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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-005-0MA06

Water resources and flood risk

MA06: Hulseheath to Manchester Airport

Flood risk assessment

M329

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Department for Transport

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Contents

Tables

Figures

1 Introduction

1.1.1 This report is an appendix to the water resources and flood risk assessment. It presents the flood risk assessment for the Proposed Scheme in relation to the Hulseheath to Manchester Airport area (MA06).

1.1.2 This appendix should be read in conjunction with:

- Volume 2, Community Area reports;
- Volume 3, Route-wide effects;
- Volume 4, Off-route effects; and
- Volume 5, Appendices.

1.1.3 The water resources and flood risk assessments include both route-wide and community area specific appendices. The route-wide appendices comprise:

- a Water Framework Directive (WFD) compliance assessment (Volume 5: Appendix WR-001-00000); and
- a Draft water resources operation and maintenance plan (Volume 5: Appendix WR-007-00000).

1.1.4 For the Hulseheath to Manchester Airport area, the relevant Hydraulic modelling reports (Volume 5: Appendices WR-006-00001 and WR-006-00007) should also be referred to as well as the Water resources assessment (Volume 5: Appendix WR-003-0MA06).

1.1.5 Additional information relevant to this assessment is set out in Background Information and Data (BID):

- Water resources assessment baseline data (BID WR-004-0MA06)[1]; and
- Water Framework Directive compliance assessment baseline data (BID WR-002-00001)[2].

1.1.6 Maps referred to throughout this assessment are contained in the Volume 2, MA06 Map Book: Map Series CT-05 and CT-06.

1.1.7 Issues associated with the Sequential Test and Exception Test in the National Planning Policy Framework (NPPF)[3] are discussed on a route-wide basis in Volume 3.

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water resources assessment baseline data,* BID WR-004-0MA06. Available online at http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

[2] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water Framework Directive compliance assessment baseline data,* BID WR-002-00001. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

[3] Department for communities and local government (2019), *National Planning Policy Framework.* Available online at: https://www.gov.uk/government/publications/national-planning-policy-framework--2.

1.2 Scope, assumptions and limitations

1.2.1 The purpose of this flood risk assessment is to consider the flood risk implications of the permanent works associated with the Proposed Scheme within the Hulseheath to Manchester Airport area.

1.2.2 Temporary works have not been assessed unless they are of a significant scale compared to the permanent works proposed and have the potential to adversely affect flood risk.

1.2.3 The risk of flooding to site compounds will be managed through the Draft Code of Construction Practice (CoCP) (see Volume 5: Appendix CT-002-00000). As far as practicable, site compounds have been located outside of Flood Zone 3. However, where this is not possible, a sequential approach will be applied to the allocation of use within the compounds, seeking primarily to avoid using areas at flood risk wherever practical, but where this is unavoidable using areas at risk of flooding for the least vulnerable components and those that will avoid/limit the potential for off-site impacts. The sites will be registered with the Environment Agency Flood Warning and Flood Alert service, if available.

1.2.4 All sources of flood risk are considered, other than tidal flooding.

1.2.5 The flood risk assessment considers the impact of the Proposed Scheme during the 1 in 100 year event plus an allowance for climate change as set out in the Environmental Impact Assessment Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-00001).

1.2.6 Receptors considered in this assessment include the Proposed Scheme itself, other existing infrastructure assets, residential, commercial and agricultural buildings and property potentially affected by the Proposed Scheme.

1.2.7 The assessment has involved an initial scoping study using existing available information, including data provided by statutory consultees and stakeholders. Visual surveys have been undertaken of accessible water features to verify the dimensions of key hydraulic structures. Not all structures have been visually surveyed due to access constraints. Hydraulic modelling techniques, or other suitable quantitative methods, have been adopted in locations where the potential for adverse impacts on flood risk were identified in the scoping study. Details of the modelling decision tree process are provided in the SMR: Technical Note: Flood risk. Hydraulic modelling has made best use of existing models provided by the Environment Agency. No new channel survey data have been obtained. Floodplain geometry was, however, updated using Light Detection and Ranging (LiDAR) data.

1.2.8 The hydraulic modelling and analysis work is based on conservative assumptions about the potential hydraulic impacts of the structures proposed. All hydraulic calculations will require refinement during the design development stage using additional topographical survey data. The models will then require further development to reflect the design development of hydraulic structures and flood risk mitigation measures.

1.2.9 The Volume 2, Community Area report for the Hulseheath to Manchester Airport area describes the avoidance strategy and mitigation measures included in the design to limit the temporary and permanent effects of the Proposed Scheme as far as is reasonably practicable. This flood risk assessment therefore assesses the impacts and effects arising following the implementation of the avoidance and mitigation measures, and reports on whether any additional mitigation may be needed where the Proposed Scheme may result in significant effects.

1.3 Location and extent

1.3.1 The location and extent of the Hulseheath to Manchester Airport study area is shown in Figure 1.

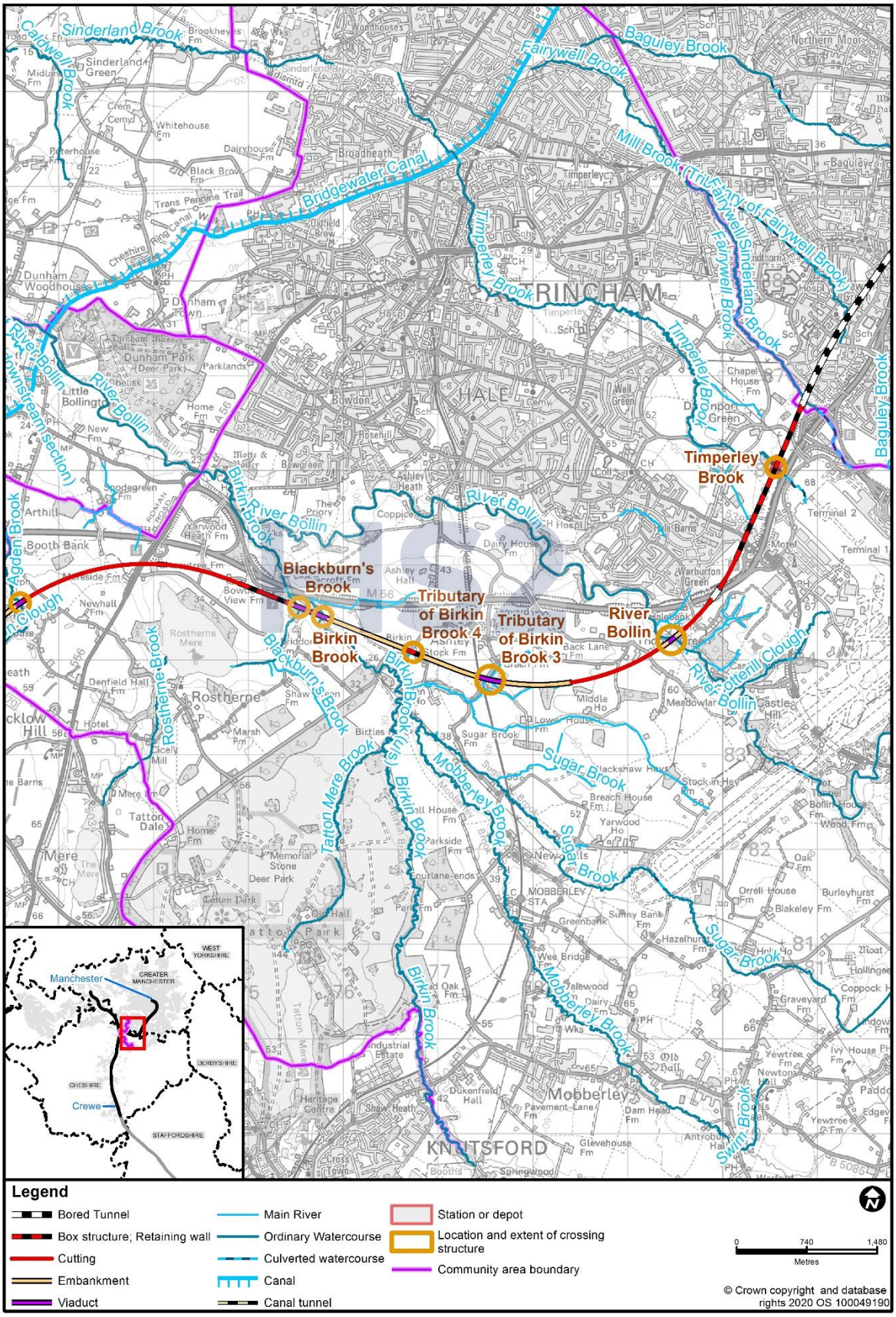
1.3.2 The study area extends 1km from the Proposed Scheme. All flood risk receptors have been identified within these limits. If modelling assessments identified potential impacts beyond these limits, the study area has been extended accordingly.

1.3.3 The extent of the land required during construction of the Proposed Scheme, Environment Agency Flood Zones 2 and 3[4], as well as the areas at risk from surface water flooding are shown on Volume 5, Water resources and flood risk Map Book: Map Series WR-01. The flood zone information is based on the Environment Agency's Flood map for planning (rivers and sea) and the risk of flooding from surface water maps (RoFSW)[5].

[4] Flood Zone 2 comprises land assessed as having between a 1 in 100 (1.0%) and 1 in 1,000 (0.1%) annual probability of river flooding; Flood Zone 3 comprises land assessed as having a 1 in 100 (1.0%) or greater annual probability of river flooding.

[5] Environment Agency (2021), *Long term flood risk information.* Available online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/.

Figure 1: Location and extent of the study area



2 Policy context and consultation

2.1 National

2.1.1 The Proposed Scheme design has been developed in general accordance with the requirements of the NPPF. This aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe, will not increase flood risk elsewhere and, where possible, reduces flood risk overall. The Sequential Test and Exception Test in the NPPF aim to achieve these policy objectives.

2.1.2 The Flood and Water Management Act 2010 requires the Environment Agency to 'develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England'. The Environment Agency therefore has oversight of all matters related to flood risk and is a statutory consultee for flood risks associated with main rivers and reservoirs. The Environment Agency has been consulted throughout the process of undertaking this assessment and has provided extensive data and guidance on the interpretation of policy.

2.2 Regional and local

2.2.1 Under the Flood and Water Management Act 2010, the statutory consultee for all matters related to local flood risk, including works affecting ordinary watercourses, is the Lead Local Flood Authority (LLFA). Cheshire East Council (CEC), Trafford Metropolitan Borough Council (TMBC) and Manchester City Council (MCC) are the LLFA in the Hulseheath to Manchester Airport area. Discussions have been held with CEC, TMBC, MCC, and the Environment Agency to agree the principles related to the hydraulic design of the Proposed Scheme and the approach adopted for the assessment of flood risk on main rivers and ordinary watercourses. The modelling is presented in the Hydraulic modelling report – Timperley Brook (Volume 5: Appendix WR-006-00007) and the Hydraulic modelling report – Millington Clough and tributaries (Volume 5: Appendix WR-006-00001).

2.2.2 The CEC Preliminary Flood Risk Assessment (PFRA)[6] was published in 2011, TMBC PFRA[7] was published in 2011, the CEC Local Flood Risk Management Strategy (LFRMS)[8] was published in

[6] Jacobs (2011), *Cheshire East Council Preliminary Flood Risk Assessment.* Available online at: https://moderngov.cheshireeast.gov.uk/ecminutes/mgAi.aspx?ID=13352.

[7] JBA Consulting (2011), *Trafford Council Preliminary Flood Risk Assessment.* Available online at: https://webarchive.nationalarchives.gov.uk/20140328094439/http://www.environment-agency.gov.uk/research/planning/135532.aspx.

[8] Cheshire East Council (2017), *Cheshire East Council Local Flood Risk Management Strategy.* Available online at: https://moderngov.cheshireeast.gov.uk/ecminutes/documents/s59547/Local%20Flood%20Risk%20Management%20Strategy%20-%20app%202.pdf.

2017, and the TMBC LFRMS[9] was published in 2014. The LFRMS contains a number of policies related to sustainable development, access to, and maintenance of, ordinary watercourses and the need to consider environmental opportunities that reinforce the objectives of the River Basin Management Plan (RBMP)[10]. The Proposed Scheme design has sought to align with these objectives where reasonably practicable.

2.2.3 The CEC Strategic Flood Risk Assessment (SFRA)[11] and the Manchester City, Salford City (SCC) and Trafford Councils Hybrid SFRA[12] cover the Hulseheath to Manchester Airport area. The key flood risk objectives outlined in the SFRA are to reduce surface water runoff, support Water Framework Directive delivery and prevent new development within sensitive development locations. The Proposed Scheme design has sought to align with these objectives where reasonably practicable.

[9] Trafford Council (2014), *Trafford Local Flood Risk Management Strategy.* Available online at: https://beta.trafford.gov.uk/planning/strategic-planning/docs/lfrms-trafford-final-2014.pdf.

[10] Environment Agenct (2015), *North West River Basin Management Plan.* Available online at: https://www.gov.uk/government/publications/north-west-river-basin-district-river-basin-management-plan.

[11] JBA Consulting (2013), *Cheshire East Council Strategic Flood Risk Assessment.* Available online at: https://www.cheshireeast.gov.uk/pdf/planning/spatial-planning/researchand-evidence/strategic-flood-assessment/cheshire-east-council-sfra-final-report-v4.0.pdf.

[12] JBA Consulting (2010), *Manchester City, Salford City and Trafford Councils Level 2 Hybrid Strategic Flood Risk Assessment.* Available online at: https://www.trafford.gov.uk/planning/strategic-planning/docs/manchester-salford-and-trafford-councils-level-2-hybrid-sfra-level-1-sfra-march-2011.pdf.

3 Flood risk baseline

3.1 Historical flooding incidents

3.1.1 The PFRA and SFRA published by CEC, TMBC and MCC report no incidents of historical flooding from watercourses or surface water sources within 1km of the Proposed Scheme.

3.1.2 A review of the Section 19[13] historical flood reports in the Hulseheath to Manchester Airport area showed no records of historical flooding within 10km of the Proposed Scheme. However, there is public information from local news articles[14] showing that one of the runways at Manchester Airport was subject to shallow surface water flooding in September 2018. Local news articles also recorded flooding on the surrounding road network (A555 and M60) in July 2019[15], November 2019 and February 2020, and recent localised flood events occurred in Northwich in October 2019[16]. These flood events may be subject to a Section 19 report in the future.

