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To	Nick Hale, South East Rivers Trust		
Project	UK20-1057 Emm Brook Remodelling		
Subject	Emm Brook: Flood Risk Assessment (Updated hydrology and remodelling)		

1. INTRODUCTION

1.1 PURPOSE OF STUDY

cbec was contracted to produce detailed designs to improve fish passage on a reach of the Emm Brook, near Woose Hill, Wokingham (see Figure 1).

As part of this study, a flood risk assessment (FRA) has been completed to assess any flood risk concerns raised by the proposed scheme, in accordance with the National Planning Policy Framework (NPPF), Flood Risk and Coastal Change. This builds on the previous FRA provided to SERT. This updated FRA was produced following a revision of the hydrology for the project in 2022 to account for an increased URBEXT parameter, and this increased the 100 year return interval flood peak estimate from the previously modelled 10.83 m^3/s to 15.10 m^3/s. Therefore, updated model runs were undertaken (see Technical Note; 20_1057_Emm_Brook_remodelling_18_05_22_cbec.pdf) and the original FRA has been updated to account for these.

1.2 SCOPE OF STUDY

The assessment is a comprehensive risk-based assessment of potential flooding from all possible sources, including fluvial flooding from adjacent watercourses, groundwater and surface water runoff. The assessment also identifies and examines the residual flood risk to the site and any neighbouring properties. The aim of this report is to consider flood risk and satisfy requirements under NPPF.

Data and information have been obtained from the following sources:

- Environment Agency (EA);
- Wokingham Borough Council;
- WBC Local Flood Risk Management Strategy, 2015;
- Thames River Basin Management Plan (RBMP), 2015; and
- Hydraulic modelling results.

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2. BACKGROUND INFORMATION

2.1 RESTORATION SITE

Emm Brook is a tributary of the River Lodden, located within the wider River Thames catchment. The restoration reach is located within Riverside Park, Woosehill, extending from SU 79910 68889 (upstream) to SU 79824 69269 (downstream), as shown in Figure 1.

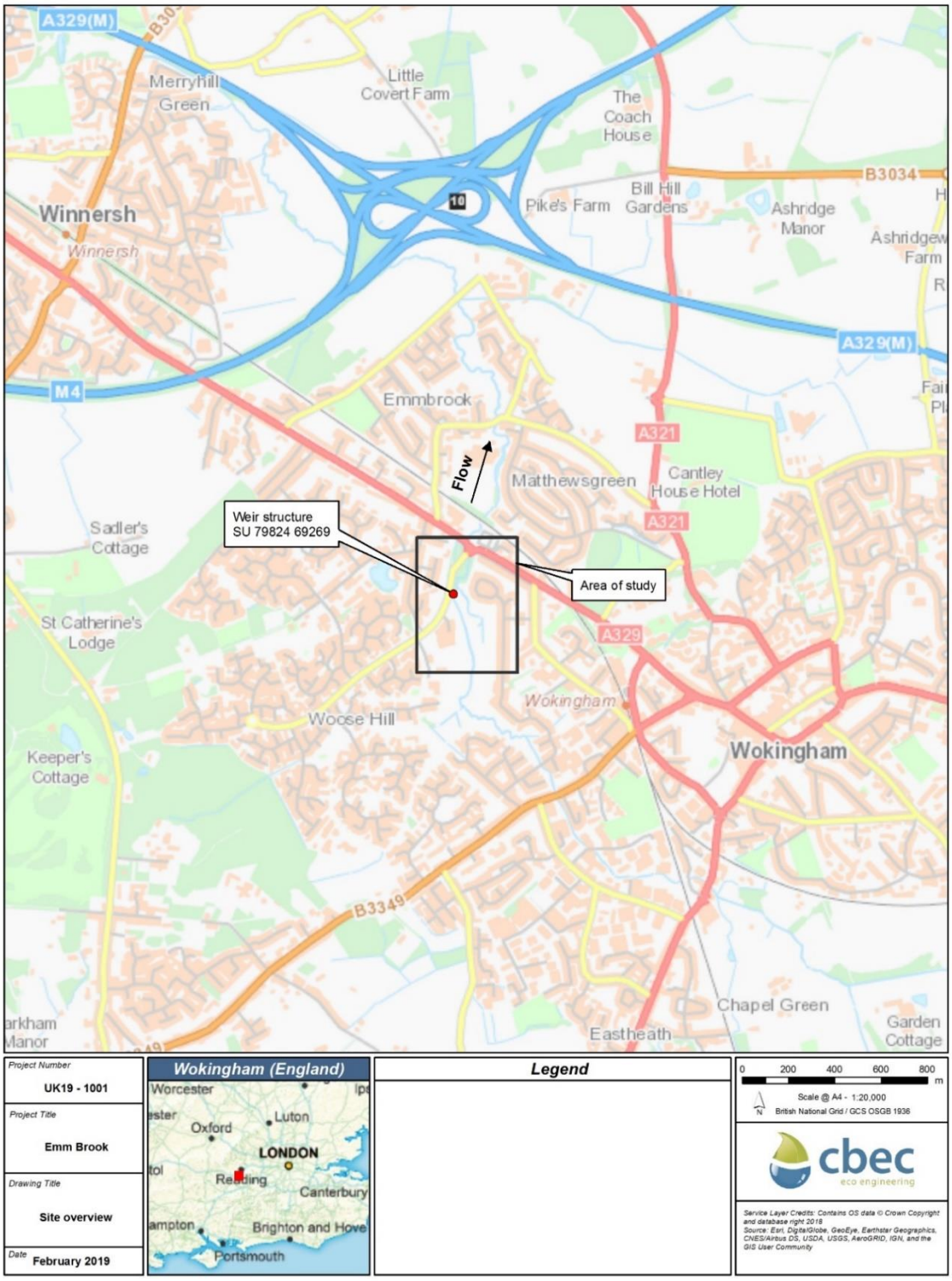

Figure 1: Restoration site location

2.2 SCHEME PROPOSALS

The proposed restoration works consist of a combination of the following measures:

- Realign and re-meander the channel onto the river right floodplain (to re-establish an historic channel located to the east of the current course of the Emm Brook, Figure 2);
- Construction of three footbridges to facilitate access across the Brook, to both the east and west sides of river side park. The upstream bridge will also include a flow control structure.

These channel realignment works aim to encourage more natural physical process within the channel and improve fish passage throughout the site, by bypassing a weir structure at the downstream end of the Park. A more detailed breakdown of the proposed restoration design is available in the Section 4 of design report (19-1001_Emm Brook Final Design Report_cbec_01.07.19).

