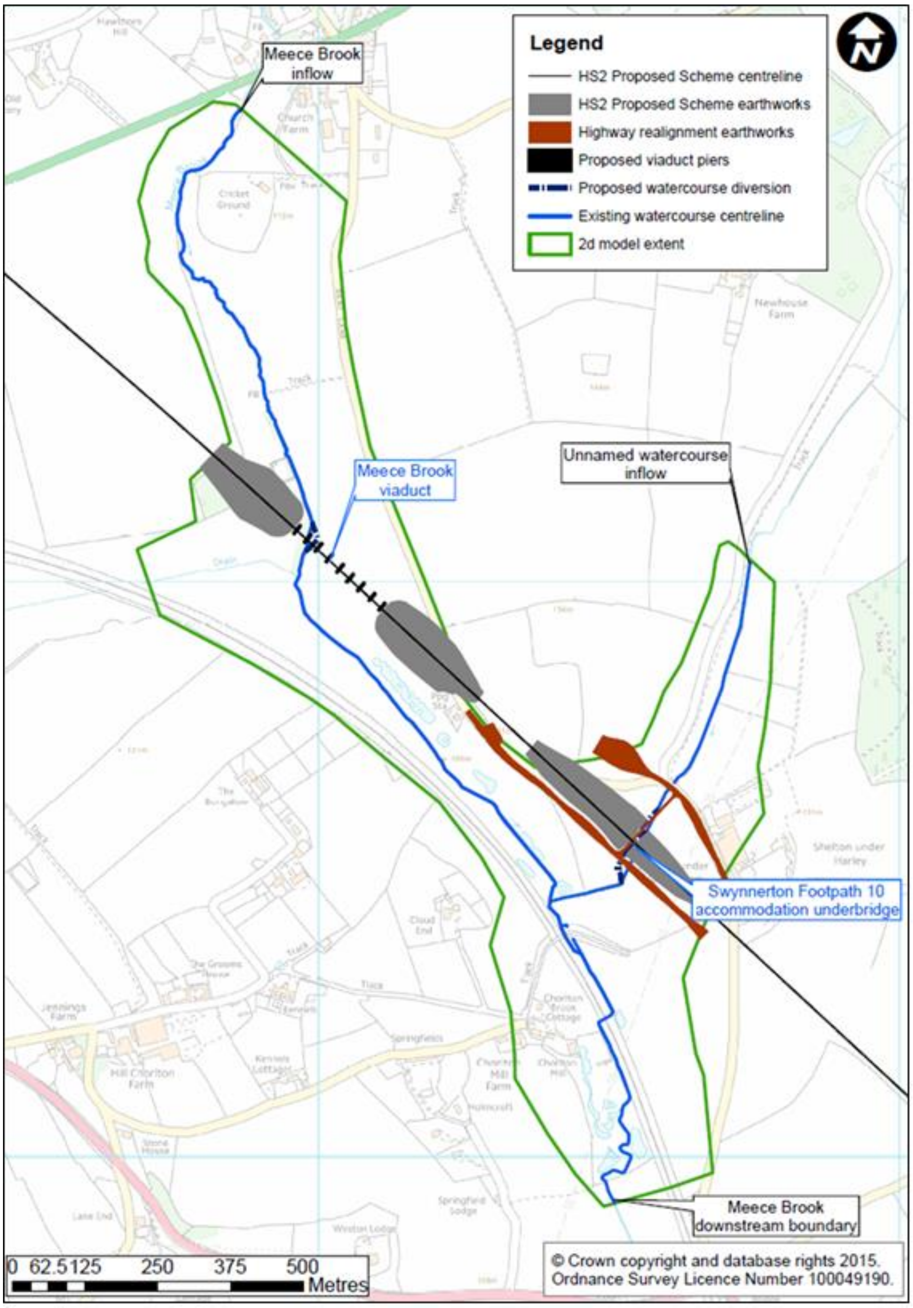
4.1.5 The design hydrographs used for the hydraulic modelling stage were generated using ReFH2 as the FEH Statistical method does not produce time series, just peak flows. The values were scaled so the peak flow for each return period matched that selected as the design value.

