



**APPLICATION OF THE NRIO
1-D HYDRODYNAMIC MODEL
TO THE SWARTKOPS ESTUARY**

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P. HUIZINGA

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SYNOPSIS

The NRIO one-dimensional hydrodynamic model has recently been modified and improved (CSIR, 1984). To determine the performance of the model, the model was applied to studies of the Swartkops River and estuary system. The Swartkops River and estuary have been well documented in previous studies and good cooperation by the University of Port Elizabeth (UPE) enabled calibration data to be collected.

After the collection of data in the field by NRIO and UPE in March 1984 the NRIO model was used to simulate the observed site conditions. Good calibration of the model was achieved. The strong capability of the model to predict water movements in an estuary over long time periods at very reasonable computer costs was confirmed.

Use of the model enabled a good understanding of the major hydrodynamic features of the estuary to be achieved. The model was also used for simulations of several river floods to determine maximum flood levels for a 1:100-year flood.

This report describes all work done at NRIO on the application of the model to the Swartkops river and estuary system. The work was done in the first half of 1984 and provided a very useful basis for gaining confidence and experience with the fully developed NRIO 1-D hydrodynamic model. A further application of the model to the Knysna Lagoon is also being done at NRIO and this includes water quality computations. The complete 1-D model (hydrodynamics and water quality) is documented in CSIR (1984).

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1. INTRODUCTION

The Swartkops River Valley and estuary is under pressure by development: upstream by the planned expansion of the Uitenhage-Despatch area and closer to the mouth by the encroachment of the growing Port Elizabeth area. The hydraulic response of the river and estuarine system to any changes brought about by proposed developments are of specific interest to the Local Authorities and planning committees. Of particular interest to the authorities is the prediction of flood levels within the system.

The Swartkops river and estuary were first modelled in 1973 by consulting engineers Hill, Kaplan and Scott (HKS) who developed a one-dimensional estuary model mainly to investigate the impact of a 1-in-100-year flood on the estuary (Hill, Kaplan and Scott, 1973). Several tests were done with this model to investigate methods of reducing flood levels in the estuary.

Since 1974, a one-dimensional explicit mathematical model has been developed at NRIO and this has been applied widely to the study of estuaries in South Africa. Growing cooperation between NRIO and the University of Port Elizabeth (UPE) resulted recently in the installation of a version of the NRIO model on the UPE computer. Although this was used for several investigations, some aspects of the calibration of the model had never really been satisfactorily investigated, in particular, the influences of wind and variations in river flow had been neglected or only roughly estimated. A joint field operation by NRIO and UPE in March 1984 provided comprehensive calibration data including river flow, wind data and water-level recordings. Topographical data used in the model are based largely on the data collected and processed by HKS.

This report describes the model simulations with the calibration data and presents a discussion of the results. Also described in the report are runs of the model to determine the maximum flood levels for a 1:100-year flood in the estuary.

2. HYDRODYNAMIC ASPECTS OF THE SWARTKOPS ESTUARY

2.1 Tidal Variation and Mouth Configuration

The tidal variation at the mouth is largely responsible for the water movements inside the estuary.

After a major flood the mouth is wide open, but even after long dry periods the exchange of water here is considerable and the closure of the mouth is not known to have occurred. However, at the mouth the situation is a dynamic one. The configuration is changing continuously, which affects the tidal movements inside the estuary. Because of wave action from the open sea it is almost impossible to obtain accurate information on the topography of the mouth area. From model runs it has become clear that during major floods the mouth can become a constraint on the flow of the floodwater to the sea.

2.2 River Flow

The river flow at the upstream end of the estuary varies very widely from no flow at dry periods to large river floods. Unfortunately, there is no flow gauge near the upstream end to monitor this river flow. This means that quantities of river flow for input to the model upstream boundary can be estimated only roughly and consequently conclusions drawn from model simulations based on estimated riverflow must be regarded with caution.

2.3 The Topography of the Estuary

2.3.1 The mouth area

As mentioned before this is a dynamic estuary mouth. During periods of low river flow the mouth will decrease in width, but never close, and during major river floods scouring will be considerable and the mouth will widen again.

2.3.2 The N2-road bridge

This bridge is situated in the mouth area where normally a channel of considerable depth is naturally maintained. The span width is about 200 m and even during major river floods this bridge will hardly be any constraint on the river flow.

2.3.3 Between N2-road bridge and the railway bridge

Here the estuary consists of a main channel with extensive flood plains which also, under normal tidal conditions, are largely flooded at high water.

2.3.4 The railway bridge and the old road bridge

This is the narrowest part of the lower estuary because of the small span width of these bridges (about 140 m for railway bridge and about 90 m for the road bridge). During normal tidal conditions this has little effect on the flow in the estuary, but during heavy river floods these bridges become a major constraint on the flow. According to unconfirmed information water-level differences of up to one metre were observed between both sides of these bridges during the 1983 river flood.

2.3.5 Between the railway bridge and Brickfields

Here the main channel widens considerably and also becomes very shallow, and during river floods a large area is inundated.

2.3.6 From Brickfields via Redhouse to Perseverance

Under normal tidal conditions the river flow is mainly in one channel of 60 to 200 m wide. But under heavy flood conditions large areas on both sides of the river become inundated. On these flood plains, between Brickfields and Redhouse are salt-pans which also will become flooded under these conditions.

3. CALIBRATION OF THE MATHEMATICAL MODEL

3.1 General

The model was calibrated satisfactorily using the field data collected during March 1984 and the topographical data collected by HKS in 1973.

3.2 The Mathematical Model

The schematization of the model is given in Figure 1. The computation system is based on an explicit finite difference method used to solve the one-dimensional long wave equations (CSIR, 1984). With this system it is very easy to provide for branched channel systems and also to take into account changes in flooded areas caused by rises in water levels. The model also includes transport dispersion routines which can, for instance, be used to compute the changes with time of salinities in the estuary. However, in this report only the results of the hydrodynamical simulations will be described. In the Swartkops version of the model the section lengths were all 250 m.

To operate the model it is necessary to provide information on the external driving forces of the estuary. These are:

- (a) The variation in the water level at the open sea.
- (b) The river flow at the upstream end.
- (c) The velocity and variation in direction of the wind during the simulation period.

The model is calibrated by comparing measured variations in water level inside the estuary with water levels computed with the model at the same positions. Differences between these data can then be reduced by corrections to the topography of the model, but this is **more often** done by adjustment of the bottom shear stress.

3.3 Field Data for Model Simulation and Calibration

A list of all the field data collected between 29/02/1984 and 08/03/1984 is given in Table 1.

Column 1: date
 Column 2: time (hours)
 Column 3: water level recording at P.E. harbour
 Column 4: water level recording at Amsterdamhoek
 Column 5: water level recording at Swartkops
 Column 6: water level recording at Redhouse
 Column 7: water level recording at Perseverance
 Column 8: wind direction at Fish Water Flats
 Column 9: wind velocity at Fish Water Flats
 Column 10: barometer pressures at H.F. Verwoerd airfield.

The water level variation at P.E. harbour was obtained from the S.A.T.S. recorder. The water levels from Amsterdamhoek, Swartkops, Redhouse and Perseverance were obtained from Ott-recorders, which were especially installed for this field exercise. The wind information was obtained with a Lamprecht wind recorder which was installed on the administration building of the Fish Water Flats sewerage works.

In addition to these recordings, minor surveys were done near the N2-road bridge and at the railway and road bridges at Swartkops (Figures 2 and 3).

During this period flow measurements were made at the causeway upstream from Perseverance. This flow was very low and the results were:

2 March at 12h45	0,05 m ³ /s
4 March at 10h10	0,01 m ³ /s
5 March at 12h00	0,08 m ³ /s
6 March at 11h15	0,04 m ³ /s
7 March at 17h30	0,10 m ³ /s.

This very low flow probably mostly consisted of sewage outflow further upstream.

On 5 and 6 March at both high and low water, salinities and temperatures were measured at several positions in the estuary. The results are given on Figures 4 and 5. The high temperature reading shown on Figure 4 close to Section 20 is caused by the outflow of warm water from a power plant at that location.

The water level, flow and wind data collected from 5 to 7 March were used in the calibration of the model. These data were comprehensive and of good quality.

3.4 Simulations for Model Calibration

3.4.1 General

The data collected from 5 to 7 March 1984 were used in all the simulations. The first day's data was used to allow the model to stabilize and for the next two days the data obtained with the model were compared with the field measurements.

3.4.2 Water level variations from field measurements

Graphs of the water level recordings are shown in Figure 6. Graph 1 is that from the Port Elizabeth tide recordings. The water-level time series from these was used in simulating the open-boundary condition in the model. The other recordings are numbered as indicated on the figure. Comparison of the different graphs shows a time lag of about one hour for most of the estuary at high water and of up to three hours at low water. It is also noticeable that the water levels at high water at Perseverance are higher than those at the other positions including that of the Port Elizabeth harbour tide. In general, the time lags between the different positions are smaller at incoming tide and larger at outgoing tide.

3.4.3 Simulation without wind and with Chezy = 37,5 + 18logR
(Figure 7A)

The results compare reasonably well with the prototype measurements. However, at both incoming and outgoing tides the time lag is considerably bigger in the results for the model. The computed water levels at high water are also lower than the field measurements.

3.4.4 Simulation with wind and Chezy = 37,5 + 18logR
(Figure 7B)

The results are very similar to those of the previous test.

3.4.5 Simulation with wind and Chezy = 47,5 + 18logR
(Figure 8IA)

Increasing the value of the Chezy coefficient means in effect a decrease of the bottom shear stress. The results show that for both incoming and outgoing tides the time lags were very similar to those for the field measurements. The water levels at high water agree more closely but the low water levels at low water have become too low.

3.4.6 Simulation with wind and Chezy = 47,5 + 18logR at incoming tide and Chezy = 37,5 + 18logR at outgoing tide
(Figure 8IB and 8II).

It is possible that due to bedforms, differences occur between bottom shear stresses at incoming and at outgoing tide. Therefore this simulation was done with at incoming tide

Chezy = 47,5 + 10logR and at outgoing tide

Chezy = 37,5 + 18logR.

The results (Figure 8^{II}) compare very well with those of the field measurements (Figures 6). Direct comparisons per station are made on Figure 8^{II} between model results and prototype measurements. There are still differences, but inaccuracies in the model topography compared with that of the prototype are the main cause of these differences. Further correction of the Chezy coefficients would be too artificial, and for normal purposes the model can be regarded as calibrated.

3.5 Discussion

As mentioned under 3.4.6 the model can be regarded as calibrated for normal applications, but there is certainly room for further improvements:

- (a) The topography at the mouth is subject to considerable changes which can be sudden during major river floods and very slow during periods of low-flow conditions. Occasional detailed surveys in this area therefore would provide information with which the model could be updated.
- (b) Constant monitoring of river inflow at the upstream end of the estuary would provide data which would make the model much more effective, especially if simulations with water-quality variables (salinity, DO and BOD) are carried out in the future.
- (c) The model can be refined in many ways, such as by the incorporation of side branches or allowing for the inflow of the Chatty river.
- (d) The program used for the model simulations is available for general applications. Models for other estuaries require only new sets of field data to be operated with the same program.

4. COMPUTATION OF FLOOD LEVELS FOR VARIOUS RIVER FLOOD CONDITIONS

4.1 General

An important aspect of the Swartkops estuary (and of every estuary in general) is the occurrence and impact of major river floods. In particular, the maximum levels to which the water will rise in different parts of the estuary during these flood conditions are important. For high-investment industrial or urban developments the vulnerability to, and occurrence of, river floods are major aspects in planning and design.

Hill, Kaplan and Scott (1973) conducted some model tests in which such river floods were simulated. In their report is a photo map on which is shown the inundated areas which resulted from the flood which occurred on 25 September 1972.

Investigations by Rhodes University in Grahamstown based on hydrographic methods have led to the determination of new river flow data for several flood occurrences. The model described here was adapted to simulate these flood conditions. However, certain assumptions had to be made and the model, having been calibrated for normal tidal conditions, cannot be regarded as being calibrated for these flood conditions. Therefore, use of the computed flood level data must be made with certain reservations. On the other hand, several improvements can be made in the reliability of the model but to implement these would fall beyond the scope of the present preliminary study (Refer Section 4.6)

4.2 The Hydrodynamic Behaviour of the Estuary Under Flood Conditions

As the river flow increases the water levels will rise at first only in the main channels, but later on the flood plains will become inundated. When these flood plains become inundated,

they will first act only as storage areas, but as the water depths on these flood plains increase, the flow over these areas will increase. At very high flood levels the major part of the flow will be over these flood plains. Where dykes or banks have been built on these flood plains to protect or support railway lines or roads major obstructions to the river flow will occur. These in turn can cause considerable rises of water levels upstream of these constructions. With the Swartkops estuary, this is the case, particularly at the old railway and road bridges near Swartkops town, but when any new development is made on the flood plains of the estuary this aspect of obstruction of flow should be considered.

Another major feature of an estuary is the size of the estuary mouth. A small mouth will be a major obstruction to the flow and will cause considerable rises in water levels in the estuary. If the mouth is wide the flow will pass through easily and the rises in water levels inside the estuary will be considerably less. A major flood will cause even greater complications, because scouring will cause a considerable increase in the size of the estuary mouth during the flood itself.

4.3 Model Adjustment for Flood Simulations

The topography used in the model is based mainly on the data obtained from the report by Hill, Kaplan and Scott (1973). In the HKS model a section length of 1 000 metres was used, compared with 250 metres in the present NRIO model. For most of the data linear interpolations were made in the preparation of the new model topography.

The new model also provides for some side branches near the mouth (see Figure 1). The topography in these branches (surface areas, cross-sectional areas and hydraulic radii) was only roughly estimated, which should have some effect on the hydrodynamics of the model. If sufficient data were to be collected in these areas the model could be adjusted accordingly.

An important adjustment in the new model are the considerable increases in the cross-sectional areas for the higher water levels. This was done because, as mentioned before, at high water levels a considerable part of the flow will go over the flood plains. In the original model these flood plains were considered to be only storage areas, and the flow was restricted to the main channels. As a result, computed water levels became unrealistically high and bottlenecks such as at the railway and road bridges at Swartkops (town) were not showing up in the results. No detailed topography maps were available when the present adjustments were made and therefore only rough estimates could be made of these cross-sectional areas. To improve the model in this respect, more accurate data on the topography are required and, if necessary, a major survey of the flood plains should be done.

Because of a total lack of flow information for flood conditions it is not possible to calibrate the model accurately for these floods.

The variation in the open-sea water level used for the open-boundary condition during flood simulations was also the variation of the recorded water level at Port Elizabeth harbour for the period 5-7 March 1984; this was also used for the model calibration for normal tidal conditions described before.

4.4 River Flood Conditions

By using various flood routing methods a number of flood conditions were computed at Rhodes University. Figure 9 shows five different 1:100-year flood conditions which were used for model tests. Besides these 1:100-year floods also a 1:50-year flood and a 1:20-year flood were simulated. A brief description of these different river floods is given here:

Flood 1: 1:100-year flood (Figure 9)

Determined with unitgraph using excess rainfall of 117,8 mm (10 hour duration). Maximum flow 2 600 m³/s.

Flood 2: 1:100-year flood (Figure 9)

Determined as run hydrograph with a maximum flow of 1 960 m³/s after 10 hours.

Flood 3: 1:100-year flood (Figure 9)

Determined as run hydrograph with a maximum flow of 2 350 m³/s after 8 hours.

Flood 4: 1:100-year flood (Figure 9)

Determined as run hydrograph with a maximum flow of 2 500 m³/s after 6 hours.

Flood 5: 1:100-year flood (Figure 9)

Determined with unitgraph using reduction factor for rainfall (26,2 mm). Maximum flow of 1 900 m³/s after 10 hours.

Flood 6: 1:50-year flood

Determined with unitgraph using reduction factor for rainfall (70,0 mm). Maximum flow of 1 545 m³/s.

Flood 7: 1:20-year flood

Determined with unitgraph using reduction factor for rainfall (50,3 mm). Maximum flow of 1 110 m³/s.

4.5 River Flood Simulations

4.5.1 Tests 1A, 1B: Flood 1, maximum 2 600 m³/s, Figure 10

Flood 1 showed the highest flow conditions and was therefore used for a number of tests. In test 1A maximum flow coincided with low water. The highest computed water level for each section is plotted on Figure 10A and graphs for the water-level variations at the open sea and at the recorder positions are shown in Figure 10B. In test 1B maximum flow coincides with high water and water-level variations with time are shown in Figure 10C.

The differences between water levels in tests 1A and 1B are minimal as can be seen by comparing Figures 10B and 10C.

In considering the results it must be remembered that no data were available for a proper calibration of the model under flood conditions.

