JOINT PEAK-VOLUME (JPV) DESIGN FLOOD HYDROGRAPHS FOR SOUTH AFRICA

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JOINT PEAK-VOLUME (JPV) DESIGN FLOOD HYDROGRAPHS FOR SOUTH AFRICA

by

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Görgens A.H.M., Lyons S., Hayes L., Makhabane M. and Maluleke D., *Modernised South African Design Flood Practice in the Context of Dam Safety* (WRC Report No 1420/2/07).

WRC/Ninham Shand. 2006. *Dam Safety Hydrology Toolbox*[1]

[1] The web-based Toolbox is available on the Ninham Shand web-site, or can be obtained on CD from Ninham Shand, PO Box 1347, Cape Town, 8000 (Tel. No. 021-4812400).

EXECUTIVE SUMMARY

While there has been continuing research interest during the past two decades in the use of probabilistic analysis for determining design flood peaks, there have been few attempts to incorporate into this research the exceedence probability of flood volumes. For dam safety assessment in relation to floods, it is important that flood volume be considered, particularly with regards to the design and safety evaluation for medium to large dams that require site-specific investigations.

Hiemstra and Francis (1979) conducted promising research on the statistical relationship between flood peak and flood volume for South African rivers, which led to the so-called "Runhydrograph" design flood approach. This research showed that peak-volume pairs sampled from 43 flow gauging station records were approximately log-Normally distributed in bi-variate space. The Runhydrograph approach, however, is not in general use in the dam safety field in South Africa. This may be due to the fact that the methodology was not developed specifically for dam safety professionals and therefore tended to fall outside their "comfort zone". It appears that some design flood hydrology practitioners were also concerned about the validity of the annual exceedence probability relationships of the peak-volume pairs used in the Runhydrograph approach.

In a promising recent development the WRC has been funding a pilot study into the generation of credible design flood hydrographs for certain KwaZulu-Natal catchments by means of continuous rainfall-runoff modelling, using the ACRU agro-hydrological catchment model (Smithers, personal communication, 2006).

Against the above background, the empirical relationships between flood peak and flood volume, on a conditional basis, have been researched as part of this Study. This new approach is called the Joint Peak-Volume (JPV) Design Flood Hydrograph Methodology.

The objective of the JPV approach is to provide the design flood hydrology practitioner with modernised procedures and tools that link the empirical frequency of flood volume exceedence to flood peak magnitude in a regional context. This enables the designer to determine on a regionally pooled basis, for any given design flood peak, the exceedence frequency of any design flood hydrograph volume, regardless of the methodology used to estimate the flood peak.

With the aid of the *EX-HYD* software, significant flood hydrographs were extracted, on a “peak-over-threshold” (POT) basis, from primary stage records provided by the DWAF for more than 200 flow-gauging stations, as well as the inflowing flood peaks and volumes for more than 80 dams across South Africa. These partial duration flood peak sequences were screened for statistical stationarity and other evidence of unacceptable upstream human impacts.

The 12 000+ joint peak-volume (JPV) pairs and 9 000+ flood hydrographs that were extracted from the 139 gauging station and dam inflow records that survived the screening were appropriately standardised to facilitate examination in various alternative regionally pooled groupings. This examination broadly confirmed the log-Normal character of the POT partial duration data sets.

For analysis purposes the joint peak-volume data pairs, as well as typical standardised observed flood hydrographs, were organised in "pooling-groups" according to two alternative regionalisation schemas that are well-established in South African design flood practice. These are the Veld Type Zones proposed in HRU (1972) and the K-Value regions for the Regional Maximum Flood approach proposed by Kovaćs (1988).

Exceedence percentiles of "standardised volumes conditional on standardised POT peaks" were derived for each of the regional pooling options. The locus of each of these exceedence percentiles in joint peak-volume space displayed a fundamentally linear character. Therefore, the JPV design tools developed include, inter alia, a set of linear functions that describe the exceedence relationships of standardised flood volumes conditional on standardised POT flood peaks for two alternative sets of regionally pooled catchments. As an illustration, the exceedence percentile relationships for the "High K-Region" pooling-group are shown in Figure E.1.

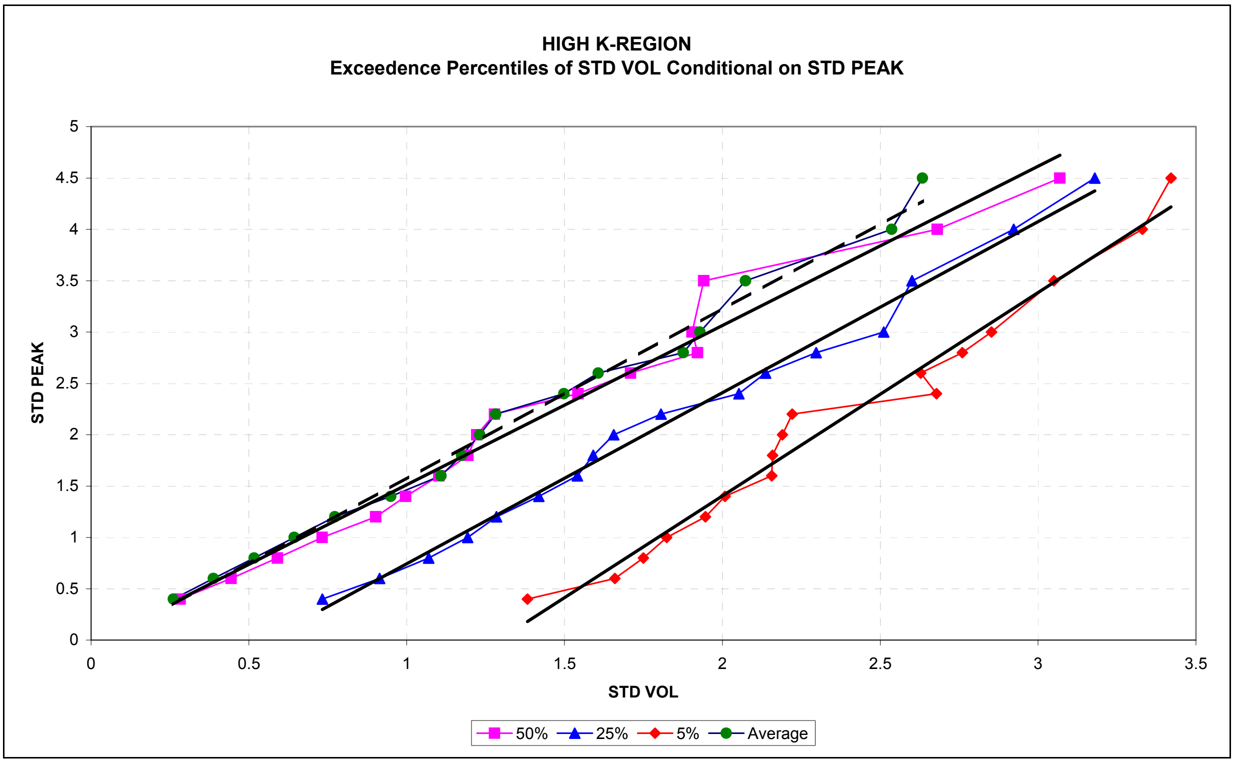

Figure E.1: Relationship between standardised flood volumes and flood peaks for the high K-Value Regions

A design flood peak provides the entry point to the JPV methodology. Once a design flood peak for a particular catchment has been determined by any method, be it empirical, deterministic, probabilistic, or their hybrids, one or more relevant typical standardised observed hydrographs as shown in Figure E.2 are selected and then dimensionalised via that design flood peak and the catchment's Basin Lag (as per HRU, 1972). The linear JPV exceedence percentile functions are then used to determine the "severity" or "conservativeness" of the design flood hydrographs in conditional volume terms.

The Report includes a pair of case studies for two widely differing catchments in which multiple 1:50 year design flood hydrographs are generated via the JPV approach and juxtaposed with a conventional Unitgraph-based design flood hydrograph. Analysis of the resulting flood volumes suggests that the Unitgraph-based volumes in this case have surprisingly high exceedence frequencies (>75%), i.e. they are perhaps not conservative enough, whereas the JPV-based volumes have more acceptable (in terms of conservativeness) exceedence percentiles of 50% to 20%.

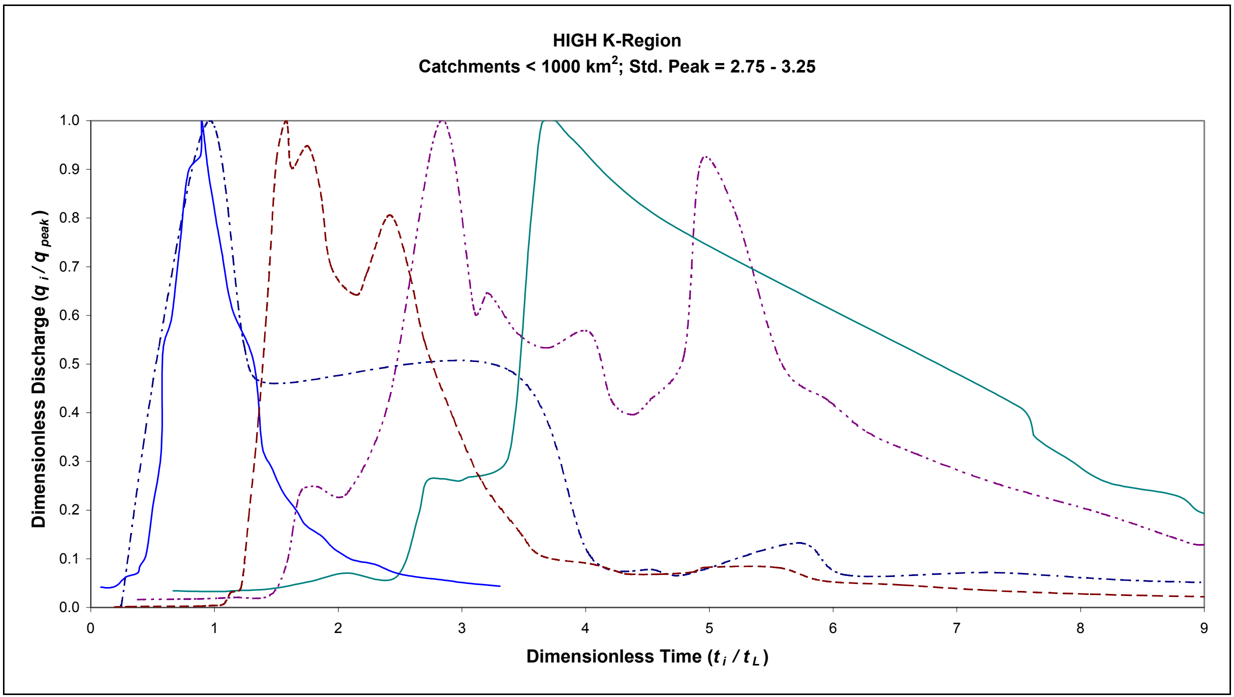

Figure E.2 Typical standardised hydrograph shapes for the "High K-Region"

In terms of design flood peaks, specifically, this research has made us aware that a modernised alternative to the ageing design flood peak estimation methods used in South African practice would be useful to design flood practitioners. Therefore, the JPV approach also includes a regional pooling method that allows the estimation of design flood peaks and volumes at ungauged sites for any given RI, based either on the two sets of large-scale pooling-groups outlined earlier, or on customised localised groupings of "hydrologically similar" catchments. For these two pooling approaches, we coined the names of "wide pooling" and "narrow pooling", respectively.

This hybrid flood peak estimation method comprises both multi-variate regression equations for index flood estimation (in which catchment descriptor values are used), and empirically weighted pooling of the statistical parameters of observed flood records for the two sets of large-scale pooling-groups outlined earlier. The latter parameters are then used for probabilistic flood peak estimation via two alternative probability distribution functions, General Extreme Value (GEV) and the Log-Pearson III (LPIII), respectively.

As illustration of the performance of this component of the JPV approach, Figure E.3 presents a comparison of the design flood peak estimates using the full (wide pooling) procedure outlined above with flood peak estimates via the Unitgraph method. These comparisons were performed for a representative data set of 75 catchments across all three Veld Zone pooling-groups. In general, the wide-pooled GEV approach, combined with regression-based prediction of index flood values, performed with sound consistency relative to the single-site probabilistic estimates, as opposed to both the wide-pooled LPIII-based and the Unitgraph-based estimates, were inconsistent and showed much greater variability than the GEV-based values.

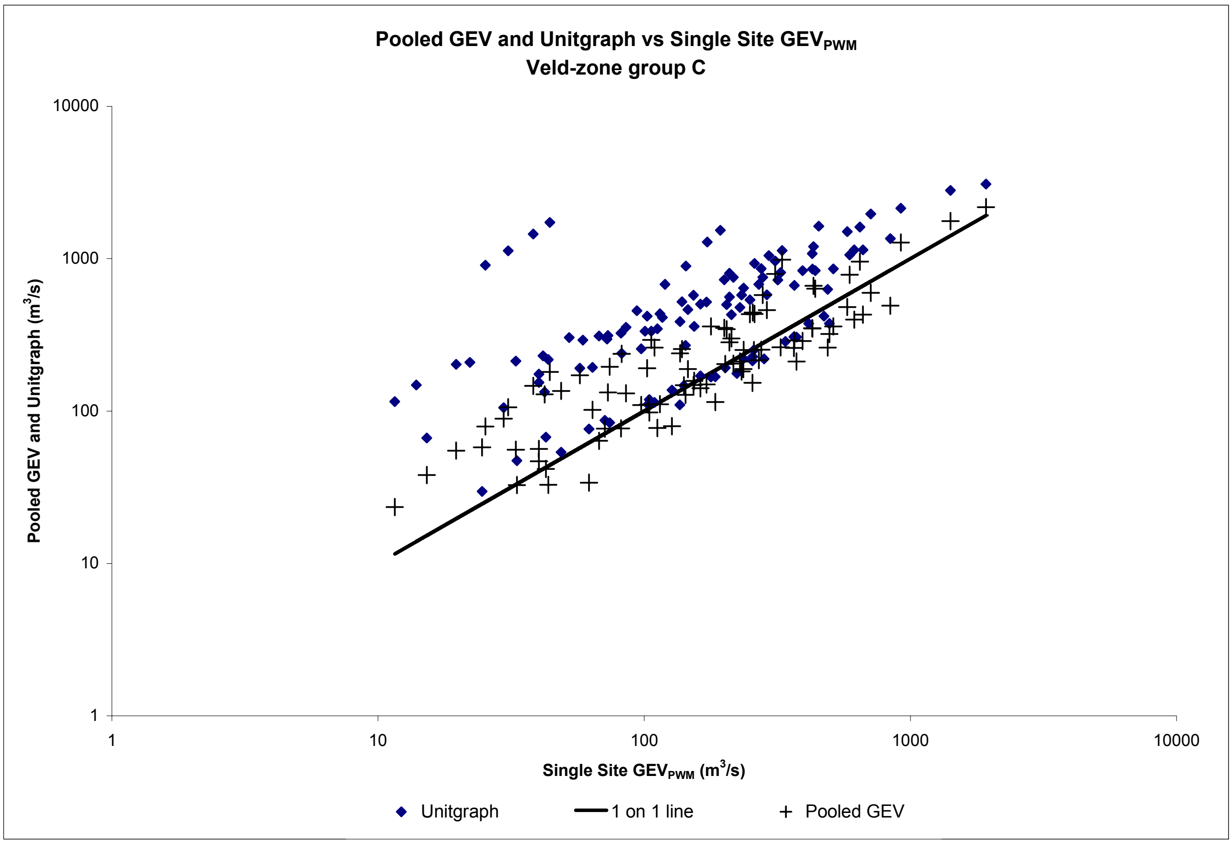

Figure E.3 Comparison of design flood estimates using pooled GEV probability analysis for Veld-Zone Group C and Unitgraph-based estimates with single-site probabilistic estimates

References for Executive Summary

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Dunisani Maluleke	Hydrologist
Tassie Clarke	GIS Scientist

LIST OF ABBREVIATIONS

AEP	Annual Exceedence Probability
DWAF	Department of Water Affairs and Forestry (South Africa)
FEH	Flood Estimation Handbook (United Kingdom)
GEV	General Extreme Value Probability Density Distribution
GIS	Geographical Information Systems
HRU	Hydrological Research Unit (University of the Witwatersrand)
JPV	Joint Peak-Volume
K	Coefficient of RMF Envelope Equation & Identity of RMF Region
LP3 or LPIII	Log-Pearson Probability Density Distribution
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
PMF	Probable Maximum Flood
POT	Peak-over-threshold
RI	Recurrence Interval
RMF	Regional Maximum Flood
SANCOLD	South African National Committee on Large Dams
SCS	Soil Conservation Service
WRC	Water Research Commission (South Africa)

LIST OF SYMBOLS

AREA	Catchment Area
CV_Q	Coefficient of Variation of Annual Max. Flood Peaks
CV^{pool}_Q	Pooled Coefficient of Variation of Annual Max. Flood Peaks
CV_{lnF}	Coefficient of Variation of Natural Logs of POT Flood Peaks
CV_{lnV}	Coefficient of Variation of Natural Logs of POT Flood Volumes
DES	Catchment Descriptor
Dist	Similarity Distance in Euclidian Space
F	POT Flood Peak
F^{Std}	POT Flood Peak Standardised in Natural Log Space
g_Q	Skewness of Annual Max. Flood Peaks
g^{pool}	Pooled Skewness
$K_{g,T}$	Frequency Factor for a Given Skewness and Recurrence Interval
ln	Natural logarithms
μ	Mean
μ_{lnQ}	Mean of natural logs of Annual Max. Flood Peaks
μ^{est}_Q	Catchment Descriptor-Based Estimate of Mean of Annual Max. Flood Peaks
μ_{lnF}	Mean of natural logs of POT Flood Peaks
μ_{lnV}	Mean of natural logs of POT Flood Volumes
MAP90	Mean Annual Rainfall (mm) as per WR90
MAR90	Mean Annual Runoff (mm) as per WR90
MAR/MAP	Runoff Coefficient (%) as per WR90
Q	Annual Maximum Flood Peaks
Q_T	Design Flood Peak of Recurrence Interval = T
S	Equal Area Slope of Longest Water-Course
σ_Q	Standard Deviation of Annual Max. Flood Peaks
σ^{est}_Q	Standard Deviation Based on Estimated Mean and Pooled CV
σ_{lnF}	Standard Deviation of Natural Logs of POT Flood Peaks
σ_{lnV}	Standard Deviation of Natural Logs of POT Flood Volumes
t_L	Basin Lag (hr) as per HRU 1/72
T	Recurrence Interval of Design Flood in Years
V	POT Flood Volume
V^{Std}	POT Flood Volume Standardised in Natural Log Space
wd	Inverted Average Similarity Distance, *DIST*
wr	Flood Record Length in Years

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1. INTRODUCTION

1.1 Outline of this Document

This document presents probabilistic procedures combined with empirical tools for design flood hydrograph estimation in South Africa. It comes in two parts: The first part presents the derivation of the Joint Peak-Volume (JPV) Design Flood Hydrograph estimation methodology. The second part comprises a series of appendices, which present the graphs, maps, and tables that constitute the tools for, and the underlying information that supported the development of, the JPV Design Flood Hydrograph estimation approach.

1.2 Rationale for JPV Approach

The first rationale of these procedures and tools stems from our recognition that the statistical linkage of flood peaks and flood volumes as joint occurrences has been under-appreciated in South African design flood practice. A second rationale is rooted in our long-standing experience that, in South African practice, a focus on flood peaks usually directs the flood hydrology design process. A third rationale flows from our understanding that observed flood hydrographs should play a critical role in various design processes, but are usually not readily accessible to the flood hydrology practitioner. This is particularly relevant in the Dam Safety field, where the flood volume and its distribution over time (i.e., the hydrograph) are critical considerations in the design of the spillway size and the non-overspill crest elevation.

A fourth rationale is provided by our realisation that no new design flood hydrograph estimation methodology, nor any substantial improvement of historical methodologies, has been established in South Africa during more than two decades, despite the expansion of the available flood data base during that time. Recognition of the availability of many hundreds of additional years of streamflow observations by the indispensable gauging networks of the Department of Water Affairs and Forestry (DWAF), juxtaposed by the daunting uncertainties inherent to design flood hydrograph estimates, has led us to initiate the development of a new generation of design flood estimation tools that conform to modernised professional requirements and that are based on updated observed flood information.

NB: It should be noted that the contents of this document do not necessarily replace or negate any existing or historical methodologies for design flood estimation in South Africa.

1.3 Overview of JPV Approach

As introduced above, the objective of the JPV approach is to provide the flood hydrology designer with modernised procedures and tools that link the empirical frequency of flood volume exceedence to flood peak magnitude in a regional context. This enables the designer to determine, for any given design flood peak, the exceedence frequency of any design flood hydrograph volume, regardless of the methodology used to estimate the flood peak.

With the aid of customised software (*EX-HYD*) developed under this WRC Project (described in the sister-document to this one, entitled: *Modernised South African Design Flood Practice in the*

Context of Dam Safety, Görgens, *et al* (2006)), significant flood hydrographs were extracted, on a "peak-over-threshold" (POT) basis, from primary stage records kindly provided by the Department of Water Affairs and Forestry (DWAF) for more than 200 flow-gauging stations as well as the inflowing flood peaks and volumes for more than 80 dams across South Africa. These partial duration flood peak sequences were screened for statistical stationarity and other evidence of unacceptable upstream human impacts.

The 12000+ joint peak-volume (JPV) pairs and 9000+ flood hydrographs that were extracted from the 139 gauging station and dam inflow records that survived the screening were appropriately standardised to facilitate examination in various alternative regionally pooled groupings. This examination broadly confirmed the log-Normal character of the POT partial duration data sets. Details of the gauging station records and statistics of the JPV data are presented in Appendix A1 of this document.

Exceedence percentiles of "*standardised volumes conditional on standardised POT peaks*" were derived for each of the regional pooling options. The locus of each of these exceedence percentiles in joint peak-volume space displayed a fundamentally linear character. Therefore, the JPV design tools presented here include, inter alia, a set of linear functions that describe the exceedence relationships of standardised flood volumes conditional on standardised POT flood peaks for two alternative sets of regionally pooled catchments.

A design flood peak provides the entry point to the JPV methodology. Once a design flood peak has been determined by any method, be it empirical, deterministic, probabilistic, or their hybrids, one or more relevant typical standardised observed hydrographs are selected and then dimensionalised via that design flood peak. The linear JPV exceedence percentile functions are then used to determine the "severity" of the design flood hydrograph in conditional volume terms.

In terms of design flood peaks, specifically, this research has made us aware that a modernised alternative to the aging design flood peak estimation methods used in South African practice would be useful to design flood practitioners. Therefore, the JPV approach also includes a regional pooling method that allows the estimation of design flood peaks and volumes at ungauged sites for any given annual exceedence probability (AEP) or recurrence interval (RI), based either on large-scale regions of "similar flood response" catchments, or on customised localised groupings of "hydrologically similar" catchments. This is a hybrid method that comprises both multi-variate regression equations in which a conveniently measurable set of physical catchment descriptors is employed, and empirically-derived pooling of the statistical parameters, skewness and coefficient of variation, of observed flood peaks and volumes for hydrologically similar sets of catchments.

2. QUANTIFICATION OF FLOOD VOLUME CONDITIONAL ON DESIGN FLOOD PEAK

2.1 Standardisation of Joint Peak-Volume Pairs

Utilisation of the statistical relationship between flood peak and flood volume on a regionally pooled basis is at the heart of the JPV approach. Earlier research on this relationship for South African rivers by Hiemstra and Francis (1979), in support of the so-called “Runhydrograph” approach, showed that peak-volume pairs sampled from 43 flow gauging station records were approximately log-Normally distributed in bi-variate space. Given this finding, and recognising that the peak-volume pairs assembled in this Study had to be scale-neutral in order to lend them to be organised in a regionally pooled manner, we employed the following standardising convention appropriate to log-Normal space.

$$\text{Standardised } lnPeak_i = (lnPeak_i - \mu_{ln\ Peaks}) / \sigma_{ln\ Peaks} \tag{2.1}$$

$$\text{Standardised } lnVolume_i = (lnVolume_i - \mu_{ln\ Volumes}) / \sigma_{ln\ Volumes} \tag{2.2}$$

where *ln* is the natural logarithm, μ is the mean and σ is the standard deviation.

2.2 Design Flood Practice Comfort Zones

The JPV methodology presented here acknowledges that established South African design flood practice operates in a “comfort zone”, which needs to be accommodated in any modernised methodology. This comfort zone has two distinguishing features, as follows:

i) The design flood estimation process is directed by a focus on the flood peak.

ii) The design flood volume is generally treated as an “AEP-neutral” entity.

The first of these comfort zone features can be illustrated by the history of the abovementioned Runhydrograph. Despite its obvious potential when it was formally proposed by Hiemstra and Francis in 1979, the Runhydrograph approach did not become established in South African design flood practice. Although certain technical concerns about the approach (e.g. its determination of AEPs) might have contributed to this unfortunate outcome, it is now generally understood that the Runhydrograph method’s combining of the joint AEPs of peaks and volumes was a source of “discomfort” for South African practitioners (and researchers), which has led to a general tardiness to embrace that approach. A typical concern that practitioners aired in this regard, was along the lines of: “How do I reconcile the AEP/RI of a design flood peak, generated by the Unitgraph and Rational Methods, for a particular ungauged site with the peak-volume *combined* AEP of a family of equally-likely Runhydrographs at the same site?”

The second of the abovementioned comfort zone features, i.e. an AEP-neutral design volume, is well illustrated by the AEP-neutral “average loss” functions of the HRU 1/72 Synthetic Regional Unitgraph approach (HRU, 1972), as well as the various local conventions to link AEP-neutral volumes under assumed discharge time distributions to design flood peaks estimated via the Rational Method and its derivatives (Alexander, 1990; 2002), via the RMF Method

(Kovaćs (1988) and, even, via single-site flood frequency analysis (Hiemstra and Francis, 1979).

2.3 Regional Pooling of Catchments

A delineation of "regions" across South Africa is proposed in which the component catchments share various characteristics that define their flood response characteristics. In recognition of the historical "comfort zones" of local flood hydrology practitioners, we decided to utilise, as equally valid alternatives to each other, the following two well-established South African regional delineations that define local practice in this context:

- K-Regions: defined by Kovaćs (1988) as extreme flood regions that frame the empirical Regional Maximum Flood (RMF) methodology.
- Veld Type Zones: typical flood runoff response regions for the Unitgraph methodology proposed in the famous design flood "manual", HRU Report 1/72 (HRU, 1972).

For the JPV methodology, each of the 139 catchments was classified according to its location in either the K-Region or the Veld Type Zone and then re-arranged into three pooled categories each, as follows:

- *K-Region catchment groupings:* High-K (K > 5), Mid-K (K = 5), and Low-K (K < 5). See Appendix A2 for the map that depicts the location of these three groupings.
- *Veld Type Zone catchment groupings:* Groups A (Veld Type Zone 2), B (Veld Type Zones 4, 5, 6, 7), and C (Veld Type Zones 1, 3, 8, 9). See Appendix A3 for the map that depicts the location of these three groupings.

2.4 Flood Volume Conditional on Design Flood Peak

The JPV methodology presented here recognises that the established South African practice has a "comfort zone" in which the design flood estimation process is directed by a focus on the flood peak. Therefore, we structured the JPV approach so that *the practitioner may engage the empirical exceedence frequency relationship of flood volumes, conditional on any specific design flood peak already estimated*.

To determine such relationships, selected exceedence percentiles of standardised observed volumes conditional on standardised observed peaks were derived for each catchment grouping in the two regional pooling options – K-Regions and Veld Type Zones. The locus of each of these exceedence percentiles in joint peak-volume space displays a fundamentally linear character, an example of which can be seen in Figure 2.1. Chapter 5 of this document describes the derivation of the full set of linear functions that describe the exceedence relationships of standardised flood volumes conditional on standardised flood peaks for alternative sets of regionally pooled catchments. The full set of exceedence percentile diagrams appear in Appendix B, organised by pooling-group.

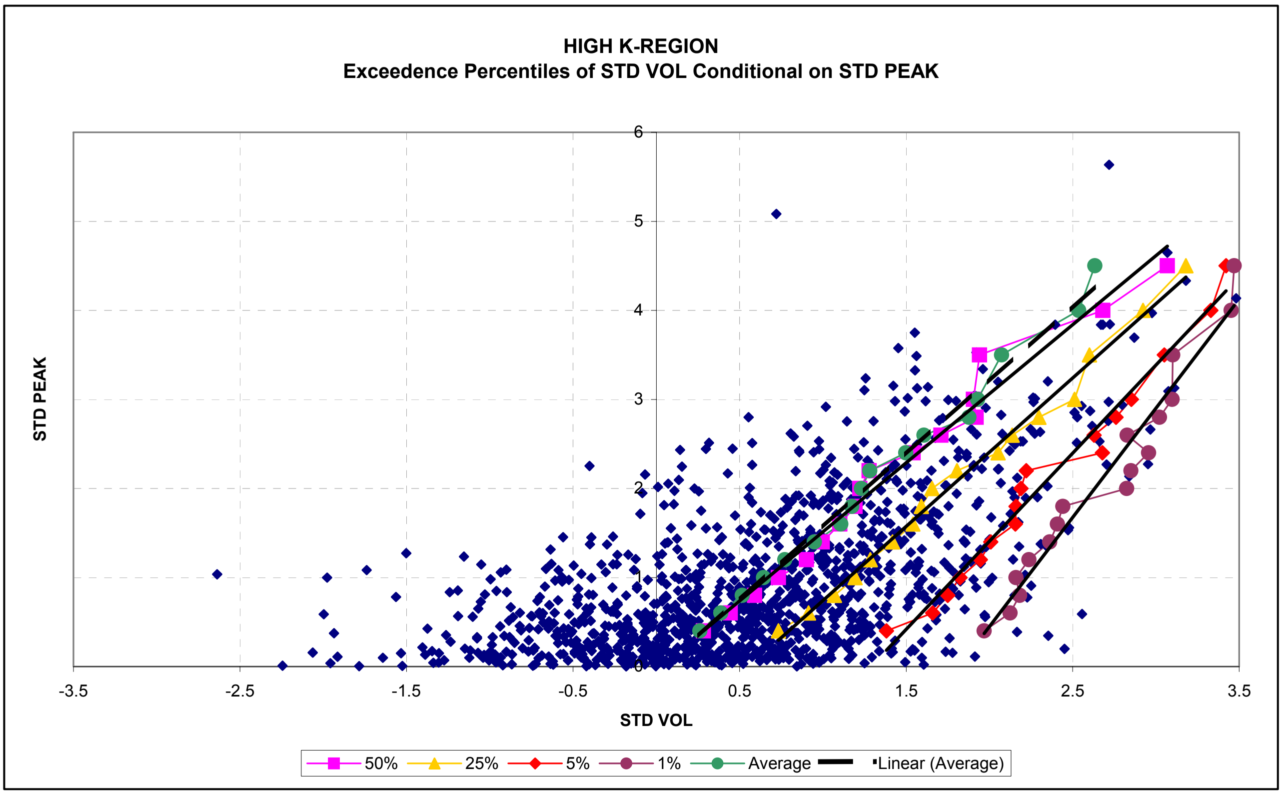

Figure 2.1 Example of Exceedence Percentiles of Regionally Pooled Standardised Flood Volumes Conditional on Standardised Flood Peaks

The comfort zone convention of an AEP-neutral design volume is automatically catered for by the JPV exceedence percentile function approach. Because this approach affords the designer a clear view of the conditional statistical behaviour of flood volume in the "vicinity" of any design flood peak magnitude, she/he can circumspectly select a design flood volume in line with her/his understanding of the reigning uncertainties and consequent need for conservatism unique to each design situation.

3. POOLING OF STATISTICAL PARAMETERS FOR DESIGN FLOOD ESTIMATION

3.1 Conceptual Orientation

Given the focus of the JPV approach on developing a "peak-led" methodology for estimating or selecting design flood volumes, it follows that the approach should include an up-to-date method for design flood peak estimation at ungauged sites. In the light of the sizeable national flood data set assembled for this Study, a logical choice of method would be one where this wealth of observed flood data could be directly employed. *Pooling*, in which observed flood peak statistical parameters from groups of catchments with "similar" flood response characteristics are combined for enhanced flood frequency analysis at ungauged sites, represents such an observation-based methodology.

Pooling across a group of similar catchments effectively increases the size of the flood peak sample on which the flood AEP/RI analysis is being performed, with the consequent benefit of increased reliability of estimates of *skewness* and *coefficient of variation*, the two dimensionless statistical parameters that have a dominant influence on the character of the appropriate underlying probability distribution function. Pooling can, therefore, markedly raise the confidence level of the estimate of a low AEP/ high RI design flood peak[2] in the presence of relatively short flood records at gauged sites, or at any ungauged site remote from a relevant flow gauging station.

A universal dilemma in the pooling process is posed by differentials in scale across any group of catchments for which flood data are combined. A simple, but effective, response to this challenge of scale is, before pooling, to transform each participating annual flood peak series into ratios of the mean (or median) of that series. In international practice this has generally become known as the "index flood method", and the mean (or median) of the annual series as the "index flood". A further dilemma is the definition of the appropriate catchment criteria for membership of any particular pooling-group. Criteria that are reported in recent literature vary as follows: fixed geographical regions; fixed non-geographical pooling-groups; similar-site pooling-groups with fixed numbers of catchments; similar-site pooling-groups with adjustable numbers of catchments.

For the JPV methodology, we designed a pooled flood AEP/RI analysis approach based on insights derived from both the definitive work of Hosking and Wallis (1997) on regional flood frequency analysis and the related subsequent pooling research in the UK Flood Estimation Handbook (*FEH*) (Institute of Hydrology, 1999). The methodology that evolved was shaped according to four core arrangements:

[2] The Flood Estimation Handbook (Institute of Hydrology, 1999) "rule-of-thumb" for optimal estimates of low AEP/high RI events is that the total record length represented by the sample data should be a factor of *five times the design RI* (the so-called 5T rule)*, or failing that, never less than a factor of two* (the 2T rule).

i) Two probability distribution functions, Log-Pearson III (LP-III) and General Extreme Value (GEV), commonly used in South African design flood estimation practice (Alexander, 1990), have been included in this component of the JPV Methodology.

ii) Appropriate information and tools are provided to allow pooling of catchments according to two alternative sets of criteria: (a) *fixed geographical pooling-groups* based on flood response regions; (b) *similar-site pooling-groups with adjustable catchment numbers*.

iii) The contribution of the flood peak or flood volume statistics of each pooling-group catchment is jointly *weighted* according to two criteria: (a) *flood record length*; and (b) a *similarity distance measure* based on the Euclidean distance in the *n*-dimensional space defined by selected catchment descriptors. The weighted pooling is applied to the skewness *(g)* and coefficient of variation *(CV)* only.

iv) The *mean annual maximum flood peak* (the "index flood peak") is estimated, either in *ln*-space, or in natural space, via both fixed and adjustable geographically pooled "regional" *multi-variate relationships* developed from selected *catchment descriptors*.

These core arrangements are described in the sub-sections that follow.

3.2 Catchment Pooling-Groups

3.2.1 Fixed Pooling-Groups ("Wide" Pooling)

Catchment descriptors, as well as statistical parameters of annual maximum flood peaks, were assembled for two sets of alternative fixed geographical catchment pooling-groups: (a) three K-Region catchment groupings; (b) three Veld Type Zone catchment groupings. These groupings are defined in Section 2.1, maps of their extent are presented in Appendices A2 and A3 and the values for the relevant descriptors, statistics and other information appear in Appendix C1. The similarity distance values, $Dist_{i\,j}$ (see Section 3.3), for each pair of catchments in these six groupings, as well as the relevant record lengths, are presented in Appendix C2.

3.2.2 Adjustable Pooling-Groups ("Narrow" Pooling)

For a particular design site, the practitioner may decide to create a "narrow" pooling-group more localised than one of the above six larger-scale fixed groupings by "cherry-picking" from the larger fixed groupings those catchments with the lowest similarity distance value relative to the design site. In the case of an ungauged design site, catchment descriptors will need to be determined to allow prior calculation of the similarity distance values of all catchments in the fixed group relative to the design site.

3.3 Similarity Distance Measure

The similarity of catchments is evaluated in terms of flood-enhancing catchment descriptors or attributes, which have been *purposefully selected to be conveniently quantifiable*. After screening various descriptors, we decided to limit the exercise to three significantly different and relatively independent descriptors:

i) Catchment area (km^2) – *AREA*: a measure of flood magnitude and scale

ii) Average main channel slope – *S*: a simple measure of drainage efficiency

iii) Mean annual runoff (in mm) according to the WR90 national water resource information (Midgley, *et al*, 1994) – *MAR90*: an integrated measure of wetness, soil storage and land-cover.

As in the *FEH*, we used the similarity distance measure concept to evaluate the similarity of pairs of catchments according to the above descriptors. If there are *n* such descriptors, then the Euclidean distance between pairs of catchments *i* and *j* is generically quantified by:

$$Dist_{i\,j} = [\, \sum (DES_{k,i} - DES_{k,j})^2 \,]^{1/2} \qquad (3.1)$$

where $DES_{k,j}$ is the k^{th} descriptor of the i^{th} catchment, and $k = 1,n.$

We modified the above generic formula for similarity distance to accommodate the peculiarities of the ranges, magnitudes and asymmetry of the chosen catchment descriptors. This modification corresponds to the findings in the *FEH* (Institute of Hydrology, 1999). *AREA* and *MAR90* were log-transformed to improve their symmetry and then each descriptor was standardised by division by its standard deviation (in its pooling-group). Also, to reduce the dominance of *AREA* in the distance calculation outcomes, the weight given to it has been halved, thus allowing *S* and *MAR90* to play a more significant role.

The similarity distance measure eventually used in the JPV approach is:

$$Dist_{i\,j} = [\, 0.5\, (lnAREA_i - lnAREA_j\,)^2 / \sigma_{lnAREA} + (lnMAR90_i - lnMAR90_j\,)^2 / \sigma_{lnMAR90} + (\, S_i - S_j\,)^2 / \sigma_S \,]^{1/2} \qquad (3.2)$$

where σ is the standard deviation of the specific descriptor. The evaluation rule is as follows: "*Catchment pairs with the smallest values of $Dist_{i\,j}$ are the most similar to each other*". For the Fixed Pooling Groups similarity distance values below 1.0 would represent strong similarity between catchments in the context of this Study.

Out of the original 139 catchments, descriptors were derived for a more efficient smaller sample of 77 catchments, on the basis of national representivity. The similarity distance values for each pair of catchments in the six fixed geographical pooling-groups (as well as the relevant record lengths) are presented in Appendix C2. For the pairings considered here, the similarity distance values varied between 0.2 and 5.

3.4 Calculating Pooled Skewness (g^{pool}_Q) and Pooled Coefficient of Variation (CV^{pool}_Q)

Pooled values for *g* and *CV* for annual maximum floods are calculated as the weighted average of the individual values for these two parameters for the catchments in any pooling-group. The weighting is a function of similarity distance and record length. If there are *m* catchments in the pooling-group, then the pooled CV_Q is calculated as follows:

$$CV^{pool}_Q = [\ (wd_i\ CV_i / \sum wd_i) + (wr_i\ CV_i / \sum wr_i\ )]\ /\ 2 \qquad (3.3)$$

where wd_i is the inverted[3] average $Dist_{i\,j}$ for each catchment, wr_i is the flood record length[4] for each catchment and $i = 1,m$. Pooled skewness, g^{pool}_Q, is obtained in the same way as pooled *CV*, using the same weights.

Matrices of the similarity distance values for each pair of catchments in the six fixed geographical pooling-groups, as well as the relevant record lengths, are presented in Appendix C2. Statistical parameters (mean, standard deviation, skewness) for the individual gauging station flood records can be found in Appendix B1, for both natural and log-transformed values. The pooled statistical parameters for annual maximum floods for the six fixed geographical pooling-groups are listed in Table 3.1.

[3] Inversion of the average similarity distance value per catchment is required, in order to ensure that the highest weightings accompany the lowest average similarity distances, i.e. the statistical parameter values of the most “similar” catchments should have the greatest influence on the pooled values.

[4] Record length is used as is, as longer records should have the highest weightings, given that longer records yield more reliable estimates of the statistical parameters of the underlying AEP distribution.

Table 3.1 Pooled Weighted Statistical Parameter Values for Annual Maximum Flood Peaks for Two Alternative Fixed Geographical Pooling-Groups

Pooling-Group	**Natural Peaks**			
	CV_Q		***g_Q***	
	Pooled	Range	Pooled	Range
High K-Region	1.27	0.60-2.51	2.35	0.47-5.77
Mid-K-Region	1.50	0.29-2.62	2.83	0.40-5.44
Low K-Region	1.30	0.39-2.52	2.86	0.57-6.52
Veld Zone Group A	1.19	0.29-1.94	2.09	0.40-4.04
Veld Zone Group B	1.36	0.60-2.62	3.06	0.47-6.52
Veld Zone Group C	1.22	0.56-2.51	2.98	0.47-5.77
Pooling-Group	***ln* Peaks**			
	CV_{lnQ}		***g_{lnQ}***	
	Pooled	Range	Pooled	Range
High K-Region	0.29	0.08-0.69	0.28	-0.73-2.24
Mid-K-Region	0.27	0.05-0.88	0.26	-1.31-1.36
Low K-Region	0.28	0.06-0.51	0.00	-1.31-1.36
Veld Zone Group A	0.39	0.05-0.88	0.15	-0.59-0.89
Veld Zone Group B	0.27	0.12-0.81	0.09	-1.31-1.36
Veld Zone Group C	0.31	0.08-0.69	0.04	-1.31-2.24

4. ESTIMATING THE DESIGN FLOOD PEAK

4.1 Estimating the Mean of the Annual Maximum Flood Peaks

4.1.1 Model to Estimate Annual Maximum Flood Peak Mean

As stated earlier, two probability distribution functions commonly used in South Africa, LPIII and GEV, are included in this Methodology. The LP-III calculations operate in log-space, whereas the GEV calculations operate with natural (untransformed) flood peak values. Consequently, estimates of two different types of means (or "index flood peak" types) are required, as follows:

- GEV: Mean Annual Maximum Flood Peak, μ_Q
- LPIII: Mean of the *ln*(Annual Maximum Flood Peak), μ_{lnQ}

where Q = annual maximum flood peak and *ln* = natural logarithms.

A multiplicative model is used for describing the relationships between each of the two index flood peak types and catchment descriptors, because we surmise that changes in descriptors would have a scaling effect on changes to the value of the index flood peak. The form of the model in natural (untransformed) space is as follows:

$$Index\ Flood\ Peak = A0\ DES_1^{A1}\ DES_2^{A2}\ DES_3^{A3}\ \ldots.., \qquad (4.1)$$

where DES_1, DES_2, … are catchment descriptors and *A0, A1, A2*, A*3,….*are constants. A logarithmic transformation of the model yields a linear equation that allows standard multi-variate regression analysis of the underlying data to quantify the constants, as follows:

$$ln(Index\ Flood\ Peak) = B_0 + B_1\ lnDES_1 + B_2\ lnDES_2 + B_3\ lnDES_3\ \ldots., \qquad (4.2)$$

where B_0, B_1, B_2, B_3 ….are standard linear regression coefficients, and $A0 = Exp\ (B_0)$. This model is suitable for estimation of both μ_Q (for GEV application) and μ_{lnQ} (for LP-III application).

4.1.2 Catchment Descriptors

The applicable index flood peak is estimated via fixed geographically pooled "regional" multi-variate relationships developed from flood-enhancing catchment descriptors or attributes, which have been *purposefully selected to be conveniently quantifiable*. After screening a range of candidate descriptors, we decided to limit the exercise to the following seven descriptors, each of which offers potentially significant information about a catchment's hydrological responsiveness:

i) Catchment area (km^2) - *AREA*: a measure of scale and flood magnitude.

ii) Mean annual precipitation (mm) according to the WR90 national water resource information (Midgley, *et al*, 1994) - *MAP90.* This is a surrogate measure of long-term wetness.

iii) Mean annual runoff (mm) according to the WR90 national water resource information (Midgley, *et al*, 1994) - *MAR90.* This is an integrated measure of wetness, soil storage and land-cover.

iv) Mean annual runoff coefficient (%) - *MAR/MAP*. This is a measure of long-term hydrological responsiveness.

v) Average main channel slope (%) – *S*. This is a simple measure of drainage efficiency.

vi) Basin Lag (HRU, 1972) (hours) – t_L. This is an integrated measure of short-term hydrological responsiveness.

vii) For K-Region pooling-groups: A digit representing the relevant HRU Veld Type Zone Group, where *Group A = 3*, *Group B = 2* and *Group C = 1*; these digits broadly mimic the ratios of the three HRU 1/72 average storm loss curves (HRU, 1972). This is a measure of average flood responsiveness.

viii) For Veld Zone pooling-groups: A digit representing the relevant K-Region, where *High = 3*, *Mid = 2* and *Low = 1*; these digits broadly mimic the ratios, in natural space[5], of the average K-values of the three K-Regions. This is a measure of extreme flood responsiveness.

It follows that some of the above descriptors would be inter-dependent/ cross-correlated, and therefore not all the descriptors could be expected to feature simultaneously in the regression equations. Particularly, *MAP90* and *MAR/MAP* on the one hand and *MAR90* on the other hand, are by their nature highly cross-correlated; as are *S* and t_L. Consequently, these two sets of cross-correlated descriptors were not included simultaneously in any of the analyses.

4.1.3 Multi-Variate Regressions: Annual Maximum Flood Peak Means

In order to converge on an efficient model, various combinations and transformations of the catchment descriptor values were explored in step-wise multi-variate regressions to maximise the degree of explanation of the variance of the observed index flood peak values. For this exploratory exercise the descriptors for the full national sample of 77 catchments were used, i.e. not the regionally pooled samples. It became clear that inclusion of basin lag, t_L, instead of average main channel slope, *S*, offered no advantage in R^2 terms. Therefore, given its relative simplicity, *S,* the average main channel slope, was preferred for mean annual maximum flood peak predictions. The R^2 values for the best-fit step-wise regressions for both index flood peak types are presented in Table 4.1.

[5] The K-value of the Francou-Rodier method embedded in the RMF approach operates in log-space. Therefore, for ratios in natural space the antilog (natural) equivalents of the K-values need to be used.

Table 4.1 Improvement in R^2 with Step-Wise Inclusion of Additional Descriptors for Estimation of Index Flood Peak [6]

Case	R^2	Variables
Index Flood Peak Type: $ln(\mu_Q)$		
With *MAP90* and *MAR/MAP*	0.58	ln *AREA*
	0.65	ln *AREA*; ln *MAR/MAP*
	0.70	ln *AREA*; ln *MAR/MAP*; ln *MAP90*
	0.71	ln *AREA*; ln *MAR/MAP*; ln *MAP90*, *S*
	0.74	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; *S*; *Veld Zone Type Group*
	0.71	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; *S*; *K-Region Group*
With *MAR90*	0.58	ln *AREA*
	0.69	ln *AREA*; ln *MAR90*
	0.70	ln *AREA*; ln *MAR90*; *S*
	0.73	ln *AREA*; ln *MAR90*; *S*; *Veld Zone Type Group*
	0.70	ln *AREA*; ln *MAR90*; *S*; *K-Region Group*
Index Flood Peak Type: μ_{lnQ}		
With *MAP90* and *MAR/MAP*	0.39	ln *AREA*
	0.56	ln *AREA*; ln *MAR/MAP*
	0.65	ln *AREA*; ln *MAR/MAP*; ln *MAP90*
	0.68	ln *AREA*; ln *MAR/MAP*; ln *MAP90*, *S*
	0.68	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; *S*; *Veld Zone Type Group*
	0.68	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; *S*; *K-Region Group*
With *MAR90*	0.39	ln *AREA*
	0.63	ln *AREA*; ln *MAR90*
	0.66	ln *AREA*; ln *MAR90*; *S*
	0.68	ln *AREA*; ln *MAR90*; *S*; *Veld Zone Type Group*
	0.66	ln *AREA*; ln *MAR90*; *S*; *K-Region Group*

The incremental R^2 values indicate that the strongest generalised predictors of annual maximum flood peak means are catchment size and inherent hydrological responsiveness (*MAR/MAP* or *MAR90*). It is also of interest to note that inclusion of *MAP90* and *MAR/MAP* combined offers no obvious advantage over *MAR90* by itself. Consequently, for the next round of regressions aimed at establishing regionally pooled equations, *MAR90* was preferred over the former two descriptors.

Appendix D1 provides a graphical overview of the goodness-of-fit of the regionally pooled regressions ultimately selected. The coefficients of these relationships are listed in Table 4.2.

[6] For this exercise a national sample of 77 gauged catchments was used.

Table 4.2 Coefficients of Pooling-Group Multi-Variate Relationships for Estimation of $\ln(\mu_Q)$ and $\mu_{\ln Q}$

Pooling-Group	*Constant* (B_0)	*ln Area* (B_1)	*S* (%) (B_2)	*ln MAR90* (B_3)	"*Region*"[7] (B_4)	R^2
			$\ln(\mu_Q)$			
Low K-Region	-1.63	0.55	0.05	0.45	0.42	0.76
Mid-K-Region	-2.56	0.69	-0.21	0.50	0.38	0.79
High K-Region	-1.14	0.77	0.38	0.04	0.14	0.84
Veld Zone Group A	-1.83	0.52	-0.29	0.89	-0.17	0.89
Veld Zone Group B	0.30	0.51	-0.56	0.28	0.06	0.84
Veld Zone Group C	-1.52	0.68	0.16	0.16	0.27	0.73
			$\mu_{\ln Q}$			
Low K-Region	-6.65	0.94	1.69	0.82	-0.07	0.58
Mid-K-Region	-5.73	0.84	-0.13	0.77	0.50	0.79
High K-Region	-3.24	0.86	0.31	0.23	0.20	0.88
Veld Zone Group A	-6.08	0.82	-0.21	1.26	-0.17	0.96
Veld Zone Group B	-3.64	0.70	-0.35	0.48	0.44	0.64
Veld Zone Group C	-3.63	0.78	0.16	0.41	0.11	0.72

4.2 Pooled Estimation of Design Flood Peaks

4.2.1 Estimating Q_T via the Linearised Design Flood AEP/RI Equation

For ease of calculation, the two selected probability distribution functions are both linearised through the use of so-called "frequency factors", which are dependent on the skewness of the underlying distribution and the exceedence probability of interest. The form of this "design flood AEP/RI equation" is as follows and it is valid for both log-space and natural space:

$$Q_T = \mu_Q + K_{g,T} . \sigma_Q \tag{4.3}$$

where Q_T = design flood peak; T = RI or 1/AEP; μ_Q = mean, g_Q = skewness, σ_Q = standard deviation, respectively, of annual maximum flood peak series, Q_i ; $K_{g,T}$ = frequency factor for the given g and T. Frequency factors are derived from standard tables in statistical text-books or in hydrology handbooks (e.g. Alexander, 1990).

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7 If the Pooling Group is a K-Region, then this variable is Veld Zone Group, and *vice versa*.

For ungauged design sites, values for μ_Q and σ_Q are estimated as described below, while a pooled value of skewness, g^{pool}_Q, is selected from Table 3.1 according to the specific catchment's K-Region /Veld Zone Group.

4.2.2 Estimating μ_Q and σ_Q by Catchment Descriptors and Pooled Statistics

An estimate of the mean of the annual maximum flood peak series, μ^{est}_Q , at an ungauged design site is derived by application of the regionally pooled multi-variate regression equations (see Table 4.2) for that specific catchment's descriptor values and K-Region /Veld Zone Group. An estimate of the standard deviation of the annual flood peak series, σ^{est}_Q , is derived by application of the appropriate pooled CV_Q for that specific catchment's K-Region /Veld Zone Group, as follows:

$$\sigma^{est}_Q = CV^{pool}_Q \cdot \mu^{est}_Q \qquad (4.4)$$

The appropriate value for CV^{pool}_Q is selected from Table 4.2.

The implication of recognising two alternative fixed geographical pooling groups, as we do here, is that two alternative pairs of estimates of μ_Q and σ_Q are possible for each application. We believe that, in the context of the JPV approach, each of the pairs is equally likely and should be individually used for alternative design flood estimations. Obviously, the implication is that two equally likely Q_T values would need to be considered.

4.2.3 Improving the Flood Peak Estimate by Narrow-Pooled g^{pool}_Q and CV^{pool}_Q

Instead of using wide-pooled estimates of g^{pool}_Q *and* CV^{pool}_Q based on the Veld Zone Group/ K-Region for a particular ungauged design site, the practitioner may decide to create a "narrow" pooling-group by "cherry-picking" from the applicable wide-pooled fixed group those catchments with the lowest similarity distance value relative to the design site. The procedure for identifying candidate catchments is as follows:

i) Determine the required catchment descriptors for the design site

ii) Calculate the similarity distance measure, $Dist_{ij}$, for all catchment pairs in Appendix C2 in the same Veld Zone/ K-Region Group as the design site, by means of the equation 3.2. (This is still part of a "wide" pooling approach.)

iii) Create a new localised or "narrow" pooling-group for the design site catchment by "cherry-picking" those catchments with the lowest similarity distance value relative to the design site from the previous step.

iv) Select that number of catchments whose aggregate record length satisfies as a minimum the "2*T* rule", or as an optimum the "5*T* rule", where *T* is the required design RI in years.

Because, by definition, this narrow pooling already comprises highly "similar" catchments, the pooled statistical parameters, g^{pool}_Q *and* CV^{pool}_Q , are derived from the component catchments' statistics that have been *weighted by record length only* (i.e. similarity distance plays no role in the weightings).

4.2.4 Transferring Annual Maximum Flood Peak Statistics from a Donor Catchment

Given the approximate and generalised nature of the multi-variate regressions and pooling approaches described in Section 4.1, the resulting estimates, μ^{est}_{Q} and σ^{est}_{Q}, can be expected to be relatively imprecise when compared with specific estimates made from gauged flood data. The latter uncertainty may be mitigated by transferring the relevant annual maximum flood peak statistics from a gauged "donor" catchment, which is regarded as hydrologically "similar" to the catchment of interest and offering flood peak data that are directly relevant to the design site. The underlying assumption is that the degree of under- or over-estimation at the donor gauging station will be indicative of the degree of under- or over-estimation at the design site. The following equation describes the adjustment procedure for the mean:

$$\text{adjusted } \mu^{est}_{Q\ design\ site} = \mu^{est}_{Q\ design\ site} \left(\mu_{Q\ donor\ gauge} / \mu^{est}_{Q\ donor\ gauge}\right) \quad (4.5)$$

Note: For standard deviation estimates a similar adjustment procedure is followed.

Section 7.4 presents the details of a number of case studies in which the benefits of adjustments based on donor catchment statistics are explored.

5. STANDARDISED POT FLOOD VOLUMES AND STANDARDISED POT FLOOD PEAKS

5.1 Exceedence Percentiles of Standardised POT Flood Volumes

In the JPV Methodology standardised flood volumes play a role in the following two instances:

- to determine the severity, in exceedence frequency terms, of the implied design flood volume resulting from the dimensionalising of a standardised flood hydrograph as described in Section 5.3 below;
- to determine the severity, in exceedence frequency terms, of a given design flood volume estimated as part of a conventional design flood determination methodology, such as the HRU 1/72 synthetic regional Unitgraph-based approach (HRU, 1972), or the South African SCS approach (Schmidt and Schulze, 1985).

The tools used for these two design flood volume components of the JPV Methodology are the set of linear functions, described in Chapter 2 and illustrated in Figure 2.1, that represent the exceedence percentile relationships of standardised flood volumes conditional on standardised POT flood peaks for alternative sets of regionally pooled gauged catchments. These exceedence percentile functions have the following form:

$$lnV^{Std}{}_{P} = A0_{P} + A1_{P}\,(lnF^{Std}{}_{P}) \qquad (5.1)$$

where V = POT flood volume, F = POT flood peak, lnV^{Std} = flood volume standardised in log-space via μ_{lnV} and $\sigma_{lnV;}$ P = exceedence percentile; $A0$ and $A1$ = constants; lnF^{Std} = flood peak standardised in log-space via μ_{lnF} and $\sigma_{lnF.}$ The coefficients of linear functions for three selected exceedence percentiles, as well as the average function, are presented in Table 5.1. All but one of the R^2 values for the 24 best-fitting straight-lines exceed 90%.

Table 5.1 Coefficients of Linear Functions of Exceedence Percentiles of Standardised Flood Volumes Conditional on Standardised Flood Peaks

K-Region Group			*Veld-Zone Type Group*		
Exceedence Percentile	***A0***	***A1***	**Exceedence Percentile**	***A0***	***A1***
Low K			*Group A*		
50%	-0.177	1.433	50%	-0.029	1.490
25%	-0.591	1.395	25%	-0.723	1.590
5%	-1.054	1.340	5%	-1.279	1.357
Average	0.006	1.369	Average	-0.202	1.658

K-Region Group			***Veld-Zone Type Group***		
Exceedence Percentile	***A0***	***A1***	**Exceedence Percentile**	***A0***	***A1***
Mid-K			*Group B*		
50%	-0.183	1.588	50%	-0.305	1.600
25%	-0.819	1.589	25%	-1.091	1.737
5%	-2.012	1.735	5%	-2.146	1.864
Average	-0.136	1.593	Average	-0.143	1.584
High K			*Group C*		
50%	-0.039	1.551	50%	-0.098	1.531
25%	-0.924	1.666	25%	-0.857	1.617
5%	-2.555	1.980	5%	-2.106	1.739
Average	-0.085	1.657	Average	-0.095	1.590

The entry point to the exceedence percentile functions defined in Table 5.1 is either a standardised flood peak or a standardised flood volume. As outlined in Chapter 2, the standardisation that underlies the above relationships was based on the statistical parameters, μ_{lnV} and σ_{lnV}, in the case of POT volumes, and μ_{lnF} and σ_{lnF}, in the case of POT peaks. The estimation of these four parameters in the case of ungauged design sites is described in Sections 5.2 and 5.3 below.

5.2 Estimating the Mean and Standard Deviation of POT Flood Volumes

5.2.1 Multi-Variate Regressions: POT Flood Volume Means (μ_{lnV})

The flood volume estimation approach is similar to the methodology for annual maximum flood peak estimation described in Chapter 4 above. As a start, various combinations and transformations of the catchment descriptor (see Section 4.1.2) values were explored in step-wise multi-variate regressions to maximise the degree of explanation of the variance of the observed mean POT flood volume values. The R^2 values for the best-fit step-wise regressions are presented in Table 5.2.

Table 5.2 Improvement in R^2 with Step-Wise Inclusion of Additional Descriptors for Estimation of Mean ln POT Flood Volume ($\mu_{ln}V$)[8]

Case	R^2	Variables
With *MAP90* and *MAR/MAP*	0.24	ln *AREA*
	0.36	ln *AREA*; ln *MAR/MAP*
	0.46	ln *AREA*; ln *MAR/MAP*; ln *MAP90*
	0.48	ln *AREA*; ln *MAR/MAP*; ln *MAP90*, ln t_L
	0.48	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; ln t_L; *Veld Zone Type Group*
	0.49	ln *AREA*; ln *MAR/MAP*; ln *MAP90*; ln t_L; *K-Region Group*
With *MAR90*	0.24	ln *AREA*
	0.46	ln *AREA*; ln *MAR90*
	0.48	ln *AREA*; ln *MAR90*; ln t_L
	0.48	ln *AREA*; ln *MAR90*; ln t_L; *Veld Zone Type Group*
	0.49	ln *AREA*; ln *MAR90*; ln t_L; *K-Region Group*

The strongest generalised predictors of μ_{lnV} were catchment size and inherent hydrological responsiveness (*MAR/MAP* or *MAR90*). Inclusion of *MAP90* and *MAR/MAP*, combined, offered no obvious advantage over *MAR90* by itself. Consequently, for the next round of regressions aimed at establishing regionally pooled equations, *MAR90* was preferred over the former two descriptors. Furthermore, in contrast to the finding for mean annual maximum flood peaks reported in Chapter 4, Basin Lag, in the form of *ln* t_L, provided a consistent improvement (albeit small) in R^2 compared with the inclusion of average main channel slope, *S.*

Appendix E1 provides a graphical overview of the goodness-of-fit of the regionally pooled regressions ultimately selected for prediction of μ_{lnV}, while the coefficients of these relationships are listed in Table 5.3.

Table 5.3 Coefficients of Pooling-Group Multi-Variate Relationships for Estimation of μ_{lnV}

Pooling-Group	*Constant* (B_0)	*ln Area* (B_1)	*ln* t_L (B_2)	*ln MAR90* (B_3)	*"Region"*[9] (B_4)	R^2
High K-Region	0.63	-0.09	0.96	0.02	-0.09	0.40
Mid-K-Region	-9.15	0.91	0.05	0.89	0.23	0.68
Low K-Region	-9.22	1.14	-0.91	0.77	0.76	0.64
Veld Type Group A	-9.47	1.01	0.14	0.90	0.05	0.90
Veld Type Group B	-6.96	0.84	-0.24	0.81	-0.26	0.54
Veld Type Group C	-2.34	0.13	0.53	0.31	0.18	0.34

[8] For this exercise the national sample of 77 gauged catchments was used, i.e. not the individual regionally pooled samples.

[9] If the Pooling Group is a K-Region, then this variable is Veld Type Zone Group, and *vice versa*.

5.2.2 Estimating μ_{lnV} and σ_{lnV} by Catchment Descriptors

An estimate of the mean POT flood volume, μ^{est}_{lnV}, at an ungauged design site is derived by application of the regionally pooled multi-variate regression equations of Table 5.3 for that specific catchment's descriptor values and K-Region / Veld Type Zone Group. An estimate of the standard deviation of the POT flood volume series, σ^{est}_{lnV}, is derived by application of the appropriate pooled CV_{lnV} for that specific catchment's K-Region / Veld Type Zone Group, as follows:

$$\sigma^{est}_{lnV} = CV^{pool}_{lnV} \cdot \mu^{est}_{lnV} \qquad (5.2)$$

The appropriate value for CV^{pool}_{lnV} is selected from Table 5.5.

The implication of recognising two alternative fixed geographical pooling groups is that two alternative pairs of estimates of μ_{lnV} and σ_{lnV} are possible for each application. We believe that, in the context of the JPV approach, each of the pairs is equally likely and should be individually used for alternative design flood volume estimations. Obviously, the implication is that two equally likely flood volume exceedence percentile values would need to be considered for any given flood peak.

5.2.3 CV_{lnV} Isozones

The CV_{lnV} values for the gauging station records analysed in this Study were plotted at the gauging station locations on the map of South Africa. With the help of GIS tools a range of isozones of CV_{lnV} values were identified, which may be used to confirm any given CV^{pool}_{lnV} value used in Section 5.2.2 above. Appendix E2 presents the CV_{lnV} isozones on a map of South Africa.

5.3 Estimating the Mean and Standard Deviation of POT Flood Peaks

5.3.1 Multi-Variate Regressions: POT Flood Peak Means (μ_{lnF})

The POT flood peak estimation approach is similar to the methodology for annual maximum flood peak estimation described in Chapter 4 above. Appendix E3 provides a graphical overview of the goodness-of-fit of the regionally pooled regressions ultimately selected for the prediction of μ_{lnF}, while the coefficients of these relationships are listed in Table 5.4.

Table 5.4 Coefficients of Pooling-Group Multi-Variate Relationships for Estimation of μ_{lnF}

Pooling-Group	*Constant* (B0)	*ln Area* (B1)	*S (%)* (B2)	*ln MAR90* (B3)	*"Region"*[10] (B4)	R^2
Low K-Region	-3.13	0.55	-0.18	0.65	0.46	0.62
Mid-K-Region	-5.46	0.84	-0.02	0.77	0.26	0.84
High K-Region	-2.37	0.81	0.35	0.09	0.11	0.78
Veld Type Group A	-5.89	0.84	-0.02	1.08	-0.15	0.89
Veld Type Group B	-1.74	0.56	-0.48	0.50	-0.02	0.66
Veld Type Group C	-3.47	0.76	0.22	0.40	0.09	0.71

5.3.2 Estimating μ_{lnF} and σ_{lnF} by Catchment Descriptors

An estimate of the mean POT flood peak, μ^{est}_{lnF}, at an ungauged design site is derived by application of the regionally pooled multi-variate regression equations (see Table 5.3) for that specific catchment's descriptor values and K-Region or Veld Type Zone Group. An estimate of the standard deviation of the POT flood peak series, σ^{est}_{lnF}, is derived by application of the appropriate pooled CV_{lnF} for that specific catchment's K-Region / Veld Type Zone Group, as follows:

$$\sigma^{est}_{lnF} = CV^{pool}_{lnF}\ \mu^{est}_{lnF} \qquad (5.3)$$

The appropriate value for CV^{pool}_{lnF} is selected from Table 5.5.

The implication of recognising two alternative fixed geographical pooling groups is that two alternative pairs of estimates of μ_{lnF} and σ_{lnF} are possible for each application. We believe that, in the context of the JPV approach, each of the pairs is equally likely and should be individually used for alternative design flood volume estimations.

5.3.3 CV_{lnF} Isozones

The CV_{lnF} values for the gauging station records analysed in this Study were plotted at the gauging station locations on the map of South Africa. With the help of GIS tools a range of isozones of CV_{lnF} values were identified, which may be used to confirm any given CV^{pool}_{lnF} value produced by the pooling described in Section 5.3.2 above. Appendix E4 presents the CV_{lnF} isozones on a map of South Africa.

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[10] If the Pooling Group is a K-Region, then this variable is Veld Type Zone Group, and *vice versa*.

Table 5.5 Wide-Pooled CV Values for POT Flood Peaks and POT Flood Volumes

Pooling-Group	CV^{pool}_{lnF}	CV^{pool}_{lnV}
Low K-Region	1.08	1.04
Mid-K-Region	1.01	0.33
High K-Region	0.52	0.67
Veld Type Group A	1.14	1.96
Veld Type Group B	0.83	0.94
Veld Type Group C	0.73	0.24

5.4 Estimating Means and Standard Deviations via the SCS Flood Hydrograph Methodology

An alternative approach to estimating means and standard deviations of both flood peaks and flood volumes for ungauged design sites is suggested by Hiemstra and Francis (1979). They firstly propose that, given the wide uncertainties inherent to an ungauged site design flood estimation process, no distinction is needed between the means of the annual maximum and the POT partial duration series. They furthermore propose that, in this uncertain data environment, it would be acceptable to equate the 1:2 year RI event with the mean of either the annual maximum or the POT partial duration series events.

On these grounds they then justify the use of design point rainfall, areal reduction factors and the SCS Flood Hydrograph Methodology (Schmidt and Schulze, 1985) to determine the 1:2 year flood peak and volume, which they then equate to mean values. The required curve number for the SCS application is calibrated against the 1:2 year RI value calculated from the flood records of a nearby or hydrologically similar gauged catchment. The required standard deviation is derived from a CV selected from a histogram of observed South African flood peak/volume CVs provided in the Runhydrograph documentation, or it is transferred from a relevant gauged catchment's flood records. It is our view that this use of the SCS Methodology, though innovative, does not necessarily yield less uncertainty in design flood estimates compared with the JPV Design Flood Estimation Methodology described above.

5.5 Prudent Design Flood Estimation Practice

In the interests of prudent design flood estimation practice, we recommend that, if circumstances and resources allow, practitioners consider using all of the approaches presented above (catchment descriptors, pooling, *CV* isozones and SCS “calibration”) as alternatives, before making final choices of the appropriate values for the means and standard deviations of POT flood peaks and flood volumes, to be used in the application of the JPV Methodology described in this document.

6. REGIONALLY POOLED STANDARDISED OBSERVED FLOOD HYDROGRAPHS

6.1 Introduction

The tools and procedures introduced in the foregoing Chapters enable an estimate of the design flood peak at ungauged sites, based on up-to-date pooled information. A convenient method is provided to make an assessment of the conditional statistical behaviour of relevant observed flood volumes, given the magnitude of that specific design flood peak. Tools and procedures are also provided to either standardise or un-standardise both flood peaks and flood volumes at ungauged sites. What is still lacking before we can offer a well-proportioned design flood "tool-box", is a flood hydrograph generation tool. The next logical step in our research was therefore to provide the flood hydrology designer with access to typical standardised observed hydrographs relevant to any region of the country.

6.2 Inventory of Typical Observed Flood Hydrographs

Typical hydrographs that are regionally representative have been selected from our database of 12000+ flood events. The procedure for selection recognised three tiers of relevant distinction among hydrographs, namely, *pooling-group, catchment size* and *relative magnitude of event*. The procedure was shaped according to the following considerations:

i) Selection of catchments to ensure spatial representivity across South Africa.

ii) Classification of flood hydrographs according to the two sets of fixed geographical pooling-groups: K-Regions and Veld Type Zones.

iii) Classification of flood hydrographs in each pooling-group according to a dual catchment size distinction: (1) "smaller" catchments (<1000 km^2); (2) "larger" catchments (>1000 km^2).

iv) Classification of all hydrographs in each catchment size group by magnitude of standardised flood peak, lnF^{Std}, according to five intervals: 1.25<lnF^{Std} <1.75; 1.75<lnF^{Std} <2.25; 2.25<lnF^{Std}<2.75; 2.75<lnF^{Std}<3.25; 3.25<lnF^{Std}.

v) Identification of a variety of "typical" hydrograph shapes, ranging from archetypal fast-rising, fast-receding uni-peak discharge distributions, to unsymmetrical multi-peak events, or longer-duration events with slower recessions, and spanning a range of unit flood volumes.

These selected hydrographs are obviously "scaled" by the flow regimes of their gauged catchments of origin and cannot summarily be transferred to ungauged sites without adjustment for scale, as well as for catchment shape characteristics. For these reasons, we *standardised* the selected hydrographs, as described below.

6.3 Standardisation of Typical Flood Hydrographs

As the primary components of a design flood hydrograph are its peak, its total volume and its shape, i.e. the time distribution of discharge of excess storm volume, we focused the standardisation of our selected hydrographs on these three characteristics, as follows:

- *Time Distribution*: By scaling the time axis by the Basin Lag, t_L, (HRU, 1972) in hours, allowance is made for catchment characteristics to play a role in transferring the general hydrograph shape between gauged and ungauged sites. The time axis is yielded dimensionless by this scaling exercise.
- *Peak-Standardised*: By proportioning all hydrograph discharge ordinates relative to the observed flood peak, a dimensionless hydrograph is created, both in terms of the y-axis (discharge) and the x-axis (time, given the above Basin Lag scaling). This peak-standardised hydrograph can be re-dimensioned by the value of Q_T, the design flood peak with RI = *T* years.
- *Re-dimensioned Hydrograph Volume:* Re-dimensioning by the value of Q_T , creates the design flood hydrograph, but with a volume unique to that shape-Q_T combination. The conditional exceedence percentile of that unique shape-Q_T combination can now be determined from Appendix B or Table 5.1.

The individual standardised hydrographs are presented in Appendix F, organised according to pooling-group, catchment size and lnF^{Std} interval. Figure 6.1 presents a typical set of standardised hydrographs.

6.4 Choosing Final Design Flood Hydrographs

The entry-point to the process of choosing final design flood hydrographs is the estimated design flood peak, Q_T. The hydrograph selection process should then be informed by the following considerations:

i) For each alternative pooling-group in which the design site is located, and recognising the lnF^{Std} interval in which lnQ_T^{Std} lies, multiple peak-standardised hydrographs should be considered according to *shape variation*, e.g. a fast-rising, fast-receding uni-peak shape, or an unsymmetrical multi-peak shape, or a longer-duration convex shape with slower recessions, etc. (see Figure 6.1).

ii) After dimensionalising the to-be-considered hydrographs, the *conservativeness* of their resulting volumes needs to be assessed via the exceedence percentile relationships of lnV^{Std} conditional on lnF^{Std}, presented in Table 5.1 and Appendix B.

iii) The required conservativeness of the final design flood hydrograph(s) should be guided by the practitioner's sense of the *uncertainties* relating to hydrological data and methods that may be relevant to the specific design situation.

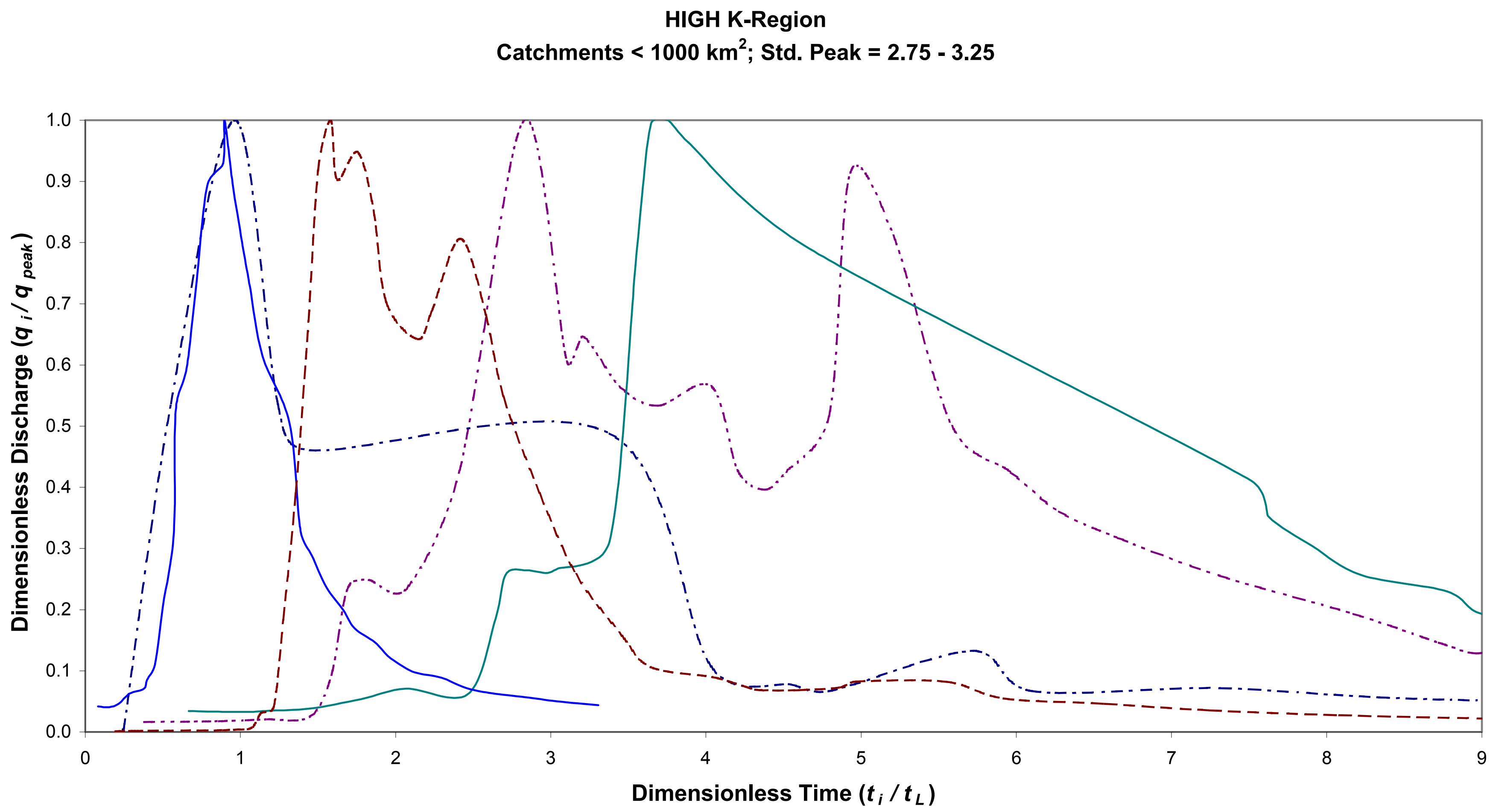


Figure 6.1 **Example of Peak-Standardised Hydrographs (from a High Standardised Flood Peak Interval Category) Proposed for Smaller Catchments in the High K-Region Pooling-Group**

7. CASE STUDIES ON THE PERFORMANCE OF JPV DESIGN FLOOD HYDROGRAPH ESTIMATION TOOLS

7.1 Introduction

To provisionally validate the design tools that support the JPV Methodology developed in this Study, we conducted a series of "performance" assessments, in which single-site probabilistic estimates of RI flood peaks were used as bench-marks. The objective was not to try to reproduce the single-site estimates – that would negate the value that the pooling process introduces in terms of increased confidence in the estimation of higher moment statistics, such as the skewness and the coefficient of variation. Rather, our objective was to gauge consistency of performance over a range of orders of magnitude. Marked deviation from the single-site probabilistic estimates would provide cues towards a need for closer examination of such instances. We also recognised that, in ungauged situations, the estimates of the required index flood peak types, μ_{lnQ} and $ln(\mu_Q)$, via multi-variate regression, as entry-points to implementation of our chosen two probability distribution functions, were inevitably not always going to be representative. This assessment approach allowed us to identify and examine, with a view to improved understanding and correction of, any irregular or outlier estimates of flood peaks via the JPV Tools.

As a further performance measurement, we also compared our wide-pooled RI flood peak estimates at gauging stations with those achieved by a Unitgraph-based approach in which we applied the regional synthetic Unitgraphs of HRU (1972). Such a Unitgraph-based approach would be one of an experienced practitioner’s primary choices for ungauged sites in South Africa. Therefore, the value of such a comparison is that it provides the practitioner with a bird’s eye view of how consistent a “new” design flood estimation methodology that is particularly devised for ungauged design site applications, would perform relative to a well-established methodology.

We start this performance assessment at a relatively coarse resolution with a national focus and then progressively refine the resolution and the focus to ensure insight into both generalised performance and site-specific or localised performance. The incremental refinements are effected firstly by changing from fixed (“wide”) to adjustable (“narrow”) pooling-groups, and secondly through introduction of simple adjustments to predicted statistical parameters by factorising against flood statistics from suitable gauged donor catchments (as outlined earlier in Section 4.2).

7.2 Generalised Performance of Wide-Pooled JPV Tools for RI Flood Peak Estimation

7.2.1 Methodology

A generalised performance assessment of the JPV Tools was done for RI flood peak estimation by comparing estimates via single-site probability analysis as well as Unitgraph applications with estimates by the combined JPV Tools of multi-variate regressions and regionalised pooling-group flood probability analysis, i.e. by "wide" pooling. The wide-pooled estimates were derived through application of the methodology described in Chapter 4. For this assessment we used the gauged catchment data set that featured in both the storm losses investigation (Part 3, Section 2) and the comparison of Unitgraph-based estimates with probabilistic estimates (Part 3, Section 4). Catchment details can be found in Part 3, Tables 4.1, 4.2 and 4.3. Flood peak estimates were compared for RIs of 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100 years.

7.2.2 Results

Figures 7.1 and 7.2 present scatter-plot comparisons of the RI flood peak estimates for the different methodologies, arranged by Veld Zone Group and by probability distribution function, GEV or LPIII. Table 7.1 outlines the performance of the wide-pooled JPV Tools and the Unitgraph-based approach in terms of % deviation from single-site RI flood peak estimates.

7.2.3 Discussion

For this pooling-group, the general performance of the JPV Tools as indicated by the correspondence of their flood peak estimates with single-site probabilistic estimates, is impressive for the wide-pooled GEV approach, but considerably less so for the LPIII approach. The wide-pooled GEV version of the JPV Tools produced a fairly balanced scatter around the 1:1 best-fit line for all Veld Zone Groups and in general a markedly better clustering around the single-site estimates than either the Unitgraph or the wide-pooled LPIII approach.

On the other hand, the LPIII-based estimates generally display a "better" clustering around the single-site estimates than the Unitgraph-based estimates. Nevertheless, for the LPIII case, the JPV-based flood peak estimates display a noticeably wider range than the GEV estimates, but a similar range to the Unitgraph-based estimates. For three catchments, H1H006, T3H006 and A2H013, the wide-pooled LPIII-based estimates were excessively large, caused by a mixture of sizeable over-estimation of their g^{pool}_{lnQ} and σ^{est}_{lnQ} values. In Sections 7.4 and 7.5 below we show how simple adjustments based on the flood peak statistics of a gauged donor catchment can serve to ameliorate this problem.

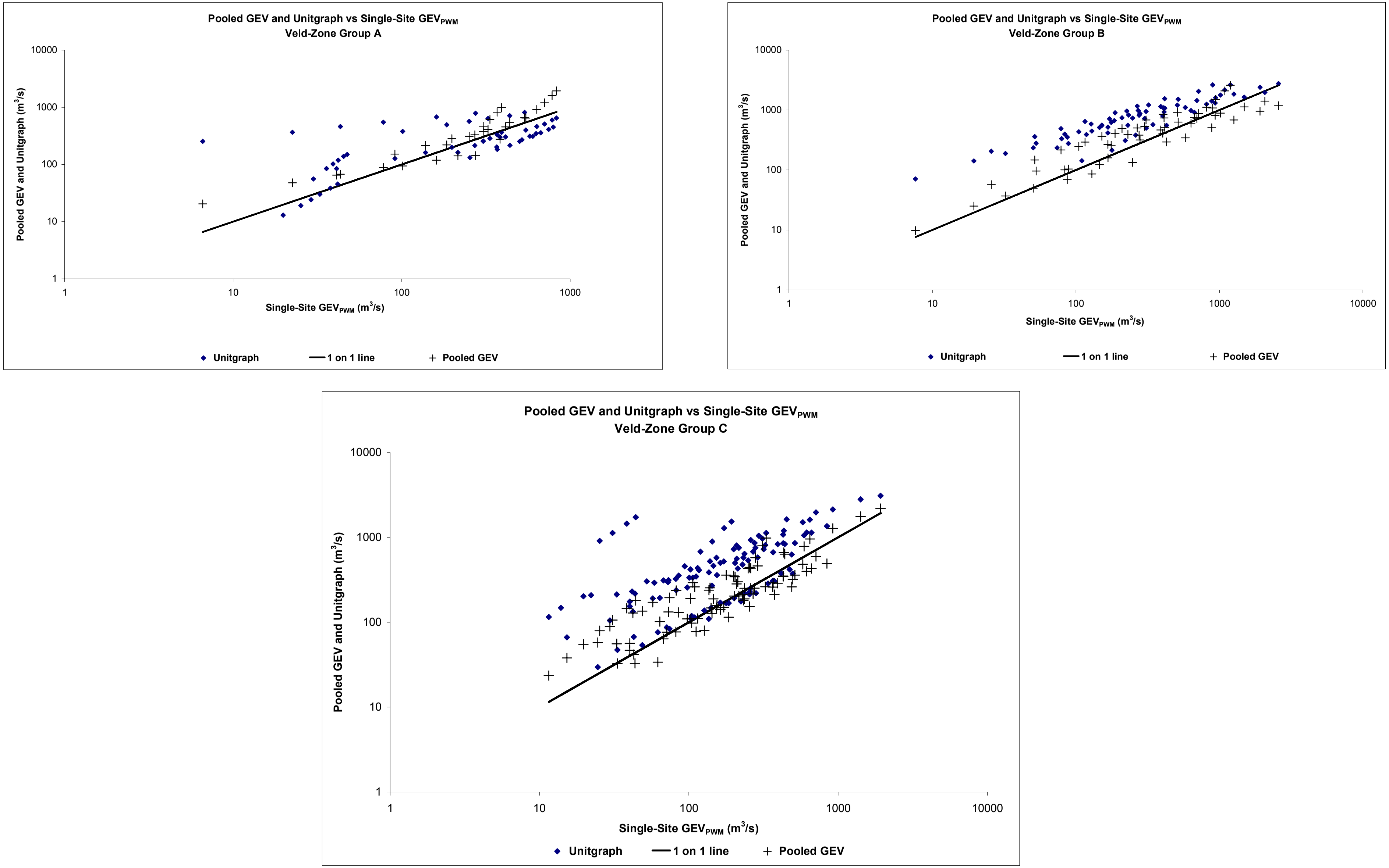


Figure 7.1 Wide-Pooled Estimates of RI Flood Peaks Versus Estimates Based on Unitgraph- and Single-Site GEV Approaches

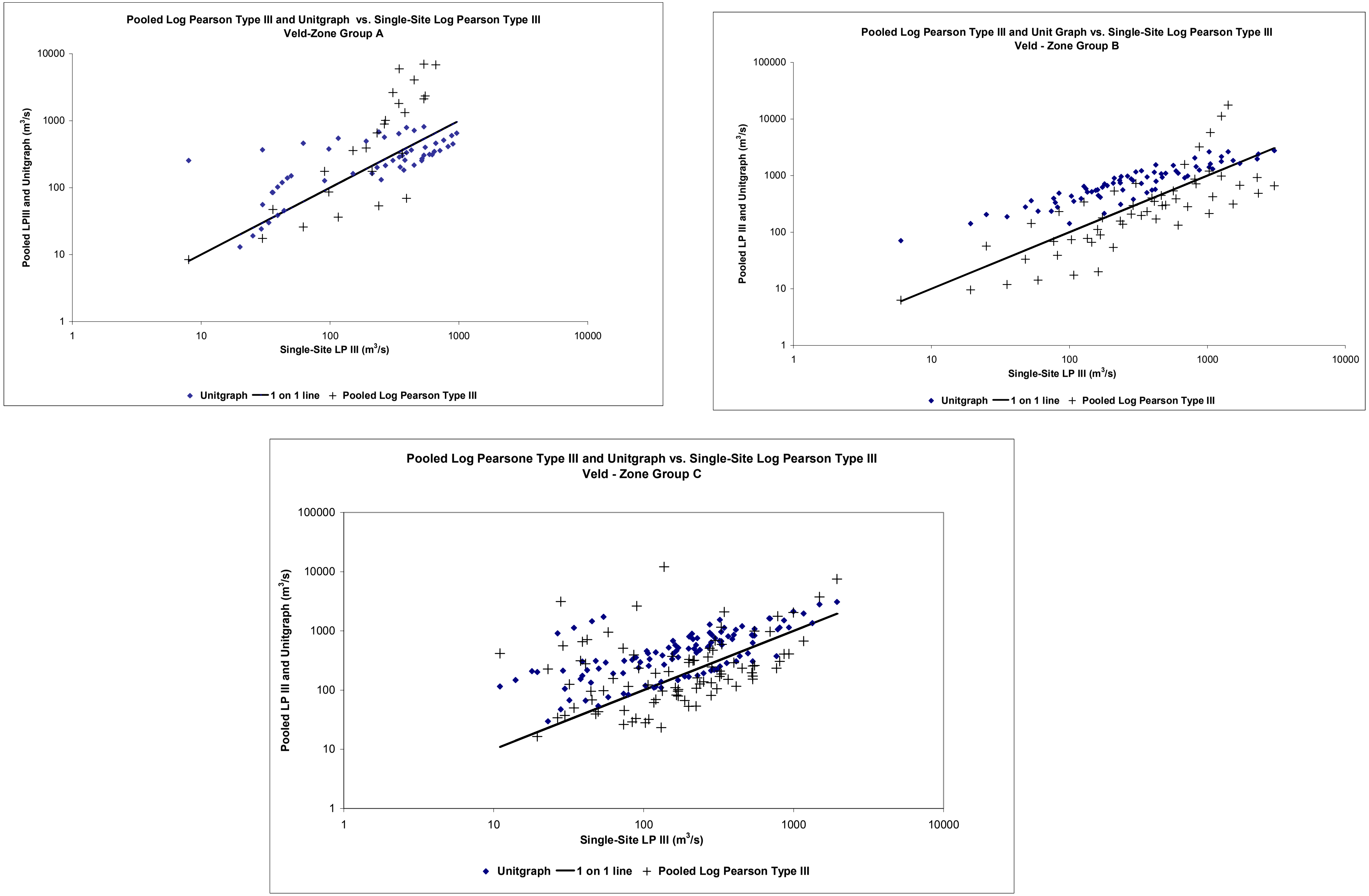


Figure 7.2 Wide-Pooled Estimates of RI Flood Peaks Versus Estimates Based on Unitgraph- and Single-Site LP III Approaches

Table 7.1 % Deviation of Wide-Pooled Estimates and Unitgraph-Based Estimates Compared with Single-Site Probabilistic Estimates of RI Flood Peaks

Pooling-Group	Average % Deviation				Median % Deviation			
	GEV		LPIII		GEV		LPIII	
	Wide-Pool	Unitgr.	Wide-Pool	Unitgr.	Wide-Pool	Unitgr.	Wide-Pool	Unitgr.
Veld Zone Gr. A	48	268	1183	203	42	17	247	7
Veld Zone Gr. B	39	223	37	211	22	193	-32	157
Veld Zone Gr. C	47	315	68	281	13	149	13	149

7.3 Site-Specific Performance of Narrow-Pooled JPV Tools for RI Flood Peak Estimates

7.3.1 Methodology

Section 7.2 describes the generalised wide-pooled performance results for fixed pooling-groups. The logical next step in assessing the performance of the JPV Tools is to examine on a site-specific basis whether *narrow* pooling might yield RI flood peak estimates that show more consistent trends relative to single-site estimates than wide-pooled estimates. For this assessment we broadly followed the steps for narrow pooling outlined in Section 4.2.3. Four gauged catchment pairs were selected from Appendix C3, so that the members of each pair have low similarity distance values relative to each other and so that all Veld Zone Groups were represented. We purposefully included some catchments for which the wide-pooled flood peak estimates reported in Section 7.2 deviated considerably from the single-site-probabilistic estimates. The rationale for this approach was that by using catchments where the wide pooling produced poor estimates, we hoped to accentuate the value or otherwise of, firstly, narrow pooling and, secondly, the use of donor catchment-based adjustments to pooled statistical parameters.

