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|---|---|---|---|
| Date | 10th June 2022 | Issued version | 3.0 |
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| Reviewer | Martin Kernan, cbec eco-engineering UK Ltd | | |
| To | South East Rivers Trust | | |
| Project | Emm Brook | | |
| Subject | Flood estimation report: Emm Brook | | |

# Introduction

This report template is a supporting document to the Environment Agency's Flood Estimation Guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results. This document can be used for one site or multiple sites. If only one site is being assessed, analysts should remove superfluous rows from tables.

Guidance notes (in red text) are included throughout this document in column titles or above tables. These should be deleted before finalising the document. Where relevant, references to specific sections of the Flood Estimation Guidelines document are included to indicate where further useful information can be found.

Note: Column size / page layout can be adapted, where necessary, to best present relevant information, for example, maps do not need to be within the tables if they would be better as a separate page.

# Contents

# Abbreviations

AEP ..... annual exceedance probability
AM ..... Annual Maximum
AREA..... Catchment area ($km^2$)
BFI..... Base Flow Index
BFIHOST..... Base Flow Index derived using the HOST soil classification
CPRE..... Council for the Protection of Rural England
FARL ..... FEH index of flood attenuation due to reservoirs and lakes
FEH ..... Flood Estimation Handbook
FSR ..... Flood Studies Report
HOST..... Hydrology of Soil Types
NRFA..... National River Flow Archive
OS ..... Ordnance Survey
POT ..... Peaks Over a Threshold
QMED..... Median Annual Flood (with return period 2 years)
ReFH ..... Revitalised Flood Hydrograph method
ReFH2 ..... Revitalised Flood Hydrograph 2 method
SAAR..... Standard Average Annual Rainfall (mm)
SPR ..... Standard percentage runoff
SPRHOST ..... Standard percentage runoff derived using the HOST soil classification
Tp(0)..... Time to peak of the instantaneous unit hydrograph
URBAN ..... Flood Studies Report index of fractional urban extent
URBEXT1990 ..... FEH index of fractional urban extent
URBEXT2000 ..... Revised index of urban extent, measured differently from URBEXT1990
WINFAP-FEH ..... Windows Frequency Analysis Package – used for FEH statistical method

# 1 SUMMARY OF ASSESSMENT

## 1.1 SUMMARY

This table provides a summary of the key information contained within the detailed assessment in the following sections. The aim of the table is to enable quick and easy identification of the type of assessment undertaken. This should assist in identifying an appropriate reviewer and the ability to compare different studies more easily.

| | |
|---|---|
| Catchment location | |
| Purpose of study and scope | The purpose of the study was, using a routine assessment, to calculate the peak flow hydrology for the Emm Brook catchment Upstream of Woosehill Spine Road (SU 79850 69350). |
| Key catchment features | The catchment headwaters are mainly rural. However, there are urban areas towards the downstream extent. There are a number of small standing water bodies within the catchment (Queens Mere, Kings Mere and Heath Lake) and there are no known additional inlets (pumped). |
| Flooding mechanisms | The main flood mechanisms for the site are fluvial, from the Emm Brook. |
| Gauged / ungauged | There is an EA level gauge at Taplow Control Structure (2605TH (Downstream Stage). However, there is no rating curve for this gauge so the waterbody is treated as ungauged. |
| Final choice of method | Pooling Group |
| Key limitations / uncertainties in results | |

## 1.2 NOTE ON FLOOD FREQUENCIES

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

Return periods are output by the Flood Estimation Handbook (FEH) software and can be expressed more succinctly than AEP. However, AEP can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval. Results tables in this document contain both return period and AEP titles; both rows can be retained or the relevant row can be retained and the other removed, depending on the requirement of the study.

The table below is provided to enable quick conversion between return periods and annual exceedance probabilities.

