Technical Note – Clarification on Paragraph 6.2.35

DATE:	30 July 2021	**CONFIDENTIALITY:**	Internal
SUBJECT:	Rother Valley Railways – Para 6.2.35 - WATER		
PROJECT:	70047158	**AUTHOR:**	Chris Patmore
CHECKED:		**APPROVED:**	

CLARIFICATION OF PROOF OF EVIDENCE OBJ/1002/CP-01

This note has been prepared as clarification of the numbers and source for the statement contained in Paragraph 6.2.35 of my Proof of Evidence OBJ/1002/CP-01.

The paragraph states:

"6.2.35. Capita (and the original EA model) adopted design flow events based on ReFH. However, a comparison of flow estimates in one location (S3) shows a 27% flow reduction in the 1% AEP estimates based on ReFH in comparison to the flow estimate indicated by the reported statistical analysis. ReFH calculated 47.3 cumecs whereas the Statistical estimate is 60.4 cumecs. This high degree of variations between two flow estimate suggests that further hydrological analysis is required. The sensitivity testing discussed earlier is absent and this could drastically impact the model results in terms of flood depths and area extents."

Section 6.2.35 of my proof of evidence OBJ/1002/CP-01 was looking at the potential uncertainty of the values used to build the flood model. This particular paragraph looked at the input hydrology with reference to other studies for the same area.

One of these studies was undertaken by Hyder on behalf of the Environment Agency to update and provide information to help update the EA published flood mapping (River Rother, Project Reference SO004 - Final Hydraulic Modelling, ABD and Hazard Mapping Report, dated 29/07/11). Extracts from which are contained as Appendix A.

Although this report and its analysis are earlier than most of the RVR submitted analysis, these demonstrate that this area can be difficult to establish hydrology and that the different methodologies available to calculate and estimate flows entering the system from wide catchments can give vary different values.

The values quoted in Paragraph 6.2.35 are taken from Table 3-3 of the main report: see below

Table 1: Table 3-3 (page 21) of the Hyder Hydraulic Modelling, ABD and Hazard Mapping Report

Table 3-3 Comparison of ReFH and Statistical Peaks at the 1 in 100 year (1% AEP) Event

	Comparison of 1-in-100 year Model Inflows (m^3/s)			
	S1	**S3**	**S5**	**S7**
ReFH 1% AEP	86.5	47.3	34.2	42.0
Statistical 1% AEP	83.4	60.4	21.2	36.5
Percentage Change	+4%	-27%	+61%	+15%

The S3 catchment is one of the identified catchments discharging into the River Rother near to and upstream of Robertsbridge – see below

Figure 1: Figure 3-1 Delineation of Hydrological Subcatchments across the Modelled Reach (page 19) of the Hyder Hydraulic Modelling, ABD and Hazard Mapping Report

