Flood Estimation Report Template

Template: LIT 65087 Published: 29/12/2022

Audience: Environment Agency

Description: This report template is a supporting document to the Environment Agency's Flood Estimation Guidelines (LIT 11832). It provides a record of the hydrological context, the method statement, the calculations, the decisions made, and the results of flood estimation. This document can be used for one site or multiple sites.

Guidance notes to help you complete this template are available separately.

Contents

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Approval

Revision stage	Analyst:	Approved by:	Amendments	Date
Method statement	Sara Liguori			03/02/2023
Calculations - Revision 1				
Calculations - Revision 2				

Abbreviations

Abbreviation	Short for
AEP	annual exceedance probability
AMAX	Annual Maximum
AREA	Catchment area (km2)
BFI	Base Flow Index
BFIHOST19	Base Flow Index derived using the HOST soil classification, revised in 2019
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
GEV	Generalised Extreme Value
GLO	Generalised Logistic
HOST	Hydrology of Soil Types
IF	Impervious Fraction
IRF	Impervious Runoff Factor
LF	Low flow statistics (flow duration curve)
NRFA	National River Flow Archive
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)
Tp	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	Windows Frequency Analysis Package (software that can be used for FEH statistical method)

1. Summary of assessment

1.1 Summary

Catchment location:

Begbroke, including Rowel Brook, Thrupp ditch and Southern Drainage ditch, Oxfordshire

Purpose of study and complexity:

Routine hydrological assessment to estimate design hydrographs needed as input to the 1D-2D hydraulic model of the watercourses in the area of study.

Key catchment features:

The site of intereset is rural but the hydrological catchments of interest for the estimation of runoff to and from the site are more variously characterised. The overall contributing catchment downstream of the site, at the downstream hydraulic model extent, is moderately urbanised. All hydrological catchments of interest are classified as small.

Flooding mechanisms:

Fluvial and pluvial.

Gauged / ungauged:

Ungauged

Final choice of method:

Statistical peak flow estimates; hydrograph shapes from ReFH2

Key limitations / uncertainties in results:

Lack of data to inform analysis and verify results.

1.2 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.

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	0.013	0.01	0.005	0.001
Return period (yrs)	2	5	10	20	30	50	75	100	200	1,000

2. Method Statement

2.1 Requirements for flood estimates

Overview and Project Scope:

This document details the hydrological analysis undertaken to derive design peak flows and hydrographs for use in a 1D-2D hydraulic model of the Rowel Brook, Thrupp ditch and Southern drainage ditch at a site near Begbroke, Oxfordshire. The results of the hydraulic modelling will be used for the purpose of informing a flood risk assessment for a proposed development.

Design peak flow estimates and hydrographs will be derived for the following AEP (%) events: 3.33, 1, and 0.1. In addition, the following AEP (%) events have been considered for the purposes of this assessment: 50, 20, 10, 2, 0.5, and 0.2. The impact of climate change on flood risk will be assessed by applying climate change allowances to the 1%AEP flow estimates. The central (20%) and higher (41%) allowances for the 2080s epoch, as defined by current climate change guidance[1] for the Gloucestershire and Vale Management Catchment, will be considered for the purposes of the hydraulic modelling.

Design estimates will be derived as lumped inflows for the Rowel Brook, Thrupp ditch, and Southern drainage ditch at the site. The contribution of the intervening area at the d/s extent of the hydraulic model will be estimated from the overall catchment at this location. A map of the approximate site boundaries and contributing catchments as defined on the FEH Web is shown in Figure 1.

It is anticipated that the FEH catchments boundaries and contributing areas will be refined on the basis of the results of a Direct Rainfall Model (DRM) built for the area of interest. The DRM will provide information about flow paths in the area on the basis of the LiDAR DTM and known local features impacting on the topography and the hydrological connectivity in the area. It is also anticipated that the distribution of runoff estimated for the intervening area will be made in accordance with the indication of relevant flow paths as shown by the results of the direct rainfall model.

It should be noted that the hydrological analysis detailed in this document is based on the assumption that the Oxford Canal is a hydrological barrier and does not require an inflow. However, this assumption might be re-examined and appropriate adjustments made should the direct raiinfall modelling indicate that a significant runoff contribution is to be taken into account for the purposes of the hydraulic model. It should also be noted that details on the DRM model build and

[1] Environment Agency. Flood risk assessments: climate change allowances. Last Updated May 2022 https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow

analysis of DRM results are outside the scope of this document and will be covered elsewhere.

