Flow resistance of aquatic weeds in ditches:

Measurements 1986

Publication 76

J.L.M.Pedroso de Lima   and   T.M.S.Pradhan

A minor thesis presented in partial fulfilment of the
requirement for the degree of
Master of Science

CONTENTS

1. INTRODUCTION

The importance of maintenance of ditches and channels emphasized in the following chapters, increased research on the flow through vegetated channels.

The present study is a continuation of the experiments on flow resistance of aquatic weeds, that is being carried out at Wageningen Agricultural University since 1983. The main objectives are:

(i) to study the resistance at different flow conditions for equal amount of aquatic weed.

(ii) to determine a relationship between the resistance coefficients and the time dependent biomass.

Owing to the limited time available and in view of the long period of time required to take the measurements, our study was concentrated on a single ditch (ditch III) with only one type of aquatic vegetation (reed).

The measurements were taken in the outdoor laboratory of the Department of Hydraulics & Catchment Hydrology of the Agricultural University Wageningen.

The scope of this experiment is to test analytical models available in literature (part two of the objectives mentioned above).

The models, described thoroughly in section 3.1, are the following:
- formula of Manning
- model of Petryk and Bosmajian(1975)
- model of Van Ieperen (1986)

This thesis describes the measurements in chapter 3, and discusses the results in chapters 4 and 5. Conclusions and suggestions for further research are presented in chapter 5.

Relevant tables, figures, photographs and computer programs are given in annex.

2. PHENOMENA AND CONTROL OF AQUATIC WEEDS

Aquatic weeds are found everywhere on the earth. In general, they can be classified into the folowing four groups:

I.Emerged weeds:

These plants are rooted or anchored with most of their leaf-stem tissue above the water surface. Their heights do not change with the water level. Example of this group is the reed (Phragmites australis) which is used in the experiment considered here.

II.Submerged weeds:

Most or all of the vegetative tissue of these plants remain below the water surface. Most of them are rooted.
Examples: hydrilla, milfoil, pondweed.

III.Floating weeds:

They are either free-floating or anchored with most of their stem-leaf tissue at, or above, the water surface. They move up and down with water level. Examples: water hyacinth, waterlilies, water lettuce.

IV.Algae:

They are lower plants without distinct tissues and can either be unicelluler or filamentous.

Excess growth of aquatic weeds can cause severe problems in drainage, irrigation and navigation canals, in agriculture and in fisheries. Dense mats of aquatic plants are very favourable breeding place and biotopes for vectors of some dangerous illnesses like bilharzia and malaria. Snails like Bulimus, Biomphalaria and Oncomelamia are the intermediate hosts of the parasite that causes Schistosomiasis, which is the most critical disease in the tropics.

Aquatic weeds can fill a water course, an irrigation canal or a drainage ditch by its growth along the banks, and/or at the bottom. It is known that the weeds can reduce conveyance capacity of a canal by as much as 97%, which puts a drainage or irrigation system to useless. A drainage ditch instead of helping drain the adjacent lands will enhance the danger of flooding it. A clean or well maintained channel has lower resistance to flow and thus requires smaller cross-section and lower construction cost. Whereas, an uncleaned channel gives higher resistance to flow thereby requires larger dimensions and higher construction cost.

Floating weeds, in particular, cause a tremendous increase in surface evaporation resulting in higher water losses which is undesirable in an irrigation network. Accumulation of decaying debris that fall from aquatic plants and interception of silt or other floating material helps the drain or canal to become more and more shallow as the years pass by.

In agriculture, weeds compete with crops for moisture and light resulting in lower crop yeilds. In severe cases, exudates from the weeds' roots can have a poisonous effect on the crop plant. Crops are more sensitive to weed competition in their early stages of growth. They sometimes hamper harvesting techniques.

In navigation canals, dense aquatic vegetation have caused damages to the propeller shafts, cooling systems and rudders of ships and boats. More severe cases are the drifting islands formed mainly by grass species and the floating mats of water hyacinth.

Aquatic weeds can also interfere with recreational use of water not only with their quantity, but also sometimes with their certain peculiarities. For instance, species of blue- green algae can produce an effect called 'swimmer's itch'.

Aquatic weeds can also cause technical problems like clogging of filters, sprinklers and pumps. Certain kind of algae can also cause corrosion of concrete and steel in the reservoir structures.

Notwithstanding its various disadvantages to agriculture, public health, fisheries etc, weeds can be beneficial if allowed for limited growth for the reasons that they supply organic matter to the soil and help control erosion on sloping terrain. Some weeds excrete substances which can control nematodes and could even be included in a crop-rotation system for that purpose.

The disadvantages and the indispensability of aquatic weeds calls for its proper management and control.The following methods are adopted for weed control:

1.Chemical Control:

Chemical cleaning of ditches is done with the help of herbicides. However, limited number of herbicides are approved for use in or around water for the reasons that they have toxic effect on water-organisms other than plants.

In drainage canals having drainage as the only function, chemicals may be used with some hesitation. In canals solely used for irrigation purpose attention has to be paid to the time gap between the application of the herbicide and the irrigation, for the crops can be damaged severely if the chemical is too persistent. On the other hand, a short-working herbicide is expensive due to its necessity of repeated applications.

2.Mechanical control:

Different machines are available now a days for mechanical cleaning of the ditches and canals. Cost of the machine to be used

influences considerably in the choice of mechanical control of aquatic vegetation.

In case of smaller ditches or ditches inaccessible for machinery, manual cleaning may be adopted. adopted.

3.Biological Control:

Several agents and methods exist for biological control of aquatic weeds. Prevention of aquatic weed problems is also possible by means of biological ways. Examples: fishes, insects, fungi, and other agents that attack weed species.

3. METHODS AND MATERIALS

3.1 BASIC EQUATIONS OF FLOW RESISTANCE

The resistance to flow due to a given vegetation is a function of many variables including flow velocity, distribution of vegetation in the streamwise vertical and lateral directions, roughness of the channel boundary, and structural and hydrodynamic properties associated with the stems and leaves of the plants.

The flow resistence in an open channel, for uniform flow, is described by the Manning's equation using Manning's coefficient, n, as a friction factor:

$$u = \frac{Q}{A} \cdot \frac{1}{n} R^{2/3} S^{1/2} \qquad \text{With} \quad R = \frac{A}{P} \qquad (1)$$

where, $\bar{u}$ = mean velocity   (m/s)
         Q = discharge   (m^3/s)
         A = cross-sectional area (m^2)
         n = Manning's coefficient (s/m$^{1/3}$)
         R = hydraulic radius   (m)
         S = energy gradient   (-)
         P = wetted perimeter   (m)

Shear stress and dimensional analysis considerations for a steady, uniform flow in a non-changing channel bed slope, results in the following expression for a flow resistance:

$$\bar{u} = \frac{1}{f} \sqrt{g R S} \qquad (2)$$

where,

       f = dimensionless number which may depend on the
    boundary roughness, on Reynolds number, and on the
cross-sectional shape (-)
       g = acceleration due to gravity (m/s)

Chezy's equation for the flow resistance is given by:

$$\bar{u} = C \sqrt{R S} \qquad (3)$$

where, C = Chezy's coefficient (m$^{1/2}$/s)

A equivalent equation of the Darcy-Weisbach equation for the flow in closed conduits, wherein the energy gradient without aquatic weeds is given by:

$$S = \frac{\Delta H}{L} = \frac{\lambda}{R} \frac{u^2}{2g} \qquad (4)$$

where, λ = wall roughness coefficient   (-)
        H = difference in total head   (m)
        L = length of the channel reach under consideration (m)

Equations (3) and (4) can be combined to obtain a relation between Chezy's coefficient and the wall roughness coefficient:

$$C^2 = \frac{2g}{\lambda}$$

The end result for fully uniform rough flow supplementing the original experiment of Nikuradse is:

$$C = 18.0 \; \log_{10} \left(\frac{12\,R}{K_s} \right)$$

where, K_s = Nikuradse's equivalent roughness value   (m)

Petryk and Bosmajian (1975) obtained the following relation for vegetated channels having both the influence of the boundary roughness and aquatic weeds:

$$S = \left(\frac{C_d \, \Sigma \, A_i}{2 \, g \, A \, L} + \frac{n^2}{R^{4/3}} \right) u^2 \qquad (7)$$

where, C_d = The drag coefficient for the vegetation   (-)
        A_i = the projected area of the ith plant in the streamwise direction (m^2)

Their (Petryk and Bosmajian 1975) flow model was based on the following assumptions:

(i) The velocity is small enough to prevent a large degree of plant bending. Consequently, the projected area in the streamwise direction is independent of the velocity.

(ii) Vegetation is distributed relatively uniformely in the lateral direction and large variation in average velocity do not accur across the channel.

(iii) Maximum flow depth is less than or equal to the maximum height of the vegetation, and large variation in flow velocity do not occur over the flow depth.

$C_d \Sigma A_i$ refers to the total area of the stems and its drag coefficient. The length of the stems can be related to the initial or the actual waterdepth in case of reed which is the sole aquatic plant used in this experiment.

$C_d \Sigma A_i$, then can be written as:

$$C_d \Sigma A_i = \mu \, d \, D \qquad\qquad (8)$$

where, μ = aquatic weed resistance   (-)
        d = actual mean water depth (in the case of reed) (-)
        D = diameter of stems   (m)

Where the details of the stems are available, equation (8) can be rewritten as:

$$C_d \Sigma A_i = \xi \, m \, l \, D \qquad\qquad (9)$$

where, ξ = drag coefficient of stems   (-)
        m = number of stems   (-)
        l = mean length of stems   (m)

In the case of reed, the mean length of the stems, l, is the actual mean water depth, as given by:

$$l = \frac{A}{B}$$

where,   B = width of the water surface   (m)

Both the coefficients, μ and ξ, depend on the Reynolds number and represent not only a drag coefficient but also the deficiencies due to the simplicity of the model.

Combination of equations (4),(7) and (9), gives (Van Ieperen 1986):

$$S = (\frac{\xi\, m\, 1\, D}{A\, L} + \frac{\lambda}{R})\, \frac{u^2}{2\, g} \qquad (10)$$
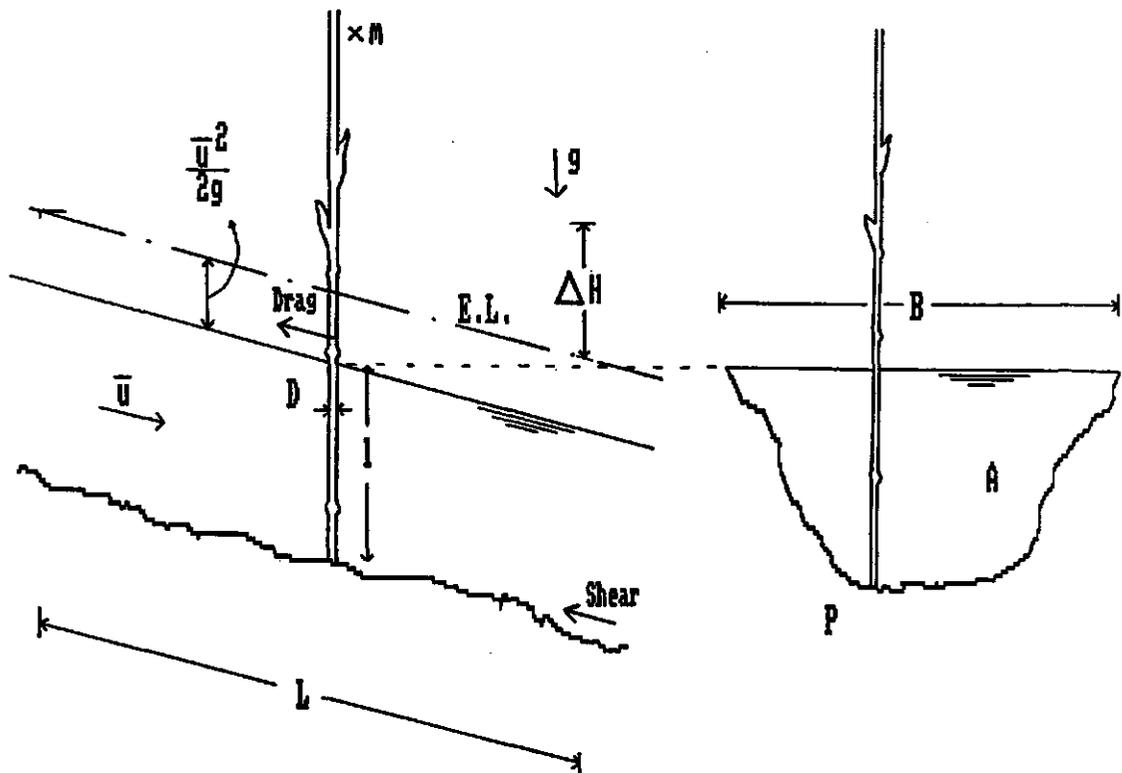
Fig. 1 - Parameters involved in the model of Van
Ieperen (1986)

3.2 HYDRAULIC MEASUREMENT

3.2.1 INTRODUCTION

The present study on the resistance to flow was carried out in an existing outdoor laboratory of the Department of Hydraulics & Catchment Hydrology of Wageningen Agicultural University, the layout of which is shown in Figures 2 and 3.
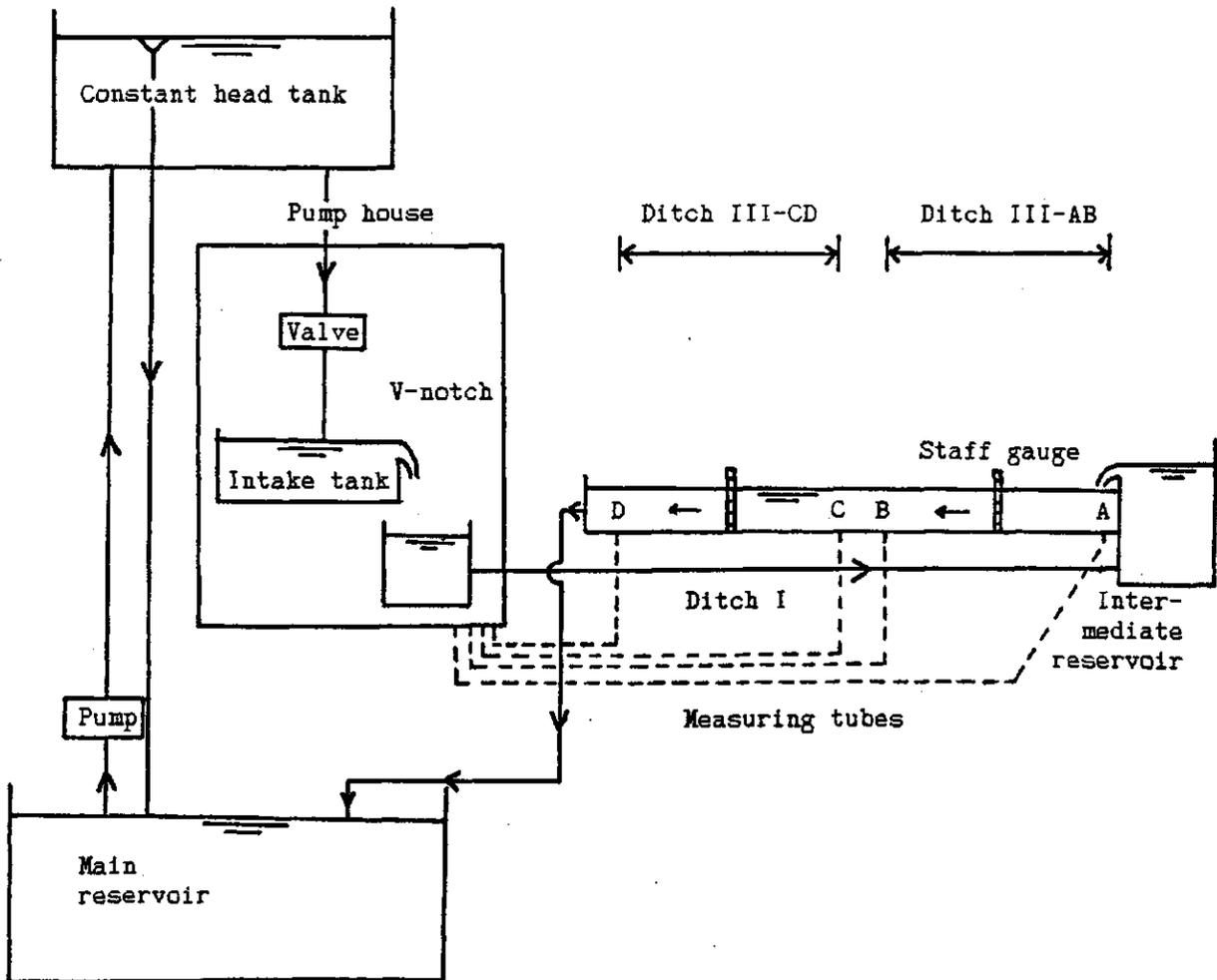
Fig. 2 - Hydraulic layout of the experiment

plan view
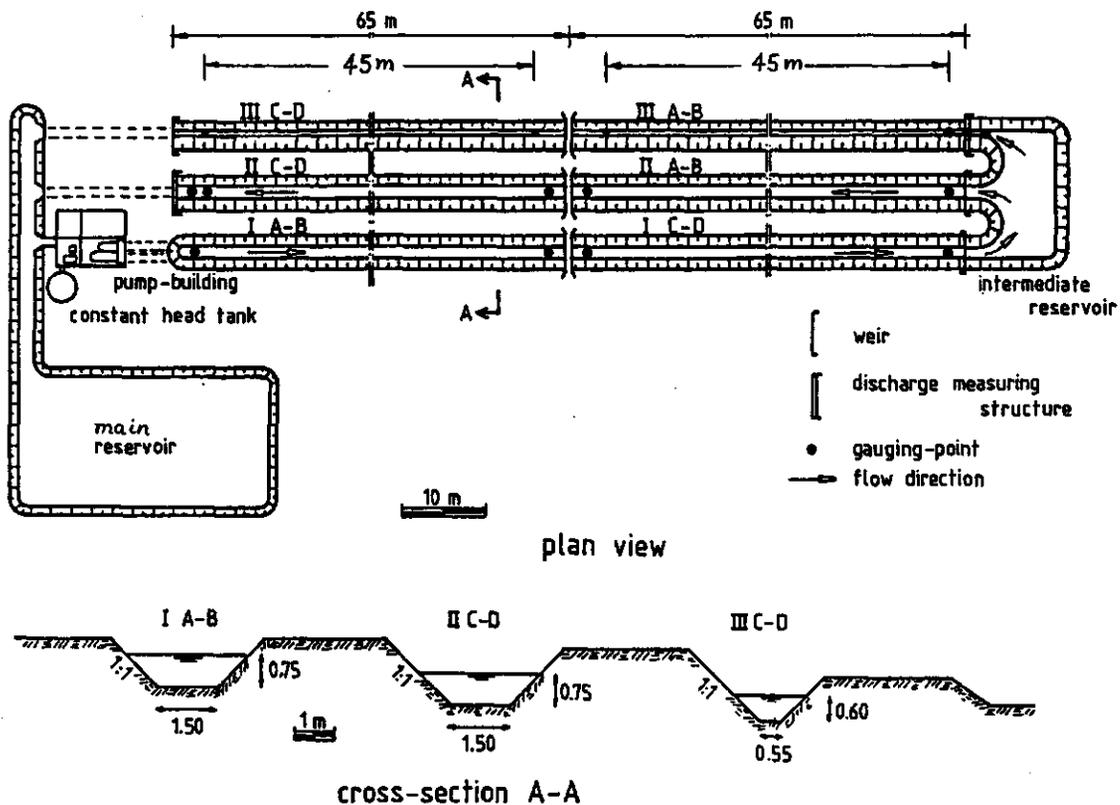
cross-section A-A

Fig. 3 - Layout of the outdoor laboratory,
(after Van Ieperen, 1986)

Measurements were carried out in the ditches III-AB and III-CD only. The total duration of each measurement was about 1 day.

The cross-sectional area and wetted perimeter of the ditch sections were obtained by levelling cross-section every 5 metres. The cross-section data recorded in 1985 after levelling, have been used in the calculation. (Annex 1, Figures 3.1 and 3.2)

3.2.2 DISCHARGE MEASUREMENT

Flow in the ditch was measured with the help of two calibrated V-notches installed at the end of the inlet tanks. Two pumps (one having about 0.08 m^3/s and the other 0.06 m^3/s discharge capacity) help lift the water from the ground reservoir to an elevated tank of constant head, which provides the required discharge to the ditches. Water height in the inlet tank was measured by means of point gauges above a stilling well fixed at the side of the tanks. Depending on the discharges required, either one or both the pumps are put into operation.

All measurements were taken for increasing discharges starting from about 0.02 till 0.120 m^3/s at an interval of preferably 0.02 m^3/s. Thus on each observation day, measurements were made for 5 to 6 different discharges.

To avoid errors, the discharge was checked against the value obtained from the measurement with the help of a broad-crested V - weir installed at the entrance of ditch III.

3.2.3 HEAD LOSS

When the flow stablizes, the difference in water height between the gauging points in the ditch is recorded with the help of pressure transducers attached to an amplifier, data logger and mini-computer. This device is calibrated every year and regularly checked during the measurements by means of additional point gauge readings at stilling wells.

3.2.4 WATER LEVELS

Staff gauges installed at halfway through the ditch III-AB and III-CD measure the water levels in the respective ditch.   The accuracy is about 0.005 m.

3.2.5 WATER TEMPERATURE

Temperature of water for every discharge was also measured with the help of a thermometer. The water temperature is read in the inlet flume installed in the pump house. The temperature recording has been done to account for the variation due to the change in day temperature and continuous operation of the pumps.

3.3 AQUATIC WEED MEASUREMENTS

3.3.1 INTRODUCTION

Aquatic weed used in this study is reed (Phragmites australis). This type of reed is often found in irrigation and drainage canals, hence its choice.

The total duration of each aquatic weed measurement was about 6 hours.

3.3.2 CHOICE OF REPRESENTATIVE SECTION

On May 20, 1986 when the reeds were still countable, the total number of reeds in the ditch III-AB and III-CD was counted with the help of an aluminium sampler grid frame of size 2.5 m * 2.5 m having 0.5 m * 0.5 m square openings. Based on this measurement, six representative sections, each of 0.2 m * 0.5 m size (two for maximum, two for average, and two for the least number of reeds) were chosen for both the ditches III-AB and III-CD. (Table 1).

Initial Representative Section		Random Representative Section	
III AB	III CD	III AB	III CD
Maximum:	Minimum:		
11.50 - 12.00	80.00 - 80.50	0.50 - 1.00	70.50 - 71.00
12.00 - 12.50	80.50 - 81.00	7.00 - 7.50	78.00 - 78.50
Average:	Average:		
27.50 - 28.00	107.5 - 108.0	11.00 - 11.50	80.00 - 80.50
29.50 - 30.00	108.0 - 108.5	29.00 - 29.5	98.50 - 99.00
Minimum:	Maximum:		
39.00 - 39.50	114.0 - 114.5	34.00 - 34.5	104.0 - 104.5
39.50 - 40.0	114.5 - 115.0	34.00 - 34.5	104.0 - 104.5

Table 1 - The representative sections

All successive measurements were limited to these 12 representative sections until July 15, 1986. In July new representative sections were again chosen based on the generation of random number. These sections were used for further measurements till the end of the observation period (i.e till October 14,1986.). This change was done because the reeds were very much disturbed and bent down inspite of careful handling while taking measurements, which had to be done by putting a ladder across the ditch. (section 2.3.4).

3.3.3 CONTROL SECTION

In addition to the 12 representative sections mentioned above, a control section of 0.30 m * 0.40 m area located in the middle section and about half way through the ditch III was also selected for measurements. The idea of this measurement was to analyse the evolution of the three weed parameters (viz. length, diameter, and density) with respect to time in a fixed and well defined area. (Table 2 and Figure 5.12).

Control Section (ditch III)			
Day of 1986	№ Stems	Diameter(m)	Length(mm)
147	29	3.4	0.952
154	29	3.3	1.103
182	32	3.4	1.373
196	37	3.7	1.710
230	45	3.4	1.761
239	41	4.0	1.832
289	35	4.2	1.696

Table 2 - Control section data

3.3.4 REED MEASUREMENTS

Reeds in every representative sections as well as in the control section were measured for their diameter, length (total height), and numbers on every observation day. A vernier calliper and a hollow aluminium square rod with a scale attatched to it, were used to measure the diameter and length of the stems respectively. Stem diameter is measured above the second knot from the channel bed.

An aluminium ladder had to be placed across the ditch near the representative section to take all these measurements.

3.3.5 WEED DESEASE

It was noticed in August 1986 that the reeds, particularly those in the ditch III-AB, were dying prematurely because of some reasons unknown.

This desease(s) seems to have started near the intermediate reservoir and advanced towards the ditch III-AB. However, in ditch reach III-CD the weeds had normal growth. This premature dying of weeds in III-AB might have its influence on the results of the experiment.

3.4 PRECAUTIONS

3.4.1 IN HYDRAULIC MEASUREMENTS

To improve the accuracy of the results the following precautions were taken:

(i) Broad-crested V - weir installed at the inlet of ditch III is cleaned off all debris, plant roots and foilage, before starting the measurements and at regular intervals during the observation period.

(ii) Debris and plant roots trapped on the trash rack and screens were removed before the begining of the measurements and later during observation period, if necessary.

(iii) All hydraulic measurements are taken only after the flow in the ditch has stablized.

(iv) The zero reading of the micro-computer display showing the head difference was checked for each set of measurement.

3.4.2 IN REED MEASUREMENTS

The following precautions were taken:

(i) Every care is taken to see that no reed is broken while placing the ladder across the ditch for taking the measurements.

(ii) Care is also taken to avoid the mistake in counting and measuring the reeds.

4. RESULTS AND ANALYSIS

The measurements carried out during the growing period of the reed (May-October, 1986) were compiled in data files (Tables 3.1 and 3.2 and Figures 3.1 and 3.2 of Annex 3). Table 3.4(Annex 2) shows the quantity and the distribution of the reeds in ditch-III on the first measurement day (May 20, 1986). From this table it is observed that the reeds in ditch III-AB were denser in its mid-section, while in III-CD they were denser along the banks.

Zero readings for the two staff gauges are given in the Table 3.3.

Computer programmes given in Annex 4, resulted in Tables 5.1 to 5.6 and Figures 5.4 to 5.11 (Annex 5). These figures show the scattering of Manning's coefficient ,n, aquatic weed resistance ,μ, and drag coefficient ,ξ, over the total duration of the experiment for both the ditches: III-AB and III-CD.

The range of variation of the three parameters are as follows:

-n: 0.09795 to 0.2693 (s/m$^{1/3}$)

-μ: 12170 to 141300 (-)

-ξ: 2.152 to 19.67 (-)

Basic data obtained in this manner were then used for regression analysis using the programmes available. The results plotted are:

(i) D, m, and mD/L against the day of the year 1986. (Figures 5.1 to 5.3).

The variation of the number of stems is rather big, which is mainly due to the inaccuracy in the measuring method adopted (mannual recording of the weed parameters). This also affected the factor mD/L. Table 3 shows the ratio between the standard deviation 'σ' and mean 'y' for the reed data in the ditch III.

Table 3 - Reed data parameters

Reed data (May/Oct, 1986)		y	σ	σ/y (10^-2)
Ditch III-AB	Number of stems (-)	7219	1892	26.2
	Diameter of stems (mm)	3.90	0.23	5.8
	mD/L (-)	6.28	0.179	28.4
Ditch III-CD	Number of stems (-)	6525	1389	21.3
	Diameter of stems (mm)	5.60	0.50	8.9
	mD/L (-)	0.806	0.132	16.3

(ii) 'μ' and 'ξ' against Reylonds number for each measurement day (Figures 5.15 to 5.18).

Both 'μ' and 'ξ' are found to decrease with increasing Reylonds number. In log-log scale the curves are almost straight lines. The curves are drawn for a certain day in the begining, middle and end of the measurement period to account for the effect of weed growth in the variation of parameters considered.

(iii) 'μ' and 'ξ' against the day of the year 1986 for three different Reyolnds number (Figures 5.21 to 5.24).

The curve of 'μ' against time shows upward convexity with its maximum value reaching in July, which is more or less the middle of the growing season. Whereas the curve of 'ξ' shows a wavy shape which is mainly due to the variation of mD/L mentioned above in section(i). The regression analysis for the variation of 'ξ' and 'μ' with time gave the ratios of σ/ξ and σ/μ of Table 4.

Table 4 - Parameters for 'μ' and 'ξ'

	Re	ξ	σ	σ/ξ (10^{-2})	μ (10^{+4})	σ (10^{+4})	σ/μ (10^{-2})
Ditch III-AB	250	11.18	4.40	39.4	8.09	3.58	44.3
	300	9.01	3.86	42.8	6.61	3.09	46.8
	350	8.02	3.29	41.0	5.89	2.83	48.0
	400	7.32	3.04	41.5	5.19	2.58	49.8
	Aver.	8.88	3.65	41.2	6.45	3.02	47.2
Ditch III-CD	250	10.00	2.91	29.1	7.00	2.53	36.1
	300	9.91	4.51	45.5	6.42	2.45	38.1
	350	8.39	3.47	41.3	5.43	1.94	35.7
	400	7.20	2.71	37.6	4.65	1.59	34.2
	Aver.	8.88	3.40	38.4	5.88	2.13	36.0

In 1985, the value of σ/ξ for ditch I-CD (white water-lily) and ditch II-AB (broad pond-weed) was found to be 30% and 10% respectively. The value of σ/ξ for 1986 was about 40% for ditch III (reed) (Table 4).

The value of Nikuradse's equivalent roughness coefficient 'k_s' has been taken as 0.15 for the calculation of 'μ' and 'ξ'. This being the wall resistance at the beginning of the season in 1985.

(iv) 'n' against the discharges for each measurement day (Fig. 5.13 to 5.14).

