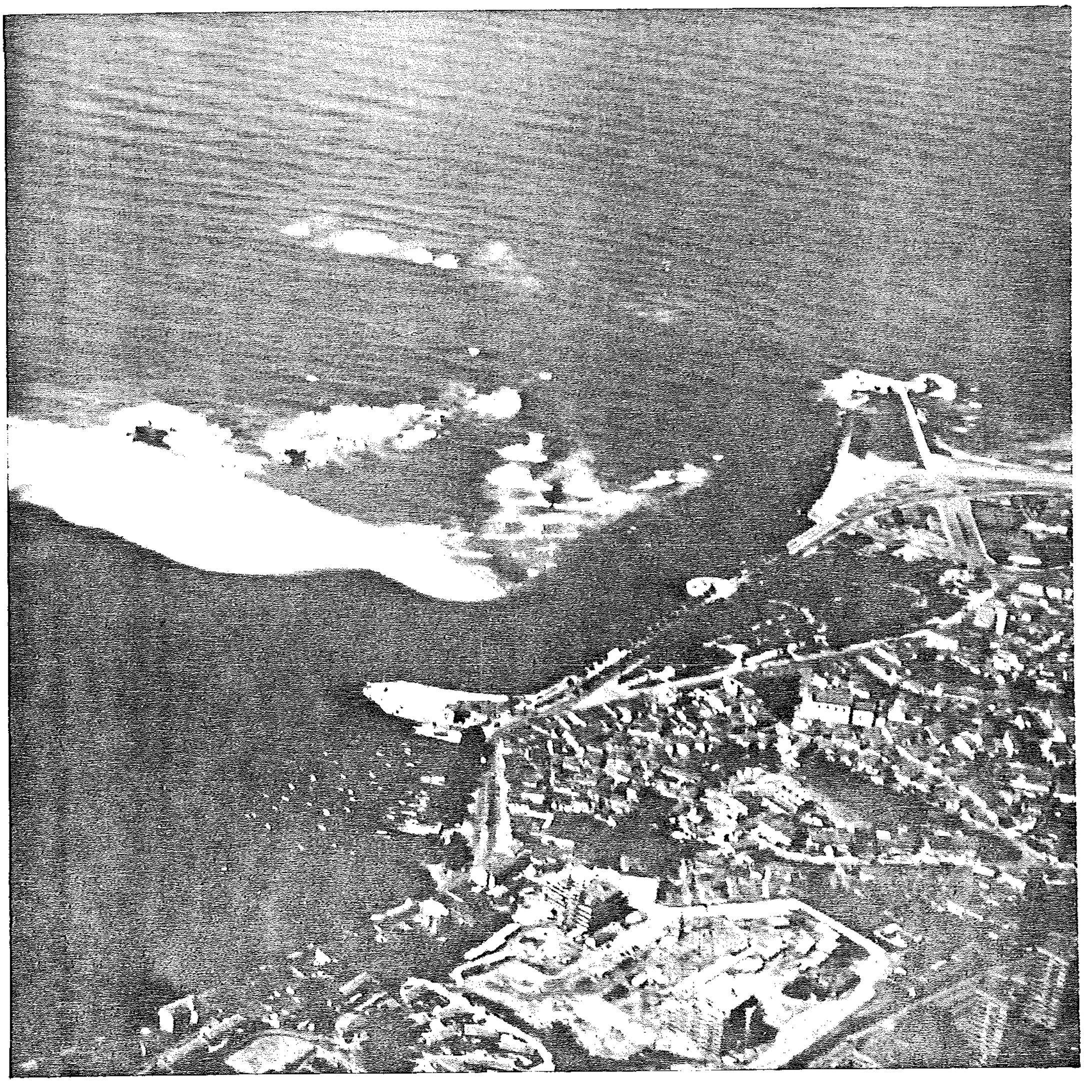
ADMINISTRAÇÂO DOS PORTOS DO DOURO E LEIXÕES

DRAFT

Hydro-morphological study Douro Estuary

Part 9
Hydro-morphological mathematical model



July 1984 / P 708

PORT AND WATERWAY ENGINEERS

hydronamic bv
sliedrecht holland

ADMINISTRAÇÃO DOS PORTOS DO DOURO E LEIXÕES

Hydro-morphological study Douro Estuary

Part 9
Hydro-morphological mathematical model

DRAFT

July 1984 / P 708

PORT AND WATERWAY ENGINEERS

hydronamic bv
sliedrecht holland

TABLE OF CONTENTS

1. INTRODUCTION

As a continuation of the initial study on the morphology of the Douro mouth, performed by Hydronamic in 1982, the Administracao dos Portos do Douro e Leixoes commisioned Hydronamic bv to construct a mathematical hydro-morphological model of the Douro mouth.
This second part of the morphological study of the Douro mouth is divided into three phases, viz.:

a. Additional measurements during a period of low river discharge. The results are presented in report part 7.
b. A statistical analysis of the topography of the Cabedelo from 1872 until 1983. The results are presented in report part 8.
c. The construction of a mathematical model of the Douro mouth.

This report presents a description of the component parts, the operation and the calibration of the mathematical model.

2. GENERAL DESCRIPTION OF THE HYDRO-MORPHOLOGICAL MODEL

2.1. Type of the model

A hydro-morphological model consists of a hydraulic part (wave penetration and tidal and river currents) and a morphological part. The morphological part is a program that calculates sediment movements as a function of waterdepths, current velocity and a number of local parameters. In the hydraulic part the current velocities are calculated.
The morphological part is generally identical for all types of hydro-morphological models, but the choice of the type of the hydraulic part largely depends on the characteristics of the estuary. One-dimensional hydraulic models (for areas with a clearly branched structure) and two-dimensional hydraulic models (for areas without branches) are most commonly used.
For many estuaries it is rather clear which type of model has to be used. The Douro estuary, however, is more complicated, and therefore first a detailed study of the morphology of the estuary has been carried out.
In the previous reports of this study the general characteristics of the morphology of the Douro estuary has been evaluated and the main conclusions are summarized briefly below:

a. The morphological changes in the mouth of the river are limited to a relatively small area.
b. At present the sediment movement in this area takes place in a relatively closed system (little sand is transported into the area or moved outside the area). The Douro estuary seems to be in a dynamic equilibrium.
c. The morphological changes occur with a high frequency (the map in report 8, 'Analysis of old charts', showing various situations of the river mouth after the extremely high flood of Christmas 1909, demonstrates this very clearly; being washed away completely in January 1910, the Cabedelo has been rebuilt in June the same year!).
d. The principal phenomena governing the sediment movement in the area are the river discharge, the tidal currents and the action of waves.
   Due to the wave action three current phenomena are important in relation to the sediment movement, viz.:

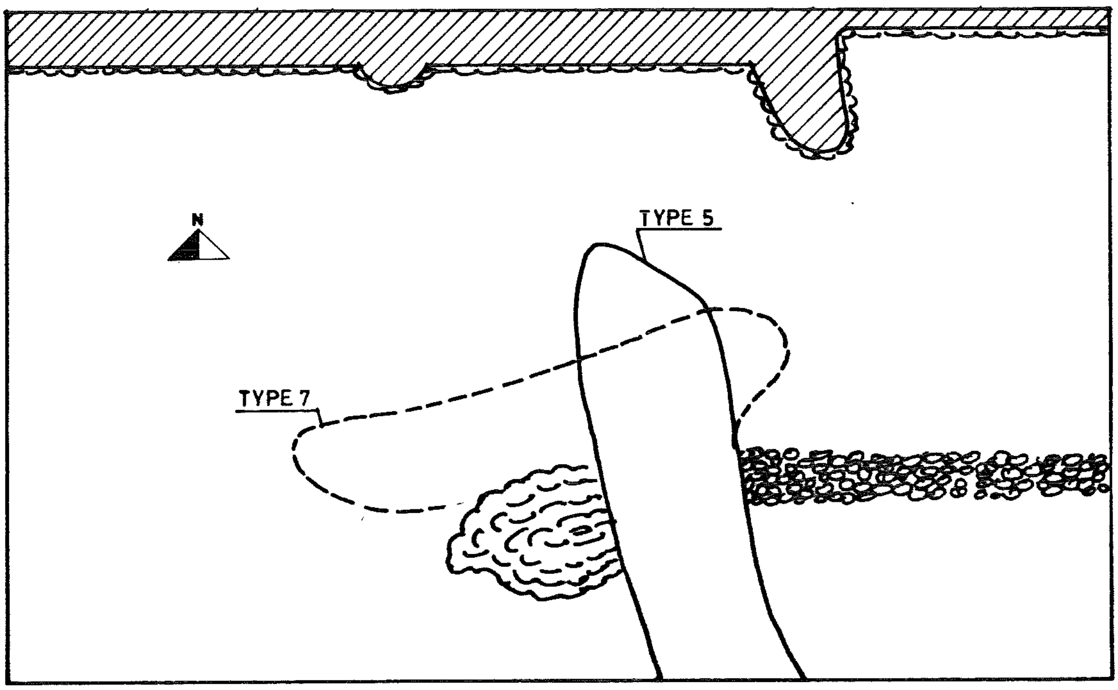
   - Longshore currents caused by obliquely breaking waves. This current is mostly directed to the south.
   - Currents towards the coast caused by solitary waves.
     Long waves with periods of 12 seconds or more, which penetrate a shallow area are transformed into a special type of wave, viz. a solitary wave. Solitary waves, in contrast with normal waves, generate an average net velocity and therefore this type of

wave is able to transport sediment. Measurements executed 400 m west of the Cabedelo have confirmed this transport towards the coast.

- Longshore currents due to differences in wave set-up along the Cabedelo coast.
  Wave set-up is a change in the average water level along a profile perpendicular to the coast. This is the result of changes in wave height by refraction, diffraction, shoaling and breaking when waves approach the coast. Differences in wave set-up along the coast generate currents parallel to the coast. During the measurement campaigns considerable differences in water levels have been observed along the Cabedelo coast. In the area north of Fogamanadas there is no set-up of the water level. South of Fogamanadas heavy wave breaking occurs and consequently there is a considerable set-up. So the water level south of Fogamanadas is higher than in the river mouth and this causes a current directed to the north.

The longshore transport due to wave set-up exceeds the longshore transport due to obliquely breaking waves.

e. In 'normal' years the shape of the head of the Cabedelo shows a seasonal cycle in accordance to the following pattern (see fig. below).



At the end of the summer the Cabedelo head has a lengthened shape, directed northward (type 5). The channel width is very narrow. After the winter period with relatively high river run-off the Cabedelo head has been turned back westward (type 7) and the channel width has been widened. In spring and summer the Cabedelo head is transformed again into the lengthened shape (type 5).

The analysis of old charts (in part 8) has shown clearly that, though the Cabedelo has withdrawn considerably to the east since river regulation started in the Douro, the pattern of the seasonal cycle has not changed during the analized period.
Before river regulation started in 1910, when the average position of the Cabedelo was more westward than at present, sand was transported southward by the waves along Seca do Bacalhao, out of the estuary area. Still this southward transport did not cause a gradual eastward migration of the Cabedelo because the Douro river supplied sufficient sand to fill the loses. Due to the construction of dams in the river, less sediment is supplied and the Cabedelo moved eastward to its present position. The seasonal cycle of the shape of the Cabedelo head still occur in 'normal' years, but the sand movements are confined within a rather closed area now; little sand is supplied by the river, but little sand is moving outside the areas as well, because the rocks of Seca do Bacalhao prevents transport to the south.

The above facts indicate that to describe the movements of the sediments in the Douro mouth, a two-dimensional mathematical model with a relatively small mesh-size must be applied. The chosen model covers an area of 1450x1950 meters and has a mesh-size of 50 meters and consists of 30x40=1200 mesh-points. In figure 1 the location of the grid is indicated.
The model must be a stochastic model, since the river discharge and the waves are stochastic variables.
Finally the model must have the ability to simulate bottom changes during a large number of tidal cycles and consequently the model requires many timesteps for a simulation run. This means that the computing time, required to make one timestep, must be as low as possible. A simplified method for calculating the hydraulic part should therefore be used. For both the wave-penetration calculation and the calculation of the current pattern this is realized. Since wave-penetration occurs over short distances, the bottom friction is neglected and because all the waves come from the north-west/south-west sector the calculation method is done in a simple way.
Also the calculation of the current pattern due to river and tidal discharge is done in a simple way. The area of the model is very restricted, and therefore the phase differences between the boundaries of the model as well as the water level differences between the boundaries can be neglected. This simplifies the current pattern calculation considerably and this means that the river discharges, known at the boundary, needs only to be redistributed over the model.
Summarizing, the hydro-morphological model is a relatively fast computer program, describing the morphological changes in the mouth of the Douro estuary adequate.

2.2. Configuration of the model

The Douro mathematical model has been built up according the configuration presented in figure 2. Three parts can be distinguished, viz. the data input part, the calculation part (this is the main part of the program) and finally the output part.

The input part contains the following data:

1. boundary data: - wave periods, wave heights and wave directions for the wave sub-module,
   - tidal water levels,
   - discharges (river + tidal) for the discharge distribution sub-module.
2. initial data: - bottom level at each grid point at time $t=t_0$
3. remaining data: - grainsizes, bed level roughness, etc.

The calculation part consists of:

1. current module, subdivided into:
   - 1.a discharge distribution sub-module - distributes river and tidal discharge over the model and calculates current velocities and directions at each grid point.
   - 1.b wave sub-module - calculates wave height, wave length and wave direction at each grid point,
     - calculates current velocities and current directions at each grid point due to wave action.
2. sediment transport module - calculates sediment transport rate at each grid point.
3. bed level module - calculates new bottom level at each grid point.

The output part presents the following results:

1. new bathymetry at each moment chosen beforehand,
2. current patterns and sediment transport rates (if desired).

The boundary data consist of deterministic input values and stochastic input values.
Tides and tidal water levels are deterministic, which means that these values can be predicted accurately. The values of the tidal water levels are stored in input files.
The wave parameters and the river discharges are stochastic input values. These values cannot be predicted; however, when long term data are available then the probability distribution of each input variable can be determined.

The frequency of occurrence of both the wave parameters and the river discharges vary throughout the seasons, and therefore the distributions must be determined per month. In this way a reasonable realistic simulation of the sediment movements can be obtained.

The current module is subdivided into a discharge distribution submodule, which calculates the currents due to the river discharge and a wave sub-module which calculates the currents due to wave action. Each of the phenomena contributes to the final current pattern (that is obtained by vectorial adding).

The final current pattern serves as input for the sediment transport module. This module calculates the sediment transport capacity in each grid point. By means of these calculated values the new bottom level is determined in the bed level module. The simulation process proceeds then for the next timestep with the new bottom level as input.

In chapters 3, 4 and 5 first the theoretical backgrounds of the modules of the calculation part will be discussed in detail.
In chapter 6 a description is given of the stochastic and deterministic input data. The selection of the stochastic input data is described as well.
The running of the mathematical model is dealt with in chapter 7.
In chapter 8 the calibration of the model is described and the results of some final test runs are discussed.
A listing of the computer program is included at the back of the report.

3. CURRENT MODULE

3.1. River discharge distribution sub-module

This module has been split up into two nearly identical subroutines. During low tide (in case of ebb currents) the distribution of the discharge over the model is done by subroutine FLOWDS1 and during high tide by FLOWDS3 (see flow chart in fig. 2). The reason for splitting up the module is explained further in this section.
In both subroutines the distribution system implies the following:

- to transfer the discharge from each mesh-point to the adjacent mesh-points
- to guide the discharges along the quays between Cantareira and Felgueiras and along the head of the Cabedelo
- to expand the outgoing flow in the offshore part of the model
- to take into account the bottom configuration, in other words the program takes care that streams are able to follow gullies.

The procedure of the distribution will be described in the remainder of this section. This procedure is executed at each time-step. Before the distribution can start, first a new value for the river and tidal discharge at the model boundary has to be selected.

The position of the head of the Cabedelo changes regularly, and therefore the first thing that has to be done is to determine this position. This position is expressed in the grid-points of the most easterly tip and the most westerly tip of the head of the Cabedelo (point 3 and 4 in fig. 3a and 3.b). These points are found by means of a search routine, which starts in fixed point 1 (Cantareira) for finding tip 3 and in fixed point 2 (Felgueiras) for finding tip 4 (see fig. 3).

The next step is to divide the total discharge along the cross-section of the river mouth at the row upon which the distribution has to start. The discharge pattern along the concerned cross-section is obtained by determining discharge vectors q(N, M) for flow-lanes with a width equal to the mesh-size of 50 m. The discharge vectors are calculated by means of the Strickler formula in the following way:

according to Strickler the unknown discharge q(N, M) is:

$$q(N,M) = \Delta L * k * D(N,M)^{5/3} * i^{1/2} \qquad (3.1)$$

in which: Δl = mesh-size
k = a constant
$D(N, M)$ = waterdepth in (N, M)
i = slope of water level

The sum of the discharge vectors must be equal to the river discharge Q_r, so:

$$Q_r = \sum_{n=3}^{13} q(N,M) = \Delta l * k * i^{1/2} \sum_{n=3}^{13} D(N,M)^{5/3} = f \sum_{n=3}^{13} D(N,M)^{5/3} \quad (3.2)$$

In factor f, the unknown values for i and k are gathered. The term $\sum D(N, M)^{5/3}$ however, can be calculated, and thus:

$$f = \frac{Q_r}{\sum_{n=3}^{13} D(N,M)^{5/3}} \quad (3.3)$$

Finally each discharge vector along the cross-section can be computed with:

$$q(N,M) = f * D(N,M)^{5/3} \quad (3.4)$$

The position of the cross-section in which the distribution starts, is different for FLOWDS1 and FLOWDS3. In FLOWDS1 distribution starts at row M=1 (east boundary) and continues to row M=40 (west boundary). The cross-section at M=1 runs from N=3 up to N=13 (Pedras do Lima), see also figure 3A.
In FLOWDS3 distribution starts at the cross-section in the gap between the most westerly tip of the head of the Cabedelo and the quay along Avenida Don Carlos (see figure 3B). The program first distributes the discharge into the direction of the ingoing flow (thus in negative M-direction) up until M=1. Then distribution continues into the offshore area of the model, starting again from the cross-section in the gap but now into opposite direction of the flow, up until M=40. Separation of the procedure into two phases is done because of the fact, that it is easier to guide the flood stream along the head of the Cabedelo into the estuary by distribution into the flow direction.

In the next part of the subroutine the direction of the discharge vectors are corrected in order to guide the discharge along obstacles. For FLOWDS1 correction of a discharge vector is carried

out if the concerning mesh-point is situated in the areas A (east of Cantareira), B (east of eastern tip of Cabedelo head), C (east of Felgueiras) and D (east of western tip of Cabedelo head). See also figure 3A.
For FLOWDS3 it concerns only three areas (see fig. 3B).
Correction of a vector-direction is done as described in the following:
Consider in area B (figure 3A) a vector q(N, M) with component qN in N-direction and component qM in M-direction. A deflection factor Δq is calculated with formula:

$$\Delta q = \frac{q_M^2}{(M(3) - M)^{3/2}} \qquad (3.5)$$

in which: M(3) = M-coordinate of eastern tip of the Cabedelo head.

so Δq is in inverse proportion to a power function of the distance between row M and the east tip of the Cabedelo head.
Vector q has to be rotated to the left, therefore the component q_N is increased to:

$$q_N' = \sqrt{q_N^2 + \Delta q} \qquad (3.6)$$

and the component q_M is decreased to:

$$q_M' = \sqrt{q^2 - (q_N')^2} \qquad (3.7)$$

The result is that vector q is rotated to the left. The magnitude of the deflected vector q' remains equal to the magnitude of the original vector q (continuity is ensured).
Correction of discharge vectors in the other areas is done in the same way, only the direction of the rotation can differ.
In addition to this correction the same procedure is repeated but now for obstacles running in M-direction (for instance the quays upstream Cantareira up to Felgueiras).

After this the discharge vectors are deflected again, but now due to the bottom configuration. Currents tend to follow gullies (or channels) and this effect plays also a role in the Douro estuary.
Deflection of a discharge vector is done in the following way. Due to the channel slope the discharge vector will deflect into the direction of the bottom contour. It is assumed that the deflection

is proportional to the slope of the gully and inverse proportional to the depth.
The angle of deflection is calculated with:

$$\Delta\beta = K * m(N,M) * e^{-(D(N,M) - m(N,M) * \Delta l) * 0.5} \quad (3.8)$$

in which:

K	=	a constant = 10.5
$m(N, M)$	=	bottom slope in point (N, M)
$D(N, M)$	=	depth in point (N, M)
$\Delta\beta$	=	angle of deflection (radian)

The original angle between the discharge vector and the local bottom contour is then decreased with $\Delta\beta$.

After these correction procedures has been executed, the deflected discharge vectors are finally ditributed to the adjacent mesh-points. Four cases can be distinguished, viz. two cases with the N-component into negative N-direction and two cases with the N-component directed into positive N-direction (see figure 4A):

case 1a: $\frac{q(m)}{q(n)} < -1$ - discharge vector is distributed to mesh-points (N-1, M+1) and (N, M+1):

$$q(N-1,M+1) = \frac{q(n)}{q(m)} * q(N,M) \quad (3.9)$$

$$q(N,M+1) = (1 - \frac{q(n)}{q(m)}) * q(N,M) \quad (3.10)$$

case 1b: $\frac{q(m)}{q(n)} > -1$ - discharge vector is distributed to mesh-points (N-1, M) and (N-1, M+1):

$$q(N-1,M+1) = \frac{q(m)}{q(n)} * q(N,M) \quad (3.11)$$

$$q(N-1,M) = (1 - \frac{q(m)}{q(n)}) * q(N,M) \quad (3.12)$$

case 2a: $\frac{q(m)}{q(n)} > 1$ - discharge vector is distributed to mesh-points (N+1, M+1) and (N, M+1):

$$q(N+1,M+1) = \frac{q(n)}{q(m)} * q(N,M) \qquad (3.13)$$

$$q(N,M+1) = (1 - \frac{q(n)}{q(m)}) * q(N,M) \qquad (3.14)$$

case 2b: $\frac{q(m)}{q(n)} < 1$ - discharge vector is distributed to mesh-points (N+1, M) and (N+1, M+1)

$$q(N+1,M+1) = \frac{q(m)}{q(n)} * q(N,M) \qquad (3.15)$$

$$q(N+1,M) = (1 - \frac{q(m)}{q(n)}) * q(N,M) \qquad (3.16)$$

The transferred vectors in the adjacent points have the same directions as the vector in point (N, M).
The distribution procedure proceeds now as follows. Consider a certain row M with discharge vectors as indicated in figure 4B. The program starts to transfer vector q_1 from point N=1 into q_{1a} in mesh-point (N=2, M) and into q_{1b} in mesh-point (N=2, M+1) (case 2b).
Vector q_{1a} is vectorial added to vector q2 in point (N=2, M). The resultant is q_{2n}. The original vector q_1 is maintained in (N=1, M). Vector q_{2n} is now distributed into q_{2na} in mesh-point (N=3, M+1) and into q_{2nb} in mesh-point (N=2, M+1) (case 2a). Vector q_{2nb} is then vectorial added to the vector q_{1b}, already being distributed from N=1. Then vector q_3 in point (N=3, M) can be handled.

In this way all the vectors in row M are distributed to the adjacent points, after which the new created discharge vectors in row M=M+1 can be distributed.
In FLOWDS3 the same procedure is applied, however, in the offshore area of the model the discharge vectors are distributed in opposite flow-direction.

In the last part of the sub-module the expanding routine is executed. This is of importance especially in the offshore area. When the flow leaves the river mouth, the stream will spread over the area. This effect has been taken into account as follows (see fig. 5).
A part of the M-component of discharge vector q in point (N, M) is transferred to the points immediately left and right from (N, M). The remainder of q_m in point (N, M) is:

$$q' = \varepsilon * q_m \qquad (3.17)$$

in which ε = a number near to 0

Both the left and the right point receive:

$$\Delta q_m = 0.5 * (1 - \varepsilon) q_m \qquad (3.18)$$

Further the expanded discharges diverge with a small angle ω from the reduced vector q' in point (N, M). The values for ε and ω in FLOWDS1 differ from those used in FLOWDS3. In FLOWDS3 even a distinction is made between the values for the estuary area and for the offshore area. In the calibration phase the various values for ε and ω are determined in such a way that acceptable flow patterns are obtained.
The same expanding procedure is applied for the N-components of the discharge vectors.
It is evident that the expanding effect is greater as the factor ε and the angle ω are chosen larger.

The result of the distribution procedure described above is, that a discharge pattern is created over the whole model. In every phase of this distribution procedure the conservation of mass is guaranteed so that no water is lost or added during the calculation.

From this discharge pattern the current pattern is obtained by dividing the magnitude of the discharge vectors by the mesh-size and the respective waterdepths.

3.2. Wave sub module

3.2.1. The subroutines of the wave sub-module

The wave sub module is composed of three subroutines. In each subroutine currents due to a specific wave action phenomenon are calculated. The three subroutines are:

1. REFRAC : - calculates wave height and wave direction at each mesh-point
   - calculates longshore current caused by obliquely breaking waves
2. EENLING : - calculates currents caused by solitary waves
3. SETUP : - calculates set-up currents caused by local wave height differences

The theoretical background of the three subroutines are described in the following sections.

3.2.2. The subroutine REFRAC

Subroutine REFRAC provides the necessary data for the determination of the longshore currents (caused by obliquely breaking waves and by wave set-up differences) and the solitary wave currents by calculating the wave height and wave direction in each mesh-point. The calculation method is based on linear wave theory which is usually applied in wave penetration models.

Because of the fact that nearly all waves come from SW-W-NW directions (between 225° and 315°) the wave penetration calculation could be simplified considerably.
The calculation starts at the seaward boundary of the model (M=40) and proceeds into the direction of wave propagation. The subroutine calculates wave heights and wave directions only at the mesh-points (data in intermediate points are of no interest) using wave data already determined at the surrounding points.
Consider point N in a certain row M, in which the wave data are determined (see figure 6). If the wave direction $\alpha(N, M)$ at this point is larger than 270°, the new wave heights and wave directions are calculated in mesh-points (N, M-1) and (N+1, M-1); if the wave direction is lower than 270°, then the new wave data are determined in mesh-points (N-1, M-1) and (N, M-1).

Figure 6 presents the case for $\alpha(N, M)$ larger than 270°. The wave orthogonal with its origin in mesh-point (N, M) intersects row M-1 in point S. The wave height H(S) in point S can be calculated using the following formula:

$$H(S) = H(N,M)\sqrt{\frac{\cos\theta(N,M)}{\cos\theta(S)}} \tag{3.19}$$

in which:

$$\theta(N,M) = \alpha(N,M) - \psi$$

$$\theta(S) = \alpha(S) - \psi$$

$\alpha(N,M), \alpha(S)$ = angles of the wave orthogonal respectively in points (N, M) and S. The angles are related to the positive N-axis.

ψ = angle of the normal perpendicular to the local bottom contour and related to the positive N-axis.

The angle ψ and the local slope m are calculated by means of a special subroutine HELNG, added to the program. ψ is considered to represent the area enclosed by the four mesh-points. H(N, M) and α(N, M) are known values. A value for $\alpha(S)$ is obtained by calculating the curvature of the wave orthogonal using the formulae:

$$\frac{d\alpha}{ds} = \frac{1}{C}\left(\frac{\partial D}{\partial N}\sin\alpha(N,M) - \frac{\partial D}{\partial M}\cos\alpha(N,M)\right)\frac{dC}{dD} \tag{3.20}$$

$$\frac{dC}{dD} = \frac{g\left[1-\left(\frac{c}{c_o}\right)^2\right]}{C + \frac{gD}{C}\left[1-\left(\frac{c}{c_o}\right)^2\right]} \tag{3.21}$$

in which:

ds = distance along wave orthogonal
c = average of the wave celerities at the four mesh-points
D = average of the depths at the four mesh-points
co = deep water wave speed

The wave direction $\alpha(s)$ in point S is then:

$$\alpha(S) = ds\frac{d\alpha}{ds} \approx \frac{\Delta l}{\sin\alpha(N,M)}\frac{d\alpha}{ds} \tag{3.22}$$

Now the wave height in S is determined applying formula (3.19). However we are interested in the wave heights and wave directions in mesh-points (N, M-1) and (N+1, M-1). Therefore H(S) is distributed to these points; the contribution of H(S) to the wave height in mesh-point (N, M-1) is realized with formula:

$$\Delta H(N,M-1) = \sqrt{\left(1+\frac{1}{tg\alpha_h}\right)}\sqrt{H(S)} \tag{3.23}$$

and the contribution of H(S) to the wave height in mesh-point (N+1, M-1) with formula:

$$\Delta H(N+1,M-1) = \sqrt{-\frac{1}{tg\alpha_h}}\sqrt{H(S)} \tag{3.24}$$

in which:

$$\alpha_h = \frac{(\alpha(N,M)+\alpha(S))}{2} \tag{3.25}$$

This calculation scheme is used for wave directions $270^\circ < \alpha(N, M) < 315^\circ$ so $tg\,\alpha_h$ is always negative.
For wave directions $225^\circ < \alpha(N, M) < 270^\circ$ the formulae are:

$$\Delta H(N,M-1) = \sqrt{\left(1-\frac{1}{tg\alpha_h}\right)}\sqrt{H(S)} \tag{3.26}$$

$$\Delta H(N-1,M-1) = \sqrt{\frac{1}{tg\alpha_h}}\sqrt{H(S)} \tag{3.27}$$

The total wave heights in mesh-points (N, M-1) and (N+1, M-1) are obtained by adding $\Delta H(N,M-1)$ and $\Delta H(N+1,M-1)$ to the values at these points which are calculated already in a previous calculation step

So the final wave heights are:

$$H(N,M-1)=\sqrt{\Delta H'(N,M-1)^2+\Delta H(N,M-1)^2} \qquad (3.28)$$

$$H(N+1,M-1)=\sqrt{\Delta H'(N+1,M-1)^2+\Delta H(N+1,M-1)^2} \qquad (3.29)$$

and finally the new wave directions are:

$$\alpha(N,M-1)=\frac{(\alpha_h \Delta H(N,M-1)^2+\alpha'(N,M-1)\Delta H'(N,M-1)^2)}{H(N,M-1)^2} \qquad (3.30)$$

$$\alpha(N+1,M-1)=\frac{(\alpha_h \Delta H(N+1,M-1)^2+\alpha'(N+1,M-1)\Delta H'(N+1,M-1)^2}{H(N+1,M-1)^2} \qquad (3.31)$$

Based on the formula mentioned above the wave heights and wave directions are calculated in the mesh-points of row M-1. The subroutine continually tests if a wave is able to reach the considered point regarding the local waterdepth. When penetrating into shallow water, wave heights can increase gradually until a certain limit is reached. Then breaking occurs. In this subroutine a simple relation between the breaker height Hbr and the waterdepth D is used, viz.:

$$H_{br}=\gamma D \qquad (3.32)$$

in which: γ = breaking index

The subroutine continually tests the calculated wave height H(N, M) to relation (3.32). If the calculated wave height exceeds Hbr then the former value is replaced by Hbr. A proper value for the breaking index γ is found during the calibration phase of the model.

Now the definitive wave heights and wave directions in row M-1 are known and the program continues by calculating the longshore current in this row, caused by obliquely breaking waves. The calculation is based on the theory of radiation stress. The bottom contours play an important role in this calculation, for the longshore current runs parallel to the bottom contours. Since the waterdepth is known in every mesh-point, the direction of the local contour in every required mesh-point can be computed by means of subroutine HELING.

In the appendix of volume 2 the phenomenon radiation stress is described. Summarized, radiation stress is a pressure force in excess of the hydrostatic pressure force caused by the presence of waves. In reality, the radiation stress is neither a true stress (force per area), nor a true force, but a force per unit length. Transformations applicable to true tresses can be applied to radiation stress.

For normal coasts neither 'tension radiation stress' or 'pressure radition stress' are causing forces parallel to the contours. Only 'shear radiation stress' causes such a force component. The formula for the shear radiation stress is:

$$S_{xy} = \frac{1}{8} \rho g n H^2 \sin\theta \cos\theta \qquad (3.33)$$

in which:

- S_{xy} = shear radiation stress parallel to the bottom contour
- ρ = density of water
- g = accelaration of gravity
- H = wave height
- θ = angle between wave orthogonal and the normal perpendicular to the bottom contour
- n = ratio between the wave celerity and velocity of the wavegroup.

Shear radiation stress differences into the direction perpendicular to the bottom contours generate the longshore currents.
The calculation method used in this subroutine is based on formula (3.33) and is described briefly below.

Consider again 4 adjacent mesh-points at row M and row M-1. The wave heights and wave directions are known. The angle of the normal prependicular to the local bottom contour and related to the positive N-axis is calculated again. First the shear radiation stresses into the direction of the local contour are calculated at each of the four mesh-points. Then the average shear radiation stress difference into the direction of the normal to the bottom contour must be determined. This is done by determining first the average shear radiation stress differences in N- and M-direction:

$$\frac{\partial S_{xy}}{\partial N} \approx \frac{\left(S_{xy}(2)+S_{xy}(4)-S_{xy}(1)-S_{xy}(3)\right)}{2\Delta l} \qquad (3.34)$$

$$\frac{\partial S_{xy}}{\partial M} \approx \frac{\left(S_{xy}(3)+S_{xy}(4)-S_{xy}(1)-S_{xy}(2)\right)}{2\Delta l} \qquad (3.35)$$

Finally the average shear radiation stress difference into the direction of the normal perpendicular to the bottom contour is:

$$\frac{\partial S_{xy}}{\partial_{norm}} = \frac{\partial S_{xy}}{\partial N} \cos\varphi + \frac{\partial S_{xy}}{\partial M} \sin\varphi \qquad (3.36)$$

The longshore current is calculated then with the following formula:

$$V_l = \frac{\partial S_{xy}}{\partial_{norm}} \cdot \frac{\pi C \sqrt{2D}}{H \sqrt{f_w}} \qquad (3.37)$$

in which:

C = Chèzy friction factor = 18 log $\left(\frac{12D}{R}\right)$

D = average of depths at the four mesh-points
H = average of wave heights at the four mesh-points
f_w = $\exp\left[-5.977+5.213\left(\frac{a}{R}\right)^{-0.194}\right]$
a = amplitude of the orbital motion at the bottom
R = bed roughness

The calculated longshore current is considered to act in mesh-point (N, M-1).

In this way the longshore currents are determined at all mesh-points of row M-1. However, there are two restrictions. First the program tests again if the considered point is not a land point and secondly, when the waterdepth at this mesh-point exceeds a certain limit value, the longshore current is considered to be zero. The largest values of the longshore currents are acting within the breaker zone, but due to turbulent forces, the longshore current also continues over a certain distance outside the breaker zone.

After calculating the wave heights, wave directions and longshore currents at row M-1 the program repeats the procedure again, now for the mesh-points at row M-2 using the wave data from row M-1. The program continues until the shore of the Cabedelo, or row M=1 is reached. Then the longshore current pattern is added by vectorial adding to the current pattern due to the tidal and river discharge.

3.2.3. The subroutine EENLING

Only long waves transform into solitary waves, and therefore this subroutine is only used if the wave period is larger than 11 seconds. The net transport velocity is equal to the wave celerity, however, this net velocity occurs only under the wave crest (that is under circa 10 percent of the wave length, or during 10 percent of the wave period).
In order to simplify the calculation it is assumed that for a solitary wave the average transport velocity Ve is:

$$V_e \approx 0.1C \qquad (3.38)$$

in which: c = wave celerity

For a solitary wave the wave celerity can be calculated using the following formula:

$$c = \sqrt{g(D+H)} \qquad (3.39)$$

in which: g = acceleration of gravity
D = waterdepth
H = wave height

With the wave data, determined in subroutine REFRAC, as input the subroutine EENLING calculates the transport velocities at each mesh-point. The directions of current vectors are equal to the directions of the wave orthogonals.

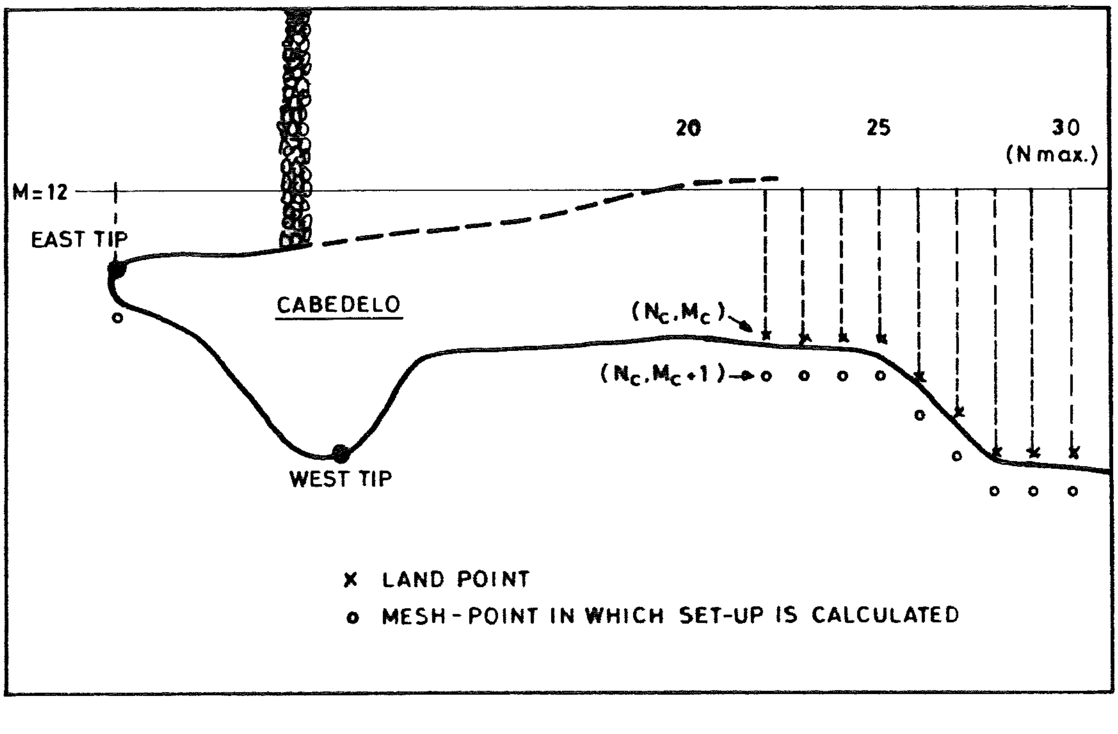
Finally the velocities are vectorial added to the current pattern already determined in the preceeding subroutines.

3.2.4. The subroutine SETUP

Wave set-up is a phenomenon also related to radiation stress. Due to refraction, shoaling and wave breaking the wave parameters change and consequently the radiation stress-component into the direction of the coast also changes. The changes in this principal stress causes a net resultant force, also into the direction of the coast. A change of the water level is the result (set-up)

In fact the set-up must be calculated by integration along the wave orthogonal, but this is not possible for this type of model. For steep coasts, however, set-up takes place mainly near the shore. Therefore, this subroutine calculates the set-up in a certain mesh-point (Nc, Mc+1), if the adjacent mesh-point (Nc, Mc) is a land point on the Cabedelo shore.

In order to calculate the set-up in the right points, first the position of the Cabedelo coast is determined. For this a search method like the method used in the discharge distribution module is applied. The search procedure starts at mesh-point NMAX at row M=12, east of the Cabedelo coast, and the procedure stops when the north tip of the Cabedelo head is found and the coastline is determined. (see figure below).



Water level rise only occurs within the breaker zone and the set-up ΔD (Nc,Mc+1) can be calculated using the following simplified formula:

$$\Delta D(N_c, M_c+1) = \frac{5}{16}\gamma H_{br} \qquad (3.40)$$

in which: γ = breaking index
Hbr = wave height of breaker at mesh-point (Nc,Mc+1)

The subroutine continually tests if the wave in mesh-point (Nc, Mc+1) is broken. Set-up is not calculated if the wave height is lower than the breaker height.

At each mesh-point (Nc, Mc+1) the Chezy-friction factor C is calculated. In general the set-up will vary along the coast and consequently the magnitude and direction of the set-up current will also vary locally. However, the average current direction is to the north and this average current is of interest for the model. Therefore, the average set-up ΔDa, the average Chézy friction factor Ca and the average depth Da along the Cabedelo coast are calculated. By means of the Chézy-formula the average set-up current is determined as follows:

$$V_{su} = C_a\sqrt{D_a i_a} \qquad (3.41)$$

in which: $i_a = \dfrac{2\Delta Da}{n\Delta l}$ (3.42)

n = number of Cabedelo land points
Δl = mesh-size

The direction for each current vector is parallel to the contour in the considered mesh-point. The local contour-directions are determined with subroutine HELNG.
The set-up current pattern is added to the existing current pattern. Now the definitive current pattern is obtained and the calculations of the sediment transport capacities can start, using the sediment transport module SEDTRAN.

4. SEDIMENT TRANSPORT MODULE

The morphological model is based on two fundamental equations, viz:

- the equation of motion
- the equation of continuity.

The equation of motion is the relation between sand transport capacity and the water velocity (sand transport formula). With the current pattern, determined in the current module, as input the sediment transport module calculates the sediment transport capacity at each mesh-point.
The bed level module calculates then the siltation pattern and this computation is based on the equation of continuity.

Sediment transport can be classified as follows:

- bed material transport, subdivided into:
  - bed load transport
  - suspended load transport
- wash load

The wash load, that is the transport of particles finer then those present in the bed, is not taken into consideration.

Many types of bed material transport formulae are developed. In volume 4 the best fitted formulae are determined for the Douro river and Douro estuary. The calibrations are based on the measurements executed in November 1982. For the offshore area, where wave action plays an important role, the Bijker formula is recommended and for the Douro river the Engelund-Hansen formula has to be applied.
Because of the fact that in almost all parts of the model-area wave action influence is noticeable, the morphological model uses only the Bijker formula for bed load transport and the Bhattacharya-TOW formula for suspended load transport.

The Bijker formlua is:

$$S_b = \frac{B D_{50} V}{C} e^{\left[\frac{-0.27 \Delta D_{50} \rho g}{\mu \tau_{cw}}\right]} \qquad (4.1)$$

in which: Sb = bed load transport (m3/s/m)
B = bed load factor
D50 = grain size diameter exceeded by 50% of the bed material

V = water velocity
C = Chézy friction factor
$\Delta = \frac{\rho_s - \rho}{\rho}$
ρ_s = mass density of sediment particles
ρ = mass density of water
g = acceleration of gravity
μ = ripple factor $= \left(\frac{C}{C'}\right)^{3/2}$
$C' = 18 \log\left(\frac{12D}{D_{90}}\right)$
D90 = grain size diameter exceeded by 10% of the bed material
τ_{cw} = bed shear stress under current and waves

The Bhattacharya-TOW formula is:

$$S_s = \frac{0.415}{(1-B_1)^2}\left[(1-B_1)\left\{\left(\frac{D}{R}\right)^{(1-B_1)} \cdot \log\left(30.2\frac{D}{R}\right) - 3.408\right\} + \left\{1 - \left(\frac{D}{R}\right)^{(1-B_1)}\right\}\right] S_b / \left[1 - B_1 \left(0.1667^{(1-B_1)}\right)\right] / (1-B_1) \quad (4.2)$$

in which:

S_s = suspended load transport ($m^3/s/m$)

$$B_1 = \frac{1.05 Z_*^{0.96}}{\left(\frac{D}{R}\right)^{0.013 Z_*}} \quad (4.3)$$

$$Z_* = \frac{V_{50}}{0.384\sqrt{\frac{\tau_{cw}}{\rho}}} \quad (4.4)$$

V_{50} = fall velocity of D_{50} grain size
S_b = bed load transport calculated with Bijker formula
R = bed roughness
D = water depth

In volume 4 the parameters of the calibrated Bijker transport formula are presented as D50 = 0.001 m, D90 = 0.0015 m, R = 0.1 m and B=5. However, further consideration of the measured data proved that a better agreement of the Bijker and Battacharya formula with the measured data could be achieved, when a linear relationship between the bed roughess R and the wave period T would be applied, instead of a constant value for R.

The following relation between R and T could be derived:

$$R = -\frac{R_o}{T_m} T + R_o \qquad (4.5)$$

in which: Ro = 0.165 m
Tm = 12.8 sec

A new calibration, in which formula (4.5) was implemented, resulted in a new value for the bed load factor, viz. B = 1.83. This value is applied in the Bijker formula. The values D50 and D90 didn't change. For a general description of the calibration method is referred to section 5 in volume 4.

With the total current pattern and with the wave heights and wave periods as input, the sediment transport components in N- and M direction at all mesh-points are computed by means of formulae (4.1), (4.2), (4.3), (4.4) and (4.5).
With respect to this computation it is remarked, that the calculation is based on the assumptions that the local sediment transports are a funtion of the local hydraulic conditions and that sufficient sand is available at the bottom. In other words the real transport in each point is equal to the calculated transport capacity. The measurements have shown, however, that the latter assumption is not always valid and certainly not for the present state of the estuary, because in some parts of the model area the bottom consists of bare rock. In that case erosion is impossible of course and therefore the possible presence of a rock bottom must be taken into account. This is done in the following way.

First the levels of the rock bottom must be known. For the present only two horizontal rock levels have been built in the model, viz. a rock level for the river mouth (from M=1 to Felgueiras) and a lower rock level for the near shore area.
At each mesh-point the program compares the instantaneous bottom level with the level of the local rock layer. When at a certain meshpoint (N, M) the level of the rock layer has been reached, then the N-component SN(N,M) of the calculated transport capacity at (N,M) is compared with SN(N-1,M) in case SN(N,M) has a positive direction, and with SN(N+1,M) in case SN(N,M) has negative direction. If, for instance, SN(N,M) exceeds SN(N-1,M) then SN(N-1,M) is carried through to mesh-point (N,M). However, SN(N,M) is maintained at (N,M) in case SN(N,M) is lower than SN(N-1,M). This procedure is repeated for the M-components of the transport capacities. The eventual result is a sediment transport pattern, which serves as input for the bed level module.

5. BED LEVEL MODULE

The calculation of the new bed level at time $t=t+\Delta t$ is based on the equation of continuity (conservation of mass). According to this equation no sediment can disappear. For a certain time interval Δt this means, that the siltation in a certain area must be equal to the difference between the total incoming and the total outgoing sediment.
Thus:

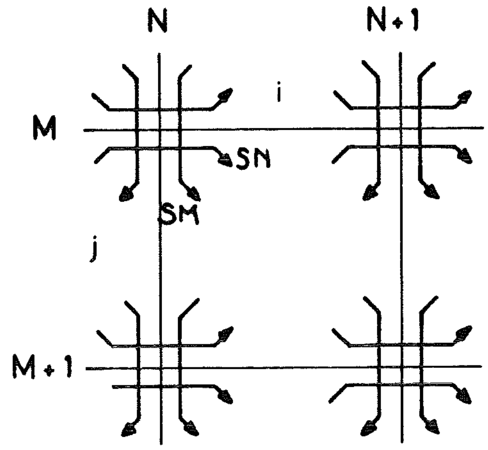
$$\Delta S = (S_{in} - S_{out})\Delta t \qquad [m^3/s/m] \tag{5.1}$$

It is more convenient to express the sedimentation in the increase (or decrease) of the bottom level. If ΔD is the increase of the bottom level, then:

$$\frac{\Delta D}{\Delta t} = \frac{\Delta S \Delta l}{\Delta l^2} = \frac{S_{in} - S_{out}}{\Delta l} \qquad [m/s] \tag{5.2}$$

in which: Δl = mesh-size

The program calculates the siltation in the squares between the mesh-points. For this purpose the N- and M- components of the sediment transports, calculated in SEDTRAN, are used. It is assumed that the sediment transport into the N-direction comes for 50% from the square above left, and for 50% from the square below left from the mesh-point. This sediment is presumed to go for 50% to the square above right, and for 50% to the square below right of the mesh-point (see figure below).



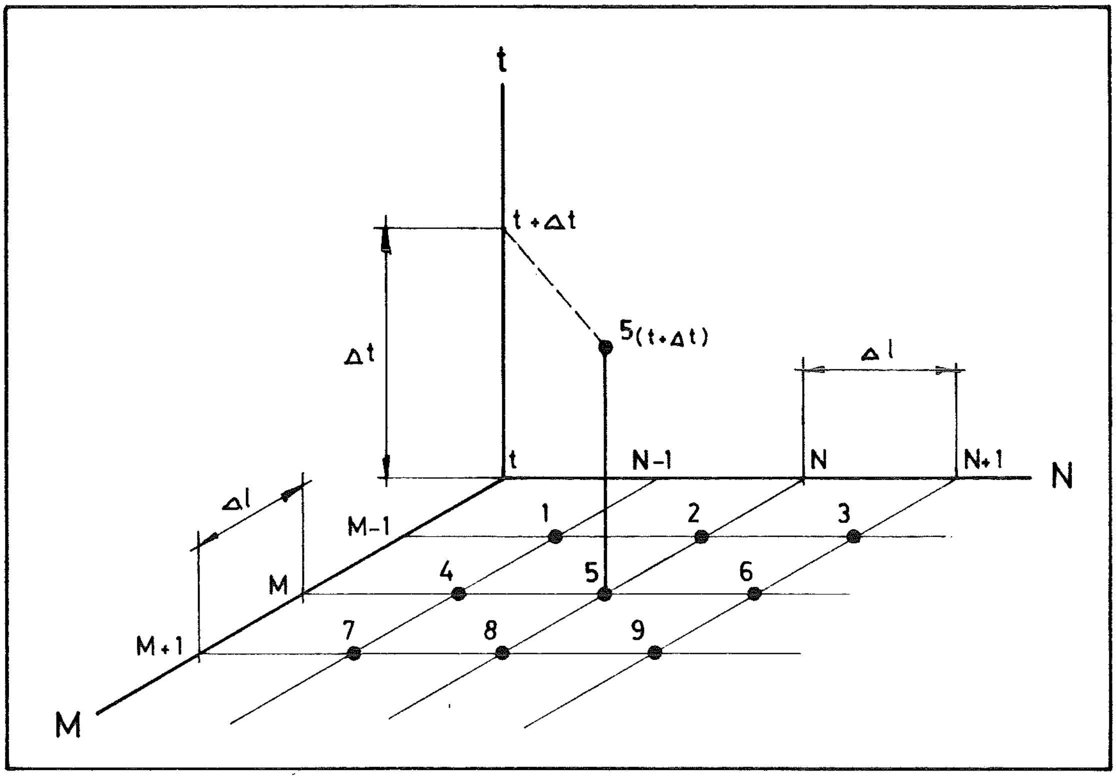
For the transport in M-direction an identical scheme can be made. The siltation in square (i, j) is computed with formula (5.2), worked out into:

$$\Delta D(i,j) = 0.5\frac{\Delta t}{\Delta l}\big(SN(N,M) - SN(N+1,M) + SN(N,M+1) - SN(N+1,M+1) + \\ + SM(N,M) - SM(N,M+1) + SM(N+1,M) - SM(N+1,M+1)\big) \quad (5.3)$$

For further cumputations it is handier to use the siltations at the mesh-points. The bottom level increase at the mesh-points is computed as the average of the siltations in the adjacent squares. Thus at mesh-point (N, M) the siltation becomes:

$$\Delta D(N,M) = \frac{1}{4}\big(\Delta D(i-1,j-1) + \Delta D(i,j-1) + \Delta D(i-1,j) + \Delta D(i,j)\big) \quad (5.4)$$

The eventual new bottom level at time t=t+Δt is computed using one of the following difference schemes (see figure below):



Difference scheme 1

$$D5(t+\Delta t) = (1-\beta)D5(t) + \frac{\beta}{8}\sum\left(D1(t)+D2(t)+D3(t)+D4(t)+D6(t)+D7(t)+D8(t)+D9(t)\right) - \Delta D5 \qquad (5.5)$$

Difference scheme 2

$$D5(t+\Delta t) = (1-\beta)\left(D5(t_0) - D5(t) + \Delta D5\right) + \frac{\beta}{8}\sum_{n=1}^{8}\left(Dn(t_0) - Dn(t) + \Delta Dn\right) \qquad (5.6)$$

Difference scheme 3

$$D5(t+\Delta t) = (1-\beta)\Delta D5 + \frac{\beta}{8}\sum_{n=1}^{8}\Delta Dn \qquad (5.7)$$

in which: $D5(t+\Delta t)$ = new bottom level in mesh-point 5 at time $t=t+\Delta t$
$D5(t)$ = bottom level in mesh point 5 at time $t=t$

D5(to)	=	bottom level in mesh point 5 at time t=to (original bottom level at the start of the simulation)
ΔD5	=	siltation in meshpoint 5, calculated at time t=t+Δt
Dn(t)	=	bottom levels in the adjacent mesh-points 1 to 9 at time t=t
Dn(to)	=	original bottom levels in the adjacent mesh-points 1 to 9 at time t=to
ΔDn	=	siltations in the adjacent mesh-points 1 to 9, calculated at time t=t+Δt
β	=	smoothing factor ($0<\beta\leqslant 1$)

Scheme 1 is the so-called modified Lax-scheme. Scheme 2 and 3 are derivations from the modified Lax-scheme. The effect of these schemes is, that extreme bottom level differences between adjacent mesh-points are leveled out. The use of one of these three schemes prevents, that peaks and holes arise in the bottom configuration during the simulation process. This fact is of special interest for this mathematical model, since so many time-steps are executed. The smoothing effect will be stronger as the β-factor increases.
The three schemes smoothe in different ways.
In scheme 1, smoothing is related to the bottom levels at time t=t.
In scheme 2, smoothing is related to the cumulative siltation layer. In other words, the layer between the bottom level at t=t+Δt and the original bottom level at t=to is levelled continually.
In scheme 3 smoothing is related only to the instantaneous siltation layer, calculated at t=t+Δt.
If the siltation rates don't differ too much over the model, then the β-factor can be a constant value. Because of the fact that in some parts of the model-area rarther high siltation rates occur, whereas the siltation rates are nearly zero in other areas, the application of a constant β-factor is less satisfactory. Better results can be expected, if the β-factor varies over the model. In other words, if the siltation rate is very small, then the value for the β-factor must be low; if the siltation rate is rather high, then a higher value for the β-factor is required. For this purpose the following relation between the local β-factor and the local siltation rate has been derived:

$$\beta(N,M) = \left(1 - e^{\frac{-\Delta D(N,M)}{\Delta De}}\right)\beta_m \qquad (5.8)$$

in which:

$\beta(N,M)$	=	smoothing factor at mesh-point (N,M)
$\Delta D(N,M)$	=	siltation at mesh-point (N,M)
ΔDe	=	a constant
βm	=	maximum value for the β-factor.

The three difference schemes and formula (5.8) are all implemented in the subroutine. In the calibration phase tests have been carried out to make out which scheme gives the best results and which values for the factors ΔDe and βm can be applied best (see paragraph 8).

The following remark has to be made in respect to the sand balance of the model. At each time-step the sand balance is computed as the net result of the addition of the positive and negative siltations $\Delta D(N,M)$.
The sand balance is not zero in all cirumstances. The surplus or the shortage of the balance is the quantity of sand that enters or leaves the model across the boundaries. The model has open boundaries, so that sand is able to pass through. However, the use of one of the three difference schemes the disadvantage, that a certain volume of sand will disappear incorrectly. This shortage has to be replenished again. For this reason the program continually determines the deficiency and covers the bottom with an extra quantity of sand equal to the shortage.
The new bottom configuration is the new start position for the next time-step.

6. INPUT DATA FILES

6.1. Introduction

The values for the input data are stored in 9 files. The concerned files are listed below in accordance with the subdivision given in section 2.2.

1A. Boundary data (stochastic values).

- for discharge distribution sub-module:
  - file QDISTR - probability distributions of river discharge

- for wave sub-module:
  - file WINDDIS - probability distributions of wave directions
  - file PERDIS - probability distributions of wave period
  - file WAVDIS - probability distributions of wave heights

1B. Boundary data (deterministic values)

- for discharge distribution sub-module:
  - file DISCH - river and tidal discharge at east boundary of the model as a function of the tidal water level

- for all modules:
  - file SEALEV - tidal water levels
  - file PAR - values for the stochastic data (river discharges, wave directions, wave periods and wave heights)

2. Initial data

- for all modules:
  - file with bottom levels at time t=to (start of simulation).

3. Data for remaining parameters

- for all modules:
  - file INFO - contains values for grainsizes, bed roughness, etc.

The contents of the input files is described in sections 6.2 and 6.3.

The stochastic input data have to be chosen from the files by means of a stochastic selection procedure. This procedure is described in section 6.4.

6.2. Data files with stochastic values

File QDISTR

Data of the daily river discharge, observed near the Crestuma dam during the years between 1932 and 1964, were available. The lowest and the highest observed discharges in this period were respectively 14 m3/sec (August 17, 1958) and 15909 m3/sec (January 3, 1962). The river Douro is also characterized by rapid changes in the daily discharge. For instance, at December 17, 1945, the discharge increased from 410 m3/sec to 1401 m3/sec in a single day.
As these discharge data cover a rather long period of 32 years, a good estimation of the cumulative probability distribution of the daily discharge could be derived in each month of an average year. For this purpose the discharge range was subdivided into 11 classes with increasing class-intervals. The 12 distributions have been stored in file QDISTR and are presented in table 1. The numbers in table 1 are percentages and must be interpreted as follows. As an example, number 73 in the probability distribution of January means, that the river discharge is lower than 1250 m3/sec during 73 percent of the time.

Files WINDDIS, PERDIS and WAVDIS

The wave parameters used in the wave sub-module are the wave direction, the wave period and the wave height. An element of the wave climate is characterized by a combination of certain values for each of the three parameters. In fact, the cumulative probability distributions of the wave elements should be determined. However, for reasons of simplicity, it is more convenient to derive the distributions for each wave parameter apart . In common with the river discharge the distributions of the 3 wave parameters are needed per month.
The probability distributions have been determined with wave data, derived from the following publication:

Estudo de Agitacao maritima em Leixoes,
Instituto Hidrografico, 1974

In this publication the results of simultaneous observations of wave height, wave period and wave direction are presented. The results are given per month. It is assumed that the wave data derived from this publication may be used without further adjustments such as refraction computations.
All observed wave directions are in the SW/NW-sector. This sector was sub-divided into five directions of respectively 230°, 248°, 270°, 293° and 310° (angles related to the north direction). Table 2 indicates the chosen classes and the 12 cumulative probability distributions. The distributions are stored in file WINDDIS.

Nearly all observed wave periods vary within the range of 7 to 15 seconds. This range was subdivided into four classes, represented by wave periods of respectively 8, 10, 12 and 14 seconds. The cumulative probability distributions of the wave period have been determined per wave-direction. This was done for each month, so 12x5=60 distributions were obtained (see table 3). The distributions are stored in file PERDIS.

Since root-mean-square values are commonly used in sediment transport computations, these parameters have been derived from the significant wave heights. Nearly all root-mean-square wave heights are lower than 3.55 m. The wave height range was subdivided into 10 classes. Table 4 presents the class-arrangement and the cumulative probability distributions per wave period. So, each month is represented by four distributions, and an average year is thus represented by 48 distributions. The distributions are stored in file WAVDIS.

6.3. Data files with deterministic values

File SEALEV

The water depths in the estuary vary with the tide, and consequently the discharge varies during the tide as well. Therefore it is necessary that the tidal water level rise (vertical tide) is taken into account. The tides are considered diurnal and one tydal cycle is assumed to have a duration of exactly 12 hours. Further, the tides are assumed to be only of astronomic origin and thus meteorological phenomena play no role. This means that the tidal water level rises can be considered as deterministic variables.
Determination of one vertical tide-curve is not sufficient, because of the fact that the tide-curve varies considerably during one month. Therefore three vertical tide-curves were selected; one curve represents the tides with higher high waters (spring-tides), one curve represents the tides with lower high waters (neap-tides) and one curve represents the tides with mean high waters (normal tides). The 3 tide-curves have been derived from tide-tables near Leixoes (source: Tabela de Mares 1983, Instituto Hydrografico).

The vertical tide-curves are divided into 12 steps (each step is one hour) and at each step the water level, related to zero hydrografico, is given in cm (see table 5). The curve for normal tide is given twice, because the frequency of normal tide is twice the frequency of spring- and neap-tide.
The four curves are stored in file SEALEV.

File DISCH

A discharge-value, chosen from one of the probability distributions in data file QDISTR, represents the river discharge, which is not affected by tides. The discharge in the estuary however, is strongly influenced by the tide and therefore curves of the discharge as a function of time are required at the east boundary of the model.
For this purpose the computer program EXPLIC has been applied.
This computer program has been used in an earlier phase of the hydro-morphological study (see part 3). The lower course of the Douro, from the Crestuma dam up untill the river mouth, has been divided into a number of branches. The program EXPLIC calculates the discharge curve in every desired branch. The program requires as input a certain vertical tide-curve at the sea-boundary and a certain river discharge in a cross-section near Crestuma.
The results of the computations, 33 discharge curves for the east boundary of the model, are stored in file DISCH (see Table 6).
The EXPLIC computer program not only calculates discharge curves, but current curves and water level curves as well. The water levels are of interest with respect to the water level differences between the east boundary and the seaward boundary of the model. The computations turned out, that for discharges more than 2000 m3/s, considerable water level differences occur, which cannot be neglected. The water level differences have been implemented in the computer model.

File PAR

Files QDISTR, WINDDIS, PERDIS and WAVDIS only contain percentages of frequency. The class arrangements to which the frequencies are related, are stored in a separate file PAR, as indicated in table 7.

File with initial bottom levels

This file contains the levels of the bottom configuration at the start of the simulation (t=to). The levels are related to zero hydrografico. The 1200 water depths are stored in 3 sub-columns, viz. the first sub-column contains the water depths of the model from N=1 to N=10, the second sub-cloumn contains the water depths from N=11 to

N=20 and the third sub-column contains the water depths from N=21 to N=30 (see figure 13).
The water depths are in dm. Negative values represent bottom levels above zero hydrografico. Fixed land points, like quays, Pedras do Lima, etc, are indicated by -99 values.

File INFO

File INFO contains the remainder of the input data (see table 8).
Line 1 contains information with respect to the model grid, viz. the number of columns (=NMAX), the number of rows (=MMAX) and the mesh-size (=MESH).
Lines 2 and 3 contain the (N, M) coordinates of Cantareira and Felgueiras and line 4 contains the N-ordinate of the Molhe (Pedras de Lima). These data are needed for the search-procedure in sub modules FLOWDS1 and FLOWDS3, used for finding the east- and west tip of the head of the Cabedelo.
Lines 5 and 6 contain values for the input parameters of the expander routine used in FLOWDS1 and FLOWDS3 (see section 3.1), viz. $\varepsilon_{general}$, ε_{river} and ε_{sea} (line 5) and $\omega_{general}$, ω_{river} and ω_{sea} (line 6).
Line 7 contains a value for the bed roughness R (in meters) as input parameter for the modules REFRAC and SEDTRAN for the computation of longshore currents and sediment transport.
In line 8 values for the grain size diameters D50 and D90 (in meters) are stored. These parameters are used in the sediment transport formula in module SEDTRAN.
Line 9 contains a value for the breaking index γ, used in modules REFRAC and SETUP. A value for the level of the rock layer in the Douro mouth , used in module SEDTRAN is stored in line 10. The level of the rock layer is related to zero hydrografico.
Line 11 contains values for β m and ΔDe, both used in the formula for the calculation of the smoothing factor in module NEWBOT (formula 5.6). The data in lines 5 to 11 can easily be changed in order to calibrate the model.

6.4. Selection procedure for the stochastic input data

The computer program completes a tidal cycle in 12 time-steps. At each time-step the program passes through all modules (see figure 2) and continually the new, instantaneous bottom configuration is computed. For each new tidal-cycle the program chooses a certain river discharge and a certain set of wave parameters (wave direction α, wave period T and wave height H). This selection procedure is carried out in the following way.
From data file QDISTR the program first selects the cumulative probability distribution of the river discharge which apply to the

concerned month. Then, by means of a special routine, a random number between 0 and 100 is generated and this number is compared with the percentages of frequency of the selected probability distribution. The frequency most near to the random generated number is selected now and the river discharge, related to this chosen frequency, is read from input file PAR. Then the proper tidal discharge curve, related to the selected river discharge, is selected from file DISCH. This discharge curve provides the discharge at the east boundary of the model at each time-step of the concerned tidal-cycle.

The following example illustrates the selection procedure. Suppose the computer program has just finished a cycle for spring-tide in March. The simulation process continues now with the following tidal cycle, that is mean-tide. Suppose number 47 is generated. From the probability distribution of the river discharge in March (line 3 in file QDISTR) the program will choose number 43, because this number is most near to the random generated number 47. This chosen percentage of frequency is related to the third number of line 4 in file PAR (the line containing the discharge values) and thus the river discharge will be 625 m3/s. Related to this river discharge is the discharge curve on the 14th line in data file DISCH. This curve provides now 12 discharge values for the next mean-tide cycle.

The next step is the choice of a certain set of wave parameters. A random number is generated again and a wave direction is chosen according to the proper probability distribution. Then a next random number is generated and a wave period is selected according to its probability distribution associated with the earlier chosen wave direction. Finally a last random number is generated and the wave height is selected according to the distribution associated with the earlier chosen wave period. The thus created set of wave parameters are maintained during the whole tidal-cycle.

The procedure, described in the example above, is also applied for the selection of the wave parameters. The sequence in which the program gets through the tidal cycles is respectively spring-, mean-, neap- and again mean-tide. This sequence is repeated continually during the simulation run.