In both tests the water levels rose quickly and maximum water levels coincided closely with the time of maximum flow. There is about two hours delay between Preseverance and Amsterdamhoek in maximum water levels.

The maximum water level reached at Redhouse during this flood is +4,10 m MSL which compares reasonably well with the highest observed water level for the 1903 flood of +3,85 m MSL. But the computed water levels at both Amsterdamhoek (+2,64 MSL) and Swartkops (+3,41 MSL) are too high compared with local information (+1,75 MSL for Swartkops). Also the constrictions at the railway and road bridges cause only a difference of water level of 0,23 m (+3,76 to +3,52 m MSL) whereas an unconfirmed difference in level of 1,00 m was observed here during the 1983 flood.

4.5.2 Test 2: Flood 2, maximum 1 960 m³/s, Figure 11

This flood had a considerably lower maximum flow than Flood 1 (see Figure 9) resulting in considerably lower flood levels. However, the computed maximum water level at Redhouse (3,90 + MSL) was still higher than that observed during the 1983 flood. The maximum levels computed for Amsterdamhoek and Swartkops were also too high and again the constriction at the railway bridge caused a drop in water level of only 0,19 m, which was too low.

4.5.3 Test 3: Flood 3, maximum 2 350 m³/s, Figure 12

As was to be expected because of the maximum flow (2 346,30 m³/s) being between those of Flood 1 and Flood 2, the computed water levels were also lower than those for Flood 1 and higher than those for Flood 2. The comments made about the previous floods apply also to this one, with water levels comparing favourably upstream and being too high near the mouth.

4.5.4 Test 4: Flood 4, maximum 2 500 m³/s, Figure 13

The maximum flow was higher than for Flood 3, but was reached in a shorter time, and after the peak the flow also decreased rapidly to zero. This resulted in lower maximum water levels than for Flood 3 and also in a more rapid drop in water levels after the maxima were reached.

4.5.5 Test 5: Flood 5, maximum 1 900 m³/s, Figure 14

The shape of the graph is the same shape as that for Flood 1 but the smaller flow rates resulted in considerably lower water levels. The computed maximum at Redhouse (+3,70 MSL) was even lower than that observed during the 1983 flood (+3,85 MSL).

4.5.6 Test 6: Flood 6, maximum 1 545 m³/s, Figure 15

The graphs in Figure 15B have the same shape as those for the previous test with, in general, lower water levels.

4.5.7 Test 7: Flood 7, maximum 1 110 m³/s, Figure 16

The shapes of the graphs in Figure 16B are also the same as those for the previous two tests, again, in general with lower water levels.

4.5.8 Test 8: Flood 1, maximum 2 600 m³/s, Figure 17

The observed unconfirmed difference of 1 m between the levels on both sides of the railway and road bridges was not achieved in the previous model tests. Therefore the cross-sectional areas at these bridges were greatly reduced; this introduced a greater obstruction to the flow. The results should be compared with those of test 1 (Figure 10A, 10B).

The obstruction caused a drop in water level at these bridges of 0,55 m compared to 0,23 m in test 1. The water levels upstream, however, were now also, in general, higher (4,35 + MSL compared with 4,18 + MSL in test 1 at Redhouse) and downstream they were, in general, about 0,05 m lower.

4.5.9 Test 9: Flood, maximum 2 600 m³/s, Figure 18 Increased opening mouth (I)

The water levels between the mouth and the railway bridge were too high in the previous tests. The main reason was most probably that in the model the opening of the mouth, expressed by the cross-sectional areas was too small above normal tidal water levels. Therefore, the cross-sectional areas for sections 1 to 4 were increased drastically above +2 m MSL. This was done with the same model version used for the previous test (test 8, Figure 17). Although some scour would also occur during floods to further increase the cross-sectional area, it is felt that this would not be a dominant factor compared to the widening of the cross-sections.

The results of test 9 were:

- (a) slight decrease in water levels upstream of railway bridge (0,02 m at Redhouse);
- (b) greater drop in water level across railway bridge (0,59 m instead of 0,55 m);

- (c) lower water level at Amsterdamhoek (2,40 m instead of 2,59 m).

The difference between the water levels at the mouth and the railway bridge is still too high.

4.5.10 Test 10: Flood 1, maximum 2 600 m³/s, Figure 19 Increased opening mouth (II)

The cross-sectional areas for the first four sections at the mouth were further increased from the level of 1,20 m + MSL upward. The results showed the same tendencies as for test 9:

- (a) slight further lowering of water levels upstream from the railway bridge (0,02 m at Redhouse);
- (b) greater drop in water level across railway bridge (0,63 m instead of 0,59 m);
- (c) lower water levels at Amsterdamhoek (1,74 m instead of 2,40 m).

However, the water levels at Swartkops (town) downstream of the railway bridge are still too high. This could be caused by the cross-sectional areas between the railway bridge and Amsterdamhoek being too small. Further manipulation of the model would, however, have become very artificial and therefore the series of flood tests was stopped.

4.6 Discussion of Flood Simulations

The results obtained with the model and discussed above must be regarded as merely preliminary. There are many ways in which these results can be improved but that would fall beyond the scope of the preliminary study presented here. However some conclusions can be drawn and some recommendations can be made:

5. CONCLUSIONS

The data collected in March 1984 were sufficient to achieve a satisfactory calibration of the hydrodynamical model for normal tidal conditions. This calibration was done with the tidal information on Port Elizabeth harbour, and any future operation of the model can be done with this data.

The simulations of the river floods must be regarded as experimental, but they give an indication of the water levels which can be expected during floods and also give an insight on the effect of physical obstructions like the railway bridge on these levels.

As discussed in the report, the model can be improved in several ways.

The model is connected to routines for the computation of transport and dispersion of pollutants and is available for such simulations.

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1	2	3	4	5	6	7	8	9	10
	0240					0.52			
	0250					0.57			
	0300					0.62	220.	20.	1014.2
	0310					0.68			
	0320					0.76			
	0330					0.81			
	0340					0.86			
	0350					0.92			
	0400					0.97	240.	12.	1014.0
	0410					1.02			
	0420					1.06			
	0430					1.09			
	0440					1.11			
	0450					1.13			
	0500					1.16	250.	15.	1014.1
	0510					1.16			
	0520					1.17			
	0530					1.18			
	0540					1.19			
	0550					1.20			
	0600					1.20	240.	16.	1014.4
	0610					1.15			
	0620					1.10			
	0630					1.05			
	0640					1.01			
	0650					0.96			
	0700					0.93	210.	16.	1015.2
	0710					0.91			
	0720					0.87			
	0730				0.91	0.84			
	0740				0.76	0.80			
	0750				0.72	0.78			
	0800				0.68	0.74	210.	22.	1015.3
	0810				0.64	0.70			
	0820				0.60	0.66			
	0830				0.57	0.62			
	0840				0.53	0.58			
	0850				0.50	0.55			
	0900				0.47	0.52	220.	16.	1015.5
	0910				0.43	0.48			
	0920				0.40	0.45			
	0930				0.36	0.42			
	0940				0.32	0.38			
	0950				0.29	0.34			
	1000				0.27	0.31	185.	26.	1015.7
	1010				0.24	0.28			
	1020				0.21	0.25			
	1030				0.17	0.22			
	1040				0.14	0.20			
	1050				0.12	0.18			
	1100				0.11	0.15	180.	25.	1015.7
	1110				0.06	0.13			
	1120				0.05	0.10			
	1130				0.04	0.08			
	1140				0.03	0.06			
	1150				0.00	0.04			
	1200				-0.02	0.01	185.	28.	1015.4
	1210				-0.03	-0.01			
	1220				-0.04	-0.02			
	1230				-0.04	-0.05			
	1240				-0.04	-0.05			
	1250				-0.04	-0.06			
	1300				-0.04	-0.06	180.	35.	1015.1

1	2	3	4	5	6	7	8	9	10
	1310				-0.02	-0.05			
	1320				-0.01	-0.03			
	1330				0.02	0.00			
	1340				0.04	0.04			
	1350				0.07	0.07			
	1400				0.10	0.10	180.	34.	1014.9
	1410				0.14	0.12			
	1420				0.17	0.15			
	1430				0.21	0.19			
	1440				0.26	0.24			
	1450				0.31	0.28			
	1500				0.36	0.34	180.	36.	1014.7
	1510				0.41	0.39			
	1520				0.46	0.44			
	1530				0.51	0.50			
	1540				0.57	0.54			
	1550				0.62	0.58			
	1600				0.68	0.64	180.	40.	1014.7
	1610				0.72	0.70			
	1620				0.76	0.75			
	1630				0.81	0.79			
	1640				0.85	0.83			
	1650				0.89	0.86			
	1700				0.92	0.89	180.	35.	1015.0
	1710				0.96	0.94			
	1720				0.98	0.98			
	1730				0.99	1.00			
	1740				1.00	1.04			
	1750				1.00	1.05			
	1800				0.98	1.05	180.	30.	1015.4
	1810				0.97	1.05			
	1820				0.94	1.02			
	1830				0.92	0.99			
	1840				0.86	0.96			
	1850				0.84	0.93			
	1900				0.82	0.90	190.	19.	1015.6
	1910				0.78	0.86			
	1920				0.74	0.82			
	1930				0.72	0.78			
	1940				0.69	0.74			
	1950				0.65	0.71			
	2000				0.62	0.68	210.	12.	1016.4
	2010				0.58	0.65			
	2020				0.56	0.62			
	2030				0.52	0.58			
	2040				0.48	0.54			
	2050				0.45	0.50			
	2100				0.42	0.46	240.	10.	1017.0
	2110				0.39	0.43			
	2120				0.36	0.41			
	2130				0.33	0.38			
	2140				0.30	0.35			
	2150				0.28	0.33			
	2200				0.24	0.30	280.	8.	1017.4
	2210				0.22	0.27			
	2220				0.20	0.24			
	2230				0.17	0.21			
	2240				0.14	0.18			
	2250				0.12	0.16			
	2300				0.10	0.14	270.	12.	1017.4
	2310				0.08	0.10			
	2320				0.06	0.09			
	2330				0.04	0.07			

1	2	3	4	5	6	7	8	9	10
	2340				0.02	0.05			
	2350				0.00	0.04			
004	0000	-0.36			-0.01	0.02	270.	11.	1017.2
	0010	-0.20			-0.03	-0.01			
	0020	-0.23			-0.04	-0.03			
	0030	-0.18			-0.04	-0.04			
	0040	-0.12			-0.04	-0.06			
	0050	-0.06			-0.04	-0.07			
	0100	0.02			-0.04	-0.08	275.	10.	1017.4
	0110	0.10			-0.04	-0.09			
	0120	0.16			-0.04	-0.10			
	0130	0.21			-0.04	-0.11			
	0140	0.26			-0.04	-0.07			
	0150	0.34			-0.03	-0.04			
	0200	0.40			0.00	-0.02	280.	7.	1017.1
	0210	0.46			0.02	0.01			
	0220	0.52			0.06	0.03			
	0230	0.60			0.09	0.06			
	0240	0.65			0.14	0.09			
	0250	0.70			0.18	0.13			
	0300	0.75			0.23	0.17	290.	7.	1016.8
	0310	0.80			0.28	0.20			
	0320	0.86			0.33	0.26			
	0330	0.89			0.39	0.31			
	0340	0.93			0.44	0.36			
	0350	0.94			0.51	0.42			
	0400	0.96			0.56	0.49	280.	6.	1016.5
	0410	0.98			0.63	0.55			
	0420	1.00			0.68	0.62			
	0430	1.02			0.74	0.69			
	0440	1.05			0.80	0.75			
	0450	1.07			0.85	0.80			
	0500	1.06			0.89	0.86	270.	6.	1016.4
	0510	1.05			0.94	0.90			
	0520	1.03			0.99	0.94			
	0530	1.02			1.02	0.99			
	0540	0.97			1.04	1.04			
	0550	0.91			1.07	1.07			
	0600	0.87			1.09	1.10	260.	4.	1016.6
	0610	0.80			1.10	1.13			
	0620	0.75			1.10	1.14			
	0630	0.71			1.07	1.14			
	0640	0.66			1.04	1.14			
	0650	0.60			1.01	1.10			
	0700	0.54			0.97	1.04	270.	4.	1016.7
	0710	0.47			0.93	0.98			
	0720	0.41			0.90	0.94			
	0730	0.36			0.85	0.90			
	0740	0.30			0.78	0.86			
	0750	0.21			0.76	0.84			
	0800	0.15			0.71	0.81	320.	4.	1016.9
	0810	0.06			0.69	0.78			
	0820	-0.02	0.41		0.66	0.75			
	0830	-0.06	0.34		0.62	0.72			
	0840	-0.14	0.29		0.58	0.68			
	0850	-0.18	0.24		0.54	0.64			
	0900	-0.23	0.20		0.51	0.61	070.	10.	1016.6
	0910	-0.27	0.16		0.48	0.58			
	0920	-0.30	0.12		0.44	0.53			
	0930	-0.35	0.09		0.41	0.50			
	0940	-0.39	0.06		0.36	0.46			
	0950	-0.42	0.03		0.33	0.42			
	1000	-0.45	-0.01		0.30	0.40	090.	15.	1016.7

2	3	4	5	6	7	8	9	10
1010	-0.48	-0.04		0.26	0.36			
1020	-0.51	-0.07		0.23	0.34			
1030	-0.54	-0.11		0.20	0.31			
1040	-0.55	-0.13		0.17	0.28			
1050	-0.56	-0.14		0.15	0.26			
1100	-0.56	-0.18		0.12	0.23	100.	20.	1016.5
1110	-0.56	-0.19		0.10	0.21			
1120	-0.54	-0.20		0.06	0.18			
1130	-0.51	-0.20		0.05	0.16			
1140	-0.47	-0.19		0.02	0.13			
1150	-0.41	-0.18		0.00	0.11			
1200	-0.38	-0.17		-0.03	0.08	100.	22.	1016.2
1210	-0.35	-0.15		-0.04	0.06			
1220	-0.30	-0.13		-0.06	0.04			
1230	-0.25	-0.10		-0.08	0.02			
1240	-0.21	-0.06		-0.08	0.00			
1250	-0.15	-0.03		-0.09	-0.01			
1300	-0.11	0.02		-0.10	-0.03	100.	23.	1016.0
1310	-0.04	0.06		-0.10	-0.04			
1320	0.02	0.10		-0.10	-0.05			
1330	0.08	0.15		-0.09	-0.06			
1340	0.14	0.20		-0.08	-0.05			
1350	0.21	0.24		-0.07	-0.02			
1400	0.27	0.28		-0.05	0.02	110.	22.	1015.8
1410	0.33	0.32		-0.03	0.04			
1420	0.38	0.37		0.00	0.06			
1430	0.44	0.41		0.04	0.08			
1440	0.49	0.46		0.07	0.11			
1450	0.54	0.49		0.10	0.14			
1500	0.59	0.54		0.15	0.19	110.	24.	1015.5
1510	0.63	0.57		0.19	0.23			
1520	0.68	0.60		0.24	0.28			
1530	0.72	0.65		0.28	0.32			
1540	0.75	0.69		0.41	0.38			
1550	0.79	0.73		0.46	0.42			
1600	0.81	0.76		0.52	0.47	110.	27.	1015.5
1610	0.85	0.80		0.56	0.52			
1620	0.87	0.82		0.61	0.56			
1630	0.88	0.85		0.66	0.61			
1640	0.88	0.87		0.72	0.68			
1650	0.89	0.89		0.76	0.74			
1700	0.89	0.90		0.80	0.78	120.	17.	1015.6
1710	0.88	0.92		0.85	0.84			
1720	0.86	0.93		0.89	0.88			
1730	0.84	0.93		0.92	0.91			
1740	0.82	0.93		0.95	0.95			
1750	0.78	0.92		0.97	0.98			
1800	0.76	0.90		0.98	1.00	140.	14.	1016.0
1810	0.70	0.88		0.98	1.01			
1820	0.64	0.85		0.99	1.02			
1830	0.60	0.83		0.98	1.02			
1840	0.57	0.80		0.94	1.02			
1850	0.51	0.78		0.92	0.98			
1900	0.45	0.74		0.88	0.92	150.	14.	1016.4
1910	0.40	0.70		0.85	0.88			
1920	0.32	0.65		0.82	0.84			
1930	0.26	0.60		0.79	0.80			
1940	0.18	0.55		0.76	0.77			
1950	0.09	0.49		0.72	0.75			
2000	0.03	0.44		0.69	0.72	140.	15.	1017.0
2010	-0.03	0.38		0.66	0.69			
2020	-0.11	0.34		0.62	0.64			
2030	-0.16	0.29		0.59	0.60			