One member of each catchment pair[11] was treated as if it was the ungauged “design site” and a narrow pooling-group for it was created by “cherry-picking” those catchments with the lowest similarity distance value relative to the “design site” from the wide-pooled values in Appendix C3. The number of catchments included in each narrow-pooled group was limited to ensure an aggregate record length that exceeded 200 years, the minimum required to satisfy the “2*T* rule” for a 1:100 year RI estimate. Table 7.2 presents the catchment details of this exercise. The multi-variate regression equations applicable to each case study catchment, as well as the resulting narrow-pooled skewness and CV values, were applied to estimate flood peaks for these catchments for RIs of 1:10, 1:20, 1:50 and 1:100 years. The whole estimation process was then reversed for the other member of each pair of catchments.

[11] The other member of each pair would be used as a donor catchment, as described in Section 7.4.

Table 7.2 Catchment Groupings for Narrow Pooling JPV Tool Assessment

K-Region				Veld Zone Group			
Gauge	***Area (km²)***	***Record Length (yr)***	***Original Similarity Distance***	***Station***	***Area (km²)***	***Record Length (yr)***	***Original Similarity Distance***
B8H010							
B7R001	165	52	1.17	X2H008	180	38	0.66
B7H004	136	38	1.28	X3H001	174	44	1.20
B8H010	477	36	0.00	B7R001	165	52	1.15
K2H002	131	41	1.02	B7H004	136	38	1.29
L9R001	138	31	1.03	B8H010	477	36	0.00
R1H005	482	16	0.85	U2H011	176	42	1.31
S6H001	90	43	0.86	B8H009	851	35	1.63
		Total = 257				*Total = 285*	
A2H012							
A2R001	477	99	0.29	B2R001	1263	98	0.42
B3R001	438	69	0.57	C7R001	2154	80	0.43
C5R003	5499	80	0.63	X1R001	1569	42	0.44
A2H012	138	45	0.00	A2R001	4120	99	0.30
				A2H012	2551	45	0.00
		Total = 293				*Total = 364*	
H1H007							
B6R001	84	47	1.54	J2R003	141	70	3.17
J2R003	141	70	3.09	G1H008	395	41	2.24
G1H008	395	41	2.27	H1H006	753	40	2.99
H1H007	84	40	0.00	H1H007	84	40	0.00
X2H008	180	38	1.19	K2H002	131	41	2.15
X3H001	174	44	1.19	L9R001	138	31	2.87
		Total = 280				*Total = 263*	
T3H006							
T3H006	4268	37	0.00	C1H001	8193	30	1.28
U2H012	438	36	1.05	V2H002	937	40	0.65
X1H001	5499	44	0.98	T4H001	715	35	1.30
T4H001	715	35	1.07	T3H006	2597	37	0.00
U2H005	2519	36	0.47	N2R001	16700	69	0.96
V5H002	28920	26	0.98				
B8H009	851	35	0.97				
T3H005	2597	37	0.25				
		Total = 286				*Total = 211*	

7.3.2 Results

The narrow-pooled skewness and CV values for the four selected catchments are presented in Table 7.3, arranged by their wide pooling-group of origin, i.e. either Veld Zone or K-Region. Figures 7.3 and 7.4 present scatter-plots of the RI flood peak estimates for both the wide and narrow pooling against the original single-site probabilistic estimates for these gauging stations originating from the Veld Zone pooling-group.

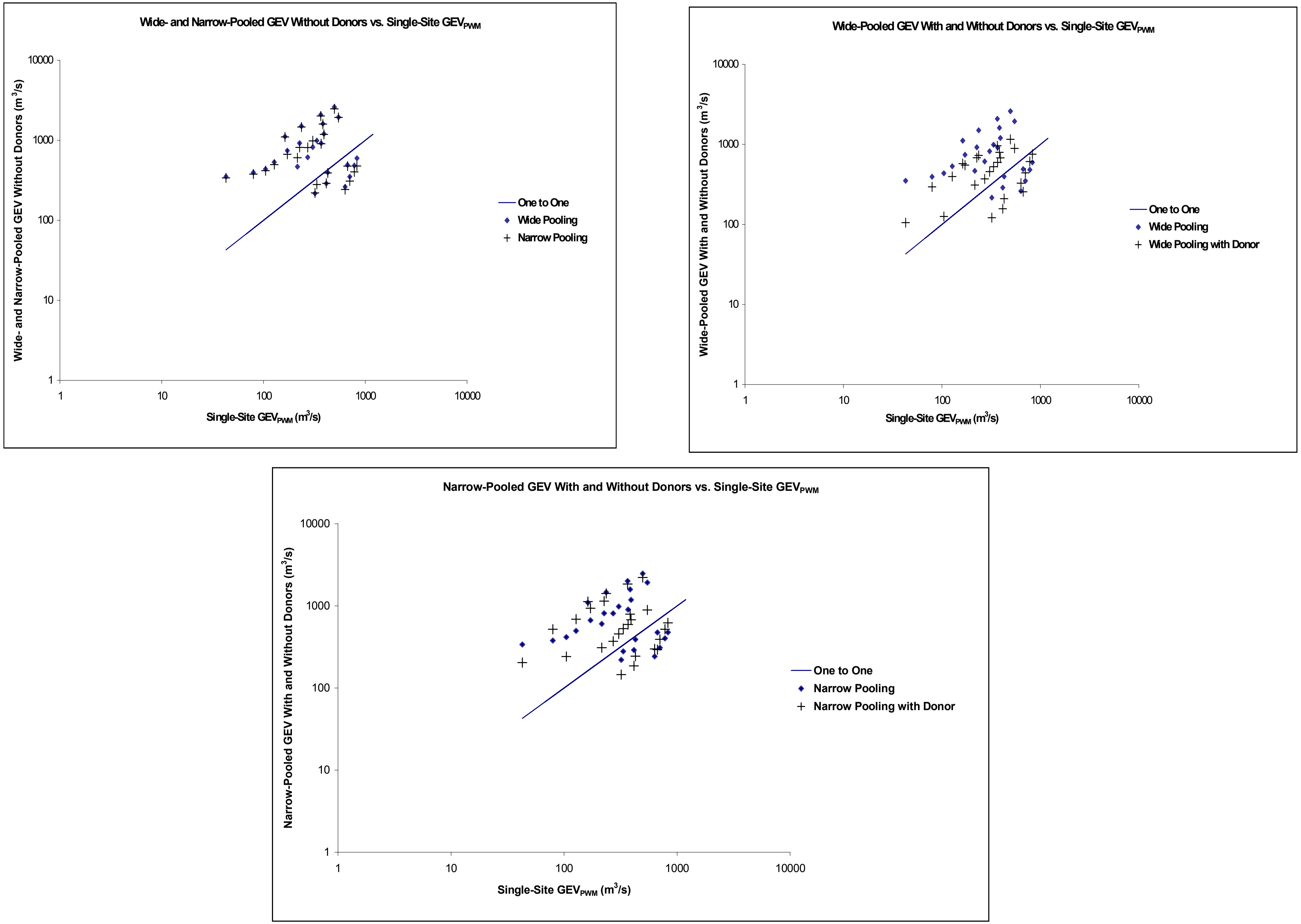


Figure 7.3 Effects of Narrow-Pooling and Adjustments Based on Donor Catchment Flood Statistics – GEV Distribution

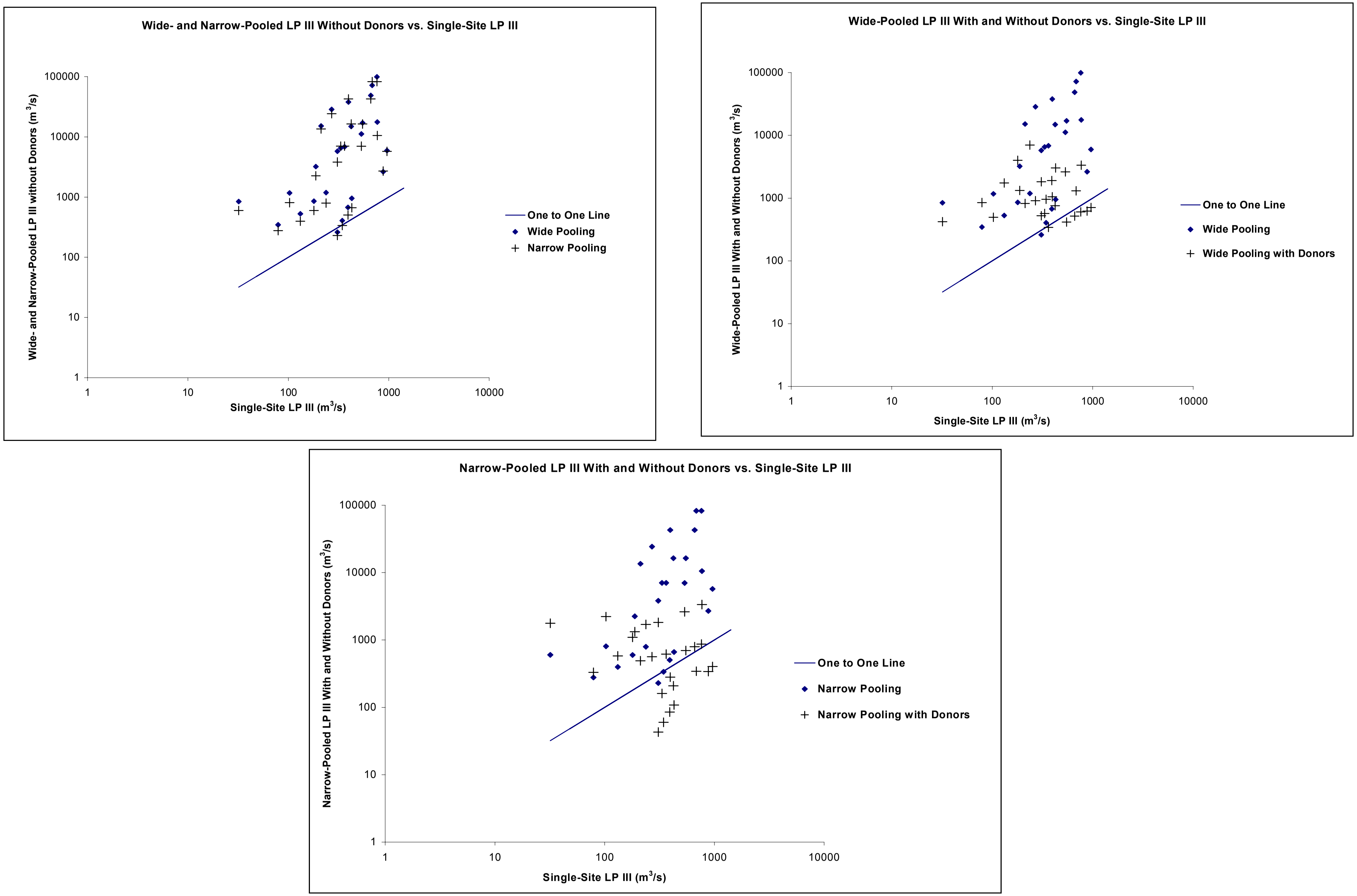


Figure 7.4 Effects of Narrow-Pooling and Adjustments Based on Donor Catchment Flood Statistics – LP III Distribution

Table 7.3 Narrow-Pooled Skewness and CV for the Selected Narrow Pooling-Groups detailed in Table 7.2

Gauge	Veld Zone				K-Region			
	Natural Space		*ln* Space		Natural Space		*ln* Space	
	g^{pool}_{Q}	CV^{pool}_{Q}	g^{pool}_{lnQ}	CV^{pool}_{lnQ}	g^{pool}_{Q}	CV^{pool}_{Q}	g^{pool}_{lnQ}	CV^{pool}_{lnQ}
A2H012	2.34	1.20	0.02	0.23	2.33	1.51	0.26	0.27
B8H010	1.84	0.98	-0.19	0.29	1.81	1.22	0.01	0.36
H1H007	2.21	1.17	0.04	0.40	2.21	1.16	-0.09	0.46
T3H006	2.63	1.30	0.27	0.22	2.54	1.24	0.46	0.17

7.3.3 Discussion

The scatter-plots show that, in general, narrow pooling can lead to a tighter clustering of RI flood peak estimates relative to wide pooling in terms of the single-site estimates, particularly for the GEV approach. The average deviation from single-site values decreased by 7% and 13%, respectively, for the LPIII and GEV cases, respectively. The primary cause of these deviation decreases appears to be "improved" g^{pool}_{lnQ} estimates for narrow-pooled catchments relative to their wide-pooled values.

7.4 Site-Specific Performance of Wide-Pooled and Narrow-Pooled JPV Tools for RI Flood Peak Estimates by Transferring Flood Statistics from Donor Catchments

7.4.1 Methodology

For each of the pairs of gauged catchments listed in Table 7.5 we followed the methodology described in Section 4.2.4 which allows the gauged annual maximum flood peak mean and standard deviation of a hydrologically similar donor catchment to influence the final estimation of the mean and standard deviation for the design site. For the four pairs of catchments, we first treated the one member of each pair as the ungauged design site with the other as the donor site and then reversed the two roles. This process was completed for both wide pooling and narrow pooling.

7.4.2. Results

Figures 7.3 and 7.4 present scatter-plots of the RI flood peak estimates for both wide pooling and narrow pooling with and without transfer of donor catchment statistics against the original single-site probabilistic estimates for four pairs of gauging stations. Only the Veld Zone Pooling-group approach results are shown, because the K-Region-based results are generally similar.

7.4.3 Discussion

The scatter-plots show that, in general, adjustments of design site statistical parameters based on donor catchment information led to dramatically improved correspondence of RI flood peak estimates relative to single-site estimates. This finding holds for both wide pooling and narrow pooling. Table 7.4 summarises the marked decreases in average deviation from single-site values brought about by factorising based on donor catchment statistics.

Table 7.4 Site-Specific Performance of JPV Tools when Pooling With and Without Donor Catchment Statistics (Veld Zone Groups)

Probability Distribution Function	Average % Deviation from Single-Site RI Flood Peak Estimates			
	Wide Pooling Without Donor	Wide pooling With Donor	Narrow Pooling Without Donor	Narrow Pooling With Donor
LPIII	1727	67	1594	59
GEV	32	0	28	3

The excessive over-estimation by the LPIII approach without donor-based adjustments is mainly due to marked over-estimation of various statistical parameters for the gauging stations H1H006, T3H006 and A2H013. Table 7.5 provides a comparison of the various statistical parameter values for these "problem" catchments and their donor sites.

Table 7.5 Comparison of Wide-Pooled Statistical Parameter Estimates and Observed Values for Problem Design Sites and Their Donor Sites (Veld Zone Groups)

Statistical Parameter	Pooling-Group	Wide-Pooled Estimate	Wide-Pooled Estimate Factorised via Donor Statistics	Observed Value	
				Design Site	Donor Site
H1H006 (Donor = H1H007)					
μ_{lnQ}	Mid K-Region	5.51	6.75	5.84	5.36
	Veld Zone Group A	5.84	6.01		
CV_{lnQ}	Mid K-Region	0.35	N/a	0.09	0.05
	Veld Zone Group A	0.39			
σ_{lnQ}	Mid K-Region	1.93	0.36	0.54	0.29
	Veld Zone Group A	2.30	0.32		
g_{lnQ}	Mid K-Region	0.03	N/a	-0.59	0.20
	Veld Zone Group A	0.15			
T3H006 (Donor = T5H004)					
μ_{lnQ}	High K-Region	5.67	5.48	5.90	4.43
	Veld Zone Group B	6.00	6.16		
CV_{lnQ}	High K-Region	0.29	N/a	0.12	0.13
	Veld Zone Group B	0.27			
σ_{lnQ}	High K-Region	1.63	0.70	0.73	0.57
	Veld Zone Group B	1.62	0.79		
g_{lnQ}	High K-Region	0.28	N/a	-0.63	0.74
	Veld Zone Group B	0.09			
A2H013 (Donor = A2H012)					
μ_{lnQ}	Mid-K-Region	3.81	3.93	3.80	4.91
	Veld Zone Group C	3.52	5.42		
CV_{lnQ}	Mid-K-Region	0.35	N/a	0.41	0.18
	Veld Zone Group C	0.27			
σ_{lnQ}	Mid-K-Region	1.34	0.69	1.57	0.87
	Veld Zone Group C	0.95	0.71		
g_{lnQ}	Mid-K-Region	0.03	N/a	-0.22	0.02
	Veld Zone Group C	0.09			

The values in Table 7.5 reveal some of the causes of these over-estimations. For all three catchments the wide-pooled g_{lnQ} estimates are substantially larger than the observed values, while in two cases (H1H006 and T3H006) this was the situation for the wide-pooled σ_{lnQ} estimates (based on μ^{est}_{lnQ} and CV^{pool}_{lnQ}). Donor-based adjustments normalised the over-estimates for σ_{lnQ} , but, of course, do not affect the skewness, as the latter is the product of the wide-pooled weighting process described earlier.

7.5 Comparison of Design Flood Hydrographs Generated from Regionally Standardised Observed Hydrographs with Unitgraph-Based Hydrographs

7.5.1 Methodology

As stated before, conventionally, the South African hydrological practitioner would primarily employ the Unitgraph-based methodology of HRU (1972) to develop a design flood hydrograph for any catchment larger than a few tens of km^2. It follows logically, therefore, that the "validation" of the regionally pooled standardised hydrograph component of the JPV Methodology should include comparisons with typical Unitgraph-based design flood hydrographs. For this case study, we focus on two gauged catchments with substantially different characteristics from two different regions of South Africa, the streamflows of which are monitored at gauging stations X1H001 (Komati River system) and H1H007 (Breede River system).

Our selection of catchments and standardised hydrographs was aimed at highlighting the various considerations that should inform the use of the JPV standardised design flood hydrograph tools, and was made as follows:

- Two catchments from different regional pooling-groups.
- Two catchments of distinctly different area sizes and other characteristics.
- Two distinctly different JPV design hydrograph shapes; one similar to the Unitgraph's conventional uni-peak shape and the other one multi-peaked.

The JPV standardised hydrographs were selected from Appendix F according to each catchment's Veld Zone / K-Region pooling-group, and then dimensionalised via each catchment's Basin Lag, t_L (x-axis) and the value for Q_{50} (y-axis). For each catchment, we quantified and then standardised the volumes of the two alternative JPV-based hydrographs as well as the Unitgraph-based hydrograph. This enabled us to read off the conditional exceedence percentile of each standardised volume, lnV^{Std} , from the exceedence percentile diagrams in Appendix B, corresponding to the Veld Zone / K-Region of each catchment. The reader is referred to Sections 6.3 and 6.4 for more background on the JPV standardised hydrograph tools and their use.

7.5.2 Results

The entry point for the case study is the 1:50 year design flood, Q_{50}, which, for purposes of demonstration, we derived through the Unitgraph-based approach of HRU (1972). Table 7.6

summarises the salient details of the sample of alternative JPV design hydrographs (with a Q_{50} peak) which we generated for the two catchments, based on a selection from the relevant tables in Appendix F. The Unitgraph-based details are also listed. Figure 7.5 presents the resulting design flood hydrographs graphically.

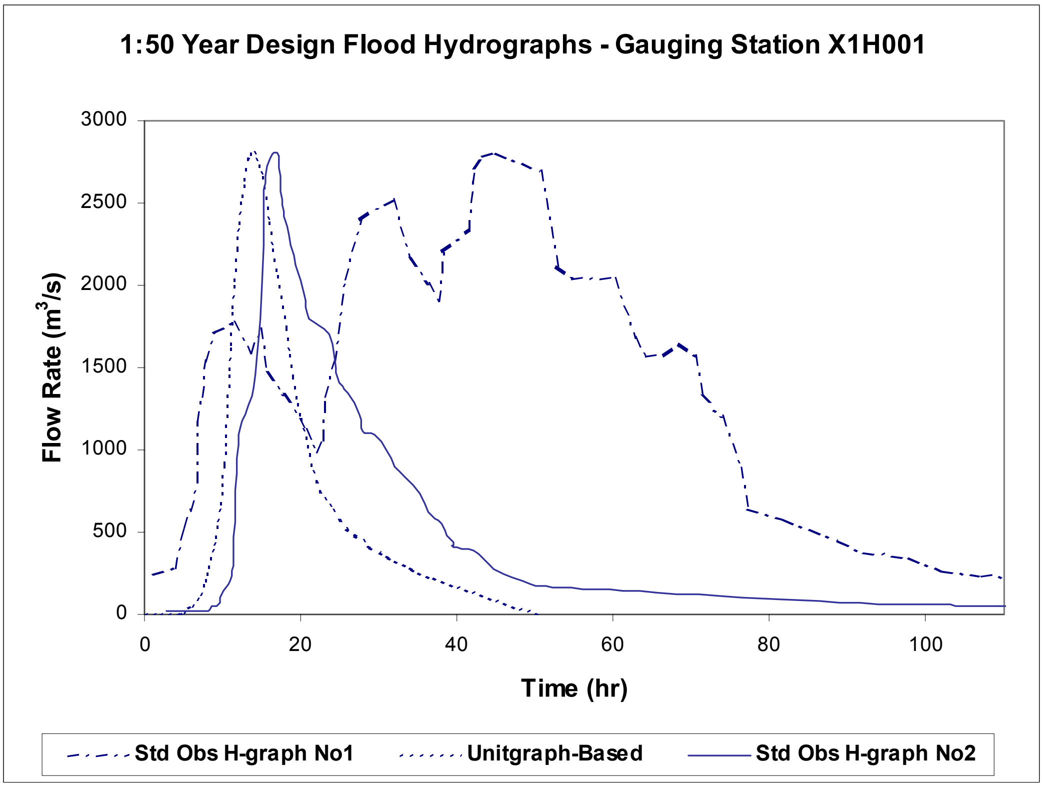
7.5.3 Discussion

The dimensionalised JPV design hydrographs in Figure 7.5 illustrate that, on a standardised and regionally pooled basis, conventional *uni-peak* observed hydrographs can plausibly be identified with volumes that far exceed those of, say, the Unitgraph-based approach for the same Q_T. As can be expected, plausible *multi-peaked* observed hydrographs that can be identified could give rise to JPV design hydrographs with markedly larger volumes than the Unitgraph-based hydrographs for the same Q_T.

The Unitgraph-based Q_{50}-hydrograph volumes for both catchments in this case study (see Table 7.6) represent surprisingly high exceedence percentile values (above 75%), conditional on their respective Q_{50} values. It is possible that these Unitgraph-based flood volumes are not "severe" enough, given the relative rareness of a Q_{50} event. On the other hand, the four JPV-based hydrograph volumes appear suitably conservative and represent exceedence percentiles across a sizeable range from about 20% to 50%[12].

When faced with the foregoing differences between the Unitgraph-based and the JPV-based hydrographs in a typical design situation, the JPV Standardised Design Flood Hydrograph Methodology would enable hydrological practitioners to exercise a degree of judgement and caution regarding the severity or conservativeness of the design volume that they link to the specific Q_T .

[12] We recognise that a baseflow volume component is lacking from the Unitgraph-based hydrographs, whereas the JPV-based hydrographs are derived from observed events that often include baseflow. However, if a baseflow adjustment were to be made to the Unitgraph-based hydrographs, the consequent increase in the Q_{50} value would simply result in proportionally larger JPV-base hydrograph volumes. Therefore, our primary finding in Section 7.5.3 would not change materially.



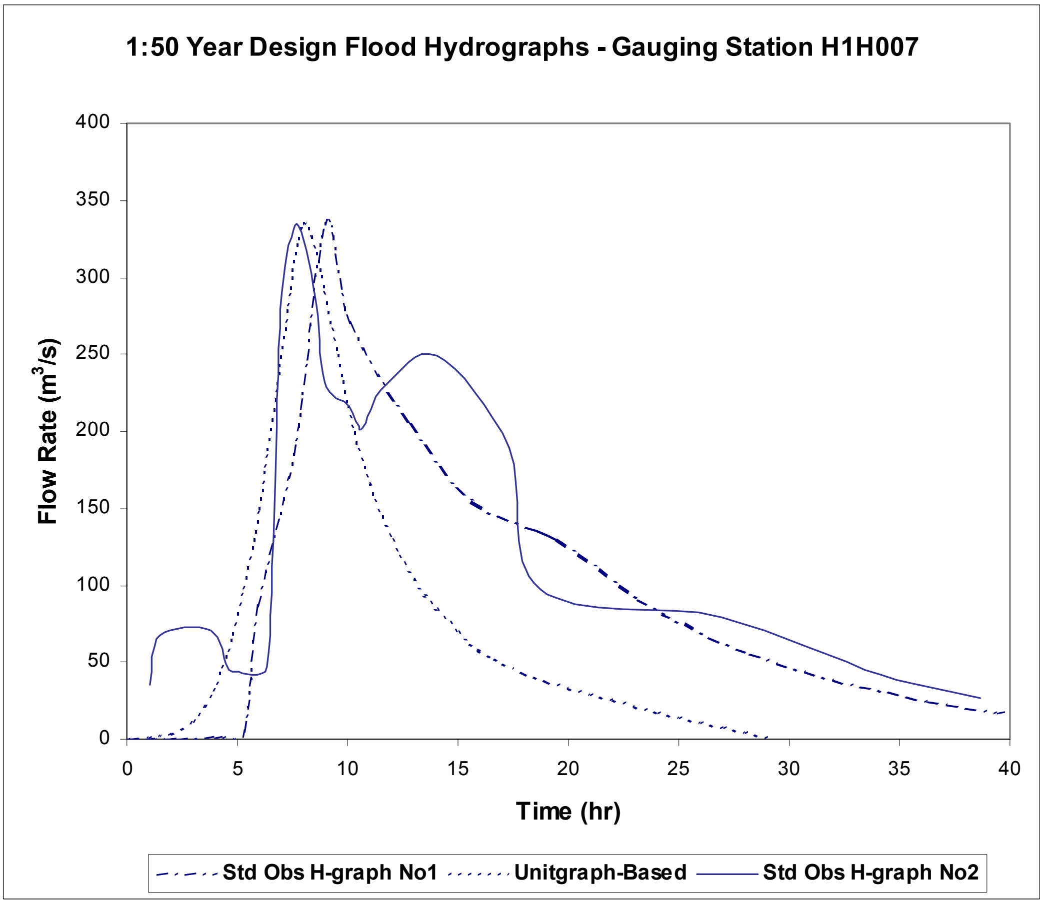


Figure 7.5 Selected JPV-Based Design Flood Hydrographs Compared with Unitgraph-Based Hydrographs for the Q_{50} Flood Peaks

Table 7.6 Comparison of Alternative Q_{50} Design Flood Hydrographs

X1H001			
Characteristic	**Value**		
Area (km^2)	5499		
Veld Zone / K-Region	Veld Zone 9 / K-Value = 5.2		
μ_{lnF}	4.88		
σ_{lnF}	0.60		
μ_{lnV}	2.48		
σ_{lnV}	0.89		
Q_{50} (m^3/s)	2803		
lnQ_{50}^{Std}	5.10		
JPV Standardised Hydrograph Category	VZ Group C / "Larger Area" / lnQ_{50}^{Std} = 2.75+		
Hydrograph Volume Item	**Unitgraph-Based Design Hydrograph**	**JPV Design Hydrograph No 1**	**JPV Design Hydrograph No 2**
Volume V ($10^6 m^3$)	115.6	550.7	183.6
lnV^{Std}	2.55	4.30	3.07
Exceedence Percentile of lnV^{Std}	>75%	25%	50%

H1H007			
Characteristic	**Value**		
Area (km^2)	84		
Veld Zone / K-Region	Veld Zone 2 / K-Value = 5.0		
μ_{lnF}	5.07		
σ_{lnF}	0.28		
μ_{lnV}	1.67		
σ_{lnV}	0.49		
Q_{50} (m^3/s)	334		
lnQ_{50}^{Std}	2.65		
JPV Standardised Hydrograph Category	Mid-K-Group / "Smaller Area" / lnQ_{50}^{Std} = 2.25 - 2.75		
Hydrograph Volume Item	**Unitgraph-Based Design Hydrograph**	**JPV Design Hydrograph No 1**	**JPV Design Hydrograph No 2**
Volume V ($10^6 m^3$)	8.2	15.0	15.8
lnV^{Std}	0.88	2.11	2.23
Exceedence Percentile of lnV^{Std}	>75%	25%	20%

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APPENDIX A

Appendix A1(a) POT Statistics for Flow Gauging Stations Used in JPV Methodology (Peak as m^3/s; Volume as Mm^3)

Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
C3H007	Peak	73.87	57.81	0.78	0.82	4.10	0.60	0.15
	FloodVol	16.44	24.87	1.51		2.08	1.21	0.58
E2H003	Peak	408.46	128.26	0.31	0.48	5.97	0.31	0.05
	FloodVol	75.12	32.06	0.43		4.22	0.46	0.11
C9H003	Peak	446.39	536.88	1.20	0.89	5.68	0.86	0.15
	FloodVol	251.43	407.29	1.62		4.53	1.45	0.32
C9h008	Peak	624.70	555.19	0.89	0.83	6.22	0.59	0.10
	FloodVol	348.84	469.10	1.34		4.86	1.67	0.34
D5H003	Peak	46.89	59.02	1.26	0.79	3.22	1.15	0.36
	FloodVol	2.15	3.70	1.72		-0.27	1.51	5.52
C2H001	Peak	10.32	12.34	1.20	0.85	2.03	0.67	0.33
	FloodVol	4.25	6.06	1.43		0.86	1.07	1.26
A2H021	Peak	55.31	84.48	1.53	0.97	3.59	0.76	0.21
	FloodVol	28.87	73.89	2.56		2.18	1.38	0.64
B1H004	Peak	9.60	6.82	0.71	0.62	2.07	0.58	0.28
	FloodVol	0.91	0.94	1.03		-0.44	0.85	1.92
C2H003	Peak	742.25	448.37	0.60	0.82	6.46	0.54	0.08
	FloodVol	211.70	312.85	1.48		4.76	1.09	0.23
C2H018	Peak	673.61	619.24	0.92	0.85	6.25	0.68	0.11
	FloodVol	246.76	481.76	1.95		4.80	1.09	0.23
C8H001	Peak	657.30	510.25	0.78	0.74	6.28	0.61	0.10
	FloodVol	181.97	149.88	0.82		4.95	0.71	0.14
C8H003	Peak	28.60	31.99	1.12	0.77	2.94	0.84	0.28
	FloodVol	2.60	3.60	1.38		0.37	1.04	2.78
W5H005	Peak	32.12	28.34	0.88	0.51	3.27	0.57	0.17
	FloodVol	3.02	3.92	1.30		0.51	1.07	2.09
C1H001	Peak	216.62	223.63	1.03	0.91	5.10	0.68	0.13
	FloodVol	38.37	56.00	1.46		3.06	1.05	0.34
A2H006	Peak	33.83	68.75	2.03	0.82	2.95	0.87	0.29
	FloodVol	2.83	5.46	1.93		0.25	1.19	4.73
A2H012	Peak	120.66	115.10	0.95	0.78	4.58	0.57	0.12
	FloodVol	6.18	7.14	1.16		1.45	0.78	0.54
A2H013	Peak	57.17	99.10	1.73	0.78	3.21	1.16	0.36
	FloodVol	2.02	2.98	1.48		-0.04	1.18	27.65
A2H019	Peak	93.58	122.79	1.31	0.81	4.22	0.67	0.16
	FloodVol	7.29	11.57	1.59		1.31	1.06	0.81
A5H004	Peak	53.46	58.71	1.10	0.52	3.61	0.77	0.21
	FloodVol	4.71	5.46	1.16		1.07	1.02	0.96
A6H006	Peak	7.89	9.42	1.19	0.81	1.69	0.79	0.47
	FloodVol	0.42	0.64	1.52		-1.42	1.01	0.72
D1H005	Peak	682.61	329.48	0.48	0.86	6.44	0.41	0.06
	FloodVol	175.49	164.28	0.94		4.78	0.92	0.19
G1H004	Peak	193.36	95.98	0.50	0.66	5.16	0.43	0.08
	FloodVol	8.61	6.11	0.71		1.98	0.58	0.29
G1H008	Peak	74.73	64.38	0.86	0.53	4.09	0.63	0.15
	FloodVol	4.72	4.05	0.86		1.30	0.70	0.54
G2H008	Peak	24.37	5.74	0.24	0.53	3.17	0.22	0.07
	FloodVol	0.96	0.56	0.59		-0.18	0.52	2.82

Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
G4H005	Peak	32.64	23.14	0.71	0.75	3.34	0.50	0.15
	FloodVol	6.74	5.09	0.76		1.68	0.67	0.40
H1H006	Peak	312.32	144.14	0.46	0.69	5.65	0.42	0.07
	FloodVol	19.87	14.84	0.75		2.79	0.60	0.22
H1H007	Peak	166.41	51.27	0.31	0.50	5.07	0.28	0.05
	FloodVol	6.09	4.04	0.66		1.67	0.49	0.29
H1H018	Peak	245.69	133.72	0.54	0.73	5.38	0.50	0.09
	FloodVol	8.51	5.68	0.67		1.96	0.60	0.30
H2H003	Peak	68.34	51.41	0.75	0.75	4.02	0.61	0.15
	FloodVol	5.95	5.06	0.85		1.46	0.81	0.56
H4H005	Peak	7.46	5.12	0.69	0.78	1.84	0.55	0.30
	FloodVol	0.27	0.19	0.68		-1.47	0.57	0.39
H4H006	Peak	189.48	157.02	0.83	0.89	5.01	0.65	0.13
	FloodVol	30.98	27.85	0.90		3.16	0.73	0.23
H7H004	Peak	6.88	10.93	1.59	0.77	1.38	0.92	0.67
	FloodVol	0.40	0.59	1.46		-1.33	0.85	0.64
H7H005	Peak	13.84	5.65	0.41	0.65	2.56	0.36	0.14
	FloodVol	0.47	0.34	0.72		-0.91	0.53	0.58
J2H005	Peak	12.04	21.03	1.75	0.73	2.09	0.77	0.37
	FloodVol	1.09	1.58	1.46		-0.82	1.50	1.84
J2H007	Peak	1.29	1.31	1.02	0.53	-0.12	0.82	7.11
	FloodVol	0.12	0.19	1.66		-3.30	1.74	0.53
K2H002	Peak	36.94	45.49	1.23	0.76	3.26	0.72	0.22
	FloodVol	1.96	2.05	1.05		0.17	1.13	6.79
K4H002	Peak	17.44	8.82	0.51	0.74	2.74	0.48	0.17
	FloodVol	0.70	0.43	0.61		-0.52	0.60	1.16
K4H003	Peak	14.71	33.17	2.26	0.89	1.92	1.02	0.53
	FloodVol	0.97	1.74	1.79		-0.62	0.95	1.54
K5H002	Peak	31.99	55.03	1.72	0.90	2.90	0.92	0.32
	FloodVol	2.12	2.76	1.30		0.31	0.86	2.72
N2H002	Peak	58.94	104.19	1.77	0.91	3.05	1.35	0.44
	FloodVol	4.23	9.22	2.18		0.34	1.35	3.94
T5H004	Peak	78.72	43.97	0.56	0.50	4.28	0.36	0.08
	FloodVol	13.24	9.53	0.72		2.34	0.73	0.31
U2H013	Peak	38.08	37.48	0.98	0.70	3.44	0.54	0.16
	FloodVol	4.01	5.30	1.32		0.93	0.97	1.05
V1H009	Peak	77.87	66.54	0.85	0.65	4.10	0.67	0.16
	FloodVol	1.40	1.57	1.13		-0.02	0.80	39.33
V2H002	Peak	76.49	108.86	1.42	0.75	4.06	0.60	0.15
	FloodVol	16.91	16.56	0.98		2.49	0.81	0.33
V3H005	Peak	56.51	39.23	0.69	0.64	3.84	0.61	0.16
	FloodVol	8.50	10.31	1.21		1.37	1.36	0.99
V3H007	Peak	26.66	13.93	0.52	0.49	3.17	0.46	0.15
	FloodVol	2.29	2.07	0.91		0.41	0.97	2.39
V6H002	Peak	899.57	292.99	0.33	0.51	6.76	0.27	0.04
	FloodVol	161.81	130.23	0.80		4.78	0.81	0.17
X1H001	Peak	168.76	196.10	1.16	0.69	4.88	0.60	0.12
	FloodVol	18.19	21.25	1.17		2.48	0.89	0.36
X2H008	Peak	34.19	32.46	0.95	0.63	3.28	0.65	0.20
	FloodVol	0.81	1.19	1.47		-0.71	0.97	1.37
X2H010	Peak	17.87	15.13	0.85	0.69	2.67	0.60	0.23
	FloodVol	0.50	0.44	0.89		-0.98	0.73	0.75

Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean In	Std Dev In	CV In
X2H011	Peak	60.40	46.73	0.77	0.56	3.89	0.61	0.16
	FloodVol	1.51	1.36	0.90		0.07	0.84	11.54
X2H015	Peak	118.05	52.68	0.45	0.34	4.69	0.38	0.08
	FloodVol	7.01	6.17	0.88		1.63	0.81	0.50
X3H001	Peak	42.70	23.10	0.54	0.04	3.64	0.48	0.13
	FloodVol	10.81	4.69	0.43		2.29	0.44	0.19
X2H013	Peak	85.46	30.23	0.35	-0.16	4.41	0.27	0.06
	FloodVol	13.31	10.07	0.76		2.29	0.83	0.36
B6H001	Peak	3.88	2.66	0.69	0.28	1.13	0.71	0.63
	FloodVol	0.11	0.12	1.08		-2.64	0.93	0.35
B8H008	Peak	241.33	220.66	0.91	0.76	5.16	0.79	0.15
	FloodVol	18.09	22.48	1.24		2.31	1.08	0.47
B7H004	Peak	43.78	51.21	1.17	0.62	3.42	0.78	0.23
	FloodVol	1.21	1.58	1.31		-0.27	0.96	3.51
K2H002	Peak	36.94	45.49	1.23	0.76	3.26	0.72	0.22
	FloodVol	1.96	2.05	1.05		0.17	1.13	6.79
Q9H002	Peak	34.49	49.64	1.44	0.74	3.08	0.84	0.27
	FloodVol	3.77	5.82	1.54		0.55	1.26	2.30
R1H005	Peak	21.92	23.97	1.09	0.77	2.79	0.70	0.25
	FloodVol	2.36	2.84	1.20		0.37	1.01	2.74
S6H001	Peak	13.22	12.62	0.96	0.74	2.31	0.67	0.29
	FloodVol	1.04	1.20	1.16		-0.40	0.91	2.29
T1H004	Peak	89.15	119.19	1.34	0.89	4.05	0.88	0.22
	FloodVol	13.32	27.44	2.06		1.90	1.14	0.60
T3H005	Peak	228.31	155.66	0.68	0.74	5.30	0.46	0.09
	FloodVol	20.04	25.09	1.25		2.50	0.97	0.39
T3H006	Peak	380.92	201.75	0.53	0.68	5.84	0.44	0.08
	FloodVol	58.52	61.82	1.06		3.67	0.87	0.24
T4H001	Peak	157.68	168.76	1.07	0.89	4.80	0.62	0.13
	FloodVol	13.48	19.99	1.48		2.08	0.94	0.45
U2H005	Peak	174.66	417.08	2.39	0.94	4.78	0.62	0.13
	FloodVol	30.99	77.38	2.50		2.32	1.55	0.67
U2H006	Peak	24.87	30.70	1.23	0.80	2.96	0.59	0.20
	FloodVol	7.73	7.68	0.99		1.73	0.76	0.44
U2H011	Peak	35.80	46.72	1.30	0.68	3.25	0.67	0.21
	FloodVol	0.95	1.18	1.24		-0.45	0.83	1.83
U2H012	Peak	27.20	44.25	1.63	0.59	2.98	0.63	0.21
	FloodVol	7.46	6.98	0.94		1.72	0.73	0.43
X3H003	Peak	13.29	11.14	0.84	0.60	2.39	0.57	0.24
	FloodVol	0.73	0.99	1.35		-0.90	1.05	1.16
X3H006	Peak	61.52	62.65	1.02	0.72	3.87	0.62	0.16
	FloodVol	7.00	7.93	1.13		1.53	0.94	0.61
B7H003	Peak	3.92	2.61	0.67	0.34	1.15	0.70	0.61
	FloodVol	0.16	0.21	1.27		-2.38	1.04	0.44
B8H009	Peak	85.82	108.19	1.26	0.64	4.05	0.78	0.19
	FloodVol	8.48	15.01	1.77		1.45	1.08	0.75
B8H010	Peak	75.95	90.46	1.19	0.77	3.90	0.85	0.22
	FloodVol	3.84	5.69	1.48		0.67	1.14	1.70
V5H002	Peak	1343.75	759.22	0.57	0.69	7.08	0.46	0.07
	FloodVol	157.34	156.49	0.99		4.74	0.78	0.17

Appendix A1(b) POT Statistics for Dam Gauging Stations Used in JPV Methodology (Peak as m^3/s; Volume as Mm^3)

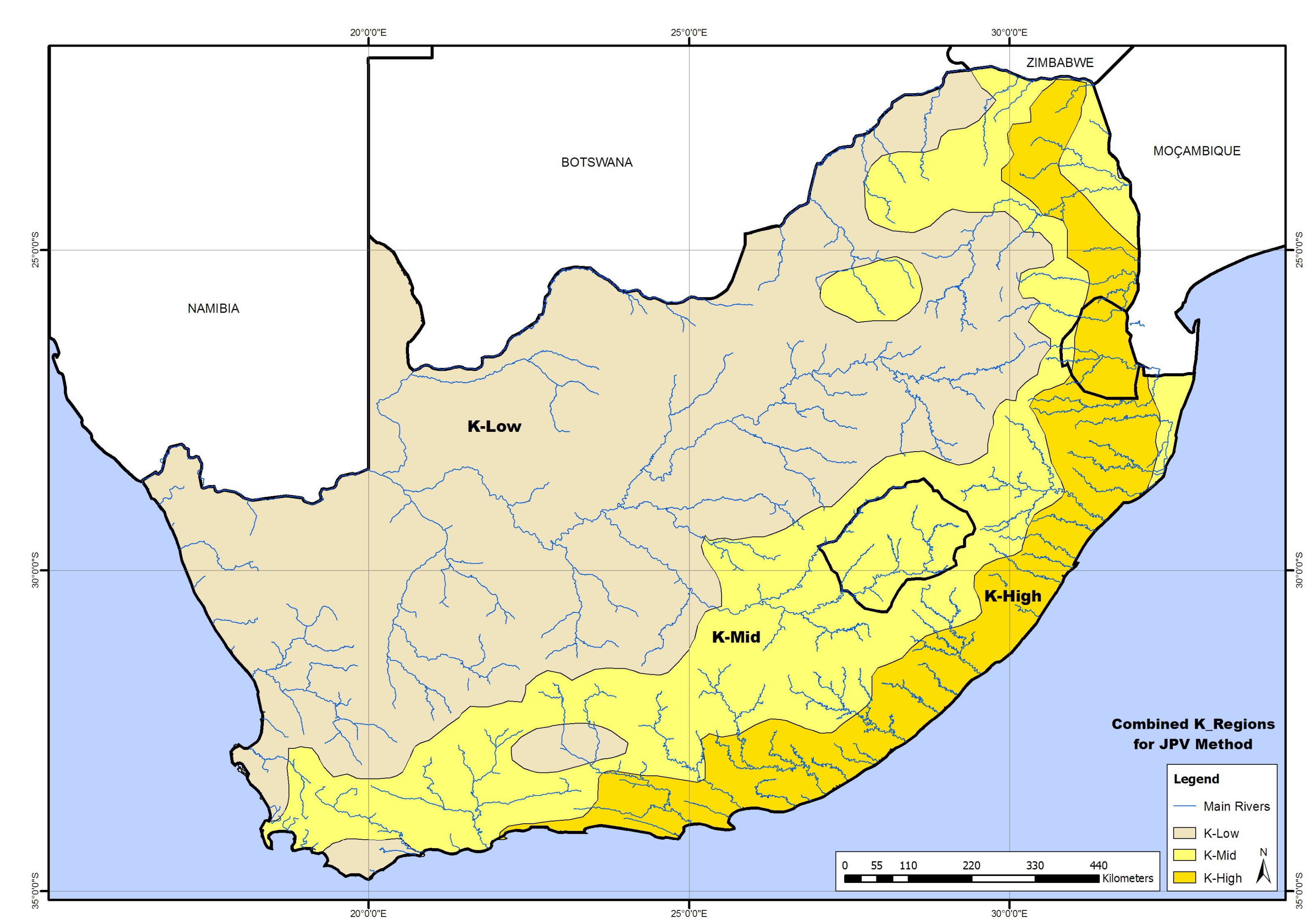
Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
A2R001	Peak	227.39	300.17	1.32	0.56	4.84	1.07	0.22
	Vol	15.45	25.50	1.65		2.20	1.03	0.47
A2R003	Peak	50.79	93.79	1.85	0.80	3.04	1.25	0.41
	Vol	3.25	6.04	1.86		0.34	1.38	4.07
A2R005	Peak	34.08	54.10	1.59	0.31	2.87	1.20	0.42
	Vol	2.14	3.13	1.46		0.13	1.20	9.18
A2R006	Peak	71.54	120.37	1.68	0.75	3.22	1.52	0.47
	Vol	3.90	7.01	1.80		0.34	1.56	4.54
A2R007	Peak	46.46	94.40	2.03	0.72	2.68	1.52	0.57
	Vol	6.02	12.06	2.00		0.85	1.40	1.64
A2R009	Peak	161.67	322.66	2.00	0.82	4.35	1.20	0.27
	Vol	3.88	4.92	1.27		0.69	1.36	1.98
A2R011	Peak	48.93	59.35	1.21	0.86	3.34	1.07	0.32
	Vol	1.82	3.65	2.00		-0.73	1.69	2.31
A2R013	Peak	30.21	60.50	2.00	0.97	1.68	2.09	1.24
	Vol	0.71	1.66	2.33		-2.72	2.12	0.78
A2R014	Peak	327.84	463.97	1.42	0.88	4.93	1.37	0.28
	Vol	37.18	87.18	2.34		2.19	1.72	0.78
A2R015	Peak	280.42	397.08	1.42	0.92	4.85	1.42	0.29
	Vol	20.85	29.02	1.39		2.33	1.19	0.51
A3R001	Peak	102.26	214.48	2.10	0.48	3.71	1.29	0.35
	Vol	10.05	14.31	1.42		1.25	1.85	1.47
A3R002	Peak	26.68	43.49	1.63	0.65	2.38	1.40	0.59
	Vol	1.71	2.25	1.32		-0.32	1.55	4.88
A3R003	Peak	49.37	62.89	1.27	0.57	3.29	1.15	0.35
	Vol	3.03	4.25	1.40		0.26	1.54	5.98
A3R004	Peak	308.56	362.82	1.18	0.91	5.34	0.83	0.15
	Vol	41.01	106.14	2.59		2.08	1.75	0.84
A4R001	Peak	138.60	261.34	1.89	0.94	4.02	1.25	0.31
	Vol	43.44	71.20	1.64		1.96	2.52	1.29
A5R002	Peak	128.58	120.75	0.94	0.75	4.38	1.20	0.27
	Vol	22.74	24.73	1.09		1.87	2.09	1.11
A6R001	Peak	36.81	42.61	1.16	0.48	3.07	1.09	0.36
	Vol	2.51	3.38	1.35		0.00	1.55	
A6R002	Peak	159.65	176.67	1.11	0.78	4.47	1.25	0.28
	Vol	19.68	26.30	1.34		1.61	2.04	1.27
A8R001	Peak	170.97	375.67	2.20	0.49	4.17	1.42	0.34
	Vol	13.25	24.51	1.85		1.34	1.70	1.27
A8R002	Peak	54.05	80.62	1.49	0.76	3.13	1.47	0.47
	Vol	2.83	5.27	1.86		-0.42	1.97	4.71
A8R003	Peak	33.78	41.92	1.24	0.57	2.84	1.26	0.44
	Vol	2.38	4.25	1.79		-0.65	2.06	3.17
A8R004	Peak	71.51	120.21	1.68	0.94	3.46	1.26	0.36
	Vol	9.12	17.89	1.96		1.08	1.62	1.51
A9R001	Peak	68.80	105.61	1.54	0.54	3.34	1.48	0.44
	Vol	4.20	6.44	1.53		0.10	1.91	19.88
A9R002	Peak	60.27	87.54	1.45	0.35	3.44	1.20	0.35
	Vol	1.51	2.54	1.68		-0.96	2.16	2.26
B1R001	Peak	328.08	483.52	1.47	0.36	4.93	1.40	0.28
	Vol	26.52	37.13	1.40		2.53	1.32	0.52
B1R002	Peak	87.48	90.28	1.03	0.79	4.08	0.90	0.22

Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
	Vol	3.19	5.88	1.84		0.38	1.28	3.39
B2R001	Peak	122.54	157.36	1.28	0.59	4.22	1.15	0.27
	Vol	12.52	20.55	1.64		1.56	1.46	0.93
B3R001	Peak	60.02	103.42	1.72	0.72	3.37	1.14	0.34
	Vol	6.09	8.70	1.43		0.64	1.98	3.11
B3R002	Peak	469.56	658.61	1.40	0.89	5.41	1.26	0.23
	Vol	92.98	121.13	1.30		3.70	1.58	0.43
B3R005	Peak	110.71	115.25	1.04	0.67	4.14	1.16	0.28
	Vol	13.51	39.13	2.90		0.17	2.12	12.76
B4R001	Peak	6.93	16.56	2.39	0.28	0.60	1.65	2.74
	Vol	0.12	0.23	1.88		-3.26	1.67	0.51
B4R002	Peak	3.74	4.87	1.31	0.27	0.71	1.16	1.64
	Vol	0.12	0.31	2.50		-3.25	1.51	0.46
B4R004	Peak	41.71	44.18	1.06	0.22	3.33	0.92	0.28
	Vol	1.34	1.19	0.88		-0.16	1.05	6.42
B5R002-Arabie	Peak	461.00	650.92	1.41	0.99	5.49	1.12	0.20
	Vol	158.13	296.64	1.88		3.39	2.15	0.63
B5R002-Flag...	Peak	461.00	650.92	1.41	0.99	5.49	1.12	0.20
	Vol	158.13	296.64	1.88		3.39	2.15	0.63
B6R001	Peak	22.00	39.34	1.79	-0.03	2.08	1.59	0.76
	Vol	1.59	2.78	1.76		-1.50	2.25	1.50
B6R003	Peak	340.58	277.29	0.81	0.57	5.43	1.06	0.19
	Vol	26.91	30.91	1.15		2.58	1.44	0.56
B7R001	Peak	61.77	92.93	1.50	0.08	3.32	1.40	0.42
	Vol	6.23	9.94	1.60		0.61	2.00	3.27
B7R003	Peak	52.67	66.84	1.27	0.20	3.17	1.30	0.41
	Vol	4.05	5.81	1.44		0.42	1.59	3.74
B8R001	Peak	19.41	32.22	1.66	0.44	2.35	1.05	0.45
	Vol	5.71	9.86	1.73		0.90	1.32	1.47
B8R002	Peak	35.45	62.82	1.77	0.93	2.88	1.13	0.39
	Vol	2.02	3.09	1.53		-0.26	1.65	6.39
B8R003	Peak	24.76	33.66	1.36	0.86	2.61	1.12	0.43
	Vol	5.03	5.03	1.00		1.03	1.36	1.32
B8R005	Peak	174.13	225.59	1.30	0.86	4.64	1.05	0.23
	Vol	11.42	24.59	2.15		1.00	1.89	1.89
B8R006	Peak	150.16	271.56	1.81	0.94	4.23	1.11	0.26
	Vol	42.15	75.73	1.80		1.40	2.69	1.93
B8R007	Peak	789.23	1165.60	1.48	0.60	5.68	1.70	0.30
	Vol	15.71	28.16	1.79		1.40	2.00	1.43
C2R003	Peak	24.57	34.61	1.41	0.96	2.52	1.15	0.46
	Vol	4.01	7.54	1.88		-0.48	2.07	4.33
C3R001	Peak	74.54	109.66	1.47	0.88	3.04	2.08	0.68
	Vol	34.34	82.12	2.39		1.06	2.82	2.65
C3R002	Peak	195.29	578.01	2.96	0.67	3.87	1.47	0.38
	Vol	46.11	98.24	2.13		2.56	1.54	0.60
C4R001	Peak	258.71	405.26	1.57	0.94	4.97	1.04	0.21
	Vol	26.78	41.41	1.55		2.54	1.31	0.52
C4R002	Peak	357.16	487.14	1.36	0.93	5.22	1.27	0.24
	Vol	39.66	45.85	1.16		3.10	1.16	0.37
C5R002	Peak	664.00	1981.15	2.98	0.94	5.15	1.58	0.31
	Vol	90.81	226.46	2.49		3.00	1.92	0.64
C5R003	Peak	158.91	397.33	2.50	0.95	4.10	1.27	0.31
	Vol	12.60	21.37	1.70		1.57	1.61	1.03
C7R001	Peak	270.15	292.15	1.08	0.53	5.14	0.97	0.19

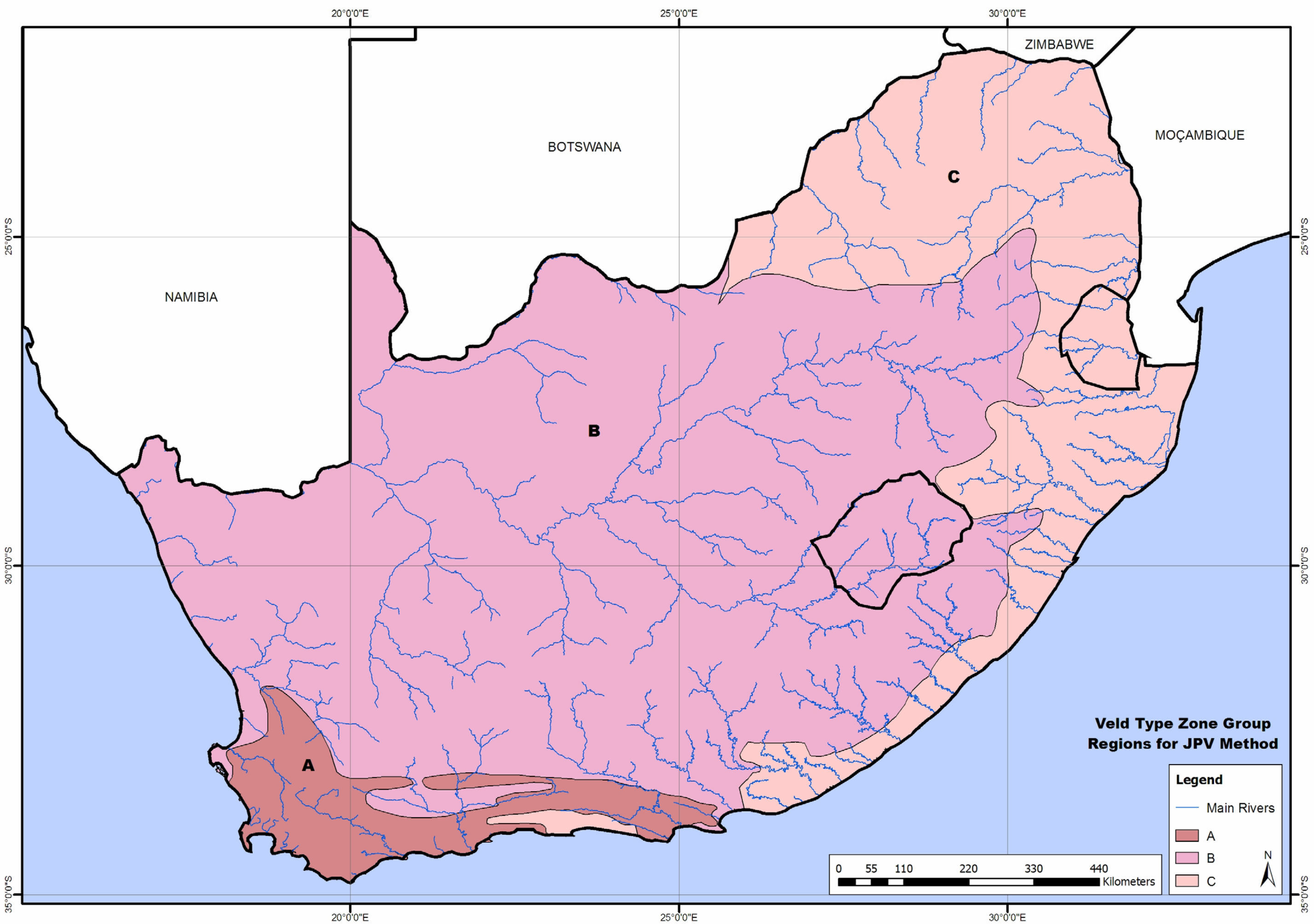
Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
	Vol	19.34	22.88	1.18		2.25	1.38	0.61
C9R002	Peak	1184.45	1426.25	1.20	0.79	6.36	1.27	0.20
	Vol	755.55	1191.55	1.58		5.51	1.58	0.29
D2R004	Peak	1172.04	762.74	0.65	0.64	6.85	0.70	0.10
	Vol	103.62	115.66	1.12		3.90	1.40	0.36
D2R006	Peak	49.29	65.53	1.33	0.87	3.23	1.21	0.38
	Vol	4.52	5.94	1.31		0.53	1.67	3.17
D3R002	Peak	3148.10	2425.77	0.77	0.94	7.77	0.79	0.10
	Vol	943.22	798.38	0.85		6.53	0.83	0.13
D7R001	Peak	980.72	1275.63	1.30	0.93	6.31	1.08	0.17
	Vol	981.82	2387.40	2.43		5.04	2.13	0.42
H2R001	Peak	30.61	42.56	1.39	0.65	2.87	1.00	0.35
	Vol	4.31	9.09	2.11		0.46	1.58	3.40
H3R001	Peak	52.92	103.11	1.95	0.14	2.53	1.82	0.72
	Vol	4.25	10.53	2.48		-0.32	2.13	6.69
H3R002	Peak	36.94	121.08	3.28	0.97	2.09	1.82	0.87
	Vol	0.94	3.79	4.03		-2.44	2.14	0.88
H4R002	Peak	47.40	151.65	3.20	0.19	2.24	1.65	0.74
	Vol	7.78	44.35	5.70		-0.24	1.50	6.14
H4R003	Peak	16.48	43.80	2.66	0.73	1.37	1.65	1.20
	Vol	0.46	0.61	1.33		-1.66	1.65	1.00
H6R001	Peak	489.33	346.87	0.71	0.80	5.94	0.76	0.13
	Vol	33.29	18.96	0.57		3.35	0.58	0.17
H7R001	Peak	222.89	144.41	0.65	0.94	5.21	0.63	0.12
	Vol	17.70	11.85	0.67		2.66	0.67	0.25
H8R001	Peak	60.61	63.82	1.05	0.47	3.76	0.79	0.21
	Vol	4.81	3.51	0.73		1.29	0.80	0.62
H9R001	Peak	29.57	24.07	0.81	0.85	3.09	0.79	0.26
	Vol	1.41	0.96	0.68		0.13	0.66	5.13
J1R002	Peak	58.02	151.43	2.61	0.90	2.31	1.89	0.82
	Vol	1.65	3.11	1.88		-0.89	1.83	2.07
J1R004	Peak	71.64	161.09	2.25	0.84	3.06	1.49	0.49
	Vol	1.39	1.88	1.35		-0.68	1.62	2.40
J2R003	Peak	13.58	26.44	1.95	0.28	1.61	1.42	0.88
	Vol	1.25	2.97	2.38		-1.42	2.05	1.44
J3R002	Peak	307.72	585.60	1.90	0.84	4.76	1.50	0.32
	Vol	12.07	20.11	1.67		1.59	1.42	0.89
K2R002	Peak	157.11	173.24	1.10	0.96	4.42	1.25	0.28
	Vol	4.46	3.69	0.83		1.15	0.91	0.79
K9R002	Peak	196.80	414.98	2.11	0.96	3.59	1.76	0.49
	Vol	17.51	32.93	1.88		1.02	2.20	2.16
L9R001	Peak	227.03	606.07	2.67	0.53	3.37	1.90	0.56
	Vol	4.71	6.57	1.39		0.49	1.67	3.41
V1R001	Peak	619.00	515.51	0.83	0.63	5.98	1.06	0.18
	Vol	63.47	62.64	0.99		3.49	1.46	0.42
V2R001	Peak	47.31	61.34	1.30	0.85	3.42	0.91	0.26
	Vol	2.22	4.92	2.21		-0.26	1.47	5.67
V3R001	Peak	350.00	277.98	0.79	0.13	5.49	0.99	0.18
	Vol	10.68	11.81	1.11		1.80	1.17	0.65
W2R001	Peak	198.59	274.21	1.38	0.88	4.65	1.16	0.25
	Vol	18.35	51.11	2.79		1.42	1.68	1.18
W3R001	Peak	460.56	617.52	1.34	0.87	5.23	1.59	0.30
	Vol	20.58	26.92	1.31		2.10	1.67	0.79
W4R001	Peak	1290.68	2955.01	2.29	0.96	6.39	1.14	0.18
	Vol	128.32	313.35	2.44		3.84	1.30	0.34

Gauge	Item	Mean	Std Dev	CV	Correl. Coef.	Mean ln	Std Dev ln	CV ln
W5R001	Peak	25.62	27.50	1.07	0.32	2.85	0.87	0.31
	Vol	3.10	3.25	1.05		0.81	0.75	0.93
W5R003	Peak	75.54	65.36	0.87	0.37	4.06	0.71	0.18
	Vol	4.68	6.62	1.41		0.70	1.34	1.91
W5R004	Peak	312.18	244.85	0.78	0.30	5.38	0.96	0.18
	Vol	5.23	4.49	0.86		1.30	0.90	0.69
X1R001	Peak	114.69	101.08	0.88	0.31	4.40	0.86	0.19
	Vol	9.05	15.35	1.70		1.32	1.48	1.12
X1R003	Peak	249.03	221.45	0.89	0.58	5.24	0.74	0.14
	Vol	19.23	26.69	1.39		1.86	1.83	0.98
X2R001	Peak	16.94	22.11	1.31	0.95	2.42	0.88	0.36
	Vol	0.63	2.30	3.67		-2.80	1.73	0.62
X2R002	Peak	33.67	62.06	1.84	0.92	2.79	1.06	0.38
	Vol	0.80	1.59	1.99		-1.59	1.72	1.09
X2R003	Peak	20.71	16.07	0.78	0.70	2.76	0.82	0.30
	Vol	1.78	2.47	1.39		-0.33	1.53	4.70
X2R004	Peak	54.51	92.39	1.69	0.44	3.07	1.48	0.48
	Vol	5.08	10.88	2.14		0.59	1.47	2.47
X2R005	Peak	93.06	48.79	0.52	0.22	4.35	0.72	0.16
	Vol	5.78	7.91	1.37		1.18	1.05	0.89
X3R001	Peak	21.10	17.44	0.83	0.46	2.82	0.66	0.23
	Vol	0.95	2.24	2.35		-1.52	1.64	1.08

Appendix A2 K-Region Pooling-Group Boundaries



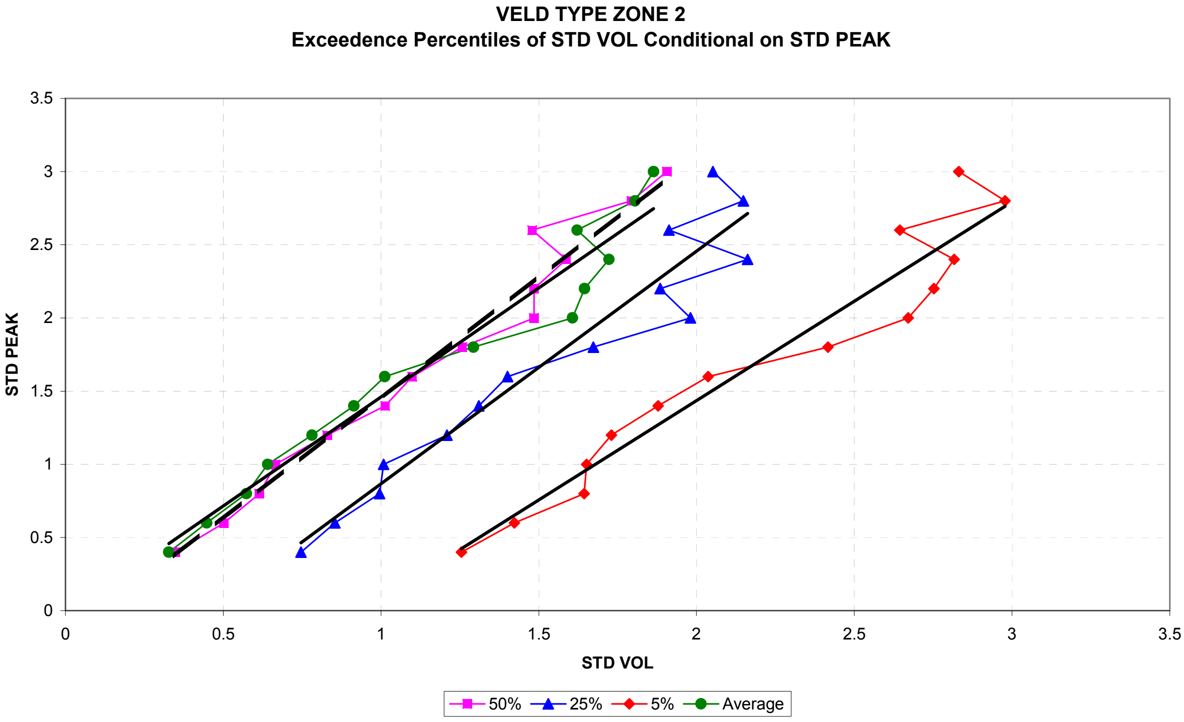
Appendix A3 Veld Type Zone Pooling-Group Boundaries



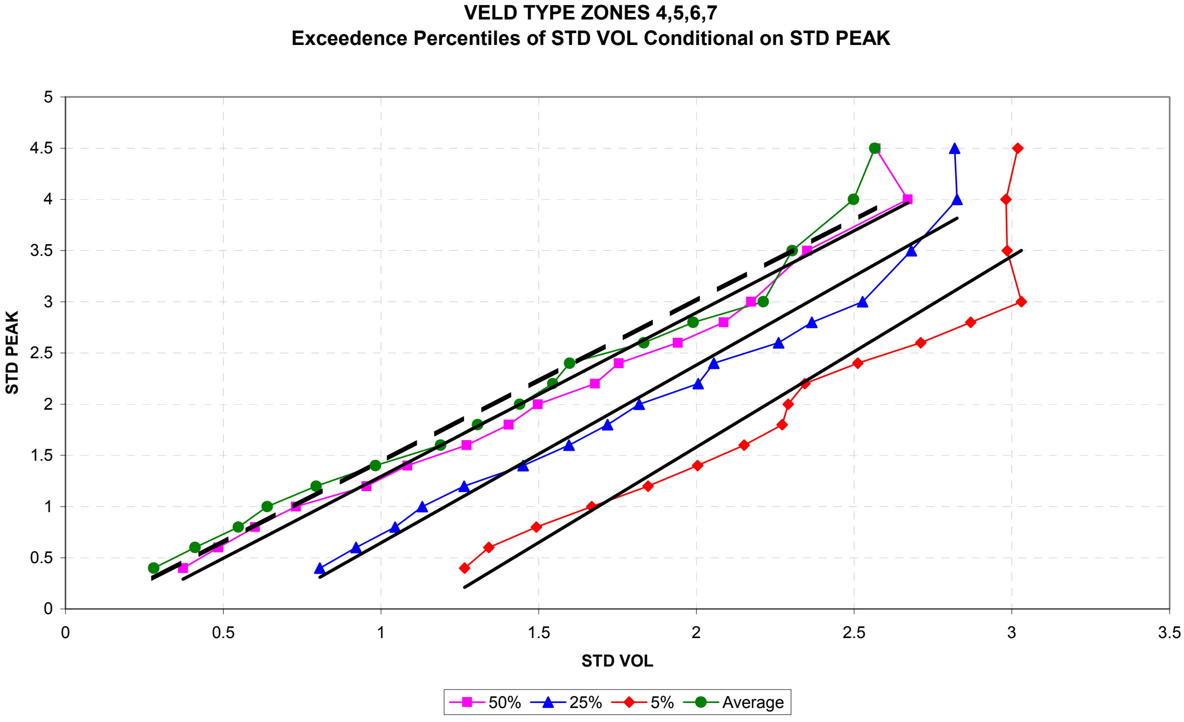
APPENDIX B

Appendix B1	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *Veld Zone Group A*
Appendix B2	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *Veld Zone Group B*
Appendix B3	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *Veld Zone Group C*
Appendix B4	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *High K - Region*
Appendix B5	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *Mid-K Region*
Appendix B6	Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: *Low K – Region*

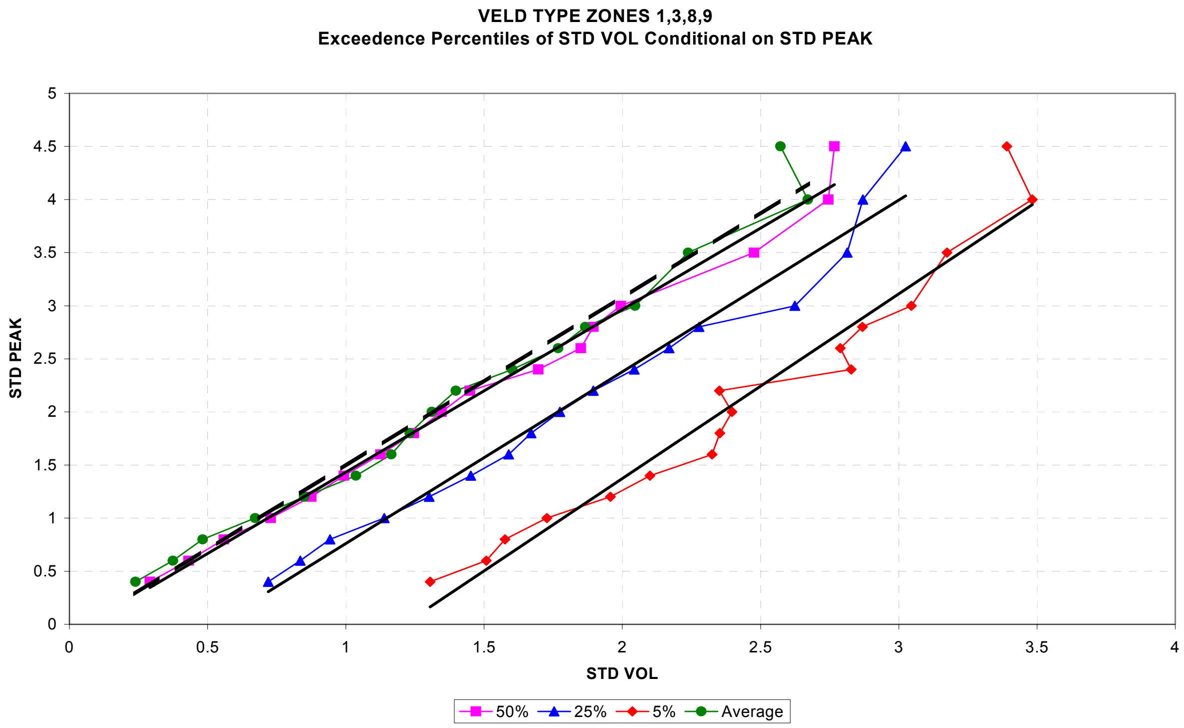
Appendix B1 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: Veld Zone Group A



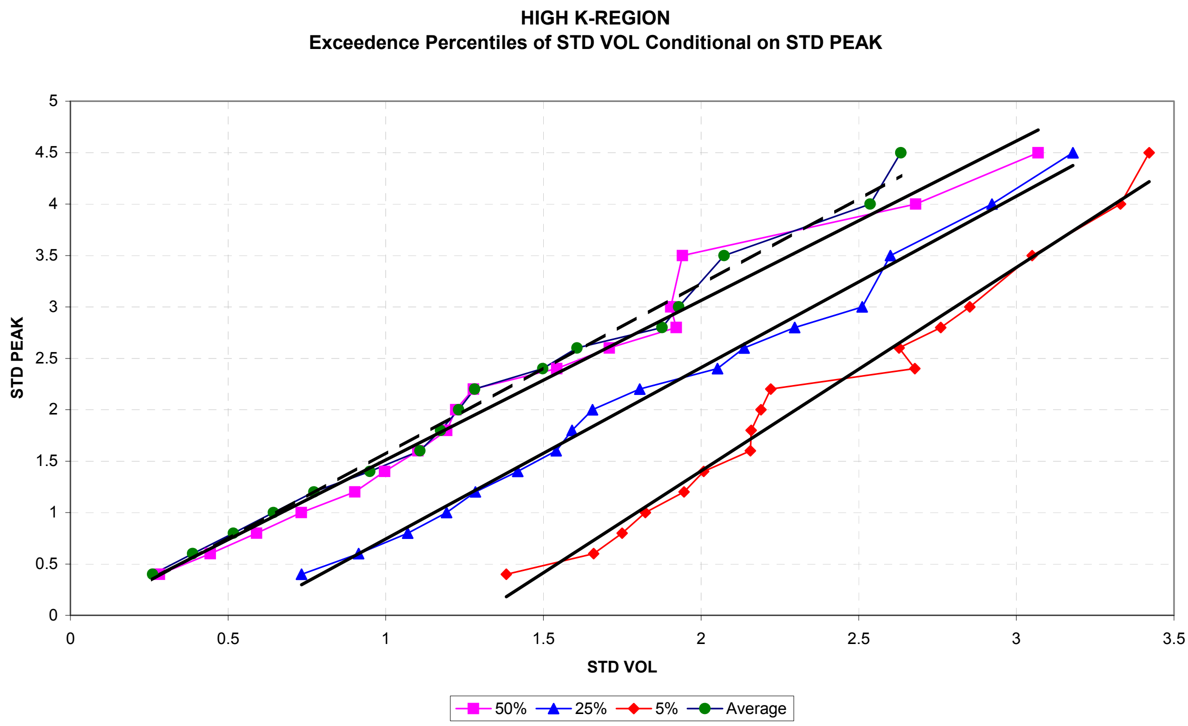
Appendix B2 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: Veld Zone Group B



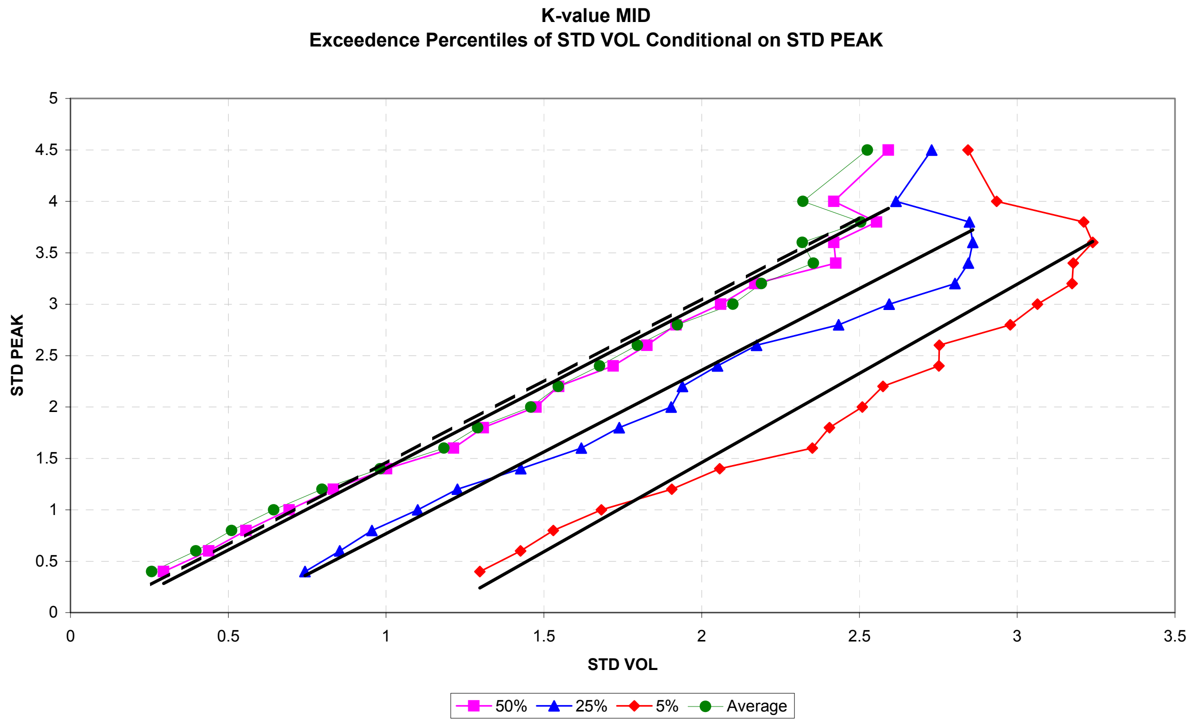
Appendix B3 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: Veld Zone Group C



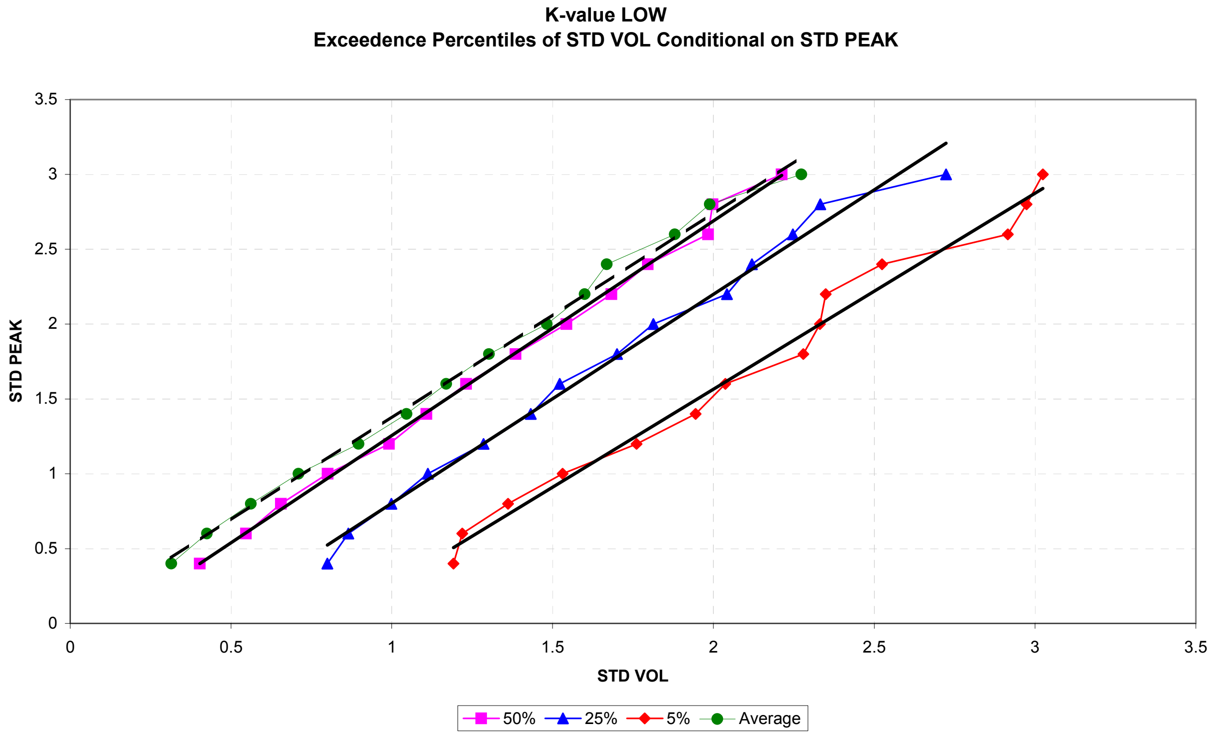
Appendix B4 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: High K - Region



Appendix B5 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: Mid-K – Region



Appendix B6 Exceedence Percentile Functions of Standardised Flood Volumes Conditional on Standardised Flood Peaks: Low K – Region



APPENDIX C

Appendix C1	Annual Maximum Flood Peak Statistics and Catchment Descriptors
Appendix C2 (a)	Low K-Region Similarity Distance Values
Appendix C2 (b)	Mid K-Region Similarity Distance Values
Appendix C2 (c)	High K-Region Similarity Distance Values
Appendix C2 (d)	Veld Type Zone A Similarity Distance Values
Appendix C2 (e)	Veld Type Zone B Similarity Distance Values
Appendix C2 (f)	Veld Type Zone C Similarity Distance Values

Appendix C1 Annual Maximum Flood Peak Statistics and Catchment Descriptors

Gauging Station	Record length (yrs)	Median Peak (m^3/s)	Mean Peak (m^3/s)	Std Dev (m^3/s)	Skew	Mean *ln*Peak	Std Dev *ln*Peak	Skew *ln*Peak	Area (km^2)	Eq.Area Mean Slope	MAR WR90 (mm)	HRU1/72 Basin Lag (hr)	HRU1/72 Veld Zone	RMF K-Region
A2R005	66	20.0	34.1	54.1	5.19	2.868	1.204	-0.306	114	0.0105	37.0	1.1	8	3.4
B3R002	65	223.0	471.5	645.8	2.58	5.441	1.240	-0.014	12262	0.0017	3.7	21.2	4	3.4
C3R002	78	57.2	141.0	355.7	6.52	4.164	1.059	0.652	26922	0.0008	2.7	15.9	6	3.4
C2H001	29	182.6	397.7	495.8	2.12	2.276	0.599	-0.414	3595	0.0025	23.0	21.9	4	4
A2R007	56	16.0	51.2	98.2	3.93	2.878	1.466	0.121	704	0.0041	21.0	3.9	8	4.6
A3R001	68	33.5	103.0	215.3	5.44	3.711	1.298	0.395	1219	0.0052	24.4	4.1	8	4.6
A3R002	96	24.5	40.4	66.9	4.42	2.824	1.430	-0.233	1180	0.0069	7.2	2.6	8	4.6
A3R003	48	21.5	49.4	63.0	2.33	3.286	1.152	-0.182	1786	0.0049	15.0	3.8	8	4.6
B1R001	98	144.5	290.3	397.7	3.00	2.132	0.581	-0.287	3541	0.0011	36.0	28.6	4	4.6
B1R002	45	46.0	75.3	81.8	2.85	3.927	0.873	0.401	1576	0.0016	28.5	23.2	4	4.6
B2R001	98	82.0	154.8	201.4	2.44	1.872	0.569	-0.250	1263	0.0030	35.0	5.9	4	4.6
C7R001	80	170.5	270.2	292.2	2.21	5.143	0.968	0.080	2154	0.0018	35.0	10.4	4	4.6
D2R004	70	790.9	960.6	679.3	1.40	6.634	0.702	-0.066	15330	0.0007	109.0	29.4	4	4.6
W5R003	53	45.1	58.3	54.3	2.44	3.734	0.826	-0.005	548	0.0031	97.0	4.8	9	4.6
X1R001	42	96.0	114.7	101.1	1.87	4.400	0.855	-0.009	1569	0.0020	41.0	17.4	4	4.6
B1H004	42	10.4	13.3	9.2	0.75	2.332	0.754	-0.168	376	0.0056	46.0	4.7	8	4.6
E2H003	24	334.8	405.8	159.7	0.57	5.938	0.374	0.298	24044	0.0037	8.0	36.5	2	4.6
A2H021	13	40.2	103.1	147.2	2.06	3.789	1.044	1.360	7483	0.0019	2.5	7.5	8	4.6
C8H003	35	42.7	55.8	48.3	1.05	3.407	1.384	-1.310	806	0.0039	70.0	7.3	4	4.6
C1H001	30	179.8	343.5	384.3	2.39	5.391	0.935	0.519	8193	0.0008	7.0	20.3	4	4.6
A2R001	99	150.7	305.4	449.1	2.79	4.986	1.137	0.248	4120	0.0033	36.0	8.8	4	5
A2R003	73	15.0	50.8	93.8	3.91	3.037	1.246	0.675	492	0.0099	23.0	3.8	4	5
A2R006	75	23.0	84.5	158.7	3.55	3.259	1.588	0.099	1078	0.0057	24.0	3.3	8	5
A6R001	64	27.0	41.7	43.1	2.09	3.185	1.084	-0.337	595	0.0044	39.0	3.4	8	5
A8R001	70	91.0	215.3	388.8	4.01	1.908	0.676	-0.571	832	0.0056	79.7	2.8	8	5