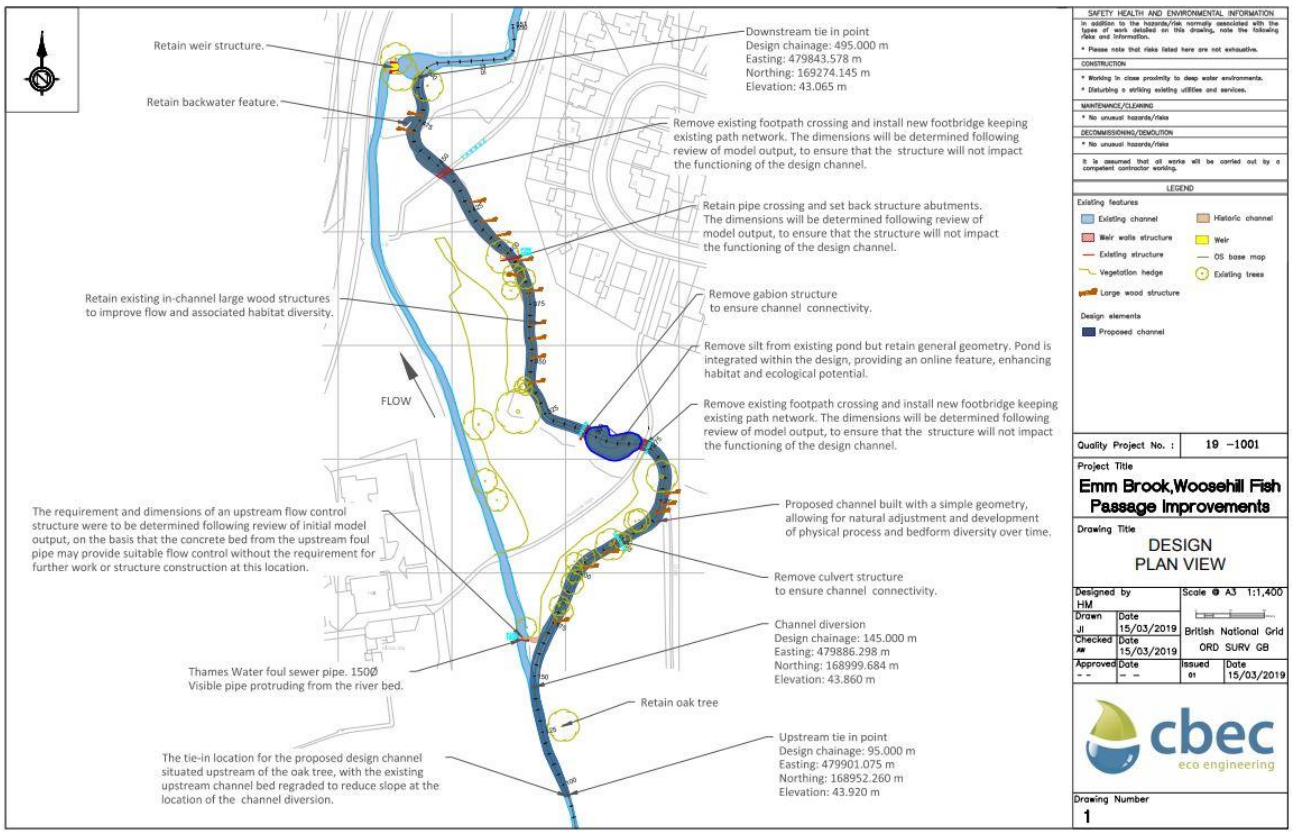

Figure 2: Proposed re-meandered channel location.

3. STATUTORY CONSULTATION

The Environment Agency and Wokingham Borough Council were initially consulted in March 2019, regarding the restoration of the Emm Brook. Since then, the hydraulic modelling has been updated, therefore a second consultation was undertaken in January 2021 to ensure that any recent flood events and proposed developments are consider in relation to the proposed works.

3.1 ENVIRONMENT AGENCY

The Environment Agency (EA), Thames area, was approached regarding any known local flood risk or historic flooding records in the area.

March 2019 - The EA provided links to their flood models for the greater area. As these models are created using LiDAR, they mimic the results shown in the EA flood model shown in Figure 3.

March 2021 – At the time of consultation (08.03.21), the EA were not aware of any other schemes, proposed for the restoration site or surrounding area, that may impact this assessment. The Agency's historic records of the Emm Brook identified that a fluvial flood event occurred in 2007. Further details of this most recent flood event were provided by WBC Flood Risk department (Section 3.2, February 2021).

3.2 WOKINGHAM BOROUGH COUNCIL

Wokingham Borough Council (WBC) were approached regarding any known local flood risk or historic flooding records in the area.

March 2019 - At the time of writing the previous version of this FRA there had been no response received from WBC.

January 2021 – Following a second consultation, in 2021, WBC confirmed that they do not hold any records of flooding at the restoration area, within their historic flooding archive for the Emm Brook. At the time of consultation (18.01.21), the Council stated that the restoration works at this site will not be impacted by any other proposals/ works that they are aware of within the catchment.

February 2021 – WBC Flood Risk department were contacted for further information. Flood records identified that the Brook breached its banks at Emmbrook School (~500 m downstream of the restoration site), in 2007. Riverside Park channel restoration could slow the flow downstream to the school, offering a potential flood risk reduction. South Wokingham distributor road project (currently in planning stage) was also highlighted as a consideration, by the flood department. This project includes the construction of a new bridge over the Emm Brook, near Chapel Green. The proposed location of this new structure is ~1.7 km upstream of the restoration site, therefore, unlikely to increase flood risk.

4. PLANNING POLICY

4.1 WOKINGHAM BOROUGH COUNCIL LOCAL FLOOD RISK MANAGEMENT STRATEGY

The Wokingham LFRMP was prepared and submitted in April 2015. It discusses historic flooding on the Emm Brook as well as the wider catchment. Although there are no records of flooding at the study site, there are historical events both upstream and downstream. Recurrent flooding issues have been recorded (October 2000, January 2003, July 2007 and during the winter of 2013/14) at the following locations;

- Sylvester close
- Emm Brook School
- Properties within the residential area downstream of Barkham Road
- Finchampstead Road, adjacent to Tesco

As the design is not intended to increase flood risk to key infrastructure and upstream/ downstream areas, it achieves the objectives of the LFRMP.

4.2 THAMES RIVER BASIN MANAGEMENT PLAN (RBMP)

The Thames River Basin District Management Plan (RBMP) was prepared and submitted in December 2015. There is no direct reference to Emm Brook. However, the aim of the management plan is to improve the environment, where possible. As this study looks at reinstating an historic channel for the purposes of habitat improvement and improved fish passage, it aligns with the objectives of the RBMP.

4.3 NPPF SEQUENTIAL TEST

NPPF provides guidance to both the controlling authorities and prospective developers for responsible, sustainable schemes on the functional floodplain. The NPPF provides a Sequential Test, which will help ensure that schemes can be safely and sustainably delivered, and developers do not promote proposals which are inappropriate on flood risk grounds. According to the information available, other forms of flooding should be treated consistently with river flooding in mapping probability and assessing vulnerability to apply the sequential approach across all flood zones.

The proposed scheme lies within Flood Zone 3, high probability of flooding (Figure 3). However, due to the nature of the scheme, i.e. channel re-meandering, it is not possible for the measures to be implemented in an area of lower flood risk, thus it satisfies the requirements of the Sequential Test.

5. ASSESSMENT OF FLOOD RISK

5.1 FLUVIAL

Environment Agency flood maps (Figure 3) reveal that the restoration site is located within the functional floodplain of Flood Zone 3, a greater than 1 in 100 chance of flood in any given year. The primary source of flooding to the site is fluvial, deriving from the Emm Brook.

