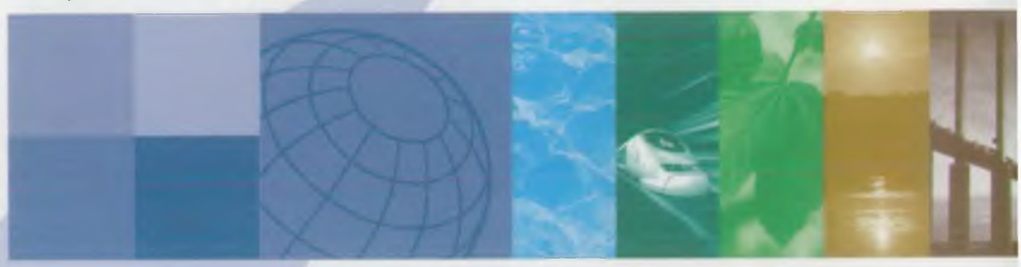
EA - South West

# Environment Agency
# South West Region

North Wessex Gauging Stations Pooling Group Review

Main Report

September 2003



**Halcrow Group Limited**

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# Environment Agency
# South West Region

North Wessex Gauging Stations Pooling Group Review

Main Report

## Contents Amendment Record

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# 1 Introduction

## 1.1 *Background*

The Environment Agency South West Region (Agency) commissioned Halcrow Group Limited (Halcrow) to determine flood frequency at 30 flow gauges in the North Wessex area using the statistical method of the Flood Estimation Handbook (FEH). Halcrow performed a similar study for South West Region South Wessex area on 13 flood warning sites which was reported in "South Wessex Flood Warning Pooling Group Review" (July 2002).

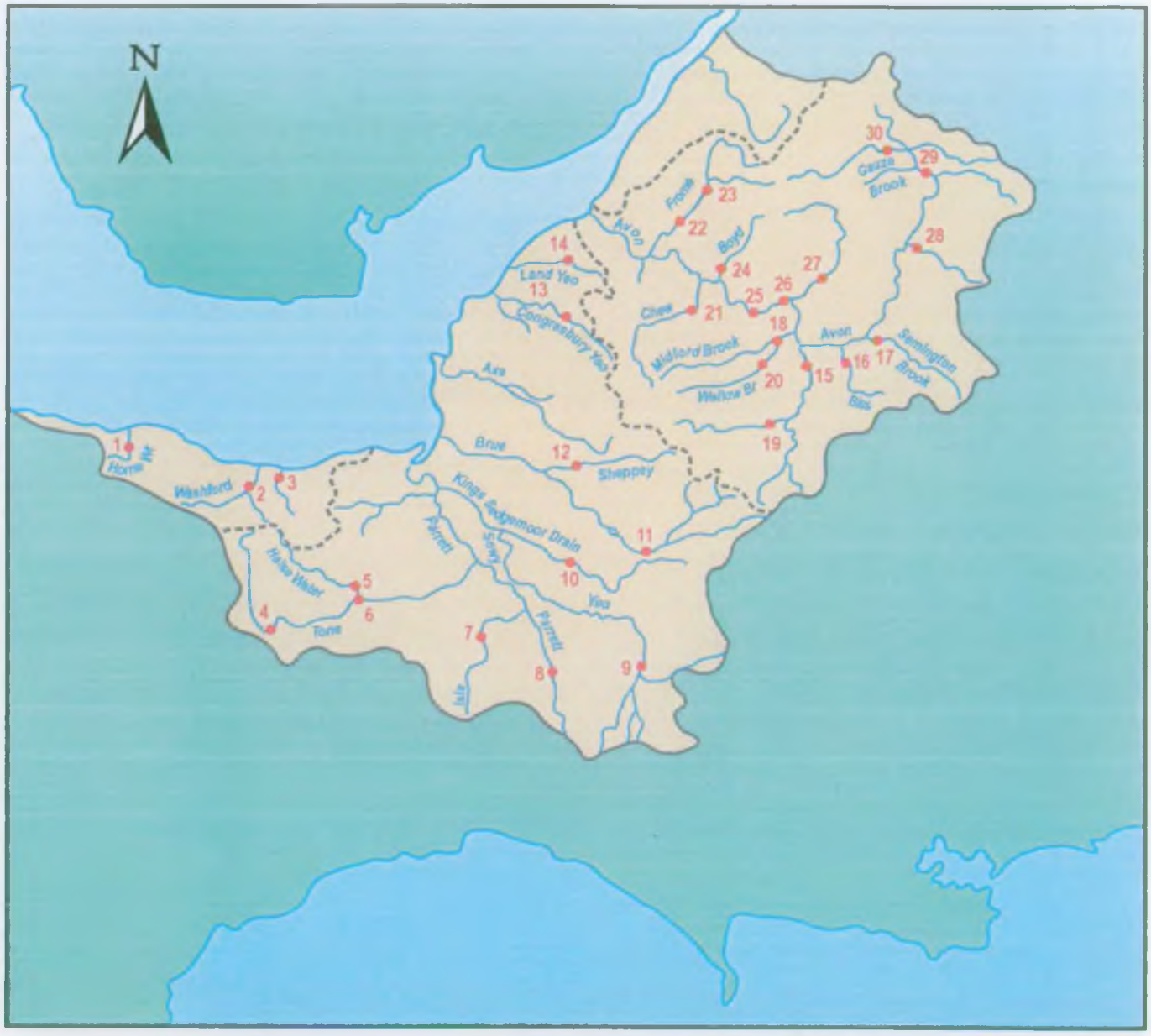
The brief was received by email from Liz Holme (Agency) to Ian Rose (Halcrow) dated 20 February 2003 and Halcrow detailed the study methodology in the Project Plan (March 2003). The brief requests that FEH statistical analysis is performed using a target return period of 200 years and the recommended flood frequency estimates increased by a factor of 20% to allow for climate change as recommended by DEFRA and PPG25. The study does not undertake any review of the gauge ratings. A full list of the 30 gauged locations for investigation is given in Appendix A.

A pilot study was undertaken on six of the thirty sites which was reported in May 2003. The pilot study methodology followed a similar format to that of the South Wessex study, and was undertaken to confirm the approach and reporting procedures with the Agency prior to commencement of the main study. This report details the results of the analysis of all thirty gauges stations, including the six pilot study sites for completeness.

## 1.2 *North Wessex Area*

North Wessex area of the Agency's South West Region covers approximately 6,000km$^2$ and includes, Somerset, parts of South Gloucestershire and north west Wiltshire. In the north lies the Bristol Avon catchment with its major tributaries rising in the Mendips, Salisbury Plain and the Cotswolds before flowing through the urban area of Bath and to the tidal limit in Bristol. This compares to the mostly rural areas of the south containing the Somerset Levels and Moors that are fed by the rivers Parrett and Tone from the Quantock Hills, Brendon Hills and Dorset Heights. As can be seen in Figure 1, the thirty gauging stations selected for analysis are spread across the whole of the North Wessex area giving a full representation of the areas characteristics.

Figure 1: **LOCATION OF PROJECT GAUGING STATIONS**




**Key to Gauging Stations**

| | | | | | |
|---|---|---|---|---|---|
| 1 | West Luccombe | 11 | Lovington | 21 | Compton Dando |
| 2 | Beggearn Huish | 12 | Fenny Castle | 22 | Frenchay |
| 3 | Swill Bridge | 13 | Iwood | 23 | Frampton Cotterell |
| 4 | Greenham | 14 | Wraxall | 24 | Bitton |
| 5 | Halsewater | 15 | Tellisford | 25 | Bath Utrasonic |
| 6 | Bishops Hull | 16 | Trowbridge | 26 | Bathford |
| 7 | Ashford Mill | 17 | Semington | 27 | Middlehill |
| 8 | Chiselborough | 18 | Midford | 28 | Stanley |
| 9 | Pen Mill | 19 | Vallis | 29 | Great Somerford |
| 10 | Somerton | 20 | Wellow | 30 | Fosseway |

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# 2 Analyses

## 2.1 *Introduction*

The methodology and reporting procedure were confirmed in the pilot study. Six of the thirty study sites were analysed in the pilot study. These were selected to be representative of the diverse nature of catchments in the North Wessex area and to include any potentially awkward or unusual sites that may raise issues in their analysis. The six sites selected for the pilot study were:

- Horner Water @ West Luccombe (51002)
  A small (20.49 km$^2$) and steep catchment draining the north of Exmoor.

- Tone @ Bishops Hull (52005)
  A medium sized catchment included to compare results with previous analysis.

- Yeo @ Pen Mill (52006)
  Mid sized rural catchment centrally located in the North Wessex area.

- Chew @ Compton Dando (53004)
  Rural catchment that contains the Chew Magna Reservoir, included in assess reservoir influence on the attenuation of flood flows.

- Frome (Bristol) @ Frenchay (53006)
  Moderately urbanised catchment (URBEXT = 0.0713) that includes the outskirts of Bristol.

- Avon @ Bathford Combined (53018)
  A large catchment with a long data record, 62 years, included to ability of FEH statistical method to reproduce long data records.

The only major issue to arise out of the pilot study was at the Chew @ Compton Dando. As a consequence of the presence of the Chew Magna reservoir there is a significant attenuation of peak flood flows. As a result the FEH Statistical Method was demonstrated to be unsuitable in the estimation of the return period of peak flood flows and a alternative methodology, such as the rainfall runoff method involving the simulation of the reservoir behaviour was recommended. From this

recommendation a FEH statistical analysis was not undertaken on the Congresbury Yeo @ Iwood (52017), only a single site analysis is included in this report. This catchment contains the Blagdon storage reservoir, and has similar catchment features to the Chew @ Compton Dando.

## 2.2 *Data Updates*

The FEH recommends that the annual maximum flow series (AMAX) be updated in the FEH database of flood peaks for all subject sites and members of the pooling groups. Preliminary pooling groups were identified using a target return period of 200 years for each of the thirty subject sites. Requests for AMAX series updates were made for each gauging station ranked in the top ten of a pooling group. As a result of the diversity of the stations under investigation, this produced a request for 110 AMAX series updates in addition to the updates of AMAX series for each of the 30 subject sites and five stations already obtained as part of a recent study.

Where available the AMAX updates include peaks from the current water year (2002 – 2003), on the assumption that the major peaks recorded in the period December 2002 to January 2003 are unlikely to be exceeded in the remainder of the water year.

Halcrow would like to thank the Agency for their assistance in obtaining updates for the data sets. In the event that data received from the Agency differed from that provided in the WINFAP database the Agency data was assumed to supplant any previous information to ensure consistency in the use of ratings.

The final study was carried out using updated information for 72 gauging stations received by Halcrow, though 9 of these stations have been discontinued. Details of all data updates obtained are listed in Appendix B. Data updates received after the pilot study did not affect those six analyses and the sites have not been revisited.

## 2.3 *Analysis*

The analyses for each of the gauging stations are summarised in data sheets in Appendix C. A data sheet for each gauging station comprises the following:

- *Summary sheet:* Includes details of the catchment and catchment descriptors, QMED estimates, flood frequency estimates, summary of analysis and selection of method and includes the following assumptions:

- Gauge ratings were not reviewed though comments on their upper limits with respect to the AMAX series are noted as well as any other issues resulting a potential loss of data quality from gauge rating information provided by the Agency.
- QMED estimated by catchment descriptors uses the equations in FEH Vol3 Ch 3.3 only and does not include any urban or permeable adjustment.
- The confidence interval for the pooled FFC is that for QMED: uncertainty in the estimation of the growth curve is not accounted for in the confidence interval.
- No urban adjustment was made to QMED estimated from AMAX data series as all non-rural sites analysed are currently gauged (FEH Vol 3 Ch 9.3).
- No adjustment for climate variation was applied to QMED. Climate variation refers to the changing variability of the flood record, unlike climate change which concerns the future trend in flood statistics. When estimated from the flood record QMED can be unrepresentative of its long term value if its record is limited to a flood-rich or flood-poor period. The climate variation adjustment aims to make QMED more representative of its long term value. FEH Vol 3 Ch20 recommends adjustment if the AMAX series is less than 14 years, is optional for longer records and unnecessary for records longer than 30 years. In this study only one station has a record of less than 14 years, the Bath Ultrasonic on the Avon, where QMED was estimated instead by data transfer from an adjacent station.
- The Climate Change Sensitivity Estimate adds 20% to the recommended method for adoption and is included as a measure of sensitivity to climate change as recommended by DEFRA. This data is particularly useful for providing the information needed under PPG25.
- For each flood frequency analysis, the index flood, QMED, was estimated from the AMAX data series for the subject site.
- The FEH statistical method was the only technique of flood frequency estimation applied.
- The recommendation of a growth curve by joint analysis, combining results of the pooled growth curve and the single site growth curve has not been made in this study. This approach is only recommended if the subject site record is longer than the target return period which is not the case for any for the thirty sites under investigation.

- *Flood frequency curves*: Plots of:
  - (i) AMAX series at the subject site project located by Gringorten plotting position.
  - (ii) Flood frequency estimated using pooling group analysis with the Generalised Logistic distribution fitted in all cases.
  - (iii) Flood frequency estimated using pooling group analysis with an urban adjustment applied where applicable (ie, URBEXT ≥ 0.025).
  - (iv) The upper and lower limits of the 95% confidence interval of the (adjusted where applicable) pooled flood frequency curve.
  - (v) Flood frequency of the single site (subject site) by generalised logistic distribution.

- *AMAX data*: A plot and tabulation of the AMAX time series. Exploratory Data Analysis (EDA) is summarised in a box plot in which the box covers the inter-quartile range of the data and the bars extend to the upper and lower cut-offs (lying 1.5 x the inter-quartile range beyond the limits of the box). Data points lying outside the cut-offs are outliers. The validity of the outliers has not been reviewed, though all data was retained for analysis. Estimates of QMED are made using catchment descriptors and from the median of the annual maximum series, as well as an estimate of the 95% confidence interval using FEH standard procedure (FEH Vol 3 Ch 12).

- *Diagnostic plots*: These plots are produced by the WINFAP-FEH software and apply to the pooled dataset after its review. The plots display certain characteristics of the project site data in comparison with the other members of the pooling group and the distribution of the pooling group in comparison with all the members of the WINFAP database.

- *Pooling group review*: This table records the steps taken in reviewing the pooling group at each site, highlighting outliers to the pooling group and reasons for retaining or removing any gauging station. A target return period of 200 years was assumed, which in order to satisfy the 5T rule for pooling groups (pooling groups should have at least 5T stations years, where T is the target return period) resulted in large pooling groups. Large pooling groups tend to display a high degree of heterogeneity ($H_2$) and hence require review. In practice, the number of station years is the dominant effect on heterogeneity and decreases as stations are removed in the review, and has only a slight influence on the shape of the pooled growth curve.

- *Pooling group*: This table details information on the gauging stations in the reviewed pooling group and in their order of ranking. Pooling groups are compiled only from gauging stations with catchments that are essentially rural (URBEXT $< 0.025$). If a subject site is essentially rural it will be included in the pooling group at rank 1, if the subject site is not essentially rural (URBEXT $\geq 0.025$) it will be excluded from the pooling group.

# 3 Discussion of Results

## 3.1 *Results of Analysis*

As demonstrated in the pilot study, the diversity of catchment types across the North Wessex area results in the varying ability of the FEH statistical method to estimate flood flows. Detailed results for all the catchments can be found in the data sheets in Appendix C. As noted in the pilot study, in the analysis of the Chew @ Compton Dando catchment, the FEH statistical method was unsuitable in estimating flood flows in catchments that contain reservoirs, or other catchment features that attenuate flood flows. The attenuation of flood flows results in an overestimation of peak values at high return periods and as a consequence full pooling group analysis was not required to be carried out on the Congresbury Yeo @ Iwood.

Evidence of overestimation of peak flows was found in eight other catchments, the reasons for which are detailed below. There must be some caution in comparing estimated flood frequency curves with plotted annual maximum data, there can be bias in the plotting positions especially of short data records.

- Washford @ Beggearn Huish (51003)
  Flow comes out of bank before flow is bankfull at the gauging station.

- Semington Brook @ Semington (53002)
  Overestimation of FEH peak flows compared to recorded values may be a result of influence of upstream mill operations and Chalk on the eastern boundary of the catchment.

- Sheppey @ Fenny Castle (52009)
  No obvious influence, though discussions with the Agency suggest that the presence of karstic limestone may result in a shallow AMAX series.

- By Brook @ Middlehill (53028)
  Bankfull flows are obstructed by footbridge, lowering peak flood levels and affecting gauge rating.

- Isle @ Ashford Mill (52004)
  Extensive flood plain storage upstream of the gauge.

- Cary @ Somerton (52011)
  Storage in fields of flood flows upstream of the gauging station.

- Mells @ Vallis (53025)
  Although gauge was installed to measure impact of upstream quarries, there is currently little evidence in the recorded AMAX series, though this may be a result of the relatively short data record.

- Frome @ Tellisford (53007)
  Lies downstream of the Mells @ Vallis and there is flood attenuation influence from upstream quarries and lakes.

One other catchment raised issues of whether the FEH statistical method is suitable for estimating flood frequency curves.

- Biss @ Trowbridge (53029)
  Hydrometric Register reports that runoff records suggest that the hydrological and topographical catchments do not overlap and the pooling group analysis flood frequency curve appears to overestimate return period peak flows when compared to the AMAX series.

### 3.2 *Impact of Pooling Group Review*

The inspection of flood frequency estimates results in the data sheets (Appendix C) indicates that review of the pooling group has little impact on flood frequency estimates when compared to that estimated from the default pooling group. There are time implications in undertaking a pooling group review for what at first glance appears to be little benefit. This is not the case since the reviewed flood frequency estimate is more robust estimate as it follows a recommended methodology. Other benefits are gained from the review procedure from the investigation into the subject site catchment properties and characteristics to compare with pooling group members. This provides valuable insight to the flood frequency estimates, their relation to the recorded AMAX series and can indicate if the FEH statistical analysis is a suitable methodology for use on the catchment.

Time saving can be achieved on repeat pooling group analysis on any of the 30 gauging stations in this study, as details for all pooling group reviews undertaken are included in the data sheets. This provides useful information on many stations included in the pooling groups and reduces time required for background research.

# 4 Recommendations

The recommendations that follow are discussed in order of priority for the benefit of improving flood frequency estimates.

## 4.1 *Gauge Reviews*

In order to assess the flood frequency at a gauging station it is essential that there is a reliable estimate of flood flows and hence reliable rating curves. The comparison of gauge rating upper thresholds with the associated annual maximum series resulted in five stations being identified as requiring reviews of the gauge ratings.

- By Brook @ Middlehill (53028) has four AMAX records from 21 greater than the upper limit of the rating.
- Tone @ Greenham (52014) has 9 AMAX records from 37 greater than the upper gauge limit.
- Land Yeo @ Wraxall (52015) where 13 of the 26 AMAX records are above the higher gauge limit, resulting in the gauge limit being almost identical to QMED.
- Halsewater @ Halsewater (52003) where as can be seen in the data sheet there is a very different pattern in the AMAX series using the post-1981 data and the whole data series. This may be as a result that the new rating does not have an allowance for out of bank flow, which occurs before bankfull at the gauging station, that the other rating contained.
- Tone @ Bishops Hull (52003) where the upper limit of rating is stage 2.6m but flow comes out of bank at 2.3m which is not taken into account in the gauge rating, resulting in uncertainties in peak flow values.

It is further recommended that any extrapolation of rating curves beyond the upper limit to estimate very large flood flows should be reviewed to ensure that the peak flow estimates are representative and take into account any bypassing or out of bank flow that may occur. Stations that have members of the AMAX series that exceed the upper limit of the gauge rating incluce:

- Avon @ Bathford Combined (53018)
- Tone @ Bishops Hull (52005)
- Parret @ Chiselborough (52007)

- Frome (Bristol) @ Frenchay (53006)
- Tone @ Greenham (52014)
- Halsewater @ Halsewater (52003)
- Congresbury Yeo @ Iwood (52017)
- Brue @ Lovington (52010)
- By Brook @ Middlehill (53028)
- Yeo @ Pen Mill (52006)
- Semington Brook @ Semington (53002)
- Cary @ Somerton (52011)
- Marden @ Stanley (53013)
- Doniford Stream @ Swill Bridge (51001)
- Frome (Somerset) @ Tellisford (53007)
- Biss @ Trowbridge (53029)
- Mells @ Vallis (53025)
- Horner Water @ West Luccombe (51002)
- Land Yeo @ Wraxall (52015)

On the completion of update of any rating it is essential that the updated AMAX series be compared with the results generated in this study to check if the current recommended flood frequency estimate is still valid or an alternative approach is required.

### 4.2 *Catchment Reviews*

Investigations into catchments, notably the ones listed in Section 3 which are potentially influenced by attenuation of flood flow due to catchment storage should be assessed for their full impact and if deemed necessary an alternative method of flood estimation should be undertaken on these catchments.

### 4.3 *AMAX Updates*

It is recommended that annual maximum series should be updated annually and a new QMED estimated together with the 95% confidence interval. The addition of extra data will improve confidence in QMED estimates.

### 4.4 *FEH Analysis Updates*

Repeat FEH analysis should be undertaken on a four to five year basis, with the update of data records for as many stations as possible in the pooling group. With the increase in length of record for pooling group members, the lower the number of stations required in the pooling group in order to achieve the pooling group 5T rule. Consequentially the less hydrologically similar catchments at the bottom of

the pooling group will no longer be required resulting in a more hydrologically similar pooling group and an improved estimate of the pooled growth curve. AMAX series updates for the repeat FEH analysis should be more easily accessible with the impending publication of the National HIFLOWS database.

### 4.5 *Flood Event Return Period Estimates*

It is recommended that in the event of a large flow event recorded at any of the sites investigated in this study, the return period can be estimated using the recommended flood frequency curve as highlighted in the appropriate summary sheet. Although at low return periods there may be separation between the pooled and the single site flood frequency curve the recommended FFC has been selected as best representing the AMAX data and catchment response. In the cases where there is a large separation it is found that the single site FFC has been recommended for flood estimation.

For a return period, T, where the length of the AMAX series is greater than 2T, single site analysis can be used as a reliable estimate of flood frequency and is recommended in the FEH. In this study only one flood frequency curve has been recommended to avoid any stepped changes in flood estimates at the T return period.

### 4.6 *Transfer of Flood Estimates*

The flood frequency curve is constructed from two parts, QMED and the growth factors. QMED can be transferred to the ungauged location by weighting using QMED estimated by catchment descriptors as described in FEH Vol3 Ch4. As can be seen from Figure 2 the flood frequency analysis of the North Wessex gauges results in a wide variation in growth factors between locations indicating the potential for variation in growth factors up and downstream of a gauged location. It is also evident from Figure 2 that single site fitted growth curves have been recommended for flood frequency estimation for the shallower AMAX series.

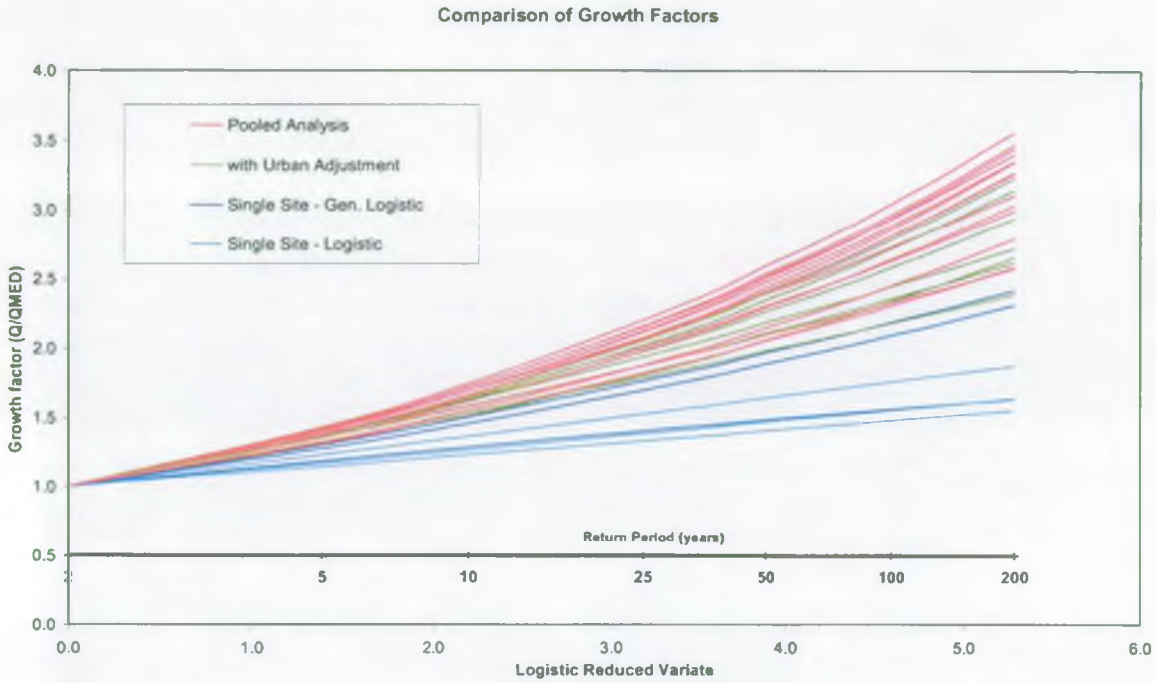



*Figure 2 Comparison of growth factors for recommended flood frequency curves*

Limited investigations have ascertained that it may be possible to transfer flood flow estimates up and downstream of a gauged site to obtain an indication of flood flows at an ungauged site.

Investigations were undertaken comparing growth factors estimated from unreviewed pooling groups of gauged sites and comparing with those obtained from subcatchments of varying sizes, also estimated without a pooling group review. This has indicated that generally there is increasing variation in the growth factors compared with those obtained for the gauged site as the return period increases. This is demonstrated in Tables 1, 2 and 3 for the catchments Avon at Bathford, Washford at Beggearn Huish and the Tone at Bishops Hull.

Growth factors from the FFCs provided may be transferred after first ensuring that there is no significant change in any of the key catchment descriptors. These flood frequency estimates should be used only as an indication and not for design purposes. The combination of the errors associated in transferring QMED and the variation in growth factors, as well as the uncertainty in the flood estimation at a gauged location requires that these estimates should only be used indicatively.

| Return period (years) | Gauged Site Growth factors | Percentage area of gauged catchment | | | | | |
|---|---|---|---|---|---|---|---|
| | | 93.0% | | 82.8% | | 64.8% | |
| | | Growth factors | % diff from gauged | Growth factors | % diff from gauged | Growth factors | % diff from gauged |
| 2 | 1.000 | 1.000 | | 1.000 | | 1.000 | |
| 5 | 1.314 | 1.312 | -0.2% | 1.300 | -1.1% | 1.304 | -0.8% |
| 10 | 1.537 | 1.534 | -0.2% | 1.530 | -0.5% | 1.521 | -1.0% |
| 25 | 1.854 | 1.849 | -0.3% | 1.842 | -0.6% | 1.831 | -1.2% |
| 50 | 2.122 | 2.115 | -0.3% | 2.106 | -0.8% | 2.094 | -1.3% |
| 100 | 2.421 | 2.412 | -0.4% | 2.402 | -0.8% | 2.389 | -1.3% |
| 200 | 2.758 | 2.746 | -0.4% | 2.733 | -0.9% | 2.722 | -1.3% |

*Table 1 Comparison of growth factors for sub catchments of the Avon at Bathford*

| Return period (years) | Gauged Site Growth factors | Percentage area of gauged catchment | | | | | |
|---|---|---|---|---|---|---|---|
| | | 95.3% | | 61.9% | | | |
| | | Growth factors | % diff from gauged | Growth factors | % diff from gauged | | |
| 2 | 1.000 | 1.000 | | 1.000 | | | |
| 5 | 1.390 | 1.386 | -0.3% | 1.386 | -0.3% | | |
| 10 | 1.680 | 1.673 | -0.4% | 1.672 | -0.5% | | |
| 25 | 2.110 | 2.097 | -0.6% | 2.095 | -0.7% | | |
| 50 | 2.488 | 2.469 | -0.8% | 2.465 | -0.9% | | |
| 100 | 2.925 | 2.897 | -1.0% | 2.891 | -1.2% | | |
| 200 | 3.432 | 3.393 | -1.1% | 3.385 | -1.4% | | |

*Table 2 Comparison of growth factors for sub catchments of the Tone at Bishops Hull*

| Return period (years) | Gauged Site Growth factors | Percentage area of gauged catchment | | | | | |
|---|---|---|---|---|---|---|---|
| | | 93.3% | | 60.4% | | 49.4% | |
| | | Growth factors | % diff from gauged | Growth factors | % diff from gauged | Growth factors | % diff from gauged |
| 2 | 1.000 | 1.000 | | 1.000 | | 1.000 | |
| 5 | 1.335 | 1.326 | -0.7% | 1.342 | 0.5% | 1.345 | 0.7% |
| 10 | 1.565 | 1.548 | -1.1% | 1.579 | 0.9% | 1.584 | 1.2% |
| 25 | 1.883 | 1.853 | -1.6% | 1.908 | 1.3% | 1.916 | 1.8% |
| 50 | 2.145 | 2.103 | -2.0% | 2.181 | 1.7% | 2.19 | 2.1% |
| 100 | 2.432 | 2.374 | -2.4% | 2.481 | 2.0% | 2.491 | 2.4% |
| 200 | 2.748 | 2.672 | -2.8% | 2.812 | 2.3% | 2.825 | 2.8% |

*Table 3 Comparison of growth factors for sub catchments of the Washford at Beggearn Huish*

# A List of Flow Gauging Stations

| | Present rating | Proposed rating | Rating review | Digitising work complete | Rating Changed | Annual Max Avail | FEH (No.) | AMAX checked and updated | Date AMAX updated |
|---|---|---|---|---|---|---|---|---|---|
| Ashford Mill | THEO = | ASH1 | y | Yes | Yes | y | 52004 | Yes Cal | 18-Nov-02 |
| Bath Ultrasonic | | n.a. | | | | y(combined) | | Yes CAL | 21-Dec-01 |
| Bathford/Combined | BAT2 | BAT2 | y | Yes | No | y | 53018 | Yes CAL | 21-Nov-02 |
| Beggearn Huish | THEO = | BEG2 | y | Yes | Renamed | y | 51003 | Yes CAL | 21-Nov-02 |
| Bishops Hull | BH02 | BH03 | y | Yes | Yes | y | 52005 | Yes CAL/LH | 22-Nov-02 |
| Bitton | BIT | BIT | y | outstanding | TBC | y | 53017 | Yes CAL | 22-Nov-02 |
| Chiselborough | THEO | CHI4 | y | Yes | Yes | y | 52007 | Yes CAL | 22-Nov-02 |
| Compton Dando | COM | COM2 | y | n/a | Yes | y | 53004 | Yes CAL | 22-Nov-02 |
| Fenny Castle | THEO = | FEN | y | n/a | Renamed | y | 52009 | Yes CAL | 22-Nov-02 |
| Fosseway | FOS | FOS | y | Yes | No | y | 53023 | Yes CAL | 22-Nov-02 |
| Frampton Cotterell | FRA | FRA | y | Yes | n/a | y | | Yes CAL | 22-Nov-02 |
| Frenchay | FRE | FRE2 | y | Yes | Yes | y | 53006 | Yes CAL | 22-Nov-02 |
| Great Somerford | SOM | review | y | Yes - Previously | No | y | 53008 | Yes CAL | 19-Dec-02 |
| Greenham | THEO | GRE2 | y | Yes | Yes | y | 52014 | Yes CAL | 19-Dec-02 |
| Halsewater | THEO | HAL3 | y | n/a | Yes | y | 52003 | Yes CAL | 19-Dec-02 |
| Iwood | THEO = | IWO1 | y | Yes | TBC | y | 52017 | Yes CAL | 19-Dec-02 |
| Lovington | THEO | LOV2 | y | Yes | Yes | y | 52010 | Yes CAL | 19-Dec-02 |
| Middlehill | ML03 = | MDL3 | y | n/a | Renamed | y | | Yes CAL | 19-Dec-02 |
| Midford | MDF | MDF | y | outstanding | TBC | y | 53005 | Yes CAL | 19-Dec-02 |
| Pen Mill | THEO | PEN2 | y | Yes | Yes | y | 52006 | Yes CAL | 19-Dec-02 |
| Semington | SEM | SEM2 | y | outstanding | Yes | y | 53002 | Yes CAL | 19-Dec-02 |
| Somerton | THEO | SOM2 | y | Yes | Renamed | y | 52011 | Yes - CAL | 19-Dec-02 |
| Stanley | STA | STA | y | Yes | TBC | y | 53013 | Yes CAL | 19-Dec-02 |
| Swill Bridge | THEO = | SWL1 | y | Yes | Renamed | y | 51001 | Yes CAL | 19-Dec-02 |
| Tellisford | TEL | TEL | y | outstanding | TBC | y | 53007 | Yes CAL | 20-Dec-02 |
| Trowbridge | TRO1 | TRO2 | y | n/a | Yes | y | | Yes CAL | 20-Dec-02 |
| Vallis | VAL | VAL | y | Yes | TBC | y | 53025 | Yes cal | 20-Dec-02 |
| Wellow | WEL | WEL | y | Yes | No | y | 53009 | Yes CAL | 20-Dec-02 |
| West Luccombe | THEO | WLC2 | y | n/a | Yes | y | 51002 | Yes - CAL | 20-Dec-02 |
| Wraxall | WRA | WRA | y | n/a | TBC | y | 52015 | Yes - CAL | 20-Dec-02 |

KEY

Outstanding = digitising work is not yet complete or the proposed rating was not adopted before HARP

TBC = Rating is To be confirmed with additional gaugings

n/a = station not included in digitising project

No = No rating change was necessary

Renamed = Rating remains the same but under a new name

* Adopted on Hydrolog for post 1992 data only -

Initial suggestion for Pilot Project

# B Summary of Data Updates Obtained

| Gauge No | Name | Status |
|---|---|---|
| 7003 | Lossie @ Sheriffmills | Updated |
| 9004 | Bogie @ Redcraig | Updated |
| 10001 | Ythan @ Ardlethen | Discontinued |
| 10003 | Ythan @ Ellon | Updated |
| 11001 | Don @ Parkhill | Updated |
| 11002 | Don @ Haughton | Updated |
| 11004 | Urie @ Pitcaple | Updated |
| 13001 | Bervie @ Inverbervie | Updated |
| 21002 | Whiteadder Water @ Hungry Snout | Discontinued |
| 21013 | Gala Water @ Galashiels | Updated |
| 21015 | Leader Water @ Earlston | Updated |
| 21016 | Eye Water @ Eyemouth Mill | Updated |
| 21025 | Ale Water @ Ancrum | Updated |
| 21027 | Blackadder Water @ Mouth Bridge | Updated |
| 23007 | Derwent @ Rowlands Gill | Updated |
| 24004 | Bedburn Beck @ Bedburn | Updated |
| 25005 | Leven @ Leven Bridge | Updated |
| 27015 | Derwent @ Stamford Bridge | Updated |
| 27041 | Derwent @ Buttercrambe | Updated |
| 27042 | Dove @ Kirkby Mills | Updated |
| 27049 | Rye @ Ness | Updated |
| 27055 | Rye @ Broadway Foot | Updated |
| 27058 | Riccal @ Crook House Farm | Updated |
| 28023 | Wye @ Ashford | Updated |
| 28046 | Dove @ Izaak Walton | Updated |
| 28055 | Ecclesbourne @ Duffield | Updated |
| 39025* | Enbourne @ Brimpton | Updated |
| 39028* | Dun @ Hungerford | Updated |
| 39033* | Winterbourne @ St Bagnor | Updated |
| 40004 | Rother @ Udiam | Updated |
| 40006 | Bourne @ Hadlow | Updated |
| 40009 | Teise @ Stone Bridge | Updated |
| 40022 | Great Stour @ Chart Leacon | Updated |
| 41003 | Cuckmere @ Sherman Bridge | Updated |
| 41005 | Ouse @ Gold Bridge | Updated |
| 41006 | Uck @ Isfield | Updated |
| 41011* | Rother @ Iping Mill | Updated |
| 41018 | Kird @ Tanyards | Discontinued |

| Gauge No | Name | Status |
|---|---|---|
| 41022 | Lod @ Halfway Bridge | Updated |
| 41025 | Loxwood Stream @ Drungewick | Updated |
| 41027 | Rother @ Princes Marsh | Updated |
| 41028 | Chess Stream @ Chess Bridge | Updated |
| 42014 | Blackwater @ Ower | Updated |
| 43006* | Nadder @ Wilton Park | Updated |
| 45003 | Culm @ Wood Mill | Updated |
| 45005 | Otter @ Dotton | Updated |
| 45012 | Creedy @ Cowley | Updated |
| 47009 | Tiddy @ Tideford | Updated |
| 48003 | Fal @ Tregony | Updated |
| 48004 | Warleggan @ Trengoffe | Updated |
| 48009 | St Neot @ Craigshill Wood | Updated |
| 48010 | Seaton @ Trebrownbridge | Updated |
| 49002 | Hayle @ st Erth | Updated |
| 49004 | Gannel @ Gwills | Updated |
| 52016 | Currypool Stream @ Currypool Farm | Updated |
| 52801 | Tone @ Wadhams Farm | Discontinued |
| 53003 | Avon @ Bath St James | Disc. Inc 53018 |
| 54008 | Teme @ Tenbury | Updated |
| 54020 | Perry @ Yeaton | Updated |
| 54027 | Frome @ Ebley Mill | Updated |
| 54029 | Teme @ Knightsford Bridge | Updated |
| 54034 | Dowles Brook @ Dowles | Updated |
| 54040 | Meese @ Tibberton | Updated |
| 54044 | Tern @ Ternhill | Updated |
| 54088 | Little Avon @ Berkeley Kennels | Updated |
| 55003 | Lugg @ Lugwardine | Updated |
| 55009 | Monnow @ Kentchurch | Discontinued |
| 55013 | Arrow @ Titley Mill | Updated |
| 55014 | Lugg @ Byton | Updated |
| 55018 | Frome @ Yarkhill | Updated |
| 55021 | Lugg @ Butts Bridge | Updated |
| 55022 | Trothy @ Mitchel Troy | Discontinued |
| 55029 | Monnow @ Grosmont | Updated |
| 56003 | Honddu @ the Forge Brecon | Discontinued |
| 56012 | Grwyne @ Millbrook | Updated |
| 58011 | Thaw @ Gigman Bridge | Updated |
| 75010 | Marron @ Ullock | Discontinued |

*Note: * - data update obtained for earlier study*

# C Data Sheets

| Gauging Station | River | Number |
|---|---|---|
| Ashford Mill | Isle | 52004 |
| Bath Ultrasonic | Avon | 53022 |
| Bathford (Combined) | Avon | 53018 |
| Beggearn Huish | Washford | 51003 |
| Bishops Hull | Tone | 52005 |
| Bitton | Boyd | 53017 |
| Chiselborough | Parrett | 52007 |
| Compton Dando | Chew | 53004 |
| Fenny Castle | Sheppey | 52009 |
| Fosseway | Sherston Avon | 53023 |
| Frampton Cotterell | Bristol Frome | 53026 |
| Frenchay | Bristol Frome | 53006 |
| Great Somerford | Avon | 53008 |
| Greenham | Tone | 52014 |
| Halsewater | Halsewater | 52003 |
| Iwood | Congresbury Yeo | 52017 |
| Lovington | Brue | 52010 |
| Middlehill | By Brook | 53028 |
| Midford | Midford Brook | 53005 |
| Pen Mill | Yeo | 52006 |
| Semington | Semington Brook | 53002 |
| Somerton | Cary | 52011 |
| Stanley | Marden | 53013 |
| Swill Bridge | Doniford Stream | 51001 |
| Tellisford | Somerset Frome | 53007 |
| Trowbridge | Biss | 53029 |
| Vallis | Mells | 53025 |
| Wellow | Wellow Brook | 53009 |
| West Luccombe | Horner Water | 51002 |
| Wraxall | Land Yeo | 52015 |

ASHFORD MIN

**Catchment:** Isle at Ashford Mill
**Station No:** 52004
**NGR:** ST 361 188

**Description:** This is a small catchment (Hydrometric Register area 90.1 $km^2$) gauged using a Crump profile weir for low flows and by flow gaugings for other flows. Station installed in 1962. Modular limit is 0.38m and downstream weed growth affects stability of the stage-discharge relationship at low flows. Extensive floodplain storage/flows occurs next to the station before bankfull and there is bypassing at high flows. There are minor groundwater abstractions in the catchment and evidence of mill/factory discharges on charts. It is an impermeable catchment of predominantly Lower Lias clays, which is very responsive and land use is rural.

**Data comments:** WINFAP annual maxima series updated to 2002 with data supplied by the Environment Agency. AMAX series is 41 years in length. AMAX series not reviewed.

**Gauge rating:** Upper limit of gauge rating is 42.73 $m^3/s$, no records exceed this limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 87.42 | 0.980 | 0.40 | 0.499 | 891 | 39.8 | 0.0100 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 16.755 $m^3/s$ |
| **Annual Maxima** | 28.249 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 31.929 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 24.642 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, permeable adjustment not applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – FEH statistical method unsuitable**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Gen Logistic x 20% |
| 2 | 28.3 | 28.3 | 28.3 | 33.9 |
| 5 | 39.7 | 39.7 | 33.5 | 40.2 |
| 10 | 47.9 | 47.8 | 36.4 | 43.6 |
| 25 | 59.7 | 59.3 | 39.7 | 47.6 |
| 50 | 69.7 | 69.1 | 42.0 | 50.4 |
| 100 | 80.9 | 80.0 | 44.2 | 53.0 |
| 200 | 93.6 | 92.2 | 46.2 | 55.5 |

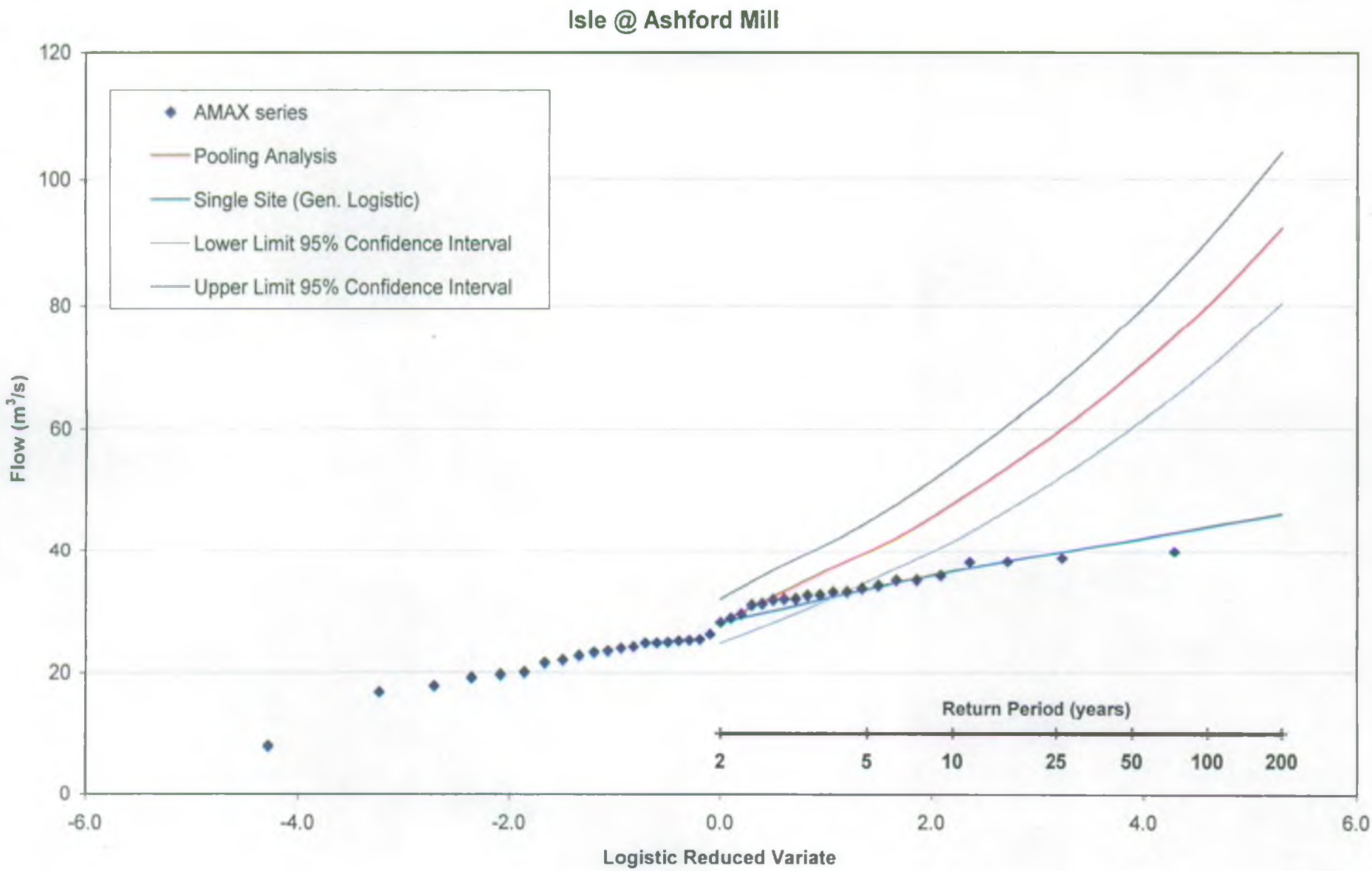
**Summary of Analysis:** The AMAX EDA reveals that there is one slight outlier in December 1975. All sites retained without review. A review of the pooled analysis leads to very little change in the flood frequency curve; an approximate 1.5% decrease at 200 years. The single site curve follows the AMAX series well and predicts a considerably lower FFC.

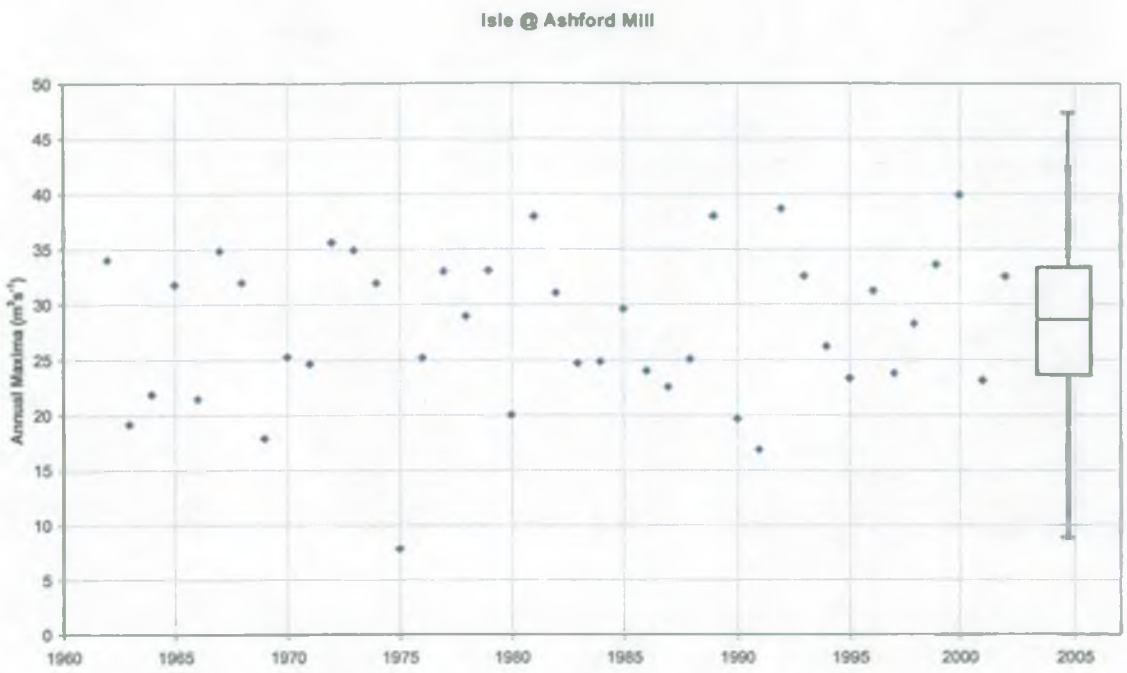
**Selection of Method:** Station comments state that there is extensive flood plain storage in the catchment. This has the effect of flattening the AMAX series resulting in majority of the AMAX series lying below the lower 95% confidence limit. The impact of the catchment storage reduces the suitability of the FEH statistical method and an alternative method of estimating flood frequency at this site may need to be considered.

*Special considerations:* A slight discrepancy between catchment area from Hydrometric Register and from FEH CD ROM, could affect the accurate identification of catchment descriptors as well as an alternative method of identifying flood frequency.

*Adopt:* Single site Gen. Logistic as shaded above to give an indication of flood frequency

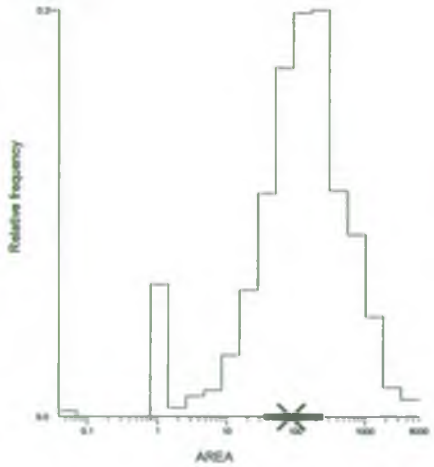
*Model parameters:* $\beta = 0.139$, $\kappa = -0.056$

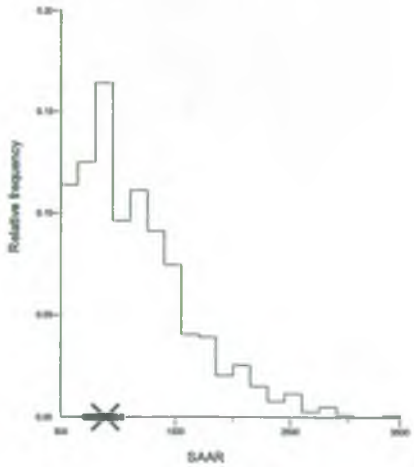

Isle @ Ashford Mill
AMAX series
Pooling Analysis
Single Site (Gen. Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
120
100
80
60
40
20
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200

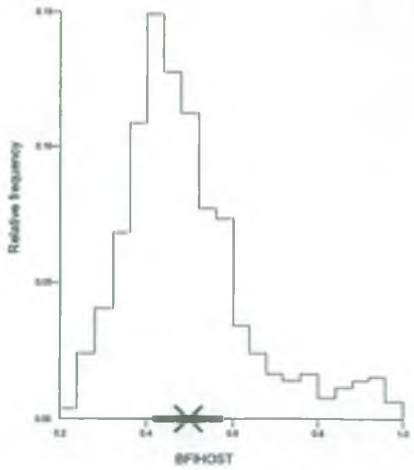


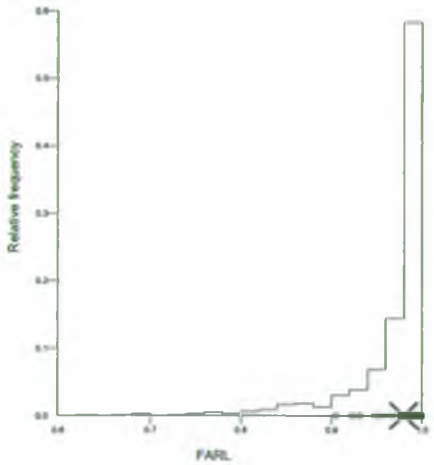

Annual Maxima series for Ashford Mill

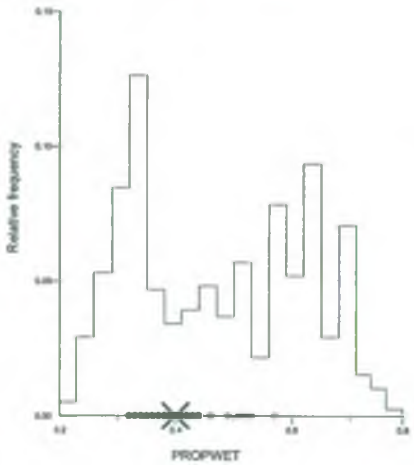
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 14 Feb 63 | 34.036 | | 25 Jan 84 | 24.676 |
| 17 Nov 63 | 19.166 | | 21 Jan 85 | 24.818 |
| 02 Aug 65 | 21.892 | | 26 Dec 85 | 29.613 |
| 29 Nov 65 | 31.821 | | 03 Apr 87 | 24.001 |
| 22 Oct 66 | 21.464 | | 31 Jan 88 | 22.541 |
| 11 Jul 68 | 34.854 | | 24 Feb 89 | 25.055 |
| 22 Feb 69 | 31.994 | | 20 Dec 89 | 38.013 |
| 14 Dec 69 | 17.876 | | 09 Jan 91 | 19.657 |
| 29 Nov 70 | 25.266 | | 08 Jan 92 | 16.832 |
| 07 Mar 72 | 24.628 | | 18 Dec 92 | 38.663 |
| 02 Dec 72 | 35.597 | | 12 Oct 93 | 32.565 |
| 11 Feb 74 | 34.900 | | 09 Nov 94 | 26.195 |
| 20 Jan 75 | 31.929 | | 22 Dec 95 | 23.341 |
| 01 Dec 75 | 7.847 | | 06 Aug 97 | 31.233 |
| 30 Nov 76 | 25.174 | | 28 Nov 97 | 23.772 |
| 09 Dec 77 | 32.994 | | 23 Apr 99 | 28.249 |
| 30 May 79 | 28.957 | | 24 Dec 99 | 33.574 |
| 27 Dec 79 | 33.066 | | 30 Oct 00 | 39.899 |
| 21 Mar 81 | 19.993 | | 04 Feb 02 | 23.116 |
| 20 Dec 81 | 37.936 | | 13 Nov 02 | 32.494 |
| 12 Nov 82 | 31.027 | | | |

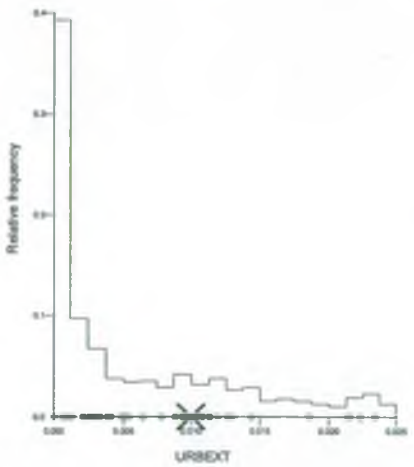

Relative frequency
AREA

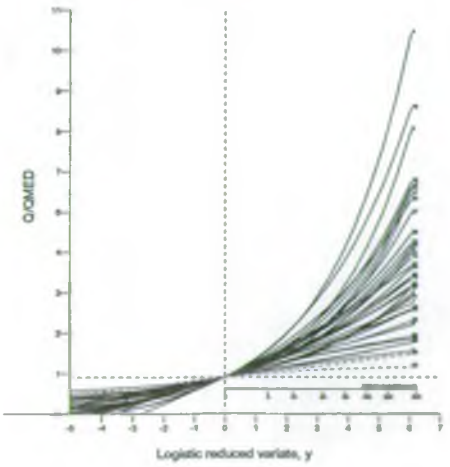

Relative frequency
SAAR

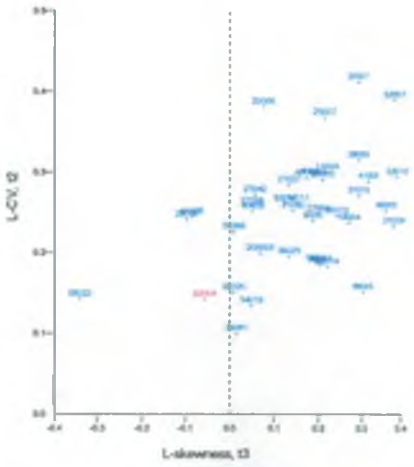

Relative frequency
BFIHOST

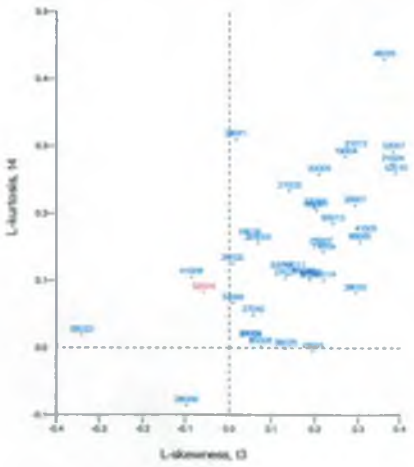

Relative frequency
FARL

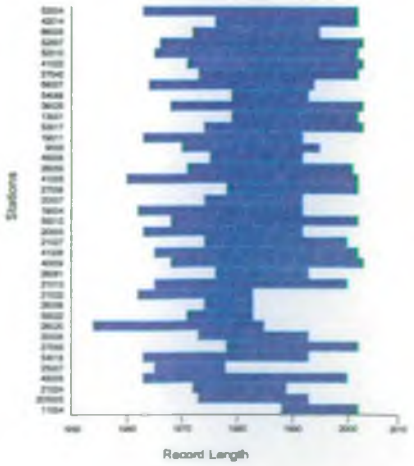

Relative frequency
PROPWET


Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Ashford Mill Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.16 | 4.28 |
| Comment | Review of pooling group is essential | Review of the pooling group is essential |
| Number of Station Years | 1098 | 991 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Sites lying upstream or downstream of the subject site are likely to be hydrologically similar and give good reason for promotion to a higher ranking in pooling group. There are no such gauges in this pooling group. | No change | 1098 | 4.16 |
| *Period of Record* | All sites have 9 or more years of data which meets the requirement of inclusion in a pooling group (minimum 8 years). | No change | 1098 | 4.16 |
| *FARL* | The value of FARL for the Isle @ Ashford Mill is 0.980 and the range of FARL for the pooling group lies between 0.876 and 1. These are indications of artificial and natural storage.<br>28002 (Blithe @ Hamstall Ridware), FARL 0.87 6– Ranked 31st. Station notes state that all data are pre-reservoir. Yet FEH vol 3, p 173 states that Blithfield reservoir had been built. To be conservative site dismissed.<br>40009 (Teise @ Stone Bridge), FARL 0.905 – Ranked 27th. Station notes state that for FEH analysis use the pre-reservoir data set to 30 September 1975. Therefore exclude data from water year 1975 onwards.<br>41005 (Ouse @ Gold Bridge), FARL 0.924 – Ranked 17th. Station notes state that after 1977 there was some attenuation from Ardingly reservoir. Therefore exclude data post 1977 | Remove 28002 (Blithe @ Hamstall Ridware) since data record includes reservoir.<br>Excluded years as noted from 40009 (Teise @ Stone Bridge) and 41005 (Ouse @ Gold Bridge) so that only data pre-reservoir construction is used. | 1031 | 4.65 |
| *PROPWET/URBEXT* | Subject site PROPWET is 0.40. The range of values for the pooling group are 0.32 to 0.64, indicating that some sites are rather wetter than the subject site.<br>8011 (Livet @ Minmore), PROPWET 0.63. Ranked 21st<br>21024 (Jed Water @ Jedburgh), PROPWET 0.57. Ranked 24th<br>205005 (Ravernet @ Ravernet), PROPWET 0.52. Ranked 32nd<br>75017 (Ellen @ Bullgill), PROPWET 0.62. Ranked 40th<br>12006 (Gairn @ Invergairn), PROPWET 0.64. Ranked 42nd<br>11004 (Urie @ Pitcaple), PROPWET 0.53. Ranked 43rd<br>All stations have URBEXT less than 0.025 and essentially rural. | There are too many station years to remove all sites. Remove the three highest PROPWET values, 8011 (Livet @ Minmore), 75017(Ellen @ Bullgill) and 12006 (Gairn @ Invergairn) and move other three highlighted sites to the bottom of the pooling group. | 991 | 4.28 |
| *Site Comments* | All site comments reviewed including indications of artificial influences and data issues. However the need for a consistent approach and a lack of data to make an accurate assessment of theses influences and the need to conserve station years precludes the removal of data or re-ranking of stations. | No change | 991 | 4.28 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Discordant Sites* | *55022 (Trothy @ Mitchel Troy)*<br>Ranked 34th, WINFAP has 10 years of data from 1970 to 1982, excluding 1979 to 1981. Discordancy is the result of the short record, in addition to comparatively small flood events in Dec 1972, and known drought period of Sept 1976 and Dec 1977. The closest gauge is the Wye at Redbrook (55023), which is located just after the confluence of the Trothy and the Wye and confirms the 1972. | Retain site and all data. | 991 | 4.28 |
| *L Moments* | The main outliers to L-moments is:<br>52007 (Parret @ Chiselborough) – 4th ranked site has two large flood peaks and several small flood events in the data series. Adjacent gauges confirm flood events and data provide by the Environment Agency for this study. Retain site as reliable source of data update.<br>Other less outliers are the 20006 (Biel Water @ Belton House), 20007 (Gifford Water @ Lennoxlove), 25007 (Clow Beck @ Croft) , 28058 (Henmore Brook @ Ashbourne) and 28061 (Churnet @ Basford Bridge) all of whose data was compared with adjacent gauges which verified outlying peaks that contribute to generating large L-moment values. | Retain all sites | 991 | 4.28 |

## Ashford Mill Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 0.981 | 0.000 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 1.107 | 0.224 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.205 | 0.234 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.857 | 0.268 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 0.829 | 0.306 |
| 41022 (Lod @ Halfway Bridge) | 33 | 0.294 | 0.190 | 0.105 | 0.224 | 0.323 |
| 27042 (Dove @ Kirkby Mills) | 30 | 0.272 | 0.058 | 0.049 | 0.377 | 0.357 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.505 | 0.361 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.326 | 0.375 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 1.377 | 0.410 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.286 | 0.411 |
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.049 | 0.413 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.041 | 0.415 |
| 9003 (Isla @ Grange) | 26 | 0.240 | 0.189 | 0.101 | 0.228 | 0.416 |
| 45008 (Otter @ Fenny Bridges) | 19 | 0.293 | 0.175 | 0.106 | 0.192 | 0.422 |
| 28055 (Ecclesbourne @ Duffield) | 23 | 0.315 | 0.295 | 0.082 | 0.986 | 0.423 |
| 41005 (Ouse @ Gold Bridge) | 19 | 0.288 | 0.319 | 0.169 | 0.484 | 0.426 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.530 | 0.432 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.992 | 0.448 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.612 | 0.454 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.147 | 0.455 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.653 | 0.477 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.163 | 0.498 |
| 41006 (Uck @ Isfield) | 39 | 0.244 | -0.085 | 0.105 | 1.395 | 0.501 |
| 40009 (Teise @ Stone Bridge) | 8 | 0.251 | 0.052 | 0.012 | 0.514 | 0.501 |
| 28061 (Churnet @ Basford Bridge) | 16 | 0.100 | 0.017 | 0.310 | 3.167 | 0.502 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.692 | 0.514 |
| 21032 (Glen @ Kirknewton) | 22 | 0.252 | 0.144 | 0.234 | 0.489 | 0.519 |
| 28058 (Henmore Brook @ Ashbourne) | 9 | 0.241 | -0.096 | -0.086 | 1.666 | 0.549 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 3.962 | 0.551 |
| 28020 (Churnet @ Rocester) | 28 | 0.150 | 0.010 | 0.125 | 0.710 | 0.552 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.144 | 0.555 |
| 27055 (Rye @ Broadway Foot) | 25 | 0.248 | 0.200 | 0.209 | 0.130 | 0.557 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 0.931 | 0.561 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 1.054 | 0.567 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 2.431 | 0.594 |
| 21024 (Jed Water @ Jedburgh) | 17 | 0.233 | 0.384 | 0.274 | 1.106 | 0.491 |
| 205005 (Ravernet @ Ravernet) | 21 | 0.199 | 0.070 | 0.156 | 0.263 | 0.545 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.197 | 0.600 |
| | | | | | | |
| Total | 991 | | | | | |
| Weighted means | | 0.247 | 0.178 | 0.141 | | |

BATH

**Catchment:** Avon at Bath (Ultrasonic)
**Station No:** 53022
**NGR:** ST 738 651

**Description:** Bath Ultrasonic Gauging Station (BUGS) operated in parallel to Bathford from Sept 1979 to Nov 1984, and from Mar 1996 to present. The quality of flow data is questionable until refurbishment in August 2000 greatly improved data quality. The catchment covers an area of 1621 $km^2$ and is predominantly rural, with some urban areas. The geology is mixed, predominantly clays and limestone, with the eastern tributaries rising from chalk-dominated areas.

**Data comments:** PoT data provided by Environment Agency for water years 2000 - 2001. QMED estimated from PoT and data transfer from donor site, the Avon @ Bathford (53018). The data was not reviewed.

**Gauge rating:** The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 1620.5 | 0.988 | 0.34 | 0.575 | 817 | 31.2 | 0.025 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 142.85 $m^3/s$ |
| **Peaks over Threshold** | 227.53 $m^3/s$ |
| **Data transfer from donor site** | 172.71 $m^3/s$ |
| **Upper Limit 95% Confidence Interval (data transfer)** | 181.70 $m^3/s$ |
| **Lower Limit 95% Confidence Interval (data transfer)** | 138.86 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.025, slightly urbanised: adjustment required.

**Climate variability:** PoT QMED estimate uses only 2 years data and affected by climate variability, transfer from donor site uses 62 years data and adjustment not required.

**Target return period:** 200 years

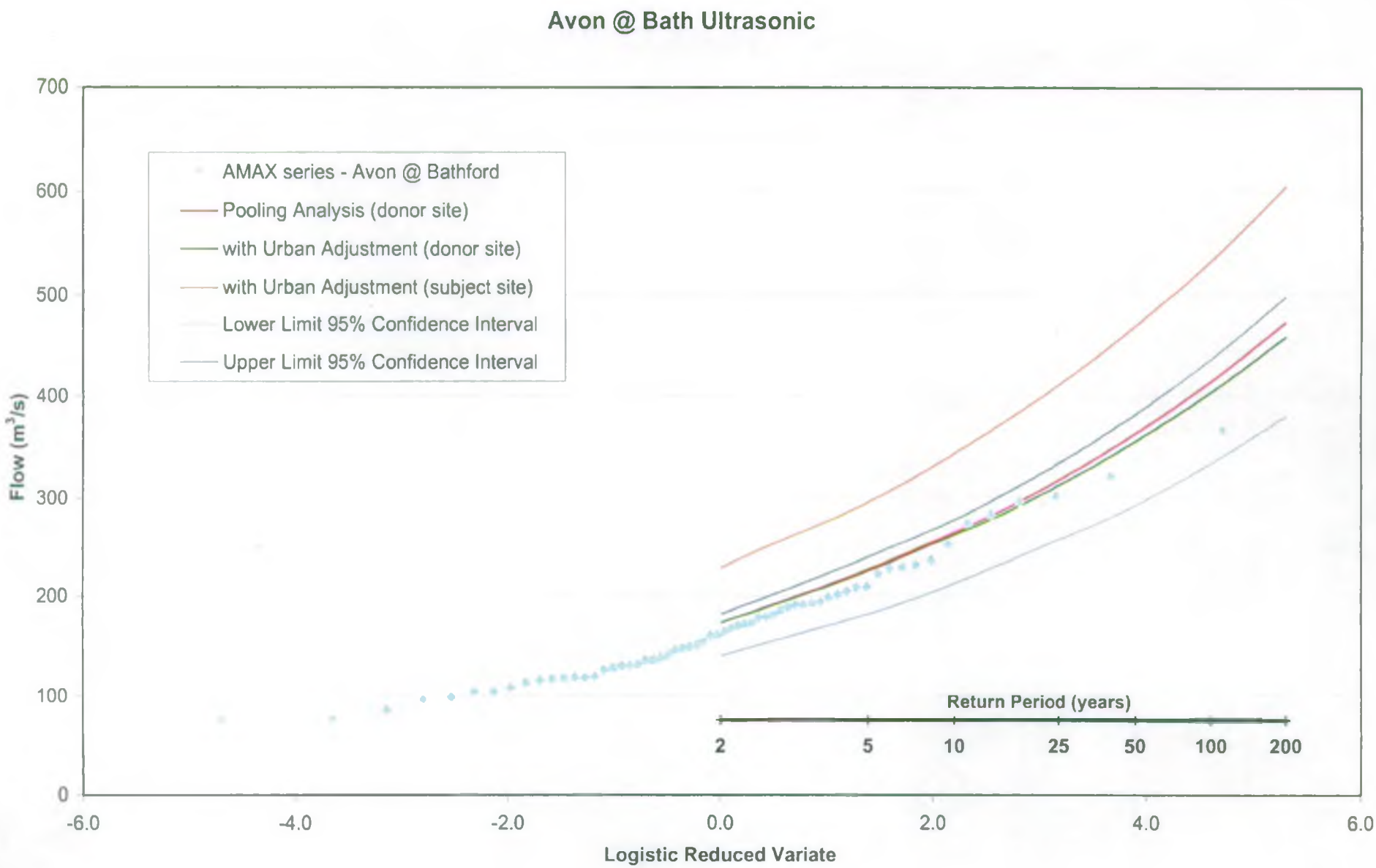
**Flood Frequency:** **Satisfactory (when using QMED from data transfer)**

| Return period (years) | Pooled Analysis (QMED from data transfer) | | | Pooled Analysis (QMED from PoT) | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Urban Adjusted | Urban Adj x 20% |
| 2 | 172.7 | 172.7 | 172.7 | 227.5 | 207.3 |
| 5 | 225.0 | 225.9 | 224.5 | 295.9 | 269.3 |
| 10 | 261.7 | 263.8 | 260.9 | 344.1 | 313.1 |
| 25 | 313.4 | 317.9 | 312.3 | 412.0 | 374.8 |
| 50 | 356.7 | 363.7 | 355.7 | 469.5 | 426.8 |
| 100 | 404.8 | 415.1 | 404.0 | 533.6 | 484.8 |
| 200 | 458.6 | 473.1 | 458.2 | 605.3 | 549.8 |

**Summary of Analysis:** Subject site has only 2 years of PoT data which shows some very high flows and includes significant flood events over a flood rich period. The data series therefore provides an inaccurate picture of the high flow series for the Avon @ Bath Ultrasonic. Avon @ Bathford selected as donor site due to hydrological similarity and located just upstream of the subject site. Single site fittings not made to PoT data.

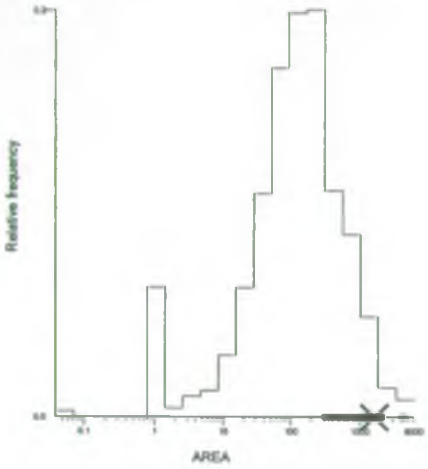
**Selection of Method:** As in the analysis of the Avon at Bathford as part of this study there is little separation between the flood frequency curves and they all represent the data well (Avon @ Bathford). Using QMED estimated from POT data generates a significantly higher FFC, as a result of data from flood rich period.

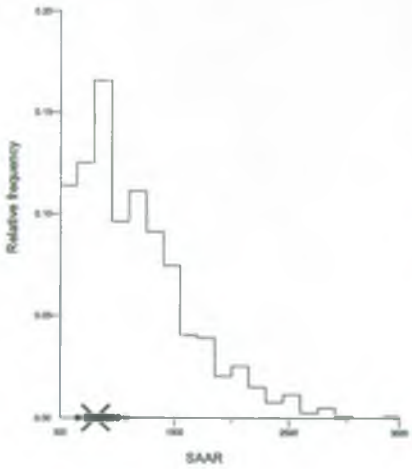
*Special considerations:* None
*Adopt:* Pooled analysis with urban adjustment, QMED estimated from donor, (shaded above)
*Model parameters:* N.A.

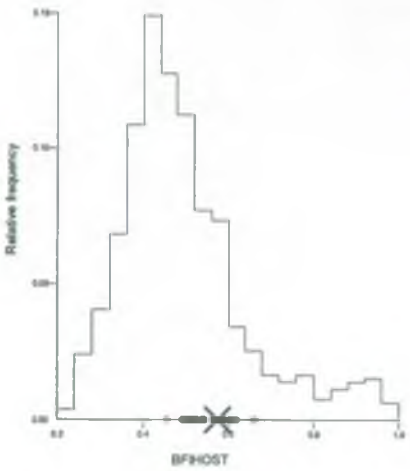

Avon @ Bath Ultrasonic
AMAX series - Avon @ Bathford
Pooling Analysis (donor site)
with Urban Adjustment (donor site)
with Urban Adjustment (subject site)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
700
600
500
400
300
200
100
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200

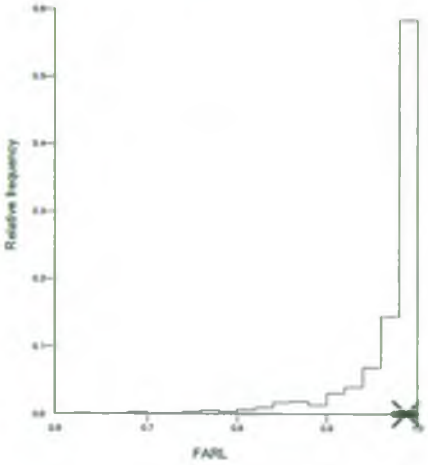
Annual Maxima and Peaks over Threshold series for Bath (Ultrasonic)

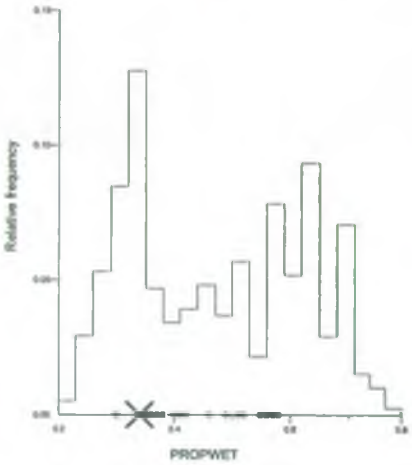
| AMAX | | | PoT | |
|---|---|---|---|---|
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
| 30 Oct 2000 | 278.7 | | 30 Oct 2000 | 278.7 |
| 27 Jan 2002 | 153.9 | | 31 Oct 2000 | 254.7 |
| | | | 07 Dec 2000 | 164.3 |
| | | | 08 Dec 2000 | 178.1 |
| | | | 12 Feb 2001 | 158.6 |
| | | | 21 Mar 2001 | 160.4 |
| | | | 26 Jan 2002 | 148.4 |
| | | | 27 Jan 2002 | 153.9 |
| | | | 28 Jan 2002 | 132.2 |
| | | | 04 Feb 2002 | 124.8 |
| | | | 11 Feb 2002 | 129.5 |
| | | | 12 Feb 2002 | 128.7 |

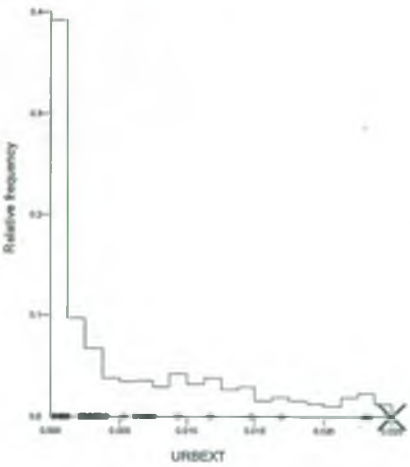

Relative frequency
AREA

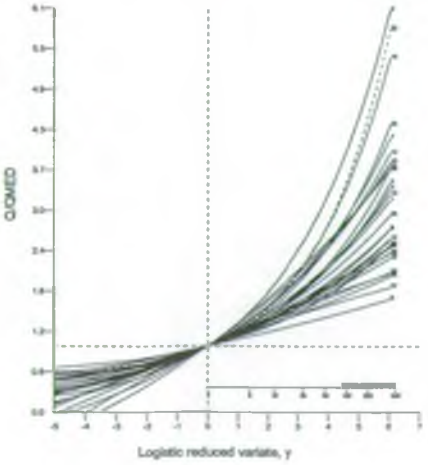

Relative frequency
SAAR

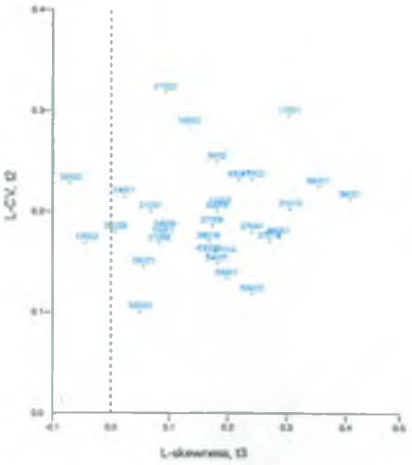

Relative frequency
BFIHOST

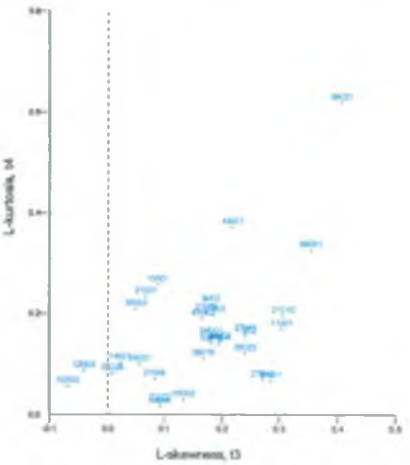

Relative frequency
FARL

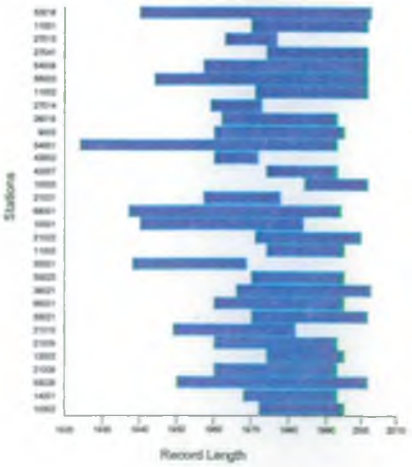

Relative frequency
PROPWET


Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Bath (Ultrasonic) Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.48 | 2.22 |
| Comment | Strongly heterogeneous, review of pooling group essential | Strongly heterogeneous, review of pooling group essential |
| Number of Station Years | 1320 | 1011 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is not included in the pooling group as it has no data, and is a slightly urbanised catchment<br>The following sites were found to result in duplication of the same events:<br>(53003) Avon @ Bath St James, ranked 1<br>(54029) Teme @ Knightsford Bridge, ranked 3<br>(21009) Tweed @ Sprouston, ranked 35<br>(54043) Severn @ Upton on Severn, ranked 29<br>(54032) Severn@ Saxons Lode, ranked 30<br>(55009) Monnow @ Kentchurch, ranked 36 | Remove the 6 sites detailed which result in the duplication of data. | 1179 | 4.16 |
| *Period of Record* | All sites have over 10 years record. | No sites require removal due to short record length | 1179 | 4.16 |
| *FARL* | Avon @ Bath (ultrasonic) has a FARL of 0.988, the pooling group has a range of 0.924 to 0.996. The outliers in the group are:<br>25th ranked, (39008) Thames @ Eynsham FARL = 0.924<br>11th ranked, (28010) Derwent @ Longbridge Weir FARL = 0.953<br>10th ranked, (54012) Tern @ Walcot FARL = 0.96<br>29th ranked, (19007) Esk @ Musleborough FARL = 0.953 | Remove all four outliers | 1011 | 2.22 |
| *PROPWET/URBEXT* | Avon @ Bath (ultrasonic) catchment has a PROPWET of 0.34 and the pooling group has a range of 0.3 to 0.58. The outliers in the group are:<br>27th ranked, (12002) Dee @ Park PROPWET = 0.58<br>28th ranked, (21008) Teviot @ Ormiston Mill PROPWET = 0.57<br>19th ranked, (11003) Don @ Bridge of Alford PROPWET = 0.56<br>7th ranked, (11002) Don @ Haughton PROPWET = 0.55<br>2nd ranked, (11001) Don @ Parkhill PROPWET = 0.52<br>15th ranked, (21031) Till @ Etal PROPWET = 0.46<br>25th ranked, (21010) Tweed @ Dryburgh PROPWET = 0.51<br>26th ranked, (21009) Tweed @ Norham PROPWET = 0.49 | Investigating sensitivity of removing outliers revealed little affect on the pooling group. Retain all sites. | 1011 | 2.22 |
| *Site Comments* | Site comments investigated but no significant requirements to remove sites. | No action | 1011 | 2.22 |
| *Discordant Sites* | *(39021) Cherwell @ Enslow Mill*<br>This site is discordant due to a large peak in April 1998. | Retain site and all data, as large peak is a result of the Easter floods in 1998, which resulted in severe flooding in the region. | 1011 | 2.22 |
| *L Moments* | Main outlier is Cherwell @ Enslow Mill, which there is no reason to remove from the pooling group for the reasons mentioned above. | Retain all sites and all data as they contain large events. | 1011 | 2.22 |

## Bath (Ultrasonic) Pooling Group – Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53018 (Avon @ Bathford) | 62 | 0.200 | 0.181 | 0.142 | 0.044 | 0.018 |
| 11001 (Don @ Parkhill) | 34 | 0.295 | 0.303 | 0.170 | 1.936 | 0.251 |
| 27015 (Derwent @ Stamford Bridge) | 15 | 0.170 | 0.270 | 0.070 | 1.255 | 0.269 |
| 27041 (Derwent @ Buttercrambe) | 29 | 0.179 | 0.241 | 0.162 | 0.283 | 0.280 |
| 54008 (Teme @ Tenbury) | 41 | 0.182 | 0.092 | 0.016 | 0.538 | 0.323 |
| 55003 (Lugg @ Lugwardine) | 44 | 0.100 | 0.049 | 0.210 | 1.827 | 0.332 |
| 11002 (Don @ Haughton) | 33 | 0.232 | 0.241 | 0.156 | 0.403 | 0.485 |
| 27014 (Rye @ Little Habton) | 15 | 0.156 | 0.193 | 0.140 | 0.313 | 0.535 |
| 28018 (Dove @ Marston on Dove) | 32 | 0.170 | 0.166 | 0.112 | 0.184 | 0.577 |
| 9002 (Deveron @ Muiresk) | 35 | 0.249 | 0.180 | 0.219 | 0.533 | 0.609 |
| 54001 (Severn @ Bewdley) | 71 | 0.148 | 0.181 | 0.155 | 0.341 | 0.636 |
| 43002 (Stour @ Ensbury) | 12 | 0.158 | 0.165 | 0.191 | 0.213 | 0.644 |
| 43007 (Stour @ Throop Mill) | 21 | 0.232 | 0.218 | 0.372 | 1.384 | 0.648 |
| 10003 (Ythan @ Ellon) | 19 | 0.228 | -0.069 | 0.056 | 1.793 | 0.660 |
| 21031 (Till @ Etal) | 22 | 0.200 | 0.067 | 0.235 | 0.822 | 0.685 |
| 68001 (Weaver @ Ashbrook) | 56 | 0.225 | 0.353 | 0.327 | 1.159 | 0.715 |
| 10001 (Ythan @ Ardlethen) | 45 | 0.175 | 0.088 | 0.258 | 0.814 | 0.718 |
| 21022 (Whiteadder Water @ Hutton Castle) | 31 | 0.318 | 0.092 | 0.024 | 2.783 | 0.736 |
| 11003 (Don @ Bridge of Alford) | 21 | 0.205 | 0.185 | 0.198 | 0.048 | 0.758 |
| 55001 (Wye @ Cadora) | 32 | 0.133 | 0.197 | 0.146 | 0.660 | 0.764 |
| 55023 (Wye @ Redbrook) | 25 | 0.118 | 0.240 | 0.122 | 1.365 | 0.768 |
| 39021 (Cherwell @ Enslow Mill) | 38 | 0.212 | 0.407 | 0.619 | 5.095 | 0.790 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 1.435 | 0.791 |
| 55021 (Lugg @ Butts Bridge) | 27 | 0.145 | 0.055 | 0.101 | 0.582 | 0.841 |
| 21010 (Tweed @ Dryburgh) | 33 | 0.202 | 0.306 | 0.196 | 0.617 | 0.846 |
| 21009 (Tweed @ Norham) | 33 | 0.186 | 0.172 | 0.203 | 0.052 | 0.856 |
| 12002 (Dee @ Park) | 22 | 0.169 | -0.042 | 0.088 | 1.212 | 0.866 |
| 21008 (Teviot @ Ormiston Mill) | 33 | 0.168 | 0.083 | 0.071 | 0.322 | 0.881 |
| 55029 (Monnow @ Grosmont) | 45 | 0.180 | 0.007 | 0.082 | 0.662 | 0.903 |
| 14001 (Eden @ Kemback) | 26 | 0.215 | 0.022 | 0.104 | 0.675 | 0.905 |
| 10002 (Ugie @ Inverugie) | 23 | 0.284 | 0.133 | 0.030 | 1.648 | 0.918 |
| | | | | | | |
| Total | 1011 | | | | | |
| Weighted means | | 0.192 | 0.182 | 0.170 | | |

BATHFORD

**Catchment:** Avon at Bathford (Combined)
**Station No:** 53018
**NGR:** ST 786 671

**Description:** Bathford, which replaced the Bath St James gauging station, is a velocity-area gauging station located immediately downstream of the confluence with the Bybrook. A d/s railway bridge acts as a control, which causes extensive inundation at high flows. All flow goes through the bridge, so measurement is not affected. Flows are augmented by a groundwater scheme high up in the catchment. The catchment is predominantly clays and limestone with eastern tributaries rising from Chalk. The land use is mostly rural though there is some urbanisation.