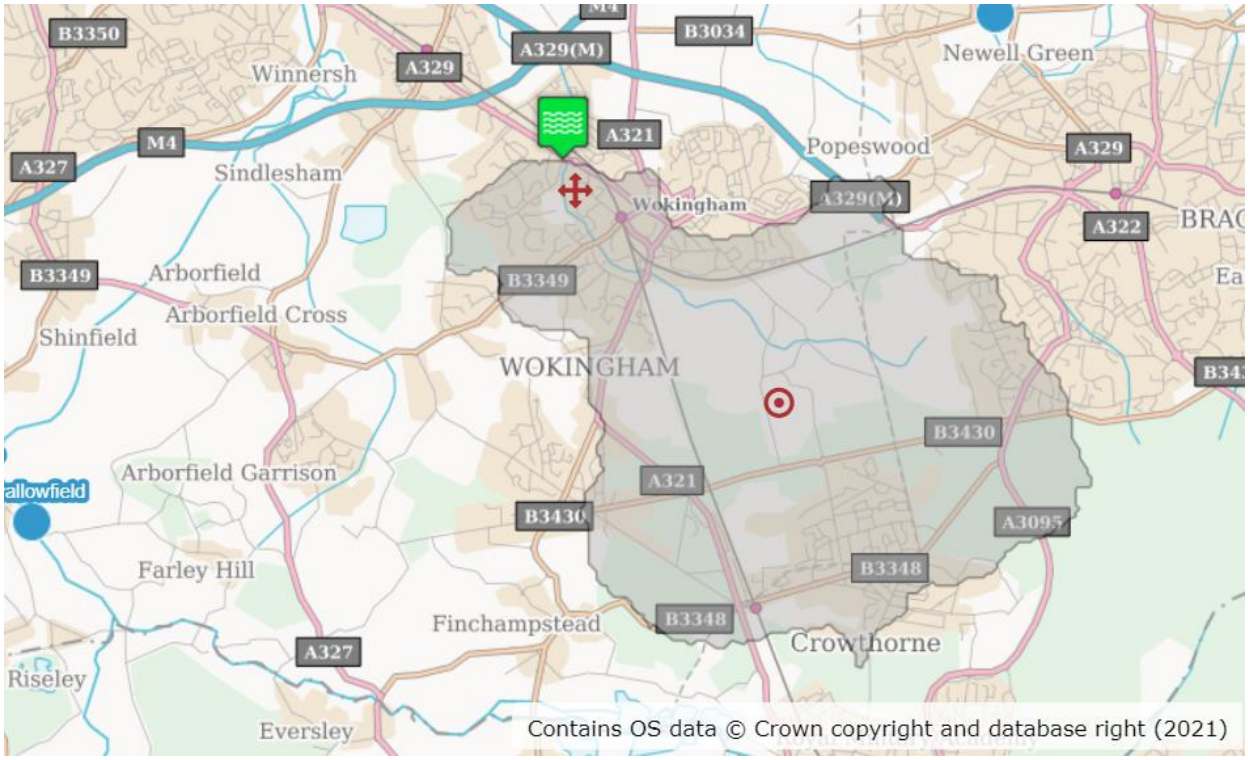
**Annual exceedance probability (AEP) and related return period reference table**

| **AEP (%)** | 50 | 20 | 10 | 5 | 3.33 | 2 | 1.33 | 1 | 0.5 | 0.1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **AEP** | 0.5 | 0.2 | 0.1 | 0.05 | 0.033 | 0.02 | 0.0133 | 0.01 | 0.005 | 0.001 |
| **Return period (yrs)** | 2 | 5 | 10 | 20 | 30 | 50 | 75 | 100 | 200 | 1,000 |

## 1.3 REQUIREMENTS FOR FLOOD ESTIMATES

| | |
|---|---|
| Overview | The purpose of the study was, using a a routine assessment, to calculate the peak flow hydrology for the Emm Brook catchment Upstream of Woosehill Spine Road (HAP1, SU 79850 69350). The peak flows were calculated using a WINFAP 5 Pooling Group and hydrographs from ReFH2 were scaled for unsteady model runs. A climate change allowance of 14% was applied according to the Loddon and tributaries Management Catchment peak river flow allowances central allowance for 2080s. |