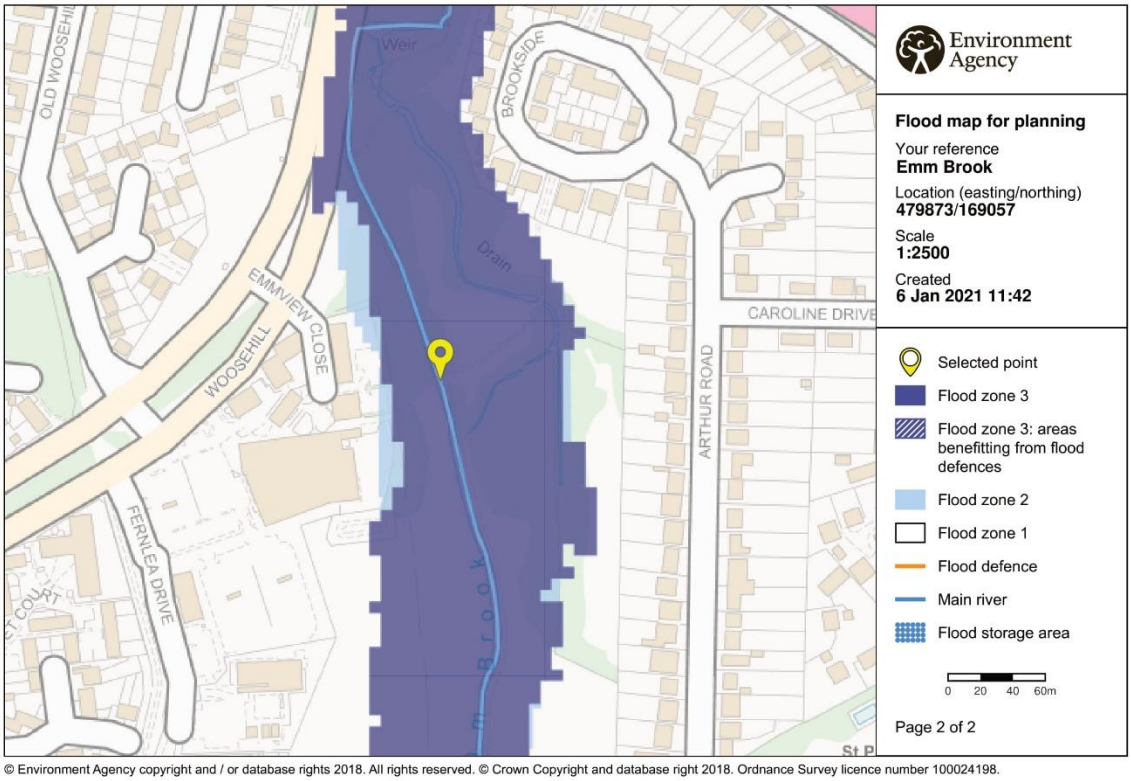

Figure 3: Environment Agency flood zone map

5.1.1. Historic flooding

The Statutory Consultation (March 2019) highlighted several historic flooding incidents throughout the Emm Brook catchment. The issues raised were not located at the proposed weir removal site. However, as flooding events have occurred both upstream and downstream (e.g. Emmbrook School in 2007), flood risk is likely to be a main concern at the site.

5.1.2. Hydrology and hydraulic modelling (original model output from 2020, for reference only)

As part of this project, 2D hydraulic modelling was carried out to determine the risk to and from the development from both current and future flood risk. Flows were generated in WiNFAP 4 using a pooling group method and are summarised in Table1.

Table1: Design peak flows

Return period [years]	Peak discharge at upstream end of site [m^3/s]
5	5.36
20	7.69
100	10.84
100 CC (25%)	13.55
100 CC (35%)	14.63

100 year flood depths and inundations (at 10.84 m^3/s) from the hydraulic model are compared in Figure 4. The design has slightly more capacity than existing conditions (the design channel and pond is excavated) and so there is a marginal reduction in flood depths in the park, as shown in the difference map in Figure 5. No properties are flooded at the 100 year return period, including climate uplifts, as a result of the design, and there is no significant difference in flood outline as a result of the design. Design flood levels are lower at the upper end of the site, and so upstream flood risk is not increased.

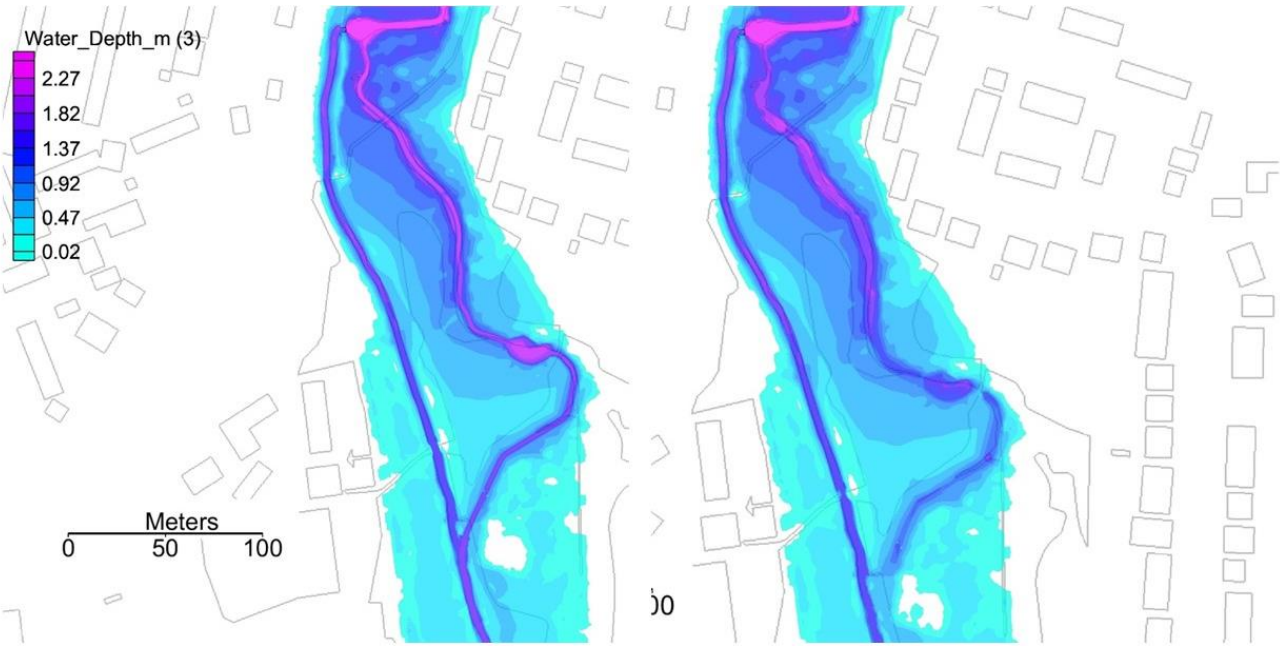

Figure 4: Comparison between inundation pattern, 100 year return period flood. Left frame design condition; right frame existing condition. Contains OS Data, Crown copyright.

