RIVER DISCHARGES DERIVED FROM SINGLE VELOCITY MEASUREMENTS

By

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DECLARATION

Hereby I, GC Cloete, declare that this thesis is my own original work and that all sources have been accurately reported and acknowledged. This document has not previously in its entirety or in part been submitted to any educational institution in order to obtain an academic qualification.

GC Cloete

SYNOPSIS

This work investigates methods to theoretically determine the lateral velocity distribution across a river from which factors may be derived to translate a single point velocity into average velocity for the river as a whole.

A wide range of field data from various rivers was analysed. This produced over a hundred velocity distributions with which to compare theoretical distribution results. Four theoretical approaches were considered: the one-dimensional method (Manning's equation), a two-dimensional flow formula solved as an initial-value-problem, a two dimensional flow formula solved as a boundary-value-problem and an empirical method developed from energy principles.

The one-dimensional and initial-value-problem approaches were unsuccessful. The boundary-value and empirical approach did however produce promising results. Surprisingly the analysis of the field data revealed patterns of similarity which could produce accurate results without the need of a theoretical approach.

SINOPSIS

Metodes word ondersoek om teoreties 'n laterale snelheidsverspreiding oor 'n rivier te bepaal en sodoende 'n faktor te vind waarmee 'n gemete enkelpuntsnelheid in die rivier omgeskakel kan word na 'n gemiddelde snelheid vir die rivier in geheel.

Vloeimeetdata van verskeie riviere is geanaliseer. Sodoende is meer as 100 snelheidsverspreidings gegenereer waarmee die teorie vergelyk kon word. Vier teoretiese benaderings is gevolg: Manning se een-dimensionele vloeivergelyking, 'n twee dimensionele vloei-vergelyking opgelos met behulp van 'n beginwaarde, 'n twee dimensionele vloei-vergelyking opgelos met behulp van randwaardes, en 'n empiriese metode ontwikkel vanuit energie beginsels.

Die een-dimensionele- en beginwaarde-benaderings was nie suksesvol nie. Die randwaarde- en empiriese benaderings het wel belowende resultate gelewer. Selfs verwerking van die gemete stroommetings het waardevolle inligting gelewer: daar bestaan duidelike ooreenkomste in die snelheidsverspreidings wat gebruik kan word om die verspreidingsfaktor mee te bereken sonder om teoretiese oplossings te soek.

PREFACE

This work is a continuation of research previously undertaken by the author in the form of a final year thesis in 2000, named "Hoogvloeimeting in riviere met behulp van drukmeting by brugpylers: 'n Gids vir installasie en gebruik". Translated it means "High flow measurements in rivers using pressure measurements against bridge piers: A guide for installation and use".

The above fieldwork showed promising results and raised interest at the South African Department of Water Affairs and Forestry, Hydrology Division. Prompted by the interest and probable significance of this approach toward open channel flow measurement, further research seemed appropriate.

The method for measuring velocity using a bridge pier has been researched extensively, with good results, at the University of Stellenbosch (Meyer et al, 2000) (Cloete & Rooseboom, 2000) (Retief & Rooseboom, 1998). Translation of this point velocity into an average velocity for the river remained an uncertainty.

This work is an extensive though not exhaustive investigation into possible methods for determining a theoretical velocity distribution laterally across a river. From this a factor is determined with which to convert a single point velocity measurement into average velocity for the river as a whole.

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LIST OF SYMBOLS

α	velocity coefficient
β	inverse of the velocity coefficient
Δ	delta factor – converts single point velocity to average river velocity
λ	lateral shear
ν_t	eddy viscosity
ρ	water density
LB	left bank of river
RB	right bank of river
Q	total discharge in a river
V	streamwise velocity associated with one-dimensional flow formula
A	discharge area
S_0	bed slope of river
K	von Karman constant (0.4)
b	width of bridge pier
B	distance between adjacent bridge piers
L	length of bridge pier
d	depth of flood plain flow
D	depth of main channel flow
y	depth of flow at a local point
y	distance laterally across a river for 2 or 3 dimensional flow formulae
W	total surface width of river
U,V,W	velocity components in the (x) streamwise, (y) lateral and (z) vertical directions, associated with 3-dimensional flow formula
U_d	depth averaged velocity, associated with 2-dimentional flow formula
h	depth of main channel below overbank level
f	D'arcy friction factor
g	gravitational acceleration
H	maximum depth of flow

LIST OF ABBREVIATIONS

CHOH	-	Coherence is the degree to which the different zones, in a river cross section, exhibit similarity (Ackers 1991)
DCM	-	Divided Channel Method: Dividing a compound river section into hydraulically homogeneous sub-divisions, calculating the discharge in each using one dimensional flow theory, and finally adding them to obtain overall discharge.
DELV	-	Dynamic Equation of Lateral Depth averaged Velocity (Wormleaton 1988)
DISADF	-	Discharge Adjustment Factor (Ackers 1992)
DWAF	-	The South African Department of Water Affairs and Forestry
FCF	-	Flood Channel Facility at Wallingford, UK, jointly sponsored by SERC and Hydraulics Research Ltd, UK
MS	-	MICRO SOFT ™ products
RSA	-	Republic of South Africa
SERC	-	Science and Engineering Research Council, UK
WRC	-	The Water Research Commission of South Africa

1 INTRODUCTION

Reliable prediction of the carrying capacity of rivers is of great significance to mitigate flood damage and prevent loss of life (Myers 1987). This statement emphasises the necessity to measure floods accurately.

Flow measurement in natural rivers is complicated in the case of high flood flows: gauging weirs become inundated, increased sediment loads hamper magnetic field measurements, and floating debris prohibits point velocity measurements using instruments suspended on a cable or rod. These are problems often encountered especially in arid regions with seasonal river flow.

There is a saying in Afrikaans, “om te meet is om te weet” which when translated would mean 'to measure is to know'. This is true, but accuracy of the measurement relies upon the calibration of the 'measuring stick'. Gauging weirs are theoretically calibrated for modular flow, and to some extent for non-modular flow. But when totally inundated, weir formula cannot estimate the flow rate. In these cases various measurement techniques, some mentioned above, are employed to fix a flow-rate to a flood peak measured at a weir. In so doing the calibration of a weir is raised above its theoretical limit.

Some reasons why the full spectrum of river flow data is necessary:

- South Africa, being a dry country, considers water to be a natural resource which must be controlled and managed. The more information known about this resource, the better it may be controlled.
- Catchment management, regarding water users in a river basin, is a new control mechanism enforced by DWAF in RSA. Agriculture requiring irrigation has increased in the drier regions of Southern Africa: grape farming has boomed along the banks of the lower Orange River in Namibia and South-Africa, as well as along the banks of the Berg River. On the other hand, the river eco-system is

also a water "user" which requires its share of river run-off to stay "healthy". The more information made available to the catchment managers regarding total annual run-off, the better the control and distribution of this resource.

- South Africa relies heavily upon its natural water resources for development and economic growth. Job creation, a present era buzzword, mainly takes place at major coastal centres where local and foreign investors build large production facilities and ship out the goods. An influx of job seekers from rural communities to these centres strain the available water sources as industries and informal settlements expand, and with them the demand on potable water.

From the above it can be seen that measurement of river run-off, over the whole spectrum of flow, is necessary for management and control. A multitude of river gauging stations accurately measure the lower part of the spectrum, but the upper part is still inaccurate, and often unmeasured due to lack of resources.

2 BACKGROUND

In Southern Africa most weirs are equipped with water level recorders, placed in a tower well above the maximum expected flood level. This allows for accurate recording of the water level even during floods, but this level can only be converted to flow rate by means of a calibration table: flow height above some relative zero datum versus flow rate. When several flood measurements correspond concerning relative height and flow rate, it is considered safe to extend the calibration table to this flow rate. A variance of 10% in measured flow rate for a given height is considered as accurate, but when the variance approaches 30- to 40%, further measurements are required before the calibration table is extended (van Heerden, DWAF).

A general explanation for the necessity of measuring flood peaks accurately may be summarised as follows:

- In any given year, for 90% of the time, a typical weir in a relatively dry region would measure 8% of the annual river run-off accurately (in the form of low flow). The remaining 92% of run-off comes in the form of floods during the rainy season over the remaining 10% of the time. During these flood peaks, large volumes of water are conveyed down the river, forming the bulk of the remaining annual run-off.

- If the weir is not calibrated accurately for the flood peaks, then a large part of the remaining 92% annual run-off is either underestimated due to the 'ceiling' in the weir discharge table, or unreliable due to assumptions made in extrapolating the discharge table to accommodate the higher flow levels.

This emphasises the saying "to measure is to know".

Some flow measurement techniques used presently are briefly discussed, as well as the new measurement approach which may incorporate some of the older techniques but arrive at results much quicker.

2.1 Flow measurement techniques in RSA

Several methods of measuring open channel stream-flow are used in RSA today, with varying degrees of accuracy and difficulty, especially during floods. Some of these are:

- Fixed calibrated measuring structures such as gauging weirs or dam walls. The theoretically calibrated weir becomes unusable when completely inundated; this however is unlikely to happen at the spillway of a dam wall, making this structure reliable even during maximum design flood flows.
- Current gaugings using flow meters suspended from a specially designed cableway or from a bridge structure. This method is relatively accurate but dangerous to use in flooded rivers with a high debris load.
- Slope-Area-Method which applies energy principles. This method determines only the flood-peak flow rate, as post-flood survey heights are taken of the debris levels in trees and bushes along a selected stretch of river. Often the energy slope is misinterpreted due to the high rotational energy content of water at the side of a river in the form of eddies and vortices, which may cause local interference with the water level. This leads to varying flow rate measurements for similar sized floods. This method is very popular in RSA for lack of better techniques.
- Float measurements are sometimes applied, but generally only to get a rough estimate of the flow rate: brightly painted wooden blocks, are thrown into the middle of a flooded river. The time it takes to travel a fixed distance is recorded. This velocity is factored by 0,8 to convert it to average velocity (this factor is an over-estimation of actual flow rate as proven by this research), an estimate is made of the discharge area, and the product of these gives discharge.

- Physical model study in a laboratory, accurate but expensive.

2.2 Flow measurement techniques used abroad

Some of the measuring techniques which have been used with success abroad are mentioned below:

- Dilution methods
- Magnetic field measurements
- Acoustic Doppler Velocimetry (ADV) (Bradley et al, 2003). ADV has been used to measure two- and three dimensional flow fields in natural waterways. It's a direct measurement technique, and thus subject to the dangers of measurement during floods.
- Particle Image Velocimetry (PIV) (Bradley et al, 2003) : photographs are taken of surface flow in quick succession (30 frames per second). With the time frame known, the distance and direction of travel for certain pixel groups are measured and so surface flow vectors are determined, which can be translated into average velocity and flow rate.
- Bubbles released from a pipe at bottom. Suspended sediment load, often present during floods, however, increases the density of the water and thus reduces the escape velocity of the air bubbles. In this case the average velocity is overestimated.

2.3 Proposed simplified measurement approach

The proposed simplified measurement approach requires only a single point-velocity, taken preferably in the middle of a river. By means of a factor, dubbed the Single Point Velocity Factor and denoted with the character delta (Δ), this single point velocity is converted into an average velocity for the river as a whole. With the section geometry known, the flow rate is determinable.

Point velocity may be determined by means of any direct measurement technique. The only requirement being that the point velocity must be converted into the average velocity for the vertical stream element. The depth averaged velocity is then converted to average velocity for the river as a whole, using the single point velocity factor, delta.

This method of discharge calculation, and its approach, are described fully in an earlier unpublished work by the author in 2000: “Hoogvloeimeting in riviere met behulp van drukmeting by brugpylers: ‘n Gids vir installasie en gebruik”.

NB. Please note that the velocity distribution factor in the former work was denoted by the Greek character alpha (α). In this work however the alpha character is applied in its more traditional form as a velocity coefficient, describing energy losses for the kinetic energy levels as discussed in chapter 7. For this reason delta (Δ) is used as the velocity distribution factor in this work.

2.4 Aim of this research

This research focuses on a theoretical approach to determine the lateral velocity distribution for single- or compound channels, from which the delta-factor is derived. This work mainly looks at compound channels, as a theory developed for compound channels should also be able to model single concave channels.

3 LITERATURE STUDY

The essence of a number of major publications are reviewed here. These publications were chosen on the basis of velocity distributions, discharge, conveyance, turbulent structures and available energy in prismatic compound channels. A publication on a simple concave channel is also included which investigates the use of one-dimensional formulae when subdividing the channel into hydraulically homogeneous sections.

3.1 Title: Flow distribution in compound channels

Author: Wormleaton, R.R., Hadjipanos, P.

Published: 1985

In previous work the authors had determined that by subdividing a compound river section into hydraulically homogeneous areas, and summing the calculated flow through each, the resulting discharge overestimates the actual flow.

Previous work only considered the total discharge. This research investigated the over- and underestimation of the main channel flow and the floodplain flow separately.

Three different interface planes were examined, namely Vertical (V), Diagonal (D) and Horizontal (H). Results for the horizontal and diagonal interface methods showed similar characteristics, thus reference is only made to the horizontal.

The interface was included (i) and excluded (e) in the main channel wetted perimeter. For the vertical interface, the main channel flow was grossly overestimated in both V_e and V_i. However in both cases the overbank flow was underestimated, correcting the total discharge to an extent. For V_e, the total flow was overestimated in all depth scenarios. For V_i the total flow was overestimated for depth ratios $(H-h)/H = 0.2$ or 0.3. But for depth ratios approaching 0.4, some measurements underestimated the flow. For both V_e and V_i, the total discharge was overestimated by 50% and 40% respectively.

3.2 Title: Velocity and discharge in compound channels

Author: **Myers, W.R.**

Published: **1987**

The author states that if the compound channel is considered as a single entity, the carrying capacity is underestimated, while in applying the divided channel method (DCM) the resulting discharge is an overestimation.

The DCM overestimates the full cross sectional carrying capacity by up to 10% and hence underestimates the flood stage for given discharges. The value of 10% is a lower limit of overestimation.

An important observation is made: lateral depth-averaged velocity distributions are independent of channel bed slope.

3.3 Title: Determination of discharge in compound channels using the dynamic equation for lateral velocity distribution

Author: **Wormleaton, R.R.**

Published: **1988**

Traditional discharge calculations (Chezy, Manning, Colebrook-White) lead to large inaccuracies in compound channels due to no provision for interference at the interface between main channel and floodplains.

The interaction between main channel and floodplain flow is a very complex three-dimensional problem, and its complete solution would require correspondingly complex and sophisticated methods. However these may be very time-consuming and not at all suited to numerical river modelling. Moreover, the detailed description of the flow and the levels of accuracy produced by these methods are not always required in practice.

A method which is fast and gives a more realistic description of the discharge than Chezy et el. is the Dynamic Equation of Lateral depth averaged Velocity distribution (DELV):

$$gS_0 - \frac{fU|U|}{8h} + \frac{\partial}{\partial y}\left(v_t \frac{\partial U}{\partial y}\right) = 0$$

The equation is a non-linear second order partial differential equation which can be solved numerically by finite differences.

DELV was found not to be scale dependent, and gives improved values for total discharge for depth ratios ≤ 0.4. Above that flow becomes distinctly three dimensional in character.

3.4 Title: A comparison of velocity measurements in straight, single meander and multiple meander compound channels

Author: **McKoegh, E.J.; Kielly, G.K.**

Published: **1990**

Mechanisms of main channel and floodplain interactions are typified by:

- The transfer of momentum from the main channel to the floodplain
- The transfer of turbulence from the floodplain to the main channel
- The creation of vortices with vertical axes at the interface

All these cause energy loss which is not included in the traditional treatment of compound channels.

A comparison of the lateral distribution of velocity indicates that a straight channel is more amenable to analytic treatment than either a single or a multiple meander. A simplified turbulence model predicting the lateral distribution of depth averaged velocity has been proposed by the authors (1989). This model is based on the simplified dynamic equation:

$$gS_0 - \frac{fU|U|}{8y} + \frac{\partial}{\partial z}\left(\nu_t \frac{\partial U}{\partial z}\right) = 0$$

Symbols: The 1989 publication of the authors work, which has not been located prior to binding this document, contains the symbols for the above equation. These symbols are therefore not disclosed in this work.

3.5 Title: Effects of momentum transfer in compound channels

Authors: **Stephenson, D., Kolovopoulos, P.**

Published: **1990**

The difference in main channel and floodplain velocities results in a bank of vortices as demonstrated by Knight & Hamed in 1984, referred to as the "turbulence phenomenon". There is therefore a lateral transfer of momentum that results in apparent shear stress.

Apparent shear stress acting on the assumed interface, proposed by Prinos & Townsend (1984), is represented by:

$$\tau_{ai} = 0.874(\Delta V)^{0.92}\left(\frac{d}{D}\right)^{-1.129}\left(\frac{W_f}{W_c}\right)^{-0.514}$$

ΔV = difference in mean velocity of main channel and flood plain

d = depth of floodplain flow

D = depth of main channel flow

W_f = floodplain width

W_c = channel width

τ_{ai} = apparent shear stress acting upon the assumed interface

To validate the equation the authors compared four existing steady state computation methods with laboratory data by Wormleaton (1982) and Knight and Dimetriou (1983), with good results. As quoted, these methods are (1) the Divided Channel Method (DCM), (2) the Inclined Interface Method by Yen and Overton (1973), (3) Area Method by Holden (1986) and (4) the K-method which, according to the authors, is an improvement on the vertical interface method.

3.6 Title: An improved method of calculation for steady uniform flow in prismatic main channel/flood plain sections

Authors: **Wormleaton, P.R.; Merrett, D.J.**

Published: **1990**

Ø-Indices are brought into the DCM calculations to modify results, allowing for a degree of interaction and momentum transfer between the main channel and floodplain sub-sections.

Ø-Indices were first suggested by Radjovic (1985) to characterise momentum transfer between adjacent sub-areas in discharge calculation methods.

The authors have applied the Ø-Indices to several discharge calculation methods, and have found a way of calculating the Ø-Indices fairly accurately using channel geometry and roughness.

3.7 Title: Calculation of total conveyance in natural channels

Authors: Garbrecht, J.; Brown, G.O.

Published: 1991

For simple concave sections, subdivision of the section into elements, ignoring lateral velocity gradients as well as shear between elements, and computation of the non-linear conveyance as a summation of components leads to overestimation of total conveyance.

For a typical trapezoidal section:

$\frac{W}{D} \approx 20$ gives 5% overestimation

$\frac{W}{D} \approx 10$ gives 10% overestimation

$\frac{W}{D} \approx 5$ gives 20% overestimation

For: W = top width

D = depth

The conveyance as a summation of elements can only be true when the hydraulic radius (R) is constant, or a linear function of area, e.g. an infinitely wide section of constant depth. As a rule of thumb, the channel should not be sub-divided when width/depth ratio ≤ 10.

3.8 Title: Turbulent structure in Compound Open-channel flows

Authors: **Tominaga, A.; Nezu, I.**

Published: **1991**

Measurements were conducted on the turbulent structures in compound open channel-flows, using a Fibre-optic Laser Doppler Anemometer (FLDA). The three-dimensional distribution of the mean velocity, and the associated turbulent characteristics, were revealed by the FLDA database.

Two types of vortices were identified: secondary currents, which are a strong pair of longitudinal vortices either side of the main channel, and vertical axis vortices at the interface of the main channel and floodplain.

The database of this experimental data is also valuable for examining the validity of numerical calculations for three-dimensional compound open channel flows, including the effect of the free surface.

A typical distribution of transverse velocity vectors, measured with the FDLA, is indicated in **Figure 3.1**. The diagram was obtained from the Journal of Hydraulic Engineering, Vol. 117, No. 1. **Figure 3.1** illustrates the large size of the vectors at the interface of the main channel and floodplain where large translational energy losses occur, as opposed to vectors with near zero length in the middle of the river where very small translational energy losses occur.

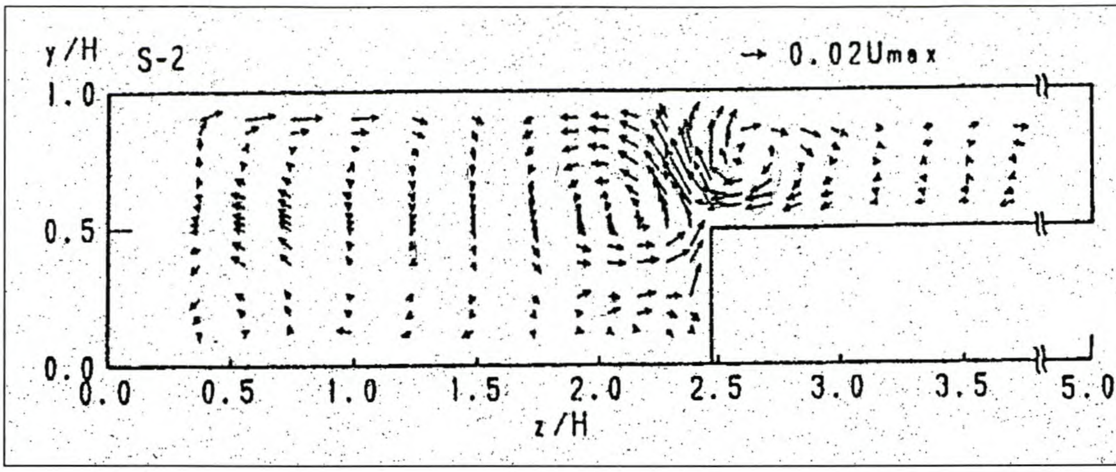

Figure 3.1: A compound cross section indicating velocity vectors perpendicular to streamwise flow direction.

3.9 Title: Hydraulic design of two-stage channels

Author: **Ackers, P.**

Published: **1992**

The author provides a new hydraulic parameter, the section Coherence (COH), which describes the degree to which the different zones exhibit flow similarity.

$$\text{COH} = \frac{\textit{Calculated flow for whole section as a unit}}{\Sigma\ \textit{separate calculated zonal flows}}$$

As COH approaches unity, the section hydraulics approaches that of a non-compound channel.

The ratio of the actual discharge to the nominal discharge, where the latter is derived as the sum of the flows estimated separately for the main channel on floodplain zones, is termed the Discharge Adjustment Factor (DISADF). Actual discharge is thus determined by multiplying the DCM with the DISADF.

This however corrects the total discharge as a whole, and not the separate zone discharges. Over much of the range of flood flows, the DISADF is between 0,95 and 0,9.

3.10 Title: Flow formulae for straight two stage (compound) channels

Authors: **Ackers, P**

Published: **1993**

The author claims much work had been done to date on the complex flow patterns of compound channels. This work had however been academically oriented and has not provided practical design procedures.

The DCM, as most text books refer to it, is attractive due to its simplicity, but it disregards head loss at the channel floodplain interface, and thus overestimates discharge.

The author suggests that the DCM be used in accordance with correction factors to allow for inter-zone interactions: A ratio of the actual- to the calculated discharge (DCM) is determined. This ratio is referred to as the Discharge Adjustment Factor (DISADF), as mentioned in section 3.9.

The author identifies four regions of flow: from only main channel flow (overbank-flow = 0) to overbank flow so deep that COH $\Rightarrow$ unity (the section hydraulics approaches that of a non-compound channel; Ackers 1992).

Formulae are presented for these four flow regions to determine the DISADF applicable to each.

3.11 Title: Refined calibration of a depth-averaged model for turbulent flow in a compound channel

Author: Knight, D.W.; Abril, J.B.

Published: 1996

The Navier-Stokes equation for streamwise motion of a small element, within the cross section of an open channel with bed inclined streamwise is:

$$\rho\left[V\frac{\partial U}{\partial y}+W\frac{\partial U}{\partial z}\right]=\rho g\sin\theta+\frac{\partial\tau_{yx}}{\partial y}+\frac{\partial\tau_{zx}}{\partial z}$$

Where [UVW] = velocity components in the xyz directions; x streamwise, y lateral and z normal to bed, ρ = water density, θ = channel bed slope, τ_{yx} = Reynolds shear stress on a plane perpendicular to y direction. Gravity force is not only expended on vertical and lateral shear during streamwise flow (U), but also to maintain secondary flows transverse to the streamwise direction with velocity components in the y & z direction.

Navier-Stokes must be integrated over depth to be of practical use:

$$\rho gHS_0-\rho\frac{f}{8}U_d^2\left(1+\frac{1}{s^2}\right)^{0.5}+\frac{\partial}{\partial y}\left\{\rho\lambda H^2\left(\frac{f}{8}\right)^{0.5}U_d\frac{\partial U_d}{\partial y}\right\}=\frac{\partial}{\partial y}\left[H(\rho UV)_d\right]$$

With	U_d	=	depth average velocity
	H	=	local water depth
	s	=	channel side slope (1: s)
	λ	=	lateral shear (via depth averaged eddy viscosity)
	Γ	=	$\frac{\partial}{\partial y}[H(\rho UV)_d]$ = secondary flow

S_0	=	channel streamwise slope
f	=	local bed friction
ρ	=	water density
g	=	gravitational acceleration

Starting values are needed for f, λ, Γ in the river channel, (f) is known and (λ, Γ) must be estimated. A depth averaged finite element model is applied to simulate turbulent flow. Results show the model accurately predicts the lateral distribution of depth mean velocity.

3.12 Title: Estimating the discharge capacity in straight compound channels

Authors: **Lambert, M.F.; Myers, W.R.**

Published: **1998**

This research presents a method for predicting the stage discharge relationship in a straight compound channel, more accurately than the traditional method termed the Divided Channel Method (DCM). The DCM refers to dividing a compound channel into relatively large homogenous sub-areas, analysing each separately and summing the results.

However turbulent momentum interaction between the main channel and floodplain extends the influence of the floodplain wetted perimeter into the main channel, past the point defined by the vertical division line. In so doing the floodplain area is increased and the main channel area decreased.

The authors propose a weighting factor (ξ) to be applied to the different average velocities calculated for the main channel and flood plain. This method is termed the Weighted Divided Channel Method (WDCM).

Using experimental results from the UK Flood Channel Facility (FCF), the WDCM produces results which more closely represent observed velocity in both the main channel and flood plain than the traditional DCM.

3.13 Title: Total energy levels in rivers

Author: **Rooseboom, A**

Published: **1988**

In typical flow sections, the velocity gradients and therefore rotational energy content, is high where translational energy content is lowest and vice versa: right against boundaries, the velocity equals zero while the rotational energy content is very high.

In a compound river section, along the flood plains, the translational energy content will be low while rotational energy content is high and the total Kinetic Energy could be higher than in the main channel, where translational energy content is high and rotational energy content low.

It is doubtful whether the cumbersome standard methods for calculating α-coefficients produce a truly representative kinetic energy height, as the kinetic energy content of flows along the flood plains is under-estimated in such calculations.

3.14 Title: Numerical Analysis, third edition

Authors: **Burdow, R.O.; Faires, J.E.**

Published: **1985**

(10.4) Finite-Difference Methods for Nonlinear Problems: for general non-linear boundary value problems, the difference method is similar to the method applied to linear problems. Here, however, the system of equations that is derived will not be linear, so an iterative process is required to solve it.

3.15 Title: Advanced Engineering Mathematics

Authors: **Zill, D.G.; Cullen, M.R.**

Published: **1992**

(15.9) Second order boundary value problems: The simplified equation reads as follows:

$$\left(1+\frac{h}{2}P_i\right)y_{i+1}+\left(-2+h^2Q_i\right)y_i+\left(1-\frac{h}{2}P_i\right)y_{i-1}=h^2f_i$$

This equation is known as a finite difference equation, and is an approximation of the differential equation. It enables one to approximate a solution at the interior mesh points (x_1, x_2, x_3, x_4, …..x_n) of an interval [a;b]. The boundary conditions must be known.

Definition of parameters are as follows:

h = $\frac{(a-b)}{n}$ = interval size

$y_i = y(x_i)$ $\quad x_i \in [a,b]$

$P_i = P(x_i)$ $\quad x_i \in [a,b]$

$Q_i = Q(x_i)$ $\quad x_i \in [a,b]$

$f_i = f(x_i)$ $\quad x_i \in [a,b]$

4 PROPOSED SIMPLIFIED FLOOD MEASUREMENT APPROACH

The simplified measurement approach to flood estimation, proposed and investigated in this study, relies upon a single velocity measurement taken somewhere around the centre of a river. Using the typical vertical velocity distribution curve for open channel flow (See **Figure 4.2**), this point velocity is translated to a depth averaged velocity. Then using the newly derived delta-factor, as presented by this work, the translated point velocity is converted into an average velocity for the entire cross-section. The product of area and average velocity then gives the discharge.

The proposed simplified flood measurement approach requires firstly determining the delta-factor for a section in a river, secondly measuring a point velocity in a river, thirdly converting the point velocity to a depth averaged velocity (standard procedure), the fourth step is to convert the depth averaged velocity into an average velocity for the whole river cross-section by applying the delta-factor. The last step is to calculate discharge as mentioned above. These steps are discussed in detail in the rest of this chapter.

4.1 Determining the Delta-factor

Delta as defined in this investigation is the ratio of the average velocity to point velocity. The average velocity being the average for the whole river cross section, and the point velocity is defined as the depth averaged velocity for any point laterally across the river. The formula for the delta-factor is as follows:

$$Delta(\Delta) = \frac{Average\ river\ velocity}{Depth\ averaged\ velocity\ at\ any\ point\ in\ the\ river} \qquad (Equation\ 4.1)$$

The process of determining delta (Δ) actually requires knowing what the lateral velocity profile looks like beforehand to calculate delta, and then using delta again to determine the average velocity in a river from a single point velocity. It may seem that one is defying the very purpose for determining delta, but fortunately once delta has been fixed for a section in a river, all future measurements require only a single point velocity which then can be converted to average river velocity by means of the delta factor.

If current gaugings are available for a specific section in a river, they may be used to determine delta. If not, then a theoretical velocity distribution is required which would closely simulate the actual distribution. This is the main objective of this work. Chapter 5 deals with methods of determining a lateral velocity distribution in a river.

In the middle of a river the point velocity is higher than the average velocity. In this case delta(Δ) will be smaller than unity, in the region of 0.7 to 0.8. At the side of the river the average velocity is higher than the point velocity. This leads to delta(Δ) being larger than unity and highly erratic: values range from 1 and can tend to infinity, depending on how close one gets to a point of zero velocity near the side of the river.

It thus becomes clear why the delta-factor must be determined near the centre of the river: adjustment to a measured point velocity will be at the most 30% in the centre of the river whereas it becomes 200-, 300- or 400 % as one moves closer to the side of the river. The margin of error with 30% adjustment is much smaller than on a 400% adjustment. The single point velocity method thus is "safer" and of more practical use when delta is determined at the centre of the river. Obviously future single point velocity measurements must be taken at the centre of the river as well.

See **Figure 4.1** for a typical delta calculation. Here delta is determined at chainage 91m, approximately the centre of the river, and at chainage 155m near the rivers edge. This distribution was generated from velocities measured in the Orange river at Irene in February 1989, when the discharge was 2411m^3/s.

4.2 Single point velocity measurements in rivers.

Several methods exist which could be employed to measure a single point velocity in the main stream of a river. Discussed under the following chapters are three methods: two tried and tested and one new approach which has recently been developed and tested at the University of Stellenbosch.

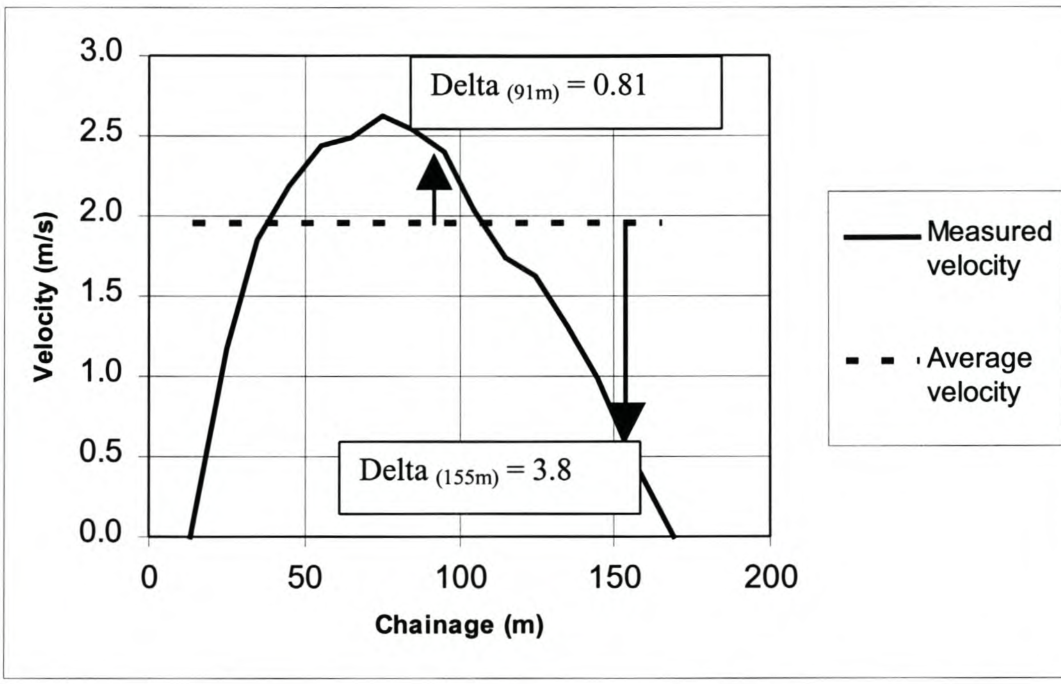

Figure 4.1: A typical velocity distribution used to determine the delta factor at the centre and near the side of a river.

4.2.1 Pressure differences at bridge piers (the new approach):

A method first investigated in the late 1990's (Retief, Rooseboom 1998) and improved on in 2000 (Meyer, Rooseboom 2000) (Cloete, Rooseboom 2000), has proven itself reliable through extensive laboratory testing and trial tests in a river.

This technique of velocity measurement has been used in the aviation industry for decades, namely the pitot tube. Here it is applied to measure water velocity in a river, and instead of using a fixed wing as a supporting structure for the pressure meters, a bridge pier in the main stream is used. The method of application relies on energy principles: Bernoulli's equation.

This technique involves measuring dynamic pressure against the upstream face of a bridge pier and static pressure against the downstream side of the pier. Given the difference in pressure, one can determine the velocity at the pier using Bernoulli's total energy equation. Through the laboratory tests, a discharge coefficient has been determined to translate the measured velocity into a true velocity, since the pier width and length influence the normal stream flow.

Table 4.1 shows results from Meyer and Rooseboom for a typical bridge pier under drowned flow conditions downstream. Note that the table makes allowance for different widths and lengths of the pier, with b_p being the width of the pier and B being the influential width of the pier: a distance equal to the centreline distance between two adjacent piers. The letter L denotes the length of the pier, upstream to downstream side.

Table 4.1: Meyer and Rooseboom (2000) discharge coefficients for different size bridge piers tested in a laboratory.

***Discharge coefficients for different size bridge piers**

Parallel approaching $flow_p$

Drowned conditions prevail downstream of the bridge pier

	L/b_p = 6.9 (Long)	L/b_p = 5.6 (Medium)	L/b_p = 4.2 (Short)
B/b_p = 19.0	0.98	0.97	0.98
B/b_p = 15.2	0.99	0.99	1.00
B/b_p = 12.2	0.98	0.97	0.98
B/b_p = 9.7	0.96	0.97	0.97

** The pressure gauges in this case were mounted close to the base of the pier. Different values may be expected if the pressure gauges are mounted higher up against the pier. Refer to Cloete and Rooseboom (2000) where one set of pressure gauges was mounted near the water surface. The discharge coefficient in this case was in the vicinity of 0.8.*

For the purpose of this exercise the Velocity coefficient (C_v) may be assumed equal to the Discharge coefficient (C_d) obtained through laboratory testing by Meyer & Rooseboom (2000). The formulae for determining the point velocity using this method is as follows:

Theoretical velocity $V_t = \sqrt{2gh}$ as derived from Bernoulli's equation

$h =$ height difference between static and dynamic pressure

To translate this value to a real point velocity, it must be factorised with an appropriate value from Meyers' table.

Real velocity $V_r = Cv \times V_t$

This represents real velocity at the base of the pier, and must be converted into depth averaged velocity for the vertical stream element.

4.2.2 Surface velocity measurements

There are several methods for determining surface velocity. Some are mentioned below:

- Surface velocity determined using float gaugings: Bright coloured floats are dropped into the main stream, upstream of a selected reach in the river. Using a stopwatch the time is taken for the float to travel a fixed distance.

- Another approach is Particle Image Velocimitry (PIV). A sequence of digital photographs of the water surface, 30 frames per second, allows one to follow the path of a most likely group of pixels (Bradley et el, 2003). The pixel-group movement may be converted into surface velocity.

4.2.3 Sub surface velocity measurements:

Velocity measurements, using a velocity meter suspended on a rod or cable beneath the water surface, gives accurate readings. Several types of velocity meters are available on the market, for example the propeller type, an electromagnetic type or an acoustic Doppler meter.

4.3 Depth Averaged Velocity for a vertical stream element:

The average velocity of a vertical stream element can be either measured with a current meter, measuring velocity at several different intervals from the top to the bottom of a vertical stream element and drawing the profile, or by applying the well known Vanoni equation (1941) and calculating the average velocity from a measured point at the surface for example.

- Using a current meter: As previously mentioned the current meter is an accurate measuring instrument, and there are various types available on the market. It can be lowered to the bottom of the stream, and measure velocity at different depths. Report no. 13 of the World Meteorological Organization (WMO) (1980) on Operational Hydrology describes several methods of measuring depth average velocity. Two methods commonly used in the RSA by DWAF are the six-tenths method and the three-point method. These types of measurement are only possible in favourable conditions.

- Applying Vanoni's equation: The depth averaged velocity (V) of a vertical stream element is obtained by applying an equation derived by Vanoni (1941), to any measured point velocity, if the depth of measurement relative to the total stream depth is known.

$$u = V + \frac{1}{K}\sqrt{gy_0S}\left(1 + 2.3\log\frac{y}{y_0}\right) \qquad \textit{(Equation 4.2)}$$

Where	y_0	=	water depth at point of measurement
	u	=	velocity at distance y from channel bed
	K	=	von Kármán constant, having a value of about 0,4 for clear water
	V	=	mean velocity
	S	=	bed slope

A typical velocity curve was also obtained through intensive investigation of vertical velocity curves by Hulsing, Smith and Cobb (1966). The following graph, **Figure 4.2**, gives the average ordinates of the vertical velocity curve.

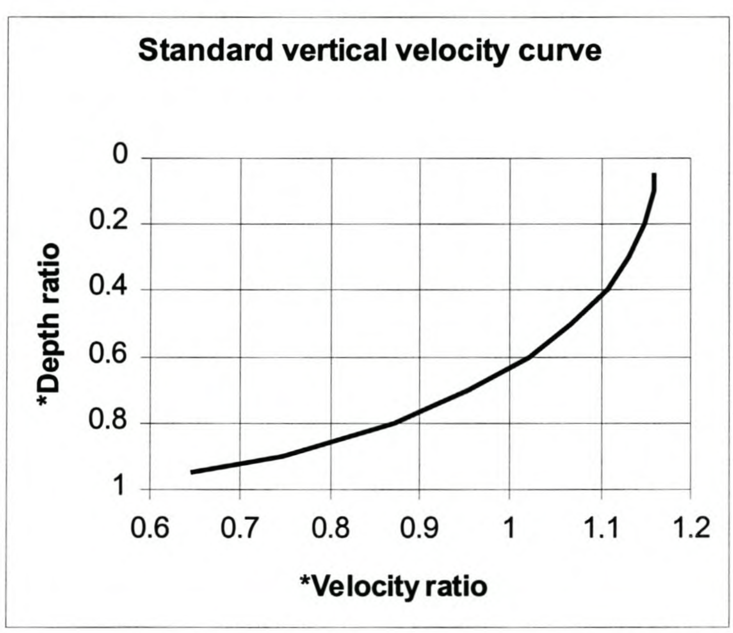

Figure 4.2: The typical vertical velocity curve by Hulsing, Smith and Cobb (1966)

* *Depth ratio is the ratio of observation depth to depth of water, Velocity ratio is the ratio of point velocity to mean velocity in the vertical.*

The average velocity may be determined from any single point velocity measured at a known depth ratio.

4.4 Calculation of total discharge

Having determined the depth averaged velocity for a vertical stream element, one may calculate the average velocity for the river by applying the delta-factor. Hence total discharge is determined as the area of discharge should be available.

$$Q = \Delta \times V_{da} \times A \qquad \textit{(Equation 4.3)}$$

Where

Q = total discharge

Δ = delta-factor which converts depth averaged point velocity (V_{da}) to average river velocity

V_{da} = depth averaged velocity for a vertical stream element at an appropriate location within the section

A = discharge area

Chapters 5, 6 and 7 deals with methods of determining the velocity distributions in rivers to enable deriving of accurate delta-factors, resulting in reliable total discharge.

5 METHODS OF DETERMINING LATERAL VELOCITY DISTRIBUTIONS

The focus of this research is to find a theoretical approach for determining the lateral velocity distribution for single- or compound river sections, "physical measurement of the velocity distribution is subject to typical measurement problems, which is why a theoretical velocity distribution is necessary for the Single Point Velocity method to be of practical use" (van Heerden 2001). It is emphasized that a theoretical approach should closely simulate a measured velocity distribution, bringing into account the energy losses encountered at the sides of the cross section. This work mainly looks at compound channels, as a theory developed for compound channels should also model single concave channels.

This work does however investigate over 100 physical gaugings done in 13 different rivers, with an average of 20 point velocities measured per gauging. This is to analyse velocity profiles for different discharge rates in typical rivers. (Chapter 6.)

Accurate prediction of the lateral velocity profile is the key to the success of the Single Point Velocity measurement method: an accurate prediction of the lateral velocity distribution is necessary for the calculation of the delta-factor which is used to convert the depth averaged velocity into an average velocity for the river cross section as a whole.

The lateral velocity profile is determinable either through direct measurements, or by means of a mathematical model, predicting the profile by taking into account energy losses due to vortices and secondary currents in the stream.

5.1 Physical Measurements:

Using a current meter to determine velocities at several chainages across a river will produce an accurate lateral velocity distribution. Unfortunately some river sections are inaccessible during floods, or conditions in flooded rivers (such as high debris load) do not permit instruments to be lowered into the water. Often in arid regions high intensity rainfall leads to flash floods in several rivers simultaneously, with limited resources one is not always able to measure all the streams at once.

5.2 Theoretical approach to lateral depth-averaged velocity distributions

A reliable mathematical model would allow for a large number of lateral velocity distributions for different stage heights. Only a few are required to determine the single point velocity factor, delta, for a point in the middle of the river. Generally delta will stay the same for the different stage heights. The only variation of this rule is in the case of a compound channel, when flood water spills over the flood plain and changes the shape of the lateral velocity profile. This has been witnessed in the analysis of the field data which is discussed in chapter 6.

It is important to note that the lateral velocity distribution profile, and the resulting single point velocity factor, delta (Δ), are not dependant on the river bed-slope: for a given cross section, a change in bed slope would not change the profile of the lateral velocity distribution but only its magnitude. Subsequently the average velocity will also change; therefore the delta-factor will stay the same. A supporting statement by Myers (1987) reads as follows, "Lateral depth-averaged velocity distributions for one cross section are independent of channel bed slope, as predicted by theory."

5.2.1 One dimensional flow theory

Most commonly the Manning or Chezy formula is used to calculate the average velocity in the vertical for any given point laterally across a river. In so doing a distribution may be determined, but this may grossly overestimate velocities near the river edge or close to the interface between a main channel and flood plain. See **Figure 5.1**.

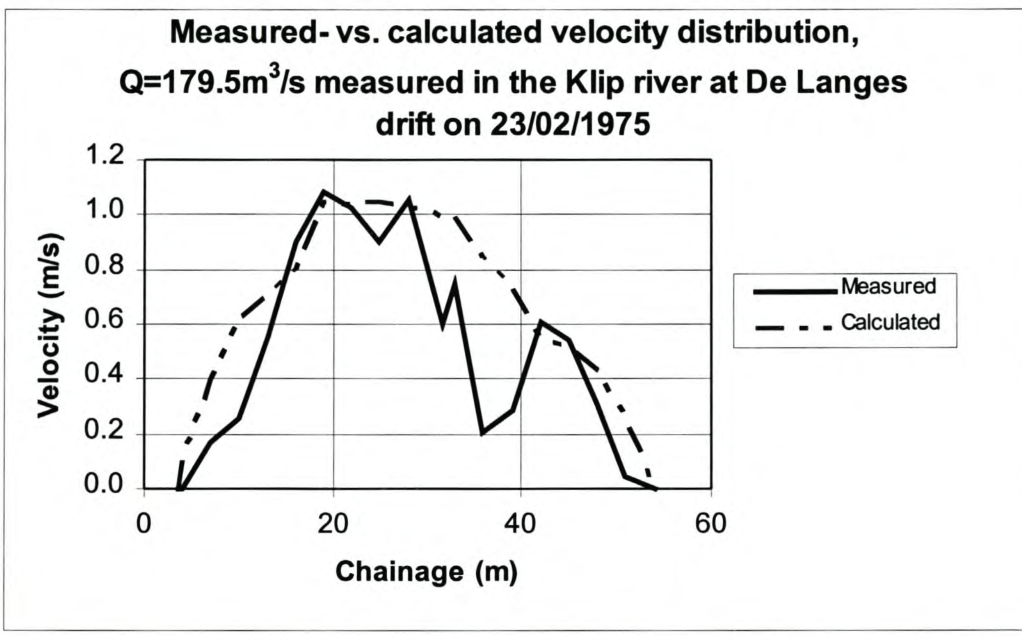

Figure 5.1: Comparison of a measured velocity distribution and a calculated velocity distribution using Manning's one-dimensional equation.

Garbrecht & Brown (1991) state that Manning's uniform flow formula has been empirically developed from undivided cross-section data with a single mean flow velocity. It's application to each section element of a cross-section divided into several elements, creates a lateral velocity gradient: each element is considered an independent channel with frictionless walls and no lateral momentum exchange, which is incorrect. This approach would however be correct for an infinitely wide channel with uniform depth and roughness.

It has been found that for a trapezoidal section with width to depth ratio (W/D) $\approx$10, subdividing into 10 or more elements leads to an overestimation in flow of approximately 10%. For W/D $\approx$ 5 the error of overestimation can be as high as 20% (Garbrecht and Brown, 1991).

This method however is very attractive due to its simplicity. Suitable correction factors, such as the Ø-indices by Wormleaton and Merrit (1990), the Weighted Divided Channel Method using the single parameter, ξ, by Lambert and Myers (1998) or the DISADF by Ackers (1993) help to solve the problem of energy losses when using one dimensional flow formula. However they only make adjustments for the average velocity of the whole cross section, or for the main channel and flood plain separately in the case of compound channels. They do not produce an accurate lateral velocity distribution, which is essential for determining the delta-factor.

5.2.2 Two- and Three-dimensional flow theory

Flow structures in compound rivers are complex and require a 3-dimensional analysis for correct interpretation. Tominagu & Nezu (1991) measured the 3-D turbulent structure of a model compound section, using a Fibre-Optic Laser Doppler Anemometer (FLDA). Longitudinal and vertical axis vortices were encountered. In **Figure 5.2** velocity vectors are plotted on a plane normal to the streamwise direction.

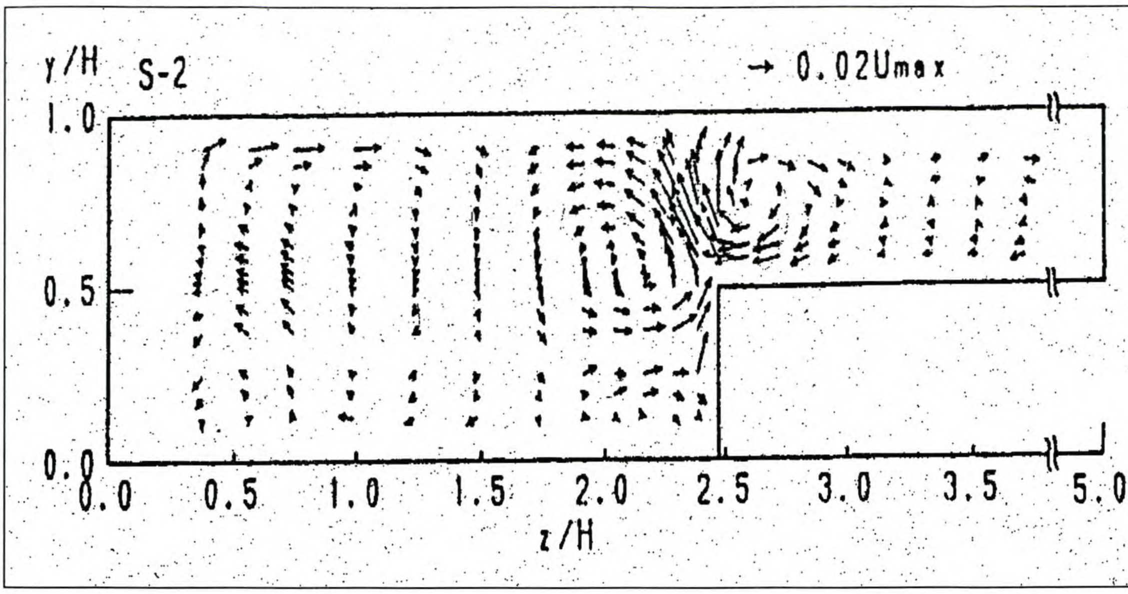

Figure 5.2: Vectors indicating velocity components normal to the flow direction in a compound channel cross section.

5.2.2.1 The Three-dimensional theory:

The well-known Navier-Stokes partial differential equation for three-dimensional flow has no analytical solution, and must therefore be solved numerically. The Navier-Stokes equation reads as follows:

$$\rho\left[\overline{V}\frac{\partial\overline{U}}{\partial y}+\overline{W}\frac{\partial\overline{U}}{\partial z}\right]=\rho g\sin\theta+\frac{\partial\tau_{yx}}{\partial y}+\frac{\partial\tau_{zx}}{\partial z}$$ *(Equation 5.1)*

where

$\{\overline{U}, \overline{V}, \overline{W}$ are local mean velocities in the x (streamwise), y (lateral) and z (normal to bed) directions

ρ = density of water

g = gravitational acceleration

θ = the bed slope ($S_0 = \sin\theta$)

τ_{ij} = shear in the j-direction perpendicular to the i-direction

There are computer packages available which apply the Navier-Stokes equation to calculate discharge or stage height for given data, such as Delft 3D or FAST3D, but these programs are expensive to purchase and not a feasible option for all river engineers. "Solution of three dimensional flow formulae for compound channels produce high levels of accuracy, but are very complex and time consuming. The detailed description of flow and the levels of accuracy produced by these methods are not always required in practice" (Wormleaton, 1988).

5.2.2.2 The Two-dimensional theory:

Three two-dimensional equations were considered, of which two were used in the theoretical approach described in detail in chapter 7. Here follows the three equations:

1) Shiono and Knight (1991) integrated the Navier-Stokes equation over depth. This produced a depth averaged-velocity equation, simpler in solution than the Navier-Stokes equation (refer to chapter 3.11):

$$\rho g H S_0 - \rho \frac{f}{8} U_d^2 \sqrt{1+\frac{1}{s^2}} + \frac{\partial}{\partial y}\left\{\rho \lambda H^2 \left(\frac{f}{8}\right)^{\frac{1}{2}} U_d \frac{\partial U_d}{\partial y}\right\} = \frac{\partial}{\partial y}\left[H\left(\rho \overline{U}\overline{V}\right)_d\right] \quad \textit{(Equation 5.2)}$$

where f is Darcy-Weisbach friction factor: $f = 8\frac{\tau_b}{\left(\rho U_d^2\right)}$

U_d = depth averaged streamwise velocity

τ_b = the local bed shear

s = the channel side slope (1 : s, vertical : horizontal) and

S_0 = channel bed slope

H = flow depth

λ = the dimensionless eddy viscosity coefficient given by

$$\bar{\varepsilon}_{yx} = \lambda H \left(\frac{f}{8}\right)^{\frac{1}{2}} U_d$$

where ε_{yx} is the depth averaged eddy viscosity

$$\tau_{yx} = \rho \varepsilon_{yx} \frac{\partial U_d}{\partial y}$$

2) Wark, Irvine and Samuels (1990) also integrated the Navier-Stokes equation over depth to produce a two-dimensional equation for steady turbulent flow which allows for lateral shear.

$$gDS_{xf} - \frac{Bf|U|U}{8} + \frac{\partial}{\partial y}\left[\nu_t D \frac{\partial U}{\partial y}\right] = 0 \qquad \textit{(Equation 5.3)}$$

Where

$B = \left(1 + S_X^2 + S_y^2\right)^{\frac{1}{2}}$: a factor relating to stress on an inclined surface to stress in the horizontal plane

D = flow depth

$f = \dfrac{8gn^2}{D^{\frac{1}{3}}}$ (The Darcy friction factor)

g = gravitational acceleration

Sx = Longitudinal slope of channel bed

Sy = Lateral slope of channel bed

x = Longitudinal coordinate direction

y = Lateral coordinate direction

U = longitudinal depth averaged velocity

ν_t = Lateral eddy viscosity

3) Wormleaton (1988) derived a differential equation from first principles, the DELV equation, which corresponds with the Wark, Irvine and Samuels version of the Navier-Stokes equation:

$$gS_0 - \frac{fU|U|}{8h} + \frac{\partial}{\partial y}\left(\nu_t \frac{\partial U}{\partial y}\right) = 0 \qquad \textit{(Equation 5.4)}$$

Where:

U = Local depth averaged velocity

f = Darcy-Weisbach friction factor.

ν_t = Depth averaged kenematic eddy viscosity

h = Flow depth

$_t = \lambda U_* h$

$$U_* = \sqrt{\frac{\tau_b}{\rho}}$$

$\tau_b = \rho g R S$ with R = hydraulic radius and S = bed slope

In Chapter 7, the Wark, Irvine and Samuels (1990) and the Wormleaton (1988) equations are used to determine lateral velocity distributions, and the resulting data are analysed.

6 FIELD DATA

The field data is analysed to provide a benchmark with which to compare the theoretical distributions, but also to see whether in practice fixed patterns exist in the velocity distributions for different discharges at the same river section.

Field data, in the form of flow measurements done by DWAF over an extended period of time, has been used: DWAF have collected several hundred, even thousands of flow measurements over the past 40 years. These vary from relatively low flow- to flood measurements in small and large rivers, and in canals. Nearly all the measured data have been gathered for the purpose of extending the calibration of gauging weirs.

In collaboration with DWAF, 13 relatively large rivers were selected for analysis. Criteria for selection were availability of flood measurement data, single-channel cross section and straight river sections upstream from the point of measurement. Approximately 8 gaugings per river were selected, all taken at the same place. The data was processed and is attached as **Appendix H**.

All these measurements were done with either a propeller or electromagnetic type flow meter, and according to the methods as described in the World Meteorological Organization report no. 13 on operational hydrology of 1980: Manual on stream gauging, volume 2, fieldwork. The six-tenths, 2-point and 3-point methods were mostly used.

6.1 Selection of appropriate river flow-data

For the purpose of this research, the appropriate river sections where velocity measurements had been taken should be prismatic, with well defined banks, of relatively large capacity and with a single cross section where all the data had been measured, i.e. a fixed cableway or a bridge.

Concerning discharge rates for the selected measurements, only high flows were considered. Flood measurements with over-bank flow, when encountered, were selected. It is assumed that during floods or relatively high discharges, all water can be considered to move in a stream-wise direction given a well-defined prismatic stretch of river.

These requirements were discussed and agreed upon in a meeting between the author and several DWAF officials of the Hydrology Division in Pretoria, August 2001. See **Appendix A** for minutes of the meeting.

6.2 Preparation of field data for use

For each individual river, the field data had to be aligned to be of practical use: in practice, DWAF officials usually take the waters edge as the zero for the cross section chainages when doing flow measurement laterally across in a river. So when plotting the cross sectional data for different magnitude floods at the same river section on a depth to width axes (water surface is zero for depth), the cross sections for different size flow measurements are not aligned around some common centre point.

See **Figure 6.1**. For each measurement the left bank water edge is taken as zero. The legend block XS (Q298), denotes the cross section for the discharge of 298 m^3/s. The DWAF number for the station is C8H030.

To align the cross sections, the largest magnitude flood was selected as datum for width and depth. Common features on the cross sections were identified and used to make horizontal shifts in the lower magnitude flow data. Thus the common features are aligned and the centre of the river is the same for lower and higher magnitude floods. (See **Figure 6.2** below).

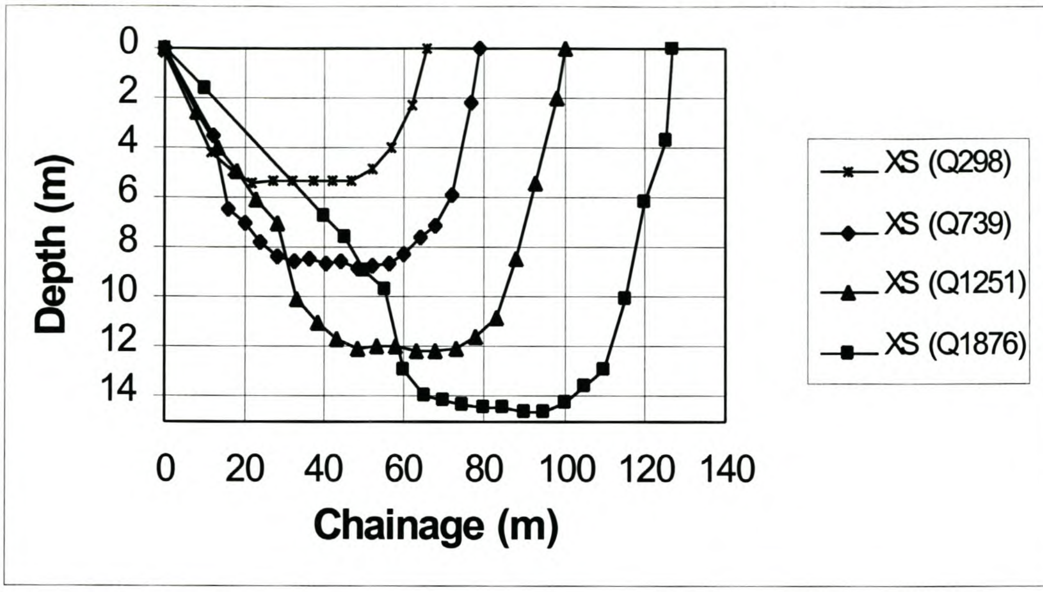

Figure 6.1: Unaligned cross section data for the Wilge river near Kimberley.

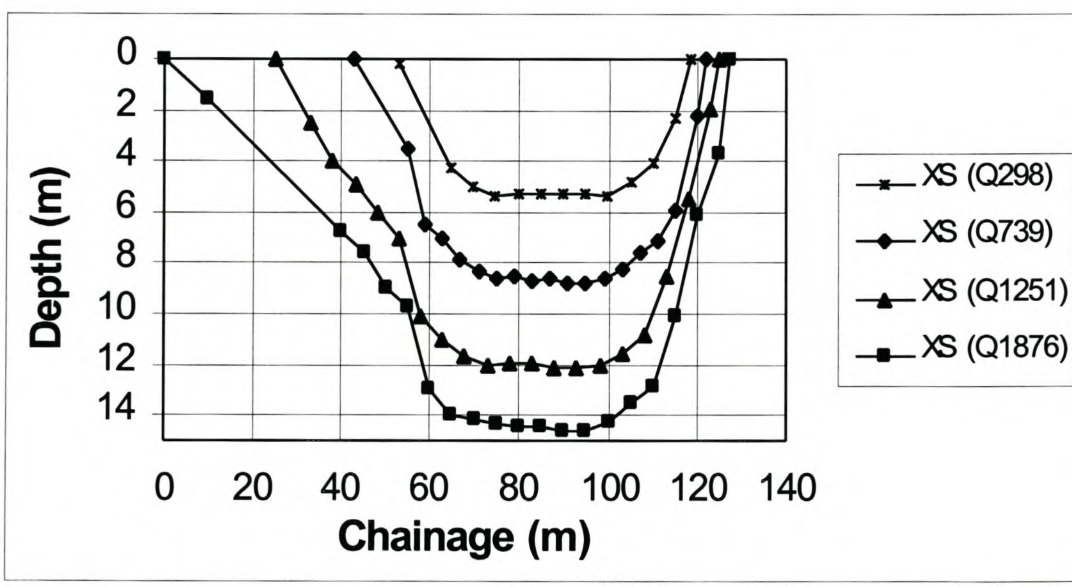

Figure 6.2: Aligned cross section data for the Wilge river near Kimberley.

6.3 Lateral velocity distribution

With the cross sections aligned for each selected river, the distribution of measured mean velocity could be plotted. These plots fitted quite well for fixed bed river sections and different size discharges. See **Figure 6.3.**The Klip river at De Langes Drift, DWAF no. C1h015. The legend block, V (Q113) and XS (Q113), denotes velocity distribution and cross section profile for the discharge of 113 m^3/s. Note that the depth scale is factored by 0.1.

Exceptions were two cross sections where erodeable bed material was present. The erodable bed channels varied in cross section profile and also in velocity distribution. This can be attributed to seasonal meandering taking place within the confines of the main river channel. See **Figure 6.4** which shows non-uniformity for velocity profiles of different size floods. The legend block, V (Q403) and XS (Q403), denotes velocity distribution and cross section profile for the discharge of 403 m^3/s. Note that the depth scale is factored by 0.5.

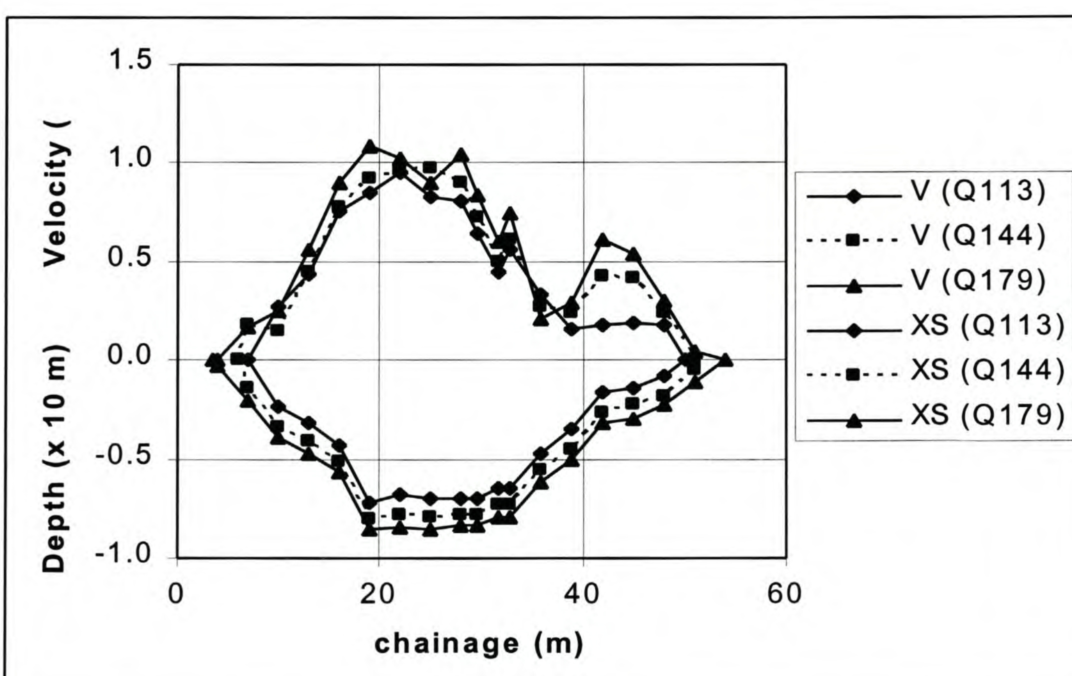

Figure 6.3: The fixed river bed produces a relatively fixed velocity profile for different discharges in the Klip river at De Langes drift.

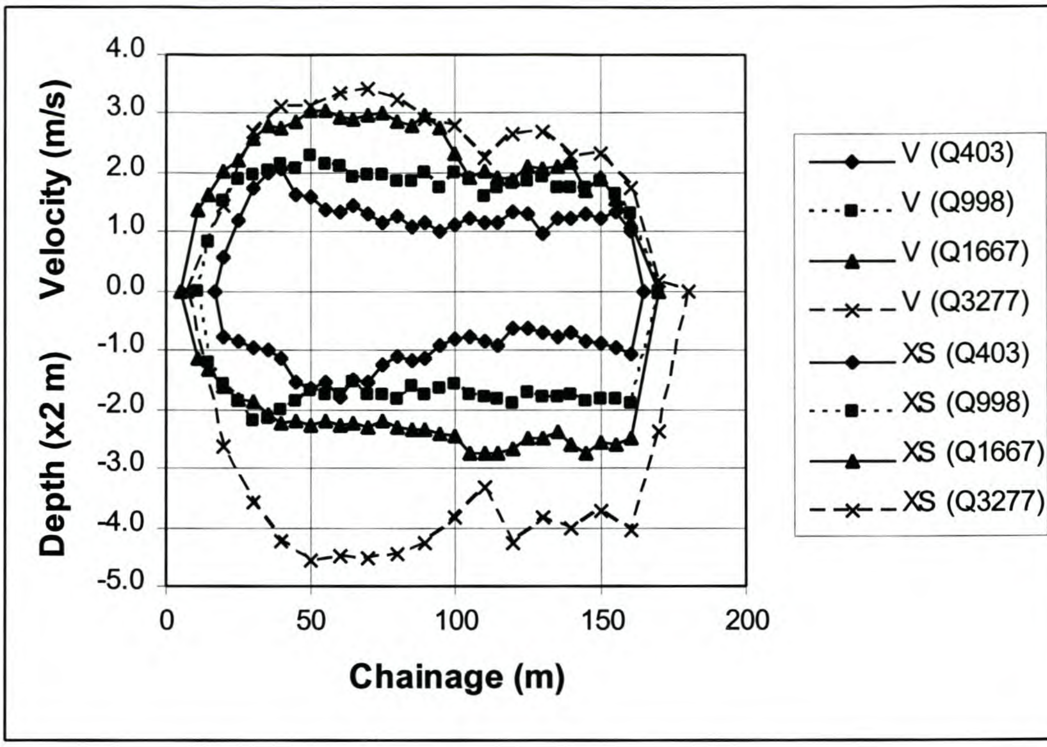

Figure 6.4: An erodable river bed influences the velocity profile for different size discharges in the Orange river at Oranjedraai, DWAF no. D1H009.

In other cases where compound channel flows occurred, a definite reduction in velocity is observed at the interface of the main channel and floodplain. This phenomenon is a result of momentum transfer between the main channel and flood plain (Lambert & Myers, 1998; Wormleaton & Merrit, 1990) and secondary currents (Tominaga & Nezu, 1991).

Another phenomenon is noticed in the velocity distribution of the compound river channel. This is when coherence (COH) approaches unity, as described by Ackers (1991): "the instance where section hydraulics for a compound channel approaches that of a non-compound channel". The turbulence caused by momentum transfer between a main channel and floodplain disappears and the channel exhibits the characteristic flow distribution of a single concave channel.

An example of this was found in a compound river section in the Wilge river near Kimberley (See **Figure 6.5**): for a discharge of 298 m^3/s, all flow was confined to the main channel resulting in a simple convex-curve velocity distribution. At a higher discharge of 1251 m^3/s a typical double curve distribution, as associated with energy losses at the main channel-floodplain interface, is noticed, then for a discharge of 1876 m^3/s the distribution takes on a single convex shape again as associated with a simple concave channel. The legend block, V (Q298) and XS (Q298), denotes velocity distribution and cross section profile for the discharge of 298 m^3/s. Note that the depth scale is factored by 0.2.

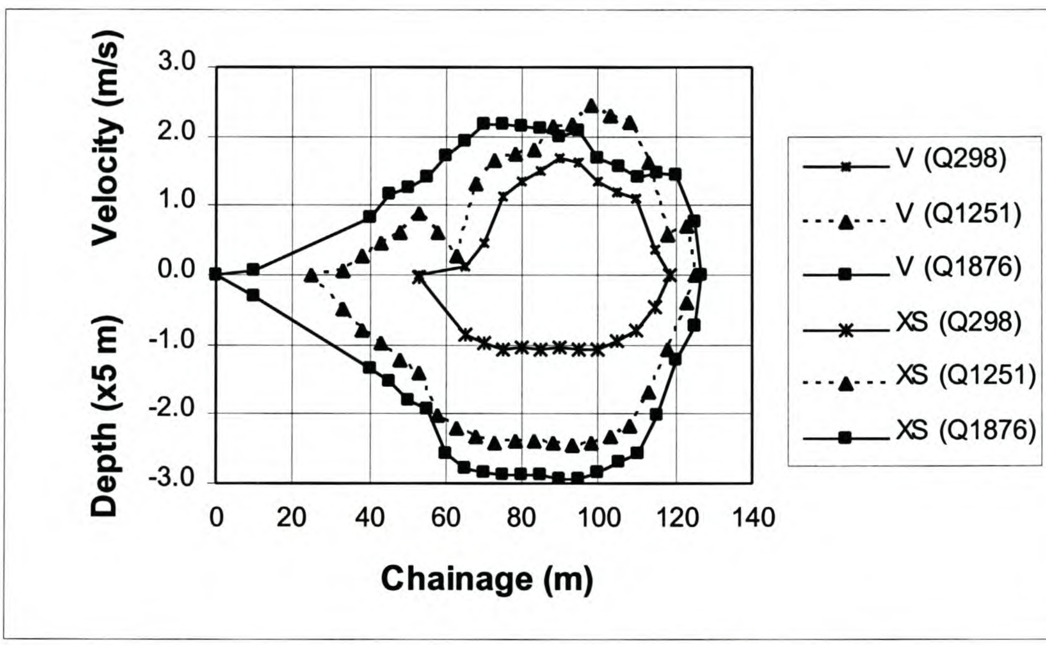

Figure 6.5: Velocity distributions go through 3 distinctive phases for different discharges in a compound river section at the Wilge river near Kimberley.

6.4 Determine the Delta-factor from field data

The delta-factor was determined at several points laterally across the main channel of each river: Consider the main channel left bank as 0% and the right bank as 100% of the channel width, then the delta-factor was determined at 20-, 30-, 40-, 50-, 60-, 70- and 80% of the distance laterally across the main channel. This was a suggestion made by Dr. Pieter Wessels during a meeting with DWAF officials specializing in open channel flow measurement in RSA (see **Appendix A** for minutes of the meeting). In so doing one may notice the effect on the delta-factor as one moves away from the centre of the river towards the side.

The approach followed above proved quite useful: Performing a statistical analysis on the delta-factors at these points, a central zone in the river was identified in which one may safely apply the single point velocity method to determine discharge within a reasonable margin of error. The nearer one moves to the side, the larger the probable error becomes. Refer to the results in section 6.5.1.

One may assume that the highest velocities occur in the centre of the river, where the lowest energy losses occur: Translational energy losses are greatest at the side of a river (Tominaga & Nezu, 1991)

6.4.1 Calculating delta (Δ)

With the field data prepared, as described in 6.2, the next step in determining the delta-factor was to identify fixed boundaries for the main channel, which would apply to the lower and the higher discharges. This was done visually. Stage-heights far below the banks of the river were not included in this study as a velocity measurement at say 20% or 80% of channel width might be near zero or worse even on dry ground, since the top of the main channel banks represented 0% and 100% of the width.

See **Figure 6.6** for a typical representation of the main channel boundaries. For calculation of delta(Δ), the centre of the main channel remains fixed at 50% main channel width, irrespective of flow depth.

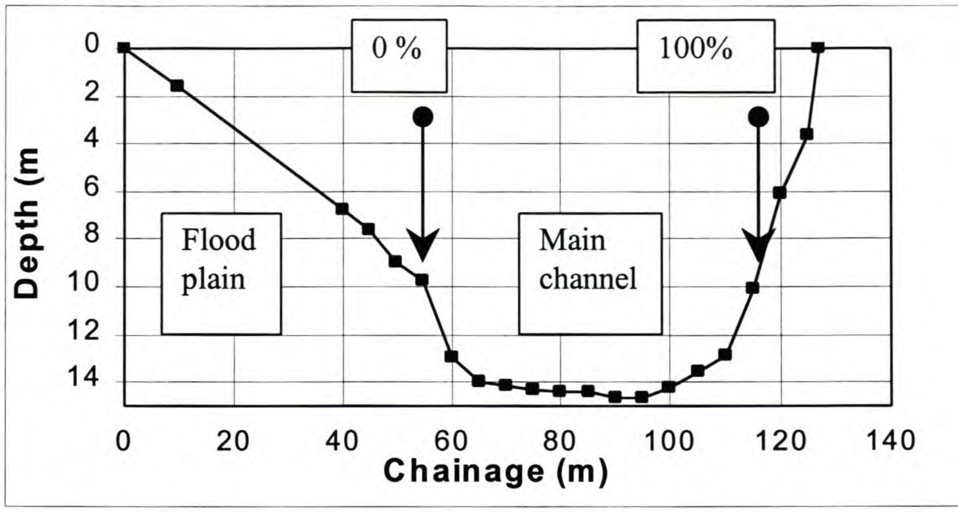

Figure 6.6: Choosing the left bank and right bank of the main channel for a typical compound river section.

With the banks fixed, a simple calculation produced chainage distances (laterally across the river) for 20% to 80% in 10% increments. The result was several distances in meters measured from some distant zero point on the left bank of the river.

Since physical measurements across a river are taken at intervals varying between 2 and 10 meters, depending on the width of the river and available time to do the measurements, it so happens that the calculated distance to determine delta(Δ) does not coincide with an actual point of measured velocity. In these cases the velocity was interpolated.

Table 6.1 presents a typical table layout used in MS Excel to calculate the measured velocity distribution and the delta-factors.

Methodology: In a typical DWAF current gauging (refer **Table 6.1**), velocity (Column 4, 5 & 6) is measured at several chainage distances laterally across a river (Column 2). The area (Column 8) for each depth averaged velocity measurement (Column 7) is determined and hence discharge through that area is calculated (Column 9). Summation of all these component discharges produces a total discharge.

At some fixed points across the river, delta is determined by dividing each point velocity by the total average velocity. See **Table 6.1**. For this field data, the 3-point method of measurement was applied, which is considered very accurate.

Table 6.1: This table represents a typical current gauging by DWAF. The smaller table at the bottom indicates percentages and the actual chainages at which delta(Δ), in the last column, was calculated..

