DGIS/DANIDA FAP-5B GOB

MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MEGHNA ESTUARY STUDY

TECHNICAL NOTE MES-017

NUMERICAL MODELLING

August 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
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Technical Note on:

NUMERICAL MODELLING OF HYDRODYNAMICS, SALINITY, WAVES AND SEDIMENT TRANSPORT IN THE MEGHNA ESTUARY

Dhaka , June 1998

Project Name	:	Meghna Estuary Study (MES)
Location	:	Meghna Estuary
Key words	:	Bathymetries, Model Set-up, Base Line Simulations, Simulation with Interventions, Salinity Modelling, Wind-Wave Modelling, Sediment Transport Modelling

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Executive Summary

Meghna Estuary Study (MES) is a component (FAP5B) of the Flood Action Plan. The study was executed from late 1995 till mid 1998 by Government of Bangladesh, Ministry of Water Resources, represented by Bangladesh Water Development Board (BWDB). DHV, The Netherlands, with associates, participated as a Consultant. Financial support for the project was granted by DGIS, The Netherlands, and Danida, Denmark.

The present report describes the numerical hydraulic modelling, which was carried out as a part of the study by Surface Water Modelling Centre (SWMC) and Danish Hydraulic Institute (DHI). Both institutes participated in the MES project organisation as specialist sub-consultants to DHV.

The purpose of the numerical hydraulic modelling was to establish a tool for description of present and future hydraulic conditions in the study area. The results are required in connection with

- assessment and comparison of development scenarios; and
- impact evaluation and design of various specific schemes.

Numerical hydraulic models have been established for the Meghna Estuary in connection with other studies. However, at the early stages of MES it was realised that the bathymetric data basis on which these models were made had grown partly obsolete and inconsistent due to the dynamic morphological environment. Therefore the modelling was suspended while a comprehensive bathymetric survey was carried out.

With the new bathymetric survey data the hydrodynamic model was set-up, calibrated and validated against available measurements. Also a local hydraulic model for the Nijhum Dwip area was set-up.

In addition to the hydrodynamic models a salinity model, a wind-wave model and a sediment transport model for the study area were set-up.

All together this comprehensive model suite constitutes a valuable and versatile tool for impact assessment in connection with the development of the estuary.

Within the present study a number of intervention scenarios were modelled and key parameters extracted for analysis and interpretation within other study tasks.

On-the-job supervision of SWMC staff by the DHI numerical modelling specialist was carried out throughout the project period. It is recommended that formal training in the further development and application of the models are made.

At the end of the study period emphasis was put on making the model suite, together with the results already obtained, readily available for future use by setting up a CD-ROM archive.

Finally, in order to visualise the results, a presentation was made on CD-ROM (for viewing in a web browser) containing the main parts of the present report together with animation of key results.

Abbreviations

ADCP	Acoustic Doppler Current Profiler
ATT	Admiralty Tide Tables
BITWA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BTM	Bangladesh Transverse Mercator
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CD	Chart Datum
CSPS	Cyclone Shelter Preparatory Study
DANIDA	Danish International Development Agency
DGIS	Directorate General for International Cooperation, The Netherlands
DHI	Danish Hydraulic Institute
DHV	DHV Consultants BV
EGIS	Environmental and Geographic Information System support Project
FAP4	Southwest Area Water Resources Management Project
FAP5B	Flood Action Plan project 5B (same as Meghna Estuary Study)
FPCO	Flood Plan Coordination Organisation
GOB	Government of Bangladesh
IFCDR	Institute of Flood Control and Drainage Research (BUET)
KMS	Kort- og Matrikelstyrelsen
LGED	Local Government Engineering Department
LRP	Land Reclamation Project
MES	Meghna Estuary Study
MIKE 21	2 Dimensional Modelling System developed by DHI
MIKE 21 AD	Advection-Dispersion Module of MIKE 21
MIKE 21 HD	Hydrodynamic Module of MIKE 21
MIKE 21 NSW	Nearshore Spectral Wind-Wave Module of MIKE 21
MIKE 21 ST	Sand Sediment Transport Module of MIKE 21
PWD	Public Works Datum
RTK	Real Time Kinematics
SSD	Survey and Study Division (of BWDB)
SPM	Shore Protection Manual
SSE	South-Southeast
SSW	South-Southwest
SWMC	Surface Water Modelling Centre

1 Introduction

1.1 Background

Meghna Estuary Study (MES) is a component (FAP5B) of the Flood Action Plan. The study was executed from late 1995 till mid 1998 by Government of Bangladesh, Ministry of Water Resources, represented by Bangladesh Water Development Board (BWDB). DHV, The Netherlands, with associates, participated as a Consultant. Financial support for the project was granted by DGIS, The Netherlands, and Danida, Denmark.

MES built on results of the Land Reclamation Project (LRP), which was executed by BWDB from 1977 to 1991. The development objectives of MES are to increase the physical safety and social security of the some two million inhabitants of the study area, and to promote sustainable development in the coastal areas and on the islands. The immediate objectives are

- to enhance and strengthen operational knowledge of hydraulic and morphological processes in the Meghna Estuary;
- to find suitable land reclamation and bank protection methods;
- to increase the capacity of BWDB to reclaim new land and protect the eroding river banks; and
- to prepare a plan with priority projects and programmes for flood protection, agricultural and socio-economic development for early implementation.

The present report describes the numerical hydraulic modelling, which was carried out as a part of the study by Surface Water Modelling Centre (SWMC) and Danish Hydraulic Institute (DHI). Both institutes participated in the MES project organisation as specialist sub-consultants to DHV.

1.2 Objectives

The numerical model can describe water levels, flow rates and current velocities, salinities, and mass budgets for solutes, as well as waves and erosive capacity. The model was established as a tool for description of present and future hydraulic conditions in the study area. The results of the modelling are required in connection with

- assessment and comparison of development scenarios; and
- impact evaluation and design of various specific schemes.

During MES, the model was applied for these purposes. Upon completion of the study, the model remains as a tool that can be used in connection with the future development of Meghna Estuary, at the general planning level as well as at the individual project level.

2 Methodology

2.1 Background

The model that was set-up, calibrated and applied for MES is the most recent in a series of numerical hydraulic models of the Estuary. In addition to LRP, previous studies comprise

- Pussur-Sibsa River and Karnafuli Entrance, Ministry of Shipping (1989-92);
- Numerical Simulation of Tides and Saline Water Intrusion, IFCDR, BUET (1989);
- Cyclone Protection Project II, BWDB (1990-91);
- Southwest Area Water Resources Management Project (FAP4), FPCO (1991-93); and
- Cyclone Shelter Preparatory Study (CSPS), Phases I and II, LGED (1995-98).

All these studies involved application of the same modelling system (DHI's MIKE 21, previously named System 21), in a set-up which was gradually upgraded in the course of time. In this connection, large amounts of data and information have been compiled.

Satellite imagery analyses made by EGIS for MES in 1996 showed, however, that the planform of the estuary had changed comprehensively in recent years due to its dynamic morphological environment. Against expectations, the data basis that was available at the time had grown partly obsolete and inconsistent, which caused considerable difficulties in connection with the CSPS model calibration. Further, during that project, it appeared that it was difficult to identify the reference level for the estimated storm surge heights in the field. This was a main reason for initiating the joint CSPS/MES geodetic survey in the area, which took place in the first half of 1996. At the same time, it was decided to suspend the MES modelling activities until better data had been produced. The work was discontinued temporarily, while nearly the entire study area was surveyed by MES from BWDB/SSD's vessel 'Anwesha'.

The MES model, as described in this report, is based on planform, bathymetry and calibration data from 1996-97. Therefore, it is superior to former models with respect to description of present conditions in the area.

2.2 Modelling Procedure

Where earlier models had adopted a nested grid philosophy i.e. with models covering not only the Meghna Estuary but also the northern part of the Bay of Bengal, it was decided to concentrate only on the Meghna Estuary in the present study. In this way it was anticipated that calibration problems which were experienced in the earlier models and which were made more complicated through the use of a nested model approach could be avoided.

Furthermore it was decided to calibrate the model not only against tidal water level variations as earlier models had been, but also against actual water level measurements combined with flow measurements. The measurements and the new bathymetric survey data would constitute a coherent set of model data thus facilitating an improved model calibration.

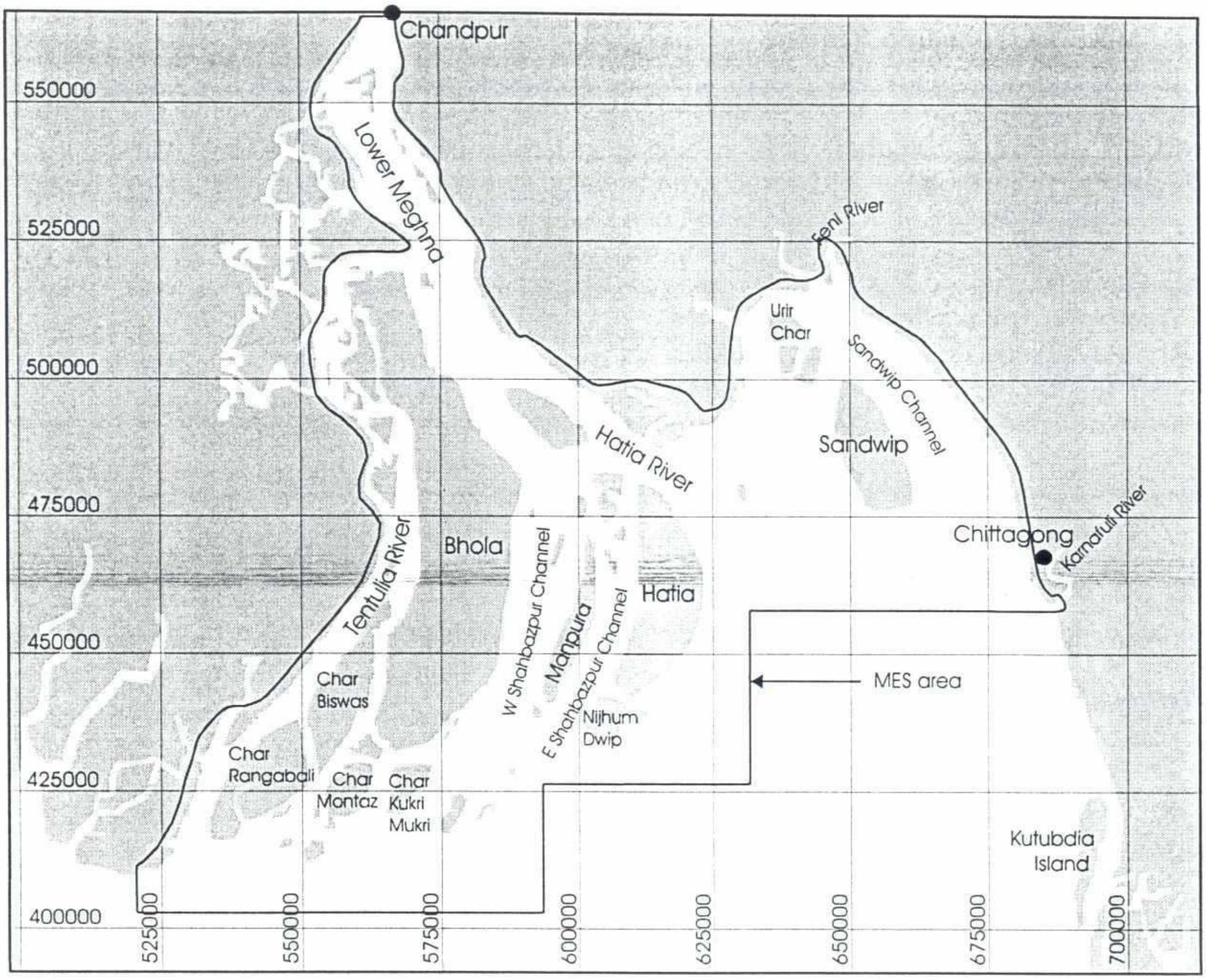
The area covered by the numerical model is shown in figure 2.1.

The grid spacing of the model was selected on the basis of:

- required resolution of the flow field within the estuary
- available computer resources

On this basis a resolution of 600 meters in the whole of the estuary was chosen with local models having a resolution (i.e grid spacing) of 200 meters.

Figure 2.1 Area covered by the numerical model



The model has two open boundaries:

- one at Chandpur to the North, where water level measurements were available
- and one to the South, where water level predictions were available at Kutubdia Island.

As the flow in the estuary differs considerable from the dry season to the monsoon season one calibration period was selected for each of these seasons. Furthermore two validation periods were selected, one from each season.

The procedure for the hydrodynamic modelling consisted of the following steps:

- making a bathymetry based on the new survey data combined with satellite imagery and other data sources
- calibration and validation
- applying the model for a number of periods with known conditions (base runs)
- applying the model for a number of selected scenarios (including intervention schemes)

In addition to hydrodynamic modelling also salinity modelling, wave modelling and sediment transport modelling were conducted for the study area.

A calibration of the salinity model was carried out while no data were available for a calibration of the wind-wave model.

Calibrating the sediment transport model was outside the scope of the present study. The results of this model are therefore to be considered as indicative only.

2.3 MIKE 21 Modelling System

For all types of modelling carried out during the numerical modelling study DHI's Modelling System for two-dimensional flows in one layer, MIKE 21, was applied. MIKE 21 is a software package containing a comprehensive modelling system for 2D free-surface flows. MIKE 21 is applicable to the simulation of hydraulic and related phenomena in lakes, estuaries, bays, coastal areas and seas where stratification can be neglected.

For the present study four different modules of MIKE 21 were applied:

- The Hydrodynamic Module, MIKE 21 HD
- The Advection-Dispersion Module, MIKE 21 AD
- The Nearshore Spectral Wind-wave Module, MIKE 21 NSW and
- The Non-cohesiveSediment Transport Module, MIKE 21 ST

Each of these modules are described in Appendices A to D.

2.4 Overview of Model Simulations

The following model simulations were carried out during the study:

Existing situation (ie with no interventions)

- Hydrodynamic simulations, each 17 days (the whole model area):
  - Dry season 1996 (calibration period and base run)
  - Monsoon season 1996 (validation period)
  - Dry season 1997 (validation period)
  - Monsoon season 1997 (calibration period and base run)
- Hydrodynamic simulation, 2 days during spring tide (local model around Nijhum Dwip):
  - Dry season 1996
- Salinity simulation, 17 days (the whole model area):
  - Dry season 1996
- Wind-wave simulations, stationary conditions (whole model area):
  - wind of 8 m/s from SSE (water level corresponding to monsoon season 1997)
  - wind of 8 m/s from SSW (water level corresponding to monsoon season 1997)
- Sediment Transport simulations (whole model area):
  - Dry season 1996, spring tide, no waves
  - Dry season 1996, neap tide, no waves
  - Monsoon season 1997, spring tide, waves from SSE
  - Monsoon season 1997, spring tide, waves from SSW
  - Monsoon season 1997, neap tide, waves from SSE
  - Monsoon season 1997, neap tide, waves from SSW

Including interventions 1 and 3 (see figure 6.1)

- Hydrodynamic simulations, each 17 days (the whole model area):
  - Dry season 1996
  - Monsoon season 1997
- Hydrodynamic simulation, 2 days during spring tide (local model around Nijhum Dwip):
  - Dry season 1996

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Including all interventions except 8 (see figure 6.1)

- Hydrodynamic simulations, each 17 days (the whole model area):
  - Dry season 1996
  - Monsoon season 1997

Including all interventions (see figure 6.1)

- Hydrodynamic simulations, each 17 days (the whole model area):
  - Dry season 1996
  - Monsoon season 1997
- Hydrodynamic simulation, 2 days during spring tide (local model around Nijhum Dwip):
  - Dry season 1996
- Salinity simulation, 17 days (the whole model area):
  - Dry season 1996

The simulations are described in Chapters 4 through 9.

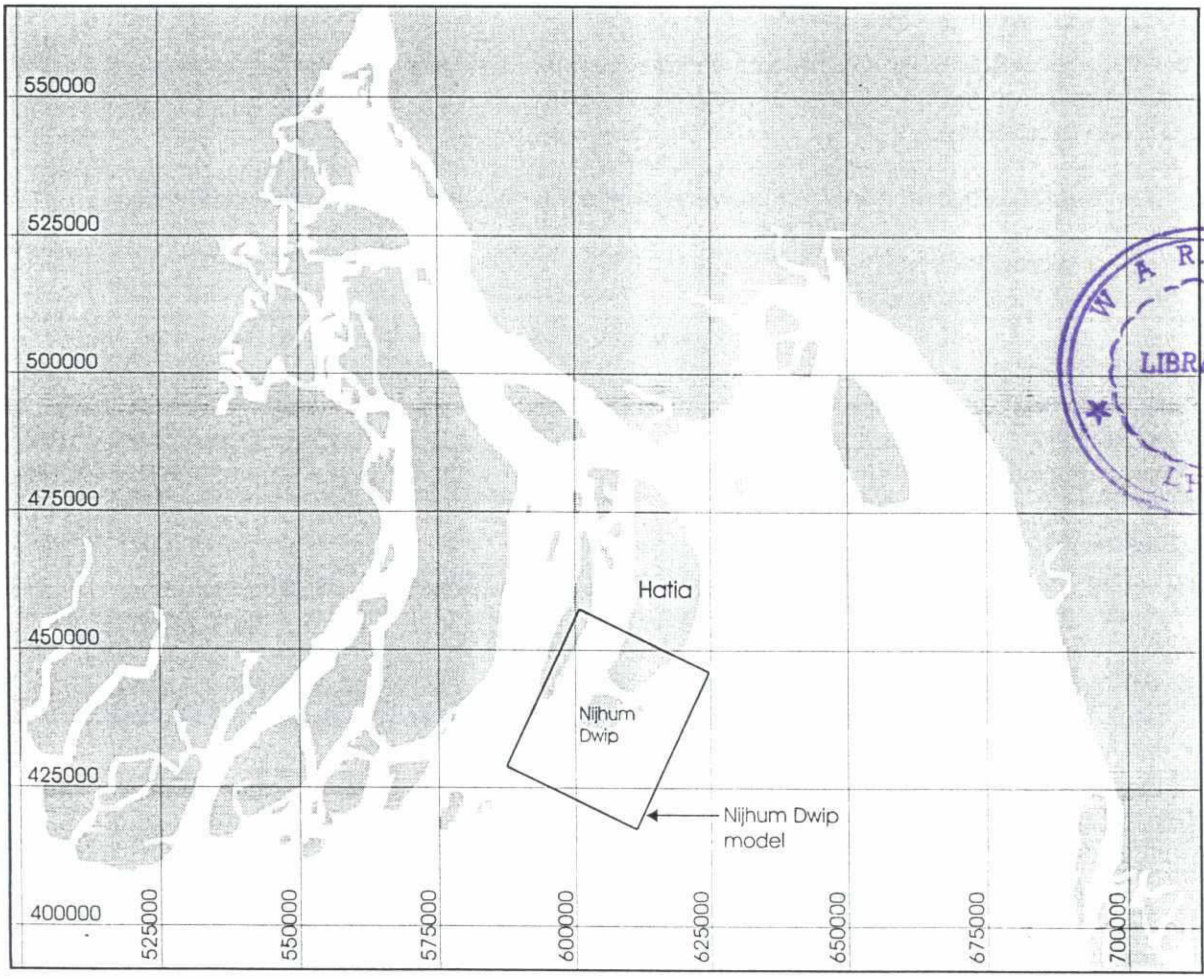
Table 3.1 Model grid definitions

	Meghna Estuary Model	Nijhum Dwip Local Model
Origo (longitude, latitude) (deg)	89.9710, 21.6329	90.8460, 21.9639
Origo (easting, northing) (m BTM)	497000, 392000	587337, 428873
Orientation (deg)	0.0	25.34
Grid extend x-dir., y-dir	0..360, 0..291	0..132, 0..157
Grid spacing (m)	600	200
Model area (km^2)	37948	841

The basic data for the bathymetry for this model was the same as was used for the 600 meter model bathymetry, and the interpolation and smoothing procedure were similar to the one applied for the 600 meter bathymetry.

Drawing 3.6 shows the 200 meter bathymetry of the Local Nijhum Dwip Model, while the model grid definition is given in table 3.1. Finally figure 3.1 shows the location of the model.

Figure 3.1 Location of Nijhum Dwip Local Model



4 Hydrodynamic Model Set-up

4.1 General

Based on the availability of measurements of water levels, wind and discharge (ADCP-data), the four simulation periods listed in table 4.1 were selected. Each simulation covers a period of 17 days allowing for warm-up of the model (1-2 days) plus a neap tide and a spring tide period.

Table 4.1 Simulation periods

Simulation name	Simulation period	
	start	end
Dry season 1996 (calibration period and base run)	03 Feb 96 00:00	20 Feb 96 00:00
Monsoon season 1996 (validation period)	23 Aug 96 00:00	09 Sep 96 00:00
Dry season 1997 (validation period)	01 Jan 97 00:00	18 Jan 97 00:00
Monsoon season 1997 (calibration period and base run)	08 Sep 97 00:00	25 Sep 97 00:00h

The simulation of the hydrodynamics in the Meghna Estuary was carried out using DHI's Hydrodynamic Model for 2D free-surface flows, MIKE 21 HD. A description of the model is included in appendix A.

For the model the following input data were applied in addition to the model bathymetry:

Basic model parameters:

- time step of 60 seconds

Initial conditions:

- water level of 0.46 m PWD corresponding to MSL
- cold start, i.e. all fluxes equal zero
- soft start of 6 hours

Boundary conditions:

- northern boundary: measured water levels (relative to PWD) at Chandpur
- southern boundary: tidal level from Kutubdia predicted from tidal constituents (from ATT [1]) as listed in table 4.2. Seasonal variations in the mean water level of -0.3 m (January), -0.4 m (February), 0.5 m (August), and 0.4 m (September) were applied. The predictions were finally related to PWD by adding 0.46 m. (See the section on model calibration for a final description of this boundary).

Driving forces:

- wind speed and direction measured at Hatia (from BMD) were applied for the whole model area (see drawings 4.1 to 4.4)
- inflow from rivers except for Lower Meghna during the two monsoon simulations: Feni River: 2500 m^3/s and Karnafuli River: 600 m^3/s. The flow from these two rivers was ignored during the dry season.

Calibration factors:

- bed resistance (see the model calibration below)
- wind friction factor: varying linearly from 0.0016 at 0 m/s to 0.0026 at 24 m/s
- momentum dispersion coefficients (eddy coefficients, E):
  $E = 0.015 \bullet \Delta x^2/\Delta t$

  where

  Δx is the grid spacing

  Δt is the time step

Table 4.2 Tidal constituents at Kutubdia Island (from ATT [1])

Tidal constituent	Amplitude (m)	Phase (deg) (UTC+6)
M2	1.16	337
S2	0.48	6
K1	0.18	349
O1	0.07	347
1/4 diurnal	0.017	241
1/6 diurnal	0.014	26

4.2 Hydrodynamic Model Calibration, 600 m Model

The model calibration was based on:

- comparison of measured water levels and predicted tidal levels with simulated water levels for the dry season period in 1996
- comparison of tidal constituents derived from the dry season period in 1996 with tidal constituents from tidal tables
- comparison of water levels, predicted tidal levels and measured discharges with simulated data for the monsoon season period in 1997.

Emphasis was put on the water level comparison for the dry season period in 1996.

The bed friction and the water level variation at the southern boundary were used as calibration factors.

The final bed friction coefficients (Manning Numbers) are shown in drawing 4.5. Manning Numbers of up to 100 $m^{1/3}/s$ were applied in those parts of the model describing flows through rivers and channels, while Manning Numbers of 60 $m^{1/3}/s$ were applied in the open parts of the model area.

The high Manning Numbers (i.e the low bed resistance) in the rivers and channels were necessary in order to compensate for the fact that a computational grid of 600 m is barely adequate to resolve the flow in the braided river channels. Especially flows running at an angle of 45° relative to the computational grid require a small grid size to be resolved without artificial loss of energy. However, using a smaller grid spacing was not possible as the CPU time requirements would thus become too high.

The final time shift of the tidal wave along the southern boundary together with the factor applied to the tidal level is listed in table 4.3.

The time shift reflects the fact that the tidal wave does not travel in an exactly south to north direction but arrives first at the western part of the boundary. The factor on the water levels shows the difference in tidal elevation along the boundary.

Table 4.3 Time shift and factor on water level along southern model boundary

Grid point	Time shift (hours)	Factor on water levels
1	+1 1/25	0.90
50	+.1 1/4	0.925
100	+1	0.95
150	+3/4	0.975
200	+1/2	1.0
250	+1/4	1.0
300	0	1.0
326	+1/4	1.0

4.3 Comparison of Measurements and Simulation Results, Dry Season 1996

Comparison between measured and calculated time series were made at 10 stations where measurements were available and 8 stations where predicted tidal elevations (from ATT [1].) were available. Results are shown in drawings 4.6 through 4.21. The stations are shown in figure 4.1 while their BTM and model coordinates are listed in table 4.4.

An evaluation of each individual station is given in table 4.5.

In addition to standard chart datum (CD) to PWD corrections it has been found necessary to apply extra corrections to the water level measurements and tidal predictions in order to achieve the fit shown. These extra corrections together with the standard corrections are listed in table 4.6.

Table 4.4 BTM and model coordinates of recording stations and tidal prediction stations

Station	BTM coordinates (m)		Model coordinates		Depth in model (m PWD)
	Easting	Northing	J	K	
Chandpur	566690	567978	114	291	-3.0
Char Chenga	610691	458354	188	111	-8.9
Chittal Khali	589871	508155	155	189	-2.9
Dasmunia	557041	458774	100	110	-11.2
Daulatkhan	573636	502898	128	185	-3.9
Dhulasar	522957	415600	43	39	-2.0
Dhulia	555110	494762	98	172	-7.6
Hatia Bar	597713	486428	168	157	-6.8
Khal No. 18	685510	457713	316	111	-3.6
Khepupara	522935	431061	43	65	-4.0
Kochopia	568946	434527	121	66	-1.2
Kutubdia Island	689408	419003	322	45	-6.3
Norman's Point	687276	454036	317	103	-5.4
Rabnabad Channel	537828	440055	68	80	-3.5

Station	BTM coordinates (m)		Model coordinates		Depth in model (m PWD)
	Easting	Northing	J	K	
Ramdaspur (Ilsa Ghat)	567662	522585	118	216	-3.5
Sandwip	649194	482135	254	150	-9.0
MES 1	540014	412723	72	35	-4.1
MES 2	591975	426766	158	58	-9.4
MES 4	664455	500204	279	180	-9.0
MES 5	637347	513778	234	203	-5.7
MES 6	592000	500000	158	180	-5.3
MES SE	694105	413510	329	36	-5.1

Figure 4.1 *Locations used for comparison of measured/predicted water levels with simulated water levels.*

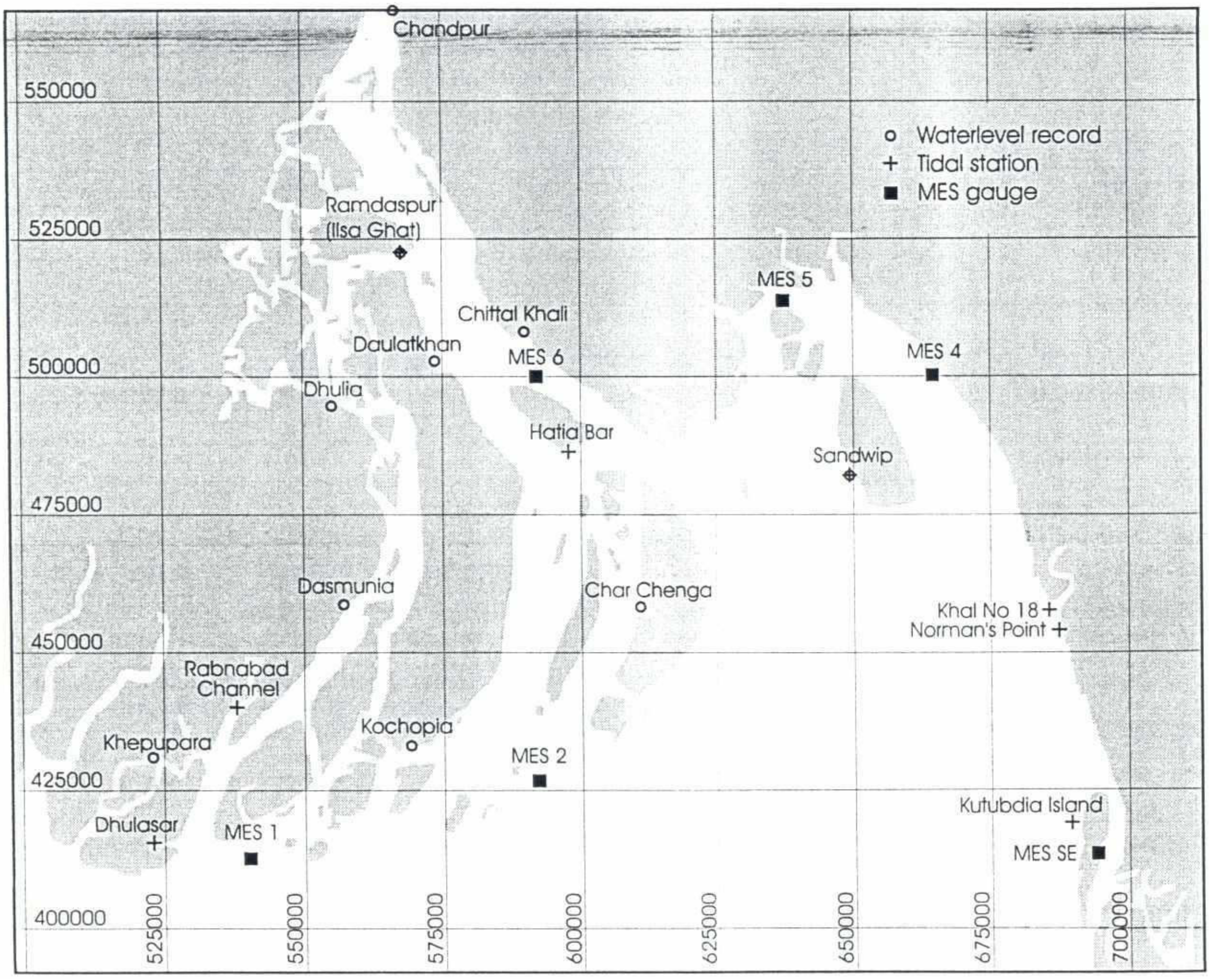


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Table 4.5 Comparison of measured/predicted water levels and simulated water levels for dry season 1996 period.

Station	Measurement (M) and/or tidal prediction (TP)	Evaluation
Chandpur	M	This is the prescribed northern boundary. Therefore a perfect fit is seen.
Char Chenga	M	A good fit.
Chittal Khali	M	A good fit.
Dasmunia	M	A good fit.
Daulatkhan	M	A good fit.
Dhulasar	TP	The amplitude of the simulation results are a little higher than the tidal prediction.
Dhulia	M	Although the amplitude of the simulation results are smaller that the measured amplitudes the fit is considered good.
Hatia Bar	TP	The simulated amplitudes are smaller than the predicted ones. These however are based on tidal constants which are most likely computed when the flow in this changing and dynamic area was different.
Khal No. 18	TP	A good fit.
Khepupara	M	Khepupara is up a small river where a 2-D model is not very accurate. Most likely this explains the phase difference between simulated and predicted water levels.
Kochopia	M	A minor shift in mean level and in phase is found. Otherwise a good fit.
Kutubdia Island	TP	A very good fit as this station is applied at the nearby southern model boundary.
Norman's Point	TP	A good fit.
Rabnabad Channel	TP	A good fit.
Ramdaspur (Ilsa Ghat)	M & TP	The amplitude of the simulation results is considerable smaller than the measurements but fit the tidal prediction reasonable well. (It should be noted that the simulation results in this part of the model are very sensitive to changes in the depth of the Lower Meghna.)
Sandwip	M & TP	A good fit.

Table 4.6 Water level corrections for measurements (meas) and tidal stations (tide)

Station	Meas*	ATT tide station no.	Season-al corr. on tide	MSL to PWD corr. for tide	Extra corr. on tide	CD to PWD corr. on meas.	Extra corr. on meas.
Chandpur	x					0.25	
Char Chenga	x					-1.18	-0.22
Chittal Khali	x					-1.35	
Dasmunia	x					-0.55	
Daulatkhan	x					0.04	

Station	Meas*	ATT tide station no.	Season-al corr. on tide	MSL to PWD corr. for tide	Extra corr. on tide	CD to PWD corr. on meas.	Extra corr. on meas.
Dhulasar		4502	**	0.46	0.18		
Dhulia	x					-0.66	0.27
Hatia Bar		4506	**	0.46	0.53		
Khal No. 18		4511	**	0.46	0.10		
Khepupara	x					-1.96	0.18
Kochopia	(x)					-1.60	
Kutubdia Island		4514	**	0.46	0.06		
Norman's Point		4510	**	0.46	0.09		
Rabnabad Channel		4503	**	0.46	0.28		
Ramdaspur (Ilsa Ghat)	x	4507a	**	0.46	1.02	-0.66	
Sandwip	x	4507	**	0.46	0.07	-1.71	-0.85
MES 1	(x)						-0.76
MES 2	(x)						-0.75
MES 4	(x)						-0.95
MES 5	(x)						-1.26
MES 6	(x)						-0.40
MES SE	(x)						-0.45

* (x): Measurements only available for one of the four calibration and validation periods, ie the dry season 1997 period.

** Seasonal variations for the four calibration and validation periods are given in table 4.7.

Table 4.7 Tidal seasonal variations (from ATT [1])

Station	ATT tide station no.	Dry season period 1996	Monsoon season period 1996	Dry season period 1997	Monsoon season period 1997
Dhulasar	4502	-0.40	0.45	-0.30	0.45
Hatia Bar	4506	-0.40	0.45	-0.30	0.45
Khal No. 18	4511	-0.40	0.45	-0.30	0.45
Kutubdia Island	4514	-0.40	0.45	-0.30	0.45
Norman's Point	4510	-0.40	0.45	-0.30	0.45
Rabnabad Channel	4503	-0.40	0.45	-0.30	0.45
Ramdaspur (Ilsa Ghat)	4507a	-0.70	0.95	-0.60	0.95
Sandwip	4507	-0.40	0.45	-0.30	0.45

A tidal analysis of the simulation has been carried out in order to make a comparison of tidal constituents from [1] with tidal constituents from the model simulation. It should be noted that the length of the simulation period (16 days) is not sufficient to extract important tidal constituents like K_2, as the magnitude of the tidal constants from the model simulations are influenced by non-resolved constituents. Furthermore wind is included in the simulation which may also influence the magnitude of the constants.

Co-tidal charts showing amplitudes and phases for the four main tidal constituents (M_2, S_2, O_1 and K_1) are shown in drawings 4.22 through 4.29. Furthermore tables 4.8a and b list a comparison between tidal constituents from [1] and from the tidal analysis of the simulation, while table 4.8c lists the shallow water corrections also included in the ATT. Generally a good agreement is found keeping in mind that the simulation was not intended for tidal analysis but for comparison on a time series basis. If tidal constituents are required for the study area a longer tide-only simulation should be carried out and a tidal analysis performed

Table 4.8a *Comparison of semi-diurnal tidal constituents from ATT [1]. and the dry season 1996 period simulation*

Station	M_2 amplitude (m)		M_2 phase (deg)		S_2 amplitude (m)		S_2 phase (deg)	
	ATT	model	ATT	model	ATT	model	ATT	model
Dhulasar	0.73	0.92	317	312	0.35	0.42	358	6
Hatia Bar	1.19	0.99	69	62	0.47	0.36	111	119
Khal No. 18	1.63	1.53	15	5	0.53	0.64	55	62
Kutubdia Island	1.16	1.31	337	335	0.48	0.58	6	27
Norman's Point	1.36	1.48	359	3	0.54	0.62	30	59
Rabnabad Channel	0.75	0.77	336	348	0.29	0.33	27	43
Ramdaspur (Ilsa Ghat)	0.67	0.57	136	118	0.67	0.19	179	174
Sandwip	1.84	1.79	33	36	0.65	0.74	81	97

Table 4.8b *Comparison of diurnal tidal constituents from [1]. and the dry season 1996 period simulation*

Station	K_1 amplitude (m)		K_1 phase (deg)		O_1 amplitude (m)		O_1 phase (deg)	
	ATT	model	ATT	model	ATT	model	ATT	model
Dhulasar	0.13	0.14	9	16	0.04	0.07	355	339
Hatia Bar	0.12	0.12	46	62	0.07	0.08	12	13
Khal No. 18	0.18	0.18	12	30	0.09	0.09	2	353
Kutubdia Island	0.18	0.18	349	18	0.07	0.08	347	346
Norman's Point	0.18	0.18	351	30	0.06	0.09	354	352
Rabnabad Channel	0.16	0.12	25	35	0.05	0.07	10	351
Ramdaspur (Ilsa Ghat)	0.11	0.08	82	104	0.07	0.06	57	49
Sandwip	0.15	0.18	25	44	0.09	0.09	1	4

Table 4.8c *Shallow water corrections included in ATT [1]*

Station	1/4 diurnal		1/6 diurnal	
	Amplitude (m)	Phase (deg)	Amplitude (m)	Phase (deg)
Dhulasar	0.095	227		
Hatia Bar	0.097	278		
Khal No. 18	0.026	249	0.007	59
Kutubdia Island	0.017	241	0.014	26
Norman's Point	0.045	240		
Rabnabad Channel	0.135	250	0.051	106
Ramdaspur (Ilsa Ghat)	0.279	280	0.080	165
Sandwip	0.041	289	0.011	67

Based on the comparisons shown and discussed above the model calibration is considered satisfactory.

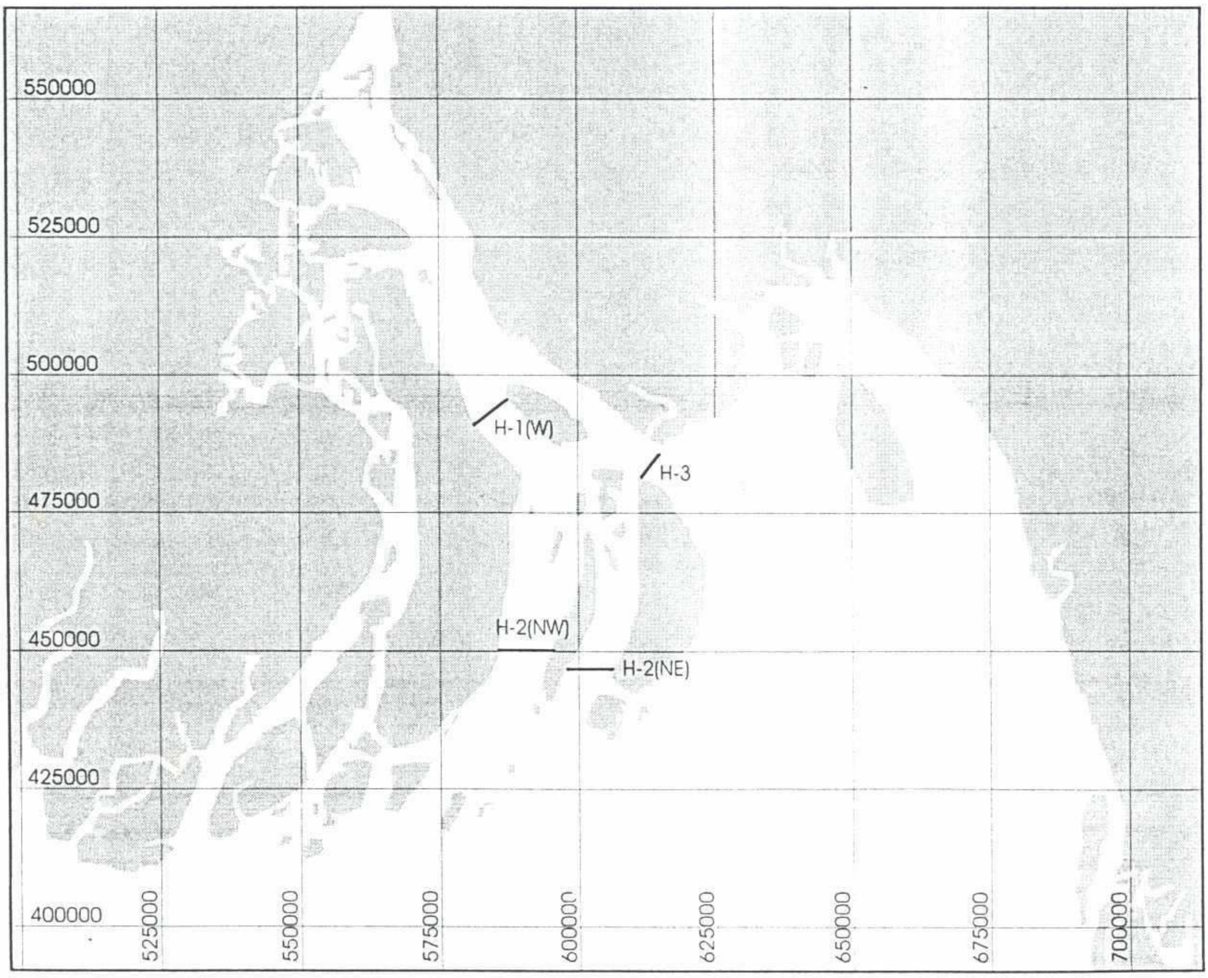
4.4 Comparison of Measurements and Simulation Results, Monsoon Season 1997

At 9 stations, water level measurements were available and at 8 stations, predicted tidal elevations (from ATT [1].) were available. Forthese stations comparisons with simulated water levels are shown in drawings 4.30 through 4.44. The stations are shown in figure 4.1 while their BTM and model coordinates are listed in table 4.4.

Also, comparisons of discharges have been made. These are shown in drawings 4.45 to 4.50. The cross sections where the ADCP measurements are made are shown in figure 4.2 Generally the measured/predicted water levels and the simulated water levels compare well although not as good as for the dry season 1996 period, while the discharge measurements and the simulated discharge compare well.

In all the calibration is considered to be satisfactory.

Figure 4.2 Locations of cross sections with ADCP measurements used for comparison with simulated discharges



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4.5 Hydrodynamic Model Validation

For validation a dry season period in 1997 and a monsoon period in 1996 (see table 4.1) were simulated using the calibrated model.

Comparisons of time series of measured/predicted and simulated water levels for the two simulations are shown in drawings 4.51 through 4.88. The stations are shown in figure 4.1 while their BTM and model coordinates are listed in table 4.4.

For both periods, the comparison is satisfactory, although the concordance is better for the dry season period than for the monsoon season period as it was the case for the model calibration.

4.6 Nijhum Dwip Local Hydrodynamic Model

No measurements were available for a calibration or validation of the Nijhum Dwip Local Model. Therefore the same model parameters were used for this model as for the surrounding 600 meter model.

A local model simulation was carried out covering 4 tidal periods during spring tide of the dry season 1996 period: 06 February 1996 00:00 to 8 February 1996 01:30. The boundary conditions were taken from the surrounding 600 meter model.

The simulation results are discussed in section 5.3.

5 Hydrodynamic Baseline Simulations

5.1 Dry Season 1996

As reference simulation (or baseline simulation) for the dry season the calibration simulation of 1996 was selected.

In order to be able to assess the impact of various interventions on the flow patterns in the estuary the following parameters were extracted for each grid point in the model:

- maximum velocities during spring tide
- maximum velocities during neap tide
- net flow during spring tide
- net flow during neap tide

These parameters are shown in drawings 5.1 to 5.4.

5.2 Monsoon Season 1997

As base line simulation for the monsoon season the calibration simulation of 1997 was selected.

The base line conditions for the monsoon season were extracted and presented similar to the dry season base line simulation.

These maximum velocities and net flows for the monsoon season base line simulation are shown in drawings 5.5 to 5.8.

5.3 Nijhum Dwip Local Model, Dry Season 1996

For the Nijhum Dwip Local Model the base line simulation covered four tidal cycles during spring tide, dry period 1996 as described under local model set-up.

From this simulation the following parameters were extracted:

- maximum velocities, spring tide (see drawing 5.9)
- net flow, spring tide (see drawing 5.10)

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6 Hydrodynamic Simulations including Intervention Schemes

6.1 Dry Season 1996

Three different scenarios involving three different combinations of intervention schemes (see figure 6.1) were considered in hydrodynamic simulations of the dry season period in 1996:

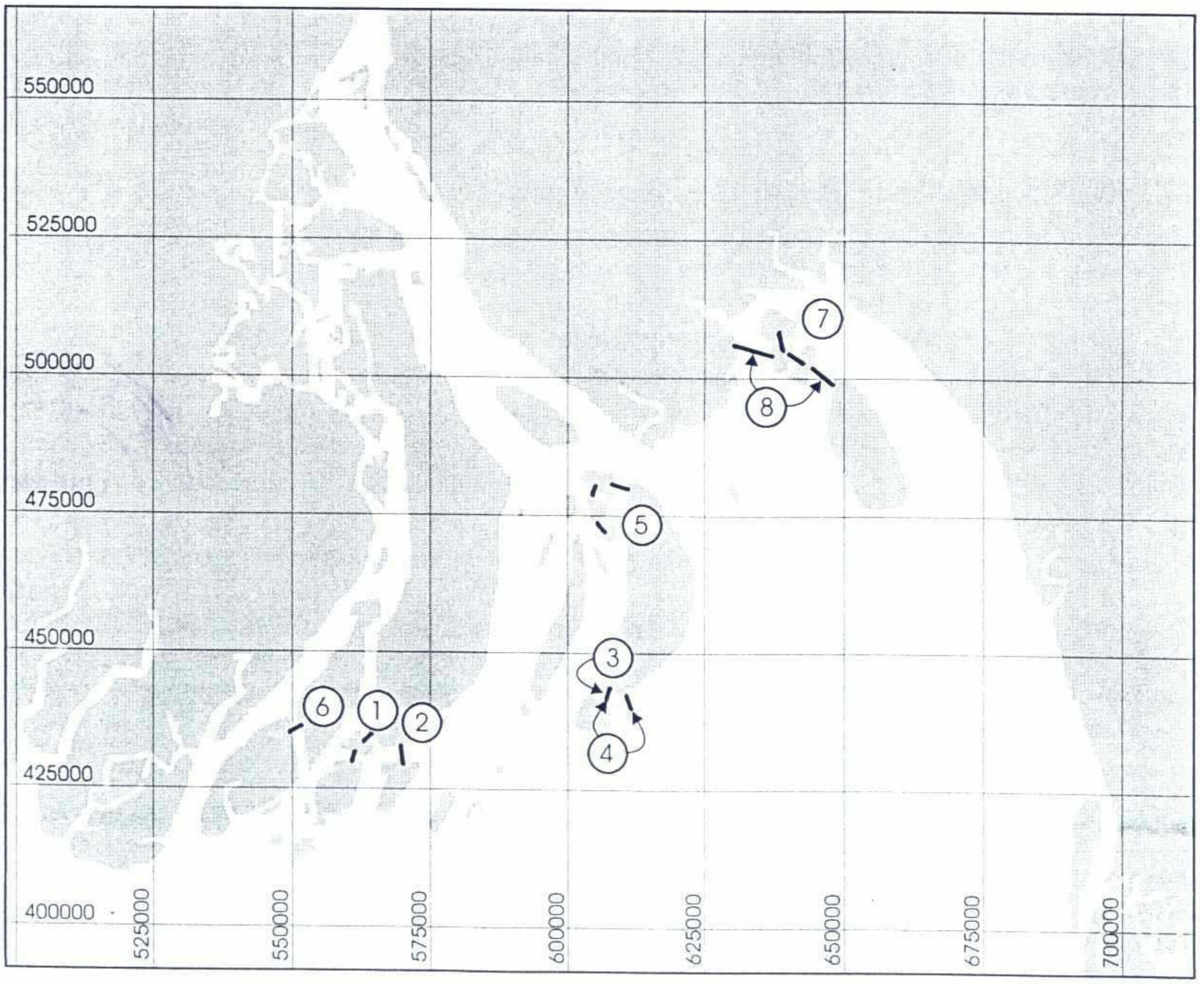
- including interventions no. 1 and 3
- including all interventions except no. 8
- including all eight interventions

For each of these three scenarios the following parameters were extracted from the simulations for comparison with the base line simulation:

- maximum velocities during spring tide
- maximum velocities during neap tide
- net flow during spring tide
- net flow during neap tide

These parameters are shown in drawings 6.1 through 6.12.