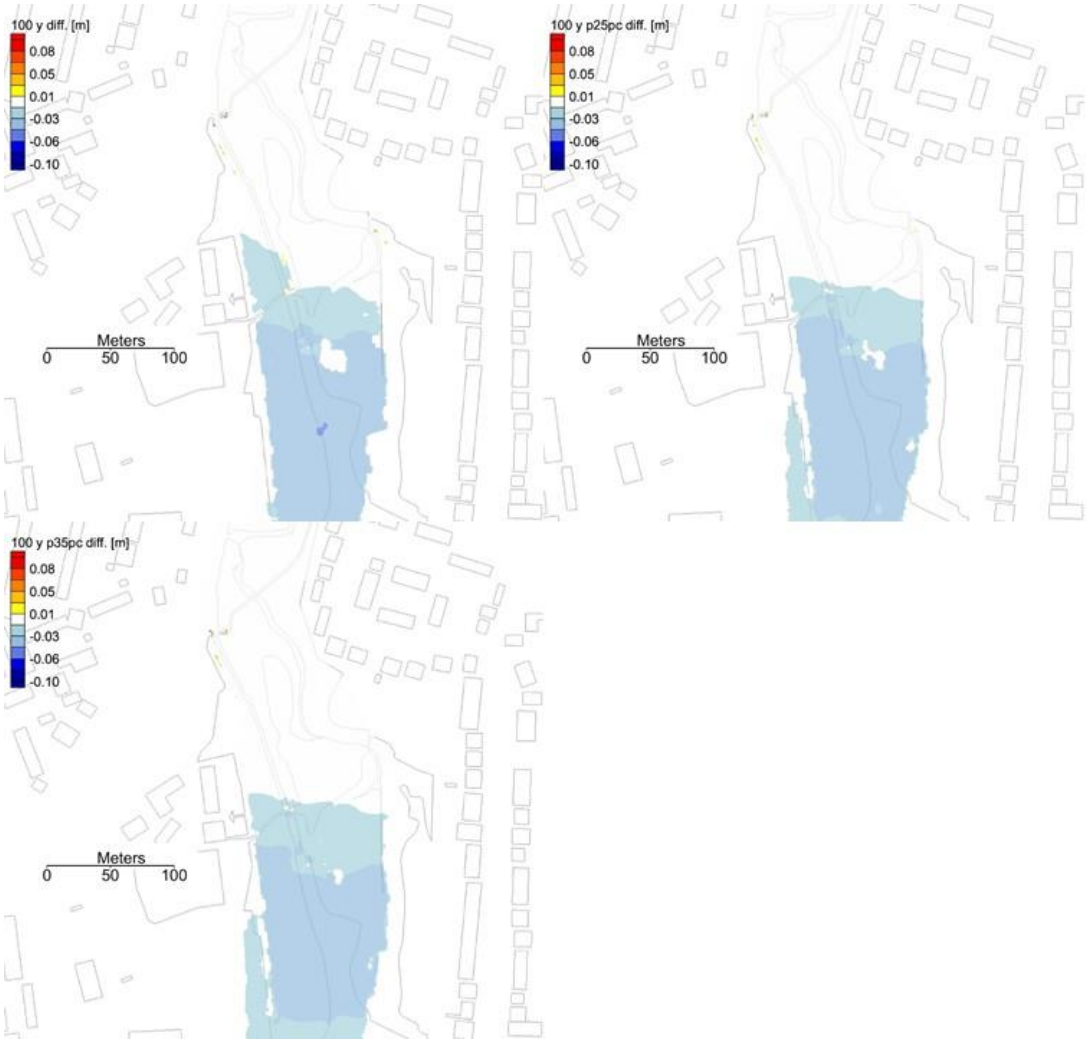

Figure 5: Water level difference maps for 100 year (top left), 100 year plus 25% climate uplift (top right) and 100 year plus 35% uplift (bottom left). Shown is design level minus existing level: the design has a marginally lower level at the upper end of the site. Contains OS Data, Crown copyright.

Downstream flood risk is assessed by computing the hydrograph at the downstream end of the site, and comparing existing and design conditions. Figure 6 compares the hydrograph at the model exit boundary computed using unsteady, time accurate modelling of the 100 year flood. There is no increase to pass forward flow during the hydrograph and so no increase to downstream flood risk.

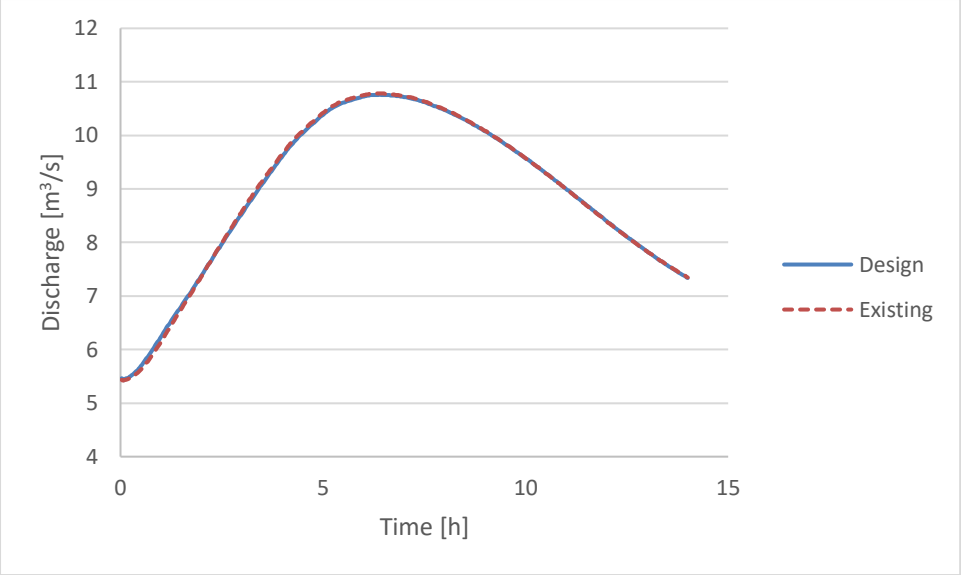

Figure 6: Pass forward hydrographs for design and existing conditions, 100 year flood.

5.1.3. Hydrology and hydraulic modelling **(updated following Environment Agency review – 2022)**

The hydrology for the project was updated in 2022 to account for an increased URBEXT parameter, and this increased the 100 year return interval flood peak estimate from the previously modelled 10.83 m^3/s to 15.10 m^3/s. Updated model runs were undertaken for unsteady (ReFH derived) hydrographs for the following flows in **Table 2**.

Table2: Peak flows used in the model.

Flow description	Discharge peak [m^3/s]
Original model 100 year RP peak (2020)[1]	10.83
Updated 100 year RP peak (2022)	15.10
Updated 100 year RP peak + 14% climate uplift	17.21
Updated 100 year RP peak + 35% climate uplift	20.38

Maximum water depth during the unsteady flood hydrograph is mapped in **Figure 7**, **Figure 8** and **Figure 9** for the updated 100 year, 100 year plus 14% (central estimate 2080) and 100 year plus 35% return period flows for the Emm Brook existing condition and design condition. Difference maps of Design water level minus existing water level peak are also included **in Figure 10**, **Figure 11** and **Figure 12**. The results are consistent with expectations and previous modelling:

[1] For reference only; this flow was modelled as part of the original 2020 study.

