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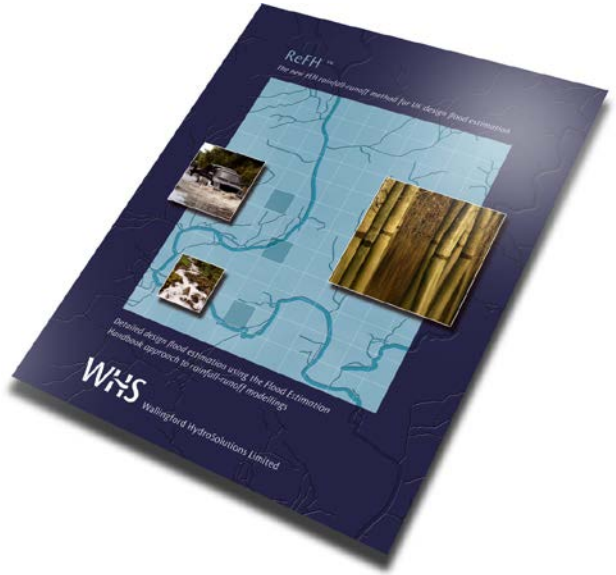
# Updating the ReFH design method: *Reconciling flood hydrograph and statistical estimates of design peak flows*

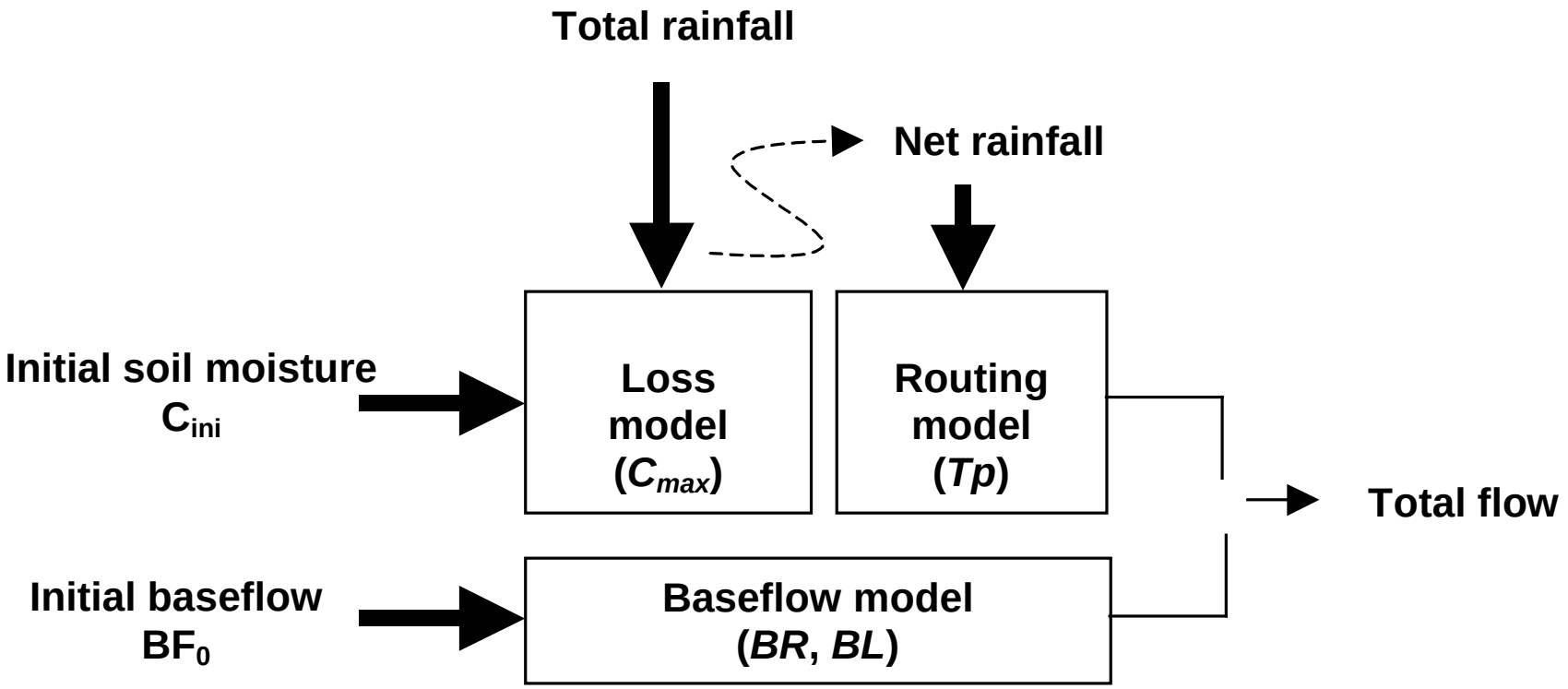



Andy Young[1], Gianni Vesuviano[2], Tracey Haxton[1], Lisa Stewart[2] &Thomas Kjeldsen[3].