## 1.4 THE CATCHMENT




| | |
|---|---|
| Description | The Emm Brook is a tributary of the Lower Loddon. The upper catchment is mainly rural with a network of field drains which later fed into the Emm Brook at Redlake Ford. There are a number of small standing water bodies within the catchment (Queens Mere, Kings Mere and Heath Lake) however reservoir flooding has not been considered further in this assessment.<br><br>The British Geological Survey (BGS) online map shows the bedrock geology comprises London Clay Formation – cay,silt and sand. This is overlain by superficial deposits made up of alluvium – clay, silt, sand and gravel.<br><br>There are no known formal flood defences along the banks of the modelled section of the Emm Brook and the Environment Agency flood map shows the proposed works as being located within Flood Zone 3 (High Risk). However this would be expected with this type of proposal. |

## 1.5 SOURCE OF FLOOD PEAK DATA

| | |
|---|---|
| Source | NRFA peak flows dataset, Version 10, released August 2021. No Changes Made |

## 1.6 OTHER DATA AVAILABLE AND HOW IT WAS OBTAINED

| Type of data | Data relevant to this study? | Data available? | Source of data | Details |
|---|---|---|---|---|
| Check flow gauging's | N/A | | | |
| Historical flood data | Not available when the assessment took place | | | |
| Flow or river level data for events | N/A | | | |
| Rainfall data for events | N/A | | | |
| Potential evaporation data | N/A | | | |
| Results from previous studies | Previous study – Flood study WSP 2016 | Yes | - | - |
| Other data or information | N/A | | | |