- There are no significant changes to inundation between existing and design
- The design slightly lowers levels upstream, by increasing conveyance through the design channel on the right floodplain.
- Water levels at the existing bridges are very slightly reduced (1-3 cm) and slightly increased by 4 cm on the most downstream design bridge, but this afflux is limited to 4 m upstream of the structure.

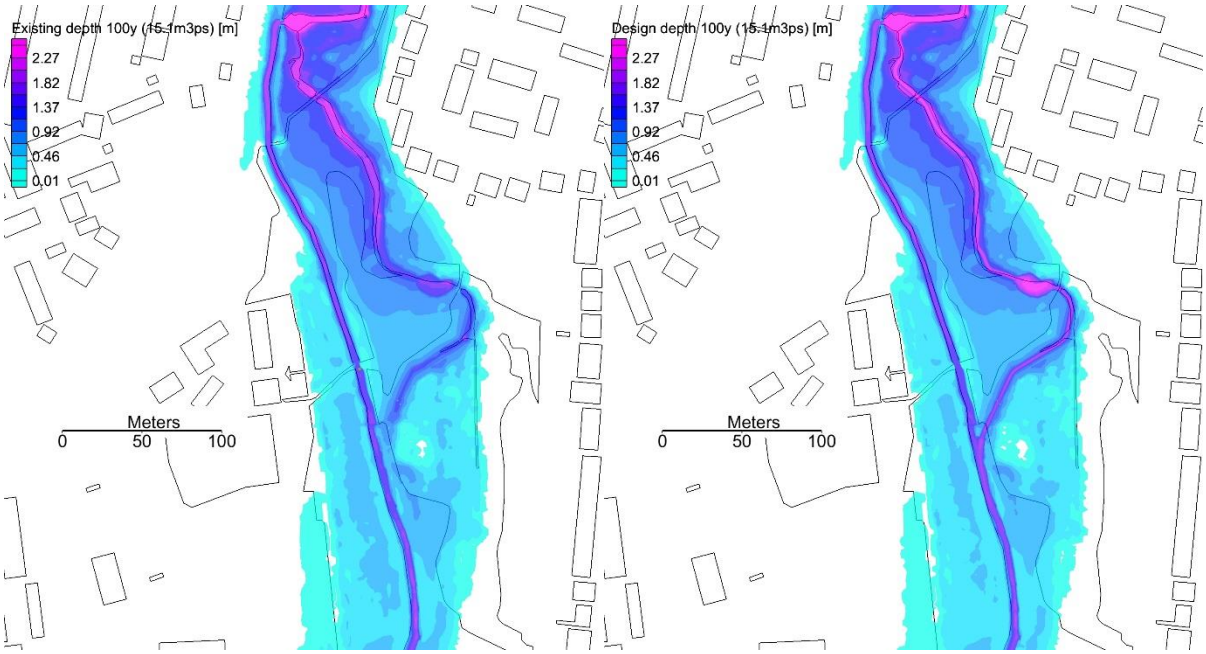

Figure 7: 100 year return period (15.10 m^3/s) peak inundation for existing (left) and design (right) condition.

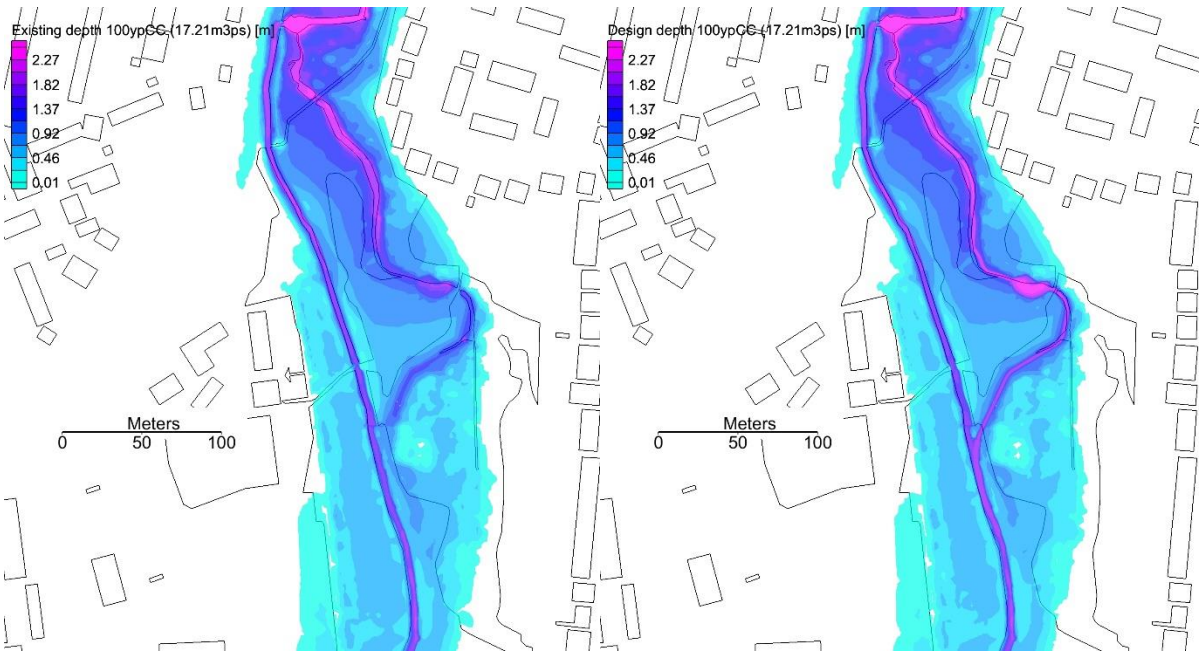

Figure 8: 100 year return period plus 14% central 2080 climate change estimate (17.21 m^3/s) peak inundation for existing (left) and design (right) condition.