STATION No. :	D1H003	START TIME :	09h10
RIVER NAME :	Oranje	Average Gaugeplate reading :	1.881 m
PLACE NAME :	Aliwal Noord		
DATE :	1994/02/12	Main Channel LEFT :	50
		Main Channel RIGHT :	160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage (m)	Vertical or effective depth (m)	Velocity 0.2d (m/s)	Velocity 0.4d (m/s)	Velocity 0.8d (m/s)	**V aver.** (m/s)	**Area** (m^2)	**Q** (m^3/s)
						2.102	**433.4**	**911.08**
1	31	0	0	0	0	0.000	0.0	0.00
2	36	0.195	0	-0.404	0	-0.404	1.0	-0.39
3	41	0.38	0	-0.222	0	-0.222	1.9	-0.42
4	46	1.39	0	0.324	0	0.324	7.0	2.25
5	51	2.17	0.391	0.902	1.349	0.886	10.9	9.61
6	56	1.52	1.176	1.437	1.842	1.473	7.6	11.19
7	61	2.08	1.015	1.277	1.665	1.309	10.4	13.61
8	66	2.87	1.243	1.382	1.716	1.431	14.4	20.53
9	71	3.7	1.441	1.745	1.669	1.650	18.5	30.53
10	76	4.277	2.23	2.104	1.56	2.000	21.4	42.76
11	81	5.367	2.205	2.458	2.015	2.284	26.8	61.29
12	86	4.577	2.618	2.564	2.256	2.501	22.9	57.22
13	91	4.696	2.407	2.72	2.433	2.570	23.5	60.34
14	96	4.746	2.407	2.884	2.572	2.687	23.7	63.76
15	101	5.182	2.294	2.741	2.897	2.668	25.9	69.13
16	106	5.081	2.197	2.745	2.985	2.668	25.4	67.78
17	111	5.313	0	2.576	0	2.576	26.6	68.43
18	116	5.307	0	2.31	0	2.310	26.5	61.30
19	121	5.24	0	1.893	0	1.893	26.2	49.60
20	126	5.402	0	2.201	0	2.201	27.0	59.45
21	131	3.929	0	2.559	0	2.559	19.6	50.27
22	136	3.889	0	2.618	0	2.618	19.4	50.91
23	141	3.441	1.838	2.18	2.294	2.123	17.2	36.53
24	146	3.167	1.475	1.361	1.205	1.351	15.8	21.39
25	151	1.29	0	0.294	0	0.294	6.5	1.90
26	156	1.55	0	0.29	0	0.290	7.3	2.13
27	160.46	0	0	0	0	0.000	0.0	0.00
50								
						2.102	**433.4**	**911.08**

Delta value calculations

Percntge	Act. Chn.	Ch-Low er	Ch-Upper	V-low er	V-Upper	V-Int	Delta
30%	**83.0**	81.00	86.00	2.28	2.50	2.37	**0.89**
40%	**94.0**	91.00	96.00	2.57	2.69	2.64	**0.80**
50%	**105.0**	101.00	106.00	2.67	2.67	2.67	**0.79**
60%	**116.0**	116.00	121.00	2.31	1.89	2.31	**0.91**
70%	**127.0**	126.00	131.00	2.20	2.56	2.27	**0.93**

The measured data and calculated delta-factors of which a typical example is presented in **Table 6.1** above, are shown in **Appendix H** for all the river gaugings (approximately 90). A graphical representation of the cross section profile, velocity profile and delta factors are also shown in **Appendix H**.

6.5 Statistical analysis of the delta-factor determined from the field data.

A statistical analysis of the delta-factors derived from measured data was done to ascertain whether these observations were substantial enough to produce delta-factors which could be applied to any river cross-section in general, or to specific profile sections, e.g. parabolic, trapezoidal, compound, and still maintain an acceptable level of accuracy.

The criteria for analysis was the average delta-factor at 20%, 30%, 40% up to 80% of the main channel width, and secondly the standard deviation of delta at each of the above intervals.

Firstly all data was used disregarding section geometry; secondly the data was grouped according to similar section profiles and re-analysed. See **Appendix B**. The geometry specific section profiles investigated were:

- Rectangular - width over depth ratio approximately 20
- Trapezoidal - width over depth ratio approximately 20
- Parabolic - width over depth ratio approximately 10

6.5.1 Results

From the results it can be seen that for all river cross sections an approximate delta value of 0.8 applied in the centre of the river will produce an average velocity with a standard deviation of 12 % from the actual velocity. When considering profile-specific cross sections, such as rectangular or trapezoidal, the standard deviation reduces to 3- or 5%, which is quite promising. Refer to **Table 6.2** which contains results for the delta values at the centre of each river.

Table 6.2: This table represents a summary of results in Appendix B

Statistical analysis of Delta-factors for combinations of measured data

Chainage as a percentage of channel width	All measured data combined: 14 river sections		Rectangular fixed bed sections: 3 river sections		Trapezium sections: 3 river sections		Parabolic section: 1 river section	
	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation
40%	0.81	0.10	0.77	0.05	0.83	0.03	0.68	0.06
50%	0.81	0.12	0.78	0.05	0.81	0.05	0.66	0.04
60%	0.84	0.12	0.82	0.07	0.82	0.10	0.75	0.05

The standard deviation around the centre of the main channel is relatively low opposed to the deviations closer to the rivers edge. For this reason application of this method must be as close to the centre of the main channel as possible. The results for the different analyses are discussed below.

Results of all data combined.

The entire population of data, 79 river gaugings with 7 delta-factors calculated for each gauging (from 20% to 80% main channel width), was used for this analysis. Despite the wide variety of section geometries the data compared fairly well: the average delta-factor for the centre of the river is 0.81 with a standard deviation of 0.12. The two adjacent delta factors, at 40% and 60% channel width, are 0.81 and 0.84 with standard deviations of 0.1 and 0.12 respectively.

Further away from the channel centre, 30% and 70% and beyond, the delta-factor becomes 0.9 and higher, with standard deviations of 0.18 up to 2.11.

Results for similar geometry sections

When considering sections of similar geometry, the delta factor becomes geometry-specific: for deep parabolic sections the delta–factor in the river centre is around 0.67 and for trapezium- or rectangular cross sections the delta factor is around 0.77. In all these cases the standard deviation is less than 0.05....which is very good.

Therefore determining the geometry-specific velocity profile, via direct measurement or an accurate theoretical model, would produce river discharges well within the 10% level of accuracy required by DWAF (See **Appendix A**).

Table 6.2 indicates a summary of the most important results, **Appendix B** contains the complete set of statistical results and indicates the river sections associated with the geometry specific results.

7 THEORETICAL VELOCITY DISTRIBUTION

Three approaches were considered in order to find a method which closely represents the measured field data distribution, namely one-dimensional and two-dimensional theory, and an empirical approach.

7.1 One-dimensional theoretical approach

For the one-dimensional theory on flow velocities, Manning's formula was used due to its simplicity. In MS-excel a spreadsheet was set up, using the chainages and depths measured during the field measurements. Assumptions were made for three parameters used in Manning's formula. These were:

First assumption: Manning's n-values for the main channel and river banks were not included in the available field data and are therefore taken from a general table (Road drainage manual, RSA) and applied to all cross sections.

Second assumption: Bedslope - The assumption is that the maximum calculated velocity is equal to the maximum measured velocity in the centre of the river: at the centre of a river where velocities are expected to be the highest, energy losses are low as it is assumed that no vertical or lateral velocities are present. Therefore all available energy produces streamwise motion. Using this as a guideline, the river bed slope is adjusted until the maximum calculated velocity equals maximum measured velocity.

Third assumption: The hydraulic radius (R) for Manning's formula is taken as equal to depth for each point velocity calculated: $R \approx y$. This would only apply to very wide sections with a constant depth.

Manning's formula reads as follows:

$$V = \frac{1}{n} R^{\frac{2}{3}} S_0^{\frac{1}{2}} \qquad \textit{(Equation 7.1)}$$

with V = velocity

n = Mannings roughness coefficient

R = hydraulic radius

S_0 = bed slope

It must be kept in mind that the use of Manning's formula in this case is not to determine discharge, but only the lateral velocity profile and average velocity to enable the calculation of the delta-factor.

For each measured velocity profile, a one-dimensional velocity profile and a range of Delta-factors were determined. This produced a large population of data for statistical analysis and comparing with the measured velocity data.

7.1.1 Results for one-dimentional theoretical approach

In all cases the one-dimentional approach (Manning's formula) overestimated the average velocity, resulting in a total over-estimation of discharge by about 10% when compared to the measured data.

See **Appendix H** for the Manning-calculated delta-factors. **Table 7.1** indicates a summary of the most important statistical results. **Appendix B** contains the complete set of statistical results and indicates the river sections associated with the geometry specific results.

Table 7.1: This table represents a summary of results in Appendix C

Statistical analysis of Delta-factors for combinations of calculated data (1-dimensional formula)

Chainage as a percentage of channel width	All measured data combined: 14 river sections		Rectangular fixed bed sections: 3 river sections		Trapezium sections: 3 river sections		Parabolic section: 1 river section	
	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation
40%	0.94	0.09	0.96	0.04	0.96	0.05	0.90	0.00
50%	0.93	0.06	0.95	0.03	0.94	0.03	0.90	0.00
60%	0.95	0.08	0.97	0.03	0.94	0.03	0.86	0.01

7.2 Two-dimensional theoretical approach

Two attempts were made to numerically solve the partial differential equations as presented by Wormleaton (1988) and by Wark, Irvine and Samuels (1990). The first attempt was to solve the Wormleaton equation as an initial value problem using the Fourth-Order Runga-Kutta Formula (Advanced Engineering Mathematics; Zill & Cullen; 1992). The second attempt was to solve the Wark, Irvine and Samuels equation as a boundary value problem using Finite-Difference Methods for Nonlinear Problems (Numerical Analysis, Third Edition; Burdon & Faires; 1985).

7.2.1 Initial value problem:

For this approach, only half of the river width is considered. The motivation for this is that the lateral velocity-gradient in the middle of the river equals zero, therefore no transverse velocities occur at this point. This gives reason to believe that conditions either side of the centre do not influence each other. Using Mannings 1-dimentional formula, an initial value is calculated for the centre of the river in order to apply the Fourth-Order Runga-Kutta method. The Wormleaton equation as described in section 5.2.2 is presented below:

$$gS_0 - \frac{fU|U|}{8h} + \frac{\partial}{\partial y}\left(\nu_t \frac{\partial U}{\partial y}\right) = 0 \qquad \textit{(Equation 7.2)}$$

is solved as follows:

$$gS_0 - \frac{fU|U|}{8h} + \nu_t \frac{\delta^2 U}{\delta y^2} = 0$$

It can now be written in a form suitable for solving using Runga-Kutta:

$$\frac{\delta^2 U}{\delta y^2} = \frac{fU^2}{8h\nu_t} - \frac{gS_0}{\nu_t}$$

Which is similar to:

$$\frac{\delta^2 U}{\delta y^2} = C_1 U^2 - C_2$$

Let $\frac{\delta U}{\delta y} = V$ then $\frac{\delta V}{\delta y} = C_1 U^2 - C_2$

after substitution of related formulae described in chapter 5, the constants C1 and C2 are as follows:

$$C_1 = \frac{f}{8h\nu_t} = \frac{8gn^2h^{\frac{-1}{3}}}{8h\left(\lambda h\sqrt{gRS_0}\right)}$$

$$C_2 = \frac{gS_0}{\nu_t} = \frac{gS_0}{\lambda h\sqrt{RS_0}}$$

The fourth-order Runga-Kutta method is as follows:

$$U_{n+1} = U_n + \frac{1}{6}(m_1 + 2m_2 + 2m_3 + m_4) \qquad \text{(Translational velocity)}$$

$$V_{n+1} = V_n + \frac{1}{6}(k_1 + 2k_2 + 2k_3 + k_4) \qquad \text{(Lateral velocity)}$$

where

$$m_1 = hf(y_n, U_n, V_n) \qquad k_1 = hg(y_n, U_n, V_n)$$

$$m_2 = hf\left(y_n + \frac{1}{2}h, U_n + \frac{1}{2}m_1, V_n + \frac{1}{2}k_1\right) \quad k_2 = hg\left(y_n + \frac{1}{2}h, U_n + \frac{1}{2}m_1, V_n + \frac{1}{2}k_1\right)$$

$$m_3 = hf\left(y_n + \frac{1}{2}h, U_n + \frac{1}{2}m_2, V_n + \frac{1}{2}k_2\right) \quad k_3 = hg\left(y_n + \frac{1}{2}h, U_n + \frac{1}{2}m_2, V_n + \frac{1}{2}k_2\right)$$

$$m_4 = hf(y_n + h, U_n + m_3, V_n + k_3) \qquad k_4 = hg(y_n + h, U_n + m_3, V_n + k_3)$$

Sample calculation:

For a sample calculation, data was used from an actual flow measurement so that results could be compared. The river section is De Langes drift in the Klip river, DWAF station number C1H015. This is a compound river section. The flow rate was 113 m^3/s. See **Appendix D** for the sample calculation.

7.2.2 Boundary value problem

The other approach was to solve the Wark, Irvine and Samuels formula as a boundary-value problem. This formula is similar to the Wormleaton formula, except for a factor (B) relating stress on an inclined surface to stress in the horizontal plane.

The approach is to solve the 2nd derivative with finite differences at a number of points on a grid between the fixed boundaries. This produces a system of equations to be solved simultaneously. However the system of equations that is derived will not be linear, so an iterative process is required to solve it. An MS Excel spreadsheet was used to do the iterations and produce results within a preset tolerance. A range of initial values for each grid point was determined using Manning's equation, these however changed during the iteration process.

The Wark, Ervine & Sammuels equation, as described in section 5.2.2, is presented below:

$$gDS_{xf} - \frac{Bf|U|U}{8} + \frac{\partial}{\partial y}\left[\nu_t D \frac{\partial U}{\partial y}\right] = 0 \qquad \textit{(Equation 7.3)}$$

The lateral shear part of the formula, which contains the second order partial differential, may be written in the Finite-Difference format as follows:

$$\left.\frac{\partial}{\partial y}\left[\nu_t D \frac{\partial U}{\partial y}\right]\right|_{y_i}$$

$$= \frac{1}{h}\left[\left(\nu_t D \frac{\partial U}{\partial y}\right)_{y_{i+\frac{1}{2}}} - \left(\nu_t D \frac{\partial U}{\partial y}\right)_{y_{i-\frac{1}{2}}}\right]$$

$$= \frac{1}{h}\left[(v_t D)_{y_{i+\frac{1}{2}}} \frac{U_{i+1} - U_i}{h} \quad - \quad (v_t D)_{y_{i-\frac{1}{2}}} \frac{U_i - U_{i-1}}{h} \right]$$

$$= \frac{1}{h^2}\left\{ (v_t D)_{y_{i-\frac{1}{2}}} U_{i-1} \quad - \quad \left[(v_t D)_{y_{i-\frac{1}{2}}} + (v_t D)_{y_{i+\frac{1}{2}}} \right] U_i \quad + \quad (v_t D)_{y_{i+\frac{1}{2}}} U_{i+1} \right\}$$

The finite difference equation, based on the above partial differential equation, is as follows:

$$gDS_{xf} - \frac{Bf|U|U}{8} + \frac{1}{h^2}\left\{ (v_t D)_{y_{i-\frac{1}{2}}} U_{i-1} - \left[(v_t D)_{y_{i-\frac{1}{2}}} + (v_t D)_{y_{i+\frac{1}{2}}} \right] U_i + (v_t D)_{y_{i+\frac{1}{2}}} U_{i+1} \right\} = 0$$

……………………………………………………………………………………….*(Equation 7.3a)*

Sample calculation:

For a sample calculation, data was used from an actual flow measurement so that results could be compared. The river section is at De Langes drift in the Klip river, DWAF station number C1H015. The measurement was done in February 1975, and a discharge of 179.48 m^3/s was measured.

For the sample calculation, the following values were used:

Roughness coefficient (n) = 0.035

Bedslope streamwise (S_x) = 0.0001

Eddy viscosity (λ) = 0.16 (Proposed by Wormleaton, 1988)

Water density (ρ) = 1000 kg/m^3

Other sample calculation data are:

Chainage distance = 25 m (The centre of the river)

Water Depth (D) = 8.6 m

Start velocity (U_i)= 0.9686 m/s (This value is to change during subsequent iterations)

Step size of grid (h) = 0.5 m

Lateral bed slope (S_y) = 0.03

Bed shear (τ_b) = $\rho g R S_0$ = 9810 x 8.6 x 0.0001 = 8.437 N/m^2

Shear velocity (U_*) = $\sqrt{\dfrac{\tau_b}{\rho}} = \sqrt{\dfrac{8.437}{1000}} = 0.0918$ m/s

Lateral eddy viscosity (ν_t) = $\lambda U_* D = 0.126$ m^2/s

Friction factor (f) = $\dfrac{8gn^2}{D^{\frac{1}{3}}} = 0.0469$

Inclined slope stress factor (B) = $\sqrt{\left(1+S_x^2+S_y^2\right)}$ = 1.000555

Substituting the above values in Equation 7.3a:

$$0.00844-\frac{0.04692\times 0.9686^2}{8}+$$

$$\frac{1}{0.5^2}\{(0.12619\times 8.590)0.9589-[(1.0840)+(1.0790)]0.9686+(0.12584\times 8.575)0.9760\}=-0.001806$$

Through a process of iterations the solution of the above equation should converge to zero.

7.2.3 Results for the two 2-dimentional theoretical approaches

Results for the initial value problem:

The results were unsatisfactory. Close to the middle of the river the calculated velocities appear correct, but as one approaches the side of the river, the velocity tends to infinity instead of converging to zero. See **Appendix D**. No illustration of results is presented for this approach: The river edge becomes a vertical asymptote where velocity theoretically tends to infinity.

Upon close inspection of the formulae and the constants, it was found that C_1 and C_2 are divided by depth (h). So as depth approaches zero at the river side, these values increase. As no sensible results were obtained, another approach had to be followed.

Results for the boundary value problem:

A table of results for the Klip river data mentioned above is presented in **Appendix E**. The graph in **Figure 7.1** indicates the resulting calculated velocity distribution compared to the measured values. The calculated data was done for step sizes h = 1m and h = 0.5m. The smaller the step size, the more accurate the velocity distribution. The measurement was done in the Klip river at De Langes drift in February 1975, the discharge was $179m^3/s$.

The resulting distribution for step size h=0.5 compares reasonably well to the measured velocities, however one problem was encountered with this method. The computational capacity of the program was unable to meet the preset tolerance. Approximately 100 equations had to be solved simultaneously. After 150 iterations the computer ends its calculation process without having achieved the preset level of accuracy.

The results gained are displayed for the h=1m interval. The velocity distribution is not realistic since the interval size is too large, for h=0,5mm the velocity distribution actually did closely relate to measured values during one run, but the same interval size produced a less representative velocity distribution during a next run: Each run randomly changes the figures during the iterative process, but does not reach the pre-set accuracy as the program abruptly stops due to the computer program's limited computational capacity.

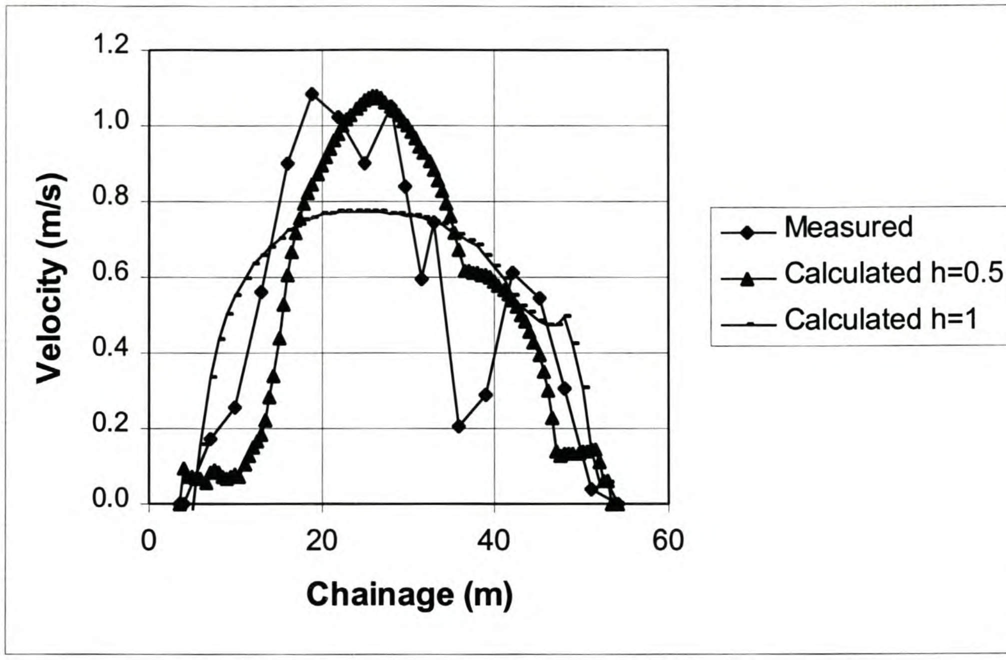

***Figure** 7.1: A comparison of a measured velocity distribution and two calculated distributions using the Finite-differences method with boundary values.*

Further attempts with the difference equation, using a program with sufficient computational capacity would allow interval sizes of h=0.1 to be solved to a required level of accuracy which might achieve acceptable results.

7.3 Empirical Approach

Not having achieved satisfactory velocity distribution results with the one- and two dimensional flow formulae, as discussed in 7.1 and 7.2, an empirical approach was investigated.

It is quite clear that a fixed pattern exists in the velocity profile distribution of the different river sections: where side slopes are steep, the velocity profile is concave, contrary to the convex shape proposed by the one-dimensional formulae, and where overbank flow occurs a distinctive dip in velocity is noticed at the interface of the horizontal floodplain and the steep side slope of the main channel. These patterns are due to a loss in translational energy, which is spent on generating rotational energy in these areas.

7.3.1 Empirical Approach Philosophy

This approach is based on the following:

Hypothesis : Energy is constant across the river.

Motivation: Water reacts rapidly to eliminate energy imbalances.

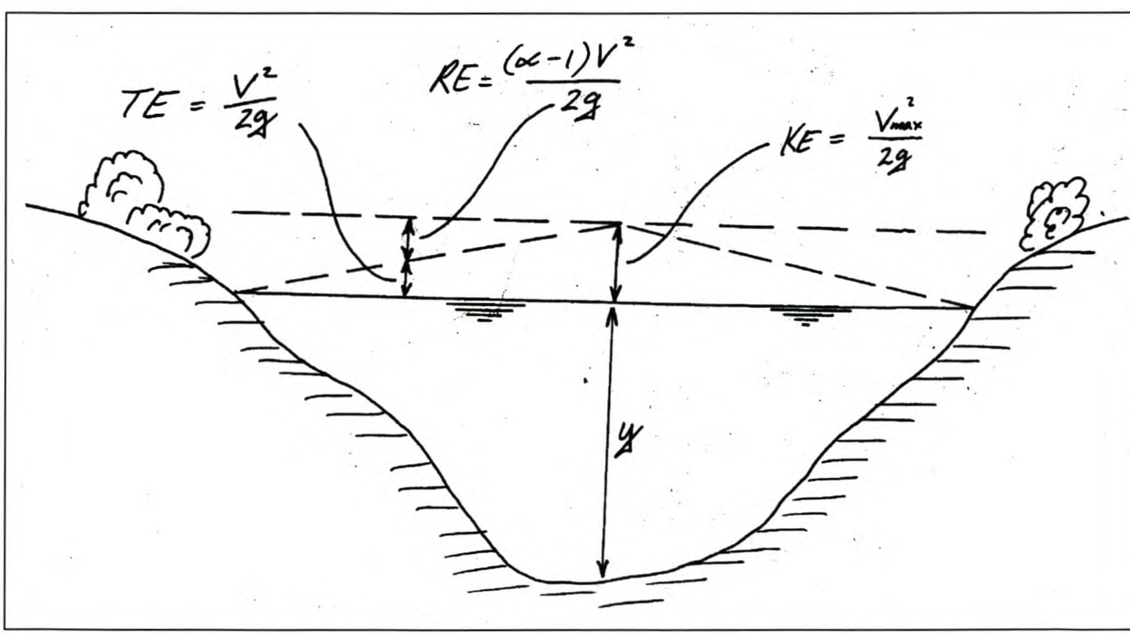

***Figure** 7.2: A typical river cross section schematically depicting the energy components which make up the total energy level.*

In the centre of a river the translational energy content is high and the rotational energy content is low, and vice versa near the side of a river. From **Figure 7.2** it follows that KE = TE + RE. (Rooseboom 1988). KE describes Kinetic energy, TE and RE describe Translational and Rotational energy respectively.

Variables controlling the stream flow: The empirical method considers the lateral bed slope and the depth ratio (point depth over maximum depth) as some of the variables instrumental to the loss of translational energy. Utilising the available field data, there are about 2000 measured points for which the lateral bed-slope and depth ratio could be determined.

The alpha (α) factor compensates for variations in velocity, likely to occur due to energy losses. For each of the above points, an alpha factor is determined. An attempt is made to find a fixed pattern between the bed slope, depth ratio and the alpha values. These parameters are presented in a three dimensional graph: bed slope and depth ratio represent the X- and Y-axis. The alpha(α) values, as determined for each measured velocity, are plotted with respect to the bed slope and depth ratio. All alpha(α) values of similar size are then joined to form iso-lines.

7.3.2 Determining the Alpha(α) factor

The kinetic energy in the centre of the river where maximum flow velocity (V_{max}) occurs, is described as follows (refer to **Figure 7.2**):

$$KE = \frac{V_{max}^2}{2g} \qquad \textit{(Equation 7.4)}$$

From the above hypothesis, energy is constant across the river. Therefore translational energy reduces toward the side of the river as translational velocity (V) decreases, and the balance is made up by the higher rotational energy component closer to the river bank. It therefore follows that:

$$KE = \frac{V^2}{2g} + \frac{(\alpha - 1)V^2}{2g}$$

$$= \frac{V^2}{2g} + \frac{\alpha V^2}{2g} - \frac{V^2}{2g}$$

$$= \frac{\alpha V^2}{2g} \qquad \textit{(Equation 7.5)}$$

V represents the depth averaged velocity for any point laterally across a river. From Equations 7.4 and 7.5 it follows that:

$$\frac{\alpha V^2}{2g} = \frac{V_{max}^2}{2g}$$

$$\alpha = \frac{V_{max}^2}{V^2} \qquad \textit{(Equation 7.6)}$$

In the middle of a river $V = V_{max}$. This produces an alpha value equal to unity. However as one approaches the side of the river, velocities approach zero, the result is very large alpha values at the river edge. The scale of alpha values then being between one and infinity. To curb this problem, a Beta (β) value was derived by dividing the alpha values into one, this resulted in a scale ratio between one and zero which is much simpler to work with. A logarithmic scale was used to represent the bed-slope values, since many of the values are below 0.1 and 0.01: On a linear scale from 0 to 1, these values would seem to lie on top of each other preventing a proper distribution of their respective weights.

A new challenge arose while plotting the near 2000 beta values on one graph, it was near impossible to identify, let alone connect, similar sized beta values.

To solve this problem, nine different graphs were created for the beta values 0.1, 0.2, 0.3 up to 1.0 , each rounded down to the closest 0.1. A best-fit power-function for each set of data was determined (See **Appendix F**). All the function lines were then plotted on a graph without the scatter of data points. See **Figure 7.3.** Note that all beta functions, accept one, plot in a sequential order from 0.1 up to 1.0: The beta function of 0.7 plots beneath the 0.5 function line.

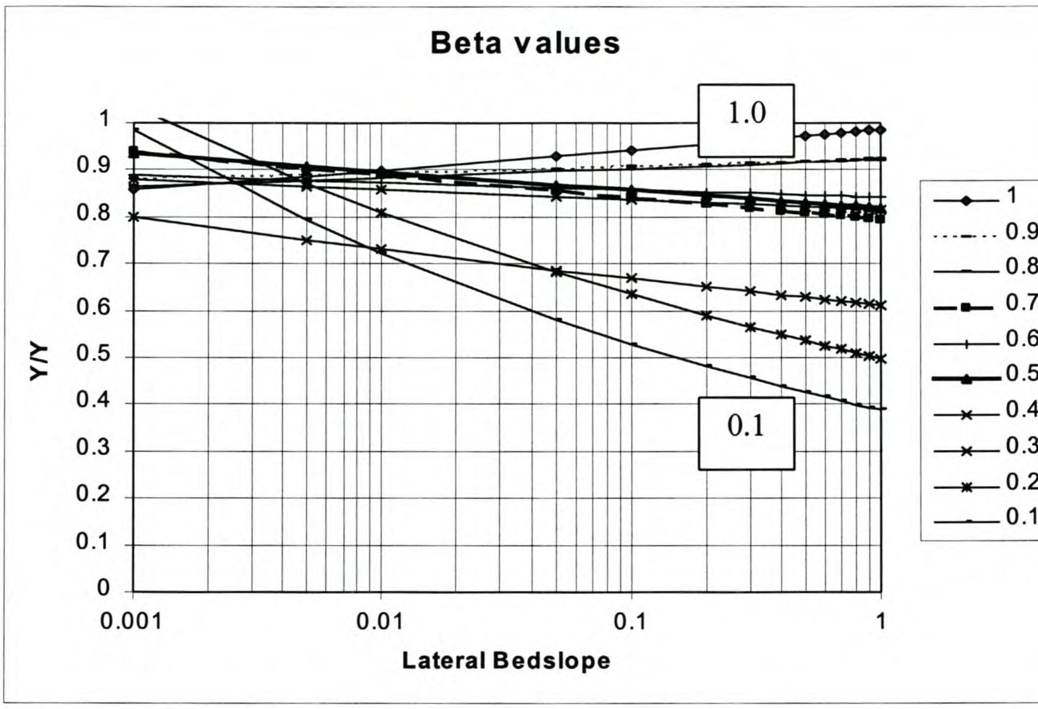

Figure 7.3: The combined beta-function plot representing all measured data.

To determine an alpha value for a specific point, one must merely calculate the bed slope and depth-ratio, read off the applicable beta value from the graph above and determine the alpha value by dividing the beta value into one.

Now, employing the above hypothesis that energy is constant across a river, one may determine a velocity for that point. Equation 7.5 may be rewritten as follows:

$$V = \sqrt{\frac{KE \times 2g}{\alpha}} \qquad \text{(Equation 7.7)}$$

7.3.3 Sample calculation

For the sample calculation the empirical approach was applied to a cross section in the Klip river at De Langes drift, DWAF station no. C1H015. Data was used from measurements done in February 1975. The calculations for the Alpha value and other parameters are presented in **Appendix G**. See **Figure 7.4** for a plot of the measured and calculated velocity distributions.

The following methodology describes a typical application of the Beta-graph for any given river cross-section. Note that the Beta-graph has been determined using over 2000 data points measured in 11 different rivers. Therefore it may be applied in general to any river.

Firstly: Using one-dimensional velocity formulae such as Chezy or Manning, calculate the maximum depth averaged velocity at the centre of a river. Now calculate the kinetic energy using Equation 7.4. The hypothesis in section 7.3.1 applies: The energy level is constant laterally across the river.

Secondly: For every point laterally across the river where a velocity is required, calculate the lateral bed slope and depth ratio $\left(\frac{y}{y_0}\right)$.

Thirdly: Using the bed-slope and depth ratios, read off applicable beta values from the Beta-graph in Appendix F

Fourth: Calculate the alpha value for each of these points $\left(alpha = \frac{1}{beta}\right)$

Fifth: Now determine a velocity for each of the above points using equation 7.7

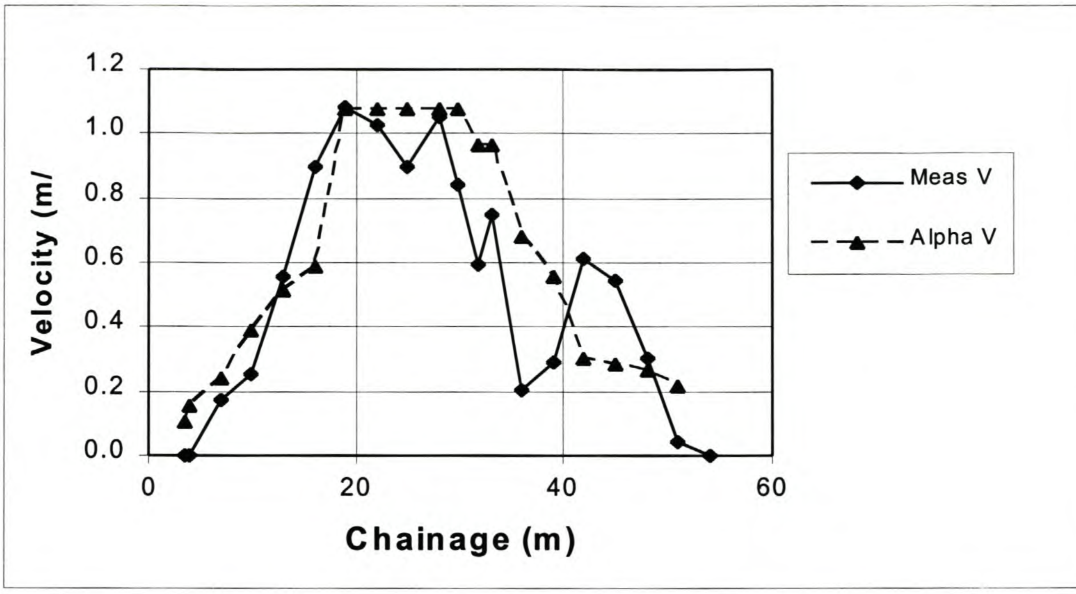

Figure 7.4: The new alpha-calculated velocity distribution (Alpha-V) compared to the measured velocity distribution (Meas-V).

7.3.4 Results:

The beta graph: The distributions of functions representing beta values for points 0.1 to 0.6, and from 0.8 to 1.0 follow in a chronological order as one would expect. There is however a discrepancy with the function for the beta value 0.7, it plots below the 0.5 beta function.

This points out a discontinuity in the system, but does not indicate exactly where it is. Other variables will have to be considered to eliminate this discontinuity.

The velocity distribution: If one were to discard the 0.7 beta function as an "outlier", it was found that the velocity distribution determined by the beta graph does not fit the measured velocity distribution closely enough to claim success, see **Figure 7.4**: For the compound section in the Klip river, the empirical method does not describe the energy losses at the interface of the flood plain and main channel.

The new velocity distribution does however show a reduction in the floodplain velocities, hence reduces the error of overestimation when calculating the total discharge: When using the Manning equation to determine the velocity distribution, the discharge was overestimated by 20%, as concluded by Garbrecht and Brown (1991) when dividing a channel into 10 or more sub-divisions. Upon applying the beta-graph methodology as presented by this work, the overestimation of total discharge is only 10%.

However, the aim of the beta–graph method is not to determine discharge but to model the velocity distribution laterally across a river, in so doing the delta factor may be determined with which to translate a point velocity to average river velocity. Other researchers have dealt with adjustment factors applied to the DCM to accurately predict total discharge; Ackers (1993), Wormleaton & Merrit (1990), Stephenson & Kolovopoulus (1990). Therefore the beta-graph is not proposed as an adjustment factor for the DCM.

8 SUMMARY OF METHODS APPLIED

To summarise the results of the approaches for determining velocity distributions in this work, the following:

General

In a nutshell, application of the method works as follows: a single point surface velocity in the centre of a river must be factored by 0.8 to obtain the depth-averaged velocity for the vertical stream element. This new velocity value must then be factored with the Delta-factor, which is approximately 0.8 in the centre of a river, to obtain the average velocity for the river as a whole. The product of average velocity and discharge area produces total discharge.

In the case of a float gauging, which is often used by DWAF, the float velocity must therefore be factored by 0.64 to obtain average velocity for the river as a whole, and not by 0.8 as mentioned in section 2.1 of this work.

Note that all approaches followed to determine the Delta(Δ) factor are applicable to straight prismatic sections in rivers. The theory has not been tested within bends in a river, and it may be expected that bends directly upstream or downstream of the considered cross section may have an influence on the lateral velocity profile.

One Dimensional Flow formula

This approach is attractively simple, but it does not produce a lateral velocity distribution to the degree of accuracy one would require for the calculation of the Delta-factor. The One-dimensional formulae do not bring into account energy losses due to transverse flow which results in an overestimation of velocity and thus discharge. However applying correction factors as suggested by Ackers (1993), Wormleaton & Merrit (1990), Stephenson & Kolvopoulus (1990), one could accurately calculate the total discharge for the river as a whole, or separately for the main channel and floodplain in the case of compound channels.

Two Dimensional Flow Formula: Initial value approach

This method did not produce useable results. It is suggested that no further investigation is done considering the Runga-Kutta approach to numerical analysis. The Wormleaton equation, which was used in this approach, however should produce better results when using another mathematical model.

Two Dimensional Flow Formula: Boundary value approach

This method did show promising results, although not to the required degree of accuracy. The iterative process is not yet complete and may require a specialized program to attain an acceptable level of accuracy.

This method is not reliable at this stage, but promises to be a serious contender for a reliable approach to the theoretical velocity distribution.

Empirical approach

The empirical approach is simple and easy to apply. The basic theory is practical and the application robust. A glitch in the set-up however prevents a flawless distribution of the beta functions in the Beta-graph. To rectify this, fine tuning of the existing Beta-graph and further investigation into variables controlling stream flow are required.

Approximately 2000 real data points were used to set up the Beta-graph. Application of this method, regarding Beta = 0.7 as an outlier, produce a velocity distribution much closer representing the actual average velocity than does the One-dimensional flow formulae. This approach may be applied if kept in mind that the method needs refinement.

Analysis of field data

This showed the most promising results of all approaches. Geometry specific calculation of the Delta-factor produced values which gave results within 5% of the measured discharges. Further analyses of field data would secure delta factors for different types of section geometries. This is a very practical way of obtaining Delta-factors applicable to a wide variety of river channel geometries.

9 DISCHAGRE AREA VARIATIONS

During relatively high discharges, or floods especially, scouring of the riverbed is likely to occur unless it is made up of rock or some hard conglomerate. This results in a larger discharge area than would be assumed by doing pre- or post flood surveys of the river section: after a flood peak passes a given cross section in a river, the scouring effect stops, velocities decrease and deposition of material takes place, building up the river to approximately its original shape prior to the flood.

Not bringing the scouring-effect into account, one would underestimate the actual discharge in the river.

This work does not cover investigations into scouring or erodable riverbeds. For all the discharge methods discussed in this work it is assumed that the riverbed is fixed and the cross section profile remains the same for low flow and flood conditions.

10 CONCLUSIONS

From the findings of this report, the following conclusions are drawn:

- Accurate measurement of flood flow in open channels is absolutely necessary to manage water resources optimally, especially in a water scarce country.
- Conventional methods of measurement such as current gaugings are accurate but often restricted due to lack of resources or accessibility to the river during upper regime discharges.
- From the processed field data it was found that fixed patterns exist for lateral velocity distributions at different flow levels in a river. This is an indication that a single delta-factor may be used as a constant, applicable for a whole range of flow levels in the application of the Single Point Velocity measurement approach to derive river discharges.
- The delta-factor at the centre of a river, and up to 20% of the main channel width either side of the centre point, is more stable than delta-values closer to the side of a river. Delta-values must therefore be determined close to the centre of a river for reliable results. The mean delta value in the centre of a river for all the measured data is 0.81, with a standard deviation of approximately 0.1.
- The delta-factor for channel-specific river profiles, such as trapezoidal or rectangular sections, has a mean value of 0.81 and 0.78 respectively in the centre of the river with standard deviations of 0.03 to 0.05, which is an indication of reliable data.
- Delta-factors for asymmetrical compound channels must be determined for each specific river section: when overbank flow occurs, the delta-factor increases as the centre of the river shifts relatively to the fixed measuring point. Therefore the general rule of delta being a constant does not apply. In a specific case of measured velocity in this work, delta changed from 0.8 up to 0.95 as the overbank flow depth increased.
- Using the method of velocity measurement by means of pressure measurements against bridge piers, allows for continuous data capturing at a fixed point in a river when using data loggers. This is ideal for application of the Single Point

Velocity Measurement method. However one must assume that the river bed remains fixed during floods.

- One dimensional-flow formulae, such as Manning's, does not give a representative velocity distribution laterally across a river. This results in an incorrect average velocity (10% to 20% overestimation) and thus incorrect delta-factors.
- The two-dimensional boundary value approach for calculating a velocity distribution approximates the measured velocity profile reasonably well, even though smaller step sizes for the numerical analysis and greater computational strength might produce more accurate velocity distributions.
- The empirical-approach showed promising results for lateral velocity distributions, but still needs refinement.

11 RECOMMENDATIONS

Based on the conclusions of this report, the following recommendations are made:

- For single channel rivers, determine a valid delta-factor and apply it as a constant to calculate upper regime discharges in the river, using the Single Point Velocity measurement approach.
- Determine delta-factors at the centre of a river, or close to the centre, to obtain the best results for reliable discharge calculations.
- From the vast resources of measured field data at DWAF head office, obtain more geometry-specific flow measurement data. Set up a large population of trapezoidal sections only, for example, and calculate their delta factors for statistical analysis. This should produce constant delta-values with low standard deviations. Such delta values would then be applicable to any trapezoidal section, with a resulting high level of accuracy expected for the calculated discharge.
- For asymmetrical compound channels, delta-factors must be calculated for each section individually: the width of the flood plain influences the variation of delta during overbank flow. Therefore delta must be calculated for flow in the main channel only, and for overbank flow conditions. These delta factors are then applicable only to this cross-section or others with similar geometry.
- Apply the pressure-measurement-against-a-bridge-pier method of point velocity measurement as described by Meyer and Rooseboom (2000) or Cloete and Rooseboom (2000). This results in a fixed point velocity measurement, operating remotely without losing data, which is ideal for application of the Single Point Velocity Measurement method.
- When applying the two-dimensional boundary value approach for calculating a lateral velocity distribution. Use smaller step sizes and larger computational capacity to solve several hundred equations simultaneously. The aim being to achieve a better represented velocity distribution.
- Further research is required to improve the empirical approach. By fine tuning the flow parameters one may achieve velocity distributions more closely representing the measured distributions, and thus accurate delta-factors.

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13 APPENDICES

APPENDIX A

MINUTES OF MEETING WITH DWAF OFFICIALS CONCERNING VELOCITY DISTRIBUTION AND THE DELTA-FACTOR

Flow measurement by means of pressure measurement at bridge piers.

Muniutes of the meeting held on 24/08/2001 in the DWAF, Hydrometry division conference room, Pretoria.

(Minutes of the meeting were initially presented in Afrikaans, but for the purpose of this thesis it was translated into English)

Attendance list:

Pieter Wessels	DWAF Hidrometry PTA	012-336 7500
Danie van der Spuy	DWAF Hidrometry PTA	012-336 7922
Johan van Heerden	DWAF Hidrometry PTA	012-336 8068
Stephan van Biljon	DWAF Hidrometry PTA	012-336 7500
Gert Cloete	DWAF Western Cape	021-950 7100

1 Introduction:

Mr Cloete welcomed all present and explained that he was doing his post graduate studies on distribution of depth averaged velocities laterally across a river. The aim was to find a theoretical approach to determine the velocity distribution and in so doing convert the point velocity determined at a bridge pier, as proposed by Meyer Rooseboom (2000) and Cloete Rooseboom (2000), to an average velocity for the river as a whole.

2 Flow measurement method

- Present methodology

Applying the pitot tube principle to pressures measured at a bridge pier, a velocity is determined at the pier. This point velocity is converted to depth averaged velocity by applying the Vanoni equation.

This depth averaged velocity is converted to average velocity for the whole river by applying a conversion factor alpha (α) (**NB. For this thesis the conversion factor has been changed to Delta (Δ), and will be referred to as such through the rest of the minutes**).

For the purpose of this work it is assumed that the river bed is stable and no scouring takes place in the river, hence no increase in discharge area.

This approach works fine where measured data are available, as in the case of the White bridge over the Breede river in the Western Cape.

3 Discussion

GC - In the case of a single concave channel the 1-dimensional flow formulae of Manning or Chezy may predict an acceptable velocity distribution, but when overbank flow occurs, another mathematical model must be considered to model the velocities at the main channel/floodplain interface

DvdS - $\Delta_{theoretical}$ and $\Delta_{measured}$ should approach each other if the slope is chosen correctly for the 1-dimensional theory.

PW - Look at different river profiles and consider isolating the main channel when determining the delta-factor. Investigate the difference in the delta-factor for the whole cross section and the main channel separately to "fine tune" for the best option.

JvH - What can the technician in the field do to get an accurate delta factor: The Orange river at Oranjedraai for example has erodeable bed material, so maybe some photos and a cross section survey would help.

Also consider determining the delta factor at sections further upstream or downstream of the gauging weir where the cross section is more stable (i.e. not erodeable).

PW - Use Chezy and sub sections with applicable roughness.

At sections with overbank flow, the delta-factor should start changing as water rises above the floodplains, consider using $\frac{Q_{overbank}}{Q_{main\ channel}}$ as a factor to change the slope of delta.

Do a sensitivity analysis by calculating the delta-factor at 50/50, 60/40 and 70/30 of the channel width.

JvH, PW, DvdS - DWAF Hydrometry division are only interested in a simple and practical method of measuring floods. A complex 3-dimensional approach with overbank flow could be too complicated for the fieldworker to apply. A method applicable to a single concave section which gives good results would be sufficient.

4 Information required

Require current gauging information with a definite main channel and flood plain to determine the variance of the delta-factor for overbank flow.

The following DWAF gauging points for current meters were identified as suitable for the purpose of this project:

C1H15, C8H028, C8H030, C6H006, D1H003, D1H009, D2H033, D3H012, D7H002, D7H012, V1H038, V1H057, V6H002, W4H013

A combined total of 130 current gaugings were selected. Foto copies of the raw field data were made and typed into an MS Excel spread sheet for further processing. Copies of the raw data are kept as reference.

5 Next meeting

No date was fixed for a following meeting. It was agreed upon that a future meeting could be arranged after processing of the field data. Results from the analysis of the field data could assist in decision making and further discussions.

Follow up meeting: A meeting was held again on the 26th of May 2003 with the same group of people, accept for Mr. Van Biljon. No formal minutes were kept, but three main points came from the discussions:

- A two dimensional flow formula should give sufficient accuracy for the theoretical approach. Different formulae are available and should be investigated to find the most suitable one for this method of application.
- Consider only the main channel when determining the delta factor at 50\50, 60\40 and 70\30 % of the channel width.
- Accuracy in final calculated discharge of within 10% from measured discharge will be considered very accurate. Regard this as the goal to achieve.

APPENDIX B

STATISTICS OF DELTA-FACTORS AS DETERMINED FROM MEASURED VELOCITIES

Statistical analysis of Delta-factors for combinations of measured data

Chainage as a percentage of channel width	All measured data combined: 14 river sections		Rectangular fixed bed sections: 3 river sections		Rectangular erodeable sections: 4 river sections		Rectangular best section: 1 river section		Trapezium sections: 3 river sections		Parabolic section: 1 river section	
	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation
20%	2.21	2.11	1.03	0.03	-	-	1.03	0.03	1.72	0.36	-	-
30%	0.89	0.18	0.84	0.05	0.86	0.10	0.75	0.01	0.89	0.14	0.83	0.05
40%	0.81	0.10	0.77	0.05	0.88	0.14	0.71	0.02	0.83	0.03	0.68	0.06
50%	0.81	0.12	0.78	0.05	0.92	0.16	0.72	0.03	0.81	0.05	0.66	0.04
60%	0.84	0.12	0.82	0.07	0.96	0.10	0.76	0.02	0.82	0.10	0.75	0.05
70%	0.91	0.16	0.88	0.10	1.03	0.13	0.81	0.03	0.82	0.07	0.83	0.07
80%	2.12	0.55	0.96	0.09	-	-	0.96	0.09	1.03	0.21	-	-
DWAF numbers of flow gauging stations where relevant data was collected	C1H15, C8H028, C8H030, C6H006, D1H003, D1H009, D2H033, D3H012, D7H002, D7H012, V1H038, V1H057, V6H002, W4H013		C8H028, V1H057, W4H013		D1H009, D7H002, D7H012, V6H002		C8H028		C6H006, D2H033, V1H038		D3H012	
Population size	*79 flow gaugings		*15 flow gaugings		*23 flow gaugings		*6 flow gaugings		*15 flow gaugings		*9 flow gaugings	

* Each gauging consists of approximately 20 depth averaged velocity measurements

APPENDIX C

STATISTICS OF DELTA-FACTORS AS DETERMINED FROM THEORETICALLY CALCULATED VELOCITIES. MANNINGS' EQUATION WAS USED

Statistical analysis of Delta-factors for combinations of calculated data (1-dimensional formula)

Chainage as a percentage of channel width	All measured data combined: 14 river sections		Rectangular fixed bed sections: 3 river sections		Rectangular erodeable sections: 4 river sections		Rectangular best section: 1 river section		Trapezium sections: 3 river sections		Parabolic section: 1 river section	
	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation	Delta average	Standard deviation
20%	1.01	0.07	0.99	0.02	-	-	0.99	0.021	1.00	0.07	-	-
30%	0.94	0.10	0.94	0.01	0.97	0.105	0.99	0.012	0.96	0.04	0.87	0.01
40%	0.94	0.09	0.96	0.04	0.99	0.125	1.01	0.018	0.96	0.05	0.90	0.00
50%	0.93	0.06	0.95	0.03	0.98	0.051	0.96	0.022	0.94	0.03	0.90	0.00
60%	0.95	0.08	0.97	0.03	1.02	0.092	0.95	0.016	0.94	0.03	0.86	0.01
70%	0.97	0.10	1.01	0.03	1.02	0.149	1.02	0.015	0.94	0.02	0.88	0.01
80%	1.03	0.05	0.97	0.02	-	-	0.97	0.016	0.98	0.09	-	-
DWAF numbers of flow gauging stations where relevant data was collected	C1H15, C8H028, C8H030, C6H006, D1H003, D1H009, D2H033, D3H012, D7H002, D7H012, V1H038, V1H057, V6H002, W4H013		C8H028, V1H057, W4H013		D1H009, D7H002, D7H012, V6H002		C8H028		C6H006, D2H033, V1H038		D3H012	
Population size	*79 flow gaugings		*15 flow gaugings		*23 flow gaugings		*6 flow gaugings		*15 flow gaugings		*9 flow gaugings	

* Each gauging consists of approximately 20 depth averaged velocity measurements

APPENDIX D

VELOCITY CALCULATIONS USING THE WORMLEATON 2-DIMENSIONAL FLOW FORMULA, SOLVED AS AN INITIAL VALUE PROBLEM USING THE FOURTH-ORDER RUNGA-KUTTA EQUATION

STATION No. : C1H015
RIVER NAME : Klip
PLACE NAME : De Langes Drift
DATE : 25/02/1975
Measured Q = 113.4 m^3/s

h= 1
n= 0.035
S = 0.00008
R = depth
lamda= 0.16 (Wormleaton, 1988)

Start values (m/s)	
*Un =	0.9
**Vn =	0

The Wormleaton 2nd order differential equation, solved as an initial value problem using the Fourth-Order Runga-Kutta Formula. Starting at the centre of the river, where initial values are known, working to the right bank (Chainage 25m to 50m)

Chainage	dy	D	C1	C2	m1	k1	m2	k2	m3	k3	m4	k4	U n+1	V n+1
25	0	7.0	0.010811	0.009454	0	-0.0007	-0.00035	-0.0007	-0.00035	-0.0007	0.899651	-0.0007	**1.04971**	-0.0007
26	1	7.0	0.010811	0.009454	-0.0007	0.002458	0.000531	0.002455	0.000529	0.002461	-0.00017	0.002464	**1.049918**	0.001761
27	2	7.0	0.010811	0.009454	0.001761	0.002463	0.002992	0.002473	0.002997	0.002479	0.004758	0.002496	**1.053001**	0.004238
28	3	7.0	0.010811	0.009454	0.004238	0.002533	0.005505	0.002556	0.005516	0.002563	0.009754	0.002593	**1.059007**	0.006799
29	4	7.0	0.010811	0.009454	0.006799	0.00267	0.008134	0.002707	0.008152	0.002714	0.014951	0.002759	**1.06806**	0.009511
30	5	7.0	0.010811	0.009454	0.009511	0.002879	0.01095	0.00293	0.010976	0.002938	0.020486	0.002997	**1.080368**	0.012446
31	6	7.0	0.010811	0.009454	0.012446	0.003164	0.014028	0.003232	0.014062	0.00324	0.026508	0.003317	**1.096224**	0.015684
32	7	6.5	0.013337	0.010565	0.015684	0.005461	0.018414	0.005566	0.018467	0.005584	0.03415	0.005708	**1.116823**	0.021262
33	8	6.5	0.013337	0.010565	0.021262	0.006069	0.024296	0.006211	0.024367	0.006231	0.045629	0.006394	**1.144193**	0.027487
34	9	6.5	0.013337	0.010565	0.027487	0.006895	0.030934	0.007078	0.031026	0.007101	0.058512	0.007309	**1.179179**	0.03458
35	10	6.5	0.013337	0.010565	0.03458	0.007979	0.03857	0.008209	0.038685	0.008236	0.073265	0.008495	**1.222905**	0.042808
36	11	4.7	0.033422	0.017184	0.042808	0.032798	0.059207	0.033514	0.059565	0.033788	0.102372	0.034789	**1.286692**	0.076506
37	12	4.7	0.033422	0.017184	0.076506	0.038149	0.09558	0.039427	0.09622	0.039746	0.172726	0.041364	**1.392164**	0.116149
38	13	4.7	0.033422	0.017184	0.116149	0.047592	0.139945	0.049533	0.140916	0.04993	0.257065	0.052301	**1.547987**	0.165952
39	14	3.5	0.077051	0.02674	0.165952	0.157895	0.2449	0.164289	0.248097	0.16733	0.414049	0.177011	**1.808986**	0.33231
40	15	3.5	0.077051	0.02674	0.33231	0.225405	0.445012	0.238207	0.451414	0.242549	0.783723	0.260187	**2.2938**	0.573494
41	16	3.5	0.077051	0.02674	0.573494	0.378667	0.762828	0.400761	0.773875	0.408055	1.347369	0.438295	**3.126178**	0.97926
42	17	1.6	0.70789	0.086513	0.97926	6.831688	4.395104	7.178292	4.568406	8.387312	5.547665	10.06562	**7.201836**	8.984012
43	18	1.6	0.70789	0.086513	8.984012	36.62921	27.29862	39.80905	28.88854	46.29142	37.87255	57.07911	**33.74031**	53.30222
44	19	1.6	0.70789	0.086513	53.30222	805.7815	456.193	824.6475	465.626	967.2487	518.9282	1135.393	**436.385**	974.1301
45	20	1.4	1.033418	0.105698	974.1301	196795.7	99371.99	197299.1	99623.66	248142.1	100597.8	299748.7	**83696.92**	232211.9
46	21	1.4	1.033418	0.105698	232211.9	7.24E+09	3.62E+09	7.24E+09	3.62E+09	9.11E+09	3.62E+09	1.1E+10	**3.02E+09**	8.49E+09
47	22	1.4	1.033418	0.105698	8.49E+09	9.4E+18	4.7E+18	9.4E+18	4.7E+18	1.18E+19	4.7E+18	1.43E+19	**3.92E+18**	1.1E+19
48	23	0.8	5.045265	0.244695	1.1E+19	7.75E+37	3.87E+37	7.75E+37	3.87E+37	1.75E+38	3.87E+37	2.73E+38	**3.23E+37**	1.43E+38
49	24	0.8	5.045265	0.244695	1.43E+38	5.26E+75	2.63E+75	5.26E+75	2.63E+75	1.19E+76	2.63E+75	1.85E+76	**2.19E+75**	9.68E+75
50	25	0.1	1826.581	5.536809	9.68E+75	8.8E+153	4.4E+153	8.8E+153	4.4E+153	4E+156	4.4E+153	8E+156	**3.7E+153**	2.7E+156

* Un represents streamwise velocity. In the middel of the river the initial value is calculated from Mannings 1-dimensional flow formula, assuming no transverse flows exist.
** Vn represents lateral velocity, which is assumed zero in the middle of the river.

APPENDIX E

VELOCITY CALCULATIONS USING THE WARK, IRVINE AND SAMUELS 2-DIMENSIONAL FLOW FORMULA, SOLVED AS A BOUNDARY VALUE PROBLEM USING THE FINITE-DIFFERENCE EQUATION

The Wark, Irvine and Samuels 2nd order differential equation, solved as a boundary value problem using Finite Differences. Starting from the left bank to the right bank.

STATION No. : C1H015	Measured Q = 179.4 m^3/s	Rho = 1000
RIVER NAME : Klip	h = 0.5	g = 9.81
PLACE NAME : De Langes Drift	n = 0.035	lambda = 0.16
DATE : 23/02/1975	So = 0.0001	

Chainage dy	Depth Interpolate	bed shear	shear velocity	nu t lat. eddy visc	f (Darcy friction factr)	B (lateral slope fact)		Streamwise velocity U
3.5		0	0	0	0	0	0.0000000	0.0000
4	0.30	0.27795	0.016672	0.000756	0.146374	1.149396	0.0000115	0.0874
4.5	0.58	0.5559	0.023578	0.002138	0.116177	1.149396	0.0001289	0.0661
5	0.87	0.83385	0.028876	0.003927	0.10149	1.149396	0.0001918	0.0638
5.5	1.15	1.1118	0.033344	0.006046	0.09221	1.149396	0.0002629	0.0624
6	1.43	1.38975	0.037279	0.00845	0.0856	1.149396	0.0001758	0.0615
6.5	1.72	1.6677	0.040837	0.011108	0.080552	1.16619	0.0011449	0.0504
7	2.00	1.97835	0.044479	0.014352	0.076094	1.183685	0.0001293	0.0743
7.5	2.32	2.289	0.047843	0.017862	0.072483	1.183685	0.0001477	0.0805
8	2.63	2.59965	0.050987	0.021618	0.069473	1.183685	0.0000926	0.0767
8.5	2.95	2.9103	0.053947	0.025607	0.066907	1.183685	0.0010096	0.0656
9	3.27	3.22095	0.056753	0.029814	0.064683	1.183685	0.0020709	0.0605
9.5	3.58	3.5316	0.059427	0.03423	0.062728	1.096586	0.0002718	0.0681
10	3.90	3.6624	0.060518	0.036149	0.061972	1.034945	0.0002884	0.0699
10.5	4.03	3.7932	0.061589	0.038103	0.061251	1.034945	0.0054562	0.0672
11	4.17	3.924	0.062642	0.040091	0.060563	1.034945	0.0003885	0.0941
11.5	4.30	4.0548	0.063677	0.042112	0.059905	1.034945	0.0009021	0.1154
12	4.43	4.1856	0.064696	0.044166	0.059274	1.034945	0.0010714	0.1345
12.5	4.57	4.3164	0.065699	0.046252	0.058669	1.044031	0.0002028	0.1525
13	4.70	4.4799	0.066932	0.048905	0.057947	1.054093	0.0067458	0.1652
13.5	4.87	4.6434	0.068142	0.051607	0.057258	1.054093	0.0073757	0.2011
14	5.03	4.8069	0.069332	0.054356	0.056602	1.054093	0.0002808	0.2585
14.5	5.20	4.9704	0.070501	0.057153	0.055974	1.054093	0.0147449	0.3085
15	5.37	5.1339	0.071651	0.059996	0.055374	1.054093	0.0003117	0.3998
15.5	5.53	5.2974	0.072783	0.062885	0.054798	1.192686	0.0002305	0.4821
16	5.70	5.77155	0.075971	0.071514	0.053254	1.390843	0.0002379	0.5513
16.5	6.18	6.2457	0.07903	0.080505	0.051871	1.390843	0.0003110	0.6066
17	6.67	6.71985	0.081975	0.089844	0.050621	1.390843	0.0003482	0.6516
17.5	7.15	7.194	0.084817	0.099519	0.049484	1.390843	0.0004807	0.6887
18	7.63	7.66815	0.087568	0.109518	0.048442	1.390843	0.0006671	0.7198
18.5	8.12	8.1423	0.090235	0.119832	0.047483	1.10353	0.0000549	0.7463
19	8.60	8.12595	0.090144	0.119471	0.047515	1.000555	0.0001512	0.7699
19.5	8.58	8.1096	0.090053	0.119111	0.047546	1.000555	0.0000047	0.7926
20	8.57	8.09325	0.089962	0.11875	0.047578	1.000555	0.0000316	0.8143
20.5	8.55	8.0769	0.089872	0.118391	0.047611	1.000555	0.0000406	0.8350
21	8.53	8.06055	0.089781	0.118032	0.047643	1.000555	0.0001432	0.8548
21.5	8.52	8.0442	0.089689	0.117673	0.047675	1	0.0001837	0.8736
22	8.50	8.06055	0.089781	0.118032	0.047643	1.000555	0.0000265	0.8912
22.5	8.52	8.0769	0.089872	0.118391	0.047611	1.000555	0.0010060	0.9080
23	8.53	8.09325	0.089962	0.11875	0.047578	1.000555	0.0009142	0.9228
23.5	8.55	8.1096	0.090053	0.119111	0.047546	1.000555	0.0003123	0.9358
24	8.57	8.12595	0.090144	0.119471	0.047515	1.000555	0.0000448	0.9478
24.5	8.58	8.1423	0.090235	0.119832	0.047483	1.000555	0.0007871	0.9589
25	8.60	8.09325	0.089962	0.11875	0.047578	1.004988	0.0017648	0.9686
25.5	8.55	8.0442	0.089689	0.117673	0.047675	1.004988	0.0014974	0.9760
26	8.50	7.99515	0.089416	0.116598	0.047772	1.004988	0.0043994	0.9813
26.5	8.45	7.9461	0.089141	0.115527	0.04787	1.004988	0.0066040	0.9815
27	8.40	7.89705	0.088865	0.114459	0.047969	1.004988	0.0002765	0.9740
27.5	8.35	7.848	0.088589	0.113394	0.048069	1.001249	0.0004557	0.9654

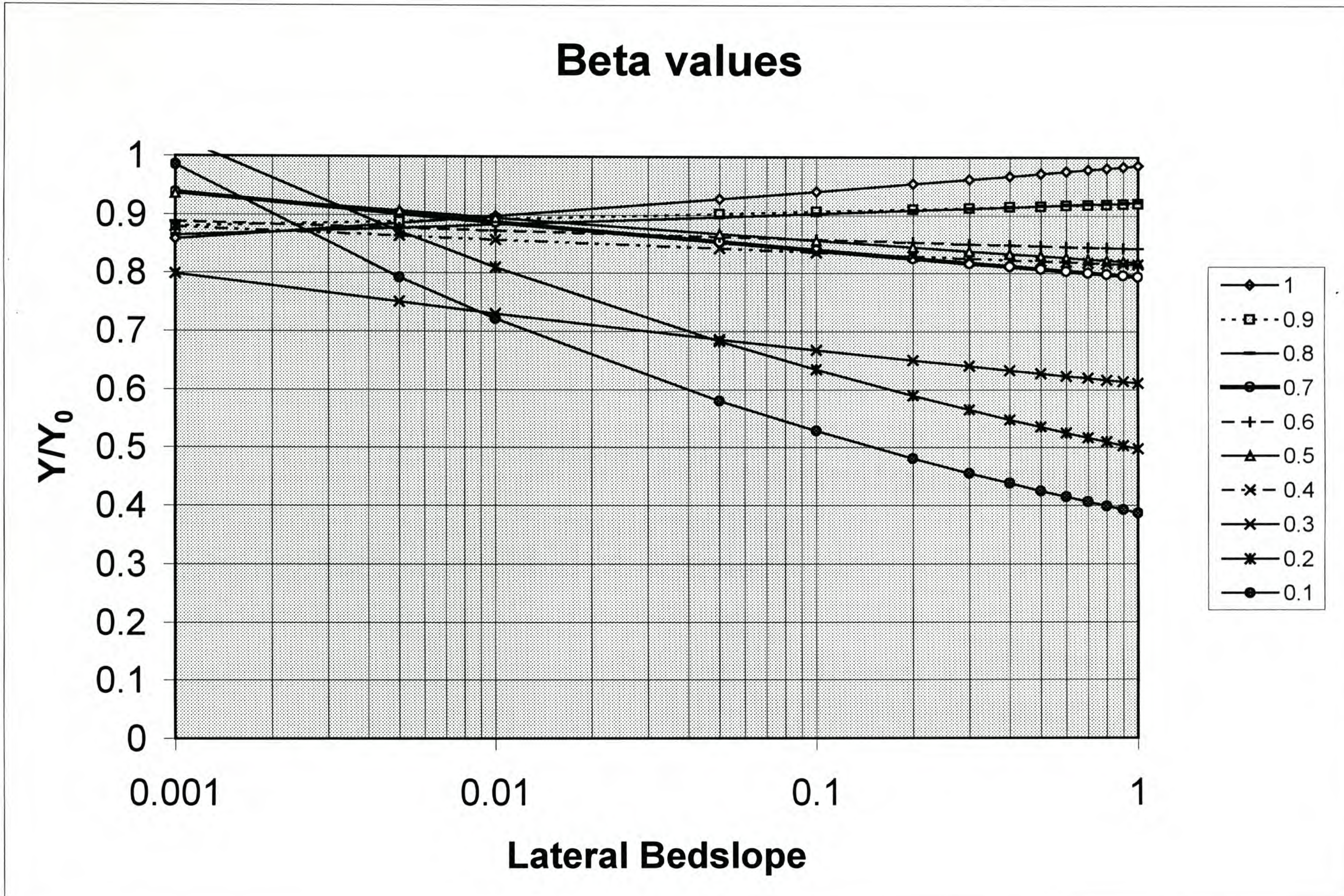
28	8.30	7.848	0.088589	0.113394	0.048069	1	0.0003669	0.9557
28.5	8.30	7.848	0.088589	0.113394	0.048069	1	0.0000451	0.9449
29	8.30	7.848	0.088589	0.113394	0.048069	1	0.0001582	0.9334
29.5	8.30	7.848	0.088589	0.113394	0.048069	1.004988	0.0000063	0.9210
30	8.30	7.7499	0.088034	0.111274	0.048271	1.019804	0.0000162	0.9076
30.5	8.20	7.6518	0.087475	0.109168	0.048476	1.019804	0.0000732	0.8931
31	8.10	7.5537	0.086912	0.107076	0.048685	1.019804	0.0000299	0.8773
31.5	8.00	7.4556	0.086346	0.104997	0.048898	1.004988	0.0000661	0.8602
32	7.90	7.4556	0.086346	0.104997	0.048898	1	0.0000389	0.8420
32.5	7.90	7.4556	0.086346	0.104997	0.048898	1.039364	0.0000030	0.8229
33	7.90	7.17765	0.084721	0.09918	0.049521	1.149396	0.0008022	0.8018
33.5	7.62	6.8997	0.083064	0.093475	0.050177	1.149396	0.0003517	0.7788
34	7.33	6.62175	0.081374	0.087884	0.05087	1.149396	0.0004499	0.7529
34.5	7.05	6.3438	0.079648	0.082409	0.051602	1.149396	0.0003388	0.7238
35	6.77	6.06585	0.077884	0.077053	0.052379	1.149396	0.0002998	0.6908
35.5	6.48	5.7879	0.076078	0.071818	0.053204	1.11068	0.0003370	0.6531
36	6.20	5.5917	0.074778	0.068197	0.053819	1.077033	0.0002281	0.6106
36.5	6.00	5.3955	0.073454	0.06464	0.054464	1.077033	0.0174474	0.5628
37	5.80	5.1993	0.072106	0.061146	0.05514	1.077033	0.0005017	0.5596
37.5	5.60	5.0031	0.070733	0.057718	0.055852	1.077033	0.0017282	0.5553
38	5.40	4.8069	0.069332	0.054356	0.056602	1.077033	0.0002629	0.5544
38.5	5.20	4.6107	0.067902	0.051062	0.057393	1.118034	0.0004300	0.5521
39	5.00	4.3164	0.065699	0.046252	0.058669	1.16619	0.0002036	0.5488
39.5	4.70	4.0221	0.06342	0.041604	0.060067	1.16619	0.0002174	0.5438
40	4.40	3.7278	0.061056	0.037122	0.061608	1.16619	0.0001802	0.5368
40.5	4.10	3.4335	0.058596	0.032814	0.06332	1.16619	0.0002211	0.5274
41	3.80	3.1392	0.056029	0.028687	0.06524	1.16619	0.0002801	0.5159
41.5	3.50	2.8449	0.053338	0.024749	0.067416	1.054093	0.0001653	0.5029
42	3.20	2.8122	0.05303	0.024323	0.067676	1.00222	0.0001760	0.4881
42.5	3.17	2.7795	0.052721	0.0239	0.067941	1.00222	0.0001761	0.4726
43	3.13	2.7468	0.05241	0.02348	0.068209	1.00222	0.0001276	0.4560
43.5	3.10	2.7141	0.052097	0.023062	0.068482	1.00222	0.0001202	0.4371
44	3.07	2.6814	0.051782	0.022646	0.068759	1.00222	0.0001472	0.4153
44.5	3.03	2.6487	0.051466	0.022233	0.069041	1.011187	0.0001048	0.3902
45	3.00	2.53425	0.050341	0.020808	0.070065	1.026861	0.0001215	0.3595
45.5	2.88	2.4198	0.049191	0.019414	0.071153	1.026861	0.0001058	0.3206
46	2.77	2.30535	0.048014	0.018053	0.072311	1.026861	0.0001048	0.2711
46.5	2.65	2.1909	0.046807	0.016726	0.073549	1.026861	0.0001574	0.2074
47	2.53	2.07645	0.045568	0.015432	0.074876	1.026861	0.0030554	0.1266
47.5	2.42	1.962	0.044294	0.014174	0.076305	1.048941	0.0007373	0.1184
48	2.30	1.7658	0.042021	0.012102	0.079032	1.077033	0.0003882	0.1197
48.5	2.10	1.5696	0.039618	0.010142	0.082197	1.077033	0.0003502	0.1205
49	1.90	1.3734	0.037059	0.008301	0.085938	1.077033	0.0002986	0.1215
49.5	1.70	1.1772	0.03431	0.006588	0.090469	1.077033	0.0002465	0.1227
50	1.50	0.981	0.031321	0.005011	0.096138	1.077033	0.0001927	0.1243
50.5	1.30	0.7848	0.028014	0.003586	0.103562	1.070955	0.0001496	0.1261
51	1.10	0.60495	0.024596	0.002427	0.112948	1.065103	0.0000640	0.1336
51.5	0.92	0.4251	0.020618	0.00143	0.127044	1.065103	0.0000307	0.1292
52	0.73	0.24525	0.01566	0.000626	0.15261	1.065103	0.0000146	0.1025
52.5	0.55	0.0654	0.008087	8.63E-05	0.237097	1.019804	0.0000040	0.0551
53	0.37	0.04905	0.007004	5.6E-05	0.260959	1.000672	0.0000117	0.0541
53.5	0.18	0.02943	0.005425	2.6E-05	0.309401	1.001249	0.0000074	0.0006
54	0.00	0	0	0	0	1	0.0000000	0.0000
							0.0965215	

The Goal-Seek value was set to achieve 0.001

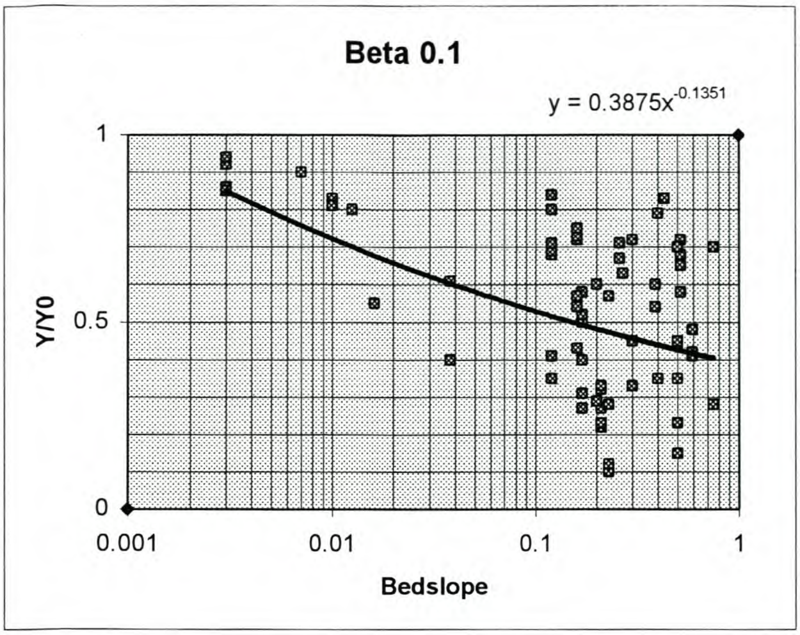
APPENDIX F

A COMBINED BETA-GRAPH FOR ALL BETA VALUES AS WELL AS BETA GRAPHS FOR THE INDIVIDUAL BETA VALUES NUMBERED FROM 0.1 UP TO 1.0 IN STEPS OF 0.1.

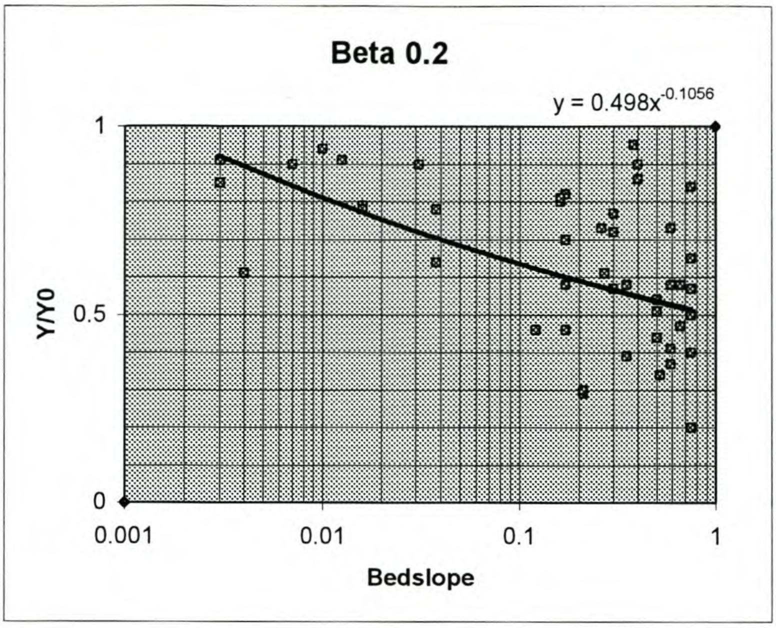
The numbers 1 to 11 on the individual beta graphs, represent data from the following DWAF station numbers in this order: C1H015, C8H028, C8H030, C6H006, D1H003, D1H009, D2H033, D3H012, D7H002, D7H012 and V1H038.