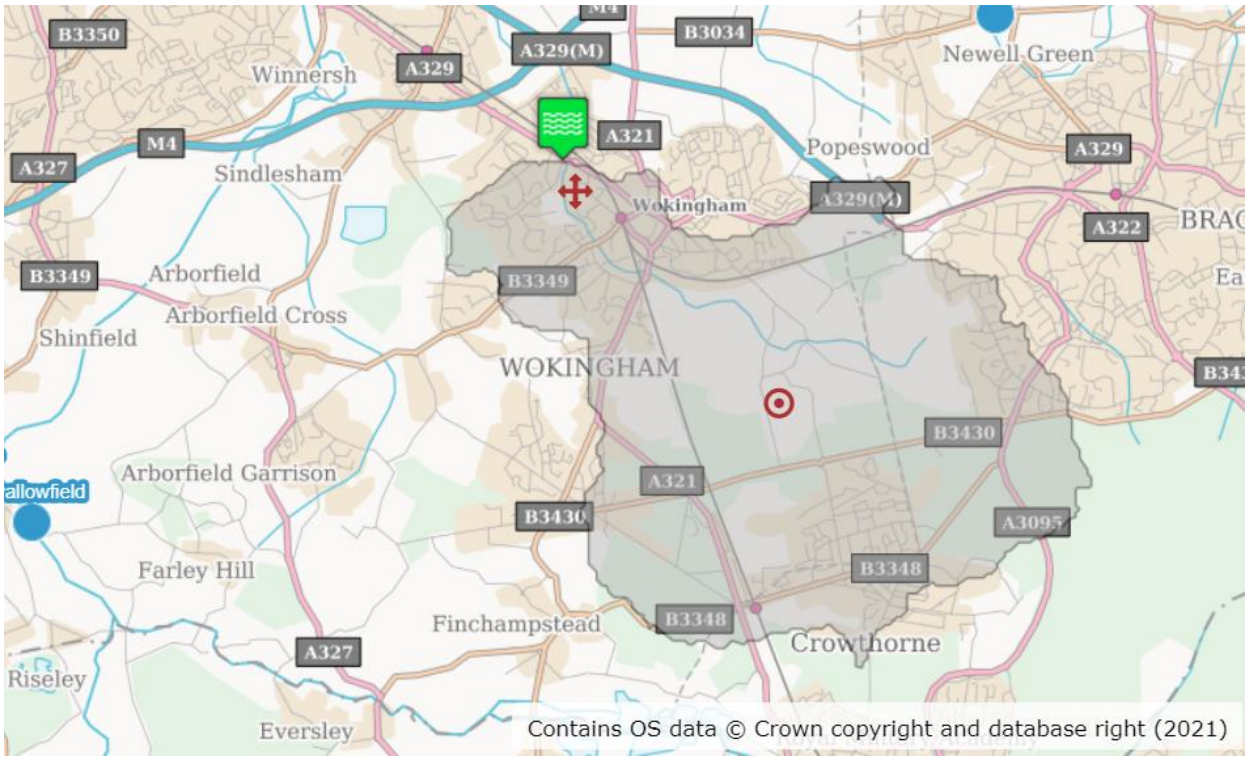
## 1.7 INITIAL CHOICE OF APPROACH

| | |
|---|---|
| Is FEH appropriate? | An initial review of catchment descriptors (0.5km2>AREA<1,000km2, BFIHOST <0.65 and URBEXT1990<0.125) indicated that FEH methods (FEH Statistical and ReFH2) are applicable to most of the flow estimation points for the study area. |
| Initial choice of method(s) and reasons<br><br>How will hydrograph shapes be derived if needed?<br><br>Will the catchment be split into sub-catchments? If so, how? | FEH statistical method will be undertaken to include similar gauge information. The ReFH2.3 method will also be used and the results compared with the most appropriate method being chosen based on the results obtained.<br><br><u>Hydrographs</u><br>Hydrographs will be generated in ReFH2 and scaled to peak flows as appropriate.<br><br>The catchment will not be split into sub-catchments as this is not required |
| Software to be used (with version numbers) | FEH Web Service[1] / WINFAP 5[2] / ReFH2.3 |

[1] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, UK.

[2] WINFAP 5 © Wallingford HydroSolutions Limited 2021.

# 2 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED




The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

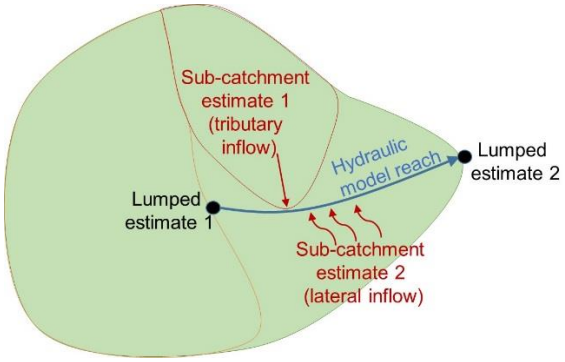
## 2.1 SUMMARY OF SUBJECT SITES

| Site code | Type of estimate<br>L: lumped catchment<br>S: Sub-catchment | Watercourse | Name or description of site | Easting | Northing | AREA on FEH web service ($km^2$) | Revised AREA if altered |
|---|---|---|---|---|---|---|---|
| HAP1 | L | Emm Brook | Upstream of Woosehill Spine Road and the downstream end of the site | 479850 | 169350 | 31.64 | N/A |

Note: Lumped catchments (L) are complete catchments draining to points at which design flows are required.

Sub-catchments (S) are catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system. There is no need to report any design flows for sub-catchments as they are not relevant: the relevant result is the hydrograph that the sub-catchment is expected to contribute to a design flood event at a point further downstream in the river system. This will be recorded within the hydraulic model output files. However, catchment descriptors and ReFH model parameters should be recorded for sub-catchments so that the results can be reproduced.

The schematic diagram illustrates the distinction between lumped and sub-catchment estimates.