2.2 The Catchment

Maps:

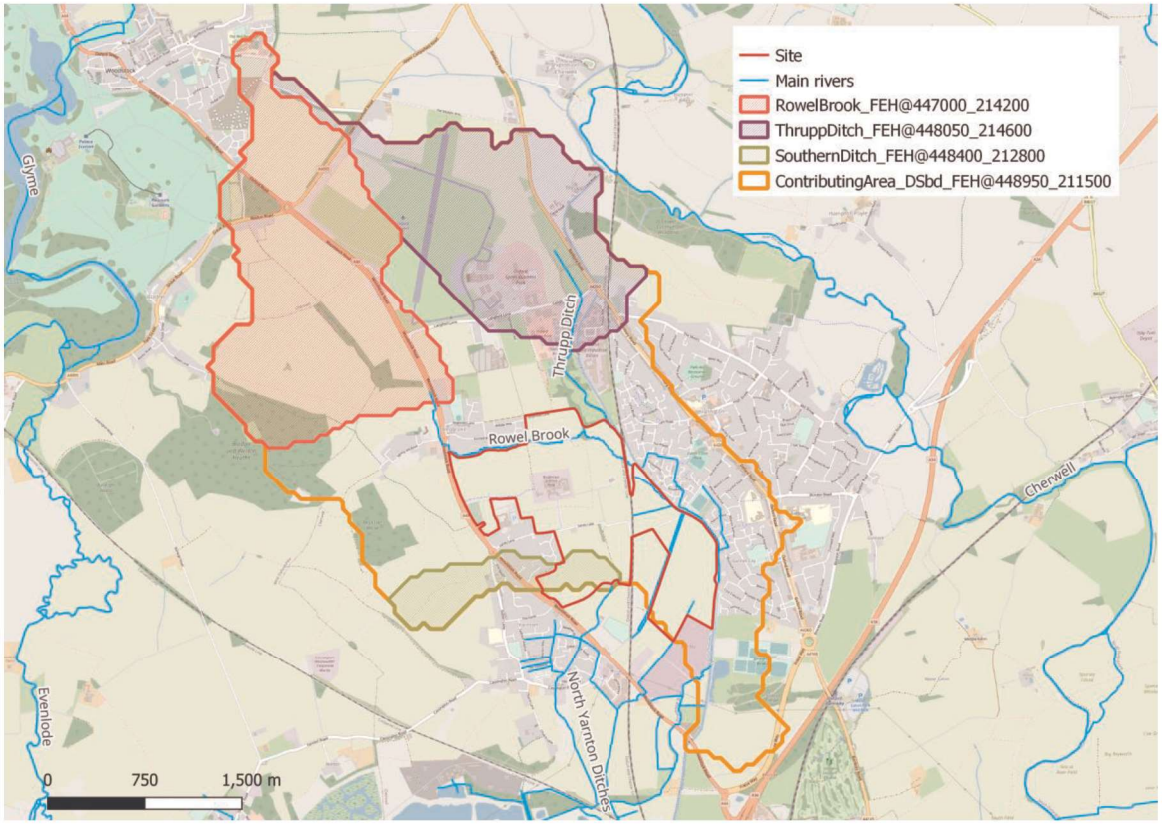

Figure 1 FEH catchments and site boundaries

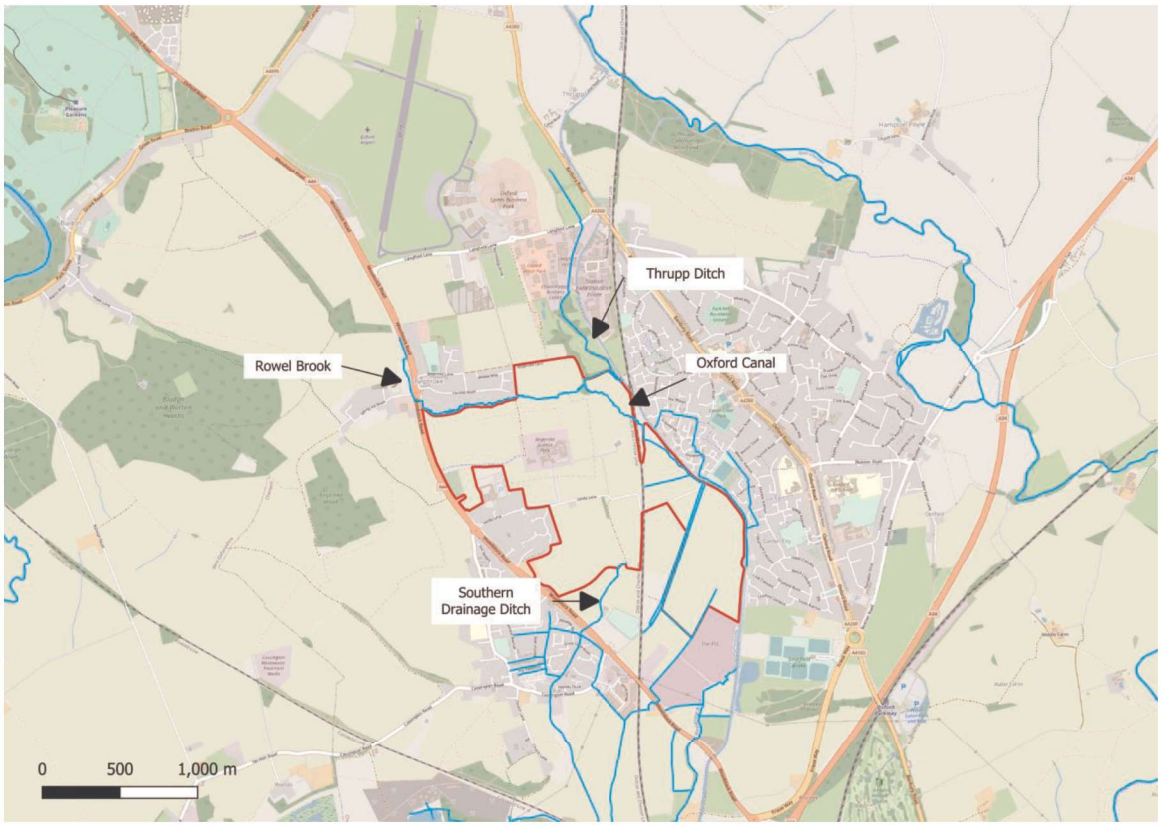

Figure 2 Watercourses in the area of interest

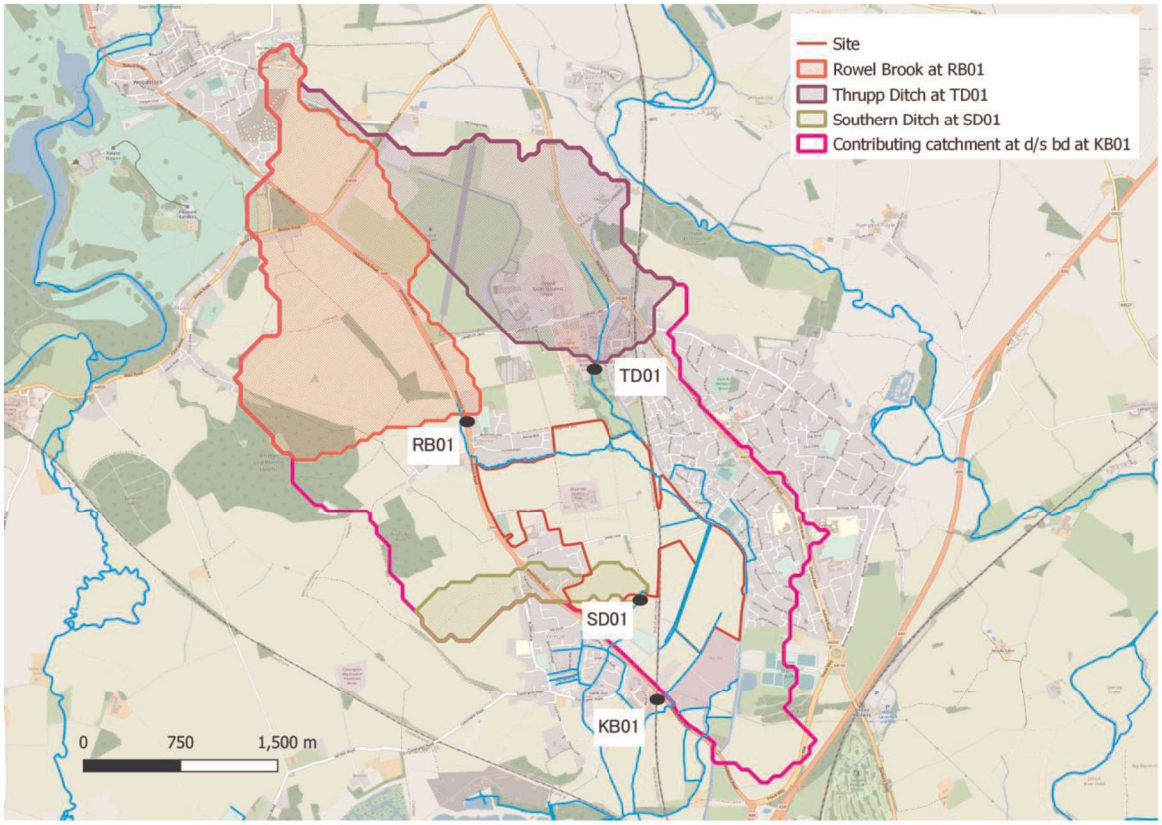

Figure 3 Locations selected for the purposes of the FEH analysis

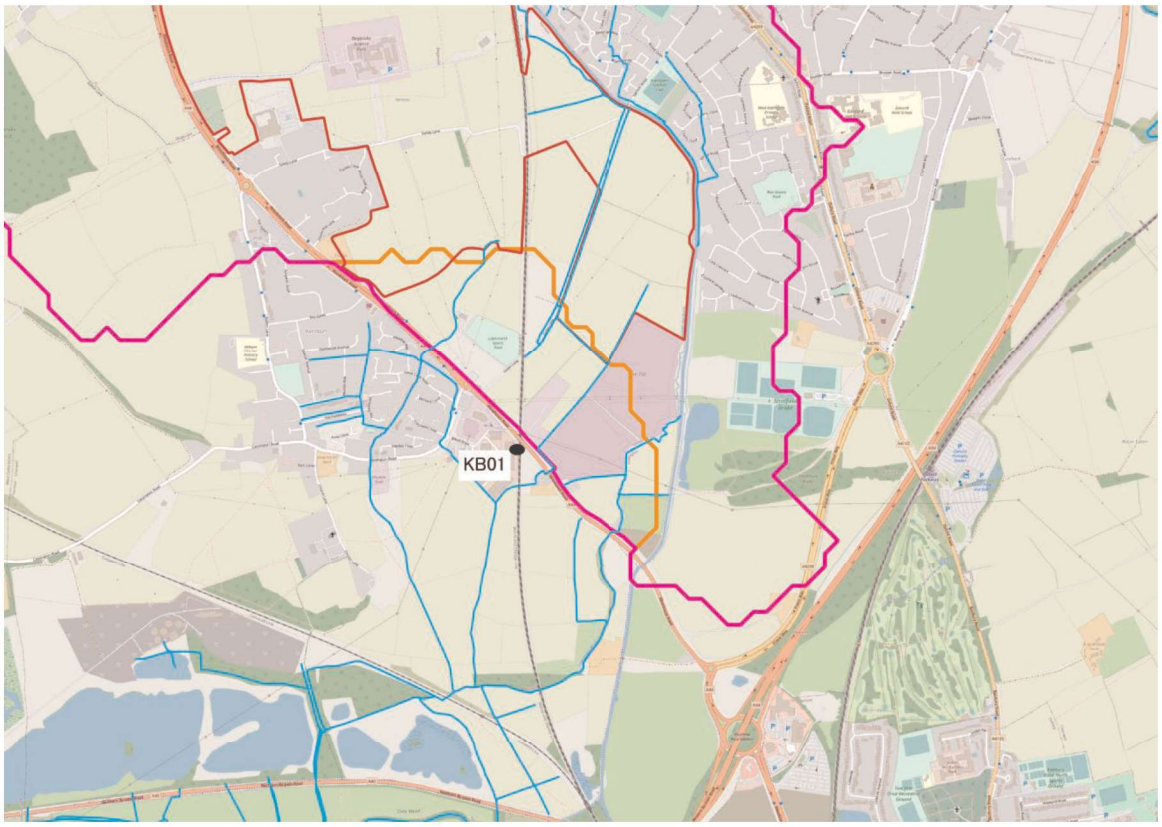

Figure 4 Changes to KB01 FEH catchment boundaries near the site

Catchment Description:

The main watercourses and ditches near and on the site of interest are shown in Figure 2. The Rowel Brook originates west of Oxford Airport and drains east the A44. It then turns south towards Begbroke, where is culverted and flows east across the northern boundary of the proposed development site. It then bifurcates, with the north eastern branch from the bifurcation flowing north and then east. This branch joins with the the Thrupp Ditch and discharges into the Oxford Canal. The south eastern branch of the Rowel Brook flows through the site, it passes through a culvert under the railway line and then flows along the eastern edge of the site. It then flows in a pair of ditches along either side of Yarnton Lane and is routed through field drainage and under the A44 south of the site.