This curve shows a decrease of 'n' with increasing discharges. In log-log scale the curves are approximately straight lines.

(v) 'n' against the day of the year 1986 for three different discharges (Fig. 5.19 and 5.20).

'n' is found to attain its maximum value in the period July/August. The regression analysis of 'n' against day of the year 1986 gave the values of the ratio between the standard deviation 'σ' and the mean 'y ' as shown in the Table 5.

Table 5 - Parameters for 'n'

	Q [1/s]	y	σ (10^{-2})	σ/y (10^{-2})
Ditch III-AB	20	0.175	5.01	28.6
	40	0.164	4.74	28.9
	60	0.158	4.52	28.6
	Average	0.166	4.75	28.7
Ditch III-CD	20	0.182	3.37	18.5
	40	0.157	3.00	19.1
	60	0.145	3.20	22.1
	Average	0.161	3.19	19.9

5. DISCUSSION AND CONCLUSIONS

Manning's coefficient 'n' is the most commonly used roughness parameter in the design of water courses. The 'n' values can be used with reasonable accuracy if it does not exceed around 0.030. However, in case of densely vegetated channels 'n' values are much higher. The 'n' value depends on a number of factors : roughness of channel bed and side slope, thickness of growth and stem length of vegetation, irregularity of alignment and hydraulic radius of the channel.

Manning's coefficient 'n' cannot be efficiently used for vegetated ditches because of :

(i) time dependancy (significant variation with the growth stage of vegetation, see Fig. 5.19 and 5.20).

(ii) dependency on depth of flow or discharge, and hydraulic radius. (This is observed in the Tables 5.1, 5.2 and Fig. 5.13, 5.14).

(iii) dependancy on size and shape of channel cross - section. This is particulary relevant in case of the maintenance of channels, e.g. in case of a wide channel cross-sectional area, cleaning of the bank has little effect on 'n'. The same does not hold true for smaller channel sections.

The 'n' values found in literatures (guides, mannuals, handbooks) for earthen channels or ditches with dense vegetation are lower than the values obtained in the present experiment. Thus, it may be mentioned here that the coefficients given in the literatures should be used with care when applied to small ditches.

In the present study the existance of other aquatic weeds in the ditch III, which are found submerged even in low discharges, was not taken into account. This may be more relevant specially in areas where reeds were scarce. These weeds, although in small quantities and submerged all the time, might have had some effect in the results.

The total quantity of reeds measured in ditch III-AB and III-CD on May 20, 1986 when compared with those calculated   using the six representative sections (Tables 3, 4 and 3.2) differed by 50% and 30% respectively. This relatively big error is due to the spatial variability of the growth of reeds in the ditch. The scattering of reeds has its influence not only on the quantity of weeds but also on other weed characteristics such as, diameter and length. An enlargement of the sample area should diminish the adverse effects of scattering. Besides the possibility of overlooking some reeds (due to its high density) there exists the individual criteria involved in the act of measuring, specially in the measurement of height and number of stems lying within

a small frame of 0.2 m *0.5 m. Sitting on a ladder stretched across the ditch and measuring the diameter of stems mannually with the help of a vernier calliper also enhances the possibility of making errors.

As compared to Manning's roughness coefficient 'n', very little experimental work has been done on aquatic weed resistance 'μ' and drag coefficient 'ξ'. As such, it is difficult to establish a comparision with other values.

The values of 'μ' and 'ξ' are closely related to the accuracy of the weed measurements, which is inefficient in the present case. An improvement of the weed measurements will yield better results, particularly with respect to 'ξ'. Had the model of Van Ieperen been perfect and the measurements sufficiently accurate, the variation of 'ξ' with time would not have occured.

Comparing our results with those of Van Ieperen for the year of 1985, the following observations are made:

1. The relation between 'μ' and Re shows a decreasing value of 'μ' for increasing Reynolds number. The average order of magnitude of the negative gradient found was 65 while in 1985, it was 400 for the ditch III.

2. The large scattering of reed data lead to high value of the ratio between σ and y. However, the values obtained are of the same order of magnitude as those of 1985 (Table 3).

3. In 1985, the values of σ/ξ for ditch I-CD (White water-lily) and for ditch II-AB (Broad pond-weed) were 30% and 10% respectively. In 1986, the σ/ξ value for ditch III (reed) is around 40% (Table 4).

Suggestions for further research:

(i) The model is sufficiently adequate for use in irrigation and drainage designs, but its practical applicability is limited. As such, effort should be made to develop a method of weed measurements, which is more practicable.

(ii) In addition to this kind of research, it is also suggested that another orientation be also made in this line, for example: methods of weed control and study of the impact of different methods, on flow resistance and other hydraulic parameters.

(iii) Modifications in the formula of Van Ieperen could be made to account for the velocity profile due to the presence of the aquatic weed. This could be achieved, for instance, by multiplying $u^2/2g$ by some correction factor. This coefficient should be established by experiments in different conditions.

(iv) Yet another modification in the formula of Van Ieperen could be an introduction of a coefficient to account for the spatial variability of the reeds in the ditch. This coefficient of unequal

distribution of the reed should be multiplied by the factor mD/L.

(v) A better method of sampling the representative sections should be thought of. The method used in this study is satisfactory although deviations are detected. The problem is how to extrapolate the values for the complete ditch length. This point deserves further discussion.

(vi) Extensive sampling does not seem to help much if incomplete. An integrated approach in the determination of weed characteristics should be attempted. Weed parameters involved should be related to hydrological data, initial biomass, soil properties and quality and quantity of water being transported. This would help predict the weed parameters to reasonable accuracy which then could be refered for design purposes.

REFERENCES

Bos, M.G., Drainage canals and related structures.,
        24th International Course on Land Drainage,
        International Institute for Land Reclamation and
        Improvement, Wageningen, 1985.

Dawson, F.H., Aquatic plant management in semi-natural
        streams : the role of marginal vegetation,
        Journal of Environmental Management, 1978.

Henderson, F.M., Open Channel Flow., Ch.4-5, pp.88-162, The
        Macmillan Company, NewYork, 1966.

Ieperen, H.J.Van and M.S. Herfst.,Laboratory Experiments on
        the flow resistance of Aquatic Weeds. In:
        Hydraulic Design in Water Resources
        Engineering : Land Drainage, Proceedings of the
        2nd International Conference, Southampton
        University, U.K., April 1986, Editors Smith &
        Rycroft.

Kempen, H.M.A., Rural Water Conveyance systems and their
        management,Ministry of Agriculture and
        Fisheries, The Netherlands, 1983.

Lencastre, A., Hidraulica Geral, Edicao Luso-
        Brasileira, 1983.

Molen,H. van der., Water Management (Drainage), M.Sc.
        syllabus, Agricultural University, Wageningen,
        1978.

Petryk, S. and G.Bosmajian., Analysis of flow through
        Vegetation, Journal of the Hydraulics Division,
        Proceedings ASCE, Vol. 101, No. HY7., July 1975.

Pitlo, R.H., Flow resistance of Aquatic Vegetation.,
        Proceedings EWRS, 6th Symposium on Aquatic
        Weeds, 1982.

Pitlo, R.H. Regulation of Aquatic Vegetation by interception
        of day light., Proceedings EWRS, 5th Symposium
        on Aquatic Weeds, 1978.

LIST OF SYMBOLS

A	Cross-sectional area	$[L^2]$
A_i	Projected area of ith plant in upstream direction	$[L^2]$
B	Width of water surface	$[L]$
C	Chezy's coefficient	$[L.T]$
C_d	Drag coefficient	$[-]$
D	Diameter of stems	$[L]$
d	Flow depth	$[L]$
f	Friction factor	$[-]$
g	Gravitational constant	$[L.T^{-2}]$
H	Total head	$[L]$
k_s	Nikuradse's equivalent roughness value	$[L]$
L	Length of the channel reach being considered	$[L]$
l	Lenght of the stem	$[L]$
m	Number of stems	$[-]$
n	Manning's coefficient	$[L^{-1/3}.T]$
P	Wetted perimeter	$[L]$
Q	Discharge	$[L^3.T]$
R	Hydraulic radius	$[L]$
Re	Reynolds number	$[-]$
S	Energy gradient	$[-]$
u	Mean velocity	$[L.T^{-1}]$
y	Mean of a group	$[...]$

Σ	Summation symbol	[-]
Δ	Differential operator	[-]
λ	Wall roughness coefficient	[-]
μ	Aquatic weed resistance	[-]
ξ	Drag coefficient	[-]
σ	Standard deviation	[-]

Annex 1

Photographs

Photograph 1 - Reed in ditch III

Photograph 2 - Aluminium grid frame for counting reed
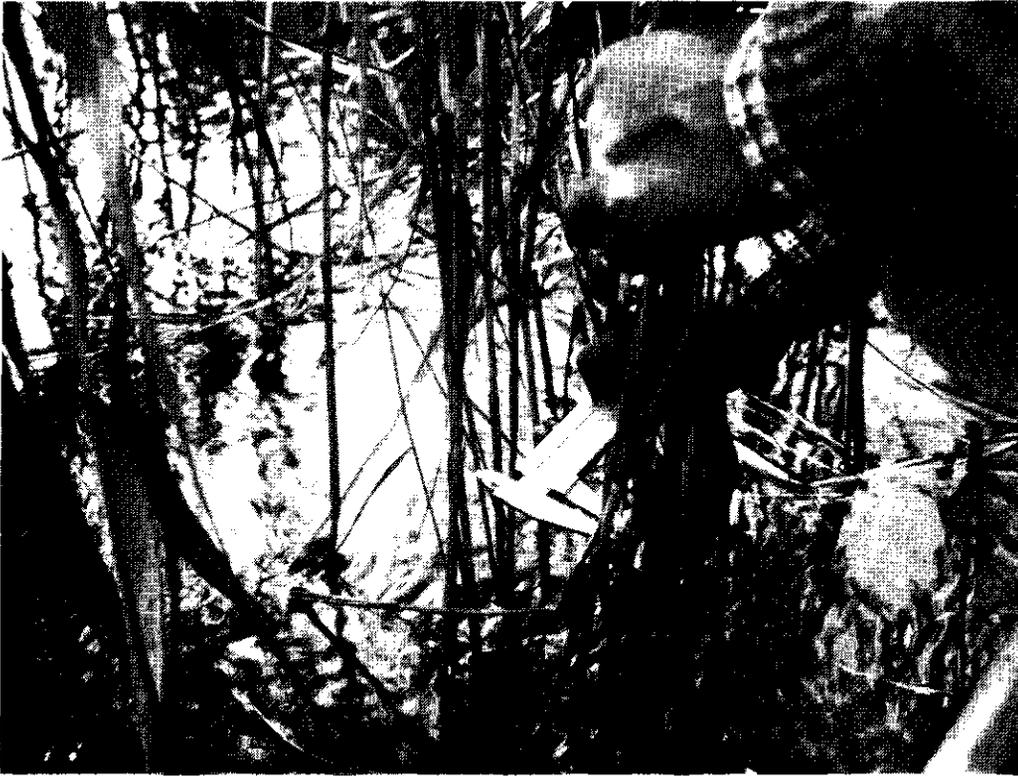
Photograph 3 - Measuring reed diameter

Photograph 4 - Staff gauge for measuring water level
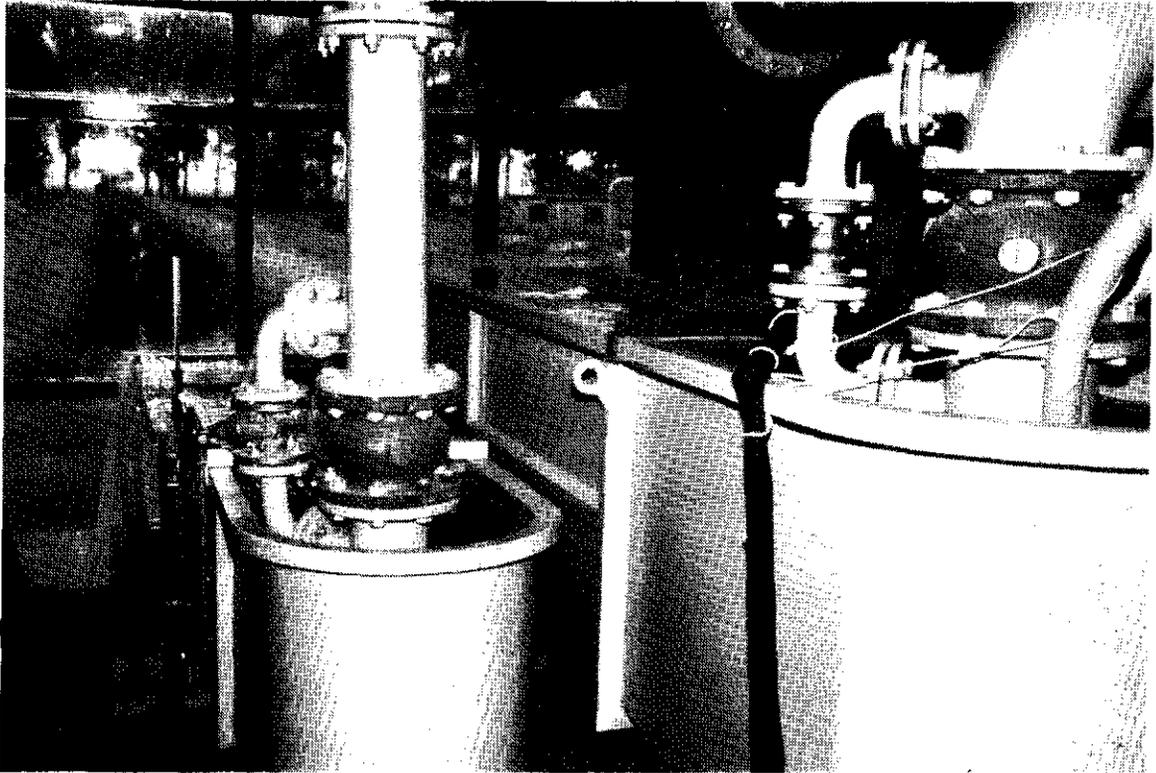
Photograph 5 - Intake tank for measuring discharge
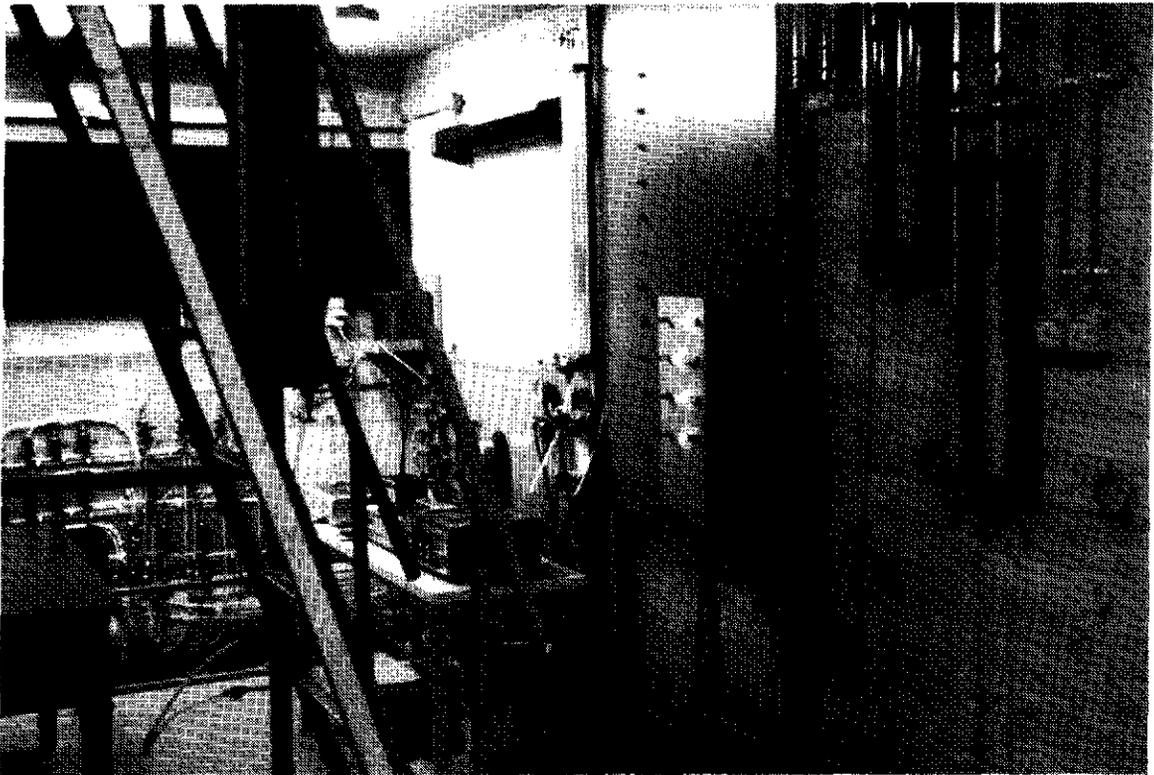
Photograph 6 - Equipment for measuring pressure difference

Annex 2

LITERATURE RETRIEVAL

LITERATURE RETRIEVAL

TABLE OF CONTENTS

1. INTRODUCTION

The aim of this report is to do literature retrieval in the subject concerning the ' Resistance to flow due to aquatic weeds in earthen canals'.

2. LIBRARIES VISITED

2.1 LIBRARIES VISITED

CENTRAL LIBRARY: Centrale Bibliotheek
             Gen. Foulkesweg 19
             6701 BK WAGENINGEN

FIBOWA: Bibliotheek Staringgebouw
       Marijkeweg 11
       6709 WAGENINGEN

2.2 UDC - NUMBERS

626.861   Open channels, ditches, trenches.
626.8   Agricultural hydraulics, irrigation, drainage.
626.143   Weed control in water courses.
631.626.1 Drainage - Open ditches
627.4   Bank protection and reinforcement, flow improvement
           works, training works.
627.74   Dredging, dredgers, machines for cleaning ditches.

2.3 SCIENTIFIC PUBLICATIONS

ROBSON, T.O., Report of a survey of the problem of aquatic weed control in England and Wales. Kidlington. 1965. (Technical report, Agriculture research council, Weed research organization: no.5)

BASSLOR JR. R.E., Grassed water way maintenance. College Park, University of Maryland (1980). (Agriculture Engineering Department, University of Maryland: no.129).

GUPTA, O.P., Aquatic weedcontrol for efficient water use. Technical bulletin, Rajasthan college of Agriculture, University of Udaipur. no.2, 1973.

IEPEREN, H.J. Van and M.S. HERFST, 'Stromingsweerstand van Slootvegetaties: Metingen 1983', Wageningen, Department of Hydraulics and Catchment Hydrology, Agricultural University, Nota 69.

IEPEREN, H.J. Van and M.S. HERFST, 'Stromingsweerstand van Slootvegetaties: Metingen 1984', Wageningen, Department of Hydraulics and Catchment Hydrology, Agricultural University, Nota 70.

3. GUIDES TO LITERATURE

GIEFER, G.J., Sources of information in Water Resources, An Annoted guide to printed materials. Berkeley, California (Water Resources center Archives). 1975.

VELLISCH, J.O., A Survey of Indexing and Abstracting Services for Water Resources Engineering. Maryland (Maryland University, Office of Water Resources Research). 1972.

MALINOWSKY, R.H., GRAY, R.A. and CURAY, D.A., Science and Engineering liyerature.

BLANCHAR, J.R. and L. FARRELL, Guide to Sources for Agricultural and Biological Research, 1981.

4. ORIENTATION IN LITERATURE

SCHWAB, G.O., et al, Soil and Water Conservation Engineering, 3rd ed. New York (John Wiley & Sons.). 1981.

ROTH, L.O., CROW, F.R., and MHONEY, G.W.A., An Introduction to Agricultural Engineering. West Port, Connecticut., AVI Publishing Company, 1977.

DAVIS, CALVIN, V., and KENNETH, E.S., Handbook of Applied Hydraulics. 3rd ed. New York, McGraw Hill, 1969.1v.

VOLLMER, E., Encyclopaedia of Hydraulics, Soil and Foundation Engineering. Amsterdam etc (Elsevier), 1967.

5. BIBLIOGRAPHIES

5.1 BIBLIOGRAPHIES

Bibliography of Agricultural Bibliographies, U.S. Department of Agricultural, Beltsville, Maryland.

Agricultural Research, Department of Agriculture and Water Supply, Republic of South Africa.

AGRIS - Agrindex, FAO.

Bibliografia Brasileira de Agricultura, Ministério da Agricultura (CENAGRI - CNPq - IBICT).

5.2 KEYWORDS

Drainage, Drainage and Irrigation.

Veeds.

6. ABSTRACT JOURNALS

6.1 ABSTRACT JOURNALS

Agriculture Engineering Abstracts. Silsoe, Bedford (National Institute of Engineering).

Veed Abstract. Commonwealth Agriculture Bureaux - Veed Research Organization.(CAB - ARC - U.K.)

Agronomy Abstracts, American Society of Agronomy, Atlanta, Georgia.

6.2 KEYWORDS

Soil and Water Management Conservation.

Soil and Water Conservation.

Aquatic Weeds.

Drainage.

Irrigation.

6.3 SCIENTIFIC ARTICLES

DAWSON, F.H., Aquatic Plant Management in Semi-natural Streams: Role of Marginal Vegetation; Journal of Environmental Management, Weed Abstrat, 1979, Vol.28, № 9.

7. SCIENTIFIC OR TECHNICAL JOURNALS

7.1 SCIENTIFIC OR TECHNICAL JOURNALS

Irrigation and Drainage Systems,(Martinus Nijhoff Publishers)

Water Resources Research, (American Geographical Union)

Journal of Hydrology. Amsterdam etc (Elsevier).

Journal of Soil and Water Conservation, Ankeny, Iowa (SCS of America)

Soil and Water conservation News. Washington DC (USDA, SCS)

Journal of Hydraulic Division (Proc. ASCE)

Post Graduate Agricultural Journal (Srilanka)

7.2 RECENT PUBLISHED ARTICLES

MAHROUF, A.R.M., Effect of Vegetative growth in flow of water in water courses (in Srilanka); Post-Graduate Agriculture Journal (Sri Lanka) 1983. V.1(1)

PETRYK, S. and G. BOSMAJIAN., Analysis of flow through vegetation, Journal of the Hydraulic Division (Proc. ASCE), Vol.101. no. HY7, July, 1975.

8. PROCEEDINGS

8.1 PROCEEDINGS

Hydraulic Design in Water Resource Engineering: Land Drainage Proceedings of International Conferences.

Proceedings, European Weed Research Society (EWRS) International Symposium on Aquatic Weeds

Proceedings, American Society of Civil Engineers (ASCE)

Proceedings of the British Weed Control Conference

Proceedings, Asian - Pacific Weed Science Society Conference

Proceedings, All India Weed Control Seminars

8.2 PAPERS

IEPEREN, H.J., and M.S. HERFST., Laboratory Experiments on the Flow Resistance of Aquatic Weeds. Hydraulic Design in Water Resource Engineering: Land Drainage, In: Proceedings of the 2nd International Conference, Southampton University; U.K. April 1986.

PITLO, R.H., Flow Resistance of Aquatic Vegetation., Proceedings. European Weed Research Society (EWRS), 6th International Symposium on Aquatic Weeds (1982).

PITLO, R.H., Regulation of aquatic vegetation by interception of daylight, Proceedings: European Weed Research Society (EWRS), 5th International Symposium on Aquatic Weeds (1978).

DAWSON, F.H., The seasonal effects of aquatic plant growth on the flow of water in a stream., In: 5th International Symposium on Aquatic Weeds, European Weed Research Society (EWRS) Yarnton, Oxford (UK); 1978.

9. OTHER LIBRARIES

NIEUWL - Hydraulica en Afvoerhydrologie
           Nieuwe Kanaal 11
           Wageningen

CENTEC - Landbouwtechniek
           Mansholtlaaw 10-12
           Wageningen

10. DOCUMENTATION AND INFORMATION SERVICES

10.1 DOCUMENTATION AND INFORMATION SERVICES

PUDOC - Centre for Agricultural Publishing and Documentation
           P.O.Box, 6700 AA Wageningen

10.2 KEYWORDS

Energy losses, flow resistance, flow retardance

Open channel flow, earth channel(s), canal(s), ditch(es)

Emergent plants, aquatic weeds, vegetation, biomass, water plants

10.3 PUBLISHED ARTICLES

TOEBSMANN, F. and MOCKENHAUPT, L., Influence of vegetation forms on banks and embankments in regard to water levels during periods of high water; Wasser und Boden (Germany, F.R.); Feb 1981 (Summary in english).

KOUWEN, N., Flow retardance in vegetated open channels, University of Waterloo, Waterloo, Ont; 1970.

HIBBERT, A.R., Managing vegetation to increase flow in the Colorado River basin. Fort Collins : U.S.D.A., 1979 (Rocky Mountain Forest and Range Experiment Station).

REFERENCES

Lamers, H.A.J.M., Writing Reports, Information Science and Applied Linguistics Section, Agricultural University, Wageningen,1986

G. Naber, Scientific information: transfer and retrieval; Wageningen, 1980, ILRI, Publication no.27

Annex 3

Initial data files

Table 3.1   - Hydraulic data

Ditch	Date	Nº	Temp. (ºC)	Q (1/s)	Water level (m)	δH (mm)
1	860520	1	17.0	13.39	0.260	12.1
2	860520	1	17.0	13.39	0.430	7.3
1	860520	2	18.1	41.22	0.320	24.6
2	860520	2	18.1	41.22	0.520	13.0
1	860520	3	18.6	63.05	0.370	32.7
2	860520	3	18.6	63.05	0.560	27.3
1	860520	4	20.0	69.59	0.400	34.2
2	860520	4	20.0	69.59	0.530	29.0
1	860520	5	21.0	105.53	0.440	44.0
2	860520	5	21.0	105.53	0.610	33.0
1	860527	6	18.6	18.34	0.270	16.4
2	860527	6	18.6	18.34	0.480	8.9
1	860527	7	18.6	44.39	0.340	25.7
2	860527	7	18.6	44.39	0.530	22.6
1	860527	8	19.0	63.97	0.335	36.0
2	860527	8	19.0	63.97	0.560	31.1
1	860527	9	20.4	84.54	0.415	42.3
2	860527	9	20.4	84.54	0.580	39.5
1	860527	10	20.6	116.19	0.480	50.1
2	860527	10	20.6	116.19	0.630	49.9
1	860603	11	15.2	22.34	0.295	18.4
2	860603	11	15.2	22.34	0.490	13.8
1	860603	12	15.2	43.91	0.355	33.4
2	860603	12	15.2	43.91	0.535	23.3
1	860603	13	15.4	61.80	0.390	38.5
2	860603	13	15.4	61.80	0.560	33.6
1	860603	14	15.4	81.35	0.430	46.5
2	860603	14	15.4	81.35	0.590	41.2
1	860603	15	15.4	98.46	0.465	52.4
2	860603	15	15.4	98.46	0.615	43.4
1	860603	16	15.8	113.80	0.495	56.9
2	860603	16	15.8	113.80	0.635	54.1
1	860612	17	16.1	54.55	0.375	36.9
2	860612	17	16.1	54.55	0.555	31.5
1	860612	18	18.7	54.29	0.380	36.0
2	860612	18	18.7	54.29	0.550	30.4
1	860612	19	19.8	100.63	0.430	54.7
2	860612	19	19.8	100.63	0.625	51.1
1	860612	20	20.6	101.02	0.480	54.2
2	860612	20	20.6	101.02	0.625	50.5
1	860617	21	22.1	20.95	0.290	19.0
2	860617	21	22.1	20.95	0.490	15.5
1	860617	22	22.7	40.61	0.350	32.0
2	860617	22	22.7	40.61	0.530	27.2
1	860617	23	23.5	59.74	0.395	41.4
2	860617	23	23.5	59.74	0.560	36.2
1	860617	24	24.2	79.95	0.440	50.8
2	860617	24	24.2	79.95	0.595	44.7
1	860617	25	25.3	96.98	0.480	57.5
2	860617	25	25.3	96.98	0.620	52.4
1	860624	26	20.1	38.93	0.485	23.1
2	860624	26	20.1	38.93	0.690	14.9
1	860624	27	20.1	39.06	0.460	25.3
2	860624	27	20.1	39.06	0.660	17.6
1	860624	28	20.2	39.15	0.435	29.3
2	860624	28	20.2	39.15	0.630	21.3
1	860624	29	20.2	39.45	0.415	32.9
2	860624	29	20.2	39.45	0.600	26.1
1	860624	30	20.4	39.54	0.400	36.6
2	860624	30	20.4	39.54	0.570	31.8

