JBA Project Code Contract Client Day, Date and Time Author Reviewer/ Sign-off Subject

2017s6220 Eastleigh Hydrological Study Eastleigh Borough Council 5<sup>th</sup> December 2017; updated on 4<sup>th</sup> May 2018 Rebecca Thrower BSc MSc Duncan Faulkner MSc DIC MA FCIWEM C.WEM CSci Hydrological Assessment of the Itchen Headwater tributaries for application in the hydraulic model



#### 1.1 Terms of Reference

JBA Consulting was commissioned by Eastleigh Borough Council to investigate hydrological and ecological constraints within one of their boroughs, as part of plans to develop housing projects. As part of this commission, JBA Consulting was asked to advise on the alignment of the proposed North Bishopstoke Bypass to ensure that it has the least possible impact and that hydrological flows and stream systems can maintain their current functions. This Technical Note details the approach taken to deriving peak flow estimates on the headwater streams that fall within the River Itchen catchment.

#### 1.2 Overview

JBA are preparing new flood risk modelling and mapping for fluvial flood risk across the full River Itchen catchment for the Environment Agency, upstream of Wood Mill, Swaythling, including a number of tributaries. The headwaters being investigated for this study mostly fall within the Itchen catchment, and as such, are covered by the Hydrological Assessment undertaken for this new flood risk modelling and mapping study. The exception to this is where the headwaters within the study extent fall in the neighbouring River Hamble catchment; a full Hydrological Assessment has been undertaken to derive the peak flows and hydrographs for these flow estimation points (FEPs) and is documented in the 2017s6220 Ford Lake FEH calculation record v1.0 report. This Technical Note concerns the Itchen FEPs only (Figure 1-1).







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Contract	Eastleigh Hydrological Study
Client	Eastleigh Borough Council
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#### 2.1 Flow Estimation Points

The locations of the required flows (FEPs) are shown on the figure below, along with their estimated catchment boundaries. The majority of the FEP catchments are not accurately defined on the FEH CD-ROM, due to their small size and FEH not being designed for small catchments (<0.5km<sup>2</sup>). Topographic catchments have therefore been designed based on 1m LIDAR data, readily available through the data.gov.uk website.

The FEPs fall within the following tributary catchments of the River Itchen:

- Bow Lake Stream
- Stoke Park Stream
- Fair Oak Stream

This Technical Note should be read in conjunction with the 2016s5115 – Itchen – Other Watercourses – FEH Calculation Record (v2.0 September 2017) report, which provides indepth information on the catchment characteristics and the methods used to derive the final peak flow estimates.

Figure 2-1 to Figure 2-3 show the estimated catchment boundaries for each FEP, in relation to LIDAR data.







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Figure 2-2: FEP catchment boundaries within Stoke Park catchment









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Key characteristics of the overall catchments for which flow estimates were derived in the Itchen Tributary hydrology, referred to hereafter as donor catchments, are summarised in the table below.

Site code	Watercourse	Area	Any unusual characteristics	Final method	
BL_US	Bow Lake	15.97	Permeable (BFIHOST: 0.802)	FEH Statistical	
BL_DS		38.41			
FOS_USE	Fair Oak Stream	0.66	Heavily urbanised (URBEXT <sub>2000</sub> : 0.204)	FEH Statistical or Urban ReFH	
FOS_USW		1.03			
FOS_DS		3.43			
SPS_US	Stoke Park	1.95	Heavily urbanised (URBEXT <sub>2000</sub> : 0.281)		
SPS_DS		3.11			

Table 2-1: Key characteristics of catchments



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Figure 2-4: Study catchments in relation to the previous study's Bow Lake catchment

As indicated in Table 2-1, the Bow Lake catchment is highly permeable, due to the chalk underlying most of the catchment. However, the headwater streams of interest to this study are underlain by London Clay, which is impermeable and of very different geology to the rest of the catchment. The underlying geology and soil types in a catchment play a key



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role in determining its behaviour and response to heavy rainfall events. Since BFIHOST is therefore an important indicator in flood estimation, it is not considered appropriate to area-weight the Bow Lake hydrology to the study headwater catchments. Instead, a more hydrologically-similar catchment will be used. This approach of transposing flow estimates from a suitable catchment, rather than applying FEH methods directly to the Bow Lake FEPs, is considered appropriate in this case because no FEH catchment descriptors are available for the Bow Lake FEPs. Provided the catchment areas and other descriptors are similar, this approach will provide flow estimates in line with those that would be derived from applying FEH methods. This approach assumes that peak flow scales linearly with catchment area within the range of areas being considered.

As the Bow Lake streams are not available on the FEH CD-ROM, the peak flow estimates from the Ford Lake catchment will be area-weighted in place of the Bow Lake catchment. The Horton Heath catchment (Ford Lake) is considered representative of the Bow Lake streams, with similar geology (London Clay) and attenuation (limited attenuation in both). Given their proximity, average rainfall (SAAR) will be similar and generally, the catchments are characterised by similar topography. The URBEXT values of four of the Bow Lake catchments which feature properties, were checked to assess the urban extent and the influence it might have on the hydrology (Table 2-2).

	BL_FEP4	BL_FEP9	BL_FEP10	BL_FEP11
URBEXT2000	0.008	0.007	0.096	0.035
URBEXT1990	0.006	0.006	0.074	0.027
	Essentially rural	Essentially rural	Moderately urbanised	Slightly urbanised

Table 2-2: URBEXT values of Bow Lake study catchments



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Figure 2-5: Study catchments in relation to the previous study's Stoke Park Stream catchment

Similarly, the URBEXT values of the Stoke Park headwater streams were checked (Table 2-3); it is apparent that the Stoke Park Stream catchments used to derive flow estimates in the Itchen Tributaries hydrological assessment are not representative of the smaller headwater streams, due to less urban extent (Figure 2-5). For consistency, the peak flow estimates and hydrographs will be scaled from the Horton Heath catchments, as for the Bow Lake estimates.