The Thrupp ditch drains a catchment north of the site. It flows south, east of Oxford Airport and west of the Oxford Canal. It joins with the Rowel Brook and Oxford Canal on the north eastern boundary of the site.

The Southern drainage ditch originates to the west of the railway within the site boundary and flows southwest through Yarnton.

2.3 Hydrometric Data

Source of flood peak data:

NRFA v11, released September 2022, contains data up to the end of September 2021.

Gauging stations (flow and level):

Watercourse	Station name	Gauging authority number	NRFA number	Catchment area (km²)	Type (rated / ultrasonic / level…)	Start of record and end if station closed
River Thames	Days Weir		39002	3444.7	Miscellaneous	1938 - 2018

Data available at each flow gauging station:

Station name	Data source	Data type	Start and end of flood peak record	Update for this study?	OK for QMED?	OK for pooling?	Data quality check needed?	Station and flow data quality summary
Days Weir	1938 - 2018	AMAX	1938 - 2018	Outside scope	Yes	Yes	Outside scope	Calculated flows within 5% of measured flows, increasing to 10% at flows over 100m3/s.

Updates or revisions to flood peak data:

Outside scope

Data quality checks carried out:

Outside scope

Rating Equations:

Station name	Type of rating e.g., theoretical, empirical; degree of extrapolation	Rating review needed?	Comments and link to any rating reviews

Rating reviews:

Other data available and how it has been obtained:

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings		No		
Historical flood data	Yes	Yes	EA Historic flood map and recorded flood outlines dataset.	Site is shown and there are some areas to the east of the site that have flooded in the past.
Flow or river level data for events		No		
Rainfall data for events		No		
Potential evaporation data		No		
Results from previous studies		No		
Other data or information		No		

Conclusions of hydrometric data review:

Station name	Rating suitability	Suitability for flood estimation calculations	Non-stationary analysis requirements
Thames@Days Weir	Rating formulae based upon gaugings - tailwater calibration applies for flows > 70 cumecs	Gauge is suitable as QMED donor for the purposes of this study	Not required

2.4 Hydrological understanding of the catchment

Plots of flood peak data and interpretation:

NA

Plots of flow data and interpretation:

NA

Plots of stage data and interpretation:

NA

Conceptual model:

The site of interest comprises the fields surrounding Oxford Science Park, as shown in Figure 1. Flooding is likely to be caused by the capacity of the Rowel Brook and nearby channels being exceeded, resulting in overland flow. Peak flows are of primary importance as finished floor levels for the proposed development will be informed by the hydraulic modelling driven by design flows estimated for this study. Only the potential sources of fluvial flooding are covered within this assessment.

The hydrological connectivity within the area of study is affected by the presence of numerous field drains and ditches and by the interaction of the main watercourses near the site of interest with the Oxford canal. Therefore, the implementation of standard FEH approaches has been aided by the implementation of a direct rainfall model to gain a more comprehensive understanding of hydrological connectivity and flow paths in the area of interest.

Unusual catchment features:

All FEH catchments in Figure 1 are classified as small. With respect to urbanisation levels, the following applies:

- Rowel Brook is classified as essentially rural;
- Thrupp ditch is classified as heavily urbanised;
- Southern drainage ditch and overall FEH catchment at d/s hydraulic model extent are both classified as moderately urbanised.

According to their BFIHOST19 values, all FEH catchments in Figure 1 except the Southern Drainage ditch catchment are classified as groundwater dominated, according to current FEH guidelines[2].

2.5 Initial choice of approach

Are FEH methods appropriate?

FEH methods are appropriate according to current FEH guidelines[2]. In line with the guidelines on the implementation of the Statistical method on small catchments, QMED should be adjusted by using one single donor and the small catchments method should be implemented in the pooling group selection process. The latest advice from the EA is, however, to assess the small catchments SDM approach against the standard SDM approach when deriving pooling groups using NRFAv11[3]. It should be noted, however, that a comparison of the recommended small catchments method with the standard method in pooling group selection has not been undertaken at this stage of analysis and will be carried out when the hydrological assessment is finalised in the next stage of analysis.

Current guidance on the implementation of ReFH2 on heavily urbanised catchments is to use:

- a Tp scaling factor of 1;
- a summer storm if the catchment is highly permeable (BFIHOST19 is > 0.65).

The indication is also for heavily urbanised catchments to treat the catchment as rural, as the small catchments research found that this approach would lead to more accurate flood frequency estimates, according to FEH guidelines[2]. The guidelines also suggest that the statistical method should be used in preference to the rainfall-runoff approach when estimating peak flows on groundwater dominated catchments.