7. RUNNING THE MODEL

The program has 2 options for running the model, viz.:
- option for a long term simulation
- option for a one time-step run

Relevant aspects of both options are discussed below.

Long term simulation

A long term simulation can be carried out not only in one, uninterrupted computation, but can be split up in several phases as well. Table 9 gives an example of the restart of an interrupted long term simulation.
With regard to some aspects of the entering procedure a few remarks are made. The remainder of the procedure, as indicated in table 9, speaks for itself.
The duration of the simulation period can be entered either in years or months. In case of an interrupted simulation, the total simulation period of the computations which preceded the new computation must be entered as well.
The time-scale factor is of special interest. In this model it is assumed that each month has 732 hours, so 61 tides of 12 hours occur. An exact simulation of bottom changes during one month requires 732 tidesteps. The computing time for the calculation of one time-step is circa 30 seconds, thus a one month simulation will need about 732x30=21960 seconds (that means a computation time of about 7 hours). It is quite clear that, without the application of a time-scale factor, a long term simulation is not possible. Apart from this aspect, the use of a time-scale is also justified for two other reasons. The first reason is that a number of tidal cycles are identical, and it is unnecessary to run them twice. The second reason is the fact, that the bottom level changes are very small per tidal cycle. By means of a time-scale factor the sediment transport is speeded up. Consequently the number of tidal-cycles can be decreased. In the example of table 9 a time-scale factor of 15.25 is used; this means that the siltation rates, calculated at a certain time-step are multiplied by a factor 15.25. In this case only 4 tydal-cycles are required to simulate bottom changes during one month.
Finally, with the time interval for printing the new bottom is meant, the frequency with which the instantaneous bottom levels can be stored as intermediate results in output files. The interval can be entered either in years or months. An interval of one month means, that after each simulated month a new file is created, in which the bottom levels at that point of time are fixed. So, the result of a long term simulation run is a number of output files with bottom levels at all mesh-points. The bottom levels are stored in the same way as the bottom levels in the initial bottom file.
A special computer program visualizes the process of bottom changes by printing contrast maps based on the produced bottom files. In paragraph 8, several contract maps are presented as results from calibration runs.

One time-step run

The option of an one time-step run enables the user to control current patterns and sediment transport rates for specific conditions. For this purpose a specific discharge in combination with a specific set of wave parameters must be entered. An example of the enter-procedure is given in table 10.
The computed N- and M-components of the velocities of the discharge current, the longshore current caused by obliquely breaking waves, the solitary wave current and the wave set-up current are stored in separate output files. The sediment transport rates are stored in a file as well. Plots of the separate current patterns as well as the total current pattern are made by a plot program, using the current files as input.
In figures 7-10 plots are given of the separate and total current patterns as a result of the one time-step example run from table 10. The depth file of figure 13, showing a rather long shallowness running westward from the head of the Cabedelo, is used in this example as bottom level file.
Figure 8 shows very clearly the longshore currents along the northern part of the shallowness and along the northern tip of the head of the Cabedelo, generated by waves, coming from WNW-directions.
The plot, showing the total current pattern (see figure 10) indicates very well, that the northward directed set-up current dominates along the Cabedelo coast.

8. CALIBRATION OF THE MODEL

The calibration of the hydro-morphological model can be subdivided into three phases.
Calibration phase 1 was carried out during the construction phase of the computer model. After completing, each module or sub-module was subjected to preliminary tests. This applied particularly to the current module and the sediment transport module. The current pattern due to river and tidal discharge, the longshore current pattern due to obliquely breaking waves and wave set-up differences, and the current pattern due to solitary waves were checked continually. So a first assessment of coefficients and parameters could be made. Special attention had to be paid to the river and tidal discharge current, in particular to the various ε and ω values in the expander routine and to the formula for taking into account the bottom influence (see section 3.1). The final ε and ω values are shown in file PAR (table 7).
The Byker-Battacharya transport formula, implemented in the sediment transport module, has been calibrated again, based on the sediment transport data measured at sea (see paragraph 4).

Calibration phase 2 was carried out after joining all modules and sub-modules together into one coherent mathematical model.
The purpose of the preliminary tests which have been carried out in this phase, was to check if the model was able to reproduce some basic characteristics of the morphology of the Douro bar. These basic characteristics, described in chapters 3 and 5 of volume 5, are the following:

- for the most part sedimentation and erosion occur in a flow lane along the Cabedelo coast,
- the sediment movements in the deeper offshore part of the model area are small in normal circumstances; only long waves transport some sediment from offshore banks towards the coast,
- when the tidal- and river discharge is thought to be zero, then the head of the Cabedelo is built up northwards due to wave set-up current and the river mouth will be closed at last,
- in case of low discharges combined with varying wave action, the head of the cabedelo will be built up in an easterly direction,
- in case of high discharges combined with varying wave action, the head of the Cabedelo will be built up in a westerly direction.

Many test runs have been made under specific conditions and the results have been compared with the basic morphological characteristics. With the help of the comparisons, the various current patterns and coefficients of formulae, determined in calibration phase 1, have been adjusted.
In this context special attention had to be paid to the longshore currents due to obliquely breaking waves and due to wave set-up.

Essential to the simulation of the bottom changes appeared to be the smoothing factor β in the difference schemes applied in the bed level module (see paragraph 5) and the time-scale factor (see paragraph 7).
With the help of test runs an indication of the limit values could be obtained and an assessment of the best fitted values, to be used in the first tests of calibration phase 3, was made.
In calibration phase 2 only difference scheme 1, in which a constant smoothing factor β had to be used, was implemented in the bed level module. The tests indicated that the upper limit value for β was 0.2-0.3 and that smoothing actually could be left out of account for rather short simultation periods (β =0).

In view of the computer costs, it is essential to carry out the simulations with a number of tidal cycles as low as possible and thus the time-scale factor has to be chosen as high as possible.
It appeared that a one month simulation, represented by 4 tidal cycles, still produced reasonable results. This means, that a time-scale factor of maximal 15.25 is still acceptable.

The tests have been executed with an initial bottom configuration, representing the situation of August 1910. This configuration has been chosen because of the fact that the available hydrographic chart of August 1910 is very detailed.

In phase 3, tests have been carried out in order to calibrate the model in such a way, that the model is able to simulate the seasonal cycle of the Cabedelo shape. This seasonal cycle, described in section 2.1 of this report and in section 5.3 of volume 8, can be observed in "normal" years. The seasonal cycle concerns morphological changes of the head of the Cabedelo which is very essential to the entrance of the Douro estuary. In other words, the model must be able to reproduce a tendency in accordance with the seasonal cycle of the Cabedelo shape.
The cycle as described in section 2.1 can be found on many charts, however mostly not documented in detail. An exeption form the charts in the years 1861/1862. In this period observations were made every 2-3 months and were recorded on charts. Figure 11, reproduced from figure 4 of volume 8, displays the various positions of the Cabedelo. The results of the calibration runs have been compared with this pattern from 1861/1862. The object of the calibration runs was not to reproduce the seasonal cycle from 1861/1862 exactly. This would be impossible because time series of river discharge data and wave data are not known. The discharge and wave conditions generated by the program in the simulation run undoubtedly differ from the real conditions in 1861/1862, so a pattern identical to the pattern of 1861/1862 could not be expected.
The initial bottom level file, which was used in calibration phase 2, had been adjusted in such a way that the position of the head of the Cabedelo corresponded as much as possible to the position in March 1862 (see figures 12 and 13).

Several one year simulation runs have been carried out, mostly splitted up into two parts. The first part concerned simulations of bottom changes from May to October (summer period) for the purpose to check the erosion of the westerly outgrowth of the head of the Cabedelo (developing of the type 7 Cabedelo into a type 5 Cabedelo). The second part concerned simulations of bottom changes from October to April (winter period) in order to check the developing of the type 7 Cabedelo back into a type 5 Cabedelo. The calculated bottom configurations in October have been used as initial bottom level file for the second part simulations.
The computations were made with a time scale factor of 15.25 (4 tidal cycles per month) and with input data as presented in tables 1/8.

In this calibration phase much attention had to be paid to the difference scheme in the bed level module. The first tests showed, that the use of a small smoothing factor β resulted in a rather unregular bottom configuration after a half year simulation. Better results could be expected if the smoothing factor was made dependent of the siltation rate (see paragrph 5). Therefore formula (5.8) had been implemented. In addition, two other difference schemes were added to the existing scheme (see paragraph 5).
Scheme 1 (smoothing of bed level profile) requires the application of a variable smoothing factor.
Schemes 2 and 3 (smoothing of respectively the cumulative and the instantaneous siltation layer) can be used with a constant smoothing factor.
The final results of two calibration runs are presented in this report and discussed below. In both tests an one year simulation run has been carried out; test A with difference scheme 1 and test B with difference scheme 3.

The results of test A are represented in figures 14/29. The contrast prints in figures 14/19, produced with time intervals of 2 months, show the bottom level changes.
Figures 20 and 21 respectively indicate the positions of the 0 m. and the 2 m. contours of the Cabedelo at the start (April) and at the end (October) of the summer simulation.
Figures 22 and 23 indicate respectively the positions of the 0 m contours and the 2 m contours of the Cabedelo at the start (October) and the end (April) of the winter simulation.
The contrast prints in figures 14, 15 and 16 and the contours in figures 20 and 21 show very clearly the erosion of the westerly outgrowth of the head of the Cabedelo due to wave action. The rate of erosion appears to be in agreement with the rate observed in the season of 1862. The simulated positions of the 0 m contours of the western tip of the Cabedelo outgrowth in June/August and in October correspond rather well with the observed positions in July and October 1862. The northern tip of the head of the Cabedelo is much less subjected to changes. This is also in agreement with the observations.
The results of the summer simulation indicate a gradual shift towards the west of the southern part of the Cabedelo slope. The same tendency can be observed in figure 11. This is caused by the south-easterly bound longshore current, which transports sand from the outgrowth to the southern part of the Cabedelo coast.

The results of the winter simulation, the contrast prints in figures 17/19, show the erosion of the northern tip of the head of the Cabedelo. This erosion is in accordance with the observations from October 1861 to March 1862. The tip eroded within two months after the start of the simulation. (compare figures 16 and 17). This rapid erosion was mainly caused by the high river discharge generated in December.
Figure 22 shows a slight westward extention of the Cabedelo outgrowth. The simulated extention is very small compared with the real extention created from October 1861 to March 1862.
Figures 17, 18 and 19 and figures 22 and 23 show that sand transport due to longshore currents along the outgrowth towards the southern Cabedelo coast continued in winter months. As a consequence the southern coast will move farther to the west as long as an extreme outgrowth exists. This tendency is confirmed in the evaluation of the Douro morphology described in volume 5.
Figures 24/29 present the output files produced in the simulation run, containing the computed bottom levels related to zero hydrografico.

The results of test B (smoothing of instantaneous siltation layer with difference scheme 3) are presented in figures 32/47. A constant value of 0.55 was applied for the smoothing factor β .
Initial bottom file DEP1861B is almost identical to bottom file DEP 1861; only the slope of the Cabadelo outgrowth has been made less steep. Comparison of figures 32/34 with fiugures 14/16 from test A show the influence of the type of the difference scheme. The 0-m contour of the Cabedelo outgrowth is much less subjected to erosion. On the other hand, figures 32/34 show a stronger tendency in developing sand banks in the eastern part of the outgrowth. The northern tip of the Cabedelo is not eroded away during winter simulation, but shifted into westerly direction.
A possible explanation for this may be the fact that lower discharges have been generated in simulation test B. The table in page 42 presents a review of the monthly averages of the discharges and wave parameters, which are generated in tests A and B.

Month	Test A				Test B			
	disch. (m3/s)	wave dir. (degr)	wave period (sec)	wave height (m)	disch. (m3/s)	wave dir. (degr)	wave period (sec)	wave height (m)
Mar.	438	282	10.5	1.43	375	282	10.5	1.43
June	406	293	8.5	0.63	313	293	8.5	0.63
July	125	288	9.5	0.63	125	288	9.5	0.63
Aug.	125	293	8.0	0.63	125	293	8.0	0.63
Sep.	125	293	8.5	0.90	125	293	8.5	0.90
Oct.	125	297	10.5	1.16	125	297	10.5	1.16
Nov.	906	293	10.0	0.90	625	293	9.5	0.90
Dec.	1281	293	11.5	1.78	844	293	11.5	1.78
Jan.	1156	276	11.5	1.16	781	276	11.5	1.16
Feb.	656	282	12.0	1.78	563	282	12.0	1.78
Mar.	1406	287	11.0	1.25	103	287	11.0	1.25
Apr.	563	293	9.5	0.63	500	293	9.5	0.63

Test runs, in which difference scheme 2 has been applied, were less satisfactory. The changes in the bottom configuration were simulated with an incorrect low erosion and sedimentation rate.

From the calibration tests it can be concluded that the hydro-morphological mathematical model is able to simulate the basic characteristics of the morphology of the Douro bar.
The results of tests A and B show, that the model is able to reproduce the seasonal cycle of the Cabedelo shape in a "normal" year simulation run, in which each month is represented by 4 tidal cycles.
The simulation run in which difference scheme 1 (smoothing of bed level profile) has been used (test A), simulated a seasonal cycle, which appears to correspond best with the observed cycle in the years 1861/1862. It is remarked once again that, although occuring in an extreme form in some degree, this observed cycle can be considered to represent the seasonal cycles of the Cabedelo shape in "normal" years.
An one year simulation run, in which one month is represented by 4 tidal cycles, requires approximately 5 to 6 hours computing time.

T A B L E S

MONTH	DISCHARGE [m³/s]										
	≤ 125	≤ 375	≤ 625	≤ 875	≤ 1250	≤ 1750	≤ 2250	≤ 3750	≤ 6250	≤ 8750	≤ 12500
JANUARY	3	28	48	58	73	80	84	96	98	100	100
FEBRUARY	2	23	46	60	71	78	83	97	99	100	100
MARCH	4	27	43	55	67	77	84	97	99	100	100
APRIL	9	32	53	68	81	89	94	100	100	100	100
MAI	15	50	72	84	94	98	99	100	100	100	100
JUNE	41	83	95	97	99	100	100	100	100	100	100
JULY	88	99	100	100	100	100	100	100	100	100	100
AUGUST	99	100	100	100	100	100	100	100	100	100	100
SEPTEMBER	96	100	100	100	100	100	100	100	100	100	100
OCTOBER	74	95	98	98	99	100	100	100	100	100	100
NOVEMBER	44	73	84	88	92	95	97	99	100	100	100
DECEMBER	9	50	64	71	81	87	91	98	100	100	100
	FREQUENCY										

TABLE 1: *CUMULATIVE PROBABILITY DISTRIBUTIONS FOR RIVER DISCHARGE (FILE QDISTR)*

MONTH	WAVE DIR. [DEGREES] ≤230	≤248	≤270	≤293	≤310
JANUARY	0	0	35	100	100
FEBRUARY	0	3	29	100	100
MARCH	0	0	8	100	100
APRIL	0	0	25	100	100
MAY	0	0	17	100	100
JUNE	0	0	7	100	100
JULY	0	0	8	100	100
AUGUST	1	1	2	90	100
SEPTEMBER	0	2	8	94	100
OCTOBER	2	2	8	92	100
NOVEMBER	0	0	7	94	100
DECEMBER	0	0	6	97	100
	FREQUENCY				

TABLE 2: *CUMULATIVE PROBABILITY DISTRIBUTIONS FOR THE WAVE DIRECTION (FILE WINDDIS)*

MONTH	WAVE DIRECTION	WAVE PERIOD [SEC] ≤8	≤10	≤12	≤14
JANUARY	230	0	0	0	0
	248	0	0	0	0
	270	0	17	75	100
	293	8	40	84	100
	310	0	0	0	0
FEBRUARY	230	0	0	0	0
	248	0	100	100	100
	270	22	44	66	100
	293	12	47	98	100
	310	0	0	0	0
MARCH	230	0	0	0	0
	248	0	0	0	0
	270	22	78	100	100
	293	10	61	93	100
	310	0	0	0	0
APRIL	230	0	0	0	0
	248	0	0	0	0
	270	44	77	100	100
	293	30	85	100	100
	310	0	0	0	0
MAY	230	0	0	0	0
	248	0	0	0	0
	270	11	33	89	100
	293	38	85	100	100
	310	0	0	0	0
JUNE	230	0	0	0	0
	248	0	0	0	0
	270	67	100	100	100
	293	64	95	100	100
	310	0	0	0	0
JULY	230	0	0	0	0
	248	0	0	0	0
	270	50	100	100	100
	293	75	100	100	100
	310	0	0	0	0
AUGUST	230	0	100	100	100
	248	0	0	0	0
	270	0	100	100	100
	293	73	98	98	100
	310	0	100	100	100
SEPTEMBER	230	0	0	0	0
	248	100	100	100	100
	270	20	80	90	100
	293	39	87	98	100
	310	100	100	100	100
OCTOBER	230	0	0	100	100
	248	0	0	0	0
	270	0	100	100	100
	293	7	67	100	100
	310	0	0	100	100
NOVEMBER	230	0	0	0	0
	248	0	0	0	0
	270	33	83	100	100
	293	7	73	96	100
	310	0	100	100	100
DECEMBER	230	0	0	0	0
	248	0	0	0	0
	270	0	67	100	100
	293	9	60	95	100
	310	0	100	100	100
		FREQUENCY			

TABLE 3: *CUMULATIVE PROBABILITY DISTRIBUTIONS FOR THE WAVE PERIOD (FILE PERDIS)*

MONTH	WAVE PERIOD [s]	≤0.18	≤0.53	≤0.90	≤1.25	≤1.60	≤1.95	≤2.30	≤2.65	≤3.00	≤3.55
JANUARY	8	0	33	66	100	100	100	100	100	100	100
	10	7	14	57	86	93	100	100	100	100	100
	12	8	25	38	51	76	84	92	92	96	100
	14	0	0	22	33	55	66	78	78	100	100
FEBRUARY	8	0	0	38	76	100	100	100	100	100	100
	10	0	0	24	57	81	91	96	100	100	100
	12	0	0	4	34	60	79	90	97	100	100
	14	0	0	0	25	25	25	50	75	75	100
MARCH	8	0	55	73	91	100	100	100	100	100	100
	10	2	26	55	75	85	90	94	100	100	100
	12	0	3	26	43	53	60	77	87	94	100
	14	0	0	0	0	0	17	50	50	100	100
APRIL	8	0	25	75	100	100	100	100	100	100	100
	10	11	44	77	77	83	100	100	100	100	100
	12	17	67	84	84	84	84	84	84	84	100
	14	0	0	0	0	0	0	0	0	0	0
MAI	8	0	36	63	81	100	100	100	100	100	100
	10	0	14	36	86	100	100	100	100	100	100
	12	0	0	11	22	55	78	89	100	100	100
	14	0	0	0	0	0	50	50	50	100	100
JUNE	8	10	54	95	100	100	100	100	100	100	100
	10	15	55	75	85	90	100	100	100	100	100
	12	0	33	67	67	100	100	100	100	100	100
	14	0	0	0	0	0	0	0	0	0	0
JULY	8	7	78	100	100	100	100	100	100	100	100
	10	20	80	100	100	100	100	100	100	100	100
	12	0	0	0	0	0	0	0	0	0	0
	14	0	0	0	0	0	0	0	0	0	0
AUGUST	8	17	66	95	100	100	100	100	100	100	100
	10	13	44	69	94	100	100	100	100	100	100
	12	0	0	0	0	0	0	0	0	0	0
	14	0	0	100	100	100	100	100	100	100	100
SEPTEMBER	8	0	44	85	88	97	100	100	100	100	100
	10	8	16	54	84	97	97	100	100	100	100
	12	25	25	25	38	63	88	100	100	100	100
	14	0	0	0	0	100	100	100	100	100	100
OCTOBER	8	0	50	100	100	100	100	100	100	100	100
	10	0	5	42	74	95	100	100	100	100	100
	12	25	25	33	66	83	91	100	100	100	100
	14	0	0	0	0	0	0	0	0	0	0
NOVEMBER	8	0	17	58	100	100	100	100	100	100	100
	10	5	21	37	67	87	93	100	100	100	100
	12	0	7	7	14	50	64	93	100	100	100
	14	0	0	0	0	50	100	100	100	100	100
DECEMBER	8	0	43	72	86	100	100	100	100	100	100
	10	0	18	42	69	87	96	100	100	100	100
	12	0	7	26	33	44	70	93	100	100	100
	14	0	20	20	20	20	40	60	80	100	100

Column group heading: WAVE HEIGHT [m]; values: FREQUENCY

TABLE 4: *CUMULATIVE PROBABILITY DISTRIBUTIONS FOR WAVE HEIGHT (FILE WAVDIS)*

TIDE	TIME STEP [HOURS] 1	2	3	4	5	6	7	8	9	10	11	12
SPRING-TIDE	352	332	276	200	124	68	48	68	124	200	276	332
MEAN-TIDE	306	292	253	200	147	108	94	108	147	200	253	292
NEAP-TIDE	260	252	230	200	170	148	140	148	170	200	230	252
MEAN-TIDE	306	292	253	200	147	108	94	108	147	200	253	292
	WATER LEVEL RISE [cm]											

TABLE 5: *VERTICAL TIDE-CURVES (FILE SEALEV)*

TIDE	RIVER DISCHARGE	TIME STEP [HOURS] 1	2	3	4	5	6	7	8	9	10	11	12
SPRING-TIDE	125	238	1042	1190	1537	1345	869	305	-316	-719	-1149	-1576	-1253
	375	599	1080	1446	1718	1488	1037	524	-15	-491	-827	-1163	-878
	625	684	1286	1691	1877	1655	1228	763	292	-196	-539	-747	-500
	875	802	1483	1918	2052	1839	1433	1008	584	121	-257	-392	-96
	1250	1107	1797	2232	2336	2135	1757	1379	1003	583	194	80	395
	1750	1581	2235	2657	2743	2554	2206	1871	1545	1168	796	676	968
	2250	2073	2690	3091	3167	2991	2671	2366	2076	1734	1378	1254	1508
	3750	3577	4095	4433	4485	4332	4090	3856	3634	3364	3077	2944	3116
	6250	6105	6503	6754	6768	6632	6467	6317	6177	6005	5815	5681	5777
	8750	8630	8947	9143	9144	9013	8892	8789	8701	8585	8447	8326	8378
	12500	12411	12645	12786	12778	12676	12581	12520	12472	12403	12295	12202	12230
MEAN-TIDE	125	251	708	898	1148	1033	692	258	-209	-537	-897	-1107	-732
	375	475	856	1142	1328	1195	878	483	73	-274	-517	-698	-440
	625	572	1061	1380	1507	1380	1084	727	359	17	-218	-308	-67
	875	770	1268	1595	1702	1581	1303	975	639	313	75	19	260
	1250	1131	1599	1915	2011	1899	1642	1349	1046	744	510	464	690
	1750	1630	2059	2355	2441	2339	2106	1845	1577	1303	1077	1031	1236
	2250	2127	2528	2808	2886	2793	2583	2343	2100	1849	1631	1585	1764
	3750	3632	3965	4197	4256	4176	4020	3836	3647	3444	3275	3215	3339
	6250	6158	6404	6571	6602	6533	6420	6305	6184	6058	5938	5875	5952
	8750	8676	8868	8997	9016	8948	8866	8785	8704	8621	8530	8473	8519
	12500	12446	12585	12677	12686	12634	12571	12519	12473	12417	12349	12306	12335
NEAP-TIDE	125	183	393	603	738	671	477	212	-80	-334	-571	-554	-240
	375	352	631	830	924	865	686	443	191	-26	-170	-210	-20
	625	558	847	1050	1130	1074	908	689	459	260	132	118	273
	875	804	1075	1271	1346	1294	1140	937	724	536	414	408	551
	1250	1180	1428	1611	1681	1636	1494	1311	1117	942	826	822	952
	1750	1683	1908	2076	2139	2100	1975	1809	1635	1474	1363	1361	1476
	2250	2182	2392	2548	2607	2573	2462	2310	2149	1999	1896	1890	1993
	3750	3686	3857	3985	4032	4001	3919	3805	3678	3559	3479	3462	3536
	6250	6203	6324	6414	6444	6417	6361	6286	6204	6126	6070	6050	6099
	8750	8713	8806	8874	8895	8871	8825	8772	8719	8666	8620	8603	8635
	12500	12474	12540	12588	12601	12583	12550	12514	12479	12443	12410	12398	12419
MEAN-TIDE	125	251	708	898	1148	1033	692	258	-209	-537	-897	-1107	-732
	375	475	856	1142	1328	1195	878	483	73	-274	-517	-698	-440
	625	572	1061	1380	1507	1380	1084	727	359	17	-218	-308	-67
	875	770	1268	1595	1702	1581	1303	975	639	313	75	19	260
	1250	1131	1599	1915	2011	1899	1642	1349	1046	744	510	464	690
	1750	1630	2059	2355	2441	2339	2106	1845	1577	1303	1077	1031	1236
	2250	2127	2528	2808	2886	2793	2583	2343	2100	1849	1631	1585	1764
	3760	3632	3965	4197	4256	4176	4020	3836	3647	3444	3275	3215	3339
	6250	6158	6404	6571	6602	6533	6420	6305	6184	6058	5938	5875	5952
	8750	8676	8868	8997	9016	8948	8866	8785	8704	8621	8530	8473	8519
	12500	12446	12585	12677	12686	12634	12571	12519	12473	12417	12349	12306	12335
		DISCHARGE [m^3/s]											

TABLE 6: *DISCHARGE CURVES AT THE EAST BOUNDARY OF THE MODEL (FILE DISCH)*

1	WAVE DIRECTIONS [DEGREES]	230 248 270 293 310
2	WAVE PERIODS [s]	8 10 12 14
3	WAVE HEIGHTS [m]	.18 .53 .9 1.25 1.60 1.95 2.3 2.65 3.0 3.55
4	RIVER DISCHARGES [m^3/s]	125 375 625 875 1250 1750 2250 3750 6250 8750 12500

TABLE 7: *CLASS-ARRANGEMENTS OF STOCHASTIC INPUT DATA (FILE PAR)*

1	30 40 50	NMAX MMAX MESH
2	5 9	CANTAREIRA
3	6 26	FELGUEIRAS
4	13	N-COORD. PEDRAS DO LIMA
5	.5 .8 .3	EPS,EPSR,EPSZ
6	15 5 20	OMEGA,OMEGAR,OMEGAZ (DEGREES)
7	.1	BED ROUGHNESS (M)
8	.001 .0015	D50,D90 (M)
9	.6	BREAKING INDEX
10	8.	LEVEL OF ROCK LAYER (M)
11	.55 200.	BETAMAX=smoothing factor; De=a constant

TABLE 8: *REMAINDER OF INPUT DATA (FILE INFO)*

```
:RUN DSIMDRO

IS THIS RUN AN ONE TIME-STEP RUN
  OR A LONGTERM SIMULATION?
      one time-step run       =1
      long term simulation    =2
ENTER your option ?2

IS THIS RUN A RESTART IN A LONG TERM SIMULATION?
(YES=1;NO=0) ?1

ENTER date (MMDDHH) ?070510

ENTER job name (max. 10 char) ?J14Z61S6

ENTER period already simulated
      number of YEARS= ?0

      number of MONTHS= ?10

      number of HOURS (max 732)= ?0

CHOICE OF TIDE TO START THE SIMULATION
     SPRING TIDE =1
     MEAN TIDE   =2 or 4
     NEAP TIDE   =3
ENTER tide-number ?1

PERIOD OF SIMULATION
      if more than 1 year ENTER 1
      if less than 1 year ENTER 2
ENTER your option ?2

ENTER period of simulation (MONTHS) ?6

ENTER time-scale factor ?15.250

TIME INTERVAL FOR PRINTING NEW BOTTOM
      if time interval in YEARS---->ENTER 1
      if time interval in MONTHS--->ENTER 2
ENTER your option ?2

ENTER time interval (MONTHS) ?1

NAME DEPTHFILE ?DEP1861B
```

TABLE 9: *EXAMPLE OF RESTART-PROCEDURE FOR A LONG TERM SIMULATION.*

```
:RUN DSIMDRO

IS THIS RUN AN ONE TIME-STEP RUN
  OR A LONGTERM SIMULATION?
      one time-step run       =1
      long term simulation    =2
ENTER your option ?1

ENTER job name (max. 10 char.) ?EXAMPLE

ENTER river discharge [cu. m/sec] ?875.

ENTER tidal water level rise [cm] ?170.

ENTER wave direction [degrees] ?293.

ENTER wave period [seconds] ?10.

ENTER wave height [m] ?0.90

ENTER time-scale factor ?1.

STORE current velocities in files?
(YES=1;NO=2) ?1

NAME DEPTHFILE ?DEP1861B
```

TABLE 10: *EXAMPLE OF STARTING AN ONE TIME-STEP SIMULATION*

F I G U R E S

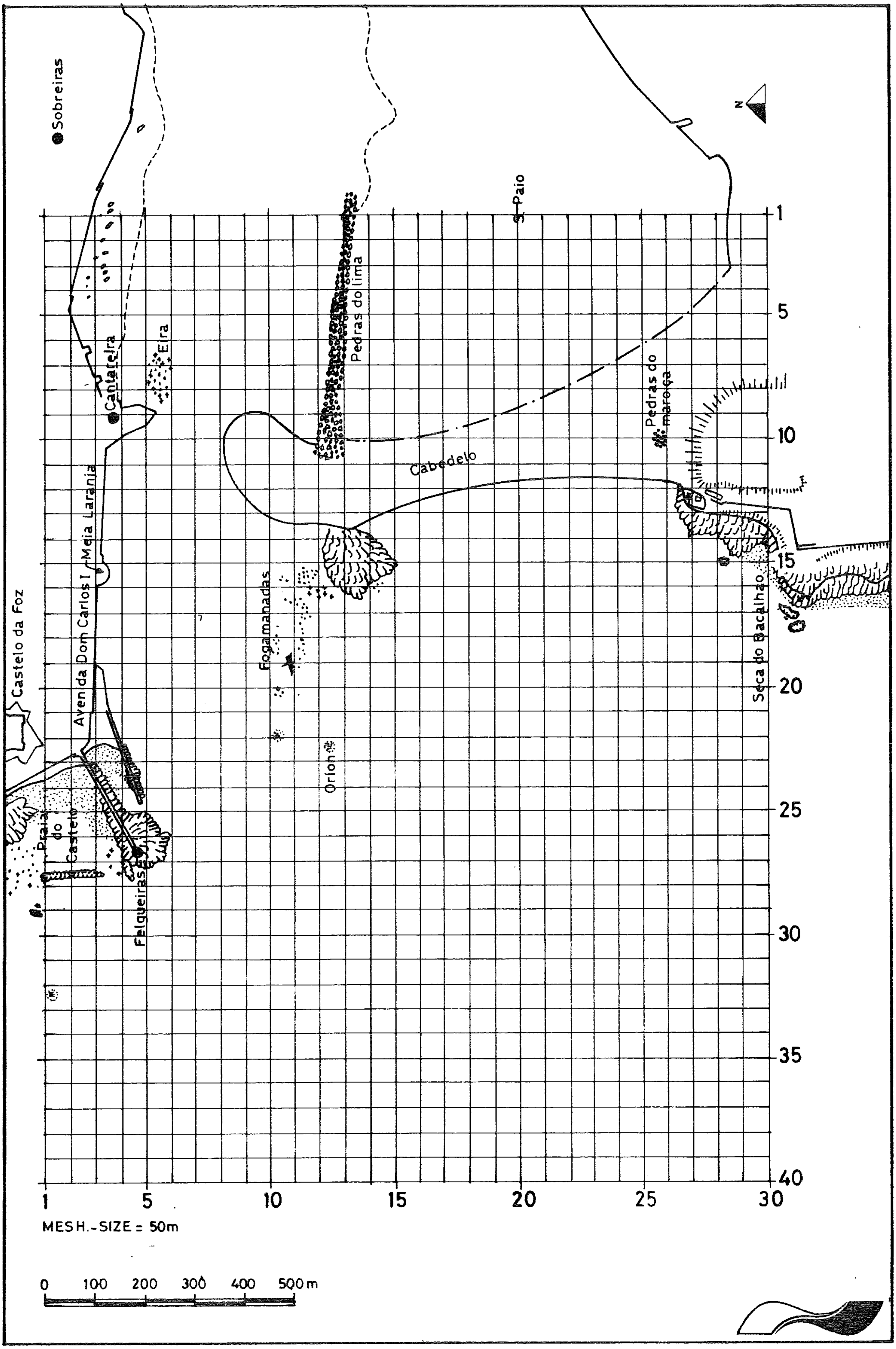


FIGURE 1: *THE MODEL AREA; LOCATION OF THE GRID*

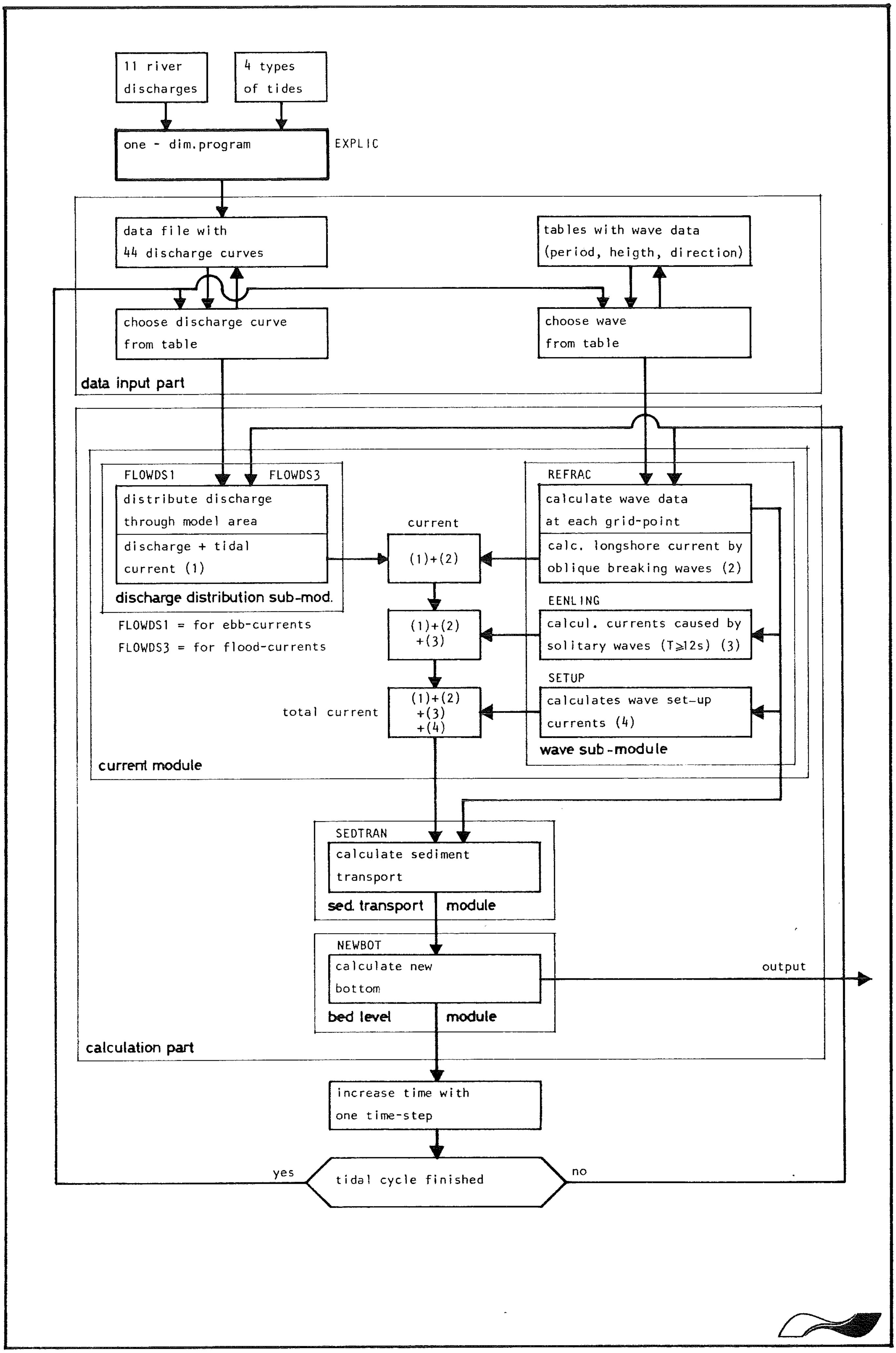
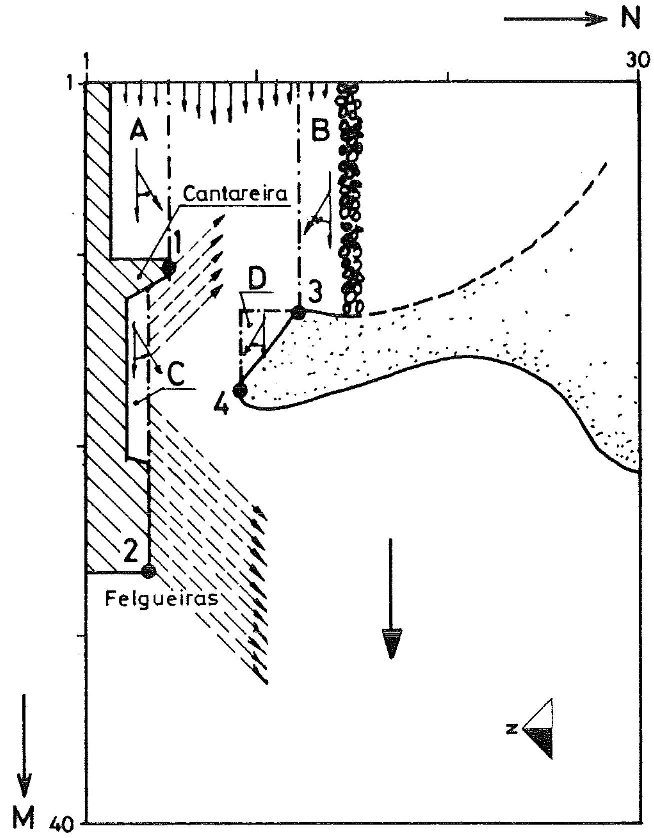
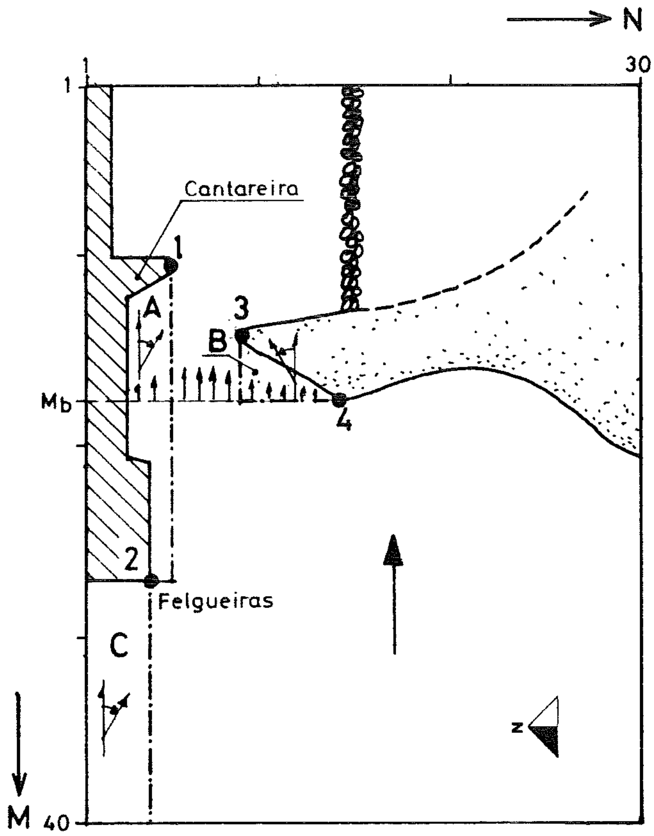


FIGURE 2: *FLOW-CHART OF THE DOURO HYDROMORPHOLOGICAL MODEL.*



A: OUT-GOING FLOW (EBB-TIDE)



B: IN-GOING FLOW (FLOOD-TIDE)