**Data comments** The data, provided by the Environment Agency, is a combined AMAX series from Bath St James from 1940 to 1969 and the Bathford gauging station from 1970 onwards. AMAX record length 62 years from 1940 to 2002 excluding 1969. The AMAX series was not reviewed.

**Gauge rating:** Upper limit of rating is 278.4m$^3$/s, which is exceeded by five entries in the AMAX data series. The rating not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 1567.16 | 0.988 | 0.34 | 0.575 | 817 | 31.1 | 0.023 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 133.478 m$^3$/s |
| **Annual Maxima** | 161.400 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 181.611 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 138.898 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

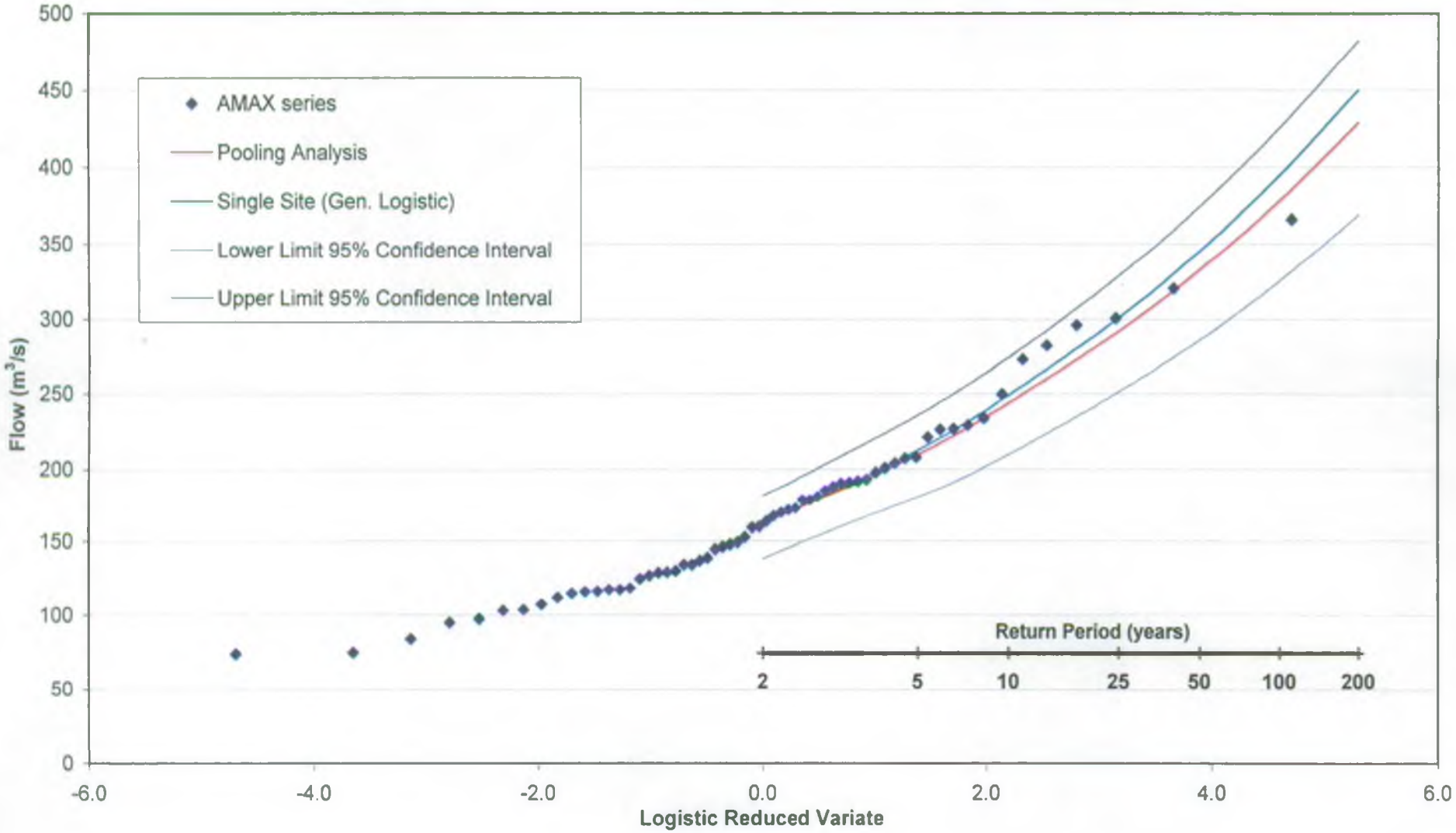
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 161.4 | 161.4 | 161.4 | 193.7 |
| 5 | 210.2 | 209.7 | 212.7 | 251.7 |
| 10 | 244.4 | 243.8 | 249.2 | 292.6 |
| 25 | 292.4 | 292.1 | 301.2 | 350.5 |
| 50 | 332.7 | 332.7 | 345.1 | 399.2 |
| 100 | 377.4 | 377.9 | 394.5 | 453.5 |
| 200 | 427.2 | 428.6 | 450.0 | 514.3 |

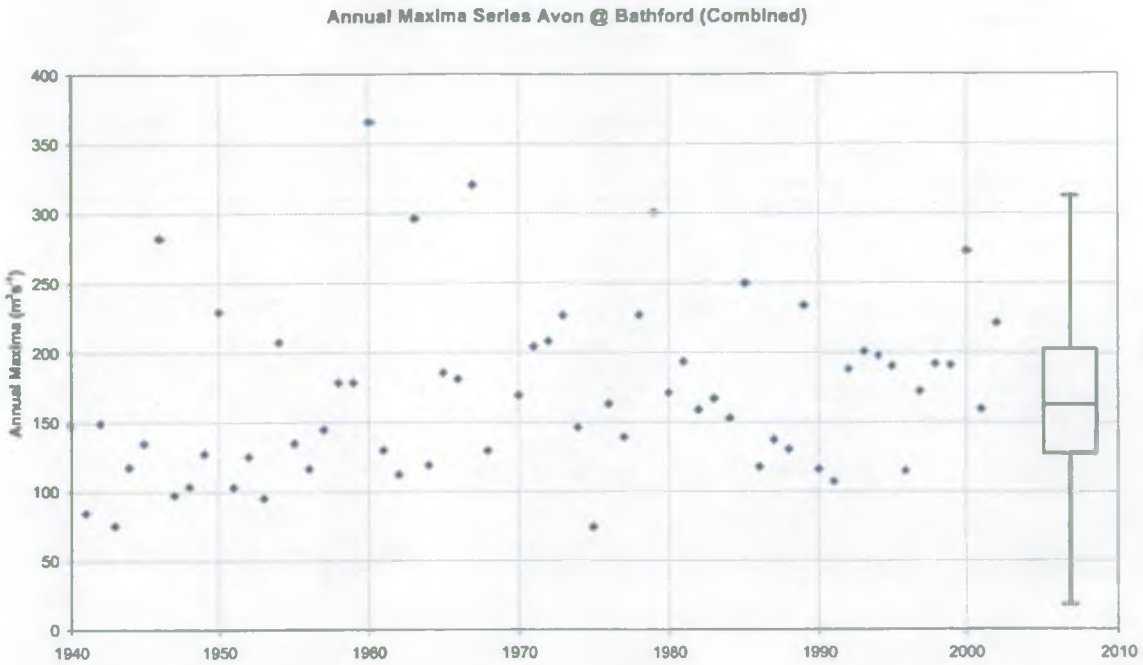
**Summary of Analysis:** AMAX series EDA revealed the peak events of water years 1960 and 1967 to be outliers. Both events are retained without review.
The review of the pooling group resulted in a change in the skewness of the FFC, with a slight decrease in lower return periods and a small increase in higher return period flows.

**Selection of Method:** The pooling analysis FFC reproduces the AMAX series well and assigns a return period of 30 Oct 2000 of just under 25 years confirming the results of the Agency's own analysis.

*Special considerations:* None
*Adopt:* Review Pooled Analysis (shaded above)
*Model parameters:* $\beta = 0.188$, $\kappa = -0.173$

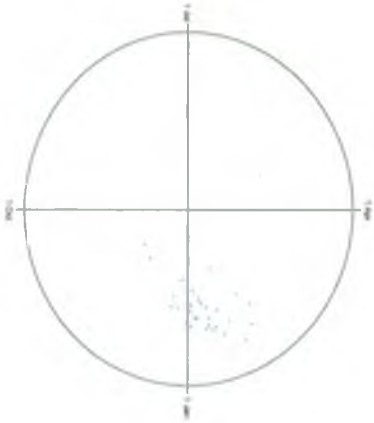
## Avon @ Bathford (Combined)

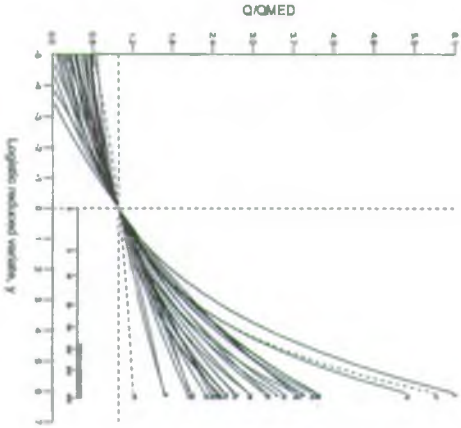


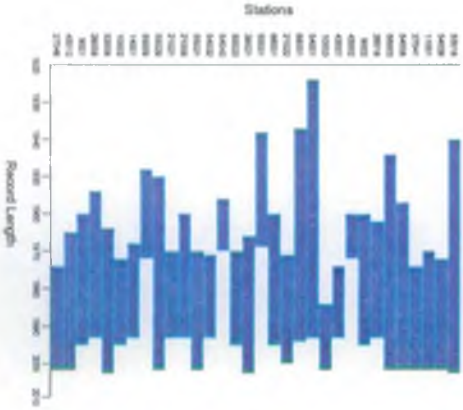


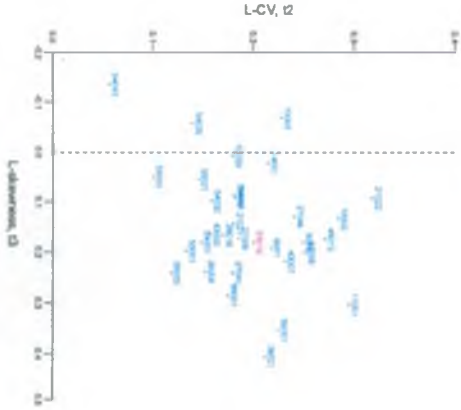

Annual Maxima series for Bathford (Combined)

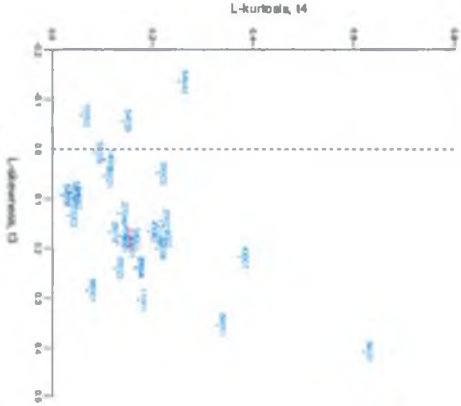
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 1940 | 147.9 | | 07 Dec 72 | 208.0 |
| 1941 | 84.4 | | 09 Feb 74 | 226.5 |
| 1942 | 149.3 | | 28 Jan 75 | 146.3 |
| 1943 | 75.3 | | 26 Sep 76 | 74.3 |
| 1944 | 117.6 | | 30 Nov 76 | 163.1 |
| 1945 | 134.8 | | 28 Jan 78 | 139.3 |
| 1946 | 282.3 | | 30 May 79 | 227.0 |
| 1947 | 97.5 | | 27 Dec 79 | 300.5 |
| 1948 | 103.6 | | 11 Mar 81 | 171.0 |
| 1949 | 127.4 | | 16 Mar 82 | 193.3 |
| 1950 | 229.4 | | 01 Feb 83 | 158.9 |
| 1951 | 103.1 | | 16 Jan 84 | 166.9 |
| 1952 | 125.2 | | 21 Jan 85 | 152.7 |
| 1953 | 95.1 | | 26 Dec 85 | 249.7 |
| 1954 | 207.3 | | 19 Nov 86 | 117.7 |
| 1955 | 134.8 | | 02 Feb 88 | 137.3 |
| 1956 | 116.4 | | 26 Feb 89 | 130.6 |
| 1957 | 144.7 | | 21 Dec 89 | 233.9 |
| 1958 | 178.4 | | 10 Jan 91 | 116.1 |
| 1959 | 178.4 | | 18 Sep 92 | 107.4 |
| 1960 | 365.7 | | 30 Nov 92 | 188.2 |
| 1961 | 129.7 | | 13 Oct 93 | 200.9 |
| 1962 | 112.1 | | 29 Jan 95 | 197.9 |
| 1963 | 296.0 | | 23 Dec 95 | 190.4 |
| 1964 | 118.7 | | 17 Feb 97 | 114.9 |
| 1965 | 185.3 | | 05 Jan 98 | 172.4 |
| 1966 | 180.7 | | 01 Nov 98 | 192.0 |
| 1967 | 320.3 | | 25 Dec 99 | 191.0 |
| 1968 | 129.4 | | 30 Oct 00 | 273.1 |
| 01 Feb 71 | 169.2 | | 27 Jan 02 | 159.7 |
| 04 Feb 72 | 204.2 | | 02 Jan 03 | 221.3 |

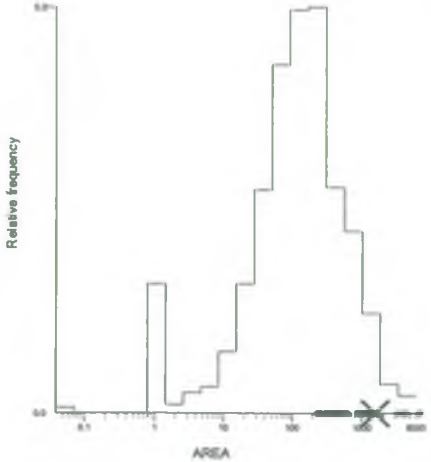


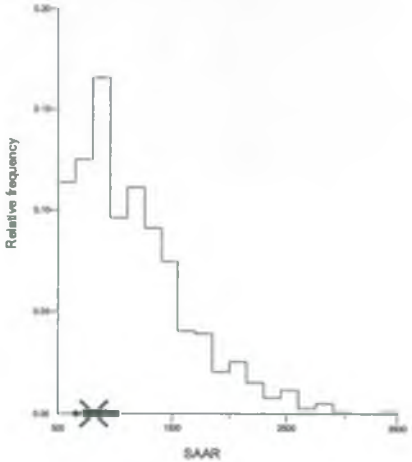

Q/QMED

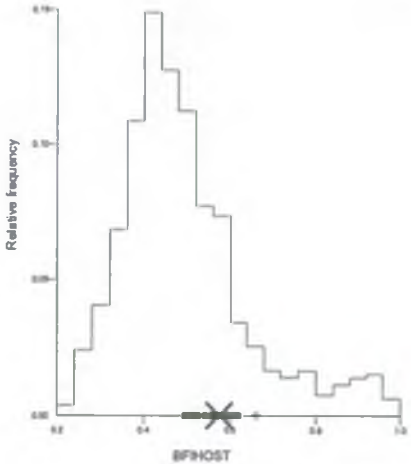

Stations
Record Length

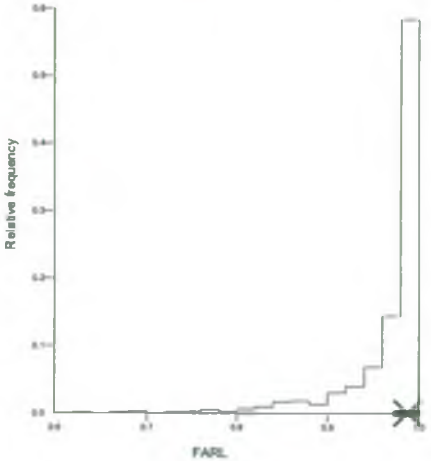

L-CV, t2

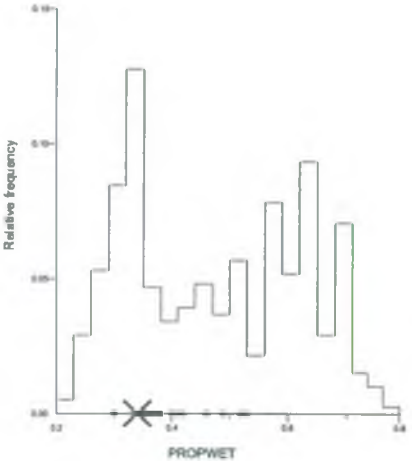

L-kurtosis, t4

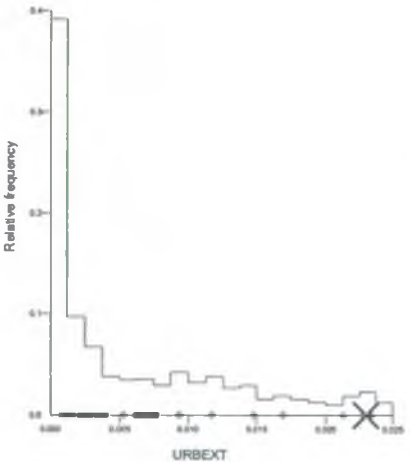

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Bathford (Combined) Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.98 | 1.55 |
| Comment | Review of pooling group is essential | Review of pooling group is optional |
| Number of Station Years | 1593 | 1032 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The station ranked 2nd in the pooling group is (53003) Avon @ Bath St James. The Bathford gauging stations superseded the Bath St James location and the AMAX data has been transferred to Bathford. | Remove Bath St James site since it is a discontinued site and leaving it in the pooling group would result in the double counting of data. | 1593 | 3.72 |
| *Period of Record* | The 41st ranked site (17002) Leven @ Leven has only 5 years of data. | Remove site since has less than recommended minimum of 8 years | 1588 | 3.81 |
| *FARL* | Bathford catchment has a FARL of 0.988 and the pooling group has a range of 0.924 – 1.000. The outliers to the pooling group are:<br>29th ranked (39008) Thames @ Eynsham FARL = 0.924<br>46th ranked (40003) Meday @ Teston FARL = 0.949<br>31st ranked (19007) Esk @ Musselbrough FARL = 0.953<br>12th ranked (54012) Tern @ Walcot FARL = 0.960<br>13th ranked 28010) Derwent @ Longbridge Weir FARL = 0.953<br>43rd ranked (28011) Derwent @ Matlock Bath FARL = 0.951 | Remove all six stations since they are outliers to the pooling group and the lower values of FARL indicates attenuation of flood flows due to the presence of reservoirs and lakes. | 1365 | 2.01 |
| *PROPWET/URBEXT* | Bathford catchment has a PROPWET of 0.34 and the pooling group has a range of 0.30 to 0.62. The outliers to the pooling group are:<br>38th ranked (12001) Dee @ Woodend PROPWET = 0.62<br>30th ranked (12002) Dee @ Park PROPWET = 0.58<br>32nd ranked (21003) Trevieot @ Ormiston Mill PROPWET = 0.57<br>20th ranked (11003) Dun @ Bridge of Alford PROPWET = 0.56<br>8th ranked (11002) Dun @ Haughton PROPWET = 0.55 | Remove all sites as they are outliers to the pooling group with the PROPWET indicating that on average the catchment is much wetter than the subject site. | 1190 | 1.60 |
| *Site Comments* | 4th ranked (27015) Derwent @ Stanford Bridge was discontinued in 1973.<br>8th ranked (27014_ Rye @ Little Habton was discontinued in 1970<br>15th ranked (21031) Till @ Etal was discontinued in 1980<br>16th ranked (10001) Ythan @ Ardlesthan was discontinued in 1982<br>26th ranked (21010) Tweed @ Dryburgh was closed in 1982<br>34th (27008) Swale @ Leckby Grange was superseded in 1980. | Remove all sites since they are all discontinued and cannot be updated. | 1032 | 1.55 |
| *Discordant Sites* | *(39021) Cherwell @ Enslow Mill*<br>The site is discordant as a result of a large peak in April 1998. | Retain site and all data as large peak is a result of the Easter floods in 1998 which resulted in severe flooding in the region. | 1032 | 1.55 |
| | *(54043) Severn @ Upton on Severn*<br>This site is discordant to the pooling group as all the AMAX data 15 years (1955 – 1969) are all very similar and has resulted in a very flat growth curve. | Retain site and all data as there is no reason to remove it because it does not demonstrate any large annual peaks | 1032 | 1.55 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *L Moments* | There are three main outliers to the L-moments and growth curve graphs this includes the Cherwell @ Enslow Mill which is kept in the pooling group for reasons given above.<br>The 3rd ranked (11011) Don @ Parkhill has a steep growth curve as a result of a wide diversity in recorded annual maxima flows.<br>13th ranked (68011) Weaver @ Ashbrook is also an outlier to growth curves as a result of a very large peaks flow recorded in 1946. This is confirmed from Hydrometric Register. | Retain all sites and all data as they contain valuable large events. | 1032 | 1.55 |

## Bathford (Combined) Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53018 (Avon @ Bathford) | 62 | 0.200 | 0.181 | 0.142 | 0.049 | 0.000 |
| 54029 (Teme @ Knightsford Bridge) | 28 | 0.140 | -0.058 | 0.138 | 1.368 | 0.169 |
| 11001 (Don @ Parkhill) | 34 | 0.295 | 0.303 | 0.170 | 1.292 | 0.243 |
| 27041 (Derwent @ Buttercrambe) | 29 | 0.179 | 0.241 | 0.162 | 0.360 | 0.280 |
| 54008 (Teme @ Tenbury) | 41 | 0.182 | 0.092 | 0.016 | 0.476 | 0.312 |
| 55003 (Lugg @ Lugwardine) | 46 | 0.070 | 0.116 | 0.375 | 2.272 | 0.315 |
| 28018 (Dove @ Marston on Dove) | 32 | 0.170 | 0.166 | 0.112 | 0.195 | 0.567 |
| 9002 (Deveron @ Muiresk) | 35 | 0.249 | 0.180 | 0.219 | 0.464 | 0.601 |
| 43002 (Stour @ Ensbury) | 12 | 0.158 | 0.165 | 0.191 | 0.142 | 0.638 |
| 43007 (Stour @ Throop Mill) | 21 | 0.232 | 0.218 | 0.372 | 1.274 | 0.643 |
| 10003 (Ythan @ Ellon) | 19 | 0.228 | -0.069 | 0.056 | 1.852 | 0.645 |
| 54001 (Severn @ Bewdley) | 71 | 0.148 | 0.181 | 0.155 | 0.319 | 0.650 |
| 68001 (Weaver @ Ashbrook) | 56 | 0.225 | 0.353 | 0.327 | 1.195 | 0.703 |
| 21022 (Whiteadder Water @ Hutton Castle) | 31 | 0.318 | 0.092 | 0.024 | 2.036 | 0.721 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 1.507 | 0.774 |
| 55001 (Wye @ Cadora) | 32 | 0.133 | 0.197 | 0.146 | 0.646 | 0.776 |
| 39021 (Cherwell @ Enslow Mill) | 38 | 0.212 | 0.407 | 0.619 | 4.681 | 0.778 |
| 55023 (Wye @ Redbrook) | 25 | 0.118 | 0.240 | 0.122 | 1.447 | 0.779 |
| 54043 (Severn @ Upton on Severn) | 15 | 0.056 | -0.135 | 0.253 | 4.085 | 0.792 |
| 54032 (Severn @ Saxons Lode) | 24 | 0.158 | 0.098 | 0.039 | 0.482 | 0.792 |
| 55021 (Lugg @ Butts Bridge) | 18 | 0.179 | 0.065 | 0.139 | 0.221 | 0.825 |
| 21009 (Tweed @ Norham) | 33 | 0.186 | 0.172 | 0.203 | 0.039 | 0.867 |
| 21021 (Tweed @ Sprouston) | 23 | 0.180 | 0.143 | 0.215 | 0.095 | 0.873 |
| 55029 (Monnow @ Grosmont) | 19 | 0.145 | 0.103 | -0.037 | 1.313 | 0.887 |
| 55009 (Monnow @ Kentchurch) | 22 | 0.181 | 0.087 | 0.037 | 0.360 | 0.887 |
| 14001 (Eden @ Kemback) | 26 | 0.215 | 0.022 | 0.104 | 0.670 | 0.888 |
| 10002 (Ugie @ Inverugie) | 23 | 0.284 | 0.133 | 0.030 | 1.097 | 0.901 |
| 53008 (Avon @ Great Somerford) | 40 | 0.252 | 0.200 | 0.208 | 0.429 | 0.920 |
| 28008 (Dove @ Rocester Weir) | 40 | 0.152 | 0.238 | 0.166 | 0.597 | 0.935 |
| 9001 (Deveron @ Avochie) | 35 | 0.218 | 0.191 | 0.130 | 0.123 | 0.954 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.613 | 0.982 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.301 | 0.995 |
| | | | | | | |
| Total | 1032 | | | | | |
| Weighted means | | 0.188 | 0.173 | 0.179 | | |

BEGGBEARN
HUISH

**Catchment:** Washford at Beggearn Huish
**Station No:** 51003
**NGR:** ST 040 395

**Description:** This is a small catchment (Hydrometric Register area 36.3 $km^2$), gauged initially by a rated section station (closed in July 1980) and then by a flat V fibreglass weir (re-opened January 1983). The weir operates for low flows, whilst higher flows are gauged by rated section. Out of bank flow occurs before bankfull at the station, although an upstream fish farm and mill do not affect dmf. The catchment is underlain by Devonion Slates, Siltstones and Sandstone and drains the Brendon Hills. Relief is steep and there are many incised valleys. Land use is predominantly rural with coniferous woodland on valley sides.

**Data comments:** WINFAP annual maxima series updated to 2002 with data supplied by the Environment Agency. AMAX record length 35 years, no data for 1980 or 1981. Data not reviewed

**Gauge rating:** Upper limit of gauge rating 12.675$m^3/s$ which none of the AMAX data exceeds. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 36.43 | 0.992 | 0.38 | 0.586 | 1153 | 31.5 | 0.0021 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 9.889 $m^3/s$ |
| **Annual Maxima** | 6.685 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 7.040 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 5.895 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, therefore permeable adjustment not applied

**Urbanisation:** URBEXT < 0.025, essentially rural: urban adjustment not applicable

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – review rating, out of bank flow before bankfull at station**

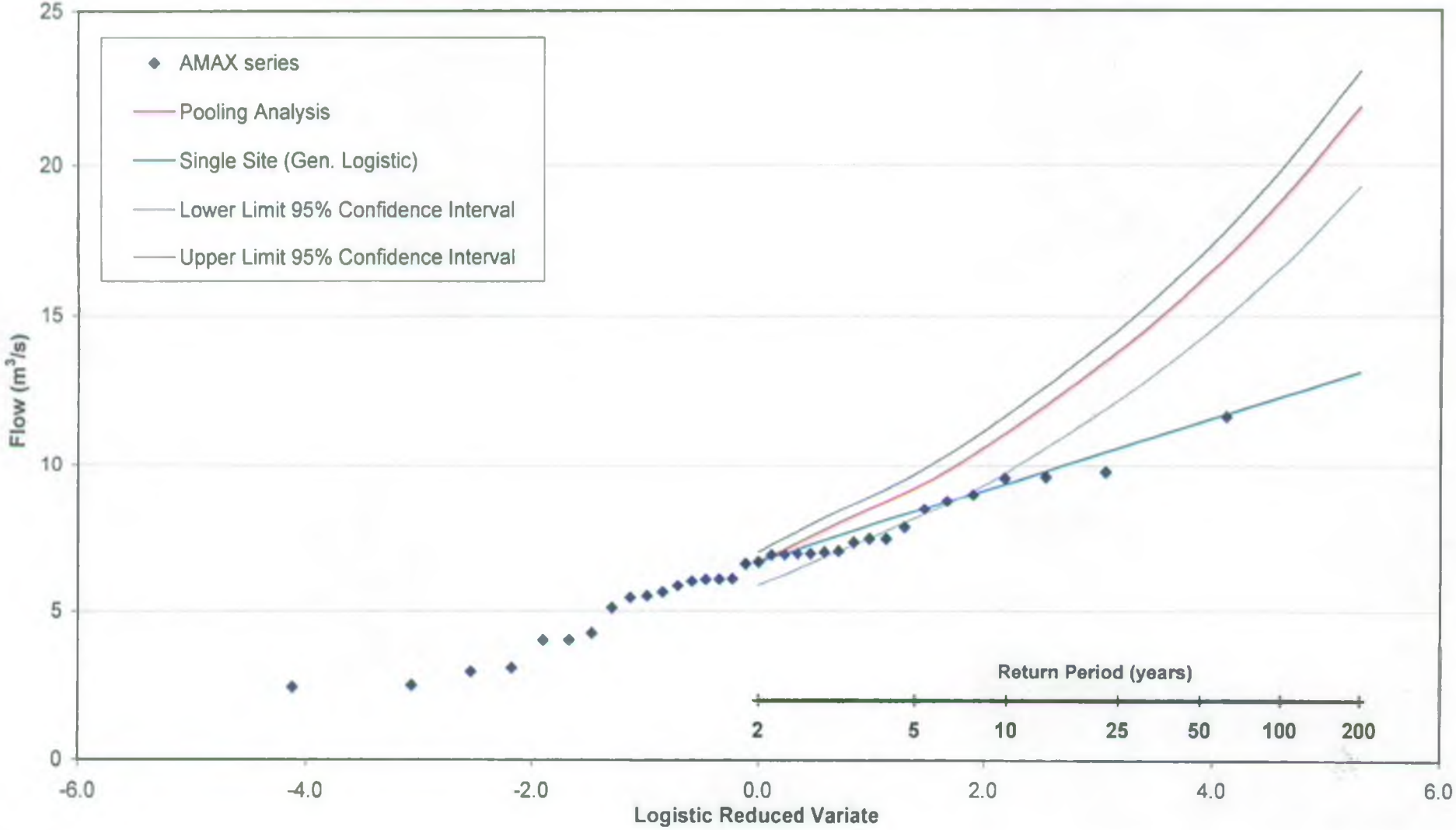
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 6.7 | 6.7 | 6.7 | 8.0 |
| 5 | 9.1 | 9.2 | 8.4 | 11.1 |
| 10 | 10.8 | 11.1 | 9.4 | 13.3 |
| 25 | 13.2 | 13.8 | 10.6 | 16.6 |
| 50 | 15.2 | 16.2 | 11.5 | 19.4 |
| 100 | 17.5 | 18.8 | 12.3 | 22.6 |
| 200 | 20.0 | 21.9 | 13.1 | 26.2 |

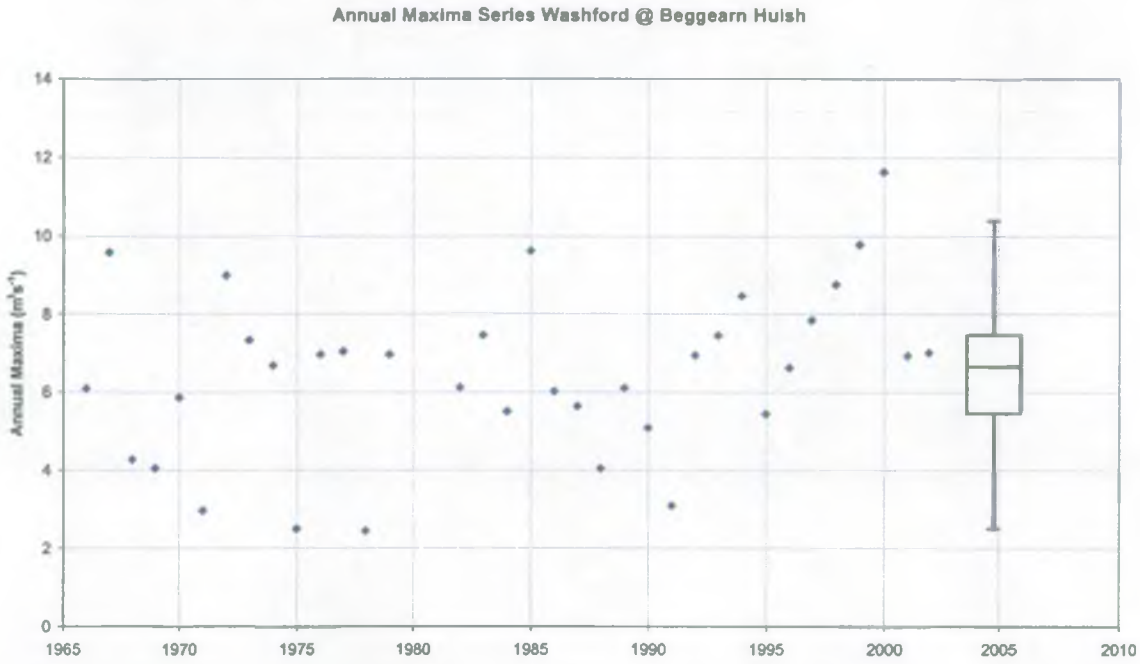
**Summary of Analysis:** AMAX EDA reveals 3 slight outliers; December 1975, March 1979, December 2000. All sites retained without review. Pooled analysis leads to an increase in the predicted flood frequency; approximately 9 % at 200 years. Single site analysis gives a reasonable representation of the AMAX data (outliers included) and would indicate a lower flood frequency.

**Selection of Method:** This is a small steep catchment, which is not represented well in the WINFAP database. The reviewed pooling group appears to overestimate the AMAX series at high return periods. The Hydrometric Register states that out of bank flow occurs before bankfull at the station which may result in the under recording of flows at the station. As a result [FEH 3.8 Table 8.3] pooled analysis prevails: refer to single site for confirmation

*Special considerations:* None
*Adopt:* Pooled analysis as shaded above
*Model parameters:* $\beta = 0.232$, $\kappa = 0.204$

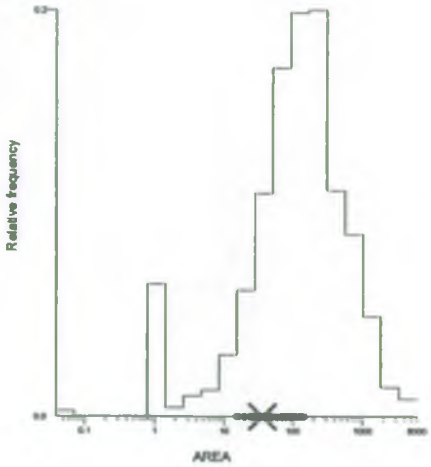
## Washford at Beggearn Huish

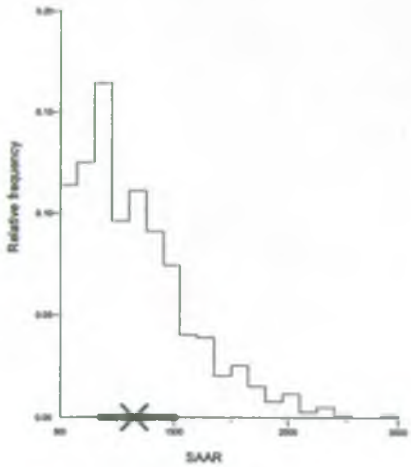


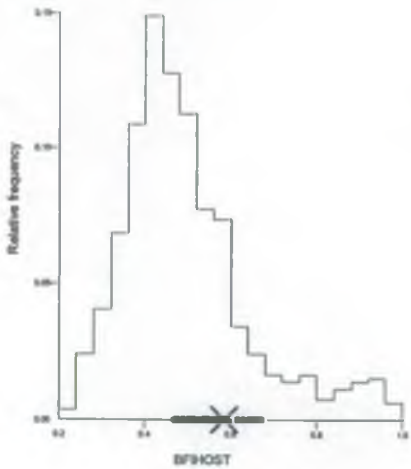


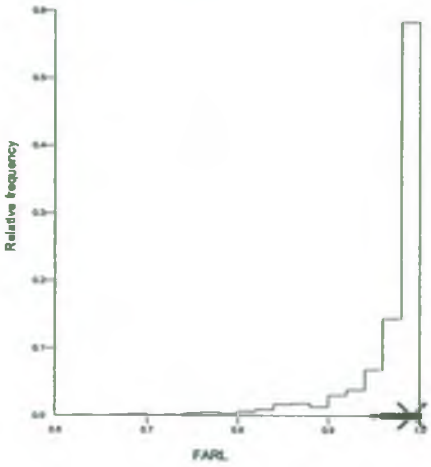

Annual Maxima series for Beggearn Huish

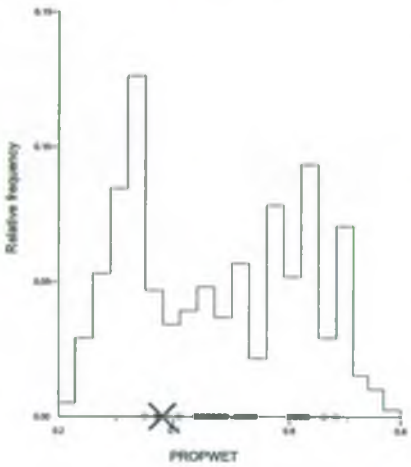
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 21 Feb 67 | 6.095 | | 19 Nov 86 | 6.027 |
| 05 Nov 67 | 9.591 | | 31 Jan 88 | 5.644 |
| 19 Jan 69 | 4.282 | | 14 Mar 89 | 4.051 |
| 23 Feb 70 | 4.054 | | 11 Feb 90 | 6.105 |
| 01 Feb 71 | 5.863 | | 06 Jan 91 | 5.094 |
| 04 Feb 72 | 2.966 | | 14 Nov 91 | 3.093 |
| 06 Dec 72 | 9.011 | | 02 Dec 92 | 6.947 |
| 10 Feb 74 | 7.337 | | 20 Dec 93 | 7.457 |
| 26 Dec 74 | 6.685 | | 27 Jan 95 | 8.477 |
| 01 Dec 75 | 2.499 | | 23 Dec 95 | 5.449 |
| 15 Oct 76 | 6.966 | | 27 Jun 97 | 6.625 |
| 25 Feb 78 | 7.047 | | 05 Jan 98 | 7.842 |
| 27 Mar 79 | 2.444 | | 31 Oct 98 | 8.774 |
| 28 Dec 79 | 6.966 | | 26 Dec 99 | 9.794 |
| 01 May 83 | 6.120 | | 07 Dec 00 | 11.636 |
| 16 Jun 84 | 7.457 | | 04 Feb 02 | 6.931 |
| 24 Nov 84 | 5.509 | | 13 Oct 02 | 7.012 |
| 26 Dec 85 | 9.631 | | | |

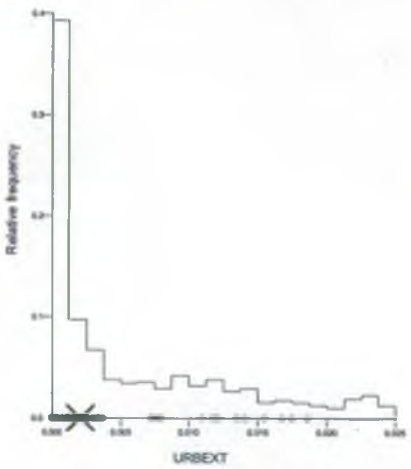

Relative frequency
AREA

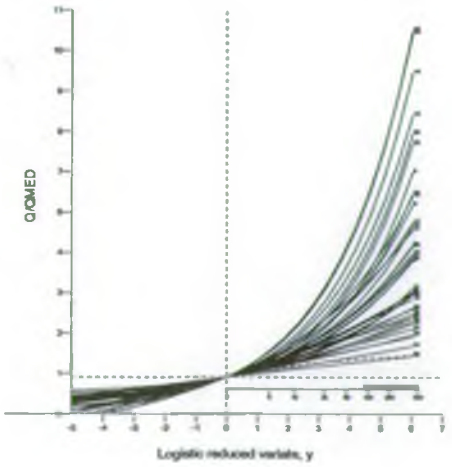

Relative frequency
SAAR

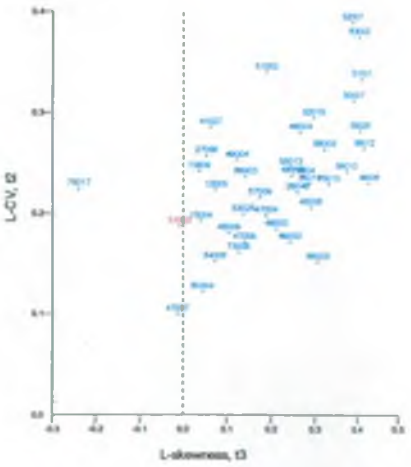

Relative frequency
BFIHOST

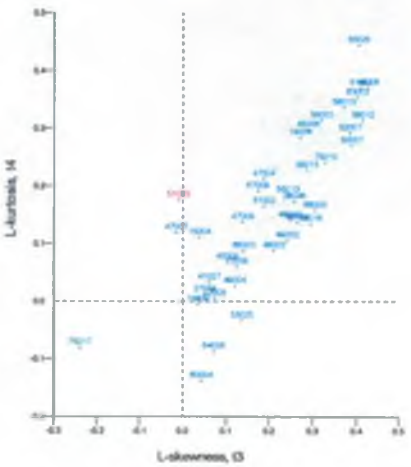

Relative frequency
FARL

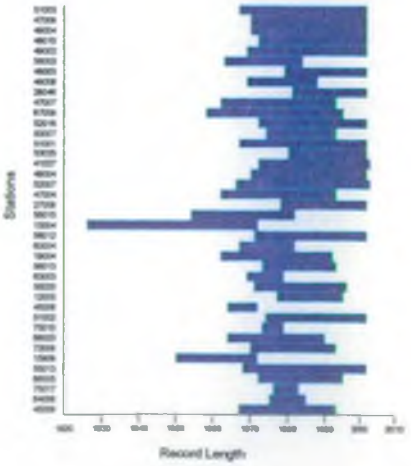

Relative frequency
PROPWET


Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Beggearn Huish Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 5.67 | 4.29 |
| Comment | Review of the pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1201 | 1011 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Any sites lying upstream or downstream of the subject site, are likely to be hydrologically similar and give good reason for promotion to a higher ranking in pooling group. No stations located directly up/downstream of Washford @ Beggearn Huish. | | 1201 | 5.67 |
| *Period of Record* | For inclusion in a pooling group sites need 8 years of annual maxima. 4th ranked Tone @ Wadhams (52801) Farm has 6 years of data. The remaining stations have eight or more years. | Remove (52801) Tone @ Wadhams Farm. | 1195 | 5.62 |
| *FARL* | The value of FARL for the Washford @ Beggearn Huish is 0.992 and the range of values for the pooling group lies between 0.800 and 1.000. Four catchments indicate significant storage effects with low FARL values.<br>21st ranked Melgan @ Loch of Linrathen (15005) – FARL = 0.800.<br>5th ranked Tone @ Greenham (52014) – FARL = 0.937.<br>11th ranked Congresbury Yeo @ Iwood (52017) – FARL = 0.890.<br>28th ranked Chew @ Compton Dando (53004) – FARL = 0.843.<br>Other stations indicate storage and artificial influences, but lowest FARL remaining is 0.950 | Remove the four sites indicated with the lowest FARL values. | 1048 | 5.04 |
| *PROPWET/URBEXT* | Subject site PROPWET is 0.38. The range of values in the pooling group was 0.35 – 0.72. Many sites had soils which are considerably wetter than the subject site and therefore too many to remove all of them.<br>The two largest outliers Manor Water @ Cademuir (21019) – PROPWET = 0.72 and Winster @ Lobby Bridge (73803) – PROPWET = 0.71<br>Other large values for PROPWET from Bela @ Beetham (73008) – 0.68, Muick @ Invermuick (12005) – 0.68, Muckle Burn @ Eastmill (15809) – 0.68, Leri @ Dolybont (64006) – 0.66, Ellen @ Bullgill (75017) – 0.62, Yscir @ Pontaryscir (56013) – 0.61, Aled @ Bryn Aled (66003)– 0.60, Homer Water @ West Luccombe (51002) – 0.54, Honddu @ Tafologn (55015) - 0.54, Llynfi @ Three Cocks (55025) – 0.54, Quarme @ Enterwell (45006) – 0.54, Inzion @ Loch of Lintrathen (15004) – 0.53, Wyre @ Llanrhystyd (63003) – 0.53, Dewi Fawr @ Glasryn Ford (60004 )– 0.52, Clwyd @ Ruthin Weir (66005)– 0.51, Exe @ Pixton (45009) – 0.51, Arrow @ Titley Mill (55013) – 0.49 and North Esk @ Dalmore Weir (19004) – 0.49.<br>All sites in pooling group have URBEXT <0.025 and are essentially rural. | Remove the two largest outliers, (73803) Winster @ Lobby Bridge and (21019) Manor Water @ Cademuir.<br>Place the remaining stations with high values of PROPWET to the bottom of the pooling group. | 1011 | 4.29 |
| *Site Comments* | All site comments reviewed. Indications of artificial influences, data and geological issues. However the need for a consistent approach and a lack of data to make an accurate assessment of theses influences and the need to conserve station years precludes the removal of data. | No change | 1011 | 4.29 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Discordant Sites* | *Ellen @ Bullgill (75017)*<br>Ranked 43rd in the pooling group, has 9 years of data, from 1975 to 1983. The AMAX series does show a relatively low flood event in Feb 77, the end of a known drought period, which results in the discordancy. However there are no gauges either up or downstream of the site with which a comparison could be made. | Retain site and all data. Having a short record and a low rank should not have great affect on the pooled growth curve. | 1011 | 4.29 |
| *L Moments* | The main outliers from the pre-review pooling review diagnostic plots show a number of outlying stations, includes<br>Ellen @ Bullgill (75017) – as noted above and retained.<br>Horner Water @ West Luccombe (51002) – has a number of small and a couple of medium/large flood events included in the AMAX series. There is no gauge up or downstream with which to compare the series, though data provided by Environment Agency for analysis in this study providing a reliable data set.<br>Parret @ Chiselborough (52007) – Has two large flood peaks and several small flood events in the data series. Adjacent gauges confirm flood events.<br>Llynfi @ Three Cocks (55025)– one very large flood event occurred in 1979 (27th Dec). The Llynfi is a tributary of the Wye and its confluence lies between Wye @ Belmont (55002) and Wye @ Ernwood (55007). Both gauges on the Wye show large flood events on 28th and 27th of December 1979 respectively confirming outlying flood data..<br>63003 (Wyre @ Llanrhystyd) – one large flood event occurred in 1972 (6th Aug 1973). To the north and within the same gauging area, the Yatwyth @ Pont Llolwyn (63001) shows that there was a relatively large flood event on 5th of Aug 1973, confirming outlying flood data. | Retain all sites and data. | 1011 | 4.29 |

## Beggearn Huish Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 2.654 | 0.000 |
| 47009 (Tiddy @ Tideford) | 33 | 0.171 | 0.138 | 0.137 | 0.426 | 0.269 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.597 | 0.335 |
| 48010 (Seaton @ Trebrownbridge) | 30 | 0.238 | 0.246 | 0.141 | 0.161 | 0.370 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 0.832 | 0.449 |
| 56003 (Honddu @ the Forge Brecon) | 21 | 0.263 | 0.320 | 0.314 | 0.459 | 0.482 |
| 48003 (Fal @ Tregony) | 24 | 0.185 | 0.210 | 0.088 | 0.522 | 0.557 |
| 48006 (Cober @ Helston) | 20 | 0.230 | 0.427 | 0.371 | 1.212 | 0.589 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.132 | 0.643 |
| 47007 (Yealm @ Puslinch) | 32 | 0.100 | -0.015 | 0.119 | 2.875 | 0.655 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.234 | 0.664 |
| 52016 (Currypool Stream @ Currypool Farm) | 32 | 0.295 | 0.295 | 0.134 | 0.938 | 0.710 |
| 50007 (Taw @ Taw Bridge) | 21 | 0.312 | 0.388 | 0.270 | 0.770 | 0.752 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.112 | 0.782 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.151 | 0.810 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.179 | 0.820 |
| 48004 (Warleggan @ Trengoffe) | 33 | 0.281 | 0.265 | 0.136 | 0.519 | 0.848 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 2.152 | 0.854 |
| 47004 (Lynher @ Pillaton Mill) | 33 | 0.198 | 0.187 | 0.213 | 0.447 | 0.919 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.825 | 0.923 |
| 55015 (Honddu @ Tafolog) | 30 | 0.229 | 0.286 | 0.228 | 0.161 | 0.407 |
| 15004 (Inzion @ Loch of Lintrathen) | 44 | 0.192 | 0.038 | 0.110 | 0.818 | 0.473 |
| 56012 (Grwyne @ Millbrook) | 23 | 0.264 | 0.416 | 0.314 | 0.699 | 0.624 |
| 60004 (Dewi Fawr @ Glasfryn Ford) | 15 | 0.122 | 0.043 | -0.138 | 2.462 | 0.660 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.430 | 0.678 |
| 56013 (Yscir @ Pontaryscir) | 22 | 0.241 | 0.371 | 0.337 | 0.695 | 0.749 |
| 63003 (Wyre @ Llanrhystyd) | 11 | 0.375 | 0.403 | 0.354 | 1.771 | 0.772 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.621 | 0.779 |
| 12005 (Muick @ Invermuick) | 18 | 0.223 | 0.073 | 0.005 | 0.478 | 0.780 |
| 45006 (Quarme @ Enterwell) | 9 | 0.206 | 0.289 | 0.298 | 0.768 | 0.792 |
| 51002 (Horner Water @ West Luccombe) | 24 | 0.340 | 0.188 | 0.165 | 1.426 | 0.792 |
| 75010 (Marron @ Ullock) | 8 | 0.229 | 0.329 | 0.241 | 0.347 | 0.796 |
| 66003 (Aled @ Bryn Aled) | 26 | 0.236 | 0.140 | 0.087 | 0.130 | 0.810 |
| 73008 (Bela @ Beetham) | 25 | 0.161 | 0.125 | 0.060 | 0.479 | 0.816 |
| 15809 (Muckle Burn @ Eastmill) | 20 | 0.242 | 0.034 | -0.005 | 0.779 | 0.820 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.025 | 0.839 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 1.574 | 0.840 |
| 75017 (Ellen @ Bullgill) | 9 | 0.225 | -0.239 | -0.081 | 4.297 | 0.857 |
| 64006 (Leri @ Dolybont) | 11 | 0.152 | 0.071 | -0.087 | 1.577 | 0.885 |
| 45009 (Exe @ Pixton) | 22 | 0.181 | 0.103 | 0.068 | 0.267 | 0.908 |
| | | | | | | |
| Total | 1011 | | | | | |
| Weighted means | | 0.232 | 0.204 | 0.166 | | |

BISHOPS HULL

**Catchment:** River Tone at Bishops Hull
**Station No:** 52005
**NGR:** ST 206 250

**Description:** The catchment is approx 203 $km^2$ and predominantly rural. Geology is mainly sandstone and marls. The current full range gauging station, which forms part of the flood warning system for Taunton, comprises a rectangular Crump profile weir (low flows) with crest tapping (non-operational). Higher flows are gauged using a rated section. Out of bank flow occurs before bankfull. Prior to construction of the weir (Mar 1968) was a velocity-area station with flows unreliable below 1.42$m^3$/s. Compensation flow maintained from Clatworthy and Luxhay Reservoirs and minor surface water abstractions for PWS further reduce runoff. Reservoirs are not large enough to have significant influence on the fairly rapid response to rainfall.

**Data comments** Updated AMAX data set provided by Environment Agency gave 42 years of annual maxima series for the period 1961 to 2002 inclusive. The AMAX series was not reviewed.

**Gauge rating:** Upper limit of rating 80.1$m^3$/s, but flow comes out of bank at 62.7$m^3$/s (2.3m stage). The upper limit is exceeded once and five further AMAX events are greater than the out of bank limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 203.63 | 0.979 | 0.36 | 0.562 | 964 | 32.9 | 0.0068 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 33.900 $m^3$/s |
| **Annual Maxima** | 42.594 $m^3$/s |
| **Upper Limit 95% Confidence Interval** | 48.918 $m^3$/s |
| **Lower Limit 95% Confidence Interval** | 38.911 $m^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – review upper limit of rating**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Gen Log. x 20% |
| 2 | 42.6 | 42.6 | 42.6 | 51.1 |
| 5 | 58.6 | 59.0 | 55.6 | 66.8 |
| 10 | 70.4 | 71.2 | 64.1 | 76.9 |
| 25 | 87.7 | 89.3 | 75.2 | 90.3 |
| 50 | 102.7 | 105.1 | 84.[illegible] | 100.8 |
| 100 | 119.8 | 123.4 | 93.3 | 111.9 |
| 200 | 139.6 | 144.6 | 103.1 | 123.7 |

**Summary of Analysis:** AMAX series EDA reveals the dataset to have no significant outliers. .

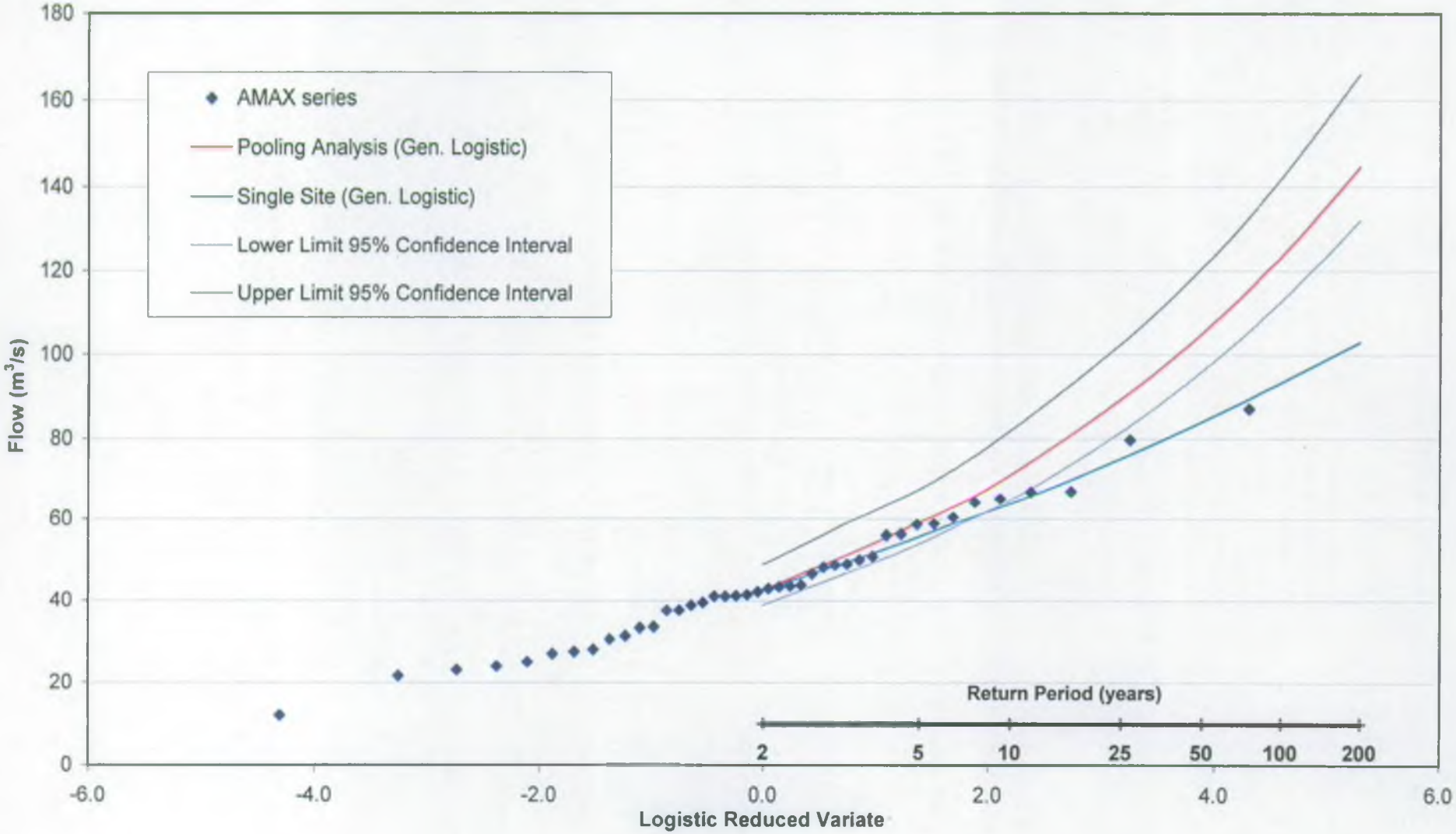
**Selection of Method:** Separation between FFCs is significant with the single site Gen. Log. curve providing the best fit to the observed AMAX data. However, FEH 3.8 (Table 8.3) recommends that pooled analysis should prevail with reference to single site for confirmation. Joint analysis inapplicable because of high target return period. However, in this instance it is recommended that the single site Gen. Log curve is more appropriate given the local knowledge discussed in special considerations below.

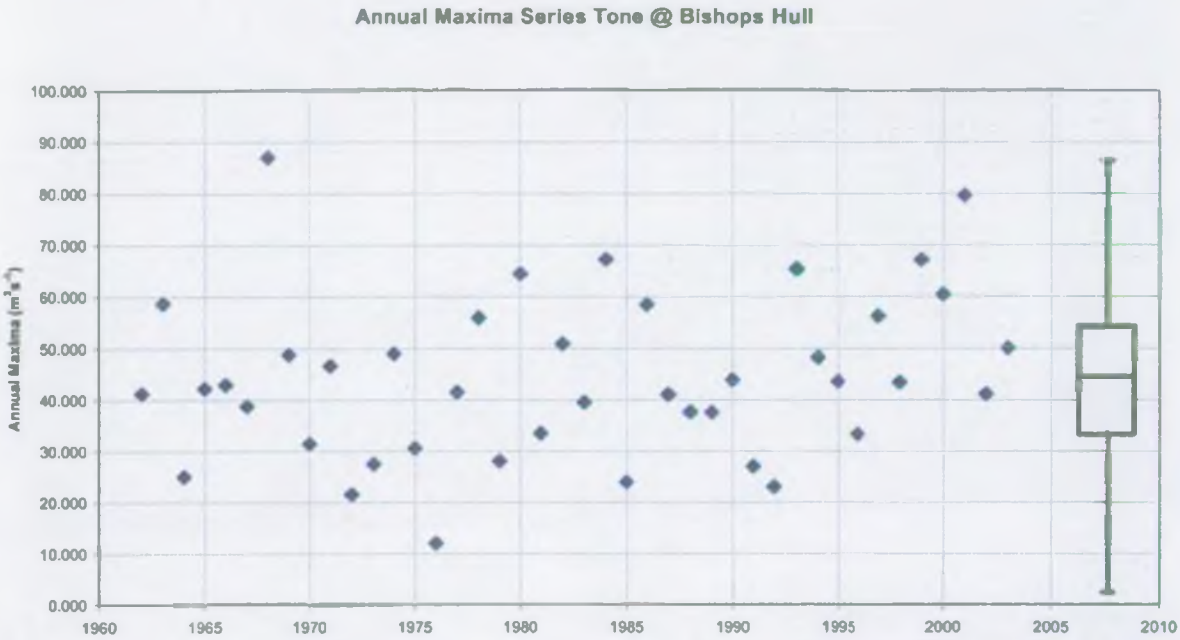
*Special considerations:* Further investigation was made of the high flow data, the highest on record being the 1968 event. Local Agency Flood Defence staff confirmed the 1968 flood event assessed to have a approx 60 year return period, based on defence level provided by Taunton FDS. This compares well with single site analysis and the Gen. Log distrib. Note: Investigation of impact of recent changes to the high flow rating is advised

*Adopt:* Single Site Analysis – Gen. Logistic distribution (as shaded above)

*Model parameters:* $\beta = 0.207$, $\kappa = -0.095$

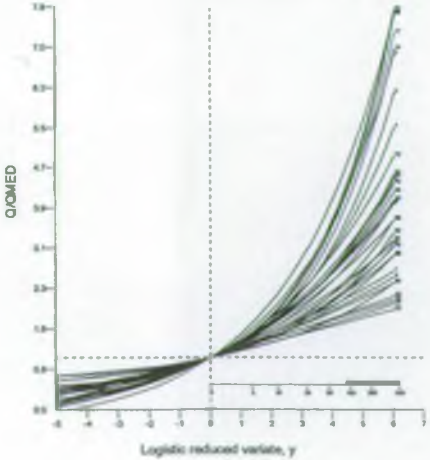
## River Tone at Bishops Hull

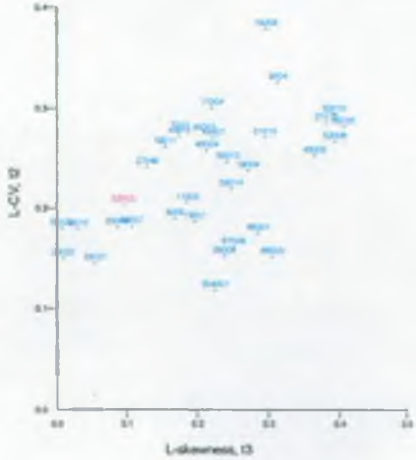


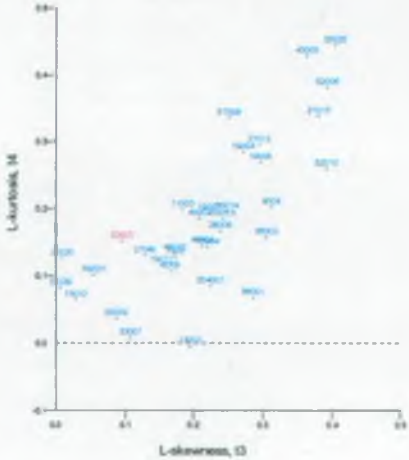


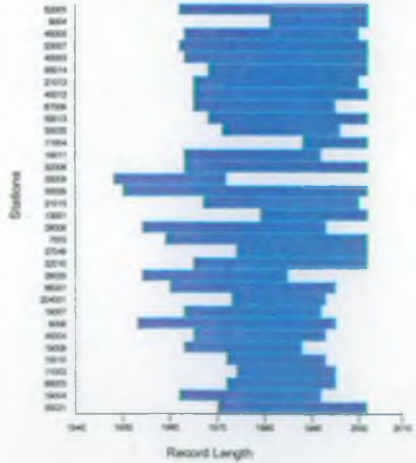

## Annual Maxima series for Bishops Hull

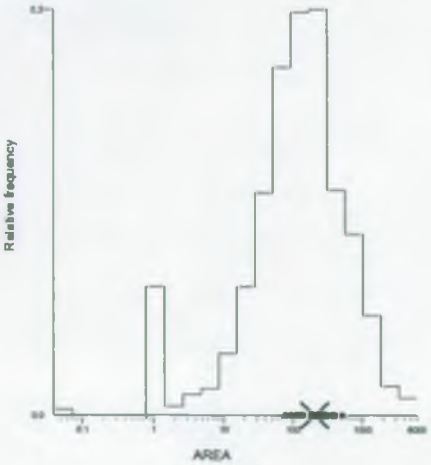
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 21 Jan 62 | 41.205 | | 12 Nov 82 | 39.528 |
| 14 Feb 63 | 58.730 | | 27 Jan 84 | 67.273 |
| 17 Nov 63 | 25.029 | | 09 Feb 85 | 23.967 |
| 20 Jan 65 | 42.197 | | 26 Dec 85 | 58.545 |
| 19 Apr 66 | 42.992 | | 03 Apr 87 | 41.043 |
| 20 Feb 67 | 38.819 | | 31Jan 88 | 37.629 |
| 11 Jul 68 | 87.029 | | 25 Feb 89 | 37.579 |
| 22 Feb 69 | 48.767 | | 27 Jan 90 | 43.874 |
| 14 Jan 70 | 31.402 | | 09 Jan 91 | 27.037 |
| 31 Jan 71 | 46.641 | | 08 Jan 92 | 23.032 |
| 03 Feb 72 | 21.564 | | 30 Nov 92 | 65.397 |
| 02 Dec 72 | 27.527 | | 20 Dec 93 | 48.221 |
| 09 Feb 74 | 48.949 | | 09 Nov 94 | 43.572 |
| 20 Jan 75 | 30.592 | | 22 Dec 95 | 33.273 |
| 01 Dec 75 | 12.038 | | 06 Aug 97 | 56.222 |
| 01 Oct 76 | 41.467 | | 05 Jan 98 | 43.421 |
| 23 Feb 78 | 55.924 | | 19 Jan 99 | 67.156 |
| 01 Feb 79 | 28.066 | | 18 Dec 99 | 60.443 |
| 27 Dec 79 | 64.456 | | 30 Oct 00 | 79.686 |
| 17 Nov 80 | 33.562 | | 26 Jan 02 | 41.093 |
| 29 Dec 81 | 50.883 | | 13 Nov 02 | 50.038 |

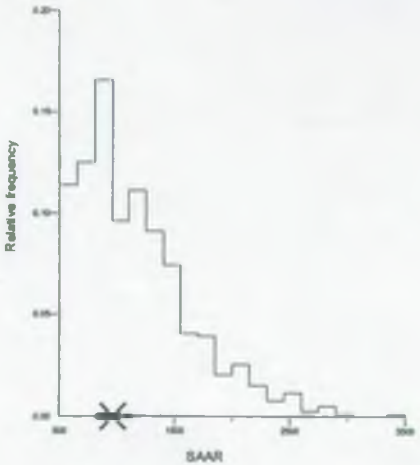

Q/QMED
Logistic reduced variate, y

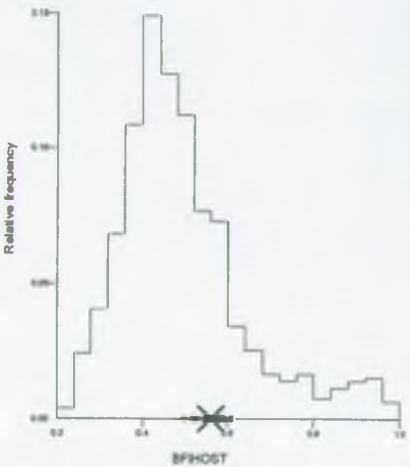

L-CV, t2
L-skewness, t3

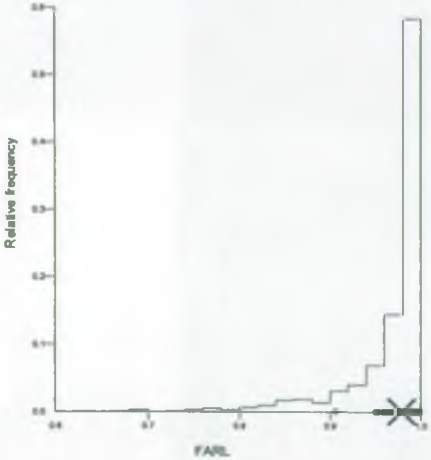

L-kurtosis, t4
L-skewness, t3

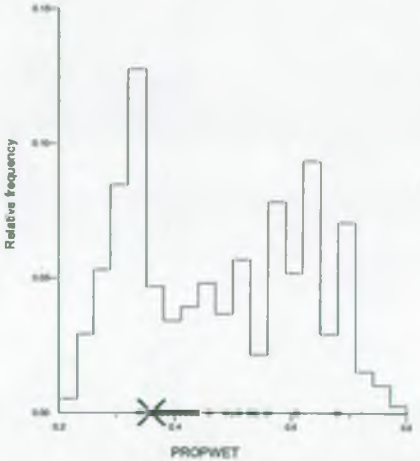

Stations
Record Length

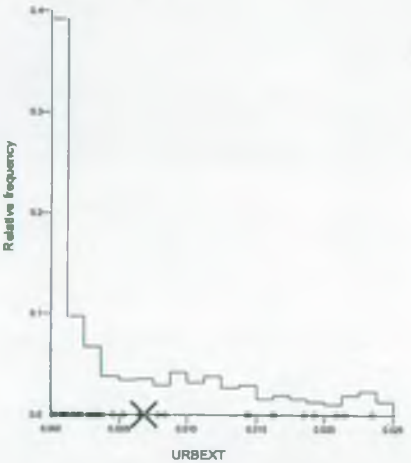

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Bishops Hull Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 2.754 | 1.600 |
| Comment | Strongly heterogeneous, review of pooling group essential | Possibly heterogeneous, review of pooling group optional |
| Number of Station Years | 1098 | 1020 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Subject site is Rank 1. A number of local sites exist but are already at top end of pooling group so no further promotion required. Sites relatively widely distributed across UK. | No action required. | 1098 | 2.754 |
| *Period of Record* | All sites have good record length (shortest = 10 years) | No action required | 1098 | 2.754 |
| *FARL* | Two main outliers:<br>17th ranked Chew @ Compton Dando (53004) (FARL = 0.843) – large storage reservoir in headwaters of catchment thought to be built prior to start of record. Potentially significant attenuation.<br>32nd ranked South Esk @ Prestonholme (19008) (FARL = 0.906) – several small storage reservoirs in headwaters. No information on dates of construction. Low placing in pooling group and limited impact. | Remove Chew at Compton Dando.<br>Retain South Esk @ Prestonholme. | 1054 | 2.190 |
| *PROPWET/URBEXT* | PROPWET:<br>Main outliers:<br>29th ranked Dulnain @ Balnaan Bridge (8009) – High PROPWET (0.680) but little additional evidence for exclusion from group and low weighting in pooling group.<br>7th ranked Petteril @ Harraby Green (76010) – High PROPWET (0.640) and high weighting in pooling group. Little additional evidence for exclusion.<br>27th ranked Bush @ Seneirl (204001) – High PROPWET (0.61) but little additional evidence for exclusion and low weighting in pooling group.<br>URBEXT: All members of pooling group are essentially rural with URBEXT <0.025 | Remove Petteril @ Harraby Green.<br>Retain Dulnain @ Balnaan Bridge and Bush @ Seneirl. | 1030 | 2.083 |
| *Site Comments* | Site comments investigated but no significant requirement to remove sites.<br>Frome (Somerset) @ Telliford, Yeo @ Pen Mill & Dove @ Rocester Weir given particular attention. | No action required. | 1030 | 2.083 |
| *Discordant Sites* | *(55022) Trothy @ Michel Troy*<br>15th ranked has high discordancy (D = 6.136) at – site with short record (10 years) with a number of years with missing AMAX data, possibly suggesting problem with high flow record. Extreme outlier in L-moments and on growth curves. | Remove from pooling group | 1020 | 1.600 |
| *L Moments* | Trothy @ Michel Troy (refer to comments on "Discordant Sites" above) | No action required | 1020 | 1.600 |

## Bishops Hull Pooling Group – Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.680 | 0.000 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 1.185 | 0.071 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 1.736 | 0.095 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.736 | 0.134 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.295 | 0.166 |
| 55014 (Lugg @ Byton) | 26 | 0.158 | 0.088 | 0.192 | 1.443 | 0.210 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.351 | 0.222 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.479 | 0.229 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 2.035 | 0.248 |
| 55013 (Arrow @ Titley Mill) | 25 | 0.280 | 0.249 | 0.232 | 0.262 | 0.261 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.797 | 0.264 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.832 | 0.271 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.488 | 0.285 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.209 | 0.291 |
| 55009 (Monnow @ Kentchurch) | 22 | 0.181 | 0.087 | 0.037 | 0.574 | 0.326 |
| 55029 (Monnow @ Grosmont) | 19 | 0.145 | 0.103 | -0.037 | 1.374 | 0.326 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 0.867 | 0.337 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.576 | 0.338 |
| 28008 (Dove @ Rocester Weir) | 40 | 0.152 | 0.238 | 0.166 | 0.857 | 0.390 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.587 | 0.399 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.410 | 0.414 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.206 | 0.426 |
| 28020 (Churnet @ Rocester) | 28 | 0.150 | 0.010 | 0.125 | 2.027 | 0.427 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 2.033 | 0.432 |
| 204001 (Bush @ Seneirl) | 21 | 0.118 | 0.225 | 0.084 | 1.832 | 0.436 |
| 19007 (Esk @ Musselburgh) | 29 | 0.270 | 0.223 | 0.193 | 0.196 | 0.450 |
| 8009 (Dulnain @ Balnaan Bridge) | 43 | 0.189 | 0.168 | 0.107 | 0.178 | 0.470 |
| 45004 (Axe @ Whitford) | 29 | 0.257 | 0.213 | 0.145 | 0.210 | 0.472 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 2.153 | 0.481 |
| 15010 (Isla @ Wester Cardean) | 21 | 0.179 | 0.030 | 0.064 | 1.081 | 0.482 |
| 11003 (Don @ Bridge of Alford) | 21 | 0.205 | 0.185 | 0.198 | 0.171 | 0.484 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 1.793 | 0.493 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.313 | 0.495 |
| 55021 (Lugg @ Butts Bridge) | 18 | 0.179 | 0.065 | 0.139 | 1.033 | 0.509 |
| | | | | | | |
| Total | 1020 | | | | | |
| Weighted means | | 0.235 | 0.222 | 0.197 | | |

BITTON

**Catchment:** Boyd at Bitton
**Station No:** 53017
**NGR:** ST 681 698

**Description:** The station is a flat V Crump profile weir, crest 8m broad. It is situated in rectangular sheet-piled section which is 4m deep. It has a full range. Maintenance difficult. Predominantly clay catchment. Land use is mainly rural with some urban areas.

**Data comments:** An updated AMAX data set provided by the Environment Agency gave 30 years of annual maxima series data for the period 1973 to 2002 inclusive. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 94.5 $m^3/s$. All recorded AMAX are less than this upper limit. The rating not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 47.88 | 0.999 | 0.35 | 0.498 | 806 | 37.5 | 0.0126 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 9.409 $m^3/s$ |
| **Annual Maxima** | 12.712 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 15.440 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 10.400 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record is 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** Satisfactory

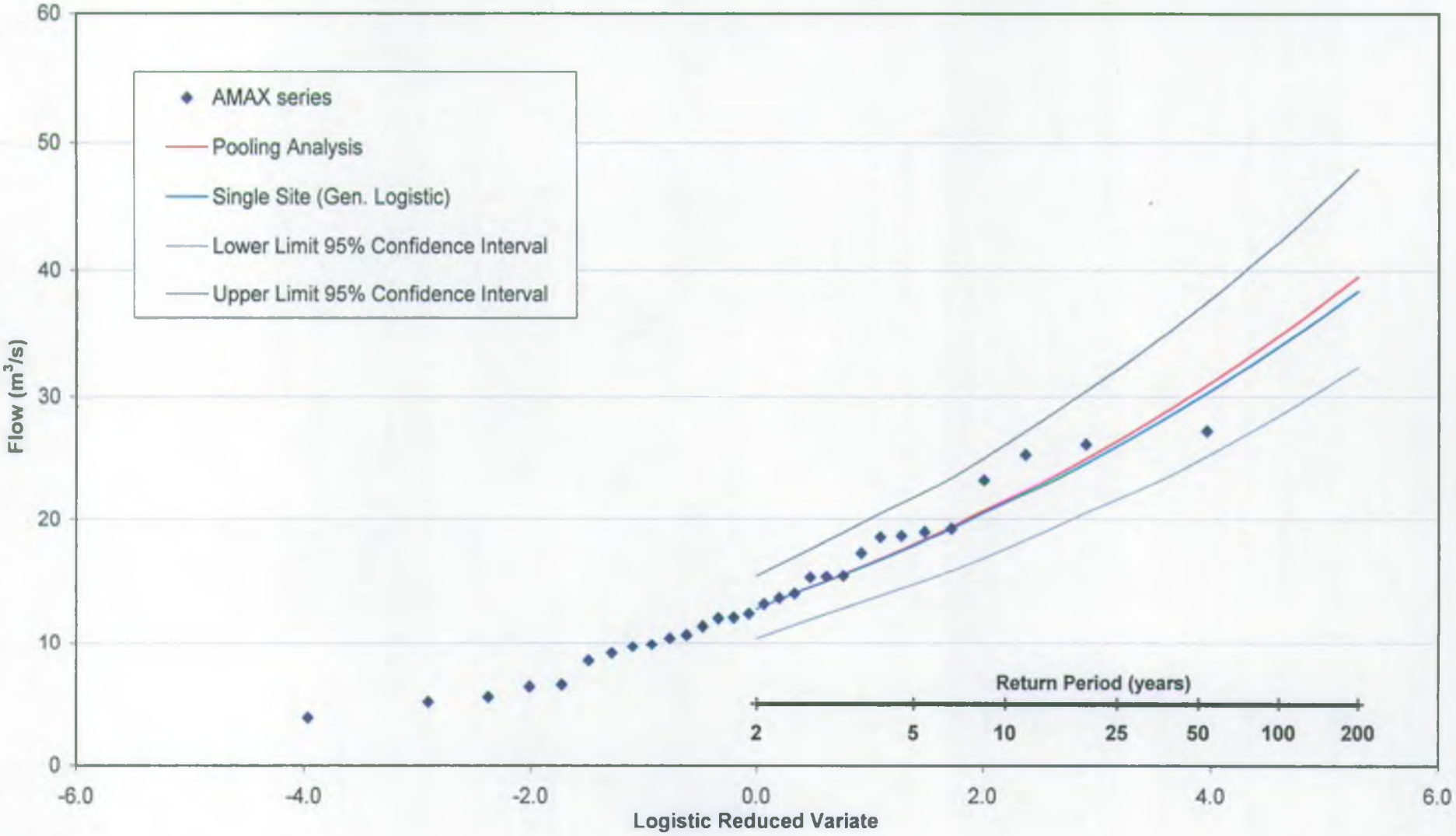
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 12.7 | 12.[illegible] | 17.9 | 15.3 |
| 5 | 18.1 | 18.[illegible] | 21.3 | 21.6 |
| 10 | 21.8 | 21.5 | 26.1 | 25.9 |
| 25 | 26.8 | 26.4 | 29.1 | 31.7 |
| 50 | 31.0 | 30.[illegible] | 29.9 | 36.5 |
| 100 | 35.6 | 34.8 | 33.9 | 41.7 |
| 200 | 40.6 | 39.5 | 38.4 | 47.4 |

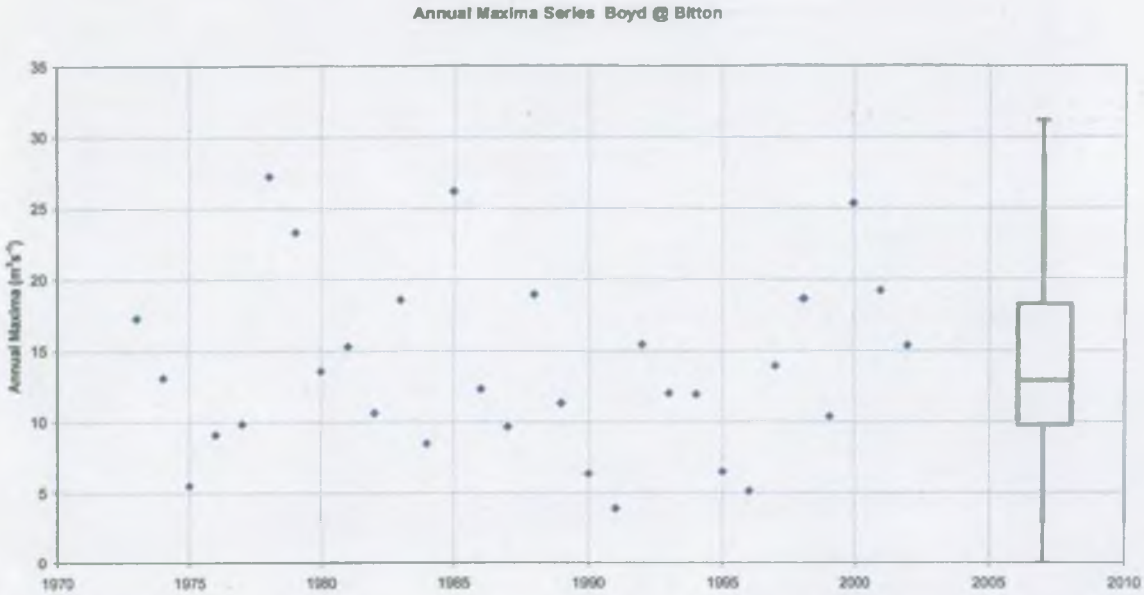
**Summary of Analysis:** AMAX series EDA reveals the dataset to have no outliers.