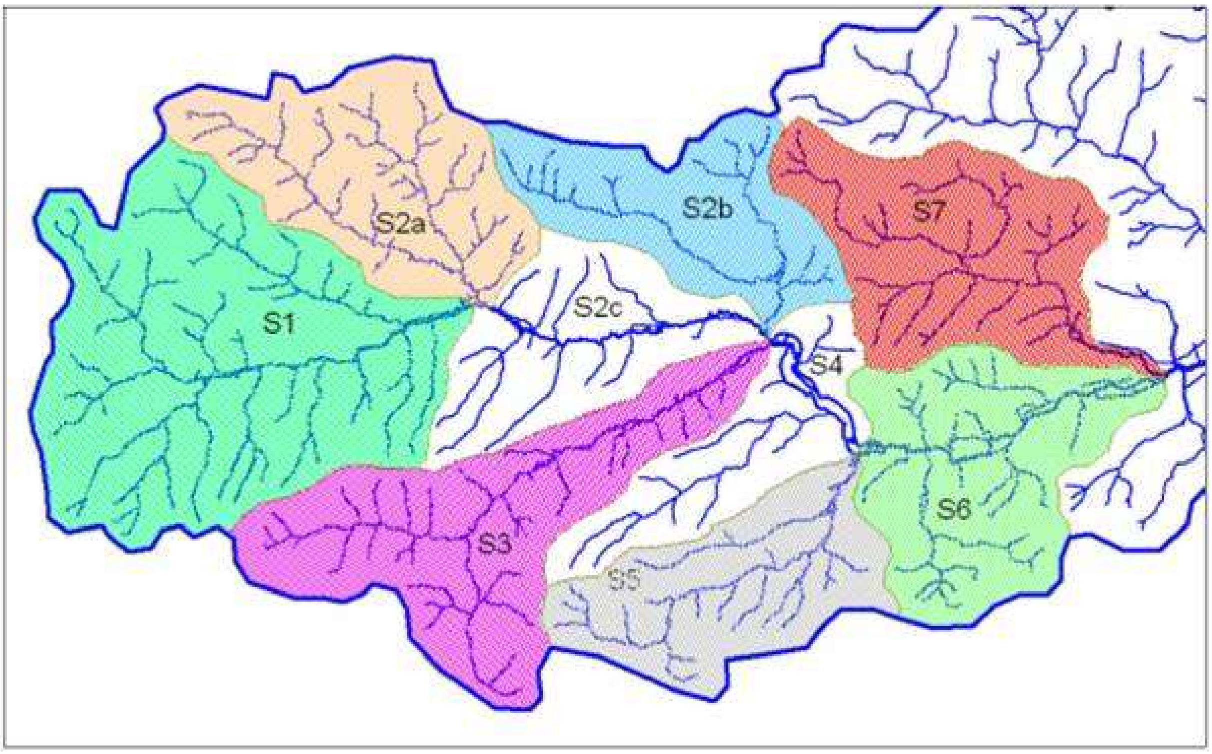

Figure 3-1 Delineation of Hydrological Subcatchments across the Modelled Reach

In terms of my evidence, the Proof of Evidence RVR/W7/2 by Mrs Callaway included the EA letter dated 26 May 2021 (Appendix B – EA confirmation flood estimation calculations are fit for purpose) which now suggests that the EA have approved at least this hydrology element of the model.

APPENDIX A

Extracts from River Rother, Project Reference SO004 - Final Hydraulic Modelling, ABD and Hazard Mapping Report