Figure 6.1 Intervention schemes considered in the numerical modelling



6.2 Monsoon Season 1997

Simulations were made for the monsoon season 1997 similar to those carried out for the dry season 1996, and maximum velocities and net flows were extracted (see drawings 6.13 through 6.24).

6.3 Nijhum Dwip Local Model, Dry Season 1996

For the local model two different scenarios (see figure 6.1) were considered in hydrodynamic simulations of four tidal periods (spring tide) during the dry season period in 1996:

- including intervention no. 3
- including interventions no. 3 and 4

For each of these scenarios the following parameters were extracted from the simulations for comparison with the baseline simulation:

- maximum velocities during spring tide
- net flow during spring tide

These parameters are shown in drawings 6.25 through 6.28.

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7 Salinity Modelling

7.1 General

The salinity in the Meghna Estuary varies considerably from area to area and from season to season depending mainly on the outflow from the rivers and the tidal flow entering from the sea. During the monsoon season the large outflow from the rivers pushes the salt water well out into the Bay of Bengal, while the salt water during the dry season enters the estuary and the southernmost parts of the rivers emptying into the estuary.

The salinity is an important factor for many parts of the present study. Examples are fisheries, agriculture (especially salinity intrusion) and sedimentation rates.

In the present numerical study only the salinity variation during the dry season has been simulated as the salinity front during this season lies within the study area. If the salinity variation during the monsoon season is to be studied a much larger model area would be required.

7.2 Set-up of Salinity Model

The hydrodynamic model described in the previous chapters is a depth-integrated model assuming one-layer vertically homogeneous flow. In estuaries stratified two-layer flow occurs often with fresh water on top of salt water. In the Meghna Estuary the two layers are, however, well mixed most of the time (according to [2]), so the use of a one-layer model is therefore justified.

DHI's Advection-Dispersion Model, MIKE 21 AD, was applied for the same model area (and using the same model bathymetry) as the hydrodynamic model described in the previous chapters. MIKE 21 AD simulates the spreading of a dissolved or suspended substance in an aquatic environment under the influence of the fluid transport and associated natural dispersion processes. A more detailed description is given in Appendix B.

In addition to simulating the transport and spreading of salt and fresh water MIKE 21 AD also takes into account the density driven currents, i.e. the current generated by the difference in density of fresh water and saline water. The results of MIKE 21 AD is thus not only salinity concentration fields but also water levels and fluxes like MIKE 21 HD. By comparing the water levels from the two models the effect of the density differences can be quantified.

7.3 Salinity Model Calibration

Two sources of salinity data for calibrating the salinity model for a dry season period were available:

- LRP data [2] (0.5 m above sea bed and 0.5 m below surface)
- MES data (profiles)

As the LRP data covered the estuary more extensively then the MES data it was decided to base the salinity modelling on the LRP data by using these data as the initial salinity concentration within the estuary and at the boundary of the salinity model. The MES data were used for model calibration in combination with the LRP data. Drawing 7.1 shows the initial salinity concentrations based on the LRP measurements.

As calibration period for the dry season the period in February 1996 already applied for the hydrodynamic model calibration was selected.

The calibration factors in MIKE 21 AD are dispersion coefficients in the x and y-direction, D_x and D_y, which describe the subgrid scale mixing. Suitable methods for determining these coefficients are subject to intense research but no final formulations have been found. A number of indicative formulations do however exist, and one of these reads:

$$D = K \bullet \Delta x^2/\Delta t$$

where D is the dispersion coefficient in the x or y direction
K is a constant
Δx is the grid spacing
Δt is the time step

Using a value for K of 0.015 as was used for the eddy coefficient in the hydrodynamic simulations yields a first guess of 90 m^2/s for the dispersion factor, which is applied both for D_x and D_y.

A salinity simulation using these dispersion factors does however give salinity concentrations, which are too small in the inner parts of the estuary when comparing both to LRP and MES data. The dispersion coefficient is therefore increased by a factor of 5 to 450 m^2/s, which yields results comparing satisfactory to the measurements (see below). As only limited data are available for calibration of the salinity no further calibration seemed justified.

Drawing 7.2 show the variation of the salinity at different stations throughout the simulation. From this drawing it is concluded that the salinity variations have reached a stable level (taking into account the varying tidal conditions) around 13 February 1996. Minimum, mean and maximum salinities are therefore extracted for the last 14 tidal cycles of the simulation, i.e from 12 February 1996 18:30 to 20 February 1996 00:00. This period also covers the transition from neap to spring tide (see the hydrodynamic model calibration for February 1996).

Table 7.1 shows a comparison of MES measurements in different parts of the estuary (see figure 7.1) with extracted salinity statistics from the simulation. The two sets of data generally show a good agreement:

- *Around northern and eastern part of Hatia*
  a very good agreement is found

- *Around northern half of Sandwip*
  the simulation results vary between 13 ppt and 19 ppt, while most of the measurements are between 3 and 4 ppt. A salinity of 16 ppt has however also been measured close to a location where 3.4 ppt was measured only two days earlier, thus documenting a large salinity variation in time. By looking at the flow pattern during the measuring period an explanation for the variation and thus the difference between the simulation results and the measurements may be found.

- *South and east of Nijhum Dwip:*
  Generally a very good agreement between measurements and simulation results is found. The only difference occurs in a location with a measured salinity of 4.5 and 8.5 ppt, where the maximum salinity simulated was 3.9 ppt.

- *Southwest corner of study and south of Char Montaz:*
  The measurements in this area vary between 10 and 14 ppt, which is comparable to the simulation results. However in one location the measurement is smaller that the simulation result while in another one the measurement is larger than the simulation results. This discrepancy illustrates the large salinity variations in this part of the study area, variations which are also found in the simulation results. The comparison is thus considered to be satisfactory.

Table 7.1 Comparison of measured and simulated salinities during the dry season.

Area	Position		Measurements		Model simulation results		
	Easting	Northing	Date	Depth average salinity (ppt)	Min. salinity (ppt)	Mean salinity (ppt)	Max. salinity (ppt)
Around Northern and Eastern part of Hatia	610150	472736	29-jan-97	12.2	1.3	4.5	10.5
	610243	473018	02-feb-97	6.3	1.3	4.6	10.6
	609563	477570	03-feb-97	10.7	1.3	4.9	11.0
	611069	486729	26-feb-97	2.5	0.2	2.6	8.9
	614263	480411	26-feb-97	3.0	0.4	5.3	12.2
	623242	454113	04-feb-97	12.3	11.3	12.8	13.9
Around Northern half of Sandwip	663610	501628	27-feb-97	3.2	15.3	17.5	19.0
	664128	499958	01-mar-97	16.4	15.7	17.7	19.2
	646987	486798	01-mar-97	3.4	14.4	15.4	16.4
	644780	493520	02-mar-97	3.4	12.9	14.9	16.7
	647021	486864	03-mar-97	3.4	14.4	15.4	16.4
South and East of Nijhum Dwip	599503	439430	22-jan-97	4.5	1.7	2.3	3.9
	600070	439411	26-feb-97	8.5	1.7	2.3	3.9
	604569	447173	24-jan-97	4.6	1.6	2.3	5.4
	591570	427291	25-jan-97	4.2	1.2	3.3	9.5
	604503	447114	25-jan-97	4.7	1.6	2.3	5.3
	609540	426473	25-jan-97	7.9	5.8	9.2	11.8
	611734	431077	27-jan-97	7.0	5.4	9.5	12.1
	603739	425163	28-jan-97	6.8	3.3	5.8	8.0
Southwest corner of study area and South of Char Montaz	536009	394292	26-mar-97	13.7	19.6	24.3	26.5
	530421	411814	28-mar-97	10.7	7.7	13.3	21.9
	526622	412950	29-mar-97	10.2	6.9	12.9	21.3
	537494	411913	30-mar-97	12.7	9.8	13.0	18.8
	552648	421998	28-mar-97	14.1	2.8	5.2	8.3
	565342	417901	27-mar-97	11.2	2.5	5.9	11.8

7.4 Salinity Model Simulations

Two salinity simulations as listed in table 7.2 have been carried out. In addition to the simulation carried out for calibration one simulation for the same period but including all intervention schemes has also been made. For each of these simulations the minimum, mean and maximum salinity have been extracted.

Furthermore the difference in mean water level caused by the inclusion of density differences in the hydrodynamic computations is shown in drawing 7.3. From this drawing it is seen that the mean water level in the estuary is increased by up to 10 cm by including this effect.

The variation of the salinity in the estuary during the simulation period is also shown as an animation on the Presentation CD-ROM prepared as part of the reporting. Looking at such an animation often gives a better explanation of the dynamic salinity variation in the Meghna Estuary than tables and drawings do. (Note for example the inflow of saline water North of Hatia.)

Figure 7.1 Location of measured salinities used for comparison with simulated salinities

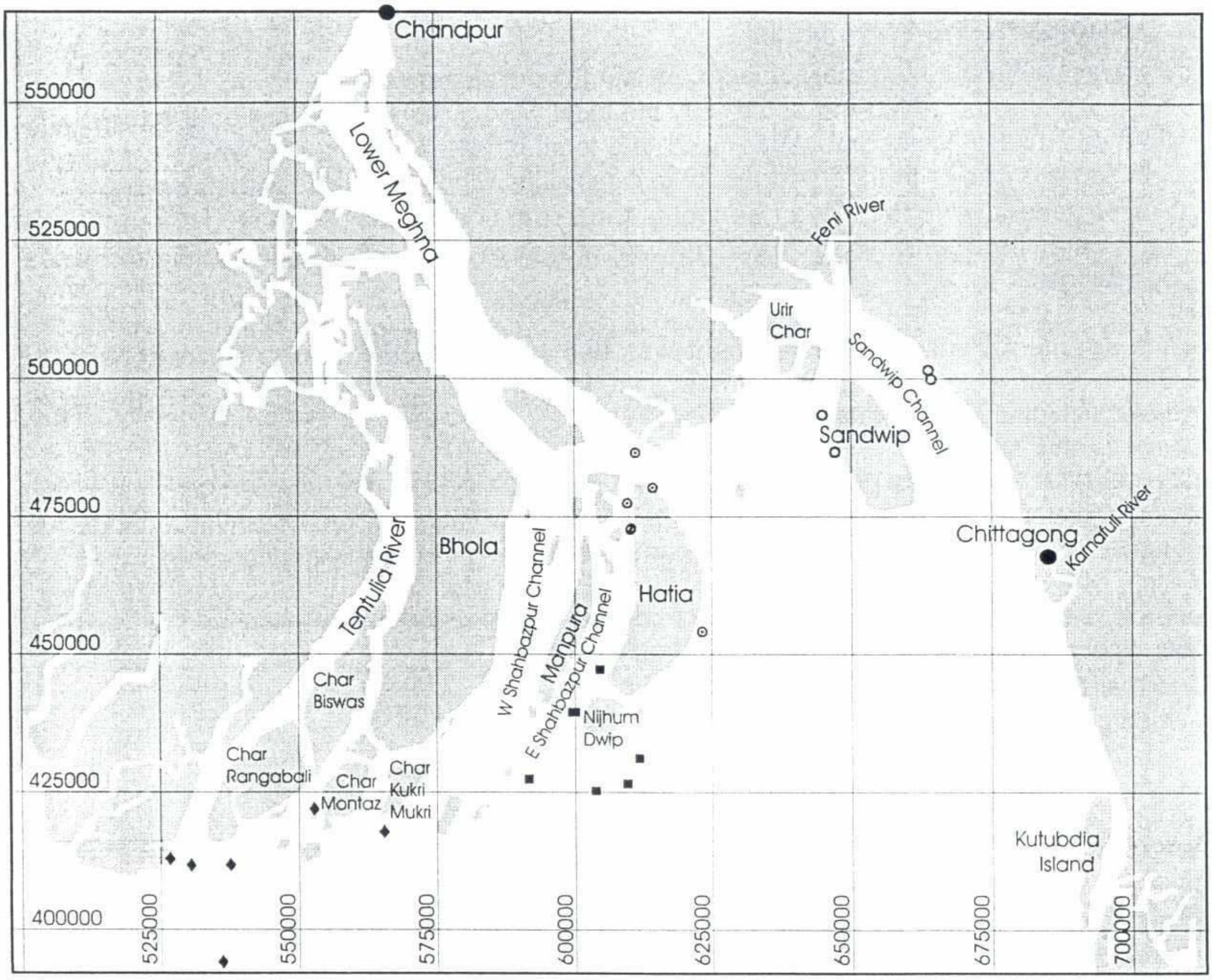

Table 7.2 Salinity model simulations

Intervention Schemes	Min., mean and max. salinity shown in drawings
Existing situation (no intervention schemes)	7.4, 7.5 and 7.6
Including all interventions	7.7, 7.8 and 7.9

8 Wind-Wave Modelling

8.1 General

The purpose of the wind-wave modelling was to determine the wind-wave fields for a number of normally occurring wave conditions within the study area. The simulated wind-wave fields were then subsequently applied in the sediment transport simulations.

8.2 Set-up of Wind-Wave Model

Wind-waves within the Meghna Estuary consist of two types of waves:

- Waves generated within the estuary by the local wind, which may either be the prevailing Northeast or Southwest monsoon wind, the local land/sea breeze, the winds associated with depressions or thunder storms, or in rare cases wind associated with a cyclone.
- Waves generated in the Bay of Bengal to the south of and outside the study area. These waves may be generated by the Southwest monsoon or by depressions or in rare cases by cyclones.

For the sediment transport simulations it was decided to consider waves corresponding to the Southwest monsoon only. On this basis, the model area and the software for making the wind-wave calculations were selected.

DHI's Nearshore Spectral Wind-Wave Model, MIKE 21 NSW, was chosen as this model computes the stationary wave field within a given area for given offshore wave conditions (i.e. wave conditions entering the area from the South) and for given wind conditions.

Generally MIKE 21 NSW describes the growth and decay of short-period waves in nearshore areas. The model takes into account the effects of

- refraction and shoaling due to varying depth
- wind generation
- energy dissipation due to bottom friction and wave breaking.

A short description of MIKE 21 NSW is given in Appendix C.

As only southwest monsoon winds were considered, the wave model area was chosen to coincide with the model area used for the hydrodynamic simulations. If for example waves generated by cyclonic winds were to be computed, a non-stationary wind-wave model covering the whole of the northern part of the Bay of Bengal should have been applied.

Due to the computational scheme applied in MIKE 21 NSW, the grid spacing in the main wave direction should be only 1/4 of the grid spacing perpendicular to the main wave direction. Therefore a grid spacing of 150 m x 600 m was applied. The model bathymetry is shown in drawing 8.1. The depth corresponds to mean sea level computed during the monsoon season simulation for 1997 by the hydrodynamic model.

As no wave measurements were available, no calibration was carried out. The wave fields computed by an uncalibrated model do however still give a good description of the wave conditions in the area. In the calculations the following parameters were applied:

- wave breaking (using Battjes and Janssens formulation): γ_1=1.0, γ_2=0.8 and α=2.0
- bottom friction: Nikuradse roughness parameter, k_N of 0.0002 m

Significant wave heights and wave periods required at the southern model boundary (i.e. the boundary facing the Bay of Bengal) were calculated using the revised Shore Protection

Manual (SPM) formulae given in [3]. A fetch length of 500 km, a 10 m wind speed of 8 m/s and the actual water depth along the boundary were applied.

8.3 Wind-Wave Model Simulations

For use in the sediment transport simulations the wind-wave model simulations listed in table 8.1 were carried out.

Table 8.1 Wind-wave model simulations

Wind conditions	Wave conditions shown in drawings
8 m/s from South-Southeast	8.2
8 m/s from South-Southwest	8.3

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9 Sediment Transport Modelling

9.1 General

Making a numerical sediment transport model of the Meghna Estuary is a large complicated task requiring extensive model calibration. Within the present study period, only a limited effort was envisaged and carried out. The results are thus indicative only and can be considered as a basis for further studies.

9.2 Set-up of Sediment Transport Model

The type of sediment transport model required for a specific area depends on the grain size of the sediment as well as on the governing transport processes. For the Meghna Estuary the sediment can be considered as largely non-cohesive, while the main governing sediment transport mechanisms are the tidal flow and the outflow from the rivers. The effect of the wind-waves on the sediment transport rates is also of importance and should be considered.

On this background DHI's Sand Transport Module of MIKE 21, MIKE 21 ST, was chosen. This model calculates sediment transport rates on a rectangular grid covering the area of interest on the basis of

- hydrodynamic data obtained from MIKE 21 HD simulations,
- wave data obtained from a simulation using MIKE 21 NSW (or another of the MIKE 21 wave models)
- characteristics of the bed material (like grain size and distribution)

When computing the sediment transport rates, MIKE 21 ST takes into account the following effects:

- pure current flow or combined wave-current flow
- arbitrary wave propagation angle relative to the flow direction
- breaking/non-breaking waves
- graded/uniform bed material
- plane/ripple-covered bed

For the present study the formulation of the total load (suspended load plus bed load) by Bijker was applied for pure current flow. For more details on MIKE 21 ST see appendix D.

The following bed material characteristics were applied in the simulations:

- d_{50} = 0.099 mm, grading = 1.44, porosity = 0.4 and relative density = 2.57

Furthermore the following model parameters were applied:

- B = 2.5 (the transport coefficient) and water temperature = 27 °C

The area covered by the sediment transport model corresponded to the area covered by the hydrodynamic model and the wind-wave model.

9.3 Sediment Transport Model Simulations

For use in the assessment of the morphological development of the Meghna Estuary a number of characteristic combinations of tidal regime, river outflow (i.e. season) and wave conditions were selected and simulated. Each simulation covers one tidal cycle (i.e. 12.5 hours) of the hydrodynamic base run simulations as listed in table 9.1, while all simulations are listed in table 9.2 together with the number of the drawing depicting the results of the simulations. The drawings show the sediment transport rates.

The wave conditions applied are described in the previous chapter.

Table 9.1 Tidal periods applied in sediment transport simulations

Season	Tidal regime	Start of tidal period	End of tidal period
Dry season 1996	Spring tide	07 Feb 1996 02:00	07 Feb 1996 14:30
Dry season 1996	Neap tide	13 Feb 1996 20:00	14 Feb 1996 08:30
Monsoon season 1997	Spring tide	18 Sep 1997 01:00	18 Sep 1997 13:30
Monsoon season 1997	Neap tide	11 Sep 1997 07:30	11 Sep 1997 20:00

Table 9.2 Sediment transport simulations

Season	Tidal regime	Wave conditions	Results shown in drawings
Dry season 1996	Spring tide	No waves	9.1
Dry season 1996	Neap tide	No waves	9.2
Monsoon season 1997	Spring tide	Waves from SSE	9.3
Monsoon season 1997	Spring tide	Waves from SSW	9.4
Monsoon season 1997	Spring tide	No waves	9.5
Monsoon season 1997	Neap tide	Waves from SSE	9.6
Monsoon season 1997	Neap tide	Waves from SSW	9.7
Monsoon season 1997	Neap tide	No waves	9.8

Please note that the sediment transport rates should only be applied qualitatively.

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10 Recommendations for Future Model Development

10.1 General

The numerical modelling of the Meghna Estuary has been an on-going learning process throughout the study period. One example is the realisation during the early phases of the study that a bathymetric survey of the entire study area was required in order to be able to describe the existing hydrodynamic conditions properly.

During the later stages of the numerical modelling a number of other possible improvements to the basic modelling data and modelling procedures have been identified. It has not been possible to include all of these in the present study and they are therefore included in this section as recommendation for future modelling work.

On-the-job supervision of SWMC staff by the DHI numerical modelling specialist was carried out throughout the project period. However, in order to properly transfer the modelling techniques it is recommended that formal training in connection with further development and application of the models are conducted.

10.2 Model Bathymetries

Although a bathymetric survey has been carried out for the major part of the study area some parts have not yet been covered. These include especially shallow areas like the shallow area to the West of Sandwip. The shallow areas are important from a hydrodynamic point of view because of their blocking effect on the flow. For the model simulations described in the present report the elevations of these shallow un-surveyed areas are only known with an accuracy of a couple of meters, which makes the degree of "blocking effect" computed by the models uncertain. Therefore it is recommended that the shallow areas within the study area be surveyed and included in the models.

Coastlines and riverbanks are changing rapidly in certain areas of the estuary. The coastlines in the present models are based on satellite mapping in February 1996 supplemented with a few data around Nijhum Dwip from November 1997. In connection with future use of the models, it is recommended that coastlines (and thus riverbanks) are updated regularly.

Due to erosion and accretion, the depths in the estuary are also changing. Regular updates of the model bathymetry are therefore required in order to keep the model up to date.

Interpolation from bathymetric survey lines to a square model grid in rivers and areas with channels in the sea bed is not well performed by standard interpolation routines. Often the depth in between survey lines will be underestimated leading to an unrealistic small flow in the area. During the set-up of the bathymetry this problem was identified but only tedious ad hoc solutions to the problem found. It is therefore recommended that alternative interpolation routines are checked and if necessary developed or acquired. In this way the bathymetric survey data will be better utilised.

10.3 Hydrodynamic Modelling

During the course of MES, water level measurements and ADCP measurements have been collected and utilised in the calibration of the hydrodynamic models. When the model bathymetry is updated with new survey data in the future, and if this update introduces significant changes in the bathymetry, a recalibration of the model with new water levels and new ADCP measurements is recommended.

If the hydrodynamic model is going to be used for modelling of cyclonic surges, a nested model approach as used in the Cyclone Shelter Preparatory Study [4] is required, because a larger area must be covered be the model.

10.4 Salinity Modelling

The salinity modelling carried out and described in the present report describes the salinity variations only during the dry season and only for one case with a known salinity distribution in the estuary. The reason is that the model applied only covers the estuary itself, while the area to the south of the model, which will effect the salinity variation within the estuary especially during the monsoon season but also during the dry season, is not included. Therefore it was only possible to do a simulation with known salinity along the southern model boundary.

If more general salinity simulations are to be made and especially if simulations during the monsoon season are to be carried out, it is recommended to adopt a nested grid approach like the one applied in the Cyclone Shelter Preparatory Study [4]. On the other hand, a demand for such simulations has not been identified.

It is also recommended to carry out more salinity measurements for the calibration of the salinity model. Only on the basis of measurements from the estuary will it be possible to improve the model calibration carried out and described in the present report. Such measurements cost next to nothing if combined with other survey activities.

10.5 Wind-Wave Modelling

The purpose of carrying out wave modelling in the present study was to support the sediment transport assessment. As the tidal flow and the river outflow are the governing forces, only minor emphasis was placed on the wave modelling. A limited number of wave measurements within the estuary to be used for future wave model calibration are however recommended.

It should also be mentioned that satellite measurements of wave heights are available. These do however presently only have an accuracy of 0.5 m or 10% (whichever is the higher) for the significant wave height, and they are only available for open sea areas. They could however be used for the open parts of the estuary as a supplement to the wave measurements.

10.6 Sediment Transport Modelling

The purpose of the sediment transport modelling carried out as part of the present study was to make an assessment of the sediment transport within the study area, while a detailed sediment transport study and a morphological study was outside the scope of the study. A sediment transport model of the Meghna Estuary is a valuable tool in for example impact assessments but it requires an extensive and detailed calibration effort with correspondingly extensive data requirements. As the estuary is a very dynamic area from a sedimentological/morphological point of view it is recommended to further develop the sediment transport model for the estuary, supported by a targeted field programme.

11 References

[1] The Hydrographer of the Navy, Admiralty Tide Tables, 1995.

[2] Meghna Estuary Study, Technical Note MES-004, Salinity Distribution in the Estuary, January 1997.

[3] Hurdle, D.P. and Stive, R. J. H., Revision of SPM 1984 Wave Hindcast Model to Avoid Inconsistencies in Engineering Applications, Coastal Engineering, Vol. 12, pp. 339-351, 1989.

[4] European Commission, Cyclone Shelter Preparatory Study, Stage II: Feasibility Phase, Final Report, Supporting Volume 1, Mathematical Modelling of Cyclone-surge and related Flooding, Appendix C: Bay of Bengal Modelling Complex (MIKE 21), May 1998.

Appendices

Appendix A

MIKE 21 HD
Hydrodynamic Module
A Short Description

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MIKE 21 HD - Release 1.1

HYDRODYNAMIC MODULE

A Short Description

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MIKE 21 HD - HYDRODYNAMIC MODULE

SHORT DESCRIPTION

Introduction

MIKE 21 is a comprehensive modelling system for 2-dimensional free surface flows where stratification can be neglected.

MIKE 21 HD is the basic module of the entire MIKE 21 system. It provides the hydrodynamic basis for the computations performed in most of the other modules, for example the Advection-Dispersion, Water Quality and Sediment Transport modules.

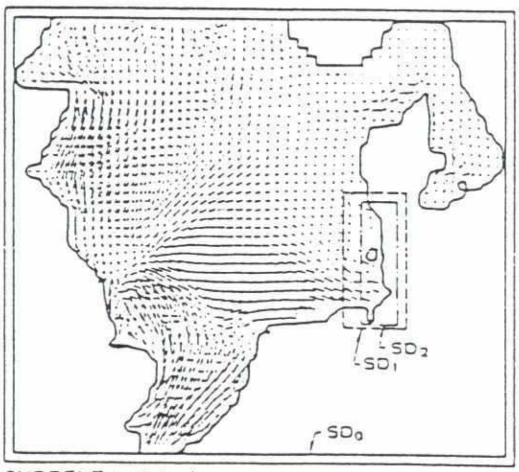
MIKE 21 HD simulates the water level variations and flows in reponse to a variety of forcing functions in lakes, estuaries, bays and coastal areas. The water levels and flows are resolved on a rectangular grid covering the area of interest when provided with the bathymetry, bed resistance coefficients, wind field, hydrographic boundary conditions, etc.

The system solves the equations of continuity and conservation of momentum using implicit finite difference methods.

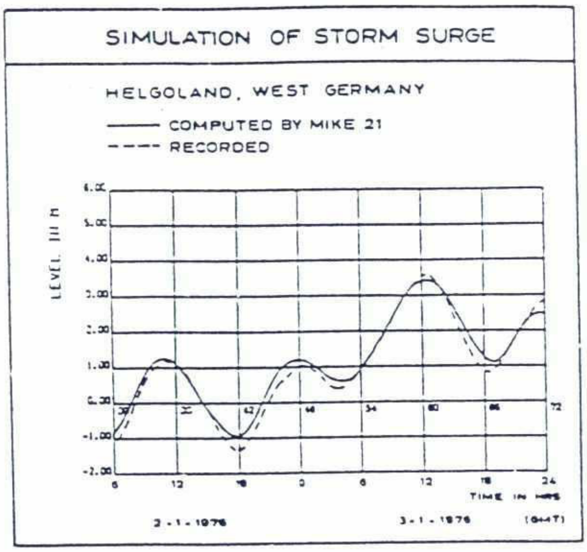
Applications

MIKE 21 HD is applicable to a wide range of hydraulic phenomena:

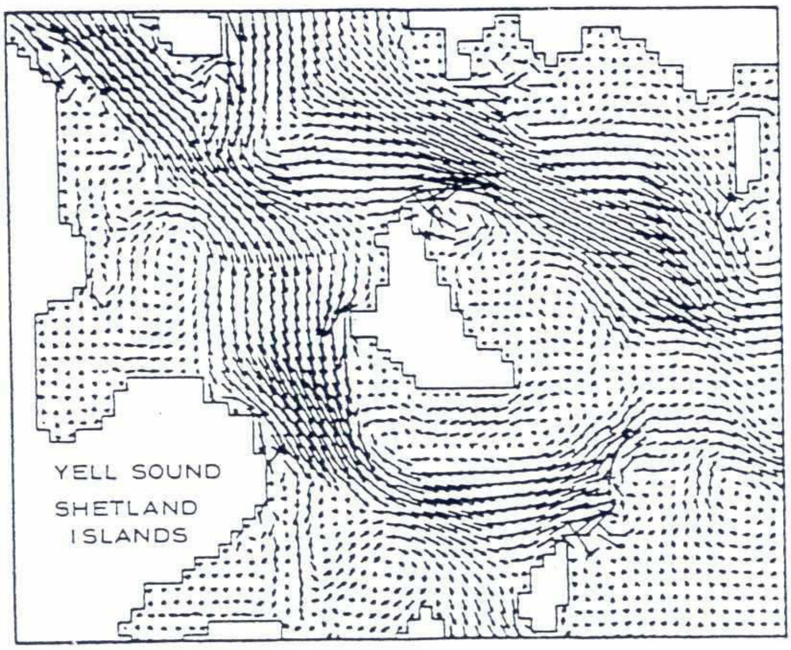
- **Tidal exchange and currents**



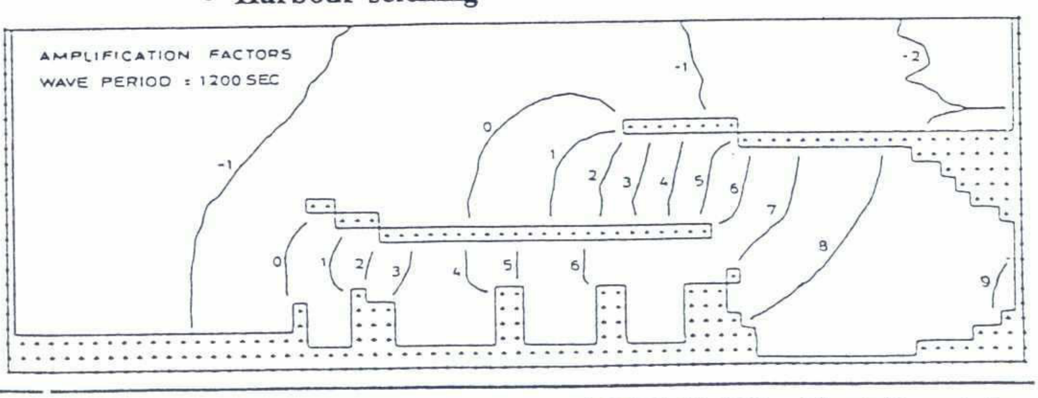
- Storm surge



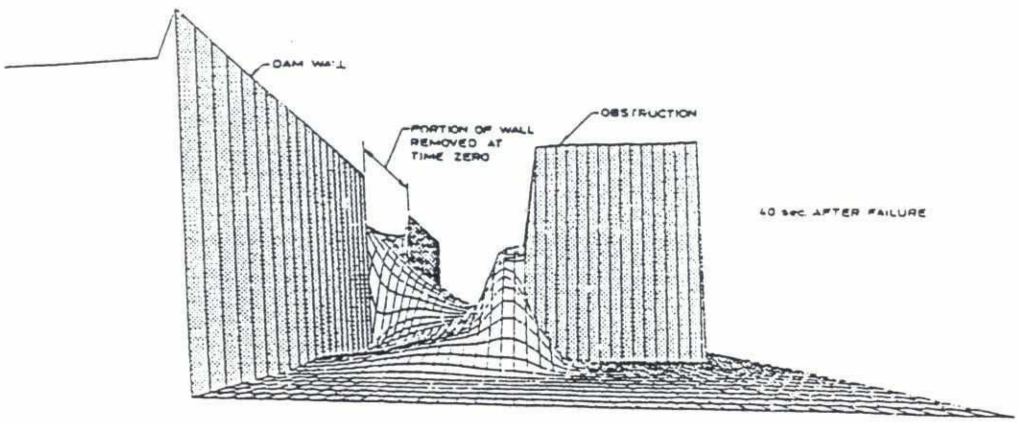
- Secondary circulations, eddies and vortices



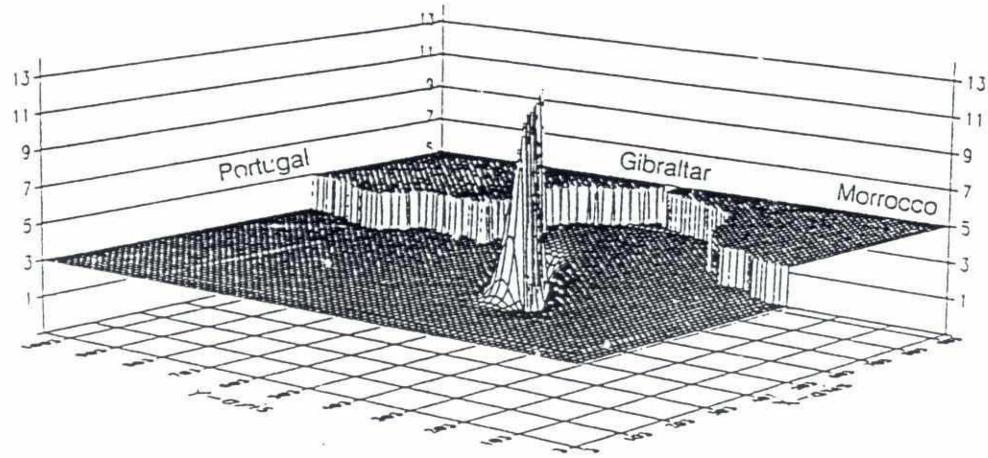
- Harbour seiching



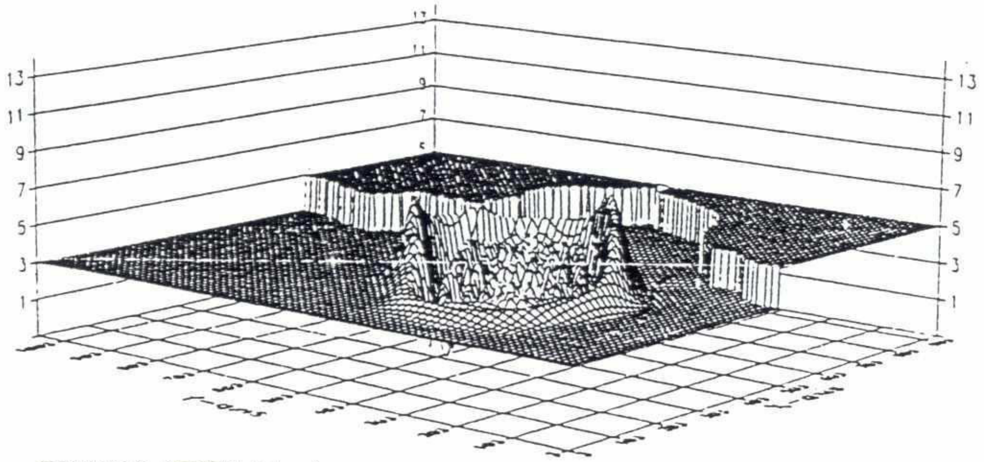
- **Dam-break**



- **Tsunamis**



SEA SURFACE IMMEDIATELY AFTER EARTHQUAKE



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Equations

The hydrodynamic module of MIKE 21 solves the vertically integrated equations of continuity and conservation of momentum in two horizontal dimensions. The following effects are included in the equations:

- convective and cross momentum
- wind shear stress at the surface
- barometric pressure gradients
- Coriolis forces
- momentum dispersion ('eddy')
- sources and sinks (both mass and impulse)
- evaporation.

Continuity

$$\frac{\partial \zeta}{\partial t} + \frac{\partial p}{\partial x} + \frac{\partial q}{\partial y} = S - e$$

x-Momentum

$$\frac{\partial p}{\partial t} + \frac{\partial}{\partial x}\left(\frac{p^2}{h}\right) + \frac{\partial}{\partial y}\left(\frac{p \cdot q}{h}\right) + gh\frac{\partial \zeta}{\partial x}$$

$$+ \frac{g\sqrt{\frac{p^2}{h^2} + \frac{q^2}{h^2}} \cdot \frac{p}{h}}{C^2} - fVV_x - \frac{h}{\rho_w} \cdot \frac{\partial p_a}{\partial x}$$

$$- \Omega q - \left(\frac{\partial}{\partial x}\left(E_x \cdot h \cdot \frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(E_y \cdot h \cdot \frac{\partial u}{\partial y}\right)\right) = S_{ix}$$

y-Momentum

$$\frac{\partial q}{\partial t} + \frac{\partial}{\partial y}\left(\frac{q^2}{h}\right) + \frac{\partial}{\partial x}\left(\frac{p \cdot q}{h}\right) + gh\frac{\partial \zeta}{\partial y}$$

$$+ \frac{g\sqrt{\frac{p^2}{h^2}+\frac{q^2}{h^2}}\cdot\frac{q}{h}}{C^2} - fVV_y - \frac{h}{\rho_w}\cdot\frac{\partial p_a}{\partial y}$$

$$+ \Omega p - \left[\frac{\partial}{\partial x}\left(E_x\cdot h\cdot\frac{\partial v}{\partial x}\right) + \frac{\partial}{\partial y}\left(E_y\cdot h\cdot\frac{\partial v}{\partial y}\right)\right] = S_{iy}$$

Symbol List

$\zeta(x,y,t)$	-	water surface level above datum (m)
$p(x,y,t)$	-	flux density in the x-direction ($m^3/s/m$)
$q(x,y,t)$	-	flux density in the y-direction ($m^3/s/m$)
$h(x,y,t)$	-	water depth (m)
S	-	source magnitude per unit horizontal area ($m^3/s/m^2$)
S_{ix}, S_{iy}	-	source impulse in x- and y-directions ($m^3/s/m^2.m/s$)
e	-	evaporation rate (m/s)
g	-	gravity (m/s^2)
C	-	Chezy resistance No. ($m^{½}/s$)
f	-	wind friction factor
$V, V_x, V_y(x,y,t)$	-	wind speed and components in x- and y-directions (m/s)
$p_a(x,y,t)$	-	barometric pressure ($kg/m/s^2$)
ρ_w	-	density of water (kg/m^3)
Ω	-	Coriolis coefficient (latitude dependent) (s^{-1})
$E(x,y)$	-	eddy or momentum dispersion coefficient (m^2/s)
x,y	-	space coordinates (m)
t	-	time (s)

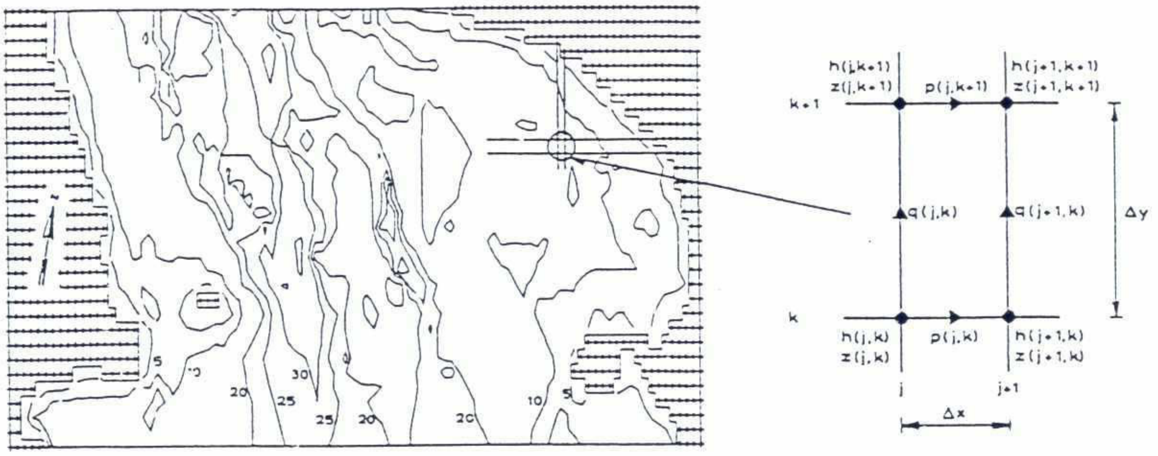
Calibration Factors

A MIKE 21 HD generated model has only three calibration factors, namely bed resistance C, wind friction factor f, and momentum dispersion coefficient E (normally called an eddy coefficient). Using these factors alone, calibration of a model is normally quite easy. In practice, the calibration of a model depends far more on the accuracy of the data, e.g. bathymetry, boundary data and wind speeds.

The bed resistance, C, and momentum dispersion coefficient, E, can both be specified as a function of space. Further, E can vary in time in accordance with a special formulation of Smagorinsky's theory for turbulence.

Solution Technique

The equations are solved by implicit finite differnce techniques with the variables defined on a space-staggered rectangular grid as shown below.



A 'fractioned-step' technique combined with an Alternating Direction Implicit (ADI) algorithm is used in the solution to avoid the necessity for iteration. Second order accuracy is ensured through the centering in time and space of all derivatives and coefficients. The ADI algorithm implies that at each time step a solution is first made in the x-direction using the continuity and x-momentum equations followed by a similar solution in the y-direction.

As a simple example, the finite difference scheme for the time derivative of flux density is shown below.

$$\frac{\partial p}{\partial t} \approx \left[\frac{p^{n+1} - p^{n}}{\Delta t}\right] - \frac{\Delta t^2}{24} \cdot \frac{\partial^3 p}{\partial t^3}$$

truncation error

The truncation error is of second order, $O(\Delta t^2)$.

The application of the implicit finite difference scheme results in a tridiagonal system of equations for each grid line in the model. The solution is obtained by inverting the tridiagonal matrix using the Double Sweep algorithm, a very fast and accurate form of Gauss elimination.

The implicit scheme is used in MIKE 21 in such a way that stability problems do not occur provided, of course, that the input data is physically reasonable, so that the time step used in the computations is limited only by accuracy requirements.

Data Requirements

The necessary data can be divided into several groups as briefly described below.

Basic Model Parameters:
Model grid size and extent
Time step and length of simulation
Type of output required and its frequency
Latitude and its orientation

Bathymetry.

Calibration Factors:
Bed resistance
Momentum dispersion coefficients
Wind friction factor

Initial Conditions:
Water surface level
Flux densities in x- and y-directions

Boundary Conditions:
Water levels or flow magnitude
Flow direction

Other Driving Forces:
Wind speed and direction
Source/sink discharge magnitude and speed.

Pre- and Post-processing Software

The MIKE 21 HD module includes a range of pre- and post-processing software which eases the input of data and analysis of simulation results. The software can be applied to the data and results of all the MIKE 21 modules.

Some examples of the software capabilities are:

- Input of time series and 2-D data
- Isoline plots of any variable
- 2-D vector plots of current patterns
- Plots of the variation in space of a variable along any line through the model
- 3-D plots of bathymetries, surface levels, concentrations
- Statistical analysis of time or space variation of any variable.

All graphical presentations can be in colour, produced with the UNIRAS graphics package.

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Appendix B

MIKE 21 AD
Advection-Dispersion Module
A Short Description

08

MIKE 21 AD - Release 1.0

ADVECTION-DISPERSION MODULE

A SHORT DESCRIPTION

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MIKE 21 AD - ADVECTION-DISPERSION MODULE

SHORT DESCRIPTION

Introduction

MIKE 21 is a comprehensive modelling system for 2-dimensional free surface flows where stratification can be neglected.

The advection-dispersion module of MIKE 21 simulates the spreading of a dissolved or suspended substance in an aquatic environment under the influence of the fluid transport and associated natural dispersion processes. The substance may be a pollutant of any kind, conservative or non-conservative, inorganic or organic: salt, heat, dissolved oxygen, inorganic phosphorus, nitrogen and other such water quality parameters.

In a similar way to the hydrodynamic stage, the concentration of the substance is calculated at each point of a rectangular grid covering the area of interest. Information on the transport, i.e. currents and water depths at each point of the grid, are provided by the hydrodynamic module. Other data required includes substance concentrations and discharge quantities at outfalls, together with concentrations at boundaries.

The system solves the equation of conservation of mass for a dissolved or suspended substance using a two-dimensional form of the QUICKEST finite difference scheme.