4.1.6 Table 1 shows the peak flows used for the computational hydraulic modelling work. Figure 4 highlights the inflow locations and the associated river networks assessed as part of this study.

Table 1: Peak flows used for hydraulic analysis

	AEP	Return period	Site code	
			Meece Brook inflow	Unnamed watercourse inflow
Flood peak (m^3/s)	50%	2yr	3.15	0.30
	20%	5yr	4.21	0.41
	5.0%	20yr	5.90	0.59
	1.33%	75yr	8.16	0.85
	1.0%	100yr	8.80	0.92
	1% + CC	100yr + CC	13.20	1.38
	0.5%	200yr	10.62	1.14
	0.1%	1000yr	16.01	1.81

Figure 4: Schematic of inflows and modelled river network



4.2 Hydraulic model build - baseline model

1D Representation

4.2.1 Culverts were included in the ESTRY component of TUFLOW. The dimensions of the two culverts on the unnamed watercourse, as seen in Figure 5, were obtained from a site visit. All other dimensions of structures were estimated using LiDAR.

2D Representation

4.2.2 The cell size of the model was set as 2m. Cell size and alignment for the 2D model grid was optimised to ensure appropriate representation of the flow pathways whilst maintaining reasonable run times. The alignment for the 2D model grid follows the rotation of the Proposed Scheme piers.

4.2.3 Channel sections have been modified in the 2D. Channels have been defined throughout the extent to represent existing channels more accurately.

4.2.4 The channel in-between the WCML and the culvert underneath the footpath (RailTrackCul - Figure 5) has been manually defined due to the heavy vegetation in the area causing poor LiDAR representation.

4.2.5 The channel to the south of the unnamed watercourse has also been manually defined due to poor LiDAR representation.

Inflow boundaries

4.2.6 The study area has two inflows. The main inflow, Meece Brook, is located at the upstream extent of the model area. The second inflow, the unnamed watercourse, starts towards the north-east of the model and joins the main channel after passing underneath Bent Lane. These are shown in Figure 4.

Downstream boundary

4.2.7 A normal depth boundary was used at the downstream extent of Meece Brook and also in the floodplain at the downstream extent. This generates a stage-discharge curve based on the bed slope which varies across the floodplain.

4.2.8 A normal depth slope of 0.0043m/m (1 in 233) was used for the Meece Brook downstream boundary. The downstream boundary for the floodplain surrounding the channel used a depth slope of 0.008m/m (1 in 125). For the separate downstream boundary, to the east of the WCML, a normal depth slope of 0.0015 m/m (1 in 666) was used. These were derived from LiDAR.