3.2 Risks associated with main rivers and ordinary watercourses

3.2.1 The key flood risk from main rivers and ordinary watercourses is that associated with the following:

- main rivers:
  - Agden Brook;
  - Blackburn's Brook and Birkin Brook;
  - River Bollin;
  - Timperley Brook; and

[13] Section 19 of the Flood and Water Management Act 2010 sets out the requirement for that on becoming aware of a flood in its area, a LLFA must investigate and report on which risk management authorities have relevant flood risk management functions and whether each authority has exercised those functions in response to the flood.

[14] Newsflare (2019), *Flash flooding causes Manchester Airport runway to close*. Available online at: https://www.newsflare.com/video/237288/travel/rushes-flash-flooding-causes-manchester-airport-runway-to-close.

[15] BBC News (2019), *Heavy rain causes travel disruption in North West.* Available online at: https://www.bbc.co.uk/news/uk-england-manchester-49149281.

[16] BBC News (2019), *Rising floodwaters lead to Northwich evacuations.* Available online at: https://www.bbc.co.uk/news/av/uk-england-manchester-50209113/rising-floodwaters-lead-to-northwich-evacuations.

  - Fairywell Brook: Fairywell Brook has not been considered further in this assessment as there is no change in flood risk for this watercourse as the Proposed Scheme passes beneath the floodplain in tunnel.
- ordinary watercourses:
  - Tributary of Birkin Brook 1;
  - Tributary of Birkin Brook 2;
  - Tributary of Birkin Brook 3; and
  - Tributary of Birkin Brook 4.

3.2.2 The areas at risk of flooding from these watercourses, the receptors potentially affected, and the climate change allowances used in the assessment of impacts and effects are considered below. Receptors have been identified based on Ordnance Survey (OS) mapping and committed development information[17].

Blackburn's Brook, Birkin Brook and the River Bollin

3.2.3 These watercourses have mapped flood zones indicated by the Environment Agency Flood map for planning (rivers and sea)[5] dataset. This dataset was used to assess the receptors at potential risk from flooding. As these watercourses have viaduct crossings that do not affect the floodplains other than at the viaduct piers, it was determined through the decision tree process that modelling was not required at these locations at this stage. Details of the modelling decision tree process are provided in the SMR Technical Note: Flood risk.

3.2.4 The receptors upstream and downstream of the Proposed Scheme that are at potential risk from these watercourses are listed below. The relative vulnerability to flooding of each receptor (as defined in NPPF and Section 21 of the SMR) is also indicated. Undeveloped agricultural land (less vulnerable[18]) is the most common receptor for these watercourses:

- Blackburn's Brook and Birkin Brook (Figure 2):
  - M56 (essential infrastructure);
  - agricultural land (less vulnerable); and
  - woodland (water compatible).
- River Bollin (Figure 3):
  - agricultural land (less vulnerable);

[17] Further details of these committed developments can be found in Volume 5: Appendix CT-004-00000, Planning data.

[18] Agricultural land is assessed to be a less vulnerable receptor irrespective of the agricultural land quality classification. The assessment of agriculture land quality is set out in Volume 2, Community Area report: Hulseheath to Manchester Airport, (MA06), Section 4.

- woodland (water compatible);
- residential property along Mill Lane (more vulnerable); and
- Mill Lane (less vulnerable).

3.2.5 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas greater than or equal to 5km^2 in size the guidance recommends that a peak river flow allowance is used. The percentage uplift in peak river flow used to assess flood risk to receptors reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance of 70% increase in peak river flow has been adopted on a precautionary basis for this assessment.

Figure 2: Extent of the Environment Agency's Flood Zones 2 and 3, Blackburn's Brook and Birkin Brook

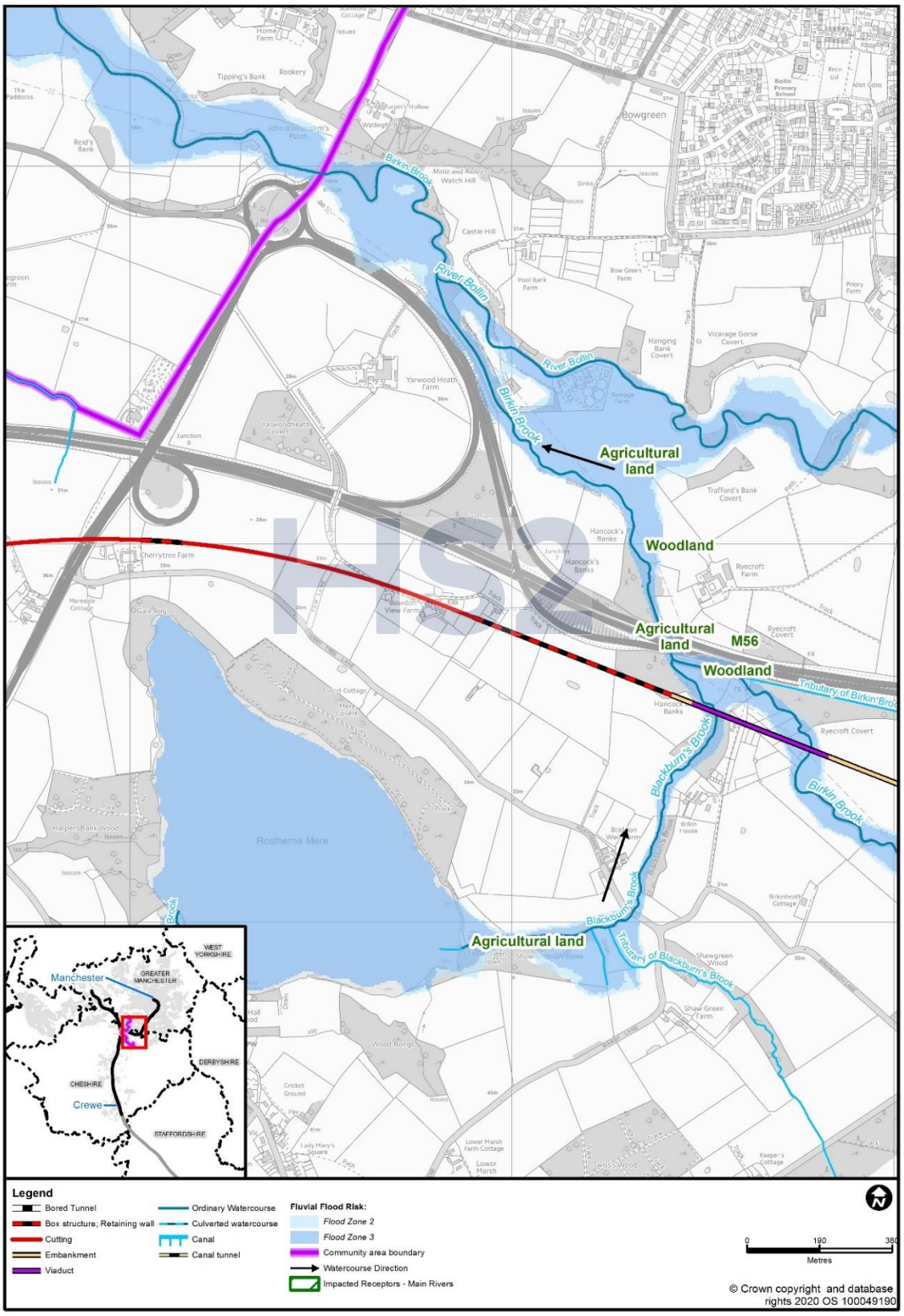
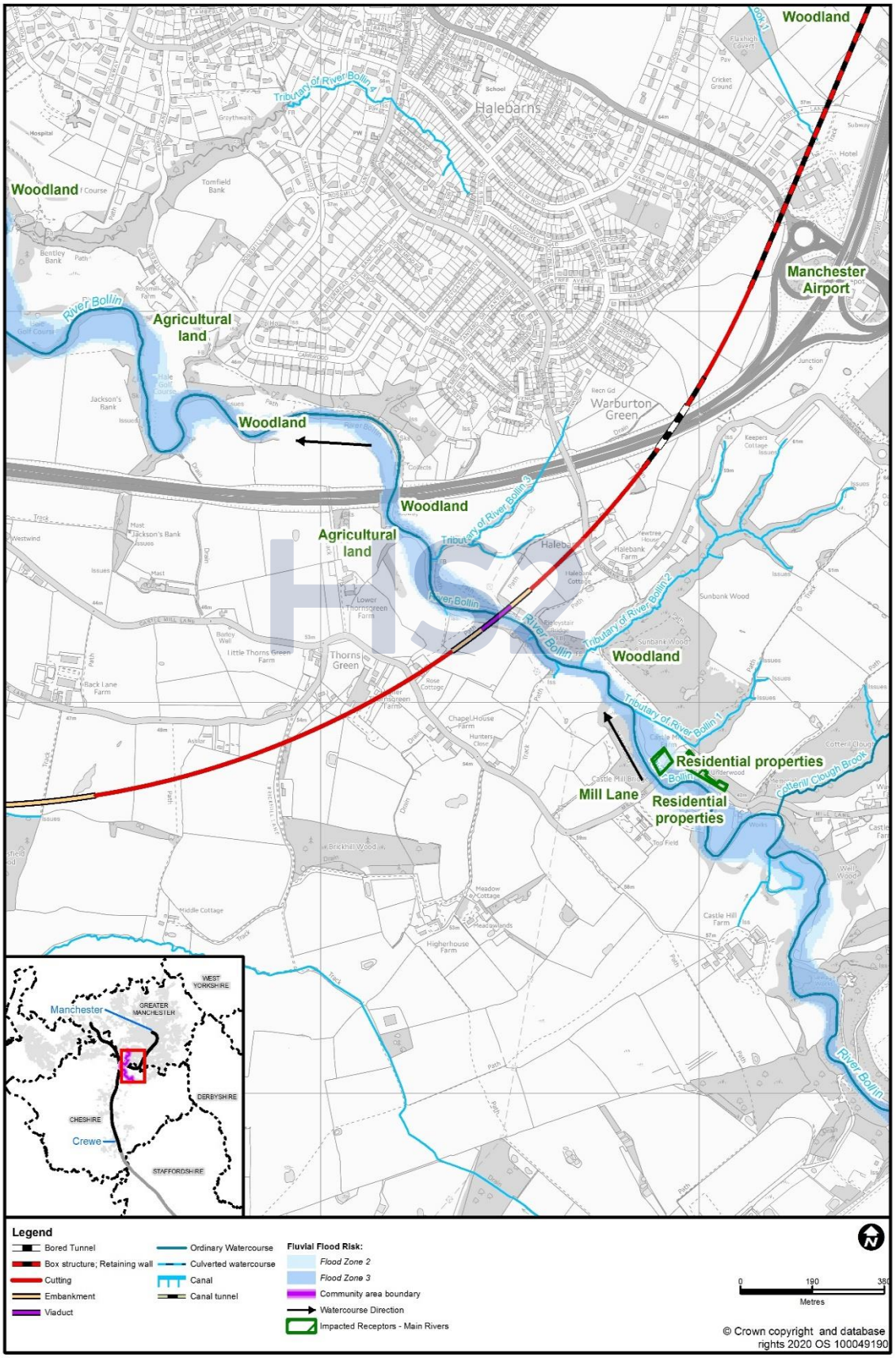


Figure 3: Extent of the Environment Agency's Flood Zones 2 and 3, River Bollin



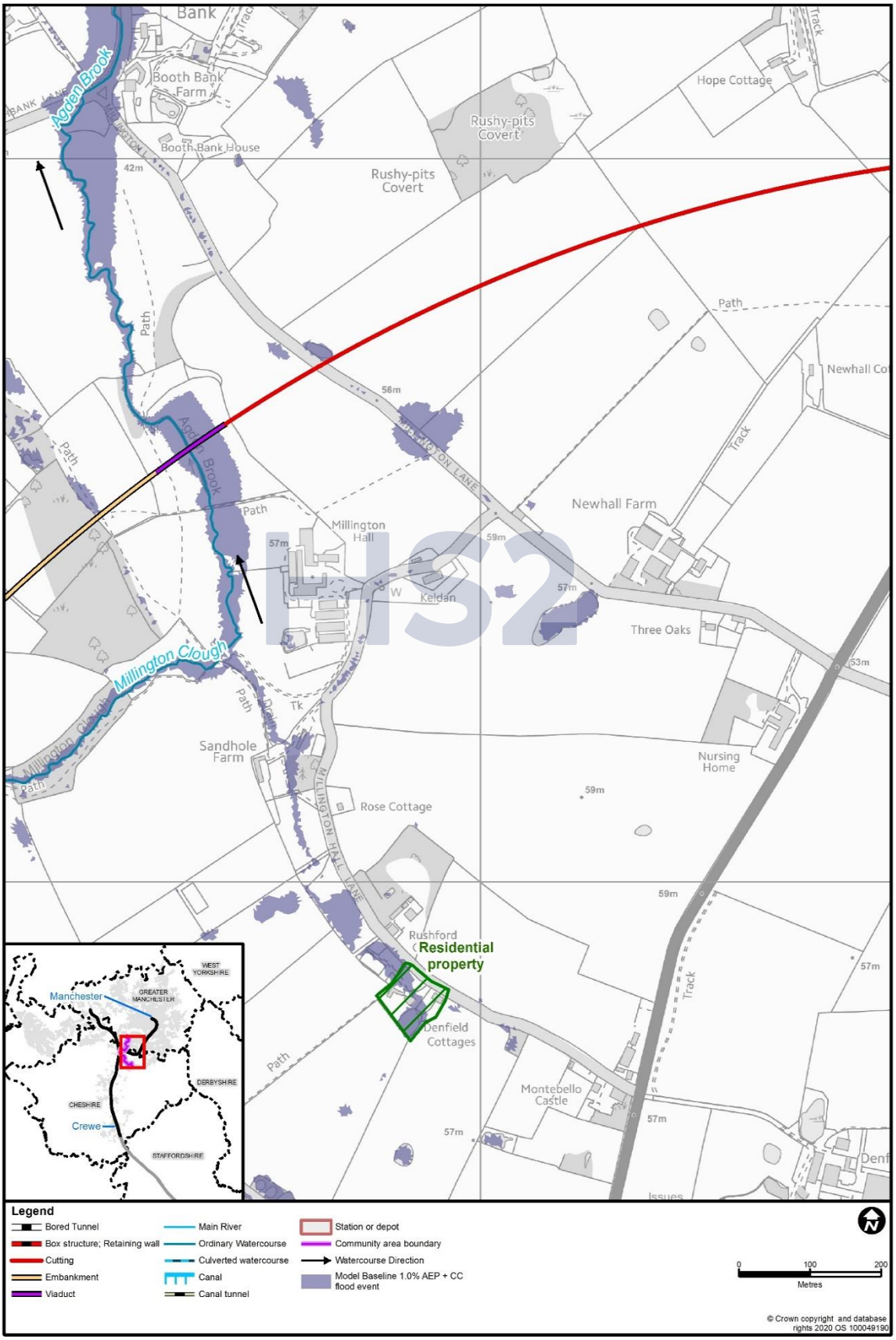
Agden Brook

3.2.6 A 2D hydraulic model of Agden Brook has been developed (as part of the Hydraulic model for the Millington Clough in the Pickmere to Agden and Hulseheath area (MA03)) to define the peak flood levels and extents associated with a range of annual probabilities. Details are reported in Hydraulic modelling report – Millington Clough and tributaries, Volume 5: Appendix WR-006-00001. The inundation extents for the 1 in 100 (1.0%) annual exceedance probability (AEP) plus climate change (CC) flood are shown in Figure 4.