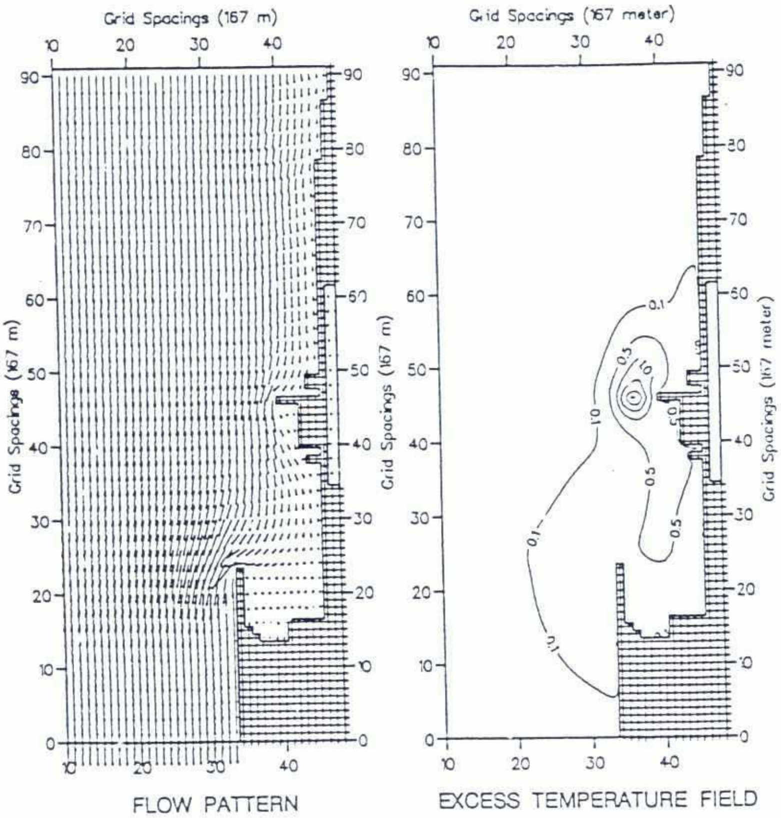
Applications

There are in principle two types of investigations for which the M21AD module is an essential part:

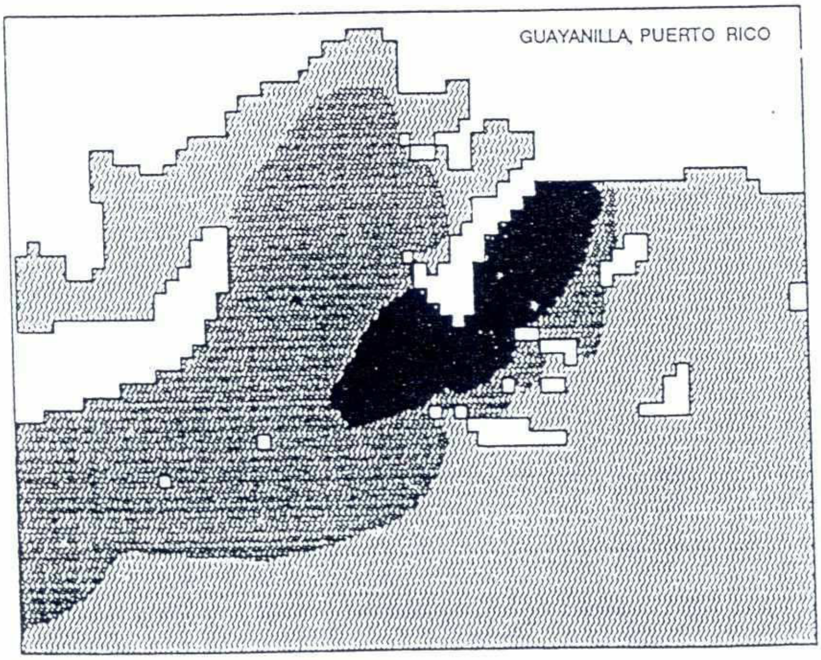
- Cooling water recirculation studies for power plants and salt recirculation studies for desalination plants
- Water quality studies connected with sewage outfalls and non-point pollution sources

Some illustrations follow:

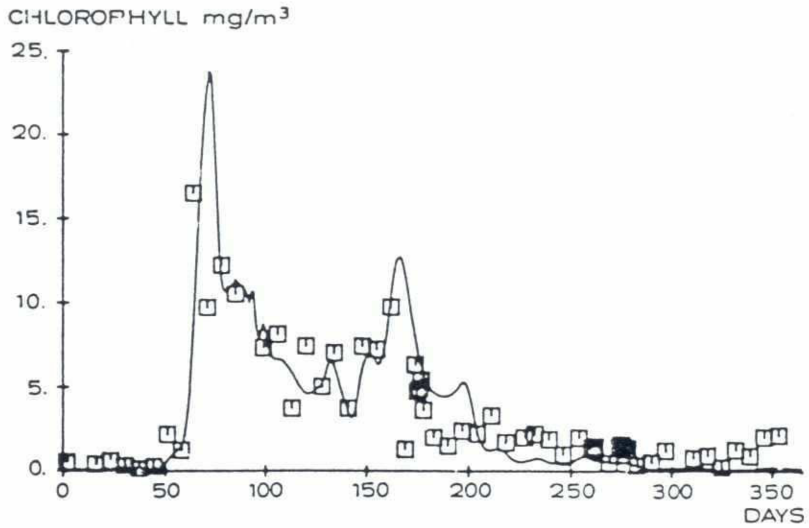
• Cooling water recirculation



• Spreading of bacteria or pollutants from sewage outfalls



• Water quality studies



Equation

M21AD solves the so-called advection-dispersion equation for dissolved or suspended substances in two dimensions. This is in reality the mass-conservation equation. Discharge quantities and compound concentrations at source and sink points are included together with a decay rate.

$$\frac{\partial}{\partial t}(hC) + \frac{\partial}{\partial x}(uhC) + \frac{\partial}{\partial x}(vhC) = \frac{\partial}{\partial x}\left[h \cdot D_x \cdot \frac{\partial C}{\partial x}\right]$$

$$+ \frac{\partial}{\partial y}\left[h \cdot D_y \frac{\partial C}{\partial y}\right] - F \cdot h \cdot C + S$$

Symbol List

C	-	compound concentration (arbitrary units)
u,v	-	horizontal velocity components in the x,y directions (m/s)
h	-	water depth (m)
D_x,D_y	-	dispersion coefficients in the x,y directions (m^2/s)
F	-	linear decay coefficient (l/s)
S	=	$Q_s \cdot (C_s\text{-}C)$
Q_s	-	source/sink discharge per unit horizontal area ($m^3/s/m^2$)

C_s	-	concentration of compound in the source/sink discharge.

Information on u, v and h at each time step is provided by the hydrodynamic module M21HD.

Calibration Factors

Calibration Factors are the dispersion coefficients D_x and D_y, and the decay coefficient F.

Suitable methods for calculating or assigning dispersion coefficients are the subject of intense research and have not yet been resolved. One of the few well-established theories is for the dispersion due to the vertical logarithmic velocity profile. Elder (1959) found that the equivalent dispersion coefficient is proportional to u_*h, where u_* is the friction velocity. This is the basis for one of the options in M21AD where the dispersion coefficient can be chosen proportional to the flux density uh.

The other option is for the user to select his own coefficients to reproduce measured dispersion. These are constant in time but can be variable in space.

Heat Dissipation

In cooling water recirculation studies, the compound concentration, C, becomes excess temperature, ΔT, and the decay rate, F, becomes the heat exchange with the atmosphere. F is primarily dependent on the wind speed and ambient temperature.

$$F = \frac{0.2388}{\rho C_p h} (4.6 - 0.09(T+C)$$

$$+ 4.06\ W)\ \exp\ (0.033\ (T+C))$$

Symbol List

T	-	reference temperature (°C)
W	-	wind speed (m/s), constant or time varying
ρ	-	density of water (kg/m^3)
C_p	-	specific heat of water.

Future Developments

Future releases of the AD module will include more advanced methods for automatic calculation of dispersion coefficients.

Solution Technique

The advection-dispersion equation is solved using an explicit, third-order finite different scheme which is generally known as the QUICKEST scheme. This scheme has been described in various papers dealing with turbulence modelling, environmental modelling and other problems involving the advection-dispersion equation. It has several advantages over other schemes, especially that it avoids the "wiggle" instability problem associated with central differencing of the advection terms, and at the same time it greatly reduces the numerical damping which is characteristic of first-order upwinding methods.

The scheme itself is a Lax-Wendroff or Leith-like scheme in the sense that it cancels out the truncation error terms due to time differencing up to a certain order by using the basic equation itself. In the case of QUICKEST, truncation error terms up to third-order are cancelled for both space and time derivatives. See Reference List for further information.

Data Requirements

Basic Model Parameters
- Model grid size and extent
- Time step and length of simulation
- Type of output required and its frequency

Bathymetry and Hydrodynamic Input

Calibration Factors
- Dispersion coefficients
- Decay coefficient

Initial Conditions
- Compound concentrations

Boundary Conditions
- Compound concentrations

Other Driving Forces

Wind speed and ambient temperature for cooling water studies

Source/sink discharge magnitude and compound concentrations.

List of References

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Appendix C

MIKE 21 NSW
Nearshore Spectral Wind-Wave Module
A Short Description

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MIKE 21 NSW - Release 1.2

NEARSHORE SPECTRAL WIND-WAVE MODULE

A SHORT DESCRIPTION

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MIKE 21 NSW - NEARSHORE SPECTRAL WIND-WAVE MODULE

SHORT DESCRIPTION

Introduction

MIKE 21 NSW is DHI's wind-wave model which describes the propagation, growth and decay of short-period waves in nearshore areas. The model takes into account the effects of refraction and shoaling due to varying depth, wind generation and energy dissipation due to bottom friction and wave breaking. The effects of current on these phenomena are included.

MIKE 21 NSW is a stationary, directionally decoupled parametric model. To take into account the effect of current the basic equations in the model are derived from the conservation equation for the spectral wave action density. A parameterization of the conservation equation in the frequency domain is performed introducing the zero-th and the first moment of the action spectrum as dependent variables. From these variables wave parameters such as the significant wave height, the mean wave period and the mean wave direction can be determined.

The basic equations are solved using an Eulerian finite-difference technique.

Basic Equations

The conservation equations for the zero-th and the first moment, m_0 and m_1, of the action spectrum A can be written (Holthuijsen et al., 1989)

$$\frac{\partial (c_{gx} m_o)}{\partial x} + \frac{\partial (c_{gy} m_o)}{\partial y} + \frac{\partial (c_\theta m_o)}{\partial \theta} = T_0$$

$$\frac{\partial (c_{gx} m_1)}{\partial x} + \frac{\partial (c_{gy} m_1)}{\partial y} + \frac{\partial (c_\theta m_1)}{\partial \theta} = T_1 \qquad (1)$$

where

$m_o(x,y,\theta)$	-	Zero-th moment of the action spectrum
$m_1(x,y,\theta)$	-	First moment of the action spectrum
c_{gx} and c_{gy}	-	Components in the x- and y-direction, respectively, of the group velocity c_g
c_θ	-	Propagation speed representing the change of action in the θ-domain
x and y	-	Cartesian coordinates
θ	-	Direction of wave propagation
T_0 and T_1	-	Source terms

The moments $m_n(\theta)$ are defined

$$m_n(\theta) = \int_0^\infty \omega^n A(\omega, \theta)\, d\omega \qquad (2)$$

where ω is the absolute frequency.

From $m_o(\theta)$ and $m_1(\theta)$ two wave parameters can be calculated: the directional action spectrum $A_o(\theta) = m_o(\theta)$ and the mean frequency per direction $\omega_o(\theta) = m_1(\theta)/m_o(\theta)$.

The propagation speeds c_{gx}, c_{gy} and c_θ are obtained using linear wave theory.

The left hand side of the basic equations (1) takes into account the effect of refraction and shoaling. The source terms T_o and T_1 take into account the effect of energy input from the wind, bottom dissipation, wave breaking and wave blocking. The effects of current on these phenomena are included. The formulation of the source terms for wind generation of waves is based on empirical formulas for the wave growth for fetch-limited sea states in deep water (Shore Protection Manual). The description of the bottom dissipation is based on the quadratic friction law to represent bottom shear stress (Svendsen and Johnsson, 1980) and the description of the wave breaking is based on the expressions given by Battjes and Janssen (1978). The effect of the bottom dissipation and wave breaking on the mean frequency is also included.

Numerical Solutions

The two coupled partial differential equations are solved using Eulerian finite-difference technique. The zero-th and the first moment are calculated on a rectangular grid for a number of discrete directions.

A once-through marching procedure is applied in the predominant direction of wave propagation restricting the angle between the direction of wave propagation and the marching direction to less than 90°. Due to stability conditions the angle is usually less than 60° depending on the mesh sizes.

Input/Output

The basic input to the model is the bathymetry, the current and wind field and the boundary condition at the up-wave boundary. The boundary conditions can be given in form of transfer-data (the directional spectrum of m_0 and m_1 along the boundary) from a previous calculation, or in form of the significant wave height, the mean wave period and the directional distribution at the boundary.

The results of the computations can be stored in the form of the discrete values of the zero-th and the first moments of the action spectrum, or in form of selected wave parameters such as the significant wave height, the mean wave period, the mean wave direction and the directional standard deviation. These results can then be presented graphically through the use of a range of service programs. It is possible to obtain for example:

- Isoline plots of any variable
- Plots of variation in space of a variable along any line through the model area
- 2D vector plots showing the mean wave direction
- 3D plots of bathymetries.

(A few examples of the graphical presentation are shown on the following page).

Calibration Factors

The main calibration factors using MIKE 21 NSW are the bottom friction coefficients - the wave friction factor f_w and the current friction factor f_c. The friction factor f_w can be given either explicit or calculated using a semi-empirical formula given the Nikuradse roughness parameter k_n.

Normally, the calibration of the model for a specific study is quite easy. In practice, the most important factor in the calibration is the accuracy of the data, e.g. bathymetry, boundary data, and wind and current fields.

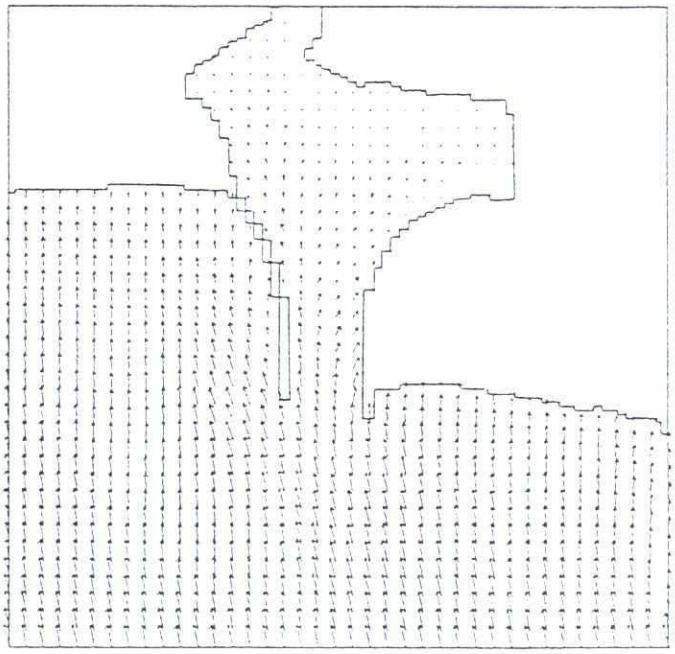

Fig. 1 *Vector plot showing the mean wave direction where the vector length is scaled relative to the significant wave heights.*

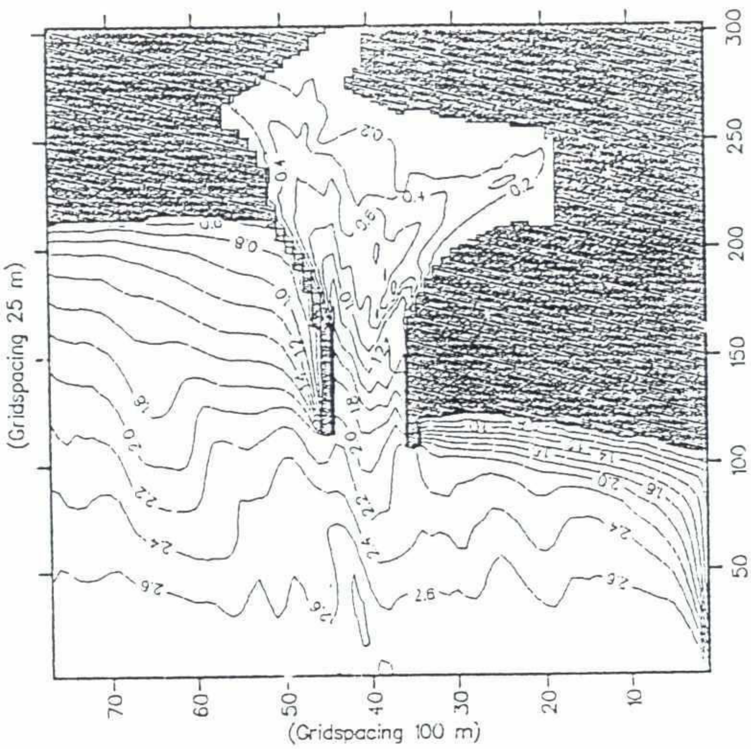

Fig. 2 Contour plot of the significant wave height.

List of References

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Appendix D

MIKE 21 ST
Non-Cohesive Sediment Transport Module
A Short Description

MIKE 21 ST - Release 2.0

NON-COHESIVE SEDIMENT TRANSPORT MODULE

A SHORT DESCRIPTION

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MIKE 21 ST - NON-COHESIVE SEDIMENT TRANSPORT MODULE

SHORT DESCRIPTION

Introduction

MIKE 21 is a comprehensive modelling system for 2-dimensional free surface flows where stratification can be neglected.

MIKE 21 ST is a sediment transport module of the system for assessing rates of bed level changes in coastal areas subject to the action of waves and currents. The sediments are assumed to be non-cohesive, i.e. sand, but may vary in grain size throughout the model area. The currents may be due to tide, they may be wind-driven or even wave-driven. The effect of both non-breaking and breaking waves are included in the module computations.

For given bathymetry, sediment type, water depth, currents and wave patterns, the MIKE 21 ST module calculates the sediment transport capacity at each point of a rectangular grid covering the area of interest. Erosion and deposition rates in the model area are thereby estimated.

The data concerning current and wave conditions is provided by other modules of the MIKE 21 system and are prepared prior to the simulations with MIKE 21 ST. The water depth and current conditions due to tide and wind will be calculated with the hydrodynamic module MIKE 21 HD which can also give the wave-driven currents through the inclusion of the wave radiation stresses. The wave fields can be calculated by MIKE 21 SW, the deterministic wave module, or by MIKE 20 NS, DHI's spectral wind-wave modelling system for near-shore areas. Even a wave field developed from a refraction/diffraction model or a desk study can be used.

The structure of the module and the possible connections with other MIKE modules are illustrated in Figure 1.

The principal applications of MIKE 21 ST concern the estimation of erosion and deposition around large coastal structures such as large groynes, breakwaters, river mouths and protection works generally.

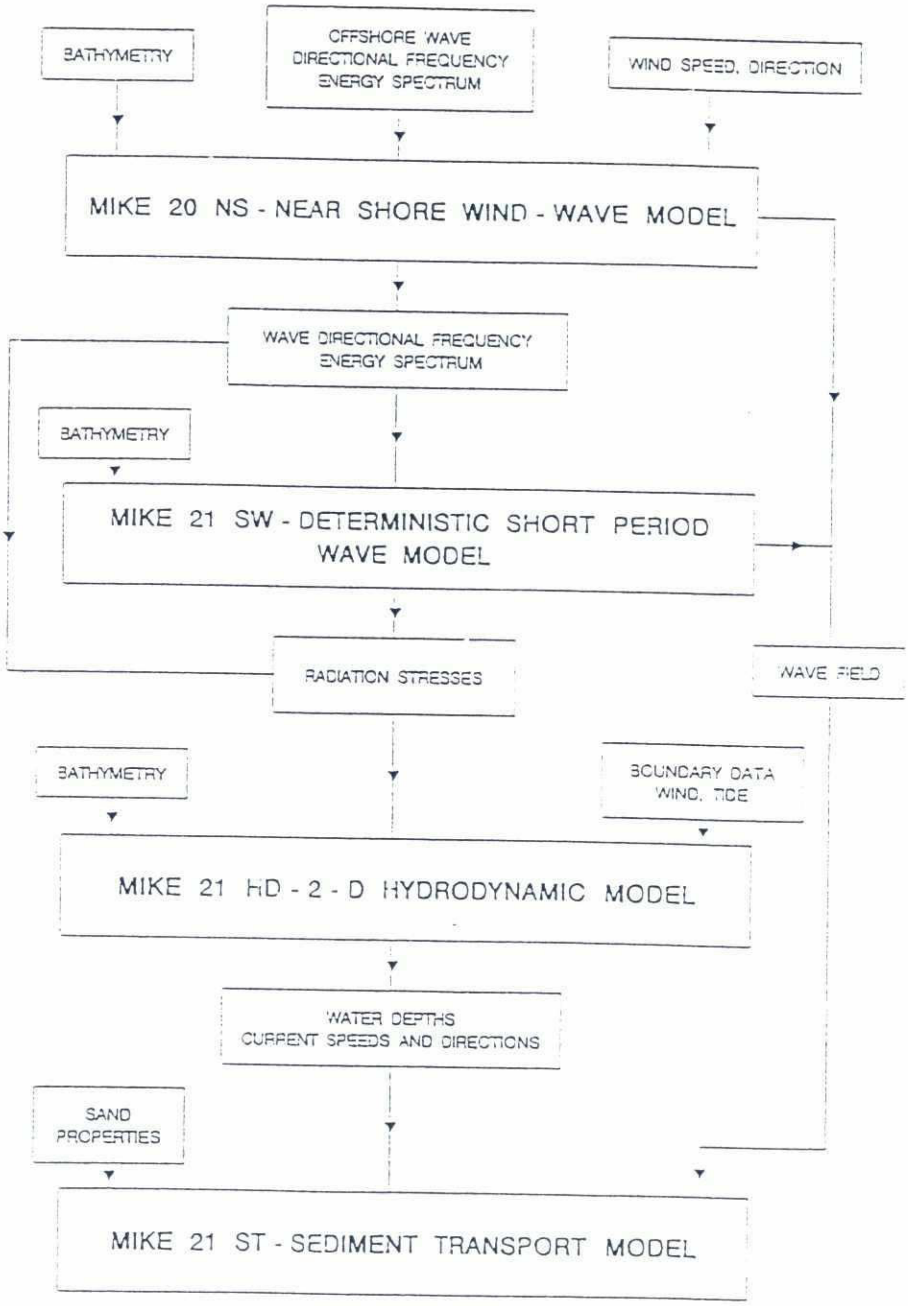

Fig. 1a The interaction of MIKE 21 ST with other modules of the MIKE system.

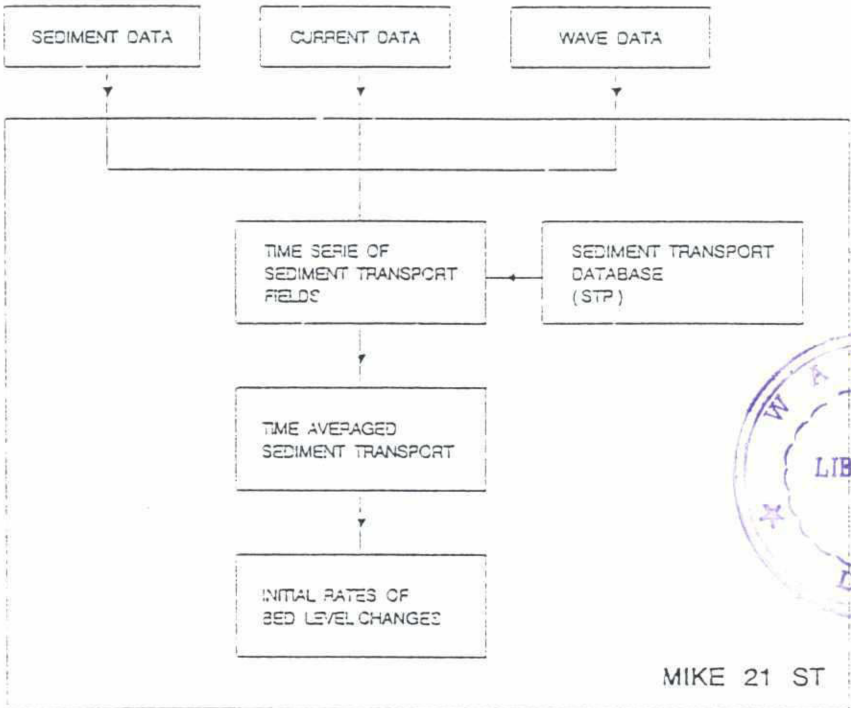

Fig. 1b Illustration of structure of MIKE 21 ST.

Theoretical Background

The core of the MIKE 21 ST is the calculation of the sediment transport capacity as function of the local wave, current and sediment conditions. This calculation is carried out by the DHI model STP which is a detailed intra-wave-period model for description of the time-varying distribution of suspended sediment and bed load over the wave period in combined wave and current motion, including effects of wave breaking if relevant.

The STP model is included directly in MIKE 21 ST where it is used to establish a comprehensive data base of transport rates corresponding to the relevant ranges of the parameters: current speed, depth, wave height and period, breaking/non-breaking waves, grain size.

The rates of bed level changes, $\partial z/\partial t$, are described by the equation of continuity:

$$\frac{\partial z}{\partial t} + \frac{1}{1-n}\frac{\partial q_x}{\partial x} + \frac{1}{1-n}\frac{\partial q_y}{\partial y} = 0 \quad ,$$

where

x,y,t are independent variables
q_x, q_y are sediment transport components in x- and y-directions
z is the bed level
n is the porosity of the bed material.

This equation is solved by a finite difference model.

The module, STP, which calculates the sediment transport rates, is briefly described below.

The Sediment Transport Module, STP

In combined waves and current the turbulent interaction in the near bed boundary layer is of importance for the bed shear stresses as well as for the eddy viscosity distribution. The basis for the sediment transport description is the model for turbulent wave-current boundary layers of Fredsøe (1984). The boundary layer is composed of two regions:

Close to the bed the turbulence and the shear stress in the wave boundary layer vary with the wave period, giving rapidly changing bed concentration and turbulent diffusion coefficients.

Outside the wave boundary layer the mean velocity is described by a log-profile. The increased turbulence level in the wave boundary layer retards the mean current, an effect which is expressed through an apparent wave roughness, k_w, which is larger than the natural bed roughness k.

The transport of non-cohesive material is calculated according to the model presented by Engelund and Fredsøe (1976). Through subsequent developments this model has been extended to cover combined waves and current, and conditions in the surf zone.

The total sediment load is split into bed load and suspended load, which are calculated separately. The bed load transport is calculated as a function of the bed shear stress through the dimensionless bed shear stress, θ:

$$\theta = U_f^2 / (s-1)gd$$

s is the relative sediment density, g the acceleration of gravity, d the grain size and U_f is the shear velocity. The bed load transport is assumed to correspond to the instantaneous bed shear stress under unsteady conditions, e.g. under wave action.

The suspended load transport, q_s, is described through the sediment concentration c, which is determined from the vertical turbulent diffusion equation:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial z} \left(\epsilon_s \frac{\partial c}{\partial z} \right) + w \frac{\partial c}{\partial z}$$

t is time, z the vertical coordinate (zero at the bed) ϵ_s the turbulent diffusion coefficient and w is the settling velocity of the sediment. ϵ_s is taken to be equal to the turbulent eddy viscosity of the flow field. The near-bed boundary condition is given as bed concentration C_b at the level z = 2d. C_b is determined as a function of θ using the dynamic considerations of Bagnold (1954), that a certain sediment concentration is required near the bed in order to transfer the shear stress to the bed through grain-grain interaction.

The bed concentration, C_b, is only valid for the plane bed case, i.e. sheet flow, which is found for θ larger than about 0.8. At smaller θ-values the bed is covered by wave ripples. The sediment transport model by Fredsøe et. al (1985) has been modified to take the effect of wave ripples into account. The modification involves the bed concentration, turbulent diffusion and the bed roughness. The values of C_b and ϵ are based directly on the laboratory measurements of Nielsen (1979). The roughness is expressed through the ripple dimensions as given by Raudkivi (1988). The sediment transport model converges gradually towards a plane bed description with increasing bed shear stress or mean current velocity.

Inside the surf zone, the wave energy is dissipated due to breaking, and the production of turbulence is very intense. This has been taken into account by use of a one-equation turbulence model (Deigaard et. al. (1986)).

Figure 2 shows the vertical mean sediment concentration profile calculated by STP, compared to full scale field measurements.

The main results from STP are

- bed load
- suspended load

in combined breaking or non-breaking waves and current.

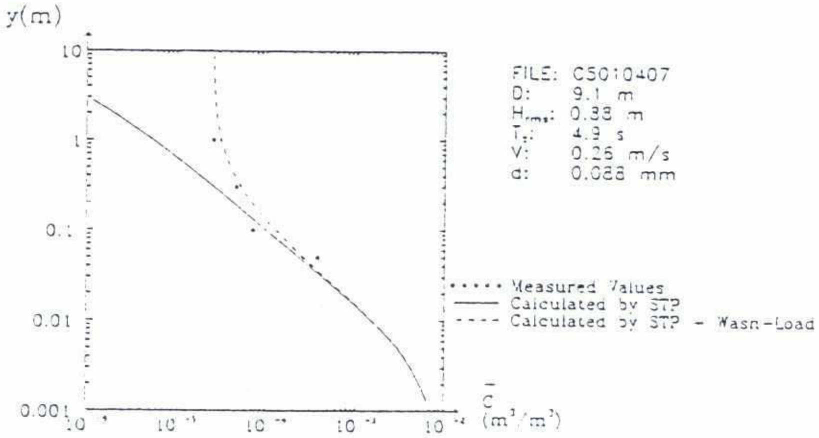

Fig. 2 **Vertical profiles of mean sediment concentrations**

Data Requirements

The basic parameters are: Model grid size and extent, bathymetry, length of simulation and time step between calculations of sediment transport fields and requirements to the output. Further, the module requires hydrodynamic input, water depths and currents, significant wave heights and periods in the defined grid points and grain size distribution over the model area. Prior to the MIKE 21 ST simulations, the service programme STP must produce a catalog of sediment transport rates. Input to STP is relevant ranges of the parameters wave heights and periods, current speed, depth, grain size ($d_{50\%}$).

Model Calibration

The hydrodynamic and wave models should be calibrated in the normal way by comparisons with field data.

The accuracy of the STP model should also be checked against field measurements of suspended sediment concentrations under a variety of wave and current conditions. However, a large number of comparisons have already been made so that the default parameter values can be used with confidence.

Further Developments

The present version of the sediment transport programme STP uses an average grain size $d_{50\%}$ and the corresponding fall velocity. A new version of STP which includes the effect of grading of the bed material will be available during 1991. This improvement requires input of a parameter all over the model area which reflects the grading of the bed material, for instance the spreading of a log normal distribution which represents the grain sizes.

The present version of STP calculates the transport rate assuming logarithmic current profiles. Inside the surf zone, the vertical distribution of flow might differ significantly from log-profiles due to undertow. Another more advanced version of STP includes calculation of the form of the current profile under quasi uniform conditions in breaking waves and current at an arbitrary angle. Implementation of this advanced version and extraction of the relevant parameters from the basic wave and current simulations, i.e. wave energy dissipation in the wave propagation direction and angle between waves and current will allow the effect of undertow to be included. This version will be tested during 1991.

The present model setup calculates the sediment transport capacity as a function of the local wave and current conditions. This assumption is good for medium to coarse sand, but for very fine sand there might be so-called time and space lag effects which attenuate the transport rates due to the time it takes to adjust the concentration profile to changed hydrodynamic conditions. A model complex which uses the MIKE 21 AD module (Advection Dispersion Module) to simulate this phenomenum is under development.

The present module MIKE 21 ST represents a single time step in a so-called morphological model with feedback from changed bathymetry to the wave and current calculations. MIKE 21 ST now works as a module in a research version of a deterministic morphological model which is currently being developed at DHI.

Applications

An example of the application of MIKE 21 ST is taken from the Venice lagoon study.

The Venice lagoon is located in the north western part of the Adriatic Sea, Figure 3.

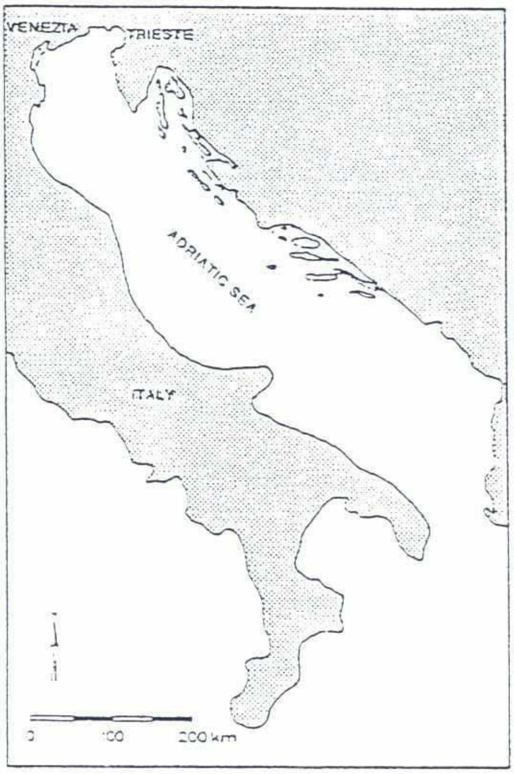

Fig. 3 Location map

The detail of the Venice coastline is shown in Figure 4.

This example treats the local area around Chioggia inlet for the existing constructions and strong Scirocco wind conditions, $H_s \approx 2.8$ m, tidal range 0.8 m.

Figure 5 shows the bathymetry of the area. The grain size of the bed material is digitized in a similar way and used as input to the model complex.

The calculated wave field is illustrated in Figure 6, in which isolines for significant wave heights are shown.

The time varying current field is calculated by the hydrodynamic model MIKE 21 HD. The driving forces included in this simulation are wind, tide and variation in the radiation stresses (wave-driven currents). As an example, the current field at maximum flood flow is shown in Figure 7.

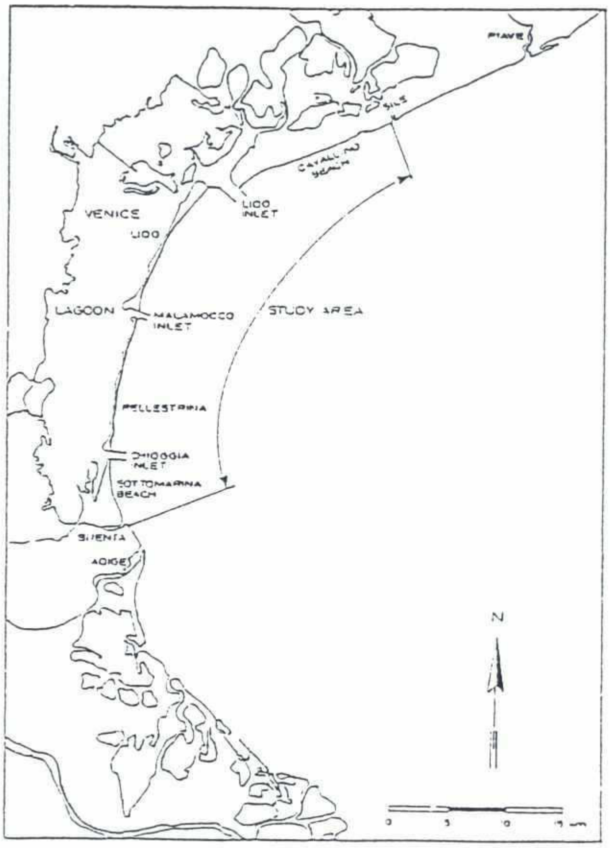

Fig. 4 Venice Lagoon and adjacent coast

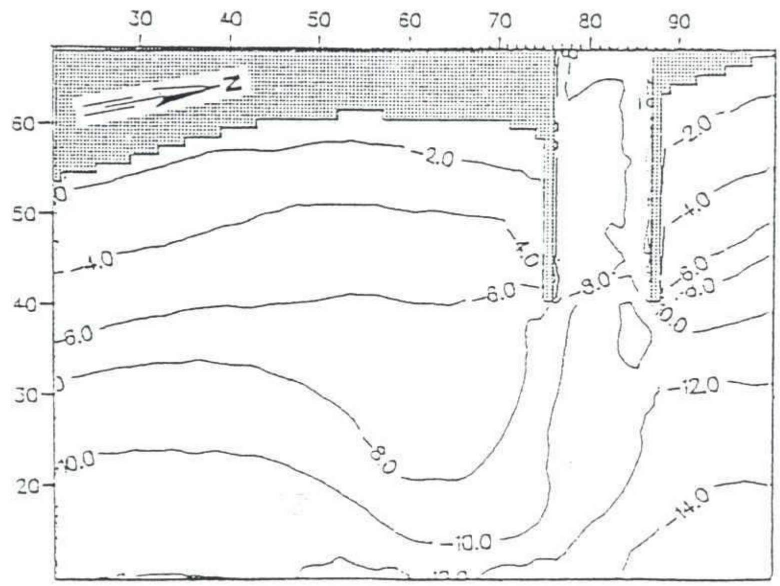

Fig. 5 Bathymetry

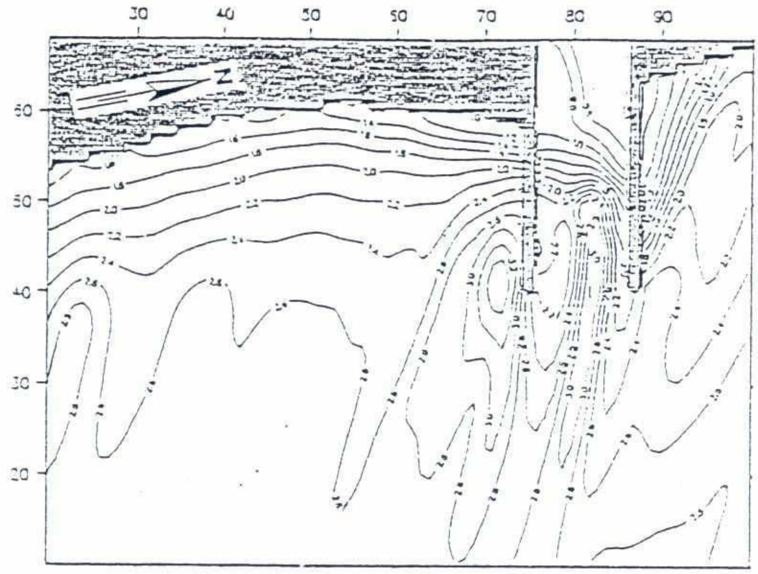

Fig. 6 Significant wave heights

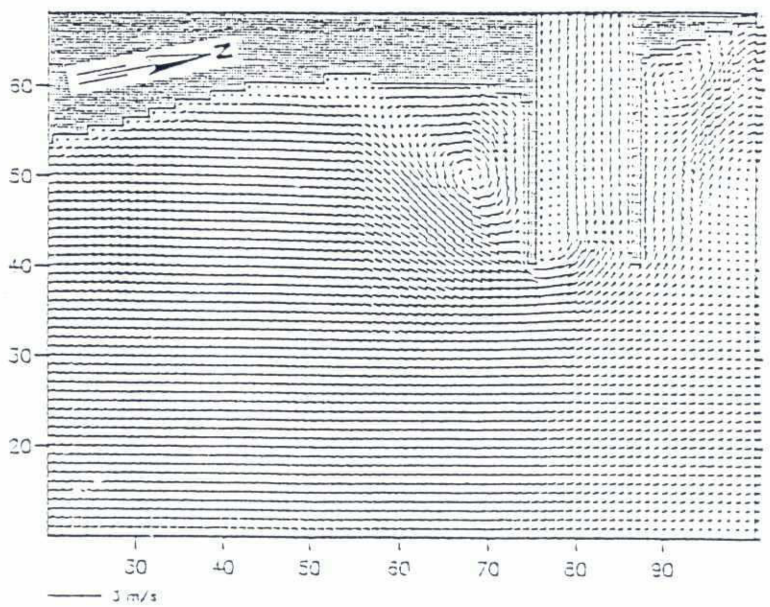

Fig. 7 Current pattern at maximum flood flow

The sediment transport field averaged over the tidal cycle has been calculated based on the wave field, the current fields and the grain size distribution.

The calculated average transport field is shown in Figure 8.

It appears that the wave-driven currents along Sottomarina carry large amounts of sediment. This socalled littoral drift is responsible for the evolution of Sottomarina Beach, which advances ~ 6m/year. Close to the southern jetty a large counter clockwise current vortex appears. This wave-driven current pattern occurs because the wave fronts are refracted around the shoal SE of the inlet. The sediment transport rates along the jetty increase strongly from outside to inside the surf zone. This is because the breaking waves are able to carry more sediment in suspension than the non-breaking waves.

The net transport in the inlet appears to be close to zero in this case. This is because the current speeds during ebb and flood flow are found from the current simulations to be nearly identical.

The duration per year of the conditions simulated in this example is estimated at 1.8 day/year - assuming that this condition represents all strong Scirocco wind cases.

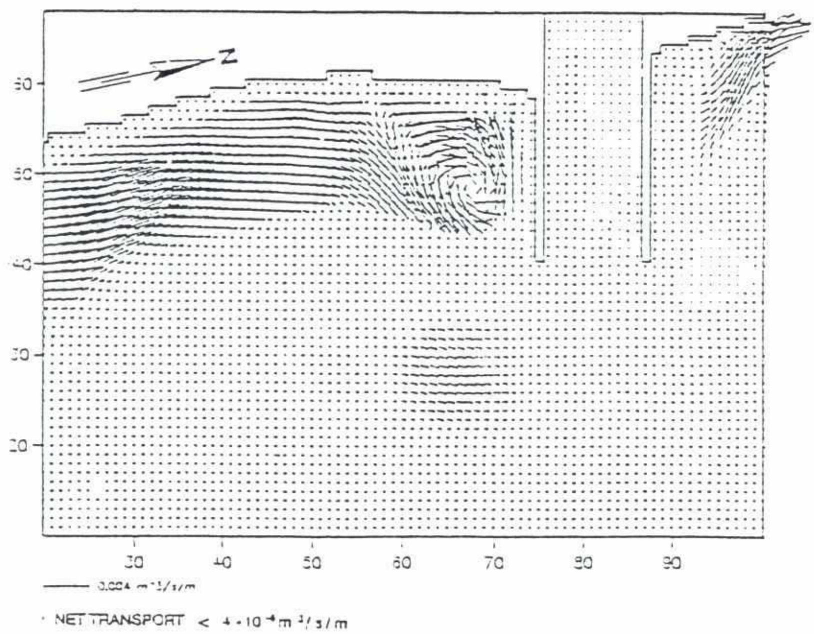

Fig. 8 **Sediment transport field averaged over the tidal cycle**

From the sediment transport field described above, the initial bed level changes per year corresponding to Scirocco wind are determined. These calculated bed level changes are illustrated in Figure 9.

The bed level changes reflect the variations in the transport capacities. Along Sottomarina Beach the decrease in littoral drift leads to large deposition areas. The counter clockwise current and sediment transport pattern south of the jetty leads to erosion where the transport capacity is increased due to the increase from outside to inside the surf zone in the amount of suspended sediment. Inside the inlet no net erosion is seen because the transport capacity is identical during ebb and flood.

The erosion NE of the inlet takes place during ebb flow where the ebb flow jet passes this area.

The pattern SE of the inlet occurs due to the shoal. Erosion takes place where the water depth decreases in the current direction, and deposition takes place where the current has passed the shoal and the water depth increases (north of the shoal).

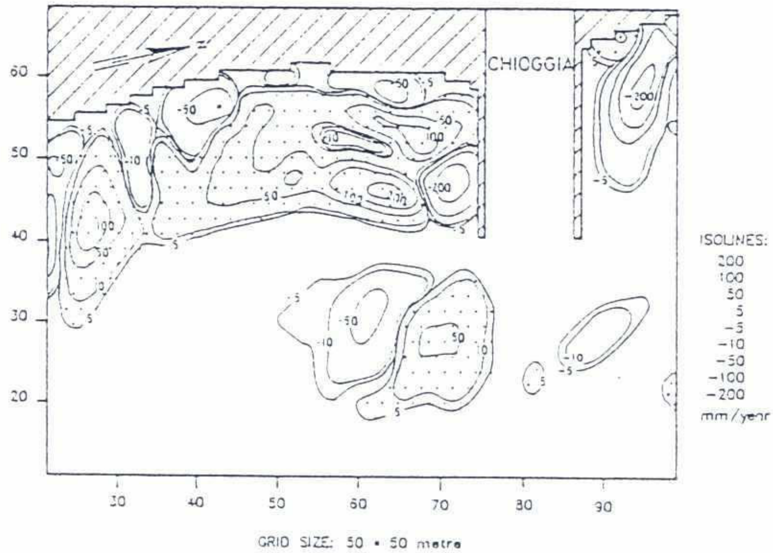

Fig. 9 Calculated initial bed level changes per year corresponding to strong scirocco wind

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Appendix E

Description of MES Numerical Modelling CD-ROM Archive

E Description of MES Numerical Modelling CD-ROM Archive

E.1 Contents of CD-ROMs

All major results from the numerical simulations have been saved in a CD-ROM archive as listed in table no. E.1, while the contents of all CD-ROM except the presentation CD-ROM are listed in sections E.3 - E.10.

Table no E.1 Contents of MES Numerical Modelling CD-ROM Archive

Volume Id	Contents
MES_DRY96A	Hydrodynamic Modelling, Dry Season 1996, calibration and base run, existing situation
MES_DRY96B	Hydrodynamic Modelling, Dry Season 1996, including intervention schemes
MES_MON96A	Hydrodynamic Modelling, Monsoon 1996, validation, existing situation
MES_DRY97A	Hydrodynamic Modelling, Dry Season 1997, validation, existing situation
MES_MON97A	Hydrodynamic Modelling, Monsoon 1997, calibration and base run, existing situation
MES_MON97B	Hydrodynamic Modelling, Monsoon 1997, including intervention schemes
MES_SALI	Salinity Modelling, Dry Season 1996, existing situation and including intervention schemes
MES_OTHER	• Wind-wave Modelling of waves from SSE and SSW for use in sediment transport modelling • Sediment Transport Modelling, Dry Season 1996 (Spring TIde and Neap Tide) and Monsoon 1997 (Spring Tide and Neap Tide) • Hydrodynamic Modelling, Dry Season 1996, Nijhum Dwip Local Model, existing situation and including interventions • Raw bathymetry files (LANDSAT data, MES survey data etc.) • Water level measurements and tidal level predictions for calibration and validation periods • Program source codes for hdflow and htmbnd.
MES_PRESENT	Presentation of Meghna Estuary Study Numerical Modelling including study report and animations of model results.

ND

E.2 Format of CD-ROM Data

The CD-ROMs have been written using Joliet filename format, while the file formats used on the CD-ROMS are described in table no E.2.

Table no. E.2 MES CD-ROM file formats

Volume Id	File Formats
MES_DRY96A MES_DRY96B MES_MON96A MES_DRY97A MES_MON97A MES_MON97B MES_SALI	All files in subdirectories of the *cat* directory are MIKE 21 data files in UNIX/DOS/Windows format, while files in *wrk* directories are MIKE 21 specification files in UNIX format. The specification files correspond to MIKE 21 version 2.6.
MES_OTHER	All files in subdirectories of the *cat* directory are MIKE 21 data files in UNIX/DOS/Windows format, while files in *wrk* and *work* directories are MIKE 21 specification files in UNIX format. The specification files correspond to MIKE 21 version 2.6. The *source* directory contains FORTRAN 77 source codes for programs hdflow (used to derive net and maximum flow from HD simulations) and htmbnd (used to compute boundary conditions for NSW simulations). The *bathyraw* directory contains XYZ data for model bathymetry generation: • orikms: MES survey data • water0: Classified Landsat data (600 m grid) • mes200: Classified Landsat data (200 m grid) • niz97: 1997 shallow area line around Nijhum Dwip • eXXX and cXXX: BITWA data from charts XXX. The *cat/bathyraw* directory contains MIKE 21 data files showing the bathymetry data sources: • bat-csps: Bathymetry data used from CSPS • bat-spot: Landsat data • bat-kms: MES survey data • bat-land: land area outside Landsat data area
MES_PRESENT	The MES Numerical Modelling Presentation CD-ROM is viewed using a web browser like Netscape Navigator or Microsoft Internet Explorer. To start viewing the CD-ROM open file index.htm in the root directory of the CD-ROM in the web browser.