Gauging Station	Record length (yrs)	Median Peak (m^3/s)	Mean Peak (m^3/s)	Std Dev (m^3/s)	Skew	Mean *ln*Peak	Std Dev *ln*Peak	Skew *ln*Peak	Area (km^2)	Eq.Area Mean Slope	MAR WR90 (mm)	HRU1/72 Basin Lag (hr)	HRU1/72 Veld Zone	RMF K-Region
B3R001	69	25.0	60.0	103.4	4.00	3.371	1.141	0.400	1145	0.0034	27.3	5.3	8	5
B6R001	47	11.0	14.9	18.9	3.50	2.074	1.243	-0.428	84	0.0310	201.0	0.8	8	5
B6R003	51	231.0	266.2	228.8	1.72	5.194	0.977	-0.514	2166	0.0084	47.0	8.1	3	5
B8R005	52	75.0	126.0	180.1	3.48	4.160	1.199	0.001	652	0.0050	323.0	6.5	3	5
C5R002	86	204.0	456.1	792.3	5.39	5.329	1.495	-0.335	10264	0.0013	11.0	9.4	7	5
C5R003	80	66.0	207.0	355.3	4.30	4.432	1.337	0.303	937	0.0030	30.0	4.8	4	5
H3R001	47	16.5	53.8	90.8	2.96	2.528	1.818	0.069	94	0.0143	58.0	3.6	2	5
H4R002	49	8.6	26.9	49.3	2.52	2.239	1.655	0.545	377	0.0134	27.0	11.3	2	5
H7R001	53	144.0	197.6	137.5	1.15	5.067	0.663	0.267	614	0.0056	164.0	9.8	2	5
J1R002	77	10.0	38.6	101.0	4.73	2.198	1.777	-0.125	546	0.0095	5.3	2.1	6	5
J2R003	70	5.3	13.6	26.4	4.04	1.614	1.422	0.048	141	0.0196	33.0	4.0	2	5
K9R002	72	131.2	211.2	234.1	2.16	4.890	0.963	0.132	856	0.0011	35.9	18.0	2	5
V2R001	37	29.0	47.3	61.3	3.92	3.419	0.905	0.254	154	0.0086	176.0	1.5	8	5
A2H006	54	30.6	75.0	141.6	4.13	3.433	1.280	0.307	1028	0.0043	15.4	10.5	8	5
A2H012	45	131.9	193.0	173.2	1.82	4.908	0.867	0.019	2551	0.0045	7.3	20.8	4	5
A2H013	42	47.7	117.4	155.5	1.91	3.804	1.569	-0.222	1171	0.0061	27.0	8.1	8	5
G1H008	41	98.3	128.0	106.5	1.82	4.539	0.836	-0.321	395	0.0228	173.0	7.3	2	5
H1H006	40	382.4	391.3	185.6	0.40	5.841	0.544	-0.592	753	0.0112	520.0	20.3	2	5
H1H007	40	222.1	222.1	65.1	1.08	5.364	0.281	0.198	84	0.0371	1063.0	6.7	2	5
J2H005	35	6.0	15.6	31.5	4.99	1.896	1.280	0.228	253	0.0278	34.0	2.8	6	5
U2H006	36	23.9	41.4	53.3	3.56	3.306	0.843	0.746	339	0.0096	232.0	4.6	5	5
V2H002	40	68.4	144.7	222.2	4.67	4.491	0.877	0.999	937	0.0051	166.0	11.4	5	5
W5H005	43	38.1	54.3	48.5	2.30	3.714	0.728	0.408	804	0.0029	106.0	7.3	9	5
X2H008	38	31.5	47.4	50.0	1.66	3.275	1.198	-0.319	180	0.0256	204.0	5.9	3	5
X2H015	41	137.6	145.3	80.9	0.47	4.755	0.771	-1.307	1554	0.0037	87.2	10.6	8	5
X3H001	44	13.8	21.0	20.3	2.23	2.684	0.856	0.192	174	0.0286	452.0	4.8	3	5
A9R001	55	41.0	88.4	133.7	2.61	3.540	1.467	-0.480	509	0.0063	56.0	2.4	8	5.2
B7R001	52	34.0	70.8	94.2	2.29	3.475	1.410	-0.728	165	0.0342	213.0	3.5	8	5.2

Gauging Station	Record length (yrs)	Median Peak (m^3/s)	Mean Peak (m^3/s)	Std Dev (m^3/s)	Skew	Mean *ln*Peak	Std Dev *ln*Peak	Skew *ln*Peak	Area (km^2)	Eq.Area Mean Slope	MAR WR90 (mm)	HRU1/72 Basin Lag (hr)	HRU1/72 Veld Zone	RMF K-Region
B7R003	54	9.8	50.0	104.6	3.54	2.453	1.682	0.430	45	0.0348	13.5	0.6	8	5.2
B8R001	52	9.3	27.5	37.4	2.58	2.617	1.190	0.223	169	0.0056	378.0	4.1	3	5.2
B7H004	38	26.4	71.9	92.0	1.85	3.450	1.401	-0.061	136	0.0353	213.0	3.0	8	5.2
B8H010	36	82.1	148.2	143.6	1.01	4.443	1.145	-0.053	477	0.0248	141.0	4.5	8	5.2
K2H002	41	35.2	65.1	76.2	1.97	3.615	1.076	0.209	131	0.0200	240.0	0.6	2	5.2
T3H006	37	361.7	455.5	273.1	0.47	5.904	0.727	-0.633	4268	0.0029	210.0	20.8	5	5.2
U2H011	42	56.9	89.3	91.7	1.97	4.045	0.983	-0.069	176	0.0128	198.0	3.9	8	5.2
U2H012	36	23.4	39.6	52.8	3.81	3.269	0.824	0.828	438	0.0075	191.0	6	8	5.2
X1H001	44	198.9	319.5	378.7	2.93	5.305	0.968	0.025	5499	0.0048	23.9	12.8	9	5.2
X3H006	40	56.8	97.8	107.6	1.95	4.103	0.971	0.416	766	0.0118	263.0	7.2	8	5.2
L9R001	31	18.5	77.4	147.0	2.71	3.374	1.896	0.887	138	0.0165	108.0	3.3	2	5.4
W4R001	58	464.0	791.0	972.6	3.15	6.242	1.098	0.472	7814	0.0031	27.0	8.0	9	5.6
Q9H002	21	19.1	49.9	78.3	2.49	3.300	1.211	0.414	1245	0.0101	42.0	3.6	8	5.2
R1H005	16	23.9	38.4	44.9	1.93	3.150	0.985	0.350	482	0.0169	106.0	2.3	5	5.2
S6H001	43	20.8	25.9	20.7	1.04	2.897	0.855	0.056	90	0.0199	157.0	1.4	5	5.2
T4H001	35	75.9	180.5	222.4	2.97	4.797	0.797	1.220	715	0.0108	225.0	7.0	5	5.2
U2H005	36	117.4	253.8	637.8	5.77	4.905	0.801	2.245	2519	0.0071	142.0	6.1	8	5.2
X3H003	39	11.9	18.5	18.0	2.52	2.534	0.899	0.103	52	0.0168	485.0	1.8	3	5.2
V5H002	26	1483.1	1917.3	1206.0	1.14	7.388	0.585	0.388	28920	0.0028	81.8	18.0	8	5.2
B8H009	35	72.1	149.2	169.3	1.54	5.519	0.930	-0.128	851	0.0091	83.0	4.3	8	5.2
T3H005	37	199.1	266.8	320.6	1.41	5.091	1.178	-0.246	2597	0.0033	187.0	7.3	5	5.2
T1H004	6	256.9	326.6	305.8	1.73	5.775	0.635	1.361	4908	0.0053	133.0	7.9	5	5.2

Appendix C2 (a) Low K-Region Similarity Distance Values

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20
A2R005	0	4.24	5.55	3.72	2.88	2.52	2.63	3.33	4.20	3.87	3.27	3.82	4.67	3.43	3.68	2.09	3.88	4.17	2.91	4.55
B3R002	4.24	0	2.91	0.95	1.92	1.94	3.04	2.61	0.68	1.10	1.22	0.86	0.47	2.17	1.02	2.35	1.21	1.08	1.67	0.88
C3R002	5.55	2.91	0	2.51	2.98	3.21	3.08	2.30	2.91	2.80	3.35	3.04	2.74	4.80	3.31	4.28	2.37	1.97	3.99	3.66
C2H001	3.72	0.95	2.51	0	1.06	1.23	2.23	1.75	0.80	0.59	0.86	0.66	1.17	2.31	0.89	1.94	1.07	0.58	1.49	1.64
A2R007	2.88	1.92	2.98	1.06	0	0.57	1.52	1.29	1.67	1.19	1.05	1.34	2.21	2.38	1.37	1.38	1.73	1.47	1.41	2.46
A3R001	2.52	1.94	3.21	1.23	0.57	0	1.37	1.39	1.87	1.51	1.14	1.53	2.31	2.34	1.54	1.16	1.58	1.65	1.34	2.51
A3R002	2.63	3.04	3.08	2.23	1.52	1.37	0	0.84	3.01	2.59	2.46	2.74	3.33	3.68	2.81	2.32	2.22	2.36	2.69	3.75
A3R003	3.33	2.61	2.30	1.75	1.29	1.39	0.84	0	2.52	2.11	2.21	2.33	2.81	3.63	2.47	2.50	1.84	1.74	2.64	3.38
B1R001	4.20	0.68	2.91	0.80	1.67	1.87	3.01	2.52	0	0.56	0.95	0.39	0.73	2.00	0.61	2.21	1.60	1.06	1.51	0.98
B1R002	3.87	1.10	2.80	0.59	1.19	1.51	2.59	2.11	0.56	0	0.74	0.38	1.22	2.06	0.58	1.94	1.64	0.98	1.38	1.49
B2R001	3.27	1.22	3.35	0.86	1.05	1.14	2.46	2.21	0.95	0.74	0	0.56	1.56	1.50	0.42	1.26	1.69	1.43	0.66	1.50
C7R001	3.82	0.86	3.04	0.66	1.34	1.53	2.74	2.33	0.39	0.38	0.56	0	1.07	1.78	0.28	1.83	1.58	1.12	1.16	1.17
D2R004	4.67	0.47	2.74	1.17	2.21	2.31	3.33	2.81	0.73	1.22	1.56	1.07	0	2.48	1.27	2.76	1.46	1.12	2.06	0.94
W5R003	3.43	2.17	4.80	2.31	2.38	2.34	3.68	3.63	2.00	2.06	1.50	1.78	2.48	0	1.51	1.54	2.94	2.85	1.00	1.77
X1R001	3.68	1.02	3.31	0.89	1.37	1.54	2.81	2.47	0.61	0.58	0.42	0.28	1.27	1.51	0	1.64	1.77	1.38	0.92	1.16
B1H004	2.09	2.35	4.28	1.94	1.38	1.16	2.32	2.50	2.21	1.94	1.26	1.83	2.76	1.54	1.64	0	2.45	2.50	0.83	2.53
E2H003	3.88	1.21	2.37	1.07	1.73	1.58	2.22	1.84	1.60	1.64	1.69	1.58	1.46	2.94	1.77	2.45	0	0.96	2.13	2.06
A2H021	4.17	1.08	1.97	0.58	1.47	1.65	2.36	1.74	1.06	0.98	1.43	1.12	1.12	2.85	1.38	2.50	0.96	0	2.07	1.87
C8H003	2.91	1.67	3.99	1.49	1.41	1.34	2.69	2.64	1.51	1.38	0.66	1.16	2.06	1.00	0.92	0.83	2.13	2.07	0	1.72
C1H001	4.55	0.88	3.66	1.64	2.46	2.51	3.75	3.38	0.98	1.49	1.50	1.17	0.94	1.77	1.16	2.53	2.06	1.87	1.72	0

Appendix C2 (b) Mid K-Region Similarity Distance Values

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15
A2R001	0	1.42	0.89	1.09	1.11	0.77	3.78	1.27	2.12	0.75	1.21	1.75	0.85	2.40	1.72
A2R003	1.42	0	0.60	0.72	1.18	0.81	2.96	1.76	2.33	1.90	2.16	2.14	0.80	1.29	0.37
A2R006	0.89	0.60	0	0.56	1.04	0.27	3.41	1.59	2.28	1.34	1.65	1.98	0.35	1.78	0.96
A6R001	1.09	0.72	0.56	0	0.64	0.48	3.18	1.37	1.83	1.70	2.09	1.56	0.36	1.47	1.02
A8R001	1.11	1.18	1.04	0.64	0	0.94	2.94	0.78	1.23	1.85	2.30	0.98	0.87	1.52	1.36
B3R001	0.77	0.81	0.27	0.48	0.94	0	3.53	1.52	2.16	1.26	1.63	1.83	0.14	1.88	1.17
B6R001	3.78	2.96	3.41	3.18	2.94	3.53	0	2.90	2.86	4.43	4.71	3.17	3.48	1.96	2.66
B6R003	1.27	1.76	1.59	1.37	0.78	1.52	2.90	0	1.05	1.97	2.40	0.89	1.50	2.00	1.87
B8R005	2.12	2.33	2.28	1.83	1.23	2.16	2.86	1.05	0	2.84	3.32	0.47	2.07	2.06	2.42
C5R002	0.75	1.90	1.34	1.70	1.85	1.26	4.43	1.97	2.84	0	0.51	2.45	1.38	3.05	2.21
N2R001	1.21	2.16	1.65	2.09	2.30	1.63	4.71	2.40	3.32	0.51	0	2.94	1.76	3.38	2.44
U2R001	1.75	2.14	1.98	1.56	0.98	1.83	3.17	0.89	0.47	2.45	2.94	0	1.74	2.12	2.30
C5R003	0.85	0.80	0.35	0.36	0.87	0.14	3.48	1.50	2.07	1.38	1.76	1.74	0	1.79	1.16
H3R001	2.40	1.29	1.78	1.47	1.52	1.88	1.96	2.00	2.06	3.05	3.38	2.12	1.79	0	1.09
H4R002	1.72	0.37	0.96	1.02	1.36	1.17	2.66	1.87	2.42	2.21	2.44	2.30	1.16	1.09	0
H7R001	1.64	1.72	1.68	1.22	0.64	1.57	2.76	0.77	0.61	2.39	2.85	0.51	1.48	1.62	1.83
J1R002	2.11	1.25	1.37	1.77	2.34	1.57	3.89	2.89	3.55	2.17	2.17	3.31	1.63	2.30	1.34
J2R003	2.50	1.39	1.92	1.73	1.75	2.07	1.62	2.07	2.30	3.11	3.39	2.39	2.02	0.58	1.08
K9R002	1.23	1.57	1.34	0.91	0.50	1.16	3.29	0.93	1.09	1.93	2.42	0.71	1.06	1.87	1.80
V2R001	2.31	1.85	2.04	1.54	1.20	2.00	2.25	1.49	1.04	3.05	3.48	1.22	1.89	1.13	1.84

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15
A2H006	0.81	0.72	0.24	0.39	0.86	0.12	3.41	1.45	2.08	1.35	1.72	1.77	0.14	1.76	1.08
A2H012	0.29	1.17	0.68	0.81	0.86	0.57	3.52	1.14	1.96	1.01	1.44	1.61	0.63	2.11	1.46
A2H013	0.76	0.69	0.29	0.44	0.78	0.31	3.26	1.31	2.00	1.36	1.72	1.72	0.34	1.70	1.00
G1H008	2.66	2.14	2.46	2.23	1.88	2.55	1.19	1.73	1.88	3.33	3.65	2.13	2.51	1.49	1.93
H1H006	2.07	2.11	2.16	1.79	1.19	2.11	2.33	0.86	0.65	2.80	3.23	0.92	2.04	1.78	2.12
H1H007	4.89	4.34	4.71	4.43	4.04	4.79	1.54	3.79	3.53	5.57	5.88	3.95	4.74	3.35	4.09
J2H005	2.89	1.85	2.36	2.38	2.42	2.57	1.66	2.58	3.03	3.38	3.54	3.12	2.57	1.52	1.48
V2H002	1.39	1.64	1.52	1.12	0.49	1.40	2.92	0.57	0.77	2.13	2.60	0.53	1.32	1.74	1.79
W5H005	1.26	1.50	1.32	0.88	0.36	1.16	3.11	0.81	1.01	1.98	2.46	0.68	1.07	1.73	1.70
X2H008	3.16	2.48	2.87	2.62	2.31	2.97	0.68	2.23	2.21	3.83	4.15	2.51	2.92	1.59	2.23
X3H001	3.72	3.19	3.53	3.25	2.86	3.61	0.83	2.65	2.47	4.40	4.73	2.85	3.55	2.27	2.96

Appendix C2 (b) Mid K-Region Similarity Distance Values (Continued)

Station	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27	d28	d29	d30	d31
A2R001	1.64	2.11	2.50	1.23	2.31	0.81	0.29	0.76	2.66	2.07	4.89	2.89	1.39	1.26	3.16	3.72
A2R003	1.72	1.25	1.39	1.57	1.85	0.72	1.17	0.69	2.14	2.11	4.34	1.85	1.64	1.50	2.48	3.19
A2R006	1.68	1.37	1.92	1.34	2.04	0.24	0.68	0.29	2.46	2.16	4.71	2.36	1.52	1.32	2.87	3.53
A6R001	1.22	1.77	1.73	0.91	1.54	0.39	0.81	0.44	2.23	1.79	4.43	2.38	1.12	0.88	2.62	3.25
A8R001	0.64	2.34	1.75	0.50	1.20	0.86	0.86	0.78	1.88	1.19	4.04	2.42	0.49	0.36	2.31	2.86
B3R001	1.57	1.57	2.07	1.16	2.00	0.12	0.57	0.31	2.55	2.11	4.79	2.57	1.40	1.16	2.97	3.61
B6R001	2.76	3.89	1.62	3.29	2.25	3.41	3.52	3.26	1.19	2.33	1.54	1.66	2.92	3.11	0.68	0.83
B6R003	0.77	2.89	2.07	0.93	1.49	1.45	1.14	1.31	1.73	0.86	3.79	2.58	0.57	0.81	2.23	2.65
B8R005	0.61	3.55	2.30	1.09	1.04	2.08	1.96	2.00	1.88	0.65	3.53	3.03	0.77	1.01	2.21	2.47
C5R002	2.39	2.17	3.11	1.93	3.05	1.35	1.01	1.36	3.33	2.80	5.57	3.38	2.13	1.98	3.83	4.40
N2R001	2.85	2.17	3.39	2.42	3.48	1.72	1.44	1.72	3.65	3.23	5.88	3.54	2.60	2.46	4.15	4.73
U2R001	0.51	3.31	2.39	0.71	1.22	1.77	1.61	1.72	2.13	0.92	3.95	3.12	0.53	0.68	2.51	2.85
C5R003	1.48	1.63	2.02	1.06	1.89	0.14	0.63	0.34	2.51	2.04	4.74	2.57	1.32	1.07	2.92	3.55
H3R001	1.62	2.30	0.58	1.87	1.13	1.76	2.11	1.70	1.49	1.78	3.35	1.52	1.74	1.73	1.59	2.27
H4R002	1.83	1.34	1.08	1.80	1.84	1.08	1.46	1.00	1.93	2.12	4.09	1.48	1.79	1.70	2.23	2.96
H7R001	0	2.94	1.88	0.63	0.83	1.49	1.43	1.41	1.73	0.71	3.68	2.63	0.28	0.48	2.11	2.54
J1R002	2.94	0	2.32	2.66	3.05	1.58	1.99	1.64	3.24	3.35	5.37	2.44	2.83	2.63	3.54	4.27
J2R003	1.88	2.32	0	2.18	1.50	1.95	2.22	1.84	1.20	1.87	3.09	0.95	1.97	2.02	1.30	2.03
K9R002	0.63	2.66	2.18	0	1.30	1.11	1.06	1.10	2.25	1.31	4.30	2.90	0.48	0.19	2.65	3.14
V2R001	0.83	3.05	1.50	1.30	0	1.90	2.05	1.84	1.51	1.00	3.24	2.38	1.08	1.17	1.70	2.15
A2H006	1.49	1.58	1.95	1.11	1.90	0	0.57	0.21	2.43	2.01	4.67	2.47	1.32	1.10	2.85	3.49

Station	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27	d28	d29	d30	d31
A2H012	1.43	1.99	2.22	1.06	2.05	0.57	0	0.50	2.43	1.88	4.67	2.66	1.20	1.05	2.91	3.49
A2H013	1.41	1.64	1.84	1.10	1.84	0.21	0.50	0	2.26	1.88	4.51	2.32	1.24	1.06	2.69	3.33
G1H008	1.73	3.24	1.20	2.25	1.51	2.43	2.43	2.26	0	1.27	2.27	1.49	1.83	2.06	0.54	1.10
H1H006	0.71	3.35	1.87	1.31	1.00	2.01	1.88	1.88	1.27	0	3.08	2.49	0.84	1.15	1.66	1.96
H1H007	3.68	5.37	3.09	4.30	3.24	4.67	4.67	4.51	2.27	3.08	0	3.12	3.86	4.12	1.86	1.19
J2H005	2.63	2.44	0.95	2.90	2.38	2.47	2.66	2.32	1.49	2.49	3.12	0	2.66	2.73	1.55	2.21
V2H002	0.28	2.83	1.97	0.48	1.08	1.32	1.20	1.24	1.83	0.84	3.86	2.66	0	0.34	2.26	2.71
W5H005	0.48	2.63	2.02	0.19	1.17	1.10	1.05	1.06	2.06	1.15	4.12	2.73	0.34	0	2.47	2.96
X2H008	2.11	3.54	1.30	2.65	1.70	2.85	2.91	2.69	0.54	1.66	1.86	1.55	2.26	2.47	0	0.74
X3H001	2.54	4.27	2.03	3.14	2.15	3.49	3.49	3.33	1.10	1.96	1.19	2.21	2.71	2.96	0.74	0

Appendix C2 (c) High K-Region Similarity Distance Values

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20	d21	d22	d23	d24
A9R001	0	3.31	2.96	2.66	3.41	2.20	2.47	2.04	1.89	1.69	1.31	2.75	1.44	1.51	0.81	1.35	2.06	1.95	1.86	3.28	2.10	2.21	1.83	1.51
B7R001	3.31	0	2.15	2.90	0.13	1.17	1.40	3.34	2.09	2.64	3.37	2.44	1.97	4.42	3.50	2.00	1.48	2.37	2.88	2.10	3.78	2.57	3.23	3.21
B7R003	2.96	2.15	0	4.09	2.13	2.05	2.71	4.18	2.98	3.42	3.71	3.88	2.18	3.82	2.79	2.29	2.23	3.38	3.75	3.67	4.37	3.70	3.99	3.75
B8R001	2.66	2.90	4.09	0	3.01	2.35	1.54	1.58	1.13	1.04	2.28	0.87	2.03	3.93	3.37	2.13	1.87	1.07	1.43	1.25	2.55	0.87	1.49	2.00
B7H004	3.41	0.13	2.13	3.01	0	1.28	1.50	3.47	2.20	2.76	3.49	2.55	2.06	4.52	3.59	2.11	1.57	2.49	3.01	2.17	3.91	2.69	3.36	3.34
B8H010	2.20	1.17	2.05	2.35	1.28	0	1.02	2.38	1.33	1.74	2.24	1.92	1.03	3.28	2.40	0.86	0.85	1.51	1.92	2.08	2.73	1.80	2.24	2.13
K2H002	2.47	1.40	2.71	1.54	1.50	1.02	0	2.21	0.77	1.36	2.43	1.29	1.15	3.78	2.94	1.29	0.61	1.15	1.78	1.09	2.89	1.33	2.07	2.23
T3H006	2.04	3.34	4.18	1.58	3.47	2.38	2.21	0	1.63	1.05	0.98	1.42	2.14	2.79	2.58	1.90	2.33	1.07	0.47	2.55	0.98	0.97	0.25	0.68
U2H011	1.89	2.09	2.98	1.13	2.20	1.33	0.77	1.63	0	0.64	1.85	1.14	0.92	3.25	2.50	1.05	0.81	0.63	1.23	1.39	2.37	0.87	1.45	1.65
U2H012	1.69	2.64	3.42	1.04	2.76	1.74	1.36	1.05	0.64	0	1.36	1.11	1.27	2.93	2.36	1.24	1.40	0.43	0.72	1.80	1.84	0.60	0.84	1.14
X1H001	1.31	3.37	3.71	2.28	3.49	2.24	2.43	0.98	1.85	1.36	0	2.13	1.90	1.82	1.68	1.56	2.32	1.46	0.97	3.09	0.81	1.60	0.89	0.34
X3H006	2.75	2.44	3.88	0.87	2.55	1.92	1.29	1.42	1.14	1.11	2.13	0	1.98	3.87	3.32	1.91	1.74	0.80	1.17	1.24	2.27	0.57	1.40	1.81
L9R001	1.44	1.97	2.18	2.03	2.06	1.03	1.15	2.14	0.92	1.27	1.90	1.98	0	2.81	1.87	0.52	0.64	1.33	1.73	2.11	2.60	1.66	1.93	1.85
W4R001	1.51	4.42	3.82	3.93	4.52	3.28	3.78	2.79	3.25	2.93	1.82	3.87	2.81	0	1.08	2.54	3.42	3.11	2.77	4.64	2.26	3.33	2.67	2.16
Q9H002	0.81	3.50	2.79	3.37	3.59	2.40	2.94	2.58	2.50	2.36	1.68	3.32	1.87	1.08	0	1.67	2.49	2.52	2.39	3.87	2.37	2.81	2.41	1.94
R1H005	1.35	2.00	2.29	2.13	2.11	0.86	1.29	1.90	1.05	1.24	1.56	1.91	0.52	2.54	1.67	0	0.93	1.21	1.47	2.30	2.21	1.55	1.71	1.52
S6H001	2.06	1.48	2.23	1.87	1.57	0.85	0.61	2.33	0.81	1.40	2.32	1.74	0.64	3.42	2.49	0.93	0	1.33	1.89	1.60	2.91	1.61	2.15	2.19
T4H001	1.95	2.37	3.38	1.07	2.49	1.51	1.15	1.07	0.63	0.43	1.46	0.80	1.33	3.11	2.52	1.21	1.33	0	0.65	1.64	1.83	0.35	0.93	1.19
U2H005	1.86	2.88	3.75	1.43	3.01	1.92	1.78	0.47	1.23	0.72	0.97	1.17	1.73	2.77	2.39	1.47	1.89	0.65	0	2.23	1.20	0.67	0.37	0.65
X3H003	3.28	2.10	3.67	1.25	2.17	2.08	1.09	2.55	1.39	1.80	3.09	1.24	2.11	4.64	3.87	2.30	1.60	1.64	2.23	0	3.42	1.58	2.45	2.82
V5H002	2.10	3.78	4.37	2.55	3.91	2.73	2.89	0.98	2.37	1.84	0.81	2.27	2.60	2.26	2.37	2.21	2.91	1.83	1.20	3.42	0	1.85	1.09	0.77
B8H009	2.21	2.57	3.70	0.87	2.69	1.80	1.33	0.97	0.87	0.60	1.60	0.57	1.66	3.33	2.81	1.55	1.61	0.35	0.67	1.58	1.85	0	0.89	1.29
T3H005	1.83	3.23	3.99	1.49	3.36	2.24	2.07	0.25	1.45	0.84	0.89	1.40	1.93	2.67	2.41	1.71	2.15	0.93	0.37	2.45	1.09	0.89	0	0.59
T1H004	1.51	3.21	3.75	2.00	3.34	2.13	2.23	0.68	1.65	1.14	0.34	1.81	1.85	2.16	1.94	1.52	2.19	1.19	0.65	2.82	0.77	1.29	0.59	0

Appendix C2 (d) Veld Type Zone A Similarity Distance Values

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11
E2H003	0	2.78	2.06	2.40	2.86	2.02	3.18	2.79	5.36	3.50	2.95
H3R001	2.78	0	1.00	1.50	0.56	1.70	1.42	1.67	3.41	1.38	0.61
H4R002	2.06	1.00	0	1.89	1.04	1.81	1.99	2.19	4.15	2.20	1.44
H7R001	2.40	1.50	1.89	0	1.83	0.63	1.71	0.72	3.63	1.61	1.31
J2R003	2.86	0.56	1.04	1.83	0	2.08	1.18	1.82	3.17	1.33	0.70
K9R002	2.02	1.70	1.81	0.63	2.08	0	2.22	1.32	4.24	2.18	1.72
G1H008	3.18	1.42	1.99	1.71	1.18	2.22	0	1.25	2.24	0.63	0.88
H1H006	2.79	1.67	2.19	0.72	1.82	1.32	1.25	0	2.99	1.17	1.22
H1H007	5.36	3.41	4.15	3.63	3.17	4.24	2.24	2.99	0	2.15	2.88
K2H002	3.50	1.38	2.20	1.61	1.33	2.18	0.63	1.17	2.15	0	0.79
L9R001	2.95	0.61	1.44	1.31	0.70	1.72	0.88	1.22	2.88	0.79	0

Appendix C2 (e) Veld Type Zone B Similarity Distance Values

Station	d1	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27	d28
B3R002	0	0.75	0.63	1.06	1.15	0.87	0.21	1.03	1.43	0.54	0.60	2.08	1.32	0.89	1.88	1.75	2.97	3.93	2.61	2.91	1.76	1.41	1.86	2.72	4.38	0.58	1.78
C2H001	0.75	0	0.40	0.45	0.67	0.44	0.85	0.64	1.07	1.02	0.46	1.50	0.70	0.59	1.86	2.08	2.78	3.68	2.60	2.82	2.00	1.70	1.74	2.05	4.05	0.58	2.32
B1R001	0.63	0.40	0	0.46	0.60	0.27	0.73	0.46	0.94	0.70	0.36	1.71	0.74	0.56	1.63	1.77	2.81	3.68	2.45	2.69	1.69	1.46	2.01	2.41	4.24	0.72	2.01
B1R002	1.06	0.45	0.46	0	0.37	0.26	1.16	0.36	0.78	1.13	0.62	1.40	0.34	0.61	1.66	2.02	2.71	3.53	2.47	2.64	1.88	1.70	2.09	2.08	4.06	0.98	2.37
B2R001	1.15	0.67	0.60	0.37	0	0.33	1.30	0.19	0.42	1.10	0.59	1.24	0.27	0.42	1.32	1.77	2.37	3.19	2.10	2.27	1.61	1.44	2.39	2.18	3.83	1.22	2.19
C7R001	0.87	0.44	0.27	0.26	0.33	0	1.00	0.21	0.70	0.88	0.41	1.48	0.48	0.43	1.49	1.78	2.63	3.47	2.31	2.51	1.66	1.45	2.15	2.27	4.06	0.93	2.11
D2R004	0.21	0.85	0.73	1.16	1.30	1.00	0	1.17	1.60	0.64	0.78	2.25	1.45	1.07	2.06	1.89	3.19	4.14	2.81	3.11	1.91	1.58	1.75	2.81	4.58	0.53	1.87
X1R001	1.03	0.64	0.46	0.36	0.19	0.21	1.17	0	0.51	0.94	0.52	1.43	0.42	0.44	1.32	1.68	2.50	3.32	2.15	2.34	1.53	1.38	2.36	2.33	4.00	1.14	2.07
C8H003	1.43	1.07	0.94	0.78	0.42	0.70	1.60	0.51	0	1.26	0.88	1.24	0.57	0.64	0.97	1.58	2.09	2.85	1.74	1.88	1.38	1.29	2.80	2.39	3.68	1.60	2.10
C1H001	0.54	1.02	0.70	1.13	1.10	0.88	0.64	0.94	1.26	0	0.70	2.19	1.34	0.91	1.49	1.27	2.86	3.77	2.30	2.60	1.28	1.04	2.37	3.04	4.47	1.06	1.36
A2R001	0.60	0.46	0.36	0.62	0.59	0.41	0.78	0.52	0.88	0.70	0	1.53	0.78	0.30	1.48	1.65	2.51	3.43	2.22	2.47	1.57	1.24	2.09	2.36	3.95	0.80	1.89
A2R003	2.08	1.50	1.71	1.40	1.24	1.48	2.25	1.43	1.24	2.19	1.53	0	1.12	1.28	1.92	2.62	1.81	2.54	2.21	2.26	2.42	2.16	2.77	1.43	2.75	2.00	3.07
C5R003	1.32	0.70	0.74	0.34	0.27	0.48	1.45	0.42	0.57	1.34	0.78	1.12	0	0.62	1.53	2.03	2.44	3.23	2.27	2.41	1.86	1.70	2.33	1.96	3.79	1.27	2.46
A2H012	0.89	0.59	0.56	0.61	0.42	0.43	1.07	0.44	0.64	0.91	0.30	1.28	0.62	0	1.31	1.64	2.25	3.15	2.01	2.23	1.51	1.20	2.28	2.25	3.71	1.06	1.97
V2H002	1.88	1.86	1.63	1.66	1.32	1.49	2.06	1.32	0.97	1.49	1.48	1.92	1.53	1.31	0	0.92	1.83	2.52	0.97	1.19	0.65	0.83	3.57	3.26	3.74	2.27	1.58
T3H006	1.75	2.08	1.77	2.02	1.77	1.78	1.89	1.68	1.58	1.27	1.65	2.62	2.03	1.64	0.92	0	2.47	3.22	1.49	1.81	0.27	0.58	3.61	3.84	4.39	2.29	0.69
R1H005	2.97	2.78	2.81	2.71	2.37	2.63	3.19	2.50	2.09	2.86	2.51	1.81	2.44	2.25	1.83	2.47	0	1.03	1.20	1.14	2.29	2.11	4.22	3.11	2.00	3.22	2.92
S6H001	3.93	3.68	3.68	3.53	3.19	3.47	4.14	3.32	2.85	3.77	3.43	2.54	3.23	3.15	2.52	3.22	1.03	0	1.76	1.49	3.02	2.97	5.16	3.75	1.97	4.16	3.73
T4H001	2.61	2.60	2.45	2.47	2.10	2.31	2.81	2.15	1.74	2.30	2.22	2.21	2.27	2.01	0.97	1.49	1.20	1.76	0	0.39	1.30	1.36	4.24	3.63	3.19	3.01	2.01
U2H006	2.91	2.82	2.69	2.64	2.27	2.51	3.11	2.34	1.88	2.60	2.47	2.26	2.41	2.23	1.19	1.81	1.14	1.49	0.39	0	1.61	1.71	4.48	3.69	3.10	3.27	2.38
T3H005	1.76	2.00	1.69	1.88	1.61	1.66	1.91	1.53	1.38	1.28	1.57	2.42	1.86	1.51	0.65	0.27	2.29	3.02	1.30	1.61	0	0.56	3.59	3.68	4.22	2.26	0.96
T1H004	1.41	1.70	1.46	1.70	1.44	1.45	1.58	1.38	1.29	1.04	1.24	2.16	1.70	1.20	0.83	0.58	2.11	2.97	1.36	1.71	0.56	0	3.22	3.37	3.93	1.92	0.93
C3R002	1.86	1.74	2.01	2.09	2.39	2.15	1.75	2.36	2.80	2.37	2.09	2.77	2.33	2.28	3.57	3.61	4.22	5.16	4.24	4.48	3.59	3.22	0	2.35	5.00	1.33	3.59
J1R002	2.72	2.05	2.41	2.08	2.18	2.27	2.81	2.33	2.39	3.04	2.36	1.43	1.96	2.25	3.26	3.84	3.11	3.75	3.63	3.69	3.68	3.37	2.35	0	3.32	2.34	4.19
J2H005	4.38	4.05	4.24	4.06	3.83	4.06	4.58	4.00	3.68	4.47	3.95	2.75	3.79	3.71	3.74	4.39	2.00	1.97	3.19	3.10	4.22	3.93	5.00	3.32	0	4.44	4.75
C5R002	0.58	0.58	0.72	0.98	1.22	0.93	0.53	1.14	1.60	1.06	0.80	2.00	1.27	1.06	2.27	2.29	3.22	4.16	3.01	3.27	2.26	1.92	1.33	2.34	4.44	0	2.35
N2R001	1.78	2.32	2.01	2.37	2.19	2.11	1.87	2.07	2.10	1.36	1.89	3.07	2.46	1.97	1.58	0.69	2.92	3.73	2.01	2.38	0.96	0.93	3.59	4.19	4.75	2.35	0

Appendix C2 (f) Veld Type Zone C Similarity Distance Values

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27
B6R003	0	1.06	2.22	2.62	1.73	2.56	2.08	1.79	1.56	2.19	2.28	1.43	1.94	1.59	1.38	0.79	1.51	2.89	2.16	1.57	1.45	1.30	0.52	1.17	2.90	3.52	3.05
B8R005	1.06	0	2.14	2.38	0.80	1.89	2.19	2.34	2.26	2.91	3.04	1.71	2.83	2.26	1.82	1.23	2.14	2.78	2.77	1.07	2.07	1.99	0.75	1.52	2.91	3.64	3.04
X2H008	2.22	2.14	0	0.73	1.97	1.33	2.05	2.91	2.87	3.23	3.49	2.31	3.72	2.82	2.55	2.25	2.91	0.68	3.36	1.62	2.79	2.65	2.44	2.21	0.82	1.72	0.93
X3H001	2.62	2.38	0.73	0	2.19	1.33	2.73	3.57	3.51	3.91	4.16	2.94	4.29	3.47	3.17	2.79	3.54	0.84	4.03	2.06	3.42	3.27	2.80	2.82	0.83	2.15	0.91
B8R001	1.73	0.80	1.97	2.19	0	1.29	2.02	2.58	2.60	3.19	3.37	1.84	3.38	2.58	2.05	1.61	2.49	2.50	3.03	0.71	2.40	2.35	1.46	1.73	2.75	3.37	2.86
X3H003	2.56	1.89	1.33	1.33	1.29	0	2.30	3.29	3.33	3.80	4.05	2.53	4.24	3.28	2.82	2.48	3.28	1.56	3.76	1.32	3.17	3.09	2.50	2.47	1.91	2.60	1.97
A2R005	2.08	2.19	2.05	2.73	2.02	2.30	0	1.32	1.53	1.75	2.04	0.86	2.66	1.45	1.13	1.42	1.54	2.42	1.71	1.34	1.43	1.44	2.13	1.03	2.70	2.38	2.78
A2R007	1.79	2.34	2.91	3.57	2.58	3.29	1.32	0	0.36	0.68	0.85	0.77	1.41	0.31	0.53	1.13	0.37	3.42	0.48	2.05	0.36	0.52	1.87	0.88	3.56	3.40	3.67
A3R001	1.56	2.26	2.87	3.51	2.60	3.33	1.53	0.36	0	0.67	0.79	0.88	1.13	0.09	0.59	1.03	0.21	3.41	0.62	2.10	0.22	0.28	1.71	0.89	3.51	3.46	3.63
A3R002	2.19	2.91	3.23	3.91	3.19	3.80	1.75	0.68	0.67	0	0.32	1.39	1.27	0.65	1.16	1.68	0.83	3.69	0.49	2.63	0.87	0.92	2.38	1.46	3.78	3.49	3.89
A3R003	2.28	3.04	3.49	4.16	3.37	4.05	2.04	0.85	0.79	0.32	0	1.59	1.05	0.80	1.33	1.82	0.92	3.98	0.53	2.85	0.98	1.05	2.45	1.65	4.05	3.80	4.16
B1H004	1.43	1.71	2.31	2.94	1.84	2.53	0.86	0.77	0.88	1.39	1.59	0	1.95	0.84	0.33	0.66	0.82	2.85	1.24	1.28	0.71	0.73	1.43	0.26	3.04	3.04	3.15
A2H021	1.94	2.83	3.72	4.29	3.38	4.24	2.66	1.41	1.13	1.27	1.05	1.95	0	1.21	1.63	1.80	1.16	4.31	1.27	3.03	1.25	1.25	2.11	1.88	4.31	4.40	4.44
A2R006	1.59	2.26	2.82	3.47	2.58	3.28	1.45	0.31	0.09	0.65	0.80	0.84	1.21	0	0.57	1.04	0.26	3.35	0.62	2.06	0.23	0.29	1.74	0.86	3.46	3.38	3.58
A6R001	1.38	1.82	2.55	3.17	2.05	2.82	1.13	0.53	0.59	1.16	1.33	0.33	1.63	0.57	0	0.64	0.50	3.10	0.99	1.55	0.40	0.45	1.41	0.37	3.26	3.26	3.37
A8R001	0.79	1.23	2.25	2.79	1.61	2.48	1.42	1.13	1.03	1.68	1.82	0.66	1.80	1.04	0.64	0	0.94	2.87	1.57	1.23	0.85	0.77	0.80	0.42	3.00	3.29	3.13
B3R001	1.51	2.14	2.91	3.54	2.49	3.28	1.54	0.37	0.21	0.83	0.92	0.82	1.16	0.26	0.50	0.94	0	3.47	0.66	2.02	0.12	0.30	1.60	0.82	3.58	3.56	3.70
B6R001	2.89	2.78	0.68	0.84	2.50	1.56	2.42	3.42	3.41	3.69	3.98	2.85	4.31	3.35	3.10	2.87	3.47	0	3.85	2.16	3.35	3.21	3.11	2.78	0.50	1.33	0.50
U2R001	2.16	2.77	3.36	4.03	3.03	3.76	1.71	0.48	0.62	0.49	0.53	1.24	1.27	0.62	0.99	1.57	0.66	3.85	0	2.52	0.73	0.88	2.24	1.35	3.98	3.74	4.09
V2R001	1.57	1.07	1.62	2.06	0.71	1.32	1.34	2.05	2.10	2.63	2.85	1.28	3.03	2.06	1.55	1.23	2.02	2.16	2.52	0	1.92	1.87	1.44	1.21	2.43	2.82	2.54
A2H006	1.45	2.07	2.79	3.42	2.40	3.17	1.43	0.36	0.22	0.87	0.98	0.71	1.25	0.23	0.40	0.85	0.12	3.35	0.73	1.92	0	0.21	1.54	0.71	3.46	3.45	3.58
A2H013	1.30	1.99	2.65	3.27	2.35	3.09	1.44	0.52	0.28	0.92	1.05	0.73	1.25	0.29	0.45	0.77	0.30	3.21	0.88	1.87	0.21	0	1.46	0.67	3.30	3.35	3.43
X2H015	0.52	0.75	2.44	2.80	1.46	2.50	2.13	1.87	1.71	2.38	2.45	1.43	2.11	1.74	1.41	0.80	1.60	3.11	2.24	1.44	1.54	1.46	0	1.20	3.18	3.78	3.32

Station	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18	d19	d20	d21	d22	d23	d24	d25	d26	d27
A9R001	1.17	1.52	2.21	2.82	1.73	2.47	1.03	0.88	0.89	1.46	1.65	0.26	1.88	0.86	0.37	0.42	0.82	2.78	1.35	1.21	0.71	0.67	1.20	0	2.95	3.06	3.07
B7R001	2.90	2.91	0.82	0.83	2.75	1.91	2.70	3.56	3.51	3.78	4.05	3.04	4.31	3.46	3.26	3.00	3.58	0.50	3.98	2.43	3.46	3.30	3.18	2.95	0	1.49	0.15
B7R003	3.52	3.64	1.72	2.15	3.37	2.60	2.38	3.40	3.46	3.49	3.80	3.04	4.40	3.38	3.26	3.29	3.56	1.33	3.74	2.82	3.45	3.35	3.78	3.06	1.49	0	1.43
B7H004	3.05	3.04	0.93	0.91	2.86	1.97	2.78	3.67	3.63	3.89	4.16	3.15	4.44	3.58	3.37	3.13	3.70	0.50	4.09	2.54	3.58	3.43	3.32	3.07	0.15	1.43	0
B8H010	1.79	2.02	0.66	1.20	2.09	1.83	1.95	2.54	2.44	2.79	3.03	2.05	3.19	2.40	2.22	1.91	2.50	1.22	2.97	1.68	2.39	2.22	2.12	1.91	1.15	1.92	1.29
U2H011	1.56	1.16	1.22	1.66	0.87	1.11	1.45	2.22	2.23	2.74	2.97	1.47	3.14	2.19	1.74	1.38	2.19	1.78	2.70	0.42	2.07	1.98	1.55	1.37	2.03	2.54	2.14
U2H012	0.98	0.58	1.80	2.20	0.82	1.72	1.62	1.91	1.86	2.47	2.64	1.22	2.62	1.85	1.38	0.85	1.77	2.43	2.37	0.63	1.68	1.60	0.83	1.04	2.60	3.15	2.73
X3H006	1.11	0.66	1.66	1.83	1.07	1.67	2.29	2.58	2.46	3.06	3.22	1.95	3.04	2.45	2.08	1.48	2.40	2.31	3.03	1.21	2.31	2.18	1.10	1.74	2.37	3.28	2.51
Q9H002	1.21	1.98	2.36	2.99	2.34	2.95	1.41	0.80	0.58	1.04	1.22	0.85	1.42	0.56	0.70	0.83	0.68	2.92	1.16	1.82	0.59	0.39	1.49	0.74	2.98	3.06	3.10
U2H005	0.32	0.93	2.35	2.67	1.69	2.58	2.33	2.06	1.84	2.48	2.55	1.67	2.13	1.87	1.63	1.02	1.77	3.03	2.42	1.66	1.71	1.58	0.44	1.42	3.03	3.74	3.18
V5H002	1.62	2.37	3.71	4.01	3.16	4.10	3.52	2.71	2.39	2.87	2.77	2.73	1.85	2.46	2.53	2.16	2.34	4.37	2.84	3.14	2.36	2.26	1.74	2.52	4.27	4.95	4.43
B8H009	0.79	0.45	1.83	2.12	1.04	1.87	2.07	2.22	2.10	2.73	2.87	1.62	2.68	2.10	1.72	1.10	2.02	2.50	2.66	1.08	1.94	1.82	0.72	1.40	2.58	3.34	2.72
W5R003	1.00	1.07	2.32	2.82	1.36	2.33	1.41	1.30	1.28	1.92	2.06	0.71	2.07	1.28	0.78	0.38	1.15	2.93	1.73	1.04	1.07	1.05	0.81	0.55	3.10	3.40	3.23
W5H005	0.82	1.00	2.39	2.87	1.43	2.45	1.62	1.37	1.29	1.96	2.07	0.87	1.96	1.31	0.87	0.35	1.16	3.03	1.78	1.19	1.10	1.06	0.60	0.68	3.17	3.54	3.30
X1H001	0.70	1.60	2.88	3.29	2.32	3.25	2.50	1.81	1.52	2.11	2.10	1.73	1.47	1.58	1.55	1.14	1.46	3.55	2.06	2.18	1.45	1.34	0.88	1.50	3.53	4.07	3.67
W4R001	1.64	2.56	3.50	4.04	3.16	4.02	2.60	1.44	1.12	1.41	1.25	1.85	0.35	1.20	1.55	1.60	1.13	4.11	1.42	2.83	1.20	1.16	1.83	1.74	4.09	4.29	4.23

Appendix C2 (f) Veld Type Zone C Similarity Distance Values (Continued)

Station	d28	d29	d30	d31	d32	d33	d34	d35	d36	d37	d38	d39
B6R003	1.79	1.56	0.98	1.11	1.21	0.32	1.62	0.79	1.00	0.82	0.70	1.64
B8R005	2.02	1.16	0.58	0.66	1.98	0.93	2.37	0.45	1.07	1.00	1.60	2.56
X2H008	0.66	1.22	1.80	1.66	2.36	2.35	3.71	1.83	2.32	2.39	2.88	3.50
X3H001	1.20	1.66	2.20	1.83	2.99	2.67	4.01	2.12	2.82	2.87	3.29	4.04
B8R001	2.09	0.87	0.82	1.07	2.34	1.69	3.16	1.04	1.36	1.43	2.32	3.16
X3H003	1.83	1.11	1.72	1.67	2.95	2.58	4.10	1.87	2.33	2.45	3.25	4.02
A2R005	1.95	1.45	1.62	2.29	1.41	2.33	3.52	2.07	1.41	1.62	2.50	2.60
A2R007	2.54	2.22	1.91	2.58	0.80	2.06	2.71	2.22	1.30	1.37	1.81	1.44
A3R001	2.44	2.23	1.86	2.46	0.58	1.84	2.39	2.10	1.28	1.29	1.52	1.12
A3R002	2.79	2.74	2.47	3.06	1.04	2.48	2.87	2.73	1.92	1.96	2.11	1.41
A3R003	3.03	2.97	2.64	3.22	1.22	2.55	2.77	2.87	2.06	2.07	2.10	1.25
B1H004	2.05	1.47	1.22	1.95	0.85	1.67	2.73	1.62	0.71	0.87	1.73	1.85
A2H021	3.19	3.14	2.62	3.04	1.42	2.13	1.85	2.68	2.07	1.96	1.47	0.35
A2R006	2.40	2.19	1.85	2.45	0.56	1.87	2.46	2.10	1.28	1.31	1.58	1.20
A6R001	2.22	1.74	1.38	2.08	0.70	1.63	2.53	1.72	0.78	0.87	1.55	1.55
A8R001	1.91	1.38	0.85	1.48	0.83	1.02	2.16	1.10	0.38	0.35	1.14	1.60
B3R001	2.50	2.19	1.77	2.40	0.68	1.77	2.34	2.02	1.15	1.16	1.46	1.13
B6R001	1.22	1.78	2.43	2.31	2.92	3.03	4.37	2.50	2.93	3.03	3.55	4.11
U2R001	2.97	2.70	2.37	3.03	1.16	2.42	2.84	2.66	1.73	1.78	2.06	1.42
V2R001	1.68	0.42	0.63	1.21	1.82	1.66	3.14	1.08	1.04	1.19	2.18	2.83
A2H006	2.39	2.07	1.68	2.31	0.59	1.71	2.36	1.94	1.07	1.10	1.45	1.20

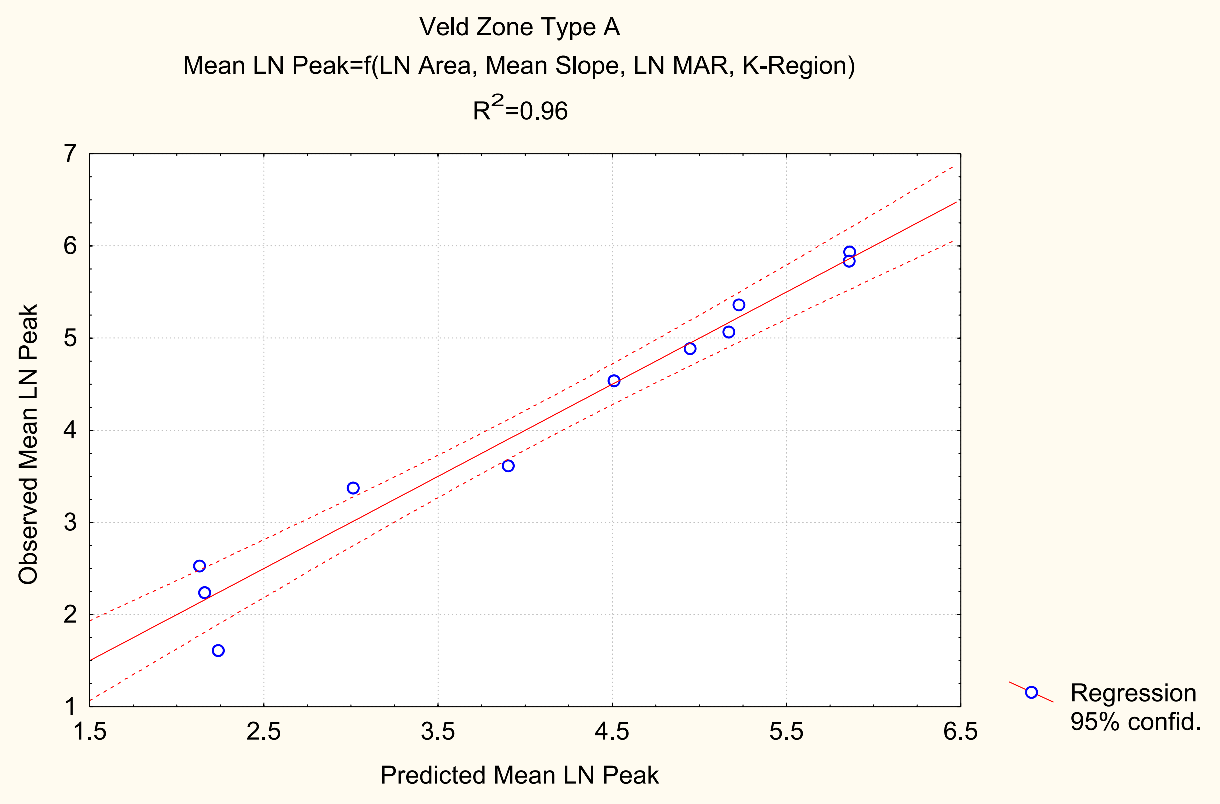
Station	d28	d29	d30	d31	d32	d33	d34	d35	d36	d37	d38	d39
A2H013	2.22	1.98	1.60	2.18	0.39	1.58	2.26	1.82	1.05	1.06	1.34	1.16
X2H015	2.12	1.55	0.83	1.10	1.49	0.44	1.74	0.72	0.81	0.60	0.88	1.83
A9R001	1.91	1.37	1.04	1.74	0.74	1.42	2.52	1.40	0.55	0.68	1.50	1.74
B7R001	1.15	2.03	2.60	2.37	2.98	3.03	4.27	2.58	3.10	3.17	3.53	4.09
B7R003	1.92	2.54	3.15	3.28	3.06	3.74	4.95	3.34	3.40	3.54	4.07	4.29
B7H004	1.29	2.14	2.73	2.51	3.10	3.18	4.43	2.72	3.23	3.30	3.67	4.23
B8H010	0	1.31	1.66	1.53	1.89	1.96	3.19	1.63	2.07	2.11	2.40	2.96
U2H011	1.31	0	0.74	1.05	1.86	1.66	3.17	1.03	1.28	1.40	2.23	2.92
U2H012	1.66	0.74	0	0.81	1.56	1.03	2.52	0.52	0.72	0.75	1.60	2.38
X3H006	1.53	1.05	0.81	0	2.05	1.01	2.47	0.40	1.45	1.39	1.75	2.74
Q9H002	1.89	1.86	1.56	2.05	0	1.53	2.28	1.73	1.17	1.17	1.35	1.29
U2H005	1.96	1.66	1.03	1.01	1.53	0	1.53	0.72	1.15	0.94	0.74	1.82
V5H002	3.19	3.17	2.52	2.47	2.28	1.53	0	2.24	2.36	2.12	1.02	1.55
B8H009	1.63	1.03	0.52	0.40	1.73	0.72	2.24	0	1.08	1.00	1.43	2.39
W5R003	2.07	1.28	0.72	1.45	1.17	1.15	2.36	1.08	0	0.24	1.37	1.88
W5H005	2.11	1.40	0.75	1.39	1.17	0.94	2.12	1.00	0.24	0	1.15	1.75
X1H001	2.40	2.23	1.60	1.75	1.35	0.74	1.02	1.43	1.37	1.15	0	1.14
W4R001	2.96	2.92	2.38	2.74	1.29	1.82	1.55	2.39	1.88	1.75	1.14	0

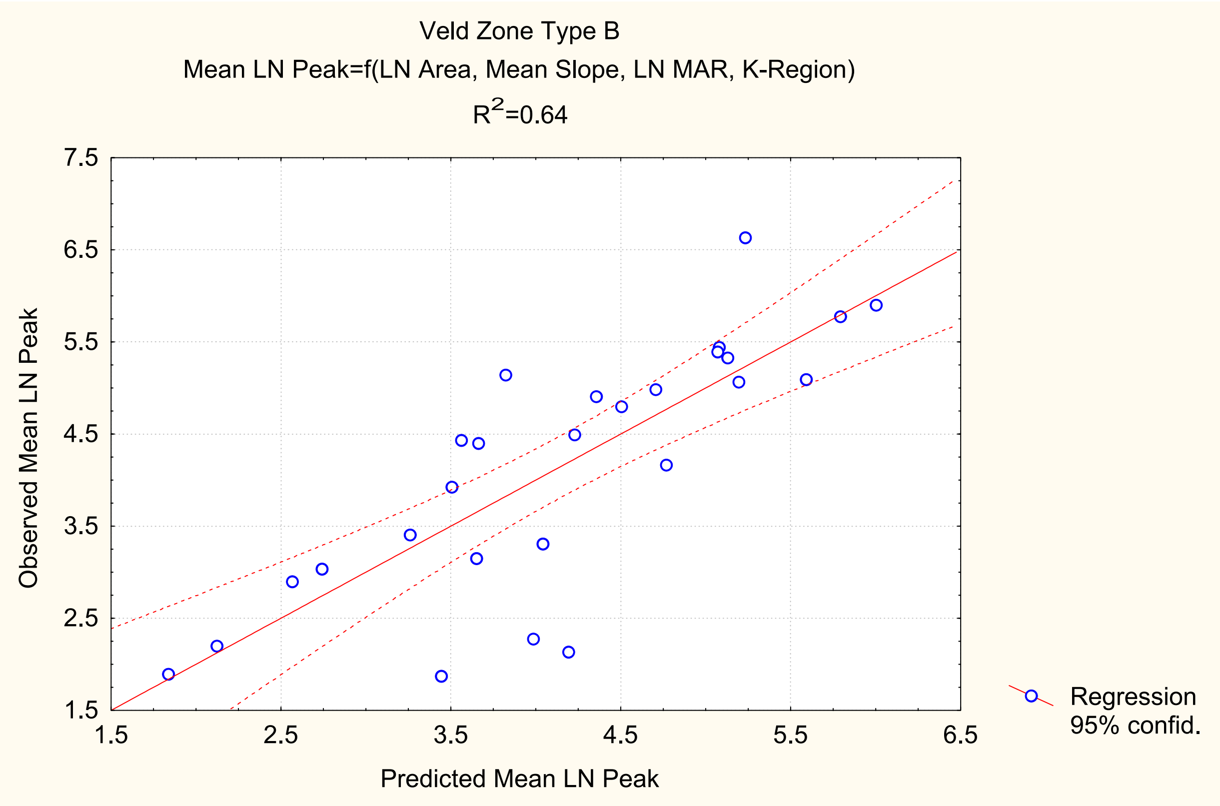
APPENDIX D

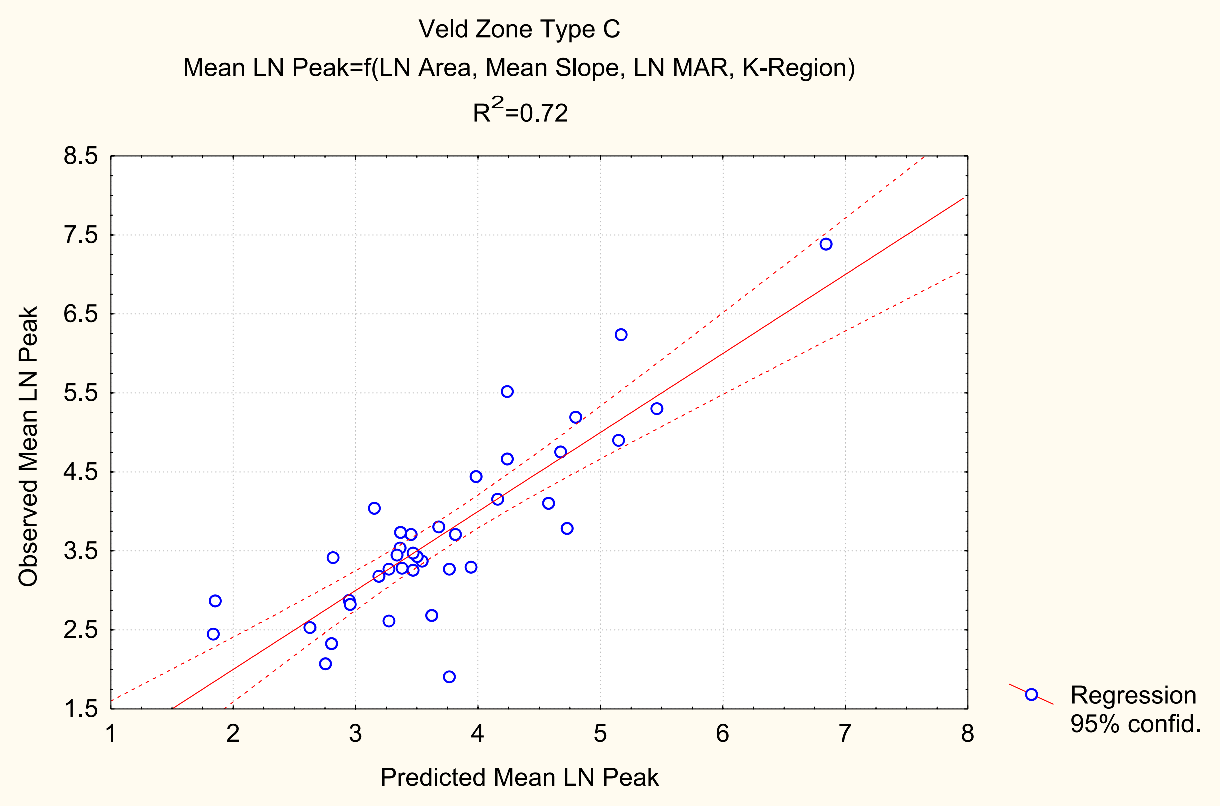
Appendix D1 (a) Scatterplots of Regression-Based Estimates of μ_{lnQ} (Annual Maxima) for Veld Zone and K-Region Pooling-Groups

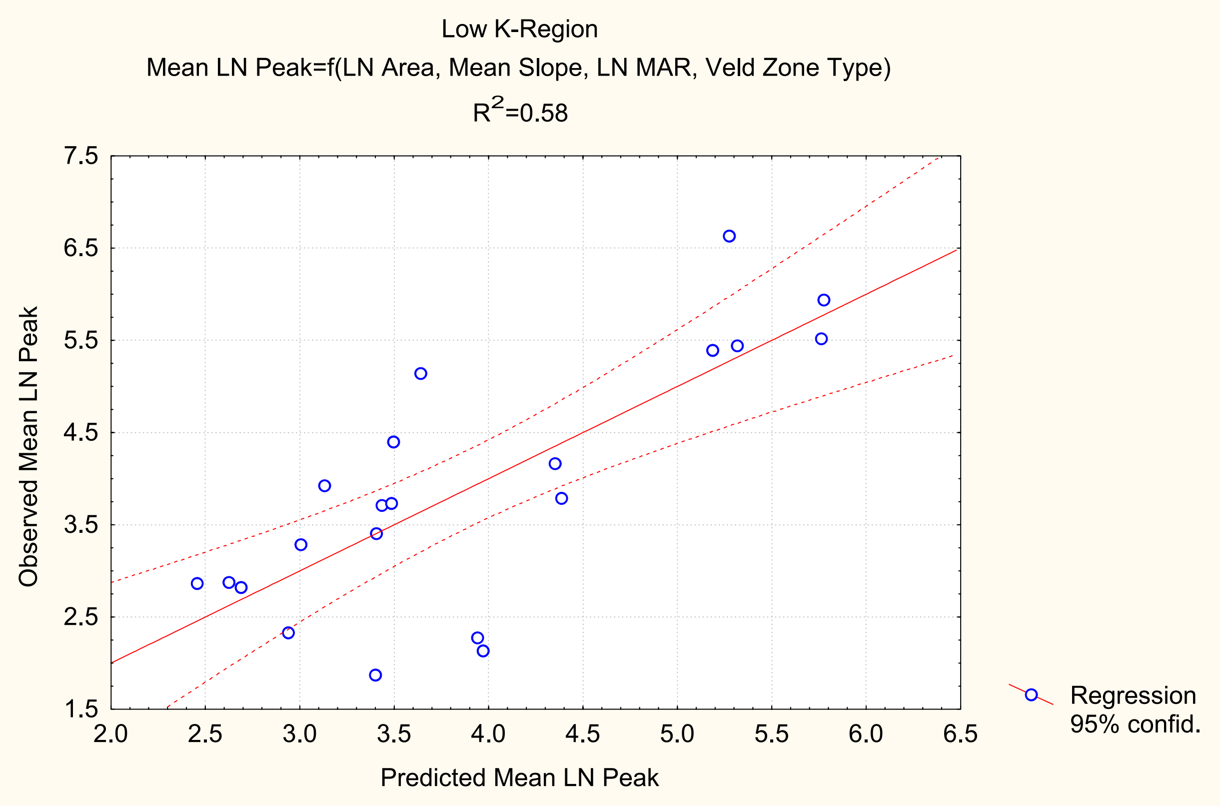
Appendix D1 (b) Scatterplots of Regression-based Estimates of $ln(\mu_Q)$ (Annual Maxima) for Veld Zone and K-Region Pooling-Groups

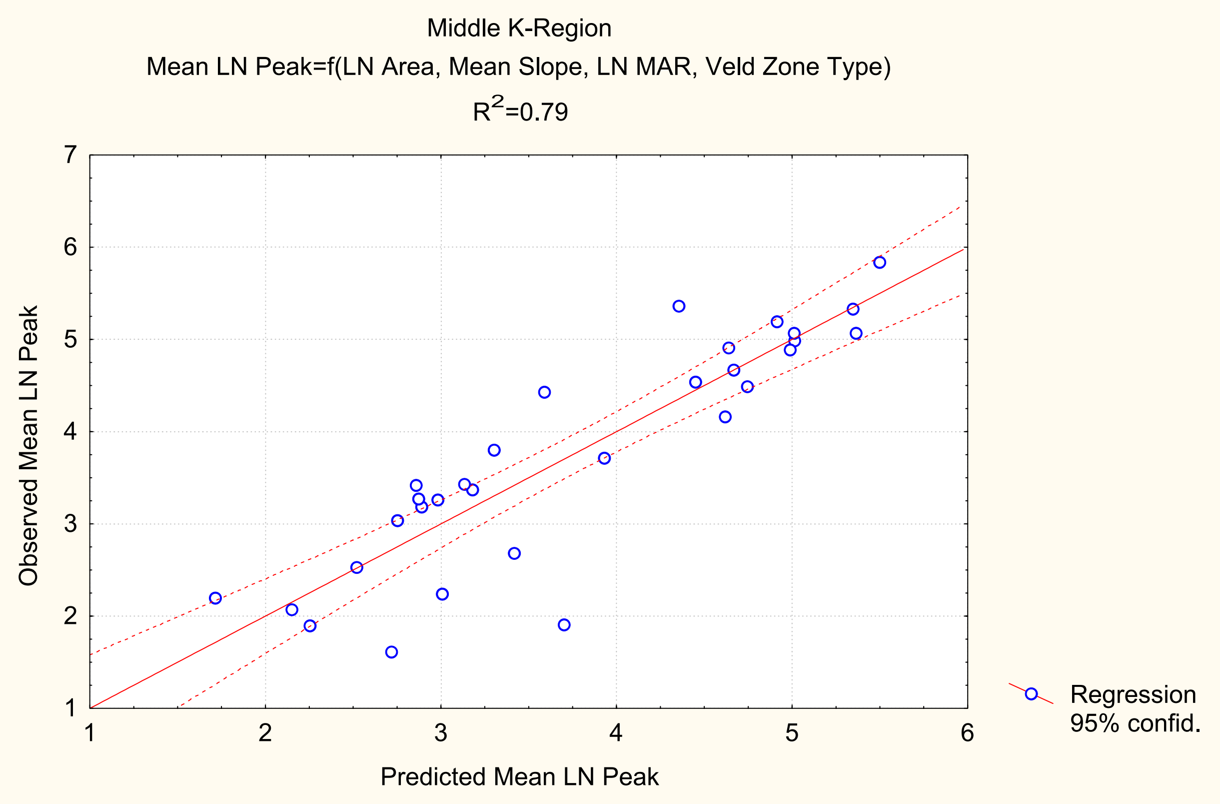
Appendix D1 (a) Scatterplots of Regression-Based Estimates of μ_{lnQ} (Annual Maxima) for Veld Zone and K-Region Pooling-Groups

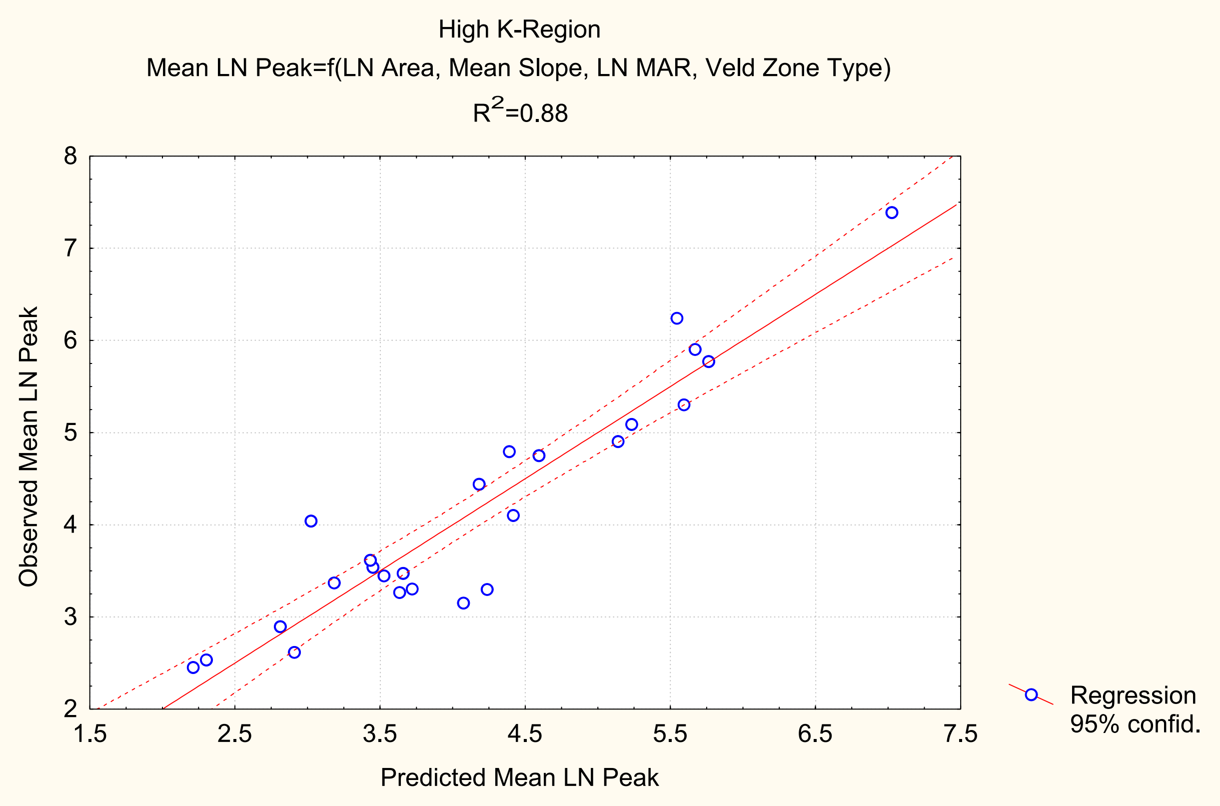




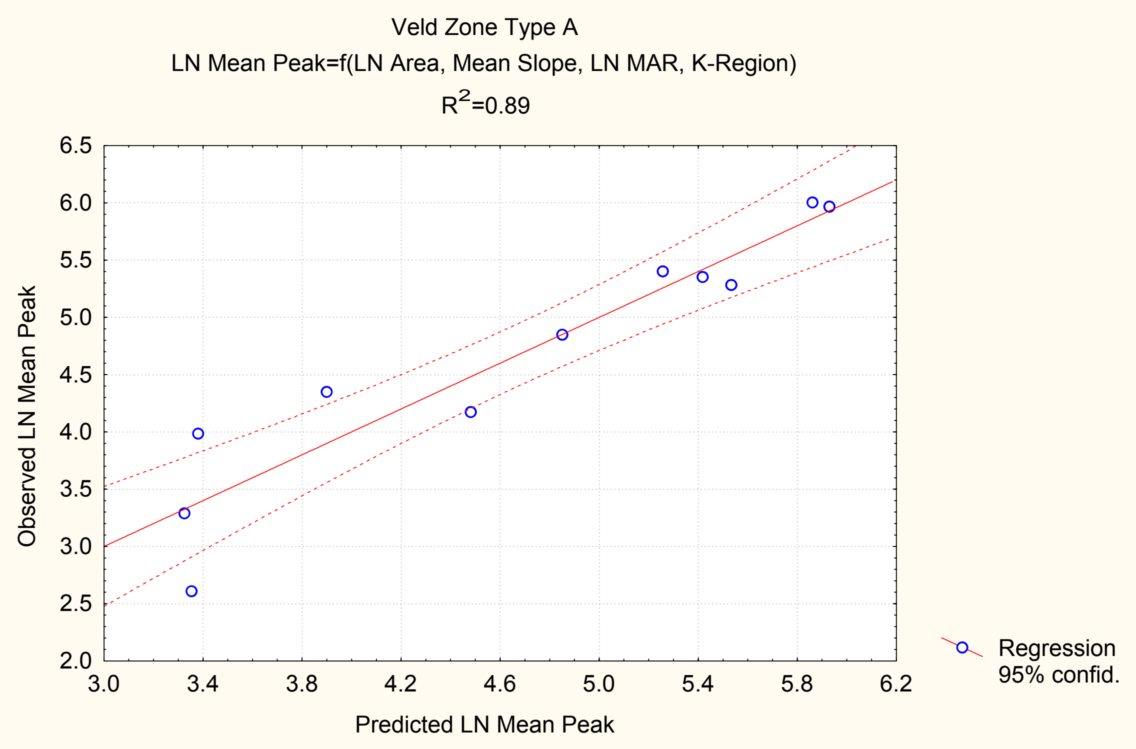

Veld Zone Type C
Mean LN Peak=f(LN Area, Mean Slope, LN MAR, K-Region)
R2=0.72
Observed Mean LN Peak
Predicted Mean LN Peak
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
1
2
3
4
5
6
7
8
Regression
95% confid.

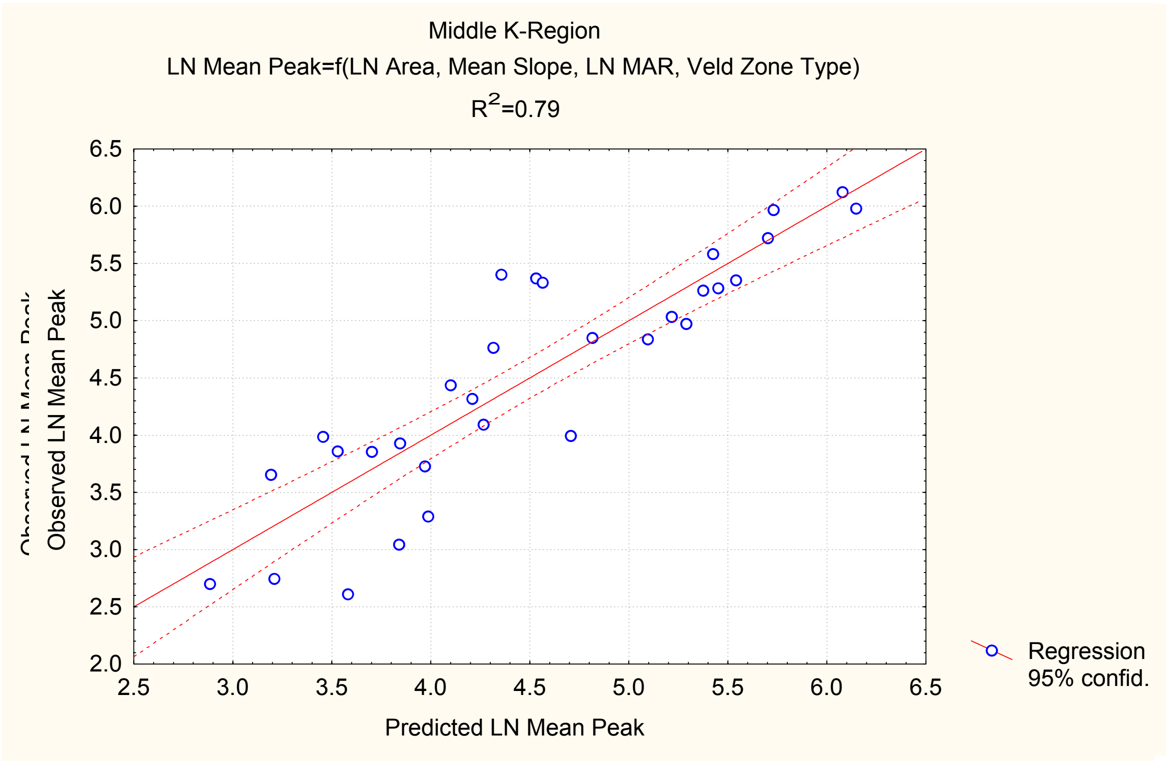

Low K-Region
Mean LN Peak=f(LN Area, Mean Slope, LN MAR, Veld Zone Type)
R2=0.58
Observed Mean LN Peak
Predicted Mean LN Peak
7.5
6.5
5.5
4.5
3.5
2.5
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
Regression
95% confid.

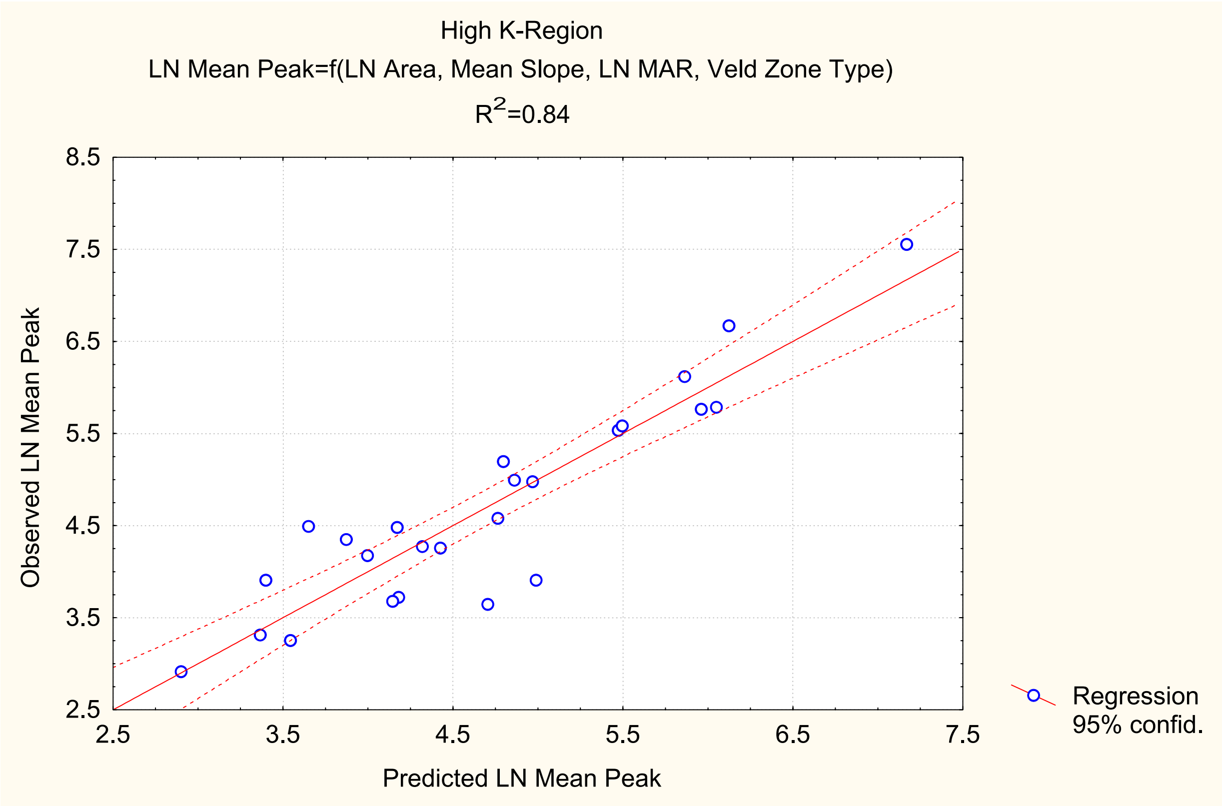

Middle K-Region
Mean LN Peak=f(LN Area, Mean Slope, LN MAR, Veld Zone Type)
R^2=0.79
Observed Mean LN Peak
Predicted Mean LN Peak
1
2
3
4
5
6
7
Regression
95% confid.


High K-Region
Mean LN Peak=f(LN Area, Mean Slope, LN MAR, Veld Zone Type)
R^2=0.88
Observed Mean LN Peak
Predicted Mean LN Peak
1.5
2.5
3.5
4.5
5.5
6.5
7.5
2
3
4
5
6
7
8
Regression
95% confid.

Appendix D1 (b) Scatterplots of Regression-Based Estimates of $ln(\mu_Q)$ (Annual Maxima) for Veld Zone and K-Region Pooling-Groups






High K-Region
LN Mean Peak=f(LN Area, Mean Slope, LN MAR, Veld Zone Type)
R^2=0.84
Observed LN Mean Peak
Predicted LN Mean Peak
8.5
7.5
6.5
5.5
4.5
3.5
2.5
2.5
3.5
4.5
5.5
6.5
7.5
Regression
95% confid.