1 Wallingford HydroSolutions; 2 Centre for Ecology and Hydrology; 3 University of Bath

British hydrological Society Symposium, University of Birmingham 2nd -4th September 2014

# ReFH model structure



# ReFH 1 ➔ ReFH 2

- $URBEXT_{1990}$ ➔ $URBEXT_{2000}$
- Urban processes not well represented in ReFH 1
- Scottish data under-represented in ReFH 1
- *ReFH 1 "alpha" parameter only calibrated to T=150 years*
- *Alpha performance related to SAAR*
- ReFH 1 not recommended for use if BFIHOST > 0.65
- Scaling of parameters for use on small catchments (plot scale)

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# Research Overview

- Expansion of the calibration catchment dataset within Scotland
- Update of the Parameter equations within Scotland
- Update of the Parameter equations with E,W & NI
- $C_{ini}$: new equation and adjustment for permeable catchments
- Design package: relationship between alpha and SAAR and calibrated up to 1000 year return period against current FEH statistical methods
- *Explicit representation of urbanisation*

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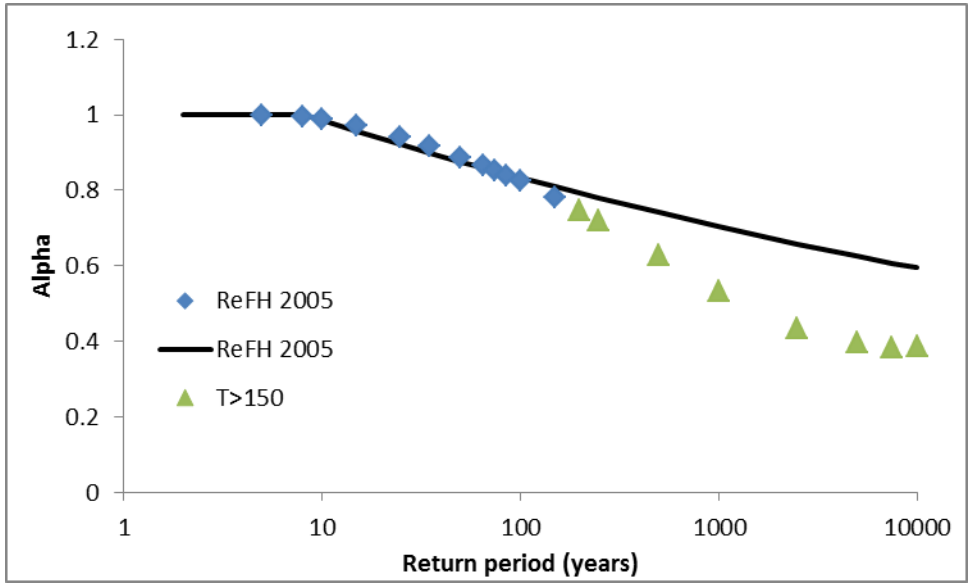
# Revision of Parameter eqns and initial conditions

- Separate equation sets developed for Scotland (19 catchments)
- Model form reassessed E, W & NI (101 catchments)
- Catchments statistically weighted by the number of events for each catchment
- Alternative formulations developed for Tp and Bl removing catchment geometric measures (e.g. replace DPLBAR with AREA)
- Equation for Cini revised to an updated exponential models (above and below BFIHOST 0.65) and to remove potential for estimating negative Cini values where BFIHOST is high and PROPWET is low.

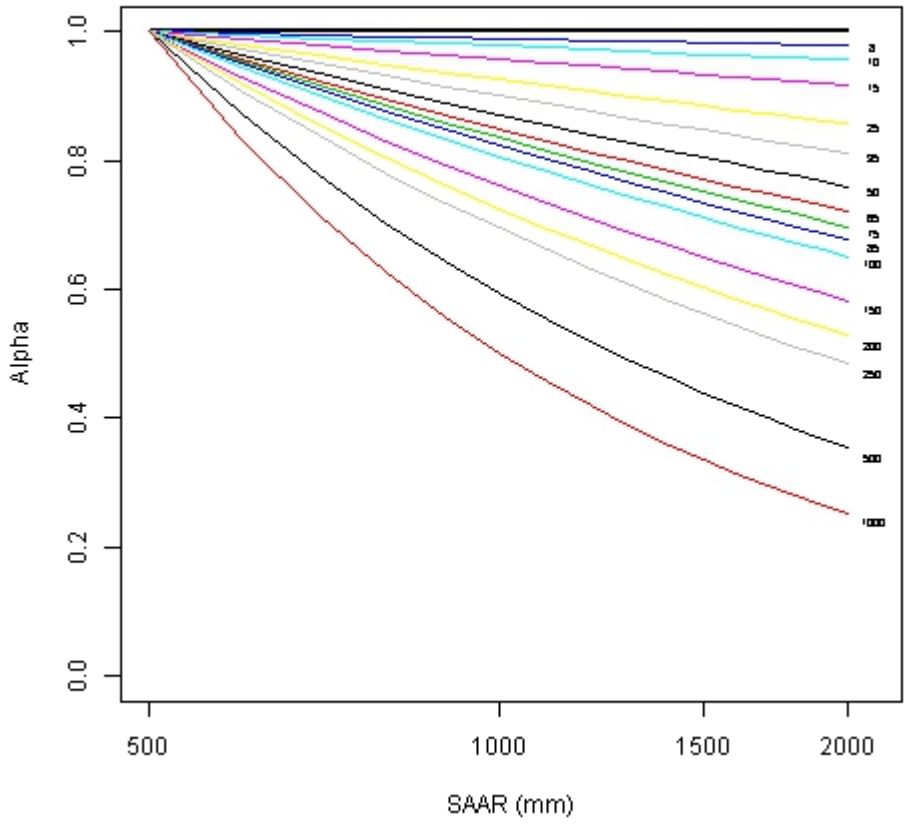
***BHS "Hydrology for Flood Risk Management" meeting held in London on the 21 November 2013***