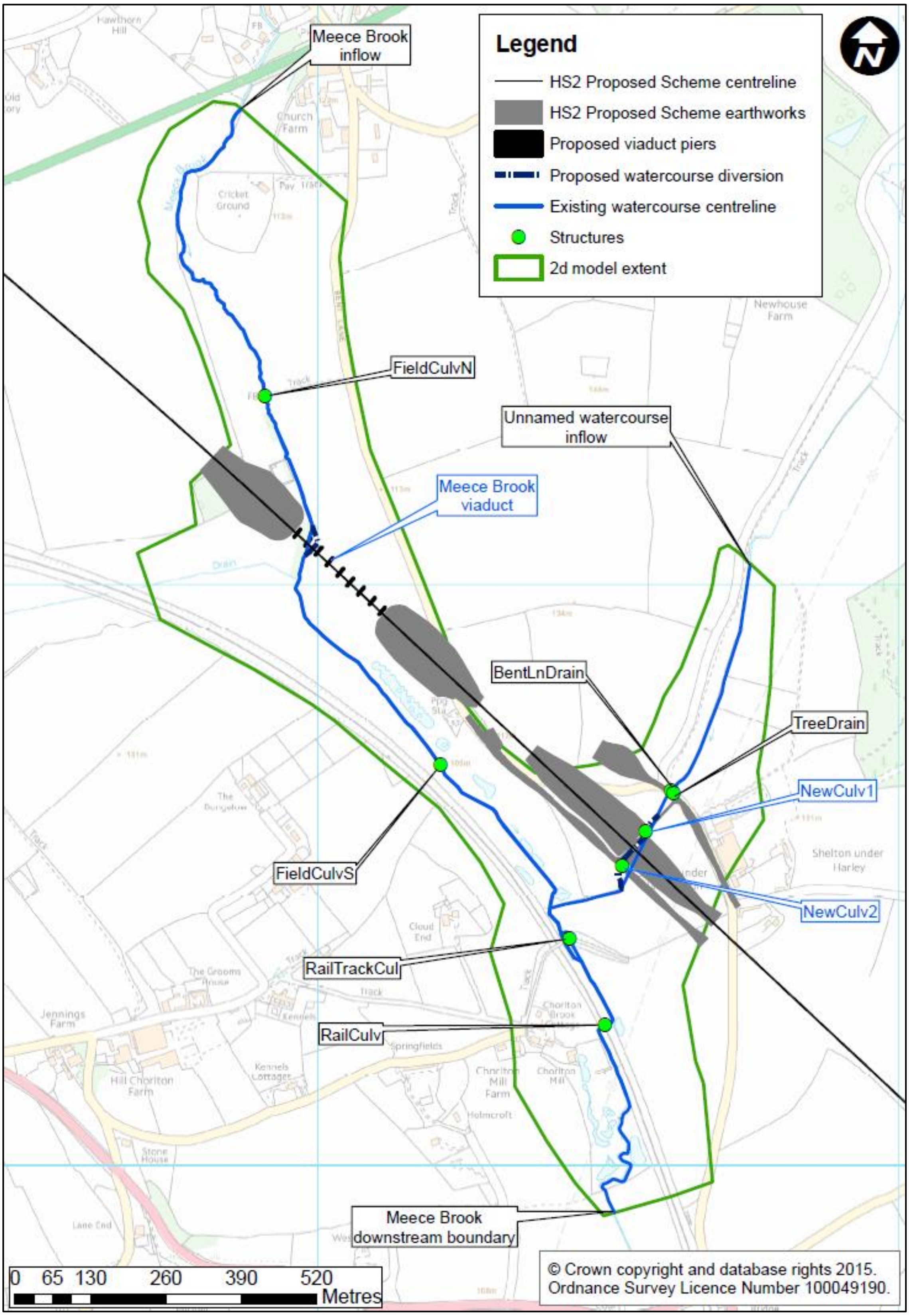
Key structures

4.2.9 There are a number of structures within the model extent that were modelled in a variety of ways. Additionally, there are a number of structures which are not modelled as no information is available. Those included in the model and deemed to be key hydraulic controls are detailed in Table 2. All structures, including key hydraulic controls, are shown in Figure 5.

Table 2: Key structures present within the modelled extent of Meece Brook

Structure reference	Structure description	Modelling representation and justification
RailTrackCul	Small culvert under West Coast Main Line (WCML) bridge 25.0m (L) x 0.9m (D)	This culvert is assumed to be a small circular culvert. Dimensions estimated from LiDAR.
RailCulv	Small culvert underneath WCML 25.0m (L) x 0.9m (D)	This culvert is assumed to be a small circular culvert. Dimensions estimated from LiDAR.
BentLnDrain	Small culvert under Bent Lane 19.0m (L) x 0.6m (D)	This culvert is a small circular culvert. Dimensions obtained from a site visit.
TreeDrain	Small culvert under Bent Lane 19.0m (L) x 0.9m (D)	This culvert is a small circular culvert. Dimensions obtained from a site visit.

Figure 5: Existing and proposed structures within the model extent



Roughness

4.2.10 Roughness values utilised are in line with the recommended values stated within Chow, 1959[4].

4.2.11 The 2D domain roughness values have been informed by the land use classifications within the current Ordnance Survey (OS) Mastermap data together with information derived from aerial and site visit photography for specific features.

4.2.12 In some locations the OS Mastermap data has been modified to suit the cell size of the hydraulic model, to ensure that key features such as woodland, roads and the channel itself are represented.