3.2.7 The receptor potentially at risk of flooding from this watercourse is a residential property at Millington Hall. The relative vulnerability to flooding of the receptor (as defined in NPPF and Section 21 of the SMR) is indicated as more vulnerable.

3.2.8 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas less than 5km^2 in size the guidance recommends that a peak rainfall intensity allowance is used. The percentage uplift in peak rainfall intensity used to assess flood risk to receptors reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance of 40% increase has been adopted on a precautionary basis for this assessment.

Figure 4: Baseline extent of the modelled 1.0% AEP + CC flood event, Agden Brook



Timperley Brook

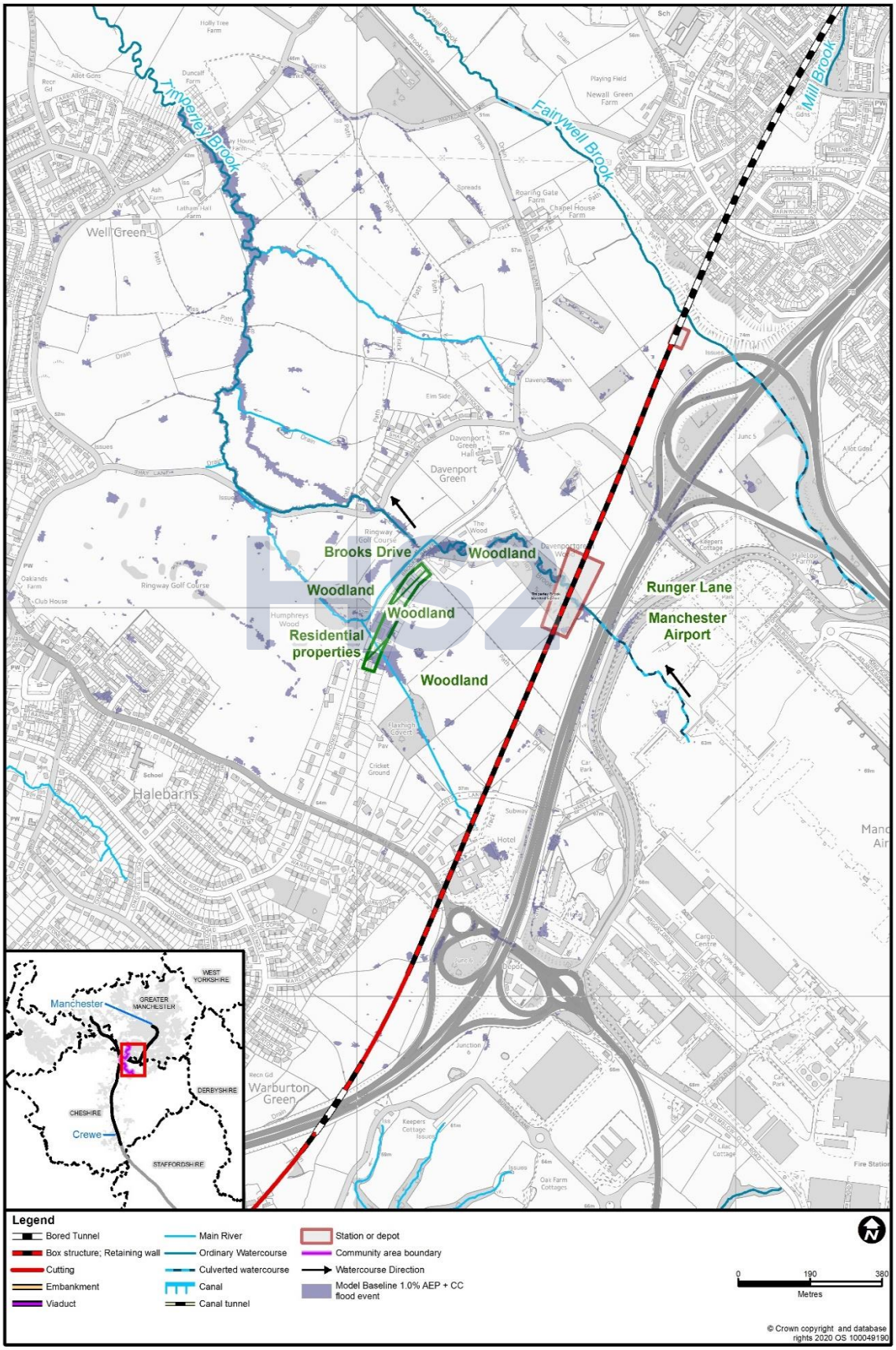
3.2.9 A 2D hydraulic model of Timperley Brook and its tributaries has been developed to define the peak flood levels and extents associated with a range of annual probabilities. Details are reported in the Hydraulic modelling report – Timperley Brook (Volume 5: Appendix WR-006-00007). The inundation extents for the 1.0% AEP + CC flood are shown in Figure 5.

3.2.10 The receptors potentially at risk of flooding from Timperley Brook and its tributaries are listed below. The relative vulnerability to flooding of the receptor (as defined in NPPF and Section 21 of the SMR) is also indicated:

- Manchester Airport (essential infrastructure);
- Runger Lane (less vulnerable);
- woodland (water compatible);
- Brook's Drive (less vulnerable); and
- residential properties on Brook's Drive (more vulnerable).

3.2.11 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas less than 5km^2 in size the guidance recommends that a peak rainfall intensity allowance is used. The percentage uplift in peak rainfall intensity used to assess flood risk to receptors reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance of 40% increase has been adopted on a precautionary basis for this assessment.

Figure 5: Baseline extent of the modelled 1.0% AEP + CC flood event, Timperley Brook



Other watercourses

3.2.12 Other ordinary watercourses located within the Hulseheath to Manchester Airport area include:

- Tributary of Birkin Brook 1 (due to the Mobberley Road realignment and Ashley railhead);
- Tributary of Birkin Brook 2 (due to the Mobberley Road realignment and Ashley railhead);
- Tributary of Birkin Brook 3 (due to the Mobberley Road realignment and Ashley railhead); and
- Tributary of Birkin Brook 4 (due to the Ashley embankment and Ashley railhead).

3.2.13 These ordinary watercourses do not have mapped flood zones indicated by the Environment Agency's Flood map for planning (rivers and sea) dataset, and so the RoFSW outputs were used to determine possible flood extents generated by these watercourses.

3.2.14 Figure 6 indicates the receptors at risk for the surface water flow paths associated with these watercourses are:

- Mobberley Road (less vulnerable);
- Mid-Cheshire Line railway (essential infrastructure); and
- undeveloped agricultural land (less vulnerable).

3.2.15 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas less than 5km^2 in size the guidance recommends that a peak rainfall intensity allowance is used. The percentage uplift in peak rainfall intensity used to assess flood risk to receptors reflects the location of the receptor in the floodplain (flood zone) and its flood risk vulnerability classification. The upper end allowance of 40% increase has been adopted on a precautionary basis for this assessment.

3.3 Risks associated with surface water

3.3.1 This section describes the risk associated with surface water as shown by the Environment Agency's RoFSW dataset for the 1 in 1000 (0.1%) AEP flood event. This dataset indicates where surface water flow paths cross the proposed scheme. One surface water flow path has been identified in the study area.

3.3.2 As indicated in Figure 7, Tom Lane (less vulnerable[18]) is at risk from surface water at Yarwoodheath Covert.

3.3.3 In line with the SMR, a climate change allowance has been adopted to assess the future flood risk to receptors associated with each watercourse crossing using the Environment Agency guidelines. For catchment areas less than 5km^2 in size the guidance recommends that a peak rainfall intensity allowance is used. The percentage uplift in peak rainfall intensity used to assess flood risk to receptors reflects the location of the receptor in the floodplain

(flood zone) and its flood risk vulnerability classification. The upper end allowance of 40% increase has been adopted on a precautionary basis for this assessment.

Figure 6: Extent of the Environment Agency's RoFSW dataset, Tributaries of Birkin Brook 1 to 4

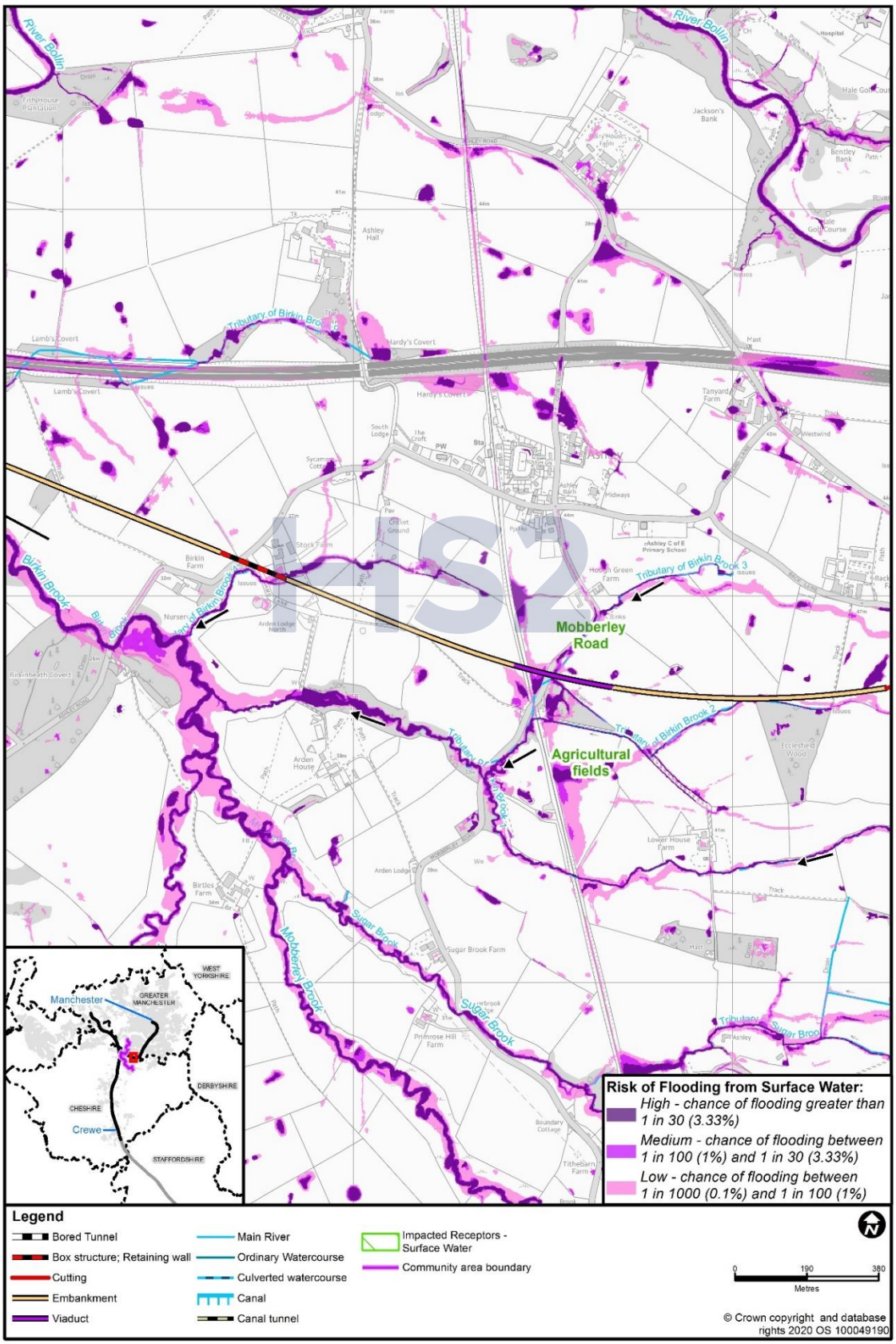
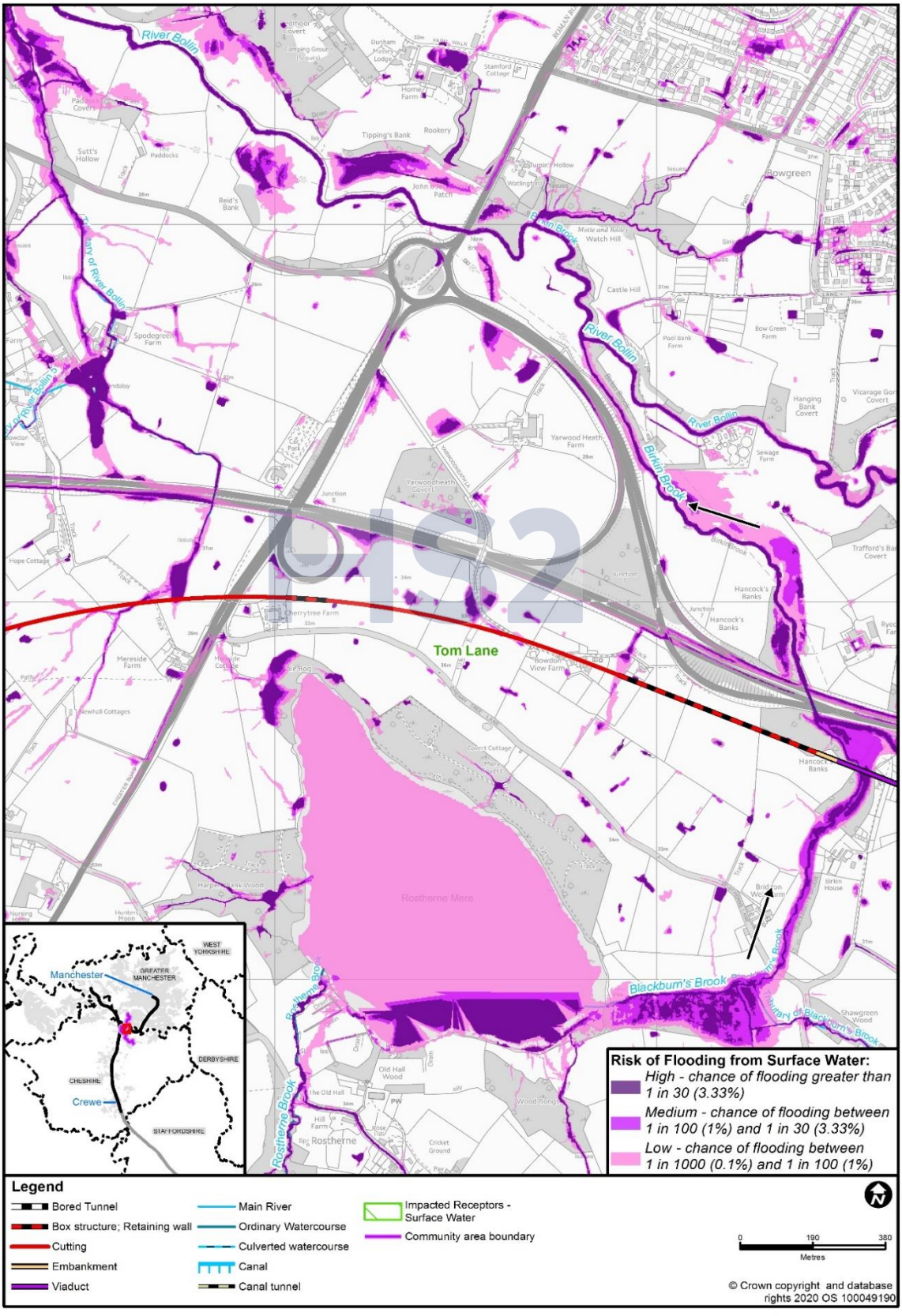