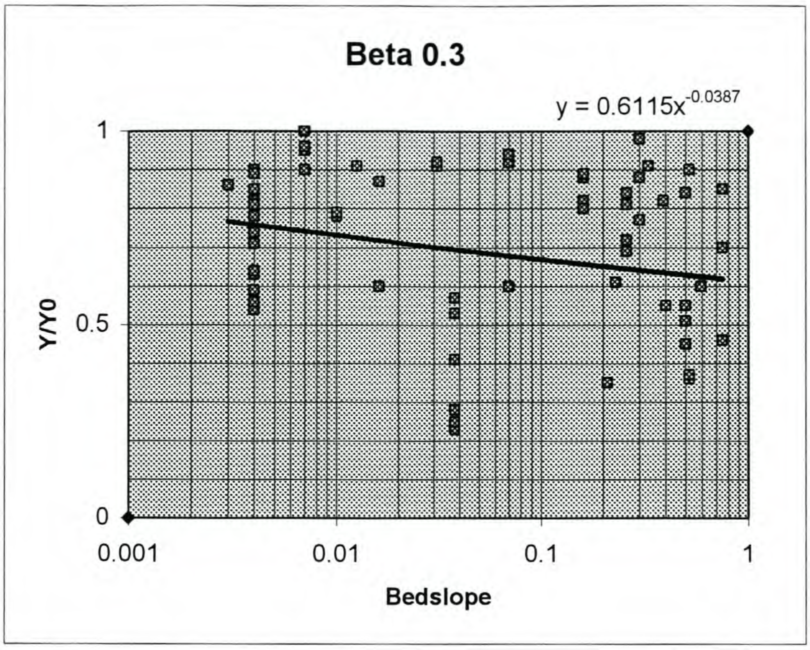
Beta values
Y/Y0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
Lateral Bedslope
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1



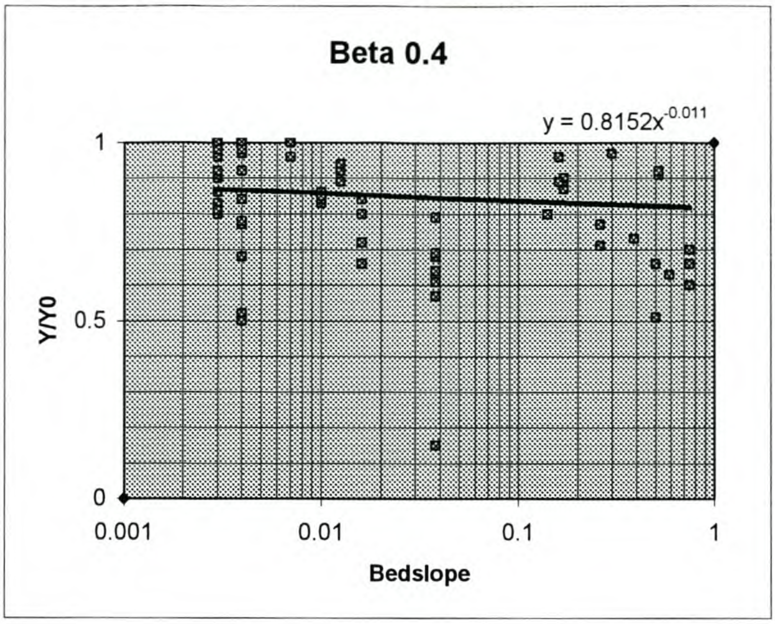
	Y/Y0	Bedslope	Beta = 0.1		Linearised bedslope
1	0.65	0.50	0.12		0.52
	0.15	0.78	0.06		0.5
	0.68	0.67	0.11		0.52
	0.32	0.18	0.12		0.21
	0.27	0.13	0.12		0.21
	0.22	0.28	0.06		0.21
	0.23	0.3	0.06		0.21
	0.44	0.47	0.07		0.5
	0.72	0.48	0.06		0.52
	0.58	0.5	0.07		0.52
	0.33	0.17	0.1		0.21
	0.45	0.45	0.06		0.5
	0.58	0.5	0.07		0.52
	0.27	0.32	0.08		0.21
2	0.92	0.32	0.07		0.003
	0.94	0.28	0.1		0.003
	0.67	0.1	0.05		0.26
	0.86	0.48	0.13		0.003
	0.71	0.32	0.07		0.26
	0.67	0.28	0.05		0.26
	0.71	0.2	0.11		0.26
	0.85	0.41	0.1		0.003
3	0.9	0.1	0.1		0.007
	0.7	0.43	0.1		0.75
	0.9	0.08	0.1		0.007
	0.28	0.86	0.13		0.75
	0.5	0.22	0.06		0.17
	0.58	0.4	0.13		0.17
	0.83	0.39	0.06		0.43
	0.52	0.19	0.13		0.17
4	0.79	0.35	0.06		0.4
	0.8	0.3	0.1		0.0125
	0.79	0.33	0.09		0.4
	0.7	0.5	0.1		0.5
	0.35	0.58	0.08		0.5
	0.35	0.27	0.14		0.4
	0.23	0.29	0.13		0.5
5	0.4	0.013	0.11		0.038
	0.28	0.082	0.11		0.23
	0.1	0.043	0.06		0.23
	0.12	0.076	0.06		0.23
	0.61	0.24	0.06		0.038
	0.63	0.17	0.12		0.27
	0.57	0.22	0.13		0.23
7	0.29	0.35	0.06		0.2
	0.6	0.29	0.12		0.2
8	0.27	0.15	0.06		0.17
	0.72	0.21	0.06		0.3
	0.31	0.16	0.06		0.17
	0.33	0.14	0.08		0.3
	0.41	0.13	0.09		0.12
	0.45	0.18	0.1		0.3
	0.35	0.11	0.09		0.12
	0.4	0.18	0.08		0.17
9	0.72	0.11	0.07		0.16
	0.68	0.18	0.07		0.12
	0.54	0.15	0.05		0.16
	0.73	0.11	0.08		0.16
	0.83	0.01	0.1		0.01
	0.8	0.07	0.12		0.12
	0.69	0.09	0.07		0.12
	0.43	0.12	0.05		0.16
	0.57	0.15	0.09		0.16
	0.75	0.11	0.11		0.16
	0.84	0.01	0.09		0.12
	0.81	0.07	0.1		0.01
	0.71	0.09	0.07		0.12
10	0.6	0.35	0.06		0.39
	0.54	0.31	0.08		0.39
	0.55	0.11	0.14		0.016
11	0.48	0.5	0.14		0.59
	0.42	0.24	0.14		0.59
	0.41	0.62	0.14		0.59



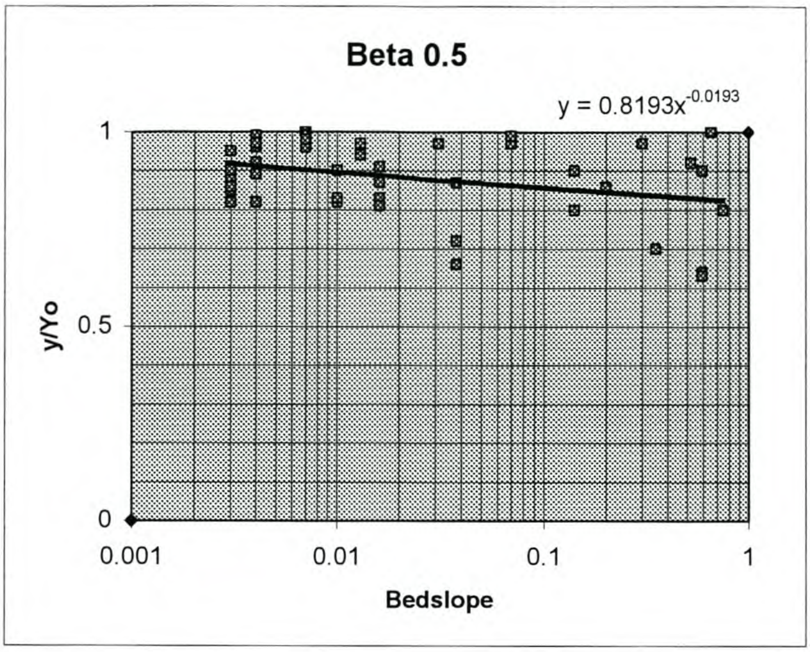
	Y/Y0	Bedslope	Beta = 0.2		Linearised bedslope
1	0.44	0.32	0.21		0.5
	0.9	0.15	0.22		0.031
	0.51	0.28	0.21		0.5
	0.34	0.37	0.2		0.52
	0.29	0.15	0.18		0.21
	0.3	0.15	0.17		0.21
	0.54	0.32	0.15		0.5
2	0.85	0.5	0.2		0.003
	0.91	0.4	0.2		0.003
	0.73	0.2	0.22		0.26
3	0.9	0.12	0.2		0.007
	0.5	0.6	0.2		0.75
	0.57	0.68	0.19		0.75
	0.58	0.4	0.21		0.17
	0.2	0.58	0.17		0.75
4	0.91	0.1	0.23		0.0125
	0.86	0.29	0.18		0.4
	0.9	0.35	0.23		0.4
5	0.78	0.11	0.23		0.038
	0.64	0.14	0.2		0.038
	0.61	0.1	0.19		0.27
6	0.61	0.04	0.24		0.004
	0.39	0.1	0.23		0.35
	0.95	0.35	0.21		0.38
	0.58	0.31	0.18		0.35
8	0.72	0.28	0.16		0.3
	0.46	0.25	0.18		0.17
	0.82	0.17	0.22		0.17
	0.57	0.35	0.19		0.3
	0.77	0.34	0.21		0.3
	0.46	0.24	0.23		0.12
	0.7	0.19	0.2		0.17
9	0.8	0.06	0.19		0.16
	0.81	0.13	0.24		0.16
10	0.47	0.46	0.21		0.66
	0.79	0.01	0.24		0.016
	0.78	0.06	0.15		0.016
	0.58	0.42	0.2		0.66
11	0.94	0.14	0.24		0.01
	0.58	0.68	0.21		0.59
	0.84	0.11	0.2		0.75
	0.37	0.7	0.24		0.59
	0.41	0.19	0.21		0.59
	0.65	0.34	0.18		0.75
	0.73	0.43	0.2		0.59
	0.4	0.54	0.17		0.75



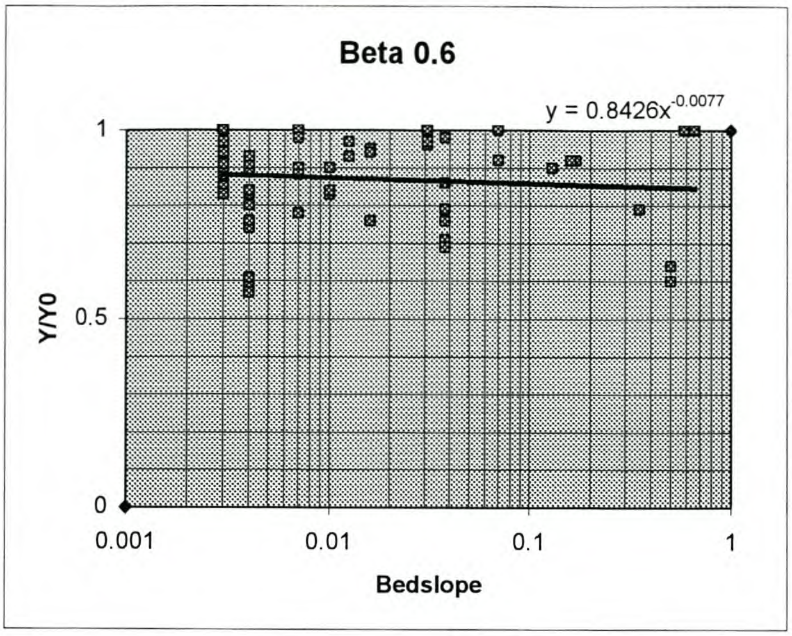
	Y/Y0	Bedslope	Beta = 0.3		Linearised bedslope
1	0.90	42.00	0.34		0.52
	0.51	0.32	0.27		0.5
	0.91	0.12	0.25		0.031
	0.91	0.15	0.26		0.031
	0.35	0.33	0.26		0.21
	0.92	0.12	0.25		0.031
	0.36	0.35	0.31		0.52
	0.55	0.3	0.27		0.5
	0.92	0.12	0.3		0.031
	0.37	0.33	0.32		0.52
	0.35	0.15	0.25		0.21
2	0.86	0.01	0.33		0.003
	0.84	0.11	0.26		0.26
	0.69	0.12	0.26		0.26
	0.72	0.08	0.29		0.26
	0.81	0.12	0.32		0.26
3	0.9	0.06	0.3		0.007
	1	0.04	0.3		0.007
	0.9	0.095	0.28		0.007
	0.7	0.55	0.32		0.75
	0.95	0.1	0.28		0.007
	0.95	0.07	0.29		0.007
	0.96	0.1	0.28		0.007
	0.46	0.65	0.31		0.75
4	0.91	0.01	0.29		0.0125
	0.84	0.5	0.27		0.5
	0.55	0.5	0.29		0.4
	0.45	0.56	0.31		0.5
5	0.28	0	0.3		0.038
	0.53	0.16	0.28		0.038
	0.23	0.08	0.32		0.038
	0.25	0.15	0.3		0.038
	0.41	0.2	0.34		0.038
	0.57	0.2	0.28		0.038
	0.6	0.05	0.28		0.07
	0.61	0.06	0.31		0.23
6	0.85	0.06	0.32		0.004
	0.82	0.01	0.34		0.004
	0.74	0.07	0.27		0.004
	0.63	0.09	0.3		0.004
	0.64	0.04	0.26		0.004
	0.54	0.04	0.28		0.004
	0.56	0.022	0.33		0.004
	0.9	0.075	0.33		0.004
	0.81	0.04	0.33		0.004
	0.78	0.05	0.313		0.004
	0.71	0.06	0.3		0.004
	0.59	0.13	0.34		0.004
	0.89	0.14	0.26		0.004
7	0.92	0.2	0.29		0.07
	0.91	0.2	0.33		0.33
	0.94	0.2	0.27		0.07
8	0.98	0.12	0.33		0.3
	0.88	0.22	0.29		0.3
	0.77	0.29	0.33		0.3
9	0.8	0.13	0.25		0.16
	0.88	0.17	0.3		0.16
	0.78	0	0.27		0.01
	0.89	0.17	0.27		0.16
	0.79	0	0.32		0.01
	0.81	0.06	0.3		0.16
	0.82	0.13	0.34		0.16
	0.8	0	0.28		0.16
10	0.87	0.2	0.34		0.016
	0.82	0.1	0.3		0.39
	0.6	0.06	0.25		0.016
11	0.85	0.33	0.26		0.75
	0.6	0.27	0.28		0.59



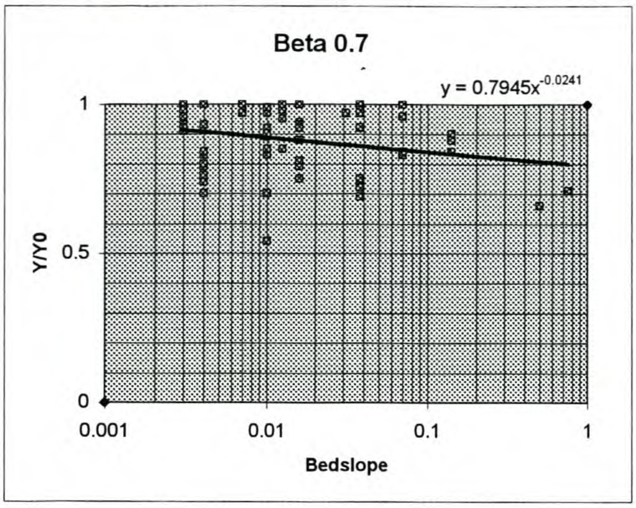
	Y/Y0	Bedslope	Beta =0.4		Linearised bedslope
1	0.91	0.40	0.40		0.52
	0.51	0.33	0.41		0.5
	0.91	0.42	0.35		0.52
	0.66	0.65	0.41		0.5
	0.92	0.4	0.39		0.52
2	0.9	0.01	0.4		0.003
	0.96	0.01	0.36		0.003
	0.92	0.03	0.39		0.003
	0.77	0.12	0.37		0.26
	0.8	0.01	0.39		0.003
	0.83	0	0.41		0.003
	0.86	0	0.44		0.003
	0.81	0.11	0.38		0.003
	0.71	0.1	0.35		0.26
	0.91	0.02	0.42		0.003
	0.92	0.06	0.36		0.003
3	0.8	0.25	0.4		0.14
	1	0.035	0.4		0.007
	1	0.02	0.44		0.007
	0.6	0.6	0.4		0.75
	0.7	0.54	0.44		0.75
	0.96	0.1	0.35		0.007
4	0.92	0.08	0.35		0.0125
	0.89	0.01	0.43		0.0125
	0.94	0.06	0.36		0.0125
5	0.68	0.14	0.38		0.038
	0.15	0.01	0.38		0.038
	0.79	0.06	0.41		0.038
	0.57	0.07	0.36		0.038
	0.61	0.07	0.39		0.038
	0.69	0.06	0.41		0.038
	0.64	0.07	0.43		0.038
6	1	0.03	0.43		0.004
	0.92	0.028	0.42		0.004
	0.92	0.02	0.41		0.004
	0.77	0.011	39		0.004
	0.52	0.001	0.39		0.004
	0.5	0.045	0.38		0.004
	1	0.07	0.44		0.004
	0.97	0.04	0.44		0.004
	0.98	0.04	0.43		0.004
	0.78	0.02	0.44		0.004
	0.68	0.03	0.36		0.004
	0.84	0.01	0.36		0.004
7	98	0.13	0.43		0.07
8	0.98	0.1	0.44		0.003
	1	0.03	0.41		0.003
	0.97	0.1	0.41		0.3
	0.98	0.1	0.39		0.003
	0.9	0.13	0.38		0.17
	0.87	0.16	0.38		0.17
9	0.96	0.02	0.44		0.16
	0.83	0.01	0.38		0.01
	0.84	0	0.4		0.01
	0.83	0.03	0.39		0.01
	0.96	0.02	0.37		0.16
	0.83	0.01	0.41		0.01
	0.84	0	0.4		0.01
	0.84	0.03	0.38		0.01
	0.89	0.17	0.36		0.16
	0.96	0.02	0.43		0.16
	0.85	0.01	0.39		0.01
	0.86	0	0.4		0.01
	0.85	0.03	0.37		0.01
10	0.8	0.05	0.38		0.016
	0.78	0.05	0.44		
	0.73	0.08	0.35		0.39
	0.84	0.06	0.41		0.016
	0.73	0.12	0.35		0.39
	0.72	0.06	0.44		0.016
	0.66	0.07	0.39		0.016
11	0.63	0.6	0.38		0.59
	0.66	0.66	0.35		0.75



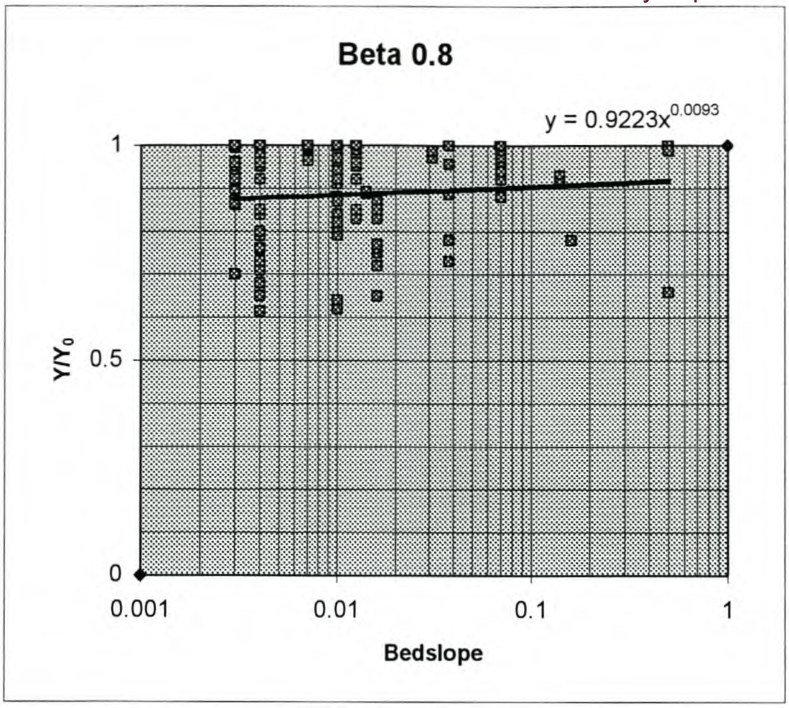
	Y/Y0	Bedslope	Beta = 0.5		Linearised bedslope
1	0.97	0.14	0.46		0.031
	0.92	0.4	0.47		0.52
2	0.88	0.06	0.47		0.003
	0.85	0.03	0.46		0.003
	0.85	0	0.46		0.003
	0.91	0.09	0.45		0.003
	0.85	0.02	0.45		0.003
	0.86	0.04	0.54		0.003
	0.95	0.01	0.52		0.003
	0.9	0.06	0.54		0.003
	0.82	0.12	0.52		0.003
3	1	0.03	0.5		0.007
	0.9	0.132	0.5		0.14
	1	0.007	0.5		0.007
	0.9	0.134	0.5		0.14
	0.8	0.146	0.5		0.14
	1	0.014	0.5		0.007
	0.8	0.15	0.5		0.14
	0.8	0.34	0.5		0.75
	1	0.022	0.51		0.007
	0.8	0.21	0.49		0.75
	0.97	0.01	0.51		0.007
	0.96	0	0.48		0.007
	0.99	0.03	0.45		0.007
	0.98	0.01	0.51		0.007
	0.98	0.01	0.53		0.007
	0.99	0.03	0.47		0.007
	0.98	0.01	0.53		0.007
4	0.96	4	0.48		0.013
	0.94	0.4	0.45		0.013
	0.97	0.05	0.54		0.013
5	0.97	0.01	0.5		0.07
	0.87	0.05	0.48		0.038
	0.66	0.13	0.48		0.038
	0.72	0.02	0.51		0.038
6	0.99	0.07	0.51		0.004
	0.89	0.003	0.51		0.004
	0.82	0.015	0.5		0.004
	0.7	0.11	0.51		0.35
	0.82	0.02	0.48		0.004
	0.96	0.02	0.46		0.004
	0.92	0.004	0.45		0.004
	0.97	0.02	0.5		0.004
	0.82	0.003	0.47		0.004
7	0.86	0.19	0.46		0.2
	0.99	0.1	0.51		0.07
8	0.97	0.1	0.47		0.3
9	0.9	0	0.5		0.01
	0.82	0	0.45		0.01
	0.83	0	0.48		0.01
10	0.91	0.06	0.47		0.016
	1	0.26	0.51		0.66
	0.81	0.02	0.53		0.016
	0.83	0	0.47		0.016
	0.83	0.02	0.51		0.016
	1	0.18	0.49		0.66
	0.87	0.01	0.53		0.016
	0.81	0.19	0.5		0.016
11	0.64	0.62	0.47		0.59
	0.9	0.09	0.49		0.59
	0.63	0.08	0.49		0.59



	Y/Y0	Bedslope	Beta = 0.6	Linearised bedslope
1	0.60	0.67	0.64	0.5
	0.96	0.11	0.64	0.031
	0.64	0.65	0.64	0.5
	0.98	0.14	0.6	0.031
	1	0.7	0.58	0.031
	0.96	0.11	0.64	0.031
	0.97	0.1	0.6	0.031
2	0.88	0.02	0.6	0.003
	1	0.04	0.64	0.003
	0.96	0.01	0.64	0.003
	0.88	0.03	0.58	0.003
	0.9	0.06	0.56	0.003
	0.85	0.08	0.57	0.003
	0.96	0.07	0.55	0.003
	1	0.01	0.64	0.003
	0.9	0.01	0.62	0.003
	0.89	0.03	0.55	0.003
	0.93	0.01	0.6	0.003
	0.94	0.01	0.58	0.003
	0.94	0.02	0.59	0.003
	0.9	0.06	0.59	0.003
	0.83	0.11	0.55	0.003
3	1	0.01	0.6	0.007
	1	0.05	0.6	0.007
	0.9	0.03	0.6	0.007
	1	0.03	0.6	0.007
	0.9	0.1	0.6	0.13
	1	0.01	0.62	0.007
	0.78	0.32	0.57	0.007
	0.883	0.31	0.63	0.007
	0.98	0.02	0.6	0.007
4	0.97	0.05	0.59	0.0125
	0.93	0.1	0.63	0.0125
5	0.79	0.17	0.55	0.038
	0.71	0.2	0.57	0.038
	0.98	0.04	0.58	0.038
	0.86	0.07	0.64	0.038
	0.76	0.05	0.59	0.038
	0.69	0.04	0.59	0.038
6	0.89	0.04	0.57	0.004
	0.59	0.029	0.59	0.004
	0.83	0.05	0.58	0.004
	0.8	0.065	0.64	0.004
	0.74	0.04	0.58	0.004
	0.57	0.058	0.58	0.004
	0.61	0.038	0.59	0.004
	0.76	0.002	0.6	0.004
	0.83	0.024	0.612	0.004
	0.91	0.06	0.56	0.004
	0.79	0.16	0.63	0.35
	0.93	0.05	0.62	0.004
	0.84	0.02	0.62	0.004
7	1	0.02	0.63	0.07
	0.92	0.17	0.63	0.07
8	0.97	0.03	0.59	0.003
	0.91	0.02	0.61	0.003
	1	0.03	0.58	0.003
	0.92	0.09	0.6	0.17
9	0.83	0.01	0.57	0.01
	0.92	0	0.57	0.16
	0.9	0.03	0.63	0.01
	0.84	0.01	0.58	0.01
10	0.95	0.03	0.62	0.016
	0.94	0.03	0.6	0.016
	1	0.21	0.55	0.66
	0.76	0.07	0.6	0.016
11	1	0.35	0.6	0.59

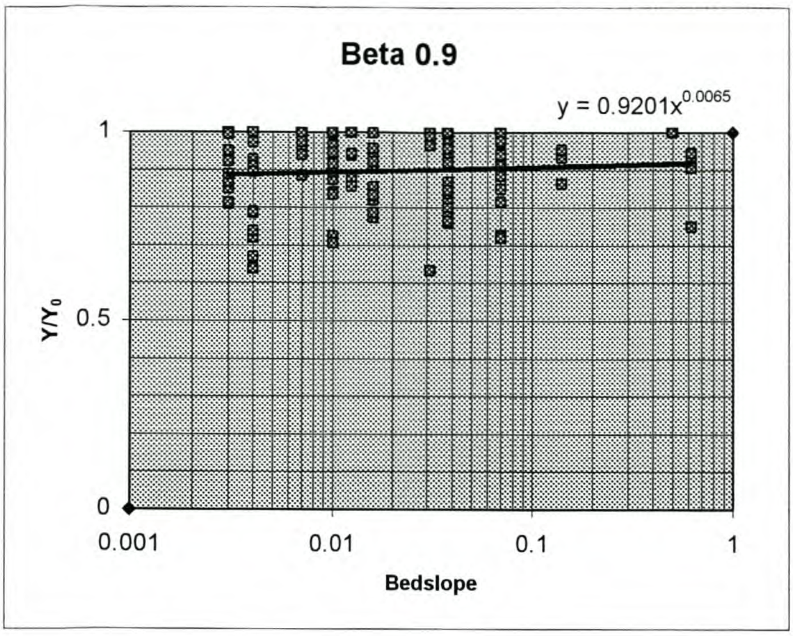


	Y/Y0	Bedslope	Beta = 0.7	Linearised bedslope
1	0.97	0.00	0.72	0.031
	0.66	0.65	0.69	0.5
2	0.96	0.04	0.71	0.003
	0.97	0.02	0.71	0.003
	1	0.02	0.7	0.003
	0.96	0	0.73	0.003
	0.97	0.01	0.72	0.003
	0.96	0.06	0.73	0.003
	1	0.05	0.73	0.003
	0.93	0.09	0.73	0.003
	0.93	0.03	0.65	0.003
	0.96	0.04	0.69	0.003
	0.97	0.03	0.69	0.003
	0.91	0.03	0.67	0.003
	0.96	0.02	0.7	0.003
3	1	0.013	0.7	0.007
	1	0.033	0.7	0.007
	1	0.01	0.7	0.007
	1	0.03	0.7	0.007
	1	0.004	0.7	0.007
	0.9	0.14	0.69	0.14
	0.97	0.039	0.69	0.007
	0.88	0.145	0.729	0.14
	0.84	0.14	0.69	0.14
	0.97	0.038	0.67	0.007
	1	0.02	0.66	0.007
	0.71	0.54	0.65	0.75
4	0.95	0.01	0.69	0.0125
	0.98	0.01	0.73	0.0125
	1	0.01	0.7	0.0125
	0.85	0.05	0.69	0.0125
	1	0.04	0.66	0.0125
	0.85	0.4	0.71	0.0125
5	0.99	0.03	0.72	0.038
	0.98	0.007	0.739	0.038
	1	0.13	0.67	0.07
	0.92	0.02	0.675	0.038
	0.747	0.1	0.74	0.038
	0.922	0.037	0.738	0.038
	1	0.03	0.667	0.038
	0.73	0.01	0.729	0.038
	0.98	0.07	0.69	0.038
	0.72	0.02	0.72	0.038
	0.75	0.04	0.75	0.038
	0.97	0.01	0.72	0.038
	0.69	0.004	0.73	0.038
	0.69	0.038	0.75	0.038
6	0.8	0.04	0.74	0.004
	0.7	0.1	0.7	0.004
	1	0.05	0.73	0.004
	0.7	0	0.72	0.004
	0.8	0.02	0.74	0.004
	0.83	0.03	0.655	0.004
	0.74	0.013	0.67	0.004
	0.8	0.04	0.69	0.004
	0.76	0.002	0.7	0.004
	0.76	0	0.71	0.004
	0.76	0.01	0.69	0.004
	0.79	0.02	0.69	0.004
	0.8	0.02	0.7	0.004
	1	0.02	0.65	0.004
	0.93	0.06	0.73	0.004
	0.84	0.09	0.67	0.004
7	0.96	0.01	0.74	0.07
	1	0.02	0.66	0.07
	0.83	0.17	0.67	0.07
	0.84	0.17	0.68	0.07
8	0.97	0.05	0.69	0.003
	0.96	0.06	0.72	0.003
	0.92	0.1	0.67	0.003
	1	0.02	0.73	0.003
	0.98	0.1	0.69	0.003
	0.98	0.08	0.73	0.003
9	0.91	0	0.69	0.01
	0.91	0	0.7	0.01
	0.89	0.03	0.65	0.01
	0.83	0.02	0.65	0.01
	0.97	0.04	0.74	0.01
	0.9	0.01	0.74	0.01
	0.92	0	0.66	0.01
	0.83	0.02	0.69	0.01
	0.97	0.04	0.72	0.01
	0.91	0.01	0.7	0.01
	0.92	0	0.71	0.01
	0.85	0.02	0.66	0.01
10	0.94	0.02	0.73	0.016
	1	0.02	0.74	0.016
	0.93	0.02	0.66	0.016
	0.79	0.03	0.65	0.016
	0.88	0.09	0.7	0.016
	0.75	0.08	0.66	0.016
	0.92	0.05	0.7	0.016
	0.81	0.04	0.68	0.016
	0.92	0.09	0.7	0.016
11	0.9	0.09	0.74	0.01
	0.99	0.06	0.65	0.01
	0.7	0.34	0.67	0.01
	0.54	0.24	0.7	0.01



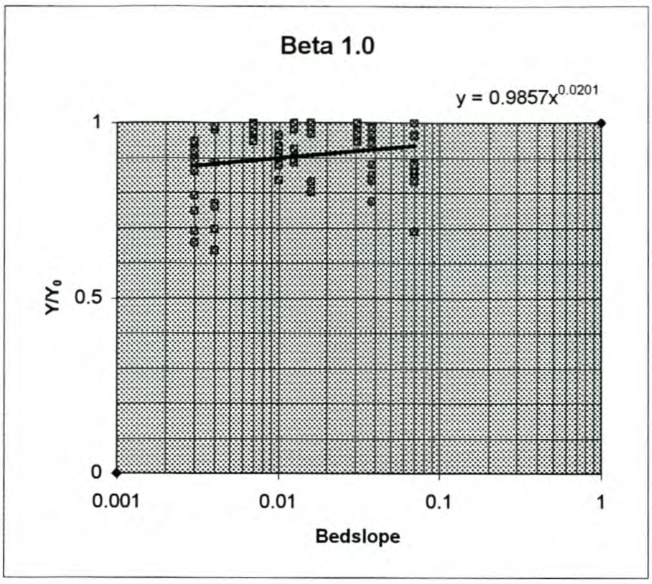
	Y/Y0	Bedslope	Beta = 0.8		Linearised bedslope
1	1.00	0.42	0.80		0.5
	0.97	0.03	0.76		0.031
	0.66	0.67	0.79		0.5
	0.99	0.00	0.83		0.031
	0.99	0.00	0.80		0.5
2	0.99	0.16	0.81		0.003
	0.86	0.14	0.84		0.003
	0.94	0.03	0.78		0.003
	0.92	0.06	0.83		0.003
	0.87	0.06	0.79		0.003
	0.87	0.03	0.78		0.003
	0.90	0.03	0.78		0.003
	0.92	0.19	0.75		0.003
	0.95	0.13	0.80		0.003
	0.87	0.06	0.77		0.003
	0.87	0.01	0.78		0.003
	0.96	0.02	0.81		0.003
	0.92	0.02	0.81		0.003
	0.95	0.05	0.78		0.003
	0.70	0.01	0.81		0.003
	0.93	0.02	0.81		0.003
	0.95	0.05	0.82		0.003
	0.92	0.01	0.76		0.003
3	1.0	0	0.8		0.007
	1.0	0.025	0.8		0.007
	1	0.068	0.8		0.007
	1	0.01	0.786		0.007
	0.964	0.01	0.755		0.007
	0.929	0.114	0.781		0.14
	0.912	0.144	0.765		0.14
	0.995	0.019	0.765		0.007
	1	0.004	0.771		0.007
	0.887	0.311	0.808		0.014
	0.995	0.019	0.805		0.007
	1	0.004	0.785		0.007
	0.892	0.311	0.831		0.014
4	0.98	0.01	0.81		0.0125
	0.95	0.04	0.76		0.0125
	0.96	0.01	0.81		0.0125
	0.99	0.07	0.78		0.0125
	0.83	0	0.76		0.0125
	0.85	0.02	0.83		0.0125
	1	0.05	0.77		0.0125
	0.92	0.05	0.84		0.0125
5	0.94	0.169	0.783		0.07
	1	0.011	0.79		0.038
	0.886	0.109	0.83		0.038
	0.78	0.145	0.827		0.038
	0.957	0.045	0.75		0.038
	0.731	0.063	0.788		0.038
6	0.614	0.022	0.761	0	0.004
	0.977	0.04	0.788		0.004
	0.839	0.062	0.815		0.004
	0.789	0.043	0.756		0.004
	0.8	0.005	0.762		0.004
	0.719	0.021	0.782		0.004
	0.65	0.029	0.772		0.004
	0.679	0.02	0.822		0.004
	0.71	0.02	0.845		0.004
	0.73	0.019	0.849		0.004
	0.758	0.012	0.831		0.004
	0.76	0.002	0.768		0.004
	0.76	0.003	0.772		0.004
	0.85	0.08	0.78		0.004
	0.95	0.014	0.765		0.004
	0.959	0.036	0.788		0.004
	0.92	0.097	0.838		0.004
	1	0.024	0.845		0.004
7	0.89	0.01	0.78		0.07
	0.88	0.01	0.84		0.07
	0.93	0.01	0.82		0.07
	0.94	0.02	0.77		0.07
	0.97	0	0.75		0.07
	1	0	0.79		0.07
	0.95	0.03	0.81		0.07
	0.99	0.02	0.76		0.07
	1	0	0.76		0.07
	0.95	0.03	0.75		0.07
	0.92	0.01	0.8		0.07

	0.94	0.02	0.83	0.07
	0.94	0.02	0.77	0.07
8	0.93	0.04	0.83	0.003
	0.92	0.08	0.78	0.003
	0.96	0.08	0.77	0.003
	1	0.03	0.8	0.003
9	0.78	0	0.75	0.16
	0.79	0.01	0.83	0.01
	0.62	0.06	0.84	0.01
	0.96	0.01	0.82	0.01
	0.81	0.04	0.78	0.01
	0.84	0.01	0.75	0.01
	0.84	0.06	0.76	0.01
	0.88	0.01	0.84	0.01
	0.88	0.01	0.76	0.01
	1	0	0.83	0.01
	1	0	0.81	0.01
	0.92	0.01	0.79	0.01
	0.96	0.02	0.82	0.01
10	0.75	0.01	0.77	0.016
	0.76	0.03	0.8	0.016
	0.83	0.01	0.8	0.016
	0.72	0.06	0.82	0.016
	0.65	0.01	0.83	0.016
	0.87	0.03	0.77	0.016
	0.77	0.01	0.8	0.016
	0.85	0.09	0.84	0.016
11	0.81	0	0.8	0.01
	0.93	0.1	0.77	0.01
	1	0.03	0.8	0.01
	0.97	0.11	0.81	0.01
	0.91	0.39	0.78	0.01
	0.87	0.03	0.82	0.01
	0.99	0.06	0.81	0.01
	1	0.02	0.8	0.01
	0.97	0.08	0.82	0.01
	0.94	0.39	0.78	0.01
	0.64	0.18	0.76	0.01
	0.92	0.39	0.75	0.01
	0.82	0.18	0.82	0.01



	Y/Y0	Bedslope	0.85-0.94 Beta = 0.9	Linearised bedslope
	0.63	0.65	0.88	0.031
	1.00	0.45	0.90	0.5
	0.98	0.02	0.86	0.031
	1.00	0.43	0.85	0.5
	0.98	0.02	0.93	0.031
	1.00	0.03	0.88	0.031
	0.99	0.00	0.89	0.031
	0.97	0.06	0.94	0.031
	0.93	0.04	0.93	0.003
	0.85	0.08	0.94	0.003
	0.85	0.06	0.91	0.003
	0.93	0.04	0.89	0.62
	0.92	0.02	0.94	0.003
	0.93	0.07	0.89	0.62
	0.75	0.04	0.86	0.62
	1.00	0.09	0.90	0.003
	0.87	0.12	0.85	0.003
	0.91	0.17	0.87	0.62
	1.00	0.09	0.85	0.003
	0.81	0.03	0.86	0.003
	0.95	0.16	0.85	0.62
	1.00	0.09	0.89	0.003
	0.81	0.05	0.86	0.003
3	1.0	0.008	0.9	0.007
	1.0	0.038333	0.9	0.007
	1.0	0.01	0.9	0.007
	1.0	0.058	0.9	0.007
	1.0	0.0155	0.9	0.007
	0.9	0.155	0.062518	0.007
	0.9	0.095	0.281983	0.007
	0.9	0.12575	0.826343	0.14
	0.9	0.1425	0.692588	0.14
	0.97469	0.053333	0.891509	0.007
	0.952342	0.1275	0.883316	0.14
	0.954313	0.1275	0.860625	0.14
4	1.00	0.01	0.89	0.0125
	0.94	0.02	0.89	0.0125
	0.88	0.05	0.89	0.0125
	0.86	0.03	0.94	0.0125
	0.94	0.01	0.93	0.0125
5	0.847279	0.0671	0.866162	0.038
	0.869308	0.0169	0.91498	0.038
	0.983525	0.0226	0.919258	0.038
	0.727323	0.1513	0.907165	0.07
	0.719919	0.0488	0.949478	0.07
	0.759554	0.0398	0.871111	0.038
	0.815081	0.0692	0.917785	0.038
	0.937104	0.0254	0.891859	0.038
	0.821575	0.0156	0.910799	0.038
	0.912021	0.0936	0.940941	0.038
	0.94252	0.013	0.905378	0.038
	0.798749	0.0636	0.903142	0.038
	0.970751	0.012	0.948377	0.038
	0.979336	0.0201	0.884252	0.038
	0.775601	0.1471	0.85265	0.038
	0.837849	0.0802	0.877712	0.038
	0.84563	0.1167	0.85144	0.038
	1	0.0872	0.892648	0.038
	0.970543	0.0046	0.87894	0.038
	0.7643	0.1583	0.850363	0.038
	0.919491	0.0087	0.925636	0.038
	1	0.1276	0.942466	0.038
	0.957427	0.0515	0.901162	0.038
6	0.64	0.04	0.90	0.004
	0.79	0.09	0.89	0.004
	0.93	0.02	0.90	0.004
	0.91	0.06	0.89	0.004
	0.79	0.01	0.88	0.004
	0.79	0.04	0.87	0.004
	0.67	0.01	0.90	0.004
	0.72	0.01	0.87	0.004
	0.74	0.02	0.85	0.004
	0.89	0.02	0.91	0.004
	1.00	0.02	0.85	0.004
	0.97	0.03	0.90	0.004
7	0.85	0.00	0.87	0.07
	0.92	0.04	0.87	0.07
	0.97	0.01	0.91	0.07

	0.94	0.03	0.89	0.07
	0.99	0.01	0.90	0.07
	0.89	0.02	0.91	0.07
	0.94	0.07	0.88	0.07
	1.00	0.02	0.85	0.07
	1.00	0.02	0.88	0.07
	0.82	0.02	0.89	0.07
	0.94	0.07	0.86	0.07
	0.88	0.01	0.88	0.07
	0.98	0.03	0.86	0.07
8	0.89	0.03	0.91	0.003
	0.99	0.04	0.88	0.003
	0.95	0.05	0.86	0.003
9	0.97	0.04	0.85	0.01
	0.96	0.02	0.94	0.01
	0.94	0.02	0.94	0.01
	0.93	0.01	0.92	0.01
	0.91	0.02	0.86	0.01
	0.89	0.01	0.88	0.01
	0.88	0.00	0.93	0.01
	0.96	0.02	0.86	0.01
	0.94	0.02	0.94	0.01
	1.00	0.00	0.89	0.01
	0.97	0.01	0.85	0.01
	0.94	0.02	0.90	0.01
	0.93	0.01	0.94	0.01
	0.90	0.01	0.86	0.01
10	0.95	0.02	0.89	0.016
	0.93	0.01	0.87	0.016
	0.92	0.04	0.89	0.016
	0.82	0.02	0.89	0.016
	0.83	0.00	0.88	0.016
	0.77	0.05	0.85	0.016
	0.86	0.02	0.93	0.016
	0.91	0.01	0.94	0.016
	0.83	0.02	0.93	0.016
	0.79	0.03	0.87	0.016
	0.96	0.04	0.86	0.016
	1.00	0.02	0.90	0.016
	0.92	0.09	0.93	0.016
11	0.84	0.07	0.94	0.01
	0.84	0.03	0.87	0.01
	0.87	0.07	0.89	0.01
	0.83	0.04	0.88	0.01
	0.89	0.09	0.85	0.01
	1.00	0.03	0.87	0.01
	0.94	0.03	0.85	0.01
	0.92	0.08	0.92	0.01
	0.95	0.06	0.88	0.01
	1.00	0.14	0.92	0.01
	0.73	0.14	0.92	0.01
	0.71	0.09	0.86	0.01

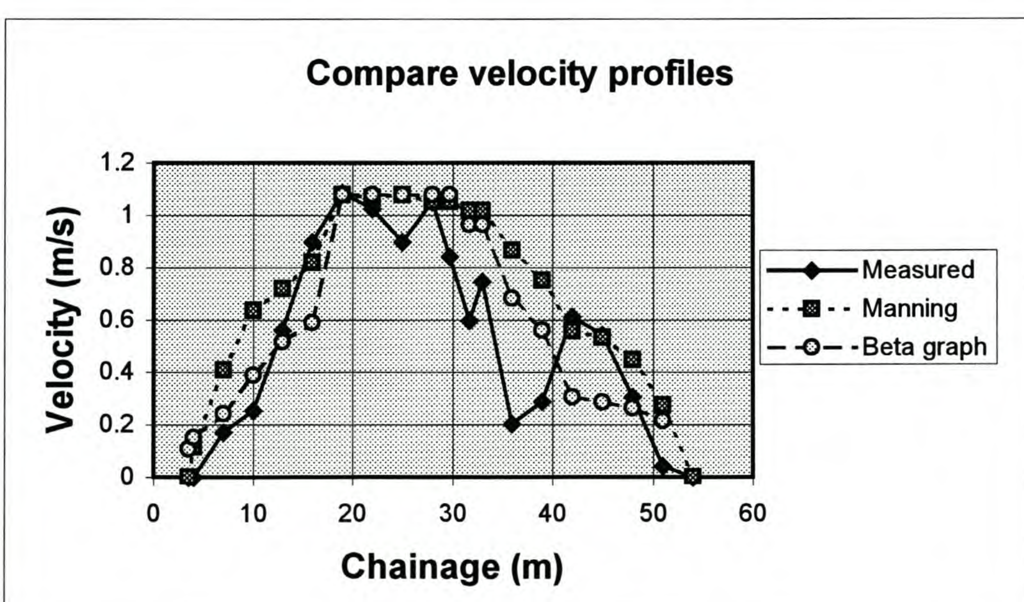


	Y/Y0	Bedslope	Beta = 1.0	Linearised bedslope
41	0.94	0.03	1.00	0.031
	1.00	0.45	0.95	0.031
	0.97	0.02	1.00	0.031
	0.99	0.02	1.00	0.031
	0.96	0.04	1.00	0.031
	0.98	0.02	0.98	0.031
	0.99	0.00	1.00	0.031
	0.98	0.02	1.00	0.031
	0.96	0.06	1.00	0.031
	1.00	0.47	1.00	0.031
42	0.657605	0.068333	1	0.003
	0.859779	0.028833	0.956339	0.003
	0.862854	0.116	0.981169	0.003
	0.747232	0.012333	0.950181	0.003
	0.885609	0.083333	1	0.003
	0.791549	0.053333	1	0.003
	0.690411	0.016667	1	0.003
	0.689269	0.012167	0.957812	0.003
	0.927431	0.135	0.986726	0.003
	0.946203	0.062833	1	0.003
	0.927402	0.137167	1	0.003
	0.926037	0.067667	0.992474	0.003
43	0.981378	0.002	1	0.007
	0.947452	0.045	1	0.007
	1	0.07375	0.980405	0.007
	0.998532	0.02475	0.99212	0.007
	0.986786	0.001	1	0.007
	0.969676	0.02175	0.952073	0.007
	1	0.02525	0.956022	0.007
	0.992532	0.02425	1	0.007
	0.982541	0.017375	1	0.007
	0.978202	0.0095	0.977043	0.007
	0.994581	0.026	0.985746	0.007
	0.974384	0.084	1	0.007
	0.992194	0.058	1	0.007
	0.992517	0.058	1	0.007
44	0.997647	0.01107	1	0.0125
	0.978972	0.01125	1	0.0125
	0.899087	0.02625	1	0.0125
	0.883614	0.11225	1	0.0125
	0.924557	0.0435	1	0.0125
	0.895349	0.071	0.956459	0.0125
45	0.878563	0.0486	1	0.038
	0.959274	0.0335	0.986276	0.038
	0.940578	0.0131	0.986091	0.038
	0.878149	0.0712	0.966401	0.038
	0.689974	0.1403	1	0.07
	0.975497	0.0372	1	0.038
	0.973195	0.050267	0.999832	0.038
	0.849971	0.1121	1	0.038
	0.961874	0.083	0.985361	0.038
	0.966792	0.0212	0.959492	0.038
	0.986383	0.0106	1	0.038
	0.774646	0.0728	1	0.038
	0.832917	0.1895	0.982662	0.038
	0.984659	0.0358	0.952936	0.038
46	0.634636	0.0347	1	0.004
	0.695506	0.0567	1	0.004
	0.769091	0.0224	1	0.004
	0.760226	0.003	1	0.004
	0.88647	0.02075	1	0.004
	0.980057	0.0051	0.969001	0.004
	0.988823	0.0033	1	0.004
47	0.855368	0.0139	1	0.07
	0.886578	0.023	0.991351	0.07
	0.86162	0.0209	1	0.07
	0.885271	0.0209	1	0.07
	0.832916	0.0209	0.973761	0.07
	0.866601	0.0169	0.950857	0.07
	0.878862	0.0209	1	0.07
	0.963246	0.0621	0.947985	0.07
	1	0.0128	1	0.07
48	0.924503	0.041875	1	0.003
	0.899244	0.018125	1	0.003
	0.893836	0.04125	1	0.003
	0.885965	0.018125	1	0.003
	0.91886	0.065	0.966411	0.003
49	0.961312	0.011667	1	0.01
	0.962701	0.011667	1	0.01
	0.918628	0.017933	1	0.01
	0.900892	0.0142	0.953191	0.01
	0.895733	0.0014	0.964133	0.01
50	0.986391	0.0141	0.966862	0.016
	0.966627	0.0156	1	0.016
	0.831354	0.0456	0.97991	0.016
	0.8011	0.00475	1	0.016
	0.80	0.00	1.00	0.016
	0.831497	0.03295	1	0.016
	1	0.0426	1	0.016
51	0.84	0.03	1.00	0.01
	0.88	0.07	0.96	0.01
	0.90	0.02	1.00	0.01
	0.93	0.04	1.00	0.01

APPENDIX G

A SAMPLE OF VELOCITY CALCULATIONS USING THE BETA GRAPH

STATION No. : C1H015			Measured Q = 179.5 m^3/s		
RIVER NAME : Klip					
PLACE NAME : De Langes Drift					
DATE : 23/02/1975					
Chainage	Y/Y0	Bedslope	Beta from table	Alpha	Velocity m/s
3.5	0	0.600	0.01	100	0.11
4	0.035	0.571	0.02	50	0.15
7	0.233	0.600	0.05	20	0.24
10	0.453	0.450	0.13	7.69	0.39
13	0.547	0.300	0.23	4.35	0.52
16	0.663	0.650	0.3	3.33	0.59
19	1.000	0.467	1	1	1.08
22	0.988	0.000	1	1	1.08
25	1.000	0.033	1	1	1.08
28	0.965	0.064	1	1	1.08
29.7	0.965	0.108	1	1	1.08
31.7	0.919	0.121	0.8	1.25	0.96
33	0.919	0.395	0.8	1.25	0.96
36	0.721	0.483	0.4	2.5	0.68
39	0.581	0.500	0.27	3.70	0.56
42	0.372	0.333	0.08	12.5	0.30
45	0.349	0.150	0.07	14.29	0.28
48	0.267	0.317	0.06	16.67	0.26
51	0.128	0.383	0.04	25	0.22
54	0.000	0.020	0.01	100	0

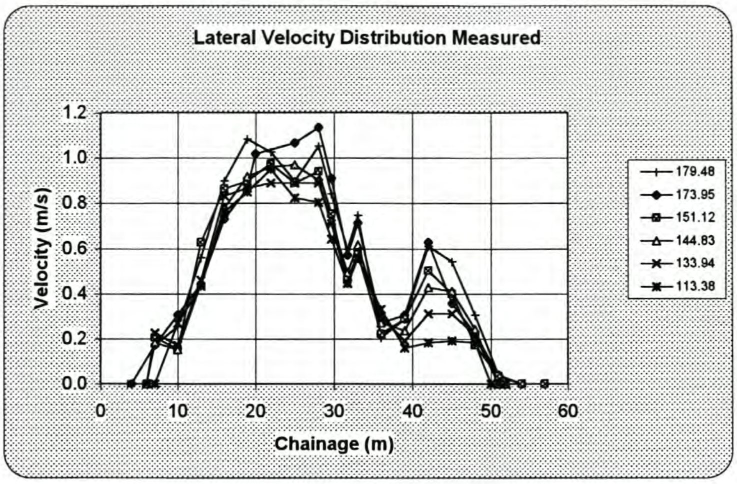


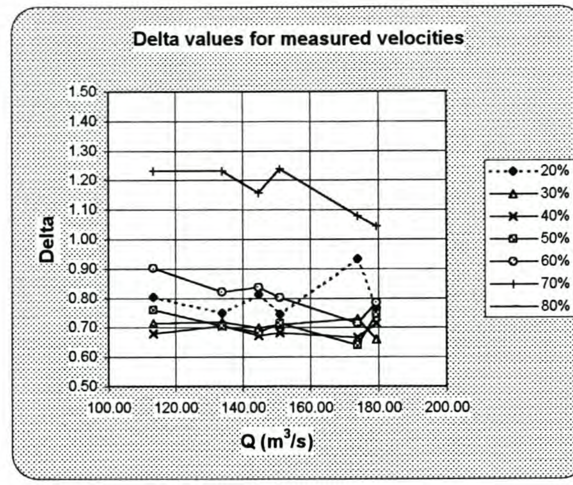
APPENDIX H

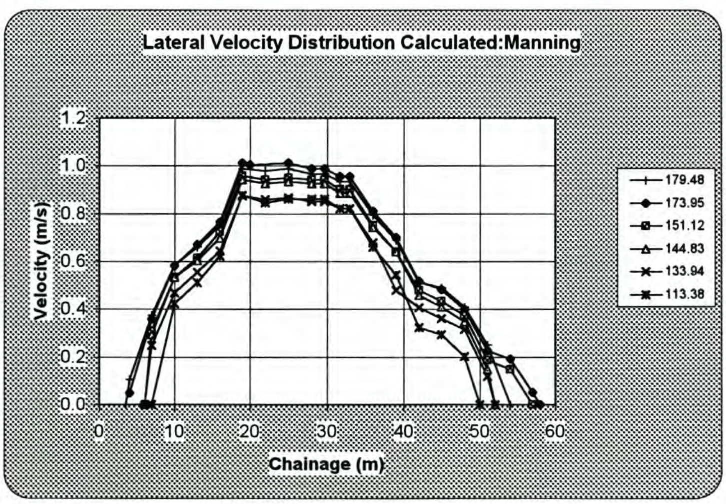
PROCESSED FIELD DATA AND CALCULATION SHEET FOR 1-DIMENSIONAL FLOW FORMULA (MANNING)

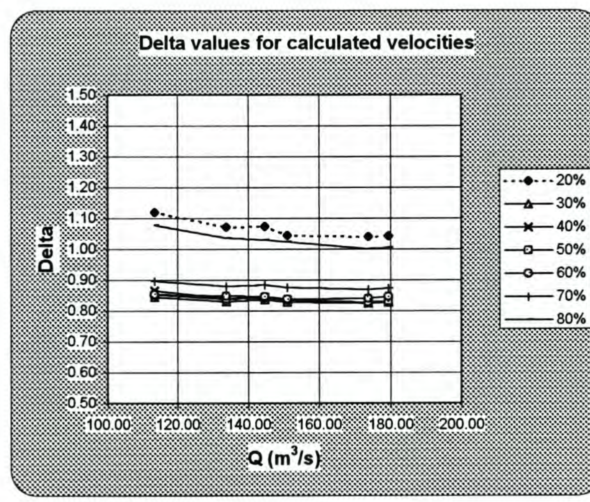
DELTA-FACTORS FOR MEASURED- AND THEORETICAL VELOCITY DISTRIBUTIONS ARE INCLUDED

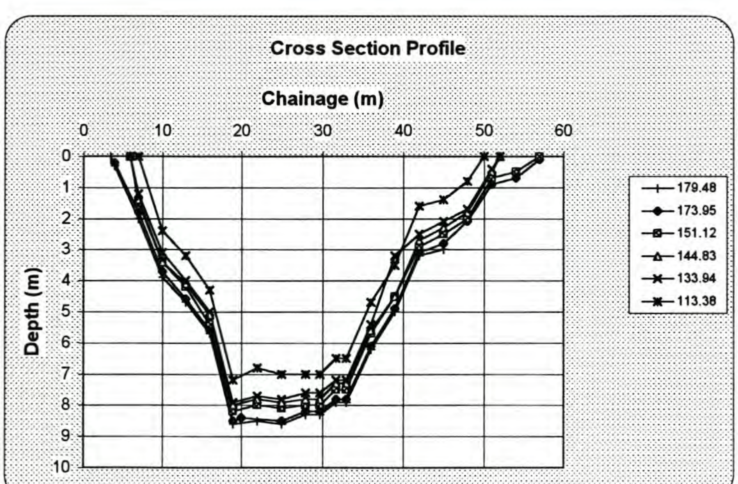
Station no.: C1H015
River: Klip
Place: De Langes Drift











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : C1H015 START TIME : 07h15
RIVER NAME : Klip Average Gaugeplate reading : 6.205 m
PLACE NAME : De Langes Drift
DATE : 25/02/1975

Main Channel LEFT : 10
Main Channel RIGHT : 42

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.622	182.4	113.38
1	7	0		0		0.000	0.0	0.00
2	10	2.4		0.2669		0.267	7.2	1.92
3	13	3.2		0.433		0.433	9.6	4.16
4	16	4.3		0.7607		0.761	12.9	9.81
5	19	7.2		0.8501		0.850	21.6	18.36
6	22	6.8		0.9481		0.948	20.4	19.34
7	25	7		0.8246		0.825	21.0	17.32
8	28	7		0.8033		0.803	16.5	13.21
9	29.7	7		0.6427		0.643	13.0	8.32
10	31.7	6.5		0.4451		0.445	10.7	4.77
11	33	6.5		0.5564		0.556	14.0	7.78
12	36	4.7		0.3308		0.331	14.1	4.66
13	39	3.5		0.1593		0.159	10.5	1.67
14	42	1.6		0.1828		0.183	4.8	0.88
15	45	1.4		0.1907		0.191	4.2	0.80
16	48	0.8		0.1829		0.183	2.0	0.37
17	50	0		0		0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						0.622	182.4	113.38

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
20%	16.4	16.00	19.00	0.76	0.85	0.77	0.80
30%	19.6	19.00	22.00	0.85	0.95	0.87	0.71
40%	22.8	22.00	25.00	0.95	0.82	0.92	0.68
50%	26.0	25.00	28.00	0.82	0.80	0.82	0.76
60%	29.2	28.00	29.70	0.80	0.64	0.69	0.90
70%	32.4	31.70	33.00	0.45	0.56	0.51	1.23
80%	35.6	33.00	36.00	0.56	0.33	0.36	1.72

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00008
Q = 134.0
V_{AVR} = 0.73

Roughness coeff. Sub	n
0	
2	0.038
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
7	0	2	0.0	5.0	0	0.00	0.00
10	2.4	2	7.2	3.0	2.4	3.04	0.42
13	3.2	2	9.6	3.0	3.2	4.91	0.51
16	4.3	2	12.9	3.0	4.3	8.05	0.62
19	7.2	2	21.6	3.0	7.2	18.96	0.88
22	6.8	2	20.4	3.0	6.8	17.23	0.84
25	7	2	21.0	3.0	7	18.09	0.86
28	7	2	16.5	2.4	7	14.17	0.86
29.7	7	2	13.0	1.9	7	11.15	0.86
31.7	6.5	2	10.7	1.7	6.5	8.79	0.82
33	6.5	2	14.0	2.2	6.5	11.46	0.82
36	4.7	2	14.1	3.0	4.7	9.31	0.66
39	3.5	2	10.5	3.0	3.5	5.70	0.54
42	1.6	2	4.8	3.0	1.6	1.56	0.32
45	1.4	2	4.2	3.0	1.4	1.24	0.29
48	0.8	2	2.0	2.5	0.8	0.41	0.20
50	0	2	0.0	1.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			182.4			134.02	0.73

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
20%	16.4	16.00	19.00	0.62	0.88	0.66	1.12
30%	19.6	19.00	22.00	0.88	0.84	0.87	0.84
40%	22.8	22.00	25.00	0.84	0.86	0.85	0.87
50%	26.0	26.00	28.00	0.86	0.86	0.86	0.85
60%	29.2	28.00	29.70	0.86	0.86	0.86	0.85
70%	32.4	31.70	33.00	0.82	0.82	0.82	0.90
80%	35.6	33.00	36.00	0.82	0.66	0.66	1.08

Measured data

STATION No. :	C1H015	START TIME :	17h00
RIVER NAME :	Klip	Average Gaugeplate reading :	6.83 m
PLACE NAME :	De Langes Drift		
DATE :	24/02/1975		
		Main Channel LEFT :	10
		Main Channel RIGHT :	42

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.627	213.7	133.94
1	6	0		0		0.000	0.0	0.00
2	7	1.2		0.2244		0.224	2.4	0.54
3	10	3.1		0.171		0.171	9.3	1.59
4	13	4		0.4585		0.459	12.0	5.50
5	16	5		0.8331		0.833	15.0	12.50
6	19	7.9		0.8672		0.867	23.7	20.55
7	22	7.7		0.8884		0.888	23.1	20.52
8	25	7.8		0.8885		0.889	23.4	20.79
9	28	7.6		0.8885		0.889	17.9	15.87
10	29.7	7.6		0.7108		0.711	14.1	9.99
11	31.7	7.2		0.4485		0.449	11.9	5.33
12	33	7.2		0.5607		0.561	15.5	8.68
13	36	5.4		0.301		0.301	16.2	4.88
14	39	3.2		0.1907		0.191	9.6	1.83
15	42	2.5		0.3095		0.310	7.5	2.32
16	45	2.1		0.3095		0.310	6.3	1.95
17	48	1.7		0.2159		0.216	5.1	1.10
18	51	0.4		0		0.000	0.8	0.00
19	52	0		0		0.000	0.0	0.00
						0.627	213.7	133.94

Delta value calculations

Per	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	**16.4**	16.00	19.00	0.83	0.87	0.84	**0.75**
30%	**19.6**	19.00	22.00	0.87	0.89	0.87	**0.72**
40%	**22.8**	22.00	25.00	0.89	0.89	0.89	**0.71**
50%	**26.0**	25.00	28.00	0.89	0.89	0.89	**0.71**
60%	**29.2**	28.00	29.70	0.89	0.71	0.76	**0.82**
70%	**32.4**	31.70	33.00	0.45	0.56	0.51	**1.23**
80%	**35.6**	33.00	36.00	0.56	0.30	0.34	**1.87**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	154.3
Slope	0.00007	V_{AVR} =	0.72

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.038	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	3.5	0	0.00	0.00
7	1.2	2	2.4	2.0	1.2	0.60	0.25
10	3.1	2	9.3	3.0	3.1	4.35	0.47
13	4	2	12.0	3.0	4	6.66	0.55
16	5	2	15.0	3.0	5	9.66	0.64
19	7.9	2	23.7	3.0	7.9	20.70	0.87
22	7.7	2	23.1	3.0	7.7	19.83	0.86
25	7.8	2	23.4	3.0	7.8	20.26	0.87
28	7.6	2	17.9	2.4	7.6	15.20	0.85
29.7	7.6	2	14.1	1.9	7.6	11.97	0.85
31.7	7.2	2	11.9	1.7	7.2	9.75	0.82
33	7.2	2	15.5	2.2	7.2	12.71	0.82
36	5.4	2	16.2	3.0	5.4	10.98	0.68
39	3.2	2	9.6	3.0	3.2	4.59	0.48
42	2.5	2	7.5	3.0	2.5	3.04	0.41
45	2.1	2	6.3	3.0	2.1	2.27	0.36
48	1.7	2	5.1	3.0	1.7	1.60	0.31
51	0.4	2	0.8	2.0	0.4	0.10	0.12
52	0	2	0.0	0.5	0	0.00	0.00
			213.7			**154.27**	**0.72**

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	**16.4**	16.00	19.00	0.64	0.87	0.67	**1.07**
30%	**19.6**	19.00	22.00	0.87	0.86	0.87	**0.83**
40%	**22.8**	22.00	25.00	0.86	0.87	0.86	**0.84**
50%	**26.0**	25.00	28.00	0.87	0.85	0.86	**0.84**
60%	**29.2**	28.00	29.70	0.85	0.85	0.85	**0.86**
70%	**32.4**	31.70	33.00	0.82	0.82	0.82	**0.88**
80%	**35.6**	33.00	36.00	0.82	0.68	0.70	**1.04**

Measured data

STATION No. : C1H015 START TIME : 11h00

RIVER NAME : Klip Average Gaugeplate reading : 7.03 m

PLACE NAME : De Langes Drift

DATE : 24/02/1975

Main Channel LEFT : 10

Main Channel RIGHT : 42

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						0.647	223.9	144.83
1	6	0		0		0.000	0.0	0.00
2	7	1.4		0.1828		0.183	2.8	0.51
3	10	3.4		0.1514		0.151	10.2	1.54
4	13	4.1		0.4457		0.446	12.3	5.48
5	16	5.1		0.7778		0.778	15.3	11.90
6	19	8		0.9183		0.918	24.0	22.04
7	22	7.8		0.9608		0.961	23.4	22.48
8	25	7.9		0.9693		0.969	23.7	22.97
9	28	7.8		0.9012		0.901	18.3	16.52
10	29.7	7.8		0.721		0.721	14.4	10.40
11	31.7	7.3		0.4928		0.493	12.0	5.94
12	33	7.3		0.616		0.616	15.7	9.67
13	36	5.6		0.2712		0.271	16.8	4.56
14	39	4.5		0.2371		0.237	13.5	3.20
15	42	2.7		0.4287		0.429	8.1	3.47
16	45	2.3		0.4117		0.412	6.9	2.84
17	48	1.8		0.2414		0.241	5.4	1.30
18	51	0.5		0		0.000	1.0	0.00
19	52	0		0		0.000	0.0	0.00
						0.647	223.9	144.83

Delta value calculations

Per	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.78	0.92	0.80	0.81
30%	19.6	19.00	22.00	0.92	0.96	0.93	0.70
40%	22.8	22.00	25.00	0.96	0.97	0.96	0.67
50%	26.0	25.00	28.00	0.97	0.90	0.95	0.68
60%	29.2	28.00	29.70	0.90	0.72	0.77	0.84
70%	32.4	31.70	33.00	0.49	0.62	0.56	1.16
80%	35.6	33.00	36.00	0.62	0.27	0.32	2.04

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.00008

Q = 175.3

V_{AVR} = 0.78

Roughness coeff. Sub	n
0	
2	0.038
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	3.5	0	0.00	0.00
7	1.4	2	2.8	2.0	1.4	0.82	0.29
10	3.4	2	10.2	3.0	3.4	5.43	0.53
13	4.1	2	12.3	3.0	4.1	7.42	0.60
16	5.1	2	15.3	3.0	5.1	10.67	0.70
19	8	2	24.0	3.0	8	22.60	0.94
22	7.8	2	23.4	3.0	7.8	21.66	0.93
25	7.9	2	23.7	3.0	7.9	22.13	0.93
28	7.8	2	18.3	2.4	7.8	16.97	0.93
29.7	7.8	2	14.4	1.9	7.8	13.36	0.93
31.7	7.3	2	12.0	1.7	7.3	10.67	0.89
33	7.3	2	15.7	2.2	7.3	13.90	0.89
36	5.6	2	16.8	3.0	5.6	12.47	0.74
39	4.5	2	13.5	3.0	4.5	8.66	0.64
42	2.7	2	8.1	3.0	2.7	3.70	0.46
45	2.3	2	6.9	3.0	2.3	2.83	0.41
48	1.8	2	5.4	3.0	1.8	1.88	0.35
51	0.5	2	1.0	2.0	0.5	0.15	0.15
0	0	2	0.0	0.5	0	0.00	0.00
			223.9			175.31	0.78

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.70	0.94	0.73	1.07
30%	19.6	19.00	22.00	0.94	0.93	0.94	0.83
40%	22.8	22.00	25.00	0.93	0.93	0.93	0.84
50%	26.0	25.00	28.00	0.93	0.93	0.93	0.84
60%	29.2	28.00	29.70	0.93	0.93	0.93	0.85
70%	32.4	31.70	33.00	0.89	0.89	0.89	0.88
80%	35.6	33.00	36.00	0.89	0.74	0.76	1.03

Measured data

STATION No. : C1H015 — START TIME : 07h00

RIVER NAME : Klip — Average Gaugeplate reading : 7.18 m

PLACE NAME : De Langes Drift

DATE : 24/02/1975

Main Channel LEFT : 10

Main Channel RIGHT : 42

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.647	233.4	151.12
1	6	0		0		0.000	0.0	0.00
2	7	1.5		0.2042		0.204	3.0	0.61
3	10	3.4		0.1549		0.155	10.2	1.58
4	13	4.2		0.6272		0.627	12.6	7.90
5	16	5.4		0.8642		0.864	16.2	14.00
6	19	8.2		0.8981		0.898	24.6	22.09
7	22	8		0.9743		0.974	24.0	23.38
8	25	8.1		0.8896		0.890	24.3	21.62
9	28	8		0.9404		0.940	18.8	17.68
10	29.7	8		0.7523		0.752	14.8	11.13
11	31.7	7.5		0.4612		0.461	12.4	5.71
12	33	7.5		0.5765		0.577	16.1	9.30
13	36	5.7		0.221		0.221	17.1	3.78
14	39	4.5		0.2887		0.289	13.5	3.90
15	42	2.9		0.5003		0.500	8.7	4.35
16	45	2.5		0.3987		0.399	7.5	2.99
17	48	2		0.1702		0.170	6.0	1.02
18	51	0.7		0.0332		0.033	2.1	0.07
19	54	0.5		0		0.000	1.5	0.00
						0.647	233.4	151.12

Delta value calculations

Per	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.86	0.90	0.87	0.75
30%	19.6	19.00	22.00	0.90	0.97	0.91	0.71
40%	22.8	22.00	25.00	0.97	0.89	0.95	0.68
50%	26.0	25.00	28.00	0.89	0.94	0.91	0.71
60%	29.2	28.00	29.70	0.94	0.75	0.81	0.80
70%	32.4	31.70	33.00	0.46	0.58	0.52	1.24
80%	35.6	33.00	36.00	0.58	0.22	0.27	2.41

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00008

Q = 184.1

V_{AVR} = 0.79

Roughness coeff. Sub	n
0	
2	0.038
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	3.5	0	0.00	0.00
7	1.5	2	3.0	2.0	1.5	0.93	0.31
10	3.4	2	10.2	3.0	3.4	5.43	0.53
13	4.2	2	12.6	3.0	4.2	7.72	0.61
16	5.4	2	16.2	3.0	5.4	11.74	0.72
19	8.2	2	24.6	3.0	8.2	23.55	0.96
22	8	2	24.0	3.0	8	22.60	0.94
25	8.1	2	24.3	3.0	8.1	23.07	0.95
28	8	2	18.8	2.4	8	17.70	0.94
29.7	8	2	14.8	1.9	8	13.93	0.94
31.7	7.5	2	12.4	1.7	7.5	11.16	0.90
33	7.5	2	16.1	2.2	7.5	14.54	0.90
36	5.7	2	17.1	3.0	5.7	12.84	0.75
39	4.5	2	13.5	3.0	4.5	8.66	0.64
42	2.9	2	8.7	3.0	2.9	4.16	0.48
45	2.5	2	7.5	3.0	2.5	3.25	0.43
48	2	2	6.0	3.0	2	2.24	0.37
51	0.7	2	2.1	3.0	0.7	0.39	0.19
54	0.5	2	1.5	3.0	0.5	0.22	0.15
			233.4			184.13	0.79

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.72	0.96	0.76	1.04
30%	19.6	19.00	22.00	0.96	0.94	0.95	0.83
40%	22.8	22.00	25.00	0.94	0.95	0.94	0.84
50%	26.0	25.00	28.00	0.85	0.94	0.85	0.83
60%	29.2	28.00	29.70	0.94	0.94	0.94	0.84
70%	32.4	31.70	33.00	0.90	0.90	0.90	0.87
80%	35.6	33.00	36.00	0.90	0.75	0.77	1.02

Measured data

STATION No. : C1H015 START TIME : 16h00
RIVER NAME : Klip Average Gaugeplate reading : 7.605 m
PLACE NAME : De Langes Drift
DATE : 24/02/1975

Main Channel LEFT : 10
Main Channel RIGHT : 42

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.697	249.7	173.95
1	4	0.2		0		0.000	0.3	0.00
2	7	1.8		0.1702		0.170	5.4	0.92
3	10	3.7		0.3056		0.306	11.1	3.39
4	13	4.6		0.441		0.441	13.8	6.09
5	16	5.6		0.7288		0.729	16.8	12.24
6	19	8.5		0.8642		0.864	17.0	14.69
7	20	8.4		1.0166		1.017	25.2	25.62
8	25	8.5		1.0674		1.067	34.0	36.29
9	28	8.2		1.1351		1.135	19.3	21.87
10	29.7	8.2		0.9081		0.908	15.2	13.78
11	31.7	7.8		0.5695		0.570	12.9	7.33
12	33	7.8		0.7119		0.712	16.8	11.94
13	36	6.1		0.2717		0.272	18.3	4.97
14	39	4.9		0.3056		0.306	14.7	4.49
15	42	3.1		0.6272		0.627	9.3	5.83
16	45	2.8		0.3564		0.356	8.4	2.99
17	48	2.1		0.221		0.221	6.3	1.39
18	51	0.9		0.0408		0.041	2.7	0.11
19	54	0.7		0		0.000	2.1	0.00
20	57	0.1		0		0.000	0.2	0.00
21	58	0				0.000	0.0	0.00
						0.697	249.7	173.95

Delta value calculations

Per	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.73	0.86	0.75	0.93
30%	19.6	19.00	20.00	0.86	1.02	0.96	0.73
40%	22.8	20.00	25.00	1.02	1.07	1.05	0.67
50%	26.0	25.00	28.00	1.07	1.14	1.09	0.64
60%	29.2	28.00	29.70	1.14	0.91	0.97	0.71
70%	32.4	31.70	33.00	0.57	0.71	0.65	1.08
80%	35.6	33.00	36.00	0.71	0.27	0.33	2.11

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.000065

Q = 207.1
V_{AVR} = 0.83

Roughness coeff

Sub	n
0	
2	0.038
0	

Area reduction factor

Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
4	0.2	2	0.3	3.5	0.085714	0.01	0.05
7	1.8	2	5.4	3.0	1.8	1.94	0.36
10	3.7	2	11.1	3.0	3.7	6.44	0.58
13	4.6	2	13.8	3.0	4.6	9.26	0.67
16	5.6	2	16.8	3.0	5.6	12.85	0.77
19	8.5	2	17.0	2.0	8.5	17.18	1.01
20	8.4	2	25.2	3.0	8.4	25.26	1.00
25	8.5	2	34.0	4.0	8.5	34.36	1.01
28	8.2	2	19.3	2.4	8.2	19.01	0.98
29.7	8.2	2	15.2	1.9	8.2	14.97	0.98
31.7	7.8	2	12.9	1.7	7.8	12.28	0.95
33	7.8	2	16.8	2.2	7.8	16.00	0.95
36	6.1	2	18.3	3.0	6.1	14.82	0.81
39	4.9	2	14.7	3.0	4.9	10.29	0.70
42	3.1	2	9.3	3.0	3.1	4.80	0.52
45	2.8	2	8.4	3.0	2.8	4.05	0.48
48	2.1	2	6.3	3.0	2.1	2.51	0.40
51	0.9	2	2.7	3.0	0.9	0.61	0.23
54	0.7	2	2.1	3.0	0.7	0.40	0.19
57	0.1	2	0.2	2.0	0.1	0.01	0.05
0	0	2	0.0	0.5	0	0.00	0.00
			249.7			207.06	0.83

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.77	1.01	0.80	1.04
30%	19.6	19.00	20.00	1.01	1.00	1.01	0.82
40%	22.8	20.00	25.00	1.00	1.01	1.01	0.82
50%	26.0	25.00	28.00	1.01	0.98	1.00	0.83
60%	29.2	28.00	29.70	0.99	0.98	0.99	0.84
70%	32.4	31.70	33.00	0.95	0.95	0.95	0.87
80%	35.6	33.00	36.00	0.95	0.81	0.83	1.00

Measured data

STATION No. : C1H015 | START TIME : 13h00
RIVER NAME : Klip | Average Gaugeplate reading : 7.67 m
PLACE NAME : De Langes Drift
DATE : 23/02/1975