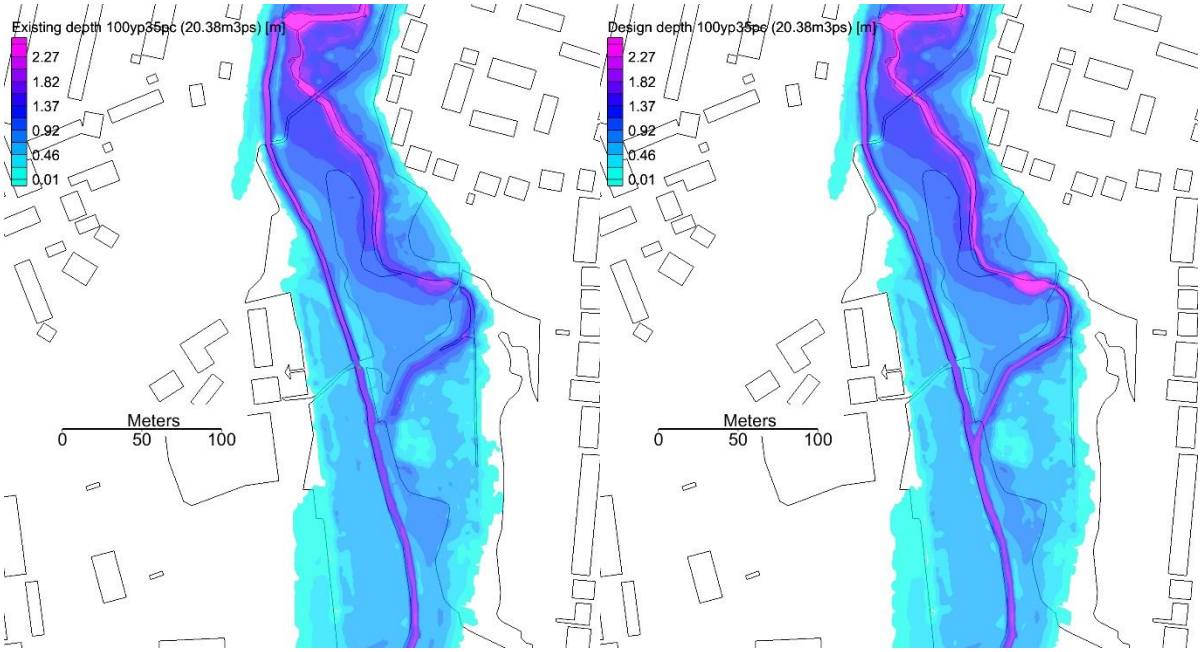

Figure 9: 100 year return period plus 35% (20.38 m^3/s) peak inundation for existing (left) and design (right) condition.

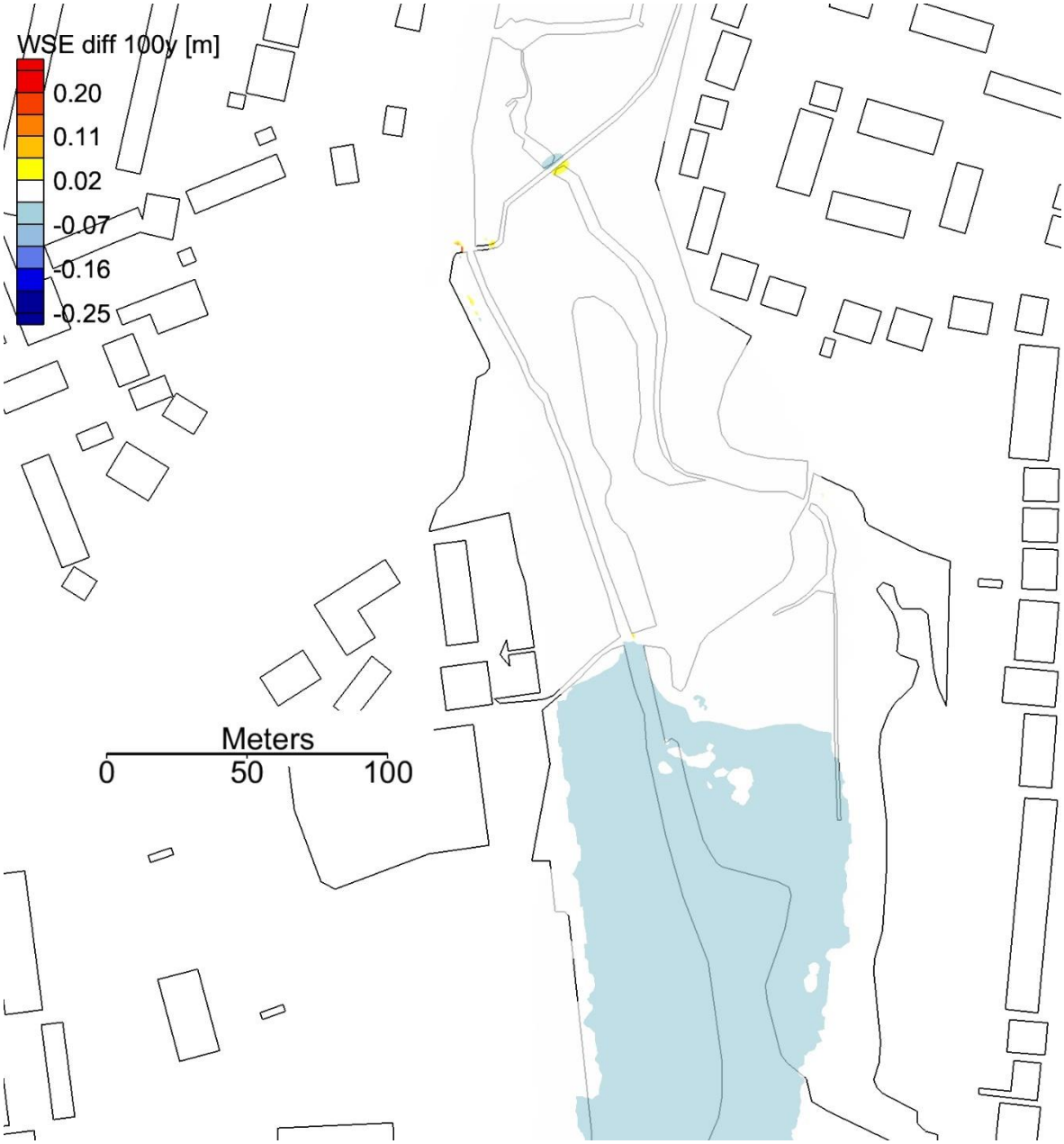

Figure 10: Peak water level difference map (design - existing) for the 100 year return period (15.10 m^3/s) flood.