**Selection of Method:** Both the original and reviewed pooling analysis represent the data well. Recommend reviewed pooling analysis

*Special considerations:* None
*Adopt:* Reviewed pooled analysis (shaded above).
*Model parameters:* $\beta = 0.258$ $\kappa = -0.138$

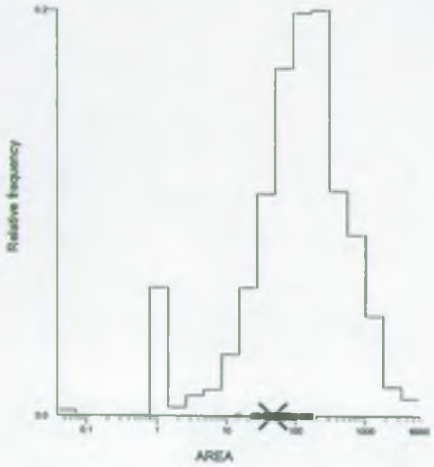
## River Boyd at Bitton

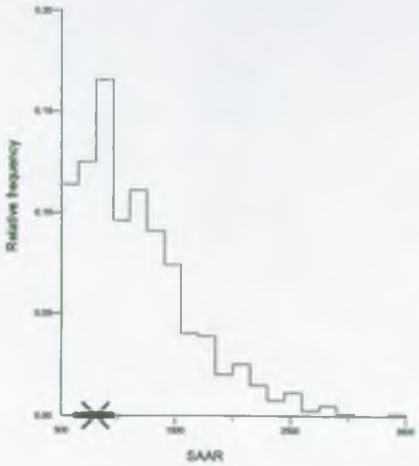


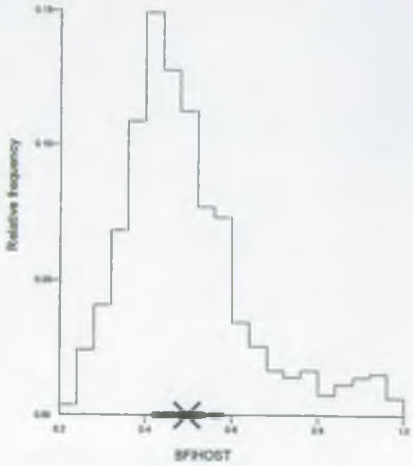


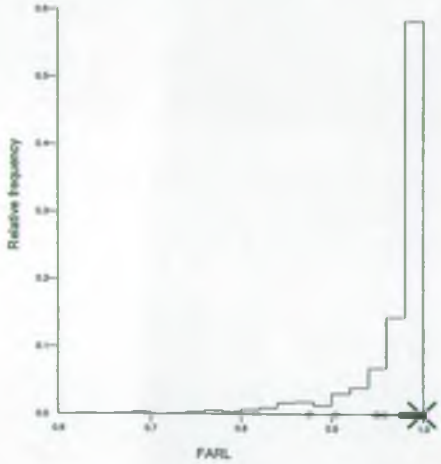

Annual Maxima series for Bitton

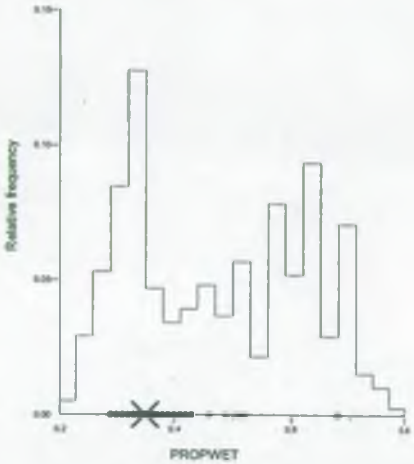
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 10 Feb 74 | 17.281 | | 25 Feb 89 | 18.970 |
| 20 Jan 75 | 13.101 | | 20 Dec 89 | 11.330 |
| 01 Dec 75 | 5.517 | | 09 Jan 91 | 6.340 |
| 20 Feb 77 | 9.109 | | 19 Nov 91 | 3.879 |
| 10 Jan 78 | 9.842 | | 30 Nov 92 | 15.444 |
| 30 May 79 | 27.238 | | 05 Jan 94 | 12.009 |
| 27 Dec 79 | 23.322 | | 27 Dec 94 | 11.938 |
| 11 Mar 81 | 13.572 | | 22 Dec 95 | 6.495 |
| 15 Mar 1982 | 15.314 | | 19 Nov 96 | 5.110 |
| 10 Dec 82 | 10.643 | | 06 Mar 98 | 13.946 |
| 02 Jan 84 | 18.570 | | 19 Jan 99 | 18.656 |
| 21 Jan 85 | 8.494 | | 23 Dec 99 | 10.372 |
| 23 Dec 85 | 26.177 | | 29 Oct 00 | 25.363 |
| 04 Apr 87 | 12.322 | | 11 Feb 02 | 19.230 |
| 01 Feb 88 | 9.670 | | 01 Jan 03 | 15.365 |

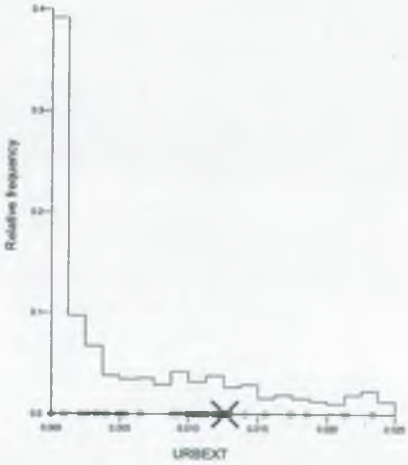

Relative frequency
AREA

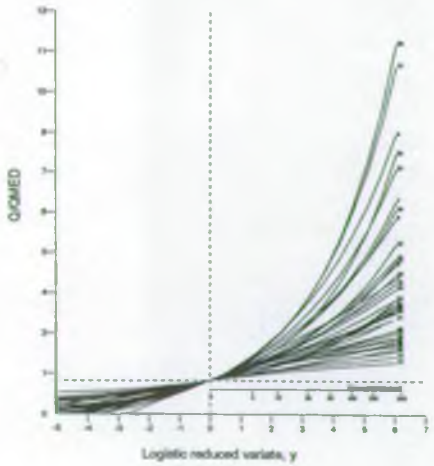

Relative frequency
SAAR

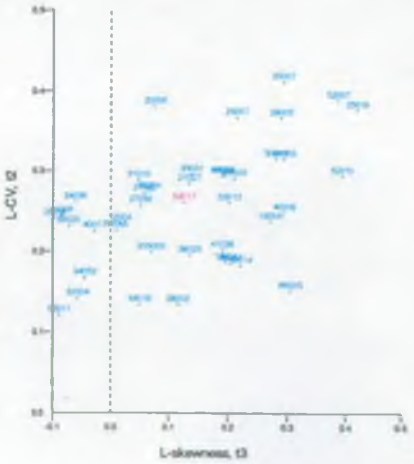

Relative frequency
BFIHOST

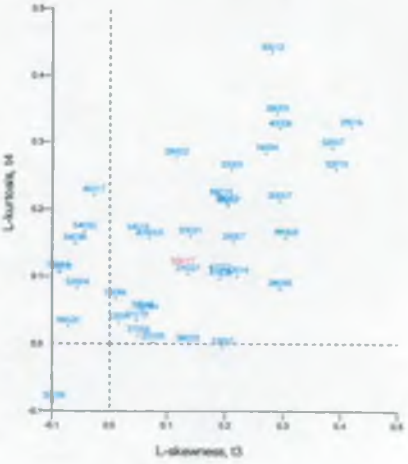

Relative frequency
FARL

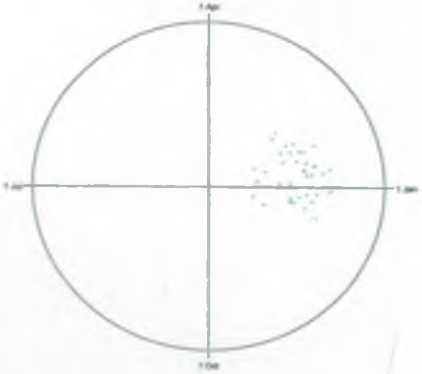

Relative frequency
PROPWET

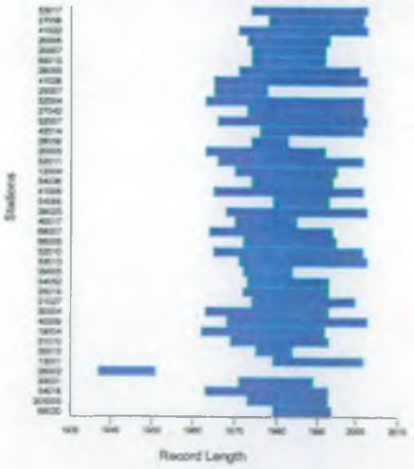

Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3




Stations
Record Length

## Bitton Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 7.19 | 5.92 |
| Comment | Review of the pooling group is essential | Review of the pooling group is essential |
| Number of Station Years | 1110 | 1052 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Subject site is rank 1. Local sites are numerous but largely absent from the pooling group due to reasons of large catchment areas and urbanisation. | None | 1110 | 7.19 |
| *Period of Record* | Generally the site record length is good. The pooling group contains one site with 8 years data and two sites with 9 year records. | None | 1110 | 7.19 |
| *FARL* | Five main outliers:-<br>41st ranked Blithe at Harnstall Ridware (28002) (FARL = 0.876) All the data present is taken from pre-reservoir.<br>14th ranked Cockhaise Brook at Holywell (41026) (FARL=0.894) Numerous reservoirs forming a cascade type feature within a small part of the catchment. But station abandoned.<br>36th Ranked Teise at Stonebridge (40009) (FARL=0.905) Pre –reservoir data has been excluded. This leaves a still significant 14 years of record.<br>45th ranked Pippingford Brook at Paygate (40809) (FARL=0.915) Large storage reservoir in catchment. There is potential for significant attenuation. | Retain Blite at Harnstall Ridware<br>Remove Cockhaise Brook at Holywell<br>Retain Teise at Stonebridge<br>Remove Pippingford Brook | 1084 | 6.73 |
| *PROPWET/URBEXT* | The subject site has PROPWET = 0.35 and the pooling group has a range of 0.29-0.68. The subject site and all members of the pooling group are essentially rural and no review is required. | Although there is a large range of PROPWET values, Bitton does lie towards the centre of the distribution and removing a number of sites would result in having to include more dissimilar sites to keep the number of station years over 1000. | 1084 | 6.73 |
| *Site Comments* | No stations require removal because of station comments, However, station 21002 (Whiteadder Water @ Hungry Snout) was closed in 1967. Station 41016 (Cuckmere at Cowbeech) was abandoned in 1982. | Remove Whiteadder Water at Hungry Snout<br>Remove Cuckmere at Cowbeech | 1060 | 6.58 |
| | *(68011) Arley Brook at Gore Farm*<br>Ranked 16th, site had a large range of values over 8 year record , finishing in 1982. | Site removed as station closed | 1052 | 5.92 |
| *L Moments* | The main outlier to L-moments and growth curves is (25019) the Leven at Eastby. It has a large range of AMAX values. | Retain sites | 1052 | 5.92 |

## Bitton Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.039 | 0.000 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.529 | 0.211 |
| 41022 (Lod @ Halfway Bridge) | 33 | 0.294 | 0.190 | 0.105 | 0.287 | 0.214 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.145 | 0.290 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.523 | 0.292 |
| 68015 (Gowy @ Huxley) | 19 | 0.293 | 0.192 | 0.217 | 0.187 | 0.314 |
| 28055 (Ecclesbourne @ Duffield) | 23 | 0.315 | 0.295 | 0.082 | 1.284 | 0.319 |
| 41028 (Chess Stream @ Chess Bridge) | 39 | 0.202 | 0.191 | 0.096 | 0.686 | 0.371 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 0.836 | 0.403 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 0.981 | 0.413 |
| 27042 (Dove @ Kirkby Mills) | 30 | 0.272 | 0.058 | 0.049 | 0.355 | 0.417 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.485 | 0.429 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 1.194 | 0.431 |
| 28058 (Henmore Brook @ Ashbourne) | 9 | 0.241 | -0.096 | -0.086 | 1.653 | 0.447 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.363 | 0.453 |
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 1.496 | 0.493 |
| 12004 (Girnock Burn @ Littlemill) | 26 | 0.235 | 0.016 | 0.032 | 0.388 | 0.513 |
| 54036 (Isbourne @ Hinton on the Green) | 21 | 0.261 | -0.060 | 0.149 | 1.338 | 0.520 |
| 41006 (Uck @ Isfield) | 39 | 0.244 | -0.085 | 0.105 | 1.192 | 0.552 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.285 | 0.562 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 1.240 | 0.577 |
| 40017 (Dudwell @ Burwash) | 17 | 0.225 | -0.028 | 0.221 | 1.473 | 0.596 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.699 | 0.599 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.451 | 0.600 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.143 | 0.621 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.115 | 0.631 |
| 29005 (Rase @ Bishopbridge) | 13 | 0.367 | 0.290 | 0.344 | 1.522 | 0.637 |
| 54052 (Bailey Brook @ Ternhill) | 22 | 0.167 | -0.044 | 0.166 | 1.141 | 0.637 |
| 25019 (Leven @ Easby) | 23 | 0.377 | 0.419 | 0.323 | 1.617 | 0.641 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.144 | 0.646 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.374 | 0.654 |
| 40009 (Teise @ Stone Bridge) | 35 | 0.248 | 0.295 | 0.321 | 0.97 | 0.657 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.712 | 0.663 |
| 31010 (Chater @ Fosters Bridge) | 26 | 0.289 | 0.048 | 0.034 | 0.575 | 0.669 |
| 30012 (Stainfield Beck @ Stainfield) | 10 | 0.315 | 0.281 | 0.435 | 2.441 | 0.673 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.085 | 0.679 |
| 28002 (Blithe @ Hamstall Ridware) | 15 | 0.134 | 0.116 | 0.277 | 1.818 | 0.687 |
| 33031 (Broughton Brook @ Broughton) | 19 | 0.296 | 0.139 | 0.160 | 0.140 | 0.688 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 1.027 | 0.692 |
| 205005 (Ravernet @ Ravernet) | 21 | 0.199 | 0.070 | 0.156 | 0.260 | 0.699 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 0.811 | 0.707 |
| | | | | | | |
| Total | 1052 | | | | | |
| Weighted means | | 0.258 | 0.138 | 0.129 | | |

CHISELBOROUGH

**Catchment:** Parrett at Chiselborough
**Station No:** 52007
**NGR:** ST 461 144

**Description:** A small catchment (Hydrometric Register area 74.8km$^2$) gauged using a crump weir. Higher flows are gauged with a rated section. Station was installed in 1966 and has had a problematic rating due to flow blockages. Some throttling of high flows in the high range and flow hydrograph exhibits considerable hysteresis. Additionally downstream bends and road bridge act as a control at medium and high flows. Bridge soffit is reached at a stage of 1.71m. Tree/shrub growth downstream may affect water levels at the gauge. Catchment is rural and predominantly Oxford Clay with a small band of Upper Greensand and Gault in headwaters.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 37 years. The data was not reviewed.

**Gauge rating:** Upper limit of the rating is 73.3 m$^3$/s. The three largest AMAX values are significantly larger than the upper limit of the rating. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 74.43 | 1.000 | 0.38 | 0.537 | 886 | 36.8 | 0.0119 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 13.93 m$^3$/s |
| **Annual Maxima** | 30.18 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 40.92 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 24.24 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – review upper limit of rating**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 30.2 | 30.2 | 30.2 | 36.2 |
| 5 | 42.9 | 43.2 | 51.8 | 51.8 |
| 10 | 51.9 | 52.7 | 70.9 | 63.2 |
| 25 | 64.9 | 66.5 | 103.7 | 79.8 |
| 50 | 76.0 | 78.4 | 136.7 | 94.1 |
| 100 | 88.4 | 92.0 | 179.4 | 110.4 |
| 200 | 102.5 | 107.5 | 234.9 | 129.0 |

**Summary of Analysis:** AMAX series reveals that there are three outliers to the data series. The first (Dec 1979) lies just outside the confidence limits, while May 1979 and Dec 2000 are extreme outliers. All events are retained without review. There is some increase in the predicted flood flows following the review of the pooling group.

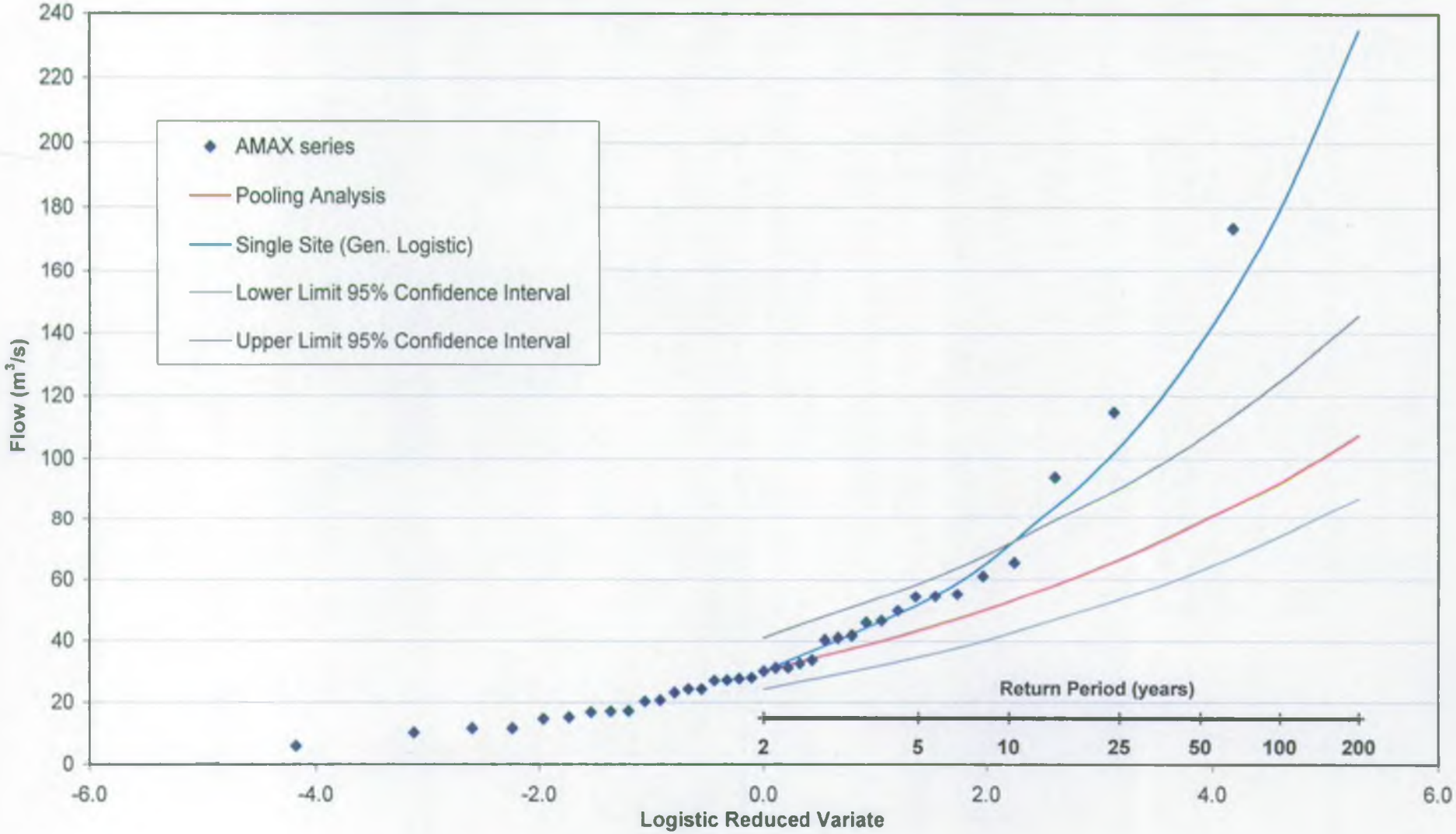
**Selection of Method:** Apart from the three outliers, the reviewed pooled analysis reproduces the AMAX data. Gen. Log. Single site analysis gives a better approximation when the outliers are included. May 1979 would have a return period of 1000 years and December 2000 of 250 years using the reviewed pooled analysis. Though the single site FFC appears to represent the AMAX series better, FEH 3.8 Table 8.3 recommends that pooled analysis should prevail with reference to single site for confirmation

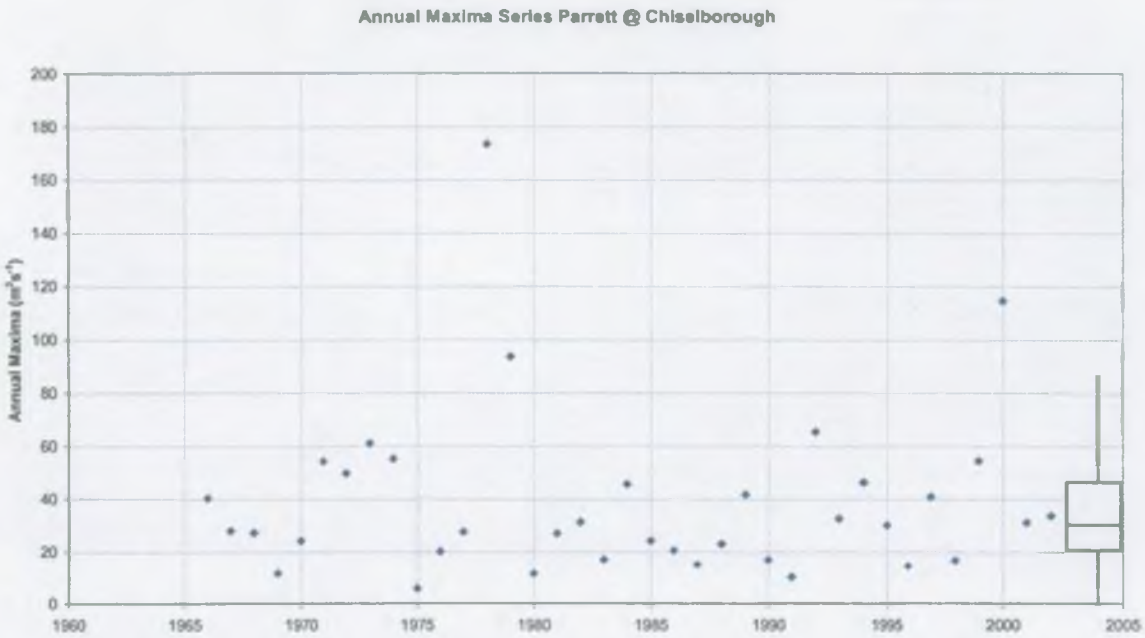
*Special considerations:* Recommend reviewed pooled analysis FFC with further investigation of the rating to identify the true flows of the outliers.

*Adopt:* Pooled analysis (shaded above).

*Model parameters:* $\beta$ =0.260, $\kappa$ = -0.203

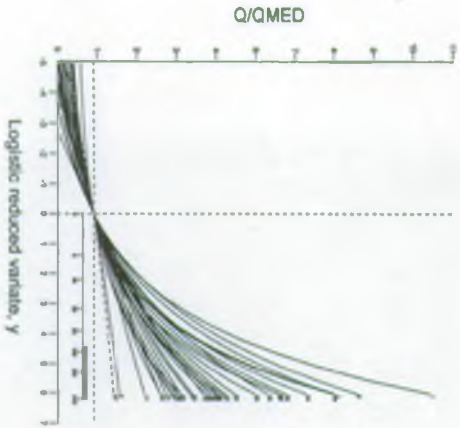
## River Parrett at Chiselborough

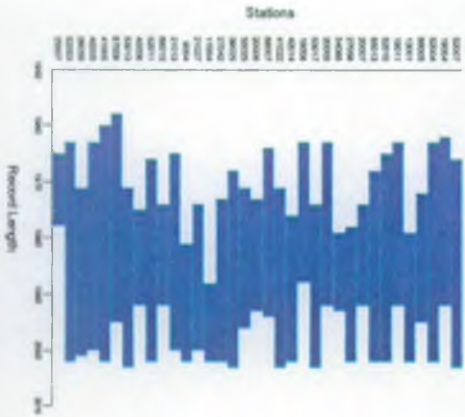


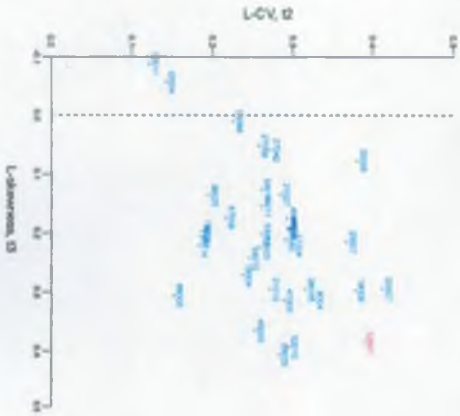


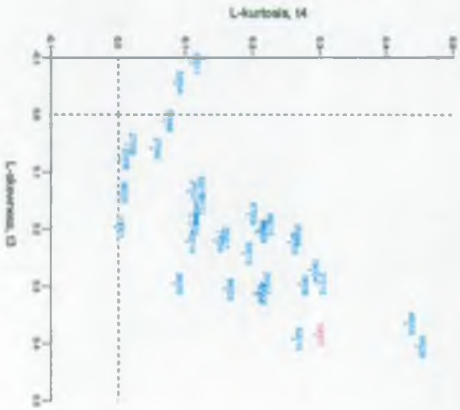

Annual Maxima series for Chilselborough

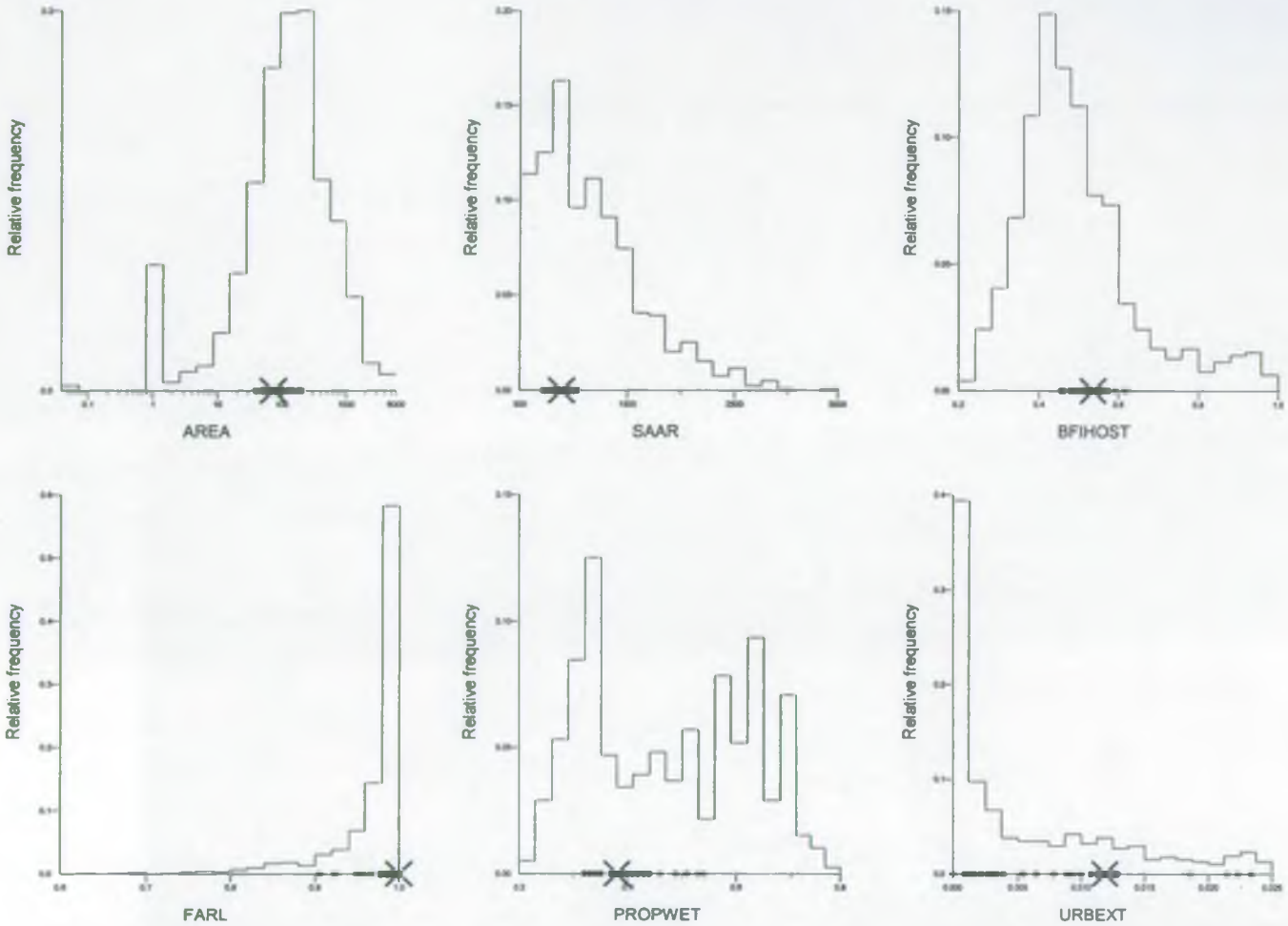
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 05 Nov 66 | 40.324 | | 28 Jan 86 | 24.241 |
| 10 Jul 68 | 28.047 | | 11 Dec 86 | 20.612 |
| 22 Feb 69 | 27.247 | | 13 Feb 88 | 15.049 |
| 22 Nov 69 | 11.598 | | 24 Feb 89 | 23.076 |
| 20 Jan 71 | 24.241 | | 20 Dec 89 | 41.698 |
| 06 Mar 72 | 54.384 | | 09 Jan 91 | 16.931 |
| 06 Dec 72 | 49.780 | | 08 Jan 92 | 10.216 |
| 10 Feb 74 | 61.092 | | 18 Dec 92 | 65.451 |
| 20 Jan 75 | 55.186 | | 20 Dec 93 | 32.665 |
| 28 Nov 75 | 5.883 | | 09 Nov 94 | 46.343 |
| 14 Oct 76 | 20.202 | | 22 Dec 95 | 30.184 |
| 27 Jan 78 | 27.689 | | 19 Nov 96 | 14.531 |
| 30 May 79 | 173.539 | | 01 Jan 98 | 40.943 |
| 27 Dec 79 | 93.781 | | 26 Dec 98 | 16.700 |
| 21 Mar 81 | 11.566 | | 24 Dec 99 | 54.544 |
| 15 Mar 82 | 27.072 | | 31 Dec 00 | 114.688 |
| 12 Nov 82 | 31.354 | | 04 Feb 02 | 31.255 |
| 27 Jan 84 | 17.107 | | 01 Jan 03 | 33.811 |
| 21 Jan 85 | 45.790 | | | |


Q/QMED
Logistic reduced variate, y


Stations
Record Length


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Relative frequency
AREA
Relative frequency
SAAR
Relative frequency
BFIHOST
Relative frequency
FARL
Relative frequency
PROPWET
Relative frequency
URBEXT

## Chilselborough Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.35 | 2.39 |
| Comment | Strongly heterogeneous, review of pooling group is essential | Heterogeneous, review of pooling group is desirable |
| Number of Station Years | 1110 | 1004 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Any sites lying upstream or downstream of the subject site are likely to be hydrologically similar and give good reason for promotion to a higher ranking in pooling group. No sites adjacent to the subject site warrant promotion. | No change | 1110 | 4.35 |
| *Period of Record* | All gauges have a minimum of ten years data. There is generally good data overlap. Station 55022 (Trothy@Mitchell Troy) has shortest record length, 10 years, and is missing data between 1979-1981. Site is also discordant. | Remove Trothy at Mitchell Troy. This pooling group has many good sites with far longer record lengths. | 1100 | 3.77 |
| *FARL* | The value of FARL for the Parrett at Chiselborough is 1.000 and the range of values for the pooling group lies between 0.843 and 1.000. The lowest values are 0.843 from the Chew at Compton Dando (53004) and the Congresby Yeo at Iwood (52017). The low values of FARL suggest that the catchment has significant storage. Both of these catchments are noted to be in close proximity to reservoirs, which will cause attenuation to flood flows. | Remove sites. | 1028 | 2.63 |
| *PROPWET/URBEXT* | Subject site PROPWET = 0.38 and URBEXT =0.0119. The range of values for the pooling group are PROPWET:0.32-0.64 and URBEXT: 0.0001-0.0234. The high value of PROPWET for Petteril at Harraby Green indicates that the soils are typically wetter than other soils within the pooling group, and particularly wetter than those for the Parrett at Chiselborough. | Remove site. | 1004 | 2.39 |
| *Site Comments* | All site comments were reviewed to assess the quality of flow data. Gowey at Huxley (68015) ranked 27th was discontinued in 1991, the data prior to 1979 is questionable. WINFAP contains 12 years of acceptable data for this site.<br>Clow Beck at Croft (25007) ranked 35th was discontinued in 1980. WINFAP contains 15 years of data for this site from 1964 to 1978. | No change. Flows are slightly lower than the Parrett at Chiselborough, but otherwise they are representative of the pooling group. The low ranking of these groups will reflect their influence on the growth curves. | 1004 | 2.39 |
| *Discordant Sites* | *Cary at Somerton (52011)*<br>Ranked 26th in the pooling group. WINFAP has 38 years of data for this site, 1965 to 2002. Peaks over thresholds data are missing for 1978, although the AMAX series contains a record for water year 1978 which was measured in February. This discrepancy in data series may have caused the discordancy. | Reason for discordancy likely to be discrepancy in data set. No grounds for removal. Retain site in pooling group. | 1004 | 2.39 |
| *L Moments* | The main outlier to L-moments and the growth curves, Cary at Somerton (52011) has already been investigated under the discordancy review and data are considered reliable. One other outlier is Isle at Ashford Mill (52004). The most likely reason for outlying L moments is the low flow experienced during the 1975 drought. The site is ranked 3rd and therefore has an important influence on the pooled growth curve. | Retain all sites | 1004 | 2.39 |

## Chilselborough Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.296 | 0.000 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.551 | 0.249 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 2.322 | 0.268 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.609 | 0.277 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.461 | 0.294 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.089 | 0.328 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 0.961 | 0.347 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.131 | 0.367 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.487 | 0.379 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.803 | 0.380 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.986 | 0.410 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.514 | 0.418 |
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.170 | 0.429 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 1.042 | 0.441 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 1.220 | 0.442 |
| 41022 (Lod @ Halfway Bridge) | 33 | 0.294 | 0.190 | 0.105 | 0.228 | 0.444 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.635 | 0.461 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.501 | 0.492 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 2.222 | 0.504 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 1.394 | 0.520 |
| 27042 (Dove @ Kirkby Mills) | 30 | 0.272 | 0.058 | 0.049 | 0.701 | 0.533 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.135 | 0.538 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.241 | 0.541 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.420 | 0.550 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.473 | 0.552 |
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 3.412 | 0.565 |
| 68015 (Gowy @ Huxley) | 19 | 0.293 | 0.192 | 0.217 | 0.307 | 0.556 |
| 45008 (Otter @ Fenny Bridges) | 19 | 0.293 | 0.175 | 0.106 | 0.198 | 0.571 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.100 | 0.574 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.271 | 0.577 |
| 41005 (Ouse @ Gold Bridge) | 44 | 0.288 | 0.314 | 0.206 | 0.359 | 0.578 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 2.159 | 0.584 |
| 28055 (Ecclesbourne @ Duffield) | 23 | 0.315 | 0.295 | 0.082 | 1.433 | 0.586 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.318 | 0.589 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 0.849 | 0.595 |
| | | | | | | |
| Total | 1004 | | | | | |
| Weighted means | | 0.260 | 0.203 | 0.167 | | |

COMPTON
DANDO

**Catchment:** River Chew at Compton Dando
**Station No:** 53004
**NGR:** ST 648 647

**Description:** Trapezoidal critical depth flume opened in 1958. Full range station but reported to overestimate flows above 2m due to backing-up/drowning (NRFA, CEH). Flow record unreliable for a year after the July 1968 flood due to bank collapse and accumulated debris. Large storage reservoir in headwaters (Chew Valley Lake) affects runoff and provides a seasonal compensation flow. Significant surface water abstractions for PWS and industry. Land use in the catchment is mainly rural, with mixed geology comprising predominantly clay and Coal Measures.

**Data comments** An updated AMAX data set provided by the Environment Agency gave 44 years of annual maxima series data for the period 1958 to 2002 inclusive. There is a gap in the data of approximately one year due to damage during the July 1968 flood event. AMAX series not reviewed.

**Gauge rating:** Upper limit of rating 34.5m$^3$/s which is greater than any recorded AMAX values. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 129.10 | 0.843 | 0.35 | 0.590 | 987 | 28.9 | 0.0089 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 15.226 m$^3$/s |
| **Annual Maxima** | 18.483 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 21.304 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 15.378 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** FEH STATISTICAL METHOD INAPPROPRIATE, USE FOLLOWING RESULTS WITH CAUTION.

| Return period (years) | Pooled Analysis | | Single Site | |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Logistic |
| 2 | 18.5 | 18.5 | 18.5 | 18.5 |
| 5 | 25.7 | 25.8 | 23.8 | 23.6 |
| 10 | 31.0 | 31.2 | 27.1 | 26.5 |
| 25 | 38.6 | 38.9 | 31.2 | 30.1 |
| 50 | 45.2 | 45.6 | 34.3 | 32.7 |
| 100 | 52.6 | 53.2 | 37.5 | 35.3 |
| 200 | 61.2 | 61.9 | 40.8 | 37.9 |

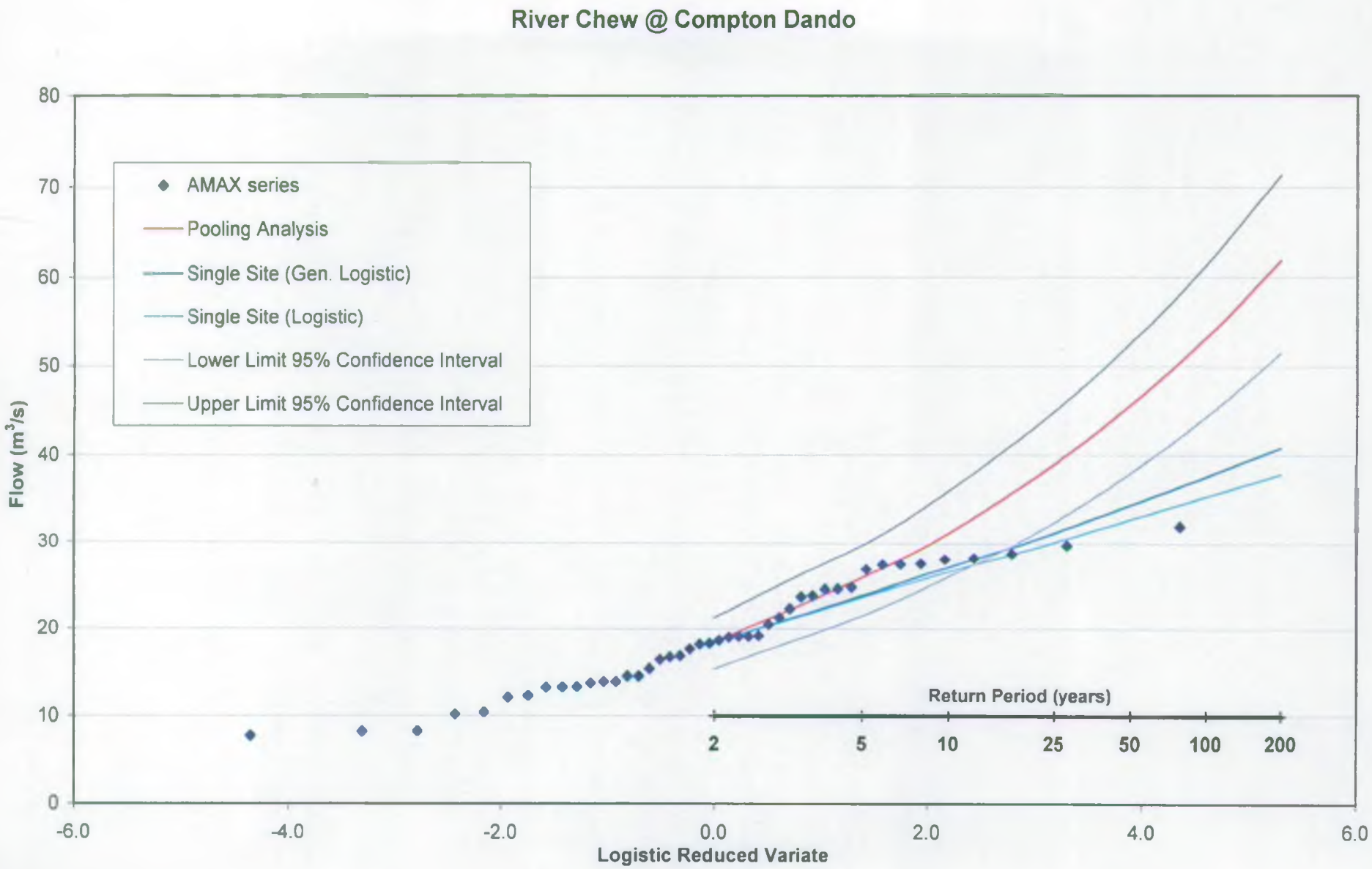
**Summary of Analysis:** AMAX series EDA reveals the dataset to have no significant outliers.

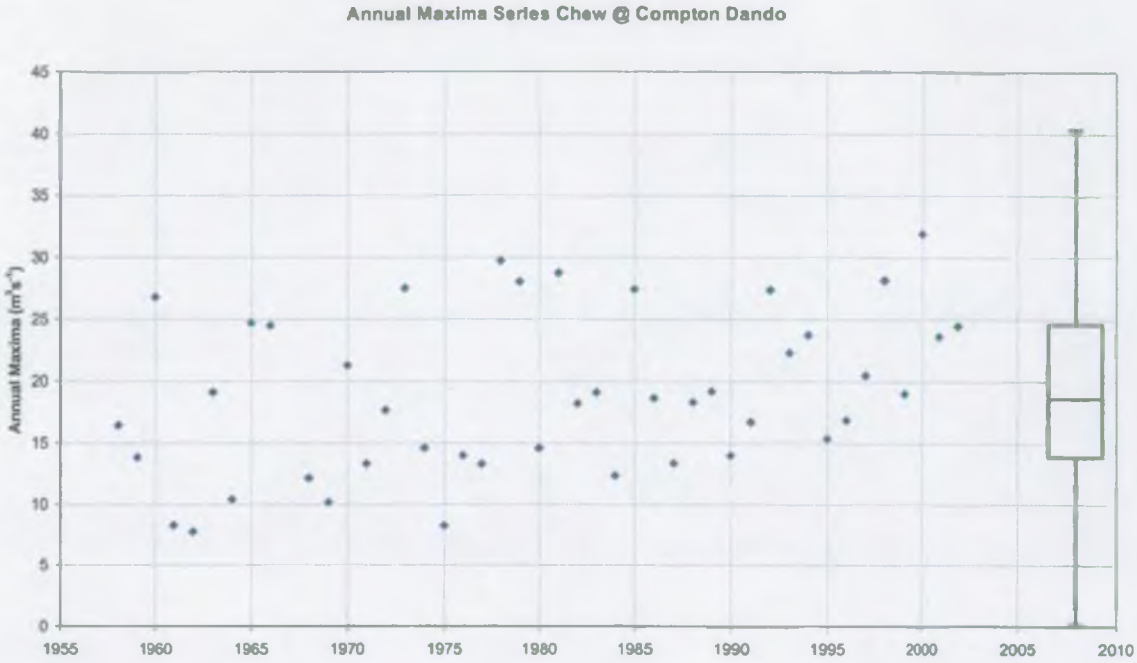
**Selection of Method:** The subject site is ranked 1st in the pooling group.
Other members of the pooling group are dissimilar from the subject site with notably higher values of FARL than at the subject site. An investigation of alternative frequency distributions to the logistic distribution yielded fitted distributions which were upper bounded close to the target return period. Such obviously upper bounded distributions are inadmissible and we recommend the advice in FEH Vol 3 7.3 to consider alternative means of establishing flood frequency at this site.

*Special considerations:* An appropriate alternative would be the rainfall-runoff method involving the simulation of the reservoir behaviour.

*Adopt:* None are recommended but we suggest that the logistic distribution fitted to the single site data may provide some indication of flood frequency.

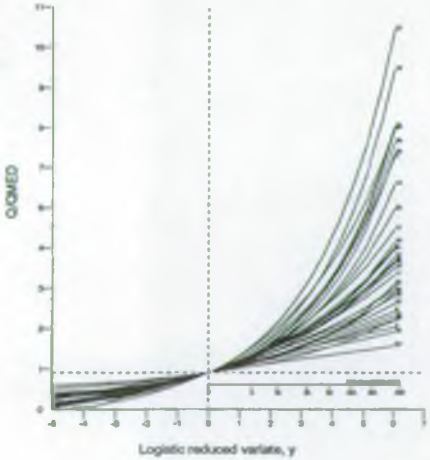
*Model parameters:* N.A.

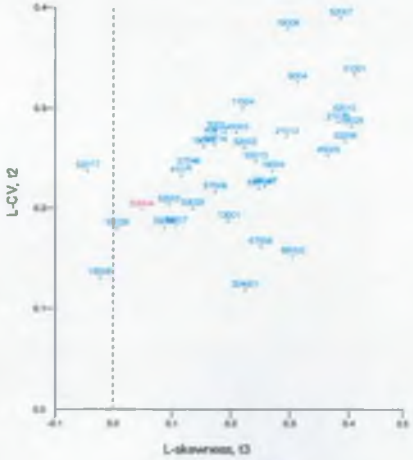

River Chew @ Compton Dando
AMAX series
Pooling Analysis
Single Site (Gen. Logistic)
Single Site (Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
80
70
60
50
40
30
20
10
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200

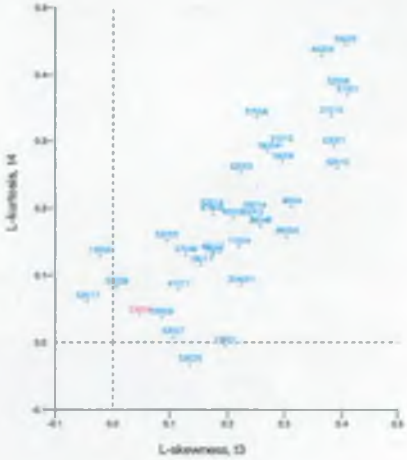


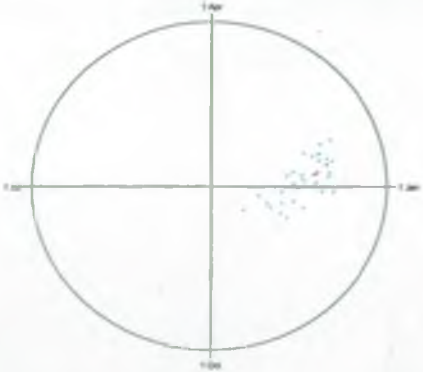

Annual Maxima series for Compton Dando

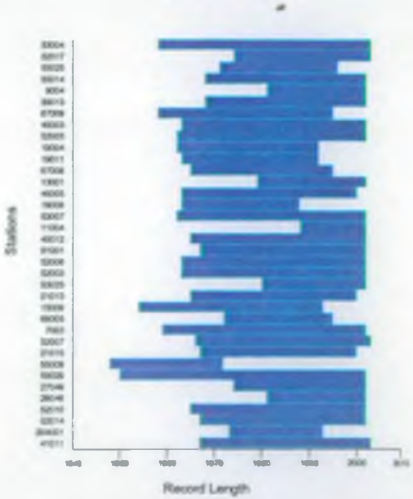
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 20 Dec 58 | 16.435 | | 30 Dec 81 | 28.753 |
| 24 Jan 60 | 13.844 | | 10 Dec 82 | 18.209 |
| 04 Dec 60 | 26.794 | | 02 Jan 84 | 19.105 |
| 10 Jan 62 | 8.309 | | 22 Nov 84 | 12.367 |
| 13 Mar 63 | 7.781 | | 23 Dec 85 | 27.437 |
| 18 Nov 63 | 19.112 | | 18 Nov 86 | 18.651 |
| 13 Jan 65 | 10.410 | | 31 Jan 88 | 13.365 |
| 09 Dec 65 | 24.713 | | 25 Feb 89 | 18.315 |
| 27 Feb 67 | 24.516 | | 20 Dec 89 | 19.186 |
| 21 Dec 68 | 12.130 | | 09 Jan 91 | 13.990 |
| 15 Jan 70 | 10.191 | | 08 Jan 92 | 16.717 |
| 29 Nov 70 | 21.284 | | 30 Nov 92 | 27.389 |
| 12 Jan 72 | 13.324 | | 13 Oct 93 | 22.321 |
| 02 Dec 72 | 17.663 | | 29 Jan 95 | 23.753 |
| 27 Sep 74 | 27.507 | | 22 Dec 95 | 15.395 |
| 20 Jan 75 | 14.587 | | 17 Feb 97 | 16.858 |
| 01 Dec 75 | 8.275 | | 06 Mar 98 | 20.506 |
| 30 Nov 76 | 13.973 | | 31 Oct 98 | 28.199 |
| 23 Jan 78 | 13.297 | | 26 Dec 99 | 19.022 |
| 30 May 79 | 29.751 | | 29 Oct 00 | 31.926 |
| 27 Dec 79 | 28.036 | | 26 Jan 02 | 23.629 |
| 10 Mar 81 | 14.577 | | 01 Jan 03 | 24.481 |


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3




Stations
Record Length

Relative frequency
FAIL


Relative frequency
AREA


Relative frequency
PROPWET


Relative frequency
SAAR


Relative frequency
URBCOT


Relative frequency
BFIHOST

## Compton Dando Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.18 | 2.82 |
| Comment | Strongly heterogeneous, requires pooling group review | Strongly heterogeneous, requires pooling group review |
| Number of Station Years | 1172 | 1138 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Sites relatively widely distributed across UK. Subject site is Rank 1. A number of local sites exist including the 17th ranked (52017) Congresbury Yeo at Iwood with relatively low FARL of 0.890. | Promote Congresbury Yeo at Iwood to rank 2 due to locality and low FARL. | 1172 | 3.18 |
| *Period of Record* | All sites have good record length with the shortest record = 10 years | No action required | 1172 | 3.18 |
| *FARL* | Very poor distribution of pooling group relative to subject site. Subject site has very low FARL of 0.843. | Retain subject site since it is not an outlier to the pooling group, but there are not enough similar catchments to generate a suitable pooling group and hence FEH statistical method is not a suitable methodology for estimating peak flood flows. | 1172 | 3.18 |
| *PROPWET/URBEXT* | PROPWET – Pooling Group Range 0.340 – 0.640. There are two significant outliers:<br>37th ranked Bush at Seneirl (204001) – PROPWET = 0.610. High PROPWET but little evidence for exclusion and relatively low weighting in pooling group.<br>4th ranked Petteril at Harraby Green (76010) – PROPWET = 0.640. High PROPWET but little additional evidence for exclusion from pooling group except for high weighting in pooling group.<br>URBEXT – Range 0.0001 – 0.0215. All gauges essentially rural. | Retain Bush at Seneirl as its low ranking in pooling group will not affect flood frequency curve significantly whereas remove Petteril at Harraby Green since it's high ranking will affect the FFC generated.<br>No change as a result of URBEXT values. | 1148 | 3.22 |
| *Site Comments* | Site comments investigated but no significant requirement to remove sites. | No action required | 1148 | 3.22 |
| *Discordant Sites* | *(55022) Trothy @ Mitchel Trothy*<br>Site is ranked 7th (D = 5.887) and has short record of 10 years with several years of missing data. It is also an extreme outlier in L-moment plots and growth curves. | Remove Trothy at Mitchel Troy | 1138 | 2.82 |
| *L Moments* | Refer to "Discordant Sites" above | As above | 1138 | 2.82 |

## Compton Dando Pooling Group – Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53004 (Chew @ Compton Dando) | 44 | 0.198 | 0.048 | 0.039 | 0.670 | 0.000 |
| 52017 (Congresbury Yeo @ Iwood) | 28 | 0.237 | -0.043 | 0.061 | 2.582 | 0.407 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.532 | 0.105 |
| 55014 (Lugg @ Byton) | 26 | 0.158 | 0.088 | 0.192 | 1.406 | 0.241 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.893 | 0.254 |
| 55013 (Arrow @ Titley Mill) | 25 | 0.280 | 0.249 | 0.232 | 0.140 | 0.256 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.159 | 0.298 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.160 | 0.307 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.578 | 0.311 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.313 | 0.331 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.318 | 0.345 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 2.134 | 0.357 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.797 | 0.363 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 1.592 | 0.370 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 1.695 | 0.373 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.734 | 0.413 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.600 | 0.439 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.307 | 0.443 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.032 | 0.447 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.041 | 0.463 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.222 | 0.476 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.420 | 0.477 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.259 | 0.485 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 2.663 | 0.503 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.211 | 0.511 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.393 | 0.531 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.947 | 0.539 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 0.675 | 0.539 |
| 55009 (Monnow @ Kentchurch) | 22 | 0.181 | 0.087 | 0.037 | 0.515 | 0.543 |
| 55029 (Monnow @ Grosmont) | 19 | 0.145 | 0.103 | -0.037 | 1.518 | 0.543 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.270 | 0.544 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.268 | 0.544 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.015 | 0.558 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.295 | 0.572 |
| 204001 (Bush @ Seneirl) | 21 | 0.118 | 0.225 | 0.084 | 2.311 | 0.583 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.339 | 0.604 |
| | | | | | | |
| Total | 1138 | | | | | |
| Weighted means | 0.242 | 0.202 | 0.195 | | | |

FENNY CASTLE

**Catchment:** Sheppey at Fenny Castle
**Station No:** 52009
**NGR:** ST 498 439

**Description:** The catchment covers an area of 60km$^2$ and is predominantly rural. The catchment has mixed geology. The upper catchment is carboniferous limestone, and the lower catchment is sandstone. The station has a crump profile weir for low flows and uses velocity-area for flows greater than 1.84 m$^3$/s.

**Data comments:** The updated AMAX data set provided by the Environment Agency gave 39 years of annual maxima series data from 1964 to 2002. The AMAX series was not reviewed.

**Gauge rating:** The maximum limit of the gauge rating is 16.1 m$^3$/s. All AMAX records are significantly lower than this value. D/s weed growth affects the stability of the rating curve so that gauging results often show lower flows than expected. However recent gaugings have been accurate, probably due to better weed-clearing procedures. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 58.61 | 1.00 | 0.37 | 0.687 | 973 | 20.2 | 0.0288 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 8.859 m$^3$/s |
| **Annual Maxima** | 7.551 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 8.125 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 7.190 m$^3$/s |

**Permeability:** SPRHOST is greater than 20% no adjustment is required.

**Urbanisation:** URBEXT = 0.0288, slightly urbanised, adjustment required.

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency: Less than satisfactory – FEH unsuitable possibly due to presence of karstic limestone**

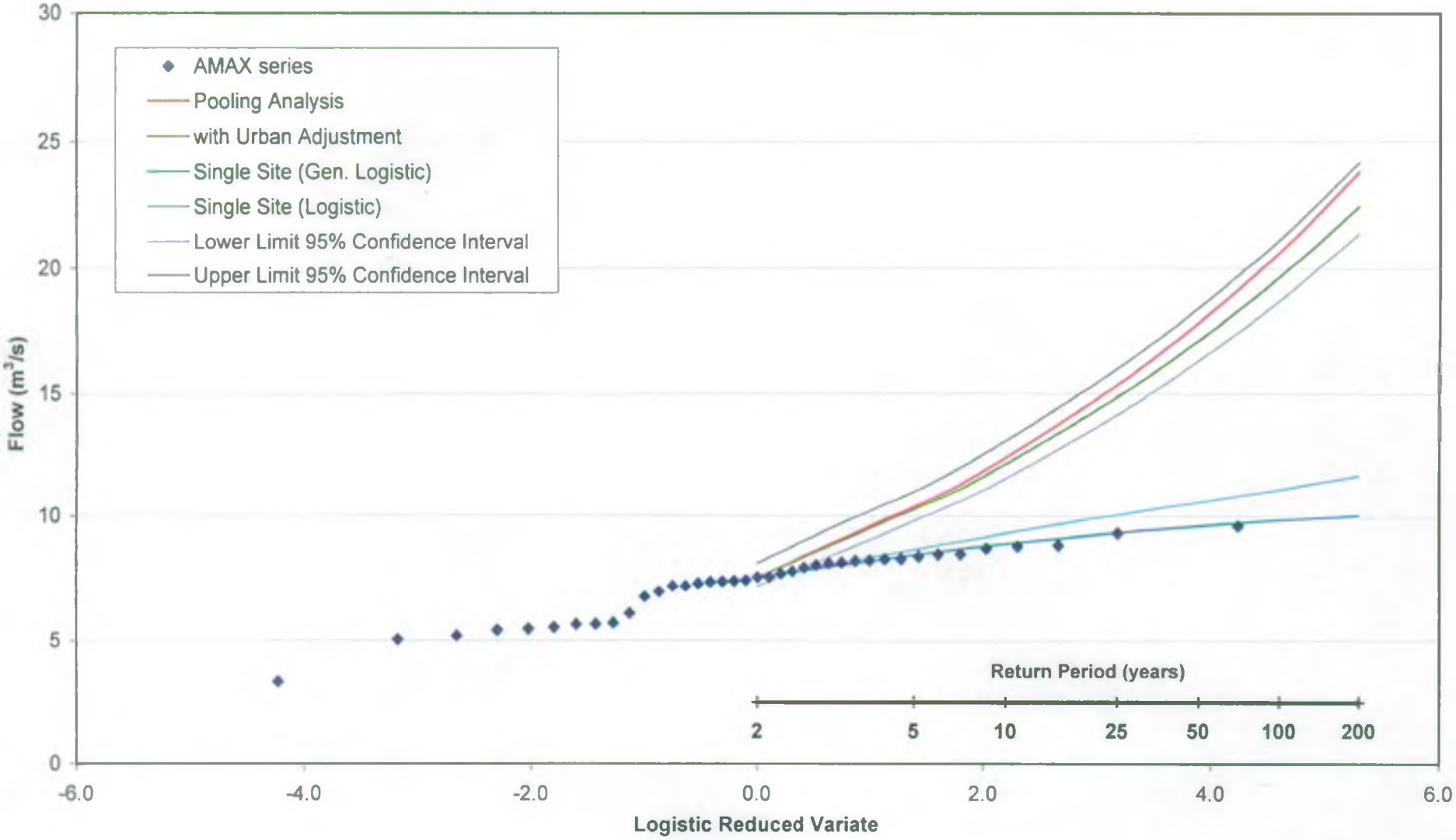
| Return period (years) | Pooled Analysis | | | Single Site | | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Logistic | Logistic x 20% |
| 2 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 9.1 |
| 5 | 10.4 | 10.4 | 10.3 | 8.4 | 8.6 | 10.4 |
| 10 | 12.4 | 12.4 | 12.2 | 8.9 | 9.3 | 11.1 |
| 25 | 15.3 | 15.4 | 14.9 | 9.3 | 10.1 | 12.1 |
| 50 | 17.7 | 17.9 | 17.1 | 9.6 | 10.6 | 12.7 |
| 100 | 20.5 | 20.6 | 19.7 | 9.8 | 11.2 | 13.4 |
| 200 | 23.5 | 23.8 | 22.5 | 10.0 | 11.7 | 14.1 |

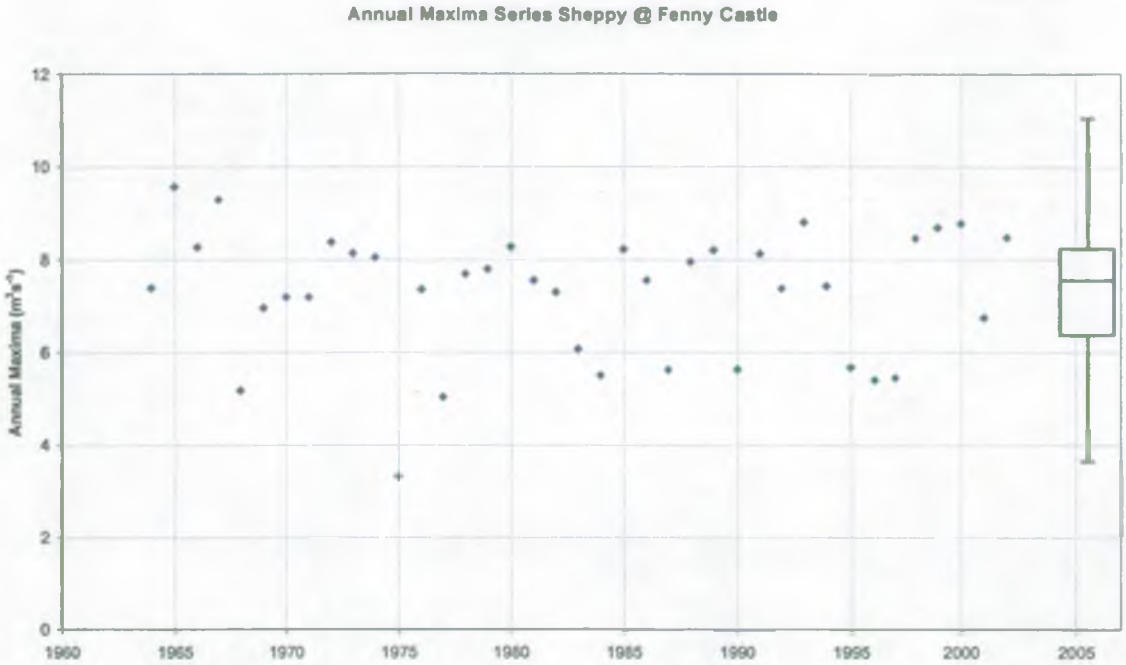
**Summary of Analysis:** AMAX series EDA revealed there to be no outliers to the data set. The effect of the pooling group review and urban adjustment results in a 6% decrease in estimated flows for the 200-year return period when compared with the initial pooled analysis.

**Selection of Method:** Separation between the flood frequency curves is significant. Consultations with the Agency indicated that the flatness of the AMAX series may be as a result of karstic limestone in the catchment attenuating peak flows. FEH 3.8 (Table 8.3) recommends that pooled analysis should prevail with reference to the single site for confirmation. Single site Logistic is recommended since the Gen. Logistic is upper bounded. The fact that the site is not contained in the pooling group because it is slightly urbanised makes the pooling group less reliable. The SPRHOST is just over the 20% limit for permeable adjustment which suggests that there may be some permeable influence on the catchment.

*Special considerations:* None
*Adopt:* Single Site Logistic distribution (as shaded).
*Model parameters:* $\beta = 0.105$

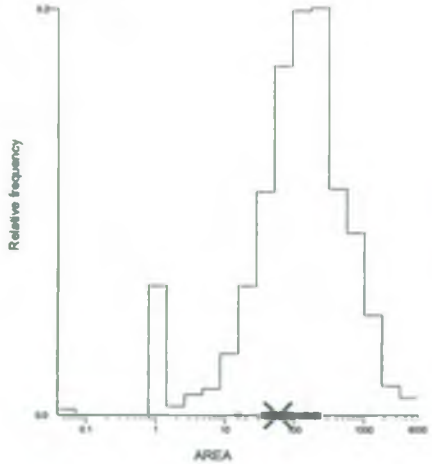
## River Sheppey at Fenny Castle

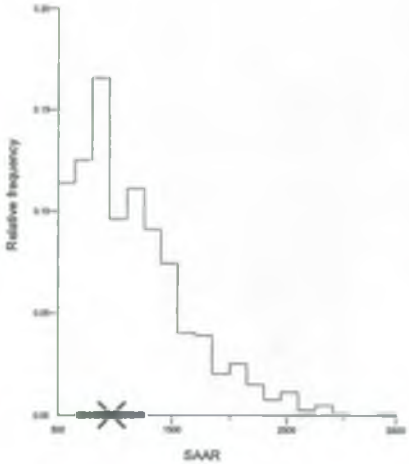





Annual Maxima series for Fenny Castle

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 25 Jul 1965 | 7.393 | | 22 Dec 1984 | 5.507 |
| 17 Dec 1965 | 9.570 | | 23 Dec 1985 | 8.222 |
| 05 Nov 1966 | 8.270 | | 31 May 1987 | 7.551 |
| 10 Jul 1968 | 9.290 | | 31 Jan 1988 | 5.628 |
| 29 Jul 1969 | 5.180 | | 09 Oct 1988 | 7.948 |
| 15 Jan 1970 | 6.960 | | 03 Feb 1990 | 8.205 |
| 18 Jun 1971 | 7.190 | | 18 Mar 1991 | 5.636 |
| 07 Mar 1972 | 7.190 | | 18 Sep 1992 | 8.123 |
| 02 Dec 1972 | 8.380 | | 30 Nov 1992 | 7.379 |
| 09 Feb 1974 | 8.139 | | 13 Oct 1993 | 8.805 |
| 08 Mar 1975 | 8.048 | | 29 Jan 1995 | 7.428 |
| 25 Sep 1976 | 3.326 | | 22 Dec 1995 | 5.676 |
| 01 Dec 1976 | 7.354 | | 19 Nov 1996 | 5.403 |
| 28 Jan 1978 | 5.035 | | 05 Jan 1998 | 5.451 |
| 30 May 1979 | 7.692 | | 31 Oct 1998 | 8.455 |
| 27 Dec 1979 | 7.791 | | 03 Apr 2000 | 8.688 |
| 09 Mar 1981 | 8.280 | | 29 Oct 2000 | 8.772 |
| 12 Jul 1982 | 7.551 | | 26 Oct 2001 | 6.747 |
| 07 Jan 1983 | 7.296 | | 13 Nov 2002 | 8.472 |
| 27 Jan 1984 | 6.072 | | | |


Relative frequency
AREA


Relative frequency
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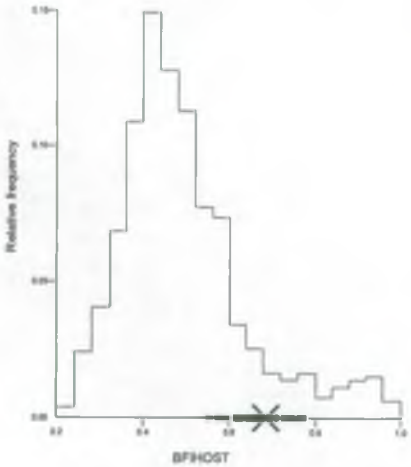
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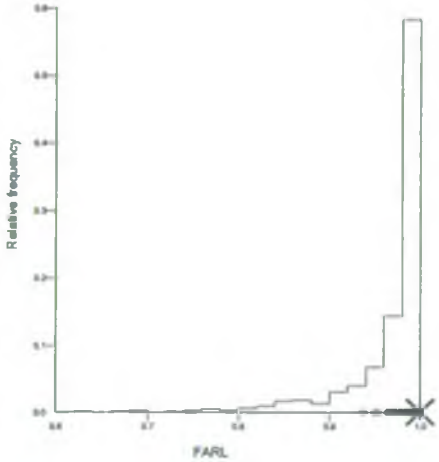
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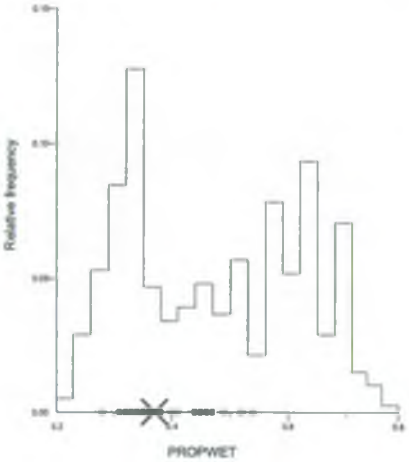
Relative frequency
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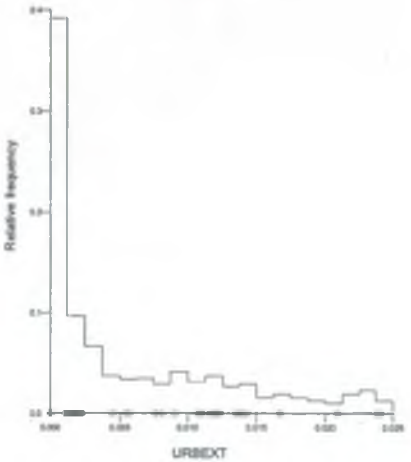
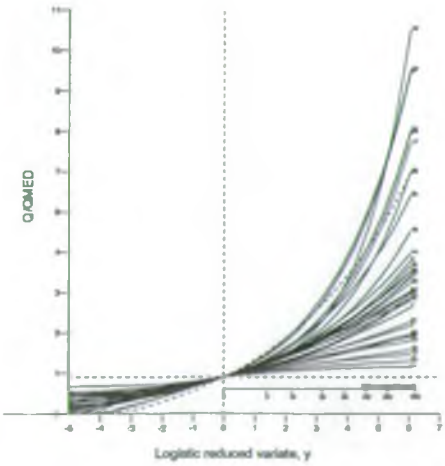
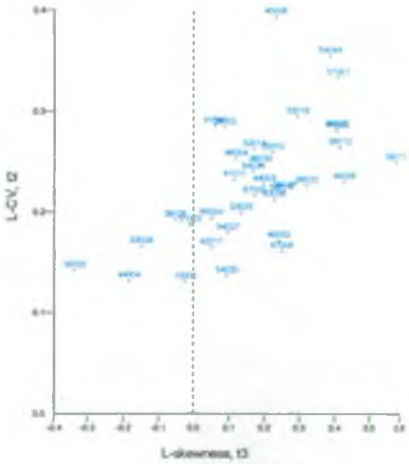
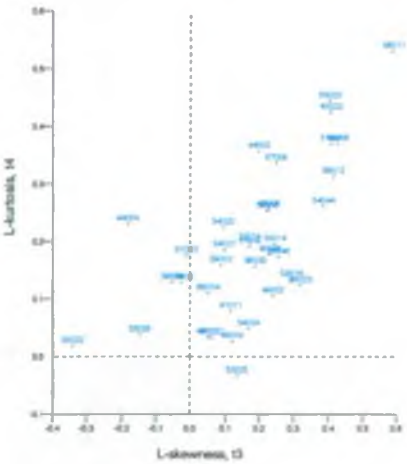
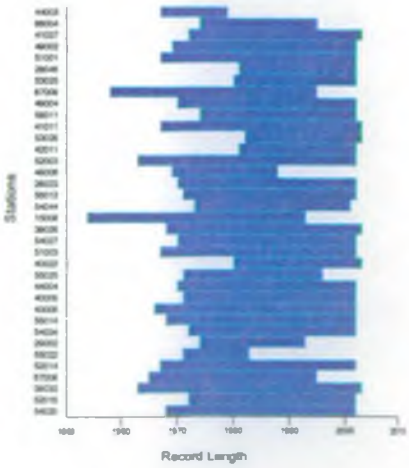

Relative frequency
URBEXT


QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Fenny Castle Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 5.42 | 4.26 |
| Comment | The pooling group is strongly heterogeneous, and a review is essential | The pooling group is strongly heterogeneous, and a review is essential |
| Number of Station Years | 1221 | 1038 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site has been excluded from the pooling group because the URBEXT value is greater than 0.025. | No change | 1221 | 5.42 |
| *Period of Record* | All sites have a good record length except for the Tone @ Wadhams Farm, which only has a 6-year record. | Remove Tone @ Wadhams Farm | 1215 | 5.30 |
| *FARL* | There are 4 main outliers, 3 of which have a FARL of less than 0.9;<br>Chew @ Compton Dando, (0.843) ranked 19th. Large storage reservoir in headwaters – Chew Valley Lake.<br>Kennal @ Ponsanooth, (0.867) ranked 35th. Substantial modifications to flows owing to exports from Stithians Reservoir. Some industrial usage also produces unpredictable hydrographs.<br>Congresbury Yeo @ Iwood (0.890) ranked 13th. Blagdon Reservoir (approx. 2km) situated close to the headwaters.<br>South Esk @ Prestonholm (0.906)ranked 21st. There are several small storage reservoirs in the headwaters. | Remove Chew @ Compton Dando, Kennal @ Ponsanooth and Congresbury Yeo @ Iwood.<br>Retain South Esk @ Prestonholm | 1119 | 4.25 |
| *PROPWET/URBEXT* | Petteril @ Harraby Green high PROPWET (0.640) ranked 25th. Clear outlier in the pooling group. Llynfi @ Three Cocks high PROPWET (0.540) Low down in the ranking. Little additional evidence for exclusion from the pooling group.<br>All sites in the pooling group are essentially rural. | Remove Petteril @ Harraby Green. | 1095 | 4.02 |
| *Site Comments* | Site comments investigated, particular attention given to the South Esk @ Prestonholm and North Esk @ Dalmore Weir, both have several small reservoirs in the headwaters of the catchment. Also consideration given to the Gannel @ Gwills and Hayle @ St. Erth, both of which have flows that may be affected by mines in the catchment. | Remove South Esk as PROPWET is 0.906, and there are reservoirs which affect the flow and the North Esk @ Dalmore Weir. | 1038 | 4.26 |
| *Discordant Sites* | *(40006) Bourne @ Hadlow*<br>Ranked 26th in the pooling group, the AMAX series is very peaky. | Retain in the pooling group, no justification to remove the station. | 1038 | 4.26 |
| *L Moments* | Station (53028) By Brook @ Middlehill outlier in L-moments. As are the Trothy @ Mitchel Troy, and the Frome @ Dorchester Total | Retain all sites, as there is no apparent hydrological reason to exclude them from the group. | 1038 | 4.26 |

## Fenny Castle Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 0.865 | 0.180 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.190 | 0.324 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.211 | 0.331 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.567 | 0.407 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.297 | 0.436 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.331 | 0.442 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.863 | 0.475 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.023 | 0.507 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.809 | 0.538 |
| 58011 (Thaw @ Gigman Bridge) | 25 | 0.249 | 0.592 | 0.531 | 2.639 | 0.540 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.310 | 0.546 |
| 53028 (By Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 0.992 | 0.564 |
| 42011 (Hamble @ Frog Mill) | 21 | 0.165 | 0.051 | 0.034 | 0.871 | 0.571 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.164 | 0.611 |
| 48006 (Cober @ Helston) | 20 | 0.230 | 0.427 | 0.371 | 0.973 | 0.613 |
| 28023 (Wye @ Ashford) | 31 | 0.227 | 0.321 | 0.124 | 1.216 | 0.693 |
| 56012 (Grwyne @ Millbrook) | 23 | 0.264 | 0.416 | 0.314 | 0.567 | 0.719 |
| 54044 (Tern @ Ternhill) | 30 | 0.355 | 0.387 | 0.262 | 1.436 | 0.772 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 0.866 | 0.823 |
| 39028 (Dun @ Hungerford) | 35 | 0.192 | -0.051 | 0.129 | 0.588 | 0.829 |
| 54027 (Frome @ Ebley Mill) | 32 | 0.180 | 0.098 | 0.186 | 0.227 | 0.842 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 0.516 | 0.846 |
| 40022 (Great Stour @ Chart Leacon) | 24 | 0.281 | 0.408 | 0.426 | 1.094 | 0.862 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.294 | 0.863 |
| 44004 (Frome @ Dorchester Total) | 33 | 0.132 | -0.183 | 0.231 | 2.832 | 0.866 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 3.349 | 0.892 |
| 43006 (Nadder @ Wilton Park) | 37 | 0.212 | 0.229 | 0.256 | 0.152 | 0.899 |
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.199 | 0.907 |
| 54034 (Dowles Brook @ Dowles) | 30 | 0.240 | 0.168 | 0.048 | 0.731 | 0.907 |
| 29002 (Great Eau @ Claythorpe Mill) | 21 | 0.284 | 0.088 | 0.159 | 0.872 | 0.928 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 2.777 | 0.931 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.185 | 0.951 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.204 | 0.968 |
| 39033 (Winterbourne @ st Bagnor) | 41 | 0.247 | 0.189 | 0.157 | 0.089 | 0.970 |
| 52016 (Currypool Stream @ Currypool Farm) | 32 | 0.295 | 0.295 | 0.134 | 0.774 | 0.973 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 0.929 | 0.976 |
| | | | | | | |
| Total | 1038 | | | | | |
| Weighted means | | 0.231 | 0.187 | 0.184 | | |

FOSSEWAY

**Catchment:** Sherston Avon at Fosseway
**Station No:** 53023
**NGR:** ST 891 870

**Description:** A rural catchment gauged using a full range flat V Crump profile weir with 7m broad crest. Flows augmented by groundwater scheme in catchment. Gate activity u/s may affect flows. Artificial influences produce the lowest flows on record in Nov 1978. Geology: predominantly Oolitic Limestone. Notably the catchment whilst gauged in WINFAP does not have catchment descriptors, only an area of 89.7km$^2$ agreeing with the Hydrometric Register. This compares with 77.76km$^2$ gained from FEH CDROM.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 27 years. The data was not reviewed.

**Gauge rating:** Rating is valid for flows up to 20.4 m$^3$/s, which is significantly higher than any of the current AMAX series. Rating may be underestimating the flow. Gauge rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 77.76 | 1.0 | 0.34 | 0.721 | 834 | 22.3 | 0.007 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 7.306 m$^3$/s |
| **Catchment Descriptors (Hydrometric Register Area)** | 8.257 m$^3$/s |
| **Annual Maxima** | 7.574 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 8.647 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 6.629 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 7.6 | 7.6 | 7.6 | 9.1 |
| 5 | 10.5 | 10.5 | 9.7 | 12.6 |
| 10 | 12.5 | 12.5 | 11.1 | 14.9 |
| 25 | 15.3 | 15.2 | 12.9 | 18.2 |
| 50 | 17.6 | 17.5 | 14.3 | 21.0 |
| 100 | 20.1 | 20.0 | 15.7 | 24.0 |
| 200 | 22.9 | 22.7 | 17.3 | 27.2 |

**Summary of Analysis:** AMAX series EDA revealed there to be no outliers to the data set.

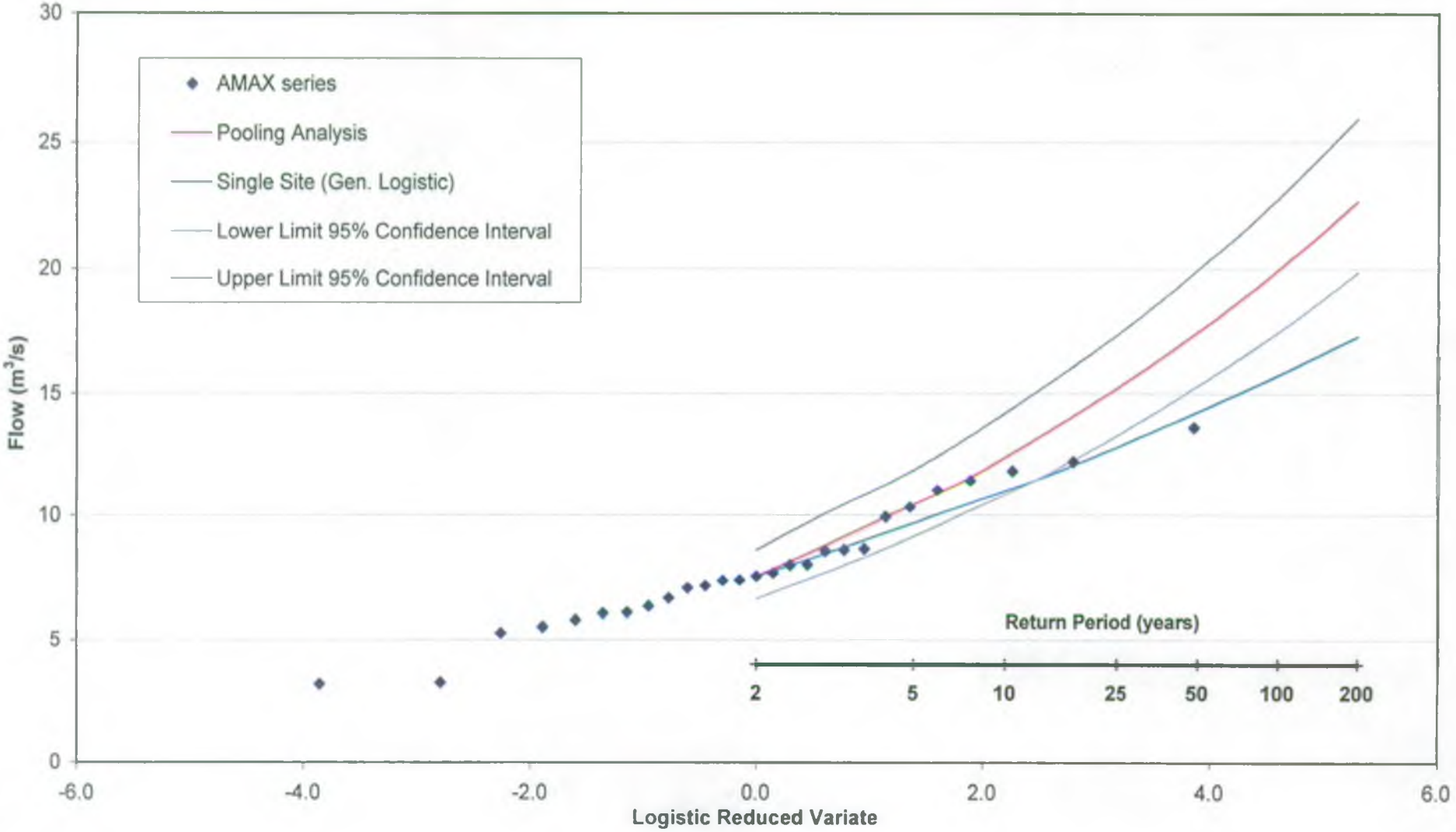
**Selection of Method:** The reviewed pooling group appears to overestimate the AMAX data at high return periods, but does represent well all but the two highest flows. The highest recorded flow lies below the bottom 95% confidence interval. There appears to be a levelling of the AMAX series at higher return periods. The Reviewed Pooled Analysis is recommended since this a short data set to draw such conclusions. Further investigation into the special considerations below may be appropriate.

*Special considerations:* There is a conflict between the area for the catchment given in the Hydrometric Register and that derived from FEH-CDROM, this could affect the accurate identification of catchment descriptors and hence generation of a suitable pooling group. Investigation should be undertaken into the conflict between the two sources and any influence that may have in flood estimation.