Main Channel LEFT : 10
Main Channel RIGHT : 42

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.707	253.8	179.48
1	3.5	0		0		0.000	0.0	0.00
2	4	0.3		0		0.000	0.5	0.00
3	7	2		0.1702		0.170	6.0	1.02
4	10	3.9		0.2548		0.255	11.7	2.98
5	13	4.7		0.5595		0.560	14.1	7.89
6	16	5.7		0.8981		0.898	17.1	15.36
7	19	8.6		1.0843		1.084	25.8	27.97
8	22	8.5		1.025		1.025	25.5	26.14
9	25	8.6		0.8981		0.898	25.8	23.17
10	28	8.3		1.0504		1.050	19.5	20.49
11	29.7	8.3		0.8403		0.840	15.4	12.90
12	31.7	7.9		0.5966		0.597	13.0	7.78
13	33	7.9		0.7457		0.746	17.0	12.67
14	36	6.2		0.204		0.204	18.6	3.79
15	39	5		0.2887		0.289	15.0	4.33
16	42	3.2		0.6103		0.610	9.6	5.86
17	45	3		0.5426		0.543	9.0	4.88
18	48	2.3		0.3056		0.306	6.9	2.11
19	51	1.1		0.0408		0.041	3.3	0.13
20	54	0		0		0.000	0.0	0.00
						0.707	253.8	179.48

Delta value calculations

Per	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.90	1.08	0.92	0.77
30%	19.6	19.00	22.00	1.08	1.03	1.07	0.66
40%	22.8	22.00	25.00	1.03	0.90	0.99	0.71
50%	26.0	25.00	28.00	0.90	1.05	0.95	0.75
60%	29.2	28.00	29.70	1.05	0.84	0.90	0.78
70%	32.4	31.70	33.00	0.60	0.75	0.68	1.04
80%	35.6	33.00	36.00	0.75	0.20	0.28	2.56

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00008

Q = 207.0
V_{AVR} = 0.82

Roughness coeff. Sub	n
0	
2	0.038
0	

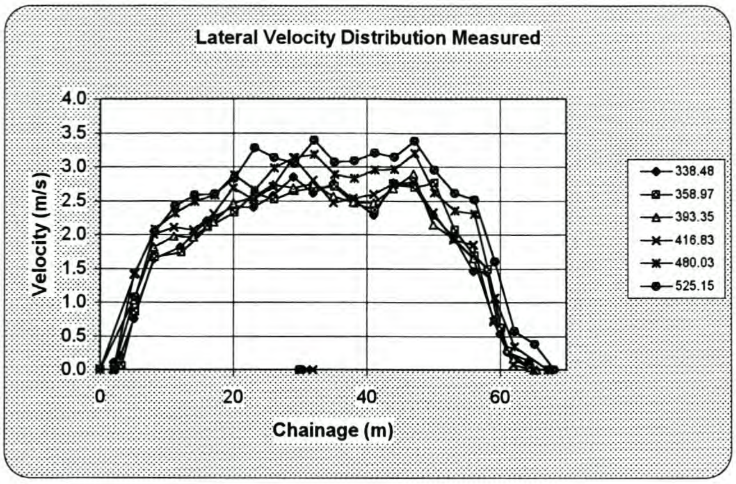
Area reduction factor Sub	f_A
0	1
2	1
0	1

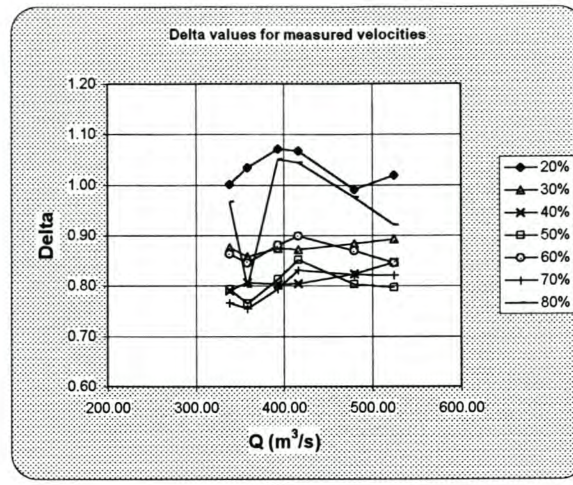
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
3.5	0	2	0.0	2.0	0	0.00	0.00
4	0.3	2	0.5	1.8	0.3	0.06	0.11
7	2	2	6.0	3.0	2	2.24	0.37
10	3.9	2	11.7	3.0	3.9	6.82	0.58
13	4.7	2	14.1	3.0	4.7	9.31	0.66
16	5.7	2	17.1	3.0	5.7	12.84	0.75
19	8.6	2	25.8	3.0	8.6	25.49	0.99
22	8.5	2	25.5	3.0	8.5	25.00	0.98
25	8.6	2	25.8	3.0	8.6	25.49	0.99
28	8.3	2	19.5	2.4	8.3	18.82	0.96
29.7	8.3	2	15.4	1.9	8.3	14.82	0.96
31.7	7.9	2	13.0	1.7	7.9	12.17	0.93
33	7.9	2	17.0	2.2	7.9	15.86	0.93
36	6.2	2	18.6	3.0	6.2	14.78	0.79
39	5	2	15.0	3.0	5	10.32	0.69
42	3.2	2	9.6	3.0	3.2	4.91	0.51
45	3	2	9.0	3.0	3	4.41	0.49
48	2.3	2	6.9	3.0	2.3	2.83	0.41
51	1.1	2	3.3	3.0	1.1	0.83	0.25
54	0	2	0.0	1.5	0	0.00	0.00
			253.8			206.99	0.82

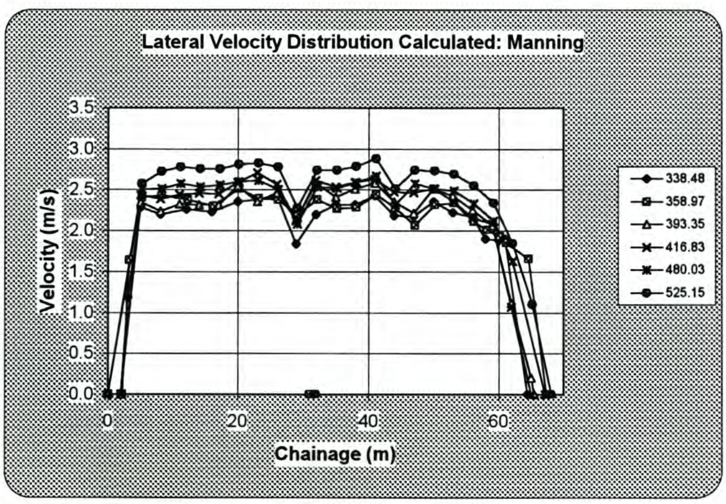
Delta value calculations

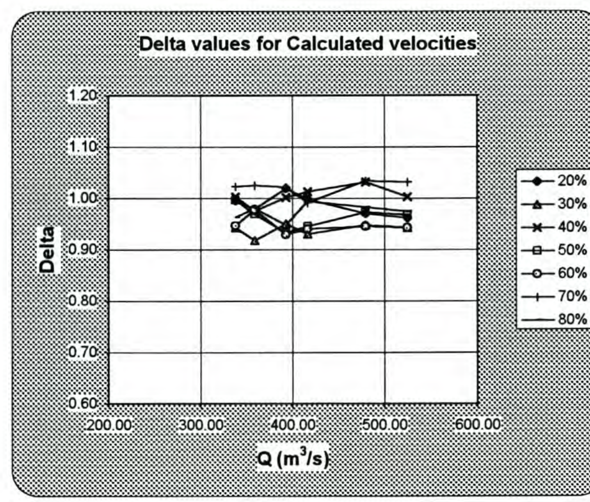
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	16.4	16.00	19.00	0.75	0.99	0.78	1.04
30%	19.6	19.00	22.00	0.99	0.98	0.99	0.83
40%	22.8	22.00	25.00	0.98	0.99	0.98	0.83
50%	26.0	25.00	28.00	0.99	0.96	0.98	0.83
60%	29.2	28.00	29.70	0.96	0.96	0.96	0.85
70%	32.4	31.70	33.00	0.93	0.93	0.93	0.87
80%	35.6	33.00	36.00	0.93	0.79	0.81	1.00

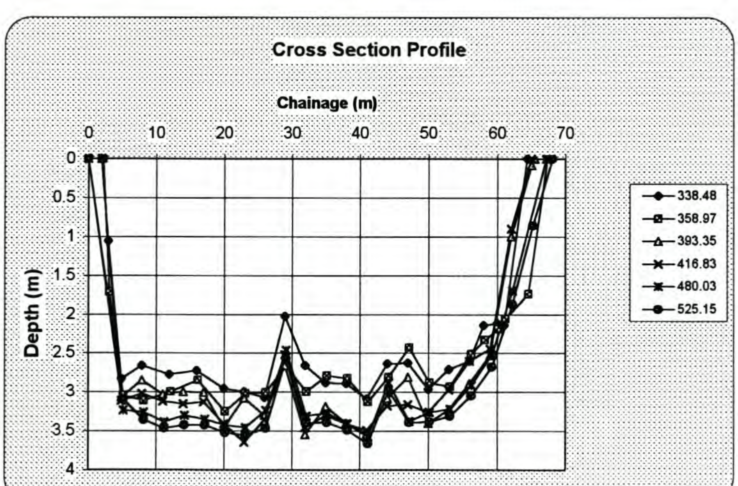
Statn No.: C8H028
River: Wilge
Place: Bavaria











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. :	C8H028	START TIME :	11h15
RIVER NAME :	Wilge	Average Gaugeplate reading :	2.1 m
PLACE NAME :	Bavaria		
DATE :	17/02/1969		
		Main Channel LEFT :	3
		Main Channel RIGHT :	63

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.106	160.8	338.48
1	2	0	0	0.101097	0	0.101	0.0	0.00
2	3	1.06	0.245067		0.15932	0.202	1.6	0.32
3	5	2.83	0.49785		1.003417	0.751	7.1	5.31
4	8	2.66	1.639733		1.631017	1.635	9.3	15.23
5	12	2.78	1.6223		1.9884	1.805	11.1	20.08
6	16	2.73	2.136583		2.267333	2.202	10.9	24.05
7	20	2.96	2.22375		2.58985	2.407	10.4	24.93
8	23	3	2.188883		2.607283	2.398	9.0	21.58
9	26	3.072	2.110433		3.0344	2.572	9.2	23.71
10	29	2.032	2.807767		2.894933	2.851	6.1	17.38
11	32	2.662	2.450383		2.764183	2.607	8.0	20.82
12	35	2.882	2.528833		2.973383	2.751	8.6	23.79
13	38	2.89	2.310917		2.7206	2.516	8.7	21.81
14	41	3.09	1.970967		2.607283	2.289	9.3	21.22
15	44	2.633	2.607283		2.921083	2.764	7.9	21.83
16	47	2.628	2.554983		2.886217	2.721	7.9	21.45
17	50	2.964	1.979683		2.598567	2.289	8.9	20.35
18	53	2.711	1.6746		2.2499	1.962	8.1	15.96
19	56	2.606	1.4654		1.447967	1.457	6.5	9.49
20	58	2.14	1.3085		1.59615	1.452	4.3	6.22
21	60	2.12	0.698333		0.3671	0.533	3.2	1.69
22	61	2.14	0.349667		0.18405	0.267	4.7	1.26
23	64.4	0	0	0.133429	0	0.133	0.0	0.00
						2.106	160.8	338.48

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
20%	**15.0**	12.00	16.00	1.81	2.20	2.10	**1.00**
30%	**21.0**	20.00	23.00	2.41	2.40	2.40	**0.88**
40%	**27.0**	26.00	29.00	2.57	2.85	2.67	**0.79**
50%	**33.0**	32.00	35.00	2.61	2.75	2.66	**0.79**
60%	**39.0**	38.00	41.00	2.52	2.29	2.44	**0.86**
70%	**45.0**	44.00	47.00	2.76	2.72	2.75	**0.77**
80%	**51.0**	50.00	53.00	2.29	1.96	2.18	**0.97**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	357.9
Slope	0.0016	V_{AVR} =	2.23

Roughness coeff		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2	0	2	0.0	1.5	0	0.00	0.00
3	1.06	2	1.6	1.5	1.06	1.89	1.19
5	2.83	2	7.1	2.5	2.83	16.18	2.29
8	2.66	2	9.3	3.5	2.66	20.43	2.19
12	2.78	2	11.1	4.0	2.78	25.13	2.26
16	2.73	2	10.9	4.0	2.73	24.38	2.23
20	2.96	2	10.4	3.5	2.96	24.41	2.36
23	3	2	9.0	3.0	3	21.40	2.38
26	3.072	2	9.2	3.0	3.072	22.26	2.42
29	2.032	2	6.1	3.0	2.032	11.18	1.83
32	2.662	2	8.0	3.0	2.662	17.53	2.20
35	2.882	2	8.6	3.0	2.882	20.01	2.31
38	2.89	2	8.7	3.0	2.89	20.10	2.32
41	3.09	2	9.3	3.0	3.09	22.48	2.42
44	2.633	2	7.9	3.0	2.633	17.21	2.18
47	2.628	2	7.9	3.0	2.628	17.16	2.18
50	2.964	2	8.9	3.0	2.964	20.97	2.36
53	2.711	2	8.1	3.0	2.711	18.07	2.22
56	2.606	2	6.5	2.5	2.606	14.10	2.16
58	2.14	2	4.3	2.0	2.14	8.12	1.90
60	2.12	2	3.2	1.5	2.12	6.00	1.89
61	2.14	2	4.7	2.2	2.14	8.94	1.90
64.4	0	2	0.0	1.7	0	0.00	0.00
			160.75			357.92	2.23

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Alpha
20%	**15.0**	12.00	16.00	2.26	2.23	2.24	**0.99**
30%	**21.0**	20.00	23.00	2.36	2.38	2.36	**0.94**
40%	**27.0**	26.00	29.00	2.42	1.83	2.22	**1.00**
50%	**33.0**	32.00	35.00	2.20	2.31	2.23	**1.00**
60%	**39.0**	38.00	41.00	2.32	2.42	2.35	**0.95**
70%	**45.0**	44.00	47.00	2.18	2.18	2.18	**1.02**
80%	**51.0**	50.00	53.00	2.36	2.22	2.31	**0.96**

Measured data

STATION No. :	C8H026	START TIME :	05h45
RIVER NAME :	Wilge	Average Gaugeplate reading :	2.145 m
PLACE NAME :	Bavaria		
DATE :	18/02/1989		
		Main Channel LEFT :	3
		Main Channel RIGHT :	63

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s) 2.057	Area (m^2) 174.5	Q (m^3/s) 358.97
1	2.2	0	0	0.029	0	0.029	0.0	0.00
2	3.2	1.72	0		0.114317	0.057	2.6	0.15
3	5.2	3.05	0.698333		1.02085	0.860	7.6	6.55
4	8.2	3.11	1.613583		1.718183	1.666	10.9	18.13
5	12.2	3	1.587433		1.875083	1.731	12.0	20.78
6	16.2	2.852	1.892517		2.310917	2.102	11.4	23.98
7	20.2	3.252	2.093		2.546267	2.320	11.4	26.40
8	23.2	3.026	2.38065		2.842633	2.612	9.1	23.71
9	26.2	3.005	2.110433		2.921083	2.516	9.0	22.68
10	29.2	2.673	2.1976		3.0867	2.642	8.0	21.19
11	32.2	2.996	2.310917		3.06055	2.686	9.0	24.14
12	35.2	2.796	2.554983		2.85135	2.703	8.4	22.67
13	38.2	2.823	2.127867		2.790333	2.459	8.5	20.83
14	41.2	3.126	1.9361		2.790333	2.363	9.4	22.16
15	44.2	2.806	2.53755		2.938517	2.738	8.4	23.05
16	47.2	2.43	2.546267		2.842633	2.694	7.3	19.64
17	50.2	2.88	2.842633		2.685733	2.764	8.6	23.88
18	53.2	2.93	1.75305		2.371933	2.062	8.8	18.13
19	56.2	2.51	1.3608		2.005833	1.683	6.3	10.56
20	58.2	2.33	1.4131		1.552567	1.483	4.7	6.91
21	60.2	2.19	0.75935		0.480417	0.620	3.3	2.04
22	61.2	2.06	0.332233		0.218917	0.276	4.5	1.25
23	64.6	1.74	0		0.0533	0.027	5.4	0.14
24	67.37	0	0	0	0	0.000	0.0	0.00
						2.057	174.5	358.97

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	15.0	12.20	16.20	1.73	2.10	1.99	1.03
30%	21.0	20.20	23.20	2.32	2.61	2.40	0.86
40%	27.0	26.20	29.20	2.52	2.64	2.55	0.81
50%	33.0	32.20	35.20	2.68	2.70	2.69	0.76
60%	39.0	38.20	41.20	2.46	2.36	2.43	0.85
70%	45.0	44.20	47.20	2.74	2.69	2.73	0.75
80%	51.0	50.20	53.20	2.76	2.06	2.58	0.80

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	396.7
Slope	0.0016	V_{AVR} =	2.27

Roughness coeff Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2.2	0	2	0.0	1.6	0	0.00	0.00
3.2	1.72	2	2.6	1.5	1.72	4.23	1.64
5.2	3.05	2	7.6	2.5	3.05	18.33	2.40
8.2	3.11	2	10.9	3.5	3.11	26.50	2.43
12.2	3	2	12.0	4.0	3	28.53	2.38
16.2	2.852	2	11.4	4.0	2.852	26.22	2.30
20.2	3.252	2	11.4	3.5	3.252	28.55	2.51
23.2	3.026	2	9.1	3.0	3.026	21.71	2.39
26.2	3.005	2	9.0	3.0	3.005	21.45	2.38
29.2	2.673	2	8.0	3.0	2.673	17.65	2.20
32.2	2.996	2	9.0	3.0	2.996	21.35	2.38
35.2	2.796	2	8.4	3.0	2.796	19.03	2.27
38.2	2.823	2	8.5	3.0	2.823	19.33	2.28
41.2	3.126	2	9.4	3.0	3.126	22.91	2.44
44.2	2.806	2	8.4	3.0	2.806	19.14	2.27
47.2	2.43	2	7.3	3.0	2.43	15.06	2.07
50.2	2.88	2	8.6	3.0	2.88	19.99	2.31
53.2	2.93	2	8.8	3.0	2.93	20.57	2.34
56.2	2.51	2	6.3	2.5	2.51	13.25	2.11
58.2	2.33	2	4.7	2.0	2.33	9.36	2.01
60.2	2.19	2	3.3	1.5	2.19	6.33	1.93
61.2	2.06	2	4.5	2.2	2.06	8.39	1.85
64.6	1.74	2	5.4	3.1	1.74	8.87	1.65
67.37	0	2	0.0	1.4	0	0.00	0.00
			174.47			396.75	2.27

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Alpha
20%	15.0	12.20	16.20	2.38	2.30	2.32	0.98
30%	21.0	20.20	23.20	2.51	2.39	2.48	0.92
40%	27.0	26.20	29.20	2.38	2.20	2.33	0.98
50%	33.0	32.20	35.20	2.38	2.27	2.35	0.97
60%	39.0	38.20	41.20	2.28	2.44	2.33	0.98
70%	45.0	44.20	47.20	2.27	2.07	2.22	1.03
80%	51.0	50.20	53.20	2.31	2.34	2.32	0.98

Measured data

STATION No. : C8H028 | START TIME : 09h30
RIVER NAME : Wilge | Average Gaugeplate reading : 4.135 m
PLACE NAME : Bavaria
DATE : 22/12/1975
Main Channel LEFT : 3
Main Channel RIGHT : 63

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.181	180.4	393.35
1	2	0		0		0.000	0.0	0.00
2	5	3.07		1.027		1.027	9.2	9.46
3	8	2.85		1.8121		1.812	8.6	15.49
4	11	3.03		1.9742		1.974	9.1	17.95
5	14	3		1.9657		1.966	9.0	17.69
6	17	3.01		2.179		2.179	9.0	19.68
7	20	3.46		2.4606		2.461	10.4	25.54
8	23	3.08		2.5545		2.555	9.2	23.60
9	26	3.3		2.7337		2.734	9.9	27.06
10	29	2.66		2.6825		2.683	8.0	21.41
11	32	3.55		2.7422		2.742	10.7	29.20
12	35	3.19		2.563		2.563	9.6	24.53
13	38	3.4		2.4777		2.478	10.2	25.27
14	41	3.54		2.4691		2.469	10.6	26.22
15	44	3.08		2.6739		2.674	9.2	24.71
16	47	2.81		2.8958		2.896	8.4	24.41
17	50	3.4		2.1449		2.145	10.2	21.88
18	53	3.23		1.9401		1.940	9.7	18.80
19	56	2.89		1.6499		1.650	8.7	14.30
20	59	2.53		0.7454		0.745	7.6	5.66
21	62	1		0.1603		0.160	3.0	0.48
22	65	0.08		0		0.000	0.1	0.00
23	65.5	0		0		0.000	0.0	0.00
						2.181	180.4	393.35

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	**15.0**	14.00	17.00	1.97	2.18	2.04	**1.07**
30%	**21.0**	20.00	23.00	2.46	2.55	2.49	**0.88**
40%	**27.0**	26.00	29.00	2.73	2.68	2.72	**0.80**
50%	**33.0**	32.00	35.00	2.74	2.56	2.68	**0.81**
60%	**39.0**	38.00	41.00	2.48	2.47	2.47	**0.88**
70%	**45.0**	44.00	47.00	2.67	2.90	2.75	**0.79**
80%	**51.0**	50.00	53.00	2.14	1.94	2.08	**1.05**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0016
Q = 424.8
V_{AVR} = 2.36

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2	0	2	0.0	2.5	0	0.00	0.00
5	3.07	2	9.2	3.0	3.07	21.62	2.35
8	2.85	2	8.6	3.0	2.85	19.10	2.23
11	3.03	2	9.1	3.0	3.03	21.15	2.33
14	3	2	9.0	3.0	3	20.80	2.31
17	3.01	2	9.0	3.0	3.01	20.92	2.32
20	3.46	2	10.4	3.0	3.46	26.38	2.54
23	3.08	2	9.2	3.0	3.08	21.73	2.35
26	3.3	2	9.9	3.0	3.3	24.38	2.46
29	2.66	2	8.0	3.0	2.66	17.02	2.13
32	3.55	2	10.7	3.0	3.55	27.54	2.59
35	3.19	2	9.6	3.0	3.19	23.04	2.41
38	3.4	2	10.2	3.0	3.4	25.63	2.51
41	3.54	2	10.6	3.0	3.54	27.41	2.58
44	3.08	2	9.2	3.0	3.08	21.73	2.35
47	2.81	2	8.4	3.0	2.81	18.65	2.21
50	3.4	2	10.2	3.0	3.4	25.63	2.51
53	3.23	2	9.7	3.0	3.23	23.53	2.43
56	2.89	2	8.7	3.0	2.89	19.55	2.25
59	2.53	2	7.6	3.0	2.53	15.66	2.06
62	1	2	3.0	3.0	1	3.33	1.11
65	0.08	2	0.1	1.8	0.08	0.03	0.21
0	0	2	0.0	0.3	0	0.00	0.00
			180.38			424.82	2.36

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Alpha
20%	**15.0**	14.00	17.00	2.31	2.32	2.31	**1.02**
30%	**21.0**	20.00	23.00	2.54	2.36	2.48	**0.95**
40%	**27.0**	26.00	29.00	2.46	2.13	2.35	**1.00**
50%	**33.0**	32.00	35.00	2.59	2.41	2.53	**0.93**
60%	**39.0**	38.00	41.00	2.51	2.58	2.54	**0.93**
70%	**45.0**	44.00	47.00	2.35	2.21	2.31	**1.02**
80%	**51.0**	50.00	53.00	2.51	2.43	2.48	**0.95**

Measured data

STATION No. :	C8H028	START TIME :	09h00
RIVER NAME :	Wilge	Average Gaugeplate reading :	4.33 m
PLACE NAME :	Bavaria		
DATE :	24/03/1976		
		Main Channel LEFT :	3
		Main Channel RIGHT :	63

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.291	182.0	416.83
1	2	0		0		0.000	0.0	0.00
2	5	3.11		1.4067		1.407	9.3	13.12
3	8	3.02		2.0041		2.004	9.1	18.16
4	11	3.12		2.1022		2.102	9.4	19.68
5	14	3.15		2.0681		2.068	9.5	19.54
6	17	3.13		2.3027		2.303	9.4	21.62
7	20	3.41		2.6825		2.683	10.2	27.44
8	23	3.65		2.5118		2.512	11.0	27.50
9	26	3.36		2.7081		2.708	10.1	27.30
10	29	2.52		3.1305		3.131	7.6	23.67
11	32	3.46		2.8019		2.802	10.4	29.08
12	35	3.3		2.4649		2.465	9.9	24.40
13	38	3.41		2.5289		2.529	10.2	25.87
14	41	3.49		2.5929		2.593	10.5	27.15
15	44	3.18		2.7507		2.751	9.5	26.24
16	47	3.16		2.7678		2.768	9.5	26.24
17	50	3.26		2.3283		2.328	9.8	22.77
18	53	2.97		1.9273		1.927	8.9	17.17
19	56	2.6		1.8462		1.846	7.8	14.40
20	59	2.45		0.7155		0.716	7.4	5.26
21	62	0.9		0.0785		0.079	2.7	0.21
22	65	0		0		0.000	0.0	0.00
						2.291	182.0	416.83

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	15.0	14.00	17.00	2.07	2.30	2.15	1.07
30%	21.0	20.00	23.00	2.68	2.51	2.63	0.87
40%	27.0	26.00	29.00	2.71	3.13	2.85	0.80
50%	33.0	32.00	35.00	2.80	2.46	2.69	0.85
60%	39.0	38.00	41.00	2.53	2.59	2.55	0.90
70%	45.0	44.00	47.00	2.75	2.77	2.76	0.83
80%	51.0	50.00	53.00	2.33	1.93	2.19	1.04

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	445.1
Slope	0.0016	V_{AVR} =	2.45

Roughness coeff		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2	0	2	0.0	2.5	0	0.00	0.00
5	3.11	2	9.3	3.0	3.11	22.72	2.43
8	3.02	2	9.1	3.0	3.02	21.63	2.39
11	3.12	2	9.4	3.0	3.12	22.84	2.44
14	3.15	2	9.5	3.0	3.15	23.21	2.46
17	3.13	2	9.4	3.0	3.13	22.96	2.45
20	3.41	2	10.2	3.0	3.41	26.48	2.59
23	3.65	2	11.0	3.0	3.65	29.87	2.71
26	3.36	2	10.1	3.0	3.36	25.84	2.56
29	2.52	2	7.6	3.0	2.52	16.00	2.12
32	3.46	2	10.4	3.0	3.46	27.14	2.61
35	3.3	2	9.9	3.0	3.3	25.08	2.53
38	3.41	2	10.2	3.0	3.41	26.49	2.59
41	3.49	2	10.5	3.0	3.49	27.53	2.63
44	3.18	2	9.5	3.0	3.18	23.58	2.47
47	3.16	2	9.5	3.0	3.16	23.33	2.46
50	3.26	2	9.8	3.0	3.26	24.57	2.51
53	2.97	2	8.9	3.0	2.97	21.04	2.36
56	2.6	2	7.8	3.0	2.6	16.86	2.16
59	2.45	2	7.4	3.0	2.45	15.27	2.08
62	0.9	2	2.7	3.0	0.9	2.88	1.07
65	0	2	0.0	1.5	0	0.00	0.00
			181.95			445.11	2.45

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Alpha
20%	15.0	14.00	17.00	2.46	2.45	2.45	1.00
30%	21.0	20.00	23.00	2.59	2.71	2.63	0.93
40%	27.0	26.00	29.00	2.56	2.12	2.41	1.01
50%	33.0	32.00	35.00	2.61	2.53	2.59	0.95
60%	39.0	38.00	41.00	2.59	2.63	2.60	0.94
70%	45.0	44.00	47.00	2.47	2.46	2.47	0.99
80%	51.0	50.00	53.00	2.51	2.36	2.46	0.99

Measured data

STATION No. :	C8H028	START TIME :	15h30
RIVER NAME :	Wilge	Average Gaugeplate reading :	4.72 m
PLACE NAME :	Bavaria		
DATE :	23/03/1976		
		Main Channel LEFT :	3
		Main Channel RIGHT :	63

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.488	192.9	480.03
1	0	0		0		0.000	0.0	0.00
2	5.2	3.235		1.4281		1.428	13.3	18.94
3	8.2	3.26		2.0809		2.081	9.8	20.35
4	11.2	3.383		2.3155		2.316	10.1	23.50
5	14.2	3.303		2.4862		2.486	9.9	24.64
6	17.2	3.349		2.5843		2.584	10.0	25.96
7	20.2	3.429		2.8745		2.875	10.3	29.57
8	23.2	3.456		2.6611		2.661	10.4	27.59
9	26.2	3.237		2.9854		2.985	9.7	28.99
10	29.2	2.46		3.1305		3.131	7.4	23.10
11	32.2	3.31		3.1774		3.177	9.9	31.55
12	35.2	3.27		2.883		2.883	9.8	28.28
13	38.2	3.407		2.8275		2.828	10.2	28.90
14	41.2	3.569		2.9513		2.951	10.7	31.60
15	44.2	2.886		2.9641		2.964	8.7	25.66
16	47.2	3.377		3.1987		3.199	10.1	32.41
17	50.2	3.263		2.6227		2.623	9.8	25.67
18	53.2	3.219		2.3539		2.354	9.7	22.73
19	56.2	2.916		2.3027		2.303	8.7	20.14
20	59.2	2.522		1.0697		1.070	7.6	8.09
21	62.2	1.697		0.3443		0.344	6.8	2.34
22	67.2	0		0		0.000	0.0	0.00
						2.488	192.9	480.03

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
20%	15.0	14.20	17.20	2.49	2.58	2.51	0.99
30%	21.0	20.20	23.20	2.87	2.66	2.82	0.88
40%	27.0	26.20	29.20	2.99	3.13	3.02	0.82
50%	33.0	32.20	35.20	3.18	2.88	3.10	0.80
60%	39.0	38.20	41.20	2.83	2.95	2.86	0.87
70%	45.0	44.20	47.20	2.96	3.20	3.03	0.82
80%	51.0	50.20	53.20	2.62	2.35	2.55	0.98

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	475.3
Slope	0.0016	V_{AVR} =	2.46

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
5.2	3.235	2	13.3	4.1	3.235	33.16	2.50
8.2	3.26	2	9.8	3.0	3.26	24.57	2.51
11.2	3.383	2	10.1	3.0	3.383	26.14	2.58
14.2	3.303	2	9.9	3.0	3.303	25.12	2.53
17.2	3.349	2	10.0	3.0	3.349	25.70	2.56
20.2	3.429	2	10.3	3.0	3.429	26.73	2.60
23.2	3.456	2	10.4	3.0	3.456	27.09	2.61
26.2	3.237	2	9.7	3.0	3.237	24.29	2.50
29.2	2.46	2	7.4	3.0	2.46	15.37	2.08
32.2	3.31	2	9.9	3.0	3.31	25.21	2.54
35.2	3.27	2	9.8	3.0	3.27	24.70	2.52
38.2	3.407	2	10.2	3.0	3.407	26.45	2.59
41.2	3.569	2	10.7	3.0	3.569	28.58	2.67
44.2	2.886	2	8.7	3.0	2.886	20.06	2.32
47.2	3.377	2	10.1	3.0	3.377	26.06	2.57
50.2	3.263	2	9.8	3.0	3.263	24.61	2.51
53.2	3.219	2	9.7	3.0	3.219	24.06	2.49
56.2	2.916	2	8.7	3.0	2.916	20.41	2.33
59.2	2.522	2	7.6	3.0	2.522	16.02	2.12
62.2	1.697	2	6.8	4.0	1.697	11.04	1.63
67.2	0	2	0.0	2.5	0	0.00	0.00
			192.90			475.35	2.46

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Alpha
20%	15.0	14.20	17.20	2.53	2.56	2.54	0.97
30%	21.0	20.20	23.20	2.60	2.61	2.60	0.95
40%	27.0	26.20	29.20	2.50	2.08	2.39	1.03
50%	33.0	32.20	36.20	2.54	2.52	2.53	0.97
60%	39.0	38.20	41.20	2.59	2.67	2.61	0.94
70%	45.0	44.20	47.20	2.32	2.57	2.38	1.03
80%	51.0	50.20	53.20	2.51	2.49	2.51	0.98

Measured data

STATION No. : C8H028 START TIME : 09h00
RIVER NAME : Wilge Average Gaugeplate reading : 4.915 m
PLACE NAME : Bavaria
DATE : 23/03/1976

Main Channel LEFT : 3
Main Channel RIGHT : 63

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						2.633	199.5	525.15
1	0	0		0		0.000	0.0	0.00
2	5.2	3.099		1.0739		1.074	12.7	13.64
3	8.2	3.36		2.0425		2.043	10.1	20.59
4	11.2	3.468		2.4179		2.418	10.4	25.16
5	14.2	3.427		2.5801		2.580	10.3	26.53
6	17.2	3.426		2.5971		2.597	10.3	26.69
7	20.2	3.525		2.8318		2.832	10.6	29.95
8	23.2	3.557		3.2755		3.276	10.7	34.95
9	26.2	3.465		3.1347		3.135	10.4	32.59
10	29.2	2.568		3.0494		3.049	7.7	23.49
11	32.2	3.398		3.395		3.395	10.2	34.61
12	35.2	3.391		3.0622		3.062	10.2	31.15
13	38.2	3.488		3.0835		3.084	10.5	32.27
14	41.2	3.664		3.1987		3.199	11.0	35.16
15	44.2	2.978		3.1433		3.143	8.9	28.08
16	47.2	3.393		3.3822		3.382	10.2	34.43
17	50.2	3.384		2.9555		2.956	10.2	30.00
18	53.2	3.307		2.6057		2.606	9.9	25.85
19	56.2	3.05		2.5118		2.512	9.2	22.98
20	59.2	2.677		1.5987		1.599	8.0	12.84
21	62.2	1.874		0.5705		0.571	5.6	3.21
22	65.2	0.863		0.3827		0.383	2.6	0.98
23	68.15	0		0		0.000	0.0	0.00
						2.633	199.5	525.15

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
20%	15.0	14.20	17.20	2.58	2.60	2.58	1.02
30%	21.0	20.20	23.20	2.83	3.28	2.95	0.89
40%	27.0	26.20	29.20	3.13	3.05	3.11	0.85
50%	33.0	32.20	35.20	3.40	3.06	3.31	0.80
60%	39.0	38.20	41.20	3.08	3.20	3.11	0.85
70%	45.0	44.20	47.20	3.14	3.38	3.21	0.82
80%	51.0	50.20	53.20	2.96	2.61	2.86	0.92

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0016

Q = 528.4
V_{AVR} = 2.65

Roughness coeff Sub	n
0	
2	0.033
0	

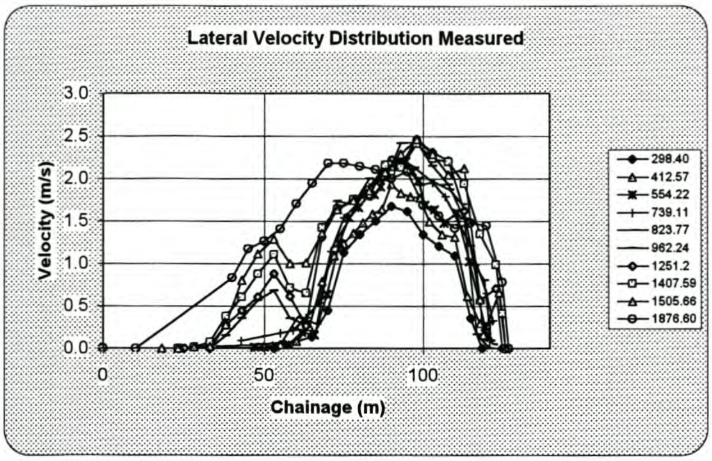
Area reduction factor Sub	f_A
0	1
2	1
0	1

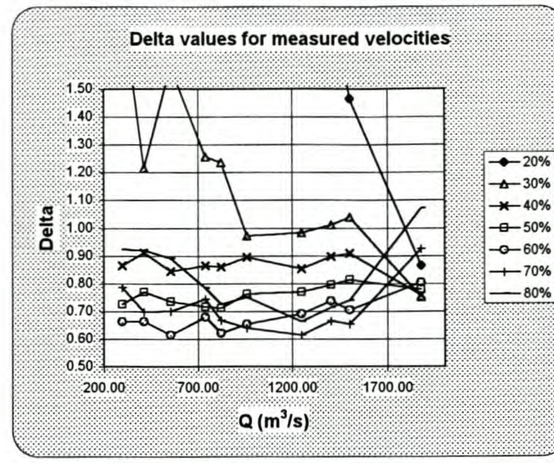
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
5.2	3.099	2	12.7	4.1	3.099	32.74	2.58
8.2	3.36	2	10.1	3.0	3.36	27.41	2.72
11.2	3.468	2	10.4	3.0	3.468	28.69	2.78
14.2	3.427	2	10.3	3.0	3.427	28.33	2.76
17.2	3.426	2	10.3	3.0	3.426	28.31	2.75
20.2	3.525	2	10.6	3.0	3.525	29.69	2.81
23.2	3.557	2	10.7	3.0	3.557	30.14	2.82
26.2	3.465	2	10.4	3.0	3.465	28.85	2.78
29.2	2.568	2	7.7	3.0	2.568	17.51	2.27
32.2	3.398	2	10.2	3.0	3.398	27.93	2.74
35.2	3.391	2	10.2	3.0	3.391	27.83	2.74
38.2	3.488	2	10.5	3.0	3.488	29.17	2.79
41.2	3.664	2	11.0	3.0	3.664	31.67	2.88
44.2	2.978	2	8.9	3.0	2.978	22.42	2.51
47.2	3.393	2	10.2	3.0	3.393	27.86	2.74
50.2	3.384	2	10.2	3.0	3.384	27.74	2.73
53.2	3.307	2	9.9	3.0	3.307	26.69	2.69
56.2	3.05	2	9.2	3.0	3.05	23.33	2.55
59.2	2.677	2	8.0	3.0	2.677	18.77	2.34
62.2	1.874	2	5.6	3.0	1.874	10.36	1.84
65.2	0.863	2	2.6	3.0	0.863	2.82	1.10
68.15	0	2	0.0	1.5	0	0.00	0.00
			199.47			528.44	2.65

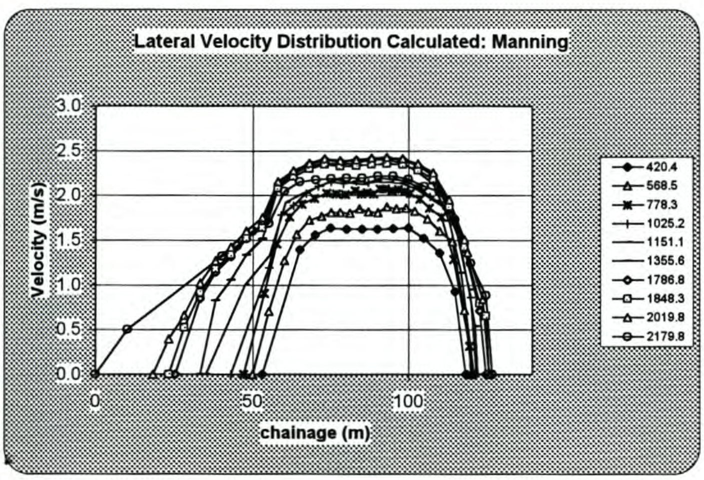
Delta value calculations

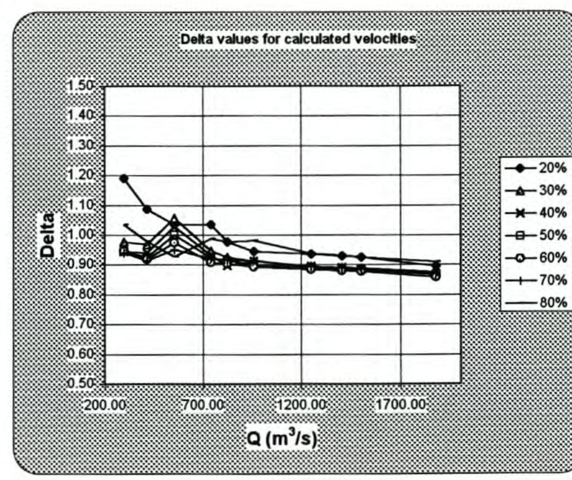
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Alpha
20%	15.0	14.20	17.20	2.76	2.75	2.76	0.96
30%	21.0	20.20	23.20	2.81	2.82	2.81	0.94
40%	27.0	26.20	29.20	2.78	2.27	2.64	1.00
50%	33.0	32.20	35.20	2.74	2.74	2.74	0.97
60%	39.0	38.20	41.20	2.79	2.88	2.81	0.94
70%	45.0	44.20	47.20	2.51	2.74	2.57	1.03
80%	51.0	50.20	53.20	2.73	2.69	2.72	0.97

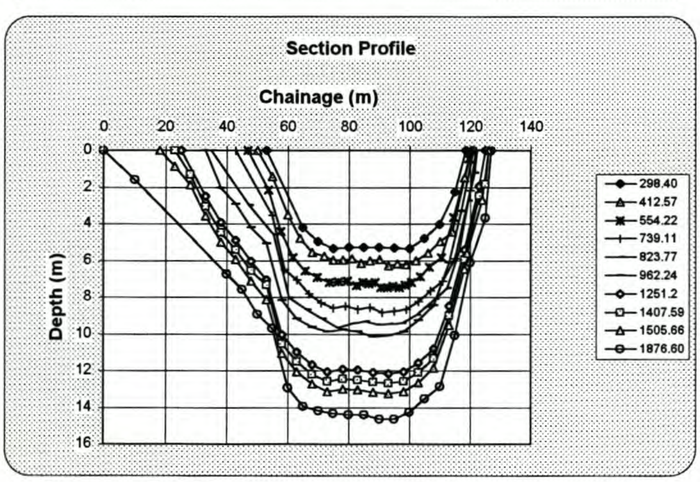
Statn No.: C8H030
River: Wilge
Place: Kimberley











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : C8H030
RIVER NAME : Wilge
PLACE NAME : Kimberley
DATE : 24/01/1988

START TIME : 07h30
Average Gaugeplate reading : 3.1 m

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.090	273.7	298.40
1	53	0		0		0.000	0.0	0.00
2	64.9	4.22		0.1327		0.133	35.7	4.73
3	69.9	4.96		0.447		0.447	24.8	11.09
4	74.9	5.37		1.1293		1.129	26.9	30.32
5	79.9	5.27		1.3417		1.342	26.4	35.35
6	84.9	5.29		1.502		1.502	26.5	39.73
7	89.9	5.27		1.671		1.671	26.4	44.03
8	94.9	5.31		1.6103		1.610	26.6	42.75
9	99.9	5.35		1.3417		1.342	26.8	35.89
10	104.9	4.81		1.2073		1.207	24.1	29.04
11	109.9	4.03		1.0903		1.090	20.2	21.97
12	114.9	2.27		0.358		0.358	9.8	3.49
13	118.5	0		0		0.000	0.0	0.00
14						0.000	0.0	0.00
						1.090	273.7	298.40

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	53.00	64.90	0.00	0.13	0.12	8.89
30%	71.0	69.90	74.90	0.45	1.13	0.80	1.83
40%	78.0	74.90	79.90	1.13	1.34	1.26	0.86
50%	85.0	84.90	89.90	1.50	1.67	1.51	0.72
60%	92.0	89.90	94.90	1.67	1.61	1.65	0.66
70%	99.0	94.90	99.90	1.61	1.34	1.39	0.78
80%	106.0	104.90	109.90	1.21	1.09	1.18	0.92

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00035

Q = 420.4
V_{AVR} = 1.54

Roughness coeff Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	53	0	2	0.0	32.5	0	0.00	0.00
95.78	64.9	4.22	2	35.7	8.5	4.22	49.77	1.40
95.04	69.9	4.96	2	24.8	5.0	4.96	38.55	1.55
94.63	74.9	5.37	2	26.9	5.0	5.37	44.01	1.64
94.73	79.9	5.27	2	26.4	5.0	5.27	42.65	1.62
94.71	84.9	5.29	2	26.5	5.0	5.29	42.92	1.62
94.73	89.9	5.27	2	26.4	5.0	5.27	42.65	1.62
94.69	94.9	5.31	2	26.6	5.0	5.31	43.19	1.63
94.65	99.9	5.35	2	26.8	5.0	5.35	43.74	1.64
95.19	104.9	4.81	2	24.1	5.0	4.81	36.63	1.52
95.97	109.9	4.03	2	20.2	5.0	4.03	27.28	1.35
97.73	114.9	2.27	2	9.8	4.3	2.27	9.01	0.92
100	118.5	0	2	0.0	1.8	0	0.00	0.00
100	0	0	2	0.0	0.0	0	0.00	0.00
				273.72			420.42	1.54

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	53.00	64.90	0.00	1.40	1.29	1.19
30%	71.0	69.90	74.90	1.55	1.64	1.57	0.98
40%	78.0	74.90	79.90	1.64	1.62	1.63	0.94
50%	85.0	84.90	89.90	1.62	1.62	1.62	0.95
60%	92.0	89.90	94.90	1.62	1.63	1.62	0.95
70%	99.0	94.90	99.90	1.63	1.64	1.63	0.94
80%	106.0	104.90	109.90	1.52	1.35	1.49	1.03

Measured data

STATION No. : C8H030 — START TIME : 07h30

RIVER NAME : Wilge — Average Gaugeplate reading : 3.9 m

PLACE NAME : Kimberley

DATE : 26/02/1989

Main Channel LEFT : 50

Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.234	334.4	412.57
1	50	0	0	0.025	0	0.025	0.0	0.00
2	55	1.44	0.044525		0.052675	0.049	7.2	0.35
3	60	3.5	0.068975		0.093425	0.081	15.8	1.28
4	64	4.79	0.193692		0.3196	0.257	19.2	4.92
5	68	5.55	0.732058		0.844942	0.789	22.2	17.50
6	72	5.76	0.9448		1.240033	1.092	20.2	22.02
7	75	5.97	1.049		1.418042	1.234	17.9	22.09
8	78	5.97	1.140175		1.57	1.355	17.9	24.27
9	81	5.93	1.339892		1.617758	1.479	17.8	26.31
10	84	6.16	1.474483		1.695908	1.585	18.5	29.29
11	87	6.01	1.483167		1.791425	1.637	18.0	29.52
12	90	5.95	1.921675		1.9347	1.928	17.9	34.42
13	93	6.28	1.656833		1.999825	1.828	18.8	34.45
14	96	6.18	1.574342		2.008508	1.791	18.5	33.21
15	99	6.22	1.548292		1.991142	1.770	18.7	33.02
16	102	6.03	1.33555		1.652492	1.494	21.1	31.53
17	106	5.61	1.105442		1.578683	1.342	22.4	30.12
18	110	4.96	1.235692		1.378967	1.307	19.8	25.94
19	114	4.44	0.497608		0.732058	0.615	17.8	10.92
20	118	1.48	0.211058		0.376042	0.294	4.8	1.41
21	120.5	0	0	0.145	0	0.145	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.234	334.4	412.57

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	64.00	68.00	0.26	0.79	0.26	4.81
30%	71.0	68.00	72.00	0.79	1.09	1.02	1.21
40%	78.0	78.00	81.00	1.36	1.48	1.36	0.91
50%	85.0	84.00	87.00	1.59	1.64	1.60	0.77
60%	92.0	90.00	93.00	1.93	1.83	1.86	0.66
70%	99.0	99.00	102.00	1.77	1.49	1.77	0.70
80%	106.0	106.00	110.00	1.34	1.31	1.34	0.92

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00035

Q = 568.5

V_{AVR} = 1.70

Roughness coeff.	
Sub	n
0	
2	0.034
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	50	0	2	0.0	27.5	0	0.00	0.00
98.56	55	1.44	2	7.2	5.0	1.44	5.05	0.70
96.5	60	3.5	2	15.8	4.5	3.5	19.98	1.27
95.21	64	4.79	2	19.2	4.0	4.79	29.98	1.56
94.45	68	5.55	2	22.2	4.0	5.55	38.29	1.72
94.24	72	5.76	2	20.2	3.5	5.76	35.64	1.77
94.03	75	5.97	2	17.9	3.0	5.97	32.43	1.81
94.03	78	5.97	2	17.9	3.0	5.97	32.43	1.81
94.07	81	5.93	2	17.8	3.0	5.93	32.07	1.80
93.84	84	6.16	2	18.5	3.0	6.16	34.17	1.85
93.99	87	6.01	2	18.0	3.0	6.01	32.79	1.82
94.05	90	5.95	2	17.9	3.0	5.95	32.25	1.81
93.72	93	6.28	2	18.8	3.0	6.28	35.29	1.87
93.82	96	6.18	2	18.5	3.0	6.18	34.38	1.85
93.78	99	6.22	2	18.7	3.0	6.22	34.73	1.86
93.97	102	6.03	2	21.1	3.5	6.03	38.47	1.82
94.39	106	5.61	2	22.4	4.0	5.61	38.98	1.74
95.04	110	4.96	2	19.8	4.0	4.96	31.75	1.60
95.56	114	4.44	2	17.8	4.0	4.44	26.40	1.49
98.52	118	1.48	2	4.8	3.3	1.48	3.44	0.71
100	120.5	0	2	0.0	1.3	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				334.44			568.48	1.70

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	64.00	68.00	1.56	1.72	1.56	1.09
30%	71.0	68.00	72.00	1.72	1.77	1.76	0.97
40%	78.0	78.00	81.00	1.81	1.80	1.81	0.94
50%	85.0	84.00	87.00	1.85	1.82	1.84	0.92
60%	92.0	90.00	93.00	1.81	1.87	1.85	0.92
70%	99.0	99.00	102.00	1.86	1.82	1.86	0.91
80%	106.0	106.00	110.00	1.74	1.80	1.74	0.98

Measured data

STATION No. : C8H030
RIVER NAME : Wilge
PLACE NAME : Kimberley
DATE : 25/02/1989

START TIME : 10h48
Average Gaugeplate reading : 5.18 m

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.343	412.6	554.22
1	47	0		0.0161		0.016	0.0	0.00
2	53.6	2.146		0.0323		0.032	11.4	0.37
3	57.6	4.424		0.0486		0.049	17.7	0.86
4	61.6	5.84		0.1894		0.189	23.4	4.42
5	65.6	6.578		0.159		0.159	26.3	4.18
6	69.6	6.908		0.6365		0.637	27.6	17.59
7	73.6	7.216		1.2444		1.244	25.3	31.43
8	76.6	7.171		1.5396		1.540	21.5	33.12
9	79.6	7.132		1.6568		1.657	21.4	35.45
10	82.6	7.381		1.7958		1.796	18.5	33.14
11	84.6	7.2		1.8131		1.813	14.4	26.11
12	86.6	7.26		1.9043		1.904	14.5	27.65
13	88.6	7.186		2.0736		2.074	14.4	29.80
14	90.6	7.492		2.1822		2.182	15.0	32.70
15	92.6	7.481		2.1952		2.195	15.0	32.84
16	94.6	7.393		2.2039		2.204	14.8	32.59
17	96.6	7.477		2.0867		2.087	15.0	31.20
18	98.6	7.331		1.9738		1.974	14.7	28.94
19	100.6	7.207		1.6916		1.692	18.0	30.48
20	103.6	6.874		1.6395		1.640	20.6	33.81
21	106.6	6.367		1.4788		1.479	22.3	32.95
22	110.6	5.854		1.6004		1.600	23.4	37.47
23	114.6	3.645		1.02373		1.024	16.4	16.79
24	119.6	0.451		0.2588		0.259	1.2	0.32
						1.343	412.6	554.22

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	61.60	65.60	0.19	0.16	0.17	7.85
30%	71.0	69.60	73.60	0.64	1.24	0.85	1.58
40%	78.0	76.60	79.60	1.54	1.66	1.59	0.84
50%	85.0	84.60	86.60	1.81	1.90	1.83	0.73
60%	92.0	90.60	92.60	2.18	2.20	2.19	0.61
70%	99.0	98.60	100.60	1.97	1.69	1.92	0.70
80%	106.0	103.60	106.60	1.64	1.48	1.51	0.89

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00038

Q = 778.3
V_{AVR} = 1.89

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	0	0	2	0.0	26.8	0	0.00	0.00
96.765	5.2	2.146	2	11.4	5.3	2.146	10.25	0.90
96.74	8.2	4.424	2	17.7	4.0	4.424	25.82	1.46
96.617	11.2	5.84	2	23.4	4.0	5.84	41.02	1.76
96.697	14.2	6.578	2	26.3	4.0	6.578	50.02	1.90
96.651	17.2	6.908	2	27.6	4.0	6.908	54.27	1.96
96.571	20.2	7.216	2	25.3	3.5	7.216	51.07	2.02
96.544	23.2	7.171	2	21.5	3.0	7.171	43.32	2.01
96.763	26.2	7.132	2	21.4	3.0	7.132	42.93	2.01
97.54	29.2	7.381	2	18.5	2.5	7.381	37.88	2.05
96.69	32.2	7.2	2	14.4	2.0	7.2	29.07	2.02
96.73	35.2	7.26	2	14.5	2.0	7.26	29.48	2.03
96.593	38.2	7.186	2	14.4	2.0	7.186	28.98	2.02
96.431	41.2	7.492	2	15.0	2.0	7.492	31.07	2.07
97.114	44.2	7.481	2	15.0	2.0	7.481	30.99	2.07
96.623	47.2	7.393	2	14.8	2.0	7.393	30.38	2.05
96.737	50.2	7.477	2	15.0	2.0	7.477	30.96	2.07
96.781	53.2	7.331	2	14.7	2.0	7.331	29.96	2.04
97.084	56.2	7.207	2	18.0	2.5	7.207	36.40	2.02
97.478	59.2	6.874	2	20.6	3.0	6.874	40.37	1.96
98.303	62.2	6.367	2	22.3	3.5	6.367	41.45	1.86
100	67.2	5.854	2	23.4	4.0	5.854	41.18	1.76
		3.645	2	16.4	4.5	3.645	21.04	1.28
		0.451	2	1.2	2.8	0.451	0.39	0.32
				412.61			778.31	1.89

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	62.20	67.20	1.86	1.76	1.82	1.03
30%	71.0	67.20	0.00	1.76	1.28	1.79	1.06
40%	78.0	67.20	0.00	1.76	1.28	1.84	1.03
50%	85.0	67.20	0.00	1.76	1.28	1.89	1.00
60%	92.0	67.20	0.00	1.76	1.28	1.93	0.98
70%	99.0	67.20	0.00	1.76	1.28	1.98	0.95
80%	106.0	67.20	0.00	1.76	1.28	2.03	0.93

Measured data

STATION No. : C8H030 START TIME : 08h00
RIVER NAME : Wilge Average Gaugeplate reading : 6.456 m
PLACE NAME : Kimberley
DATE : 18/02/1989

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.433	515.8	739.11
1	42.9	0	0	0.092	0	0.092	0.0	0.00
2	55	3.54	0.035887		0.332967	0.184	28.5	5.26
3	59	6.49	0.13325		0.28955	0.211	26.0	5.49
4	63	7.07	0.254817		0.4719	0.363	28.3	10.28
5	67	7.83	0.506633		0.567417	0.537	31.3	16.82
6	71	8.31	1.166567		1.114467	1.141	33.2	37.91
7	75	8.59	1.6702		1.401017	1.536	34.4	52.76
8	79	8.488	1.913333		1.479167	1.696	34.0	57.59
9	83	8.664	2.052267		1.757033	1.905	34.7	66.01
10	87	8.57	2.156467		2.0349	2.096	34.3	71.84
11	91	8.838	1.974117		2.225933	2.100	35.4	74.24
12	95	8.772	2.052267		2.2433	2.148	35.1	75.36
13	99	8.644	1.59205		2.261	1.927	34.6	66.61
14	103	8.256	1.791767		2.11305	1.952	33.0	64.48
15	107	7.638	1.59205		1.9828	1.787	30.6	54.61
16	111	7.116	1.392		1.600733	1.496	28.5	42.59
17	115	5.92	1.140517		1.288133	1.214	26.6	32.35
18	120	2.18	0.558733		0.749767	0.654	7.5	4.92
19	121.9	0	0	0.327	0	0.327	0.0	0.00
20						0.000	0.0	0.00
21						0.000	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.433	515.8	739.11

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
20%	64.0	63.00	67.00	0.36	0.54	0.41	3.52
30%	71.0	71.00	75.00	1.14	1.54	1.14	1.26
40%	78.0	75.00	79.00	1.54	1.70	1.66	0.87
50%	85.0	83.00	87.00	1.90	2.10	2.00	0.72
60%	92.0	91.00	95.00	2.10	2.15	2.11	0.68
70%	99.0	99.00	103.00	1.93	1.95	1.93	0.74
80%	106.0	103.00	107.00	1.95	1.79	1.83	0.78

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00035

Q = 1025.2
V_{AVR} = 1.99

Roughness coeff.	
Sub	n
0	
2	0.0365
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	42.9	0	2	0.0	27.5	0	0.00	0.00
96.46	55	3.54	2	28.5	8.1	3.54	33.93	1.19
93.51	59	6.49	2	26.0	4.0	6.49	46.30	1.78
92.93	63	7.07	2	28.3	4.0	7.07	53.39	1.89
92.17	67	7.83	2	31.3	4.0	7.83	63.30	2.02
91.69	71	8.31	2	33.2	4.0	8.31	69.80	2.10
91.41	75	8.59	2	34.4	4.0	8.59	73.87	2.15
91.512	79	8.488	2	34.0	4.0	8.488	72.41	2.13
91.336	83	8.664	2	34.7	4.0	8.664	74.93	2.16
91.43	87	8.57	2	34.3	4.0	8.57	73.58	2.15
91.162	91	8.838	2	35.4	4.0	8.838	77.46	2.19
91.228	95	8.772	2	35.1	4.0	8.772	76.49	2.18
91.356	99	8.644	2	34.6	4.0	8.644	74.64	2.16
91.744	103	8.256	2	33.0	4.0	8.256	69.14	2.09
92.362	107	7.638	2	30.6	4.0	7.638	60.73	1.99
92.884	111	7.116	2	28.5	4.0	7.116	53.98	1.90
94.08	115	5.92	2	26.6	4.5	5.92	44.68	1.68
97.82	120	2.18	2	7.5	3.5	2.18	6.48	0.86
100	121.9	0	2	0.0	1.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				515.76			1025.22	1.99

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
20%	64.0	63.00	67.00	1.89	2.02	1.92	1.03
30%	71.0	71.00	75.00	2.10	2.15	2.10	0.95
40%	78.0	75.00	79.00	2.15	2.13	2.14	0.93
50%	85.0	83.00	87.00	2.16	2.15	2.15	0.92
60%	92.0	91.00	95.00	2.19	2.18	2.19	0.91
70%	99.0	99.00	103.00	2.16	2.09	2.16	0.92
80%	106.0	103.00	107.00	2.09	1.99	2.01	0.99

Measured data

STATION No. : C8H030 START TIME : 17h55
RIVER NAME : Wilge Average Gaugeplate reading : 7.18 m
PLACE NAME : Kimberley
DATE : 17/02/1989

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.390	592.7	823.77
1	35	0	0	0.023	0	0.023	0.0	0.00
2	47.4	2.983	0.027943		0.059717	0.044	30.4	1.33
3	55.4	4.596	0.035887		0.099433	0.068	29.9	2.02
4	60.4	8.02	0.306917		0.437167	0.372	44.1	16.41
5	66.4	8.71	0.220083		0.350333	0.285	47.9	13.66
6	71.4	9.19	1.3576		1.036317	1.197	46.0	55.00
7	76.4	9.68	1.7223		1.270767	1.497	48.4	72.43
8	81.4	9.429	2.043583		1.713617	1.879	42.4	79.71
9	85.4	9.33	2.104367		1.817817	1.961	37.3	73.19
10	89.4	9.511	2.286717		2.225933	2.256	38.0	85.84
11	93.4	9.469	2.1391		2.32145	2.230	37.9	84.47
12	97.4	9.435	1.974117		2.286717	2.130	42.5	90.45
13	102.4	8.989	1.730983		2.21725	1.974	36.0	70.98
14	105.4	8.524	1.757033		2.095683	1.926	25.6	49.26
15	108.4	8.121	1.661517		2.087	1.874	28.4	53.27
16	112.4	7.527	1.791767		1.609417	1.701	30.1	51.20
17	116.4	5.51	0.60215		1.348917	0.976	19.3	18.81
18	119.4	2.76	0.567417		1.045	0.806	6.9	5.56
19	121.4	1.2	0	0.091	0	0.091	1.7	0.15
20	122.22	0	0	0.046	0	0.046	0.0	0.00
21						0.000	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.390	592.7	823.77

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	60.40	66.40	0.37	0.29	0.32	4.34
30%	71.0	66.40	71.40	0.29	1.20	1.12	1.24
40%	78.0	76.40	81.40	1.50	1.88	1.62	0.86
50%	85.0	81.40	85.40	1.88	1.96	1.95	0.71
60%	92.0	89.40	93.40	2.26	2.23	2.24	0.62
70%	99.0	97.40	102.40	2.13	1.97	2.08	0.67
80%	106.0	105.40	108.40	1.93	1.87	1.92	0.73

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00035

Q = 1151.1
V_{AVR} = 1.94

Roughness coeff.	
Sub	n
0	
2	0.039
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	35	0	2	0.0	23.7	0	0.00	0.00
97.017	47.4	2.983	2	30.4	10.2	2.983	30.25	0.99
95.404	55.4	4.596	2	29.9	6.5	4.596	39.61	1.33
91.98	60.4	8.02	2	44.1	5.5	8.02	84.78	1.92
91.29	66.4	8.71	2	47.9	5.5	8.71	97.28	2.03
90.81	71.4	9.19	2	46.0	5.0	9.19	96.71	2.10
90.32	76.4	9.68	2	48.4	5.0	9.68	105.45	2.18
90.571	81.4	9.429	2	42.4	4.5	9.429	90.84	2.14
90.67	85.4	9.33	2	37.3	4.0	9.33	79.34	2.13
90.489	89.4	9.511	2	38.0	4.0	9.511	81.92	2.15
90.531	93.4	9.469	2	37.9	4.0	9.469	81.32	2.15
90.565	97.4	9.435	2	42.5	4.5	9.435	90.94	2.14
91.011	102.4	8.989	2	36.0	4.0	8.989	74.57	2.07
91.476	105.4	8.524	2	25.6	3.0	8.524	51.19	2.00
91.879	108.4	8.121	2	28.4	3.5	8.121	55.09	1.94
92.473	112.4	7.527	2	30.1	4.0	7.527	55.47	1.84
94.49	116.4	5.51	2	19.3	3.5	5.51	28.86	1.50
97.24	119.4	2.76	2	6.9	2.5	2.76	6.51	0.94
98.8	121.4	1.2	2	1.7	1.4	1.2	0.92	0.54
100	122.22	0	2	0.0	0.4	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				592.73			1151.05	1.94

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	60.40	66.40	1.92	2.03	1.99	0.98
30%	71.0	66.40	71.40	2.03	2.10	2.10	0.93
40%	78.0	76.40	81.40	2.18	2.14	2.17	0.90
50%	85.0	81.40	85.40	2.14	2.13	2.13	0.91
60%	92.0	89.40	93.40	2.15	2.15	2.15	0.90
70%	99.0	97.40	102.40	2.14	2.07	2.12	0.92
80%	106.0	105.40	108.40	2.00	1.94	1.99	0.98

Measured data

STATION No. : C8H030   START TIME : 08h25
RIVER NAME : Wilge   Average Gaugeplate reading : 7.7675 m
PLACE NAME : Kimberley
DATE : 16/03/1988

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.518	633.9	962.24
1	33	0		0		0.000	0.0	0.00
2	38	2.035		0.1553		0.155	10.2	1.58
3	43	2.937		0.3577		0.358	14.7	5.25
4	48	4.198		0.5665		0.567	21.0	11.89
5	53	5.077		0.6796		0.680	25.4	17.25
6	58	8.18		0.3534		0.353	40.9	14.45
7	63	9.175		0.2837		0.284	45.9	13.01
8	68	9.65		1.3104		1.310	48.3	63.23
9	73	9.89		1.7323		1.732	49.5	85.66
10	78	9.77		1.6975		1.698	48.9	82.92
11	83	9.89		1.9977		1.998	49.5	98.79
12	88	10.15		1.9803		1.980	50.8	100.50
13	93	10.095		2.4153		2.415	50.5	121.91
14	98	9.89		2.4327		2.433	49.5	120.30
15	103	9.255		2.1499		2.150	46.3	99.49
16	108	8.45		1.9324		1.932	42.3	81.64
17	113	6.113		1.5322		1.532	27.5	42.15
18	117	3.288		0.1676		0.168	13.2	2.20
19	121	0		0		0.000	0.0	0.00
20	121.2	0	0	0.3	0	0.300	0.0	0.00
21						0.000	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.518	633.9	962.24

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	0.28	1.31	0.49	3.10
30%	71.0	68.00	73.00	1.31	1.73	1.56	0.97
40%	78.0	78.00	83.00	1.70	2.00	1.70	0.89
50%	85.0	83.00	88.00	2.00	1.98	1.99	0.76
60%	92.0	88.00	93.00	1.98	2.42	2.33	0.65
70%	99.0	98.00	103.00	2.43	2.15	2.38	0.64
80%	106.0	103.00	108.00	2.15	1.93	2.02	0.75

Calculated data, 1-dimensional flow theory

Manning or Chezy: M   Slope 0.00038

Q = 1355.6
V_{AVR} = 2.14

Roughness coeff.	
Sub	n
0	
2	0.038
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	33	0	2	0.0	19.0	0	0.00	0.00
97.965	38	2.035	2	10.2	5.0	2.035	8.36	0.82
97.063	43	2.937	2	14.7	5.0	2.937	15.45	1.05
95.802	48	4.198	2	21.0	5.0	4.198	28.02	1.33
94.923	53	5.077	2	25.4	5.0	5.077	38.47	1.52
91.82	58	8.18	2	40.9	5.0	8.18	85.18	2.08
90.825	63	9.175	2	45.9	5.0	9.175	103.14	2.25
90.35	68	9.65	2	48.3	5.0	9.65	112.19	2.33
90.11	73	9.89	2	49.5	5.0	9.89	116.88	2.36
90.23	78	9.77	2	48.9	5.0	9.77	114.53	2.34
90.11	83	9.89	2	49.5	5.0	9.89	116.88	2.36
89.85	88	10.15	2	50.8	5.0	10.15	122.05	2.40
89.905	93	10.095	2	50.5	5.0	10.095	120.95	2.40
90.11	98	9.89	2	49.5	5.0	9.89	116.88	2.36
90.745	103	9.255	2	46.3	5.0	9.255	104.64	2.26
91.55	108	8.45	2	42.3	5.0	8.45	89.92	2.13
93.887	113	6.113	2	27.5	4.5	6.113	47.18	1.72
96.712	117	3.288	2	13.2	4.0	3.288	14.92	1.13
100	121	0	2	0.0	2.1	0	0.00	0.00
100	121.2	0	2	0.0	0.1	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				633.87			1355.64	2.14

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	2.25	2.33	2.26	0.94
30%	71.0	68.00	73.00	2.33	2.36	2.35	0.91
40%	78.0	78.00	83.00	2.34	2.36	2.34	0.91
50%	85.0	83.00	88.00	2.36	2.40	2.38	0.90
60%	92.0	88.00	93.00	2.40	2.40	2.40	0.89
70%	99.0	98.00	103.00	2.36	2.26	2.34	0.91
80%	106.0	103.00	108.00	2.26	2.13	2.16	0.98

Measured data

STATION No. :	C8H030	START TIME :	15h50
RIVER NAME :	Wilge	Average Gaugeplate reading :	9.8975 m
PLACE NAME :	Kimberley		
DATE :	15/03/1988		
		Main Channel LEFT :	50
		Main Channel RIGHT :	120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.490	839.8	1251.2
1	25	0		0		0.000	0.0	0.00
2	33	2.52		0		0.000	16.4	0.00
3	38	3.945		0.2707		0.271	19.7	5.34
4	43	4.897		0.4447		0.445	24.5	10.89
5	48	6.056		0.6057		0.606	30.3	18.34
6	53	7.056		0.8754		0.875	35.3	30.88
7	58	10.05		0.6144		0.614	50.3	30.87
8	63	11		0.262		0.262	55.0	14.41
9	68	11.675		1.3104		1.310	58.4	76.49
10	73	12.08		1.654		1.654	60.4	99.90
11	78	11.925		1.7497		1.750	59.6	104.33
12	83	11.98		1.7932		1.793	59.9	107.41
13	88	12.11		2.1499		2.150	60.6	130.18
14	93	12.17		2.1586		2.159	60.9	131.35
15	98	12.075		2.4588		2.459	60.4	148.45
16	103	11.59		2.3109		2.311	58.0	133.92
17	108	10.8		2.2108		2.211	54.0	119.38
18	113	8.48		1.6236		1.624	42.4	68.84
19	118	5.418		0.5665		0.567	27.1	15.35
20	123	1.954		0.7057		0.706	6.8	4.83
21	125	0		0		0.000	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.490	839.8	1251.16

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	0.28	1.31	0.47	3.16
30%	71.0	68.00	73.00	1.31	1.65	1.52	0.98
40%	78.0	78.00	83.00	1.75	1.79	1.75	0.85
50%	85.0	83.00	88.00	1.79	2.15	1.94	0.77
60%	92.0	88.00	93.00	2.15	2.16	2.16	0.69
70%	99.0	98.00	103.00	2.46	2.31	2.43	0.61
80%	106.0	103.00	108.00	2.31	2.21	2.25	0.66

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	1786.8
Slope	0.0003	V_{AVR} =	2.13

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.038	2	1
0		0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	25	0	2	0.0	16.5	0	0.00	0.00
97.48	33	2.52	2	16.4	6.5	2.52	13.83	0.84
96.055	38	3.945	2	19.7	5.0	3.945	22.45	1.14
95.103	43	4.897	2	24.5	5.0	4.897	32.16	1.31
93.944	48	6.056	2	30.3	5.0	6.056	45.86	1.51
92.944	53	7.056	2	35.3	5.0	7.056	59.16	1.68
89.95	58	10.05	2	50.3	5.0	10.05	106.67	2.12
89	63	11	2	55.0	5.0	11	123.99	2.25
88.325	68	11.675	2	58.4	5.0	11.675	136.93	2.35
87.92	73	12.08	2	60.4	5.0	12.08	144.94	2.40
88.075	78	11.925	2	59.6	5.0	11.925	141.85	2.38
88.02	83	11.98	2	59.9	5.0	11.98	142.95	2.39
87.89	88	12.11	2	60.6	5.0	12.11	145.54	2.40
87.83	93	12.17	2	60.9	5.0	12.17	146.75	2.41
87.925	98	12.075	2	60.4	5.0	12.075	144.84	2.40
88.41	103	11.59	2	58.0	5.0	11.59	135.28	2.33
89.2	108	10.8	2	54.0	5.0	10.8	120.26	2.23
91.52	113	8.48	2	42.4	5.0	8.48	80.37	1.90
94.582	118	5.418	2	27.1	5.0	5.418	38.09	1.41
98.046	123	1.954	2	6.8	3.5	1.954	4.87	0.71
100	125	0	2	0.0	1.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				839.75			1786.80	2.13

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	2.25	2.35	2.27	0.94
30%	71.0	68.00	73.00	2.35	2.40	2.38	0.89
40%	78.0	78.00	83.00	2.38	2.39	2.38	0.89
50%	85.0	83.00	88.00	2.39	2.40	2.39	0.89
60%	92.0	88.00	93.00	2.40	2.41	2.41	0.88
70%	99.0	98.00	103.00	2.40	2.33	2.39	0.89
80%	106.0	103.00	108.00	2.33	2.23	2.27	0.94

Measured data

STATION No. : C8H030 START TIME : 11H35
RIVER NAME : Wilge Average Gaugeplate reading : 10.42 m
PLACE NAME : Kimberley
DATE : 15/03/1988

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.576	893.1	1407.59
1	23	0		0		0.000	0.0	0.00
2	28	1.336		0.0151		0.015	6.7	0.10
3	33	3.054		0.0728		0.073	15.3	1.11
4	38	4.47		0.3795		0.380	22.4	8.48
5	43	5.422		0.6057		0.606	27.1	16.42
6	48	6.581		0.8754		0.875	32.9	28.81
7	53	7.339		1.1059		1.106	36.7	40.58
8	58	10.53		0.7144		0.714	52.7	37.61
9	63	11.525		0.6535		0.654	57.6	37.66
10	68	12.2		1.4278		1.428	61.0	87.10
11	73	12.605		1.6453		1.645	63.0	103.70
12	78	12.45		1.7584		1.758	62.3	109.46
13	83	12.505		1.8672		1.867	62.5	116.75
14	88	12.635		2.1586		2.159	63.2	136.37
15	93	12.695		2.1325		2.133	63.5	135.36
16	98	12.6		2.4066		2.407	63.0	151.62
17	103	12.115		2.2326		2.233	60.6	135.24
18	108	11.325		2.1934		2.193	56.6	124.20
19	113	9.005		1.9411		1.941	45.0	87.40
20	118	5.943		1.3452		1.345	29.7	39.97
21	123	2.479		0.9841		0.984	8.7	8.54
22	125	1.854		0.4056		0.406	2.8	1.13
23	126	0		0		0.000	0.0	0.00
24						0.000	0.0	0.00
						1.576	893.1	1407.59

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	0.65	1.43	0.81	1.95
30%	71.0	68.00	73.00	1.43	1.65	1.56	1.01
40%	78.0	78.00	83.00	1.76	1.87	1.76	0.90
50%	85.0	83.00	88.00	1.87	2.16	1.98	0.79
60%	92.0	88.00	93.00	2.16	2.13	2.14	0.74
70%	99.0	98.00	103.00	2.41	2.23	2.37	0.66
80%	106.0	103.00	108.00	2.23	2.19	2.21	0.71

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0003

Q = 1848.3
V_{AVR} = 2.07

Roughness coeff	
Sub	n
0	
2	0.04
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	23	0	2	0.0	14.0	0	0.00	0.00
98.664	28	1.336	2	6.7	5.0	1.336	3.51	0.53
96.946	33	3.054	2	15.3	5.0	3.054	13.92	0.91
95.53	38	4.47	2	22.4	5.0	4.47	26.26	1.18
94.578	43	5.422	2	27.1	5.0	5.422	36.23	1.34
93.419	48	6.581	2	32.9	5.0	6.581	50.04	1.52
92.661	53	7.339	2	36.7	5.0	7.339	60.01	1.64
89.47	58	10.53	2	52.7	5.0	10.53	109.53	2.08
88.475	63	11.525	2	57.6	5.0	11.525	127.31	2.21
87.8	68	12.2	2	61.0	5.0	12.2	139.98	2.29
87.395	73	12.605	2	63.0	5.0	12.605	147.81	2.35
87.55	78	12.45	2	62.3	5.0	12.45	144.79	2.33
87.495	83	12.505	2	62.5	5.0	12.505	145.86	2.33
87.365	88	12.635	2	63.2	5.0	12.635	148.40	2.35
87.305	93	12.695	2	63.5	5.0	12.695	149.57	2.36
87.4	98	12.6	2	63.0	5.0	12.6	147.71	2.34
87.885	103	12.115	2	60.6	5.0	12.115	138.36	2.28
88.675	108	11.325	2	56.6	5.0	11.325	123.65	2.18
90.995	113	9.005	2	45.0	5.0	9.005	84.39	1.87
94.057	118	5.943	2	29.7	5.0	5.943	42.22	1.42
97.521	123	2.479	2	8.7	3.5	2.479	6.88	0.79
98.146	125	1.854	2	2.8	1.5	1.854	1.82	0.65
100	126	0	2	0.0	0.5	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				893.13			1848.25	2.07