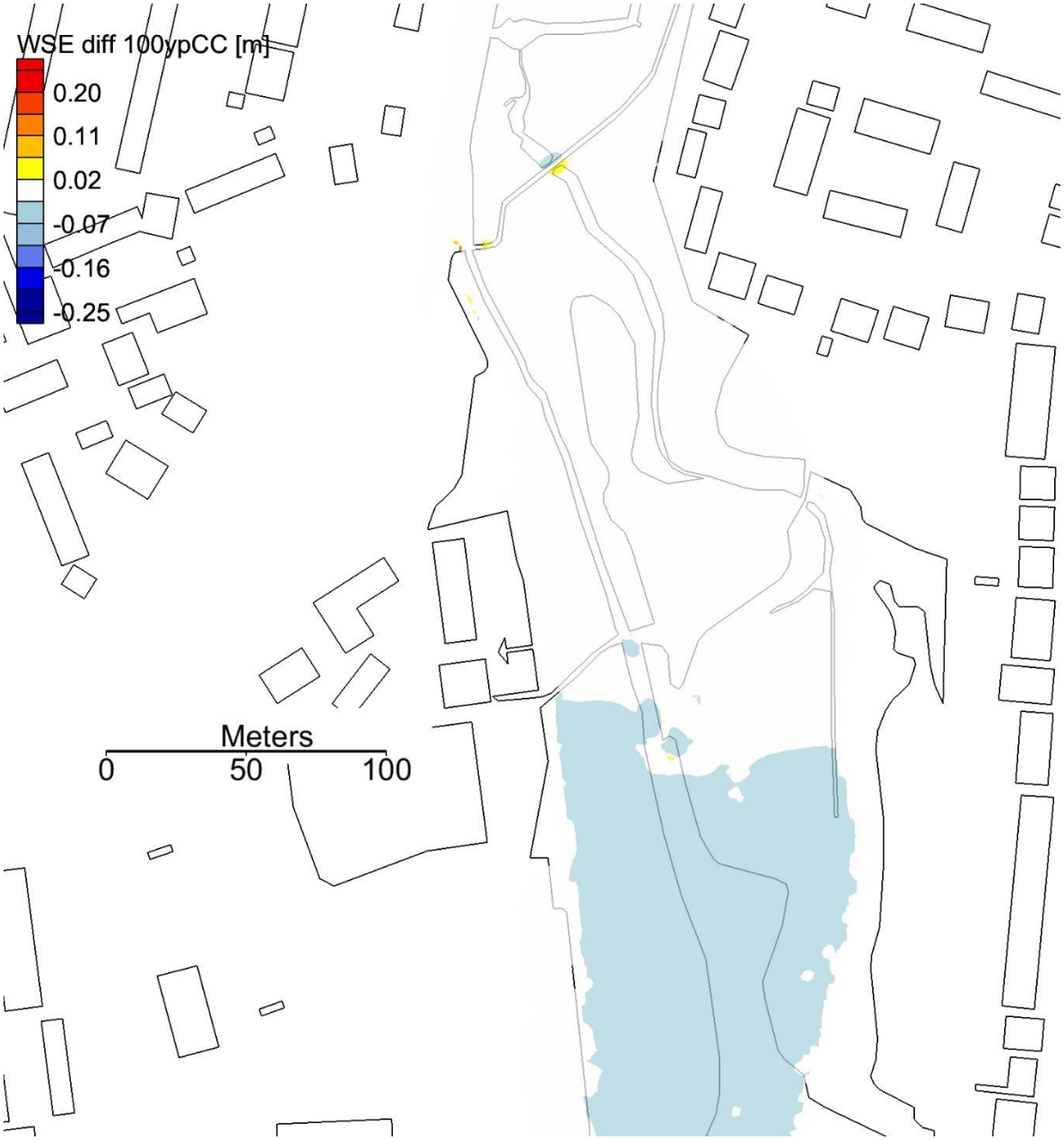

Figure 11: Peak water level difference map (design - existing) for the 100 year return period plus 14% central 2080 climate change estimate (17.21 m^3/s) flood.

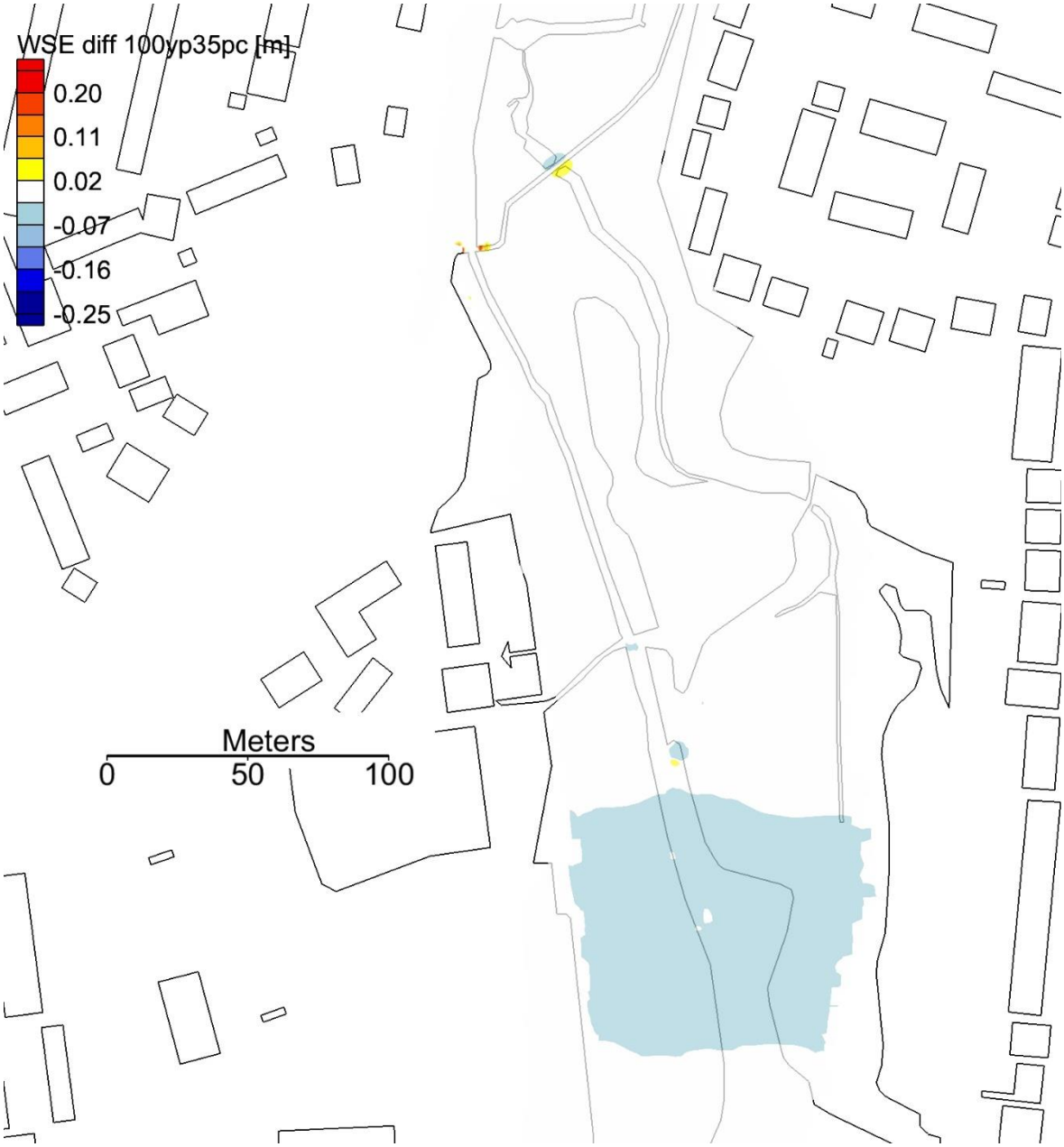

Figure 12: Peak water level difference map (design - existing) for the 100 year return period plus 35% (20.38 m^3/s) flood.

Downstream pass-forward flow was calculated for each modelled flow and is tabulated in **Table 3**. There is no increase in pass-forward flow as a result of the design. **Error! Reference source not found.** shows the pass-forward flow hydrograph for the 100 year plus 14% climate uplift flood. At no point in this hydrograph are design pass-forward flows higher than those for the existing condition.

Table 3: Pass-forward flow peaks.