FIGURE 3: *START PROCEDURE FOR RIVER DISCHARGE DISTRIBUTION.*

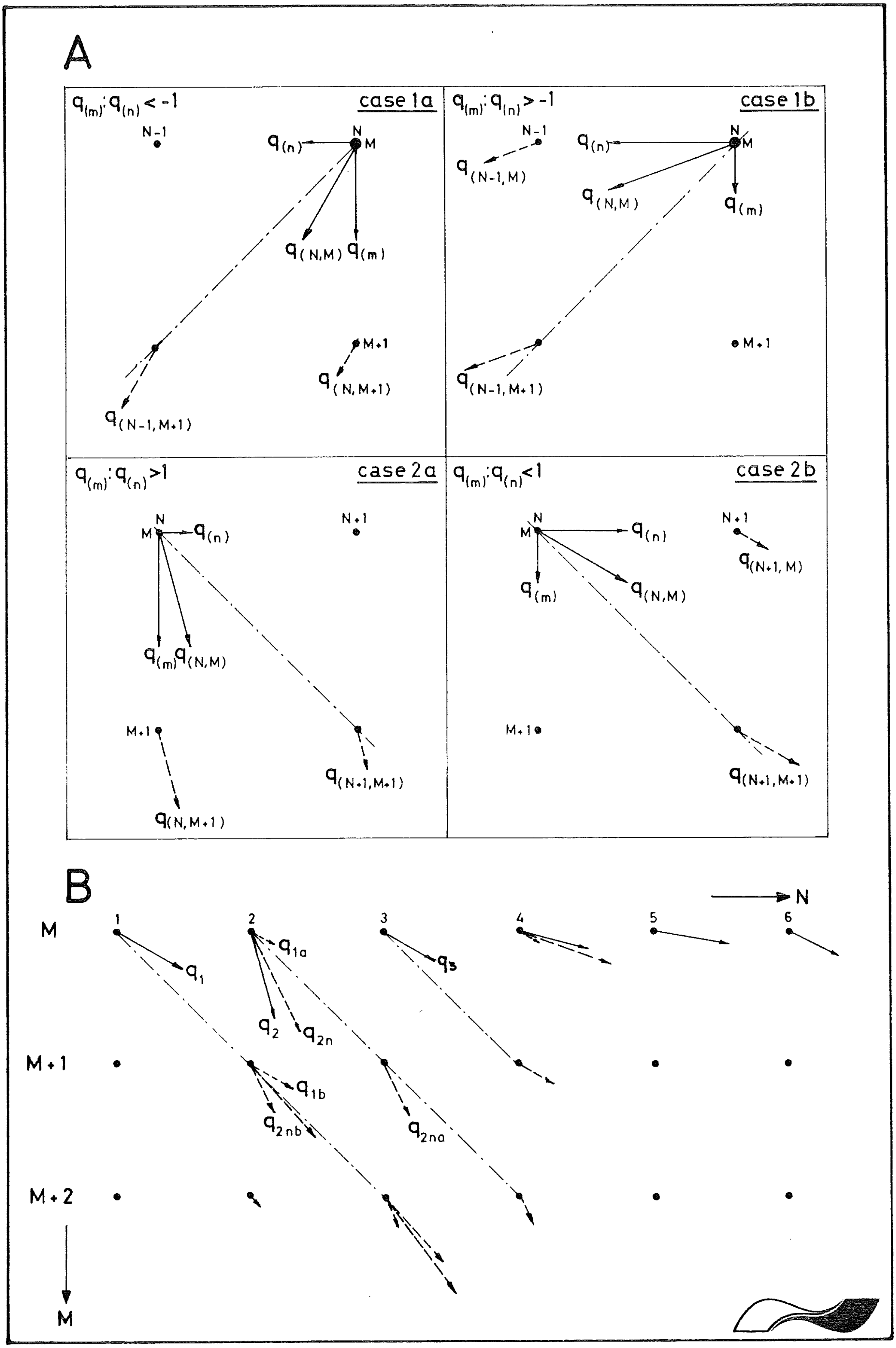


FIGURE 4: *DISTRIBUTION PROCEDURE OF RIVER DISCHARGE.*

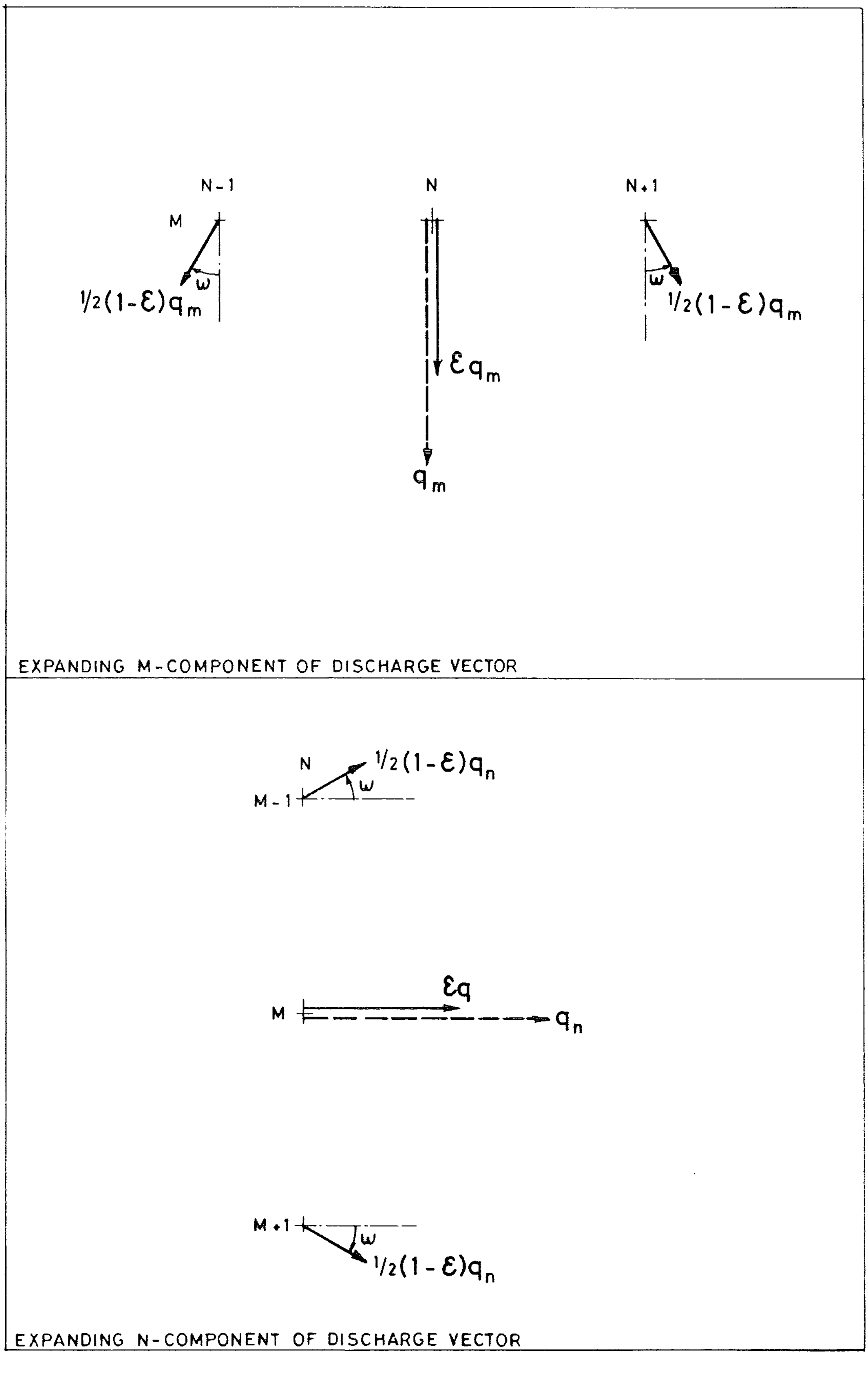


FIGURE 5: *EXPANDING PROCEDURE FOR DISCHARGE COMPONENTS.*

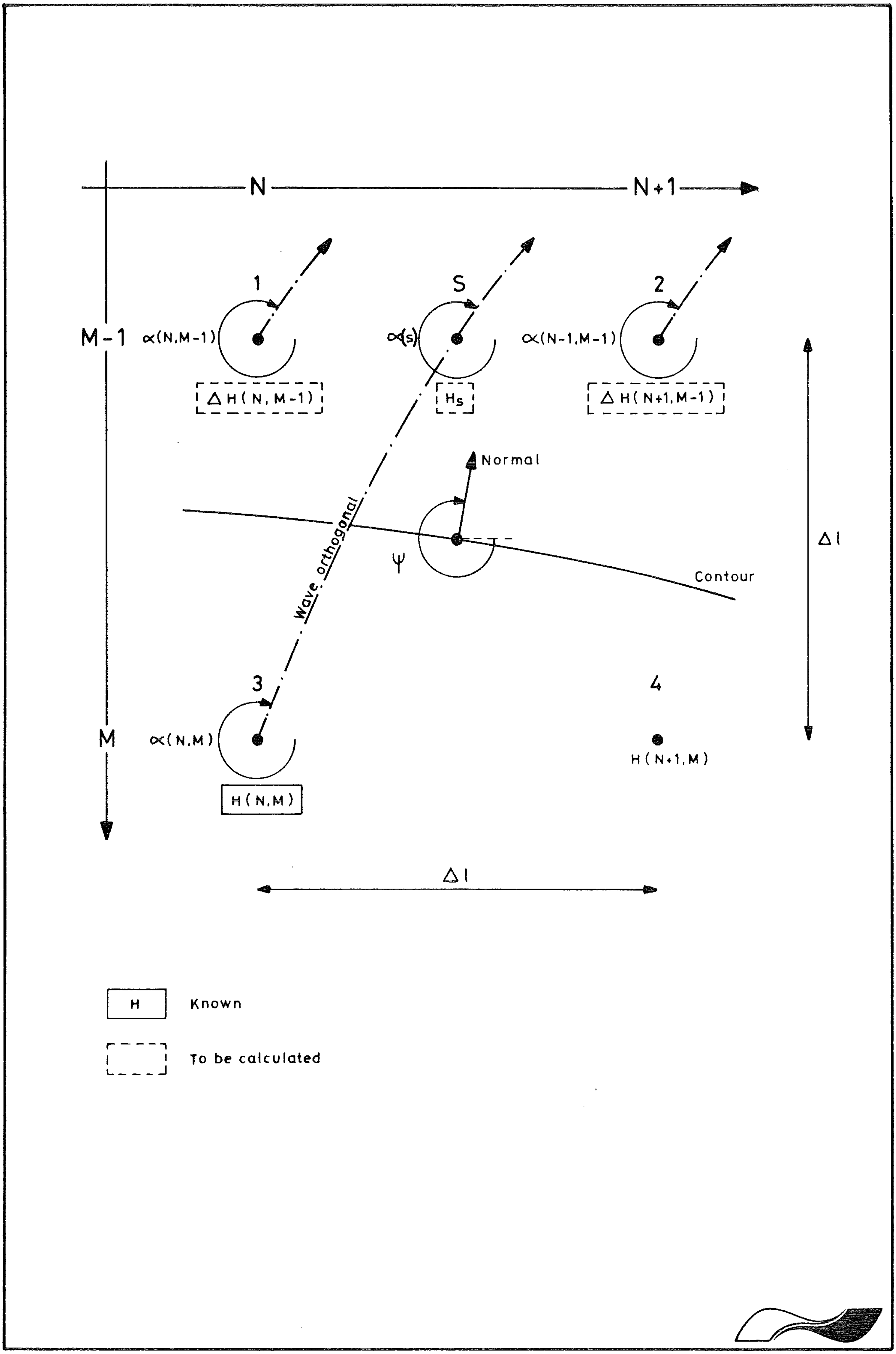


FIGURE 6: *WAVE PENETRATION CALCULATION.*

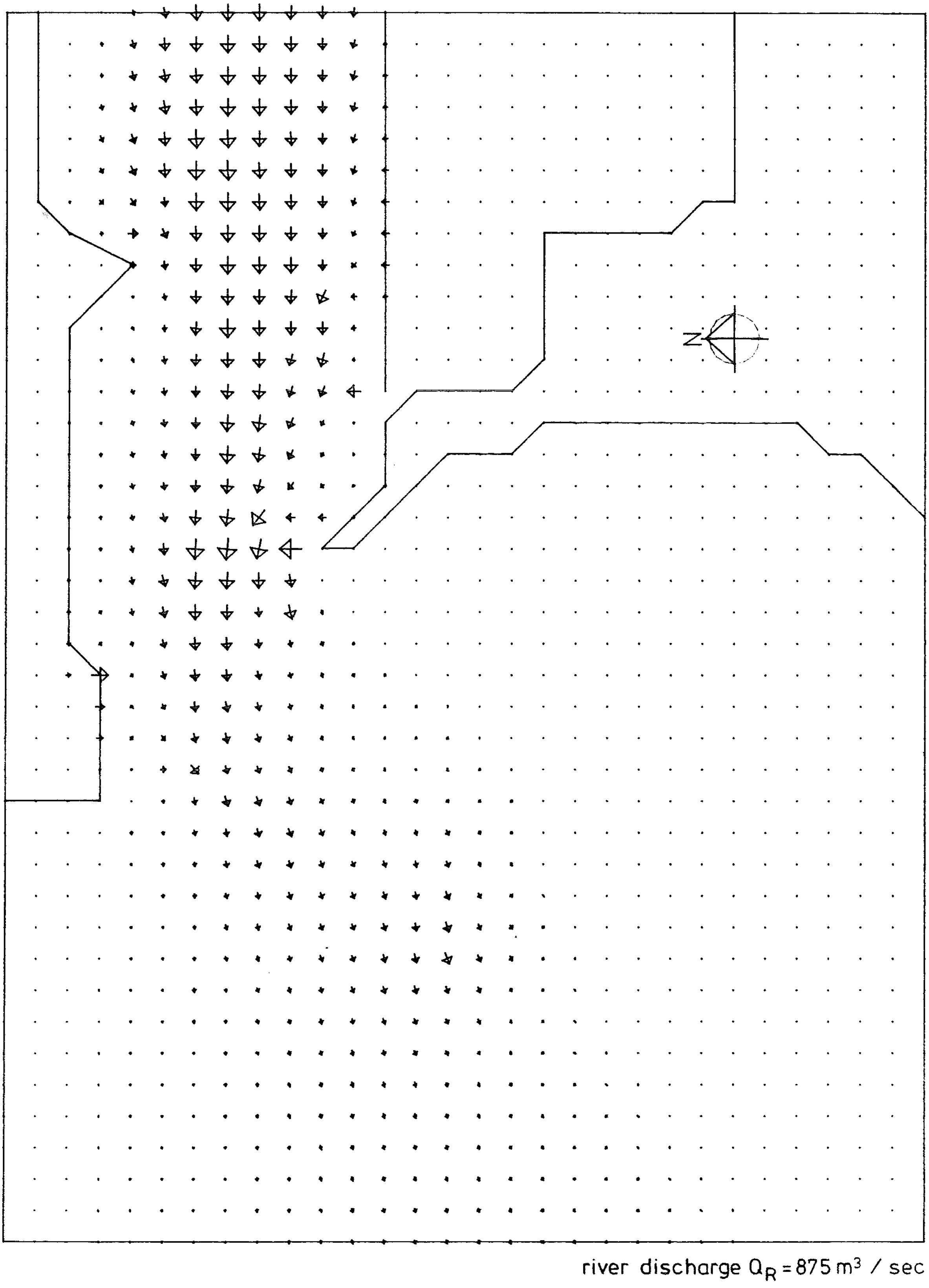


FIGURE 7: *EXAMPLE OF CURRENT PATTERN DUE TO RIVER DISCHARGE.*

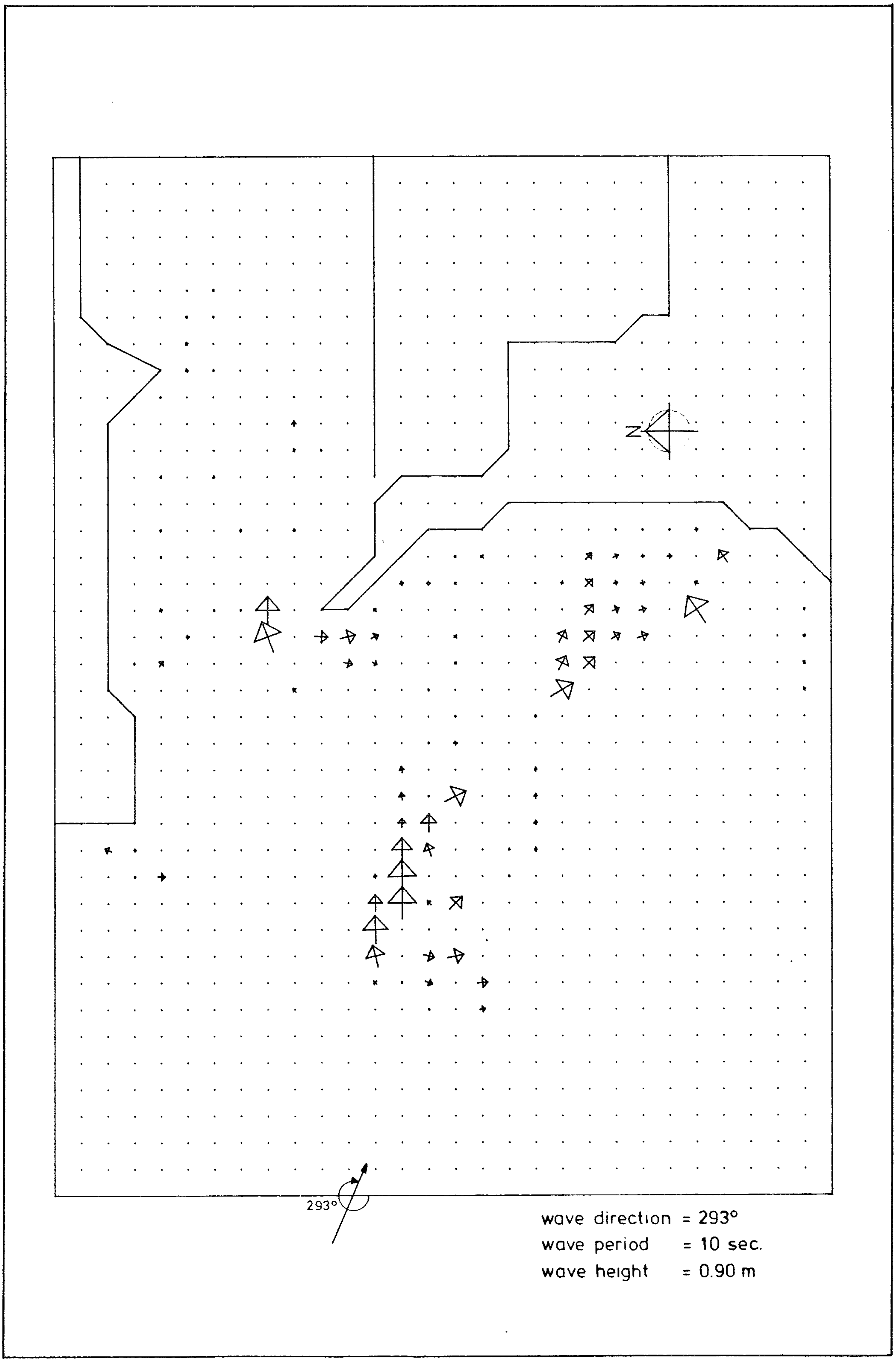


FIGURE 8: *EXAMPLE OF LONGSHORE CURRENT PATTERN DUE TO OBLIQUELY BREAKING WAVES.*

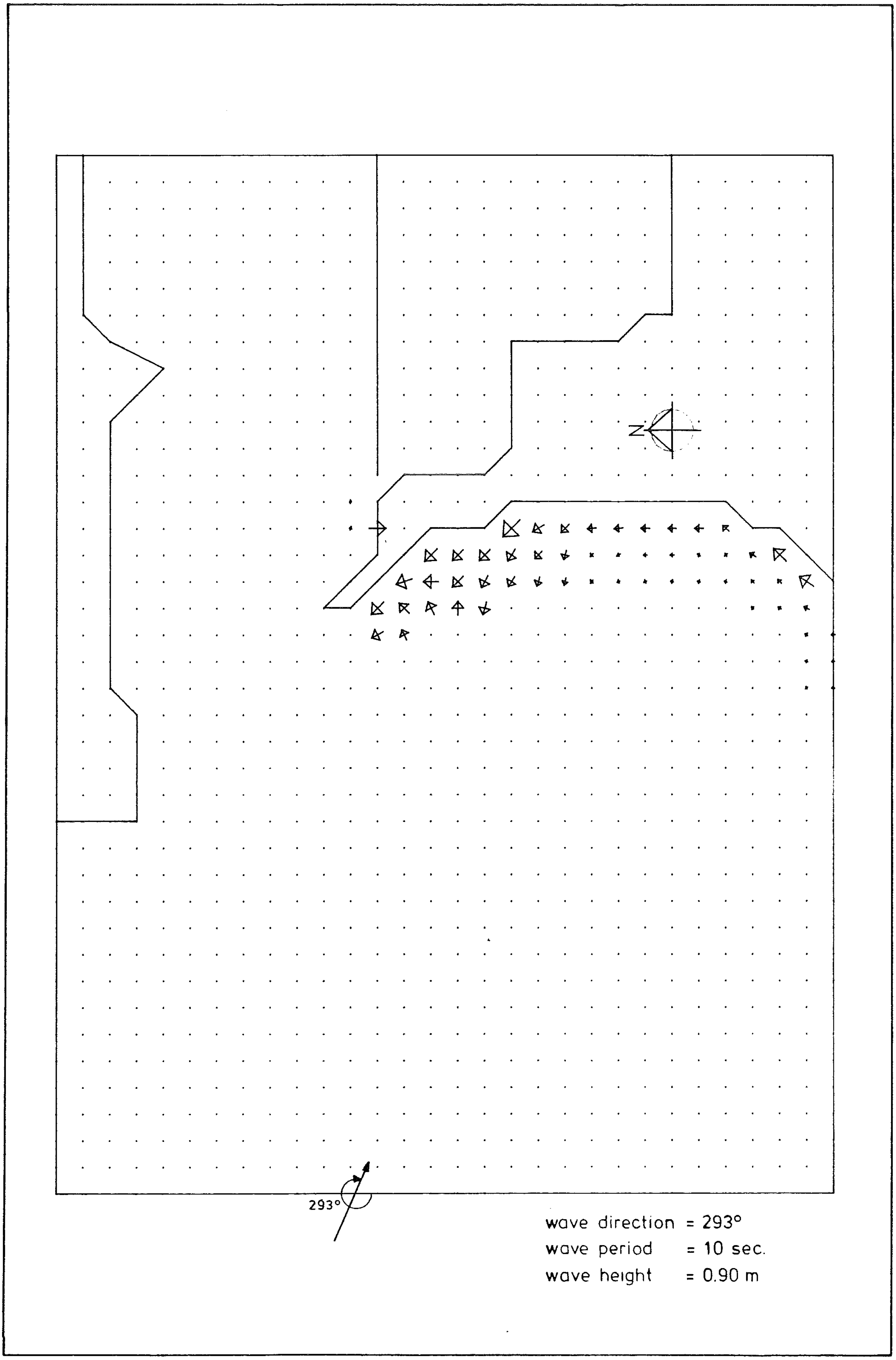


FIGURE 9: *EXAMPLE OF SET-UP CURRENT DUE TO WAVE SET-UP DIFFERENCES.*

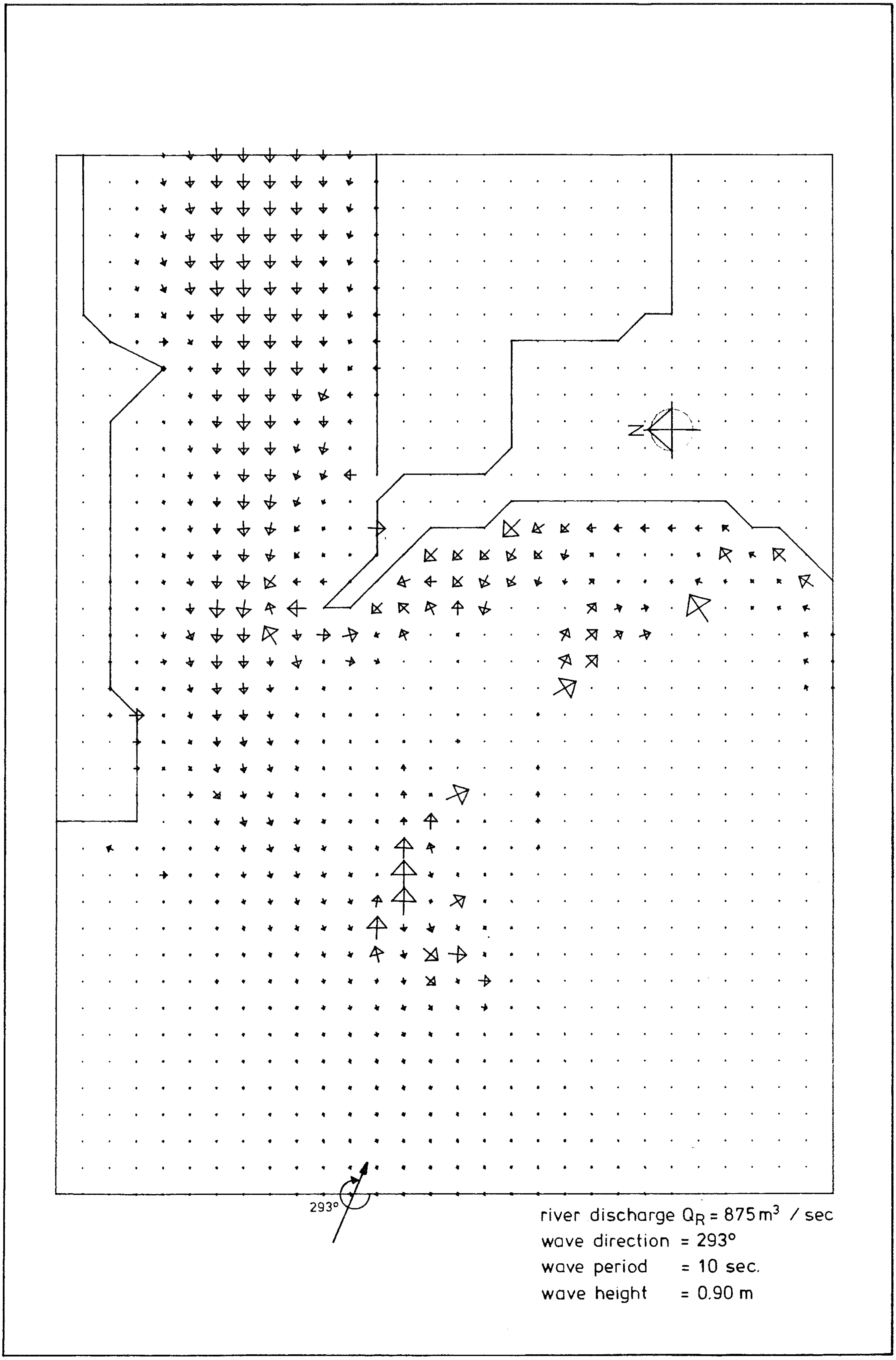


FIGURE 10: *EXAMPLE OF TOTAL CURRENT PATTERN.*

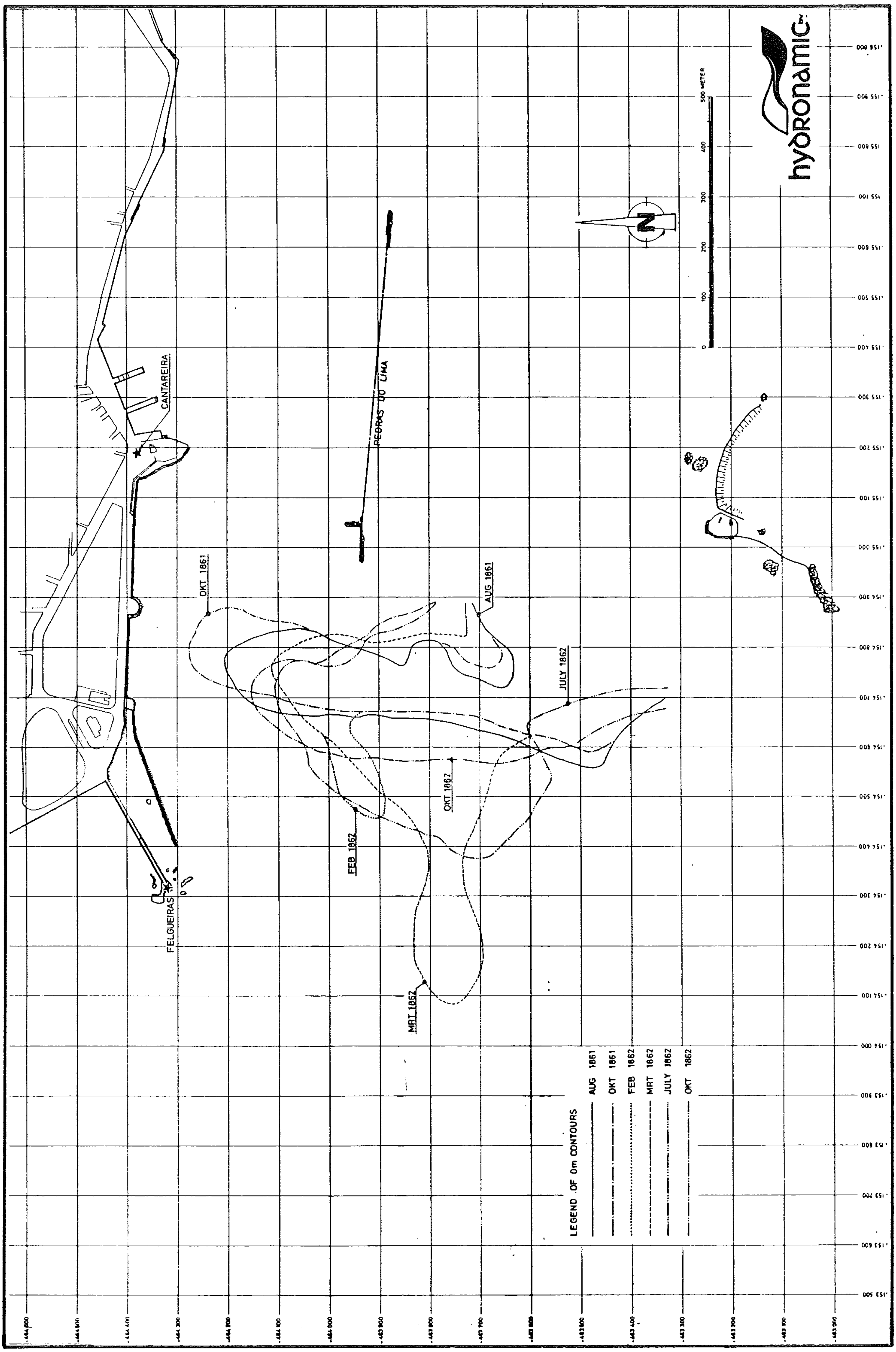


FIGURE 11: *POSITION OF THE CABEDELO IN 1861 / 1862.*

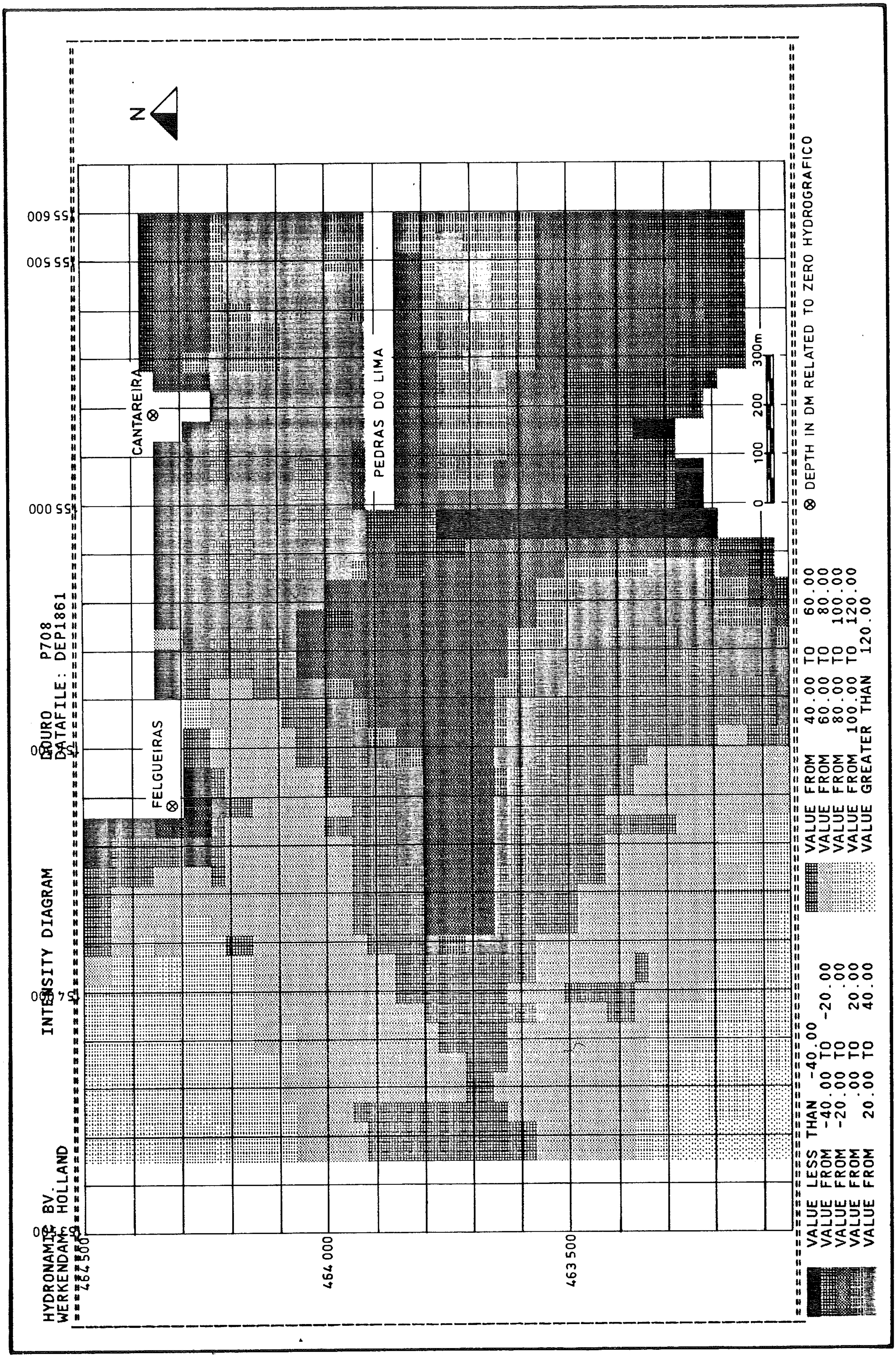


FIGURE 12: *INITIAL BOTTOM LEVEL CONFIGURATION DEP 1861; CALIBRATION PHASE 3 (TEST A)*

DEP1861 FRI, JUL 13, 1984, 10:37 AM

DEPDOUR INITIAL DEPTHMATRIX FROM MARCH 1861 DEPTH IN DM

SUB-COLUMN 1
N=1-10

1	-99	-99	-27	-17	-5	12	30	33	33	23
	-99	-99	-25	-16	-5	9	27	30	31	22
	-99	-99	-23	-15	-3	9	24	26	27	22
	-99	-99	-21	-12	-1	9	20	25	27	24
	-99	-99	-21	-11	-3	7	14	23	27	27
	-99	-99	-23	-10	-3	8	12	17	26	28
	-99	-99	-26	-10	0	20	15	19	24	27
	-99	-99	-99	-9	-3	32	21	21	23	30
	-99	-99	-99	-99	-99	38	26	22	24	27
10	-99	-99	-99	-99	31	43	28	24	29	33
	-99	-99	-99	25	31	48	28	20	33	38
	-99	-99	-99	25	31	40	31	29	33	41
	-99	-99	-99	25	30	35	39	32	35	47
	-99	-99	-99	29	28	38	45	31	33	43
	-99	-99	-99	25	23	44	45	31	38	35
	-99	-99	-99	25	25	43	45	45	42	40
	-99	-99	-99	27	30	38	37	37	35	20
	-99	-99	-99	38	34	39	30	29	20	-20
	-99	-99	-99	60	30	41	45	40	20	-5
20	-99	-99	-99	35	41	51	48	47	44	-2
	-99	-99	-99	38	54	65	60	54	48	30
	-99	-99	-99	-99	81	75	65	60	54	45
	-99	-99	-99	-99	55	80	70	65	60	52
	-99	-99	-99	-99	40	73	70	67	60	55
	-99	-99	-99	-99	28	50	64	68	62	60
	-99	-99	-99	-99	-2	38	57	64	64	63
	20	23	21	-2	-2	42	62	75	63	61
	29	46	41	40	38	46	78	64	62	60
	49	52	51	61	64	58	68	61	62	61
30	57	62	61	61	73	73	70	64	63	62
	56	64	68	68	82	75	77	70	66	64
	58	60	80	75	86	80	45	74	68	66
	78	81	91	101	90	84	82	76	65	68
	88	90	91	95	93	88	82	78	75	65
	94	95	95	91	89	92	84	77	78	70
	92	94	98	96	90	94	88	77	80	69
	96	95	98	90	89	91	90	80	80	72
	100	97	96	92	97	94	93	84	77	75
	102	100	99	97	103	97	93	87	81	74
40	102	103	100	99	98	100	96	88	83	75

SUB-COLUMN 2
N=11-20

1	16	7	-99	13	1	8	7	4	1	-20
	18	11	-99	5	1	24	13	7	2	-20
	18	12	-99	-1	1	22	20	11	3	-20
	23	15	-99	-2	1	21	29	13	2	-20
	27	19	-99	-3	1	19	20	10	0	-20
	26	20	-99	-4	1	15	18	9	0	-20
	27	27	-99	-5	-1	9	20	12	8	-20
	32	36	-99	-6	-2	7	16	20	-20	-20
	38	28	-99	-7	-3	5	14	12	-20	-20
10	33	22	-99	-8	-4	6	8	6	-20	-20
	32	-17	-99	-9	-5	5	5	2	-20	-20
	30	-18	-99	-10	-6	2	0	-1	-20	-20
	32	-20	-99	-20	-20	-20	-20	-20	-20	-20
	40	33	-23	-25	-30	-70	-70	-70	-70	-70
	34	30	-10	-30	-30	-25	-17	-12	-8	-7
	30	10	-15	-32	-10	-9	-9	-8	-6	-4
	-10	-20	-20	-10	-9	-9	-8	-7	-4	0
	-30	-20	-10	-8	-8	-8	-8	-5	-2	0
	-10	-10	-8	-6	-8	-8	-8	-3	0	10
20	-4	-5	-5	-5	-7	-8	-7	-2	5	20
	8	-2	-3	-4	-7	-7	-7	0	10	30
	30	10	-1	-3	-6	-6	-6	10	30	50
	50	30	10	-2	-5	-5	-5	10	30	50
	54	50	30	10	-4	-4	-4	20	38	52
	57	54	50	20	-4	-4	-4	17	50	52
	60	55	51	30	-1	-3	-1	30	50	53
	59	55	52	30	-1	-3	-1	30	51	53
	60	57	53	30	-1	-2	-1	30	51	53
	61	57	53	43	-1	-2	-1	40	51	55
30	61	58	53	49	-1	-1	-1	43	52	57
	63	59	54	50	-1	-1	-1	46	52	57
	63	60	57	52	26	10	26	30	53	60
	65	62	60	55	50	48	50	52	57	60
	68	64	61	56	53	52	53	55	60	62
	69	65	62	60	56	54	55	59	57	60
	70	66	64	62	60	59	57	57	60	63
	70	67	66	64	62	60	58	59	61	65
	65	70	68	66	63	61	57	61	64	67
	70	59	54	55	50	48	52	56	62	66
40	76	65	57	54	49	46	48	50	59	64

SUB-COLUMN 3
N=21-30

1	-12	-15	-17	-19	-22	-25	-27	-30	-99	-99
	-11	-13	-16	-18	-20	-23	-26	-29	-99	-99
	-9	-12	-14	-16	-18	-21	-25	-29	-99	-99
	-6	-9	-12	-14	-18	-21	-25	-29	-99	-99
	-5	-7	-10	-14	-17	-20	-25	-29	-99	-99
	-5	-8	-9	-14	-18	-21	-25	-29	-99	-99
	-8	-15	-18	-17	-19	-23	-27	-30	-99	-99
	-40	-40	-40	-40	-40	-40	-40	-99	-99	-99
	-40	-40	-40	-40	-40	-40	-99	-99	-99	-99
10	-40	-40	-40	-70	-70	-99	-99	-99	-99	-99
	-40	-40	-40	-40	-40	-99	-99	-99	-99	-99
	-40	-40	-40	-40	-40	-60	-99	-99	-99	-99
	-40	-40	-40	-40	-40	-50	-99	-99	-99	-99
	-70	-70	-70	-70	-70	-70	-50	-99	-99	-99
	-4	-3	-3	-3	-3	-3	-20	-35	-40	-99
	10	14	18	18	20	21	0	-10	-35	-99
	14	22	24	25	24	21	17	7	-10	-30
	22	30	32	35	32	28	25	17	5	-5
	28	37	42	44	43	29	31	25	20	14
20	38	45	48	50	50	48	45	35	26	24
	45	51	52	52	52	52	51	45	40	31
	51	52	53	54	54	53	51	50	45	35
	52	53	53	56	55	53	55	60	54	50
	53	54	56	57	60	63	67	65	64	60
	53	54	58	60	60	64	70	71	71	71
	53	56	60	61	61	65	70	73	73	73
	53	56	58	54	56	62	68	78	82	82
	53	56	60	63	61	64	68	82	83	84
	55	59	63	65	65	64	74	79	84	86
30	58	62	65	67	67	66	75	84	92	93
	59	62	64	65	65	70	77	88	93	100
	62	63	64	64	64	65	77	88	93	103
	61	62	62	59	72	68	77	87	98	107
	56	56	55	64	77	76	84	90	102	107
	61	61	57	70	85	85	90	96	112	105
	65	70	64	71	94	95	96	105	116	113
	69	72	68	70	99	114	111	109	117	118
	70	71	71	71	100	122	113	114	121	124
	70	70	70	78	100	125	116	117	127	126
40	70	71	72	83	101	122	124	127	132	126

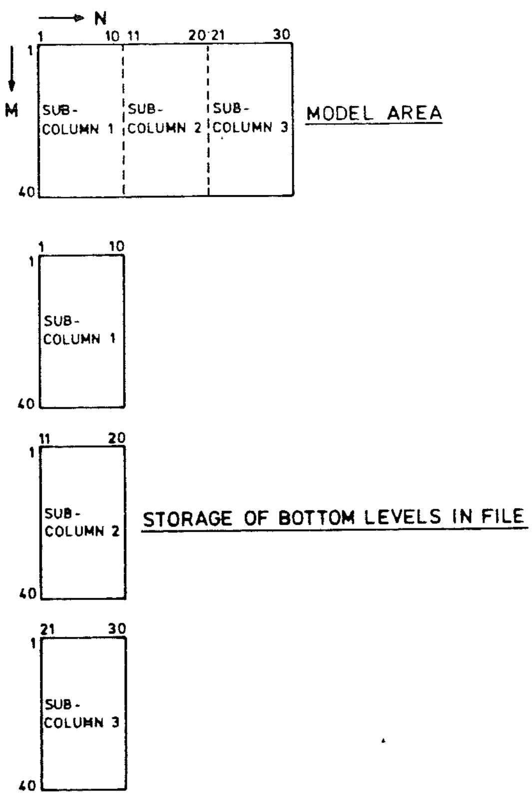


FIGURE 13: *INITIAL BOTTOM LEVEL FILE DEP 1861; CALIBRATION PHASE 3 (TEST A)*

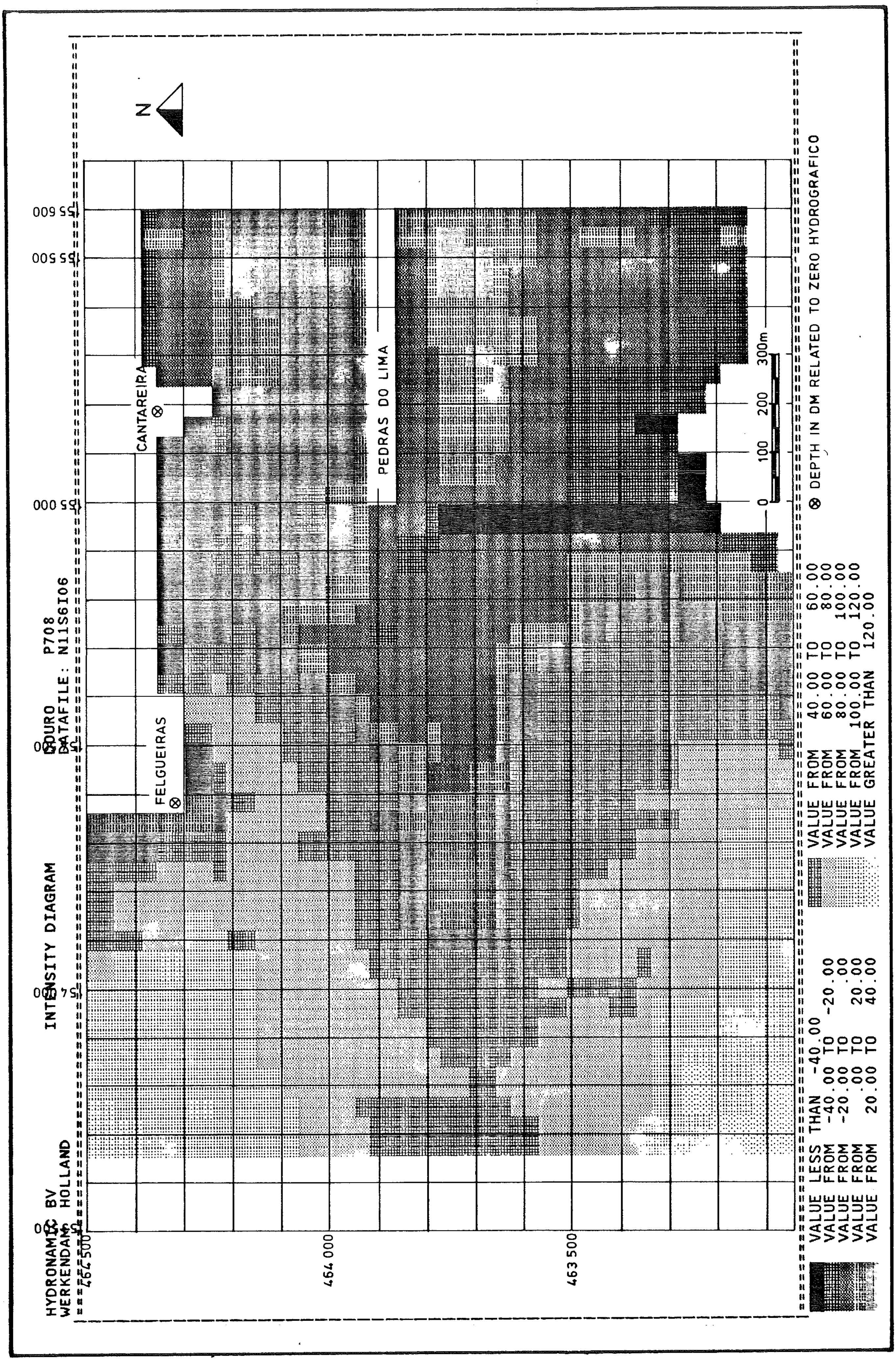


FIGURE 14: *BOTTOM LEVEL CONFIGURATION IN JUNE; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

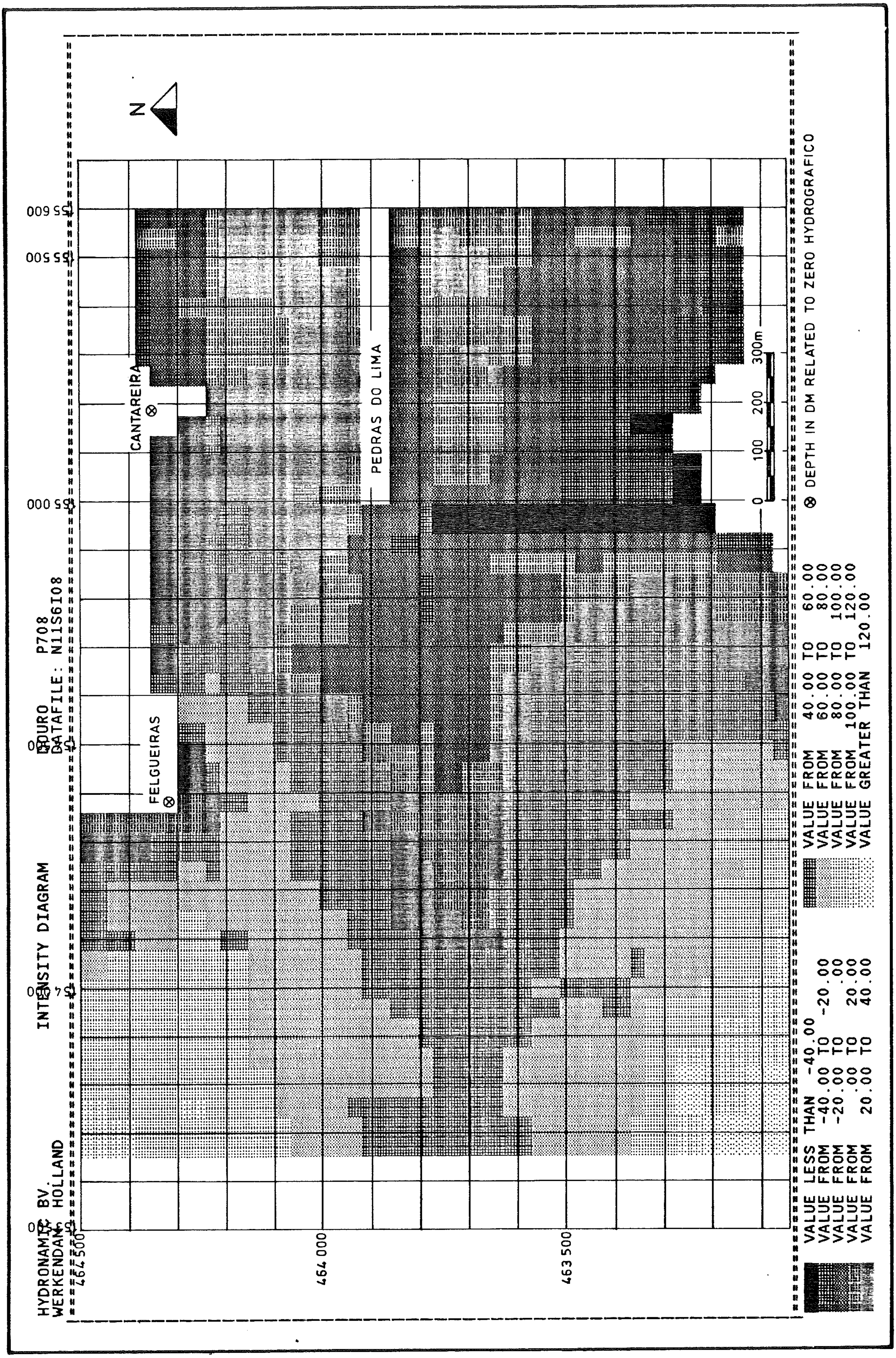


FIGURE 15: *BOTTOM LEVEL CONFIGURATION IN AUGUST; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

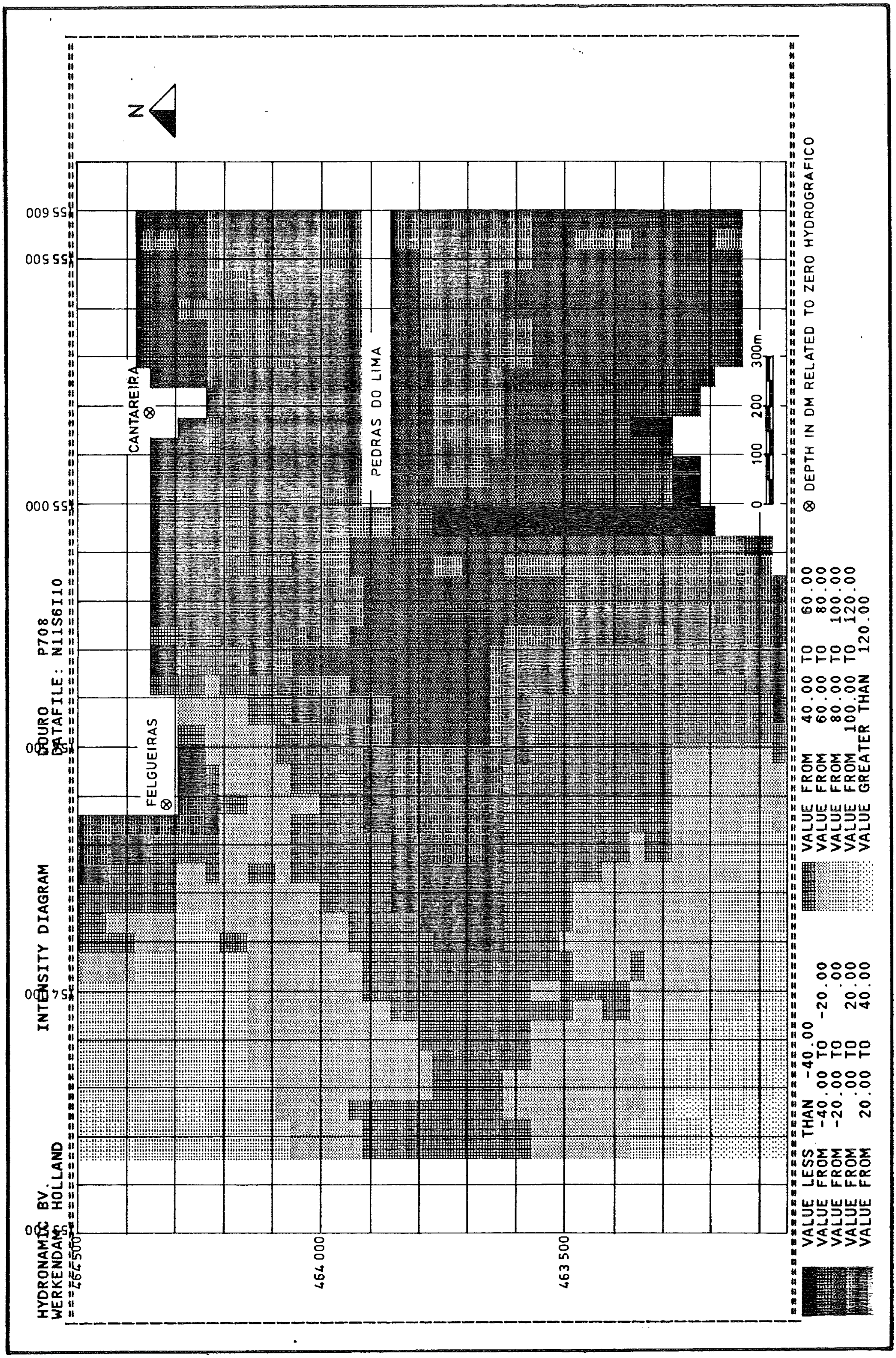


FIGURE 16: *BOTTOM LEVEL CONFIGURATION IN OCTOBER; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

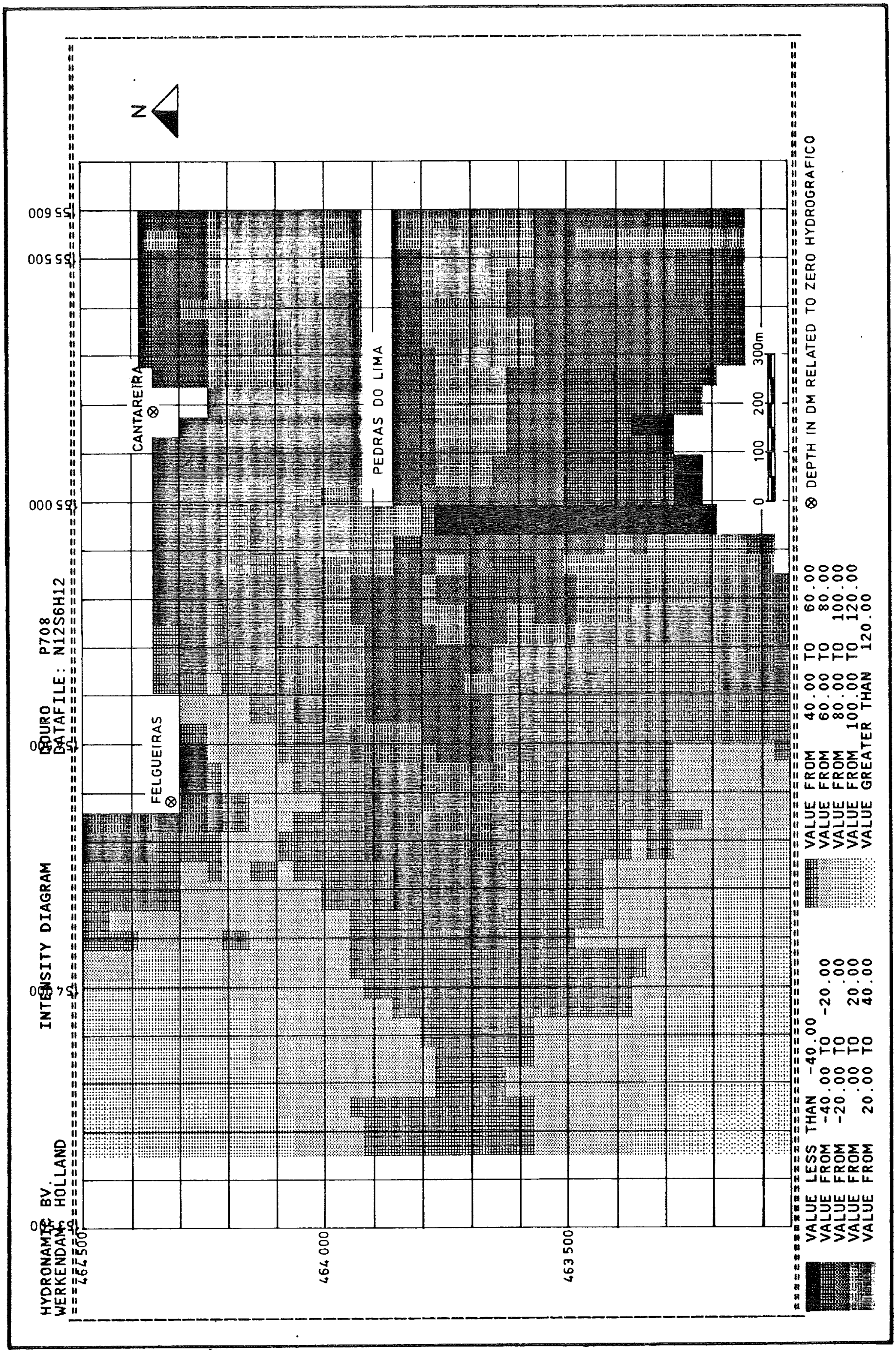


FIGURE 17: *BOTTOM LEVEL CONFIGURATION IN DECEMBER; SMOOTHING OF BED LEVEL PROFILE (TEST A).*

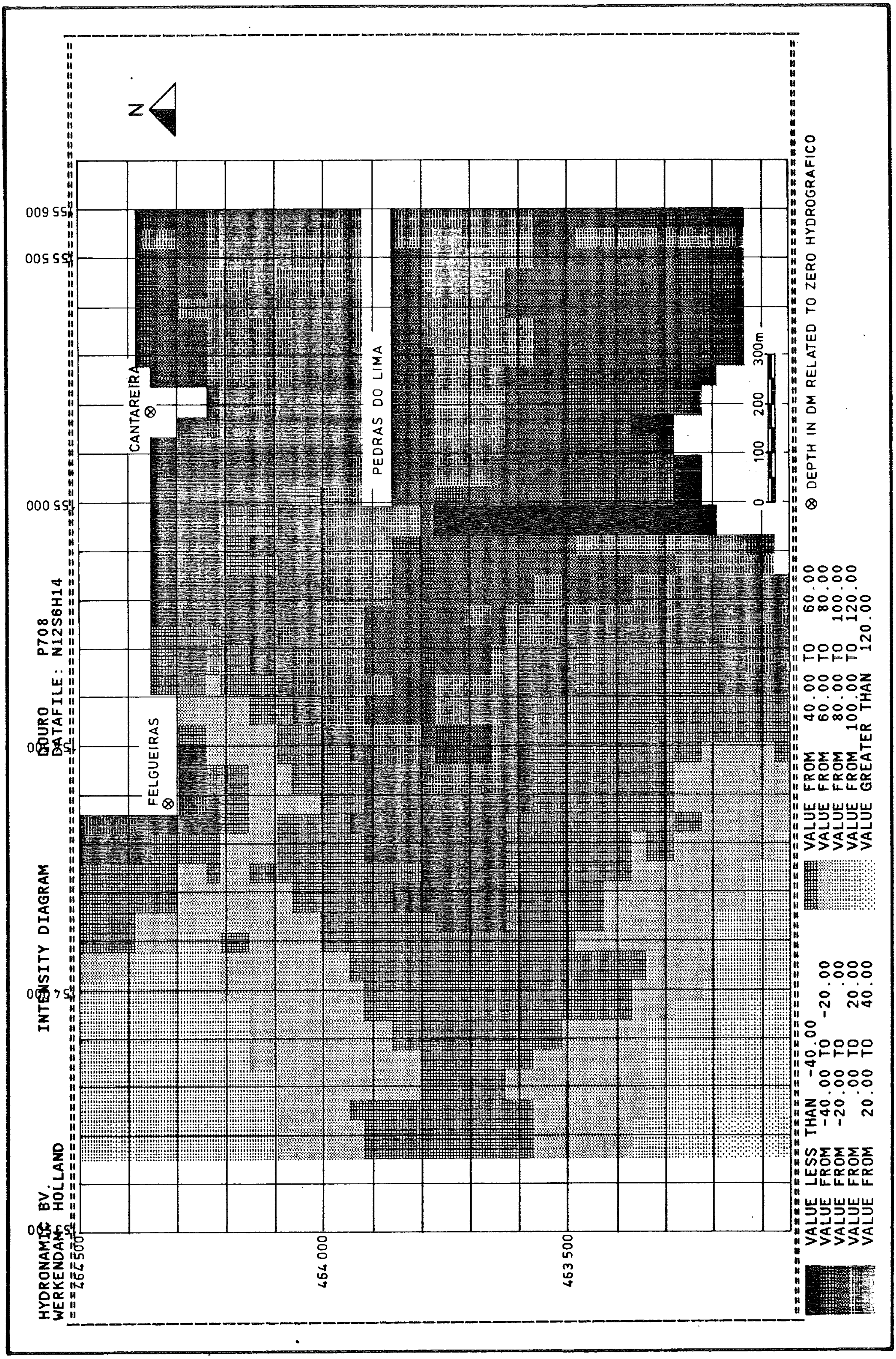


FIGURE 18: *BOTTOM LEVEL CONFIGURATION IN FEBRUARY; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

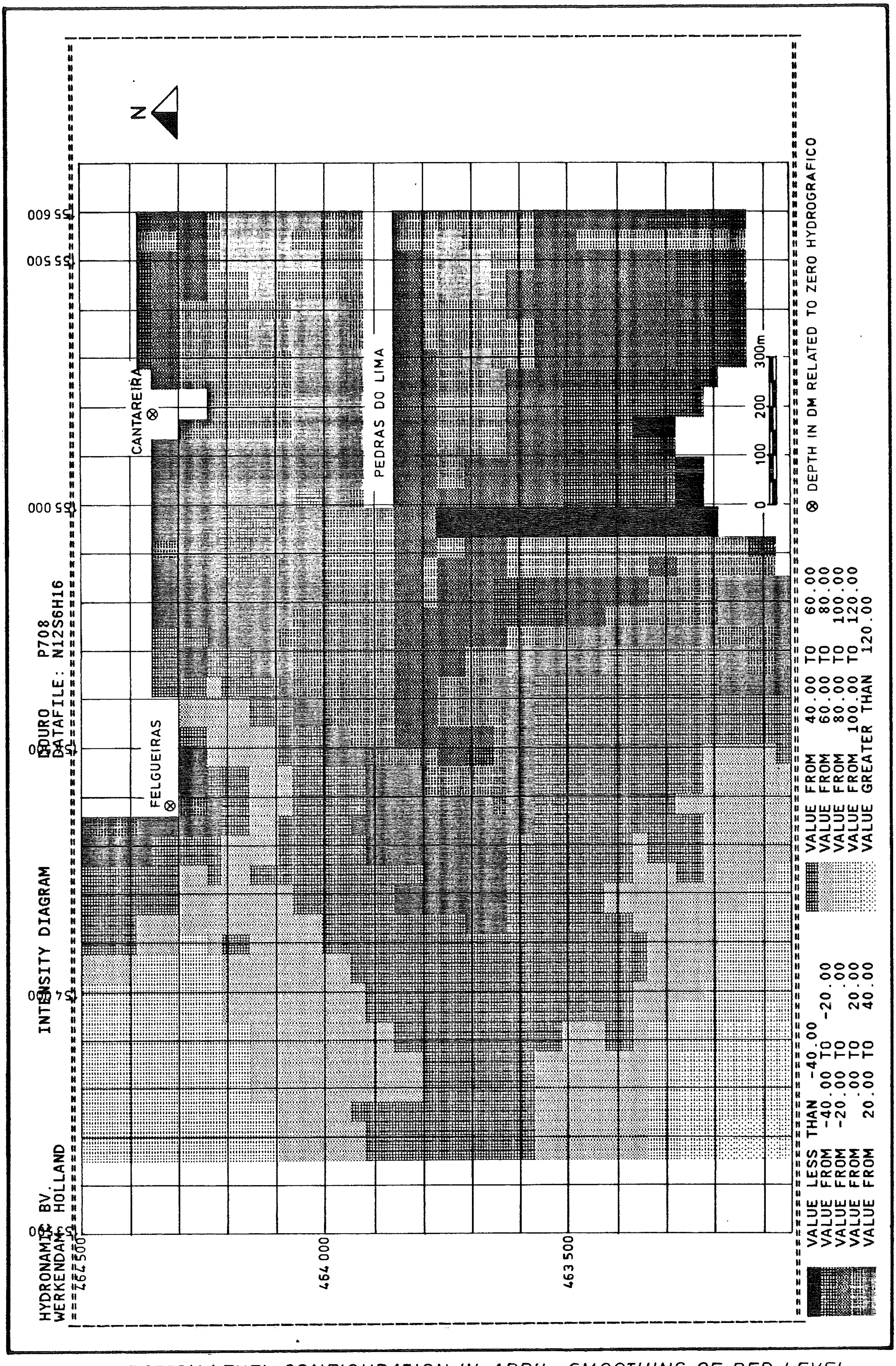


FIGURE 19: *BOTTOM LEVEL CONFIGURATION IN APRIL; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

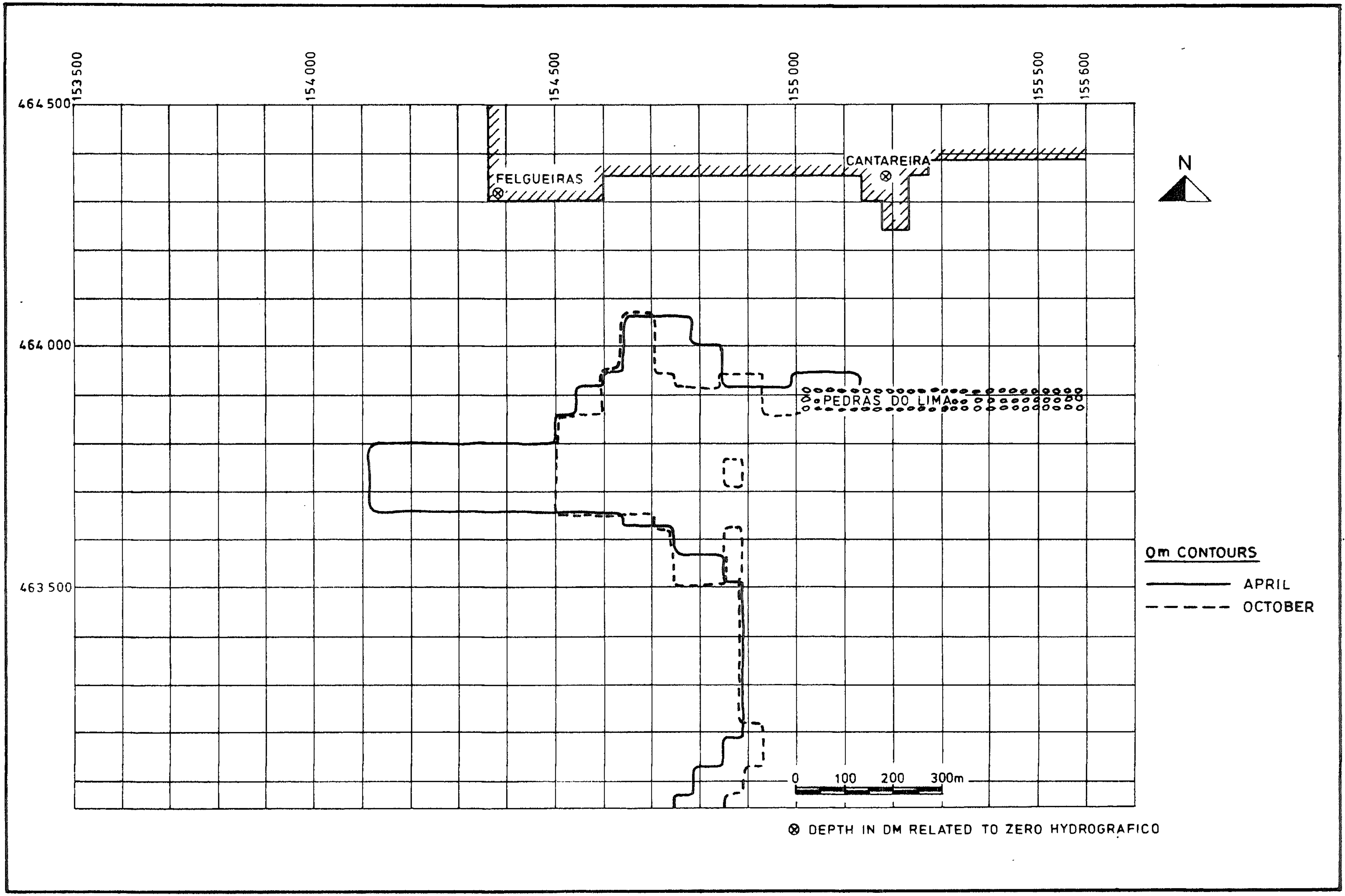


FIGURE 20: *POSITION OF 0m CONTOURS (SUMMER PERIOD; TEST A)*

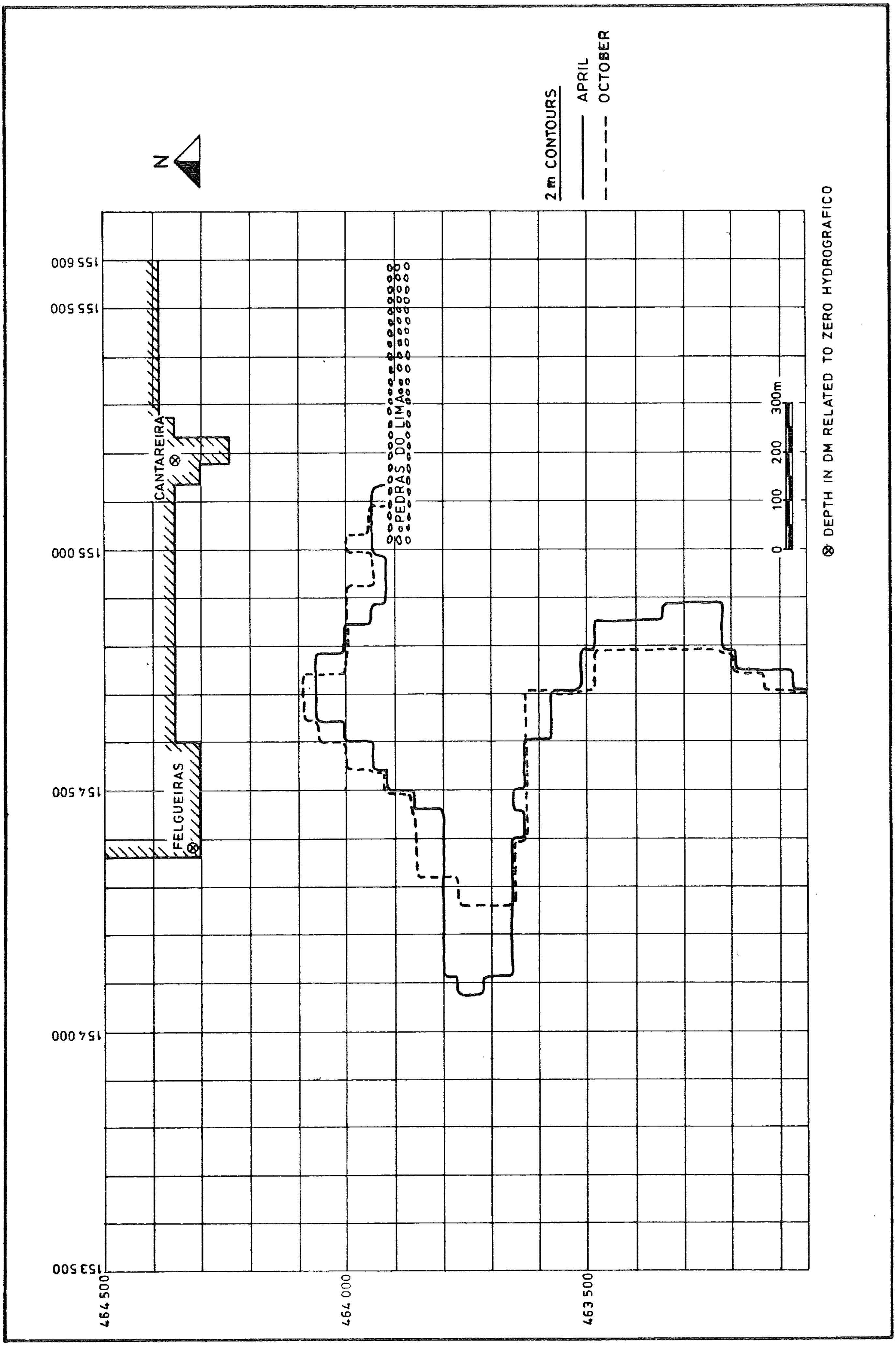


FIGURE 21: *POSITION OF 2m CONTOURS (SUMMER PERIOD, TEST A)*

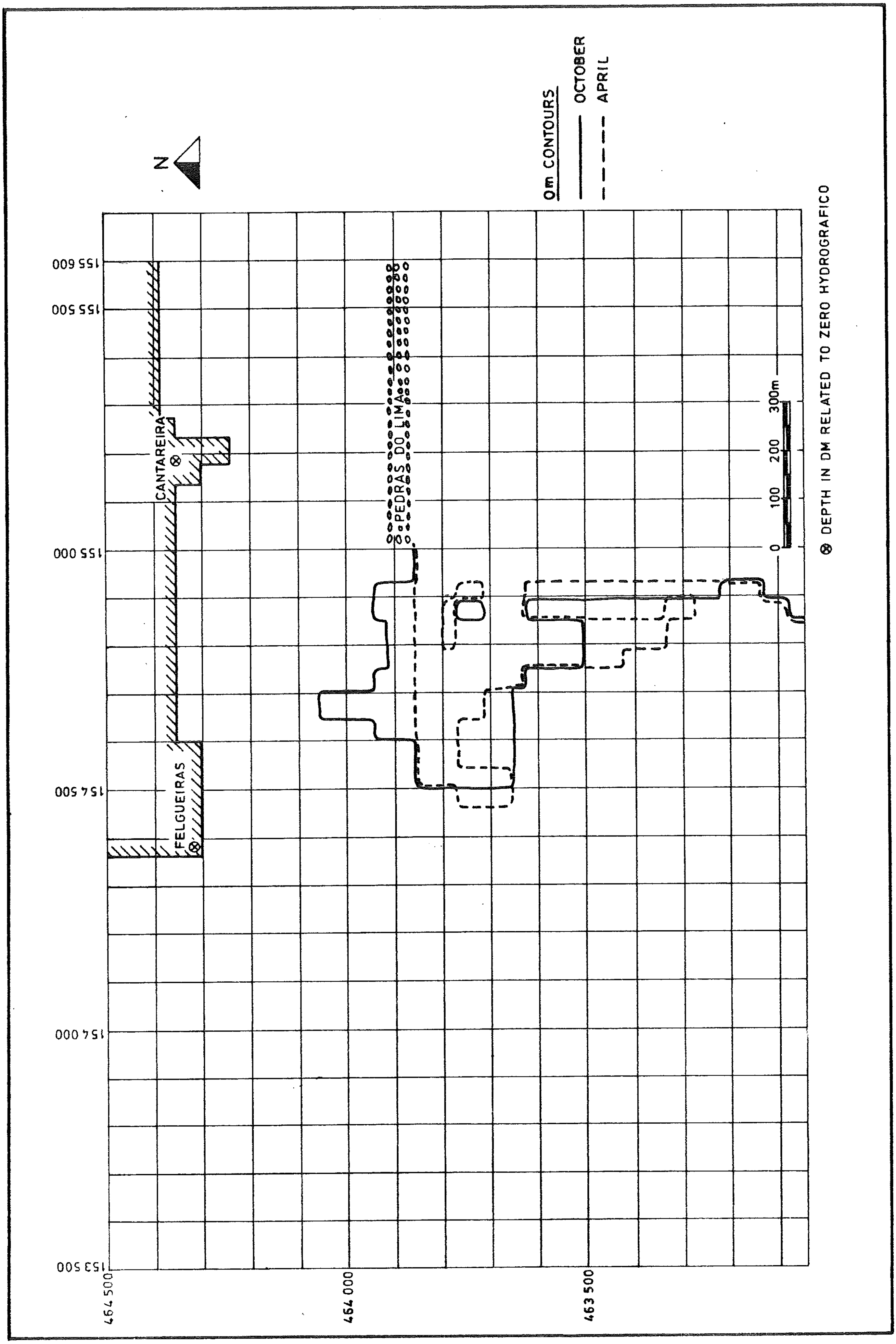


FIGURE 22: *POSITION OF 0m CONTOURS (WINTER PERIOD; TEST A)*

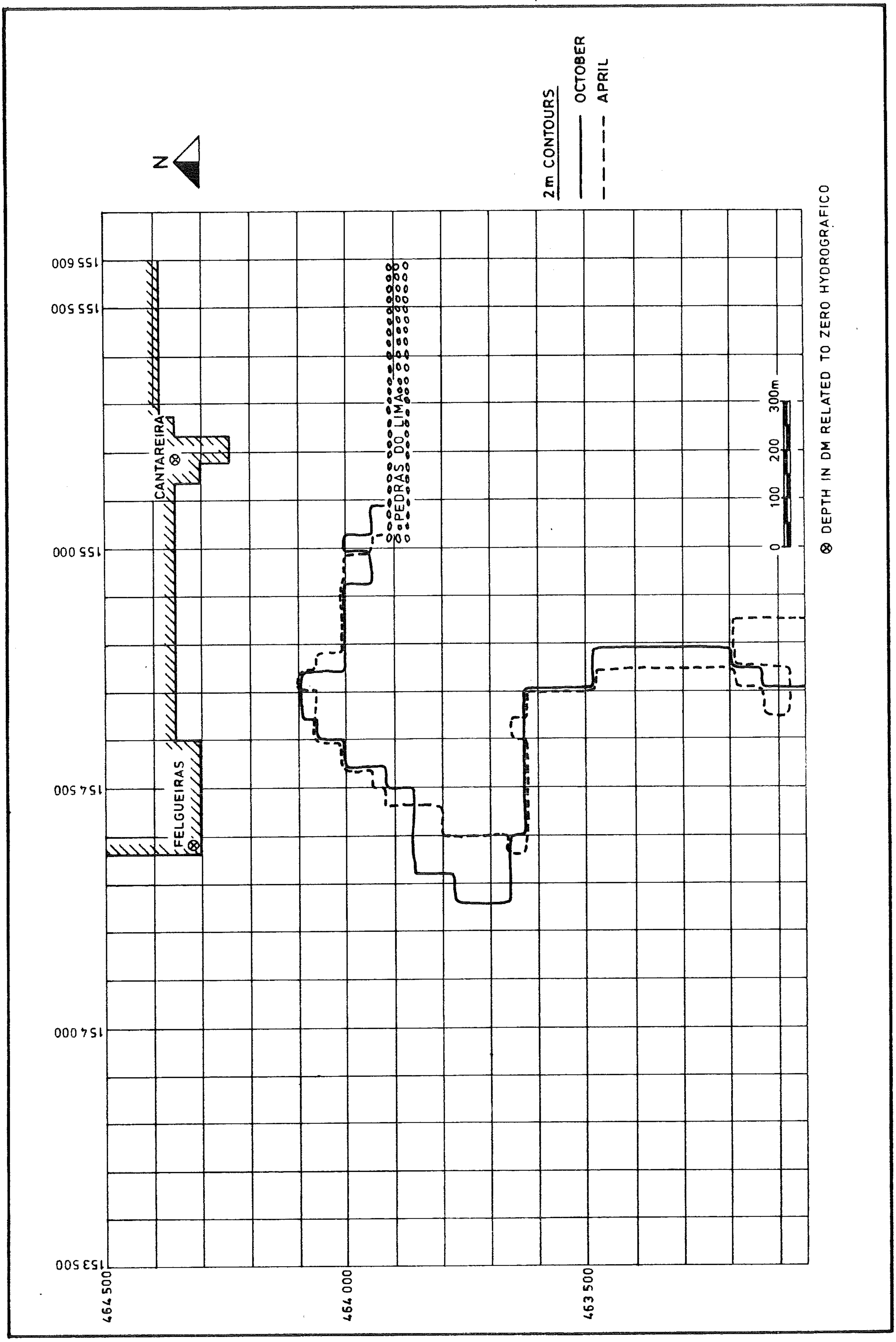


FIGURE 23: *POSITION OF 2m CONTOURS (WINTER PERIOD; TEST A).*

N11S6I06 FRI, JUL 13, 1984, 10:37 AM

J11Z61S6 YR 0; MTH 6 NP 6 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.2	-17.5	-5.6	11.4	29.4	32.4	32.4	22.4
-99.0	-99.0	-.0	-.0	-5.6	8.4	26.4	29.4	30.4	21.4
-99.0	-99.0	-23.3	-15.5	-3.0	8.8	23.5	25.3	25.9	21.3
-99.0	-99.0	-21.4	-12.5	-.2	9.8	20.6	24.5	25.4	23.0
-99.0	-99.0	-21.4	-11.1	-.4	8.2	15.3	21.6	25.7	26.1
-99.0	-99.0	-23.3	-9.8	-4.2	6.8	10.1	13.4	23.5	27.4
-99.0	-99.0	-26.2	-10.4	-2.4	12.3	13.0	13.2	20.7	26.1
-99.0	-99.0	-99.0	-8.7	-3.3	21.0	17.5	18.0	21.7	29.3
-99.0	-99.0	-99.0	-99.0	-99.0	30.8	25.9	24.1	23.6	26.6
-99.0	-99.0	-99.0	-99.0	30.3	41.3	31.3	26.8	27.3	30.8
-99.0	-99.0	-99.0	24.3	30.3	44.0	27.2	20.6	31.3	36.2
-99.0	-99.0	-99.0	24.2	28.9	34.8	30.6	28.9	32.3	39.6
-99.0	-99.0	-99.0	25.7	29.3	33.4	39.5	33.8	34.6	44.8
-99.0	-99.0	-99.0	28.9	28.9	38.9	45.4	33.8	32.4	42.0
-99.0	-99.0	-99.0	24.0	22.3	43.2	44.4	30.5	36.8	34.4
-99.0	-99.0	-99.0	24.5	24.7	42.2	44.5	44.4	41.4	39.1
-99.0	-99.0	-99.0	25.7	28.5	37.4	38.7	35.4	31.3	26.2
-99.0	-99.0	-99.0	36.1	33.5	38.9	30.7	25.2	13.4	7.1
-99.0	-99.0	-99.0	57.9	32.0	39.5	41.1	26.4	6.0	-7.1
-99.0	-99.0	-99.0	37.1	40.6	48.4	46.2	37.6	20.5	1.0
-99.0	-99.0	-99.0	41.1	55.0	63.8	58.3	51.5	44.7	26.7
-99.0	-99.0	-99.0	-99.0	78.7	74.2	64.2	59.1	54.3	45.0
-99.0	-99.0	-99.0	-99.0	54.6	79.2	69.4	64.2	59.5	51.7
-99.0	-99.0	-99.0	-99.0	39.9	71.6	69.6	66.2	59.3	54.4
-99.0	-99.0	-99.0	-99.0	27.6	45.9	63.1	67.2	61.7	59.5
-99.0	-99.0	-99.0	-99.0	2.9	33.6	55.9	63.2	63.6	62.4
19.2	18.5	19.4	10.1	9.8	39.5	61.1	73.5	62.1	60.1
31.0	35.7	35.0	41.5	41.1	45.8	76.7	63.3	61.2	59.1
48.7	50.3	49.4	60.1	63.4	57.4	67.1	60.3	61.2	60.2
56.7	61.4	60.7	60.5	72.4	72.2	69.1	63.3	62.3	61.2
55.2	63.2	67.3	67.4	81.2	74.3	73.2	66.8	65.3	63.3
57.7	59.6	79.2	74.3	85.1	80.6	45.2	69.8	67.2	65.3
77.6	80.6	90.2	100.0	89.2	84.3	81.5	74.3	64.3	67.3
87.5	89.5	90.4	94.3	92.3	87.1	81.1	77.1	74.2	64.3
93.4	94.4	94.3	90.4	88.3	91.0	83.1	76.2	77.0	69.2
91.4	93.3	97.3	95.3	89.3	93.0	87.0	76.2	78.8	68.2
95.3	94.0	96.0	88.6	87.8	90.0	89.0	79.0	78.5	71.1
99.2	96.0	94.3	90.5	95.2	93.0	91.9	82.9	75.9	74.0
101.3	99.3	98.3	96.4	102.2	96.2	92.1	86.1	80.0	73.0
101.4	102.3	99.3	98.4	97.4	99.2	95.1	87.1	81.8	74.0
15.4	6.4	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
17.4	10.4	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.4	11.5	-99.0	-1.0	1.0	22.0	20.0	11.9	3.7	-18.4
22.0	14.4	-99.0	-2.0	1.0	21.0	29.0	12.1	-.4	-19.8
26.3	18.4	-99.0	-3.0	1.0	19.0	19.9	9.1	-2.6	-19.7
25.6	19.4	-99.0	-4.0	1.0	15.0	18.0	9.9	1.3	-17.9
26.2	26.2	-99.0	-5.0	-1.0	9.0	20.0	12.7	7.7	-17.8
31.3	35.4	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
37.4	27.9	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
31.9	26.2	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
30.1	18.8	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
25.9	5.9	-99.0	-10.1	-6.1	2.0	-.0	-1.0	-20.0	-20.0
17.9	-.0	-99.0	-5.7	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
25.3	.3	-18.6	-6.0	-28.2	-70.0	-70.0	-70.0	-70.0	-70.0
32.4	2.7	-13.4	-28.5	-31.6	-8.2	-6.1	-6.4	-6.3	-5.7
28.1	6.9	-4.1	-23.0	-11.4	-14.9	-8.8	-3.1	-5.9	-6.4
15.0	1.8	.-4.1	-9.8	-12.0	-12.4	-14.3	-11.6	-8.1	-4.2

4.9	-7.5	-8.7	-13.2	-16.1	-5.4	-11.5	-13.7	-7.2	-2.3
-13.5	-19.1	-20.4	-15.7	-13.0	-6.1	-5.2	-2.2	5.0	9.3
-9.0	-16.0	-17.5	-13.6	-7.5	-7.4	-7.0	.7	17.5	27.3
6.4	-3.0	-6.5	-7.9	-6.8	-6.7	-6.9	3.3	25.6	40.0
28.9	9.6	-3.0	-8.0	-6.7	-7.6	-7.1	9.2	30.6	48.9
49.1	29.4	7.9	-3.3	.2	-4.5	-5.0	11.5	31.1	49.3
53.3	49.1	24.2	6.2	2.2	-.5	-1.5	20.1	40.3	52.6
56.5	53.3	47.0	17.8	-2.5	-1.3	5.0	17.8	49.2	53.3
59.2	54.0	47.4	23.4	1.3	.0	7.7	28.6	47.7	52.6
58.1	53.9	38.7	16.7	4.9	.6	3.5	25.7	47.8	51.5
59.2	56.1	47.8	23.5	10.7	5.1	6.0	29.7	50.5	53.7
60.1	56.1	51.7	33.1	17.3	11.3	10.1	38.3	49.9	55.3
60.1	56.9	45.5	30.4	18.4	15.1	16.1	41.0	51.1	56.1
62.1	57.9	49.3	38.6	24.6	18.1	15.6	41.9	50.8	55.6
62.2	59.1	55.6	46.8	35.2	24.2	24.9	30.7	52.0	58.8
64.2	61.1	59.1	53.4	50.8	48.2	47.7	50.8	56.8	59.4
67.2	63.2	60.2	55.3	53.0	52.5	52.7	54.2	59.3	61.2
68.1	64.2	61.3	59.4	55.6	54.1	54.9	58.1	56.1	59.2
69.1	65.2	63.3	61.4	59.3	58.5	56.6	56.2	59.0	62.3
69.2	66.2	65.3	63.3	61.2	59.3	57.4	58.3	60.3	64.4
64.3	69.0	66.9	64.9	62.0	60.1	56.3	60.1	63.2	66.3
69.1	58.4	53.5	54.4	49.7	47.7	51.5	55.4	61.3	65.3
74.8	64.1	56.3	53.4	48.5	45.5	47.5	49.5	58.2	63.3
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	-18.0	-20.0	-23.0	-26.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.0	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-5.5	-4.7	-3.8	-3.3	-3.2	-7.6	-11.6	-33.9	-40.0	-99.0
1.9	1.2	5.8	13.9	15.6	8.3	3.8	3.4	-31.4	-99.0
8.9	15.7	17.6	22.0	22.2	19.8	13.7	7.8	3.8	1.7
15.3	27.8	30.0	31.6	31.8	30.7	25.6	16.5	12.1	11.3
19.7	32.9	40.6	42.7	43.6	33.7	31.5	22.7	20.5	20.6
31.6	42.1	47.7	49.3	49.5	47.8	44.6	32.7	26.9	29.6
42.9	48.1	51.6	51.2	51.3	51.5	50.3	43.5	39.8	33.9
50.1	49.9	52.5	53.2	53.4	52.5	50.3	49.3	45.4	37.8
51.1	51.1	52.5	55.5	54.6	52.6	54.5	59.4	53.9	50.6
51.7	51.8	55.1	56.6	59.5	62.1	66.3	64.5	63.6	59.9
53.3	52.9	57.2	59.5	59.5	63.1	69.1	70.5	70.6	70.6
52.6	54.7	58.7	60.2	60.5	64.2	69.1	72.5	72.8	72.8
52.2	54.5	56.7	53.5	55.6	61.3	67.2	77.2	81.5	81.6
53.5	55.3	59.0	62.4	60.5	63.5	67.3	81.1	82.4	83.6
55.0	58.3	62.0	64.2	64.5	63.5	73.3	78.2	83.4	85.6
57.4	61.3	63.8	65.9	66.5	65.4	74.1	83.1	91.4	92.6
58.3	61.3	62.9	63.9	64.6	69.5	76.1	87.0	92.4	99.5
61.3	62.5	63.0	63.0	63.6	64.8	76.2	86.8	92.2	102.4
60.2	61.0	60.7	58.2	71.3	67.7	76.4	85.9	97.0	106.4
55.3	55.3	54.3	63.4	76.2	75.6	83.6	89.3	101.2	106.5
60.5	60.7	57.0	69.3	83.9	84.4	89.5	95.4	111.2	104.4
64.5	69.4	63.7	70.2	92.3	94.2	95.5	104.4	115.3	112.3
68.3	71.4	67.6	69.4	97.5	112.8	110.3	108.5	116.4	117.3