***Scottish Hydrological Group AGM meeting held in Perth on the 16th April 2014***

# ReFH ≠ Statistical method




- reducing the rainfall depth as return period increases;
- specifying increasingly dry initial soil conditions at higher return periods;
- modifying the ReFH model structure depending on return period.


Alpha
0.0
0.2
0.4
0.6
0.8
1.0
500
1000
1500
2000
SAAR (mm)

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# Modelling design flood hydrographs in catchments with mixed urban and rural land cover

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## ABSTRACT

The effect of urban land cover on catchment flood response is evaluated using a lumped rainfall–runoff model to analyse flood events from selected UK catchments with mixed urban and rural land use. The present study proposes and evaluates a series of three extensions to an existing model to enable a better representation of urban effects, namely: an increase in runoff volume, reduced response time and a decrease in baseflow (resulting from decreased infiltration). Based on observed flood events from seven catchments, cross-validation methods are used to compare the predictive ability of the model variants with that of the original unmodified model. The results show that inclusion of urban effects increases the predictive ability of the model across catchments, despite large between-event variability of model performance. More detailed investigations into the relationship between model performance and individual event characteristics (antecedent soil moisture, rainfall duration, depth and intensity) did not reveal systematic inabilities of the model to reproduce certain types of events. Finally, it is demonstrated that the new extended model has the ability to simulate urban effects in accordance with the expected changes in storm runoff patterns

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# Evaluation of ReFH 2 across HiFlows database V3.3.4 (August 2014)

- Considered “as rural” HiFlows catchments classified as suitable for pooling and/or Qmed
- As rural (Urbext 2000 < 3%)
- No surface water attenuation (FARL> 0.9)
- 522 catchments suitable for Qmed only and 351 catchments suitable for Qmed and pooling

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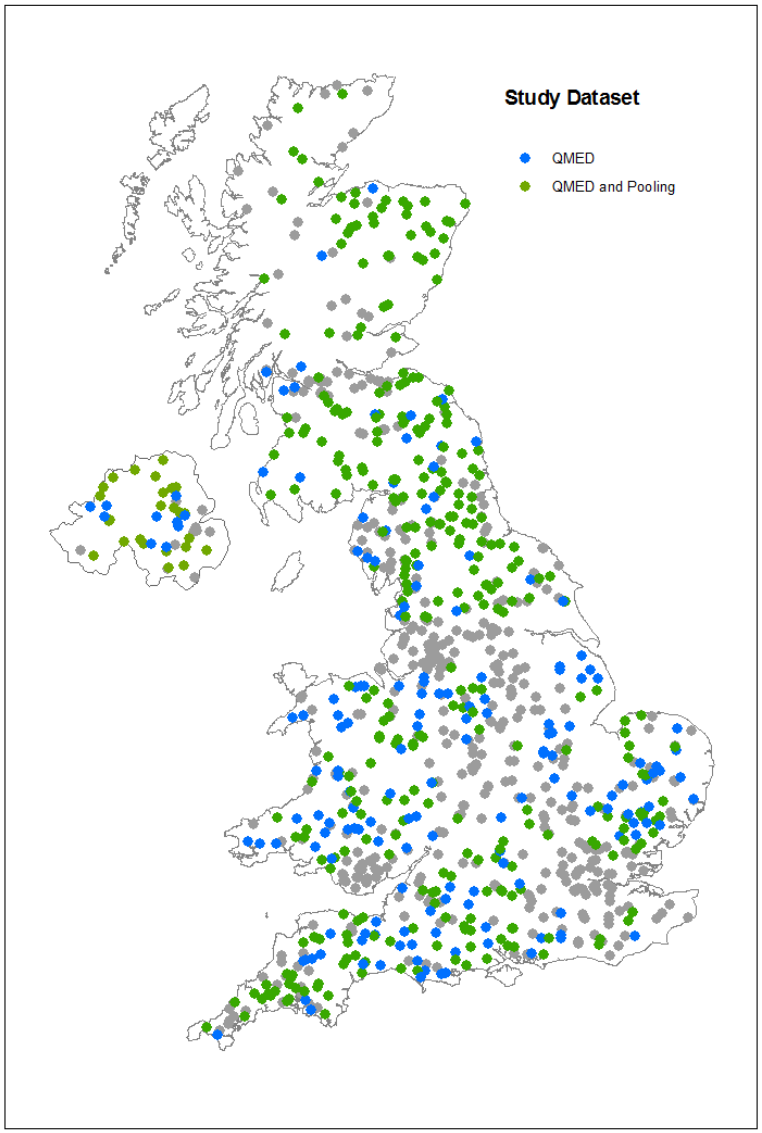
# HiFlows V3.3.4