4.3 Hydraulic model build – Proposed Scheme

4.3.1 The Proposed Scheme model has been edited from the baseline to include the following:

Viaduct piers

4.3.2 The proposed Meece Brook viaduct spans approximately 240m and will be supported by nine piers, spaced approximately 20-25m apart.

4.3.3 A deactivated code layer was used to represent the piers. The modelled dimensions of each pier constitute a deactivated area of the model of either 36m^2 or 32m^2 per pier, for piers of 2m x 18m (36m^2) and 2m x 16m (32m^2) respectively.

4.3.4 The reason for the differing pier sizes is due to the viaduct widening as it goes north to allow room for the tracks to spread as they split apart in preparation for entering Whitmore Heath tunnel further north.

Topographic changes

4.3.5 The Proposed Scheme embankments (Stableford North and Meece embankments) and the associated realignments and closure to the west and diversion to the east of Bent Lane have been included using the relevant heights for the embankment crest and road alignment. The footprints of the embankments for the Proposed Scheme are based on the design as shown in Map CT-06-229 in the Volume 2 Map Book.

4.3.6 The Stableford North embankment is located in the modelled flood zones for baseline conditions at its northern extent.

4.3.7 The OS Mastermap layer was modified to correctly represent any changes to the roughness and planting associated with the Proposed Scheme.

[4] Chow, V.T (1959), *Open-channel hydraulics*, McGraw-Hill, New York

Replacement floodplain storage areas

4.3.8 Although there are only localised changes between baseline and post-development, provision for replacement floodplain storage has been made based on the 1.0% + CC AEP levels, on a level for level, volume for volume basis. This has not been included within the hydraulic modelling.

Channel realignment or diversions

4.3.9 A channel realignment was required underneath the proposed Meece Brook viaduct as the existing watercourse will be blocked by a pier so the channel was realigned to avoid this.

4.3.10 A second channel realignment was required on the unnamed watercourse between the Stableford North embankment and under the Swynnerton Footpath 10 accommodation underbridge before reconnecting with the natural path of the existing channel after the embankment.

4.3.11 No diversions of the river channel have been proposed.

Production of flood extents

4.3.12 Flood extents have been derived using the direct output options now available in TUFLOW to produce ASCII output for the maximum depth and height. This has then been converted into a polygon and cleaned to remove all bow ties (where two polygons overlap) as well as any dry islands less than 48m².

Modelling assumptions made

4.3.13 Existing LiDAR is assumed to be correct as no other information is available.

4.3.14 Culvert sizes have been assumed in a number of places within the model. Where a site visit to provide photos or measurements was not possible, they have been approximated based on LiDAR information. This provided road levels and ground levels and the measured width of the top of structures from aerial photography.

4.4 Climate change

4.4.1 The climate change allowance for Meece Brook is 50% based on the new climate change approach developed by the Environment Agency and published in February 2016.[5]

4.4.2 This climate change percentage considers the design life of the Proposed Scheme (120 years), the River Basin District (Humber) and the receptors within the existing Flood Map for Planning. Due to the presence of more vulnerable

[5] Environment Agency, *Flood risk assessments: climate change allowances*, https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

receptors (National Planning Policy Framework Table 2[6]), the upper end value for the longest duration was chosen.

4.4.3 The new climate change guidance recommends consideration of the H++ scenario[7]. While these percentages have not been explicitly assessed, the sensitivity for the 20% increase in flow on the 1.0% + CC AEP event is assumed to be representative of an event greater than the H++ scenario.

5 Model results

5.1.1 The model has been run for the 50%, 20%, 5.0%, 1.33%, 1.0%, 1.0%+CC, 0.5% and 0.1% AEPs. The 1.0%+CC simulation is based on a 50% increase in flows.

5.1.2 The water level difference has been mapped for the 1.0%+CC and 5.0% AEPs. These flood maps are reported in Appendix A.

5.1.3 In all return periods modelled there are very localised impacts at the proposed Meece Brook viaduct due to channel realignment of up to 100mm.

5.1.4 Above the 1.0% + CC AEP, there are localised extent changes, specifically at the southern abutment of the viaduct, as this sits within the flood zone in existing conditions.