APPENDIX E

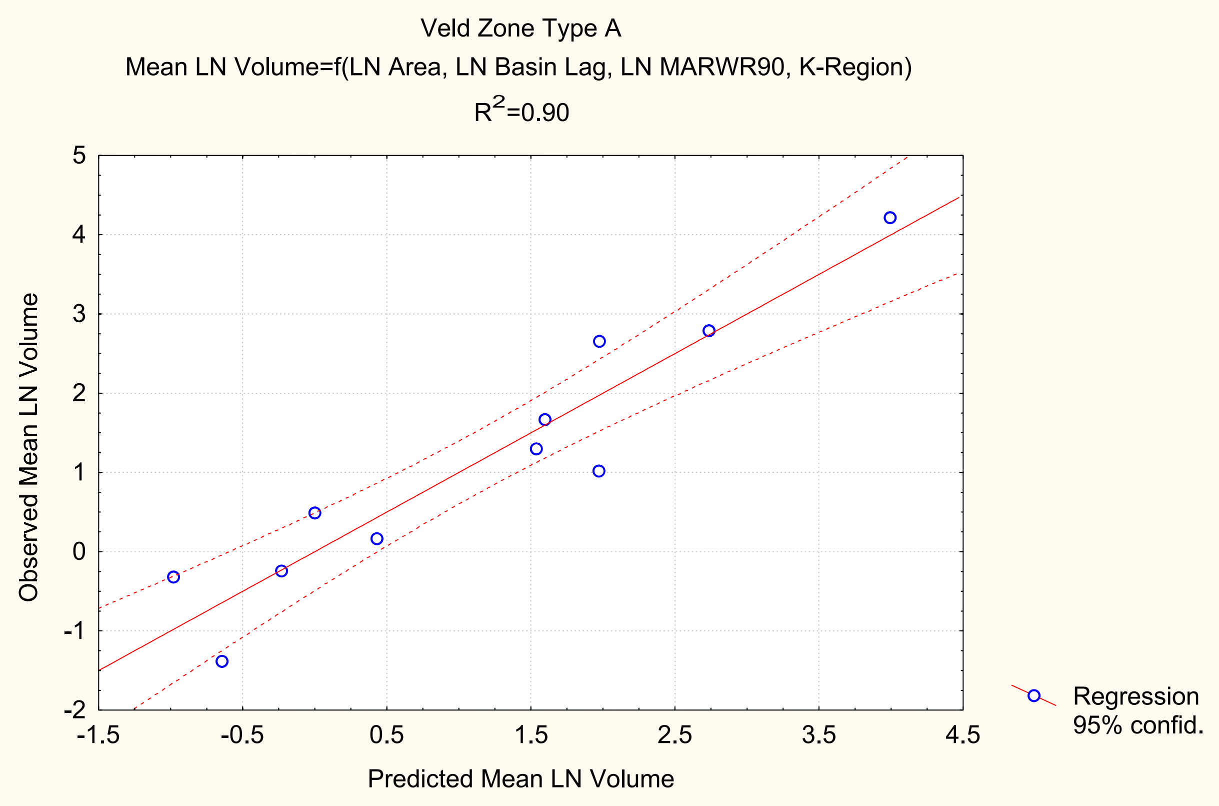
Appendix E1 Scatterplots of Regression-Based Estimates of μ_{lnV} (*ln* POT Volume Values) for Veld Zone and K-Region Pooling-Groups

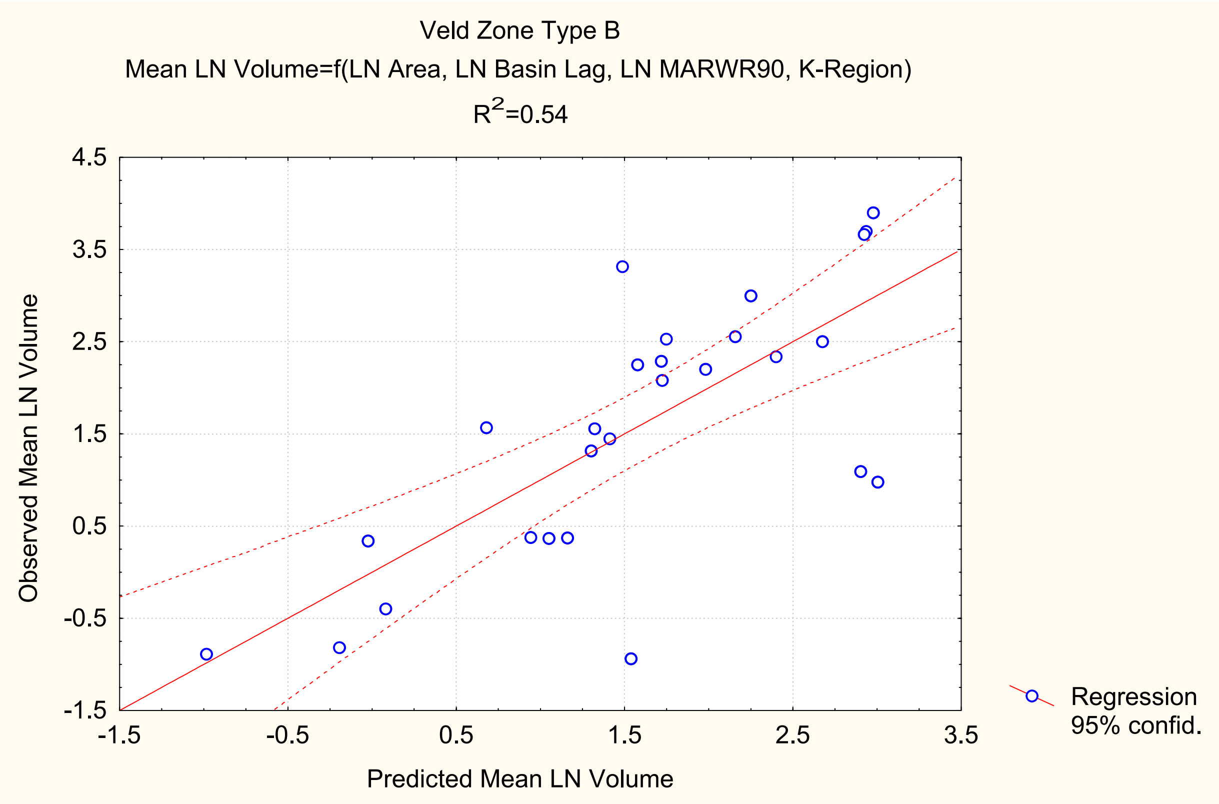
Appendix E2 Isozones of Coefficient of Variation of Natural Logs of POT Flood Volumes ($CV_{ln\ V}$)

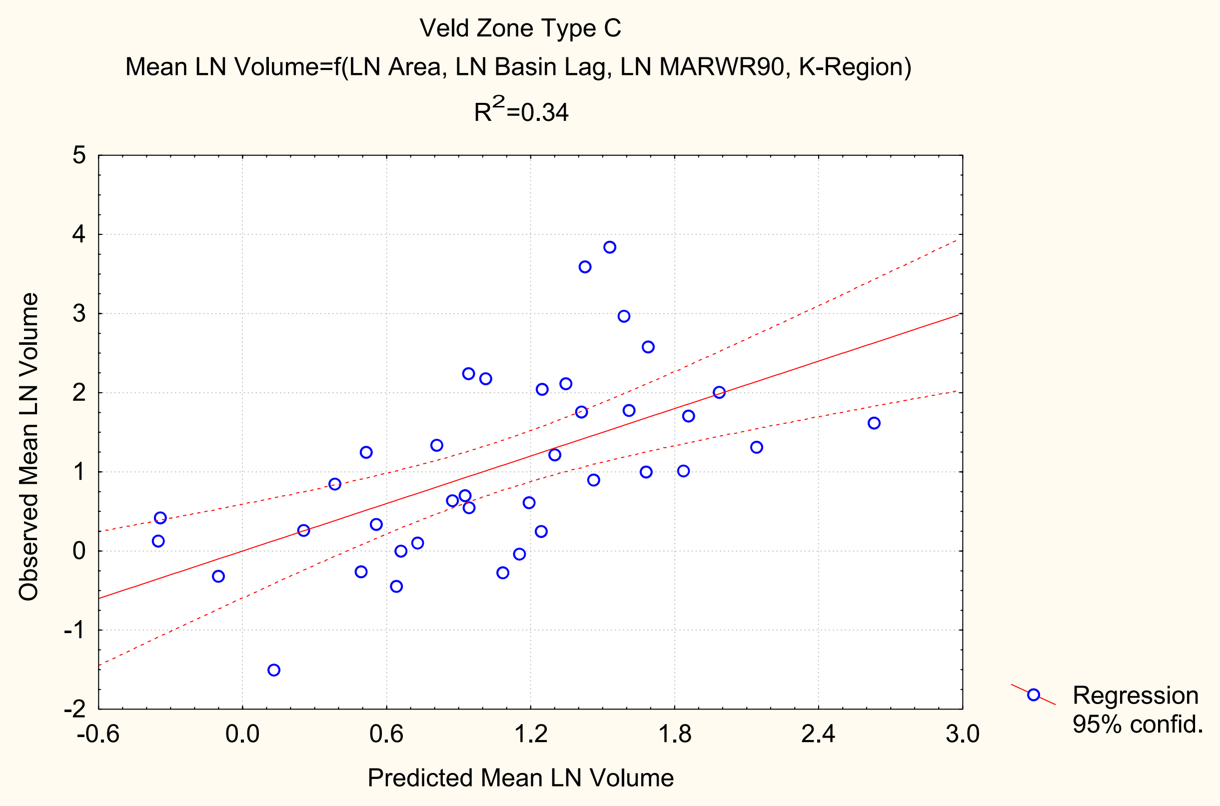
Appendix E3 Scatterplots of Regression-Based Estimates of (μ_{lnF} (*ln* POT Peak Values) for Veld Zone and K-Region Pooling-Groups

Appendix E4 Isozones of Coefficient of Variation of Natural Logs of POT Flood Peaks ($CV_{ln\ F}$)

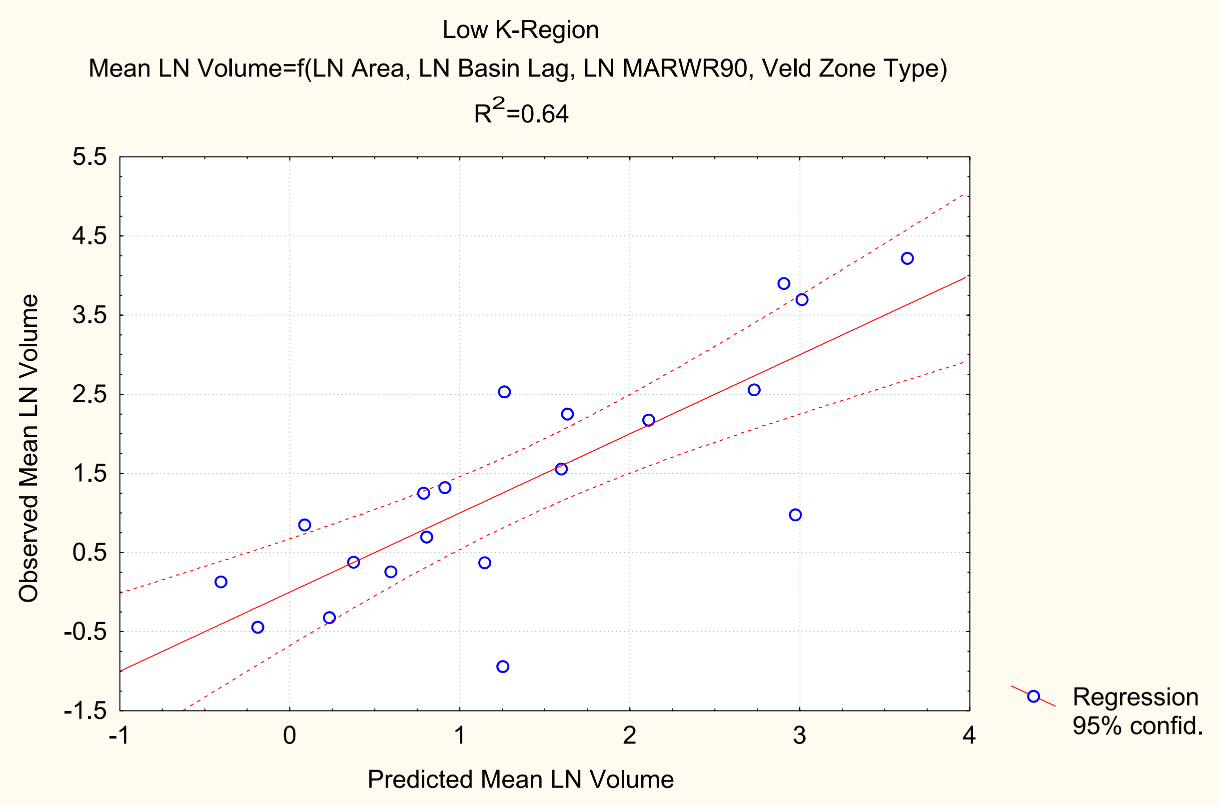
Appendix E1 Scatterplots of Regression-Based Estimates of μ_{lnV} (*ln* POT Volume Values) for Veld Zone and K-Region Pooling-Groups



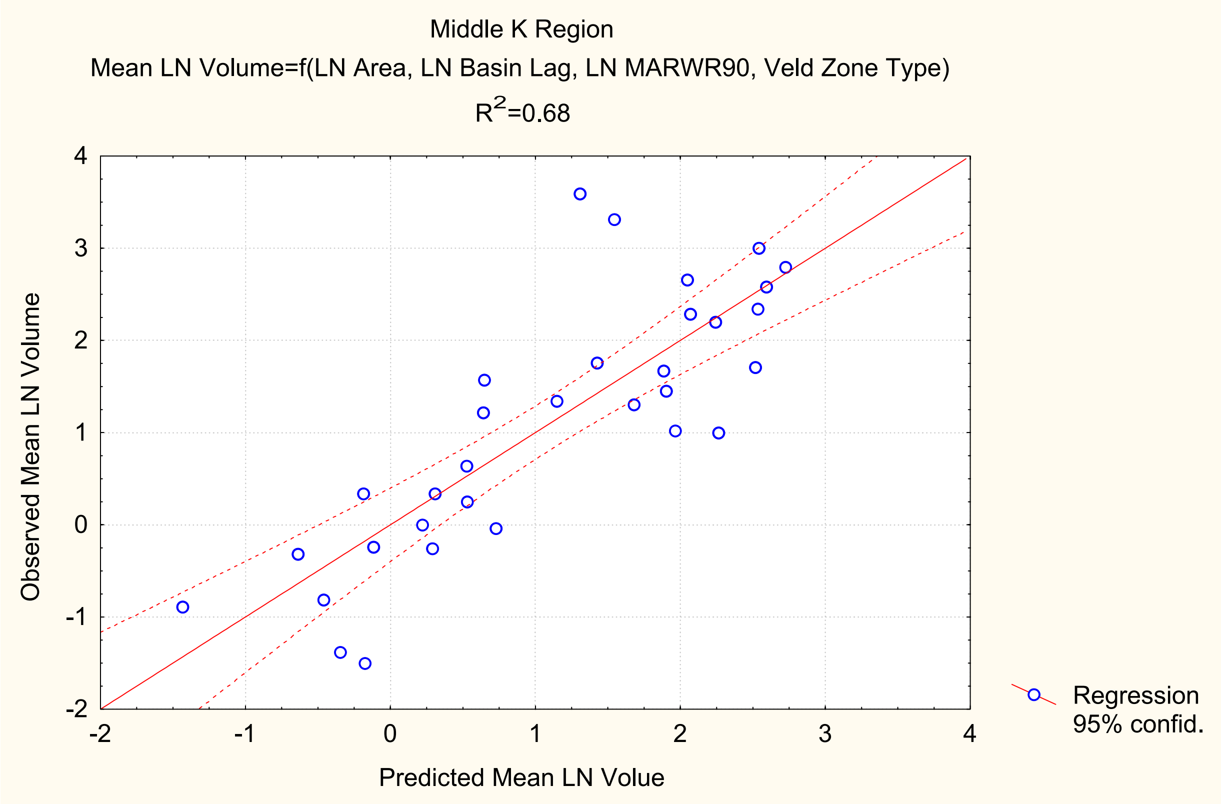


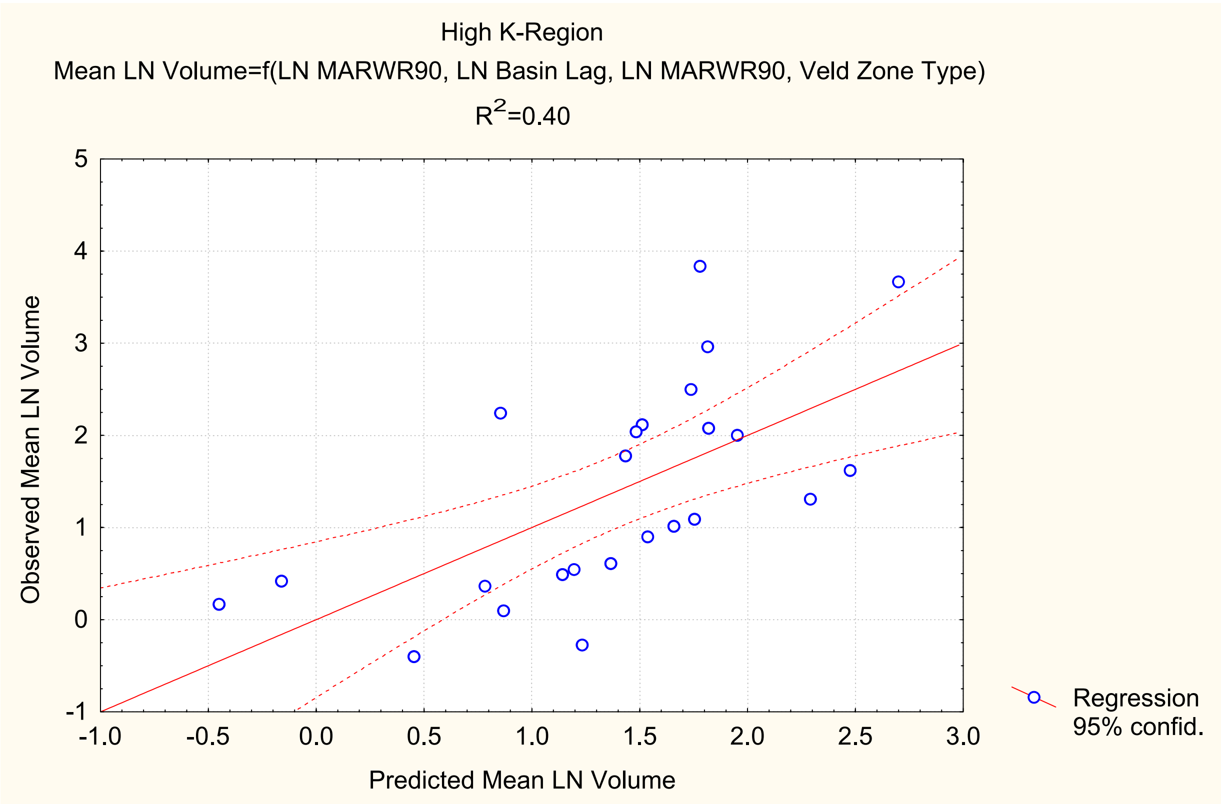


Veld Zone Type C
Mean LN Volume=f(LN Area, LN Basin Lag, LN MARWR90, K-Region)
R2=0.34
Observed Mean LN Volume
Predicted Mean LN Volume
5
4
3
2
1
0
-1
-2
-0.6
0.0
0.6
1.2
1.8
2.4
3.0
Regression
95% confid.

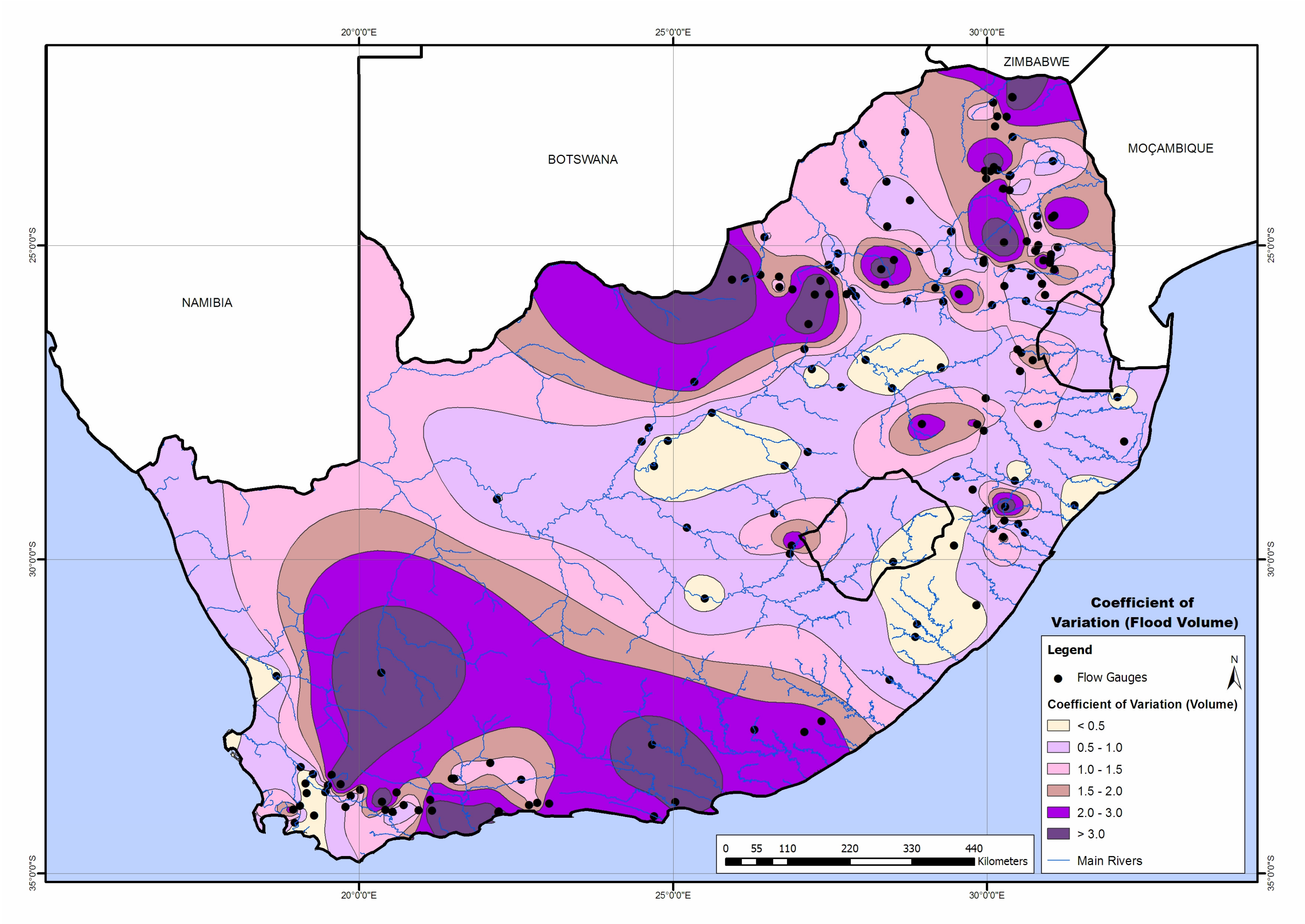


Low K-Region
Mean LN Volume=f(LN Area, LN Basin Lag, LN MARWR90, Veld Zone Type)
R2=0.64
Observed Mean LN Volume
Predicted Mean LN Volume
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
-1
0
1
2
3
4
Regression
95% confid.

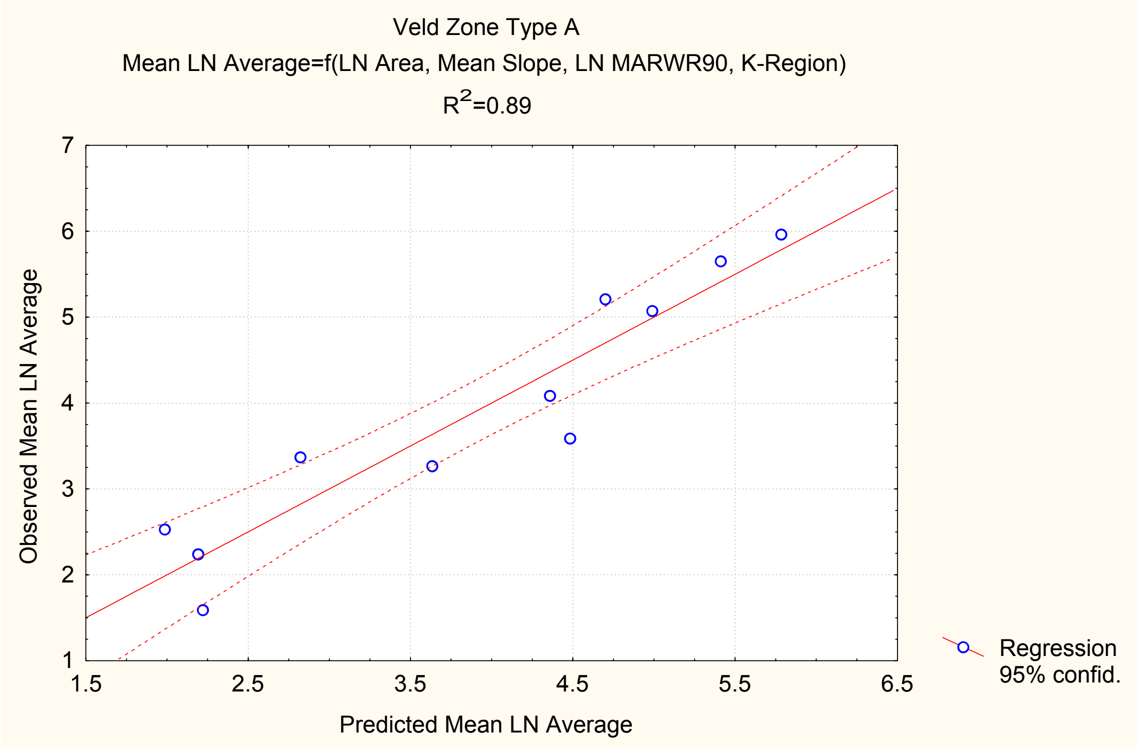

Middle K Region
Mean LN Volume=f(LN Area, LN Basin Lag, LN MARWR90, Veld Zone Type)
R2=0.68
Observed Mean LN Volume
Predicted Mean LN Volue
4
3
2
1
0
-1
-2
-2
-1
0
1
2
3
4
Regression
95% confid.

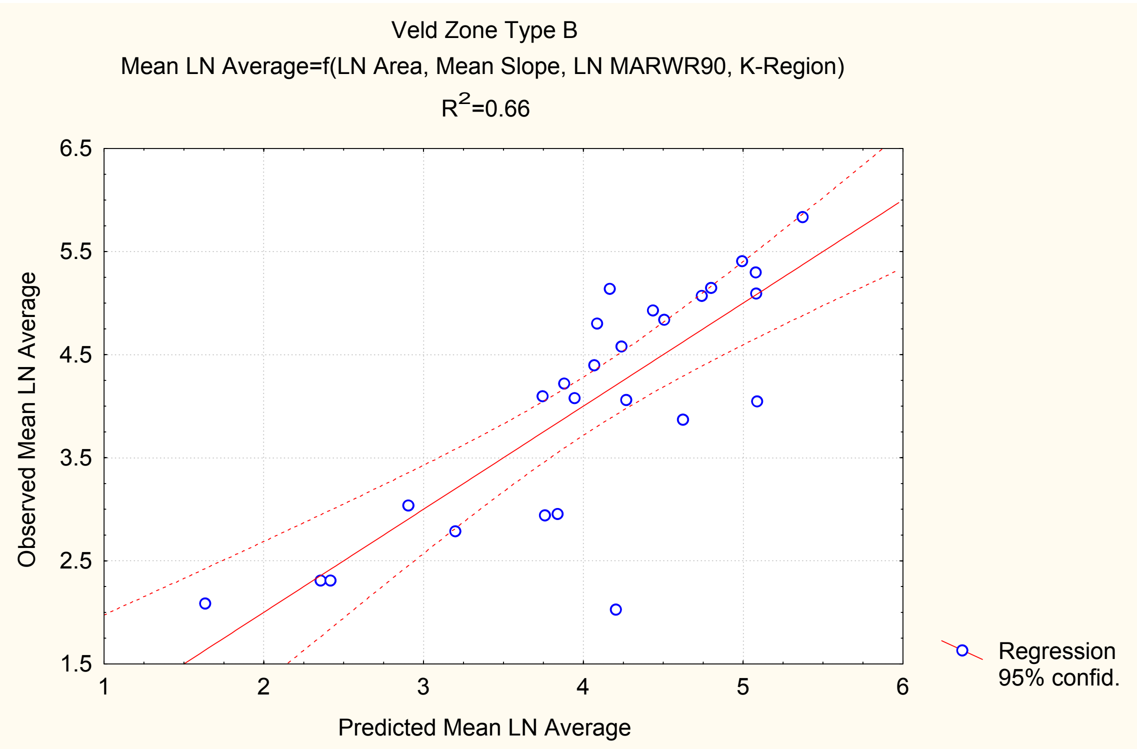

High K-Region
Mean LN Volume=f(LN MARWR90, LN Basin Lag, LN MARWR90, Veld Zone Type)
R2=0.40
Observed Mean LN Volume
Predicted Mean LN Volume
5
4
3
2
1
0
-1
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Regression
95% confid.

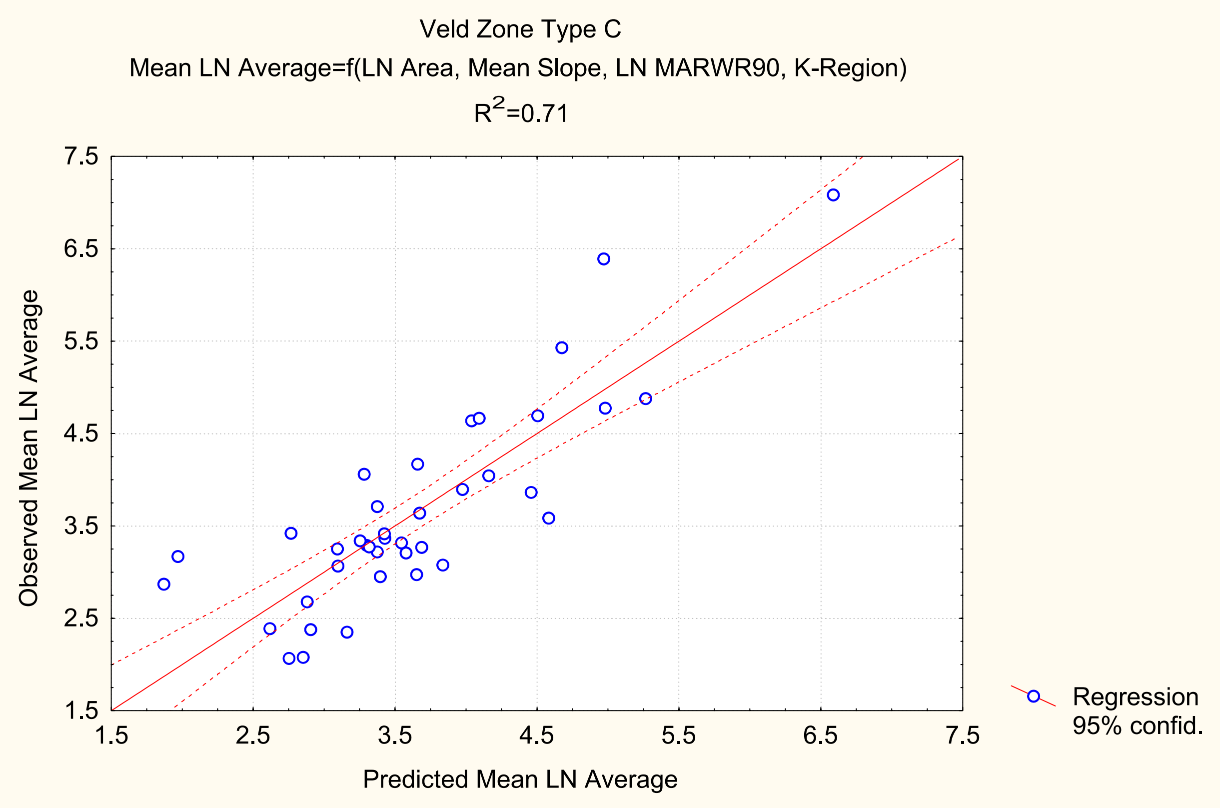
Appendix E2 Isozones of Coefficient of Variation of Natural Logs of POT Flood Volumes ($CV_{ln\ V}$)

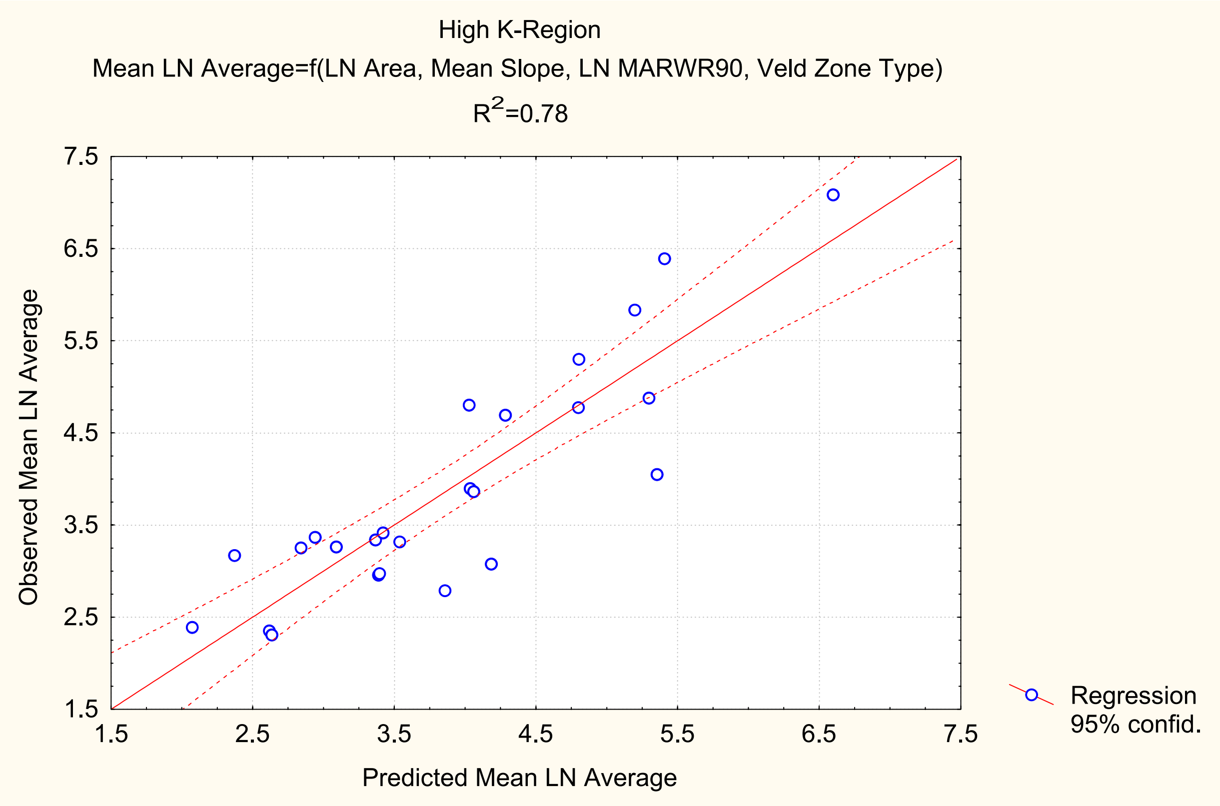


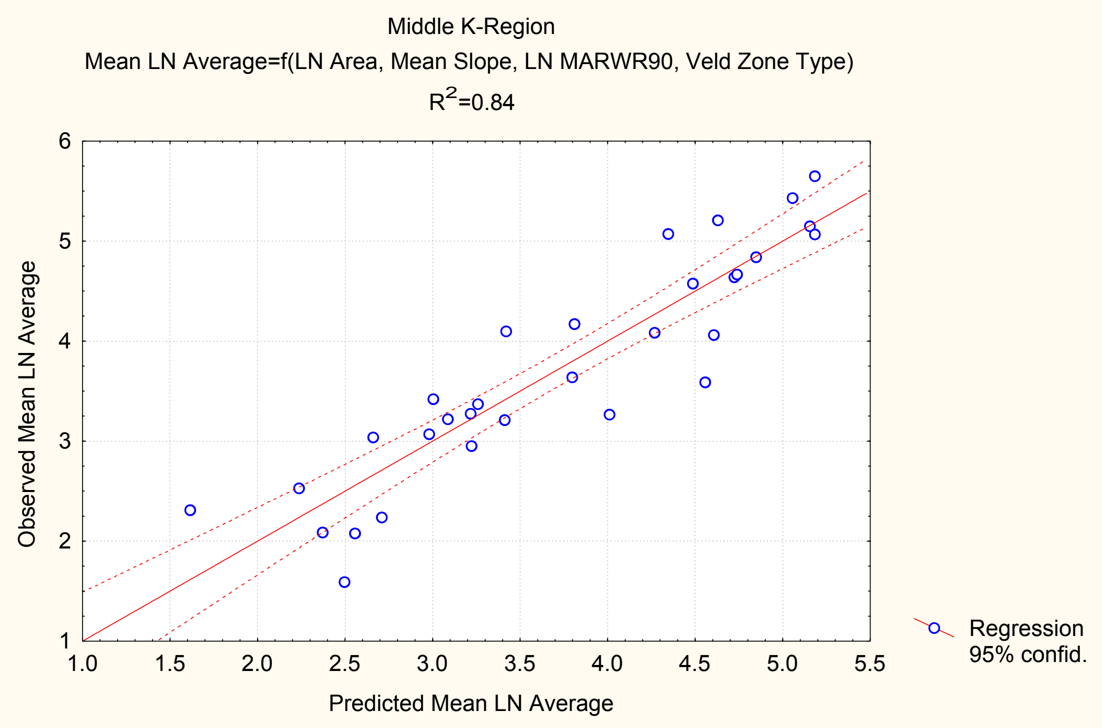
Appendix E3 Scatterplots of Regression-Based Estimates of μ_{lnF} (*ln* POT Peak Values) for Veld Zone and K-Region Pooling-Groups

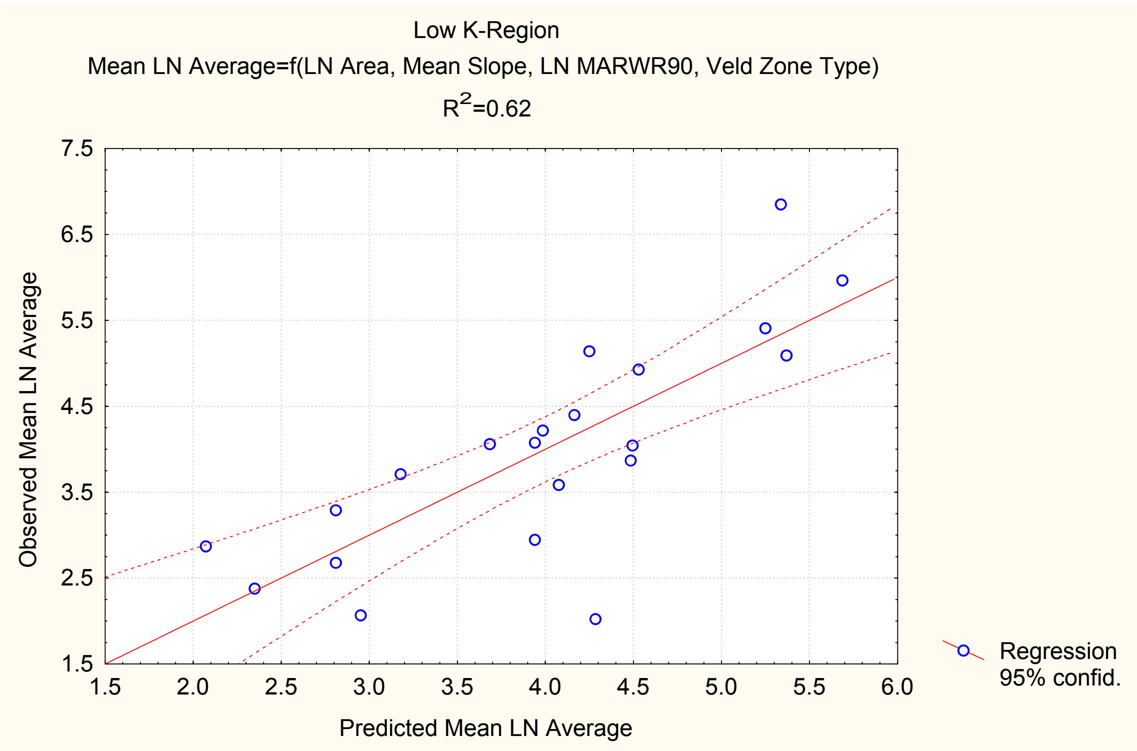




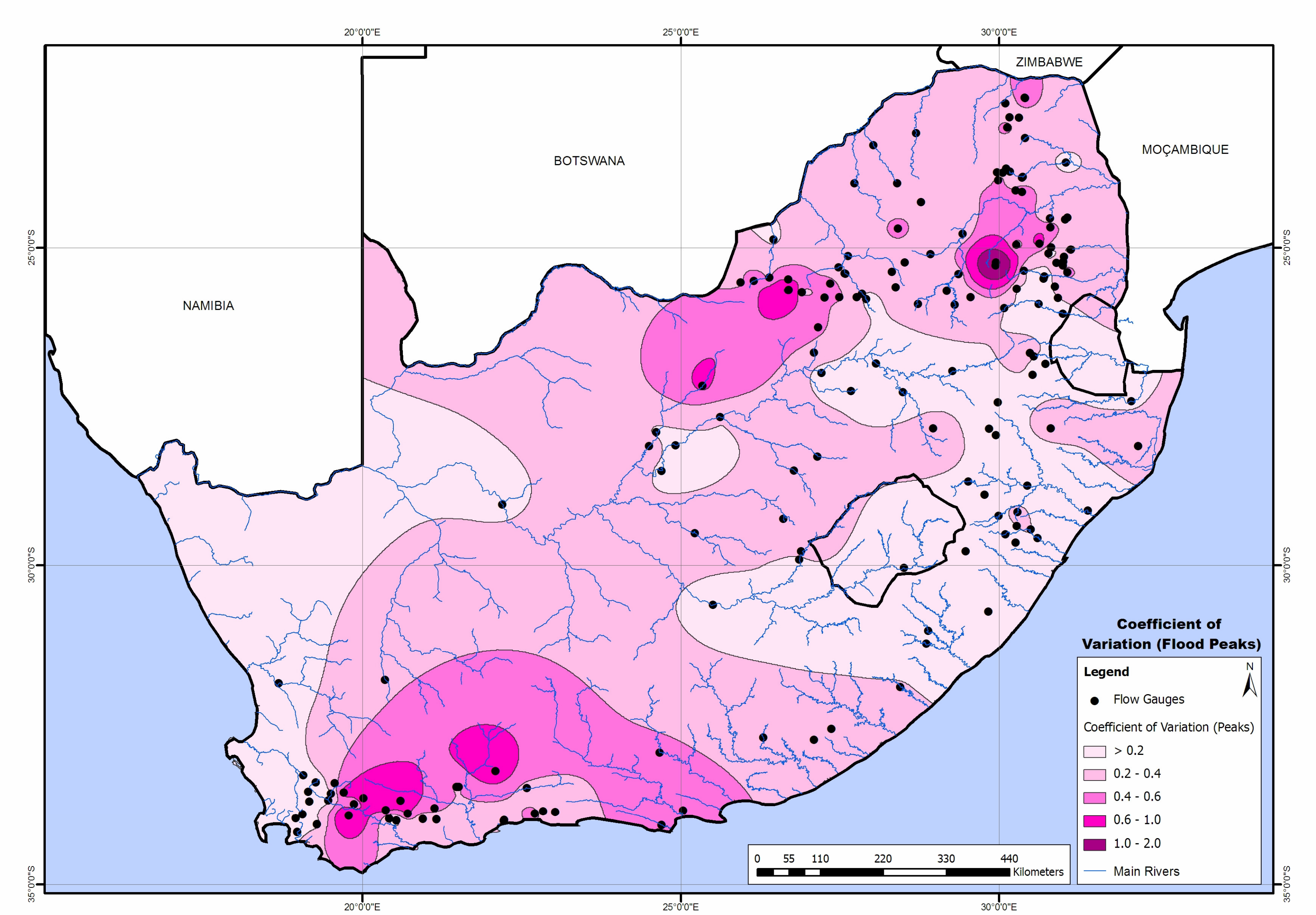

Veld Zone Type C
Mean LN Average=f(LN Area, Mean Slope, LN MARWR90, K-Region)
R2=0.71
Observed Mean LN Average
Predicted Mean LN Average
1.5
2.5
3.5
4.5
5.5
6.5
7.5
Regression
95% confid.


High K-Region
Mean LN Average=f(LN Area, Mean Slope, LN MARWR90, Veld Zone Type)
R2=0.78
Observed Mean LN Average
Predicted Mean LN Average
1.5
2.5
3.5
4.5
5.5
6.5
7.5
Regression
95% confid.


Middle K-Region
Mean LN Average=f(LN Area, Mean Slope, LN MARWR90, Veld Zone Type)
R2=0.84
Observed Mean LN Average
Predicted Mean LN Average
1
2
3
4
5
6
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
Regression
95% confid.


Low K-Region
Mean LN Average=f(LN Area, Mean Slope, LN MARWR90, Veld Zone Type)
R2=0.62
Observed Mean LN Average
Predicted Mean LN Average
1.5
2.5
3.5
4.5
5.5
6.5
7.5
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Regression
95% confid.

Appendix E4 Isozones of Coefficient of Variation of Natural Logs of POT Flood Peaks ($CV_{ln\ F}$)

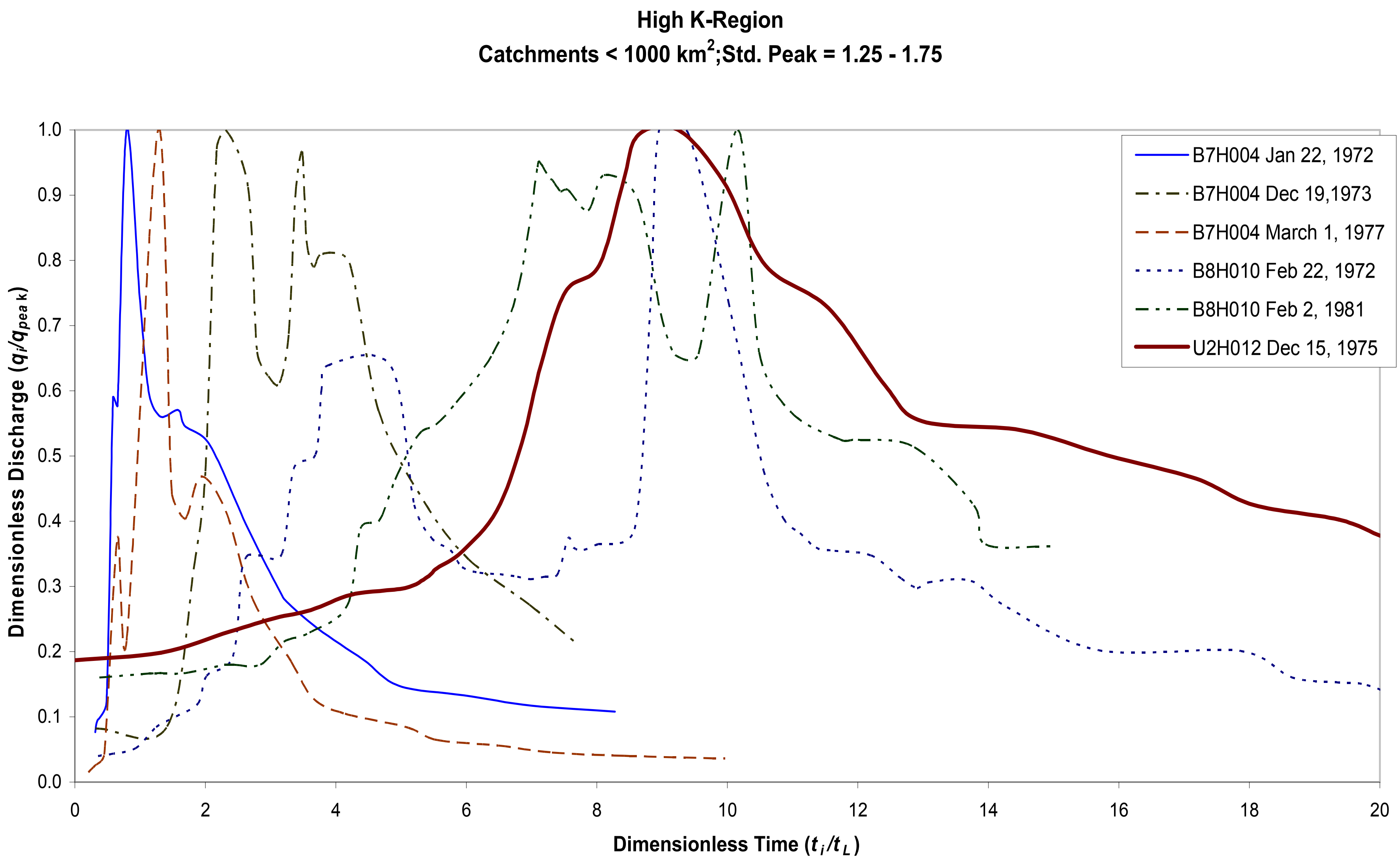


APPENDIX F

REGIONALLY POOLED STANDARDISED OBSERVED FLOOD HYDROGRAPHS

Appendix F1(a)	High K-Region; Catchments < 1000 km^2
Appendix F1(b)	High K-Region; Catchments > 1000 km^2
Appendix F2 (a)	Middle K-Region; Catchments < 1000 km^2
Appendix F2 (b)	Middle K-Region; Catchments > 1000 km^2
Appendix F3 (a)	Low K-Region; Catchments < 1000 km^2
Appendix F3 (b)	Low K-Region; Catchments > 1000 km^2
Appendix F4 (a)	Veld-Zone Group A; Catchments < 1000 km^2
Appendix F4 (b)	Veld Zone Group A; Catchments > 1000 km^2
Appendix F5 (a)	Veld-Zone Group B; Catchments < 1000 km^2
Appendix F5 (b)	Veld Zone Group B; Catchments > 1000 km^2
Appendix F6 (a)	Veld-Zone Group C; Cachments < 1000 km^2
Appendix F6 (b)	Veld-Zone Group C; Catchments > 1000 km^2

Appendix F1 (a)

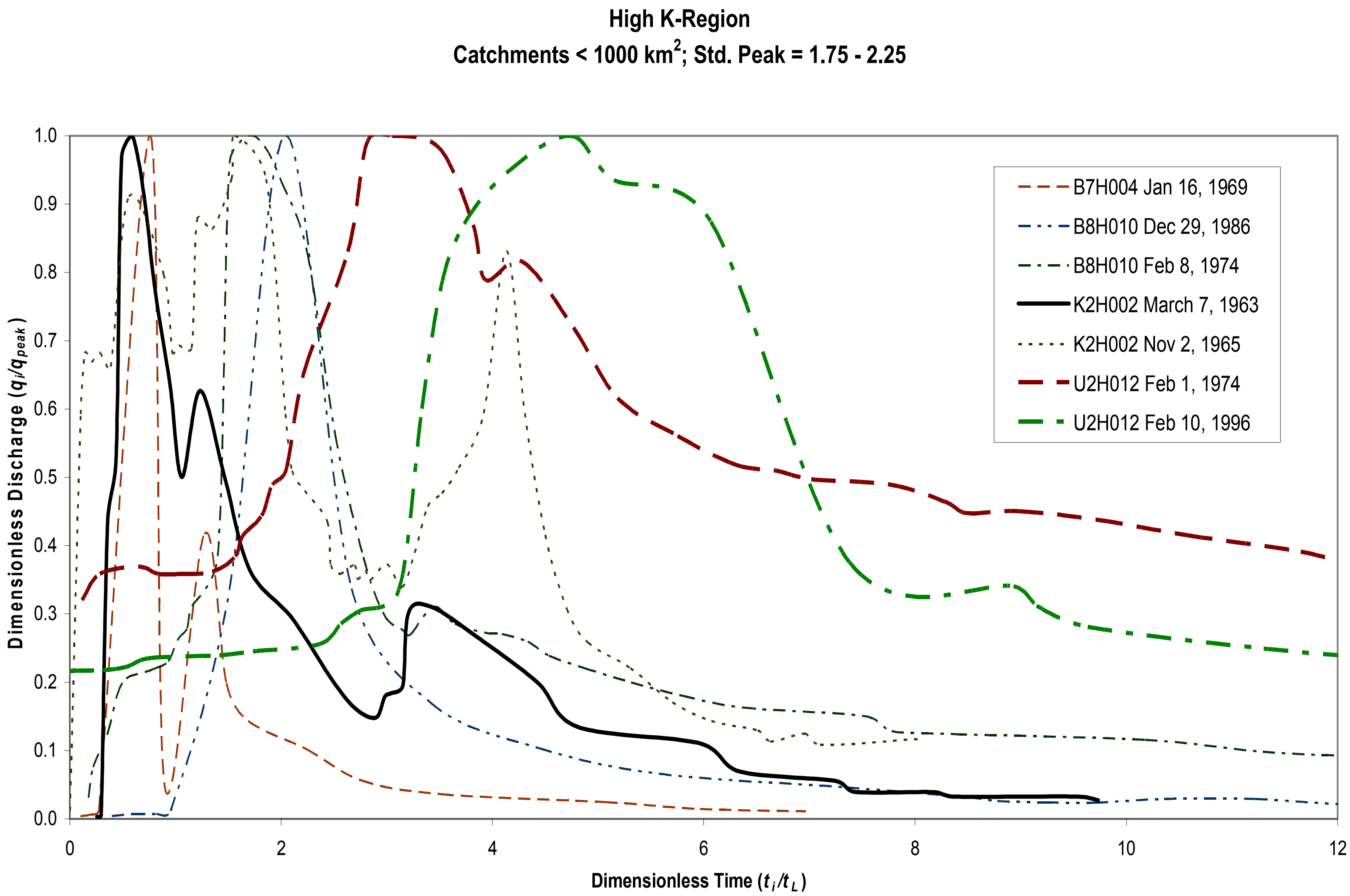


Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

B7H004	January 22, 1972	B7H004	December 19, 1973	B7H004	March 1, 1977	B8H010	February 22, 1972	B8H010	February 2, 1981	U2H012	December 15, 1975
Peak	92.4	**Peak**	91.7	**Peak**	113.7	**Peak**	145.8	**Peak**	149.5	**Peak**	58.3
Volume	2.0	**Volume**	3.2	**Volume**	1.8	**Volume**	11.2	**Volume**	18.1	**Volume**	19.0
Area	136	**Area**	136	**Area**	136	**Area**	477	**Area**	477	**Area**	438
Basin Lag	2.9	**Basin Lag**	2.9	**Basin Lag**	2.9	**Basin Lag**	4.5	**Basin Lag**	4.5	**Basin Lag**	6.0
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/Lag**	**Flow/Peak**
0.310	0.077	0.310	0.082	0.207	0.015	0.356	0.040	0.378	0.160	0.000	0.187
0.345	0.095	1.414	0.085	0.310	0.026	0.556	0.043	1.222	0.167	1.317	0.198
0.483	0.123	1.828	0.331	0.448	0.042	0.933	0.052	1.667	0.167	2.383	0.231
0.586	0.590	2.000	0.477	0.655	0.375	1.244	0.084	2.289	0.180	3.067	0.252
0.655	0.577	2.172	0.970	0.793	0.217	1.556	0.101	2.311	0.180	3.617	0.264
0.793	1.000	2.310	1.000	1.276	1.000	1.889	0.121	2.444	0.180	4.250	0.288
1.000	0.737	2.655	0.912	1.483	0.446	2.022	0.163	2.844	0.180	5.067	0.298
1.138	0.595	2.793	0.660	1.690	0.403	2.422	0.193	3.200	0.215	5.400	0.315
1.310	0.560	2.966	0.622	1.931	0.468	2.556	0.324	3.600	0.229	5.550	0.328
1.586	0.570	3.138	0.612	2.310	0.415	2.644	0.347	4.178	0.271	5.933	0.353
1.690	0.546	3.276	0.687	2.724	0.281	2.822	0.348	4.378	0.389	6.467	0.417
2.069	0.517	3.379	0.901	3.310	0.185	3.178	0.351	4.667	0.402	6.850	0.520
2.655	0.388	3.483	0.966	3.655	0.128	3.356	0.481	4.911	0.464	7.150	0.642
3.172	0.287	3.552	0.830	4.138	0.105	3.689	0.502	5.267	0.532	7.517	0.751
3.241	0.277	3.655	0.790	5.069	0.085	3.778	0.601	5.533	0.548	8.033	0.792
3.724	0.235	3.793	0.810	5.552	0.065	3.889	0.639	5.844	0.582	8.400	0.919
4.414	0.188	4.207	0.796	6.483	0.056	4.844	0.637	6.400	0.657	8.633	0.992
4.966	0.148	4.655	0.569	7.310	0.045	5.200	0.425	6.800	0.760	9.250	1.000
5.966	0.133	5.345	0.431	8.414	0.040	5.467	0.374	7.089	0.943	9.950	0.919
7.000	0.117	6.034	0.341	9.966	0.036	5.756	0.356	7.111	0.952	10.583	0.792
8.276	0.108	6.966	0.272			5.933	0.330	7.289	0.924	11.550	0.727
		7.690	0.213			6.200	0.321	7.311	0.924	12.417	0.608
						6.511	0.319	7.444	0.906	12.983	0.554
						6.778	0.315	7.556	0.908	14.500	0.540
						6.978	0.311	7.867	0.877	15.817	0.501
						7.200	0.315	8.111	0.931	17.183	0.465
						7.400	0.319	8.622	0.894	18.067	0.425
						7.556	0.374	8.978	0.719	19.367	0.403
						7.644	0.359	9.200	0.655	20.050	0.376
						7.800	0.356	9.556	0.657	20.517	0.362
						8.022	0.365	10.156	1.000	21.600	0.352
						8.578	0.388	10.489	0.659	22.833	0.335
						8.822	0.737	10.978	0.567	24.567	0.313
						8.956	1.000	11.733	0.525	25.850	0.281
						9.400	0.994	12.000	0.525	26.650	0.254
						10.022	0.735	12.867	0.514		
						10.556	0.477	13.778	0.424		
						10.867	0.403	13.956	0.365		
						11.111	0.382	15.000	0.362		

						11.356	0.360				
						11.644	0.355				
						12.200	0.348				
						12.667	0.312				
						12.911	0.298				
						13.089	0.307				
						13.733	0.308				
						14.289	0.268				
						15.689	0.202				
						17.867	0.201				
						18.644	0.161				
						19.333	0.153				
						19.800	0.149				
						20.511	0.120				



High K-Region
Catchments < 1000 km2; Std. Peak = 1.75 - 2.25
Dimensionless Discharge (qi/qpeak)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
Dimensionless Time (ti/tL)
B7H004 Jan 16, 1969
B8H010 Dec 29, 1986
B8H010 Feb 8, 1974
K2H002 March 7, 1963
K2H002 Nov 2, 1965
U2H012 Feb 1, 1974
U2H012 Feb 10, 1996

Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 1.75 – 2.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

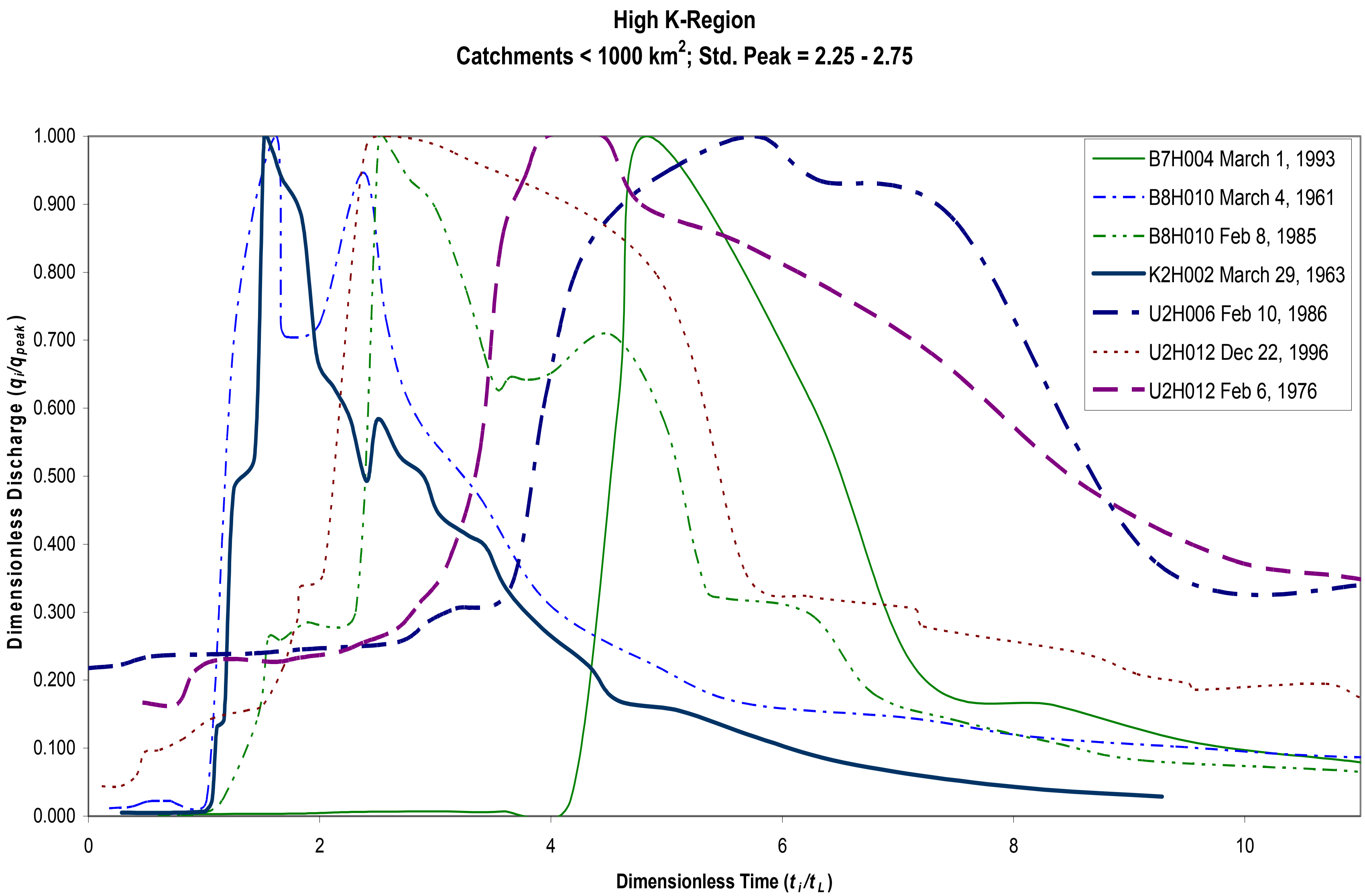
B7H004	**January 16, 1969**	**B8H010**	**December 29, 1986**	**U2H012**	**February 10, 1996**	**K2H002**	**March 7, 1963**
Peak	125.5	**Peak**	287.6	**Peak**	79.8	**Peak**	68.6
Volume	0.8	**Volume**	6.4	**Volume**	22.6	**Volume**	4.1
Area	136	**Area**	477	**Area**	438	**Area**	131
Basin Lag	2.9	**Basin Lag**	4.5	**Basin Lag**	6.0	**Basin Lag**	9.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.103	0.004	0.400	0.004	0.000	0.217	0.255	0.004
0.207	0.006	0.600	0.007	0.317	0.218	0.296	0.005
0.276	0.012	0.822	0.007	0.533	0.223	0.357	0.429
0.759	1.000	0.956	0.011	0.733	0.235	0.439	0.530
0.897	0.050	1.511	0.336	1.100	0.238	0.490	0.968
1.276	0.417	2.044	1.000	1.417	0.239	0.592	1.000
1.483	0.198	2.667	0.337	1.733	0.245	0.704	0.911
1.690	0.143	3.422	0.169	2.367	0.256	0.806	0.776
2.241	0.102	4.444	0.103	2.567	0.286	0.949	0.634
2.759	0.056	5.578	0.066	2.750	0.305	1.061	0.500
3.517	0.036	7.356	0.046	3.117	0.336	1.235	0.627
5.069	0.025	8.511	0.032	3.333	0.600	1.469	0.498
5.966	0.015	8.778	0.026	3.517	0.780	1.704	0.364
6.966	0.011	9.244	0.024	3.733	0.871	2.102	0.294
		9.711	0.024	4.133	0.946	2.480	0.204
		10.356	0.029	4.733	1.000	2.704	0.162
		11.222	0.029	5.150	0.936	2.898	0.148
		12.089	0.021	6.067	0.874	2.980	0.179
		13.556	0.016	7.400	0.372	3.041	0.184
				8.933	0.341	3.153	0.196
				9.150	0.312	3.204	0.301
				9.633	0.281	3.418	0.311
				11.300	0.250	3.847	0.267
				12.317	0.238	4.429	0.199
				13.817	0.233	4.806	0.135
				14.083	0.218	5.969	0.110
				15.667	0.190	6.337	0.070
				17.483	0.170	7.245	0.056
				17.600	0.150	7.429	0.040
						8.184	0.039
						8.367	0.033
						9.541	0.033
						9.735	0.027

Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

K2H002	November 2, 1965	U2H012	February 1, 1974	B8H010	February 8, 1974
Peak	84.5	**Peak**	63.5	**Peak**	254.8
Volume	5.2	**Volume**	13.2	**Volume**	15.4
Area	131	**Area**	438	**Area**	477
Basin Lag	9.8	**Basin Lag**	6.0	**Basin Lag**	4.5
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.002	0.012	0.117	0.320	0.178	0.031
0.102	0.593	0.283	0.358	0.222	0.076
0.143	0.682	0.650	0.369	0.356	0.124
0.204	0.669	0.833	0.359	0.444	0.179
0.286	0.682	1.033	0.358	0.533	0.205
0.388	0.662	1.350	0.362	0.711	0.215
0.561	0.911	1.567	0.385	0.800	0.220
0.888	0.797	1.633	0.413	0.933	0.231
0.969	0.682	1.817	0.444	1.022	0.262
1.031	0.693	1.917	0.489	1.111	0.279
1.153	0.689	2.050	0.512	1.156	0.311
1.204	0.878	2.217	0.653	1.400	0.385
1.347	0.863	2.633	0.830	1.511	0.960
1.531	0.937	2.817	0.991	1.689	1.000
1.561	1.000	3.050	1.000	1.844	0.984
1.857	0.937	3.500	0.982	2.000	0.934
2.041	0.593	3.817	0.870	2.244	0.830
2.102	0.510	3.933	0.789	2.511	0.564
2.224	0.480	4.283	0.816	2.778	0.383
2.439	0.434	4.767	0.719	2.978	0.298
2.469	0.372	5.183	0.616	3.156	0.276
2.561	0.359	5.750	0.561	3.222	0.269
2.694	0.371	6.300	0.519	3.444	0.311
2.724	0.351	6.683	0.510	3.644	0.285
2.796	0.364	7.017	0.497	3.933	0.273
2.847	0.350	7.767	0.489	4.089	0.271
3.000	0.373	8.300	0.463	4.333	0.259
3.143	0.339	8.483	0.448	4.533	0.239
3.265	0.389	8.983	0.450	4.867	0.221
3.388	0.457	9.733	0.438	5.311	0.200
3.520	0.477	10.583	0.415	5.800	0.180
3.684	0.514	11.650	0.391	6.378	0.163
3.918	0.594	12.333	0.366	7.533	0.150
4.133	0.831	13.433	0.351	7.778	0.128
4.306	0.594	13.833	0.335	8.378	0.124
4.500	0.416	14.700	0.329	10.178	0.116
4.704	0.307	15.300	0.325	11.289	0.098
4.908	0.258	15.833	0.324	12.222	0.091
5.306	0.221	16.200	0.329	13.533	0.085

5.704	0.171	16.433	0.336	15.000	0.078
6.071	0.143	17.100	0.343	16.844	0.073
6.510	0.129	17.783	0.350	18.200	0.067
6.633	0.113	18.417	0.354	20.244	0.064
6.959	0.125	19.017	0.353	21.489	0.060
7.102	0.108	19.517	0.349	21.889	0.051


High K-Region
Catchments < 1000 km²; Std. Peak = 2.25 - 2.75
Dimensionless Discharge (q_i/q_{peak})
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
2
4
6
8
10
Dimensionless Time (t_i/t_L)
B7H004 March 1, 1993
B8H010 March 4, 1961
B8H010 Feb 8, 1985
K2H002 March 29, 1963
U2H006 Feb 10, 1986
U2H012 Dec 22, 1996
U2H012 Feb 6, 1976

Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 2.25 – 2.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

B7H004	**March 1, 1993**	**B8H010**	**March 2, 1961**	**B8H010**	**February 8, 1985**	**K2H002**	**March 29, 1963**
Peak	241.6	**Peak**	347.2	**Peak**	333.6	**Peak**	145.7
Volume	4.7	**Volume**	14.1	**Volume**	17.3	**Volume**	9.8
Area	136	**Area**	477	**Area**	477	**Area**	131
Basin Lag	2.9	**Basin Lag**	4.5	**Basin Lag**	4.5	**Basin Lag**	9.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.897	0.003	0.178	0.012	0.600	0.001	0.286	0.005
1.828	0.004	0.333	0.013	0.800	0.002	0.541	0.005
2.310	0.006	0.400	0.015	0.978	0.004	0.643	0.005
3.034	0.007	0.511	0.022	1.156	0.023	0.776	0.005
3.586	0.007	0.644	0.022	1.467	0.147	0.898	0.005
4.172	0.025	0.711	0.022	1.556	0.263	0.980	0.007
4.586	0.612	1.022	0.024	1.667	0.259	1.020	0.009
4.828	1.000	1.267	0.716	1.889	0.285	1.071	0.026
6.241	0.612	1.622	1.000	2.311	0.300	1.112	0.131
7.172	0.212	1.667	0.720	2.511	1.000	1.173	0.144
8.379	0.162	1.711	0.705	2.622	0.979	1.255	0.479
9.586	0.108	2.000	0.725	2.778	0.937	1.439	0.530
10.966	0.080	2.378	0.946	3.000	0.895	1.520	1.000
11.586	0.063	2.578	0.727	3.267	0.773	1.592	0.979
12.310	0.064	2.822	0.592	3.422	0.680	1.673	0.938
12.897	0.070	3.378	0.471	3.533	0.628	1.847	0.878
14.897	0.070	3.978	0.312	3.622	0.642	1.980	0.673
18.414	0.049	4.911	0.220	3.667	0.646	2.122	0.630
21.517	0.033	5.667	0.166	3.800	0.642	2.265	0.583
22.724	0.027	7.111	0.144	4.000	0.651	2.408	0.493
26.690	0.032	8.156	0.117	4.511	0.709	2.500	0.584
		9.400	0.102	4.978	0.581	2.694	0.529
		10.689	0.088	5.244	0.392	2.898	0.500
		12.667	0.079	5.356	0.328	3.031	0.445
		13.422	0.068	5.511	0.320	3.276	0.414
		15.644	0.064	6.244	0.297	3.439	0.395
		15.867	0.056	6.778	0.181	3.612	0.335
		16.111	0.056	7.511	0.141	3.929	0.275
		16.667	0.058	8.378	0.107	4.327	0.221
		17.200	0.068	9.111	0.082	4.571	0.171
		17.333	0.075	10.689	0.068	5.112	0.155
		17.467	0.076	12.067	0.054	5.776	0.116
		17.711	0.076	12.533	0.045	6.439	0.082
		17.867	0.072			7.296	0.057
		18.267	0.071			8.265	0.039
		18.578	0.070			9.286	0.029
		19.800	0.068				
		20.822	0.056				
		23.511	0.051				

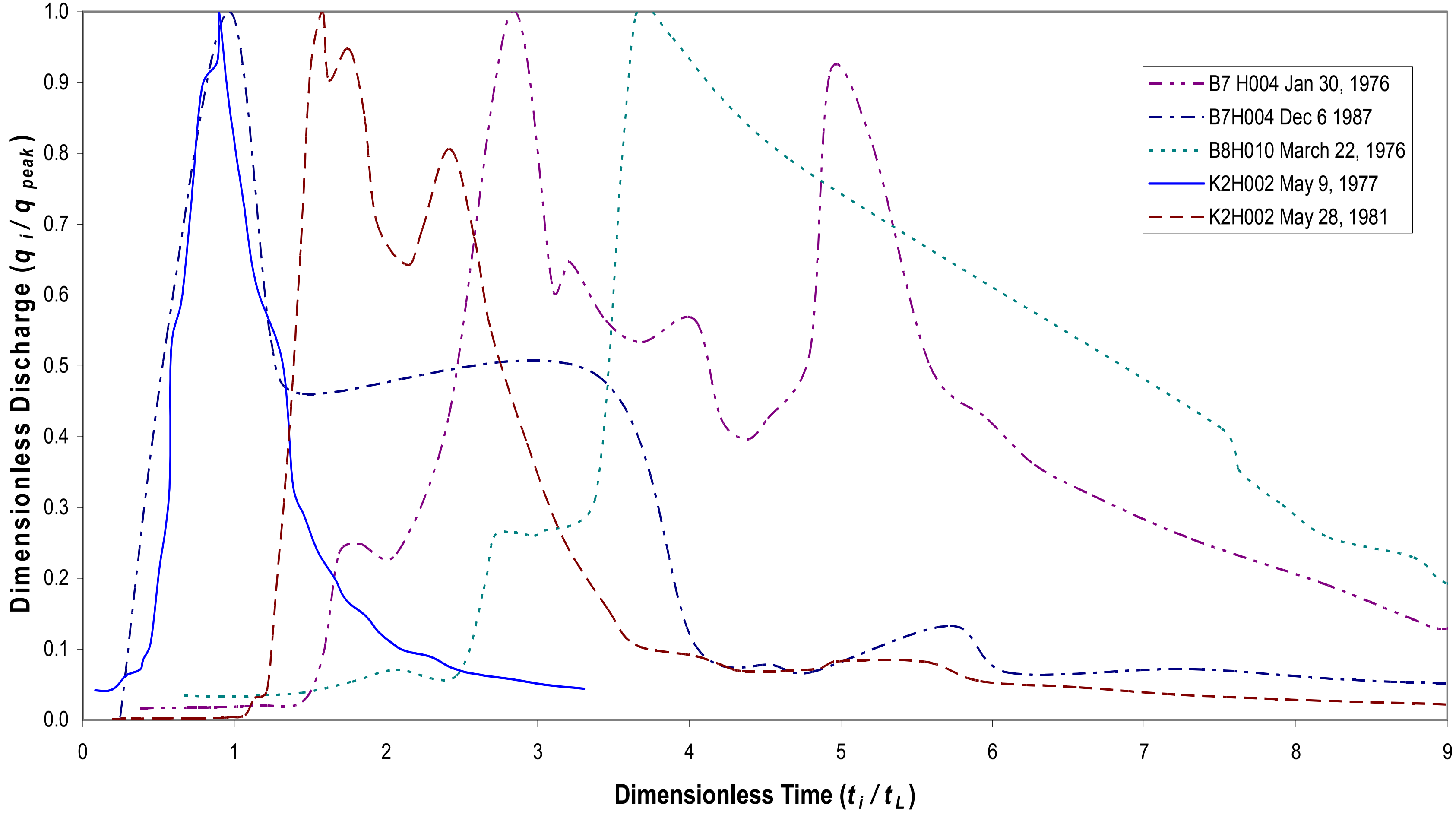
		23.511	0.045				
		25.556	0.041				
		27.511	0.039				

Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 2.25 – 2.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H006	February 10, 1996	U2H012	December 22, 1996	U2H012	February 6, 1976
Peak	79.8	**Peak**	89.4	**Peak**	85.0
Volume	22.6	**Volume**	10.5	**Volume**	12.1
Area	339	**Area**	438	**Area**	438
Basin Lag	4.6	**Basin Lag**	6.0	**Basin Lag**	6.0
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.000	0.218	0.117	0.044	0.467	0.167
0.283	0.223	0.283	0.044	0.767	0.165
0.543	0.235	0.417	0.060	0.917	0.213
1.022	0.238	0.483	0.094	1.167	0.231
1.435	0.239	0.617	0.097	1.617	0.227
1.848	0.245	0.817	0.113	1.833	0.233
2.674	0.256	1.067	0.143	2.167	0.242
2.935	0.286	1.367	0.155	2.383	0.255
3.174	0.305	1.517	0.165	2.667	0.275
3.652	0.336	1.683	0.218	2.867	0.314
3.935	0.600	1.767	0.266	3.100	0.368
4.174	0.780	1.817	0.298	3.383	0.534
4.457	0.871	1.833	0.338	3.567	0.840
4.978	0.946	2.033	0.357	3.783	0.943
5.761	1.000	2.267	0.792	3.950	0.998
6.304	0.936	2.400	0.983	4.450	1.000
7.500	0.874	2.583	1.000	4.783	0.900
9.239	0.372	3.167	0.975	5.700	0.838
11.239	0.341	4.917	0.795	7.200	0.692
11.522	0.312	5.683	0.357	8.567	0.491
12.152	0.281	6.233	0.323	9.850	0.379
14.326	0.250	7.150	0.305	10.833	0.353
15.652	0.238	7.217	0.279	11.667	0.333
17.609	0.233	8.583	0.240	12.717	0.313
17.957	0.218	9.067	0.209	13.667	0.292
20.022	0.190	9.517	0.195	14.767	0.277
22.391	0.170	9.567	0.186	15.367	0.259
22.543	0.150	10.700	0.195		
		11.033	0.172		
		11.517	0.166		
		12.733	0.161		
		13.700	0.151		
		14.617	0.141		
		15.550	0.129		

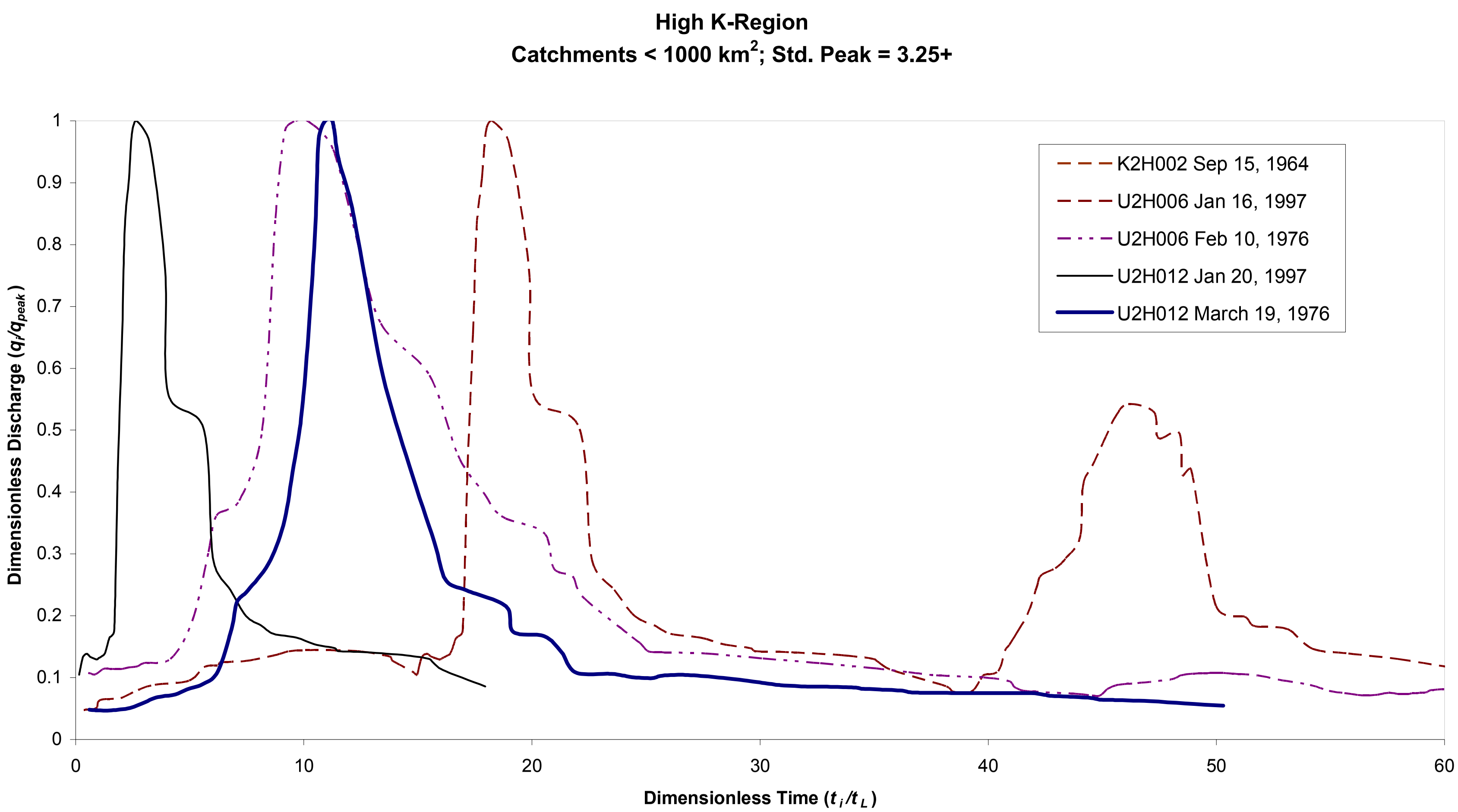
HIGH K-Region
Catchments < 1000 km²; Std. Peak = 2.75 - 3.25



Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 2.75 – 3.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

B7H004	January 30, 1976	B7H004	December 6, 1987	B8H010	March 22, 1976	K2H002	May 9, 1977	K2H002	May 28, 1981
Peak	336.0	Peak	273.3	Peak	526.2	Peak	247.1	Peak	211.1
Volume	14.7	Volume	5.6	Volume	35.1	Volume	7.0	Volume	11.1
Area	136	Area	136	Area	477	Area	131	Area	131
Basin Lag	2.9	Basin Lag	2.9	Basin Lag	4.5	Basin Lag	9.8	Basin Lag	9.8
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.379	0.016	0.241	0.004	0.667	0.034	0.082	0.042	0.194	0.001
0.759	0.017	0.247	0.005	0.911	0.033	0.153	0.041	0.316	0.002
0.862	0.018	0.552	0.538	1.067	0.033	0.214	0.046	0.510	0.002
1.034	0.019	0.966	1.000	1.200	0.035	0.286	0.063	0.724	0.002
1.172	0.021	1.241	0.536	1.444	0.038	0.378	0.071	0.888	0.003
1.448	0.025	1.448	0.461	1.778	0.054	0.398	0.085	0.969	0.004
1.586	0.094	3.379	0.488	2.067	0.071	0.449	0.110	1.071	0.007
1.690	0.235	4.034	0.107	2.467	0.062	0.500	0.205	1.133	0.031
1.828	0.248	4.552	0.078	2.644	0.185	0.571	0.327	1.214	0.041
2.069	0.234	4.793	0.067	2.711	0.258	0.582	0.524	1.276	0.184
2.414	0.428	5.724	0.133	2.844	0.264	0.653	0.594	1.357	0.394
2.828	1.000	6.103	0.067	2.978	0.260	0.714	0.729	1.439	0.672
3.103	0.606	7.310	0.072	3.044	0.267	0.786	0.893	1.500	0.918
3.207	0.647	8.690	0.053	3.378	0.311	0.888	0.930	1.582	1.000
3.448	0.564	11.793	0.040	3.556	0.791	0.898	1.000	1.622	0.903
3.690	0.534	12.310	0.026	3.644	0.994	0.949	0.897	1.755	0.948
4.034	0.565	14.759	0.019	3.756	1.000	1.010	0.800	1.857	0.853
4.207	0.426	15.759	0.014	3.889	0.963	1.061	0.729	1.939	0.702
4.379	0.396	16.586	0.016	4.667	0.790	1.143	0.615	2.143	0.642
4.517	0.425	19.897	0.016	7.511	0.411	1.316	0.504	2.235	0.689
4.793	0.516	20.862	0.013	7.622	0.353	1.388	0.329	2.418	0.806
4.931	0.915	22.207	0.011	7.911	0.303	1.459	0.289	2.582	0.682
5.207	0.812	25.655	0.011	8.222	0.257	1.551	0.237	2.694	0.549
5.586	0.500			8.778	0.230	1.663	0.199	2.929	0.391
5.966	0.425			9.000	0.193	1.735	0.170	3.163	0.258
6.276	0.361			9.467	0.188	1.867	0.147	3.459	0.157
6.655	0.317			9.800	0.196	1.949	0.125	3.643	0.106
7.310	0.256			10.111	0.185	2.031	0.110	4.041	0.090
8.172	0.193			10.422	0.180	2.122	0.098	4.255	0.074
8.724	0.146			10.511	0.173	2.296	0.089	4.347	0.069
8.966	0.129			10.756	0.174	2.408	0.076	4.602	0.069
9.172	0.143			11.400	0.171	2.500	0.069	4.867	0.073
9.310	0.130			12.000	0.145	2.622	0.063	4.969	0.082
9.483	0.138			12.333	0.128	2.837	0.057	5.551	0.082
9.586	0.131			12.778	0.123	3.041	0.050	5.918	0.055
9.655	0.138			13.289	0.120	3.306	0.044	6.571	0.046

9.828	0.192			13.911	0.117			7.245	0.035
10.000	0.180			14.711	0.110			8.082	0.028
10.379	0.207			15.422	0.103			9.020	0.022
10.724	0.165			16.800	0.097				
10.931	0.184			18.067	0.088				
11.207	0.200			18.111	0.080				
11.310	0.227			18.889	0.069				
11.448	0.228			19.644	0.068				
12.034	0.226			20.911	0.065				
12.448	0.179			22.156	0.061				
13.483	0.153			23.467	0.057				
14.621	0.122			26.089	0.053				
15.828	0.099			27.289	0.047				
16.759	0.084			27.867	0.045				
				28.733	0.044				
				29.222	0.045				
				29.667	0.047				
				30.044	0.047				
				30.800	0.046				
				31.378	0.043				
				32.244	0.042				
				33.156	0.040				
				34.111	0.039				
				35.467	0.038				
				36.778	0.037				
				38.111	0.035				
				39.489	0.034				
				40.844	0.034				
				41.778	0.032				
				42.444	0.031				


High K-Region
Catchments < 1000 km²; Std. Peak = 3.25+
Dimensionless Discharge (q_i/q_{peak})
Dimensionless Time (t_i/t_L)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
10
20
30
40
50
60
K2H002 Sep 15, 1964
U2H006 Jan 16, 1997
U2H006 Feb 10, 1976
U2H012 Jan 20, 1997
U2H012 March 19, 1976