## 2.2 IMPORTANT CATCHMENT DESCRIPTORS AT EACH SUBJECT SITE (INCORPORATING ANY CHANGES MADE)

| Site code | FARL | PROPWET | BFIHOST | DPLBAR (km) | DPSBAR (m/km) | SAAR (mm) | URBEXT 2000 | FPEXT |
|---|---|---|---|---|---|---|---|---|
| HAP 1 | 0.9600 | 0.290 | 0.527 | 6.09 | 24.20 | 663 | 0.1972<br>0.4230 | 0.1209 |

## 2.3 CHECKING CATCHMENT DESCRIPTORS

| | |
|---|---|
| Record how catchment boundary was checked and describe any changes | The catchment boundaries were derived by the FEH Online portal, These were visually checked using Ordnance Survey (OS) mapping. This showed that the catchment boundaries defined by the FEH Online portal were reasonable and no changes have been made<br>URBEXT2000 was updated using OS 50,000 scale mapping, this found the catchment descriptors underestimate the urban extent of the catchment and the updated value has been applied to this analysis. |
| Record how other catchment descriptors were checked and describe any changes. | A visual check was undertaken to compare the urban extent in the FEH Online Portal compared to current OS mapping; the urban area shown on the Web Portal did not match the urban areas shown on the OS mapping and therefore URBEXT2000 was updated accordingly.<br><br>There are three main types of soil in the catchment:<br><br>- Naturally wet, very acidic sandy and loamy soils (Arable and horticultural some wet lowland heath)<br><br>- Freely draining slightly acidic loamy soils (Arable and grassland)<br><br>- Loamy spoils with naturally high groundwater (Arable grassland/woodland)<br><br>These soils are common in the south of England, which suggests the catchment descriptors are reasonable for this site. |
| Source of URBEXT | URBEXT 2000 Statistical Method |
| Method for updating of URBEXT | Updated using OS Mapping (1:50,000 scale) |

# 3 STATISTICAL METHOD

## 3.1 OVERVIEW OF ESTIMATION OF QMED AT EACH SUBJECT SITE

| Site code | QMED (rural) from CDs ($m^3/s$) | Data transfer | | | | | Urban adjust-ment factor UAF | Final estimate of QMED Urban ($m^3/s$) |
|---|---|---|---|---|---|---|---|---|
| | | NRFA numbers for donor sites used (see 3.3) | Distance between centroids $d_{ij}$ (km) | Moderated QMED adjustment factor, $(A/B)^a$ | If more than one donor | | | |
| | | | | | Weight | Weighted ave. adjustment | | |
| HAP 1 | 3.439 | 39052 | 7.05 | | 0.418 | 0.92 | 1.602 | 5.069 |
| | | 39007 | 11.87 | | 0.364 | | | |
| | | 39022 | 21.08 | | 0.302 | | | |
| | | 39023 | 29.21 | | 0.256 | | | |
| | | 39011 | 29.24 | | 0.256 | | | |
| | | | | | | | | |

| | |
|---|---|
| Are the values of QMED spatially consistent? | |
| Method used for urban adjustment for subject and donor sites | WINFAP v4[3] |

**Parameters used for WINFAP v4 urban adjustment if applicable**

| Impervious fraction for built-up areas, IF | Percentage runoff for impervious surfaces, $PR_{imp}$ | Method for calculating fractional urban cover, URBAN |
|---|---|---|
| 0.3 | 70% | From updated URBEXT2000 |

**Notes**

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).

The QMED adjustment factor A/B for each donor site is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial (rural) estimate from catchment descriptors.

**Important note on urban adjustment**

The method used to adjust QMED for urbanisation published in Kjeldsen (2010)**Error! Bookmark not defined.** in which PRUAF is c alculated from BFIHOST is not correctly applied in WINFAP-FEH v3.0.003. Significant differences occur only on urban catchments that are highly permeable. This is discussed in Wallingford HydroSolutions (2016)[3].

## 3.2 SEARCH FOR DONOR SITES FOR QMED (IF APPLICABLE)

| | |
|---|---|
| Comment on potential donor sites | It is best practice to use donors located on the studied watercourse however in this study there is no flow gauge station within the study area. |

[3] Wallingford HydroSolutions (2016). WINFAP 4 Urban adjustment procedures.