Rural catchments, High FARL



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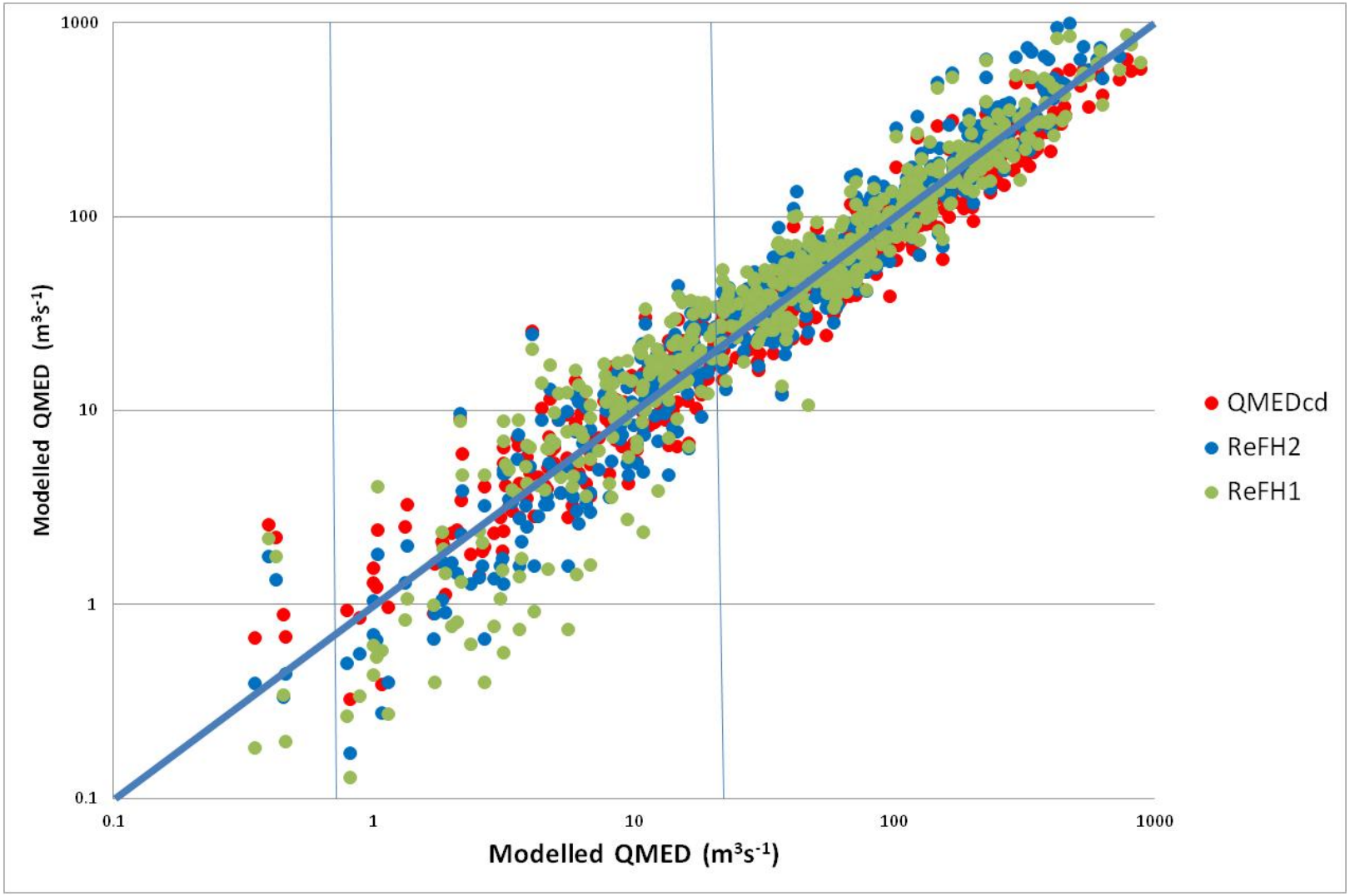
# Estimation of QMED



# Analysis of QMED normalised errors

| | QMEDcd | ReFH2 | ReFH1 |
|---|---|---|---|
| **All catchments** | | | |
| Bias | 5 | 15 | 18 |
| Median | -5 | 7 | 9 |
| 68%LL | -31 | -30 | -28 |
| 68%UL | 34 | 52 | 58 |
| Std.dev | 55 | 56 | 61 |
| | | | |
| **Catchments < 25km$^2$** | | | |
| Bias | 35 | 13 | 23 |
| Median | 13 | 0 | 5 |
| 68%LL | -34 | -40 | -36 |
| 68%UL | 55 | 31 | 47 |
| Std.dev | 103 | 82 | 94 |