E.3 Contents of CD-ROM MES_DRY96A

```
 Volume in drive F is MES_DRY96A
 Volume Serial Number is 0B96-8A51

 Directory of F:\

CAT            <DIR>        05-18-98  3:22p cat
WRKHDD~7       <DIR>        05-18-98  3:22p wrkHDdry96
         0 file(s)              0 bytes

 Directory of F:\cat

.              <DIR>        05-18-98  3:22p .
..             <DIR>        05-18-98  3:22p ..
BATHY          <DIR>        05-18-98  3:22p bathy
BOUND          <DIR>        05-18-98  3:22p bound
DRY96          <DIR>        05-18-98  3:22p Dry96
WIND           <DIR>        05-18-98  3:22p wind
         0 file(s)              0 bytes

 Directory of F:\cat\bathy

.              <DIR>        05-18-98  3:22p .
..             <DIR>        05-18-98  3:22p ..
BATHYFIN CT2         1,052  04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2       421,648  04-27-98 11:07a bathyfin.dt2
BEDFRIC  CT2         1,052  05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2       421,648  04-21-98  3:40p bedfric.dt2
         4 file(s)        845,400 bytes

 Directory of F:\cat\bound

.              <DIR>        05-18-98  3:22p .
..             <DIR>        05-18-98  3:22p ..
CHAN02~6 CT0         1,052  04-19-98 11:03a chan0296PW.ct0
CHAN02~8 DT0        76,640  04-19-98 11:03a chan0296PW.dt0
S96DRY   CT1         1,052  05-03-98 12:08p s96Dry.ct1
S96DRY   DT1     2,129,432  03-07-98 12:11p s96Dry.dt1
         4 file(s)      2,208,176 bytes

 Directory of F:\cat\Dry96

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..             <DIR>        05-18-98  3:22p ..
HD       CT2         1,052  05-04-98  2:33a hd.ct2
HD       DT2   324,668,960  05-04-98  2:33a hd.dt2
HDFLNM   CT2         1,052  05-26-98  2:38p hdflNm.ct2
HDFLNM   DT2     1,686,592  05-26-98  2:38p hdflNm.dt2
HDFLNN   CT2         1,052  05-26-98  2:38p hdflNn.ct2
HDFLNN   DT2     1,686,592  05-26-98  2:38p hdflNn.dt2
HDFLSM   CT2         1,052  05-26-98  2:39p hdflSm.ct2
HDFLSM   DT2     1,686,592  05-26-98  2:39p hdflSm.dt2
HDFLSN   CT2         1,052  05-26-98  2:39p hdflSn.ct2
```

```
HDFLSN    DT2      1,686,592  05-26-98  2:39p hdflSn.dt2
HDMAX     CT2          1,052  05-17-98  4:21p hdmax.ct2
HDMAX     DT2        843,296  05-17-98  4:21p hdmax.dt2
HDMEAN    CT2          1,052  05-17-98  4:24p hdmean.ct2
HDMEAN    DT2        843,296  05-17-98  4:24p hdmean.dt2
HDMIN     CT2          1,052  05-17-98  4:26p hdmin.ct2
HDMIN     DT2        843,296  05-17-98  4:26p hdmin.dt2
NEAP96    CT2          1,052  05-04-98  2:33a Neap96.ct2
NEAP96    DT2    126,916,048  05-03-98 11:41p Neap96.dt2
SIM0296A CT0           1,052  05-12-98 10:04a sim0296A.ct0
SIM0296A DT0          49,216  05-12-98 10:04a sim0296A.dt0
SIM0296B CT0           1,052  05-12-98 10:23a sim0296B.ct0
SIM0296B DT0          24,608  05-12-98 10:23a sim0296B.dt0
SPRING96 CT2           1,052  05-04-98  2:33a Spring96.ct2
SPRING96 DT2     126,916,048  05-03-98  6:48p Spring96.dt2
TIDCON    CT2          1,052  05-23-98  6:02a tidcon.ct2
TIDCON    DT2      4,638,128  05-23-98  6:02a tidcon.dt2
        26 file(s)     592,502,940 bytes

Directory of F:\cat\wind

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..             <DIR>          05-18-98  3:22p ..
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HATIA0~8 DT0           1,792  04-23-98 12:37p hatia0296.dt0
         2 file(s)            2,844 bytes

Directory of F:\wrkHDdry96

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..             <DIR>          05-18-98  3:22p ..
M21HD     INP          5,012  05-03-98  3:23p m21hd.inp
         1 file(s)            5,012 bytes

Total files listed:
        37 file(s)     595,564,372 bytes
        18 dir(s)                0 bytes free
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E.4 Contents of CD-ROM MES_DRY96B

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 Volume Serial Number is A403-09FF


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WRKHDD~7       <DIR>        05-26-98  5:13p wrkHDdry96
         0 file(s)              0 bytes

Directory of F:\cat

.              <DIR>        05-26-98  5:13p .
..             <DIR>        05-26-98  5:13p ..
BATHY          <DIR>        05-26-98  5:13p bathy
BOUND          <DIR>        05-26-98  5:13p bound
DRY96          <DIR>        05-26-98  5:13p Dry96
WIND           <DIR>        05-26-98  5:13p wind
         0 file(s)              0 bytes

Directory of F:\cat\bathy

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..             <DIR>        05-26-98  5:13p ..
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BATHYI13 DT2        421,648 05-24-98 10:16a bathyI13.dt2
BATHY~10 CT2          1,052 05-24-98 11:04a bathyIall.ct2
BATHY~12 DT2        421,648 05-24-98 11:04a bathyIall.dt2
BATHY~14 CT2          1,052 05-24-98 10:27a bathyIex8.ct2
BATHY~16 DT2        421,648 05-24-98 10:27a bathyIex8.dt2
BEDFRIC  CT2          1,052 05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2        421,648 04-21-98  3:40p bedfric.dt2
         8 file(s)      1,690,800 bytes

Directory of F:\cat\bound

.              <DIR>        05-26-98  5:13p .
..             <DIR>        05-26-98  5:13p ..
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CHAN02~8 DT0         76,640 04-19-98 11:03a chan0296PW.dt0
S96DRY   CT1          1,052 05-03-98 12:08p s96Dry.ct1
S96DRY   DT1      2,129,432 03-07-98 12:11p s96Dry.dt1
         4 file(s)      2,208,176 bytes

Directory of F:\cat\Dry96

.              <DIR>        05-26-98  5:13p .
..             <DIR>        05-26-98  5:13p ..
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HDFLI1~8 DT2      1,686,592 05-26-98  3:02p hdflI13Nm.dt2
HDFLI~10 CT2          1,052 05-26-98  3:03p hdflI13Sm.ct2
HDFLI~12 DT2      1,686,592 05-26-98  3:02p hdflI13Nn.dt2
HDFLI~14 CT2          1,052 05-26-98  3:03p hdflI13Sn.ct2
HDFLI~16 DT2      1,686,592 05-26-98  3:03p hdflI13Sm.dt2
```

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HDFLI~18 CT2          1,052  05-26-98  3:02p hdflI13Nm.ct2
HDFLI~20 DT2      1,686,592  05-26-98  3:03p hdflI13Sn.dt2
HDFLI~22 CT2          1,052  05-26-98  3:17p hdflIallNm.ct2
HDFLI~24 DT2      1,686,592  05-26-98  3:17p hdflIallNm.dt2
HDFLI~26 CT2          1,052  05-26-98  3:17p hdflIallNn.ct2
HDFLI~28 DT2      1,686,592  05-26-98  3:17p hdflIallNn.dt2
HDFLI~30 CT2          1,052  05-26-98  3:18p hdflIallSm.ct2
HDFLI~32 DT2      1,686,592  05-26-98  3:18p hdflIallSm.dt2
HDFLI~34 CT2          1,052  05-26-98  3:18p hdflIallSn.ct2
HDFLI~36 DT2      1,686,592  05-26-98  3:18p hdflIallSn.dt2
HDFLI~38 CT2          1,052  05-26-98  3:11p hdflIex8Nm.ct2
HDFLI~40 DT2      1,686,592  05-26-98  3:11p hdflIex8Nm.dt2
HDFLI~42 CT2          1,052  05-26-98  3:11p hdflIex8Nn.ct2
HDFLI~44 DT2      1,686,592  05-26-98  3:11p hdflIex8Nn.dt2
HDFLI~46 CT2          1,052  05-26-98  3:12p hdflIex8Sm.ct2
HDFLI~48 DT2      1,686,592  05-26-98  3:12p hdflIex8Sm.dt2
HDFLI~50 CT2          1,052  05-26-98  3:12p hdflIex8Sn.ct2
HDFLI~52 DT2      1,686,592  05-26-98  3:12p hdflIex8Sn.dt2
HDI13MAX CT2          1,052  05-25-98 11:18a hdI13max.ct2
HDI13MAX DT2        843,296  05-25-98 11:18a hdI13max.dt2
HDI13MIN CT2          1,052  05-25-98 12:08p hdI13min.ct2
HDI13MIN DT2        843,296  05-25-98 12:08p hdI13min.dt2
HDI13TSA CT0          1,052  05-25-98 10:17a hdI13tsA.ct0
HDI13TSA DT0         49,216  05-25-98 10:16a hdI13tsA.dt0
HDI13TSB CT0          1,052  05-25-98 10:28a hdI13tsB.ct0
HDI13TSB DT0         24,608  05-25-98 10:27a hdI13tsB.dt0
HDI13~62 CT2          1,052  05-25-98 11:51a hdI13mean.ct2
HDI13~64 DT2        843,296  05-25-98 11:51a hdI13mean.dt2
HDIALL   CT2          1,052  05-26-98  2:55a hdIall.ct2
HDIALL   DT2    324,668,960  05-26-98  2:55a hdIall.dt2
HDIAL~78 CT0          1,052  05-26-98 12:14p hdIalltsA.ct0
HDIAL~80 CT2          1,052  05-26-98 12:06p hdIallmax.ct2
HDIAL~82 DT0         49,216  05-26-98 12:14p hdIalltsA.dt0
HDIAL~84 DT2        843,296  05-26-98 12:06p hdIallmax.dt2
HDIAL~86 CT0          1,052  05-26-98 12:14p hdIalltsB.ct0
HDIAL~88 CT2          1,052  05-26-98 12:14p hdIallmean.ct2
HDIAL~90 DT0         24,608  05-26-98 12:14p hdIalltsB.dt0
HDIAL~92 DT2        843,296  05-26-98 12:14p hdIallmean.dt2
HDIAL~94 CT2          1,052  05-26-98 12:14p hdIallmin.ct2
HDIAL~96 DT2        843,296  05-26-98 12:14p hdIallmin.dt2
HDIEX~98 CT0          1,052  05-25-98 10:41a hdIex8tsA.ct0
HDIE~100 CT2          1,052  05-25-98 12:24p hdIex8max.ct2
HDIE~102 DT0         49,216  05-25-98 10:41a hdIex8tsA.dt0
HDIE~104 DT2        843,296  05-25-98 12:24p hdIex8max.dt2
HDIE~106 CT0          1,052  05-25-98 10:45a hdIex8tsB.ct0
HDIE~108 CT2          1,052  05-25-98 12:39p hdIex8mean.ct2
HDIE~110 DT0         24,608  05-25-98 10:45a hdIex8tsB.dt0
HDIE~112 DT2        843,296  05-25-98 12:39p hdIex8mean.dt2
HDIE~114 CT2          1,052  05-25-98 12:45p hdIex8min.ct2
HDIE~116 DT2        843,296  05-25-98 12:45p hdIex8min.dt2
NEAP~118 CT2          1,052  05-26-98  2:55a Neap96Iall.ct2
NEAP~120 DT2    126,916,048  05-25-98  5:18p Neap96Iall.dt2
SPR9~122 CT2          1,052  05-26-98  2:55a Spr96Iall.ct2
SPR9~124 DT2    126,916,048  05-24-98 11:38p Spr96Iall.dt2
        60 file(s)    606,582,856 bytes

Directory of F:\cat\wind

.              <DIR>         05-26-98  5:13p .
..             <DIR>         05-26-98  5:13p ..
HATIA0~6 CT0          1,052  04-23-98 12:37p hatia0296.ct0
```

```
HATIA0~8 DT0           1,792  04-23-98 12:37p hatia0296.dt0
         2 file(s)            2,844 bytes

Directory of F:\wrkHDdry96

.               <DIR>         05-26-98  5:13p .
..              <DIR>         05-26-98  5:13p ..
M21HDI13 INP           5,048  05-24-98 11:08a m21hdI13.inp
M21HDI~8 INP           5,067  05-24-98 11:11a m21hdIex8.inp
M21HD~10 INP           5,052  05-24-98 11:12a m21hdIall.inp
         3 file(s)           15,167 bytes

Total files listed:
        77 file(s)    610,499,843 bytes
        18 dir(s)               0 bytes free
```

E.5 Contents of CD-ROM MES_MON96A

```
 Volume in drive F is MES_MON96A

 Volume Serial Number is E97E-793F


Directory of F:\


CAT                <DIR>        05-22-98 10:23a cat
WRKHDM~7           <DIR>        05-22-98 10:23a wrkHDmon96
         0 file(s)                   0 bytes

Directory of F:\cat

.                  <DIR>        05-22-98 10:23a .
..                 <DIR>        05-22-98 10:23a ..
BATHY              <DIR>        05-22-93 10:23a bathy
BOUND              <DIR>        05-22-98 10:23a bound
MON96              <DIR>        05-22-98 10:23a Mon96
WIND               <DIR>        05-22-98 10:23a wind
         0 file(s)                   0 bytes

Directory of F:\cat\bathy

.                  <DIR>        05-22-98 10:23a .
..                 <DIR>        05-22-98 10:23a ..
BATHYFIN CT2              1,052  04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2            421,648  04-27-98 11:07a bathyfin.dt2
BEDFRIC  CT2              1,052  05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2            421,648  04-21-98  3:40p bedfric.dt2
         4 file(s)          845,400 bytes

Directory of F:\cat\bound

.                  <DIR>        05-22-98 10:23a .
..                 <DIR>        05-22-98 10:23a ..
CHAN08~6 CT0              1,052  04-19-98  3:12p chan0896PW.ct0
CHAN08~8 DT0              4,800  04-19-98  3:12p chan0896PW.dt0
S96MCN   CT1              1,052  05-03-98 12:09p s96Mon.ct1
S96MON   DT1          2,253,312  04-16-98 12:05p s96Mon.dt1
         4 file(s)        2,260,216 bytes

Directory of F:\cat\Mon96

.                  <DIR>        05-22-98 10:23a .
..                 <DIR>        05-22-98 10:23a ..
HD       CT2              1,052  05-05-98  5:37a hd.ct2
HD       DT2        324,668,960  05-05-98  5:37a hd.dt2
HDMAX    CT2              1,052  05-22-98 11:01a hdmax.ct2
HDMAX    DT2            843,296  05-22-98 11:01a hdmax.dt2
HDMEAN   CT2              1,052  05-22-98 11:32a hdmean.ct2
HDMEAN   DT2            843,296  05-22-98 11:32a hdmean.dt2
HDMIN    CT2              1,052  05-22-98 11:27a hdmin.ct2
HDMIN    DT2            843,296  05-22-98 11:27a hdmin.dt2
NEAP96   CT2              1,052  05-05-98  5:37a Neap96.ct2
NEAP96   DT2        126,916,048  05-05-98  3:58a Neap96.dt2
```

```
SIM0996A CT0           1,052  05-12-98  9:23a sim0996A.ct0
SIM0996A DT0          49,216  05-12-98  9:23a sim0996A.dt0
SIM0996B CT0           1,052  05-12-98  9:23a sim0996B.ct0
SIM0996B DT0          24,608  05-12-98  9:23a sim0996B.dt0
SPRING96 CT2           1,052  05-05-98  5:37a Spring96.ct2
SPRING96 DT2     126,916,048  05-04-98  7:02p Spring96.dt2
        16 file(s)     581,113,184 bytes

Directory of F:\cat\wind

.              <DIR>          05-22-98 10:23a .
..             <DIR>          05-22-98 10:23a ..
HATIA0~6 CT0           1,052  04-23-98 12:31p hatia0996.ct0
HATIA0~8 DT0           1,920  04-23-98 12:31p hatia0996.dt0
         2 file(s)          2,972 bytes

Directory of F:\wrkHDmon96

.              <DIR>          05-22-98 10:23a .
..             <DIR>          05-22-98 10:23a ..
M21HD    INP           5,011  05-03-98  3:17p m21hd.inp
         1 file(s)          5,011 bytes

Total files listed:
        27 file(s)     584,226,783 bytes
        18 dir(s)                0 bytes free
```

E.6 Contents of CD-ROM MES_DRY97A

```
 Volume in drive F is MES_DRY97A

 Volume Serial Number is 9CF3-E5D2


Directory of F:\

CAT            <DIR>        05-21-98  4:07p cat
WRKHDD~7       <DIR>        05-21-98  4:07p wrkHDdry97
         0 file(s)              0 bytes

Directory of F:\cat

.              <DIR>        05-21-98  4:07p .
..             <DIR>        05-21-98  4:07p ..
BATHY          <DIR>        05-21-98  4:07p bathy
BOUND          <DIR>        05-21-98  4:07p bound
DRY97          <DIR>        05-21-98  4:07p Dry97
WIND           <DIR>        05-21-98  4:07p wind
         0 file(s)              0 bytes

Directory of F:\cat\bathy

.              <DIR>        05-21-98  4:07p .
..             <DIR>        05-21-98  4:07p ..
BATHYFIN CT2          1,052 04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2        421,648 04-27-98 11:07a bathyfin.dt2
BEDFRIC  CT2          1,052 05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2        421,648 04-21-98  3:40p bedfric.dt2
         4 file(s)        845,400 bytes

Directory of F:\cat\bound

.              <DIR>        05-21-98  4:07p .
..             <DIR>        05-21-98  4:07p ..
CHAN01~6 CT0          1,052 04-19-98 11:11a Chan0197PW.ct0
CHAN01~8 DT0         11,328 04-19-98 11:11a Chan0197PW.dt0
S97DRY   CT1          1,052 05-03-98  5:36p s97Dry.ct1
S97DRY   DT1      2,145,080 05-03-98  5:36p s97Dry.dt1
         4 file(s)      2,158,512 bytes

Directory of F:\cat\Dry97

.              <DIR>        05-21-98  4:07p .
..             <DIR>        05-21-98  4:07p ..
HD       CT2          1,052 05-04-98  8:07p hd.ct2
HD       DT2    324,668,960 05-04-98  8:07p hd.dt2
HDMAX    CT2          1,052 05-22-98 11:11a hdmax.ct2
HDMAX    DT2        843,296 05-22-98 11:11a hdmax.dt2
HDMEAN   CT2          1,052 05-22-98 11:34a hdmean.ct2
HDMEAN   DT2        843,296 05-22-98 11:34a hdmean.dt2
HDMIN    CT2          1,052 05-22-98 11:30a hdmin.ct2
HDMIN    DT2        843,296 05-22-98 11:29a hdmin.dt2
NEAP97   CT2          1,052 05-04-98  8:07p Neap97.ct2
NEAP97   DT2    126,916,048 05-04-98 11:08a Neap97.dt2
SIM0197A CT0          1,052 05-11-98  3:43p sim0197A.ct0
SIM0197A DT0         49,216 05-11-98  3:43p sim0197A.dt0
```

DD

```
SIM0197B CT0          1,052  05-11-98  3:47p sim0197B.ct0
SIM0197B DT0         24,608  05-11-98  3:47p sim0197B.dt0
SPRING97 CT2          1,052  05-04-98  8:07p Spring97.ct2
SPRING97 DT2    126,916,048  05-04-98  4:25p Spring97.dt2
        16 file(s)    581,113,184 bytes

Directory of F:\cat\wind

.              <DIR>         05-21-98  4:07p .
..             <DIR>         05-21-98  4:07p ..
HATIA0~6 CT0          1,052  04-23-98 12:45p hatia0197.ct0
HATIA0~8 DT0          1,408  04-23-98 12:45p hatia0197.dt0
         2 file(s)          2,460 bytes

Directory of F:\wrkHDdry97

.              <DIR>         05-21-98  4:07p .
..             <DIR>         05-21-98  4:07p ..
M21HD    INP          5,012  05-03-98  3:49p m21hd.inp
         1 file(s)          5,012 bytes

Total files listed:
        27 file(s)    584,124,568 bytes
        18 dir(s)               0 bytes free
```

200

E.7 Contents of CD-ROM MES_MON97A

```
 Volume in drive F is MES_MON97A

 Volume Serial Number is 0F9A-8453

Directory of F:\

CAT              <DIR>         05-22-98  4:51p cat
WRKHDM~7         <DIR>         05-22-98  4:51p wrkHDmon97
         0 file(s)                 0 bytes

Directory of F:\cat

.                <DIR>         05-22-98  4:51p .
..               <DIR>         05-22-98  4:51p ..
BATHY            <DIR>         05-22-98  4:51p bathy
BOUND            <DIR>         05-22-98  4:51p bound
MON97            <DIR>         05-22-98  4:51p Mon97
WIND             <DIR>         05-22-98  4:51p wind
         0 file(s)                 0 bytes

Directory of F:\cat\bathy

.                <DIR>         05-22-98  4:51p .
..               <DIR>         05-22-98  4:51p ..
BATHYFIN CT2           1,052  04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2         421,648  04-27-98 11:07a bathyfin.dt2
BEDFRIC  CT2           1,052  05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2         421,648  04-21-98  3:40p bedfric.dt2
         4 file(s)           845,400 bytes

Directory of F:\cat\bound

.                <DIR>         05-22-98  4:51p .
..               <DIR>         05-22-98  4:51p ..
CHAN08~6 CT0           1,052  04-19-98 11:17a Chan0897PW.ct0
CHAN08~8 DT0           6,352  04-19-98 11:17a Chan0897PW.dt0
S97MON   CT1           1,052  05-03-98 12:09p s97Mon.ct1
S97MON   DT1       3,999,368  04-23-98  5:20p s97Mon.dt1
         4 file(s)         4,007,824 bytes

Directory of F:\cat\Mon97

.                <DIR>         05-22-98  4:51p .
..               <DIR>         05-22-98  4:51p ..
HD       CT2           1,052  05-04-98  9:02a hd.ct2
HD       DT2     324,668,960  05-04-98  9:02a hd.dt2
HDFLNM   CT2           1,052  05-26-98  2:52p hdflNm.ct2
HDFLNM   DT2       1,686,592  05-26-98  2:52p hdflNm.dt2
HDFLNN   CT2           1,052  05-26-98  2:52p hdflNn.ct2
HDFLNN   DT2       1,686,592  05-26-98  2:52p hdflNn.dt2
HDFLSM   CT2           1,052  05-26-98  2:52p hdflSm.ct2
HDFLSM   DT2       1,686,592  05-26-98  2:52p hdflSm.dt2
HDFLSN   CT2           1,052  05-26-98  2:52p hdflSn.ct2
HDFLSN   DT2       1,686,592  05-26-98  2:52p hdflSn.dt2
HDMAX    CT2           1,052  05-17-98  4:04p hdmax.ct2
HDMAX    DT2         843,296  05-17-98  4:04p hdmax.dt2
HDMEAN   CT2           1,052  05-22-98 10:23a hdmean.ct2
HDMEAN   DT2         843,296  05-22-98 10:23a hdmean.dt2
```

```
HDMIN     CT2          1,052  05-17-98  4:04p hdmin.ct2
HDMIN     DT2        843,296  05-17-98  4:04p hdmin.dt2
NEAP97    CT2          1,052  05-04-98  9:02a Neap97.ct2
NEAP97    DT2    126,916,048  05-03-98  6:18p Neap97.dt2
SIM0997A  CT0          1,052  05-11-98  4:36p sim0997A.ct0
SIM0997A  DT0         49,216  05-11-98  4:36p sim0997A.dt0
SIM0997B  CT0          1,052  05-11-98  4:37p sim0997B.ct0
SIM0997B  DT0         24,608  05-11-98  4:37p sim0997B.dt0
SPRING97  CT2          1,052  05-04-98  9:02a Spring97.ct2
SPRING97  DT2    126,916,048  05-04-98  2:35a Spring97.dt2
        24 file(s)    587,863,760 bytes

Directory of F:\cat\wind

.              <DIR>          05-22-98  4:51p .
..             <DIR>          05-22-98  4:51p ..
HATIA0~6  CT0          1,052  04-23-98 12:58p hatia0897.ct0
HATIA0~8  DT0          3,912  04-23-98 12:58p hatia0897.dt0
         2 file(s)            4,964 bytes

Directory of F:\wrkHDmon97

.              <DIR>          05-22-98  4:51p .
..             <DIR>          05-22-98  4:51p ..
M21HD     INP          5,329  05-03-98  3:21p m21hd.inp
         1 file(s)            5,329 bytes

Total files listed:
        35 file(s)    592,727,277 bytes
        18 dir(s)                   0 bytes free
```

E.8 Contents of CD-ROM MES_MON97B

```
 Volume in drive F is MES_MON97B

 Volume Serial Number is 3108-0570

Directory of F:\

CAT            <DIR>        05-28-98 12:20p cat
WRKHDM~7       <DIR>        05-28-98 12:20p wrkHDmon97
         0 file(s)                0 bytes

Directory of F:\cat

.              <DIR>        05-28-98 12:20p .
..             <DIR>        05-28-98 12:20p ..
BATHY          <DIR>        05-28-98 12:20p bathy
BOUND          <DIR>        05-28-98 12:20p bound
MON97          <DIR>        05-28-98 12:20p Mon97
WIND           <DIR>        05-28-98 12:20p wind
         0 file(s)                0 bytes

Directory of F:\cat\bathy

.              <DIR>        05-28-98 12:20p .
..             <DIR>        05-28-98 12:20p ..
BATHYI13 CT2          1,052 05-24-98 11:13a bathyI13.ct2
BATHYI13 DT2        421,648 05-24-98 10:16a bathyI13.dt2
BATHY~10 CT2          1,052 05-24-98 11:04a bathyIall.ct2
BATHY~12 DT2        421,648 05-24-98 10:27a bathyIex8.dt2
BATHY~14 CT2          1,052 05-24-98 10:27a bathyIex8.ct2
BATHY~16 DT2        421,648 05-24-98 11:04a bathyIall.dt2
BEDFRIC  CT2          1,052 05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2        421,648 04-21-98  3:40p bedfric.dt2
         8 file(s)      1,690,800 bytes

Directory of F:\cat\bound

.              <DIR>        05-28-98 12:20p .
..             <DIR>        05-28-98 12:20p ..
CHAN08~6 CT0          1,052 04-19-98 11:17a Chan0897PW.ct0
CHAN08~8 DT0          6,352 04-19-98 11:17a Chan0897PW.dt0
S97MON   CT1          1,052 05-03-98 12:09p s97Mon.ct1
S97MON   DT1      3,999,368 04-23-98  5:20p s97Mon.dt1
         4 file(s)      4,007,824 bytes

Directory of F:\cat\Mon97

.              <DIR>        05-28-98 12:20p .
..             <DIR>        05-28-98 12:20p ..
HDFLI1~6 CT2          1,052 05-27-98  2:53p hdflI13Nn.ct2
HDFLI1~8 DT2      1,686,592 05-27-98  2:52p hdflI13Nm.dt2
HDFLI~10 CT2          1,052 05-27-98  2:54p hdflI13Sm.ct2
HDFLI~12 DT2      1,686,592 05-27-98  2:53p hdflI13Nn.dt2
HDFLI~14 CT2          1,052 05-27-98  2:55p hdflI13Sn.ct2
HDFLI~16 DT2      1,686,592 05-27-98  2:54p hdflI13Sm.dt2
HDFLI~18 CT2          1,052 05-27-98  2:52p hdflI13Nm.ct2
HDFLI~20 DT2      1,686,592 05-27-98  2:55p hdflI13Sn.dt2
HDFLI~22 CT2          1,052 05-28-98  9:40a hdflIallNm.ct2
HDFLI~24 DT2      1,686,592 05-28-98  9:40a hdflIallNm.dt2
```

```
HDFLI~26 CT2           1,052  05-28-98   9:41a hdflIallNn.ct2
HDFLI~28 DT2       1,686,592  05-28-98   9:41a hdflIallNn.dt2
HDFLI~30 CT2           1,052  05-28-98   9:42a hdflIallSm.ct2
HDFLI~32 DT2       1,686,592  05-28-98   9:42a hdflIallSm.dt2
HDFLI~34 CT2           1,052  05-28-98   9:43a hdflIallSn.ct2
HDFLI~36 DT2       1,686,592  05-28-98   9:43a hdflIallSn.dt2
HDFLI~38 CT2           1,052  05-28-98   8:54a hdflIex8Nm.ct2
HDFLI~40 DT2       1,686,592  05-28-98   8:54a hdflIex8Nm.dt2
HDFLI~42 CT2           1,052  05-28-98   8:55a hdflIex8Nn.ct2
HDFLI~44 DT2       1,686,592  05-28-98   8:55a hdflIex8Nn.dt2
HDFLI~46 CT2           1,052  05-28-98   8:56a hdflIex8Sm.ct2
HDFLI~48 DT2       1,686,592  05-28-98   8:56a hdflIex8Sm.dt2
HDFLI~50 CT2           1,052  05-28-98   8:56a hdflIex8Sn.ct2
HDFLI~52 DT2       1,686,592  05-28-98   8:56a hdflIex8Sn.dt2
HDI13MAX CT2           1,052  05-27-98   3:09p hdI13max.ct2
HDI13MAX DT2         843,296  05-27-98   3:09p hdI13max.dt2
HDI13MIN CT2           1,052  05-27-98   3:27p hdI13min.ct2
HDI13MIN DT2         843,296  05-27-98   3:27p hdI13min.dt2
HDI13TSA CT0           1,052  05-27-98   3:34p hdI13tsA.ct0
HDI13TSA DT0          49,216  05-27-98   3:34p hdI13tsA.dt0
HDI13TSB CT0           1,052  05-27-98   3:41p hdI13tsB.ct0
HDI13TSB DT0          24,608  05-27-98   3:41p hdI13tsB.dt0
HDI13~62 CT2           1,052  05-27-98   3:18p hdI13mean.ct2
HDI13~64 DT2         843,296  05-27-98   3:18p hdI13mean.dt2
HDIALL   CT2           1,052  05-28-98   5:44a hdIall.ct2
HDIALL   DT2     324,668,960  05-28-98   5:44a hdIall.dt2
HDIAL~78 CT0           1,052  05-28-98  10:23a hdIalltsA.ct0
HDIAL~80 CT2           1,052  05-28-98   9:52a hdIallmax.ct2
HDIAL~82 DT0          49,216  05-28-98  10:23a hdIalltsA.dt0
HDIAL~84 DT2         843,296  05-28-98   9:52a hdIallmax.dt2
HDIAL~86 CT0           1,052  05-28-98  10:30a hdIalltsB.ct0
HDIAL~88 CT2           1,052  05-28-98  10:04a hdIallmean.ct2
HDIAL~90 DT0          24,608  05-28-98  10:30a hdIalltsB.dt0
HDIAL~92 DT2         843,296  05-28-98  10:04a hdIallmean.dt2
HDIAL~94 CT2           1,052  05-28-98  10:16a hdIallmin.ct2
HDIAL~96 DT2         843,296  05-28-98  10:16a hdIallmin.dt2
HDIEX~98 CT0           1,052  05-28-98   9:33a hdIex8tsA.ct0
HDIE~100 CT2           1,052  05-28-98   9:06a hdIex8max.ct2
HDIE~102 DT0          49,216  05-28-98   9:32a hdIex8tsA.dt0
HDIE~104 DT2         843,296  05-28-98   9:06a hdIex8max.dt2
HDIE~106 CT0           1,052  05-28-98   9:39a hdIex8tsB.ct0
HDIE~108 CT2           1,052  05-28-98   9:16a hdIex8mean.ct2
HDIE~110 DT0          24,608  05-28-98   9:39a hdIex8tsB.dt0
HDIE~112 DT2         843,296  05-28-98   9:16a hdIex8mean.dt2
HDIE~114 CT2           1,052  05-28-98   9:25a hdIex8min.ct2
HDIE~116 DT2         843,296  05-28-98   9:25a hdIex8min.dt2
NEAP~118 CT2           1,052  05-28-98   5:44a Neap97Iall.ct2
NEAP~120 DT2     126,916,048  05-27-98   8:40p Neap97Iall.dt2
SPR9~122 CT2           1,052  05-28-98   5:44a Spr97Iall.ct2
SPR9~124 DT2     126,916,048  05-28-98   1:51a Spr97Iall.dt2
        60 file(s)     606,582,856 bytes

Directory of F:\cat\wind

.                <DIR>        05-28-98  12:20p .
..               <DIR>        05-28-98  12:20p ..
HATIA0~6 CT0           1,052  04-23-98  12:58p hatia0897.ct0
HATIA0~8 DT0           3,912  04-23-98  12:58p hatia0897.dt0
         2 file(s)          4,964 bytes

Directory of F:\wrkHDmon97
```

708

```
.                  <DIR>          05-28-98 12:20p .
..                 <DIR>          05-28-98 12:20p ..
M21HDI13 INP             5,044  05-26-98  3:59p m21hdI13.inp
M21HDI~8 INP             5,048  05-26-98  4:02p m21hdIex8.inp
M21HD~10 INP             5,033  05-26-98  4:04p m21hdIall.inp
         3 file(s)             15,125 bytes

Total files listed:
        77 file(s)    612,301,569 bytes
        18 dir(s)                0 bytes free
```

E.9 Contents of CD-ROM MES_SALI

```
 Volume in drive F is MES_SALI
 Volume Serial Number is 3B40-EEDE

Directory of F:\

CAT            <DIR>        05-27-98 11:54a cat
WRKAD          <DIR>        05-27-98 11:54a wrkAD
         0 file(s)                0 bytes

Directory of F:\cat

.              <DIR>        05-27-98 11:54a .
..             <DIR>        05-27-98 11:54a ..
BATHY          <DIR>        05-27-98 11:54a bathy
BOUND          <DIR>        05-27-98 11:54a bound
SALI           <DIR>        05-27-98 11:54a sali
WIND           <DIR>        05-27-98 11:54a wind
         0 file(s)                0 bytes

Directory of F:\cat\bathy

.              <DIR>        05-27-98 11:54a .
..             <DIR>        05-27-98 11:54a ..
BATHYFIN CT2          1,052  04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2        421,648  04-27-98 11:07a bathyfin.dt2
BATHY~10 CT2          1,052  05-24-98 11:04a bathyIall.ct2
BATHY~12 DT2        421,648  05-24-98 11:04a bathyIall.dt2
BEDFRIC  CT2          1,052  05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2        421,648  04-21-98  3:40p bedfric.dt2
         6 file(s)      1,268,100 bytes

Directory of F:\cat\bound

.              <DIR>        05-27-98 11:54a .
..             <DIR>        05-27-98 11:54a ..
CHAN02~6 CT0          1,052  04-19-98 11:03a chan0296PW.ct0
CHAN02~8 DT0         76,640  04-19-98 11:03a chan0296PW.dt0
S96DRY   CT1          1,052  05-03-98 12:08p s96Dry.ct1
S96DRY   DT1      2,129,432  03-07-98 12:11p s96Dry.dt1
         4 file(s)      2,208,176 bytes

Directory of F:\cat\sali

.              <DIR>        05-27-98 11:54a .
..             <DIR>        05-27-98 11:54a ..
AD       CT2          1,052  05-27-98  4:04a ad.ct2
AD       DT2    324,668,960  05-27-98  4:04a ad.dt2
AD0296A  CT0          1,052  05-27-98  8:53a ad0296A.ct0
AD0296A  DT0         49,216  05-27-98  8:53a ad0296A.dt0
AD0296B  CT0          1,052  05-27-98  9:01a ad0296B.ct0
AD0296B  DT0         24,608  05-27-98  9:01a ad0296B.dt0
ADI0296A CT0          1,052  05-26-98 11:33a adI0296A.ct0
ADI0296A DT0         22,272  05-26-98 11:32a adI0296A.dt0
```

```
ADI0296B CT0         1,052  05-26-98 11:38a adI0296B.ct0
ADI0296B DT0        11,136  05-26-98 11:38a adI0296B.dt0
ADIALL   CT2         1,052  05-26-98  7:52a adIall.ct2
ADIALL   DT2   147,155,152  05-26-98  7:52a adIall.dt2
ADIMAX   CT2         1,052  05-26-98  9:00a adImax.ct2
ADIMAX   DT2       843,296  05-26-98  9:00a adImax.dt2
ADIMEAN  CT2         1,052  05-26-98  9:11a adImean.ct2
ADIMEAN  DT2       843,296  05-26-98  9:11a adImean.dt2
ADIMIN   CT2         1,052  05-26-98  9:06a adImin.ct2
ADIMIN   DT2       843,296  05-26-98  9:06a adImin.dt2
ADMAX    CT2         1,052  05-27-98  9:11a admax.ct2
ADMAX    DT2       843,296  05-27-98  9:11a admax.dt2
ADMEAN   CT2         1,052  05-27-98  9:18a admean.ct2
ADMEAN   DT2       843,296  05-27-98  9:18a admean.dt2
ADMIN    CT2         1,052  05-27-98  9:15a admin.ct2
ADMIN    DT2       843,296  05-27-98  9:15a admin.dt2
HD0296A  CT0         1,052  05-27-98  9:04a hd0296A.ct0
HD0296A  DT0        22,272  05-27-98  9:04a hd0296A.dt0
HD0296B  CT0         1,052  05-27-98  9:08a hd0296B.ct0
HD0296B  DT0        11,136  05-27-98  9:08a hd0296B.dt0
HDDIFF   CT2         1,052  05-27-98 10:23a hddiff.ct2
HDDIFF   DT2       421,648  05-27-98 10:23a hddiff.dt2
HDI0296A CT0         1,052  05-26-98 11:42a hdI0296A.ct0
HDI0296A DT0        22,272  05-26-98 11:42a hdI0296A.dt0
HDI0296B CT0         1,052  05-26-98 11:43a hdI0296B.ct0
HDI0296B DT0        11,136  05-26-98 11:43a hdI0296B.dt0
HDIDIFF  CT2         1,052  05-26-98  6:11p hdIdiff.ct2
HDIDIFF  DT2       421,648  05-26-98  6:11p hdIdiff.dt2
HDIMAX   CT2         1,052  05-26-98 10:52a hdImax.ct2
HDIMAX   DT2       843,296  05-26-98 10:52a hdImax.dt2
HDIMEAN  CT2         1,052  05-26-98 10:55a hdImean.ct2
HDIMEAN  DT2       843,296  05-26-98 10:55a hdImean.dt2
HDIMIN   CT2         1,052  05-26-98 10:58a hdImin.ct2
HDIMIN   DT2       843,296  05-26-98 10:58a hdImin.dt2
HDSMAX   CT2         1,052  05-27-98  9:26a hdSmax.ct2
HDSMAX   DT2       843,296  05-27-98  9:26a hdSmax.dt2
HDSMEAN  CT2         1,052  05-27-98  9:30a hdSmean.ct2
HDSMEAN  DT2       843,296  05-27-98  9:30a hdSmean.dt2
HDSMIN   CT2         1,052  05-27-98  9:22a hdSmin.ct2
HDSMIN   DT2       843,296  05-27-98  9:22a hdSmin.dt2
HDXMAX   CT2         1,052  05-25-98  1:21p hdXmax.ct2
HDXMAX   DT2       843,296  05-25-98  1:21p hdXmax.dt2
HDXMEAN  CT2         1,052  05-25-98  1:43p hdXmean.ct2
HDXMEAN  DT2       843,296  05-25-98  1:43p hdXmean.dt2
HDXMIN   CT2         1,052  05-25-98  1:31p hdXmin.ct2
HDXMIN   DT2       843,296  05-25-98  1:31p hdXmin.dt2
HDYMAX   CT2         1,052  05-26-98 11:11a hdYmax.ct2
HDYMAX   DT2       843,296  05-26-98 11:11a hdYmax.dt2
HDYMEAN  CT2         1,052  05-26-98 11:18a hdYmean.ct2
HDYMEAN  DT2       843,296  05-26-98 11:18a hdYmean.dt2
HDYMIN   CT2         1,052  05-26-98 11:25a hdYmin.ct2
HDYMIN   DT2       843,296  05-26-98 11:25a hdYmin.dt2
SALIINI  CT2         1,052  05-05-98  6:36p saliini.ct2
SALIINI  DT2       421,648  05-05-98  6:36p saliini.dt2
SBND     CT1         1,052  05-18-98 11:38a sbnd.ct1
SBND     DT1         2,608  05-05-98  6:30p sbnd.dt1
        64 file(s)    488,478,704 bytes

Directory of F:\cat\wind

.              <DIR>        05-27-98 11:54a .
```

```
..              <DIR>        05-27-98 11:54a ..
HATIA0~6 CT0          1,052  04-23-98 12:37p hatia0296.ct0
HATIA0~8 DT0          1,792  04-23-98 12:37p hatia0296.dt0
         2 file(s)           2,844 bytes

Directory of F:\wrkAD

.               <DIR>        05-27-98 11:54a .
..              <DIR>        05-27-98 11:54a ..
M21AD    INP          6,818  05-26-98 12:06p m21ad.inp
M21ADI~8 INP          6,852  05-25-98  4:54p m21adIall.inp
         2 file(s)          13,670 bytes

Total files listed:
        78 file(s)    491,971,494 bytes
        18 dir(s)               0 bytes free
```

E.10 Contents of CD-ROM MES_OTHER

```
 Volume in drive F is MES_OTHER

 Volume Serial Number is 904C-4115


Directory of F:\


BATHYRAW       <DIR>         06-01-98  4:33p bathyraw

CAT            <DIR>         06-01-98  4:33p cat

SOURCE         <DIR>         06-01-98  4:33p source

WORKNZ         <DIR>         06-01-98  4:33p workNZ
WRKNSW         <DIR>         06-01-98  4:33p wrkNSW
WRKST          <DIR>         06-01-98  4:33p wrkST
         0 file(s)                0 bytes

Directory of F:\bathyraw

.              <DIR>         06-01-98  4:33p .
..             <DIR>         06-01-98  4:33p ..
C18294   XYZ          7,727  10-30-97  3:26p c18294.xyz
C186_95  XYZ         37,768  11-16-97 12:11p c186_95.xyz
E169_96  XYZ         26,207  10-13-97  7:19p e169_96.xyz
ED182BP  XYZ          8,064  11-02-97  4:14p ed182bp.xyz
ED_14994 XYZ          6,615  10-28-97  9:16a ed_14994.xyz
MES200   XYZ     21,361,536  03-16-98  5:08p mes200.xyz
NIZ97    XYZ         12,988  03-16-98 12:00p niz97.xyz
ORIKMS   XYZ     69,116.892  02-12-98  3:21p orikms.xyz
WATER0   XYZ      2,370,816  03-16-98  2:17p water0.xyz
         9 file(s)     92,948,613 bytes

Directory of F:\cat

.              <DIR>         06-01-98  4:33p .
..             <DIR>         06-01-98  4:33p ..
BATHY          <DIR>         06-01-98  4:33p bathy
BATHYRAW       <DIR>         06-01-98  4:33p bathyraw
BATLOC         <DIR>         06-01-98  4:33p batLoc
BNDLOC         <DIR>         06-01-98  4:33p bndLoc
MEAS0296       <DIR>         06-01-98  4:33p meas0296
MEAS0297       <DIR>         06-01-98  4:33p meas0297
MEAS0996       <DIR>         06-01-98  4:33p meas0996
MEAS0997       <DIR>         06-01-98  4:33p meas0997
MESWL          <DIR>         06-01-98  4:33p meswl
SEDI           <DIR>         06-01-98  4:33p sedi
TIDE0296       <DIR>         06-01-98  4:33p tide0296
TIDE0297       <DIR>         06-01-98  4:33p tide0297
TIDE0996       <DIR>         06-01-98  4:33p tide0996
TIDE0997       <DIR>         06-01-98  4:33p tide0997
WAVES          <DIR>         06-01-98  4:33p waves
         0 file(s)                0 bytes

Directory of F:\cat\bathy
```

```
.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
BAT-MES  CT2           1,052  04-27-98 10:46a bat-MES.ct2
BAT-MES  DT2         421,648  04-27-98  9:58a bat-MES.dt2
BAT-NIZ  CT2           1,052  04-27-98 10:37a bat-niz.ct2
BAT-NIZ  DT2         421,648  04-27-98 10:37a bat-niz.dt2
BATHYBND CT2           1,052  03-04-98  3:30p bathybnd.ct2
BATHYBND DT2         421,648  03-04-98  3:30p bathybnd.dt2
BATHYFIN CT2           1,052  04-27-98 11:07a bathyfin.ct2
BATHYFIN DT2         421,648  04-27-98 11:07a bathyfin.dt2
BATHYNSW CT2           1,052  05-04-98  9:29a bathyNSW.ct2
BATHYNSW DT2       1,682,260  05-04-98  9:29a bathyNSW.dt2
BEDFRIC  CT2           1,052  05-03-98 11:54a bedfric.ct2
BEDFRIC  DT2         421,648  04-21-98  3:40p bedfric.dt2
FINAL~30 CT2           1,052  03-07-98 12:08p finaldhul.ct2
FINAL~32 DT2         421,648  03-07-98 12:08p finaldhul.dt2
        14 file(s)      4,219,512 bytes

Directory of F:\cat\bathyraw

.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
BAT-CSPS CT2           1,052  02-22-98  5:03p bat-csps.ct2
BAT-CSPS DT2         490,960  02-22-98  5:03p bat-csps.dt2
BAT-KMS  CT2           1,052  03-12-98  5:10p bat-kms.ct2
BAT-KMS  DT2         516,952  03-12-98  5:10p bat-kms.dt2
BAT-LAND CT2           1,052  02-22-98  4:49p bat-land.ct2
BAT-LAND DT2         421,648  02-22-98  4:49p bat-land.dt2
BAT-SPOT CT2           1,052  05-18-98 11:44a bat-spot.ct2
BAT-SPOT DT2         503,956  05-18-98 11:44a bat-spot.dt2
BIWTA~22 CT2           1,052  02-19-98 11:10a biwta_pwd.ct2
BIWTA~24 DT2         503,956  02-19-98 11:10a biwta_pwd.dt2
        10 file(s)      2,442,732 bytes

Directory of F:\cat\batLoc

.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
BATHYLOC CT2           1,052  05-30-98 10:37a bathyLoc.ct2
BATHYLOC DT2          84,056  05-26-98  9:24a bathyLoc.dt2
BATILOC  CT2           1,052  05-30-98 10:36a batILoc.ct2
BATILOC  DT2          84,056  05-27-98  5:40p batILoc.dt2
BATIL~14 CT2           1,052  06-02-98 10:06a batILoc13.ct2
BATIL~16 DT2          84,056  06-02-98 10:06a batILoc13.dt2
BEDFRIC  CT2           1,052  05-19-98  3:21p bedfric.ct2
BEDFRIC  DT2          84,056  05-19-98  3:21p bedfric.dt2
HDFLI~22 CT2           1,052  06-04-98 12:04p hdflI13Sn.ct2
HDFLI~24 DT2         336,224  06-04-98 12:03p hdflI13Sm.dt2
HDFLI~26 CT2           1,052  06-04-98 12:03p hdflI13Sm.ct2
HDFLI~28 DT2         336,224  06-04-98 12:04p hdflI13Sn.dt2
HDFLI~30 CT2           1,052  05-30-98  3:14p hdflIallSn.ct2
HDFLI~32 DT2         336,224  05-30-98  3:13p hdflIallSm.dt2
HDFLI~34 CT2           1,052  05-30-98  3:13p hdflIallSm.ct2
HDFLI~36 DT2         336,224  05-30-98  3:14p hdflIallSn.dt2
HDFLSM   CT2           1,052  05-30-98  3:09p hdflSm.ct2
HDFLSM   DT2         336,224  05-30-98  3:09p hdflSm.dt2
HDFLSN   CT2           1,052  05-30-98  3:10p hdflSn.ct2
HDFLSN   DT2         336,224  05-30-98  3:10p hdflSn.dt2
HDNZ     CT2           1,052  05-30-98 10:13a hdNZ.ct2
HDNZ     DT2      25,300,856  05-27-98  9:12p hdNZ.dt2
HDNZI13  CT2           1,052  06-03-98  7:03p hdNZI13.ct2
```

```
DHU0296C CT0          1,052  05-14-98 11:55a dhu0296C.ct0
DHU0296C DT0          5,568  05-14-98 11:55a dhu0296C.dt0
K100296C CT0          1,052  05-13-98  3:23p k100296C.ct0
K100296C DT0          2,780  05-13-98  3:23p k100296C.dt0
KHE0296C CT0          1,052  05-14-98  4:08p khe0296C.ct0
KHE0296C DT0          5,564  05-14-98  4:08p khe0296C.dt0
KOCHO~38 CT0          1,052  05-14-98 11:32a Kocho0296C.ct0
KOCHO~40 DT0          6,000  05-14-98 11:32a Kocho0296C.dt0
RAM0296C CT0          1,052  05-13-98  3:28p ram0296C.ct0
RAM0296C DT0          5,568  05-13-98  3:28p ram0296C.dt0
SAN0296C CT0          1,052  03-08-98  9:42a san0296C.ct0
SAN0296C DT0          5,568  03-08-98  9:42a san0296C.dt0
        22 file(s)        136,428 bytes