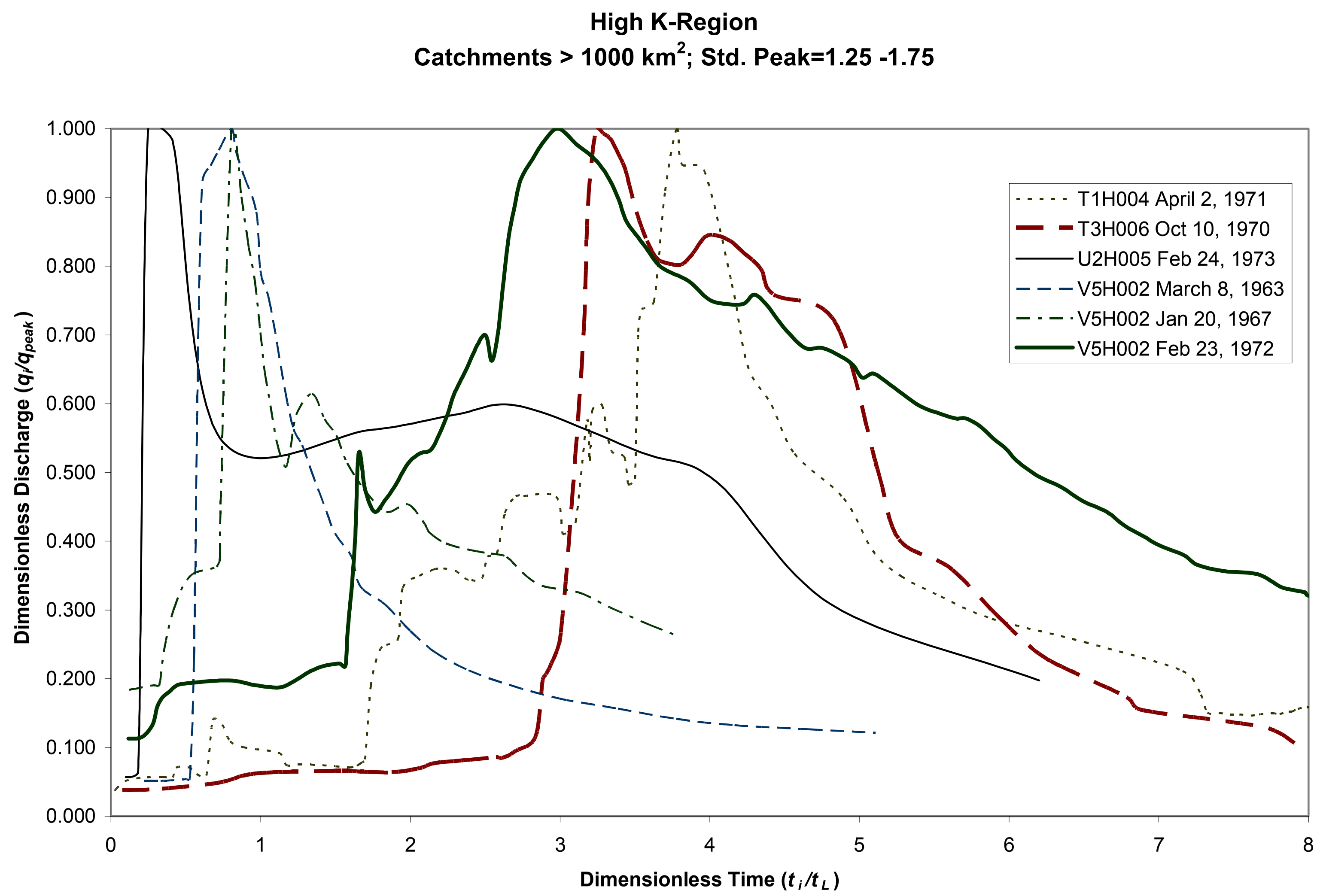
Standardised Hydrographs: High K-Region; Area < 1000 km^2; Std. Peak 3.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H006	January 16, 1997	U2H006	February 10, 1976	U2H012	January 20, 1997	U2H012	March 18, 1976
Peak	157.0	**Peak**	197.6	**Peak**	157.0	**Peak**	294.4
Volume	17.2	**Volume**	54.9	**Volume**	17.5	**Volume**	57.7
Area	339	**Area**	339	**Area**	438	**Area**	438
Basin Lag	4.6	**Basin Lag**	4.6	**Basin Lag**	6.0	**Basin Lag**	6.0
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.348	0.048	0.543	0.108	0.150	0.105	0.600	0.048
0.543	0.049	0.870	0.105	0.217	0.117	0.933	0.047
0.913	0.051	1.217	0.114	0.333	0.134	1.567	0.047
1.087	0.064	1.500	0.114	0.500	0.138	2.383	0.051
1.978	0.067	1.957	0.114	0.633	0.134	3.033	0.060
2.739	0.080	2.326	0.116	0.767	0.132	3.433	0.067
3.478	0.089	2.717	0.119	0.900	0.130	3.800	0.070
4.978	0.095	3.022	0.124	0.967	0.130	4.367	0.073
5.630	0.117	4.152	0.130	1.000	0.131	4.867	0.081
6.261	0.120	5.109	0.191	1.133	0.135	5.533	0.089
6.326	0.125	5.826	0.303	1.283	0.139	6.217	0.109
7.500	0.127	6.174	0.362	1.433	0.160	6.833	0.179
8.739	0.136	7.174	0.386	1.500	0.166	7.067	0.221
9.348	0.143	8.174	0.499	1.683	0.175	7.550	0.241
10.065	0.144	8.761	0.842	1.850	0.439	8.450	0.284
11.022	0.144	9.174	0.984	2.033	0.654	9.100	0.346
12.522	0.142	9.652	1.000	2.150	0.825	9.500	0.431
13.761	0.134	10.196	0.999	2.333	0.907	9.967	0.550
13.891	0.127	11.283	0.954	2.467	0.981	10.450	0.795
14.761	0.110	12.391	0.799	2.667	1.000	10.650	0.970
14.957	0.105	13.370	0.673	3.250	0.963	10.933	1.000
15.043	0.117	15.500	0.589	3.917	0.761	11.250	1.000
15.196	0.134	16.761	0.459	4.050	0.559	11.517	0.939
15.413	0.138	17.870	0.399	5.617	0.502	12.083	0.866
15.587	0.134	18.652	0.361	6.033	0.290	12.717	0.738
15.761	0.132	20.522	0.334	6.783	0.242	13.467	0.588
15.935	0.130	20.957	0.277	7.467	0.200	14.633	0.441
16.022	0.130	21.783	0.264	8.133	0.184	15.717	0.319
16.065	0.131	22.217	0.231	8.667	0.171	16.217	0.258
16.239	0.135	24.370	0.166	9.667	0.165	17.133	0.241
16.435	0.139	24.761	0.155	10.450	0.154	18.867	0.215
16.630	0.160	25.087	0.143	11.367	0.148	19.183	0.174
16.717	0.166	25.522	0.141	11.500	0.143	20.533	0.167
16.957	0.175	27.587	0.139	12.733	0.141	21.283	0.142
17.174	0.439	30.109	0.131	14.500	0.136	21.917	0.108
17.413	0.654	32.630	0.123	15.483	0.130	23.483	0.106
17.565	0.825	34.848	0.116	15.650	0.125	24.317	0.101
17.804	0.907	36.500	0.109	16.100	0.112	24.800	0.099
17.978	0.981	37.717	0.104	17.950	0.086	25.300	0.099
18.239	1.000	39.891	0.100			25.617	0.103

19.000	0.963	40.913	0.094			26.083	0.104
19.870	0.761	41.152	0.085			26.833	0.104
20.043	0.559	41.609	0.079			28.050	0.101
22.087	0.502	43.826	0.074			29.417	0.095
22.630	0.290	44.543	0.071			30.417	0.090
23.609	0.242	44.891	0.071			30.900	0.088
24.500	0.200	45.261	0.082			31.517	0.087
25.370	0.184	45.717	0.088			32.183	0.085
26.065	0.171	46.543	0.091			33.383	0.085
27.370	0.165	48.022	0.097			34.267	0.083
28.391	0.154	48.457	0.104			34.450	0.082
29.587	0.148	48.891	0.106			35.250	0.081
29.761	0.143	49.500	0.107			36.233	0.079
31.370	0.141	49.913	0.108			36.583	0.076
33.674	0.136	50.304	0.108			37.217	0.076
34.957	0.130	50.848	0.106			37.367	0.076
35.174	0.125	51.783	0.104			37.667	0.075
35.761	0.112	52.761	0.096			37.867	0.075
38.174	0.086	54.109	0.088			38.583	0.075
38.435	0.077	54.935	0.079			39.417	0.075
39.239	0.077	55.609	0.075			41.033	0.075
39.674	0.097	56.196	0.072			41.883	0.075
39.804	0.104	56.587	0.071			42.433	0.072
40.435	0.110	57.065	0.072			42.767	0.071
40.739	0.143	57.457	0.075			43.483	0.070
40.957	0.154	57.739	0.075			44.450	0.067
41.239	0.172	57.978	0.074			44.883	0.064
41.717	0.201	58.370	0.074			45.300	0.064
42.109	0.244	58.609	0.075			47.067	0.062
42.304	0.265	59.196	0.076			48.633	0.058
42.935	0.277	59.391	0.080			50.300	0.055
43.391	0.293	60.022	0.082				
44.022	0.327	60.435	0.085				
44.152	0.411	60.848	0.085				
44.565	0.442	61.717	0.085				
45.022	0.479	62.848	0.080				
45.587	0.522	63.848	0.074				
46.130	0.542	65.304	0.071				
47.261	0.529	66.435	0.069				
47.457	0.487	67.870	0.068				
48.370	0.496	68.500	0.065				
48.522	0.427	70.022	0.061				
48.891	0.436	70.370	0.055				
49.978	0.216	72.087	0.053				
51.239	0.198						
51.674	0.183						
53.087	0.179						
54.196	0.147						

55.783	0.139						
57.935	0.130						
60.152	0.117						
62.043	0.108						
63.935	0.089						
64.065	0.082						
65.261	0.078						
65.435	0.070						
66.609	0.065						
67.957	0.063						
68.739	0.061						
70.304	0.059						
71.870	0.057						

Appendix F 1 (b)



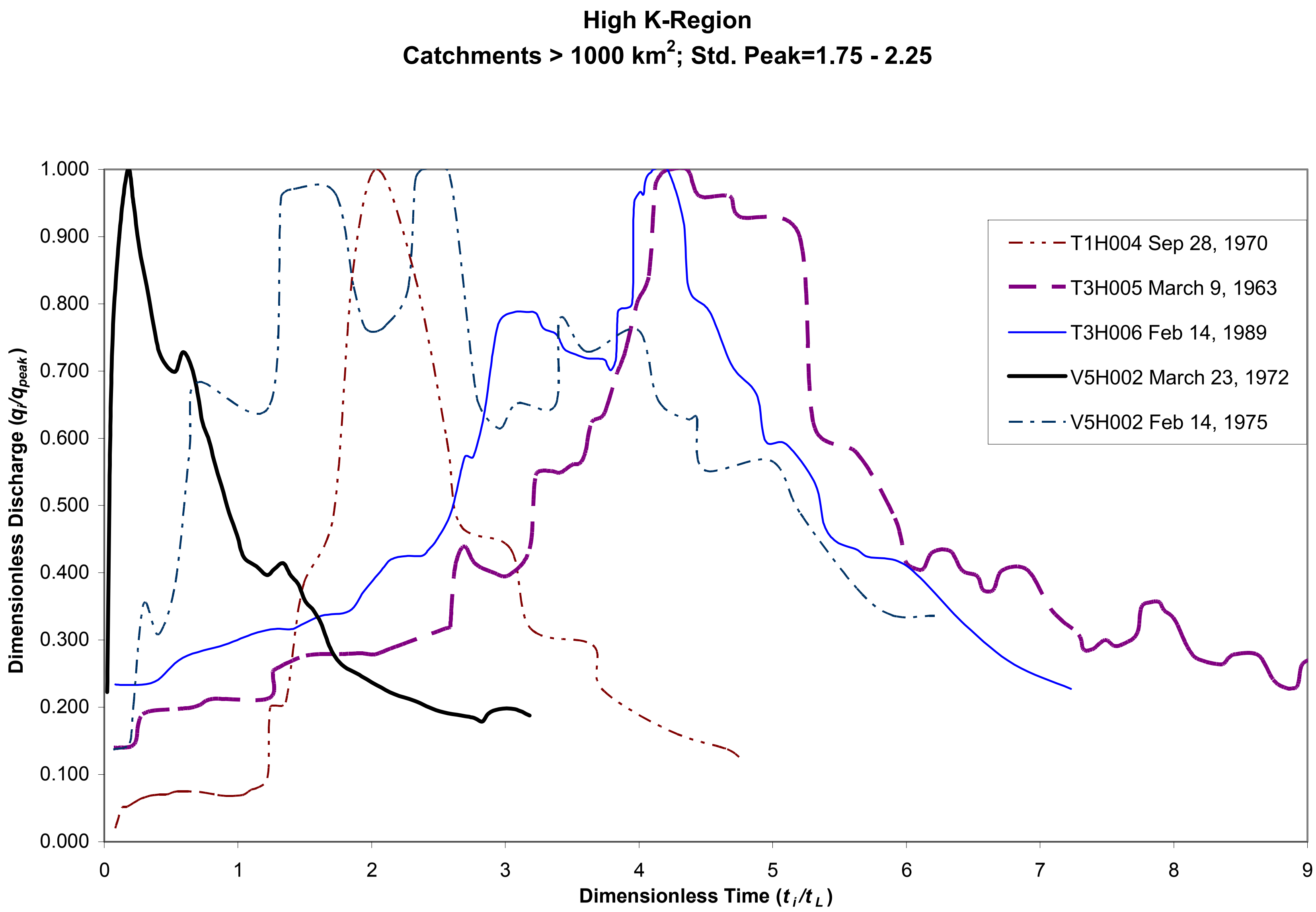
Standardised Hydrographs: High K-Region; Area > 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

T1H004	April 2, 1971	T3H006	October 10, 1970	U2H005	February 24, 1973	V5H002	March 8, 1963	V5H002	January 20, 1967	V5H002	February 23, 1972
Peak	247.9	**Peak**	659.8	**Peak**	330.3	**Peak**	2332.0	**Peak**	2295.7	**Peak**	2461.0
Volume	40.8	**Volume**	134.9	**Volume**	37.1	**Volume**	200.6	**Volume**	227.5	**Volume**	799.4
Area	4908	**Area**	4268	**Area**	2519	**Area**	28920	**Area**	28920	**Area**	28920
Basin Lag	18.2	**Basin Lag**	20.8	**Basin Lag**	6.1	**Basin Lag**	18.0	**Basin Lag**	18.0	**Basin Lag**	18.0
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.027	0.037	0.077	0.038	0.099	0.057	0.222	0.051	0.122	0.184	0.117	0.113
0.033	0.039	0.341	0.040	0.181	0.065	0.333	0.051	0.289	0.190	0.172	0.113
0.093	0.050	0.721	0.049	0.247	1.000	0.500	0.054	0.322	0.190	0.205	0.115
0.170	0.055	0.899	0.060	0.412	0.983	0.527	0.054	0.355	0.242	0.239	0.121
0.242	0.057	1.072	0.064	0.726	0.551	0.555	0.227	0.416	0.299	0.283	0.136
0.346	0.057	1.543	0.066	1.732	0.562	0.583	0.706	0.527	0.349	0.305	0.156
0.412	0.057	1.668	0.065	2.309	0.585	0.611	0.923	0.705	0.363	0.339	0.171
0.434	0.070	1.875	0.064	2.738	0.596	0.666	0.946	0.727	0.377	0.389	0.181
0.516	0.071	2.048	0.069	3.546	0.529	0.722	0.969	0.733	0.453	0.444	0.191
0.571	0.061	2.163	0.077	4.041	0.487	0.805	1.000	0.805	1.000	0.539	0.194
0.637	0.059	2.341	0.081	4.816	0.307	0.833	0.969	0.872	0.900	0.788	0.198
0.681	0.140	2.572	0.086	6.201	0.198	0.888	0.931	0.916	0.834	0.955	0.191
0.742	0.133	2.601	0.084			0.972	0.879	0.961	0.778	1.072	0.187
0.797	0.109	2.649	0.087			0.999	0.793	0.999	0.703	1.138	0.187
0.885	0.100	2.707	0.095			1.055	0.752	1.027	0.645	1.205	0.194
1.121	0.092	2.837	0.116			1.110	0.686	1.066	0.596	1.283	0.204
1.170	0.074	2.885	0.198			1.166	0.617	1.110	0.542	1.338	0.211
1.253	0.075	2.909	0.207			1.221	0.563	1.166	0.508	1.421	0.218
1.335	0.075	2.942	0.222			1.277	0.539	1.199	0.536	1.527	0.222
1.500	0.072	3.000	0.259			1.332	0.506	1.238	0.584	1.566	0.218
1.593	0.071	3.077	0.450			1.388	0.473	1.344	0.614	1.582	0.271
1.643	0.073	3.159	0.704			1.444	0.441	1.427	0.578	1.627	0.389
1.665	0.077	3.188	0.888			1.499	0.410	1.505	0.554	1.655	0.528
1.698	0.083	3.240	1.000			1.610	0.376	1.577	0.514	1.699	0.474
1.736	0.189	3.288	0.993			1.666	0.334	1.693	0.475	1.760	0.443
1.797	0.242	3.337	0.985			1.832	0.308	1.838	0.443	1.827	0.458
1.841	0.249	3.389	0.963			1.999	0.270	1.982	0.453	1.893	0.479
1.918	0.258	3.438	0.938			2.165	0.238	2.088	0.427	1.949	0.500
1.951	0.332	3.510	0.879			2.387	0.212	2.132	0.412	1.999	0.517
2.060	0.349	3.582	0.837			2.665	0.191	2.237	0.397	2.065	0.528
2.159	0.359	3.649	0.811			2.998	0.171	2.404	0.387	2.138	0.533
2.220	0.360	3.726	0.804			3.387	0.156	2.537	0.382	2.193	0.556
2.302	0.357	3.808	0.802			3.775	0.141	2.643	0.377	2.249	0.584
2.363	0.346	3.880	0.816			4.164	0.132	2.754	0.353	2.293	0.614
2.407	0.343	3.966	0.842			4.664	0.127	2.882	0.335	2.360	0.644
2.478	0.346	4.038	0.845			5.108	0.122	3.120	0.326	2.493	0.700
2.516	0.377	4.135	0.837					3.331	0.304	2.543	0.662
2.577	0.382	4.226	0.820					3.598	0.278	2.587	0.706
2.632	0.441	4.341	0.796					3.792	0.262	2.626	0.785

2.703	0.465	4.428	0.759							2.659	0.847
2.758	0.466	4.837	0.718							2.698	0.889
2.973	0.465	5.120	0.504							2.737	0.926
3.016	0.411	5.264	0.403							2.815	0.955
3.049	0.413	5.601	0.362							2.904	0.985
3.104	0.428	5.918	0.292							2.993	1.000
3.181	0.575	6.149	0.245							3.109	0.977
3.198	0.518	6.303	0.223							3.198	0.962
3.214	0.589	6.784	0.173							3.265	0.948
3.280	0.598	6.875	0.155							3.331	0.926
3.341	0.532	7.447	0.138							3.392	0.896
3.429	0.522	7.745	0.127							3.437	0.868
3.456	0.483	7.928	0.103							3.503	0.847
3.500	0.490									3.576	0.826
3.522	0.705									3.675	0.799
3.544	0.737									3.859	0.778
3.626	0.748									3.992	0.752
3.703	0.909									4.103	0.745
3.780	1.000									4.225	0.745
3.813	0.948									4.297	0.758
3.962	0.939									4.375	0.745
4.148	0.774									4.442	0.726
4.253	0.656									4.514	0.706
4.412	0.598									4.636	0.681
4.566	0.527									4.753	0.681
4.896	0.462									4.875	0.669
5.088	0.386									4.958	0.656
5.280	0.349									5.019	0.638
5.544	0.319									5.091	0.644
5.885	0.287									5.180	0.632
6.505	0.253									5.291	0.614
7.159	0.211									5.408	0.596
7.280	0.176									5.552	0.584
7.324	0.151									5.646	0.579
7.401	0.150									5.713	0.579
7.473	0.148									5.807	0.567
7.538	0.148									5.891	0.550
7.615	0.146									5.985	0.533
7.670	0.148									6.052	0.517
7.758	0.150									6.191	0.495
7.808	0.149									6.346	0.479
7.868	0.152									6.490	0.458
7.890	0.152									6.651	0.443
7.929	0.156									6.768	0.423
7.989	0.159									6.890	0.408
8.104	0.159									7.007	0.394
8.165	0.158									7.168	0.379

8.192	0.181									7.257	0.366
8.253	0.186									7.434	0.356
8.286	0.187									7.662	0.352
8.324	0.190									7.812	0.334
8.368	0.207									7.884	0.330
8.423	0.215									7.978	0.325
8.473	0.220									8.001	0.321
8.489	0.237									8.668	0.321
8.538	0.260									8.689	0.321
8.588	0.290									8.783	0.317
8.654	0.294									8.905	0.304
8.791	0.292									9.022	0.296
8.874	0.282									9.139	0.296
8.984	0.272									9.250	0.291
9.478	0.251									9.394	0.283
9.709	0.175									9.461	0.279
9.791	0.158									9.538	0.275
10.005	0.155									9.605	0.283
10.275	0.142									9.699	0.287
10.401	0.133									9.766	0.287
10.571	0.130									9.838	0.279
10.659	0.124									9.922	0.267
10.934	0.124									10.010	0.259
11.319	0.117									10.127	0.252
11.621	0.109									10.255	0.244
11.934	0.094									10.360	0.237
12.082	0.092									10.493	0.233
12.495	0.092									10.793	0.226
12.670	0.079									11.015	0.208
13.060	0.074									11.126	0.201
										11.243	0.201
										11.371	0.201
										11.487	0.201
										11.604	0.194


High K-Region
Catchments > 1000 km²; Std. Peak=1.75 - 2.25
Dimensionless Discharge (q_i/q_peak)
Dimensionless Time (t_i/t_L)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
1
2
3
4
5
6
7
8
9
T1H004 Sep 28, 1970
T3H005 March 9, 1963
T3H006 Feb 14, 1989
V5H002 March 23, 1972
V5H002 Feb 14, 1975

Standardised Hydrographs: High K-Region; Area > 1000 km^2; Std. Peak 1.75 – 2.25

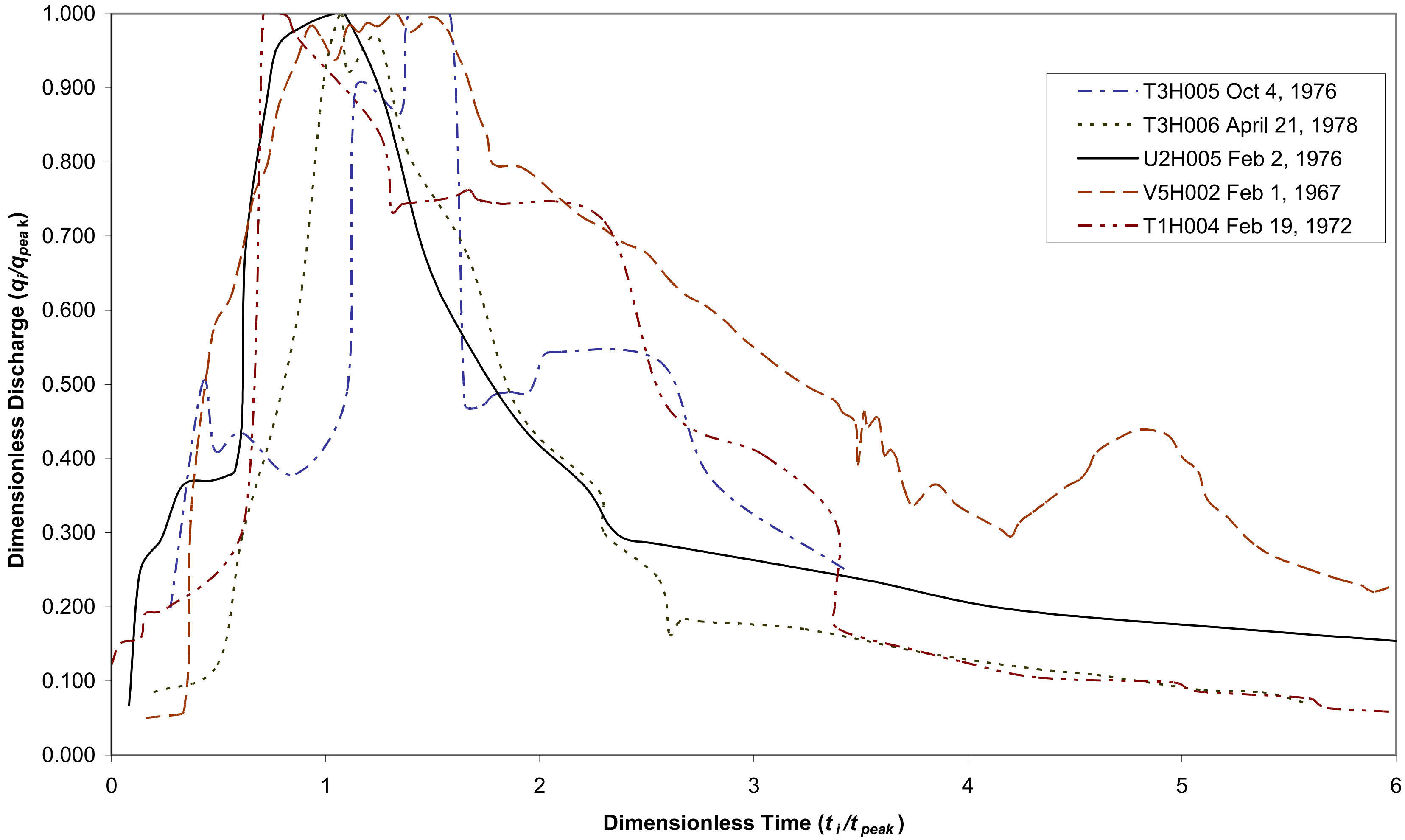
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

T1H004	September 28, 1970	T3H005	March 9, 1963	T3H006	February 14, 1989	V5H002	March 23, 1972	V5H002	February 14, 1975
Peak	329.6	**Peak**	562.1	**Peak**	904.3	**Peak**	2909.3	**Peak**	3215.6
Volume	36.3	**Volume**	89.7	**Volume**	233.1	**Volume**	237.1	**Volume**	1060.9
Area	4908	**Area**	2597	**Area**	4268	**Area**	28920	**Area**	28920
Basin Lag	18.2	**Basin Lag**	14.9	**Basin Lag**	20.8	**Basin Lag**	18.0	**Basin Lag**	18.0
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.082	0.020	0.074	0.140	0.082	0.234	0.022	0.223	0.067	0.137
0.132	0.050	0.114	0.140	0.139	0.233	0.056	0.705	0.189	0.147
0.176	0.052	0.228	0.146	0.375	0.238	0.111	0.898	0.217	0.201
0.264	0.063	0.289	0.189	0.587	0.273	0.178	1.000	0.294	0.353
0.341	0.068	0.550	0.198	0.899	0.293	0.217	0.952	0.405	0.308
0.412	0.070	0.638	0.199	1.125	0.310	0.261	0.885	0.533	0.385
0.473	0.070	0.711	0.203	1.279	0.317	0.316	0.827	0.638	0.585
0.511	0.073	0.812	0.213	1.399	0.316	0.366	0.771	0.694	0.683
0.549	0.075	1.228	0.213	1.486	0.324	0.422	0.722	1.238	0.649
0.720	0.074	1.262	0.249	1.625	0.336	0.527	0.699	1.321	0.957
0.846	0.069	1.268	0.255	1.832	0.343	0.589	0.728	1.416	0.971
0.934	0.068	1.510	0.277	1.942	0.372	0.655	0.705	1.727	0.964
1.033	0.069	1.758	0.279	2.072	0.403	0.700	0.664	1.865	0.826
1.093	0.077	1.919	0.280	2.144	0.420	0.733	0.625	1.943	0.767
1.220	0.095	2.027	0.279	2.255	0.425	0.783	0.597	2.015	0.758
1.242	0.200	2.141	0.287	2.375	0.425	0.822	0.566	2.104	0.768
1.357	0.207	2.550	0.317	2.423	0.434	0.877	0.529	2.271	0.820
1.484	0.378	2.591	0.319	2.495	0.451	0.933	0.489	2.326	0.983
1.714	0.484	2.592	0.327	2.596	0.492	0.994	0.456	2.382	1.000
1.857	0.846	2.617	0.401	2.697	0.572	1.044	0.423	2.582	0.993
2.038	1.000	2.664	0.434	2.760	0.572	1.138	0.410	2.787	0.659
2.319	0.845	2.705	0.438	2.841	0.635	1.216	0.396	2.954	0.614
2.560	0.600	2.772	0.414	2.913	0.737	1.271	0.405	3.087	0.652
2.659	0.472	2.906	0.401	2.962	0.776	1.338	0.414	3.376	0.649
3.038	0.436	3.027	0.396	3.063	0.787	1.394	0.396	3.409	0.779
3.187	0.317	3.181	0.435	3.159	0.788	1.449	0.383	3.614	0.729
3.654	0.292	3.228	0.545	3.231	0.786	1.505	0.358	3.992	0.761
3.720	0.228	3.329	0.551	3.284	0.764	1.560	0.345	4.142	0.657
4.225	0.165	3.409	0.549	3.380	0.755	1.621	0.325	4.369	0.628
4.659	0.138	3.503	0.561	3.442	0.733	1.677	0.294	4.431	0.632
4.780	0.121	3.557	0.563	3.529	0.725	1.727	0.275	4.486	0.553
		3.597	0.578	3.615	0.719	1.793	0.261	4.986	0.567
		3.644	0.623	3.736	0.718	1.893	0.250	5.208	0.488
		3.738	0.636	3.764	0.708	2.038	0.233	5.630	0.376
		3.832	0.695	3.793	0.702	2.171	0.219	5.891	0.337
		3.893	0.726	3.827	0.719	2.321	0.210	6.213	0.336
		3.987	0.801	3.841	0.788	2.510	0.194		
		4.074	0.842	3.865	0.793	2.754	0.185		
		4.121	0.974	3.947	0.800	2.826	0.179		

		4.168	0.994	3.957	0.919	2.876	0.191		
		4.235	1.000	3.966	0.953	2.954	0.197		
		4.362	0.999	3.981	0.959	3.070	0.197		
		4.450	0.961	4.010	0.967	3.181	0.188		
		4.678	0.960	4.034	0.963				
		4.752	0.929	4.043	0.979				
		5.195	0.903	4.063	0.991				
		5.309	0.618	4.091	0.996				
		5.624	0.579	4.111	1.000				
		5.913	0.481	4.212	1.000				
		5.993	0.417	4.332	0.922				
		6.054	0.407	4.375	0.822				
		6.128	0.406	4.529	0.788				
		6.195	0.430	4.697	0.708				
		6.329	0.432	4.880	0.665				
		6.416	0.403	4.947	0.596				
		6.530	0.395	5.101	0.591				
		6.570	0.375	5.317	0.533				
		6.651	0.375	5.385	0.472				
		6.718	0.404	5.476	0.446				
		6.906	0.404	5.630	0.434				
		7.087	0.344	5.712	0.424				
		7.289	0.308	6.005	0.410				
		7.322	0.286	6.438	0.323				
		7.389	0.286	6.808	0.263				
		7.463	0.298	7.231	0.227				
		7.503	0.299						
		7.550	0.291						
		7.617	0.294						
		7.725	0.309						
		7.758	0.349						
		7.832	0.356						
		7.893	0.356						
		7.926	0.345						
		8.007	0.330						
		8.094	0.293						
		8.174	0.273						
		8.356	0.264						
		8.409	0.273						
		8.463	0.279						
		8.631	0.278						
		8.745	0.241						
		8.826	0.230						
		8.886	0.228						
		8.926	0.232						
		8.953	0.260						
		8.993	0.269						

		9.040	0.270						
		9.081	0.260						
		9.134	0.260						
		9.262	0.278						
		9.383	0.268						
		9.490	0.237						
		9.758	0.237						
		9.906	0.195						
		10.517	0.183						
		10.805	0.159						

High K-Region
Catchments > 1000 km^2; Std. Peak= 2.25 +



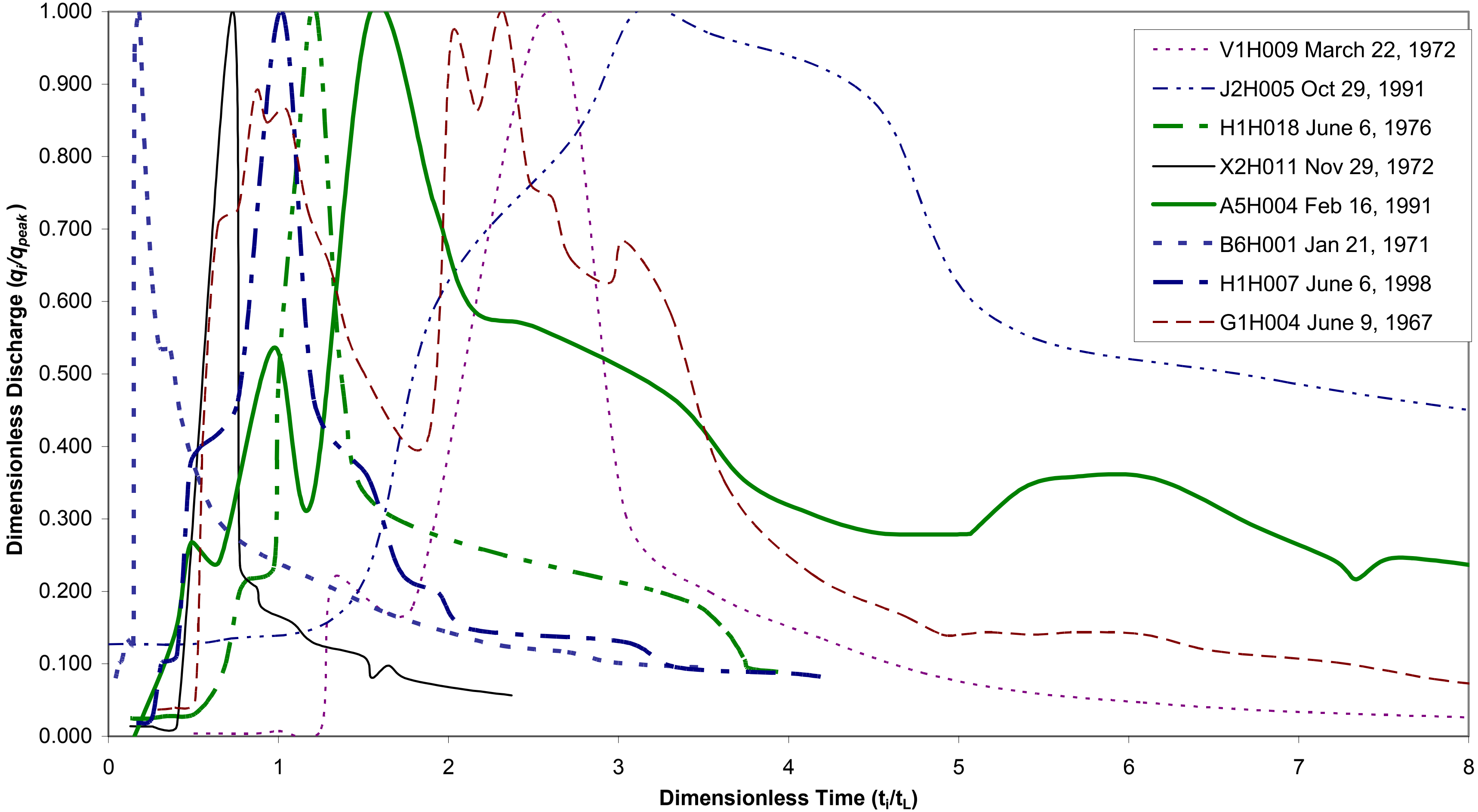
Standardised Hydrographs: High K-Region; Area > 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

T3H005	October 4, 1976	T3H006	April 21, 1978	U2H005	February 7, 1976	V5H002	February 1, 1967	T1H004	February 19, 1972
Peak	651.1	**Peak**	925.7	**Peak**	564.6	**Peak**	4178.9	**Peak**	909.0
Volume	96.4	**Volume**	136.0	**Volume**	24.8	**Volume**	891.0	**Volume**	233.8
Area	2597	**Area**	4268	**Area**	2519	**Area**	28920	**Area**	4908
Basin Lag	14.9	**Basin Lag**	20.8	**Basin Lag**	6.1	**Basin Lag**	18.0	**Basin Lag**	18.2
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.275	0.198	0.197	0.084	0.082	0.067	0.161	0.050	0.000	0.122
0.423	0.499	0.495	0.122	0.132	0.246	0.328	0.055	0.044	0.151
0.483	0.410	0.611	0.294	0.231	0.291	0.339	0.061	0.137	0.158
0.611	0.434	0.769	0.459	0.330	0.363	0.361	0.129	0.159	0.192
0.859	0.378	0.889	0.629	0.462	0.370	0.366	0.298	0.258	0.198
1.101	0.491	0.990	0.909	0.544	0.377	0.400	0.412	0.621	0.316
1.141	0.900	1.072	1.000	0.577	0.384	0.450	0.524	0.709	0.996
1.349	0.865	1.106	0.922	0.610	0.455	0.483	0.580	0.786	1.000
1.389	1.000	1.245	0.967	0.627	0.682	0.555	0.616	0.830	0.993
1.584	0.995	1.380	0.815	0.726	0.884	0.589	0.653	0.868	0.967
1.651	0.473	1.663	0.674	0.775	0.955	0.627	0.701	1.247	0.840
1.732	0.472	1.899	0.465	0.907	0.985	0.666	0.756	1.308	0.733
1.785	0.485	2.274	0.357	1.039	1.000	0.727	0.797	1.357	0.743
1.859	0.490	2.303	0.299	1.089	1.000	0.772	0.866	1.505	0.748
1.953	0.490	2.558	0.236	1.270	0.884	0.816	0.904	1.610	0.754
2.013	0.537	2.606	0.163	1.468	0.671	0.866	0.938	1.670	0.762
2.060	0.544	2.644	0.177	1.682	0.545	0.927	0.983	1.709	0.749
2.564	0.530	2.678	0.184	1.930	0.439	0.983	0.966	1.797	0.744
2.812	0.368	2.750	0.180	2.210	0.363	1.049	0.938	2.302	0.720
3.436	0.248	3.240	0.170	2.325	0.309	1.105	0.983	2.593	0.471
		3.798	0.138	2.408	0.291	1.155	0.975	3.049	0.404
		4.327	0.116	2.540	0.285	1.194	0.987	3.379	0.317
		4.601	0.108	2.903	0.268	1.249	0.983	3.379	0.207
		5.101	0.088	3.529	0.236	1.327	1.000	3.396	0.170
		5.375	0.085	4.206	0.196	1.394	0.975	3.780	0.140
		5.591	0.069	5.294	0.169	1.494	0.996	3.973	0.126
				6.614	0.141	1.566	0.979	4.330	0.104
				7.587	0.119	1.610	0.949	4.962	0.098
				8.362	0.108	1.660	0.915	5.055	0.086
				8.576	0.101	1.710	0.866	5.593	0.076
				9.219	0.101	1.754	0.834	5.676	0.063
				10.011	0.094	1.782	0.797	6.247	0.056
				10.836	0.091	1.921	0.792	6.648	0.055
				12.089	0.087	2.093	0.751	6.973	0.053
						2.199	0.726	7.033	0.050
						2.293	0.711	7.088	0.050
						2.387	0.691	7.297	0.053
						2.498	0.677	7.473	0.048
						2.598	0.644	7.555	0.047
						2.682	0.621	7.962	0.047
						2.770	0.607	8.077	0.057

						2.870	0.584	8.593	0.057
						2.948	0.562	8.703	0.051
						3.059	0.536	8.747	0.051
						3.154	0.515	8.791	0.052
						3.265	0.495	8.846	0.053
						3.376	0.478	8.978	0.055
						3.415	0.462	9.049	0.067
						3.476	0.447	9.159	0.070
						3.487	0.390	9.236	0.069
						3.514	0.462	9.626	0.067
						3.531	0.443	10.225	0.060
						3.581	0.454	10.231	0.052
						3.609	0.405	10.538	0.044
						3.637	0.412	10.863	0.043
						3.664	0.401	11.396	0.036
						3.703	0.358		
						3.748	0.337		
						3.848	0.365		
						3.948	0.337		
						4.047	0.321		
						4.153	0.304		
						4.203	0.295		
						4.242	0.314		
						4.303	0.327		
						4.364	0.341		
						4.458	0.361		
						4.525	0.372		
						4.564	0.386		
						4.603	0.409		
						4.703	0.427		
						4.808	0.439		
						4.936	0.431		
						5.002	0.401		
						5.075	0.383		
						5.119	0.344		
						5.213	0.321		
						5.286	0.298		
						5.347	0.282		
						5.435	0.267		
						5.580	0.252		
						5.730	0.238		
						5.835	0.229		
						5.902	0.221		
						6.074	0.235		
						6.257	0.229		
						6.451	0.223		
						6.696	0.218		

Appendix F2 (a)

Middle K-Region
Catchments < 1000 km^2; Std. Peak = 1.25 - 1.75



Standardised Hydrographs: Middle K-Region; Area < 1000 km^2; Std. Peak 1.25 – 1.75

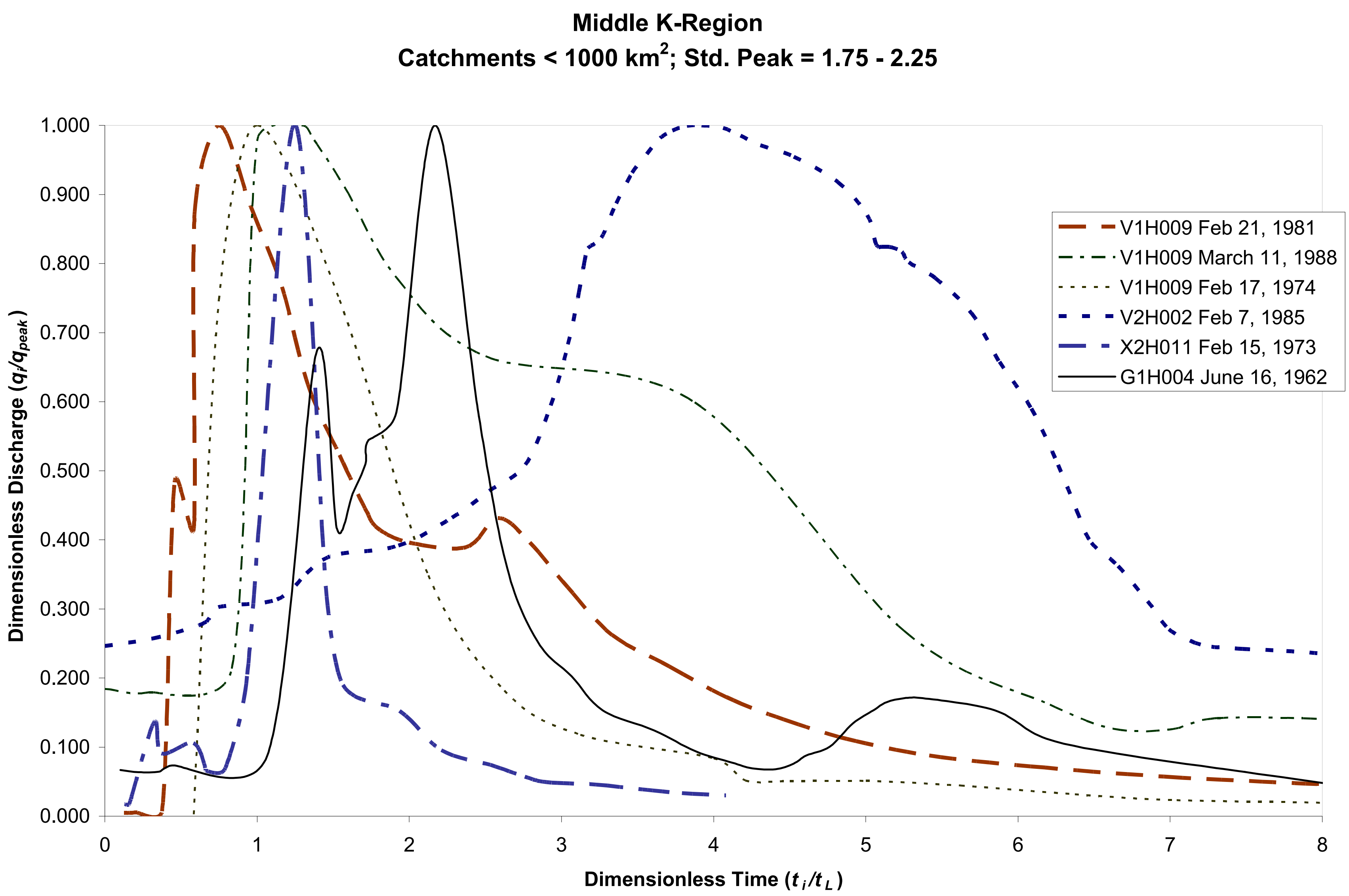
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

V1H009	**March 22, 1972**	**J2H005**	**October 29, 1991**	**H1H018**	**June 1, 1976**	**X2H011**	**November 29, 1972**
Peak	153.1	**Peak**	27.3	**Peak**	436.2	**Peak**	112.6
Volume	1.7	**Volume**	2.8	**Volume**	6.6	**Volume**	1.1
Area	196	**Area**	253	**Area**	113	**Area**	402
Basin Lag	2.4	**Basin Lag**	2.8	**Basin Lag**	7.7	**Basin Lag**	6.2
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.500	0.004	0.000	0.127	0.130	0.025	0.129	0.014
0.875	0.004	0.679	0.133	0.169	0.024	0.258	0.014
1.000	0.007	1.464	0.198	0.247	0.024	0.403	0.016
1.250	0.010	1.929	0.597	0.249	0.025	0.726	1.000
1.333	0.221	2.750	0.832	0.351	0.028	0.774	0.236
1.792	0.180	3.107	1.000	0.519	0.033	0.871	0.206
2.583	1.000	3.536	0.970	0.675	0.089	0.903	0.177
3.042	0.306	4.500	0.875	0.766	0.195	1.081	0.157
3.542	0.199	5.179	0.581	0.818	0.217	1.210	0.128
4.208	0.134	6.893	0.490	0.974	0.234	1.500	0.110
4.792	0.087	10.357	0.358	1.000	0.487	1.548	0.081
5.375	0.062	12.464	0.168	1.091	0.749	1.645	0.098
6.083	0.046	15.250	0.139	1.221	1.000	1.742	0.081
6.833	0.035	18.321	0.120	1.377	0.486	2.016	0.067
7.875	0.027	19.786	0.111	1.636	0.308	2.371	0.057
9.000	0.020	20.536	0.111	3.247	0.198		
10.250	0.016	21.250	0.089	3.468	0.180		
10.833	0.013	23.750	0.080	3.636	0.144		
11.375	0.013	24.143	0.069	3.740	0.106		
11.625	0.012	24.429	0.064	3.766	0.094		
		26.107	0.059	3.987	0.088		
		26.893	0.053				
		27.750	0.042				
		28.500	0.039				
		28.679	0.039				
		28.964	0.045				
		30.357	0.045				

Standardised Hydrographs: Middle K-Region; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

A5H004	February 16, 1991	B6H001	January 21, 1971	H1H007	June 6, 1998	G1H004	June 9, 1967
Peak	116.5	**Peak**	10.7	**Peak**	256.0	**Peak**	346.1
Volume	13.5	**Volume**	0.3	**Volume**	5.7	**Volume**	19.9
Area	629	**Area**	518	**Area**	84	**Area**	70
Basin Lag	7.2	**Basin Lag**	14.3	**Basin Lag**	6.7	**Basin Lag**	5.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.153	0.140	0.042	0.080	0.164	0.019	0.288	0.037
0.389	0.267	0.063	0.101	0.254	0.024	0.390	0.039
0.486	0.242	0.077	0.103	0.313	0.102	0.508	0.048
0.653	0.536	0.112	0.134	0.403	0.112	0.559	0.430
0.972	0.323	0.147	0.127	0.478	0.371	0.644	0.705
1.194	1.000	0.154	0.944	0.537	0.398	0.763	0.728
1.542	0.735	0.182	1.000	0.761	0.462	0.864	0.889
1.917	0.590	0.210	0.822	1.015	1.000	0.932	0.847
2.139	0.563	0.259	0.624	1.209	0.464	1.051	0.864
2.528	0.469	0.301	0.537	1.522	0.359	1.169	0.728
3.306	0.354	0.364	0.532	1.716	0.227	1.305	0.647
3.736	0.308	0.427	0.439	1.940	0.198	1.475	0.513
4.125	0.282	0.524	0.359	2.119	0.149	1.881	0.413
4.486	0.279	0.657	0.294	3.030	0.130	2.017	0.965
4.806	0.279	0.888	0.252	3.328	0.096	2.169	0.864
5.069	0.282	1.294	0.207	4.015	0.087	2.322	1.000
5.083	0.342	1.643	0.169	4.284	0.079	2.475	0.766
5.375	0.357	2.007	0.143			2.610	0.743
5.653	0.355	2.315	0.125			2.712	0.661
6.153	0.289	2.699	0.116			2.949	0.626
6.750	0.243	2.972	0.102			3.034	0.683
7.208	0.218	3.490	0.095			3.305	0.584
7.319	0.219					3.627	0.349
7.361	0.243					4.136	0.224
7.500	0.246					4.678	0.166
7.667	0.230					4.898	0.141
8.181	0.206					5.017	0.141
8.528	0.203					5.169	0.144
8.653	0.226					5.441	0.141
8.917	0.224					5.695	0.144
9.375	0.202					6.085	0.141
10.292	0.176					6.508	0.118
10.500	0.217					7.220	0.102
10.681	0.217					7.797	0.079
11.028	0.177					8.186	0.069
11.681	0.153					8.492	0.065
11.944	0.126					9.203	0.062
12.667	0.102						
13.625	0.085						
14.375	0.081						
15.681	0.075						
17.306							


Middle K-Region
Catchments < 1000 km²; Std. Peak = 1.75 - 2.25
Dimensionless Discharge (q_i/q_{peak})
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
1
2
3
4
5
6
7
8
Dimensionless Time (t_i/t_L)
V1H009 Feb 21, 1981
V1H009 March 11, 1988
V1H009 Feb 17, 1974
V2H002 Feb 7, 1985
X2H011 Feb 15, 1973
G1H004 June 16, 1962

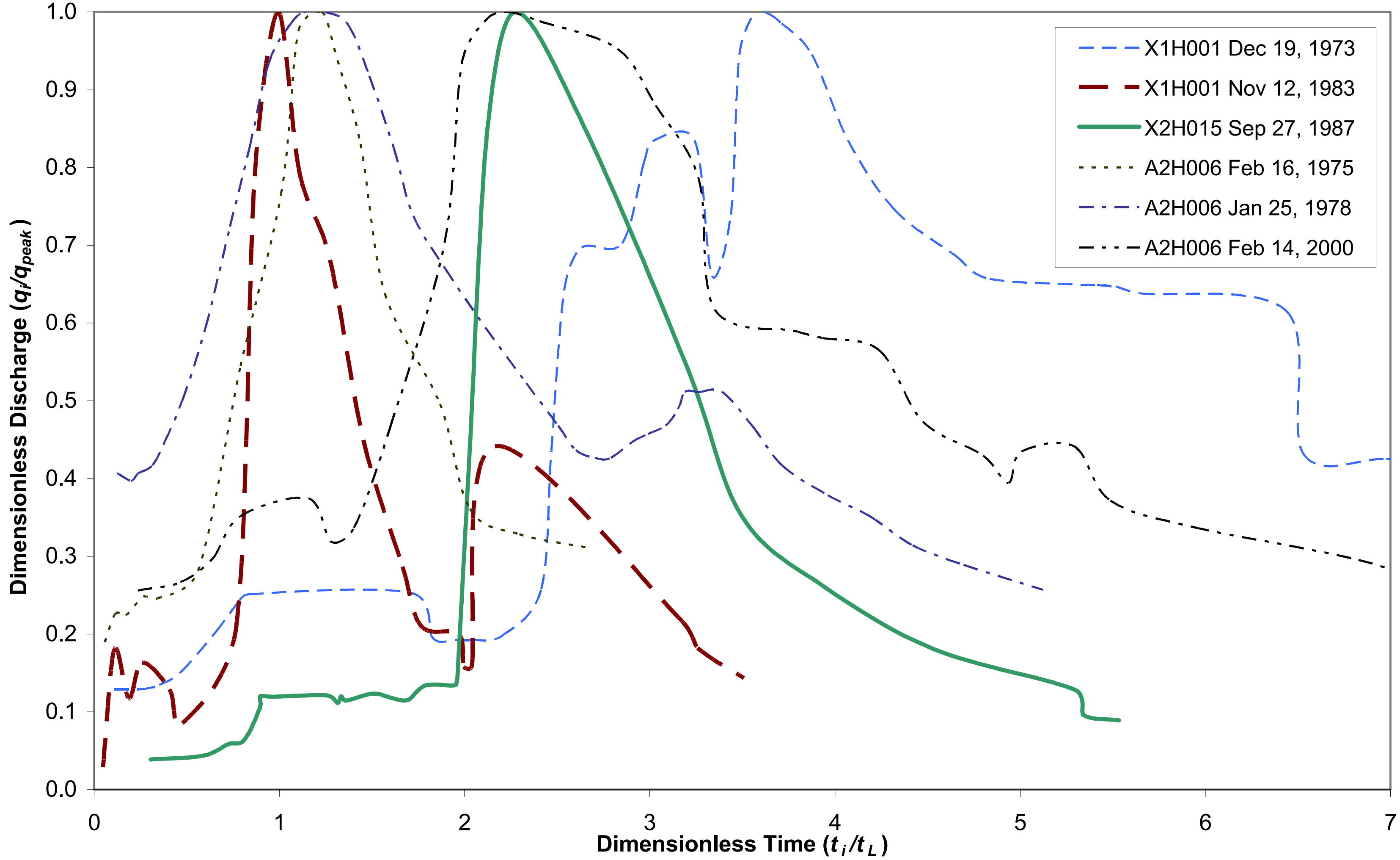
Standardised Hydrographs: Middle K-Region; Area < 1000 km^2; Std. Peak 1.75 – 2.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

V1H009	February 21, 1981	V1H009	March 11, 1988	V1H009	February 17, 1974	V2H002	February 7, 1985	X2H011	May 15, 1973	G1H004	June 19, 1962
Peak	236.2	**Peak**	196.9	**Peak**	270.4	**Peak**	215.0	**Peak**	173.2	**Peak**	453.7
Volume	3.0	**Volume**	6.6	**Volume**	3.2	**Volume**	51.0	**Volume**	2.3	**Volume**	16.3
Area	196	**Area**	196	**Area**	196	**Area**	937	**Area**	402	**Area**	70
Basin Lag	2.4	**Basin Lag**	2.4	**Basin Lag**	2.4	**Basin Lag**	11.4	**Basin Lag**	6.2	**Basin Lag**	5.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.125	0.004	0.000	0.184	0.583	0.003	0.000	0.246	0.129	0.018	0.102	0.067
0.208	0.005	0.292	0.179	0.750	0.748	0.316	0.257	0.161	0.018	0.220	0.064
0.375	0.007	0.833	0.213	1.000	1.000	0.649	0.279	0.323	0.136	0.356	0.064
0.458	0.483	1.000	0.977	1.542	0.747	0.746	0.302	0.371	0.091	0.441	0.073
0.583	0.417	1.292	1.000	2.125	0.348	1.132	0.314	0.581	0.106	1.068	0.088
0.590	0.875	1.375	0.978	2.625	0.182	1.325	0.352	0.661	0.068	1.390	0.672
0.750	1.000	1.583	0.908	3.125	0.118	1.430	0.371	0.664	0.066	1.525	0.416
0.958	0.883	1.917	0.779	4.000	0.084	1.553	0.380	0.790	0.069	1.627	0.467
1.167	0.764	2.500	0.666	4.208	0.052	1.930	0.391	0.935	0.205	1.712	0.510
1.333	0.625	3.875	0.599	4.500	0.051	2.281	0.432	1.242	1.000	1.729	0.543
1.542	0.523	5.250	0.269	5.000	0.051	2.526	0.471	1.452	0.331	1.915	0.584
1.708	0.446	6.208	0.161	5.625	0.044	2.763	0.509	1.565	0.190	2.169	1.000
1.792	0.417	6.625	0.126	6.375	0.031	2.930	0.595	1.935	0.152	2.458	0.578
2.000	0.396	7.000	0.125	7.042	0.023	3.044	0.683	2.210	0.096	2.644	0.359
2.375	0.389	7.292	0.142	8.375	0.018	3.114	0.758	2.532	0.074	2.847	0.251
2.583	0.431	7.875	0.142	9.792	0.013	3.149	0.801	2.758	0.057	3.068	0.202
2.792	0.396	10.292	0.122	11.583	0.009	3.175	0.822	2.903	0.049	3.271	0.153
3.042	0.331	12.125	0.062	13.542	0.007	3.263	0.837	3.226	0.046	3.610	0.124
3.333	0.262	13.708	0.043			3.360	0.887	3.532	0.039	3.881	0.094
3.708	0.217	13.792	0.035			3.465	0.931	3.790	0.033	4.119	0.078
4.083	0.172					3.561	0.959	4.081	0.030	4.254	0.069
4.458	0.140					3.649	0.981			4.407	0.068
4.875	0.112					3.728	0.992			4.525	0.076
5.417	0.088					3.825	0.999			4.610	0.088
6.083	0.072					3.921	1.000			4.763	0.100
6.958	0.057					4.061	0.996			4.915	0.134
8.042	0.046					4.175	0.985			5.051	0.153
9.417	0.036					4.307	0.971			5.136	0.165
10.458	0.029					4.526	0.955			5.254	0.171
11.042	0.024					4.816	0.918			5.373	0.171
						5.009	0.870			5.847	0.153
						5.070	0.827			6.186	0.112
						5.114	0.824			6.729	0.088
						5.158	0.824			7.492	0.064
						5.237	0.817			8.136	0.044
						5.281	0.802				
						5.456	0.779				
						5.693	0.728				
						5.877	0.658				

						6.088	0.590				
						6.263	0.509				
						6.386	0.442				
						6.482	0.396				
						6.658	0.362				
						6.851	0.311				
						6.991	0.271				
						7.149	0.252				
						7.272	0.245				
						7.474	0.242				
						7.763	0.239				
						8.018	0.236				
						8.377	0.232				
						8.649	0.226				
						8.816	0.220				
						9.018	0.216				
						9.430	0.209				
						10.088	0.193				
						10.298	0.170				
						10.632	0.164				
						10.754	0.156				
						10.991	0.154				
						11.088	0.152				
						11.132	0.152				

Appendix F2 (b)

Middle K-Region
Catchments > 1000 km^2; Std. Peak = 1.25 - 1.75

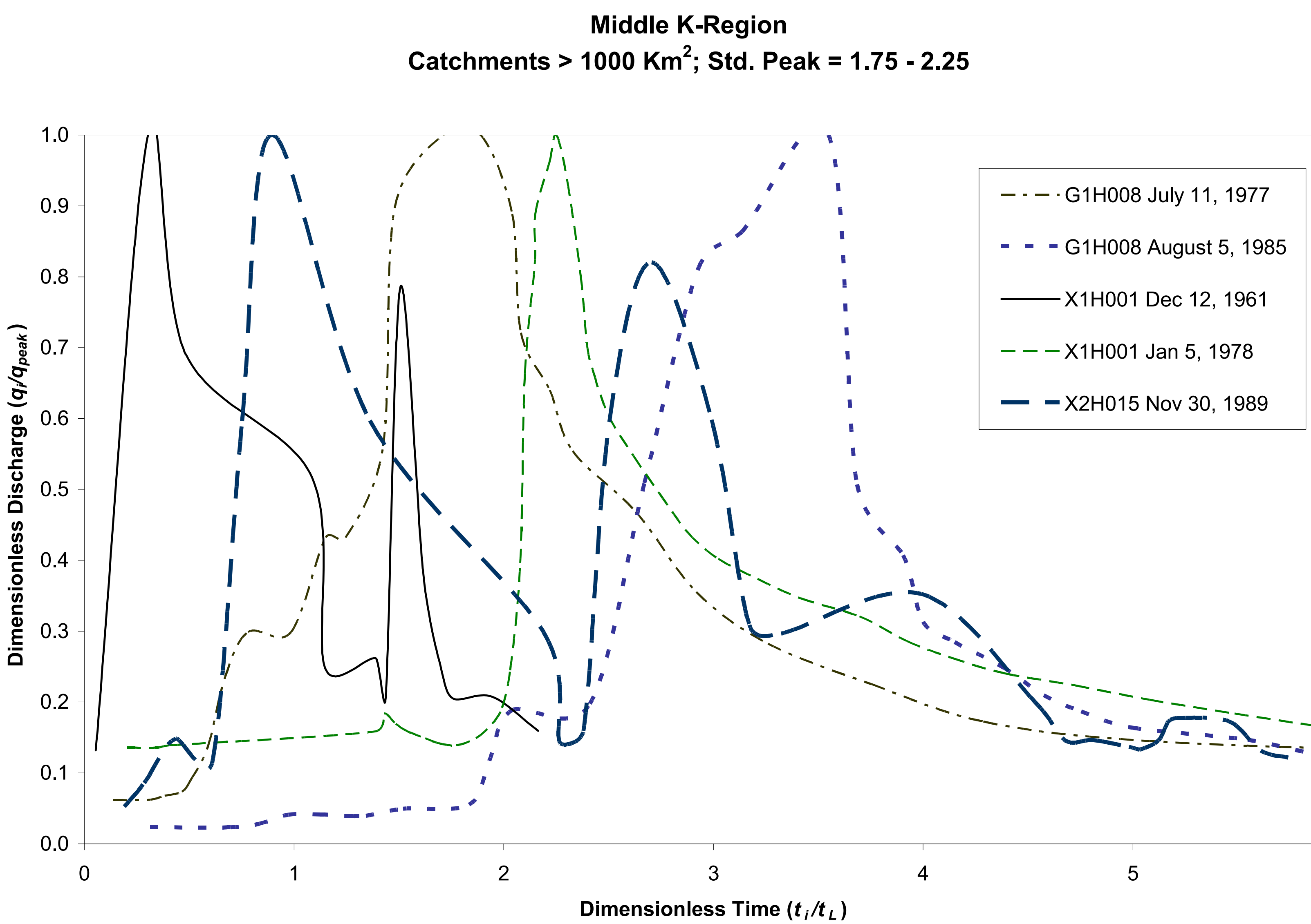


Standardised Hydrographs: Middle K-Region; Area > 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

X2H015	September 27, 1987	A2H006	February 16, 1975	A2H006	January 25, 1978	A2H006	February 14, 2000	X1H001	December 19, 1973	X1H001	November 12, 1983
Peak	185.0	**Peak**	71.4	**Peak**	57.2	**Peak**	67.4	**Peak**	294.5	**Peak**	345.9
Volume	9.5	**Volume**	3.3	**Volume**	5.8	**Volume**	10.7	**Volume**	61.4	**Volume**	12.2
Area	1554	**Area**	1028	**Area**	1028	**Area**	1028	**Area**	5499	**Area**	5499
Basin Lag	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	12.8	**Basin Lag**	12.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.305	0.039	0.057	0.190	0.124	0.407	0.237	0.256	0.109	0.129	0.047	0.029
0.590	0.044	0.114	0.226	0.200	0.397	0.467	0.267	0.250	0.129	0.109	0.180
0.724	0.058	0.171	0.224	0.238	0.407	0.641	0.298	0.352	0.135	0.188	0.117
0.810	0.064	0.267	0.248	0.314	0.417	0.789	0.351	0.469	0.151	0.258	0.164
0.895	0.105	0.343	0.246	0.381	0.447	1.156	0.375	0.656	0.203	0.406	0.129
0.897	0.120	0.562	0.281	0.476	0.500	1.281	0.318	0.773	0.239	0.477	0.085
0.962	0.119	0.790	0.544	0.600	0.593	1.403	0.336	0.836	0.251	0.766	0.206
1.257	0.121	1.010	0.767	0.733	0.724	1.598	0.466	1.711	0.253	0.867	0.789
1.314	0.111	1.105	0.977	0.838	0.825	1.892	0.703	1.828	0.195	0.992	1.000
1.333	0.120	1.229	1.000	0.943	0.934	1.984	0.933	1.953	0.193	1.109	0.794
1.362	0.114	1.314	0.938	1.057	0.983	2.106	0.987	2.039	0.193	1.273	0.681
1.505	0.124	1.438	0.830	1.133	1.000	2.229	1.000	2.203	0.198	1.453	0.450
1.619	0.117	1.571	0.637	1.248	1.000	2.405	0.988	2.414	0.258	1.664	0.287
1.695	0.116	1.867	0.496	1.371	0.983	2.825	0.953	2.469	0.436	1.766	0.210
1.790	0.134	2.029	0.361	1.486	0.918	3.032	0.880	2.539	0.643	1.969	0.200
1.952	0.135	2.295	0.328	1.619	0.825	3.265	0.785	2.633	0.697	1.992	0.158
1.962	0.148	2.676	0.311	1.724	0.738	3.351	0.617	2.852	0.703	2.039	0.158
2.029	0.441			1.895	0.670	3.783	0.590	2.969	0.806	2.164	0.442
2.124	0.851			2.114	0.593	3.932	0.581	3.016	0.834	3.172	0.217
2.276	1.000			2.333	0.523	4.238	0.565	3.242	0.835	3.258	0.182
2.648	0.851			2.505	0.468	4.475	0.473	3.336	0.660	3.508	0.143
3.200	0.544			2.600	0.437	4.800	0.430	3.438	0.739		
3.495	0.352			2.705	0.427	4.937	0.394	3.484	0.945		
3.943	0.261			2.790	0.427	5.008	0.435	3.570	1.000		
4.533	0.181			2.905	0.447	5.292	0.441	3.641	0.998		
5.295	0.129			2.990	0.457	5.487	0.372	3.711	0.985		
5.343	0.096			3.086	0.468	5.940	0.338	3.875	0.945		
5.533	0.089			3.152	0.489	6.827	0.295	4.070	0.835		
				3.190	0.511	7.370	0.252	4.320	0.746		
				3.267	0.511	7.852	0.222	4.648	0.687		
				3.390	0.511	8.179	0.204	4.836	0.657		
				3.552	0.468	8.773	0.183	5.414	0.649		
				3.714	0.417	9.322	0.166	5.516	0.647		
				3.962	0.378	9.698	0.158	5.648	0.638		
				4.190	0.351			6.438	0.615		
				4.419	0.314			6.531	0.431		
				4.695	0.289			6.977	0.426		
				5.124	0.257			7.359	0.421		

								8.250	0.385		
								8.391	0.293		
								8.531	0.286		
								8.656	0.286		
								8.805	0.290		
								9.008	0.306		
								9.086	0.352		
								9.211	0.355		
								9.805	0.344		
								10.023	0.248		

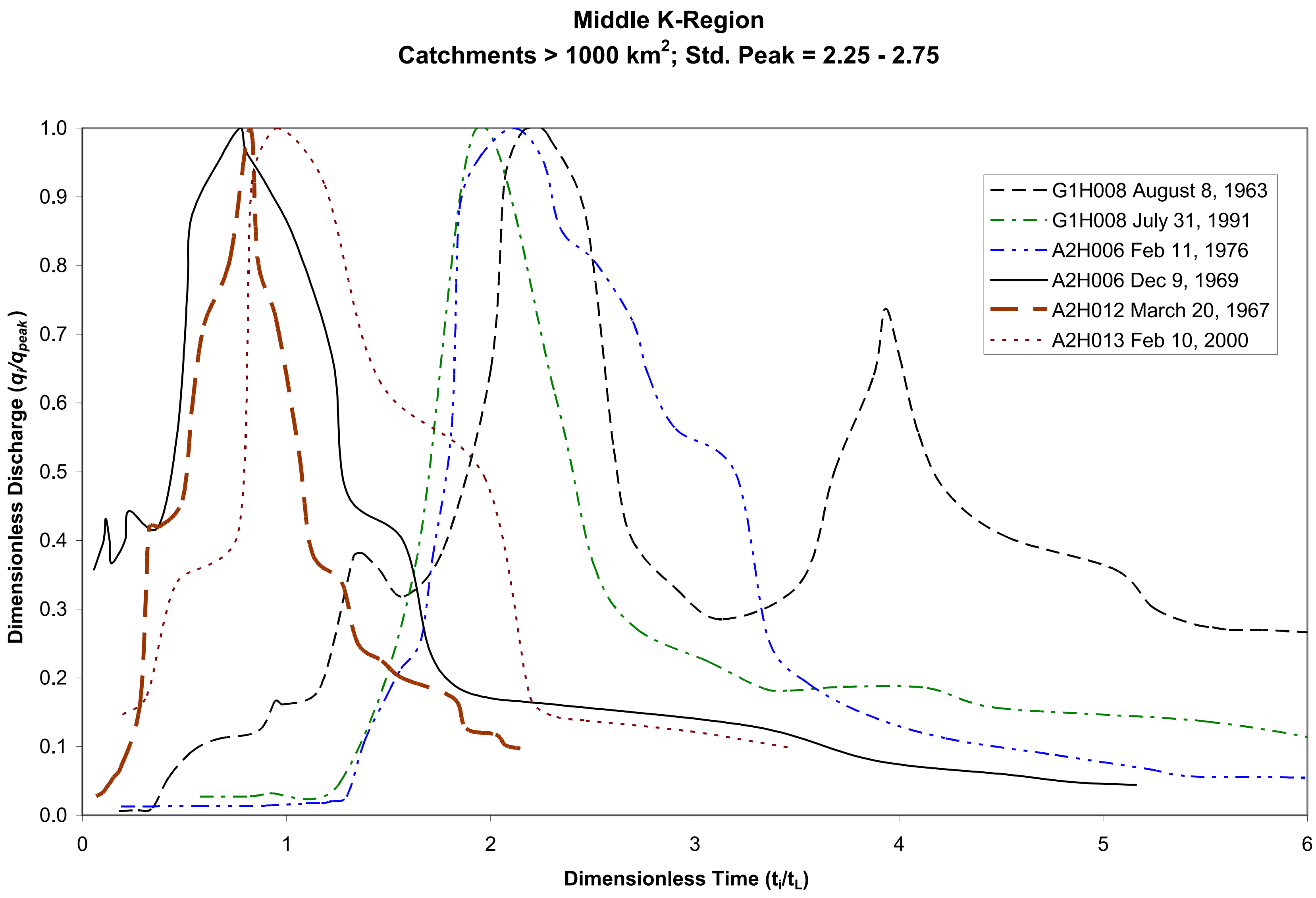

Middle K-Region
Catchments > 1000 Km^2; Std. Peak = 1.75 - 2.25
Dimensionless Discharge (q_i/q_{peak})
Dimensionless Time (t_i/t_L)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
G1H008 July 11, 1977
G1H008 August 5, 1985
X1H001 Dec 12, 1961
X1H001 Jan 5, 1978
X2H015 Nov 30, 1989

Standardised Hydrographs: Middle K-Region; Area > 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	July 11, 1977	G1H008	August 5, 1985	X1H001	December 12, 1961	X1H001	January 5, 1978	X2H015	November 30, 1989
Peak	189.01	**Peak**	202.42	**Peak**	380.28	**Peak**	428.69	**Peak**	251.79
Volume	9.49	**Volume**	9.79	**Volume**	11.45	**Volume**	37.67	**Volume**	7.00
Area	1690	**Area**	1690	**Area**	5499	**Area**	5499	**Area**	1554
Basin Lag	7.30	**Basin Lag**	7.30	**Basin Lag**	12.80	**Basin Lag**	12.80	**Basin Lag**	10.50
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.137	0.062	0.315	0.023	0.055	0.132	0.203	0.136	0.190	0.052
0.301	0.062	0.699	0.023	0.305	1.000	0.352	0.136	0.286	0.086
0.384	0.068	0.836	0.028	0.484	0.691	0.406	0.139	0.438	0.148
0.466	0.074	0.973	0.041	1.086	0.517	1.391	0.159	0.610	0.113
0.507	0.089	1.123	0.041	1.148	0.248	1.430	0.184	0.752	0.597
0.589	0.137	1.274	0.039	1.391	0.262	1.484	0.169	0.895	1.000
0.671	0.235	1.342	0.040	1.438	0.205	1.539	0.159	1.362	0.597
0.781	0.299	1.521	0.049	1.508	0.786	1.625	0.149	2.190	0.298
0.986	0.299	1.836	0.055	1.617	0.379	1.688	0.142	2.267	0.143
1.151	0.432	1.932	0.117	1.703	0.246	1.773	0.139	2.381	0.159
1.247	0.432	2.041	0.189	1.758	0.205	1.867	0.149	2.505	0.597
1.425	0.561	2.411	0.198	1.945	0.208	1.945	0.169	2.705	0.821
1.479	0.897	2.671	0.509	2.164	0.159	1.992	0.192	2.990	0.598
1.712	1.000	2.932	0.814			2.031	0.245	3.171	0.309
1.890	1.000	3.137	0.864			2.078	0.396	3.324	0.297
2.041	0.889	3.548	1.000			2.102	0.664	3.990	0.352
2.082	0.721	3.685	0.507			2.148	0.818	4.533	0.200
2.219	0.640	3.904	0.407			2.150	0.888	4.676	0.146
2.329	0.554	4.000	0.313			2.219	0.962	4.810	0.146
2.630	0.469	4.151	0.284			2.250	1.000	4.981	0.137
2.918	0.355	4.384	0.249			2.305	0.934	5.038	0.133
3.260	0.282	4.575	0.210			2.367	0.801	5.124	0.146
3.753	0.225	4.753	0.187			2.398	0.703	5.171	0.173
4.288	0.173	5.000	0.164			2.430	0.664	5.219	0.178
5.041	0.146	5.548	0.147			2.500	0.604	5.457	0.173
6.630	0.126	5.959	0.121			2.617	0.548	5.610	0.131
7.712	0.099	6.452	0.107			2.742	0.494	5.743	0.121
9.096	0.089	6.959	0.095			2.883	0.438		
10.164	0.080	7.452	0.087			3.023	0.402		
11.986	0.074	8.301	0.080			3.211	0.374		
						3.414	0.347		
						3.695	0.321		
						3.922	0.286		
						4.133	0.263		
						4.391	0.240		
						4.727	0.223		
						5.078	0.203		
						5.484	0.184		
						5.891	0.166		
						6.188	0.155		

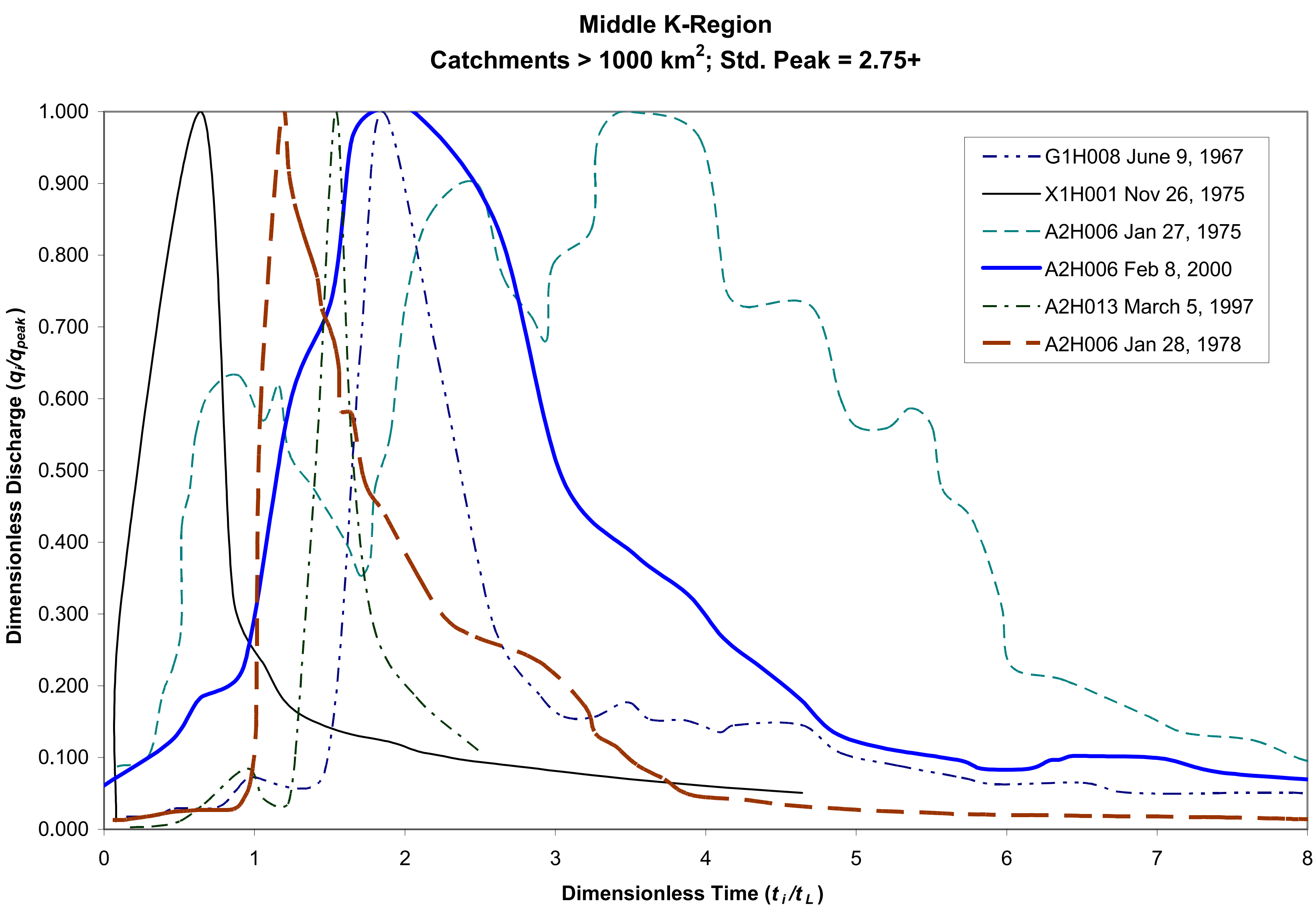
						6.469	0.145		
						6.781	0.136		
						7.000	0.130		
						7.305	0.126		
						7.609	0.121		
						7.727	0.118		
						7.805	0.115		
						7.914	0.115		
						7.961	0.116		
						8.109	0.121		
						8.398	0.120		
						8.719	0.118		
						8.930	0.114		
						9.172	0.111		
						9.477	0.107		
						9.773	0.104		


Middle K-Region
Catchments > 1000 km²; Std. Peak = 2.25 - 2.75
Dimensionless Discharge (q/q_peak)
Dimensionless Time (t_i/t_L)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
G1H008 August 8, 1963
G1H008 July 31, 1991
A2H006 Feb 11, 1976
A2H006 Dec 9, 1969
A2H012 March 20, 1967
A2H013 Feb 10, 2000

Standardised Hydrographs: Middle K-Region; Area > 1000 km^2; Std. Peak 2.25 – 2.75
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	August 8, 1963	G1H008	July 31, 1991	A2H006	February 11, 1976	A2H006	December 9, 1969	A2H012	March 20, 1967	A2H013	February 10, 2000
Peak	274.6	Peak	292.7	Peak	207.5	Peak	146.0	Peak	369.1	Peak	417.9
Volume	7.7	Volume	8.0	Volume	12.3	Volume	7.1	Volume	20.8	Volume	14.3
Area	1690	Area	1690	Area	1028	Area	1028	Area	2551	Area	1171
Basin Lag	7.3	Basin Lag	7.3	Basin Lag	10.5	Basin Lag	10.5	Basin Lag	20.8	Basin Lag	8.1
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.178	0.006	0.575	0.027	0.190	0.013	0.057	0.358	0.067	0.028	0.198	0.146
0.274	0.007	0.822	0.027	0.314	0.013	0.105	0.401	0.101	0.033	0.317	0.174
0.342	0.010	0.918	0.032	0.552	0.014	0.114	0.431	0.130	0.044	0.465	0.340
0.425	0.056	1.260	0.047	0.895	0.014	0.133	0.401	0.154	0.055	0.765	0.413
0.534	0.092	1.630	0.361	1.095	0.017	0.143	0.367	0.188	0.069	0.829	0.918
0.658	0.110	1.932	1.000	1.171	0.017	0.210	0.401	0.284	0.164	0.953	1.000
0.863	0.123	2.315	0.613	1.219	0.021	0.229	0.443	0.327	0.419	1.187	0.917
0.945	0.167	2.507	0.363	1.295	0.027	0.371	0.420	0.375	0.419	1.455	0.632
0.986	0.162	2.712	0.272	1.381	0.107	0.467	0.559	0.490	0.459	1.971	0.491
1.164	0.186	3.068	0.223	1.495	0.176	0.514	0.759	0.538	0.597	2.193	0.172
1.329	0.377	3.329	0.185	1.562	0.213	0.533	0.868	0.596	0.713	2.323	0.143
1.370	0.381	3.466	0.182	1.657	0.254	0.667	0.951	0.721	0.807	2.465	0.138
1.452	0.358	3.726	0.187	1.714	0.372	0.771	1.000	0.822	1.000	2.981	0.122
1.575	0.318	4.137	0.185	1.810	0.565	0.800	0.967	0.861	0.807	3.467	0.098
1.767	0.386	4.479	0.156	1.848	0.882	0.895	0.921	0.952	0.718		
2.000	0.647	5.507	0.136	1.943	0.956	1.048	0.832	1.063	0.525		
2.068	0.925	6.411	0.095	2.114	1.000	1.229	0.660	1.125	0.382		
2.151	0.993	7.219	0.077	2.257	0.951	1.295	0.470	1.269	0.339		
2.247	1.000	7.452	0.070	2.343	0.853	1.571	0.399	1.346	0.251		
2.288	0.986	7.699	0.071	2.505	0.807	1.695	0.245	1.466	0.225		
2.466	0.871	7.986	0.070	2.695	0.719	1.810	0.192	1.567	0.200		
2.603	0.534	8.274	0.077	2.771	0.641	1.990	0.171	1.817	0.171		
2.685	0.406	8.425	0.098	2.905	0.563	2.333	0.161	1.880	0.126		
2.904	0.331	8.507	0.100	3.200	0.497	3.295	0.129	2.024	0.118		
3.137	0.285	8.753	0.108	3.362	0.254	3.886	0.079	2.072	0.102		
3.521	0.340	8.863	0.102	3.552	0.192	4.533	0.059	2.144	0.097		
3.685	0.502	9.000	0.102	3.838	0.147	4.867	0.048				
3.877	0.641	9.151	0.105	4.229	0.112	5.162	0.044				
3.932	0.737	9.534	0.105	4.762	0.088						
4.000	0.670	10.027	0.085	5.219	0.067						
4.096	0.555	10.945	0.071	5.429	0.057						
4.233	0.471	12.370	0.057	6.019	0.055						
4.521	0.406	13.055	0.047	6.571	0.044						
5.055	0.358	14.110	0.039	7.238	0.039						
5.247	0.302			7.952	0.033						
5.452	0.278			8.267	0.029						
5.534	0.274			9.162	0.029						
5.616	0.270			9.533	0.025						
5.740	0.270			10.010	0.025						

6.000	0.266			10.771	0.023						
6.219	0.259			11.152	0.021						
6.822	0.231			11.695	0.020						
7.219	0.180										
7.562	0.153										
7.945	0.125										
8.630	0.104										
9.247	0.087										
10.301	0.073										
11.562	0.061										
12.904	0.052										
13.753	0.045										
13.986	0.042										
14.685	0.042										
15.767	0.040										


Middle K-Region
Catchments > 1000 km²; Std. Peak = 2.75+
Dimensionless Discharge (q_i/q_peak)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
1
2
3
4
5
6
7
8
Dimensionless Time (t_i/t_L)
G1H008 June 9, 1967
X1H001 Nov 26, 1975
A2H006 Jan 27, 1975
A2H006 Feb 8, 2000
A2H013 March 5, 1997
A2H006 Jan 28, 1978

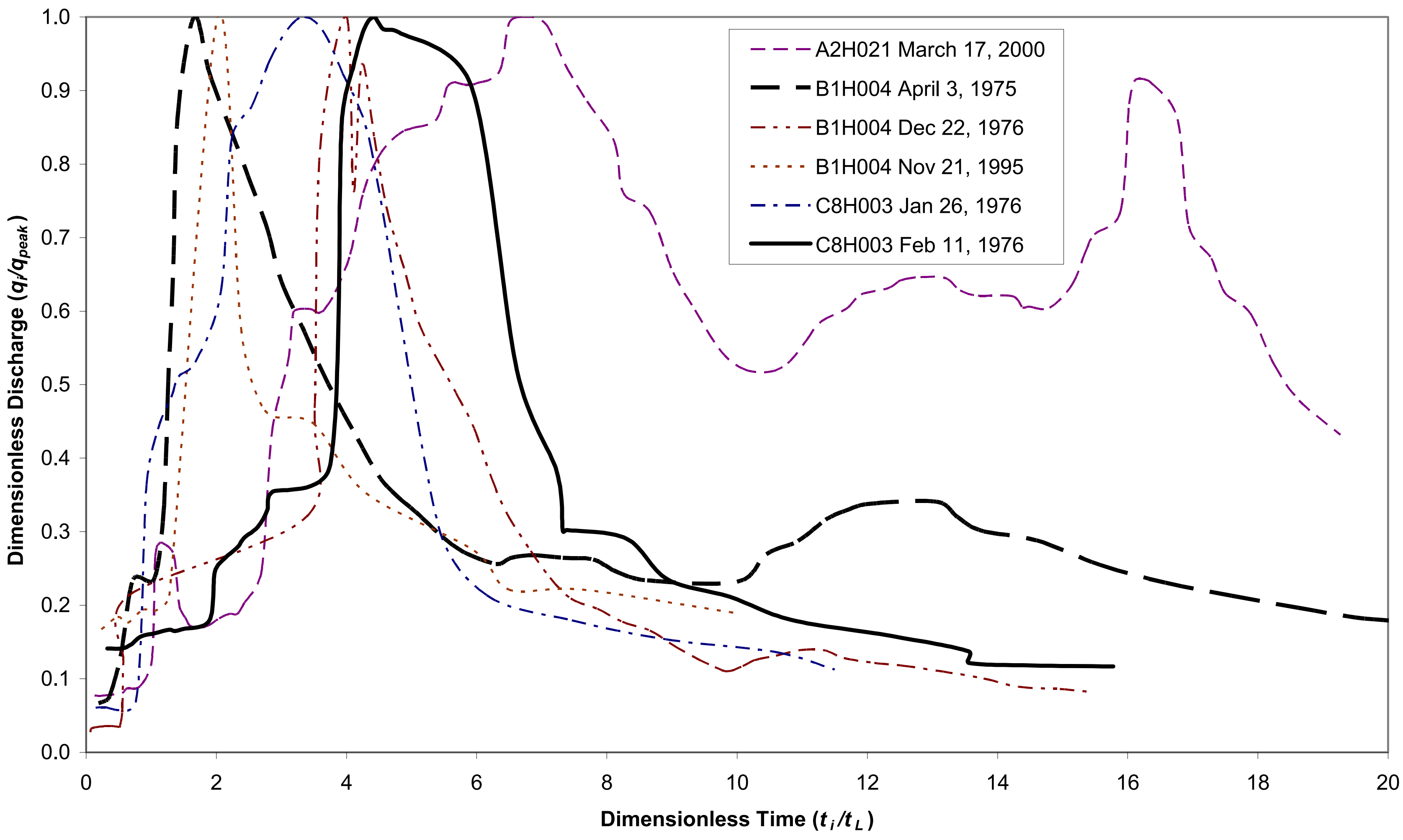
Standardised Hydrographs: Middle K-Region; Area > 1000 km^2; Std. Peak 2.75 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	June 9, 1967	X1H001	November 26, 1975	A2H006	January 27, 1975	A2H006	February 8, 2000	A2H013	March 5, 1997	A2H006	January 28, 1978
Peak	415.0	**Peak**	849.0	**Peak**	244.1	**Peak**	295.1	**Peak**	698.0	**Peak**	878.2
Volume	13.5	**Volume**	16.9	**Volume**	37.5	**Volume**	29.7	**Volume**	8.7	**Volume**	35.1
Area	1690	**Area**	5499	**Area**	1028	**Area**	1028	**Area**	1171	**Area**	1028
Basin Lag	7.3	**Basin Lag**	12.8	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	8.1	**Basin Lag**	10.5
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.151	0.017	0.078	0.011	0.086	0.088	0.000	0.061	0.173	0.003	0.057	0.013
0.356	0.019	0.079	0.011	0.295	0.102	0.444	0.123	0.333	0.004	0.124	0.013
0.466	0.029	0.117	0.324	0.390	0.188	0.641	0.183	0.506	0.011	0.162	0.014
0.753	0.030	0.641	1.000	0.457	0.225	0.929	0.226	0.667	0.036	0.257	0.017
0.877	0.054	0.859	0.324	0.514	0.284	1.238	0.594	0.951	0.085	0.362	0.020
0.986	0.073	1.070	0.227	0.516	0.417	1.516	0.743	1.062	0.042	0.448	0.024
1.466	0.080	1.242	0.170	0.571	0.474	1.646	0.960	1.222	0.035	0.552	0.026
1.699	0.655	1.555	0.137	0.610	0.551	1.787	1.000	1.272	0.104	0.638	0.027
1.849	1.000	1.906	0.121	0.705	0.610	2.079	0.996	1.420	0.551	0.714	0.027
2.219	0.655	2.086	0.109	0.895	0.632	2.619	0.837	1.543	1.000	0.752	0.027
2.589	0.285	2.242	0.103	1.057	0.569	3.044	0.490	1.642	0.551	0.876	0.029
2.904	0.185	2.391	0.097	1.162	0.618	3.527	0.383	1.790	0.285	0.943	0.048
3.055	0.157	2.758	0.087	1.229	0.526	3.883	0.327	2.074	0.184	0.971	0.065
3.260	0.157	3.336	0.073	1.390	0.475	4.119	0.266	2.519	0.105	1.010	0.135
3.479	0.177	3.977	0.061	1.610	0.399	4.365	0.226			1.038	0.579
3.630	0.153	4.641	0.051	1.705	0.353	4.625	0.182			1.181	1.000
3.863	0.152			1.771	0.377	4.849	0.135			1.229	0.917
4.096	0.135			1.800	0.475	5.175	0.114			1.267	0.872
4.192	0.145			1.905	0.551	5.697	0.096			1.314	0.836
4.630	0.146			2.000	0.729	5.835	0.084			1.362	0.806
4.890	0.107			2.162	0.855	6.149	0.084			1.419	0.767
5.274	0.089			2.476	0.900	6.281	0.096			1.448	0.726
5.699	0.072			2.648	0.772	6.354	0.097			1.495	0.701
5.932	0.063			2.838	0.716	6.430	0.102			1.514	0.689
6.507	0.065			2.943	0.682	6.578	0.102			1.533	0.677
6.740	0.052			2.981	0.785	7.027	0.099			1.562	0.641
7.068	0.050			3.238	0.835	7.411	0.080			1.571	0.583
7.877	0.051			3.267	0.937	8.059	0.069			1.648	0.579
8.192	0.045			3.295	0.970					1.733	0.484
8.466	0.041			3.381	0.994					1.867	0.439
9.027	0.030			3.505	1.000					2.086	0.354
9.288	0.023			3.962	0.962					2.267	0.295
				4.133	0.752					2.467	0.268
				4.257	0.728					2.886	0.234
				4.705	0.728					3.190	0.173
				4.895	0.600					3.267	0.133
				5.000	0.561					3.400	0.116
				5.210	0.559					3.543	0.089
				5.362	0.587					3.724	0.070