Ditch	Date	№	Temp. (ºC)	Q (l/s)	Water level (m)	δH (mm)
1	360624	31	20.4	39.67	0.360	43.4
2	360624	31	20.4	39.67	0.540	39.6
1	860625	32	18.2	62.54	0.430	40.7
2	860625	32	18.2	62.54	0.655	29.0
1	860625	33	18.2	62.94	0.475	41.6
2	360625	33	18.2	62.94	0.645	31.5
1	860625	34	18.7	63.05	0.465	43.2
2	860625	34	18.7	63.05	0.630	34.0
1	360625	35	19.3	62.33	0.455	44.5
2	360625	35	19.3	62.33	0.610	36.7
1	860625	36	20.2	62.03	0.445	46.0
2	360625	36	20.2	62.03	0.600	39.5
1	860625	37	21.5	62.88	0.435	47.9
2	860625	37	21.5	62.88	0.535	42.6
1	860625	38	21.8	62.88	0.425	49.2
2	860625	38	21.8	62.88	0.570	46.3
1	860701	39	22.8	20.95	0.305	25.6
2	860701	39	22.8	20.95	0.500	21.5
1	860701	40	22.8	41.05	0.370	41.7
2	860701	40	22.8	41.05	0.535	30.3
1	860701	41	22.8	60.07	0.430	53.7
2	860701	41	22.8	60.07	0.570	49.4
1	860701	42	24.1	84.48	0.490	66.3
2	860701	42	24.1	84.48	0.610	61.4
1	860701	43	24.6	93.56	0.510	71.0
2	860701	43	24.6	93.56	0.620	65.4
1	860703	44	23.6	53.10	0.410	48.6
2	860703	44	23.6	53.10	0.560	40.0
1	860703	45	23.8	53.10	0.410	48.1
2	360703	45	23.8	53.10	0.560	39.7
1	860703	46	25.4	38.35	0.505	63.8
2	860703	46	25.4	38.35	0.620	60.4
1	860703	47	25.8	84.59	0.490	65.6
2	360703	47	25.8	84.59	0.610	57.6
1	860708	48	18.2	21.23	0.430	11.2
2	860708	48	18.2	21.23	0.655	5.4
1	360708	49	18.8	41.44	0.445	30.2
2	860708	49	18.8	41.44	0.640	17.2
1	860708	50	19.3	64.72	0.475	52.0
2	860708	50	19.3	64.72	0.630	34.8
1	360708	51	19.7	79.52	0.495	64.6
2	860708	51	19.7	79.52	0.630	49.0
1	860708	52	20.1	99.23	0.530	78.4
2	860708	52	20.1	99.23	0.635	66.6
1	860715	53	18.6	20.50	0.310	29.5
2	860715	53	18.6	20.50	0.500	19.6
1	860715	54	19.0	40.28	0.385	47.9
2	860715	54	19.0	40.28	0.540	36.2
1	860715	55	19.7	61.22	0.445	61.6
2	360715	55	19.7	61.22	0.575	48.3
1	360715	56	20.7	79.68	0.490	73.1
2	360715	56	20.7	79.68	0.605	53.4
1	860715	57	21.4	102.04	0.540	84.0
2	860715	57	21.4	102.04	0.635	63.2
1	360806	58	18.0	20.44	0.300	28.4
2	360806	58	18.0	20.44	0.500	16.8
1	360806	59	18.0	36.80	0.365	43.3
2	360806	59	18.0	36.80	0.535	32.4
1	360806	60	18.3	53.25	0.423	54.4
2	360806	60	18.3	53.25	0.565	45.6

Ditch	Date	№	Temp. (ºC)	Q (l/s)	Water level (m)	δH (mm)
1	860806	61	19.2	66.24	0.455	60.3
2	860806	61	19.2	66.24	0.585	53.4
1	860806	62	20.0	79.81	0.490	65.2
2	860806	62	20.0	79.81	0.610	60.7
1	860806	63	20.6	93.85	0.525	70.0
2	860806	63	20.6	93 85	0.630	68.0
1	860818	64	17.8	22.49	0.310	29.8
2	860818	64	17.8	22.49	0.500	17.4
1	860818	65	17.8	47.37	0.390	50.1
2	860818	65	17.8	47.37	0.540	38.5
1	860818	66	18.4	54.86	0.420	54.5
2	860818	66	18.4	54.86	0.560	45.2
1	860818	67	18.6	57.62	0.430	55.4
2	860818	67	18.6	57.62	0.570	47.0
1	860818	68	18.8	77.17	0.490	64.0
2	860818	68	18.8	77.17	0.610	61.5
1	860818	69	19.4	88.07	0.520	67.2
2	860818	69	19.4	88.07	0.620	68.5
1	860827	70	14.6	20.63	0.310	29.9
2	860827	70	14.6	20.63	0.500	16.7
1	860827	71	14.8	26.29	0.330	35.9
2	860827	71	14.8	26.29	0.510	22.4
1	860827	72	14.8	49.20	0.410	52.8
2	860827	72	14.8	49.20	0.560	43.3
1	860827	73	14.8	68.35	0.470	60.9
2	860827	73	14.8	68.35	0.590	57.2
1	860827	74	14.8	77.46	0.500	64.6
2	860827	74	14.8	77.46	0.610	63.8
1	860827	75	14.8	82.13	0.515	65.3
2	860827	75	14.8	82.13	0.620	66.6
1	861014	76	14.0	6.13	0.230	3.7
2	861014	76	14.0	6.13	0.460	3.9
1	861014	77	13.9	32.54	0.270	26.9
2	861014	77	13.9	32.54	0.480	28.3
1	861014	78	14.1	57.99	0.410	42.8
2	861014	78	14.1	57.99	0.550	45.7
1	861014	79	14.5	69.06	0.450	48.7
2	861014	79	14.5	69.06	0.580	52.5
1	861014	80	14.8	81.12	0.490	56.2
2	861014	80	14.8	81.12	0.610	61.6
1	861014	81	15.0	104.45	0.500	63.0
2	861014	81	15.0	104.45	0.610	69.8

Table 3.3   - Zero readings

Zero readings of the staff gauge	
Ditch III-AB	Ditch III-CD
6.967 m	6.729 m

Table 3.2   - Weed data

Ditch	Date	Section type	m	d (mm)	σd (mm)	l (m)	σl (m)
1	860520	0	31	3.9	0.6	0.000	0.000
1	860520	0	48	4.3	0.8	0.000	0.000
1	860520	0	20	4.1	0.3	0.000	0.000
1	860520	0	32	3.2	0.5	0.000	0.000
1	860520	0	23	3.6	1.5	0.000	0.000
1	860520	0	8	3.9	0.7	0.000	0.000
2	860520	0	20	5.4	2.2	0.000	0.000
2	860520	0	26	4.9	1.8	0.000	0.000
2	860520	0	33	6.1	1.7	0.000	0.000
2	860520	0	16	5.7	1.7	0.000	0.000
2	860520	0	23	6.8	2.3	0.000	0.000
2	860520	0	33	5.8	1.9	0.000	0.000
1	860527	0	32	4.3	1.8	0.938	0.142
1	860527	0	50	3.3	0.9	0.960	0.185
1	860527	0	22	4.0	1.0	0.919	0.159
1	860527	0	35	3.2	0.8	0.765	0.159
1	860527	0	23	3.9	1.0	0.926	0.157
1	860527	0	14	3.7	1.0	0.922	0.152
2	860527	0	24	5.5	1.8	0.898	0.273
2	860527	0	32	5.2	1.8	0.900	0.193
2	860527	0	15	5.4	1.4	0.971	0.321
2	860527	0	10	5.7	2.1	1.131	0.225
2	860527	0	26	6.3	2.2	1.195	0.254
2	860527	0	38	6.3	2.0	1.332	0.245
1	860527	1	29	3.4	0.8	0.952	0.249
1	860603	0	32	3.3	0.9	0.943	0.216
1	860603	0	59	4.0	1.0	1.234	0.165
1	860603	0	19	3.6	1.1	0.998	0.226
1	860603	0	13	3.2	0.8	0.915	0.152
1	860603	0	20	2.6	2.0	0.920	0.230
1	860603	0	5	3.1	0.3	0.828	0.227
2	860603	0	29	5.7	2.6	1.093	0.335
2	860603	0	36	5.1	2.5	1.088	0.447
2	860603	0	21	4.9	1.2	0.994	0.179
2	860603	0	19	4.8	3.4	1.247	0.447
2	860603	0	22	6.4	2.3	1.316	0.245
2	860603	0	43	6.5	2.1	1.600	0.199
1	860603	1	29	3.3	0.8	1.103	0.242
1	860617	0	42	4.3	1.5	1.180	0.361
2	860617	0	44	6.2	2.1	1.770	0.440
1	860617	1	30	3.7	1.0	1.727	0.399
1	860701	0	23	3.1	0.8	0.965	0.333
1	860701	0	38	4.4	1.1	1.422	0.257
1	860701	0	24	3.3	0.8	0.930	0.160
1	860701	0	14	4.0	0.4	1.466	0.089
1	860701	0	24	4.2	0.8	1.203	0.293
1	860701	0	23	4.4	0.6	1.671	0.239
2	860701	0	25	5.7	1.9	1.733	0.428
2	860701	0	32	5.0	1.9	1.803	0.410
2	860701	0	21	6.1	2.2	1.692	0.464
2	860701	0	17	5.5	1.7	1.922	0.455
2	860701	0	19	6.7	2.7	1.699	0.533
2	860701	0	28	6.1	1.3	2.136	0.491
1	860701	1	32	3.4	0.7	1.373	0.351
1	860715	0	51	3.8	0.9	1.611	0.448
1	860715	0	35	4.4	1.1	1.738	0.364
1	860715	0	19	3.6	1.3	1.567	0.324
2	860715	0	29	5.2	1.7	2.054	0.535
2	860715	0	24	7.6	2.2	2.559	0.394

Ditch	Date	Section type	m	d (mm)	σd (mm)	l (m)	σl (m)
2	860715	0	37	6.0	1.2	1.824	0.516
1	860715	1	37	3.7	1.1	1.710	0.423
1	860818	0	26	3.6	1.1	1.733	0.254
1	860818	0	62	3.7	1.4	1.736	0.238
1	860818	0	29	3.9	1.3	1.406	0.366
1	860818	0	58	3.5	0.7	1.671	0.254
1	860818	0	41	3.9	0.9	1.741	0.265
1	860818	0	41	3.9	0.9	1.741	0.265
2	860818	0	47	5.0	1.7	2.109	0.264
2	860818	0	33	4.8	1.6	2.026	0.281
2	860818	0	52	4.4	1.8	1.691	0.480
2	360818	0	33	4.6	1.4	1.979	0.445
2	860818	0	40	6.6	2.5	2.221	0.597
2	860818	0	33	5.5	1.7	1.764	0.724
1	860818	1	45	3.4	0.9	1.761	0.300
1	860827	0	32	4.6	0.9	1.797	0.266
1	860827	0	33	4.8	1.3	1.908	0.276
1	860827	0	46	4.0	0.9	1.713	0.261
1	860827	0	44	3.7	0.6	1.730	0.201
1	860827	0	46	4.1	0.9	1.903	0.144
1	360827	0	46	4.1	0.9	1.903	0.144
2	860827	0	30	4.5	0.9	2.326	0.356
2	860827	0	36	5.2	1.2	2.398	0.233
2	860827	0	31	5.1	2.1	2.310	0.451
2	860827	0	26	5.5	1.3	2.360	0.612
2	860827	0	31	5.0	1.4	2.447	0.519
2	860827	0	23	5.2	1.8	2.140	0.280
1	860827	1	41	4.0	0.9	1.832	0.232
1	861014	0	22	4.3	1.3	1.436	0.317
1	861014	0	28	5.0	1.7	1.844	0.441
1	861014	0	23	3.6	0.9	1.343	0.316
1	861014	0	34	3.9	0.7	1.817	0.195
1	861014	0	42	4.1	0.9	1.819	0.225
1	861014	0	42	4.1	0.9	1.819	0.225
2	861014	0	47	4.1	1.0	1.850	0.312
2	861014	0	27	5.5	2.0	2.207	0.611
2	861014	0	29	5.3	2.3	2.258	0.628
2	861014	0	30	4.7	1.7	2.112	0.625
2	861014	0	29	6.2	1.8	2.672	0.418
2	861014	0	30	5.6	1.7	2.540	0.536
1	861014	1	35	4.2	2.0	1.696	0.325

Section type:

0 - Sections of ditch III (1.50m×0.25m)

1 - Control section (0.50m×0.50m)

Table 3.4 - Weed distribution

Ditch III-AB

0	13	5	17	0
1	15	3	5	0
0	7	15	1	0
0	6	12	3	0
0	38	16	11	0
9	37	23	16	0
3	22	3	13	0
2	5	12	21	2
0	13	18	1	0
0	31	16	11	2
1	19	17	20	1
4	24	9	17	0
4	7	16	31	1
6	32	8	10	0
0	20	26	8	1
3	33	27	15	0
4	20	5	1	0
2	24	6	0	0
2	35	17	5	0
7	16	8	9	0
13	15	18	8	1
11	22	3	12	0
5	25	17	12	3
3	21	16	26	1
5	28	15	14	4
10	13	6	4	3
9	39	7	0	2
12	12	22	5	0
6	28	6	6	0
9	16	7	4	0
7	14	15	7	0
4	19	9	7	0
4	22	22	7	0
6	20	29	17	0
3	15	5	21	0
9	8	15	22	0
2	37	12	23	0
3	22	19	26	1
4	9	19	25	0
6	17	7	9	0
6	16	6	6	0
0	23	26	14	0
3	15	6	7	0
0	6	2	7	0
0	6	0	27	0
1	21	11	20	4
0	12	0	9	0
0	7	18	9	0
1	6	5	7	0
3	10	13	9	0
7	4	7	6	0
0	13	35	11	0
1	4	5	19	0
6	11	7	15	0
0	27	10	23	0
4	19	4	16	0
7	23	22	8	0
2	27	4	12	0
0	4	22	5	0
1	6	19	8	0
1	20	23	7	0
0	21	4	12	0
1	17	5	13	0
0	10	6	6	0
0	18	10	5	0
2	4	6	10	0
2	3	14	11	0
3	17	8	12	0
9	8	9	10	0
5	11	12	10	0
3	18	4	15	2
3	4	18	28	1
0	7	16	23	0
9	8	1	11	3
10	11	1	0	0
0	1	0	0	0
0	6	2	1	0
3	16	4	7	0
1	4	9	11	0
0	7	15	7	0
0	7	13	8	2
0	11	14	11	0
2	10	24	13	8
7	20	26	28	3
2	10	12	25	2
0	28	12	13	6
3	7	7	21	0
6	14	6	5	0
2	2	7	9	6
2	17	1	8	0

Ditch III-CD

13	9	14	1	3
12	16	9	11	4
8	5	9	6	8
14	6	4	8	8
6	8	7	16	4
7	5	3	12	5
4	5	3	13	16
0	2	2	17	17
4	15	1	16	18
8	4	6	15	13
5	21	8	9	16
6	9	12	9	4
3	10	11	13	4
9	10	3	6	9
11	16	7	7	13
17	7	8	10	3
16	1	6	9	5
9	10	7	11	3
16	11	3	13	6
16	12	7	4	4
11	17	7	4	2
16	4	15	11	1
4	3	11	8	0
2	13	5	5	0
0	0	6	5	1
6	11	11	8	0
15	20	5	9	0
12	13	15	10	0
13	6	1	9	4
17	6	4	16	10
5	7	7	7	8
10	10	5	18	14
5	13	4	17	8
12	12	11	19	24
8	7	7	24	13
9	6	6	20	5
10	4	6	18	4
11	8	7	8	6
11	5	6	27	5
10	4	5	26	2
18	3	10	15	1
16	8	4	20	2
23	12	5	10	3
22	14	8	11	10
18	10	1	14	8
12	8	5	9	10
10	16	7	27	5
15	9	10	10	4
12	12	4	19	4
16	10	6	22	12
13	6	3	20	5
13	7	4	8	4
2	10	9	11	4
12	8	8	17	12
14	12	6	12	4
8	4	16	31	8
25	10	2	9	4
12	6	4	10	3
6	10	4	13	17
8	4	3	16	19
12	12	2	14	22
23	9	3	6	6
9	10	0	9	7
12	10	9	6	15
17	12	4	13	24
12	13	6	9	11
14	19	2	10	7
14	19	8	16	11
15	11	0	13	19
9	4	4	6	14
8	5	15	12	3
7	3	9	11	4
6	0	7	9	10
4	2	5	12	21
20	5	0	12	12
29	10	1	20	3
21	7	2	6	6
10	13	0	4	12
4	16	0	12	11
8	3	1	16	16
3	3	0	33	18
11	15	2	17	9
22	6	0	37	10
15	6	1	22	18
9	5	0	25	26
17	4	0	26	21
19	13	2	10	18
17	8	4	15	10
10	4	2	19	13
12	17	2	27	23

Figure 3.1 - Characteristics (Ditch III-AB)
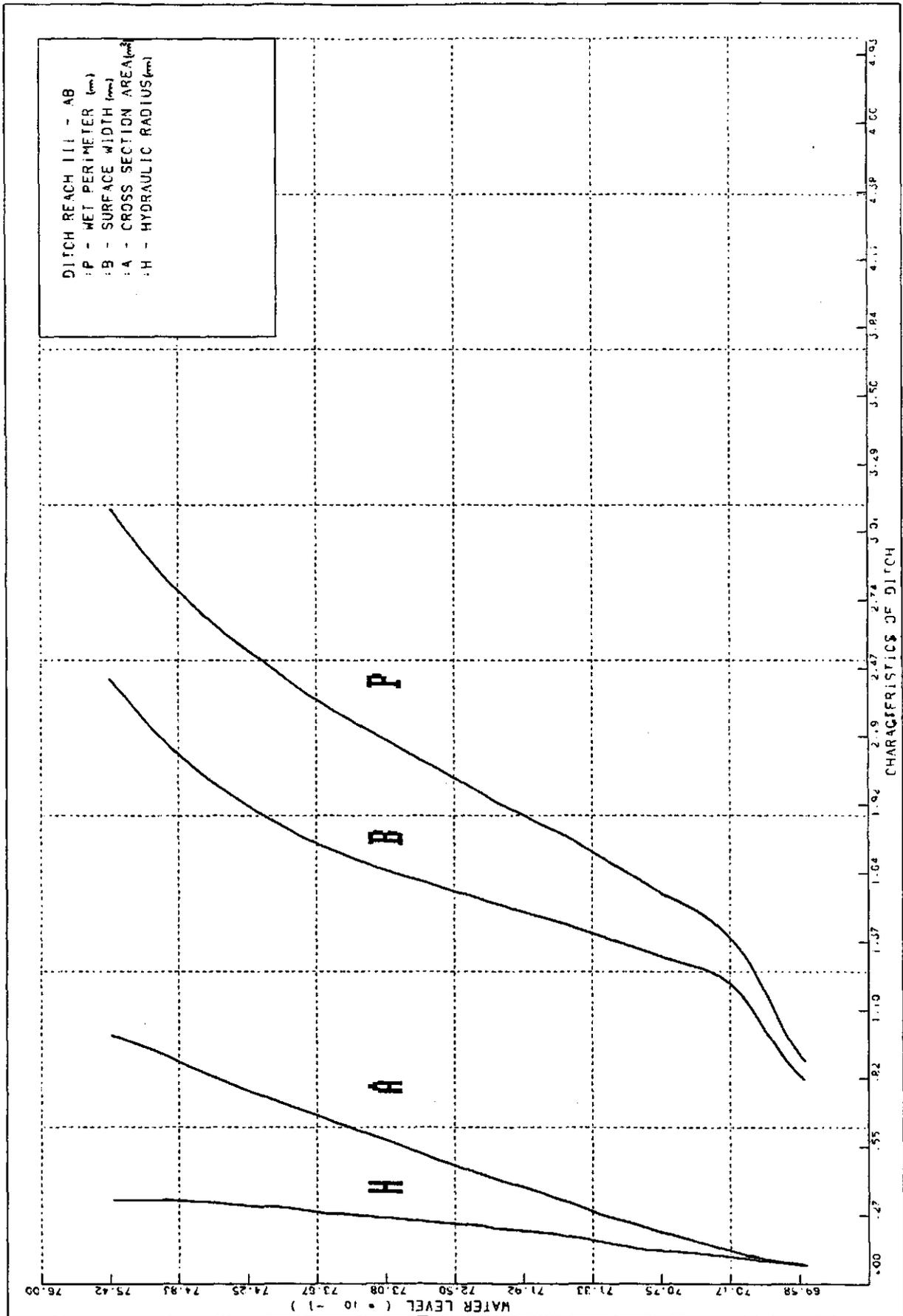
Figure 3.2 - Characterirtics (Ditch III-CD)
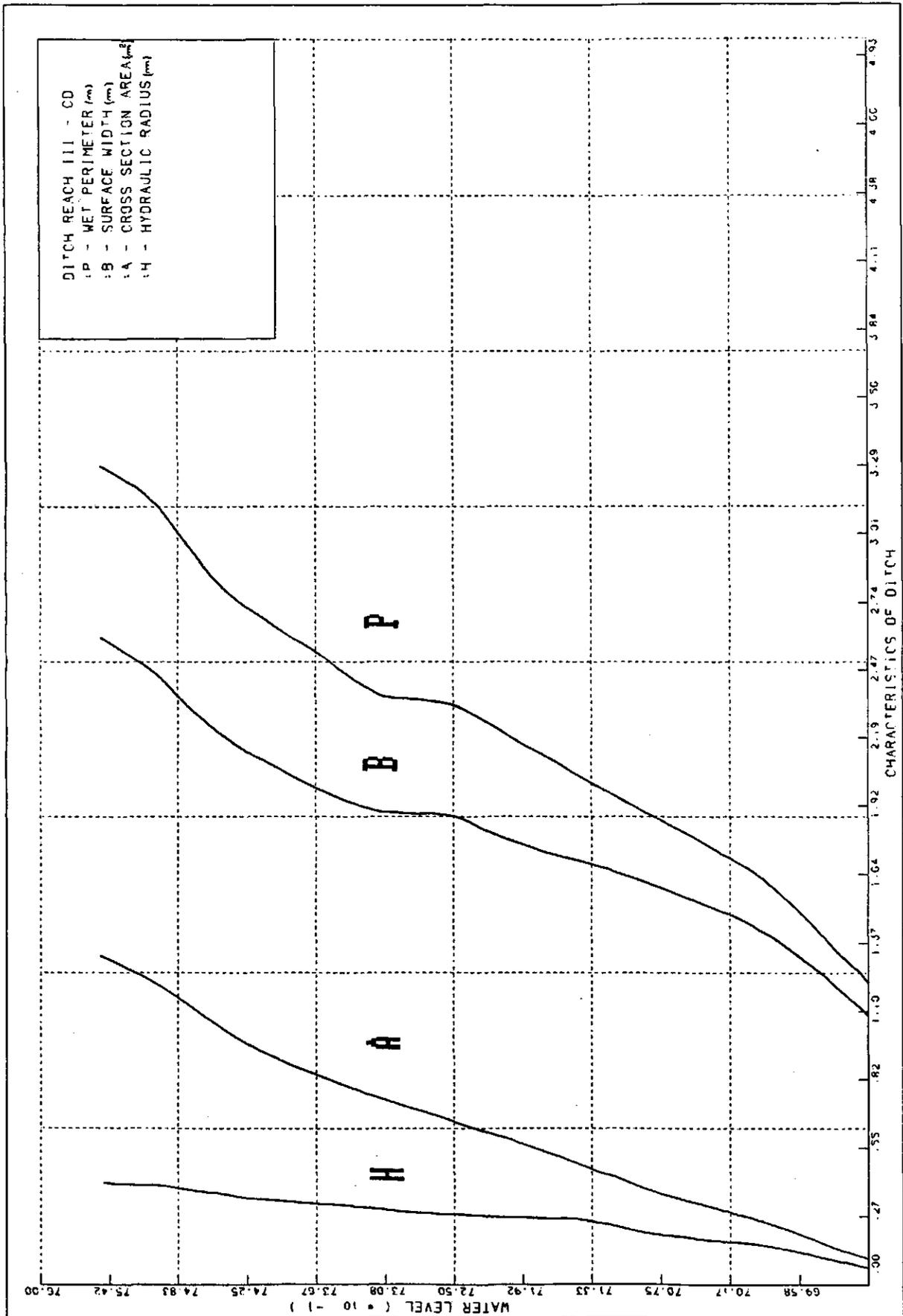
Annex 4