Table 2-3: URBEXT values of Stoke Park Stream study catchments

	SP_FEP1	SP_FEP2
URBEXT2000	0.045	0.062
URBEXT1990	0.035	0.048
	Slightly urbanised	Slightly urbanised / moderately urbanised





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Figure 2-6: Study catchments in relation to the previous study's Fair Oak stream catchment

The study catchments are of relatively similar extent to the previous study's catchments, for which flow estimates were derived. As such, catchment characteristics will be broadly the same and the flow estimates are therefore considered representative. The only exception is the urban extent at FOS\_W\_FEP1, which will be essentially rural compared to the heavily urbanised nature of the downstream catchment. However, the impact on factors such as time to peak, is considered likely to be minimal, given the catchment's size.

#### 3 AREA-WEIGHTED APPROACH

The final hydrographs from each of the donor catchments have been scaled based on the area-weighting factor presented in Table 3-1. This has been carried out in an Excel spreadsheet, with the scaling factor applied to the whole hydrograph.

The estimated areas for each of the catchments based on the digitised catchment boundaries are shown in Table 3-1. Note, for some of the upstream FEPs which had a very small catchment, the catchment has been digitised from its downstream extent. Table 3-1 also shows the areas of the donor catchments, and the FEP which will be used for each study catchment. The flow hydrographs from these donor catchments will be area-weighted to the study catchments. Representative hydrograph shapes for the donor catchments are shown in Figure 3-1.

For the Bow Lake and Stoke Park Stream FEPs, which will use flow estimates from the Horton Heath Streams, two donor catchments have been selected (based on similar



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characteristics) and differ only in their urban extent; HAM\_FEP4 is considered essentially rural and HAM\_FEP9 is considered slightly urbanised.

Table 3-1: Area-weighted scaling factors

Donor catchment			Study catchment		Scaling
Donor catchment	Donor FEP	Area (km²)	Study FEP	Area (km²)	Tactor
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP1	0.07	0.18
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP2	0.11	0.28
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP3	0.03	0.08
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP4	0.26	0.67
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP4_IA	0.08	0.21
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP5	0.09	0.23
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP5_IA	0.06	0.15
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP6	0.37	0.95
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP6_IA	0.02	0.05
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP7	0.04	0.10
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP8	0.03	0.08
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP9	0.41	1.05
Horton Heath Stream	HAM_FEP4	0.39	BL_FEP9_IA	0.35	0.90
Horton Heath Stream	HAM_FEP9	0.21	BL_FEP10	0.08	0.38
Horton Heath Stream	HAM_FEP9	0.21	BL_FEP11	0.21	1.00
Horton Heath Stream	HAM_FEP9	0.21	BL_FEP11_IA	0.13	0.62
Horton Heath Stream	HAM_FEP9	0.21	SP_FEP1	0.06	0.29
Horton Heath Stream	HAM_FEP9	0.21	SP_FEP2	0.42	2.00
Horton Heath Stream	HAM_FEP9	0.21	SP_FEP2_IA	0.36	1.71
Horton Heath Stream	HAM_FEP4	0.39	SP_FEP3	0.04	0.10
Horton Heath Stream	HAM_FEP4	0.39	SP_FEP4	0.19	0.38
Horton Heath Stream	HAM_FEP4	0.39	SP_FEP4_IA	0.15	0.08
Fair Oak Stream (West)	FOS_USW	1.03	FOS_W_FEP1	0.12	0.12
Fair Oak Stream (West)	FOS_USW	1.03	FOS_W_FEP2	0.92	0.89
Fair Oak Stream (West)	FOS_USW	1.03	FOS_W_FEP2 _IA	0.80	0.78
Fair Oak Stream (West)	FOS_USW	1.03	FOS_W_FEP3	0.08	0.08
Fair Oak Stream (East)	FOS_USE	0.66	FOS_E_FEP1	0.05	0.08





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Fair Oak Stream (East)	FOS_USE	0.66	FOS_E_FEP2	0.26	0.39
Fair Oak Stream (East)	FOS_USE	0.66	FOS_E_FEP2 _IA	0.21	0.32
<b>Note</b> : HAM_FEP4 was chosen to represent the essentially rural Bow Lake catchments and HAM_FEP9 was chosen to represent the slightly urbanised to moderately urbanised BL_FEP11 and BL_FEP10.					
The study FEPs highlighted in bold are the ones that will be applied to the hydraulic model.					



Figure 3-1: Representative hydrograph shapes

#### 4 SUMMARY

All streams that fall within the Bow Lake catchment have been applied hydrology from the Horton Heath catchment. Refer to the report titled, *2017s6220 Ford Lake FEH calculation record*, for full details on the hydrological assessment for this catchment. Equally, the



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hydrology of the streams within the upper Stoke Park Stream catchment will also be informed by this donor catchment.

The hydrological estimates for the streams within the Fair Oak catchment will be informed by the peak flow estimates and hydrographs taken from the previous study on the Itchen tributaries, given the similarities in catchment descriptors. For further details about the catchment and the methods used to derive the hydrology, refer to the report titled, 2016s5115 – Itchen – Other Watercourses – FEH Calculation Record (v2.0 September 2017).

A limitation of this hydrological assessment is the lack of observed data available for the study streams. The streams considered for flow estimation within this study are ungauged and therefore it is not possible to verify or improve the flow estimates with observed catchment data. The methods used in this assessment are considered appropriate to data available at the time and to the scope of the study.