*Adopt:* Reviewed Pooled Analysis (shaded above)

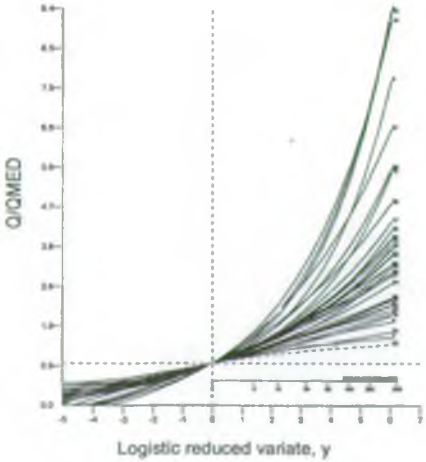
*Model parameters:* $\beta = 0.238$, $\kappa = -0.149$

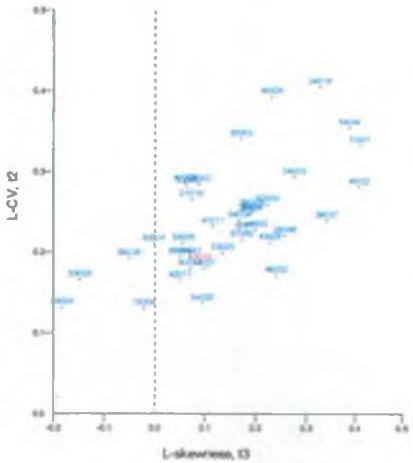
## Sherston Avon @ Fosseway

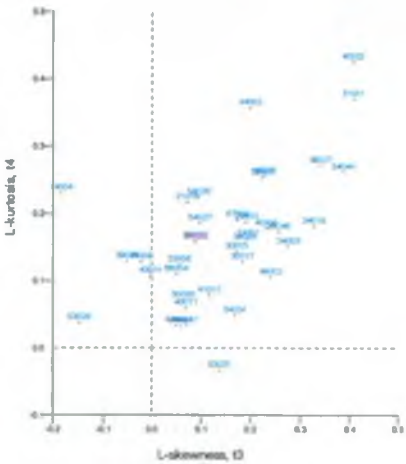


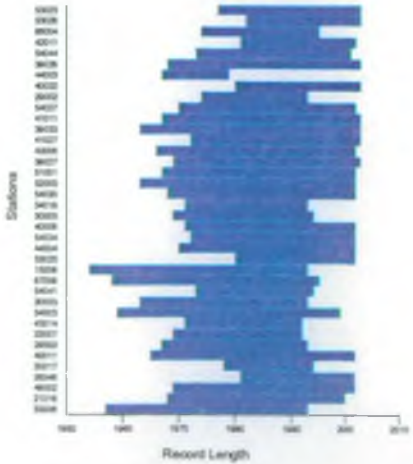
Annual Maxima series for Fosseway

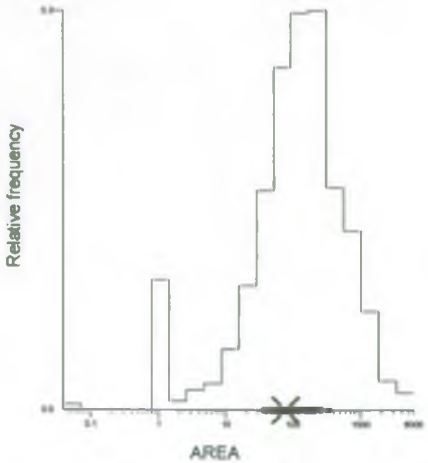
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 11 Feb 1977 | 6.326 | | 09 Mar 1991 | 5.505 |
| 28 Jan 1978 | 5.774 | | 09 Nov 1991 | 3.176 |
| 30 May 1979 | 11.526 | | 30 Nov 1992 | 11.910 |
| 27 Dec 1979 | 7.707 | | 05 Jan 1994 | 8.603 |
| 11 Mar 1981 | 7.574 | | 29 Jan 1995 | 8.643 |
| 30 Dec 1981 | 8.683 | | 24 Dec 1995 | 7.386 |
| 01 May 1983 | 5.259 | | 24 Feb 1997 | 3.242 |
| 02 Jan 1984 | 7.083 | | 04 Jan 1998 | 7.405 |
| 23 Nov 1984 | 6.664 | | 19 Jan 1999 | 12.277 |
| 26 Dec 1985 | 10.341 | | 24 Dec 1999 | 8.033 |
| 21 Nov 1986 | 7.176 | | 30 Oct 2000 | 13.642 |
| 31 Jan 1988 | 6.082 | | 11 Feb 2002 | 9.936 |
| 26 Feb 1989 | 6.047 | | 02 Jan 2003 | 11.103 |
| 20 Dec 1989 | 8.053 | | | |

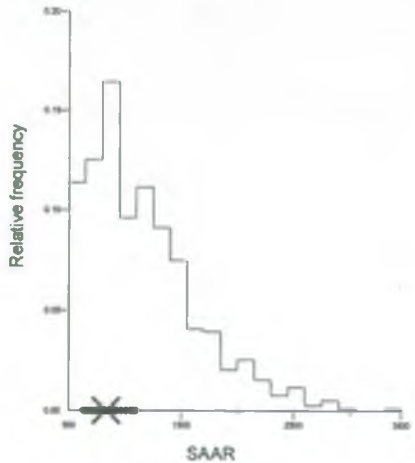

Q/QMED
Logistic reduced variate, y

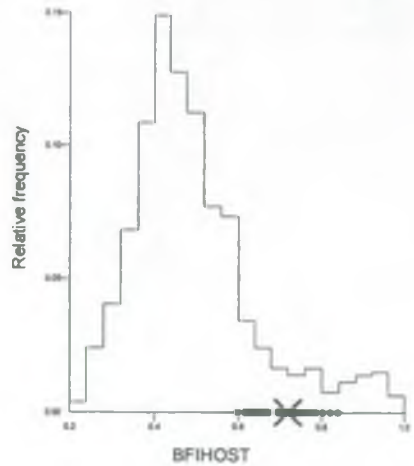

L-CV, t2
L-skewness, t3

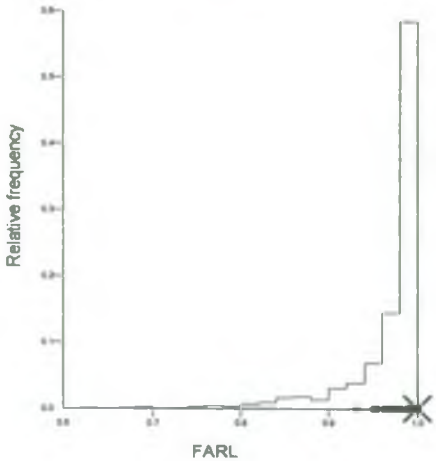

L-kurtosis, t4
L-skewness, t3

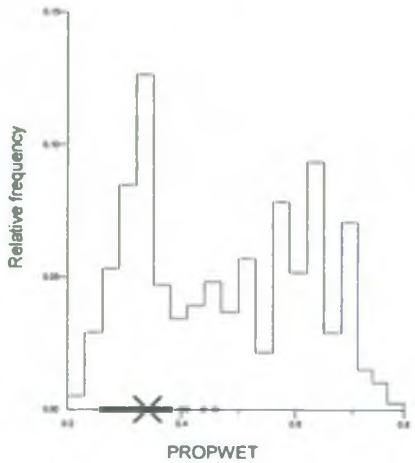

Stations
Record Length

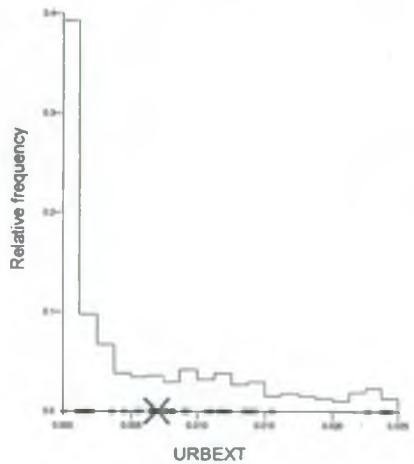

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Fosseway Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 5.09 | 4.35 |
| Comment | Review of pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1202 | 1117 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No station warrants promotion or demotion as a result of proximity to the subject site | No change | 1202 | 5.09 |
| *Period of Record* | 39th ranked (31006) Gwash @ Belmesthrope has only 6 years of data | Remove site since data set less than recommended minimum of 8 years. | 1196 | 5.14 |
| *FARL* | The Sherston Avon at Fosseway has a FARL = 1.000 and the pooling group has a range of 0.89 – 1.000. The two main outliers to the pooling group are:<br>39th ranked (52017) Congresbury Yeo @ Iwood FARL = 0.89<br>37th ranked (19008) South Esk @ Prestonholm FARL = 0.906 | Remove both sites as growth curves will be affected by attenuation of lakes and/or reservoirs present. | 1142 | 4.83 |
| *PROPWET/URBEXT* | All members of the pooling group have an URBEXT <0.025 and all essentially rural.<br>The subject site has PROPWET = 0.34 and the pooling group has a range of 0.26 – 0.47. | Retain all sites as essentially rural, and Fosseway PROPWET value lies in the middle of the pooling group range. No change. | 1142 | 4.83 |
| *Site Comments* | Review of gauging station comments reveals no issues of data quality. | No change | 1142 | 4.83 |
| *Discordant Sites* | *(44004) Frome @ Dorchester Total*<br>The site is ranked 27th in the pooling group. The discordancy is as a result of low AMAX values for the years 1975, 1990, 1991 and 1996. Catchment is influenced by groundwater dominated headwaters, and low AMX peaks occur in known groundwater drought periods. | Retain site and all data. | 1142 | 4.83 |
| | *(58011) Thaw @ Gigman Bridge*<br>35th ranked site has a very unusual AMAX profile with three very large peaks recorded in year 2000 – 2002 inclusive, whereas the remainder of the data is all very similar. | Remove site as unable to ascertain validity of data. | 1117 | 4.35 |
| *L Moments* | There are no extreme outliers to the L-moments and growth curves graphs, but the 5th ranked (54004) Tern @ Ternhill, 16th ranked (51001) Doniford Stream @ Swill Bridge, and 19th ranked (34018) Stiffkey @ Warham All Saints, have the highest and very similar growth curves. | No change since all are very similar and have been recently updated from Agency data. | 1117 | 4.35 |

## Fosseway Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53023 (Sherston Avon @ Fosseway) | 27 | 0.186 | 0.091 | 0.157 | 0.206 | 0.000 |
| 53028 (by Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 1.632 | 0.141 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.195 | 0.220 |
| 42011 (Hamble @ Frog Mill) | 21 | 0.165 | 0.051 | 0.034 | 0.862 | 0.253 |
| 54044 (Tern @ Ternhill) | 30 | 0.355 | 0.387 | 0.262 | 1.304 | 0.370 |
| 39028 (Dun @ Hungerford) | 35 | 0.192 | -0.051 | 0.129 | 0.883 | 0.375 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.649 | 0.400 |
| 40022 (Great Stour @ Chart Leacon) | 24 | 0.281 | 0.408 | 0.426 | 2.662 | 0.404 |
| 29002 (Great Eau @ Claythorpe Mill) | 21 | 0.284 | 0.088 | 0.159 | 0.673 | 0.495 |
| 54027 (Frome @ Ebley Mill) | 32 | 0.180 | 0.098 | 0.186 | 0.345 | 0.504 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.267 | 0.547 |
| 39033 (Winterbourne @ st Bagnor) | 41 | 0.247 | 0.189 | 0.157 | 0.059 | 0.573 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.206 | 0.580 |
| 43006 (Nadder @ Wilton Park) | 37 | 0.212 | 0.229 | 0.256 | 0.610 | 0.620 |
| 39027 (Pang @ Pangbourne) | 35 | 0.240 | 0.341 | 0.272 | 1.171 | 0.647 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.877 | 0.650 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.306 | 0.669 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 1.220 | 0.737 |
| 34018 (Stiffkey @ Warham All Saints) | 23 | 0.405 | 0.327 | 0.181 | 2.269 | 0.752 |
| 30005 (Witham @ Saltersford Total) | 26 | 0.282 | 0.065 | 0.071 | 0.870 | 0.764 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 2.294 | 0.768 |
| 54034 (Dowles Brook @ Dowles) | 30 | 0.240 | 0.168 | 0.048 | 0.776 | 0.788 |
| 44004 (Frome @ Dorchester Total) | 33 | 0.132 | -0.183 | 0.231 | 4.082 | 0.788 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 2.126 | 0.789 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 0.921 | 0.790 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.140 | 0.802 |
| 54041 (Tern @ Eaton on Tern) | 23 | 0.194 | 0.071 | 0.033 | 0.664 | 0.806 |
| 30003 (Bain @ Fulsby Lock) | 32 | 0.341 | 0.172 | 0.143 | 1.205 | 0.806 |
| 34003 (Bure @ Ingworth) | 41 | 0.293 | 0.277 | 0.151 | 0.529 | 0.807 |
| 43014 (East Avon @ Upavon) | 22 | 0.211 | -0.003 | 0.108 | 0.465 | 0.820 |
| 33007 (Nar @ Marham) | 25 | 0.251 | 0.195 | 0.163 | 0.061 | 0.830 |
| 29003 (Lud @ Louth) | 28 | 0.255 | 0.192 | 0.188 | 0.045 | 0.834 |
| 40011 (Great Stour @ Horton) | 39 | 0.180 | 0.070 | 0.060 | 0.543 | 0.839 |
| 30017 (Witham @ Colsterworth) | 16 | 0.226 | 0.183 | 0.129 | 0.224 | 0.846 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.660 | 0.859 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.966 | 0.883 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.890 | 0.918 |
| 33006 (Wissey @ Northwold) | 37 | 0.211 | 0.057 | 0.124 | 0.142 | 0.930 |
| | | | | | | |
| Total | 1117 | | | | | |
| Weighted means | | 0.238 | 0.149 | 0.172 | | |

FRAMPTON C.

**Catchment:** Bristol Frome at Frampton Cotterell
**Station No:** 53026
**NGR:** ST 667 822

**Description:** This is a small catchment (Hydrometric Register area 78.5 km$^2$). It is gauged by a Crump profile weir, which although full range drowns out at highest flows. The catchment is responsive, however detention lakes 4 to 6 km upstream may truncate peaks. It is mostly underlain by Carboniferous Limestone, with Coal Measures to the east of the River Frome and Lias to the west. Land use is predominantly rural.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX series record length 26 years. The data has not been reviewed.

**Gauge rating:** The rating has not been reviewed and is suitable for the range of AMAX values. Upper limit of rating is 47.9m$^3$/s which is greater than any recorded AMAX value, although it is possible that flows are 5% greater than calculated.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 80.72 | 0.992 | 0.35 | 0.397 | 800 | 41.1 | 0.0440 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 19.830 m$^3$/s |
| **Annual Maxima** | 12.357 m$^3$/s |
| **Upper Limit 95% Confidence Interval Urban Adjusted** | 15.214 m$^3$/s |
| **Lower Limit 95% Confidence Interval Urban Adjusted** | 10.625 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.0440, slightly urbanised: adjustment required

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

**Flood Frequency:** Satisfactory

| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 12.4 | 12.4 | 12.4 | 12.4 | 14.8 |
| 5 | 17.1 | 16.9 | 16.7 | 15.7 | 20.1 |
| 10 | 20.4 | 19.9 | 19.6 | 17.8 | 23.5 |
| 25 | 25.0 | 23.9 | 23.3 | 20.7 | 28.0 |
| 50 | 28.7 | 27.0 | 26.3 | 23.0 | 31.5 |
| 100 | 32.7 | 30.4 | 29.4 | 25.5 | 35.2 |
| 200 | 37.4 | 34.1 | 32.7 | 28.2 | 39.2 |

**Summary of Analysis:** AMAX series EDA reveals that there are no outliers in the data series. Pooled analysis review leads to some decrease in the predicted flood; approximately 12% at 200 years. Single site analysis suggests a smaller flood frequency curve, however pooled analysis provides a better representation of the AMAX series. The AMAX series within the return period range is contained by the 95 % confidence limits.

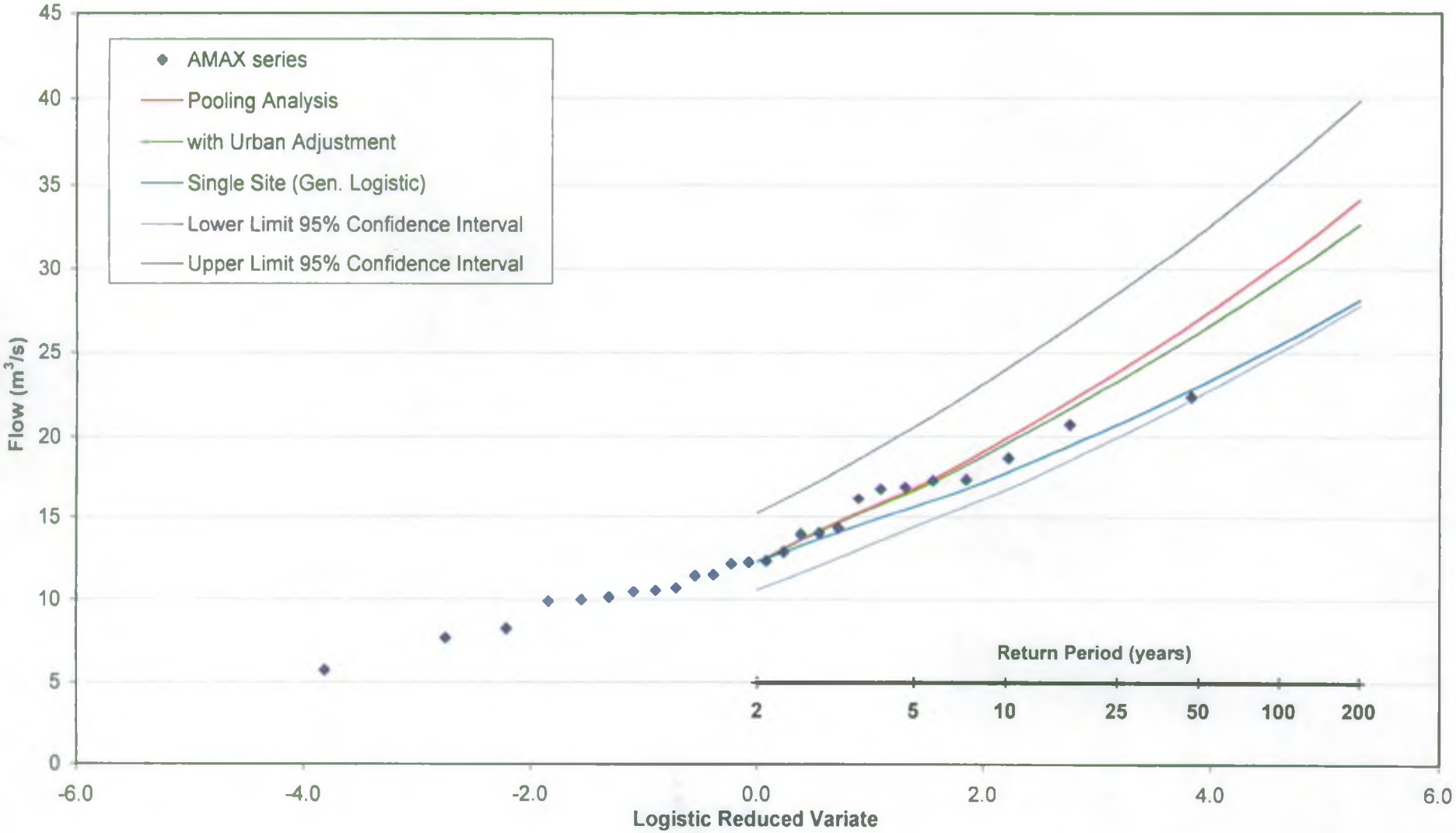
**Selection of Method:** [FEH 3.8 Table 8.3] Pooled analysis prevails: refer to single site for confirmation

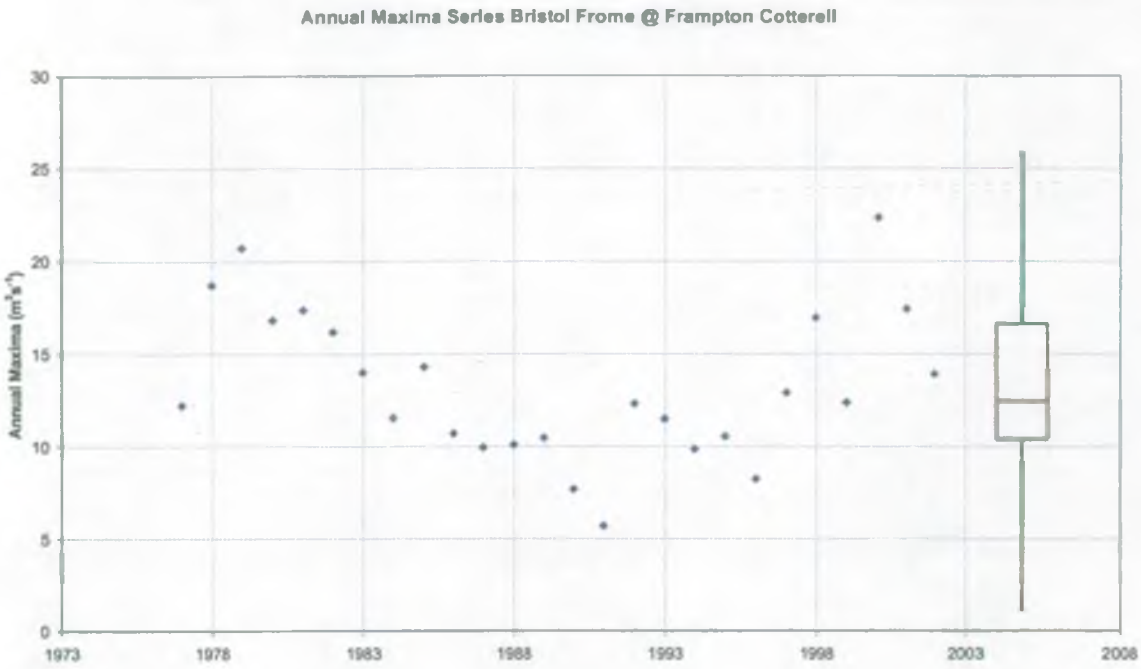
*Special considerations:* At present the AMAX series does not appear to be influenced by the detention lakes upstream of the catchment. This influence will need to be monitored and any changes may affect the suitability of the FEH Statistical method for estimating flood frequency at this site.

*Adopt:* Pooled Analysis Urban Adjusted as shaded above.

*Model parameters:* N.A.

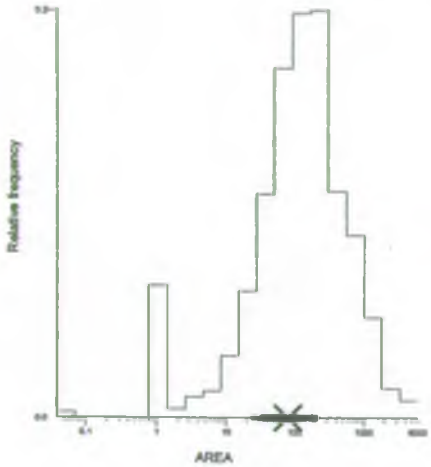
## Bristol Frome at Frampton Cotterell

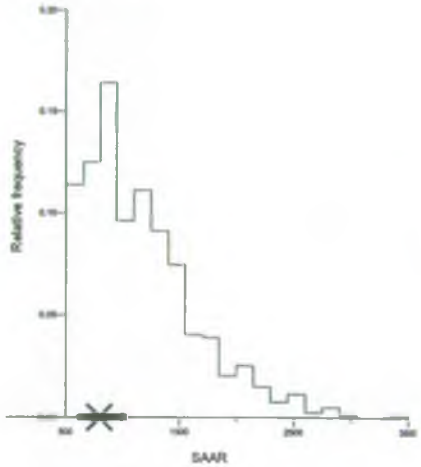


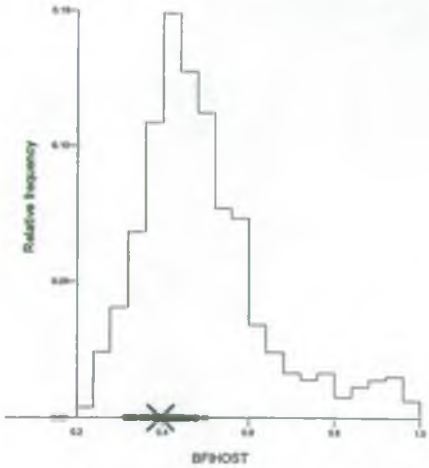


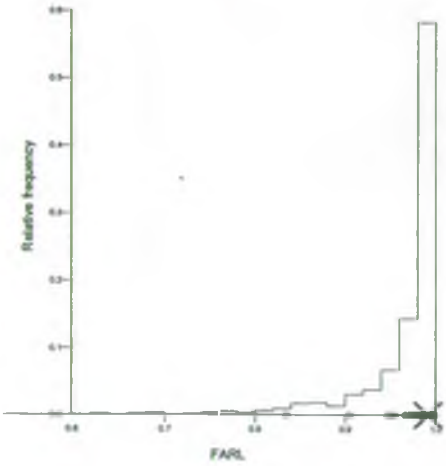

Annual Maxima series for Frampton Cotterell

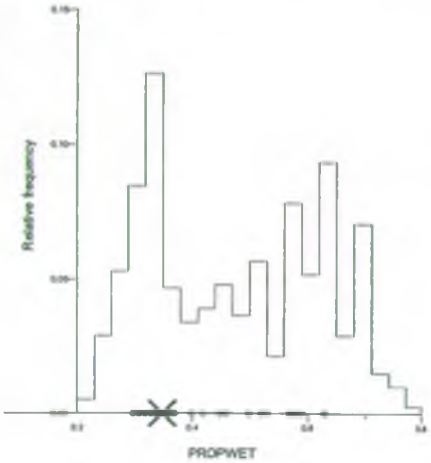
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 10 Jan 78 | 12.226 | | 09 Jan 91 | 7.687 |
| 30 May 79 | 18.712 | | 09 Jan 92 | 5.695 |
| 27 Dec 79 | 20.716 | | 01 Dec 92 | 12.321 |
| 11 Mar 81 | 16.823 | | 13 Oct 93 | 11.501 |
| 15 Mar 82 | 17.37 | | 29 Jan 95 | 9.864 |
| 02 May 83 | 16.185 | | 22 Dec 95 | 10.547 |
| 03 Jan 84 | 14.001 | | 13 Feb 97 | 8.247 |
| 23 Nov 84 | 11.547 | | 07 Mar 98 | 12.92 |
| 24 Dec 85 | 14.302 | | 20 Jan 99 | 16.959 |
| 04 Apr 87 | 10.704 | | 24 Dec 99 | 12.392 |
| 12 Nov 87 | 9.951 | | 30 Oct 00 | 22.343 |
| 25 Feb 89 | 10.105 | | 06 Jan 02 | 17.425 |
| 07 Feb 90 | 10.458 | | 02 Jan 03 | 13.926 |

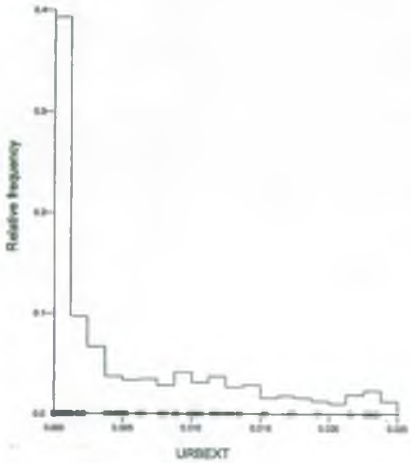

Relative frequency
AREA

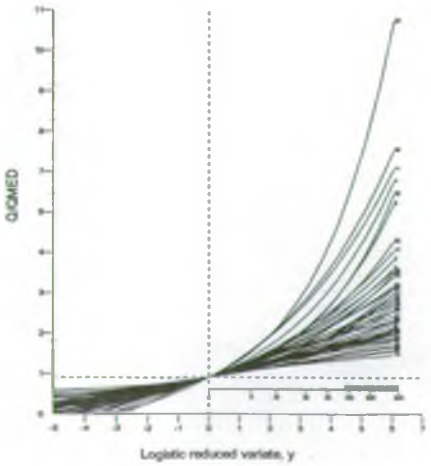

Relative frequency
SAAR

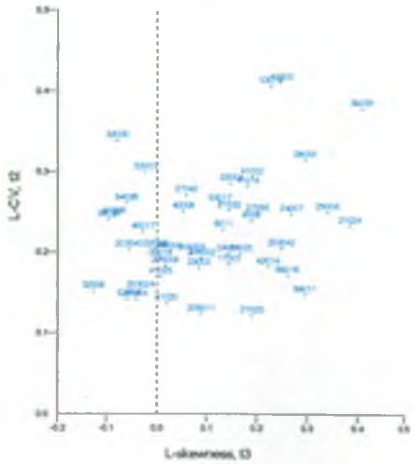

Relative frequency
BFIHOST

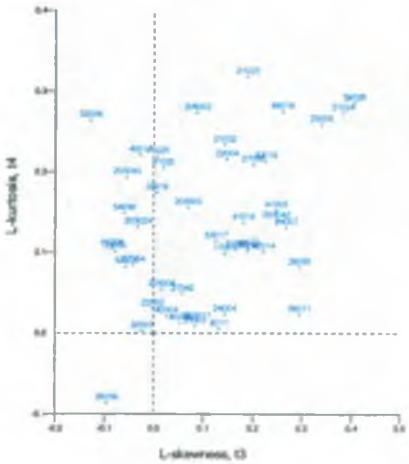

Relative frequency
FARL

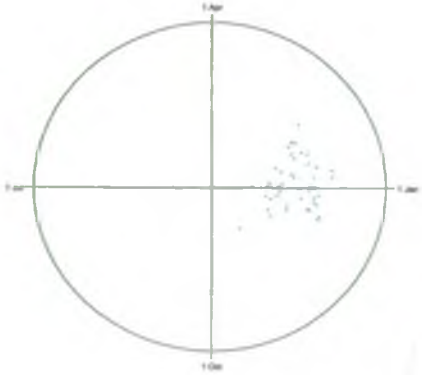

Relative frequency
PROPWET

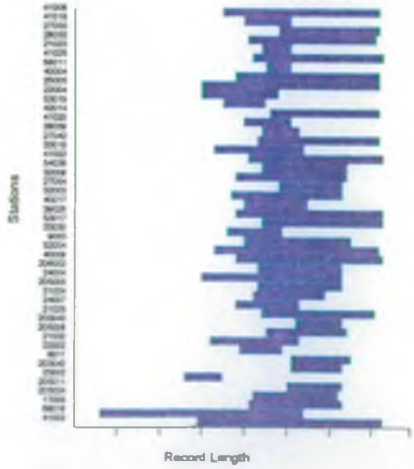

Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3




Stations
Record Length

## Frampton Cotterell Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 5.66 | 5.43 |
| Comment | Review of the pooling group is essential | Review of the pooling group is essential |
| Number of Station Years | 1194 | 1014 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Sites lying up or downstream of the subject site are likely to be hydrologically similar and may warrant promotion in the pooling group. 53006 (Frome (Bristol) @ Frenchay) lies downstream, but not essentially rural and not included in pooling group | No change | 1194 | 5.66 |
| *Period of Record* | For inclusion in a pooling group sites need 8 years of annual maxima. 205010 (Lagen @ Banoge) has 7 years of data. The remaining sites have the required station years. | Remove 205010 (Lagan @ Banoge) | 1187 | 5.93 |
| *FARL* | FARL for the Bristol Frome @ Frampton Cotterell is 0.992 and the range of values for the pooling group lies between 0.85 and 1.000. Sites investigated were:<br>46th ranked 23002 (Derwent at Eddy's Bridge), FARL 0.835. Flows controlled by reservoir from 1965. Flow record for water years 1955 - 1964. Retain assuming date of reservoir influence applies in water years and retain in position as only limited online waterbodies exist.<br>23rd ranked 28002 (Blithe @ Hamstall Ridware), FARL 0.876. WINFAP station notes indicate that the reservoir was built in 1952.<br>18th ranked 41026 (Cockhaise Brook @ Holywell), FARL 0.894. No evidence of reservoir in catchment, therefore FARL probably due to lake effects.<br>30th ranked 40010 (Eden @ Penhurst), FARL 0.925. FARL is due to presence of Hever Lake and other smaller lakes throughout the catchment.<br>37th ranked 28061 (Churnet @ Basford Bridge), FARL 0.931. 2 medium sized lakes exist on the upper tributaries, with other online lakes present in the catchment.<br>39th ranked 40809 (Pippingford Brook @ Paygate), FARL 0.915. 1 medium-sized lake in the centre of the catchment and various other small online lakes exist.<br>40th ranked 40007 (Medway @ Chafford Weir), FARL 0.939. Includes Weir Wood Reservoir which provides compensation flows and other various online lakes.<br>51st ranked 23007 (Derwent @ Rowlands Gill), FARL 0.910. Flow regime affected by Derwent Reservoirs which started impounding in 1965. Site dismissed as record is from 1965 - 1993.<br>7th ranked 40009 (Teise @ Stone Bridge), FARL 0.905. Reservoir constructed in 1976.<br>8th ranked 21002 (Whiteadder @ Hungry Snout), FARL 0.930. Medium-large sized lake directly upstream of the gauging station.<br>9th ranked 205005 (Ravernet @ Ravernet ), FARL 0.949. Significant storage reported in headwaters due to loughs, although this is partly balanced by minimal soil cover in many areas. | Remove al highlighted sites apart from:<br>40009 (Teise @ Stone Bridge) from which data is excluded from 1975 onwards, when the reservoir was constructed and it moved to the bottom of the pooling group.<br>205005 (Ravernet @ Ravernet) is moved out of the top 10 to rank 11. | 1014 | 5.51 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *PROPWET/URBEXT* | PROPWET lies between 0.3 an 0.63, with a subject site PROPWET of 0.35. Considering that sites above 0.45 may have soils which are considerably wetter than those of the Bristol Frome at Frampton Cottterell. All station exceeding a PROPWET of 0.45 are moved to the end of the pooling group. The sites moved are:<br>206002 (Jerrestpass @ Jerretspass), 24004 (Bedburn Beck @ Bedburn), 205005 (Ravernet @ Ravernet), 21024 (Jed Water @ Jeburgh), 24007 (Browney @ Lanchester), 21025 (Ale Water @ Ancrum), 203043 (Oonawater @ Shanmoy U/s), 205008 (Lagan @ Drummiller), 21032 (Glen @ Kirknewton), 22002 (Coquet @ Bygate), 8011 (Livet @ Minmore), 203042 (Crumlin @ Cidercourt Bridge), 23002 (Derwent @ Eddy's Bridge), 205011 (Annacloy @ Kilmore), 203024 (Crusher @ Gamble's Bridge), 17005 (Avon @ Polmonthill) and 68018 (Dane @ Congleton Park)<br>All sites in the pooling group are essentially rural (URBEXT <0.025). | Reordered sites noted as; too many station years to remove the sites. The removal of sites would also require the introduction of less similar catchments to the pooling group. | 1014 | 5.23 |
| *Site Comments* | All site comments examined where provided including evidence of poor gauging and artificial influences. 41003 (Cuckmere @ Sherman Bridge) is commented that is sometimes tidally influenced. | Move site to end of pooling group. | 1014 | 5.43 |
| *Discordant Sites* | Discordant sites in original pooling group already removed by other criteria. | No change | 1014 | 5.43 |
| *L Moments* | Main outliers to L-moments are 39026 (Cherwell @ Banbury), 41003 (Cuckmere @ Sherman Bridge), 53019 (Woodbridge Brook @ Crab Mill)<br>39026 (Cherwell @ Banbury) and 41003 (Cuckmere @ Sherman Bridge) are ranked 23rd and 46th positions respectively and will have a limited influence on the resultant frequency curves.<br>53019 (Woodbridge Brook @ Crab Mill) ranked 11th in the pooling group has a 12 year record, with several peaks and troughs in the AMAX series. 53008 (Avon @ Great Somerford) downstream of the gauge after its confluence with the Avon confirms the peak flood events. | No change. Retain all sites and data. | 1014 | 5.43 |

Frampton Cotterell Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 41006 (Uck @ Isfield) | 39 | 0.244 | -0.085 | 0.105 | 0.878 | 0.242 |
| 41018 (Kird @ Tanyards) | 13 | 0.282 | 0.182 | 0.137 | 0.247 | 0.273 |
| 27055 (Rve @ Broadway Foot) | 25 | 0.248 | 0.200 | 0.209 | 0.295 | 0.400 |
| 28055 (Ecclesbourne @ Duffield) | 23 | 0.315 | 0.295 | 0.082 | 1.221 | 0.494 |
| 21023 (Leet Water @ Coldstream) | 9 | 0.122 | 0.190 | 0.318 | 2.313 | 0.500 |
| 41025 (Loxwood Stream @ Drungewick) | 32 | 0.170 | 0.007 | 0.220 | 0.803 | 0.521 |
| 68011 (Arley Brook @ Gore Farm) | 8 | 0.147 | 0.295 | 0.023 | 2.617 | 0.521 |
| 40004 (Rother @ Udiam) | 35 | 0.202 | 0.025 | 0.021 | 0.502 | 0.528 |
| 25005 (Leven @ Leven Bridge) | 42 | 0.250 | 0.340 | 0.260 | 1.240 | 0.538 |
| 22004 (Aln @ Hawkhill) | 19 | 0.286 | 0.148 | 0.215 | 0.500 | 0.544 |
| 53019 (Woodbridge Brook @ Crab Mill) | 12 | 0.407 | 0.227 | 0.214 | 2.464 | 0.566 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 0.700 | 0.580 |
| 41020 (Bevern Stream @ Clappers Bridge) | 13 | 0.137 | 0.019 | 0.205 | 0.925 | 0.585 |
| 28058 (Henmore Brook @ Ashbourne) | 9 | 0.241 | -0.096 | -0.086 | 2.148 | 0.595 |
| 27042 (Dove @ Kirkby Mills) | 30 | 0.272 | 0.058 | 0.049 | 0.462 | 0.596 |
| 33018 (Tove @ Cappenham Bridge) | 22 | 0.193 | 0.006 | 0.174 | 0.385 | 0.600 |
| 41022 (Lod @ Halfway Bridge) | 33 | 0.294 | 0.190 | 0.105 | 0.424 | 0.614 |
| 54036 (Isbourne @ Hinton on the Green) | 21 | 0.261 | -0.060 | 0.149 | 0.949 | 0.650 |
| 32008 (Nene/Kislingbury @ Dodford) | 27 | 0.152 | -0.127 | 0.264 | 2.492 | 0.652 |
| 27054 (Hodge Beck @ Cherry Farm) | 17 | 0.142 | -0.041 | 0.085 | 0.719 | 0.671 |
| 32003 (Harpers Brook @ Old Mill Bridge) | 25 | 0.300 | -0.024 | 0.003 | 1.382 | 0.681 |
| 40017 (Dudwell @ Burwash) | 17 | 0.225 | -0.028 | 0.221 | 0.968 | 0.689 |
| 39026 (Cherwell @ Banbury) | 34 | 0.379 | 0.406 | 0.286 | 2.846 | 0.705 |
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.095 | 0.728 |
| 33030 (Clipstone Brook @ Clipstone) | 13 | 0.339 | -0.079 | 0.101 | 2.227 | 0.731 |
| 9003 (Isla @ Grange) | 26 | 0.240 | 0.189 | 0.101 | 0.217 | 0.733 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 0.782 | 0.738 |
| 40009 (Teise @ Stone Bridge) | 8 | 0.251 | 0.052 | 0.012 | 0.607 | 0.410 |
| 206002 (Jerretspass @ Jerretspass) | 21 | 0.193 | 0.088 | 0.273 | 0.949 | 0.322 |
| 24004 (Bedburn Beck @ Bedburn) | 34 | 0.198 | 0.144 | 0.023 | 0.709 | 0.377 |
| 205005 (Ravernet @ Ravernet) | 21 | 0.199 | 0.070 | 0.156 | 0.106 | 0.477 |
| 21024 (Jed Water @ Jedburgh) | 17 | 0.233 | 0.384 | 0.274 | 1.764 | 0.524 |
| 24007 (Browney @ Lanchester) | 15 | 0.248 | 0.268 | 0.131 | 0.520 | 0.529 |
| 21025 (Ale Water @ Ancrum) | 28 | 0.199 | 0.167 | 0.104 | 0.259 | 0.560 |
| 203043 (Oonawater @ Shanmoy U/s) | 9 | 0.203 | -0.055 | 0.194 | 0.881 | 0.592 |
| 205008 (Lagan @ Drummiller) | 19 | 0.184 | 0.016 | 0.055 | 0.367 | 0.631 |
| 21032 (Glen @ Kirknewton) | 22 | 0.252 | 0.144 | 0.234 | 0.431 | 0.653 |
| 22002 (Coquet @ Bygate) | 11 | 0.204 | -0.003 | 0.030 | 0.480 | 0.667 |
| 8011 (Livet @ Minmore) | 14 | 0.229 | 0.133 | 0.005 | 0.743 | 0.698 |
| 203042 (Crumlin @ Cidercourt Bridge) | 12 | 0.205 | 0.248 | 0.140 | 0.538 | 0.718 |
| 23002 (Derwent @ Eddys Bridge) | 10 | 0.181 | 0.084 | 0.009 | 0.758 | 0.720 |
| 205011 (Annacloy @ Kilmore) | 13 | 0.124 | 0.088 | 0.015 | 1.397 | 0.727 |
| 203024 (Cusher @ Gamble's Bridge) | 22 | 0.153 | -0.032 | 0.132 | 0.600 | 0.729 |
| 17005 (Avon @ Polmonthill) | 22 | 0.186 | 0.144 | 0.098 | 0.281 | 0.735 |
| 68018 (Dane @ Congleton Park) | 32 | 0.172 | 0.261 | 0.275 | 1.392 | 0.738 |
| 41003 (Cuckmere @ Sherman Bridge) | 43 | 0.411 | 0.247 | 0.152 | 2.412 | 0.288 |
| | | | | | | |
| Total | 1014 | | | | | |
| Weighted means | | 0.235 | 0.106 | 0.141 | | |

FRENCHAY

**Catchment:** Frome (Bristol) at Frenchay
**Station No:** 53006
**NGR:** ST 637 772

**Description:** The Frome at Frenchay is gauged with a full range trapezoidal flume opened in 1961 and designed based on pre-urbanisation flows, it now lies in the suburbs of Bristol. Drowning does not occur. The geology of the catchment is complex with the eastern and central catchment dominated by sandstones with the west being less permeable.

**Data comments** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 42 years. The data series was not reviewed.

**Gauge rating:** Upper limit of rating is 74.2m$^3$/s which is exceeded twice in the AMAX series. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 150.61 | 0.995 | 0.35 | 0.362 | 792 | 43.5 | 0.0713 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 36.319 m$^3$/s |
| **Annual Maxima** | 34.546 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 41.152 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 30.893 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.0713, moderately urbanised: adjustment required

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

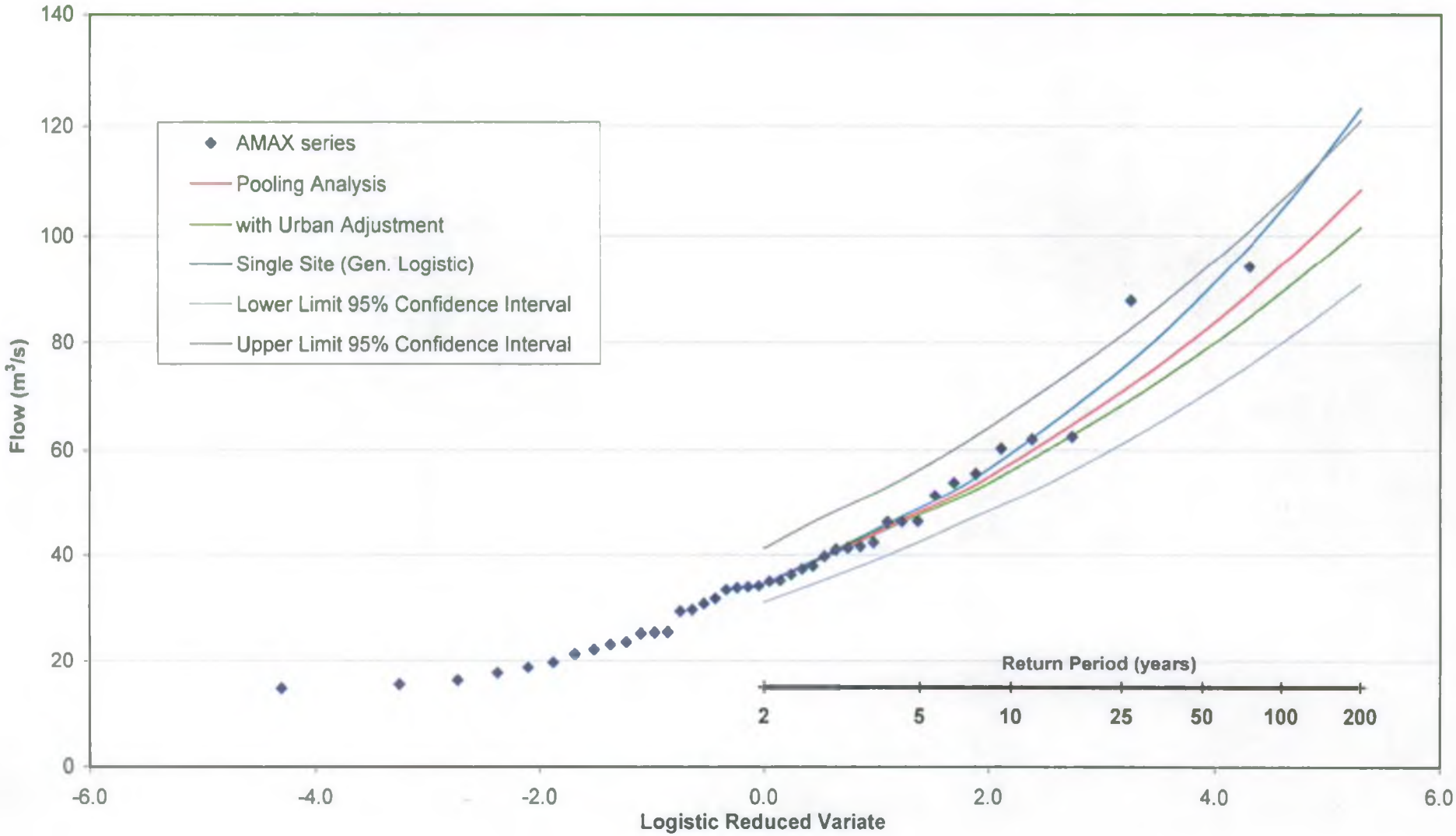
| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 34.5 | 34.5 | 34.5 | 34.5 | 41.5 |
| 5 | 48.4 | 48.0 | 47.4 | 48.8 | 56.8 |
| 10 | 58.1 | 57.4 | 5[illegible] | 59.4 | 67.4 |
| 25 | 71.8 | 70.8 | 68.3 | 75.1 | 82.0 |
| 50 | 83.4 | 82.0 | 78.4 | 88.9 | 94.0 |
| 100 | 96.3 | 94.4 | 89.4 | 104.7 | 107.2 |
| 200 | 110.7 | 108.3 | 101.6 | 123.2 | 121.9 |

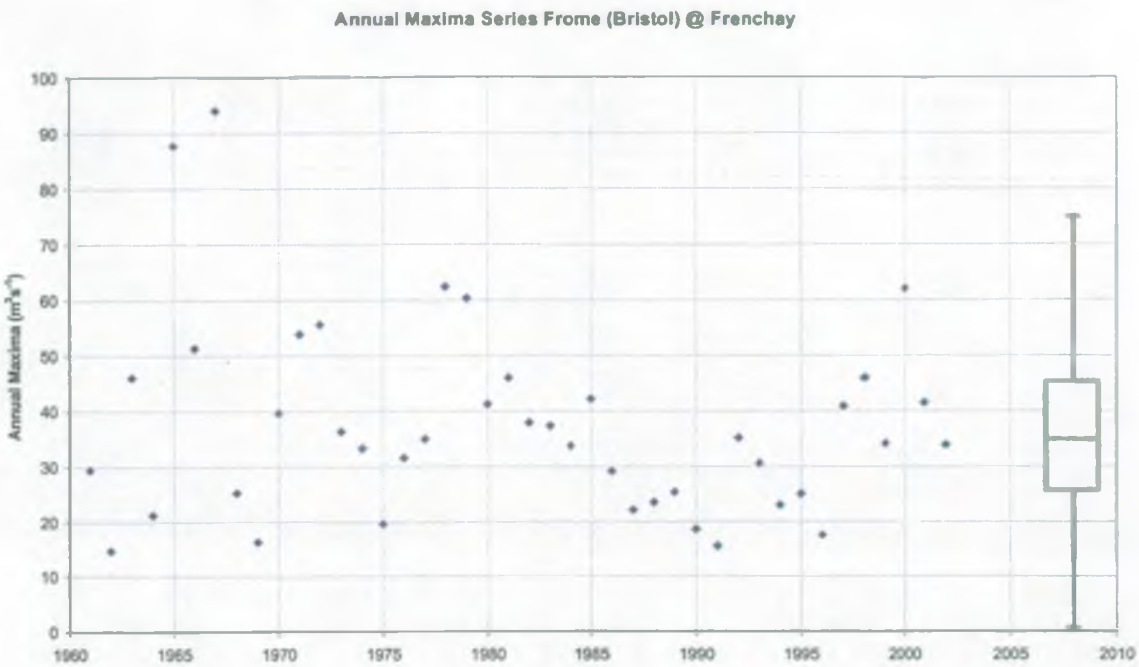
**Summary of Analysis:** AMAX series EDA revealed two outliers to the data July 1968 and December 1965, of which the Hydrometric Register comments "site swamped in storms of 1965 and 1968". Both events are retained.
The pooling group review resulted in a small reduction in the estimated flood return period peaks, which were further reduced on the application of the urban adjustment.

**Selection of Method:** From the plot of FFCs all represent the AMAX data well. Recommend pooled analysis urban adjusted as standard FEH procedure.

*Special considerations:* None
*Adopt:* Pooled Analysis Urban Adjusted (as shaded above)
*Model parameters:* N. A.

## Frome (Bristol) @ Frenchay






Annual Maxima series for Frenchay

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 11 Jan 62 | 29.435 | | 01 May 83 | 37.911 |
| 17 Mar 63 | 14.657 | | 02 Jan 84 | 37.294 |
| 19 Nov 63 | 46.064 | | 23 Nov 84 | 33.697 |
| 23 Jul 65 | 21.291 | | 24 Dec 85 | 42.218 |
| 19 Dec 65 | 87.777 | | 04 Apr 87 | 29.177 |
| 20 Feb 67 | 51.353 | | 24 Jan 88 | 22.170 |
| 10 Jul 68 | 94.061 | | 25 Feb 89 | 23.532 |
| 22 Dec 68 | 25.267 | | 01 Feb 90 | 25.358 |
| 16 Jan 70 | 16.227 | | 09 Jan 91 | 18.654 |
| 29 Nov 70 | 39.703 | | 09 Jan 92 | 15.431 |
| 19 Oct 71 | 53.911 | | 30 Nov 92 | 35.168 |
| 07 Dec 72 | 55.609 | | 13 Oct 93 | 30.589 |
| 09 Feb 74 | 36.314 | | 27 Jan 95 | 23.053 |
| 20 Jan 75 | 33.322 | | 22 Dec 95 | 25.074 |
| 01 Dec 75 | 19.642 | | 12 Feb 97 | 17.585 |
| 19 Dec 76 | 31.614 | | 06 Mar 98 | 40.905 |
| 08 Jan 78 | 34.973 | | 19 Jan 99 | 45.948 |
| 30 May 79 | 62.426 | | 24 Dec 99 | 34.118 |
| 27 Dec 79 | 60.308 | | 29 Oct 00 | 61.980 |
| 11 Mar 81 | 41.258 | | 11 Feb 02 | 41.514 |
| 30 Dec 81 | 45.992 | | 02 Jan 03 | 33.888 |

Q/QMED
Logistic reduced variate, y


Stations
Record Length


L-CV, t2
L-dimension, t3




L-kurtosis, t4
L-dimension, t3

Relative frequency
PAIL


Relative frequency
VRAY


Relative frequency
PROPMET


Relative frequency
SAVS


Relative frequency
URBSCT


Relative frequency
BRHOST

## Frenchay Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.69 | 3.39 |
| Comment | Review of pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1279 | 1034 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No station requires promotion or demotion as a result of proximity to the subject site. | No change. | 1279 | 3.69 |
| *Period of Record* | 23rd ranked site (205010) Lanag @ Banoge has only 7 years of data. | Remove site as it has less than the 8 years recommended minimum data. | 1272 | 3.67 |
| *FARL* | The Frenchay catchment has a FARL = 0.995 and the pooling group has a range of 0.835 – 1.000. The outliers to the pooling group are:<br>22nd ranked (23002) Derwent @ Eddys Bridge FARL = 0.835<br>31st ranked (28002) Blithe @ Hamstall Ridware FARL = 0.876<br>19th ranked (40009) Teise @ Stone Bridge FARL = 0.905<br>5th ranked (23007) Derwent @ Rowlands Gill FARL = 0.910 | Remove all four sites since flows will be significantly affected by the attenuation of flows due to lakes and reservoirs in the catchments. | 1185 | 4.02 |
| *PROPWET/URBEXT* | The subject site has a PROPWET = 0.35 and the pooling group has a range of values of 0.28 – 0.59. The main outliers to the pooling group are:<br>31st ranked (203043) Oonawater @ Shanmoy u/s PROPWET = 0.59<br>26th ranked (24007) Browney @ Lanchester PROPWET = 0.59<br>13th ranked (24004) Bedburn Beck @ Bedburn PROPWET = 0.59<br>All members of the pooling group are essentially rural, but an urban adjustment will need to be applied to the final growth curve and Qmed since the subject sight is slightly urbanised. | Remove all three sites. Although the pooling group still has several catchments with large values of PROPWET the removal of these has to be counterbalanced with the addition of further less similar catchments at the bottom of the pooling group to ensure the 5T rule is met for pooling group station years. | 1127 | 4.38 |
| *Site Comments* | 3rd ranked (41003) Cuckmere @ Shermans Bridge. Received updated AMAX series as part of study from EA Southern Region with warning that the data was tidally affected.<br>16th ranked (41014) Arun @ Pallingham. Received updated AMAX series as part of study from EA Southern Region with warning that gauge is tidally affects and in inaccurate over 55 m³/s.<br>30th ranked (23010) Tarset Burn @ Greenhaugh discontinued in 1980. | Remove all three sites as for the two Southern Region datasets, AMAX series were unreliable and did not look right and the other station is no longer active. | 1043 | 3.71 |
| *Discordant Sites* | *(31021) Welland @ Ashley*<br>12 years of AMAX data with one low flow peak value for 1975. | Retain all data and site since low peak occurs in known drought year. | 1043 | 3.71 |
| | *(21002) Whiteadder Water @ Hungry Snout*<br>9 years of AMAX data with a large peak of 4 August 1996. | The gauging station lies downstream of a reservoir and there are no adjacent sites to confirm peak value. It is a short data record Remove site. | 10334 | 3.39 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *L Moments* | There are three stations which are outliers in both the L-moments graphs and the growth curves graphs. These are<br>14th ranked (40010) Eden @ Penshurst. Has one extreme peak on 15 September 1968 which is confirmed from downstream data from gauge (40003) Medway @ Teston.<br>15th ranked (41007) Arun @ Park Mound. Also has an extreme value on 15 September 1968, which lies is a similar region to the Eden @ Penshurst. Stations upstream and downstream of Park Mound do not cover this period.<br>19th ranked (39026) Cherwell @ Banbury. Comments that it is a responsive catchment and has extreme value for 9 April 1998 which is the known Easter 1998 floods. | Retain all three sites and all data. | 1034 | 3.39 |

## Frenchay Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 25005 (Leven @ Leven Bridge) | 42 | 0.250 | 0.340 | 0.260 | 0.513 | 0.293 |
| 40004 (Rother @ Udiam) | 35 | 0.202 | 0.025 | 0.021 | 0.762 | 0.316 |
| 22007 (Wansbeck @ Mitford) | 18 | 0.303 | 0.140 | 0.049 | 1.052 | 0.346 |
| 41025 (Loxwood Stream @ Drungewick) | 32 | 0.170 | 0.007 | 0.220 | 0.547 | 0.381 |
| 206002 (Jerretspass @ Jerretspass) | 21 | 0.193 | 0.088 | 0.273 | 0.417 | 0.402 |
| 41018 (Kird @ Tanyards) | 13 | 0.282 | 0.182 | 0.137 | 0.311 | 0.436 |
| 21025 (Ale Water @ Ancrum) | 28 | 0.199 | 0.167 | 0.104 | 0.432 | 0.461 |
| 22004 (Aln @ Hawkhill) | 19 | 0.286 | 0.148 | 0.215 | 0.287 | 0.475 |
| 33018 (Tove @ Cappenham Bridge) | 22 | 0.193 | 0.006 | 0.174 | 0.333 | 0.482 |
| 40005 (Beult @ Stile Bridge) | 28 | 0.272 | 0.229 | 0.117 | 0.466 | 0.487 |
| 22006 (Blyth @ Hartford Bridge) | 32 | 0.345 | 0.276 | 0.124 | 1.223 | 0.489 |
| 21023 (Leet Water @ Coldstream) | 9 | 0.122 | 0.190 | 0.318 | 1.519 | 0.493 |
| 27055 (Rye @ Broadway Foot) | 25 | 0.248 | 0.200 | 0.209 | 0.034 | 0.495 |
| 40010 (Eden @ Penshurst) | 29 | 0.329 | 0.545 | 0.559 | 3.785 | 0.501 |
| 41007 (Arun @ Park Mound) | 15 | 0.371 | 0.336 | 0.452 | 2.629 | 0.547 |
| 41006 (Uck @ Isfield) | 39 | 0.244 | -0.085 | 0.105 | 1.114 | 0.550 |
| 203024 (Cusher @ Gamble's Bridge) | 22 | 0.153 | -0.032 | 0.132 | 0.615 | 0.604 |
| 40007 (Medway @ Chafford Weir) | 24 | 0.202 | 0.378 | 0.284 | 1.207 | 0.606 |
| 39026 (Cherwell @ Banbury) | 34 | 0.379 | 0.406 | 0.286 | 1.649 | 0.609 |
| 21024 (Jed Water @ Jedburgh) | 17 | 0.233 | 0.384 | 0.274 | 0.914 | 0.624 |
| 54010 (Stour @ Alscot Park) | 32 | 0.243 | 0.118 | 0.227 | 0.110 | 0.642 |
| 31021 (Welland @ Ashley) | 12 | 0.194 | -0.260 | 0.208 | 3.355 | 0.664 |
| 53019 (Woodbridge Brook @ Crab Mill) | 12 | 0.407 | 0.227 | 0.214 | 2.273 | 0.675 |
| 23008 (Rede @ Rede Bridge) | 22 | 0.179 | 0.231 | 0.165 | 0.627 | 0.684 |
| 17005 (Avon @ Polmonthill) | 22 | 0.186 | 0.144 | 0.098 | 0.471 | 0.688 |
| 21032 (Glen @ Kirknewton) | 22 | 0.252 | 0.144 | 0.234 | 0.104 | 0.689 |
| 205005 (Ravernet @ Ravernet) | 21 | 0.199 | 0.070 | 0.156 | 0.122 | 0.724 |
| 205011 (Annacloy @ Kilmore) | 13 | 0.124 | 0.088 | 0.015 | 1.711 | 0.750 |
| 22001 (Coquet @ Morwick) | 30 | 0.239 | 0.232 | 0.193 | 0.121 | 0.763 |
| 68018 (Dane @ Congleton Park) | 32 | 0.172 | 0.261 | 0.275 | 0.782 | 0.765 |
| 205008 (Lagan @ Drumnillier) | 19 | 0.184 | 0.016 | 0.055 | 0.580 | 0.772 |
| 28061 (Churnet @ Basford Bridge) | 16 | 0.100 | 0.017 | 0.310 | 1.925 | 0.772 |
| 31005 (Welland @ Tixover) | 32 | 0.290 | 0.244 | 0.229 | 0.245 | 0.797 |
| 32008 (Nene/Kislingbury @ Dodford) | 27 | 0.152 | -0.127 | 0.264 | 1.968 | 0.807 |
| 203042 (Crumlin @ Cidercourt Bridge) | 12 | 0.205 | 0.248 | 0.140 | 0.577 | 0.814 |
| 50810 (Little Dart @ Dart Bridge) | 8 | 0.244 | 0.123 | -0.012 | 1.241 | 0.820 |
| 32006 (Nene/Kislingbury @ Upton) | 53 | 0.208 | 0.128 | 0.349 | 0.845 | 0.822 |
| 41020 (Bevern Stream @ Clappers Bridge) | 13 | 0.137 | 0.019 | 0.205 | 0.717 | 0.823 |
| 9003 (Isla @ Grange) | 26 | 0.240 | 0.189 | 0.101 | 0.376 | 0.824 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 0.902 | 0.825 |
| 37014 (Roding @ High Ongar) | 30 | 0.299 | -0.002 | 0.205 | 1.352 | 0.828 |
| 32003 (Harpers Brook @ Old Mill Bridge) | 25 | 0.300 | -0.024 | 0.003 | 1.844 | 0.833 |
| 28024 (Wreake @ Syston Mill) | 25 | 0.264 | 0.367 | 0.369 | 0.943 | 0.840 |
| | | | | | | |
| Total | 1034 | | | | | |
| Weighted means | | 0.240 | 0.170 | 0.199 | | |

GT. SOMERFORD

**Catchment:** Avon at Great Somerford
**Station No:** 53008
**NGR:** ST 966 832

**Description:** This is a medium sized catchment (Hydrometric Register area 303.0km$^2$) gauged using a compound Crump profile weir. Opened in 1963, it is situated 90m downstream of Great Somerford road bridge. Out of bank flow occurs u/s before bankfull at the structure. However it is a full range station, with all except extreme flows contained. Only the July 1968 flood drowned the weir. The station is also modular in all but extreme events. Flows are augmented by a groundwater scheme in the catchment; the station now forms part of the Malmesbury groundwater investigation scheme. The catchment geology is mainly Oolitic Limestone with left-bank tributaries draining off clays. Land use is predominantly rural.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX series record length 40 years. Data not reviewed

**Gauge rating:** Gauge rating not reviewed. Investigations ongoing into which of two ratings to adopt.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 305.11 | 0.989 | 0.34 | 0.622 | 804 | 28.0 | 0.0077 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 30.625 m$^3$/s |
| **Annual Maxima** | 36.794 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 43.623 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 32.039 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, permeable adjustment not applied

**Urbanisation:** URBEXT < 0.025, essentially rural: urban adjustment not applicable

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory – may need to assess influence of out of bank flow u/s of gauge**

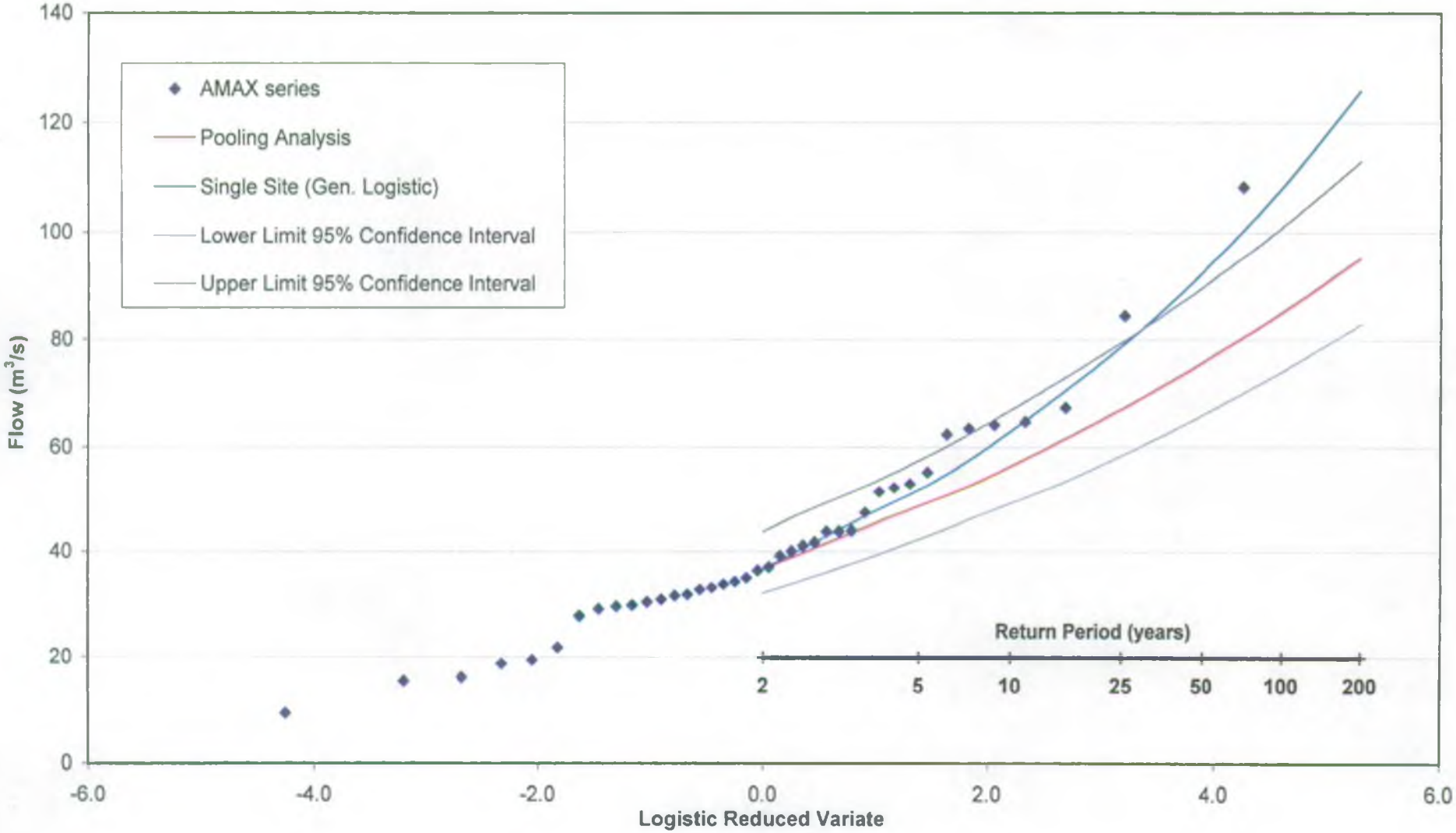
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 36.8 | 36.8 | 36.8 | 44.2 |
| 5 | 49.1 | 48.5 | 51.9 | 58.2 |
| 10 | 57.5 | 56.3 | 62.9 | 67.6 |
| 25 | 69.0 | 67.0 | 78.8 | 80.4 |
| 50 | 78.5 | 75.7 | 92.5 | 90.8 |
| 100 | 88.8 | 85.1 | 108.0 | 102.1 |
| 200 | 100.1 | 95.2 | 125.8 | 114.3 |

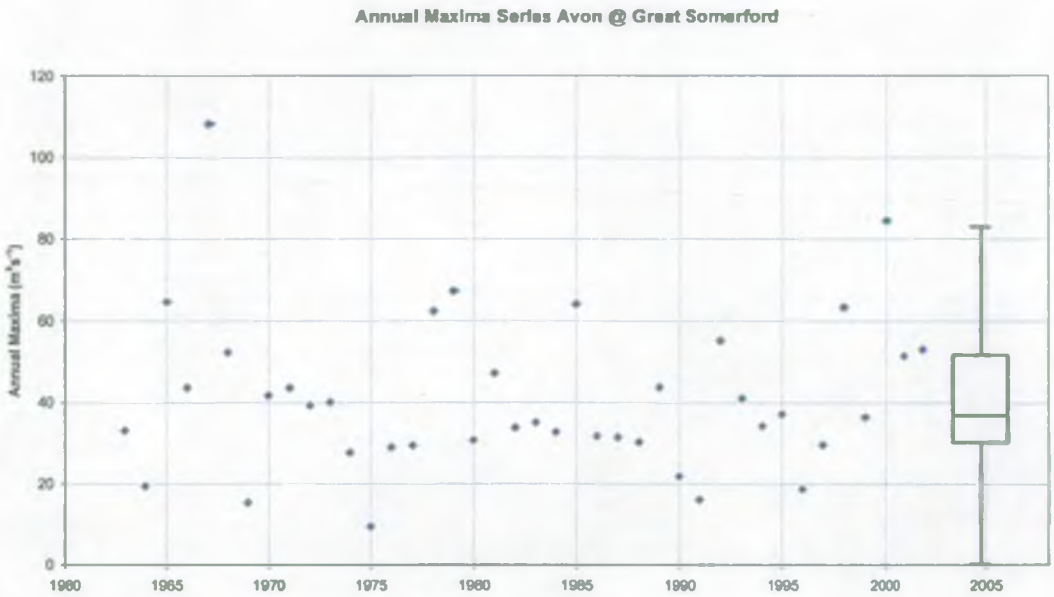
**Summary of Analysis:** AMAX EDA reveals that there are two outliers to the data set July 1968 and October 2000. All data is retained without review. A review of the pooled analysis leads to a decrease in the flood frequency curve; approximately 5 % at 200 years. The AMAX series lies within the 95 % confidence limits. The single site analysis suggests a higher FFC, providing a reasonable fit to the AMAX series, although largest flood event is outside of the upper 95% confidence limit.

**Selection of Method:** [FEH 3.8 Table 8.3] Pooled analysis prevails: refer to single site for confirmation. The July 1968 is reported to be approx. 1 in 100 year event, which lies just outside the 95% confidence interval.

*Special considerations:* None
*Adopt:* Pooled analysis as shaded above
*Model parameters:* $\beta = 0.204$, $\kappa = 0.129$

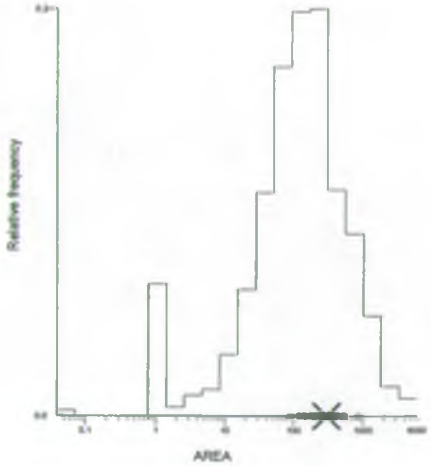
## Avon at Great Somerford

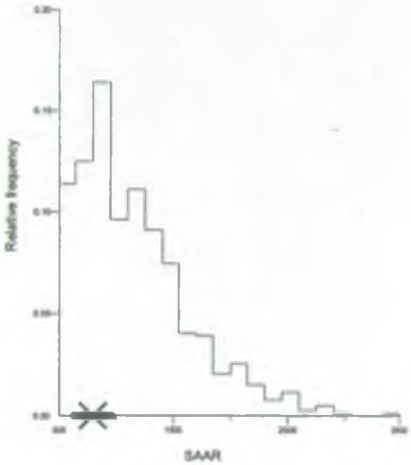


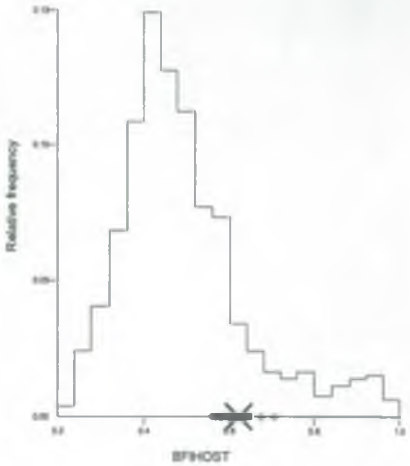


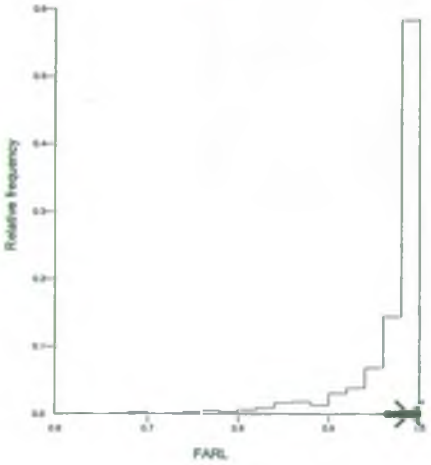

Annual Maxima series for Great Somerford

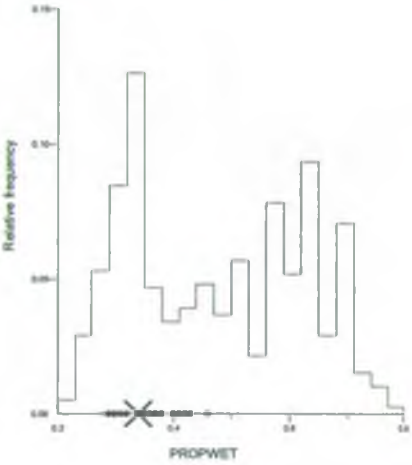
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 19 Mar 64 | 33.098 | | 03 Jan 84 | 35.068 |
| 21 Jul 65 | 19.405 | | 08 Feb 85 | 32.700 |
| 19 Dec 65 | 64.655 | | 24 Dec 85 | 64.085 |
| 27 Feb 67 | 43.644 | | 27 Mar 87 | 31.760 |
| 11 Jul 68 | 108.249 | | 31 Jan 88 | 31.514 |
| 26 May 69 | 52.286 | | 25 Feb 89 | 30.298 |
| 30 Jan 70 | 15.401 | | 20 Dec 89 | 43.810 |
| 31 Jan 71 | 41.688 | | 11 Jan 91 | 21.828 |
| 03 Feb 72 | 43.575 | | 09 Jan 92 | 16.129 |
| 06 Dec 72 | 39.216 | | 30 Nov 92 | 55.260 |
| 09 Feb 74 | 40.093 | | 05 Jan 94 | 41.040 |
| 20 Jan 75 | 27.685 | | 29 Jan 95 | 34.305 |
| 02 Dec 75 | 9.436 | | 22 Dec 95 | 37.132 |
| 20 Feb 77 | 28.975 | | 25 Feb 97 | 18.715 |
| 23 Jan 78 | 29.433 | | 04 Jan 98 | 29.672 |
| 30 May 79 | 62.320 | | 20 Jan 99 | 63.389 |
| 27 Dec 79 | 67.279 | | 24 Dec 99 | 36.456 |
| 11 Mar 81 | 30.782 | | 30 Oct 00 | 84.478 |
| 15 Mar 82 | 47.132 | | 11 Feb 02 | 51.463 |
| 02 May 83 | 33.750 | | 02 Jan 03 | 53.053 |

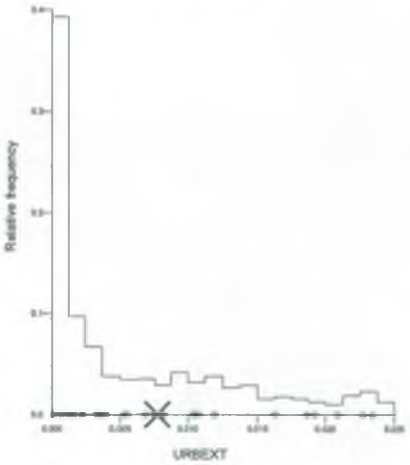

Relative frequency
AREA

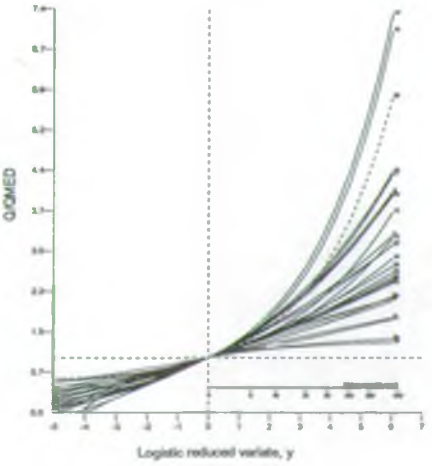

Relative frequency
SAAR

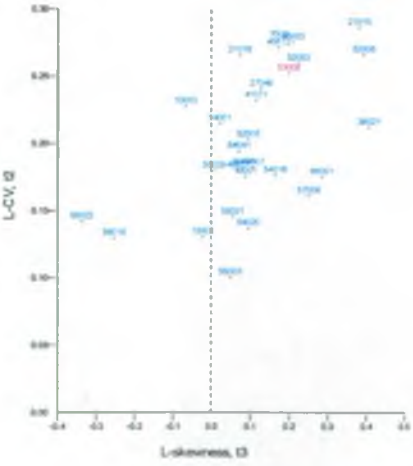

Relative frequency
BFIHOST

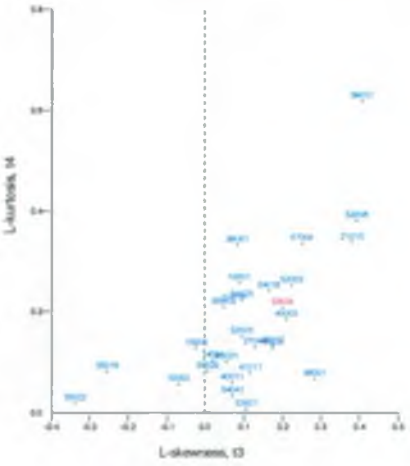

Relative frequency
FARL

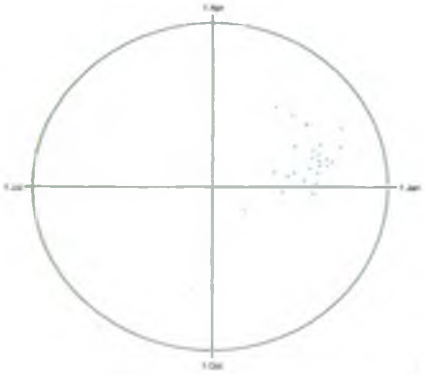

Relative frequency
PROPWET

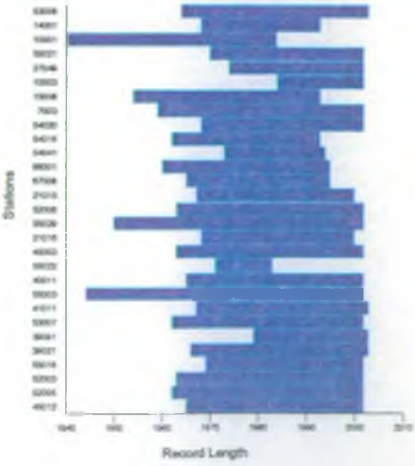

Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3




Stations
Record Length

## Great Somerford Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.42 | 3.66 |
| Comment | Review of the pooling group is desirable | Review of the pooling group is desirable |
| Number of Station Years | 1199 | 997 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Any sites lying upstream or downstream of the subject site, are likely to be hydrologically similar and give good reason for promotion to a higher ranking in pooling group. No such stations in this pooling group. | No change | 1199 | 3.42 |
| *Period of Record* | For inclusion in a pooling group sites need a minimum of 8 years of annual maxima. 54065 (Roden @ Stanton) has only 5 years of data.<br>55009 (Monnow @ Kentchurch) replaced in 1972 by 55029 (Monnow @ Grosmont). Records overlap, but do not match probably due to shoaling at 55009. | Remove 54065 (Roden @ Stanton) as insufficient data.<br>Remove 55009 (Monnow @ Kentchurch). | 1172 | 3.60 |
| *FARL* | The FARL for the Avon @ Great Somerford is 0.989, with the range of values in the pooling group being 0.906 – 0.999. Two stations have values which suggest significant storage in the catchment<br>27th ranked 19008 (South Esk @ Prestonholm), FARL 0.906.<br>22nd ranked 54040 (Meese @ Tibberton) FARL 0.935.<br>11th ranked 19007 (Esk @ Musselborough), FARL 0.953<br>Several stations indicate artificial storage influences, however FARLs do not suggest significant storage. 53007 (Frome(Somerset) @ Tellisford), FARL 0.967, notes that truncation of peaks. | Remove 19008 (South Esk @ Prestonholm) and 54040 (Meese @ Tibberton) as catchment influence by lakes and/or reservoirs.<br>Move 19007 (Esk @ Musselborough) to 11th position so that top ten stations have range 0.965 – 0.999. | 1118 | 3.46 |
| *PROPWET/URBEXT* | PROPWET lies between 0.290 & 0.640, with the subject PROPWET being 0.34. Therefore there are several sites with soils considerably wetter than the Avon @ Great Somerford.<br>19007 (Esk @ Musselborough), PROPWET 0.49<br>11004 (Urie @ Pitcaple), PROPWET 0.53<br>45012 (Creedy @ Cowley), PROPWET 0.46<br>11004 (Petteril @ Harraby Green), PROPWET 0.64<br>76010 (Lugg @ Byton), PROPWET 0.49<br>9004 (Bogie @ Redcraig), PROPWET 0.53 | Remove the five sites with highest PROPWET, 19007, 11004, 76010, 55014 and 9004.<br>Move 45012 (Creedy @ Cowley) to end of pooling group since only just an outlier. | 997 | 3.66 |
| *Site Comments* | All site comments reviewed considering indications of artificial influences and data issues. . Ythan @ Ardlethan and Ythan @ Ellon found to be overlapping for one year, with conflicting values. Unable to assess which is incorrect. Therefore data retained as effect on resulting growth factors should be minimal. | No change | 997 | 3.66 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Discordant Sites* | *39021 (Cherwell @ Enslow Mill)*<br>Ranked 25th site has 38 years of data from 1965 to 2002. Discordancy result of one large peak in 1997 and one very small peak in known drought year of 1975. There are no convenient gauges up or downstream with which to make a direct comparison; the Sor Brook is influent before the gauge on the Cherwell @ Banbury. Comparison with this station reveals the same date for the 1975 small event indicating that it probably was a real event. The 1997 dates do not concur. Without further data retain site due to a need to conserve station years. | Retain the site and all data | 997 | 3.66 |
| | *55022 (Trothy @ Mitchel Troy)*<br>Ranked 19th has 10 years of data 1970 to 1982, excluding 1979 to 1981. The discordancy is result of the short record, and comparatively small flood events in Dec 1972, Sept 1976 and Dec 1977. 1976 is a known drought year. There are no gauges directly up or downstream with which to compare it. The nearest gauge is the Wye at Redbrook (55023), which is located just after the confluence of the Trothy and the Wye. A comparison of the three small flood events show the 1972 events are similar in date, although the other floods do not concur. The short record remains the most likely explanation for the discordancy. | Retain site and all data as reason for initial discordancy ascertained | 997 | 3.66 |
| *L Moments* | From the L-moments graphs for the initial pooling group the main outliers are<br>19008 (South Esk @Prestonholm), removed due to FARL<br>39021 (Cherwell @ Enslow Mill ), see previously<br>55018 (Frome @ Yarkhill), has a number of small flood events in the AMAX series, one of which corresponds to the 1976 drought. It is not possible to compare the series with that of a nearby site, however being 26th in the pooling group once adjustments have been made, the site should not assert a great influence over the growth factors.<br>55022 (Trothy @ Mitchel Troy), see previously | Retain sites 39021, 55018, 55022 | 997 | 3.66 |

## Great Somerford Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53008 (Avon @ Great Somerford) | 40 | 0.252 | 0.200 | 0.208 | 0.308 | 0.000 |
| 14001 (Eden @ Kemback) | 26 | 0.215 | 0.022 | 0.104 | 0.247 | 0.082 |
| 10001 (Ythan @ Ardlethen) | 45 | 0.175 | 0.088 | 0.258 | 0.333 | 0.235 |
| 55021 (Lugg @ Butts Bridge) | 27 | 0.145 | 0.055 | 0.101 | 0.618 | 0.260 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.276 | 0.291 |
| 10003 (Ythan @ Ellon) | 19 | 0.228 | -0.069 | 0.056 | 0.992 | 0.302 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 0.650 | 0.310 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.853 | 0.362 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 0.718 | 0.390 |
| 54016 (Roden @ Rodington) | 33 | 0.176 | 0.165 | 0.242 | 0.267 | 0.401 |
| 54041 (Tern @ Eaton on Tern) | 23 | 0.194 | 0.071 | 0.033 | 0.566 | 0.409 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 2.920 | 0.420 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.097 | 0.427 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 1.223 | 0.440 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.193 | 0.442 |
| 55029 (Monnow @ Grosmont) | 45 | 0.180 | 0.007 | 0.082 | 0.210 | 0.531 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 1.193 | 0.569 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.678 | 0.575 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 2.962 | 0.583 |
| 40011 (Great Stour @ Horton) | 39 | 0.180 | 0.070 | 0.060 | 0.452 | 0.595 |
| 55003 (Lugg @ Lugwardine) | 44 | 0.100 | 0.049 | 0.210 | 1.529 | 0.606 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.418 | 0.613 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 1.203 | 0.618 |
| 39081 (Ock @ Abingdon) | 24 | 0.182 | 0.083 | 0.334 | 0.998 | 0.623 |
| 39021 (Cherwell @ Enslow Mill) | 38 | 0.212 | 0.407 | 0.619 | 3.870 | 0.633 |
| 55018 (Frome @ Yarkhill) | 32 | 0.129 | -0.252 | 0.082 | 2.039 | 0.639 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.453 | 0.641 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.015 | 0.659 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.721 | 0.448 |
| | | | | | | |
| Total | 997 | | | | | |
| Weighted means | | 0.204 | 0.129 | 0.178 | | |

GREEN HAM

**Catchment:** Tone at Greenham
**Station No:** 52014
**NGR:** ST 078 202

**Description:** This is a very small catchment (Hydrometric Register area 57.2 $Km^2$) gauged using a compound flat 'V' crump profile weir (low flows), constructed in 1980. It forms part of the flood warning system for Taunton. Higher flows are gauged by a rated section. Prior to Aug 1979 flow was measured as a rated section with unstable bed. Gaugings are taken at a section near a bend and are not accurate, particularly at high flow. Data from 1978 to mid-1981 are missing and since 1981 flows above 9.66 $m^3/s$ are truncated. Bankfull 1.6m. Low flows are maintained from Clatworthy Reservoir and may be affected by abstractions taken for water supply. The upper part of the catchment drains the Brendon Hills and is rural. Geology: predominantly ORS.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 37 years. The data was not reviewed.