Computer programs

```
!***********************************************************************!
!*   PROGRAM    :SORTER                                                *!
!*   PURPOSE    :To sort out hydraulic resistance data stored in the   *!
!*              files for the ditches III AB and III CD.               *!
!*   INTERFACE :User terminal and files.                              *!
!*   NAME       :Lima and Pradhan                                      *!
!***********************************************************************!

      PROGRAM SORTER

!*Declaration of the variables.
      IMPLICIT NONE
      INTEGER PM, I, J, K, MP,MM
      PARAMETER (PM=500)
      REAL A(PM,4:9),DD
      INTEGER AA(PM,3)
      CHARACTER NAME(2)*10

!*Input data
      I=0
      OPEN (10, ACCESS='SEQUENTIAL', FILE='SLOM86', STATUS='OLD')
         DO 100 WHILE (.TRUE.)
            I=I+1
            READ (10,*, END=130),(AA(I,J), J=1,3),(A(I,J),J=4,9)
100      CONTINUE
130   CLOSE (10)
      MP=I-1

!*Change date from Julian to day number
      DO 150 I=1,MP
         MM= (AA(I,2)-860000)/100
         DD= (AA(I,2)-860000)-MM*100
         IF (MM.EQ.5) AA(I,2)=DD+120
         IF (MM.EQ.6) AA(I,2)=DD+151
         IF (MM.EQ.7) AA(I,2)=DD+181
         IF (MM.EQ.8) AA(I,2)=DD+212
         IF (MM.EQ.9) AA(I,2)=DD+243
         IF (MM.EQ.10) AA(I,2)=DD+273
150   CONTINUE

!*Output of data
      NAME(1)='SLOM861'
      NAME(2)='SLOM862'
      DO 200 K=1,2
         OPEN (UNIT=K, ACCESS='SEQUENTIAL', FILE=NAME(K), STATUS='NEW')
            DO 170 I=1,MP
               IF (AA(I,1).EQ.K) THEN
               WRITE (K,1000),(AA(I,J),J=1,3),(A(I,J),J=4,7)
1000           FORMAT(I3,I5,I6,F7.1,F9.2,F8.3,F8.1)
               ENDIF
170         CONTINUE
200   CONTINUE
      CLOSE(1)
      CLOSE(2)
      END
```

```
!*****************************************************************************!
!*  PROGRAM   :SORTWEED                                                      *!
!*  PURPOSE   :To sort out Weed-data stored in the files for the            *!
!*             ditches III A9 and III CO.                                    *!
!*  INTERFACE :User terminal and files.                                     *!
!*  NAME      :Lima and Pradhan                                             *!
!*****************************************************************************!

        PROGRAM SORTWEED

!*Declaration of the variables.
        IMPLICIT NONE
        INTEGER PM, I, J, K, MP,MM
        PARAMETER (PM=500)
        REAL A(PM,5:8),DD
        INTEGER AA(PM,4)
        CHARACTER NAME(2)*10

!*Input of data
        I=0
        OPEN (10, ACCESS='SEQUENTIAL', FILE='SLREED', STATUS='OLD')
           DO 100 WHILE (.TRUE.)
              I=I+1
              READ (10, *, END=130),(AA(I,J), J=1,4),(A(I,J),J=5,8)
100        CONTINUE
130     CLOSE (10)
        MP=I-1

!*Change date from Julian to day number
        DO 150 I=1,MP
           MM= (AA(I,2)-360000)/100
           DD= (AA(I,2)-360000)-MM*100
           IF (MM.EQ.5) AA(I,2)=DD+120
           IF (MM.EQ.6) AA(I,2)=DD+151
           IF (MM.EQ.7) AA(I,2)=DD+181
           IF (MM.EQ.8) AA(I,2)=DD+212
           IF (MM.EQ.9) AA(I,2)=DD+243
           IF (MM.EQ.10) AA(I,2)=DD+273
150     CONTINUE

!*Output data
        NAME(1)='SLREED1'
        NAME(2)='SLREED2'
        DO 200 K=1,2
           OPEN (UNIT=K, ACCESS='SEQUENTIAL', FILE=NAME(K), STATUS='NEW')
              DO 170 I=1,MP
                 IF (AA(I,3).EQ.1)THEN
                 ELSE
                   IF (AA(I,1).EQ.K) THEN
                   WRITE (K,1000),(AA(I,J),J=1,4),(A(I,J),J=5,8)
1000               FORMAT(I3,I7,I3,I6,F7.1,F7.1,F7.3,F7.3)
                   ENDIF
                 ENDIF
170           CONTINUE
200     CONTINUE
        CLOSE(1)
        CLOSE(2)
        END
```

```
!****************************************************************************!
!*PROGRAM     :WEEDATA                                                     *!
!*PURPOSE     :To work out weed data for ditches III AP and III CD         *!
!*INTERFACE   :User terminal and files                                     *!
!*NAME        :Lima and Pradhan                                            *!
!****************************************************************************!


        PPOGRAM WEEDATA

!*Declaration of the variables.
        IMPLICIT NONE
        INTEGER PM,I,J,MP,M,N
        PARAMETER (PM=1000)
        INTEGER SUM,NUMT,DAY(PM)
        REAL A(PM,5:8),D(PM),NUM(PM),L(PM),RD(PM),SUMD,AA(PM,4)
        REAL DST,RDFIN,SUML,NSTEMS(PM),MD45(PM),DATE(PM)
        CHARACTER SLREED*20,WEED*20

   !*Read file
        PRINT *,'Give the name of weed data file:'
        READ '(A20)',SLREED
        OPEN (1,ACCESS='SEQUENTIAL',FILE=SLREED,STATUS='OLD')
        I=0
        DO 100 WHILE (.TRUE.)
            I=I+1
            READ (1,*,END=150),(AA(I,J),J=1,4),(A(I,J),J=5,8)
100     CONTINUE
150     CLOSE (1)
        MP=I-1

!*Calculations.
        M=0
        N=0
        SUM=0
        SUMD=0
        SUML=0
        NUMT=0
        DO 200 I=1,MP
            N=N+1
              SUM=SUM+AA(I,4)
                  SUMD=SUMD+AA(I,4)*A(I,5)
                      SUML=SUML+AA(I,4)*A(I,7)
                          NUMT=NUMT+AA(I,4)
            IF (I.EQ.MP) THEN
                  M=M+1
                      DATE(M)=AA(I,2)
                        D(M)=SUMD*1.E-3/SUM
                          NUM(M)=SUM
                            L(M)=SUML/SUM
                                DAY(M)=N
            ELSE
                IF (AA(I,2).NE.AA(I+1,2)) THEN
                        M=M+1
                        DATE(M)=AA(I,2)
                        D(M)=SUMD*1.E-3/SUM
                        L(M)=SUML/SUM
                        NUM(M)=SUM
```

```
                        DAY(M)=N
                        SUM=0
                        SUMD=0
                        SUML=0
                        N=0
                ELSE
                ENDIF
            ENDIF
200     CONTINUE
        DST=0
        DO 300 I=1,M
            DST=DST+D(I)
! Weed density
            RD(I)=NUM(I)/0.2/1.5/DAY(I)
! The number of stems in the ditch
            NSTEMS(I)=NUM(I)*45./.2/DAY(I)
! The term mD/L
            MD45(I)=NSTEMS(I)*D(I)/45.
300     CONTINUE
! The average diameter of stems (over all the experiments)
        DST=DST/M
        PRINT *,'The average diameter=',DST
! The average weed density per unit area (over the all experiments)
        RDFIN=NUMT/0.2/1.5/MP
        PRINT *,'The average weed density=',RDFIN

! Store data in file
        PRINT *,'Give the name of output data file:'
        READ '(A20)',WEED
        OPEN (2, FILE=WEED, ACCESS='SEQUENTIAL',STATUS='NEW')
        DO 400 I=1,M
        WRITE (2,350),DATE(I),NSTEMS(I),D(I),L(I),MD45(I)
350     FORMAT (5(1PE12.3))
400     CONTINUE
        CLOSE (2)
        END
```

```
!******************************************************************************!
!*   PROGRAM    :MANCOEF                                                      *!
!*   PURPOSE    :To determine time dependent Manning's coefficient 'n', for*!
!*              the ditches III AB and III CD.                               *!
!*   INTERFACE :User terminal and files.                                     *!
!*   NAME       :Lima and Pradhan                                            *!
!******************************************************************************!

      PROGRAM MANCOEF

!*Declaration of variables    *!
      IMPLICIT NONE
      INTEGER  PM,K,I,J,M,T,COUNT
      PARAMETER (PM=1000 )
      REAL ZLG,HH,S,N,SUM,D,VISC,AR,Q,U,RH,F,RE,DST,AA(PM,3)
      REAL A(PM,4:7),H(PM),B(PM),P(PM),AAA(PM),R(PM),NDAY(PM)
      INTEGER DATE(PM)
      CHARACTER SLOMB6*20, SLVAK*20,NDATA*20,AVERN*20

   !*Input Data from terminal *!
      PRINT *,'Give name of canal data file: '
      READ '(A20)', SLOMB6
      PRINT *,'Give name of section data file: '
      READ '(A20)', SLVAK
      PRINT *,'Give the name of output file :'
      READ '(A20)',NDATA
      PRINT *,'Give the name of output file with NDAY values:'
      READ '(A20)',AVERN
      PRINT*, 'Give zero level of the staff gauge:'
      READ *, ZLG
      PRINT *,'Give the average diameter of stems (in meters):'
      READ *,DST

   !*Input data from files  *!
      OPEN (1, ACCESS= 'SEQUENTIAL', STATUS='OLD', FILE=SLOMB6)
      I=0
      DO 100 WHILE (.TRUE.)
          I=I+1
          READ (1, *, END=150),(AA(I,J), J=1,3),(A(I,J),J=4,7)
100   CONTINUE
150   CLOSE (1)
          K=I-1
      OPEN (2, ACCESS='SEQUENTIAL', STATUS='OLD', FILE=SLVAK)
      J=0
      DO 200 WHILE (.TRUE.)
          J=J+1
          READ (2, *, END=250), H(J),B(J),P(J),AAA(J),R(J)
200   CONTINUE
250   CLOSE (2)

  !*Calculations
          M=0
          SUM=0
          T=0
      OPEN(4,ACCESS='SEQUENTIAL',STATUS='NEW',FILE=NDATA)
      DO 300 I=1,K
  !*To obtain values of from file SLVAK  *!
          HH= A(I,6)+ZLG
```

```
            COUNT=(HH-H(1))*1001+1
   !*Calculations *!
            S=A(I,7)*1.E-3/45
            VISC=1.722E-6/(1.00251419+34.081355E-3*A(I,4)
     *           +226.5053E-6*A(I,4)**2)
              AP=AAA(COUNT)
                D=AR/B(COUNT)
                  Q=A(I,5)*1.E-3
                    U=Q/AR
                      RH=R(COUNT)
                        F=SQRT(9.612*RH*S)/U
                          RE=U*DST/VISC
                           N=RH**(2./3.)*SQRT(S)/U
  !*Store data in the file  *!
          WRITE (4,275),AA(I,3),AA(I,2),Q,AR,RH,S,F,RE,U,D,N
275       FORMAT (11(1PE12.3))

  !*Determine the daily average N and file results  *!
            SUM=SUM+N
            T=T+1
            IF (I.EQ.K)THEN
                M=M+1
                  DATE(M)=AA(I,2)
                    NDAY(M)=SUM/T
            ELSE
                IF (AA(I,2).NE.AA(I+1,2))THEN
                    M=M+1
                      DATE(M)=AA(I,2)
                        NDAY(M)=SUM/T
                          SUM=0
                            T=0
                ENDIF
            ENDIF
300     CONTINUE
        CLOSE (4)

   !*Store average N data in a file  *!
        OPEN (3,FILE=AVERN,ACCESS='SEQUENTIAL', STATUS='NEW')
        DO 400 I=1,M
            WRITE (3,350 ), DATE(I), NDAY(I)
350         FORMAT (I9,F9.3)
400     CONTINUE
        CLOSE (3)
        END
```

```
!******************************************************************!
!*PROGRAM     :AQWEEDRES                                         *!
!*PURPOSE     :To determine time dependent aquatic weed resistance *!
!*            cient '"U', for ditches III AB and III CD.         *!
!*INTERFACE   :User terminal andf files                         *!
!*NAME        :Lima and Pradhan                                 *!
!******************************************************************!


      PROGRAM AQWEEDRES

!Declaration of variables.
      IMPLICIT NONE
      INTEGER PM,K,I,COUNT,J
      PARAMETER (PM=1000)
      REAL DST, ZLG
      REAL A(PM,4:7),H(PM),B(PM),P(PM),R(PM),VISC,HH,RH,COEF1
      REAL COEF2,COEF3,Q,U,D,RE,MU,AAA(PM),AR,S,C,AA(PM,3),F
      CHARACTER SLOM86*20,SLVAK*20,MUDATA*20

!Input of datas.
      PRINT *,'Give the average diameter of stems (in meters):'
      READ *,DST
      PRINT *,'Give zero level of the staff gauge:'
      READ *,ZLG
      PRINT *,'Give the name of control data file:'
      READ '(A20)',SLOM86
      PRINT *,'Give the name of section data file:'
      READ '(A20)',SLVAK
      PRINT *,'Give the name of the output file:'
      READ '(A20)',MUDATA

!Input of data from the files.
      OPEN (1,ACCESS='SEQUENTIAL', STATUS='OLD', FILE=SLOM86)
      I=0
      DO 100 WHILE(.TRUE.)
         I=I+1
         READ (1,*,END=150)(AA(I,J),J=1,3),(A(I,J),J=4,7)
100   CONTINUE
150   CLOSE (1)
      K=I-1
      OPEN (2,ACCESS='SEQUENTIAL',STATUS='OLD',FILE=SLVAK)
      I=0
      DO 200 WHILE (.TRUE.)
         I=I+1
         READ (2,*,END=250),H(I),B(I),P(I),AAA(I),R(I)
200   CONTINUE
250   CLOSE (2)

!The calculations.
      OPEN (3,FILE=MUDATA,ACCESS='SEQUENTIAL',STATUS='NEW')
      DO 300 I=1,K
   !*To obtain values from file SLVAK *!
         HH=A(I,6)+ZLG
            COUNT=(HH-H(1))*1001+1
   !*Calculations *!
         RH=R(COUNT)
            Q=A(I,5)*1.E-3
```

```
          AR=AAA(COUNT)
             D=AR/B(COUNT)
          VISC=1.792E-6/(1.00251419+34.081355E-3*A(I,4)
     *       +226.50553E-6*A(I,4)**2)
          S=A(I,7)*1.E-3/45
          U=Q/AR
          C=18*LOG10(12*RH/0.15)
          F=19.624/C**2.
          COEF3=U**2/19.624
             COEF2=F/RH
               COEF1=S/COEF3-COEF2
                  MU=COEF1*AR*45./DST/D
                     RE=U*DST/VISC
     !*Store data in a file *!
          WRITE (3,350),AA(I,3),AA(I,2),Q,AR,S,COEF1,COEF2,COEF3,RE,MU
350       FORMAT (10(1PE12.3))
300       CONTINUE
          CLOSE (3)
          END
```

```
!****************************************************************!
!*PROGRAM    :DRAGSTEMS                                        *!
!*PURPOSE    :To determine time dependent drag coefficient of  *!
!*            stems 'XI', for ditches III AB and III CD.       *!
!*INTERFACE  :User terminal and files                          *!
!*NAME       :Lima and Pradhan                                 *!
!****************************************************************!

       PROGRAM DRAGSTEMS

!*Declaration of variables.   *!
       IMPLICIT NONE
       INTEGER PM,I,K,J,COUNT
       PARAMETER (PM=1000)
       REAL A(PM,4:7),H(PM),B(PM),P(PM),AAA(PM),R(PM)
       REAL D,HH,RH,Q,AR,DEPTH,XI,FACTOR,X(PM),Y(PM)
       REAL AA(PM,3),ZLG,VISC,S,U,C,F,RE,COEF4,COEF3,COEF2,COEF1
       CHARACTER SLOMB6*20,SLVAK*20,REGRE*20,DRAG*20,XICOEF*20

!*Input of datas from terminal  *!
       PRINT *,'Give the name of canal data file:'
       READ '(A20)', SLOMB6
       PRINT *,'Give the name of section data file:'
       READ '(A20)', SLVAK
       PRINT *,'Give the name of weed data file:'
       READ '(A20)', REGRE
       PRINT *,'Give the name of output file:'
       READ '(A20)',XICOEF
       PRINT *,'Give zero level of the staff gauge:'
       READ *,ZLG

!*To read data from files   *!
       OPEN (1,ACCESS='SEQUENTIAL',STATUS='OLD',FILE=SLOMB6)
       I=0
       DO 100 WHILE (.TRUE.)
            I=I+1
          READ (1,*,END=150),(AA(I,J),J=1,3),(A(I,J),J=4,7)
100    CONTINUE
150    CLOSE (1)
       K=I-1
       OPEN (2,ACCESS='SEQUENTIAL',STATUS='OLD',FILE=SLVAK)
       I=0
       DO 200 WHILE (.TRUE.)
           I=I+1
          READ (2,*,END=250),H(I),B(I),P(I),AAA(I),R(I)
200    CONTINUE
250    CLOSE (2)
       OPEN (3,ACCESS='SEQUENTIAL',STATUS='OLD',FILE=REGRE)
       I=0
       DO 300 WHILE (.TRUE.)
           I=I+1
          READ (3,*,END=350),X(I),Y(I)
          PRINT *,X(I),Y(I)
300    CONTINUE
350    CLOSE (3)

!*Calcutations  *!
       OPEN (4,FILE=XICOEF,ACCESS='SEQUENTIAL',STATUS='NEW')
```

```
          DO 400 I=1,K

   !*To obtain values from the file SLVAK  *!
              HH=A(I,6)+ZLG
                 COUNT=(HH-H(1))*1001+1

   !*Calculations  *!
              RH=R(COUNT)
              Q=A(I,5)*1.E-3
              AR=AAA(COUNT)
              DEPTH=AR/B(COUNT)
              VISC=1.792E-6/(1.00251419+34.031355E-3*A(I,4)
          *        +226.5053E-6*A(I,4)**2)
              S=A(I,7)*1.E-3/45
              U=Q/AR
              C=13*LOG10(12*RH/0.15)
              F=19.624/C**2

   !*To obtain values from the file REGRE  *!
              D=X(1)+X(2)*AA(I,2)+X(3)*AA(I,2)**2+X(4)*AA(I,2)**3
          *                   +X(5)*AA(I,2)**4+X(6)*AA(I,2)**5
              FACTOR=Y(1)+Y(2)*AA(I,2)+Y(3)*AA(I,2)**2+Y(4)*AA(I,2)**3
          *                   +Y(5)*AA(I,2)**4+Y(6)*AA(I,2)**5

              RE=U*D/VISC
              COEF4=DEPTH*FACTOR
              COEF3=U**2./19.624
              COEF2=F/RH
              COEF1=S/COEF3-COEF2
              XI=COEF1*AR/COEF4

   !*Store the datas in a file  *!
          WRITE (4,450),AA(I,3),AA(I,2),Q,AR,S,COEF1,COEF2,
          *        COEF3,COEF4,RE,XI
   450    FORMAT (11(1PE12.3))
   400    CONTINUE
          CLOSE (4)
          END
```

Annex 5

Results (tables and figures)

Table 5.1   - 'n' data (Ditch III-AB)

Meas. Nr.	Day Nr.	q [m^3/s]	A [m^2]	R [m]	s [-]	f [-]	Re [-]	u [m/s]	d [m]	n [s/m^1/3]
1.000E+00	1.400E+02	1.839E-02	4.320E-01	2.254E-01	2.689E-04	5.577E-01	1.566E+02	4.373E-02	2.882E-01	1.389E-01
2.000E+00	1.400E+02	4.122E-02	5.246E-01	2.534E-01	5.467E-04	4.692E-01	2.896E+02	7.857E-02	3.306E-01	1.192E-01
3.000E+00	1.400E+02	6.305E-02	6.063E-01	2.728E-01	7.267E-04	4.241E-01	3.881E+02	1.040E-01	3.591E-01	1.090E-01
4.000E+00	1.400E+02	6.959E-02	6.577E-01	2.856E-01	7.600E-04	4.362E-01	4.087E+02	1.058E-01	3.781E-01	1.130E-01
5.000E+00	1.400E+02	1.055E-01	7.288E-01	3.008E-01	9.778E-04	3.710E-01	5.729E+02	1.448E-01	3.999E-01	9.495E-02
6.000E+00	1.470E+02	1.834E-02	4.470E-01	2.301E-01	3.644E-04	6.991E-01	1.531E+02	4.103E-02	2.952E-01	1.747E-01
7.000E+00	1.470E+02	4.439E-02	5.565E-01	2.619E-01	5.711E-04	4.804E-01	2.976E+02	7.975E-02	3.432E-01	1.227E-01
8.000E+00	1.470E+02	6.397E-02	6.318E-01	2.792E-01	8.000E-04	4.624E-01	3.816E+02	1.013E-01	3.685E-01	1.193E-01
9.000E+00	1.470E+02	8.454E-02	6.840E-01	2.916E-01	9.400E-04	4.195E-01	4.320E+02	1.236E-01	3.867E-01	1.090E-01
1.000E+01	1.470E+02	1.162E-01	8.042E-01	3.119E-01	1.113E-03	4.040E-01	5.662E+02	1.445E-01	4.127E-01	1.062E-01
1.100E+01	1.540E+02	2.234E-02	4.699E-01	2.372E-01	4.089E-04	6.489E-01	1.627E+02	4.754E-02	3.059E-01	1.630E-01
1.200E+01	1.540E+02	4.391E-02	5.812E-01	2.812E-01	7.422E-04	5.254E-01	2.881E+02	8.415E-02	3.529E-01	1.347E-01
1.300E+01	1.540E+02	6.180E-02	6.404E-01	2.813E-01	8.556E-04	5.036E-01	3.321E+02	9.650E-02	3.717E-01	1.301E-01
1.400E+01	1.540E+02	8.135E-02	7.107E-01	2.970E-01	1.033E-03	4.794E-01	3.939E+02	1.145E-01	3.947E-01	1.250E-01
1.500E+01	1.540E+02	9.846E-02	7.753E-01	3.078E-01	1.164E-03	4.670E-01	4.370E+02	1.270E-01	4.082E-01	1.225E-01
1.600E+01	1.540E+02	1.138E-01	8.338E-01	3.157E-01	1.264E-03	4.585E-01	4.585E+02	1.365E-01	4.164E-01	1.208E-01
2.100E+01	1.680E+02	2.095E-02	4.776E-01	2.395E-01	4.222E-04	7.181E-01	1.782E+02	4.387E-02	3.094E-01	1.807E-01
2.200E+01	1.680E+02	4.061E-02	5.729E-01	2.662E-01	7.111E-04	6.080E-01	2.920E+02	7.088E-02	3.496E-01	1.557E-01
2.300E+01	1.680E+02	5.974E-02	6.490E-01	2.834E-01	9.200E-04	5.495E-01	3.863E+02	9.205E-02	3.749E-01	1.375E-01
2.400E+01	1.680E+02	7.995E-02	7.288E-01	3.008E-01	1.129E-03	5.262E-01	4.679E+02	1.097E-01	3.999E-01	1.363E-01
2.500E+01	1.680E+02	9.698E-02	8.042E-01	3.119E-01	1.278E-03	5.186E-01	5.275E+02	1.206E-01	4.127E-01	2.241E-01
3.900E+01	1.820E+02	2.095E-02	5.009E-01	2.464E-01	5.689E-04	8.867E-01	1.727E+02	4.182E-02	3.200E-01	1.819E-01
4.000E+01	1.820E+02	4.105E-02	6.063E-01	2.728E-01	9.267E-04	7.356E-01	2.796E+02	6.771E-02	3.591E-01	1.738E-01
4.100E+01	1.820E+02	6.007E-02	7.107E-01	2.970E-01	1.193E-03	6.977E-01	3.490E+02	8.452E-02	4.153E-01	1.714E-01
4.200E+01	1.820E+02	8.448E-02	8.239E-01	3.145E-01	1.484E-03	6.601E-01	4.364E+02	1.025E-01	4.199E-01	2.513E-01
4.300E+01	1.820E+02	9.356E-02	8.643E-01	3.193E-01	1.578E-03	6.495E-01	4.660E+02	1.082E-01	3.235E-01	2.186E-01
5.300E+01	1.960E+02	2.050E-02	5.088E-01	2.487E-01	6.556E-04	9.927E-01	1.504E+02	4.029E-02	3.685E-01	2.009E-01
5.400E+01	1.960E+02	4.028E-02	6.319E-01	3.024E-01	1.064E-03	8.470E-01	2.403E+02	6.375E-02	4.016E-01	1.927E-01
5.500E+01	1.960E+02	6.122E-02	7.380E-01	3.145E-01	1.369E-03	7.683E-01	3.181E+02	8.295E-02	4.155E-01	1.858E-01
5.600E+01	1.960E+02	7.968E-02	8.239E-01	3.145E-01	1.624E-03	7.321E-01	3.799E+02	9.671E-02	4.241E-01	2.367E-01
5.700E+01	1.960E+02	1.020E-01	9.230E-01	2.441E-01	1.817E-03	7.019E-01	4.393E+02	1.100E-01	3.599E-01	2.108E-01
5.800E+01	2.180E+02	2.044E-02	4.931E-01	2.706E-01	6.311E-04	9.379E-01	1.524E+02	4.145E-02	3.937E-01	2.052E-01
5.900E+01	2.180E+02	3.680E-02	5.978E-01	2.963E-01	9.622E-04	8.211E-01	2.263E+02	6.156E-02	4.053E-01	1.895E-01
6.000E+01	2.180E+02	5.325E-02	7.072E-01	3.052E-01	1.209E-03	7.873E-01	2.824E+02	7.530E-02	4.155E-01	1.817E-01
6.100E+01	2.180E+02	6.624E-02	7.565E-01	3.145E-01	1.340E-03	7.235E-01	3.317E+02	8.756E-02	4.215E-01	1.768E-01
6.200E+01	2.180E+02	7.981E-02	8.239E-01	3.220E-01	1.449E-03	6.903E-01	6.903E+02	9.687E-02	4.053E-01	2.302E-01
6.300E+01	2.300E+02	9.335E-02	8.956E-01	2.487E-01	1.556E-03	6.690E-01	4.107E+02	1.048E-01	4.155E-01	1.937E-01
6.400E+01	2.300E+02	2.249E-02	5.088E-01	2.813E-01	6.622E-04	9.094E-01	1.617E+02	4.420E-02	3.235E-01	1.940E-01
6.500E+01	2.300E+02	4.737E-02	6.404E-01	2.933E-01	1.113E-03	7.494E-01	2.706E+02	7.397E-02	3.717E-01	1.926E-01
6.600E+01	2.300E+02	5.486E-02	6.928E-01	2.970E-01	1.211E-03	7.456E-01	2.941E+02	7.919E-02	3.895E-01	1.862E-01
6.700E+01	2.300E+02	5.762E-02	7.107E-01	3.145E-01	1.231E-03	7.388E-01	3.026E+02	8.107E-02	3.947E-01	1.821E-01
6.800E+01	2.300E+02	7.717E-02	8.239E-01	3.211E-01	1.422E-03	7.073E-01	3.513E+02	9.366E-02	4.153E-01	2.514E-01
6.900E+01	2.390E+02	8.307E-02	8.851E-01	2.487E-01	1.493E-03	6.894E-01	3.787E+02	9.950E-02	4.209E-01	2.352E-01
7.000E+01	2.390E+02	2.063E-02	5.088E-01	2.487E-01	6.644E-04	9.931E-01	1.366E+02	4.055E-02	3.370E-01	2.057E-01
7.100E+01	2.390E+02	2.629E-02	5.405E-01	2.577E-01	7.978E-04	9.234E-01	1.648E+02	4.864E-02	3.539E-01	1.931E-01
7.200E+01	2.390E+02	4.920E-02	6.752E-01	2.895E-01	1.173E-03	7.923E-01	2.468E+02	7.287E-02	4.097E-01	1.919E-01
7.300E+01	2.390E+02	6.835E-02	7.847E-01	3.091E-01	1.353E-03	7.357E-01	2.950E+02	8.708E-02	4.177E-01	1.899E-01
7.400E+01	2.870E+02	7.746E-02	8.439E-01	3.170E-01	1.436E-03	7.280E-01	3.109E+02	9.179E-02	4.203E-01	1.473E-01
7.500E+01	2.870E+02	8.213E-02	8.746E-01	3.202E-01	1.451E-03	7.190E-01	3.181E+02	9.391E-02	3.193E-01	1.757E-01
7.700E+01	2.870E+02	3.254E-02	4.994E-01	2.460E-01	5.979E-04	5.830E-01	2.155E+02	6.516E-02	4.012E-01	1.704E-01
7.800E+01	2.870E+02	5.799E-02	7.343E-01	3.089E-01	9.511E-04	6.720E-01	2.626E+02	7.897E-02	3.511E-01	1.709E-01
7.900E+01	2.370E+02	6.906E-02	7.830E-01	3.170E-01	1.082E-03	6.494E-01	2.964E+02	8.320E-02	4.094E-01	—
8.000E+01	2.370E+02	8.112E-02	8.439E-01	3.170E-01	1.249E-03	6.484E-01	3.256E+02	9.613E-02	4.177E-01	1.533E-01
8.100E+01	2.870E+02	1.045E-01	9.085E-01	3.234E-01	1.600E-03	5.797E-01	3.915E+02	1.150E-01	4.228E-01	—

Table 5.2 - 'n' data (Ditch III-CD)

Meas. Nr.	Day Nr.	Q [m^3/s]	A [m^2/s]	R [m]	s [-]	f [-]	Re [-]	u [m/s]	d [m]	n [s/m^1/3]
1.000E+00	1.400E+02	1.389E-02	5.761E-01	2.645E-01	1.622E-04	6.258E-01	1.683E+02	3.279E-02	3.253E-01	1.601E-01
2.000E+00	1.400E+02	4.122E-02	6.483E-01	2.827E-01	4.000E-04	5.239E-01	3.365E+02	6.355E-02	3.510E-01	1.355E-01
3.000E+00	1.400E+02	6.305E-02	6.845E-01	2.850E-01	6.067E-04	4.472E-01	4.936E+02	9.211E-02	3.773E-01	1.158E-01
4.000E+00	1.400E+02	6.959E-02	7.212E-01	2.939E-01	6.444E-04	4.468E-01	5.352E+02	9.649E-02	3.900E-01	1.163E-01
5.000E+00	1.400E+02	1.055E-01	7.774E-01	3.073E-01	8.444E-04	3.717E-01	7.713E+02	1.357E-01	4.092E-01	9.743E-02
6.000E+00	1.470E+02	1.834E-02	5.761E-01	2.645E-01	1.978E-04	7.117E-01	1.706E+02	3.183E-02	3.258E-01	1.820E-01
7.000E+00	1.470E+02	4.439E-02	6.669E-01	2.874E-01	5.022E-04	4.654E-01	5.567E+02	9.346E-02	3.578E-01	1.466E-01
8.000E+00	1.470E+02	6.397E-02	7.212E-01	2.850E-01	6.911E-04	4.292E-01	5.058E+02	1.172E-01	3.773E-01	1.216E-01
9.000E+00	1.470E+02	8.454E-02	7.774E-01	2.939E-01	8.788E-04	4.112E-01	6.565E+02	1.424E-01	3.900E-01	1.117E-01
1.000E+01	1.470E+02	1.162E-01	8.158E-01	3.153E-01	1.102E-03	5.568E-01	8.015E+02	3.762E-02	4.203E-01	1.083E-01
1.100E+01	1.540E+02	2.234E-02	5.938E-01	2.694E-01	3.067E-04	3.067E-01	1.849E+02	7.233E-02	3.327E-01	1.942E-01
1.200E+01	1.540E+02	4.891E-02	6.845E-01	2.897E-01	6.289E-04	5.845E-01	3.555E+02	9.028E-02	3.610E-01	1.518E-01
1.300E+01	1.540E+02	6.180E-02	7.397E-01	2.850E-01	7.467E-04	5.061E-01	4.461E+02	1.100E-01	3.773E-01	1.311E-01
1.400E+01	1.540E+02	8.135E-02	7.869E-01	2.984E-01	9.156E-04	4.708E-01	5.434E+02	1.251E-01	3.964E-01	1.229E-01
1.500E+01	1.540E+02	9.846E-02	8.255E-01	3.094E-01	1.076E-03	4.567E-01	6.182E+02	1.379E-01	4.125E-01	1.199E-01
1.600E+01	1.540E+02	1.113E-01	8.255E-01	3.169E-01	1.202E-03	4.435E-01	6.882E+02	3.528E-02	4.224E-01	1.169E-01
2.100E+01	1.680E+02	2.095E-02	5.938E-01	2.694E-01	3.446E-04	8.553E-01	2.053E+02	6.089E-02	3.327E-01	2.194E-01
2.200E+01	1.680E+02	4.061E-02	6.669E-01	2.874E-01	6.044E-04	6.780E-01	3.602E+02	8.728E-02	3.578E-01	1.758E-01
2.300E+01	1.680E+02	5.974E-02	6.845E-01	2.850E-01	8.046E-04	5.434E-01	5.260E+02	1.067E-01	3.773E-01	1.407E-01
2.400E+01	1.630E+02	7.995E-02	7.491E-01	3.006E-01	9.933E-04	5.072E-01	6.537E+02	1.213E-01	3.996E-01	1.325E-01
2.500E+01	1.680E+02	9.698E-02	7.965E-01	3.115E-01	1.164E-03	4.900E-01	7.647E+02	3.424E-01	4.152E-01	1.288E-01
3.900E+01	1.820E+02	2.095E-02	6.118E-01	2.741E-01	4.778E-04	1.047E+00	2.030E+02	3.599E-01	3.393E-01	2.693E-01
4.000E+01	1.820E+02	4.105E-02	7.662E-01	2.897E-01	6.846E-04	7.266E-01	3.599E+02	5.068E-02	3.610E-01	1.887E-01
4.100E+01	1.820E+02	6.007E-02	7.023E-01	2.894E-01	6.532E-04	6.532E-01	5.068E+02	8.547E-02	3.836E-01	1.696E-01
4.200E+01	1.820E+02	8.448E-02	7.774E-01	3.073E-01	1.364E-03	5.902E-01	6.641E+02	1.087E-01	4.092E-01	1.548E-01
4.300E+01	1.820E+02	9.356E-02	7.965E-01	3.115E-01	1.453E-03	5.674E-01	7.261E+02	1.175E-01	4.152E-01	1.491E-01
5.300E+01	1.960E+02	2.050E-02	6.118E-01	2.741E-01	4.356E-04	4.356E-01	1.796E+02	1.351E-02	3.393E-01	2.625E-01
5.400E+01	1.960E+02	4.028E-02	6.856E-01	2.921E-01	8.046E-04	8.173E-01	3.180E+02	5.875E-02	3.646E-01	2.125E-01
5.500E+01	1.960E+02	6.122E-02	7.119E-01	2.917E-01	7.073E-04	6.445E-01	4.735E+02	8.600E-02	3.867E-01	1.676E-01
5.600E+01	1.960E+02	7.968E-02	7.679E-01	3.051E-01	1.293E-03	6.007E-01	5.853E+02	1.038E-01	4.060E-01	1.573E-01
5.700E+01	1.960E+02	1.020E-01	8.255E-01	3.169E-01	1.516E-03	5.554E-01	7.091E+02	1.236E-01	4.226E-01	1.464E-01
5.800E+01	2.180E+02	2.044E-02	6.118E-01	2.741E-01	3.733E-04	9.484E-01	1.764E+02	3.341E-02	3.393E-01	2.440E-01
5.900E+01	2.180E+02	3.680E-02	6.762E-01	2.897E-01	7.200E-04	8.313E-01	2.873E+02	5.442E-02	3.610E-01	2.159E-01
6.000E+01	2.180E+02	5.325E-02	6.936E-01	2.872E-01	1.018E-03	6.960E-01	4.134E+02	7.677E-02	3.805E-01	1.805E-01
6.100E+01	2.130E+02	6.624E-02	7.304E-01	2.961E-01	1.187E-03	6.474E-01	4.932E+02	9.069E-02	3.932E-01	1.687E-01
6.200E+01	2.180E+02	7.981E-02	7.774E-01	3.073E-01	1.349E-03	6.212E-01	5.694E+02	1.027E-01	4.092E-01	1.629E-01
6.300E+01	2.180E+02	9.385E-02	8.158E-01	3.153E-01	1.511E-03	5.943E-01	6.474E+02	1.150E-01	4.203E-01	1.565E-01
6.400E+01	2.300E+02	2.249E-02	6.118E-01	2.741E-01	3.867E-04	8.772E-01	1.931E+02	3.676E-02	3.393E-01	2.237E-01
6.500E+01	2.300E+02	4.737E-02	6.856E-01	2.921E-01	8.555E-04	7.167E-01	3.629E+02	5.909E-02	3.646E-01	1.864E-01
6.600E+01	2.300E+02	5.486E-02	7.028E-01	2.850E-01	1.006E-03	6.613E-01	4.274E+02	8.015E-02	3.773E-01	1.713E-01
6.700E+01	2.300E+02	3.762E-02	7.774E-01	2.894E-01	1.044E-03	6.842E-01	4.393E+02	8.199E-02	3.836E-01	1.725E-01
6.800E+01	2.300E+02	7.717E-02	7.965E-01	3.073E-01	1.367E-03	6.467E-01	5.346E+02	9.927E-02	4.092E-01	1.690E-01
6.900E+01	2.390E+02	8.807E-02	6.299E-01	3.115E-01	1.522E-03	6.169E-01	6.043E+02	9.927E-02	4.152E-01	1.621E-01
7.000E+01	2.390E+02	2.063E-02	6.845E-01	2.741E-01	3.711E-04	9.369E-01	1.632E+02	3.372E-02	3.393E-01	2.411E-01
7.100E+01	2.390E+02	2.629E-02	7.397E-01	2.780E-01	4.978E-04	8.829E-01	2.030E+02	4.174E-02	3.446E-01	2.277E-01
7.200E+01	2.390E+02	4.920E-02	7.965E-01	2.850E-01	9.622E-04	7.217E-01	3.496E+02	7.188E-02	3.773E-01	1.869E-01
7.300E+01	2.390E+02	6.835E-02	6.373E-01	2.984E-01	1.276E-03	6.602E-01	4.495E+02	9.240E-02	3.964E-01	1.723E-01
7.400E+01	2.390E+02	7.746E-02	7.566E-01	3.073E-01	1.418E-03	6.562E-01	4.847E+02	9.964E-02	4.092E-01	1.771E-01
7.500E+01	2.390E+02	8.213E-02	7.965E-01	3.115E-01	1.480E-03	6.523E-01	5.016E+02	1.031E-01	4.152E-01	1.714E-01
7.700E+01	2.870E+02	3.254E-02	6.373E-01	2.799E-01	6.289E-04	8.139E-01	3.811E+02	5.106E-02	3.471E-01	2.102E-01
7.800E+01	2.870E+02	5.799E-02	7.267E-01	2.952E-01	1.016E-03	6.797E-01	4.405E+02	7.980E-02	3.919E-01	1.771E-01
7.900E+01	2.870E+02	6.906E-02	7.566E-01	3.024E-01	1.167E-03	6.446E-01	4.954E+02	9.128E-02	4.022E-01	1.686E-01
8.000E+01	2.370E+02	8.112E-02	7.965E-01	3.115E-01	1.369E-03	6.351E-01	6.100E+02	1.018E-01	4.152E-01	1.669E-01
8.100E+01	2.370E+02	1.045E-01	8.373E-01	3.192E-01	1.551E-03	5.587E-01	6.100E+02	1.247E-01	4.255E-01	1.475E-01