Environment Agency

River Rother

Project Reference SO004

Final Hydraulic Modelling, ABD and Hazard Mapping Report

S7	Point inflow	27	Catchment area of the Kent Ditch

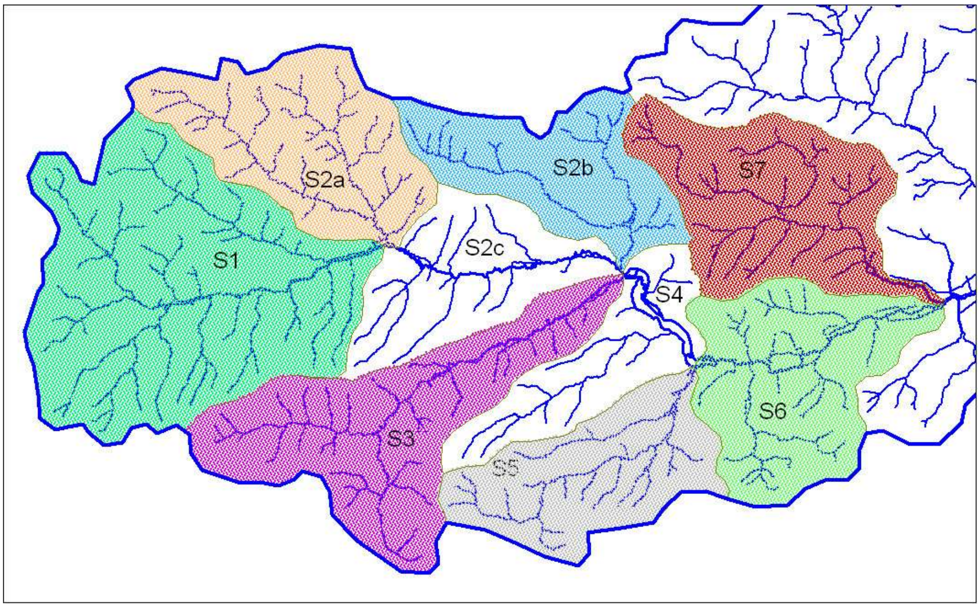

Figure 3-1 Delineation of Hydrological Subcatchments across the Modelled Reach

3.3 Model Calibration

The subcatchment inflows listed in Table 3-1 were defined in the hydraulic model as ReFH units. For those subcatchments representing discrete tributaries, catchment descriptors were imported directly from the FEH CD-ROM (v3). In the case of the lateral inflows, however, the catchment descriptors were calculated manually based on the procedures outlined in Volume 5 of the Flood Estimation Handbook[4].

Once all ReFH boundaries were created, observed rainfall was defined for each of the calibration events (October 12th 2000, October 30th 2000 and November 6th 2000) based on an appropriate area weighting of the recorded rainfall at Coggins Mill and Robertsbridge TBR raingauges.

Whilst the model calibration is further described in section 0, the relevance for the hydrological assessment is that the best model simulation of the historical events was achieved without any adjustment factors to the time-to-peak, baseflow or percentage runoff parameters. In particular the simulated flood outline for the October 12th 2000 event agreed closely with the EA's historical outline, and matched the recorded flow at Udiam based on the revised rating.

Indeed, the rating at Udiam was revised as part of this study because it was recognised that the flows given by the previous rating, derived by Atkins, for the October 12th event were much lower than the model indicated was necessary upstream at Robertsbridge to obtain the recorded flood extent. Detail of the revision to the rating at Udiam is given in the Hydrology Addendum Report[3].

[4] Bayliss. A, 1999, Flood Estimation Handbook – Volume 5: *Catchment Descriptors*, pp.64-68

3.4 Design Flood Estimation

3.4.1 Approach

For each return period assessed, design rainfall was obtained from a ReFH unit representing the entire Rother catchment at Udiam gauge; using the recommended critical storm duration of 14.5 hours. (The storm duration of 14.5 hours is considered the most appropriate for simulation given that it corresponds both to the critical duration at Udiam and Robertsbridge.) This rainfall was then applied to each of the inflow boundaries such that a spatially uniform catchment-wide storm could be represented. Based on the results of the hydraulic calibration exercise, no adjustments were applied to either peak flow or time-to-peak parameters.

The only adjustments made were that the design storms at Udiam were derived using both Areal Reduction Factor (ARF) and Seasonal Correction Factor (SCF) values of unity. ARF and SCF parameters vary between one and zero; reducing these values has the effect of reducing the depth of the design rainfall (as a proportion of rainfall obtained from the Depth Duration Frequency model). Kept unchanged, the resultant design rainfall was shown to be overly low when compared with the rainfall depths that had led to a successful calibration to the October 12th 2000 flood outline. Given that neither of these factors have a bearing on the rainfall used in the calibration events, it was decided to set them both to unity in order to ensure that the design rainfall is consistent in magnitude with the calibration event rainfall.

Using the above described approach, the resultant peak inflows for all of the hydrological nodes are summarised in Table 3-2 below.