## 3.3 DONOR SITES CHOSEN AND QMED ADJUSTMENT FACTORS

| NRFA no. | Method (AM or POT) | Adjustment for climatic variation? | QMED from flow data (A) | QMED from catchment descriptors Urban(B) | Adjustment ratio (A/B) |
|---|---|---|---|---|---|
| 39052 | AM | No | 7.531 | 9.554 | 0.788256228 |
| 39007 | AM | No | 22.4 | 17.821 | 1.256944055 |
| 39022 | AM | No | 16.6 | 13.039 | 1.273103766 |
| 39023 | AM | No | 2.71 | 6.671 | 0.406235947 |
| 39011 | AM | No | 25.850 | 22.962 | 1.125773016 |

## 3.4 DERIVATION OF POOLING GROUP

| Name of group | Site code from whose descriptors group was derived | Subject site treated as gauged? | Changes made to default pooling group, with reasons | Weighted average L-moments |
|---|---|---|---|---|
| HAP1 | HAP1 | No | Removed due to high SAAR:<br>- 7011 (Black Burn @ Pluscarden Abbey)<br>Removed due to geology:<br>- 36010 (Bumpstead Brook @ Broad Green)<br>Removed due to location:<br>- 26003 (Foston Beck @ Foston Mill)<br>Removed due to high discordancy:<br>- 26013 (Driffield Trout Stream @ Driffield) | L-CV - 0.254<br>L-Skew - 0.154 |

**Note:** Pooling groups were derived using the procedures from Science Report SC050050 (2008).

## 3.5 POOLING GROUP

| Name of group | NRFA ID | Station | Distance | Years of Data | QMED AM |
|---|---|---|---|---|---|
| HAP1 | 33054 | (Babingley @ Castle Rising) | 0.611 | 44 | 1.132 |
| | 41020 | (Bevern Stream @ Clappers Bridge) | 0.794 | 51 | 13.66 |
| | 33032 | (Heacham @ Heacham) | 0.82 | 52 | 0.442 |
| | 36003 | (Box @ Polstead) | 0.946 | 60 | 3.875 |
| | 36004 | (Chad Brook @ Long Melford) | 0.963 | 53 | 4.938 |
| | 36007 | (Belchamp Brook @ Bardfield Bridge) | 1.049 | 55 | 4.63 |
| | 53017 | (Boyd @ Bitton) | 1.071 | 47 | 13.87 |
| | 41022 | (Lod @ Halfway Bridge) | 1.09 | 50 | 16.25 |
| | 38002 | (Ash @ Mardock) | 1.523 | 79 | 6.735 |
| | 38004 | (Rib @ Wades mill) | 2.196 | 61 | 11.621 |
| | - | - | - | 552 | - |

**Note:** Pooling groups were derived using the procedures from Science Report SC050050 (2008).

## 3.6 DERIVATION OF FLOOD GROWTH CURVES AT SUBJECT SITES

| Site code | Method | If P, ESS or J, name of pooling group | Distribution used and reason for choice | Note any urban adjustment or permeable adjustment | Parameters of distribution | Growth factor for 100-year return period / 1% AEP |
|---|---|---|---|---|---|---|
| HAP1 | P | HAP1 | Generalised Logistic distribution gives an acceptable fit. | An urban adjustment factor of 1.602 has been applied | Scale 0.323<br>Shape -0.073 | 2.815 |

**Notes**
Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis
Urban adjustments are all carried out using the method of Kjeldsen (2010).
Growth curves were derived using the procedures from Science Report SC050050 (2008).