5.1.5 Additionally, there are extent changes where the channel has been realigned on the unnamed watercourse, with the Proposed Scheme modelling showing a reduction in flood extent at all return periods.

5.1.6 In the 1.0% + CC AEP results, increases in peak water level of greater than 400mm surrounding the channel realignment at Stableford North embankment are observed alongside increases of 10-50mm upstream of Bent Lane.

5.1.7 In the 0.1%AEP, the proposed diversion of Bent Lane, the Bent Lane (North) diversion and Bent Lane (South) realignment, causes increases in peak water level of greater than 100mm as the road holds back some of the flood water in the field upstream. The river levels return to baseline water levels within 75m upstream of the crossing.

5.1.8 Model results conclude that the current proposed design ensures a freeboard of a minimum of 1m to the rail track in a 0.1%AEP event and a minimum of 0.6m to the viaduct soffit in a 1.0%AEP + CC (50%) event for all scenarios.

[6] Gov.uk, *Flood Zone and flood risk tables*, https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables
[7] Environment Agency, *Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/571572/LIT_5707.pdf

6 Model Proving

6.1 Introduction

6.1.1 This section of the report presents the analysis of the model undertaken to ensure confidence in the stability of the model build, its response to input values and consistency with previous modelling.

6.2 Run performance

6.2.1 Model output has been assessed across all open channel and model structures to assess model stability and overall model performance.

6.2.2 Final cumulative mass balance error is within +/-1.0% for all return periods and blockage and sensitivity cases simulated.

6.3 Calibration and validation

6.3.1 There is no gauge situated within an appropriate distance of this location to provide calibration or validation data. Although, Meece Brook is gauged further downstream at Stableford.

6.3.2 There is no additional anecdotal evidence available for any effective model validation exercise.

6.4 Verification

6.4.1 Model outputs have been compared with other readily available flood risk data such as Environment Agency Flood Maps for Planning.

6.4.2 Flood extents generated for this study are similar to the Environment Agency Flood Maps for Planning as the flooding remains relatively confined to the channel.

6.5 Sensitivity analysis

6.5.1 Sensitivity scenarios were undertaken as below:

- increase in flow by 20% (compared to 1.0%AEP+CC Proposed Scheme);
- increase in roughness (channel, structures and floodplain) (Manning's n) by 20% (compared to 1.0%AEP+CC Proposed Scheme);
- decrease in roughness (channel, structures and floodplain) (Manning's n) by 20% (compared to 1.0%AEP+CC Proposed Scheme);
- increase in downstream boundary gradient by 20% (compared to 1.0%AEP+CC Proposed Scheme); and
- decrease in downstream boundary gradient by 20% (compared to 1.0%AEP+CC Proposed Scheme).

Roughness

6.5.2 The model is sensitive to increases in roughness, with a 20% increase resulting in increases in peak water level of between 10-50mm throughout and greater than 500mm in some small, very localised patches. The greatest impact is near the culvert inlet on Bent Lane, while there are increases in water passing across the WCML causing increased extents.

6.5.3 Decreasing the roughness by 20% results in a general decrease in up to 25mm in peak water level throughout the model. There are negligible changes to the flood extent.

Inflows

6.5.4 An increase in inflow of 20% results in an increase of up to 300mm which is seen at the inlet to the Bent Lane culvert. This has no impact on the Proposed Scheme, as it holds more water behind Bent Lane without overtopping. More generally, impacts of between 50-100mm are observed across the model extent. As with increased roughness, there is more water passing over the WCML, increasing the flood extent.

Downstream boundary

6.5.5 There is no impact to the proposed Meece Brook viaduct when the downstream boundary is reduced and increased by 20%. A small impact of between 10-50mm at the downstream boundary. No impact is seen greater than 35m from the downstream extent.

Summary

6.5.6 The sensitivity analysis shows the model is sensitive to changes in flows and roughness values at the proposed Meece Brook viaduct. The changes in the downstream boundary gradient had no impact at the proposed Meece Brook viaduct with minimal impact at the downstream boundary of the model.

6.5.7 Sensitivity tests conclude that the current proposed design ensures a freeboard of a minimum of 0.6m to the viaduct soffit in a 1.0%AEP +CC (50%) event for all scenarios.