Figure 7: Extent of the Environment Agency's RoFSW dataset, surface water flow path Yarwoodheath Covert



3.4 Risks associated with groundwater

3.4.1 The British Geological Society (BGS) susceptibility to groundwater flooding dataset[19] provides the main dataset used to scope the future risk of groundwater flooding. The assessment of susceptibility is based on rock type and estimated groundwater levels during periods of extended intense rainfall. The dataset shows groundwater flooding susceptibility, on a 50m grid, using the following three classes:

- A – limited potential for groundwater flooding to occur;
- B – potential for groundwater flooding of property situated below ground level; and
- C – potential for groundwater flooding to occur at the surface.

3.4.2 The BGS groundwater flooding dataset is a hazard dataset based on favourable geological conditions for groundwater flooding. The dataset is not based on risk and as such does not show the likelihood of a groundwater flooding event actually occurring.

3.4.3 The BGS groundwater flooding susceptibility dataset (presented in Figure 8) indicates that there is potential for groundwater flooding to occur at surface at the following locations:

- Birkin Brook floodplain;
- River Bollin floodplain; and
- Hales Barns.

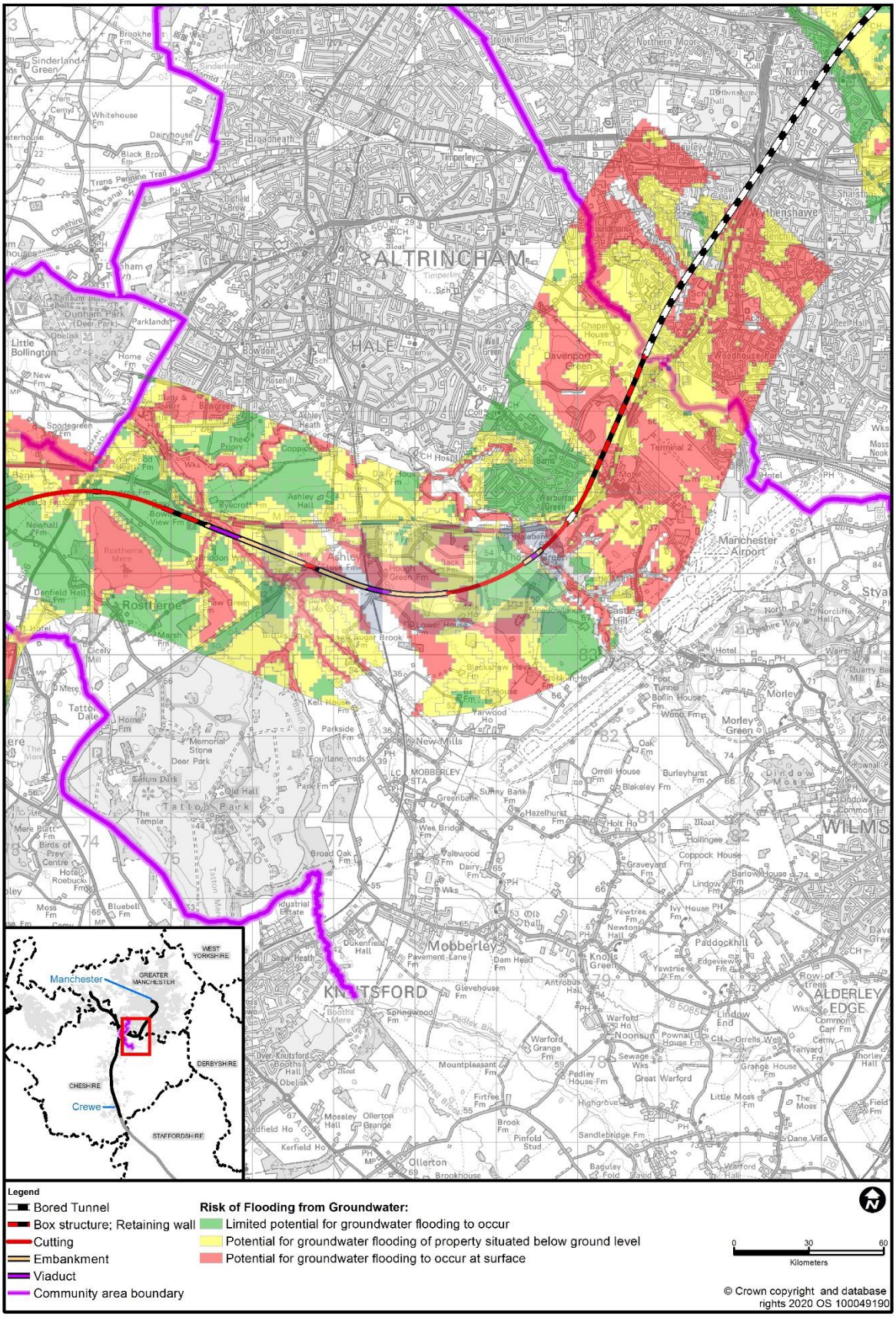
3.4.4 The receptors located in these areas that are potentially at risk from groundwater flooding at surface are listed below. The relative vulnerability to flooding of each receptor (as defined in NPPF and Section 21 of the SMR) is also indicated.

- agricultural land (less vulnerable);
- woodland (water compatible);
- M56 (essential infrastructure);
- Manchester Airport (essential infrastructure);
- roads (less vulnerable); and
- residential properties (more vulnerable).

3.4.5 Neither the CEC SFRA[11] and LFRMS[8], or the MCC, SCC and TMBC hybrid SFRA[12] and LRFMS[9] report any historic groundwater flooding incidents within the study area. This is due to the nature of the superficial deposits (glacial till).

[19] British Geological Survey (2018), *Susceptibility to groundwater flooding*. Available online at: http://www.bgs.ac.uk/products/hydrogeology/groundwaterFlooding.html.

Figure 8: Risk of flooding from groundwater throughout the study area



3.5 Risks associated with artificial sources

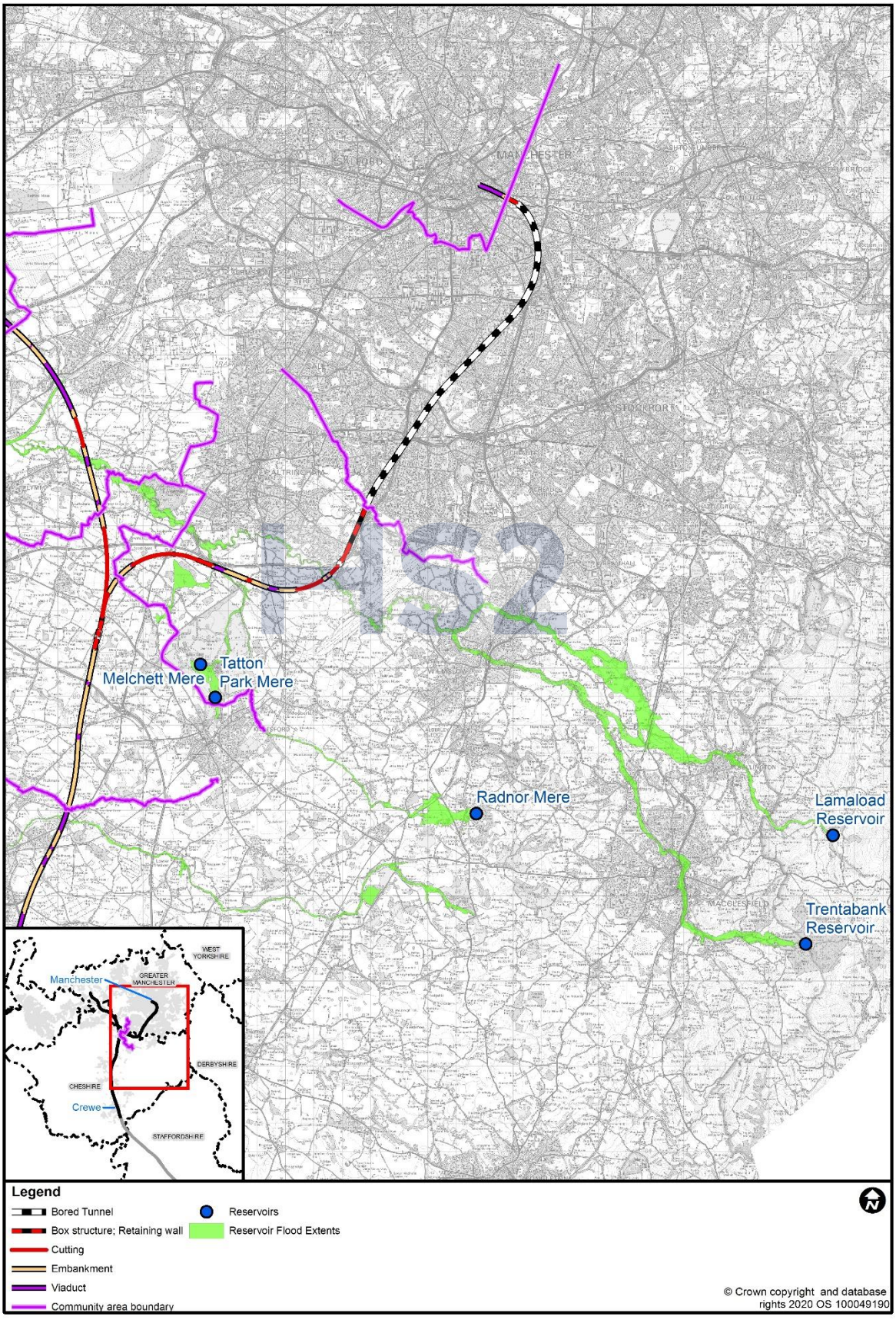
3.5.1 Flooding from artificial water bodies may occur due to failure of an impounding structure, such as a dam or canal embankment. The following features have been identified within the study area that are a potential source of flood risk:

- Tatton Park Mere and Melchett Mere are approximately 3.5km south of the Proposed Scheme. These are large, raised reservoirs or impounded water bodies[20] and are shown on the Environment Agency's flood risk from reservoirs mapping[5]. At the crossing of the Proposed Scheme the risk from these sources is of similar extent to the Flood Zones 2 and 3. Other artificial water bodies, or artificially raised water bodies, outside of the study area but with potential to affect flood risks of relevance to the Proposed Scheme are Radnor Mere and Lamaload Reservoir; and
- major water supply pipelines and sewerage (foul and surface water) infrastructure has potential to cause flooding should it fail. However, this infrastructure, and its potential failure, is accounted for in the assessment of surface water flooding and in the design of the Proposed Scheme, as shown in Volume 2, MA06 Map Book: Map Series CT-05 and CT-06.

3.5.2 Figure 9 shows the location of artificial sources within the Hulseheath to Manchester Airport area and a summary of the baseline flood risk from artificial sources is provided in Table 1.

[20] Meres listed have been analysed for dam breach by the Environment Agency and are included in the Reservoir flood maps dataset.

Figure 9: Artificial flood sources in the vicinity of the study area



3.6 Summary of baseline flood risk

3.6.1 Table 1 provides a summary of all the relevant sources of flood risk identified, the receptors potentially affected, their relative vulnerability and the climate change allowances used in the modelling assessments and calculations.