**Gauge rating:** Rating valid to 16.7 $m^3/s$ (1.6m). 10 of the 37 years of AMAX exceed the upper limit of rating leading to possible errors in estimating higher return period flows. Indeed, wide scatter of high flow gaugings makes this a bad site for flood measurement. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 57.34 | 0.937 | 0.35 | 0.553 | 1101 | 33.3 | 0.0001 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 13.073 $m^3/s$ |
| **Annual Maxima** | 13.891 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 15.395 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 10.910 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural; no adjustment applied.

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

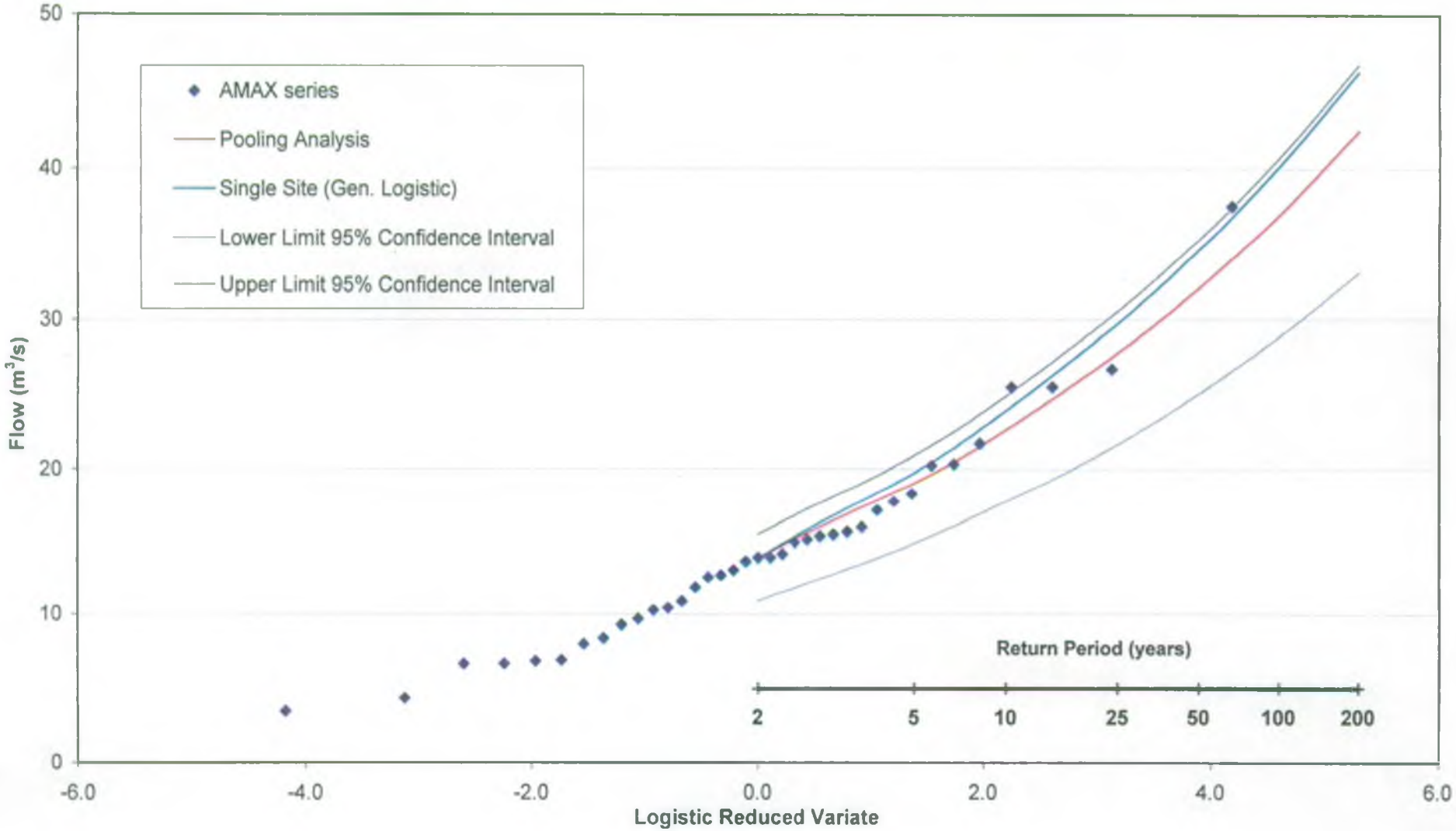
**Flood Frequency:** **Satisfactory – still need to confirm rating at high flows**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 13.9 | 13.9 | 13.9 | 16.7 |
| 5 | 18.8 | 19.0 | 19.8 | 22.8 |
| 10 | 22.3 | 22.6 | 23.9 | 26.7 |
| 25 | 27.1 | 27.[illegible] | 29.8 | 33.3 |
| 50 | 31.2 | 32.1 | 34.7 | 38.5 |
| 100 | 35.6 | 37.0 | 40.2 | 44.4 |
| 200 | 40.6 | 42.5 | 46.3 | 51.0 |

**Summary of Analysis:** AMAX series reveals that there are no outliers to the data series. There is very little separation between the pooled and single site analyses. All AMAX data lie within the 95% confidence interval even though there are concerns highlighted above that the gauge rating is not valid for the 10 highest Annual Maxima recorded.

**Selection of Method:** [FEH 3.8 Table 8.3] Pooled analysis prevails: refer to single site for confirmation.
*Special considerations:* None
*Adopt:* Pooled analysis as shaded above.
*Model parameters:* $\beta = 0.227$ , $\kappa = -0.179$

## River Tone at Greenham



Annual Maxima series for Greenham

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 20 Feb 67 | 13.891 | | 25 Dec 85 | 20.224 |
| 10 Jul 68 | 25.490 | | 18 Nov 86 | 8.403 |
| 18 Sep 69 | 25.470 | | 31 Jan 88 | 13.911 |
| 14 Jan 70 | 14.910 | | 14 Mar 89 | 9.301 |
| 22 Nov 70 | 15.400 | | 11 Feb 90 | 10.282 |
| 12 Jan 72 | 10.440 | | 01 Jan 91 | 6.945 |
| 06 Dec 72 | 8.010 | | 31 Oct 91 | 3.467 |
| 09 Feb 74 | 37.542 | | 30 Nov 92 | 15.074 |
| 19 Jan 75 | 20.331 | | 20 Dec 93 | 12.695 |
| 01 Dec 75 | 4.353 | | 28 Dec 94 | 13.053 |
| 22 Feb 77 | 17.048 | | 21 Dec 95 | 6.690 |
| 23 Feb 78 | 14.133 | | 06 Aug 97 | 6.864 |
| 01 Feb 79 | 11.849 | | 05 Jan 98 | 15.591 |
| 27 Dec 79 | 13.633 | | 19 Jan 99 | 21.725 |
| 09 Mar 81 | 12.552 | | 18 Dec 99 | 17.666 |
| 09 Mar 82 | 10.873 | | 07 Dec 00 | 26.673 |
| 11 Nov 82 | 15.271 | | 04 Feb 02 | 15.897 |
| 02 Jan 84 | 9.694 | | 13 Nov 02 | 18.226 |
| 08 Feb 85 | 6.678 | | | |

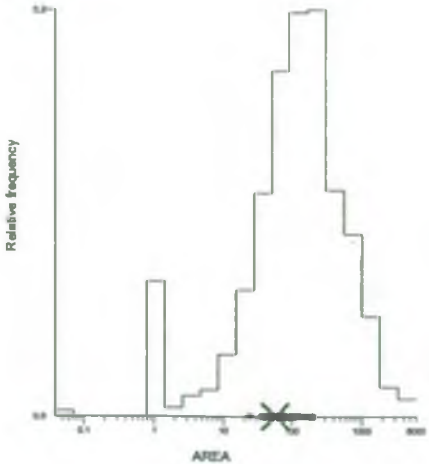
Q/QMED
Logistic reduced variate, y

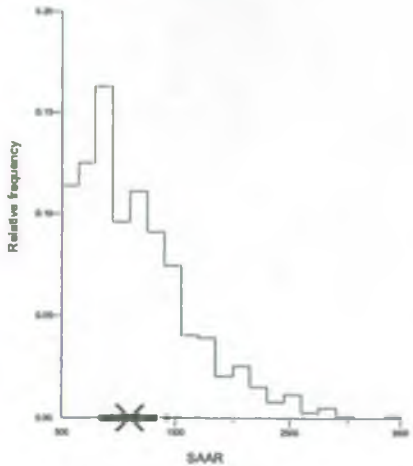

Stations
Record Length

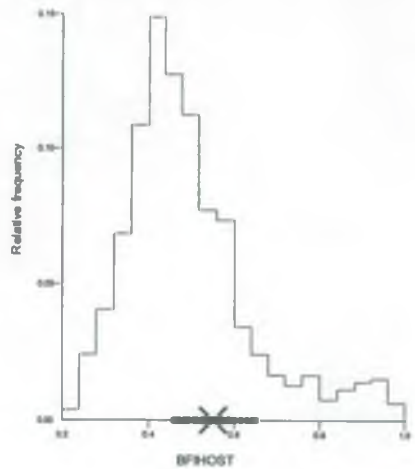

L-CV, t2
L-skewness, t3

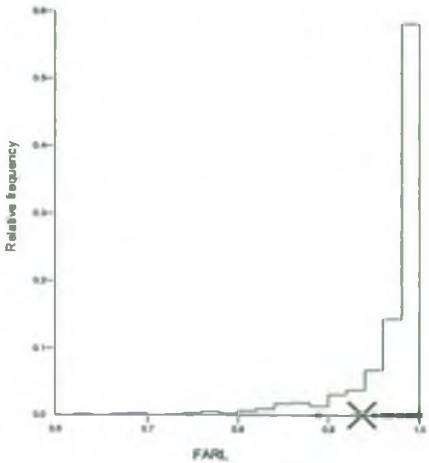


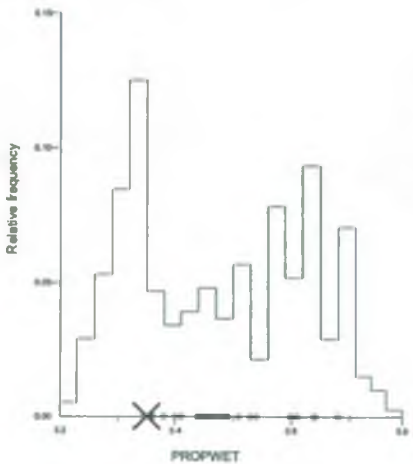

L-kurtosis, t4
L-skewness, t3

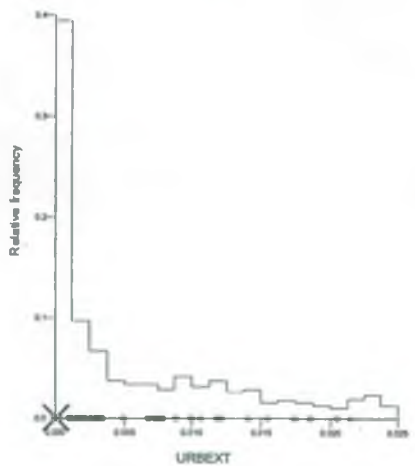

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Greenham Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 5.96 | 3.96 |
| Comment | Pooling group strongly heterogeneous, review is essential | Pooling group strongly heterogeneous, review is essential |
| Number of Station Years | 1232 | 1093 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The pooling group was reviewed for stations near to the subject site. The Tone at Bishops Hull (52005), ranked 45th, is downstream on the same catchment, with a record length of 42 years covering the periods which are missed by the subject site. This site warrants promotion. | Promote Tone at Bishops Hull to 2nd place | 1232 | 6.19 |
| *Period of Record* | The records for Tone at Bishops Hull and Tone at Greenham encompass the record for Tone at Wadhams Farm (52801) , which has a record length of only 6 years. Ellen at Bullgill (75017) has a record length of only 9 years, WINFAP recommends a minimum of 10 years. The record length for Trothy at Mitchel Troy (55022), ranked 43rd, is only 10 years. While this site will have little influence on the pooling group, it is also discordant.. | Remove Tone at Wadhams Farm, Ellen at Bullgill and Trothy at Mitchel Troy as there are many sites within the pooling group with far longer record lengths. | 1190 | 5.24 |
| *FARL* | The value of FARL for the Tone at Greenham is 0.937 and the range of values for the pooling group lie between 1.000 and 0.800. The lower value is for Melgan at Loch of Lintrathan (15005), ranked 13th. This value of FARL suggests there is significant storage in the catchment which may cause attenuation of flood flows. Two other sites with low FARL values are Chew at Compton Dando (53004) at 0.843, which is noted to have reservoirs in the headwaters, and Congresby Yeo at Iwood (52017) at 0.89. | Remove Melgan at Loch of Lintrathan, while this site has a long record it is for the period 1926-1967, which may skew data.<br>Remove Chew at Compton Dando. Retain Congresby Yeo at Iwood, review later. | 1108 | 4.51 |
| *PROPWET/URBEXT* | Subject site PROPWET = 0.35 and URBEXT = 0.0001. The range of values for the pooling group are PROPWET: 0.35-0.72 and URBEXT: 0-0.0215. Manor Water at Cademuir (21019), ranked 32nd has the highest value of PROPWET, other sites with high PROPWET values are Bela at Beetham (73008), Petteril at Harraby Green (76010) and Yscir at Pontaryscir (56013). | Retain all sites. Due to its ranking, Manor Water at Cademuir has very little influence on the pooling group. The other sites match the pooling group very well in all respects other than the value of PROPWET. | 1108 | 4.51 |
| *Site Comments* | All site comments were examined to assess the quality of flow data. The Fal at Tregony (48003), ranked 4th, is not ideal for high flows as the bankfull stage is above the range of the rating curve. WINFAP contains 24 years of contemporary data for this site from 1978 to 2002. | Retain site, overall this site matches the pooling group very well. | 1108 | 4.51 |
| *Discordant Sites* | *Manor Water at Cademuir (21019)*<br>Ranked 32nd in the pooling group, WINFAP has 25 years of data for this site. The discordancy is possibly due to its high PROPWET value and low flow values for the drought year of 1975. This is the only discordant site. | This site was investigated for PROPWET and found to have little influence on the FFC due to its ranking. Remove site. | 1083 | 3.96 |
| *L Moments* | The four main outliers to L-moments and the growth curves are: Llynfi at Three Cocks (55025), Otter at Dotton (45005), Parrett at Chiselborough (52007) and Wyre at Llanrhystyd (63003). The Wyre at Llanrhystyd has a short record length, leading to outlying L-Moments. The other sites all contain at least one record of very high flows, which tally with other rivers. | Retain all sites. | 1083 | 3.96 |

## Greenham Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.355 | 0.000 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.445 | 0.757 |
| 56003 (Honddu @ the Forge Brecon) | 21 | 0.263 | 0.320 | 0.314 | 0.486 | 0.237 |
| 48003 (Fal @ Tregony) | 24 | 0.185 | 0.210 | 0.088 | 0.571 | 0.345 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 2.243 | 0.347 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.399 | 0.433 |
| 52017 (Congresbury Yeo @ Iwood) | 28 | 0.237 | -0.043 | 0.061 | 1.967 | 0.442 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 1.088 | 0.481 |
| 15004 (Inzion @ Loch of Lintrathen) | 44 | 0.192 | 0.038 | 0.110 | 0.736 | 0.487 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 1.560 | 0.513 |
| 47009 (Tiddy @ Tideford) | 33 | 0.171 | 0.138 | 0.137 | 0.322 | 0.516 |
| 50007 (Taw @ Taw Bridge) | 21 | 0.312 | 0.388 | 0.270 | 0.774 | 0.521 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.952 | 0.528 |
| 12005 (Muick @ Invermuick) | 18 | 0.223 | 0.073 | 0.005 | 0.961 | 0.533 |
| 66003 (Aled @ Bryn Aled) | 26 | 0.236 | 0.140 | 0.087 | 0.325 | 0.542 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.032 | 0.546 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.148 | 0.574 |
| 48010 (Seaton @ Trebrownbridge) | 30 | 0.238 | 0.246 | 0.141 | 0.214 | 0.587 |
| 45008 (Otter @ Fenny Bridges) | 19 | 0.293 | 0.175 | 0.106 | 0.931 | 0.587 |
| 56013 (Yscir @ Pontaryscir) | 22 | 0.241 | 0.371 | 0.337 | 0.830 | 0.590 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 2.181 | 0.598 |
| 63003 (Wyre @ Llanrhystyd) | 11 | 0.375 | 0.403 | 0.354 | 1.807 | 0.606 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 0.834 | 0.609 |
| 73008 (Bela @ Beetham) | 25 | 0.161 | 0.125 | 0.060 | 0.526 | 0.618 |
| 55015 (Honddu @ Tafolog) | 30 | 0.229 | 0.286 | 0.228 | 0.144 | 0.653 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.407 | 0.680 |
| 47007 (Yealm @ Puslinch) | 32 | 0.100 | -0.015 | 0.119 | 2.385 | 0.683 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.126 | 0.693 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.758 | 0.693 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 1.915 | 0.699 |
| 76010 (Petteril @ Harraby Green) | 24 | 0.178 | 0.289 | 0.109 | 1.294 | 0.720 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.982 | 0.723 |
| 203033 (Upper Bann @ Bannfield) | 18 | 0.154 | 0.144 | 0.054 | 0.714 | 0.725 |
| 56012 (Grwyne @ Millbrook) | 23 | 0.264 | 0.416 | 0.314 | 0.793 | 0.728 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.199 | 0.729 |
| 203019 (Claudy @ Glenone Bridge) | 22 | 0.131 | 0.271 | 0.186 | 1.610 | 0.734 |
| 67005 (Ceiriog @ Brynkinalt Weir) | 18 | 0.217 | 0.331 | 0.221 | 0.498 | 0.736 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 1.458 | 0.736 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 2.032 | 0.745 |
| | | | | | | |
| Total | 1083 | | | | | |
| Weighted means | | 0.227 | 0.179 | 0.168 | | |

HALSEWATER

**Catchment:** Halsewater at Halsewater
**Station No:** 52003
**NGR:** ST 206 253

**Description:** The station was opened in 1961 and operated as a rated section with unstable bed control until a truncated flat-V crump weir was built in 1981. The weir gauges low flows, with a rated section for higher flows. There is the possibility of by-passing at the highest water levels and some flow does not reach the station from approximately 1.4m. Out-of-bank storage and flow occurs in 1 out of 3 years. Current gauging station is located 0.5 km upstream of the confluence with the River Tone and is part of the flood warning system for Taunton. The catchment covers an area of 94 $km^2$ and is predominantly rural. The geology of the catchment is mainly limestone, sandstone and marl.

**Data comments:** The updated AMAX data set from the Agency provides 41 years of annual maxima series data, for the period 1962 – 2002. AMAX data was not reviewed.

**Gauge rating:** The upper limit of the rating is 12.4 $m^3/s$. Nearly one half of the AMAX series exceed this upper limit, indicating some uncertainty in the values of the upper flows and flood estimates. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 93.55 | 0.990 | 0.35 | 0.622 | 851 | 30.6 | 0.006 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 12.3 $m^3/s$ |
| **Annual Maxima** | 12.2 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 14.1 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 10.6 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment required

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied.

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency :** **Less than satisfactory – review of rating required post 1981**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 12.2 | 12.2 | 12.2 | 14.7 |
| 5 | 17.1 | 17.3 | 17.5 | 20.8 |
| 10 | 20.6 | 21.0 | 21.4 | 25.2 |
| 25 | 25.5 | 26.4 | 27.2 | 31.7 |
| 50 | 29.7 | 31.0 | 32.2 | 37.3 |
| 100 | 34.5 | 36.3 | 38.1 | 43.5 |
| 200 | 39.8 | 43.4 | 44.9 | 50.9 |

**Summary of Analysis:** AMAX series EDA revealed two outliers to the data set, July 1968 and Dec 1979. The AMAX series also demonstrates a reduction in variation after the construction of the weir in 1981.

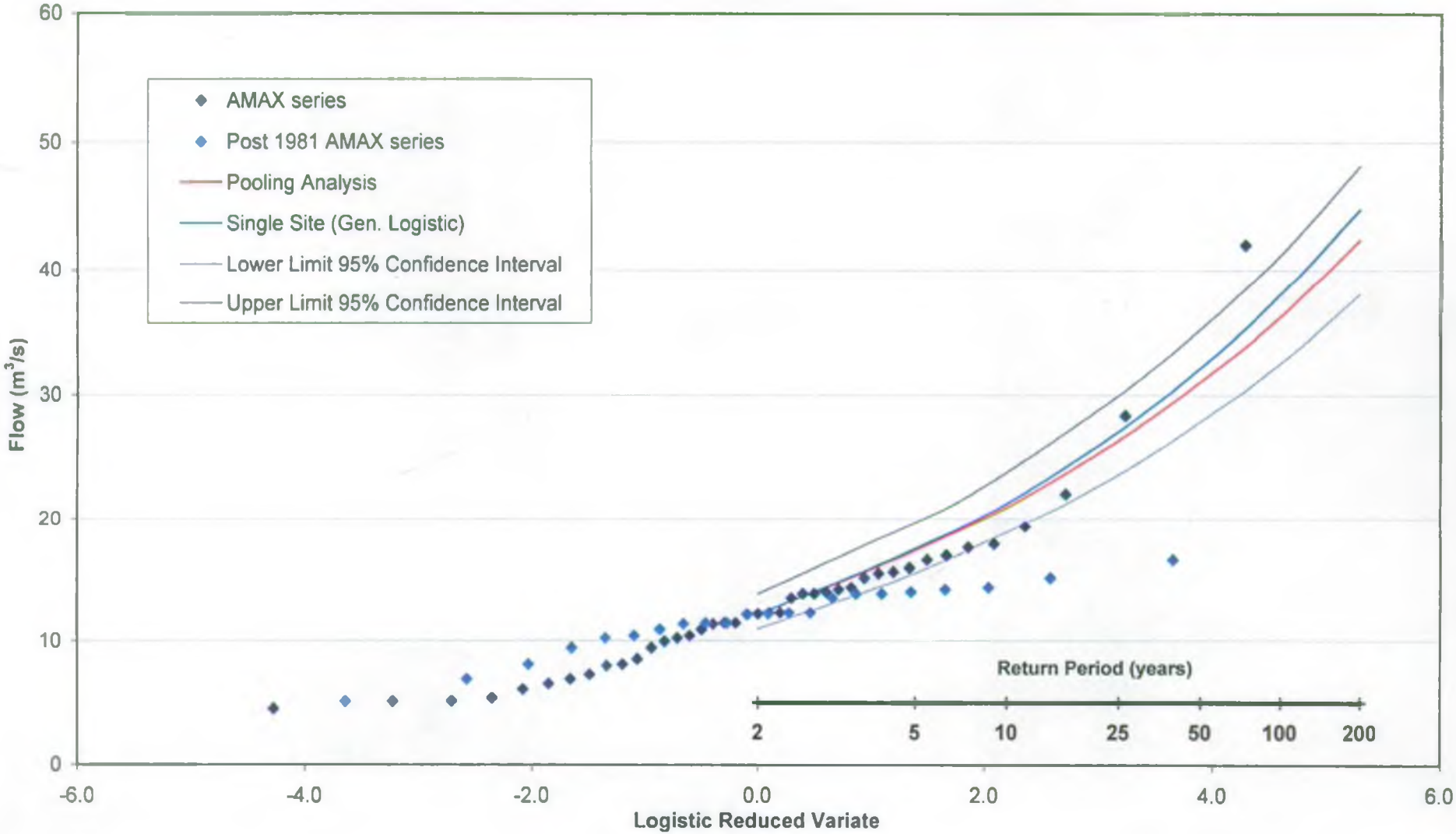
**Selection of Method:** There is little separation between the flood frequency curves for the full period of record. The pooled analysis and the single site General Logistic analysis have almost identical curves. The post 1981 data has a much shallower growth curve and is significantly overestimated by the pooling group.
FEH 3.8, Table 8.3 recommends that pooled analysis should prevail with reference to the single site confirmation. The post 1981 data and complete data set estimate very similar QMED which will not impact on the pooled analysis being recommended.

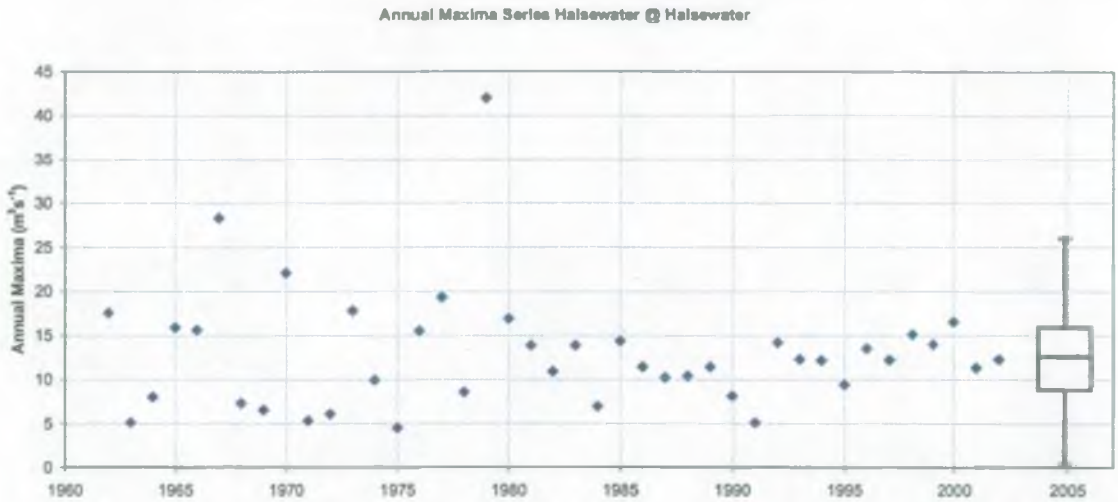
*Special considerations:* Rating Limitations – recommend further review of the stage-discharge relationship with respect to the high flow series notably after 1981.

*Adopt:* Pooled Analysis (as shaded)

*Model parameters:* $\beta = 0.251$, $\kappa = -0.203$

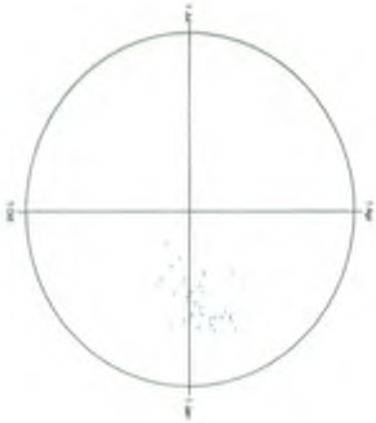
## Halsewater @ Halsewater

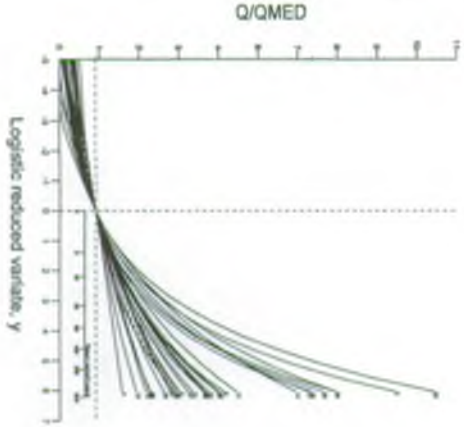


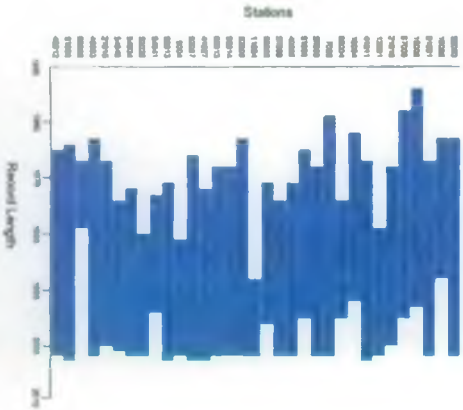


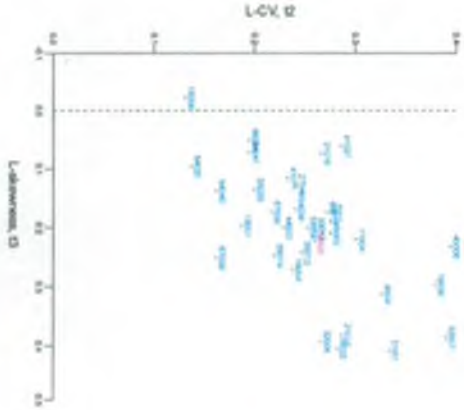

Annual Maxima series for Halsewater

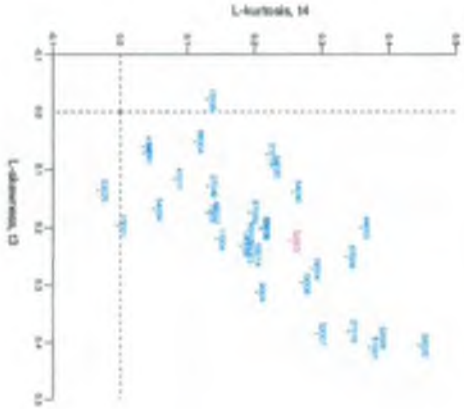
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 14 Feb 1963 | 17.550 | | 27 Jan 1984 | 13.871 |
| 19 Nov 1963 | 5.135 | | 09 Feb 1985 | 6.936 |
| 20 Jan 1965 | 8.018 | | 26 Dec 1985 | 14.395 |
| 19 Apr 1966 | 15.920 | | 03 Apr 1987 | 11.456 |
| 20 Feb 1967 | 15.630 | | 31 Jan 1988 | 10.212 |
| 10 Jul 1968 | 28.320 | | 25 Feb 1989 | 10.406 |
| 29 Jul 1969 | 7.300 | | 27 Jan 1990 | 11.456 |
| 14 Jan 1970 | 6.540 | | 09 Jan 1991 | 8.138 |
| 31 Jan 1971 | 22.090 | | 08 Jan 1992 | 5.107 |
| 03 Feb 1972 | 5.340 | | 30 Nov 1992 | 14.225 |
| 06 Dec 1972 | 6.091 | | 20 Dec 1993 | 12.291 |
| 09 Feb 1974 | 17.812 | | 09 Nov 1994 | 12.163 |
| 19 Jan 1975 | 9.939 | | 22 Dec 1995 | 9.435 |
| 22 Mar 1976 | 4.498 | | 06 Aug 1997 | 13.520 |
| 30 Nov 1976 | 15.500 | | 05 Jan 1998 | 12.214 |
| 23 Feb 1978 | 19.330 | | 19 Jan 1999 | 15.142 |
| 01 Feb 1979 | 8.558 | | 18 Dec 1999 | 14.012 |
| 27 Dec 1979 | 42.000 | | 30 Oct 2000 | 16.561 |
| 16 Oct 1980 | 16.920 | | 26 Jan 2002 | 11.364 |
| 15 Mar 1982 | 13.879 | | 13 Nov 2002 | 12.297 |
| 12 Nov 1982 | 10.917 | | | |

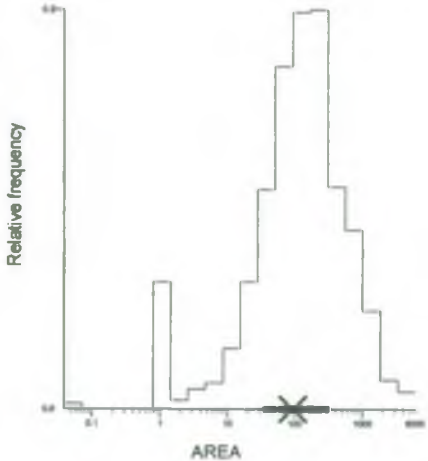



Q/QMED
Logistic reduced variate, y


Stations
Record Length


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Relative frequency
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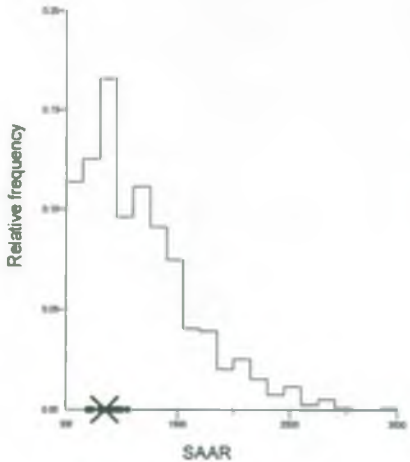
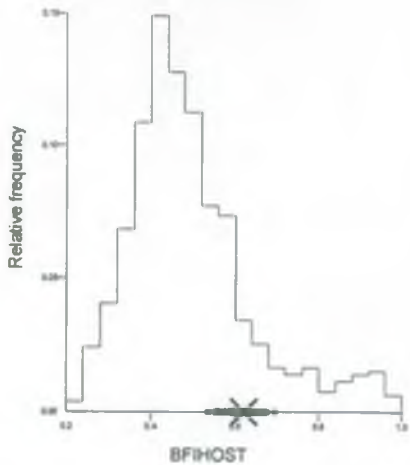
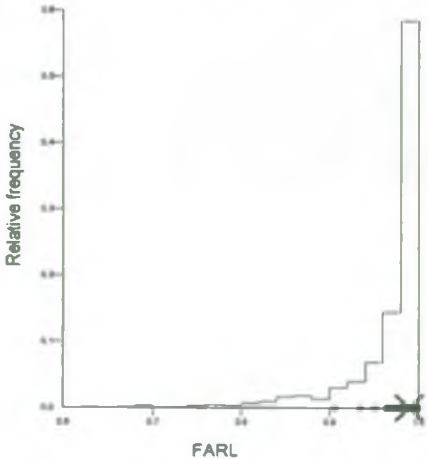
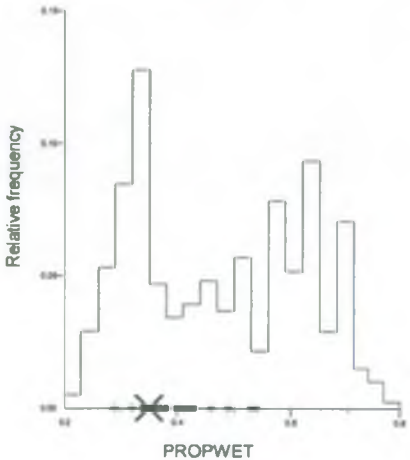
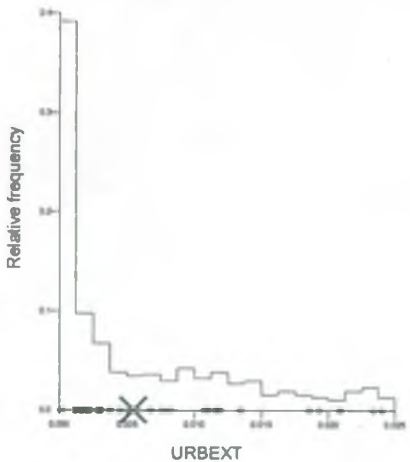

Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Halsewater Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 2.21 | 0.63 |
| Comment | The pooling group is strongly heterogeneous, a review is essential | Pooling group is acceptably homogeneous and no further action is required. |
| Number of Station Years | 1177 | 1012 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is included at the top of the pooling group.<br>There are 2 sets of duplicated data due to being from sites which react to the same events. These are the North Esk @ Dalmore Weir and North Esk @ Dalkeith and the Tern @ Eaton on Tern and Tern @ Ternhill. All site have a good period of record and no obvious reasons for preferential exclusion. | The North Esk @ Dalkeith Palace ranked 14th and the Tern @ Tern Hill ranked 33rd were removed as they both had less years of data than the alternative site. | 1118 | 2.16 |
| *Period of Record* | All sites except one had a good period of record, the site with the shortest record is the Trothy @ Mitchel Troy, with has a record of ten years, and also has a high discordancy of 5.102. All other sites in the pooling group have a record length of 15 years or over. | Remove the Troy @ Mitchel Troy due to short record length, high discordancy, and being an outlier on the L-moments. | 1108 | 1.83 |
| *FARL* | The pooling group sites have FARL values ranging from 0.843 – 1.000, the subject site has a value of 0.990, and is therefore near to the top end of values.<br>3 sites were noticed to be outliers on the FARL plot, these sites all have a low FARL, indicating reservoirs in the catchment. The 3 sites are: the Chew @ Compton Dando (0.843), this river has the Chew Reservoir in its catchment; the Congresbury Yeo @ Iwood (0.890), this site has a patchy AMAX record prior to 1975, and has the Blagdon Reservoir at its headwaters; and the South Esk @ Prestonholm (0.906) | Remove the Chew @ Compton Dando ranked 8th and Congresbury Yeo @ Iwood ranked 9th from the pooling group as both sites have FARL values of less than 0.9, and the catchment descriptions mention that they have reservoirs in their catchments. | 1036 | 0.79 |
| *PROPWET/URBEXT* | PROPWET values range from 0.290 – 0.640. The subject site has a PROPWET value of 0.35, and is in the middle of the range. The Petteril @ Harraby Green is a clear outlier in the PROPWET graph.<br>The remaining pooling group has an URBEXT range of 0.002 – 0.0241 and there are no obvious outliers. | Remove the Petteril @ Harraby Green | 1012 | 0.63 |
| *Site Comments* | A review of the station comments for all sites in the pooling group was made and no sites stood out as being particularly problematic. | No action taken | | |
| *Discordant Sites* | There are no discordant sites | No change | 1012 | 0.63 |
| *L Moments* | The Bervie @ Inverbervie is the only discordant site remaining in the pooling group, discordancy value = 3.288. No hydrological reasons for removal can be found; therefore the Bervie @ Inverbervie is retained.<br>Flood seasonality and L-moments were assessed and there were found to be no sites that could justifiably be removed from the pooling group | No action taken. | 1012 | 0.63 |

## Halsewater Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52003 (Halsewater @ Halsewater) | 41 | 0.259 | 0.224 | 0.253 | 0.114 | 0.000 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 1.452 | 0.219 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.37 | 1.223 | 0.223 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 2.107 | 0.338 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.110 | 0.345 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 2.147 | 0.457 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 3.163 | 0.492 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.367 | 0.493 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.328 | 0.499 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.737 | 0.537 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.242 | 0.539 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 1.409 | 0.542 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.692 | 0.545 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 2.225 | 0.553 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.208 | 0.554 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.702 | 0.555 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.357 | 0.561 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.381 | 0.567 |
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.492 | 0.580 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.209 | 0.583 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.553 | 0.586 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.596 | 0.589 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.676 | 0.592 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.030 | 0.594 |
| 54041 (Tern @ Eaton on Tern) | 23 | 0.194 | 0.071 | 0.033 | 0.774 | 0.612 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 2.194 | 0.624 |
| 54034 (Dowles Brook @ Dowles) | 30 | 0.240 | 0.168 | 0.048 | 0.818 | 0.626 |
| 54040 (Meese @ Tibberton) | 28 | 0.161 | 0.137 | 0.256 | 1.059 | 0.630 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 0.979 | 0.635 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.061 | 0.635 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.392 | 0.639 |
| 53008 (Avon @ Great Somerford) | 40 | 0.252 | 0.200 | 0.208 | 0.018 | 0.641 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.185 | 0.647 |
| | | | | | | |
| Total | 1012 | | | | | |
| Weighted means | | 0.251 | 0.203 | 0.205 | | |

H2002

**Catchment:** Congresbury Yeo at Iwood
**Station No:** 52017
**NGR:** ST 452 631

**Description:** A small catchment (Hydrometric Register area 66.6 $km^2$) gauged using a rectangular Crump profile weir for low flows and a rated section for higher flows. Station is bypassed at high flows, bankfull 1.3m, and it is not capable of measuring the flow related to the highest observed level. Station equipped with telemetry facilities in 1986. Flows affected by Blagdon Reservoir (approx 2$km^2$) in catchment headwaters. Predominantly rural with some small settlements, underlain by Carboniferous Limestone, Keuper Marl and estuarine alluvium.

**Data comments:** WINFAP annual maxima series updated to 2002, with data provided by the Environment Agency. AMAX record length 28 years, with no records for 1977 and 1978. Data not reviewed.

**Gauge rating:** Gauge rating not reviewed. Limit of gauge rating 12.07 $m^3/s$ which is exceeded by the two highest AMAX values.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 60.64 | 0.890 | 0.35 | 0.602 | 984 | 25.5 | 0.0106 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 8.937 $m^3/s$ |
| **Annual Maxima** | 8.274 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 9.775 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 6.188 $m^3/s$ |

**Permeability:** SPRHOST greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

**Flood Frequency:** **FEH STATISTICAL METHOD INAPPROPRIATE, USE FOLLOWING RESULTS WITH CAUTION.**

| Return period (years) | Single Site | |
|---|---|---|
| | Gen. Logistic | Logistic |
| 2 | 8.3 | 8.3 |
| 5 | 10.9 | 11.0 |
| 10 | 12.3 | 12.6 |
| 25 | 14.0 | 14.5 |
| 50 | 15.2 | 15.9 |
| 100 | 16.3 | 17.3 |
| 200 | 17.4 | 18.6 |

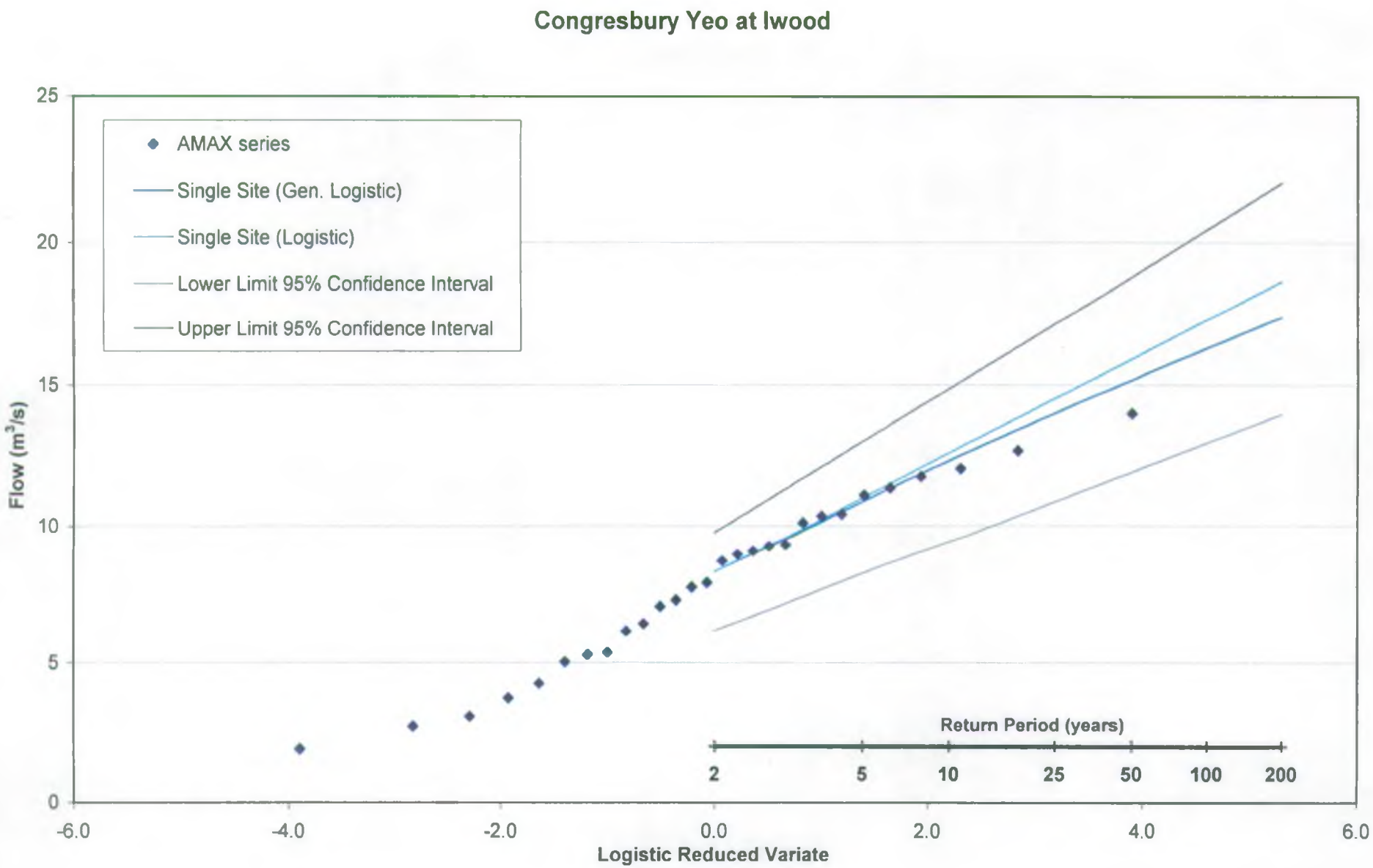
**Summary of Analysis:** The AMAX EDA reveals that there are no outliers.

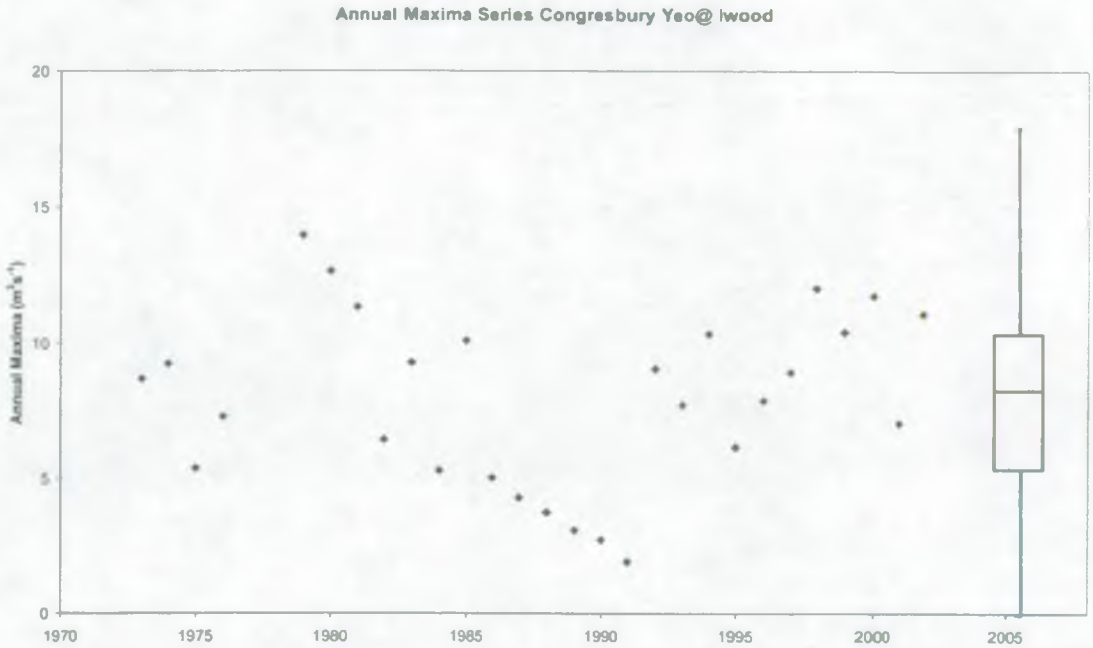
**Selection of Method:** Pooling analysis not undertaken since catchment is heavily influenced by the presence of the reservoir and the FEH statistical method is inappropriate as is demonstrated by the flattening of the AMAX series at higher return periods.

*Special considerations:* An appropriate alternative would be the rainfall-runoff method involving the simulation of the reservoir behaviour

*Adopt:* None are recommended but suggest that the Gen. Logistic distribution fitted to the single site data may provide a reasonable indication of flood frequency

*Model parameters:* $\beta = 0.232$, $\kappa = 0.043$


Congresbury Yeo at Iwood
AMAX series
Single Site (Gen. Logistic)
Single Site (Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
25
20
15
10
5
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200




Annual Maxima series for Iwood

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 08 Feb 74 | 8.670 | | 02 Feb 90 | 3.067 |
| 28 Jan 75 | 9.243 | | 03 Jan 91 | 2.713 |
| 01 Dec 75 | 5.371 | | 09 Jan 92 | 1.899 |
| 30 Nov 76 | 7.278 | | 30 Nov 92 | 9.051 |
| 24 Dec 79 | 13.970 | | 28 Feb 94 | 7.725 |
| 15 Oct 80 | 12.648 | | 27 Jan 95 | 10.349 |
| 30 Dec 81 | 11.338 | | 22 Dec 95 | 6.161 |
| 13 May 83 | 6.434 | | 24 Nov 96 | 7.879 |
| 26 Jan 84 | 9.296 | | 06 Mar 98 | 8.924 |
| 08 Feb 85 | 5.287 | | 19 Jan 99 | 12.028 |
| 23 Dec 85 | 10.108 | | 21 Dec 99 | 10.415 |
| 20 Nov 86 | 5.027 | | 07 Dec 00 | 11.744 |
| 02 Sep 88 | 4.277 | | 26 Jan 02 | 7.047 |
| 10 Oct 88 | 3.745 | | 01 Jan 03 | 11.080 |

LOVINGTON

**Catchment:** Brue at Lovington
**Station No:** 52010
**NGR:** ST 590 318

**Description:** A medium sized catchment (Hydrometric Register 135.2km$^2$) gauged by a rectangular crump profile weir for low flows, and velocity-area station for flows >2.2 m$^3$/s. Reliable extension of rating curves to bankfull; exceptional flood flows less reliable but section is deep and contains all but extreme peaks. River goes onto a shoulder on the left bank (at approx 3.2 – 3.3 m) before complete bankfull (3.9 m). Headwaters fed by Mendip and Salisbury Plain springs. Catchment predominantly rural. Geology: Oxford Clay & Great Oolite in upper catchment; Yeovil Sands & Inferior Oolite in lower catchment.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 39 years. The data was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 91.4 m$^3$/s. The two highest recorded AMAX values exceed this limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 139.52 | 0.998 | 0.37 | 0.524 | 867 | 36.4 | 0.0065 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 24.221 m$^3$/s |
| **Annual Maxima** | 36.135 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 43.745 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 27.894 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%; no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural; no adjustment

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – review rating of high flows**

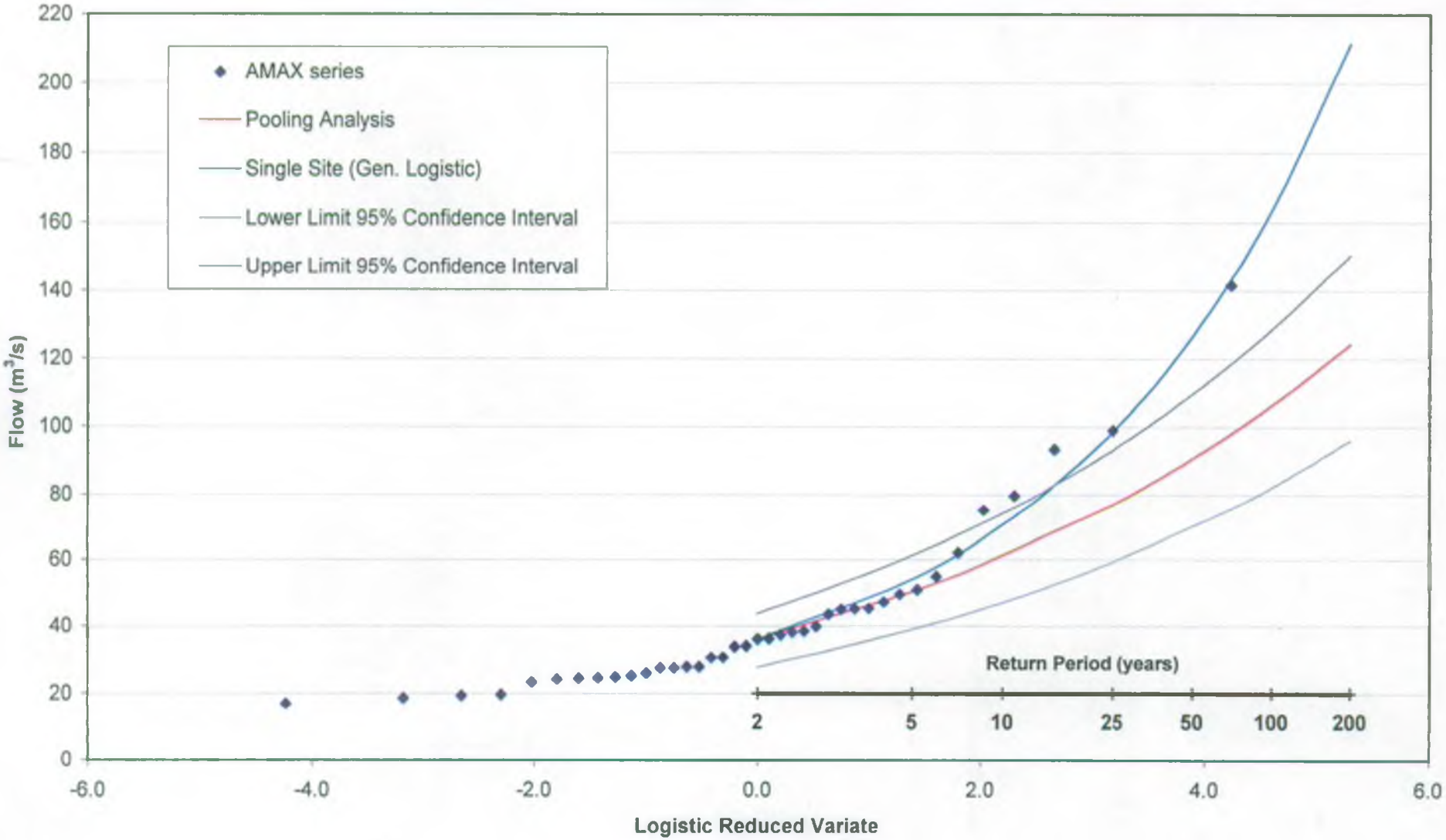
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 36.1 | 36.1 | 36.1 | 43.4 |
| 5 | 50.7 | 50.6 | 54.3 | 60.7 |
| 10 | 61.4 | 61.2 | 70.5 | 73.5 |
| 25 | 77.0 | 76.9 | 98.5 | 92.3 |
| 50 | 90.6 | 90.6 | 126.7 | 108.7 |
| 100 | 106.1 | 106.3 | 163.5 | 127.5 |
| 200 | 123.9 | 124.4 | 211.6 | 149.3 |

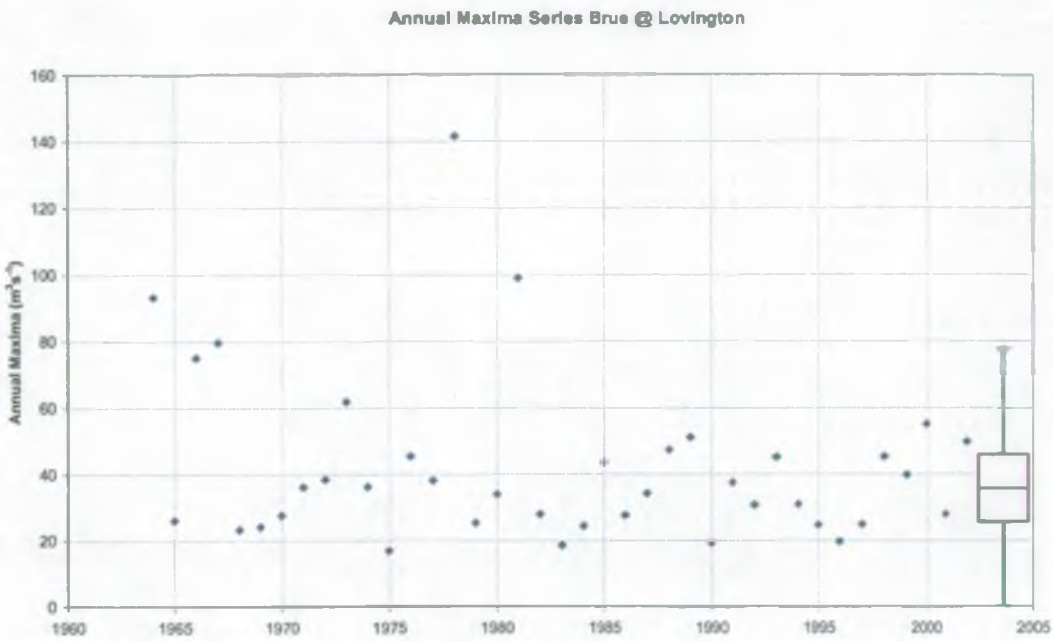
**Summary of Analysis:** AMAX series reveals that there are four outliers. One of these lies just above the upper confidence limit, while May 1979, August 1965 and July 1982 are extreme outliers. All events have been retained without review.

**Selection of Method:** Apart from the outliers, the reviewed pooled analysis recreates the AMAX series. The Gen. Log single site analysis gives a better approximation when the outliers are included. The events would have the following return periods under the reviewed pooled analysis: May 1979 -250 years, July 1982 -75 years and August 1965 -50 years. Though the single site FFC appears to fit the data better the two largest peaks should be treated with care since they exceed the upper limit of the rating curve. FEH 3.8 Table 8.3 recommends that pooled analysis prevails with confirmation from the single site analysis.

*Special considerations:* None
*Adopt:* Pooled Analysis (as shaded above).
*Model parameters:* $\beta = 0.242$ , $\kappa = -0.216$

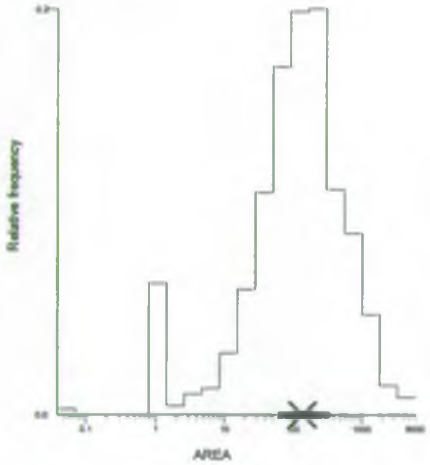
## River Brue at Lovington

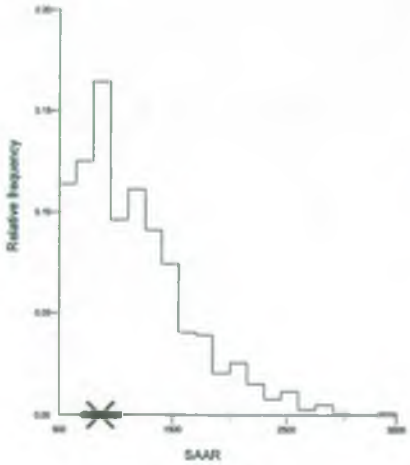


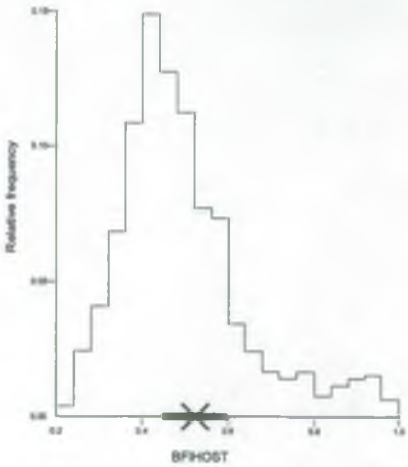


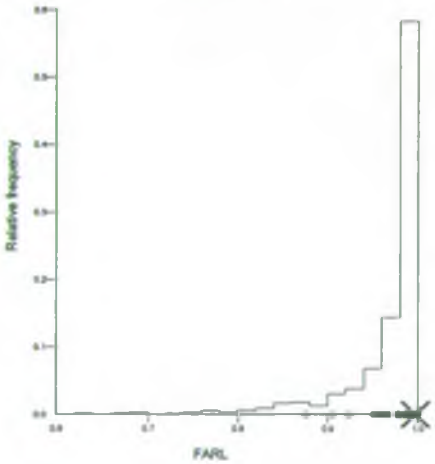

Annual Maxima series for Lovington

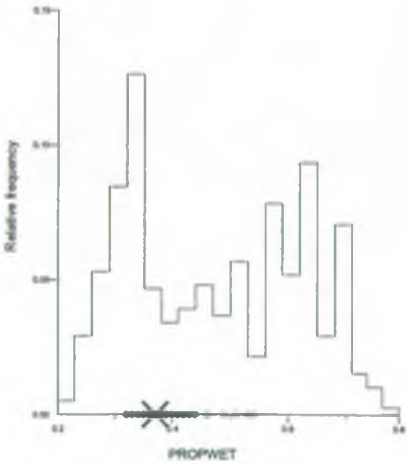
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 02 Aug 65 | 93.287 | | 21 Jan 85 | 24.451 |
| 29 Nov 65 | 26.086 | | 26 Dec 85 | 43.557 |
| 05 Nov 66 | 75.126 | | 11 Dec 86 | 27.661 |
| 10 Jul 68 | 79.664 | | 01 Sep 88 | 34.229 |
| 25 Dec 68 | 23.325 | | 09 Oct 88 | 47.412 |
| 15 Jan 70 | 24.214 | | 20 Dec 89 | 51.187 |
| 19 Jun 71 | 27.646 | | 18 Mar 91 | 19.278 |
| 03 Feb 72 | 36.135 | | 18 Sep 92 | 37.478 |
| 06 Dec 72 | 38.535 | | 06 Dec 92 | 30.774 |
| 27 Sep 74 | 61.907 | | 13 Oct 93 | 45.151 |
| 20 Jan 75 | 36.285 | | 09 Nov 94 | 30.844 |
| 12 Feb 76 | 16.864 | | 22 Dec 95 | 24.632 |
| 30 Nov 76 | 45.444 | | 25 Nov 96 | 19.625 |
| 09 Dec 77 | 38.166 | | 05 Jan 98 | 24.835 |
| 30 May 79 | 141.568 | | 03 Nov 98 | 45.256 |
| 21 Jan 80 | 25.338 | | 18 Dec 99 | 39.841 |
| 16 Oct 80 | 33.974 | | 30 Oct 00 | 55.099 |
| 12 Jul 82 | 98.923 | | 20 Oct 01 | 27.926 |
| 07 Jan 83 | 27.943 | | 13 Nov 02 | 49.813 |
| 20 Dec 83 | 18.51 | | | |

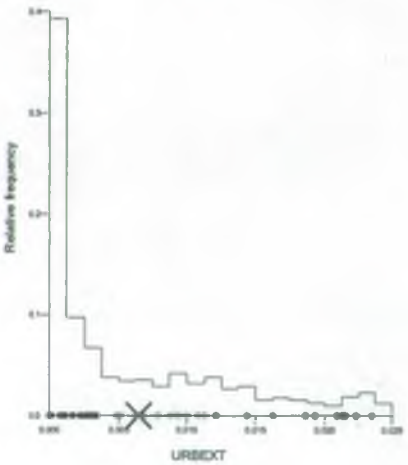

Relative frequency
AREA

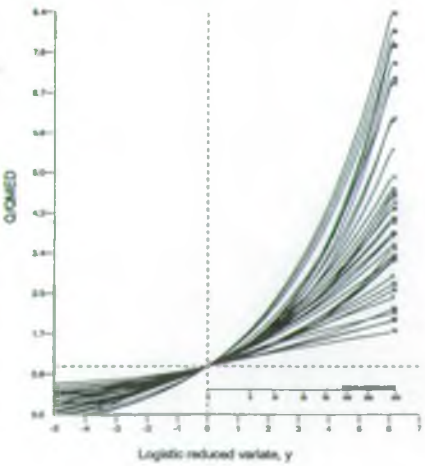

Relative frequency
SAAR

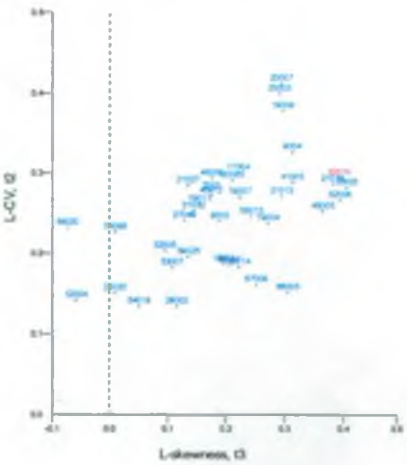

Relative frequency
BFIHOST

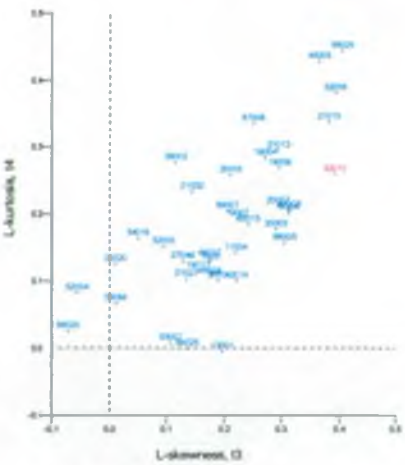

Relative frequency
FARL

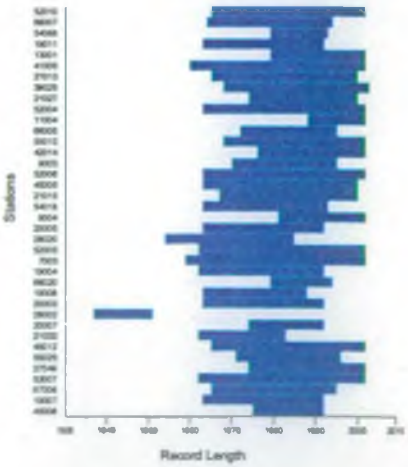

Relative frequency
PROPWET


Relative frequency
URBEXT


QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Lovington Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.85 | 2.52 |
| Comment | Strongly heterogeneous, pooling group review is essential. | Heterogeneous, pooling group review is desirable. |
| Number of Station Years | 1239 | 1115 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The pooling group was reviewed for sites which lie upstream or downstream of the subject site as these are likely to be hydrologically similar and give good reason for promotion to a higher ranking in the pooling group. No sites adjacent to the subject site which warrant promotion. | No change. | 1239 | 3.85 |
| *Period of Record* | All sites have a minimum of ten years of data and there is good data overlap. | No change. | 1239 | 3.85 |
| *FARL* | The value of FARL for the Brue at Lovington is 0.998 and the range of values for the pooling group lies between 0.876 and 1.000. The lower value is for the Blithe at Hamstall Ridware, ranked 34th. This value of FARL suggests that there is significant storage in the catchment, which can cause attenuation of flood flows. A review of the comments reveals that the AMAX series all date prior to the construction of the reservoir. | No change. The presence of the reservoir has probably influenced the FARL value, which has no relevance to the AMAX series. | 1239 | 3.85 |
| *PROPWET/URBEXT* | The values of PROPWET and URBEXT for the subject site are 0.37 and 867, respectively. The range of values for the pooling group are PROPWET: 0.320-0.640 and URBEXT: 0.0089-0.0235. The higher value of PROPWET occurs for the Petteril at Harraby Green. This value of PROPWET suggests that the soils are typically wetter than those for the subject catchment. The Petteril at Harraby Green is in an urban area, which may have influenced the PROPWET value. | Remove site, its location and PROPWET values suggest that it is significantly different from the subject site. | 1215 | 3.78 |
| *Site Comments* | All site comments were reviewed to assess the quality of flow data. Gowy at Picton (68002), ranked 29th was discontinued in 1979 after severe weed problems, which cast doubt on the quality of flow data. Ugie at Inverugie (10002), ranked 31st, is controlled by a long and broken weir and is unstable and insensitive. Frome (Somerset) at Tellisford (53007), ranked 39th, has detention lakes in the upstream which may truncate flood peaks. Enborne at Brimpton (39025), ranked 8th, can suffer drowning at flows above 10 $m^3/s$ and the highest flows are underestimated. Alyn at Pont-y-Capel (67008), ranked 40th, has a major loss of water in the upstream 70$km^2$ of the catchment due to limestone and mining tunnels. | Remove Gowy at Picton and Ugie at Inverugie. This pooling group contains many data sets with good records over a long period.<br>Retain Frome (Somerset) at Tellisford, this site has a long record and has no other indications of problems.<br>Retain Enborne at Brimpton, flows compare reasonably with those for Kennet at Theale (downstream site).<br>Retain Alyn at Pont-y-Capel. The low ranking of the site will not have a great influence on the pooling group result. | 1162 | 3.00 |
| *Discordant Sites* | *Trothy at Mitchel Troy (55022)*<br>Ranked 12th in the pooling group, WINFAP has only 10 years of data for this site between 1970 and 1983. The record misses out water years 1979-1981 inclusive. The discordancy is most likely due to this short, interrupted record length. The high position of this site gives it greater influence in the pooling group, | Remove site. The pooling group has many more sites with longer records. | 1152 | 2.60 |
| *L Moments* | The three main outliers to L-moments and growth curves are the Parrett at Chiselborough (52007), Llynfi at Three Cocks (55025) and Otter at Dotton (45005). The Parrett rating curves require review, therefore this growth curve may not be reliable. | Remove Parrett at Chiselborough.<br>Removal of this site results in no data overlap for the Blithe at Hamstall Ridware. Although the Blithe should also be removed, it is | 1115 | 2.52 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| | The most likely reasons for the outlying L-moments for the Llynfi at Three Cocks are the high flood flow in 1979 and several missing records. This data is otherwise considered to be reliable, and is unlikely to have a large influence on the pooling group due to its low position.<br>The outlying L-moments for the Otter at Dotton are due to a very high flood flow in 1969, removal of this record decreases the L-kurtosis value considerably. There are no records available to verify this flood. However, as the gauging station had to be rebuilt after the flood it is reasonable to assume that the flow was for a very high return period. | ranked 34th and therefore has little influence on the pooling group.<br>Retain Blithe at Hamstall Ridware.<br>Retain Llynfi at Three Cocks and Otter at Dotton. | | |

Lovington Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 0.982 | 0.000 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.384 | 0.189 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.01 | 0.067 | 1.032 | 0.194 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.192 | 0.215 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.552 | 0.220 |
| 41005 (Ouse @ Gold Bridge) | 44 | 0.288 | 0.314 | 0.206 | 0.423 | 0.269 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.334 | 0.279 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 1.432 | 0.295 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.473 | 0.306 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 1.89 | 0.306 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.337 | 0.309 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.645 | 0.331 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.096 | 0.339 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 1.193 | 0.348 |
| 9003 (Isla @ Grange) | 26 | 0.240 | 0.189 | 0.101 | 0.316 | 0.372 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.205 | 0.379 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 1.709 | 0.389 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 0.819 | 0.391 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 1.242 | 0.402 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.598 | 0.409 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.519 | 0.409 |
| 28020 (Churnet @ Rocester) | 28 | 0.150 | 0.010 | 0.125 | 1.236 | 0.410 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.364 | 0.426 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.214 | 0.436 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.323 | 0.455 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 2.289 | 0.465 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 1.398 | 0.474 |
| 20003 (Tyne @ Spilmersford) | 29 | 0.399 | 0.291 | 0.178 | 1.822 | 0.483 |
| 28002 (Blithe @ Hamstall Ridware) | 15 | 0.134 | 0.116 | 0.277 | 1.879 | 0.490 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 2.079 | 0.494 |
| 21032 (Glen @ Kirknewton) | 22 | 0.252 | 0.144 | 0.234 | 0.634 | 0.495 |
| 45012 (Greedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.161 | 0.503 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.844 | 0.506 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.158 | 0.511 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 1.190 | 0.514 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.564 | 0.541 |
| 19007 (Esk @ Musselburgh) | 29 | 0.270 | 0.223 | 0.193 | 0.038 | 0.541 |
| 45008 (Otter @ Fenny Bridges) | 19 | 0.293 | 0.175 | 0.106 | 0.433 | 0.545 |
| | | | | | | |
| Total | 1115 | | | | | |
| Weighted means | | 0.242 | 0.216 | 0.183 | | |

MIDDLEHILL

**Catchment:** By Brook at Middlehill
**Station No:** 53028
**NGR:** ST 815 688

**Description:** The current full range gauging station comprises a flat V weir for low flows and a rated section for higher flows. The highest flows are at bankfull and at that level flows start to be obstructed by the footbridge at the station.
The catchment covers an area of 100 $km^2$ and is predominantly rural. The geology of the catchment is mainly Oolitic Limestone and Lias Limestone.

**Data comments:** The updated AMAX data set provided by the Agency gave 21 years of annual maxima series data for the period 1982 to 2002 inclusive. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 12.7$m^3/s$. This is exceeded by 20% of the records in the AMAX series. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 99.52 | 1.000 | 0.34 | 0.729 | 835 | 22.00 | 0.010 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 8.750 $m^3/s$ |
| **Annual Maxima** | 10.692 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 11.947$m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 8.229$m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied.

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – asses impact from u/s footbridge on high flows and rating**

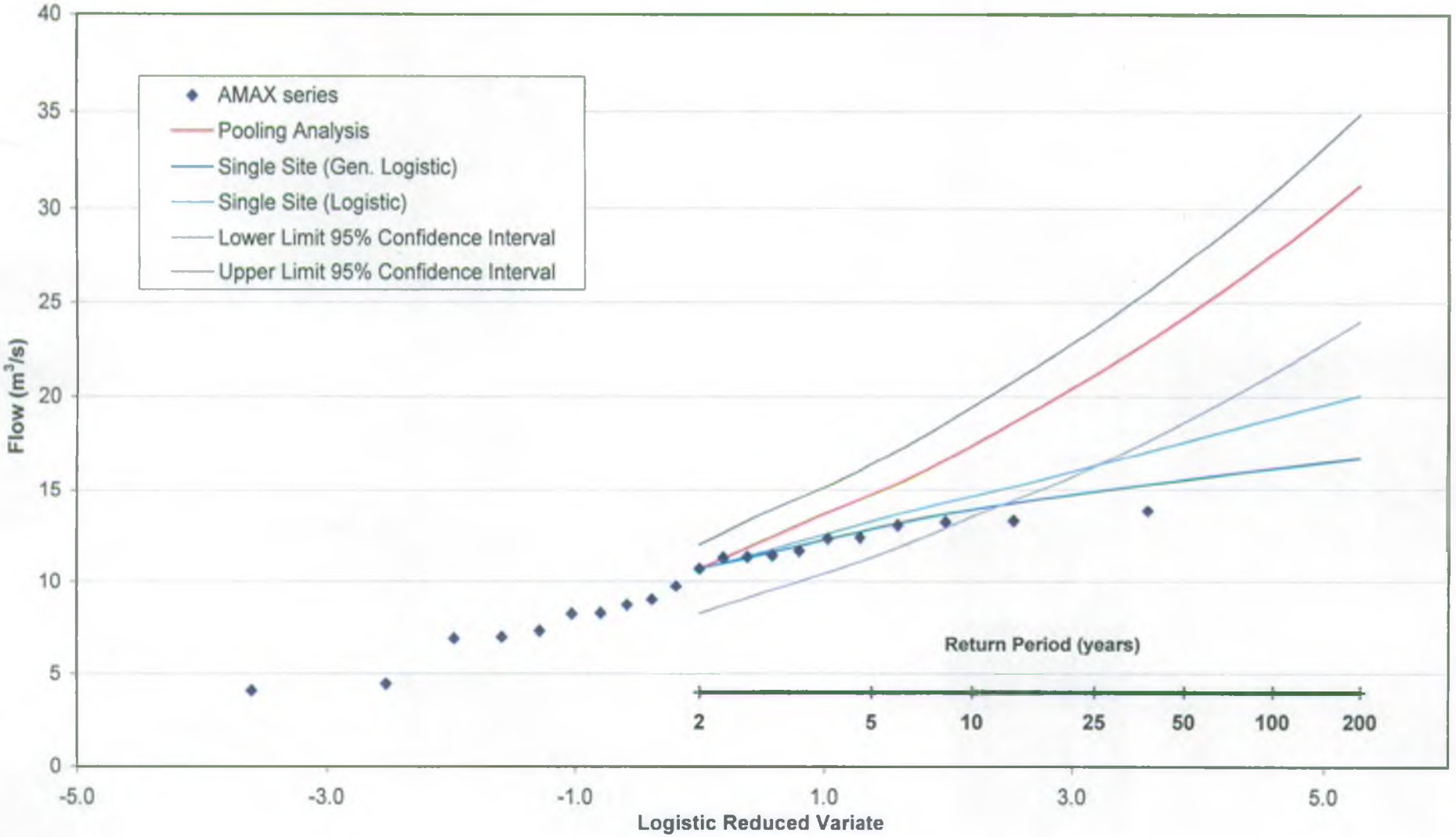
| Return period (years) | Pooled Analysis | | Single Site | | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Logistic | Logistic x 20% |
| 2 | 10.7 | 10.7 | 10.7 | 10.7 | 12.8 |
| 5 | 14.7 | 14.7 | 12.8 | 13.2 | 15.8 |
| 10 | 17.4 | 17.4 | 13.8 | 14.6 | 17.5 |
| 25 | 21.2 | 21.1 | 14.9 | 16.3 | 19.6 |
| 50 | 24.2 | 24.2 | 15.6 | 17.6 | 21.1 |
| 100 | 27.6 | 27.5 | 16.2 | 18.8 | 22.6 |
| 200 | 31.3 | 31.2 | 16.7 | 20.1 | 24.1 |

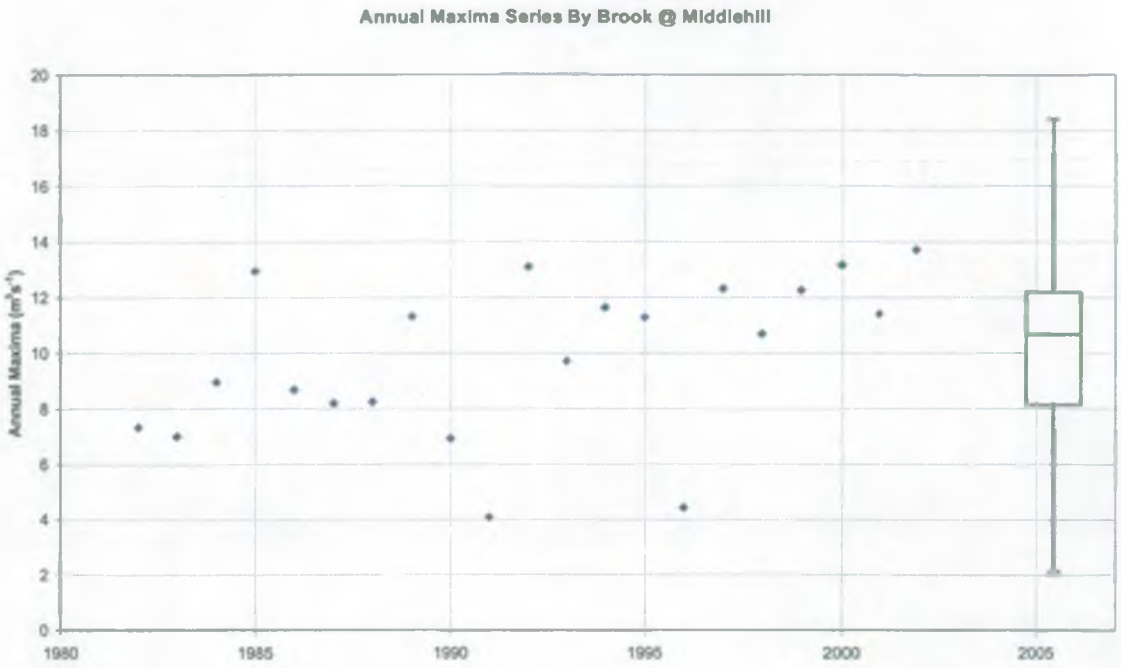
**Summary of Analysis:** The pooling group review resulted in a small reduction in the estimated flow for a given return period. The reduction was very small; at the 200 year estimated peak the review of the pooling group reduced the flow by approximately 0.4%.

**Selection of Method:** From the plot of flood frequency curves both the single site Logistic and the single site General Logistic represent the AMAX data reasonably well. Bankfull levels are obstructed by the footbridge resulting in the plateauing of the AMAX series. As a result single site Logistic is recommended as a indication of flood frequency as the General Logistic is upper bounded.