Table 5.3   - 'μ' data (Ditch III-AB)

Meas. Nr. [-]	Day Nr. [-]	Q [m³/s]	A [m²]	S [-]	Mu·d·B/AL [1/m]	λ/R [1/m]	u²/2g [m]	Re [-]	Mu [-]
1.000E+00	1.400E+02	1.339E-02	4.320E-01	2.689E-04	2.589E+00	1.703E-01	9.743E-05	1.568E+02	4.479E+04
2.000E+00	1.400E+02	4.122E-02	5.246E-01	5.467E-04	1.598E+00	1.399E-01	3.146E-04	2.896E+02	2.925E+04
3.000E+00	1.400E+02	6.305E-02	6.063E-01	7.267E-04	1.195E+00	1.238E-01	5.511E-04	3.881E+02	2.327E+04
4.000E+00	1.400E+02	6.959E-02	6.577E-01	7.600E-04	1.217E+00	1.149E-01	5.705E-04	4.087E+02	2.443E+04
5.000E+00	1.400E+02	9.778E-02	7.288E-01	9.778E-04	8.096E-01	1.055E-01	1.068E-03	5.729E+02	1.702E+04
6.000E+00	1.470E+02	1.834E-02	4.470E-01	3.644E-04	4.086E-01	1.645E-01	8.579E-05	1.531E+02	7.155E+04
7.000E+00	1.470E+02	4.439E-02	5.566E-01	5.711E-04	1.630E+00	1.325E-01	3.241E-04	2.976E+02	3.049E+04
8.000E+00	1.470E+02	8.397E-02	6.318E-01	8.000E-04	1.412E+00	1.192E-01	5.224E-04	3.816E+02	2.793E+04
9.000E+00	1.470E+02	9.454E-02	6.840E-01	9.000E-04	1.096E+00	1.111E-01	7.784E-04	4.820E+02	2.238E+04
1.000E+01	1.470E+02	1.162E-01	8.042E-01	1.113E-03	9.472E-01	9.949E-02	1.064E-03	5.662E+02	2.129E+04
1.100E+01	1.540E+02	2.234E-02	4.699E-01	4.089E-04	3.394E+00	1.563E-01	1.152E-04	1.627E+02	6.016E+04
1.200E+01	1.540E+02	4.891E-02	5.812E-01	7.422E-04	1.930E+00	1.272E-01	3.609E-04	2.881E+02	3.667E+04
1.300E+01	1.540E+02	6.180E-02	6.404E-01	8.556E-04	1.685E+00	1.077E-01	4.677E-04	3.321E+02	3.350E+04
1.400E+01	1.540E+02	8.135E-02	7.107E-01	1.033E-03	1.440E+00	1.077E-01	6.677E-04	3.939E+02	2.992E+04
1.500E+01	1.540E+02	9.846E-02	7.753E-01	1.164E-03	1.315E+00	1.016E-01	8.218E-04	4.370E+02	2.382E+04
1.600E+01	1.540E+02	1.138E-01	8.338E-01	1.264E-03	1.235E+00	9.755E-02	9.492E-04	4.745E+02	2.852E+04
1.700E+01	1.680E+02	2.095E-02	4.222E-01	1.484E-03	4.152E+00	9.816E-02	9.805E-05	1.782E+02	7.396E+04
1.800E+01	1.680E+02	4.061E-02	4.776E-01	1.578E-03	2.648E+00	9.578E-02	2.560E-04	2.920E+02	5.008E+04
1.900E+01	1.680E+02	5.974E-02	5.729E-01	6.556E-04	2.014E+00	1.444E-01	4.318E-04	3.863E+02	4.023E+04
2.000E+01	1.680E+02	7.995E-02	6.490E-01	1.064E-03	1.735E+00	1.192E-01	6.132E-04	4.679E+02	3.649E+04
2.100E+01	1.680E+02	9.698E-02	7.288E-01	1.369E-03	1.625E+00	1.055E-01	7.411E-04	5.275E+02	3.653E+04
2.200E+01	1.820E+02	2.095E-02	5.009E-01	1.624E-03	6.235E+00	1.466E-01	8.914E-05	1.727E+02	1.126E+05
2.300E+01	1.820E+02	4.105E-02	6.063E-01	1.867E-03	3.843E+00	1.233E-01	2.336E-04	2.796E+02	7.486E+04
2.400E+01	1.820E+02	6.007E-02	7.107E-01	6.311E-04	3.170E+00	1.077E-01	3.640E-04	3.490E+02	6.587E+04
2.500E+01	1.820E+02	8.448E-02	8.239E-01	9.209E-04	2.673E+00	9.816E-02	5.358E-04	4.364E+02	6.113E+04
2.600E+01	1.820E+02	9.356E-02	8.643E-01	1.340E-03	2.547E+00	9.449E-02	5.971E-04	4.660E+02	6.048E+04
2.700E+01	1.960E+02	2.052E-02	5.088E-01	1.449E-03	7.780E+00	1.444E-01	8.272E-05	1.504E+02	1.412E+05
2.800E+01	1.960E+02	4.028E-02	6.318E-01	1.556E-03	5.020E+00	1.177E-01	2.071E-04	2.403E+02	9.930E+04
2.900E+01	1.960E+02	6.122E-02	7.107E-01	6.622E-04	3.799E+00	1.077E-01	3.507E-04	3.181E+02	8.046E+04
3.000E+01	1.960E+02	7.968E-02	8.239E-01	1.113E-03	3.310E+00	9.816E-02	4.766E-04	3.799E+02	7.577E+04
3.100E+01	1.960E+02	1.020E-01	9.280E-01	1.211E-03	2.937E+00	9.299E-02	6.161E-04	4.393E+02	7.414E+04
3.200E+01	2.180E+02	2.044E-02	4.931E-01	1.231E-03	7.059E+00	1.490E-01	8.756E-05	1.524E+02	1.269E+05
3.300E+01	2.180E+02	3.680E-02	5.978E-01	1.422E-03	4.857E+00	1.031E-01	1.931E-04	2.263E+02	9.414E+04
3.400E+01	2.180E+02	5.325E-02	7.072E-01	1.493E-03	4.076E+00	1.031E-01	2.889E-04	2.824E+02	8.449E+04
3.500E+01	2.180E+02	6.624E-02	7.565E-01	6.644E-04	3.327E+00	9.816E-02	3.902E-04	3.317E+02	7.165E+04
3.600E+01	2.180E+02	7.981E-02	8.239E-01	7.978E-04	2.932E+00	9.449E-02	4.782E-04	3.741E+02	6.712E+04
3.700E+01	2.300E+02	2.249E-02	5.088E-01	1.173E-03	2.685E+00	1.444E-01	5.596E-04	4.107E+02	6.584E+04
3.800E+01	2.300E+02	4.737E-02	6.404E-01	1.353E-03	6.507E+00	1.177E-01	9.956E-05	1.617E+02	1.181E+05
3.900E+01	2.300E+02	5.486E-02	6.928E-01	1.436E-03	3.875E+00	1.077E-01	2.783E-04	2.706E+02	7.704E+04
4.000E+01	2.300E+02	7.107E-02	7.107E-01	1.451E-03	3.680E+00	9.816E-02	3.195E-04	2.941E+02	7.554E+04
4.100E+01	2.300E+02	7.717E-02	8.239E-01	5.973E-04	3.563E+00	9.491E-02	3.350E-04	3.026E+02	7.413E+04
4.200E+01	2.390E+02	8.307E-02	8.851E-01	9.511E-04	3.083E+00	1.366E-01	4.471E-04	3.513E+02	7.058E+04
4.300E+01	2.390E+02	2.065E-02	5.083E-01	1.092E-03	7.787E+00	1.648E-01	5.045E-04	3.787E+02	6.951E+04
4.400E+01	2.390E+02	2.629E-02	5.405E-01	1.249E-03	6.481E+00	1.123E-01	8.378E-05	1.366E+02	1.413E+05
4.500E+01	2.390E+02	4.920E-02	6.752E-01	1.400E-03	4.224E+00	1.010E-01	1.206E-04	1.648E+02	1.199E+05
4.600E+01	2.390E+02	6.635E-02	7.849E-01	1.436E-03	3.401E+00	9.535E-02	2.708E-04	2.468E+02	8.572E+04
4.700E+01	2.390E+02	7.746E-02	8.439E-01	1.451E-03	3.247E+00	4.293E-02	3.664E-04	2.950E+02	7.519E+04
4.800E+01	2.870E+02	3.213E-02	8.746E-01	5.973E-04	3.134E+00	9.535E-02	4.293E-04	3.109E+02	7.524E+04
4.900E+01	2.870E+02	3.254E-02	4.994E-01	9.511E-04	2.616E+00	1.470E-01	4.494E-04	3.181E+02	4.721E+04
5.000E+01	2.370E+02	5.799E-02	7.343E-01	1.092E-03	2.838E+00	1.050E-01	2.165E-04	2.155E+02	6.098E+04
5.100E+01	2.870E+02	6.906E-02	7.830E-01	1.249E-03	2.629E+00	1.011E-01	3.178E-04	2.626E+02	5.802E+04
5.200E+01	2.870E+02	8.112E-02	8.437E-01	1.400E-03	2.555E+00	9.691E-02	3.964E-04	2.964E+02	5.957E+04
5.300E+01	2.870E+02	1.045E-01	9.085E-01	1.400E-03	1.985E+00	9.383E-02	6.736E-04	3.915E+02	4.921E+04

Table 5.4   - 'μ' data (Ditch III-CD)

Meas. Nr. [-]	Day Nr. [-]	q [m^3/s]	A [m^2]	s [-]	Mu*d*O/AL [1/m]	λ/R [1/m]	u^2/2g [m]	Re [-]	Mu [-]
1.000E+00	1.400E+02	1.889E-02	5.761E-01	1.622E-04	2.331E+00	1.303E-01	5.479E-05	1.688E+02	4.022E+04
2.000E+00	1.400E+02	4.122E-02	6.483E-01	4.000E-04	1.825E+00	1.168E-01	2.060E-04	3.365E+02	2.708E+04
3.000E+00	1.400E+02	6.305E-02	6.845E-01	6.067E-04	1.288E+00	1.152E-01	4.324E-04	4.236E+02	1.878E+04
4.000E+00	1.400E+02	6.959E-02	7.212E-01	6.098E-04	1.249E+00	1.096E-01	4.745E-04	5.352E+02	1.856E+04
5.000E+00	1.400E+02	1.055E-01	7.744E-01	8.444E-04	7.974E-01	1.019E-01	9.390E-04	7.713E+02	1.217E+04
6.000E+00	1.470E+02	1.834E-02	5.761E-01	1.973E-04	3.699E+00	1.303E-01	5.164E-05	1.706E+02	5.255E+04
7.000E+00	1.470E+02	4.439E-02	6.669E-01	5.022E-04	2.111E+00	1.137E-01	2.253E-04	3.567E+02	3.162E+04
8.000E+00	1.470E+02	6.397E-02	6.845E-01	6.911E-04	1.438E+00	1.152E-01	4.451E-04	5.058E+02	2.096E+04
9.000E+00	1.470E+02	8.454E-02	7.212E-01	8.778E-04	1.144E+00	1.096E-01	7.002E-04	6.565E+02	1.700E+04
1.000E+01	1.470E+02	1.162E-01	8.158E-01	1.109E-03	9.750E-01	9.775E-02	1.034E-03	8.015E+02	1.521E+04
1.100E+01	1.540E+02	2.234E-02	5.933E-01	3.067E-04	4.125E+00	1.264E-01	7.213E-05	1.349E+02	5.917E+04
1.200E+01	1.540E+02	4.391E-02	6.762E-01	6.289E-04	2.247E+00	1.122E-01	2.666E-04	3.555E+02	3.381E+04
1.300E+01	1.540E+02	6.180E-02	6.845E-01	7.467E-04	1.682E+00	1.152E-01	4.154E-04	4.461E+02	2.453E+04
1.400E+01	1.540E+02	8.135E-02	7.397E-01	9.156E-04	1.379E+00	1.069E-01	6.163E-04	5.434E+02	2.067E+04
1.500E+01	1.540E+02	9.246E-02	7.369E-01	1.076E-03	1.247E+00	1.003E-01	7.978E-04	6.182E+02	1.913E+04
1.600E+01	1.540E+02	1.138E-01	8.255E-01	1.202E-03	1.144E+00	9.696E-02	9.684E-04	6.882E+02	1.797E+04
2.100E+01	1.680E+02	1.138E-01	8.255E-01	1.202E-03	1.247E+00	1.003E-01	9.684E-04	6.882E+02	1.797E+04
2.200E+01	1.680E+02	2.095E-02	5.938E-01	3.446E-04	5.304E+00	1.264E-01	6.343E-05	2.058E+02	7.607E+04
2.300E+01	1.680E+02	4.061E-02	6.669E-01	6.044E-04	3.085E+00	1.137E-01	1.890E-04	3.602E+02	4.021E+04
2.400E+01	1.680E+02	5.974E-02	6.845E-01	8.044E-04	1.957E+00	1.152E-01	3.881E-04	5.260E+02	2.854E+04
2.500E+01	1.680E+02	7.995E-02	7.491E-01	9.933E-04	1.606E+00	1.056E-01	5.805E-04	6.537E+02	2.418E+04
3.900E+01	1.680E+02	9.698E-02	7.965E-01	1.164E-03	1.442E+00	9.969E-02	7.554E-04	7.642E+02	2.222E+04
4.000E+01	1.820E+02	2.095E-02	6.118E-01	4.778E-04	3.873E+00	1.229E-01	5.975E-05	2.030E+02	1.141E+05
4.100E+01	1.820E+02	4.105E-02	7.762E-01	6.844E-04	3.532E+00	1.122E-01	1.878E-04	3.599E+02	5.316E+04
4.200E+01	1.820E+02	6.007E-02	7.774E-01	1.098E-03	2.836E+00	1.124E-01	3.723E-04	5.068E+02	4.175E+04
4.300E+01	1.820E+02	8.448E-02	7.774E-01	1.364E-03	2.165E+00	1.019E-01	6.018E-04	6.641E+02	3.306E+04
5.300E+01	1.820E+02	9.356E-02	7.965E-01	1.453E-03	1.967E+00	9.969E-02	7.031E-04	7.261E+02	3.033E+04
5.400E+01	1.960E+02	2.050E-02	6.118E-01	4.356E-04	7.490E+00	1.229E-01	5.721E-05	1.796E+02	1.085E+05
5.500E+01	1.960E+02	4.028E-02	6.856E-01	8.044E-04	4.463E+00	1.107E-01	1.759E-04	3.180E+02	6.748E+04
5.600E+01	1.960E+02	6.122E-02	7.119E-01	1.073E-03	2.737E+00	1.109E-01	3.768E-04	4.735E+02	4.049E+04
5.700E+01	1.960E+02	7.968E-02	7.679E-01	1.298E-03	2.262E+00	1.031E-01	5.487E-04	5.853E+02	2.904E+04
5.800E+01	1.960E+02	2.044E-02	8.255E-01	1.516E-03	1.850E+00	9.696E-02	7.736E-04	7.091E+02	9.332E+04
5.900E+01	2.180E+02	3.680E-02	6.118E-01	3.733E-04	6.441E+00	1.229E-01	5.688E-05	1.764E+02	7.011E+04
6.000E+01	2.180E+02	5.325E-02	6.762E-01	7.200E-04	4.658E+00	1.122E-01	1.509E-04	2.873E+02	4.776E+04
6.100E+01	2.180E+02	6.624E-02	6.936E-01	1.013E-03	3.260E+00	1.138E-01	3.004E-04	4.134E+02	4.065E+04
6.200E+01	2.180E+02	7.981E-02	7.304E-01	1.187E-03	2.723E+00	1.083E-01	4.191E-04	4.932E+02	3.679E+04
6.300E+01	2.180E+02	9.385E-02	7.774E-01	1.369E-03	2.410E+00	1.019E-01	5.371E-04	5.694E+02	3.343E+04
6.400E+01	2.300E+02	2.249E-02	8.158E-01	1.511E-03	2.143E+00	9.775E-02	6.744E-04	6.474E+02	7.958E+04
6.500E+01	2.300E+02	4.737E-02	6.856E-01	3.867E-04	5.492E+00	1.229E-01	6.886E-05	1.931E+02	5.150E+04
6.600E+01	2.300E+02	5.486E-02	7.023E-01	1.004E-03	3.406E+00	1.107E-01	2.433E-04	3.629E+02	4.306E+04
6.700E+01	2.300E+02	5.762E-02	7.774E-01	1.044E-03	2.953E+00	1.152E-01	3.273E-04	4.274E+02	4.323E+04
6.800E+01	2.300E+02	7.717E-02	7.965E-01	1.367E-03	2.937E+00	1.124E-01	3.425E-04	4.393E+02	3.999E+04
6.900E+01	2.300E+02	8.307E-02	6.373E-01	1.522E-03	2.620E+00	1.019E-01	5.021E-04	5.346E+02	3.613E+04
7.000E+01	2.300E+02	2.063E-02	7.267E-01	3.711E-04	2.344E+00	9.969E-02	6.230E-04	6.043E+02	9.102E+04
7.100E+01	2.390E+02	2.629E-02	7.566E-01	4.978E-04	6.282E+00	1.229E-01	5.794E-05	1.632E+02	8.064E+04
7.200E+01	2.390E+02	4.920E-02	6.299E-01	9.622E-04	5.488E+00	1.201E-01	8.877E-05	2.030E+02	5.161E+04
7.400E+01	2.390E+02	6.835E-02	6.845E-01	1.271E-03	3.540E+00	1.152E-01	2.633E-04	3.496E+02	4.221E+04
7.500E+01	2.390E+02	7.746E-02	7.397E-01	1.418E-03	2.315E+00	1.069E-01	4.351E-04	4.495E+02	4.123E+04
7.700E+01	2.390E+02	8.213E-02	7.774E-01	1.480E-03	2.700E+00	1.019E-01	5.059E-04	4.847E+02	4.057E+04
7.800E+01	2.390E+02	3.254E-02	7.965E-01	1.367E-03	2.632E+00	9.969E-02	5.418E-04	5.015E+02	4.809E+04
7.900E+01	2.870E+02	5.799E-02	6.373E-01	6.259E-04	4.615E+00	1.187E-01	1.328E-04	2.425E+02	4.501E+04
8.000E+01	2.370E+02	6.906E-02	7.267E-01	1.016E-03	3.021E+00	1.088E-01	3.245E-04	3.811E+02	3.966E+04
8.100E+01	2.870E+02	8.112E-02	7.965E-01	1.369E-03	2.643E+00	1.046E-01	4.246E-04	4.405E+02	3.839E+04
	2.370E+02	1.045E-01	8.373E-01	1.551E-03	1.860E+00	9.583E-02	5.286E-04	4.954E+02	2.942E+04

Table 5.5   - 'ξ' data (Ditch III-AB)

Meas. Nr. [-]	Day Nr. [-]	Q [m^3/s]	A [m^2]	S [-]	XI=dD/AL [1/m]	λ/R [1/m]	u^2/2g [m]	m=dD/L [m]	Re [-]	XI [-]
1.000E+00	1.400E+02	1.889E-02	5.761E-01	1.622E-04	2.831E+00	1.303E-01	5.479E-05	2.295E-01	1.757E+02	7.111E+00
2.000E+00	1.400E+02	4.122E-02	6.483E-01	4.000E-04	1.825E+00	1.168E-01	2.060E-04	2.471E-01	3.502E+02	4.789E+00
3.000E+00	1.400E+02	6.305E-02	6.845E-01	6.067E-04	1.288E+00	1.152E-01	4.324E-04	2.655E-01	5.137E+02	3.320E+00
4.000E+00	1.400E+02	6.959E-02	7.212E-01	6.444E-04	1.249E+00	1.096E-01	4.745E-04	2.745E-01	5.569E+02	3.281E+00
5.000E+00	1.400E+02	1.055E-01	7.774E-01	8.444E-04	7.974E-01	1.019E-01	9.390E-04	2.880E-01	6.026E+02	2.152E+00
6.003E+00	1.400E+02	1.834E-02	5.761E-01	1.978E-04	3.699E+00	1.303E-01	5.164E-05	2.500E-01	1.733E+02	8.524E+00
7.000E+00	1.470E+02	4.439E-02	5.761E-01	5.022E-04	2.111E+00	1.137E-01	2.258E-04	2.746E-01	3.624E+02	5.127E+00
8.000E+00	1.470E+02	6.397E-02	6.669E-01	6.911E-04	1.633E+00	1.152E-01	4.451E-04	2.395E-01	5.139E+02	3.399E+00
9.000E+00	1.470E+02	8.454E-02	6.845E-01	8.778E-04	1.144E+00	1.096E-01	7.002E-04	2.995E-01	6.670E+02	2.757E+00
1.000E+01	1.470E+02	1.162E-01	8.158E-01	1.109E-03	9.750E-01	9.775E-02	1.034E-03	3.225E-01	8.143E+02	2.466E+00
1.100E+01	1.540E+02	2.234E-02	5.938E-01	3.067E-04	4.125E+00	1.264E-01	7.213E-05	2.476E-01	1.885E+02	9.892E+00
1.200E+01	1.540E+02	4.891E-02	6.762E-01	6.289E-04	2.247E+00	1.122E-01	2.666E-04	2.688E-01	3.624E+02	5.653E+00
1.300E+01	1.540E+02	6.180E-02	6.845E-01	7.467E-04	1.682E+00	1.152E-01	4.154E-04	2.808E-01	4.547E+02	4.100E+00
1.400E+01	1.540E+02	8.135E-02	7.397E-01	9.156E-04	1.379E+00	1.069E-01	6.163E-04	2.951E-01	5.538E+02	3.456E+00
1.500E+01	1.540E+02	9.846E-02	7.869E-01	1.076E-03	1.247E+00	1.008E-01	7.973E-04	3.069E-01	6.301E+02	3.198E+00
1.600E+01	1.540E+02	1.138E-01	8.255E-01	1.202E-03	1.144E+00	9.696E-02	9.684E-04	3.145E-01	7.014E+02	3.004E+00
2.100E+01	1.680E+02	2.095E-02	5.938E-01	3.444E-04	5.304E+00	1.264E-01	6.343E-05	2.213E-01	2.180E+02	1.423E+01
2.200E+01	1.680E+02	4.061E-02	6.669E-01	6.044E-04	3.085E+00	1.137E-01	1.890E-04	2.380E-01	3.816E+02	8.646E+00
2.400E+01	1.680E+02	5.974E-02	6.845E-01	8.044E-04	1.957E+00	1.152E-01	3.881E-04	2.510E-01	5.572E+02	5.339E+00
2.500E+01	1.680E+02	7.491E-02	7.491E-01	9.933E-04	1.606E+00	1.056E-01	5.805E-04	2.658E-01	6.925E+02	4.525E+00
3.900E+01	1.680E+02	9.698E-02	7.965E-01	1.164E-03	1.442E+00	9.969E-02	7.554E-04	2.762E-01	8.101E+02	4.158E+00
4.000E+01	1.820E+02	2.095E-02	6.118E-01	4.778E-04	7.873E+00	1.229E-01	5.975E-05	2.448E-01	2.214E+02	1.967E+01
4.200E+01	1.820E+02	4.105E-02	6.762E-01	6.844E-04	3.532E+00	1.122E-01	1.878E-04	2.605E-01	3.926E+02	3.947E+00
4.300E+01	1.820E+02	7.981E-02	7.028E-01	1.098E-03	2.410E+00	1.124E-01	3.723E-04	2.768E-01	5.527E+02	7.201E+00
5.400E+01	1.820E+02	8.448E-02	7.774E-01	1.364E-03	2.165E+00	1.019E-01	6.018E-04	2.955E-01	7.242E+02	5.701E+00
5.500E+01	1.820E+02	9.356E-02	7.965E-01	1.453E-03	1.967E+00	9.969E-02	7.031E-04	2.996E-01	7.919E+02	5.230E+00
5.600E+01	1.960E+02	2.050E-02	6.118E-01	4.356E-04	7.490E+00	1.229E-01	5.721E-05	3.107E-01	1.944E+02	1.475E+01
5.700E+01	1.960E+02	6.122E-02	6.856E-01	8.044E-04	4.463E+00	1.107E-01	1.759E-04	3.336E-01	3.443E+02	9.171E+00
5.800E+01	1.960E+02	7.968E-02	7.119E-01	1.073E-03	2.737E+00	1.109E-01	3.768E-04	3.541E-01	5.126E+02	5.503E+03
5.900E+01	1.960E+02	2.020E-01	7.679E-01	1.298E-03	2.262E+00	1.031E-01	5.487E-04	3.717E-01	6.337E+02	4.673E+00
6.000E+01	1.960E+02	2.044E-02	8.255E-01	1.516E-03	1.850E+00	9.696E-02	7.786E-04	3.868E-01	7.677E+02	3.947E+00
6.100E+01	2.180E+02	3.680E-02	6.118E-01	3.733E-04	6.441E+00	1.229E-01	5.688E-05	3.854E-01	1.755E+02	1.022E+01
6.300E+01	2.180E+02	5.325E-02	6.762E-01	7.200E-04	4.653E+00	1.122E-01	1.509E-04	4.101E-01	2.859E+02	7.681E+00
6.400E+01	2.180E+02	6.624E-02	6.936E-01	1.013E-03	3.260E+00	1.138E-01	3.004E-04	4.322E-01	4.114E+02	5.232E+00
6.500E+01	2.180E+02	7.981E-02	7.304E-01	1.187E-03	2.723E+00	1.083E-01	4.191E-04	4.466E-01	4.908E+02	4.453E+00
6.600E+01	2.300E+02	9.385E-02	7.774E-01	1.349E-03	2.410E+00	1.019E-01	5.371E-04	4.648E-01	5.666E+02	4.030E+00
6.700E+01	2.300E+02	2.249E-02	8.158E-01	1.511E-03	2.143E+00	9.775E-02	6.744E-04	4.774E-01	6.442E+02	3.662E+00
6.800E+01	2.300E+02	4.737E-02	6.118E-01	3.867E-04	5.492E+00	1.229E-01	6.886E-05	3.416E-01	1.802E+02	9.837E+00
6.900E+01	2.300E+02	5.486E-02	6.856E-01	8.556E-04	3.406E+00	1.107E-01	2.433E-04	3.663E-01	3.387E+02	6.367E+00
7.000E+01	2.300E+02	5.762E-02	6.845E-01	1.004E-03	2.953E+00	1.152E-01	3.273E-04	3.798E-01	3.988E+02	5.323E+00
7.100E+01	2.300E+02	7.717E-02	7.028E-01	1.044E-03	2.937E+00	1.124E-01	3.425E-04	3.862E-01	4.100E+02	5.344E+00
7.200E+01	2.300E+02	8.807E-02	7.774E-01	1.367E-03	2.620E+00	1.019E-01	5.021E-04	4.119E-01	4.989E+02	4.944E+00
7.300E+01	2.300E+02	2.063E-02	7.965E-01	1.522E-03	2.344E+00	9.969E-02	6.230E-04	4.180E-01	5.640E+02	4.466E+00
7.400E+01	2.390E+02	2.629E-02	6.118E-01	3.711E-04	6.282E+00	1.229E-01	5.794E-05	2.558E-01	1.458E+02	1.502E+01
7.500E+01	2.390E+02	4.920E-02	6.299E-01	4.978E-04	5.488E+00	1.201E-01	8.877E-05	2.597E-01	1.815E+02	1.331E+01
7.700E+01	2.390E+02	6.855E-02	6.845E-01	9.622E-04	3.540E+00	1.152E-01	2.633E-04	2.844E-01	3.125E+02	8.518E+00
7.800E+01	2.390E+02	7.746E-02	7.397E-01	1.271E-03	2.815E+00	1.069E-01	4.351E-04	2.988E-01	4.013E+02	6.967E+00
7.900E+01	2.390E+02	8.213E-02	7.774E-01	1.418E-03	2.700E+00	1.019E-01	5.059E-04	3.085E-01	4.332E+02	6.805E+00
8.000E+01	2.870E+02	3.254E-02	7.965E-01	1.480E-03	2.632E+00	9.969E-02	5.418E-04	3.130E-01	4.483E+02	6.697E+00
8.100E+01	2.870E+02	5.799E-02	6.373E-01	6.289E-04	4.615E+00	1.187E-01	1.328E-04	2.889E-01	2.252E+02	1.018E+01
8.200E+01	2.870E+02	6.906E-02	7.266E-01	1.016E-03	3.021E+00	1.083E-01	3.245E-04	3.262E-01	3.538E+02	6.731E+00
8.300E+01	2.870E+02	8.112E-02	7.965E-01	1.167E-03	2.490E+00	9.769E-02	5.286E-04	3.348E-01	4.600E+02	5.975E+00
8.400E+01	2.870E+02	1.045E-01	8.373E-01	1.551E-03	1.860E+00	9.583E-02	7.930E-04	3.541E-01	5.646E+02	4.398E+00