69.3	70.4	70.5	70.5	98.8	120.5	112.3	113.5	120.3	123.2
69.3	69.4	69.5	77.3	98.8	122.9	115.2	116.4	126.2	125.3
69.3	70.5	71.5	82.2	99.7	119.9	122.9	126.1	131.1	125.3

FIGURE 24: *BOTTOM LEVELS IN JUNE; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

H11S6I08 FRI, JUL 13, 1984, 10:38 AM

J11Z61S6 YR 0; MTH 8 NP 8 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.3	-17.6	-5.9	11.1	29.1	32.1	32.1	22.1
-99.0	-99.0	-.0	-.0	-5.9	8.1	26.1	29.1	30.1	21.1
-99.0	-99.0	-23.4	-15.7	-3.1	8.7	23.1	24.5	24.8	21.1
-99.0	-99.0	-21.5	-12.7	-.4	10.0	20.4	23.4	24.1	22.8
-99.0	-99.0	-21.5	-10.9	.1	8.7	15.2	18.6	22.6	25.7
-99.0	-99.0	-23.4	-9.6	-4.3	6.4	9.9	11.6	19.6	27.0
-99.0	-99.0	-26.3	-10.6	-3.2	9.5	13.1	13.5	19.0	25.9
-99.0	-99.0	-99.0	-8.8	-3.4	17.8	18.9	20.6	22.6	29.1
-99.0	-99.0	-99.0	-99.0	-99.0	29.5	27.4	25.8	24.3	26.6
-99.0	-99.0	-99.0	-99.0	30.1	40.8	32.0	27.0	26.7	30.3
-99.0	-99.0	-99.0	24.0	29.9	43.4	27.3	20.7	30.8	35.8
-99.0	-99.0	-99.0	23.9	28.3	33.8	30.7	29.2	32.2	39.4
-99.0	-99.0	-99.0	25.9	29.2	33.2	39.7	34.3	34.5	44.1
-99.0	-99.0	-99.0	29.0	29.2	39.2	45.5	34.5	32.2	37.5
-99.0	-99.0	-99.0	23.7	22.1	42.7	44.2	30.3	36.5	33.5
-99.0	-99.0	-99.0	24.4	24.5	41.7	44.3	44.1	41.2	39.1
-99.0	-99.0	-99.0	25.3	28.1	36.8	38.3	35.8	32.8	27.9
-99.0	-99.0	-99.0	35.6	33.3	38.8	30.5	26.0	21.3	19.3
-99.0	-99.0	-99.0	57.5	32.7	39.6	40.6	24.1	9.0	10.1
-99.0	-99.0	-99.0	37.3	40.4	47.9	45.9	33.2	12.3	-2.1
-99.0	-99.0	-99.0	41.5	55.0	63.5	57.6	48.5	31.2	11.4
-99.0	-99.0	-99.0	-99.0	78.4	73.9	63.9	58.7	53.3	42.3
-99.0	-99.0	-99.0	-99.0	54.4	78.9	69.1	63.9	59.2	51.4
-99.0	-99.0	-99.0	-99.0	39.6	71.2	69.4	65.9	59.0	54.1
-99.0	-99.0	-99.0	-99.0	27.4	45.1	62.9	66.9	61.5	59.3
-99.0	-99.0	-99.0	-99.0	3.6	33.1	55.6	62.9	63.3	62.2
18.0	17.9	19.4	12.1	12.4	39.4	60.8	73.0	61.8	59.8
27.9	32.7	34.7	41.5	41.2	45.7	76.4	63.1	60.9	58.8
45.9	48.3	49.0	59.8	63.1	57.1	66.8	60.1	60.9	59.9
56.0	60.8	60.4	60.2	72.1	72.0	68.8	63.0	62.0	60.9
55.0	62.9	67.1	67.1	80.9	74.1	72.9	66.5	65.0	63.0
57.4	59.3	79.0	74.1	84.9	80.3	45.0	69.6	66.9	65.0
77.4	80.3	90.0	99.8	88.9	84.1	81.1	74.0	64.0	67.0
87.3	89.2	90.1	94.1	92.0	86.9	80.9	76.9	74.0	64.1
93.1	94.1	94.1	90.1	88.1	90.8	82.8	76.0	76.8	68.9
91.1	93.1	97.0	95.1	89.0	92.7	86.7	76.0	78.5	67.9
95.0	93.8	95.8	88.3	87.5	89.7	88.7	78.8	78.3	70.8
99.0	95.8	94.1	90.3	94.9	92.7	91.7	82.7	75.6	73.7
101.1	99.1	98.0	96.1	102.0	95.9	91.8	85.8	79.7	72.8
101.1	102.0	99.1	98.1	97.1	99.0	94.9	86.8	81.6	73.7
15.1	6.1	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
17.1	10.1	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.5	11.3	-99.0	-1.0	1.0	22.0	20.0	12.2	3.9	-17.6
21.8	14.1	-99.0	-2.0	1.0	21.0	29.0	12.1	-.5	-19.8
26.0	18.2	-99.0	-3.0	1.0	19.0	19.9	8.6	-3.6	-19.6
25.4	19.1	-99.0	-4.0	1.0	15.0	18.0	9.8	1.3	-17.5
25.9	25.9	-99.0	-5.0	-1.0	9.0	20.0	13.0	7.6	-16.7
31.0	35.1	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
37.1	27.7	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
31.7	26.2	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
30.2	20.8	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
26.1	9.8	-99.0	-10.1	-6.1	2.0	-.0	-1.0	-20.0	-20.0
18.5	14.4	-99.0	-1.2	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
22.5	6.9	-8.9	-3.9	-26.1	-70.0	-70.0	-70.0	-70.0	-70.0
21.1	-6.2	-17.0	-27.5	-19.1	-1.6	-3.8	-8.3	-3.2	-4.3
18.6	-1.9	-5.4	-12.2	-12.2	-5.7	-3.0	1.5	3.0	.6
17.1	5.7	-9.7	-16.7	-21.9	-18.3	-4.9	-14.3	-14.7	-4.5
12.3	-.4	-11.3	-11.9	-23.5	-19.3	-7.8	-17.4	-15.5	-3.9
5.9	-2.9	-12.9	-8.8	-9.0	-12.7	-6.8	-2.4	5.0	10.9
-8.9	-13.6	-8.6	-9.5	-5.7	-6.2	-7.0	.7	16.9	26.3
-1.5	-4.6	-5.3	-6.5	-6.6	-6.9	-6.3	4.0	25.9	39.2
25.6	9.0	-1.7	-6.7	-6.5	-8.4	-6.4	9.4	30.7	48.7
48.5	28.5	7.1	-3.4	.2	-2.0	-2.4	11.9	30.8	49.2
53.0	48.7	18.6	2.6	4.4	-1.7	-1.3	20.8	40.2	52.4
56.2	53.0	41.1	15.1	6.5	-1.2	2.7	18.9	48.8	53.2
58.9	53.6	46.8	24.3	12.8	9.0	8.5	28.8	47.3	52.0
57.8	53.5	36.6	16.4	12.6	10.7	10.1	26.5	47.7	51.2
58.9	55.8	46.0	21.4	15.3	12.5	11.8	30.7	50.3	53.7
59.9	55.8	50.1	31.0	22.8	16.1	13.4	38.5	49.6	55.0
59.8	56.5	44.5	28.6	21.8	15.8	16.9	40.9	50.8	55.8
61.8	57.6	49.0	37.7	28.1	20.7	17.2	41.7	50.5	55.4
61.9	58.8	55.3	46.8	37.0	26.4	25.2	31.0	51.7	58.5
63.9	60.9	58.8	53.1	50.4	47.8	47.3	50.4	56.5	59.1
66.9	62.9	59.9	55.0	52.8	52.4	52.6	54.0	59.1	60.9
67.8	63.9	61.0	59.1	55.3	53.9	54.7	57.8	55.8	58.9
68.8	64.9	63.1	61.1	59.1	58.3	56.4	56.0	68.8	62.0
68.9	65.9	65.0	63.0	60.9	59.1	57.2	58.0	60.0	64.1
64.1	68.7	66.6	64.6	61.8	59.8	56.1	59.9	62.9	66.1
68.9	58.1	53.3	54.2	49.5	47.5	51.3	55.1	61.0	65.0
74.5	63.8	56.0	53.2	48.4	45.4	47.3	49.3	58.0	63.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	-18.0	-20.0	-23.0	-26.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.0	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-3.9	-3.8	-3.8	-3.9	-4.7	-7.9	-4.3	-30.7	-40.0	-99.0
.2	-.1	4.6	11.9	11.8	5.3	5.4	-1.2	-7.6	-99.0
5.9	13.3	17.4	21.4	21.4	18.4	13.1	6.4	9.1	12.2
14.8	26.0	29.6	31.1	31.5	30.5	25.2	17.3	13.5	12.1
20.9	32.7	40.4	42.3	43.4	33.6	31.2	22.7	20.5	20.2
31.0	41.7	47.4	49.0	49.2	47.6	44.3	32.4	26.5	29.0
41.5	47.1	51.3	50.9	51.0	51.2	50.0	43.2	39.4	33.6
49.6	49.3	52.3	52.9	53.1	52.3	50.0	49.1	45.1	37.5
51.2	51.1	52.2	55.3	54.4	52.4	54.3	59.2	53.6	50.3
51.3	51.7	54.9	56.4	59.2	61.9	66.0	64.2	63.3	59.6
53.1	52.8	56.9	59.3	59.2	62.9	68.8	70.2	70.3	70.4
52.1	54.5	58.4	60.0	60.2	63.9	68.8	72.2	72.5	72.6
51.7	54.3	56.4	53.2	55.3	61.1	66.9	77.0	81.2	81.3
53.3	55.1	58.8	62.1	60.3	63.2	67.1	80.9	82.2	83.3
54.8	58.1	61.8	64.0	64.2	63.3	73.1	78.0	83.2	85.4
57.2	61.1	63.6	65.7	66.3	65.2	73.8	82.8	91.1	92.3
58.0	61.1	62.6	63.6	64.4	69.3	75.8	86.7	92.1	99.2
61.0	62.2	62.7	62.7	63.3	64.6	76.0	86.5	91.9	102.1
60.0	60.7	60.4	57.9	71.1	67.5	76.2	85.7	96.7	106.2
55.1	55.0	54.0	63.2	76.0	75.3	83.3	89.0	100.9	106.3
60.2	60.4	56.8	69.1	83.7	84.2	89.3	95.1	110.9	104.2
64.2	69.2	63.4	69.9	92.0	93.9	95.2	104.2	115.0	112.0
68.1	71.1	67.3	69.1	97.2	112.5	110.0	108.3	116.1	117.1
69.1	70.1	70.3	70.2	98.5	120.2	112.0	113.2	120.0	123.0
69.1	69.2	69.2	77.1	98.5	122.6	115.0	116.1	125.9	125.0
69.1	70.2	71.2	81.9	99.4	119.6	122.7	125.8	130.8	125.1

FIGURE 25 *BOTTOM LEVELS IN AUGUST; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

N11S6I10 FRI, JUL 13, 1984, 10:38 AM

J11Z61S6 YR 0; MTH 10 NP10 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.4	-17.9	-6.3	10.7	28.7	31.7	31.7	21.7
-99.0	-99.0	-.0	-.0	-6.3	7.7	25.7	28.7	29.7	20.7
-99.0	-99.0	-23.6	-15.9	-3.3	8.4	22.5	23.3	23.2	20.8
-99.0	-99.0	-21.7	-13.0	-.7	9.8	19.7	21.4	22.2	22.6
-99.0	-99.0	-21.7	-10.9	.2	9.1	14.7	15.5	19.3	25.3
-99.0	-99.0	-23.6	-9.5	-4.0	6.0	9.7	10.0	17.0	26.9
-99.0	-99.0	-26.4	-10.8	-3.7	7.3	13.4	15.3	19.5	26.1
-99.0	-99.0	-99.0	-9.0	-3.4	15.3	19.6	22.4	24.0	28.9
-99.0	-99.0	-99.0	-99.0	-99.0	28.6	28.3	26.9	25.2	26.5
-99.0	-99.0	-99.0	-99.0	29.9	40.1	32.6	27.3	26.5	29.9
-99.0	-99.0	-99.0	23.5	28.4	40.7	28.0	20.6	29.3	35.3
-99.0	-99.0	-99.0	24.0	24.5	28.4	31.6	29.2	30.8	38.9
-99.0	-99.0	-99.0	30.3	30.4	30.8	40.2	35.3	33.9	43.5
-99.0	-99.0	-99.0	31.1	33.2	39.9	45.5	35.1	31.7	36.4
-99.0	-99.0	-99.0	22.9	21.7	39.8	44.0	30.1	36.0	32.5
-99.0	-99.0	-99.0	26.2	25.2	38.8	44.1	43.8	40.8	38.5
-99.0	-99.0	-99.0	25.8	28.6	35.8	37.6	35.3	32.7	28.1
-99.0	-99.0	-99.0	33.5	33.2	39.6	28.9	24.2	22.1	20.5
-99.0	-99.0	-99.0	56.4	35.6	40.5	39.1	22.6	14.8	13.6
-99.0	-99.0	-99.0	39.4	40.4	46.5	46.9	34.2	13.3	-.6
-99.0	-99.0	-99.0	44.2	56.1	63.0	57.3	47.0	27.9	10.8
-99.0	-99.0	-99.0	-99.0	77.9	73.4	63.5	57.8	50.6	34.8
-99.0	-99.0	-99.0	-99.0	54.2	78.4	68.8	63.5	58.8	50.8
-99.0	-99.0	-99.0	-99.0	39.5	70.2	68.9	65.4	58.6	53.8
-99.0	-99.0	-99.0	-99.0	27.3	43.8	62.4	66.4	61.1	58.9
-99.0	-99.0	-99.0	-99.0	8.3	31.4	55.1	62.4	62.9	61.7
10.8	14.2	19.6	18.0	15.1	37.5	60.2	72.1	61.2	59.3
19.8	25.3	34.4	43.2	43.8	45.8	75.2	62.6	60.4	58.3
39.8	43.8	47.9	59.1	62.5	56.7	66.2	59.8	60.6	59.5
54.9	59.7	59.7	59.7	71.4	71.5	68.3	62.7	61.7	60.7
54.4	62.2	66.4	66.7	80.1	73.9	71.0	64.5	64.7	62.7
57.1	59.1	78.1	73.7	84.2	80.9	45.2	67.0	66.6	64.6
76.9	79.6	89.1	99.1	88.5	84.4	80.8	72.8	63.9	66.6
86.9	88.7	89.6	93.6	91.6	86.5	80.4	76.4	73.6	63.7
92.7	93.7	93.6	89.7	87.6	90.2	82.3	75.5	76.2	68.5
90.8	92.7	96.1	94.2	88.5	92.0	86.2	75.5	77.9	67.6
94.7	93.4	95.0	87.8	87.1	89.3	88.2	78.3	77.6	70.3
98.6	95.4	93.6	89.8	94.4	92.3	91.2	82.2	75.1	73.2
100.7	98.7	97.6	95.6	101.3	95.5	91.4	85.3	79.1	72.3
100.8	101.7	98.7	97.7	96.6	98.3	94.4	86.3	80.9	73.2
14.7	5.7	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
16.7	9.7	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.7	11.0	-99.0	-1.0	1.0	22.0	20.0	12.9	4.4	-16.1
21.8	13.8	-99.0	-2.0	1.0	21.0	28.9	11.9	-.8	-19.7
25.8	17.9	-99.0	-3.0	1.0	19.0	19.9	7.2	-6.6	-19.3
25.2	18.8	-99.0	-4.0	1.0	15.0	18.0	9.7	1.5	-16.6
25.6	25.5	-99.0	-5.0	-1.0	9.0	20.0	13.9	7.4	-13.6
30.6	34.7	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
36.7	27.4	-99.0	-7.0	-3.0	5.0	14.0	12.0	-19.9	-20.0
31.3	26.0	-99.0	-8.0	-4.0	6.0	8.0	6.0	-19.9	-20.0
30.0	21.4	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
25.9	10.1	-99.0	-10.1	-6.1	1.9	-.0	-1.0	-20.0	-20.0
18.1	14.3	-99.0	-1.8	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
23.3	7.5	-.0	-1.0	-25.0	-70.0	-70.0	-70.0	-70.0	-70.0
18.0	-3.7	-15.0	-27.2	-16.6	-1.4	-4.3	-7.3	-4.4	-4.1
13.0	-5.5	-9.5	-8.0	-3.3	3.3	-3.8	-11.1	3.4	8.5
15.1	4.5	-3.1	-8.0	-1.8	-13.1	-18.1	-13.8	-17.6	-9.2
12.5	5.5	-8.2	-12.5	-9.5	-23.3	-20.7	-10.6	-18.6	-10.8
7.4	-.3	-15.6	-14.6	-4.9	-8.7	-10.7	-3.7	8.3	8.1
-1.7	-8.9	-6.6	-9.9	-6.9	-6.2	-8.0	3.5	21.3	26.9
.1	-3.6	-3.6	-7.6	-7.3	-8.2	-8.7	6.8	29.4	39.9
19.0	6.9	.4	-3.2	-2.3	-8.4	-9.0	8.4	30.8	48.7
45.8	23.8	9.0	-1.2	-.6	-1.2	-.1	12.8	31.4	49.5
52.3	43.5	20.6	5.0	5.2	2.4	.4	18.1	39.6	51.6
56.0	52.7	36.9	15.2	12.3	7.4	4.1	17.7	47.1	52.6
58.4	49.6	36.8	19.6	14.9	14.3	14.7	29.0	46.4	51.6
57.2	48.2	31.9	19.4	19.5	16.3	14.5	26.1	46.7	50.8
58.3	54.7	42.7	24.4	20.5	19.0	17.9	29.7	49.1	53.3
59.3	55.2	46.8	28.6	24.3	22.2	20.7	36.8	49.1	54.9
59.3	56.1	46.0	33.5	29.4	23.4	23.2	39.7	50.5	55.4
61.3	57.6	50.3	40.6	32.1	29.0	25.4	38.1	49.9	54.8
61.4	58.5	55.0	48.0	40.5	38.0	30.7	31.5	50.6	58.1
63.4	60.5	58.5	53.1	50.5	49.5	47.3	46.9	55.2	58.5
66.3	62.4	59.6	54.9	52.8	53.4	53.1	53.5	58.5	60.3
67.2	63.4	60.6	58.7	55.2	54.2	54.9	57.5	55.4	58.3
68.2	64.5	62.6	60.7	58.8	58.1	56.3	55.7	68.1	61.2
68.3	65.4	64.6	62.6	60.7	58.9	57.0	57.6	69.4	63.3
63.6	67.8	65.6	63.8	61.3	59.5	55.8	59.4	62.3	65.5
68.4	57.8	52.9	53.7	49.4	47.5	51.0	54.7	60.5	64.6
73.8	63.4	55.5	52.8	48.2	45.2	47.0	49.1	57.5	62.6
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	-18.0	-20.0	-23.0	-26.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.1	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-2.3	-3.9	-6.3	-6.8	-5.7	-4.4	.2	.5	-40.0	-99.0
5.6	1.1	2.3	6.0	7.6	1.9	1.8	10.3	8.2	-99.0
5.1	12.3	14.2	16.3	18.2	15.6	11.6	12.4	13.7	12.7
8.0	26.0	25.0	26.8	29.0	30.6	26.0	19.8	15.7	14.5
16.4	34.7	38.5	39.9	42.4	34.2	31.0	25.0	19.5	15.8
26.3	41.6	47.5	48.0	48.7	47.2	43.8	34.3	24.9	22.0
38.2	44.3	51.0	50.4	50.5	50.9	49.6	43.2	37.7	30.6
47.7	47.7	51.5	52.2	52.6	52.3	50.0	49.0	44.6	37.2
50.1	50.6	51.9	54.6	53.9	52.4	54.2	58.8	52.4	48.4
50.7	51.7	54.8	56.0	58.7	61.5	65.6	63.9	61.9	57.7
52.8	52.5	56.6	58.9	58.9	62.5	68.4	69.7	68.9	68.0
51.6	53.9	58.0	59.6	59.9	63.7	68.4	71.6	71.5	71.2
51.0	53.5	56.1	52.8	54.8	60.4	66.4	76.3	80.0	79.4
52.7	54.4	58.3	61.7	59.6	62.3	66.4	80.2	81.2	81.8
54.3	57.3	61.2	63.6	63.8	62.7	72.3	77.5	82.3	84.1
56.4	60.4	63.1	65.2	65.8	64.7	73.3	82.3	90.0	90.8
57.3	60.6	62.2	63.2	63.9	68.7	75.3	86.3	91.3	97.5
60.5	61.7	62.3	62.3	63.0	64.2	75.5	86.1	91.2	100.3
59.5	60.3	60.0	57.6	70.6	67.0	75.5	85.1	95.6	103.7
54.7	54.6	53.7	62.7	75.4	74.8	82.5	88.4	99.6	104.0
59.9	60.0	56.5	68.2	82.8	83.7	88.7	94.6	108.7	102.7
63.7	68.6	62.9	69.3	91.0	93.5	94.9	103.7	112.8	109.7
67.4	70.6	67.0	68.7	96.5	112.0	109.7	107.9	114.5	114.7
68.6	69.7	70.0	70.0	98.1	119.8	111.8	112.8	118.4	120.2
68.6	68.8	68.9	76.8	98.2	122.2	114.7	115.7	123.9	122.4
68.6	69.8	71.0	81.6	99.1	119.2	122.2	125.2	128.1	122.7

FIGURE 26: *BOTTOM LEVELS IN OCTOBER; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

N12S6H12 FRI, JUL 13, 1984, 10:39 AM

J12W61S6 YR 0; MTH 12 NP12 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.6	-18.3	-6.9	10.1	28.1	31.1	31.1	21.1
-99.0	-99.0	-.0	-.0	-6.9	7.1	25.1	28.1	29.1	20.1
-99.0	-99.0	-23.8	-16.3	-3.5	7.9	22.2	23.9	23.5	20.4
-99.0	-99.0	-22.0	-13.5	-1.3	9.6	20.0	21.7	21.3	21.2
-99.0	-99.0	-22.0	-10.7	1.6	11.0	18.4	20.6	21.1	24.3
-99.0	-99.0	-23.8	-8.1	-1.3	9.0	15.0	15.9	18.4	26.3
-99.0	-99.0	-26.6	-9.9	-3.1	4.2	8.2	9.2	14.8	23.8
-99.0	-99.0	-99.0	-8.5	-3.6	5.9	9.6	13.0	18.3	26.6
-99.0	-99.0	-99.0	-99.0	-99.0	21.0	21.8	23.0	23.5	25.8
-99.0	-99.0	-99.0	-99.0	29.1	38.1	31.9	27.0	25.5	28.6
-99.0	-99.0	-99.0	22.8	27.7	39.8	27.6	20.0	27.8	34.1
-99.0	-99.0	-99.0	23.5	23.3	26.8	30.2	27.4	29.2	38.3
-99.0	-99.0	-99.0	30.6	29.8	29.4	39.5	34.6	33.1	42.7
-99.0	-99.0	-99.0	30.9	33.0	39.4	45.0	35.1	31.3	35.7
-99.0	-99.0	-99.0	22.1	21.1	37.7	43.4	29.5	34.9	30.8
-99.0	-99.0	-99.0	26.9	25.0	36.4	43.5	43.1	40.2	34.8
-99.0	-99.0	-99.0	25.7	28.2	34.7	37.3	36.4	32.9	25.0
-99.0	-99.0	-99.0	31.8	33.0	40.0	27.9	24.9	25.2	23.0
-99.0	-99.0	-99.0	55.5	37.4	41.1	36.8	20.4	18.4	21.6
-99.0	-99.0	-99.0	40.1	39.9	45.2	46.4	30.6	14.6	15.2
-99.0	-99.0	-99.0	45.0	56.0	62.1	56.6	43.8	27.7	12.2
-99.0	-99.0	-99.0	-99.0	77.1	72.6	62.8	56.1	45.2	25.6
-99.0	-99.0	-99.0	-99.0	53.8	77.6	68.1	62.9	57.9	46.8
-99.0	-99.0	-99.0	-99.0	39.1	68.5	68.0	64.8	58.1	53.2
-99.0	-99.0	-99.0	-99.0	26.8	43.0	61.3	65.5	60.8	58.4
-99.0	-99.0	-99.0	-99.0	14.4	29.1	54.3	61.7	62.5	61.2
9.9	12.6	19.6	28.6	17.8	33.1	58.9	71.0	60.5	58.9
23.5	25.3	35.2	46.5	46.8	44.2	73.7	62.2	59.9	57.9
44.3	44.3	46.3	58.6	61.6	56.0	65.5	59.5	60.1	59.0
55.9	59.4	58.4	58.9	70.4	70.6	67.6	62.2	61.2	60.1
53.1	60.5	65.0	65.7	77.9	71.9	69.4	63.9	64.2	62.1
56.4	58.6	76.5	73.0	82.6	78.6	46.0	66.2	66.0	63.9
76.4	79.0	88.1	97.8	87.7	83.4	79.6	71.9	63.4	65.9
86.2	88.0	88.8	92.5	90.7	85.7	79.6	75.6	73.0	63.2
91.8	92.7	92.7	88.8	86.5	88.8	81.4	74.6	75.4	67.9
90.1	91.8	95.2	93.2	87.3	90.4	85.2	74.7	76.9	67.0
94.2	92.7	94.2	87.1	86.4	88.4	87.3	77.6	76.7	69.6
98.1	94.8	92.9	89.2	93.6	91.5	90.3	81.5	74.4	72.3
100.2	98.2	97.0	94.9	100.5	94.7	90.6	84.5	78.3	71.6
100.3	101.2	98.1	97.0	95.8	97.5	93.5	85.4	80.0	72.5
14.1	5.1	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
16.1	9.1	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.0	10.5	-99.0	-1.0	1.0	22.0	20.0	14.2	5.5	-12.6
20.6	13.1	-99.0	-2.0	1.0	21.0	28.8	11.8	-1.0	-19.7
24.8	17.3	-99.0	-3.0	1.0	19.0	19.9	6.1	-8.4	-19.1
24.7	18.2	-99.0	-4.0	1.0	15.0	18.0	9.4	1.6	-15.6
24.8	24.7	-99.0	-5.0	-1.0	9.0	20.0	14.6	7.5	-11.3
29.8	34.0	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
36.1	27.2	-99.0	-7.0	-3.0	5.0	14.0	12.0	-19.8	-20.0
30.7	26.0	-99.0	-8.0	-4.0	6.0	8.0	6.0	-19.8	-20.0
30.4	24.2	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
27.3	13.9	-99.0	-11.1	-7.0	1.8	-.0	-1.0	-20.0	-20.0
17.3	12.1	-99.0	-2.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
21.9	11.2	7.7	2.2	-21.8	-70.0	-70.0	-70.0	-70.0	-70.0
20.4	13.9	10.0	-26.1	-11.1	-2.4	-7.5	-9.8	-10.3	-7.7
17.7	10.7	4.7	-4.4	-4.2	2.6	-10.6	-25.7	-22.2	-9.7
13.9	-1.3	-9.3	-2.3	3.3	-.9	-23.6	-24.7	-15.6	-11.7
10.9	-2.9	-6.6	-7.9	11.3	8.0	-21.5	-6.8	1.3	-7.9
15.1	6.0	-4.7	-15.8	-9.9	8.8	-9.6	-6.6	11.5	12.8
13.6	4.3	-6.2	-29.7	-25.2	-4.6	-5.7	7.5	24.6	28.8
6.9	1.0	-4.4	-11.9	-9.9	-2.1	3.2	17.0	31.6	41.4
13.2	1.4	-1.1	-8.0	-9.6	-8.7	-9.7	8.9	27.5	48.5
36.3	15.0	10.0	2.8	-3.5	-10.1	-11.4	8.8	29.5	48.7
51.3	33.7	18.4	9.2	6.0	-1.5	-6.2	7.7	37.8	50.9
55.3	49.7	34.5	20.2	17.2	14.8	2.0	12.0	43.0	51.9
57.5	47.3	37.4	27.5	19.2	20.8	19.7	24.3	44.5	50.7
56.5	41.0	27.5	19.6	20.7	19.1	14.7	23.6	45.6	50.4
57.7	49.8	38.9	27.2	24.4	24.0	18.5	26.4	47.5	53.4
58.6	55.9	48.8	34.8	27.8	27.0	27.0	34.9	48.1	55.0
58.5	56.0	44.9	34.3	32.8	28.5	27.4	37.5	49.7	54.9
60.6	57.0	48.2	44.1	36.9	34.3	30.7	33.9	48.1	54.4
60.8	57.9	54.6	51.0	43.5	44.2	36.1	31.5	47.7	57.4
62.8	59.9	57.9	53.1	50.5	51.4	47.4	43.2	52.7	57.5
65.6	61.8	59.0	54.6	52.6	53.9	53.2	52.4	57.5	59.7
66.4	62.8	60.0	58.1	54.7	54.3	54.7	56.5	54.7	57.8
67.4	63.8	62.0	60.1	58.2	57.5	55.6	54.7	56.7	60.0
67.5	64.7	63.9	62.0	60.2	58.3	56.2	56.5	57.8	61.7
62.9	66.9	64.6	62.9	60.6	58.7	55.1	58.6	61.3	64.3
67.6	57.3	52.4	53.0	49.3	47.3	50.4	54.0	59.7	63.9
72.8	62.5	54.5	51.7	47.8	44.9	46.4	48.5	56.7	62.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	.0	.0	.0	.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.2	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-3.0	-1.3	1.6	-1.5	1.3	3.2	3.7	5.5	-40.0	-99.0
7.1	8.4	6.1	5.3	8.1	4.7	1.3	8.4	9.4	-99.0
-8.0	4.7	10.1	13.2	15.2	13.9	13.8	18.6	19.2	16.2
-4.4	11.1	19.7	23.3	24.8	29.2	28.3	21.6	13.3	13.6
18.4	35.0	35.4	37.8	39.4	34.1	30.8	17.7	11.7	13.8
28.4	41.8	47.4	47.3	46.7	46.4	43.5	27.2	19.4	21.4
37.5	39.1	50.3	49.5	49.0	49.8	48.9	39.4	35.3	33.4
47.6	44.8	50.6	50.6	51.3	51.5	49.3	48.6	45.7	40.9
49.0	50.0	52.0	53.2	53.0	52.0	53.7	58.2	51.9	47.9
50.5	51.6	55.0	55.4	57.8	60.5	64.7	63.3	61.2	56.8
52.3	51.8	56.1	58.3	58.0	61.4	67.4	69.0	68.0	66.8
50.3	52.7	57.3	58.8	58.9	62.5	67.3	70.9	70.6	70.2
49.5	51.6	55.5	52.2	54.0	59.2	65.3	75.4	79.0	78.0
52.2	52.8	57.6	61.1	58.7	60.9	65.2	79.2	80.2	80.5
54.3	56.5	60.4	62.8	62.8	61.4	70.7	76.6	81.3	82.8
55.6	59.6	62.4	64.3	64.6	63.5	71.8	81.2	88.7	89.3
56.4	59.8	61.5	62.4	63.0	67.6	74.1	85.3	90.3	95.9
59.7	60.9	61.5	61.7	62.5	63.7	74.9	85.5	90.2	98.3
58.8	59.4	58.9	57.0	69.9	66.4	74.5	83.6	93.3	100.1
54.3	53.9	52.8	61.6	74.5	74.1	81.3	87.0	96.8	100.4
59.5	58.9	55.0	65.5	80.8	83.1	87.9	93.7	105.7	100.4
62.9	67.0	60.9	67.4	88.8	93.1	94.2	102.4	109.4	106.3
66.4	69.7	66.2	68.1	95.6	111.3	108.8	106.8	111.7	111.1
67.8	69.0	69.3	69.6	97.4	119.0	111.2	112.0	115.8	116.2
68.0	68.1	68.3	76.2	97.5	121.4	114.2	115.1	121.1	118.7
68.0	69.2	70.5	81.0	98.3	118.4	121.5	124.3	124.9	119.5

FIGURE 27: *BOTTOM LEVELS IN DECEMBER; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

N12S6H14 FRI, JUL 13, 1984, 10:39 AM

J12W61S6 YR 1; MTH 2 NP14 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.7	-18.7	-7.5	9.4	27.4	30.4	30.4	20.4
-99.0	-99.0	-.0	-.0	-7.5	6.4	24.4	27.4	28.4	19.4
-99.0	-99.0	-24.1	-16.6	-4.2	7.6	22.1	23.8	22.7	19.7
-99.0	-99.0	-22.3	-13.9	-2.4	8.9	19.7	20.6	19.6	19.7
-99.0	-99.0	-22.3	-11.1	.8	10.8	19.0	20.3	19.8	22.8
-99.0	-99.0	-24.1	-7.9	-.1	8.9	14.3	16.4	18.3	25.4
-99.0	-99.0	-26.8	-8.7	-2.0	6.2	11.6	9.6	11.8	22.5
-99.0	-99.0	-99.0	-7.0	-3.9	6.7	13.4	12.0	13.2	24.2
-99.0	-99.0	-99.0	-99.0	-99.0	9.3	20.6	19.4	20.7	25.2
-99.0	-99.0	-99.0	-99.0	21.4	19.5	28.0	24.5	22.6	27.6
-99.0	-99.0	-99.0	29.1	31.6	33.0	30.9	24.5	24.6	32.7
-99.0	-99.0	-99.0	22.9	22.3	25.3	31.2	29.2	27.2	37.5
-99.0	-99.0	-99.0	30.6	29.0	27.7	38.9	36.0	32.6	41.5
-99.0	-99.0	-99.0	29.4	31.2	38.2	44.9	40.3	32.7	34.4
-99.0	-99.0	-99.0	20.3	20.4	36.3	43.5	31.4	33.0	29.8
-99.0	-99.0	-99.0	25.2	23.7	35.0	43.7	43.0	38.8	34.0
-99.0	-99.0	-99.0	25.3	26.1	28.0	30.1	34.2	33.4	25.3
-99.0	-99.0	-99.0	31.2	34.8	35.6	23.9	23.1	24.4	21.5
-99.0	-99.0	-99.0	53.6	40.1	40.5	35.1	24.9	19.1	20.3
-99.0	-99.0	-99.0	42.5	39.7	43.4	48.6	37.9	22.7	17.9
-99.0	-99.0	-99.0	48.0	56.6	61.5	58.1	45.6	31.3	15.9
-99.0	-99.0	-99.0	-99.0	75.3	71.4	62.2	54.8	44.1	25.6
-99.0	-99.0	-99.0	-99.0	53.4	75.6	67.6	62.2	56.7	43.5
-99.0	-99.0	-99.0	-99.0	39.2	64.9	67.2	64.0	57.3	52.5
-99.0	-99.0	-99.0	-99.0	26.6	41.0	59.7	64.2	60.2	57.4
-99.0	-99.0	-99.0	-99.0	16.4	28.3	52.3	60.6	61.8	60.2
14.0	15.0	20.4	29.7	21.4	33.2	57.3	69.2	59.6	58.0
28.1	30.3	38.1	47.6	48.7	46.0	71.5	61.3	59.1	57.0
45.8	44.8	46.3	58.1	60.8	65.9	64.2	58.9	59.5	58.2
56.0	58.9	57.8	58.3	69.7	69.8	66.4	61.5	60.6	59.4
52.1	59.4	64.1	65.1	76.6	70.9	67.0	62.0	63.5	61.2
56.5	58.6	75.6	72.4	81.5	78.1	46.5	64.0	65.4	63.0
76.0	78.6	87.1	96.5	86.8	82.8	78.6	70.5	62.8	65.1
85.6	87.3	88.1	91.6	89.7	84.5	78.5	74.6	72.1	62.5
91.1	91.9	91.8	87.9	85.5	87.2	80.0	73.5	73.8	66.8
89.6	91.1	94.2	92.2	86.2	88.5	83.5	73.6	74.9	65.9
93.7	92.0	92.9	86.2	85.4	87.1	85.7	76.4	75.0	68.3
97.4	94.1	91.8	88.2	92.5	90.4	88.7	80.1	73.0	70.9
99.5	97.5	96.2	94.1	99.2	93.6	89.3	83.1	76.8	70.3
99.6	100.3	97.4	96.1	94.9	96.2	92.3	84.1	78.2	71.2
13.4	4.4	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
15.4	8.4	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
16.6	10.2	-99.0	-1.0	1.0	22.0	20.0	14.8	6.1	-10.6
19.7	12.7	-99.0	-2.0	1.0	20.9	28.7	11.7	-1.0	-19.7
24.0	16.8	-99.0	-3.0	1.0	19.0	19.9	5.9	-8.6	-19.1
24.3	17.6	-99.0	-4.0	1.0	15.1	18.1	9.4	1.6	-15.6
24.1	23.8	-99.0	-5.0	-1.0	9.0	20.0	14.6	7.5	-11.1
29.0	33.3	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
35.5	26.9	-99.0	-7.0	-3.0	5.0	14.0	12.0	-19.7	-20.0
30.1	25.7	-99.0	-8.0	-4.0	6.0	8.0	6.0	-19.7	-20.0
30.2	25.1	-99.0	-9.0	-5.0	4.9	5.0	2.0	-20.0	-20.0
28.8	17.9	-99.0	-12.4	-8.0	1.5	-.0	-1.0	-20.0	-20.0
17.6	10.9	-99.0	-2.6	-19.6	-20.1	-20.0	-20.0	-20.0	-20.0
18.6	7.2	5.1	2.0	-12.2	-70.0	-70.0	-70.0	-70.0	-70.0
19.4	12.8	8.5	-23.3	-7.0	-3.1	-2.0	-13.1	-18.9	-9.8
19.7	16.3	8.6	-5.7	-20.6	-16.6	-3.9	-18.9	-16.4	-7.1
16.4	9.9	1.6	-3.0	-20.0	-16.4	-.2	-7.5	-.9	1.3

9.4	1.9	-2.5	-7.8	-11.2	-4.5	2.5	-.9	4.4	4.9
12.4	3.4	-2.0	-14.3	-15.6	-10.4	-11.0	-5.2	13.8	18.8
14.0	2.9	-1.8	-19.5	-20.5	-11.1	-6.3	9.6	26.3	29.8
8.4	3.1	.2	-5.8	-8.6	1.8	6.5	16.9	33.0	36.9
12.6	2.3	-.6	-7.5	-8.3	3.3	21.1	21.4	25.0	44.9
26.1	9.8	5.6	2.6	-3.1	-20.2	-10.7	12.0	23.7	48.0
40.4	23.5	14.7	9.8	3.4	-21.4	-34.2	5.3	24.9	51.0
52.2	42.5	31.6	23.1	17.8	9.3	10.8	16.3	27.4	51.8
52.7	42.8	39.1	33.6	26.4	21.7	21.3	21.9	34.0	49.8
49.4	36.1	26.7	23.0	24.1	27.5	27.3	27.4	40.0	48.4
55.9	49.8	36.1	29.9	31.5	31.9	31.3	31.4	45.4	52.3
57.9	56.1	45.3	40.4	34.0	32.2	32.3	32.4	46.5	54.4
57.5	54.3	40.8	36.9	36.2	36.4	36.1	35.9	47.1	53.3
59.5	55.7	43.8	44.5	43.1	39.3	38.7	39.0	48.1	53.4
59.8	56.9	53.7	54.5	48.2	44.6	43.4	42.8	49.8	56.4
61.8	59.1	57.4	54.2	50.4	51.8	51.5	49.1	53.3	56.5
64.5	60.7	58.0	54.3	52.4	54.1	54.5	53.4	56.9	58.9
65.2	61.9	59.3	57.6	54.5	54.5	54.9	56.0	54.1	57.1
66.1	63.0	61.3	59.4	57.6	57.3	55.6	54.3	56.1	59.2
66.3	63.6	62.9	60.9	59.2	57.6	55.9	55.9	57.0	60.7
62.1	65.3	62.6	61.0	59.3	57.7	54.5	57.6	60.2	63.5
66.5	56.4	51.7	52.2	48.9	47.0	49.7	53.2	58.9	63.2
71.1	61.1	53.4	51.0	47.6	44.7	45.8	48.0	56.1	61.4
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	.0	.0	.0	.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.2	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-8.3	.7	5.9	.0	.0	2.7	7.7	4.7	-40.0	-99.0
-8.6	-12.9	-10.0	-3.4	-.3	4.7	13.5	8.0	10.7	-99.0
-2.6	-16.3	-11.6	.9	9.1	13.6	22.7	26.6	25.9	22.1
.5	3.6	10.6	16.6	18.4	23.6	27.7	27.3	21.6	19.0
20.5	23.5	29.7	34.1	36.4	32.3	26.3	13.4	9.8	24.0
32.5	41.0	45.8	45.4	45.6	46.5	42.3	20.3	17.7	30.2
36.0	42.7	50.1	48.7	48.5	49.4	48.7	34.3	31.2	37.5
45.7	44.6	50.9	50.0	50.5	50.9	48.8	45.6	44.8	44.9
47.8	49.3	52.5	53.0	52.5	51.6	53.3	57.4	52.6	50.6
51.0	50.9	54.4	55.3	57.3	59.4	63.6	62.6	60.8	57.3
52.0	50.8	55.1	57.9	57.4	60.2	66.2	68.2	67.5	66.5
49.4	51.0	55.3	58.1	58.1	61.4	66.2	70.0	70.2	70.1
49.1	50.8	53.7	52.0	53.4	58.3	64.3	74.3	78.1	77.5
52.5	53.1	56.2	60.4	58.2	60.1	64.3	77.8	79.4	80.0
54.5	56.1	59.1	61.7	62.1	60.6	69.3	75.5	80.5	82.4
55.0	58.6	60.6	62.5	63.8	62.6	70.3	79.7	87.5	88.6
55.3	59.0	60.0	60.7	62.5	67.1	72.9	83.7	89.2	94.7
58.6	60.4	60.1	60.2	62.2	63.9	74.0	83.9	89.1	96.9
57.8	57.9	56.8	55.9	69.0	66.2	73.7	82.2	91.5	97.9
53.7	53.1	52.0	61.1	73.1	73.6	80.7	86.0	94.9	98.0
58.8	58.3	55.2	64.3	78.7	82.5	87.4	93.0	103.5	98.7
61.9	65.9	60.2	66.0	86.0	92.2	93.7	101.5	107.4	104.5
65.4	68.9	66.0	67.5	93.3	109.2	107.8	106.1	110.1	109.2

66.8	68.1	68.8	69.3	95.7	116.5	110.3	111.4	114.2	114.0
67.1	67.3	67.8	75.5	95.8	118.3	113.1	114.3	119.2	116.6
67.2	68.6	70.1	80.1	96.5	115.3	119.8	122.8	122.7	117.6

FIGURE 28: *BOTTOM LEVELS IN FEBRUARY; SMOOTHING OF BED LEVEL PROFILE (TEST A).*

N12S6H16 FRI, JUL 13, 1984, 10:39 AM

J12W61S6 YR 1; MTH 4 NP16 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.8	-18.9	-7.9	9.0	27.0	30.0	30.0	20.0
-99.0	-99.0	-.0	-.0	-7.9	6.0	24.0	27.0	28.0	19.0
-99.0	-99.0	-24.3	-16.7	-3.3	7.9	22.3	25.3	24.4	20.2
-99.0	-99.0	-22.5	-14.2	-2.8	8.0	19.3	21.1	19.9	18.9
-99.0	-99.0	-22.5	-11.5	.4	10.3	18.6	19.0	17.4	20.1
-99.0	-99.0	-24.3	-8.2	1.8	10.6	17.4	20.1	20.3	24.8
-99.0	-99.0	-26.9	-8.6	2.1	10.3	15.6	16.7	17.7	23.3
-99.0	-99.0	-99.0	-5.7	1.1	7.2	10.2	11.2	12.2	22.3
-99.0	-99.0	-99.0	-99.0	-99.0	5.4	7.9	9.7	13.7	22.2
-99.0	-99.0	-99.0	-99.0	19.8	16.1	16.5	15.5	17.4	24.8
-99.0	-99.0	-99.0	28.8	31.2	31.6	28.7	22.5	22.2	30.2
-99.0	-99.0	-99.0	22.5	21.9	25.4	31.1	28.0	25.9	36.6
-99.0	-99.0	-99.0	30.3	28.7	27.2	37.9	34.7	31.8	40.9
-99.0	-99.0	-99.0	29.1	30.9	37.7	44.6	40.2	33.2	34.0
-99.0	-99.0	-99.0	19.8	20.1	35.9	43.1	31.0	32.3	28.3
-99.0	-99.0	-99.0	24.7	23.2	34.2	43.1	42.4	38.0	33.1
-99.0	-99.0	-99.0	24.8	25.6	27.9	31.6	35.9	34.7	26.3
-99.0	-99.0	-99.0	30.8	34.7	35.4	24.9	27.2	27.4	19.6
-99.0	-99.0	-99.0	53.1	40.0	39.7	33.3	23.7	17.9	19.7
-99.0	-99.0	-99.0	42.3	39.4	42.9	46.6	33.3	20.4	19.0
-99.0	-99.0	-99.0	47.8	56.2	60.9	57.3	44.3	30.9	16.7
-99.0	-99.0	-99.0	-99.0	74.7	70.8	61.6	54.2	42.9	25.8
-99.0	-99.0	-99.0	-99.0	53.1	75.0	67.1	61.7	55.5	40.9
-99.0	-99.0	-99.0	-99.0	38.8	63.5	66.4	63.6	57.0	51.5
-99.0	-99.0	-99.0	-99.0	26.3	40.4	58.5	63.4	60.0	56.9
-99.0	-99.0	-99.0	-99.0	17.2	28.2	51.7	60.0	61.7	59.5
13.7	14.9	20.4	34.7	21.8	32.6	56.6	68.6	59.1	57.3
29.2	29.6	37.3	48.6	49.4	44.7	70.7	61.0	58.5	56.4
47.4	45.3	45.7	57.7	60.4	55.8	63.7	58.5	58.9	57.7
56.0	58.7	57.2	57.8	69.0	69.3	65.8	61.0	60.1	59.0
51.4	58.6	63.4	64.5	75.5	69.9	66.1	61.4	63.2	60.9
56.0	58.2	74.8	72.0	80.8	77.0	46.7	63.5	65.0	62.7
75.7	78.2	86.5	95.7	86.3	82.2	77.8	69.9	62.5	64.7
85.1	86.8	87.6	91.1	89.1	84.0	77.9	74.0	71.6	62.3
90.7	91.4	91.2	87.4	85.0	86.5	79.5	73.0	73.3	66.4
89.2	90.6	93.6	91.7	85.7	87.8	83.0	73.1	74.4	65.5
93.3	91.5	92.4	85.8	85.0	86.6	85.2	76.0	74.4	67.9
97.0	93.7	91.3	87.8	91.9	89.9	88.2	79.7	72.6	70.4
99.1	97.1	95.7	93.6	98.5	93.0	88.7	82.6	76.3	69.8
99.2	99.9	97.0	95.6	94.2	95.5	91.6	83.5	77.7	70.7
13.0	4.0	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
15.0	8.0	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
16.1	10.0	-99.0	-1.0	1.0	22.0	20.0	15.7	7.0	-7.4
18.7	12.2	-99.0	-2.0	1.0	20.9	28.6	11.7	-1.0	-19.7
22.6	16.5	-99.0	-3.0	1.0	19.0	19.9	5.9	-8.7	-19.0
23.9	17.2	-99.0	-4.0	1.0	15.1	18.1	9.4	1.6	-15.6
23.6	23.1	-99.0	-5.0	-1.0	9.0	20.0	14.7	7.5	-11.0
28.3	32.9	-99.0	-6.0	-2.0	7.0	16.0	20.0	-20.0	-20.0
35.1	27.2	-99.0	-7.0	-3.0	5.0	14.0	12.0	-19.6	-20.0
29.5	25.9	-99.0	-8.0	-4.0	6.0	8.0	6.0	-19.7	-20.0
30.0	25.9	-99.0	-9.0	-5.0	4.9	5.0	2.0	-20.0	-20.0
30.7	23.1	-99.0	-13.3	-6.9	1.4	-.1	-1.0	-20.0	-20.0
21.2	15.0	-99.0	-8.0	-18.6	-20.0	-20.0	-20.0	-20.0	-20.0
17.0	5.4	1.9	-5.9	-11.6	-70.0	-70.0	-70.0	-70.0	-70.0
16.9	8.9	6.6	-18.4	-.8	.9	-6.5	-7.1	1.6	4.7
19.2	16.0	9.6	-.4	1.4	-3.0	-15.7	-13.1	5.5	9.1
18.7	13.5	5.3	-1.8	1.3	-1.9	-18.8	-24.3	-20.4	-16.9
9.8	7.2	2.7	-4.8	-3.5	-4.5	-17.0	-26.5	-25.5	-20.5
13.8	4.6	.6	-4.8	-12.3	-8.4	-9.4	-5.6	3.3	11.9
16.1	3.5	.8	-12.8	-20.0	-1.8	5.5	12.0	23.3	31.5
9.4	5.8	3.6	-5.7	-9.6	7.4	16.9	25.5	36.1	42.1
13.0	4.5	1.8	-7.1	-8.1	4.1	18.5	19.8	25.3	45.1
22.1	9.0	2.2	-.7	-1.6	-11.4	-1.9	8.0	20.5	47.8
35.7	20.6	11.2	11.1	7.9	-11.7	-31.0	5.1	20.5	50.4
49.4	40.6	29.2	24.7	17.6	9.1	9.9	16.0	24.5	51.4
51.6	43.0	39.0	34.7	28.3	24.4	22.0	19.8	31.8	48.7
47.7	35.5	29.9	28.8	24.9	29.1	27.9	25.9	39.7	47.6
54.6	48.9	38.7	33.9	31.3	32.7	31.5	30.1	44.9	52.1
57.4	55.9	46.1	41.3	34.5	33.0	32.9	32.6	46.2	54.1
57.0	54.0	41.0	36.9	35.8	36.3	35.9	35.4	46.8	53.0
59.1	55.4	43.5	43.7	42.7	40.5	38.5	36.8	45.3	52.7
59.5	56.5	53.1	53.8	48.0	45.3	44.6	41.5	46.8	55.3
61.5	58.8	57.0	53.7	50.0	51.3	52.3	50.3	52.4	55.8
64.1	60.4	57.6	54.0	52.1	53.7	54.3	53.3	56.4	58.4
64.8	61.5	58.9	57.2	54.2	54.3	54.6	55.7	53.6	56.7
65.7	62.6	61.0	59.0	57.2	57.0	55.3	54.0	55.6	58.6
65.9	63.2	62.4	60.4	58.8	57.2	55.5	55.5	56.5	60.1
61.7	64.8	62.0	60.5	58.9	57.2	54.0	57.1	59.6	62.8
66.0	56.2	51.4	51.7	48.7	46.8	49.3	52.7	58.4	62.8
70.4	60.6	52.9	50.3	47.2	44.4	45.5	47.6	55.5	61.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	.0	.0	.0	.0	.0	.0	.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.0	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.0	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-5.0	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-8.2	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
5.5	7.1	8.6	8.9	9.8	10.9	13.8	11.2	-40.0	-99.0
9.0	7.7	3.5	.2	-1.7	8.4	19.9	13.9	14.3	-99.0
-11.6	-8.1	-5.5	-4.2	.1	5.7	18.2	27.3	28.4	24.6
-11.3	-3.6	3.1	14.1	15.8	13.3	17.1	29.1	28.3	24.2
18.1	21.0	28.7	31.3	34.6	28.0	25.0	16.4	10.1	24.3
33.7	35.5	45.5	44.6	44.9	46.7	43.0	21.2	15.3	26.5
41.1	40.2	49.1	48.3	48.0	49.3	48.6	31.8	28.1	36.7
45.4	42.9	50.0	49.7	50.2	50.6	48.4	44.3	43.4	44.5
47.2	48.0	52.1	52.7	52.2	51.4	53.0	57.0	52.2	50.1
50.5	50.2	54.2	54.9	56.7	58.7	62.9	62.1	60.3	56.7
51.4	50.7	54.9	57.3	56.6	59.3	65.5	67.7	66.8	65.7
48.6	50.4	54.7	57.4	57.3	60.7	65.7	69.7	69.7	69.4
48.5	50.3	53.2	51.6	53.0	57.7	63.7	73.8	77.4	76.5
52.2	52.7	55.8	60.0	57.6	59.4	63.6	77.3	78.7	79.1
54.1	55.6	58.5	61.1	61.2	59.7	68.4	75.0	79.8	81.5
54.6	58.1	60.1	61.9	62.9	61.8	69.4	79.0	86.6	87.3
54.9	58.6	59.6	60.3	62.0	66.5	72.3	83.1	88.4	93.3
58.1	59.9	59.6	59.9	61.9	63.5	73.7	83.6	88.4	95.4
57.3	56.9	55.9	55.7	68.6	65.8	73.2	81.6	90.2	95.8
53.4	52.4	51.5	61.0	72.4	73.2	80.1	85.2	93.2	95.8
58.5	57.6	54.6	63.3	77.4	82.0	87.0	92.5	101.8	97.1
61.5	65.1	59.3	65.0	85.0	91.8	93.4	101.0	105.7	102.5
64.8	68.4	65.6	67.2	92.9	108.8	107.4	105.7	108.6	107.2
66.3	67.6	68.4	69.0	95.3	116.0	109.9	110.9	112.7	111.8
66.7	66.9	67.4	75.2	95.5	117.9	112.7	113.9	117.6	114.6
66.8	68.3	69.8	79.7	96.2	114.8	119.3	122.1	120.9	115.7

FIGURE 29: *BOTTOM LEVELS IN APRIL; SMOOTHING OF BED LEVEL PROFILE (TEST A)*

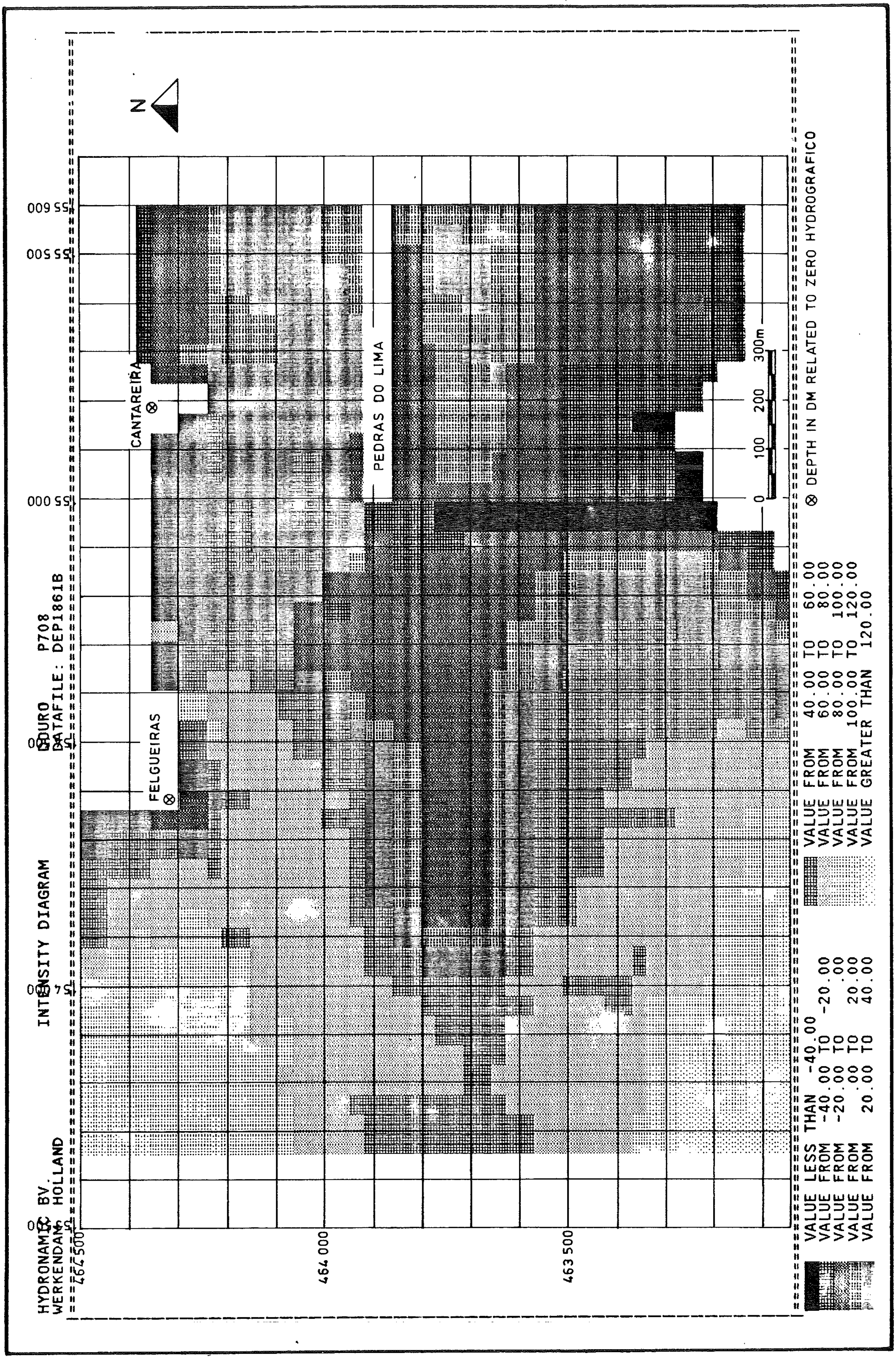


FIGURE 30: *ADJUSTED INITIAL BOTTOM LEVEL CONFIGURATION DEP 1861 B (TEST B)*

DEP1861B FRI, JUL 13, 1984, 10:37 AM

DEPDOUR INITIAL DEPTHMATRIX FROM MARCH 1861 DEPTH IN DM

-99	-99	-27	-17	-5	12	30	33	33	23
-99	-99	-25	-16	-5	9	27	30	31	22
-99	-99	-23	-15	-3	9	24	26	27	22
-99	-99	-21	-12	-1	9	20	25	27	24
-99	-99	-21	-11	-3	7	14	23	27	27
-99	-99	-23	-10	-3	8	12	17	26	28
-99	-99	-26	-10	0	20	15	19	24	27
-99	-99	-99	-9	-3	32	21	21	23	30
-99	-99	-99	-99	-99	38	26	22	24	27
-99	-99	-99	-99	31	43	28	24	29	33
-99	-99	-99	25	31	48	28	20	33	38
-99	-99	-99	25	31	40	31	29	33	41
-99	-99	-99	25	30	35	39	32	35	47
-99	-99	-99	29	28	38	45	31	33	43
-99	-99	-99	25	23	44	45	31	38	35
-99	-99	-99	25	25	43	45	45	42	40
-99	-99	-99	27	30	38	37	37	35	20
-99	-99	-99	38	34	39	30	29	20	-20
-99	-99	-99	60	30	41	45	40	20	-5
-99	-99	-99	35	41	51	48	47	44	-2
-99	-99	-99	38	54	65	60	54	48	30
-99	-99	-99	-99	81	75	65	60	54	45
-99	-99	-99	-99	55	80	70	65	60	52
-99	-99	-99	-99	40	73	70	67	60	55
-99	-99	-99	-99	28	50	64	68	62	60
-99	-99	-99	-99	-2	38	57	64	64	63
20	23	21	-2	-2	42	62	75	63	61
29	46	41	40	38	46	78	64	62	60
49	52	51	61	64	58	68	61	62	61
57	62	61	61	73	73	70	64	63	62
56	64	68	68	82	75	77	70	66	64
58	60	80	75	86	80	45	74	68	66
78	81	91	101	90	84	82	76	65	68
88	90	91	95	93	88	82	78	75	65
94	95	95	91	89	92	84	77	78	70
92	94	98	96	90	94	88	77	80	69
96	95	98	90	89	91	90	80	80	72
100	97	96	92	97	94	93	84	77	75
102	100	99	97	103	97	93	87	81	74
102	103	100	99	98	100	96	88	83	75
16	7	-99	13	1	8	7	4	1	-20
18	11	-99	5	1	24	13	7	2	-20
18	12	-99	-1	1	22	20	11	3	-20
23	15	-99	-2	1	21	29	13	2	-20
27	19	-99	-3	1	19	20	10	0	-20
26	20	-99	-4	1	15	18	9	0	-20
27	27	-99	-5	-1	9	20	12	8	-20
32	36	-99	-6	-2	7	16	20	-20	-20
38	28	-99	-7	-3	6	14	12	-20	-20
33	22	-99	-8	-4	6	8	6	-20	-20
32	-17	-99	-9	-5	5	5	2	-20	-20
30	-18	-99	-10	-6	2	0	-1	-20	-20
32	-20	-99	-20	-20	-20	-20	-20	-20	-20
40	33	-23	-25	-30	-70	-70	-70	-70	-70
34	30	-10	-30	-30	-25	-17	-12	-8	-7
30	10	-15	-32	-10	-9	-9	-8	-6	-4
-10	-20	-20	-10	-9	-9	-8	-7	-4	0

-30	-20	-10	-8	-8	-8	-8	-5	-2	0
-10	-10	-8	-6	-8	-8	-8	-3	0	10
-4	-5	-5	-5	-7	-8	-7	-2	5	20
8	-2	-3	-4	-7	-7	-7	0	10	30
30	10	-1	-3	-6	-6	-6	10	30	50
50	30	10	-2	-5	-5	-5	10	30	50
54	50	30	10	-4	-4	-4	13	32	52
57	54	35	15	-4	-4	-4	14	33	52
60	55	35	17	-1	-3	-1	16	34	53
59	55	36	18	-1	-3	-1	16	34	53
60	57	37	18	-1	-2	-1	17	35	53
61	57	38	19	-1	-2	-1	17	35	55
61	58	39	19	-1	-1	-1	18	37	57
63	59	40	20	-1	-1	-1	18	37	57
63	60	42	27	17	10	17	19	40	60
65	62	55	45	35	27	36	38	50	60
68	64	61	56	53	52	53	55	60	62
69	65	62	60	56	54	55	59	57	60
70	66	64	62	60	59	57	57	60	63
70	67	66	64	62	60	58	59	61	65
65	70	68	66	63	61	57	61	64	67
70	59	54	55	50	48	52	56	62	66
76	65	57	54	49	46	48	50	59	64
-12	-15	-17	-19	-22	-25	-27	-30	-99	-99
-11	-13	-16	-18	-20	-23	-26	-29	-99	-99
-9	-12	-14	-16	-18	-21	-25	-29	-99	-99
-6	-9	-12	-14	-18	-21	-25	-29	-99	-99
-5	-7	-10	-14	-17	-20	-25	-29	-99	-99
-5	-8	-9	-14	-18	-21	-25	-29	-99	-99
-8	-15	-18	-17	-19	-23	-27	-30	-99	-99
-40	-40	-40	-40	-40	-40	-40	-99	-99	-99
-40	-40	-40	-40	-40	-40	-99	-99	-99	-99
-40	-40	-40	-70	-70	-99	-99	-99	-99	-99
-40	-40	-40	-40	-40	-99	-99	-99	-99	-99
-40	-40	-40	-40	-40	-60	-99	-99	-99	-99
-40	-40	-40	-40	-40	-50	-99	-99	-99	-99
-70	-70	-70	-70	-70	-70	-50	-99	-99	-99
-4	-3	-3	-3	-3	-3	-20	-35	-40	-99
10	14	18	18	20	21	0	-10	-35	-99
14	22	24	25	24	21	17	7	-10	-30
22	30	32	35	32	28	25	17	5	-5
28	37	42	44	43	29	31	25	20	14
38	45	48	50	50	48	45	35	26	24
45	51	52	52	52	52	51	45	40	31
51	52	53	54	54	53	51	50	45	35
52	53	53	56	55	53	55	60	54	50
53	54	56	57	60	63	67	65	64	60
53	54	58	60	60	64	70	71	71	71
53	56	60	61	61	65	70	73	73	73
53	56	58	54	56	62	68	78	82	82
53	56	60	63	61	64	68	82	83	84
55	59	63	65	65	64	74	79	84	86
58	62	65	67	67	66	75	84	92	93
59	62	64	65	65	70	77	88	93	100
62	63	64	64	64	65	77	88	93	103
61	62	62	59	72	68	77	87	98	107
56	56	55	64	77	76	84	90	102	107
61	61	57	70	85	85	90	96	112	105
65	70	64	71	94	95	96	105	116	113
69	72	68	70	99	114	111	109	117	118