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1	2	3	4	5	6	7	8	9	10
	2040	-0.21	0.25		0.56	0.57			
	2050	-0.26	0.21		0.52	0.54			
	2100	-0.31	0.17		0.49	0.50	130.	11.	1017.5
	2110	-0.35	0.13		0.46	0.47			
	2120	-0.39	0.09		0.43	0.44			
	2130	-0.45	0.06		0.40	0.42			
	2140	-0.48	0.02		0.37	0.38			
	2150	-0.54	-0.02		0.34	0.36			
	2200	-0.59	-0.04		0.32	0.33	130.	10.	1017.6
	2210	-0.62	-0.04		0.29	0.31			
	2220	-0.64	-0.04		0.26	0.28			
	2230	-0.66	-0.04		0.23	0.25			
	2240	-0.66	-0.04		0.20	0.22			
	2250	-0.65	-0.04		0.18	0.19			
	2300	-0.64	-0.04		0.15	0.18	110.	9.	1017.6
	2310	-0.64	-0.04		0.13	0.15			
	2320	-0.62	-0.04		0.11	0.13			
	2330	-0.60	-0.04		0.09	0.10			
	2340	-0.59	-0.04		0.07	0.08			
	2350	-0.56	-0.04		0.05	0.05			
	0000	-0.51	-0.04		0.03	0.03	110.	9.	1017.2
	0010	-0.48	-0.04		0.02	0.01			
	0020	-0.44	-0.04		-0.01	-0.01			
	0030	-0.38	-0.04		-0.02	-0.03			
	0040	-0.34	-0.04		-0.02	-0.05			
	0050	-0.30	-0.04		-0.02	-0.06			
	0100	-0.22	-0.04		-0.02	-0.07	130.	7.	1016.8
	0110	-0.18	-0.04		-0.02	-0.09			
	0120	-0.11	-0.04		-0.02	-0.10			
	0130	-0.04	-0.01		-0.02	-0.12			
	0140	0.04	0.04		-0.02	-0.13			
	0150	0.08	0.09		-0.02	-0.13			
	0200	0.14	0.14		-0.02	-0.13	230.	3.	1016.6
	0210	0.19	0.18		-0.02	-0.11			
	0220	0.24	0.21		-0.02	-0.07			
	0230	0.32	0.26		-0.02	-0.05			
	0240	0.40	0.31		0.01	-0.03			
	0250	0.46	0.36		0.04	0.00			
	0300	0.52	0.40		0.07	0.02	300.	4.	1016.3
	0310	0.57	0.46		0.11	0.05			
	0320	0.62	0.50		0.15	0.09			
	0330	0.69	0.54		0.19	0.13			
	0340	0.75	0.58		0.24	0.18			
	0350	0.80	0.63		0.30	0.22			
	0400	0.83	0.68		0.36	0.28	260.	3.	1015.8
	0410	0.88	0.73		0.40	0.34			
	0420	0.91	0.76		0.46	0.39			
	0430	0.94	0.79		0.53	0.46			
	0440	0.96	0.82		0.58	0.52			
	0450	0.98	0.84		0.64	0.58			
	0500	1.00	0.87		0.70	0.65	260.	4.	1015.9
	0510	1.00	0.90		0.74	0.71			
	0520	1.02	0.93		0.80	0.77			
	0530	1.00	0.95		0.85	0.83			
	0540	0.98	0.97		0.89	0.87			
	0550	0.95	0.97		0.93	0.91			
	0600	0.90	0.97		0.98	0.96	260.	3.	1015.9
	0610	0.87	0.97		1.00	1.00			
	0620	0.84	0.96		1.02	1.02			
	0630	0.80	0.94		1.03	1.06			
	0640	0.77	0.91		1.04	1.07			
	0650	0.73	0.88		1.04	1.07			
	0700	0.65	0.86		1.02	1.06	330.	3.	1015.4

1	2	3	4	5	6	7	8	9	10
	0710	0.63	0.84	0.88	0.99	1.02			
	0720	0.57	0.79	0.87	0.97	0.98			
	0730	0.50	0.76	0.84	0.94	0.93			
	0740	0.45	0.68	0.81	0.90	0.89			
	0750	0.36	0.64	0.77	0.86	0.86			
	0800	0.29	0.59	0.73	0.82	0.83	060.	5.	1015.5
	0810	0.22	0.53	0.68	0.79	0.80			
	0820	0.16	0.46	0.64	0.76	0.78			
	0830	0.10	0.42	0.59	0.74	0.75			
	0840	0.04	0.37	0.55	0.70	0.71			
	0850	-0.04	0.32	0.51	0.67	0.68			
	0900	-0.12	0.26	0.46	0.63	0.65	070.	7.	1015.5
	0910	-0.17	0.22	0.41	0.60	0.60			
	0920	-0.21	0.18	0.37	0.56	0.58			
	0930	-0.26	0.15	0.34	0.53	0.54			
	0940	-0.31	0.11	0.28	0.49	0.51			
	0950	-0.37	0.08	0.25	0.46	0.47			
	1000	-0.41	0.04	0.21	0.44	0.44	100.	11.	1015.1
	1010	-0.45	0.02	0.17	0.39	0.40			
	1020	-0.48	-0.01	0.14	0.36	0.38			
	1030	-0.50	-0.04	0.10	0.32	0.35			
	1040	-0.52	-0.08	0.06	0.29	0.32			
	1050	-0.54	-0.10	0.04	0.26	0.30			
	1100	-0.55	-0.13	-0.01	0.24	0.27	120.	13.	1014.4
	1110	-0.54	-0.15	-0.04	0.22	0.25			
	1120	-0.54	-0.17	-0.08	0.19	0.23			
	1130	-0.53	-0.19	-0.11	0.17	0.20			
	1140	-0.51	-0.21	-0.14	0.15	0.19			
	1150	-0.49	-0.23	-0.17	0.12	0.16			
	1200	-0.46	-0.25	-0.19	0.10	0.13	120.	18.	1013.6
	1210	-0.43	-0.26	-0.20	0.08	0.11			
	1220	-0.40	-0.26	-0.22	0.06	0.09			
	1230	-0.36	-0.24	-0.22	0.03	0.06			
	1240	-0.31	-0.23	-0.22	0.02	0.04			
	1250	-0.28	-0.21	-0.21	0.00	0.02			
	1300	-0.23	-0.18	-0.18	-0.01	0.00	110.	20.	1012.8
	1310	-0.18	-0.14	-0.17	-0.02	-0.01			
	1320	-0.11	-0.10	-0.12	-0.03	-0.02			
	1330	-0.05	-0.06	-0.08	-0.03	-0.04			
	1340	0.00	-0.01	-0.05	-0.03	-0.05			
	1350	0.06	0.04	0.00	-0.04	-0.06			
	1400	0.13	0.08	0.04	-0.04	-0.06	090.	25.	1012.2
	1410	0.18	0.12	0.06	-0.04	-0.06			
	1420	0.23	0.16	0.13	-0.03	-0.04			
	1430	0.29	0.20	0.16	-0.01	0.00			
	1440	0.34	0.24	0.20	0.01	0.04			
	1450	0.39	0.28	0.24	0.04	0.06			
	1500	0.46	0.32	0.29	0.07	0.09	100.	24.	1011.7
	1510	0.50	0.36	0.33	0.10	0.13			
	1520	0.55	0.40	0.37	0.14	0.16			
	1530	0.61	0.45	0.40	0.18	0.20			
	1540	0.66	0.50	0.46	0.23	0.24			
	1550	0.70	0.54	0.51	0.28	0.28			
	1600	0.75	0.58	0.56	0.32	0.32	100.	24.	1011.3
	1610	0.80	0.62	0.60	0.37	0.36			
	1620	0.83	0.66	0.64	0.42	0.41			
	1630	0.85	0.70	0.66	0.46	0.45			
	1640	0.87	0.74	0.72	0.52	0.50			
	1650	0.89	0.76	0.76	0.57	0.56			
	1700	0.90	0.79	0.78	0.62	0.61	100.	23.	1011.1
	1710	0.92	0.81	0.82	0.67	0.66			
	1720	0.93	0.83	0.84	0.73	0.72			
	1730	0.92	0.86	0.86	0.78	0.78			

1	2	3	4	5	6	7	8	9	10
	1740	0.91	0.88	0.90	0.82	0.84			
	1750	0.88	0.89	0.91	0.87	0.89			
	1800	0.86	0.90	0.93	0.90	0.93	100.	20.	1010.7
	1810	0.82	0.90	0.94	0.94	0.97			
	1820	0.79	0.89	0.94	0.96	1.00			
	1830	0.76	0.88	0.94	0.98	1.02			
	1840	0.73	0.86	0.92	1.00	1.04			
	1850	0.69	0.84	0.90	1.00	1.05			
	1900	0.64	0.83	0.88	1.00	1.05	100.	21.	1010.7
	1910	0.60	0.80	0.87	0.98	1.05			
	1920	0.52	0.77	0.85	0.96	1.04			
	1930	0.47	0.73	0.82	0.93	0.99			
	1940	0.41	0.68	0.80	0.91	0.94			
	1950	0.33	0.65	0.76	0.86	0.90			
	2000	0.28	0.61	0.72	0.83	0.87	110.	20.	1010.9
	2010	0.20	0.56	0.68	0.80	0.84			
	2020	0.13	0.51	0.64	0.77	0.81			
	2030	0.06	0.44	0.60	0.74	0.78			
	2040	-0.02	0.38	0.56	0.70	0.74			
	2050	-0.07	0.33	0.50	0.67	0.70			
	2100	-0.12	0.28	0.47	0.64	0.66	120.	15.	1011.6
	2110	-0.18	0.24	0.44	0.61	0.62			
	2120	-0.22	0.20	0.40	0.57	0.60			
	2130	-0.27	0.17	0.35	0.54	0.56			
	2140	-0.31	0.12	0.32	0.51	0.52			
	2150	-0.36	0.08	0.27	0.48	0.49			
	2200	-0.40	0.04	0.23	0.45	0.46	150.	13.	1012.0
	2210	-0.45	0.01	0.19	0.42	0.43			
	2220	-0.48	-0.02	0.15	0.38	0.40			
	2230	-0.52	-0.05	0.11	0.36	0.38			
	2240	-0.56	-0.08	0.08	0.33	0.34			
	2250	-0.58	-0.11	0.04	0.30	0.32			
	2300	-0.59	-0.14	0.00	0.27	0.29	180.	9.	1012.1
	2310	-0.59	-0.16	-0.03	0.25	0.26			
	2320	-0.58	-0.18	-0.05	0.22	0.23			
	2330	-0.57	-0.21	-0.08	0.20	0.20			
	2340	-0.56	-0.22	-0.11	0.18	0.18			
	2350	-0.55	-0.24	-0.14	0.15	0.15			
0306	0000	-0.53	-0.26	-0.17	0.13	0.13	195.	17.	1012.0
	0010	-0.50	-0.27	-0.19	0.11	0.10			
	0020	-0.46	-0.28	-0.20	0.09	0.08			
	0030	-0.42	-0.29	-0.22	0.06	0.06			
	0040	-0.38	-0.29	-0.23	0.04	0.04			
	0050	-0.34	-0.28	-0.24	0.02	0.02			
	0100	-0.30	-0.26	-0.24	0.01	0.00	195.	26.	1011.9
	0110	-0.26	-0.23	-0.23	-0.01	-0.01			
	0120	-0.21	-0.20	-0.18	-0.02	-0.03			
	0130	-0.16	-0.16	-0.16	-0.02	-0.05			
	0140	-0.11	-0.11	-0.11	-0.02	-0.06			
	0150	-0.05	-0.07	-0.05	-0.02	-0.08			
	0200	0.01	-0.02	-0.02	-0.02	-0.09	200.	32.	1011.9
	0210	0.07	0.04	0.02	-0.02	-0.09			
	0220	0.15	0.09	0.06	-0.02	-0.09			
	0230	0.22	0.14	0.11	-0.02	-0.09			
	0240	0.28	0.19	0.16	-0.02	-0.05			
	0250	0.34	0.23	0.19	-0.02	-0.03			
	0300	0.40	0.28	0.24	0.00	0.00	200.	32.	1012.0
	0310	0.47	0.33	0.28	0.02	0.02			
	0320	0.54	0.38	0.32	0.06	0.04			
	0330	0.59	0.43	0.36	0.09	0.08			
	0340	0.65	0.48	0.42	0.12	0.11			
	0350	0.69	0.53	0.47	0.16	0.15			
	0400	0.74	0.57	0.51	0.21	0.20	200.	37.	1011.3

2	3	4	5	6	7	8	9	10
0410	0.78	0.61	0.56	0.26	0.25			
0420	0.83	0.65	0.60	0.31	0.30			
0430	0.86	0.69	0.64	0.37	0.36			
0440	0.90	0.73	0.68	0.43	0.42			
0450	0.92	0.76	0.72	0.48	0.48			
0500	0.95	0.79	0.76	0.54	0.54	200.	39.	1011.5
0510	0.93	0.82	0.80	0.59	0.60			
0520	0.98	0.85	0.83	0.65	0.66			
0530	0.98	0.87	0.86	0.70	0.72			
0540	0.99	0.90	0.89	0.75	0.77			
0550	0.99	0.92	0.92	0.80	0.82			
0600	0.98	0.94	0.94	0.84	0.86	200.	36.	1011.5
0610	0.98	0.95	0.95	0.89	0.92			
0620	0.95	0.95	0.96	0.92	0.96			
0630	0.92	0.95	0.97	0.96	0.99			
0640	0.89	0.94	0.98	0.97	1.02			
0650	0.85	0.94	0.98	0.99	1.04			
0700	0.80	0.92	0.98	1.00	1.06	200.	40.	1011.6
0710	0.75	0.90	0.95	1.00	1.06			
0720	0.69	0.87	0.93	1.00	1.06			
0730	0.64	0.84	0.90	0.99	1.05			
0740	0.59	0.82	0.88	0.96	1.01			
0750	0.54	0.76	0.86	0.94	0.97			
0800	0.49	0.70	0.83	0.90	0.92	200.	44.	1012.2
0810	0.42	0.66	0.80	0.86	0.88			
0820	0.35	0.61	0.77	0.83	0.86			
0830	0.28	0.56	0.72	0.80	0.83			
0840	0.22	0.54	0.68	0.76	0.80			
0850	0.14	0.45	0.64	0.74	0.78			
0900	0.09	0.40	0.59	0.71	0.74	230.	32.	1012.1
0910	0.02	0.35	0.54	0.68	0.72			
0920	-0.02	0.30	0.50	0.64	0.68			
0930	-0.05	0.26	0.45	0.60	0.64			
0940	-0.10	0.22	0.41	0.57	0.61			
0950	-0.16	0.18	0.38	0.54	0.56			
1000	-0.22	0.14	0.34	0.51	0.52	230.	27.	1012.2
1010	-0.26	0.10	0.30	0.47	0.49			
1020	-0.31	0.06	0.26	0.43	0.46			
1030	-0.35	0.02	0.22	0.40	0.43			
1040	-0.39	-0.01	0.18	0.38	0.40			
1050	-0.43	-0.03	0.14	0.34	0.38			
1100	-0.46	-0.07	0.10	0.32	0.37	210.	27.	1012.7
1110	-0.47	-0.09	0.06	0.29	0.32			
1120	-0.48	-0.13	0.04	0.26	0.29			
1130	-0.50	-0.15	0.00	0.23	0.26			
1140	-0.49	-0.17	-0.03	0.21	0.23			
1150	-0.48	-0.19	-0.07	0.19	0.20			
1200	-0.46	-0.21	-0.09	0.15	0.18	200.	25.	1012.8
1210	-0.43	-0.22	-0.11	0.13	0.16			
1220	-0.41	-0.22	-0.14	0.11	0.14			
1230	-0.39	-0.21	-0.16	0.08	0.11			
1240	-0.35	-0.20	-0.18	0.07	0.09			
1250	-0.32	-0.19	-0.18	0.04	0.07			
1300	-0.30	-0.18	-0.18	0.03	0.04	200.	35.	1013.1
1310	-0.27	-0.16	-0.17	0.00	0.02			
1320	-0.24	-0.14	-0.16	-0.01	0.00			
1330	-0.20	-0.11	-0.16	-0.03	-0.01			
1340	-0.15	-0.08	-0.13	-0.04	-0.03			
1350	-0.11	-0.04	-0.11	-0.05	-0.04			
1400	-0.03	0.00	-0.08	-0.05	-0.06	200.	43.	1012.9
1410	0.02	0.04	-0.05	-0.05	-0.07			
1420	0.09	0.08	0.00	-0.05	-0.05			
1430	0.15	0.13	0.02	-0.05	-0.09			