Directory of F:\cat\meas0297

.              <DIR>          06-01-98  4:33p .
..             <DIR>          06-01-98  4:33p ..
CHAND0~6 CT0          1,052  04-20-98  2:36p Chand0197C.ct0
CHAND0~8 DT0         11,328  04-20-98  2:36p Chand0197C.dt0
CHANG~10 CT0          1,052  05-13-98 11:17a Chang0197C.ct0
CHANG~12 DT0         11,328  05-13-98 11:17a Chang0197C.dt0
CHIT0~14 CT0          1,052  05-13-98 11:18a Chit0197C.ct0
CHIT0~16 DT0         11,328  05-13-98 11:18a Chit0197C.dt0
DAS0197C CT0          1,052  05-13-98 11:19a Das0197C.ct0
DAS0197C DT0         11,324  05-13-98 11:19a Das0197C.dt0
DAU0197C CT0          1,052  05-13-98 11:26a Dau0197C.ct0
DAU0197C DT0            440  05-13-98 11:26a Dau0197C.dt0
DHULI~26 CT0          1,052  05-14-98  1:10p Dhuli0197C.ct0
DHULI~28 DT0         11,332  05-14-98  1:10p Dhuli0197C.dt0
KH100~30 CT0          1,052  05-13-98 12:00p Kh100197C.ct0
KH100~32 DT0          5,664  05-13-98 12:00p Kh100197C.dt0
KHEP0~34 CT0          1,052  05-14-98  4:06p Khep0197C.ct0
KHEP0~36 DT0         11,328  05-14-98  4:06p Khep0197C.dt0
KOCH0~38 CT0          1,052  05-14-98 12:46p Koch0197C.ct0
KOCH0~40 DT0          5,664  05-14-98 12:46p Koch0197C.dt0
RAMDA~42 CT0          1,052  05-13-98 11:32a Ramda0197C.ct0
RAMDA~44 DT0         11,328  05-13-98 11:32a Ramda0197C.dt0
SAND0~46 CT0          1,052  05-14-98 12:27p Sand0197C.ct0
SAND0~48 DT0         11,328  05-14-98 12:27p Sand0197C.dt0
        22 file(s)        113,964 bytes

Directory of F:\cat\meas0996

.              <DIR>          06-01-98  4:33p .
..             <DIR>          06-01-98  4:33p ..
0809CH~6 CT0          1,052  05-14-98  9:35a 0809Char96.ct0
0809CH~8 DT0          3,188  05-14-98  9:35a 0809Char96.dt0
CHAR0~10 CT0          1,052  05-14-98  9:39a Char0996C.ct0
CHAR0~12 DT0          3,188  05-14-98  9:39a Char0996C.dt0
CHIT0~14 CT0          1,052  05-14-98  9:44a Chit0996C.ct0
CHIT0~16 DT0          3,072  05-14-98  9:44a Chit0996C.dt0
DAS0996C CT0          1,052  05-14-98  9:46a Das0996C.ct0
DAS0996C DT0          3,072  05-14-98  9:46a Das0996C.dt0
DAUL0~22 CT0          1,052  05-14-98 12:14p Daul0996C.ct0
DAUL0~24 DT0            800  05-14-98 12:14p Daul0996C.dt0
DHUL0~26 CT0          1,052  05-14-98 10:44a Dhul0996C.ct0
DHUL0~28 DT0          3,072  05-14-98 10:44a Dhul0996C.dt0
KH100~30 CT0          1,052  05-14-98  2:57p kh100996C.ct0
KH100~32 DT0          2,784  05-14-98  2:57p kh100996C.dt0
KHEP0~34 CT0          1,052  05-14-98  4:04p Khep0996C.ct0
```

```
KHEP0~36 DT0            3,072  05-14-98  4:04p Khep0996C.dt0
KOCH0~38 CT0            1,052  05-16-98  2:44p Koch0996C.ct0
KOCH0~40 DT0            2,784  05-16-98  2:44p Koch0996C.dt0
RAM0996C CT0            1,052  05-14-98 10:54a Ram0996C.ct0
RAM0996C DT0            3,072  05-14-98 10:54a Ram0996C.dt0
SAND0~46 CT0            1,052  05-14-98 11:13a Sand0996C.ct0
SAND0~48 DT0            3,072  05-14-98 11:18a Sand0996C.dt0
        22 file(s)         42,748 bytes

Directory of F:\cat\meas0997

.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
CHAND0~6 CT0            1,052  04-26-98  9:07a Chand0897.ct0
CHAND0~8 DT0           11,712  04-26-98  9:07a Chand0897.dt0
CHANG~10 CT0            1,052  05-13-98  3:00p Chang0997C.ct0
CHANG~12 DT0           11,712  05-13-98  3:00p Chang0997C.dt0
CHIT0~14 CT0            1,052  05-13-98  2:58p Chit0997C.ct0
CHIT0~16 DT0           11,712  05-13-98  2:58p Chit0997C.dt0
DAS0997C CT0            1,052  05-13-98  2:34p Das0997C.ct0
DAS0997C DT0           11,712  05-13-98  2:34p Das0997C.dt0
DAU0997C CT0            1,052  05-13-98  2:48p Dau0997C.ct0
DAU0997C DT0            1,088  05-13-98  2:48p Dau0997C.dt0
DHULI~26 CT0            1,052  05-14-98  1:41p Dhuli0997C.ct0
DHULI~28 DT0           11,712  05-14-98  1:41p Dhuli0997C.dt0
K100997C CT0            1,052  05-13-98  2:31p K100997C.ct0
K100997C DT0            5,856  05-13-98  2:31p K100997C.dt0
KHEP0~34 CT0            1,052  05-14-98  4:06p Khep0997C.ct0
KHEP0~36 DT0           11,712  05-14-98  4:06p Khep0997C.dt0
RAM0997C CT0            1,052  05-13-98  2:44p Ram0997C.ct0
RAM0997C DT0           11,712  05-13-98  2:44p Ram0997C.dt0
SAND0~42 CT0            1,052  05-14-98  1:54p Sand0997C.ct0
SAND0~44 DT0           11,712  05-14-98  1:54p Sand0997C.dt0
        20 file(s)        111,160 bytes

Directory of F:\cat\meswl

.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
MES1C    CT0            1,052  05-13-98 12:34p mes1C.ct0
MES1C    DT0            6,612  05-13-98 12:34p mes1C.dt0
MES2C    CT0            1,052  05-13-98 12:47p mes2C.ct0
MES2C    DT0            4,748  05-13-98 12:47p mes2C.dt0
MES4C    CT0            1,052  05-13-98 12:48p mes4C.ct0
MES4C    DT0            6,044  05-13-98 12:48p mes4C.dt0
MES5C    CT0            1,052  05-13-98 12:51p mes5C.ct0
MES5C    DT0            6,124  05-13-98 12:51p mes5C.dt0
MES6C    CT0            1,052  05-13-98 12:52p mes6C.ct0
MES6C    DT0            5,812  05-13-98 12:52p mes6C.dt0
SEC      CT0            1,052  05-13-98 12:53p seC.ct0
SEC      DT0            4,596  05-13-98 12:53p seC.dt0
        12 file(s)         40,248 bytes

Directory of F:\cat\sedi

.               <DIR>          06-01-98  4:33p .
..              <DIR>          06-01-98  4:33p ..
DRYSNN~6 CT2            1,052  05-28-98  3:56p drySNnowT.ct2
DRYSNN~8 DT2        1,686,592  05-28-98  3:56p drySNnowT.dt2
DRYSP~10 CT2            1,052  05-28-98  4:33p drySPnowT.ct2
DRYSP~12 DT2        1,686,592  05-28-98  4:33p drySPnowT.dt2
```

```
MONSN~14 CT2           1,052  05-28-98  7:18p monSNnowT.ct2
MONSN~16 DT2       1,686,592  05-28-98  7:18p monSNnowT.dt2
MONSN~18 CT2           1,052  05-28-98  5:48p monSNsseT.ct2
MONSN~20 DT2       1,686,592  05-28-98  5:48p monSNsseT.dt2
MONSN~22 CT2           1,052  05-28-98  4:56p monSNsswT.ct2
MONSN~24 DT2       1,686,592  05-28-98  4:56p monSNsswT.dt2
MONSP~26 CT2           1,052  05-16-98  6:01p monSPnowT.ct2
MONSP~28 DT2       1,686,592  05-16-98  6:01p monSPnowT.dt2
MONSP~30 CT2           1,052  05-16-98  5:02p monSPsseT.ct2
MONSP~32 DT2       1,686,592  05-16-98 12:37p monSPsswT.dt2
MONSP~34 CT2           1,052  05-16-98 12:37p monSPsswT.ct2
MONSP~36 DT2       1,686,592  05-16-98  5:02p monSPsseT.dt2
        16 file(s)     13,501,152 bytes

Directory of F:\cat\tide0296

.               <DIR>         06-01-98  4:33p .
..              <DIR>         06-01-98  4:33p ..
4502N    CT0           1,052  05-31-98  8:57a 4502N.ct0
4502N    DT0          11,524  05-31-98  8:57a 4502N.dt0
4503N    CT0           1,052  05-31-98  9:23a 4503N.ct0
4503N    DT0          11,524  05-31-98  9:23a 4503N.dt0
4506N    CT0           1,052  05-31-98  9:14a 4506N.ct0
4506N    DT0          11,524  05-31-98  9:14a 4506N.dt0
4507AN   CT0           1,052  05-31-98  9:24a 4507aN.ct0
4507AN   DT0          11,524  05-31-98  9:24a 4507aN.dt0
4507C    CT0           1,052  05-31-98 12:37p 4507C.ct0
4507C    DT0          11,524  05-31-98 12:37p 4507C.dt0
4510N    CT0           1,052  05-31-98  9:20a 4510N.ct0
4510N    DT0          11,524  05-31-98  9:20a 4510N.dt0
4511N    CT0           1,052  05-31-98  9:16a 4511N.ct0
4511N    DT0          11,524  05-31-98  9:16a 4511N.dt0
4514N    CT0           1,052  05-31-98  9:18a 4514N.ct0
4514N    DT0          11,524  05-31-98  9:18a 4514N.dt0
        16 file(s)        100,608 bytes

Directory of F:\cat\tide0297

.               <DIR>         06-01-98  4:33p .
..              <DIR>         06-01-98  4:33p ..
4502N    CT0           1,052  05-31-98 10:24a 4502N.ct0
4502N    DT0           1,924  05-31-98 10:24a 4502N.dt0
4503N    CT0           1,052  05-31-98 10:37a 4503N.ct0
4503N    DT0           1,924  05-31-98 10:37a 4503N.dt0
4506N    CT0           1,052  05-31-98 10:27a 4506N.ct0
4506N    DT0           1,924  05-31-98 10:27a 4506N.dt0
4507AN   CT0           1,052  05-31-98 10:38a 4507aN.ct0
4507AN   DT0           1,924  05-31-98 10:38a 4507aN.dt0
4507C    CT0           1,052  05-31-98 12:38p 4507C.ct0
4507C    DT0           1,924  05-31-98 12:38p 4507C.dt0
4510N    CT0           1,052  05-31-98 10:36a 4510N.ct0
4510N    DT0           1,924  05-31-98 10:36a 4510N.dt0
4511N    CT0           1,052  05-31-98 10:34a 4511N.ct0
4511N    DT0           1,924  05-31-98 10:34a 4511N.dt0
4514N    CT0           1,052  05-31-98 10:35a 4514N.ct0
4514N    DT0           1,924  05-31-98 10:35a 4514N.dt0
        16 file(s)         23,808 bytes

Directory of F:\cat\tide0996

.               <DIR>         06-01-98  4:33p .
```

```
..                  <DIR>           06-01-98  4:33p ..
4502N     CT0             1,052  05-31-98  9:53a 4502N.ct0
4502N     DT0             3,076  05-31-98  9:53a 4502N.dt0
4503N     CT0             1,052  05-31-98 10:00a 4503N.ct0
4503N     DT0             3,076  05-31-98 10:00a 4503N.dt0
4506N     CT0             1,052  05-31-98  9:54a 4506N.ct0
4506N     DT0             2,884  05-31-98  9:54a 4506N.dt0
4507AN    CT0             1,052  05-31-98 10:02a 4507aN.ct0
4507AN    DT0             2,884  05-31-98 10:02a 4507aN.dt0
4507C     CT0             1,052  05-31-98 10:00a 4507C.ct0
4507C     DT0             2,884  05-31-98 10:00a 4507C.dt0
4510N     CT0             1,052  05-31-98  9:59a 4510N.ct0
4510N     DT0             2,884  05-31-98  9:59a 4510N.dt0
4511N     CT0             1,052  05-31-98  9:55a 4511N.ct0
4511N     DT0             2,884  05-31-98  9:55a 4511N.dt0
4514N     CT0             1,052  05-31-98  9:57a 4514N.ct0
4514N     DT0             1,540  05-31-98  9:57a 4514N.dt0
         16 file(s)           30,528 bytes

Directory of F:\cat\tide0997

.                   <DIR>           06-01-98  4:33p .
..                  <DIR>           06-01-98  4:33p ..
4502N     CT0             1,052  05-31-98 10:40a 4502N.ct0
4502N     DT0             2,500  05-31-98 10:40a 4502N.dt0
4503N     CT0             1,052  05-31-98 10:44a 4503N.ct0
4503N     DT0             2,500  05-31-98 10:44a 4503N.dt0
4506N     CT0             1,052  05-31-98 10:41a 4506N.ct0
4506N     DT0             2,500  05-31-98 10:41a 4506N.dt0
4507AN    CT0             1,052  05-31-98 10:46a 4507aN.ct0
4507AN    DT0             2,500  05-31-98 10:46a 4507aN.dt0
4507C     CT0             1,052  05-31-98 12:33p 4507C.ct0
4507C     DT0             2,500  05-31-98 12:33p 4507C.dt0
4510N     CT0             1,052  05-31-98 10:44a 4510N.ct0
4510N     DT0             2,500  05-31-98 10:44a 4510N.dt0
4511N     CT0             1,052  05-31-98 10:42a 4511N.ct0
4511N     DT0             2,500  05-31-98 10:42a 4511N.dt0
4514N     CT0             1,052  05-31-98 10:43a 4514N.ct0
4514N     DT0             2,500  05-31-98 10:43a 4514N.dt0
         16 file(s)           28,416 bytes

Directory of F:\cat\waves

.                   <DIR>           06-01-98  4:33p .
..                  <DIR>           06-01-98  4:33p ..
BND157    CT1             1,052  05-04-98 10:48a bnd157.ct1
BND157    DT1             7,220  05-04-98 10:48a bnd157.dt1
BND202    CT1             1,052  05-04-98 10:49a bnd202.ct1
BND202    DT1             7,220  05-04-98 10:49a bnd202.dt1
HDMEA~14  CT2             1,052  05-04-98  9:21a hdmeanNSW.ct2
HDMEA~16  DT2         3,364,520  05-04-98  9:21a hdmeanNSW.dt2
NOW0T     CT2             1,052  05-16-98  4:11p now0t.ct2
NOW0T     DT2         2,951,536  05-16-98  4:11p now0t.dt2
NOW0TN96  CT2             1,052  05-28-98  2:21p now0tN96.ct2
NOW0TN96  DT2         2,951,536  05-28-98  2:19p now0tN96.dt2
NOW0TN97  CT2             1,052  05-28-98  2:21p now0tN97.ct2
NOW0TN97  DT2         2,951,536  05-28-98  2:16p now0tN97.dt2
NOW0TS96  CT2             1,052  05-28-98  2:22p now0tS96.ct2
NOW0TS96  DT2         2,951,536  05-28-98  2:19p now0tS96.dt2
SSE8      CT2             1,052  05-04-98 11:26a sse8.ct2
SSE8      DT2         2,951,536  05-04-98 11:26a sse8.dt2
```

```
SSE8T    CT2          1,052  05-05-98  8:38a sse8t.ct2
SSE8T    DT2      2,951,536  05-04-98 11:42a sse8t.dt2
SSE8TN97 CT2          1,052  05-28-98  2:22p sse8tN97.ct2
SSE8TN97 DT2      2,951,536  05-28-98  2:17p sse8tN97.dt2
SSW8     CT2          1,052  05-04-98 11:11a ssw8.ct2
SSW8     DT2      2,951,536  05-04-98 11:11a ssw8.dt2
SSW8T    CT2          1,052  05-05-98  8:38a ssw8t.ct2
SSW8T    DT2      2,951,536  05-04-98 11:19a ssw8t.dt2
SSW8TN97 CT2          1,052  05-28-98  2:23p ssw8tN97.ct2
SSW8TN97 DT2      2,951,536  05-28-98  2:18p ssw8tN97.dt2
        26 file(s)     32,907,996 bytes

Directory of F:\source

.               <DIR>        06-01-98  4:33p .
..              <DIR>        06-01-98  4:33p ..
HDFLOW          <DIR>        06-01-98  4:33p hdflow
HTMBND          <DIR>        06-01-98  4:33p htmbnd
         0 file(s)              0 bytes

Directory of F:\source\hdflow

.               <DIR>        06-01-98  4:33p .
..              <DIR>        06-01-98  4:33p ..
CAT      CHC          2,754  03-05-98 10:57a cat.chc
CHCMEM   I              513  03-05-98 10:57a chcmem.i
CMPUTE   F            4,074  05-16-98  2:08p cmpute.f
HDFLOW   F            3,727  05-13-98 11:25a hdflow.f
HDFLOW   I            1,119  03-05-98 12:38p hdflow.i
HPQ2UV   F            1,438  05-13-98 11:36a hpq2uv.f
INPUT    F            4,365  05-13-98 11:23a input.f
MAKEFILE                745  05-13-98 10:34a makefile
PRO      INC            319  03-05-98 10:57a pro.inc
         9 file(s)         19,054 bytes

Directory of F:\source\htmbnd

.               <DIR>        06-01-98  4:33p .
..              <DIR>        06-01-98  4:33p ..
HTMBND   F            1,715  05-04-98 10:36a htmbnd.f
         1 file(s)          1,715 bytes

Directory of F:\workNZ

.               <DIR>        06-01-98  4:33p .
..              <DIR>        06-01-98  4:33p ..
HDFLI1~6 INP            297  06-04-98 12:03p hdflI13Sn.inp
HDFLI1~8 INP            296  06-04-98 12:02p hdflI13Sm.inp
M21HDI13 INP          4,082  06-04-98 12:22p m21hdI13.inp
M21HDSF  INP          4,050  05-30-98 10:17a m21hdSf.inp
M21HD~12 INP          4,081  05-30-98 10:18a m21hdIall.inp
M21TRN-E INP            566  05-19-98  1:33p m21trn-e.inp
M21TRN-S INP            569  05-19-98  3:19p m21trn-s.inp
M21TR~20 INP            565  05-19-98  2:46p m21trn-w2.inp
M21TR~22 INP            576  05-28-98 11:30a m21trn-Ie.inp
M21TR~24 INP            582  05-27-98  5:04p m21trn-In1.inp
M21TR~26 INP            580  05-28-98 12:46p m21trn-In2.inp
M21TR~28 INP            579  05-27-98  5:26p m21trn-Is.inp
M21TR~30 INP            576  05-27-98  5:23p m21trn-Iw1.inp
M21TR~32 INP            575  05-27-98  5:24p m21trn-Iw2.inp
M21TR~34 INP            572  05-19-98  1:17p m21trn-n1.inp
```

```
M21TR~36 INP            570  05-19-98  1:18p m21trn-n2.inp
M21TR~38 INP            566  05-19-98  2:38p m21trn-w1.inp
        17 file(s)          19,682 bytes

Directory of F:\wrkNSW

.              <DIR>         06-01-98  4:33p .
..             <DIR>         06-01-98  4:33p ..
M21SSE8  INP          3,297  05-04-98 10:55a m21sse8.inp
M21SSW8  INP          3,297  05-04-98 10:52a m21ssw8.inp
         2 file(s)           6,594 bytes

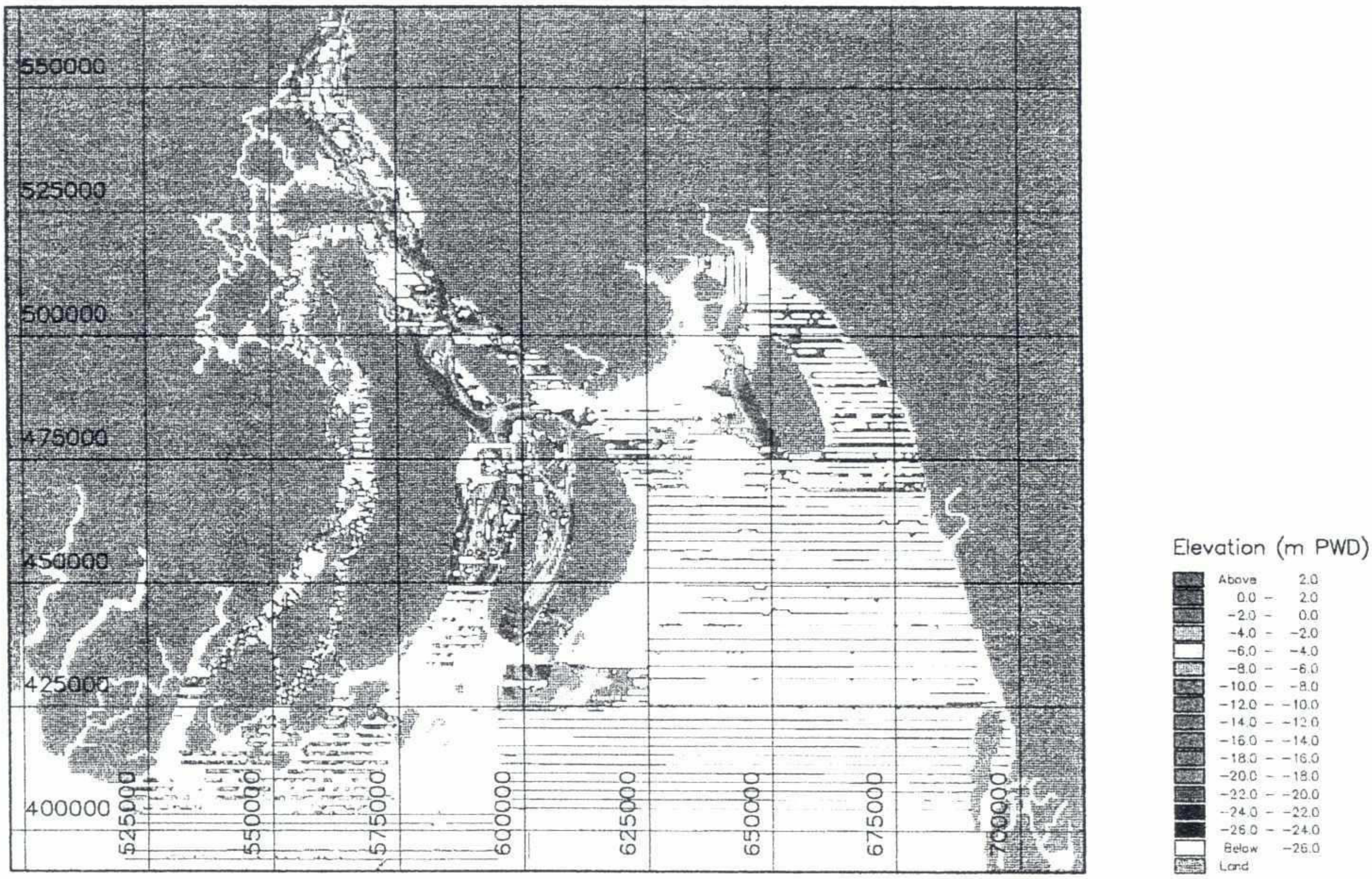
Directory of F:\wrkST

.              <DIR>         06-01-98  4:33p .
..             <DIR>         06-01-98  4:33p ..
M21D96~6 INP          2,204  05-29-98 10:13a m21D96Snow.inp
M21D96~8 INP          2,202  05-28-98  2:33p m21D96Nnow.inp
M21M9~10 INP          2,189  05-16-98 11:22a m21M97Sssw.inp
M21M9~12 INP          2,192  05-28-98  5:12p m21M97Nnow.inp
M21M9~14 INP          2,202  05-28-98  2:30p m21M97Nsse.inp
M21M9~16 INP          2,206  05-28-98  2:31p m21M97Nssw.inp
M21M9~18 INP          2,197  05-16-98  4:12p m21M97Snow.inp
M21M9~20 INP          2,189  05-16-98  4:02p m21M97Ssse.inp
         8 file(s)          17,581 bytes