6.6 Blockage analysis

6.6.1 Three blockage scenarios were assessed:

- blockage scenario 1 – 2% blockage at the proposed Meece Brook viaduct;
- blockage scenario 2 – 50% blockage of the culvert alongside the WCML (RailTrackCul); and
- blockage scenario 3 – 50% blockage of the culvert under the WCML (RailCul).

6.6.2 These blockage scenario results were compared to the 0.1% AEP results for the Proposed Scheme model.

6.6.3 The viaduct blockage of 2% was represented for the proposed Meece Brook viaduct by expanding the size of the pier standing nearest to the main channel by 2% of the length of the viaduct.

6.6.4 The blockage of the culverts alongside and under the WCML was represented by reducing the width of each structure by 50%.

6.6.5 The results of blockage scenario 1 show negligible impact to peak water levels and extents apart from a localised impact of between 10-50mm under the proposed Meece Brook viaduct.

6.6.6 The results of blockage scenario 2 show an increase in peak water level of greater than 100mm on the downstream side of the WCML as more water is being forced over the railway line due to the blockage, thus increasing the extent. Impacts are observed upstream of 10-50mm.

6.6.7 The results of blockage scenario 3 show minimal impact to peak water levels with an increase of between 10-50mm around the culvert inlet however slightly more water is forced over the WCML increasing the extent.

6.6.8 Blockage tests conclude that the current proposed design ensures a freeboard of a minimum of 1m to the rail track in a 0.1%AEP event for all scenarios.

6.7 Run parameters

6.7.1 There is no deviation from default run parameters for all model runs.

6.7.2 The time step parameters used were 0.5 seconds for ESTRY and 1 second for the 2D model. This is the suggested approach for a grid size of 2m.

7 Limitations

7.1.1 Land access for new topographic survey was not possible and therefore all channels have been represented in 2D, meaning channel conveyance will not be fully represented in the model; however, this will lead to a conservative estimation of flood risk for the purposes of the Environmental Impact Assessment. Onsite observations have been used to reduce the number of assumptions. Culvert dimensions have been estimated based upon ground levels and watercourse size, which may impact flood extent and level predictions if these were to change.

7.1.2 No survey data was available for the watercourse and the model has been developed based on the LiDAR provided.

7.1.3 Calibration has not been able to be carried out due to a lack of available data.

8 Conclusions and recommendations

8.1.1 The aim of developing a hydraulic model of Meece Brook was to simulate the baseline and Proposed Scheme and to determine the peak water levels and flows throughout the catchment has been met.

8.1.2 Increases in water level observed due to the Proposed Scheme reach less than 10mm over a localised area close to the viaduct. These are detailed for a range of AEP and flood maps provided in Appendix A.

8.1.3 Blockage and sensitivity analyses have demonstrated that changes in key variables such as roughness, model inflows and downstream boundary location and gradient result in modelled water levels that remain below the critical freeboard requirements.

8.1.4 At detailed design stage, the hydraulic modelling of the watercourse should be revisited. Topographic survey data of the channel and associated structures should be collected and if preliminary results deem it necessary, this model should then be converted into a linked 1D-2D model. This will provide better representation of the channel conveyance processes and refine the model outputs, allowing the model to be used to confirm flood risk from the Phase 2a scheme.

9 References

Chow, V.T (1959), *Open-channel hydraulics*, McGraw-Hill, New York.

Environment Agency, *Flood risk assessments: climate change allowances*. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

Environment Agency, *Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/571572/LIT_5707.pdf.

Gov.uk, *Flood map for planning*. Available online at: https://flood-map-for-planning.service.gov.uk.

Gov.uk, *Flood Zone and flood risk tables*. Available online at: https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables.

Gov.uk, *Long term flood risk information*. Available online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=SurfaceWater.

HS2 Ltd (2017), *High Speed Rail (West Midlands - Crewe) Environmental Statement (ES)*. www.gov.uk/hs2.

Appendix A: Flood level impact maps

1.1.1 The water level difference has been mapped for 5.0%AEP and 1.0%+CC AEP as described in Section 5, see Figures A-1 and A-2.