70	71	71	71	100	122	113	114	121	124
70	70	70	78	100	125	116	117	127	126
70	71	72	83	101	122	124	127	132	126

FIGURE 31: *ADJUSTED INITIAL BOTTOM LEVEL FILE DEP 1861B (TEST B)*

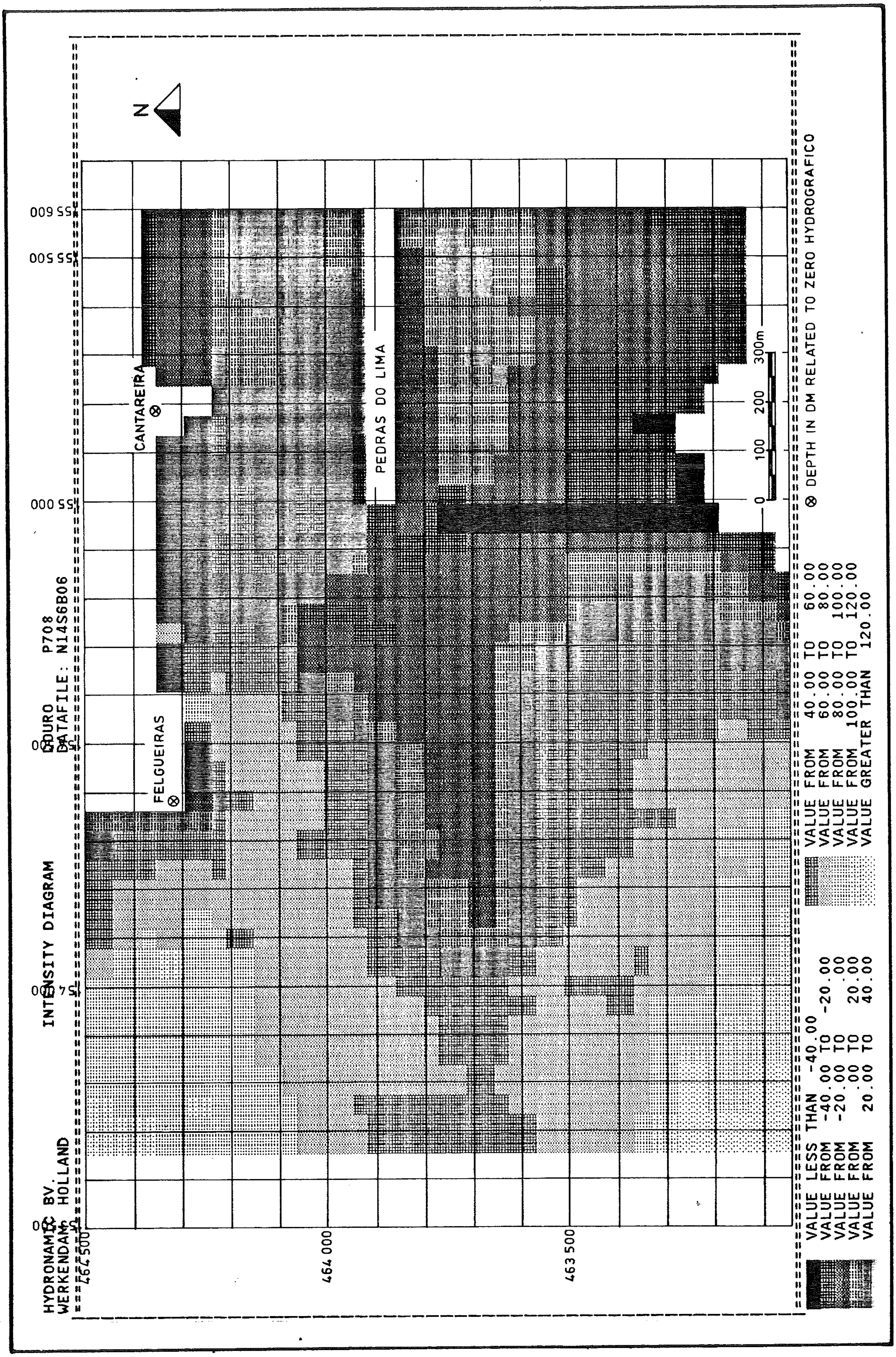


FIGURE 32: *BOTTOM LEVEL CONFIGURATION IN JUNE; SMOOTHING OF SILTATION LAYER (TEST B)*

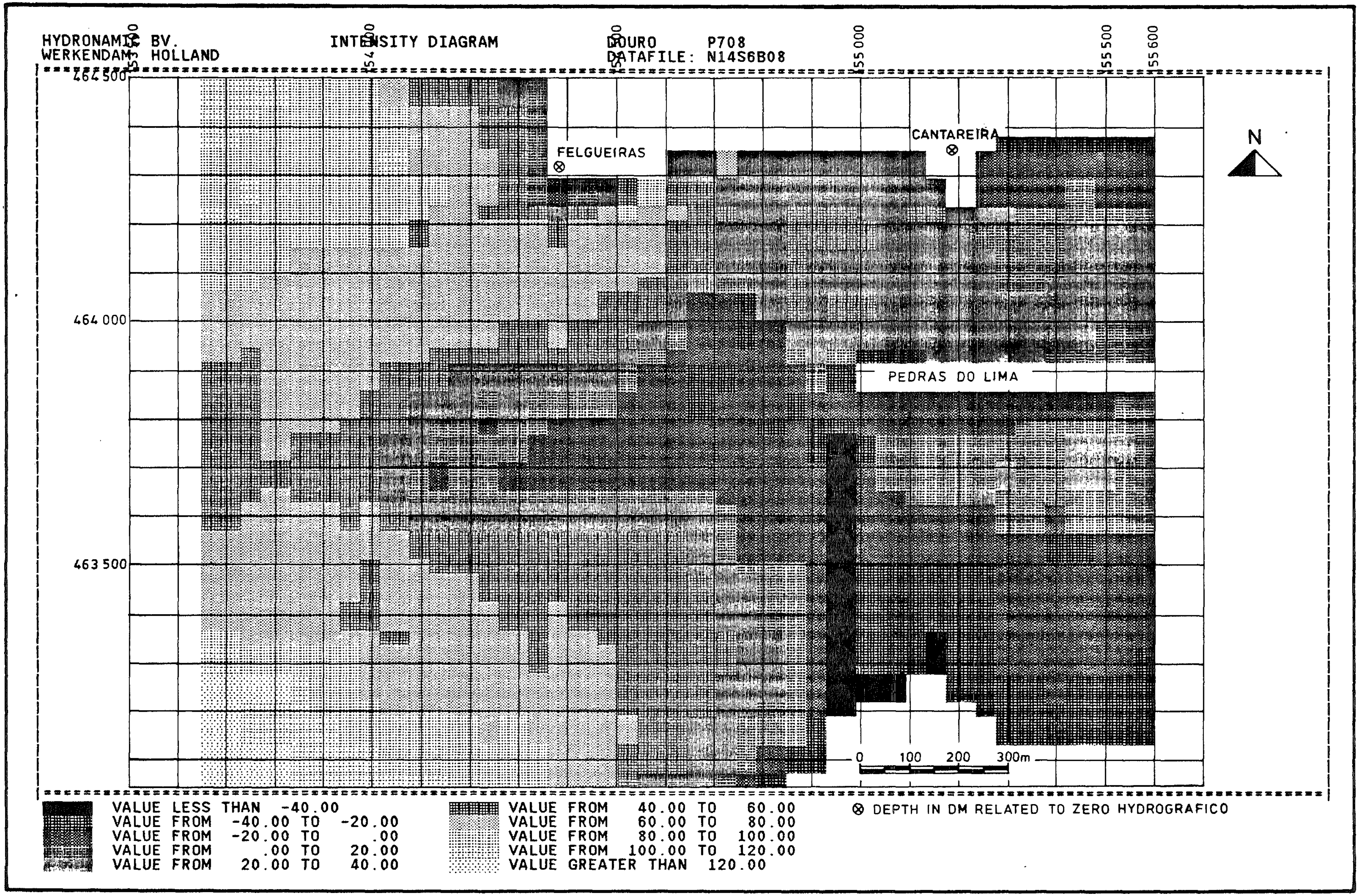


FIGURE 33: *BOTTOM LEVEL CONFIGURATION IN AUGUST; SMOOTHING OF SILTATION LAYER (TEST B)*

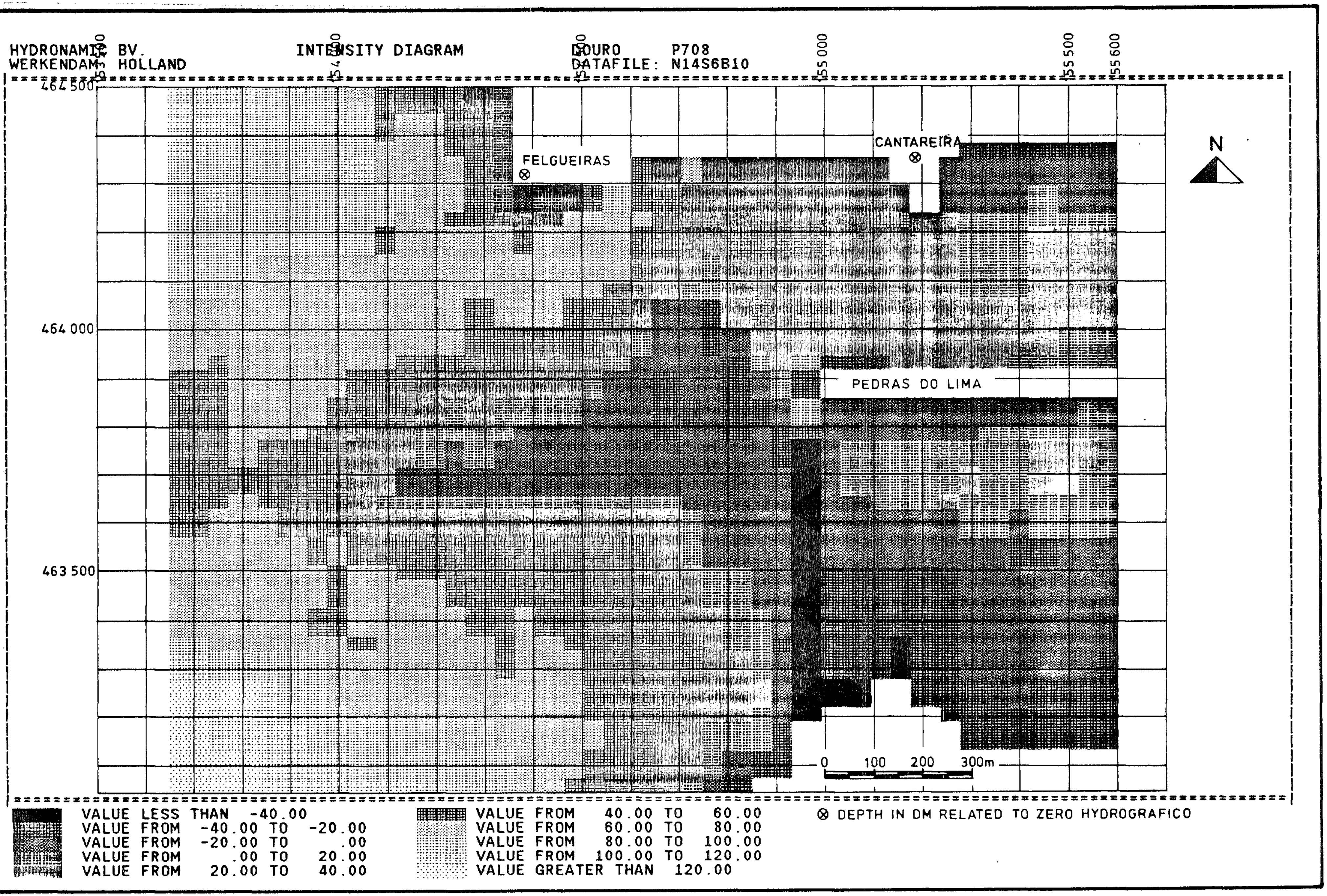


FIGURE 34: *BOTTOM LEVEL CONFIGURATION IN OCTOBER; SMOOTHING OF SILTATION LAYER (TEST B)*

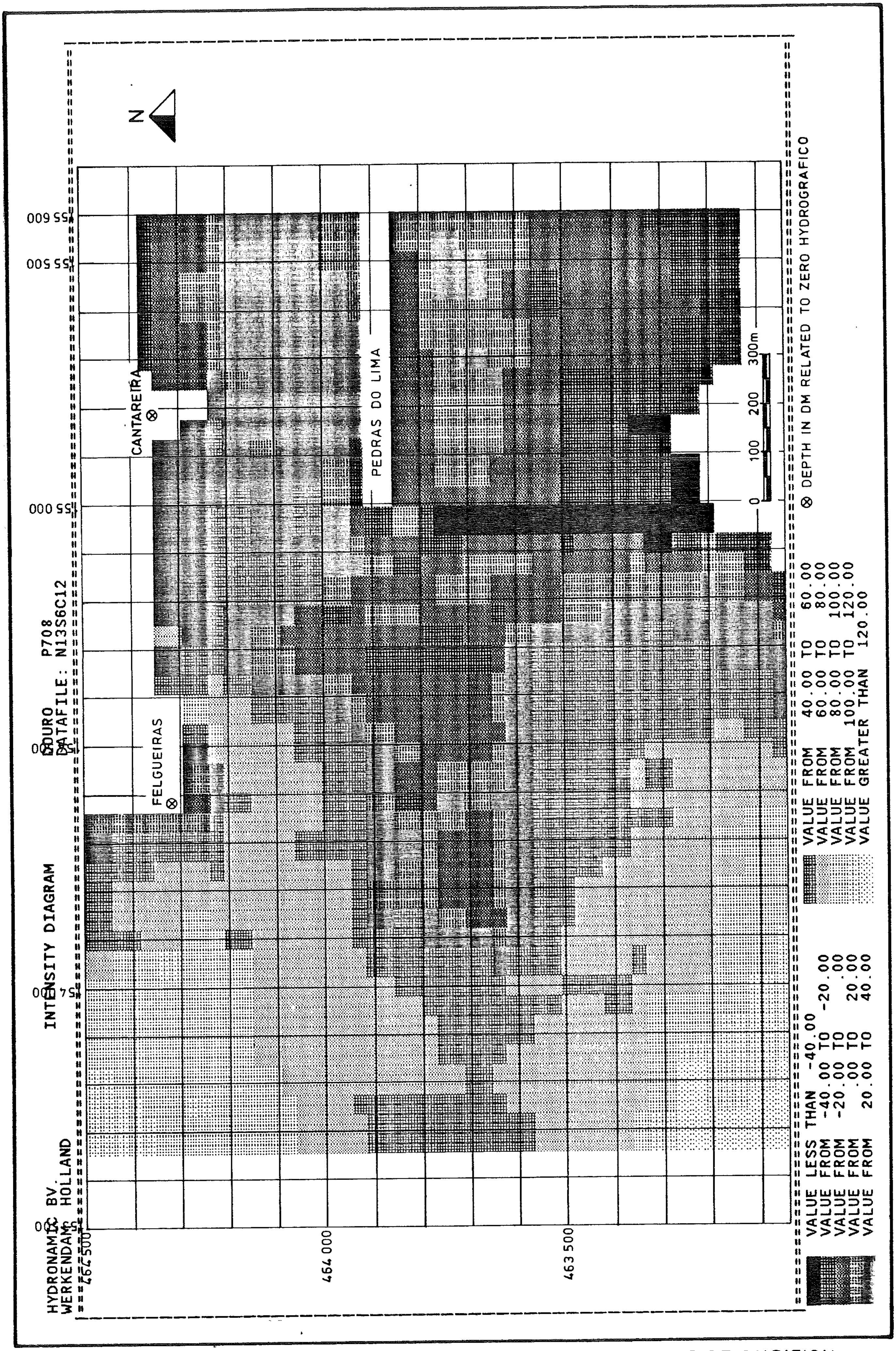


FIGURE 35: *BOTTOM LEVEL CONFIGURATION IN DECEMBER; SMOOTHING OF SILTATION LAYER (TEST B)*

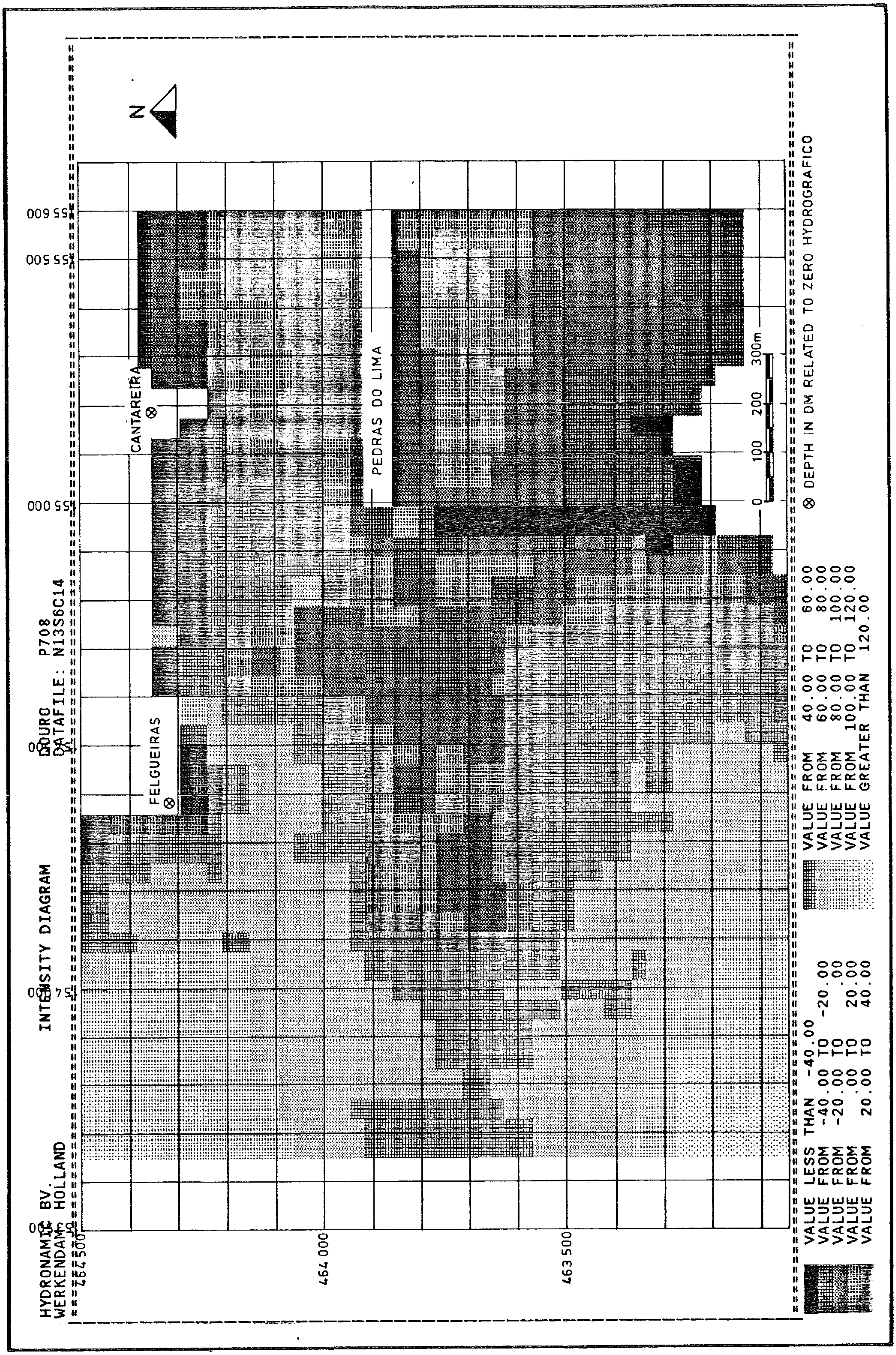


FIGURE 36: *BOTTOM LEVEL CONFIGURATION IN FEBRUARY; SMOOTHING OF SILTATION LAYER (TEST B)*

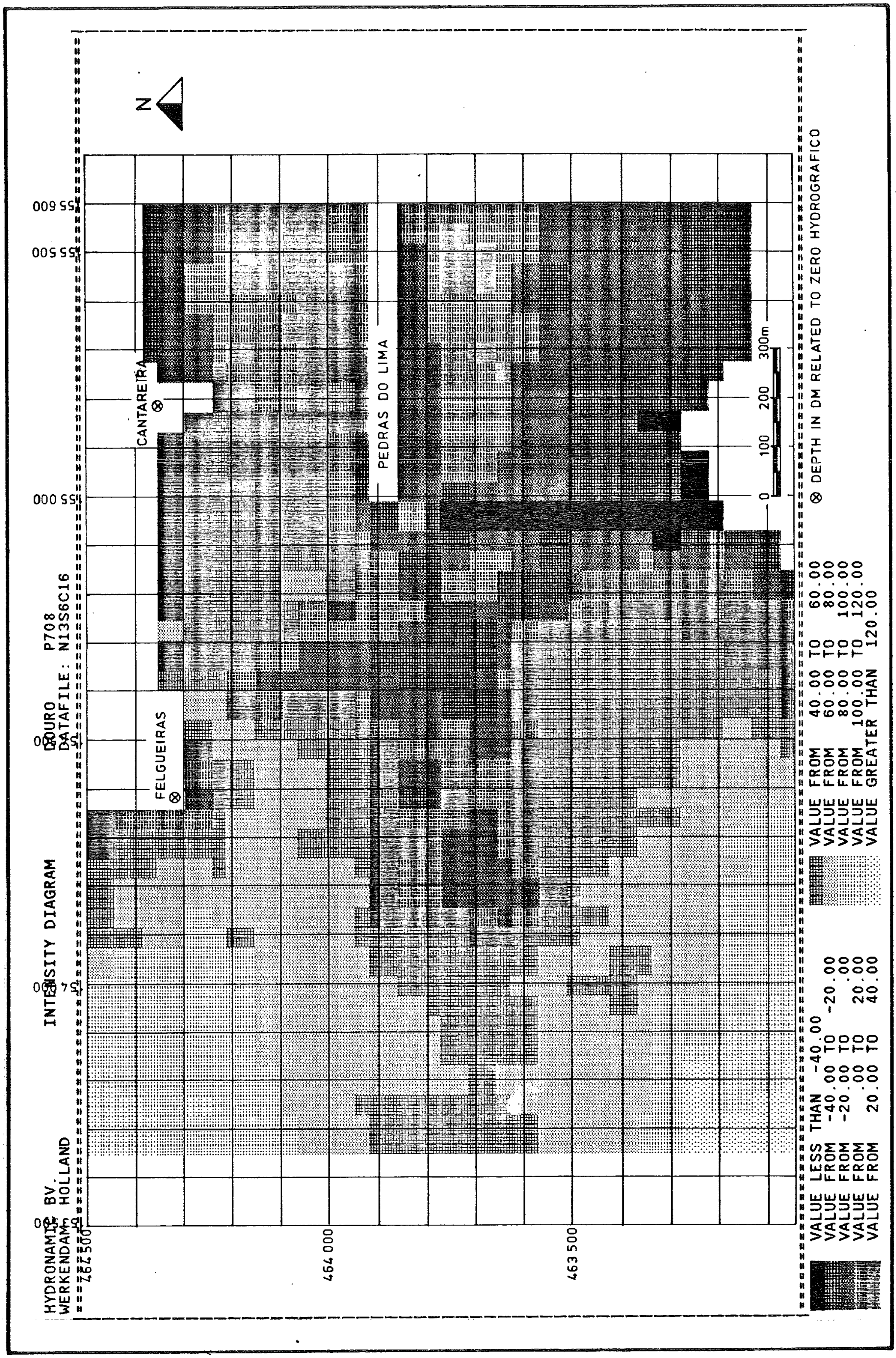


FIGURE 37: *BOTTOM LEVEL CONFIGURATION IN APRIL; SMOOTHING OF SILTATION LAYER (TEST B)*

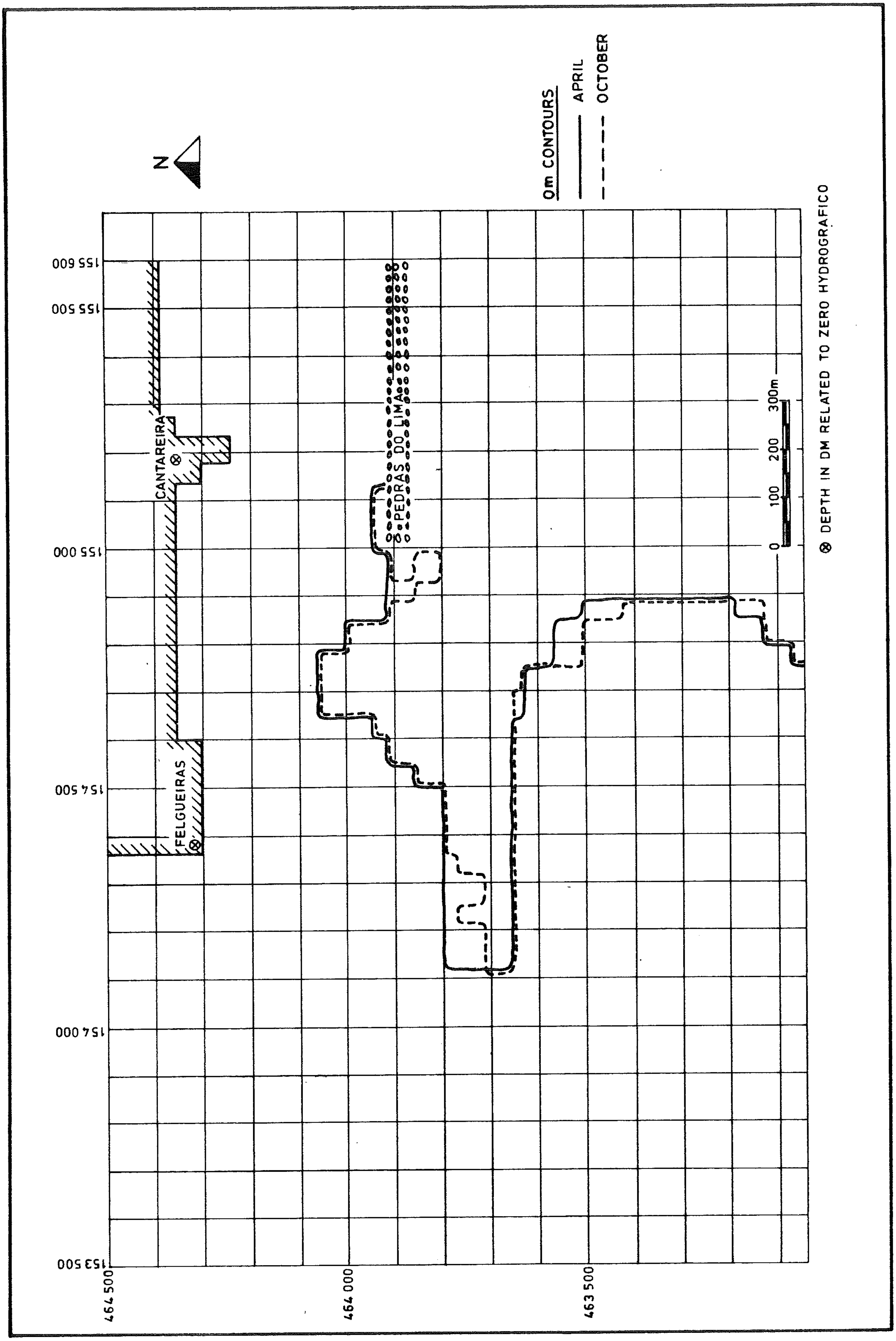


FIGURE 38: *POSITION OF 0m CONTOURS (SUMMER PERIOD, TEST B)*

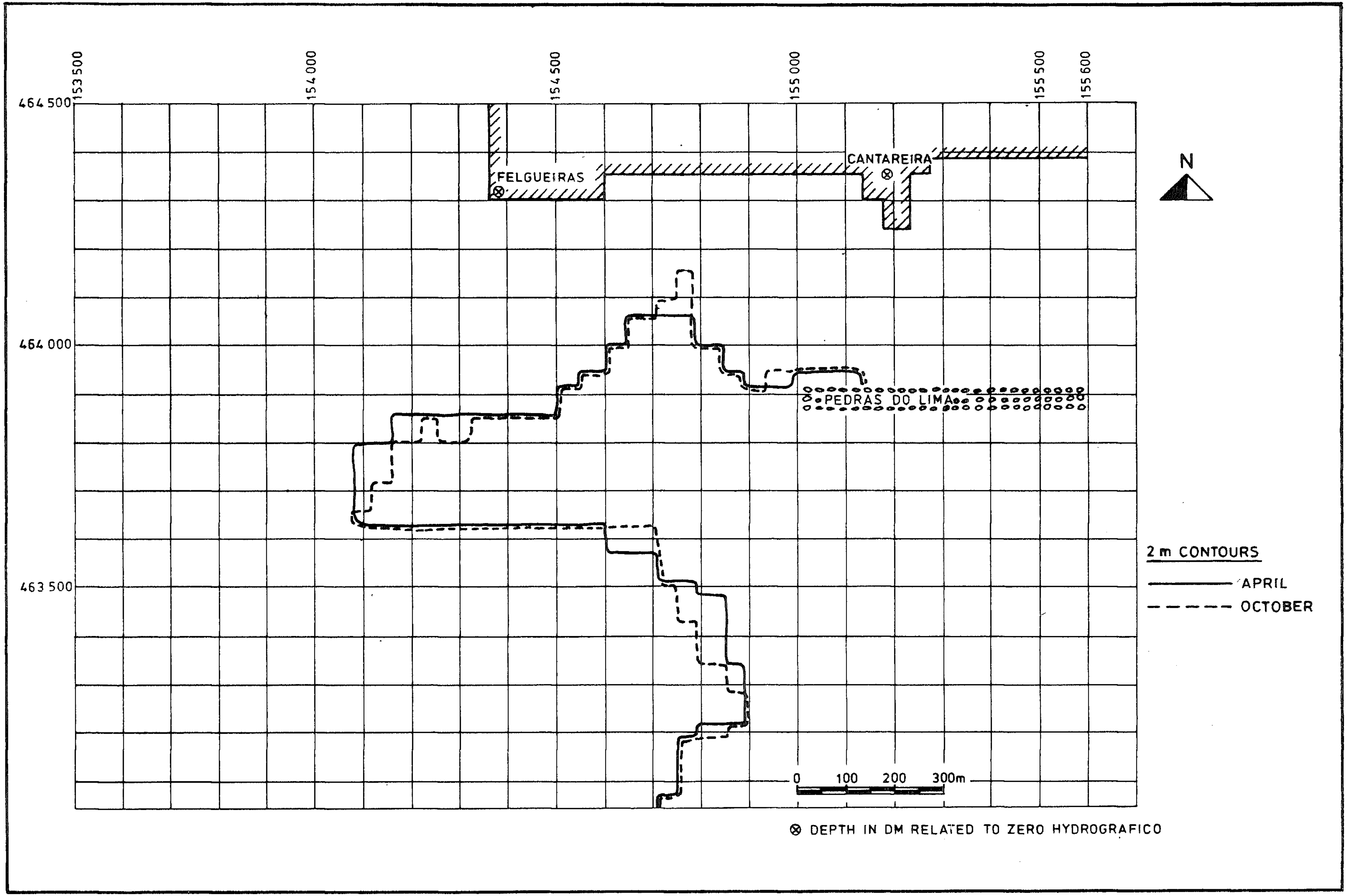


FIGURE 39: *POSITION OF 2m CONTOURS (SUMMER PERIOD, TEST B)*

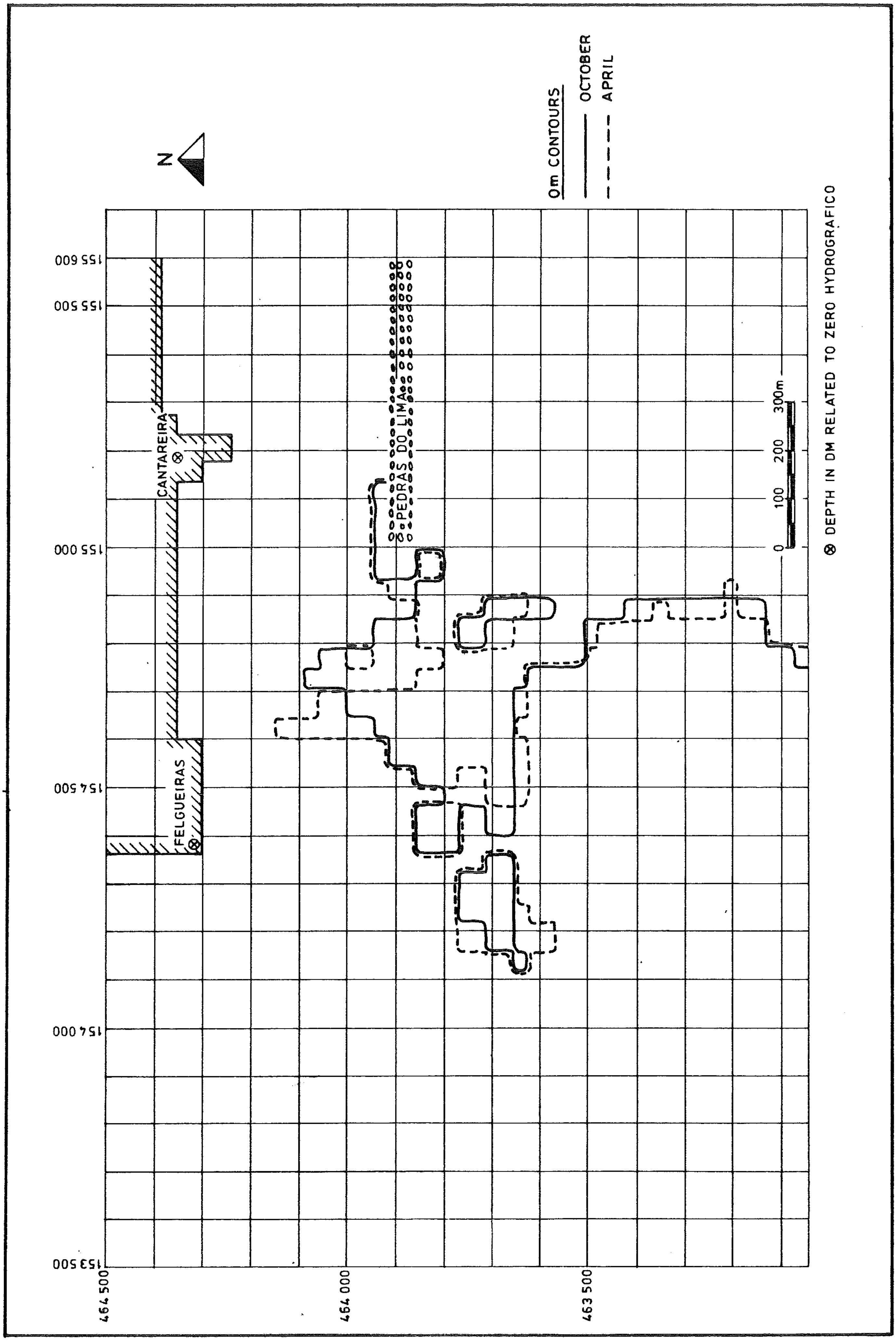


FIGURE 40: *POSITION OF 0m CONTOURS (WINTER PERIOD; TEST B)*

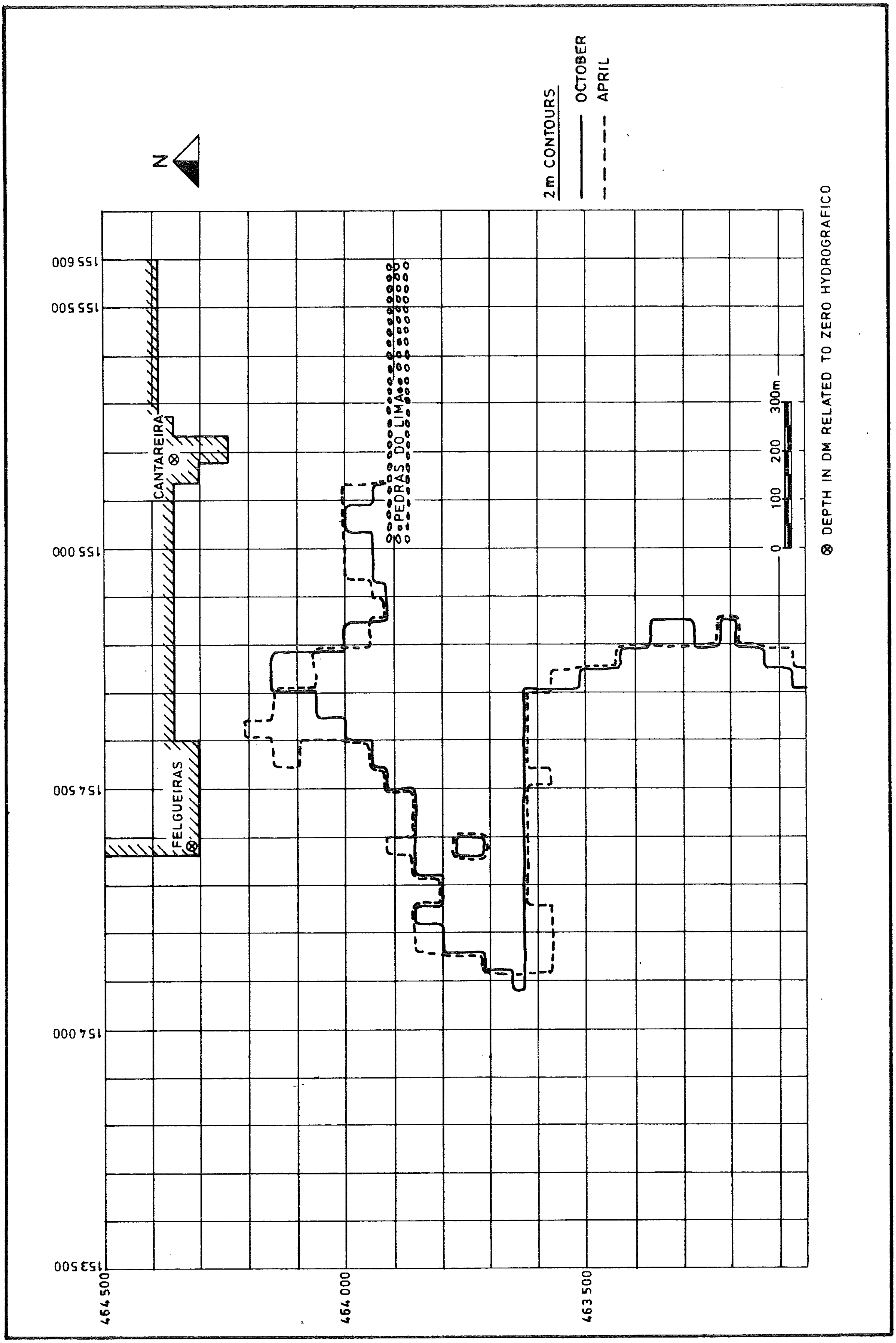


FIGURE 41: *POSITION OF 2m CONTOURS (WINTER PERIOD; TEST B)*

N14S6B06 FRI, JUL 13, 1984, 10:45 AM

J14Z61S6 YR 0; MTH 6 NP 6 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.0	-17.0	-4.9	12.0	30.0	33.0	33.0	23.0
-99.0	-99.0	-25.0	-16.0	-4.9	9.0	27.0	30.0	31.0	22.0
-99.0	-99.0	-23.0	-15.0	-2.6	9.5	24.4	25.9	26.5	21.7
-99.0	-99.0	-21.0	-11.9	-.2	10.0	20.9	24.9	26.4	23.8
-99.0	-99.0	-21.0	-10.9	-2.1	7.9	12.8	20.4	25.6	26.8
-99.0	-99.0	-23.0	-10.0	-2.8	9.8	9.8	10.9	23.3	27.8
-99.0	-99.0	-26.0	-10.0	-.4	21.6	13.7	13.6	21.3	26.8
-99.0	-99.0	-99.0	-9.0	-3.4	30.5	18.8	19.3	22.3	30.2
-99.0	-99.0	-99.0	-99.0	-99.0	36.8	26.7	23.9	24.5	27.1
-99.0	-99.0	-99.0	-99.0	30.5	43.0	30.0	26.4	29.6	32.0
-99.0	-99.0	-99.0	24.9	30.5	46.8	27.8	21.1	33.5	36.8
-99.0	-99.0	-99.0	24.9	30.2	38.7	31.2	30.2	33.5	39.8
-99.0	-99.0	-99.0	25.1	29.9	35.4	41.2	34.2	35.8	45.9
-99.0	-99.0	-99.0	29.0	28.2	39.5	47.8	33.0	33.5	42.4
-99.0	-99.0	-99.0	24.8	23.0	44.7	45.8	31.4	38.0	34.8
-99.0	-99.0	-99.0	24.8	25.1	43.5	45.6	45.3	42.8	41.1
-99.0	-99.0	-99.0	26.6	29.7	38.8	38.2	35.9	34.3	23.2
-99.0	-99.0	-99.0	37.6	34.1	39.5	29.0	22.8	13.3	-20.8
-99.0	-99.0	-99.0	60.1	30.2	40.6	42.0	33.8	15.6	-6.1
-99.0	-99.0	-99.0	35.5	41.2	50.4	46.4	45.3	45.5	-.2
-99.0	-99.0	-99.0	38.5	54.4	64.9	59.6	53.8	49.1	30.9
-99.0	-99.0	-99.0	-99.0	81.0	75.0	64.9	60.1	54.9	45.9
-99.0	-99.0	-99.0	-99.0	54.6	79.9	70.1	65.2	60.4	52.5
-99.0	-99.0	-99.0	-99.0	37.9	71.7	69.5	66.9	60.0	55.1
-99.0	-99.0	-99.0	-99.0	22.4	45.0	62.0	67.8	62.1	60.1
-99.0	-99.0	-99.0	-99.0	-5.7	34.3	56.0	63.9	64.0	63.1
16.6	18.3	18.3	.7	1.3	43.0	62.7	75.1	62.9	60.9
27.7	44.3	40.6	43.7	42.3	47.4	78.3	64.1	62.0	59.9
48.7	52.1	51.7	62.2	65.2	58.5	68.0	61.0	62.0	60.9
56.9	62.3	61.5	61.3	73.2	72.9	69.6	63.7	62.9	61.9
56.0	64.0	68.1	68.1	82.2	75.0	75.8	68.6	65.6	63.9
58.1	60.1	80.0	74.9	86.3	81.2	44.7	72.3	67.5	65.9
78.3	81.2	91.0	101.0	90.3	85.2	82.8	75.4	64.6	67.9
88.2	90.2	91.1	95.0	93.1	88.2	82.1	77.9	74.9	64.9
94.1	95.1	95.0	91.0	88.9	91.8	83.8	76.8	77.8	69.8
92.0	93.9	97.9	95.9	89.9	93.8	87.7	76.7	79.7	68.7
96.0	94.7	97.3	89.4	88.6	90.7	89.7	79.5	79.4	71.6
99.9	96.7	95.3	91.4	96.6	93.7	92.7	83.5	76.4	74.6
102.0	99.9	98.9	96.9	102.9	96.8	92.8	86.7	80.6	73.7
102.1	103.1	100.0	99.0	98.0	99.9	95.8	87.8	82.7	74.6
16.0	7.0	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
18.0	11.0	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
18.0	12.0	-99.0	-1.0	1.0	22.0	20.0	11.4	3.7	-19.7
23.1	15.1	-99.0	-2.0	1.0	21.0	28.9	12.3	.7	-20.8
27.2	19.1	-99.0	-3.0	1.0	19.0	19.9	9.1	-1.6	-20.8
26.2	20.1	-99.0	-4.0	1.0	15.0	18.1	9.5	1.1	-19.2
27.1	27.1	-99.0	-5.0	-1.0	9.0	20.2	13.0	9.8	-18.8
32.2	36.1	-99.0	-6.0	-2.0	7.0	16.1	20.3	-19.6	-19.6
38.3	28.3	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
32.2	22.9	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
28.7	-17.2	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
25.3	-20.8	-99.0	-9.6	-5.7	2.0	-.0	-1.0	-20.0	-20.0
26.3	-28.3	-99.0	-16.9	-18.5	-20.1	-20.0	-20.0	-20.0	-20.0
35.7	23.5	-23.8	-17.3	-30.9	-70.0	-70.0	-70.0	-70.0	-70.0
33.5	30.8	-3.8	-26.4	-31.8	-26.7	-14.3	-7.6	-7.7	-11.5
31.3	15.6	-6.3	-31.5	-11.8	-10.5	-9.0	-6.9	-6.0	-8.1
-6.8	-19.7	-15.4	-10.0	-13.5	-12.4	-11.4	-8.6	-4.6	-2.7

70.0	71.1	71.1	70.9	99.6	121.7	112.9	114.0	121.0	124.0
70.0	70.1	70.1	77.9	99.5	124.5	115.8	117.0	127.0	126.0
70.0	71.1	72.1	82.8	100.5	121.4	123.7	126.9	132.0	126.0

-29.6	-23.7	-16.4	-10.6	-10.2	-12.3	-12.6	-6.0	-1.8	-2.1
-12.2	-21.3	-21.9	-13.3	-8.6	-8.2	-8.7	-.6	5.6	11.5
-5.6	-13.0	-18.3	-13.3	-7.4	-6.4	-5.8	2.4	18.6	31.2
7.3	-3.8	-7.1	-7.3	-7.2	-6.4	-6.2	3.9	23.3	44.1
30.4	9.9	-2.2	-3.7	-6.6	-6.7	-6.0	11.7	35.2	55.8
50.3	29.8	8.5	-3.1	-5.9	-6.5	-5.7	10.2	31.0	51.0
54.1	49.7	28.5	8.6	-4.9	-5.9	-5.8	12.5	32.6	53.3
57.1	53.5	33.1	12.4	-4.5	-7.1	-9.7	11.9	33.2	53.2
59.9	54.6	32.3	11.4	-4.5	-6.6	-6.1	13.4	33.2	53.5
58.8	54.6	35.9	17.9	-.5	-2.2	-2.6	12.5	31.8	52.8
59.6	55.8	35.8	19.7	1.7	-1.1	-2.4	13.5	32.6	52.6
60.4	54.1	31.8	15.8	-.8	-1.0	-.4	14.4	32.5	54.2
60.3	54.8	35.4	23.9	8.6	4.7	-1.5	12.5	32.4	55.0
62.4	57.9	43.1	31.8	12.5	6.0	-2.8	12.2	32.9	54.7
62.7	60.3	46.2	34.3	25.8	18.3	18.2	17.0	39.5	59.1
64.8	62.2	56.5	47.2	40.1	33.3	37.8	38.3	51.0	60.1
67.8	63.9	61.1	56.6	55.1	54.4	54.0	55.5	60.5	62.0
68.8	64.9	61.9	60.2	56.7	55.0	55.7	59.2	57.0	60.0
69.8	65.9	64.0	62.1	60.1	59.3	57.3	57.1	60.0	63.1
69.8	66.9	65.9	63.9	61.8	59.8	57.9	58.9	61.0	65.1
64.8	69.8	67.8	65.8	62.8	60.7	56.8	60.9	63.9	67.0
69.8	58.8	53.8	54.9	50.0	48.0	52.0	56.0	62.0	66.0
75.7	64.8	56.9	54.0	49.1	46.1	48.1	50.0	59.0	64.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.1	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.1	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.9	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.7	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-12.6	-11.0	-9.0	-7.5	-11.3	-14.8	-21.8	-34.9	-40.0	-99.0
3.6	5.0	10.1	14.1	15.5	17.1	1.6	-6.1	-35.0	-99.0
10.4	15.1	16.4	21.0	21.6	21.5	18.2	6.6	-8.4	-29.7
18.4	24.5	26.5	32.0	32.7	31.3	26.0	15.2	6.2	-3.9
25.5	34.3	39.1	43.6	46.0	32.9	32.1	23.5	20.1	14.8
39.6	44.6	47.3	50.2	51.0	49.3	45.4	34.3	26.6	24.4
49.6	51.4	52.1	52.0	52.1	52.2	50.9	44.8	40.4	31.5
52.9	51.6	52.9	54.0	54.1	53.1	51.0	50.1	45.5	35.3
51.6	51.8	52.7	56.1	55.2	53.1	55.1	60.2	54.4	50.2
53.3	53.2	55.7	57.2	60.1	63.0	67.1	65.2	64.2	60.2
54.1	54.1	57.9	60.1	60.1	63.9	69.9	71.2	71.2	71.1
53.8	56.2	59.9	61.1	61.1	64.9	69.9	73.1	73.3	73.1
53.2	55.8	57.6	54.0	56.1	62.0	67.9	78.0	82.2	82.1
53.0	55.7	59.6	62.9	61.1	64.1	68.0	82.0	83.1	84.1
54.9	58.8	62.7	64.9	65.1	64.1	74.0	78.9	84.0	86.1
57.5	61.8	64.7	66.7	67.1	66.1	74.9	83.9	92.0	93.1
58.3	61.8	63.6	64.7	65.1	70.1	76.9	87.8	93.0	100.0
61.6	62.9	63.7	63.7	64.1	65.2	76.9	87.7	92.8	103.0
60.8	61.8	61.6	58.7	72.0	68.2	77.0	86.7	97.8	107.0
55.9	55.9	54.9	63.9	77.0	76.1	84.1	89.9	101.9	107.0
61.1	61.2	57.2	70.0	84.9	85.0	90.1	96.0	112.0	105.0
65.1	70.3	64.2	70.8	93.6	94.9	96.0	105.1	116.0	113.0
69.1	72.1	68.1	69.8	98.6	113.8	111.0	109.1	117.1	118.0

FIGURE 42: *BOTTOM LEVELS IN JUNE; SMOOTHING OF SILTATION LAYER (TEST B)*

N14S6B08

FRI, JUL 13, 1984, 10:45 AM

J14261S6 YR 0; MTH 8 NP 8 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.0	-17.0	-4.9	12.1	30.1	33.1	33.1	23.1
-99.0	-99.0	-25.0	-16.0	-4.9	9.1	27.1	30.1	31.1	22.1
-99.0	-99.0	-23.0	-14.9	-2.3	9.9	24.6	25.5	25.8	21.4
-99.0	-99.0	-21.0	-11.8	.3	10.9	21.4	24.3	25.1	23.3
-99.0	-99.0	-21.0	-10.8	-1.5	8.7	13.0	18.3	22.8	25.8
-99.0	-99.0	-23.0	-9.9	-3.1	9.4	8.7	7.2	19.5	26.8
-99.0	-99.0	-26.0	-10.0	-1.4	20.4	13.4	12.0	19.4	26.5
-99.0	-99.0	-99.0	-9.0	-4.2	29.5	19.8	21.1	23.1	30.7
-99.0	-99.0	-99.0	-99.0	-99.0	36.8	28.4	26.3	25.7	27.5
-99.0	-99.0	-99.0	-99.0	30.6	43.5	31.1	27.7	30.2	31.9
-99.0	-99.0	-99.0	24.8	30.6	47.4	28.5	21.8	34.0	36.3
-99.0	-99.0	-99.0	24.8	30.1	39.4	32.7	31.4	33.9	39.0
-99.0	-99.0	-99.0	25.3	30.1	36.1	42.8	35.5	36.3	45.2
-99.0	-99.0	-99.0	29.2	28.6	40.0	48.6	33.7	33.8	42.1
-99.0	-99.0	-99.0	24.9	23.0	44.8	46.0	31.4	38.0	34.8
-99.0	-99.0	-99.0	25.0	25.2	43.7	46.0	46.0	44.1	42.7
-99.0	-99.0	-99.0	26.5	29.6	39.3	39.6	36.9	36.5	28.0
-99.0	-99.0	-99.0	37.6	34.2	39.9	28.5	20.0	10.5	-21.8
-99.0	-99.0	-99.0	60.5	30.6	40.3	39.4	28.1	8.9	-12.2
-99.0	-99.0	-99.0	36.1	41.4	49.9	44.7	42.2	42.7	-3.9
-99.0	-99.0	-99.0	39.2	54.9	64.9	59.0	53.4	49.0	29.3
-99.0	-99.0	-99.0	-99.0	81.2	75.1	64.9	60.1	54.9	45.7
-99.0	-99.0	-99.0	-99.0	54.7	80.0	70.2	65.2	60.5	52.5
-99.0	-99.0	-99.0	-99.0	36.6	71.0	69.3	66.9	60.1	55.2
-99.0	-99.0	-99.0	-99.0	18.3	42.4	61.6	67.9	62.2	60.2
-99.0	-99.0	-99.0	-99.0	-5.9	33.3	55.8	64.0	64.1	63.1
16.8	18.5	19.1	3.7	5.1	44.6	62.9	75.1	63.0	61.0
27.9	44.5	41.2	45.1	43.8	48.2	78.6	64.2	62.0	60.0
48.8	52.2	51.9	62.4	65.4	58.6	68.1	61.1	62.1	61.0
57.0	62.4	61.6	61.3	73.2	73.0	69.7	63.8	62.9	62.0
56.1	64.1	68.2	68.1	82.3	75.1	75.8	68.6	65.7	64.0
58.2	60.1	80.0	75.0	86.4	81.3	44.8	72.3	67.5	66.0
78.4	81.3	91.1	101.0	90.4	85.4	82.9	75.5	64.6	68.0
88.3	90.2	91.1	95.1	93.2	88.2	82.1	78.0	74.9	65.0
94.2	95.2	95.1	91.1	89.0	91.9	83.9	76.9	77.9	69.9
92.1	94.0	97.9	95.9	89.9	93.9	87.8	76.8	79.7	68.8
96.0	94.8	97.4	89.4	88.7	90.8	89.8	79.6	79.5	71.7
100.0	96.8	95.4	91.4	96.7	93.8	92.8	83.6	76.5	74.7
102.1	100.0	98.9	96.9	102.9	96.9	92.8	86.8	80.7	73.7
102.2	103.1	100.1	99.1	98.1	100.0	95.9	87.8	82.7	74.7
16.1	7.1	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
18.1	11.1	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
18.1	12.2	-99.0	-1.0	1.0	22.0	20.0	11.5	3.8	-19.6
23.2	15.2	-99.0	-2.0	1.0	21.0	28.8	12.1	.5	-20.9
27.3	19.3	-99.0	-3.0	1.0	19.0	19.8	8.5	-2.4	-21.2
26.3	20.2	-99.0	-4.0	1.0	15.0	18.0	9.4	1.1	-19.1
27.3	27.2	-99.0	-5.0	-1.0	9.0	20.2	13.4	10.7	-18.2
32.4	36.2	-99.0	-6.0	-2.0	7.0	16.1	20.5	-19.4	-19.3
38.6	28.7	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
32.1	23.4	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
27.2	-17.5	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
22.4	-22.6	-99.0	-9.5	-5.7	2.0	-.0	-1.0	-20.0	-20.0
22.5	-30.5	-99.0	-14.9	-17.1	-20.1	-20.0	-20.0	-20.0	-20.0
33.4	17.1	-21.2	-7.4	-31.1	-70.0	-70.0	-70.0	-70.0	-70.0
32.7	31.2	4.2	-16.5	-33.3	-25.2	-9.3	-6.8	-11.2	-14.0
33.0	18.0	-3.7	-31.9	-16.8	-14.2	-7.4	-4.6	-8.1	-11.4
-1.8	-15.3	-12.9	-14.5	-21.1	-15.1	-12.3	-10.2	-5.9	-4.2

-29.5	-15.3	-7.2	-9.2	-11.0	-9.8	-13.7	-10.0	-3.0	-1.7
-17.7	-17.7	-22.5	-18.7	-10.5	-6.5	-7.2	-.8	5.9	12.5
-12.1	-17.4	-26.8	-24.0	-12.4	-8.4	-6.7	3.4	20.9	32.8
4.4	-3.9	-6.6	-9.6	-8.4	-8.4	-8.2	4.3	25.2	45.7
30.4	10.2	-2.3	-3.8	-5.4	-6.9	-7.7	11.3	35.5	56.2
50.4	29.6	7.4	-4.4	-5.2	-5.2	-5.7	10.3	31.1	51.0
54.2	49.5	28.0	8.7	-4.2	-5.2	-5.2	13.0	33.1	53.5
57.1	52.8	30.9	10.5	-5.1	-7.9	-10.3	12.0	33.6	53.5
60.0	53.9	27.0	3.3	-7.9	-8.1	-7.5	13.8	33.5	53.6
58.9	54.0	34.2	17.2	.9	-1.4	-2.5	13.1	32.1	52.8
59.7	55.2	36.2	24.4	6.2	.5	-.7	14.6	33.0	52.6
60.4	53.4	28.5	14.9	-.6	.2	3.4	15.5	32.6	54.4
60.3	53.9	33.2	24.9	11.8	8.9	1.6	12.0	32.1	55.2
62.5	57.7	43.8	35.3	17.6	10.7	-1.7	10.6	32.4	54.8
62.7	60.4	47.1	36.1	28.4	21.5	19.1	16.0	39.1	59.2
64.9	62.3	56.7	47.5	40.9	34.2	38.0	38.1	50.9	60.1
67.9	64.0	61.1	56.6	55.2	54.6	54.1	55.5	60.5	62.1
68.9	64.9	62.0	60.2	56.7	55.1	55.8	59.3	57.1	60.1
69.9	65.9	64.0	62.1	60.2	59.4	57.4	57.2	60.1	63.1
69.9	66.9	66.0	64.0	61.9	59.8	58.0	59.0	61.1	65.1
64.9	69.9	67.9	65.9	62.9	60.8	56.9	61.0	64.0	67.1
69.8	58.9	53.9	55.0	50.1	48.1	52.1	56.1	62.1	66.1
75.8	64.9	57.0	54.1	49.2	46.2	48.2	50.1	59.1	64.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.2	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.1	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.9	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.6	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-10.8	-9.9	-11.5	-15.5	-19.7	-16.5	-15.2	-34.6	-40.0	-99.0
2.2	4.5	8.1	9.7	12.1	19.1	8.8	-.0	-34.9	-99.0
8.5	13.5	15.4	20.2	21.1	22.3	19.8	7.6	-6.9	-29.5
17.5	22.6	25.8	31.7	32.7	31.7	26.1	15.3	7.6	-3.3
25.0	32.9	38.6	43.5	46.2	33.3	32.3	23.8	20.5	15.3
39.0	43.7	47.1	50.3	51.1	49.5	45.6	34.3	26.6	24.5
49.7	61.1	52.1	52.1	52.1	52.3	51.0	44.9	40.4	31.5
53.1	51.6	53.0	54.1	54.1	53.2	51.1	50.2	45.6	35.4
51.5	51.7	52.7	56.2	55.2	53.2	55.2	60.3	54.4	50.3
53.2	53.1	55.7	57.2	60.2	63.1	67.1	65.3	64.3	60.2
54.3	54.2	57.9	60.2	60.2	64.0	70.0	71.2	71.3	71.2
53.9	56.3	60.0	61.2	61.2	65.0	70.0	73.2	73.3	73.2
53.2	55.8	57.7	54.1	56.2	62.1	68.0	78.1	82.2	82.2
52.8	55.6	59.7	63.0	61.2	64.2	68.1	82.0	83.1	84.2
54.8	58.8	62.8	64.9	65.2	64.2	74.1	79.0	84.1	86.1
57.7	61.9	64.7	66.8	67.2	66.2	74.9	83.9	92.1	93.1
58.4	61.9	63.7	64.8	65.2	70.2	76.9	87.9	93.0	100.1
61.6	63.0	63.8	63.8	64.2	65.3	77.0	87.8	92.9	103.1
60.9	61.8	61.7	58.8	72.1	68.3	77.1	86.8	97.9	107.0
56.0	56.0	54.9	64.0	77.0	76.2	84.2	90.0	102.0	107.1
61.1	61.3	57.3	70.1	84.9	85.1	90.2	96.1	112.1	105.1
65.2	70.3	64.3	70.9	93.7	94.9	96.1	105.1	116.1	113.1
69.2	72.2	68.2	69.9	98.7	113.8	111.1	109.2	117.1	118.1

70.1	71.2	71.2	71.0	99.7	121.7	113.0	114.1	121.1	124.1
70.1	70.2	70.2	77.9	99.6	124.6	115.8	117.0	127.1	126.1
70.1	71.2	72.2	82.9	100.5	121.5	123.8	127.0	132.0	126.1

FIGURE 43: *BOTTOM LEVELS IN AUGUST; SMOOTHING OF SILTATION LAYER (TEST B)*

N14S6B10   FRI, JUL 13, 1984, 10:46 AM

J14261S6 YR 0; MTH 10 NP10 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.0	-16.9	-4.9	12.1	30.1	33.1	33.1	23.1
-99.0	-99.0	-25.0	-15.9	-4.9	9.1	27.1	30.1	31.1	22.1
-99.0	-99.0	-23.0	-14.9	-2.2	10.0	24.5	24.6	24.3	20.5
-99.0	-99.0	-21.0	-11.7	.7	11.4	21.6	23.1	23.2	22.4
-99.0	-99.0	-21.0	-10.6	-.9	9.4	12.8	15.1	18.7	24.3
-99.0	-99.0	-23.0	-9.9	-3.4	9.1	8.4	3.7	15.3	25.7
-99.0	-99.0	-26.0	-10.0	-2.5	19.5	14.5	12.3	18.4	26.7
-99.0	-99.0	-99.0	-9.1	-5.0	29.2	21.8	23.7	24.5	31.4
-99.0	-99.0	-99.0	-99.0	-99.0	37.2	30.1	28.3	26.9	28.0
-99.0	-99.0	-99.0	-99.0	30.6	44.3	32.1	28.5	30.7	31.9
-99.0	-99.0	-99.0	23.9	29.7	47.5	29.1	22.1	34.2	36.0
-99.0	-99.0	-99.0	24.5	28.6	38.6	33.7	32.4	34.2	38.5
-99.0	-99.0	-99.0	26.5	30.9	36.5	44.1	36.7	36.7	44.8
-99.0	-99.0	-99.0	30.1	29.7	41.2	49.8	34.5	34.0	42.0
-99.0	-99.0	-99.0	24.8	22.7	45.0	46.4	31.6	37.9	34.8
-99.0	-99.0	-99.0	25.2	25.5	43.7	46.2	46.2	44.7	43.6
-99.0	-99.0	-99.0	26.4	29.3	39.4	40.2	36.9	37.2	31.5
-99.0	-99.0	-99.0	37.3	34.6	40.8	28.2	17.9	9.6	-22.3
-99.0	-99.0	-99.0	61.1	31.8	41.0	37.9	22.9	3.6	-13.2
-99.0	-99.0	-99.0	37.4	42.3	50.0	43.5	38.0	38.8	-4.4
-99.0	-99.0	-99.0	40.5	56.0	65.1	58.4	52.6	49.0	29.8
-99.0	-99.0	-99.0	-99.0	81.7	75.3	64.9	60.1	55.1	46.0
-99.0	-99.0	-99.0	-99.0	54.6	80.0	70.2	65.3	60.5	52.6
-99.0	-99.0	-99.0	-99.0	34.5	69.8	68.9	67.0	60.1	55.2
-99.0	-99.0	-99.0	-99.0	12.3	38.3	60.9	67.9	62.2	60.3
-99.0	-99.0	-99.0	-99.0	-8.1	30.8	55.2	63.9	64.1	63.2
18.3	19.4	19.9	6.2	8.3	45.7	62.7	75.0	62.8	60.8
29.4	45.4	42.2	46.8	45.3	49.0	78.7	64.1	61.9	59.7
49.5	52.5	52.0	62.7	65.6	58.7	68.1	61.1	62.2	60.9
57.0	62.4	61.5	61.2	73.2	72.9	69.7	63.8	63.0	62.1
55.9	63.9	68.0	68.0	82.2	75.1	75.5	68.2	65.7	64.1
58.0	59.8	79.8	74.8	86.3	81.6	44.6	71.8	67.5	66.0
78.2	81.0	90.8	100.9	90.4	85.7	83.0	75.3	64.6	68.0
88.2	90.1	90.9	94.9	93.1	88.2	82.1	78.0	74.9	65.0
94.1	95.0	95.0	90.9	88.8	91.7	83.7	76.7	77.8	69.8
92.0	93.9	97.8	95.7	89.7	93.6	87.6	76.5	79.5	68.6
96.0	94.7	97.3	89.3	88.5	90.7	89.6	79.3	79.2	71.5
100.0	96.7	95.3	91.3	96.5	93.7	92.7	83.5	76.3	74.5
102.1	100.0	98.9	96.8	102.8	96.8	92.8	86.7	80.6	73.6
102.2	103.1	100.1	99.0	98.0	99.9	95.8	87.8	82.7	74.7
16.1	7.1	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
18.1	11.1	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
18.1	12.3	-99.0	-1.0	1.0	22.0	20.0	11.5	3.8	-19.6
23.3	15.5	-99.0	-2.0	1.0	21.0	28.8	12.1	.4	-21.0
27.4	19.4	-99.0	-3.0	1.0	19.0	19.8	8.4	-2.6	-21.3
26.5	20.4	-99.0	-4.0	1.0	15.0	18.0	9.4	1.1	-19.1
27.5	27.2	-99.0	-5.0	-1.0	9.0	20.2	13.5	10.9	-18.1
32.7	36.3	-99.0	-6.0	-2.0	7.0	16.2	20.5	-19.3	-19.3
38.9	28.7	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
31.8	23.3	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
26.0	-18.1	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
20.8	-23.4	-99.0	-8.4	-5.0	2.0	-.0	-1.0	-20.0	-20.0
20.1	-30.7	-99.0	-8.6	-14.6	-20.0	-20.0	-20.0	-20.0	-20.0
31.0	8.0	-20.6	2.4	-30.1	-70.0	-70.0	-70.0	-70.0	-70.0
30.4	24.2	1.3	-10.3	-33.5	-22.8	-6.1	-8.3	-11.6	-11.9
32.0	11.6	-13.6	-32.5	-16.9	-16.1	-7.6	-2.0	-6.8	-12.5
-.4	-21.1	-21.8	-21.9	-22.8	-14.2	-11.3	-13.2	-8.2	-6.7