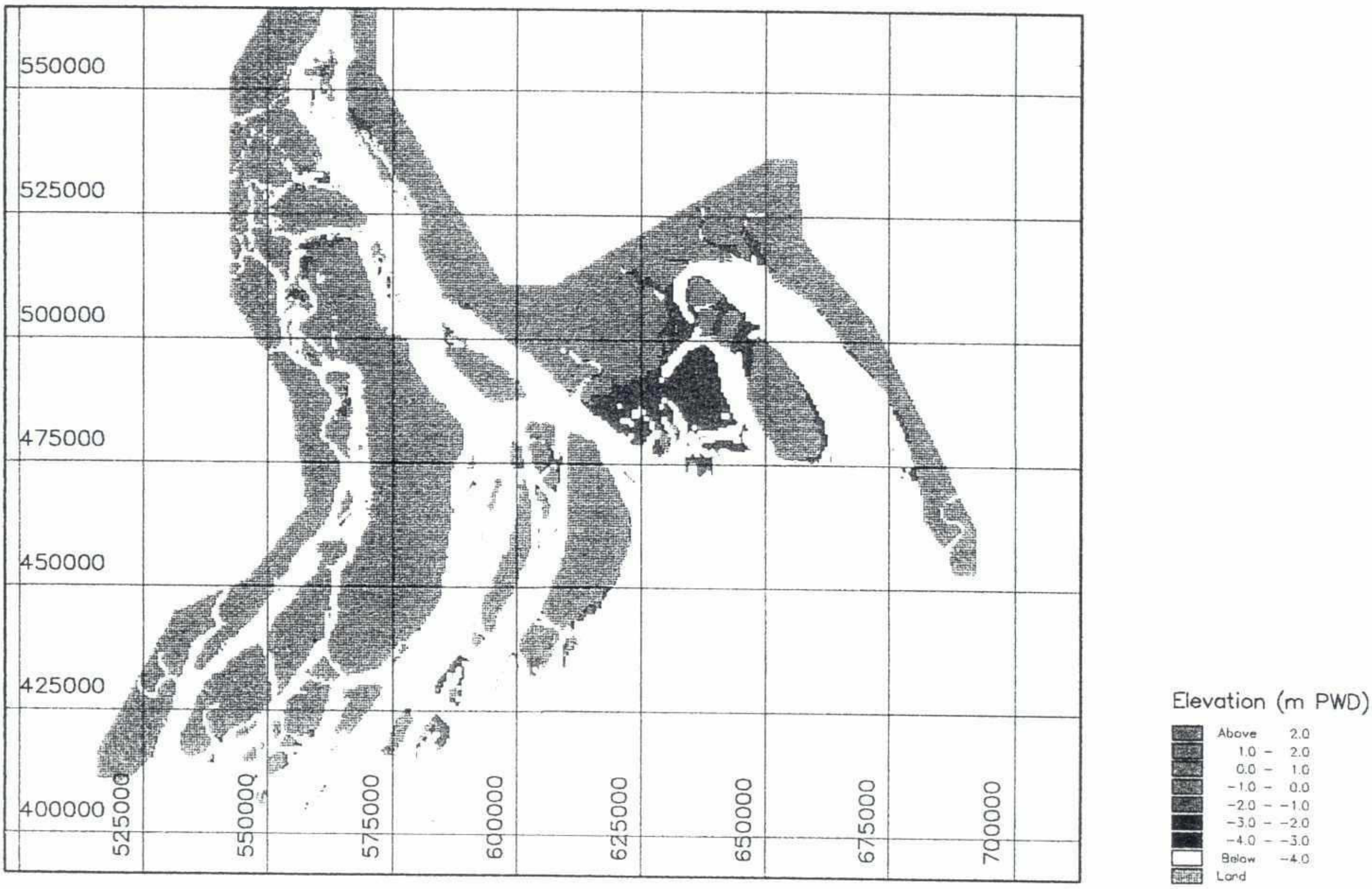
Total files listed:
       336 file(s)    226,480,887 bytes
        69 dir(s)               0 bytes free
```

Drawings

229



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Bathymetry data coverage MES bathymetric survey	Drawing no. 3.1
Scale: 1:1500000	Init: p5011		



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Bathymetry data coverage	Drawing no.	
Scale: 1:1500000	Init: p5011	Landsat image, February 1996	3.2	

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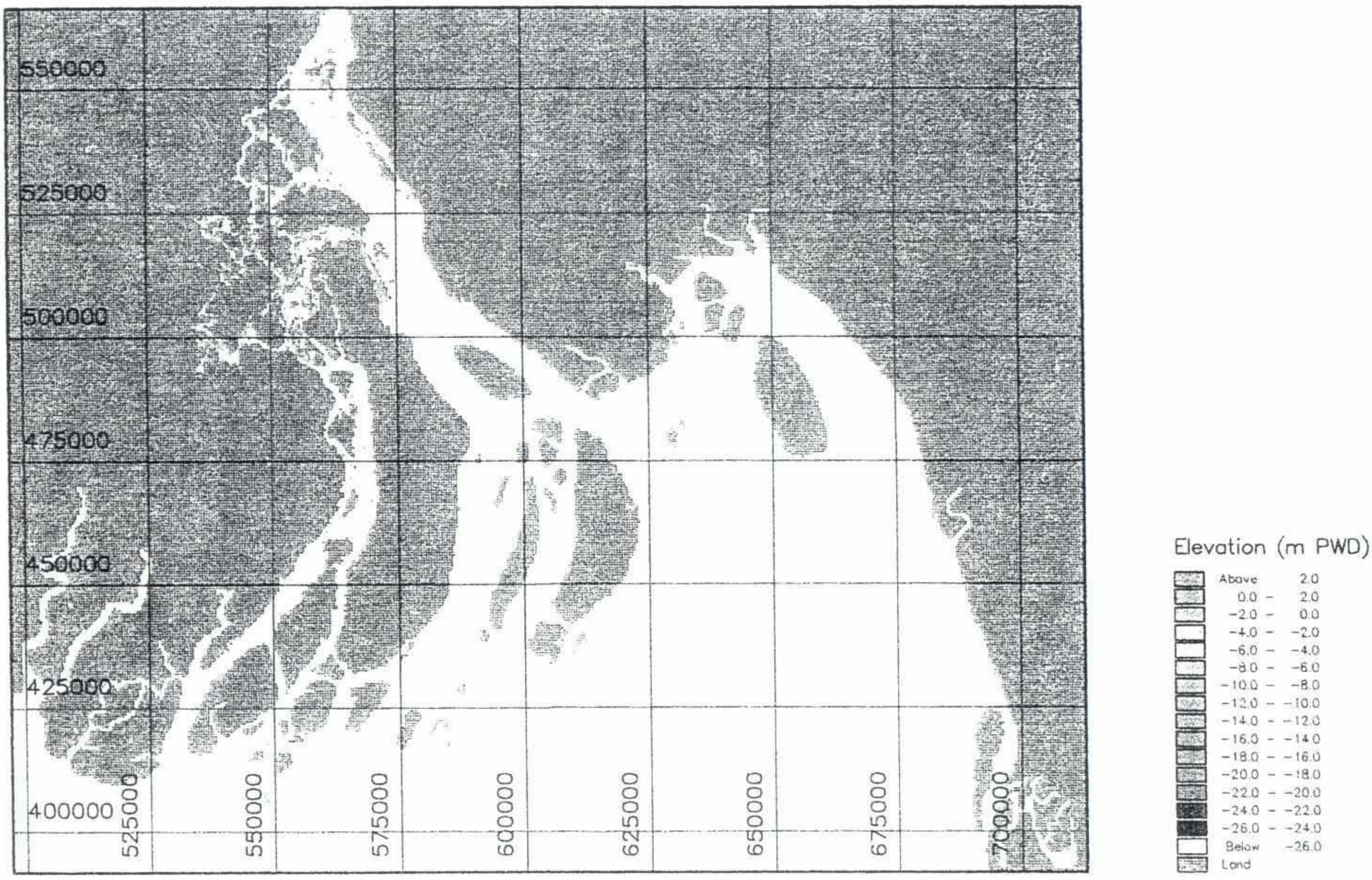
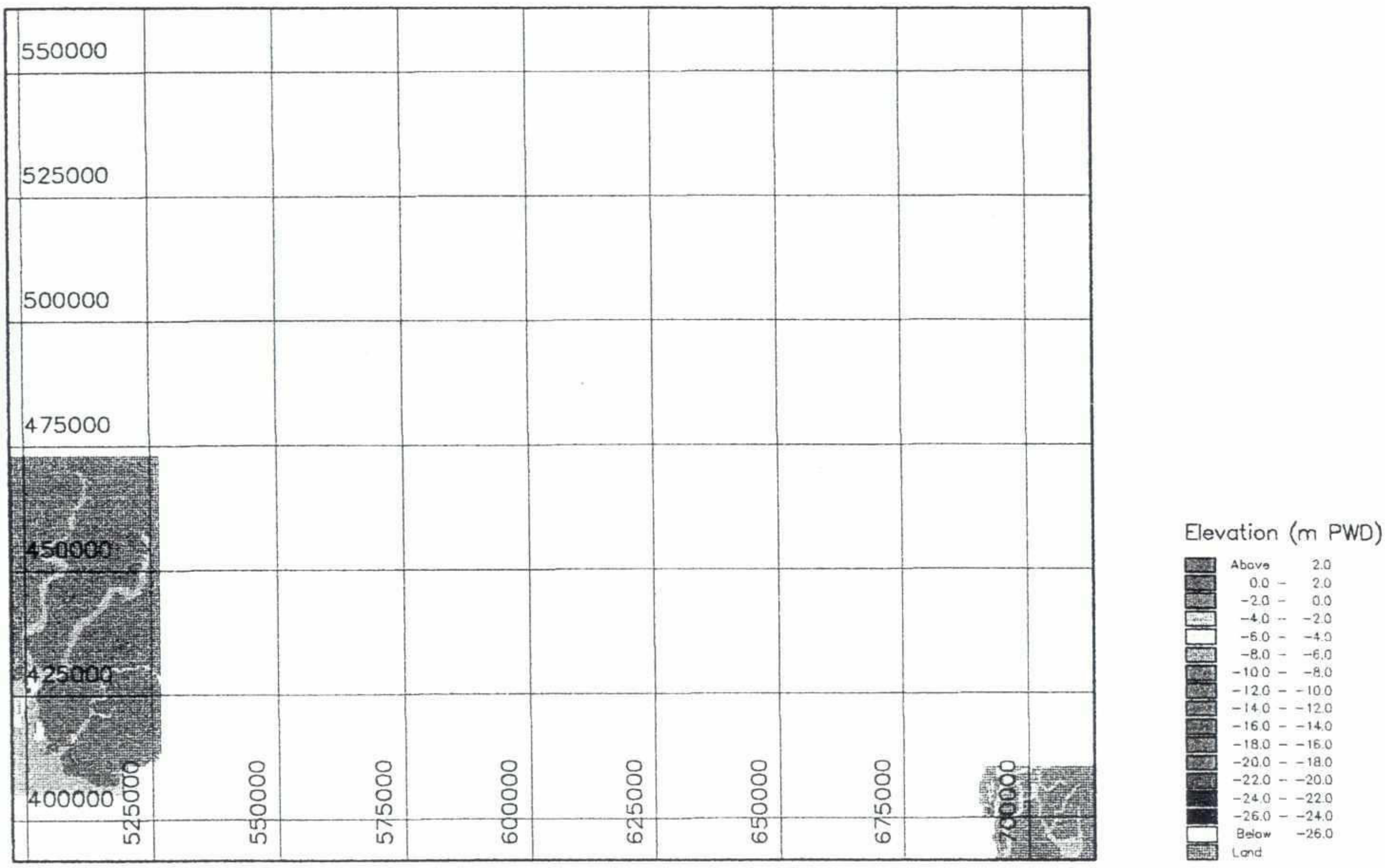
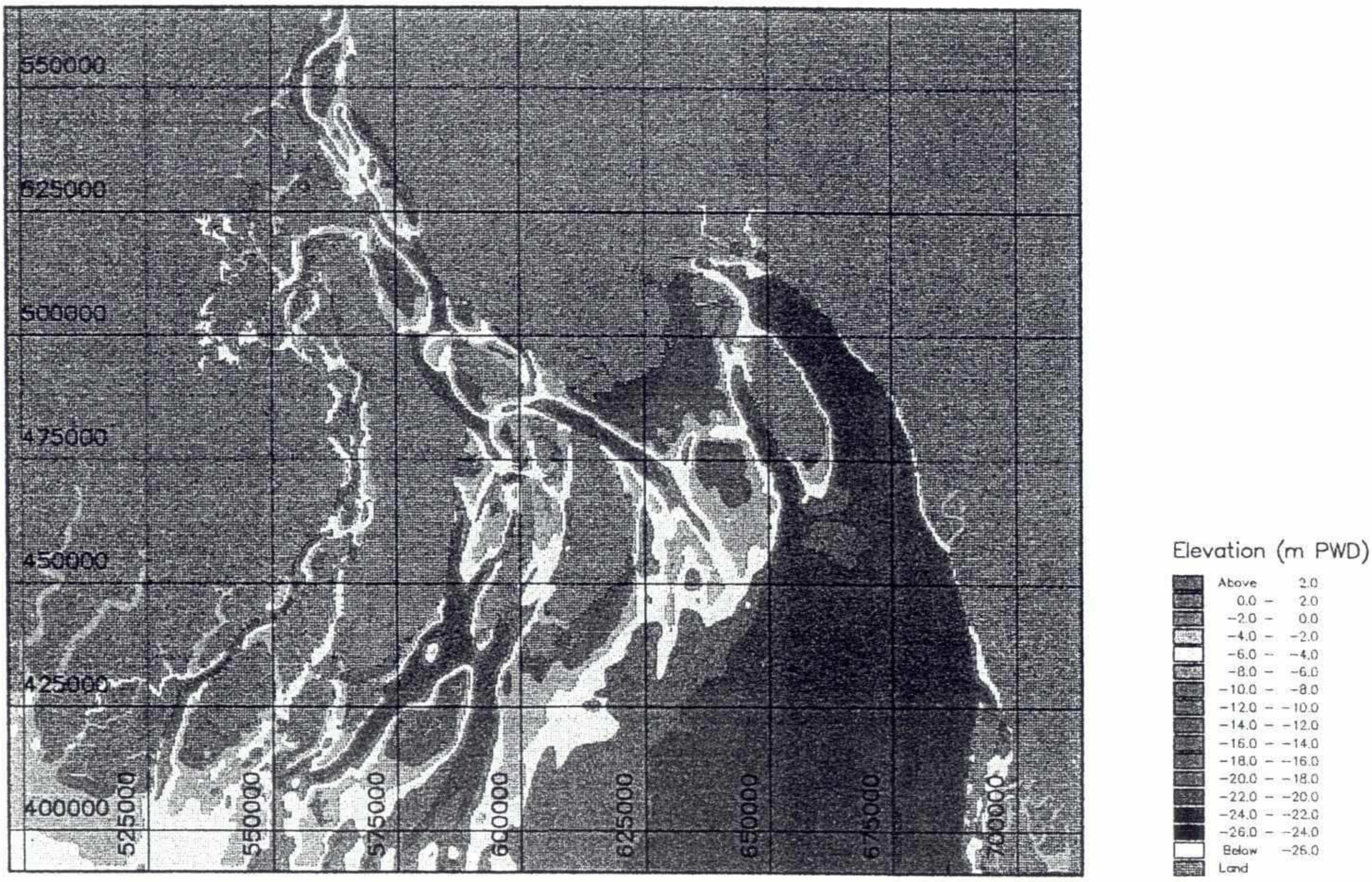


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Bathymetry data coverage BIWTA sea charts	Drawing no. 3.3
Scale: 1:1500000	Init: p5011		

120

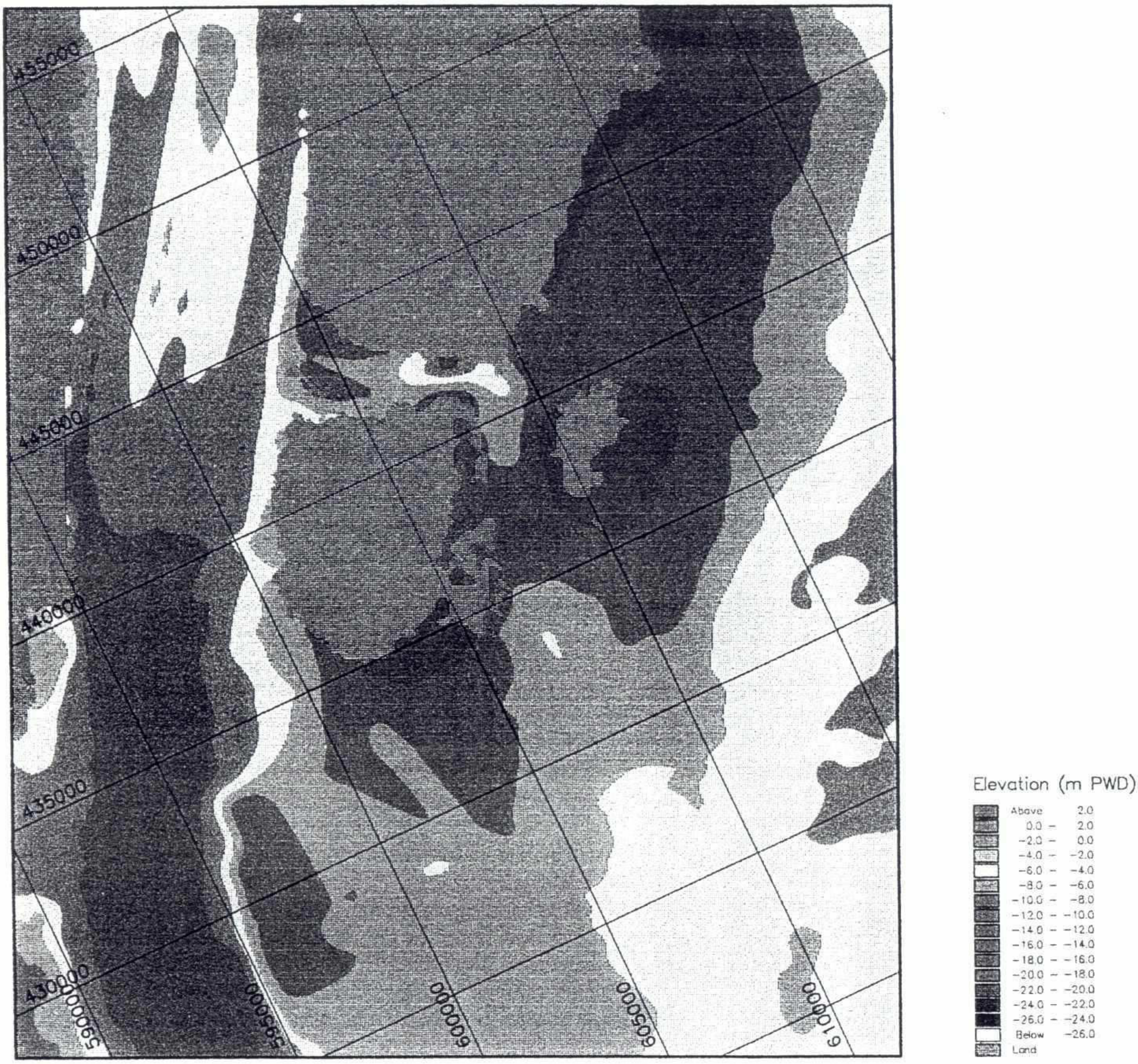


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Bathymetry data coverage	Drawing no. 3.4	
Scale: 1:1500000	Init: p5011	British Admiralty Charts (CSPS)		



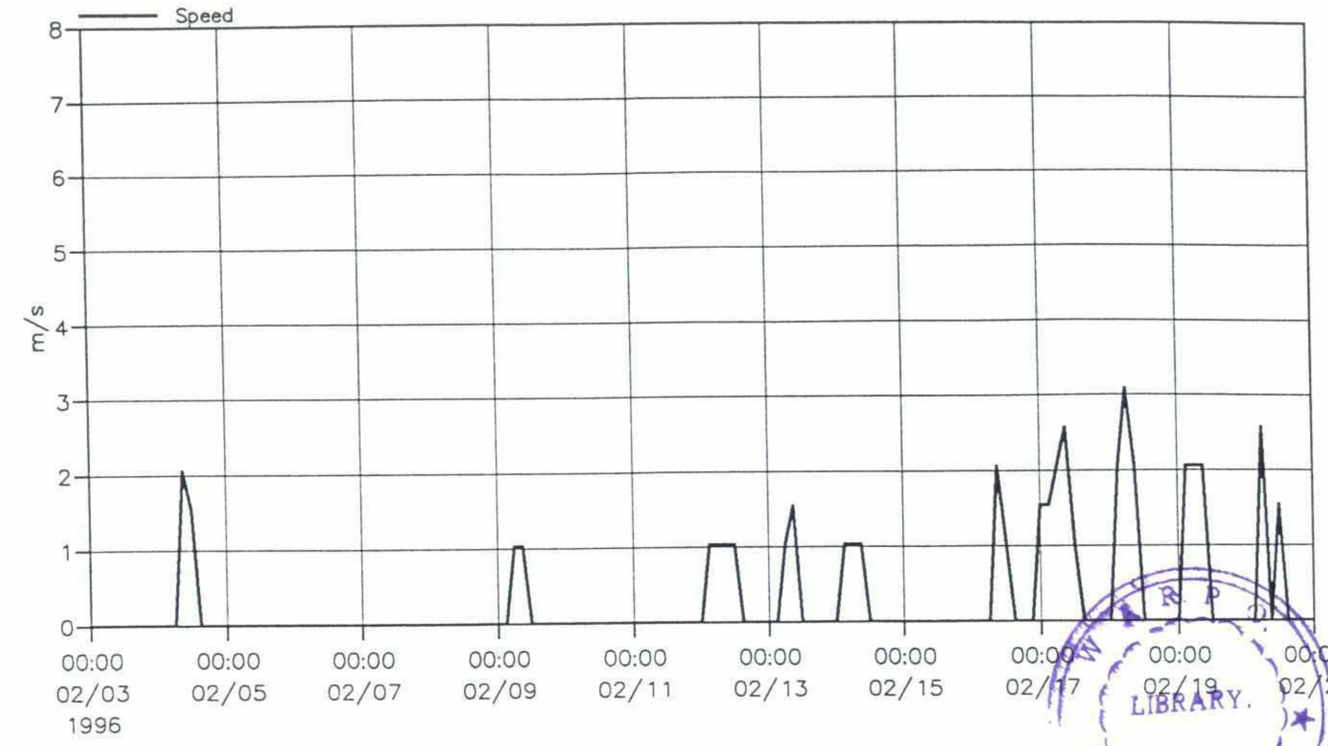
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Model bathymetry Meghna Estuary Model	Drawing no. 3.5	
Scale: 1:1500000	Init: p5011			

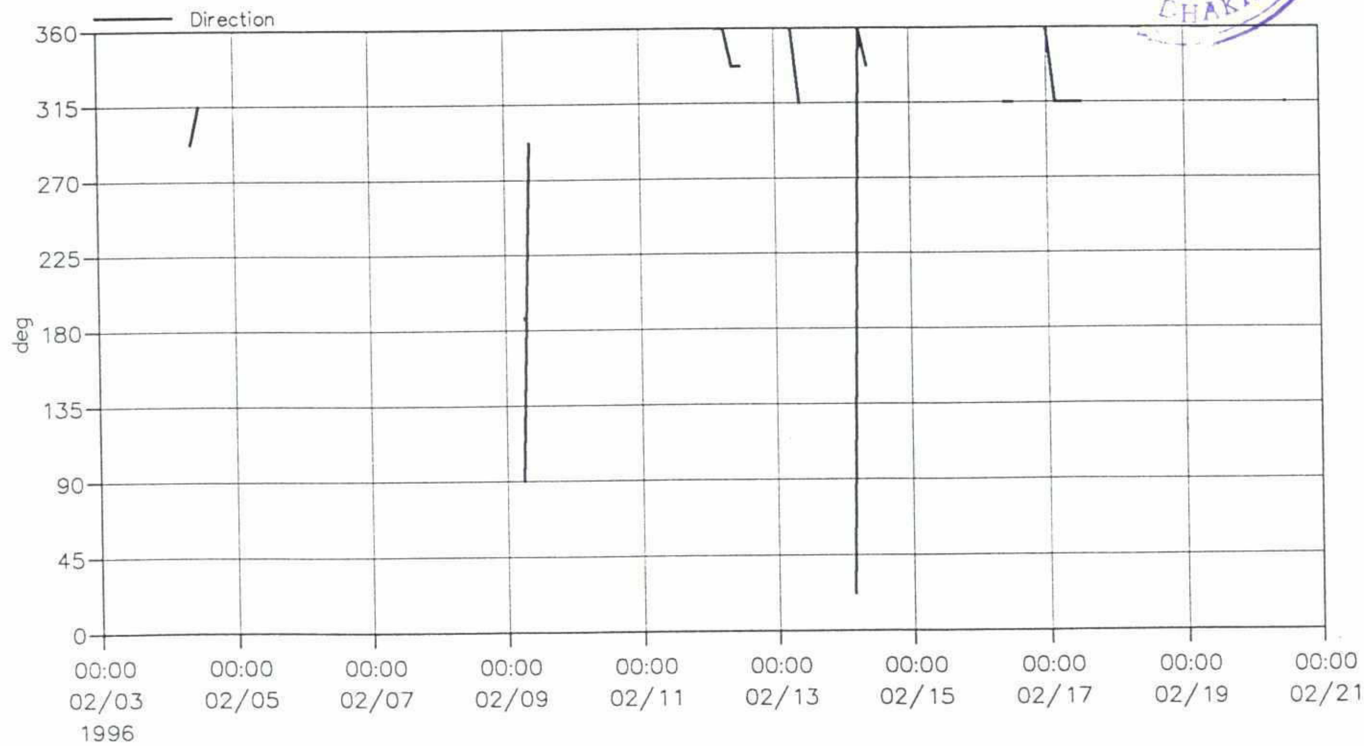
222



SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Model bathymetry	Drawing no. 3.6
Scale: 1:185000	Init: p5011	Nijhum Dwip Local Model	

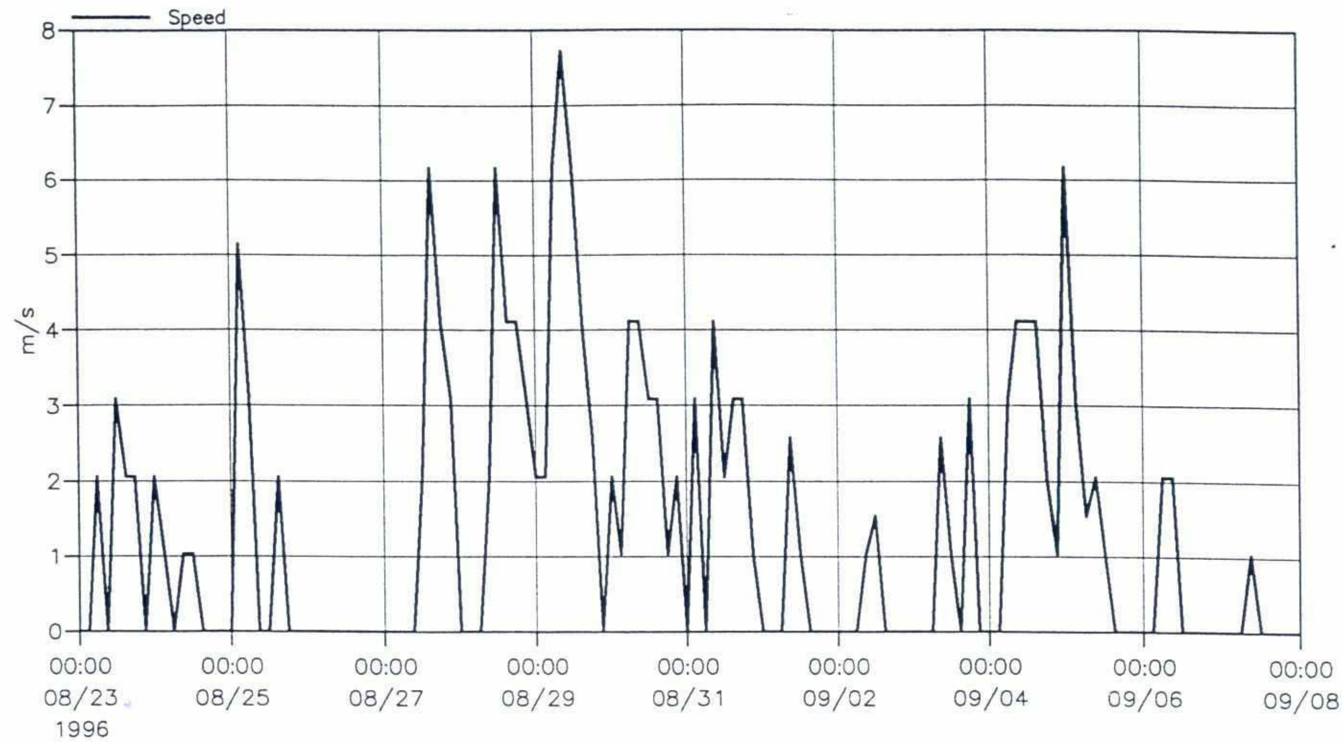
n6

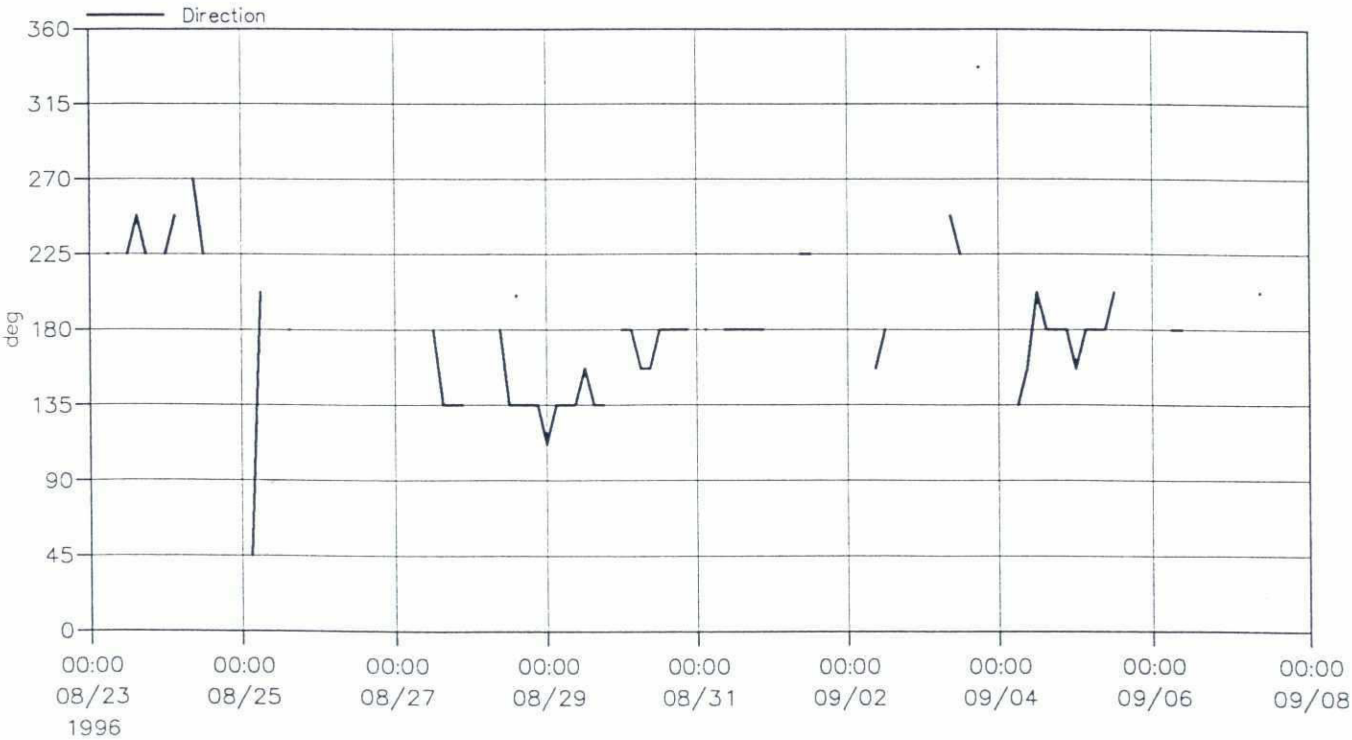




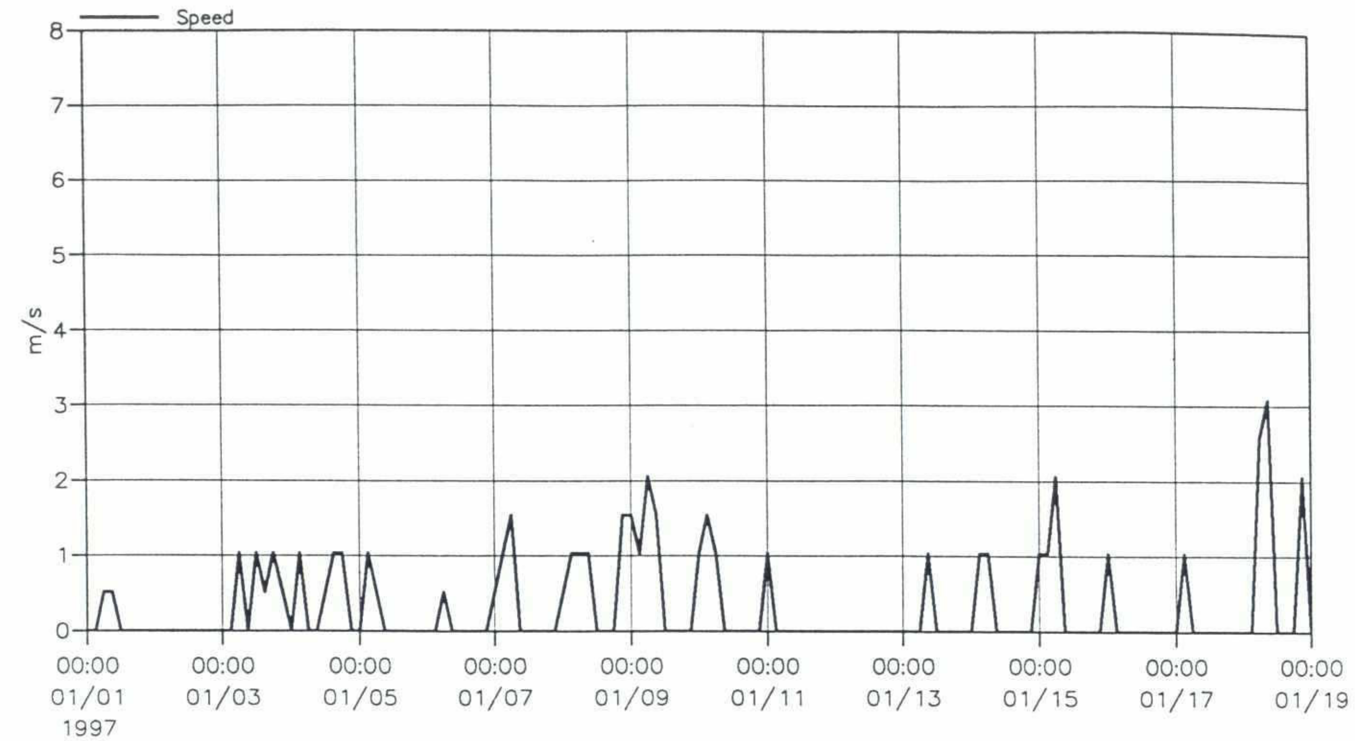
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Thu Apr 23 1998	Hatia	Drawing no. 4.1
Scale:	Init: p5011	Wind data for Dry Period Run 1996	

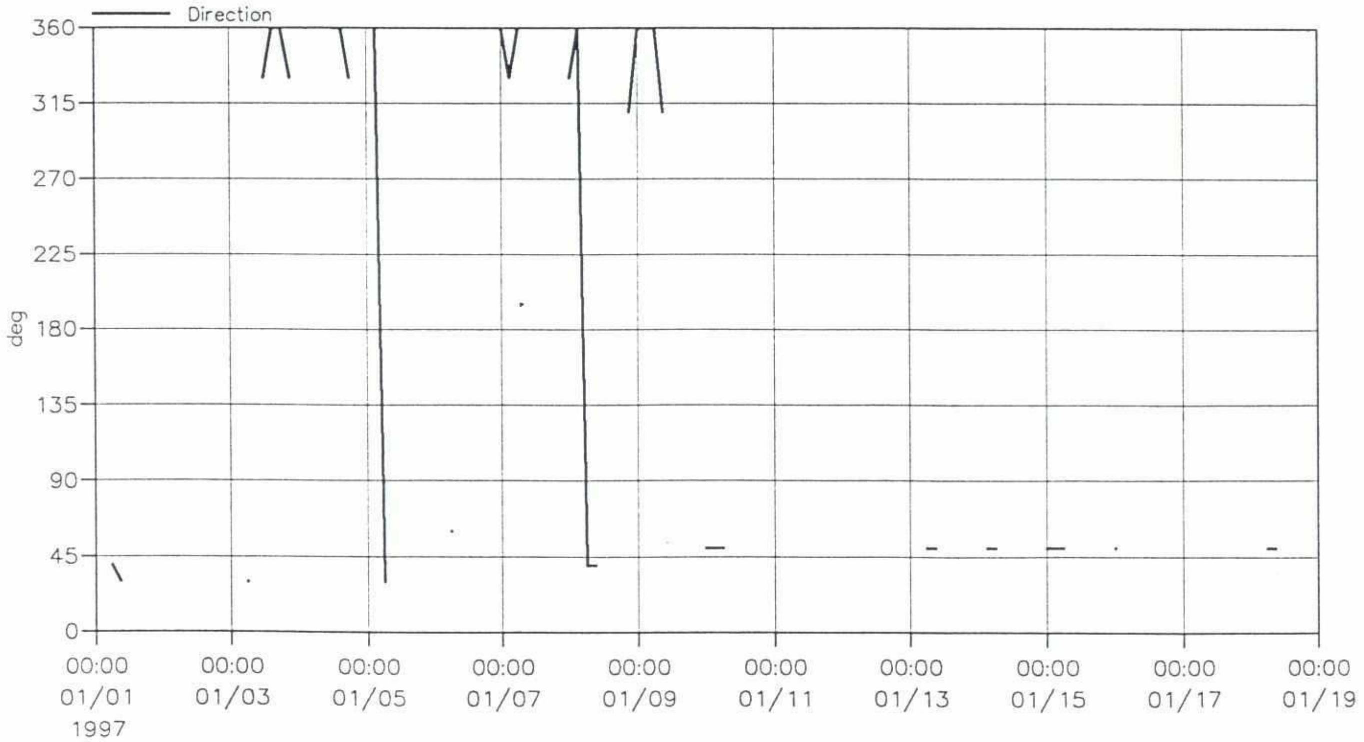
329



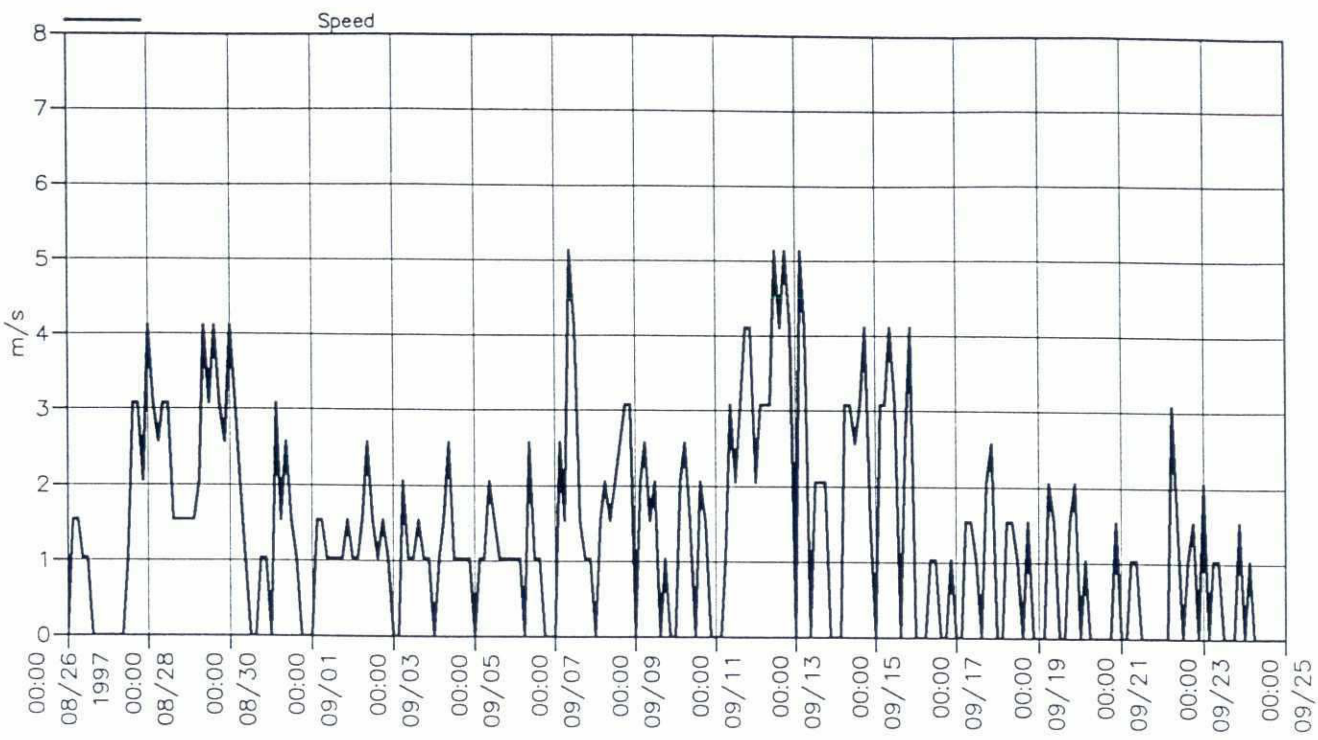


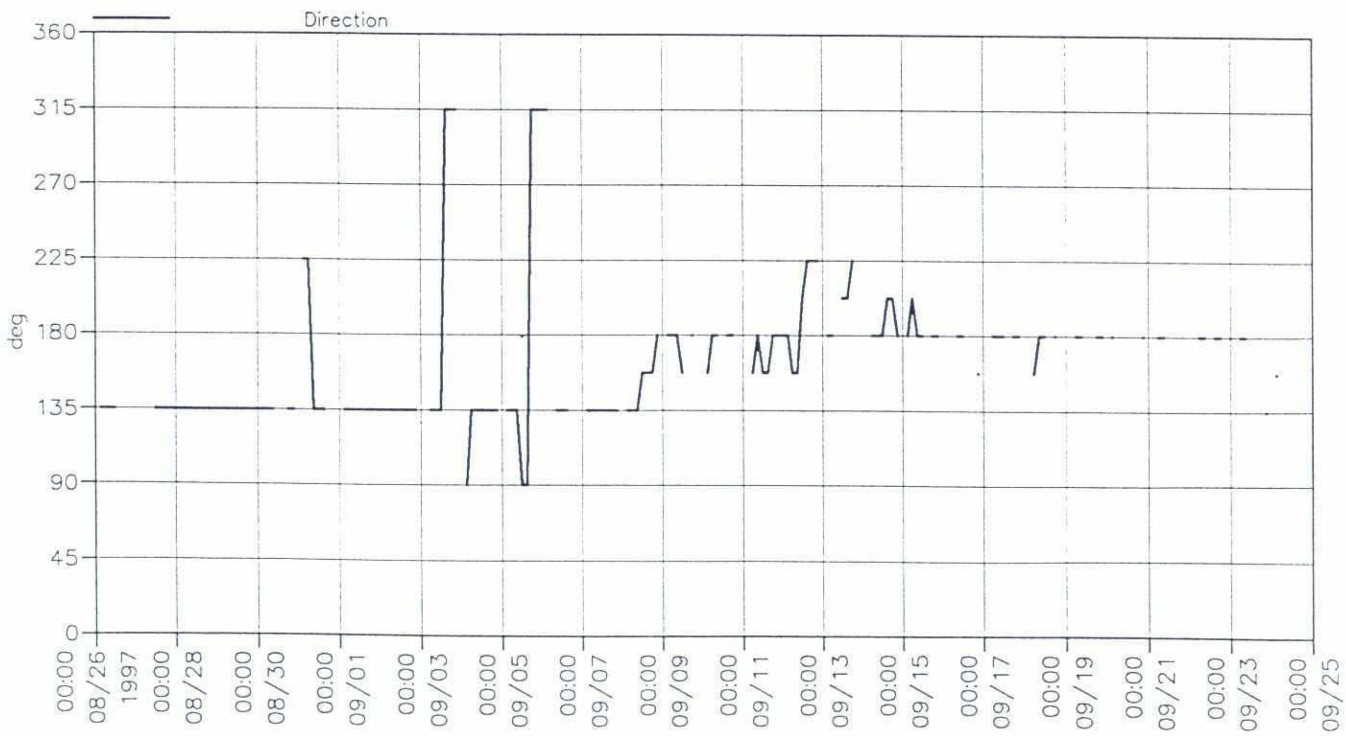
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Thu Apr 23 1998	Hatia	Drawing no. 4.2
Scale:	Init: p5011	Wind data for Monsoon Run 1996	



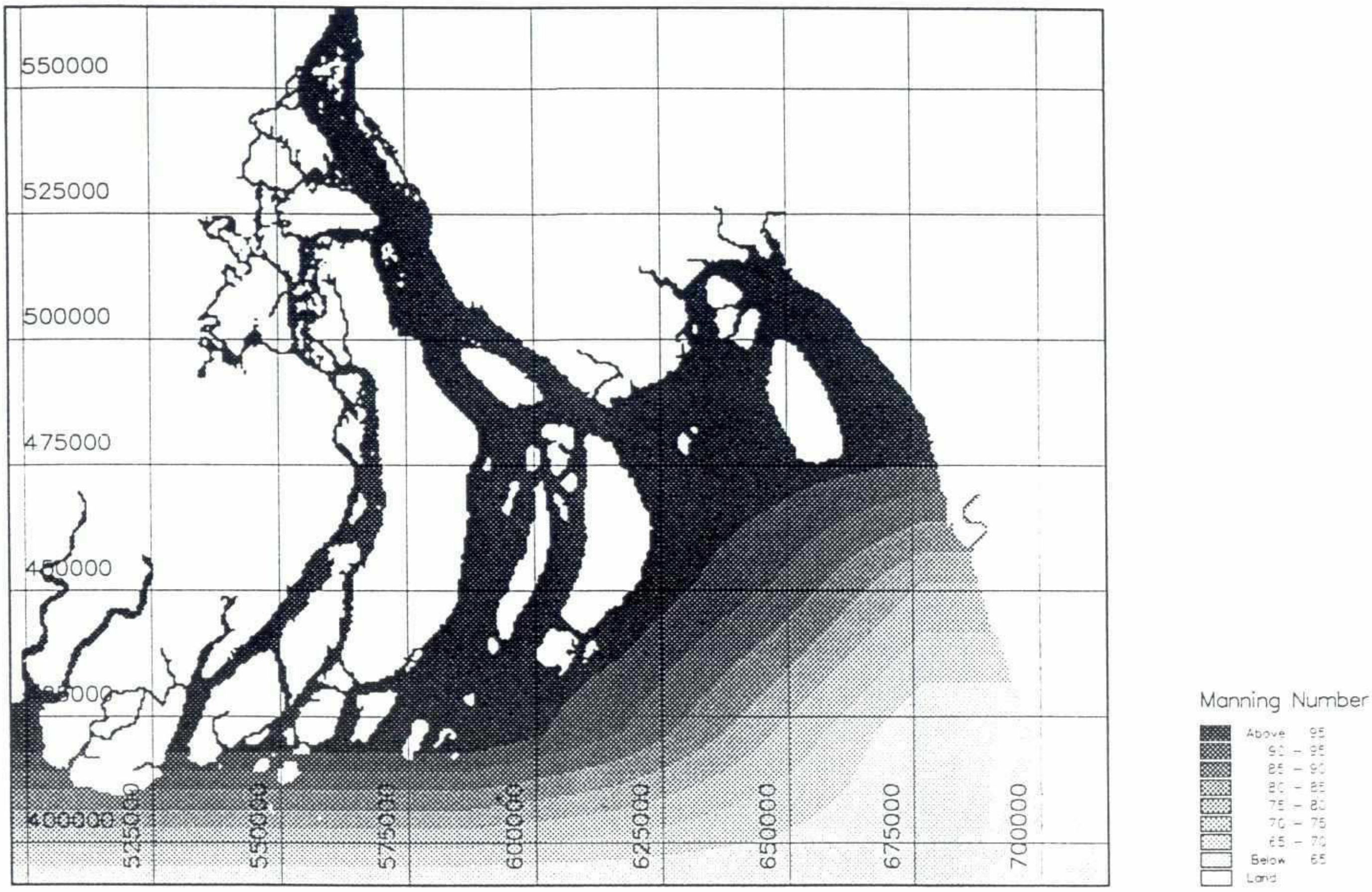


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Thu Apr 23 1998	Hatia	Drawing no.	
Scale:	Init: p5011	Wind data for Dry Period Run 1997	4.3	

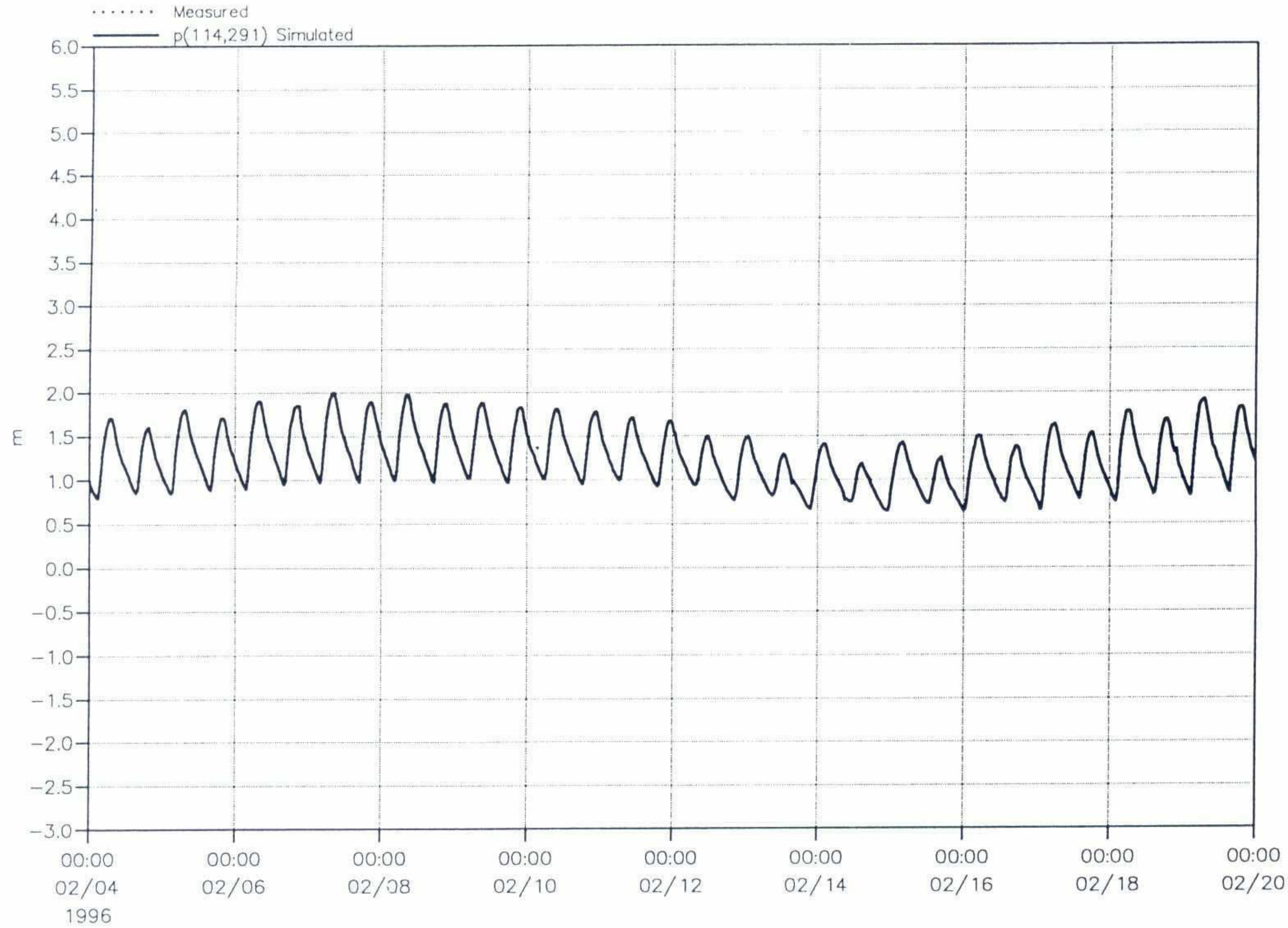




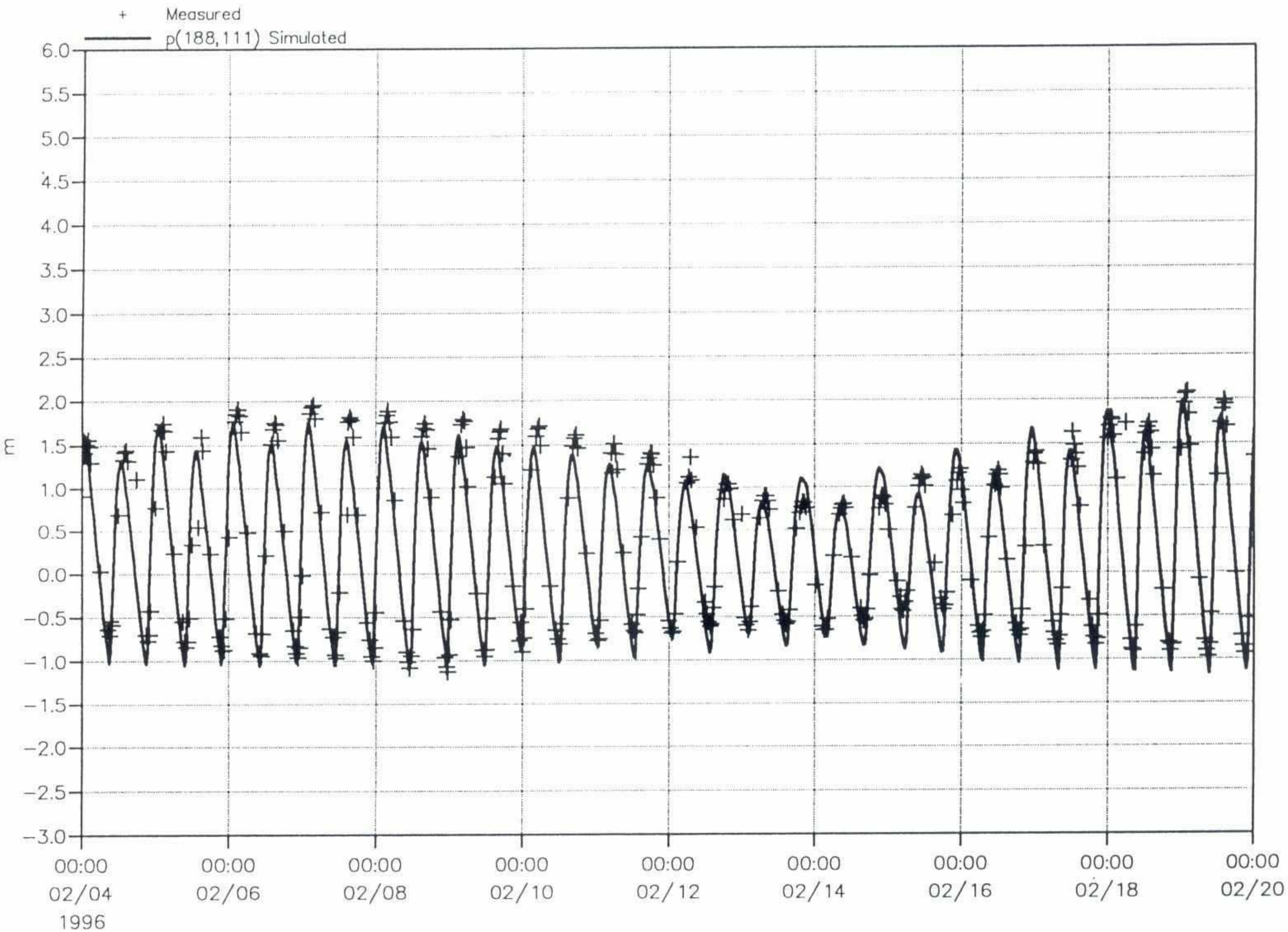
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Thu Apr 23 1998	Hatia	Drawing no. 4.4	
Scale:	Init: p5011	Wind data for Monsoon 1997		



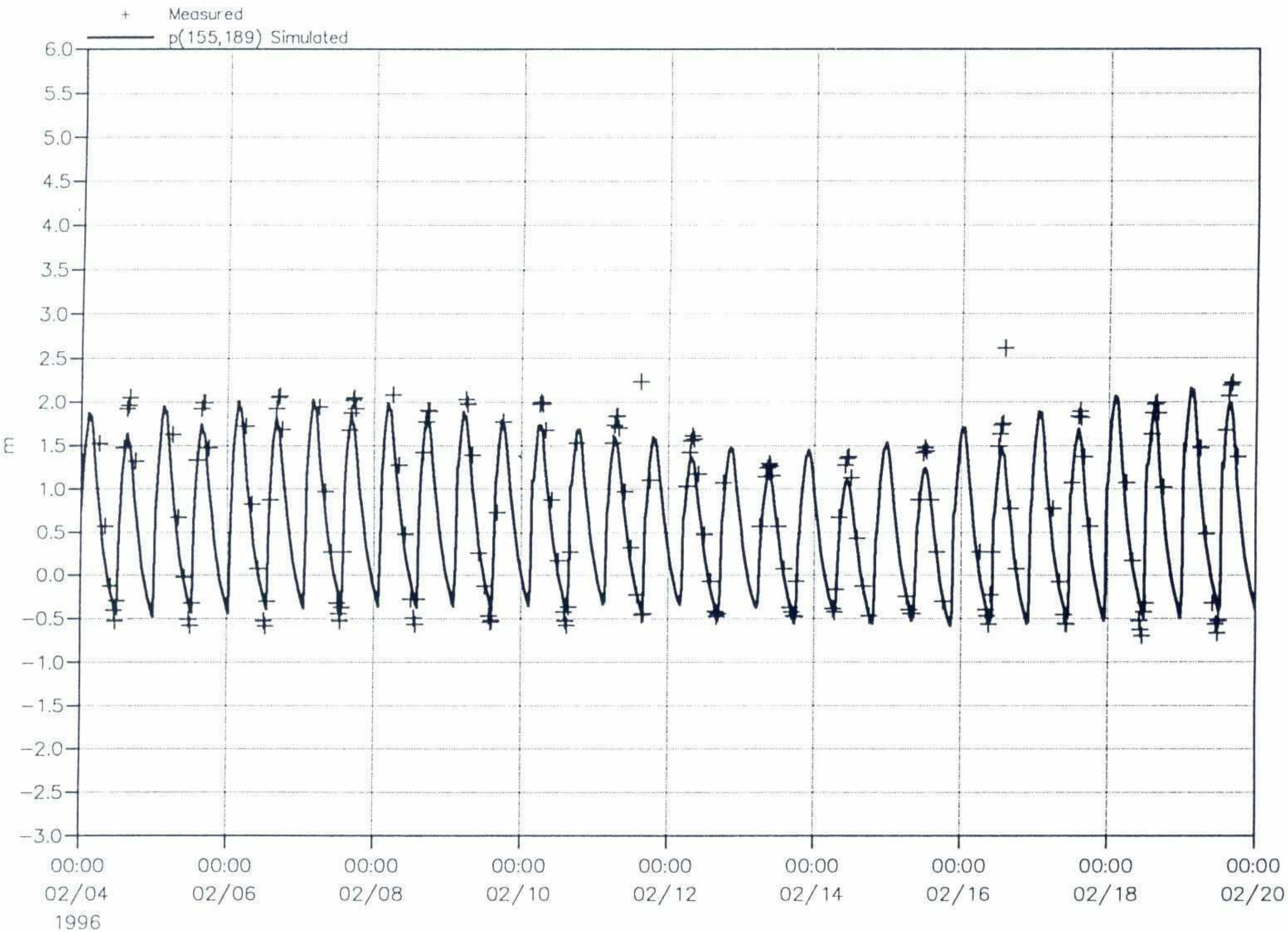
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Bed friction coefficients	Drawing no. 4.5