Figure A-1: Meece Brook at Whitmore Impact Map for 5% AEP (1 in 20 year)

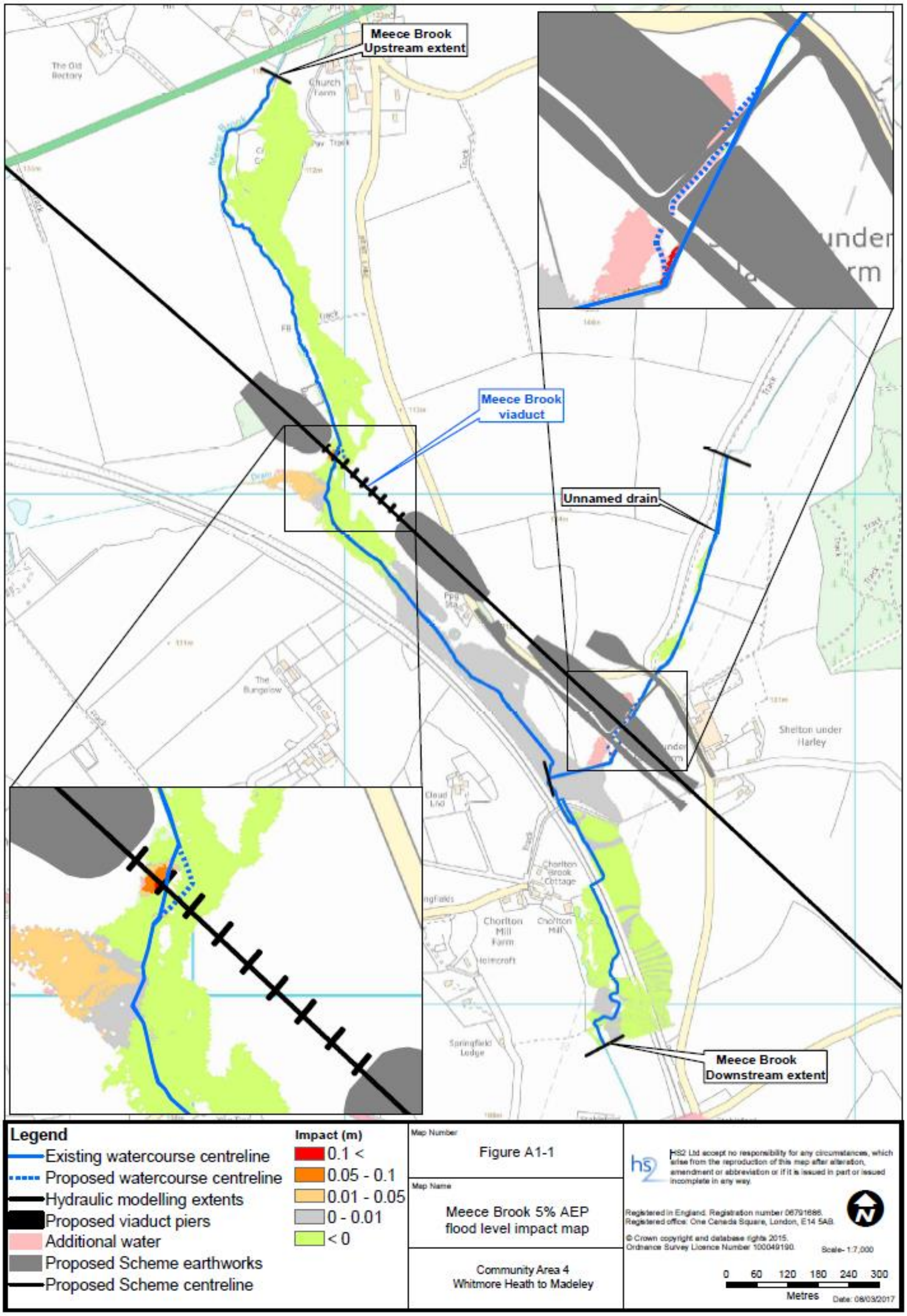
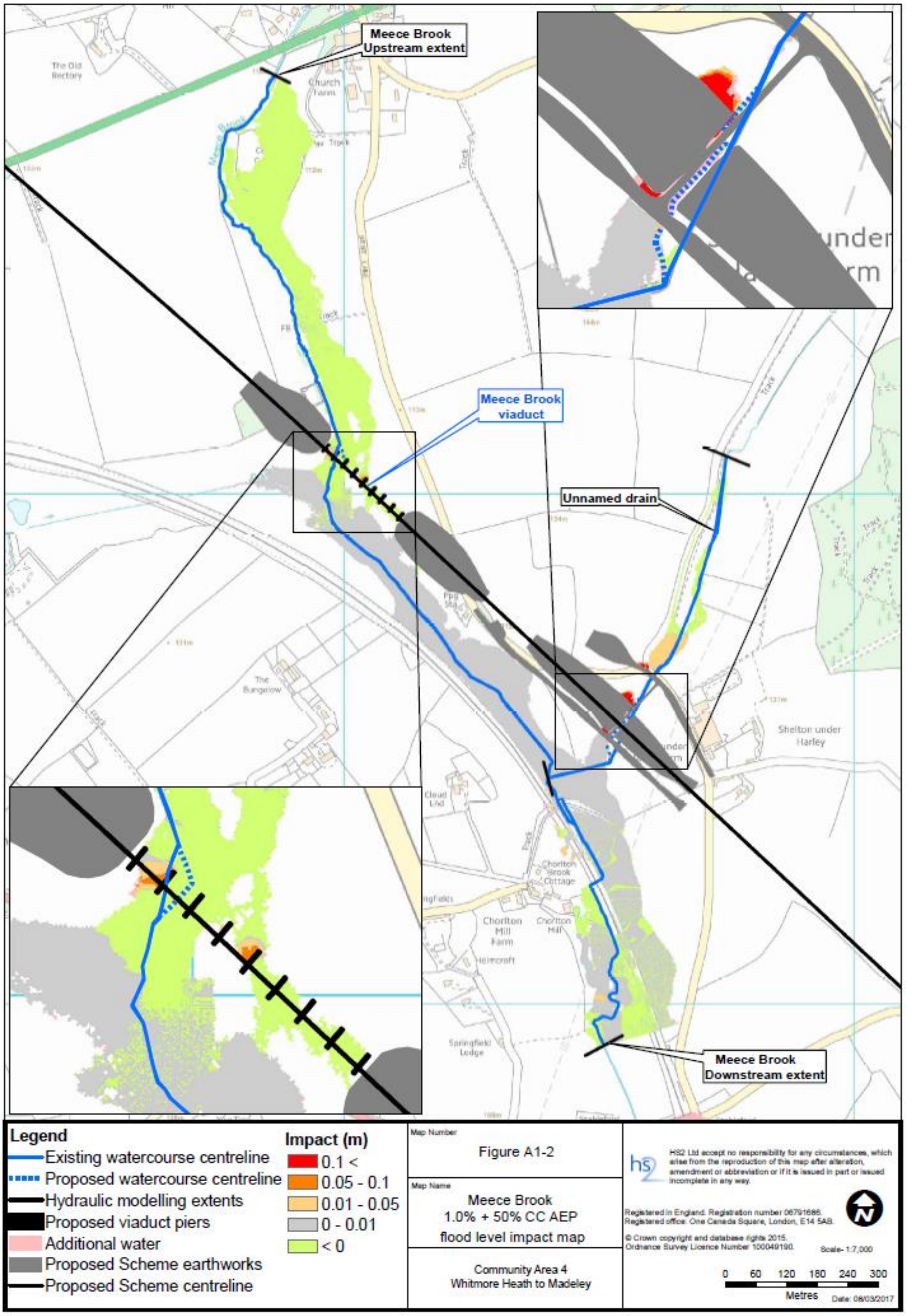


Figure A-2: Meece Brook at Whitmore Impact Map for 1% AEP (1 in 100 year) plus 50% climate change allowance



High Speed Two (HS2) Limited
Two Snowhill
Snow Hill Queensway
Birmingham B4 6GA

08081 434 434
HS2Enquiries@hs2.org.uk

E138