*Special considerations:* Further investigation in to rating with review of FFC selection.
*Adopt:* Single Site Logistic (as shaded)
*Model parameters:* $\beta = 0.166$

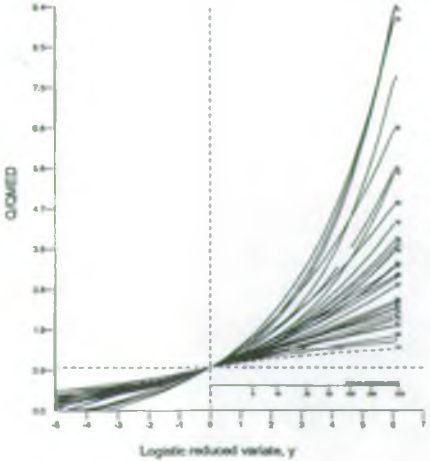
## River By Brook at Middlehill

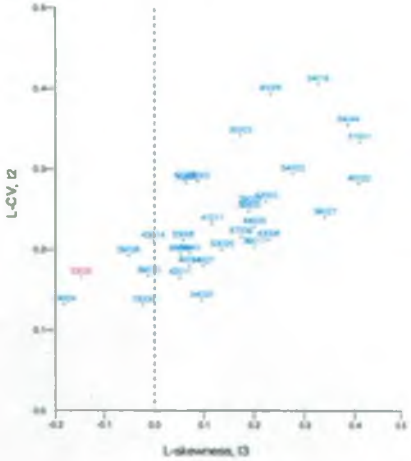


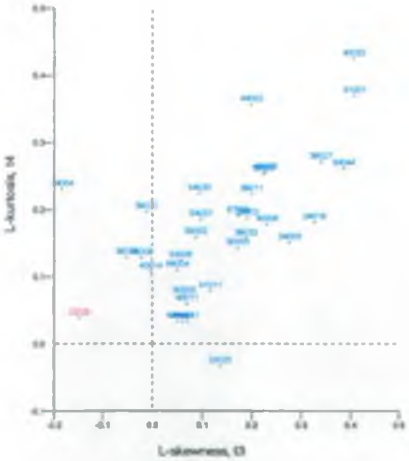


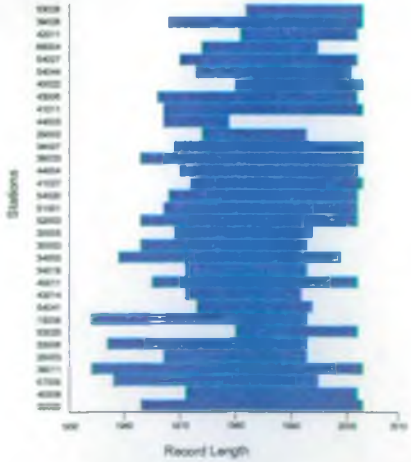

Annual Maxima series for Middlehill

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 12 Dec 82 | 7.335 | | 06 Jan 94 | 9.719 |
| 02 Jan 84 | 7.006 | | 29 Jan 95 | 11.640 |
| 25 Nov 84 | 8.970 | | 23 Dec 95 | 11.285 |
| 26 Dec 85 | 12.951 | | 14 Feb 97 | 4.437 |
| 21 Nov 86 | 8.684 | | 05 Jan 98 | 12.323 |
| 03 Feb 88 | 8.207 | | 20 Jan 99 | 10.692 |
| 26 Feb 89 | 8.252 | | 26 Dec 99 | 12.263 |
| 21 Dec 89 | 11.321 | | 31 Oct 00 | 13.168 |
| 11 Jan 91 | 6.934 | | 11 Feb 02 | 11.409 |
| 21 Nov 91 | 4.088 | | 02 Jan 03 | 13.710 |
| 30 Nov 92 | 13.101 | | | |


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

Relative frequency
FAIL


Relative frequency
AREA


Relative frequency
PROPMET


Relative frequency
SAME


Relative frequency
LIBRICKT


Relative frequency
BRHOST

## Middlehill Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.53 | 4.55 |
| Comment | Review of the pooling group is essential | Review of the pooling group is essential |
| Number of Station Years | 1023 | 1021 |

| Criteria for Review | Comment | Action | Station Years | $H_1$ |
|---|---|---|---|---|
| *Station Location* | The subject site is ranked 1 in the pooling group. | No change | 1151 | 4.53 |
| *Period of Record* | All sites have a good record length, with the exception of the Gwash @ Belmesthorpe ranked 35th, this site has only 6 years of data. | Remove the Gwash @ Belmesthorpe due to insufficient years of data | 1145 | 4.84 |
| *FARL* | FARL value ranges from 0.909 – 1.000, the subject site has a value of 1.000, so is at the top end of the range. There are 2 clear outliers, the Windrush @ Newbridge, ranked 32nd, which has a FARL value of 0.909, and the Nar @ Marham, ranked 24th, with a FARL value of 0.932. | Remove both the Windrush @ Newbridge and the Nar @ Marham, as they are clear outliers compared to all other sites in the pooling group. | 1067 | 5.12 |
| *PROPWET/URBEXT* | The subject site has a PROPWET value of 0.34, the pooling group has a range of 0.270 – 0.470. There are 2 possible outliers in the pooling group, the Thaw @ Gigman Bridge (0.470) and the Dove @ Isaak Walton (0.460).<br>There is a good spread of URBEXT values throughout the pooling group. The subject site has a value of 0.0110, and is in the middle of the range. There are 4 sites which could be seen as possible outliers, these are: the Lud @ Louth (0.0244), the Frome @ Ebly Mill (0.0239), the Wey @ Tilford (0.0236), and the Great Stour @ Horton (0.0227), all other sites have URBEXT values between 0.0156, and 0.0016. | Remove the Thaw @ Gigman Bridge, as it is a possible outlier with regards to PROPWET, and it is also highly discordant (discordancy = 4.262) and the Dove @ Isaak Walton<br>At this stage it is unnecessary to remove any of the sites that are possible outliers with regards to URBEXT, as there are no other hydrological reasons to exclude them from the pooling group. | 1021 | 4.55 |
| *Site Comments* | Site comments and flood seasonality were assessed. No sites needed to be excluded from the pooling group due to the site comments. | No action to be taken | 1021 | 4.55 |
| *Discordant Sites* | *(44004) (Frome @ Dorchester Total)*<br>Ranked 14th in the pooling group with discordancy of 3.821. The site has a good record length, of 33 years. The site is a slight outlier on the L-Moments graphs, however there are no obvious hydrological reasons to remove this site from the pooling group. | No action to be taken | 1021 | 4.55 |
| *L Moments* | No other significant outliers | No action to be taken | 1021 | 4.55 |

## Middlehill Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53028 (By Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 1.396 | 0.000 |
| 39028 (Dun @ Hungerford) | 35 | 0.192 | -0.051 | 0.129 | 0.760 | 0.305 |
| 42011 (Hamble @ Frog Mill) | 21 | 0.165 | 0.051 | 0.034 | 1.075 | 0.329 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.180 | 0.338 |
| 54027 (Frome @ Ebley Mill) | 32 | 0.180 | 0.098 | 0.186 | 0.287 | 0.366 |
| 54044 (Tern @ Ternhill) | 30 | 0.355 | 0.387 | 0.262 | 1.150 | 0.383 |
| 40022 (Great Stour @ Chart Leacon) | 24 | 0.281 | 0.408 | 0.426 | 2.287 | 0.435 |
| 43006 (Nadder @ Wilton Park) | 37 | 0.212 | 0.229 | 0.256 | 0.579 | 0.483 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.344 | 0.504 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.391 | 0.510 |
| 29002 (Great Eau @ Claythorpe Mill) | 21 | 0.284 | 0.088 | 0.159 | 0.672 | 0.519 |
| 39027 (Pang @ Pangbourne) | 35 | 0.240 | 0.341 | 0.272 | 1.267 | 0.575 |
| 39033 (Winterbourne @ st Bagnor) | 41 | 0.247 | 0.189 | 0.157 | 0.119 | 0.627 |
| 44004 (Frome @ Dorchester Total) | 33 | 0.132 | -0.183 | 0.231 | 3.821 | 0.688 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.082 | 0.704 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 1.058 | 0.706 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.623 | 0.715 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.242 | 0.716 |
| 30005 (Witham @ Saltersford Total) | 26 | 0.282 | 0.065 | 0.071 | 0.788 | 0.718 |
| 30003 (Bain @ Fulsby Lock) | 32 | 0.341 | 0.172 | 0.143 | 1.130 | 0.720 |
| 34003 (Bure @ Ingworth) | 41 | 0.293 | 0.277 | 0.151 | 0.604 | 0.727 |
| 34018 (Stiffkey @ Warham All Saints) | 23 | 0.405 | 0.327 | 0.181 | 2.008 | 0.727 |
| 40011 (Great Stour @ Horton) | 39 | 0.180 | 0.070 | 0.060 | 0.703 | 0.730 |
| 43014 (East Avon @ Upavon) | 22 | 0.211 | -0.003 | 0.108 | 0.382 | 0.773 |
| 54041 (Tern @ Eaton on Tern) | 23 | 0.194 | 0.071 | 0.033 | 0.829 | 0.774 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 0.756 | 0.775 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 2.708 | 0.792 |
| 33006 (Wissey @ Northwold) | 37 | 0.211 | 0.057 | 0.124 | 0.105 | 0.832 |
| 29003 (Lud @ Louth) | 28 | 0.255 | 0.192 | 0.188 | 0.050 | 0.832 |
| 39011 (Wey @ Tilford) | 49 | 0.203 | 0.200 | 0.223 | 0.463 | 0.848 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.170 | 0.852 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 2.185 | 0.859 |
| 39020 (Coln @ Bibury) | 40 | 0.167 | -0.012 | 0.197 | 0.785 | 0.862 |
| | | | | | | |
| Total | 1021 | | | | | |
| Weighted means | | 0.234 | 0.141 | 0.176 | | |

3 ID ARD

**Catchment:** Midford Brook at Midford
**Station No:** 53005
**NGR:** ST 763 611

**Description:** The station was opened in 1961. The structure is a full range trapezoidal critical depth flume, 2.4 km upstream of the confluence with the River Avon.
The catchment is predominantly impermeable; the geology is mainly Lias with Coal Measures. There are also deep-sided valleys, which cause the catchment to respond quickly to rainfall. The catchment is mainly rural, although there are some large quarries within the catchment.

**Data comments:** The updated AMAX data set from the Agency provided 42 years of annual maxima series data for the period 1962-2002. The AMAX data was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 56.7 $m^3/s$. All AMAX series values are below this upper limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 147.70 | 0.993 | 0.36 | 0.625 | 965 | 29.1 | 0.0301 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 22.081 $m^3/s$ |
| **Annual Maxima** | 29.653$m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 31.211 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 25.713 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.0301, slightly urbanised, adjustment required.

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** Satisfactory

| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 29.7 | 29.7 | 29.7 | 29.7 | 35.6 |
| 5 | 40.8 | 41.3 | 41.0 | 38.8 | 49.2 |
| 10 | 48.8 | 49.8 | 49.1 | 45.0 | 59.0 |
| 25 | 60.3 | 62.3 | 61.0 | 53.4 | 73.2 |
| 50 | 70.1 | 73.1 | 71.1 | 60.3 | 85.4 |
| 100 | 81.1 | 85.5 | 82.7 | 67.8 | 99.2 |
| 200 | 93.6 | 99.7 | 95.8 | 76.0 | 115.0 |

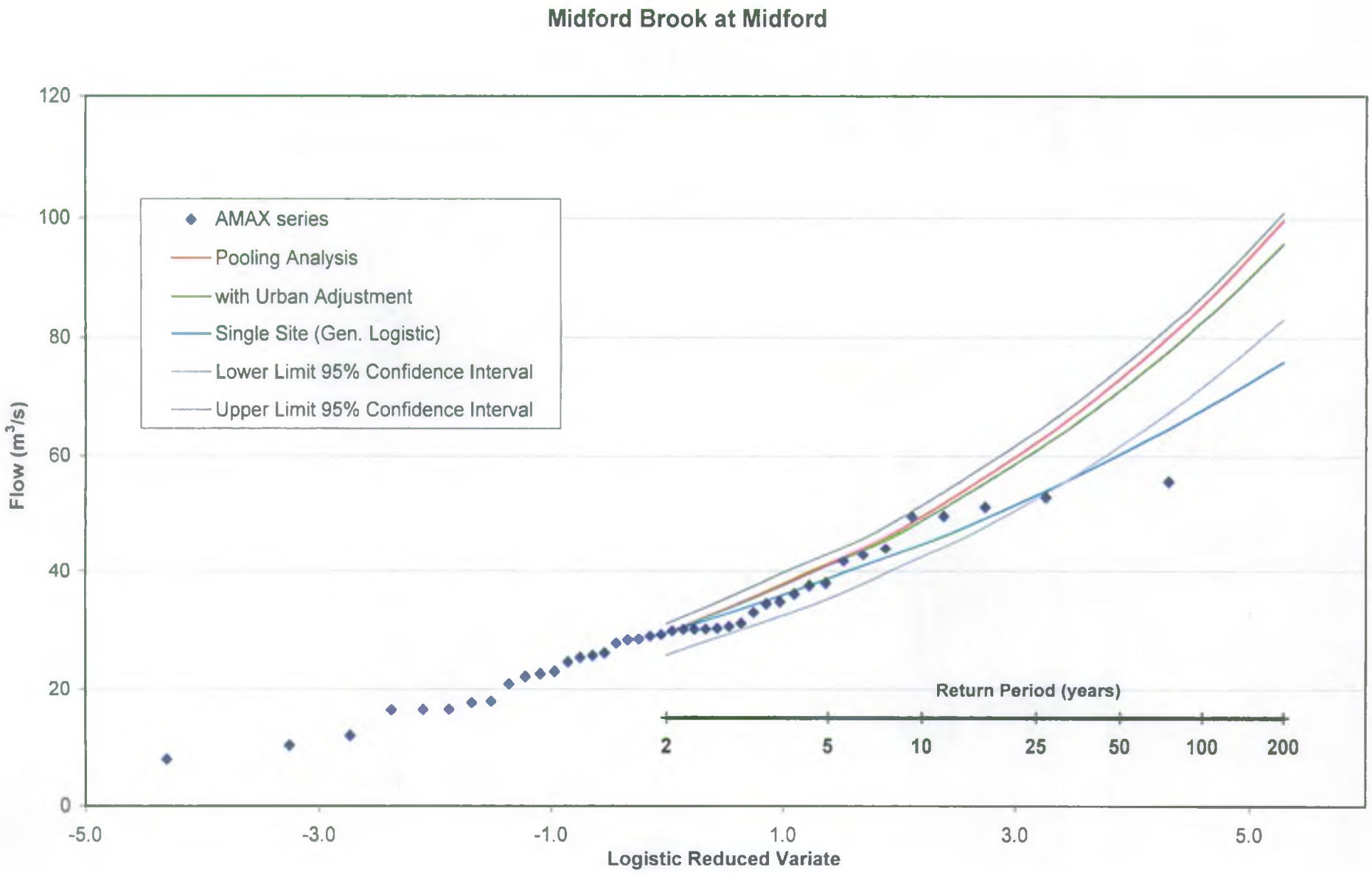
**Summary of Analysis:** AMAX series EDA revealed one slight outlier to the data series, July 1968. All data retained without review. The effect of the pooling group review and application of the urban adjustment factor is not very significant; there is approximately a 2% increase in the 200-year flood for the reviewed pooling group value with the urban adjustment compared to the original pooled analysis.

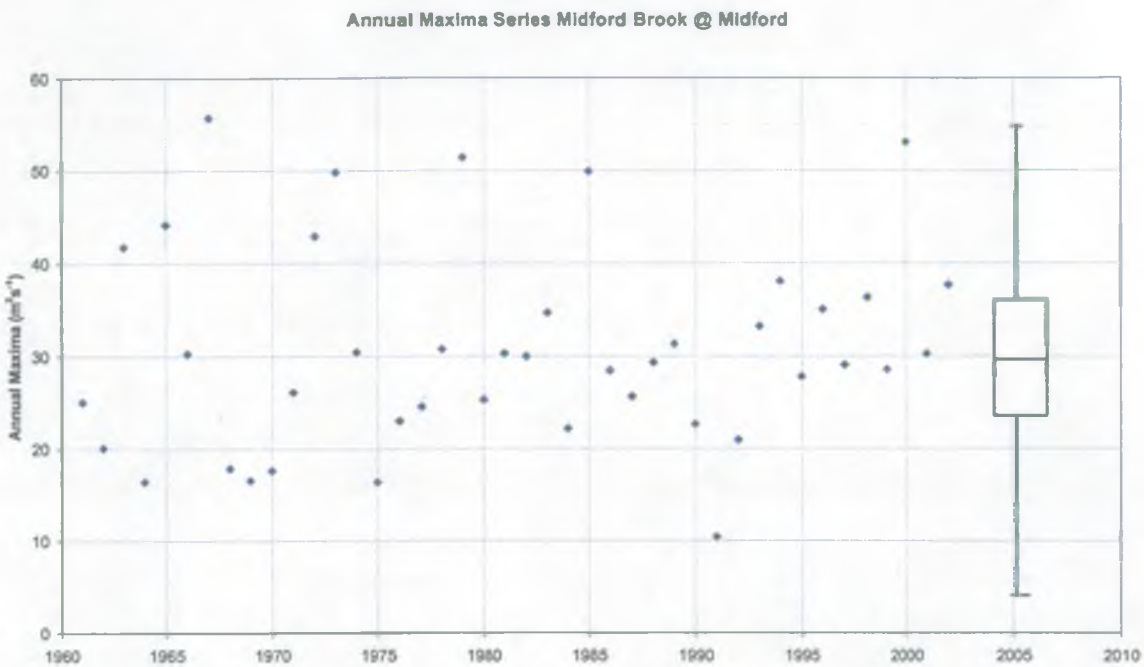
**Selection of Method:** The AMAX series appears to flatten at higher return periods and may be upper bounded. Though the catchment is not permeable and there is no record of potential flood storage in the catchment which often results in upper bounding of AMAX series. As a result the pooled analysis urban adjusted FFC is recommended since it fits the data well at lower return periods.

*Special considerations:* Investigations into catchment properties should be undertaken to see if AMAX series is upper bounded and may affect the selection of FFC methodology.

*Adopt:* Pooled Analysis Urban Adjusted (as shaded above)

*Model parameters:* N.A


Midford Brook at Midford
AMAX series
Pooling Analysis
with Urban Adjustment
Single Site (Gen. Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m3/s)
120
100
80
60
40
20
0
-5.0
-3.0
-1.0
1.0
3.0
5.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200




Annual Maxima series for Midford

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 21 Jan 1962 | 25.060 | | 19 Dec 1982 | 29.987 |
| 13 Mar 1963 | 20.067 | | 16 Jan 1984 | 34.667 |
| 19 Nov 1963 | 41.770 | | 22 Nov 1984 | 22.191 |
| 30 Jul 1965 | 16.452 | | 25 Dec 1985 | 49.900 |
| 09 Dec 1965 | 44.174 | | 18 Nov 1986 | 28.429 |
| 20 Feb 1967 | 30.270 | | 31 Jan 1988 | 25.649 |
| 10 Jul 1968 | 55.727 | | 14 Mar 1989 | 29.319 |
| 22 Dec 1968 | 17.874 | | 20 Dec 1989 | 31.283 |
| 14 Dec 1969 | 16.555 | | 09 Jan 1991 | 22.656 |
| 18 Jun 1971 | 17.642 | | 18 Sep 1992 | 10.432 |
| 07 Mar 1972 | 26.109 | | 13 Jan 1993 | 20.943 |
| 02 Dec 1972 | 42.931 | | 13 Oct 1993 | 33.211 |
| 09 Feb 1974 | 49.830 | | 27 Jan 1995 | 38.059 |
| 28 Jan 1975 | 30.440 | | 22 Dec 1995 | 27.780 |
| 01 Dec 1975 | 16.390 | | 17 Feb 1997 | 35.019 |
| 30 Nov 1976 | 22.990 | | 03 Jan 1998 | 29.043 |
| 23 Jan 1978 | 24.560 | | 19 Jan 1999 | 36.292 |
| 01 Feb 1979 | 30.770 | | 26 Dec 1999 | 28.533 |
| 27 Dec 1979 | 51.420 | | 30 Oct 2000 | 53.057 |
| 11 Mar 1981 | 25.310 | | 26 Jan 2002 | 30.213 |
| 15 Mar 1982 | 30.293 | | 14 Nov 2002 | 37.658 |

Q/QMED
Logistic reduced variates, y


Stations
Record Length


L-CV, t2
L-skewness, t3




L-kurtosis, t4
L-skewness, t3

Relative frequency
PAIR


Relative frequency
AREA


Relative frequency
PROPMET


Relative frequency
SAVR


Relative frequency
USBDCT


Relative frequency
BRIGHST

## Midford Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.55 | 1.80 |
| Comment | The pooling group is strongly heterogeneous and a review is essential | The pooling group is possibly homogeneous and a review is optional. |
| Number of Station Years | 1153 | 1025 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is slightly urbanised, (URBEXT 0.032) and has been excluded from the pooling group.<br>There are 2 gauging sites included in the pooling group with the same data. These sites are the Monnow @ Kentchurch and the Monnow @ Grosmont. The Monnow at Grosmont has replaced the gauging station at Kentchurch. | Remove the Monnow @ Kentchurch from the pooling group | 1131 | 3.40 |
| *Period of Record* | All sites have a good period of record. The only site that has a short record is the Trothy @ Mitchel Troy, which has a record of 10 years. | The record length of the Trothy @ Mitchel Troy is above the threshold limit of 8 years, and so will be left in the pooling group until further analysis has been carried out. | 1131 | 3.40 |
| *FARL* | There are 3 outlying sites with respect to FARL, these sites are the Chew @ Compton Dando (0.843), the Congresbury Yeo @ Iwood (0.890), and the South Esk @ Prestonholm (0.906) | Remove the Chew @ Compton Dando and Congresbury Yeo @ Iwood due to outlying FARL values. | 1059 | 2.28 |
| *PROPWET/URBEXT* | There is a wide spread of PROPWET values, the Petteril @ Harraby appears to be an outlier.<br>There is a wide spread in the URBEXT values of the pooling group, the subject site has a very high URBEXT value, and so is not included in the pooling group. One of the sites at the lower end of the URBEXT graph is the Petteril @ Harraby. | Remove the Petteril @ Harraby, due to being an outlier in the PROPWET value graph, and a slight outlier in the URBEXT values | 1035 | 2.28 |
| *Site Comments* | All sites comments were looked at; there were no sites that particularly stood out as being hydrological dissimilar to the subject site. | Add a site to the bottom of the pooling group to compensate for the removal of sites | | |
| *Discordant Sites* | *(55022) Trothy @ Mitchel Troy*<br>It is a highly discordant site, with a value of 5.669. This site also has a short period of record at 10 years. It is a clear outlier in the L-moments graphs. | Remove the Trothy @ Mitchel Troy due to high discordance and short record length | 1025 | 1.80 |
| *L-Moments* | No large outliers to L-moments | No change | 1025 | 1.80 |

## Midford Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.179 | 0.274 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.156 | 0.312 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.377 | 0.336 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 2.261 | 0.345 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.584 | 0.351 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.265 | 0.354 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.432 | 0.357 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 2.731 | 0.378 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.251 | 0.393 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 2.514 | 0.399 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 1.040 | 0.404 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.244 | 0.409 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.618 | 0.453 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.445 | 0.470 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.291 | 0.480 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.038 | 0.487 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.819 | 0.502 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.121 | 0.513 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.776 | 0.522 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.446 | 0.523 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.375 | 0.523 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.808 | 0.527 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.294 | 0.532 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 1.572 | 0.540 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.557 | 0.542 |
| 55029 (Monnow @ Grosmont) | 45 | 0.180 | 0.007 | 0.082 | 1.424 | 0.543 |
| 55021 (Lugg @ Butts Bridge) | 27 | 0.145 | 0.055 | 0.101 | 1.190 | 0.550 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 0.743 | 0.588 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 2.728 | 0.604 |
| 28023 (Wye @ Ashford) | 31 | 0.227 | 0.321 | 0.124 | 1.593 | 0.613 |
| 53008 (Avon @ Great Somerford) | 40 | 0.252 | 0.200 | 0.208 | 0.129 | 0.615 |
| | | | | | | |
| Total | 1025 | | | | | |
| Weighted means | | 0.238 | 0.209 | 0.194 | | |

PEN MILL

**Catchment:** Yeo at Pen Mill
**Station No:** 52006
**NGR:** ST 573 162

**Description:** Pen Mill is a medium-sized catchment (216.17 km$^2$) with the gauging station located on the outskirts of Yeovil. The station was installed in 1963. The rectangular Crump weir (low flows) is affected by downstream weed growths at low flows. Higher flows are gauged by a rated section. All flows contained until above bankfull levels. Backing up from downstream causes the floodplain to fill up at these levels, but all flows still pass through a bridge upstream and can be gauged. The catchment is Oxford Clay and Great Oolite in the headwaters, with Yeovil Sands and Inferior Oolite in the lower catchment.

**Data comments** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 41 years. AMAX series not reviewed.

**Gauge rating:** Upper limit of rating is 116.6m$^3$/s which is exceeded by two events in the AMAX series. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 216.17 | 0.965 | 0.38 | 0.569 | 865 | 34.3 | 0.0193 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 27.654 m$^3$/s |
| **Annual Maxima** | 49.038 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 55.703 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 43.806 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** Satisfactory – review two peak events

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 49.0 | 49.0 | 49.0 | 58.8 |
| 5 | 68.1 | 67.9 | 70.9 | 81.5 |
| 10 | 82.0 | 81.6 | 90.4 | 97.9 |
| 25 | 102.1 | 101.5 | 124.1 | 121.8 |
| 50 | 119.5 | 118.6 | 158.2 | 142.3 |
| 100 | 139.2 | 138.0 | 202.5 | 165.6 |
| 200 | 161.8 | 160.2 | 260.6 | 192.2 |

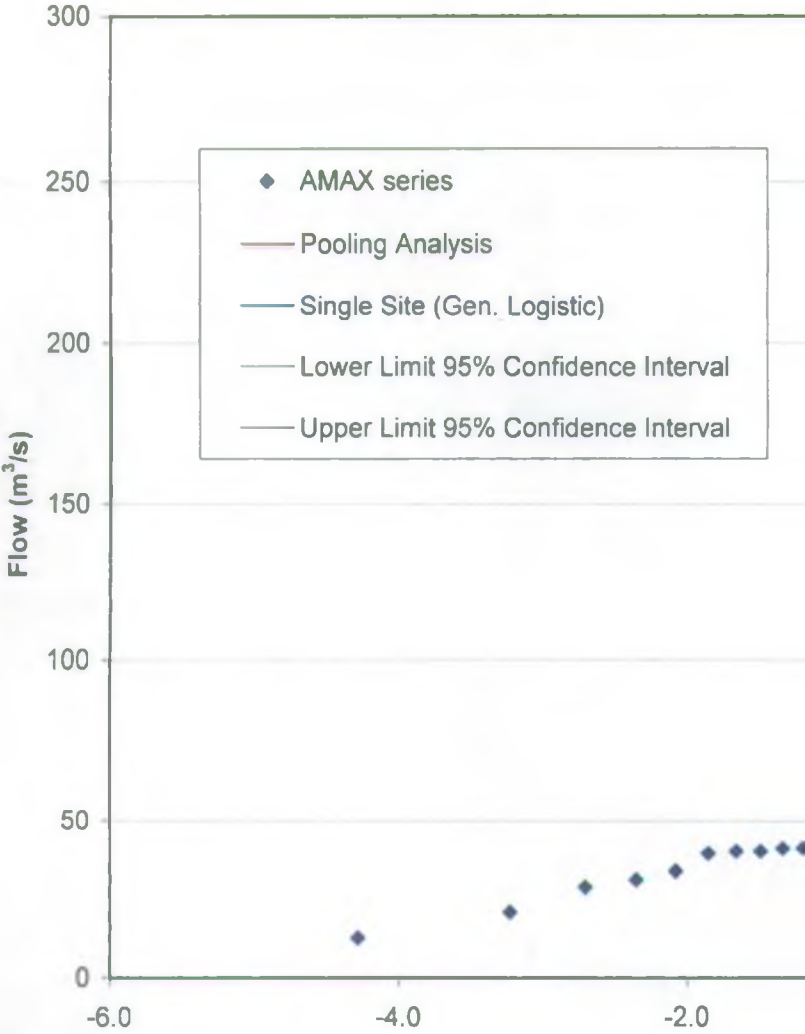
**Summary of Analysis:** AMAX series EDA reveals four outliers to the data. Two lie just outside December 2001 and February 1974, with May 1979 and December 1979 being extreme outliers. All events are retained without review. There is a small reduction in the predicted flood flows following the review of the pooling group.

**Selection of Method:** Apart from the two large outliers (May and December 1979) the reviewed pooled analysis reproduces the AMAX data though including the two large outliers Gen. Log. single site gives a better approximation. These two large events would using the reviewed pooled analysis have return periods of 150 and over 500 years, respectively. Though the single site FFC appears to represent the AMAX series better, FEH 3.8 Table 8.3 recommends that pooled analysis should prevail with reference to single site for confirmation.

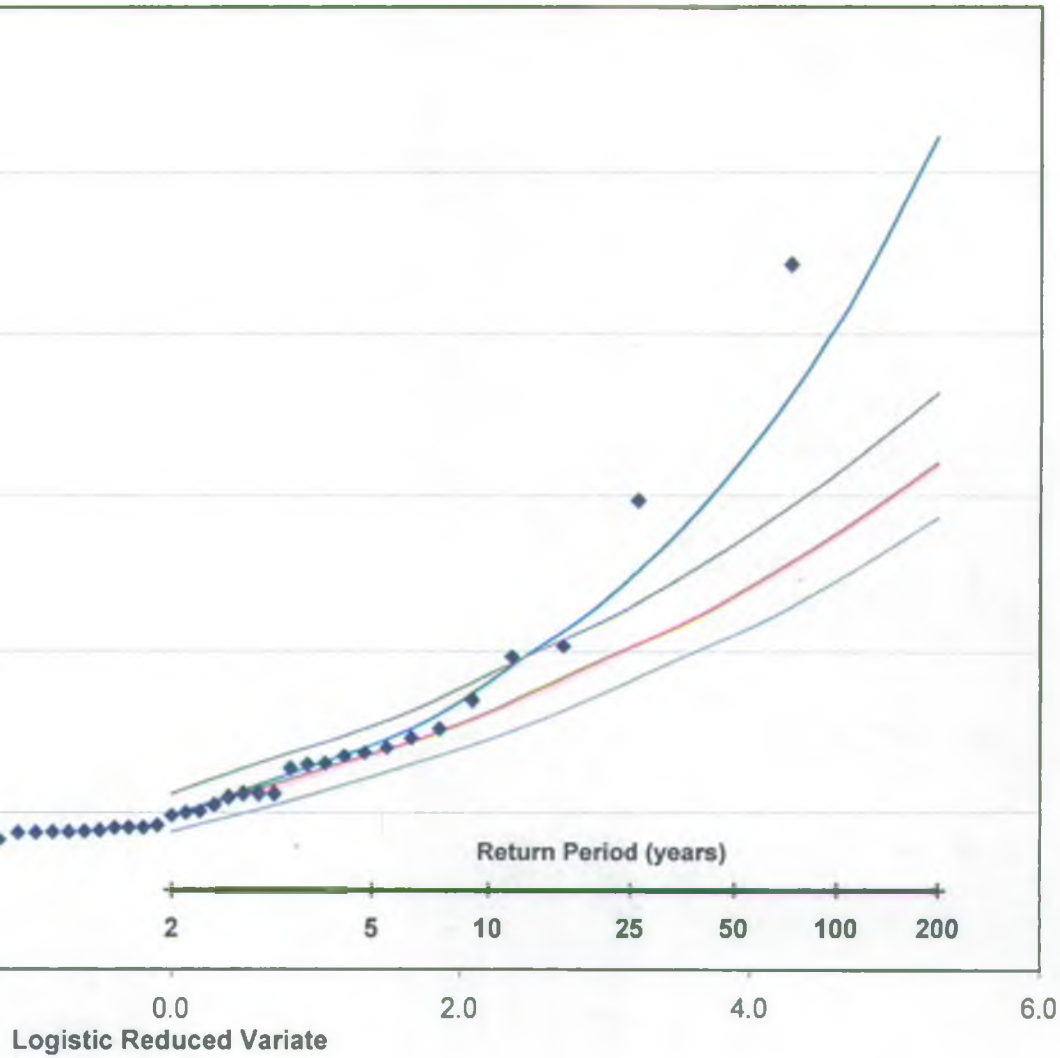
*Special considerations:* Recommend review pooled analysis FFC with further investigations into the return periods of the two extreme outliers who may appear to have lower return periods as a result of bias in the plotting positions.

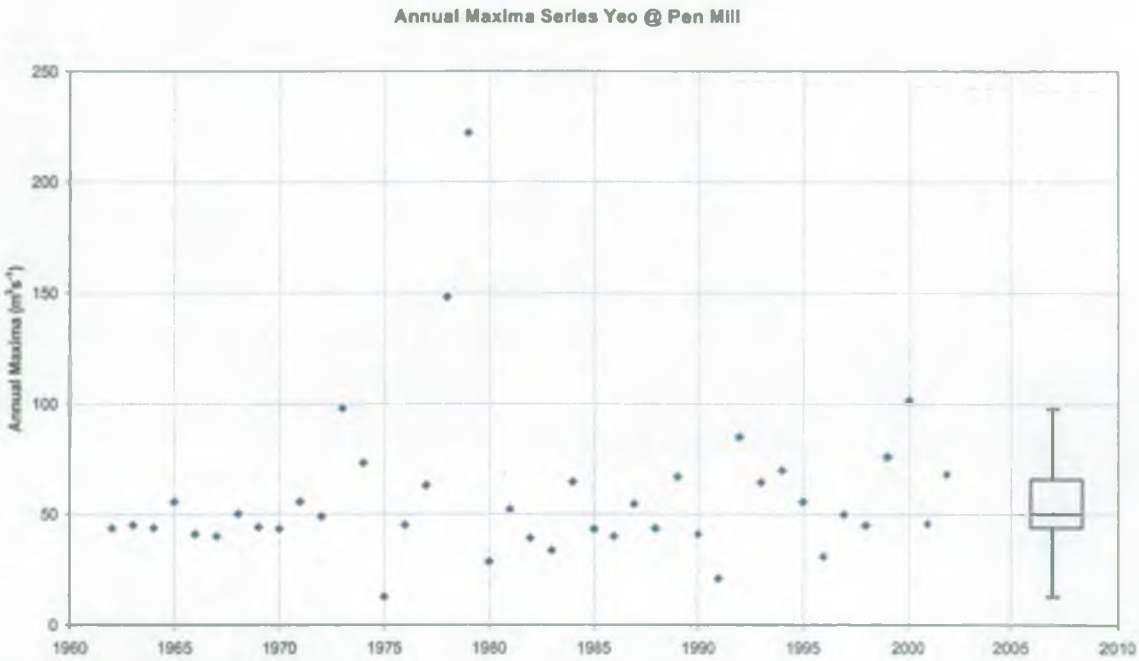
*Adopt:* Pooled analysis (as shaded above)

*Model parameters:* $\beta = 0.236$, $\kappa = -0.200$


300
250
200
150
100
50
0
Flow (m³/s)
-6.0
-4.0
-2.0
AMAX series
Pooling Analysis
Single Site (Gen. Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval

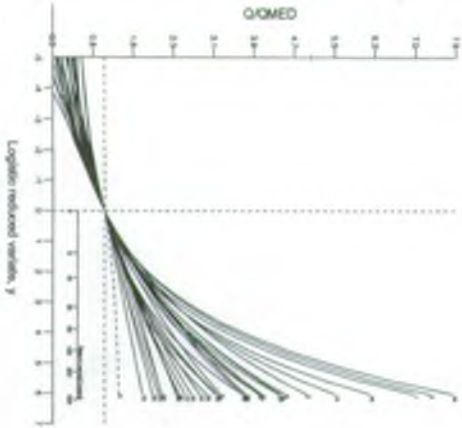
Yeo @ Pen Mill

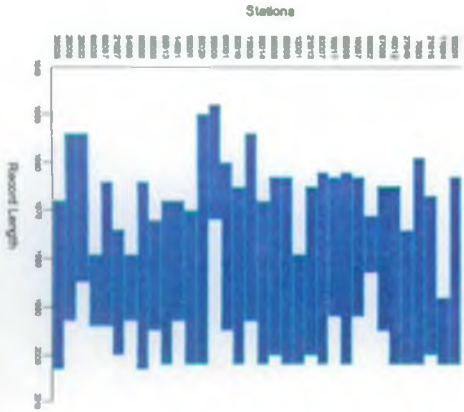

Return Period (years)
2
5
10
25
50
100
200
0.0
2.0
4.0
6.0
Logistic Reduced Variate

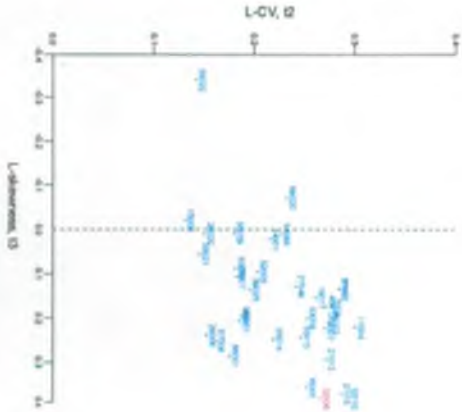


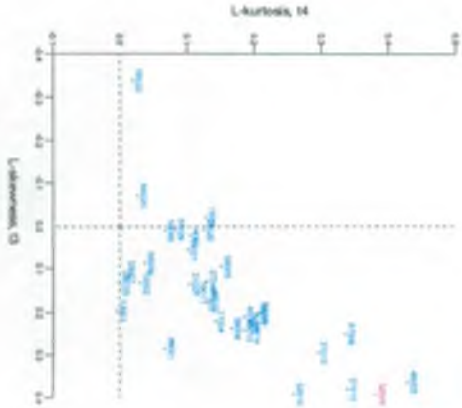

Annual Maxima series for Pen Mill

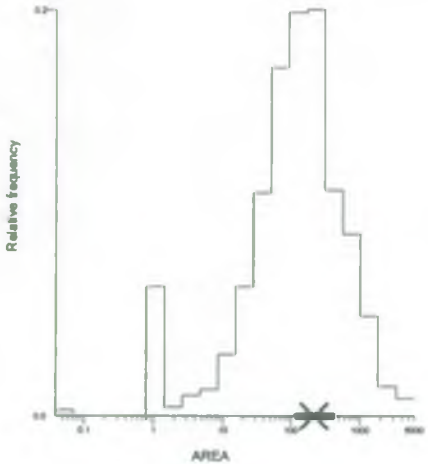
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 14 Feb 63 | 43.681 | | 25 Jan 84 | 33.676 |
| 19 Mar 64 | 45.008 | | 21 Jan 85 | 64.771 |
| 13 Jan 65 | 43.846 | | 26 Dec 85 | 43.384 |
| 25 Feb 66 | 55.703 | | 27 Mar 87 | 40.045 |
| 04 Nov 66 | 41.072 | | 13 Feb 88 | 54.723 |
| 16 Oct 67 | 40.109 | | 24 Feb 89 | 43.714 |
| 22 Feb 69 | 50.310 | | 01 Feb 90 | 67.069 |
| 14 Dec 69 | 44.177 | | 08 Mar 91 | 41.056 |
| 21 Jan 71 | 43.516 | | 08 Jan 92 | 20.990 |
| 07 Mar 72 | 55.703 | | 18 Dec 92 | 85.121 |
| 06 Dec 72 | 49.038 | | 20 Dec 93 | 64.448 |
| 11 Feb 74 | 98.134 | | 09 Nov 94 | 69.959 |
| 20 Jan 75 | 73.321 | | 09 Feb 96 | 55.703 |
| 28 Nov 75 | 12.763 | | 19 Nov 96 | 30.897 |
| 15 Oct 76 | 45.091 | | 05 Jan 98 | 49.925 |
| 09 Dec 77 | 63.173 | | 26 Dec 98 | 45.075 |
| 30 May 79 | 148.29 | | 24 Dec 99 | 76.264 |
| 27 Dec 79 | 221.935 | | 31 Dec 00 | 101.716 |
| 21 Mar 81 | 28.559 | | 04 Feb 02 | 45.864 |
| 15 Mar 82 | 52.275 | | 13 Nov 02 | 68.246 |
| 23 Jun 83 | 39.314 | | | |

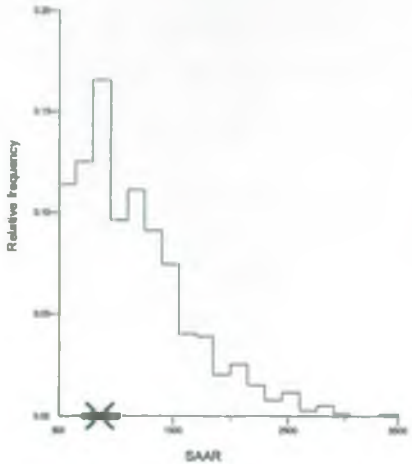

Q/QMED
Logistic regional variable, y

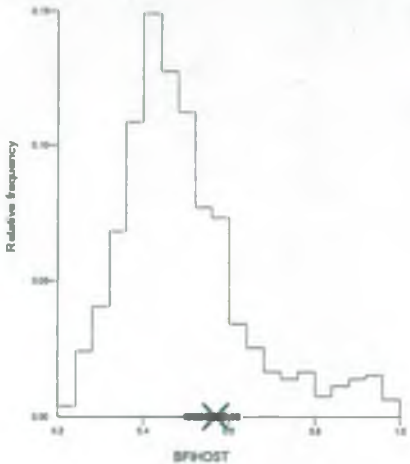

Stations
Record Length

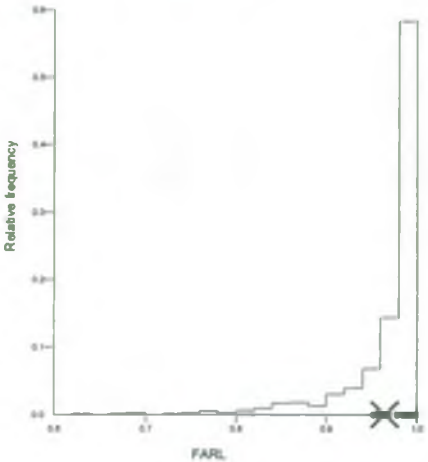

L-CV, t2
L-skewness, t3

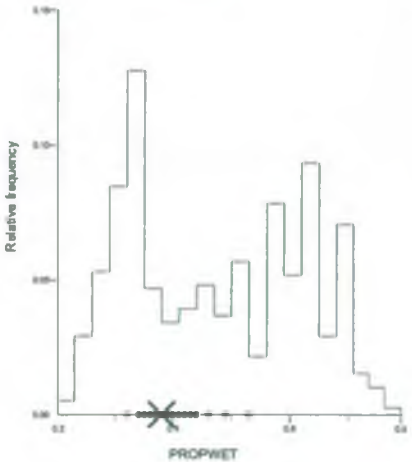

L-kurtosis, t4
L-skewness, t3

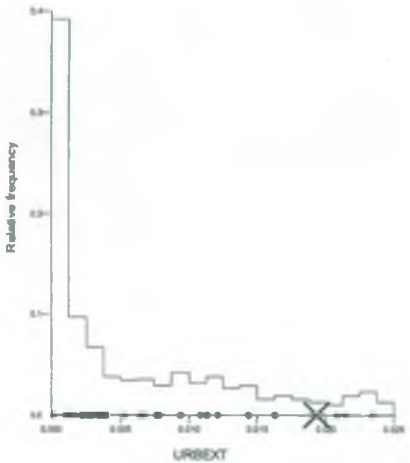

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Pen Mill Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.72 | 3.48 |
| Comment | Review of pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1306 | 1028 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No stations deserve promotion or demotion in the pooling group as a result of proximity to the subject site. | No change. | 1306 | 4.72 |
| *Period of Record* | All stations have date records of 10 or more years (greater than the 8 year minimum requirement). | No change | 1306 | 4.72 |
| *FARL* | The Yeo @ Pen Mill has a FARL of 0.965 and the pooling group has a range of 0.843 to 1.000. The outliers to the pooling group are the 33rd ranked (53004) Chew @ Compton Dando (FARL = 0.843), 21st ranked (19008) South Esk @ Prestonholm (FARL = 0.906) and the 37th ranked (41005) Ouse @ Gold Bridge (FARL = 0.924). | Remove all three sites as data records will be significantly affected by the influence of reservoirs in the catchment. | 1192 | 4.21 |
| *PROPWET/URBEXT* | The subject site has a PROPWET = 0.38, with the pooling group having a range of 0.34 – 0.64. The outliers to the pooling group are the<br>12th ranked (76010) Peteril @ Harraby Green (PROPWET = 0.64)<br>37th ranked (11003) Done @ Bridge of Alford (PROPWET = 0.56)<br>31st ranked (55025) Llynfli @ Three Cocks (PROPWET = 0.54)<br>10th ranked (9004) Bogie @ Redcraig (PROPWET = 0.53)<br>2nd ranked (11004) Urie @ Pitcapel (PROPWET = 0.53) | Remove four of the sites but retain the Urie @ Pitcapel which is second in the pooling group and is very similar to the subject site is all catchment descriptors apart from PROPWET. | 1103 | 4.29 |
| *Site Comments* | The 21st ranked (55009) Monnow @ Kentchurch with 22 years of data was discontinued in 1972 but replaced in 1973 with the 22nd ranked (55029) Monnow @ Grosnant with 19 years of data.<br>31st ranked (10001) Ythan @ Ardlethan was closed in 1982.<br>33rd ranked (68002) Gowy @ Picton abandoned in 1979. | Retain the two Monnow stations as catchment descriptors are very similar, they lie adjacent to each other in the pooling group and have 41 station years of data.<br>Remove (10001) Ythan @ Ardlethan since discontinued and no updates available from SEPA and (68002) Gowy @ Picton. | 1028 | 3.48 |
| *Discordant Sites* | *(55022) Truthy @ Mitchel Troy*<br>10 years of data with on very low peak value in the known drought year of 1975. | Retain site along with all data. | 1028 | 3.48 |
| *L Moments* | There are no extreme outliers to L-Moments and growth curve graphs but the three largest values are from the 19th ranked (52010) Brue @ Lovington which has two very large peak flows on 30 May 1979 and 12 July 1998 which were verified from the adjacent catchment (52009) Sheppey @ Fenny Castle.<br>3rd ranked (21015) Leader Water @ Earlston which is extreme as a result of two very large peaks on the 1 Nov 1984 and 1 Jan 1982 which were confirmed by comparison with adjacent catchment (21013) Gala Water @ Galashiels and the subject site is also an outlier. | Retain all sites. All peak values which result in large growth factors at high return periods and high skewness values have been confirmed as well as the subject site discussed in the introduction to Pen Mill. | 1028 | 3.48 |

## Pen Mill Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.471 | 0.000 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.861 | 0.073 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 1.126 | 0.080 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.481 | 0.113 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.101 | 0.153 |
| 45012 (Greedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.374 | 0.176 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 2.158 | 0.217 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 4.752 | 0.231 |
| 19007 (Esk @ Musselburgh) | 29 | 0.270 | 0.223 | 0.193 | 0.271 | 0.231 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.131 | 0.291 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.303 | 0.306 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.790 | 0.306 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.634 | 0.311 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.707 | 0.317 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.341 | 0.324 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 2.101 | 0.334 |
| 55014 (Lugg @ Byton) | 26 | 0.158 | 0.088 | 0.192 | 0.838 | 0.360 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 1.350 | 0.377 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.029 | 0.379 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 2.085 | 0.381 |
| 55009 (Monnow @ Kentchurch) | 22 | 0.181 | 0.087 | 0.037 | 0.456 | 0.383 |
| 55029 (Monnow @ Grosmont) | 19 | 0.145 | 0.103 | -0.037 | 1.884 | 0.383 |
| 55021 (Lugg @ Butts Bridge) | 18 | 0.179 | 0.065 | 0.139 | 0.320 | 0.391 |
| 14001 (Eden @ Kemback) | 26 | 0.215 | 0.022 | 0.104 | 0.371 | 0.393 |
| 55013 (Arrow @ Titley Mill) | 25 | 0.280 | 0.249 | 0.232 | 0.448 | 0.414 |
| 10002 (Ugie @ Inverugie) | 23 | 0.284 | 0.133 | 0.030 | 1.304 | 0.415 |
| 53008 (Avon @ Great Somerford) | 40 | 0.252 | 0.200 | 0.208 | 0.164 | 0.442 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.506 | 0.449 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.788 | 0.476 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.456 | 0.477 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 1.285 | 0.536 |
| 28020 (Churnet @ Rocester) | 28 | 0.150 | 0.010 | 0.125 | 0.823 | 0.537 |
| 28008 (Dove @ Rocester Weir) | 40 | 0.152 | 0.238 | 0.166 | 1.333 | 0.550 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 0.960 | 0.565 |
| | | | | | | |
| Total | 1028 | | | | | |
| Weighted means | | 0.236 | 0.200 | 0.186 | | |

SEMINGTON

**Catchment:** Semington Brook at Semington
**Station No:** 53002
**NGR:** ST 907 605

**Description:** The station consists of a formalised trapezoidal section with cableway, which replaced the velocity-area station downstream. Flood records for the period prior to April 1970 are therefore poor. Some groundwater and surface water abstractions in catchment, and there is an operational mill upstream of the station. Flow measurement is imprecise for medium to high flows. The gauge is affected by backing from the Avon, making this a very bad site for flood flow measurement. Catchment covers an area of approx. 154 $km^2$ and is predominantly rural. Catchment is flat and low-lying, with geology mainly clay with Chalk at the eastern boundaries.

**Data comments:** The updated AMAX dataset provided by the Agency, provides 29 years of annual maxima series data for the period between 1970 and 2002 excluding 1988 to 1991. The data was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 17.9 $m^3/s$. Three of the AMAX values exceed this upper limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 153.62 | 0.991 | 0.34 | 0.564 | 712 | 33.0 | 0.0261 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 17.129 $m^3/s$ |
| **Annual Maxima** | 14.255 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 15.719 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 13.193 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.0261, slightly urbanised, adjustment required.

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – problems with backing up of flow from river Avon**

| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 14.3 | 14.3 | 14.3 | 14.3 | 17.1 |
| 5 | 19.1 | 18.9 | 19.1 | 16.4 | 22.7 |
| 10 | 22.2 | 21.8 | 22.2 | 17.5 | 26.2 |
| 25 | 26.2 | 25.5 | 26.2 | 18.8 | 30.6 |
| 50 | 29.3 | 28.3 | 29.3 | 19.6 | 33.9 |
| 100 | 32.5 | 31.1 | 32.5 | 20.4 | 37.4 |
| 200 | 35.8 | 34.1 | 35.9 | 21.2 | 40.9 |

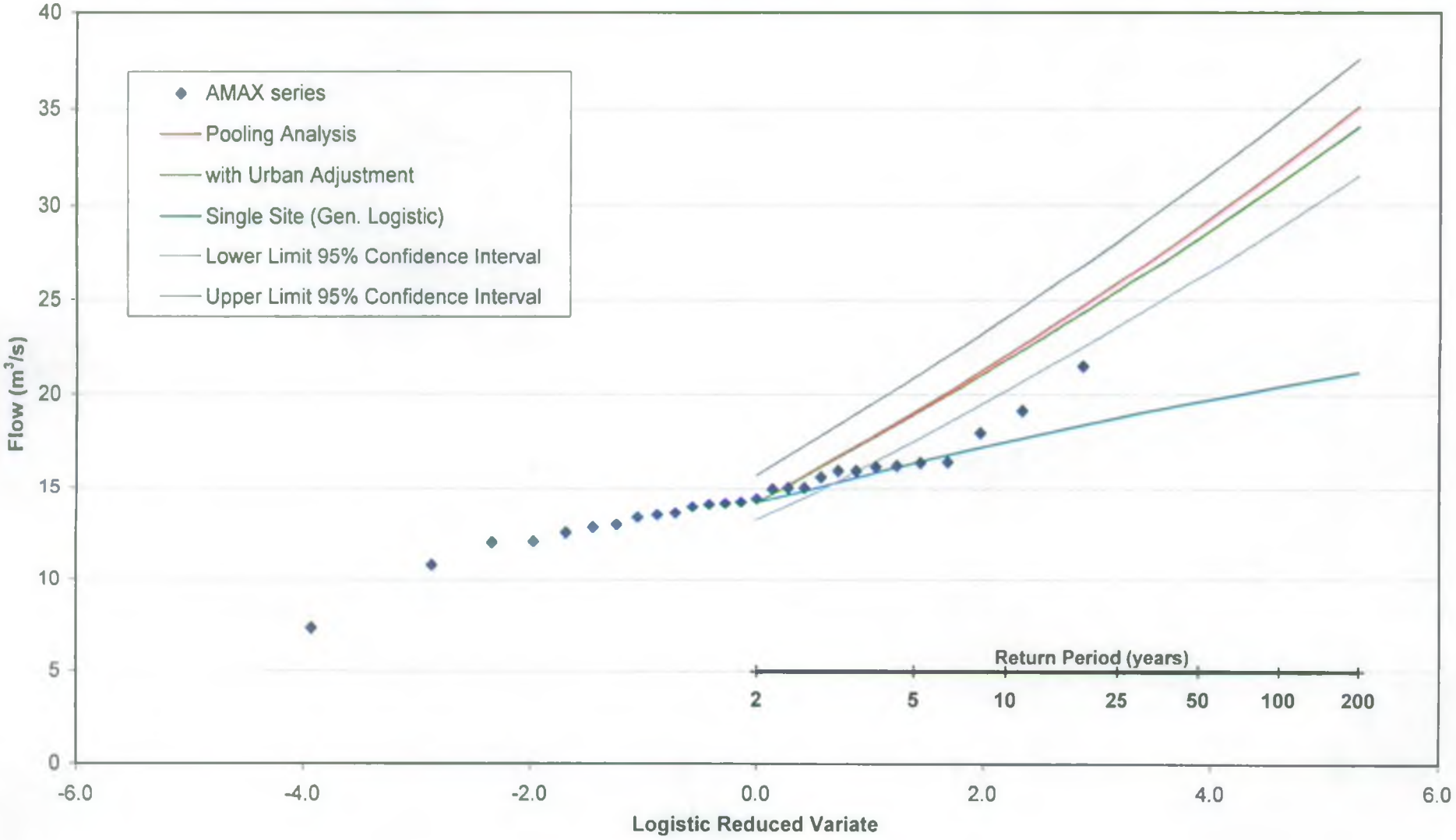
**Summary of Analysis:** AMAX series EDA reveals there to be one outlier to the data series, Dec 1979, which was a large flood event in the region. All data retained without review. The pooling group review results in a slight increase in flood peaks for an estimated return period.

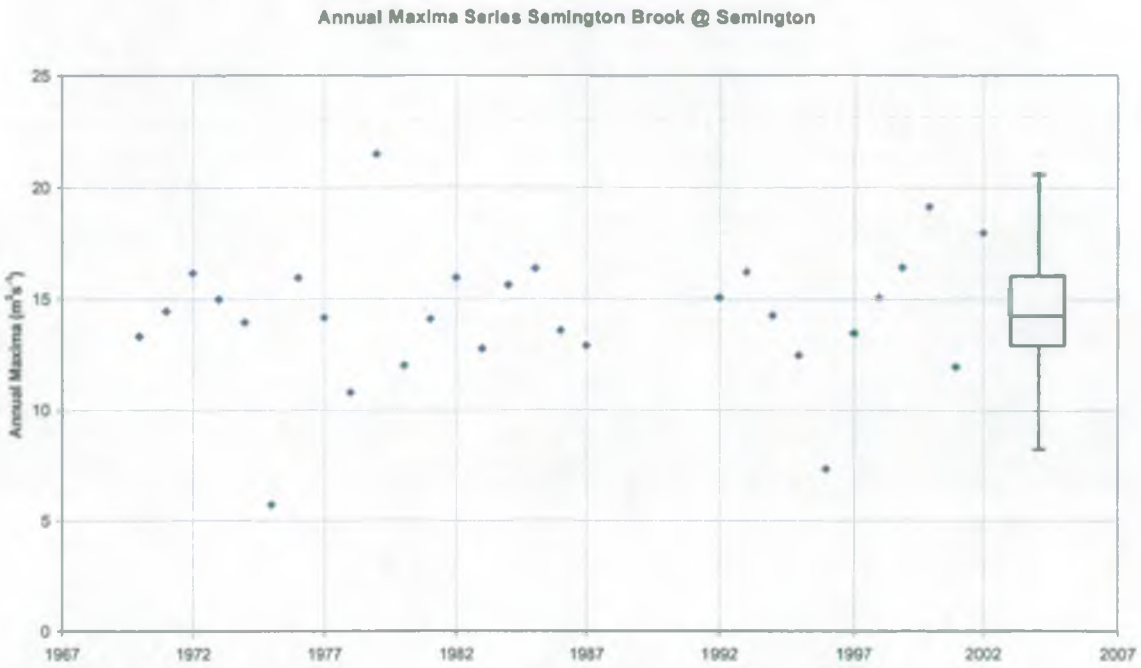
**Selection of Method:** From the plot of the Flood Frequency Curves none fit the AMAX data well. At low return periods the single site fitting appears to fit the AMAX data well. However once flows reach 16 $m^3/s$, there is a change in the AMAX data and the reviewed pooling group with urban adjustment may be more suitable as a first approximation.

*Special considerations:* FEH techniques may not be suitable for this site, due to the poor accuracy of the rating and the wide error bands, largely associated with backing up from the River Avon, there remains high uncertainty regarding the estimation of high flows at this site and the urban nature of the catchment. Potential uncertainties in the existing stage-discharge relationship should be investigated and an alternative flood frequency estimation method may need to be employed.

*Adopt:* Pooled Analysis Urban Adjusted (as shaded above)
*Model parameters:* N. A.

## Semington Brook @ Semington






Annual Maxima series for Semington

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 11 Jun 71 | 13.319 | | 26 Dec 85 | 16.370 |
| 04 Feb 72 | 14.435 | | 04 Apr 87 | 13.575 |
| 06 Dec 72 | 16.151 | | 01 Feb 88 | 12.904 |
| 27 Sep 74 | 14.989 | | 18 Dec 92 | 15.053 |
| 20 Jan 75 | 13.947 | | 13 Oct 93 | 16.210 |
| 26 Sep 76 | 5.719 | | 29 Jan 95 | 14.255 |
| 30 Nov 76 | 15.954 | | 22 Dec 95 | 12.472 |
| 28 Jan 78 | 14.171 | | 17 Feb 97 | 7.340 |
| 01 Feb 79 | 10.789 | | 03 Jan 98 | 13.468 |
| 27 Dec 79 | 21.489 | | 01 Nov 98 | 15.053 |
| 03 Mar 81 | 12.009 | | 25 Dec 99 | 16.414 |
| 15 Mar 82 | 14.096 | | 30 Oct 00 | 19.128 |
| 09 Dec 82 | 15.954 | | 26 Jan 02 | 11.951 |
| 26 Jan 84 | 12.755 | | 01 Jan 03 | 17.958 |
| 21 Jan 85 | 15.620 | | | |

Q/QMED
Upper-tail fitted distribution
Upper-tail observed variates, Y


Stations
Record Length


L-CV, t2
L-dimension, t2




L-kurtosis, t4
L-dimension, t3

Relative frequency
VGAV


Relative frequency
FVAL


Relative frequency
SAVR


Relative frequency
PROPMST


Relative frequency
BPROST


Relative frequency
UPBOST

Semington Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 6.780 | 7.01 |
| Comment | The pooling group is strongly heterogeneous, and a review of the pooling group is essential | The pooling group is strongly heterogeneous, and a review of the pooling group is essential |
| Number of Station Years | 1116 | 1041 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is not included in the pooling group due to its high URBEXT value, 0.0261. All sites were checked to ensure that none reacted to the same rainfall events | Add five sites to the bottom of the pooling group to compensate for those that may be removed | 1116 | 6.78 |
| *Period of Record* | All sites except one, the Roden @ Stanton have an acceptable period of record. The Roden has only 5 years of data. | Remove the Roden @ Stanton. | 1111 | 6.82 |
| *FARL* | All sites have a FARL value of greater than 0.900, there are 2 possible outliers in the group., the South Esk @ Prestonholm (0.906), which has several reservoirs in the headwaters and the Nene Brampton @ St. Andrews (0.919), which has water extracted for 3 water supply reservoirs this affects the low flows. | Remove the South Esk @ Prestonholm ranked 32nd in the pooling group. Retain the Nene Brampton @ St Andrews until other factors have been looked at more closely | 1085 | 6.79 |
| *PROPWET/URBEXT* | All sites have a PROPWET value of below 0.6, there are 2 possible outliers, the Urie @ Pitcaple (0.530) and the Esk @ Musselborough (0.490)<br>There is a broad spread of URBEXT values throughout the pooling group, the subject site is not included in the pooling group due to it being highly urbanised, the Esk @ Musselborugh appears to be a possible outlier with regards to URBEXT values; as it has a high value, 0.0235. | Remove the Esk @ Musselborough, due to it being a possible outlier with regards to both PROPWET and URBEXT<br>Remove the Urie @ Pitcaple | 1041 | 7.01 |
| *Site Comments* | Comments were looked at for all sites in the pooling group, and no hydrological reasons were found for exclusion. | No action to be taken | 1041 | 7.01 |
| *Discordant Sites* | *(39025) Enbourne @ Brimpton*<br>The Enbourne @ Brimpton has a discordancy of 3.207, however there is no obvious hydrological reason to exclude it from the pooling group | No action | 1041 | 7.01 |
| *L Moments* | The Trothy @ Mitchel Troy and the Frome @ Yarkhill are possible outliers. | Retain both sites as no hydrological reason to remove. | 1041 | 7.01 |

## Semington Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 55018 (Frome @ Yarkhill) | 32 | 0.129 | -0.252 | 0.082 | 1.543 | 0.046 |
| 54040 (Meese @ Tibberton) | 28 | 0.161 | 0.137 | 0.256 | 0.985 | 0.168 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 0.651 | 0.197 |
| 68002 (Gowy @ Picton) | 30 | 0.105 | -0.220 | 0.156 | 2.055 | 0.202 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.202 | 0.236 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.841 | 0.270 |
| 20003 (Tyne @ Spilmersford) | 29 | 0.399 | 0.291 | 0.178 | 1.566 | 0.305 |
| 32007 (Nene Brampton @ st Andrews) | 53 | 0.227 | -0.033 | 0.057 | 0.344 | 0.359 |
| 33046 (Thet @ Red Bridge) | 26 | 0.284 | 0.075 | 0.155 | 0.408 | 0.369 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.316 | 0.372 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.760 | 0.374 |
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 0.683 | 0.376 |
| 33057 (Ouzel @ Leighton Buzzard) | 13 | 0.100 | -0.079 | 0.118 | 0.972 | 0.392 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 0.743 | 0.432 |
| 34001 (Yare @ Colney) | 29 | 0.249 | 0.160 | 0.099 | 0.542 | 0.434 |
| 68005 (Weaver @ Audlem) | 25 | 0.104 | -0.126 | 0.101 | 0.914 | 0.439 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.261 | 0.441 |
| 54016 (Roden @ Rodington) | 33 | 0.176 | 0.165 | 0.242 | 0.766 | 0.452 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.263 | 0.460 |
| 33051 (Cam @ Chesterford) | 24 | 0.256 | -0.072 | 0.071 | 0.756 | 0.464 |
| 30002 (Barlings Eau @ Langworth Bridge) | 21 | 0.221 | 0.115 | 0.221 | 0.323 | 0.482 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 3.207 | 0.507 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.114 | 0.508 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.655 | 0.509 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.844 | 0.523 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 1.646 | 0.529 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 1.093 | 0.536 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 2.012 | 0.539 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 2.374 | 0.544 |
| 30001 (Witham @ Claypole Mill) | 35 | 0.280 | 0.188 | 0.086 | 0.789 | 0.551 |
| 54041 (Tern @ Eaton on Tern) | 23 | 0.194 | 0.071 | 0.033 | 1.363 | 0.555 |
| 33063 (Little Ouse @ Knettishall) | 13 | 0.286 | -0.073 | 0.113 | 1.606 | 0.559 |
| 31010 (Chater @ Fosters Bridge) | 26 | 0.289 | 0.048 | 0.034 | 0.843 | 0.559 |
| 14001 (Eden @ Kemback) | 26 | 0.215 | 0.022 | 0.104 | 0.074 | 0.569 |
| 54020 (Perry @ Yeaton) | 26 | 0.137 | 0.095 | 0.224 | 0.995 | 0.576 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 2.295 | 0.582 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.196 | 0.585 |
| | | | | | | |
| Total | 1041 | | | | | |
| Weighted means | | 0.223 | 0.065 | 0.147 | | |

SOMERTON

**Catchment:** Cary at Somerton
**Station No:** 52011
**NGR:** ST 498 291

**Description:** The current full range gauging station comprises a compound crump weir. It is a velocity-area station for flows greater than 4.4m$^3$/s, downstream, summer weed growth affects stability of the stage-discharge relationship. Rating curve is also unstable at high flows. Bank contains all but exceptional floods, and there is storage in fields before river reaches bankfull, but no apparent bypassing of the station. Catchment is predominantly rural and covers an area of 85km$^2$. Catchment geology is mainly lower Lias and Oolitic limestone.

**Data comments:** The updated AMAX dataset provided by the Environment Agency gave 38 years of annual maxima series data, for the period 1965 to 2002 inclusive. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 12.0 m3/s. This is exceeded 6 times in the AMAX series leading to quality issues if estimating higher return period flows. The gauge rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 84.83 | 1.00 | 0.37 | 0.533 | 716 | 37.9 | 0.0127 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 11.129 m$^3$/s |
| **Annual Maxima** | 9.693 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 10.848 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 9.003 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment required.

**Urbanisation:** URBEXT < 0.025, essentially rural, no adjustment required.

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – FEH unsuitable due to flood storage in catchment**

| Return period (years) | Pooled Analysis | | Single Site | | Climate Change Sensitivity Analysis |
|---|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Logistic | Logisitc x 20% |
| 2 | 9.7 | 9.7 | 9.7 | 9.7 | 11.6 |
| 5 | 13.4 | 13.4 | 11.2 | 11.5 | 13.6 |
| 10 | 15.7 | 15.8 | 12.0 | 12.3 | 14.7 |
| 25 | 17.7 | 18.8 | 12.8 | 13.4 | 16.1 |
| 50 | 21.1 | 21.2 | 13.4 | 14.2 | 17.1 |
| 100 | 23.6 | 23.7 | 14.0 | 15.1 | 18.1 |
| 200 | 26.2 | 26.3 | 14.5 | 15.9 | 19.1 |

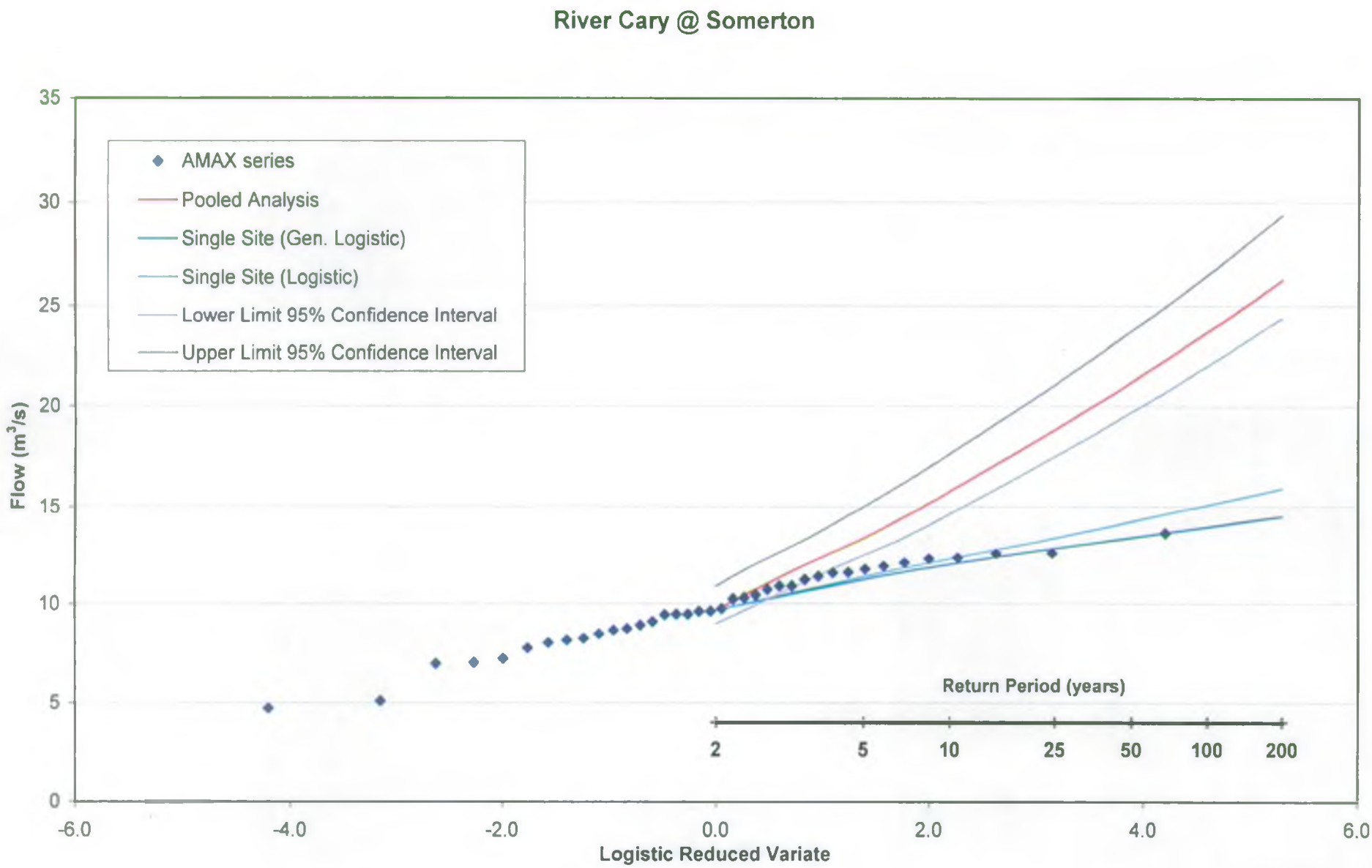
**Summary of Analysis:** Assessment of AMAX series revealed the data set to have no significant outliers. The pooling group review did not have a significant effect estimating return period flows.

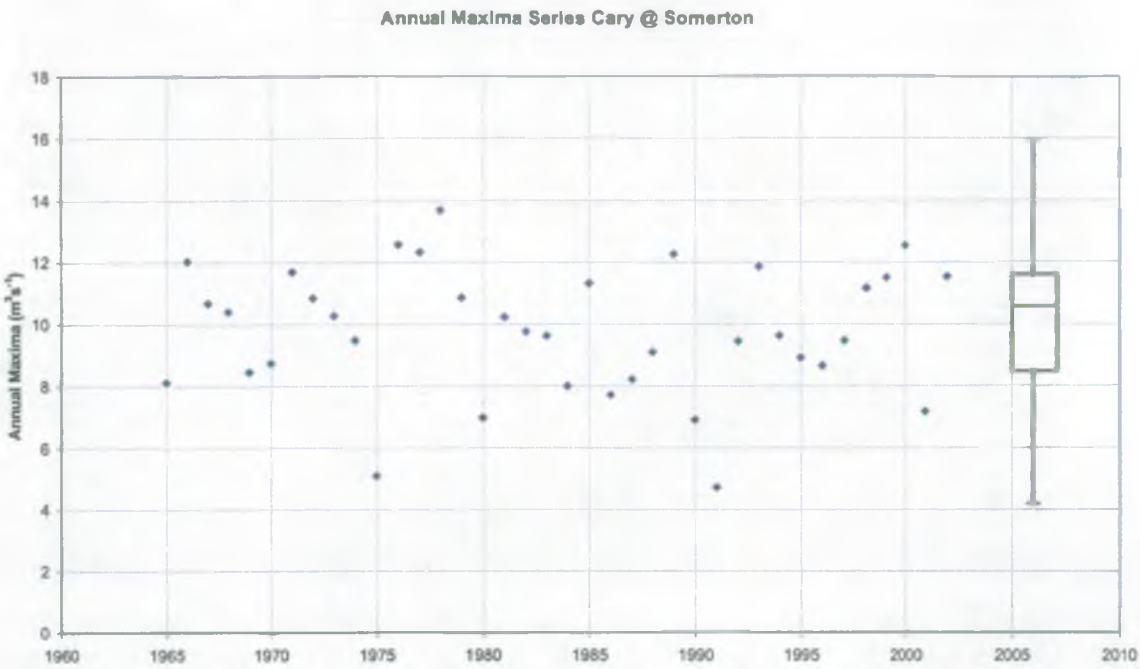
**Selection of Method:** Separation between pooled analysis flood frequency curve and the AMAX data is significant. The shape of the AMAX data appears to suggest that the catchment storage is significant and is attenuating the peak flows. FEH recommends that pooled analysis is used in preference to the single site analysis, in this case it is more appropriate to use the single site Logistic data, as the flood frequency curve is similar to the actual observed data and the Gen Logistic single site fitting is upper bounded.

*Special considerations:* The influence of catchment storage on peak flows should be investigated. If demonstrated to be significant an alternative flood frequency estimation method will be required. Use single site fitting as a indication of flood peaks.

*Adopt:* Single Site General Logistic Curve (as shaded)

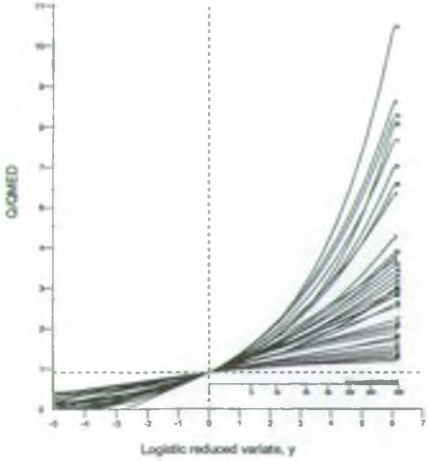
*Model parameters:* $\beta = 1.20$, $\kappa = 0.089$

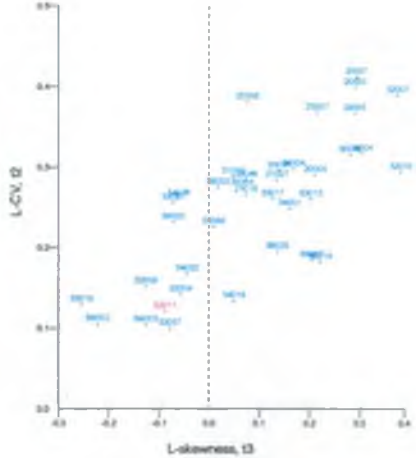

River Cary @ Somerton
AMAX series
Pooled Analysis
Single Site (Gen. Logistic)
Single Site (Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
35
30
25
20
15
10
5
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200

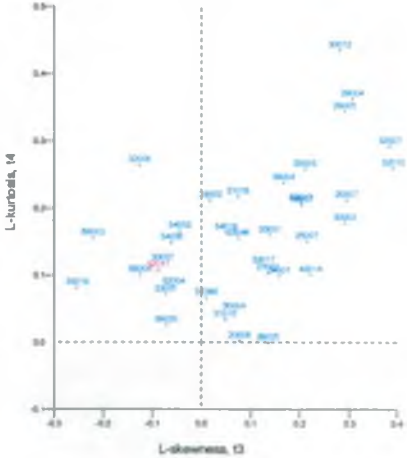


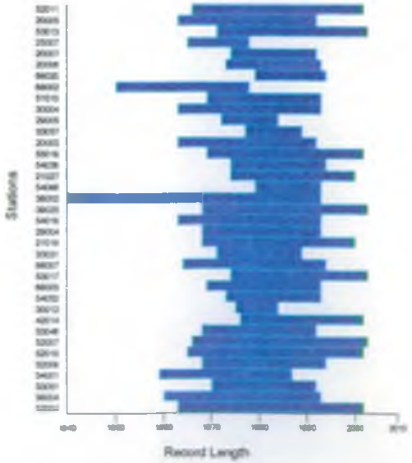

Annual Maxima series for Somerton

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 10 Feb 66 | 8.13 | | 09 Feb 85 | 7.80 |
| 06 Nov 66 | 12.04 | | 26 Dec 85 | 11.32 |
| 11 Jul 68 | 10.68 | | 01 Jan 87 | 7.71 |
| 25 Dec 68 | 10.41 | | 01 Feb 88 | 8.22 |
| 23 Nov 69 | 8.46 | | 26 Feb 89 | 9.10 |
| 22 Jan 71 | 8.74 | | 21 Dec 89 | 12.26 |
| 08 Mar 72 | 11.69 | | 10 Jan 91 | 6.91 |
| 08 Dec 72 | 10.85 | | 09 Jan 92 | 4.72 |
| 29 Sep 74 | 10.28 | | 09 Jan 93 | 9.46 |
| 20 Jan 75 | 9.48 | | 13 Oct 93 | 11.85 |
| 22 Mar 76 | 5.09 | | 10 Nov 94 | 9.63 |
| 01 Dec 76 | 12.57 | | 22 Dec 95 | 8.92 |
| 23 Feb 78 | 12.32 | | 07 Aug 97 | 8.66 |
| 31 May 79 | 13.67 | | 05 Jan 98 | 9.47 |
| 28 Dec 79 | 10.85 | | 25 Sep 99 | 11.16 |
| 11 Mar 81 | 6.98 | | 26 Dec 99 | 11.50 |
| 16 Mar 82 | 10.23 | | 31 Oct 00 | 12.54 |
| 10 Dec 82 | 9.756 | | 27 May 02 | 7.18 |
| 27 Jan 84 | 9.623 | | 15 Nov 02 | 11.53 |


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

Relative frequency
FAIL


Relative frequency
AREA


Relative frequency
PROPMET


Relative frequency
SAAR


Relative frequency
URBEXT


Relative frequency
BFIHOST

Somerton Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 6.95 | 7.23 |
| Comment | The pooling group is strongly heterogeneous, and a review is essential | The pooling group is strongly heterogeneous, and a review is essential |
| Number of Station Years | 1121 | 1006 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is at the top of the pooling group. There is one case of duplication of data, on the Gowy. The Gowy @ Huxley duplicates data from both the Gowy @ Bridge Trafford and Gowy @ Picton | Remove the Gowy @ Huxley, it duplicates data provided by other stations in the pooling group, and the site comments mention that it should be treated with caution until the high flow rating has been established. | 1102 | 7.44 |
| *Period of Record* | All sites have a good of period of record, with the exception of the Stainfield Beck @ Stainfield; this had a 10-year record. All other sites have a record that is 13 years or longer. | No action | | |
| *FARL* | There are 6 sites that could be seen as possible outliers with regards to FARL value, these seemed to be in two groups<br>Blithe @ Hamstall Ridware (0.876), Nene Brampton @ St Andrews (0.919), Meese @ Tiberton (0.935). And the second group, Thet @ Red Bridge ( 0.956), Wincham Brook @ Lostock Gralam (0.958) and the Yare @ Colney (0.966)<br>All other sites in the pooling group have a FARL value of between 0.980 and 1.000 | Remove the Blith @ Hamstall Ridware, Nene Brampton @ St Andrews and Meese @ Tiberton as excessive outliers. | 1006 | 7.28 |
| *PROPWET/URBEXT* | All sites in the pooling group have a PROPWET value of less than 0.5, The Ancholme @ Bishopbridge has a PROPWET value of 0.260 and might be considered as a minor outlier. | No action to be taken. | 1006 | 7.28 |
| *Site Comments* | A review of comments of all sites was made, and no reasons to remove any sites were apparent | No action to be taken | 1006 | 7.28 |
| *Discordant Sites* | There are no discordant sites | No action to be taken. | 1006 | 7.28 |
| *L Moments* | All sites are hydrologically acceptable, and there are no obvious outliers in the group | No action to be taken | 1006 | 7.28 |

## Somerton Pooling Group – Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 0.725 | 0.000 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.345 | 0.168 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.276 | 0.200 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 0.713 | 0.203 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.140 | 0.229 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.650 | 0.240 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 0.816 | 0.307 |
| 68002 (Gowy @ Picton) | 30 | 0.105 | -0.220 | 0.156 | 1.685 | 0.311 |
| 31010 (Chater @ Fosters Bridge) | 26 | 0.289 | 0.048 | 0.034 | 0.842 | 0.316 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.610 | 0.329 |
| 29005 (Rase @ Bishopbridge) | 13 | 0.367 | 0.290 | 0.344 | 1.367 | 0.342 |
| 33057 (Ouzel @ Leighton Buzzard) | 13 | 0.100 | -0.079 | 0.118 | 1.019 | 0.348 |
| 20003 (Tyne @ Spilmersford) | 29 | 0.399 | 0.291 | 0.178 | 1.023 | 0.360 |
| 55018 (Frome @ Yarkhill) | 32 | 0.129 | -0.252 | 0.082 | 1.582 | 0.361 |
| 54036 (Isbourne @ Hinton on the Green) | 21 | 0.261 | -0.060 | 0.149 | 0.903 | 0.367 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.275 | 0.391 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.297 | 0.401 |
| 38002 (Ash @ Mardock) | 53 | 0.275 | 0.018 | 0.212 | 0.686 | 0.428 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 2.178 | 0.433 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 0.989 | 0.438 |
| 29004 (Ancholme @ Bishopbridge) | 26 | 0.317 | 0.306 | 0.362 | 1.419 | 0.474 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.255 | 0.482 |
| 33031 (Broughton Brook @ Broughton) | 19 | 0.296 | 0.139 | 0.160 | 0.102 | 0.484 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 1.367 | 0.486 |
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.177 | 0.493 |
| 68005 (Weaver @ Audlem) | 25 | 0.104 | -0.126 | 0.101 | 0.931 | 0.504 |
| 54052 (Bailey Brook @ Ternhill) | 22 | 0.167 | -0.044 | 0.166 | 0.408 | 0.520 |
| 30012 (Stainfield Beck @ Stainfield) | 10 | 0.315 | 0.281 | 0.435 | 2.585 | 0.543 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 2.300 | 0.551 |
| 33046 (Thet @ Red Bridge) | 26 | 0.284 | 0.075 | 0.155 | 0.166 | 0.564 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.211 | 0.565 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.732 | 0.571 |
| 32008 (Nene/Kislingbury @ Dodford) | 27 | 0.152 | -0.127 | 0.264 | 2.035 | 0.573 |
| 34001 (Yare @ Colney) | 29 | 0.249 | 0.160 | 0.099 | 0.510 | 0.610 |
| 33051 (Cam @ Chesterford) | 24 | 0.256 | -0.072 | 0.071 | 0.863 | 0.611 |
| 38004 (Rib @ Wadesmill) | 35 | 0.298 | 0.168 | 0.238 | 0.246 | 0.611 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 0.575 | 0.619 |
| | | | | | | |
| Total | 1006 | | | | | |
| Weighted means | | 0.249 | 0.078 | 0.150 | | |

STANLEY

**Catchment:** Marden at Stanley
**Station No:** 53013
**NGR:** ST 955 729

**Description:** The structure is a Trapezoidal critical depth flume. Full range station. Prior to Jul 1969 level only station. Bridge 100 - 150m u/s causes throttling at high flows. Backing up of flow may be occurring. Minor surface water abstractions and discharges in catchment. The catchment is predominantly clay, with Chalk outcrop in the headwaters. The catchment is essentially rural.