## 3.7 FLOOD ESTIMATES FROM THE STATISTICAL METHOD

| Site code | Flood peak ($m^3/s$) for the following return periods (in years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 75 | 100 | 200 | 500 |
| | Flood peak ($m^3/s$) for the following AEP (%) events | | | | | | | | |
| | 50 | 20 | 10 | 4 | 2 | 1.5 | 1 | 0.5 | 0.2 |
| **HAP 1 Catchment Descriptors** | **5.51** | **7.73** | **9.26** | **11.4** | **13.16** | **14.27** | **15.1** | **17.24** | **20.45** |
| **HAP 1 Donor catchments** | **5.07** | **7.11** | **8.52** | **10.48** | **12.11** | **13.13** | **13.89** | **15.87** | **18.81** |

**Notes**
Both catchment descriptors and donor catchments were used to calculate return periods however catchment descriptors provided a more suitable result when compared with other methods and previous studies.

# 4 REVITALISED FLOOD HYDROGRAPH 2 (REFH2) METHOD

## 4.1 PARAMETERS FOR REFH2 MODEL

| Site code | Method | $Tp_{rural}$ (hours) | $Tp_{urban}$ (hours) | $C_{max}$ (mm) | BL (hours) | BR |
|---|---|---|---|---|---|---|
| HAP1 | Catchment descriptors | 8.03 | 6.02 | 453.08 | 54.9 | 2.56 |
| Brief description of any flood event analysis carried out | | | None taken as lack of flow data | | | |

## 4.2 DESIGN EVENTS FOR REFH2 METHOD: LUMPED CATCHMENTS]

| Site code | Urban or rural | Season of design event (summer or winter) | Critical Storm duration (hours) | Recommended storm duration (hours) | TP Scaling Factor |
|---|---|---|---|---|---|
| HAP 1 | Urban | Summer | 3 | 13 | 0.75 |

ADDITIONAL URBAN PARAMETERS

| Site code | Urban Area ($km^2$) | Impervious Runoff Factor | Imperviousness Factor | TP Scaling Factor | Depression Storage |
|---|---|---|---|---|---|
| HAP 1 | 13.38 | 0.7 | 0.4 | 0.75 | 0.5 |

The Critical storm duration was calculated using FEH Rainfall Runoff module in Flood Modeller, this was calculated as 3 hours as shown and was used in the analysis to represent a more convective summer storm. Rainfall data from the Bracknell rainfall gauge was used to check the time to peak on the Emm brook using the level gauge at the Taplow Control Structure. This gauge does not appear to be on the mainstem Emm Brook, instead it is located on a drainage ditch adjacent to the mainstem, so is used with caution however using a number of events it verifies the time to peak from a rainfall event to be in line with the time to peak calculated in ReFH2.3 using the Urban parameters.

Urban drainage has been considered but not analysed fully as part of this assessment as this was not deemed necessary due to the nature of the works. It is believe that urban drainage could impact peak flows/ runoff rates however this is not expected to have an impact on the risk to or from the design. The design is classed as 'Water-Compatible development' under the NPPF and modelling has shown no impact to flood risk at the full range of flows

Urban drainage routes could change the area of the catchment which drains into the Emm Brook, potentially reducing the catchment area. Looking at the catchment on FEH Web service it is unlikely that the drainage area would be increased. Sustainable Urban Drainage schemes (SUDs) are also likely to improve flood storage which could result in slower runoff rates. The assessment carried out does not consider either of these factors so treats them as 'at capacity' which would simulate a flood where no additional storage is available and all water falling on the catchment is treated as runoff into the watercourse. The resulting peak flows are therefore a conservative estimate for runoff into the Emm Brook.

## 4.3 FLOOD ESTIMATES FROM THE REFH2 METHOD

| Site code | Flood peak ($m^3/s$) for the following return periods (in years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 75 | 100 | 200 | 500 |
| | Flood peak ($m^3/s$) for the following AEP (%) events | | | | | | | | |
| | 50 | 20 | 10 | 4 | 2 | 1.5 | 1 | 0.5 | 0.2 |
| HAP 1 | 4.49 | 6.49 | 7.92 | 9.86 | 11.47 | 12.48 | 13.24 | 15.3 | 18.82 |