				5.505	0.560					3.838	0.053
				5.571	0.475					3.971	0.045
				5.771	0.431					4.257	0.041
				5.962	0.316					4.524	0.034
				6.029	0.228					4.848	0.029
				6.381	0.208					5.133	0.026
				6.924	0.159					5.467	0.023
				7.190	0.134					5.743	0.021
				7.638	0.124					6.095	0.020
				7.981	0.096					6.638	0.019
				8.362	0.084					7.381	0.017
				9.124	0.076					7.857	0.015
				9.410	0.063					8.133	0.013
				10.019	0.058						

Appendix F3 (a)

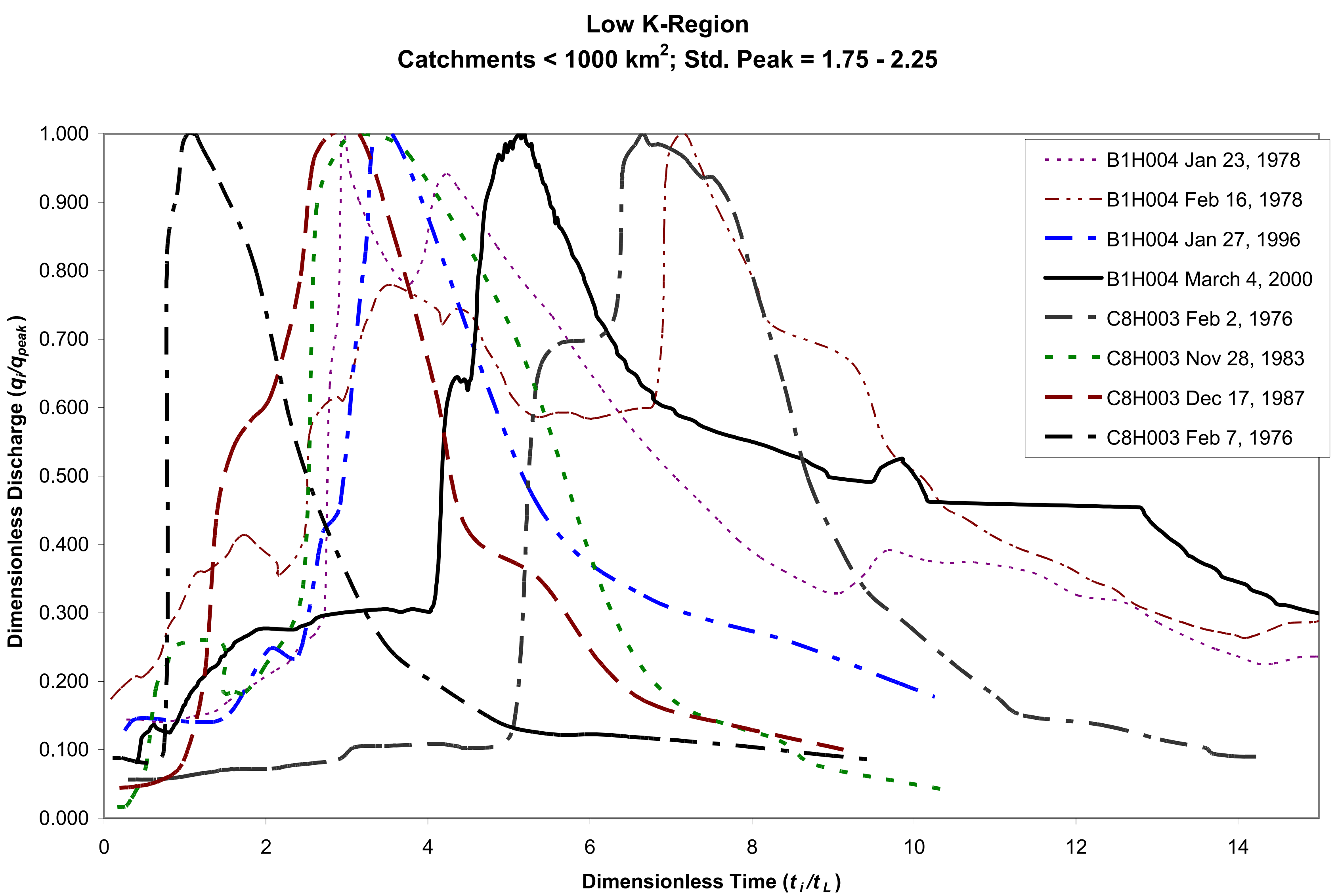
Low K-Region
Catchments < 1000km^2; Std. Peak = 1.25 - 1.75



Standardised Hydrographs: Low K-Region; Area < 1000 km^2; Std. Peak 1.25 – 1.75
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

A2H021	March 17, 2000	B1H004	April 3, 1975	B1H004	December 22, 1976	B1H004	November 21, 1995	C8H003	January 26, 1976	C8H003	February 11, 1976
Peak	102.93	**Peak**	18.39	**Peak**	19.09	**Peak**	17.59	**Peak**	62.17	**Peak**	54.80
Volume	69.82	**Volume**	1.94	**Volume**	1.02	**Volume**	0.88	**Volume**	6.86	**Volume**	7.28
Area	7483	**Area**	376	**Area**	376	**Area**	376	**Area**	806	**Area**	806
Basin Lag	15.90	**Basin Lag**	4.70	**Basin Lag**	4.70	**Basin Lag**	4.70	**Basin Lag**	7.33	**Basin Lag**	7.33
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.131	0.077	0.191	0.066	0.064	0.028	0.234	0.167	0.150	0.061	0.327	0.141
0.213	0.077	0.298	0.070	0.085	0.033	0.489	0.184	0.218	0.062	0.545	0.141
0.555	0.081	0.362	0.076	0.277	0.036	0.638	0.176	0.286	0.062	0.682	0.146
0.590	0.084	0.532	0.130	0.383	0.036	0.872	0.194	0.764	0.068	0.846	0.157
0.631	0.087	0.723	0.235	0.511	0.035	1.043	0.192	0.927	0.363	1.064	0.162
0.830	0.090	1.043	0.235	0.514	0.034	1.277	0.213	1.105	0.439	1.268	0.167
1.010	0.125	1.191	0.328	0.553	0.054	2.021	1.000	1.309	0.483	1.364	0.165
1.057	0.259	1.255	0.483	0.574	0.124	2.383	0.575	1.418	0.511	1.486	0.168
1.081	0.278	1.340	0.664	0.638	0.212	2.745	0.465	1.677	0.530	1.896	0.179
1.111	0.283	1.404	0.862	3.383	0.320	3.489	0.447	2.073	0.627	1.977	0.245
1.160	0.285	1.660	1.000	3.511	0.468	4.298	0.353	2.237	0.834	2.127	0.263
1.343	0.269	1.894	0.923	3.596	0.822	5.957	0.274	2.550	0.879	2.318	0.279
1.430	0.200	2.170	0.858	4.000	1.000	6.489	0.221	2.823	0.941	2.441	0.293
1.529	0.182	2.447	0.794	4.106	0.763	7.617	0.221	3.109	0.985	2.632	0.306
1.608	0.172	2.787	0.710	4.234	0.935	10.043	0.188	3.355	1.000	2.782	0.329
1.829	0.171	3.000	0.640	4.426	0.837			3.628	0.982	2.864	0.355
2.043	0.182	3.319	0.579	4.617	0.740			3.928	0.926	3.750	0.391
2.202	0.188	3.574	0.528	4.915	0.649			4.364	0.828	3.928	0.856
2.323	0.188	3.872	0.475	5.106	0.584			5.414	0.308	4.105	0.932
2.430	0.203	4.170	0.426	5.383	0.537			6.150	0.214	4.268	0.983
2.692	0.245	4.489	0.377	5.681	0.489			7.460	0.180	4.418	1.000
2.855	0.434	4.766	0.349	5.957	0.440			8.905	0.154	4.568	0.983
3.099	0.530	5.064	0.327	6.234	0.371			10.596	0.136	4.814	0.979
3.179	0.597	5.468	0.294	6.468	0.324			11.496	0.113	5.919	0.905
3.266	0.602	5.809	0.272	6.830	0.274					6.614	0.520
3.453	0.602	6.298	0.256	7.128	0.237					7.228	0.382
3.560	0.598	6.532	0.265	7.447	0.209					7.323	0.301
3.656	0.602	6.851	0.268	7.851	0.195					7.391	0.302
3.828	0.626	7.319	0.265	8.234	0.177					8.305	0.290
4.058	0.677	7.787	0.262	8.660	0.165					8.932	0.235
4.259	0.761	8.149	0.245	9.000	0.147					9.887	0.211
4.481	0.808	8.617	0.234	9.362	0.128					10.828	0.180
4.696	0.833	10.000	0.232	9.660	0.116					12.369	0.158
4.891	0.845	10.447	0.269	9.851	0.110					13.555	0.137
5.032	0.849	10.936	0.287	10.085	0.117					13.560	0.121
5.381	0.860	11.362	0.316	10.277	0.125					14.537	0.118
5.541	0.904	11.660	0.328	10.596	0.131					15.778	0.117
5.656	0.911	12.043	0.338	10.979	0.139						
5.823	0.908	13.064	0.341	11.319	0.139						

6.008	0.910	13.383	0.320	11.638	0.128						
6.350	0.926	13.745	0.301	12.106	0.122						
6.488	0.990	14.596	0.288	12.511	0.118						
6.659	1.000	15.574	0.255	13.085	0.111						
7.043	0.992	16.574	0.231	13.787	0.100						
7.362	0.934	17.596	0.213	14.319	0.089						
7.691	0.885	18.617	0.197	14.957	0.086						
8.117	0.829	19.638	0.182	15.468	0.082						
8.253	0.761	20.830	0.175								
8.654	0.736	21.809	0.169								
9.017	0.652	22.702	0.158								
9.350	0.602	23.638	0.149								
9.721	0.549	24.447	0.140								
10.073	0.522	25.553	0.133								
10.481	0.517	26.681	0.124								
10.778	0.529										
11.050	0.558										
11.283	0.585										
11.669	0.603										
11.907	0.623										
12.325	0.631										
12.520	0.642										
12.817	0.646										
13.201	0.645										
13.422	0.628										
13.700	0.621										
14.223	0.620										
14.384	0.605										
14.488	0.606										
14.800	0.604										
15.149	0.637										
15.350	0.680										
15.493	0.705										
15.885	0.734										
16.021	0.882										
16.102	0.912										
16.193	0.916										
16.369	0.910										
16.765	0.861										
16.937	0.716										
17.282	0.672										
17.484	0.626										
17.876	0.597										


Low K-Region
Catchments < 1000 km^2; Std. Peak = 1.75 - 2.25
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Dimensionless Discharge (q_i/q_{peak})
0
2
4
6
8
10
12
14
Dimensionless Time (t_i/t_L)
B1H004 Jan 23, 1978
B1H004 Feb 16, 1978
B1H004 Jan 27, 1996
B1H004 March 4, 2000
C8H003 Feb 2, 1976
C8H003 Nov 28, 1983
C8H003 Dec 17, 1987
C8H003 Feb 7, 1976

Standardised Hydrographs: Low K-Region; Area < 1000 km^2; Std. Peak 1.75 – 2.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

C8H003	November 28, 1983	C8H003	December 17, 1987	C8H003	February 7, 1976	B1H004	January 27, 1996
Peak	92.3	**Peak**	90.6	**Peak**	92.1	**Peak**	25.8
Volume	7.9	**Volume**	7.6	**Volume**	5.9	**Volume**	1.6
Area	806	**Area**	806	**Area**	806	**Area**	376
Basin Lag	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	4.7
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.164	0.016	0.191	0.044	0.109	0.088	0.255	0.128
0.273	0.018	0.382	0.046	0.177	0.088	0.426	0.146
0.341	0.030	0.696	0.055	0.205	0.088	1.128	0.141
0.382	0.038	0.982	0.083	0.736	0.098	1.553	0.153
0.518	0.076	1.241	0.210	0.777	0.824	2.043	0.247
0.641	0.190	1.391	0.444	0.900	0.911	2.404	0.238
0.777	0.224	1.582	0.536	0.968	0.982	2.702	0.417
0.900	0.253	1.800	0.579	1.036	1.000	2.915	0.458
1.459	0.255	2.032	0.610	1.105	1.000	3.213	0.810
1.473	0.186	2.223	0.683	1.132	1.000	3.553	1.000
1.609	0.185	2.427	0.793	1.200	0.982	5.298	0.470
1.746	0.184	2.577	0.956	1.432	0.929	6.660	0.326
1.977	0.221	2.796	0.998	1.868	0.802	8.489	0.257
2.455	0.336	3.150	1.000	2.387	0.543	9.723	0.201
2.618	0.887	3.559	0.859	2.987	0.359	10.255	0.177
2.918	0.981	4.091	0.625	3.518	0.248		
3.191	1.000	4.473	0.425	4.159	0.192		
3.764	0.970	5.373	0.349	4.678	0.153		
5.087	0.700	6.109	0.230	4.978	0.135		
6.219	0.315	6.723	0.169	5.291	0.126		
7.023	0.173	7.760	0.135	5.632	0.122		
8.332	0.114	9.178	0.099	5.932	0.123		
8.796	0.077			6.232	0.122		
10.337	0.042			6.532	0.119		
				6.982	0.115		
				7.828	0.106		
				8.796	0.094		
				9.573	0.084		

Standardised Hydrographs: Low K-Region; Area < 1000 km^2; Std. Peak 1.75 – 2.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

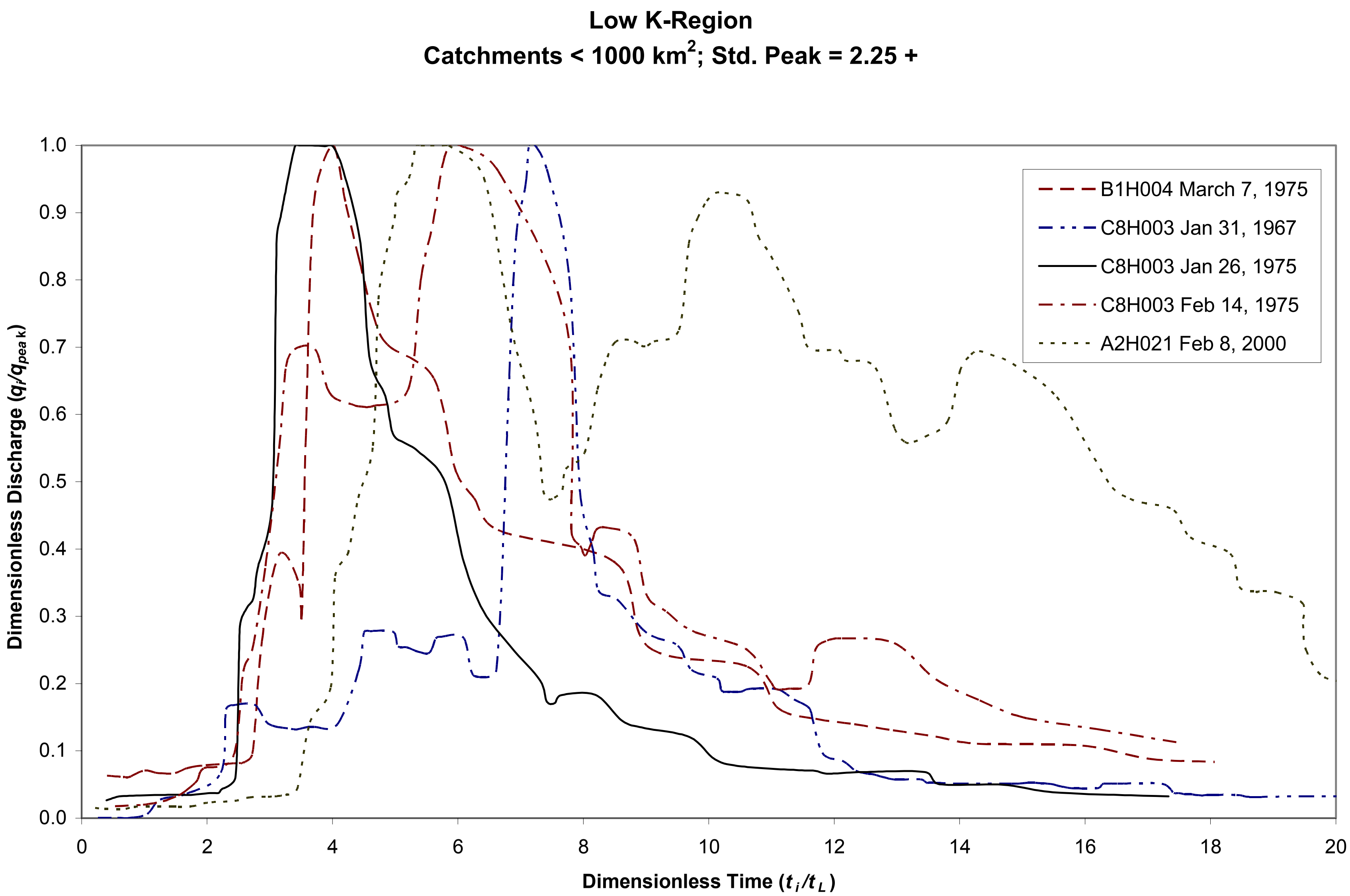
B1H004	January 23, 1978	B1H004	February 16, 1978	B1H004	March 4, 2000	C8H003	February 2, 1976
Peak	24.9	**Peak**	23.5	**Peak**	28.8	**Peak**	98.4
Volume	3.1	**Volume**	2.9	**Volume**	1.5	**Volume**	11.3
Area	376	**Area**	376	**Area**	376	**Area**	806
Basin Lag	4.7	**Basin Lag**	4.7	**Basin Lag**	4.7	**Basin Lag**	7.3
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.277	0.144	0.085	0.174	0.404	0.082	0.300	0.057
0.447	0.144	0.213	0.190	0.426	0.088	0.655	0.057
0.681	0.140	0.383	0.207	0.447	0.102	0.927	0.060
0.872	0.143	0.489	0.207	0.468	0.118	1.173	0.065
1.106	0.149	0.681	0.234	0.532	0.126	1.405	0.069
1.362	0.155	0.787	0.277	0.553	0.127	1.432	0.070
1.532	0.171	0.936	0.306	0.574	0.132	1.677	0.072
1.723	0.185	1.128	0.357	0.617	0.137	2.073	0.072
1.936	0.202	1.277	0.361	0.638	0.133	2.237	0.076
2.128	0.216	1.511	0.383	0.681	0.129	2.332	0.077
2.277	0.228	1.617	0.404	0.809	0.125	2.414	0.079
2.426	0.252	1.745	0.414	0.830	0.128	2.891	0.086
2.574	0.266	1.915	0.396	0.851	0.132	3.096	0.104
2.638	0.276	2.128	0.374	0.872	0.137	3.464	0.106
2.723	0.303	2.170	0.356	0.894	0.140	4.078	0.109
2.787	0.633	2.468	0.410	0.915	0.145	4.364	0.105
2.894	0.745	2.532	0.559	0.936	0.151	4.473	0.103
2.936	1.000	2.681	0.598	0.957	0.157	5.046	0.130
3.043	0.942	2.872	0.615	0.979	0.164	5.250	0.516
3.149	0.902	2.957	0.611	1.000	0.166	5.359	0.647
3.298	0.859	3.064	0.652	1.021	0.173	5.605	0.692
3.468	0.819	3.191	0.711	1.043	0.176	6.287	0.726
3.638	0.790	3.298	0.741	1.064	0.182	6.410	0.952
3.787	0.781	3.404	0.770	1.085	0.185	6.560	0.984
3.915	0.810	3.574	0.779	1.106	0.189	6.655	1.000
3.979	0.839	4.106	0.744	1.149	0.194	6.737	0.984
4.043	0.890	4.170	0.721	1.170	0.200	6.873	0.984
4.106	0.923	4.340	0.744	1.234	0.207	7.132	0.968
4.234	0.942	4.553	0.732	1.277	0.213	7.255	0.952
4.362	0.923	4.702	0.690	1.319	0.218	7.391	0.935
4.596	0.885	4.894	0.652	1.383	0.223	7.528	0.935
4.851	0.835	5.021	0.618	1.426	0.229	7.773	0.885
5.213	0.778	5.213	0.594	1.447	0.235	8.060	0.771
5.532	0.733	5.383	0.586	1.489	0.238	8.401	0.632
5.851	0.676	5.574	0.592	1.511	0.244	8.687	0.498
6.149	0.626	5.766	0.592	1.574	0.249	9.069	0.399
6.426	0.582	5.936	0.585	1.617	0.257	9.423	0.331
6.723	0.540	6.085	0.585	1.702	0.263	9.887	0.286
7.064	0.497	6.426	0.595	1.809	0.270	10.446	0.229

7.340	0.465	6.638	0.600	1.894	0.275	11.019	0.177
7.596	0.435	6.787	0.604	2.000	0.277	11.346	0.150
7.830	0.406	6.894	0.709	2.340	0.275	12.314	0.136
8.106	0.381	6.915	0.856	2.426	0.280	13.037	0.115
8.383	0.362	6.936	0.936	2.553	0.285	13.596	0.103
8.617	0.347	7.000	0.980	2.660	0.294	13.678	0.095
8.872	0.332	7.170	1.000	2.957	0.300	13.951	0.091
9.085	0.329	7.340	0.958	3.468	0.306	14.224	0.090
9.234	0.340	7.574	0.890	3.660	0.301		
9.362	0.353	7.851	0.828	3.809	0.306		
9.447	0.364	8.064	0.774	4.021	0.301		
9.511	0.376	8.255	0.719	4.043	0.307		
9.681	0.392	9.234	0.665	4.064	0.311		
9.936	0.384	9.660	0.544	4.085	0.322		
10.170	0.376	10.128	0.495	4.106	0.344		
10.447	0.373	10.362	0.456	4.128	0.372		
10.745	0.374	10.638	0.437	4.149	0.426		
11.468	0.359	10.936	0.415	4.170	0.493		
12.021	0.326	11.255	0.396	4.191	0.545		
12.596	0.315	11.553	0.383	4.213	0.582		
13.021	0.285	11.894	0.367	4.234	0.604		
13.404	0.263	12.191	0.347	4.255	0.618		
13.723	0.247	12.468	0.335	4.298	0.636		
13.979	0.237	12.723	0.313	4.362	0.645		
14.234	0.226	13.021	0.298	4.404	0.638		
14.447	0.226	13.298	0.287	4.447	0.641		
14.745	0.235	13.532	0.278	4.468	0.638		
14.936	0.236	13.745	0.272	4.489	0.625		
15.277	0.238	13.957	0.268	4.511	0.638		
15.766	0.230	14.106	0.264	4.532	0.643		
16.213	0.214	14.383	0.275	4.553	0.665		
16.681	0.204	14.617	0.285	4.574	0.693		
17.149	0.193	14.936	0.287	4.596	0.725		
17.553	0.187	15.149	0.291	4.617	0.784		
18.170	0.183	15.489	0.293	4.638	0.809		
18.574	0.174	15.830	0.291	4.660	0.829		
19.191	0.167	16.149	0.286	4.681	0.869		
19.872	0.163	16.553	0.277	4.702	0.892		
20.617	0.166	17.000	0.255	4.723	0.906		
21.064	0.158	17.404	0.250	4.745	0.914		
		17.766	0.238	4.787	0.930		
		18.149	0.231	4.809	0.940		
		18.553	0.221	4.830	0.953		
		18.979	0.207	4.851	0.962		
		19.468	0.202	4.872	0.970		
		19.894	0.192	4.915	0.962		
		20.277	0.187	4.936	0.973		

		20.872	0.183	4.957	0.985		
		21.489	0.172	4.979	0.973		
				5.000	0.982		
				5.021	0.988		
				5.043	0.978		
				5.064	0.990		
				5.128	1.000		
				5.149	0.993		
				5.191	1.000		
				5.213	0.988		
				5.255	0.982		
				5.277	0.985		
				5.298	0.968		
				5.319	0.962		
				5.340	0.952		
				5.362	0.955		
				5.383	0.947		
				5.404	0.936		
				5.426	0.928		
				5.447	0.925		
				5.468	0.916		
				5.489	0.909		
				5.511	0.896		
				5.553	0.887		
				5.574	0.869		
				5.596	0.877		
				5.617	0.866		
				5.660	0.859		
				5.723	0.844		
				5.766	0.830		
				5.787	0.822		
				5.851	0.810		
				5.894	0.799		
				5.915	0.794		
				5.936	0.784		
				6.000	0.766		
				6.064	0.744		
				6.085	0.733		
				6.170	0.720		
				6.213	0.710		
				6.255	0.701		
				6.319	0.689		
				6.340	0.678		
				6.426	0.669		
				6.468	0.656		
				6.574	0.647		
				6.638	0.632		

				6.766	0.622		
				6.787	0.611		
				6.894	0.603		
				7.021	0.598		
				7.085	0.589		
				7.277	0.581		
				7.383	0.573		
				7.638	0.561		
				8.000	0.550		
				8.213	0.542		
				8.447	0.532		
				8.638	0.524		
				8.745	0.517		
				8.894	0.508		
				8.936	0.501		
				8.957	0.498		
				9.468	0.491		
				9.532	0.500		
				9.574	0.510		
				9.596	0.512		
				9.702	0.520		
				9.851	0.526		
				9.872	0.520		
				9.936	0.512		
				9.979	0.505		
				10.021	0.498		
				10.064	0.491		
				10.106	0.480		
				10.149	0.471		
				10.191	0.462		
				12.787	0.454		
				12.830	0.449		
				12.851	0.444		
				12.894	0.438		
				12.915	0.434		
				12.957	0.428		
				13.000	0.424		
				13.064	0.418		
				13.128	0.411		
				13.191	0.406		
				13.277	0.399		
				13.340	0.391		
				13.383	0.384		
				13.426	0.382		
				13.553	0.373		
				13.702	0.366		
				13.766	0.359		

				13.809	0.353		
				13.915	0.348		
				14.106	0.341		
				14.170	0.334		
				14.340	0.326		
				14.426	0.320		
				14.489	0.313		
				14.617	0.311		
				14.809	0.304		
				14.915	0.301		
				15.149	0.295		
				15.383	0.289		
				15.596	0.282		
				15.638	0.280		
				15.915	0.273		
				15.957	0.270		
				16.362	0.265		
				16.511	0.259		
				16.787	0.254		
				16.872	0.250		
				17.085	0.246		
				17.234	0.241		
				17.574	0.235		
				17.617	0.230		
				17.830	0.225		
				18.085	0.220		
				18.255	0.216		
				18.426	0.210		
				18.787	0.206		
				19.064	0.198		
				19.213	0.192		
				19.340	0.188		
				19.511	0.183		
				19.745	0.181		
				20.043	0.177		
				20.170	0.173		
				20.638	0.168		
				20.894	0.163		
				20.936	0.161		
				21.213	0.156		
				21.447	0.153		
				22.213	0.149		
				22.553	0.144		
				22.979	0.138		


Low K-Region
Catchments < 1000 km²; Std. Peak = 2.25 +
Dimensionless Discharge (q_i/q_{peak})
Dimensionless Time (t_i/t_L)
B1H004 March 7, 1975
C8H003 Jan 31, 1967
C8H003 Jan 26, 1975
C8H003 Feb 14, 1975
A2H021 Feb 8, 2000
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
2
4
6
8
10
12
14
16
18
20

Standardised Hydrographs: Low K-Region; Area < 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

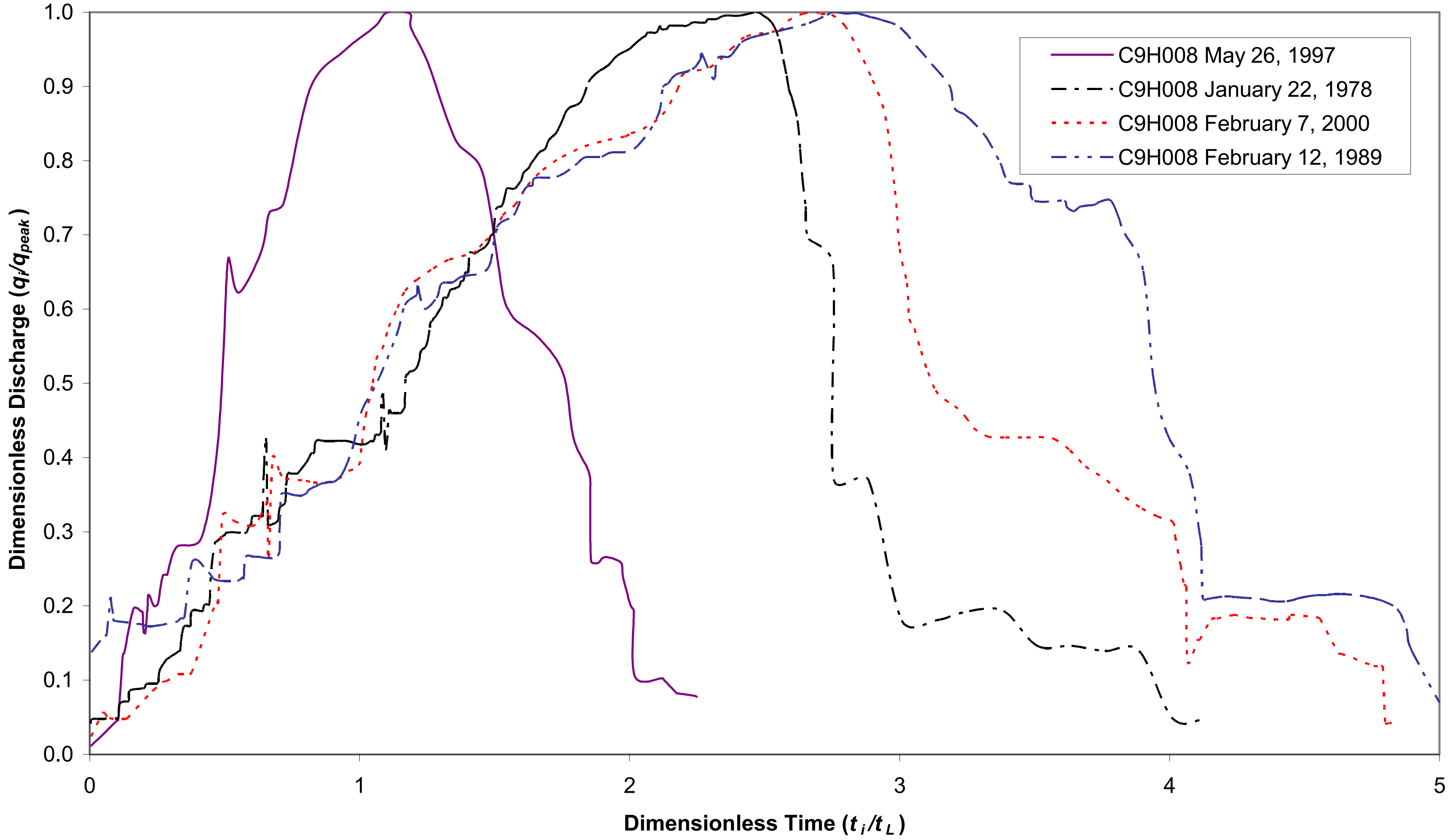
B1H004	**March 7, 1975**	**C8H003**	**January 31, 1967**	**C8H003**	**January 26, 1975**	**C8H003**	**February 14, 1975**	**A2H021**	**February 8, 2000**
Flow	31.7	**Flow**	146.2	**Flow**	163.7	**Flow**	160.5	**Flow**	430.3
Volume	2.6	**Volume**	11.7	**Volume**	3.2	**Volume**	23.9	**Volume**	305.4
Area	376	**Area**	806	**Area**	806	**Area**	806	**Area**	7483
Basin Lag	4.7	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	15.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.404	0.063	0.259	0.000	0.395	0.026	0.532	0.018	0.213	0.015
0.660	0.061	0.573	0.000	0.641	0.033	0.982	0.020	0.364	0.014
0.766	0.061	0.764	0.000	1.459	0.035	1.296	0.025	0.703	0.014
1.000	0.071	1.050	0.006	1.746	0.035	1.541	0.033	0.833	0.017
1.213	0.067	1.255	0.027	2.046	0.037	1.705	0.044	1.448	0.017
1.489	0.067	1.677	0.036	2.182	0.037	1.841	0.056	1.537	0.017
1.702	0.075	2.223	0.068	2.237	0.043	1.950	0.074	1.767	0.018
1.979	0.079	2.305	0.162	2.455	0.062	2.414	0.091	1.945	0.022
2.255	0.081	2.427	0.168	2.523	0.285	2.577	0.218	2.072	0.024
2.511	0.082	2.755	0.169	2.632	0.312	2.727	0.253	2.442	0.026
2.553	0.082	2.932	0.144	2.741	0.328	2.932	0.375	2.683	0.031
2.723	0.095	3.068	0.137	2.809	0.371	3.150	0.549	2.973	0.032
2.872	0.262	3.341	0.133	3.041	0.469	3.259	0.671	3.081	0.032
3.149	0.392	3.437	0.132	3.109	0.861	3.396	0.697	3.131	0.033
3.468	0.348	3.614	0.136	3.177	0.895	3.723	0.697	3.251	0.035
3.511	0.296	3.709	0.136	3.218	0.916	3.955	0.632	3.437	0.043
3.574	0.559	4.078	0.139	3.355	0.981	4.296	0.615	3.645	0.143
3.702	0.913	4.418	0.220	3.409	1.000	4.500	0.611	3.973	0.195
4.000	1.000	4.500	0.276	3.478	1.000	4.650	0.612	4.043	0.360
4.213	0.913	4.609	0.278	3.668	1.000	5.209	0.637	4.244	0.393
4.426	0.830	4.964	0.277	3.873	0.999	5.414	0.803	4.412	0.476
4.638	0.752	5.046	0.255	4.009	0.998	5.605	0.885	4.644	0.553
4.872	0.704	5.182	0.254	4.159	0.966	5.755	0.971	4.736	0.771
5.617	0.653	5.359	0.247	4.446	0.854	5.878	1.000	4.862	0.841
5.957	0.519	5.550	0.246	4.596	0.683	6.028	1.000	4.991	0.892
6.255	0.476	5.646	0.267	4.841	0.628	6.641	0.962	5.025	0.927
6.638	0.428	5.728	0.270	4.964	0.572	7.732	0.734	5.218	0.951
8.511	0.379	6.082	0.269	5.155	0.558	7.814	0.424	5.333	1.000
9.043	0.254	6.205	0.220	5.359	0.546	7.951	0.405	5.410	1.000
10.617	0.225	6.287	0.210	5.796	0.500	8.032	0.390	5.560	1.000
11.106	0.163	6.614	0.220	6.096	0.380	8.141	0.412	5.770	1.000
11.702	0.148	6.819	0.658	6.410	0.308	8.210	0.429	5.851	1.000
12.319	0.140	6.928	0.863	6.846	0.254	8.373	0.432	6.415	0.951
12.936	0.131	7.078	0.942	7.310	0.205	8.810	0.415	6.855	0.728
13.617	0.121	7.132	1.000	7.419	0.173	9.001	0.333	7.236	0.591
14.277	0.111	7.228	1.000	7.541	0.171	9.328	0.307	7.357	0.487
15.957	0.108	7.419	0.965	7.651	0.183	9.737	0.278	7.447	0.474
17.021	0.088	7.773	0.805	8.196	0.183	10.583	0.252	7.537	0.476
18.064	0.084	7.951	0.484	8.619	0.145	10.964	0.205	7.666	0.488

		8.155	0.398	8.960	0.134	11.060	0.192	7.720	0.519
		8.237	0.339	9.696	0.121	11.183	0.191	8.020	0.543
		8.537	0.325	10.105	0.087	11.264	0.192	8.226	0.637
		8.851	0.290	10.528	0.077	11.592	0.199	8.383	0.685
		9.082	0.271	11.387	0.072	11.701	0.250	8.501	0.707
		9.505	0.256	11.687	0.070	11.892	0.264	8.658	0.711
		9.723	0.220	11.851	0.066	12.124	0.267	8.813	0.709
		10.132	0.208	12.014	0.066	12.955	0.260	8.926	0.702
		10.201	0.190	12.478	0.069	13.624	0.206	9.021	0.702
		10.337	0.188	13.446	0.069	14.319	0.175	9.128	0.709
		10.514	0.188	13.678	0.051	15.015	0.150	9.527	0.726
		10.664	0.192	14.674	0.050	16.187	0.132	9.681	0.854
		11.087	0.192	15.342	0.040	17.538	0.111	9.827	0.892
		11.360	0.176	15.915	0.036			9.970	0.917
		11.537	0.168	16.542	0.034			10.104	0.929
		11.619	0.160	17.333	0.032			10.254	0.929
		11.810	0.097					10.615	0.918
		12.137	0.085					10.787	0.865
		12.342	0.071					10.988	0.836
		12.533	0.066					11.423	0.753
		12.614	0.065					11.546	0.705
		12.737	0.062					11.702	0.695
		12.805	0.061					12.073	0.695
		12.969	0.057					12.158	0.681
		13.378	0.058					12.656	0.669
		13.474	0.053					12.963	0.579
		13.555	0.053					13.128	0.559
		13.924	0.052					13.270	0.560
		14.728	0.052					13.456	0.567
		14.919	0.051					13.814	0.590
		15.083	0.053					14.008	0.665
		15.246	0.052					14.182	0.689
		15.451	0.051					14.311	0.694
		15.615	0.047					14.487	0.689
		15.696	0.046					14.847	0.675
		15.819	0.044					15.548	0.626
		16.201	0.045					16.145	0.535
		16.297	0.051					16.434	0.491
		16.515	0.051					16.716	0.475
		17.224	0.051					16.928	0.469
		17.415	0.037					17.414	0.457
		17.483	0.037					17.679	0.417
		17.592	0.035					18.314	0.393
		17.674	0.035					18.458	0.344
		17.851	0.034					18.717	0.337
		17.988	0.035					18.833	0.338
		18.410	0.035					19.068	0.335

		18.574	0.032					19.470	0.319
		18.697	0.032					19.476	0.288
		19.433	0.032					19.527	0.249
		21.001	0.032					19.813	0.209
		21.724	0.021					20.437	0.199
		22.079	0.016					20.690	0.184
		22.474	0.015					21.053	0.180
		22.597	0.015					21.492	0.168
		22.774	0.014					21.722	0.159
		22.965	0.014					22.260	0.153
								22.699	0.143
								23.114	0.135
								23.210	0.123
								23.360	0.122
								23.616	0.123
								23.889	0.122
								24.111	0.118
								24.328	0.111
								24.613	0.110
								24.784	0.110
								25.284	0.109
								25.568	0.101
								25.882	0.095
								26.586	0.092
								26.773	0.091
								27.224	0.088
								27.518	0.082
								27.697	0.081
								27.954	0.079
								28.247	0.075
								28.646	0.073
								28.740	0.066
								29.338	0.060
								29.606	0.055
								30.029	0.054
								30.132	0.051
								30.619	0.051
								30.986	0.048

Appendix F3 (b)

Low K-Region
Catchments > 1000 km^2; Std. Peak = 1.75 - 2.75



Standardised Hydrographs: Low K-Region; Area > 1000 km^2; Std. Peak 1.75 – 2.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

C9H008	May 26, 1997	C9H008	January 22, 1978	C9H008	February 7, 2000	C9H008	February 12, 1989
Peak	2097.8	**Peak**	1537.7	**Peak**	1567.4	**Peak**	1782.0
Volume	1499.2	**Volume**	1025.0	**Volume**	1221.9	**Volume**	1948.9
Area	115057	**Area**	115057	**Area**	115057	**Area**	115057
Basin Lag	95.6	**Basin Lag**	95.6	**Basin Lag**	95.6	**Basin Lag**	95.6
Time/lag	**Flow/Peak**	**Time/lag**	**H-V/P-V**	**Time/lag**	**H-V/P-V**	**Time/lag**	**H-V/P-V**
0.006	0.012	0.004	0.041	0.006	0.024	0.006	0.137
0.102	0.046	0.008	0.047	0.047	0.056	0.056	0.161
0.106	0.046	0.101	0.049	0.054	0.056	0.062	0.160
0.123	0.135	0.107	0.049	0.073	0.049	0.077	0.212
0.128	0.136	0.111	0.069	0.131	0.048	0.078	0.210
0.162	0.196	0.141	0.071	0.137	0.048	0.088	0.183
0.192	0.192	0.145	0.072	0.231	0.085	0.089	0.180
0.196	0.192	0.149	0.086	0.236	0.087	0.180	0.176
0.199	0.165	0.191	0.089	0.268	0.097	0.231	0.173
0.204	0.163	0.200	0.089	0.276	0.098	0.325	0.179
0.206	0.163	0.204	0.090	0.283	0.098	0.333	0.182
0.213	0.194	0.212	0.095	0.327	0.108	0.340	0.184
0.214	0.194	0.247	0.096	0.334	0.108	0.350	0.184
0.218	0.215	0.250	0.096	0.371	0.109	0.381	0.260
0.237	0.200	0.254	0.097	0.377	0.109	0.439	0.245
0.249	0.201	0.259	0.114	0.470	0.206	0.468	0.235
0.253	0.203	0.286	0.128	0.476	0.203	0.547	0.234
0.271	0.240	0.290	0.129	0.493	0.324	0.568	0.239
0.287	0.242	0.332	0.139	0.529	0.317	0.570	0.236
0.289	0.245	0.335	0.139	0.535	0.314	0.577	0.266
0.323	0.280	0.340	0.158	0.600	0.307	0.606	0.267
0.413	0.291	0.341	0.161	0.625	0.316	0.622	0.266
0.476	0.424	0.344	0.165	0.630	0.320	0.697	0.267
0.508	0.653	0.350	0.173	0.653	0.335	0.703	0.303
0.515	0.669	0.369	0.173	0.658	0.343	0.709	0.350
0.551	0.622	0.373	0.173	0.663	0.265	0.728	0.352
0.635	0.678	0.378	0.193	0.677	0.400	0.763	0.349
0.666	0.730	0.414	0.193	0.703	0.380	0.789	0.349
0.717	0.742	0.418	0.193	0.723	0.372	0.805	0.353
0.818	0.898	0.425	0.201	0.801	0.369	0.812	0.356
0.942	0.948	0.440	0.201	0.828	0.366	0.861	0.365
1.056	0.980	0.444	0.201	0.877	0.366	0.880	0.367
1.102	1.000	0.451	0.251	0.920	0.371	0.912	0.369
1.187	0.998	0.464	0.286	0.960	0.382	0.940	0.381
1.190	0.979	0.469	0.286	0.997	0.389	0.973	0.411
1.253	0.932	0.497	0.295	1.009	0.420	1.006	0.461
1.355	0.828	0.502	0.295	1.023	0.456	1.067	0.503
1.455	0.784	0.505	0.299	1.049	0.500	1.136	0.564
1.533	0.616	0.573	0.299	1.061	0.532	1.167	0.605

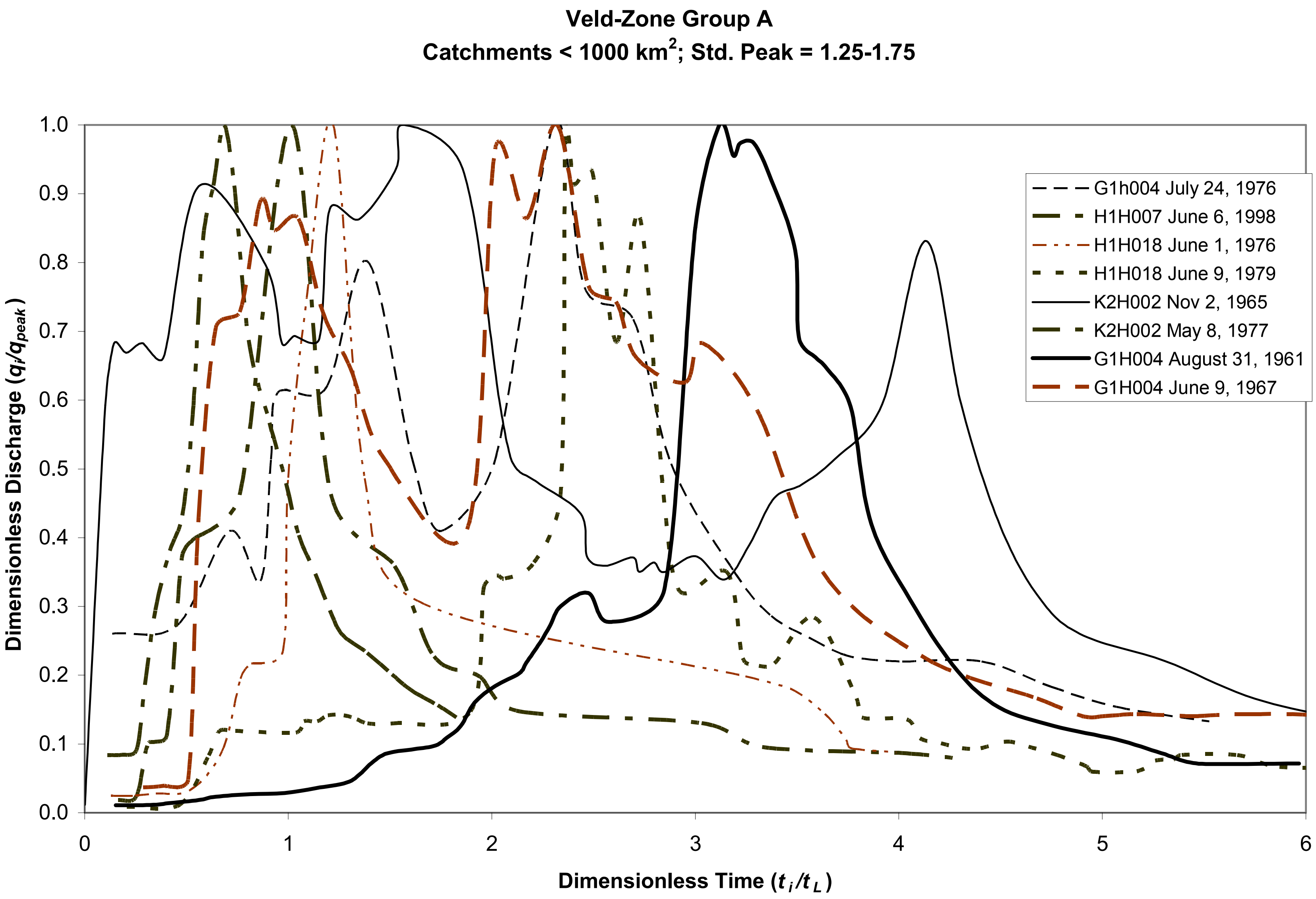
1.566	0.590	0.581	0.299	1.084	0.546	1.210	0.619
1.581	0.584	0.594	0.310	1.108	0.576	1.215	0.631
1.671	0.558	0.599	0.310	1.141	0.601	1.238	0.600
1.756	0.511	0.604	0.321	1.168	0.624	1.285	0.615
1.793	0.426	0.635	0.321	1.212	0.639	1.303	0.634
1.849	0.380	0.640	0.321	1.272	0.655	1.345	0.636
1.854	0.344	0.645	0.382	1.331	0.667	1.379	0.644
1.857	0.261	0.653	0.426	1.419	0.675	1.475	0.655
1.881	0.258	0.661	0.310	1.444	0.683	1.508	0.710
1.903	0.265	0.675	0.310	1.465	0.692	1.571	0.727
1.931	0.265	0.695	0.313	1.504	0.703	1.605	0.757
1.969	0.258	0.699	0.317	1.530	0.726	1.621	0.765
1.975	0.240	0.700	0.321	1.574	0.740	1.640	0.767
2.001	0.204	0.703	0.332	1.622	0.766	1.650	0.777
2.009	0.197	0.715	0.336	1.678	0.787	1.730	0.778
2.015	0.193	0.725	0.340	1.750	0.805	1.798	0.794
2.019	0.105	0.727	0.363	1.835	0.819	1.836	0.804
2.122	0.102	0.729	0.366	1.920	0.828	1.897	0.806
2.126	0.101	0.733	0.378	1.984	0.833	1.930	0.811
2.174	0.083	0.747	0.378	2.005	0.837	2.019	0.817
2.178	0.082	0.768	0.378	2.049	0.843	2.104	0.859
2.244	0.079	0.770	0.378	2.121	0.862	2.123	0.899
2.249	0.078	0.803	0.394	2.177	0.896	2.143	0.904
		0.811	0.398	2.203	0.918	2.171	0.916
		0.821	0.406	2.298	0.926	2.232	0.923
		0.826	0.406	2.375	0.951	2.263	0.936
		0.831	0.406	2.433	0.968	2.267	0.944
		0.839	0.422	2.556	0.976	2.311	0.910
		0.869	0.422	2.586	0.988	2.325	0.938
		0.907	0.422	2.644	0.998	2.372	0.941
		0.950	0.422	2.689	1.000	2.414	0.959
		0.994	0.418	2.707	0.998	2.461	0.967
		1.017	0.418	2.748	0.996	2.550	0.975
		1.023	0.418	2.796	0.982	2.664	0.985
		1.042	0.422	2.844	0.951	2.731	0.996
		1.044	0.422	2.899	0.908	2.753	1.000
		1.048	0.422	2.946	0.860	2.804	0.998
		1.053	0.422	2.983	0.759	2.838	0.999
		1.059	0.431	3.001	0.681	2.884	0.994
		1.068	0.431	3.027	0.635	2.930	0.990
		1.073	0.431	3.036	0.587	3.001	0.979
		1.078	0.435	3.054	0.574	3.062	0.954
		1.082	0.481	3.079	0.543	3.126	0.927
		1.087	0.486	3.105	0.515	3.185	0.901
		1.096	0.410	3.133	0.490	3.203	0.871
		1.109	0.464	3.168	0.478	3.248	0.860
		1.117	0.460	3.204	0.470	3.315	0.835

		1.123	0.460	3.245	0.454	3.372	0.797
		1.144	0.460	3.275	0.440	3.404	0.771
		1.152	0.460	3.325	0.428	3.479	0.767
		1.161	0.464	3.391	0.427	3.498	0.746
		1.166	0.468	3.469	0.427	3.610	0.746
		1.169	0.507	3.517	0.428	3.618	0.738
		1.174	0.512	3.574	0.424	3.644	0.732
		1.178	0.512	3.631	0.410	3.672	0.738
		1.185	0.516	3.687	0.388	3.723	0.741
		1.195	0.516	3.767	0.369	3.736	0.743
		1.210	0.520	3.835	0.346	3.778	0.747
		1.223	0.534	3.898	0.331	3.803	0.731
		1.226	0.543	3.954	0.321	3.834	0.702
		1.248	0.552	4.011	0.313	3.903	0.651
		1.259	0.575	4.020	0.293	3.940	0.505
		1.260	0.579	4.037	0.260	3.991	0.432
		1.267	0.584	4.041	0.254	4.073	0.379
		1.269	0.584	4.053	0.229	4.110	0.301
		1.276	0.589	4.062	0.226	4.117	0.281
		1.279	0.589	4.066	0.125	4.123	0.210
		1.299	0.601	4.103	0.154	4.141	0.210
		1.304	0.605	4.111	0.154	4.203	0.213
		1.311	0.616	4.155	0.182	4.248	0.212
		1.318	0.616	4.175	0.183	4.346	0.209
		1.325	0.616	4.237	0.188	4.373	0.207
		1.333	0.623	4.292	0.184	4.434	0.206
		1.338	0.627	4.339	0.183	4.487	0.211
		1.344	0.627	4.440	0.182	4.533	0.214
		1.368	0.630	4.448	0.188	4.573	0.214
		1.376	0.638	4.550	0.184	4.620	0.216
		1.384	0.638	4.556	0.183	4.705	0.214
		1.391	0.649	4.625	0.136	4.733	0.212
		1.396	0.649	4.634	0.136	4.775	0.208
		1.402	0.649	4.756	0.119	4.843	0.196
		1.407	0.676	4.783	0.119	4.877	0.169
		1.421	0.676	4.790	0.118	4.883	0.154
		1.431	0.676	4.799	0.043	4.896	0.140
		1.446	0.679	4.815	0.042	4.997	0.071
		1.464	0.683	4.821	0.042	5.006	0.072
		1.479	0.691			5.016	0.072
		1.485	0.699			5.050	0.037
		1.496	0.703			5.090	0.037
		1.504	0.734			5.095	0.037
		1.519	0.738				
		1.525	0.738				
		1.531	0.742				
		1.545	0.762				

		1.554	0.762				
		1.575	0.762				
		1.585	0.766				
		1.593	0.771				
		1.599	0.775				
		1.606	0.783				
		1.617	0.787				
		1.629	0.791				
		1.634	0.795				
		1.650	0.803				
		1.666	0.812				
		1.687	0.816				
		1.702	0.828				
		1.727	0.837				
		1.746	0.850				
		1.760	0.862				
		1.776	0.871				
		1.820	0.880				
		1.848	0.906				
		1.881	0.919				
		1.918	0.928				
		1.954	0.941				
		1.998	0.950				
		2.040	0.964				
		2.059	0.968				
		2.068	0.973				
		2.098	0.973				
		2.107	0.977				
		2.113	0.982				
		2.117	0.977				
		2.135	0.977				
		2.139	0.977				
		2.146	0.982				
		2.161	0.982				
		2.166	0.982				
		2.174	0.982				
		2.184	0.982				
		2.192	0.982				
		2.213	0.982				
		2.234	0.986				
		2.254	0.986				
		2.280	0.986				
		2.289	0.991				
		2.292	0.991				
		2.323	0.991				
		2.353	0.995				
		2.407	0.995				

		2.469	1.000				
		2.495	0.995				
		2.526	0.986				
		2.553	0.964				
		2.569	0.937				
		2.582	0.915				
		2.589	0.897				
		2.605	0.880				
		2.621	0.854				
		2.632	0.816				
		2.639	0.779				
		2.652	0.738				
		2.662	0.695				
		2.753	0.660				
		2.756	0.370				
		2.883	0.370				
		3.007	0.181				
		3.134	0.181				
		3.258	0.193				
		3.385	0.193				
		3.509	0.146				
		3.636	0.146				
		3.760	0.139				
		3.887	0.139				
		4.012	0.048				
		4.138	0.048				

Appendix F4 (a)



Standardised Hydrographs: Veld-Zone Group A; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

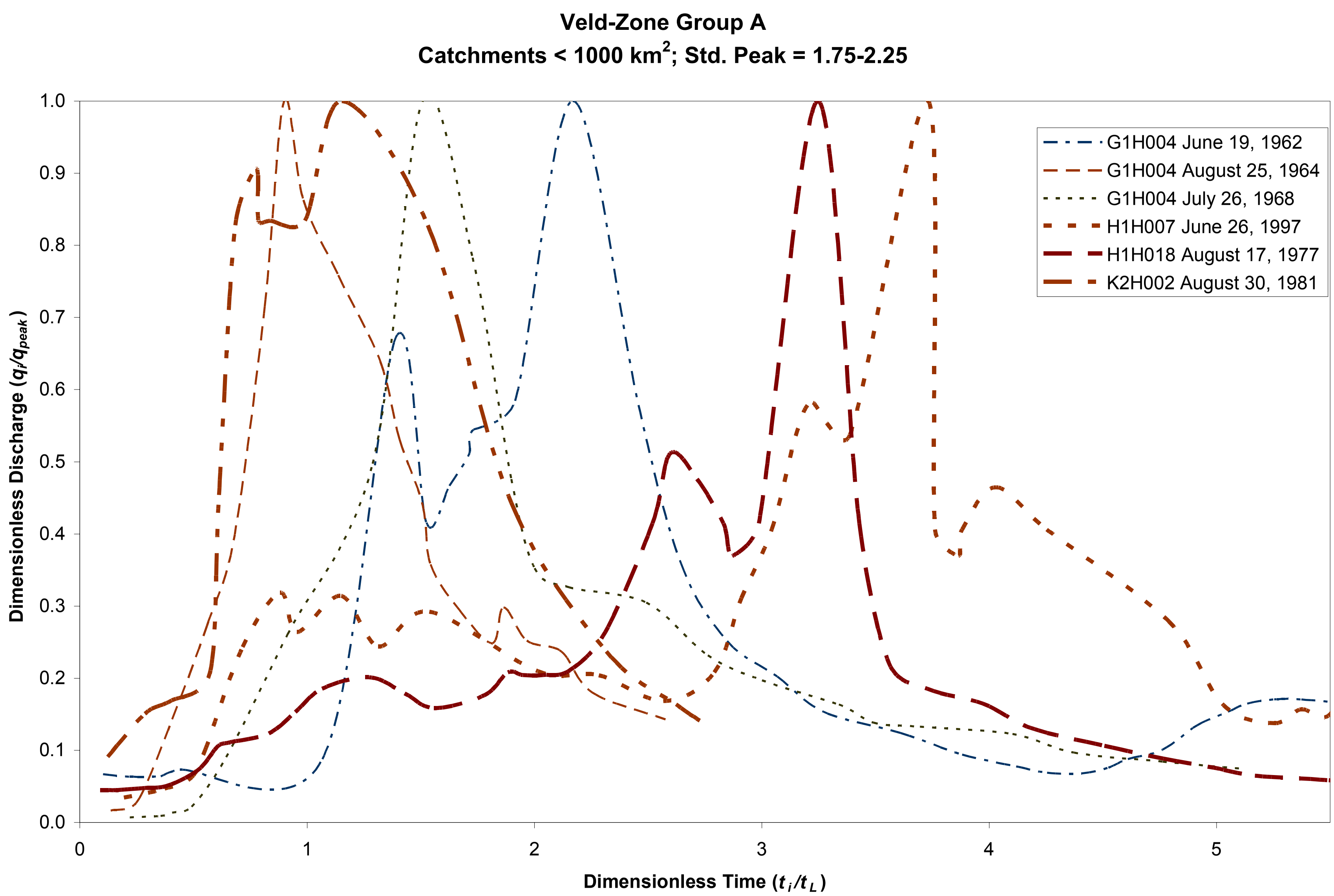
G1H004	**July 24, 1976**	**H1H007**	**June 6, 1998**	**H1H018**	**June 1, 1976**	**K2H002**	**May 8, 1977**
Peak	358.5	**Peak**	256.0	**Peak**	436.2	**Peak**	88.5
Volume	16.4	**Volume**	5.7	**Volume**	6.6	**Volume**	2.0
Area	70	**Area**	84	**Area**	113	**Area**	131
Basin Lag	5.9	**Basin Lag**	6.7	**Basin Lag**	7.7	**Basin Lag**	9.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.136	0.260	0.164	0.019	0.130	0.025	0.112	0.084
0.458	0.273	0.254	0.024	0.169	0.024	0.184	0.084
0.712	0.409	0.313	0.102	0.247	0.024	0.255	0.091
0.864	0.337	0.403	0.112	0.249	0.025	0.296	0.186
0.915	0.514	0.478	0.371	0.351	0.028	0.347	0.295
0.949	0.611	0.537	0.398	0.519	0.033	0.418	0.381
1.186	0.618	0.761	0.462	0.675	0.089	0.480	0.432
1.390	0.802	1.015	1.000	0.766	0.195	0.531	0.579
1.610	0.514	1.209	0.464	0.818	0.217	0.582	0.833
1.746	0.409	1.522	0.359	0.974	0.234	0.633	0.912
2.017	0.514	1.716	0.227	1.000	0.487	0.684	1.000
2.305	1.000	1.940	0.198	1.091	0.749	0.735	0.912
2.458	0.763	2.119	0.149	1.221	1.000	0.806	0.687
2.695	0.717	3.030	0.130	1.377	0.486	0.908	0.567
2.881	0.507	3.328	0.096	1.636	0.308	0.990	0.479
3.186	0.352	4.015	0.087	3.247	0.198	1.051	0.404
3.373	0.286	4.284	0.079	3.468	0.180	1.133	0.348
3.576	0.252			3.636	0.144	1.204	0.295
3.712	0.232			3.740	0.106	1.265	0.259
3.831	0.224			3.766	0.094	1.388	0.232
4.017	0.220			3.987	0.088	1.510	0.201
4.407	0.220					1.602	0.178
4.746	0.184					1.735	0.156
5.068	0.154					1.827	0.139
5.525	0.133						

Standardised Hydrographs: Veld-Zone Group A; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak (m^3/s), Volume (Mm^3), Area (km^2), Basin lag (hr)]

1H018	June 9, 1979	K2H002	November 2, 1965	G1H004	August 31, 1961	G1H004	September 9, 1967
Peak	446.6	**Peak**	84.5	**Peak**	331.1	**Peak**	346.1
Volume	15.6	**Volume**	5.2	**Volume**	10.2	**Volume**	19.9
Area	113	**Area**	131	**Area**	70	**Area**	70
Basin Lag	7.7	**Basin Lag**	9.8	**Basin Lag**	5.9	**Basin Lag**	5.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.208	0.009	0.002	0.012	0.153	0.011	0.288	0.037
0.468	0.012	0.102	0.593	0.322	0.011	0.390	0.039
0.610	0.083	0.143	0.682	0.424	0.014	0.508	0.048
0.662	0.119	0.204	0.669	0.559	0.018	0.559	0.430
0.740	0.119	0.286	0.682	0.644	0.023	0.644	0.705
1.039	0.116	0.388	0.662	0.814	0.027	0.763	0.728
1.078	0.133	0.561	0.911	0.983	0.029	0.864	0.889
1.143	0.133	0.888	0.797	1.136	0.036	0.932	0.847
1.195	0.142	0.969	0.682	1.288	0.044	1.051	0.864
1.273	0.142	1.031	0.693	1.356	0.057	1.169	0.728
1.338	0.136	1.153	0.689	1.407	0.072	1.305	0.647
1.390	0.130	1.204	0.878	1.492	0.087	1.475	0.513
1.519	0.130	1.347	0.863	1.712	0.097	1.881	0.413
1.896	0.147	1.531	0.937	1.780	0.109	2.017	0.965
1.961	0.327	1.561	1.000	1.847	0.126	2.169	0.864
2.026	0.345	1.857	0.937	1.915	0.160	2.322	1.000
2.065	0.340	2.041	0.593	2.017	0.184	2.475	0.766
2.208	0.364	2.102	0.510	2.136	0.203	2.610	0.743
2.338	0.462	2.224	0.480	2.169	0.218	2.712	0.661
2.364	1.000	2.439	0.434	2.237	0.247	2.949	0.626
2.403	0.913	2.469	0.372	2.288	0.273	3.034	0.683
2.494	0.932	2.561	0.359	2.339	0.300	3.305	0.584
2.610	0.684	2.694	0.371	2.475	0.320	3.627	0.349
2.727	0.865	2.724	0.351	2.576	0.277	4.136	0.224
2.844	0.462	2.796	0.364	2.847	0.324	4.678	0.166
2.922	0.322	2.847	0.350	3.000	0.851	4.898	0.141
3.156	0.350	3.000	0.373	3.119	1.000	5.017	0.141
3.234	0.225	3.143	0.339	3.186	0.956	5.169	0.144
3.312	0.214	3.265	0.389	3.220	0.973	5.441	0.141
3.390	0.217	3.388	0.457	3.288	0.973	5.695	0.144
3.584	0.284	3.520	0.477	3.373	0.920	6.085	0.141
3.792	0.166	3.684	0.514	3.492	0.818	6.508	0.118
3.818	0.139	3.918	0.594	3.508	0.691	7.220	0.102
4.039	0.136	4.133	0.831	3.593	0.661	7.797	0.079
4.104	0.109	4.306	0.594	3.644	0.647	8.186	0.069
4.208	0.101	4.500	0.416	3.763	0.590	8.492	0.065
4.312	0.094	4.704	0.307	3.864	0.420	9.203	0.062
4.403	0.094	4.908	0.258	4.085	0.296		
4.532	0.103	5.306	0.221	4.288	0.206		

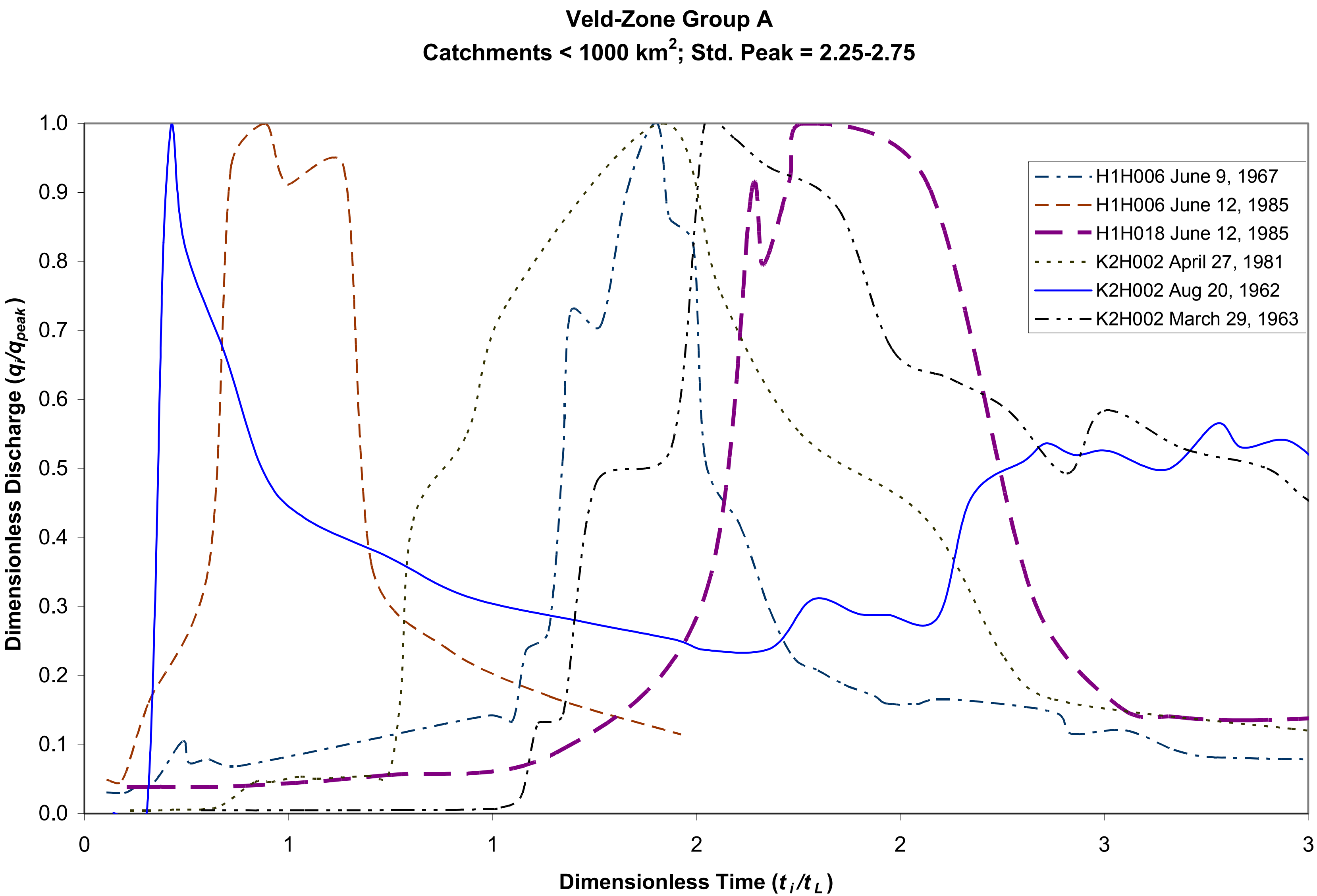
4.636	0.096	5.704	0.171	4.492	0.153		
4.779	0.084	6.071	0.143	4.763	0.126		
4.922	0.067	6.510	0.129	5.068	0.107		
4.948	0.060	6.633	0.113	5.288	0.087		
5.169	0.060	6.959	0.125	5.407	0.075		
5.260	0.076	7.102	0.108	5.508	0.071		
5.351	0.077	8.061	0.117	5.966	0.071		
5.390	0.084						
5.662	0.084						
5.870	0.067						
6.325	0.065						
6.403	0.048						
6.597	0.048						
6.857	0.047						
7.169	0.047						


Veld-Zone Group A
Catchments < 1000 km^2; Std. Peak = 1.75-2.25
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
Dimensionless Time (t_i/t_L)
G1H004 June 19, 1962
G1H004 August 25, 1964
G1H004 July 26, 1968
H1H007 June 26, 1997
H1H018 August 17, 1977
K2H002 August 30, 1981

Standardised Hydrographs: Veld-Zone Group A; Area < 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H004	June 19, 1962	G1H004	August 25, 1962	G1H004	July 26, 1968	H1H007	June 26, 1997	H1H018	August 17, 1977	K2H002	August 30, 1981
Peak	453.7	Peak	394.1	Peak	450.1	Peak	289.7	Peak	523.2	Peak	100.3
Volume	16.3	Volume	7.9	Volume	13.5	Volume	9.4	Volume	17.2	Volume	4.0
Area	70	Area	70	Area	70	Area	84	Area	113	Area	131
Basin Lag	5.9	Basin Lag	5.9	Basin Lag	5.9	Basin Lag	6.7	Basin Lag	7.7	Basin Lag	9.8
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.102	0.067	0.136	0.017	0.220	0.007	0.194	0.034	0.091	0.045	0.122	0.091
0.220	0.064	0.254	0.030	0.356	0.009	0.373	0.047	0.169	0.045	0.286	0.151
0.356	0.064	0.407	0.143	0.407	0.013	0.493	0.063	0.286	0.048	0.398	0.168
0.441	0.073	0.559	0.273	0.492	0.022	0.552	0.101	0.364	0.049	0.571	0.206
1.068	0.088	0.678	0.392	0.644	0.090	0.716	0.243	0.442	0.058	0.612	0.454
1.390	0.672	0.814	0.715	0.915	0.261	0.881	0.318	0.532	0.076	0.684	0.828
1.525	0.416	0.898	1.000	1.288	0.497	0.955	0.264	0.610	0.106	0.776	0.907
1.627	0.467	0.983	0.863	1.508	1.000	1.149	0.314	0.662	0.111	0.786	0.834
1.712	0.510	1.136	0.758	1.729	0.783	1.313	0.244	0.831	0.123	0.837	0.834
1.729	0.543	1.322	0.639	1.898	0.476	1.537	0.292	0.948	0.153	0.990	0.834
1.915	0.584	1.407	0.531	2.000	0.353	2.015	0.210	1.065	0.185	1.153	1.000
2.169	1.000	1.508	0.440	2.153	0.326	2.284	0.204	1.273	0.201	1.531	0.828
2.458	0.578	1.542	0.358	2.492	0.305	2.567	0.168	1.429	0.179	1.898	0.443
2.644	0.359	1.661	0.298	2.763	0.232	2.791	0.208	1.558	0.158	2.316	0.237
2.847	0.251	1.814	0.248	3.000	0.197	2.910	0.311	1.779	0.176	2.622	0.164
3.068	0.202	1.864	0.298	3.339	0.163	3.045	0.407	1.883	0.208	2.755	0.135
3.271	0.153	1.966	0.252	3.492	0.138	3.149	0.536	1.948	0.205		
3.610	0.124	2.119	0.237	3.695	0.133	3.224	0.582	2.039	0.205		
3.881	0.094	2.254	0.180	4.102	0.123	3.388	0.537	2.156	0.211		
4.119	0.078	2.576	0.143	4.373	0.097	3.731	1.000	2.312	0.264		
4.254	0.069			4.763	0.084	3.761	0.406	2.519	0.415		
4.407	0.068			5.119	0.074	3.866	0.369	2.597	0.511		
4.525	0.076					3.881	0.406	2.714	0.476		
4.610	0.088					4.030	0.465	2.831	0.415		
4.763	0.100					4.254	0.406	2.870	0.370		
4.915	0.134					4.791	0.279	2.987	0.415		
5.051	0.153					5.030	0.163	3.247	1.000		
5.136	0.165					5.254	0.138	3.429	0.415		
5.254	0.171					5.373	0.157	3.558	0.221		
5.373	0.171					5.493	0.148	3.727	0.185		
5.847	0.153					5.657	0.213	3.974	0.164		
6.186	0.112					5.955	0.147	4.182	0.131		
6.729	0.088					6.075	0.108	4.506	0.106		
7.492	0.064					6.642	0.112	4.766	0.088		
8.136	0.044							4.987	0.076		
								5.169	0.065		
								5.494	0.059		
								5.753	0.050		

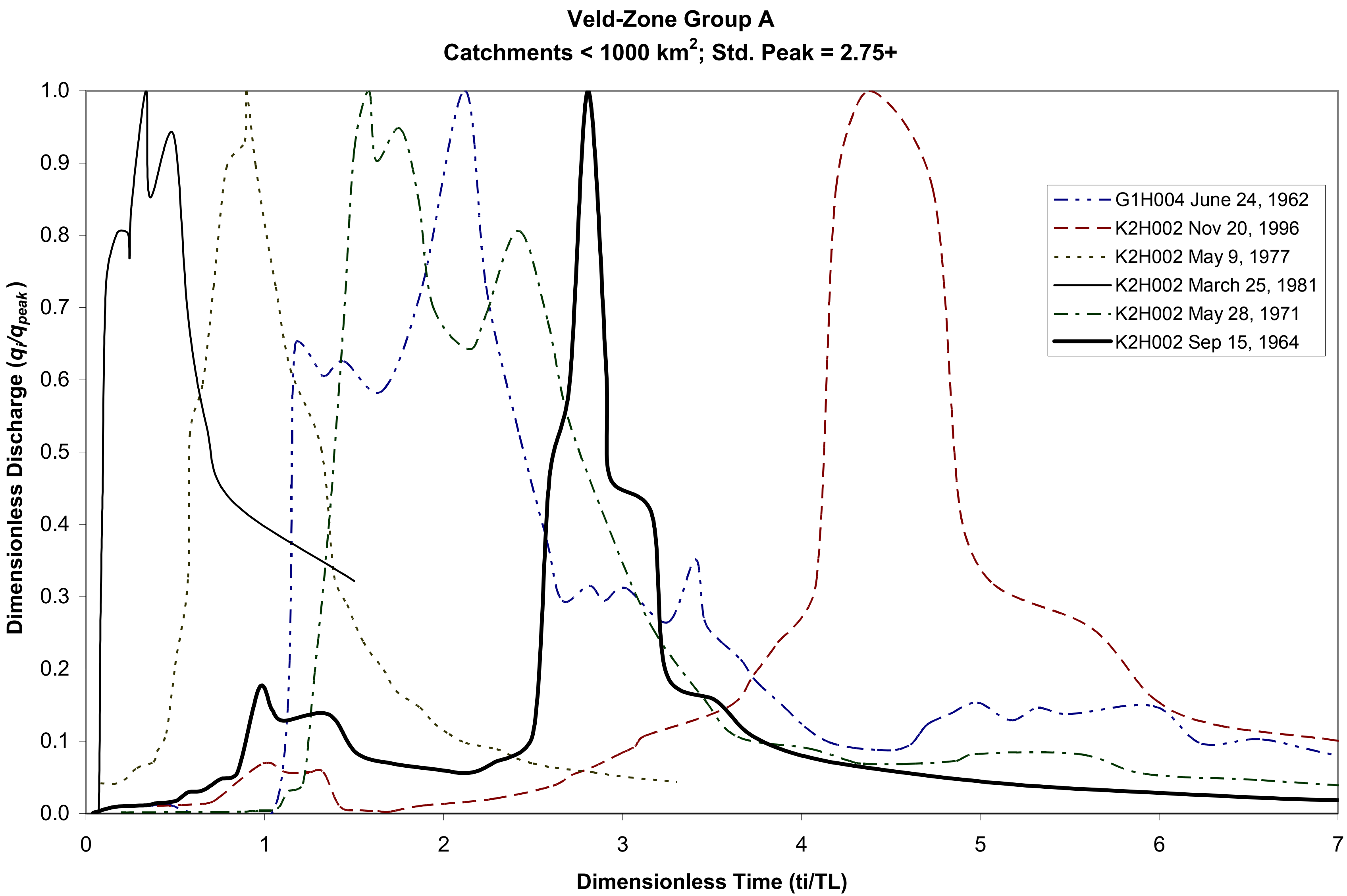

Veld-Zone Group A
Catchments < 1000 km²; Std. Peak = 2.25-2.75
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
1
2
2
3
3
Dimensionless Time (t_i/t_L)
H1H006 June 9, 1967
H1H006 June 12, 1985
H1H018 June 12, 1985
K2H002 April 27, 1981
K2H002 Aug 20, 1962
K2H002 March 29, 1963

Standardised Hydrographs: Veld-Zone Group A; Area < 1000 km^2; Std. Peak 2.25 – 2.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

H1H006	**June 9, 1967**	**H1H006**	**June 12, 1985**	**H1H018**	**June 12, 1985**	**K2H002**	**April 27, 1981**	**K2H002**	**August 20, 1962**	**K2H002**	**March 29, 1963**
Peak	876.3	**Peak**	756.5	**Peak**	705.1	**Peak**	149.7	**Peak**	182.5	**Peak**	145.7
Volume	39.1	**Volume**	28.5	**Volume**	22.0	**Volume**	5.3	**Volume**	3.3	**Volume**	9.8
Area	753	**Area**	753	**Area**	113	**Area**	131	**Area**	131	**Area**	131
Basin Lag	20.3	**Basin Lag**	20.3	**Basin Lag**	7.7	**Basin Lag**	9.8	**Basin Lag**	9.8	**Basin Lag**	9.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.054	0.031	0.054	0.049	0.104	0.039	0.112	0.004	0.071	0.001	0.286	0.005
0.099	0.030	0.094	0.049	0.156	0.039	0.153	0.004	0.153	0.002	0.541	0.005
0.128	0.038	0.158	0.161	0.377	0.040	0.224	0.006	0.194	0.827	0.643	0.005
0.172	0.046	0.305	0.359	0.727	0.055	0.286	0.006	0.214	1.000	0.776	0.005
0.241	0.105	0.360	0.938	1.156	0.088	0.337	0.012	0.245	0.827	0.898	0.005
0.256	0.074	0.443	1.000	1.519	0.312	0.418	0.046	0.347	0.662	0.980	0.007
0.305	0.079	0.498	0.912	1.636	0.905	0.459	0.046	0.439	0.496	1.020	0.009
0.374	0.068	0.635	0.938	1.662	0.794	0.531	0.054	0.541	0.428	1.071	0.026
0.990	0.142	0.704	0.359	1.727	0.914	0.571	0.051	0.745	0.372	1.112	0.131
1.049	0.133	0.882	0.242	1.766	1.000	0.694	0.055	0.939	0.314	1.173	0.144
1.084	0.237	1.138	0.170	2.065	0.915	0.745	0.055	1.224	0.278	1.255	0.479
1.138	0.264	1.463	0.115	2.325	0.314	0.776	0.174	1.449	0.252	1.439	0.530
1.172	0.511			2.532	0.157	0.806	0.425	1.520	0.237	1.520	1.000
1.192	0.727			2.675	0.140	0.939	0.551	1.684	0.240	1.592	0.979
1.266	0.707			2.844	0.135	1.041	0.743	1.786	0.310	1.673	0.938
1.330	0.902			3.299	0.139	1.418	1.000	1.898	0.289	1.847	0.878
1.404	1.000			3.429	0.096	1.561	0.752	1.969	0.288	1.980	0.673
1.433	0.864			4.182	0.099	1.755	0.551	2.092	0.284	2.122	0.630
1.493	0.825			4.545	0.058	2.061	0.428	2.173	0.457	2.265	0.583
1.522	0.511			4.857	0.048	2.255	0.225	2.306	0.512	2.408	0.493
1.606	0.419			5.338	0.042	2.378	0.165	2.357	0.537	2.500	0.584
1.680	0.295			5.701	0.033	2.959	0.123	2.429	0.520	2.694	0.529
1.739	0.226			6.130	0.029	3.663	0.084	2.510	0.526	2.898	0.500
1.798	0.207			6.727	0.026			2.653	0.499	3.031	0.445
1.862	0.187			7.688	0.023			2.776	0.565	3.276	0.414
1.936	0.170							2.837	0.531	3.439	0.395
1.966	0.160							2.949	0.541	3.612	0.335
2.039	0.159							3.051	0.494	3.929	0.275
2.089	0.166							3.112	0.474	4.327	0.221
2.222	0.161							3.224	0.486	4.571	0.171
2.384	0.145							3.449	0.420	5.112	0.155
2.419	0.116							3.571	0.329	5.776	0.116
2.552	0.121							3.653	0.307	6.439	0.082
2.670	0.093							3.704	0.322	7.296	0.057
2.764	0.082							3.786	0.391	8.265	0.039
3.030	0.078							3.878	0.418	9.286	0.029
3.123	0.069							3.949	0.386		
3.167	0.063							4.031	0.367		
3.197	0.062							4.173	0.382		

3.325	0.063							4.306	0.325		
								4.459	0.284		
								4.551	0.242		
								4.653	0.248		
								4.704	0.243		
								4.745	0.247		
								4.867	0.280		
								4.939	0.257		
								5.061	0.270		
								5.418	0.226		
								5.684	0.154		
								6.112	0.118		
								6.459	0.087		
								6.939	0.068		
								7.735	0.052		
								8.388	0.037		
								9.316	0.029		
								10.429	0.022		


Veld-Zone Group A
Catchments < 1000 km²; Std. Peak = 2.75+
Dimensionless Discharge (qi/qpeak)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
Dimensionless Time (ti/TL)
G1H004 June 24, 1962
K2H002 Nov 20, 1996
K2H002 May 9, 1977
K2H002 March 25, 1981
K2H002 May 28, 1971
K2H002 Sep 15, 1964

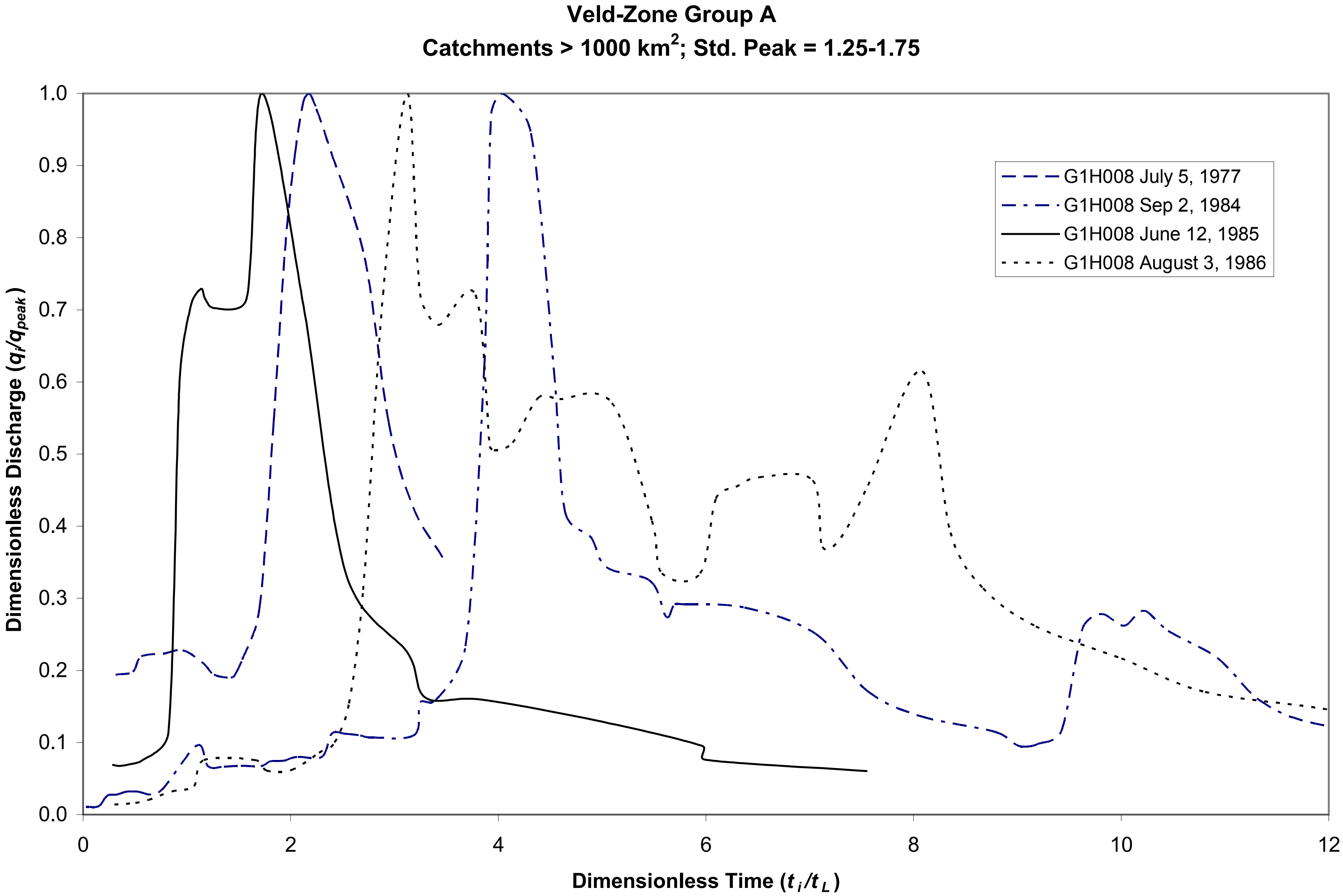
Standardised Hydrographs: Veld-Zone Group A; Area < 1000 km^2; Std. Peak 2.25 +