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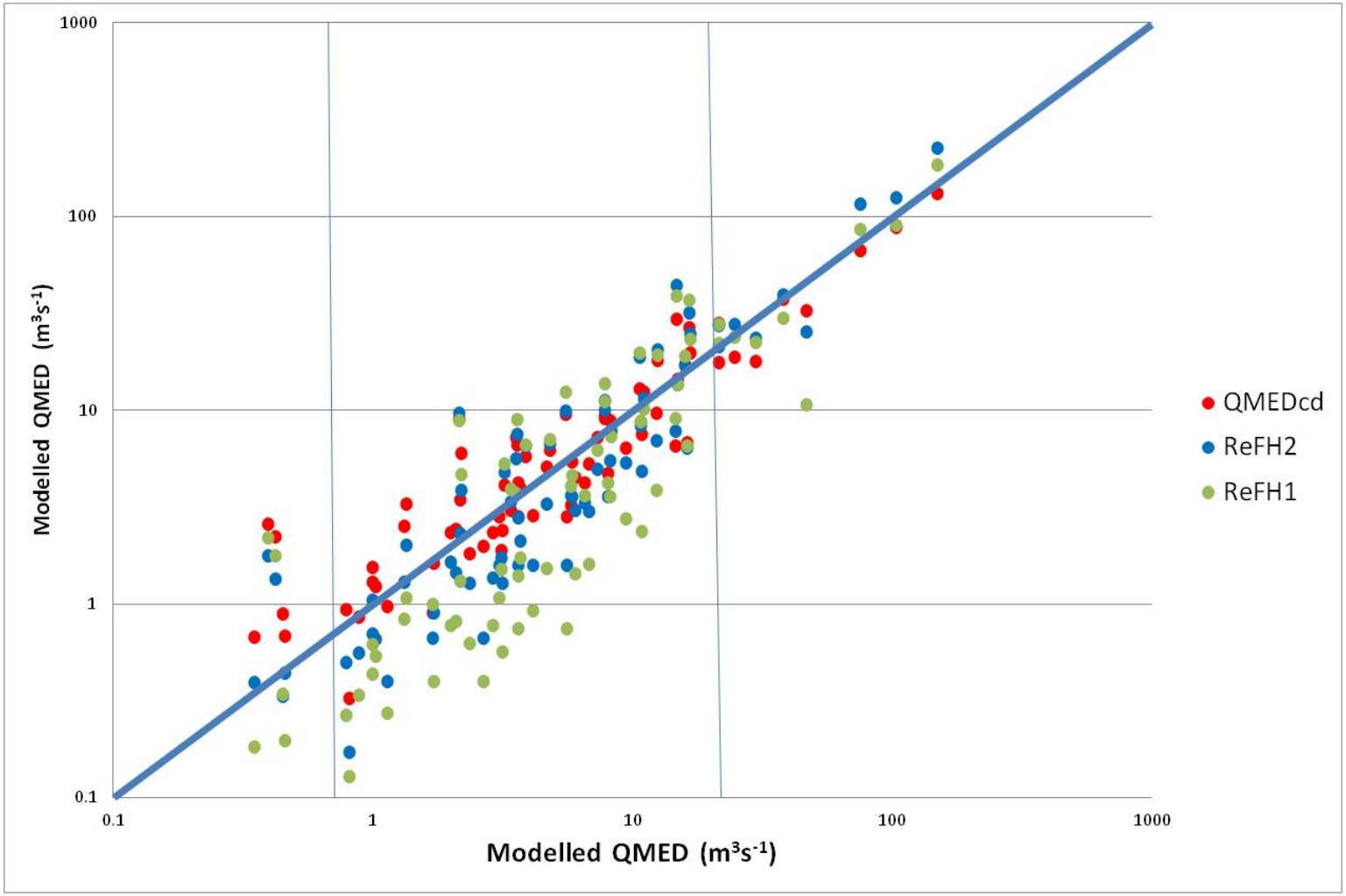
# Estimation of QMED in permeable catchments BFIHOST<0.65)



# Permeable catchments QMED normalised errors

| | QMEDcd | ReFH2 | ReFH1 |
|---|---|---|---|
| Permeable catchments | | | |
| Bias | 27 | 6 | -3 |
| Median | -1 | -15 | -37 |
| 68%LL | -31 | -53 | -74 |
| 68%UL | 66 | 56 | 58 |
| Std.dev | 99 | 82 | 98 |