Initial choice of method(s) and reasons:

The Statistical method and ReFH2 model are going to be applied to derive and compare peak flow estimates at the main inflow locations, namely RB01, TD01, and SD01 in Figure 3. The same standard FEH approaches are going to provide estimates for the FEH catchment at the d/s location KB01, also shown in Figure 3. It is anticipated that, given the characteristics of the study catchments, statistical estimates are going to be preferred. Hydrograph shapes are going to

2 LIT11832 Environment Agency Flood Estimation Guidelines, published 23/12/2022

3 Environment Agency, Flood estimation impacts of updating from NRFA v10 to v11 Evidence & Risk – National Flood Hydrology Team Published: 22/12/2022

be derived from ReFH2, with one or more appropriate storms selected to be applied across all subcatchments in order to represent the conditions maximizing flood risk at relevant locations.

How will hydrograph shapes be derived if needed?

ReFH2

Will the catchment be split into sub-catchments? If so, how?

The intervening area at KB01 is to be split into sub-catchments defined according to the DRM results.

Software to be used:

WINFAP5

ReFH2 version3.3

3. Locations where flood estimates are required

3.1 Summary of subject sites

Site code	Type of estimate: lumped (L) or sub-catchment (S)	Water-course	Site name / descrip-tion	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA (if altered) (km^2)
RB01	L	Rowel Brook	Upstream inflow	446041	215112	3.24	n/a
TD01	L	Thrupp ditch	Upstream inflow	447477	215536	2.49	n/a
SD01	L	Southern drainage ditch	Upstream inflow	447443	212772	0.505	n/a
KB01	L	Kingsbridge Brook	Downstream estimation point	447376	214287	12.66	13.25
IC01	S	Kingsbridge Brook	Intervening catchment	447376	214287		7.015

3.2 Catchment Descriptors

Final catchment descriptors at each subject site:

Site code	FARL	PROPWET	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
RB01	1	0.32	0.807	1.85	16.2	628	0.0167	0.1381
TD01	1	0.32	0.87	1.53	14.9	618	0.216	0.2098
SD01	1	0.32	0.637	1.02	24.4	619	0.088	0.1584
KB01	1	0.32	0.759	4.12	15.4	620	0.122	0.2049

Catchment boundary checks and revisions:

The only adjustment made to catchment boundaries is for the catchment at KB01 to include a small southern portion of the site not included in the original FEH

catchment, thus increasing the catchment area to 13.25km^2 (see Figure 4). However, the assessment of the boundaries of the FEH catchment at KB01 against LiDAR DTM and knowledge of local features has highlighted that the catchment might not be well defined. It has, therefore, been assumed, that the overall FEH catchment at KB01 should be used as a base catchment for design peak flow and hydrograph calculations for the intervening area but a refinement to its boundaries would be needed. The results of the DRM model built for the area of interest are being used for this purpose. The DRM model has provided information about the flow paths which is also being used to refine catchment boundaries at the main inflow locations (RB01, TD01, and SD01) and the distribution of inflows from off and on site subcatchments to the main watercourses on site. Preliminary DRM results and subcatchments delineation are shown in Figure 5 and Figure 6.