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	2.21	2.29	2.23	0.93
30%	71.0	68.00	73.00	2.29	2.35	2.33	0.89
40%	78.0	78.00	83.00	2.33	2.33	2.33	0.89
50%	85.0	83.00	88.00	2.33	2.35	2.34	0.88
60%	92.0	88.00	93.00	2.35	2.36	2.35	0.88
70%	99.0	98.00	103.00	2.34	2.28	2.33	0.89
80%	106.0	103.00	108.00	2.28	2.18	2.22	0.93

Measured data

STATION No. : C8H030 START TIME : 07H50

RIVER NAME : Wilge Average Gaugeplate reading : 10.965 m

PLACE NAME : Kimberley

DATE : 15/03/1988

Main Channel LEFT : 50

Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.582	952.0	1505.66
1	18	0		0		0.000	0.0	0.00
2	23	0.863		0		0.000	4.3	0.00
3	28	1.878		0.0151		0.015	9.4	0.14
4	33	3.596		0.0234		0.023	18.0	0.42
5	38	5.012		0.2794		0.279	25.1	7.00
6	43	5.964		0.8014		0.801	29.8	23.90
7	48	7.123		1.1146		1.115	35.6	39.70
8	53	8.123		1.2886		1.289	40.6	52.34
9	58	11.072		1.0015		1.002	55.4	55.44
10	63	12.067		1.0102		1.010	60.3	60.95
11	68	12.742		1.3539		1.354	63.7	86.26
12	73	13.147		1.6366		1.637	65.7	107.58
13	78	12.992		1.741		1.741	65.0	113.10
14	83	13.047		1.8585		1.859	65.2	121.24
15	88	13.177		2.076		2.076	65.9	136.78
16	93	13.237		2.2891		2.289	66.2	151.50
17	98	13.142		2.4588		2.459	65.7	161.57
18	103	12.657		2.289		2.289	63.3	144.86
19	108	11.867		2.0455		2.046	59.3	121.37
20	113	9.547		2.1238		2.124	47.7	101.38
21	118	6.485		0.5752		0.575	19.5	11.19
22	119	5.588		0.1594		0.159	16.8	2.67
23	124	2.708		0.6622		0.662	9.5	6.28
24	126	0		0		0.000	0.0	0.00
						1.582	952.0	1505.66

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	1.01	1.35	1.08	1.47
30%	71.0	68.00	73.00	1.35	1.64	1.52	1.04
40%	78.0	78.00	83.00	1.74	1.86	1.74	0.91
50%	85.0	83.00	88.00	1.86	2.08	1.95	0.81
60%	92.0	88.00	93.00	2.08	2.29	2.25	0.70
70%	99.0	98.00	103.00	2.46	2.29	2.42	0.65
80%	106.0	103.00	108.00	2.29	2.05	2.14	0.74

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.0003

Q = 2019.8

V_{AVR} = 2.12

Roughness coeff. Sub	n
0	
2	0.04
0	

Area reduction factor Sub	f_r
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	18	0	2	0.0	11.5	0	0.00	0.00
99.137	23	0.863	2	4.3	5.0	0.863	1.69	0.39
98.122	28	1.878	2	9.4	5.0	1.878	6.19	0.66
96.404	33	3.596	2	18.0	5.0	3.596	18.27	1.02
94.988	38	5.012	2	25.1	5.0	5.012	31.78	1.27
94.036	43	5.964	2	29.8	5.0	5.964	42.47	1.42
92.877	48	7.123	2	35.6	5.0	7.123	57.09	1.60
91.877	53	8.123	2	40.6	5.0	8.123	71.07	1.75
88.928	58	11.072	2	55.4	5.0	11.072	119.06	2.15
87.933	63	12.067	2	60.3	5.0	12.067	137.45	2.28
87.258	68	12.742	2	63.7	5.0	12.742	150.50	2.36
86.853	73	13.147	2	65.7	5.0	13.147	158.56	2.41
87.008	78	12.992	2	65.0	5.0	12.992	155.45	2.39
86.953	83	13.047	2	65.2	5.0	13.047	156.55	2.40
86.823	88	13.177	2	65.9	5.0	13.177	159.16	2.42
86.763	93	13.237	2	66.2	5.0	13.237	160.37	2.42
86.858	98	13.142	2	65.7	5.0	13.142	158.46	2.41
87.343	103	12.657	2	63.3	5.0	12.657	148.83	2.35
88.133	108	11.867	2	59.3	5.0	11.867	133.67	2.25
90.453	113	9.547	2	47.7	5.0	9.547	93.02	1.95
93.515	118	6.485	2	19.5	3.0	6.485	29.30	1.51
94.412	119	5.588	2	16.8	3.0	5.588	22.86	1.36
97.292	124	2.708	2	9.5	3.5	2.708	7.97	0.84
100	126	0	2	0.0	1.0	0	0.00	0.00
				951.96			2019.78	2.12

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	64.0	63.00	68.00	2.28	2.36	2.29	0.92
30%	71.0	68.00	73.00	2.36	2.41	2.39	0.89
40%	78.0	78.00	83.00	2.39	2.40	2.39	0.89
50%	85.0	83.00	88.00	2.40	2.42	2.41	0.88
60%	92.0	88.00	93.00	2.42	2.42	2.42	0.88
70%	99.0	98.00	103.00	2.41	2.36	2.40	0.88
80%	106.0	103.00	108.00	2.35	2.25	2.29	0.93

Measured data

STATION No. : C8H030
RIVER NAME : Wilge
PLACE NAME : Kimberley
DATE : 14/03/1988

START TIME : 16h30
Average Gaugeplate reading : 12.2525 m

Main Channel LEFT : 50
Main Channel RIGHT : 120

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.638	1145.8	1876.60
1	0	0		0		0.000	0.0	0.00
2	10	1.591		0		0.000	31.8	0.00
3	40	6.74		0.8364		0.836	118.0	98.65
4	45	7.593		1.1773		1.177	38.0	44.70
5	50	8.956		1.2635		1.264	44.8	56.58
6	55	9.714		1.4059		1.406	48.6	68.28
7	60	12.93		1.7056		1.706	64.7	110.27
8	65	13.965		1.9436		1.944	69.8	135.71
9	70	14.19		2.1815		2.182	71.0	154.78
10	75	14.315		2.1815		2.182	71.6	156.14
11	80	14.4		2.144		2.144	72.0	154.37
12	85	14.415		2.1065		2.107	72.1	151.83
13	90	14.635		2.0016		2.002	73.2	146.47
14	95	14.635		2.0841		2.084	73.2	152.50
15	100	14.25		1.6907		1.691	71.3	120.46
16	105	13.535		1.5595		1.560	67.7	105.54
17	110	12.885		1.4171		1.417	64.4	91.30
18	115	10.083		1.4808		1.481	50.4	74.65
19	120	6.124		1.4471		1.447	30.6	44.31
20	125	3.684		0.7802		0.780	12.9	10.06
21	127	0		0		0.000	0.0	0.00
22						0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.638	1145.8	1876.60

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	**64.0**	60.00	65.00	1.71	1.94	1.90	**0.86**
30%	**71.0**	70.00	75.00	2.18	2.18	2.18	**0.75**
40%	**78.0**	75.00	80.00	2.18	2.14	2.16	**0.76**
50%	**85.0**	85.00	90.00	2.11	2.00	2.11	**0.78**
60%	**92.0**	90.00	95.00	2.00	2.08	2.03	**0.80**
70%	**99.0**	95.00	100.00	2.08	1.69	1.77	**0.93**
80%	**106.0**	105.00	110.00	1.56	1.42	1.53	**1.07**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00022

Q = 2179.8
V_{AVR} = 1.90

Roughness coeff. Sub	n
0	
2	0.04
0	

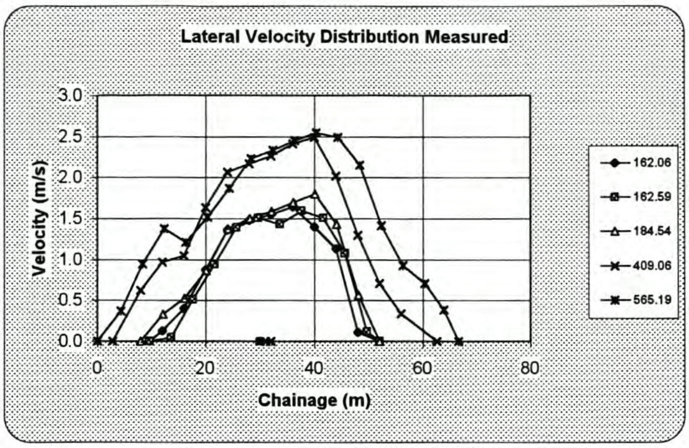
Area reduction factor Sub	f_A
0	1
2	1
0	1

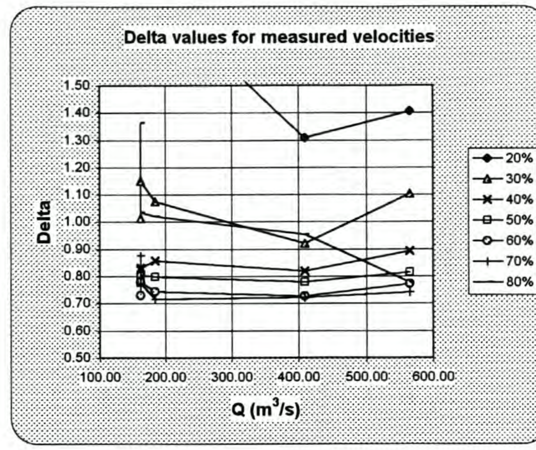
HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	0	0	2	0.0	0.0	0	0.00	0.00
98.409	10	1.591	2	31.8	20.0	1.591	16.08	0.51
93.26	40	6.74	2	118.0	17.5	6.74	156.06	1.32
92.407	45	7.593	2	38.0	5.0	7.593	54.38	1.43
91.044	50	8.956	2	44.8	5.0	8.956	71.61	1.60
90.286	55	9.714	2	48.6	5.0	9.714	81.99	1.69
87.07	60	12.93	2	64.7	5.0	12.93	132.06	2.04
86.035	65	13.965	2	69.8	5.0	13.965	150.15	2.15
85.81	70	14.19	2	71.0	5.0	14.19	154.20	2.17
85.685	75	14.315	2	71.6	5.0	14.315	156.47	2.19
85.6	80	14.4	2	72.0	5.0	14.4	158.02	2.19
85.585	85	14.415	2	72.1	5.0	14.415	158.30	2.20
85.365	90	14.635	2	73.2	5.0	14.635	162.35	2.22
85.365	95	14.635	2	73.2	5.0	14.635	162.35	2.22
85.75	100	14.25	2	71.3	5.0	14.25	156.29	2.18
86.465	105	13.535	2	67.7	5.0	13.535	142.52	2.11
87.115	110	12.885	2	64.4	5.0	12.885	131.30	2.04
89.917	115	10.083	2	50.4	5.0	10.083	87.25	1.73
93.876	120	6.124	2	30.6	5.0	6.124	38.01	1.24
96.316	125	3.684	2	12.9	3.5	3.684	11.40	0.88
100	127	0	2	0.0	1.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				1145.79			2179.81	1.90

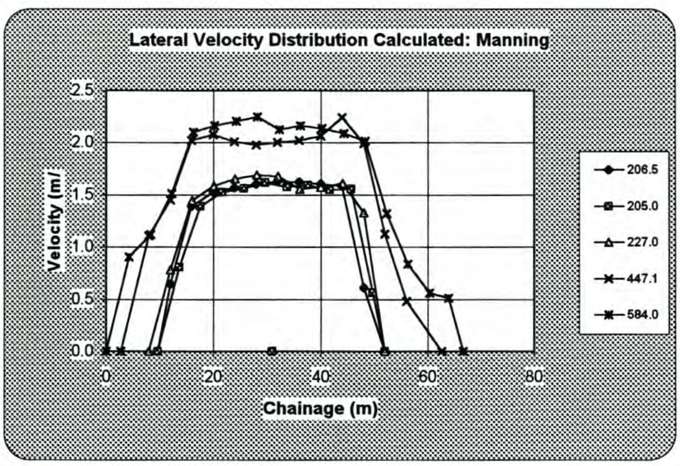
Delta value calculations

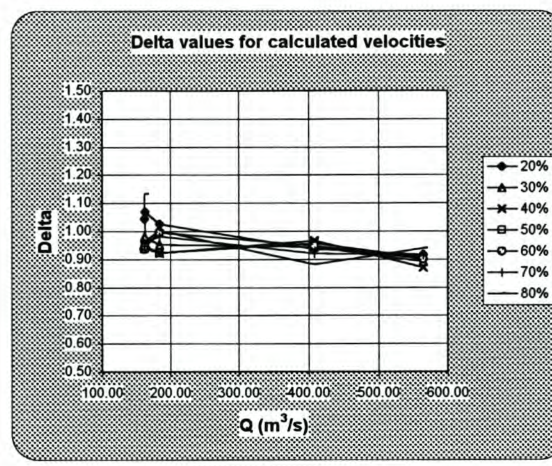
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	**64.0**	60.00	65.00	2.04	2.15	2.13	**0.89**
30%	**71.0**	70.00	75.00	2.17	2.19	2.18	**0.87**
40%	**78.0**	75.00	80.00	2.19	2.19	2.19	**0.87**
50%	**85.0**	85.00	90.00	2.20	2.22	2.20	**0.87**
60%	**92.0**	90.00	95.00	2.22	2.22	2.22	**0.86**
70%	**99.0**	95.00	100.00	2.22	2.18	2.19	**0.87**
80%	**106.0**	105.00	110.00	2.11	2.04	2.09	**0.91**

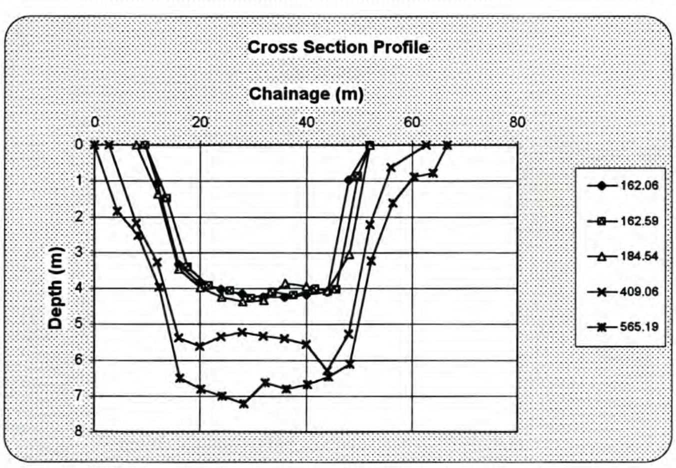
Statn No.: C6H006
River: Vals
Place: Tweefontein (Bothaville)











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : C6H006
START TIME : 11h49
RIVER NAME : Vals
Average Gaugeplate reading : 3.659 m
PLACE NAME : Tweefontein (Bothaville)
DATE : 1/24/93
Main Channel LEFT : 9
Main Channel RIGHT : 54

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.193	135.9	162.06
1	9.7	0		0		0.000	0.0	0.00
2	12	1.06		0.129		0.129	3.3	0.43
3	16	3.35		0.397		0.397	13.4	5.32
4	20	3.86		0.875		0.875	15.4	13.51
5	24	4.03		1.358		1.358	16.1	21.89
6	28	4.16		1.478		1.478	16.6	24.59
7	32	4.25		1.547		1.547	17.0	26.30
8	36	4.24		1.638		1.638	17.0	27.78
9	40	4.17		1.396		1.396	16.7	23.29
10	44	4.1		1.129		1.129	16.4	18.52
11	48	0.97		0.113		0.113	3.9	0.44
12	52	0		0		0.000	0.0	0.00
13						0.000	0.0	0.00
14						0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
18						0.000	0.0	0.00
						1.193	135.9	162.06

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.00	20.00	0.40	0.88	0.64	1.88
30%	22.5	20.00	24.00	0.88	1.36	1.18	1.01
40%	27.0	24.00	28.00	1.36	1.48	1.45	0.82
50%	31.5	28.00	32.00	1.48	1.55	1.54	0.78
60%	36.0	36.00	40.00	1.64	1.40	1.64	0.73
70%	40.5	40.00	44.00	1.40	1.13	1.36	0.88
80%	45.0	44.00	48.00	1.13	0.11	0.88	1.36

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00047

Q = 206.5
V_{AVR} = 1.52

Roughness coeff. Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	9.7	0	2	0.0	6.0	0	0.00	0.00
98.94	12	1.06	2	3.3	3.2	1.06	2.15	0.64
96.65	16	3.35	2	13.4	4.0	3.35	18.58	1.39
96.14	20	3.86	2	15.4	4.0	3.86	23.53	1.52
95.97	24	4.03	2	16.1	4.0	4.03	25.29	1.57
95.84	28	4.16	2	16.6	4.0	4.16	26.66	1.60
95.75	32	4.25	2	17.0	4.0	4.25	27.63	1.63
95.76	36	4.24	2	17.0	4.0	4.24	27.52	1.62
95.83	40	4.17	2	16.7	4.0	4.17	26.77	1.60
95.9	44	4.1	2	16.4	4.0	4.1	26.02	1.59
99.03	48	0.97	2	3.9	4.0	0.97	2.36	0.61
100	52	0	2	0.0	2.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				135.86			206.61	1.52

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.00	20.00	1.39	1.52	1.46	1.04
30%	22.5	20.00	24.00	1.52	1.57	1.55	0.98
40%	27.0	24.00	28.00	1.57	1.60	1.59	0.95
50%	31.5	28.00	32.00	1.60	1.63	1.62	0.94
60%	36.0	36.00	40.00	1.62	1.60	1.62	0.94
70%	40.5	40.00	44.00	1.60	1.59	1.60	0.95
80%	45.0	44.00	48.00	1.59	0.61	1.34	1.13

Measured data

STATION No. : C6H006
RIVER NAME : Vals
PLACE NAME : Tweefontein (Bothaville)
DATE : 1/24/93

START TIME : 09h00
Average Gaugeplate reading : 3.649 m

Main Channel LEFT : 9
Main Channel RIGHT : 54

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.187	137.0	162.59
1	9.7	0		0		0.000	0.0	0.00
2	13.7	1.5		0.048		0.048	6.0	0.29
3	17.7	3.42		0.509		0.509	13.7	6.96
4	21.7	3.93		0.944		0.944	15.7	14.84
5	25.7	4.07		1.388		1.388	16.3	22.60
6	29.7	4.28		1.508		1.508	17.1	25.82
7	33.7	4.11		1.431		1.431	16.4	23.53
8	37.7	4.19		1.594		1.594	16.8	26.72
9	41.7	4.02		1.504		1.504	16.1	24.18
10	45.7	4.04		1.073		1.073	16.2	17.34
11	49.7	0.87		0.117		0.117	2.7	0.32
12	52	0		0		0.000	0.0	0.00
13						0.000	0.0	0.00
14						0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
18						0.000	0.0	0.00
						1.187	137.0	162.59

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	17.70	21.70	0.51	0.94	0.54	2.19
30%	22.5	21.70	25.70	0.94	1.39	1.03	1.15
40%	27.0	25.70	29.70	1.39	1.51	1.43	0.83
50%	31.5	29.70	33.70	1.51	1.43	1.47	0.81
60%	36.0	33.70	37.70	1.43	1.59	1.52	0.78
70%	40.5	37.70	41.70	1.59	1.50	1.53	0.78
80%	45.0	41.70	45.70	1.50	1.07	1.15	1.03

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00046

Q = 205.0
V_{AVR} = 1.50

Roughness coeff Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	9.7	0	2	0.0	6.9	0	0.00	0.00
98.5	13.7	1.5	2	6.0	4.0	1.5	4.82	0.80
96.58	17.7	3.42	2	13.7	4.0	3.42	19.03	1.39
96.07	21.7	3.93	2	15.7	4.0	3.93	23.99	1.53
95.93	25.7	4.07	2	16.3	4.0	4.07	25.43	1.56
95.72	29.7	4.28	2	17.1	4.0	4.28	27.66	1.62
95.89	33.7	4.11	2	16.4	4.0	4.11	25.65	1.57
95.81	37.7	4.19	2	16.8	4.0	4.19	26.69	1.59
95.98	41.7	4.02	2	16.1	4.0	4.02	24.91	1.55
95.96	45.7	4.04	2	16.2	4.0	4.04	25.12	1.55
99.13	49.7	0.87	2	2.7	3.2	0.87	1.53	0.56
100	52	0	2	0.0	1.2	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				136.98			205.03	1.50

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	17.70	21.70	1.39	1.53	1.40	1.07
30%	22.5	21.70	25.70	1.53	1.56	1.53	0.98
40%	27.0	25.70	29.70	1.56	1.62	1.58	0.95
50%	31.5	29.70	33.70	1.62	1.57	1.60	0.94
60%	36.0	33.70	37.70	1.57	1.59	1.58	0.94
70%	40.5	37.70	41.70	1.59	1.55	1.56	0.96
80%	45.0	41.70	45.70	1.55	1.55	1.55	0.96

Measured data

STATION No. : C6H006 START TIME : 06h46

RIVER NAME : Vals Average Gaugeplate reading : 4.088 m

PLACE NAME : Tweefontein (Bothaville)

DATE : 11/11/92

Main Channel LEFT : 9

Main Channel RIGHT : 54

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.259	146.6	184.54
1	8	0		0		0.000	0.0	0.00
2	12.1	1.37		0.331		0.331	5.5	1.84
3	16.1	3.46		0.526		0.526	13.8	7.28
4	20.1	3.98		0.86		0.860	15.9	13.69
5	24.1	4.24		1.377		1.377	17.0	23.35
6	28.1	4.38		1.503		1.503	17.5	26.33
7	32.1	4.33		1.589		1.589	17.3	27.52
8	36.1	3.858		1.694		1.694	15.4	26.14
9	40.1	3.938		1.798		1.798	15.8	28.32
10	44.1	4.068		1.429		1.429	16.3	23.25
11	48.1	3.05		0.565		0.565	12.0	6.81
12	52	0		0		0.000	0.0	0.00
13						0.000	0.0	0.00
14						0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
18						0.000	0.0	0.00
						1.259	146.6	184.54

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.10	20.10	0.53	0.86	0.68	1.84
30%	22.5	20.10	24.10	0.86	1.38	1.17	1.08
40%	27.0	24.10	28.10	1.38	1.50	1.47	0.86
50%	31.5	28.10	32.10	1.50	1.59	1.58	0.80
60%	36.0	32.10	36.10	1.59	1.69	1.69	0.74
70%	40.5	40.10	44.10	1.80	1.43	1.76	0.71
80%	45.0	44.10	48.10	1.43	0.57	1.23	1.02

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.00046

Q = 227.0

V_{AVR} = 1.55

Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.034	2	1
0		0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	8	0	2	0.0	6.1	0	0.00	0.00
98.63	12.1	1.37	2	5.5	4.1	1.37	4.32	0.78
96.54	16.1	3.46	2	13.8	4.0	3.46	19.97	1.44
96.02	20.1	3.98	2	15.9	4.0	3.98	25.22	1.58
95.76	24.1	4.24	2	17.0	4.0	4.24	28.03	1.65
95.62	28.1	4.38	2	17.5	4.0	4.38	29.59	1.69
95.67	32.1	4.33	2	17.3	4.0	4.33	29.03	1.68
96.142	36.1	3.858	2	15.4	4.0	3.858	23.95	1.55
96.062	40.1	3.938	2	15.8	4.0	3.938	24.78	1.57
95.932	44.1	4.068	2	16.3	4.0	4.068	26.16	1.61
96.95	48.1	3.05	2	12.0	4.0	3.05	15.98	1.33
100	52	0	2	0.0	2.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				146.61			227.01	1.55

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.10	20.10	1.44	1.58	1.51	1.03
30%	22.5	20.10	24.10	1.58	1.65	1.63	0.95
40%	27.0	24.10	28.10	1.65	1.69	1.68	0.92
50%	31.5	28.10	32.10	1.69	1.68	1.68	0.92
60%	36.0	32.10	36.10	1.68	1.55	1.55	1.00
70%	40.5	40.10	44.10	1.57	1.61	1.58	0.98
80%	45.0	44.10	48.10	1.61	1.33	1.54	1.00

Measured data

STATION No. : C6H006 START TIME : 15h53
RIVER NAME : Vals Average Gaugeplate reading : 6.325 m
PLACE NAME : Tweefontein (Bothaville)
DATE : 11/10/92
Main Channel LEFT : 9
Main Channel RIGHT : 54

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.754	233.2	409.06
1	2.8	0		0		0.000	0.0	0.00
2	8	2.19		0.617		0.617	10.1	6.22
3	12	3.273		0.969		0.969	13.1	12.69
4	16	5.391		1.047		1.047	21.6	22.58
5	20	5.615		1.633		1.633	22.5	36.68
6	24	5.348		2.067		2.067	21.4	44.22
7	28	5.231		2.167		2.167	20.9	45.34
8	32	5.332		2.262		2.262	21.3	48.24
9	36	5.4		2.414		2.414	21.6	52.14
10	40	5.565		2.488		2.488	22.3	55.38
11	44	6.298		2.019		2.019	25.2	50.86
12	48	5.28		1.294		1.294	21.1	27.33
13	52	2.23		0.704		0.704	8.9	6.28
14	56	0.62		0.335		0.335	3.3	1.10
15	62.6	0		0		0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
18						0.000	0.0	0.00
						1.754	233.2	409.06

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.00	20.00	1.05	1.63	1.34	1.31
30%	22.5	20.00	24.00	1.63	2.07	1.90	0.92
40%	27.0	24.00	28.00	2.07	2.17	2.14	0.82
50%	31.5	28.00	32.00	2.17	2.26	2.25	0.78
60%	36.0	36.00	40.00	2.41	2.49	2.41	0.73
70%	40.5	40.00	44.00	2.49	2.02	2.43	0.72
80%	45.0	44.00	48.00	2.02	1.29	1.84	0.95

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00047

Q = 447.1
V_{AVR} = 1.92

Roughness coeff. Sub	n
0	
2	0.033
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	2.8	0	2	0.0	4.0	0	0.00	0.00
97.81	8	2.19	2	10.1	4.6	2.19	11.16	1.11
96.727	12	3.273	2	13.1	4.0	3.273	18.96	1.45
94.609	16	5.391	2	21.6	4.0	5.391	43.56	2.02
94.385	20	5.615	2	22.5	4.0	5.615	46.61	2.08
94.652	24	5.348	2	21.4	4.0	5.348	42.98	2.01
94.769	28	5.231	2	20.9	4.0	5.231	41.42	1.98
94.668	32	5.332	2	21.3	4.0	5.332	42.76	2.01
94.6	36	5.4	2	21.6	4.0	5.4	43.68	2.02
94.435	40	5.565	2	22.3	4.0	5.565	45.92	2.06
93.702	44	6.298	2	25.2	4.0	6.298	56.44	2.24
94.72	48	5.28	2	21.1	4.0	5.28	42.07	1.99
97.77	52	2.23	2	8.9	4.0	2.23	10.00	1.12
99.38	56	0.62	2	3.3	5.3	0.62	1.57	0.48
100	62.6	0	2	0.0	3.3	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
		0	2	0.0	0.0	0	0.00	0.00
				233.21			447.14	1.92

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.00	20.00	2.02	2.08	2.05	0.94
30%	22.5	20.00	24.00	2.08	2.01	2.03	0.94
40%	27.0	24.00	28.00	2.01	1.98	1.99	0.96
50%	31.5	28.00	32.00	1.98	2.01	2.00	0.96
60%	36.0	36.00	40.00	2.02	2.06	2.02	0.95
70%	40.5	40.00	44.00	2.06	2.24	2.09	0.92
80%	45.0	44.00	48.00	2.24	1.99	2.18	0.88

Measured data

STATION No. : C6H006
START TIME : 09h14
RIVER NAME : Vals
Average Gaugeplate reading : 7.206 m
PLACE NAME : Tweefontein (Bothaville)
DATE : 11/10/92
Main Channel LEFT : 9
Main Channel RIGHT : 54

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.884	299.9	565.19
1	0	0		0		0.000	0.0	0.00
2	4.3	1.84		0.366		0.366	7.6	2.79
3	8.3	2.53		0.943		0.943	10.1	9.54
4	12.3	3.97		1.377		1.377	15.9	21.87
5	16.3	6.515		1.212		1.212	26.1	31.58
6	20.3	6.803		1.516		1.516	27.2	41.25
7	24.3	7.003		1.867		1.867	28.0	52.30
8	28.3	7.224		2.232		2.232	28.9	64.50
9	32.3	6.636		2.332		2.332	26.5	61.90
10	36.3	6.816		2.453		2.453	27.3	66.88
11	40.3	6.679		2.544		2.544	26.7	67.97
12	44.3	6.468		2.488		2.488	25.9	64.37
13	48.3	6.111		2.149		2.149	24.4	52.53
14	52.3	3.237		1.416		1.416	12.9	18.33
15	56.3	1.626		0.93		0.930	6.5	6.05
16	60.3	0.89		0.704		0.704	3.4	2.38
17	63.9	0.78		0.383		0.383	2.5	0.94
18	66.6	0		0		0.000	0.0	0.00
						1.884	299.9	565.19

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.30	20.30	1.21	1.52	1.34	1.40
30%	22.5	20.30	24.30	1.52	1.87	1.71	1.10
40%	27.0	24.30	28.30	1.87	2.23	2.11	0.89
50%	31.5	28.30	32.30	2.23	2.33	2.31	0.82
60%	36.0	32.30	36.30	2.33	2.45	2.44	0.77
70%	40.5	40.30	44.30	2.54	2.49	2.54	0.74
80%	45.0	44.30	48.30	2.49	2.15	2.43	0.78

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00047

Q = 584.0
V_{AVR} = 1.95

Roughness coeff. Sub	n
0	
2	0.036
0	

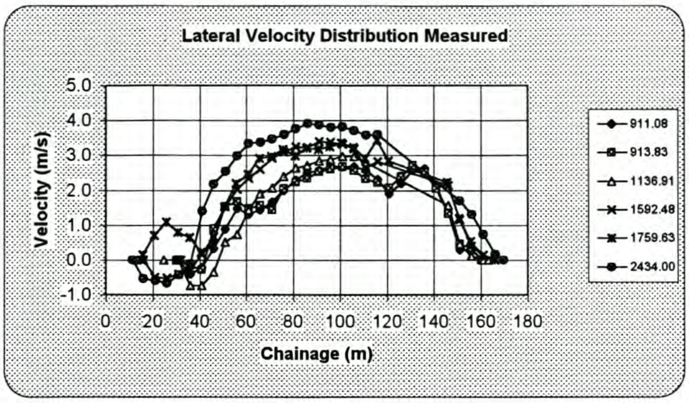
Area reduction factor Sub	f_A
0	1
2	1
0	1

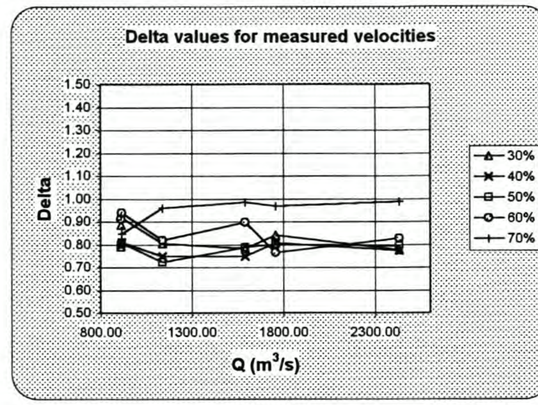
HH	Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
100	0	0	2	0.0	0.0	0	0.00	0.00
98.16	4.3	1.84	2	7.6	4.2	1.84	6.90	0.90
97.47	8.3	2.53	2	10.1	4.0	2.53	11.32	1.12
96.03	12.3	3.97	2	15.9	4.0	3.97	23.98	1.51
93.485	16.3	6.515	2	26.1	4.0	6.515	54.74	2.10
93.197	20.3	6.803	2	27.2	4.0	6.803	58.84	2.16
92.997	24.3	7.003	2	28.0	4.0	7.003	61.75	2.20
92.776	28.3	7.224	2	28.9	4.0	7.224	65.03	2.25
93.364	32.3	6.636	2	26.5	4.0	6.636	56.45	2.13
93.184	36.3	6.816	2	27.3	4.0	6.816	59.02	2.16
93.321	40.3	6.679	2	26.7	4.0	6.679	57.06	2.14
93.532	44.3	6.468	2	25.9	4.0	6.468	54.09	2.09
93.889	48.3	6.111	2	24.4	4.0	6.111	49.20	2.01
96.763	52.3	3.237	2	12.9	4.0	3.237	17.06	1.32
98.374	56.3	1.626	2	6.5	4.0	1.626	5.42	0.83
99.11	60.3	0.89	2	3.4	3.8	0.89	1.88	0.56
99.22	63.9	0.78	2	2.5	3.2	0.78	1.25	0.51
100	66.6	0	2	0.0	1.4	0	0.00	0.00
				299.95			583.99	1.95

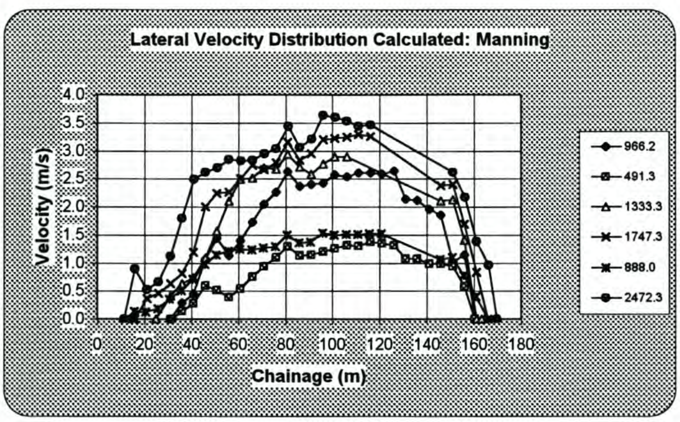
Delta value calculations

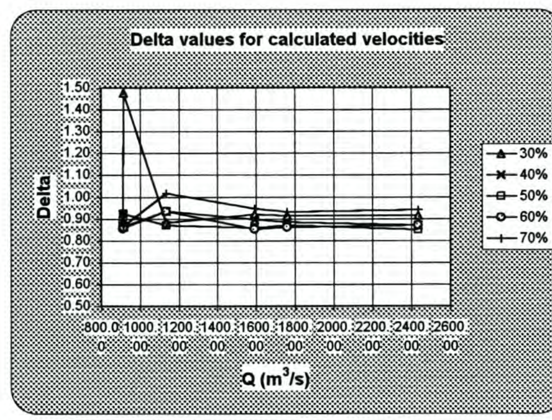
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
20%	18.0	16.30	20.30	2.10	2.16	2.13	0.92
30%	22.5	20.30	24.30	2.16	2.20	2.19	0.89
40%	27.0	24.30	28.30	2.20	2.25	2.24	0.87
50%	31.5	28.30	32.30	2.25	2.13	2.15	0.90
60%	36.0	32.30	36.30	2.13	2.16	2.16	0.90
70%	40.5	40.30	44.30	2.14	2.09	2.13	0.91
80%	45.0	44.30	48.30	2.09	2.01	2.08	0.94

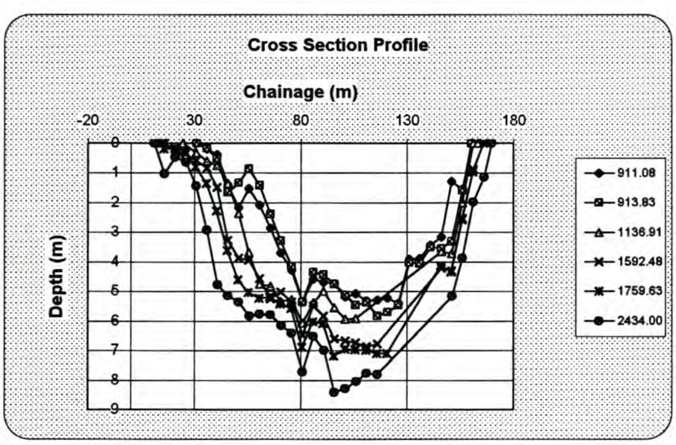
Statn No.: D1H003
River: Oranje
Place: Aliwal Noord











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : D1H003 START TIME : 09h10
RIVER NAME : Oranje Average Gaugeplate reading : 1.881 m
PLACE NAME : Aliwal Noord
DATE : 2/12/94

Main Channel LEFT : 50
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.102	433.4	911.08
1	31	0	0	0	0	0.000	0.0	0.00
2	36	0.195	0	-0.404	0	-0.404	1.0	-0.39
3	41	0.38	0	-0.222	0	-0.222	1.9	-0.42
4	46	1.39	0	0.324	0	0.324	7.0	2.25
5	51	2.17	0.391	0.902	1.349	0.886	10.9	9.61
6	56	1.52	1.176	1.437	1.842	1.473	7.6	11.19
7	61	2.08	1.015	1.277	1.665	1.309	10.4	13.61
8	66	2.87	1.243	1.382	1.716	1.431	14.4	20.53
9	71	3.7	1.441	1.745	1.669	1.650	18.5	30.53
10	76	4.277	2.23	2.104	1.56	2.000	21.4	42.76
11	81	5.367	2.205	2.458	2.015	2.284	26.8	61.29
12	86	4.577	2.618	2.564	2.256	2.501	22.9	57.22
13	91	4.696	2.407	2.72	2.433	2.570	23.5	60.34
14	96	4.746	2.407	2.884	2.572	2.687	23.7	63.76
15	101	5.182	2.294	2.741	2.897	2.668	25.9	69.13
16	106	5.081	2.197	2.745	2.985	2.668	25.4	67.78
17	111	5.313	0	2.576	0	2.576	26.6	68.43
18	116	5.307	0	2.31	0	2.310	26.5	61.30
19	121	5.24	0	1.893	0	1.893	26.2	49.60
20	126	5.402	0	2.201	0	2.201	27.0	59.45
21	131	3.929	0	2.559	0	2.559	19.6	50.27
22	136	3.889	0	2.618	0	2.618	19.4	50.91
23	141	3.441	1.838	2.18	2.294	2.123	17.2	36.53
24	146	3.167	1.475	1.361	1.205	1.351	15.8	21.39
25	151	1.29	0	0.294	0	0.294	6.5	1.90
26	156	1.55	0	0.29	0	0.290	7.3	2.13
27	160.46	0	0	0	0	0.000	0.0	0.00
28						0.000	0.0	0.00
						2.102	433.4	911.08

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	81.00	86.00	2.28	2.50	2.37	0.89
40%	94.0	91.00	96.00	2.57	2.69	2.64	0.80
50%	105.0	101.00	106.00	2.67	2.67	2.67	0.79
60%	116.0	116.00	121.00	2.31	1.89	2.31	0.91
70%	127.0	126.00	131.00	2.20	2.56	2.27	0.93

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0009

Q = 966.2
V_{AVR} = 2.23

Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
31	0	2	0.0	18.0	0	0.00	0.00
36	0.195	2	1.0	5.0	0.195	0.28	0.29
41	0.38	2	1.9	5.0	0.38	0.86	0.45
46	1.39	2	7.0	5.0	1.39	7.42	1.07
51	2.17	2	10.9	5.0	2.17	15.59	1.44
56	1.52	2	7.6	5.0	1.52	8.61	1.13
61	2.08	2	10.4	5.0	2.08	14.53	1.40
66	2.87	2	14.4	5.0	2.87	24.84	1.73
71	3.7	2	18.5	5.0	3.7	37.93	2.05
76	4.277	2	21.4	5.0	4.277	48.30	2.26
81	5.367	2	26.8	5.0	5.367	70.51	2.63
86	4.577	2	22.9	5.0	4.577	54.07	2.36
91	4.696	2	23.5	5.0	4.696	56.44	2.40
96	4.746	2	23.7	5.0	4.746	57.44	2.42
101	5.182	2	25.9	5.0	5.182	66.50	2.57
106	5.081	2	25.4	5.0	5.081	64.26	2.53
111	5.313	2	26.6	5.0	5.313	69.33	2.61
116	5.307	2	26.5	5.0	5.307	69.20	2.61
121	5.24	2	26.2	5.0	5.24	67.76	2.59
126	5.402	2	27.0	5.0	5.402	71.28	2.64
131	3.929	2	19.6	5.0	3.929	41.93	2.13
136	3.889	2	19.4	5.0	3.889	41.22	2.12
141	3.441	2	17.2	5.0	3.441	33.61	1.95
146	3.167	2	15.8	5.0	3.167	29.27	1.85
151	1.29	2	6.5	5.0	1.29	6.55	1.02
156	1.55	2	7.3	4.7	1.55	8.42	1.15
160.46	0	2	0.0	2.2	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			433.38			966.23	2.23

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	81.00	86.00	2.63	2.38	2.52	0.88
40%	94.0	91.00	96.00	2.40	2.42	2.41	0.92
50%	105.0	101.00	106.00	2.57	2.53	2.54	0.88
60%	116.0	116.00	121.00	2.61	2.59	2.61	0.85
70%	127.0	126.00	131.00	2.64	2.13	2.54	0.88

Measured data

STATION No. :	D1H003	START TIME :	13H35
RIVER NAME :	Oranje	Average Gaugeplate reading :	1.822 m
PLACE NAME :	Aliwal Noord		
DATE :	2/12/94		
		Main Channel LEFT :	50
		Main Channel RIGHT :	160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.085	438.2	913.83
1	31.4	0		0		0.000	0.0	0.00
2	36	0.18		-0.162		-0.162	0.9	-0.14
3	41	0.515		-0.271		-0.271	2.6	-0.70
4	46	1.65		0.906		0.906	8.3	7.47
5	51	1.33		1.534		1.534	6.7	10.20
6	56	0.86		1.686		1.686	4.3	7.25
7	61	1.43		1.475		1.475	7.2	10.55
8	66	2.4		1.572		1.572	12.0	18.86
9	71	3.3		1.429		1.429	16.5	23.58
10	76	4.163		2.045		2.045	20.8	42.57
11	81	5.353		2.23		2.230	26.8	59.69
12	86	4.358		2.336		2.336	21.8	50.90
13	91	4.432		2.534		2.534	22.2	56.15
14	96	4.756		2.601		2.601	23.8	61.85
15	101	5.124		2.669		2.669	25.6	68.38
16	106	5.468		2.564		2.564	27.3	70.10
17	111	5.378		2.332		2.332	26.9	62.71
18	116	5.835		2.218		2.218	29.2	64.71
19	121	5.711		2.062		2.062	28.6	58.88
20	126	5.468		2.403		2.403	27.3	65.70
21	131	4.026		2.715		2.715	20.1	54.65
22	136	4.065		2.5		2.500	20.3	50.81
23	141	3.52		2.04		2.040	17.6	35.90
24	146	3.562		1.319		1.319	17.8	23.49
25	151	3.306		0.467		0.467	16.5	7.72
26	156	1.59		0.349		0.349	7.3	2.54
27	160.15	0		0		0.000	0.0	0.00
28						0.000	0.0	0.00
						2.085	438.2	913.83

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**83.0**	81.00	86.00	2.23	2.34	2.27	**0.92**
40%	**94.0**	91.00	96.00	2.53	2.60	2.57	**0.81**
50%	**105.0**	101.00	106.00	2.67	2.56	2.59	**0.81**
60%	**116.0**	116.00	121.00	2.22	2.06	2.22	**0.94**
70%	**127.0**	126.00	131.00	2.40	2.72	2.47	**0.85**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	491.3
Slope	0.00022	V_{AVR} =	1.12

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
50	0	2	0.0	18.0	0	0.00	0.00
57	0.18	2	0.9	4.8	0.18	0.12	0.14
62	0.515	2	2.6	5.0	0.515	0.70	0.27
67	1.65	2	8.3	5.0	1.65	4.88	0.59
71	1.33	2	6.7	5.0	1.33	3.41	0.51
75	0.86	2	4.3	5.0	0.86	1.65	0.38
79	1.43	2	7.2	5.0	1.43	5.86	0.64
83	2.4	2	12.0	5.0	2.4	9.12	0.76
87	3.3	2	16.5	5.0	3.3	15.50	0.94
91	4.163	2	20.8	5.0	4.163	22.83	1.10
94	5.353	2	26.8	5.0	5.353	34.71	1.30
97	4.358	2	21.8	5.0	4.358	24.64	1.13
100	4.432	2	22.2	5.0	4.432	25.34	1.14
104	4.756	2	23.8	5.0	4.756	28.50	1.20
108	5.124	2	25.6	5.0	5.124	32.27	1.26
113	5.468	2	27.3	5.0	5.468	35.96	1.32
118	5.378	2	26.9	5.0	5.378	34.98	1.30
	5.835	2	29.2	5.0	5.835	40.07	1.37
	5.711	2	28.6	5.0	5.711	38.68	1.36
	5.468	2	27.3	5.0	5.468	35.96	1.32
	4.026	2	20.1	5.0	4.026	21.59	1.07
	4.065	2	20.3	5.0	4.065	21.94	1.08
	3.52	2	17.6	5.0	3.52	17.26	0.98
	3.562	2	17.8	5.0	3.562	17.60	0.99
	3.306	2	16.5	5.0	3.306	15.55	0.94
	1.59	2	7.3	4.6	1.59	4.20	0.58
	0	2	0.0	2.1	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			438.19			491.27	1.12

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**83.0**	83.00	87.00	0.76	0.94	0.76	**1.48**
40%	**94.0**	94.00	97.00	1.30	1.13	1.30	**0.86**
50%	**105.0**	104.00	108.00	1.20	1.26	1.21	**0.92**
60%	**116.0**	113.00	118.00	1.32	1.30	1.31	**0.86**
70%	**127.0**	118.00	0.00	1.30	1.37	1.30	**0.87**

Measured data

STATION No. : D1H003
RIVER NAME : Oranje
PLACE NAME : Aliwal Noord
DATE : 2/11/94

START TIME : 10H38
Average Gaugeplate reading : 2.228 m

Main Channel LEFT : 50
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.142	530.7	1136.91
1	24.8	0		0		0.000	0.0	0.00
2	31	0.32		0		0.000	1.8	0.00
3	36	0.6		-0.742		-0.742	3.0	-2.23
4	41	0.75		-0.734		-0.734	3.8	-2.75
5	46	1.36	-0.57	-0.095	-0.69	-0.363	6.8	-2.47
6	51	2.36	0.64	0.459	0.509	0.517	11.8	6.10
7	56	3.688	0.927	0.758	0.518	0.740	18.4	13.65
8	61	4.749	1.475	1.332	1.585	1.431	23.7	33.98
9	66	4.825	1.99	1.935	1.749	1.902	24.1	45.89
10	71	5.333	2.184	2.197	1.711	2.072	26.7	55.26
11	76	5.282	2.049	2.762	1.994	2.392	26.4	63.17
12	81	6.081	2.597	2.812	2.353	2.644	30.4	80.38
13	86	5.39	2.703	2.859	2.399	2.705	27.0	72.90
14	91	4.996	2.871	2.968	2.526	2.833	25.0	70.77
15	96	5.546	2.707	3.04	2.732	2.880	27.7	79.86
16	101	5.932	2.492	3.108	3.167	2.969	29.7	88.05
17	106	5.918	2.399	3.091	3.293	2.969	133.2	395.27
18	146	3.67	1.754	1.661	1.193	1.567	82.6	129.42
19	151	3.73	0.497	0.429	0.475	0.458	18.7	8.53
20	156	2.01	0.126	0.162	0	0.113	10.1	1.13
21	161	0	0	0	0	0.000	0.0	0.00
22	163.2	0	0	0	0	0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
25						0.000	0.0	0.00
26						0.000	0.0	0.00
27						0.000	0.0	0.00
28						0.000	0.0	0.00
						2.142	530.7	1136.91

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	83.0	81.00	86.00	2.64	2.71	2.67	0.80
40%	94.0	91.00	96.00	2.83	2.88	2.86	0.75
50%	105.0	101.00	106.00	2.97	2.97	2.97	0.72
60%	116.0	106.00	146.00	2.97	1.57	2.62	0.82
70%	127.0	106.00	146.00	2.97	1.57	2.23	0.96

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0009

Q = 1333.3
V_{AVR} = 2.51

Roughness coeff. Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
24.8	0	2	0.0	15.5	0	0.00	0.00
31	0.32	2	1.8	5.6	0.32	0.74	0.41
36	0.6	2	3.0	5.0	0.6	1.88	0.63
41	0.75	2	3.8	5.0	0.75	2.73	0.73
46	1.36	2	6.8	5.0	1.36	7.37	1.08
51	2.36	2	11.8	5.0	2.36	18.46	1.56
56	3.688	2	18.4	5.0	3.688	38.84	2.11
61	4.749	2	23.7	5.0	4.749	59.19	2.49
66	4.825	2	24.1	5.0	4.825	60.78	2.52
71	5.333	2	26.7	5.0	5.333	71.82	2.69
76	5.282	2	26.4	5.0	5.282	70.68	2.68
81	6.081	2	30.4	5.0	6.081	89.38	2.94
86	5.39	2	27.0	5.0	5.39	73.10	2.71
91	4.996	2	25.0	5.0	4.996	64.41	2.58
96	5.546	2	27.7	5.0	5.546	76.66	2.76
101	5.932	2	29.7	5.0	5.932	85.76	2.89
106	5.918	2	133.2	22.5	5.918	384.40	2.89
146	3.67	2	82.6	22.5	3.67	173.35	2.10
151	3.73	2	18.7	5.0	3.73	39.56	2.12
156	2.01	2	10.1	5.0	2.01	14.12	1.41
161	0	2	0.0	3.6	0	0.00	0.00
	0	2	0.0	1.1	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			530.68			1333.26	2.51

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	83.0	81.00	86.00	2.94	2.71	2.85	0.88
40%	94.0	91.00	96.00	2.58	2.76	2.69	0.93
50%	105.0	101.00	106.00	2.89	2.89	2.89	0.87
60%	116.0	106.00	146.00	2.89	2.10	2.69	0.93
70%	127.0	106.00	146.00	2.89	2.10	2.47	1.02

Measured data

STATION No. : D1H003 START TIME : 15h10

RIVER NAME : Oranje Average Gaugeplate reading : 2.676 m

PLACE NAME : Aliwal Noord

DATE : 2/10/94

Main Channel LEFT : 50

Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.533	628.6	1592.48
1	16	0		0		0.000	0.0	0.00
2	21	0.25		-0.509		-0.509	1.3	-0.64
3	26	0.36		-0.524		-0.524	1.8	-0.94
4	31	0.58		-0.411		-0.411	2.9	-1.19
5	36	0.85		-0.288		-0.288	4.3	-1.22
6	41	1.49		0.154		0.154	7.5	1.15
7	46	3.27		0.661		0.661	16.4	10.81
8	51	3.87		1.522		1.522	19.4	29.45
9	56	3.94		2.032		2.032	19.7	40.03
10	61	4.555		2.348		2.348	22.8	53.48
11	66	5.254		2.606		2.606	26.3	68.46
12	71	5.024		2.905		2.905	25.1	72.97
13	76	5.359		3.095		3.095	26.8	82.93
14	81	6.477		3.238		3.238	32.4	104.86
15	86	5.489		3.234		3.234	27.4	88.76
16	91	5.841		3.403		3.403	29.2	99.38
17	96	6.61		3.378		3.378	33.1	111.64
18	101	6.671		3.314		3.314	33.4	110.54
19	106	6.73		3.2		3.200	33.7	107.68
20	111	6.872		2.635		2.635	34.4	90.54
21	116	6.791		2.825		2.825	118.8	335.73
22	146	4.216		2.133		2.133	73.8	157.37
23	151	4.3		1.159		1.159	21.5	24.92
24	156	2.53		0.404		0.404	12.7	5.11
25	161	0.88		0.15		0.150	4.4	0.66
26	166	0		0		0.000	0.0	0.00
27						0.000	0.0	0.00
28						0.000	0.0	0.00
						2.533	628.6	1592.48

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	83.0	81.00	86.00	3.24	3.23	3.24	0.78
40%	94.0	91.00	96.00	3.40	3.38	3.39	0.75
50%	105.0	101.00	106.00	3.31	3.20	3.22	0.79
60%	116.0	116.00	146.00	2.83	2.13	2.83	0.90
70%	127.0	116.00	146.00	2.83	2.13	2.57	0.99

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.0009

Q = 1747.3

V_{AVR} = 2.78

Roughness coeff. Sub	n
0	
2	0.033
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
16	0	2	0.0	10.5	0	0.00	0.00
21	0.25	2	1.3	5.0	0.25	0.45	0.36
26	0.36	2	1.8	5.0	0.36	0.83	0.46
31	0.58	2	2.9	5.0	0.58	1.83	0.63
36	0.85	2	4.3	5.0	0.85	3.47	0.82
41	1.49	2	7.5	5.0	1.49	8.84	1.19
46	3.27	2	16.4	5.0	3.27	32.75	2.00
51	3.87	2	19.4	5.0	3.87	43.36	2.24
56	3.94	2	19.7	5.0	3.94	44.68	2.27
61	4.555	2	22.8	5.0	4.555	56.88	2.50
66	5.254	2	26.3	5.0	5.254	72.18	2.75
71	5.024	2	25.1	5.0	5.024	66.99	2.67
76	5.359	2	26.8	5.0	5.359	74.60	2.78
81	6.477	2	32.4	5.0	6.477	102.30	3.16
86	5.489	2	27.4	5.0	5.489	77.64	2.83
91	5.841	2	29.2	5.0	5.841	86.11	2.95
96	6.61	2	33.1	5.0	6.61	105.82	3.20
101	6.671	2	33.4	5.0	6.671	107.46	3.22
106	6.73	2	33.7	5.0	6.73	109.04	3.24
111	6.872	2	34.4	5.0	6.872	112.91	3.29
116	6.791	2	118.8	17.5	6.791	387.44	3.26
146	4.216	2	73.8	17.5	4.216	175.04	2.37
151	4.3	2	21.5	5.0	4.3	51.66	2.40
156	2.53	2	12.7	5.0	2.53	21.35	1.69
161	0.88	2	4.4	5.0	0.88	3.67	0.83
166	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			628.63			1747.31	2.78

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	83.0	81.00	86.00	3.16	2.83	3.03	0.92
40%	94.0	91.00	96.00	2.95	3.20	3.10	0.90
50%	105.0	101.00	106.00	3.22	3.24	3.24	0.86
60%	116.0	116.00	146.00	3.26	2.37	3.26	0.85
70%	127.0	116.00	146.00	3.26	2.37	2.93	0.95

Measured data

STATION No. : D1H003 — START TIME : 08h15

RIVER NAME : Oranje — Average Gaugeplate reading : 2.835 m

PLACE NAME : Aliwal Noord

DATE : 2/10/94

Main Channel LEFT : 50

Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.596	677.8	1759.63
1	14.8	0	0	0	0	0.000	0.0	0.00
2	15.7	0.2	0	0.148	0	0.148	0.6	0.09
3	20.7	0.18	0	0.699	0	0.699	0.9	0.63
4	25.7	0.29	0	1.087	0	1.087	1.5	1.58
5	30.7	0.79	0.852	0.778	0.72	0.782	4.0	3.09
6	35.7	1.35	0	0.636	0	0.636	6.8	4.29
7	40.7	2.28	0	0.21	0	0.210	11.4	2.39
8	45.7	3.62	0.471	0.526	0.311	0.459	18.1	8.30
9	50.7	4.6	1.492	1.635	1.37	1.533	23.0	35.26
10	55.7	5.03	2.399	2.197	1.981	2.194	25.2	55.17
11	60.7	5.227	2.749	2.551	1.948	2.450	26.1	64.02
12	65.7	5.188	2.922	3.057	2.585	2.905	25.9	75.36
13	70.7	5.417	3.082	3.108	2.568	2.967	27.1	80.35
14	75.7	5.582	3.154	3.403	2.72	3.170	27.9	88.47
15	80.7	6.888	2.496	3.289	2.85	2.981	34.4	102.67
16	85.7	6.03	3.078	3.365	3.057	3.216	30.2	96.97
17	90.7	6.086	2.715	3.382	3.192	3.168	30.4	96.39
18	95.7	7.197	2.753	3.445	3.331	3.244	36.0	116.72
19	100.7	6.958	3.078	3.487	3.399	3.363	34.8	116.99
20	105.7	6.985	2.682	3.323	3.546	3.219	34.9	112.41
21	110.7	7.004	2.209	2.88	3.673	2.911	35.0	101.93
22	115.7	7.099	0	3.433	0	3.433	35.5	121.85
23	120.7	7.11	0	2.838	0	2.838	106.7	302.67
24	145.7	4.13	0	2.234	0	2.234	62.0	138.40
25	150.7	4.35	1.062	1.197	1.344	1.200	21.8	26.10
26	155.7	2.59	0.674	0.513	0.45	0.538	13.0	6.96
27	160.7	0.96	0	0.117	0	0.117	4.9	0.57
28	165.9	0	0	0.000	0	0.000	0.0	0.00
						2.596	677.8	1759.63

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	80.70	85.70	2.98	3.22	3.09	0.84
40%	94.0	90.70	95.70	3.17	3.24	3.22	0.81
50%	105.0	100.70	105.70	3.36	3.22	3.24	0.80
60%	116.0	115.70	120.70	3.43	2.84	3.40	0.76
70%	127.0	120.70	145.70	2.84	2.23	2.69	0.97

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00022

Q = 888.0

V_{AVR} = 1.31

Roughness coeff. Sub	n
0	
2	0,036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
14.8	0	2	0.0	7.9	0	0.00	0.00
15.7	0.2	2	0.6	3.0	0.2	0.08	0.14
20.7	0.18	2	0.9	5.0	0.18	0.12	0.13
25.7	0.29	2	1.5	5.0	0.29	0.26	0.18
30.7	0.79	2	4.0	5.0	0.79	1.39	0.35
35.7	1.35	2	6.8	5.0	1.35	3.40	0.50
40.7	2.28	2	11.4	5.0	2.28	8.14	0.71
45.7	3.62	2	18.1	5.0	3.62	17.58	0.97
50.7	4.6	2	23.0	5.0	4.6	26.21	1.14
55.7	5.03	2	25.2	5.0	5.03	30.42	1.21
60.7	5.227	2	26.1	5.0	5.227	32.43	1.24
65.7	5.188	2	25.9	5.0	5.188	32.03	1.23
70.7	5.417	2	27.1	5.0	5.417	34.42	1.27
75.7	5.582	2	27.9	5.0	5.582	36.18	1.30
80.7	6.888	2	34.4	5.0	6.888	51.37	1.49
85.7	6.03	2	30.2	5.0	6.03	41.15	1.36
90.7	6.086	2	30.4	5.0	6.086	41.79	1.37
95.7	7.197	2	36.0	5.0	7.197	55.27	1.54
100.7	6.958	2	34.8	5.0	6.958	52.24	1.50
105.7	6.985	2	34.9	5.0	6.985	52.58	1.51
110.7	7.004	2	35.0	5.0	7.004	52.82	1.51
115.7	7.099	2	35.5	5.0	7.099	54.02	1.52
120.7	7.11	2	106.7	15.0	7.11	162.47	1.52
145.7	4.13	2	62.0	15.0	4.13	65.70	1.06
150.7	4.35	2	21.8	5.0	4.35	23.88	1.10
155.7	2.59	2	13.0	5.0	2.59	10.06	0.78
160.7	0.96	2	4.9	5.1	0.96	1.96	0.40
165.9	0	2	0.0	2.6	0	0.00	0.00
			677.79			887.99	1.31

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	80.70	85.70	1.49	1.36	1.43	0.91
40%	94.0	90.70	95.70	1.37	1.54	1.48	0.88
50%	105.0	100.70	105.70	1.50	1.51	1.50	0.87
60%	116.0	115.70	120.70	1.52	1.52	1.52	0.86
70%	127.0	120.70	145.70	1.52	1.06	1.41	0.93

Measured data

STATION No. : D1H003 START TIME : 09h33
RIVER NAME : Oranje Average Gaugeplate reading : 3.406 m
PLACE NAME : Aliwal Noord
DATE : 2/9/94

Main Channel LEFT : 50
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.962	821.7	2434.00
1	11.3	0		0		0.000	0.0	0.00
2	16.1	1.03		-0.546		-0.546	5.0	-2.76
3	21.1	0.47		-0.59		-0.590	2.4	-1.39
4	26.1	0.65		-0.662		-0.662	3.3	-2.15
5	31.1	1.45		-0.429		-0.429	7.3	-3.11
6	36.1	2.93		-0.12		-0.120	14.7	-1.76
7	41.1	4.78		1.395		1.395	23.9	33.34
8	46.1	5.15		2.167		2.167	25.8	55.80
9	51.1	5.37		2.551		2.551	26.9	68.49
10	56.1	5.844		2.99		2.990	29.2	87.37
11	61.1	5.771		3.344		3.344	28.9	96.49
12	66.1	5.801		3.373		3.373	29.0	97.83
13	71.1	6.149		3.466		3.466	30.7	106.56
14	76.1	6.427		3.601		3.601	32.1	115.72
15	81.1	7.732		3.757		3.757	38.7	145.25
16	86.1	6.514		3.905		3.905	32.6	127.19
17	91.1	7.004		3.871		3.871	35.0	135.56
18	96.1	8.409		3.791		3.791	42.0	159.39
19	101.1	8.28		3.812		3.812	41.4	157.82
20	106.1	8.051		3.707		3.707	40.3	149.23
21	111.1	7.765		3.58		3.580	38.8	138.99
22	116.1	7.822		3.589		3.589	156.4	561.46
23	151.1	5.158		1.699		1.699	103.2	175.27
24	156.1	3.886		1.302		1.302	19.4	25.30
25	161.1	1.98		0.741		0.741	9.9	7.34
26	166.1	1.14		0.154		0.154	5.0	0.76
27	169.8	0		0		0.000	0.0	0.00
28						0.000	0.0	0.00
						2.962	821.7	2434.00

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	81.10	86.10	3.76	3.91	3.81	0.78
40%	94.0	91.10	96.10	3.87	3.79	3.82	0.77
50%	105.0	101.10	106.10	3.81	3.71	3.73	0.79
60%	116.0	111.10	116.10	3.58	3.59	3.59	0.83
70%	127.0	116.10	151.10	3.69	1.70	3.00	0.99

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.001

Q = 2472.3
V_{AVR} = 3.01

Roughness coeff.	
Sub	n
0	
2	0.036
0	

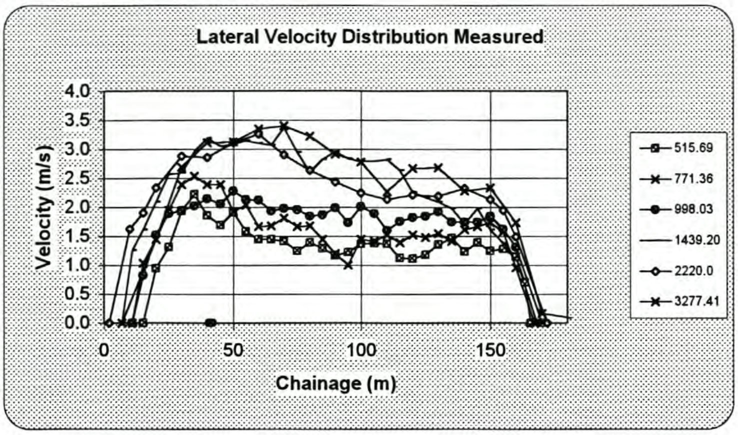
Area reduction factor	
Sub	f_A
0	1
2	1
0	1

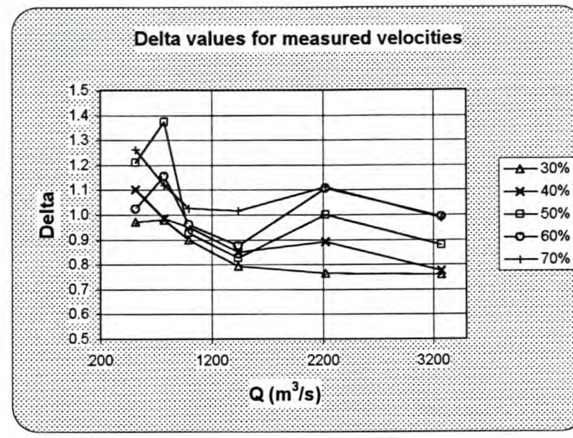
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
11.3	0	2	0.0	6.1	0	0.00	0.00
16.1	1.03	2	5.0	4.9	1.03	4.62	0.90
21.1	0.47	2	2.4	5.0	0.47	1.25	0.53
26.1	0.65	2	3.3	5.0	0.65	2.14	0.66
31.1	1.45	2	7.3	5.0	1.45	8.16	1.13
36.1	2.93	2	14.7	5.0	2.93	26.36	1.80
41.1	4.78	2	23.9	5.0	4.78	59.57	2.49
46.1	5.15	2	25.8	5.0	5.15	67.45	2.62
51.1	5.37	2	26.9	5.0	5.37	72.33	2.69
56.1	5.844	2	29.2	5.0	5.844	83.28	2.85
61.1	5.771	2	28.9	5.0	5.771	81.56	2.83
66.1	5.801	2	29.0	5.0	5.801	82.26	2.84
71.1	6.149	2	30.7	5.0	6.149	90.64	2.95
76.1	6.427	2	32.1	5.0	6.427	97.58	3.04
81.1	7.732	2	38.7	5.0	7.732	132.79	3.43
86.1	6.514	2	32.6	5.0	6.514	99.79	3.06
91.1	7.004	2	35.0	5.0	7.004	112.61	3.22
96.1	8.409	2	42.0	5.0	8.409	152.72	3.63
101.1	8.28	2	41.4	5.0	8.28	148.84	3.60
106.1	8.051	2	40.3	5.0	8.051	142.04	3.53
111.1	7.765	2	38.8	5.0	7.765	133.73	3.44
116.1	7.822	2	156.4	20.0	7.822	541.49	3.46
151.1	5.158	2	103.2	20.0	5.158	270.52	2.62
156.1	3.886	2	19.4	5.0	3.886	42.19	2.17
161.1	1.98	2	9.9	5.0	1.98	13.71	1.39
166.1	1.14	2	5.0	4.4	1.14	4.76	0.96
169.8	0	2	0.0	1.9	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			821.67			2472.26	3.01

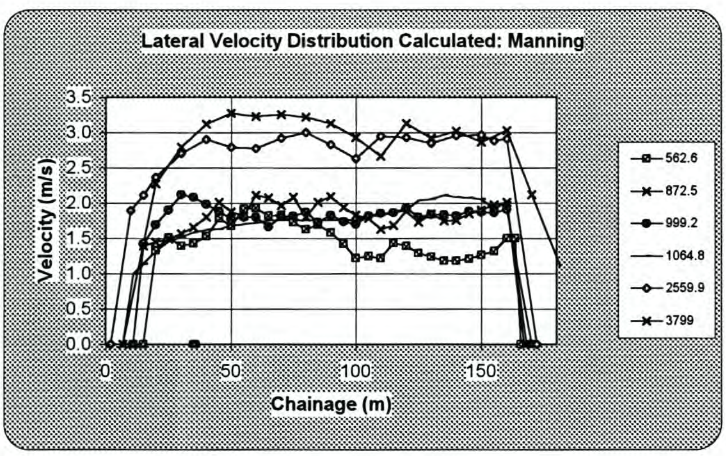
Delta value calculations

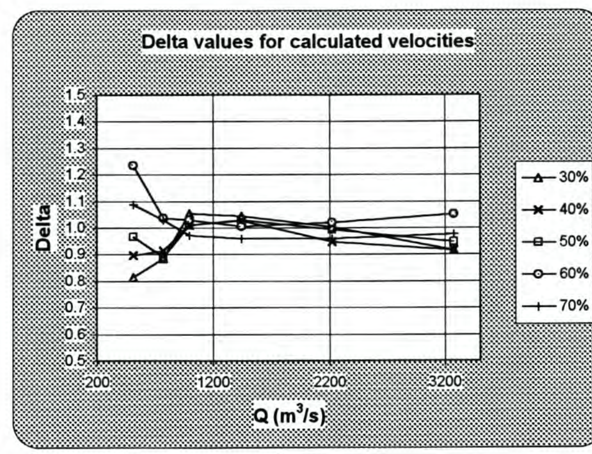
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	83.0	81.10	86.10	3.43	3.06	3.29	0.91
40%	94.0	91.10	96.10	3.22	3.63	3.46	0.87
50%	105.0	101.10	106.10	3.60	3.53	3.54	0.85
60%	116.0	111.10	116.10	3.44	3.46	3.46	0.87
70%	127.0	116.10	151.10	3.46	2.62	3.20	0.94

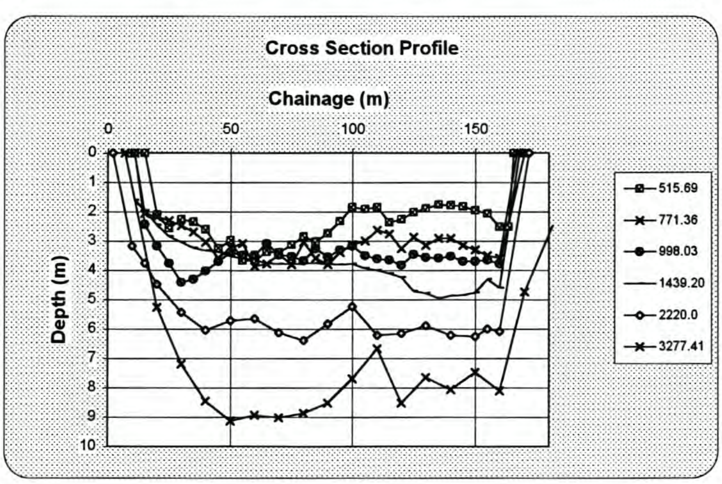
Statn No.: D1H009
River: Oranje
Place: Oranjedraai











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. :	D1H009	START TIME :	10h10
RIVER NAME :	Oranje	Average Gaugeplate reading :	1.96 m
PLACE NAME :	Oranjedraai		
DATE :	2/12/91		
		Main Channel LEFT :	20
		Main Channel RIGHT :	160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.405	367.2	515.69
1	15	0	0	0	0	0.000	0.0	0.00
2	20	2.11	0.84818	0.9485	1.04882	0.949	10.6	10.01
3	25	2.556	0.89416	1.43338	1.50444	1.316	12.8	16.82
4	30	2.261	1.81794	1.9726	1.97678	1.935	11.3	21.87
5	35	2.338	2.10636	2.23176	2.30282	2.218	11.7	25.93
6	40	2.608	1.41248	1.9099	2.18578	1.855	13.0	24.18
7	45	3.265	1.471	1.6382	1.98932	1.684	16.3	27.49
8	50	2.971	1.68	1.93498	2.07292	1.906	14.9	28.31
9	55	3.664	1.43756	1.57966	1.71344	1.578	18.3	28.90
10	60	3.684	1.1993	1.46682	1.66328	1.449	18.4	26.69
11	65	3.375	1.27454	1.41666	1.66328	1.443	16.9	24.35
12	70	3.4	1.22856	1.38322	1.6591	1.414	17.0	24.03
13	75	3.136	1.06136	1.18258	1.55878	1.246	15.7	19.54
14	80	2.846	1.25782	1.3874	1.52116	1.388	14.2	19.76
15	85	3.03	1.13242	1.2411	1.5337	1.287	15.2	19.50
16	90	2.746	0.98612	1.15332	1.35396	1.162	13.7	15.95
17	95	2.321	1.20348	1.1575	1.34978	1.217	11.6	14.12
18	100	1.852	1.25782	1.39994	1.41248	1.368	9.3	12.66
19	105	1.917	1.2829	1.39158	1.43756	1.376	9.6	13.19
20	110	1.842	1.33724	1.36232	1.38322	1.361	9.2	12.54
21	115	2.371	0.85236	1.22438	1.20348	1.126	11.9	13.35
22	120	2.261	0.71024	1.21602	1.2829	1.106	11.3	12.51
23	125	2.022	1.03628	1.12824	1.43756	1.183	10.1	11.96
24	130	1.882	1.25364	1.35814	1.4501	1.355	9.4	12.75
25	135	1.767	1.4292	1.41666	1.58386	1.462	8.8	12.91
26	140	1.772	1.10316	1.27454	1.29126	1.236	8.9	10.95
27	145	1.822	1.22438	1.41248	1.5128	1.391	9.1	12.67
28	150	1.954	1.14078	1.195	1.42502	1.239	9.8	12.11
29	155	2.074	1.1366	1.266	1.4501	1.280	10.4	13.27
30	160	2.526	0.94014	1.199	1.24946	1.147	10.7	12.31
31	163.5	2.525	0.56394	0.748	0.74786	0.702	7.2	5.05
32	165.7	0	0	0.000	0	0.000	0.0	0.00
						1.405	367.2	515.69

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.0**	60.00	65.00	1.45	1.44	1.45	**0.97**
40%	**76.0**	75.00	80.00	1.25	1.39	1.27	**1.10**
50%	**90.0**	90.00	95.00	1.16	1.22	1.16	**1.21**
60%	**104.0**	100.00	105.00	1.37	1.38	1.37	**1.02**
70%	**118.0**	115.00	120.00	1.13	1.11	1.11	**1.26**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	562.6
Slope	0.0008	V_{AVR} =	1.53

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
15	0	2	0.0	10.0	0	0.00	0.00
20	2.11	2	10.6	5.0	2.11	14.03	1.33
25	2.556	2	12.8	5.0	2.556	19.31	1.51
30	2.261	2	11.3	5.0	2.261	15.74	1.39
35	2.338	2	11.7	5.0	2.338	16.64	1.42
40	2.608	2	13.0	5.0	2.608	19.97	1.53
45	3.265	2	16.3	5.0	3.265	29.03	1.78
50	2.971	2	14.9	5.0	2.971	24.81	1.67
55	3.664	2	18.3	5.0	3.664	35.19	1.92
60	3.684	2	18.4	5.0	3.684	35.61	1.93
65	3.375	2	16.9	5.0	3.375	30.68	1.82
70	3.4	2	17.0	5.0	3.4	31.06	1.83
75	3.136	2	15.7	5.0	3.136	27.15	1.73
80	2.846	2	14.2	5.0	2.846	23.09	1.62
85	3.03	2	15.2	5.0	3.03	25.64	1.69
90	2.746	2	13.7	5.0	2.746	21.76	1.58
95	2.321	2	11.6	5.0	2.321	16.44	1.42
100	1.852	2	9.3	5.0	1.852	11.29	1.22
105	1.917	2	9.6	5.0	1.917	11.95	1.25
110	1.842	2	9.2	5.0	1.842	11.18	1.21
115	2.371	2	11.9	5.0	2.371	17.03	1.44
120	2.261	2	11.3	5.0	2.261	15.74	1.39
125	2.022	2	10.1	5.0	2.022	13.06	1.29
130	1.882	2	9.4	5.0	1.882	11.69	1.23
135	1.767	2	8.8	5.0	1.767	10.44	1.18
140	1.772	2	8.9	5.0	1.772	10.48	1.18
145	1.822	2	9.1	5.0	1.822	10.98	1.21
150	1.954	2	9.8	5.0	1.954	12.34	1.26
155	2.074	2	10.4	5.0	2.074	13.63	1.31
160	2.526	2	10.7	4.3	2.526	16.09	1.50
163.5	2.525	2	7.2	2.8	2.525	10.78	1.50
165.7	0	2	0.0	1.1	0	0.00	0.00
			367.17			562.64	1.53