Return period & flow uplift%	Existing peak [m3/s]	Design peak [m3/s]
100	15.08	15.07
100+14% CC	17.20	17.16
100+35%	20.36	20.33

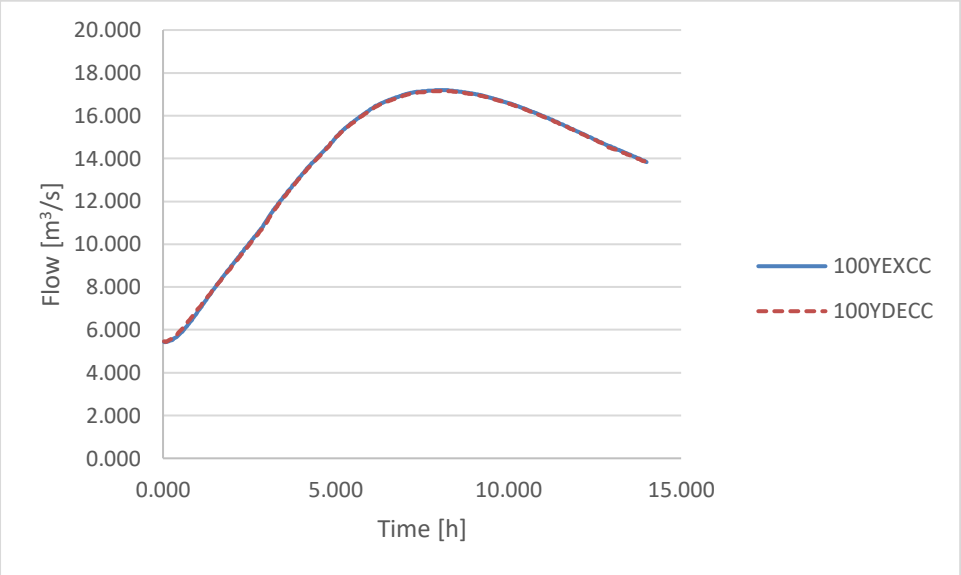

Figure 13:Pass-forward flow hydrograph for the 100 year return period flood plus 14% central 2080 estimate of climate uplift.

5.2 SURFACE WATER

5.2.1. Surface water flood risk to the scheme

While the primary source of flooding to the proposed scheme is fluvial, Figure 7 highlights the risk of surface water flooding to the site.

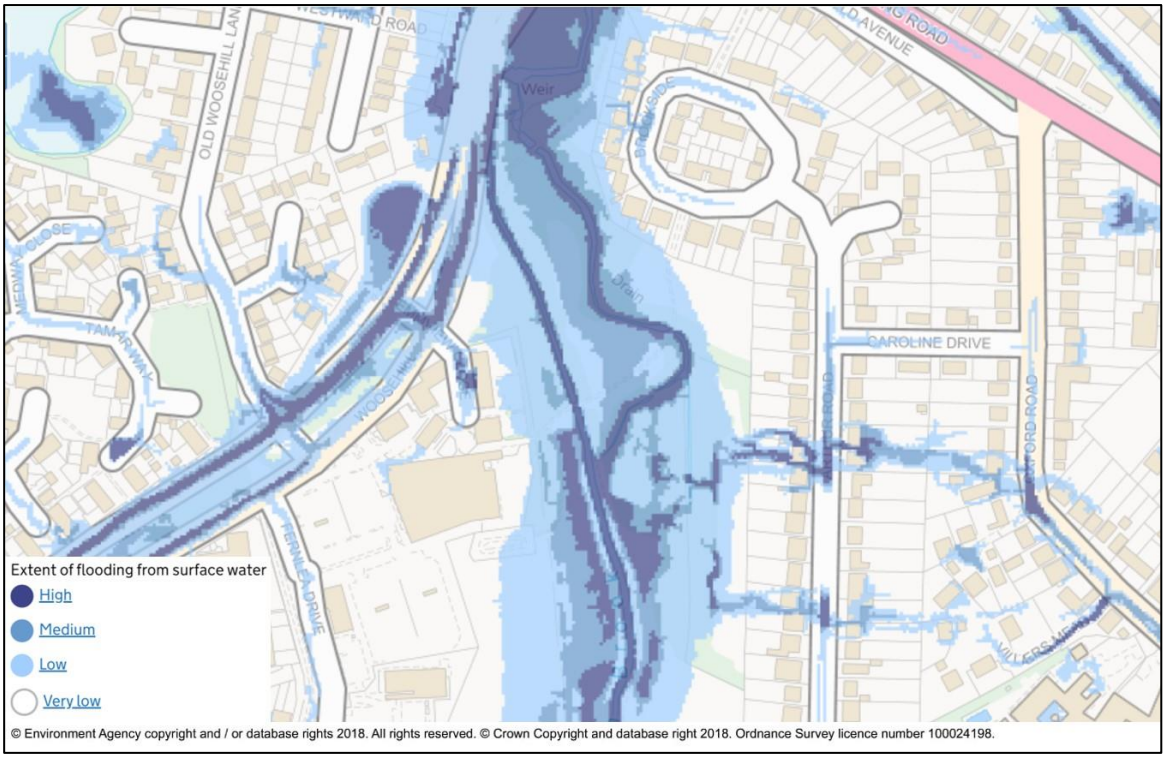

Figure 14: Environment Agency surface water flood zone map

Riverside Park is located within a medium risk area for surface water flooding (the chance of flooding is between 1 in 30 and 1 in 100 each year). Localised areas of high surface water flood risk (greater than 1 in 30 each year) are shown at the upstream extent of the restoration works, where the historic channel diverges from the current Emm Brook channel and at the downstream extent, near the weir.

5.2.2. Surface water flood risk to/from the scheme

As the site is currently Greenfield and will remain Greenfield after construction, it is unlikely that the proposed works will have any impact on, nor will it be impacted by, surface water flood risk.

5.3 GROUNDWATER

5.3.1. Groundwater flood risk to/from the scheme

As the proposed scheme will not add any hardstanding areas or impact any potential groundwater sources or flowpaths, there will be no impact to groundwater flood risk caused by the scheme. As the river is already located at the site, it is not expected that groundwater will impact the proposed scheme.

5.4 STRUCTURES

The proposed works do not pose any threat of increased flood risk to local structures.

5.5 SEWERAGE INFRASTRUCTURE

Two foul sewer pipes are located within the site boundaries. One crosses the existing channel approximately 50 m upstream of the upstream footbridge crossing located at SU 79872 69056 and is not envisaged to be impacted by the works. The second crosses the historic channel approximately 50 m upstream of the footpath crossing at SU 79849 69227. As the pipe is cast iron, Thames Water have confirmed that it has no issue with the historic channel being reinstated, and has advised that the concrete abutments could be trimmed/ set back by up to 1m if required, to improve conveyance at this location.

6. MITIGATION OPTIONS

Whilst the proposed scheme is located within the functional floodplain, as the restoration works are designed to return this section of the Emm Brook to a more natural state, and impact to upstream and downstream flood risk is minimal, no mitigation measures are required.

7. CONCLUSIONS

The proposed scheme lies within the functional floodplain of flood zone 3. However, as the scheme comprises channel realignment and re-meandering with the aim of returning this stretch to a more natural state and improving the fish passage, the works cannot be located within an area of lower flood risk. The scheme does not conflict with policies set out in the Thames River Basin Management Plan (RBMP) and the Wokingham Borough Council Local Flood Risk Management Strategy (LFRMS). Hydraulic modelling demonstrates that the proposed design does not increase flood risk either upstream or downstream and that no properties are at risk from flooding at the 100 year plus climate uplift events.

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