-28.9	-14.2	-4.4	-7.0	-11.4	-3.0	-9.2	-14.8	-5.1	-.6
-15.8	-11.0	-19.9	-25.7	-14.8	-3.4	-2.7	-.2	7.9	16.2
-9.1	-12.9	-27.8	-30.5	-20.8	-11.8	-7.1	4.7	25.4	37.1
5.6	-2.5	-5.6	-11.5	-12.6	-12.3	-11.3	3.9	28.1	48.6
30.7	10.8	-1.1	-3.3	-4.9	-8.7	-12.1	9.4	35.4	56.8
50.4	29.4	6.9	-4.1	-3.6	-6.5	-8.5	9.8	31.2	50.9
54.2	49.8	28.4	9.7	-3.1	-5.4	-5.8	13.7	34.1	53.5
57.1	53.1	31.7	13.3	-1.2	-9.0	-14.3	10.8	33.8	53.8
59.9	52.5	24.8	3.8	-6.2	-13.8	-15.4	11.8	33.2	53.7
58.5	53.0	34.2	18.5	2.0	-5.1	-8.4	11.2	32.0	52.6
59.2	54.5	36.1	28.6	13.4	1.1	-4.8	13.2	33.1	52.5
60.1	51.4	23.3	17.3	3.9	-6.0	-2.3	14.2	32.5	54.6
60.5	52.1	27.6	26.7	15.2	6.8	-1.5	7.1	30.5	55.2
62.7	57.1	44.2	41.6	25.8	21.7	-.3	.8	29.0	54.6
62.8	61.0	50.7	42.6	36.3	32.6	20.4	7.2	35.6	59.0
64.9	62.7	57.9	49.4	44.6	38.9	37.9	34.3	48.8	59.8
67.8	63.9	61.2	57.0	56.3	55.8	54.2	54.7	59.9	61.9
68.8	64.8	62.0	60.3	57.0	55.4	56.0	59.2	57.0	59.9
69.7	65.9	64.0	62.1	60.2	59.5	57.5	57.2	59.9	62.9
69.7	66.8	65.9	63.9	61.8	59.9	58.0	58.9	60.8	64.9
64.7	69.8	67.7	65.8	62.8	60.8	56.9	60.9	63.9	66.9
69.8	58.8	53.8	54.8	50.0	48.1	52.2	56.1	62.0	66.0
75.8	64.9	56.9	53.9	49.0	46.2	48.3	50.2	59.0	64.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.2	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.1	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.9	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.6	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-11.6	-16.7	-19.4	-21.1	-17.5	-11.4	-10.8	-34.7	-40.0	-99.0
-.3	-.1	3.6	7.3	11.6	20.2	11.2	.6	-35.0	-99.0
3.9	9.2	13.3	19.9	21.0	21.8	20.3	7.3	-6.1	-28.8
13.8	17.3	23.6	30.3	32.1	32.7	28.0	17.1	10.7	-2.2
24.0	29.1	36.9	42.7	46.2	34.3	33.2	24.9	21.5	16.1
39.2	42.5	46.7	50.2	51.1	49.7	45.7	34.3	26.4	24.5
50.3	51.0	52.1	52.1	52.1	52.3	51.1	45.0	40.3	31.4
53.3	51.5	52.8	54.0	54.1	53.2	51.2	50.4	45.5	35.2
51.3	51.6	52.6	56.1	55.3	53.2	55.3	60.3	54.0	50.1
53.0	53.0	55.7	57.2	60.2	63.1	67.2	65.1	63.8	59.9
54.3	54.0	57.9	60.2	60.2	64.0	70.0	71.0	70.8	70.9
54.0	56.3	60.0	61.2	61.2	65.0	69.9	72.9	72.9	73.0
52.8	55.6	57.7	54.0	56.0	61.8	67.7	77.8	81.9	82.0
52.3	55.3	59.6	62.9	61.0	63.8	67.7	81.8	82.8	84.0
54.6	58.5	62.6	64.9	65.0	63.9	73.8	78.8	83.8	86.0
57.5	61.7	64.6	66.7	67.0	66.0	74.7	83.7	91.8	93.0
58.1	61.7	63.6	64.7	65.1	70.1	76.8	87.7	92.8	100.0
61.5	62.8	63.7	63.7	64.1	65.2	76.9	87.6	92.6	102.9
60.8	61.8	61.6	68.7	72.0	68.1	76.9	86.5	97.4	106.8
55.9	55.9	54.8	63.8	76.9	76.0	83.9	89.6	101.4	106.8
61.1	61.2	57.1	69.7	84.6	84.9	90.0	95.8	111.4	104.8
65.1	70.3	64.0	70.5	93.4	94.8	96.1	104.9	115.5	112.8
69.0	72.2	68.2	69.8	98.6	113.8	111.1	108.9	116.5	117.8

70.0	71.2	71.2	70.9	99.7	121.8	113.0	113.9	120.5	123.8
70.0	70.2	70.2	77.9	99.6	124.6	115.9	116.7	126.3	125.7
70.1	71.2	72.2	83.0	100.6	121.6	123.8	126.6	131.2	125.6

FIGURE 44: *BOTTOM LEVELS IN OCTOBER; SMOOTHING OF SILTATION LAYER. (TEST B)*

N13S6C12

FRI, JUL 13, 1984, 10:43 AM

J13W61S6 YR 0; MTH 12 NP12 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.0	-17.0	-4.9	12.1	30.1	33.1	33.1	23.1
-99.0	-99.0	-25.0	-16.0	-4.9	9.1	27.1	30.1	31.1	22.1
-99.0	-99.0	-22.9	-14.6	-1.8	9.8	23.9	24.4	24.6	20.8
-99.0	-99.0	-20.9	-11.5	1.1	11.3	21.1	22.7	22.9	22.1
-99.0	-99.0	-20.9	-9.8	.8	8.9	20.5	22.2	22.4	23.8
-99.0	-99.0	-23.0	-8.2	-2.6	12.0	20.4	22.7	22.6	25.2
-99.0	-99.0	-26.0	-8.0	-4.2	17.6	20.3	21.5	22.5	26.2
-99.0	-99.0	-99.0	-6.6	-6.8	24.5	18.9	20.3	23.2	31.5
-99.0	-99.0	-99.0	-99.0	-99.0	35.9	29.8	27.3	25.5	28.0
-99.0	-99.0	-99.0	-99.0	31.7	46.9	35.4	29.6	29.6	31.1
-99.0	-99.0	-99.0	24.1	30.1	48.7	29.0	19.8	32.7	35.6
-99.0	-99.0	-99.0	24.5	28.8	38.2	30.3	27.5	31.9	37.6
-99.0	-99.0	-99.0	26.6	31.5	36.8	43.6	35.1	35.1	42.8
-99.0	-99.0	-99.0	29.4	29.4	42.5	52.8	35.8	33.0	40.4
-99.0	-99.0	-99.0	24.1	21.5	44.4	46.9	31.0	36.1	34.0
-99.0	-99.0	-99.0	26.5	26.2	43.6	47.7	47.5	46.2	46.7
-99.0	-99.0	-99.0	27.1	29.6	40.3	45.7	48.3	55.6	53.5
-99.0	-99.0	-99.0	37.2	34.7	41.6	35.8	33.2	34.2	-17.7
-99.0	-99.0	-99.0	61.0	32.3	41.4	36.1	8.2	-4.4	-12.4
-99.0	-99.0	-99.0	36.6	42.0	49.1	31.6	3.8	10.4	-14.0
-99.0	-99.0	-99.0	40.0	55.7	63.3	49.5	35.8	34.2	22.5
-99.0	-99.0	-99.0	-99.0	81.2	74.5	62.9	57.0	52.8	45.7
-99.0	-99.0	-99.0	-99.0	54.5	80.1	70.2	65.2	61.0	53.3
-99.0	-99.0	-99.0	-99.0	35.4	70.8	69.5	67.0	60.6	55.8
-99.0	-99.0	-99.0	-99.0	7.4	34.0	60.4	67.8	63.0	61.0
-99.0	-99.0	-99.0	-99.0	-11.7	26.0	54.8	64.0	64.7	63.6
18.5	18.1	18.4	8.8	9.8	44.9	63.0	75.1	62.8	60.6
31.4	47.0	43.7	49.3	45.4	47.1	78.2	64.2	61.7	59.3
50.0	53.2	52.5	62.8	65.5	58.2	68.0	61.1	61.9	60.6
56.9	62.4	61.3	60.7	72.9	72.8	69.7	63.8	62.9	61.9
54.7	62.8	67.0	67.0	81.4	74.9	75.1	68.0	65.9	64.1
56.9	58.9	78.8	73.9	85.5	81.7	44.4	71.3	67.7	66.0
78.0	80.7	90.4	100.5	89.8	85.7	83.0	75.1	64.6	67.9
88.1	90.0	90.7	94.5	92.6	87.7	81.7	77.7	74.9	64.9
93.9	94.8	94.7	90.5	88.1	91.1	83.4	76.5	77.7	69.7
91.9	93.8	97.6	95.4	89.1	93.0	87.3	76.3	79.4	68.6
96.2	94.6	97.1	88.9	88.2	90.4	89.4	79.1	79.0	71.4
100.1	96.7	95.1	91.0	96.2	93.5	92.5	83.3	76.1	74.3
102.2	100.1	98.9	96.7	102.6	96.6	92.5	86.5	80.4	73.4
102.3	103.2	100.1	98.9	97.8	99.6	95.6	87.5	82.4	74.4
16.1	7.1	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
18.1	11.1	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
18.0	11.9	-99.0	-1.0	1.0	22.0	20.0	11.7	4.3	-19.4
23.0	15.1	-99.0	-2.0	1.0	21.0	28.7	11.5	-.6	-21.6
27.1	19.1	-99.0	-3.0	1.0	19.0	19.5	6.4	-5.9	-22.9
26.3	20.1	-99.0	-4.0	1.0	15.0	17.9	9.2	1.6	-18.5
26.9	27.0	-99.0	-5.0	-1.0	9.0	20.3	15.0	14.1	-16.1
32.4	36.2	-99.0	-6.0	-2.0	7.0	16.3	20.8	-18.9	-18.9
39.4	29.3	-99.0	-7.0	-3.0	5.0	14.0	12.0	-20.0	-20.0
31.2	25.9	-99.0	-8.0	-4.0	6.0	8.0	6.0	-20.0	-20.0
20.3	-17.9	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
13.2	-23.6	-99.0	-8.0	-4.7	2.0	-.0	-1.0	-20.0	-20.0
15.7	-30.9	-99.0	-2.4	-15.7	-19.9	-20.0	-20.0	-20.0	-20.0
28.1	-7.6	-25.2	6.7	-29.6	-70.0	-70.0	-70.0	-70.0	-70.0
31.4	19.0	-2.0	-18.7	-35.0	-31.4	-6.5	-6.5	-3.6	-12.3
39.5	30.5	15.8	-33.0	-19.9	-1.1	5.8	11.3	5.9	-10.7
16.3	-4.3	-1.5	-5.5	-9.8	13.8	1.4	-16.0	-17.4	-13.8

69.7	70.9	71.1	70.9	99.6	121.7	112.9	113.3	119.2	123.2
70.0	70.1	70.1	77.9	99.6	124.5	115.7	116.2	125.0	125.2
70.1	71.2	72.2	83.0	100.5	121.4	123.6	126.1	129.9	125.1

-27.3	-8.3	1.6	5.6	-17.0	-17.7	-16.8	-26.3	-17.6	-7.3
-15.4	-11.1	-16.4	-20.0	-24.0	-24.7	-15.2	-7.1	10.1	22.4
-12.0	-18.9	-29.3	-30.8	-23.4	-24.7	-21.3	-1.4	28.5	45.6
2.1	-6.7	-11.2	-14.3	-15.0	-16.9	-14.9	2.0	27.9	51.9
30.3	11.4	-1.5	-7.9	-10.5	-13.5	-14.2	6.5	32.4	55.8
51.2	31.0	8.6	-5.5	-5.8	-8.9	-16.6	-.5	26.8	50.3
54.6	60.4	28.1	8.0	-2.2	-1.3	-12.7	1.5	28.7	53.6
57.2	52.6	28.8	-6.3	-14.4	11.2	7.3	12.2	31.6	53.8
59.5	50.1	17.4	-25.8	-6.6	33.3	14.3	20.1	34.1	53.7
57.8	51.4	32.1	13.3	19.0	18.5	-4.0	12.8	31.8	52.5
58.5	55.5	39.4	32.3	17.1	-.9	-9.7	11.7	32.6	52.7
60.3	54.4	21.3	12.5	4.0	-11.8	-10.7	12.4	32.9	55.6
61.3	55.5	19.6	19.6	11.2	-5.7	-10.5	2.2	29.5	54.5
63.0	57.1	36.2	40.2	24.7	17.9	-3.5	-10.2	22.5	52.1
62.8	59.4	49.1	47.0	38.3	34.1	24.5	3.3	29.1	56.4
64.8	62.3	58.4	50.8	44.9	42.1	44.3	38.0	47.8	57.9
67.8	64.0	61.5	57.1	56.2	57.5	55.9	55.4	60.3	61.5
68.7	64.8	61.9	60.2	56.8	55.6	56.0	58.8	56.6	59.9
69.6	65.8	64.0	62.0	60.1	59.4	57.3	56.7	59.3	62.5
69.6	66.7	65.8	63.8	61.7	59.6	57.7	58.4	60.1	64.2
64.6	69.6	67.6	65.6	62.6	60.5	56.6	60.6	63.4	66.5
69.5	58.6	53.5	54.5	49.9	47.9	52.0	55.8	61.9	66.0
75.5	64.6	56.6	53.6	48.8	45.9	48.0	50.0	58.8	64.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.3	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.2	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.8	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.5	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-20.9	-17.9	-16.8	-17.9	-51.9	-25.5	8.6	-35.3	-40.0	-99.0
-.1	-8.4	-1.5	6.7	-14.4	-8.1	16.8	2.9	-35.5	-99.0
2.1	6.7	10.6	15.7	14.4	10.9	25.8	10.4	-8.4	-28.6
13.7	16.8	20.9	25.6	27.8	35.7	40.0	23.7	22.0	-1.5
29.6	32.2	37.3	39.8	43.1	36.3	35.7	26.5	28.8	18.3
45.5	46.5	48.4	49.7	49.6	49.4	45.7	34.3	29.4	26.3
52.8	52.5	52.5	51.4	51.2	51.9	51.1	45.3	41.4	32.0
52.8	51.1	52.1	52.9	53.7	53.0	51.0	50.9	46.1	35.4
50.8	51.8	52.7	55.7	55.3	53.2	55.2	60.5	54.0	50.1
53.2	53.3	56.3	57.3	60.0	62.7	66.9	65.2	63.5	59.9
54.4	53.7	57.7	60.1	59.9	63.4	69.6	70.9	70.5	70.9
53.8	55.8	59.7	60.9	60.8	64.4	69.3	72.7	72.6	72.9
51.9	54.7	57.4	53.8	55.5	61.0	66.9	77.4	81.5	81.9
51.9	54.5	59.4	62.8	60.5	62.8	66.8	81.2	82.4	83.8
55.0	58.2	62.3	64.6	64.6	63.1	72.9	78.2	83.4	85.8
57.4	61.4	64.2	66.3	66.5	65.2	73.9	83.2	91.3	92.8
57.5	61.3	63.3	64.3	64.7	69.5	76.2	87.3	92.3	99.8
61.1	62.3	63.4	63.5	63.9	65.0	76.6	87.2	91.9	102.6
60.4	61.4	61.1	58.3	71.7	67.8	76.3	85.5	96.2	106.4
55.8	55.5	54.2	63.1	76.4	75.7	83.4	88.6	100.1	106.3
61.1	60.8	55.7	68.2	84.0	84.8	89.7	95.0	110.0	104.3
64.9	69.5	62.6	69.0	92.7	94.8	95.9	104.3	114.1	112.3
68.5	71.7	67.7	69.3	98.3	113.8	111.0	108.5	115.3	117.3

FIGURE 45: *BOTTOM LEVELS IN DECEMBER; SMOOTHING OF SILTATION LAYER (TEST B)*

N13S6C14 FRI, JUL 13, 1984, 10:43 AM

J13W61S6 YR 1; MTH 2 NP14 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-27.0	-17.0	-5.1	11.9	29.9	32.9	32.9	22.9
-99.0	-99.0	-25.0	-16.0	-5.1	8.9	26.9	29.9	30.9	21.9
-99.0	-99.0	-23.0	-14.5	-1.6	10.0	23.1	22.9	23.8	20.4
-99.0	-99.0	-21.0	-11.5	1.5	12.5	20.3	20.0	21.7	21.8
-99.0	-99.0	-21.0	-9.7	1.5	10.9	19.9	19.0	20.8	23.3
-99.0	-99.0	-23.0	-7.8	-1.3	14.2	21.2	21.1	21.1	24.6
-99.0	-99.0	-26.0	-6.9	-2.9	22.9	23.4	16.8	18.7	25.2
-99.0	-99.0	-99.0	-5.4	-5.1	30.6	18.7	9.9	17.7	30.5
-99.0	-99.0	-99.0	-99.0	-99.0	37.6	27.0	19.4	20.9	27.1
-99.0	-99.0	-99.0	-99.0	31.6	45.0	32.0	26.5	27.1	30.0
-99.0	-99.0	-99.0	23.7	29.9	49.5	31.0	19.1	29.9	34.1
-99.0	-99.0	-99.0	24.2	28.8	42.1	35.6	26.3	28.1	35.6
-99.0	-99.0	-99.0	26.3	31.8	39.0	46.0	35.1	33.9	40.4
-99.0	-99.0	-99.0	29.0	29.1	43.7	56.1	38.1	32.6	38.0
-99.0	-99.0	-99.0	23.7	21.1	45.0	49.3	31.5	33.8	32.0
-99.0	-99.0	-99.0	26.4	26.2	44.6	50.3	48.1	45.1	47.7
-99.0	-99.0	-99.0	27.0	29.8	41.7	48.6	50.9	59.3	64.1
-99.0	-99.0	-99.0	37.0	34.4	42.6	40.4	42.4	44.1	-8.1
-99.0	-99.0	-99.0	60.9	31.4	37.7	35.6	16.7	5.1	-6.1
-99.0	-99.0	-99.0	36.6	40.6	41.9	19.8	-9.3	.1	-17.7
-99.0	-99.0	-99.0	39.9	54.4	58.6	37.7	16.1	15.7	11.8
-99.0	-99.0	-99.0	-99.0	80.5	72.8	59.1	51.3	47.6	43.2
-99.0	-99.0	-99.0	-99.0	53.9	79.7	69.9	65.0	61.5	54.1
-99.0	-99.0	-99.0	-99.0	33.4	69.3	68.4	66.5	60.8	56.1
-99.0	-99.0	-99.0	-99.0	4.1	29.2	56.4	66.5	63.2	61.2
-99.0	-99.0	-99.0	-99.0	-13.3	23.1	52.3	62.9	64.8	63.8
20.4	16.3	15.8	9.6	11.3	46.2	63.7	74.8	62.5	60.4
35.5	48.7	44.1	51.9	48.1	47.9	78.4	64.1	61.4	58.9
52.1	54.7	53.3	63.6	66.2	58.4	67.8	60.9	61.7	60.3
56.8	62.2	61.0	60.4	72.7	72.4	68.9	63.1	62.6	61.6
54.0	62.1	66.2	66.2	81.1	74.8	73.2	65.7	65.3	63.8
56.6	58.4	78.1	73.0	85.3	83.3	43.8	68.8	66.9	65.7
78.1	80.7	90.1	100.0	89.8	87.1	83.8	74.2	64.0	67.6
88.1	89.9	90.5	94.3	92.4	87.4	81.3	77.3	74.5	64.6
93.6	94.5	94.4	90.2	87.7	90.4	82.7	75.9	77.1	69.2
91.6	93.3	96.9	94.8	88.4	92.3	86.5	75.5	78.6	68.0
95.9	94.0	95.5	87.0	86.7	89.4	88.6	78.1	77.9	70.5
100.0	96.1	93.6	88.9	94.6	92.5	91.6	82.3	75.0	73.5
102.1	99.8	98.4	96.0	101.9	96.0	91.8	85.8	79.6	72.5
102.3	103.2	100.0	98.7	97.5	99.2	95.1	86.8	81.5	73.4
15.9	6.9	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
17.9	10.9	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.6	11.5	-99.0	-1.0	1.0	22.0	20.0	12.0	4.8	-19.1
22.8	14.9	-99.0	-2.0	1.0	21.0	28.4	10.7	-1.6	-22.2
26.9	19.0	-99.0	-3.0	1.0	19.0	19.2	4.0	-9.4	-24.5
26.1	19.9	-99.0	-4.0	1.0	15.0	17.8	8.7	1.8	-17.8
26.6	26.8	-99.0	-5.0	-1.0	9.0	20.5	16.7	17.7	-13.7
32.3	36.2	-99.0	-6.0	-2.0	7.0	16.5	21.5	-18.0	-18.0
39.7	29.6	-99.0	-7.0	-3.0	5.0	14.0	12.1	-19.9	-20.0
31.1	26.8	-99.0	-8.0	-4.0	6.0	8.0	6.1	-19.9	-20.0
18.5	-19.2	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
9.7	-25.2	-99.0	-7.7	-4.6	1.9	-.0	-1.0	-20.0	-20.0
11.1	-30.1	-99.0	-1.5	-15.8	-20.0	-20.0	-20.0	-20.0	-20.0
23.5	-10.8	-26.4	5.0	-29.8	-70.0	-70.0	-70.0	-70.0	-70.0
29.4	15.7	-6.2	-20.3	-35.3	-30.9	-8.1	-10.1	-12.2	-23.5
42.7	33.3	15.1	-33.4	-21.4	.8	4.6	7.7	1.4	-17.9
29.2	2.9	.7	-8.6	-16.0	12.7	5.1	-20.8	-25.2	-17.0

-21.5	-1.1	5.3	9.3	-19.4	-24.5	-16.8	-30.0	-24.1	-3.4
-10.9	-7.3	-10.1	-15.6	-25.4	-29.7	-21.3	-7.8	14.9	30.5
-15.0	-18.0	-26.9	-31.0	-24.9	-27.8	-24.1	-1.8	33.2	50.7
-3.8	-10.9	-13.3	-15.6	-18.6	-20.6	-17.9	.2	28.0	53.3
28.8	8.9	-4.2	-9.6	-14.3	-18.3	-19.3	-.2	28.7	55.3
51.6	30.6	7.4	-6.5	-6.0	-7.2	-18.4	-8.7	22.9	49.7
54.5	50.1	27.9	7.6	-2.6	3.4	-10.2	-2.7	27.0	53.9
56.2	51.2	28.7	-8.6	-17.3	15.3	12.8	11.0	30.3	53.7
58.6	48.8	18.2	-26.7	-10.7	36.9	15.8	14.4	29.7	52.3
57.6	51.8	34.3	12.9	16.1	15.7	-9.7	6.9	29.8	52.0
58.5	55.7	39.6	31.6	15.3	-3.8	-12.7	13.0	35.2	52.8
60.4	55.1	19.7	8.5	.7	-12.6	-13.2	4.4	22.5	49.3
61.5	57.5	16.4	13.0	7.1	-7.5	-14.1	-14.0	8.9	42.6
63.1	57.8	32.6	37.1	24.6	17.0	-.9	-6.1	19.9	46.6
62.6	59.0	48.7	49.2	42.4	37.2	33.3	20.6	41.4	58.4
64.5	62.1	59.0	52.8	48.4	46.0	50.1	47.3	55.0	59.7
67.4	63.7	61.5	57.5	57.1	58.8	57.5	57.4	61.9	61.8
68.2	64.4	61.7	60.1	56.8	55.8	56.3	59.1	56.7	59.9
69.1	65.4	63.7	61.8	60.0	59.3	57.2	56.6	59.2	62.3
69.1	66.3	65.5	63.6	61.5	59.5	57.4	58.1	59.8	63.9
64.0	69.1	67.0	65.1	62.3	60.3	56.3	60.2	63.2	66.3
68.8	57.9	52.8	53.9	49.5	47.6	51.7	55.6	61.7	65.9
74.6	63.8	55.9	53.1	48.6	45.7	47.7	49.8	58.7	64.0
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.4	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.3	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.6	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.0	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-22.0	-17.5	-20.3	-18.3	-51.9	-27.5	4.0	-35.3	-40.0	-99.0
-11.9	-12.2	-4.2	.2	-14.2	-7.9	16.2	-1.0	-35.5	-99.0
-3.5	3.0	12.2	12.5	10.1	11.0	30.8	11.9	-9.5	-28.2
17.1	16.7	24.2	27.2	27.4	36.9	44.5	27.2	25.7	-.5
34.4	34.9	40.3	41.4	43.5	36.9	36.0	27.7	31.5	19.6
47.9	48.5	49.7	50.0	49.4	49.5	45.7	34.1	29.7	26.8
54.3	53.3	52.6	51.0	50.9	51.9	50.9	45.3	41.8	32.1
52.8	51.2	52.0	52.5	53.3	52.8	50.8	51.1	46.6	35.6
50.3	51.9	53.1	55.6	55.1	53.0	55.0	60.5	54.2	50.1
53.3	53.5	56.7	57.4	59.8	62.1	66.4	65.0	63.5	59.9
54.2	53.2	57.4	60.0	59.4	62.5	68.8	70.6	70.4	70.8
52.7	54.7	58.9	60.5	60.4	63.7	68.6	72.4	72.6	72.8
50.7	53.2	56.4	53.5	55.2	60.5	66.3	77.1	81.4	81.8
51.4	53.7	58.5	62.4	60.3	62.4	66.2	80.7	82.1	83.7
53.8	57.9	61.5	64.0	64.3	62.7	72.2	77.6	82.9	85.6
54.3	60.5	63.0	65.3	66.2	64.8	73.1	82.4	90.8	92.6
54.8	60.3	62.1	63.3	64.5	69.3	75.5	86.5	91.8	99.4
60.3	61.8	62.5	62.7	63.8	65.0	76.1	86.0	90.8	102.0
60.3	60.9	60.1	57.3	71.4	67.7	75.8	84.2	94.8	105.8
55.5	55.2	53.4	62.2	75.8	75.4	83.0	87.7	99.1	105.8
61.0	60.6	55.1	67.1	83.0	84.4	89.5	94.5	109.3	103.9
64.7	69.3	62.0	67.9	91.6	94.3	95.7	103.9	113.5	111.9
68.2	71.5	67.5	68.7	97.4	113.1	110.7	108.2	114.7	116.9

69.4	70.7	71.0	70.5	98.8	120.8	112.3	112.8	118.5	122.8
69.8	69.9	69.9	77.5	98.6	123.3	114.8	115.5	124.3	124.8
70.0	71.2	72.1	82.5	99.3	120.0	122.6	125.3	129.1	124.6

FIGURE 46: *BOTTOM LEVELS IN FEBRUARY; SMOOTHING OF SILTATION LAYER (TEST B)*

N13S6C16 FRI, JUL 13, 1984, 10:44 AM

J13W61S6 YR 1; MTH 4 NP16 ALPHA= .0 JRSTAP 1 MNDSTAP 732

-99.0	-99.0	-26.9	-16.9	-5.0	12.0	30.0	33.0	33.0	23.0
-99.0	-99.0	-24.9	-15.9	-5.0	9.0	27.0	30.0	31.0	22.0
-99.0	-99.0	-22.9	-14.4	-1.2	10.6	24.3	24.8	25.5	21.0
-99.0	-99.0	-20.9	-11.4	2.4	14.7	22.2	20.6	21.9	21.7
-99.0	-99.0	-20.9	-9.2	3.0	12.7	19.4	16.6	19.5	22.7
-99.0	-99.0	-22.9	-6.7	-.8	12.7	18.8	19.5	20.5	24.2
-99.0	-99.0	-25.9	-4.4	-4.8	17.1	21.6	18.6	19.7	25.0
-99.0	-99.0	-99.0	-2.8	-7.4	23.5	16.9	11.0	17.3	30.1
-99.0	-99.0	-99.0	-99.0	-99.0	33.8	25.3	17.3	17.7	26.1
-99.0	-99.0	-99.0	-99.0	30.4	42.6	29.7	25.2	25.4	29.1
-99.0	-99.0	-99.0	23.8	29.2	46.9	29.6	20.1	30.3	34.8
-99.0	-99.0	-99.0	24.3	28.4	40.7	36.0	27.0	27.1	35.1
-99.0	-99.0	-99.0	26.4	31.8	39.0	47.2	35.9	32.6	35.6
-99.0	-99.0	-99.0	29.1	29.3	44.3	57.4	39.2	32.1	32.7
-99.0	-99.0	-99.0	23.8	21.3	45.4	49.8	31.4	32.6	29.2
-99.0	-99.0	-99.0	26.5	26.3	44.9	50.6	47.7	45.2	49.7
-99.0	-99.0	-99.0	27.0	29.9	42.2	49.6	51.6	61.2	75.5
-99.0	-99.0	-99.0	37.1	35.0	45.2	46.3	50.6	50.4	3.0
-99.0	-99.0	-99.0	61.2	32.0	41.9	52.8	44.1	23.8	3.0
-99.0	-99.0	-99.0	36.9	39.9	39.2	25.9	7.3	9.7	-18.0
-99.0	-99.0	-99.0	40.1	52.4	46.9	12.0	-10.3	-1.8	-.2
-99.0	-99.0	-99.0	-99.0	78.3	62.5	33.0	19.8	28.3	34.3
-99.0	-99.0	-99.0	-99.0	53.2	76.6	63.2	57.4	56.1	51.7
-99.0	-99.0	-99.0	-99.0	33.8	70.0	68.5	65.9	60.7	56.4
-99.0	-99.0	-99.0	-99.0	4.5	29.1	64.9	65.2	63.5	61.7
-99.0	-99.0	-99.0	-99.0	-13.5	22.8	50.5	61.5	64.9	64.2
20.4	16.1	16.1	10.2	11.7	46.5	63.7	74.4	62.3	60.4
35.9	49.3	45.0	53.2	49.0	48.1	78.6	64.3	61.3	58.7
52.5	55.1	63.8	64.0	66.5	58.5	67.9	60.9	61.7	60.2
56.7	62.1	60.8	60.2	72.6	72.3	69.0	63.2	62.6	61.6
53.2	61.4	65.6	65.6	80.7	74.5	73.0	65.7	65.4	63.8
55.9	57.7	77.5	72.5	84.9	83.0	43.6	68.7	67.0	65.8
78.0	80.6	89.9	99.8	89.6	86.9	83.6	74.2	64.1	67.7
88.2	89.9	90.5	94.3	92.4	87.3	81.3	77.3	74.6	64.7
93.7	94.6	94.5	90.3	87.7	90.4	82.6	75.9	77.2	69.3
91.7	93.3	97.0	94.9	88.4	92.2	86.5	75.5	78.6	68.0
96.0	94.0	95.6	87.0	86.7	89.3	88.6	78.1	77.9	70.6
100.1	96.2	93.7	89.0	94.6	92.5	91.6	82.4	75.0	73.5
102.3	100.0	98.5	96.0	101.9	95.9	91.8	85.8	79.6	72.6
102.4	103.3	100.1	98.7	97.5	99.1	95.0	86.8	81.5	73.4
16.0	7.0	-99.0	13.0	1.0	8.0	7.0	4.0	1.0	-20.0
18.0	11.0	-99.0	5.0	1.0	24.0	13.0	7.0	2.0	-20.0
17.6	11.4	-99.0	-1.0	1.0	22.0	20.0	12.0	4.8	-19.1
22.5	14.8	-99.0	-2.0	1.0	21.0	28.3	10.6	-1.7	-22.3
26.7	19.0	-99.0	-3.0	1.0	19.0	19.1	3.6	-10.0	-24.7
25.9	19.9	-99.0	-4.0	1.0	15.0	17.8	8.5	1.8	-17.6
26.4	26.7	-99.0	-5.0	-1.0	9.0	20.5	17.0	18.3	-13.3
32.3	36.3	-99.0	-6.0	-2.0	7.0	16.5	21.6	-17.9	-17.8
40.4	30.5	-99.0	-7.0	-3.0	5.0	14.0	12.1	-19.9	-20.0
31.8	29.1	-99.0	-8.0	-4.0	6.0	8.0	6.1	-19.9	-20.0
19.3	-18.3	-99.0	-9.0	-5.0	5.0	5.0	2.0	-20.0	-20.0
9.4	-25.6	-99.0	-7.4	-4.4	1.9	-.0	-1.0	-20.0	-20.0
3.9	-29.5	-99.0	-.5	-15.9	-20.1	-20.0	-20.0	-20.0	-20.0
13.2	-16.2	-27.7	4.0	-30.1	-70.0	-70.0	-70.0	-70.0	-70.0
24.4	8.8	-11.2	-19.2	-35.3	-30.2	-9.3	-14.6	-16.8	-22.6
45.5	34.2	13.7	-33.4	-21.2	-.5	.7	3.4	-3.7	-21.4
46.6	11.6	1.4	-12.0	-26.6	3.3	3.1	-24.6	-29.5	-24.6

-8.7	8.7	10.2	12.1	-25.8	-29.3	-18.5	-32.1	-28.9	-8.6
.8	6.7	.9	-9.2	-23.2	-29.6	-24.1	-9.4	13.3	30.4
-9.0	-8.0	-25.4	-31.1	-23.9	-27.5	-24.8	-1.6	34.5	51.4
-13.7	-17.2	-18.8	-20.3	-20.7	-21.8	-18.2	.8	28.5	53.6
20.7	.2	-11.9	-14.6	-17.9	-20.6	-21.5	-4.0	27.3	55.3
50.3	28.7	4.7	-9.0	-5.2	.4	-18.5	-17.2	19.6	49.4
54.8	50.3	27.9	7.4	.3	13.1	-8.7	-11.3	23.6	53.5
56.4	51.4	29.3	-8.9	-17.5	18.8	14.7	8.9	28.8	53.4
58.6	48.6	19.2	-26.7	-12.4	38.1	18.5	14.9	28.7	51.8
57.5	51.8	35.2	12.9	15.0	15.5	-9.6	6.9	29.9	51.9
58.5	55.6	39.4	31.6	15.0	-4.5	-13.3	13.6	36.0	53.0
60.7	57.1	22.3	9.2	-.0	-13.1	-14.2	-.3	17.5	46.7
62.0	60.9	20.0	13.4	6.1	-6.3	-13.0	-18.1	-1.7	36.9
63.6	59.1	32.8	36.7	25.0	20.9	5.5	-6.8	15.6	43.5
62.8	59.1	48.5	49.7	44.0	41.2	38.5	23.9	43.3	59.0
64.7	62.2	59.2	53.3	49.4	48.0	51.8	48.4	55.8	60.2
67.5	63.9	61.7	57.8	57.5	59.2	57.9	57.6	62.0	62.0
68.4	64.6	61.9	60.3	57.0	56.0	56.4	59.1	56.9	60.0
69.2	65.5	63.9	62.0	60.2	59.4	57.3	56.6	59.2	62.4
69.2	66.5	65.7	63.7	61.7	59.6	57.4	58.0	59.7	63.8
64.1	69.3	67.2	65.3	62.4	60.4	56.3	60.2	63.1	66.3
68.8	58.0	52.9	54.1	49.7	47.8	51.7	55.6	61.8	66.0
74.7	63.9	56.0	53.2	48.8	45.8	47.8	49.7	58.7	64.1
-12.0	-15.0	-17.0	-19.0	-22.0	-25.0	-27.0	-30.0	-99.0	-99.0
-11.0	-13.0	-16.0	-18.0	-20.0	-23.0	-26.0	-29.0	-99.0	-99.0
-9.0	-12.0	-14.0	-16.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-6.5	-9.0	-12.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-5.3	-7.0	-10.0	-14.0	-17.0	-20.0	-25.0	-29.0	-99.0	-99.0
-4.6	-8.0	-9.0	-14.0	-18.0	-21.0	-25.0	-29.0	-99.0	-99.0
-7.0	-15.0	-18.0	-17.0	-19.0	-23.0	-27.0	-30.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-70.0	-70.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-99.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-60.0	-99.0	-99.0	-99.0	-99.0
-40.0	-40.0	-40.0	-40.0	-40.0	-50.0	-99.0	-99.0	-99.0	-99.0
-70.0	-70.0	-70.0	-70.0	-70.0	-70.0	-50.0	-99.0	-99.0	-99.0
-18.4	-15.1	-16.0	-11.1	-51.9	-28.3	.4	-35.3	-40.0	-99.0
-15.4	-15.0	-5.0	.0	-15.3	-13.3	8.4	-6.0	-35.5	-99.0
-6.7	.8	11.8	10.5	6.4	5.1	30.3	13.2	-10.4	-27.8
17.2	17.0	24.7	28.5	26.7	36.4	50.1	32.4	28.7	.2
35.0	35.7	41.3	42.6	44.1	37.4	37.1	29.9	34.2	20.6
48.3	49.0	50.2	50.4	49.6	49.6	45.9	34.5	30.3	27.5
54.5	53.5	52.8	51.3	51.1	52.0	51.1	45.6	42.4	32.4
52.9	51.3	52.1	52.6	53.5	52.8	50.9	51.4	47.0	35.8
50.3	52.0	53.2	55.7	55.2	53.0	55.0	60.6	54.3	50.3
53.4	53.5	56.8	57.4	59.6	61.8	66.2	65.0	63.5	59.9
54.1	53.2	57.4	59.8	59.0	61.9	68.4	70.6	70.4	70.9
52.3	54.4	58.8	60.4	60.1	63.4	68.4	72.4	72.6	72.9
50.7	53.2	56.4	53.5	55.1	60.2	66.1	77.0	81.4	81.8
51.7	53.9	58.6	62.4	60.2	62.1	66.0	80.7	82.1	83.7
53.2	57.8	61.5	63.9	64.2	62.4	72.0	77.5	82.9	85.6
52.1	60.0	63.0	65.3	66.1	64.5	72.9	82.3	90.7	92.6
52.5	59.7	62.2	63.3	64.4	69.2	75.4	86.3	91.7	99.4
59.8	61.4	62.4	62.7	63.9	65.0	76.1	85.9	90.5	102.0
60.4	60.7	59.8	57.1	71.4	67.7	75.7	83.8	94.2	105.6
55.6	55.0	53.1	61.8	75.5	75.4	82.9	87.3	98.6	105.5
61.1	60.5	54.7	66.6	82.8	84.5	89.5	94.2	108.7	103.7
64.8	69.2	61.6	67.5	91.6	94.4	95.8	103.8	113.0	111.7
68.2	71.5	67.6	68.7	97.4	113.3	110.8	108.0	114.3	116.7

69.4	70.8	71.1	70.7	98.9	121.0	112.4	112.7	118.1	122.6
70.0	70.0	70.0	77.6	98.7	123.4	114.8	115.3	123.8	124.5
70.1	71.3	72.1	82.5	99.3	120.1	122.6	125.1	128.6	124.3