**Data comments:** An updated AMAX data set provided by the Environment Agency gave 33 years of annual maxima series data for the period 1970 to 2002 inclusive. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 40.1m$^3$/s, which is exceeded once in the AMAX series. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 99.28 | 0.98 | 0.34 | 0.56 | 724 | 32.4 | 0.024 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 12.09 m$^3$/s |
| **Annual Maxima** | 15.77 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 20.12 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 13.93 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

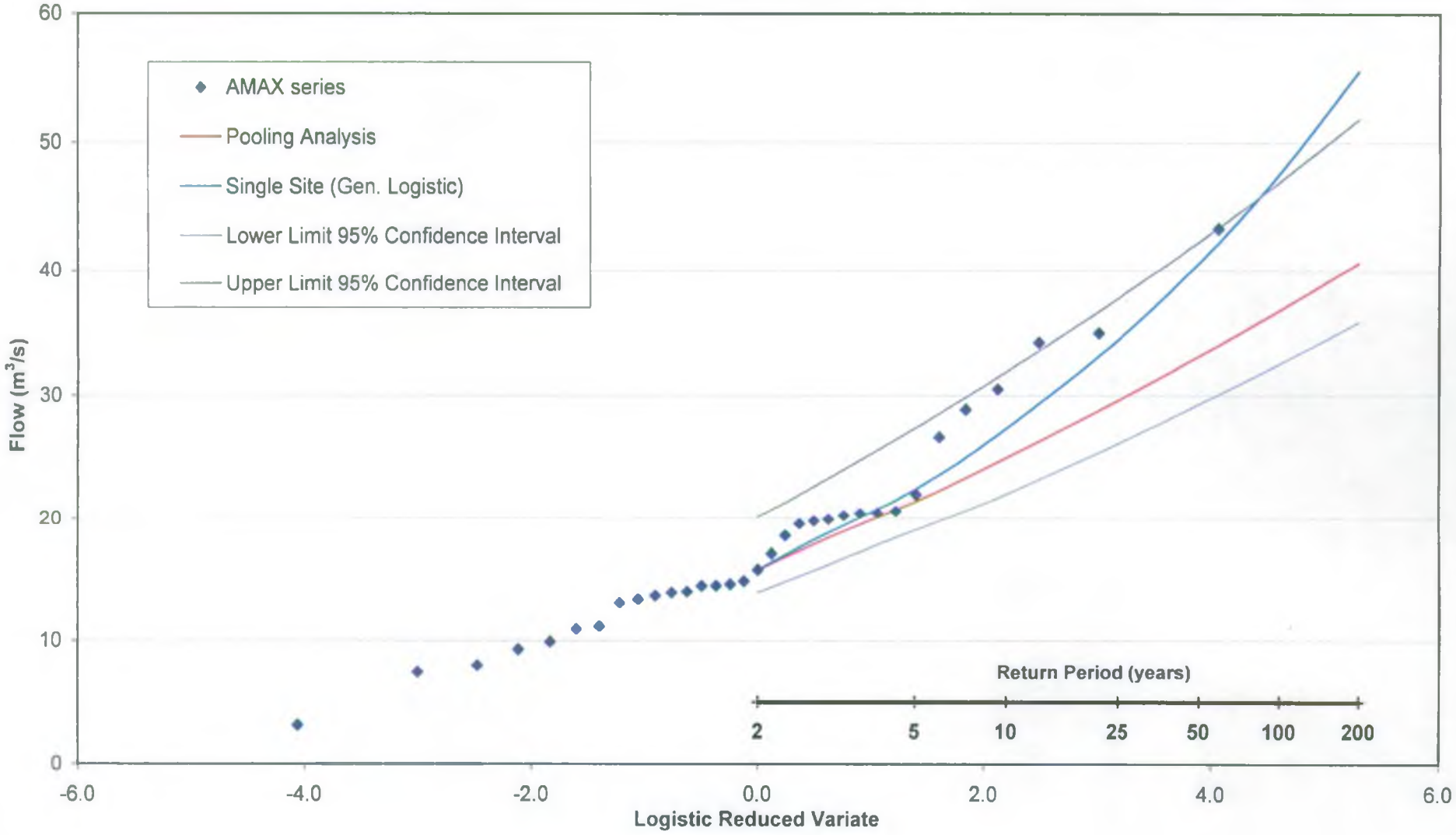
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 15.8 | 15.8 | 15.8 | 18.9 |
| 5 | 21.7 | 21.4 | 22.5 | 25.7 |
| 10 | 25.4 | 25.0 | 27.4 | 29.9 |
| 25 | 30.3 | 29.6 | 34.5 | 35.4 |
| 50 | 34.0 | 33.1 | 40.6 | 39.5 |
| 100 | 38.0 | 36.8 | 47.6 | 43.9 |
| 200 | 42.1 | 40.6 | 55.5 | 48.4 |

**Summary of Analysis:** AMAX series EDA reveals three outliers to the data:- 1970, 1979 and 2000. All events are retained without review. There is a small reduction in the predicted flood flows following the review of the pooling group.

**Selection of Method:** The single site Gen. Logistic gives a better approximation to the AMAX series. However, Table 8.3 in FEH volume 3 states that pooled analysis should prevail in this case as the site analysis is for confirmation only.

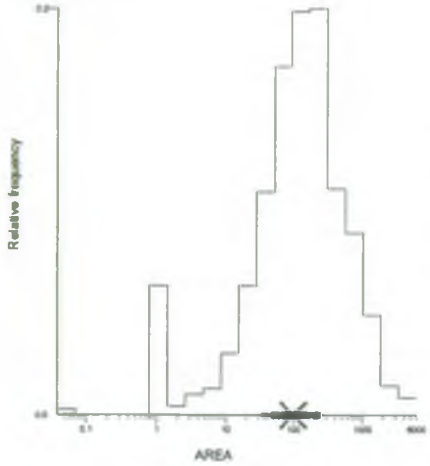
*Special considerations:* None
*Adopt:* Pooled Analysis (as shaded above)
*Model parameters:* $\beta = 0.247$ $\kappa = -0.068$

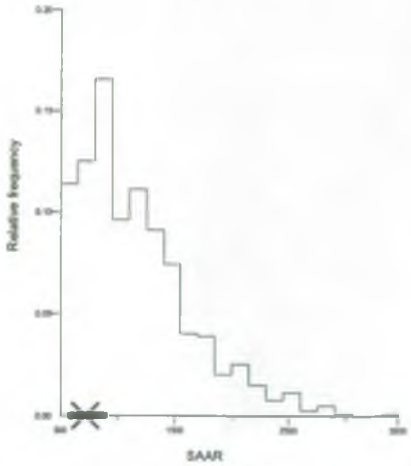
## Marden at Stanley

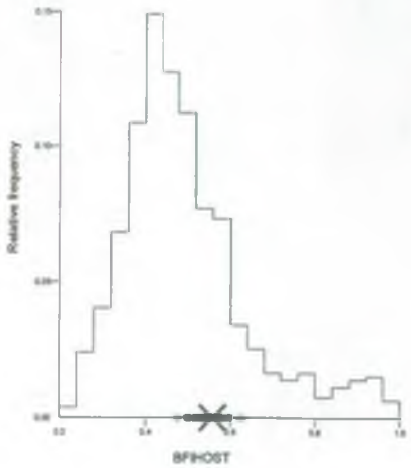


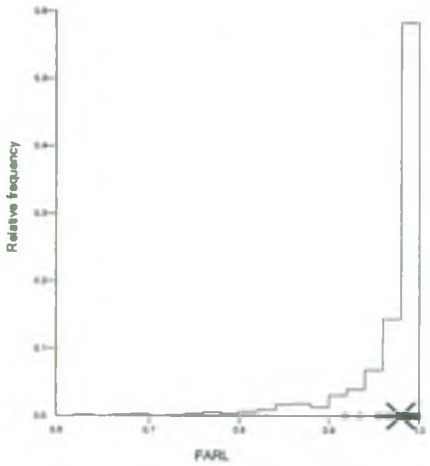
Annual Maxima series for Stanley

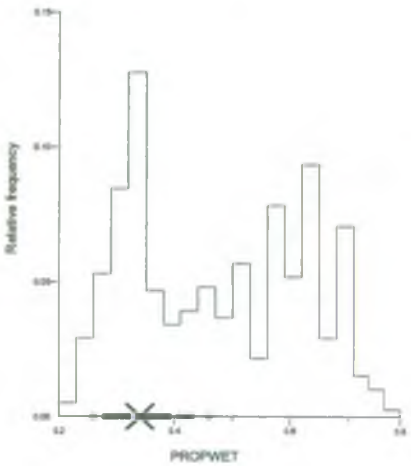
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 11 Jun 71 | 34.221 | | 01 Feb 88 | 10.893 |
| 04 Feb 72 | 20.626 | | 18 Oct 88 | 14.863 |
| 27 Jun 73 | 11.121 | | 03 Feb 90 | 22.050 |
| 09 Feb 74 | 20.223 | | 07 Mar 91 | 9.262 |
| 20 Jan 75 | 19.507 | | 07 Apr 92 | 7.976 |
| 01 Dec 75 | 3.145 | | 18 Dec 92 | 19.894 |
| 24 Feb 77 | 17.026 | | 05 Jan 94 | 26.641 |
| 09 Dec 77 | 9.863 | | 27 Jan 95 | 13.906 |
| 30 May 79 | 20.451 | | 20 Dec 95 | 15.771 |
| 27 Dec 79 | 34.981 | | 24 Feb 97 | 7.438 |
| 12 Mar 81 | 13.988 | | 03 Jan 98 | 13.660 |
| 15 Mar 82 | 13.369 | | 21 Oct 98 | 20.410 |
| 10 Dec 82 | 13.082 | | 03 Apr 00 | 18.474 |
| 16 Jan 84 | 14.489 | | 30 Oct 00 | 43.308 |
| 21 Jan 85 | 14.472 | | 26 Jan 02 | 14.624 |
| 24 Dec 85 | 30.487 | | 01 Jan 03 | 28.832 |
| 27 Feb 87 | 19.751 | | | |

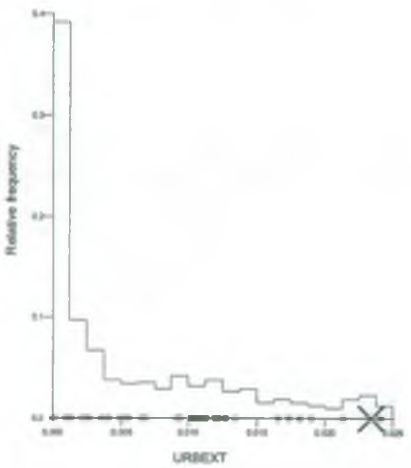

Relative frequency
AREA

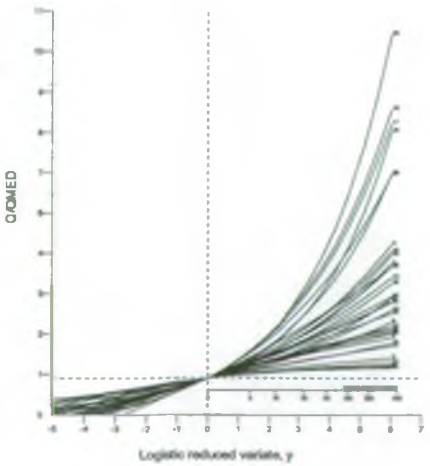

Relative frequency
SAAR

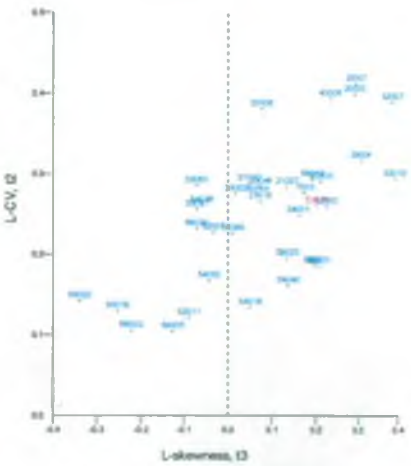

Relative frequency
BFIHOST

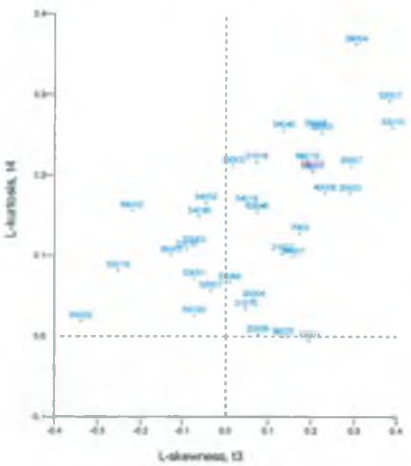

Relative frequency
FARL

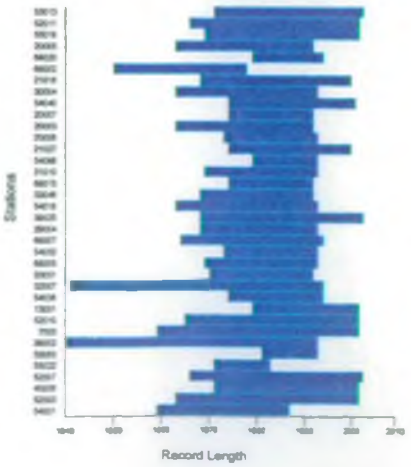

Relative frequency
PROPWET


Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Stanley Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 7.84 | 7.60 |
| Comment | A review of the pooling group is essential | A review of the pooling group is essential |
| Number of Station Years | 1124 | 1037 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The site is ranked 1 in the pooling group. Other local sites have large areas and are therefore not represented in the pooling group. | None | 1124 | 7.84 |
| *Period of Record* | The period of record is good. Only one site has less than the recommended 8 years of data. Site number 29, The Roden at Stanton. | Remove the Roden at Stanton | 1119 | 8.12 |
| *FARL* | The site has a FARL of 0.98, and the pooling group has a range of 0.906 to 0.996. The outlier of the pooling group is 23rd ranked South Esk at Prestholm (19008) FARL = 0.906 | Remove The south Esk at Prestholm | 1093 | 7.55 |
| *PROPWET/URBEXT* | The site has a PROPWET of 0.34 with the pooling group having a 0.26 to 0.53. The outlier in the group is 40th ranked Urie at Pitcaple (110004) with a PROPWET of 0.53. | Remove the Urie at Pitcaple | 1078 | 7.76 |
| *Site Comments* | The 36th ranked Trothy at Mitchel Troy (55022) has a short record finishing in 1982.<br>13th Ranked Clow Beck at Croft (25007) was discontinued in 1980.<br>20th ranked Rase at Bishopbride (29005) has a record ceasing in 1983. Lack of modularity above 9m3/s and weed growth.<br>15th ranked Ouzel at Leighton Buzzard (33057) is subject to drowning and losses through infiltration | Retain Trothy at Mitchel Troy.<br>Remove Clow Beck at Croft<br>Remove Rase at Bishopbridge<br>Remove Ouzel at Leighton Buzzard | 1037 | 7.60 |
| *Discordant Sites* | *Bervie at Inverbevie (13001)*<br>The site is ranked 27th in the pooling group and has a wide variation in AMAX data. | Retain the Bervie at Inverbevie | 1037 | 7.60 |
| *L Moments* | 29004 (Ancholme at Bishopbridge) and 55022 (Trothy at Mitchel Troy) are both outliers. 55022 has a short record of only 10 years and 29004 has a large range of AMAX data. | Retain all sites | 1037 | 7.60 |

## Stanley Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.279 | 0.000 |
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 0.808 | 0.200 |
| 55018 (Frome @ Yarkhill) | 32 | 0.129 | -0.252 | 0.082 | 1.364 | 0.212 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.540 | 0.220 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 0.616 | 0.272 |
| 68002 (Gowy @ Picton) | 30 | 0.105 | -0.220 | 0.156 | 1.789 | 0.280 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.403 | 0.282 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.544 | 0.311 |
| 54040 (Meese @ Tibberton) | 28 | 0.161 | 0.137 | 0.256 | 1.423 | 0.327 |
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.285 | 0.340 |
| 20003 (Tyne @ Spilmersford) | 29 | 0.399 | 0.291 | 0.178 | 1.083 | 0.380 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.371 | 0.386 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.228 | 0.402 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.239 | 0.414 |
| 31010 (Chater @ Fosters Bridge) | 26 | 0.289 | 0.048 | 0.034 | 0.728 | 0.430 |
| 68015 (Gowy @ Huxley) | 19 | 0.293 | 0.192 | 0.217 | 0.251 | 0.436 |
| 33046 (Thet @ Red Bridge) | 26 | 0.284 | 0.075 | 0.155 | 0.138 | 0.463 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 1.010 | 0.482 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 2.266 | 0.497 |
| 29004 (Ancholme @ Bishopbridge) | 26 | 0.317 | 0.306 | 0.362 | 1.957 | 0.510 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 1.159 | 0.517 |
| 54052 (Bailey Brook @ Ternhill) | 22 | 0.167 | -0.044 | 0.166 | 0.510 | 0.530 |
| 68005 (Weaver @ Audlem) | 25 | 0.104 | -0.126 | 0.101 | 1.031 | 0.540 |
| 33051 (Cam @ Chesterford) | 24 | 0.256 | -0.072 | 0.071 | 0.555 | 0.542 |
| 32007 (Nene Brampton @ st Andrews) | 53 | 0.227 | -0.033 | 0.057 | 0.315 | 0.547 |
| 54036 (Isbourne @ Hinton on the Green) | 21 | 0.261 | -0.060 | 0.149 | 0.712 | 0.547 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 3.436 | 0.558 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.411 | 0.561 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.215 | 0.565 |
| 38002 (Ash @ Mardock) | 53 | 0.275 | 0.018 | 0.212 | 0.774 | 0.566 |
| 33063 (Little Ouse @ Knettishall) | 13 | 0.286 | -0.073 | 0.113 | 0.969 | 0.570 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 2.080 | 0.573 |
| | | | | | | |
| Total | 1037 | | | | | |
| Weighted means | | 0.237 | 0.069 | 0.144 | | |

SWITLBRIDGE

**Catchment:** Doniford Stream at Swill Bridge
**Station No:** 51001
**NGR:** ST 088 428

**Description:** Flat V weir (low flows) installed in Aug 1983. Prior to this velocity-area station with rock control. High flows measured from a gauging bridge constructed u/s of the weir. Flow data unavailable Aug-Dec 1983. The catchment is essentially rural and drains the Devonian/Triassic sandstones between Quantock and Brendon Hills

**Data comments:** An updated AMAX data set provided by the Environment Agency gave 36 years of annual maxima series data for the period 1966 to 2002 (Ex 1967) inclusive. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 45.4 $m^3/s$ which is exceeded twice in the AMAX series. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 74.38 | 0.991 | 0.35 | 0.63 | 911 | 27.6 | 0.0077 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 11.11 $m^3/s$ |
| **Annual Maxima** | 12.72 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 15.87 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 10.87 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory – review two peak outliers**

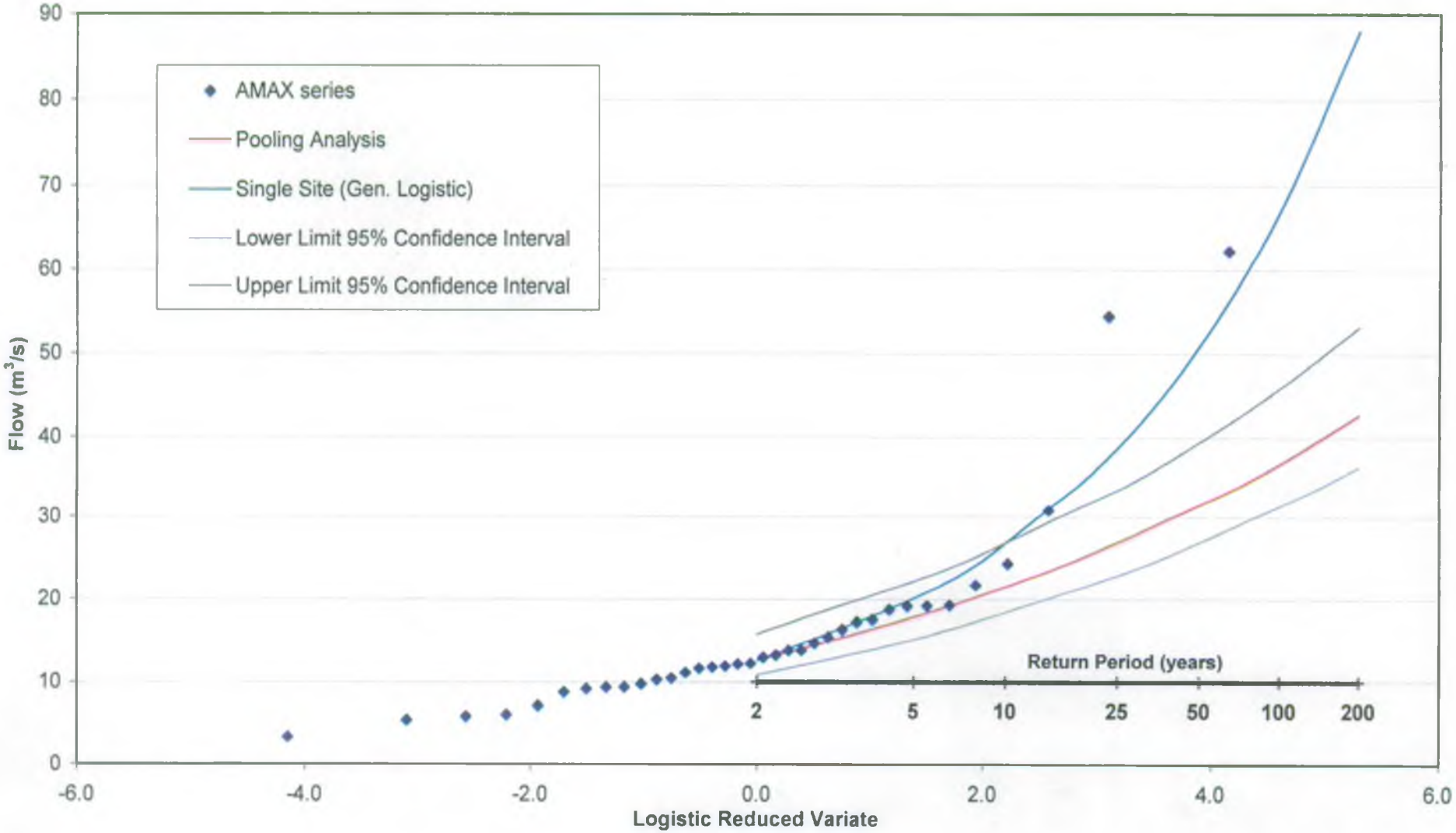
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 12.7 | 12.7 | 12.7 | 15.3 |
| 5 | 17.8 | 17.9 | 20.2 | 21.3 |
| 10 | 21.5 | 21.6 | 26.9 | 35.2 |
| 25 | 26.7 | 27.0 | 38.8 | 31.7 |
| 50 | 31.1 | 31.6 | 50.9 | 37.0 |
| 100 | 36.1 | 36.8 | 66.9 | 42.9 |
| 200 | 41.7 | 42.7 | 88.0 | 49.6 |

**Summary of Analysis:** AMAX series EDA reveals two outliers to the data. One in 2000 and the other in December 1979. Both are retained without review.

**Selection of Method:** Apart from the two outliers, 2000 and 1979, the reviewed pooling group reproduces the AMAX data. Including these, the single site General Logistic gives a better approximation. As a rough guide, the EA suggests that the weir is modular to around 45 $m^3/s$, which includes all the AMAX series except for the two outliers. For this reason, the reviewed pooling analysis has been adopted.

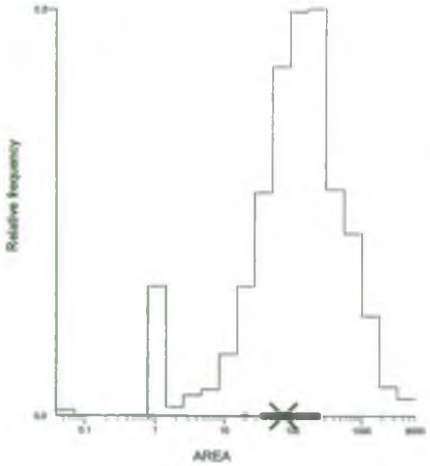
*Special considerations:* None
*Adopt:* Reviewed Pooled Analysis (as shaded above)
*Model parameters:* $\beta = 0.253$ $\kappa = -0.194$

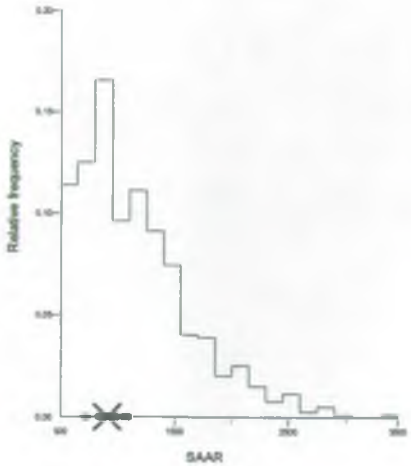
## Doniford Stream at Swill Bridge



Annual Maxima series for Swill Bridge

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 20 Feb 67 | 19.189 | | 26 Dec 85 | 9.362 |
| 22 Feb 69 | 16.410 | | 03 Apr 87 | 11.158 |
| 14 Jan 70 | 12.000 | | 31 Jan 88 | 9.765 |
| 31 Jan 71 | 19.290 | | 25 Feb 89 | 9.404 |
| 18 Feb 72 | 10.470 | | 01 Feb 90 | 13.944 |
| 06 Dec 72 | 13.115 | | 09 Jan 91 | 6.069 |
| 10 Feb 74 | 18.740 | | 09 Jan 92 | 5.864 |
| 26 Dec 74 | 11.880 | | 30 Nov 92 | 14.84 |
| 01 Dec 75 | 3.390 | | 20 Dec 93 | 10.308 |
| 14 Oct 76 | 17.580 | | 09 Nov 94 | 12.252 |
| 23 Feb 78 | 30.875 | | 21 Dec 95 | 8.781 |
| 13 Feb 79 | 9.200 | | 26 Jun 97 | 17.261 |
| 27 Dec 79 | 62.290 | | 05 Jan 98 | 13.969 |
| 16 Oct 80 | 21.790 | | 19 Jan 99 | 19.200 |
| 30 Dec 81 | 24.492 | | 18 Dec 99 | 15.522 |
| 16 May 83 | 12.326 | | 07 Dec 00 | 54.476 |
| 12 Jan 84 | 7.144 | | 26 Jan 02 | 11.711 |
| 23 Nov 84 | 5.414 | | 13 Nov 02 | 13.394 |


Relative frequency
AREA


Relative frequency
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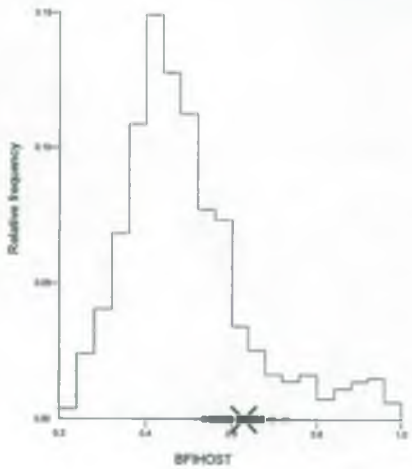
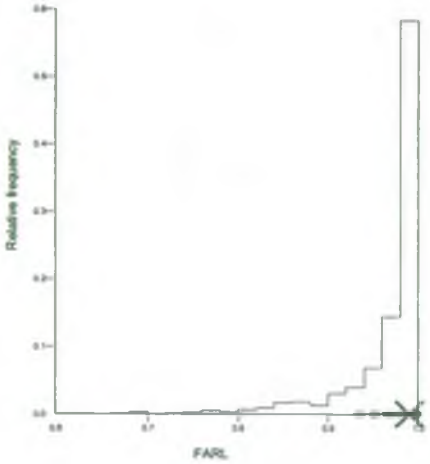
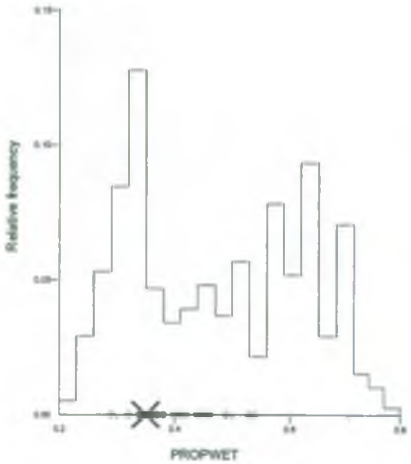
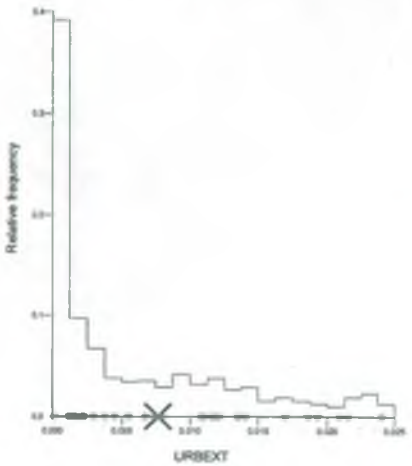
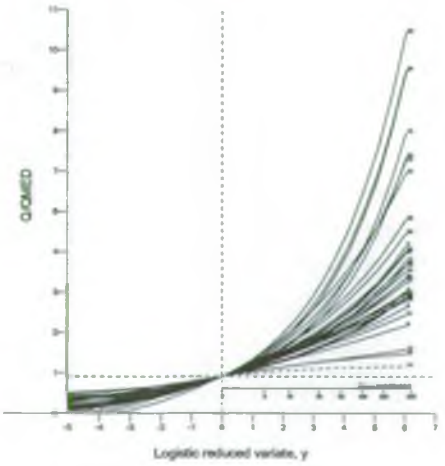
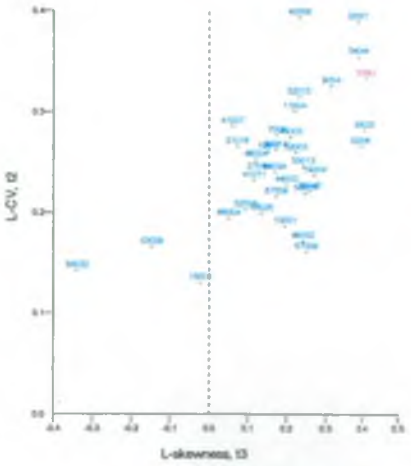

Relative frequency
BFIHOST

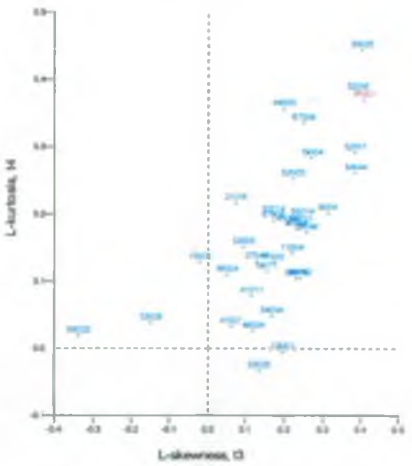

Relative frequency
FARL

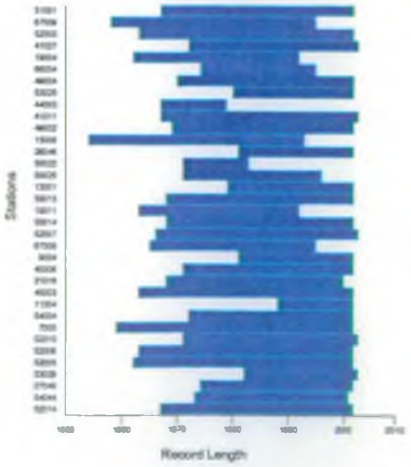

Relative frequency
PROPWET


Relative frequency
URBEXT


QDMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Swill Bridge Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.24 | 2.41 |
| Comment | A review of the pooling group is essential | A review of the pooling group is optional |
| Number of Station Years | 1168 | 1046 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The site is ranked 1 in the pooling group. The only local station in the pooling group (All the others are significantly smaller in area than the subject site) is 51003 (the Washford at Beggearn Huish) at position number 43. | None | 1168 | 3.30 |
| *Period of Record* | The period of record is good. Only one site has a 10 year record, the rest are greater than 13 years of record. | None | 1168 | 3.30 |
| *FARL* | The site has a FARL of 0.991, and the pooling group has a range of 0.843 to 0.999. The outliers of the pooling group are 4th ranked Congresbury Yeo at Iwood (52017) FARL = 0.89. and 7th ranked Chew at Compton Dando (FARL=0.843) | Remove both the chew at Compton Dando and Congresbury Yeo at Iwood. | 1096 | 2.49 |
| *PROPWET/URBEXT* | The site has a PROPWET of 0.35 with the pooling group having a 0.24 to 0.64. The outlier in the group is the 13th station 76010 (Petterill @ Green) with a PROPWET of 0.64. | Remove Petterill at Harraby Green | 1072 | 2.21 |
| *Site Comments* | The 4th ranked South Esk at Prestholm was closed in 1990 and the data is not fully reliable.<br>The 19th ranked Asker at Bridport (440033)was replaced by another station in 1978, thae data for which is not available.<br>The 15th ranked Trothy at Mitchel Troy (55022) has a short record finishing in 1982.<br>33rd in the pooling group is the Tone at Greenham (52014) which has an AMAX series finishing in 1980 as flows after this date are truncated | Remove the South Esk at Prestholm<br>Retain the Asker at Bridport<br>Retain Trothy at Mitchel Troy.<br>Retain The Tone at Greenham. | 1046 | 2.41 |
| *Discordant Sites* | *(55022) Trothy at Mitchel Troy*<br>10 years of data with one very low peak value in the known drought year of 1975. | Retain all sites along with data | 1046 | 2.41 |
| *L Moments* | Extreme outliers for the growth curves are the Trothy at Mitchel Troy(55022) (See discordant sites) and The Bourne at Hadlow (40006) which has an extreme ranges of AMAX data | Retain all sites and data. | 1046 | 2.41 |

## Swill Bridge Pooling Group – Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.173 | 0.000 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.150 | 0.191 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.189 | 0.223 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.063 | 0.429 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.456 | 0.467 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.324 | 0.471 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.665 | 0.489 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.797 | 0.490 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.455 | 0.495 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.224 | 0.496 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.787 | 0.499 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 1.352 | 0.507 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.488 | 0.518 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 4.914 | 0.521 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.899 | 0.533 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.299 | 0.578 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.122 | 0.601 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.133 | 0.611 |
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.382 | 0.612 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389. | 0.386 | 0.292 | 1.691 | 0.624 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 2.196 | 0.641 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 0.543 | 0.645 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 2.394 | 0.657 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.995 | 0.674 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.059 | 0.685 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.336 | 0.693 |
| 54034 (Dowles Brook @ Dowles) | 30 | 0.240 | 0.168 | 0.048 | 0.622 | 0.705 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.179 | 0.707 |
| 52015 (Land Yeo @ Wraxall Bridge) | 26 | 0.315 | 0.231 | 0.104 | 0.742 | 0.707 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.276 | 0.708 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.215 | 0.714 |
| 53028 (By Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 1.729 | 0.715 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.057 | 0.720 |
| 54044 (Tern @ Ternhill) | 30 | 0.355 | 0.387 | 0.262 | 1.001 | 0.726 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.094 | 0.729 |
| | | | | | | |
| Total | 1046 | | | | | |
| Weighted means | | 0.246 | 0.195 | 0.177 | | |

TELLISFORD

**Catchment:** Frome (Somerset) at Tellisford
**Station No:** 53007
**NGR:** ST 805 564

**Description:** This is a medium sized catchment (Hydrometric register 261.6km$^2$). Flow is gauged at a full range trapezoidal critical depth flume. The channel around the station is deeply incised, containing all but extreme floods. The gauge is purported not to drown. Substantial groundwater abstractions in catchment. Catchment geology is predominantly limestone with impermeable clays in Frome Gap and Coal Measures in Mells Valley. This is a responsive catchment, however detention lakes 5 to 6km u/s may truncate peaks. Land use: predominantly rural, with quarry activity.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 42 years. The data was not reviewed

**Gauge rating:** The upper limit of the gauge rating is 97.7 m$^3$/s, but there are no gaugings for confirmation of medium to high flow rating. The two largest recorded AMAX values exceed the upper limit. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 261.85 | 0.967 | 0.36 | 0.565 | 965 | 29.8 | 0.0163 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 41.635 m$^3$/s |
| **Annual Maxima** | 58.833 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 67.941 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 49.379 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%; site is not permeable, no adjustment applied

**Urbanisation:** URBEXT < 0.025, site is essentially rural, no adjustment applied.

**Climate variability:** Data record longer than 30 years, adjustment not required.

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – FEH may be unsuitable due to quarries in catchment**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Gen Logistic x 20% |
| 2 | 58.8 | 58.8 | 58.8 | 70.6 |
| 5 | 80.1 | 80.6 | 75.1 | 90.1 |
| 10 | 95.6 | 96.5 | 85.7 | 102.9 |
| 25 | 118.0 | 119.7 | 100.0 | 120.0 |
| 50 | 137.3 | 139.8 | 111.3 | 133.5 |
| 100 | 159.3 | 162.7 | 123.7 | 148.0 |
| 200 | 184.4 | 189.0 | 136.2 | 163.4 |

**Summary of Analysis:** There are no outliers to the series. There is a slight increase in the predicted flood flows following the pooling group review.

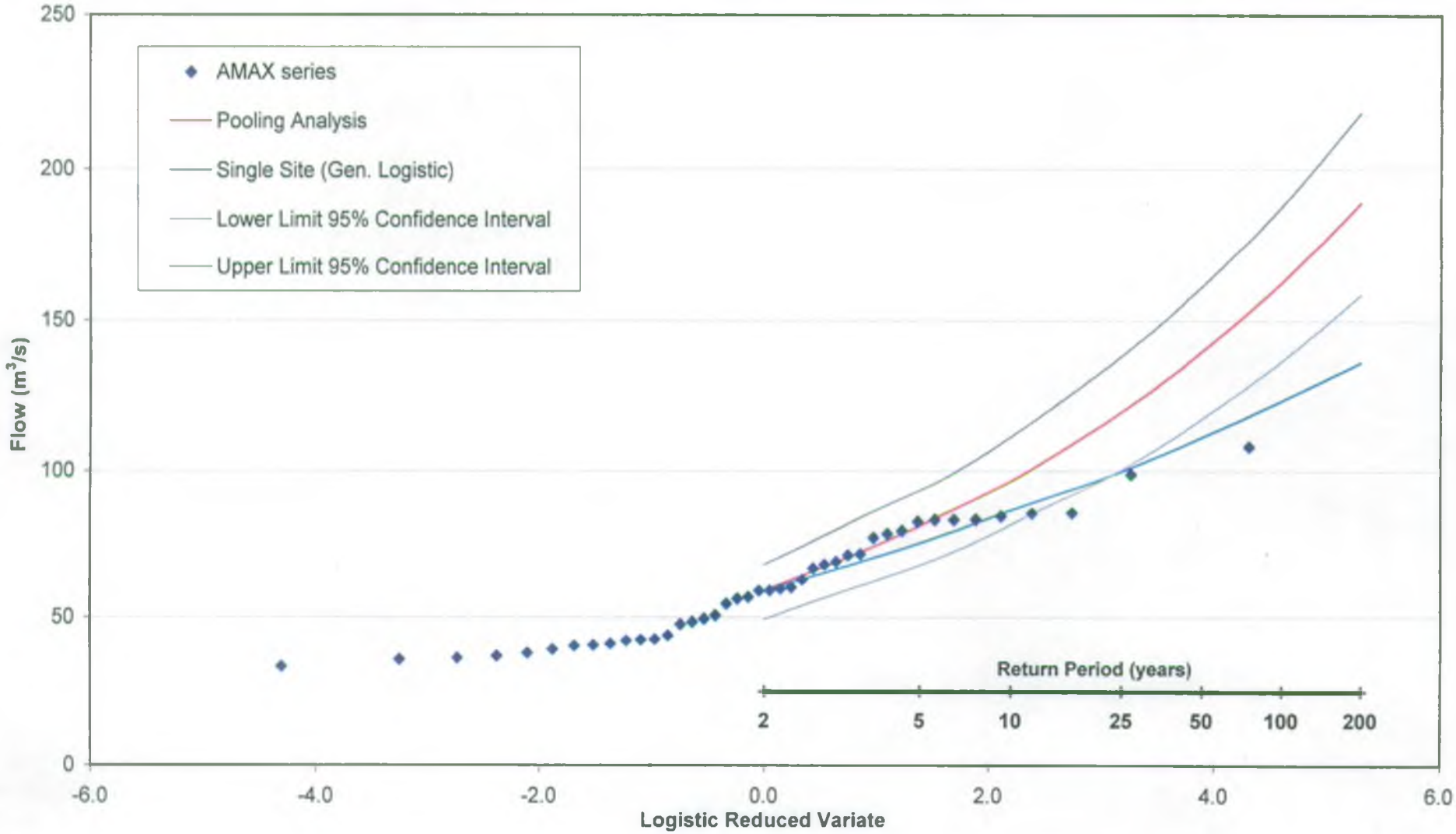
**Selection of Method:** The quarries in the upstream part of the catchment obviously have a great impact on higher return period flows, despite the relatively high value of FARL for this catchment. The single site fittings represent the AMAX series better than the pooled analysis which overestimates at high return periods. The single site analysis may be used as an initial estimate but further investigation is recommended to confirm the results.

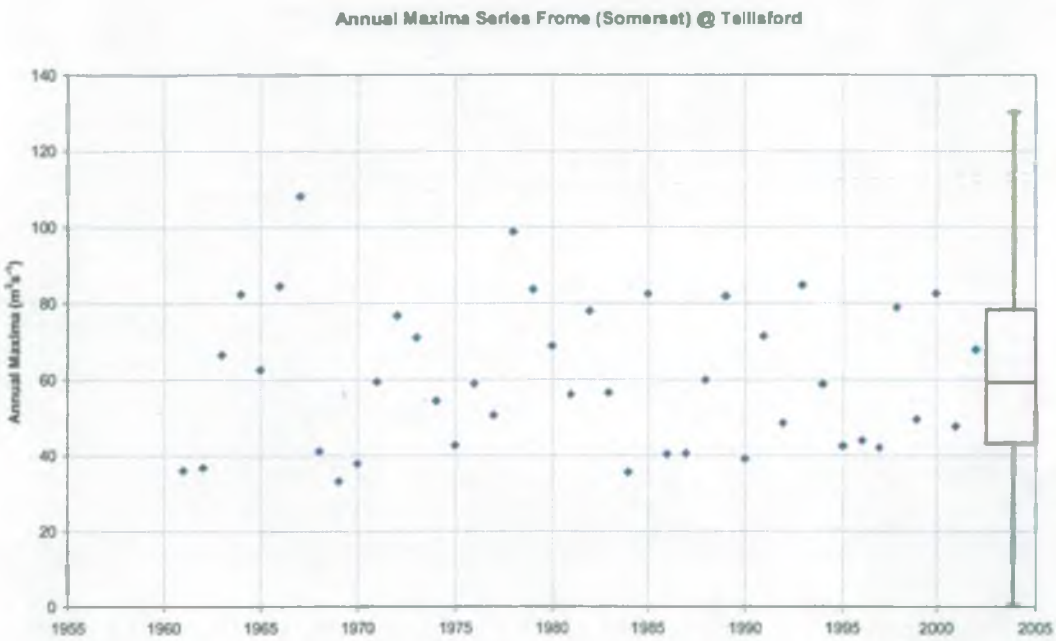
*Special considerations:* The impact of the quarries should be further investigated. Their influence on flood attenuation makes the use of FEH unsuitable and an alternative approach should be examined (such as rainfall-runoff).

*Adopt:* Single Site (General Logistic) as shaded above.

*Model parameters:* $\alpha = 0.184$, $\beta = 0.107$

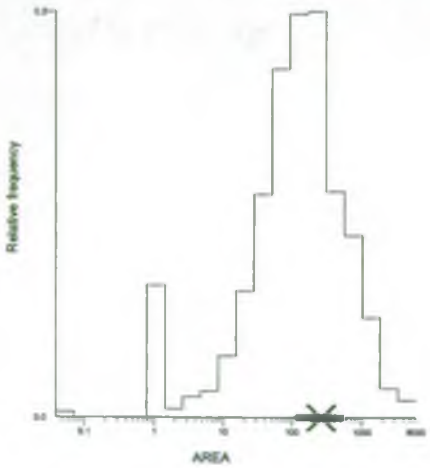
## River Frome (Somerset) at Tellisford

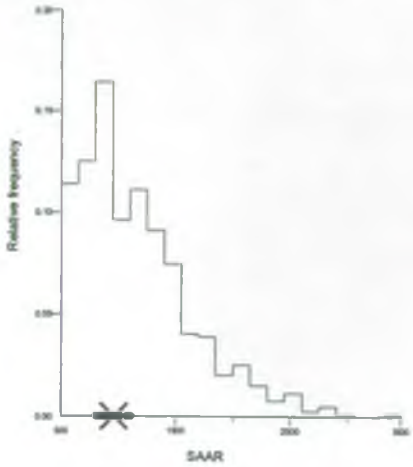


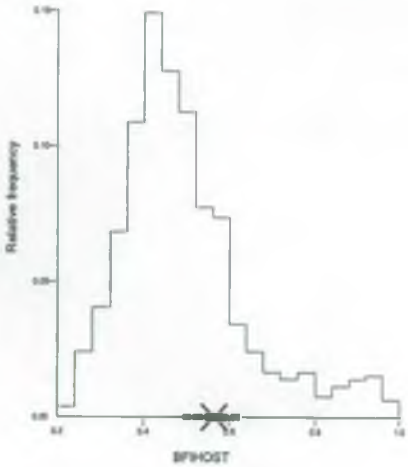


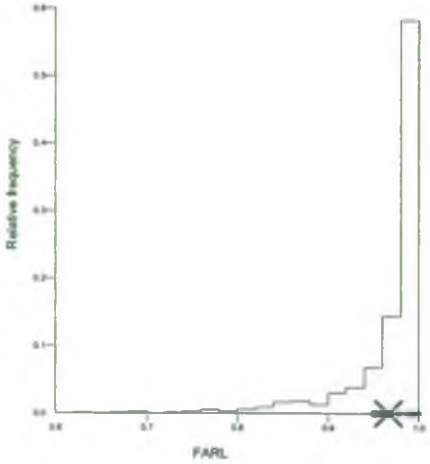

Annual Maxima series for Tellisford

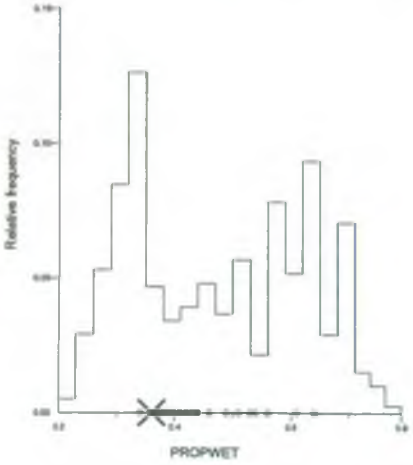
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 21 Jan 62 | 36.100 | | 31 Jan 83 | 77.989 |
| 17 Mar 63 | 36.810 | | 16 Jan 84 | 56.572 |
| 19 Nov 63 | 66.540 | | 22 Nov 84 | 35.617 |
| 02 Aug 65 | 82.486 | | 26 Dec 85 | 82.500 |
| 09 Dec 65 | 62.580 | | 11 Dec 86 | 40.348 |
| 05 Nov 66 | 84.580 | | 31 Jan 88 | 40.608 |
| 10 Nov 67 | 108.112 | | 09 Oct 88 | 59.904 |
| 22 Feb 69 | 41.119 | | 20 Dec 89 | 81.888 |
| 14 Dec 69 | 33.224 | | 18 Mar 91 | 39.159 |
| 20 Jan 71 | 37.893 | | 18 Sep 92 | 71.421 |
| 03 Feb 72 | 59.430 | | 10 Jan 93 | 48.473 |
| 06 Dec 72 | 76.749 | | 13 Oct 93 | 84.715 |
| 27 Sep 74 | 71.030 | | 29 Jan 95 | 58.787 |
| 28 Jan 75 | 54.368 | | 22 Dec 95 | 42.485 |
| 25 Sep 76 | 42.610 | | 17 Feb 97 | 43.944 |
| 30 Nov 76 | 58.880 | | 03 Jan 98 | 42.153 |
| 10 Dec 77 | 50.590 | | 31 Oct 98 | 78.986 |
| 30 May 79 | 98.800 | | 18 Apr 00 | 49.528 |
| 27 Dec 79 | 83.640 | | 30 Oct 00 | 82.586 |
| 09 Mar 81 | 68.830 | | 20 Feb 02 | 47.711 |
| 15 Mar 82 | 56.089 | | 14 Nov 02 | 67.797 |

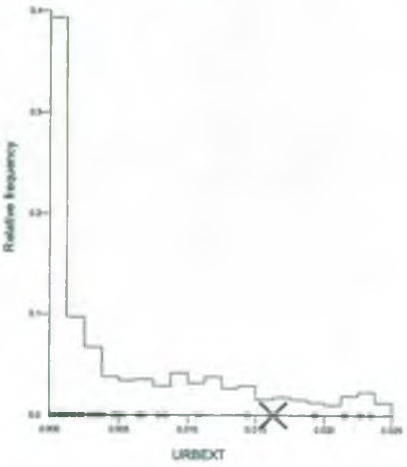

Relative frequency
AREA

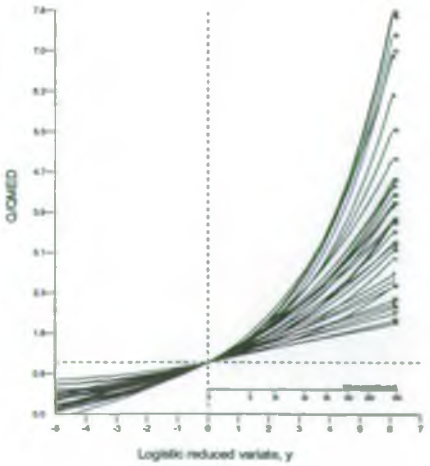

Relative frequency
SAAR

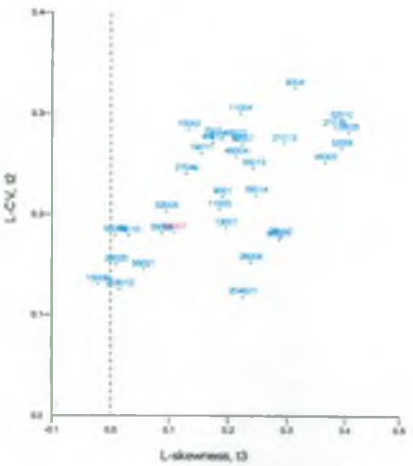

Relative frequency
BFIHOST

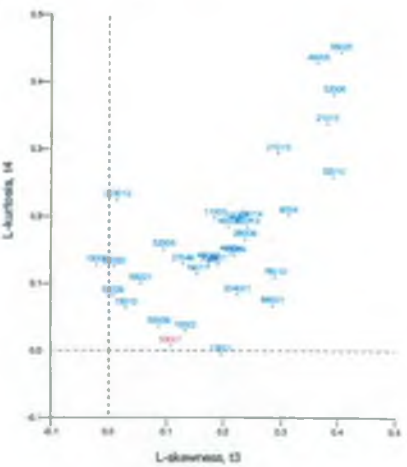

Relative frequency
FARL

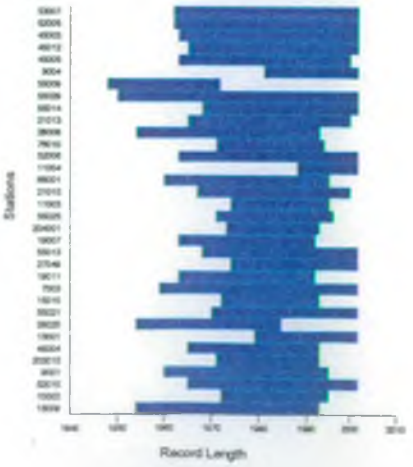

Relative frequency
PROPWET


Relative frequency
URBEXT


Q/QMED
Logistic reduced variate, y


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3


Stations
Record Length

## Tellisford Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 3.77 | 3.20 |
| Comment | Pooling group is strongly heterogeneous; review is essential. | Pooling group is strongly heterogeneous; review is essential. |
| Number of Station Years | 1210 | 1062 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | Any site which is situated upstream or downstream of the subject site is likely to be hydrologically similar and give good reason for promotion to a higher ranking in the pooling group. No sites adjacent to the subject site warrant promotion. | No change. | 1210 | 3.77 |
| *Period of Record* | All records have a minimum of 10 years and there is good data overlap. (Leven at Leven (17002) with a record length of 5 years data was removed during initial stage of forming pooling group). | No change. | 1210 | 3.77 |
| *FARL* | The value of FARL for the Somerset Frome at Tellisford is 0.967. The range of values for the pooling group is 0.843 – 1.000, with the lowest value from the Chew at Compton Dando (53004). This value of FARL suggests that the lake at the source of the Chew provides significant storage in the catchment and would attenuate flood flows. | Remove site. | 1166 | 3.44 |
| *PROPWET/URBEXT* | The values of PROPWET and URBEXT at the subject site are 0.36 and 0.0163, respectively. The range of values for the pooling group are PROPWET: 0.34 – 0.68 and URBEXT: 0.0002 – 0.0235. The higher values of PROPWET occur for Dulnain at Balnaan Bridge (8009), 0.68, and Carnowen at Carnowen Terrace (201005), 0.64. Dulnain is situated in the highlands and as such has soils which are wetter for a greater proportion of the time; Carnowen also has a high value of URBEXT, suggesting that the urban area has a strong influence on the proportion of time for which the soils are wet. | Remove both sites. | 1102 | 3.37 |
| *Site Comments* | All station comments have been reviewed to assess the quality of the flow data. Alyn at Pont-y-Capel (67008), ranked 10th, suffers major loss of water in the upstream 70km² due to mine and drainage tunnels. Clwyd at Pont-y-Cambwll (66001), ranked 16th, has significant storage in the upstream parts of the catchment. WINFAP has 30 and 36 years of data, respectively, for these sites. | Remove Alyn at Pont-y-Capel as the tunnels will have a significant influence on flooding.<br>Retain Clwyd at Pont-y-Cambwll and review later. | 1072 | 3.52 |
| *Discordant Sites* | *Trothy at Mitchel Troy (55022)*<br>WINFAP has 10 years of data for this site between 1970 and 1983, the water years 1979-1981 are missing. It is most likely that the discordancy of this site is due to the interupted and short spanning AMAX series. | Remove this site, as the pooling group contains many sites with longer and more reliable records. | 1062 | 3.20 |
| *L Moments* | The four main outliers to the L-moments and the growth curves are: Llynfi at Three Cocks (55025), Otter at Dotton (45005), Brue at Lovington (52010) and Yeo at Pen Mill (52006). While the subject site has little variability in AMAX data, these sites all exhibit series containing several high flows and therefore have high values of L-moments. | Retain all sites as theses are outliers due to high return period flows. | 1062 | 3.20 |

## Tellisford Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.750 | 0.000 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.372 | 0.134 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.378 | 0.152 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.523 | 0.177 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 2.114 | 0.177 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 1.184 | 0.193 |
| 55009 (Monnow @ Kentchurch) | 22 | 0.181 | 0.087 | 0.037 | 0.487 | 0.202 |
| 55029 (Monnow @ Grosmont) | 45 | 0.18 | 0.007 | 0.082 | 0.923 | 0.202 |
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.125 | 0.232 |
| 21013 (Gala Water @ Galashiels) | 37 | 0.271 | 0.295 | 0.295 | 0.522 | 0.273 |
| 28008 (Dove @ Rocester Weir) | 40 | 0.152 | 0.238 | 0.166 | 1.176 | 0.275 |
| 76010 (Petteril @ Harraby Green) | 24 | 0.178 | 0.289 | 0.109 | 1.611 | 0.301 |
| 52006 (Yeo @ Pen Mill) | 41 | 0.266 | 0.393 | 0.382 | 1.465 | 0.306 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.918 | 0.314 |
| 66001 (Clwyd @ Pont-y-cambwll) | 36 | 0.175 | 0.286 | 0.067 | 2.130 | 0.320 |
| 21015 (Leader Water @ Earlston) | 33 | 0.286 | 0.381 | 0.339 | 1.017 | 0.331 |
| 11003 (Don @ Bridge of Alford) | 21 | 0.205 | 0.185 | 0.198 | 0.130 | 0.351 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 2.234 | 0.381 |
| 204001 (Bush @ Seneirl) | 21 | 0.118 | 0.225 | 0.084 | 2.459 | 0.390 |
| 19007 (Esk @ Musselburgh) | 29 | 0.270 | 0.223 | 0.193 | 0.263 | 0.394 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.071 | 0.395 |
| 27049 (Rye @ Ness) | 28 | 0.241 | 0.129 | 0.130 | 0.330 | 0.402 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.495 | 0.403 |
| 7003 (Lossie @ Sheriffmills) | 45 | 0.277 | 0.174 | 0.128 | 0.646 | 0.407 |
| 15010 (Isla @ Wester Cardean) | 21 | 0.179 | 0.030 | 0.064 | 0.664 | 0.419 |
| 55021 (Lugg @ Butts Bridge) | 27 | 0.145 | 0.055 | 0.101 | 0.730 | 0.429 |
| 28020 (Churnet @ Rocester) | 28 | 0.150 | 0.010 | 0.125 | 1.192 | 0.445 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.620 | 0.453 |
| 45004 (Axe @ Whitford) | 29 | 0.257 | 0.213 | 0.145 | 0.205 | 0.456 |
| 203012 (Ballinderry @ Ballinderry Bridge) | 23 | 0.126 | 0.015 | 0.225 | 2.717 | 0.481 |
| 9001 (Deveron @ Avochie) | 35 | 0.218 | 0.191 | 0.130 | 0.054 | 0.492 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 0.993 | 0.514 |
| 10002 (Ugie @ Inverugie) | 23 | 0.284 | 0.133 | 0.030 | 1.708 | 0.549 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 1.794 | 0.566 |
| | | | | | | |
| Total | 1062 | | | | | |
| Weighted means | | 0.227 | 0.207 | 0.176 | | |

TADWBRIDGE

**Catchment:** Biss at Trowbridge
**Station No:** 53029
**NGR:** ST 854 579

**Description:** Crump profile Flat V weir, 7.13m wide, set in a deep culvert with vertical walls. Weir gauges low flows, whilst higher flows are gauged via a rectangular concrete rated section. Good approach, large d/s fall, but backing up of flow occurs due to debris d/s. Moderate influence on low flows by abstractions and discharges. Runoff figures suggest topographical and hydrological catchment areas do no coincide. Moderate relief catchment situated along the Frome gap. Drains the Chalk scarp to the SE. Underlying geology – Jurassic clays. Predominantly rural; arable farming. Contains Westbury.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX series record length 19 years. The data has not been reviewed.

**Gauge rating:** The rating has not been reviewed. Upper limit of rating 17.6 $m^3/s$ which is only just exceeded by the highest recorded AMAX value. There is high uncertainty attached to medium and high flows.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 77.64 | 0.986 | 0.35 | 0.528 | 760 | 34.5 | 0.045 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 11.805 $m^3/s$ |
| **Annual Maxima** | 11.416 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 13.247 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 10.180 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT = 0.045, slightly urbanised: adjustment required

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

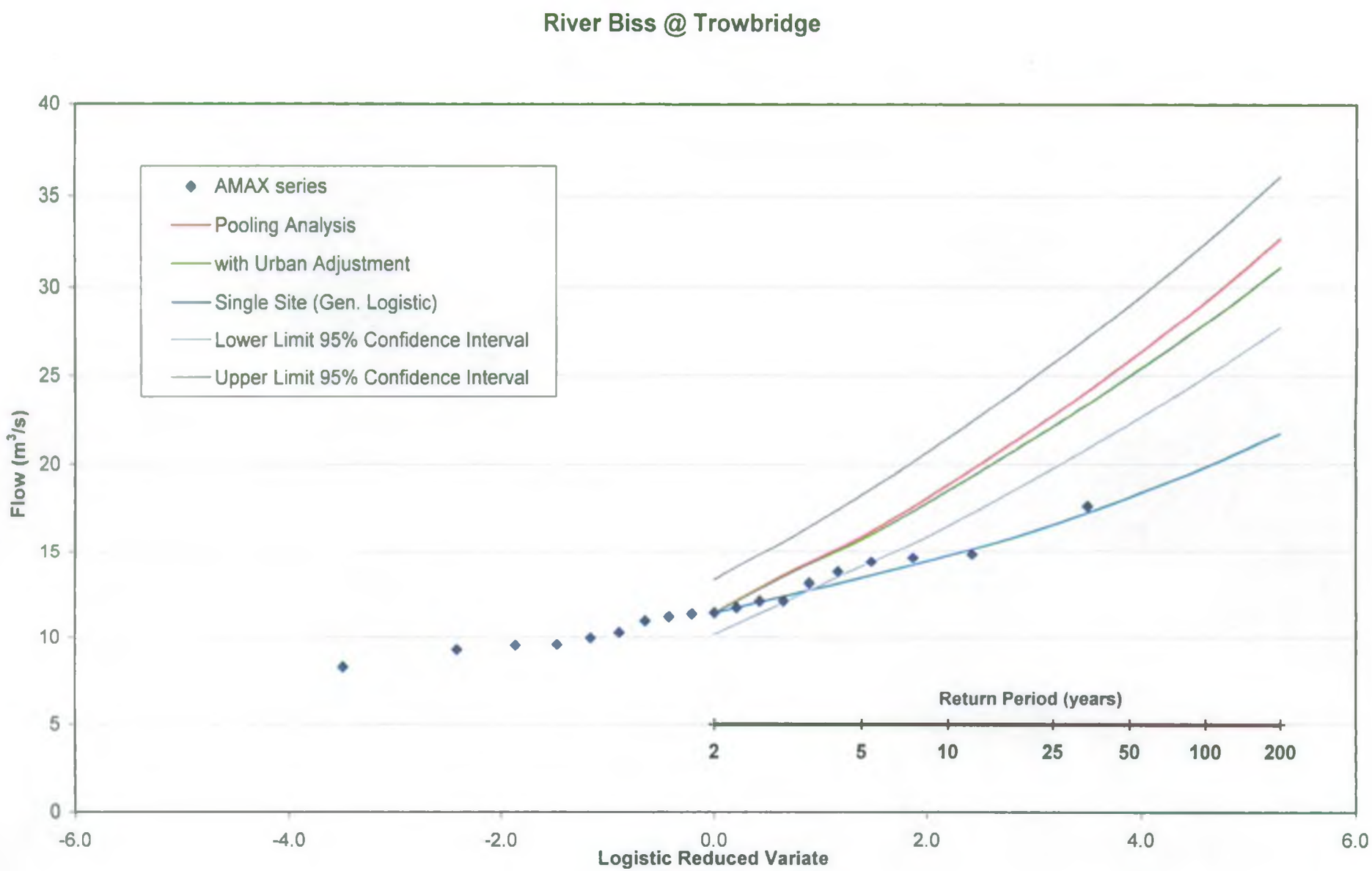
**Flood Frequency:** **Less than satisfactory – problems with catchment area and chalk influence**

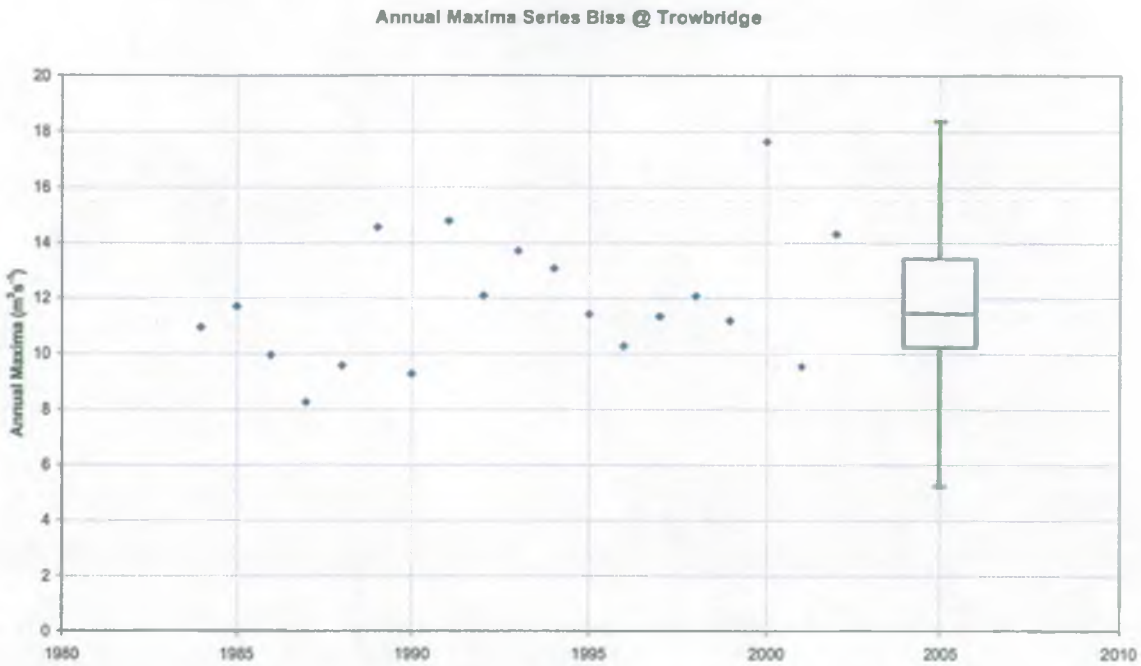
| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 11.4 | 11.4 | 11.4 | 11.4 | 13.7 |
| 5 | 15.9 | 15.9 | 15.8 | 13.4 | 18.9 |
| 10 | 18.9 | 18.8 | 18.5 | 14.7 | 22.2 |
| 25 | 22.8 | 22.8 | 22.1 | 16.6 | 26.6 |
| 50 | 25.9 | 25.9 | 25.0 | 18.1 | 30.0 |
| 100 | 29.3 | 29.2 | 28.0 | 19.8 | 33.5 |
| 200 | 32.9 | 32.7 | 31.1 | 21.7 | 37.3 |

**Summary of Analysis:** AMAX series EDA reveals that there are no outliers in the data series. The AMAX series does not have a very steep growth curve as a result the pooled analysis FFCs all over estimate flood frequency at the higher return periods.

**Selection of Method:** The Hydrometric Register suggests that there are discrepancies between the topographical and hydrological catchment which may influence the flood frequency estimation and the shape of the AMAX series indicates that the drainage of the Chalk scarp is influencing the runoff. Urban adjusted pooled analysis is recommended with recommendation for investigation into runoff influences in the catchment.

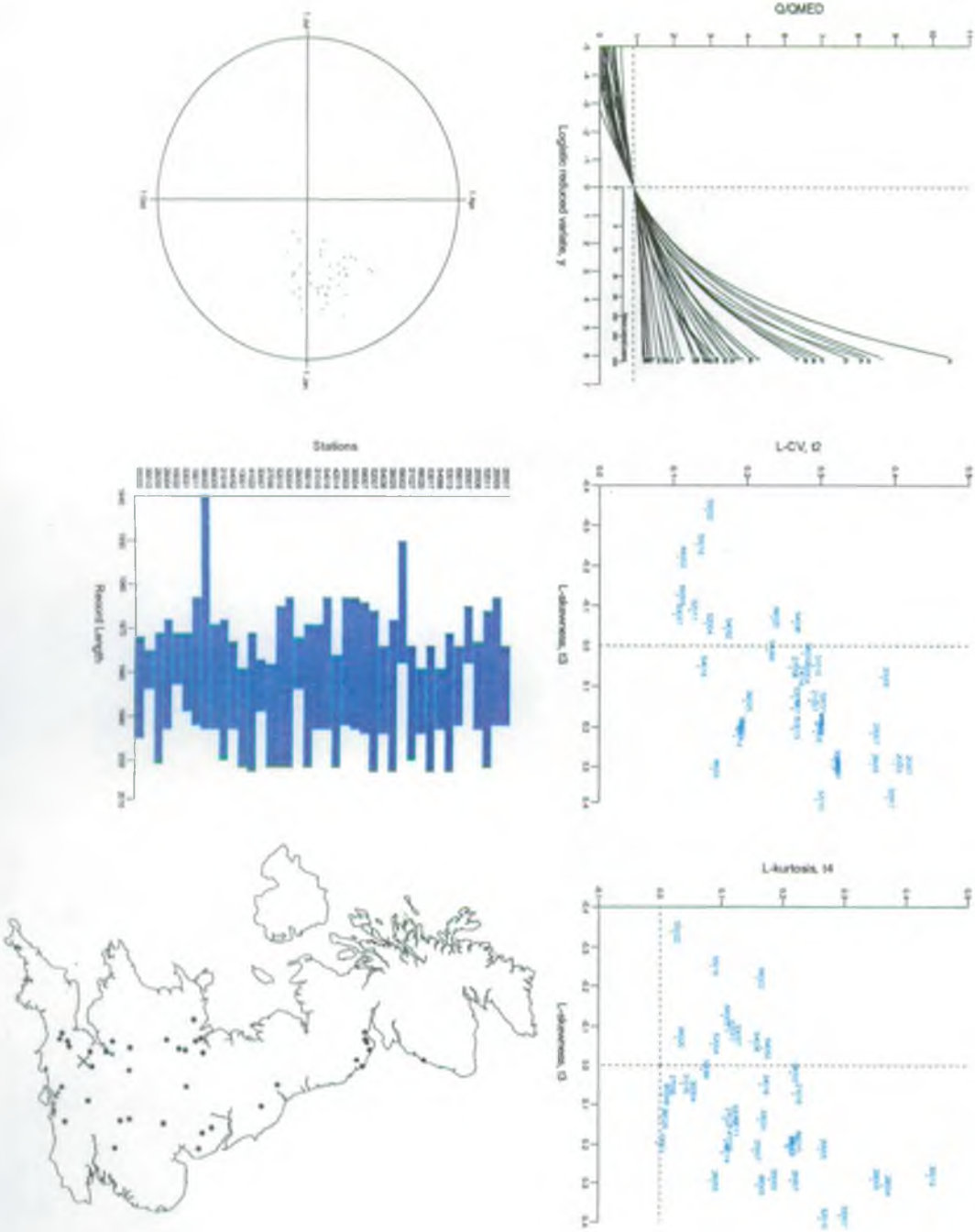
*Special considerations:* None
*Adopt:* Pooled Analysis Urban Adjusted (as shaded above)
*Model parameters:* N.A.


River Biss @ Trowbridge
AMAX series
Pooling Analysis
with Urban Adjustment
Single Site (Gen. Logistic)
Lower Limit 95% Confidence Interval
Upper Limit 95% Confidence Interval
Flow (m³/s)
40
35
30
25
20
15
10
5
0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Logistic Reduced Variate
Return Period (years)
2
5
10
25
50
100
200




## Annual Maxima series for Trowbridge

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 21 Jan 1985 | 10.947 | | 29 Jan 1995 | 13.053 |
| 29 Jan 1986 | 11.702 | | 22 Dec 1995 | 11.416 |
| 04 Apr 1987 | 9.956 | | 17 Feb 1997 | 10.277 |
| 01 Feb 1988 | 8.261 | | 03 Jan 1998 | 11.344 |
| 14 Mar 1989 | 9.579 | | 31 Oct 1998 | 12.064 |
| 20 Dec 1989 | 14.568 | | 03 Apr 2000 | 11.189 |
| 09 Jan 1991 | 9.272 | | 30 Oct 2000 | 17.631 |
| 18 Sep 1992 | 14.786 | | 26 Jan 2002 | 9.543 |
| 10 Jan 1993 | 12.077 | | 01 Jan 2003 | 14.325 |
| 13 Oct 1993 | 13.711 | | | |


Q/QMED
Logistic reduced variate, y
Stations
Record Length
L-CV, t2
L-skewness, t3
L-kurtosis, t4

Relative frequency
FAVL


Relative frequency
ABSA


Relative frequency
PROMMT


Relative frequency
SAVS


Relative frequency
USBEXT


Relative frequency
BRHOST

## Trowbridge Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 8.25 | 8.57 |
| Comment | Review of pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1160 | 1047 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site is not in the pooling group since it is slightly urbanised. No stations warrant promotion or demotion as a result of proximity to the subject site. | No change | 1160 | 8.25 |
| *Period of Record* | All stations have 10 years or more data. | No change | 1160 | 8.25 |
| *FARL* | The subject site has a FARL = 0.986 and the pooling group has a range of 0.876 to 1.000. The outliers to the pooling group are:<br>38th ranked (28002) Blithe @ Hamstall Ridware FARL = 0.876<br>36th ranked (19008) South Est @ Prestonholme FARL = 0.906<br>34th ranked (41005) Ouse @ Gold Bridge FARL = 0.924<br>39th ranked (54040) Meese @ Tibberston FARL = 0.935 | Remove all four sites as hydrologically very different from the subject site. | 1047 | 8.57 |
| *PROPWET/URBEXT* | All stations in the pooling group are essentially rural.<br>The subject site has a PROPWET = 0.35 and the pooling group has a range 0.26 – 0.51. | Retain all sites since there are no large outliers to the pooling group. | 1047 | 8.57 |
| *Site Comments* | The 5th ranked (25007) Clow Beck @ Croft was discontinued in 1980 and has 15 station years of data. The 12th ranked (68002) Gowy @ Picton was abandoned in 1979 and has 30 station years of data. | Retain both sites as hydrologically similar to the subject site and have good data records. | 1047 | 8.57 |
| *Discordant Sites* | There are no discordant sites. | No change | 1047 | 8.57 |
| *L Moments* | The tow main outliers to the L-moments graph and the growth curves are the 15th ranked (52007) Parrett @ Chisleborough and the 39th ranked (30012) Stainfield Beck @ Stainfield. | Retain Parrett @ Chiselborough since data updated as part of study and reliable. Retain Stainfield Back @ Stainfield as short data record of 10 years results in minor outliers but it is lowly ranked and will have minimal affect on pooled results | 1047 | 8.57 |

## Trowbridge Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 20007 (Gifford Water @ Lennoxlove) | 19 | 0.412 | 0.294 | 0.212 | 1.192 | 0.081 |
| 20005 (Birns Water @ Saltoun Hall) | 30 | 0.290 | 0.211 | 0.258 | 0.414 | 0.106 |
| 52011 (Cary @ Somerton) | 38 | 0.121 | -0.089 | 0.107 | 0.743 | 0.167 |
| 20006 (Biel Water @ Belton House) | 20 | 0.381 | 0.076 | 0.002 | 2.564 | 0.177 |
| 25007 (Clow Beck @ Croft) | 15 | 0.368 | 0.215 | 0.151 | 0.727 | 0.222 |
| 68015 (Gowy @ Huxley) | 19 | 0.293 | 0.192 | 0.217 | 0.192 | 0.260 |
| 53013 (Marden @ Stanley) | 33 | 0.260 | 0.203 | 0.208 | 0.195 | 0.280 |
| 54088 (Little Avon @ Berkeley Kennels) | 16 | 0.226 | 0.010 | 0.067 | 0.223 | 0.328 |
| 53017 (Boyd @ Bitton) | 30 | 0.261 | 0.126 | 0.114 | 0.070 | 0.359 |
| 68020 (Gowy @ Bridge Trafford) | 15 | 0.232 | -0.071 | 0.026 | 0.721 | 0.370 |
| 21027 (Blackadder Water @ Mouth Bridge) | 27 | 0.284 | 0.135 | 0.103 | 0.186 | 0.375 |
| 68002 (Gowy @ Picton) | 30 | 0.105 | -0.220 | 0.156 | 1.814 | 0.375 |
| 39025 (Enborne @ Brimpton) | 36 | 0.196 | 0.135 | -0.001 | 1.348 | 0.383 |
| 54036 (Isbourne @ Hinton on the Green) | 21 | 0.261 | -0.060 | 0.149 | 0.824 | 0.399 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.198 | 0.409 |
| 68007 (Wincham Brook @ Lostock Gralam) | 30 | 0.185 | 0.205 | 0.204 | 0.940 | 0.413 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.503 | 0.414 |
| 20003 (Tyne @ Spilmersford) | 29 | 0.399 | 0.291 | 0.178 | 1.036 | 0.418 |
| 42014 (Blackwater @ Ower) | 26 | 0.182 | 0.221 | 0.100 | 1.306 | 0.434 |
| 54018 (Rea Brook @ Hookagate) | 30 | 0.134 | 0.050 | 0.164 | 0.845 | 0.444 |
| 31010 (Chater @ Fosters Bridge) | 26 | 0.289 | 0.048 | 0.034 | 0.753 | 0.457 |
| 55018 (Frome @ Yarkhill) | 32 | 0.129 | -0.252 | 0.082 | 1.525 | 0.459 |
| 29005 (Rase @ Bishopbridge) | 13 | 0.367 | 0.290 | 0.344 | 1.494 | 0.464 |
| 52004 (Isle @ Ashford Mill) | 41 | 0.142 | -0.056 | 0.083 | 0.507 | 0.465 |
| 52010 (Brue @ Lovington) | 39 | 0.294 | 0.392 | 0.260 | 1.192 | 0.465 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.716 | 0.489 |
| 33057 (Ouzel @ Leighton Buzzard) | 13 | 0.100 | -0.079 | 0.118 | 1.015 | 0.502 |
| 41022 (Lod @ Halfway Bridge) | 33 | 0.294 | 0.190 | 0.105 | 0.303 | 0.505 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 2.118 | 0.514 |
| 54052 (Bailey Brook @ Ternhill) | 22 | 0.167 | -0.044 | 0.166 | 0.523 | 0.536 |
| 21016 (Eye Water @ Eyemouth Mill) | 33 | 0.265 | 0.073 | 0.217 | 0.358 | 0.541 |
| 68005 (Weaver @ Audlem) | 25 | 0.104 | -0.126 | 0.101 | 0.971 | 0.554 |
| 38002 (Ash @ Mardock) | 53 | 0.275 | 0.018 | 0.212 | 0.714 | 0.561 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.116 | 0.565 |
| 33031 (Broughton Brook @ Broughton) | 19 | 0.296 | 0.139 | 0.160 | 0.117 | 0.581 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 2.390 | 0.595 |
| 29004 (Ancholme @ Bishopbridge) | 26 | 0.317 | 0.306 | 0.362 | 1.535 | 0.610 |
| 28055 (Ecclesbourne @ Duffield) | 23 | 0.315 | 0.295 | 0.082 | 1.053 | 0.611 |
| 30012 (Stainfield Beck @ Stainfield) | 10 | 0.315 | 0.281 | 0.435 | 2.811 | 0.618 |
| 66005 (Clwyd @ Ruthin Weir) | 19 | 0.152 | 0.305 | 0.157 | 2.749 | 0.623 |
| | | | | | | |
| Total | 1047 | | | | | |
| Weighted means | | 0.250 | 0.105 | 0.140 | | |

VALLIS

**Catchment:** Mells at Vallis
**Station No:** 53025
**NGR:** ST 757 491

**Description:** The station opened in 1980 in connection with monitoring the impacts of Mendip quarrying. The current full range station comprises a crump weir (crest width 6m); all but the highest maxima are contained with the structure. By-passing of the weir occurs at lower stages.
The catchment covers an area of approximately 118 $km^2$ and is predominantly rural. The geology of the catchment is mainly carboniferous limestone, with coal measures.

**Data comments:** The updated AMAX data set provided by the Agency gave 24 years of annual maxima series data for the period 1979 to 2002. The AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 36.3 $m^3/s$, which is exceeded once in the AMAX series provided. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 118.04 | 0.951 | 0.37 | 0.656 | 1056 | 19.9 | 0.011 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 16.767 $m^3/s$ |
| **Annual Maxima** | 21.570 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 29.236 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 16.667 $m^3/s$ |

**Permeability:** SPRHOST is less than 20%, permeable adjustment may need to be applied.
AMAX examined and found that no adjustment required as no flows smaller than the specified criteria, QMED/2.