# 7 DISCUSSION AND SUMMARY OF RESULTS

## 7.1 COMPARISON OF RESULTS FROM DIFFERENT METHODS

| Site code | Ratio of peak flow to FEH Statistical peak | | | |
|---|---|---|---|---|
| | Return period 2 years / 50% AEP | | Return period 100 years / 1% AEP | |
| | ReFH2 | Pooled | ReFH2 | Pooled |
| HAP 1 | 4.49 | **5.51** | 13.24 | **15.1** |

## 7.2 FINAL CHOICE OF METHOD

| | |
|---|---|
| Choice of method and reasons | Donor Catchment information was used to try and improve flow estimates however it was decided that catchment descriptor information with updated URBEXT was more appropriate for the analysis. Therefore the statistical method using Catchment Descriptors was used in favour of the donor catchment method.<br>When comparing the FEH statistical and ReFH2.3 methods, while both flows were comparable, the WINFAP Pooling method provided slightly more conservative flow estimates which were subsequently used. The statistical approach is based on actual gauged data included a large dataset of flood events. This approach has been more directly calibrated to reproduce flood frequency on UK catchment so is the preferred approach. |
| How will the flows be applied to a hydraulic model | As a final approach it was decided to use the flood hydrographs estimated with the ReFH2 method scaled to the WINFAP pooling group peak flows to allow unsteady model inputs. These flows will be input into the model through a single inflow point at the top of the model. |

## 7.3 ASSUMPTIONS, LIMITATIONS AND UNCERTAINTY

| | |
|---|---|
| List the main assumptions made (specific to this study) | - The pooling group generated is representative for the Emm Brook catchment |
| Discuss any particular limitations, | - The FEH Statistical method is not recommended for predicting flow estimates for the return periods greater than 200-years. However these flows were not used in the model, they were produced in this assessment as standard practice.<br>- Urban drainage has not been fully assessed, this could alter peak flows/runoff rates into the catchment with urban drainage potentially bypassing the catchment and also storage such as SUDs schemes not being accounted for. |
| Provide information on the uncertainty in the design peak flow estimates and the methodology used | - The FEH Statistical method was chosen so uncertainty in the results will be checked within model. |
| Comment on the suitability of the results for future studies, | - The results can be replicated and updated for the future studies in chosen locations. However the results presented in this report are considered in the context of this study needs only. |
| Give any other comments on the study | - N/A |

## 7.4 CHECKS

| | |
|---|---|
| Are the results consistent, for example at confluences? | The results are consistent with previous studies. However there is only one assessment point so there are no confluences etc to check. |

| | |
|---|---|
| What do the results imply regarding the return periods / frequency of floods during the period of record? | Flow data are not available. |
| What is the range of 100-year / 1% AEP growth factors? Is this realistic? | The 100 Year growth factor for ReFH2 is between 2.5 – 3 which are within the typical range according to guidance.<br>Q100 WINFAP Pooling group = 2.815<br>Q100 ReFH2.3 = 2.9<br>Q1000 WINFAP Pooling group = 4.193<br>Q1000 ReFH2.3 = 4.97 |
| If 1000-year / 0.1% AEP flows have been derived, what is the range of ratios for 1000-year / 0.1% AEP flow over 100-year / 1% AEP flow? | These flows have not been derived as they were not required. |
| How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred. | The results in this study are extremely comparable to the study by WSP in 2016 for site EM100. |
| Are the results compatible with the longer-term flood history?. | No flood history was available at the time of the study. |
| Describe any other checks on the results | Sensitivity checks will be conducted in the hydraulic modelling. |

## 7.5 FINAL RESULTS

| Site code | Flood peak ($m^3/s$) for the following return periods (in years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 75 | 100 | 200 | 500 |
| | Flood peak ($m^3/s$) for the following AEP (%) events | | | | | | | | |
| | 50 | 20 | 10 | 4 | 2 | 1.5 | 1 | 0.5 | 0.2 |
| HAP 1 | 5.51 | 7.73 | 9.26 | 11.4 | 13.16 | 14.27 | 15.1 | 17.24 | 20.45 |

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