Table 1: Summary of baseline flood risk

Source / pathway	Receptors	Data source	Highest receptor vulnerability level	Climate change allowance used for assessment
Blackburn's Brook and Birkin Brook	M56 (essential infrastructure)	Environment Agency Flood Zones 2 and 3	Essential infrastructure	70% (increase to peak river flow)
	Agricultural land (less vulnerable)			
	Woodland (water compatible)			
River Bollin	Agricultural land (less vulnerable)	Environment Agency Flood Zones 2 and 3	More vulnerable	70% (increase to peak river flow)
	Woodland (water compatible)			
	Residential property along Mill Lane (more vulnerable)			
	Mill Lane (less vulnerable)			
Agden Brook	Residential property at Millington Hall (more vulnerable)	1.0% AEP + CC flood extent	More vulnerable	40% (increase in peak rainfall intensity)
Timperley Brook and its tributaries	Manchester Airport (essential infrastructure)	1.0% AEP + CC flood extent	Essential infrastructure	40% (increase in peak rainfall intensity)
	Runger Lane (less vulnerable)			
	Woodland (water compatible)			
	Brook's Drive (less vulnerable)			
	Residential properties on Brook's Drive (more vulnerable)			
Tributaries of Birkin Brook 1, 2 and 3	Agricultural land (less vulnerable)	RoFSW 0.1% AEP flood extent	Essential infrastructure	40% (increase in peak rainfall intensity)
	Mobberley Road (less vulnerable)			
	Mid-Cheshire Railway (essential infrastructure)			
Tributary of Birkin Brook 4	Agricultural land (less vulnerable)	RoFSW 0.1% AEP flood extent	Less vulnerable	40% (increase in peak rainfall intensity)

Source / pathway	Receptors	Data source	Highest receptor vulnerability level	Climate change allowance used for assessment
Surface water flow path south of Yarwoodheath Covert	Tom Lane (less vulnerable)	RoFSW 0.1% AEP flood extent	Less vulnerable	40% (increase in peak rainfall intensity)
Tatton Park Mere, Melchett Mere, and Radnor Mere	M56 (essential infrastructure)	Environment Agency long-term flood risk information	Essential infrastructure	Not defined
	Agricultural land (less vulnerable)			
	Woodland (water compatible)			
Lamaload Reservoir	Agricultural land (less vulnerable)	Environment Agency long-term flood risk information	Less vulnerable	Not defined
	Woodland (water compatible)			
Groundwater	Agricultural land (less vulnerable)	BGS groundwater flooding susceptibility dataset	Essential infrastructure	Not defined
	Woodland (water compatible)			
	M56 (essential infrastructure)			
	Manchester Airport (essential infrastructure)			
	Roads (less vulnerable)			
	Residential properties (more vulnerable)			

4 Flood risk impacts and effects

4.1 Rivers and ordinary watercourses

Viaducts

4.1.1 The Proposed Scheme within the Hulseheath to Manchester Airport area includes viaduct crossings of the Blackburn's Brook, Birkin Brook, and the River Bollin. As these crossings have mapped flood zones and the Proposed Scheme at crossings does not affect the floodplains, other than at the viaduct piers, it was determined that detailed modelling was not required. Hydraulic analysis of these watercourses has been used in the assessment of the Proposed Scheme to determine the likely impact on flood levels from intermediate piers, or any other permanent features associated with the Proposed Scheme that are within the flood zones or predicted flood extents.

4.1.2 The hydraulic analysis was undertaken using simplified 2D modelling with LiDAR data defining the 2D surface and refinements made to represent the watercourse and piers. This analysis has been used to provide greater certainty over the level of impacts the Proposed Scheme is likely to have on peak flood levels. The hydraulic analysis was used to define the impact on the 1.0% AEP plus an allowance for CC flood level.

Blackburn's Brook North viaduct

4.1.3 The Blackburn's Brook North viaduct is approximately 380m in length and spans Blackburn's Brook and Birkin Brook. The hydraulic analysis of head loss associated with the piers indicates that there is a negligible (less than a 1mm change) impact on water levels due to the piers at Blackburn's Brook. This results in a negligible effect, which is not significant.

4.1.4 At Birkin Brook, hydraulic analysis of head loss associated with the piers indicates that the piers have the potential to cause localised (within 10m) increases in peak flood levels of up to 60mm upstream of the piers and decreases in peak flood levels of 20mm downstream of the piers. The increase in peak flood level is classified as a minor impact as it is a highly localised impact constrained to the immediate vicinity of the piers, and will affect agricultural land, a moderate value receptor (as set out in Section 21 of the SMR). This results in a minor adverse effect, which is not significant.

4.1.5 Replacement floodplain storage (RFS) has been identified as a precautionary measure to address the loss of floodplain storage at this crossing (Figure 10), in accordance with the SMR Technical Note: Flood risk and climate change. The hydraulic analysis will be refined during design development in consultation with the Environment Agency to ensure that where reasonably practicable adverse impacts which could lead progressively to significant flood risk effects either local to the watercourse crossing, or elsewhere within the catchment as a result of a cumulative effect, are fully mitigated. The volume required has been

estimated using the Flood Zone 2 (1 in 1000 year) extent which is considered to be similar to the 1 in 100 year flood extent including climate change.

4.1.6 Further topographical survey, other surveys as required, hydraulic modelling, including incorporation of the proposed RFS, design development, and refinement of the mitigation measures will be undertaken at the design development stage with the aim of ensuring no impacts on peak flood levels.

River Bollin East viaduct

4.1.7 The River Bollin East viaduct is approximately 100m in length. Hydraulic analysis of head loss associated with the piers indicates that the viaduct piers have the potential to cause localised (within 5m) increases in peak flood levels of up to 60mm upstream and decreases in peak flood levels of 80mm downstream of the piers. The increase in peak flood level is classified as a minor impact as it is a highly localised impact and will affect woodland, a low value receptor, and agricultural land, a moderate value receptor (as set out in Section 21 of the SMR). This results in a minor adverse effect, which is not significant.

4.1.8 RFS has been identified as a precautionary measure to address the loss of floodplain storage at this crossing (Figure 11). The hydraulic analysis will be refined during design development in consultation with the Environment Agency to ensure that where reasonably practicable adverse impacts which could lead progressively to significant flood risk effects either local to the watercourse crossing, or elsewhere within the catchment as a result of a cumulative effect, are fully mitigated. The volume required has been estimated using the Flood Zone 2 (1 in 1000 year) extent which is considered to be similar to the 1 in 100 year flood extent including climate change.

4.1.9 Further topographical survey, other surveys as required, hydraulic modelling, including incorporation of the proposed RFS, design development, and refinement of the mitigation measures will be undertaken at the design development stage with the aim of ensuring no impacts on peak flood levels.

Agden Brook

4.1.10 Agden Brook has been included as part of the Millington Clough and tributaries hydraulic model. Further details can be found in the Hydraulic modelling report – Millington Clough and tributaries, Volume 5, Appendix WR-006-00001.

4.1.11 The Proposed Scheme has been modelled as a raised embankment with a 120m wide opening to represent Agden Brook viaduct. No RFS has been included in the modelling. The modelled impact of the Proposed Scheme on peak flood levels is shown in Figure 13. This indicates that without RFS there is potential for decreases in peak flood levels up to 50mm upstream and downstream of the Proposed Scheme viaduct crossing. This is due to the runoff being intercepted by the Proposed Scheme embankment upstream of the viaduct, on the north side of the HS2 Manchester Spur. The intercepted runoff will enter the Proposed

Scheme drainage ponds at the embankment, where increases in peak flood level are modelled. This runoff would be collected into the toe drains of the embankment and discharged back into Agden Brook downstream of the Agden Brook viaduct (not included in the model at this time).

4.1.12 The decreases in peak flood level are assessed to be minor (beneficial) impacts, impacting moderate value agricultural land, which is not significant.

4.1.13 RFS has been identified as a precautionary measure to address the loss of floodplain storage at this crossing due to the viaduct piers, this is shown in Figure 12. The hydraulic modelling will be refined during design development in consultation with the Environment Agency to ensure that where reasonably practicable adverse impacts which could lead progressively to significant flood risk effects either local to the watercourse crossing, or elsewhere within the catchment as a result of a cumulative effect, are fully mitigated.

Figure 10: Replacement floodplain storage areas Blackburn's Brook and Birkin Brook