62

Table 5.6   - 'ξ' data (Ditch III-CD)

| Meas. Nr. [-]	Day Nr.	q [m^3/s]	A [m^2]	S [-]	XI*mdD/AL [1/m]	λ/R [1/m]	u*2/2g [m]	m*dD/L [m]	Re [-]	XI [-]
1.000E+00	1.400E+02	1.889E-02	4.320E-01	2.689E-04	2.589E+00	1.703E-01	9.743E-05	1.570E-01	1.572E+02	7.125E+00
2.000E+00	1.400E+02	4.122E-02	5.246E-01	5.467E-04	1.598E+00	1.399E-01	3.166E-04	1.301E-01	2.904E+02	4.653E+00
3.000E+00	1.400E+02	6.305E-02	6.063E-01	7.267E-04	1.195E+00	1.238E-01	5.511E-04	1.957E-01	3.891E+02	3.703E+00
4.000E+00	1.400E+02	6.959E-02	6.572E-01	7.600E-04	1.217E+00	1.149E-01	5.705E-04	2.060E-01	4.098E+02	3.887E+00
5.000E+03	1.400E+02	1.055E-01	7.288E-01	9.773E-04	8.096E-01	1.055E-01	1.063E-03	2.179E-01	5.745E+02	2.708E+00
6.000E+00	1.400E+02	1.334E-02	4.470E-01	3.646E-04	4.084E+00	1.645E-01	8.578E-05	1.488E-01	1.447E+02	1.226E+01
7.000E+00	1.470E+02	4.439E-02	5.566E-01	5.711E-04	1.630E+00	1.325E-01	3.241E-04	1.731E-01	2.813E+02	5.241E+00
8.000E+00	1.470E+02	6.397E-02	6.318E-01	6.000E-04	1.412E+00	1.192E-01	5.224E-04	1.858E-01	3.607E+02	4.801E+00
9.000E+00	1.470E+02	8.454E-02	6.840E-01	9.400E-04	1.096E+00	1.111E-01	7.784E-04	1.950E-01	4.556E+02	3.846E+00
1.000E+01	1.470E+02	1.162E-01	8.042E-01	1.113E-03	9.472E-01	9.949E-02	1.064E-03	2.081E-01	5.352E+02	3.660E+00
1.100E+01	1.540E+02	2.234E-02	4.699E-01	4.089E-04	3.394E+00	1.563E-01	1.152E-04	1.442E-01	1.537E+02	1.106E+01
1.200E+01	1.540E+02	4.891E-02	5.812E-01	7.422E-04	1.930E+00	1.272E-01	3.609E-04	1.663E-01	2.720E+02	6.742E+00
1.300E+01	1.540E+02	6.180E-02	6.404E-01	8.556E-04	1.685E+00	1.177E-01	4.746E-04	1.752E-01	3.135E+02	6.160E+00
1.400E+01	1.540E+02	8.135E-02	7.107E-01	1.033E-03	1.440E+00	1.077E-01	6.677E-04	1.860E-01	3.719E+02	5.502E+00
1.500E+01	1.540E+02	9.846E-02	7.753E-01	1.164E-03	1.315E+00	1.016E-01	8.218E-04	1.924E-01	4.126E+02	5.300E+00
1.600E+01	1.540E+02	1.138E-01	8.338E-01	1.264E-03	1.235E+00	9.755E-02	9.492E-04	1.963E-01	4.680E+02	5.244E+00
1.700E+01	1.630E+02	2.095E-02	4.776E-01	4.222E-04	4.152E+00	1.538E-01	9.805E-05	1.412E-01	1.779E+02	1.404E+01
1.800E+01	1.630E+02	4.061E-02	5.729E-01	7.111E-04	2.648E+00	1.290E-01	2.560E-04	1.595E-01	2.915E+02	9.510E+00
2.100E+01	1.680E+02	5.974E-02	6.490E-01	9.200E-04	2.016E+00	1.163E-01	4.318E-04	1.711E-01	3.857E+02	7.641E+00
2.200E+01	1.680E+02	7.995E-02	7.288E-01	1.129E-03	1.735E+00	1.055E-01	6.132E-04	1.825E-01	4.672E+02	6.929E+00
2.300E+01	1.680E+02	9.698E-02	8.042E-01	1.278E-03	1.625E+00	9.949E-02	7.411E-04	1.884E-01	5.266E+02	6.937E+00
2.400E+01	1.680E+02	2.095E-02	5.009E-01	5.689E-04	6.235E+00	1.466E-01	8.914E-05	1.661E-01	1.772E+02	1.880E+01
2.500E+01	1.820E+02	4.105E-02	6.063E-01	2.267E-04	3.843E+00	1.238E-01	2.336E-04	1.865E-01	2.868E+02	1.250E+01
3.900E+01	1.820E+02	6.007E-02	7.107E-01	1.173E-03	3.170E+00	1.077E-01	3.640E-04	2.049E-01	3.515E+02	1.010E+01
4.000E+01	1.820E+02	8.448E-02	8.239E-01	1.484E-03	2.673E+00	9.816E-02	5.358E-04	2.156E-01	3.858E+02	1.021E+01
4.100E+01	1.820E+02	9.356E-02	8.643E-01	1.578E-03	2.547E+00	9.578E-02	5.971E-04	2.180E-01	4.476E+02	1.010E+01
4.200E+01	1.320E+02	2.050E-02	5.038E-01	6.556E-04	7.780E+00	1.444E-01	2.072E-05	2.057E-01	4.780E+02	1.924E+01
4.300E+01	1.820E+02	4.028E-02	6.318E-01	1.044E-03	5.020E+00	1.192E-01	2.071E-04	2.344E-01	1.499E+02	1.353E+01
4.400E+01	1.960E+02	6.122E-02	7.380E-01	1.369E-03	3.799E+00	1.046E-01	3.507E-04	2.557E-01	3.171E+02	1.096E+01
5.300E+01	1.960E+02	7.968E-02	8.239E-01	1.624E-03	3.310E+00	9.816E-02	4.766E-04	2.641E-01	3.787E+02	1.033E+01
5.400E+01	1.960E+02	1.020E-01	9.280E-01	1.867E-03	2.937E+00	9.299E-02	6.161E-04	2.697E-01	4.379E+02	1.010E+01
5.500E+01	1.960E+02	2.044E-02	4.931E-01	6.311E-04	7.059E+00	1.490E-01	8.756E-05	2.569E-01	2.126E+02	1.355E+01
5.600E+01	1.960E+02	3.680E-02	5.978E-01	9.622E-04	4.857E+00	1.255E-01	1.931E-04	2.889E-01	2.653E+02	1.005E+01
5.700E+01	2.180E+02	5.325E-02	7.072E-01	1.209E-03	4.076E+00	1.081E-01	2.889E-04	3.195E-01	3.115E+02	9.022E+00
5.800E+01	2.180E+02	6.624E-02	7.565E-01	1.340E-03	3.327E+00	1.031E-01	3.907E-04	3.289E-01	3.515E+02	7.651E+00
5.900E+01	2.180E+02	7.981E-02	8.239E-01	1.449E-03	2.932E+00	9.816E-02	4.782E-04	3.370E-01	3.858E+02	7.167E+00
6.000E+01	2.180E+02	9.385E-02	8.956E-01	1.556E-03	2.685E+00	9.449E-02	5.596E-04	3.420E-01	3.858E+02	7.031E+00
6.100E+01	2.180E+02	2.249E-02	5.088E-01	6.622E-04	6.507E+00	1.446E-01	9.956E-05	2.734E-01	1.579E+02	1.211E+01
6.200E+01	2.300E+02	4.737E-02	6.404E-01	1.113E-03	3.875E+00	1.177E-01	2.788E-04	3.142E-01	2.643E+02	7.898E+00
6.300E+01	2.300E+02	7.746E-02	6.923E-01	1.211E-03	3.486E+00	1.100E-01	2.923E-04	3.292E-01	2.872E+02	7.744E+00
6.400E+01	2.300E+02	5.486E-02	7.107E-01	1.231E-03	3.568E+00	1.077E-01	3.350E-04	3.336E-01	2.955E+02	7.600E+00
6.500E+01	2.300E+02	5.762E-02	8.239E-01	1.422E-03	3.083E+00	9.816E-02	4.471E-04	3.511E-01	3.431E+02	7.235E+00
6.600E+01	2.300E+02	7.717E-02	8.851E-01	1.493E-03	2.865E+00	9.491E-02	5.045E-04	3.558E-01	3.699E+02	7.126E+00
6.700E+01	2.300E+02	8.807E-02	5.083E-01	6.644E-04	7.787E+00	1.444E-01	8.378E-05	2.676E-01	1.443E+02	1.481E+01
6.800E+01	2.390E+02	2.063E-02	5.405E-01	7.978E-04	6.481E+00	1.361E-01	1.206E-04	2.788E-01	1.740E+02	1.256E+01
6.900E+01	2.390E+02	2.629E-02	6.752E-01	1.173E-03	4.224E+00	1.123E-01	2.706E-04	2.607E-01	2.607E+02	8.980E+00
7.000E+01	2.390E+02	4.920E-02	7.849E-01	1.353E-03	3.401E+00	1.010E-01	3.864E-04	3.176E-01	3.115E+02	7.877E+00
7.100E+01	2.390E+02	6.835E-02	8.439E-01	1.636E-03	3.247E+00	9.691E-02	4.293E-04	3.389E-01	3.284E+02	7.929E+00
7.200E+01	2.390E+02	7.746E-02	8.746E-01	1.451E-03	3.134E+00	9.535E-02	4.494E-04	3.456E-01	3.359E+02	7.882E+00
7.300E+01	2.390E+02	3.213E-02	7.107E-01	1.231E-03	3.568E+00	1.077E-01	4.494E-04	3.477E-01	3.359E+02	7.882E+00
7.400E+01	2.870E+02	3.256E-02	4.994E-01	5.978E-04	2.616E+00	1.470E-01	2.163E-04	2.163E-01	2.293E+02	6.040E+00
7.500E+01	2.870E+02	5.799E-02	7.343E-01	5.511E-04	2.883E+00	1.050E-01	3.178E-04	2.718E-01	2.793E+02	7.803E+00
7.700E+01	2.870E+02	6.906E-02	7.830E-01	1.082E-04	2.629E+00	1.011E-01	3.964E-04	2.773E-01	3.155E+02	7.424E+00
7.300E+01	2.370E+02	8.112E-02	8.439E-01	1.249E-03	2.555E+00	9.691E-02	4.709E-04	2.829E-01	3.463E+02	7.622E+00
8.000E+01	2.870E+02	1.045E-01	9.035E-01	1.400E-03	1.985E+00	9.383E-02	6.730E-04	2.864E-01	4.164E+02	6.296E+00

63

Figure 5.1 - Number of stems (Ditch III)
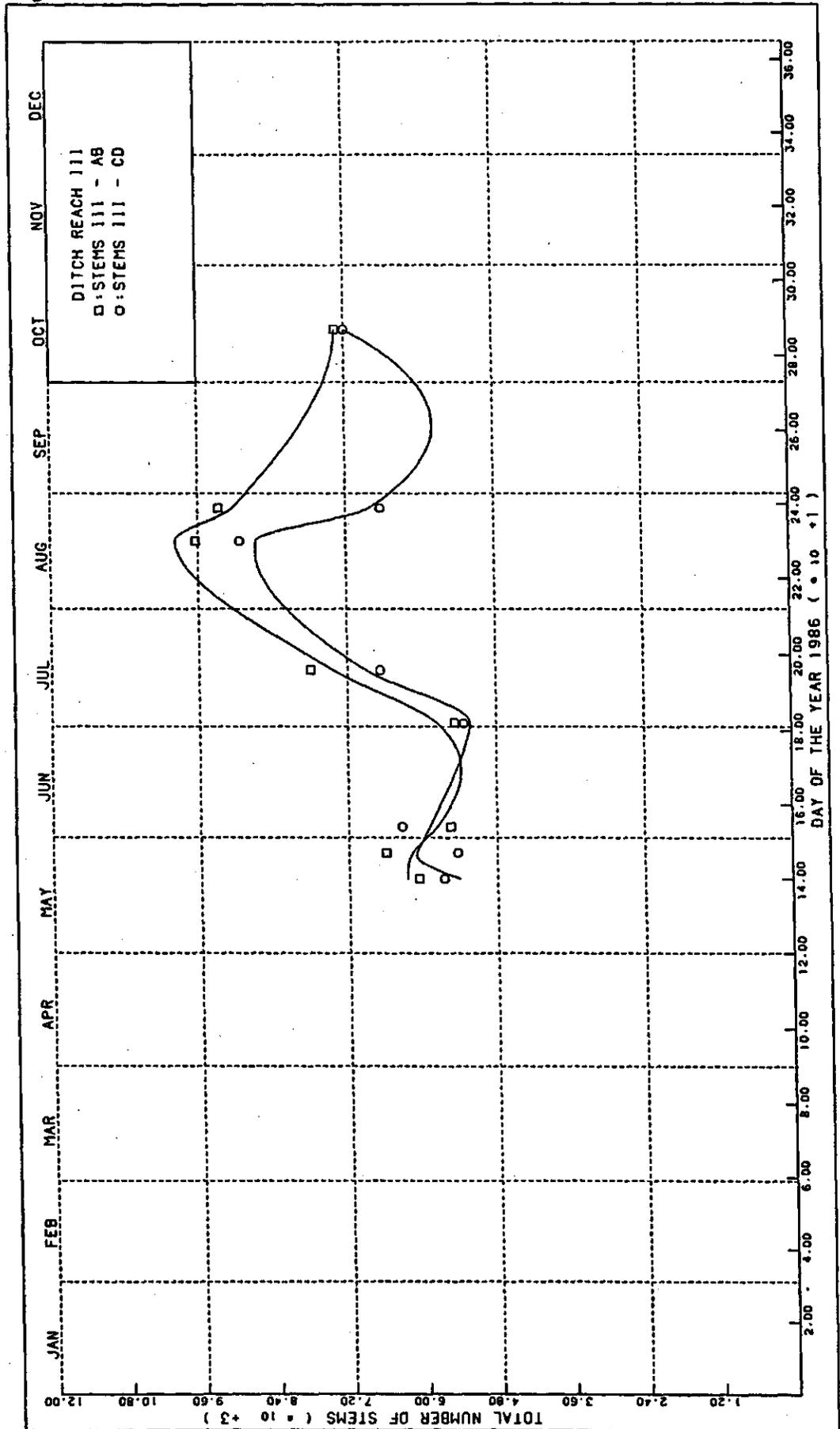
Figure 5.2 - Diameter (Ditch III)
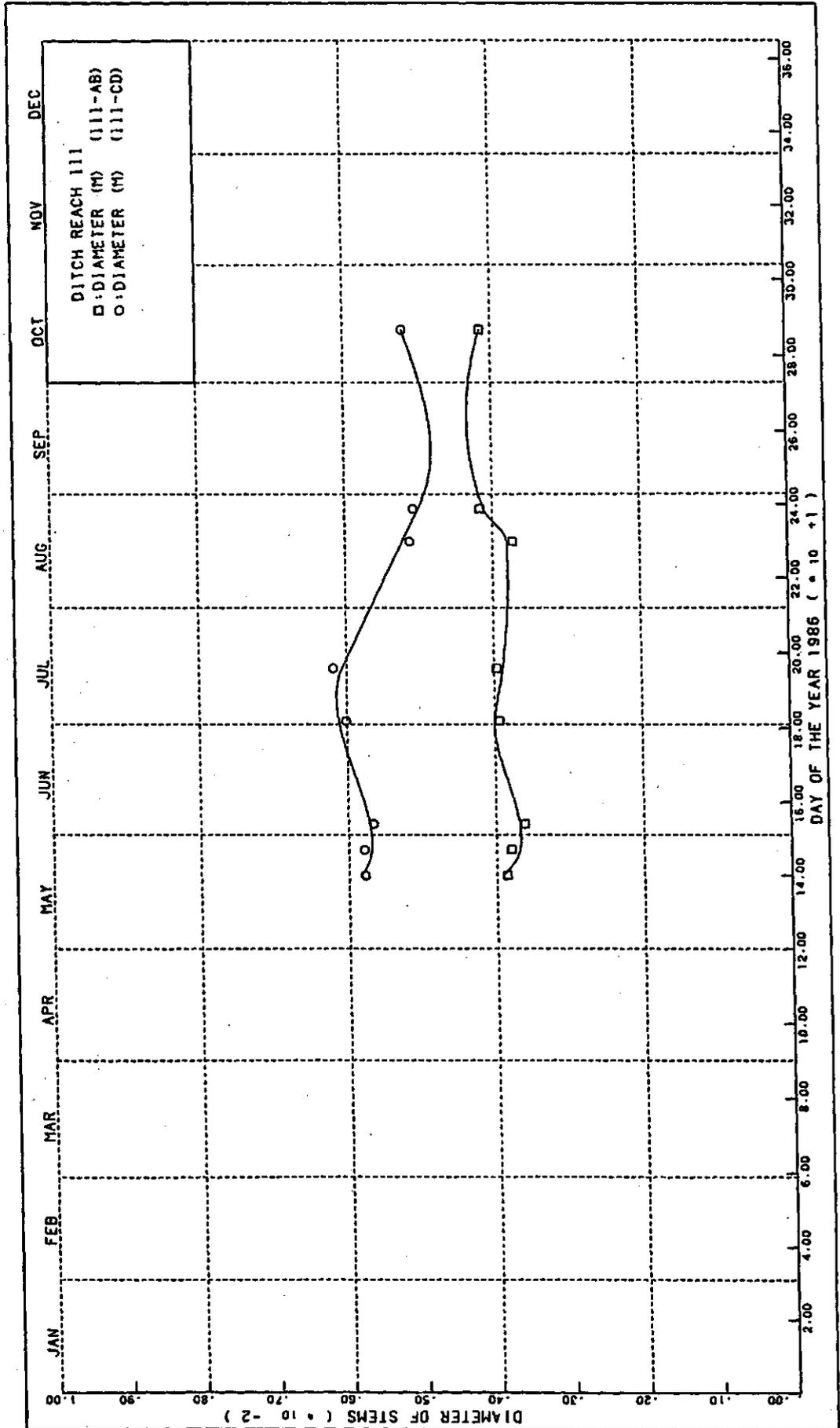
Figure 5.3 - M*D/L (Ditch III)

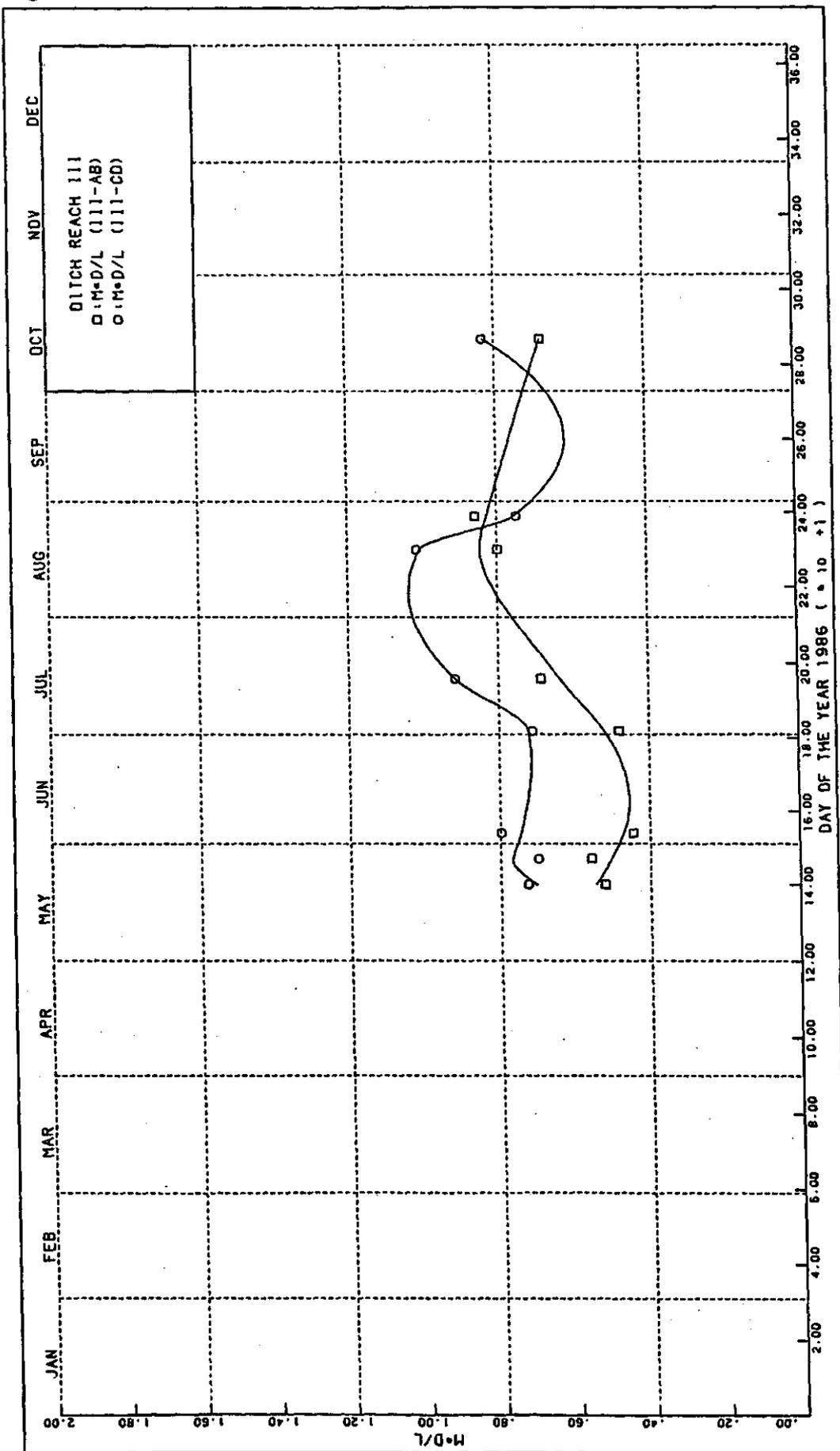Figure 5.4   - Scattering of M*D*H/L (Ditch III-AB)