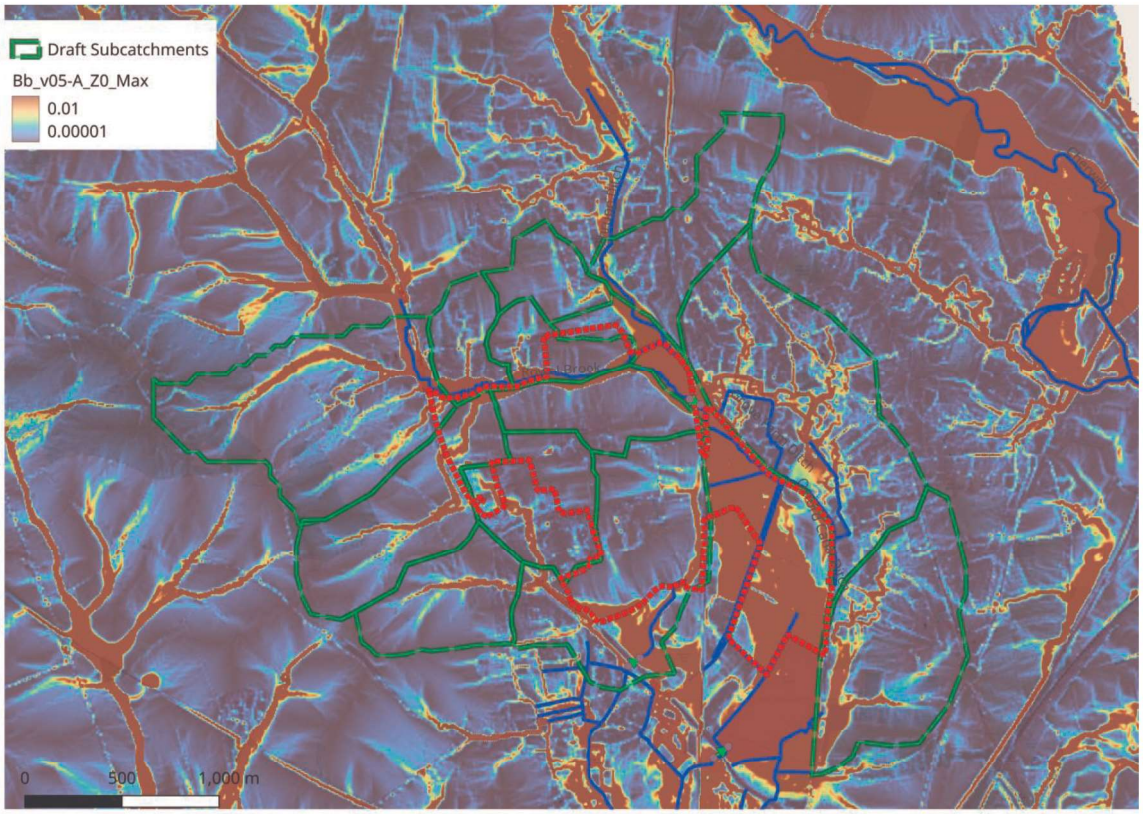

Figure 5 Preliminary results of the Direct Rainfall Model (unit flow, m2/s)

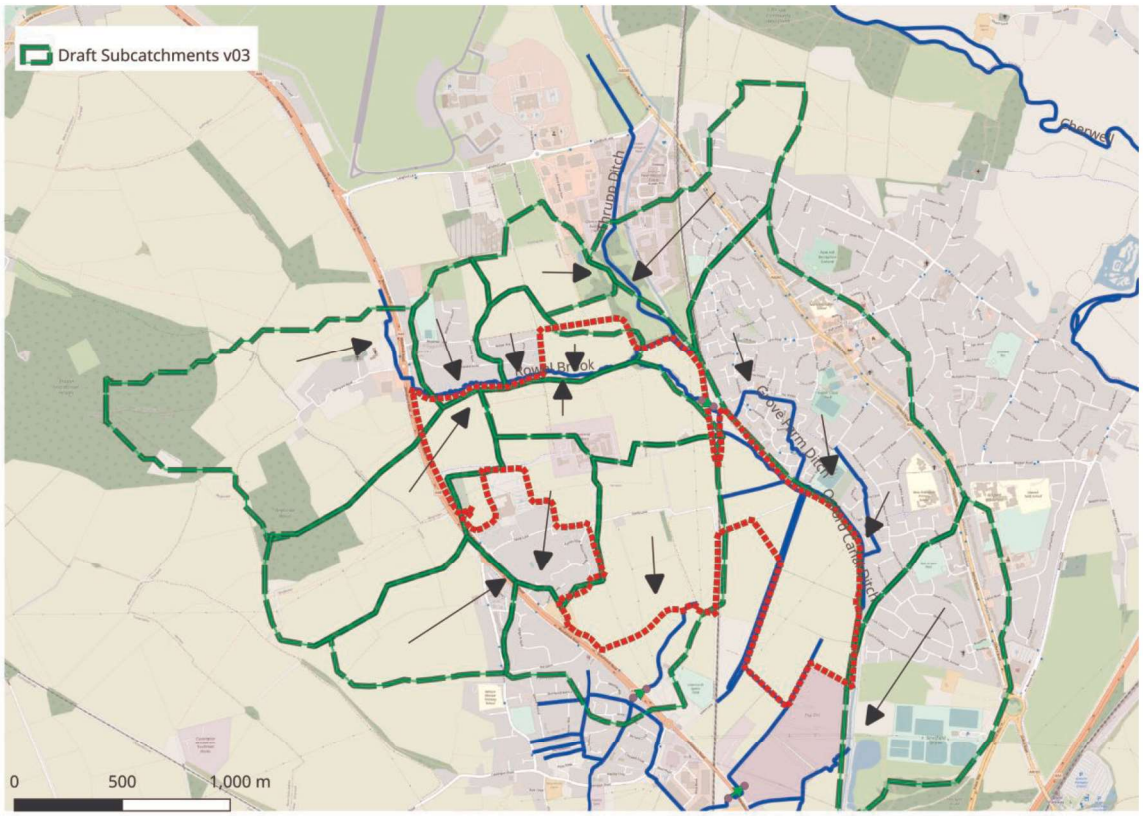

Figure 6 Draft subcatchments and associated direction of flow.