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.0**	60.00	65.00	1.93	1.82	1.88	**0.81**
40%	**76.0**	75.00	80.00	1.73	1.62	1.71	**0.90**
50%	**90.0**	90.00	95.00	1.58	1.42	1.58	**0.97**
60%	**104.0**	100.00	105.00	1.22	1.25	1.24	**1.23**
70%	**118.0**	116.00	120.00	1.44	1.39	1.41	**1.09**

Measured data

STATION No. : D1H009
RIVER NAME : Oranje
PLACE NAME : Oranjedraai
DATE : 10/6/87

START TIME : 12h04
Average Gaugeplate reading : 2.257 m

Main Channel LEFT : 20
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.640	470.3	771.36
1	11	0		0		0.000	0.0	0.00
2	15	2.07		1.0335		1.034	9.3	9.63
3	20	2.18		1.45		1.450	10.9	15.81
4	25	2.294		1.943		1.943	11.5	22.29
5	30	2.474		2.3935		2.394	12.4	29.61
6	35	2.693		2.5295		2.530	13.5	34.06
7	40	3.041		2.385		2.385	15.2	36.26
8	45	3.585		2.3935		2.394	17.9	42.90
9	50	3.223		1.9175		1.918	16.1	30.90
10	55	3.083		2.0365		2.037	15.4	31.39
11	60	3.872		1.671		1.671	19.4	32.35
12	65	3.772		1.6795		1.680	18.9	31.68
13	70	3.465		1.8155		1.816	17.3	31.45
14	75	3.797		1.6625		1.663	19.0	31.56
15	80	3.053		1.6795		1.680	15.3	25.64
16	85	3.592		1.45		1.450	18.0	26.04
17	90	3.8		1.195		1.195	19.0	22.71
18	95	3.4		0.9995		1.000	17.0	16.99
19	100	3.12		1.4415		1.442	15.6	22.49
20	105	3		1.416		1.416	15.0	21.24
21	110	2.62		1.518		1.518	13.1	19.89
22	115	2.753		1.3905		1.391	13.8	19.14
23	120	3.263		1.518		1.518	16.3	24.77
24	125	2.86		1.4755		1.476	14.3	21.10
25	130	3.15		1.5435		1.544	15.8	24.31
26	135	2.916		1.4075		1.408	14.6	20.52
27	140	2.923		1.6115		1.612	14.6	23.55
28	145	3.153		1.671		1.671	15.8	26.34
29	150	3.295		1.731		1.731	16.5	28.51
30	155	3.503		1.578		1.578	17.5	27.63
31	160	3.59		0.957		0.957	21.5	20.61
32	167	0		0.000		0.000	0.0	0.00
						1.640	470.3	771.36

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	65.00	1.67	1.68	1.67	0.98
40%	76.0	75.00	80.00	1.66	1.68	1.67	0.98
50%	90.0	90.00	95.00	1.20	1.00	1.20	1.37
60%	104.0	100.00	105.00	1.44	1.42	1.42	1.15
70%	118.0	115.00	120.00	1.39	1.52	1.47	1.12

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0008

Q = 872.5
V_{AVR} = 1.86

Roughness coeff.	
Sub	n
0	
2	0.033
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
11	0	2	0.0	7.5	0	0.00	0.00
15	2.07	2	9.3	4.5	2.07	12.97	1.39
20	2.18	2	10.9	5.0	2.18	15.71	1.44
25	2.294	2	11.5	5.0	2.294	17.10	1.49
30	2.474	2	12.4	5.0	2.474	19.39	1.57
35	2.693	2	13.5	5.0	2.693	22.34	1.66
40	3.041	2	15.2	5.0	3.041	27.35	1.80
45	3.585	2	17.9	5.0	3.585	35.99	2.01
50	3.223	2	16.1	5.0	3.223	30.14	1.87
55	3.083	2	15.4	5.0	3.083	27.99	1.82
60	3.872	2	19.4	5.0	3.872	40.92	2.11
65	3.772	2	18.9	5.0	3.772	39.17	2.08
70	3.465	2	17.3	5.0	3.465	34.00	1.96
75	3.797	2	19.0	5.0	3.797	39.60	2.09
80	3.053	2	15.3	5.0	3.053	27.53	1.80
85	3.592	2	18.0	5.0	3.592	36.10	2.01
90	3.8	2	19.0	5.0	3.8	39.66	2.09
95	3.4	2	17.0	5.0	3.4	32.95	1.94
100	3.12	2	15.6	5.0	3.12	28.55	1.83
105	3	2	15.0	5.0	3	26.74	1.78
110	2.62	2	13.1	5.0	2.62	21.34	1.63
115	2.753	2	13.8	5.0	2.753	23.17	1.68
120	3.263	2	16.3	5.0	3.263	30.76	1.89
125	2.86	2	14.3	5.0	2.86	24.70	1.73
130	3.15	2	15.8	5.0	3.15	29.01	1.84
135	2.916	2	14.6	5.0	2.916	25.51	1.76
140	2.923	2	14.6	5.0	2.923	25.61	1.75
145	3.153	2	15.8	5.0	3.153	29.06	1.84
150	3.295	2	16.5	5.0	3.295	31.27	1.90
155	3.503	2	17.5	5.0	3.503	34.63	1.98
160	3.59	2	21.5	6.0	3.59	43.29	2.01
167	0	2	0.0	3.5	0	0.00	0.00
			470.26			872.52	1.86

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	65.00	2.11	2.08	2.10	0.88
40%	76.0	75.00	80.00	2.09	1.80	2.03	0.91
50%	90.0	90.00	95.00	2.09	1.94	2.09	0.89
60%	104.0	100.00	105.00	1.83	1.78	1.79	1.04
70%	118.0	115.00	120.00	1.68	1.89	1.80	1.03

Measured data

STATION No. : D1H009 | START TIME : 08h36
RIVER NAME : Oranje | Average Gaugeplate reading : 2.6 m
PLACE NAME : Oranjedraai
DATE : 10/10/87

Main Channel LEFT : 20
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.841	542.0	998.03
1	11	0		0		0.000	0.0	0.00
2	15	2.43		0.821		0.821	10.9	8.98
3	20	3.17		1.5265		1.527	15.9	24.20
4	25	3.768		1.8835		1.884	18.8	35.49
5	30	4.413		1.943		1.943	22.1	42.87
6	35	4.313		2.0195		2.020	21.6	43.55
7	40	4.017		2.147		2.147	20.1	43.12
8	45	3.702		2.0535		2.054	18.5	38.01
9	50	3.394		2.2745		2.275	17.0	38.60
10	55	3.478		2.13		2.130	17.4	37.04
11	60	3.478		2.1215		2.122	17.4	36.89
12	65	3.088		1.9345		1.935	15.4	29.87
13	70	3.481		1.977		1.977	17.4	34.41
14	75	3.516		1.96		1.960	17.6	34.46
15	80	3.669		1.841		1.841	18.3	33.77
16	85	3.25		1.8665		1.867	16.3	30.33
17	90	3.539		1.9855		1.986	17.7	35.13
18	95	3.297		1.7305		1.731	16.5	28.53
19	100	3.171		2.011		2.011	15.9	31.88
20	105	3.508		1.892		1.892	17.5	33.19
21	110	3.615		1.603		1.603	18.1	28.97
22	115	3.655		1.756		1.756	18.3	32.09
23	120	3.832		1.824		1.824	19.2	34.95
24	125	3.463		1.8495		1.850	17.3	32.02
25	130	3.57		1.9175		1.918	17.9	34.23
26	135	3.582		1.7475		1.748	17.9	31.30
27	140	3.523		1.7475		1.748	17.6	30.78
28	145	3.705		1.748		1.748	18.5	32.37
29	150	3.692		1.850		1.850	18.5	34.14
30	155	3.655		1.620		1.620	18.3	29.61
31	160	3.78		1.314		1.314	28.4	37.25
32	170	0		0.000		0.000	0.0	0.00
						1.841	542.0	998.03

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	62.0	60.00	65.00	2.12	1.93	2.05	0.90
40%	76.0	75.00	80.00	1.96	1.84	1.94	0.95
50%	90.0	90.00	95.00	1.99	1.73	1.99	0.93
60%	104.0	100.00	105.00	2.01	1.89	1.92	0.96
70%	118.0	115.00	120.00	1.76	1.82	1.80	1.02

Calculated data, 1-dimensional flow theory

Manning or Chezy: M | Slope 0.0008 | Q = 999.2 | V_{AVR} = 1.84

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
11	0	2	0.0	7.5	0	0.00	0.00
15	2.43	2	10.9	4.5	2.43	15.53	1.42
20	3.17	2	15.9	5.0	3.17	26.87	1.70
25	3.768	2	18.8	5.0	3.768	35.84	1.90
30	4.413	2	22.1	5.0	4.413	46.64	2.11
35	4.313	2	21.6	5.0	4.313	44.89	2.08
40	4.017	2	20.1	5.0	4.017	39.88	1.99
45	3.702	2	18.5	5.0	3.702	34.80	1.88
50	3.394	2	17.0	5.0	3.394	30.11	1.77
55	3.478	2	17.4	5.0	3.478	31.36	1.80
60	3.478	2	17.4	5.0	3.478	31.36	1.80
65	3.088	2	15.4	5.0	3.088	25.72	1.67
70	3.481	2	17.4	5.0	3.481	31.41	1.80
75	3.516	2	17.6	5.0	3.516	31.94	1.82
80	3.669	2	18.3	5.0	3.669	34.29	1.87
85	3.25	2	16.3	5.0	3.25	28.01	1.72
90	3.539	2	17.7	5.0	3.539	32.29	1.82
95	3.297	2	16.5	5.0	3.297	28.59	1.74
100	3.171	2	15.9	5.0	3.171	26.89	1.70
105	3.508	2	17.5	5.0	3.508	31.82	1.81
110	3.615	2	18.1	5.0	3.615	33.45	1.85
115	3.655	2	18.3	5.0	3.655	34.07	1.86
120	3.832	2	19.2	5.0	3.832	36.86	1.92
125	3.463	2	17.3	5.0	3.463	31.14	1.80
130	3.57	2	17.9	5.0	3.57	32.76	1.84
135	3.582	2	17.9	5.0	3.582	32.94	1.84
140	3.523	2	17.6	5.0	3.523	32.04	1.82
145	3.705	2	18.5	5.0	3.705	34.85	1.88
150	3.692	2	18.5	5.0	3.692	34.65	1.88
155	3.655	2	18.3	5.0	3.655	34.07	1.86
160	3.78	2	28.4	7.5	3.78	54.05	1.91
170	0	2	0.0	5.0	0	0.00	0.00
			542.01			999.22	1.84

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	62.0	60.00	65.00	1.80	1.67	1.75	1.05
40%	76.0	75.00	80.00	1.82	1.87	1.83	1.01
50%	90.0	90.00	95.00	1.82	1.74	1.82	1.01
60%	104.0	100.00	105.00	1.70	1.81	1.79	1.03
70%	118.0	115.00	120.00	1.86	1.92	1.90	0.97

Measured data

STATION No. : D1H009 — START TIME : 14h36

RIVER NAME : Oranje — Average Gaugeplate reading : 3.27 m

PLACE NAME : Oranjedraai

DATE : 10/3/87

Main Channel LEFT : 20

Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.444	588.9	1439.20
1	7	0		0		0.000	0.0	0.00
2	11	1.6		1.2545		1.255	6.4	8.03
3	15	1.954		1.6115		1.612	8.8	14.17
4	20	2.458		2.0875		2.088	12.3	25.66
5	25	2.853		2.5635		2.564	14.3	36.57
6	30	3.034		2.589		2.589	15.2	39.28
7	35	3.232		2.9545		2.955	16.2	47.74
8	40	3.322		3.184		3.184	16.6	52.89
9	45	3.371		3.048		3.048	16.9	51.37
10	50	3.519		3.0905		3.091	17.6	54.38
11	55	3.578		3.1415		3.142	17.9	56.20
12	60	3.656		3.099		3.099	18.3	56.65
13	65	3.763		3.065		3.065	18.8	57.67
14	70	3.773		3.3625		3.363	18.9	63.43
15	75	3.793		2.946		2.946	19.0	55.87
16	80	3.753		2.5975		2.598	18.8	48.74
17	85	3.771		2.827		2.827	18.9	53.30
18	90	3.776		2.9545		2.955	18.9	55.78
19	95	3.799		2.8355		2.836	19.0	53.86
20	100	3.776		2.7845		2.785	18.9	52.57
21	105	3.934		2.793		2.793	19.7	54.94
22	110	4.004		2.8185		2.819	20.0	56.43
23	115	4.113		2.6315		2.632	20.6	54.12
24	120	4.246		2.2575		2.258	21.2	47.93
25	125	4.716		2.164		2.164	23.6	51.03
26	130	4.784		2.0875		2.088	23.9	49.93
27	135	4.963		1.977		1.977	24.8	49.06
28	140	4.861		1.714		1.714	24.3	41.65
29	145	4.842		1.977		1.977	24.2	47.86
30	150	4.761		1.612		1.612	23.8	38.36
31	155	4.311		1.382		1.382	21.6	29.79
32	160	4.6		1.136		1.136	29.9	33.95
33	168	0		0.000		0.000	0.0	0.00
						2.444	588.9	1439.20

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	65.00	3.10	3.07	3.09	0.79
40%	76.0	75.00	80.00	2.95	2.60	2.88	0.85
50%	90.0	90.00	95.00	2.95	2.84	2.95	0.83
60%	104.0	100.00	105.00	2.78	2.79	2.79	0.88
70%	118.0	115.00	120.00	2.63	2.26	2.41	1.02

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.0008

Q = 1064.8

V_{AVR} = 1.81

Roughness coeff. Sub	n
0	
2	0.039
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
7	0	2	0.0	5.5	0	0.00	0.00
11	1.6	2	6.4	4.0	1.6	6.35	0.99
15	1.954	2	8.8	4.5	1.954	9.97	1.13
20	2.458	2	12.3	5.0	2.458	16.23	1.32
25	2.853	2	14.3	5.0	2.853	20.81	1.46
30	3.034	2	15.2	5.0	3.034	23.06	1.52
35	3.232	2	16.2	5.0	3.232	25.62	1.59
40	3.322	2	16.6	5.0	3.322	26.82	1.61
45	3.371	2	16.9	5.0	3.371	27.48	1.63
50	3.519	2	17.6	5.0	3.519	29.52	1.68
55	3.578	2	17.9	5.0	3.578	30.35	1.70
60	3.656	2	18.3	5.0	3.656	31.46	1.72
65	3.763	2	18.8	5.0	3.763	33.01	1.75
70	3.773	2	18.9	5.0	3.773	33.16	1.76
75	3.793	2	19.0	5.0	3.793	33.45	1.76
80	3.753	2	18.8	5.0	3.753	32.87	1.75
85	3.771	2	18.9	5.0	3.771	33.13	1.76
90	3.776	2	18.9	5.0	3.776	33.20	1.76
95	3.799	2	19.0	5.0	3.799	33.54	1.77
100	3.776	2	18.9	5.0	3.776	33.20	1.76
105	3.934	2	19.7	5.0	3.934	35.56	1.81
110	4.004	2	20.0	5.0	4.004	36.61	1.83
115	4.113	2	20.6	5.0	4.113	38.28	1.86
120	4.246	2	21.2	5.0	4.246	40.27	1.90
125	4.716	2	23.6	5.0	4.716	48.09	2.04
130	4.784	2	23.9	5.0	4.784	49.25	2.06
135	4.963	2	24.8	5.0	4.963	52.36	2.11
140	4.861	2	24.3	5.0	4.861	50.58	2.08
145	4.842	2	24.2	5.0	4.842	50.25	2.08
150	4.761	2	23.8	5.0	4.761	48.86	2.05
155	4.311	2	21.6	5.0	4.311	41.41	1.92
160	4.6	2	29.9	6.5	4.6	59.98	2.01
168	0	2	0.0	4.0	0	0.00	0.00
			588.90			1064.85	1.81

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	65.00	1.72	1.75	1.73	1.04
40%	76.0	75.00	80.00	1.76	1.75	1.76	1.03
50%	90.0	90.00	95.00	1.75	1.77	1.76	1.03
60%	104.0	100.00	105.00	1.76	1.81	1.80	1.01
70%	118.0	115.00	120.00	1.86	1.90	1.89	0.96

Measured data

STATION No. : D1H009
RIVER NAME : Oranje
PLACE NAME : Oranjedraai
DATE : 10/1/87

START TIME : 15h45
Average Gaugeplate reading : 4.545 m

Main Channel LEFT : 20
Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.438	910.6	2220.0
1	2	0		0		0.000	0.0	0.00
2	10	3.18		1.62		1.620	20.7	33.49
3	15	3.752		1.9005		1.901	18.8	35.65
4	20	4.469		2.334		2.334	33.5	78.23
5	30	5.436		2.878		2.878	54.4	156.45
6	40	6.045		2.8525		2.853	60.5	172.43
7	50	5.711		3.1075		3.108	57.1	177.47
8	60	5.661		3.2605		3.261	56.6	184.58
9	70	6.126		2.895		2.895	61.3	177.35
10	80	6.386		2.6315		2.632	63.9	168.05
11	90	5.835		2.436		2.436	58.4	142.14
12	100	5.232		2.249		2.249	52.3	117.67
13	110	6.213		2.13		2.130	62.1	132.34
14	120	6.143		2.2065		2.207	61.4	135.55
15	130	5.887		2.1895		2.190	58.9	128.90
16	140	6.219		2.317		2.317	62.2	144.09
17	150	6.267		2.13		2.130	47.0	100.12
18	155	6.008		1.943		1.943	30.0	58.37
19	160	6.079		1.4925		1.493	51.7	77.12
20	172	0		0		0.000	0.0	0.00
						2.438	910.6	2219.98

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	70.00	3.26	2.90	3.19	0.76
40%	76.0	70.00	80.00	2.90	2.63	2.74	0.89
50%	90.0	90.00	100.00	2.44	2.25	2.44	1.00
60%	104.0	100.00	110.00	2.25	2.13	2.20	1.11
70%	118.0	110.00	120.00	2.13	2.21	2.19	1.11

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0011

Q = 2559.9
V_{AVR} = 2.81

Roughness coeff	
Sub	n
0	
2	0.038
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2	0	2	0.0	5.0	0	0.00	0.00
10	3.18	2	20.7	6.5	3.18	39.01	1.89
15	3.752	2	18.8	5.0	3.752	39.54	2.11
20	4.469	2	33.5	7.5	4.469	79.37	2.37
30	5.436	2	54.4	10.0	5.436	146.68	2.70
40	6.045	2	60.5	10.0	6.045	175.08	2.90
50	5.711	2	57.1	10.0	5.711	159.28	2.79
60	5.661	2	56.6	10.0	5.661	156.94	2.77
70	6.126	2	61.3	10.0	6.126	179.01	2.92
80	6.386	2	63.9	10.0	6.386	191.85	3.00
90	5.835	2	58.4	10.0	5.835	165.06	2.83
100	5.232	2	52.3	10.0	5.232	137.62	2.63
110	6.213	2	62.1	10.0	6.213	183.27	2.95
120	6.143	2	61.4	10.0	6.143	179.64	2.93
130	5.887	2	58.9	10.0	5.887	167.52	2.85
140	6.219	2	62.2	10.0	6.219	183.56	2.95
150	6.267	2	47.0	7.5	6.267	139.45	2.97
155	6.008	2	30.0	5.0	6.008	86.65	2.88
160	6.079	2	51.7	8.5	6.079	150.22	2.91
172	0	2	0.0	6.0	0	0.00	0.00
			910.60			2559.92	2.81

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	62.0	60.00	70.00	2.77	2.92	2.80	1.00
40%	76.0	70.00	80.00	2.92	3.00	2.97	0.95
50%	90.0	90.00	100.00	2.83	2.63	2.83	0.99
60%	104.0	100.00	110.00	2.63	2.95	2.76	1.02
70%	118.0	110.00	120.00	2.96	2.93	2.93	0.96

Measured data

STATION No. : D1H009 START TIME : 10h43

RIVER NAME : Oranje Average Gaugeplate reading : 6.439 m

PLACE NAME : Oranjedraai

DATE : 2/17/89

Main Channel LEFT : 20

Main Channel RIGHT : 160

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.552	1284.2	3277.41
1	7	0	0	0	0	0.000	0.0	0.00
2	20	5.261	1.246	1.467	1.5775	1.439	60.5	87.08
3	30	7.185	2.487	2.742	2.7845	2.689	71.9	193.20
4	40	8.462	2.844	3.099	3.4135	3.114	84.6	263.50
5	50	9.126	2.9205	3.15	3.286	3.127	91.3	285.34
6	60	8.944	3.0735	3.3965	3.524	3.348	89.4	299.41
7	70	9.024	3.269	3.371	3.592	3.401	90.2	306.88
8	80	8.878	2.946	3.2435	3.473	3.227	88.8	286.45
9	90	8.512	2.538	2.9035	3.2775	2.906	85.1	247.33
10	100	7.696	2.6655	2.708	3.048	2.782	77.0	214.13
11	110	6.677	1.722	2.1725	2.9885	2.264	66.8	151.16
12	120	8.515	2.2575	2.708	3.0055	2.670	85.2	227.33
13	130	7.659	2.589	2.674	2.759	2.674	76.6	204.80
14	140	8.058	1.637	2.3935	2.674	2.275	80.6	183.28
15	150	7.472	2.1555	2.334	2.4955	2.330	74.7	174.08
16	160	8.108	1.637	1.7815	1.722	1.731	81.1	140.31
17	170	4.735	0.112	0.226	0.089	0.163	80.5	13.14
18	194	0	0	0	0	0.000	0.0	0.00
19						0.000	0.0	0.00
						2.552	1284.2	3277.41

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	**62.0**	60.00	70.00	3.35	3.40	3.36	**0.76**
40%	**76.0**	70.00	80.00	3.40	3.23	3.30	**0.77**
50%	**90.0**	90.00	100.00	2.91	2.78	2.91	**0.88**
60%	**104.0**	100.00	110.00	2.78	2.26	2.57	**0.99**
70%	**118.0**	110.00	120.00	2.26	2.67	2.59	**0.99**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.0009

Q = 3799

V_{AVR} = 2.96

Roughness coeff. Sub	n
0	
2	0.04
0	

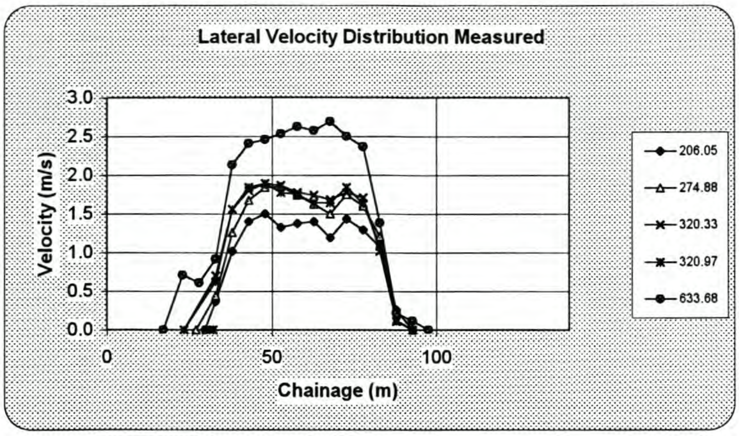
Area reduction factor Sub	f_A
0	1
2	1
0	1

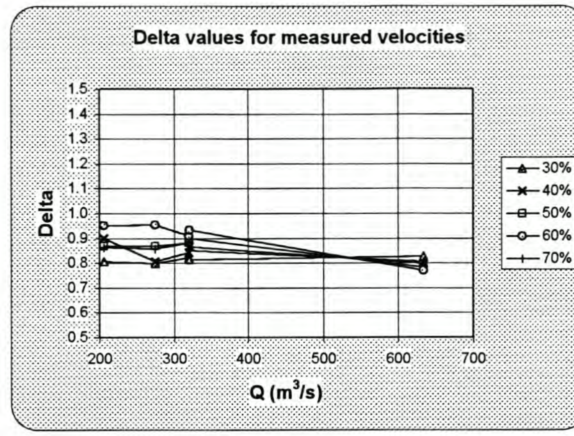
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
7	0	2	0.0	10.0	0	0.00	0.00
20	5.261	2	60.5	11.5	5.261	137.26	2.27
30	7.185	2	71.9	10.0	7.185	200.65	2.79
40	8.462	2	84.6	10.0	8.462	263.54	3.11
50	9.126	2	91.3	10.0	9.126	298.90	3.28
60	8.944	2	89.4	10.0	8.944	289.03	3.23
70	9.024	2	90.2	10.0	9.024	293.36	3.25
80	8.878	2	88.8	10.0	8.878	285.49	3.22
90	8.512	2	85.1	10.0	8.512	266.14	3.13
100	7.696	2	77.0	10.0	7.696	224.99	2.92
110	6.677	2	66.8	10.0	6.677	177.57	2.66
120	8.515	2	85.2	10.0	8.515	266.30	3.13
130	7.659	2	76.6	10.0	7.659	223.19	2.91
140	8.058	2	80.6	10.0	8.058	242.91	3.01
150	7.472	2	74.7	10.0	7.472	214.19	2.87
160	8.108	2	81.1	10.0	8.108	245.42	3.03
170	4.735	2	80.5	17.0	4.735	170.23	2.11
194	0	2	0.0	12.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			1284.16			3799.17	2.96

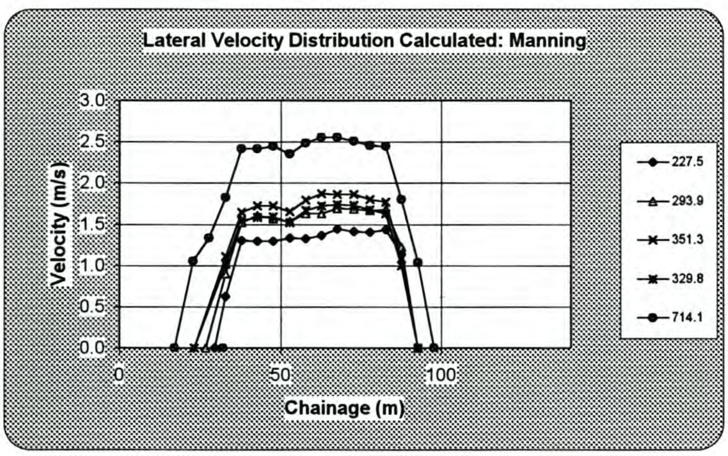
Delta value calculations

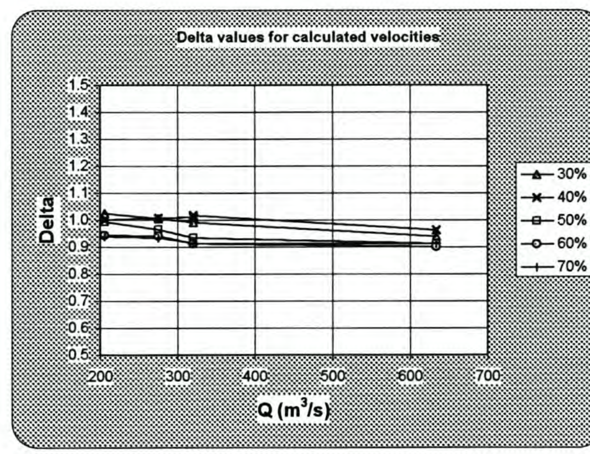
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	**62.0**	60.00	70.00	3.23	3.25	3.24	**0.91**
40%	**76.0**	70.00	80.00	3.25	3.22	3.23	**0.92**
50%	**90.0**	90.00	100.00	3.13	2.92	3.13	**0.95**
60%	**104.0**	100.00	110.00	2.92	2.66	2.82	**1.05**
70%	**118.0**	110.00	120.00	2.66	3.13	3.03	**0.98**

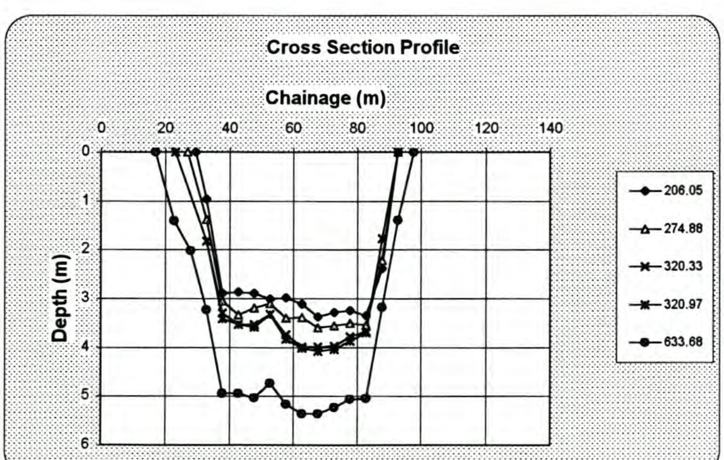
Statn No.: D2H033
River: Caledon
Place: Welbedachtdam











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : D2H033 | START TIME : 09h45

RIVER NAME : Caledon | Average Gaugeplate reading : 2.13 m

PLACE NAME : Welbedachtdam

DATE : 11/12/92

Main Channel LEFT : 30

Main Channel RIGHT : 90

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.204	171.1	206.05
1	29.5	0		0		0.000	0.0	0.00
2	32.8	0.97		0.366		0.366	4.0	1.47
3	37.8	2.896		1.015		1.015	14.5	14.70
4	42.8	2.873		1.399		1.399	14.4	20.10
5	47.8	2.892		1.501		1.501	14.5	21.70
6	52.8	3.012		1.328		1.328	15.1	20.00
7	57.8	2.982		1.378		1.378	14.9	20.55
8	62.8	3.112		1.403		1.403	15.6	21.83
9	67.8	3.381		1.188		1.188	16.9	20.08
10	72.8	3.292		1.433		1.433	16.5	23.59
11	77.8	3.242		1.294		1.294	16.2	20.98
12	82.8	3.355		1.07		1.070	16.8	17.95
13	87.8	2.386		0.26		0.260	11.9	3.10
14	92.8	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
						1.204	171.1	206.05

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	48.0	47.80	52.80	1.50	1.33	1.49	0.81
40%	54.0	52.80	57.80	1.33	1.38	1.34	0.90
50%	60.0	57.80	62.80	1.38	1.40	1.39	0.87
60%	66.0	62.80	67.80	1.40	1.19	1.27	0.95
70%	72.0	67.80	72.80	1.19	1.43	1.39	0.86

Calculated data, 1-dimensional flow theory

Manning or Chezy: M | Slope 0.0005

Q = 227.5

V_{AVR} = 1.33

Roughness coeff.	
Sub	n
0	
2	0.035
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
29.5	0	2	0.0	16.4	0	0.00	0.00
32.8	0.97	2	4.0	4.2	0.97	2.52	0.63
37.8	2.896	2	14.5	5.0	2.896	18.80	1.30
42.8	2.873	2	14.4	5.0	2.873	18.55	1.29
47.8	2.892	2	14.5	5.0	2.892	18.75	1.30
52.8	3.012	2	15.1	5.0	3.012	20.07	1.33
57.8	2.982	2	14.9	5.0	2.982	19.73	1.32
62.8	3.112	2	15.6	5.0	3.112	21.19	1.36
67.8	3.381	2	16.9	5.0	3.381	24.33	1.44
72.8	3.292	2	16.5	5.0	3.292	23.27	1.41
77.8	3.242	2	16.2	5.0	3.242	22.69	1.40
82.8	3.355	2	16.8	5.0	3.355	24.02	1.43
87.8	2.386	2	11.9	5.0	2.386	13.61	1.14
92.8	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			171.14		18.960	227.52	1.33

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	48.0	47.80	52.80	1.30	1.33	1.30	1.02
40%	54.0	52.80	57.80	1.33	1.32	1.33	1.00
50%	60.0	57.80	62.80	1.32	1.36	1.34	0.99
60%	66.0	62.80	67.80	1.36	1.44	1.41	0.94
70%	72.0	67.80	72.80	1.44	1.41	1.42	0.94

Measured data

STATION No. : D2H033 — START TIME : 21h40
RIVER NAME : Caledon — Average Gaugeplate reading : 2.39 m
PLACE NAME : Welbedachtdam
DATE : 11/10/92

Main Channel LEFT : 30
Main Channel RIGHT : 90

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.468	187.2	274.88
1	26.8	0		0		0.000	0.0	0.00
2	32.8	1.385		0.442		0.442	7.6	3.37
3	37.8	3.053		1.26		1.260	15.3	19.23
4	42.8	3.337		1.673		1.673	16.7	27.91
5	47.8	3.197		1.838		1.838	16.0	29.38
6	52.8	3.107		1.846		1.846	15.5	28.68
7	57.8	3.406		1.745		1.745	17.0	29.72
8	62.8	3.387		1.623		1.623	16.9	27.49
9	67.8	3.606		1.496		1.496	18.0	26.97
10	72.8	3.563		1.754		1.754	17.8	31.25
11	77.8	3.513		1.602		1.602	17.6	28.14
12	82.8	3.543		1.205		1.205	17.7	21.35
13	87.8	2.214		0.126		0.126	11.1	1.39
14	92.8	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
						1.468	187.2	274.88

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.84	1.85	1.84	**0.80**
40%	**54.0**	52.80	57.80	1.85	1.75	1.82	**0.81**
50%	**60.0**	57.80	62.80	1.75	1.62	1.69	**0.87**
60%	**66.0**	62.80	67.80	1.62	1.50	1.54	**0.95**
70%	**72.0**	67.80	72.80	1.50	1.75	1.71	**0.86**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.0006

Q = 293.9
V_{AVR} = 1.57

Roughness coeff. Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
26.8	0	2	0.0	16.4	0	0.00	0.00
32.8	1.385	2	7.6	5.5	1.385	6.82	0.90
37.8	3.053	2	15.3	5.0	3.053	23.14	1.52
42.8	3.337	2	16.7	5.0	3.337	26.84	1.61
47.8	3.197	2	16.0	5.0	3.197	24.99	1.56
52.8	3.107	2	15.5	5.0	3.107	23.83	1.53
57.8	3.406	2	17.0	5.0	3.406	27.77	1.63
62.8	3.387	2	16.9	5.0	3.387	27.52	1.62
67.8	3.606	2	18.0	5.0	3.606	30.55	1.69
72.8	3.563	2	17.8	5.0	3.563	29.94	1.68
77.8	3.513	2	17.6	5.0	3.513	29.24	1.66
82.8	3.543	2	17.7	5.0	3.543	29.66	1.67
87.8	2.214	2	11.1	5.0	2.214	13.55	1.22
92.8	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			187.25		24.488	293.86	1.57

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.56	1.53	1.56	**1.00**
40%	**54.0**	52.80	57.80	1.53	1.63	1.56	**1.01**
50%	**60.0**	57.80	62.80	1.63	1.62	1.63	**0.96**
60%	**66.0**	62.80	67.80	1.62	1.69	1.67	**0.94**
70%	**72.0**	67.80	72.80	1.69	1.68	1.68	**0.93**

Measured data

STATION No. : D2H033 START TIME : 14h54

RIVER NAME : Caledon Average Gaugeplate reading : 2.73 m

PLACE NAME : Welbedachtdam

DATE : 11/12/92

Main Channel LEFT : 30

Main Channel RIGHT : 90

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.552	206.3	320.33
1	23.2	0		0		0.000	0.0	0.00
2	32.8	1.82		0.699		0.699	13.3	9.29
3	37.8	3.295		1.555		1.555	16.5	25.62
4	42.8	3.534		1.804		1.804	17.7	31.88
5	47.8	3.534		1.893		1.893	17.7	33.45
6	52.8	3.325		1.868		1.868	16.6	31.06
7	57.8	3.743		1.779		1.779	18.7	33.29
8	62.8	3.992		1.745		1.745	20.0	34.83
9	67.8	3.986		1.685		1.685	19.9	33.58
10	72.8	3.978		1.779		1.779	19.9	35.38
11	77.8	3.779		1.707		1.707	18.9	32.25
12	82.8	3.674		1.02		1.020	18.4	18.74
13	87.8	1.77		0.109		0.109	8.9	0.96
14	92.8	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
						1.552	206.3	320.33

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.89	1.87	1.89	**0.82**
40%	**54.0**	52.80	57.80	1.87	1.78	1.85	**0.84**
50%	**60.0**	57.80	62.80	1.78	1.75	1.76	**0.88**
60%	**66.0**	62.80	67.80	1.75	1.69	1.71	**0.91**
70%	**72.0**	67.80	72.80	1.69	1.78	1.76	**0.88**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.0006

Q = 351.3

V_{AVR} = 1.70

Roughness coeff. Sub	n
0	
2	0.033
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
23.2	0	2	0.0	16.4	0	0.00	0.00
32.8	1.82	2	13.3	7.3	1.82	14.70	1.11
37.8	3.295	2	16.5	5.0	3.295	27.08	1.64
42.8	3.534	2	17.7	5.0	3.534	30.43	1.72
47.8	3.534	2	17.7	5.0	3.534	30.43	1.72
52.8	3.325	2	16.6	5.0	3.325	27.49	1.65
57.8	3.743	2	18.7	5.0	3.743	33.49	1.79
62.8	3.992	2	20.0	5.0	3.992	37.28	1.87
67.8	3.986	2	19.9	5.0	3.986	37.19	1.87
72.8	3.978	2	19.9	5.0	3.978	37.07	1.86
77.8	3.779	2	18.9	5.0	3.779	34.03	1.80
82.8	3.674	2	18.4	5.0	3.674	32.47	1.77
87.8	1.77	2	8.9	5.0	1.77	9.61	1.09
92.8	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			206.34		29.272	351.26	1.70

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.72	1.65	1.72	**0.99**
40%	**54.0**	52.80	57.80	1.65	1.79	1.69	**1.01**
50%	**60.0**	57.80	62.80	1.79	1.87	1.82	**0.93**
60%	**66.0**	62.80	67.80	1.87	1.87	1.87	**0.91**
70%	**72.0**	67.80	72.80	1.87	1.86	1.86	**0.91**

Measured data

STATION No. : D2H033
RIVER NAME : Caledon
PLACE NAME : Welbedachtdam
DATE : 11/12/92

START TIME : 16h16
Average Gaugeplate reading : 2.73 m

Main Channel LEFT : 30
Main Channel RIGHT : 90

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.534	209.2	320.97
1	23.2	0		0		0.000	0.0	0.00
2	32.8	1.82		0.627		0.627	13.3	8.33
3	37.8	3.415		1.555		1.555	17.1	26.55
4	42.8	3.534		1.842		1.842	17.7	32.55
5	47.8	3.584		1.889		1.889	17.9	33.85
6	52.8	3.325		1.779		1.779	16.6	29.58
7	57.8	3.833		1.754		1.754	19.2	33.62
8	62.8	4.022		1.644		1.644	20.1	33.06
9	67.8	4.078		1.644		1.644	20.4	33.52
10	72.8	4.048		1.838		1.838	20.2	37.20
11	77.8	3.868		1.635		1.635	19.3	31.62
12	82.8	3.704		1.083		1.083	18.5	20.06
13	87.8	1.77		0.117		0.117	8.9	1.04
14	92.8	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
						1.534	209.2	320.97

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.89	1.78	1.88	**0.81**
40%	**54.0**	52.80	57.80	1.78	1.75	1.77	**0.87**
50%	**60.0**	57.80	62.80	1.75	1.64	1.71	**0.90**
60%	**66.0**	62.80	67.80	1.64	1.64	1.64	**0.93**
70%	**72.0**	67.80	72.80	1.64	1.84	1.81	**0.85**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0006

Q = 329.8
V_{AVR} = 1.58

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
23.2	0	2	0.0	16.4	0	0.00	0.00
32.8	1.82	2	13.3	7.3	1.82	13.48	1.01
37.8	3.415	2	17.1	5.0	3.415	26.35	1.54
42.8	3.534	2	17.7	5.0	3.534	27.89	1.58
47.8	3.584	2	17.9	5.0	3.584	28.56	1.59
52.8	3.325	2	16.6	5.0	3.325	25.20	1.52
57.8	3.833	2	19.2	5.0	3.833	31.94	1.67
62.8	4.022	2	20.1	5.0	4.022	34.61	1.72
67.8	4.078	2	20.4	5.0	4.078	35.41	1.74
72.8	4.048	2	20.2	5.0	4.048	34.98	1.73
77.8	3.868	2	19.3	5.0	3.868	32.43	1.68
82.8	3.704	2	18.5	5.0	3.704	30.17	1.63
87.8	1.77	2	8.9	5.0	1.77	8.81	1.00
92.8	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			209.19		27.484	**329.81**	**1.58**

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	1.59	1.52	1.59	**0.99**
40%	**54.0**	52.80	57.80	1.52	1.67	1.55	**1.02**
50%	**60.0**	57.80	62.80	1.67	1.72	1.69	**0.93**
60%	**66.0**	62.80	67.80	1.72	1.74	1.73	**0.91**
70%	**72.0**	67.80	72.80	1.74	1.73	1.73	**0.91**

Measured data

STATION No. : C8H030 | START TIME : 17h40
RIVER NAME : Wilge | Average Gaugeplate reading : 4.145 m
PLACE NAME : Kimberley
DATE : 19/02/1989

Main Channel LEFT : 30
Main Channel RIGHT : 90

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.037	311.1	633.68
1	17	0		0		0.000	0.0	0.00
2	22.8	1.411		0.707		0.707	7.6	5.39
3	27.8	2.02		0.61		0.610	10.1	6.16
4	32.8	3.239		0.914		0.914	16.2	14.80
5	37.8	4.939		2.133		2.133	24.7	52.67
6	42.8	4.937		2.412		2.412	24.7	59.54
7	47.8	5.035		2.458		2.458	25.2	61.88
8	52.8	4.739		2.534		2.534	23.7	60.04
9	57.8	5.163		2.623		2.623	25.8	67.71
10	62.8	5.36		2.572		2.572	26.8	68.93
11	67.8	5.36		2.694		2.694	26.8	72.20
12	72.8	5.232		2.496		2.496	26.2	65.30
13	77.8	5.057		2.365		2.365	25.3	59.80
14	82.8	5.043		1.387		1.387	25.2	34.97
15	87.8	3.179		0.218		0.218	15.9	3.47
						2.037	311.1	633.68

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	2.46	2.53	2.46	**0.83**
40%	**54.0**	52.80	57.80	2.53	2.62	2.56	**0.80**
50%	**60.0**	57.80	62.80	2.62	2.57	2.60	**0.78**
60%	**66.0**	62.80	67.80	2.57	2.69	2.65	**0.77**
70%	**72.0**	67.80	72.80	2.69	2.50	2.53	**0.81**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M | Slope 0.0009

Q = 714.1
V_{AVR} = 2.30

Roughness coeff. Sub	n
0	
2	0.036
0	

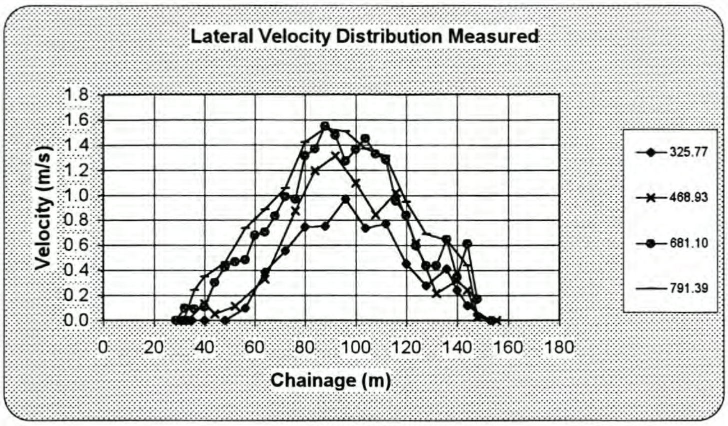
Area reduction factor Sub	f_A
0	1
2	1
0	1

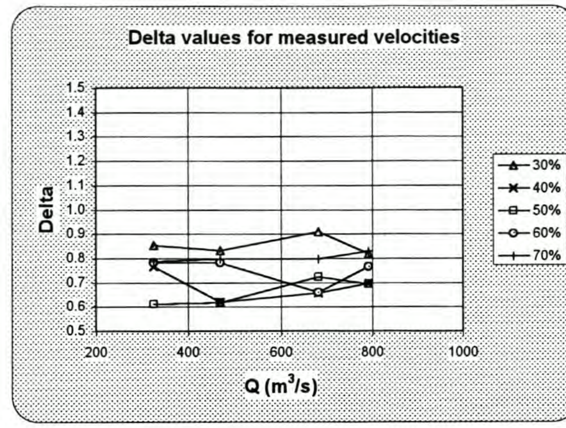
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
17	0	2	0.0	11.4	0	0.00	0.00
22.8	1.411	2	7.6	5.4	1.411	7.99	1.05
27.8	2.02	2	10.1	5.0	2.02	13.45	1.33
32.8	3.239	2	16.2	5.0	3.239	29.54	1.82
37.8	4.939	2	24.7	5.0	4.939	59.68	2.42
42.8	4.937	2	24.7	5.0	4.937	59.64	2.42
47.8	5.035	2	25.2	5.0	5.035	61.63	2.45
52.8	4.739	2	23.7	5.0	4.739	55.71	2.35
57.8	5.163	2	25.8	5.0	5.163	64.26	2.49
62.8	5.36	2	26.8	5.0	5.36	68.40	2.55
67.8	5.36	2	26.8	5.0	5.36	68.40	2.55
72.8	5.232	2	26.2	5.0	5.232	65.70	2.51
77.8	5.057	2	25.3	5.0	5.057	62.08	2.46
82.8	5.043	2	25.2	5.0	5.043	61.79	2.45
87.8	3.179	2	15.9	5.0	3.179	28.64	1.80
			311.09		47.610	714.14	2.30

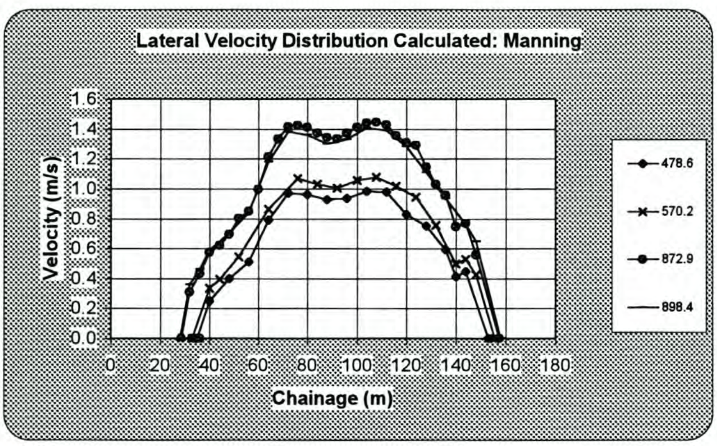
Delta value calculations

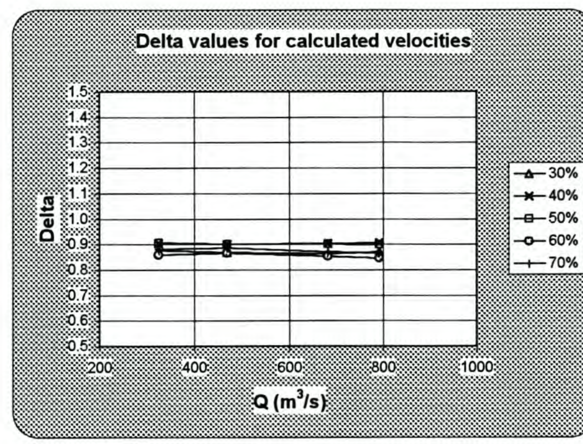
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**48.0**	47.80	52.80	2.45	2.35	2.44	**0.94**
40%	**54.0**	52.80	57.80	2.35	2.49	2.38	**0.96**
50%	**60.0**	57.80	62.80	2.49	2.55	2.52	**0.91**
60%	**66.0**	62.80	67.80	2.55	2.55	2.55	**0.90**
70%	**72.0**	67.80	72.80	2.55	2.51	2.52	**0.91**

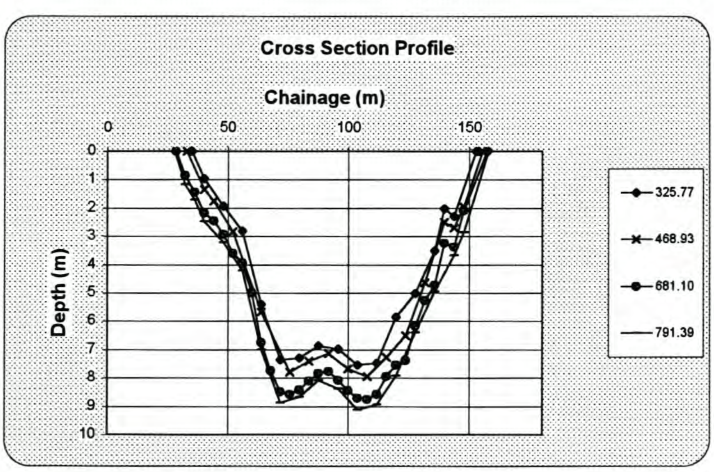
Statn No.: D3H012
River: Oranje
Place: Doornkuiken











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : D3H012 START TIME : 9h55
RIVER NAME : Oranje Average Gaugeplate reading : 2.829 m
PLACE NAME : Doornkuiken
DATE : 10/29/87
Main Channel LEFT : 50
Main Channel RIGHT : 140

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.574	567.1	325.77
1	35	0		0		0.000	0.0	0.00
2	40	0.97		0		0.000	6.3	0.00
3	48	1.94		0		0.000	15.5	0.00
4	56	2.82		0.096		0.096	22.6	2.17
5	64	5.41		0.387		0.387	43.3	16.75
6	72	7.37		0.557		0.557	59.0	32.84
7	80	7.29		0.744		0.744	58.3	43.39
8	88	6.88		0.753		0.753	55.0	41.45
9	96	6.98		0.965		0.965	55.8	53.89
10	104	7.55		0.735		0.735	60.4	44.39
11	112	7.47		0.77		0.770	59.8	46.02
12	120	5.85		0.455		0.455	46.8	21.29
13	128	5.03		0.277		0.277	40.2	11.15
14	136	3.51		0.413		0.413	21.1	8.70
15	140	2.03		0.243		0.243	8.1	1.97
16	144	2.29		0.119		0.119	14.9	1.77
17	153	0		0		0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						0.574	567.1	325.77

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	77.0	72.00	80.00	0.56	0.74	0.67	0.85
40%	86.0	80.00	88.00	0.74	0.75	0.75	0.77
50%	95.0	88.00	96.00	0.75	0.97	0.94	0.61
60%	104.0	104.00	112.00	0.74	0.77	0.74	0.78
70%	113.0	112.00	120.00	0.77	0.46	0.73	0.79

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00008
Q = 478.6
V_{AVR} = 0.84

Roughness coeff. Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
35	0	2	0.0	20.0	0	0.00	0.00
40	0.97	2	6.3	6.5	0.97	1.58	0.25
48	1.94	2	15.5	8.0	1.94	6.17	0.40
56	2.82	2	22.6	8.0	2.82	11.51	0.51
64	5.41	2	43.3	8.0	5.41	34.08	0.79
72	7.37	2	59.0	8.0	7.37	57.06	0.97
80	7.29	2	58.3	8.0	7.29	56.03	0.96
88	6.88	2	55.0	8.0	6.88	50.88	0.92
96	6.98	2	55.8	8.0	6.98	52.12	0.93
104	7.55	2	60.4	8.0	7.55	59.40	0.98
112	7.47	2	59.8	8.0	7.47	58.36	0.98
120	5.85	2	46.8	8.0	5.85	38.83	0.83
128	5.03	2	40.2	8.0	5.03	30.19	0.75
136	3.51	2	21.1	6.0	3.51	12.43	0.59
140	2.03	2	8.1	4.0	2.03	3.33	0.41
144	2.29	2	14.9	6.5	2.29	6.61	0.44
153	0	2	0.0	4.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			567.09			478.58	0.84

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	77.0	72.00	80.00	0.97	0.96	0.96	0.88
40%	86.0	80.00	88.00	0.96	0.92	0.93	0.90
50%	95.0	88.00	96.00	0.92	0.93	0.93	0.91
60%	104.0	104.00	112.00	0.98	0.98	0.98	0.86
70%	113.0	112.00	120.00	0.98	0.83	0.96	0.88

Measured data

STATION No. : D3H012 | START TIME : 16h48
RIVER NAME : Oranje | Average Gaugeplate reading : 3.209 m
PLACE NAME : Doornkuiken
DATE : 10/28/87

Main Channel LEFT : 50
Main Channel RIGHT : 140

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.758	618.3	468.93
1	33	0		0		0.000	0.0	0.00
2	40	1.36		0.135		0.135	7.5	1.01
3	44	1.75		0.05		0.050	10.5	0.53
4	52	2.84		0.112		0.112	28.4	3.18
5	64	5.68		0.328		0.328	68.2	22.36
6	76	7.8		0.872		0.872	78.0	68.02
7	84	7.4		1.195		1.195	59.2	70.74
8	92	7.14		1.314		1.314	57.1	75.06
9	100	7.69		1.093		1.093	61.5	67.24
10	108	7.94		0.846		0.846	63.5	53.74
11	116	7.28		1.016		1.016	58.2	59.17
12	124	6.51		0.617		0.617	52.1	32.13
13	132	4.64		0.217		0.217	37.1	8.06
14	140	2.49		0.319		0.319	14.9	4.77
15	144	2.71		0.243		0.243	10.8	2.63
16	148	1.95		0.027		0.027	11.2	0.30
17	155.5	0		0		0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						0.758	618.3	468.93

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**77.0**	76.00	84.00	0.87	1.20	0.91	**0.83**
40%	**86.0**	84.00	92.00	1.20	1.31	1.22	**0.62**
50%	**95.0**	92.00	100.00	1.31	1.09	1.23	**0.62**
60%	**104.0**	100.00	108.00	1.09	0.85	0.97	**0.78**
70%	**113.0**	108.00	116.00	0.85	1.02	0.95	**0.80**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00008

Q = 570.2
V_{AVR} = 0.92

Roughness coeff Sub	n
0	
2	0.033
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
33	0	2	0.0	20.0	0	0.00	0.00
40	1.36	2	7.5	5.5	1.36	2.49	0.33
44	1.75	2	10.5	6.0	1.75	4.13	0.39
52	2.84	2	28.4	10.0	2.84	15.44	0.54
64	5.68	2	68.2	12.0	5.68	58.81	0.86
76	7.8	2	78.0	10.0	7.8	83.15	1.07
84	7.4	2	59.2	8.0	7.4	60.93	1.03
92	7.14	2	57.1	8.0	7.14	57.41	1.00
100	7.69	2	61.5	8.0	7.69	64.96	1.06
108	7.94	2	63.5	8.0	7.94	68.52	1.08
116	7.28	2	58.2	8.0	7.28	59.29	1.02
124	6.51	2	52.1	8.0	6.51	49.21	0.94
132	4.64	2	37.1	8.0	4.64	27.99	0.75
140	2.49	2	14.9	6.0	2.49	7.44	0.50
144	2.71	2	10.8	4.0	2.71	5.71	0.53
148	1.95	2	11.2	5.8	1.95	4.74	0.42
155.5	0	2	0.0	3.8	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			618.33			570.23	0.92

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**77.0**	76.00	84.00	1.07	1.03	1.06	**0.87**
40%	**86.0**	84.00	92.00	1.03	1.00	1.02	**0.90**
50%	**95.0**	92.00	100.00	1.00	1.06	1.02	**0.90**
60%	**104.0**	100.00	108.00	1.06	1.08	1.07	**0.86**
70%	**113.0**	108.00	116.00	1.08	1.02	1.04	**0.89**

Measured data

STATION No. : D3H012 START TIME : 11h35
RIVER NAME : Oranje Average Gaugeplate reading : 3.875 m
PLACE NAME : Doornkuiken
DATE : 10/22/87

Main Channel LEFT : 50
Main Channel RIGHT : 140

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.957	711.6	681.10
1	28.5	0		0		0.000	0.0	0.00
2	32	0.86		0.1		0.100	3.2	0.32
3	36	1.435		0.092		0.092	5.7	0.53
4	40	2.19		0.108		0.108	8.8	0.95
5	44	2.465		0.306		0.306	9.9	3.02
6	48	2.93		0.428		0.428	11.7	5.02
7	52	3.61		0.467		0.467	14.4	6.74
8	56	3.95		0.484		0.484	15.8	7.65
9	60	5.01		0.679		0.679	20.0	13.61
10	64	6.75		0.706		0.706	27.0	19.06
11	68	7.75		0.831		0.831	31.0	25.76
12	72	8.49		0.988		0.988	34.0	33.55
13	76	8.575		0.966		0.966	34.3	33.13
14	80	8.43		1.313		1.313	33.7	44.27
15	84	8.1		1.37		1.370	32.4	44.39
16	88	7.83		1.548		1.548	31.3	48.48
17	92	7.77		1.478		1.478	31.1	45.94
18	96	8.09		1.27		1.270	32.4	41.10
19	100	8.45		1.361		1.361	33.8	46.00
20	104	8.71		1.452		1.452	34.8	50.59
21	108	8.76		1.326		1.326	35.0	46.46
22	112	8.585		1.283		1.283	34.3	44.06
23	116	7.955		0.949		0.949	31.8	30.20
24	120	7.54		0.836		0.836	30.2	25.21
25	124	7.39		0.597		0.597	29.6	17.65
26	128	6.17		0.435117		0.435	24.7	10.74
27	132	5.26		0.439458		0.439	21.0	9.25
28	136	4.725		0.648		0.648	18.9	12.24
29	140	3.25		0.344		0.344	13.0	4.47
30	144	3.385		0.613		0.613	13.5	8.30
31	148	2.1		0.170		0.170	14.2	2.41
32	157.5	0		0.000		0.000	0.0	0.00
						0.957	711.6	681.10

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	77.0	76.00	80.00	0.97	1.31	1.05	0.91
40%	86.0	84.00	88.00	1.37	1.55	1.46	0.66
50%	95.0	92.00	96.00	1.48	1.27	1.32	0.72
60%	104.0	104.00	108.00	1.45	1.33	1.45	0.66
70%	113.0	112.00	116.00	1.28	0.95	1.20	0.80

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00015
Q = 872.9
V_{AVR} = 1.23

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
28.5	0	2	0.0	16.0	0	0.00	0.00
32	0.86	2	3.2	3.8	0.86	0.99	0.31
36	1.435	2	5.7	4.0	1.435	2.48	0.43
40	2.19	2	8.8	4.0	2.19	5.03	0.57
44	2.465	2	9.9	4.0	2.465	6.12	0.62
48	2.93	2	11.7	4.0	2.93	8.16	0.70
52	3.61	2	14.4	4.0	3.61	11.56	0.80
56	3.95	2	15.8	4.0	3.95	13.43	0.85
60	5.01	2	20.0	4.0	5.01	19.96	1.00
64	6.75	2	27.0	4.0	6.75	32.81	1.22
68	7.75	2	31.0	4.0	7.75	41.30	1.33
72	8.49	2	34.0	4.0	8.49	48.06	1.42
76	8.575	2	34.3	4.0	8.575	48.89	1.43
80	8.43	2	33.7	4.0	8.43	47.52	1.41
84	8.1	2	32.4	4.0	8.1	44.46	1.37
88	7.83	2	31.3	4.0	7.83	42.02	1.34
92	7.77	2	31.1	4.0	7.77	41.48	1.33
96	8.09	2	32.4	4.0	8.09	44.37	1.37
100	8.45	2	33.8	4.0	8.45	47.71	1.41
104	8.71	2	34.8	4.0	8.71	50.18	1.44
108	8.76	2	35.0	4.0	8.76	50.66	1.45
112	8.585	2	34.3	4.0	8.585	48.98	1.43
116	7.955	2	31.8	4.0	7.955	43.14	1.36
120	7.54	2	30.2	4.0	7.54	39.45	1.31
124	7.39	2	29.6	4.0	7.39	38.15	1.29
128	6.17	2	24.7	4.0	6.17	28.26	1.14
132	5.26	2	21.0	4.0	5.26	21.65	1.03
136	4.725	2	18.9	4.0	4.725	18.11	0.96
140	3.25	2	13.0	4.0	3.25	9.70	0.75
144	3.385	2	13.5	4.0	3.385	10.38	0.77
148	2.1	2	14.2	6.8	2.1	7.91	0.56
157.5	0	2	0.0	4.8	0	0.00	0.00
			711.62			872.92	1.23

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	77.0	76.00	80.00	1.43	1.41	1.42	0.86
40%	86.0	84.00	88.00	1.37	1.34	1.36	0.90
50%	95.0	92.00	96.00	1.33	1.37	1.36	0.90
60%	104.0	104.00	108.00	1.44	1.45	1.44	0.85
70%	113.0	112.00	116.00	1.43	1.36	1.41	0.87

Measured data

STATION No. : D3H012 | START TIME : 11h05
RIVER NAME : Oranje | Average Gaugeplate reading : 4.185 m
PLACE NAME : Doornkuiken
DATE : 10/21/87
Main Channel LEFT : 50
Main Channel RIGHT : 140

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.049	754.6	791.39
1	28	0		0		0.000	0.0	0.00
2	32	1.18		0.026		0.026	4.7	0.12
3	36	1.72		0.241		0.241	6.9	1.66
4	40	2.47		0.349		0.349	14.8	5.17
5	48	3.23		0.462		0.462	25.8	11.94
6	56	4.22		0.736		0.736	33.8	24.85
7	64	7		0.884		0.884	56.0	49.50
8	72	8.87		1.053		1.053	71.0	74.72
9	80	8.67		1.422		1.422	69.4	98.63
10	88	8.08		1.535		1.535	64.6	99.22
11	96	8.38		1.509		1.509	67.0	101.16
12	104	9.12		1.37		1.370	73.0	99.96
13	112	8.94		1.309		1.309	71.5	93.62
14	120	7.92		0.944		0.944	63.4	59.81
15	128	6.4		0.688		0.688	51.2	35.23
16	136	4.95		0.645		0.645	39.6	25.54
17	144	3.66		0.436		0.436	22.0	9.57
18	148	2.85		0.034		0.034	20.0	0.68
19	158	0		0		0.000	0.0	0.00
						1.049	754.6	791.39

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**77.0**	72.00	80.00	1.05	1.42	1.28	**0.82**
40%	**86.0**	80.00	88.00	1.42	1.54	1.51	**0.70**
50%	**95.0**	88.00	96.00	1.54	1.51	1.51	**0.69**
60%	**104.0**	104.00	112.00	1.37	1.31	1.37	**0.77**
70%	**113.0**	112.00	120.00	1.31	0.94	1.26	**0.83**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00015
Q = 898.4
V_{AVR} = 1.19

Roughness coeff.	
Sub	n
0	
2	0.038
0	

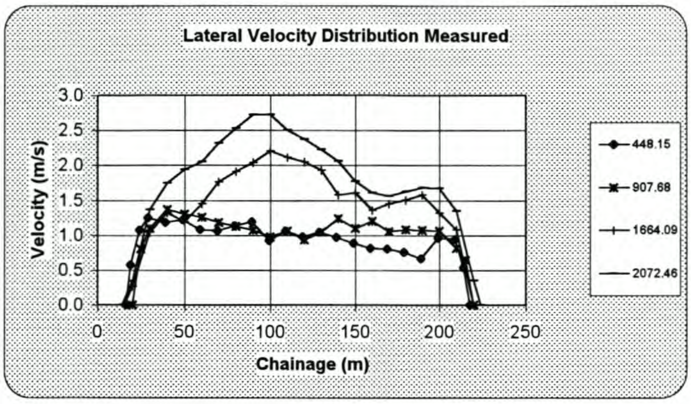
Area reduction factor	
Sub	f_A
0	1
2	1
0	1

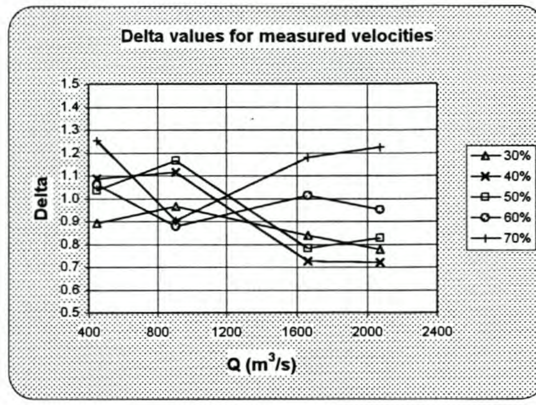
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
28	0	2	0.0	16.0	0	0.00	0.00
32	1.18	2	4.7	4.0	1.18	1.70	0.36
36	1.72	2	6.9	4.0	1.72	3.18	0.46
40	2.47	2	14.8	6.0	2.47	8.73	0.59
48	3.23	2	25.8	8.0	3.23	18.20	0.70
56	4.22	2	33.8	8.0	4.22	28.41	0.84
64	7	2	56.0	8.0	7	66.05	1.18
72	8.87	2	71.0	8.0	8.87	98.00	1.38
80	8.67	2	69.4	8.0	8.67	94.34	1.36
88	8.08	2	64.6	8.0	8.08	83.89	1.30
96	8.38	2	67.0	8.0	8.38	89.14	1.33
104	9.12	2	73.0	8.0	9.12	102.65	1.41
112	8.94	2	71.5	8.0	8.94	99.29	1.39
120	7.92	2	63.4	8.0	7.92	81.14	1.28
128	6.4	2	51.2	8.0	6.4	56.88	1.11
136	4.95	2	39.6	8.0	4.95	37.07	0.94
144	3.66	2	22.0	6.0	3.66	16.81	0.77
148	2.85	2	20.0	7.0	2.85	12.93	0.65
158	0	2	0.0	5.0	0	0.00	0.00
			754.57			898.41	1.19

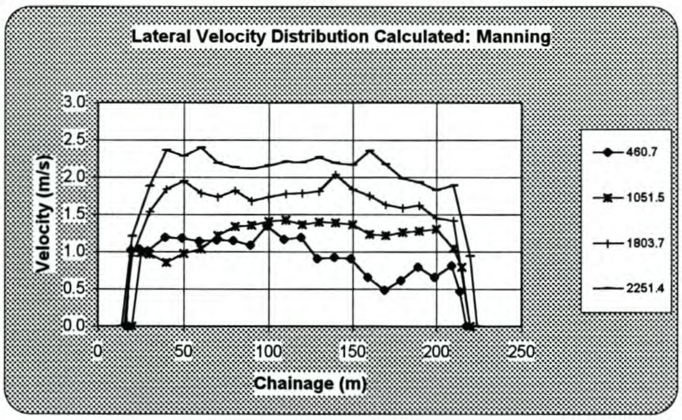
Delta value calculations

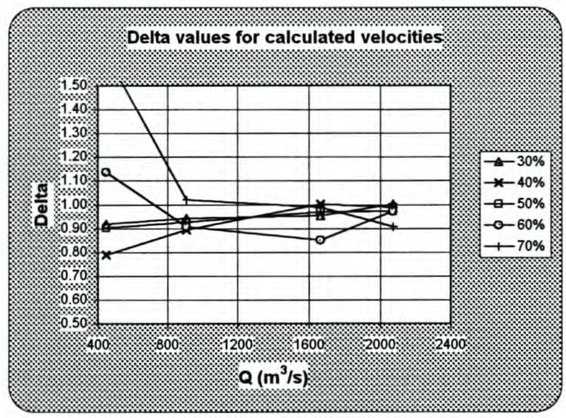
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**77.0**	72.00	80.00	1.38	1.36	1.37	**0.87**
40%	**86.0**	80.00	88.00	1.36	1.30	1.31	**0.91**
50%	**95.0**	88.00	96.00	1.30	1.33	1.33	**0.90**
60%	**104.0**	104.00	112.00	1.41	1.39	1.41	**0.85**
70%	**113.0**	112.00	120.00	1.39	1.28	1.37	**0.87**

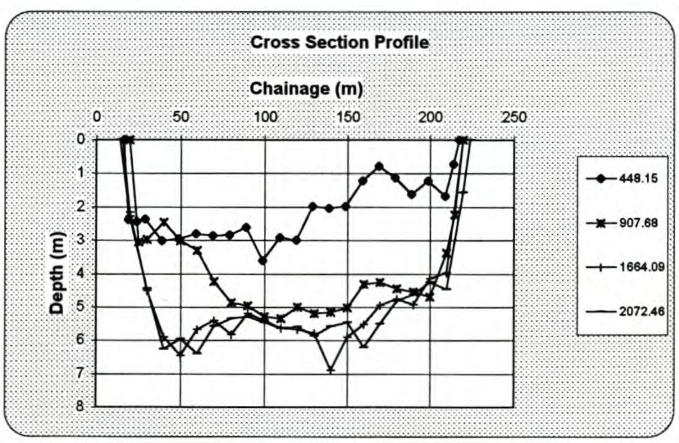
Statn No.: D7H002
River: Oranje
Place: Prieska











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : D7H002 | START TIME : 10h45
RIVER NAME : Oranje | Average Gaugeplate reading : 2.195 m
PLACE NAME : Prieska
DATE : 10/31/87

Main Channel LEFT : 20
Main Channel RIGHT : 220

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.016	440.9	448.15
1	16.5	0		0		0.000	0.0	0.00
2	19	2.39		0.5745		0.575	9.0	5.15
3	24	2.45		1.0675		1.068	12.3	13.08
4	29	2.36		1.246		1.246	17.7	22.05
5	39	3.02		1.178		1.178	30.2	35.58
6	49	2.96		1.2205		1.221	29.6	36.13
7	59	2.8		1.076		1.076	28.0	30.13
8	69	2.87		1.059		1.059	28.7	30.39
9	79	2.84		1.135		1.135	28.4	32.23
10	89	2.62		1.1865		1.187	26.2	31.09
11	99	3.61		0.923		0.923	36.1	33.32
12	109	2.92		1.059		1.059	29.2	30.92
13	119	2.99		0.974		0.974	29.9	29.12
14	129	1.98		1.042		1.042	19.8	20.63
15	139	2.05		0.9654		0.965	20.5	19.79
16	149	1.99		0.8889		0.889	19.9	17.69
17	159	1.23		0.8124		0.812	12.3	9.99
18	169	0.78		0.804		0.804	7.8	6.27
19	179	1.12		0.7614		0.761	11.2	8.53
20	189	1.63		0.668		0.668	16.3	10.89
21	199	1.22		0.957		0.957	12.2	11.68
22	209	1.68		0.9399		0.940	12.6	11.84
23	214	0.73		0.5319		0.532	3.1	1.65
24	217.5	0		0		0.000	0.0	0.00
						1.016	440.9	448.15

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	80.0	79.00	89.00	1.14	1.19	1.14	0.89
40%	100.0	99.00	109.00	0.92	1.06	0.94	1.09
50%	120.0	119.00	129.00	0.97	1.04	0.98	1.04
60%	140.0	139.00	149.00	0.97	0.89	0.96	1.06
70%	160.0	159.00	169.00	0.81	0.80	0.81	1.25

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0004

Q = 460.7
V_{AVR} = 1.04

Roughness coeff.	
Sub	n
0	
2	0.035
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
16.5	0	2	0.0	9.5	0	0.00	0.00
19	2.39	2	9.0	3.8	2.39	9.15	1.02
24	2.45	2	12.3	5.0	2.45	12.72	1.04
29	2.36	2	17.7	7.5	2.36	17.93	1.01
39	3.02	2	30.2	10.0	3.02	36.06	1.19
49	2.96	2	29.6	10.0	2.96	34.87	1.18
59	2.8	2	28.0	10.0	2.8	31.79	1.14
69	2.87	2	28.7	10.0	2.87	33.12	1.15
79	2.84	2	28.4	10.0	2.84	32.55	1.15
89	2.62	2	26.2	10.0	2.62	28.45	1.09
99	3.61	2	36.1	10.0	3.61	48.54	1.34
109	2.92	2	29.2	10.0	2.92	34.09	1.17
119	2.99	2	29.9	10.0	2.99	35.46	1.19
129	1.98	2	19.8	10.0	1.98	17.84	0.90
139	2.05	2	20.5	10.0	2.05	18.90	0.92
149	1.99	2	19.9	10.0	1.99	17.99	0.90
159	1.23	2	12.3	10.0	1.23	8.07	0.66
169	0.78	2	7.8	10.0	0.78	3.78	0.48
179	1.12	2	11.2	10.0	1.12	6.90	0.62
189	1.63	2	16.3	10.0	1.63	12.90	0.79
199	1.22	2	12.2	10.0	1.22	7.96	0.65
209	1.68	2	12.6	7.5	1.68	10.18	0.81
214	0.73	2	3.1	4.3	0.73	1.44	0.46
217.5	0	2	0.0	1.8	0	0.00	0.00
			440.92			460.68	1.04

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	80.0	79.00	89.00	1.15	1.09	1.14	0.92
40%	100.0	99.00	109.00	1.34	1.17	1.33	0.79
50%	120.0	119.00	129.00	1.19	0.90	1.16	0.90
60%	140.0	139.00	149.00	0.92	0.90	0.92	1.14
70%	160.0	159.00	169.00	0.66	0.48	0.64	1.64

Measured data

STATION No. : D7H002
RIVER NAME : Oranje
PLACE NAME : Prieska
DATE : 4/27/88

START TIME : 08h45
Average Gaugeplate reading : 2.82 m

Main Channel LEFT : 20
Main Channel RIGHT : 220

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.086	835.6	907.68
1	20	0		0		0.000	0.0	0.00
2	25	3.06		0.804		0.804	15.3	12.30
3	30	2.98		1.1015		1.102	22.4	24.62
4	40	2.47		1.365		1.365	24.7	33.72
5	50	3.02		1.297		1.297	30.2	39.17
6	60	3.3		1.2545		1.255	33.0	41.40
7	70	4.24		1.178		1.178	42.4	49.95
8	80	4.87		1.127		1.127	48.7	54.88
9	90	4.97		1.0675		1.068	49.7	53.05
10	100	5.28		0.974		0.974	52.8	51.43
11	110	5.35		1.059		1.059	53.5	56.66
12	120	5		0.9315		0.932	50.0	46.58
13	130	5.2		1.042		1.042	52.0	54.18
14	140	5.16		1.2375		1.238	51.6	63.86
15	150	5.03		1.1015		1.102	50.3	55.41
16	160	4.32		1.2035		1.204	43.2	51.99
17	170	4.25		1.0505		1.051	42.5	44.65
18	180	4.44		1.076		1.076	44.4	47.77
19	190	4.55		1.0675		1.068	45.5	48.57
20	200	4.7		1.059		1.059	47.0	49.77
21	210	3.37		0.8125		0.813	25.3	20.54
22	215	2.24		0.6425		0.643	11.2	7.20
23	220	0		0		0.000	0.0	0.00
24						0.000	0.0	0.00
						1.086	835.6	907.68