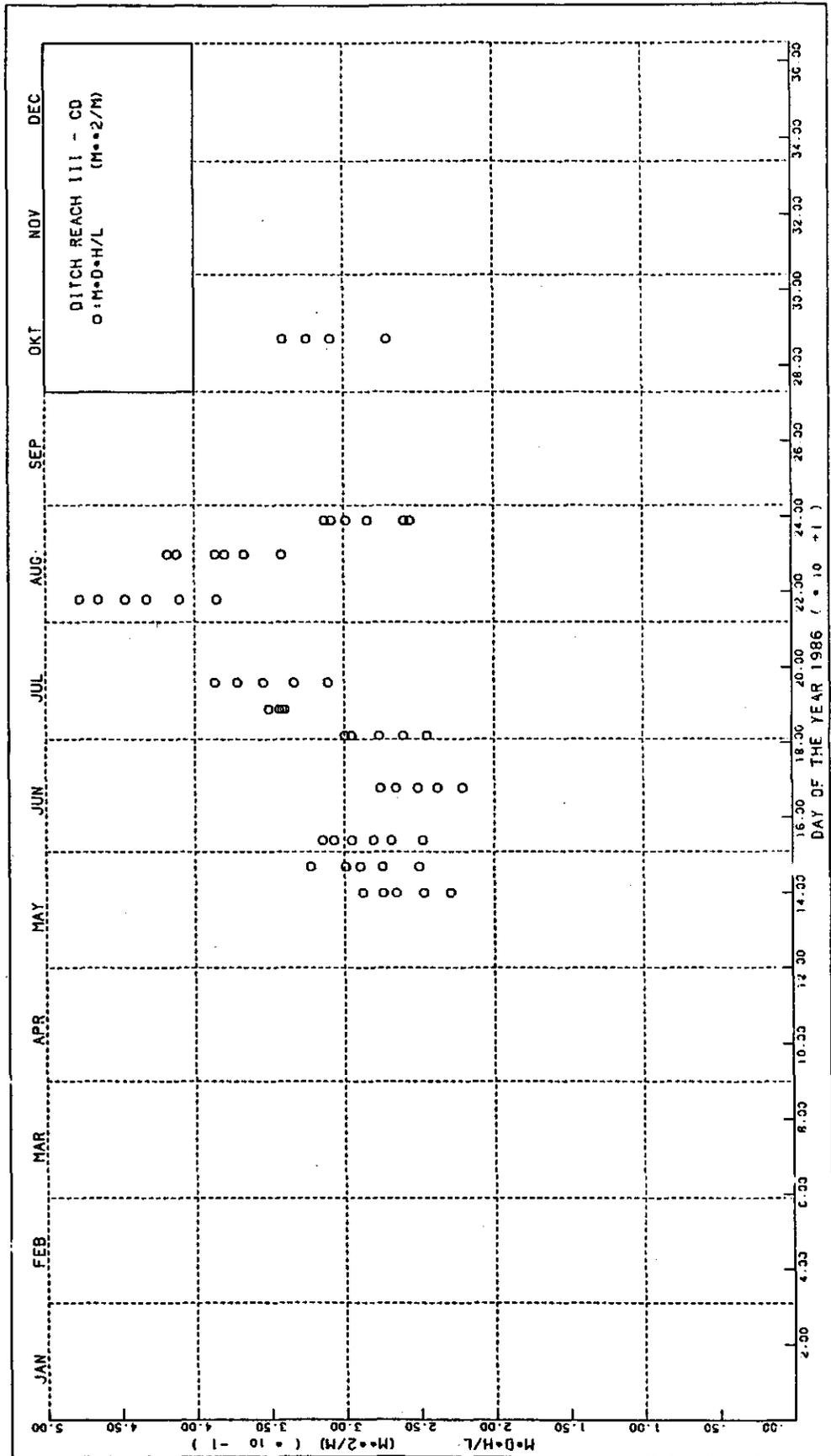Figure 5.5 - Scattering of M*D*H/L (Ditch III-CD)
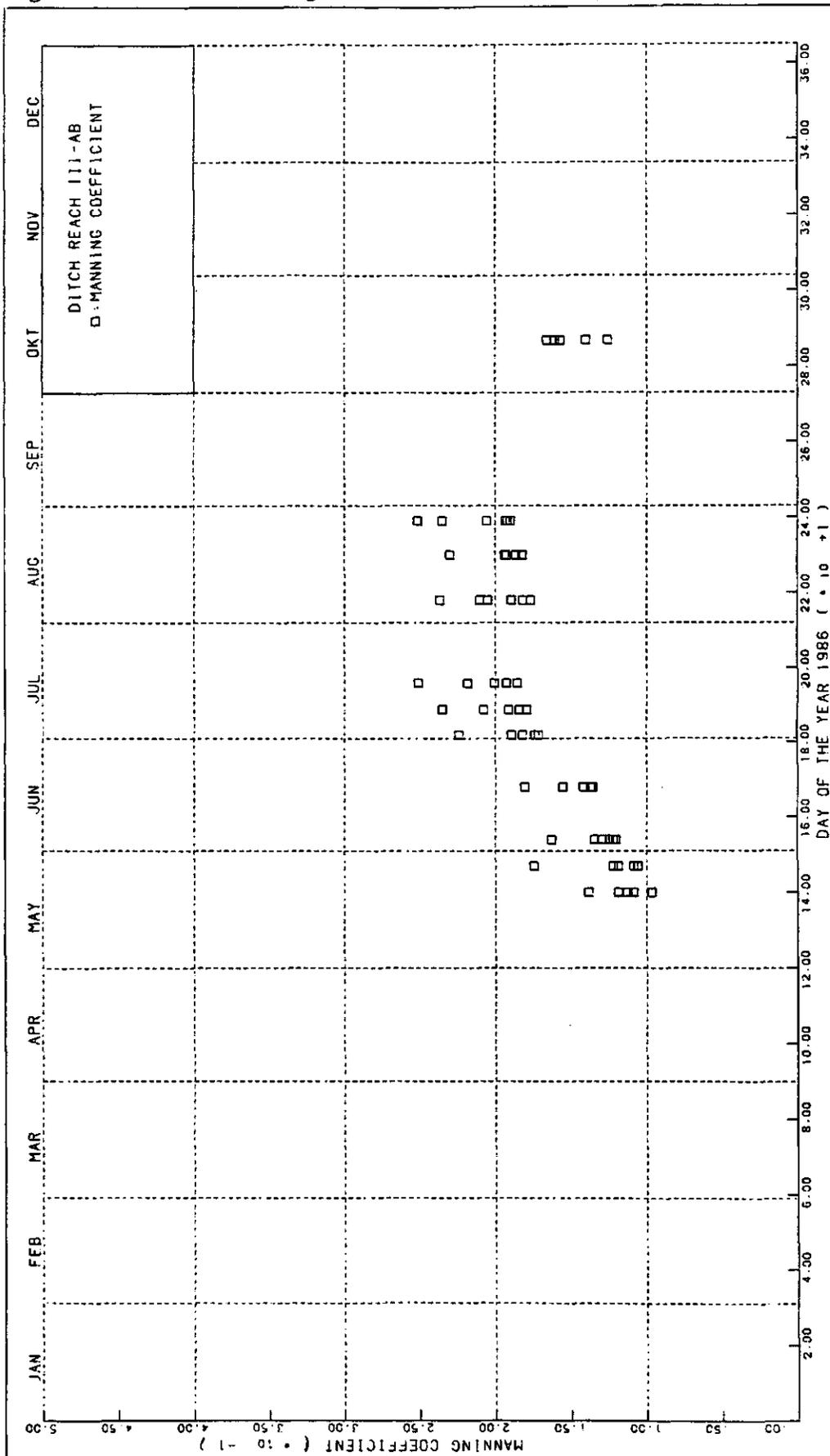
Figure 5.6 - Scattering of 'n' (Ditch III-AB)
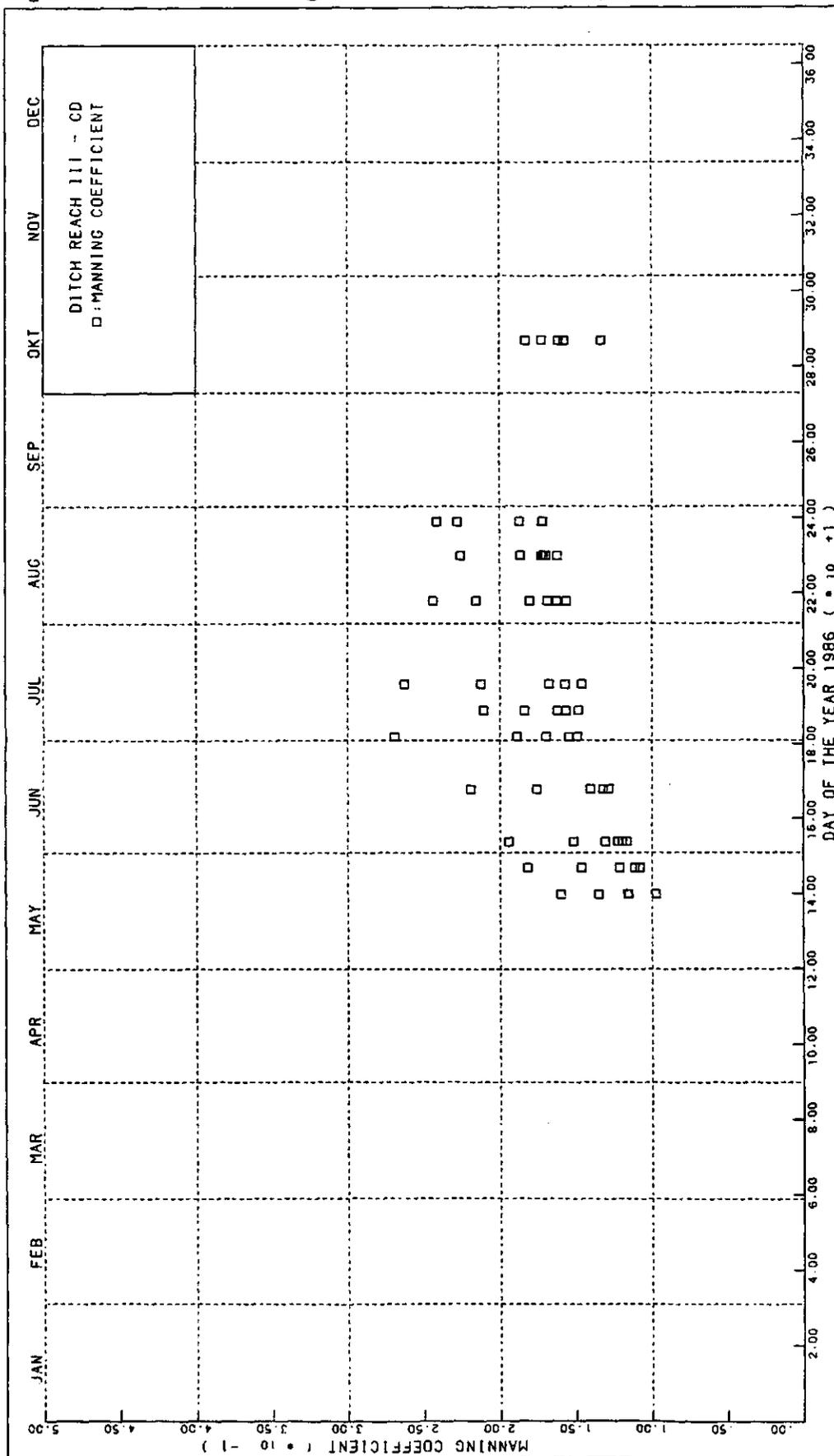
Figure 5.7 - Scattering of 'n' (Ditch III-CD)

Figure 5.8 - Scattering of 'μ' (Ditch III-AB)

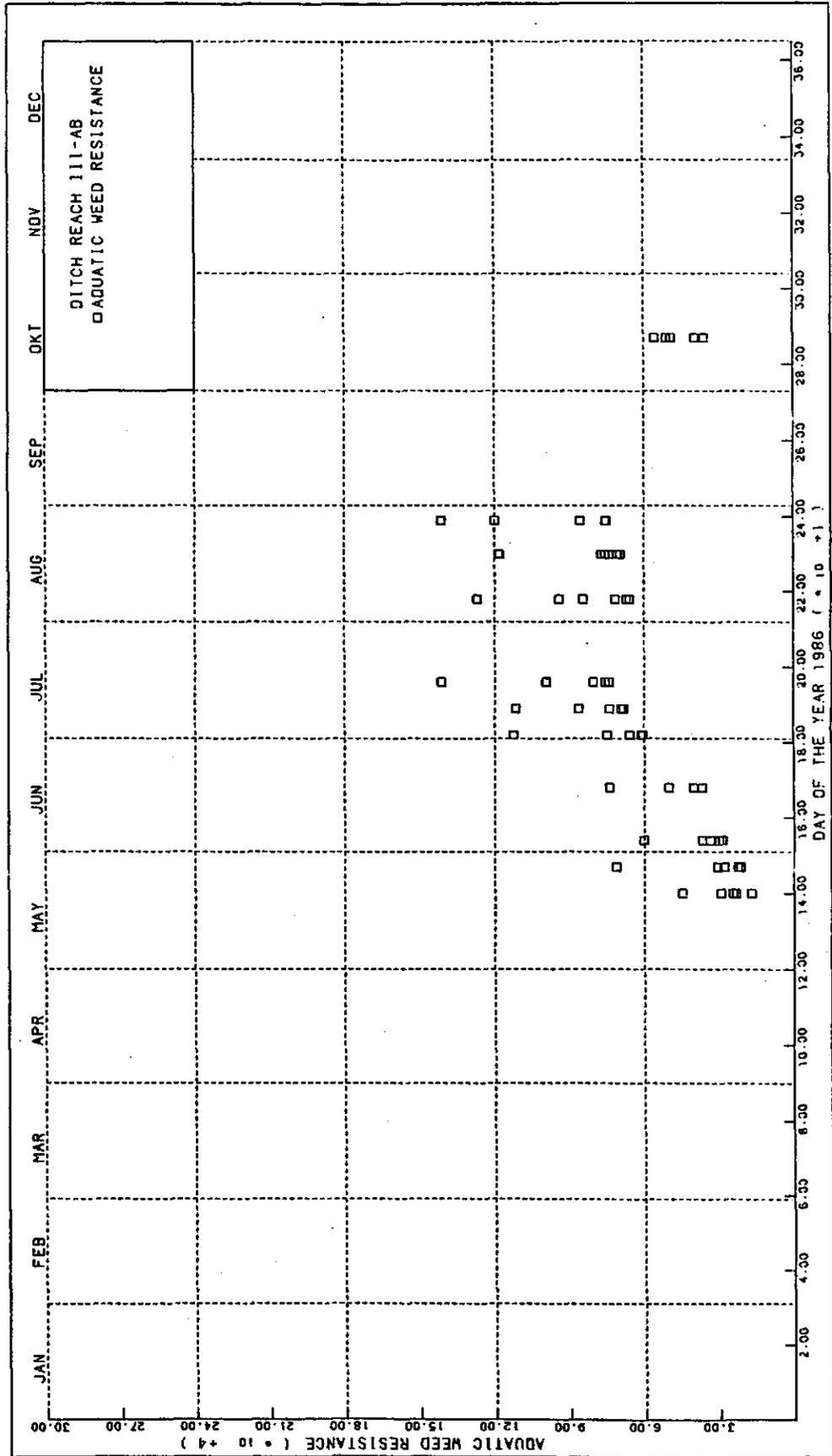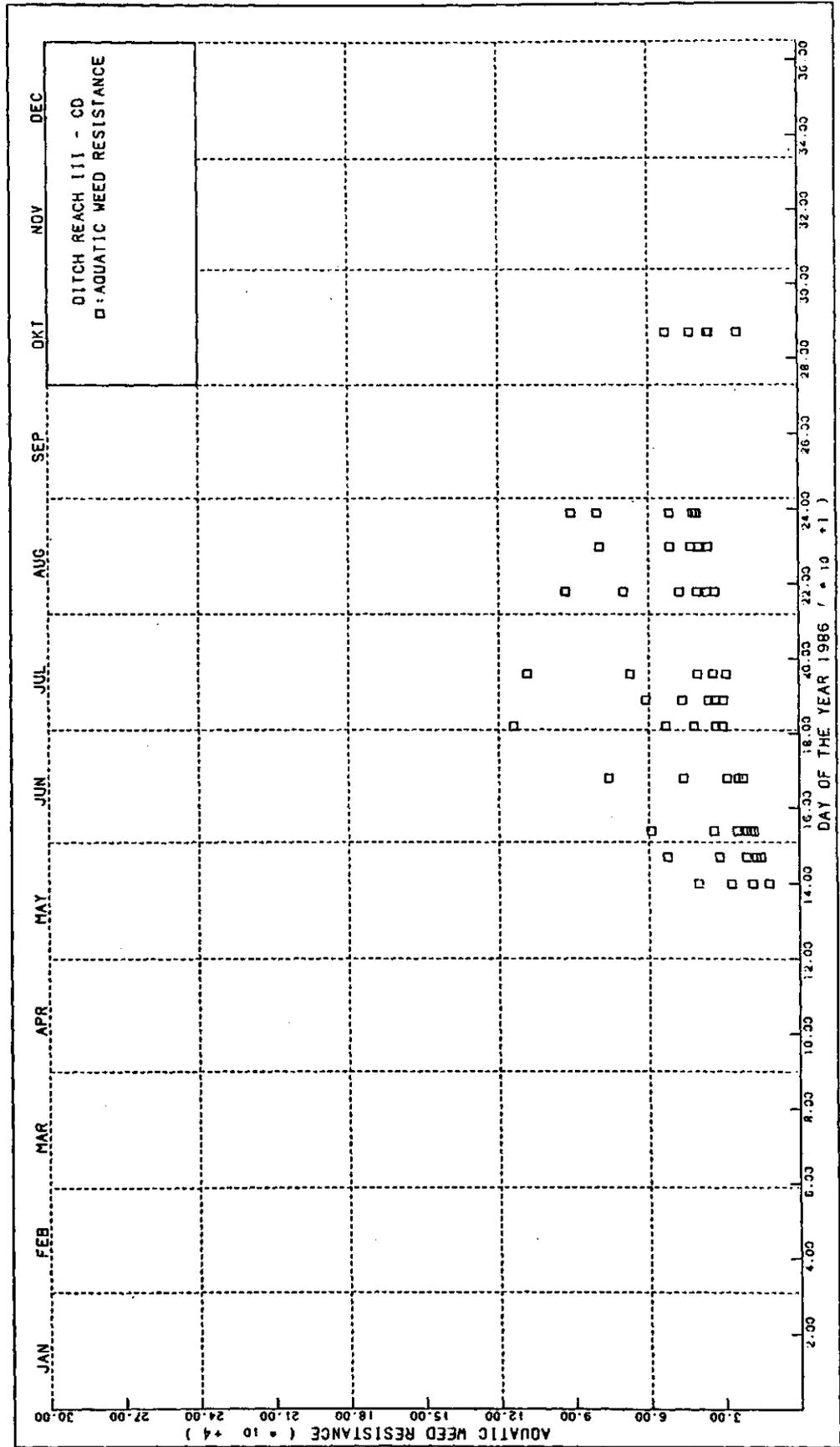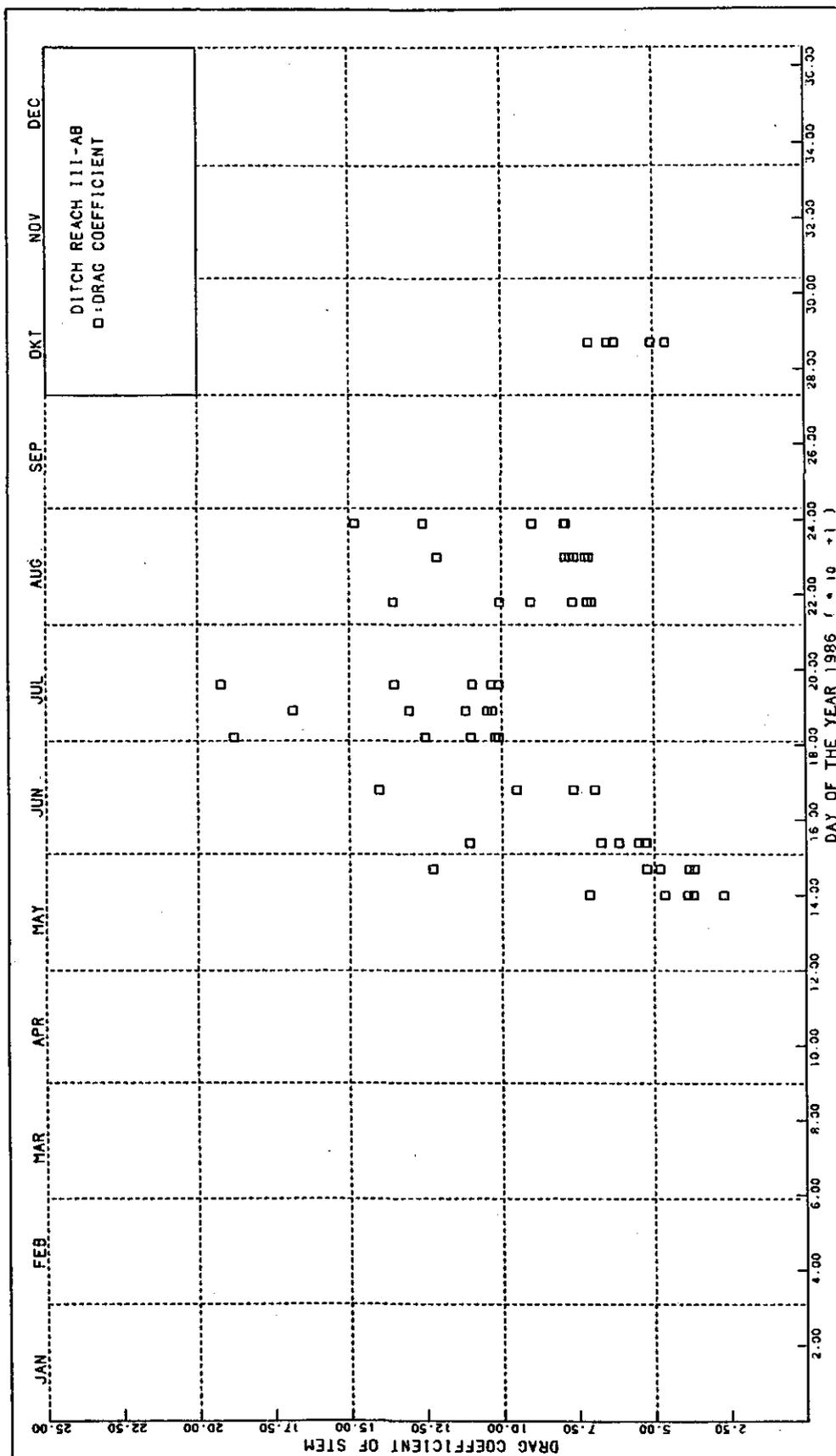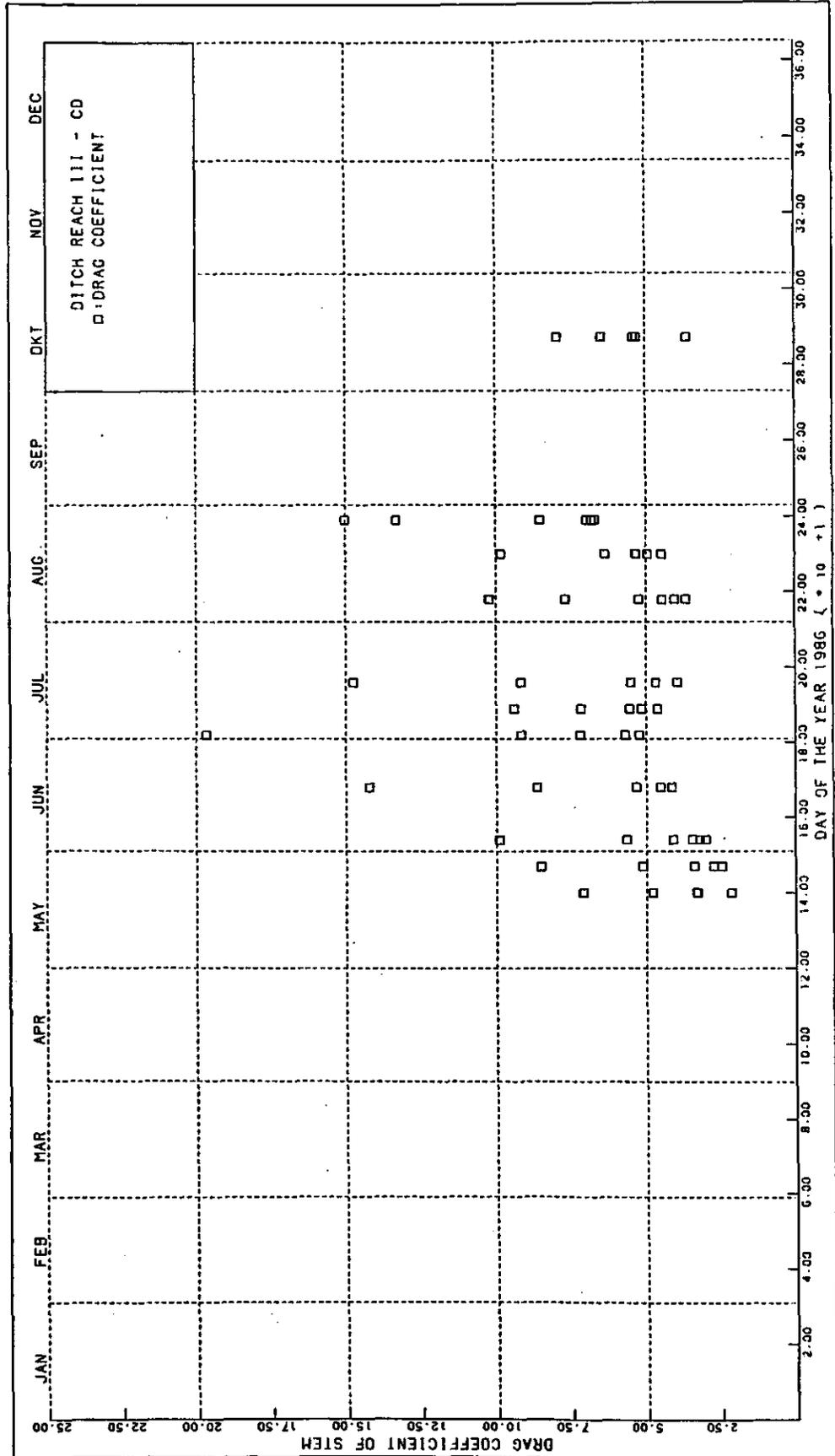Figure 5.9 - Scattering of 'μ' (Ditch III-CD)

Figure 5.10 - Scattering of 'ξ' (Ditch III-AB)

73

Figure 5.11 - Scattering of 'ξ' (Ditch III-CD)