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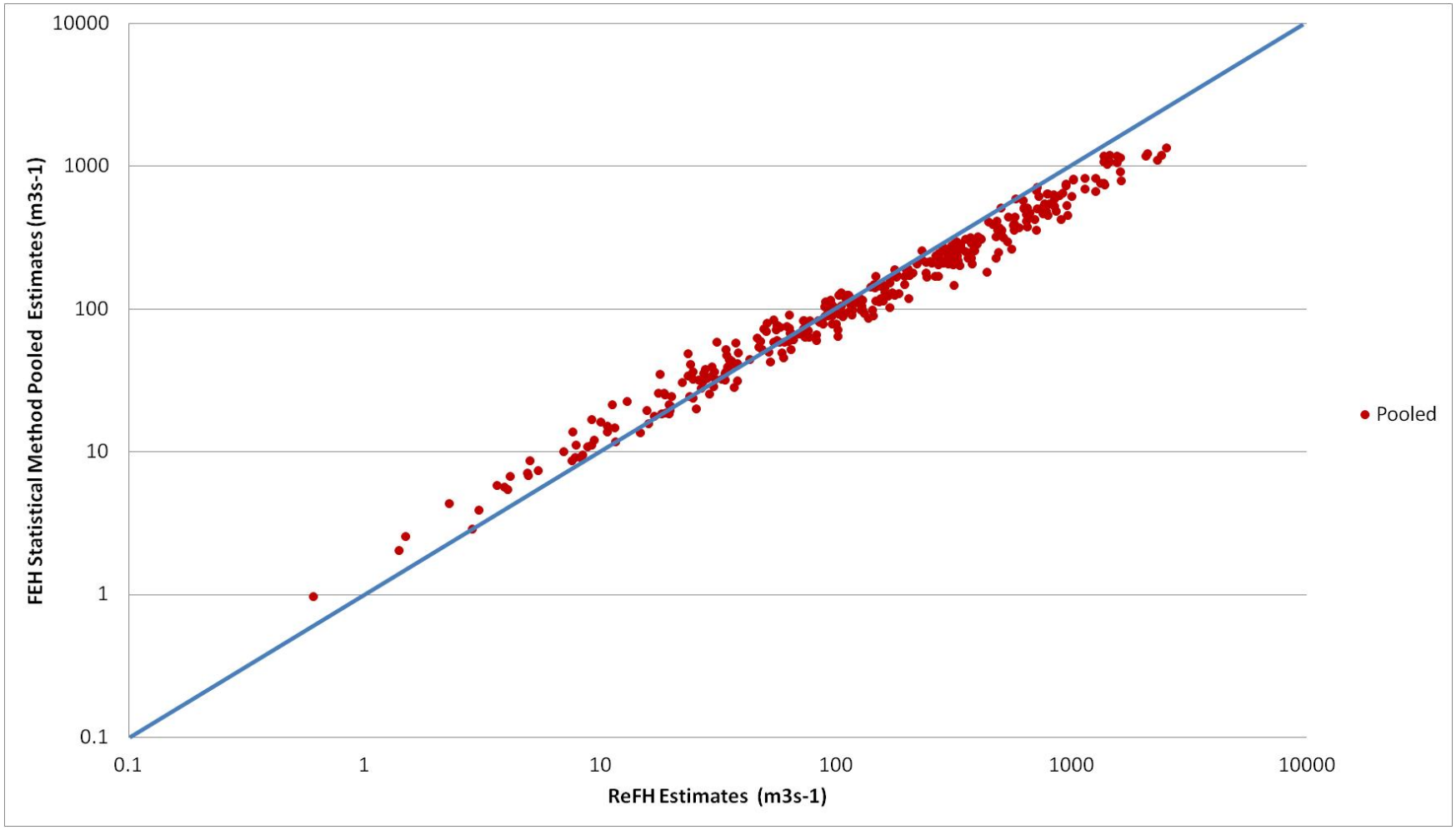
# Comparison of T=100 pooled estimates with ReFH 2