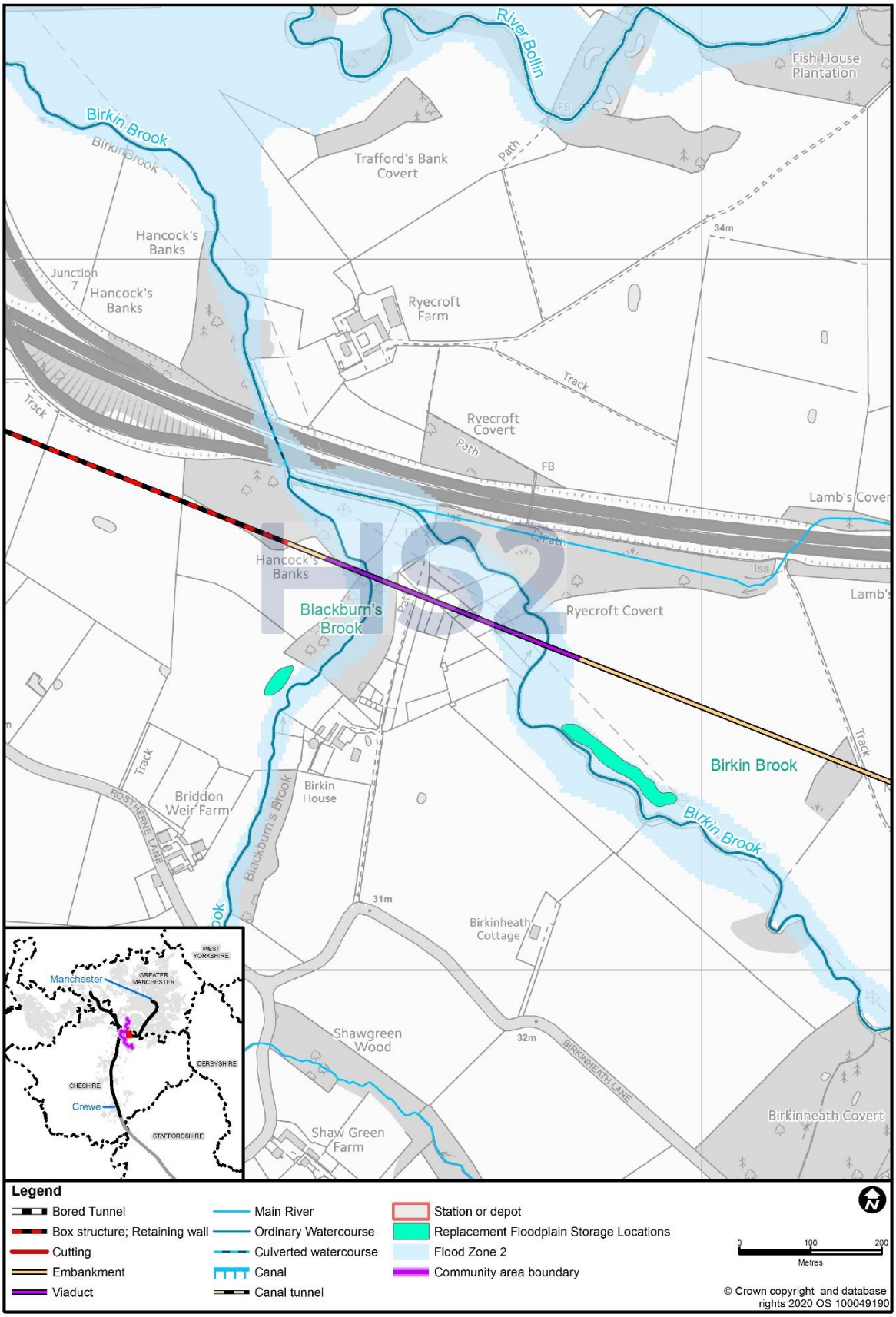


Figure 11: Replacement floodplain storage area River Bollin

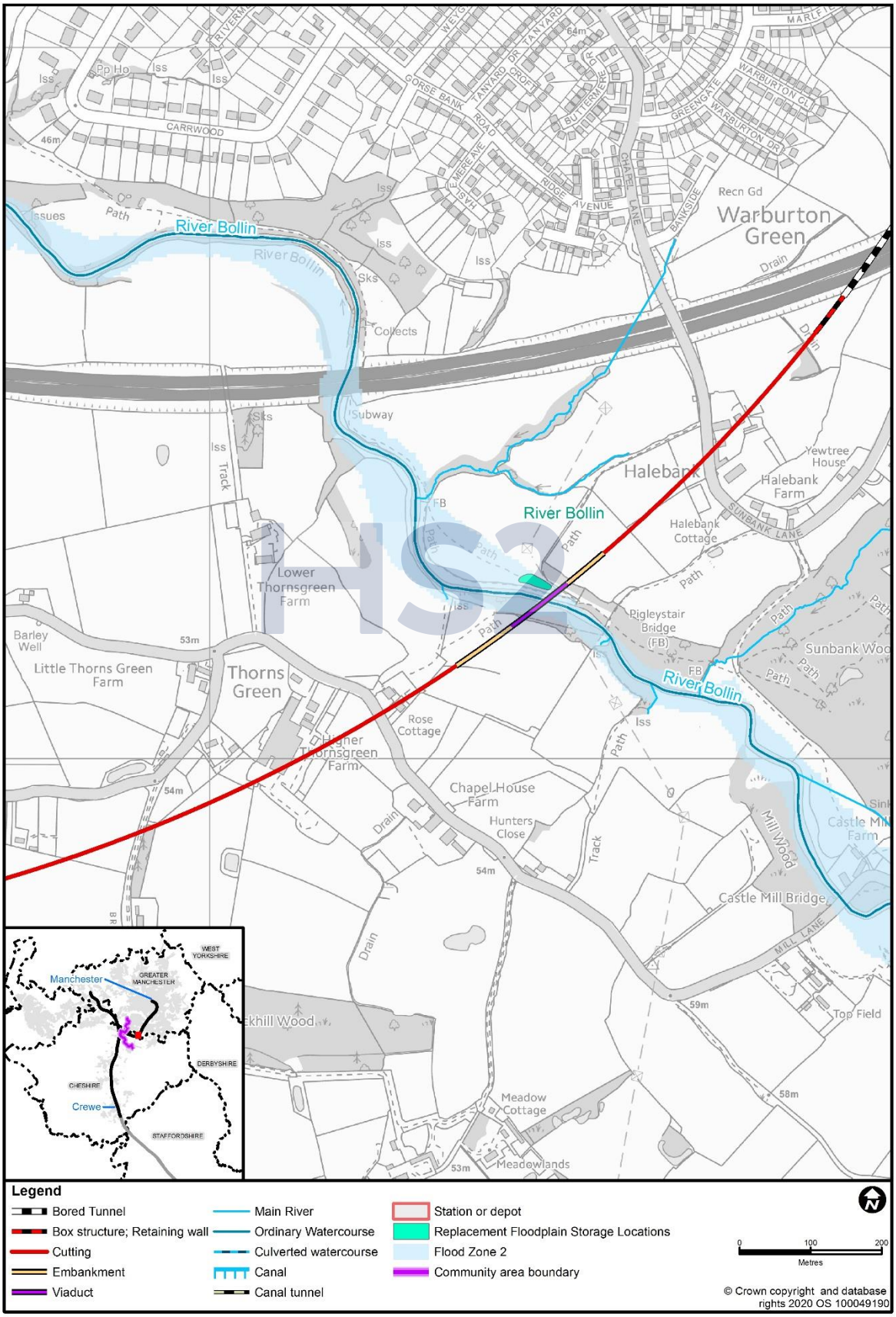


Figure 12: Replacement floodplain storage area Agden Brook

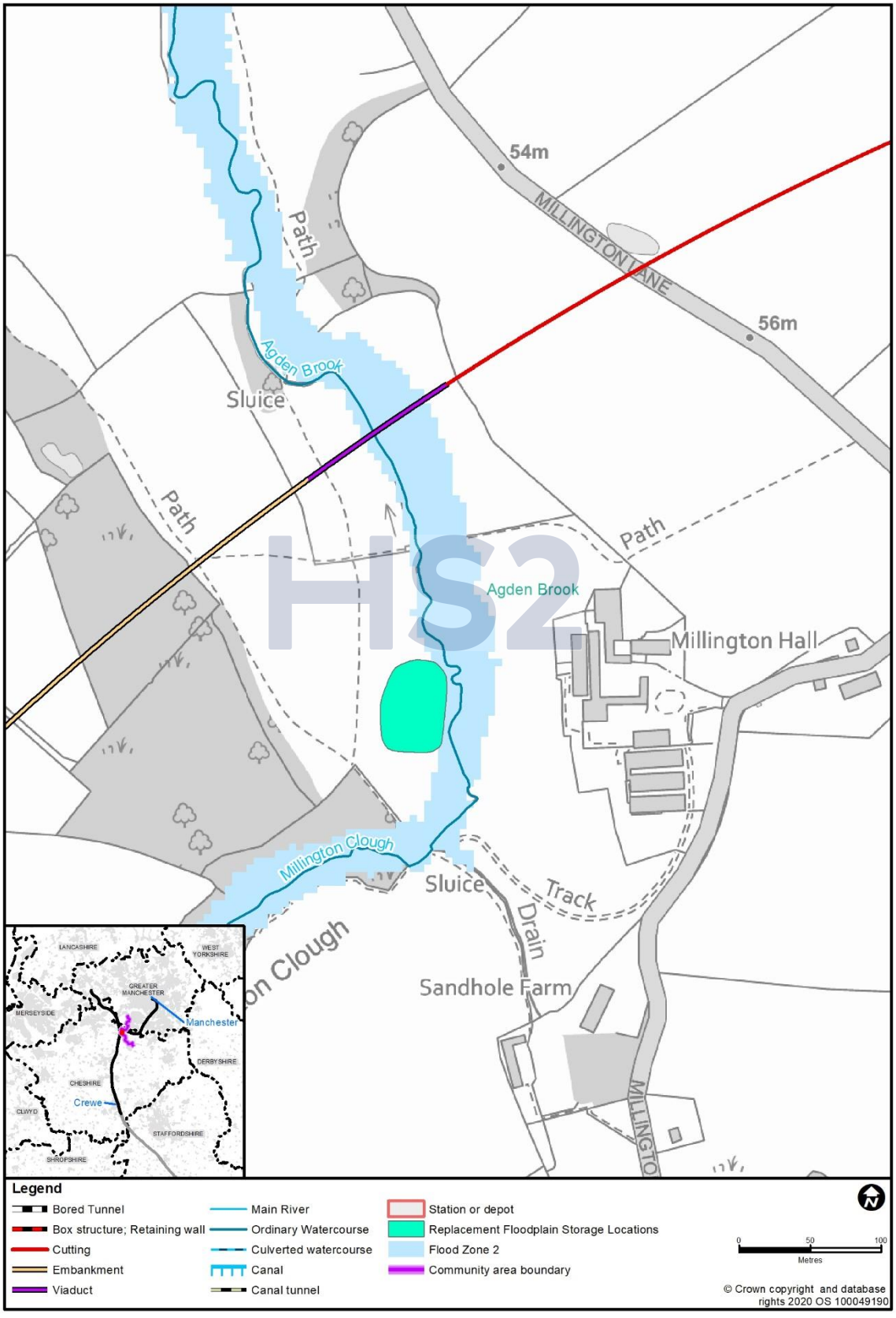
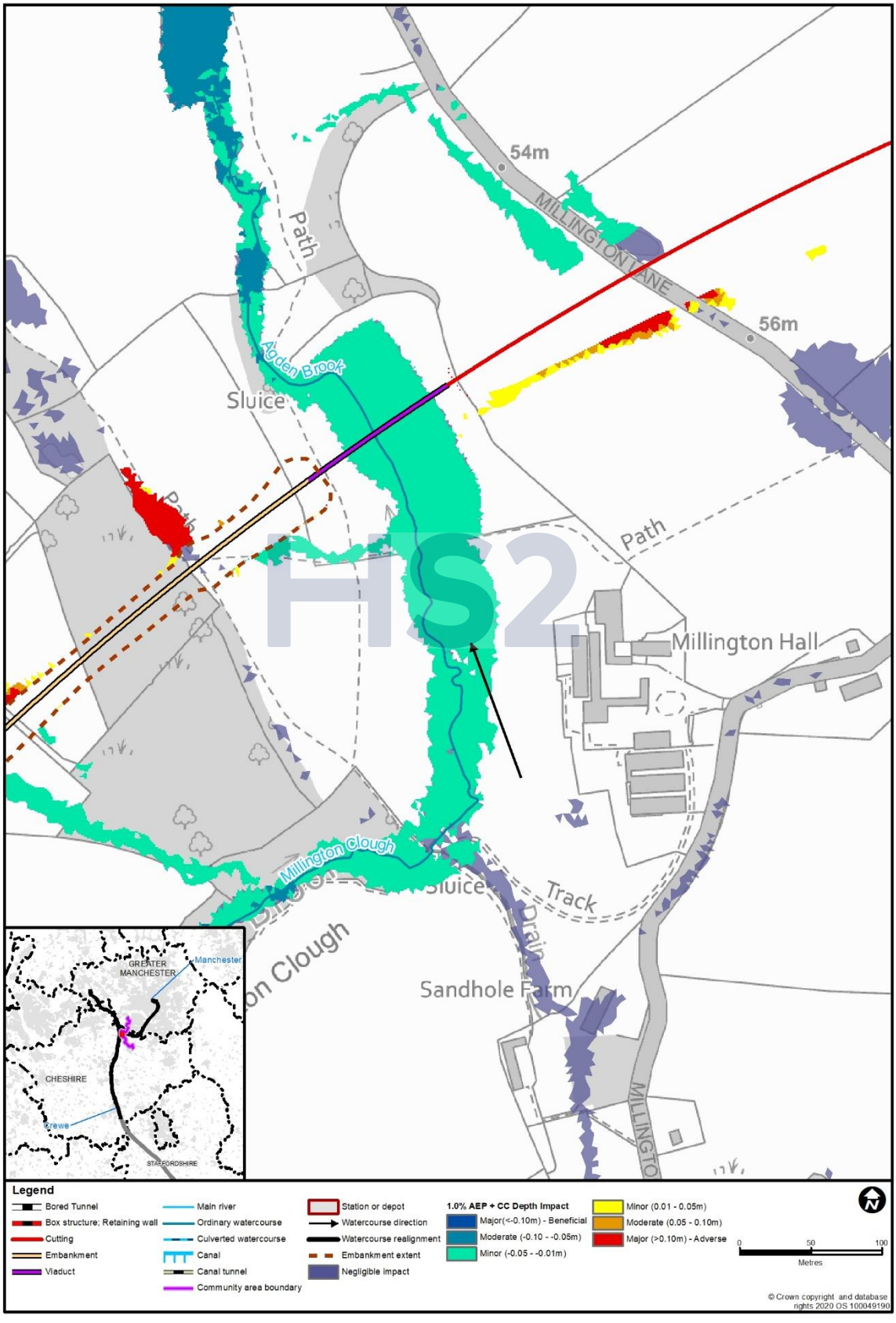


Figure 13: Agden Brook impact map for the 1.0% AEP + CC flood event



Culverts and channel realignments

4.1.14 The Proposed Scheme within the Hulseheath to Manchester Airport area includes crossings of main rivers and ordinary watercourses via culverts. Hydraulic modelling of these watercourses has been used in the design and assessment of the Proposed Scheme to determine the likely impact on local peak flood levels. This was undertaken at Agden Brook, Tributaries of Birkin Brook 1 to 3 and Timperley Brook.

4.1.15 Agden Brook passes under the Agden Brook viaduct and therefore no culvert is required.

4.1.16 Tributary of Birkin Brook 1 currently passes under the Mid-Cheshire Line in a culvert. The proposed Ashley railhead and Mobberley Road diversion require this watercourse to be diverted to the north. It is proposed that the diverted watercourse will pass under the Mid-Cheshire Railway through an existing culvert on Tributary of Birkin Brook 2.

4.1.17 Timperley Brook crosses the route of the Proposed Scheme via an inverted twin siphon. The following calculation procedure has been undertaken to size the siphon:

- use of the Revitalised Rainfall-Runoff Model version 2.2 (ReFH2)[21] to determine the peak flow generated during the 0.1% AEP storm event;
- determination of the existing gradient of the watercourse using OS mapping and LiDAR data;
- determination of the roughness characteristics of the crossing; and
- selection of a cross sectional area with the capacity to convey the 0.1% AEP peak flow, plus a 1m freeboard allowance.

4.1.18 The Proposed Scheme baseline models were edited to include the design elements shown in Table 2.

4.1.19 Details of all the hydraulic modelling assessments undertaken for these watercourses can be found in the supporting hydraulic modelling reports contained in Volume 5, Appendix: WR-006-00001 (Millington Clough and tributaries) and Volume 5, Appendix: WR-006-00007 (Timperley Brook). The results of these assessments are reported below.

[21] Wallingford HydroSolutions (2016), *Revitalised Flood Hydrograph Model ReFH2: Technical Guidance*. Available online at: http://files.hydrosolutions.co.uk/refh2/ReFH2_Technical_Report.

Table 2: Details of culvert design at modelled main river crossings

Watercourse/ location	Structure name	Estimated 1.0% AEP peak flow (m^3/s)	Climate change allowance (increase in peak rainfall intensity)	Estimated 1.0% AEP + CC peak flow (m^3/s)	Estimated 0.1% AEP peak flow (m^3/s)	Culvert dimensions (m)	Culvert capacity (m^3/s)
Agden Brook	This watercourse passes under the Agden Brook viaduct; therefore, no culvert is required.						
Timperley Brook	Timperley Brook inverted siphon	2.80	40%	4.03	5.01	Twin 1.35m x 1.35m inverted siphon	6.6

Timperley Brook

4.1.20 The Timperley Brook baseline model was edited to include the design elements shown in Table 2. The Proposed Scheme has been modelled as a raised embankment, with an inverted twin siphon beneath. The siphon has been sized to convey the 0.1% AEP event plus a 1m freeboard.

4.1.21 A new manhole is proposed at the boundary between the M56 culvert and the Timperley Brook siphon and extended culvert. This manhole will receive flows from the M56 culvert and from a new culvert that will convey runoff from an M56 outfall (725m west of the Proposed Scheme crossing).

4.1.22 Upstream of the proposed inverted siphon, a new culvert is to be installed, downstream of Hasty Lane culvert, from the outfall of the existing M56 Timperley Brook culvert to the inverted siphon to ensure that the channel crosses at a ninety-degree angle to the Proposed Scheme station. As part of design development, a smaller bore barrel may be considered to allow for dry weather flow. This will include an upstream chamber with side weirs. This arrangement will allow dry weather baseflow to continue along the small bore culvert to maintain a self-cleansing velocity. During higher flow events, once the side weir crest levels are exceeded, the larger bore twin siphon culverts are activated.

4.1.23 The modelled impact of the Proposed Scheme on peak flood levels is shown in Figure 14. This indicates the potential for decreases in peak flood levels of approximately 10mm immediately upstream and downstream of the Proposed Scheme siphon. However, there are increases of over 100mm along the upstream side of the Proposed Scheme embankment and increase of up to 50mm downstream of the siphon.

4.1.24 The upstream increases in flood risk relate to ponding of water on the upstream side of the retained cutting. This water will be collected by scheme drainage to prevent any increase in flood risk.

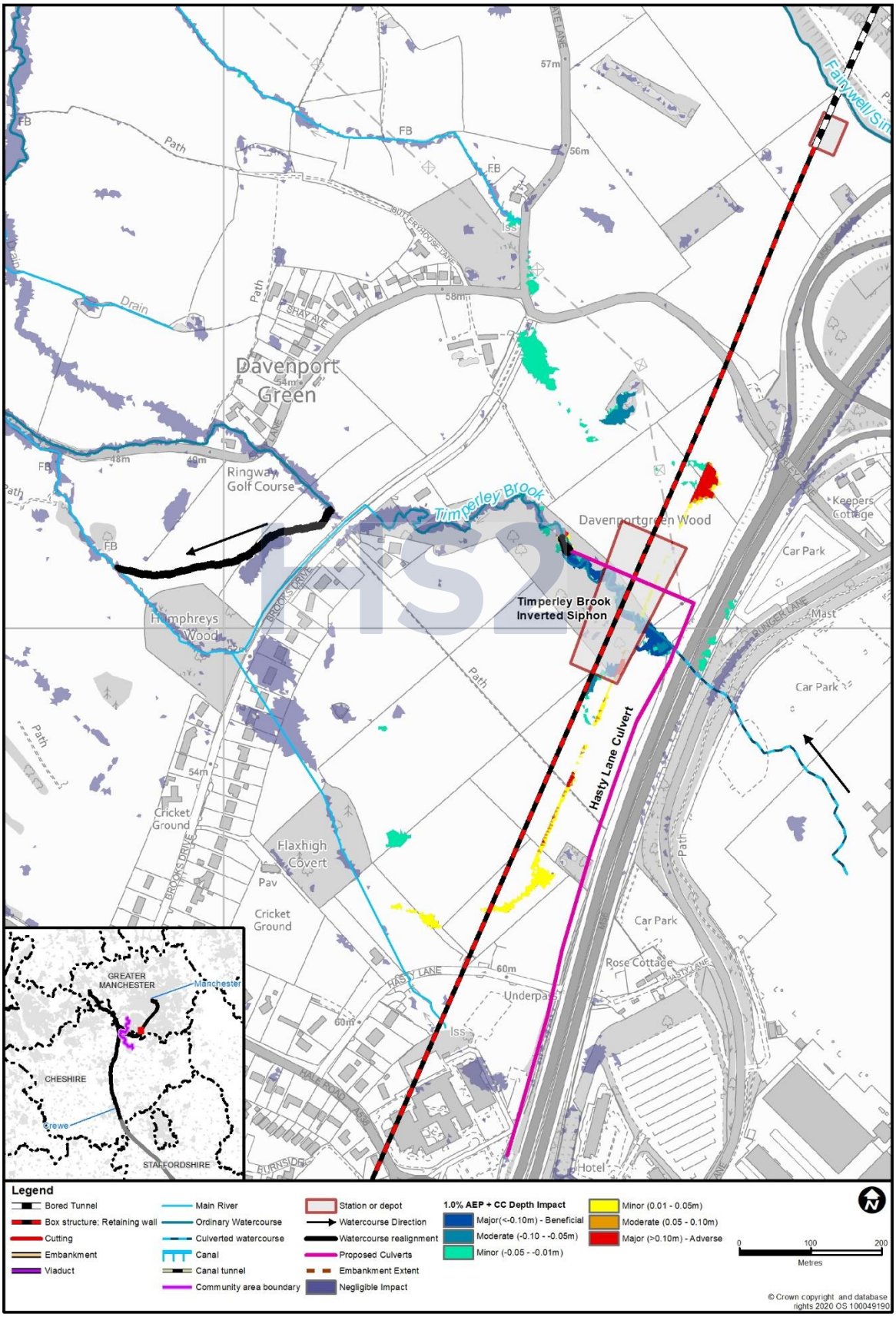
4.1.25 The modelling, without mitigation, has shown flood risk to the airport and the airport car park is unchanged. Two sensitivity runs were undertaken to assess peak flood levels at

Manchester Airport when a larger inflow from the airport is applied (as there is uncertainty associated with the area contributing to Timperley Brook), or there is a partial blockage of the siphon. When the upstream inflow from Manchester Airport was increased by 20%, the peak water level increased by 15mm at the inlet of the siphon, with no change to peak flood levels at the airport. When there was a 50% blockage of the siphon, there was no increase in peak flood level upstream of the siphon for the 0.1% AEP event. This demonstrates that, even without the precautionary mitigation measures, peak flood levels are unchanged when the airport inflow is increased, or the siphon is partially blocked. This gives confidence that a Proposed Scheme design can be refined at the design development stage to ensure there is no change in flood risk in the Timperley Brook area or at Manchester Airport.