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**80.0**	80.00	90.00	1.13	1.07	1.13	**0.96**
40%	**100.0**	100.00	110.00	0.97	1.06	0.97	**1.12**
50%	**120.0**	120.00	130.00	0.93	1.04	0.93	**1.17**
60%	**140.0**	140.00	150.00	1.24	1.10	1.24	**0.88**
70%	**160.0**	160.00	170.00	1.20	1.05	1.20	**0.90**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00028

Q = 1051.5
V_{AVR} = 1.26

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
20	0	2	0.0	12.5	0	0.00	0.00
25	3.06	2	15.3	5.0	3.06	14.99	0.98
30	2.98	2	22.4	7.5	2.98	21.61	0.96
40	2.47	2	24.7	10.0	2.47	20.98	0.85
50	3.02	2	30.2	10.0	3.02	29.33	0.97
60	3.3	2	33.0	10.0	3.3	34.00	1.03
70	4.24	2	42.4	10.0	4.24	51.63	1.22
80	4.87	2	48.7	10.0	4.87	65.04	1.34
90	4.97	2	49.7	10.0	4.97	67.28	1.35
100	5.28	2	52.8	10.0	5.28	74.42	1.41
110	5.35	2	53.5	10.0	5.35	76.07	1.42
120	5	2	50.0	10.0	5	67.96	1.36
130	5.2	2	52.0	10.0	5.2	72.65	1.40
140	5.16	2	51.6	10.0	5.16	71.62	1.39
150	5.03	2	50.3	10.0	5.03	68.64	1.36
160	4.32	2	43.2	10.0	4.32	53.26	1.23
170	4.25	2	42.5	10.0	4.25	51.83	1.22
180	4.44	2	44.4	10.0	4.44	55.75	1.26
190	4.55	2	45.5	10.0	4.55	58.07	1.28
200	4.7	2	47.0	10.0	4.7	61.30	1.30
210	3.37	2	25.3	7.5	3.37	26.41	1.04
215	2.24	2	11.2	5.0	2.24	8.91	0.80
220	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			835.63			1051.52	1.26

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**80.0**	80.00	90.00	1.34	1.35	1.34	**0.94**
40%	**100.0**	100.00	110.00	1.41	1.42	1.41	**0.89**
50%	**120.0**	120.00	130.00	1.36	1.40	1.36	**0.93**
60%	**140.0**	140.00	150.00	1.39	1.36	1.39	**0.91**
70%	**160.0**	160.00	170.00	1.23	1.22	1.23	**1.02**

Measured data

STATION No. : D7H002 — START TIME : 13h00
RIVER NAME : Oranje — Average Gaugeplate reading : 3.765 m
PLACE NAME : Prieska
DATE : 4/23/88
Main Channel LEFT : 20
Main Channel RIGHT : 220

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.598	1041.2	1664.09
1	15.5	0		0		0.000	0.0	0.00
2	20	2.16		0.2685		0.269	15.7	4.20
3	30	4.51		1.042		1.042	45.1	46.99
4	40	5.9		1.3225		1.323	59.0	78.03
5	50	6.46		1.195		1.195	64.6	77.20
6	60	5.67		1.45		1.450	56.7	82.22
7	70	5.41		1.7645		1.765	54.1	95.46
8	80	5.82		1.909		1.909	58.2	111.10
9	90	5.19		2.0365		2.037	51.9	105.69
10	100	5.41		2.2065		2.207	54.1	119.37
11	110	5.64		2.113		2.113	56.4	119.17
12	120	5.67		2.045		2.045	56.7	115.95
13	130	5.79		1.926		1.926	57.9	111.52
14	140	6.9		1.5775		1.578	69.0	108.85
15	150	5.9		1.603		1.603	59.0	94.58
16	160	5.52		1.3565		1.357	55.2	74.88
17	170	4.95		1.45		1.450	49.5	71.78
18	180	4.76		1.501		1.501	47.6	71.45
19	190	4.92		1.5775		1.578	49.2	77.61
20	200	4.15		1.3225		1.323	41.5	54.88
21	210	3.98		1.0845		1.085	39.8	43.16
22	220	0		0		0.000	0.0	0.00
23						0.000	0.0	0.00
24						0.000	0.0	0.00
						1.598	1041.2	1664.09

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	**80.0**	80.00	90.00	1.91	2.04	1.91	**0.84**
40%	**100.0**	100.00	110.00	2.21	2.11	2.21	**0.72**
50%	**120.0**	120.00	130.00	2.05	1.93	2.05	**0.78**
60%	**140.0**	140.00	150.00	1.58	1.60	1.58	**1.01**
70%	**160.0**	160.00	170.00	1.36	1.45	1.36	**1.18**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00042

Q = 1803.7
V_{AVR} = 1.73

Roughness coeff. Sub	n
0	
2	0.0365
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
15.5	0	2	0.0	10.0	0	0.00	0.00
20	2.16	2	15.7	7.3	2.16	14.69	0.94
30	4.51	2	45.1	10.0	4.51	69.12	1.53
40	5.9	2	59.0	10.0	5.9	108.16	1.83
50	6.46	2	64.6	10.0	6.46	125.81	1.95
60	5.67	2	56.7	10.0	5.67	101.23	1.79
70	5.41	2	54.1	10.0	5.41	93.61	1.73
80	5.82	2	58.2	10.0	5.82	105.73	1.82
90	5.19	2	51.9	10.0	5.19	87.35	1.68
100	5.41	2	54.1	10.0	5.41	93.61	1.73
110	5.64	2	56.4	10.0	5.64	100.34	1.78
120	5.67	2	56.7	10.0	5.67	101.23	1.79
130	5.79	2	57.9	10.0	5.79	104.82	1.81
140	6.9	2	69.0	10.0	6.9	140.42	2.04
150	5.9	2	59.0	10.0	5.9	108.16	1.83
160	5.52	2	55.2	10.0	5.52	96.80	1.75
170	4.95	2	49.5	10.0	4.95	80.72	1.63
180	4.76	2	47.6	10.0	4.76	75.63	1.59
190	4.92	2	49.2	10.0	4.92	79.91	1.62
200	4.15	2	41.5	10.0	4.15	60.17	1.45
210	3.98	2	39.8	10.0	3.98	56.12	1.41
220	0	2	0.0	5.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			1041.16			1803.66	1.73

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	**80.0**	80.00	90.00	1.82	1.68	1.82	**0.95**
40%	**100.0**	100.00	110.00	1.73	1.78	1.73	**1.00**
50%	**120.0**	120.00	130.00	1.79	1.81	1.79	**0.97**
60%	**140.0**	140.00	150.00	2.04	1.83	2.04	**0.85**
70%	**160.0**	160.00	170.00	1.75	1.63	1.75	**0.99**

Measured data

STATION No. : D7H002 — START TIME : 14h15
RIVER NAME : Oranje — Average Gaugeplate reading : 4.165 m
PLACE NAME : Prieska
DATE : 4/21/88

Main Channel LEFT : 20
Main Channel RIGHT : 220

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.962	1056.5	2072.46
1	14	0		0		0.000	0.0	0.00
2	20	2.29		0.345		0.345	18.3	6.32
3	30	4.44		1.365		1.365	44.4	60.61
4	40	6.26		1.7475		1.748	62.6	109.39
5	50	5.96		1.9345		1.935	59.6	115.30
6	60	6.4		2.045		2.045	64.0	130.88
7	70	5.58		2.317		2.317	55.8	129.29
8	80	5.34		2.5295		2.530	53.4	135.08
9	90	5.28		2.725		2.725	52.8	143.88
10	100	5.46		2.725		2.725	54.6	148.79
11	110	5.64		2.504		2.504	56.4	141.23
12	120	5.6		2.3765		2.377	56.0	133.08
13	130	5.86		2.2235		2.224	58.6	130.30
14	140	5.58		2.062		2.062	55.8	115.06
15	150	5.47		1.773		1.773	54.7	96.98
16	160	6.2		1.603		1.603	62.0	99.39
17	170	5.5		1.5603		1.560	55.0	85.82
18	180	4.81		1.6285		1.629	48.1	78.33
19	190	4.62		1.6795		1.680	46.2	77.59
20	200	4.25		1.671		1.671	42.5	71.02
21	210	4.47		1.348		1.348	44.7	60.26
22	220	1.57		0.3535		0.354	11.0	3.88
23	224	0		0		0.000	0.0	0.00
24						0.000	0.0	0.00
						1.962	1056.5	2072.46

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**80.0**	80.00	90.00	2.53	2.73	2.53	**0.78**
40%	**100.0**	100.00	110.00	2.73	2.50	2.73	**0.72**
50%	**120.0**	120.00	130.00	2.38	2.22	2.38	**0.83**
60%	**140.0**	140.00	150.00	2.06	1.77	2.06	**0.95**
70%	**160.0**	160.00	170.00	1.60	1.56	1.60	**1.22**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0007

Q = 2251.4
V_{AVR} = 2.13

Roughness coeff.	
Sub	n
0	
2	0.038
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
14	0	2	0.0	10.0	0	0.00	0.00
20	2.29	2	18.3	8.0	2.29	22.16	1.21
30	4.44	2	44.4	10.0	4.44	83.51	1.88
40	6.26	2	62.6	10.0	6.26	148.04	2.36
50	5.96	2	59.6	10.0	5.96	136.41	2.29
60	6.4	2	64.0	10.0	6.4	153.60	2.40
70	5.58	2	55.8	10.0	5.58	122.22	2.19
80	5.34	2	53.4	10.0	5.34	113.69	2.13
90	5.28	2	52.8	10.0	5.28	111.47	2.11
100	5.46	2	54.6	10.0	5.46	117.87	2.16
110	5.64	2	56.4	10.0	5.64	124.42	2.21
120	5.6	2	56.0	10.0	5.6	122.95	2.20
130	5.86	2	58.6	10.0	5.86	132.62	2.26
140	5.58	2	55.8	10.0	5.58	122.22	2.19
150	5.47	2	54.7	10.0	5.47	118.23	2.16
160	6.2	2	62.0	10.0	6.2	145.69	2.35
170	5.5	2	55.0	10.0	5.5	119.32	2.17
180	4.81	2	48.1	10.0	4.81	95.43	1.98
190	4.62	2	46.2	10.0	4.62	89.23	1.93
200	4.25	2	42.5	10.0	4.25	77.64	1.83
210	4.47	2	44.7	10.0	4.47	84.46	1.89
220	1.57	2	11.0	7.0	1.57	10.34	0.94
224	0	2	0.0	2.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			1056.51			2251.42	2.13

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**80.0**	80.00	90.00	2.13	2.11	2.13	**1.00**
40%	**100.0**	100.00	110.00	2.16	2.21	2.16	**0.99**
50%	**120.0**	120.00	130.00	2.20	2.26	2.20	**0.97**
60%	**140.0**	140.00	150.00	2.19	2.16	2.19	**0.97**
70%	**160.0**	160.00	170.00	2.35	2.17	2.35	**0.91**

Measured data

STATION No. : D7H002 | START TIME : 08h29
RIVER NAME : Oranje | Average Gaugeplate reading : 8.365 m
PLACE NAME : Prieska
DATE : 3/22/88

Main Channel LEFT : 10
Main Channel RIGHT : 310

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.767	2126.2	5883.37
1	9.7	0		0.2686		0.269	0.0	0.00
2	10	2.16		0.3361		0.336	11.1	3.74
3	20	3.26		0.6873		0.687	32.6	22.41
4	30	4.327		0.8844		0.884	43.3	38.27
5	40	5.989		1.0643		1.064	59.9	63.74
6	50	6.558		1.6896		1.690	40.0	67.59
7	52.2	6.686		2.0152		2.015	20.4	41.09
8	56.1	7.341		2.2122		2.212	28.6	63.34
9	60	7.997		2.6748		2.675	55.6	148.66
10	70	7.561		3.3601		3.360	75.6	254.06
11	80	8.049		3.7371		3.737	80.5	300.80
12	90	8.323		3.7028		3.703	83.2	308.18
13	100	7.994		3.9255		3.926	79.9	313.80
14	110	8.001		4.054		4.054	72.0	291.92
15	118	7.784		3.9255		3.926	58.4	229.17
16	125	7.76		3.8913		3.891	66.0	256.67
17	135	7.566		3.7628		3.763	56.7	213.52
18	140	7.401		3.797		3.797	55.5	210.76
19	150	7.353		3.917		3.917	73.5	288.02
20	160	7.429		3.7199		3.720	74.3	276.35
21	170	7.494		2.6577		2.658	74.9	199.17
22	180	7.605		3.3944		3.394	95.1	322.68
23	195	7.404		3.2573		3.257	92.6	301.46
24	205	6.897		3.2573		3.257	86.2	280.82
						2.767	2126.2	5883.37

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	100.00	110.00	3.93	4.05	3.93	0.70
40%	130.0	125.00	135.00	3.89	3.76	3.83	0.72
50%	160.0	160.00	170.00	3.72	2.66	3.72	0.74
60%	190.0	180.00	195.00	3.39	3.26	3.30	0.84
70%	220.0	220.00	230.00	3.15	2.67	3.15	0.88

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0015

$Q =$ 7427.6
$V_{AVR} =$ 3.49

Roughness coeff.	
Sub	n
0	
2	0.04
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
23	0	2	0.0	5.0	0	0.00	0.00
28	2.16	2	11.1	5.2	2.16	18.00	1.62
33	3.26	2	32.6	10.0	3.26	69.40	2.13
38	4.327	2	43.3	10.0	4.327	111.25	2.57
43	5.989	2	59.9	10.0	5.989	191.24	3.19
48	6.558	2	40.0	6.1	6.558	135.71	3.39
53	6.686	2	20.4	3.1	6.686	70.07	3.44
58	7.341	2	28.6	3.9	7.341	104.71	3.66
63	7.997	2	55.6	7.0	7.997	215.20	3.87
68	7.561	2	75.6	10.0	7.561	282.02	3.73
73	8.049	2	80.5	10.0	8.049	313.01	3.89
78	8.323	2	83.2	10.0	8.323	330.97	3.98
83	7.994	2	79.9	10.0	7.994	309.45	3.87
88	8.001	2	72.0	9.0	8.001	278.91	3.87
93	7.784	2	58.4	7.5	7.784	222.02	3.80
98	7.76	2	66.0	8.5	7.76	250.33	3.80
103	7.566	2	56.7	7.5	7.566	211.76	3.73
108	7.401	2	55.5	7.5	7.401	204.11	3.68
113	7.353	2	73.5	10.0	7.353	269.21	3.66
118	7.429	2	74.3	10.0	7.429	273.86	3.69
123	7.494	2	74.9	10.0	7.494	277.87	3.71
125	7.605	2	95.1	12.5	7.605	355.95	3.74
126	7.404	2	92.6	12.5	7.404	340.41	3.68
	6.897	2	86.2	12.5	6.897	302.46	3.51
			2126.21			7427.61	3.49

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	98.00	103.00	3.80	3.73	3.77	0.93
40%	130.0	126.00	0.00	3.68	3.51	3.68	0.95
50%	160.0	126.00	0.00	3.68	3.51	3.72	0.94
60%	190.0	126.00	0.00	3.68	3.51	3.76	0.93
70%	220.0	126.00	0.00	3.68	3.51	3.80	0.92

Measured data

STATION No. : D7H002
RIVER NAME : Oranje
PLACE NAME : Prieska
DATE : 3/15/88

START TIME : 10h37
Average Gaugeplate reading : 8.675 m

Main Channel LEFT : 10
Main Channel RIGHT : 310

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						2.873	2258.5	6487.94
1	9.7	0		0.3646		0.365	0.0	0.00
2	10	2.37		0.4552		0.455	12.2	5.56
3	20	3.2		0.7827		0.783	32.0	25.05
4	30	4.637		0.9176		0.918	46.4	42.55
5	40	6.299		1.2074		1.207	63.0	76.05
6	50	6.868		1.8502		1.850	41.9	77.51
7	52.2	6.996		2.0921		2.092	21.3	44.64
8	56.1	7.651		2.2275		2.228	29.8	66.47
9	60	8.307		2.5821		2.582	57.7	149.07
10	70	7.871		3.0032		3.003	78.7	236.38
11	80	8.359		3.6634		3.663	83.6	306.22
12	90	8.633		3.8348		3.835	86.3	331.06
13	100	8.304		3.9562		3.956	83.0	328.52
14	110	8.311		4.2662		4.266	74.8	319.11
15	118	8.094		4.141		4.141	60.7	251.38
16	125	7.98		3.7839		3.784	67.8	256.66
17	135	7.876		4.2359		4.236	78.8	333.62
18	145	7.711		4.1949		4.195	57.8	242.60
19	150	7.663		4.2056		4.206	57.5	241.71
20	160	7.739		4.0415		4.042	77.4	312.77
21	170	7.804		3.6689		3.669	78.0	286.32
22	180	7.915		3.4681		3.468	98.9	343.13
23	195	7.714		3.4537		3.454	96.4	333.02
24	205	7.207		3.5487		3.549	90.1	319.69
						2.873	2258.5	6487.94

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	100.00	110.00	3.96	4.27	3.96	0.73
40%	130.0	125.00	135.00	3.78	4.24	4.01	0.72
50%	160.0	160.00	170.00	4.04	3.67	4.04	0.71
60%	190.0	180.00	195.00	3.47	3.45	3.46	0.83
70%	220.0	220.00	230.00	3.21	2.88	3.21	0.89

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0015

Q = 8118.4
V_{AVR} = 3.59

Roughness coeff. Sub	n
0	
2	0.04
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
9.7	0	2	0.0	5.0	0	0.00	0.00
10	2.37	2	12.2	5.2	2.37	21.01	1.72
20	3.2	2	32.0	10.0	3.2	67.28	2.10
30	4.637	2	46.4	10.0	4.637	124.85	2.69
40	6.299	2	63.0	10.0	6.299	208.02	3.30
50	6.868	2	41.9	6.1	6.868	146.57	3.50
52.2	6.996	2	21.3	3.1	6.996	75.57	3.54
56.1	7.651	2	29.8	3.9	7.651	112.18	3.76
60	8.307	2	57.7	7.0	8.307	229.29	3.97
70	7.871	2	78.7	10.0	7.871	301.56	3.83
80	8.359	2	83.6	10.0	8.359	333.36	3.99
90	8.633	2	86.3	10.0	8.633	351.77	4.07
100	8.304	2	83.0	10.0	8.304	329.71	3.97
110	8.311	2	74.8	9.0	8.311	297.16	3.97
118	8.094	2	60.7	7.5	8.094	236.95	3.90
125	7.98	2	67.8	8.5	7.98	262.27	3.87
135	7.876	2	78.8	10.0	7.876	301.88	3.83
145	7.711	2	57.8	7.5	7.711	218.56	3.78
150	7.663	2	57.5	7.5	7.663	216.29	3.76
160	7.739	2	77.4	10.0	7.739	293.18	3.79
170	7.804	2	78.0	10.0	7.804	297.29	3.81
180	7.915	2	98.9	12.5	7.915	380.46	3.85
195	7.714	2	96.4	12.5	7.714	364.50	3.78
205	7.207	2	90.1	12.5	7.207	325.45	3.61
			2258.54			8118.40	3.59

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	100.00	110.00	3.97	3.97	3.97	0.91
40%	130.0	125.00	135.00	3.87	3.83	3.85	0.93
50%	160.0	160.00	170.00	3.79	3.81	3.79	0.95
60%	190.0	180.00	195.00	3.85	3.78	3.80	0.95
70%	220.0	220.00	230.00	3.60	3.57	3.60	1.00

Measured data

STATION No. : D7H002 START TIME : 09h00
RIVER NAME : Oranje Average Gaugeplate reading : 9.35 m
PLACE NAME : Prieska
DATE : 3/17/88
Main Channel LEFT : 10
Main Channel RIGHT : 310

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						2.935	2476.9	7270.72
1	9.7	3		0.6076		0.608	0.5	0.27
2	10	3		0.759		0.759	15.5	11.73
3	20	4.04		1.0077		1.008	40.4	40.71
4	30	5.307		1.3358		1.336	53.1	70.89
5	40	6.969		1.4439		1.444	69.7	100.63
6	50	7.538		2.391		2.391	46.0	109.94
7	52.2	7.666		2.5354		2.535	23.4	59.28
8	56.1	8.321		2.6137		2.614	32.5	84.82
9	60	8.977		2.8505		2.851	62.4	177.84
10	70	8.541		3.2927		3.293	85.4	281.23
11	80	9.029		3.6848		3.685	90.3	332.70
12	90	9.303		4.1005		4.101	93.0	381.47
13	100	8.974		3.9436		3.944	89.7	353.90
14	110	8.981		4.0057		4.006	80.8	323.78
15	118	8.764		4.117		4.117	65.7	270.61
16	125	8.65		4.2071		4.207	73.5	309.33
17	135	8.546		4.3487		4.349	64.1	278.73
18	140	8.381		4.2457		4.246	62.9	266.87
19	150	8.333		4.27		4.270	83.3	355.82
20	160	8.409		4.024		4.024	84.1	338.38
21	170	8.474		3.6317		3.632	84.7	307.75
22	180	8.585		3.6724		3.672	107.3	394.09
23	195	8.384		3.4585		3.459	104.8	362.45
24	205	7.877		3.5292		3.529	98.5	347.49
						2.935	2476.9	7270.72

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	100.00	110.00	3.94	4.01	3.94	0.74
40%	130.0	125.00	135.00	4.21	4.35	4.28	0.69
50%	160.0	160.00	170.00	4.02	3.63	4.02	0.73
60%	190.0	180.00	195.00	3.67	3.46	3.53	0.83
70%	220.0	220.00	230.00	3.31	2.94	3.31	0.89

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0015

Q = 9420.6
V_{AVR} = 3.80

Roughness coeff. Sub	n
0	
2	0.04
0	

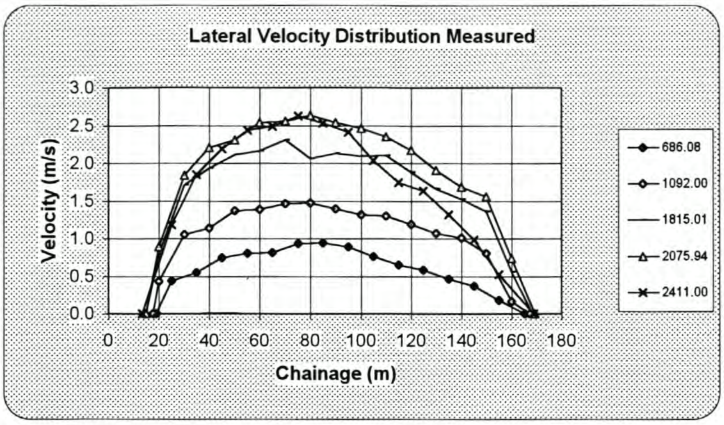
Area reduction factor Sub	f_A
0	1
2	1
0	1

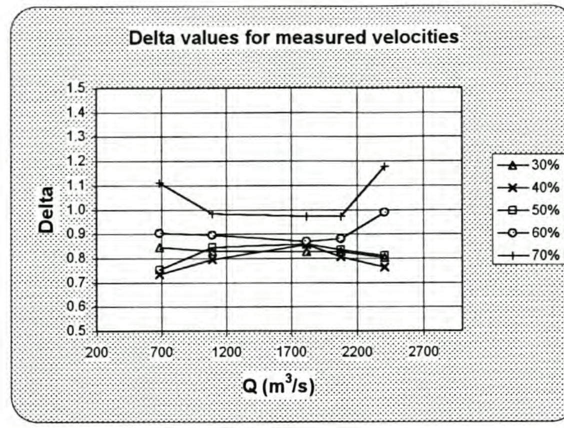
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
9.7	3	2	0.5	5.0	0.09	0.09	0.19
10	3	2	15.5	5.2	3	31.12	2.01
20	4.04	2	40.4	10.0	4.04	99.23	2.46
30	5.307	2	53.1	10.0	5.307	156.34	2.95
40	6.969	2	69.7	10.0	6.969	246.19	3.53
50	7.538	2	46.0	6.1	7.538	171.16	3.72
52.2	7.666	2	23.4	3.1	7.666	88.02	3.76
56.1	8.321	2	32.5	3.9	8.321	129.03	3.98
60	8.977	2	62.4	7.0	8.977	260.93	4.18
70	8.541	2	85.4	10.0	8.541	345.54	4.05
80	9.029	2	90.3	10.0	9.029	379.07	4.20
90	9.303	2	93.0	10.0	9.303	398.43	4.28
100	8.974	2	89.7	10.0	8.974	375.23	4.18
110	8.981	2	80.8	9.0	8.981	338.14	4.18
118	8.764	2	65.7	7.5	8.764	270.53	4.12
125	8.65	2	73.5	8.5	8.65	299.98	4.08
135	8.546	2	64.1	7.5	8.546	259.41	4.05
140	8.381	2	62.9	7.5	8.381	251.12	3.99
150	8.333	2	83.3	10.0	8.333	331.63	3.98
160	8.409	2	84.1	10.0	8.409	336.69	4.00
170	8.474	2	84.7	10.0	8.474	341.04	4.02
180	8.585	2	107.3	12.5	8.585	435.64	4.06
195	8.384	2	104.8	12.5	8.384	418.78	4.00
205	7.877	2	98.5	12.5	7.877	377.42	3.83
			2476.93			9420.56	3.80

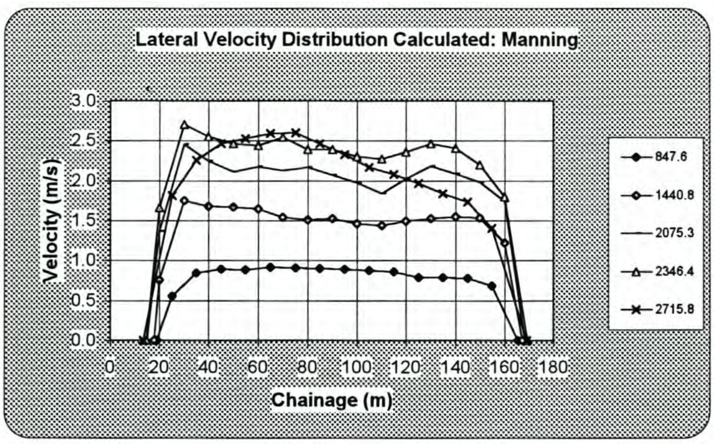
Delta value calculations

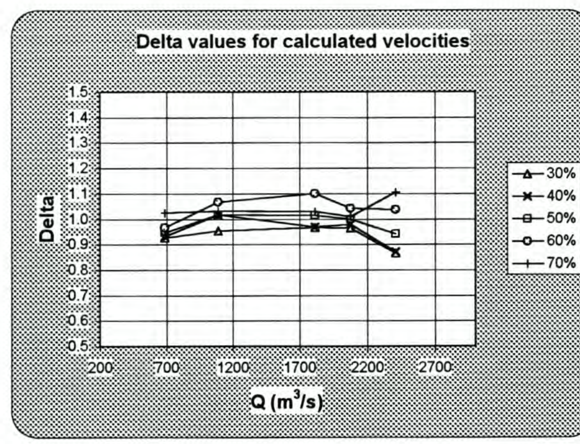
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	100.0	100.00	110.00	4.18	4.18	4.18	0.91
40%	130.0	125.00	135.00	4.08	4.05	4.06	0.94
50%	160.0	160.00	170.00	4.00	4.02	4.00	0.95
60%	190.0	180.00	195.00	4.06	4.00	4.02	0.95
70%	220.0	220.00	230.00	3.82	3.79	3.82	1.00

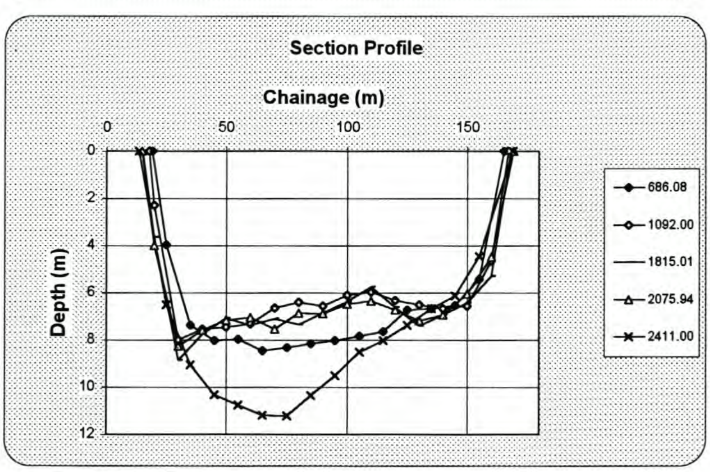
Statn No.: D7H012
River: Oranje
Place: Irene











The values in the legend block describe measured discharge
for the profile indicated

Measured data

STATION No. :	D7H012	START TIME :	14h08
RIVER NAME :	Oranje	Average Gaugeplate reading :	2.375 m
PLACE NAME :	Irene		
DATE :	3/16/89		
		Main Channel LEFT :	20
		Main Channel RIGHT :	163

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.682	1005.3	686.08
1	19	0	0	0	0	0.000	0.0	0.00
2	25	3.96	0.485	0.400	0.447	0.433	31.7	13.72
3	35	7.38	0.497	0.510	0.674	0.548	73.8	40.42
4	45	8.03	0.670	0.766	0.771	0.743	80.3	59.68
5	55	7.98	0.745	0.808	0.855	0.804	79.8	64.18
6	65	8.45	0.716	0.813	0.897	0.810	84.5	68.40
7	75	8.335	0.787	0.973	0.981	0.928	83.4	77.38
8	85	8.168	0.888	0.973	0.943	0.944	81.7	77.12
9	95	8.023	0.867	0.897	0.897	0.889	80.2	71.36
10	105	7.849	0.670	0.787	0.813	0.764	78.5	59.99
11	115	7.659	0.623	0.632	0.703	0.648	76.6	49.60
12	125	6.72	0.430	0.623	0.657	0.583	67.2	39.21
13	135	6.68	0.358	0.464	0.569	0.464	66.8	30.96
14	145	6.55	0.384	0.363	0.371	0.370	65.5	24.23
15	155	5.43	0.161	0.182	0.186	0.177	55.4	9.83
16	165.4	0	0	0	0	0.000	0.0	0.00
17						0.000	0.0	0.00
						0.682	1005.3	686.08

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	62.9	55.00	65.00	0.80	0.81	0.81	0.84
40%	77.2	75.00	85.00	0.93	0.94	0.93	0.73
50%	91.5	85.00	95.00	0.94	0.89	0.91	0.75
60%	105.8	105.00	115.00	0.76	0.65	0.75	0.90
70%	120.1	115.00	125.00	0.65	0.58	0.61	1.11

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	847.6
Slope	0.00006	V_{AVR} =	0.84

Roughness coeff		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.035	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
19	0	2	0.0	12.5	0	0.00	0.00
25	3.96	2	31.7	8.0	3.96	17.55	0.55
35	7.38	2	73.8	10.0	7.38	61.91	0.84
45	8.03	2	80.3	10.0	8.03	71.26	0.89
55	7.98	2	79.8	10.0	7.98	70.53	0.88
65	8.45	2	84.5	10.0	8.45	77.58	0.92
75	8.335	2	83.4	10.0	8.335	75.83	0.91
85	8.168	2	81.7	10.0	8.168	73.32	0.90
95	8.023	2	80.2	10.0	8.023	71.16	0.89
105	7.849	2	78.5	10.0	7.849	68.61	0.87
115	7.659	2	76.6	10.0	7.659	65.86	0.86
125	6.72	2	67.2	10.0	6.72	52.96	0.79
135	6.68	2	66.8	10.0	6.68	52.44	0.78
145	6.55	2	65.5	10.0	6.55	50.75	0.77
155	5.43	2	55.4	10.2	5.43	37.87	0.68
165.4	0	2	0.0	5.2	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			1005.31			847.62	0.84

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	62.9	55.00	65.00	0.88	0.92	0.91	0.93
40%	77.2	75.00	85.00	0.91	0.90	0.91	0.93
50%	91.5	85.00	95.00	0.90	0.89	0.89	0.96
60%	105.8	105.00	115.00	0.87	0.86	0.87	0.97
70%	120.1	115.00	125.00	0.86	0.79	0.82	1.02

Measured data

STATION No. : D7H012
RIVER NAME : Oranje
PLACE NAME : Irene
DATE : 3/6/89

START TIME : 10h05
Average Gaugeplate reading : 3.14 m

Main Channel LEFT : 20
Main Channel RIGHT : 163

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.168	934.9	1092.00
1	17.8	0	0	0	0	0.000	0.0	0.00
2	20	2.29	0.473	0.473	0.294	0.428	14.0	5.98
3	30	7.999	0.804	1.161	1.085	1.053	80.0	84.20
4	40	7.539	0.957	1.161	1.280	1.140	75.4	85.93
5	50	7.455	1.323	1.399	1.365	1.371	74.6	102.24
6	60	7.32	1.238	1.433	1.450	1.388	73.2	101.63
7	70	6.65	1.280	1.493	1.569	1.459	66.5	96.99
8	80	6.408	1.348	1.501	1.544	1.473	64.1	94.41
9	90	6.555	1.272	1.416	1.467	1.393	65.6	91.29
10	100	6.097	1.161	1.323	1.476	1.320	61.0	80.50
11	110	5.967	1.136	1.314	1.416	1.295	59.7	77.27
12	120	6.336	1.102	1.187	1.280	1.189	63.4	75.31
13	130	6.51	1.008	1.059	1.153	1.070	65.1	69.63
14	140	6.664	0.923	1.025	1.051	1.006	66.6	67.03
15	150	6.575	0.762	0.864	0.736	0.806	65.8	53.00
16	160	4.655	0.2345	0.1325	0.158	0.164	40.1	6.60
17	167.25	0	0	0	0	0.000	0.0	0.00
						1.168	934.9	1092.00

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	62.9	60.00	70.00	1.39	1.46	1.41	0.83
40%	77.2	70.00	80.00	1.46	1.47	1.47	0.80
50%	91.5	90.00	100.00	1.39	1.32	1.38	0.85
60%	105.8	100.00	110.00	1.32	1.29	1.31	0.89
70%	120.1	120.00	130.00	1.19	1.07	1.19	0.98

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00022

Q = 1440.8
V_{AVR} = 1.54

Roughness coeff. Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
17.8	0	2	0.0	10.0	0	0.00	0.00
20	2.29	2	14.0	6.1	2.29	10.59	0.76
30	7.999	2	80.0	10.0	7.999	139.57	1.74
40	7.539	2	75.4	10.0	7.539	126.45	1.68
50	7.455	2	74.6	10.0	7.455	124.11	1.66
60	7.32	2	73.2	10.0	7.32	120.39	1.64
70	6.65	2	66.5	10.0	6.65	102.59	1.54
80	6.408	2	64.1	10.0	6.408	96.44	1.51
90	6.555	2	65.6	10.0	6.555	100.16	1.53
100	6.097	2	61.0	10.0	6.097	88.77	1.46
110	5.967	2	59.7	10.0	5.967	85.64	1.44
120	6.336	2	63.4	10.0	6.336	94.64	1.49
130	6.51	2	65.1	10.0	6.51	99.01	1.52
140	6.664	2	66.6	10.0	6.664	102.95	1.54
150	6.575	2	65.8	10.0	6.575	100.67	1.53
160	4.655	2	40.1	8.6	4.655	48.83	1.22
167.25	0	2	0.0	3.6	0	0.00	0.00
			934.87			1440.81	1.54

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	62.9	60.00	70.00	1.64	1.54	1.62	0.95
40%	77.2	70.00	80.00	1.54	1.51	1.52	1.02
50%	91.5	90.00	100.00	1.53	1.46	1.52	1.02
60%	105.8	100.00	110.00	1.46	1.44	1.44	1.07
70%	120.1	120.00	130.00	1.49	1.52	1.49	1.03

Measured data

STATION No. : D7H012
RIVER NAME : Oranje
PLACE NAME : Irene
DATE : 3/4/89

START TIME : 08h30
Average Gaugeplate reading : 4.149 m

Main Channel LEFT : 20
Main Channel RIGHT : 163

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.824	995.3	1815.01
1	15	0	0	0	0	0.000	0.0	0.00
2	20	3.66	0.651	0.719	1.051	0.785	27.5	21.54
3	30	8.867	1.476	1.739	1.875	1.707	88.7	151.37
4	40	7.76	1.629	1.969	2.156	1.930	77.6	149.79
5	50	7.071	2.088	2.113	2.122	2.109	70.7	149.11
6	60	7.369	1.952	2.190	2.317	2.162	73.7	159.31
7	70	7.119	1.994	2.402	2.428	2.306	71.2	164.19
8	80	7.346	1.909	1.994	2.351	2.062	73.5	151.47
9	90	6.858	1.952	2.122	2.334	2.132	68.6	146.22
10	100	6.377	1.739	2.147	2.343	2.094	63.8	133.53
11	110	5.745	1.969	2.088	2.283	2.107	57.5	121.03
12	120	6.633	1.680	1.901	2.028	1.877	66.3	124.51
13	130	7.403	1.340	1.722	1.833	1.654	74.0	122.45
14	140	6.951	1.391	1.561	1.586	1.524	69.5	105.96
15	150	6.431	1.306	1.374	1.382	1.359	64.3	87.37
16	160	5.305	0.6085	0.464	0.702	0.560	48.5	27.16
17	168.3	0	0	0	0	0.000	0.0	0.00
						1.824	995.3	1815.01

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	**62.9**	60.00	70.00	2.16	2.31	2.20	**0.83**
40%	**77.2**	70.00	80.00	2.31	2.06	2.13	**0.86**
50%	**91.5**	90.00	100.00	2.13	2.09	2.13	**0.86**
60%	**105.8**	100.00	110.00	2.09	2.11	2.10	**0.87**
70%	**120.1**	120.00	130.00	1.88	1.65	1.87	**0.97**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0005

$Q = 2075.3$
$V_{AVR} = 2.09$

Roughness coeff	
Sub	n
0	
2	0.039
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
15	0	2	0.0	10.0	0	0.00	0.00
20	3.66	2	27.5	7.5	3.66	37.38	1.36
30	8.867	2	88.7	10.0	8.867	217.80	2.46
40	7.76	2	77.6	10.0	7.76	174.39	2.25
50	7.071	2	70.7	10.0	7.071	149.36	2.11
60	7.369	2	73.7	10.0	7.369	159.99	2.17
70	7.119	2	71.2	10.0	7.119	151.05	2.12
80	7.346	2	73.5	10.0	7.346	159.16	2.17
90	6.858	2	68.6	10.0	6.858	141.93	2.07
100	6.377	2	63.8	10.0	6.377	125.73	1.97
110	5.745	2	57.5	10.0	5.745	105.66	1.84
120	6.633	2	66.3	10.0	6.633	134.26	2.02
130	7.403	2	74.0	10.0	7.403	161.23	2.18
140	6.951	2	69.5	10.0	6.951	145.16	2.09
150	6.431	2	64.3	10.0	6.431	127.51	1.98
160	5.305	2	48.5	9.2	5.305	84.65	1.74
168.3	0	2	0.0	4.2	0	0.00	0.00
			995.29			2075.25	2.09

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	**62.9**	60.00	70.00	2.17	2.12	2.16	**0.97**
40%	**77.2**	70.00	80.00	2.12	2.17	2.15	**0.97**
50%	**91.5**	90.00	100.00	2.07	1.97	2.05	**1.01**
60%	**105.8**	100.00	110.00	1.97	1.84	1.89	**1.10**
70%	**120.1**	120.00	130.00	2.02	2.18	2.03	**1.03**

Measured data

STATION No. :	D7H012	START TIME :	16h16
RIVER NAME :	Oranje	Average Gaugeplate reading :	4.429 m
PLACE NAME :	Irene	Main Channel LEFT :	20
DATE :	3/3/89	Main Channel RIGHT :	163

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s) 2.106	8 Area (m^2) 985.8	9 Q (m^3/s) 2075.94
1	14.8	0	0	0	0	0.000	0.0	0.00
2	20	3.99	0.796	0.847	1.068	0.889	30.3	26.96
3	30	8.261	1.561	1.960	1.858	1.835	82.6	151.56
4	40	7.586	2.020	2.283	2.224	2.202	75.9	167.06
5	50	7.168	2.088	2.385	2.377	2.309	71.7	165.47
6	60	7.067	2.436	2.555	2.623	2.542	70.7	179.66
7	70	7.545	2.436	2.564	2.674	2.559	75.5	193.10
8	80	6.869	2.394	2.674	2.793	2.634	68.7	180.90
9	90	6.886	2.411	2.555	2.640	2.540	68.9	174.91
10	100	6.499	2.300	2.513	2.513	2.459	65.0	159.83
11	110	6.36	2.258	2.402	2.351	2.353	63.6	149.66
12	120	6.726	1.943	2.283	2.164	2.168	67.3	145.84
13	130	7.193	1.731	1.935	2.037	1.909	71.9	137.31
14	140	6.953	1.484	1.748	1.773	1.688	69.5	117.37
15	150	6.06	1.450	1.629	1.510	1.554	60.6	94.18
16	160	4.49	0.464	0.77	0.9315	0.734	43.8	32.13
17	169.5	0	0	0	0	0.000	0.0	0.00
						2.106	**985.8**	**2075.94**

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.9**	60.00	70.00	2.54	2.56	2.55	**0.83**
40%	**77.2**	70.00	80.00	2.56	2.63	2.61	**0.81**
50%	**91.5**	90.00	100.00	2.54	2.46	2.53	**0.83**
60%	**105.8**	100.00	110.00	2.46	2.35	2.40	**0.88**
70%	**120.1**	120.00	130.00	2.17	1.91	2.17	**0.97**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	**M**	**Q =**	**2346.4**
Slope	0.0007	**V_{AVR} =**	**2.38**

Roughness coeff. Sub	n
0	
2	0.04
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
14.8	0	2	0.0	10.0	0	0.00	0.00
20	3.99	2	30.3	7.6	3.99	50.46	1.66
30	8.261	2	82.6	10.0	8.261	223.29	2.70
40	7.586	2	75.9	10.0	7.586	193.72	2.55
50	7.168	2	71.7	10.0	7.168	176.26	2.46
60	7.067	2	70.7	10.0	7.067	172.14	2.44
70	7.545	2	75.5	10.0	7.545	191.98	2.54
80	6.869	2	68.7	10.0	6.869	164.18	2.39
90	6.886	2	68.9	10.0	6.886	164.85	2.39
100	6.499	2	65.0	10.0	6.499	149.70	2.30
110	6.36	2	63.6	10.0	6.36	144.41	2.27
120	6.726	2	67.3	10.0	6.726	158.52	2.36
130	7.193	2	71.9	10.0	7.193	177.29	2.46
140	6.953	2	69.5	10.0	6.953	167.54	2.41
150	6.06	2	60.6	10.0	6.06	133.23	2.20
160	4.49	2	43.8	9.8	4.49	78.81	1.80
169.5	0	2	0.0	4.8	0	0.00	0.00
			985.83			**2346.37**	**2.38**

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.9**	60.00	70.00	2.44	2.54	2.47	**0.96**
40%	**77.2**	70.00	80.00	2.54	2.39	2.43	**0.98**
50%	**91.5**	90.00	100.00	2.39	2.30	2.38	**1.00**
60%	**105.8**	100.00	110.00	2.30	2.27	2.28	**1.04**
70%	**120.1**	120.00	130.00	2.36	2.46	2.36	**1.01**

Measured data

STATION No. : D7H012 — START TIME : 12h43
RIVER NAME : Oranje — Average Gaugeplate reading : 4.767 m
PLACE NAME : Irene
DATE : 2/27/89
Main Channel LEFT : 20
Main Channel RIGHT : 163

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.984	1215.4	2411.00
1	13.5	0	0	0	0	0.000	0.0	0.00
2	25	6.52	1.170	1.238	1.059	1.176	70.1	82.42
3	35	9.047	1.595	2.011	1.765	1.845	90.5	166.94
4	45	10.335	2.011	2.309	2.139	2.192	103.4	226.50
5	55	10.749	2.173	2.521	2.513	2.432	107.5	261.39
6	65	11.195	2.232	2.504	2.708	2.487	112.0	278.42
7	75	11.223	2.419	2.683	2.700	2.621	112.2	294.14
8	85	10.343	2.309	2.606	2.606	2.532	103.4	261.85
9	95	9.52	2.283	2.513	2.317	2.406	95.2	229.08
10	105	8.525	1.850	2.071	2.139	2.032	85.3	173.25
11	115	8.038	1.552	1.756	1.909	1.743	80.4	140.12
12	125	7.389	1.459	1.722	1.612	1.629	73.9	120.33
13	135	6.68	1.331	1.391	1.161	1.318	66.8	88.06
14	145	6.13	0.906	1.076	0.889	0.987	61.3	60.49
15	155	4.46	0.473	0.592	0.439	0.524	53.5	28.02
16	169	0	0	0	0	0.000	0.0	0.00
17						0.000	0.0	0.00
						1.984	1215.4	2411.00

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.9**	55.00	65.00	2.43	2.49	2.48	**0.80**
40%	**77.2**	75.00	85.00	2.62	2.53	2.60	**0.76**
50%	**91.5**	85.00	95.00	2.53	2.41	2.45	**0.81**
60%	**105.8**	105.00	115.00	2.03	1.74	2.01	**0.99**
70%	**120.1**	115.00	125.00	1.74	1.63	1.68	**1.18**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00043 — Q = 2715.8 — V_{AVR} = 2.23

Roughness coeff Sub	n
0	
2	0.04
0	

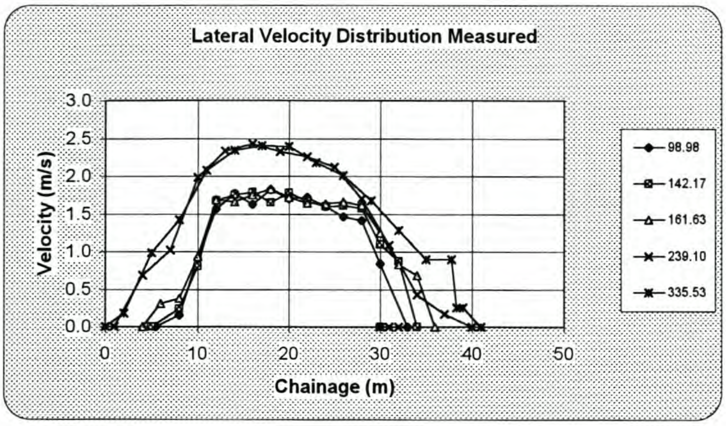
Area reduction factor Sub	f_A
0	1
2	1
0	1

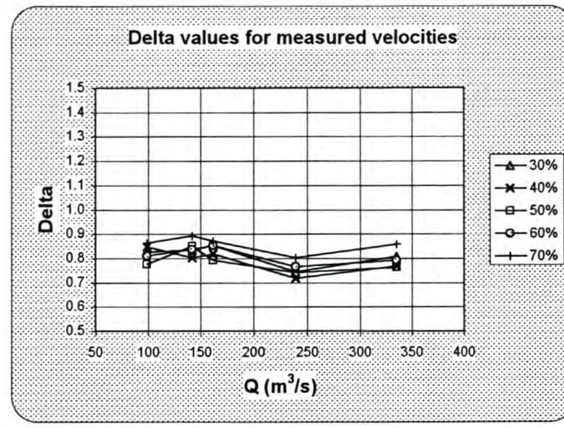
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
13.5	0	2	0.0	12.5	0	0.00	0.00
25	6.52	2	70.1	10.8	6.52	126.81	1.81
35	9.047	2	90.5	10.0	9.047	203.63	2.25
45	10.335	2	103.4	10.0	10.335	254.21	2.46
55	10.749	2	107.5	10.0	10.749	271.41	2.52
65	11.195	2	112.0	10.0	11.195	290.43	2.59
75	11.223	2	112.2	10.0	11.223	291.65	2.60
85	10.343	2	103.4	10.0	10.343	254.54	2.46
95	9.52	2	95.2	10.0	9.52	221.68	2.33
105	8.525	2	85.3	10.0	8.525	184.43	2.16
115	8.038	2	80.4	10.0	8.038	167.21	2.08
125	7.389	2	73.9	10.0	7.389	145.32	1.97
135	6.68	2	66.8	10.0	6.68	122.83	1.84
145	6.13	2	61.3	10.0	6.13	106.44	1.74
155	4.46	2	53.5	12.0	4.46	75.18	1.40
169	0	2	0.0	7.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			1215.35			2715.76	2.23

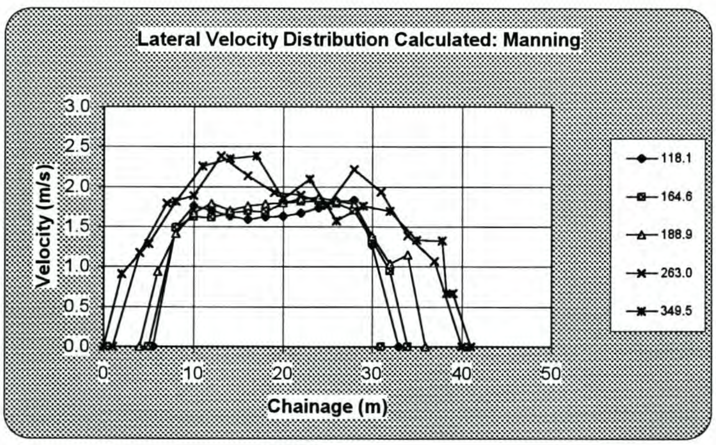
Delta value calculations

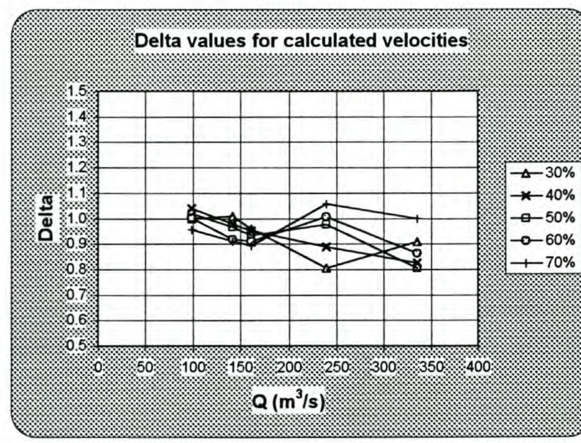
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**62.9**	55.00	65.00	2.52	2.59	2.58	**0.87**
40%	**77.2**	75.00	85.00	2.60	2.46	2.57	**0.87**
50%	**91.5**	85.00	95.00	2.46	2.33	2.37	**0.94**
60%	**105.8**	105.00	115.00	2.16	2.08	2.16	**1.04**
70%	**120.1**	115.00	125.00	2.08	1.97	2.02	**1.10**

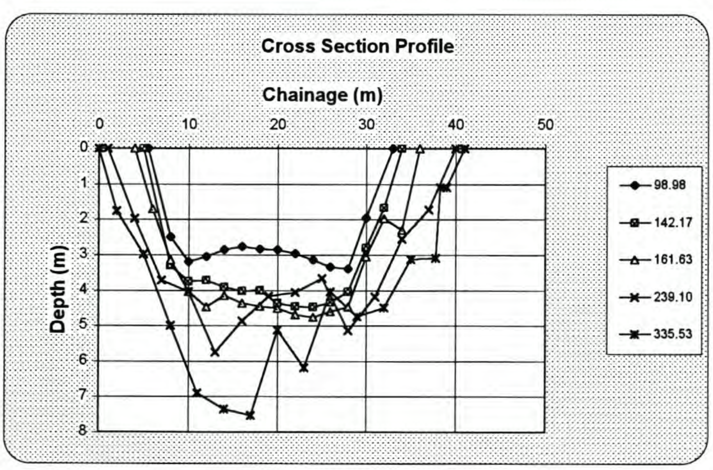
Statn No.: V1H038
River: Klip
Place: Ladysmith











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : V1H038
RIVER NAME : Klip
PLACE NAME : Ladysmith
DATE : 2/17/81

START TIME : 14H15
Average Gaugeplate reading : 3 m

Main Channel LEFT : 5
Main Channel RIGHT : 32

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.387	71.4	98.98
1	5.5	0		0		0.000	0.0	0.00
2	8	2.5		0.158		0.158	5.6	0.89
3	10	3.2		0.895		0.895	6.4	5.73
4	12	3.05		1.564		1.564	6.1	9.54
5	14	2.85		1.767		1.767	5.7	10.07
6	16	2.76		1.623		1.623	5.5	8.96
7	18	2.84		1.818		1.818	5.7	10.33
8	20	2.86		1.699		1.699	5.7	9.72
9	22	2.97		1.716		1.716	5.9	10.19
10	24	3.15		1.598		1.598	6.3	10.07
11	26	3.35		1.462		1.462	6.7	9.80
12	28	3.4		1.411		1.411	6.8	9.59
13	30	1.96		0.836		0.836	4.9	4.10
14	33	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.387	71.4	98.98

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.56	1.77	1.68	0.83
40%	15.8	14.00	16.00	1.77	1.62	1.64	0.85
50%	18.5	18.00	20.00	1.82	1.70	1.79	0.78
60%	21.2	20.00	22.00	1.70	1.72	1.71	0.81
70%	23.9	22.00	24.00	1.72	1.60	1.60	0.86

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0008

Q = 118.1
V_{AVR} = 1.65

Roughness coeff	
Sub	n
0	
2	0.035
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
5.5	0	2	0.0	4.0	0	0.00	0.00
8	2.5	2	5.6	2.3	2.5	8.37	1.49
10	3.2	2	6.4	2.0	3.2	11.23	1.75
12	3.05	2	6.1	2.0	3.05	10.37	1.70
14	2.85	2	5.7	2.0	2.85	9.26	1.62
16	2.76	2	5.5	2.0	2.76	8.78	1.59
18	2.84	2	5.7	2.0	2.84	9.21	1.62
20	2.86	2	5.7	2.0	2.86	9.31	1.63
22	2.97	2	5.9	2.0	2.97	9.92	1.67
24	3.15	2	6.3	2.0	3.15	10.94	1.74
26	3.35	2	6.7	2.0	3.35	12.12	1.81
28	3.4	2	6.8	2.0	3.4	12.43	1.83
30	1.96	2	4.9	2.5	1.96	6.20	1.27
33	0	2	0.0	1.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			71.39			118.13	1.65

Delta value calculations

Delta	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.70	1.62	1.66	1.00
40%	15.8	14.00	16.00	1.62	1.59	1.59	1.04
50%	18.5	18.00	20.00	1.62	1.63	1.62	1.02
60%	21.2	20.00	22.00	1.63	1.67	1.65	1.00
70%	23.9	22.00	24.00	1.67	1.74	1.73	0.95

Measured data

STATION No. : V1H038 — START TIME : 12H40
RIVER NAME : Klip — Average Gaugeplate reading : 3.75 m
PLACE NAME : Ladysmith
DATE : 2/17/81

Main Channel LEFT : 5
Main Channel RIGHT : 32

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.430	99.4	142.17
1	5	0		0		0.000	0.0	0.00
2	8	3.3		0.243		0.243	8.3	2.00
3	10	3.75		0.802		0.802	7.5	6.02
4	12	3.73		1.674		1.674	7.5	12.49
5	14	3.92		1.75		1.750	7.8	13.72
6	16	4.02		1.784		1.784	8.0	14.34
7	18	4		1.649		1.649	8.0	13.19
8	20	4.36		1.776		1.776	8.7	15.49
9	22	4.46		1.665		1.665	8.9	14.85
10	24	4.47		1.598		1.598	8.9	14.29
11	26	4.35		1.606		1.606	8.7	13.97
12	28	4.05		1.572		1.572	8.1	12.73
13	30	2.81		1.098		1.098	5.6	6.17
14	32	1.67		0.87		0.870	3.3	2.91
15	34	0		0		0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.430	99.4	142.17

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.67	1.75	1.72	0.83
40%	15.8	14.00	16.00	1.75	1.78	1.78	0.80
50%	18.5	18.00	20.00	1.65	1.78	1.68	0.85
60%	21.2	20.00	22.00	1.78	1.67	1.71	0.84
70%	23.9	22.00	24.00	1.67	1.60	1.60	0.89

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00055

Q = 164.6
V_{AVR} = 1.66

Roughness coeff. Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
5	0	2	0.0	4.0	0	0.00	0.00
8	3.3	2	8.3	2.5	3.3	12.25	1.49
10	3.75	2	7.5	2.0	3.75	12.13	1.62
12	3.73	2	7.5	2.0	3.73	12.02	1.61
14	3.92	2	7.8	2.0	3.92	13.06	1.67
16	4.02	2	8.0	2.0	4.02	13.62	1.69
18	4	2	8.0	2.0	4	13.51	1.69
20	4.36	2	8.7	2.0	4.36	15.59	1.79
22	4.46	2	8.9	2.0	4.46	16.19	1.82
24	4.47	2	8.9	2.0	4.47	16.26	1.82
26	4.35	2	8.7	2.0	4.35	15.53	1.79
28	4.05	2	8.1	2.0	4.05	13.79	1.70
30	2.81	2	5.6	2.0	2.81	7.50	1.33
32	1.67	2	3.3	2.0	1.67	3.15	0.94
34	0	2	0.0	1.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			99.43			164.61	1.66

Delta value calculations

Delta	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.61	1.67	1.64	1.01
40%	15.8	14.00	16.00	1.67	1.69	1.69	0.98
50%	18.5	18.00	20.00	1.69	1.79	1.71	0.97
60%	21.2	20.00	22.00	1.79	1.82	1.80	0.92
70%	23.9	22.00	24.00	1.82	1.82	1.82	0.91

Measured data

STATION No. : V1H038
RIVER NAME : Klip
PLACE NAME : Ladysmith
DATE : 2/17/81

START TIME : 11h50
Average Gaugeplate reading : 4.2 m

Main Channel LEFT : 5
Main Channel RIGHT : 32

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.424	113.5	161.63
1	4	0		0		0.000	0.0	0.00
2	6	1.7		0.311		0.311	3.4	1.06
3	8	3.15		0.379		0.379	6.3	2.39
4	10	4.05		0.933		0.933	8.1	7.56
5	12	4.48		1.682		1.682	9.0	15.07
6	14	4.15		1.657		1.657	8.3	13.75
7	16	4.37		1.75		1.750	8.7	15.30
8	18	4.45		1.826		1.826	8.9	16.25
9	20	4.52		1.716		1.716	9.0	15.51
10	22	4.7		1.64		1.640	9.4	15.42
11	24	4.77		1.632		1.632	9.5	15.57
12	26	4.61		1.657		1.657	9.2	15.28
13	28	4.47		1.615		1.615	8.9	14.44
14	30	3.05		1.251		1.251	6.1	7.63
15	32	1.98		0.827		0.827	4.0	3.27
16	34	2.3		0.683		0.683	4.6	3.14
17	36	0		0		0.000	0.0	0.00
						1.424	113.5	161.63

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.68	1.66	1.67	0.85
40%	15.8	14.00	16.00	1.66	1.75	1.74	0.82
50%	18.5	18.00	20.00	1.83	1.72	1.80	0.79
60%	21.2	20.00	22.00	1.72	1.64	1.67	0.85
70%	23.9	22.00	24.00	1.64	1.63	1.63	0.87

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0005

Q = 188.9
V_{AVR} = 1.66

Roughness coeff Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
4	0	2	0.0	3.0	0	0.00	0.00
6	1.7	2	3.4	2.0	1.7	3.19	0.94
8	3.15	2	6.3	2.0	3.15	8.90	1.41
10	4.05	2	8.1	2.0	4.05	13.54	1.67
12	4.48	2	9.0	2.0	4.48	16.01	1.79
14	4.15	2	8.3	2.0	4.15	14.10	1.70
16	4.37	2	8.7	2.0	4.37	15.36	1.76
18	4.45	2	8.9	2.0	4.45	15.84	1.78
20	4.52	2	9.0	2.0	4.52	16.25	1.80
22	4.7	2	9.4	2.0	4.7	17.35	1.85
24	4.77	2	9.5	2.0	4.77	17.78	1.86
26	4.61	2	9.2	2.0	4.61	16.80	1.82
28	4.47	2	8.9	2.0	4.47	15.95	1.78
30	3.05	2	6.1	2.0	3.05	8.44	1.38
32	1.98	2	4.0	2.0	1.98	4.11	1.04
34	2.3	2	4.6	2.0	2.3	5.27	1.15
36	0	2	0.0	1.0	0	0.00	0.00
			113.50			188.88	1.66

Delta value calculations

Delta	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	12.00	14.00	1.79	1.70	1.74	0.96
40%	15.8	14.00	16.00	1.70	1.76	1.75	0.95
50%	18.5	18.00	20.00	1.76	1.80	1.78	0.93
60%	21.2	20.00	22.00	1.80	1.85	1.83	0.91
70%	23.9	22.00	24.00	1.85	1.86	1.88	0.89

Measured data

STATION No. :	V1H038	START TIME :	14h15
RIVER NAME :	Klip	Average Gaugeplate reading :	5.98 m
PLACE NAME :	Ladysmith		
DATE :	2/26/85		
		Main Channel LEFT :	5
		Main Channel RIGHT :	32

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.738	137.6	239.10
1	1	0		0		0.000	0.0	0.00
2	4	1.98		0.683		0.683	5.9	4.06
3	7	3.73		1.018		1.018	11.2	11.39
4	10	4.04		1.987		1.987	12.1	24.08
5	13	5.75		2.334		2.334	17.3	40.26
6	16	4.87		2.427		2.427	14.6	35.46
7	19	4.17		2.326		2.326	12.5	29.10
8	22	4.06		2.254		2.254	12.2	27.45
9	25	3.66		2.118		2.118	11.0	23.26
10	28	5.15		1.699		1.699	15.5	26.25
11	31	4.19		1.085		1.085	12.6	13.64
12	34	2.55		0.425		0.425	7.7	3.25
13	37	1.72		0.175		0.175	5.2	0.90
14	40	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.738	137.6	239.10

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	13.00	16.00	2.33	2.43	2.34	0.74
40%	15.8	13.00	16.00	2.33	2.43	2.42	0.72
50%	18.5	16.00	19.00	2.43	2.33	2.34	0.74
60%	21.2	19.00	22.00	2.33	2.25	2.27	0.76
70%	23.9	22.00	25.00	2.25	2.12	2.17	0.80

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	263.0
Slope	0.0006	V_{AVR} =	1.91

Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.033	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
1	0	2	0.0	2.0	0	0.00	0.00
4	1.98	2	5.9	3.0	1.98	6.95	1.17
7	3.73	2	11.2	3.0	3.73	19.98	1.79
10	4.04	2	12.1	3.0	4.04	22.82	1.88
13	5.75	2	17.3	3.0	5.75	41.10	2.38
16	4.87	2	14.6	3.0	4.87	31.16	2.13
19	4.17	2	12.5	3.0	4.17	24.06	1.92
22	4.06	2	12.2	3.0	4.06	23.01	1.89
25	3.66	2	11.0	3.0	3.66	19.36	1.76
28	5.15	2	15.5	3.0	5.15	34.20	2.21
31	4.19	2	12.6	3.0	4.19	24.25	1.93
34	2.55	2	7.7	3.0	2.55	10.60	1.39
37	1.72	2	5.2	3.0	1.72	5.50	1.07
40	0	2	0.0	1.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			137.61			262.97	1.91

Delta value calculations

Delta	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	13.00	16.00	2.38	2.13	2.37	0.80
40%	15.8	13.00	16.00	2.38	2.13	2.15	0.89
50%	18.5	16.00	19.00	2.13	1.92	1.98	0.98
60%	21.2	19.00	22.00	1.92	1.89	1.90	1.01
70%	23.9	22.00	25.00	1.89	1.76	1.81	1.06

Measured data

STATION No. : V1H038 — START TIME : 11h30
RIVER NAME : Klip — Average Gaugeplate reading : 6.86 m
PLACE NAME : Ladysmith
DATE : 2/26/85

Main Channel LEFT : 5
Main Channel RIGHT : 32

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.825	183.8	335.53
1	0	0		0		0.000	0.0	0.00
2	2	1.77		0.179		0.179	4.4	0.79
3	5	2.98		0.984		0.984	8.9	8.80
4	8	5		1.415		1.415	15.0	21.23
5	11	6.91		2.08		2.080	20.7	43.12
6	14	7.35		2.339		2.339	22.1	51.57
7	17	7.53		2.398		2.398	22.6	54.17
8	20	5.12		2.389		2.389	15.4	36.70
9	23	6.18		2.178		2.178	18.5	40.38
10	26	4.04		2.008		2.008	12.1	24.34
11	29	4.75		1.678		1.678	14.3	23.91
12	32	4.5		1.28		1.280	13.5	17.28
13	35	3.13		0.895		0.895	9.1	8.12
14	37.8	3.1		0.895		0.895	5.1	4.58
15	38.3	1.1		0.256		0.256	0.7	0.17
16	39	1.1		0.256		0.256	1.5	0.38
17	41	0		0		0.000	0.0	0.00
						1.825	183.8	335.53

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	11.00	14.00	2.08	2.34	2.26	0.81
40%	15.8	14.00	17.00	2.34	2.40	2.37	0.77
50%	18.5	17.00	20.00	2.40	2.39	2.39	0.76
60%	21.2	20.00	23.00	2.39	2.18	2.30	0.79
70%	23.9	23.00	26.00	2.18	2.01	2.13	0.86

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.0005

Q = 349.5
V_{AVR} = 1.90

Roughness coeff. Sub	n
0	
2	0.036
0	

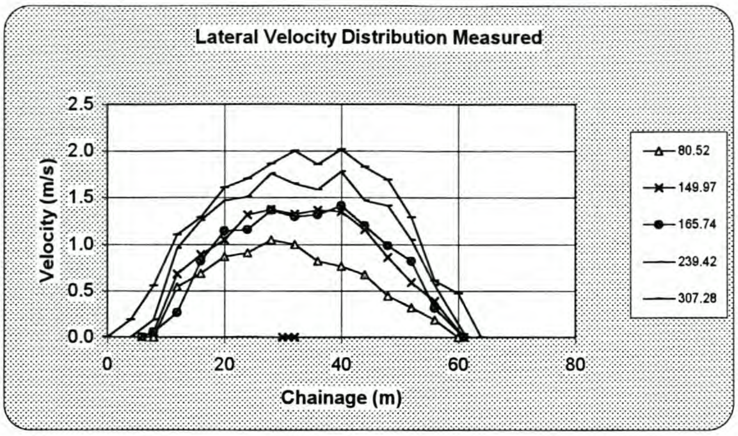
Area reduction factor Sub	f_A
0	1
2	1
0	1

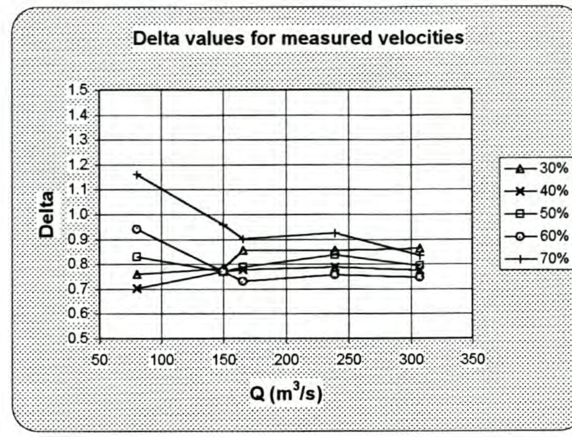
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
5.2	1.77	2	4.4	2.5	1.77	4.02	0.91
8.2	2.98	2	8.9	3.0	2.98	11.50	1.29
11.2	5	2	15.0	3.0	5	27.24	1.82
14.2	6.91	2	20.7	3.0	6.91	46.71	2.25
17.2	7.35	2	22.1	3.0	7.35	51.77	2.35
20.2	7.53	2	22.6	3.0	7.53	53.90	2.39
23.2	5.12	2	15.4	3.0	5.12	28.34	1.85
26.2	6.18	2	18.5	3.0	6.18	38.78	2.09
29.2	4.04	2	12.1	3.0	4.04	19.10	1.58
32.2	4.75	2	14.3	3.0	4.75	25.01	1.76
35.2	4.5	2	13.5	3.0	4.5	22.86	1.69
38.2	3.13	2	9.1	2.9	3.13	12.06	1.33
41.2	3.1	2	5.1	1.7	3.1	6.75	1.32
44.2	1.1	2	0.7	0.6	1.1	0.44	0.66
47.2	1.1	2	1.5	1.4	1.1	0.98	0.66
50.2	0	2	0.0	1.0	0	0.00	0.00
			183.84			349.48	1.90

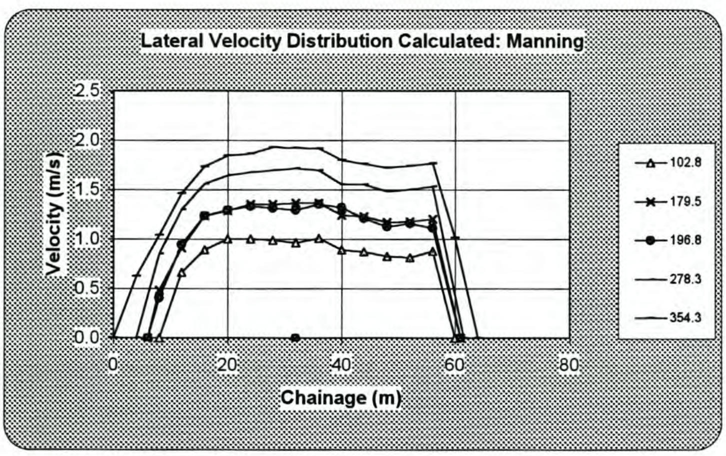
Delta value calculations

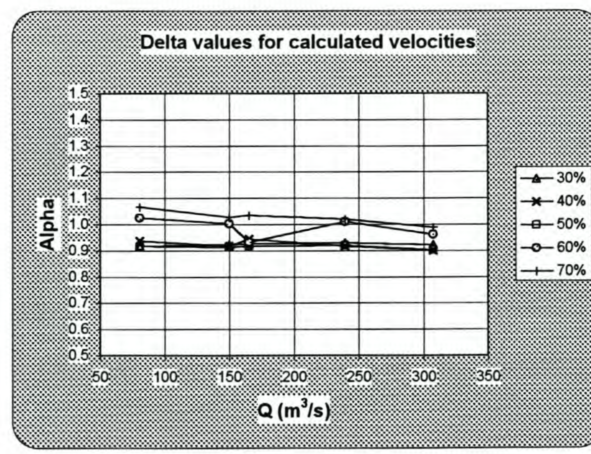
Delta	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	13.1	11.20	14.20	1.82	2.25	2.09	0.91
40%	15.8	14.20	17.20	2.25	2.35	2.30	0.83
50%	18.5	17.20	20.20	2.35	2.39	2.38	0.80
60%	21.2	20.20	23.20	2.39	1.85	2.21	0.86
70%	23.9	23.20	26.20	1.85	2.09	1.90	1.00

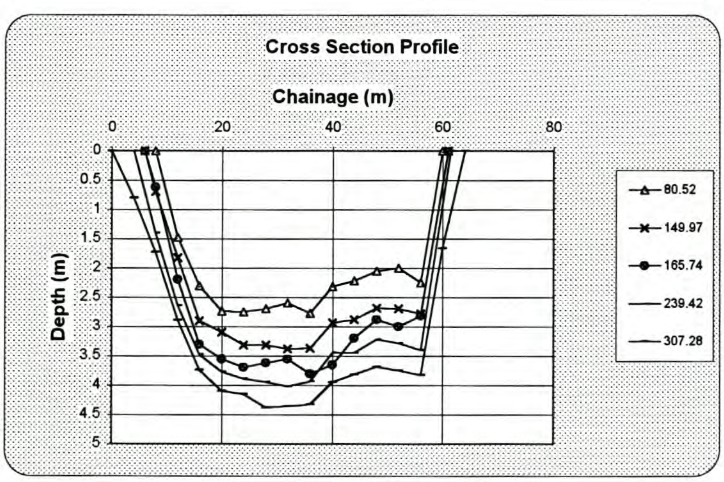
Statn No.: V1H057
River: Tugela
Place: Spioenkop dam











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : V1H057
RIVER NAME : Tugela
PLACE NAME : Spioenkop dam
DATE : 2/10/86

START TIME : 15H15
Average Gaugeplate reading : 2.6 m
Main Channel LEFT : 10
Main Channel RIGHT : 60

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.715	112.7	80.52
1	8	0		0		0.000	0.0	0.00
2	12	1.48		0.54		0.540	5.9	3.20
3	16	2.3		0.688		0.688	9.2	6.33
4	20	2.74		0.866		0.866	11.0	9.49
5	24	2.75		0.907		0.907	11.0	9.98
6	28	2.7		1.044		1.044	10.8	11.28
7	32	2.6		0.994		0.994	10.4	10.34
8	36	2.77		0.817		0.817	11.1	9.05
9	40	2.31		0.759		0.759	9.2	7.01
10	44	2.22		0.673		0.673	8.9	5.98
11	48	2.05		0.444		0.444	8.2	3.64
12	52	2		0.32		0.320	8.0	2.56
13	56	2.25		0.185		0.185	9.0	1.67
14	60	0		0		0.000	0.0	0.00
15						0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						0.715	112.7	80.52

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	0.91	1.04	0.94	0.76
40%	30.0	28.00	32.00	1.04	0.99	1.02	0.70
50%	35.0	32.00	36.00	0.99	0.82	0.86	0.83
60%	40.0	40.00	44.00	0.76	0.67	0.76	0.94
70%	45.0	44.00	48.00	0.67	0.44	0.62	1.16

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0003

Q = 102.8
V_{AVR} = 0.91

Roughness coeff Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
8	0	2	0.0	6.0	0	0.00	0.00
12	1.48	2	5.9	4.0	1.48	3.92	0.66
16	2.3	2	9.2	4.0	2.3	8.17	0.89
20	2.74	2	11.0	4.0	2.74	10.93	1.00
24	2.75	2	11.0	4.0	2.75	11.00	1.00
28	2.7	2	10.8	4.0	2.7	10.67	0.99
32	2.6	2	10.4	4.0	2.6	10.02	0.96
36	2.77	2	11.1	4.0	2.77	11.13	1.00
40	2.31	2	9.2	4.0	2.31	8.23	0.89
44	2.22	2	8.9	4.0	2.22	7.70	0.87
48	2.05	2	8.2	4.0	2.05	6.74	0.82
52	2	2	8.0	4.0	2	6.47	0.81
56	2.25	2	9.0	4.0	2.25	7.87	0.87
60	0	2	0.0	2.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			112.68			102.84	0.91

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.00	0.99	1.00	0.92
40%	30.0	28.00	32.00	0.99	0.96	0.98	0.94
50%	35.0	32.00	36.00	0.96	1.00	0.99	0.92
60%	40.0	40.00	44.00	0.89	0.87	0.89	1.03
70%	45.0	44.00	48.00	0.87	0.82	0.86	1.07