1	2	3	4	5	6	7	8	9	10
	1440	0.21	0.17	0.06	-0.05	-0.08			
	1450	0.26	0.21	0.10	-0.04	-0.06			
	1500	0.32	0.26	0.14	-0.03	-0.02	200.	43.	1013.0
	1510	0.38	0.30	0.18	-0.01	0.01			
	1520	0.43	0.33	0.22	0.02	0.04			
	1530	0.48	0.37	0.27	0.05	0.07			
	1540	0.54	0.40	0.30	0.08	0.10			
	1550	0.58	0.44	0.35	0.11	0.12			
	1600	0.62	0.48	0.38	0.16	0.16	230.	45.	1013.1
	1610	0.66	0.52	0.43	0.19	0.20			
	1620	0.70	0.55	0.47	0.23	0.23			
	1630	0.73	0.58	0.50	0.28	0.27			
	1640	0.76	0.62	0.54	0.32	0.31			
	1650	0.80	0.66	0.58	0.36	0.35			
	1700	0.84	0.70	0.62	0.41	0.39	190.	40.	1013.0
	1710	0.88	0.73	0.65	0.46	0.44			
	1720	0.90	0.75	0.68	0.51	0.49			
	1730	0.91	0.78	0.74	0.55	0.54			
	1740	0.89	0.80	0.76	0.60	0.58			
	1750	0.87	0.82	0.78	0.65	0.64			
	1800	0.86	0.84	0.81	0.69	0.67	180.	37.	1013.4
	1810	0.86	0.85	0.82	0.74	0.73			
	1820	0.86	0.86	0.83	0.78	0.78			
	1830	0.84	0.86	0.83	0.80	0.84			
	1840	0.81	0.86	0.86	0.82	0.87			
	1850	0.77	0.84	0.86	0.84	0.90			
	1900	0.73	0.81	0.87	0.87	0.91	160.	15.	1014.3
	1910	0.69	0.79	0.87	0.89	0.92			
	1920	0.64	0.76	0.85	0.89	0.92			
	1930	0.60	0.74	0.83	0.90	0.94			
	1940	0.56	0.72	0.80	0.88	0.96			
	1950	0.52	0.70	0.78	0.87	0.96			
	2000	0.48	0.67	0.76	0.85	0.95	170.	12.	1015.2
	2010	0.40	0.64	0.75	0.82	0.89			
	2020	0.32	0.59	0.72	0.79	0.84			
	2030	0.29	0.55	0.69	0.74	0.80			
	2040	0.22	0.50	0.66	0.72	0.77			
	2050	0.15	0.45	0.60	0.69	0.73			
	2100	0.09	0.40	0.56	0.66	0.70	170.	8.	1016.5
	2110	0.02	0.35	0.52	0.62	0.67			
	2120	-0.04	0.30	0.48	0.60	0.64			
	2130	-0.09	0.25	0.44	0.57	0.60			
	2140	-0.17	0.21	0.40	0.54	0.57			
	2150	-0.20	0.17	0.37	0.50	0.54			
	2200	-0.23	0.14	0.32	0.48	0.51	180.	10.	1017.2
	2210	-0.25	0.10	0.27	0.44	0.48			
	2220	-0.30	0.07	0.24	0.41	0.45			
	2230	-0.33	0.04	0.20	0.38	0.42			
	2240	-0.38	0.00	0.16	0.37	0.39			
	2250	-0.43	-0.03	0.12	0.33	0.36			
	2300	-0.47	-0.07	0.09	0.30	0.33	200.	10.	1017.9
	2310	-0.49	-0.10	0.06	0.28	0.30			
	2320	-0.50	-0.12	0.02	0.25	0.27			
	2330	-0.50	-0.14	-0.01	0.22	0.25			
	2340	-0.50	-0.16	-0.05	0.20	0.22			
	2350	-0.50	-0.19	-0.08	0.18	0.20			
40307	0000	-0.50	-0.20	-0.11	0.15	0.17	210.	18.	1018.4
	0010	-0.49	-0.22	-0.13	0.13	0.14			
	0020	-0.47	-0.24	-0.15	0.11	0.12			
	0030	-0.45	-0.24	-0.18	0.09	0.10			
	0040	-0.43	-0.24	-0.19	0.07	0.08			
	0050	-0.40	-0.23	-0.20	0.05	0.06			
	0100	-0.37	-0.22	-0.20	0.03	0.04	200.	17.	1018.8

2	3	4	5	6	7	8	9	10
0110	-0.34	-0.22	-0.20	0.01	0.03			
0120	-0.30	-0.21	-0.20	-0.01	0.01			
0130	-0.28	-0.18	-0.20	-0.02	-0.01			
0140	-0.21	-0.14	-0.19	-0.03	-0.03			
0150	-0.15	-0.10	-0.15	-0.04	-0.05			
0200	-0.11	-0.06	-0.10	-0.04	-0.06	210.	15.	1018.7
0210	-0.05	-0.02	-0.06	-0.04	-0.07			
0220	0.02	0.02	-0.02	-0.04	-0.08			
0230	0.06	0.07	0.01	-0.04	-0.08			
0240	0.14	0.12	0.06	-0.04	-0.08			
0250	0.21	0.17	0.09	-0.04	-0.07			
0300	0.26	0.22	0.14	-0.04	-0.04	210.	13.	1018.7
0310	0.34	0.27	0.18	-0.04	-0.02			
0320	0.39	0.30	0.22	-0.01	0.00			
0330	0.43	0.34	0.25	0.01	0.03			
0340	0.49	0.38	0.29	0.03	0.05			
0350	0.54	0.43	0.33	0.07	0.08			
0400	0.60	0.48	0.37	0.11	0.12	210.	13.	1018.6
0410	0.65	0.51	0.42	0.15	0.16			
0420	0.69	0.56	0.46	0.19	0.20			
0430	0.72	0.58	0.50	0.24	0.26			
0440	0.76	0.62	0.54	0.29	0.30			
0450	0.80	0.67	0.58	0.34	0.35			
0500	0.84	0.71	0.61	0.39	0.40	230.	14.	1018.7
0510	0.88	0.74	0.66	0.43	0.46			
0520	0.91	0.77	0.70	0.48	0.51			
0530	0.93	0.80	0.74	0.54	0.56			
0540	0.94	0.82	0.76	0.59	0.62			
0550	0.94	0.84	0.79	0.63	0.66			
0600	0.95	0.86	0.82	0.69	0.72	210.	15.	1019.6
0610	0.95	0.87	0.84	0.73	0.78			
0620	0.95	0.90	0.86	0.77	0.82			
0630	0.94	0.92	0.88	0.81	0.87			
0640	0.92	0.92	0.90	0.85	0.90			
0650	0.90	0.93	0.92	0.89	0.94			
0700	0.89	0.93	0.93	0.91	0.96	220.	17.	1020.3
0710	0.86	0.92	0.94	0.94	0.99			
0720	0.82	0.90	0.95	0.96	1.01			
0730	0.76	0.88	0.95	0.97	1.02			
0740	0.72	0.86	0.92	0.97	1.03			
0750	0.67	0.84	0.90	0.97	1.03			
0800	0.62	0.80	0.88	0.96	1.03	230.	12.	1020.8
0810	0.56	0.76	0.86	0.94	0.99			
0820	0.50	0.73	0.84	0.92	0.94			
0830	0.44	0.70	0.81	0.89	0.89			
0840	0.40	0.66	0.78	0.86	0.85			
0850	0.34	0.62	0.75	0.83	0.82			
0900	0.29	0.58	0.71	0.79	0.80	200.	19.	1021.6
0910	0.23	0.53	0.67	0.76	0.78			
0920	0.16	0.49	0.64	0.72	0.74			
0930	0.08	0.38	0.60	0.69	0.71			
0940	0.04	0.32	0.56	0.66	0.67			
0950	-0.04	0.28	0.50	0.62	0.64			
1000	-0.09	0.24	0.46	0.60	0.60	195.	18.	1022.0
1010	-0.13	0.20	0.44	0.56	0.57			
1020	-0.18	0.16	0.40	0.53	0.54			
1030	-0.22	0.12	0.36	0.50	0.50			
1040	-0.26	0.09	0.32	0.48	0.47			
1050	-0.30	0.04	0.28	0.44	0.44			
1100	-0.32	0.02	0.24	0.42	0.44	180.	20.	1022.0
1110	-0.35	-0.01	0.20	0.39	0.41			
1120	-0.37	-0.05	0.17	0.36	0.38			
1130	-0.39	-0.07	0.14	0.32	0.34			

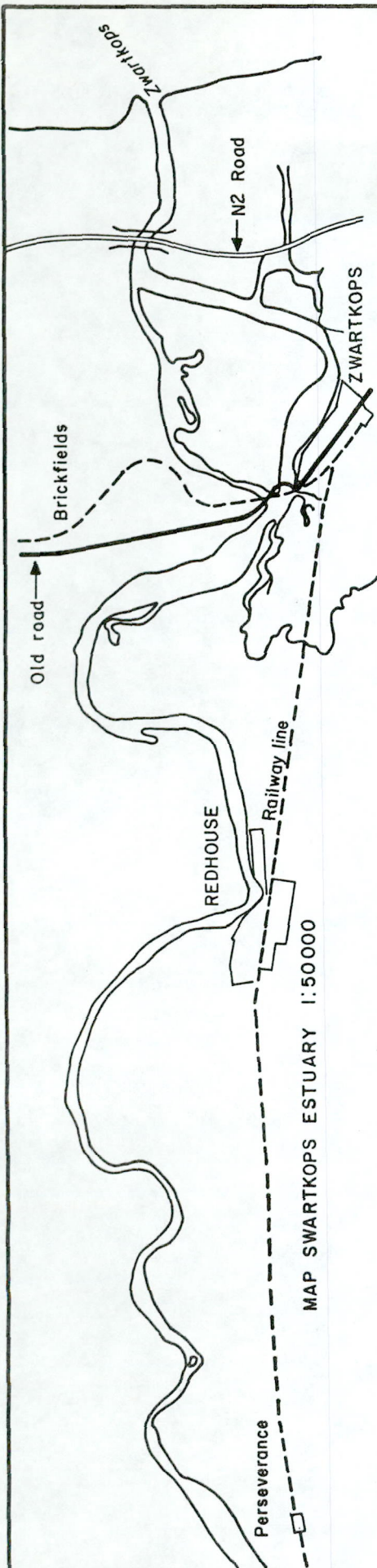
2	3	4	5	6	7	8	9	10
1140	-0.42	-0.11	0.10	0.30	0.32			
1150	-0.43	-0.14	0.06	0.27	0.29			
1200	-0.43	-0.15	0.03	0.24	0.25	180.	26.	1021.8
1210	-0.43	-0.17	-0.01	0.21	0.23			
1220	-0.42	-0.18	-0.04	0.18	0.20			
1230	-0.42	-0.20	-0.06	0.17	0.18			
1240	-0.40	-0.22	-0.08	0.15	0.16			
1250	-0.39	-0.23	-0.10	0.13	0.15			
1300	-0.36	-0.23	-0.12	0.10	0.11	180.	20.	1022.0
1310	-0.34	-0.21	-0.14	0.08	0.09			
1320	-0.31	-0.21	-0.16	0.06	0.07			
1330	-0.28	-0.18	-0.17	0.04	0.05			
1340	-0.24	-0.16	-0.17	0.02	0.03			
1350	-0.20	-0.12	-0.17	0.01	0.01			
1400	-0.15	-0.08	-0.14	-0.01	0.00	180.	22.	1021.7
1410	-0.09	-0.05	-0.11	-0.02	-0.02			
1420	-0.02	0.00	-0.07	-0.04	-0.03			
1430	0.01	0.02	-0.02	-0.04	-0.05			
1440	0.07	0.06	0.01	-0.04	-0.06			
1450	0.11	0.09	0.04	-0.04	-0.06			
1500	0.15	0.13	0.07	-0.04	-0.05	180.	21.	1021.6
1510	0.19	0.16	0.10	-0.03	-0.02			
1520	0.23	0.18	0.14	-0.02	0.01			
1530	0.28	0.21	0.16	-0.01	0.04			
1540	0.33	0.24	0.18	0.01	0.06			
1550	0.38	0.29	0.20	0.04	0.08			
1600	0.43	0.33	0.24	0.07	0.11	180.	23.	1021.8
1610	0.48	0.37	0.28	0.10	0.14			
1620	0.52	0.41	0.31	0.12	0.16			
1630	0.56	0.45	0.36	0.15	0.18			
1640	0.59	0.49	0.40	0.18	0.21			
1650	0.62	0.52	0.43	0.23	0.24			
1700	0.65	0.56	0.45	0.26	0.28	180.	15.	1022.0
1710	0.67	0.59	0.50	0.31	0.33			
1720	0.70	0.62	0.54	0.36	0.38			
1730	0.72	0.64	0.58	0.40	0.43			
1740	0.73	0.66	0.60	0.44	0.46			
1750	0.74	0.68	0.63	0.48	0.51			
1800	0.74	0.70	0.65	0.53	0.56	170.	14.	1022.3
1810	0.74	0.71	0.67	0.57	0.61			
1820	0.74	0.72	0.70	0.61	0.66			
1830	0.74	0.73	0.72	0.65	0.70			
1840	0.73	0.74	0.73	0.68	0.74			
1850	0.72	0.75	0.74	0.71	0.77			
1900	0.70	0.76	0.75	0.74	0.80	160.	13.	1022.8
1910	0.66	0.76	0.77	0.76	0.81			
1920	0.63	0.74	0.78	0.78	0.83			
1930	0.60	0.71	0.78	0.80	0.84			
1940	0.56	0.68	0.78	0.81	0.85			
1950	0.52	0.64	0.76	0.81	0.86			
2000	0.48	0.62	0.74	0.81	0.86	150.	12.	1023.5
2010	0.42	0.59	0.71	0.80	0.85			
2020	0.37	0.56	0.68	0.77	0.81			
2030	0.33	0.52	0.66	0.75	0.75			
2040	0.28	0.48	0.64	0.73	0.71			
2050	0.22	0.44	0.60	0.69	0.68			
2100	0.17	0.40	0.58	0.66	0.65	150.	8.	1024.3
2110	0.12	0.35	0.55	0.63	0.62			
2120	0.06	0.29	0.51	0.60	0.60			
2130	0.00	0.24	0.48	0.57	0.58			
2140	-0.07	0.20	0.44	0.55	0.54			
2150	-0.16	0.16	0.40	0.52	0.52			
2200	-0.20	0.12	0.36	0.49	0.50	150.	9.	1024.4

	2	3	4	5	6	7	8	9	10
	2210	-0.27	0.08	0.32	0.47	0.46			
	2220	-0.30	0.04	0.28	0.44	0.44			
	2230	-0.33	0.01	0.24	0.41	0.42			
	2240	-0.37	-0.01	0.21	0.39	0.38			
	2250	-0.40	-0.04	0.17	0.35	0.36			
	2300	-0.42	-0.07	0.13	0.32	0.33	150.	17.	1024.9
	2310	-0.45	-0.09	0.10	0.30	0.30			
	2320	-0.47	-0.14	0.06	0.27	0.28			
	2330	-0.50	-0.16	0.03	0.25	0.26			
	2340	-0.52	-0.20	0.00	0.22	0.23			
	2350	-0.53	-0.23	-0.02	0.20	0.21			
840308	0000	-0.53	-0.25	-0.05	0.17	0.19	150.	16.	1025.2
	0010	-0.53	-0.27	-0.08	0.15	0.17			
	0020	-0.53	-0.27	-0.12	0.12	0.14			
	0030	-0.53	-0.28	-0.14	0.11	0.13			
	0040	-0.52	-0.30	-0.16	0.09	0.11			
	0050	-0.50	-0.30	-0.19	0.07	0.09			
	0100	-0.48	-0.30	-0.20	0.05	0.07	160.	11.	1025.3
	0110	-0.45	-0.30	-0.22	0.03	0.05			
	0120	-0.42	-0.29	-0.22	0.01	0.03			
	0130	-0.38	-0.27	-0.24	-0.01	0.01			
	0140	-0.35	-0.26	-0.24	-0.02	-0.01			
	0150	-0.32	-0.23	-0.24	-0.04	-0.03			
	0200	-0.27	-0.19	-0.24	-0.04	-0.04	150.	12.	1025.5
	0210	-0.22	-0.17	-0.22	-0.04	-0.06			
	0220	-0.17	-0.14	-0.17	-0.04	-0.07			
	0230	-0.15	-0.10	-0.13	-0.04	-0.08			
	0240	-0.10	-0.06	-0.11	-0.04	-0.09			
	0250	-0.06	-0.02	-0.08	-0.04	-0.10			
	0300	0.00	0.04	-0.05	-0.04	-0.10	120.	15.	1025.4
	0310	0.05	0.08	-0.03	-0.04	-0.10			
	0320	0.10	0.11	0.02	-0.04	-0.10			
	0330	0.15	0.14	0.06	-0.04	-0.08			
	0340	0.20	0.18	0.09	-0.04	-0.07			
	0350	0.25	0.22	0.13	-0.04	-0.05			
	0400	0.30	0.27	0.16	-0.03	-0.03	150.	10.	1025.6
	0410	0.35	0.30	0.20	0.00	0.01			
	0420	0.40	0.34	0.24	0.02	0.04			
	0430	0.45	0.36	0.27	0.04	0.08			
	0440	0.49	0.36	0.31	0.08	0.10			
	0450	0.53	0.36	0.35	0.11	0.14			
	0500	0.56	0.36	0.38	0.16	0.18	200.	5.	1025.7
	0510	0.59	0.36	0.41	0.19	0.22			
	0520	0.62	0.36	0.45	0.23	0.25			
	0530	0.64	0.36	0.49	0.28	0.30			
	0540	0.66	0.36	0.53	0.32	0.34			
	0550	0.68	0.36	0.56	0.36	0.38			
	0600	0.70	0.36	0.58	0.41	0.42	240.	3.	1026.0
	0610	0.71	0.36	0.61	0.46	0.46			
	0620	0.71	0.36	0.64	0.49	0.52			
	0630	0.71	0.36	0.67	0.54	0.56			
	0640	0.71	0.36	0.69	0.57	0.62			
	0650	0.69	0.36	0.71	0.61	0.66			
	0700	0.68	0.36	0.72	0.65	0.70	280.	7.	1026.5
	0710	0.66	0.36	0.74	0.69	0.74			
	0720	0.64	0.36	0.75	0.72	0.77			
	0730	0.63	0.36	0.75	0.75	0.79			
	0740	0.61	0.70	0.75	0.77	0.81			
	0750	0.59	0.66	0.75	0.78	0.82			
	0800	0.56	0.65	0.75	0.78	0.82	040.	6.	1026.7
	0810	0.52	0.63	0.73	0.78	0.82			
	0820	0.47	0.60	0.71	0.77	0.82			
	0830	0.42	0.56	0.70	0.76	0.79			