4.1.26 A 20m channel realignment is proposed at the outlet of siphon. A further 330m realignment is proposed further downstream west of Brooks Drive. The realigned channel is designed to be wider than the current channel, with a more natural meandering shape. This will provide flood mitigation on a precautionary basis and will mitigate for the loss of approximate 275m of open channel due to the siphon. This proposed realignment has not been modelled at this stage but will be included at the design development stage.

4.1.27 The maintenance of the siphon will be important to ensure that flood risk is not increased due to blockage. The Draft water resources and flood risk operation and maintenance plan sets out the approach to the operation and maintenance of water management assets for the Proposed Scheme and will be updated and expanded during design development.

Figure 14: Timperley Brook impact map for the 1.0% AEP + CC flood event



4.1.28 The maintenance of the siphon will be important to ensure no increase in flood risk due to blockage. The draft water resources and flood risk operation and maintenance plan sets out the approach to the long term maintenance of the scheme including this siphon.

Other watercourses

4.1.29 In addition to the modelled watercourse crossings, a highway realignment and a proposed temporary railhead will cross ordinary watercourses that have not been modelled or mapped as part of the Environment Agency's Flood map for planning (rivers and sea) dataset[5]. Therefore, the RoFSW[5] data set has been used to indicate the potential flood extent generated and the receptors affected along these watercourses.

4.1.30 At the locations where these ordinary watercourses cross the Proposed Scheme, or offline features, culverts are required to convey the water under the route. Figure 16 shows the location of proposed culverts. The following calculation procedure has been undertaken to size the culverts:

- use of the ReFH2[21] to determine the peak flow generated during the 1.0% AEP storm event;
- determination of the appropriate climate change allowance to be applied following the procedure outlined in SMR;
- determination of the existing gradient of the watercourse using OS mapping and LiDAR data;
- determination of the roughness characteristics of the culvert; and
- selection of a cross sectional area with the capacity to convey the 1.0% AEP peak flow, incorporating the appropriate allowance for climate change, whilst ensuring a minimum of 300mm freeboard to the culvert soffit above this design flood level and allowing for 300mm substrate at the culvert invert.

4.1.31 The details of the culvert design applied to the ordinary watercourses are provided in Table 3.

Table 3: Details of culvert design at ordinary watercourse crossings

Watercourse/ location	Structure name	Estimated 1.0% AEP peak flow (m^3/s)	Climate change allowance (increase in peak rainfall intensity)	Estimated 1.0% AEP + CC peak flow (m^3/s)	Culvert dimensions of opening (m)	Culvert capacity (m^3/s)[22]
Tributary of Birkin Brook 1 – offline	Ashley Road offline east culvert	2.38	40%	3.51	1.65m high x 1.35m wide	6.20
Tributary of Birkin Brook 4 – offline	Ashley Road offline west culvert	0.83	40%	1.23	1.35m high x 1.35m wide	6.40
Tributary of Timperley Brook 1 – offline	Hasty Lane offline culvert	0.5	40%	0.64	1.35m high x 1.35m wide	4.6

4.1.32 By following this design approach, the potential to increase flood risk to the receptors will be reduced.

4.1.33 Each of the ordinary watercourse crossings in Table 3 is associated with a channel realignment to reduce the length of culvert required as far as is reasonably practicable. The watercourses identified are affected by highway diversions and permanent access requirements as follows:

- Tributary of Birkin Brook 1 will be diverted in a northerly direction at the existing railway line, east of Mobberley Road, passing under the realigned Mobberley Road offline overbridge, before joining Tributary of Birkin Brook 2 and passing under the existing Mid-Cheshire Railway;
- a small upstream reach of Tributary of Birkin Brook 3 and the upstream reach of Tributary of Birkin Brook 2, upstream of the realigned Mobberley Road, will be realigned in a south-westerly direction to join the realigned Tributary of Birkin Brook 1;
- Tributary of Birkin Brook 1 downstream of the existing railway line will be realigned to join the new Ashley Road offline east culvert; and
- Tributary of Birkin Brook 4 passes under the new Ashley Road at the Ashley Road offline west culvert.

4.1.34 The realigned channels will have the same hydraulic capacity as the existing channel unless it is identified at the design development stage that a change in size is required to ensure no adverse impacts on flood risk.

[22] Culvert may be designed to contain not only flow for the watercourse but for provision of other services, such as footpath or ecological reasons. This results in a culvert size larger than that required to convey just the flow from the watercourse.

4.1.35 The Tributary of Birkin Brook 1 will be diverted north into an existing culvert beneath the Mid-Cheshire Railway embankment on Tributary of Birkin Brook 2. Due to land access constraints, surveys of this culvert were not possible and therefore the size of this culvert has been estimated based on aerial photographs. Hydraulic analysis suggests that as a result of the additional peak flow through this culvert there is potential for increased depth of flooding of greater than 100mm. This is assessed to be a major adverse impact affecting moderate value agricultural land to the east and the very high value Mid-Cheshire Railway, leading to major adverse effects, which are significant. The existing culvert dimensions and flows, pre and post diversion, are shown in Table 4 and the location of the culverts are shown in Figure 15.

Table 4: Details of existing culverts

Watercourse/ location	Structure name	Estimated culvert dimensions (m)	Estimated culvert capacity (m^3/s)	Estimated 1.0% AEP + CC peak flow (m^3/s) pre diversion	Estimated 1.0% AEP + CC peak flow (m^3/s) post diversion
Tributary of Birkin Brook 1	Unnamed culvert	2m x 2m	24.8	4.5	0
Tributary of Birkin Brook 2	Unnamed culvert	0.9m diameter	2.25	0.5	7.5

4.1.36 Tributary of Timperley Brook 1 starts as a spring and flows northwest towards Timperley Brook. However, this spring is located beneath the footprint of the cutting and therefore will be lost during construction and may require diverting. The flow in the watercourse at this location will be supported by discharge from two attenuation holding tanks that take drainage water from the local road network and track drainage. These will be piped to discharge into the Tributary of Timperley Brook 1 to the northwest of the route of the Proposed Scheme.

Figure 15: Mobberley Road existing culverts

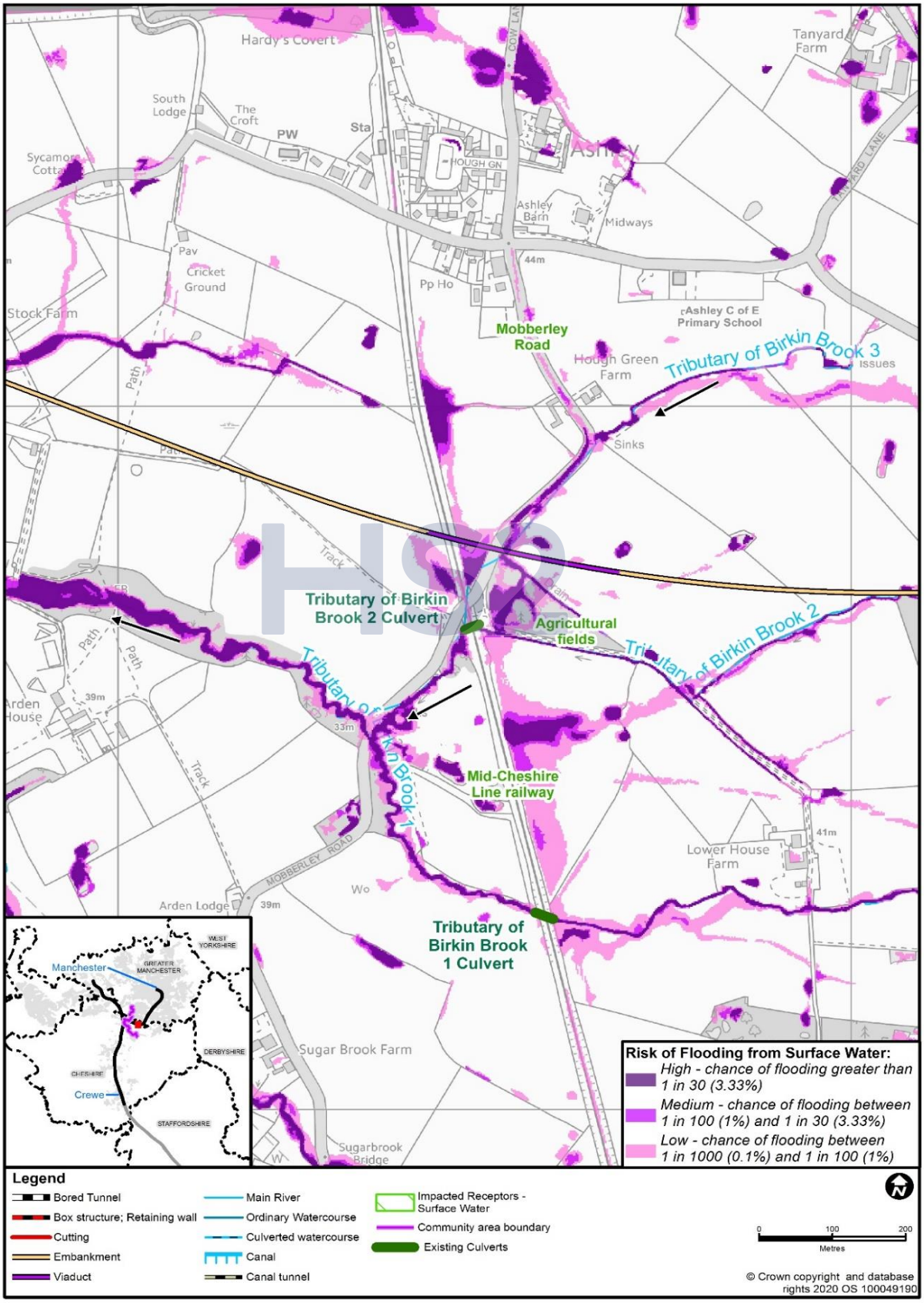
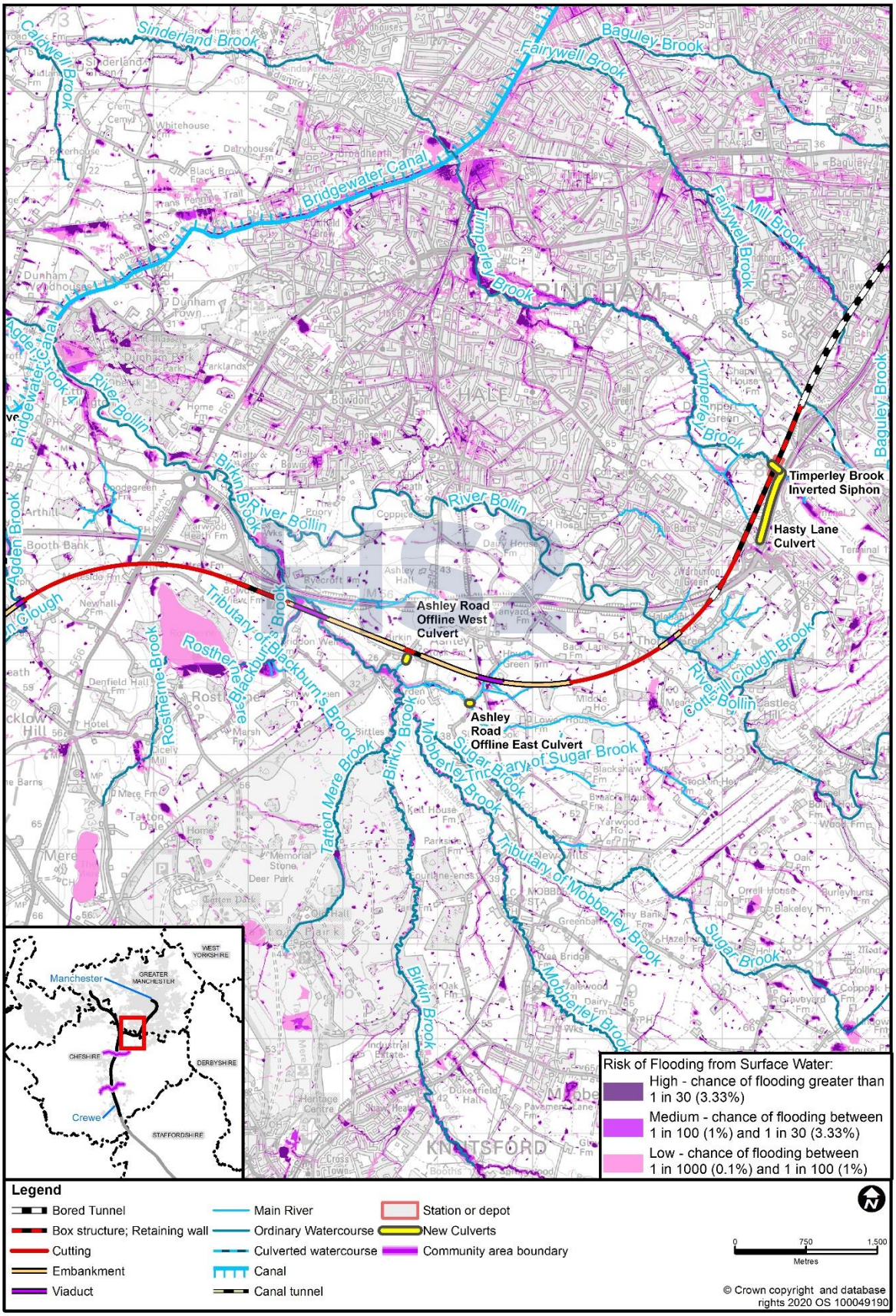


Figure 16: Proposed culverts



Temporary construction compounds and stockpiles

4.1.37 Table 5 highlights the temporary site compounds and stockpiles located in areas at risk of flooding. A proposed satellite compound is located on the bank of Birkin Brook causing it to be within Flood Zones 2 and 3. Several proposed stockpiles are located within existing surface water flow paths.