Figure 5.12 - Control section data
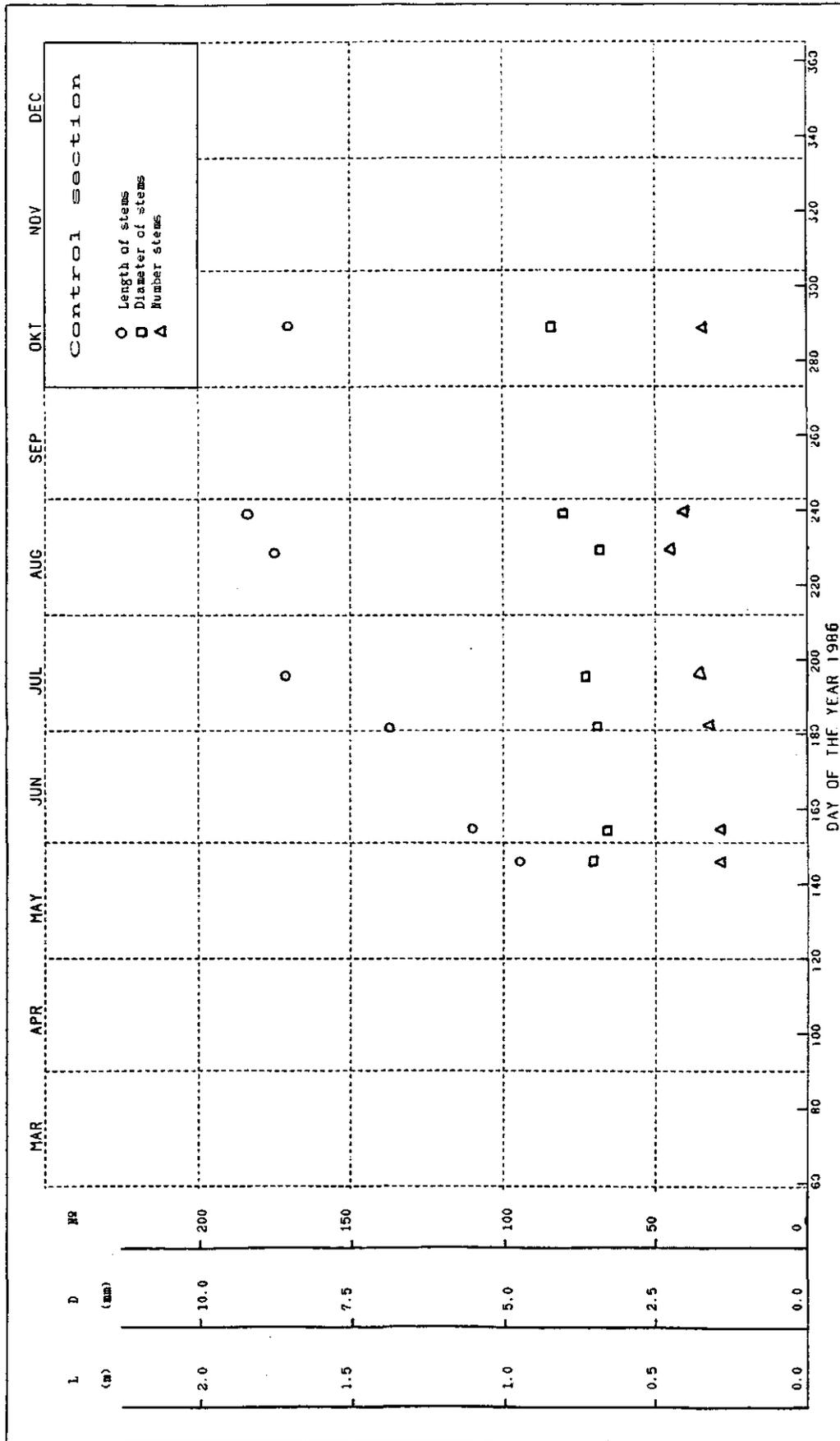
Figure 5.13 - 'n' against discharge (Ditch III-AB)
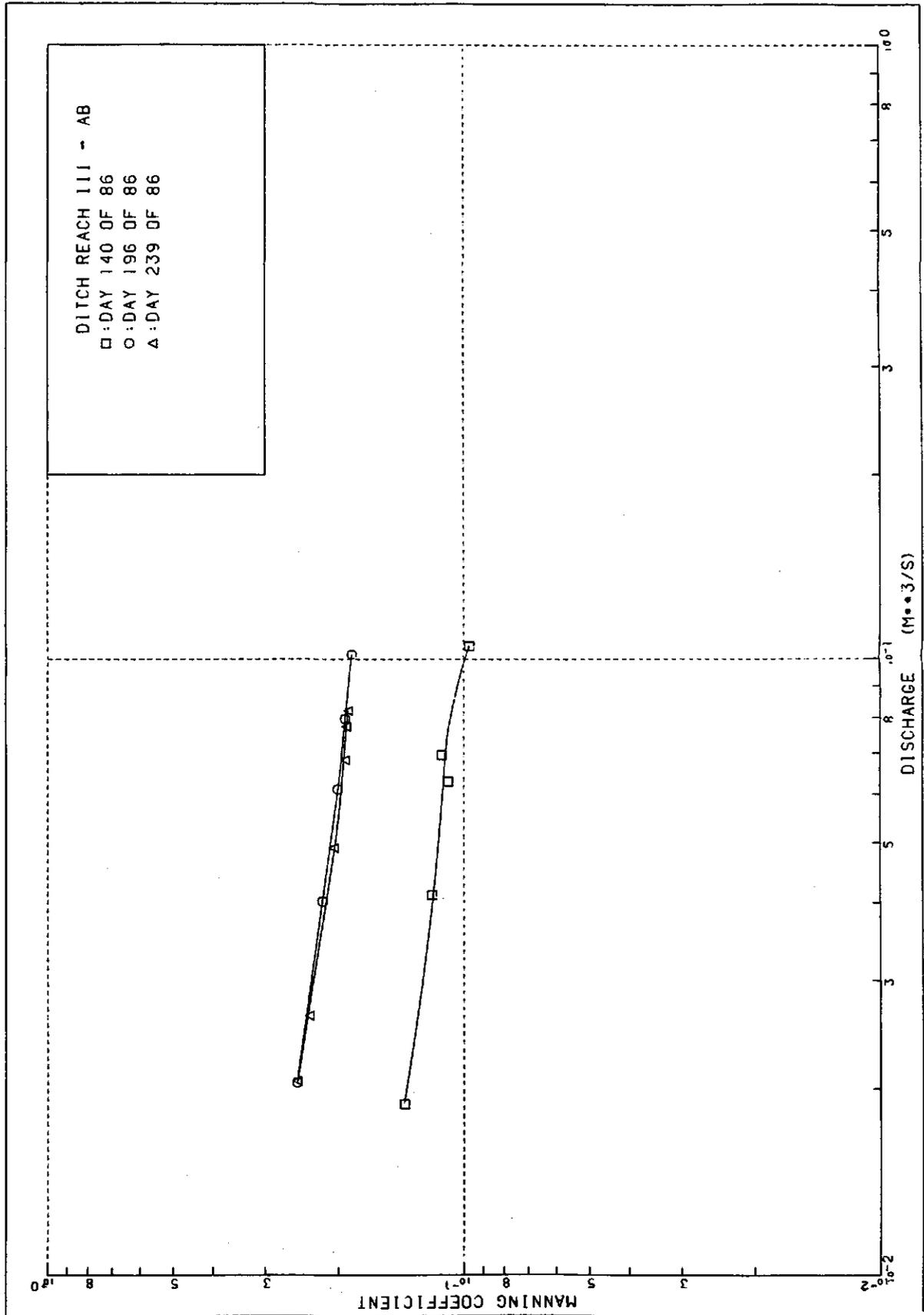
Figure 5.14 - 'n' against discharge (Ditch III-CD)
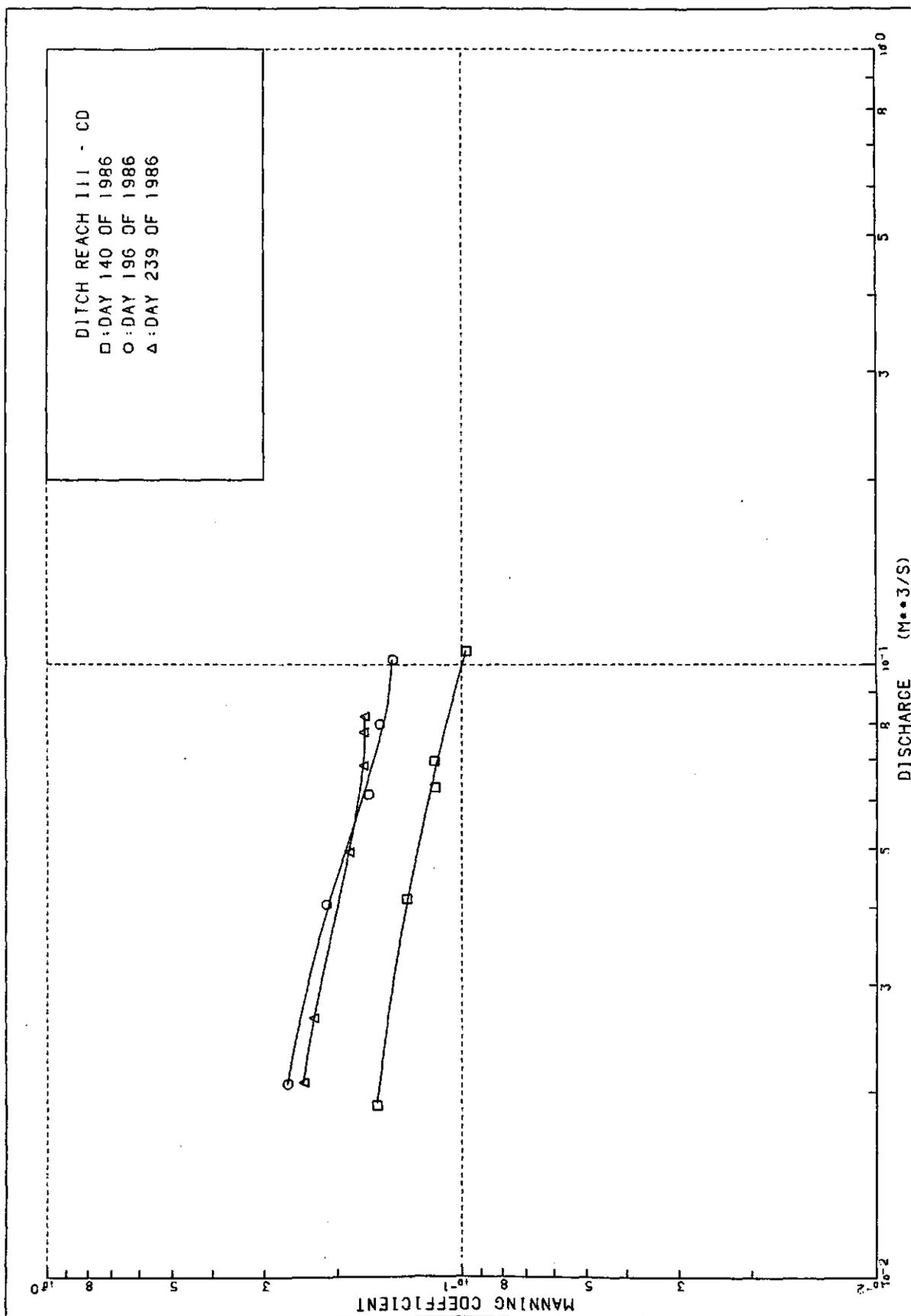
Figure 5.15 - 'μ' against Re (Ditch III-AB)
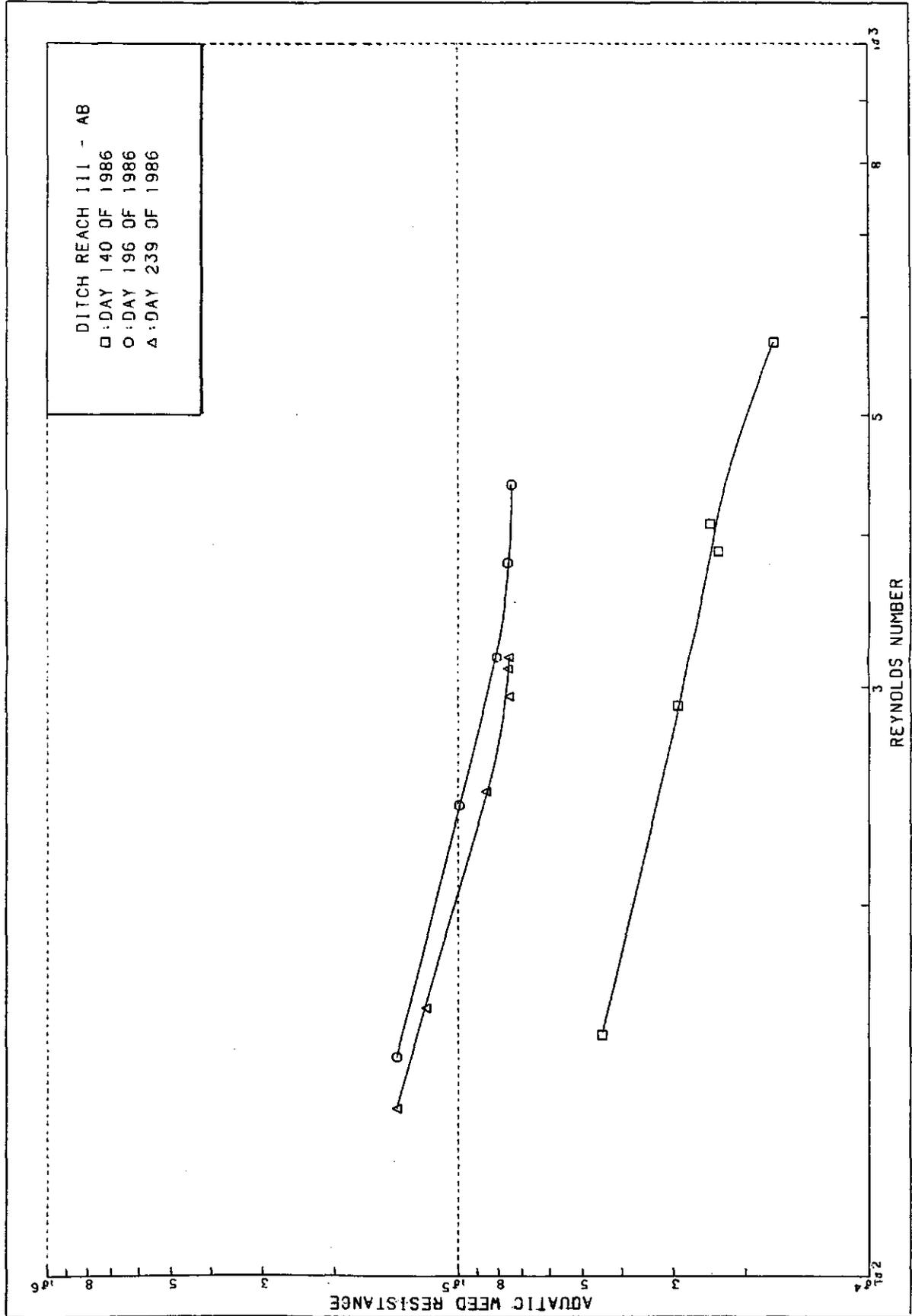
Figure 5.16 - 'μ' against Re (Ditch III-CD)
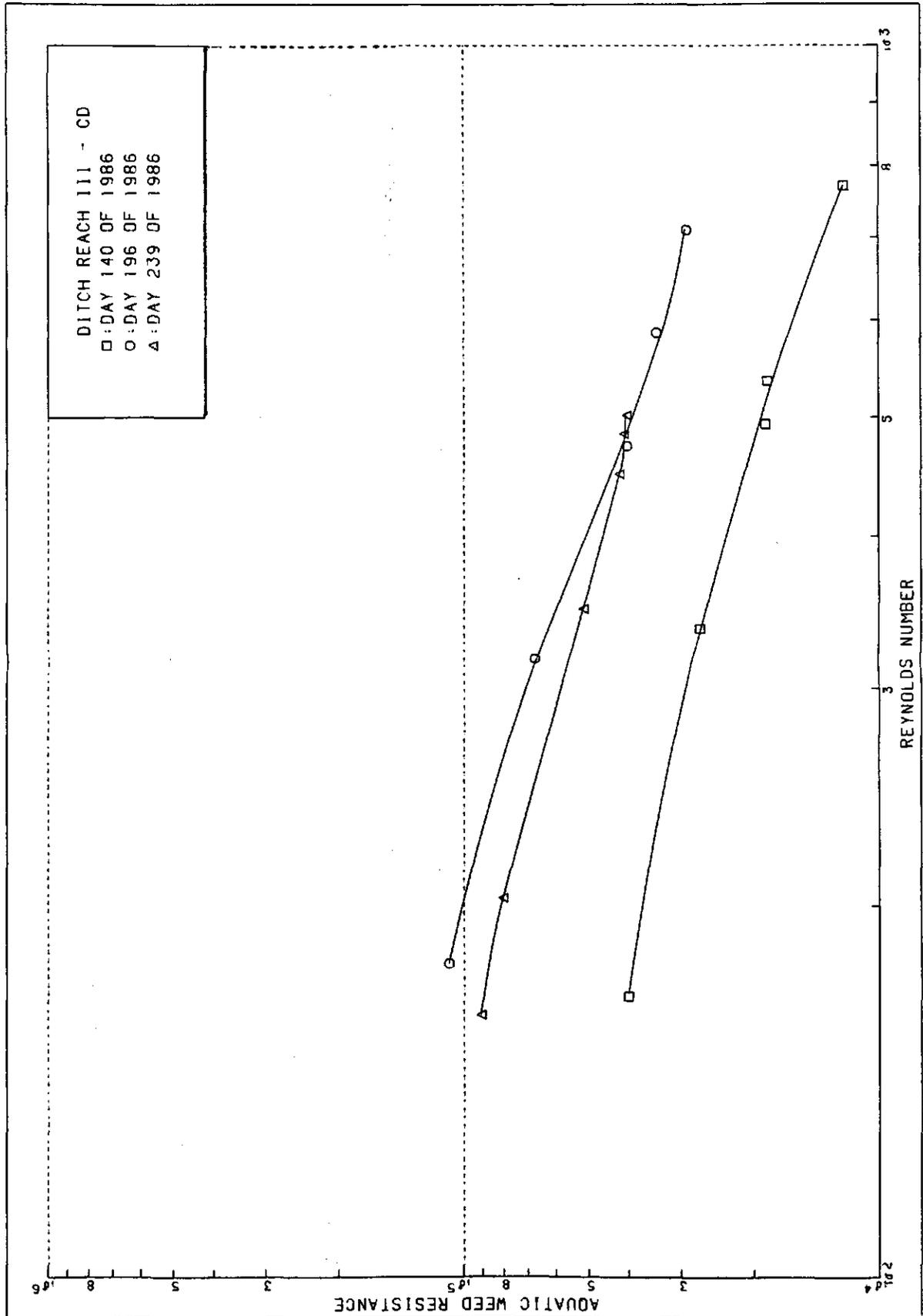
Figure 5.17 - 'ξ' against Re (Ditch III-AB)
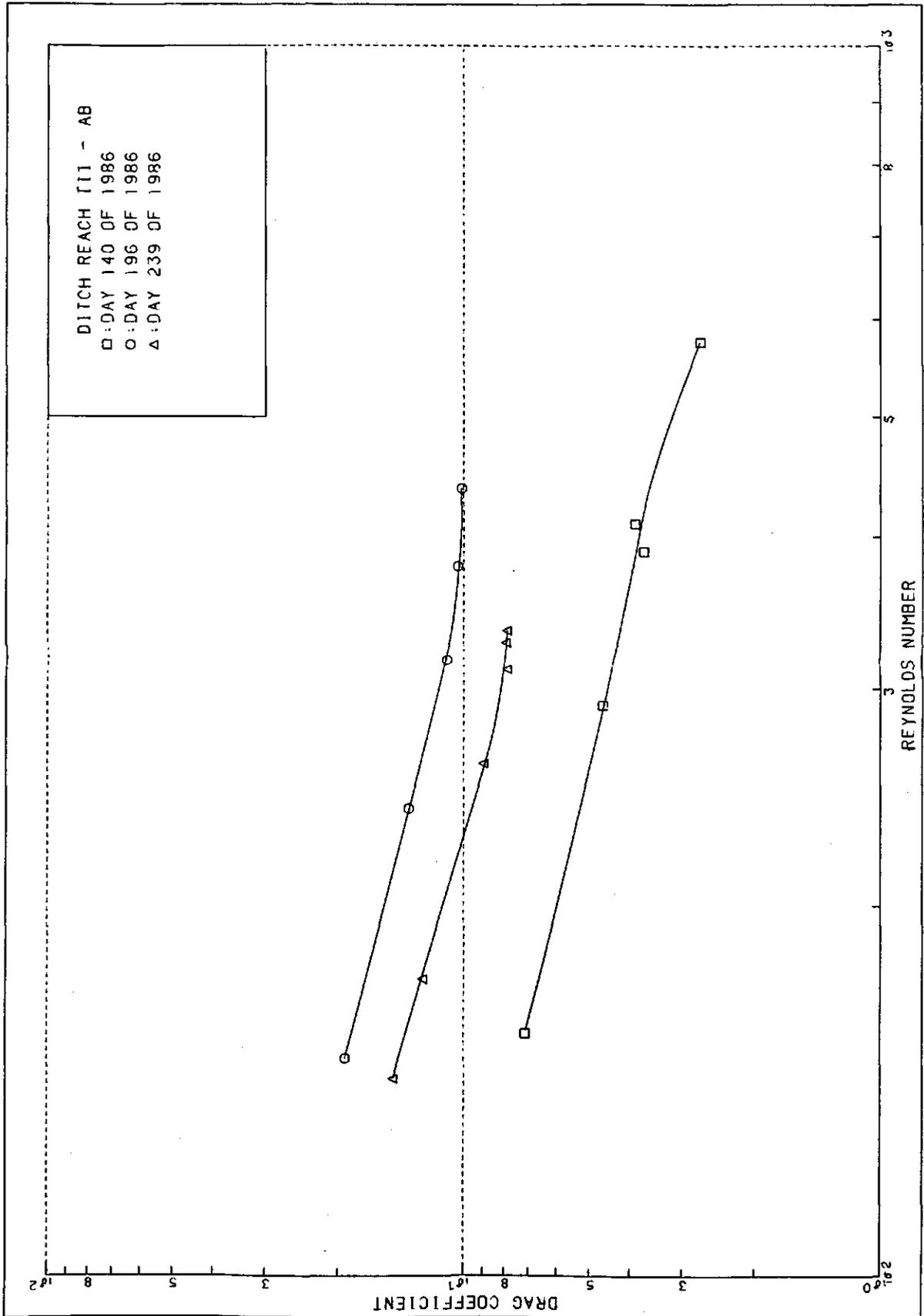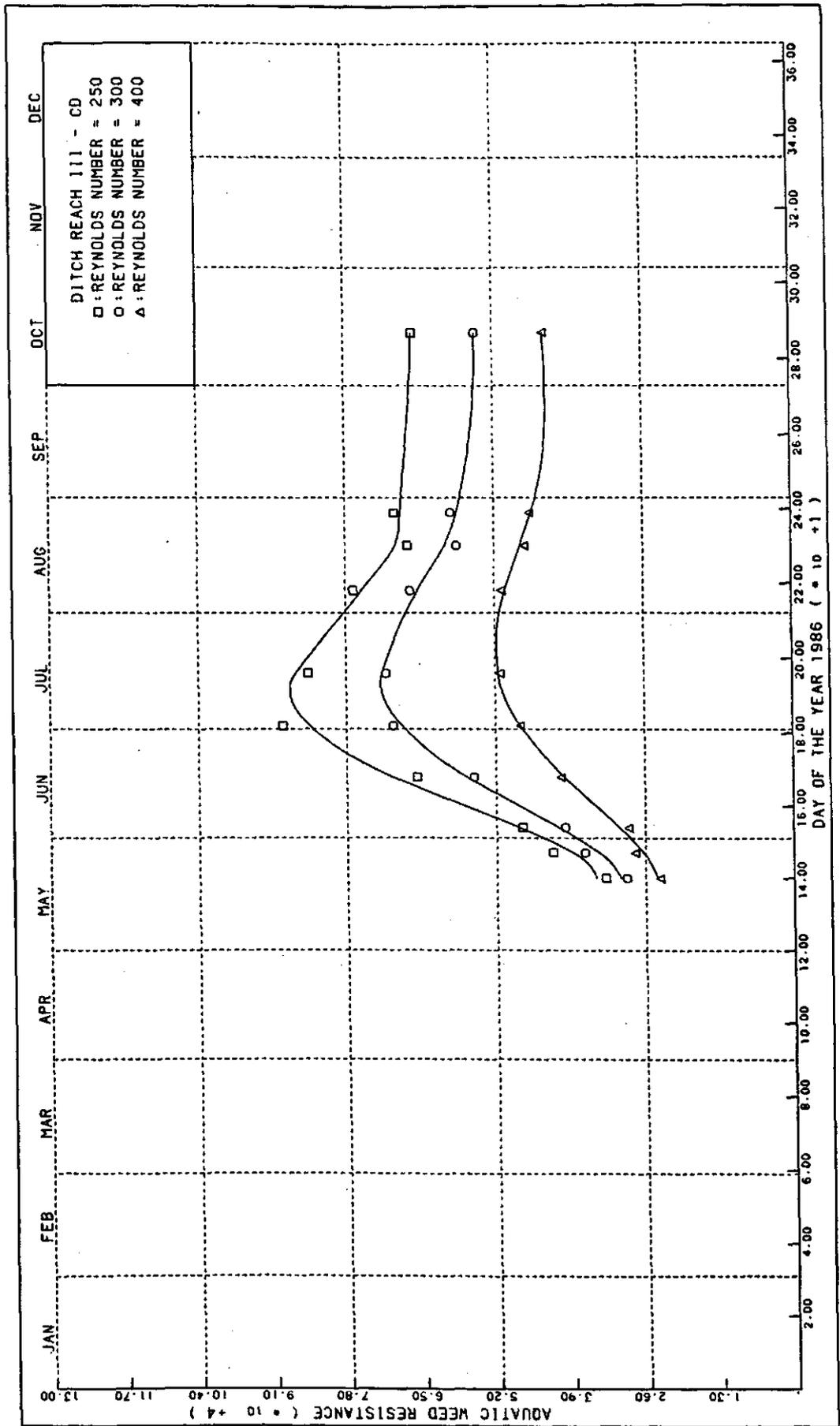
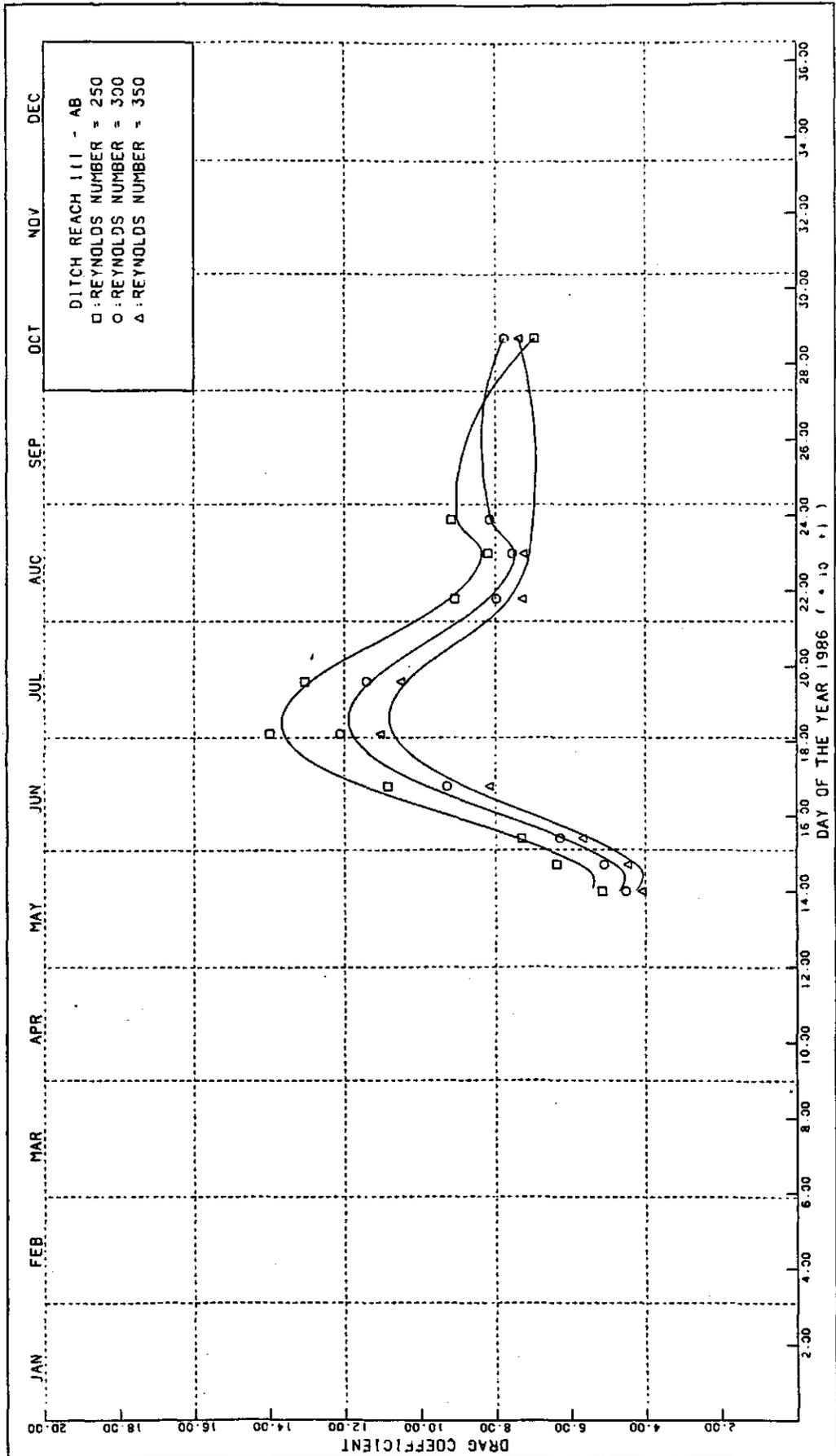Figure 5.18 - 'ξ' against Re (Ditch III-CD)
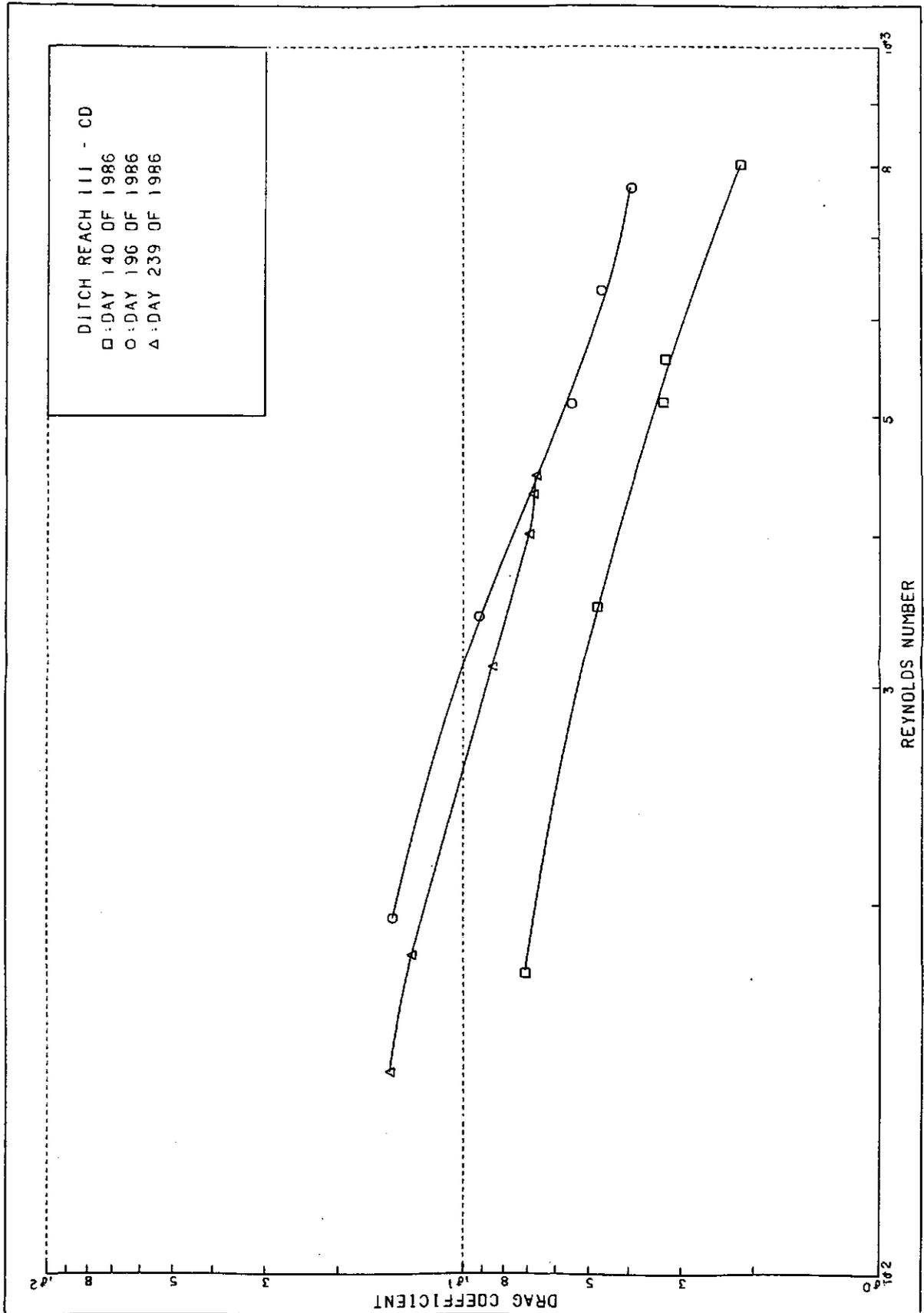
Figure 5.19 - 'n' against day of 1986 (Ditch III-AB)
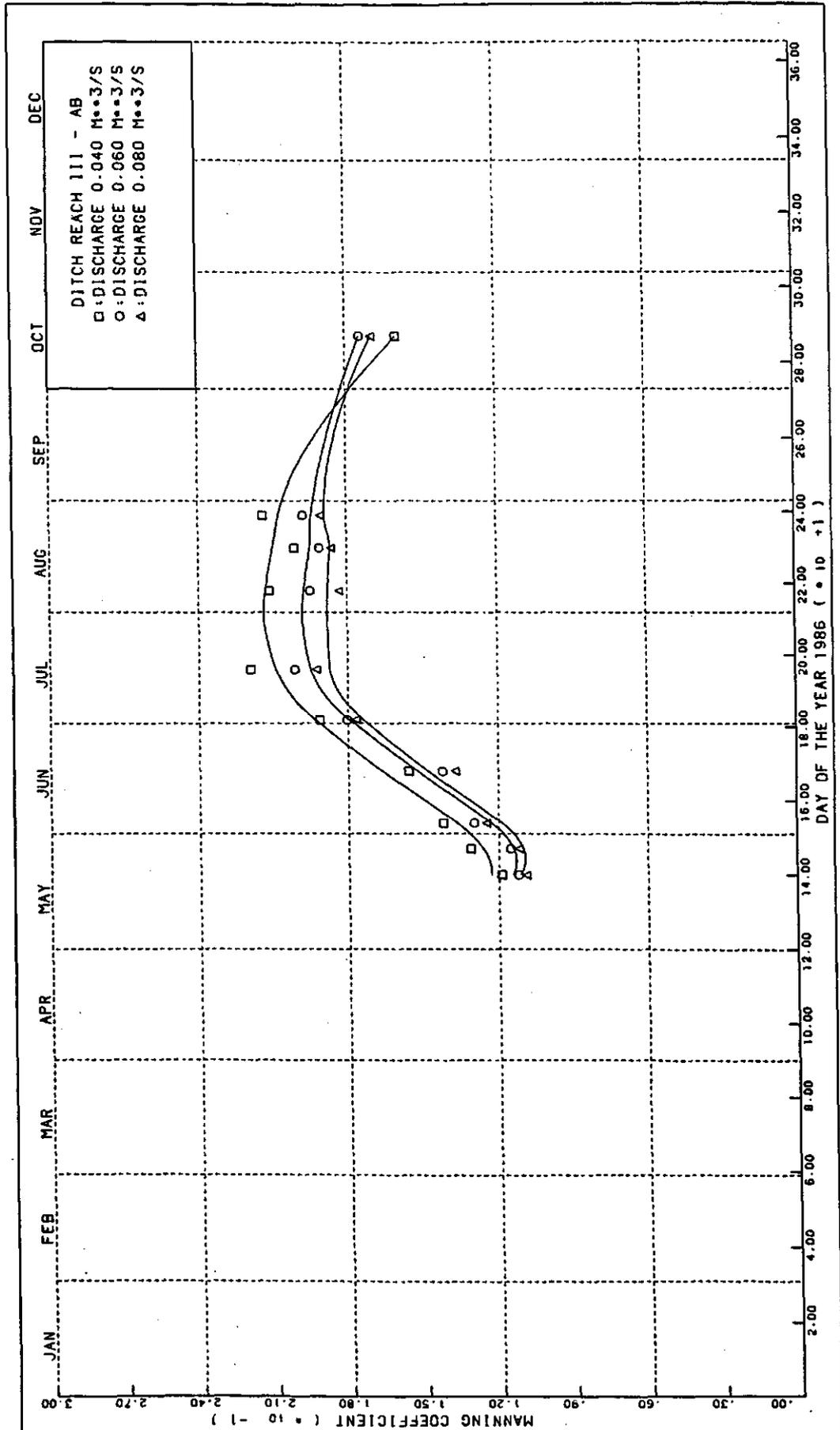
Figure 5.20 - 'n' against day of 1986 (Ditch III-CD)

Figure 5.21 - 'μ' against day of 1986 (Ditch III-AB)

Figure 5.22 - 'μ' against day of 1986 (Ditch III-CD)

Figure 5.23 - 'ξ' against day of 1986 (Ditch III-AB)

Figure 5.24 - 'ξ' against day of 1986 (Ditch III-CD)