1	2	3	4	5	6	7	8	9	10
	0840		0.54	0.67	0.73	0.76			
	0850		0.50	0.66	0.71	0.72			
	0900		0.46	0.63	0.69	0.68	050.	8.	
	0910		0.42	0.60	0.66	0.66			
	0920		0.39	0.56	0.61	0.64			
	0930		0.36	0.52	0.59	0.62			
	0940		0.32	0.49	0.57	0.58			
	0950		0.27	0.47	0.54	0.55			
	1000		0.23	0.43	0.52	0.52	060.	10.	
	1010		0.19	0.40	0.48	0.50			
	1020		0.15	0.36	0.44	0.46			
	1030		0.11	0.32	0.42	0.44			
	1040		0.07	0.29	0.40				
	1050		0.04	0.25	0.36				
	1100		0.00	0.21	0.32		070.	14.	
	1110		-0.04	0.18					
	1120		-0.06	0.15					
	1130		-0.10	0.11					
	1140		-0.12	0.07					
	1150		-0.14	0.04					
	1200		-0.16	0.01			090.	17.	
	1210		-0.17	-0.03					
	1220			-0.06					
	1230			-0.09					
	1240			-0.12					
	1250			-0.14					
	1300			-0.16					

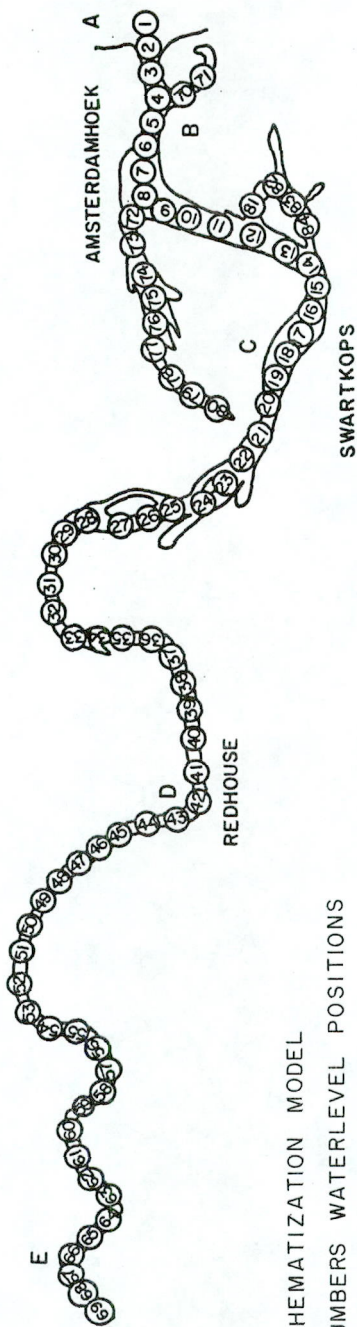
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1.155KLNS.

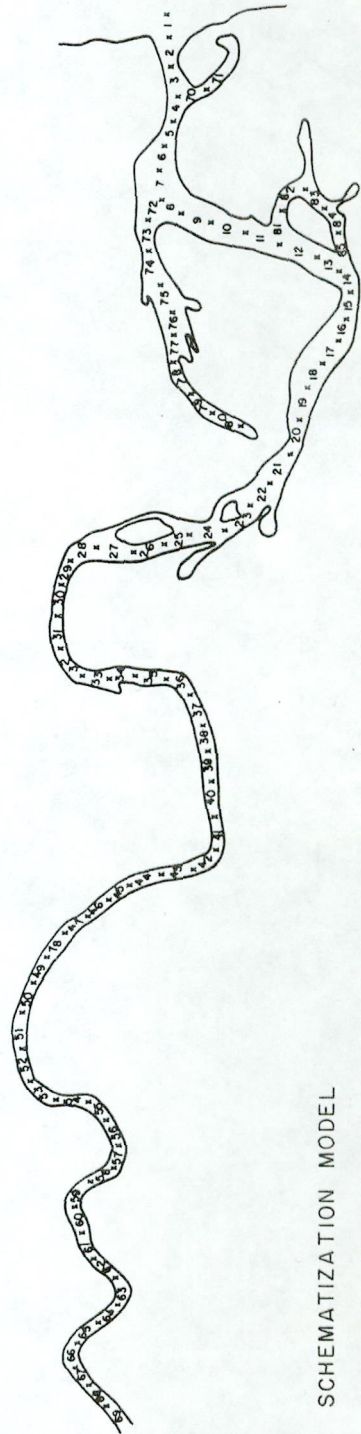


MAP SWARTKOPS ESTUARY 1:50000

- W.L. RECORDINGS
 A = SEA TIDE
 B = AMSTERDAMHOEK
 C = SWARTKOPS
 D = REDHOUSE
 E = PERSEVERANCE



SCHEMATIZATION MODEL
 NUMBERS WATERLEVEL POSITIONS

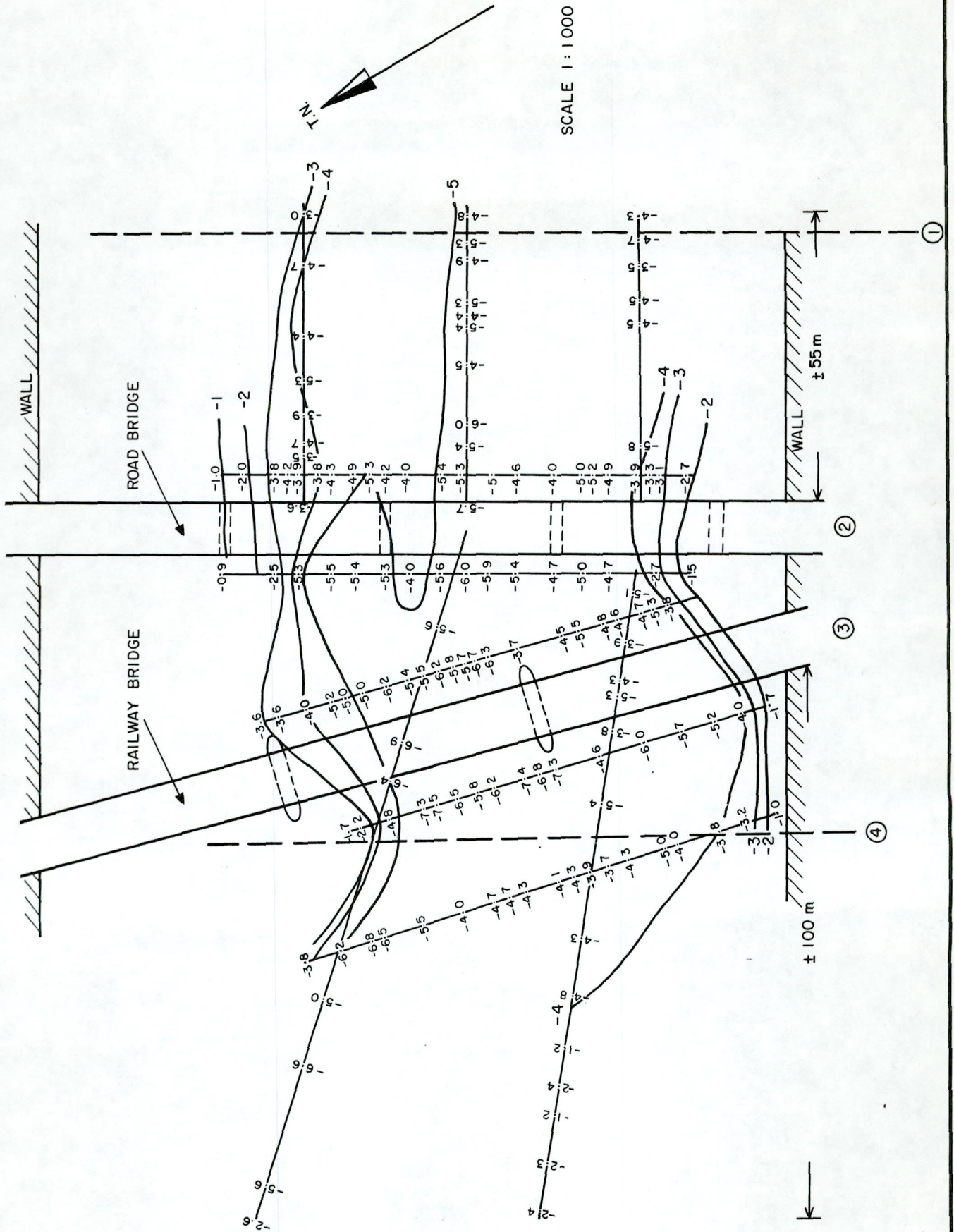


SCHEMATIZATION MODEL
 NUMBERS OF SECTIONS BETWEEN WATERLEVEL POSITIONS WHERE
 RIVERFLOW IS COMPUTED

TRACED: H.R.
 CHECKED:
 DATE:
 REF:

1-DIMENSIONAL HYDRODYNAMIC MODEL
 MAP OF SWARTKOPS ESTUARY WITH MODEL
 SCHEMATIZATION

FIGURE
 1



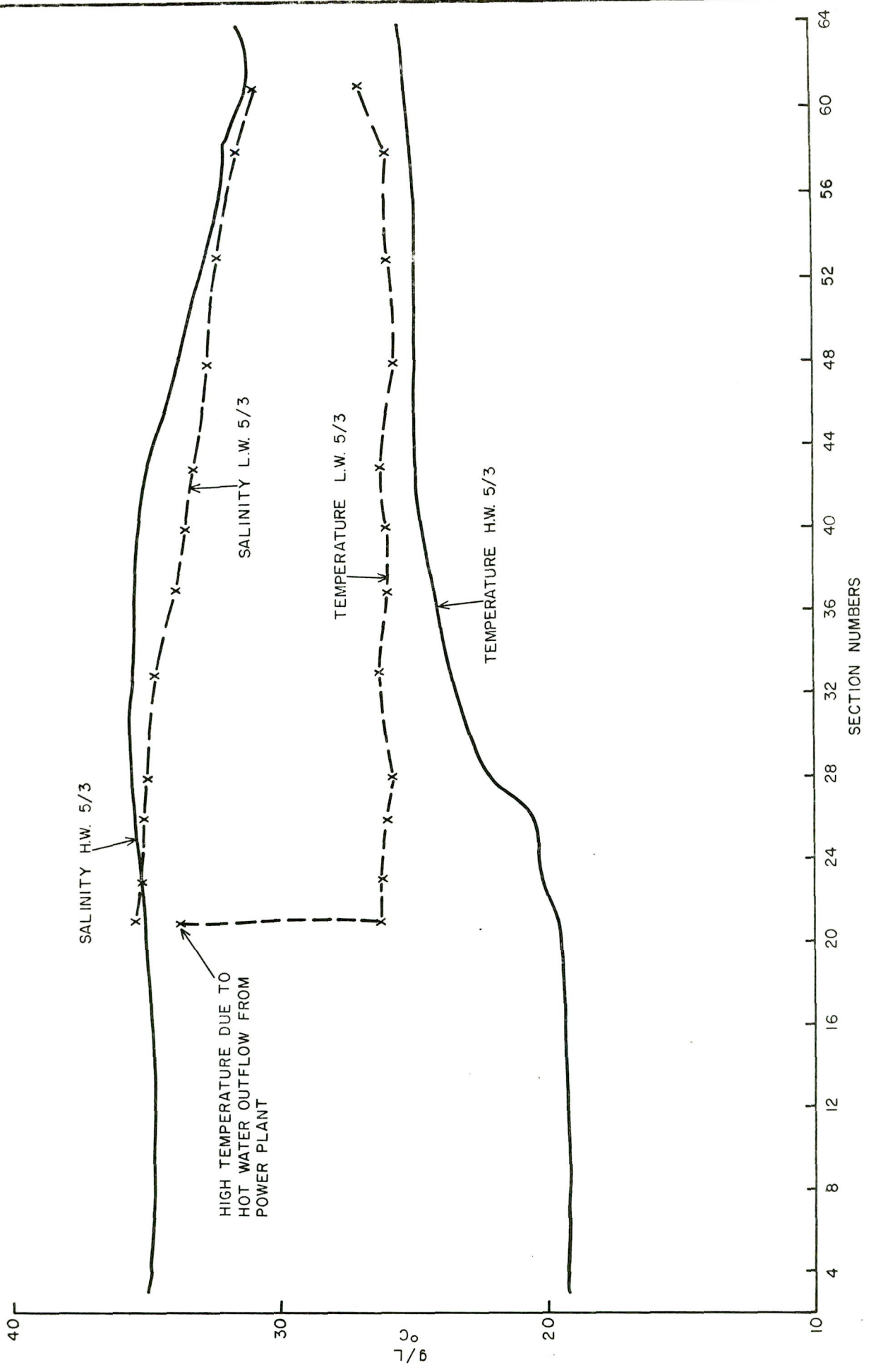
TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL

SURVEY NEAR RAILWAY AND ROAD BRIDGES
 AT SWARTKOPS (TOWN) 6 MARCH 1984

FIGURE

3



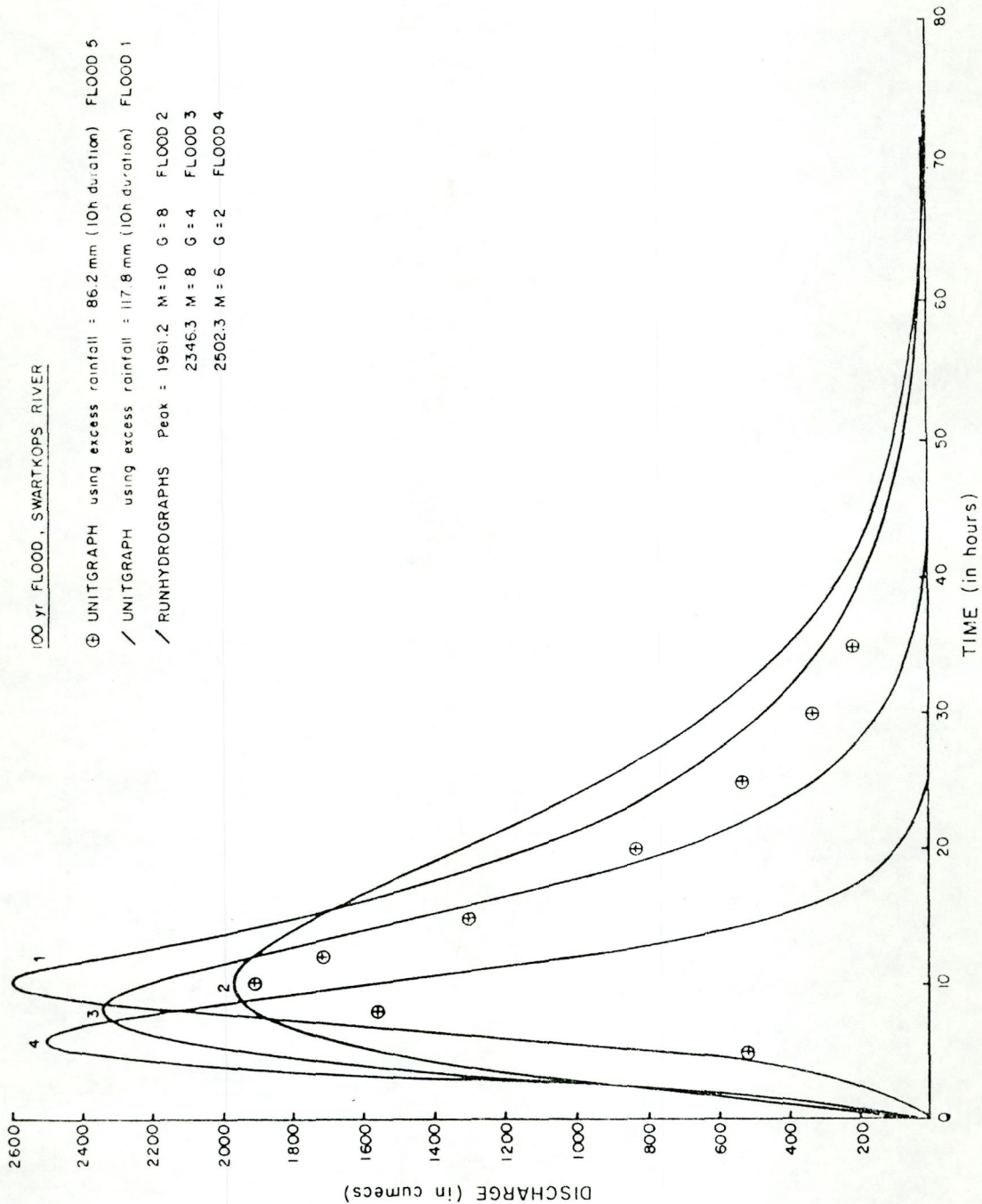
TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL
 SWARTKOPS FIELD MEASUREMENTS: 5.3.1984
 H.W. 06h20 - 09h01 / L.W. 12h43 - 13h30