FIGURE 47: *BOTTOM LEVELS IN APRIL; SMOOTHING OF SILTATION LAYER (TEST B)*

LISTING OF

COMPUTER PROGRAM

```
$CONTROL USLINIT,NOSOURCE
      PROGRAM DSIMDRO
C
C  ************************************************************
C  ************************************************************
C  **                                                        **
C  **                                                        **
C  **  ADMINISTRACAO DOS PORTOS DO DOURO E LEIXOES            **
C  **                                                        **
C  **                                                        **
C  **  TWO DIMENSIONAL SIMULATION PROGRAM DESCRIBING          **
C  **  MORPHOLOGICAL CHANGES IN THE COASTAL ZONE OF           **
C  **  THE DOURO ESTUARY                                      **
C  **                                                        **
C  **  CALCULATES:   -tidal currents [FLOWDS1,FLOWDS3]        **
C  **                -longshore currents  *                   **
C  **                   rad.stress        *                   **
C  **                   wave setup        **[REFRAC]          **
C  **                -currents by         *                   **
C  **                   solitary waves    *                   **
C  **                -sand transp. cap. [SEDTRAN]             **
C  **                -new bottom        [NEWBOT]              **
C  **                                                        **
C  **  FILES                                                 **
C  **    input       -INFO    (FTN12)                        **
C  **                -DEPTHFL ( ,,11)  [dm]                  **
C  **                -QDISTR  ( ,,20)                        **
C  **                -DISCH   ( ,,21)  [m**3/sec]            **
C  **                -SEALEV  ( ,,22)  [cm]                  **
C  **                -WINDDIS ( ,,23)                        **
C  **                -PERDIS  ( ,,24)                        **
C  **                -WAVDIS  ( ,,25)  [m]                   **
C  **                -PAR     ( ,,26)                        **
C  **                                                        **
C  **   output                                               **
C  **                -NEWBOT  ( ,,17)  [DM]                  **
C  **                                                        **
C  **                                                        **
C  **  HYDRONAMIC BV    JUNE 20,1984     H.VERHAGEN          **
C  **                                    J.OLTHOF            **
C  ************************************************************
C  ************************************************************
C
C
C
      DIMENSION QTYP(11),WAVDR(5),WAVPR(4),WAVH(10),WDR(5),PER(4)
     *          ,WH(10),RISEI(12),QVAL(12),Q(11),HEL(30),PSI(30)
      REAL D(30,40),ALF(30,40),WFO(30,40)
     *          ,U(30,40),V(30,40),DNUL(30,40)
      INTEGER FPX(4),FPY(4)
      REAL MESH
      CHARACTER NAME*10
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                  ,DNUL
C
C     !!!!!MESH[MM],D[MM],ALF[RAD.*100],WFO[DM**2],U,V[DM/SEC]
C
      DOUBLE PRECISION R
      LOGICAL LL
      COMMON /RAN/R,LL
      JREIND=-1
      MNDEIND=-1
      LL=.TRUE.
      DGRNS=8000.
      FRGH=5.
      NBA=0
      NBB=1
      NBC=0
      NBD=0
      NBE=1
      NBF=1
      IALPHA=0
      DDRED=10.
C
C
C  *******PROEF  LATER WEGHALEN*********************
C
      DISPLAY'IS THIS RUN AN ONE TIME-STEP RUN'
      DISPLAY'  OR A LONGTERM SIMULATION?'
      DISPLAY'      one time-step run       =1'
      DISPLAY'      long term simulation    =2'
      DISPLAY'ENTER your option'
      ACCEPT IANT
      IF(IANT.EQ.2) GOTO 500
      DISPLAY'ENTER job name (max. 10 char.)'
      ACCEPT NAME
      JR=1
      MND=1
      TIDE=1
      TIDESTEP=1
      IDDP=1
      DISPLAY'ENTER river discharge [cu. m/sec]'
      ACCEPT VO
      Q1=VO
      DISPLAY'ENTER tidal water level rise [cm]'
      ACCEPT RISE2
      RISE=RISE2*10.
      DISPLAY'ENTER wave direction [degrees]'
      ACCEPT ALFABOUND
      DISPLAY'ENTER wave period [seconds]'
      ACCEPT TH
      DISPLAY'ENTER wave height [m]'
      ACCEPT HO
      DISPLAY'ENTER time-scale factor'
      ACCEPT DELU
      HRS=DELU
      DELTAT=DELU*3600
      DISPLAY'STORE current velocities in files?'
      DISPLAY'(YES=1;NO=2)'
      ACCEPT IANTW
      CALL FILES('11','NAME DEPTHFILEN')
      DISPLAY'NBA=',NBA,'NBB=',NBB,'NBC=',NBC,'NBD=',NBD
      DISPLAY'NBE=',NBE,'NBF=',NBF,'IALPHA=',IALPHA
      CALL FILES('12','NINFO    ')
      READ(12,*)NMAX,MMAX,MESH
      READ(12,*)FPX(1),FPY(1)
      READ(12,*)FPX(2),FPY(2)
      READ(12,*) MOLME
      READ(12,*) EPS,EPSR,EPSZ
      READ(12,*) ALFA,ALFAR,ALFAZ
      READ(12,*) ROUGH
      READ(12,*) D50,D90
      READ(12,*) GAMMA
      READ(12,*) DDRED
      READ(12,*) ALPMAX,DDGEXTR
C
C     !!!!ALFA,ALFAR,ALFAZ in graden!!!!
C     !!!!ALPHA is egaliserings factor voor NEWBOT!!!
C
C
C!!!!!!!!!!!inlezen kopregel van initiele dieptematrix!!!!!!!!!
      READ(11,*)
C!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
C
      DO 503 I=1,NMAX,10
      DO 504 M=1,MMAX
      READ(11,*) (D(N,M),N=I,I+9)
  504 CONTINUE
  503 CONTINUE
      CALL UNITCONTROL(11,8)
      CALL UNITCONTROL(12,8)
C
C  ****MESH en D(N,M) omrekenen naar MM*****
C
      MESH=MESH*1000.
      DO 505 M=1,MMAX
      DO 506 N=1,NMAX
      D(N,M)=D(N,M)*100.
      DNUL(N,M)=D(N,M)
  506 CONTINUE
  505 CONTINUE
      DRISE=0
      IF(Q1.GE.2000.AND.Q1.LT.4000) DRISE=350.
      IF(Q1.GE.4000.AND.Q1.LT.6500) DRISE=750.
      IF(Q1.GE.6500.AND.Q1.LT.9000) DRISE=1250.
      IF(Q1.GE.9000.AND.Q1.LT.15000) DRISE=1950.
      IF(VO.GE.0) CALL FLOWDS1(VO,RISE,EPS,ALFA,MOLME,DRISE)
      IF(VO.LT.0) CALL FLOWDS3(VO,RISE,EPSR,ALFAR,EPSZ,ALFAZ,MOLME)
      CALL REFTEST(GAMMA,ROUGH,ALFABOUND,TH,HO,RISE,DGRNS,FRGH)
      CALL SEDTRAN(D50,D90,RISE,TH,ROUGH,DROTS,DRISE)
      CALL NEWBOT(DDRED,DELTAT,RISE,DRISE,DROTS,ALPMAX,DDGEXTR
     &            ,NBA,NBB,NBC,NBD,NBE,NBF,IALPHA)
      CALL PRNTBOT(NAME,JR,MND,IDDP,ALPHA,0,0)
      DISPLAY JR,MND,Q1,TIDE,TIDESTEP,HRS,VO,HO,TH,ALFABOUND,RISE
      GOTO 1000
C
C         ********************************
C
C
C
C
  500 DISPLAY'IS THIS RUN A RESTART IN A LONG TERM SIMULATION?'
      DISPLAY'(YES=1;NO=0)'
      ACCEPT IRES
      DISPLAY'ENTER date (MMDDHH)'
      ACCEPT R
      R=R*1000
      DISPLAY'ENTER job name (max. 10 char)'
      ACCEPT NAME
      IF(IRES.NE.1) GOTO 27
      DISPLAY'ENTER period already simulated'
      DISPLAY'        number of YEARS='
      ACCEPT JR
      DISPLAY'        number of MONTHS='
      ACCEPT MND
      DISPLAY'        number of HOURS (max 732)='
      ACCEPT HRS
      DISPLAY'CHOICE OF TIDE TO START THE SIMULATION'
      DISPLAY'      SPRING TIDE =1'
      DISPLAY'      MEAN TIDE   =2 or 4'
      DISPLAY'      NEAP TIDE   =3'
      DISPLAY'ENTER tide-number'
      ACCEPT TIDE
      GOTO 26
   27 JR=0
      MND=0
      HRS=0
      TIDE=1
   26 DISPLAY'PERIOD OF SIMULATION'
      DISPLAY'        if more than 1 year ENTER 1'
      DISPLAY'        if less than 1 year ENTER 2'
      DISPLAY'ENTER your option'
      ACCEPT IEND
      IF(IEND.EQ.2) GOTO 7
      DISPLAY'ENTER period of simulation (YEARS)'
      ACCEPT JREIND1
      JREIND=JREIND1+JR
      GOTO 8
    7 DISPLAY'ENTER period of simulation (MONTHS)'
      ACCEPT MNDEIND1
      MNDEIND=MNDEIND1+MND+JR*12
    8 DISPLAY'ENTER time-scale factor'
      ACCEPT DELU
      JRSTAP=1
      MNDSTAP=1
      MNDPR=20000
      JRPR=1000
      DISPLAY'TIME INTERVAL FOR PRINTING NEW BOTTOM'
      DISPLAY'       if time interval in YEARS---->ENTER 1'
      DISPLAY'       if time interval in MONTHS--->ENTER 2'
      DISPLAY'ENTER your option'
      ACCEPT INTERVAL
      IF(INTERVAL.EQ.2) GOTO 1
      DISPLAY'ENTER time interval (YEARS)'
      ACCEPT JRSTAP
      JRPR=JRSTAP+JR
      GOTO 2
    1 DISPLAY'ENTER time interval (MONTHS)'
      ACCEPT RMNDSTAP
      MNDSTAP=732*RMNDSTAP
      MNDPR=HRS+MNDSTAP+732*MND
    2 DELTAT=3600*DELU
      IANTW=2
C
C   ****initialiseren files*******************
C
      CALL FILES('11','NAME DEPTHFILEN')
      CALL FILES('12','NINFO    ')
```

```
      CALL FILES('20','#QDISTR  ')
      CALL FILES('21','#DISCH   ')
      CALL FILES('22','#SEALEV  ')
      CALL FILES('23','#WINDDIS ')
      CALL FILES('24','#PERDIS  ')
      CALL FILES('25','#WAVDIS  ')
      CALL FILES('26','#PAR     ')
C
C  ***inlezen INFO-file en initiele dieptematrix DEPDOUR****
C
      READ(12,*)NMAX,MMAX,MESH
      READ(12,*)FPX(1),FPY(1)
      READ(12,*)FPX(2),FPY(2)
      READ(12,*) MOLHE
      READ(12,*) EPS,EPSR,EPSZ
      READ(12,*) ALFA,ALFAR,ALFAZ
      READ(12,*) ROUGH
      READ(12,*) D50,D90
      READ(12,*) GAMMA
      READ(12,*) DDRED
      READ(12,*) ALPMAX,DDGEXTR
C
C     !!!!ALFA,ALFAR,ALFAZ in graden!!!!
C     !!!!ALPHA is egaliserings factor voor NEWBOT!!!
      DISPLAY'DGRNS=',DGRNS,'FRGH=',FRGH
      DISPLAY'ALPMAX=',ALPMAX,'DDGEXTR=',DDGEXTR
C!!!!!!!!!!!inlezen kopregel van initiele dieptematrix!!!!!!!!!
      READ(11,*)
C!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
C
      DO 3 I=1,NMAX,10
      DO 4 M=1,MMAX
      READ(11,*) (D(N,M),N=I,I+9)
    4 CONTINUE
    3 CONTINUE
      CALL UNITCONTROL(11,8)
      CALL UNITCONTROL(12,8)
C
C  ****MESH en D(N,M) omrekenen naar mm*****
C
      MESH=MESH*1000.
      DO 5 M=1,MMAX
      DO 6 N=1,NMAX
      D(N,M)=D(N,M)*100.
      DNUL(N,M)=D(N,M)
    6 CONTINUE
    5 CONTINUE
C
C  ****inlezen parameters van golfklimaat (golfrichting **
C  *   =WDR,golfperiode=PER,golfhoogte=WH)               *
C  *   en klassenindeling van rivierafvoer Q             *
C  *                                                     *
C
      READ(26,*) (WDR(I),I=1,5)
      READ(26,*) (PER(I),I=1,4)
      READ(26,*) (WH(I),I=1,10)
      READ(26,*) (Q(I),I=1,11)
      CALL UNITCONTROL(26,8)
C
C         *************************
C
      DISPLAY'NBA=',NBA,'NBB=',NBB,'NBC=',NBC,'NBD=',NBD
      DISPLAY'NBE=',NBE,'NBF=',NBF,'IALPHA=',IALPHA
C
C         *************************
C
C
C  *****bepalen jaarnr.,maandnr en soort getij***********
C
      MND=MND+1
      MNDCNT=MND+JR*12
      MNDU=732
      TIDE=TIDE-1
      TIDESTEP=12
      IDDP=(JR*8784+MNDPR)/MNDSTAP
C
C
   24 HRS=HRS+DELU
      MNDU=(MND-1)*732+HRS
      IF(MNDU.LE.MNDPR) GOTO 11
      CALL PRNTBOT(NAME,JR,MND,IDDP,ALPHA,JRSTAP,MNDSTAP)
      MNDPR=MNDPR+MNDSTAP
      IDDP=(JR*8784+MNDPR)/MNDSTAP
   11 IF(HRS.LE.732) GOTO 10
      HRS=DELU
      MND=MND+1
      MNDCNT=MNDCNT+1
      IF(MNDCNT.GT.MNDEIND) GOTO 1000
      IF(MND.LT.13) GOTO 10
      MND=1
      IF(MNDPR.GE.20000) GOTO 25
      MNDPR=MNDPR-12*732
   25 JR=JR+1
      IF(JR.LT.JRPR) GOTO 13
      IDDP=JRPR
      CALL PRNTBOT(NAME,JR,MND,IDDP,ALPHA,JRSTAP,MNDSTAP)
      JRPR=JRPR+JRSTAP
   13 IF(JR.EQ.JREIND) GOTO 1000
C
   10 READ(20 @MND,*) (QTYP(I),I=1,11)
      READ(23 @MND,*) (WAVDR(I),I=1,5)
    8 TIDESTEP=TIDESTEP+1
      IF(TIDESTEP.LE.12) GOTO 14
      TIDE=TIDE+1
      TIDESTEP=1
      IF(TIDE.GT.4) TIDE=1
      WRITE (6,299) JR,MND,TIDE,MNDSTAP,IDDP
  299 FORMAT(///X,I3,2X,I2,2X,F2.0,10X,I5,2X,I4)
C
C         ************************
C
C
C  ****bepalen golfklimaat en rivierafvoer**************
C  *  voor elke getijcyclus worden nieuwe golfklimaat  *
C  *  en rivierafvoer bepaald                          *
C  *
C  *                                                   *
C  *              eerst golfklimaat                    *
C
      CALL RANDOM(Y)
      IU1=Y*100
      DO 15 I=1,5
      IF(WAVDR(I).GT.IU1) GOTO 16
   15 CONTINUE
   16 ALFABOUND=WDR(I)
      IR=(MND-1)*5+I
      READ(24 @IR,*) (WAVPR(I),I=1,4)
      CALL RANDOM(Y)
      IU2=100*Y
      DO 17 I=1,4
      IF(WAVPR(I).GT.IU2) GOTO 18
   17 CONTINUE
      DISPLAY'!!! WAVE PERIOD CANNOT BE DETERMINED !!!'
      DISPLAY'    A MEAN PERIOD OF 10 SEC IS USED     '
      I=2
   18 TH=PER(I)
      IR=(MND-1)*4+I
      READ(25 @IR,*) (WAVH(I),I=1,10)
      CALL RANDOM(Y)
      IU3=100*Y
      DO 19 I=1,10
      IF(WAVH(I).GT.IU3) GOTO 20
   19 CONTINUE
      DISPLAY'!!! WAVE HEIGHT CANNOT BE DETERMINED!!!'
      DISPLAY'    A MEAN WAVE HEIGHT OF 0.9 M IS USED'
      I=3
   20 HO=WH(I)
C
C  ***bepalen waterstanden en rivierafvoer****
C
      CALL RANDOM(Y)
      IU4=100*Y
      DO 21 I=1,11
      IF(QTYP(I).GT.IU4) GOTO 22
   21 CONTINUE
   22 IF(I.GT.1.AND.IU4.GE.50) GOTO 30
      Q1=Q(I)
      GOTO 31
   30 I=I-1
      Q1=Q(I)
   31 IR=(TIDE-1)*11+I
      READ(22 @TIDE,*) (RISE1(I),I=1,12)
      READ(21 @IR,*) (QVAL(I),I=1,12)
C
C  ***bepaling extra waterstandsverhoging a.g.v *****
C  *  zeer hoge rivierafvoeren                      *
C  *                                                *
      DRISE=0
      IF(Q1.GE.2000.AND.Q1.LT.4000) DRISE=350.
      IF(Q1.GE.4000.AND.Q1.LT.6500) DRISE=750.
      IF(Q1.GE.6500.AND.Q1.LT.9000) DRISE=1250.
      IF(Q1.GE.9000.AND.Q1.LT.15000) DRISE=1950.
      WRITE(6,300) IU1,ALFABOUND,IU2,TH,IU3,HO,IU4,Q1
  300 FORMAT(X,I2,X,F4.0,3X,I2,X,F3.0,3X,I2,X,F4.2,3X,I2,X,F6.0)
   14 RISE=RISE1(TIDESTEP)*10.
      VO=QVAL(TIDESTEP)
C
C          *******************
C
C
C    ****simulatie voor een tijdstap********
C
      WRITE(6,301) TIDESTEP,HRS,VO,RISE+DRISE
  301 FORMAT(X,F3.0,2X,F7.3,2X,F6.0,2X,F5.0)
      IF(VO.GE.0) CALL FLOWDS1(VO,RISE,EPS,ALFA,MOLHE,DRISE)
      IF(VO.LT.0) CALL FLOWDS3(VO,RISE,EPSR,ALFAR,EPSZ,ALFAZ,MOLHE)
      CALL REFTEST(GAMMA,ROUGH,ALFABOUND,TH,HO,RISE,DGRNS,FRGH)
      CALL SEDTRAN(D50,D90,RISE,TH,ROUGH,DROTS,DRISE)
      CALL NEWBOT(DDRED,DELTAT,RISE,DRISE,DROTS,ALPMAX,DDGEXTR
     &            ,NBA,NBB,NBC,NBD,NBE,NBF,IALPHA)
      GOTO 24
 1000 STOP
      END
C
C
C
C
C
C
$CONTROL SEGMENT=RANDOM
      SUBROUTINE RANDOM(Y)
      DOUBLE PRECISION R
      LOGICAL LL
      COMMON/RAN/R,LL
      Y=RANF(.7)
      RETURN
      END
C
C
      FUNCTION RANF(Z)
      DOUBLE PRECISION T,TD,A,R
      LOGICAL LL
      COMMON/RAN/R,LL
      IF(LL) GOTO 10
      LL=.TRUE.
      R=123456789.
   10 A=100003.
      T=1.00000E+10
      TD=1.00000E-10
      A=A*R*TD
      R=(A-DDINT(A))*T
      RANF=SNGL(R*TD)
      RETURN
      END
C
C
C
C
C
C
$CONTROL SEGMENT=PRNTBOT
      SUBROUTINE PRNTBOT(NAME,JR,MND,IDDP,ALPHA,JRSTAP,MNDSTAP)
      REAL D(30,40),ALF(30,40),WFO(30,40),U(30,40)
     *     ,V(30,40),PSI(30),HEL(30),DNUL(30,40)
      INTEGER FPX(4),FPY(4)
      REAL MESH
      CHARACTER BUFFER*72,FNAAM*9,NAME*10
      LOGICAL LDDP
      EQUIVALENCE (LDDP,ID)
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
```

```
     &                      ,DMUL
      SYSTEM INTRINSIC ASCII
C
C     ************************************************
C     *                                              *
C     *     PROGRAMMA VOOR HET WEGSCHRIJVEN VAN DE   *
C     *     NIEUWE BODEM                             *
C     *                                              *
C     *     PROGRAMMA BOUWT STEEDS NIEUWE WEGSCHRIJFFILE  *
C     *                                              *
C     *                 wegschrijffile=MDEPxxx[FTN17]     *
C     *                                              *
C     ************************************************
C
C
      ID=IDDP
      BUFFER[1:6]='BUILD '
      BUFFER[7:4]='MDEP'
      BUFFER[11:3]='000'
      NUMCHAR=ASCII(LDDP,-10,BUFFER[13:3])
      BUFFER[14:28]=';REC=-70,7,F,ASCII;DISC=121'
      BUFFER[42:1]=%15C
      FNAAM[1:8]='M
      FNAAM[2:7]=BUFFER[7:7]
      CALL COMMAND(BUFFER,IPARM,IERP)
      CALL FILES('17',FNAAM)
      WRITE(17,1) NAME,JR,MND,IDDP,ALPHA,JRSTAP,MNDSTAP
    1 FORMAT(X,A10,X,'YR ',I2,'; MTH ',I2,'  NP',I2,
     &         '  ALPHA=',F3.1,' JRSTAP ',I2,' MNDSTAP ',I4)
      DO 2 I=1,NMAX,10
      DO 3 M=1,MMAX
      WRITE(17,4) (.01*D(N,M),N=I,I+9)
    4 FORMAT(10F8.1)
    3 CONTINUE
    2 CONTINUE
      CALL UNITCONTROL(17,8)
      RETURN
      END
C
C
C
$CONTROL SEGMENT=HELNG,NOSOURCE
      SUBROUTINE HELNG(M,RISE,NB,NE)
      INTEGER FPX(4),FPY(4)
      REAL MESH
      REAL PSI(30),HEL(30),DMUL(30,40)
      REAL D(30,40),ALF(30,40),WFO(30,40),U(30,40),V(30,40)
      COMMON /GENERAL/ NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,
     *                 IANTW,PSI,HEL,DMUL
      DO 10 N=1,NMAX
      PSI(N)=15.708
      HEL(N)=0
   10 CONTINUE
      DO 502 N=NB,NE
      IF(D(N,M)+RISE.LE.0) GOTO 502
      D1=D(N,M)+RISE
      D2=D(N+1,M)+RISE
      D3=D(N,M+1)+RISE
      D4=D(N+1,M+1)+RISE
      IF(D3.LE.0.AND.(D2.LE.0.OR.D4.LE.0)) GOTO 502
      IF(D3.LE.0) GOTO 535
      IF(D2.LE.0.OR.D4.LE.0) GOTO 534
      DHDX=(D4+D2-D3-D1)/2./MESH
      DHDY=(D4-D2+D3-D1)/2./MESH
      DELER=4.
      GOTO 536
  534 DHDY=(D3-D1)/MESH
      DHDX=0
      DELER=2
      IF(D2.LE.0.AND.D4.LE.0) GOTO 536
      IF(D2.LE.0) DHDX=(D4-D3)/MESH
      IF(D4.LE.0) DHDX=(D2-D1)/MESH
      DELER=3.
      GOTO 536
  535 DHDX=(D2-D1)/MESH
      DHDY=(D4-D2)/MESH
      DELER=3.
  536 IF(DHDX.EQ.0.AND.DHDY.EQ.0) GOTO 503
      PSI1=ATAN2(DHDY,DHDX)
      PSI(N)=PSI1
      COSPSI=ABS(COS(PSI1))
      SINPSI=ABS(SIN(PSI1))
      IF(COSPSI.GE..01.AND.SINPSI.GE..01) GOTO 504
      IF(COSPSI.LT..01) HEL1=DHDY*SINPSI
      IF(SINPSI.LT..01) HEL1=DHDX*COSPSI
      GOTO 506
  504 HEL1=ABS(DHDX*COSPSI)+ABS(DHDY*SINPSI)
  506 HEL(N)=ABS(HEL1)
      GOTO 502
C
C  *****VLAKKE BODEM**********************************
C
  503 PSI(N)=9.425
      HEL(N)=0
  502 CONTINUE
      RETURN
      END
C
C
C
C
C
C
$CONTROL SEGMENT=FLOWDS1,INIT
      SUBROUTINE FLOWDS1(VO,RISE,EPS,ALFA,MOLHE,DRISE)
C     !!!VO[M**3],RISE[MM],ALFA[DEGREES]!!!
C************************************************
C*                                              *
C*       PROGRAMMA VOOR STROOMDISTRIBUTIE       *
C*                                              *
C*           VAN RIVIER NAAR ZEE                *
C*                                              *
C*          berekent:  hellingsrichtingen       *
c*                     -hellingen               *
C*                     -oost en westpunt Cabedelo  *
C*                     -bijsturen snelheden in X-  *
C*                      en Y-richting           *
C*                     -invloed bodemfiguratie  *
C*                     -stroom distributie      *
C*                     -expanderen              *
C*                     -plotten op terminalscherm  *
C*                                              *
C*    stroomsnelheden U en V in [dm/sec]        *
C*                                              *
C************************************************
C
      REAL U(30,40),V(30,40),DUU(30),DVV(30),DMUL(30,40)
      REAL D(30,40),ALF(30,40),WFO(30,40),PSI(30),HEL(30)
      REAL MESH
      INTEGER FPX(4),FPY(4)
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                ,DMUL
      COMMON /FLOWDS/DUU,DVV
C
C       +--------> N,U,X
C       |
C       |
C       V  M,V,Y
C
C
      DBETM=1.05
      ALFAO=ALFA
      RISEO=RISE
      PI=3.141
      ALFA=ALFA*.01745
      E1=0.5*(1.0-EPS)*COS(ALFA)
      E2=0.5*(1.0-EPS)*SIN(ALFA)
C     DISPLAY E1,E2
C
      DO 510 N=1,NMAX
      DO 510 M=1,MMAX
      U(N,M)=0
      V(N,M)=0
  510 CONTINUE
C
C  ****VASTSTELLEN VAN VASTE PUNTEN VOOR CLOSER*********
C  *                                                    *
C  *  FIXED POINT 2 - FELGUEIRAS (INLEZEN VIA FILE 12) *
C  *  FIXED POINT 3 - CABEDELO EAST                     *
C  *  FIXED POINT 4 - CABEDELO WEST                     *
C  *  X - COORDINAAT MOLHE LUIZ DE CARVALHO: MOLHE      *
C  *                                                    *
C  * INDIEN FPX(1) EN FPY(1) BEIDE NUL ZIJN, WORDT CLOSER OVERGESLAGEN
C  *FIND FIXED POINT 3 (CABEDELO EAST)                  *
C  *START HIERVOOR BIJ CANTAREIRA                        *
C*                                                      *
C  * van diepte wordt DR=300 mm afgetrokken             *
C  *                                                    *
C*******************************************************
C
      DR=300.
      IF(FPX(1).EQ.0.AND.FPY(1).EQ.0) GOTO 116
      DO 112 MM=FPY(1),MMAX
      M=MM
      N=FPX(1)+1
  111 IF(D(N,M)+RISE-DR.LE.0) GOTO 113
      GOTO 117
  113 IF(N.EQ.13.AND.M.LE.13) GOTO 112
      GOTO 118
  117 N=N+1
      M=M-1
      IF(M.LE.0) GOTO 112
      IF(N.GT.MOLHE) GOTO 112
      GOTO 111
  112 CONTINUE
      DISPLAY'WARNING  PUNT CABEDELO EAST IS NIET GEVONDEN'
      DISPLAY'VOOR FP3 EN FP4 WORDT NU WEST KOP VAN MOLHE GENOMEN'
      FPX(3)=13
      FPY(3)=13
      GOTO 119
  118 FPX(3)=N
      FPY(3)=M
C   FIND FIXED POINT 4 (CABEDELO WEST)
C   START HIERVOER TEN ZUIDEN VAN FELGUEIRAS
  119 DO 115 MM=FPY(2),1,-1
      M=MM
      N=FPX(1)+1
  114 IF(D(N,M)+RISE-DR.LE.0) GOTO 116
      N=N+1
      M=M+1
      IF(M.GT.MMAX) GOTO 115
      IF(N.GT.MOLHE+1) GOTO 115
      GOTO 114
  115 CONTINUE
      DISPLAY'WARNING  PUNT CABEDELO WEST NIET GEVONDEN'
      DISPLAY'VOOR FP3 EN FP4 WORDT NU WEST KOP VAN MOLHE GENOMEN'
      FPX(4)=13
      FPY(4)=13
      GOTO 299
  116 FPX(4)=N
      FPY(4)=M
C   ALL FIXED POINTS GEVONDEN, COORD. IN ARRAYS FPX EN FPY
C************INITIEEL WERK IS KLAAR*********************************
C
C
C
C
C************BEGIN VAN LUS OVER M-WAARDEN***************************
C
  299 DO 20 M=1,MMAX-1
C
C   ****extra waterstandsverhoging t.g.v. zeer****
C   *    hoge waterstanden                       *
C
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) GOTO 34
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
   34 RISE=RISE-DR
C
      IF(M.NE.1) GOTO 120
C  ******* BEPALEN STROOMSNELHEDEN OP RAND M=1*******
C  *          TUSSEN N=1 EN MOLHE                   *
C  *                                                *
C  *    Strickler  : q=Kh**(5/3)                    *
C  *    VO=Q [M**3/SEC]                             *
C  *                                                *
      SOMD=0
      DO 32 N=1,MOLHE-1
```

```
      IF(D(N,M)+RISE.LE.O) GOTO 32
      DM=.001*(D(N,M)+RISE)
      DMM=DM**1.67
      SOMD=SOMD+DMM
   32 CONTINUE
      F=VO/SOMD
      DO 33 N=1,MOLHE-1
      IF(D(N,M)+RISE.LE.O) GOTO 33
      DM=.001*(D(N,M)+RISE)
      V(N,M)=F*DM**1.67
C
C   !!!!!!V(N,M) = DEBIET PER MAASWIJDTE IN M**3/SEC!!!!!!!!!
C
C     DISPLAY N,M,U(N,M),V(N,M),SOMD,'RVW'
   33 CONTINUE
C *****************
C
C
C
C   ***START LUS VOOR CLOSING SYSTEEM *  VAN BINNEN NAAR BUITEN**
  120 IF(FPX(1).EQ.O.AND.FPY(1).EQ.O) GOTO 125
      DO 125  N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 125
      VV=V(N,M)
      UU=U(N,M)
C   VIER AFGESLOTEN GEBIEDEN GEDEFINIEERD, ZIE TEKENING
C   EERST AFTESTEN OF PUNT N,M IN EEN VAN DEZE GEBIEDEN ZIT
      IF(N.LE.FPX(1).AND.M.LT.FPY(1))GOTO 121
      IF(N.GE.FPX(3).AND.M.LT.FPY(3))GOTO 122
      IF(N.LE.FPX(2).AND.M.LT.FPY(2))GOTO 123
      IF(N.GE.FPX(4).AND.M.LT.FPY(4).AND.M.GT.FPY(3))GOTO 124
      GOTO 125
  121 PARM=VV*VV/((FPY(1)-M)**1.5)
      DIFF=1.
      GOTO 133
  122 PARM=VV*VV/((FPY(3)-M)**1.5)
      DIFF=-1.
      GOTO 133
  123 PARM=VV*VV/((FPY(2)-M)**1.5)
      DIFF=1.
      GOTO 133
  124 PARM=VV*VV/((FPY(4)-M)**1.5)
      DIFF=-1.
      GOTO 133
  133 GGK=UU*UU+VV*VV
      DIFF1=UU*ABS(UU)+PARM*DIFF
      UUN=SIGN(SQRT(ABS(DIFF1)),DIFF1)
      GGK1=GGK-UUN*UUN
      IF(GGK1.LE.O) GOTO 140
      V(N,M)=SQRT(GGK1)
      U(N,M)=UUN
C     DISPLAY N,M,U(N,M),V(N,M),'CL. M-RI.'
      GOTO 125
  140 V(N,M)=O
      U(N,M)=UUN
C     DISPLAY N,M,U(N,M),V(N,M),'CL. M-RI.'
  125 CONTINUE
C *******EINDE CLOSING OUTFLOW IN M-RICHTING******
C
C
C
C   ******START CLOSING OUTFLOW  N-RICHTING ****************
C
C  ***vaststellen X-coordinaten van eventueel****
C  *  aanwezige linker- en rechteroever op       *
C  *  M=M                                        *
C  *      indien beide oevers aanwezig           *
C  *      dan zijn :    NLINKS > -1              *
C  *                    NRECHTS> -1              *
C  *                                             *
C
      NLINKS=-1
      NRECHTS=-1
      IF(D(1,M)+RISE.GT.O) NLINKS=O
      DO 128 N=1,NMAX-1
      IF(NLINKS.NE.-1)GOTO 127
      IF(D(N,M)+RISE.LE.O.AND.D(N+1,M)+RISE.GT.O)
     *NLINKS=N
  127 IF(NRECHTS.NE.-1) GOTO 128
      IF(D(N,M)+RISE.GT.O.AND.D(N+1,M)+RISE.LE.O)
     *NRECHTS=N+1
  128 CONTINUE
      DO 129 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 129
      UU=U(N,M)
      VV=V(N,M)
      IF(UU) 129,129,130
  130 IF(NRECHTS.EQ.-1) GOTO 129
      IF(NRECHTS-N.GT.5.OR.NRECHTS-N.LE.O) GOTO 129
      PARM=UU*UU/((NRECHTS-N)**.5)
      V(N,M)=SQRT(VV*VV+PARM)
      U(N,M)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U(N,M),V(N,M),'CL. N-RI.'
  129 CONTINUE
      DO 131 N=NMAX,1,-1
      IF(D(N,M)+RISE.LE.O) GOTO 131
      UU=U(N,M)
      VV=V(N,M)
      IF(UU) 132,131,131
  132 IF(NLINKS.EQ.O) GOTO 131
      IF(N-NLINKS.GT.5.OR.N-NLINKS.LE.O) GOTO 131
      PARM=UU*UU/((N-NLINKS)**.5)
      V(N,M)=SQRT(VV*VV+PARM)
      U(N,M)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U(N,M),V(N,M),'CL. N-RI.'
  131 CONTINUE
 9999 CONTINUE
      RISE=RISE+DR
C**************************************************
C*          INVLOED BODEMCONFIGURATIE            *
C*                                               *
C*   de snelheidsvectoren worden bijgedraaid in de *
C*   richting van de lokale dieptelijn.          *
C*                                               *
C*   max. bijdraaihoek=DBETM                     *
C*                                               *
C*   bijdraaihoek DBETA=FACDP*FACHL*waterdiepte  *
C*                                               *
C*                      FACDP=EXP(-(D(N,M)+RISE)) *
C*                      FACHL=bodemhelling*10    *
C*                                               *
C*   als U(N,M) <O dan HEL1=HEL(N-1)             *
C*                     PSI1=PSI1(N-1)            *
C*   als U(N,M) =O dan grootste van HEL(N),HEL(N-1)*
C*                     + bijbehorende PSI1       *
C*   als U(N,M) >O dan HEL1=HEL(N)               *
C*                     PSI1=PSI1(N)              *
C*                                               *
C**************************************************
C
      CALL HELNG(M,RISE,1,NMAX-1)
      DO 601 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 801
      UU=U(N,M)
      VV=V(N,M)
      NN=N
      IF(UU) 511,512,513
  511 IF(N.NE.1) NN=N-1
      GOTO 513
  512 IF(N.EQ.1) GOTO 513
      IF(HEL(N-1).GT.HEL(N)) NN=N-1
  513 HEL1=HEL(NN)
      PSI1=PSI(NN)
      IF(PSI1.GE.9.111) GOTO 801
      IF(VV.EQ.O.AND.UU.EQ.O) GOTO 801
      HOEK=ATAN2(VV,UU)
      IF(PSI1.GE.-1.5708.AND.PSI1.LT.1.5708) GOTO 806
C
C   ****PSI1 ligt in 2e of 3e kwadrant**********
C
      IF(PSI1.LT.O) PSI1=PSI1+6.283
      IF(HOEK.LT.O) HOEK=HOEK+6.283
      PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 607
C   *****dit betekent;water stroomt van ondiep naar diep****
      PSI1=PSI1-3.1416
      IF(HOEK.GE.3.1416) HOEK=HOEK-6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..O) D1=.O
      GOTO 607
C                   **************
C
C   *******PSI1 ligt in 1e of 4e kwadrant**********
C
  806 PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 607
C   ****dit betekent: water stroomt van ondiep naar diep***
      PSI1=PSI1+3.1416
      IF(HOEK.LT.O) HOEK=HOEK+6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..O) D1=.O
      GOTO 607
C
C   *****bijdraaien snelheden (=DBETA)          ******
C   *   -max. bijdraaihoek=DBETM                     *
C   *   -water van diep naar ondiep wordt sterker    *
C   *    bijgedraaid dan van ondiep naar diep        *
C
  607 BETA=HOEK-PSI1
      IF(ABS(BETA).LT..00175) GOTO 601
      FACDP=EXP(-D1)
      FACHL=HEL1*10.
      DBETA=O
      IF(FACDP.LT..001.AND.FACHL.LT..001) GOTO 808
      DBETA=FACDP*FACHL*DBETM
  808 BETAN=SIGN(ABS(BETA)+DBETA,BETA)
      IF(ABS(BETAN).GT.1.5708) BETAN=SIGN(1.5708,BETA)
      HOEKN=PSI1+BETAN
      GGK=SQRT(UU*UU+VV*VV)
      U(N,M)=GGK*COS(HOEKN)
      V(N,M)=GGK*SIN(HOEKN)
C     DISPLAY N,M,U(N,M),V(N,M),HOEK,PSI1,HEL1,BETA,FACDP,DBETA,
C    &        BETAN,HOEKN,'B. CONF'
      IF(V(N,M).GE.O) GOTO 801
      U(N,M)=SIGN(GGK,U(N,M))
      V(N,M)=O
  801 CONTINUE
      RISE=RISE-DR
C
C******START DISTRIBUTOR***********
      DO 16 N=1,NMAX
      DUU(N)=U(N,M)
      DVV(N)=V(N,M)
   16 CONTINUE
      DO 19 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 8
      UU=U(N,M)
      VV=V(N,M)
      IF(UU.EQ.O.AND.VV.EQ.O) GOTO 8
      IF(UU) 19,2,3
    2 IF(VV.EQ.O) GOTO 8
      CALL DISTSUB(U(N,M+1),V(N,M+1),UU,VV,1.,O,NMAX,MMAX)
      GOTO 8
    3 VU=VV/UU
      IF(VV.EQ.O) GOTO 14
      UV=UU/VV
      IF(VU-1) 6,6,7
    6 CALL DISTSUB(DUU(N+1),DVV(N+1),UU,VV,1.O-VU,N+1,NMAX,MMAX)
      IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB(U(N+1,M+1),V(N+1,M+1),UU,VV,VU,O,NMAX,MMAX)
      GOTO 8
    7 IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB(U(N+1,M+1),V(N+1,M+1),UU,VV,UV,O,NMAX,MMAX)
      CALL DISTSUB(U(N,M+1),V(N,M+1),UU,VV,1.O-UV,O,NMAX,MMAX)
      GOTO 8
   14 IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB(DUU(N+1),DVV(N+1),UU,VV,1.,N+1,NMAX,MMAX)
      GOTO 8
    8 CONTINUE
   19 CONTINUE
      DO 17 N=NMAX,1,-1
      UU=U(N,M)
```

```
      IF(UU) 1,17,17
    1 VV=V(N,M)
      IF(VV.EQ.0) GOTO 15
      VU=VV/UU
      UV=UU/VV
      IF(VU+1)4,4,5
    4 CALL DISTSUB(U(N,M+1),V(N,M+1),UU,VV,1.0+UV,0,NMAX,MMAX)
      IF(N.EQ.1) GOTO 17
      CALL DISTSUB(U(N-1,M+1),V(N-1,M+1),UU,VV,-UV,0,NMAX,MMAX)
      GOTO 17
    5 CALL DISTSUB(U(N-1,M+1),V(N-1,M+1),UU,VV,-VU,0,NMAX,MMAX)
      IF(N.EQ.1) GOTO 17
      CALL DISTSUB(DUU(N-1),DVV(N-1),UU,VV,1.0+VU,-(N-1),NMAX,MMAX)
      GOTO 17
   15 IF(N.EQ.1) GOTO 17
      CALL DISTSUB(DUU(N-1),DVV(N-1),UU,VV,1.,-(N-1),NMAX,MMAX)
   17 CONTINUE
      DO 18 N=1,NMAX
      U(N,M)=DUU(N)
      V(N,M)=DVV(N)
   18 CONTINUE
C*******EINDE DISTRIBUTOR*************************
C
C*******START EXPANDER****************************************
C*  vertikale snelheid                                        *
C*   expanderen V op M=M+1 naar N-1 en N+1                    *
C*                                                            *
C*************************************************************
      DO 30 N=1,NMAX
      DUU(N)=0
      DVV(N)=0
   30 CONTINUE
      DO 29 N=1,NMAX
      IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 24
      IF(M.EQ.MMAX) GOTO 24
      IF(D(N,M+1)+RISE.LE.0) GOTO 23
      ISIGN1=1
      ISIGN2=1
      NMIN=N-1
      NPLUS=N+1
      IF(D(N-1,M+1)+RISE.GT.0) GOTO 21
      ISIGN1=-ISIGN1
      NMIN=N
   21 IF(D(N+1,M+1)+RISE.GT.0) GOTO 22
      ISIGN2=-ISIGN2
      NPLUS=N
   22 VMIN=V(N,M+1)
      DVV(N)=DVV(N)+EPS*VMIN
      DVV(NMIN)=DVV(NMIN)+E1*VMIN
      DVV(NPLUS)=DVV(NPLUS)+E1*VMIN
      DUU(NMIN)=DUU(NMIN)-E2*VMIN*ISIGN1
      DUU(NPLUS)=DUU(NPLUS)+E2*VMIN*ISIGN2
C     DISPLAY N,M,V(N,M),U(N,M)
C     DISPLAY DVV(NMIN),DVV(N),DVV(NPLUS),DUU(NMIN),DUU(N),DUU(NPLUS)
   23 CONTINUE
C
C*****expanderen horizontale snelheid U*********
C*    expanderen op M=M+1 naar N=N-1 en N=N+1***
C
      IF(D(N,M)+RISE.LE.0) GOTO 28
      ISIG=1
      MMIN=M-1
      MPLUS=M+1
      IF(D(N,M-1)+RISE.GT.0) GOTO 26
      ISIGN=-ISIGN
      MMIN=M
   26 IF(D(N,M+1)+RISE.GT.0) GOTO 27
      ISIGN=-ISIGN
      MPLUS=M
   27 UMIN=U(N,M+1)
      DUU(N)=EPS*UMIN+DUU(N)
      DUU(N-1)=DUU(N-1)+E1*UMIN
      DUU(N+1)=DUU(N+1)+E1*UMIN
      DVV(N-1)=DVV(N-1)+E2*UMIN*ISIGN
      DVV(N+1)=DVV(N+1)-E2*UMIN*ISIGN
   28 CONTINUE
   24 CONTINUE
C
   29 CONTINUE
      DO 31 N=1,NMAX
      IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 31
      IF(M.EQ.MMAX) GOTO 31
      U(N,M+1)=DUU(N)
      V(N,M+1)=DVV(N)
   31 CONTINUE
C*******EINDE EXPANDER*****************************
C
C
C****************OPSCHALEN U EN V*******************
C
      SOMPL=0
      SOM=0
      MPL=M+1
      DO 980 N=1,NMAX
      UU=U(N,M)
      VV=V(N,M)
      SOM=SOM+SQRT(UU*UU+VV*VV)
      UUP=U(N,MPL)
      VVP=V(N,MPL)
      SOMPL=SOMPL+SQRT(UUP*UUP+VVP*VVP)
  980 CONTINUE
      SOM1=0
      IF(M.EQ.1) TOTAL=SOM
      DO 990 N=1,NMAX
      IF(SOM.EQ.0) GOTO 990
      IF(SOMPL.EQ.0) GOTO 990
      UU=U(N,M)
      VV=V(N,M)
      U(N,M)=UU*TOTAL/SOM
      V(N,M)=VV*TOTAL/SOM
C     DISPLAY N,M,U(N,M),V(N,M),'OPSCH'
      UUP=U(N,MPL)
      VVP=V(N,MPL)
      U(N,MPL)=UUP*TOTAL/SOMPL
      V(N,MPL)=VVP*TOTAL/SOMPL
      UU=U(N,M)
      VV=V(N,M)
      SOM1=SOM1+SQRT(UU*UU+VV*VV)
  990 CONTINUE
      IF(M.EQ.MMAX-2) SOM2=SOM1
   20 CONTINUE
      WRITE(6,300) FPX(3),FPY(3),FPX(4),FPY(4),TOTAL,SOM2
  300 FORMAT(X,'(',I2,',',I2,')  (',I2,',',I2,')',5X,F5.0,X,F5.0)
      DO 891 M=1,MMAX
C
C   ****extra waterstandsverhoging t.g.v. zeer****
C   *     hoge rivierafvoeren                     *
C
      RISE=RISE0
      FPY2=FPY(2)
      IF(M.GT.FPY2) GOTO 35
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
C
   35 DO 892 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 892
      D1=.001*(D(N,M)+RISE)
      UU=U(N,M)
      VV=V(N,M)
      IF(VV.EQ.0.AND.UU.EQ.0) GOTO 892
      GGK=SQRT(UU*UU+VV*VV)
      HK=ATAN2(VV,UU)
      GGKD=1000.*GGK/MESH/D1
      VMAX=SQRT(9.81*D1)
      IF(GGKD.GT.VMAX) GGKD=VMAX
      U(N,M)=10.*GGKD*COS(HK)
      V(N,M)=10.*GGKD*SIN(HK)
C     DISPLAY N,M,U(N,M),V(N,M),'CUR. VEL'
C
C   !!!!!!U(N,M) EN V(N,M) IN DM/SEC!!!!!!!!!!!!!
C
  892 CONTINUE
  891 CONTINUE
      IF(IANTW.EQ.2) GOTO 550
      CALL FILES('30','*UVELDS  ')
      CALL FILES('31','*VVELDS  ')
      DO 893 M=1,MMAX
      DO 894 I=1,NMAX,10
      WRITE(30,895) (U(N,M),N=I,I+9)
      WRITE(31,895) (V(N,M),N=I,I+9)
  895 FORMAT(10F8.1)
  894 CONTINUE
  893 CONTINUE
      CALL UNITCONTROL(30,8)
      CALL UNITCONTROL(31,8)
  550 ALFA=ALFA0
      RISE=RISE0
      RETURN
      END
C
C
C
C
$CONTROL SEGMENT=DISTSUB
      SUBROUTINE DISTSUB(U,V,UU,VV,PARM,II,NMAX,MMAX)
      REAL DUU(30),DVV(30),U,V
      DOUBLE PRECISION H2,UUU,VVV
      COMMON /FLOWDS/DUU,DVV
      IF(ABS(U).LT..00001) U=0
      IF(ABS(V).LT..00001) V=0
      IF(ABS(UU).LT..00001) UU=0
      IF(ABS(VV).LT..00001) VV=0
      IF(ABS(PARM).LT..00001) PARM=0
      U1=U
      V1=V
      H1=SQRT(U1*U1+V1*V1)+SQRT(1.*UU*UU+1.*VV*VV)*PARM
      UUU=U+UU*PARM
      VVV=V+VV*PARM
      IF(UUU.EQ.0)GOTO 5
      H2=ATAN((VVV)/(UUU))
      XU=SIGN(H1*COS(H2),UUU)
      YV=SIGN(H1*SIN(H2),VVV)
      GOTO 4
    5 XU=0.0
      YV=H1
    4 IF(II) 1,2,3
    1 DUU(-II)=XU
      DVV(-II)=YV
      RETURN
    2 U=XU
      V=YV
      RETURN
    3 DUU(II)=XU
      DVV(II)=YV
      RETURN
      END
C
C
C
C
C
C
$CONTROL SEGMENT=FLOWDS3
      SUBROUTINE FLOWDS3(VO,RISE,EPSR,ALFAR,EPSZ,ALFAZ,MOLHE)
C     !!!VO[M**3/SEC],RISE[MM],ALFAR,ALFAZ[DEGREES]!!!
C*************************************************
C*                                               *
C*      PROGRAMMA VOOR STROOMDISTRIBUTIE         *
C*                                               *
C*           VAN ZEE NAAR RIVIER                 *
C*                                               *
C*         berekent:  hellingsrichtingen         *
C*                    -hellingen                 *
C*                    -oost en westpunt Cabedelo *
C*                    -bijsturen snelheden in X- *
C*                     en Y-richting             *
C*                    -invloed bodemfiguratie    *
C*                    -stroom distributie        *
C*                    -expanderen                *
C*                    -plotten op terminalscherm *
C*                                               *
C*   stroomsnelheden U en V in [dm/sec]          *
C*                                               *
C*************************************************
C
      REAL U(30,40),V(30,40),DUU(30),DVV(30),U1(30),V1(30),
     *     PSI(30),HEL(30),DNUL(30,40)
      REAL D(30,40),ALF(30,40),WFO(30,40)
      REAL MESH
      INTEGER FPX(4),FPY(4)
```

```
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                ,DNUL
      COMMON /FLOWDS/DUU,DVV
C
C       +-------> N,U,X
C       |
C       |
C       V  M,V,Y
C
C
      DBETM=1.05
      PI=3.141
      ALFARO=ALFAR
      ALFAZO=ALFAZ
      ALFAR=ALFAR*.01745
      ALFAZ=ALFAZ*.01745
      E1=0.5*(1.0-EPSR)*COS(ALFAR)
      E2=0.5*(1.0-EPSR)*SIN(ALFAR)
C     DISPLAY E1,E2
      DO 510 N=1,NMAX
      DO 510 M=1,MMAX
      U(N,M)=0
      V(N,M)=0
  510 CONTINUE
C
C  ****VASTSTELLEN VAN VASTE PUNTEN VOOR CLOSER**********
C  *                                                    *
C  *   FIXED POINT 2 - FELGUEIRAS (INLEZEN VIA FILE 12) *
C  *   FIXED POINT 3 - CABEDELO EAST                    *
C  *   FIXED POINT 4 - CABEDELO WEST                    *
C  *   X - COORDINAAT MOLHE LUIZ DE CARVALHO: MOLHE     *
C  *                                                    *
C  * INDIEN FPX(1) EN FPY(1) BEIDE NUL ZIJN, WORDT CLOSER OVERGESLAGEN
C  *FIND FIXED POINT 3 (CABEDELO EAST)                  *
C  *START HIERVOOR BIJ CANTAREIRA                       *
C*                                                      *
C*  van diepte wordt DR=300 mm afgetrokken              *
C*                                                      *
C*******************************************************
C
      DR=300.
      IF(FPX(1).EQ.0.AND.FPY(1).EQ.0) GOTO 118
      DO 112 MM=FPY(1),MMAX
      M=MM
      N=FPX(1)+1
  111 IF(D(N,M)+RISE-DR.LE.0) GOTO 113
      GOTO 117
  113 IF(N.EQ.13.AND.M.LE.13) GOTO 112
      GOTO 118
  117 N=N+1
      M=M-1
      IF(M.LE.0) GOTO 112
      IF(N.GT.MOLHE) GOTO 112
      GOTO 111
  112 CONTINUE
      DISPLAY'WARNING  PUNT CABEDELO EAST IS NIET GEVONDEN'
      DISPLAY'VOOR FP3 EN FP4 WORDT NU WEST KOP VAN MOLHE GENOMEN'
      FPX(3)=13
      FPY(3)=13
      GOTO 119
  118 FPX(3)=N
      FPY(3)=M
C   FIND FIXED POINT 4 (CABEDELO WEST)
C   START HIERVOER TEN ZUIDEN VAN FELGUEIRAS
  119 DO 115 MM=FPY(2),1,-1
      M=MM
      N=FPX(1)+1
  114 IF(D(N,M)+RISE-DR.LE.0) GOTO 116
      N=N+1
      M=M+1
      IF(M.GT.MMAX) GOTO 115
      IF(N.GT.MOLHE+1) GOTO 115
      GOTO 114
  115 CONTINUE
      DISPLAY'WARNING  PUNT CABEDELO WEST NIET GEVONDEN'
      DISPLAY'VOOR FP3 EN FP4 WORDT NU WEST KOP VAN MOLHE GENOMEN'
      FPX(4)=13
      FPY(4)=13
      GOTO 299
  116 FPX(4)=N
      FPY(4)=M
C   ALL FIXED POINTS GEVONDEN, COORD. IN ARRAYS FPX EN FPY
C************INITIEEL WERK IS KLAAR*********************************
C
C
C
C
C************BEGIN VAN LUS OVER M-WAARDEN************************
C*                                                             *
C*       eerst van Cabedelo opening (M=fpy(4)) naar boven (M=1) *
C*                                                             *
C****************************************************************
C
C
  299 RISEO=RISE
      RISE=RISE-DR
      DO 20 M=FPY(4),2,-1
      IF(M.NE.FPY(4)) GOTO 120
C  ******* BEPALEN STROOMSNELHEDEN IN CABEDELO OPENING ******
C*                                                         *
C*       Strickler  : q=Kh**(5/3)                          *
C*       VO=Q [M**3/SEC]                                   *
C*                                                         *
      SOMD=0
      DO 32 N=1,FPX(4)-1
      IF(D(N,M)+RISE.LE.0) GOTO 32
      DM=.001*(D(N,M)+RISE)
      DMM=DM**1.67
      SOMD=SOMD+DMM
   32 CONTINUE
      F=VO/SOMD
      DO 33 N=1,FPX(4)-1
      IF(D(N,M)+RISE.LE.0) GOTO 33
      DM=.001*(D(N,M)+RISE)
      V(N,M)=F*DM**1.67
C
C   !!!!!!V(N,M) = DEBIET PER MAASWIJDTE IN M**3/SEC!!!!!!!!!
C
C     DISPLAY N,M,U(N,M),V(N,M)
   33 CONTINUE
C ******************
C
C
C
C   ***START LUS VOOR CLOSING SYSTEEM *  VAN BINNEN NAAR BUITEN**
  120 IF(FPX(1).EQ.0.AND.FPY(1).EQ.0) GOTO 125
      DO 125  N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 125
      VV=V(N,M)
      UU=U(N,M)
C   DRIE AFGESLOTEN GEBIEDEN GEDEFINIEERD, ZIE TEKENING
C   EERST AFTESTEN OF PUNT N,M IN EEN VAN DEZE GEBIEDEN ZIT
      IF(N.LE.FPX(1).AND.M.GT.FPY(1).AND.M.LT.FPY(2))GOTO 121
      IF(N.GE.FPX(3).AND.M.GT.FPY(3).AND.N.LT.FPX(4))GOTO 122
      IF(N.LE.FPX(2).AND.M.GT.FPY(2))GOTO 123
      GOTO 125
  121 PARM=VV*VV/((M-FPY(1))**1.5)
      DIFF=1.
      GOTO 133
  122 PARM=VV*VV/((M-FPY(3))**1.5)
      DIFF=-1.
      GOTO 133
  123 PARM=VV*VV/((M-FPY(2))**1.5)
      DIFF=1.
      GOTO 133
  133 GGK=UU*UU+VV*VV
      DIFF1=UU*ABS(UU)+PARM*DIFF
      UUN=SIGN(SQRT(ABS(DIFF1)),DIFF1)
      GGK1=GGK-UUN*UUN
      IF(GGK1.LE.0) GOTO 140
      V(N,M)=-SQRT(GGK1)
      U(N,M)=UUN
C     DISPLAY N,M,U(N,M),V(N,M),'CLOSER'
      GOTO 125
  140 V(N,M)=0
      U(N,M)=UUN
C     DISPLAY N,M,U(N,M),V(N,M),'CLOSER'
  125 CONTINUE
C *******EINDE CLOSING OUTFLOW IN M-RICHTING******
C
C
C
C   ******START CLOSING OUTFLOW  N-RICHTING ****************
C
C  ***vaststellen X-coordinaten van eventueel****
C  *  aanwezige linker- en rechteroever op      *
C  *  M=M                                       *
C  *       indien beide oevers aanwezig         *
C  *       dan zijn :    NLINKS > -1            *
C  *                     NRECHTS> -1            *
C  *                                            *
C
      NLINKS=-1
      NRECHTS=-1
      IF(D(1,M)+RISE.GT.0) NLINKS=0
      DO 126 N=1,NMAX-1
      IF(NLINKS.NE.-1)GOTO 127
      IF(D(N,M)+RISE.LE.0.AND.D(N+1,M)+RISE.GT.0)
     *NLINKS=N
  127 IF(NRECHTS.NE.-1) GOTO 126
      IF(D(N,M)+RISE.GT.0.AND.D(N+1,M)+RISE.LE.0)
     *NRECHTS=N+1
  126 CONTINUE
      DO 129 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 129
      UU=U(N,M)
      VV=V(N,M)
      IF(UU) 129,129,130
  130 IF(NRECHTS.EQ.-1) GOTO 129
      IF(NRECHTS-N.GT.5.OR.NRECHTS-N.LE.0) GOTO 129
      PARM=UU*UU/((NRECHTS-N)**.5)
      V(N,M)=-SQRT(VV*VV+PARM)
      U(N,M)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U(N,M),V(N,M),'RECHTS'
  129 CONTINUE
      DO 131 N=NMAX,1,-1
      IF(D(N,M)+RISE.LE.0) GOTO 131
      UU=U(N,M)
      VV=V(N,M)
      IF(UU) 132,131,131
  132 IF(NLINKS.EQ.0) GOTO 131
      IF(N-NLINKS.GT.5.OR.N-NLINKS.LE.0) GOTO 131
      PARM=UU*UU/((N-NLINKS)**.5)
C     IF(N-NLINKS.EQ.1) DISPLAY N,M,UU,VV
      V(N,M)=-SQRT(VV*VV+PARM)
      U(N,M)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U(N,M),V(N,M),'LINKS'
  131 CONTINUE
 9999 CONTINUE
      RISE=RISEO
C*************************************************
C*        INVLOED BODEMCONFIGURATIE              *
C*                                               *
C*  de snelheidsvectoren worden bijgedraaid in de *
C*  richting van de lokale dieptelijn.           *
C*                                               *
C*  max. bijdraaihoek=DBETM                      *
C*                                               *
C*  bijdraaihoek DBETA=FACDP*FACHL*waterdiepte   *
C*                                               *
C*                    FACDP=EXP(-(D(N,M)+RISE))  *
C*                    FACHL=bodenhelling*10      *
C*                                               *
C*  als U(N,M) <0 dan HEL1=HEL(N-1)              *
C*                    PSI1=PSI1(N-1)             *
C*  als U(N,M) =0 dan grootste van HEL(N),HEL(N-1)*
C*                    + bijbehorende PSI1        *
C*  als U(N,M) >0 dan HEL1=HEL(N)                *
C*                    PSI1=PSI1(N)               *
C*                                               *
C*                                               *
C*************************************************
C
      CALL HELNG(M-1,RISE,1,NMAX-1)
      DO 601 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 601
      UU=U(N,M)
      VV=V(N,M)
      NN=N
      IF(UU) 511,512,513
```

```
  511 IF(N.NE.1) NN=N-1
      GOTO 513
  512 IF(N.EQ.1) GOTO 513
      IF(HEL(N-1).GT.HEL(N)) NN=N-1
  513 HEL1=HEL(NN)
      PSI1=PSI(NN)
C
C  *****bijdraaien vectoren (hor. snelheid positief)*****
C
C     DISPLAY PSI1
      IF(PSI1.GE.9.111) GOTO 801
      IF(VV.EQ.0.AND.UU.EQ.0) GOTO 801
      HOEK=ATAN2(VV,UU)
      IF(PSI1.GE.-1.5708.AND.PSI1.LT.1.5708) GOTO 606
C
C  ****PSI1 ligt in 2e of 3e kwadrant**********
C
      IF(PSI1.LT.O) PSI1=PSI1+6.283
      IF(HOEK.LT.O) HOEK=HOEK+6.283
      PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 607
C  *****dit betekent;water stroomt van ondiep naar diep****
      PSI1=PSI1-3.1416
      IF(HOEK.GE.3.1416) HOEK=HOEK-6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..O) D1=.O
      GOTO 607
C                   **************
C
C  *******PSI1 ligt in 1e of 4e kwadrant**********
C
  606 PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 607
C  ****dit betekent: water stroomt van ondiep naar diep***
      PSI1=PSI1+3.1416
      IF(HOEK.LT.O) HOEK=HOEK+6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..O) D1=.O
      GOTO 607
C
C  *****bijdraaien snelheden (=DBETA)         ******
C  *   -max. bijdraaihoek=DBETM                    *
C  *   -water van diep naar ondiep wordt sterker   *
C  *     bijgedraaid dan van ondiep naar diep      *
C
  607 BETA=HOEK-PSI1
      IF(ABS(BETA).LT..00175) GOTO 801
      FACDP=EXP(-D1)
      FACHL=HEL1*10.
      DBETA=0
      IF(FACDP.LT..001.AND.FACHL.LT..001) GOTO 608
      DBETA=FACDP*FACHL*DBETM
  608 BETAN=SIGN(ABS(BETA)+DBETA,BETA)
      IF(ABS(BETAN).GT.1.5708) BETAN=SIGN(1.5708,BETA)
      HOEKN=PSI1+BETAN
      GGK=SQRT(UU*UU+VV*VV)
      U(N,M)=GGK*COS(HOEKN)
      V(N,M)=GGK*SIN(HOEKN)
      IF(V(N,M).LE.O) GOTO 801
      U(N,M)=SIGN(GGK,U(N,M))
      V(N,M)=0
C     DISPLAY N,M,U(N,M),V(N,M),'BODEM'
  801 CONTINUE
      RISE=RISEO-DR
C
C*******START DISTRIBUTOR***********
      DO 16 N=1,NMAX
      DUU(N)=U(N,M)
      DVV(N)=V(N,M)
   16 CONTINUE
      DO 19 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 8
      UU=U(N,M)
      VV=V(N,M)
      IF(UU.EQ.O.AND.VV.EQ.O) GOTO 8
      IF(UU) 19,2,3
    2 IF(VV.EQ.O) GOTO 8
      CALL DISTSUB1(U(N,M-1),V(N,M-1),UU,VV,1.,O,NMAX,MMAX)
      GOTO 8
    3 VU=-VV/UU
      IF(VV.EQ.O) GOTO 14
      UV=-UU/VV
      IF(VU-1) 6,6,7
    6 CALL DISTSUB1(DUU(N+1),DVV(N+1),UU,VV,1.O-VU,N+1,NMAX,MMAX)
      IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB1(U(N+1,M-1),V(N+1,M-1),UU,VV,VU,O,NMAX,MMAX)
      GOTO 8
    7 IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB1(U(N+1,M-1),V(N+1,M-1),UU,VV,UV,O,NMAX,MMAX)
      CALL DISTSUB1(U(N,M-1),V(N,M-1),UU,VV,1.O-UV,O,NMAX,MMAX)
      GOTO 8
   14 IF(N.EQ.NMAX) GOTO 8
      CALL DISTSUB1(DUU(N+1),DVV(N+1),UU,VV,1.,N+1,NMAX,MMAX)
      GOTO 8
    8 CONTINUE
   19 CONTINUE
      DO 17 N=NMAX,1,-1
      UU=U(N,M)
      IF(UU) 1,17,17
    1 VV=V(N,M)
      IF(VV.EQ.O) GOTO 15
      VU=-VV/UU
      UV=-UU/VV
      IF(VU+1)4,4,5
    4 CALL DISTSUB1(U(N,M-1),V(N,M-1),UU,VV,1.O+UV,O,NMAX,MMAX)
      IF(N.EQ.1) GOTO 17
      CALL DISTSUB1(U(N-1,M-1),V(N-1,M-1),UU,VV,-UV,O,NMAX,MMAX)
      GOTO 17
    5 CALL DISTSUB1(U(N-1,M-1),V(N-1,M-1),UU,VV,-VU,O,NMAX,MMAX)
      IF(N.EQ.1) GOTO 17
      CALL DISTSUB1(DUU(N-1),DVV(N-1),UU,VV,1.O+VU,-(N-1),NMAX,MMAX)
      GOTO 17
   15 IF(N.EQ.1) GOTO 17
      CALL DISTSUB1(DUU(N-1),DVV(N-1),UU,VV,1.,-(N-1),NMAX,MMAX)
   17 CONTINUE
      DO 18 N=1,NMAX
      U(N,M)=DUU(N)
      V(N,M)=DVV(N)
C     IF(M.EQ.8.AND.N.EQ.5) DISPLAY N+1,M-1,U(N+1,M-1),V(N+1,M-1)
C     DISPLAY N,M,U(N,M),V(N,M)
   18 CONTINUE
C*******EINDE DISTRIBUTOR***************************
C
C*******START EXPANDER*****************************
C*  vertikale snelheid                             *
C*   expanderen V op M=M+1 naar N-1 en N+1         *
C*                                                 *
C**************************************************
      DO 30 N=1,NMAX
      DUU(N)=0
      DVV(N)=0
   30 CONTINUE
      DO 29 N=1,NMAX
      IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 24
      IF(M.EQ.1) GOTO 24
      IF(D(N,M-1)+RISE.LE.O) GOTO 23
      ISIGN1=1
      ISIGN2=1
      NMIN=N-1
      NPLUS=N+1
      IF(D(N-1,M-1)+RISE.GT.O) GOTO 21
      ISIGN1=-ISIGN1
      NMIN=N
   21 IF(D(N+1,M-1)+RISE.GT.O) GOTO 22
      ISIGN2=-ISIGN2
      NPLUS=N
   22 VMIN=V(N,M-1)
      DVV(N)=DVV(N)+EPSR*VMIN
      DVV(NMIN)=DVV(NMIN)+E1*VMIN
      DVV(NPLUS)=DVV(NPLUS)+E1*VMIN
      DUU(NMIN)=DUU(NMIN)+E2*VMIN*ISIGN1
      DUU(NPLUS)=DUU(NPLUS)-E2*VMIN*ISIGN2
C     DISPLAY N,M,V(N,M),U(N,M)
C     DISPLAY DVV(NMIN),DVV(N),DVV(NPLUS),DUU(NMIN),DUU(N),DUU(NPLUS) ,
   23 CONTINUE
   24 CONTINUE
C
   29 CONTINUE
      DO 31 N=1,NMAX
      IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 31
      IF(M.EQ.1) GOTO 31
      U(N,M-1)=DUU(N)+U(N,M-1)
      V(N,M-1)=DVV(N)
C     IF(M.EQ.8.AND.N.EQ.6) DISPLAY N,M-1,U(N,M-1),V(N,M-1),'EXP'
   31 CONTINUE
C
C*****expanderen horizontale snelheid U*********
C*    expanderen naar M=M-1 en naar M=M+1*******
C
      IF(M.EQ.1) GOTO 870
      DO 28 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 28
      IF(U(N,M).GE.O) ISIG1=1
      IF(U(N,M).LT.O) ISIG1=-1
      ISIG2=ISIG1
      MMIN=M+1
      MPLUS=M-1
      IF(D(N,MMIN)+RISE.GT.O) GOTO 26
      ISIG1=-ISIG1
      MMIN=M
   26 IF(D(N,MPLUS)+RISE.GT.O) GOTO 27
      ISIG2=-ISIG2
      MPLUS=M
   27 UMIN=U(N,M)
      U(N,M)=EPSR*UMIN
      U(N,MMIN)=U(N,MMIN)+E1*UMIN
      U(N,MPLUS)=U(N,MPLUS)+E1*UMIN
      V(N,MMIN)=V(N,MMIN)+E2*UMIN*ISIG1
      V(N,MPLUS)=V(N,MPLUS)-E2*UMIN*ISIG2
   28 CONTINUE
  870 CONTINUE
C*******EINDE EXPANDER****************************
C
C
C****************OPSCHALEN U EN V******************
C
      SOMPL=0
      MPL=M-1
      SOM=0
      DO 980 N=1,NMAX
      UU=U(N,M)
      VV=V(N,M)
      SOM=SOM+SQRT(UU*UU+VV*VV)
      UUP=U(N,MPL)
      VVP=V(N,MPL)
      SOMPL=SOMPL+SQRT(UUP*UUP+VVP*VVP)
  980 CONTINUE
      SOM1=0
      IF(M.EQ.FPY(4)) TOTAL=SOM
      DO 990 N=1,NMAX
      IF(SOM.EQ.O) GOTO 990
      IF(SOMPL.EQ.O) GOTO 990
      UU=U(N,M)
      VV=V(N,M)
      U(N,M)=UU*TOTAL/SOM
      V(N,M)=VV*TOTAL/SOM
      UUP=U(N,MPL)
      VVP=V(N,MPL)
      U(N,MPL)=UUP*TOTAL/SOMPL
      V(N,MPL)=VVP*TOTAL/SOMPL
      UU=U(N,M)
      VV=V(N,M)
      SOM1=SOM1+SQRT(UU*UU+VV*VV)
  990 CONTINUE
      IF(M.EQ.1) SOM2=SOM1
   20 CONTINUE
C     DISPLAY TOTAL,SOM2
C
C     ****************************
C
C
C
```

```
C
C
C
C
C
C
C*************************************************************
C*************************************************************
C**                                                         **
C**       NU VAN M=FPY(4) NAAR M=MMAX                       **
C**                                                         **
C**                                                         **
C*************************************************************
C*************************************************************
C
C
C***********BEGIN VAN LUS OVER M-WAARDEN*****************
C***********                            *****************
C
      E1=.5*(1.-EPSZ)*COS(ALFAZ)
      E2=.5*(1.-EPSZ)*SIN(ALFAZ)
      EPSZU=.8
      E1U=.5*(1.-EPSZU)*COS(ALFAZ)
      E2U=.5*(1.-EPSZU)*SIN(ALFAZ)
      RISE=RISEO
      RISE=RISE-DR
      DO 850 M=FPY(4),MMAX-1
C     IF(M.NE.FPY(4)+1) GOTO 252
C*****BEPALEN SNELHEDEN OP RAND M=FPY(4)+1**************
C*                            EN OP M=FPY(2)+1         *
C*                                                     *
C     DO 219 N=1,FPX(4)-2
C     IF(D(N,M)+RISE.LE.O) GOTO 219
C     U(N,M)=U(N,FPY(4))
C     V(N,M)=V(N,FPY(4))
C 219 CONTINUE
C     U4=U(FPX(4)-1,FPY(4))
C     V4=V(FPX(4)-1,FPY(4))
C     VV4=SQRT(U4*U4+V4*V4)
C     U(FPX(4)-1,FPY(4)+1)=-.8*VV4
C     V(FPX(4)-1,FPY(4)+1)=-.8*VV4
C     DO 218 N=FPX(4),FPX(4)+8
C     IF(D(N+1,FPY(4)+1)+RISE.LE.O) GOTO 250
C     U(N,FPY(4)+1)=-.8*VV4
C     V(N,FPY(4)+1)=0
C     GOTO 218
C 250 U(N,FPY(4)+1)=-.8*VV4
C     V(N,FPY(4)+1)=-.8*VV4
C     GOTO 252
C 218 CONTINUE
C 251 IF(M.NE.FPY(2)+1) GOTO 252
C     U2=U(FPX(2)+1,FPY(2)+1)
C     V2=V(FPX(2)+1,FPY(2)+1)
C     VV2=SQRT(U2*U2+V2*V2)
C     U(FPX(2)+1,FPY(2)+1)=.8*VV2
C     V(FPX(2)+1,FPY(2)+1)=.6*VV2
C     DO 253 N=FPX(2),1,-1
C     IF(D(N-1,FPY(2)+1)+RISE.LE.O) GOTO 254
C     U(N,M)=.6*VV2
C     V(N,M)=0
C     GOTO 253
C 254 U(N,M)=.6*VV2
C     V(N,M)=.6*VV2
C     GOTO 252
C 253 CONTINUE
C*****************************************
C
C*******START CLOSING *********************
C*    voor vert. snelheden               *
C
  252 DO 838 N=1,NMAX
      U1(N)=U(N,M)
      V1(N)=V(N,M)
  838 CONTINUE
      IF(FPX(1).EQ.0.AND.FPY(1).EQ.0) GOTO 725
      DO 725  N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 725
      VV=V(N,M)
      UU=U(N,M)
C   DRIE GEBIEDEN GEDEFINIEERD, ZIE TEKENING
C   EERST AFTESTEN OF PUNT N,M IN EEN VAN DEZE GEBIEDEN ZIT
      IF(N.LE.FPX(2).AND.M.LT.FPY(2)) GOTO 835
      IF(N.GE.FPX(4).AND.M.GT.FPY(4)) GOTO 836
      IF(N.LE.FPX(2).AND.M.GT.FPY(2)) GOTO 837
      GOTO 725
  835 PARM=VV*VV/((FPY(2)-M)**1.5)
      DIFF=-1.
      GOTO 733
  836 PARM=VV*VV/((M-FPY(4))**1.5)
      DIFF=+1.
      IF(M.GT.FPY(4)+1) GOTO 733
      U1(N)=UU-.2*UU
      V1(N)=.6*UU
      GOTO 725
  837 PARM=VV*VV/((M-FPY(2))**1.5)
      DIFF=1.
      GOTO 733
  733 GGK=UU*UU+VV*VV
      DIFF1=UU*ABS(UU)+PARM*DIFF
      UUN=SIGN(SQRT(ABS(DIFF1)),DIFF1)
      GGK1=GGK-UUN*UUN
      IF(GGK1.LE.0) GOTO 740
      V1(N)=SIGN(SQRT(GGK1),VV)
      U1(N)=UUN
      GOTO 725
  740 V1(N)=0
      U1(N)=UUN
  725 CONTINUE
C ******EINDE CLOSING OUTFLOW IN M-RICHTING******
C
C
C
C   ******START CLOSING OUTFLOW  N-RICHTING ***************
C
C  ***vaststellen X-coordinaten van eventueel****
C  *  aanwezige linker- en rechteroever op      *
C  *  M=M                                       *
C  *      indien beide oevers aanwezig          *
C  *      dan zijn :    NLINKS > -1             *
C  *                    NRECHTS> -1             *
C  *                                            *
C
      NLINKS=-1
      NRECHTS=-1
      IF(D(1,M)+RISE.GT.O) NLINKS=0
      DO 726 N=1,NMAX-1
      IF(NLINKS.NE.-1)GOTO 727
      IF(D(N,M)+RISE.LE.O.AND.D(N+1,M)+RISE.GT.O)
     *NLINKS=N
  727 IF(NRECHTS.NE.-1) GOTO 726
      IF(D(N,M)+RISE.GT.O.AND.D(N+1,M)+RISE.LE.O)
     *NRECHTS=N+1
  726 CONTINUE
      DO 729 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 729
      UU=U1(N)
      VV=V1(N)
      IF(UU) 729,729,730
  730 IF(NRECHTS.EQ.-1) GOTO 729
      IF(NRECHTS-N.GT.5.OR.NRECHTS-N.LE.O) GOTO 729
      PARM=UU*UU/((NRECHTS-N)**.5)
      V1(N)=-SQRT(VV*VV+PARM)
      U1(N)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U1(N),V1(N),'RECHTS'
  729 CONTINUE
      DO 731 N=NMAX,1,-1
      IF(D(N,M)+RISE.LE.O) GOTO 731
      UU=U1(N)
      VV=V1(N)
      IF(UU) 732,731,731
  732 IF(NLINKS.EQ.O) GOTO 731
      IF(N-NLINKS.GT.5.OR.N-NLINKS.LE.O) GOTO 731
      PARM=UU*UU/((N-NLINKS)**.5)
C     IF(N-NLINKS.EQ.1) DISPLAY N,M,UU,VV
      V1(N)=-SQRT(VV*VV+PARM)
      U1(N)=SIGN(SQRT(UU*UU-PARM),UU)
C     DISPLAY N,M,U1(N),V1(N),'LINKS'
  731 CONTINUE
      RISE=RISEO
C
C*************************************************
C
C*************************************************
C*      INVLOED BODEMCONFIGURATIE                *
C*                                               *
C*   de snelheidsvectoren worden bijgedraaid in de *
C*   richting van de lokale dieptelijn.          *
C*                                               *
C*   max. bijdraaihoek=DBETM                     *
C*                                               *
C*   bijdraaihoek DBETA=FACDP*FACHL*waterdiepte  *
C*                                               *
C*                  FACDP=EXP(-(D(N,M)+RISE))    *
C*                  FACHL=bodemhelling*10        *
C*                                               *
C*   als U(N,M) <0 dan HEL1=HEL(N-1)             *
C*                     PSI1=PSI1(N-1)            *
C*   als U(N,M) =0 dan grootste van HEL(N),HEL(N-1)*
C*                     + bijbehorende PSI1       *
C*   als U(N,M) >0 dan HEL1=HEL(N)               *