Measured data

STATION No. : V1H057
RIVER NAME : Tugela
PLACE NAME : Spioenkop dam
DATE : 1/29/81

START TIME : 12H20
Average Gaugeplate reading : 3.28 m

Main Channel LEFT : 10
Main Channel RIGHT : 60

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.040	144.3	149.97
1	6	0		0		0.000	0.0	0.00
2	8	0.7		0.058		0.058	2.1	0.12
3	12	1.83		0.68		0.680	7.3	4.98
4	16	2.9		0.883		0.883	11.6	10.24
5	20	3.1		1.048		1.048	12.4	13.00
6	24	3.32		1.315		1.315	13.3	17.46
7	28	3.32		1.374		1.374	13.3	18.25
8	32	3.38		1.324		1.324	13.5	17.90
9	36	3.37		1.362		1.362	13.5	18.36
10	40	2.93		1.353		1.353	11.7	15.86
11	44	2.88		1.158		1.158	11.5	13.34
12	48	2.68		0.862		0.862	10.7	9.24
13	52	2.7		0.591		0.591	10.8	6.38
14	56	2.78		0.387		0.387	12.5	4.84
15	61	0		0		0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.040	144.3	149.97

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**25.0**	24.00	28.00	1.32	1.37	1.33	**0.78**
40%	**30.0**	28.00	32.00	1.37	1.32	1.35	**0.77**
50%	**35.0**	32.00	36.00	1.32	1.36	1.35	**0.77**
60%	**40.0**	40.00	44.00	1.35	1.16	1.35	**0.77**
70%	**45.0**	44.00	48.00	1.16	0.86	1.08	**0.96**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0004

Q = 179.5
V_{AVR} = 1.24

Roughness coeff	
Sub	n
0	
2	0.033
0	

Area reduction factor	
Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	4.0	0	0.00	0.00
8	0.7	2	2.1	3.0	0.7	1.00	0.48
12	1.83	2	7.3	4.0	1.83	6.64	0.91
16	2.9	2	11.6	4.0	2.9	14.30	1.23
20	3.1	2	12.4	4.0	3.1	15.98	1.29
24	3.32	2	13.3	4.0	3.32	17.91	1.35
28	3.32	2	13.3	4.0	3.32	17.91	1.35
32	3.38	2	13.5	4.0	3.38	18.45	1.36
36	3.37	2	13.5	4.0	3.37	18.36	1.36
40	2.93	2	11.7	4.0	2.93	14.54	1.24
44	2.88	2	11.5	4.0	2.88	14.13	1.23
48	2.68	2	10.7	4.0	2.68	12.54	1.17
52	2.7	2	10.8	4.0	2.7	12.69	1.18
56	2.78	2	12.5	4.5	2.78	14.99	1.20
61	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			144.25			179.45	1.24

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**25.0**	24.00	28.00	1.35	1.35	1.35	**0.92**
40%	**30.0**	28.00	32.00	1.35	1.36	1.36	**0.92**
50%	**35.0**	32.00	36.00	1.36	1.36	1.36	**0.91**
60%	**40.0**	40.00	44.00	1.24	1.23	1.24	**1.00**
70%	**45.0**	44.00	48.00	1.23	1.17	1.21	**1.03**

Measured data

STATION No. : V1H057 START TIME : 08h20
RIVER NAME : Tugela Average Gaugeplate reading : 5.73 m
PLACE NAME : Spioenkop dam
DATE : 1/28/81

Main Channel LEFT : 10
Main Channel RIGHT : 60

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.034	160.4	165.74
1	6	0		0		0.000	0.0	0.00
2	8	0.62		0.054		0.054	1.9	0.10
3	12	2.2		0.26		0.260	8.8	2.29
4	16	3.3		0.819		0.819	13.2	10.81
5	20	3.55		1.141		1.141	14.2	16.20
6	24	3.7		1.158		1.158	14.8	17.14
7	28	3.62		1.362		1.362	14.5	19.72
8	32	3.55		1.294		1.294	14.2	18.37
9	36	3.8		1.319		1.319	15.2	20.05
10	40	3.65		1.413		1.413	14.6	20.63
11	44	3.2		1.2		1.200	12.8	15.36
12	48	2.88		0.98		0.980	11.5	11.29
13	52	3		0.819		0.819	12.0	9.83
14	56	2.82		0.311		0.311	12.7	3.95
15	61	0		0		0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.034	160.4	165.74

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.16	1.36	1.21	0.85
40%	30.0	28.00	32.00	1.36	1.29	1.33	0.78
50%	35.0	32.00	36.00	1.29	1.32	1.31	0.79
60%	40.0	40.00	44.00	1.41	1.20	1.41	0.73
70%	45.0	44.00	48.00	1.20	0.98	1.15	0.90

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0004
Q = 196.8
V_{AVR} = 1.23

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	4.0	0	0.00	0.00
8	0.62	2	1.9	3.0	0.62	0.75	0.40
12	2.2	2	8.8	4.0	2.2	8.27	0.94
16	3.3	2	13.2	4.0	3.3	16.25	1.23
20	3.55	2	14.2	4.0	3.55	18.36	1.29
24	3.7	2	14.8	4.0	3.7	19.67	1.33
28	3.62	2	14.5	4.0	3.62	18.97	1.31
32	3.55	2	14.2	4.0	3.55	18.36	1.29
36	3.8	2	15.2	4.0	3.8	20.56	1.35
40	3.65	2	14.6	4.0	3.65	19.23	1.32
44	3.2	2	12.8	4.0	3.2	15.44	1.21
48	2.88	2	11.5	4.0	2.88	12.96	1.12
52	3	2	12.0	4.0	3	13.87	1.16
56	2.82	2	12.7	4.5	2.82	14.07	1.11
61	0	2	0.0	2.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			160.35			196.76	1.23

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.33	1.31	1.32	0.93
40%	30.0	28.00	32.00	1.31	1.29	1.30	0.94
50%	35.0	32.00	36.00	1.29	1.35	1.34	0.92
60%	40.0	40.00	44.00	1.32	1.21	1.32	0.93
70%	45.0	44.00	48.00	1.21	1.12	1.19	1.03

Measured data

STATION No. : V1H057 START TIME : 09h00
RIVER NAME : Tugela Average Gaugeplate reading : 3.88 m
PLACE NAME : Spioenkop dam
DATE : 2/4/81

Main Channel LEFT : 10
Main Channel RIGHT : 60

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.344	178.1	239.42
1	4	0		0		0.000	0.0	0.00
2	8	1.4		0.188		0.188	5.6	1.05
3	12	2.64		0.957		0.957	10.6	10.11
4	16	3.48		1.252		1.252	13.9	17.43
5	20	3.77		1.468		1.468	15.1	22.14
6	24	3.89		1.511		1.511	15.6	23.51
7	28	3.95		1.762		1.762	15.8	27.84
8	32	4.02		1.649		1.649	16.1	26.52
9	36	3.94		1.589		1.589	15.8	25.04
10	40	3.45		1.779		1.779	13.8	24.55
11	44	3.45		1.468		1.468	13.8	20.26
12	48	3.22		1.416		1.416	12.9	18.24
13	52	3.28		1.044		1.044	13.1	13.70
14	56	3.4		0.56		0.560	16.2	9.04
15	61.5	0		0		0.000	0.0	0.00
16						0.000	0.0	0.00
17						0.000	0.0	0.00
						1.344	178.1	239.42

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.51	1.76	1.57	0.85
40%	30.0	28.00	32.00	1.76	1.65	1.71	0.79
50%	35.0	32.00	36.00	1.65	1.59	1.60	0.84
60%	40.0	40.00	44.00	1.78	1.47	1.78	0.76
70%	45.0	44.00	48.00	1.47	1.42	1.46	0.92

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0007
Q = 278.3
V_{AVR} = 1.56

Roughness coeff Sub	n
0	
2	0.039
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
4	0	2	0.0	4.0	0	0.00	0.00
8	1.4	2	5.6	4.0	1.4	4.75	0.85
12	2.64	2	10.6	4.0	2.64	13.68	1.30
16	3.48	2	13.9	4.0	3.48	21.69	1.56
20	3.77	2	15.1	4.0	3.77	24.78	1.64
24	3.89	2	15.6	4.0	3.89	26.11	1.68
28	3.95	2	15.8	4.0	3.95	26.78	1.70
32	4.02	2	16.1	4.0	4.02	27.58	1.72
36	3.94	2	15.8	4.0	3.94	26.67	1.69
40	3.45	2	13.8	4.0	3.45	21.38	1.55
44	3.45	2	13.8	4.0	3.45	21.38	1.55
48	3.22	2	12.9	4.0	3.22	19.05	1.48
52	3.28	2	13.1	4.0	3.28	19.65	1.50
56	3.4	2	16.2	4.8	3.4	24.77	1.53
61.5	0	2	0.0	2.8	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			178.11			278.27	1.56

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.68	1.70	1.68	0.93
40%	30.0	28.00	32.00	1.70	1.72	1.71	0.92
50%	35.0	32.00	36.00	1.72	1.69	1.70	0.92
60%	40.0	40.00	44.00	1.55	1.55	1.55	1.01
70%	45.0	44.00	48.00	1.55	1.48	1.53	1.02

Measured data

STATION No. : V1H057 | START TIME : 14h45

RIVER NAME : Tugela | Average Gaugeplate reading : 4.22 m

PLACE NAME : Spioenkop dam

DATE : 2/3/81

Main Channel LEFT : 10

Main Channel RIGHT : 60

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.501	204.7	307.28
1	0	0		0		0.000	0.0	0.00
2	4	0.8		0.184		0.184	3.2	0.59
3	8	1.73		0.551		0.551	6.9	3.81
4	12	2.89		1.098		1.098	11.6	12.69
5	16	3.74		1.286		1.286	15.0	19.24
6	20	4.1		1.606		1.606	16.4	26.34
7	24	4.15		1.701		1.701	16.6	28.24
8	28	4.38		1.866		1.866	17.5	32.69
9	32	4.36		2.004		2.004	17.4	34.95
10	36	4.33		1.857		1.857	17.3	32.16
11	40	3.95		2.013		2.013	15.8	31.81
12	44	3.82		1.831		1.831	15.3	27.98
13	48	3.69		1.693		1.693	14.8	24.99
14	52	3.75		1.286		1.286	15.0	19.29
15	56	3.83		0.611		0.611	15.3	9.36
16	60	1.66		0.473		0.473	6.6	3.14
17	64	0		0		0.000	0.0	0.00
						1.501	204.7	307.28

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.70	1.87	1.74	0.86
40%	30.0	28.00	32.00	1.87	2.00	1.94	0.78
50%	35.0	32.00	36.00	2.00	1.86	1.89	0.79
60%	40.0	40.00	44.00	2.01	1.83	2.01	0.75
70%	45.0	44.00	48.00	1.83	1.69	1.80	0.84

Calculated data, 1-dimensional flow theory

Manning or Chezy: M | Slope 0.00075

Q = 354.3

V_{AVR} = 1.73

Roughness coeff	
Sub	n
0	
2	0.038
0	

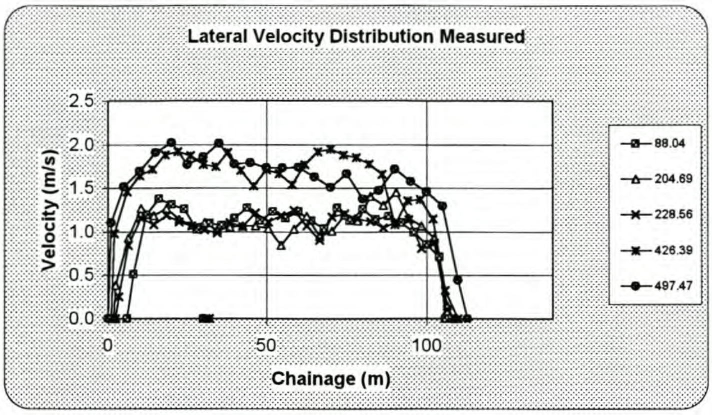
Area reduction factor	
Sub	f_A
0	1
2	1
0	1

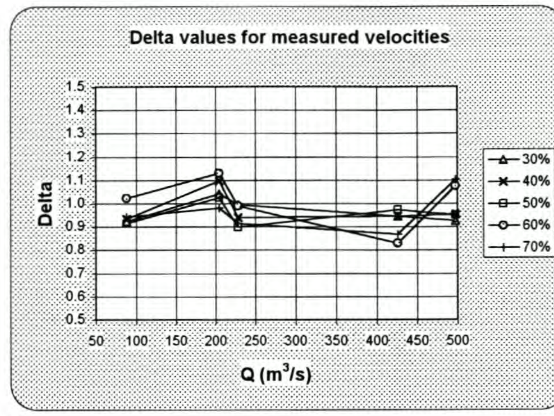
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
4	0.8	2	3.2	4.0	0.8	1.99	0.62
8	1.73	2	6.9	4.0	1.73	7.19	1.04
12	2.89	2	11.6	4.0	2.89	16.90	1.46
16	3.74	2	15.0	4.0	3.74	25.98	1.74
20	4.1	2	16.4	4.0	4.1	30.28	1.85
24	4.15	2	16.6	4.0	4.15	30.89	1.86
28	4.38	2	17.5	4.0	4.38	33.80	1.93
32	4.36	2	17.4	4.0	4.36	33.54	1.92
36	4.33	2	17.3	4.0	4.33	33.16	1.91
40	3.95	2	15.8	4.0	3.95	28.45	1.80
44	3.82	2	15.3	4.0	3.82	26.91	1.76
48	3.69	2	14.8	4.0	3.69	25.40	1.72
52	3.75	2	15.0	4.0	3.75	26.09	1.74
56	3.83	2	15.3	4.0	3.83	27.03	1.76
60	1.66	2	6.6	4.0	1.66	6.71	1.01
64	0	2	0.0	2.0	0	0.00	0.00
			204.72			354.33	1.73

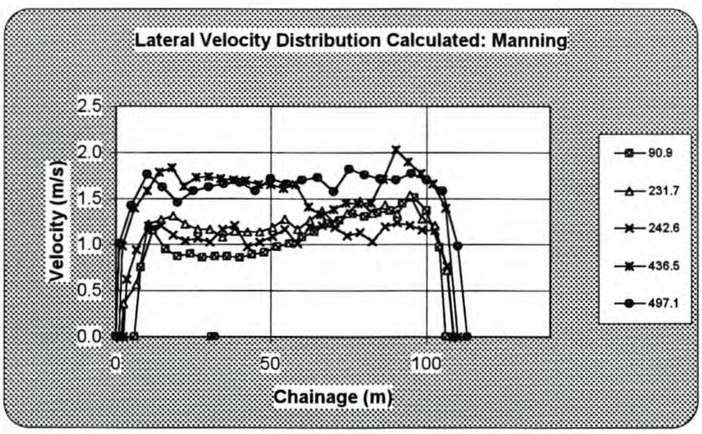
Delta value calculations

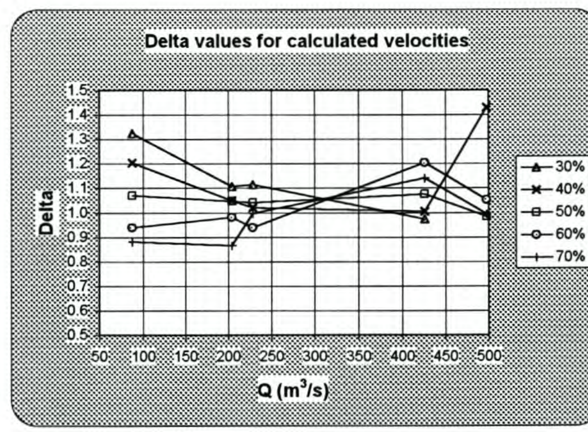
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	25.0	24.00	28.00	1.86	1.93	1.88	0.92
40%	30.0	28.00	32.00	1.93	1.92	1.93	0.90
50%	35.0	32.00	36.00	1.92	1.91	1.92	0.90
60%	40.0	40.00	44.00	1.80	1.76	1.80	0.96
70%	45.0	44.00	48.00	1.76	1.72	1.75	0.99

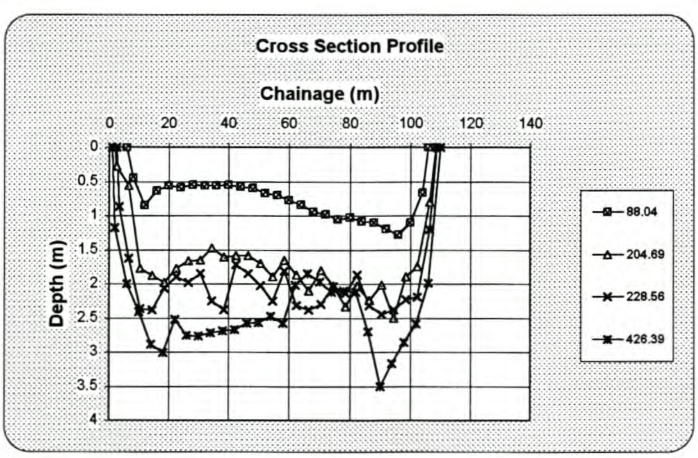
Statn No.: V6H002
River: Tugela
Place: Tugela Ferry











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : V6H002 START TIME : 9h40
RIVER NAME : Tugela Average Gaugeplate reading : 0.745 m
PLACE NAME : Tugela Ferry
DATE : 12/2/93

Main Channel LEFT : 15
Main Channel RIGHT : 105

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.121	78.5	88.04
1	6	0		0		0.000	0.0	0.00
2	8	0.45		0.5103		0.510	1.4	0.69
3	12	0.85		1.1895		1.190	3.4	4.04
4	16	0.64		1.3736		1.374	2.6	3.52
5	20	0.56		1.3081		1.308	2.2	2.93
6	24	0.59		1.2591		1.259	2.4	2.97
7	28	0.55		1.0217		1.022	2.2	2.25
8	32	0.56		1.0913		1.091	2.2	2.44
9	36	0.56		1.0749		1.075	2.2	2.41
10	40	0.55		1.1568		1.157	2.2	2.54
11	44	0.58		1.2754		1.275	2.3	2.96
12	48	0.6		1.124		1.124	2.4	2.70
13	52	0.67		1.2263		1.226	2.7	3.29
14	56	0.7		1.1568		1.157	2.8	3.24
15	60	0.78		1.2263		1.226	3.1	3.83
16	64	0.84		1.124		1.124	3.4	3.78
17	68	0.94		1.0381		1.038	3.8	3.90
18	72	0.98		1.2754		1.275	3.9	5.00
19	76	1.06		1.124		1.124	4.2	4.77
20	80	1.03		1.2591		1.259	4.1	5.19
21	84	1.08		1.1404		1.140	4.3	4.93
22	88	1.1		1.1731		1.173	4.4	5.16
23	92	1.2		1.1036		1.104	4.8	5.30
24	96	1.28		0.989		0.989	5.1	5.06
25	100	1.1		0.854		0.854	4.4	3.76
26	104	0.66		0.7067		0.707	2.0	1.40
27	106	0		0		0.000	0.0	0.00
28						0.000	0.0	0.00
29						0.000	0.0	0.00
						1.121	78.5	88.04

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	40.00	44.00	1.16	1.28	1.22	0.92
40%	51.0	48.00	52.00	1.12	1.23	1.20	0.93
50%	60.0	60.00	64.00	1.23	1.12	1.23	0.91
60%	69.0	68.00	72.00	1.04	1.28	1.10	1.02
70%	78.0	76.00	80.00	1.12	1.26	1.19	0.94

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.002
Q = 90.9
V_{AVR} = 1.16

Roughness coeff Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
6	0	2	0.0	4.0	0	0.00	0.00
8	0.45	2	1.4	3.0	0.45	1.01	0.75
12	0.85	2	3.4	4.0	0.85	3.90	1.15
16	0.64	2	2.6	4.0	0.64	2.43	0.95
20	0.56	2	2.2	4.0	0.56	1.94	0.87
24	0.59	2	2.4	4.0	0.59	2.12	0.90
28	0.55	2	2.2	4.0	0.55	1.89	0.86
32	0.56	2	2.2	4.0	0.56	1.94	0.87
36	0.56	2	2.2	4.0	0.56	1.94	0.87
40	0.55	2	2.2	4.0	0.55	1.89	0.86
44	0.58	2	2.3	4.0	0.58	2.06	0.89
48	0.6	2	2.4	4.0	0.6	2.18	0.91
52	0.67	2	2.7	4.0	0.67	2.62	0.98
56	0.7	2	2.8	4.0	0.7	2.82	1.01
60	0.78	2	3.1	4.0	0.78	3.38	1.08
64	0.84	2	3.4	4.0	0.84	3.82	1.14
68	0.94	2	3.8	4.0	0.94	4.61	1.23
72	0.98	2	3.9	4.0	0.98	4.94	1.26
76	1.06	2	4.2	4.0	1.06	5.63	1.33
80	1.03	2	4.1	4.0	1.03	5.37	1.30
84	1.08	2	4.3	4.0	1.08	5.81	1.35
88	1.1	2	4.4	4.0	1.1	5.99	1.36
92	1.2	2	4.8	4.0	1.2	6.93	1.44
96	1.28	2	5.1	4.0	1.28	7.71	1.51
100	1.1	2	4.4	4.0	1.1	5.99	1.36
104	0.66	2	2.0	3.0	0.66	1.92	0.97
106	0	2	0.0	1.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			78.53			90.86	1.16

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	40.00	44.00	0.86	0.89	0.87	1.32
40%	51.0	48.00	52.00	0.91	0.98	0.96	1.20
50%	60.0	60.00	64.00	1.08	1.14	1.08	1.07
60%	69.0	68.00	72.00	1.23	1.26	1.23	0.94
70%	78.0	76.00	80.00	1.33	1.30	1.32	0.88

Measured data

STATION No. : V6H002
RIVER NAME : Tugela
PLACE NAME : Tugela Ferry
DATE : 1/4/94

START TIME : 11h20
Average Gaugeplate reading : 1.73 m

Main Channel LEFT : 15
Main Channel RIGHT : 105

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.109	184.6	204.69
1	1.9	0		0		0.000	0.0	0.00
2	2.5	0.28		0.383		0.383	0.6	0.25
3	6.5	0.56		0.924		0.924	2.2	2.07
4	10.5	1.78		1.267		1.267	7.1	9.02
5	14.5	1.88		1.181		1.181	7.5	8.88
6	18.5	1.98		1.267		1.267	7.9	10.03
7	22.5	1.78		1.136		1.136	7.1	8.09
8	26.5	1.66		1.071		1.071	6.6	7.11
9	30.5	1.65		1.099		1.099	6.6	7.25
10	34.5	1.48		1.014		1.014	5.9	6.00
11	38.5	1.61		1.05		1.050	6.4	6.76
12	42.5	1.59		1.067		1.067	6.4	6.79
13	46.5	1.59		1.067		1.067	6.4	6.79
14	50.5	1.7		1.034		1.034	6.8	7.03
15	54.5	1.9		0.846		0.846	7.6	6.43
16	58.5	1.65		1.026		1.026	6.6	6.77
17	62.5	1.87		1.173		1.173	7.5	8.77
18	66.5	2.1		0.944		0.944	8.4	7.93
19	70.5	1.8		1.005		1.005	7.2	7.24
20	74.5	2.03		1.189		1.189	8.1	9.65
21	78.5	2.34		1.124		1.124	9.4	10.52
22	82.5	2.03		1.406		1.406	8.1	11.42
23	86.5	2.24		1.304		1.304	9.0	11.68
24	90.5	2.02		1.447		1.447	8.1	11.69
25	94.5	2.5		1.157		1.157	10.0	11.57
26	98.5	1.9		1.067		1.067	7.6	8.11
27	102.5	1.75		0.924		0.924	7.0	6.47
28	106.5	0.8		0.149		0.149	2.4	0.36
29	108.5	0		0.000		0.000	0.0	0.00
						1.109	184.6	204.69

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**42.0**	38.50	42.50	1.05	1.07	1.06	**1.04**
40%	**51.0**	50.50	54.50	1.03	0.85	1.01	**1.10**
50%	**60.0**	58.50	62.50	1.03	1.17	1.08	**1.03**
60%	**69.0**	66.50	70.50	0.94	1.01	0.98	**1.13**
70%	**78.0**	74.50	78.50	1.19	1.12	1.13	**0.98**

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope: 0.0008

Q = 231.7
V_{AVR} = 1.25

Roughness coeff Sub	n
0	
2	0.034
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
1.9	0	2	0.0	1.3	0	0.00	0.00
2.5	0.28	2	0.6	2.3	0.28	0.25	0.38
6.5	0.56	2	2.2	4.0	0.56	1.27	0.57
10.5	1.78	2	7.1	4.0	1.78	8.70	1.22
14.5	1.88	2	7.5	4.0	1.88	9.53	1.27
18.5	1.98	2	7.9	4.0	1.98	10.39	1.31
22.5	1.78	2	7.1	4.0	1.78	8.70	1.22
26.5	1.66	2	6.6	4.0	1.66	7.74	1.17
30.5	1.65	2	6.6	4.0	1.65	7.67	1.16
34.5	1.48	2	5.9	4.0	1.48	6.40	1.08
38.5	1.61	2	6.4	4.0	1.61	7.36	1.14
42.5	1.59	2	6.4	4.0	1.59	7.21	1.13
46.5	1.59	2	6.4	4.0	1.59	7.21	1.13
50.5	1.7	2	6.8	4.0	1.7	8.06	1.18
54.5	1.9	2	7.6	4.0	1.9	9.70	1.28
58.5	1.65	2	6.6	4.0	1.65	7.67	1.16
62.5	1.87	2	7.5	4.0	1.87	9.44	1.26
66.5	2.1	2	8.4	4.0	2.1	11.46	1.36
70.5	1.8	2	7.2	4.0	1.8	8.86	1.23
74.5	2.03	2	8.1	4.0	2.03	10.83	1.33
78.5	2.34	2	9.4	4.0	2.34	13.72	1.47
82.5	2.03	2	8.1	4.0	2.03	10.83	1.33
86.5	2.24	2	9.0	4.0	2.24	12.76	1.42
90.5	2.02	2	8.1	4.0	2.02	10.74	1.33
94.5	2.5	2	10.0	4.0	2.5	15.32	1.53
98.5	1.9	2	7.6	4.0	1.9	9.70	1.28
102.5	1.75	2	7.0	4.0	1.75	8.46	1.21
106.5	0.8	2	2.4	3.0	0.8	1.72	0.72
108.5	0	2	0.0	1.0	0	0.00	0.00
			184.60			231.67	1.25

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**42.0**	38.50	42.50	1.14	1.13	1.13	**1.11**
40%	**51.0**	50.50	54.50	1.16	1.28	1.20	**1.05**
50%	**60.0**	58.50	62.50	1.16	1.28	1.20	**1.05**
60%	**69.0**	66.50	70.50	1.36	1.23	1.28	**0.98**
70%	**78.0**	74.50	78.50	1.33	1.47	1.45	**0.87**

Measured data

STATION No. : V6H002   START TIME : 12h35

RIVER NAME : Tugela   Average Gaugeplate reading : 1.842 m

PLACE NAME : Tugela Ferry

DATE : 3/16/94

Main Channel LEFT : 15

Main Channel RIGHT : 105

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.063	217.0	228.56
1	2.5	0		0		0.000	0.0	0.00
2	3.5	0.87		0.252		0.252	1.7	0.44
3	6.5	1.63		0.842		0.842	5.7	4.80
4	10.5	2.36		1.157		1.157	9.4	10.92
5	14.5	2.38		1.079		1.079	9.5	10.27
6	18.5	2.07		1.181		1.181	8.3	9.78
7	22.5	1.9		1.108		1.108	7.6	8.42
8	26.5	1.98		1.063		1.063	7.9	8.42
9	30.5	1.85		1.018		1.018	7.4	7.53
10	34.5	2.25		0.985		0.985	9.0	8.87
11	38.5	2.38		1.104		1.104	9.5	10.51
12	42.5	1.72		1.054		1.054	6.9	7.25
13	46.5	1.85		1.21		1.210	7.4	8.95
14	50.5	2.03		1.112		1.112	8.1	9.03
15	54.5	2.25		1.181		1.181	9.0	10.63
16	58.5	1.81		1.239		1.239	7.2	8.97
17	62.5	2.32		1.063		1.063	9.3	9.86
18	66.5	2.38		0.899		0.899	9.5	8.56
19	70.5	2.3		1.165		1.165	9.2	10.72
20	74.5	2.04		1.206		1.206	8.2	9.84
21	78.5	2.14		1.144		1.144	8.6	9.79
22	82.5	1.87		1.116		1.116	7.5	8.35
23	86.5	2.32		1.042		1.042	9.3	9.67
24	90.5	2.45		1.108		1.108	9.8	10.86
25	94.5	2.38		1.14		1.140	9.5	10.85
26	98.5	2.23		0.809		0.809	8.9	7.22
27	102.5	2.2		0.87		0.870	8.8	7.66
28	106.5	1.21		0.104		0.104	3.8	0.39
29	108.7	0		0.000		0.000	0.0	0.00
						1.063	217.0	228.56

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**42.0**	38.50	42.50	1.10	1.05	1.06	**0.99**
40%	**51.0**	50.50	54.50	1.11	1.18	1.12	**0.94**
50%	**60.0**	58.50	62.50	1.24	1.06	1.17	**0.90**
60%	**69.0**	66.50	70.50	0.90	1.17	1.07	**0.99**
70%	**78.0**	74.50	78.50	1.21	1.14	1.15	**0.91**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M		Q =	242.6
	Slope	0.0005	V_{AVR} =	1.12

Roughness coeff.		Area reduction factor	
Sub	n	Sub	f_A
0		0	1
2	0.033	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
2.5	0	2	0.0	1.8	0	0.00	0.00
3.5	0.87	2	1.7	2.0	0.87	1.07	0.62
6.5	1.63	2	5.7	3.5	1.63	5.36	0.94
10.5	2.36	2	9.4	4.0	2.36	11.34	1.20
14.5	2.38	2	9.5	4.0	2.38	11.50	1.21
18.5	2.07	2	8.3	4.0	2.07	9.11	1.10
22.5	1.9	2	7.6	4.0	1.9	7.90	1.04
26.5	1.98	2	7.9	4.0	1.98	8.46	1.07
30.5	1.85	2	7.4	4.0	1.85	7.56	1.02
34.5	2.25	2	9.0	4.0	2.25	10.47	1.16
38.5	2.38	2	9.5	4.0	2.38	11.50	1.21
42.5	1.72	2	6.9	4.0	1.72	6.69	0.97
46.5	1.85	2	7.4	4.0	1.85	7.56	1.02
50.5	2.03	2	8.1	4.0	2.03	8.82	1.09
54.5	2.25	2	9.0	4.0	2.25	10.47	1.16
58.5	1.81	2	7.2	4.0	1.81	7.29	1.01
62.5	2.32	2	9.3	4.0	2.32	11.02	1.19
66.5	2.38	2	9.5	4.0	2.38	11.50	1.21
70.5	2.3	2	9.2	4.0	2.3	10.86	1.18
74.5	2.04	2	8.2	4.0	2.04	8.89	1.09
78.5	2.14	2	8.6	4.0	2.14	9.63	1.13
82.5	1.87	2	7.5	4.0	1.87	7.69	1.03
86.5	2.32	2	9.3	4.0	2.32	11.02	1.19
90.5	2.45	2	9.8	4.0	2.45	12.07	1.23
94.5	2.38	2	9.5	4.0	2.38	11.50	1.21
98.5	2.23	2	8.9	4.0	2.23	10.32	1.16
102.5	2.2	2	8.8	4.0	2.2	10.09	1.15
106.5	1.21	2	3.8	3.1	1.21	2.89	0.77
108.7	0	2	0.0	1.1	0	0.00	0.00
			217.04			242.57	1.12

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**42.0**	38.50	42.50	1.21	0.97	1.00	**1.12**
40%	**51.0**	50.50	54.50	1.09	1.16	1.10	**1.02**
50%	**60.0**	58.50	62.50	1.01	1.19	1.07	**1.04**
60%	**69.0**	66.50	70.50	1.21	1.18	1.19	**0.94**
70%	**78.0**	74.50	78.50	1.09	1.13	1.12	**1.00**

Measured data

STATION No. : V6H002 START TIME : 10h00
RIVER NAME : Tugela Average Gaugeplate reading : 2.455 m
PLACE NAME : Tugela Ferry
DATE : 2/6/94

Main Channel LEFT : 15
Main Channel RIGHT : 105

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.606	265.5	426.39
1	1	0		0		0.000	0.0	0.00
2	2	1.18		0.974		0.974	3.0	2.87
3	6	2		1.457		1.457	8.0	11.66
4	10	2.41		1.64		1.640	9.6	15.81
5	14	2.89		1.714		1.714	11.6	19.81
6	18	3.01		1.876		1.876	12.0	22.59
7	22	2.52		1.915		1.915	10.1	19.30
8	26	2.76		1.871		1.871	11.0	20.66
9	30	2.77		1.771		1.771	11.1	19.62
10	34	2.72		1.749		1.749	10.9	19.03
11	38	2.69		1.906		1.906	10.8	20.51
12	42	2.67		1.701		1.701	10.7	18.17
13	46	2.58		1.523		1.523	10.3	15.72
14	50	2.57		1.71		1.710	10.3	17.58
15	54	2.48		1.662		1.662	9.9	16.49
16	58	2.58		1.54		1.540	10.3	15.89
17	62	2.02		1.767		1.767	8.1	14.28
18	66	1.85		1.915		1.915	7.4	14.17
19	70	1.97		1.945		1.945	7.9	15.33
20	74	2.12		1.88		1.880	8.5	15.94
21	78	2.1		1.85		1.850	8.4	15.54
22	82	2.12		1.775		1.775	8.5	15.05
23	86	2.7		1.658		1.658	10.8	17.91
24	90	3.5		1.083		1.083	14.0	15.16
25	94	3.17		1.357		1.357	12.7	17.21
26	98	2.86		1.366		1.366	11.4	15.63
27	102	2.59		1.148		1.148	10.4	11.89
28	106	1.99		0.324		0.324	8.0	2.58
29	110	0		0.000		0.000	0.0	0.00
						1.606	265.5	426.39

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	42.00	46.00	1.70	1.52	1.70	0.94
40%	51.0	50.00	54.00	1.71	1.66	1.70	0.95
50%	60.0	58.00	62.00	1.54	1.77	1.65	0.97
60%	69.0	66.00	70.00	1.92	1.95	1.94	0.83
70%	78.0	78.00	82.00	1.85	1.78	1.85	0.87

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.001
Q = 436.5
V_{AVR} = 1.64

Roughness coeff. Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
1	0	2	0.0	1.0	0	0.00	0.00
2	1.18	2	3.0	2.5	1.18	2.89	0.98
6	2	2	8.0	4.0	2	11.16	1.39
10	2.41	2	9.6	4.0	2.41	15.22	1.58
14	2.89	2	11.6	4.0	2.89	20.60	1.78
18	3.01	2	12.0	4.0	3.01	22.05	1.83
22	2.52	2	10.1	4.0	2.52	16.40	1.63
26	2.76	2	11.0	4.0	2.76	19.08	1.73
30	2.77	2	11.1	4.0	2.77	19.20	1.73
34	2.72	2	10.9	4.0	2.72	18.62	1.71
38	2.69	2	10.8	4.0	2.69	18.28	1.70
42	2.67	2	10.7	4.0	2.67	18.06	1.69
46	2.58	2	10.3	4.0	2.58	17.05	1.65
50	2.57	2	10.3	4.0	2.57	16.94	1.65
54	2.48	2	9.9	4.0	2.48	15.97	1.61
58	2.58	2	10.3	4.0	2.58	17.05	1.66
62	2.02	2	8.1	4.0	2.02	11.34	1.40
66	1.85	2	7.4	4.0	1.85	9.80	1.32
70	1.97	2	7.9	4.0	1.97	10.88	1.38
74	2.12	2	8.5	4.0	2.12	12.29	1.45
78	2.1	2	8.4	4.0	2.1	12.10	1.44
82	2.12	2	8.5	4.0	2.12	12.29	1.45
86	2.7	2	10.8	4.0	2.7	18.39	1.70
90	3.5	2	14.0	4.0	3.5	28.35	2.02
94	3.17	2	12.7	4.0	3.17	24.04	1.90
98	2.86	2	11.4	4.0	2.86	20.25	1.77
102	2.59	2	10.4	4.0	2.59	17.16	1.66
106	1.99	2	8.0	4.0	1.99	11.06	1.39
110	0	2	0.0	2.0	0	0.00	0.00
			265.51			436.52	1.64

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	42.00	46.00	1.69	1.65	1.69	0.97
40%	51.0	50.00	54.00	1.65	1.61	1.64	1.00
50%	60.0	58.00	62.00	1.65	1.40	1.53	1.08
60%	69.0	66.00	70.00	1.32	1.38	1.37	1.20
70%	78.0	78.00	82.00	1.44	1.45	1.44	1.14

Measured data

STATION No. : V6H002
RIVER NAME : Tugela
PLACE NAME : Tugela Ferry
DATE : 2/6/94

START TIME : 12h30
Average Gaugeplate reading : 2.555 m

Main Channel LEFT : 15
Main Channel RIGHT : 105

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.648	301.9	497.47
1	0	0		0		0.000	0.0	0.00
2	1	1.33		1.104		1.104	3.3	3.67
3	5	2.22		1.518		1.518	10.0	15.16
4	10	3.07		1.693		1.693	15.4	25.99
5	15	2.71		1.906		1.906	13.6	25.83
6	20	2.31		2.02		2.020	11.6	23.33
7	25	2.62		1.767		1.767	13.1	23.15
8	30	2.71		1.854		1.854	13.6	25.12
9	35	2.8		2.015		2.015	14.0	28.21
10	40	2.84		1.775		1.775	14.2	25.21
11	45	2.61		1.793		1.793	13.1	23.40
12	50	2.94		1.732		1.732	14.7	25.46
13	55	2.8		1.728		1.728	14.0	24.19
14	60	2.92		1.736		1.736	14.6	25.35
15	65	2.99		1.627		1.627	15.0	24.32
16	70	2.59		1.51		1.510	13.0	19.55
17	75	3.22		1.667		1.667	16.1	26.84
18	80	3.06		1.379		1.379	15.3	21.10
19	85	2.95		1.47		1.470	14.8	21.68
20	90	2.92		1.719		1.719	14.6	25.10
21	95	3.09		1.575		1.575	15.5	24.33
22	100	2.92		1.457		1.457	14.6	21.27
23	105	2.62		1.292		1.292	13.1	16.93
24	110	1.28		0.446		0.446	5.1	2.28
25	113	0		0		0.000	0.0	0.00
26						0.000	0.0	0.00
27						0.000	0.0	0.00
28						0.000	0.0	0.00
29						0.000	0.0	0.00
						1.648	301.9	497.47

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	40.00	45.00	1.78	1.79	1.78	0.92
40%	51.0	50.00	55.00	1.73	1.73	1.73	0.95
50%	60.0	60.00	65.00	1.74	1.63	1.74	0.95
60%	69.0	65.00	70.00	1.63	1.51	1.53	1.07
70%	78.0	75.00	80.00	1.67	1.38	1.49	1.10

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0009

Q = 497.1
V_{AVR} = 1.65

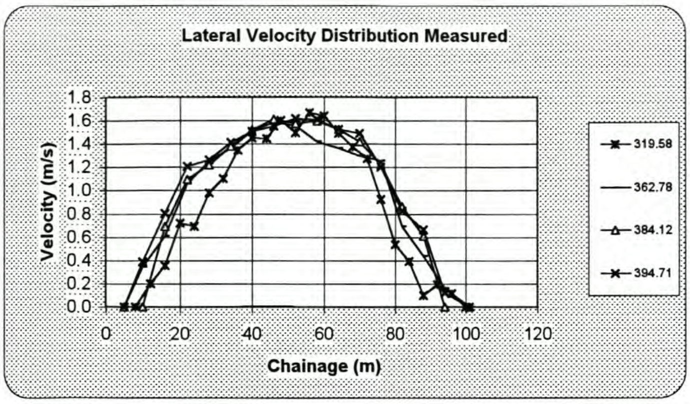
Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.036	2	1
0		0	1

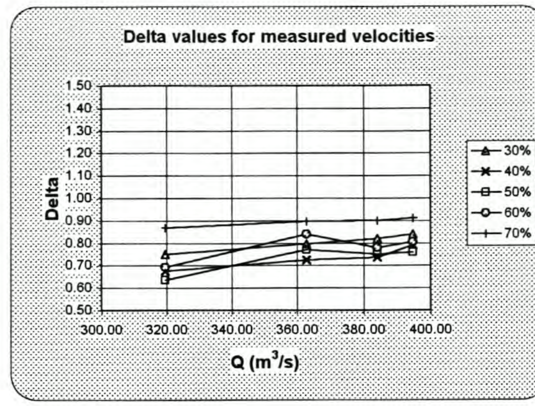
Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
45	0	2	0.0	0.0	0	0.00	0.00
49.6	1.33	2	3.3	2.5	1.33	3.35	1.01
53.6	2.22	2	10.0	4.5	2.22	14.17	1.42
57.6	3.07	2	15.4	5.0	3.07	27.02	1.76
61.6	2.71	2	13.6	5.0	2.71	21.95	1.62
65.6	2.31	2	11.6	5.0	2.31	16.82	1.45
69.6	2.62	2	13.1	5.0	2.62	20.75	1.58
73.6	2.71	2	13.6	5.0	2.71	21.95	1.62
77.6	2.8	2	14.0	5.0	2.8	23.18	1.66
81.6	2.84	2	14.2	5.0	2.84	23.73	1.67
85.6	2.61	2	13.1	5.0	2.61	20.62	1.58
89.6	2.94	2	14.7	5.0	2.94	25.14	1.71
93.6	2.8	2	14.0	5.0	2.8	23.16	1.66
97.6	2.92	2	14.6	5.0	2.92	24.86	1.70
101.6	2.99	2	15.0	5.0	2.99	25.86	1.73
105.6	2.59	2	13.0	5.0	2.59	20.35	1.57
109.6	3.22	2	16.1	5.0	3.22	29.26	1.82
113.6	3.06	2	15.3	5.0	3.06	26.87	1.76
117.6	2.95	2	14.8	5.0	2.95	25.28	1.71
121.2	2.92	2	14.6	5.0	2.92	24.86	1.70
	3.09	2	15.5	5.0	3.09	27.31	1.77
	2.92	2	14.6	5.0	2.92	24.86	1.70
	2.62	2	13.1	5.0	2.62	20.75	1.58
	1.28	2	5.1	4.0	1.28	5.03	0.98
	0	2	0.0	1.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			301.89			497.12	1.65

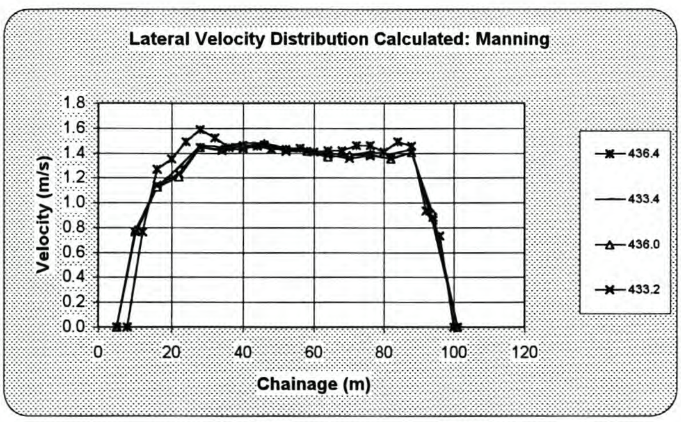
Delta value calculations

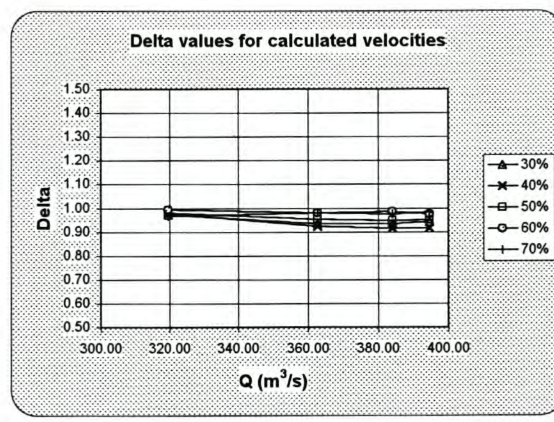
% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	42.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
40%	51.0	49.60	53.60	1.01	1.42	1.15	1.43
50%	60.0	57.60	61.60	1.76	1.62	1.68	0.98
60%	69.0	65.60	69.60	1.46	1.58	1.58	1.05
70%	78.0	77.60	81.60	1.66	1.67	1.66	0.99

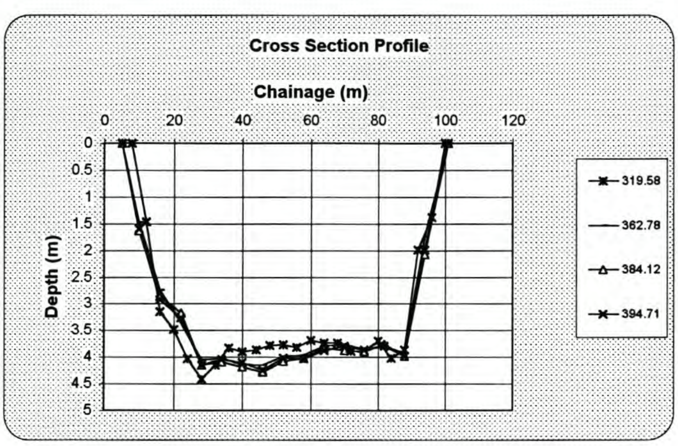
Statn No.: W4H013
River: Pongola
Place: Josini











The values in the legend block describe measured discharge for the profile indicated

Measured data

STATION No. : W4H013
RIVER NAME : Pongola
PLACE NAME : Josini
DATE : 9/16/84

START TIME : 13h00
Average Gaugeplate reading : 1.44 m
Main Channel LEFT : 30
Main Channel RIGHT : 74

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						0.434	223.0	96.81
1	0	0		0		0.000	0.0	0.00
2	4	1.82		0.079		0.079	7.3	0.58
3	8	2.34		0.487		0.487	9.4	4.56
4	12	2.35		0.585		0.585	9.4	5.50
5	16	2.37		0.712		0.712	9.5	6.75
6	20	2.37		0.832		0.832	9.5	7.89
7	24	2.35		0.75		0.750	9.4	7.05
8	28	2.3		0.836		0.836	9.2	7.69
9	32	2.65		0.866		0.866	10.6	9.18
10	36	2.82		0.838		0.838	11.3	9.45
11	40	3.09		0.804		0.804	12.4	9.94
12	44	3.44		0.662		0.662	13.8	9.11
13	48	3.88		0.588		0.588	15.5	9.13
14	52	4.65		0.21		0.210	18.6	3.91
15	56	5.51		0.118		0.118	22.0	2.60
16	60	5.32		0.07		0.070	21.3	1.49
17	64	4.4		0.081		0.081	17.6	1.43
18	68	3.27		0.035		0.035	16.4	0.57
19	74	0		0		0.000	0.0	0.00
						0.434	223.0	96.81

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	43.2	40.00	44.00	0.80	0.66	0.69	0.63
40%	47.6	44.00	48.00	0.66	0.59	0.60	0.73
50%	52.0	52.00	56.00	0.21	0.12	0.21	2.07
60%	56.4	56.00	60.00	0.12	0.07	0.11	3.84
70%	60.8	60.00	64.00	0.07	0.08	0.07	6.01

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.00005

Q = 104.6
V_{AVR} = 0.47

Roughness coeff. Sub	n
0	
2	0.035
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
4	1.82	2	7.3	4.0	1.82	2.19	0.30
8	2.34	2	9.4	4.0	2.34	3.33	0.36
12	2.35	2	9.4	4.0	2.35	3.36	0.36
16	2.37	2	9.5	4.0	2.37	3.40	0.36
20	2.37	2	9.5	4.0	2.37	3.40	0.36
24	2.35	2	9.4	4.0	2.35	3.36	0.36
28	2.3	2	9.2	4.0	2.3	3.24	0.35
32	2.65	2	10.6	4.0	2.65	4.10	0.39
36	2.82	2	11.3	4.0	2.82	4.55	0.40
40	3.09	2	12.4	4.0	3.09	5.30	0.43
44	3.44	2	13.8	4.0	3.44	6.33	0.46
48	3.88	2	15.5	4.0	3.88	7.74	0.50
52	4.65	2	18.6	4.0	4.65	10.47	0.56
56	5.51	2	22.0	4.0	5.51	13.89	0.63
60	5.32	2	21.3	4.0	5.32	13.10	0.62
64	4.4	2	17.6	4.0	4.4	9.55	0.54
68	3.27	2	16.4	5.0	3.27	7.28	0.45
74	0	2	0.0	3.0	0	0.00	0.00
			222.99			104.60	0.47

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	43.2	40.00	44.00	0.43	0.46	0.45	1.03
40%	47.6	44.00	48.00	0.46	0.50	0.50	0.95
50%	52.0	52.00	56.00	0.56	0.63	0.56	0.83
60%	56.4	56.00	60.00	0.63	0.62	0.63	0.75
70%	60.8	60.00	64.00	0.62	0.54	0.60	0.78

Measured data

STATION No. :	W4H013	START TIME :	07h30
RIVER NAME :	Pongola	Average Gaugeplate reading :	3.9 m
PLACE NAME :	Josini		
DATE :	9/16/84		
		Main Channel LEFT :	30
		Main Channel RIGHT :	74

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						0.575	246.3	141.59
1	0	0		0		0.000	0.0	0.00
2	4	1.45		0.043		0.043	5.8	0.25
3	8	2.58		0.397		0.397	10.3	4.10
4	12	2.63		0.735		0.735	10.5	7.73
5	16	2.61		0.911		0.911	10.4	9.51
6	20	2.6		1.037		1.037	10.4	10.78
7	24	2.62		1.155		1.155	10.5	12.10
8	28	2.64		1.029		1.029	10.6	10.87
9	32	2.82		1.099		1.099	11.3	12.40
10	36	2.93		1.02		1.020	11.7	11.95
11	40	3.19		1.067		1.067	12.8	13.61
12	44	3.5		1.048		1.048	14.0	14.67
13	48	3.93		0.919		0.919	15.7	14.45
14	52	4.41		0.631		0.631	17.6	11.13
15	56	5.22		0.154		0.154	20.9	3.22
16	60	5.72		0.043		0.043	22.9	0.98
17	64	4.99		0.062		0.062	20.0	1.24
18	68	4.1		0.091		0.091	16.4	1.49
19	72	2.9		0.076		0.076	14.5	1.10
						0.575	**246.3**	**141.59**

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	**43.2**	40.00	44.00	1.07	1.05	1.05	**0.55**
40%	**47.6**	44.00	48.00	1.05	0.92	0.93	**0.62**
50%	**52.0**	52.00	56.00	0.63	0.15	0.63	**0.91**
60%	**56.4**	56.00	60.00	0.15	0.04	0.14	**4.02**
70%	**60.8**	60.00	64.00	0.04	0.06	0.05	**12.29**

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	154.0
Slope	0.00008	V_{AVR} =	0.63

Roughness coeff Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.034	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
4	1.45	2	5.8	4.0	1.45	1.95	0.34
8	2.58	2	10.3	4.0	2.58	5.11	0.49
12	2.63	2	10.5	4.0	2.63	5.27	0.50
16	2.61	2	10.4	4.0	2.61	5.21	0.50
20	2.6	2	10.4	4.0	2.6	5.17	0.50
24	2.62	2	10.5	4.0	2.62	5.24	0.50
28	2.64	2	10.6	4.0	2.64	5.31	0.50
32	2.82	2	11.3	4.0	2.82	5.92	0.53
36	2.93	2	11.7	4.0	2.93	6.31	0.54
40	3.19	2	12.8	4.0	3.19	7.27	0.57
44	3.5	2	14.0	4.0	3.5	8.49	0.61
48	3.93	2	15.7	4.0	3.93	10.30	0.66
52	4.41	2	17.6	4.0	4.41	12.48	0.71
56	5.22	2	20.9	4.0	5.22	16.53	0.79
60	5.72	2	22.9	4.0	5.72	19.25	0.84
64	4.99	2	20.0	4.0	4.99	15.33	0.77
68	4.1	2	16.4	4.0	4.1	11.05	0.67
72	2.9	2	14.5	5.0	2.9	7.76	0.53
			246.26			**153.96**	**0.63**

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	**43.2**	40.00	44.00	0.57	0.61	0.60	**1.04**
40%	**47.6**	44.00	48.00	0.61	0.66	0.65	**0.96**
50%	**52.0**	52.00	56.00	0.71	0.79	0.71	**0.88**
60%	**56.4**	56.00	60.00	0.79	0.84	0.80	**0.78**
70%	**60.8**	60.00	64.00	0.84	0.77	0.83	**0.76**

Measured data

STATION No. : W4H013 | START TIME : 06h00
RIVER NAME : Pongola | Average Gaugeplate reading : 1.94 m
PLACE NAME : Josini
DATE : 9/17/84
Main Channel LEFT : 30
Main Channel RIGHT : 74

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						0.778	269.6	209.81
1	0	0		0		0.000	0.0	0.00
2	4	1.58		0.049		0.049	6.3	0.31
3	8	2.82		0.487		0.487	11.3	5.49
4	12	2.95		0.812		0.812	11.8	9.58
5	16	2.93		1.063		1.063	11.7	12.46
6	20	2.86		1.262		1.262	11.4	14.44
7	24	2.94		1.277		1.277	11.8	15.02
8	28	2.97		1.359		1.359	11.9	16.14
9	32	2.99		1.493		1.493	12.0	17.86
10	36	3.21		1.339		1.339	12.8	17.19
11	40	3.49		1.496		1.496	14.0	20.88
12	44	3.94		1.367		1.367	15.8	21.54
13	48	4.24		1.251		1.251	17.0	21.22
14	52	4.8		0.9		0.900	19.2	17.28
15	56	5.68		0.472		0.472	22.7	10.72
16	60	6.05		0.17		0.170	24.2	4.11
17	64	5.53		0.108		0.108	22.1	2.39
18	68	4.45		0.097		0.097	17.8	1.73
19	72	3.24		0.104		0.104	13.0	1.35
						0.778	269.6	209.81

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	43.2	40.00	44.00	1.50	1.37	1.39	0.56
40%	47.6	44.00	48.00	1.37	1.25	1.26	0.62
50%	52.0	52.00	56.00	0.90	0.47	0.90	0.86
60%	56.4	56.00	60.00	0.47	0.17	0.44	1.76
70%	60.8	60.00	64.00	0.17	0.11	0.16	4.94

Calculated data, 1-dimensional flow theory

Manning or Chezy: M | Slope 0.00013 | Q = 233.3 | V_{AVR} = 0.87

Roughness coeff. Sub	n
0	
2	0.033
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
4	1.58	2	6.3	4.0	1.58	2.96	0.47
8	2.82	2	11.3	4.0	2.82	7.78	0.69
12	2.95	2	11.8	4.0	2.95	8.39	0.71
16	2.93	2	11.7	4.0	2.93	8.29	0.71
20	2.86	2	11.4	4.0	2.86	7.96	0.70
24	2.94	2	11.8	4.0	2.94	8.34	0.71
28	2.97	2	11.9	4.0	2.97	8.48	0.71
32	2.99	2	12.0	4.0	2.99	8.58	0.72
36	3.21	2	12.8	4.0	3.21	9.65	0.75
40	3.49	2	14.0	4.0	3.49	11.10	0.79
44	3.94	2	15.8	4.0	3.94	13.58	0.86
48	4.24	2	17.0	4.0	4.24	15.35	0.91
52	4.8	2	19.2	4.0	4.8	18.88	0.98
56	5.68	2	22.7	4.0	5.68	24.99	1.10
60	6.05	2	24.2	4.0	6.05	27.76	1.15
64	5.53	2	22.1	4.0	5.53	23.90	1.08
68	4.45	2	17.8	4.0	4.45	16.64	0.93
72	3.24	2	13.0	4.0	3.24	9.80	0.76
			269.55			233.30	0.87

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	43.2	40.00	44.00	0.79	0.86	0.85	1.02
40%	47.6	44.00	48.00	0.86	0.91	0.90	0.96
50%	52.0	52.00	56.00	0.98	1.10	0.98	0.88
60%	56.4	56.00	60.00	1.10	1.15	1.10	0.78
70%	60.8	60.00	64.00	1.15	1.08	1.13	0.76

Measured data

STATION No. : W4H013 — START TIME : 08h45
RIVER NAME : Pongola — Average Gaugeplate reading : 2.48 m
PLACE NAME : Josini
DATE : 8/25/94

Main Channel LEFT : 10
Main Channel RIGHT : 100

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s)	8 Area (m^2)	9 Q (m^3/s)
						1.030	310.3	319.58
1	8	0		0		0.000	0.0	0.00
2	12	1.47		0.199		0.199	5.9	1.17
3	16	3.15		0.355		0.355	12.6	4.47
4	20	3.48		0.719		0.719	13.9	10.01
5	24	4.03		0.694		0.694	16.1	11.19
6	28	4.42		0.981		0.981	17.7	17.34
7	32	4.15		1.104		1.104	16.6	18.33
8	36	3.83		1.345		1.345	15.3	20.61
9	40	3.9		1.451		1.451	15.6	22.64
10	44	3.87		1.447		1.447	15.5	22.40
11	48	3.78		1.603		1.603	15.1	24.24
12	52	3.77		1.496		1.496	15.1	22.56
13	56	3.82		1.668		1.668	15.3	25.49
14	60	3.69		1.64		1.640	14.8	24.21
15	64	3.73		1.488		1.488	14.9	22.20
16	68	3.74		1.374		1.374	15.0	20.56
17	72	3.89		1.275		1.275	15.6	19.84
18	76	3.89		0.924		0.924	15.6	14.38
19	80	3.7		0.535		0.535	14.8	7.92
						1.030	310.3	319.58

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	36.00	40.00	1.35	1.45	1.37	0.75
40%	46.0	44.00	48.00	1.45	1.60	1.53	0.68
50%	55.0	52.00	56.00	1.50	1.67	1.63	0.63
60%	64.0	64.00	68.00	1.49	1.37	1.49	0.69
70%	73.0	72.00	76.00	1.28	0.92	1.19	0.87

Calculated data, 1-dimensional flow theory

Manning or Chezy: M — Slope 0.00045

Q = 436.4
V_{AVR} = 1.41

Roughness coeff Sub	n
0	
2	0.036
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
8	0	2	0.0	6.0	0	0.00	0.00
12	1.47	2	5.9	4.0	1.47	4.48	0.76
16	3.15	2	12.6	4.0	3.15	15.95	1.27
20	3.48	2	13.9	4.0	3.48	18.84	1.35
24	4.03	2	16.1	4.0	4.03	24.06	1.49
28	4.42	2	17.7	4.0	4.42	28.06	1.59
32	4.15	2	16.6	4.0	4.15	25.26	1.52
36	3.83	2	15.3	4.0	3.83	22.10	1.44
40	3.9	2	15.6	4.0	3.9	22.78	1.46
44	3.87	2	15.5	4.0	3.87	22.48	1.45
48	3.78	2	15.1	4.0	3.78	21.62	1.43
52	3.77	2	15.1	4.0	3.77	21.52	1.43
56	3.82	2	15.3	4.0	3.82	22.00	1.44
60	3.69	2	14.8	4.0	3.69	20.77	1.41
64	3.73	2	14.9	4.0	3.73	21.15	1.42
68	3.74	2	15.0	4.0	3.74	21.24	1.42
72	3.89	2	15.6	4.0	3.89	22.68	1.46
76	3.89	2	15.6	4.0	3.89	22.68	1.46
80	3.7	2	14.8	4.0	3.7	20.86	1.41
			310.28			436.42	1.41

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	36.00	40.00	1.44	1.46	1.45	0.97
40%	46.0	44.00	48.00	1.45	1.43	1.44	0.98
50%	55.0	52.00	56.00	1.43	1.44	1.44	0.98
60%	64.0	64.00	68.00	1.42	1.42	1.42	0.99
70%	73.0	72.00	76.00	1.46	1.46	1.46	0.97

Measured data

STATION No. : W4H013
RIVER NAME : Pongola
PLACE NAME : Josini
DATE : 3/7/85

START TIME : 10h00
Average Gaugeplate reading : 2.58 m

Main Channel LEFT : 10
Main Channel RIGHT : 100

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.146	316.7	362.78
1	5	0		0		0.000	0.0	0.00
2	10	1.48		0.345		0.345	8.1	2.81
3	16	2.74		0.611		0.611	16.4	10.04
4	22	3.36		1.056		1.056	20.2	21.29
5	28	4.06		1.251		1.251	24.4	30.47
6	34	4.02		1.361		1.361	24.1	32.83
7	40	4.14		1.513		1.513	24.8	37.58
8	46	4.15		1.585		1.585	24.9	39.47
9	52	3.98		1.559		1.559	23.9	37.23
10	58	3.96		1.42		1.420	23.8	33.74
11	64	3.8		1.365		1.365	22.8	31.12
12	70	3.76		1.297		1.297	22.6	29.26
13	76	3.85		1.259		1.259	23.1	29.08
14	82	3.79		0.692		0.692	22.7	15.74
15	88	3.93		0.438		0.438	23.6	10.33
16	94	1.74		0.158		0.158	11.3	1.79
17	101	0		0		0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						1.146	316.7	362.78

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	1.36	1.51	1.44	0.80
40%	46.0	46.00	52.00	1.59	1.56	1.59	0.72
50%	55.0	52.00	58.00	1.56	1.42	1.49	0.77
60%	64.0	64.00	70.00	1.37	1.30	1.37	0.84
70%	73.0	70.00	76.00	1.30	1.26	1.28	0.90

Calculated data, 1-dimensional flow theory

Manning or Chezy: M

Slope 0.0005

Q = 433.4
V_{AVR} = 1.37

Roughness coeff. Sub	n
0	
2	0.039
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
5	0	2	0.0	5.0	0	0.00	0.00
10	1.48	2	8.1	5.5	1.48	6.06	0.74
16	2.74	2	16.4	6.0	2.74	18.46	1.12
22	3.36	2	20.2	6.0	3.36	25.93	1.29
28	4.06	2	24.4	6.0	4.06	35.55	1.46
34	4.02	2	24.1	6.0	4.02	34.96	1.45
40	4.14	2	24.8	6.0	4.14	36.72	1.48
46	4.15	2	24.9	6.0	4.15	36.87	1.48
52	3.98	2	23.9	6.0	3.98	34.39	1.44
58	3.96	2	23.8	6.0	3.96	34.10	1.44
64	3.8	2	22.8	6.0	3.8	31.83	1.40
70	3.76	2	22.6	6.0	3.76	31.28	1.39
76	3.85	2	23.1	6.0	3.85	32.53	1.41
82	3.79	2	22.7	6.0	3.79	31.69	1.39
88	3.93	2	23.6	6.0	3.93	33.67	1.43
94	1.74	2	11.3	6.5	1.74	9.38	0.83
101	0	2	0.0	3.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			316.69			433.42	1.37

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	1.45	1.48	1.46	0.93
40%	46.0	46.00	52.00	1.48	1.44	1.48	0.92
50%	55.0	52.00	58.00	1.44	1.44	1.44	0.95
60%	64.0	64.00	70.00	1.40	1.39	1.40	0.98
70%	73.0	70.00	76.00	1.39	1.41	1.40	0.98

Measured data

STATION No. :	W4H013	START TIME :	09H17
RIVER NAME :	Pongola	Average Gaugeplate reading :	2.67 m
PLACE NAME :	Josini		
DATE :	3/8/85		
		Main Channel LEFT :	10
		Main Channel RIGHT :	100

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.187	323.7	384.12
1	5	0	0	0	0	0.000	0.0	0.00
2	10	1.64	0	0	0	0.000	9.0	0.00
3	16	2.86	0.92467	0.624091	0.602924	0.694	17.2	11.91
4	22	3.17	1.216781	1.132111	0.916203	1.099	19.0	20.91
5	28	4.15	1.398822	1.250649	0.971238	1.218	24.9	30.32
6	34	4.09	1.563928	1.415756	1.119411	1.379	24.5	33.83
7	40	4.19	1.724801	1.572395	1.199847	1.517	25.1	38.15
8	46	4.28	1.758669	1.623197	1.436923	1.610	25.7	41.36
9	52	4.08	1.78407	1.563928	1.373421	1.571	24.5	38.47
10	58	4.02	1.77137	1.60203	1.398822	1.594	24.1	38.44
11	64	3.83	1.610497	1.576629	1.331086	1.524	23.0	35.01
12	70	3.88	1.487725	1.483492	1.212548	1.417	23.3	32.98
13	76	3.9	1.487725	1.19138	1.017807	1.222	23.4	28.60
14	82	3.76	0.933137	0.92467	0.68336	0.866	22.6	19.55
15	88	3.98	0.649492	0.628325	0.539421	0.611	23.9	14.60
16	94	2.08	0	0	0	0.000	13.5	0.00
17	101	0	0	0	0	0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						1.187	323.7	384.12

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-int	Delta
30%	37.0	34.00	40.00	1.38	1.52	1.45	0.82
40%	46.0	46.00	52.00	1.61	1.57	1.61	0.74
50%	55.0	52.00	58.00	1.57	1.59	1.58	0.75
60%	64.0	64.00	70.00	1.52	1.42	1.52	0.78
70%	73.0	70.00	76.00	1.42	1.22	1.32	0.90

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	436.0
Slope	0.0005	V_{AVR} =	1.35

Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.04	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
5	0	2	0.0	5.0	0	0.00	0.00
10	1.64	2	9.0	5.5	1.64	7.01	0.78
16	2.86	2	17.2	6.0	2.86	19.33	1.13
22	3.17	2	19.0	6.0	3.17	22.94	1.21
28	4.15	2	24.9	6.0	4.15	35.85	1.44
34	4.09	2	24.5	6.0	4.09	35.08	1.43
40	4.19	2	25.1	6.0	4.19	36.53	1.45
46	4.28	2	25.7	6.0	4.28	37.84	1.47
52	4.08	2	24.5	6.0	4.08	34.94	1.43
58	4.02	2	24.1	6.0	4.02	34.09	1.41
64	3.83	2	23.0	6.0	3.83	31.45	1.37
70	3.88	2	23.3	6.0	3.88	32.13	1.38
76	3.9	2	23.4	6.0	3.9	32.41	1.39
82	3.76	2	22.6	6.0	3.76	30.49	1.35
88	3.98	2	23.9	6.0	3.98	33.53	1.40
94	2.08	2	13.5	6.5	2.08	12.32	0.91
101	0	2	0.0	3.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			323.68			436.04	1.35

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-int	Delta
30%	37.0	34.00	40.00	1.43	1.45	1.44	0.93
40%	46.0	46.00	52.00	1.47	1.43	1.47	0.91
50%	55.0	52.00	58.00	1.43	1.41	1.42	0.95
60%	64.0	64.00	70.00	1.37	1.38	1.37	0.98
70%	73.0	70.00	76.00	1.38	1.39	1.38	0.97

Measured data

STATION No. : W4H013
RIVER NAME : Pongola
PLACE NAME : Josini
DATE : 3/9/85

START TIME : 07H55
Average Gaugeplate reading : 2.665 m

Main Channel LEFT : 10
Main Channel RIGHT : 100

1	2	3	4	5	6	7	8	9
Vertical number	Chainage	Vertical or effective depth	Velocity 0.2d	Velocity 0.4d	Velocity 0.8d	V aver. (m/s)	Area (m^2)	Q (m^3/s)
						1.225	322.3	394.71
1	5	0		0		0.000	0.0	0.00
2	10	1.6		0.386		0.386	8.8	3.40
3	16	2.92		0.802		0.802	17.5	14.05
4	22	3.27		1.208		1.208	19.6	23.70
5	28	4.15		1.263		1.263	24.9	31.45
6	34	4.05		1.411		1.411	24.3	34.29
7	40	4.1		1.505		1.505	24.6	37.02
8	46	4.25		1.551		1.551	25.5	39.55
9	52	4.02		1.619		1.619	24.1	39.05
10	58	4.03		1.606		1.606	24.2	38.83
11	64	3.88		1.522		1.522	23.3	35.43
12	70	3.79		1.49		1.490	22.7	33.88
13	76	3.87		1.2		1.200	23.2	27.86
14	82	3.79		0.827		0.827	22.7	18.81
15	88	3.98		0.662		0.662	23.9	15.81
16	94	1.99		0.122		0.122	12.9	1.58
17	101	0		0		0.000	0.0	0.00
18						0.000	0.0	0.00
19						0.000	0.0	0.00
						1.225	322.3	394.71

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	1.41	1.51	1.46	0.84
40%	46.0	46.00	52.00	1.55	1.62	1.55	0.79
50%	55.0	52.00	58.00	1.62	1.61	1.61	0.76
60%	64.0	64.00	70.00	1.52	1.49	1.52	0.80
70%	73.0	70.00	76.00	1.49	1.20	1.35	0.91

Calculated data, 1-dimensional flow theory

Manning or Chezy: M
Slope 0.0005

Q = 433.2
V_{AVR} = 1.34

Roughness coeff Sub	n
0	
2	0.04
0	

Area reduction factor Sub	f_A
0	1
2	1
0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
5	0	2	0.0	5.0	0	0.00	0.00
10	1.6	2	8.8	5.5	1.6	6.73	0.76
16	2.92	2	17.5	6.0	2.92	20.01	1.14
22	3.27	2	19.6	6.0	3.27	24.16	1.23
28	4.15	2	24.9	6.0	4.15	35.95	1.44
34	4.05	2	24.3	6.0	4.05	34.51	1.42
40	4.1	2	24.6	6.0	4.1	35.23	1.43
46	4.25	2	25.5	6.0	4.25	37.40	1.47
52	4.02	2	24.1	6.0	4.02	34.09	1.41
58	4.03	2	24.2	6.0	4.03	34.23	1.42
64	3.88	2	23.3	6.0	3.88	32.13	1.38
70	3.79	2	22.7	6.0	3.79	30.90	1.36
76	3.87	2	23.2	6.0	3.87	32.00	1.38
82	3.79	2	22.7	6.0	3.79	30.90	1.36
88	3.98	2	23.9	6.0	3.98	33.53	1.40
94	1.99	2	12.9	6.5	1.99	11.44	0.88
101	0	2	0.0	3.5	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
	0	2	0.0	0.0	0	0.00	0.00
			322.34			433.21	1.34

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	1.42	1.43	1.43	0.94
40%	46.0	46.00	52.00	1.47	1.41	1.47	0.92
50%	55.0	52.00	58.00	1.41	1.42	1.41	0.95
60%	64.0	64.00	70.00	1.38	1.36	1.38	0.97
70%	73.0	70.00	76.00	1.36	1.38	1.37	0.98

Measured data

STATION No. :	W4H013	START TIME :	14H15
RIVER NAME :	Pongola	Average Gaugeplate reading :	3.15 m
PLACE NAME :	Josini		
DATE :	9/17/84		
		Main Channel LEFT :	10
		Main Channel RIGHT :	100

1 Vertical number	2 Chainage	3 Vertical or effective depth	4 Velocity 0.2d	5 Velocity 0.4d	6 Velocity 0.8d	7 V aver. (m/s) 1.500	8 Area (m^2) 392.6	9 Q (m^3/s) 588.98
1	0	0		0		0.000	0.0	0.00
2	4	0.65		0.184		0.184	3.3	0.60
3	10	2.17		0.937		0.937	13.0	12.20
4	16	3.35		1.439		1.439	20.1	28.92
5	22	4		1.657		1.657	24.0	39.77
6	28	4.7		1.788		1.788	28.2	50.42
7	34	4.49		2.008		2.008	26.9	54.10
8	40	4.68		2.017		2.017	28.1	56.64
9	46	4.62		2.055		2.055	27.7	56.96
10	52	4.53		2.068		2.068	27.2	56.21
11	58	4.43		1.89		1.890	26.6	50.24
12	64	4.27		1.852		1.852	25.6	47.45
13	70	4.21		1.805		1.805	25.3	45.59
14	76	4.33		1.433		1.433	26.0	37.23
15	82	4.45		1.052		1.052	26.7	28.09
16	88	3.96		0.506		0.506	23.8	12.02
17	94	2.25		0.531		0.531	13.5	7.17
18	100	2.43		0.201		0.201	26.7	5.37
19	116	0		0		0.000	0.0	0.00
						1.500	392.6	588.98

Delta value calculations

% Width	Act. Chn.	Ch-Lower	Ch-Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	2.01	2.02	2.01	0.75
40%	46.0	46.00	52.00	2.06	2.07	2.06	0.73
50%	55.0	52.00	58.00	2.07	1.89	1.98	0.76
60%	64.0	64.00	70.00	1.85	1.81	1.85	0.81
70%	73.0	70.00	76.00	1.81	1.43	1.62	0.93

Calculated data, 1-dimensional flow theory

Manning or Chezy:	M	Q =	712.9
Slope	0.00075	V_{AVR} =	1.82

Roughness coeff. Sub	n	Area reduction factor Sub	f_A
0		0	1
2	0.038	2	1
0		0	1

Chainage	Vertical or effective depth	Sub Section	Area A	Wetted P P	H-Radius R	Q (m^3/s)	V Velocity
0	0	2	0.0	0.0	0	0.00	0.00
4	0.65	2	3.3	5.0	0.65	1.76	0.54
10	2.17	2	13.0	6.0	2.17	15.73	1.21
16	3.35	2	20.1	6.0	3.35	32.43	1.61
22	4	2	24.0	6.0	4	43.58	1.82
28	4.7	2	28.2	6.0	4.7	57.02	2.02
34	4.49	2	26.9	6.0	4.49	52.84	1.96
40	4.68	2	28.1	6.0	4.68	56.62	2.02
46	4.62	2	27.7	6.0	4.62	55.42	2.00
52	4.53	2	27.2	6.0	4.53	53.63	1.97
58	4.43	2	26.6	6.0	4.43	51.67	1.94
64	4.27	2	25.6	6.0	4.27	48.60	1.90
70	4.21	2	25.3	6.0	4.21	47.46	1.88
76	4.33	2	26.0	6.0	4.33	49.74	1.91
82	4.45	2	26.7	6.0	4.45	52.06	1.95
88	3.96	2	23.8	6.0	3.96	42.86	1.80
94	2.25	2	13.5	6.0	2.25	16.71	1.24
100	2.43	2	26.7	11.0	2.43	34.82	1.30
116	0	2	0.0	8.0	0	0.00	0.00
			392.62			712.95	1.82

Delta value calculations

% Width	Act. Chn.	Lower	Upper	V-lower	V-Upper	V-Int	Delta
30%	37.0	34.00	40.00	1.96	2.02	1.99	0.91
40%	46.0	46.00	52.00	2.00	1.97	2.00	0.91
50%	55.0	52.00	58.00	1.97	1.94	1.96	0.93
60%	64.0	64.00	70.00	1.90	1.88	1.90	0.96
70%	73.0	70.00	76.00	1.88	1.91	1.90	0.96