4.1.38 The risk of flooding to these compounds and stockpiles will be managed through the draft CoCP. A sequential approach will be applied to the allocation of use within the compounds, seeking primarily to avoid using areas at flood risk wherever practical, but where this is unavoidable using areas at risk of flooding for the least vulnerable components and those that will avoid/limit the potential for off-site impacts. The sites will be registered with the Environment Agency Flood Warning and Flood Alert service, if applicable. Further mitigation measures are discussed in Table 5.

Table 5: Details of temporary site compounds and stockpiles at risk of flooding

Watercourse / location	Construction compound	Flood zone	Risk of flooding from surface water	Location constraints	Potential mitigation
Fairywell Brook	Manchester tunnel South portal main compound	N/A	Surface water flow path along the western edge known to flood Roaring Gate Lane[23].	Site location required for tunnel construction. River constraint to the north.	Use perimeter drainage around the compound to intercept surface water flows.
Tributary of River Bollin 6	A556 Chester Road satellite compound	N/A	Surface water flow path across eastern corner of site.	Site location required.	Use perimeter drainage around the compound to intercept surface water flows.
	Stockpile	N/A	Stockpile covers a flow path.	Satellite compound to the north, proposed scheme to the south.	If required, stockpiles will be located either side of the flow path. Stockpiles in use short term.
Birkin Brook	Birkin Brook viaduct satellite compound	Approx - imately 30% of the site within Flood Zone 2 and 3.	N/A	The site location is constrained due to a railhead construction on	At this location it has been assessed that there is a potential risk if the activities within the compound cannot be constrained to the area of

[23] Today News Altrincham (2019), *Pictures and videos: New flood warning issued for Timperley Brook as unprecedented flooding hits Altrincham area*. Available online at: https://altrincham.todaynews.co.uk/2019/07/31/news/pictures-videos-new-flood-warning-issued-timperley-brook-unprecedented-flooding-hits-altrincham-area/.

Watercourse / location	Construction compound	Flood zone	Risk of flooding from surface water	Location constraints	Potential mitigation
				the north side, Birkin Brook to the south and a utilities compound to the east.	the site outside of the flood zones. Mitigation will be to potentially shift the compound location or use the sequential approach to demonstrate that work within the compound will only use the areas outside of the flood zones. There is also the possibility of using a portion of the utility compound depending on timing however this will need to be reviewed as the design progresses.
Tributary of Timperley Brook 3	Stockpile	N/A	Approximately 40% of the stockpile over a flow path.	Utilities compound location constraints.	This stockpile is for topsoil stripped from the area of the excavated material transfer node. The hard standing for the transfer node will incorporate internal and perimeter drainage.
	Temporary earthworks stockpile	N/A	Surface water flow path runs through the stockpile.	Utilities compound location constraints.	Major transfer node for excavated material, the hard standing will incorporate internal and perimeter drainage.
	Stockpile	N/A	Approximately 40% of the stockpile over a flow path.	Utilities compound location constraints.	This stockpile is for topsoil stripped from the area of the excavated material transfer node. The hard standing for the transfer node will incorporate internal and perimeter drainage.

4.2 Surface water

4.2.1 As outlined previously the RoFSW[5] dataset and inspection of topographical survey information has identified surface water flow paths that are not represented by any formal channel feature and so are not watercourses.

4.2.2 The surface water flow paths in the Yarwoodheath Covert area, around Tom Lane, will be addressed using land drainage ditches (designed to replicate the natural pattern of overland flow as far as practicable) to ensure the risk of surface water flooding is unchanged.

4.3 Groundwater

4.3.1 The principal mechanism by which the Proposed Scheme could increase groundwater flood risk is where sub surface structures of lower permeability than the existing geology, such as lined tunnels or pile walls, may act as a barrier to groundwater flow. These barriers have the potential to cause a rise in groundwater level in the vicinity of the structures. Other below ground features, that could cause changes to the local groundwater levels, such as drained cuttings, are not assumed to increase groundwater flood risk as the drainage design will take account of groundwater flow entering the cutting and discharge it to a suitable location at an agreed rate with no net impact on flood risk.

4.3.2 To assess the possible changes to groundwater levels and flow, and the associated change in groundwater flood risk, a high-level assessment of the groundwater conditions along the route has been undertaken to understand where the Proposed Scheme is likely to interact with groundwater. The high-level assessment identified where elements of the scheme design such as cuttings, retaining walls, viaduct and bridge foundations, basements, excavations and temporary works intercept aquifers that pose a groundwater flood risk. An assessment has been made of the degree to which the design features encroach on the aquifer and the potential changes in groundwater level and restrictions on groundwater flow. Receptors within the area at risk of potential changes in groundwater level or flow were then identified. The likely maximum zone of influence from any dewatering taking place has also been assessed.

4.3.3 The assessment has shown that there are no features of the Proposed Scheme in the Hulseheath to Manchester Airport area that will act as a significant barrier to groundwater flow. Therefore, there are unlikely to be any significant increases groundwater levels across the aquifers that could lead to increased risks of groundwater flooding as a result of the Proposed Scheme. Further details of groundwater level changes are set out in the Water resources assessment (Volume 5, Appendix WR-003-0MA06).

4.4 Artificial sources

4.4.1 Tatton Park Mere and Melchett Mere are located approximately 3.5km south of the Proposed Scheme and are shown on the Environment Agency's flood risk from reservoirs mapping dataset[5]. The reservoir inundation mapping extents are similar to the flood zones at the River Bollin, Blackburn's Brook and Birkin Brook crossings. However south of the proposed scheme on Birkin Brook the reservoir inundation extents are in some places slightly larger than the flood zones. This data set indicates that, in the event of a failure of these assets, the Tatton Mere Brook and Birkin Brook floodplains will be affected. In the event of a dam failure at Radnor Mere (approximately 14km south-east of the Proposed Scheme), the Birkin Brook floodplain will be affected. However, the Proposed Scheme crosses the affected floodplains on viaducts and therefore it is very unlikely that these would be impacted if failure did occur.

4.4.2 These large reservoirs are subject to the requirements of the Reservoirs Act 1975[24], and as such are inspected annually. This increases the likelihood that any degradation in the operational performance of a reservoir will be identified and addressed before there is an increased risk of failure. Therefore, whilst the consequences of failure are potentially very high, this inspection and maintenance regime means that the overall risk of flooding from this source is considered low. As the Proposed Scheme does not encroach into any of the reservoir locations the risk of failure is very unlikely to change as a result of the Proposed Scheme.

4.4.3 Major water supply pipelines and sewerage (foul and surface water) infrastructure has been identified and are accounted for on the Volume 2, MA06 Map Book: Map Series CT-05 and CT-06. This infrastructure has been identified and diverted where appropriate. Measures will be taken to safeguard the local receptors during this diversion process.

4.4.4 The Proposed Scheme does not change the flood risk posed by failure of artificial water sources.

4.5 Off-site impacts and effects (surface water management)

4.5.1 Runoff from the footprint of the Proposed Scheme could occur more rapidly post-construction due to steeper slope angles and the permeability of the newly-created surfaces.

4.5.2 The design aim of drainage systems is to ensure that there will be no significant increases in flood risk, during storms up to and including the 1.0% AEP + CC event, as set out in the SMR.

4.5.3 Balancing ponds for new sections of highway and railway drainage have been sized on a precautionary basis, pending more detailed information about the permeability and runoff characteristics of existing and proposed ground surfaces[25]. Details of the proposed ponds are discussed in the Water resources assessment, (Volume 5 Appendix WR-003-0MA06).

[24] Department for Communities and Local Government (2014), *Reservoirs: owner and operator requirements*. Available online at: https://www.gov.uk/guidance/reservoirs-owner-and-operator-requirements.

[25] High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E21: Balancing Ponds and replacement flood storage areas.*

5 Additional flood risk management measures

5.1.1 The next stage of the design process will involve incorporation of topographical survey information into the existing hydraulic models to improve the representation of existing watercourses. Designs for the viaducts, bridges and culverts will be incorporated into the hydraulic models along with the identified areas of RFS, and the mitigation measures will be refined during design development to remove potential significant effects on flood risk as far as is reasonably practicable. The effect of RFS areas on the agricultural land quality classification is reported in Volume 2, Community Area report: Hulseheath to Manchester Airport (MA06), Section 4: Agriculture, forestry and soils.

5.1.2 The hydraulic analysis of the viaduct crossings at Birkin Brook and the River Bollin indicates that the Proposed Scheme has the potential to lead to localised increases in water level, due to head losses around the viaduct piers. The impacts of increased water levels are considered minor, and therefore not significant. RFS has been proposed on a precautionary basis for Blackburn's Brook, Birkin Brook, River Bollin and Agden Brook to address potentially significant flood risk effects caused by the loss of floodplain storage associated with the viaduct piers, either local to the watercourse crossing or elsewhere within the catchment as a result of a cumulative effect. The provision for RFS has been made using a 1m excavation depth and doubling the calculated compensation volume required.

5.1.3 A precautionary flood risk management measure has been included in the design at Timperley Brook. This comprises a realignment of Timperley Brook to a wider channel with a more natural meandering shape, incorporating RFS areas along both banks, downstream of the Proposed Scheme crossing. This measure will mitigate flood risk posed by the Proposed Scheme, resulting in a negligible impact and a negligible effect, which is not significant.

5.1.4 As part of design development, a smaller bore barrel will be included in the proposed siphon to allow for dry weather flow. This will include an upstream chamber with side weirs. This arrangement will allow dry weather baseflow to continue along the small bore culvert to maintain a self-cleansing velocity.

5.1.5 Mitigation measures are required to reduce the flood risk at the Mid-Cheshire Line crossing associated with the diversion of Tributary of Birkin Brook 1. Measures may include:

- provision of RFS upstream of the Mid-Cheshire Line embankment;
- design of the channel diversion cross section, slope and meanders to manage the increase in peak flow rates;
- high flow channel and long culvert beneath the Mid-Cheshire Line and proposed Ashley Railhead along the existing channel alignment of the Tributary of Birkin Brook 1; and
- increasing the size of the existing culvert under the railway.

5.1.6 These measures will be developed in consultation with the Environment Agency during the progression of the hybrid Bill.

5.1.7 The above activities will be undertaken in close consultation with the Environment Agency and the LLFA. If any residual effects are identified, the affected landowners will also be consulted. The aim will be to ensure that no parties are affected by unacceptable increases in flood risk.

6 Summary of significant flood risk effects

6.1.1 Hydraulic analysis indicates a potential for major adverse impacts in peak flood level affecting agricultural land and the Mid-Cheshire Line. This is due to the diversion of Tributary of Birkin Brook 1 through the existing culvert for Tributary of Birkin Brook 2 beneath the Mid-Cheshire (Railway) embankment. This results in a major adverse effect, which is significant. Further mitigation measures are required to reduce the flood risk. Measures may include provision of RFS upstream of the Mid-Cheshire (Railway) embankment, channel design and increasing the size of the existing culvert under the railway. Further assessment and refinement of the models and mitigation measures will be developed in consultation with the Environment Agency during the progression of the hybrid Bill.

6.1.2 Due to the flood risk management measures embedded in the design, there are no other significant effects on flood risk.

6.2 Conclusions

6.2.1 This flood risk assessment presents the impacts and effects of the Proposed Scheme, taking into account avoidance and mitigation measures described in Volume 2, Community Area report for the Hulseheath to Manchester Airport area. Additional mitigation measures have been developed to further reduce the temporary and permanent impacts of construction stage activities, where there is potential for the Proposed Scheme to result in significant effects.

6.2.2 The hydraulic modelling of Timperley Brook, without RFS mitigation, has shown no change to peak flood levels upstream of the proposed Timperley Brook siphon, indicating flood risk to Manchester Airport including areas of airport car parking is unchanged. Sensitivity tests were run by increasing model inflows and simulating a partial blockage of the siphon for the 0.1% AEP event. These tests demonstrated no change in peak flood levels at the airport upstream of the siphon. This allows for refinement of the Proposed Scheme design and the precautionary flood risk management measures at the design development stage to ensure there is no change in flood risk in the Timperley Brook area or at Manchester Airport.

6.2.3 RFS mitigation has been identified, on a precautionary basis, to address the loss of floodplain storage caused by the intermediate piers at all the viaduct crossings. Further assessment and refinement of the models and mitigation measures at the design development stage will ensure any localised impacts on peak flood levels are mitigated and flood risk is unchanged as a result of the Proposed Scheme.

6.2.4 The assessment indicates that, in the Hulseheath to Manchester Airport area, the Proposed Scheme will result in significant adverse effects on flood risk, due to the diversion of Tributary of Birkin Brook 1. Further mitigation measures are required to reduce the flood risk and will be developed in consultation with the Environment Agency during the progression of the hybrid Bill.

6.2.5 Subject to the implementation of the avoidance and mitigation measures identified, and the measures included in the Draft water resources operation and maintenance, no other significant adverse effects have been identified on flood risk in the Hulseheath to Manchester Airport area.

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