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H004	June 24, 1962	K2H002	November 20, 1996	K2H002	May 9, 1977	K2H002	March 25, 1981	K2H002	May 28, 1981	K2H002	September 15, 1964
Flow	679.0	Flow	260.0	Flow	247.1	Flow	189.2	Flow	211.1	Flow	320.5
Volume	22.5	Volume	12.1	Volume	7.0	Volume	4.3	Volume	11.1	Volume	6.9
Area	70	Area	131	Area	131	Area	131	Area	131	Area	131
Basin Lag	5.9	Basin Lag	9.8	Basin Lag	9.8	Basin Lag	9.8	Basin Lag	9.8	Basin Lag	9.8
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.203	0.010	0.398	0.010	0.082	0.042	0.051	0.003	0.194	0.001	0.041	0.001
0.339	0.010	0.653	0.014	0.153	0.041	0.071	0.005	0.316	0.002	0.163	0.009
0.373	0.011	0.724	0.018	0.214	0.046	0.082	0.254	0.510	0.002	0.337	0.011
0.441	0.013	0.990	0.069	0.286	0.063	0.092	0.430	0.724	0.002	0.398	0.015
1.068	0.015	1.112	0.057	0.378	0.071	0.112	0.732	0.888	0.003	0.500	0.017
1.169	0.647	1.245	0.057	0.398	0.085	0.173	0.803	0.969	0.004	0.571	0.029
1.322	0.605	1.327	0.057	0.449	0.110	0.235	0.803	1.071	0.007	0.653	0.032
1.441	0.626	1.418	0.010	0.500	0.205	0.245	0.769	1.133	0.031	0.755	0.048
1.661	0.585	1.531	0.005	0.571	0.327	0.255	0.841	1.214	0.041	0.847	0.057
1.881	0.730	1.633	0.003	0.582	0.524	0.337	1.000	1.276	0.184	0.969	0.174
2.119	1.000	1.704	0.003	0.653	0.594	0.357	0.853	1.357	0.394	1.041	0.144
2.237	0.730	1.867	0.011	0.714	0.729	0.490	0.939	1.439	0.672	1.102	0.129
2.424	0.523	2.276	0.020	0.786	0.893	0.571	0.688	1.500	0.918	1.357	0.137
2.576	0.379	2.612	0.039	0.888	0.930	0.673	0.537	1.582	1.000	1.510	0.084
2.661	0.295	2.714	0.053	0.898	1.000	0.816	0.433	1.622	0.903	1.714	0.069
2.814	0.315	2.827	0.063	0.949	0.897	1.500	0.322	1.755	0.948	1.969	0.061
2.898	0.295	2.990	0.083	1.010	0.800			1.857	0.853	2.143	0.056
3.017	0.312	3.071	0.093	1.061	0.729			1.939	0.702	2.286	0.071
3.254	0.265	3.122	0.107	1.143	0.615			2.143	0.642	2.500	0.110
3.407	0.352	3.592	0.147	1.316	0.504			2.235	0.689	2.592	0.466
3.458	0.268	3.735	0.192	1.388	0.329			2.418	0.806	2.704	0.593
3.542	0.240	3.867	0.236	1.459	0.289			2.582	0.682	2.806	1.000
3.661	0.213	4.082	0.317	1.551	0.237			2.694	0.549	2.908	0.615
3.746	0.183	4.194	0.864	1.663	0.199			2.929	0.391	2.929	0.465
3.898	0.149	4.378	1.000	1.735	0.170			3.163	0.258	3.163	0.414
4.017	0.120	4.735	0.864	1.867	0.147			3.459	0.157	3.245	0.194
4.136	0.101	4.888	0.419	1.949	0.125			3.643	0.106	3.520	0.157
4.271	0.092	5.071	0.317	2.031	0.110			4.041	0.090	3.724	0.107
4.424	0.088	5.622	0.256	2.122	0.098			4.255	0.074	4.051	0.077
4.525	0.088	5.969	0.159	2.296	0.089			4.347	0.069	4.571	0.057
4.610	0.095	6.316	0.123	2.408	0.076			4.602	0.069	5.224	0.039
4.661	0.110	6.959	0.102	2.500	0.069			4.867	0.073	6.071	0.028
4.712	0.124	7.551	0.081	2.622	0.063			4.969	0.082	6.908	0.019
4.831	0.137	7.969	0.070	2.837	0.057			5.551	0.082	8.010	0.014
4.983	0.153	8.194	0.065	3.041	0.050			5.918	0.055		
5.169	0.129	8.316	0.065	3.306	0.044			6.571	0.046		
5.322	0.146	8.429	0.022					7.245	0.035		
5.492	0.137	8.520	0.010					8.082	0.028		
5.966	0.149	8.602	0.008					9.020	0.022		

6.237	0.097										
6.576	0.103										
7.068	0.080										
7.424	0.104										
7.678	0.088										
7.932	0.070										
8.136	0.059										
8.356	0.056										
8.627	0.056										
9.119	0.048										
9.390	0.038										
9.847	0.032										

Appendix F4 (b)

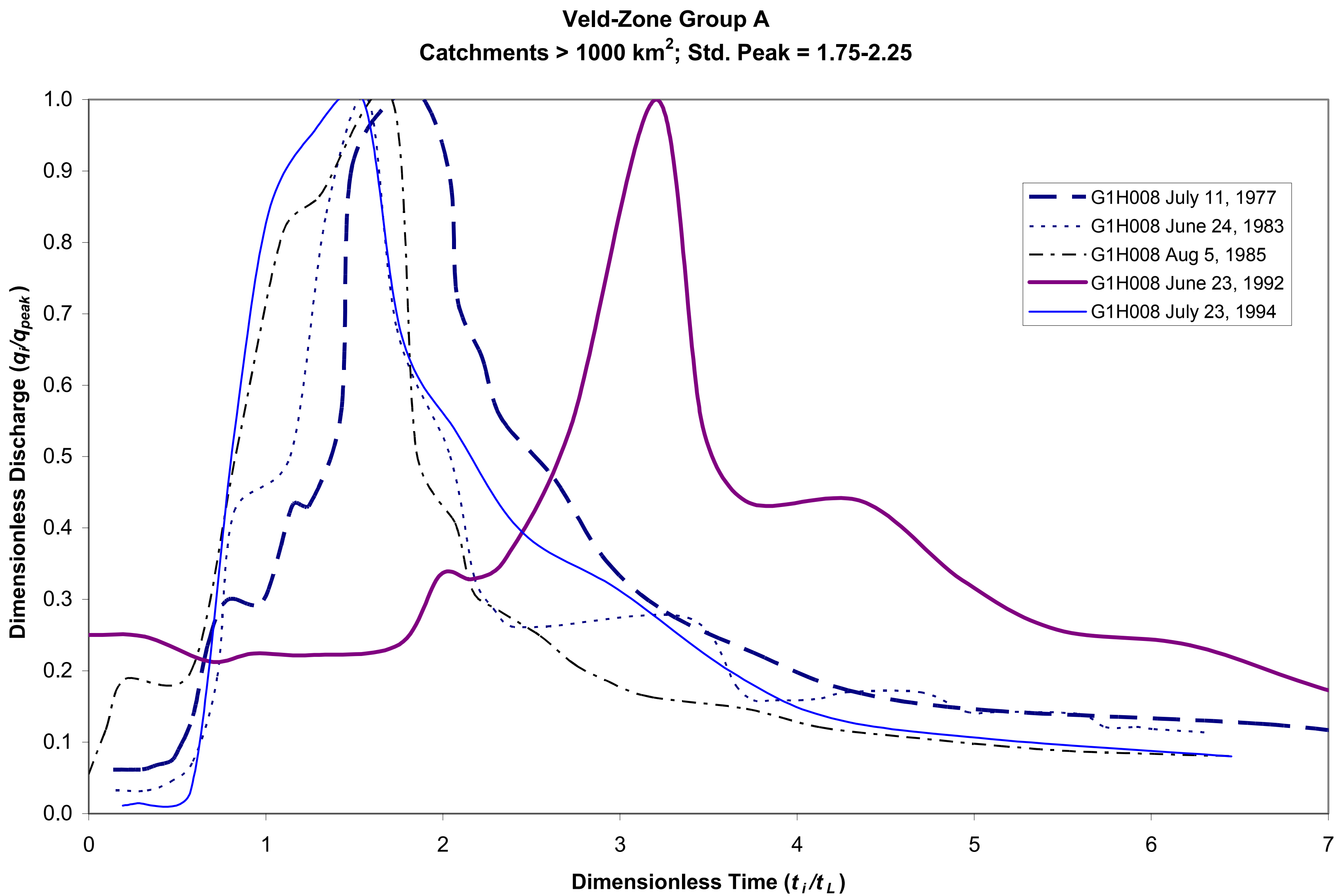


Standardised Hydrographs: Veld-Zone Group A; Area > 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	July 5, 1977	G1H008	September 3, 1984	G1H008	June 12, 1985	G1H008	August 3, 1986
Peak	130.6	**Peak**	169.5	**Peak**	149.4	**Peak**	149.1
Volume	5.0	**Volume**	8.5	**Volume**	7.0	**Volume**	17.3
Area	1690	**Area**	1690	**Area**	1690	**Area**	1690
Basin Lag	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.315	0.194	0.027	0.011	0.288	0.069	0.301	0.014
0.479	0.198	0.151	0.012	0.356	0.068	0.507	0.016
0.562	0.219	0.233	0.026	0.452	0.070	0.630	0.021
0.781	0.223	0.329	0.028	0.589	0.077	0.863	0.032
0.959	0.228	0.425	0.032	0.822	0.114	1.068	0.040
1.151	0.211	0.521	0.032	0.932	0.604	1.164	0.076
1.260	0.194	0.740	0.032	1.041	0.708	1.658	0.076
1.425	0.190	1.096	0.096	1.137	0.729	1.767	0.061
1.466	0.194	1.205	0.067	1.178	0.715	2.014	0.062
1.534	0.215	1.356	0.066	1.274	0.702	2.274	0.085
1.699	0.286	1.521	0.068	1.575	0.716	2.425	0.100
1.836	0.544	1.712	0.067	1.726	1.000	2.562	0.154
1.945	0.782	1.808	0.074	2.123	0.705	2.699	0.312
2.041	0.916	1.932	0.075	2.534	0.334	2.890	0.722
2.123	0.989	2.068	0.080	3.123	0.225	3.123	1.000
2.178	1.000	2.301	0.080	3.301	0.162	3.247	0.722
2.247	0.979	2.397	0.112	3.836	0.160	3.425	0.679
2.397	0.916	2.521	0.112	4.932	0.131	3.781	0.721
2.712	0.772	2.671	0.110	5.973	0.095	3.918	0.511
2.945	0.544	2.767	0.107	5.986	0.076	3.959	0.505
3.178	0.426	3.192	0.111	7.548	0.060	4.137	0.516
3.466	0.356	3.247	0.156			4.384	0.578
		3.397	0.159			4.589	0.576
		3.685	0.234			5.096	0.571
		3.863	0.618			5.479	0.408
		3.932	0.972			5.575	0.335
		4.041	1.000			5.945	0.335
		4.315	0.945			6.096	0.438
		4.534	0.618			6.288	0.454
		4.644	0.419			6.521	0.468
		4.890	0.385			7.027	0.463
		5.041	0.343			7.123	0.371
		5.466	0.324			7.301	0.384
		5.616	0.274			7.562	0.456
		5.699	0.292			8.082	0.615
		5.795	0.292			8.356	0.391
		6.370	0.287			8.671	0.314
		7.055	0.251			9.178	0.261
		7.548	0.172			10.000	0.217

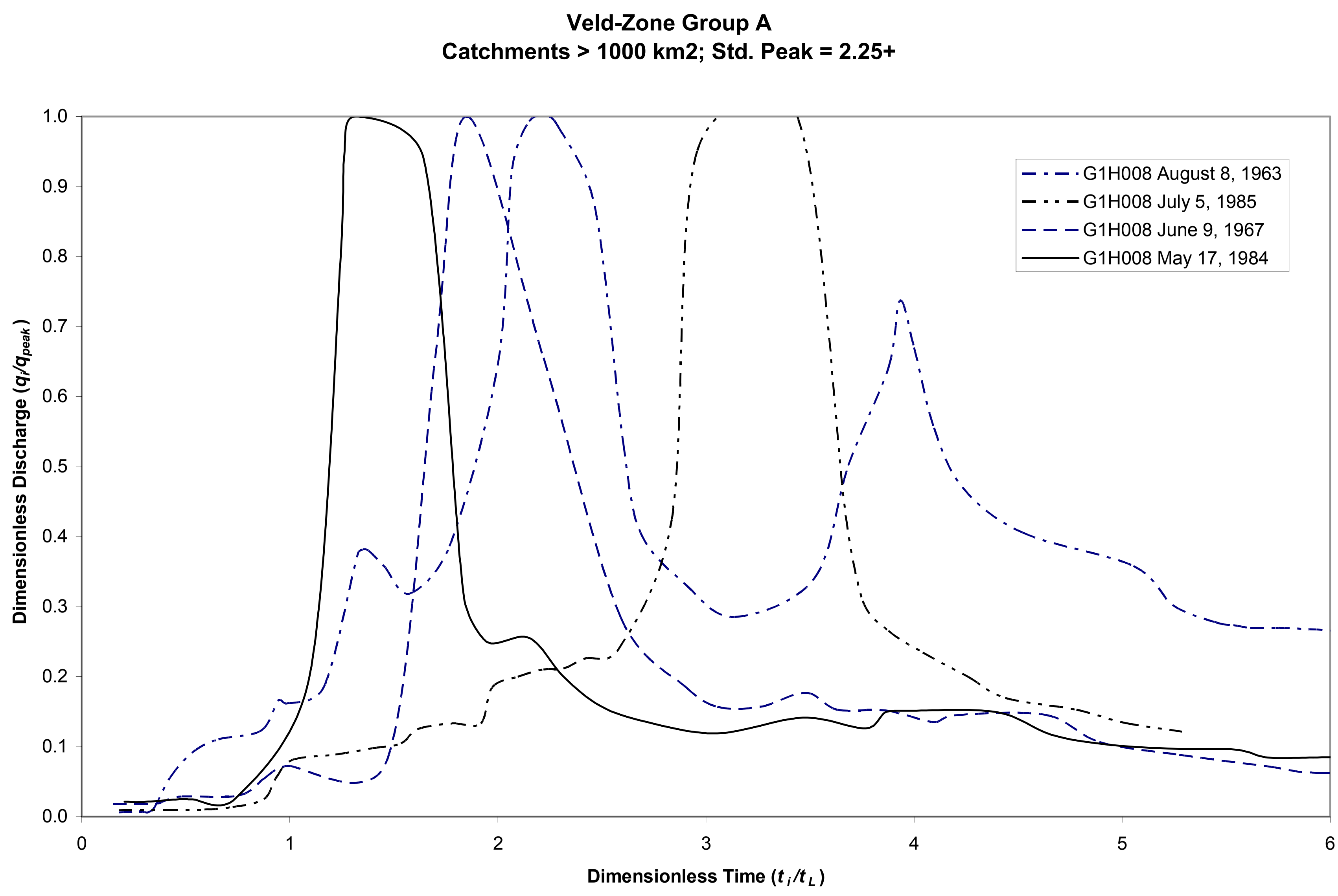
		8.055	0.137			10.808	0.170
		8.781	0.115			12.068	0.143
		8.986	0.097			12.151	0.112
		9.096	0.094			13.274	0.091
		9.219	0.099			13.534	0.082
		9.425	0.116			14.753	0.078
		9.630	0.258			15.479	0.070
		9.808	0.278				
		10.027	0.262				
		10.219	0.283				
		10.452	0.255				
		10.932	0.217				
		11.329	0.159				
		11.822	0.128				
		12.795	0.108				
		14.041	0.087				
		14.534	0.071				
		14.767	0.056				


Veld-Zone Group A
Catchments > 1000 km2; Std. Peak = 1.75-2.25
Dimensionless Discharge (qi/qpeak)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
Dimensionless Time (ti/tL)
G1H008 July 11, 1977
G1H008 June 24, 1983
G1H008 Aug 5, 1985
G1H008 June 23, 1992
G1H008 July 23, 1994

Standardised Hydrographs: Veld-Zone Group A; Area > 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	July 11, 1977	G1H008	June 24, 1983	G1H008	August 5, 1985	G1H008	June 23, 1992	G1H008	July 23, 1994
Peak	189.0	**Peak**	209.3	**Peak**	202.4	**Peak**	196.3	**Peak**	199.7
Volume	9.5	**Volume**	9.3	**Volume**	9.8	**Volume**	17.1	**Volume**	9.5
Area	1690	**Area**	1690	**Area**	1690	**Area**	1690	**Area**	1690
Basin Lag	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.137	0.062	0.151	0.032	0.000	0.055	0.000	0.250	0.192	0.011
0.301	0.062	0.329	0.032	0.096	0.117	0.315	0.248	0.274	0.015
0.384	0.068	0.466	0.045	0.205	0.189	0.685	0.213	0.575	0.031
0.466	0.074	0.589	0.073	0.575	0.198	0.932	0.224	0.822	0.533
0.507	0.089	0.726	0.192	0.836	0.509	1.247	0.222	1.014	0.840
0.589	0.137	0.822	0.423	1.096	0.814	1.753	0.237	1.260	0.951
0.671	0.235	1.137	0.501	1.301	0.864	1.986	0.335	1.548	1.000
0.781	0.299	1.342	0.841	1.712	1.000	2.164	0.329	1.767	0.669
0.986	0.299	1.575	1.000	1.849	0.507	2.342	0.353	2.082	0.532
1.151	0.432	1.740	0.679	2.068	0.407	2.726	0.544	2.452	0.393
1.247	0.432	2.041	0.501	2.164	0.313	3.205	1.000	2.986	0.314
1.425	0.561	2.178	0.330	2.315	0.284	3.466	0.542	3.630	0.198
1.479	0.897	2.288	0.286	2.548	0.249	3.726	0.436	4.192	0.134
1.712	1.000	2.384	0.262	2.740	0.210	4.370	0.437	5.096	0.105
1.890	1.000	2.589	0.262	2.918	0.187	4.932	0.327	6.452	0.080
2.041	0.889	3.384	0.274	3.164	0.164	5.466	0.258		
2.082	0.721	3.658	0.178	3.712	0.147	6.219	0.236		
2.219	0.640	3.753	0.159	4.123	0.121	7.027	0.171		
2.329	0.554	3.877	0.159	4.616	0.107	7.822	0.132		
2.630	0.469	4.014	0.159	5.123	0.095	9.055	0.110		
2.918	0.355	4.137	0.162	5.616	0.087	10.425	0.091		
3.260	0.282	4.288	0.170	6.466	0.080	11.260	0.076		
3.753	0.225	4.699	0.170						
4.288	0.173	4.959	0.142						
5.041	0.146	5.164	0.142						
6.630	0.126	5.589	0.140						
7.712	0.099	5.740	0.121						
9.096	0.089	5.918	0.121						
10.164	0.080	6.014	0.119						
11.986	0.074	6.329	0.114						

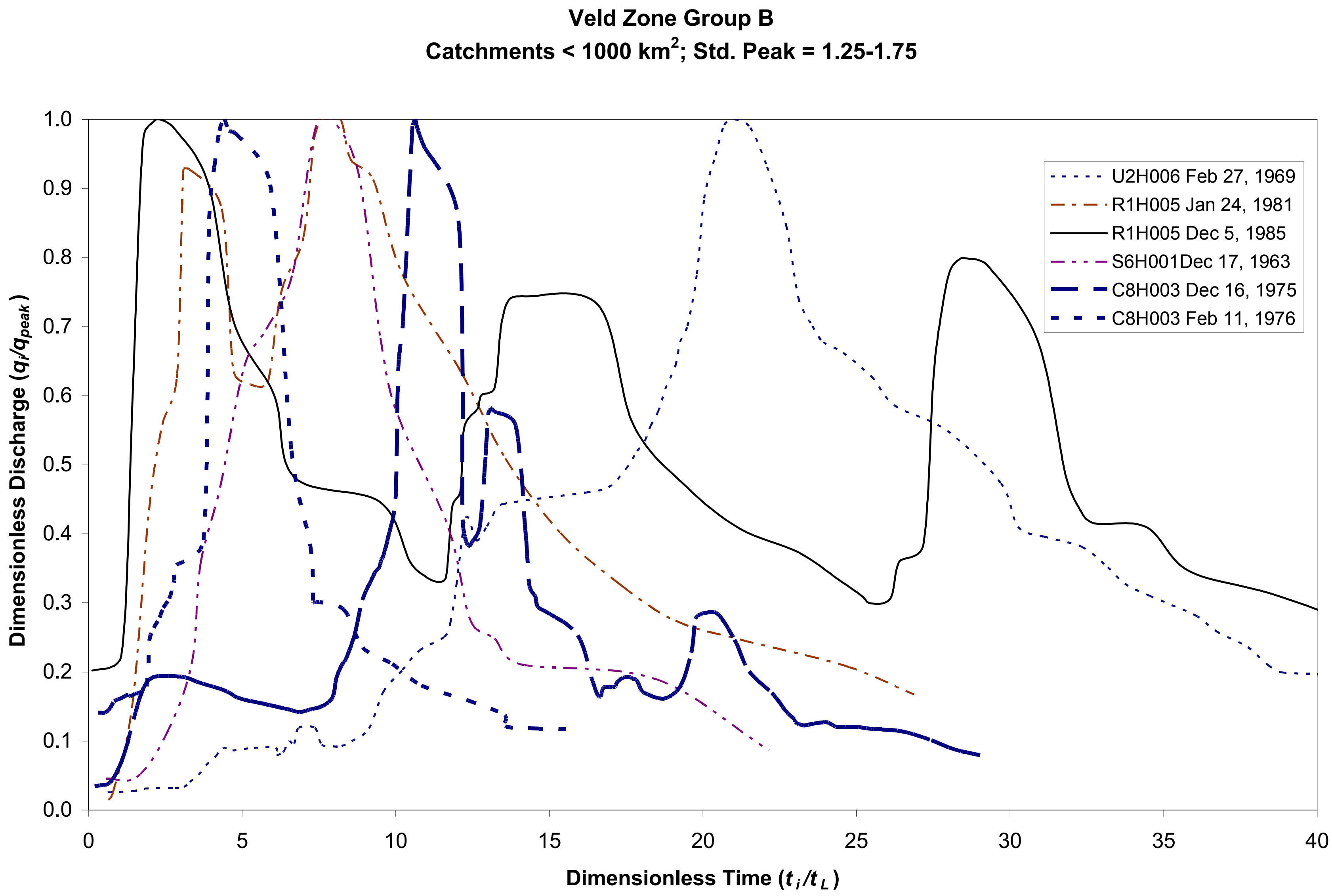

Veld-Zone Group A
Catchments > 1000 km2; Std. Peak = 2.25+
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
Dimensionless Time (t_i/t_L)
G1H008 August 8, 1963
G1H008 July 5, 1985
G1H008 June 9, 1967
G1H008 May 17, 1984

Standardised Hydrographs: Veld-Zone Group A; Area > 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

G1H008	August 8, 1963	G1H008	July 5, 1985	G1H008	June 9, 1967	G1H008	May 15, 1984
Peak	274.6	**Peak**	247.5	**Peak**	415.0	**Peak**	517.2
Volume	7.7	**Volume**	12.8	**Volume**	13.5	**Volume**	15.9
Area	1690	**Area**	1690	**Area**	1690	**Area**	1690
Basin Lag	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.178	0.006	0.178	0.009	0.151	0.017	0.205	0.021
0.274	0.007	0.397	0.010	0.356	0.019	0.288	0.021
0.342	0.010	0.589	0.010	0.466	0.029	0.479	0.025
0.425	0.056	0.726	0.014	0.753	0.030	0.534	0.025
0.534	0.092	0.877	0.025	0.877	0.054	0.740	0.027
0.658	0.110	0.932	0.054	0.986	0.073	1.096	0.203
0.863	0.123	1.014	0.081	1.466	0.080	1.247	0.809
0.945	0.167	1.219	0.089	1.699	0.655	1.260	0.939
0.986	0.162	1.397	0.098	1.849	1.000	1.315	1.000
1.164	0.186	1.534	0.105	2.219	0.655	1.644	0.939
1.329	0.377	1.616	0.125	2.589	0.285	1.836	0.316
1.370	0.381	1.781	0.133	2.904	0.185	1.945	0.250
1.452	0.358	1.918	0.133	3.055	0.157	2.151	0.255
1.575	0.318	1.973	0.184	3.260	0.157	2.315	0.200
1.767	0.386	2.096	0.200	3.479	0.177	2.493	0.158
2.000	0.647	2.219	0.210	3.630	0.153	2.712	0.135
2.068	0.925	2.315	0.212	3.863	0.152	3.055	0.119
2.151	0.993	2.425	0.226	4.096	0.135	3.466	0.141
2.247	1.000	2.575	0.237	4.192	0.145	3.767	0.126
2.288	0.986	2.836	0.425	4.630	0.146	3.863	0.149
2.466	0.871	2.959	0.952	4.890	0.107	3.973	0.152
2.603	0.534	3.438	1.000	5.274	0.089	4.397	0.149
2.685	0.406	3.671	0.429	5.699	0.072	4.658	0.117
2.904	0.331	3.753	0.308	5.932	0.063	4.932	0.103
3.137	0.285	3.877	0.266	6.507	0.065	5.260	0.097
3.521	0.340	4.041	0.234	6.740	0.052	5.548	0.096
3.685	0.502	4.260	0.200	7.068	0.050	5.699	0.085
3.877	0.641	4.438	0.170	7.877	0.051	5.918	0.085
3.932	0.737	4.781	0.153	8.192	0.045	6.301	0.090
4.000	0.670	5.014	0.134	8.466	0.041	6.452	0.121
4.096	0.555	5.288	0.121	9.027	0.030	6.562	0.121
4.233	0.471	5.493	0.107	9.288	0.023	7.014	0.116
4.521	0.406	5.986	0.101			7.260	0.085
5.055	0.358	6.671	0.095			7.425	0.082
5.247	0.302	7.699	0.087			7.521	0.082
5.452	0.278	8.699	0.079			7.753	0.085
5.534	0.274	9.219	0.073			8.274	0.085
5.616	0.270	10.493	0.064			8.589	0.064
5.740	0.270	11.767	0.061			8.836	0.059

6.000	0.266	13.247	0.059			9.603	0.058
6.219	0.259					9.849	0.058
6.822	0.231					10.000	0.059
7.219	0.180					10.411	0.059
7.562	0.153					10.904	0.052
7.945	0.125					11.575	0.047
8.630	0.104					12.068	0.044
9.247	0.087					13.274	0.038
10.301	0.073					14.260	0.033
11.562	0.061					14.644	0.030
12.904	0.052					15.205	0.029
13.753	0.045					16.384	0.029
13.986	0.042					16.986	0.024
14.685	0.042						
15.767	0.040						

Appendix F5 (a)



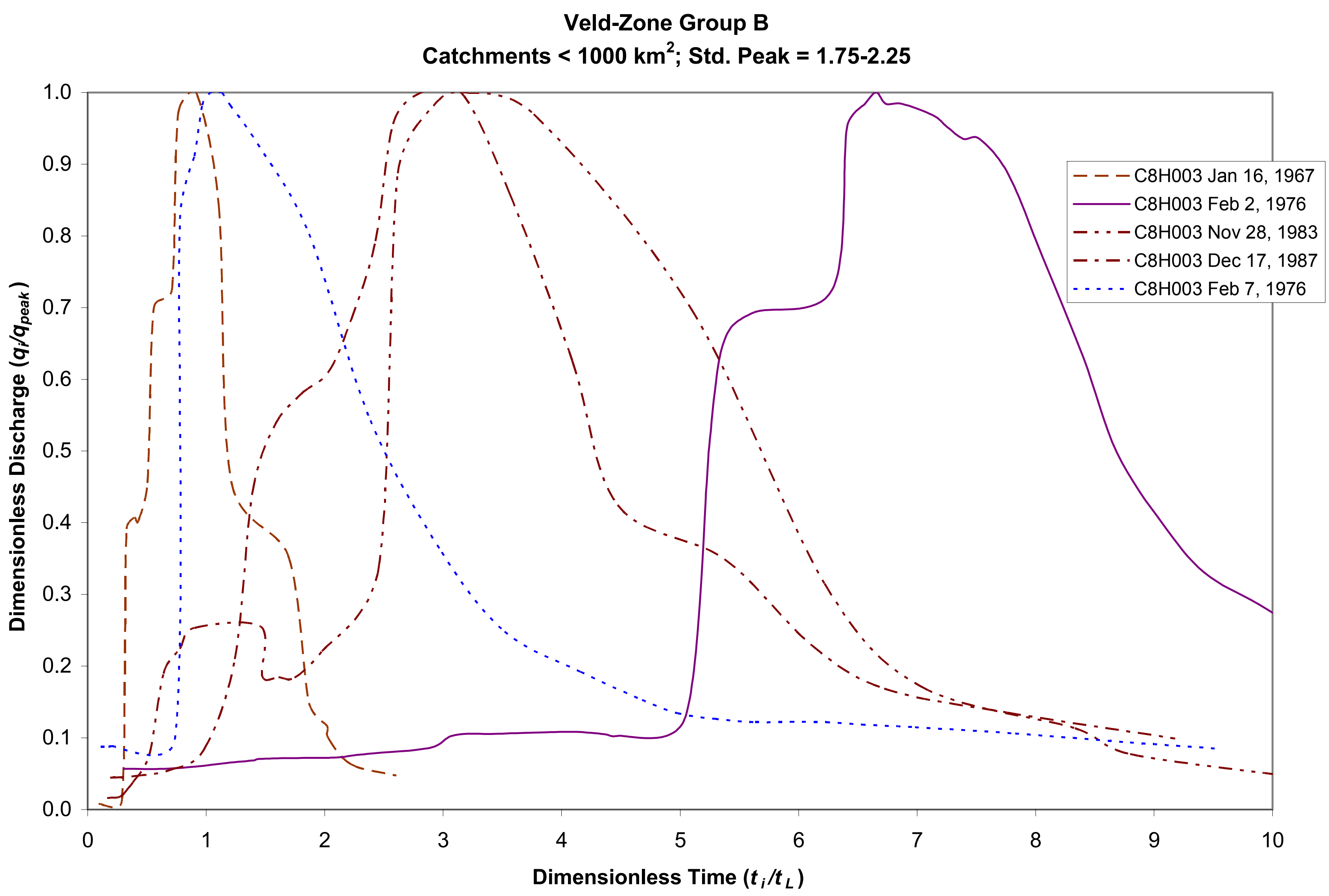
Standardised Hydrographs: Veld-Zone Group B; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H006	February 27, 1969	R1H005	January 24, 1981	R1H005	December 5, 1985	S6H001	February 17, 1963	C8H003	December 16, 1975	C8H003	February 11, 1976
Peak	46.1	Peak	39.4	Peak	49.9	Peak	32.2	Peak	70.5	Peak	54.8
Volume	12.0	Volume	3.9	Volume	2.6	Volume	1.2	Volume	12.7	Volume	7.3
Area	339	Area	482	Area	482	Area	90	Area	806	Area	806
Basin Lag	4.6	Basin Lag	2.3	Basin Lag	2.3	Basin Lag	1.4	Basin Lag	7.3	Basin Lag	7.3
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.630	0.026	0.644	0.015	0.129	0.202	0.572	0.046	0.205	0.034	0.327	0.141
1.435	0.027	0.773	0.021	1.073	0.224	1.572	0.047	0.314	0.035	0.545	0.141
1.826	0.031	1.417	0.149	1.417	0.576	2.502	0.107	0.409	0.036	0.682	0.146
2.609	0.032	1.975	0.434	1.631	0.843	3.359	0.211	0.736	0.041	0.846	0.157
2.826	0.032	2.404	0.558	1.803	0.978	3.645	0.355	1.132	0.076	1.064	0.162
3.109	0.033	2.876	0.626	2.103	0.996	4.289	0.468	1.473	0.131	1.268	0.167
3.304	0.041	3.091	0.927	2.318	1.000	5.075	0.642	1.705	0.166	1.364	0.165
3.587	0.051	3.305	0.927	2.790	0.987	5.790	0.696	1.936	0.187	1.486	0.168
3.826	0.065	4.336	0.870	3.906	0.906	6.647	0.778	2.291	0.194	1.896	0.179
4.152	0.078	4.722	0.635	4.722	0.708	7.505	1.000	2.891	0.193	1.977	0.245
4.370	0.090	5.280	0.616	6.053	0.600	8.720	0.935	3.205	0.191	2.127	0.263
4.696	0.087	5.838	0.620	6.697	0.482	9.506	0.683	3.628	0.184	2.318	0.279
5.391	0.090	6.267	0.749	9.487	0.446	10.078	0.570	4.064	0.179	2.441	0.293
6.087	0.090	6.997	0.829	10.474	0.359	11.722	0.408	4.514	0.171	2.632	0.306
6.130	0.079	7.341	0.970	10.946	0.339	12.437	0.274	4.909	0.162	2.782	0.329
6.326	0.084	7.598	1.000	11.333	0.331	13.223	0.248	5.687	0.154	2.864	0.355
6.370	0.086	8.199	1.000	11.633	0.336	14.009	0.211	6.478	0.146	3.750	0.391
6.522	0.100	8.543	0.941	11.848	0.440	18.441	0.190	6.860	0.142	3.928	0.856
6.696	0.096	9.272	0.913	12.106	0.462	22.158	0.086	7.173	0.145	4.105	0.932
6.848	0.119	10.217	0.775	12.234	0.554			7.637	0.151	4.268	0.983
7.370	0.119	12.148	0.633	12.664	0.581			7.951	0.164	4.418	1.000
7.587	0.095	13.565	0.509	12.792	0.601			8.073	0.191	4.568	0.983
7.978	0.092	15.368	0.401	13.222	0.612			8.237	0.209	4.814	0.979
8.239	0.093	17.343	0.325	13.436	0.701			8.401	0.221	5.919	0.905
8.565	0.100	19.103	0.274	13.694	0.739			8.660	0.253	6.614	0.520
9.130	0.118	21.206	0.247	14.209	0.744			8.919	0.304	7.228	0.382
9.609	0.172	24.597	0.209	16.613	0.730			9.219	0.334	7.323	0.301
10.217	0.203	26.873	0.167	17.729	0.558			9.355	0.346	7.391	0.302
10.783	0.231			19.446	0.469			9.478	0.352	8.305	0.290
11.587	0.251			21.206	0.407			9.519	0.362	8.932	0.235
11.783	0.272			23.095	0.374			9.587	0.366	9.887	0.211
11.978	0.327			24.426	0.333			9.751	0.394	10.828	0.180
12.283	0.423			25.155	0.311			9.996	0.451	12.369	0.158
12.630	0.391			25.456	0.299			10.078	0.636	13.555	0.137
12.978	0.411			26.100	0.306			10.242	0.708	13.560	0.121
13.174	0.427			26.400	0.360			10.433	0.888	14.537	0.118
13.478	0.443			27.173	0.384			10.555	0.992	15.778	0.117
16.217	0.460			27.516	0.630			10.637	1.000		
16.935	0.467			27.774	0.722			10.705	0.987		

17.500	0.495			28.032	0.780			10.923	0.961		
17.870	0.520			28.332	0.797			12.042	0.853		
18.130	0.536			28.633	0.798			12.178	0.420		
18.304	0.557			29.276	0.788			12.260	0.395		
18.543	0.577			30.908	0.679			12.328	0.385		
18.783	0.610			31.809	0.484			12.410	0.382		
19.109	0.644			32.238	0.438			12.492	0.389		
19.261	0.678			32.754	0.415			12.737	0.410		
19.500	0.701			34.428	0.410			12.928	0.513		
19.804	0.776			35.801	0.347			13.010	0.572		
20.043	0.886			38.506	0.313			13.119	0.582		
20.413	0.948			41.468	0.267			13.215	0.577		
20.696	0.992			43.614	0.234			13.910	0.556		
21.043	1.000			45.417	0.214			14.237	0.397		
21.543	0.988			48.250	0.200			14.360	0.324		
22.087	0.931			50.268	0.182			14.537	0.310		
22.717	0.846			50.568	0.172			14.633	0.294		
23.109	0.741			51.384	0.172			14.987	0.285		
23.565	0.701							15.928	0.253		
23.913	0.678							16.419	0.184		
24.565	0.662							16.597	0.164		
25.500	0.627							16.678	0.164		
26.239	0.586							16.719	0.172		
27.957	0.549							16.774	0.178		
29.696	0.473							16.883	0.179		
30.261	0.410							17.033	0.178		
31.109	0.396							17.087	0.179		
32.348	0.381							17.142	0.179		
33.174	0.352							17.210	0.185		
33.739	0.327							17.401	0.191		
34.543	0.310							17.606	0.192		
36.043	0.281							17.701	0.191		
36.717	0.258							17.851	0.188		
37.739	0.236							18.001	0.173		
38.413	0.209							18.192	0.168		
38.870	0.199							18.533	0.162		
41.261	0.197							18.888	0.164		
42.087	0.198							19.297	0.181		
43.457	0.191							19.624	0.228		
45.152	0.179							19.760	0.277		
45.761	0.161							19.938	0.284		
46.261	0.155							20.088	0.286		
47.804	0.149							20.483	0.284		
49.152	0.136							21.029	0.247		
50.587	0.132							21.506	0.201		
52.304	0.127							22.242	0.170		
54.022	0.114							22.692	0.143		

55.478	0.102							22.979	0.131		
								23.020	0.127		
								23.279	0.122		
								23.620	0.125		
								24.002	0.127		
								24.138	0.125		
								24.370	0.120		
								24.997	0.120		
								25.611	0.117		
								25.815	0.117		
								25.938	0.116		
								26.511	0.114		
								27.438	0.101		
								28.188	0.088		
								29.020	0.079		


Veld-Zone Group B
Catchments < 1000 km2; Std. Peak = 1.75-2.25
Dimensionless Discharge (qi/qpeak)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
9
10
Dimensionless Time (ti/tL)
C8H003 Jan 16, 1967
C8H003 Feb 2, 1976
C8H003 Nov 28, 1983
C8H003 Dec 17, 1987
C8H003 Feb 7, 1976

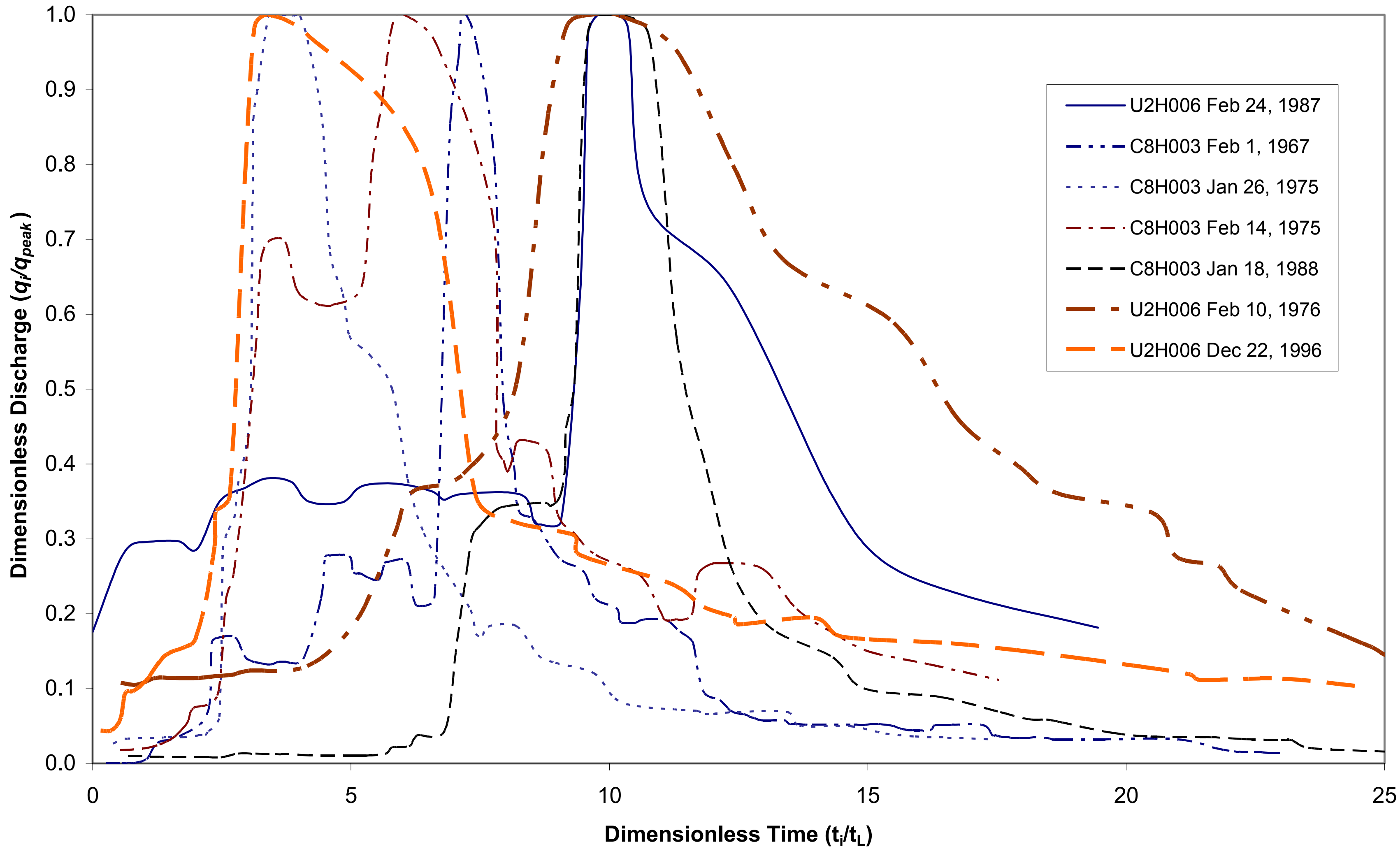
Standardised Hydrographs: Veld-Zone Group B; Area < 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

C8H003	January 16, 1967	C8H003	February 2, 1976	C8H003	November 28, 1983	C8H003	December 17, 1987	C8H003	February 7, 1976
Peak	89.5	**Peak**	98.4	**Peak**	92.3	**Peak**	90.6	**Peak**	92.1
Volume	2.0	**Volume**	11.3	**Volume**	7.9	**Volume**	7.6	**Volume**	5.9
Area	806	**Area**	806	**Area**	806	**Area**	806	**Area**	806
Basin Lag	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3	**Basin Lag**	7.3
Time/lag	**Peak/Flow**	**Time/lag**	**Peak/Flow**	**Time/lag**	**Peak/Flow**	**Time/lag**	**Peak/Flow**	**Time/lag**	**Peak/Flow**
0.095	0.008	0.300	0.057	0.164	0.016	0.191	0.044	0.109	0.088
0.286	0.011	0.655	0.057	0.273	0.018	0.382	0.046	0.177	0.088
0.327	0.391	0.927	0.060	0.341	0.030	0.696	0.055	0.205	0.088
0.395	0.408	1.173	0.065	0.382	0.038	0.982	0.083	0.736	0.098
0.423	0.401	1.405	0.069	0.518	0.076	1.241	0.210	0.777	0.824
0.505	0.455	1.432	0.070	0.641	0.190	1.391	0.444	0.900	0.911
0.559	0.700	1.677	0.072	0.777	0.224	1.582	0.536	0.968	0.982
0.709	0.724	2.073	0.072	0.900	0.253	1.800	0.579	1.036	1.000
0.764	0.971	2.237	0.076	1.459	0.255	2.032	0.610	1.105	1.000
0.914	1.000	2.332	0.077	1.473	0.186	2.223	0.683	1.132	1.000
1.105	0.843	2.414	0.079	1.609	0.185	2.427	0.793	1.200	0.982
1.214	0.456	2.891	0.086	1.746	0.184	2.577	0.956	1.432	0.929
1.691	0.354	3.096	0.104	1.977	0.221	2.796	0.998	1.868	0.802
1.868	0.149	3.464	0.106	2.455	0.336	3.150	1.000	2.387	0.543
2.018	0.117	4.078	0.109	2.618	0.887	3.559	0.859	2.987	0.359
2.032	0.099	4.364	0.105	2.918	0.981	4.091	0.625	3.518	0.248
2.223	0.063	4.473	0.103	3.191	1.000	4.473	0.425	4.159	0.192
2.605	0.047	5.046	0.130	3.764	0.970	5.373	0.349	4.678	0.153
		5.250	0.516	5.087	0.700	6.109	0.230	4.978	0.135
		5.359	0.647	6.219	0.315	6.723	0.169	5.291	0.126
		5.605	0.692	7.023	0.173	7.760	0.135	5.632	0.122
		6.287	0.726	8.332	0.114	9.178	0.099	5.932	0.123
		6.410	0.952	8.796	0.077			6.232	0.122
		6.560	0.984	10.337	0.042			6.532	0.119
		6.655	1.000					6.982	0.115
		6.737	0.984					7.828	0.106
		6.873	0.984					8.796	0.094
		7.132	0.968					9.573	0.084
		7.255	0.952						
		7.391	0.935						
		7.528	0.935						
		7.773	0.885						
		8.060	0.771						
		8.401	0.632						
		8.687	0.498						
		9.069	0.399						
		9.423	0.331						
		9.887	0.286						
		10.446	0.229						

		11.019	0.177						
		11.346	0.150						
		12.314	0.136						
		13.037	0.115						
		13.596	0.103						
		13.678	0.095						
		13.951	0.091						
		14.224	0.090						

Veld-Zone Group B
Catchments < 1000 km^2; Std. Peak = 2.25+



Standardised Hydrographs: Veld-Zone Group B; Area < 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H006	February 23, 1987	C8H003	January 26, 1975	C8H003	February 14, 1975	C8H003	January 18, 1988
Peak	110.6	Peak	163.7	Peak	160.5	Peak	156.4
Volume	19.4	Volume	3.2	Volume	23.9	Volume	16.4
Area	339	Area	806	Area	806	Area	806
Basin Lag	4.6	Basin Lag	7.3	Basin Lag	7.3	Basin Lag	7.3
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.000	0.176	0.395	0.026	0.532	0.018	0.682	0.009
0.478	0.264	0.641	0.033	0.982	0.020	2.141	0.008
0.717	0.291	1.459	0.035	1.296	0.025	2.482	0.008
1.043	0.296	1.746	0.035	1.541	0.033	2.809	0.013
1.652	0.297	2.046	0.037	1.705	0.044	3.150	0.013
2.022	0.286	2.182	0.037	1.841	0.056	3.532	0.013
2.457	0.350	2.237	0.043	1.950	0.074	3.982	0.011
2.957	0.368	2.455	0.062	2.414	0.091	4.418	0.011
3.370	0.381	2.523	0.285	2.577	0.218	4.978	0.010
3.848	0.376	2.632	0.312	2.727	0.253	5.250	0.011
4.174	0.350	2.741	0.328	2.932	0.375	5.659	0.013
4.826	0.349	2.809	0.371	3.150	0.549	5.809	0.022
5.217	0.371	3.041	0.469	3.259	0.671	6.123	0.023
5.891	0.374	3.109	0.861	3.396	0.697	6.219	0.032
6.565	0.364	3.177	0.895	3.723	0.697	6.300	0.038
6.804	0.352	3.218	0.916	3.955	0.632	6.819	0.044
7.130	0.360	3.355	0.981	4.296	0.615	7.050	0.163
8.283	0.359	3.409	1.000	4.500	0.611	7.255	0.265
8.543	0.323	3.478	1.000	4.650	0.612	7.350	0.303
8.674	0.319	3.668	1.000	5.209	0.637	7.514	0.319
9.065	0.324	3.873	0.999	5.414	0.803	7.732	0.335
9.435	0.630	4.009	0.998	5.605	0.885	7.978	0.343
9.587	0.973	4.159	0.966	5.755	0.971	8.755	0.348
9.783	1.000	4.446	0.854	5.878	1.000	8.864	0.344
10.348	0.986	4.596	0.683	6.028	1.000	9.042	0.356
10.696	0.753	4.841	0.628	6.641	0.962	9.137	0.392
12.370	0.632	4.964	0.572	7.732	0.734	9.164	0.448
14.304	0.358	5.155	0.558	7.814	0.424	9.328	0.513
15.283	0.271	5.359	0.546	7.951	0.405	9.451	0.816
16.913	0.223	5.796	0.500	8.032	0.390	9.573	0.971
19.457	0.181	6.096	0.380	8.141	0.412	9.696	0.999
		6.410	0.308	8.210	0.429	9.792	1.000
		6.846	0.254	8.373	0.432	10.760	0.973
		7.310	0.205	8.810	0.415	11.305	0.567
		7.419	0.173	9.001	0.333	11.878	0.393
		7.541	0.171	9.328	0.307	12.314	0.271
		7.651	0.183	9.737	0.278	12.696	0.214
		8.196	0.183	10.583	0.252	13.228	0.176
		8.619	0.145	10.964	0.205	14.319	0.142

		8.960	0.134	11.060	0.192	14.919	0.100
		9.696	0.121	11.183	0.191	16.392	0.089
		10.105	0.087	11.264	0.192	17.565	0.069
		10.528	0.077	11.592	0.199	18.110	0.059
		11.387	0.072	11.701	0.250	18.451	0.059
		11.687	0.070	11.892	0.264	18.669	0.056
		11.851	0.066	12.124	0.267	19.706	0.041
		12.014	0.066	12.955	0.260	20.470	0.036
		12.478	0.069	13.624	0.206	21.547	0.035
		13.446	0.069	14.319	0.175	22.229	0.033
		13.678	0.051	15.015	0.150	22.992	0.031
		14.674	0.050	16.187	0.132	23.197	0.032
		15.342	0.040	17.538	0.111	23.524	0.021
		15.915	0.036			24.888	0.016
		16.542	0.034			25.870	0.015
		17.333	0.032				

Standardised Hydrographs: Veld-Zone Group B; Area < 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

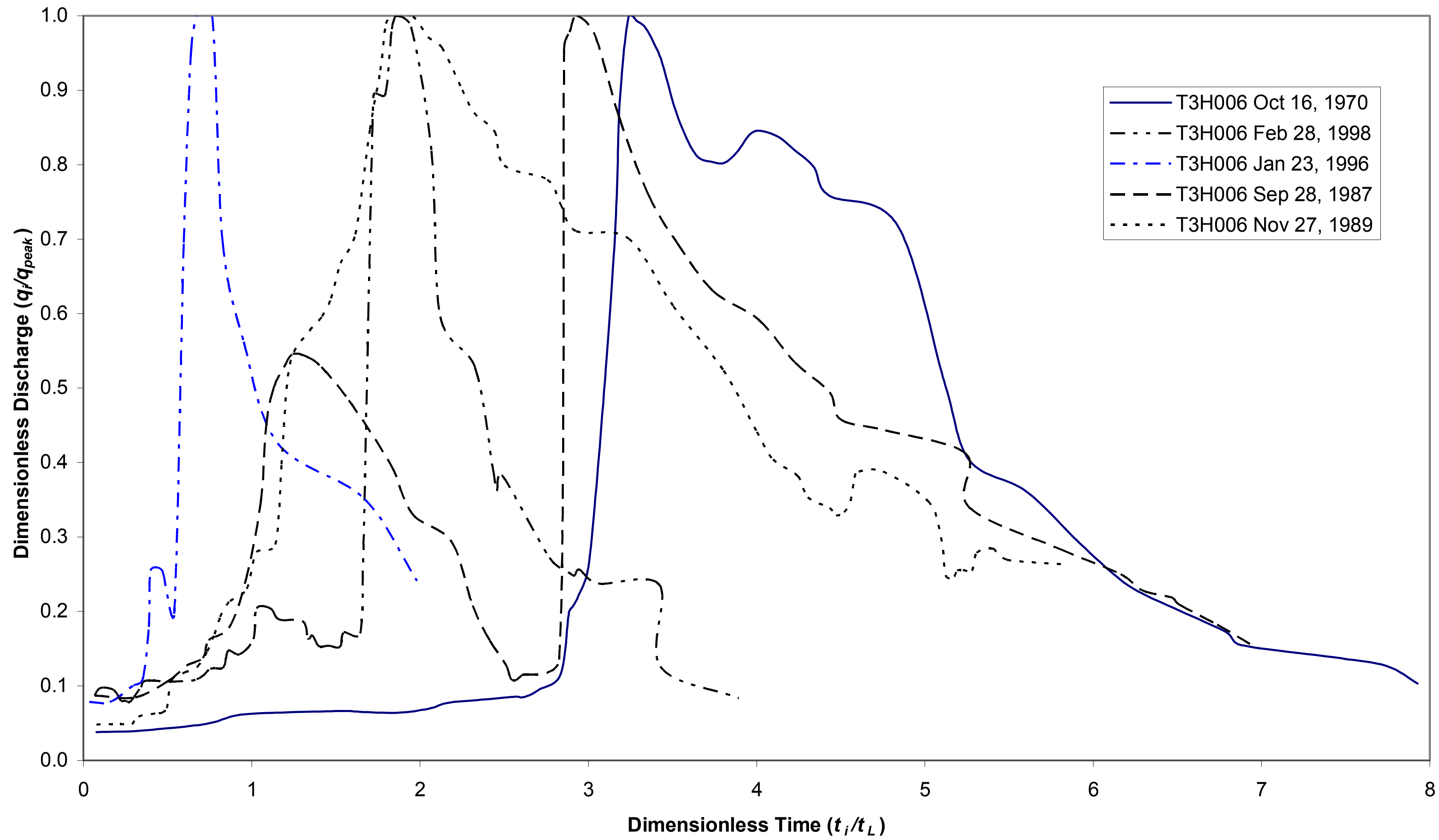
U2H006	December 22, 1996	U2H006	February 10, 1976	C8H003	January 31, 1967
Peak	89.4	**Peak**	197.6	**Peak**	146.2
Volume	10.5	**Volume**	54.9	**Volume**	11.7
Area	339	**Area**	339	**Area**	806
Basin Lag	4.6	**Basin Lag**	4.6	**Basin Lag**	7.3
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.152	0.044	0.543	0.108	0.259	0.000
0.370	0.044	0.870	0.105	0.573	0.000
0.543	0.060	1.217	0.114	0.764	0.000
0.630	0.094	1.500	0.114	1.050	0.006
0.804	0.097	1.957	0.114	1.255	0.027
1.065	0.113	2.326	0.116	1.677	0.036
1.391	0.143	2.717	0.119	2.223	0.068
1.783	0.155	3.022	0.124	2.305	0.162
1.978	0.165	4.152	0.130	2.427	0.168
2.196	0.218	5.109	0.191	2.755	0.169
2.304	0.266	5.826	0.303	2.932	0.144
2.370	0.298	6.174	0.362	3.068	0.137
2.391	0.338	7.174	0.386	3.341	0.133
2.652	0.357	8.174	0.499	3.437	0.132
2.957	0.792	8.761	0.842	3.614	0.136
3.130	0.983	9.174	0.984	3.709	0.136
3.370	1.000	9.652	1.000	4.078	0.139
4.130	0.975	10.196	0.999	4.418	0.220
6.413	0.795	11.283	0.954	4.500	0.276
7.413	0.357	12.391	0.799	4.609	0.278
8.130	0.323	13.370	0.673	4.964	0.277
9.326	0.305	15.500	0.589	5.046	0.255
9.413	0.279	16.761	0.459	5.182	0.254
11.196	0.240	17.870	0.399	5.359	0.247
11.826	0.209	18.652	0.361	5.550	0.246
12.413	0.195	20.522	0.334	5.646	0.267
12.478	0.186	20.957	0.277	5.728	0.270
13.957	0.195	21.783	0.264	6.082	0.269
14.391	0.172	22.217	0.231	6.205	0.220
15.022	0.166	24.370	0.166	6.287	0.210
16.609	0.161	24.761	0.155	6.614	0.220
17.870	0.151	25.087	0.143	6.819	0.658
19.065	0.141	25.522	0.141	6.928	0.863
20.283	0.129	27.587	0.139	7.078	0.942
21.239	0.119	30.109	0.131	7.132	1.000
21.413	0.112	32.630	0.123	7.228	1.000
23.022	0.113	34.848	0.116	7.419	0.965
24.435	0.104	36.500	0.109	7.773	0.805
		37.717	0.104	7.951	0.484

		39.891	0.100	8.155	0.398
		40.913	0.094	8.237	0.339
		41.152	0.085	8.537	0.325
		41.609	0.079	8.851	0.290
		43.826	0.074	9.082	0.271
		44.543	0.071	9.505	0.256
		44.891	0.071	9.723	0.220
		45.261	0.082	10.132	0.208
		45.717	0.088	10.201	0.190
		46.543	0.091	10.337	0.188
		48.022	0.097	10.514	0.188
		48.457	0.104	10.664	0.192
		48.891	0.106	11.087	0.192
		49.500	0.107	11.360	0.176
		49.913	0.108	11.537	0.168
		50.304	0.108	11.619	0.160
		50.848	0.106	11.810	0.097
		51.783	0.104	12.137	0.085
		52.761	0.096	12.342	0.071
		54.109	0.088	12.533	0.066
		54.935	0.079	12.614	0.065
		55.609	0.075	12.737	0.062
		56.196	0.072	12.805	0.061
		56.587	0.071	12.969	0.057
		57.065	0.072	13.378	0.058
		57.457	0.075	13.474	0.053
		57.739	0.075	13.555	0.053
		57.978	0.074	13.924	0.052
		58.370	0.074	14.728	0.052
		58.609	0.075	14.919	0.051
		59.196	0.076	15.083	0.053
		59.391	0.080	15.246	0.052
		60.022	0.082	15.451	0.051
		60.435	0.085	15.615	0.047
		60.848	0.085	15.696	0.046
		61.717	0.085	15.819	0.044
		62.848	0.080	16.201	0.045
		63.848	0.074	16.297	0.051
		65.304	0.071	16.515	0.051
		66.435	0.069	17.224	0.051
		67.870	0.068	17.415	0.037
		68.500	0.065	17.483	0.037
		70.022	0.061	17.592	0.035
		70.370	0.055	17.674	0.035
		72.087	0.053	17.851	0.034
				17.988	0.035
				18.410	0.035

				18.574	0.032
				18.697	0.032
				19.433	0.032
				21.001	0.032
				21.724	0.021
				22.079	0.016
				22.474	0.015
				22.597	0.015
				22.774	0.014
				22.965	0.014

Appendix F5 (b)

Veld-Zone Group B
Catchment > 1000 km^2; Std. Peak = 1.25-1.75

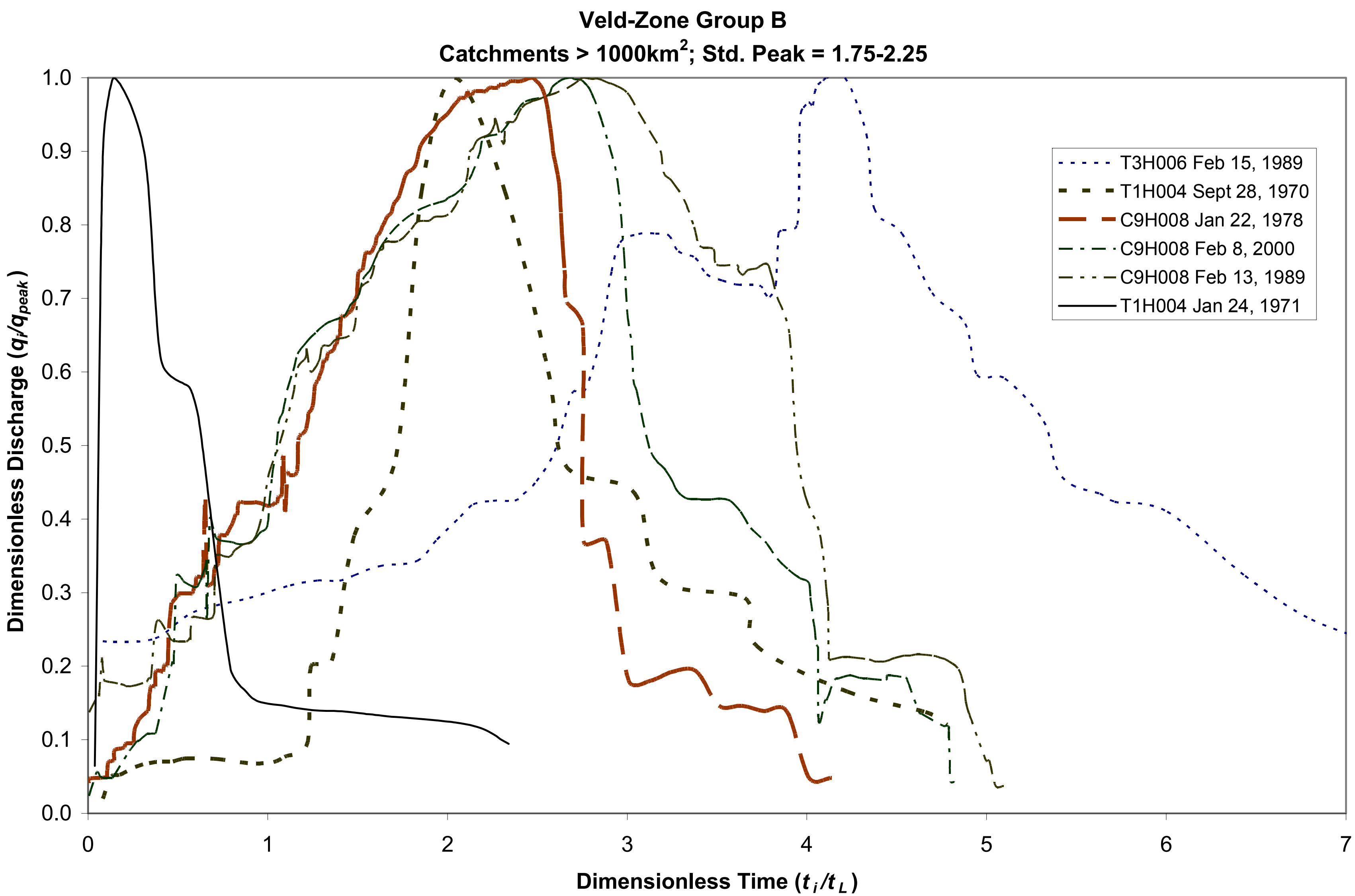


Standardised Hydrographs: Veld-Zone Group B; Area > 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

T3H006	October 10, 1970	T3H006	February 28, 1998	T3H006	January 23, 1996	T3H006	September 28, 1987	T3H006	November 27, 1989
Peak	659.8	**Peak**	708.8	**Peak**	593.1	**Peak**	608.5	**Peak**	672.3
Volume	134.9	**Volume**	72.6	**Volume**	32.0	**Volume**	102.1	**Volume**	145.6
Area	4268	**Area**	4268	**Area**	4268	**Area**	4268	**Area**	4268
Basin Lag	20.8	**Basin Lag**	20.8	**Basin Lag**	20.8	**Basin Lag**	20.8	**Basin Lag**	20.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.077	0.038	0.067	0.087	0.034	0.079	0.067	0.087	0.077	0.048
0.341	0.040	0.101	0.097	0.159	0.078	0.308	0.084	0.216	0.049
0.721	0.049	0.178	0.095	0.298	0.101	0.505	0.107	0.288	0.049
0.899	0.060	0.221	0.081	0.351	0.108	0.615	0.127	0.327	0.059
1.072	0.064	0.250	0.080	0.389	0.179	0.712	0.138	0.447	0.063
1.543	0.066	0.279	0.079	0.399	0.255	0.745	0.162	0.466	0.064
1.668	0.065	0.341	0.098	0.471	0.254	0.865	0.178	0.495	0.070
1.875	0.064	0.370	0.107	0.538	0.197	0.962	0.240	0.524	0.107
2.048	0.069	0.505	0.106	0.596	0.695	1.053	0.345	0.601	0.118
2.163	0.077	0.673	0.109	0.639	0.952	1.087	0.449	0.678	0.126
2.341	0.081	0.755	0.123	0.673	1.000	1.130	0.499	0.736	0.146
2.572	0.086	0.822	0.124	0.764	0.999	1.192	0.528	0.779	0.169
2.601	0.084	0.841	0.130	0.827	0.696	1.245	0.546	0.813	0.193
2.649	0.087	0.861	0.147	0.952	0.562	1.327	0.542	0.851	0.208
2.707	0.095	0.928	0.142	1.154	0.426	1.413	0.528	0.870	0.214
2.837	0.116	1.010	0.163	1.668	0.351	1.577	0.483	0.971	0.231
2.885	0.198	1.029	0.204	1.981	0.241	1.822	0.399	1.029	0.280
2.909	0.207	1.111	0.204			1.952	0.332	1.139	0.290
2.942	0.222	1.163	0.189			2.188	0.293	1.178	0.398
3.000	0.259	1.303	0.187			2.313	0.208	1.226	0.532
3.077	0.450	1.332	0.163			2.413	0.161	1.346	0.577
3.159	0.704	1.346	0.164			2.510	0.129	1.418	0.596
3.188	0.888	1.361	0.168			2.538	0.110	1.471	0.620
3.240	1.000	1.399	0.153			2.572	0.108	1.529	0.668
3.288	0.993	1.457	0.154			2.615	0.116	1.615	0.707
3.337	0.985	1.524	0.152			2.827	0.136	1.702	0.847
3.389	0.963	1.548	0.172			2.856	0.957	1.764	0.927
3.438	0.938	1.644	0.171			2.889	0.978	1.798	0.990
3.510	0.879	1.663	0.284			2.933	1.000	1.846	1.000
3.582	0.837	1.692	0.596			3.038	0.974	1.957	0.999
3.649	0.811	1.716	0.842			3.183	0.864	2.048	0.971
3.726	0.804	1.726	0.895			3.356	0.760	2.130	0.957
3.808	0.802	1.793	0.895			3.524	0.696	2.250	0.900
3.880	0.816	1.832	0.982			3.740	0.630	2.322	0.869
3.966	0.842	1.861	1.000			4.010	0.592	2.442	0.844
4.038	0.845	1.947	0.985			4.226	0.535	2.500	0.799
4.135	0.837	2.067	0.819			4.433	0.494	2.755	0.780
4.226	0.820	2.120	0.596			4.500	0.458	2.837	0.746
4.341	0.796	2.327	0.528			4.764	0.443	2.928	0.711

4.428	0.759	2.433	0.391			5.245	0.411	3.240	0.701
4.837	0.718	2.457	0.362			5.260	0.341	3.505	0.610
5.120	0.504	2.486	0.383			5.803	0.284	3.803	0.524
5.264	0.403	2.769	0.272			6.163	0.250	4.000	0.441
5.601	0.362	2.885	0.252			6.288	0.229	4.096	0.404
5.918	0.292	2.918	0.248			6.466	0.219	4.245	0.381
6.149	0.245	2.947	0.256			6.510	0.209	4.303	0.354
6.303	0.223	3.058	0.237			6.736	0.182	4.433	0.339
6.784	0.173	3.423	0.236			6.942	0.155	4.471	0.329
6.875	0.155	3.428	0.126					4.519	0.333
7.447	0.138	3.894	0.084					4.558	0.349
7.745	0.127							4.582	0.380
7.928	0.103							4.606	0.388
								4.750	0.388
								5.019	0.348
								5.096	0.299
								5.125	0.247
								5.173	0.247
								5.192	0.255
								5.226	0.256
								5.279	0.255
								5.308	0.279
								5.404	0.284
								5.486	0.270
								5.827	0.263


Veld-Zone Group B
Catchments > 1000km^2; Std. Peak = 1.75-2.25
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
Dimensionless Time (t_i/t_L)
T3H006 Feb 15, 1989
T1H004 Sept 28, 1970
C9H008 Jan 22, 1978
C9H008 Feb 8, 2000
C9H008 Feb 13, 1989
T1H004 Jan 24, 1971

Standardised Hydrographs: Veld-Zone Group B; Area > 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

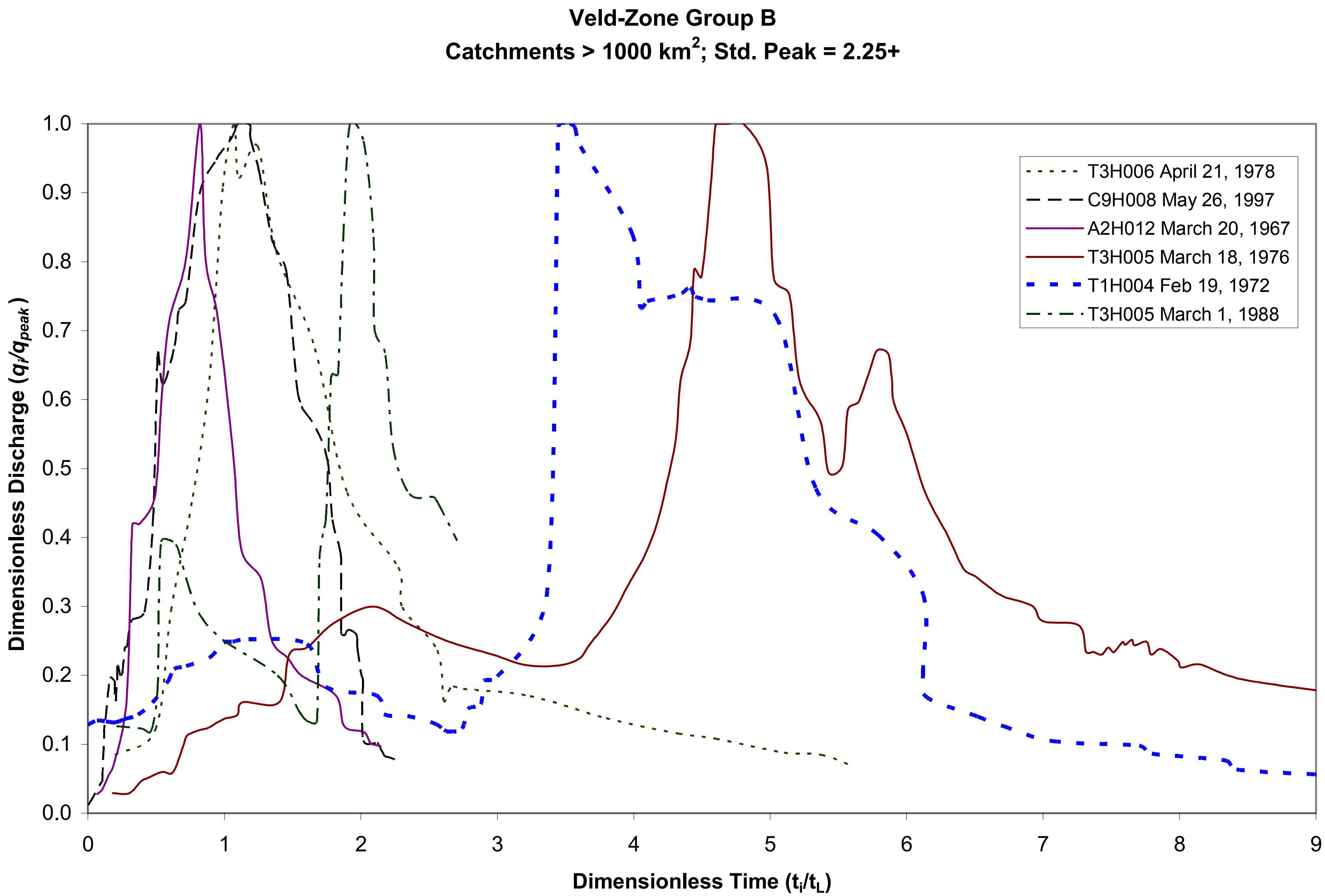
C9H008	January 22, 1978	C9H008	February 7, 2000	C9H008	February 12, 1989	T3H006	February 14, 1989	T1H004	September 28, 1970	T1H004	January 24, 1971
Peak	1537.7	Peak	1567.4	Peak	1782.0	Peak	904.3	Peak	329.6	Peak	312.7
Volume	1025.0	Volume	1221.9	Volume	1948.9	Volume	233.1	Volume	36.3	Volume	17.8
Area	115057	Area	115057	Area	115057	Area	4268	Area	4908	Area	4908
Basin Lag	95.6	Basin Lag	95.6	Basin Lag	95.6	Basin Lag	20.8	Basin Lag	18.2	Basin Lag	18.2
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.004	0.041	0.006	0.024	0.006	0.137	0.082	0.234	0.082	0.020	0.038	0.064
0.008	0.047	0.047	0.056	0.056	0.161	0.139	0.233	0.132	0.050	0.082	0.900
0.101	0.049	0.054	0.056	0.062	0.160	0.375	0.238	0.176	0.052	0.143	1.000
0.107	0.049	0.073	0.049	0.077	0.212	0.587	0.273	0.264	0.063	0.313	0.898
0.111	0.069	0.131	0.048	0.078	0.210	0.899	0.293	0.341	0.068	0.407	0.616
0.141	0.071	0.137	0.048	0.088	0.183	1.125	0.310	0.412	0.070	0.566	0.578
0.145	0.072	0.231	0.085	0.089	0.180	1.279	0.317	0.473	0.070	0.621	0.528
0.149	0.086	0.236	0.087	0.180	0.176	1.399	0.316	0.511	0.073	0.791	0.199
0.191	0.089	0.268	0.097	0.231	0.173	1.486	0.324	0.549	0.075	0.879	0.165
0.200	0.089	0.276	0.098	0.325	0.179	1.625	0.336	0.720	0.074	0.951	0.152
0.204	0.090	0.283	0.098	0.333	0.182	1.832	0.343	0.846	0.069	1.071	0.147
0.212	0.095	0.327	0.108	0.340	0.184	1.942	0.372	0.934	0.068	1.247	0.140
0.247	0.096	0.334	0.108	0.350	0.184	2.072	0.403	1.033	0.069	1.412	0.139
0.250	0.096	0.371	0.109	0.381	0.260	2.144	0.420	1.093	0.077	1.637	0.133
0.254	0.097	0.377	0.109	0.439	0.245	2.255	0.425	1.220	0.095	2.126	0.120
0.259	0.114	0.470	0.206	0.468	0.235	2.375	0.425	1.242	0.200	2.341	0.094
0.286	0.128	0.476	0.203	0.547	0.234	2.423	0.434	1.357	0.207		
0.290	0.129	0.493	0.324	0.568	0.239	2.495	0.451	1.484	0.378		
0.332	0.139	0.529	0.317	0.570	0.236	2.596	0.492	1.714	0.484		
0.335	0.139	0.535	0.314	0.577	0.266	2.697	0.572	1.857	0.846		
0.340	0.158	0.600	0.307	0.606	0.267	2.760	0.572	2.038	1.000		
0.341	0.161	0.625	0.316	0.622	0.266	2.841	0.635	2.319	0.845		
0.344	0.165	0.630	0.320	0.697	0.267	2.913	0.737	2.560	0.600		
0.350	0.173	0.653	0.335	0.703	0.303	2.962	0.776	2.659	0.472		
0.369	0.173	0.658	0.343	0.709	0.350	3.063	0.787	3.038	0.436		
0.373	0.173	0.663	0.265	0.728	0.352	3.159	0.788	3.187	0.317		
0.378	0.193	0.677	0.400	0.763	0.349	3.231	0.786	3.654	0.292		
0.414	0.193	0.703	0.380	0.789	0.349	3.284	0.764	3.720	0.228		
0.418	0.193	0.723	0.372	0.805	0.353	3.380	0.755	4.225	0.165		
0.425	0.201	0.801	0.369	0.812	0.356	3.442	0.733	4.659	0.138		
0.440	0.201	0.828	0.366	0.861	0.365	3.529	0.725	4.780	0.121		
0.444	0.201	0.877	0.366	0.880	0.367	3.615	0.719				
0.451	0.251	0.920	0.371	0.912	0.369	3.736	0.718				
0.464	0.286	0.960	0.382	0.940	0.381	3.764	0.708				
0.469	0.286	0.997	0.389	0.973	0.411	3.793	0.702				
0.497	0.295	1.009	0.420	1.006	0.461	3.827	0.719				
0.502	0.295	1.023	0.456	1.067	0.503	3.841	0.788				
0.505	0.299	1.049	0.500	1.136	0.564	3.865	0.793				
0.573	0.299	1.061	0.532	1.167	0.605	3.947	0.800				

0.581	0.299	1.084	0.546	1.210	0.619	3.957	0.919				
0.594	0.310	1.108	0.576	1.215	0.631	3.966	0.953				
0.599	0.310	1.141	0.601	1.238	0.600	3.981	0.959				
0.604	0.321	1.168	0.624	1.285	0.615	4.010	0.967				
0.635	0.321	1.212	0.639	1.303	0.634	4.034	0.963				
0.640	0.321	1.272	0.655	1.345	0.636	4.043	0.979				
0.645	0.382	1.331	0.667	1.379	0.644	4.063	0.991				
0.653	0.426	1.419	0.675	1.475	0.655	4.091	0.996				
0.661	0.310	1.444	0.683	1.508	0.710	4.111	1.000				
0.675	0.310	1.465	0.692	1.571	0.727	4.212	1.000				
0.695	0.313	1.504	0.703	1.605	0.757	4.332	0.922				
0.699	0.317	1.530	0.726	1.621	0.765	4.375	0.822				
0.700	0.321	1.574	0.740	1.640	0.767	4.529	0.788				
0.703	0.332	1.622	0.766	1.650	0.777	4.697	0.708				
0.715	0.336	1.678	0.787	1.730	0.778	4.880	0.665				
0.725	0.340	1.750	0.805	1.798	0.794	4.947	0.596				
0.727	0.363	1.835	0.819	1.836	0.804	5.101	0.591				
0.729	0.366	1.920	0.828	1.897	0.806	5.317	0.533				
0.733	0.378	1.984	0.833	1.930	0.811	5.385	0.472				
0.747	0.378	2.005	0.837	2.019	0.817	5.476	0.446				
0.768	0.378	2.049	0.843	2.104	0.859	5.630	0.434				
0.770	0.378	2.121	0.862	2.123	0.899	5.712	0.424				
0.803	0.394	2.177	0.896	2.143	0.904	6.005	0.410				
0.811	0.398	2.203	0.918	2.171	0.916	6.438	0.323				
0.821	0.406	2.298	0.926	2.232	0.923	6.808	0.263				
0.826	0.406	2.375	0.951	2.263	0.936	7.231	0.227				
0.831	0.406	2.433	0.968	2.267	0.944						
0.839	0.422	2.556	0.976	2.311	0.910						
0.869	0.422	2.586	0.988	2.325	0.938						
0.907	0.422	2.644	0.998	2.372	0.941						
0.950	0.422	2.689	1.000	2.414	0.959						
0.994	0.418	2.707	0.998	2.461	0.967						
1.017	0.418	2.748	0.996	2.550	0.975						
1.023	0.418	2.796	0.982	2.664	0.985						
1.042	0.422	2.844	0.951	2.731	0.996						
1.044	0.422	2.899	0.908	2.753	1.000						
1.048	0.422	2.946	0.860	2.804	0.998						
1.053	0.422	2.983	0.759	2.838	0.999						
1.059	0.431	3.001	0.681	2.884	0.994						
1.068	0.431	3.027	0.635	2.930	0.990						
1.073	0.431	3.036	0.587	3.001	0.979						
1.078	0.435	3.054	0.574	3.062	0.954						
1.082	0.481	3.079	0.543	3.126	0.927						
1.087	0.486	3.105	0.515	3.185	0.901						
1.096	0.410	3.133	0.490	3.203	0.871						
1.109	0.464	3.168	0.478	3.248	0.860						
1.117	0.460	3.204	0.470	3.315	0.835						

1.123	0.460	3.245	0.454	3.372	0.797						
1.144	0.460	3.275	0.440	3.404	0.771						
1.152	0.460	3.325	0.428	3.479	0.767						
1.161	0.464	3.391	0.427	3.498	0.746						
1.166	0.468	3.469	0.427	3.610	0.746						
1.169	0.507	3.517	0.428	3.618	0.738						
1.174	0.512	3.574	0.424	3.644	0.732						
1.178	0.512	3.631	0.410	3.672	0.738						
1.185	0.516	3.687	0.388	3.723	0.741						
1.195	0.516	3.767	0.369	3.736	0.743						
1.210	0.520	3.835	0.346	3.778	0.747						
1.223	0.534	3.898	0.331	3.803	0.731						
1.226	0.543	3.954	0.321	3.834	0.702						
1.248	0.552	4.011	0.313	3.903	0.651						
1.259	0.575	4.020	0.293	3.940	0.505						
1.260	0.579	4.037	0.260	3.991	0.432						
1.267	0.584	4.041	0.254	4.073	0.379						
1.269	0.584	4.053	0.229	4.110	0.301						
1.276	0.589	4.062	0.226	4.117	0.281						
1.279	0.589	4.066	0.125	4.123	0.210						
1.299	0.601	4.103	0.154	4.141	0.210						
1.304	0.605	4.111	0.154	4.203	0.213						
1.311	0.616	4.155	0.182	4.248	0.212						
1.318	0.616	4.175	0.183	4.346	0.209						
1.325	0.616	4.237	0.188	4.373	0.207						
1.333	0.623	4.292	0.184	4.434	0.206						
1.338	0.627	4.339	0.183	4.487	0.211						
1.344	0.627	4.440	0.182	4.533	0.214						
1.368	0.630	4.448	0.188	4.573	0.214						
1.376	0.638	4.550	0.184	4.620	0.216						
1.384	0.638	4.556	0.183	4.705	0.214						
1.391	0.649	4.625	0.136	4.733	0.212						
1.396	0.649	4.634	0.136	4.775	0.208						
1.402	0.649	4.756	0.119	4.843	0.196						
1.407	0.676	4.783	0.119	4.877	0.169						
1.421	0.676	4.790	0.118	4.883	0.154						
1.431	0.676	4.799	0.043	4.896	0.140						
1.446	0.679	4.815	0.042	4.997	0.071						
1.464	0.683	4.821	0.042	5.006	0.072						
1.479	0.691			5.016	0.072						
1.485	0.699			5.050	0.037						
1.496	0.703			5.090	0.037						
1.504	0.734			5.095	0.037						
1.519	0.738										
1.525	0.738										
1.531	0.742										
1.545	0.762										

1.554	0.762										
1.575	0.762										
1.585	0.766										
1.593	0.771										
1.599	0.775										
1.606	0.783										
1.617	0.787										
1.629	0.791										
1.634	0.795										
1.650	0.803										
1.666	0.812										
1.687	0.816										
1.702	0.828										
1.727	0.837										
1.746	0.850										
1.760	0.862										
1.776	0.871										
1.820	0.880										
1.848	0.906										
1.881	0.919										
1.918	0.928										
1.954	0.941										
1.998	0.950										
2.040	0.964										
2.059	0.968										
2.068	0.973										
2.098	0.973										
2.107	0.977										
2.113	0.982										
2.117	0.977										
2.135	0.977										
2.139	0.977										
2.146	0.982										
2.161	0.982										
2.166	0.982										
2.174	0.982										
2.184	0.982										
2.192	0.982										
2.213	0.982										
2.234	0.986										
2.254	0.986										
2.280	0.986										
2.289	0.991										
2.292	0.991										
2.323	0.991										
2.353	0.995										
2.407	0.995										

2.469	1.000										
2.495	0.995										
2.526	0.986										
2.553	0.964										
2.569	0.937										
2.582	0.915										
2.589	0.897										
2.605	0.880										
2.621	0.854										
2.632	0.816										
2.639	0.779										
2.652	0.738										
2.662	0.695										
2.753	0.660										
2.756	0.370										
2.883	0.370										
3.007	0.181										
3.134	0.181										
3.258	0.193										
3.385	0.193										
3.509	0.146										
3.636	0.146										
3.760	0.139										
3.887	0.139										
4.012	0.048										
4.138	0.048										


Veld-Zone Group B
Catchments > 1000 km²; Std. Peak = 2.25+
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Dimensionless Discharge (q_i/q_{peak})
0
1
2
3
4
5
6
7
8
9
Dimensionless Time (t_i/t_L)
T3H006 April 21, 1978
C9H008 May 26, 1997
A2H012 March 20, 1967
T3H005 March 18, 1976
T1H004 Feb 19, 1972
T3H005 March 1, 1988

Standardised Hydrographs: Veld-Zone Group B; Area > 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