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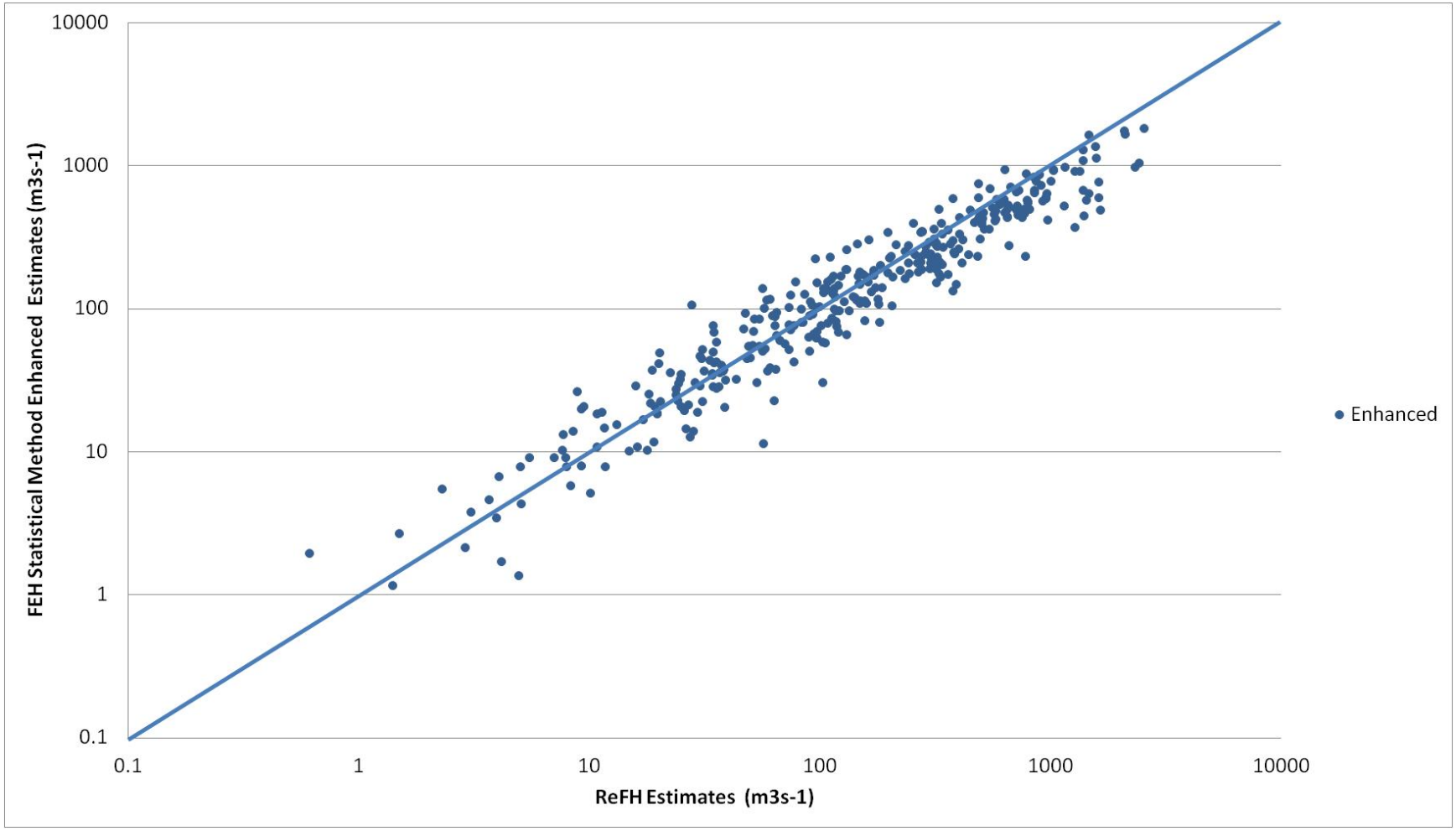
# Comparison of T=100 Enhanced Single Site estimates & ReFH 2