C*                     PSI1=PSI1(N)              *
C*                                               *
C*************************************************
C
      CALL HELNG(M,RISE,1,NMAX-1)
      DO 605 N=1,NMAX
      IF(D(N,M)+RISE.LE.O) GOTO 605
      UU=U1(N)
      VV=V1(N)
      NN=N
      IF(UU) 514,515,516
  514 IF(N.NE.1) NN=N-1
      GOTO 516
  515 IF(N.EQ.1) GOTO 516
      IF(HEL(N-1).GT.HEL(N)) NN=N-1
  516 HEL1=HEL(NN)
      PSI1=PSI(NN)
C
C  *****bijdraaien vectoren (hor. snelheid positief)*****
C
C     DISPLAY PSI1
      IF(PSI1.GE.9.111) GOTO 605
      IF(VV.EQ.O.AND.UU.EQ.O) GOTO 605
      HOEK=ATAN2(VV,UU)
      IF(PSI1.GE.-1.5708.AND.PSI1.LT.1.5708) GOTO 809
C
C  ****PSI1 ligt in 2e of 3e kwadrant**********
C
      IF(PSI1.LT.O) PSI1=PSI1+6.283
      IF(HOEK.LT.O) HOEK=HOEK+6.283
      PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 610
C  *****dit betekent;water stroomt van ondiep naar diep****
      PSI1=PSI1-3.1416
      IF(HOEK.GE.3.1416) HOEK=HOEK-6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..0) D1=.0
      GOTO 610
C              **************
C
C
C  *******PSI1 ligt in 1e of 4e kwadrant**********
C
  809 PSIP=PSI1+1.5708
      PSIM=PSI1-1.5708
      DELER=1000.
      D1=(D(N,M)+RISE+MESH*HEL1)/DELER
      IF(HOEK.GT.PSIM.AND.HOEK.LT.PSIP) GOTO 610
C  ****dit betekent: water stroomt van ondiep naar diep***
      PSI1=PSI1+3.1416
      IF(HOEK.LT.:, HOEK=HOEK+6.283
      DELER=2000.
      D1=(D(N,M)+RISE-(MESH*HEL1))/DELER
      IF(D1.LT..0) D1=.0
      GOTO 610
C
C  *****bijdraaien snelheden (=DBETA)      ******
```

```
      C   *    -max. bijdraaihoek=DBETM                           *
      C   *    -water van diep naar ondiep wordt sterker          *
      C   *     bijgedraaid dan van ondiep naar diep              *
      C
        610 BETA=HOEK-PSI1
            IF(ABS(BETA).LT..00175) GOTO 605
            FACDP=EXP(-D1)
            FACHL=HEL1*10.
            DBETA=0
            IF(FACDP.LT..001.AND.FACHL.LT..001) GOTO 611
            DBETA=FACDP*FACHL*DBETM
        611 BETAN=SIGN(ABS(BETA)+DBETA,BETA)
            IF(ABS(BETAN).GT.1.5708) BETAN=SIGN(1.5708,BETA)
            HOEKN=PSI1+BETAN
            GGK=SQRT(UU*UU+VV*VV)
            U1(N)=GGK*COS(HOEKN)
            V1(N)=GGK*SIN(HOEKN)
            IF(V1(N).LE.0) GOTO 605
            U1(N)=SIGN(GGK,U1(N))
            V1(N)=0
      C     DISPLAY N,M,U1(N),V1(N),'BODEM'
        605 CONTINUE
            RISE=RISEO-DR
      C
      C*******START DISTRIBUTOR***********
            DO 741 N=1,NMAX
            DUU(N)=U1(N)
            DVV(N)=V1(N)
        741 CONTINUE
            DO 719 N=NMAX,1,-1
            IF(D(N,M)+RISE.LE.0) GOTO 708
            UU=U1(N)
            VV=V1(N)
            IF(UU.EQ.0.AND.VV.EQ.0) GOTO 708
            IF(UU) 719,702,703
        702 IF(VV.EQ.0) GOTO 708
            CALL DISTSUB1(U(N,M+1),V(N,M+1),UU,VV,1.,0,NMAX,MMAX)
      C     DISPLAY N,M+1,U(N,M+1),V(N,M+1),UU,VV,U1(N),V1(N)
            GOTO 708
        703 VU=VV/UU
            IF(VV.EQ.0) GOTO 714
            UV=UU/VV
            IF(VU+1)704,704,705
        704 CALL DISTSUB1(U(N,M+1),V(N,M+1),UU,VV,1.0+UV,0,NMAX,MMAX)
            IF(N.EQ.1) GOTO 708
            CALL DISTSUB1(U(N-1,M+1),V(N-1,M+1),UU,VV,-UV,0,NMAX,MMAX)
            GOTO 708
        705 IF(N.EQ.1) GOTO 708
            CALL DISTSUB1(U(N-1,M+1),V(N-1,M+1),UU,VV,-VU,0,NMAX,MMAX)
            IF(N.EQ.1) GOTO 708
            CALL DISTSUB1(DUU(N-1),DVV(N-1),UU,VV,1.0+VU,-(N-1),NMAX,MMAX)
            GOTO 708
        714 IF(N.EQ.1) GOTO 708
            CALL DISTSUB1(DUU(N-1),DVV(N-1),UU,VV,1.,-(N-1),NMAX,MMAX)
            GOTO 708
        708 CONTINUE
        719 CONTINUE
            DO 717 N=1,NMAX
            IF(D(N,M)+RISE.LE.0) GOTO 717
            UU=U1(N)
            IF(UU) 701,717,717
        701 VV=V1(N)
            IF(VV.EQ.0) GOTO 715
            VU=VV/UU
            UV=UU/VV
            IF(VU-1) 706,706,707
        706 IF(N.EQ.NMAX) GOTO 717
            CALL DISTSUB1(DUU(N+1),DVV(N+1),UU,VV,1.0-VU,N+1,NMAX,MMAX)
            IF(N.EQ.NMAX) GOTO 717
            CALL DISTSUB1(U(N+1,M+1),V(N+1,M+1),UU,VV,VU,0,NMAX,MMAX)
            GOTO 717
        707 IF(N.EQ.NMAX) GOTO 717
            CALL DISTSUB1(U(N+1,M+1),V(N+1,M+1),UU,VV,UV,0,NMAX,MMAX)
            CALL DISTSUB1(U(N,M+1),V(N,M+1),UU,VV,1.0-UV,0,NMAX,MMAX)
            GOTO 717
        715 IF(N.EQ.NMAX) GOTO 717
            CALL DISTSUB1(DUU(N+1),DVV(N+1),UU,VV,1.,(N+1),NMAX,MMAX)
        717 CONTINUE
            DO 718 N=1,NMAX
            IF(M.EQ.FPY(4)+1.OR.M.EQ.FPY(2)+1) GOTO 718
            U(N,M)=DUU(N)
            V(N,M)=DVV(N)
        718 CONTINUE
      C*******EINDE DISTRIBUTOR**************************
      C
      C*******START EXPANDER*******************************
      C*  vertikale snelheid                              *
      C*    expanderen V op M=M+1 naar N-1 en N+1         *
      C*                                                  *
      C***************************************************
            DO 830 N=1,NMAX
            DUU(N)=0
            DVV(N)=0
        830 CONTINUE
            DO 829 N=1,NMAX
            IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 824
            IF(M.EQ.MMAX) GOTO 824
            IF(D(N,M+1)+RISE.LE.0) GOTO 823
            ISIGN1=1
            ISIGN2=1
            NMIN=N-1
            NPLUS=N+1
            IF(D(N-1,M+1)+RISE.GT.0) GOTO 821
            ISIGN1=-ISIGN1
            NMIN=N
        821 IF(D(N+1,M+1)+RISE.GT.0) GOTO 822
            ISIGN2=-ISIGN2
            NPLUS=N
        822 VMIN=V(N,M+1)
            DVV(N)=DVV(N)+EPSZ*VMIN
            DVV(NMIN)=DVV(NMIN)+E1*VMIN
            DVV(NPLUS)=DVV(NPLUS)+E1*VMIN
            DUU(NMIN)=DUU(NMIN)-E2*VMIN*ISIGN1
            DUU(NPLUS)=DUU(NPLUS)+E2*VMIN*ISIGN2
      C     DISPLAY N,M,V(N,M),U(N,M)
      C     DISPLAY DVV(NMIN),DVV(N),DVV(NPLUS),DUU(NMIN),DUU(N),DUU(NPLUS)
        823 CONTINUE
        824 CONTINUE
      C
        829 CONTINUE
            DO 831 N=1,NMAX
            IF(N.EQ.1.OR.N.EQ.NMAX) GOTO 831
            IF(M.EQ.MMAX) GOTO 831
            U(N,M+1)=DUU(N)+U(N,M+1)
            V(N,M+1)=DVV(N)
        831 CONTINUE
      C
      C
      C*****expanderen horizontale snelheid U*********
      C*    expanderen naar M=M-1 en naar M=M+1*******
      C
            IF(M.EQ.MMAX) GOTO 871
            DO 828 N=1,NMAX
            IF(D(N,M)+RISE.LE.0) GOTO 828
            IF(U(N,M).GE.0) ISIG1=1
            IF(U(N,M).LT.0) ISIG1=-1
            ISIG2=ISIG1
            MMIN=M-1
            MPLUS=M+1
            IF(D(N,MMIN)+RISE.GT.0) GOTO 826
            ISIG1=-ISIG1
            MMIN=M
        826 IF(D(N,MPLUS)+RISE.GT.0) GOTO 827
            ISIG2=-ISIG2
            MPLUS=M
        827 UMIN=U(N,M)
            U(N,M)=EPSZU*UMIN
            U(N,MMIN)=U(N,MMIN)+E1U*UMIN
            U(N,MPLUS)=U(N,MPLUS)+E1U*UMIN
            V(N,MMIN)=V(N,MMIN)-E2U*UMIN*ISIG1
            V(N,MPLUS)=V(N,MPLUS)+E2U*UMIN*ISIG2
        828 CONTINUE
        871 CONTINUE
        221 CONTINUE
      C******EINDE EXPANDER****************************
      C
      C
      C**************OPSCHALEN U EN V****************
      C
            SOMPL=0
            SOMMIN=0
            SOM=0
            MMIN=M-1
            MPL=M+1
      C     IF(M.NE.FPY(4)+1) GOTO 881
      C     KK=1
      C     IF(FPY(4).EQ.FPY(2)) KK=FPX(2)
      C     DO 882 N=KK,FPX(4)
      C     UU=U(N,M)
      C     VV=V(N,M)
      C     SOM=SOM+SQRT(UU*UU+VV*VV)
      C 882 CONTINUE
      C     GOTO 883
      C 881 IF(M.NE.FPY(2)+1) GOTO 884
      C     DO 885 N=FPX(2),NMAX
      C     UU=U(N,M)
      C     VV=V(N,M)
      C     SOM=SOM+SQRT(UU*UU+VV*VV)
      C 885 CONTINUE
      C     GOTO 883
        884 DO 880 N=1,NMAX
            UU=U(N,M)
            VV=V(N,M)
            SOM=SOM+SQRT(UU*UU+VV*VV)
            UUM=U(N,MMIN)
            VVM=V(N,MMIN)
            SOMMIN=SOMMIN+SQRT(UUM*UUM+VVM*VVM)
            UUP=U(N,MPL)
            VVP=V(N,MPL)
            SOMPL=SOMPL+SQRT(UUP*UUP+VVP*VVP)
        880 CONTINUE
        883 SOM1=0
            IF(M.EQ.FPY(4)) TOTAL=SOM
            DO 890 N=1,NMAX
            IF(SOM.EQ.0) GOTO 890
            IF(SOMMIN.EQ.0) GOTO 890
            U(N,M)=U(N,M)*TOTAL/SOM
            V(N,M)=V(N,M)*TOTAL/SOM
            U(N,MMIN)=U(N,MMIN)*TOTAL/SOMMIN
            V(N,MMIN)=V(N,MMIN)*TOTAL/SOMMIN
            U(N,MPL)=U(N,MPL)*TOTAL/SOMPL
            V(N,MPL)=V(N,MPL)*TOTAL/SOMPL
            UU=U(N,M)
            VV=V(N,M)
            SOM1=SOM1+SQRT(UU*UU+VV*VV)
      C     IF(M.NE.20.OR.M.NE.25.OR.M.NE.30.OR.M.NE.35.OR.M.NE.39)
      C    * GOTO 890
      C     DISPLAY N,M,U(N,M),V(N,M),U(N,M-1),V(N,M-1),U(N,MPL),V(N,MPL)
      C    *         ,SOM,SOMMIN,SOMPL,SOM1
        890 CONTINUE
            IF(M.EQ.MMAX-2) SOM2=SOM1
        850 CONTINUE
            RISE=RISEO
            WRITE(6,300) FPX(3),FPY(3),FPX(4),FPY(4),TOTAL,SOM2
        300 FORMAT(X,'(',I2,',',I2,')  (',I2,',',I2,')',5X,F5.0,X,F5.0)
            DO 891 M=1,MMAX
            DO 892 N=1,NMAX
            IF(D(N,M)+RISE.LE.0) GOTO 892
            D1=.001*(D(N,M)+RISE)
            UU=U(N,M)
            VV=V(N,M)
            IF(VV.EQ.0.AND.UU.EQ.0) GOTO 892
            GGK=SQRT(UU*UU+VV*VV)
            HK=ATAN2(VV,UU)
            GGKD=1000.*GGK/MESH/D1
            VMAX=SQRT(9.81*D1)
            IF(GGKD.GT.VMAX) GGKD=VMAX
            U(N,M)=10.*GGKD*COS(HK)
            V(N,M)=10.*GGKD*SIN(HK)
      C
      C   !!!!!!U(N,M) EN V(N,M) IN DM/SEC!!!!!!!!!!!!!
      C
        892 CONTINUE
        891 CONTINUE
            IF(IANTW.EQ.2) GOTO 550
            CALL FILES('30','#UVELDS  ')
            CALL FILES('31','#VVELDS  ')
            DO 893 M=1,MMAX
            DO 894 I=1,NMAX,10
            WRITE(30,895) (U(N,M),N=I,I+9)
```

```
      WRITE(31,895) (V(N,M),M=1,I+9)
  895 FORMAT(10F6.1)
  894 CONTINUE
  893 CONTINUE
      CALL UNITCONTROL(30,8)
      CALL UNITCONTROL(31,8)
  550 ALFAR=ALFARO
      ALFAZ=ALFAZO
      RETURN
      END
C
C
C
C
$CONTROL SEGMENT=DISTSUB1
      SUBROUTINE DISTSUB1(U,V,UU,VV,PARM,II,NMAX,MMAX)
      REAL DUU(30),DVV(30),U,V
      DOUBLE PRECISION H2,UUU,VVV
      COMMON /FLOWDS/DUU,DVV
      IF(ABS(U).LT..00001) U=0
      IF(ABS(V).LT..00001) V=0
      IF(ABS(UU).LT..00001) UU=0
      IF(ABS(VV).LT..00001) VV=0
      IF(ABS(PARM).LT..00001) PARM=0
      U1=U
      V1=V
      H1=SQRT(U1*U1+V1*V1)+SQRT(1.*UU*UU+1.*VV*VV)*PARM
      UUU=U+UU*PARM
      VVV=V+VV*PARM
      IF(UUU.EQ.0)GOTO 5
      H2=ATAN((VVV)/(UUU))
      XU=SIGN(H1*COS(H2),UUU)
      YV=SIGN(H1*SIN(H2),VVV)
      GOTO 4
    5 XU=0.0
      IF(VVV.EQ.0) GOTO 6
      YV=H1*VVV/ABS(VVV)
      GOTO 4
    6 YV=0
    4 IF(II) 1,2,3
    1 DUU(-II)=XU
      DVV(-II)=YV
      RETURN
    2 U=XU
      V=YV
      RETURN
    3 DUU(II)=XU
      DVV(II)=YV
      RETURN
      END
C
C
C
C
C
C
$CONTROL SEGMENT=REFTEST
      SUBROUTINE REFTEST(GAMMA,ROUGH,ALFABOUND,TH,HO,RISE,DGRNS,FRGH)
C     !!!ROUGH[M],ALFABOUND[DEGREES],TH[SEC],HO[M],RISE[MM]!!!
      REAL D(30,40),WFO(30,40),ALF(30,40),U(30,40),V(30,40)
     *    ,PSI(30),HEL(30),DNUL(30,40)
      REAL MESH
      INTEGER FPX(4),FPY(4)
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                ,DNUL
C
C     ******************************************************
C     * M                                                  *
C     *  PROGRAMMA VOOR HET BEREKENEN VAN STROOM-          *
C     *  SNELHEDEN T.G.V. LONGSHORE CURRENT VLSS[dm/sec]   *
C     *  EENLINGGOLVEN VVEE[dm/sec] SETUP VVSU[dm/sec]     *
C     *                                                    *
C     *  stroomsnelheden worden achtereenvolgens op-       *
C     *  geteld bij U en V[dm/sec]                         *
C     *                                                    *
C     *     subroutines:     REFRAC                        *
C     *                      EENLING                       *
C     *                      SETUP                         *
C     *                                                    *
C     ******************************************************
C
C
C        +-------> M,U,X
C        |
C        |
C        V  N,V,Y
C
C
      PI=3.141593
      HOOLD=HO
      ALFABOUNDO=ALFABOUND
      HO=HO*10.
      ALFABOUND=ALFABOUND*1.745
      WLO=1.56*TH*TH
      CALL REFRAC(HO,TH,ALFABOUND,RISE,GAMMA,ROUGH,DGRNS,FRGH)
C
C     !!!!HO[dm],TH[sec],ALFABOUND[rad*100],RISE[mm],ROUGH[m]!!!
C
      DISPLAY IANTW,'R2231'
      IF(TH.GE.12) CALL EENLING(WLO,RISE,HO)
C     DISPLAY IANTW,'R2232'
      CALL SETUP(RISE,GAMMA,WLO,ROUGH)
C
C     !!!!WLO[m],RISE[mm],HO[dm],ROUGH[m]!!!
C
  107 HO=HOOLD
      ALFABOUND=ALFABOUNDO
      RETURN
      END
C
C
C
C
$CONTROL SEGMENT=REFRAC
      SUBROUTINE REFRAC(HO,TH,ALFABOUND,RISE,GAMMA,ROUGH,DGRNS,FRGH)
      REAL C(30),CPLUS(30),PSI(30),DHDX1(30),DHDY1(30)
      REAL SINFID1(30),HEL(30)
      REAL D(30,40),WFO(30,40),U(30,40),V(30,40),ULS(30),VLS(30)
      REAL ALF(30,40),DNUL(30,40)
      INTEGER FPX(4),FPY(4)
      REAL MESH
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                ,DNUL
      VMAX1=1.8
      PI=3.141593
      G=9.81
      CO=1.56*TH
      WLO=CO*TH
      DO 2 M=1,MMAX
      DO 2 N=1,NMAX
      ALF(N,M)=0
      WFO(N,M)=0
    2 CONTINUE
      DO 99 M=MMAX,2,-1
      IF(M.LT.MMAX) GOTO 11
      DO 10 N=1,NMAX
      IF(D(N,M)+RISE.LE.500.) GOTO 10
      WL=WLO*SQRT(TANH(6.283*(D(N,M)+RISE)/1000./WLO))
      DO 91 J=1,6
      WL1=WLO*TANH(6.283*(D(N,M)+RISE)/1000./WL)
      WL=(2.*WL1+WL)/3
   91 CONTINUE
      CPLUS(N)=WL/TH
      ALF(N,M)=ALFABOUND
      WFO(N,M)=HO*HO
   10 CONTINUE
      SOMWF=0
   11 DO 12 N=1,NMAX
      C(N)=CPLUS(N)
      CPLUS(N)=0
      IF(D(N,M-1)+RISE.LE.0) GOTO 12
      SOMWF=SOMWF+WFO(N,M)
      WL=WLO*SQRT(TANH(6.283*(D(N,M-1)+RISE)/1000./WLO))
      DO 92 J=1,6
      WL1=WLO*TANH(6.283*(D(N,M-1)+RISE)/1000./WL)
      WL=(2.*WL1+WL)/3
   92 CONTINUE
      CPLUS(N)=WL/TH
   12 CONTINUE
      IF(SOMWF.EQ.0) GOTO 100
      DO 13 N=1,NMAX
      IF (D(N,M)+RISE.LE.0) GOTO 13
      ALFA=ALF(N,M)/100.
      IF(ALFA.LT.4.712) GOTO 29
C
C     ********** ALFA GT. 270  DEGREES *****
C
      IF(N.EQ.NMAX) GOTO 13
      D1=D(N,M-1)+RISE
      D2=D(N+1,M-1)+RISE
      D3=D(N,M)+RISE
      D4=D(N+1,M)+RISE
      IF(D1.LE.O.AND.(D2.LE.O.OR.D4.LE.O)) GOTO 13
      IF(D1.LE.O) GOTO 35
      IF(D2.LE.O.OR.D4.LE.O) GOTO 34
      DHDX=(D4+D2-D3-D1)/2./MESH
      DHDY=(D4-D2+D3-D1)/2./MESH
      DELER=4.
      DD=(D1+D2+D3+D4)/DELER
      GOTO 36
   34 DHDY=(D3-D1)/MESH
      DHDX=0
      DELER=2
      DD=(D1+D3)/DELER
      IF(D2.LE.O.AND.D4.LE.O) GOTO 36
      IF(D2.LE.O) DHDX=(D4-D3)/MESH
      IF(D4.LE.O) DHDX=(D2-D1)/MESH
      DELER=3.
      IF(D2.LE.O) DD=(D1+D3+D4)/DELER
      IF(D4.LE.O) DD=(D1+D2+D3)/DELER
      GOTO 36
   35 DHDX=(D4-D3)/MESH
      DHDY=(D4-D2)/MESH
      DELER=3.
      DD=(D2+D3+D4)/DELER
   36 DHDX1(N)=DHDX
      DHDY1(N)=DHDY
      IF(DHDX.EQ.O.AND.DHDY.EQ.O) GOTO 18
      PSI1=ATAN2(DHDY,DHDX)
      PSI(N)=PSI1
      COSPSI=ABS(COS(PSI1))
      SINPSI=ABS(SIN(PSI1))
      IF(COSPSI.GE..01.AND.SINPSI.GE..01) GOTO 504
      IF(COSPSI.LT..01) HEL1=DHDY*SINPSI
      IF(SINPSI.LT..01) HEL1=DHDX*COSPSI
      GOTO 506
  504 HEL1=ABS(DHDX*COSPSI)+ABS(DHDY*SINPSI)
  506 HEL(N)=ABS(HEL1)
      CC=(C(N)+C(N+1)+CPLUS(N)+CPLUS(N+1))/DELER
      CCC=1.-(CC/CO)*(CC/CO)
      DD=.001*DD
      DCDH=G*CCC/(CC+G*DD/CC*CCC)
      DALFADS=(DHDX*SIN(ALFA)-DHDY*COS(ALFA))/CC*DCDH
      S=-.001*MESH/SIN(ALFA)
      ALFAOLD=ALFA
      ALFA=ALFA+S*DALFADS
      IF(ALFA.LT.3.927) ALFA=3.927
      IF(ALFA.GT.5.498) ALFA=5.498
      HULPALFA=.5*(ALFA+ALFAOLD)
      IF(HULPALFA.LT.4.712)  GOTO 24
C
C               ***********************
C
C
C     ******BEREKENING VAN REFRACTIECOEFFICIENT******
C
   14 PSI1=PSI(N)+PI
  152 FIO=ALFAOLD-PSI1
      FIN=ALFA-PSI1
C     IF(N.LE.24)DISPLAY 180*PSI/PI,180*FIO/PI,180*FIN/PI
      GOTO 17
C
C     SPECIAAL GEVAL VLAKKE BODEM
C
   18 ALFAOLD=ALFA
      HULPALFA=ALFA
      PSI(N)=9.425
      HEL(N)=0
      FIO=1
      FIN=1
```

```
   17 FACTOR=1
      IF(ABS(HULPALFA-4.712).LT..01) FACTOR=0
      IF(FACTOR.NE.O) FACTOR=1/TAN(HULPALFA)
      IF(D(N,M-1)+RISE.LE.O) GOTO 15
      COSFIO=COS(FIO)
      COSFIN=COS(FIN)
      IF(ABS(COSFIO).LT.ABS(COSFIN)) GOTO 143
      COSFIN=1
      COSFIO=1
  143 WF=WFO(N,M)*(1.+FACTOR)*ABS(COSFIO/COSFIN)
      IF(WF+WFO(N,M-1).LE.O) GOTO 13
      IF(WF.GT.20000.) GOTO 13
      ALFM=.01*ALF(N,M-1)
      ALFM=(HULPALFA*WF+ALFM*WFO(N,M-1))/(WF+WFO(N,M-1))
      ALF(N,M-1)=ALFM*100
C     DISPLAY N,M,WFO(N,M),WF,ALFAOLD,ALFA,PSI
      WFO(N,M-1)=WFO(N,M-1)+WF
   15 IF(D(N+1,M-1)+RISE.LE.O) GOTO 16
      WF=WFO(N,M)*(-1.O/TAN(HULPALFA))*ABS(COSFIO/COSFIN)
      IF(WF+WFO(N+1,M-1).LE.O) GOTO 13
      ALFP=.01*ALF(N+1,M-1)
      ALFP=(HULPALFA*WF+ALFP*WFO(N+1,M-1))/
     &  (WF+WFO(N+1,M-1))
      ALF(N+1,M-1)=ALFP*100
      WFO(N+1,M-1)=WFO(N+1,M-1)+WF
   16 CONTINUE
C     IF(M.LE.24)DISPLAY HULPALFA,N,M,WF,WFO(N,M-1),WFO(N+1,M-1)
      GOTO 13
C
C     ********* ALFA LT 270 DEGREES ********
C
   29 IF(N.EQ.1) GOTO 13
      IF(ALFA.LT.3.927) ALFA=3.927
      D1=D(N-1,M-1)+RISE
      D2=D(N,M-1)+RISE
      D3=D(N-1,M)+RISE
      D4=D(N,M)+RISE
      IF(D2.LE.O.AND.(D3.LE.O.OR.D1.LE.O)) GOTO 13
      IF(D2.LE.O) GOTO 31
      IF(D1.LE.O.OR.D3.LE.O) GOTO 32
      DHDX=.5*(D4+D2-D3-D1)/MESH
      DHDY=.5*(D4-D2+D3-D1)/MESH
      DELER=4
      DD=(D1+D2+D3+D4)/DELER
      GOTO 33
   32 DHDY=(D4-D2)/MESH
      DHDX=0
      DELER=2
      DD=(D2+D4)/DELER
      IF(D1.LE.O.AND.D3.LE.O) GOTO 33
      IF(D1.LE.O) DHDX=(D4-D3)/MESH
      IF(D3.LE.O) DHDX=(D2-D1)/MESH
      DELER=3
      IF(D1.LE.O) DD=(D2+D3+D4)/DELER
      IF(D3.LE.O) DD=(D1+D2+D4)/DELER
      GOTO 33
   31 DHDX=(D4-D3)/MESH
      DHDY=(D3-D1)/MESH
      DELER=3.
      DD=(D1+D3+D4)/DELER
   33 DHDX1(N)=DHDX
      DHDY1(N)=DHDY
      IF(DHDX.EQ.O.AND.DHDY.EQ.O) GOTO 28
      PSI1=ATAN2(DHDY,DHDX)
      PSI(N)=PSI1
      COSPSI=ABS(COS(PSI1))
      SINPSI=ABS(SIN(PSI1))
      IF(COSPSI.GE..01.AND.SINPSI.GE..01) GOTO 507
      IF(COSPSI.LT..01) HEL1=DHDY*SINPSI
      IF(SINPSI.LT..01) HEL1=DHDX*COSPSI
      GOTO 508
  507 HEL1=ABS(DHDX*COSPSI)+ABS(DHDY*SINPSI)
  508 HEL(N)=ABS(HEL1)
      CC=(C(N)+C(N-1)+CPLUS(N)+CPLUS(N-1))/DELER
      CCC=1.-(CC/CO)*(CC/CO)
      DD=.001*DD
      DCDH=G*CCC/(CC+G*DD/CC*CCC)
      DALFADS=(DHDX*SIN(ALFA)-DHDY*COS(ALFA))/CC*DCDH
      S=-.001*MESH/SIN(ALFA)
      ALFAOLD=ALFA
      ALFA=ALFA+S*DALFADS
      IF(ALFA.LT.3.927) ALFA=3.927
      IF(ALFA.GT.5.498) ALFA=5.498
      HULPALFA=.5*(ALFA+ALFAOLD)
      IF(HULPALFA.GT.4.7123) GOTO 14
C     BEREKENING VAN REFRACTIECOEFFICIENT******
   24 PSI1=PSI(N-1)+PI
  162 FIO=ALFAOLD-PSI1
      FIN=ALFA-PSI1
C     IF(M.LE.24)DISPLAY '*',180*PSI/PI,180*FIO/PI,180*FIN/PI
      GOTO 27
C
C     SPECIAAL GEVAL VLAKKE BODEM
C
   28 ALFAOLD=ALFA
      HULPALFA=ALFA
      PSI(N-1)=9.425
      HEL(N-1)=0
      FIO=1
      FIN=1
   27 FACTOR=1
      IF(ABS(HULPALFA-4.712).LT..01) FACTOR=0
      IF(FACTOR.NE.O) FACTOR=1/TAN(HULPALFA)
      IF(D(N,M-1)+RISE.LE.O) GOTO 25
      COSFIO=COS(FIO)
      COSFIN=COS(FIN)
      IF(ABS(COSFIO).LT.ABS(COSFIN)) GOTO 170
      COSFIO=1
      COSFIN=1
  170 WF=WFO(N,M)*(1.-FACTOR)*ABS(COSFIO/COSFIN)
      IF(WF+WFO(N,M-1).LE.O) GOTO 13
      IF(WF.GT.20000.) GOTO 13
      ALFM=.01*ALF(N,M-1)
      ALFM=(HULPALFA*WF+ALFM*WFO(N,M-1))/(WF+WFO(N,M-1))
      ALF(N,M-1)=ALFM*100
C     DISPLAY N,M,WFO(N,M),WF,ALFAOLD,ALFA,PSI
      WFO(N,M-1)=WFO(N,M-1)+WF
   25 IF(D(N-1,M-1)+RISE.LE.O) GOTO 28
      IF(FACTOR.EQ.O) GOTO 28
      WF=WFO(N,M)*FACTOR*ABS(COSFIO/COSFIN)
      IF(WF+WFO(N-1,M-1).LE.O) GOTO 13
      ALFP=.01*ALF(N-1,M-1)
      ALFP=(HULPALFA*WF+ALFP*WFO(N-1,M-1))/
     &  (WF+WFO(N-1,M-1))
      ALF(N-1,M-1)=ALFP*100
      WFO(N-1,M-1)=WFO(N-1,M-1)+WF
   28 CONTINUE
C     IF(M.LE.24)DISPLAY '*',HULPALFA,N,M,WF,WFO(N,M-1),WFO(N-1,M-1)
      GOTO 13
C
   13 CONTINUE
C
C     **korrigeren golfhoogten indien breking optreedt*********
C
   85 DO 21 N=1,NMAX
      IF(D(N,M-1)+RISE.LE.O) GOTO 21
      SHOAL=O.4466*SQRT(SQRT(WLO*1000./(D(N,M-1)+RISE)))
C     IF(WFO(N,M-1).LT.O) DISPLAY N,M-1,D(N,M-1),WFO(N,M-1),'   '
      H=SQRT(1.*WFO(N,M-1))*SHOAL*100.
      IF(H.LT.GAMMA*(D(N,M-1)+RISE)) GOTO 21
      H=GAMMA*.01*(D(N,M-1)+RISE)
      WFO(N,M-1)=H*H/SHOAL/SHOAL
   21 CONTINUE
      ALF(1,M-1)=ALF(2,M-1)
      ALF(NMAX,M-1)=ALF(NMAX-1,M-1)
      WFO(1,M-1)=WFO(2,M-1)
      WFO(NMAX,M-1)=WFO(NMAX-1,M-1)
C
C     ******LONGSHORE CURRENT*********************
C
C     ** longshore current VLSS in M/SEC        **
C     ** VLSS altijd kleiner dan SQRT(G*D)      **
C     ** en kan nooit VMAX1 overschrijden       **
C     ** Alleen longshore current als H>Hbr     **
C     **                                        **
C
      K=0
      SOM=0
      SOMG=0
      DO 180 N=1,NMAX
      ULS(N)=0
      VLS(N)=0
  180 CONTINUE
      DO 122 N=1,NMAX
      IF(D(N,M-1)+RISE.LE.O) GOTO 122
      IF(D(N,M-1)+RISE.GE.DGRNS) GOTO 122
      IF(D(N,M)+RISE.LE.O) GOTO 122
      MESH1=.001*MESH
      SHOAL1=0
      SHOAL2=0
      SHOAL3=0
      SHOAL4=0
      SXY1=0
      SXY2=0
      SXY3=0
      SXY4=0
      ALFAA=ALF(N,M)*.01
      IF(ALFAA.LT.4.712) GOTO 200
      D1=D(N,M-1)+RISE
      D2=D(N+1,M-1)+RISE
      D3=D(N,M)+RISE
      D4=D(N+1,M)+RISE
      DD=D1
      WF1=WFO(N,M-1)
      IF(WF1.LE..0) GOTO 122
      WF2=WFO(N+1,M-1)
      WF3=WFO(N,M)
      WF4=WFO(N+1,M)
      ALFA1=ALF(N,M-1)*.01
      ALFA2=ALF(N+1,M-1)*.01
      ALFA3=ALF(N,M)*.01
      ALFA4=ALF(N+1,M)*.01
      ALFF=ALFA1
      GOTO 201
  200 D1=D(N-1,M-1)+RISE
      D2=D(N,M-1)+RISE
      D3=D(N-1,M)+RISE
      D4=D(N,M)+RISE
      DD=D2
      WF1=WFO(N-1,M-1)
      WF2=WFO(N,M-1)
      IF(WF2.LE..0) GOTO 122
      WF3=WFO(N-1,M)
      WF4=WFO(N,M)
      ALFA1=ALF(N-1,M-1)*.01
      ALFA2=ALF(N,M-1)*.01
      ALFA3=ALF(N-1,M)*.01
      ALFA4=ALF(N,M)*.01
      ALFF=ALFA2
  201 IF(D1.LE.O) GOTO 203
      SHOAL1=.4466*SQRT(SQRT(1000.*WLO/D1))
  203 IF(D2.LE.O) GOTO 205
      SHOAL2=.4466*SQRT(SQRT(1000.*WLO/D2))
  205 IF(D3.LE.O) GOTO 207
      SHOAL3=.4466*SQRT(SQRT(1000.*WLO/D3))
  207 IF(D4.LE.O) GOTO 209
      SHOAL4=.4466*SQRT(SQRT(1000.*WLO/D4))
  209 H12=WF1*SHOAL1*.01
      H22=WF2*SHOAL2*.01
      H32=WF3*SHOAL3*.01
      H42=WF4*SHOAL4*.01
      PSI1=PSI(N)
      IF(PSI1.GE.15.708) GOTO 122
      IF(PSI1.EQ.9.425) GOTO 122
      PSIN=PSI1+PI
      FI1=ALFF-PSIN
      IF(ABS(FI1).GE.1.555) GOTO 116
      FI1=ALFA1-PSIN
      IF(ABS(FI1).GE.1.555) GOTO 210
      SXY1=H12*SIN(FI1)*COS(FI1)
  210 FI2=ALFA2-PSIN
      IF(ABS(FI2).GE.1.555) GOTO 211
      SXY2=H22*SIN(FI2)*COS(FI2)
  211 FI3=ALFA3-PSIN
      IF(ABS(FI3).GE.1.555) GOTO 212
      SXY3=H32*SIN(FI3)*COS(FI3)
  212 FI4=ALFA4-PSIN
      IF(ABS(FI4).GE.1.555) GOTO 213
      SXY4=H42*SIN(FI4)*COS(FI4)
  213 DSXYDX=(SXY2+SXY4-SXY1-SXY3)/2./MESH1
```

```
      DSXYDY=(SXY3+SXY4-SXY1-SXY2)/2./MESH1
      DSXYDPSI=DSXYDX*COS(PSI1)+DSXYDY*SIN(PSI1)
      IF(DSXYDPSI.LT.0) GOTO 122
C   BEPALING fw FACTOR
      WL=CPLUS(N)*TH
      RKK=6.28/WL
      OMEG=6.28/TH
      SHOAL=.4466*SQRT(SQRT(1000.*WLO/DD))
      H=SQRT(WFO(N,M-1))*SHOAL/10.
      IF(H.LE..O) GOTO 116
      UO=.5*OMEG*H/SINH(RKK*.001*(D(N,M-1)+RISE))
      BOTDIS=UO/OMEG
      FW=.32
      IF(BOTDIS/(FRGH*ROUGH).GT.1.47)
     &FW=EXP(-5.977+5.213*(FRGH*ROUGH/BOTDIS)**.194)
C   BEPALING LONGSHORE CURRENT VLSS
      CH=18.*ALOG10(.012*(D(N,M-1)+RISE)/(FRGH*ROUGH))
C     DISPLAY N,M-1,D(N,M-1),SIN(FI),SINFID,CH,HEL,FW
C    *,CO,CPLUS(N),H,ALFA,PSI
C
C****** VLSS IN M. PER SEC. !! (VANWEGE CHEZY)*********
C
      VLSS=DSXYDPSI*3.141*CH*SQRT(.002*DD)/(H*SQRT(FW))
      IF(VLSS.EQ.0) GOTO 87
      VMAX=SQRT(.00981*(D(N,M-1)+RISE))
      IF(VMAX.GT.VMAX1) VMAX=VMAX1
      IF(VLSS.GT.VMAX) VLSS=VMAX
      K=K+1
      SOM=SOM+VLSS
C   BEPALING RIGHTING (=HOEK) LONGSHORE CURRENT
   87 ALFA=ALF(N,M-1)*.01
      FI=ALFA-PSIN
      IF(ABS(FI).GE.1.555) GOTO 116
      IF(FI.LT.0) GOTO 118
      HOEK=PSI1-1.571
      GOTO 120
  118 HOEK=PSI1+1.571
      GOTO 120
  116 VLSS=0
      HOEK=0
      GOTO 122
C   BEPALING HOR. EN VERT. DEEL VAN VLS
  120 UVLS=VLSS*COS(HOEK)
      VVLS=VLSS*SIN(HOEK)
C     DISPLAY UVLS,VVLS
      ULS(N)=UVLS*10.
      VLS(N)=VVLS*10.
      U(N,M-1)=U(N,M-1)+ULS(N)
      V(N,M-1)=V(N,M-1)+VLS(N)
  122 CONTINUE
   99 CONTINUE
  100 CONTINUE
C     DISPLAY IANTW,'R2589'
      IF(IANTW.EQ.2) GOTO 896
      CALL FILES('32','#UVELLS  ')
      CALL FILES('33','#VVELLS  ')
      DO 893 M=1,MMAX
      DO 894 I=1,NMAX,10
      WRITE(32,895) (U(N,M),N=I,I+9)
      WRITE(33,895) (V(N,M),N=I,I+9)
```

```
  895 FORMAT(10F8.1)
  894 CONTINUE
  893 CONTINUE
      CALL UNITCONTROL(32,8)
      CALL UNITCONTROL(33,8)
  896 RETURN
      END
C
C
C
C
C
$CONTROL SEGMENT=EENLING
      SUBROUTINE EENLING(WLO,RISE,MO)
      REAL D(30,40),ALF(30,40),WFO(30,40),U(30,40),V(30,40)
     *    ,PSI(30),HEL(30),DNUL(30,40)
      INTEGER UEE(30),VEE(30),FPX(4),FPY(4)
      REAL MESH
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                    ,DNUL
C
C     ************************************************
C     *        STROOM (VVEE) DOOR EENLINGGOLVEN      *
C     *    GEM. SNELHEID: VVEE=0.1*VOORTPL.SNELN. GOLF *
C     *    SNELHEIDSRICHTING = GOLFRICHTING          *
C     *                                              *
C     ************************************************
C
      DO 1 M=MMAX,2,-1
      DO 2 N=1,NMAX
      UEE(N)=0
      VEE(N)=0
    2 CONTINUE
      DO 3 N=1,NMAX-1
      IF(D(N,M)+RISE.LE.0) GOTO 3
      IF(WFO(N,M).EQ.0) GOTO 3
      SHOAL=.4466*SQRT(SQRT(WLO*1000./(D(N,M)+RISE)))
      H=SQRT(1.*WFO(N,M))*SHOAL
      DD=.01*(D(N,M)+RISE)
      CEE=SQRT(9.81*10.*(DD+H))
      VVEE=.1*CEE
      ALFA=.01*ALF(N,M)
      UEE(N)=VVEE*COS(ALFA)
      VEE(N)=VVEE*SIN(ALFA)
    3 CONTINUE
      DO 4 N=1,NMAX-1
      U(N,M)=U(N,M)+UEE(N)
      V(N,M)=V(N,M)+VEE(N)
C     IF(N.EQ.21) DISPLAY N,M,U(N,M),V(N,M)
    4 CONTINUE
    1 CONTINUE
      IF(IANTW.EQ.2) GOTO 896
      CALL FILES('34','#UVELEE  ')
      CALL FILES('35','#VVELEE  ')
      DO 893 M=1,MMAX
      DO 894 I=1,NMAX,10
      WRITE(34,895) (U(N,M),N=I,I+9)
      WRITE(35,895) (V(N,M),N=I,I+9)
  895 FORMAT(10F6.1)
  894 CONTINUE
```

```
  893 CONTINUE
      CALL UNITCONTROL(34,8)
      CALL UNITCONTROL(35,8)
  896 RETURN
      END
C
C
C
C
C
$CONTROL SEGMENT=SETUP
      SUBROUTINE SETUP(RISE,GAMMA,WLO,ROUGH)
      REAL D(30,40),WFO(30,40),ALF(30,40),U(30,40),V(30,40)
      INTEGER SHX1(200),SHY1(200),FPX(4),FPY(4),SHX2(100),SHY2(100)
      INTEGER SHX3(100),SHY3(100),SHX(200),SHY(200)
      REAL PSI(30),HEL(30),SU1(200),SU3(100),DNUL(30,40)
      REAL MESH
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                 ,DNUL
      COMMON /STUP/ SHX1,SHX3
C
C     ***********************************************************
C     *                                                         *
C     *  LONGSHORE CURRENT VVSU T.G.V. SETUP DOOR GOLVEN        *
C     *    alleen setup in N,M, als N,M-1 landpunt is           *
C     *    en de golf in dit punt gebroken is                   *
C     *                                                         *
C     *    SETUP=5/16*GAMMA*Hbr                                 *
C     *                                                         *
C     ***********************************************************
C
C
C
C     *******bepalen SETUPLIJN (een gridpoint onder kustlijn)*****
C     *       rechts van FPX(4)                                 *
C     *                                                         *
C     *       Zoeken vanaf M=FPY(2)                             *
C
C     DISPLAY IANTW,'R2692'
      PI=3.141
      M2=FPY(2)
      DO 1 I=1,200
      SHX(I)=0
      SHY(I)=0
      SU1(I)=0
    1 CONTINUE
      FPX3=FPX(3)
      FPY3=FPY(3)
      FPX4=FPX(4)
      FPY4=FPY(4)
      I=2
      IF(FPX4.LE.FPX3) NSTOP=FPX4
      IF(FPX4.GT.FPX3) NSTOP=FPX3
      MBEG=12
      MSTOP=32
      SHX(1)=30
      SHY(1)=19
      DO 2 N=NMAX-1,NSTOP,-1
      MO=-1
      M1=-1
```

```
      DO 3 M=MBEG,MSTOP
      IF(MO.NE.-1) GOTO 20
      IF(D(N,M)+RISE.GT.0.AND.D(N,M+1)+RISE.LE.0) MO=M+1
   20 IF(M1.NE.-1) GOTO 22
      IF(D(N,M)+RISE.LE.0.AND.D(N,M+1)+RISE.GT.0)
     *  M1=M
    3 CONTINUE
   22 SHX(I)=N
      SHY(I)=M1+1
C
C   *******eerst testen of kop van Cabedelo is bereikt********
C
      IF(MO.EQ.-1.AND.M1.EQ.-1) GOTO 21
      IDIF=MO-SHY(I-1)
      IF(IDIF.GE.1) GOTO 21
      MDIFF=SHY(I)-SHY(I-1)
      IF(ABS(MDIFF).EQ.1.OR.ABS(MDIFF).EQ.0) GOTO 5
C
C   ******Doornummeren van SHX en SHY tussen N=N en N=N-1*******
C
      J=I+ABS(MDIFF)
      IF(J.GT.200) GOTO 21
      IF(MDIFF.GT.0) GOTO 7
      F1=-1
      F2=0
      SHX(J)=N
      SHY(J)=SHY(I)
      SHX(I)=N
      SHY(I)=SHY(I-1)
      I=I+1
      GOTO 23
    7 F1=1
      F2=1
      SHX(J)=N
      SHY(J)=SHY(I)
      SHX(J-1)=N+1
      SHY(J-1)=SHY(J)
   23 DO 8 K=I,I+ABS(MDIFF)-2
      SHX(K)=N+F2*I
      SHY(K)=SHY(K-1)+F1*1
    8 CONTINUE
      I=J
C
C   **************
C
    5 CONTINUE
      I=I+1
      IF(I.GE.200) GOTO 21
    2 CONTINUE
   21 IEIND=I-1
C     DO 25 I=1,IEIND
C     DISPLAY I,SHX(I),SHY(I),(D(SHX(I),SHY(I))+RISE)/100.
C  25 CONTINUE
C
C   ***************************************************
C
C
C
C
C   ***Bepalen SETUP (SU1(I)) in mm ***************************
```

```
C    * indien golfhoogte lager dan (GAMMA-1                        *
C    * dan geen setup                                              *
C    *                                                              *
C    *  beginnen bij N=NMAX                                         *
C    *  bepalen gem. set up ; dit geeft een basis verhang*
C    *   VERHB en veroorzaakt een basis setup current     *
C    *   noordwaarts                                                *
C
C       DISPLAY IANTW,'R2778'
        SOMSUB=0
        SOMD11=0
        SOMCH=0
        DO 8 I=1,IEIND
        N=SHX(I)
        M=SHY(I)
        D1=D(N,M)+RISE
        IF(D1.LE.0) GOTO 26
        D11=.001*D1
        CHN=18.*ALOG10(12.*D11/ROUGH)
        SOMCH=SOMCH+CHN
        SOMD11=SOMD11+D11
        SHOAL=.4466*SQRT(SQRT(WLO*1000./D1))
        H=SQRT(1.*WFO(N,M))*SHOAL
        HBR=(GAMMA-.1)*.01*D1
C       IF(H.LE.HBR) GOTO 8
        SU1(I)=.313*GAMMA*H*100.
C       DISPLAY I,N,M,H,SU1(I)
        GOTO 40
     26 SU1(I)=SU1(I-1)
     40 SOMSUB=SOMSUB+SU1(I)
      8 CONTINUE
C       DISPLAY IANTW,'R2801'
        CH=SOMCH/IEIND
        DGEM=SOMD11/IEIND
        SUG=SOMSUB/IEIND
        AFST=(IEIND-1)*MESH
        IF(AFST.LE.0) AFST=MESH
        VERHB=2.*SUG/AFST
        SQVERHB=SQRT(VERHB)
        VGEM=CH*SQRT(DGEM)*SQVERHB
C       DISPLAY IANTW,'R2808',CH,DGEM,SUG,AFST,VERHB
        DO 9 II=IEIND,1,-1
        N=SHX(II)
        M=SHY(II)
        KEIND=1
        MP=SHY(II+1)
        MMM=SHY(II-1)
        IF(II.EQ.IEIND) GOTO 34
        IF(II.EQ.1) GOTO 35
        GOTO 37
     34 NP=SHX(II)-1
        NM=SHX(II-1)
        GOTO 36
     35 NP=SHX(II+1)
        NM=SHX(II)+1
        GOTO 36
     37 NP=SHX(II+1)
        NM=SHX(II-1)
     36 IF(NP.NE.N.AND.NM.NE.N) GOTO 38
        IF(NP.EQ.N.AND.NM.NE.N.AND.MP.LT.M) GOTO 38
        IF(NP.NE.N.AND.NM.EQ.N.AND.MMM.LT.M) GOTO 38
        GOTO 39
     38 KEIND=3
     39 DO 30 K=1,KEIND
        MM=M+(K-1)
        IF(MM.EQ.0) GOTO 30
        IF(D(N,MM)+RISE.LE.0) GOTO 30
        D1=.001*(D(N,MM)+RISE)
        FACD=DGEM/D1
        VVVS=FACD*VGEM
        IF(VVVS.LT..0001) GOTO 30
        VMAX=SQRT(9.81*D1)
        IF(VVVS.GT.VMAX) VVVS=VMAX
        CALL HELNG(MM,RISE,N,N+1)
        PSI1=PSI(N)
        IF(PSI1.EQ.15.708) GOTO 30
        IF(PSI1.NE.9.425) GOTO 32
        KK=II+1
        IF(KK.EQ.IEIND+1) GOTO 30
        N1=SHX(KK)
        M1=SHY(KK)+(K-1)
        CALL HELNG(M1,RISE,N1,N1+1)
        PSI1=PSI(N1)
     32 PSI1=PSI1+1.571
        UVVSU=VVVS*COS(PSI1)*10.
        VVVSU=VVVS*SIN(PSI1)*10.
        U(N,MM)=U(N,MM)+UVVSU
        V(N,MM)=V(N,MM)+VVVSU
C       DISPLAY N,MM,D1,PSI1,IANTW
     30 CONTINUE
      9 CONTINUE
C       DISPLAY IANTW,'R2838'
C
C       DISPLAY IANTW
        IF(IANTW.EQ.2) GOTO 896
        CALL FILES('36','#UVELSU  ')
        CALL FILES('37','#VVELSU  ')
C       DISPLAY'UNITS 36 AND 37 OPENED'
        DO 893 M=1,MMAX
        DO 894 I=1,NMAX,10
        WRITE(36,895) (U(N,M),N=I,I+9)
        WRITE(37,895) (V(N,M),N=I,I+9)
    895 FORMAT(10F6.1)
    894 CONTINUE
    893 CONTINUE
        CALL UNITCONTROL(36,8)
        CALL UNITCONTROL(37,8)
    896 RETURN
        END
C
C
C
C
C
C
$CONTROL SEGMENT=SEDTRAN
        SUBROUTINE SEDTRAN(D50,D90,RISE,TH,ROUGH,DROTS,DRISE)
C       !!!D50[M],D90[M],RISE[MM],DRISE[MM],TH[SEC],ROUGH[M],DROTS[M]!!!
        REAL U(30,40),V(30,40),D(30,40),WFO(30,40),DNUL(30,40)
     *       ,ALF(30,40),SU(30,40),SV(30,40),PSI(30),HEL(30)
        REAL MESH,L1,KSI,MU,K,KAPPA,KS,KB
        INTEGER FPX(4),FPY(4)
        COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                  ,DNUL
        COMMON /SEDTR/ SU,SV
C
C
C    *************************************************
C    *                                               *
C    *  BEREKENING SEDIMENTTRANSPORTCAPACITEIT       *
C    *    MET BIJKER/BATTACHARIA                     *
C    *                                               *
C    *                                               *
C    *                    B=1.83                     *
C    *        RIBBELFACTOR LIN. AFHANKELIJK VAN TH   *
C    *                                               *
C    *    transp.cap. in U-ri. = SU                  *
C    *                                               *
C    *                                               *
C    *    transp.cap. in V-ri. = SV                  *
C    *                                               *
C    *                                               *
C    *                                               *
C    *    SU en SV in [m**3/sec]                     *
C    *                                               *
C    *  voor M > FPY(2) ligt rotsboden op -20 m      *
C    *                                               *
C    *************************************************
C
C
        RISE0=RISE
        DROTS0=DROTS
        DROTSZ=20000.
        DROTS=DROTS*1000.
        DELTA=1.65
        WLO=1.56*TH*TH
        FAC=1.83
        SAL=.02
        TEMP=20.
        RHOS=2650
        RHOB=1800
        R0=.165
        TM=12.8
        CALL WATPARMS(TEMP,SAL,VISK,RHO)
C
C    *******ribbelfaktor R lin. afhankelijk van golfperiode TH****
C    *   R0 is doorsnijding R-as                                 *
C    *   TM is doorsnijding T -as                                *
C    *   R=AA*TH+BB                                              *
C
        AA=-R0/TM
        BB=R0
        IF(TH.LT.TM) GOTO 40
        R=AA*(TM-1) +BB
        GOTO 41
     40 R=AA*TH+BB
     41 DO 1 M=1,MMAX
C
C    ***extra waterstandsverhoging t.g.v zeer hoge***
C    *   rivierafvoeren                                *
C
        RISE=RISE0
        FPY2=FPY(2)
        IF(M.GT.FPY2) DROTS=DROTSZ
        IF(M.GT.FPY2) GOTO 34
        DDRISE=(FPY2-M)*DRISE/FPY2
        RISE=RISE+DDRISE
C
     34 DO 2 N=1,NMAX
        SU(N,M)=0
        SV(N,M)=0
      2 CONTINUE
        DO 3 N=1,NMAX
        IF(D(N,M)+RISE.LE.0) GOTO 3
        UU=U(N,M)
        VV=V(N,M)
        VVV=.1*SQRT(UU*UU+VV*VV)
C       DISPLAY N,M,VVV
        IF(UU.EQ.0.AND.VV.EQ.0) GOTO 3
        HOEK=ATAN2(VV,UU)
        IF(VVV.EQ.0) GOTO 3
        SHOAL=.4466*SQRT(SQRT(WLO*1000./(D(N,M)+RISE)))
        H=SQRT(WFO(N,M))*SHOAL*.1
        D1=.001*(D(N,M)+RISE)
C
C***********************************************************************
C       SUBROUTINE FOR COMPUTING WAVE PARAMETERS
C       acc. to linear wave theory
C
C       INPUT : H      wave height                         (m)
C               TH      wave period                         (s)
C               D1      water depth                         (m)
C               U0     amplitude bed orbital velocity      (m/s)
C       OUTPUT: A0     amplitude bed orbital motion        (m)
C               U0     amplitude bed orbital velocity      (m/s)
C               WI     wave length                         (m)
C
C       version October 14th 1982        GJA LOMAN / HYDRONAMIC bv
C***********************************************************************
C
        PI=3.14159
        G=9.81
        A0=0
        U0=0
        WL=0
        IF(H.EQ.0.OR.TH.EQ.0.) GOTO 50
        OMEG=2.*PI/TH
        WLO=G/2./PI*TH*TH
        WL=WLO*SQRT(TANH(2.*PI*D1/WLO))
        DO 51 I=1,6
        WL1=WLO*TANH(2.*PI*D1/WL)
        WL=(2.*WL1+WL)/3.
     51 CONTINUE
        K=2.*PI/WL
        U0=0.5*OMEG*H/SINH(K*D1)
        A0=U0/OMEG
C
C                  ***************************
C
C
```

```
C*********************************************************************
C       SUBROUTINE FOR COMPUTING BED LOAD TRANSPORT
C       acc. to BIJKER-FRIJLINK formula
C
C       INPUT : D50    50% bed grain size by weight      (m)
C               D90    90% bed grain size by weight      (m)
C               R      Nikuradse bed rougness             (m)
C               D1      water depth                       (m)
C               VVV      depth-averaged flow intensity    (m/s)
C               U0     amplitude bed orbital velocity    (m/s)
C               A0     amplitude bed orbital motion      (m)
C               Rho    water density                     (kg/cum)
C               Rhos   grain density                     (kg/cum)
C               Rhob   dry bulk density                  (kg/cum)
C               Visk   kinematic water viscosity         (sqm/s)
C               FAC      proportional bed load factor      (-)
C       OUTPUT: Sb     bed load transport                (cum/s/m)
C               Tcw    bed shear stress current & waves  (Pa)
C               Tc     bed shear stress current          (Pa)
C               Cb     bed load concentration            (ppt wg)
C
C       version October 14th 1982       GJA LOMAN / HYDRONAMIC bv
C*********************************************************************
C
   50 G=9.81
      CB=0.
      SB=0.
      TCW=0
      TC=0
      IF(VVV.EQ.0..OR.D1.LE.0.) GOTO 52
      DMIN=D1
      IF(DMIN.LT.R) DMIN=R
      Cr=18.*ALOG10(12.*DMIN/R)
      MU=(Cr/18./ALOG10(12.*DMIN/D90))**1.5
      FW=0.32
      IF(A0/R.GT.1.47)
     &FW=EXP(-5.977+5.213*(R/A0)**0.194)
      TC=RHO*G*VVV*VVV/Cr/Cr
      TCW=TC+0.25*RHO*FW*U0*U0
      PARM=-0.27*(RHOS-RHO)*D50*G/MU/TCW
      IF(PARM.LE.-100) GOTO 52
      SB=FAC*D50*VVV/Cr*SQRT(G)*EXP(PARM)*1800./RHOB
      CB=SB/SQRT(TC/RHO)/6.34/R*RHOB/RHO*1000
C
C                  *******************
C
C
C*********************************************************************
C       SUBROUTINE FOR COMPUTING PARTICLE FALL VELOCITY
C       acc. to Delft Hydraulics Laboratory formulae
C
C       INPUT : D50    50% susp grain size by weight     (m)
C               Visk    kinematic water viscosity         (sqm/s)
C               Rho    water density                     (kg/cum)
C               Rhos   grain density                     (kg/cum)
C       OUTPUT: V50    fall velocity of D50 grain        (m/s)
C
C       version October 14th 1982       GJA LOMAN / HYDRONAMIC bv
C*********************************************************************
C
   52 V50=10.**(-0.447*ALOG10(D50)*ALOG10(D50)-
     & 1.961*ALOG10(D50)-2.738)
      V50=V50*(RHOS-RHO)/RHO/1.65*1.014E-6/VISK
C
C                  *********************
C
C
C*********************************************************************
C       SUBROUTINE FOR COMPUTING SUSPENDED LOAD TRANSPORT
C       acc. to BHATTACHARYA-TOW formula
C
C       INPUT : V50    fall velocty of D550 grain size  (m/s)
C               R      Nikuradse bed rougness            (m)
C               D1      water depth                      (m)
C               Tcw    bed shear stress current & waves (Pa)
C               Rho    water density                    (kg/cum)
C               Sb     bed load transport               (cum/s/m)
C       OUTPUT: SSUS   suspended load transport         (cum/s/m)
C
C       version October 14th 1982       GJA LOMAN / HYDRONAMIC bv
C*********************************************************************
C
      KAPPA=0.384
      SSUS=0.
      IF(SB.EQ.0.OR.D1.LE.R) GOTO 53
      ZX=V50/KAPPA/SQRT(TCW/RHO)
      AAA=D1/R
      B1=1.05*(ZX**0.96)/(AAA**(0.013*ZX))
      B2=1-B1
      IF(ABS(B2).LT.1E-5) B2=1.E-5
      KB=(1.-B1*(0.1667**B2))/B2
      KS=0.415*(B2*((AAA**B2)*ALOG(30.2*AAA)-3.4078418)+
     &(1.-AAA**B2))/B2/B2
      SSUS=SB*KS/KB
C
C                  *********************
C
   53 S=SSUS+SB
      SSU=S*COS(HOEK)
      SSV=S*SIN(HOEK)
      SU(N,M)=SSU
      SV(N,M)=SSV
C     DISPLAY N,M,SU(N,M),SV(N,M)
    3 CONTINUE
C
C
C   ***bepalen transp. cap. in U-richting tpv rotspunten**
C   *  indien randpunt rotsboden dan is:                  *
C   *  in   N=1------->SU=SU1                             *
C   *       N=NMAX---->SU=SUNM                            *
C   *                                                     *
C
      SU1=1.E-20
      SUNM=1.E-20
      IF(D(1,M).GE.DROTS.AND.SU(1,M).GT.0) SU(1,M)=SU1
C
C   ******eerst van links naar rechts******
C
      DO 6 N=2,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 6
      IF(D(N,M).LT.DROTS) GOTO 6
      IF(SU(N,M).LT.0) GOTO 6
C
C     !!N,M is een rotspunt en SU(N,M) is positief!!!
C
      IF(SU(N-1,M).LT.0) SU(N,M)=0
      IF(SU(N,M).GE.SU(N-1,M)) SU(N,M)=SU(N-1,M)
    6 CONTINUE
C
C   ********nu van rechts naar links********
C
      IF(D(NMAX,M).GE.DROTS.AND.SU(NMAX,M).LT.0) SU(NMAX,M)=SUNM
      DO 7 N=NMAX-1,1,-1
      IF(D(N,M)+RISE.LE.0) GOTO 7
      IF(D(N,M).LT.DROTS) GOTO 7
      IF(SU(N,M).GE.0) GOTO 7
C
C     !!N,M is rotspunt en SU(N,M) is negatief!!!!!!!!
C
      IF(SU(N+1,M).GT.0) SU(N,M)=0
      IF(SU(N,M).LE.SU(N+1,M)) SU(N,M)=SU(N+1,M)
    7 CONTINUE
    1 CONTINUE
      DROTS=DROTS0*1000.
C
C          ***********************************
C
C
C
C   ***bepalen transp.cap. SV in V-richting tpv rotspunten**
C   *  indien randpunt rotsboden dan is:                    *
C   *  in     M=1---------->SV1=SV11                        *
C   *         M=MMAX------->SV1=SVMM                        *
C
C
      DO 9 N=1,NMAX
C
C   ******bepalen SV tpv rotspunten***************
C   *   eerst van boven naar beneden             *
C
      SV11=0
      SVMM=0
      IF(D(N,1).GE.DROTS.AND.SV(N,1).GT.0) SV(N,1)=SV11
      DO 12 M=2,MMAX
C
C   ***extra waterstandsverhoging t.g.v zeer hoge***
C   *   rivierafvoeren                             *
C
      RISE=RISE0
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 35
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
C
   35 IF(D(N,M)+RISE.LE.0) GOTO 12
      IF(D(N,M).LT.DROTS) GOTO 12
      IF(SV(N,M).LT.0) GOTO 12
C
C     !!!!N,M is rotsboden en SV(M) is positief!!!!
C
      IF(SV(N,M-1).LT.0) SV(N,M)=0
      IF(SV(N,M).GE.SV(N,M-1)) SV(N,M)=SV(N,M-1)
   12 CONTINUE
C
C   ********nu van onder naar boven**********
C
      IF(D(N,MMAX).GE.DROTS.AND.SV(N,MMAX).LT.0)
     *SV(N,MMAX)=SVMM
      DO 13 M=MMAX-1,1,-1
C
C   ***extra waterstandsverhoging t.g.v zeer hoge***
C   *   rivierafvoeren                             *
C
      RISE=RISE0
      FPY2=FPY(2)
      IF(M.LE.FPY2) DROTS=DROTS0*1000.
      IF(M.GT.FPY2) GOTO 36
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
C
   36 IF(D(N,M)+RISE.LE.0) GOTO 13
      IF(D(N,M).LT.DROTS) GOTO 13
      IF(SV(N,M).GE.0) GOTO 13
C
C     !!!N,M is rotspunt en SV(M) is negatief!!!!
C
      IF(SV(N,M+1).GT.0) SV(N,M)=0
      IF(SV(N,M).LE.SV(N,M+1)) SV(N,M)=SV(N,M+1)
   13 CONTINUE
   10 CONTINUE
    9 CONTINUE
      RISE=RISE0
      DROTS=DROTS0
      IF(IAMTW.EQ.2.) GOTO 63
      CALL FILES('15','#SEDU    ')
      CALL FILES('16','#SEDV    ')
      DO 60 M=1,MMAX
      DO 61 I=1,NMAX,10
      WRITE(15,62) (SU(N,M),N=I,I+9)
      WRITE(16,62) (SV(N,M),N=I,I+9)
   62 FORMAT(10E10.3)
   61 CONTINUE
   60 CONTINUE
      CALL UNITCONTROL(15,8)
      CALL UNITCONTROL(16,8)
   63 RETURN
      END
C
C
C
C
C
C
$CONTROL SEGMENT=NEWBOT
      SUBROUTINE NEWBOT(DDRED,DELTAT,RISE,DRISE,DROTS,ALPMAX,DDGEXTR
     &                 ,NBA,NBB,NBC,NBD,NBE,NBF,IALPHA)
C     !!!DDRED[M],DELTAT[SEC],RISE[MM]!!!
      REAL U(30,40),V(30,40),D(30,40),DNUL(30,40),ALF(30,40),WF0(30,40)
      INTEGER FPX(4),FPY(4)
```

```fortran
      REAL SU(30,40),SV(30,40),DD(30,2),PSI(30),HEL(30),DEG(9)
      REAL MESH,MESH1
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,HEL
     &                ,DNUL
      COMMON /SEDTR/ SU,SV
C
C
C    **************************************************
C    *              BEREKENING NIEUWE BODEM             *
C    *                                                  *
C    *     BEREKENING MET MODIFIED LAX SCHEMA           *
C    *     (GEWOGEN MIDDELING OVER 9 DIEPTEPUNTEN)      *
C    *                                                  *
C    *        ROTSBODEM OP Z.H. -                       *
C    *                                                  *
C    *                     -------->N,I,U               *
C    *                     |                            *
C    *                     |                            *
C    *                     |                            *
C    *                     |                            *
C    *                     V                            *
C    *                   M,J,V                          *
C    *                                                  *
C    * Egaliseren met algemene formule (zie handleiding *
C    * egaliseren op cum. deken:A=1,B=1,C=0,D=1,E=1,F=0 *
C    *                                                  *
C    * egaliseren op deken :    A=0,B=1,C=0,D=0,E=1,F=1 *
C    *                                                  *
C    * egaliseren op bodem :    A=0,B=0,C=1,D=-1,E=0,F=1 *
C    *                                                  *
C    *    WFO=DD      (silt. in gebieden tussen maaspunten*
C    *    ALF=DDi*                                      *
C    *    D=Di                                          *
C    *    U=DD       (geegalis. siltation in mesh-points) *
C    *    V=Di+delta t                                  *
C    *    tenslotte : D=V                               *
C    *                                                  *
C    **************************************************
C
C
      DROTSO=DROTS
      DROTSZ=20000.
      DROTS=DROTS*1000
      RISEO=RISE
      BAL1=0
      BAL2=0
      UITSCH1=0
      UITSCH2=0
      AANZ1=0
      AANZ2=0
      DO 50 M=1,MMAX
      DO 51 N=1,NMAX
      WFO(N,M)=0
      ALF(N,M)=0
      U(N,M)=0
      V(N,M)=0
   51 CONTINUE
   50 CONTINUE
C
C   *****bepaling siltation in gebieden tussen mesh-points***
C
      MESH1=.001*MESH
      DO 100 M=1,MMAX-1
      DO 101 N=1,NMAX-1
      DS=.5*(SU(N,M)+SU(N,M+1)-SU(N+1,M)-SU(N+1,M+1)
     *      +SV(N,M)-SV(N,M+1)+SV(N+1,M)-SV(N+1,M+1))
      WFO(N,M)=1000.*DS*DELTAT/MESH1
C
C     !!!!!!WFO(N,M) in mm!!!!!!!
C
      IF(DS.GE.0) GOTO 71
C
C   !!!!!! DS=neg. ,dus uitschuring!!!!!
C
      UITSCH1=UITSCH1+DS
      GOTO 101
   71 CONTINUE
C
C   !!!!!! DS=pos. , dus aanzanding!!!!!!!!
C
      AANZ1=AANZ1+DS
  101 CONTINUE
  100 CONTINUE
C
C   ***bepaling siltation in mesh-point (1,MMAX)*********
C
      IF(D(1,MMAX)+RISE.LE.0) GOTO 102
      ALF(1,MMAX)=WFO(1,MMAX-1)
C
C   ***bepaling siltation in mesh-point (NMAX,MMAX)*********
C
  102 IF(D(NMAX,MMAX)+RISE.LE.0) GOTO 103
      ALF(NMAX,MMAX)=WFO(NMAX,MMAX-1)
C
C   ***bepaling siltation in mesh-points op M=1**********
C
  103 RISE=RISEO+DRISE
      DO 104 N=2,NMAX-1
      IF(D(N,1)+RISE.LE.0) GOTO 104
      ALF(N,1)=.5*(WFO(N-1,1)+WFO(N,1))
  104 CONTINUE
C
C   ***bepaling siltation in meshpoints op M=MMAX************
C
      RISE=RISEO
      DO 105 N=2,NMAX-1
      IF(D(N,MMAX)+RISE.LE.0) GOTO 105
      ALF(N,MMAX)=.5*(WFO(N-1,MMAX-1)+WFO(N,MMAX-1))
  105 CONTINUE
      DO 106 M=2,MMAX-1
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 120
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
  120 IF(D(1,M)+RISE.LE.0) GOTO 107
      ALF(1,M)=.5*(WFO(1,M-1)+WFO(1,M))
  107 IF(D(NMAX,M)+RISE.LE.0) GOTO 106
      ALF(NMAX,M)=.5*(WFO(NMAX,M-1)+WFO(NMAX,M))
  106 CONTINUE
C
C   ***bepaling siltation in overige mesh-points (N,M)***********
C
      DO 108 M=2,MMAX-1
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 121
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
  121 DO 109 N=2,NMAX-1
      IF(D(N,M)+RISE.LE.0)GOTO 109
      ALF(N,M)=.25*(WFO(N-1,M-1)+WFO(N,M-1)+WFO(N-1,M)+WFO(N,M))
  109 CONTINUE
  108 CONTINUE
      DO 110 N=1,NMAX
      V(N,1)=D(N,1)
      V(N,2)=D(N,2)
  110 CONTINUE
C
C              ***********************
C
C
C      ******egaliseren van M=3 tot en met M=MMAX-1****
C
      DO 4 M=3,MMAX-1
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 54
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
   54 KK=M-2
      IA=3
      IF(D(1,M)+RISE.LE.0) GOTO 12
      DDG1=ALF(1,M)
      ALPHA=(1-IALPHA*EXP(-ABS(DDG1)/DDGEXTR))*ALPMAX
      JJJ=0
      IB=2
      II=5
      IC=6
      ID=3
      CALL EGAL(ALPHA,KK,IA,JJJ,IB,II,IC,ID,RISE,NBA,NBB,NBD,SDEGG)
      U(1,M)=(NBE-ALPHA)*(NBA*DNUL(1,M)-NBD*D(1,M)+NBB*ALF(1,M))
     &        +SDEGG-NBC*ALF(1,M)
   12 IF(D(NMAX,M)+RISE.LE.0) GOTO 13
      DDGNM=ALF(NMAX,M)
      ALPHA=(1-IALPHA*EXP(-ABS(DDGNM)/DDGEXTR))*ALPMAX
      JJJ=NMAX-2
      IB=2
      II=5
      IC=6
      ID=4
      CALL EGAL(ALPHA,KK,IA,JJJ,IB,II,IC,ID,RISE,NBA,NBB,NBD,SDEGG)
      U(NMAX,M)=(NBE-ALPHA)*(NBA*DNUL(NMAX,M)-NBD*D(NMAX,M)+
     &          NBB*ALF(NMAX,M))+SDEGG-NBC*ALF(NMAX,M)
   13 IB=3
      IC=9
      ID=5
      DO 8 N=2,NMAX-1
      IF(D(N,M)+RISE.LE.0) GOTO 9
      II=8
      DDG=ALF(N,M)
      ALPHA=(1-IALPHA*EXP(-ABS(DDG)/DDGEXTR))*ALPMAX
      JJJ=N-2
C
C   ************egaliseren*******************
C
      I=0
      DO 29 K=1,IA
      KKK=KK+K
      DO 30 J=1,IB
      JJ=JJJ+J
      I=I+1
      IF(D(JJ,KKK)+RISE.LE.0) GOTO 31
      DEG(I)=NBA*DNUL(JJ,KKK)-NBD*D(JJ,KKK)+NBB*ALF(JJ,KKK)
      GOTO 30
   31 DEG(I)=0
      II=II-1
   30 CONTINUE
   29 CONTINUE
      DEG(ID)=0
      SDEG=0
      DO 32 I=1,IC
      SDEG=SDEG+DEG(I)
   32 CONTINUE
      IF(II.EQ.0) GOTO 33
      SDEGG=ALPHA*SDEG/II
      GOTO 34
   33 SDEGG=0
C
C                      ************
C
   34 U(N,M)=(NBE-ALPHA)*(NBA*DNUL(N,M)-NBD*D(N,M)+
     &          NBB*ALF(N,M))+SDEGG-NBC*ALF(N,M)
    9 CONTINUE
    4 CONTINUE
C
C   ****egaliseren op M=MMAX*****************************
C
      KK=MMAX-2
      IA=2
      IF(D(1,MMAX)+RISE.LE.0) GOTO 14
      DDG=ALF(1,MMAX)
      ALPHA=(1-IALPHA*EXP(-ABS(DDG)/DDGEXTR))*ALPMAX
      DISPLAY'ALPHA=',ALPHA
      JJJ=0
      IB=2
      II=3
      IC=4
      ID=3
      CALL EGAL(ALPHA,KK,IA,JJJ,IB,II,IC,ID,RISE,NBA,NBB,NBD,SDEGG)
      U(1,MMAX)=(NBE-ALPHA)*(NBA*DNUL(1,MMAX)-NBD*D(1,MMAX)+
     &          NBB*ALF(1,MMAX))+SDEGG-NBC*ALF(1,MMAX)
   14 IF(D(NMAX,MMAX)+RISE.LE.0) GOTO 15
      DDG=ALF(NMAX,MMAX)
      ALPHA=(1-IALPHA*EXP(-ABS(DDG)/DDGEXTR))*ALPMAX
      JJJ=NMAX-2
```

```
      IB=2
      II=3
      IC=4
      ID=4
      CALL EGAL(ALPHA,KK,IA,JJJ,IB,II,IC,ID,RISE,NBA,NBB,NBD,SDEGG)
      U(NMAX,MMAX)=(NBE-ALPHA)*(NBA*DNUL(NMAX,MMAX)-NBD*D(NMAX,MMAX)+
     &          NBB*ALF(NMAX,MMAX))+SDEGG-NBC*ALF(NMAX,MMAX)
   15 IB=3
      IC=6
      ID=5
      DO 10 N=2,NMAX-1
      IF(D(N,MMAX)+RISE.LE.0) GOTO 10
      II=5
      DDG=ALF(N,MMAX)
      ALPHA=(1-IALPHA*EXP(-ABS(DDG)/DDGEXTR))*ALPMAX
      JJJ=N-2
C
C   *********egaliseren***************
C
      I=0
      DO 35 K=1,IA
      KKK=KK+K
      DO 36 J=1,IB
      JJ=JJJ+J
      I=I+1
      IF(D(JJ,KKK)+RISE.LE.0) GOTO 37
      DEG(I)=NBA*DNUL(JJ,KKK)-NBD*D(JJ,KKK)+NBB*ALF(JJ,KKK)
      GOTO 36
   37 DEG(I)=0
      II=II-1
   36 CONTINUE
   35 CONTINUE
      DEG(ID)=0
      SDEG=0
      DO 38 I=1,IC
      SDEG=SDEG+DEG(I)
   38 CONTINUE
      IF(II.EQ.0) GOTO 39
      SDEGG=ALPHA*SDEG/II
      GOTO 40
   39 SDEGG=0
C
C                    ************
C
   40 U(N,MMAX)=(NBE-ALPHA)*(NBA*DNUL(N,MMAX)-NBD*D(N,MMAX)+
     &          NBB*ALF(N,MMAX))+SDEGG-NBC*ALF(N,MMAX)
   10 CONTINUE
      IF(NBC.EQ.1) GOTO 113
      DO 111 M=3,MMAX
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 130
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
  130 DO 112 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 112
      DN1=NBA*DNUL(N,M)+NBF*D(N,M)-U(N,M)
      IF(DN1.GT.DROTS) DN1=DROTS
      V(N,M)=DN1
  112 CONTINUE
  111 CONTINUE
      GOTO 114
  113 DO 115 M=3,MMAX
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) DROTS=DROTSZ
      IF(M.GT.FPY2) GOTO 131
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
  131 DO 116 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 116
      DN1=D(N,M)+U(N,M)
      IF(DN1.GT.DROTS) DN1=DROTS
      V(N,M)=DN1
  116 CONTINUE
  115 CONTINUE
  114 DO 20 M=1,MMAX
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) GOTO 22
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
   22 DO 21 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 21
      DDIF=V(N,M)-D(N,M)
      IF(DDIF.LE.0) GOTO 55
C
C    !!!!!!! DDIF = pos. , dus uitschuring !!!!!!!!!
C
      UITSCH2=UITSCH2+DDIF
      GOTO 61
   55 CONTINUE
C
C    !!!!!!! DDIF = neg. , dus aanzanding!!!!!!!!!
C
      AANZ2=AANZ2+DDIF
   61 D(N,M)=V(N,M)
   21 CONTINUE
   20 CONTINUE
      AANZ1T=50.*DELTAT*AANZ1
      UITSCH1T=50.*DELTAT*UITSCH1
      AANZ2T=-2.5*AANZ2
      UITSCH2T=-2.5*UITSCH2
      BAL1=AANZ1T+UITSCH1T
C
C!!!!!BAL1 is hoeveelheid zand dat via randen uit het gebied!!!!!
C!!!!!verdwijnt of het gebied binnenkont                       !!!!!
C
      BAL2=AANZ2T+UITSCH2T
      DISPLAY AANZ1T,UITSCH1T,BAL1,'xxM**3xx',AANZ2T,UITSCH2T,BAL2
C    ***Verschil tussen BAL1 en BAL2 wordt omgerekend in extra***
C    ***bodemverandering voor alle onder waterpunten en       ***
C    ***toegevoegd bij de nieuw bepaalde boden                ***
C
      VERSCH=BAL1-BAL2
      MESH1=.001*MESH
      OPP=MESH1*MESH1*((NMAX-1)*(MMAX-1)-250)
      DEXTR=1000.*VERSCH/OPP
C
C!!!!!              DEXTR in mm!            !!!!!!
C
      DO 80 M=1,MMAX
      RISE=RISEO
      FPY2=FPY(2)
      IF(M.GT.FPY2) GOTO 83
      DDRISE=(FPY2-M)*DRISE/FPY2
      RISE=RISE+DDRISE
   83 DO 81 N=1,NMAX
      IF(D(N,M)+RISE.LE.0) GOTO 81
      IF(N.GE.13.AND.M.LE.14) GOTO 80
      D(N,M)=D(N,M)-DEXTR
   81 CONTINUE
   80 CONTINUE
      DROTS=DROTSO
      RISE=RISEO
      RETURN
      END
C
C
C
C
C
$CONTROL SEGMENT=EGAL
      SUBROUTINE EGAL(ALPHA,KK,IA,JJJ,IB,II,IC,ID,RISE
     &                ,NBA,NBB,NBD,SDEGG)
      REAL U(30,40),V(30,40),D(30,40),DEG(9),ALF(30,40),WFO(30,40)
      REAL MESH
      REAL PSI(30),MEL(30),DNUL(30,40)
      INTEGER FPX(4),FPY(4)
      COMMON /GENERAL/NMAX,MMAX,MESH,D,ALF,WFO,U,V,FPX,FPY,IANTW,PSI,MEL
     &                ,DNUL
      I=0
      DO 1 K=1,IA
      KKK=KK+K
      DO 2 J=1,IB
      JJ=JJJ+J
      I=I+1
      IF(D(JJ,KKK)+RISE.LE.0) GOTO 3
      DEG(I)=NBA*DNUL(JJ,KKK)-NBD*D(JJ,KKK)+NBB*ALF(JJ,KKK)
      GOTO 2
    3 DEG(I)=0
      II=II-1
    2 CONTINUE
    1 CONTINUE
      DEG(ID)=0
      SDEG=0
      DO 4 I=1,IC
      SDEG=SDEG+DEG(I)
    4 CONTINUE
      IF(II.EQ.0) GOTO 5
      SDEGG=ALPHA*SDEG/II
      GOTO 6
    5 SDEGG=0
    6 RETURN
      END
```