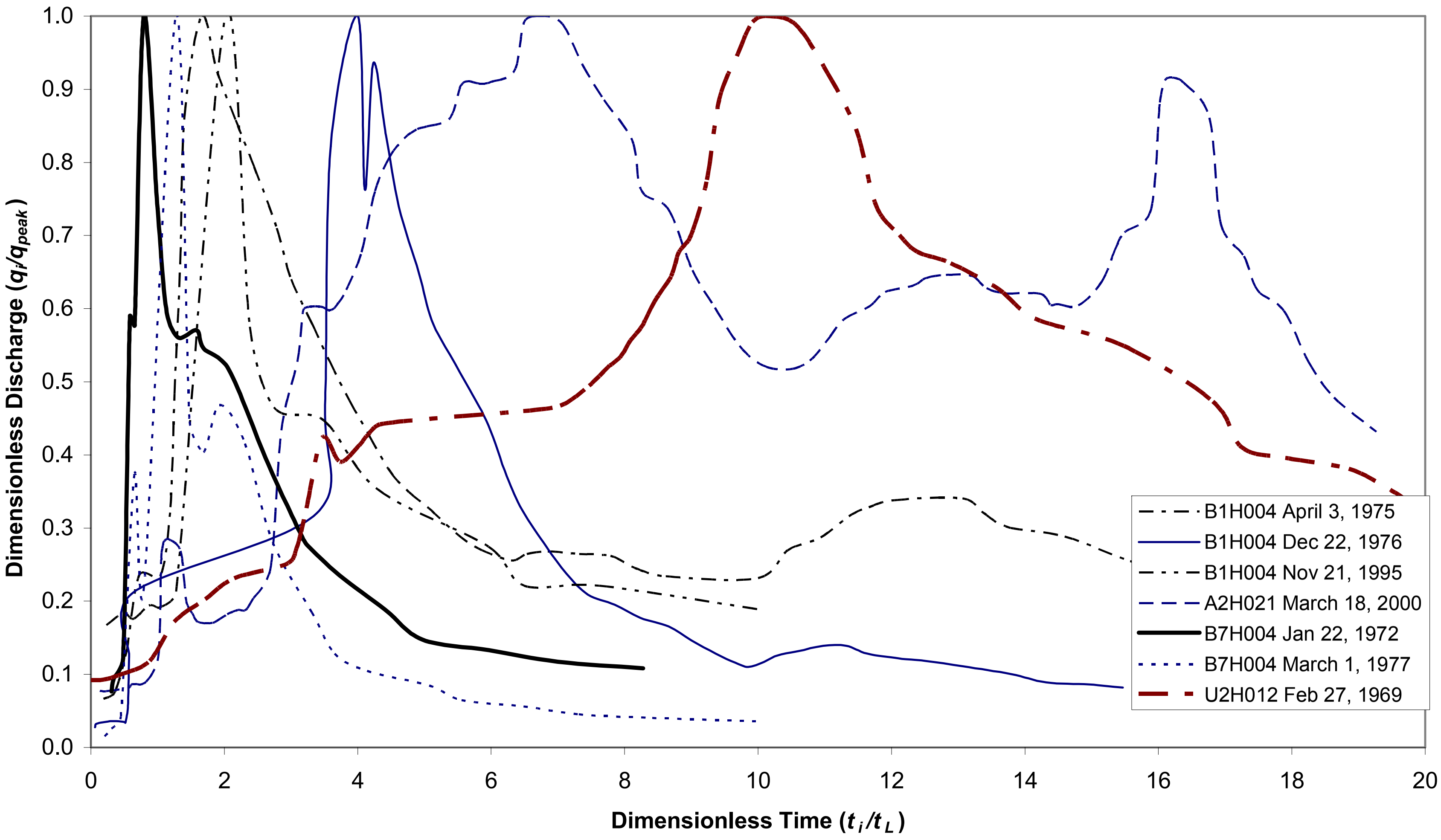
T3H006	April 21, 1978	C9H008	May 26, 1997	A2H012	March 20, 1967	T3H005	March 18, 1976	T1H004	February 19, 1972	T1H005	March 1, 1988
Peak	925.7	**Peak**	2097.8	**Peak**	369.1	**Peak**	1191.6	**Peak**	909.0	**Peak**	613.1
Volume	136.0	**Volume**	1499.2	**Volume**	20.8	**Volume**	162.4	**Volume**	233.8	**Volume**	30.5
Area	4268	**Area**	115057	**Area**	2551	**Area**	2597	**Area**	4908	**Area**	2597
Basin Lag	20.8	**Basin Lag**	95.6	**Basin Lag**	20.8	**Basin Lag**	14.9	**Basin Lag**	18.2	**Basin Lag**	14.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.197	0.084	0.006	0.012	0.067	0.028	0.181	0.029	0.000	0.128	0.208	0.126
0.495	0.122	0.102	0.046	0.101	0.033	0.302	0.029	0.066	0.134	0.389	0.123
0.611	0.294	0.106	0.046	0.130	0.044	0.389	0.046	0.132	0.133	0.463	0.119
0.769	0.459	0.123	0.135	0.154	0.055	0.443	0.052	0.187	0.131	0.510	0.177
0.889	0.629	0.128	0.136	0.188	0.069	0.544	0.060	0.231	0.133	0.537	0.393
0.990	0.909	0.162	0.196	0.284	0.164	0.624	0.060	0.275	0.137	0.644	0.390
1.072	1.000	0.192	0.192	0.327	0.419	0.698	0.097	0.368	0.143	0.725	0.337
1.106	0.922	0.196	0.192	0.375	0.419	0.725	0.112	0.473	0.160	0.819	0.288
1.245	0.967	0.199	0.165	0.490	0.459	0.805	0.120	0.588	0.192	1.000	0.250
1.380	0.815	0.204	0.163	0.538	0.597	0.886	0.124	0.632	0.209	1.389	0.200
1.663	0.674	0.206	0.163	0.596	0.713	0.993	0.136	0.720	0.213	1.550	0.146
1.899	0.465	0.213	0.194	0.721	0.807	1.094	0.142	0.896	0.226	1.611	0.133
2.274	0.357	0.214	0.194	0.822	1.000	1.134	0.161	0.995	0.247	1.678	0.133
2.303	0.299	0.218	0.215	0.861	0.807	1.403	0.161	1.060	0.249	1.698	0.368
2.558	0.236	0.237	0.200	0.952	0.718	1.477	0.231	1.176	0.252	1.732	0.413
2.606	0.163	0.249	0.201	1.063	0.525	1.611	0.241	1.604	0.245	1.745	0.428
2.644	0.177	0.253	0.203	1.125	0.382	1.799	0.275	1.742	0.183	1.779	0.627
2.678	0.184	0.271	0.240	1.269	0.339	2.087	0.300	2.115	0.171	1.792	0.638
2.750	0.180	0.287	0.242	1.346	0.251	2.329	0.276	2.170	0.143	1.832	0.637
3.240	0.170	0.289	0.245	1.466	0.225	2.631	0.250	2.341	0.141	1.872	0.835
3.798	0.138	0.323	0.280	1.567	0.200	2.966	0.230	2.538	0.130	1.919	1.000
4.327	0.116	0.413	0.291	1.817	0.171	3.215	0.215	2.610	0.121	2.020	0.975
4.601	0.108	0.476	0.424	1.880	0.126	3.450	0.214	2.643	0.119	2.094	0.836
5.101	0.088	0.508	0.653	2.024	0.118	3.597	0.224	2.742	0.122	2.101	0.703
5.375	0.085	0.515	0.669	2.072	0.102	3.678	0.245	2.786	0.151	2.181	0.664
5.591	0.069	0.551	0.622	2.144	0.097	3.839	0.287	2.879	0.158	2.235	0.532
		0.635	0.678			3.946	0.326	2.901	0.192	2.356	0.463
		0.666	0.730			4.081	0.374	3.000	0.198	2.530	0.459
		0.717	0.742			4.174	0.422	3.363	0.316	2.564	0.450
		0.818	0.898			4.242	0.478	3.451	0.996	2.705	0.395
		0.942	0.948			4.309	0.543	3.527	1.000		
		1.056	0.980			4.342	0.627	3.571	0.993		
		1.102	1.000			4.416	0.685	3.610	0.967		
		1.187	0.998			4.443	0.789	3.989	0.840		
		1.190	0.979			4.497	0.778	4.049	0.733		
		1.253	0.932			4.557	0.892	4.099	0.743		
		1.355	0.828			4.597	0.998	4.247	0.748		
		1.455	0.784			4.631	1.000	4.352	0.754		
		1.533	0.616			4.658	1.000	4.412	0.762		

		1.566	0.590			4.691	1.000	4.451	0.749		
		1.581	0.584			4.805	1.000	4.538	0.744		
		1.671	0.558			4.973	0.940	5.044	0.720		
		1.756	0.511			5.027	0.775	5.335	0.471		
		1.793	0.426			5.141	0.752	5.791	0.404		
		1.849	0.380			5.215	0.628	6.121	0.317		
		1.854	0.344			5.369	0.568	6.121	0.207		
		1.857	0.261			5.430	0.494	6.137	0.170		
		1.881	0.258			5.530	0.504	6.522	0.140		
		1.903	0.265			5.570	0.585	6.714	0.126		
		1.931	0.265			5.644	0.596	7.071	0.104		
		1.969	0.258			5.705	0.628	7.703	0.098		
		1.975	0.240			5.772	0.667	7.797	0.086		
		2.001	0.204			5.799	0.673	8.335	0.076		
		2.009	0.197			5.866	0.666	8.418	0.063		
		2.015	0.193			5.893	0.628	8.989	0.056		
		2.019	0.105			5.906	0.595	9.390	0.055		
		2.122	0.102			6.007	0.547	9.714	0.053		
		2.126	0.101			6.134	0.465	9.775	0.050		
		2.174	0.083			6.302	0.402	9.830	0.050		
		2.178	0.082			6.416	0.355	10.038	0.053		
		2.244	0.079			6.503	0.344	10.214	0.048		
		2.249	0.078			6.604	0.328	10.297	0.047		
						6.711	0.314	10.703	0.047		
						6.919	0.301	10.819	0.057		
						7.000	0.278	11.335	0.057		
						7.262	0.272	11.445	0.051		
						7.315	0.234	11.489	0.051		
						7.369	0.234	11.533	0.052		
						7.430	0.230	11.588	0.053		
						7.477	0.240	11.720	0.055		
						7.517	0.234	11.791	0.067		
						7.557	0.243	11.901	0.070		
						7.584	0.248	11.978	0.069		
						7.604	0.244	12.368	0.067		
						7.651	0.252	12.967	0.060		
						7.671	0.244	12.973	0.052		
						7.758	0.249	13.280	0.044		
						7.792	0.230	13.604	0.043		
						7.852	0.238	14.137	0.036		
						7.906	0.234				
						7.987	0.221				
						8.013	0.211				
						8.141	0.216				
						8.289	0.205				
						8.450	0.194				
						8.738	0.185				

						9.141	0.174				
						9.463	0.157				
						9.953	0.150				
						10.463	0.136				
						10.658	0.122				
						10.792	0.121				
						10.993	0.116				
						11.450	0.116				
						11.846	0.103				
						12.074	0.097				
						12.805	0.081				

Appendix F6 (a)

Veld-Zone Group C
Catchments < 1000 km^2; Std. Peak = 1.25-1.75



Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

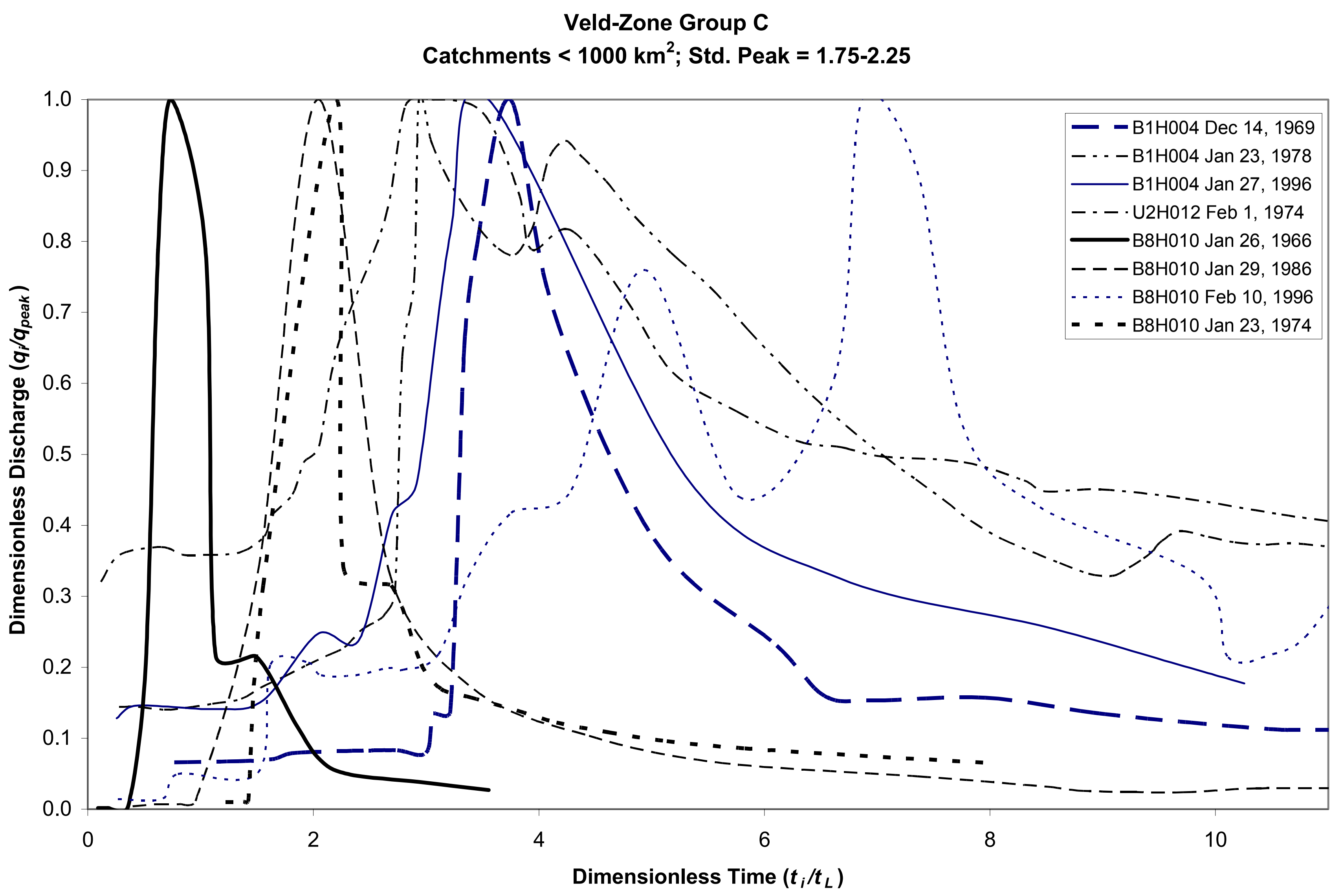
B1H004	April 3, 1975	B1H004	December 22, 1976	U2H012	February 27, 1969	A2H021	March 17, 2000
Peak	18.4	**Peak**	19.1	**Peak**	46.1	**Peak**	102.9
Volume	1.9	**Volume**	1.0	**Volume**	12.0	**Volume**	69.8
Area	376	**Area**	376	**Area**	438	**Area**	7483
Basin Lag	4.7	**Basin Lag**	4.7	**Basin Lag**	6.0	**Basin Lag**	15.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.191	0.066	0.064	0.028	0.000	0.092	0.131	0.077
0.298	0.070	0.085	0.033	0.200	0.093	0.213	0.077
0.362	0.076	0.277	0.036	0.450	0.100	0.555	0.081
0.532	0.130	0.383	0.036	0.883	0.118	0.590	0.084
0.723	0.235	0.511	0.035	1.250	0.172	0.631	0.087
1.043	0.235	0.514	0.034	1.717	0.203	0.830	0.090
1.191	0.328	0.553	0.054	2.150	0.231	1.010	0.125
1.255	0.483	0.574	0.124	2.933	0.251	1.057	0.259
1.340	0.664	0.638	0.212	3.083	0.272	1.081	0.278
1.404	0.862	3.383	0.320	3.233	0.327	1.111	0.283
1.660	1.000	3.511	0.468	3.467	0.423	1.160	0.285
1.894	0.923	3.596	0.822	3.733	0.391	1.343	0.269
2.170	0.858	4.000	1.000	4.000	0.411	1.430	0.200
2.447	0.794	4.106	0.763	4.150	0.427	1.529	0.182
2.787	0.710	4.234	0.935	4.383	0.443	1.608	0.172
3.000	0.640	4.426	0.837	6.483	0.460	1.829	0.171
3.319	0.579	4.617	0.740	7.033	0.467	2.043	0.182
3.574	0.528	4.915	0.649	7.467	0.495	2.202	0.188
3.872	0.475	5.106	0.584	7.750	0.520	2.323	0.188
4.170	0.426	5.383	0.537	7.950	0.536	2.430	0.203
4.489	0.377	5.681	0.489	8.083	0.557	2.692	0.245
4.766	0.349	5.957	0.440	8.267	0.577	2.855	0.434
5.064	0.327	6.234	0.371	8.450	0.610	3.099	0.530
5.468	0.294	6.468	0.324	8.700	0.644	3.179	0.597
5.809	0.272	6.830	0.274	8.817	0.678	3.266	0.602
6.298	0.256	7.128	0.237	9.000	0.701	3.453	0.602
6.532	0.265	7.447	0.209	9.233	0.776	3.560	0.598
6.851	0.268	7.851	0.195	9.417	0.886	3.656	0.602
7.319	0.265	8.234	0.177	9.700	0.948	3.828	0.626
7.787	0.262	8.660	0.165	9.917	0.992	4.058	0.677
8.149	0.245	9.000	0.147	10.183	1.000	4.259	0.761
8.617	0.234	9.362	0.128	10.567	0.988	4.481	0.808
10.000	0.232	9.660	0.116	10.983	0.931	4.696	0.833
10.447	0.269	9.851	0.110	11.467	0.846	4.891	0.845
10.936	0.287	10.085	0.117	11.767	0.741	5.032	0.849
11.362	0.316	10.277	0.125	12.117	0.701	5.381	0.860
11.660	0.328	10.596	0.131	12.383	0.678	5.541	0.904
12.043	0.338	10.979	0.139	12.883	0.662	5.656	0.911
13.064	0.341	11.319	0.139	13.600	0.627	5.823	0.908

13.383	0.320	11.638	0.128	14.167	0.586	6.008	0.910
13.745	0.301	12.106	0.122	15.483	0.549	6.350	0.926
14.596	0.288	12.511	0.118	16.817	0.473	6.488	0.990
15.574	0.255	13.085	0.111	17.250	0.410	6.659	1.000
16.574	0.231	13.787	0.100	17.900	0.396	7.043	0.992
17.596	0.213	14.319	0.089	18.850	0.381	7.362	0.934
18.617	0.197	14.957	0.086	19.483	0.352	7.691	0.885
19.638	0.182	15.468	0.082	19.917	0.327	8.117	0.829
20.830	0.175			20.533	0.310	8.253	0.761
21.809	0.169			21.017	0.281	8.654	0.736
22.702	0.158			21.533	0.258	9.017	0.652
23.638	0.149			22.317	0.236	9.350	0.602
24.447	0.140			22.833	0.209	9.721	0.549
25.553	0.133			23.183	0.199	10.073	0.522
26.681	0.124			25.017	0.197	10.481	0.517
				25.650	0.198	10.778	0.529
				26.700	0.191	11.050	0.558
				28.000	0.179	11.283	0.585
				28.467	0.161	11.669	0.603
				28.850	0.155	11.907	0.623
				30.033	0.149	12.325	0.631
				31.067	0.136	12.520	0.642
				32.167	0.132	12.817	0.646
				33.483	0.127	13.201	0.645
				34.800	0.114	13.422	0.628
				35.917	0.102	13.700	0.621
						14.223	0.620
						14.384	0.605
						14.488	0.606
						14.800	0.604
						15.149	0.637
						15.350	0.680
						15.493	0.705
						15.885	0.734
						16.021	0.882
						16.102	0.912
						16.193	0.916
						16.369	0.910
						16.765	0.861
						16.937	0.716
						17.282	0.672
						17.484	0.626

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

B7H004	January 22, 1972	B7H004	March 1, 1977	B1H004	November 21, 1995
Peak	92.4	**Peak**	113.7	**Peak**	17.6
Volume	2.0	**Volume**	1.8	**Volume**	0.9
Area	136	**Area**	136	**Area**	376
Basin Lag	2.9	**Basin Lag**	2.9	**Basin Lag**	4.7
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.310	0.077	0.207	0.015	0.234	0.167
0.345	0.095	0.310	0.026	0.489	0.184
0.483	0.123	0.448	0.042	0.638	0.176
0.586	0.590	0.655	0.375	0.872	0.194
0.655	0.577	0.793	0.217	1.043	0.192
0.793	1.000	1.276	1.000	1.277	0.213
1.000	0.737	1.483	0.446	2.021	1.000
1.138	0.595	1.690	0.403	2.383	0.575
1.310	0.560	1.931	0.468	2.745	0.465
1.586	0.570	2.310	0.415	3.489	0.447
1.690	0.546	2.724	0.281	4.298	0.353
2.069	0.517	3.310	0.185	5.957	0.274
2.655	0.388	3.655	0.128	6.489	0.221
3.172	0.287	4.138	0.105	7.617	0.221
3.241	0.277	5.069	0.085	10.043	0.188
3.724	0.235	5.552	0.065		
4.414	0.188	6.483	0.056		
4.966	0.148	7.310	0.045		
5.966	0.133	8.414	0.040		
7.000	0.117	9.966	0.036		
8.276	0.108				


Veld-Zone Group C
Catchments < 1000 km²; Std. Peak = 1.75-2.25
Dimensionless Discharge (q_i/q_peak)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
Dimensionless Time (t_i/t_L)
B1H004 Dec 14, 1969
B1H004 Jan 23, 1978
B1H004 Jan 27, 1996
U2H012 Feb 1, 1974
B8H010 Jan 26, 1966
B8H010 Jan 29, 1986
B8H010 Feb 10, 1996
B8H010 Jan 23, 1974

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 1.75 – 2.25
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

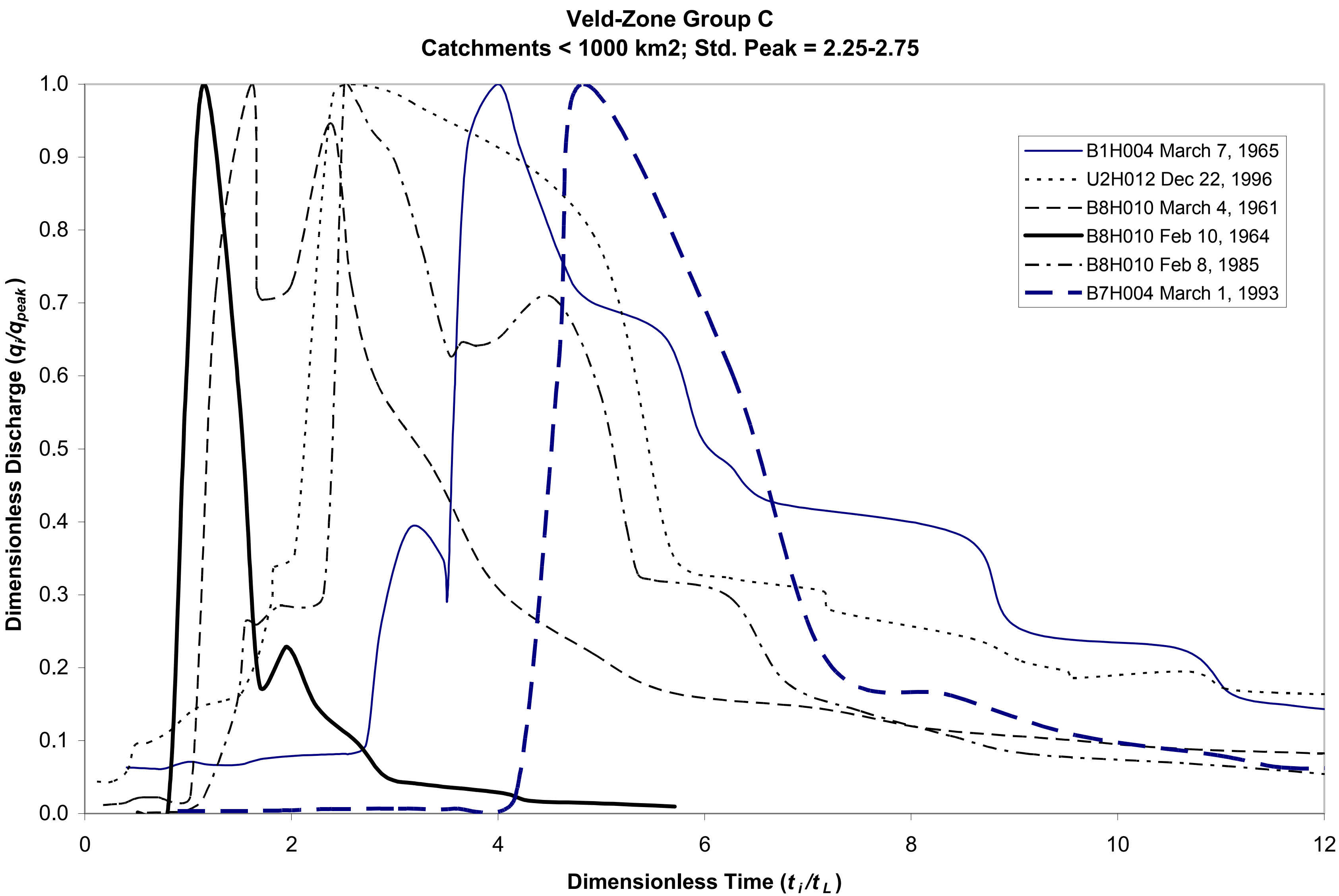
B8H010	January 26, 1966	B8H010	December 29, 1986	B8H010	February 10, 1996	B8H010	January 22, 1974
Peak	259.9	**Peak**	287.6	**Peak**	295.9	**Peak**	308.9
Volume	2.6	**Volume**	6.4	**Volume**	23.2	**Volume**	6.0
Area	477	**Area**	477	**Area**	477	**Area**	477
Basin Lag	4.5	**Basin Lag**	4.5	**Basin Lag**	4.5	**Basin Lag**	4.5
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.089	0.002	0.400	0.004	0.267	0.014	1.222	0.010
0.178	0.002	0.600	0.007	0.667	0.015	1.378	0.010
0.356	0.003	0.822	0.007	0.800	0.050	1.422	0.011
0.511	0.200	0.956	0.011	1.511	0.052	1.556	0.315
0.622	0.788	1.511	0.336	1.622	0.204	2.200	1.000
0.733	1.000	2.044	1.000	1.956	0.206	2.267	0.341
1.044	0.790	2.667	0.337	2.067	0.189	2.689	0.315
1.133	0.217	3.422	0.169	2.378	0.189	2.956	0.205
1.489	0.216	4.444	0.103	2.667	0.199	3.133	0.169
1.844	0.120	5.578	0.066	2.800	0.197	3.400	0.157
2.067	0.068	7.356	0.046	3.111	0.218	3.822	0.138
2.333	0.049	8.511	0.032	3.378	0.329	4.156	0.122
2.933	0.039	8.778	0.026	3.756	0.417	4.622	0.108
3.556	0.027	9.244	0.024	4.289	0.450	5.133	0.096
		9.711	0.024	4.933	0.760	5.822	0.086
		10.356	0.029	5.778	0.440	6.844	0.076
		11.222	0.029	6.622	0.609	8.000	0.065
		12.089	0.021	6.867	1.000		
		13.556	0.016	7.356	0.899		
				7.756	0.540		
				8.444	0.425		
				9.867	0.327		
				10.111	0.214		
				10.511	0.219		
				10.800	0.243		
				11.200	0.328		
				11.400	0.353		
				11.844	0.328		
				12.133	0.263		
				12.356	0.327		
				12.622	0.353		
				13.067	0.327		
				13.244	0.255		
				13.933	0.177		
				14.400	0.221		
				14.844	0.325		
				15.044	0.427		
				15.444	0.324		

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

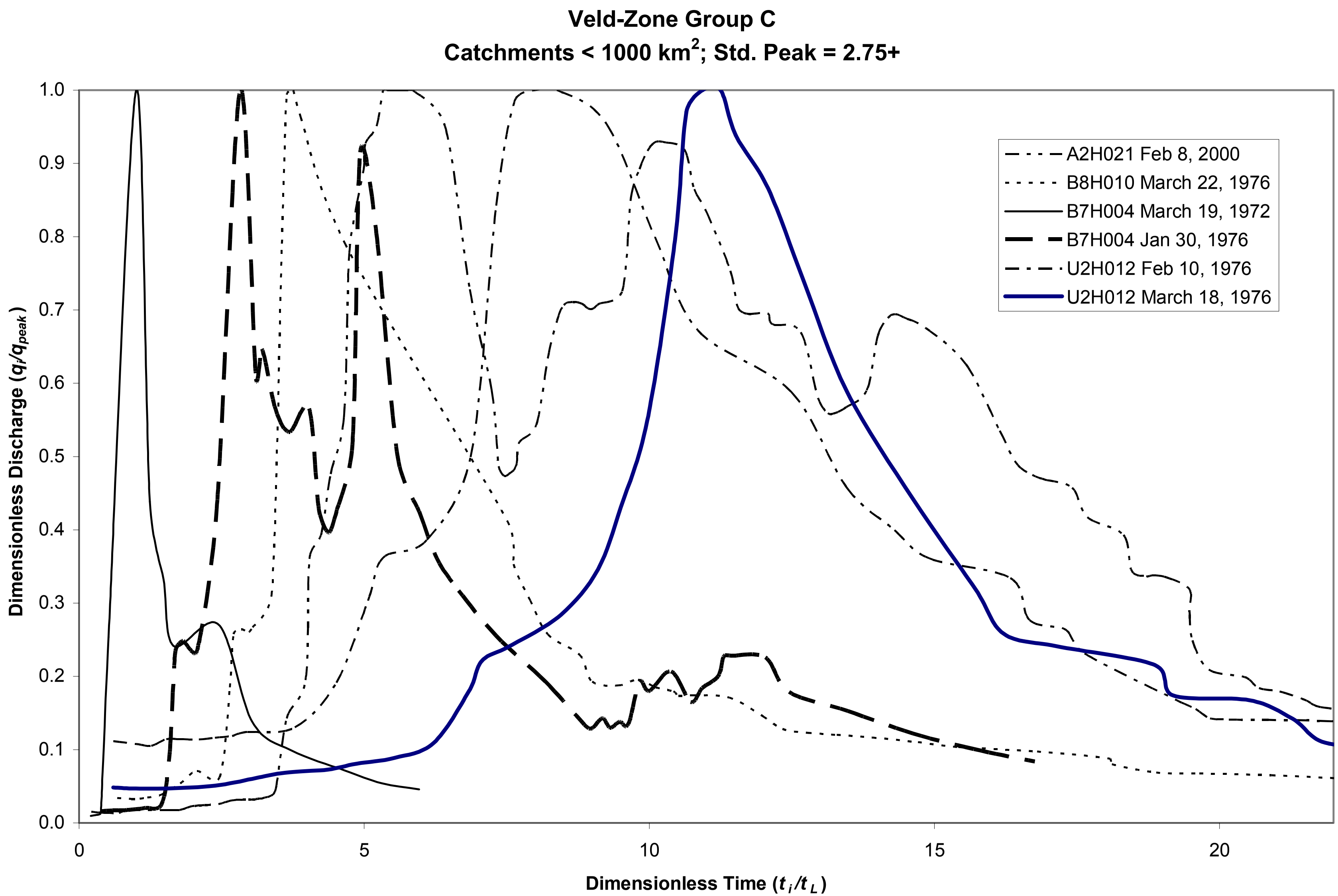
B1H004	**December 14, 1969**	**B1H004**	**January 23, 1978**	**U2H012**	**February 1, 1974**	**B1H004**	**January 27, 1996**
Peak	23.7	**Peak**	24.9	**Peak**	63.5	**Peak**	25.8
Volume	0.8	**Volume**	3.1	**Volume**	13.2	**Volume**	1.6
Area	376	**Area**	376	**Area**	438	**Area**	376
Basin Lag	4.7	**Basin Lag**	4.7	**Basin Lag**	6.0	**Basin Lag**	4.7
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.766	0.066	0.277	0.144	0.117	0.320	0.255	0.128
1.234	0.067	0.447	0.144	0.283	0.358	0.426	0.146
1.638	0.070	0.681	0.140	0.650	0.369	1.128	0.141
1.830	0.079	0.872	0.143	0.833	0.359	1.553	0.153
2.489	0.083	1.106	0.149	1.033	0.358	2.043	0.247
2.745	0.083	1.362	0.155	1.350	0.362	2.404	0.238
3.000	0.079	1.532	0.171	1.567	0.385	2.702	0.417
3.064	0.135	1.723	0.185	1.633	0.413	2.915	0.458
3.213	0.137	1.936	0.202	1.817	0.444	3.213	0.810
3.340	0.653	2.128	0.216	1.917	0.489	3.553	1.000
3.447	0.790	2.277	0.228	2.050	0.512	5.298	0.470
3.745	1.000	2.426	0.252	2.217	0.653	6.660	0.326
4.128	0.704	2.574	0.266	2.633	0.830	8.489	0.257
5.021	0.380	2.638	0.276	2.817	0.991	9.723	0.201
6.106	0.231	2.723	0.303	3.050	1.000	10.255	0.177
6.532	0.159	2.787	0.633	3.500	0.982		
6.979	0.153	2.894	0.745	3.817	0.870		
7.957	0.157	2.936	1.000	3.933	0.789		
8.915	0.136	3.043	0.942	4.283	0.816		
9.681	0.123	3.149	0.902	4.767	0.719		
10.511	0.113	3.298	0.859	5.183	0.616		
10.957	0.111	3.468	0.819	5.750	0.561		
11.702	0.110	3.638	0.790	6.300	0.519		
12.085	0.100	3.787	0.781	6.683	0.510		
13.128	0.097	3.915	0.810	7.017	0.497		
13.404	0.087	3.979	0.839	7.767	0.489		
		4.043	0.890	8.300	0.463		
		4.106	0.923	8.483	0.448		
		4.234	0.942	8.983	0.450		
		4.362	0.923	9.733	0.438		
		4.596	0.885	10.583	0.415		
		4.851	0.835	11.650	0.391		
		5.213	0.778	12.333	0.366		
		5.532	0.733	13.433	0.351		
		5.851	0.676	13.833	0.335		
		6.149	0.626	14.700	0.329		
		6.426	0.582	15.300	0.325		
		6.723	0.540	15.833	0.324		
		7.064	0.497	16.200	0.329		

		7.340	0.465	16.433	0.336		
		7.596	0.435	17.100	0.343		
		7.830	0.406	17.783	0.350		
		8.106	0.381	18.417	0.354		
		8.383	0.362	19.017	0.353		
		8.617	0.347	19.517	0.349		
		8.872	0.332				
		9.085	0.329				
		9.234	0.340				
		9.362	0.353				
		9.447	0.364				
		9.511	0.376				
		9.681	0.392				
		9.936	0.384				
		10.170	0.376				
		10.447	0.373				
		10.745	0.374				
		11.468	0.359				
		12.021	0.326				
		12.596	0.315				
		13.021	0.285				
		13.404	0.263				
		13.723	0.247				
		13.979	0.237				
		14.234	0.226				
		14.447	0.226				
		14.745	0.235				
		14.936	0.236				
		15.277	0.238				
		15.766	0.230				
		16.213	0.214				
		16.681	0.204				
		17.149	0.193				
		17.553	0.187				
		18.170	0.183				
		18.574	0.174				
		19.191	0.167				
		19.872	0.163				
		20.617	0.166				
		21.064	0.158				


Veld-Zone Group C
Catchments < 1000 km2; Std. Peak = 2.25-2.75
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
Dimensionless Time (t_i/t_L)
B1H004 March 7, 1965
U2H012 Dec 22, 1996
B8H010 March 4, 1961
B8H010 Feb 10, 1964
B8H010 Feb 8, 1985
B7H004 March 1, 1993

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 2.25 – 2.75
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

B8H010	March 4, 1961	B8H010	February 9, 1964	B8H010	February 8, 1985	B1H004	March 7, 1975	U2H012	December 22, 1996	B7H004	March 1, 1993
Peak	347.2	Peak	438.1	Peak	333.6	Peak	31.7	Peak	89.4	Peak	241.6
Volume	14.1	Volume	5.0	Volume	17.3	Volume	2.6	Volume	10.5	Volume	4.7
Area	477	Area	477	Area	477	Area	376	Area	438	Area	136
Basin Lag	4.5	Basin Lag	4.5	Basin Lag	4.5	Basin Lag	4.7	Basin Lag	6.0	Basin Lag	2.9
Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak	Time/lag	Flow/Peak
0.178	0.012	0.511	0.002	0.600	0.001	0.404	0.063	0.117	0.044	0.897	0.003
0.333	0.013	0.800	0.002	0.800	0.002	0.660	0.061	0.283	0.044	1.828	0.004
0.400	0.015	0.978	0.582	0.978	0.004	0.766	0.061	0.417	0.060	2.310	0.006
0.511	0.022	1.156	1.000	1.156	0.023	1.000	0.071	0.483	0.094	3.034	0.007
0.644	0.022	1.489	0.581	1.467	0.147	1.213	0.067	0.617	0.097	3.586	0.007
0.711	0.022	1.689	0.178	1.556	0.263	1.489	0.067	0.817	0.113	4.172	0.025
1.022	0.024	1.956	0.229	1.667	0.259	1.702	0.075	1.067	0.143	4.586	0.612
1.267	0.716	2.244	0.147	1.889	0.285	1.979	0.079	1.367	0.155	4.828	1.000
1.622	1.000	2.644	0.096	2.311	0.300	2.255	0.081	1.517	0.165	6.241	0.612
1.667	0.720	2.911	0.051	2.511	1.000	2.511	0.082	1.683	0.218	7.172	0.212
1.711	0.705	3.289	0.040	2.622	0.979	2.553	0.082	1.767	0.266	8.379	0.162
2.000	0.725	4.044	0.028	2.778	0.937	2.723	0.095	1.817	0.298	9.586	0.108
2.378	0.946	4.311	0.017	3.000	0.895	2.872	0.262	1.833	0.338	10.966	0.080
2.578	0.727	4.933	0.014	3.267	0.773	3.149	0.392	2.033	0.357	11.586	0.063
2.822	0.592	5.711	0.010	3.422	0.680	3.468	0.348	2.267	0.792	12.310	0.064
3.378	0.471			3.533	0.628	3.511	0.296	2.400	0.983	12.897	0.070
3.978	0.312			3.622	0.642	3.574	0.559	2.583	1.000	14.897	0.070
4.911	0.220			3.667	0.646	3.702	0.913	3.167	0.975	18.414	0.049
5.667	0.166			3.800	0.642	4.000	1.000	4.917	0.795	21.517	0.033
7.111	0.144			4.000	0.651	4.213	0.913	5.683	0.357	22.724	0.027
8.156	0.117			4.511	0.709	4.426	0.830	6.233	0.323	26.690	0.032
9.400	0.102			4.978	0.581	4.638	0.752	7.150	0.305		
10.689	0.088			5.244	0.392	4.872	0.704	7.217	0.279		
12.667	0.079			5.356	0.328	5.617	0.653	8.583	0.240		
13.422	0.068			5.511	0.320	5.957	0.519	9.067	0.209		
15.644	0.064			6.244	0.297	6.255	0.476	9.517	0.195		
15.867	0.056			6.778	0.181	6.638	0.428	9.567	0.186		
16.111	0.056			7.511	0.141	8.511	0.379	10.700	0.195		
16.667	0.058			8.378	0.107	9.043	0.254	11.033	0.172		
17.200	0.068			9.111	0.082	10.617	0.225	11.517	0.166		
17.333	0.075			10.689	0.068	11.106	0.163	12.733	0.161		
17.467	0.076			12.067	0.054	11.702	0.148	13.700	0.151		
17.711	0.076			12.533	0.045	12.319	0.140	14.617	0.141		
17.867	0.072					12.936	0.131	15.550	0.129		
18.267	0.071					13.617	0.121	16.283	0.119		
18.578	0.070					14.277	0.111	16.417	0.112		
19.800	0.068					15.957	0.108	17.650	0.113		
20.822	0.056					17.021	0.088	18.733	0.104		


Veld-Zone Group C
Catchments < 1000 km²; Std. Peak = 2.75+
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Dimensionless Discharge (q/q_peak)
0
5
10
15
20
Dimensionless Time (t_i/t_L)
A2H021 Feb 8, 2000
B8H010 March 22, 1976
B7H004 March 19, 1972
B7H004 Jan 30, 1976
U2H012 Feb 10, 1976
U2H012 March 18, 1976

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 2.25 +

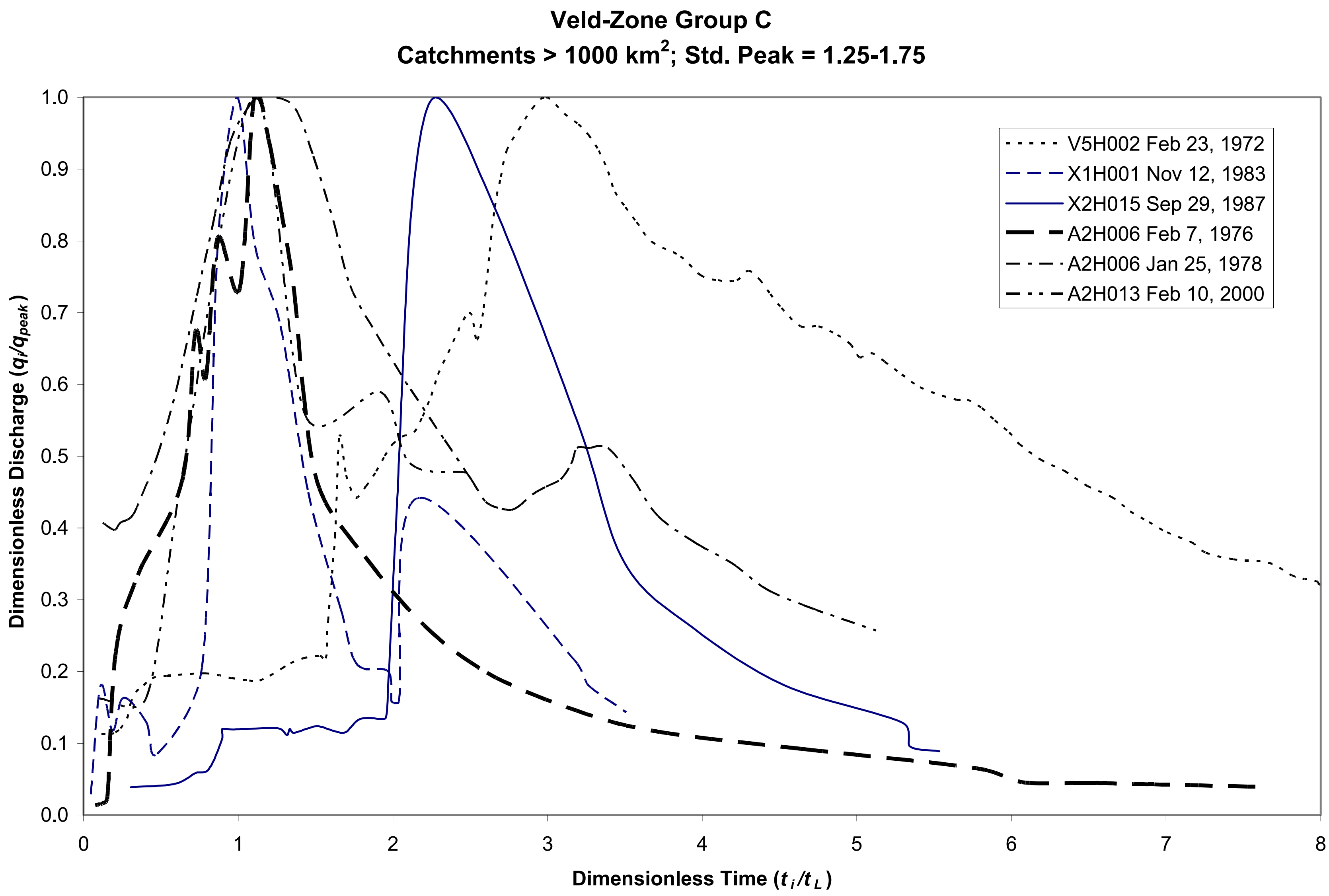
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H012	February 10, 1976	U2H012	March 18, 1976	A2H021	February 8, 2000	B8H010	March 22, 1976	B7H004	March 19, 1972	B7H004	January 30, 1976
Peak	197.6	**Peak**	294.4	**Peak**	430.3	**Peak**	526.2	**Peak**	352.1	**Peak**	336.0
Volume	45.9	**Volume**	57.7	**Volume**	305.4	**Volume**	35.1	**Volume**	3.0	**Volume**	14.7
Area	438	**Area**	438	**Area**	7483	**Area**	477	**Area**	136	**Area**	136
Basin Lag	6.0	**Basin Lag**	6.0	**Basin Lag**	15.9	**Basin Lag**	4.5	**Basin Lag**	2.9	**Basin Lag**	2.9
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.600	0.112	0.600	0.048	0.213	0.015	0.667	0.034	0.207	0.010	0.379	0.016
1.017	0.108	0.933	0.047	0.364	0.014	0.911	0.033	0.310	0.011	0.759	0.017
1.267	0.105	1.567	0.047	0.703	0.014	1.067	0.033	0.379	0.014	0.862	0.018
1.533	0.114	2.383	0.051	0.833	0.017	1.200	0.035	0.517	0.254	1.034	0.019
1.750	0.114	3.033	0.060	1.448	0.017	1.444	0.038	1.000	1.000	1.172	0.021
2.100	0.114	3.433	0.067	1.537	0.017	1.778	0.054	1.241	0.438	1.448	0.025
2.383	0.116	3.800	0.070	1.767	0.018	2.067	0.071	1.483	0.333	1.586	0.094
2.683	0.119	4.367	0.073	1.945	0.022	2.467	0.062	1.655	0.242	1.690	0.235
2.917	0.124	4.867	0.081	2.072	0.024	2.644	0.185	2.448	0.271	1.828	0.248
3.783	0.130	5.533	0.089	2.442	0.026	2.711	0.258	3.034	0.138	2.069	0.234
4.517	0.191	6.217	0.109	2.683	0.031	2.844	0.264	3.724	0.099	2.414	0.428
5.067	0.303	6.833	0.179	2.973	0.032	2.978	0.260	4.655	0.072	2.828	1.000
5.333	0.362	7.067	0.221	3.081	0.032	3.044	0.267	5.310	0.054	3.103	0.606
6.100	0.386	7.550	0.241	3.131	0.033	3.378	0.311	5.966	0.046	3.207	0.647
6.867	0.499	8.450	0.284	3.251	0.035	3.556	0.791			3.448	0.564
7.317	0.842	9.100	0.346	3.437	0.043	3.644	0.994			3.690	0.534
7.633	0.984	9.500	0.431	3.645	0.143	3.756	1.000			4.034	0.565
8.000	1.000	9.967	0.550	3.973	0.195	3.889	0.963			4.207	0.426
8.417	0.999	10.450	0.795	4.043	0.360	4.667	0.790			4.379	0.396
9.250	0.954	10.650	0.970	4.244	0.393	7.511	0.411			4.517	0.425
10.100	0.799	10.933	1.000	4.412	0.476	7.622	0.353			4.793	0.516
10.850	0.673	11.250	1.000	4.644	0.553	7.911	0.303			4.931	0.915
12.483	0.589	11.517	0.939	4.736	0.771	8.222	0.257			5.207	0.812
13.450	0.459	12.083	0.866	4.862	0.841	8.778	0.230			5.586	0.500
14.300	0.399	12.717	0.738	4.991	0.892	9.000	0.193			5.966	0.425
14.900	0.361	13.467	0.588	5.025	0.927	9.467	0.188			6.276	0.361
16.333	0.334	14.633	0.441	5.218	0.951	9.800	0.196			6.655	0.317
16.667	0.277	15.717	0.319	5.333	1.000	10.111	0.185			7.310	0.256
17.300	0.264	16.217	0.258	5.410	1.000	10.422	0.180			8.172	0.193
17.633	0.231	17.133	0.241	5.560	1.000	10.511	0.173			8.724	0.146
19.283	0.166	18.867	0.215	5.770	1.000	10.756	0.174			8.966	0.129
19.583	0.155	19.183	0.174	5.851	1.000	11.400	0.171			9.172	0.143
19.833	0.143	20.533	0.167	6.415	0.951	12.000	0.145			9.310	0.130
20.167	0.141	21.283	0.142	6.855	0.728	12.333	0.128			9.483	0.138
21.750	0.139	21.917	0.108	7.236	0.591	12.778	0.123			9.586	0.131
23.683	0.131	23.483	0.106	7.357	0.487	13.289	0.120			9.655	0.138
25.617	0.123	24.317	0.101	7.447	0.474	13.911	0.117			9.828	0.192
27.317	0.116	24.800	0.099	7.537	0.476	14.711	0.110			10.000	0.180
28.583	0.109	25.300	0.099	7.666	0.488	15.422	0.103			10.379	0.207

29.517	0.104	25.617	0.103	7.720	0.519	16.800	0.097			10.724	0.165
31.183	0.100	26.083	0.104	8.020	0.543	18.067	0.088			10.931	0.184
31.967	0.094	26.833	0.104	8.226	0.637	18.111	0.080			11.207	0.200
32.150	0.085	28.050	0.101	8.383	0.685	18.889	0.069			11.310	0.227
32.500	0.079	29.417	0.095	8.501	0.707	19.644	0.068			11.448	0.228
34.200	0.074	30.417	0.090	8.658	0.711	20.911	0.065			12.034	0.226
		30.900	0.088	8.813	0.709	22.156	0.061			12.448	0.179
		31.517	0.087	8.926	0.702	23.467	0.057			13.483	0.153
		32.183	0.085	9.021	0.702	26.089	0.053			14.621	0.122
		33.383	0.085	9.128	0.709	27.289	0.047			15.828	0.099
		34.267	0.083	9.527	0.726	27.867	0.045			16.759	0.084
		34.450	0.082	9.681	0.854	28.733	0.044				
		35.250	0.081	9.827	0.892	29.222	0.045				
		36.233	0.079	9.970	0.917	29.667	0.047				
		36.583	0.076	10.104	0.929	30.044	0.047				
		37.217	0.076	10.254	0.929	30.800	0.046				
		37.367	0.076	10.615	0.918	31.378	0.043				
		37.667	0.075	10.787	0.865	32.244	0.042				
		37.867	0.075	10.988	0.836	33.156	0.040				
		38.583	0.075	11.423	0.753	34.111	0.039				
		39.417	0.075	11.546	0.705	35.467	0.038				
		41.033	0.075	11.702	0.695	36.778	0.037				
		41.883	0.075	12.073	0.695	38.111	0.035				
		42.433	0.072	12.158	0.681	39.489	0.034				
		42.767	0.071	12.656	0.669	40.844	0.034				
		43.483	0.070	12.963	0.579	41.778	0.032				
		44.450	0.067	13.128	0.559	42.444	0.031				
		44.883	0.064	13.270	0.560						
		45.300	0.064	13.456	0.567						
		47.067	0.062	13.814	0.590						
		48.633	0.058	14.008	0.665						
		50.300	0.055	14.182	0.689						
				14.311	0.694						
				14.487	0.689						
				14.847	0.675						
				15.548	0.626						
				16.145	0.535						
				16.434	0.491						
				16.716	0.475						
				16.928	0.469						
				17.414	0.457						
				17.679	0.417						
				18.314	0.393						
				18.458	0.344						
				18.717	0.337						
				18.833	0.338						
				19.068	0.335						

				19.470	0.319				
				19.476	0.288				
				19.527	0.249				
				19.813	0.209				
				20.437	0.199				
				20.690	0.184				
				21.053	0.180				
				21.492	0.168				
				21.722	0.159				
				22.260	0.153				
				22.699	0.143				
				23.114	0.135				
				23.210	0.123				
				23.360	0.122				
				23.616	0.123				
				23.889	0.122				
				24.111	0.118				
				24.328	0.111				
				24.613	0.110				
				24.784	0.110				
				25.284	0.109				
				25.568	0.101				
				25.882	0.095				
				26.586	0.092				
				26.773	0.091				
				27.224	0.088				
				27.518	0.082				
				27.697	0.081				
				27.954	0.079				
				28.247	0.075				
				28.646	0.073				
				28.740	0.066				
				29.338	0.060				
				29.606	0.055				
				30.029	0.054				
				30.132	0.051				
				30.619	0.051				
				30.986	0.048				
				31.323	0.045				

Appendix F6 (b)



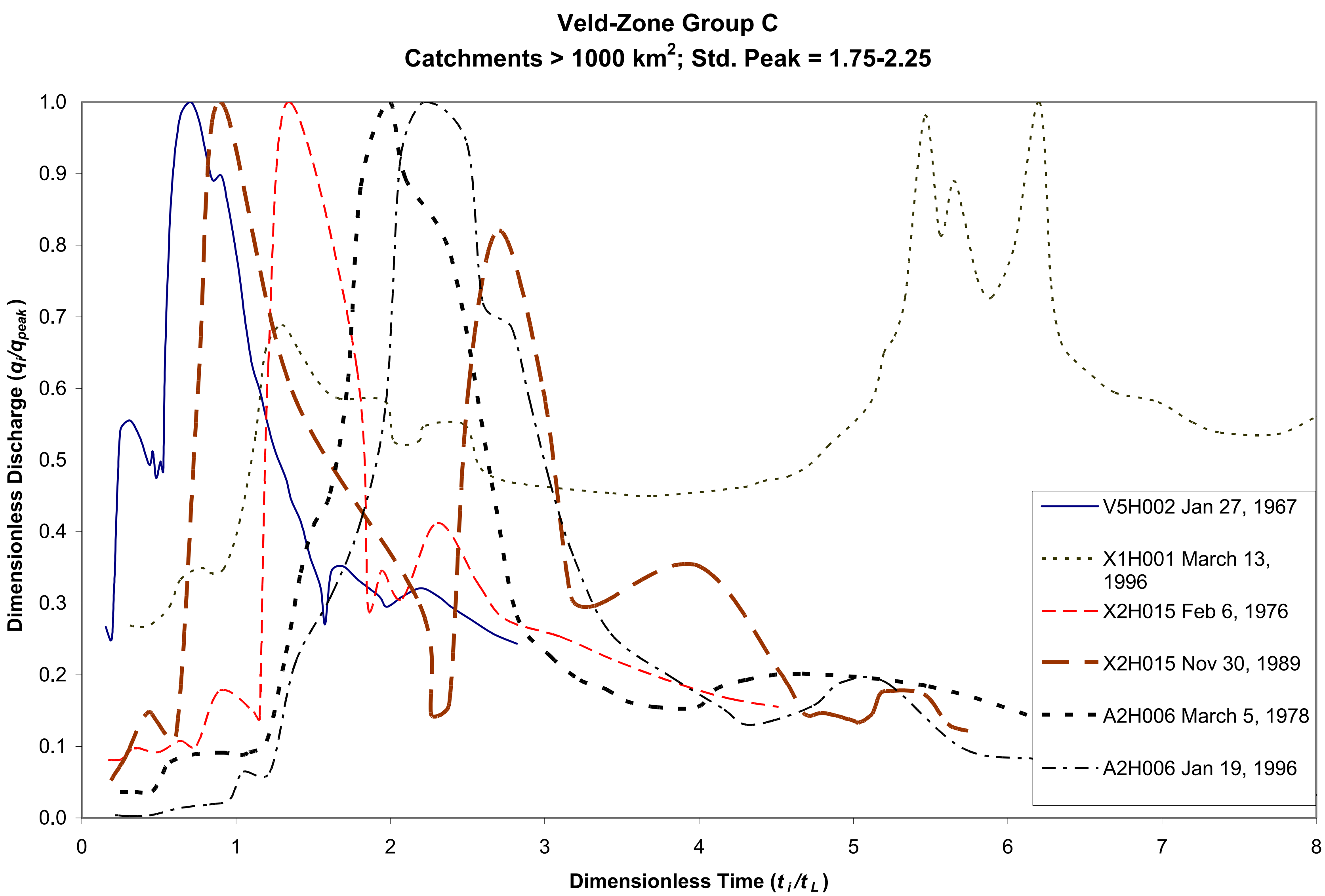
Standardised Hydrographs: Veld-Zone Group C; Area > 1000 km^2; Std. Peak 1.25 – 1.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

X2H015	September 27, 1987	A2H006	February 7, 1976	A2H006	January 25, 1978	A2H013	February 9, 2000	V5H002	February 23, 1972	X1H001	November 12, 1983
Peak	185.0	**Peak**	85.4	**Peak**	57.2	**Peak**	152.5	**Peak**	2461.0	**Peak**	345.9
Volume	9.5	**Volume**	4.6	**Volume**	5.8	**Volume**	6.0	**Volume**	799.4	**Volume**	12.2
Area	1554	**Area**	1028	**Area**	1028	**Area**	1171	**Area**	28920	**Area**	5499
Basin Lag	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	8.1	**Basin Lag**	18.0	**Basin Lag**	12.8
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.305	0.039	0.076	0.014	0.124	0.407	0.103	0.163	0.117	0.113	0.047	0.029
0.590	0.044	0.105	0.015	0.200	0.397	0.407	0.164	0.172	0.113	0.109	0.180
0.724	0.058	0.152	0.022	0.238	0.407	0.638	0.475	0.205	0.115	0.188	0.117
0.810	0.064	0.210	0.228	0.314	0.417	1.103	1.000	0.239	0.121	0.258	0.164
0.895	0.105	0.352	0.334	0.381	0.447	1.434	0.557	0.283	0.136	0.406	0.129
0.897	0.120	0.638	0.467	0.476	0.500	1.918	0.590	0.305	0.156	0.477	0.085
0.962	0.119	0.724	0.673	0.600	0.593	2.109	0.490	0.339	0.171	0.766	0.206
1.257	0.121	0.790	0.609	0.733	0.724	2.481	0.477	0.389	0.181	0.867	0.789
1.314	0.111	0.867	0.804	0.838	0.825			0.444	0.191	0.992	1.000
1.333	0.120	1.010	0.734	0.943	0.934			0.539	0.194	1.109	0.794
1.362	0.114	1.105	1.000	1.057	0.983			0.788	0.198	1.273	0.681
1.505	0.124	1.200	0.938	1.133	1.000			0.955	0.191	1.453	0.450
1.619	0.117	1.267	0.857	1.248	1.000			1.072	0.187	1.664	0.287
1.695	0.116	1.362	0.730	1.371	0.983			1.138	0.187	1.766	0.210
1.790	0.134	1.419	0.596	1.486	0.918			1.205	0.194	1.969	0.200
1.952	0.135	1.524	0.456	1.619	0.825			1.283	0.204	1.992	0.158
1.962	0.148	1.819	0.360	1.724	0.738			1.338	0.211	2.039	0.158
2.029	0.441	2.200	0.265	1.895	0.670			1.421	0.218	2.164	0.442
2.124	0.851	2.610	0.198	2.114	0.593			1.527	0.222	3.172	0.217
2.276	1.000	3.124	0.150	2.333	0.523			1.566	0.218	3.258	0.182
2.648	0.851	3.676	0.118	2.505	0.468			1.582	0.271	3.508	0.143
3.200	0.544	4.638	0.092	2.600	0.437			1.627	0.389		
3.495	0.352	5.771	0.065	2.705	0.427			1.655	0.528		
3.943	0.261	6.067	0.046	2.790	0.427			1.699	0.474		
4.533	0.181	6.505	0.045	2.905	0.447			1.760	0.443		
5.295	0.129	6.848	0.043	2.990	0.457			1.827	0.458		
5.343	0.096	7.629	0.039	3.086	0.468			1.893	0.479		
5.533	0.089			3.152	0.489			1.949	0.500		
				3.190	0.511			1.999	0.517		
				3.267	0.511			2.065	0.528		
				3.390	0.511			2.138	0.533		
				3.552	0.468			2.193	0.556		
				3.714	0.417			2.249	0.584		
				3.962	0.378			2.293	0.614		
				4.190	0.351			2.360	0.644		
				4.419	0.314			2.493	0.700		
				4.695	0.289			2.543	0.662		
				5.124	0.257			2.587	0.706		
								2.626	0.785		

								2.659	0.847		
								2.698	0.889		
								2.737	0.926		
								2.815	0.955		
								2.904	0.985		
								2.993	1.000		
								3.109	0.977		
								3.198	0.962		
								3.265	0.948		
								3.331	0.926		
								3.392	0.896		
								3.437	0.868		
								3.503	0.847		
								3.576	0.826		
								3.675	0.799		
								3.859	0.778		
								3.992	0.752		
								4.103	0.745		
								4.225	0.745		
								4.297	0.758		
								4.375	0.745		
								4.442	0.726		
								4.514	0.706		
								4.636	0.681		
								4.753	0.681		
								4.875	0.669		
								4.958	0.656		
								5.019	0.638		
								5.091	0.644		
								5.180	0.632		
								5.291	0.614		
								5.408	0.596		
								5.552	0.584		
								5.646	0.579		
								5.713	0.579		
								5.807	0.567		
								5.891	0.550		
								5.985	0.533		
								6.052	0.517		
								6.191	0.495		
								6.346	0.479		
								6.490	0.458		
								6.651	0.443		
								6.768	0.423		
								6.890	0.408		
								7.007	0.394		
								7.168	0.379		

								7.257	0.366		
								7.434	0.356		
								7.662	0.352		
								7.812	0.334		
								7.884	0.330		
								7.978	0.325		
								8.001	0.321		
								8.668	0.321		
								8.689	0.321		
								8.783	0.317		
								8.905	0.304		
								9.022	0.296		
								9.139	0.296		
								9.250	0.291		
								9.394	0.283		
								9.461	0.279		
								9.538	0.275		
								9.605	0.283		
								9.699	0.287		
								9.766	0.287		
								9.838	0.279		
								9.922	0.267		
								10.010	0.259		
								10.127	0.252		
								10.255	0.244		
								10.360	0.237		
								10.493	0.233		
								10.793	0.226		
								11.015	0.208		
								11.126	0.201		
								11.243	0.201		
								11.371	0.201		
								11.487	0.201		
								11.604	0.194		
								11.731	0.191		
								11.854	0.181		
								12.009	0.178		
								12.120	0.171		
								12.248	0.165		

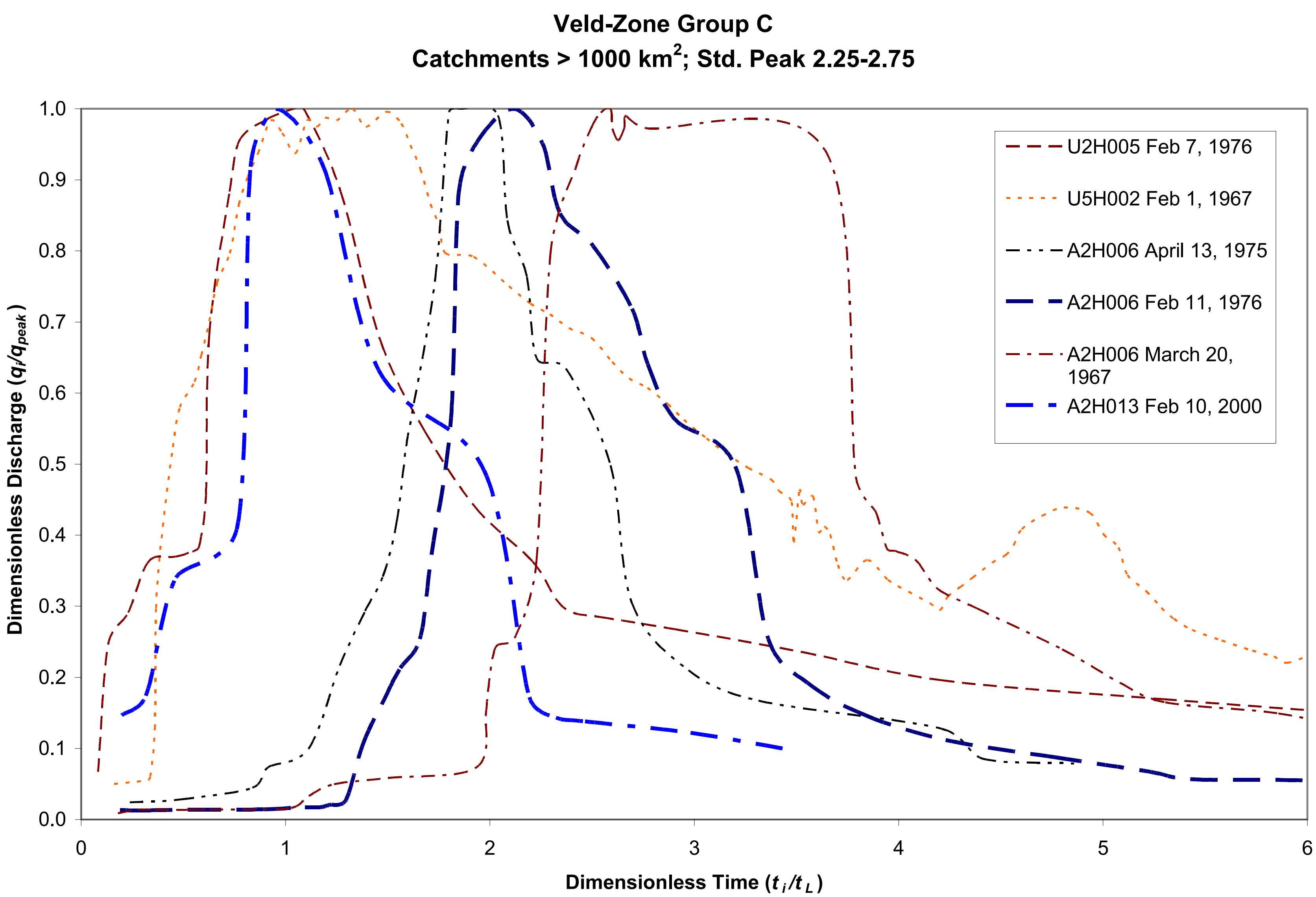

Veld-Zone Group C
Catchments > 1000 km²; Std. Peak = 1.75-2.25
Dimensionless Discharge (q_i/q_{peak})
Dimensionless Time (t_i/t_L)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
V5H002 Jan 27, 1967
X1H001 March 13, 1996
X2H015 Feb 6, 1976
X2H015 Nov 30, 1989
A2H006 March 5, 1978
A2H006 Jan 19, 1996

Standardised Hydrographs: Veld-Zone Group C; Area < 1000 km^2; Std. Peak 1.75 – 2.25

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

V5H002	February 7, 1967	X1H001	March 13, 1996	X2H015	February 6, 1976	X2H015	November 30, 1989	A2H006	March 5, 1978	A2H006	January 19, 1996
Peak	3243.3	**Peak**	404.0	**Peak**	236.2	**Peak**	251.8	**Peak**	132.8	**Peak**	116.0
Volume	268.8	**Volume**	114.0	**Volume**	10.2	**Volume**	7.0	**Volume**	12.1	**Volume**	8.6
Area	28920	**Area**	5499	**Area**	1554	**Area**	1554	**Area**	1028	**Area**	1028
Basin Lag	18.0	**Basin Lag**	12.8	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.155	0.267	0.313	0.269	0.171	0.081	0.190	0.052	0.248	0.036	0.219	0.003
0.194	0.250	0.375	0.266	0.257	0.082	0.286	0.086	0.343	0.036	0.305	0.003
0.211	0.325	0.453	0.271	0.343	0.098	0.438	0.148	0.457	0.037	0.438	0.004
0.250	0.541	0.570	0.295	0.495	0.092	0.610	0.113	0.524	0.062	0.648	0.014
0.311	0.556	0.641	0.333	0.638	0.108	0.752	0.597	0.571	0.078	0.829	0.019
0.378	0.531	0.773	0.349	0.743	0.101	0.895	1.000	0.714	0.089	0.962	0.026
0.439	0.493	0.828	0.342	0.895	0.178	1.362	0.597	0.905	0.091	1.048	0.065
0.461	0.512	0.922	0.348	1.114	0.149	2.190	0.298	1.029	0.088	1.219	0.063
0.483	0.475	1.022	0.413	1.152	0.138	2.267	0.143	1.086	0.091	1.381	0.214
0.511	0.498	1.128	0.535	1.210	0.632	2.381	0.159	1.200	0.107	1.619	0.311
0.527	0.484	1.190	0.652	1.343	1.000	2.505	0.597	1.324	0.230	1.810	0.416
0.539	0.632	1.296	0.689	1.781	0.631	2.705	0.821	1.419	0.343	1.971	0.580
0.561	0.776	1.409	0.652	1.857	0.293	2.990	0.598	1.505	0.409	2.067	0.924
0.589	0.891	1.530	0.610	1.943	0.345	3.171	0.309	1.610	0.453	2.219	1.000
0.638	0.980	1.663	0.586	2.076	0.306	3.324	0.297	1.724	0.609	2.495	0.943
0.705	1.000	1.964	0.582	2.305	0.412	3.990	0.352	1.810	0.883	2.600	0.720
0.761	0.974	2.025	0.526	2.571	0.326	4.533	0.200	1.990	1.000	2.781	0.687
0.805	0.929	2.184	0.526	2.743	0.278	4.676	0.146	2.095	0.894	2.905	0.581
0.849	0.891	2.227	0.548	3.095	0.254	4.810	0.146	2.390	0.785	3.029	0.473
0.905	0.897	2.482	0.549	3.476	0.218	4.981	0.137	2.657	0.468	3.190	0.362
0.949	0.854	2.585	0.488	3.876	0.187	5.038	0.133	2.819	0.283	3.429	0.257
0.988	0.806	2.786	0.469	4.200	0.167	5.124	0.146	3.038	0.225	3.819	0.197
1.022	0.759	3.440	0.453	4.514	0.155	5.171	0.173	3.229	0.193	4.162	0.152
1.060	0.691	3.703	0.450			5.219	0.178	3.400	0.180	4.276	0.132
1.105	0.632	4.288	0.462			5.457	0.173	3.524	0.163	4.438	0.133
1.155	0.596	4.415	0.471			5.610	0.131	3.714	0.155	4.743	0.157
1.205	0.551	4.578	0.477			5.743	0.121	3.990	0.155	4.924	0.189
1.255	0.512	4.715	0.493					4.105	0.180	5.210	0.189
1.321	0.475	4.839	0.520					4.305	0.193	5.714	0.096
1.360	0.443	5.111	0.580					4.667	0.202	6.219	0.081
1.421	0.413	5.198	0.649					5.486	0.184	6.724	0.055
1.477	0.368	5.268	0.673					6.248	0.135	7.105	0.040
1.549	0.321	5.336	0.727					6.400	0.116	7.514	0.038
1.577	0.270	5.465	0.980					7.190	0.115	7.781	0.033
1.616	0.344	5.563	0.814					7.629	0.115	8.267	0.031
1.693	0.352	5.645	0.890					8.343	0.107	8.990	0.031
1.793	0.332	5.710	0.846					8.657	0.088		
1.927	0.310	5.802	0.754					8.819	0.084		
1.977	0.295	5.895	0.727					8.895	0.084		

2.082	0.310	6.044	0.801					9.000	0.090		
2.199	0.321	6.204	1.000					9.105	0.089		
2.310	0.310	6.283	0.744					9.238	0.082		
2.393	0.295	6.344	0.666					9.371	0.076		
2.521	0.277	6.430	0.640					9.524	0.078		
2.671	0.257	6.548	0.617					9.857	0.083		
2.820	0.243	6.694	0.594					10.219	0.082		
		6.974	0.581					10.362	0.076		
		7.198	0.552					10.810	0.078		
		7.376	0.539					11.343	0.071		
		7.745	0.536					11.867	0.064		
		8.004	0.560					12.390	0.060		
		8.202	0.573					13.400	0.055		
		8.447	0.572					14.019	0.050		
		8.707	0.557					14.676	0.048		
		9.199	0.534					15.210	0.046		
		9.651	0.469								
		10.135	0.409								
		10.572	0.372								
		11.147	0.354								
		12.016	0.329								
		12.409	0.277								

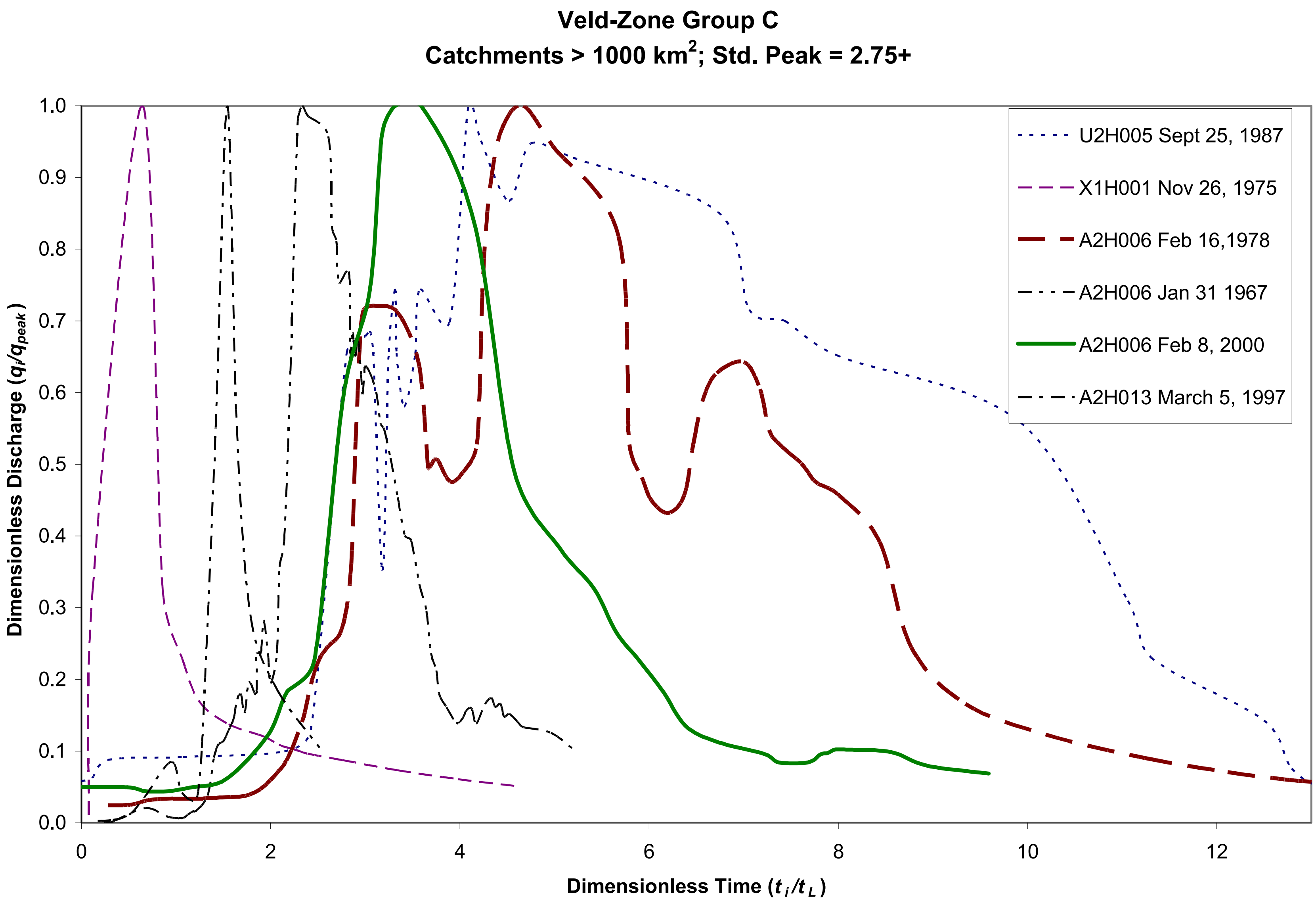

Veld-Zone Group C
Catchments > 1000 km²; Std. Peak 2.25-2.75
Dimensionless Discharge (qi/qpeak)
Dimensionless Time (ti/tL)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6
U2H005 Feb 7, 1976
U5H002 Feb 1, 1967
A2H006 April 13, 1975
A2H006 Feb 11, 1976
A2H006 March 20, 1967
A2H013 Feb 10, 2000

Standardised Hydrographs: Veld-Zone Group C; Area > 1000 km^2; Std. Peak 2.25 – 2.75

[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H005	February 7, 1976	V5H002	February 1, 1967	A2H006	April 13, 1975	A2H006	February 11, 1976	A2H006	March 20, 1967	A2H013	February 10, 2000
Peak	564.6	**Peak**	4178.9	**Peak**	150.5	**Peak**	207.5	**Peak**	157.3	**Peak**	417.9
Volume	24.8	**Volume**	891.0	**Volume**	7.1	**Volume**	12.3	**Volume**	12.4	**Volume**	14.3
Area	2519	**Area**	28920	**Area**	1028	**Area**	1028	**Area**	1028	**Area**	1171
Basin Lag	6.1	**Basin Lag**	18.0	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	8.1
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.082	0.067	0.161	0.050	0.238	0.024	0.190	0.013	0.181	0.009	0.198	0.146
0.132	0.246	0.328	0.055	0.486	0.028	0.314	0.013	0.276	0.014	0.317	0.174
0.231	0.291	0.339	0.061	0.838	0.044	0.552	0.014	0.362	0.014	0.465	0.340
0.330	0.363	0.361	0.129	0.914	0.073	0.895	0.014	0.476	0.014	0.765	0.413
0.462	0.370	0.366	0.298	1.114	0.100	1.095	0.017	0.543	0.014	0.829	0.918
0.544	0.377	0.400	0.412	1.267	0.216	1.171	0.017	0.629	0.014	0.953	1.000
0.577	0.384	0.450	0.524	1.390	0.293	1.219	0.021	0.790	0.014	1.187	0.917
0.610	0.455	0.483	0.580	1.476	0.342	1.295	0.027	1.029	0.016	1.455	0.632
0.627	0.682	0.555	0.616	1.543	0.418	1.381	0.107	1.114	0.033	1.971	0.491
0.726	0.884	0.589	0.653	1.590	0.525	1.495	0.176	1.238	0.050	2.193	0.172
0.775	0.955	0.627	0.701	1.629	0.586	1.562	0.213	1.505	0.058	2.323	0.143
0.907	0.985	0.666	0.756	1.733	0.762	1.657	0.254	1.933	0.073	2.465	0.138
1.039	1.000	0.727	0.797	1.800	0.995	1.714	0.372	1.981	0.150	2.981	0.122
1.089	1.000	0.772	0.866	1.857	1.000	1.810	0.565	1.990	0.180	3.467	0.098
1.270	0.884	0.816	0.904	2.038	0.991	1.848	0.882	2.029	0.243		
1.468	0.671	0.866	0.938	2.086	0.843	1.943	0.956	2.124	0.256		
1.682	0.545	0.927	0.983	2.181	0.763	2.114	1.000	2.229	0.364		
1.930	0.439	0.983	0.966	2.229	0.649	2.257	0.951	2.295	0.794		
2.210	0.363	1.049	0.938	2.371	0.635	2.343	0.853	2.419	0.916		
2.325	0.309	1.105	0.983	2.590	0.498	2.505	0.807	2.495	0.972		
2.408	0.291	1.155	0.975	2.695	0.304	2.695	0.719	2.543	0.995		
2.540	0.285	1.194	0.987	2.971	0.210	2.771	0.641	2.590	1.000		
2.903	0.268	1.249	0.983	3.314	0.167	2.905	0.563	2.600	0.972		
3.529	0.236	1.327	1.000	4.210	0.128	3.200	0.497	2.629	0.956		
4.206	0.196	1.394	0.975	4.410	0.086	3.362	0.254	2.657	0.973		
5.294	0.169	1.494	0.996	4.857	0.079	3.552	0.192	2.667	0.990		
6.614	0.141	1.566	0.979			3.838	0.147	2.762	0.973		
7.587	0.119	1.610	0.949			4.229	0.112	3.638	0.942		
8.362	0.108	1.660	0.915			4.762	0.088	3.790	0.482		
8.576	0.101	1.710	0.866			5.219	0.067	3.886	0.434		
9.219	0.101	1.754	0.834			5.429	0.057	3.943	0.381		
10.011	0.094	1.782	0.797			6.019	0.055	3.981	0.378		
10.836	0.091	1.921	0.792			6.571	0.044	4.086	0.364		
12.089	0.087	2.093	0.751			7.238	0.039	4.190	0.324		
		2.199	0.726			7.952	0.033	4.381	0.297		
		2.293	0.711			8.267	0.029	4.800	0.239		
		2.387	0.691			9.162	0.029	5.086	0.192		
		2.498	0.677			9.533	0.025	5.305	0.165		
		2.598	0.644			10.010	0.025	5.857	0.149		

		2.682	0.621			10.771	0.023	6.410	0.117		
		2.770	0.607			11.152	0.021	6.790	0.095		
		2.870	0.584			11.695	0.020	7.371	0.082		
		2.948	0.562					7.733	0.067		
		3.059	0.536					7.943	0.059		
		3.154	0.515					8.505	0.055		
		3.265	0.495					8.971	0.049		
		3.376	0.478					9.410	0.045		
		3.415	0.462								
		3.476	0.447								
		3.487	0.390								
		3.514	0.462								
		3.531	0.443								
		3.581	0.454								
		3.609	0.405								
		3.637	0.412								
		3.664	0.401								
		3.703	0.358								
		3.748	0.337								
		3.848	0.365								
		3.948	0.337								
		4.047	0.321								
		4.153	0.304								
		4.203	0.295								
		4.242	0.314								
		4.303	0.327								
		4.364	0.341								
		4.458	0.361								
		4.525	0.372								
		4.564	0.386								
		4.603	0.409								
		4.703	0.427								
		4.808	0.439								
		4.936	0.431								
		5.002	0.401								
		5.075	0.383								
		5.119	0.344								
		5.213	0.321								
		5.286	0.298								
		5.347	0.282								
		5.435	0.267								
		5.580	0.252								
		5.730	0.238								


Veld-Zone Group C
Catchments > 1000 km²; Std. Peak = 2.75+
Dimensionless Discharge (q_i/q_{peak})
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
Dimensionless Time (t_i/t_L)
U2H005 Sept 25, 1987
X1H001 Nov 26, 1975
A2H006 Feb 16,1978
A2H006 Jan 31 1967
A2H006 Feb 8, 2000
A2H013 March 5, 1997

Standardised Hydrographs: Veld-Zone Group C; Area > 1000 km^2; Std. Peak 2.25 +
[Peak - m^3/s, Volume - Mm^3, Area - km^2, Basin Lag - hr]

U2H005	September 25, 1987	X1H001	November 26, 1975	A2H006	February 16, 1978	A2H006	January 31, 1967	A2H006	February 8, 2000	A2H013	March 5, 1997
Peak	3927.0	**Peak**	849.0	**Peak**	222.2	**Peak**	242.8	**Peak**	295.1	**Peak**	698.5
Volume	689.3	**Volume**	16.9	**Volume**	33.4	**Volume**	12.8	**Volume**	29.7	**Volume**	8.7
Area	2519	**Area**	5499	**Area**	1028	**Area**	1028	**Area**	1028	**Area**	1171
Basin Lag	6.1	**Basin Lag**	12.8	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	10.5	**Basin Lag**	8.1
Time/lag	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**	**Time/lag**	**Flow/Peak**
0.000	0.058	0.078	0.011	0.286	H-V/P-V	0.238	0.001	0.000	0.050	0.173	0.003
0.115	0.063	0.079	0.011	0.486	0.024	0.324	0.001	0.486	0.050	0.333	0.004
0.280	0.088	0.117	0.324	0.600	0.025	0.676	0.020	0.670	0.044	0.506	0.011
1.072	0.092	0.641	1.000	0.724	0.028	0.895	0.009	0.833	0.044	0.667	0.036
2.144	0.100	0.859	0.324	0.971	0.032	1.010	0.007	0.968	0.045	0.951	0.085
2.424	0.130	1.070	0.227	1.257	0.034	1.076	0.007	1.149	0.049	1.062	0.042
2.804	0.656	1.242	0.170	1.457	0.034	1.124	0.011	1.532	0.061	1.222	0.035
3.002	0.679	1.555	0.137	1.686	0.035	1.181	0.016	1.976	0.123	1.272	0.104
3.051	0.685	1.906	0.121	1.800	0.037	1.210	0.016	2.173	0.183	1.420	0.551
3.084	0.656	2.086	0.109	1.924	0.041	1.333	0.038	2.460	0.226	1.543	1.000
3.183	0.352	2.242	0.103	2.067	0.050	1.400	0.091	2.770	0.594	1.642	0.551
3.249	0.656	2.391	0.097	2.181	0.069	1.448	0.109	3.048	0.743	1.790	0.285
3.315	0.744	2.758	0.087	2.333	0.090	1.505	0.114	3.178	0.960	2.074	0.184
3.332	0.656	3.336	0.073	2.429	0.140	1.571	0.133	3.319	1.000	2.519	0.105
3.414	0.581	3.977	0.061	2.514	0.194	1.610	0.145	3.611	0.996		
3.529	0.654	4.641	0.051	2.600	0.228	1.648	0.172	4.151	0.837		
3.579	0.744			2.752	0.245	1.686	0.180	4.576	0.490		
3.892	0.699			2.848	0.271	1.724	0.153	5.059	0.383		
4.090	1.000			2.895	0.354	1.771	0.196	5.414	0.327		
4.222	0.951			2.952	0.521	1.848	0.180	5.651	0.266		
4.519	0.868			2.990	0.693	1.849	0.236	5.897	0.226		
4.750	0.947			3.124	0.716	1.895	0.236	6.157	0.182		
5.195	0.928			3.343	0.721	1.924	0.282	6.381	0.135		
6.729	0.852			3.562	0.711	1.971	0.236	6.706	0.114		
7.059	0.716			3.648	0.643	2.000	0.194	7.229	0.096		
7.438	0.699			3.667	0.527	2.067	0.236	7.367	0.084		
7.983	0.652			3.752	0.494	2.095	0.357	7.681	0.084		
9.929	0.558			3.857	0.507	2.143	0.392	7.813	0.096		
11.061	0.310			3.924	0.482	2.210	0.630	7.886	0.097		
11.309	0.230			4.029	0.475	2.286	0.978	7.962	0.102		
12.496	0.143			4.181	0.488	2.333	1.000	8.110	0.102		
12.793	0.076			4.248	0.527	2.390	0.986	8.559	0.099		
13.172	0.049			4.324	0.766	2.610	0.957	8.943	0.080		
14.013	0.049			4.448	0.891	2.648	0.831	9.590	0.069		
14.558	0.040			4.667	0.969	2.695	0.811				
15.333	0.020			4.981	1.000	2.724	0.753				
				5.676	0.944	2.829	0.769				
				5.790	0.818	2.838	0.650				
				5.924	0.527	2.867	0.684				
				6.019	0.482	2.895	0.651				

				6.200	0.450	2.924	0.675				
				6.371	0.432	2.952	0.630				
				6.467	0.456	2.971	0.598				
				6.571	0.527	2.990	0.630				
				6.714	0.590	3.000	0.637				
				7.000	0.627	3.038	0.630				
				7.171	0.643	3.114	0.601				
				7.267	0.605	3.162	0.557				
				7.381	0.548	3.200	0.548				
				7.610	0.527	3.267	0.509				
				7.762	0.501	3.343	0.454				
				8.010	0.475	3.419	0.401				
				8.438	0.456	3.486	0.393				
				8.771	0.392	3.571	0.333				
				9.343	0.245	3.648	0.295				
				10.190	0.166	3.695	0.236				
				11.238	0.123	3.752	0.212				
				12.114	0.090	3.781	0.180				
				12.714	0.071	3.857	0.161				
				13.057	0.061	3.962	0.140				
					0.056	4.029	0.145				
						4.067	0.156				
						4.124	0.159				
						4.171	0.138				
						4.267	0.165				
						4.333	0.174				
						4.371	0.161				
						4.429	0.166				
						4.467	0.148				
						4.514	0.152				
						4.562	0.148				
						4.648	0.135				
						4.686	0.133				
						4.962	0.125				
						5.219	0.101				