**Urbanisation:** URBEXT < 0.025, essentially rural, no adjustment required.

**Climate variability:** Data record less than 30 years, adjustment advised but not applied.

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 21.6 | 21.6 | 21.6 | 25.9 |
| 5 | 29.7 | 29.8 | 28.2 | 35.8 |
| 10 | 35.5 | 35.9 | 32.7 | 43.1 |
| 25 | 44.0 | 44.9 | 38.9 | 53.9 |
| 50 | 51.3 | 52.7 | 43.9 | 63.2 |
| 100 | 59.6 | 61.8 | 49.4 | 74.2 |
| 200 | 69.0 | 72.2 | 55.3 | 86.6 |

**Summary of Analysis:** AMAX series EDA revels there to be no outliers to the data set. The effect of reviewing the pooling group is significant, producing approximately a 5% increase in the estimated flow at the 200-year return period

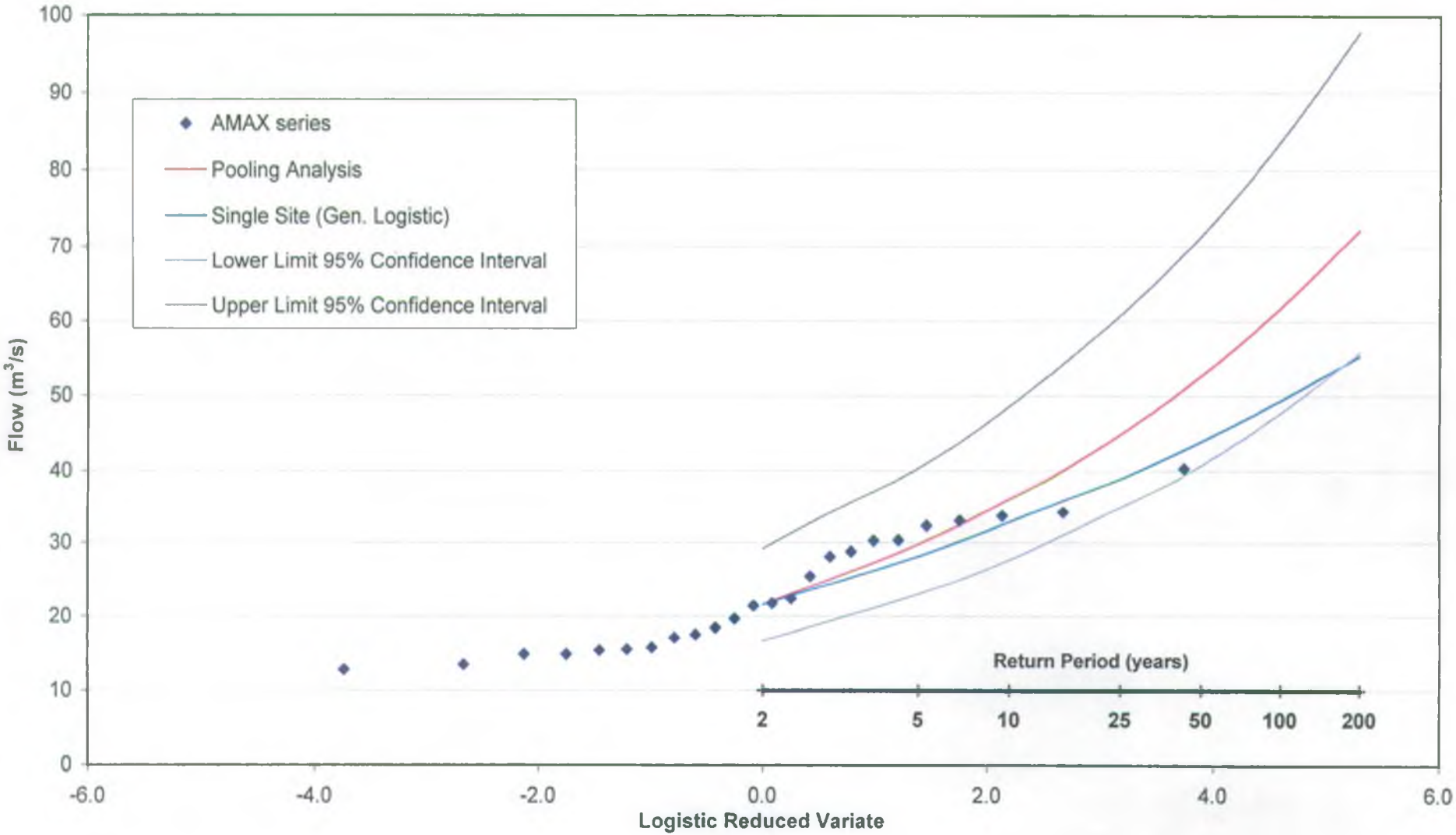
**Selection of Method:** Separation between the flood frequency curves is quite small, with the single site General Logistic curve providing the best fit to the AMAX data. The General Logistic pooled analysis curve is somewhat higher than single site curve, and is further away from the actual AMAX data series. There appears from the current AMAX series to be little influence in truncating flood flows by the quarries in the catchment as is evident from the Frome @ Tellisford.

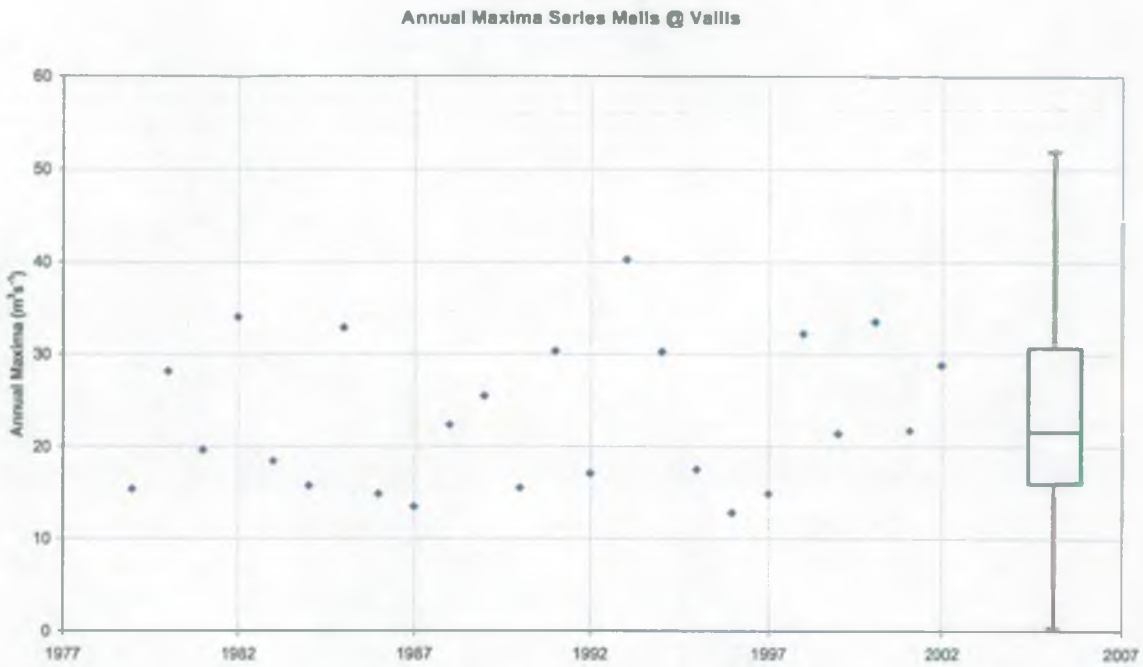
*Special considerations:* With current AMAX data recommend pooled analysis results. Recommend the investigation of the impact of the quarries on flood flows and monitor the AMAX series in the future to see if an alternative approach may be required.

*Adopt:* Pooled Analysis (as shaded above)

*Model parameters:* $\beta = 0.232$, $\kappa = -0.219$

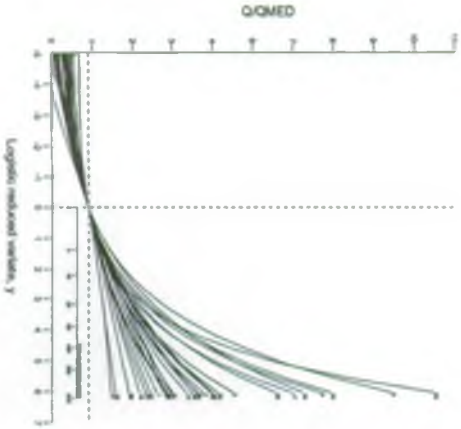
## River Mells at Vallis

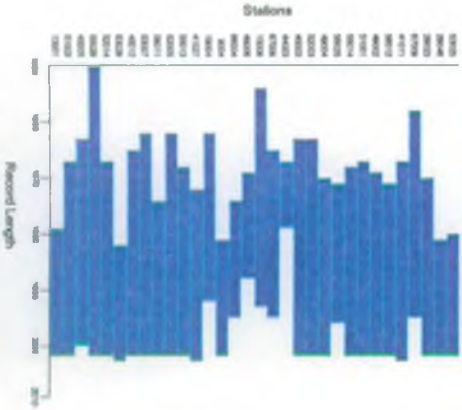


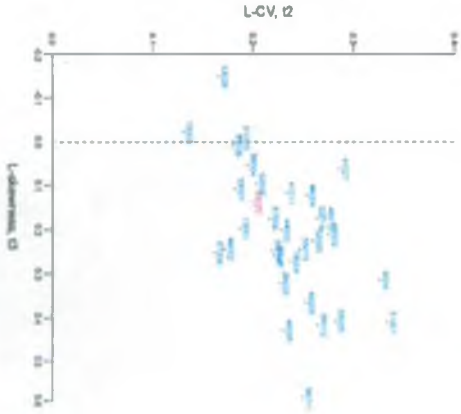


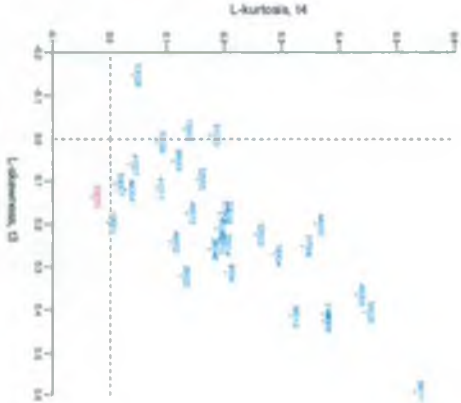

Annual Maxima series for Vallis

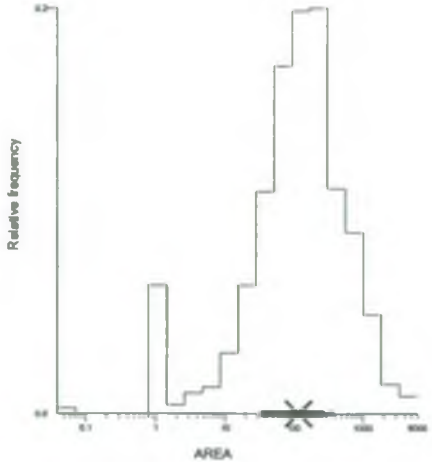
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 04 Feb 80 | 15.36 | | 25 Jul 92 | 30.32 |
| 09 Mar 81 | 28.14 | | 30 Nov 92 | 17.08 |
| 15 Mar 82 | 19.64 | | 07 Oct 93 | 40.27 |
| 31 Jan 83 | 34.00 | | 21 Jan 95 | 30.23 |
| 16 Jan 84 | 18.44 | | 16 Dec 95 | 17.50 |
| 04 Aug 85 | 15.74 | | 11 Feb 97 | 12.81 |
| 25 Dec 85 | 32.86 | | 28 Dec 97 | 14.86 |
| 11 Dec 86 | 14.86 | | 25 Oct 98 | 32.20 |
| 31 Jan 88 | 13.49 | | 26 Feb 00 | 21.41 |
| 09 Oct 88 | 22.35 | | 23 Oct 00 | 33.50 |
| 20 Dec 89 | 25.46 | | 19 Feb 02 | 21.74 |
| 18 Mar 91 | 15.52 | | 13 Nov 02 | 28.82 |

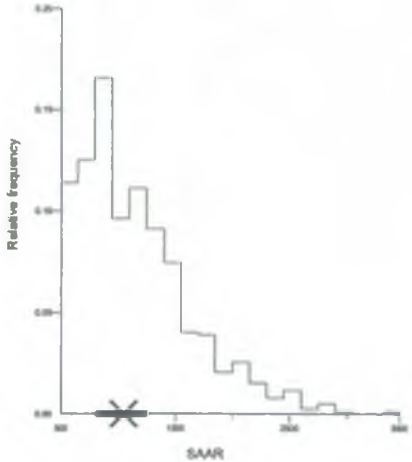

Q/QMED
Logistic transformed statistic, Y

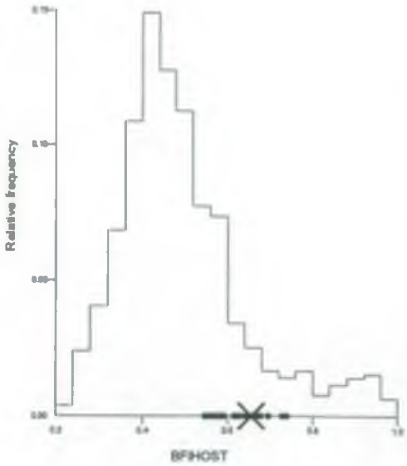

Stations
Record Length

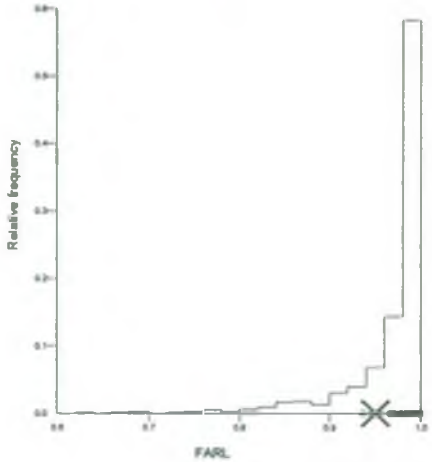

L-CV, t2
L-skewness, t3

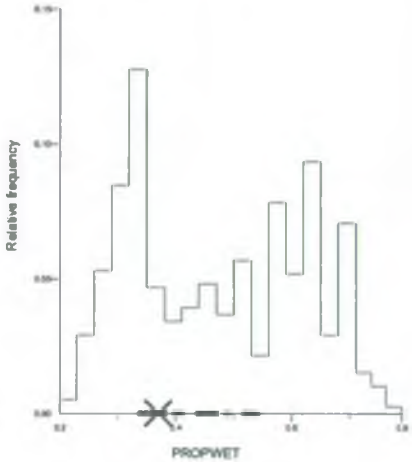

L-kurtosis, t4
L-skewness, t3

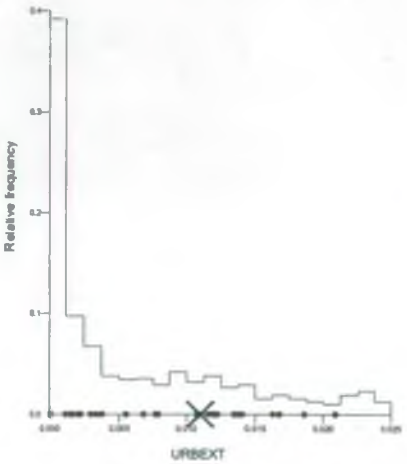

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Vallis Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.69 | 3.23 |
| Comment | The pooling group is strongly heterogeneous, and a review is essential | The pooling group is possibly homogeneous and a review is optional. |
| Number of Station Years | 1197 | 993 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | The subject site was first in the pooling group<br>The North Esk @ Dalkeith Palace and the North Esk @ Dalmore Weir both react to the same flood events and have the same period of record (1961 – 1992) and are located within the same catchment., similarly for the Monnow @ Grosmont and the Monnow @ Kentchurch | Remove the North Esk @ Dalkeith Palace as it is ranked lower in the pooling group than the North Esk @ Dalmore. It also has a slightly shorter record length, and remove the Monnow @ Kentchurch | 1146 | 4.64 |
| *Period of Record* | All sites had a good period of record. Except for the Trothy @ Mitchel Troy which has a record length of 10 years, and is also discordant | Remove the Trothy @ Mitchel Troy | 1136 | 4.38 |
| *FARL* | There are 3 main outliers, 2 of which have a FARL of less than 0.9;<br>Chew @ Compton Dando, (0.843) Large storage reservoir in headwaters – Chew Valley Lake.<br>Congresbury Yeo @ Iwood (0.890) Blagdon Reservoir (approx. 2km) situated close to the headwaters.<br>South Esk @ Prestonholm (0.906) There are several small storage reservoirs in the headwaters | Remove Chew @ Compton Dando ranked 7th and Congresbury Yeo @ Iwood ranked 10th due to FARL values being below 0.900. Also remove South Esk @ Prestonholm, ranked 20th as FARL value was near to 0.9, and it was a slightly discordant site. | 1038 | 3.38 |
| *PROPWET/ URBEXT* | Peteril @ Harraby Green has a PROPWET value of 0.640, and is a clear outlier in the pooling group (which has a range of 0.34 – 0.64).<br>The Bush @ Seneil is also an outlier with regards to PROPWET, (0.61)<br>Alyn @ Pont-y-Capel URBEXT = 0.0209, this is a possible outlier compared to the rest of the pooling group. | Remove Peteril @ Harraby green due to high PROPWET value and high discordancy. Also remove the Bush @ Seneirl. | 993 | 3.23 |
| *Site Comments* | All site comments were checked. No obvious reason to remove any particular site. | No change | 993 | 3.23 |
| *Discordant sites* | There are no discordant sites | No change | 993 | 3.23 |
| *L-Moments* | There are no significant outliers | No change | 993 | 3.23 |

## Vallis Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.428 | 0.000 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.232 | 0.200 |
| 28023 (Wye @ Ashford) | 31 | 0.227 | 0.321 | 0.124 | 1.211 | 0.329 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.046 | 0.401 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.290 | 0.410 |
| 56012 (Grwyne @ Millbrook) | 23 | 0.264 | 0.416 | 0.314 | 0.652 | 0.471 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.476 | 0.477 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.775 | 0.490 |
| 55014 (Station @ Location) | 31 | 0.219 | 0.247 | 0.195 | 0.119 | 0.548 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.184 | 0.562 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.860 | 0.617 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.281 | 0.624 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.466 | 0.628 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.159 | 0.644 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.739 | 0.664 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 1.895 | 0.678 |
| 48006 (Cober @ Helston) | 20 | 0.230 | 0.427 | 0.371 | 1.000 | 0.678 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.392 | 0.681 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 1.691 | 0.689 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.146 | 0.717 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.870 | 0.726 |
| 55013 (Station @ Location) | 31 | 0.246 | 0.243 | 0.185 | 0.087 | 0.730 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.246 | 0.730 |
| 58011 (Thaw @ Gigman Bridge) | 25 | 0.249 | 0.592 | 0.531 | 2.728 | 0.749 |
| 53007 (Frome(somerset) @ Tellisford) | 42 | 0.182 | 0.107 | 0.007 | 0.920 | 0.775 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.562 | 0.783 |
| 53028 (By Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 2.164 | 0.792 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.411 | 0.793 |
| 55029 (Monnow @ Grosmont) | 45 | 0.180 | 0.007 | 0.082 | 0.663 | 0.802 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 0.990 | 0.806 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 1.411 | 0.810 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.905 | 0.816 |
| | | | | | | |
| Total | 993 | | | | | |
| Weighted means | | 0.232 | 0.219 | 0.186 | | |

WELLOW

**Catchment:** Wellow Brook at Wellow
**Station No:** 53009
**NGR:** ST 741 581

**Description:** This is a small catchment gauged by a trapezoidal critical depth flume. Full range station. Slight bypassing on right-hand bank. Backing up from bridge downstream occurred during Jul 1968 flood. The catchment is predominantly rural with mixed geology of Lias and Oolitic Limestone

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 37 years from 1996 to 2002. The AMAX series was not reviewed.

**Gauge rating:** The upper limit for the gauge rating is 43.5 $m^3/s$ this is not exceeded by any of the AMAX data provided. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 73.47 | 0.987 | 0.37 | 0.643 | 999 | 27.3 | 0.0383 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 11.975 $m^3/s$ |
| **Annual Maxima** | 13.480 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 14.820 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 12.160 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT > 0.025, slightly urbanised: adjustment required

**Climate variability:** Data record longer than 30 years, adjustment not required

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

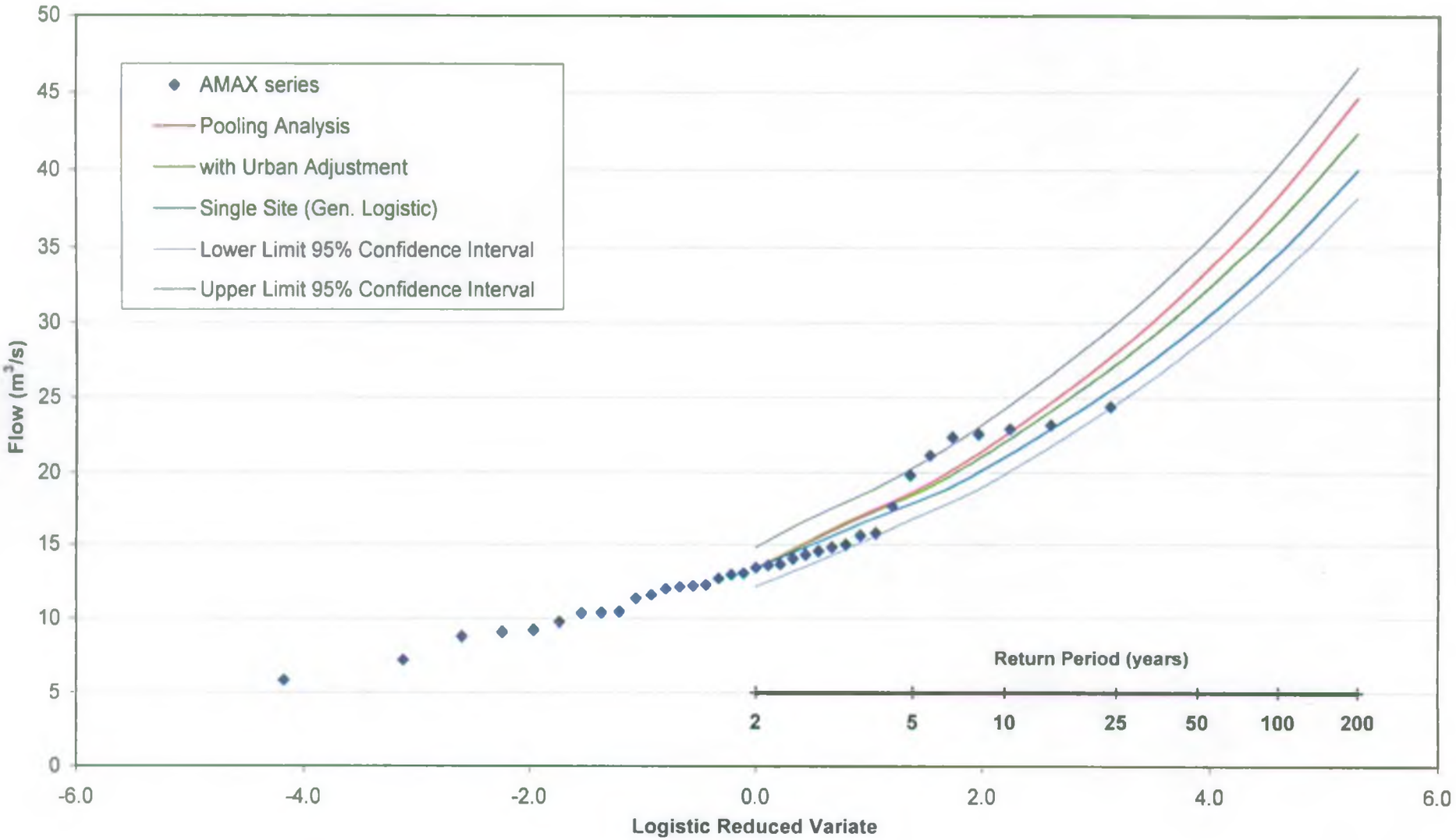
| Return period (years) | Pooled Analysis | | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|---|
| | Initial | Reviewed | Urban Adjusted | Gen. Logistic | Urban Adj. x 20% |
| 2 | 13.5 | 13.5 | 13.5 | 13.5 | 16.2 |
| 5 | 18.7 | 18.7 | 18.5 | 17.8 | 22.2 |
| 10 | 22.4 | 22.5 | 22.1 | 21.0 | 26.5 |
| 25 | 27.8 | 28.0 | 27.2 | 25.8 | 33.6 |
| 50 | 32.4 | 32.8 | 31.7 | 29.9 | 38.1 |
| 100 | 37.6 | 38.3 | 36.7 | 34.6 | 44.1 |
| 200 | 43.5 | 44.7 | 42.4 | 40.1 | 51.0 |

**Summary of Analysis:** AMAX series EDA reveals the dataset to have only one significant outlier in 1968. Whilst there are 5 other outliers, the EDA reveals these to be largely insignificant.

**Selection of Method:** The plot of all FFCs show that none of the curves fit the data well. However, the FEH recommended method is a pooling group urban adjusted FFC and this is the method that should be adopted. Removal of the 1968 flood when backing up occurred has little effect on the fittings.

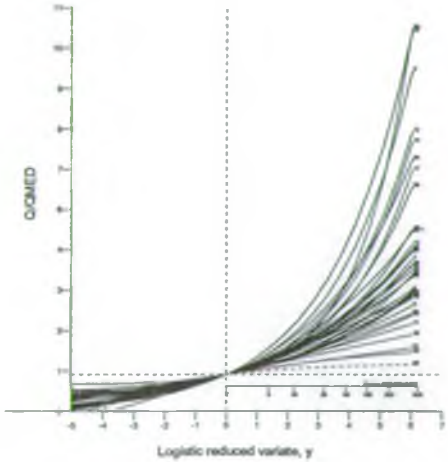
*Special considerations:* None
*Adopt:* Pooled Analysis Urban Adjusted (as shaded)
*Model parameters:* $\beta = 0.239$ $\kappa = -0.209$

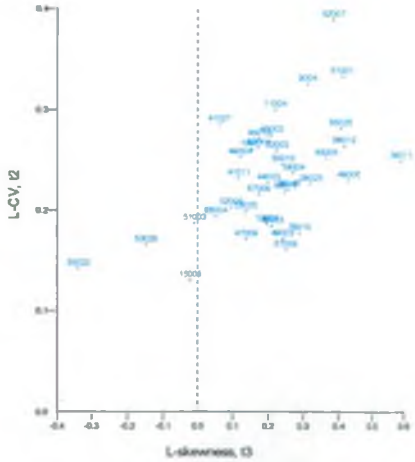
## Wellow Brook @ Wellow

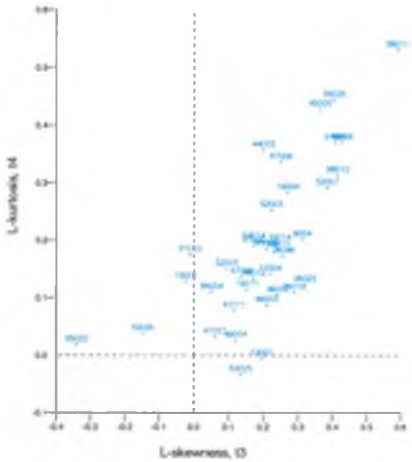


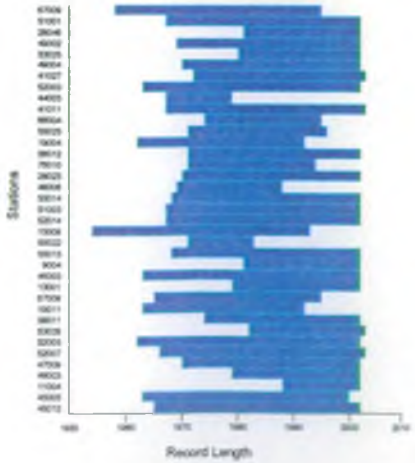
Annual Maxima series for Wellow

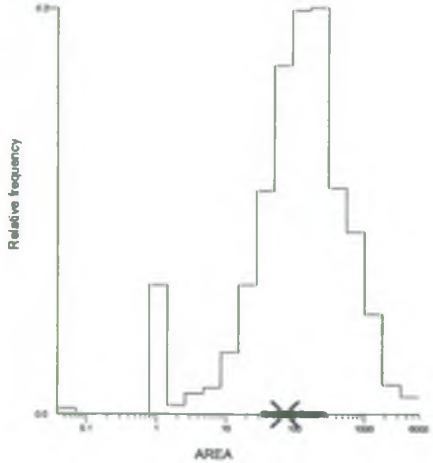
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 20 Feb 67 | 14.344 | | 23 Dec 85 | 22.905 |
| 09 Jul 68 | 30.141 | | 18 Nov 86 | 12.019 |
| 20 Dec 68 | 9.255 | | 31 Jan 88 | 12.157 |
| 14 Jan 70 | 9.771 | | 14 Mar 89 | 12.297 |
| 24 Jan 71 | 9.11 | | 20 Dec 89 | 15.568 |
| 06 Mar 72 | 14.076 | | 09 Jan 91 | 10.379 |
| 01 Dec 72 | 21.157 | | 18 Sep 92 | 5.831 |
| 08 Feb 74 | 22.555 | | 30 Nov 92 | 14.577 |
| 27 Jan 75 | 14.991 | | 13 Oct 93 | 19.817 |
| 30 Nov 75 | 7.242 | | 27 Jan 95 | 17.59 |
| 29 Nov 76 | 10.447 | | 21 Dec 95 | 12.997 |
| 22 Jan 78 | 10.338 | | 17 Feb 97 | 15.718 |
| 29 May 79 | 23.152 | | 03 Jan 98 | 11.584 |
| 26 Dec 79 | 24.384 | | 31 Oct 98 | 12.234 |
| 10 Mar 81 | 13.71 | | 26 Dec 99 | 13.106 |
| 30 Dec 81 | 13.63 | | 29 Oct 00 | 22.348 |
| 19 Dec 82 | 13.48 | | 26 Jan 02 | 12.728 |
| 20 Dec 83 | 11.364 | | 01 Jan 03 | 14.823 |
| 21 Jan 85 | 8.833 | | | |

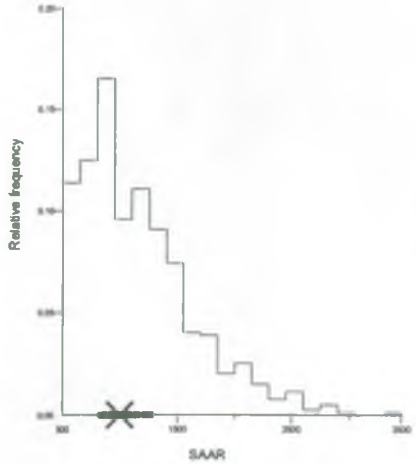

Q/QMED
Logistic reduced variate, y

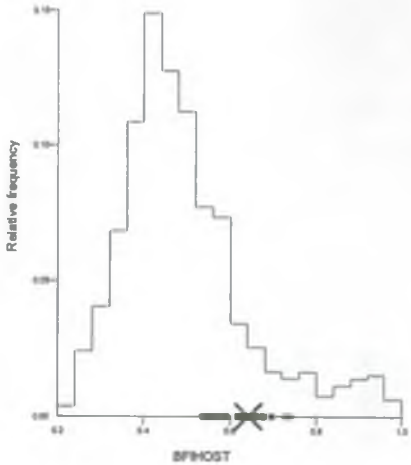

L-CV, t2
L-skewness, t3

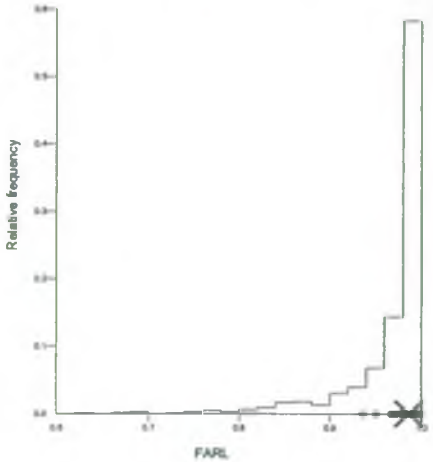

L-kurtosis, t4
L-skewness, t3

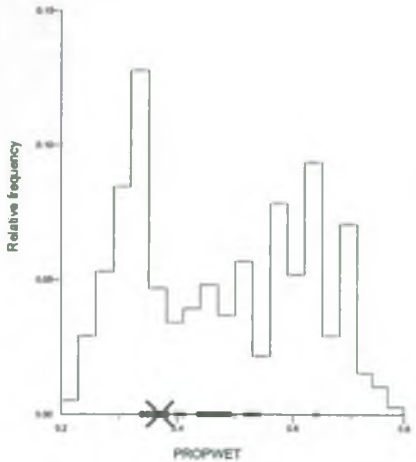

Stations
Record Length

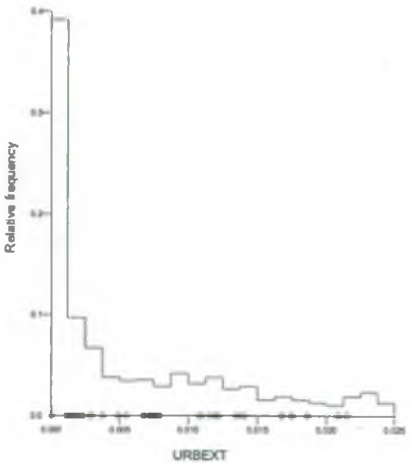

Relative frequency
AREA


Relative frequency
SAAR


Relative frequency
BFIHOST


Relative frequency
FARL


Relative frequency
PROPWET


Relative frequency
URBEXT

## Wellow Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.08 | 2.80 |
| Comment | Review of the pooling group is essential | Review of the pooling group is essential |
| Number of Station Years | 1182 | 1078 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No ststion requires promotion or demotion as a result of proximity to the subject site | None | 1182 | 4.08 |
| *Period of Record* | The period of record is good, only 1 station has less than the recommended 8 years of data. | Remove the Tone at Wadhams Farm | 1176 | 3.73 |
| *FARL* | The site has a FARL of 0.991, and the pooling group has a range of 0.843 to 0.999. The outliers of the pooling group are 5th ranked Congresbury Yeo at Iwood (52017) FARL = 0.89. and 10th ranked Chew at Compton Dando (FARL=0.843) | Remove both the chew at Compton Dando and Congresbury Yeo at Iwood. | 1104 | 2.69 |
| *PROPWET/URBEXT* | The subject site has PROPWET = 0.37 and the pooling group has a range of 0.34-0.64. 16th ranked Petterill at Haraby Green is the greates outlier at | Although there is a large range of PROPWET values, removing a nuymber of sites would result in having to include more dissimilar sites to keep the number of station years over 1000. | 1104 | 2.69 |
| *Site Comments* | No stations require removal because of station comments. However, the 14th ranked South Esk at Prestholm was closed in 1990 and the data is not fully reliable.<br>The 9th ranked Asker at Bridport (440033)was replaced by another station in 1978, thae data for which is not available. | Remove the South Esk at Prestholm<br>Retain the Asker at Bridport | 1078 | 2.80 |
| *Discordant Sites* | *(55022) Trothy at Mitchel Troy*<br>10 years of data with one very low peak value in the known drought year of 1975. | Retain site and data | 1078 | 2.80 |
| *L Moments* | Extreme outliers for the growth curves are the Trothy at Mitchel Troy(55022) (See discordant sites) and (58011) Thaw at Gigman Bridge and (52007) Parrett at Chiselborough, both of which have an extreme range of AMAX data. | Retain all sites and data | 1078 | 2.80 |

## Wellow Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.045 | 0.209 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.324 | 0.258 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.187 | 0.268 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.165 | 0.291 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.441 | 0.302 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.803 | 0.374 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.448 | 0.458 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.207 | 0.462 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.155 | 0.464 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.273 | 0.502 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.301 | 0.529 |
| 55025 (Llynfi @ Three Cocks) | 22 | 0.282 | 0.405 | 0.445 | 1.294 | 0.548 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.190 | 0.558 |
| 56012 (Grwyne @ Millbrook) | 23 | 0.264 | 0.416 | 0.314 | 0.537 | 0.577 |
| 76010 (Petteril @ Harraby Green) | 24 | 0.178 | 0.289 | 0.109 | 1.503 | 0.580 |
| 28023 (Wye @ Ashford) | 31 | 0.227 | 0.321 | 0.124 | 0.951 | 0.607 |
| 48006 (Cober @ Helston) | 20 | 0.230 | 0.427 | 0.371 | 0.986 | 0.625 |
| 55014 (Lugg @ Byton) | 31 | 0.219 | 0.247 | 0.195 | 0.106 | 0.634 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 1.026 | 0.651 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.251 | 0.665 |
| 15008 (Dean Water @ Cookston) | 40 | 0.131 | -0.022 | 0.128 | 1.397 | 0.665 |
| 55022 (Trothy @ Mitchel Troy) | 10 | 0.142 | -0.338 | 0.018 | 4.287 | 0.666 |
| 55013 (Arrow @ Titley Mill) | 31 | 0.246 | 0.243 | 0.185 | 0.051 | 0.671 |
| 9004 (Bogie @ Redcraig) | 22 | 0.326 | 0.313 | 0.202 | 1.106 | 0.708 |
| 45003 (Culm @ Wood Mill) | 40 | 0.275 | 0.210 | 0.185 | 0.280 | 0.717 |
| 13001 (Bervie @ Inverbervie) | 24 | 0.187 | 0.196 | -0.005 | 1.722 | 0.722 |
| 67008 (Alyn @ Pont-y-capel) | 30 | 0.161 | 0.251 | 0.336 | 1.601 | 0.723 |
| 19011 (North Esk @ Dalkeith Palace) | 29 | 0.261 | 0.154 | 0.115 | 0.334 | 0.736 |
| 58011 (Thaw @ Gigman Bridge) | 25 | 0.249 | 0.592 | 0.531 | 2.790 | 0.756 |
| 53028 (By Brook @ Middlehill) | 21 | 0.166 | -0.148 | 0.038 | 1.581 | 0.760 |
| 52005 (Tone @ Bishops Hull) | 42 | 0.203 | 0.095 | 0.151 | 0.183 | 0.768 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 2.868 | 0.774 |
| 47009 (Tiddy @ Tideford) | 33 | 0.171 | 0.138 | 0.137 | 0.442 | 0.814 |
| 48003 (Fal @ Tregony) | 24 | 0.185 | 0.210 | 0.088 | 0.806 | 0.828 |
| 11004 (Urie @ Pitcaple) | 15 | 0.300 | 0.220 | 0.142 | 0.796 | 0.831 |
| 45005 (Otter @ Dotton) | 39 | 0.252 | 0.364 | 0.429 | 1.184 | 0.833 |
| 45012 (Creedy @ Cowley) | 38 | 0.271 | 0.174 | 0.134 | 0.378 | 0.842 |
| | | | | | | |
| Total | 1078 | | | | | |
| Weighted means | | 0.234 | 0.209 | 0.183 | | |

WEST
LUCCOMBE

**Catchment:** Horner Water at West Luccombe
**Station No:** 51002
**NGR:** SS 898 458

**Description:** West Luccombe is a small catchment (20.49 km$^2$) on the north of Devon, draining Exmoor. The catchment is steep and is essentially rural with deciduous woodland on the valley sides. The gauging station was opened in 1973, but closed for the period of September 1979 to April 1985. It comprises a triangular crump weir for low flows and a rated section for higher flows. All flows contained. The catchment geology is composed of Mid Devonian Grits and Lower Devonian ORS.

**Data comments** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 24 years from 1973 to 2002 but missing six years from 1979 to 1984 inclusive. AMAX series not reviewed.

**Gauge rating:** Upper limit of rating is 17.4m$^3$/s which is exceeded by 25% of the AMAX data series. The rating was not reviewed.

**Catchment Descriptors:**

| Area (km$^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 20.49 | 0.978 | 0.54 | 0.540 | 1484 | 29.7 | 0.000 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 10.341 m$^3$/s |
| **Annual Maxima** | 13.351 m$^3$/s |
| **Upper Limit 95% Confidence Interval** | 16.940 m$^3$/s |
| **Lower Limit 95% Confidence Interval** | 8.762 m$^3$/s |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

**Flood Frequency:** **Satisfactory**

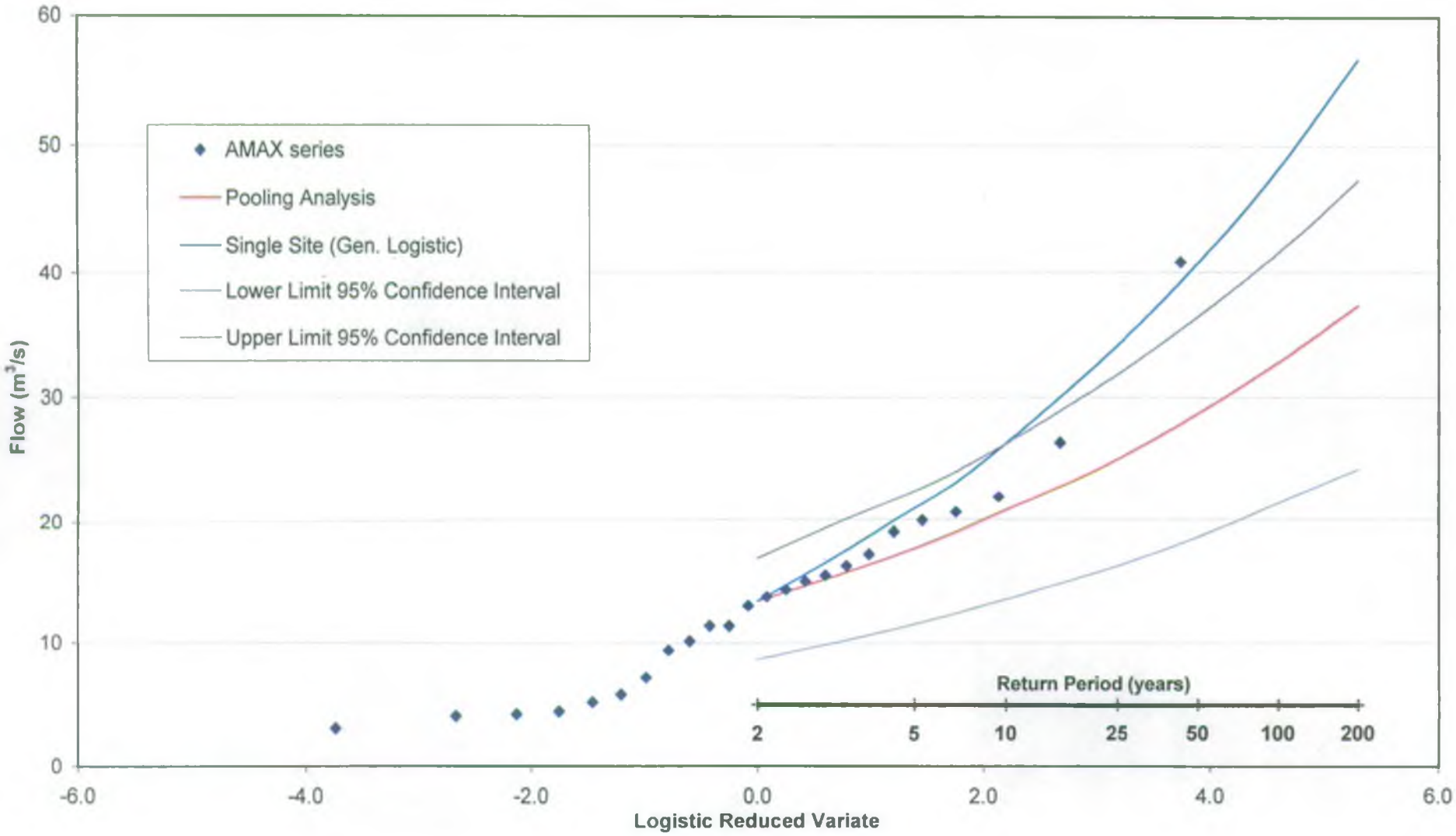
| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 13.4 | 13.4 | 13.4 | 16.1 |
| 5 | 17.9 | 17.7 | 20.9 | 21.2 |
| 10 | 21.1 | 20.7 | 26.3 | 24.8 |
| 25 | 25.6 | 25.1 | 34.1 | 30.1 |
| 50 | 29.4 | 28.7 | 40.7 | 34.4 |
| 100 | 33.6 | 32.8 | 48.2 | 39.4 |
| 200 | 38.4 | 37.3 | 56.7 | 44.8 |

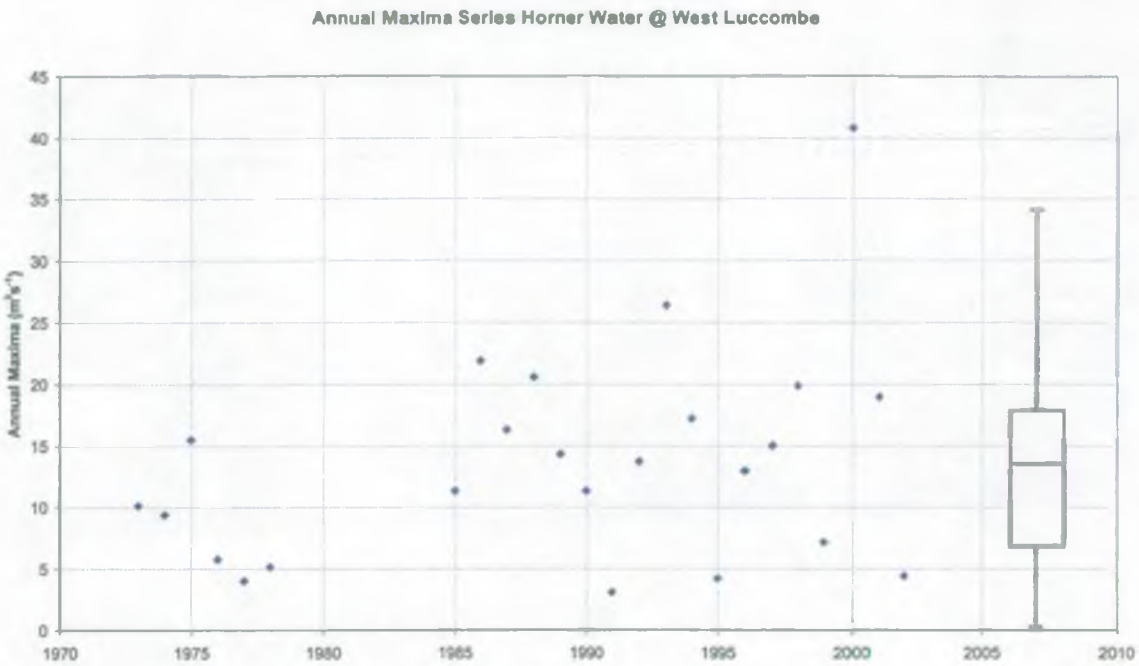
**Summary of Analysis:** AMAX series EDA revealed the event of October 2000 to be an outlier. The event is retained without review.

**Selection of Method:** This is a small steep catchment, which is not well represented in the WINFAP database. The reviewed pooling group analysis appears to underestimate the AMAX data at higher return periods and gives the outlier October 2000 a return period of over 200 years. However FEH 3.8 Table 8.3 recommends that pooled analysis should prevail with reference to single site for confirmation. Pooled analysis is the recommended FFC with October 2000 treated as an extreme event.

*Special considerations:* None
*Adopt:* Reviewed Pooled Analysis (shaded above)
*Model parameters:* $\beta = 0.204$, $\kappa = -0.172$

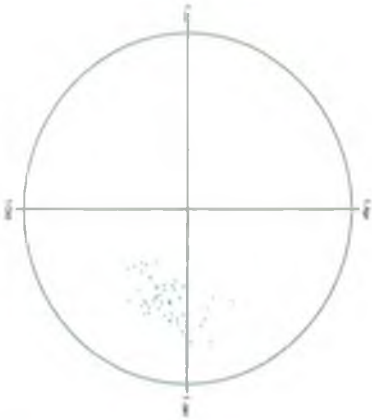
## Horner Water @ West Luccombe






Annual Maxima series for West Luccombe

| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 26 Sep 74 | 10.157 | | 21 Sep 92 | 3.086 |
| 22 Jan 75 | 9.414 | | 30 Nov 92 | 13.728 |
| 01 Dec 75 | 15.512 | | 18 Dec 93 | 26.396 |
| 14 Oct 76 | 5.786 | | 30 Oct 94 | 17.222 |
| 16 Feb 78 | 4.047 | | 19 Dec 95 | 4.194 |
| 01 Feb 79 | 5.152 | | 26 Jun 97 | 12.973 |
| 25 Dec 85 | 11.344 | | 02 Jan 98 | 15.026 |
| 18 Nov 86 | 21.895 | | 24 Oct 98 | 19.894 |
| 01 Jan 88 | 16.299 | | 18 Dec 99 | 7.159 |
| 08 Nov 88 | 20.585 | | 29 Oct 00 | 40.801 |
| 07 Feb 90 | 14.321 | | 25 Feb 02 | 18.996 |
| 01 Jan 91 | 11.344 | | 13 Oct 02 | 4.412 |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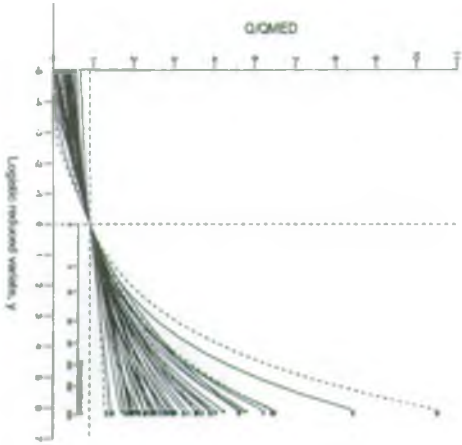
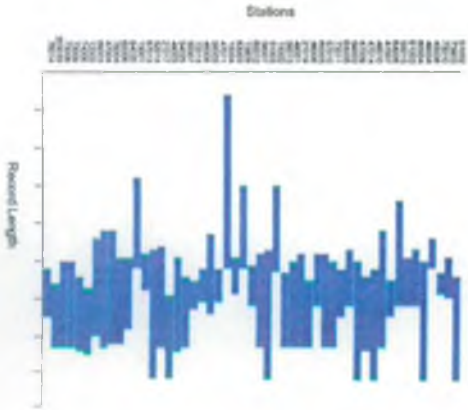
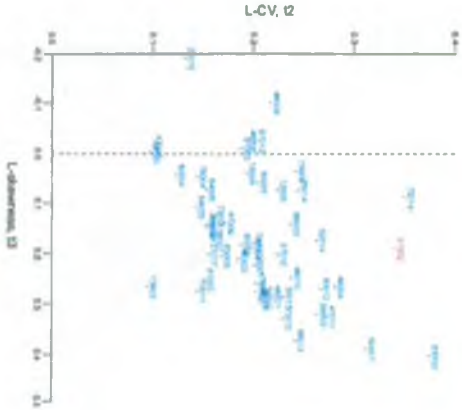
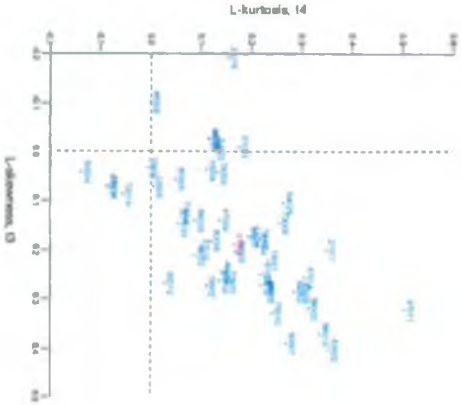
90°
180°
270°


Q/QMED
Logistic reduced variate, y


Stations
Record Length


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3

Relative frequency
PAVL


Relative frequency
AREA


Relative frequency
PROPMET


Relative frequency
SAVR


Relative frequency
LNSECT


Relative frequency
BRHOST

## West Luccombe Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 2.21 | 1.94 |
| Comment | Review of pooling group is essential | Review of pooling group is optional |
| Number of Station Years | 1205 | 1104 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No station requires promotion or demotion as a result of proximity to the subject site. | No change | 1205 | 2.21 |
| *Period of Record* | 22nd ranked (52801) Tone @ Wadhams Farm and 51st ranked (54013) Clywedog @ Cribynau have only 6 years data and the 40the ranked (55017) Cheufru @ Carreg-y-wen has only 5 years data. | Remove all three stations as they have less than the recommended minimum of 8 years data. | 1188 | 2.43 |
| *FARL* | West Luccombe catchment has a FARL of 0.978 and the pooling group has a range of FRAL 0.635 – 1.000. The main outliers to the pooling group are:<br>10th ranked (48009) St Neot @ Craigshill Wood FARL = 0.635<br>52nd ranked (21001) Fruid Water @ Fruid FARL = 0.778<br>36th ranked (15005) Melgan @ Loch of Lintrathen FARL = 0.800 | Remove all three sites since they are all dominated by reservoirs which will affect the flood attenuation. | 1104 | 1.94 |
| *PROPWET/URBEXT* | The subject site has PROPWET = 0.54 and the pooling group has a range of 0.35 – 0.72.<br>The subject site and all members of the pooling group are essentially rural and no review is required. | Retain all sites, although there is a large range of PROPWET, West Luccombe does lie in the centre of range of distribution. Removing a number of sites would result in having to include more dissimilar sites to keep the number of station years over 1000. | 1104 | 1.94 |
| *Site Comments* | No stations require removal because of station comments. | No change | 1104 | 1.94 |
| *Discordant Sites* | *(21019) Manor Water @ Cademuir*<br>20th ranked, 25 years of data record with low annual peak recorded in water years, 1975, 1976, 1986 and 1988, no outlying peak values. | Retain site and all data. | 1104 | 1.94 |
| | *(63003) Wyre @ Llanthystd*<br>28th ranked, 11 years of AMAX records with one very large peak of 6 August 1975. This is confirmed from records from adjacent catchments (63001) Ystywth @ Port Illwyn and (63002) Ehiedol @ Llanbudurn Farm. | Retain site and all data. | 1104 | 1.94 |
| | *(47011) Plym @ Cam Wood*<br>30th ranked, data series of 10 years with a large peak recorded on 27 December 1979. This value causes discordancy and is confirmed in records from adjacent catchments (47107), Walkham @ Horrabridge and (46007) West Dart @ Dunnebridge. | Retain site and all data. | 1104 | 1.94 |
| | *(72014) Condor @ Galgate*<br>33rd ranked, one low AMAX value out of 9 years of record recorded in known drought year of 1976. | Retain site and all data. | 1104 | 1.94 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *L Moments* | The main outliers to L-moments and growth curves are the discordant sites listed above, the Wyre @ Lanthystd, Plym @ Corn Wood and Condor @ Galgate, all of whose data and sites are retained for the same reasons as given above. Another outlier is the 34th ranked gauging station (50007) Taw @ Taw Bridge. This has two very large peaks recorded on the 27 December 1979 and 8 November 1982. Both events are verified from the adjacent catchment (45012) Creedy @ Cowley. | Retain all sites | 1104 | 1.94 |

## West Luccombe Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 51002 (Horner Water @ West Luccombe) | 24 | 0.340 | 0.188 | 0.165 | 1.927 | 0.000 |
| 73803 (Winster @ Lobby Bridge) | 12 | 0.095 | 0.265 | 0.151 | 2.379 | 0.060 |
| 75010 (Marron @ Ullock) | 8 | 0.229 | 0.329 | -0.241 | 0.550 | 0.152 |
| 45006 (Quarme @ Enterwell) | 9 | 0.206 | 0.289 | 0.298 | 0.508 | 0.209 |
| 48004 (Warleggan @ Trengoffe) | 33 | 0.281 | 0.265 | 0.136 | 0.681 | 0.297 |
| 60004 (Dewi Fawr @ Glasfryn Ford) | 15 | 0.122 | 0.043 | -0.138 | 2.632 | 0.364 |
| 61003 (Gwaun @ Cilrhedyn Bridge) | 15 | 0.151 | 0.250 | 0.220 | 0.690 | 0.391 |
| 55015 (Honddu @ Tafolog) | 30 | 0.229 | 0.286 | 0.228 | 0.293 | 0.402 |
| 64006 (Leri @ Dolybont) | 11 | 0.152 | 0.071 | -0.087 | 1.646 | 0.502 |
| 47007 (Yealm @ Puslinch) | 32 | 0.100 | -0.015 | 0.119 | 1.247 | 0.548 |
| 48010 (Seaton @ Trebrownbridge) | 30 | 0.238 | 0.246 | 0.141 | 0.277 | 0.556 |
| 47014 (Walkham @ Horrabridge) | 22 | 0.203 | 0.258 | 0.306 | 0.497 | 0.587 |
| 47009 (Tiddy @ Tideford) | 33 | 0.171 | 0.138 | 0.137 | 0.104 | 0.612 |
| 59002 (Loughor @ Tir-y-dail) | 16 | 0.210 | 0.285 | 0.285 | 0.428 | 0.662 |
| 65005 (Erch @ Pencaenewydd) | 13 | 0.168 | 0.204 | 0.169 | 0.264 | 0.667 |
| 73011 (Mint @ Mint Bridge) | 24 | 0.144 | 0.274 | 0.220 | 1.001 | 0.670 |
| 57010 (Ely @ Lanelay) | 26 | 0.224 | 0.200 | 0.098 | 0.237 | 0.694 |
| 60005 (Bran @ Llandovery) | 15 | 0.204 | 0.057 | 0.049 | 0.342 | 0.703 |
| 46006 (Erme @ Ermington) | 16 | 0.193 | -0.026 | 0.114 | 1.006 | 0.713 |
| 21019 (Manor Water @ Cademuir) | 25 | 0.132 | -0.191 | 0.153 | 3.924 | 0.727 |
| 48001 (Fowey @ Trekeivesteps) | 25 | 0.219 | 0.284 | 0.229 | 0.29 | 0.75 |
| 56013 (Yscir @ Pontaryscir) | 22 | 0.241 | 0.371 | 0.337 | 0.978 | 0.755 |
| 15002 (Newton Burn @ Newton) | 24 | 0.202 | 0.274 | 0.110 | 0.755 | 0.779 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 1.182 | 0.792 |
| 56007 (Senni @ Pont Hen Hafod) | 23 | 0.160 | 0.173 | 0.193 | 0.243 | 0.804 |
| 60012 (Twrch @ Ddol Las) | 13 | 0.267 | 0.269 | 0.027 | 1.492 | 0.804 |
| 15809 (Muckle Burn @ Eastmill) | 20 | 0.242 | 0.034 | -0.005 | 0.963 | 0.824 |
| 63003 (Wyre @ Llanrhystyd) | 11 | 0.375 | 0.403 | 0.354 | 3.080 | 0.836 |
| 15004 (Inzion @ Loch of Lintrathen) | 44 | 0.192 | 0.038 | 0.110 | 0.377 | 0.840 |
| 47011 (Plym @ Carn Wood) | 10 | 0.272 | 0.323 | 0.504 | 3.068 | 0.848 |
| 56003 (Honddu @ the Forge Brecon) | 21 | 0.263 | 0.320 | 0.314 | 0.759 | 0.861 |
| 46008 (Avon @ Loddiswell) | 10 | 0.217 | -0.101 | -0.001 | 1.910 | 0.863 |
| 72014 (Conder @ Galgate) | 9 | 0.350 | 0.088 | -0.057 | 3.513 | 0.895 |
| 50007 (Taw @ Taw Bridge) | 21 | 0.312 | 0.388 | 0.270 | 1.423 | 0.897 |
| 54025 (Dulas @ Rhos-y-pentref) | 26 | 0.142 | 0.107 | 0.264 | 0.905 | 0.936 |
| 48003 (Fal @ Tregony) | 24 | 0.185 | 0.210 | 0.088 | 0.49 | 0.943 |
| 21017 (Ettrick Water @ Brockhoperig) | 28 | 0.155 | 0.200 | 0.348 | 1.218 | 0.957 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.450 | 0.959 |
| 67013 (Hirnant @ Plas Rhiwedog) | 12 | 0.202 | -0.025 | 0.117 | 1.083 | 0.974 |
| 15001 (Isla @ Forter) | 26 | 0.200 | 0.222 | 0.234 | 0.147 | 0.980 |
| 84020 (Glazert Water @ Milton of Campsie) | 19 | 0.097 | -0.004 | 0.128 | 1.252 | 0.981 |
| 60006 (Gwili @ Glangwili) | 25 | 0.188 | 0.181 | 0.119 | 0.139 | 1.000 |
| 47004 (Lynher @ Pillaton Mill) | 33 | 0.198 | 0.187 | 0.213 | 0.078 | 1.004 |
| 66003 (Aled @ Bryn Aled) | 26 | 0.236 | 0.140 | 0.087 | 0.233 | 1.010 |
| 12005 (Muick @ Invermuick) | 18 | 0.223 | 0.073 | 0.005 | 0.597 | 1.021 |
| 74006 (Calder @ Calder Hall) | 21 | 0.200 | 0.178 | 0.217 | 0.097 | 1.029 |
| 73009 (Sprint @ Sprint Mill) | 24 | 0.152 | 0.145 | 0.255 | 0.593 | 1.033 |
| 73008 (Bela @ Beetham) | 25 | 0.161 | 0.125 | 0.060 | 0.404 | 1.051 |
| 203033 (Upper Bann @ Bannfield) | 18 | 0.154 | 0.144 | 0.054 | 0.601 | 1.056 |
| 76014 (Eden @ Kirkby Stephen) | 14 | 0.244 | 0.074 | -0.084 | 1.564 | 1.058 |
| | | | | | | |
| Total | 1104 | | | | | |
| Weighted means | | 0.204 | 0.172 | 0.165 | | |

WRAXALL

**Catchment:** Land Yeo at Wraxall
**Station No:** 52015
**NGR:** ST 483 716

**Description:** A small catchment (Hydrometric Register area 23.3 $km^2$). Catchment is gauged using a triangular profile Crump weir, crest 5m wide, for low flows and using a rated section within the wing walls for higher flows. All flows contained. Closed from Sep 1979 to May 1985. Reopened following installation of telemetry. River weedy but weir cleared regularly. Barrow Gurney reservoirs in catchment (Approx. 0.75 $km^2$). Drains Dundry Hill. Moderate relief in headwaters, low relief in lower reaches. Mixed geology of lower and middle Coal Measures, Carboniferous oolitic l'st and Triassic marls and s'sts. Land use is predominantly rural, some urbanisation.

**Data comments:** WINFAP annual maxima series updated to 2002 with data provided by the Environment Agency. AMAX record length 26 years from 1971 to 2002 excluding water years 1979 to 1984. AMAX series was not reviewed.

**Gauge rating:** The upper limit of the gauge rating is 2.82 $m^3/s$, which is the same as QMED as estimated using the AMAX data. Flood frequency estimates should be treated with caution because of the unreliability of gauging high flows. The rating was not reviewed.

**Catchment Descriptors:**

| Area ($km^2$) | FARL | PROPWET | BFIHOST | SAAR | SPRHOST | URBEXT |
|---|---|---|---|---|---|---|
| 20.51 | 0.934 | 0.35 | 0.659 | 902 | 21.8 | 0.017 |

**QMED:**

| | |
|---|---|
| **Catchment Descriptors** | 0.385 $m^3/s$ |
| **Annual Maxima** | 2.825 $m^3/s$ |
| **Upper Limit 95% Confidence Interval** | 3.943 $m^3/s$ |
| **Lower Limit 95% Confidence Interval** | 2.029 $m^3/s$ |

**Permeability:** SPRHOST is greater than 20%, no adjustment applied.

**Urbanisation:** URBEXT < 0.025, essentially rural: no adjustment applied

**Climate variability:** Data record less than 30 years, adjustment recommended but not applied

**Target return period:** 200 years

**Flood Frequency:** **Less than satisfactory – requires rating review**

| Return period (years) | Pooled Analysis | | Single Site | Climate Change Sensitivity Estimate |
|---|---|---|---|---|
| | Initial | Reviewed | Gen. Logistic | Reviewed x 20% |
| 2 | 2.83 | 2.8 | 2.8 | 3.4 |
| 5 | 4.0 | 4.0 | 4.3 | 4.8 |
| 10 | 4.8 | 4.9 | 5.5 | 5.8 |
| 25 | 6.0 | 6.1 | 7.1 | 7.3 |
| 50 | 7.1 | 7.1 | 8.6 | 8.6 |
| 100 | 8.2 | 8.3 | 10.4 | 10.0 |
| 200 | 9.5 | 9.6 | 12.4 | 11.5 |

**Summary of Analysis:** AMAX series EDA revealed there to be no outliers to the data set.

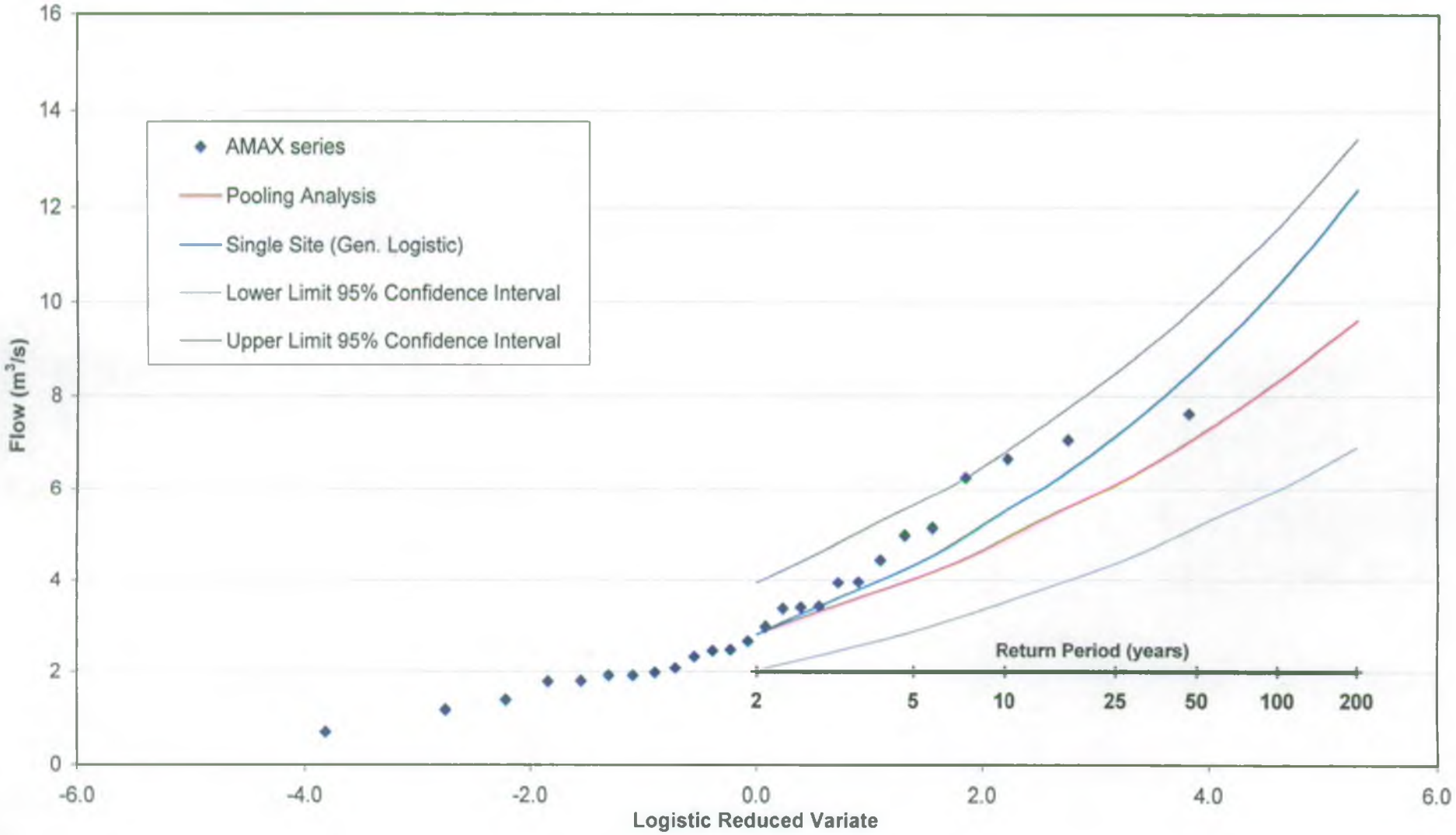
**Selection of Method:** This is a small catchment, which is not well represented in the WINFAP database. All AMAX data lies within the 95% confidence interval for the reviewed pooling group analysis. The AMAX series does not demonstrate an upper bound as often seen in catchments with reservoirs. This may be as a result of the limitations of the rating curve and extrapolating beyond its low stage limit.

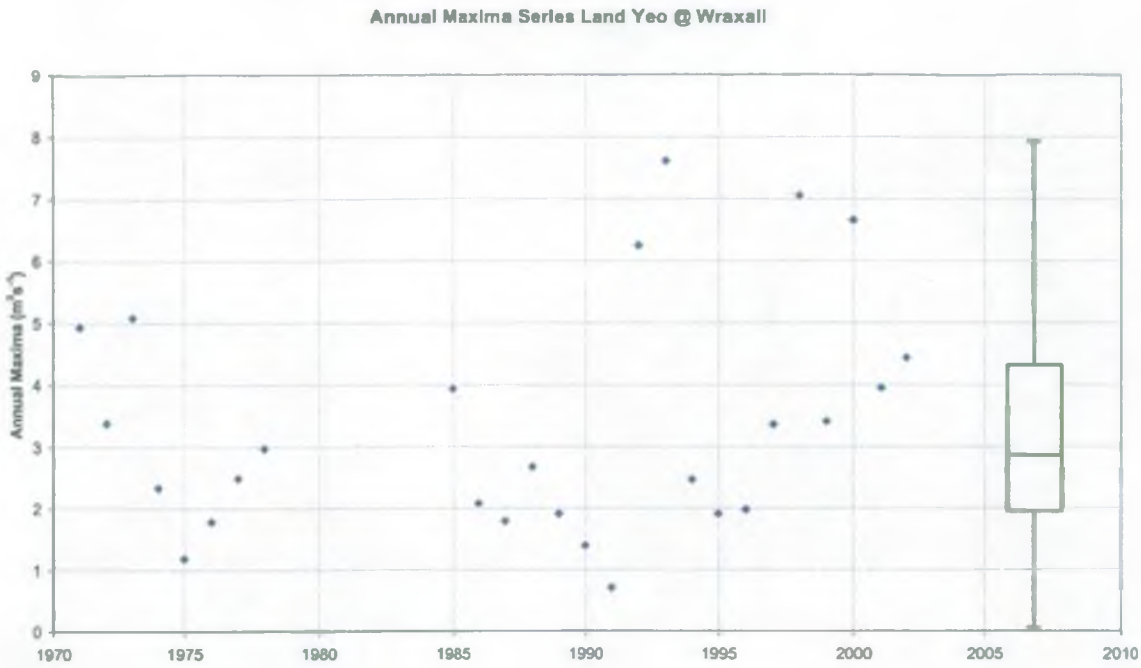
*Special considerations:* Further improvements are required to the rating curve in order to assess the impact of reservoirs and extend the upper limit from 2.82 $m^3/s$. If there is an influence an alternative methodology will need to be used. From the analysis of the current AMAX data set the pooling group analysis appears suitable.

*Adopt:* Reviewed Pooled Analysis (shaded above)

*Model parameters:* $\beta = 0.266$, $\kappa = 0.186$

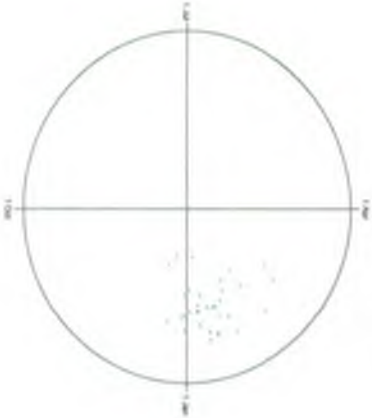
## Land Yeo @ Wraxall

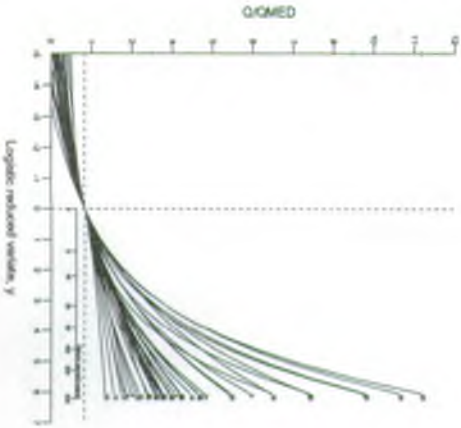


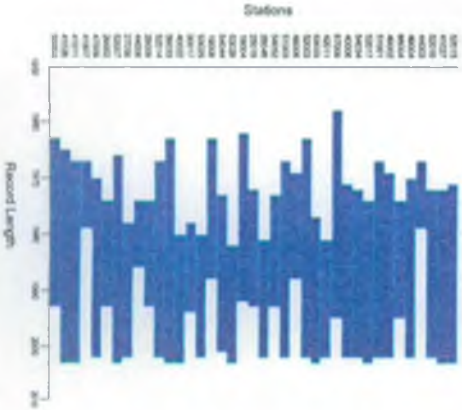


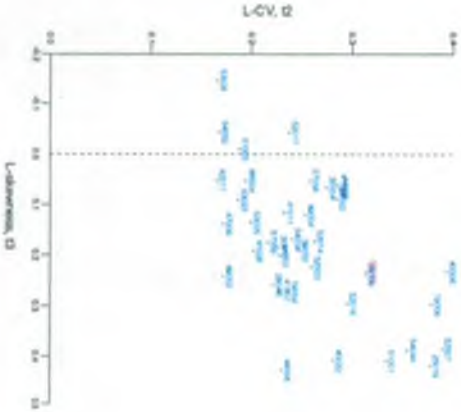

Annual Maxima series for Wraxall

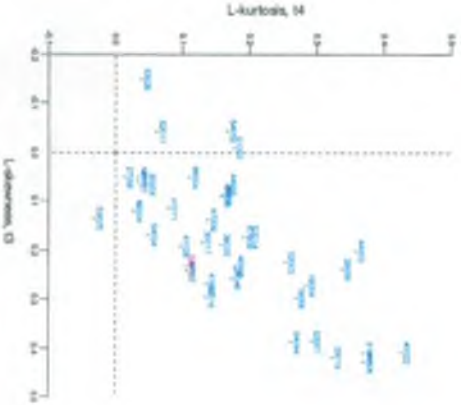
| Date | Flow ($m^3/s$) | | Date | Flow ($m^3/s$) |
|---|---|---|---|---|
| 19 Oct 1971 | 4.937 | | 09 Jan 1991 | 1.394 |
| 06 Dec 1972 | 3.385 | | 09 Jan 1992 | 0.710 |
| 27 Sep 1974 | 5.090 | | 30 Nov 1992 | 6.249 |
| 22 Jan 1975 | 2.337 | | 16 Jul 1994 | 7.612 |
| 01 Dec 1975 | 1.184 | | 27 Jan 1995 | 2.466 |
| 20 Feb 1977 | 1.783 | | 22 Dec 1995 | 1.911 |
| 27 Jan 1978 | 2.488 | | 30 Aug 1997 | 1.980 |
| 30 May 1979 | 2.976 | | 06 Mar 1998 | 3.361 |
| 26 Dec 1985 | 3.937 | | 19 Jan 1999 | 7.054 |
| 19 Nov 1986 | 2.080 | | 24 Dec 1999 | 3.410 |
| 01 Feb 1988 | 1.795 | | 30 Oct 2000 | 6.655 |
| 25 Feb 1989 | 2.674 | | 11 Feb 2002 | 3.950 |
| 01 Feb 1990 | 1.911 | | 01 Jan 2003 | 4.439 |




Q/QMED
Logistic reduced variate, y


Stations
Record Length


L-CV, t2
L-skewness, t3


L-kurtosis, t4
L-skewness, t3

Relative frequency
FAIL


Relative frequency
ADSA


Relative frequency
PROPMET


Relative frequency
SAAN


Relative frequency
UNBSCT


Relative frequency
BRHOST

## Wraxall Pooling Group Review

| | Pre-Review | Post Review |
|---|---|---|
| Heterogeneity ($H_2$) | 4.83 | 3.67 |
| Comment | Review of pooling group is essential | Review of pooling group is essential |
| Number of Station Years | 1220 | 1071 |

| Criteria for Review | Comment | Action | Station Years | $H_2$ |
|---|---|---|---|---|
| *Station Location* | No stations warrant promotion or demotion as a result of proximity to the subject site. | No change. | 1220 | 4.83 |
| *Period of Record* | The requirement for a station to be a valid member of a pooling group is a minimum of 8 station years of data. 18th ranked (52801) Tone @ Wadham Farm and 20th ranked (54058) Stoke Park Brook @ Stoke Park both only have 6 years of data. | Remove both stations. | 1208 | 4.85 |
| *FARL* | The subject has a FARL = 0.934 and the pooling group has a range of 0.834 – 1.000. The three main outliers are:<br>43rd ranked (53004) Chew @ Compton Dando, FARL = 0.834<br>41st ranked (48007) Kennall @ Ponsanooth, FARL = 0.867<br>9th ranked (52017) Congresbury Yeo @ Iwood, FARL = 0.890 | Remove the two lowest ranked stations since they are not hydrologically similar to the subject site. Retain the Congresbury Yeo @ Iwood as it is a similar catchment and contains a reservoir as does the Land Yeo @ Wraxall | 1140 | 4.32 |
| *PROPWET/URBEXT* | The Land Yeo @ Wraxall has a PROPWET = 0.35, and the pooling group has a range of 0.26 – 0.53. The outlier to the pooling group is the 24th ranked (15004) Inzion @ Lock of Lintrathen, with PROPWET = 0.54.<br>All stations have URBEXT <0.025 and are essentially rural. | Remove site as will be significantly wetter to subject site. Subject site lies in the centre of the PROPWET range for reviewed pooling group 0.26 – 0.49 | 1096 | 3.97 |
| *Site Comments* | Review of station comments in WINFAP gave no reason to remove any sites as a result of data quality issues. | No change | 1096 | 3.97 |
| *Discordant Sites* | *(58011) Thaw@ Gigman Bridge*<br>The site is ranked 20th in the pooling group. Reviewing the 25 years of AMAX data, the three records for 1999 – 2001 are very significantly higher then the previous 22 years of data which has some gaps. | Remove site a data set does not look typical of a catchment response. | 1071 | 3.67 |
| *L Moments* | The three largest outliers to the L-moments and growth factors graphs are:<br>20th ranked (25019) Leven @ Easby. AMAX series contains a couple of very large peaks that are confirmed by adjacent catchment (25005) Leven @ Leven Bridge.<br>33rd ranked (52007) Parrett @ Chiselborough. Two very large peaks in 1979 and 2000 which were two large flood events in the region. Data updated by Environment Agency as part of this study.<br>27th ranked (40022) Great Stour @ Chart Leacon. AMAX series contains a large peak in Dec 1985 which is confirmed from downstream station (40011) Great Stour @ Horton. | Retain all sites, as extreme events confirmed to be reliable. | 1071 | 3.67 |

## Wraxall Pooling Group - Reviewed

| | Years | L-CV | L-Skew | L-Kurtosis | Discordancy | Distance |
|---|---|---|---|---|---|---|
| 52015 (Land Yeo @ Wraxall Bridge) | 26 | 0.315 | 0.231 | 0.104 | 0.788 | 0.000 |
| 41027 (Rother @ Princes Marsh) | 31 | 0.286 | 0.061 | 0.033 | 1.009 | 0.322 |
| 52016 (Currypool Stream @ Currypool Farm) | 32 | 0.295 | 0.295 | 0.134 | 0.779 | 0.515 |
| 44003 (Asker @ Bridport) | 13 | 0.228 | 0.200 | 0.358 | 1.831 | 0.522 |
| 49004 (Gannel @ Gwills) | 32 | 0.253 | 0.120 | 0.026 | 0.692 | 0.603 |
| 66004 (Wheeler @ Bodfari) | 18 | 0.194 | 0.051 | 0.110 | 0.397 | 0.652 |
| 49002 (Hayle @ st Erth) | 33 | 0.172 | 0.241 | 0.105 | 1.763 | 0.660 |
| 51001 (Doniford Stream @ Swill Bridge) | 36 | 0.333 | 0.409 | 0.370 | 1.187 | 0.707 |
| 52017 (Congresbury Yeo @ Iwood) | 28 | 0.237 | -0.043 | 0.061 | 1.150 | 0.724 |
| 54034 (Dowles Brook @ Dowles) | 30 | 0.240 | 0.168 | 0.048 | 0.669 | 0.742 |
| 40006 (Bourne @ Hadlow) | 27 | 0.393 | 0.233 | 0.178 | 2.012 | 0.789 |
| 67009 (Alyn @ Rhydymwyn) | 38 | 0.216 | 0.174 | 0.191 | 0.218 | 0.809 |
| 42011 (Hamble @ Frog Mill) | 21 | 0.165 | 0.051 | 0.034 | 0.826 | 0.826 |
| 53023 (Sherston Avon @ Fosseway) | 27 | 0.186 | 0.091 | 0.157 | 0.490 | 0.841 |
| 52003 (Halse Water @ Bishops Hull) | 41 | 0.259 | 0.224 | 0.253 | 0.230 | 0.852 |
| 48006 (Cober @ Helston) | 20 | 0.230 | 0.427 | 0.371 | 2.362 | 0.854 |
| 51003 (Washford @ Beggearn Huish) | 35 | 0.187 | -0.010 | 0.176 | 1.434 | 0.864 |
| 54052 (Bailey Brook @ Ternhill) | 22 | 0.167 | -0.044 | 0.166 | 1.886 | 0.904 |
| 28046 (Dove @ Izaak Walton) | 21 | 0.221 | 0.258 | 0.173 | 0.559 | 0.916 |
| 25019 (Leven @ Easby) | 23 | 0.377 | 0.419 | 0.323 | 1.409 | 0.934 |
| 19004 (North Esk @ Dalmore Weir) | 31 | 0.237 | 0.271 | 0.284 | 0.597 | 0.975 |
| 53028 (by Brook @ Middle Hill) | 21 | 0.166 | -0.148 | 0.038 | 2.120 | 0.977 |
| 54044 (Tern @ Ternhill) | 30 | 0.355 | 0.387 | 0.262 | 1.031 | 1.002 |
| 19008 (South Esk @ Prestonholm) | 26 | 0.378 | 0.297 | 0.269 | 1.320 | 1.011 |
| 53025 (Mells @ Vallis) | 24 | 0.199 | 0.136 | -0.033 | 1.821 | 1.013 |
| 30017 (Witham @ Colsterworth) | 16 | 0.226 | 0.183 | 0.129 | 0.188 | 1.016 |
| 40022 (Great Stour @ Chart Leacon) | 24 | 0.281 | 0.408 | 0.426 | 1.908 | 1.018 |
| 39033 (Winterbourne @ st Bagnor) | 41 | 0.247 | 0.189 | 0.157 | 0.025 | 1.025 |
| 52014 (Tone @ Greenham) | 37 | 0.263 | 0.172 | 0.199 | 0.079 | 1.034 |
| 29009 (Ancholme @ Toft Newton) | 20 | 0.313 | 0.238 | 0.337 | 1.209 | 1.043 |
| 44008 (Sth Winterbourne @ W'bourne Steepleton) | 12 | 0.287 | 0.067 | 0.167 | 0.939 | 1.045 |
| 27058 (Riccal @ Crook House Farm) | 25 | 0.257 | 0.051 | 0.012 | 0.832 | 1.055 |
| 52007 (Parrett @ Chiselborough) | 37 | 0.389 | 0.386 | 0.292 | 1.502 | 1.061 |
| 29002 (Great Eau @ Claythorpe Mill) | 21 | 0.284 | 0.088 | 0.159 | 0.623 | 1.065 |
| 47009 (Tiddy @ Tideford) | 33 | 0.171 | 0.138 | 0.137 | 0.679 | 1.067 |
| 41807 (Bevern Stream @ East Chiltington) | 12 | 0.229 | 0.269 | 0.135 | 0.798 | 1.069 |
| 41011 (Rother @ Iping Mill) | 37 | 0.232 | 0.116 | 0.078 | 0.216 | 1.081 |
| 41028 (Chess Stream @ Chess Bridge) | 39 | 0.202 | 0.191 | 0.096 | 0.687 | 1.083 |
| 30004 (Partney Lymn @ Partney Mill) | 31 | 0.274 | 0.066 | 0.046 | 0.734 | 1.094 |
| | | | | | | |
| Total | 1071 | | | | | |
| Weighted means | | 0.257 | 0.186 | 0.164 | | |

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