FIGURE
 4

100 yr FLOOD, SWARTKOPS RIVER

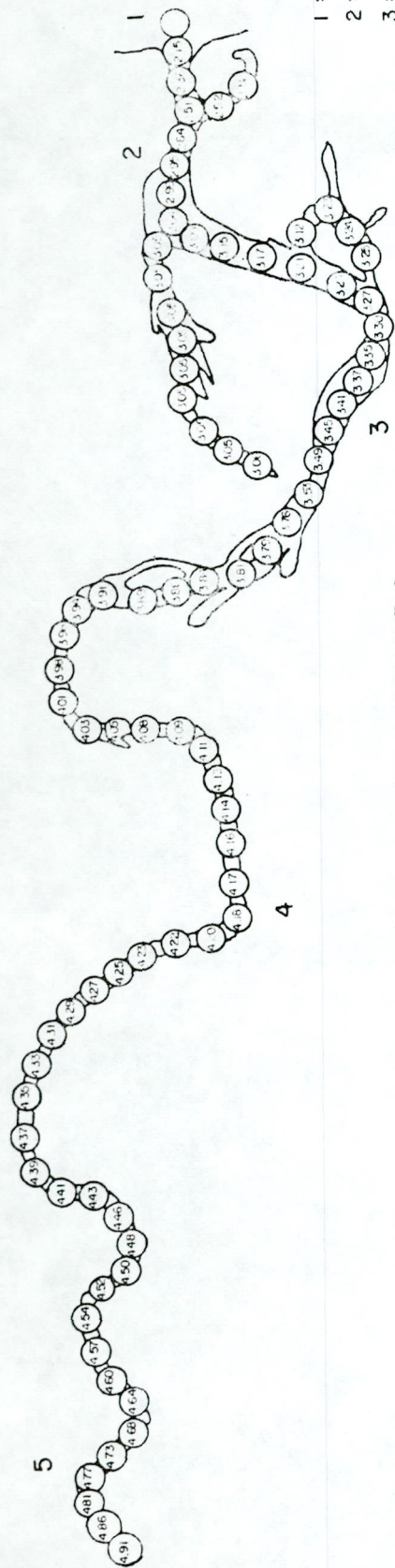
- ⊕ UNITGRAPH using excess rainfall = 86.2 mm (10h duration) FLOOD 5
- / UNITGRAPH using excess rainfall = 117.8 mm (10h duration) FLOOD 1
- ⊕ RUNHYDROGRAPHS Peak = 1961.2 M=10 G=8 FLOOD 2
- 2346.3 M=8 G=4 FLOOD 3
- 2502.3 M=6 G=2 FLOOD 4



TRACED M
 CHECKED
 DATE
 REF

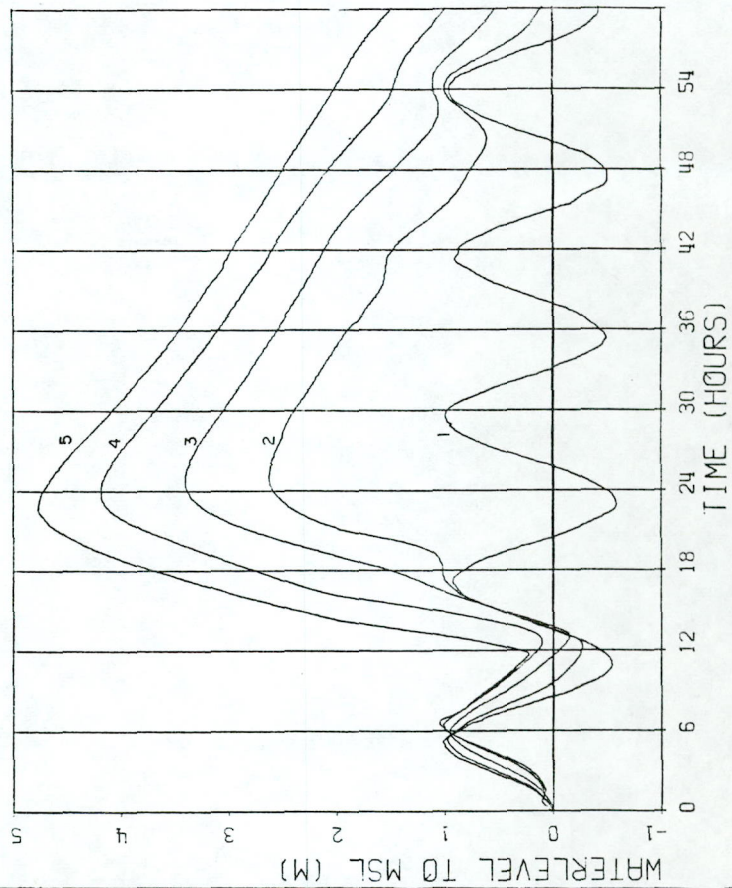
1-DIMENSIONAL HYDRODYNAMIC MODEL
 ESTIMATIONS OF 1:100 YEAR FLOOD CONDITIONS PROVIDED BY RHODES UNIVERSITY

FIGURE
 9

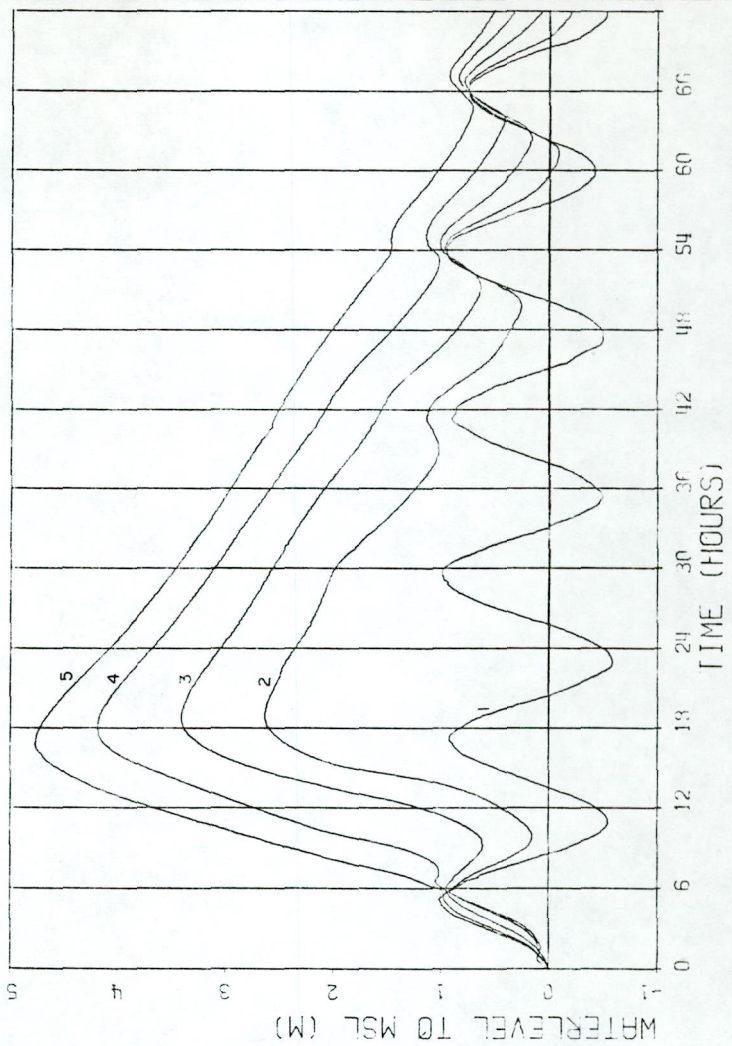


- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = S'WARTKOPS
- 4 = REDHOUSE
- 5 = FERSEVERANCE

A : TEST 1A : MAXIMUM WATERLEVELS



B : TEST 1A : WATERLEVELS AT RECORDING POSITIONS

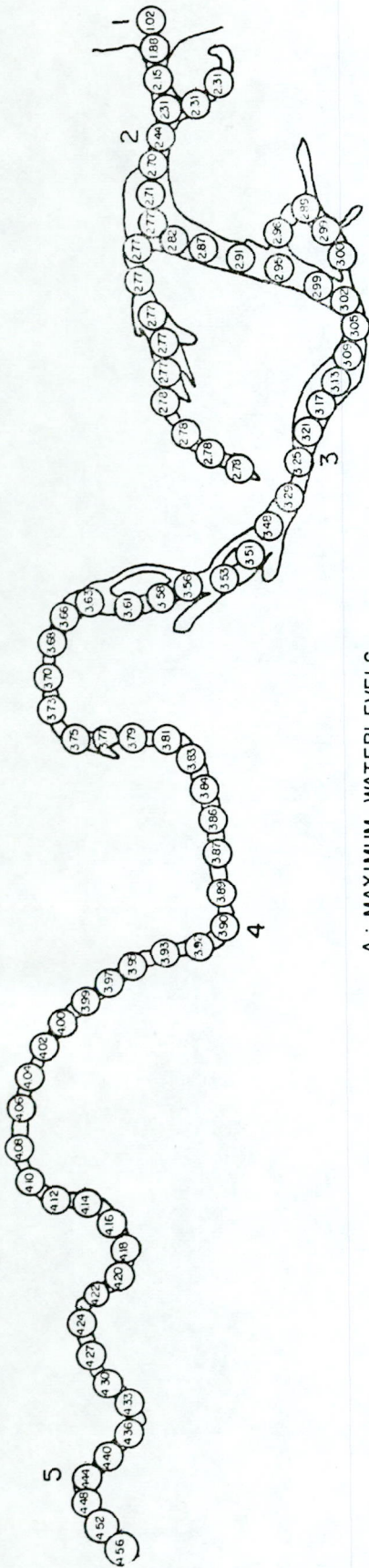


C : TEST 1B : WATERLEVELS AT RECORDING POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

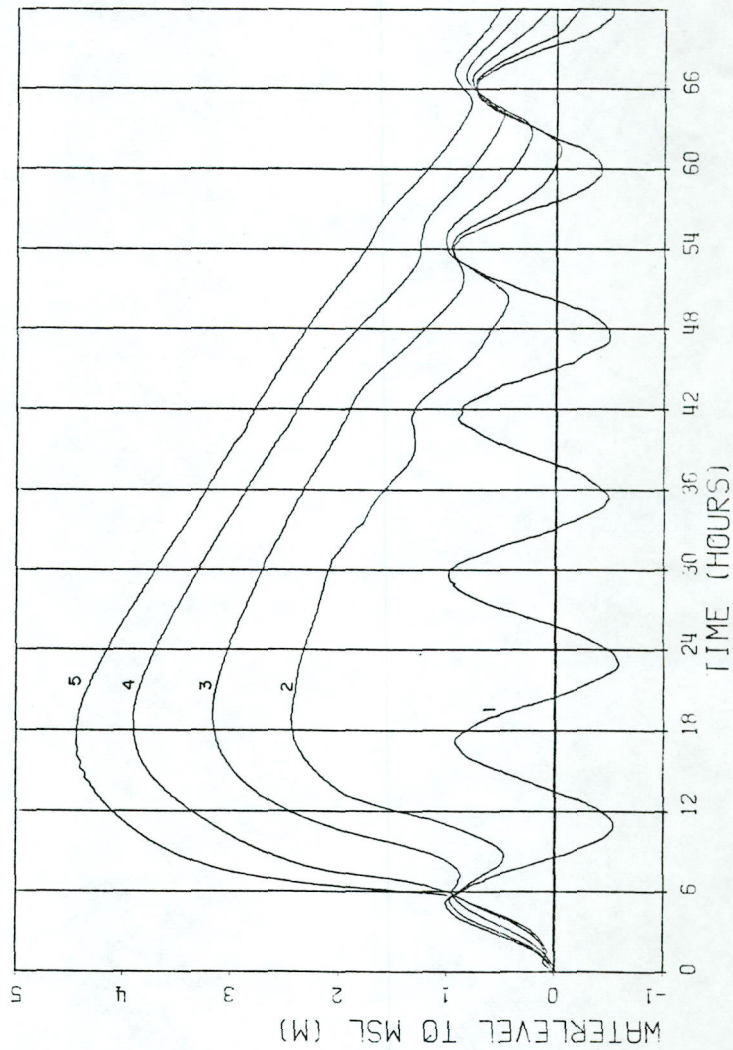
1-DIMENSIONAL HYDRODYNAMIC MODEL
 TESTS 1A AND 1B. FLOOD 1 (max. 2600 M³/5)
 TEST 1A : MAX. AT 21.00 HRS
 TEST 1B : MAX. AT 15.00 HRS

FIGURE
 10



A : MAXIMUM WATERLEVELS

- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERENCE



B : WATERLEVELS AT RECORDER POSITIONS

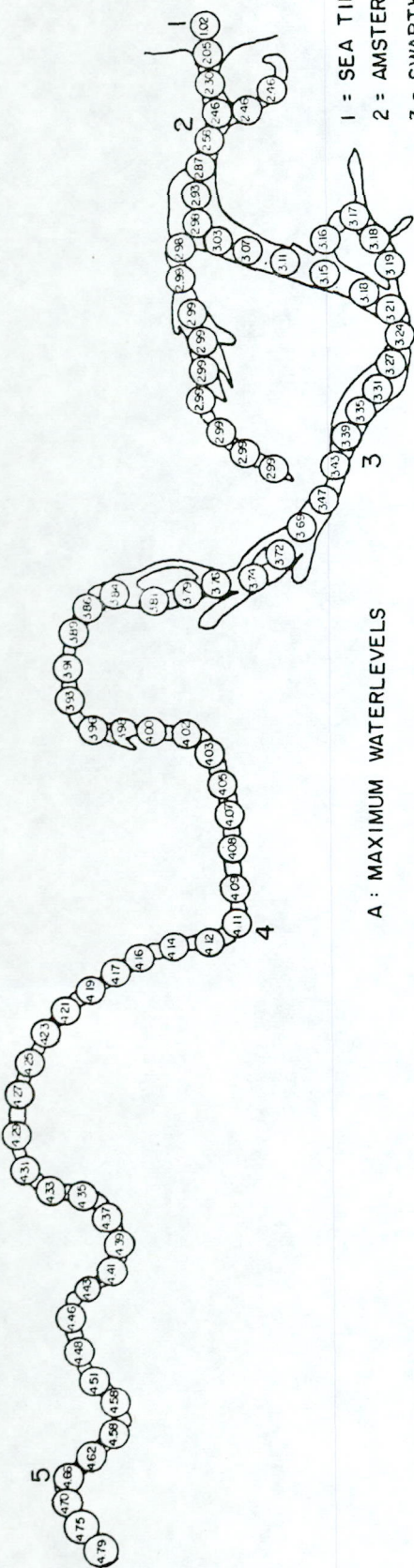
TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL

TEST 2 FLOOD 2

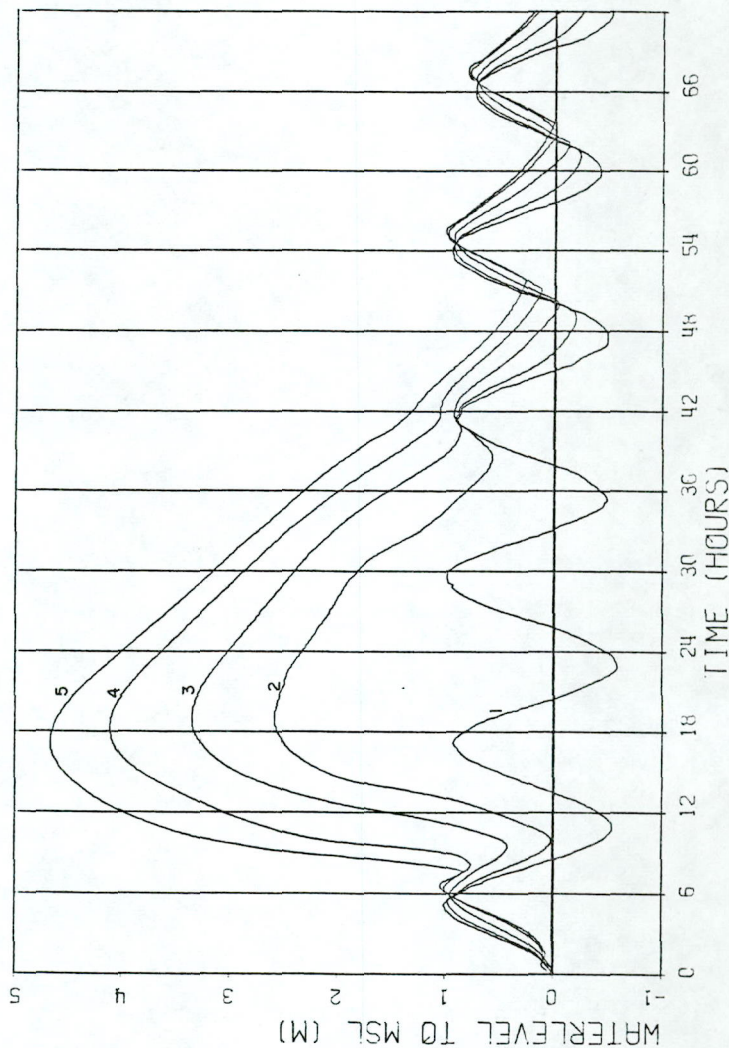
FIGURE

11



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS



B : WATERLEVELS AT RECORDER POSITIONS

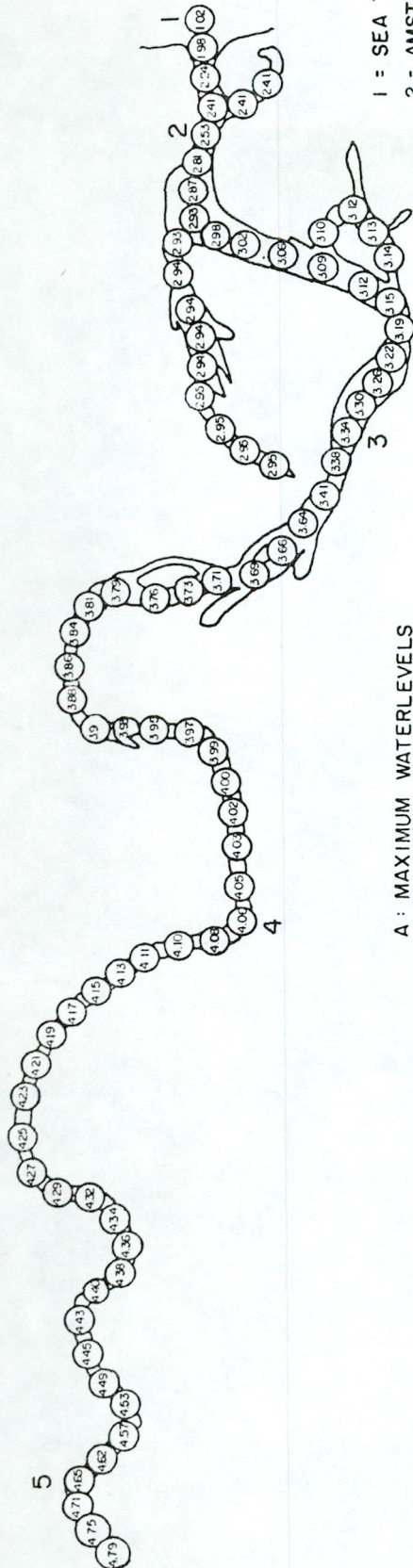
TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL

TEST 3 FLOOD 3

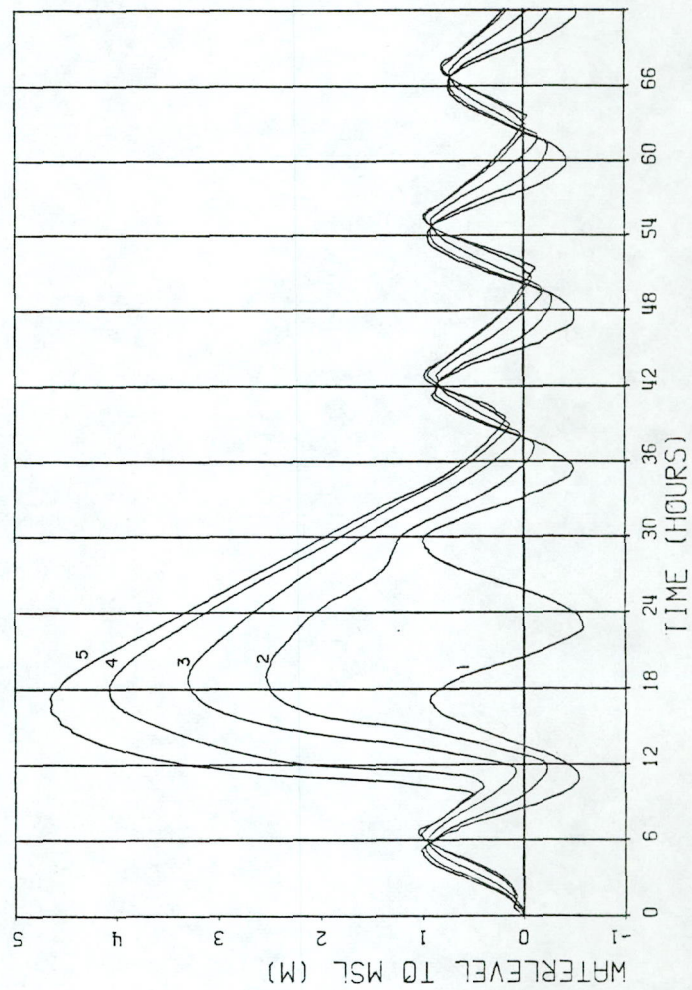
FIGURE

12



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS

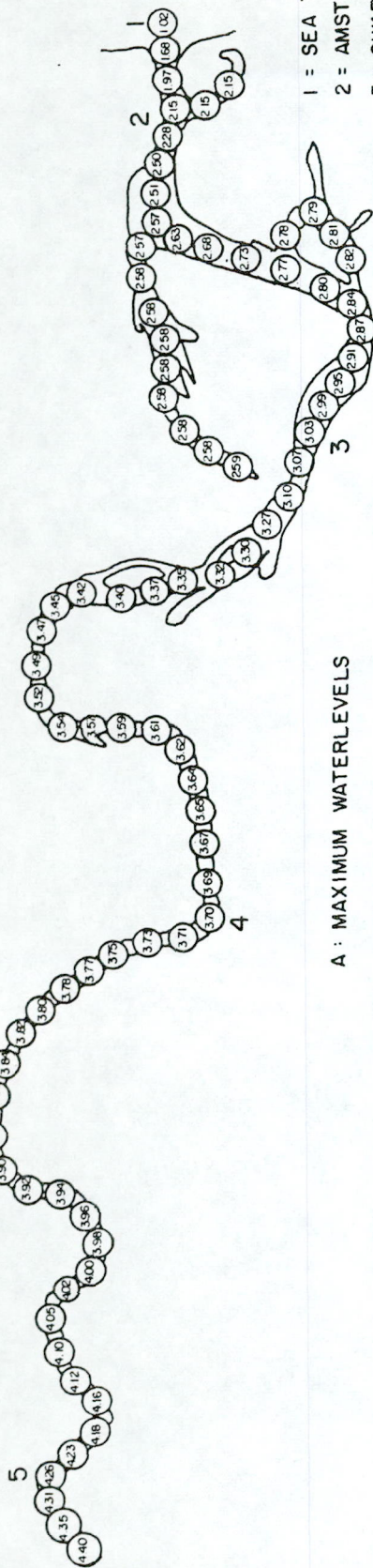


B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

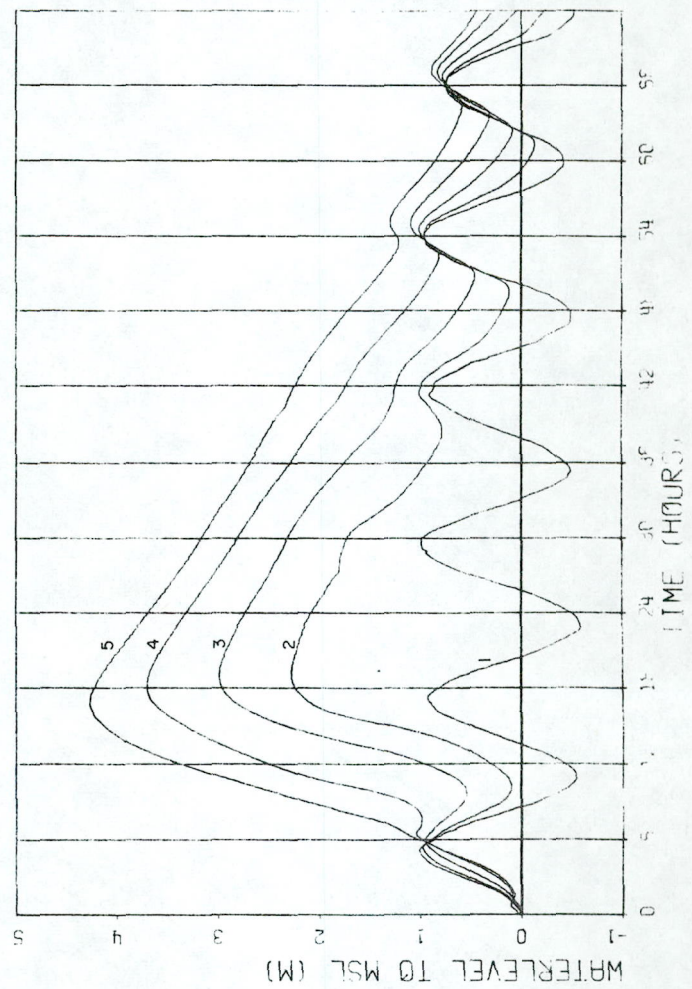
1- DIMENSIONAL HYDRODYNAMIC MODEL
 TEST 4 FLOOD 4

FIGURE
 13



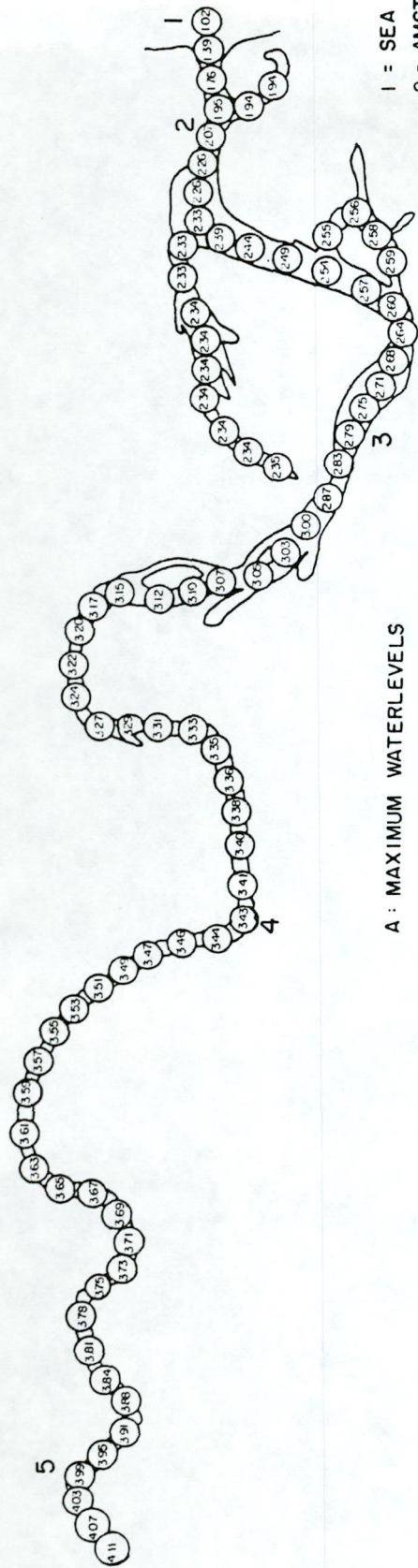
- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS



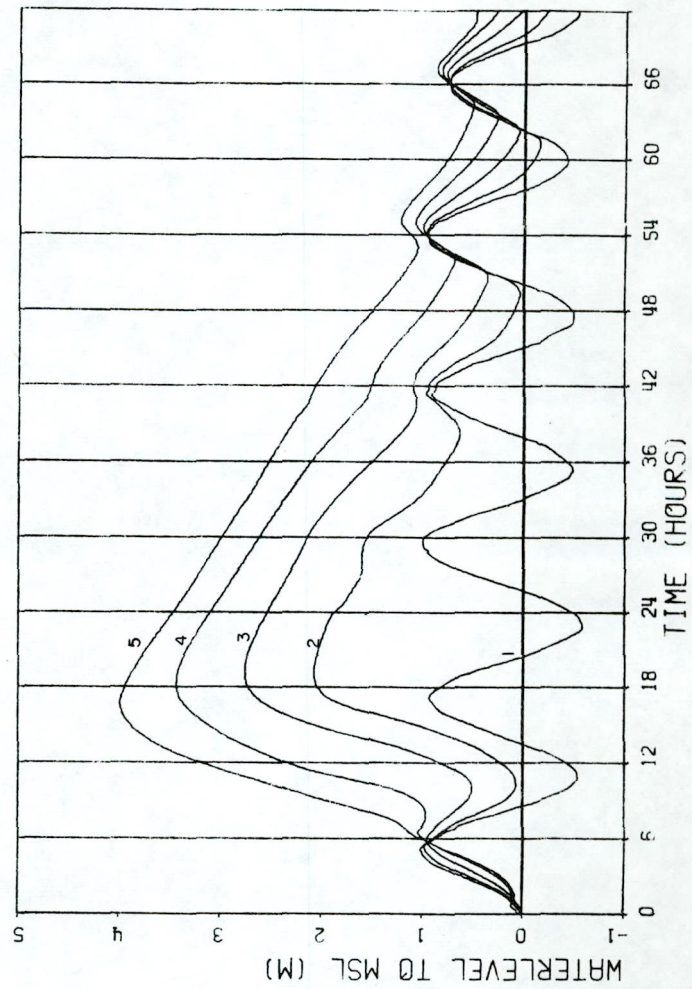
B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS CHECKED: DATE: REF.:	1-DIMENSIONAL HYDRODYNAMIC MODEL TEST 5 FLOOD 5	FIGURE 14
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS

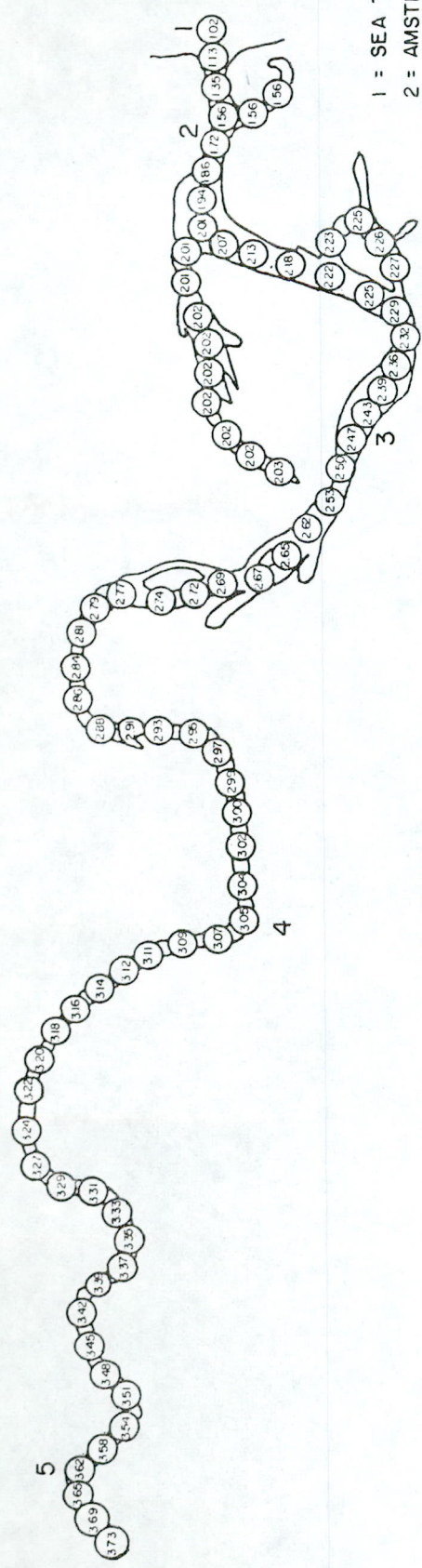


B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

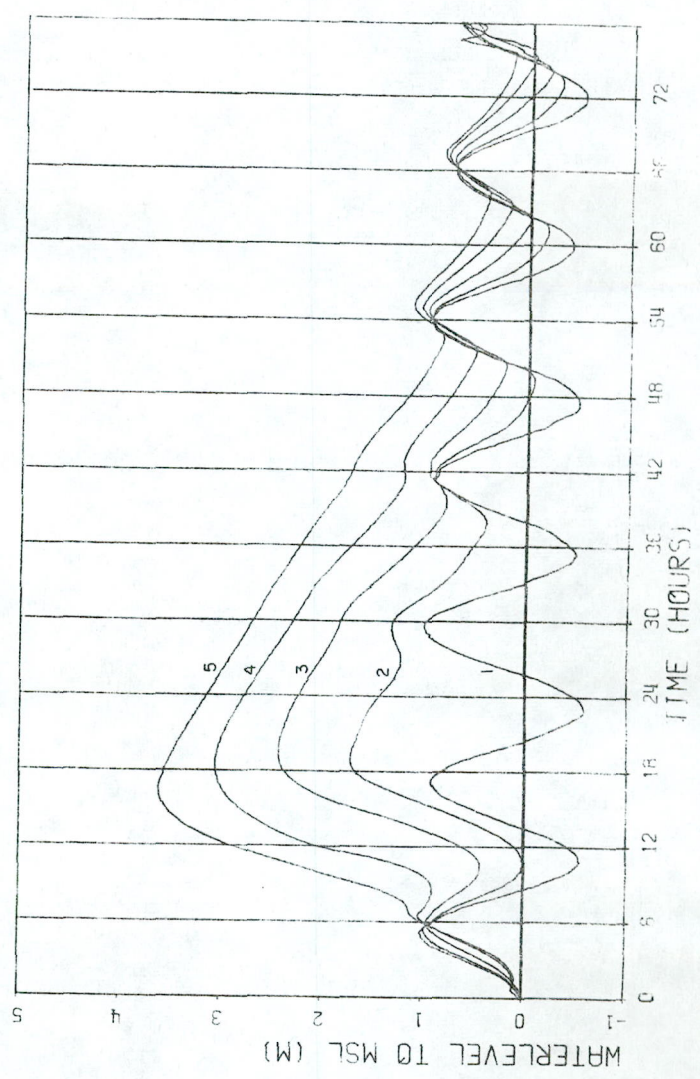
1-DIMENSIONAL HYDRODYNAMIC MODEL
 TEST 6 FLOOD 6

FIGURE
 15



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS



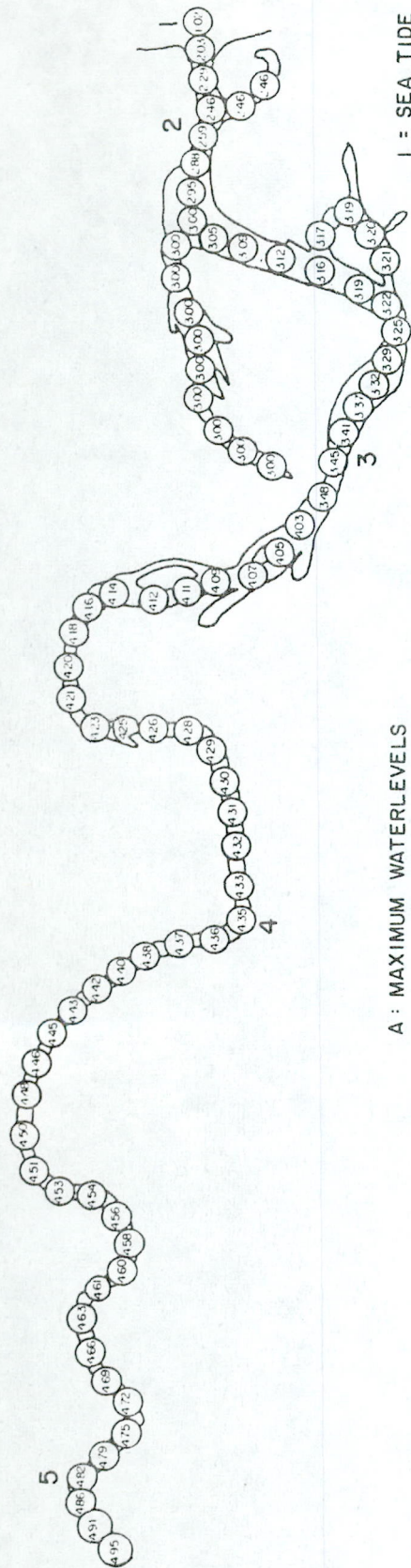
B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL

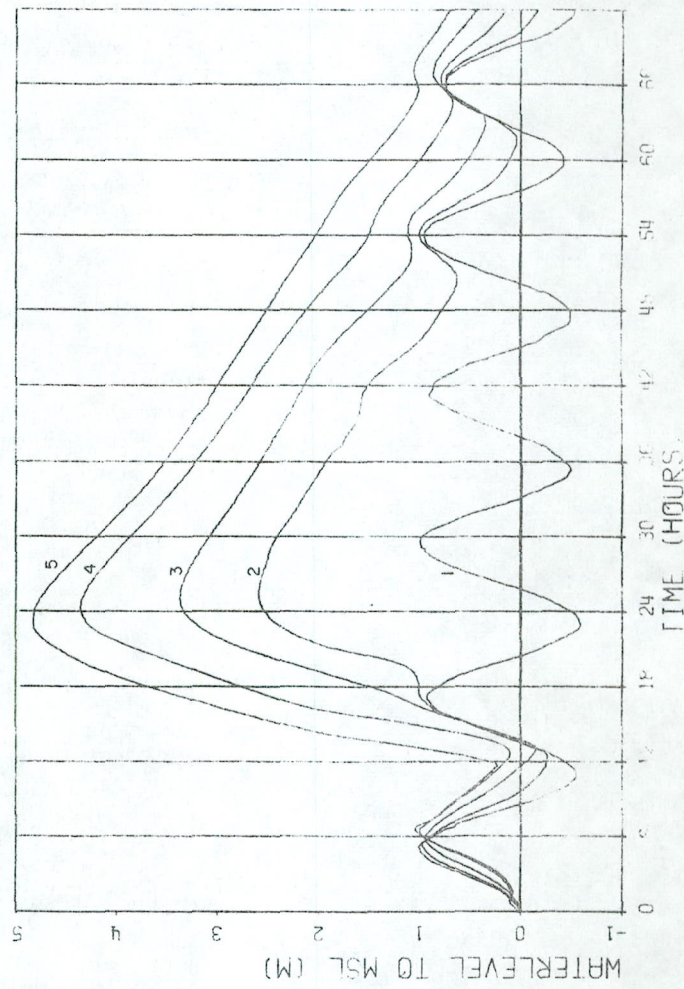
TEST 7 FLOOD 7

FIGURE
 16



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS

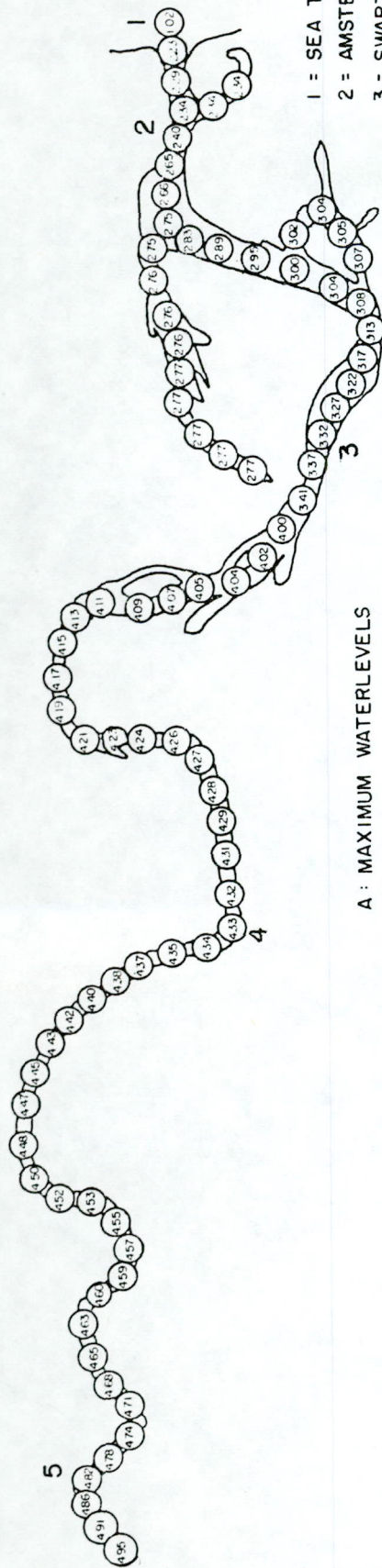


B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

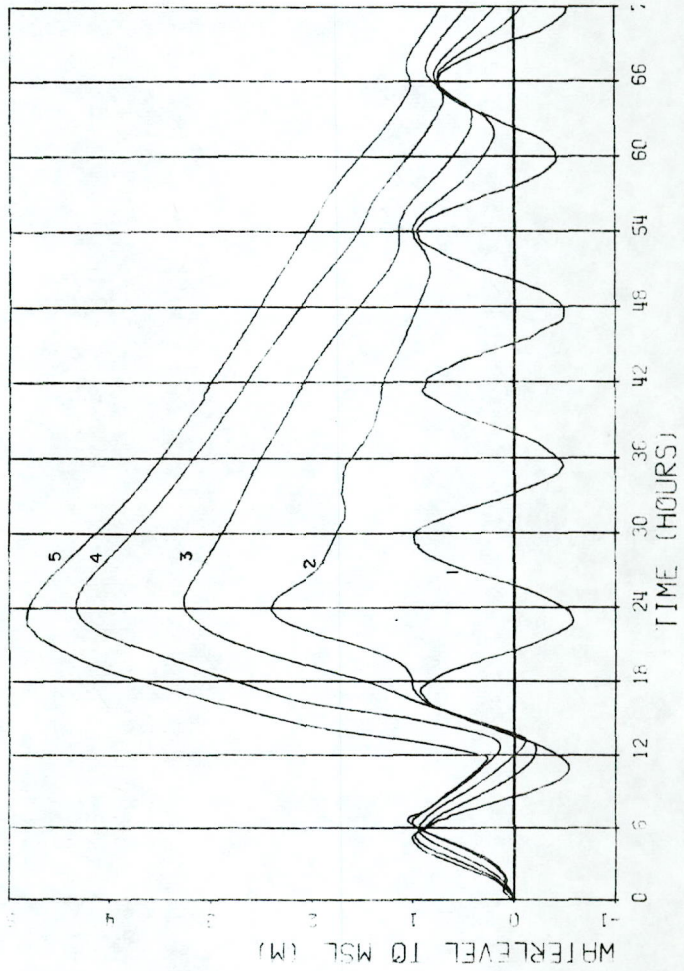
1- DIMENSIONAL HYDRODYNAMIC MODEL
TEST 8 FLOOD 1 (max. 2600 m³/s)
SECTION AT RAILWAY BRIDGE NARROWED

FIGURE
 17



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS

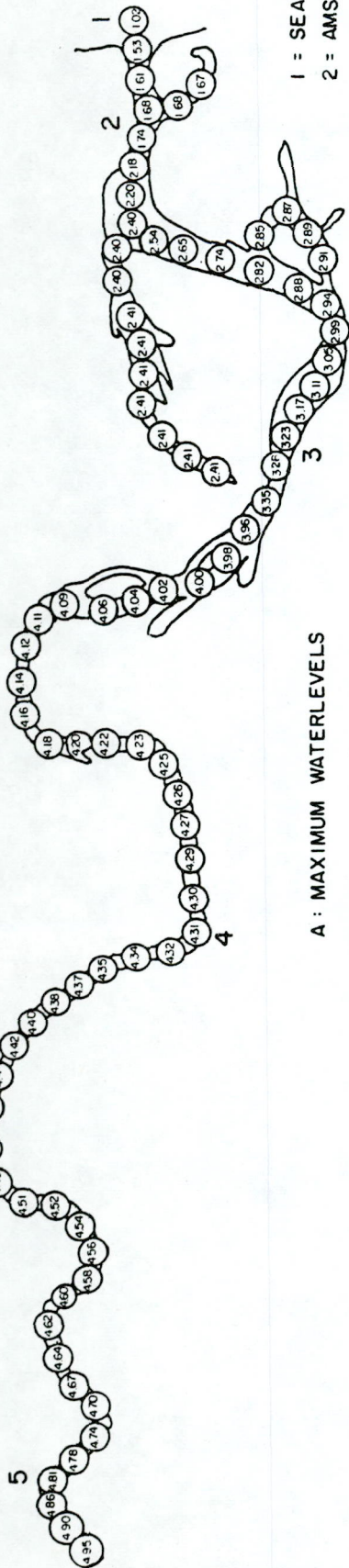


B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

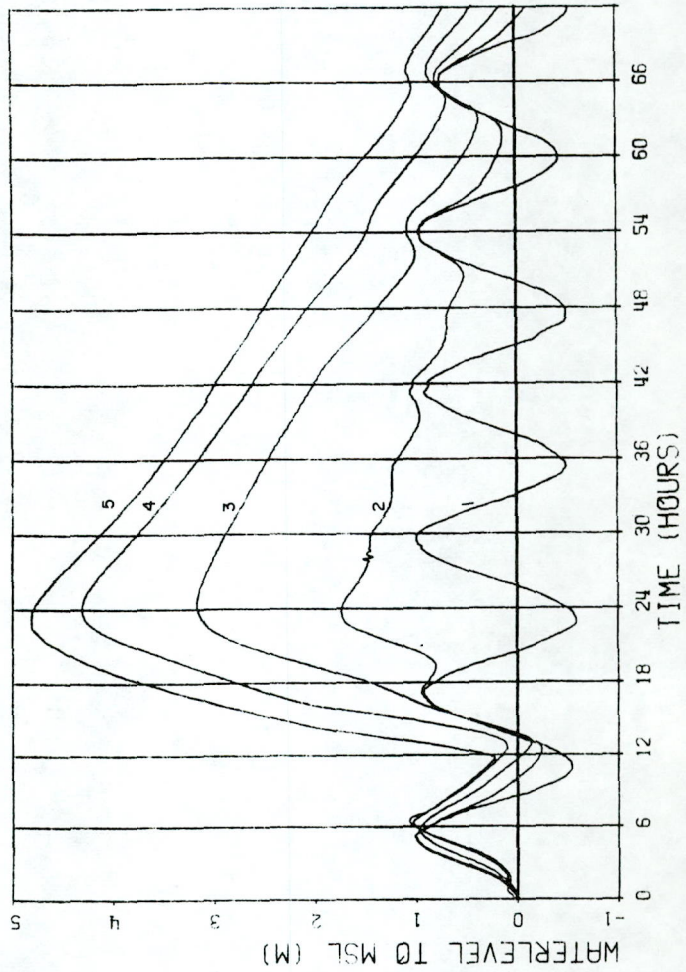
1-DIMENSIONAL HYDRODYNAMIC MODEL
 TEST 9 AS TEST 8 FLOOD 1 (max. 2600 m³/s)
 NEW MOUTH SECTION (I)

FIGURE
 18



- 1 = SEA TIDE
- 2 = AMSTERDAMHOEK
- 3 = SWARTKOPS
- 4 = REDHOUSE
- 5 = PERSEVERANCE

A : MAXIMUM WATERLEVELS



B : WATERLEVELS AT RECORDER POSITIONS

TRACED: HRS
 CHECKED:
 DATE:
 REF.:

1-DIMENSIONAL HYDRODYNAMIC MODEL
 TEST 10, AS TEST 8 FLOOD 1 (max. 2600m³/s)
 NEW MOUTH SECTION (2)

FIGURE
 19