Scale: 1:1500000	Init: p5011	Manning Numbers (m 1/3 / s)	



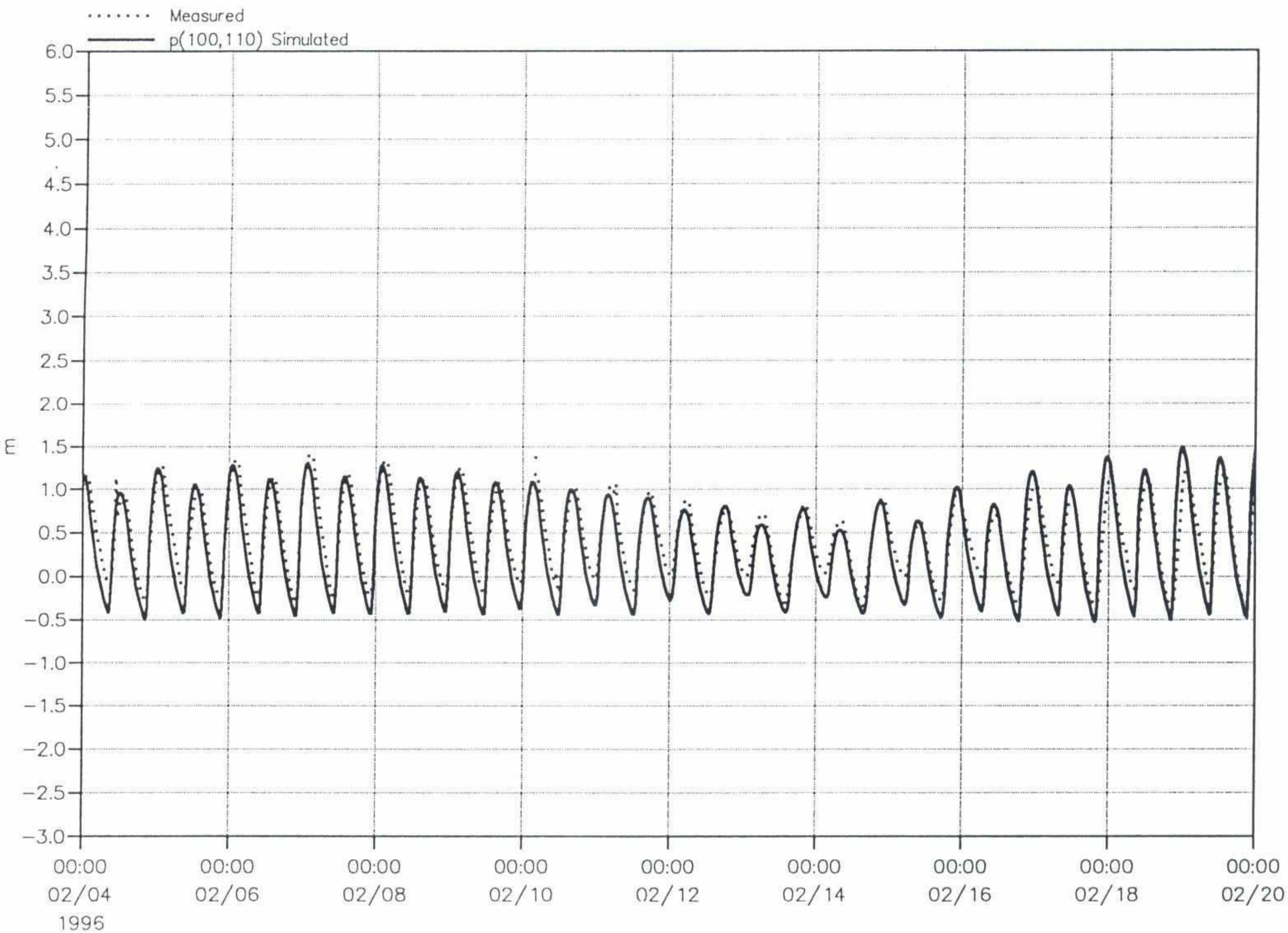
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and simulated water level at Chandpur (PWD) Dry Season 1996	Drawing no. 4.6
Scale:	Init: p5011		



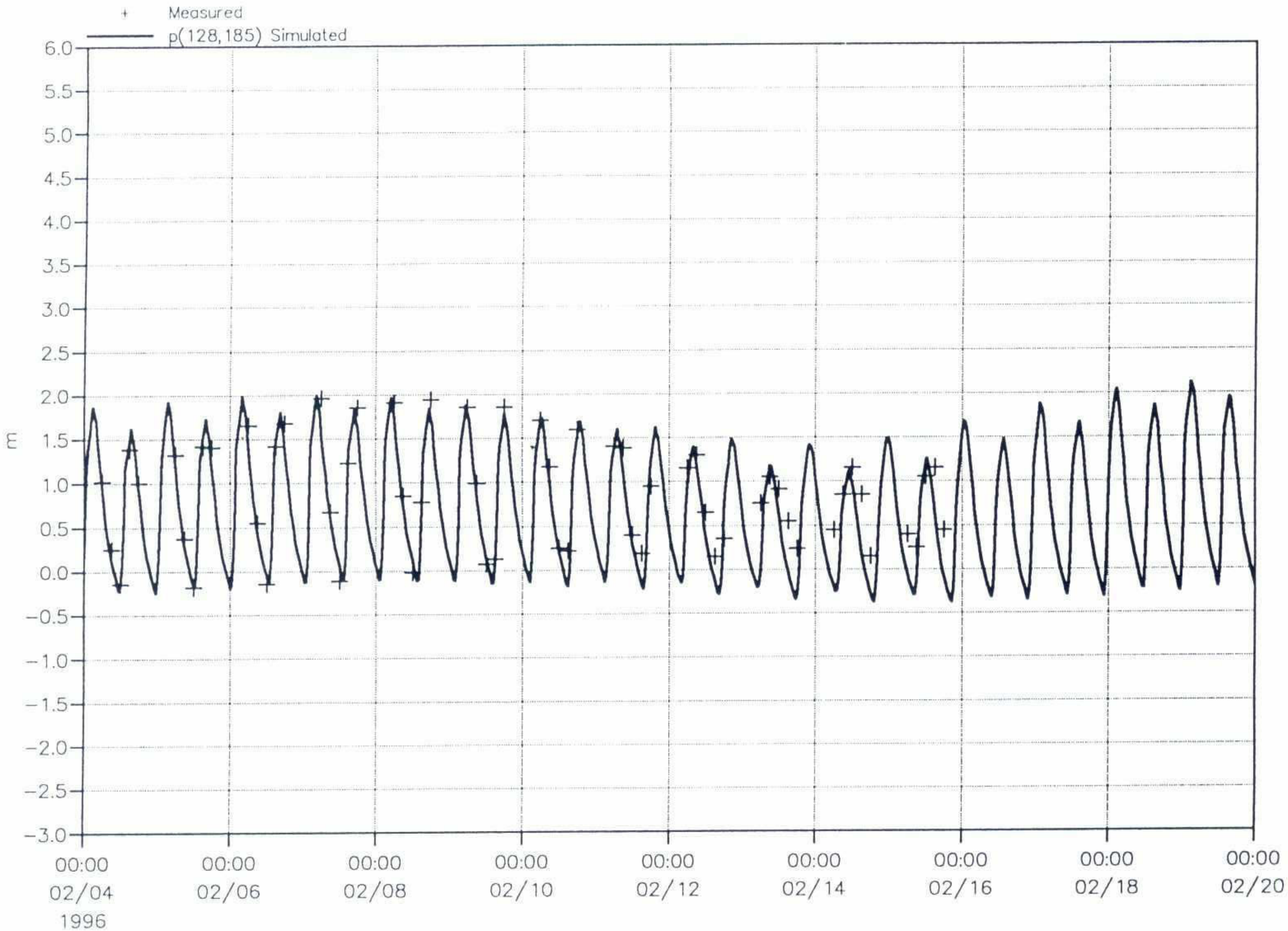
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Char Chenga (PWD) Dry Season 1996	Drawing no. 4.7
Scale:	Init: p5011		



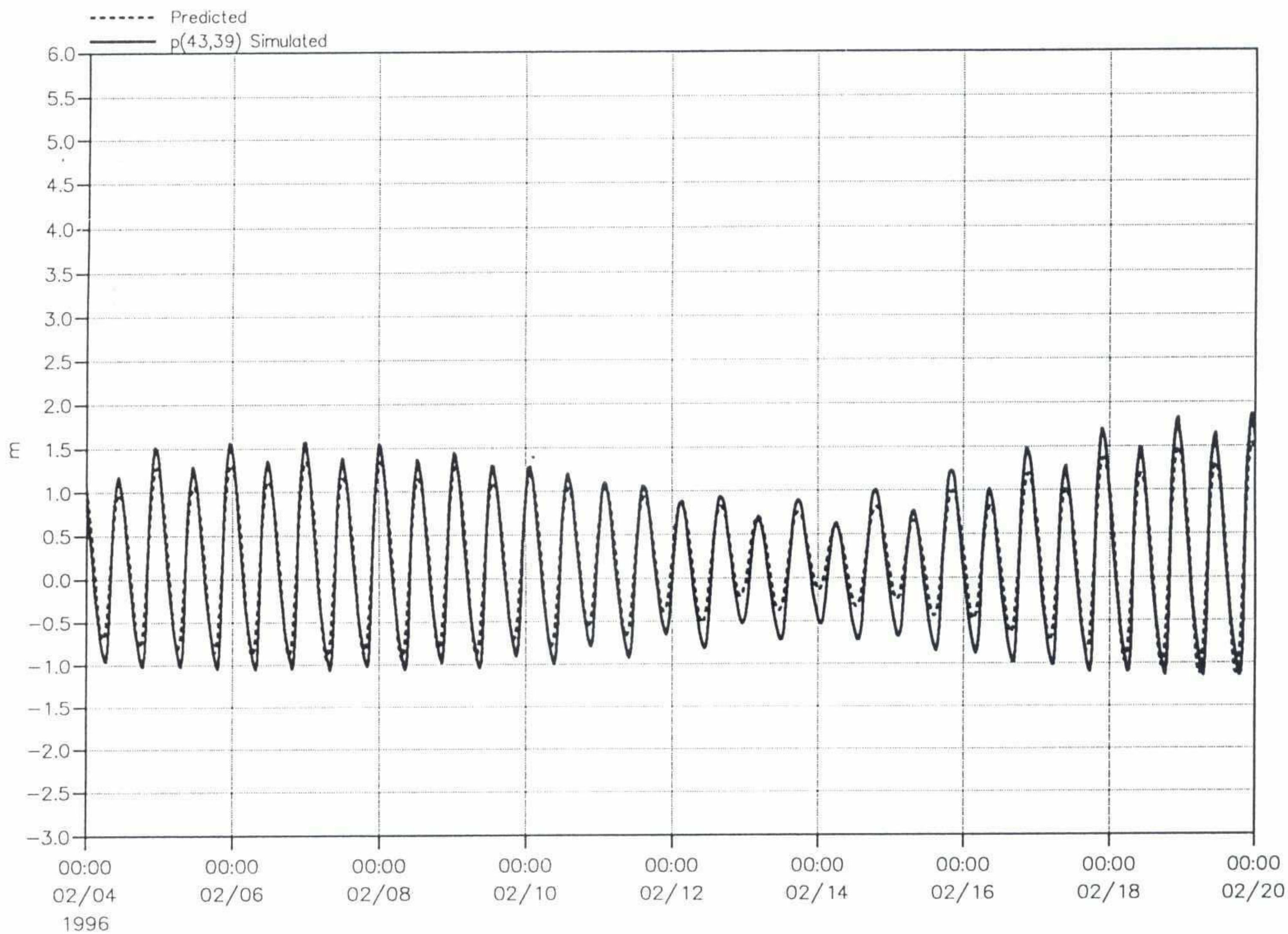
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chitalkhali (PWD) Dry Season 1996	Drawing no. 4.8
Scale:	Init: p5011		



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Dasmunia (PWD) Dry Season 1996	Drawing no. 4.9
Scale:	Init: p5011		

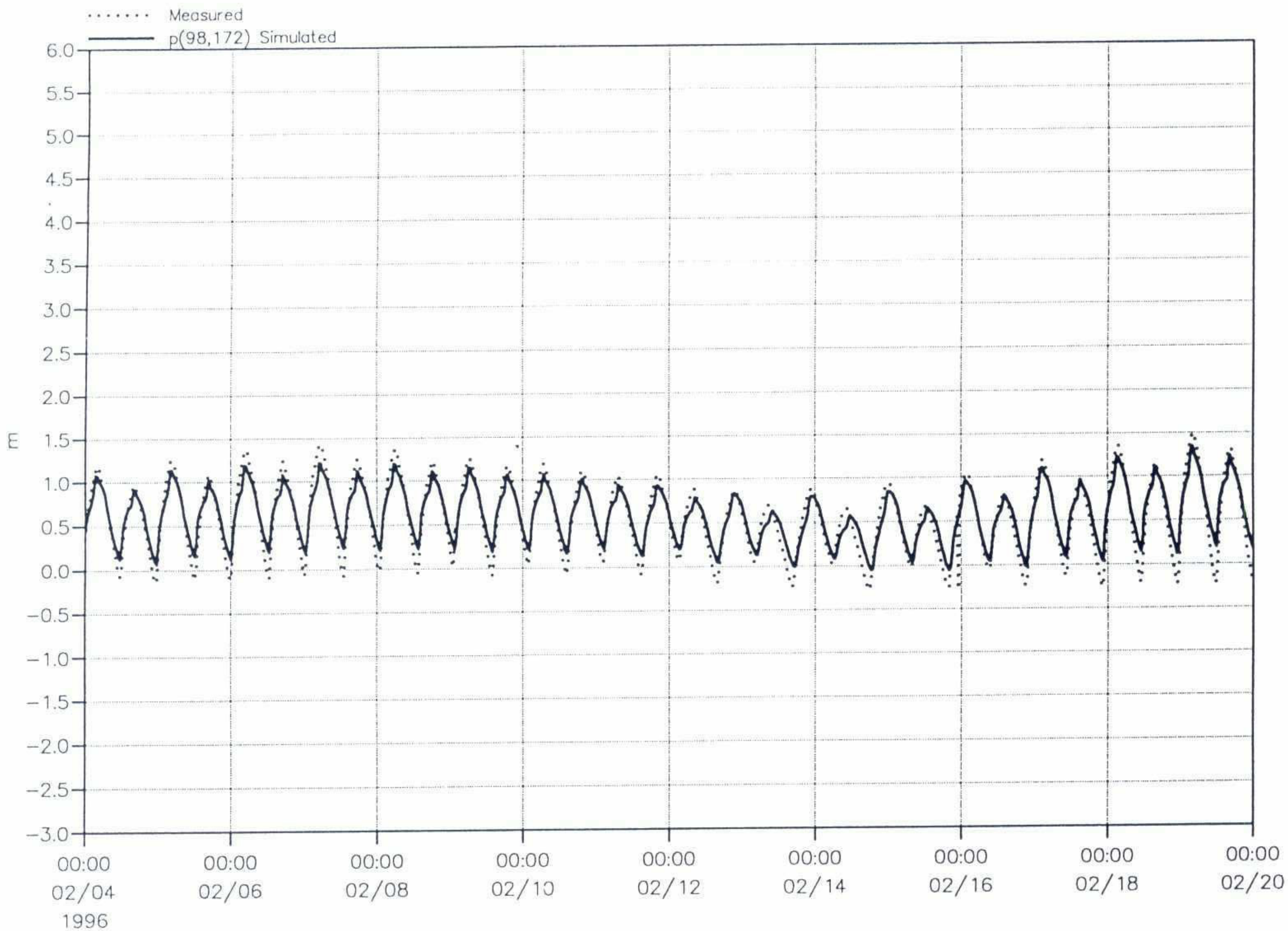


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and simulated water level at Daulatkhan (PWD), BWDB Dry Season 1996	Drawing no. 4.10	
Scale:	Init: p5011			

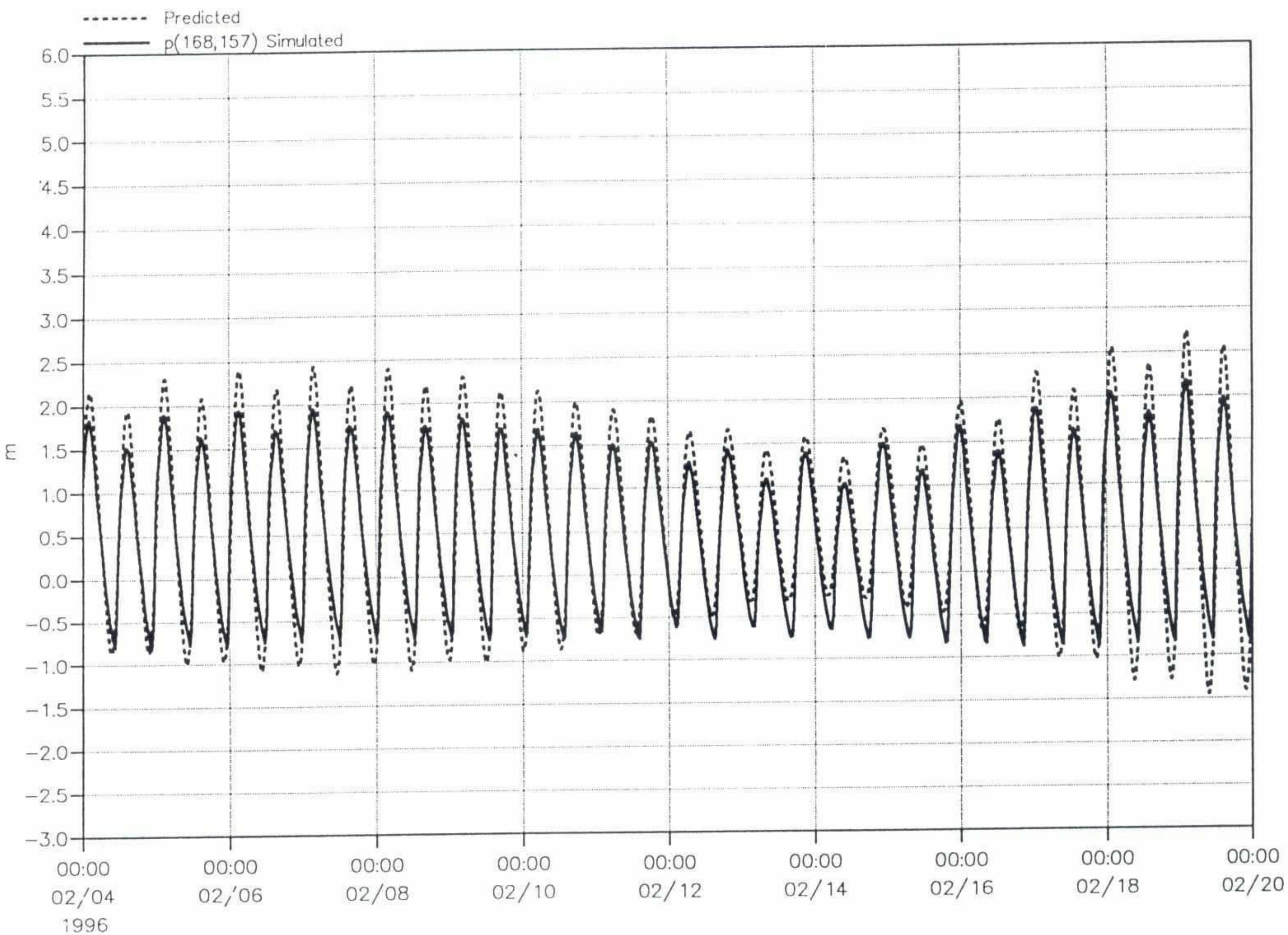


SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Date: Sun May 31 1998	Measured and predicted water level at Dhulasar (PWD) Dry Season 1996	Drawing no. 4.11
Scale: / Init: p5011		

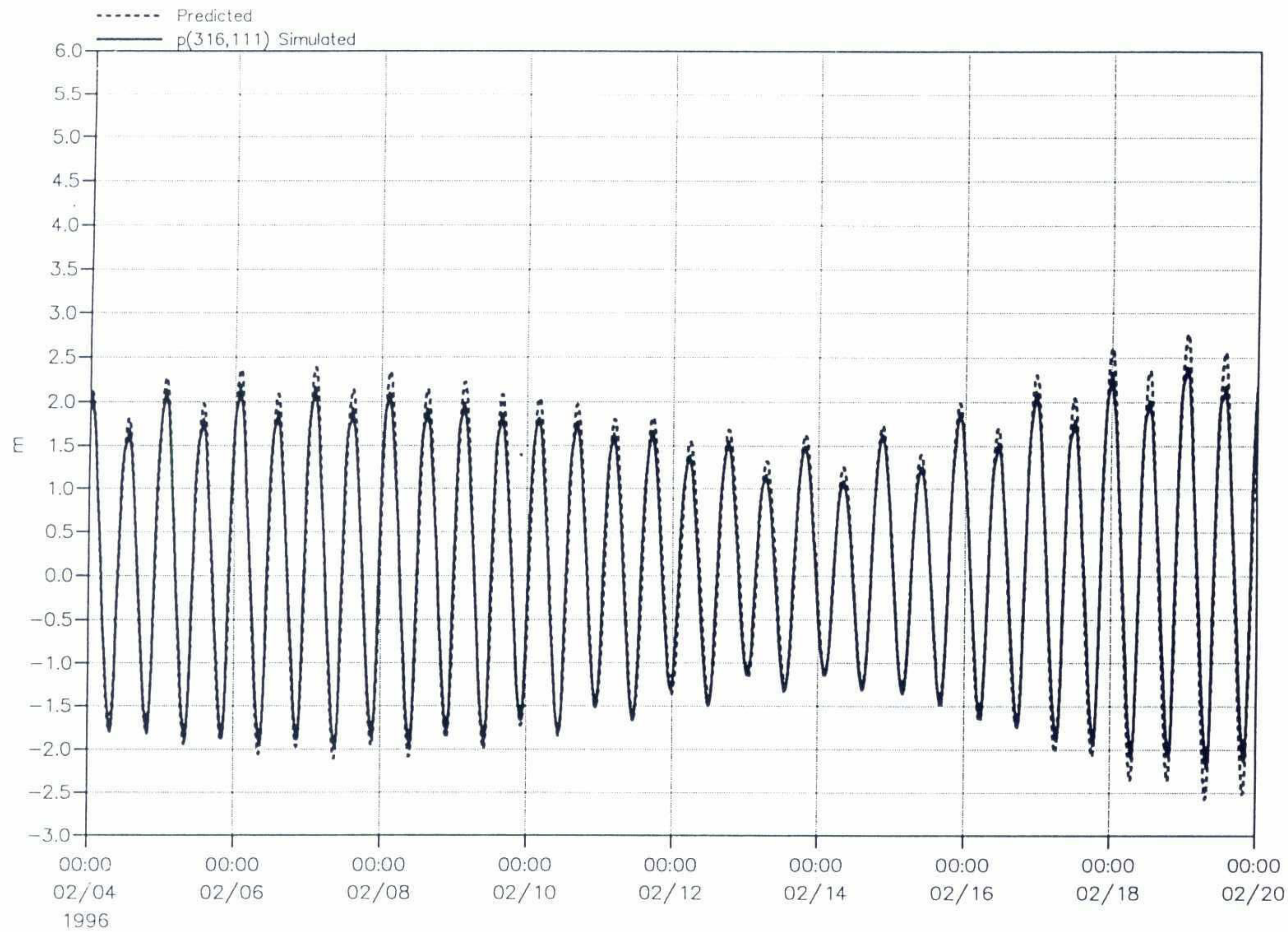
266



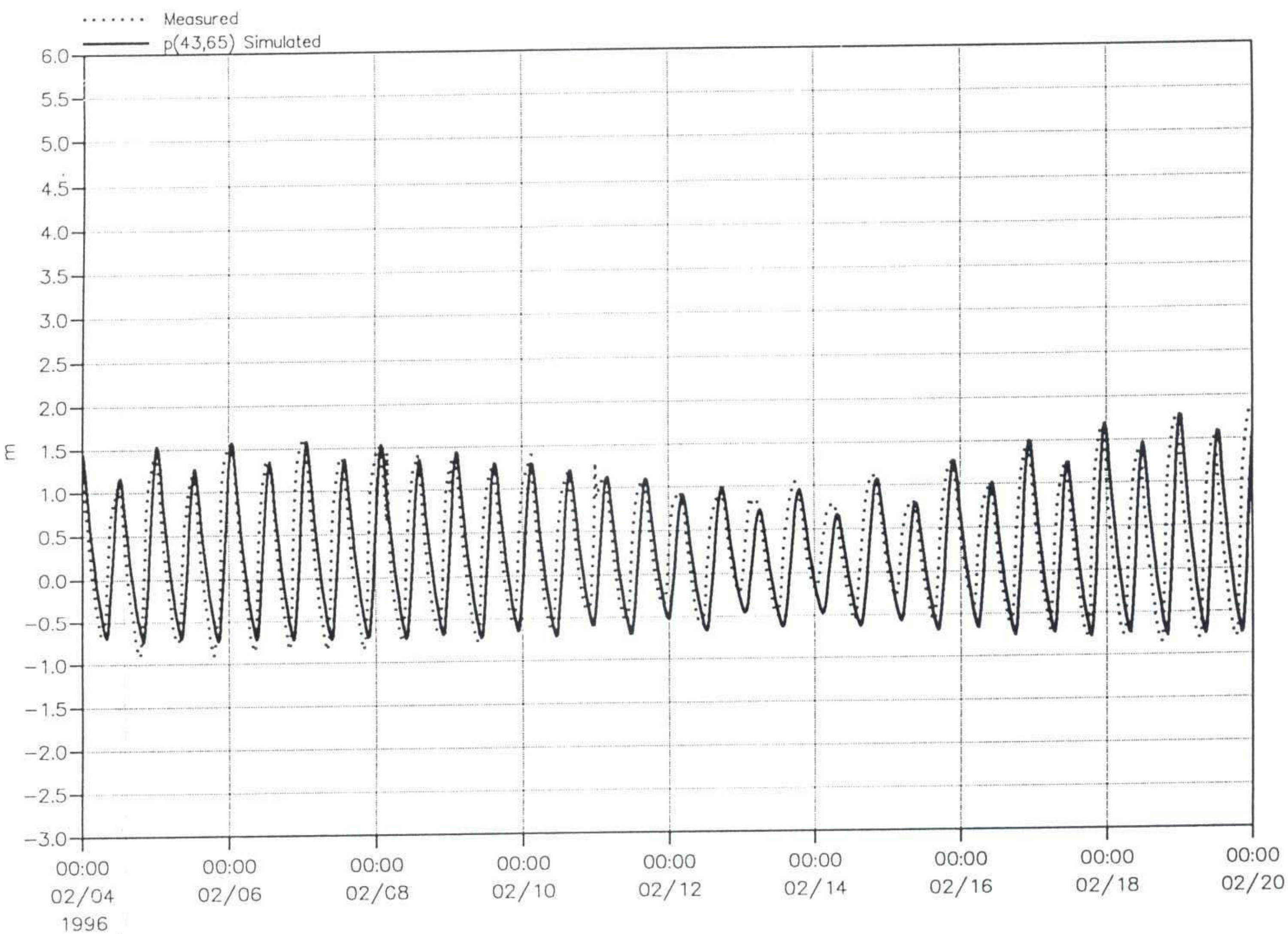
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and simulated water level at Dhulia (PWD) Dry Season 1996	Drawing no. 4.12	
Scale:	Init: p5011			



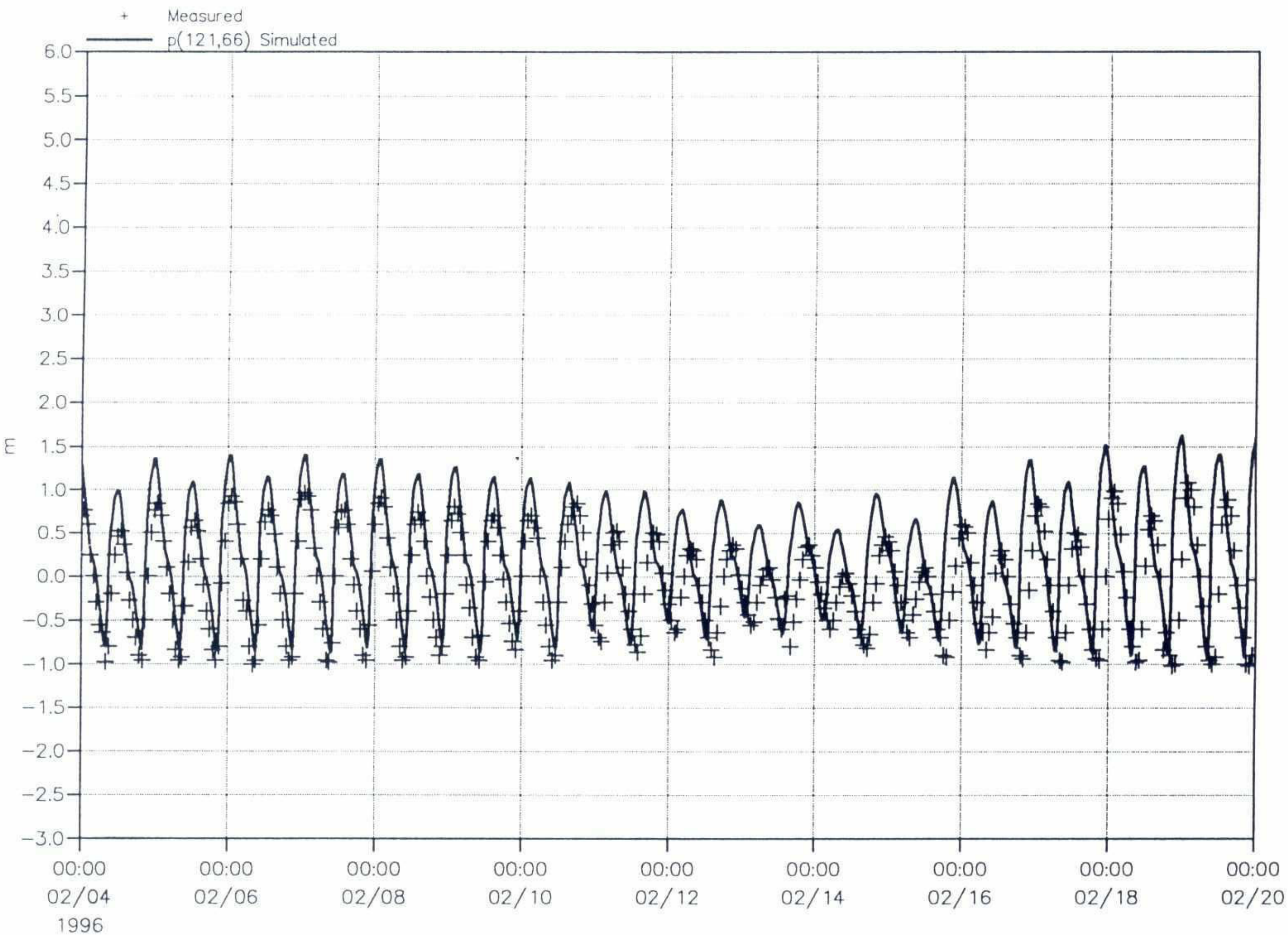
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Hatia Bar (PWD) Dry Season 1996	Drawing no. 4.13
Scale:	Init: p5011		



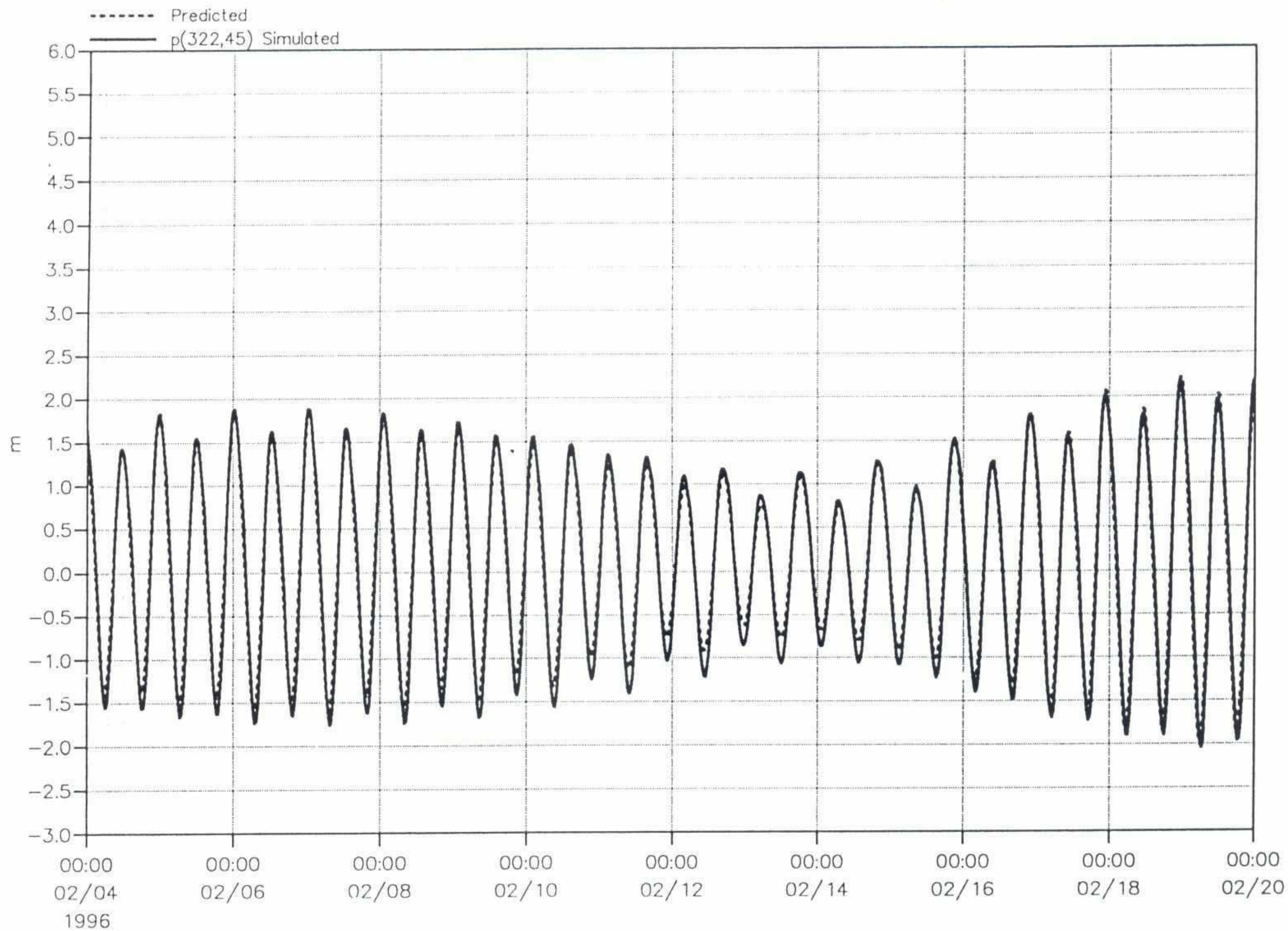
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Khal No. 18 (PWD) Dry Season 1996	Drawing no. 4.14
Scale:	Init: p5011		



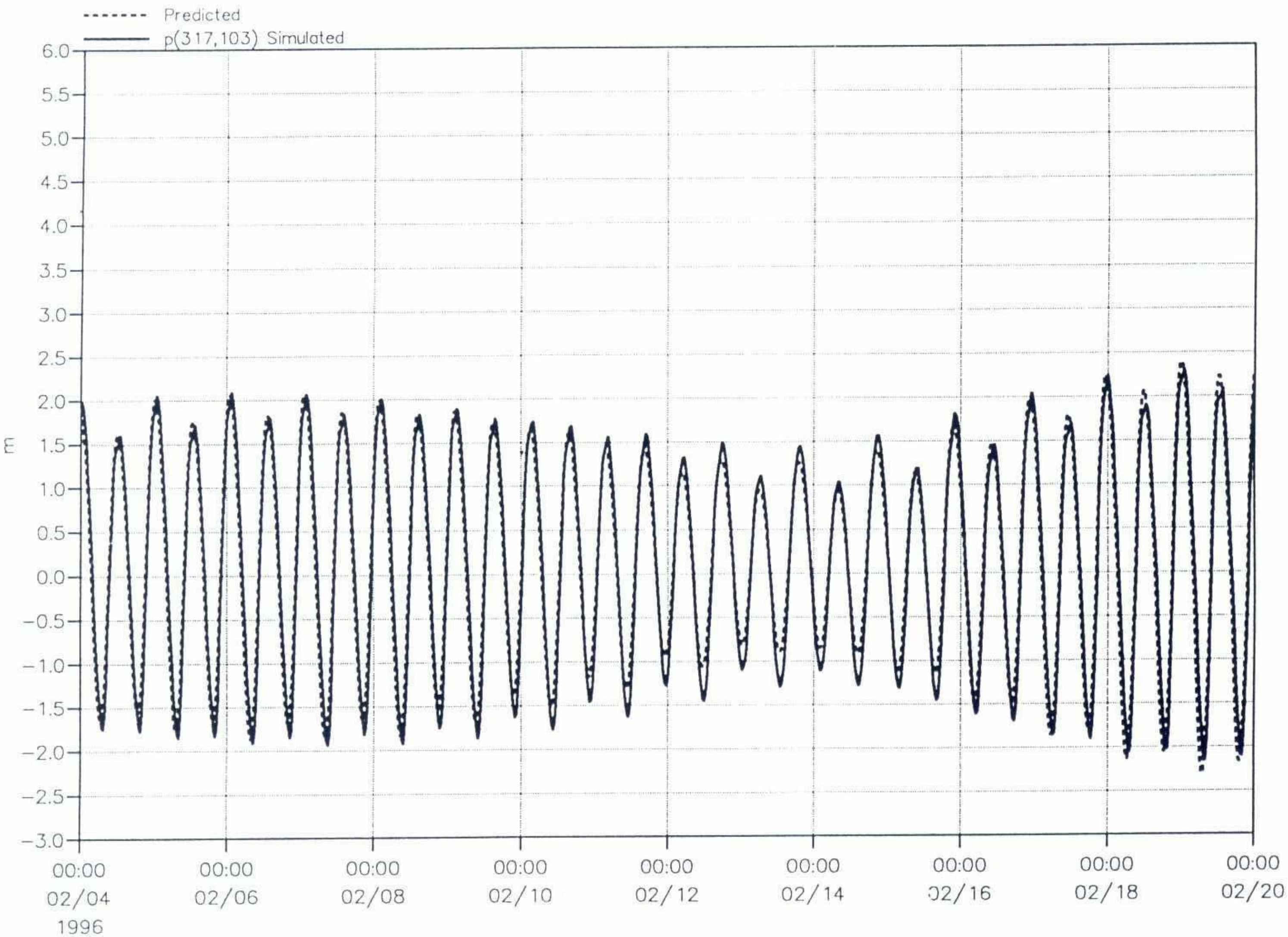
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Khepupara (PWD) Dry Season 1996	Drawing no. 4.15
Scale:	Init: p5011		



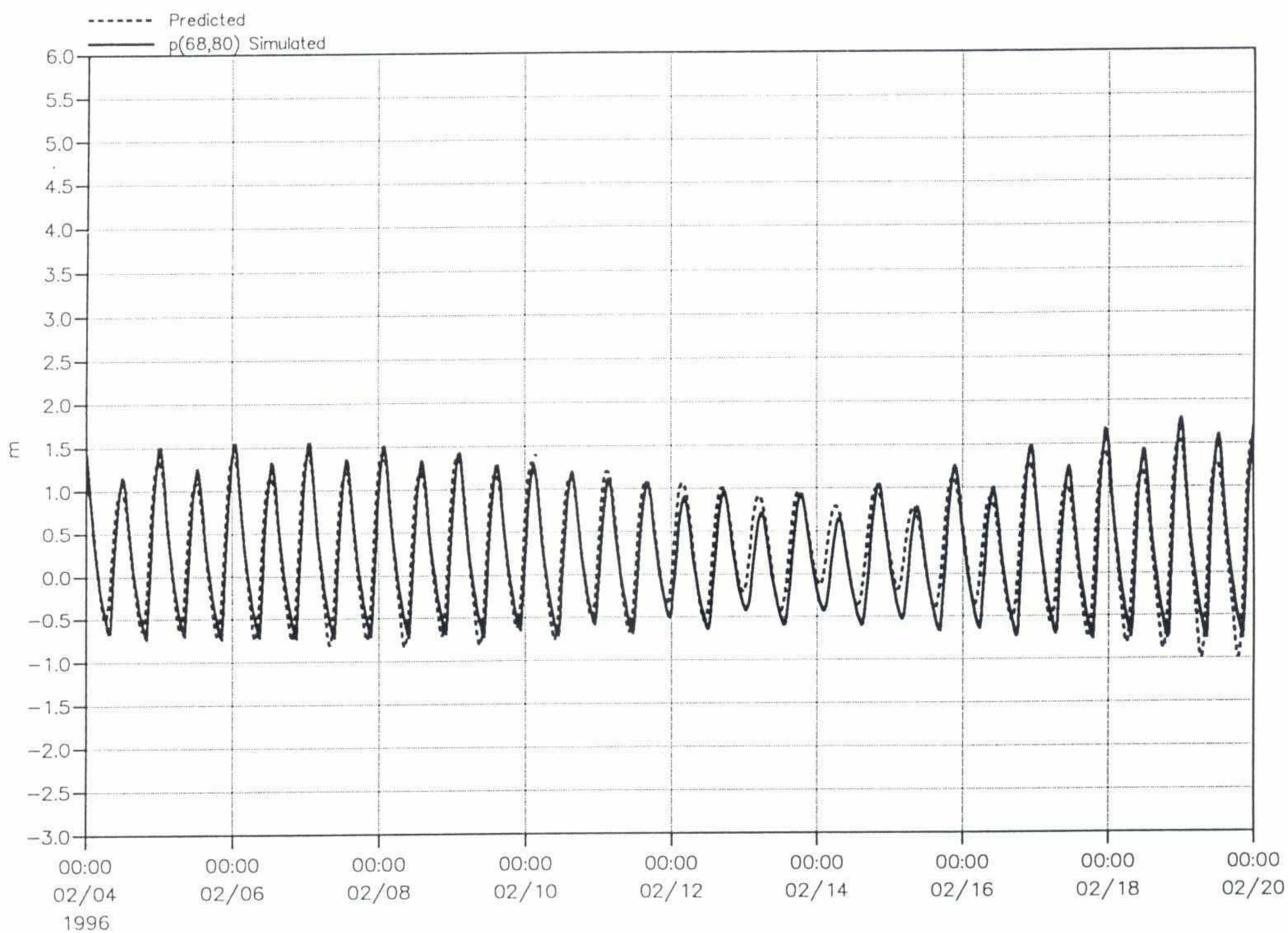
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Kochopia (PWD) Dry Season 1996	Drawing no. 4.16
Scale:	Init: p5011		



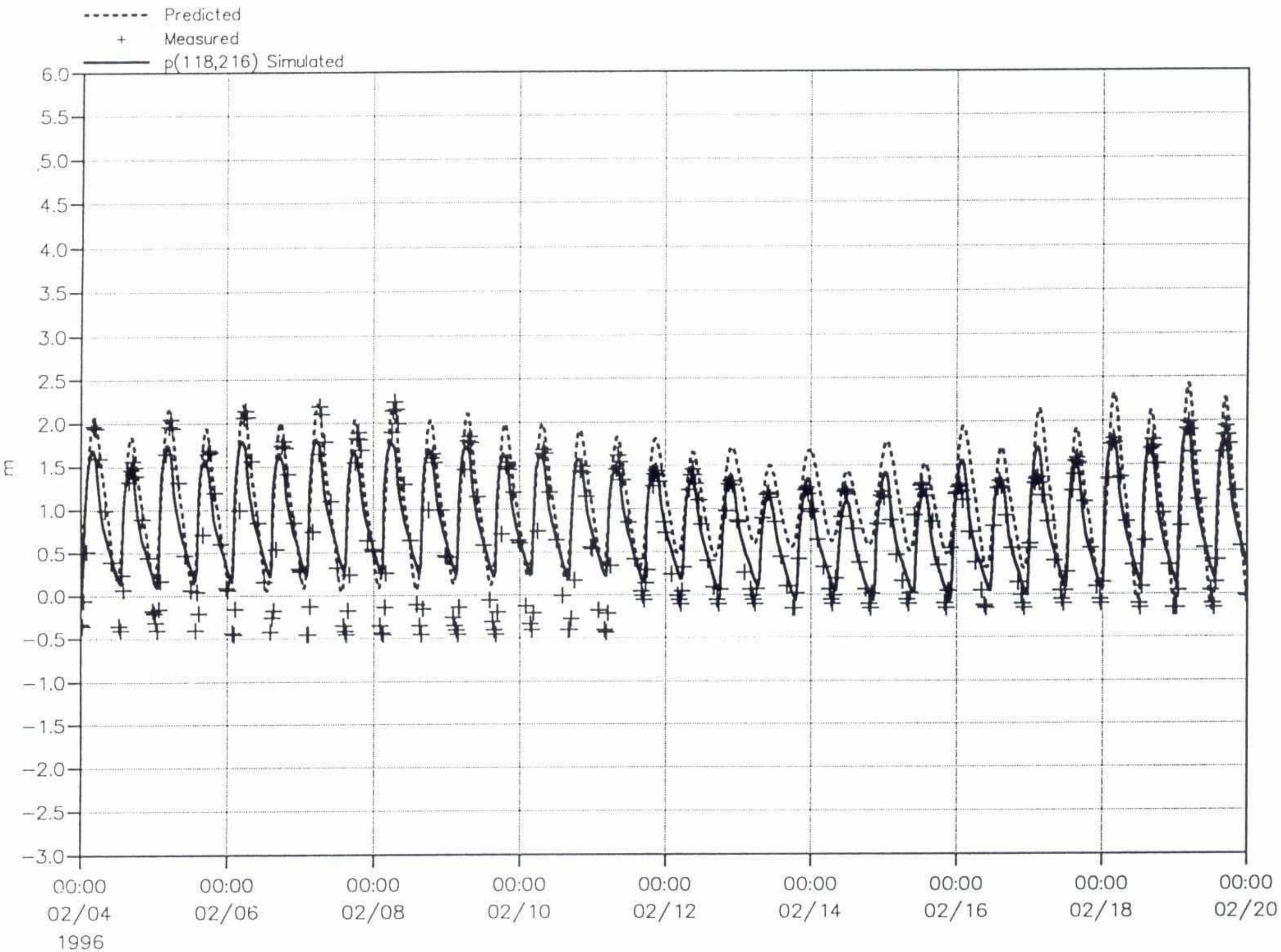
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Kutubdia Island (PWD) Dry Season 1996	Drawing no. 4.17
Scale:	Init: p5011		



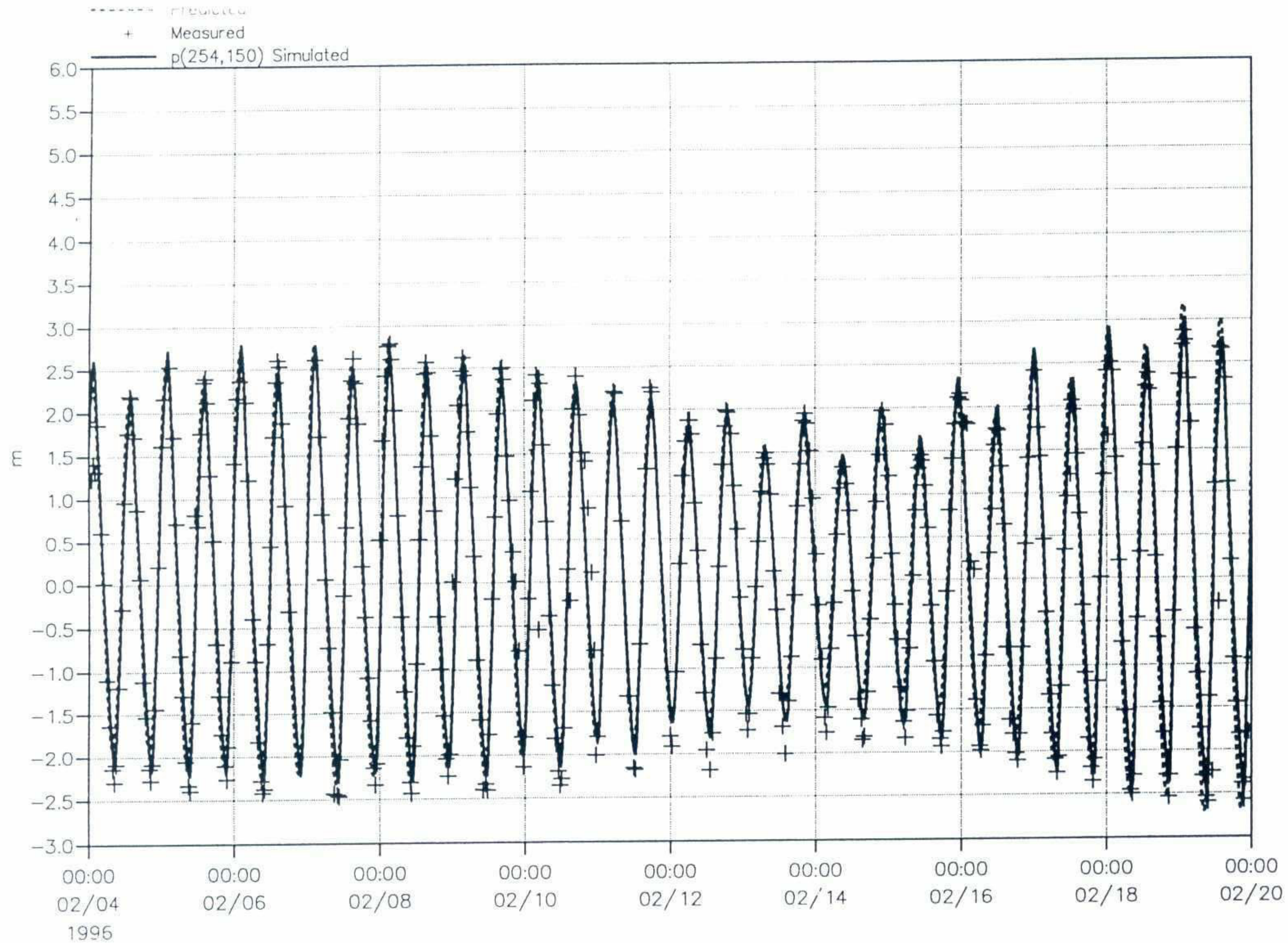
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Normans Point (PWD) Dry Season 1996	Drawing no. 4.18
Scale:	Init: p5011		