Table 3-2 Peak Flows Determined from ReFH Units

Return Period	Design Flood Event Peak flows (m^3/s)								
	S1	**S2a**	**S2b**	**S2c**	**S3**	**S4 ***	**S5**	**S6 ***	**S7**
5	35.6	21.4	13.4	22.0	19.6	12.0	14.0	21.2	17.3
10	43.6	26.4	16.5	27.2	24.0	14.8	17.2	26.1	21.2
20	53.4	32.4	20.2	33.5	29.3	18.1	21.1	32.0	25.9
50	70.0	42.7	26.5	44.1	38.4	23.8	27.7	42.1	34.0
75	79.2	48.3	30.0	50.0	43.4	26.9	31.3	47.6	38.4
100	86.5	52.9	32.7	54.7	47.3	29.3	34.2	52.1	42.0
100+CC	103.7	63.4	39.3	65.7	56.8	35.2	41.0	62.5	50.3
250	115.4	70.8	43.7	73.4	63.1	39.1	45.6	69.6	56.0
1000	182.7	112.3	69.3	117.0	100.0	62.1	72.2	110.4	88.8

** Note that flows at S4 and S6 are for their respective subcatchments and are not directly comparable with values quoted in the Interim Hydrology Report which referred to estimates on the Rother for the total catchment upstream thereof*

3.4.2 Comparison with Statistical Method Inflows

The flow estimates which are directly comparable with statistical estimates of design flows given in the Hydrology Addendum Report[3] are those at nodes S1, S3, S5 and S7. These estimates were previously based on a flood growth curve determined from a statistical method single-site analysis undertaken at Burwash gauging station. Comparisons of the 1 in 100 year (1% AEP) flows are given in Table 3-3 below.

Table 3-3 Comparison of ReFH and Statistical Peaks at the 1 in 100 year (1% AEP) Event

	Comparison of 1-in-100 year Model Inflows (m^3/s)			
	S1	**S3**	**S5**	**S7**
ReFH 1% AEP	86.5	47.3	34.2	42.0
Statistical 1% AEP	83.4	60.4	21.2	36.5
Percentage Change	+4%	-27%	+61%	+15%

In relative terms, the flow estimates at nodes S1 and S7 agree well with the statistical method analysis. At S5, the apparent increase in flow is largely a result of the fact that this subcatchment (the River Darwell) has a FARL value of 0.87 indicating a potentially significant influence of reservoirs on flood risk. While this parameter is accounted for by the statistical analysis (through the estimation of QMED), in the ReFH method it is not taken into account. As a result the statistical estimates are lower; although in reality the response of the Darwell will depend on the antecedent water level in the reservoirs when the design storm commences.

The apparent reduction in the 1 in 100 year (1% AEP) estimate at S3 is thought to be largely a function of the QMED adjustment factor derived at Burwash. Since the magnitude of the QMED adjustment is a function of distance between catchment centroids, this adjustment has a greater influence at node S3 than the other nodes given in Table 3-3. As such, the degree of variation between the two flow estimates at S3 is likely to reflect the degree of uncertainty in the QMED estimated from AMAX data at Burwash.

Therefore it is considered that the statistical estimates and the ReFH estimates are in broad agreement.

3.4.3 Comparison at Udiam

In terms of understanding whether the catchment as a whole was representing the design flood events as expected, a comparison was made between the modelled output at Udiam gauging station and the statistical method estimates determined at this location (documented in the Hydrology Addendum Report[3]). This comparison is shown in Table 3-4 below.

Table 3-4 Comparison of ReFH and Statistical Peak Flows at Udiam

Return Period	Design Flood Estimates at Udiam (m^3/s)		
	Model Output	Statistical Single-site (GEV), $QMED_{AMAX}$ = 39.3m^3/s	Statistical Single-site (GEV), $QMED_{CD}$ = 49.9m^3/s
1 in 5 year (20% AEP)	76.8	64.7	82.0
1 in 10 year (10% AEP)	102.9	86.1	109.2
1 in 20 year (5% AEP)	129.2	110.3	139.9
1 in 50 year (2% AEP)	182.9	148.2	188.0
1 in 75 year (1.33% AEP)	210.1	167.6	212.5