It should be noted, however, that the revision of FEH catchments boundaries and subcatchments delineation is likely to require further adjustments in the next stage of analysis upon gathering of additional information on local features and flow pathways. Therefore, at this stage of analysis, FEH catchments boundaries have not been amended and a preliminary FEH analysis has been carried out on the basis of FEH areas and associated descriptors as detailed in Tables 3.1 and 3.2. The outcome of this analysis is going to be revised once all adjustments have been finalised but it is anticipated that changes in terms of estimated peak flows are going to be relatively small.

URBEXT source and method for updating:

Default URBEXT2000 updated according to UEF (Section 2.3 FEH guidelines[2]) to present day.

BFIHOST source, checks and updates:

BFIHOST19 values are consistent with soils and geology maps. The area lies on a Limestone and mudstone sedimentary bedrock formation. The hydrological catchments include a variety of soils, mostly base-rich loamy and clayey.

Checks and revisions to other catchment descriptors:

FARL was checked against OS mapping and found to be appropriate.

4. Stationary statistical methods

4.1 Method overview

What is the purpose of applying these methods?

Peak flow estimation at all required inflow lacations and in addition at downstream location KB01.

What methods will be used to estimate QMED and growth curves?

Site code	Methods used for QMED	Methods used for growth curves
RB01	DT	
TD01	DT	
SD01	DT	
KB01	DT	Pooling, small catchment method

4.2 Estimating QMED

QMED at gauged subject sites:

Site code	Method (AM/ POT/LF)	Initial QMED (m^3/s)	Number of water years of data used	Adjustment for climatic variation?	Final QMED (m^3/s)

Methods: AM – Annual maxima; POT – Peaks over threshold; LF – Low flow (flow duration curve) statistics.

QMED at ungauged subject sites:

Site code	Method (CD/ DT/BCW)	Initial QMED (rural) from CDs (m^3/s)	Donors used (NRFA numbers)	Donor distances from subject centroid (km)	Individual donor weights	Combined and weighted donor adjustment factor	Urban adjustment factor	Final QMED (m^3/s)
RB01	DT	0.154	39002	15.28		1.020	1.045	0.164
TD01	DT	0.085	39002	16.76		1.015	1.901	0.164
SD01	DT	0.065	39002	16.52		1.022	1.142	0.075
KB01	DT	0.619	39002	16.51		1.019	1.289	0.814

Methods: CD - Catchment descriptors alone; DT - catchment descriptors with donor transfer; BCW - catchment descriptors with bankfull channel width.

Urban adjustment of QMED:

Urban adjustment procedures applied in WINFAP5 based on updated URBEXT2000 to present day.

Search for donor sites:

The search for potential suitable donors to all subject sites has mainly focused on evaluating the suitability of the closest gauge. This is also in line with current guidance on peak flow estimation on small catchments. The closest NRFA gauge to all subject sites except TD01 is 39002 (Thames@DaysWeir). The guage is approximately 15-16km away from all subject sites. Despite being characterised by a catchment area substiantially larger than all subject sites, 39002 has been selected as QMED donor, as it is a suitable donor and also provides conservative estimates of QMED at allnsubject sites. With respect to TD01, gauge 39002 is the second nearest suitable gauge to the subject site, the closest gauge being NRFA 39034 (Evenlode@Cassington). However, 39002 provides a more conservative estimate and has also been selected to ensure consistency in the donor adjustment factors calculated across the area of study.

Donor sites chosen and QMED adjustment factors:

NRFA no.	Method (AM/ POT/LF)	Adjustment for climatic variation?	QMED from flow data (m^3/s)	De-urbanised QMED from flow data (m^3/s) (A)	QMED from catchment descriptors (m^3/s) (B)	Adjustment ratio (A/B)
39002	AM	No	148.014	141.243	133.189	1.060

Methods: AM – Annual maxima; POT – Peaks over threshold; LF – Low flow (flow duration curve) statistics.