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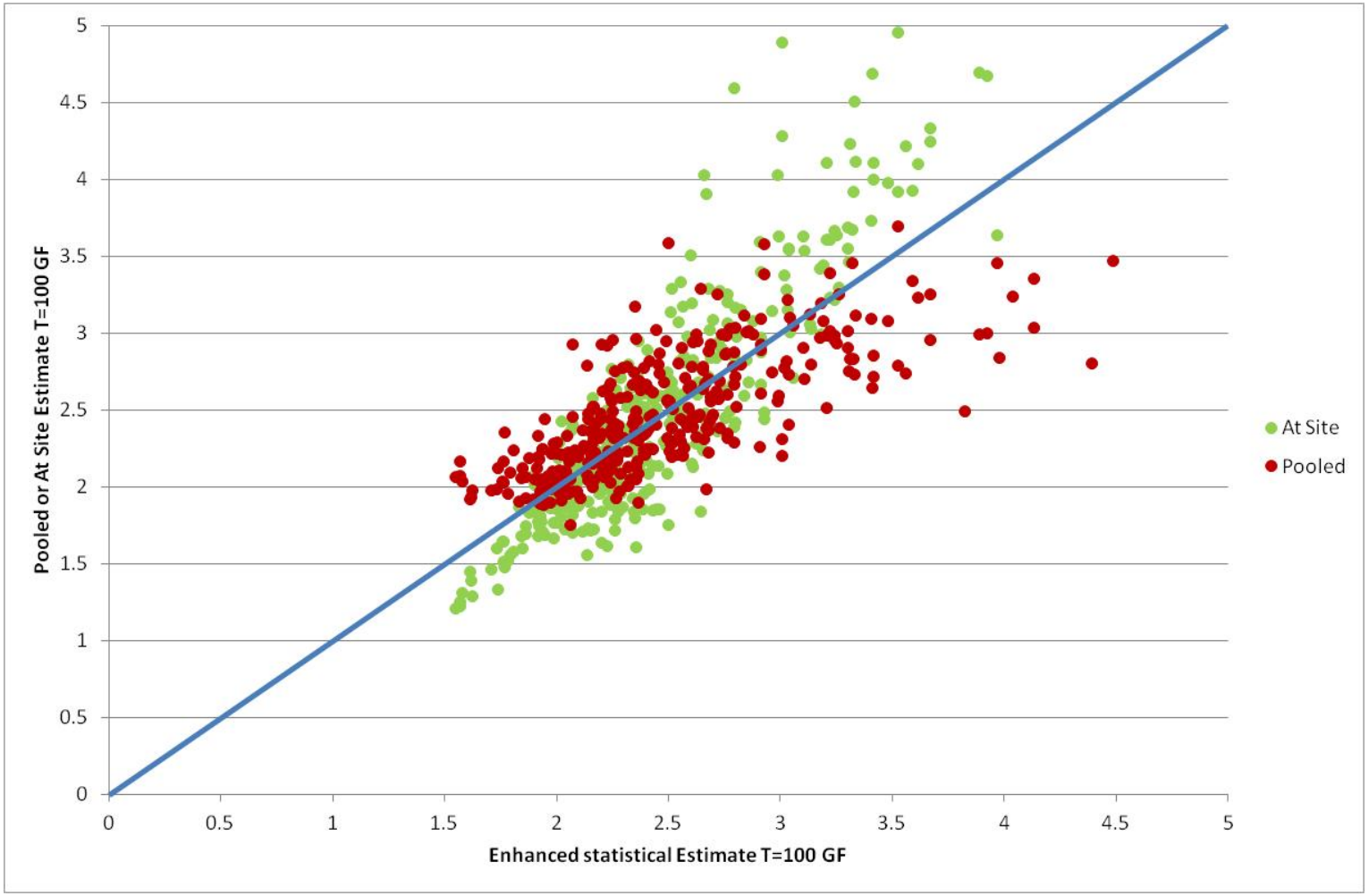
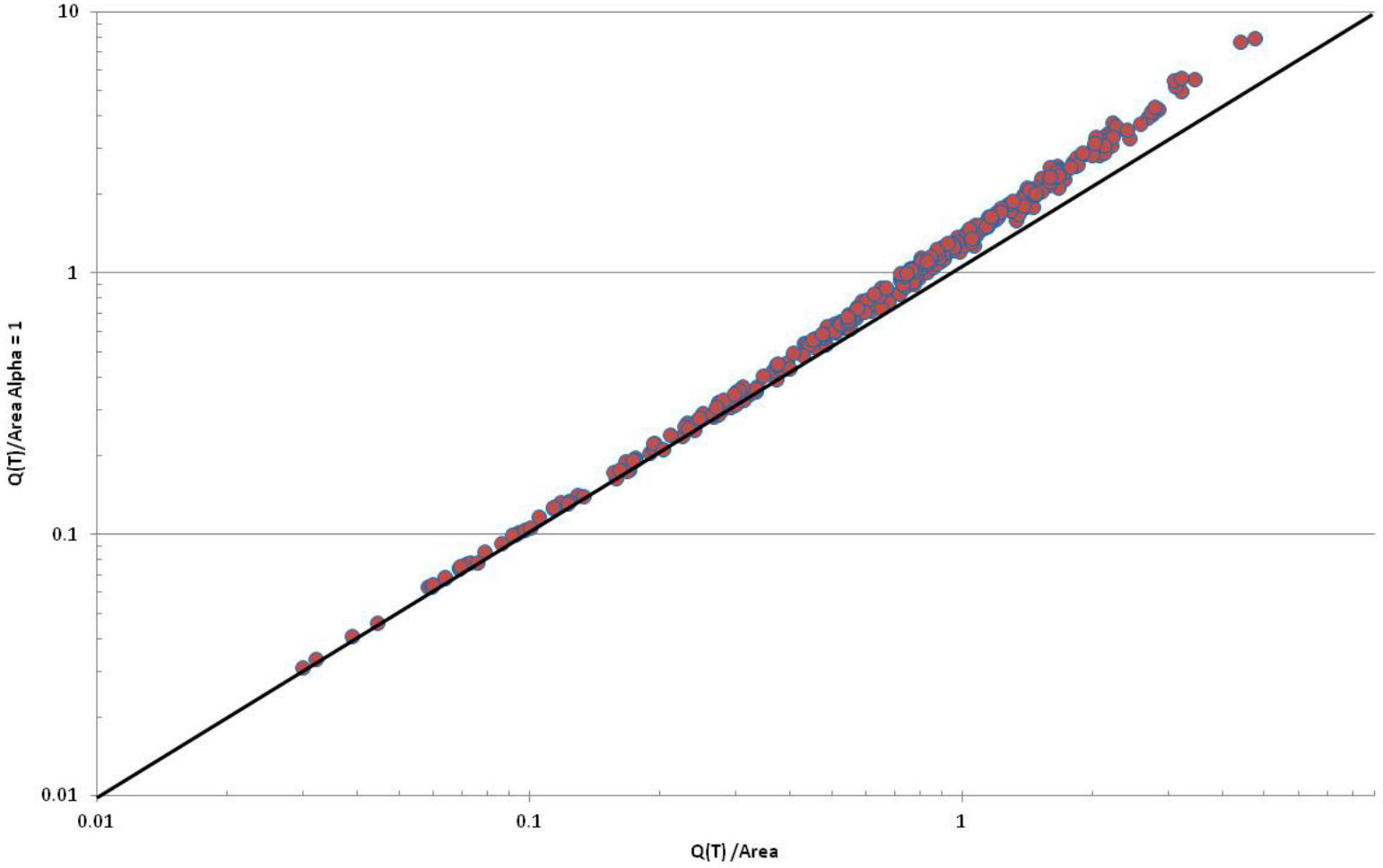
# Comparison of T=100 Growth factors



# Influence of alpha T=200



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A beta test version of ReFH2 is available for download from :

HTTP://files.hydrosolutions.co.uk/ReFH

Or contact us at

software@hydrosolutions.co.uk