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Rabnabad Channel (PWD) Dry Season 1996	Drawing no. 4.19
Scale:	Init: p5011		

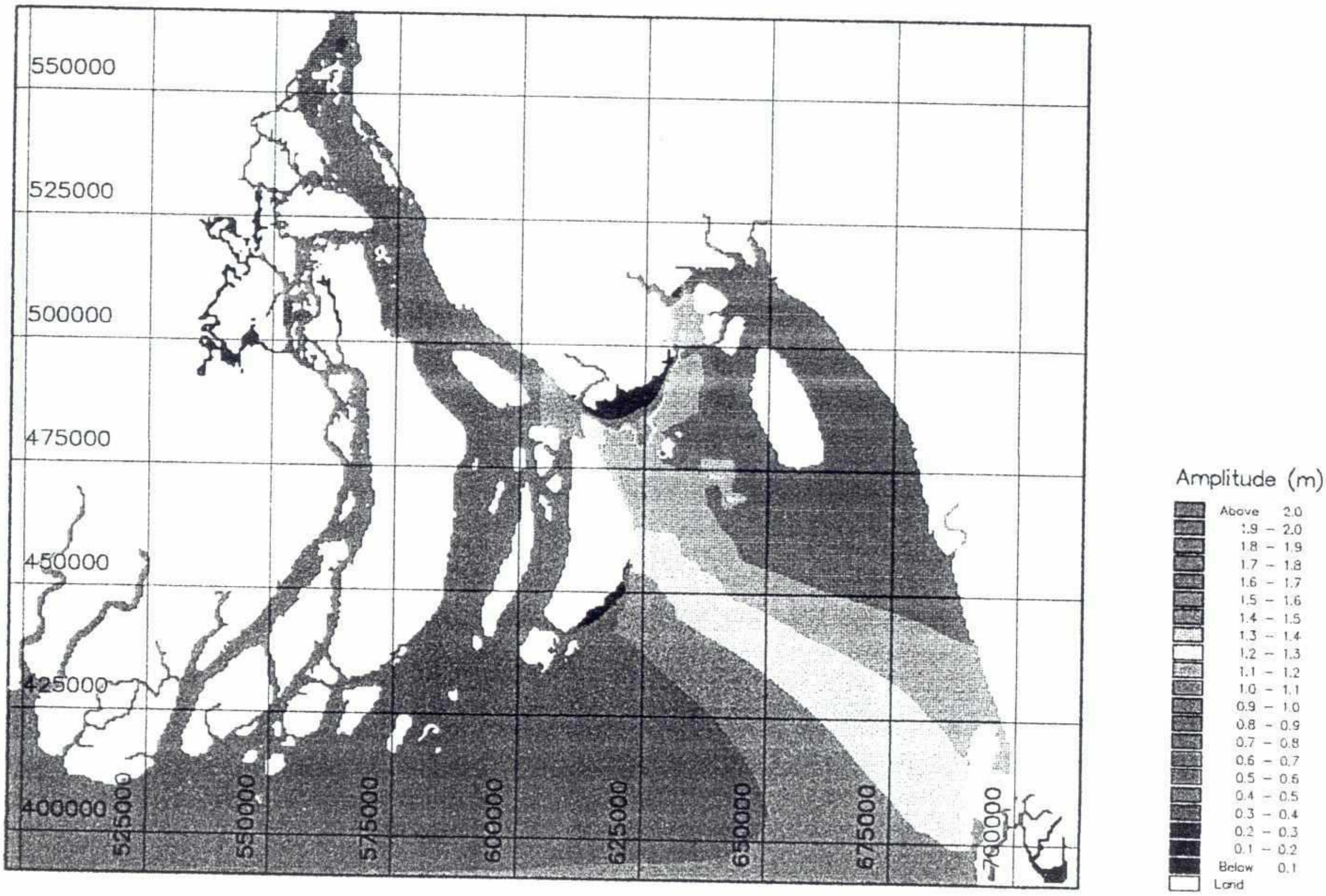


SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured, simulated and predicted wated level at Ramdaspur (PWD) Dry Season 1996	Drawing no. 4.20
Scale:	Init: p5011		



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured, simulated and predicted water level at Sandwip (PWD) Dry Season 1996	Drawing no. 4.21
Scale:	Init: p5011		

288



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996 M2 amplitude	Drawing no. 4.22
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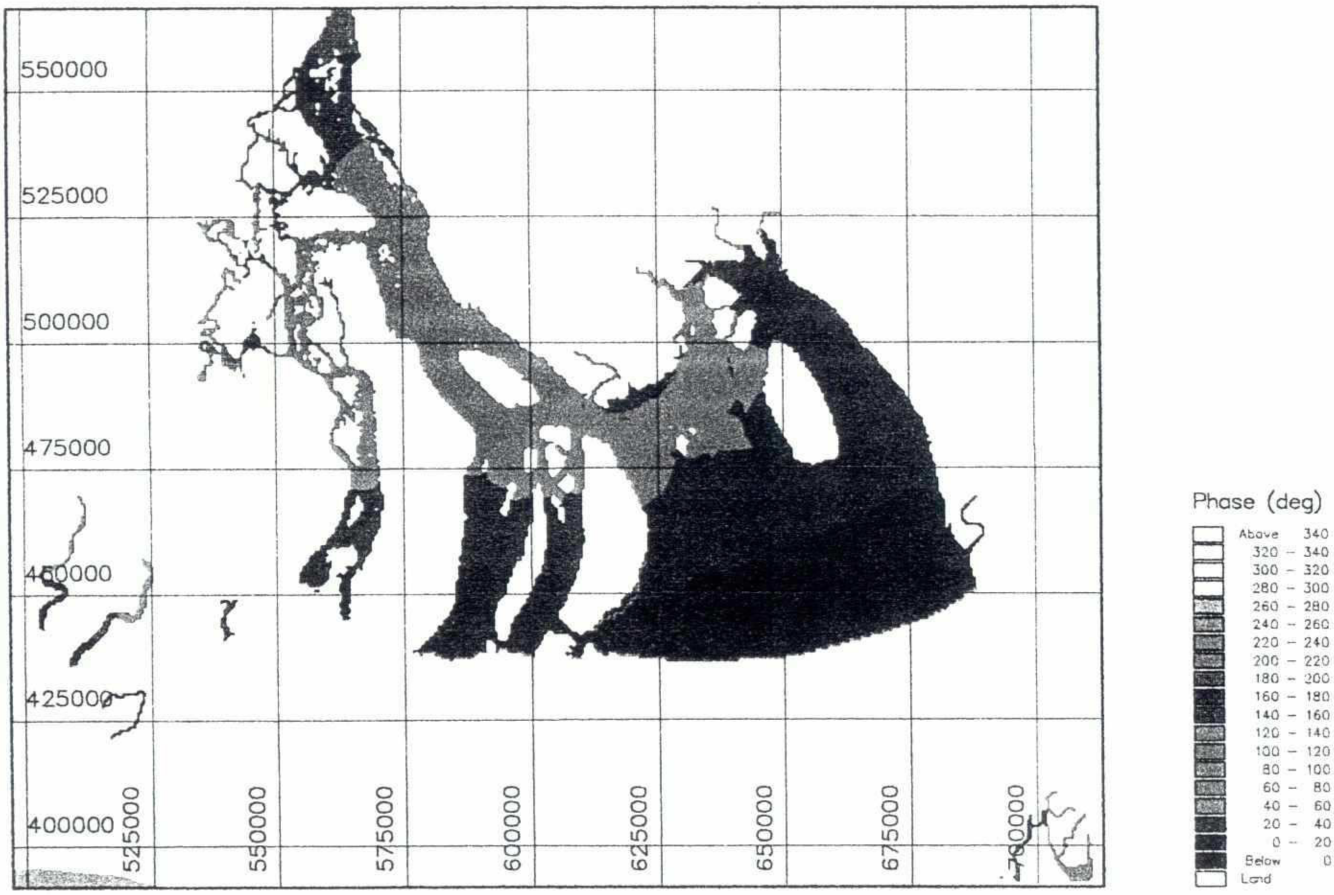
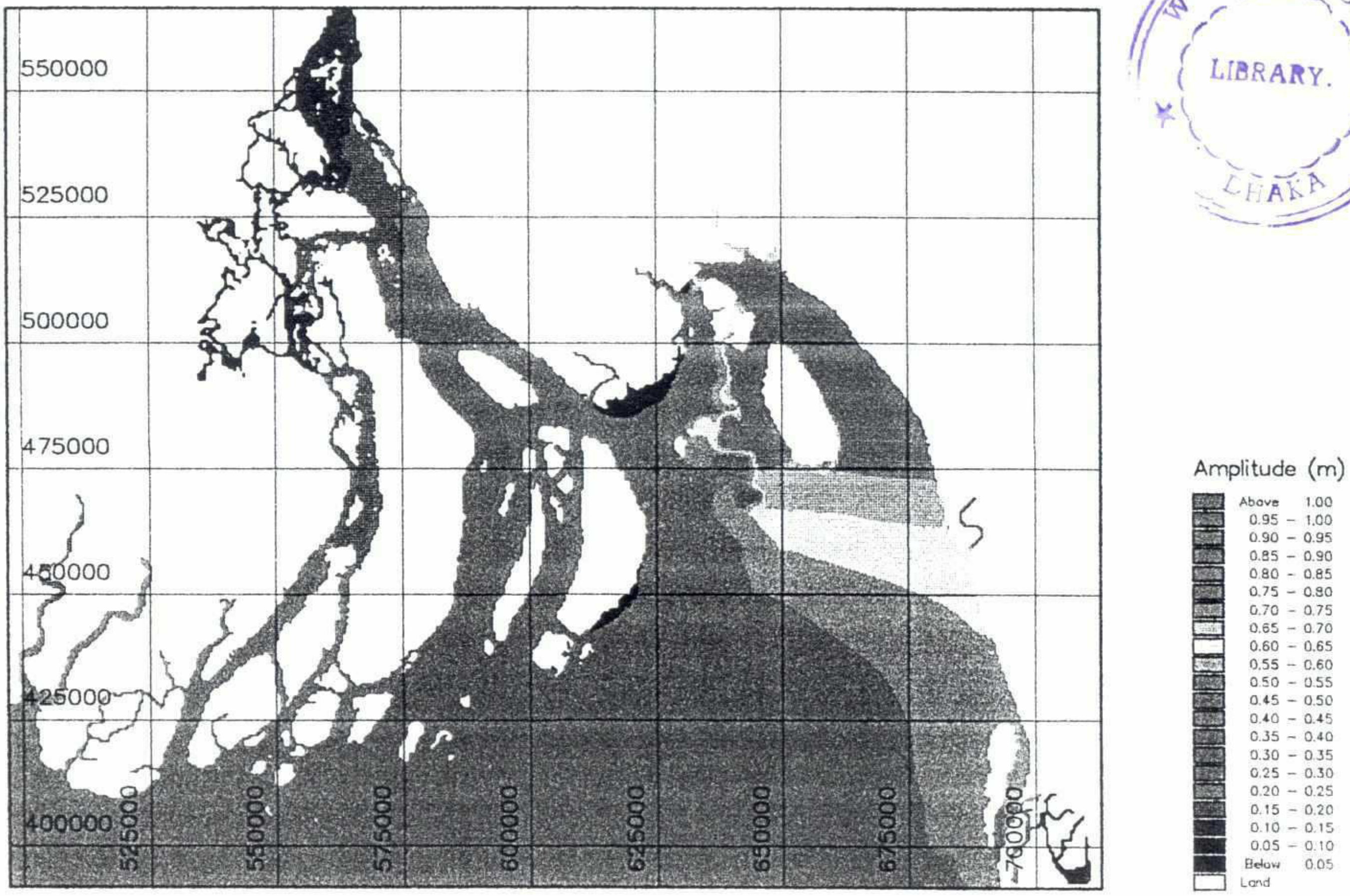


SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.23
Scale: 1:1500000	Init: p5011	M2 phase	



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996 S2 amplitude	Drawing no. 4.24
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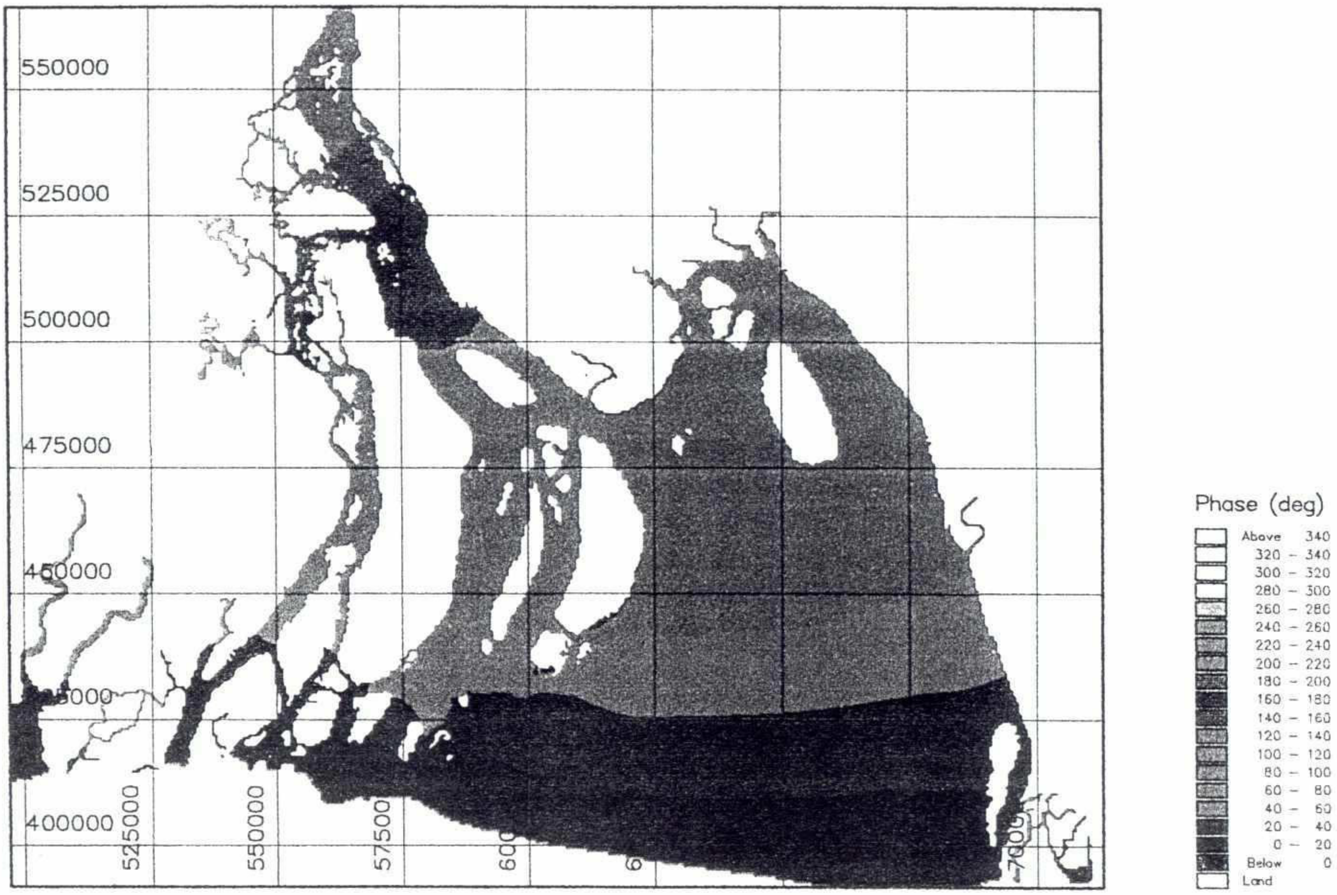
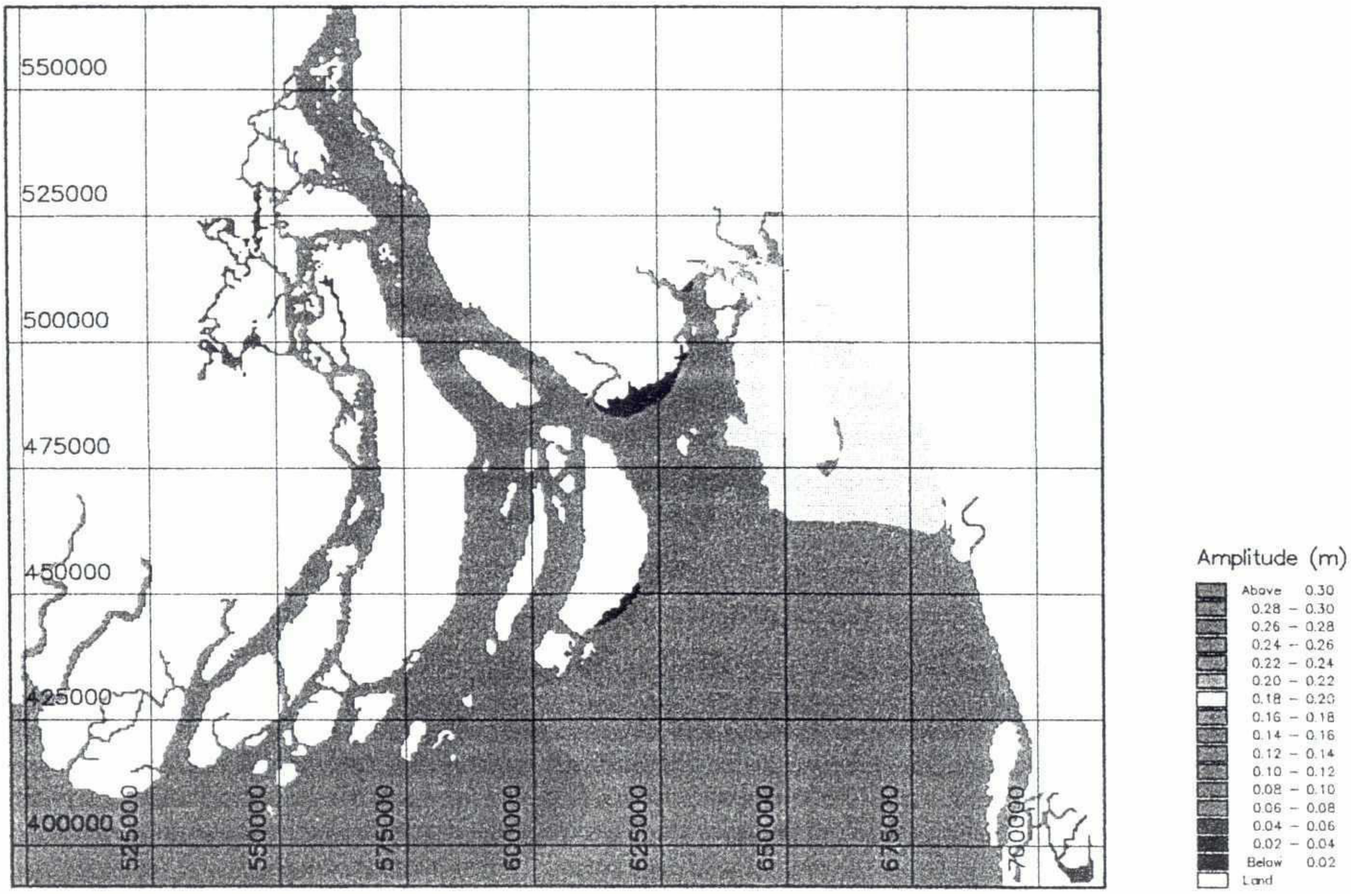
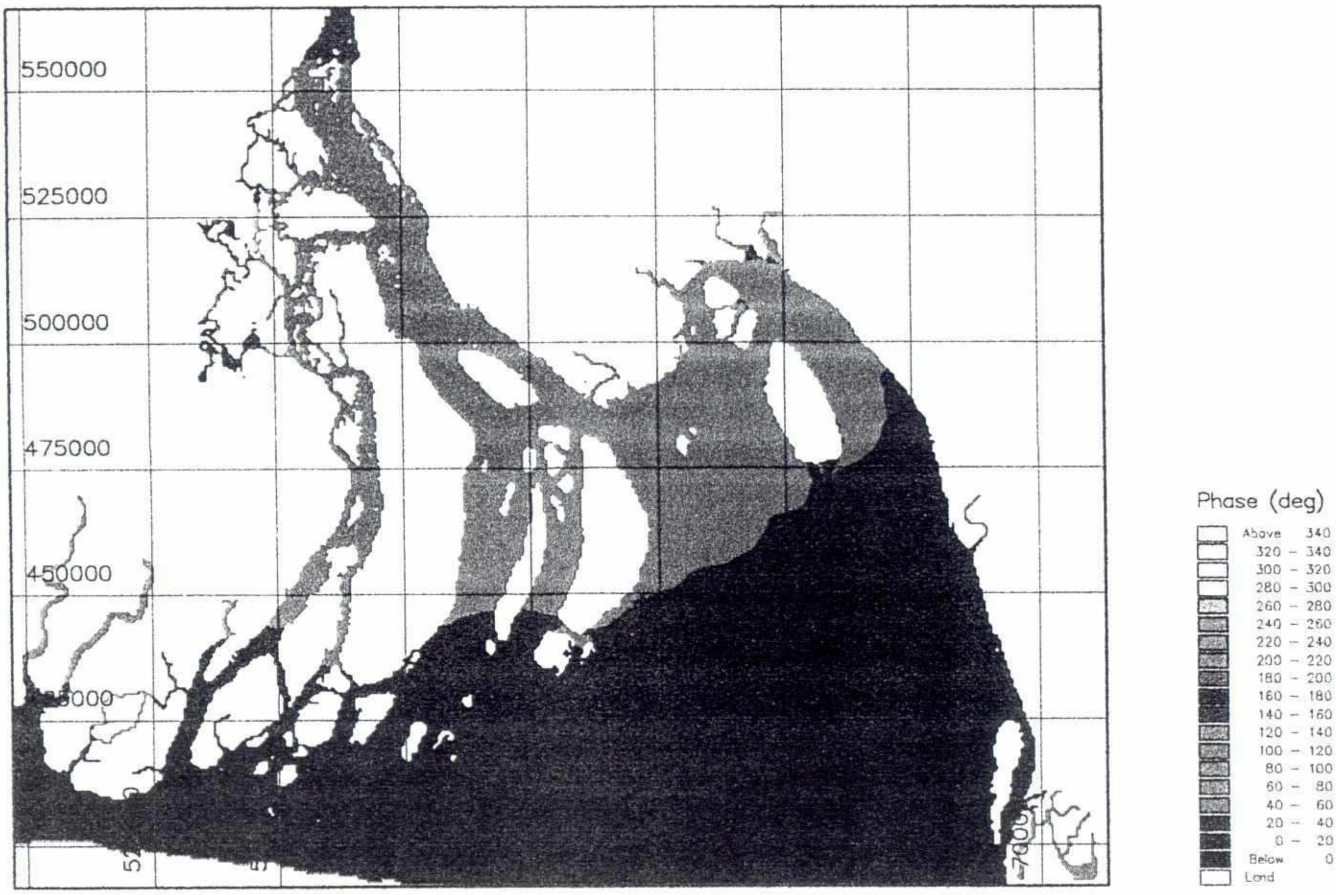


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.25	
Scale: 1:1500000	Init: p5011	S2 phase		

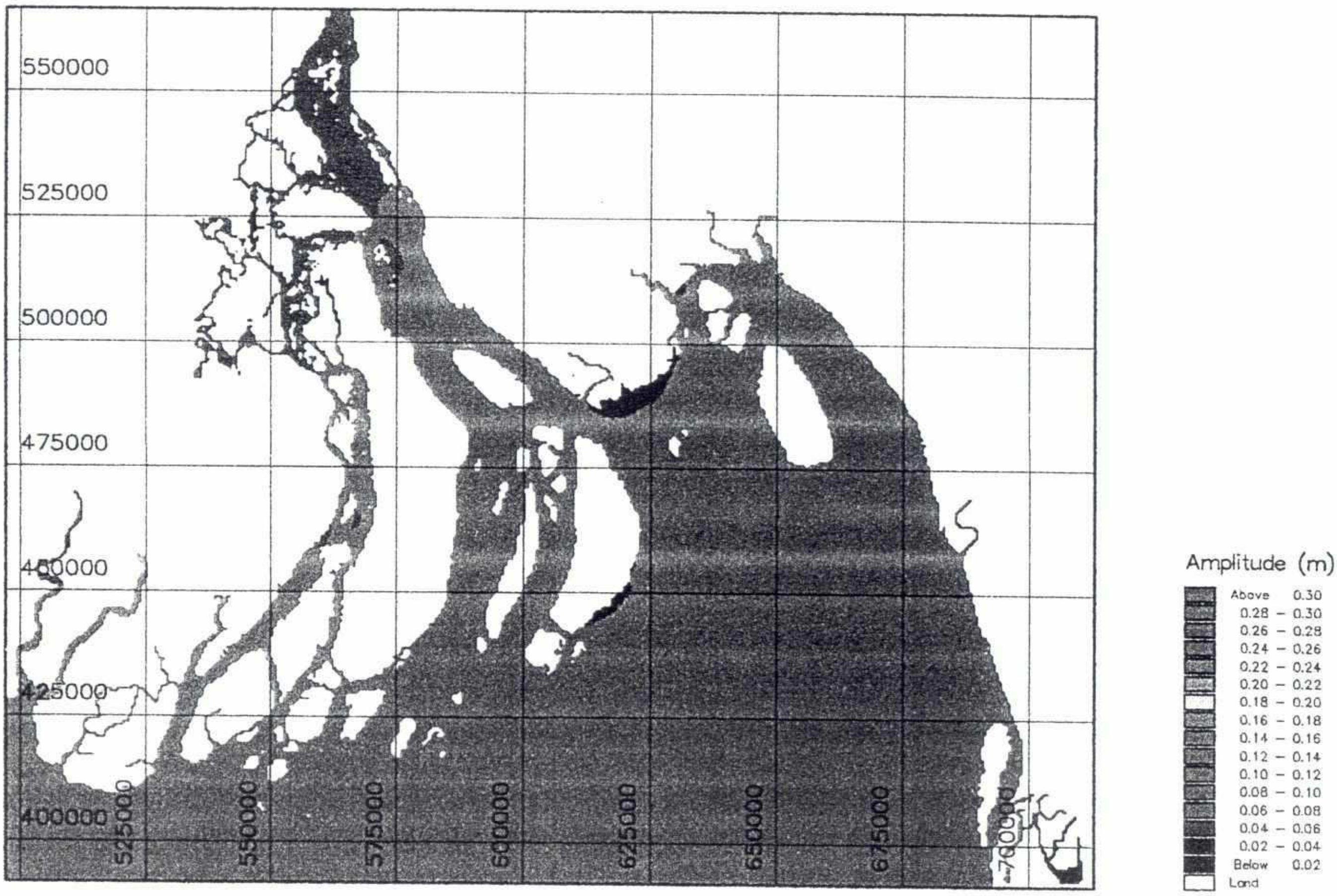


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.26	
Scale: 1:1500000	Init: p5011	K1 amplitude		



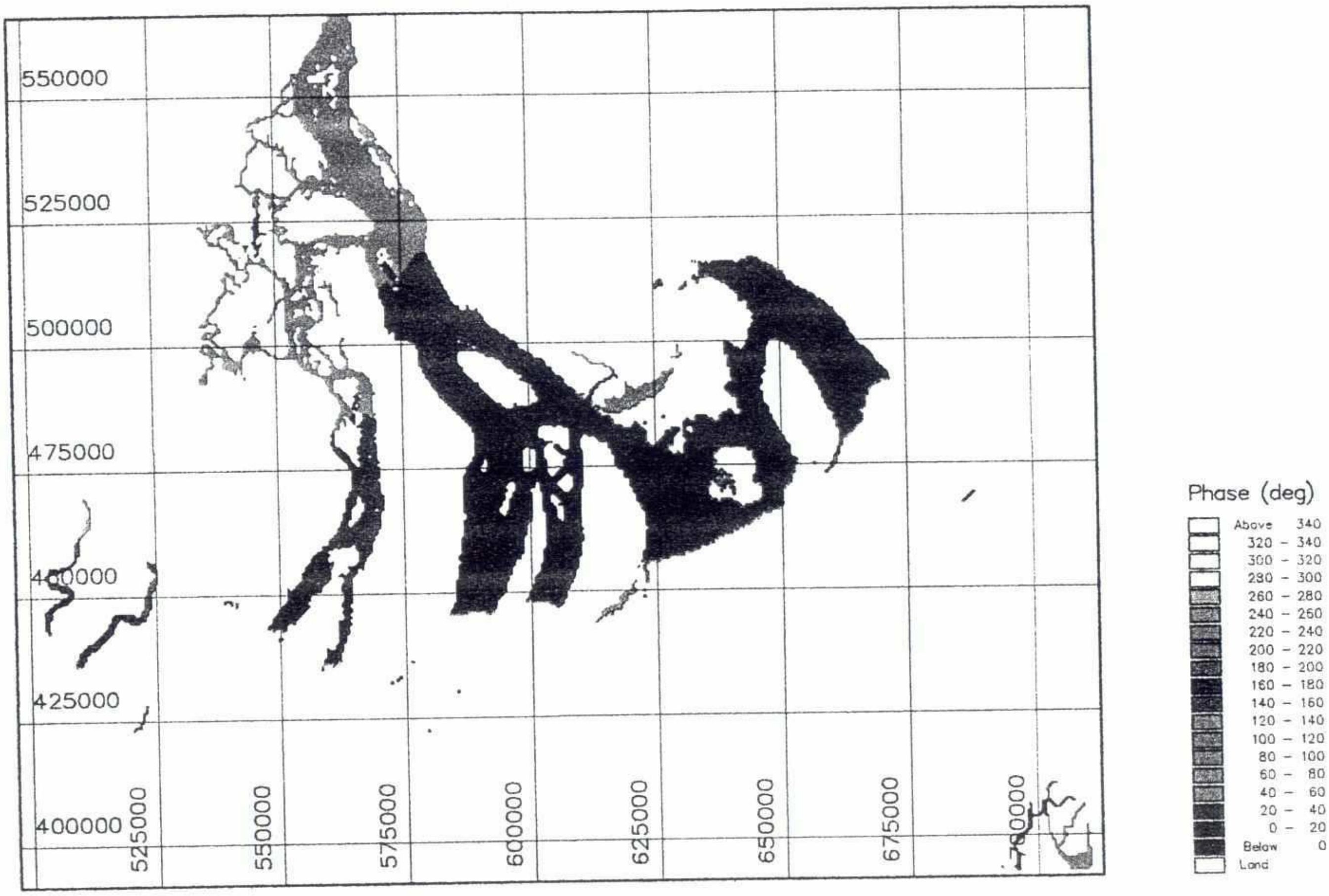
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.27	
Scale: 1:1500000	Init: p5011	K1 phase		

370



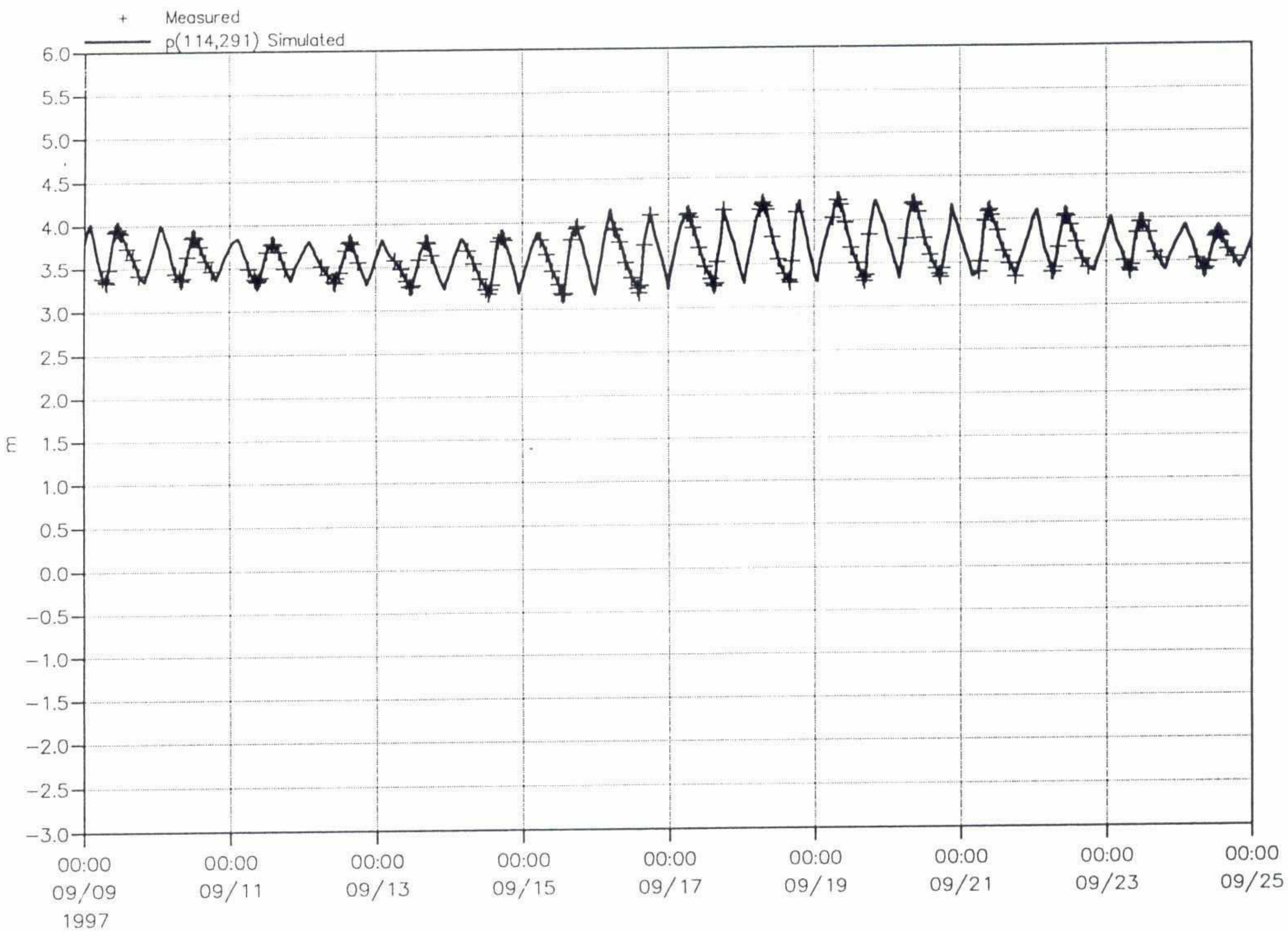
SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.28
Scale: 1:1500000	Init: p5011	O1 amplitude	

202

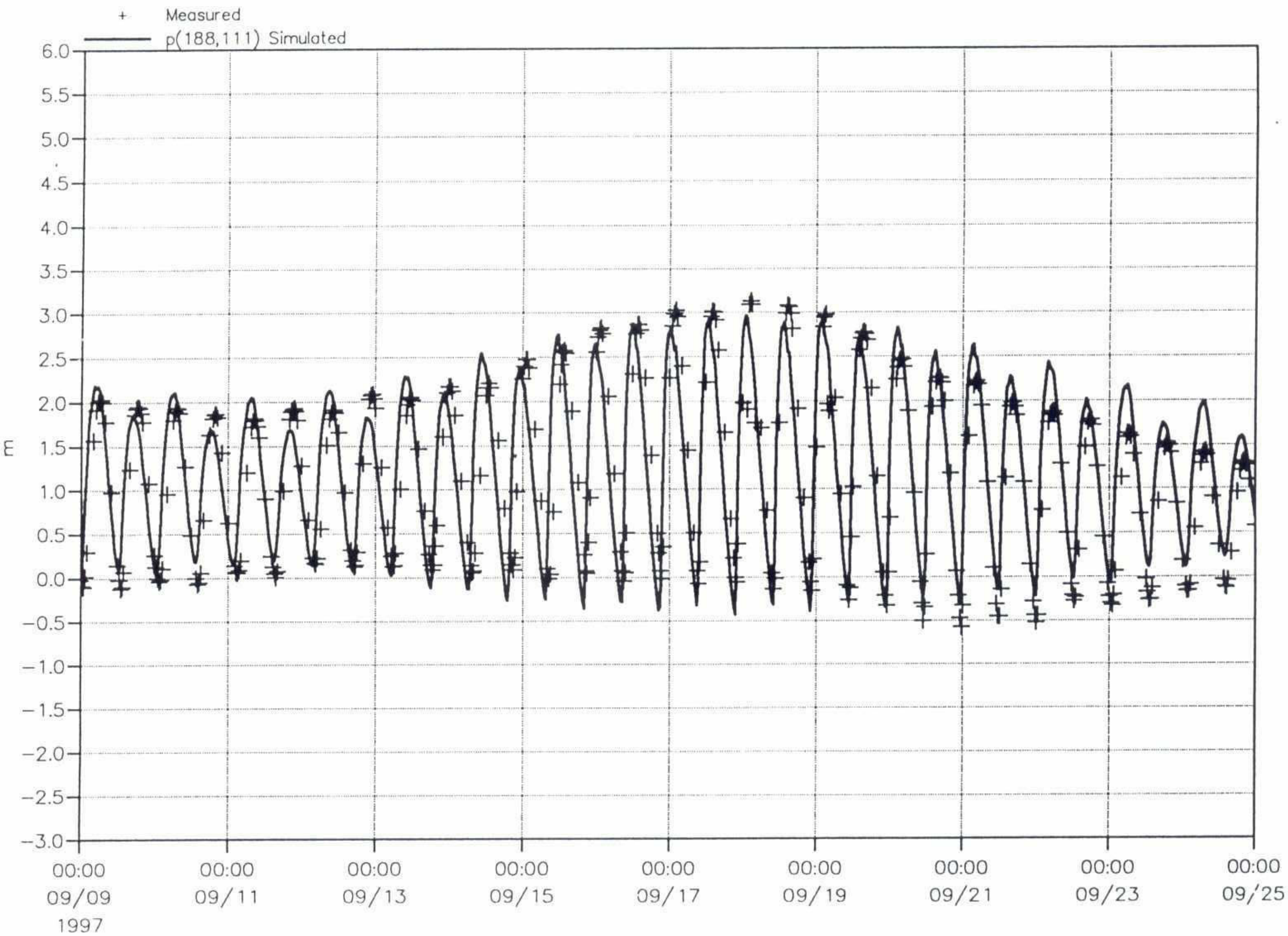


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Tidal analysis, Dry season 1996	Drawing no. 4.29
Scale: 1:1500000	Init: p5011	O1 phase	

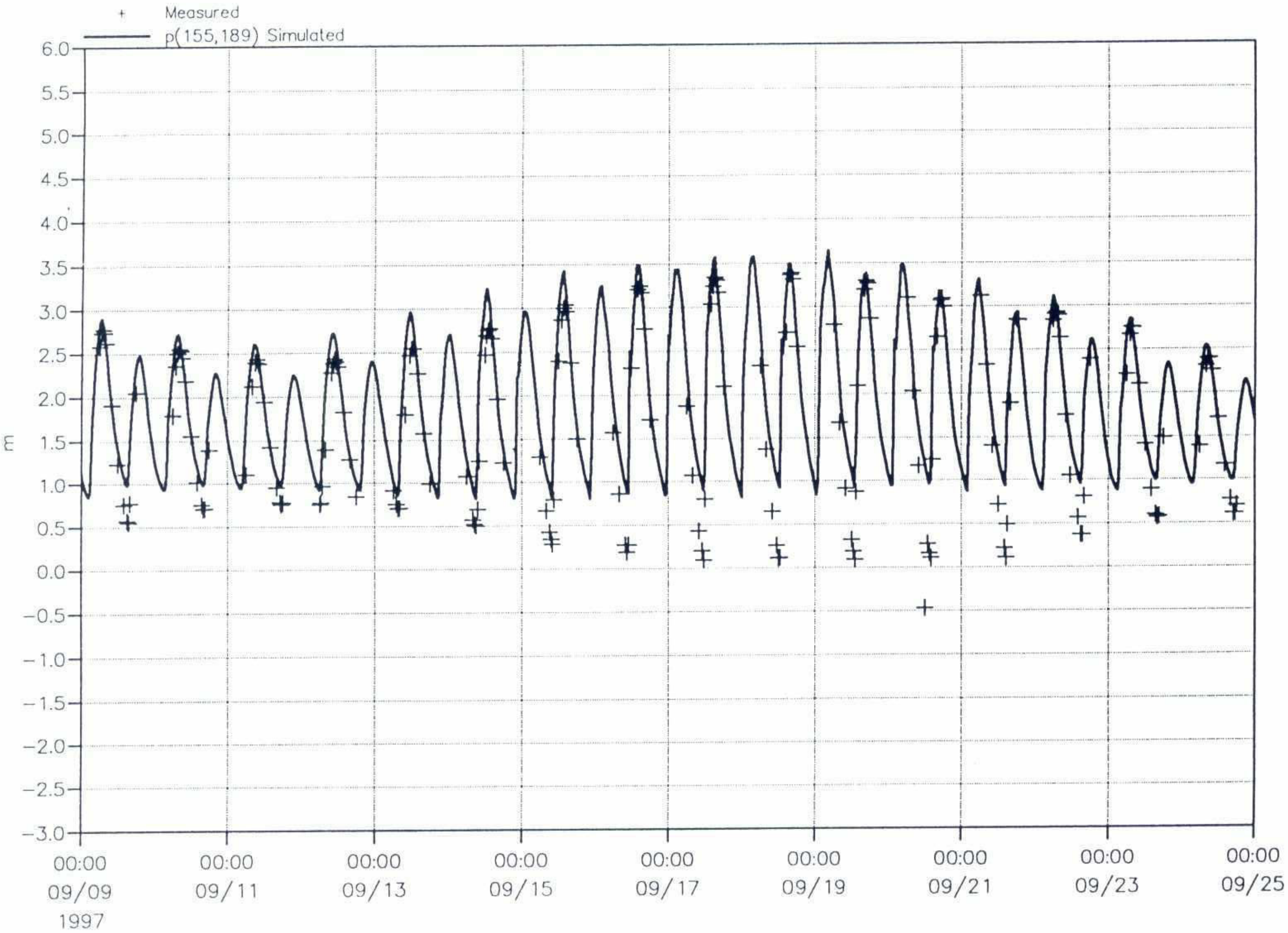
Mon97 sim0997A
meas0997 Chand0897



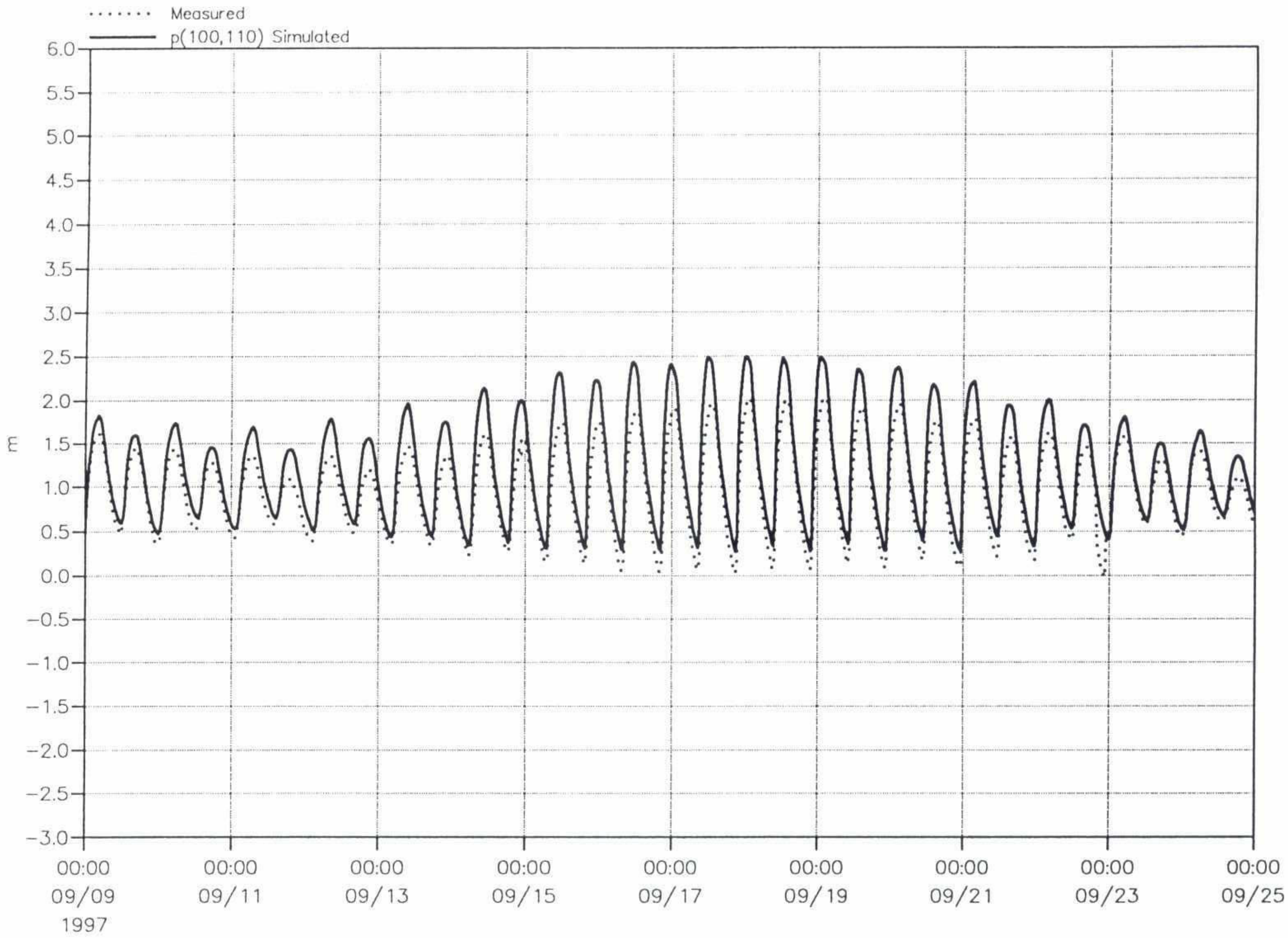
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chandpur (PWD) Monsoon Season 1997	Drawing no. 4.30
Scale:	Init: p5011		



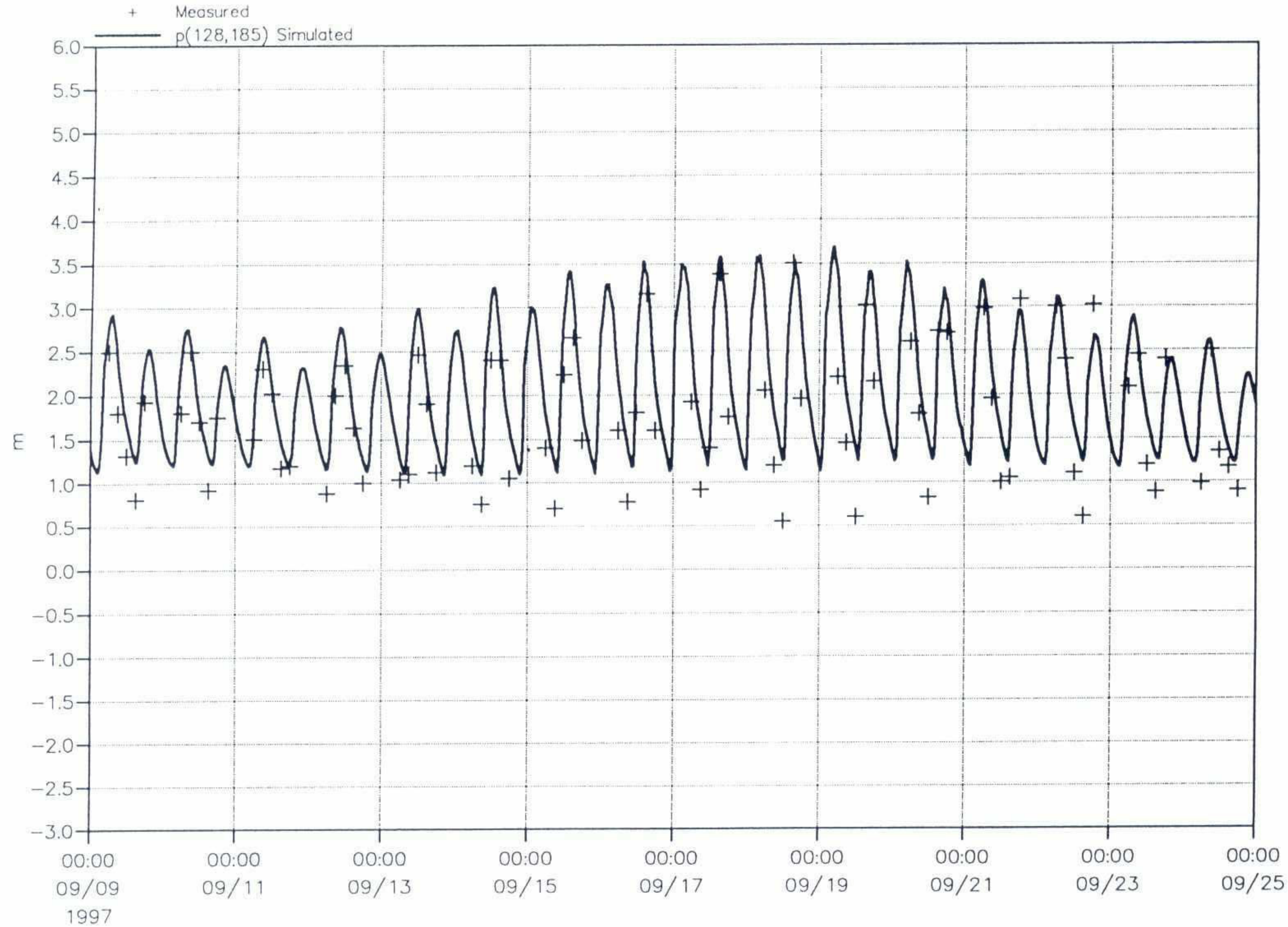
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Char Chenga (PWD) Monsoon Season 1997	Drawing no. 4.31
Scale:	Init: p5011		



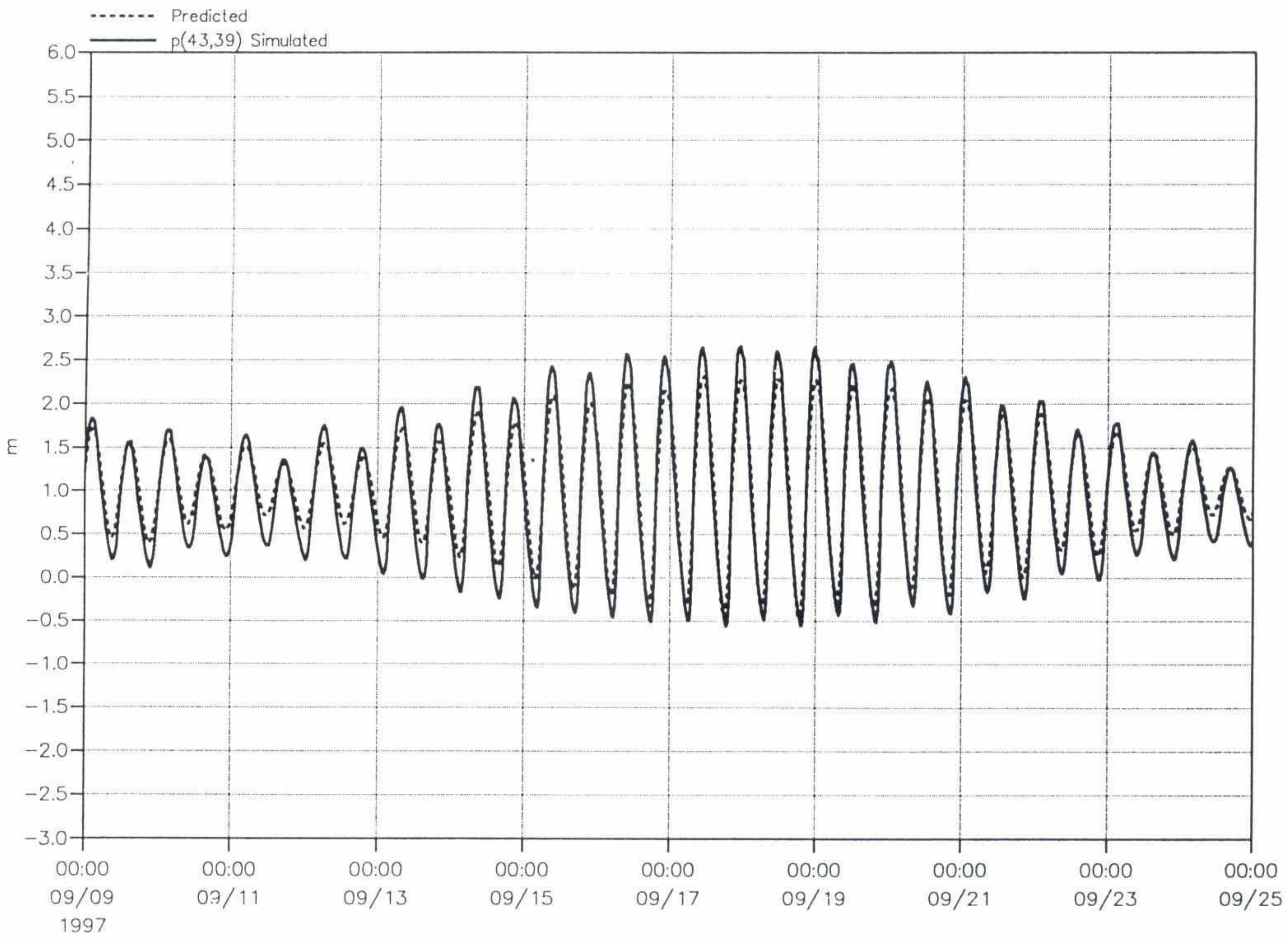
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and simulated water level at Chitalkhali (PWD) Monsoon season 1997	Drawing no. 4.32
Scale:	Init: p5011		



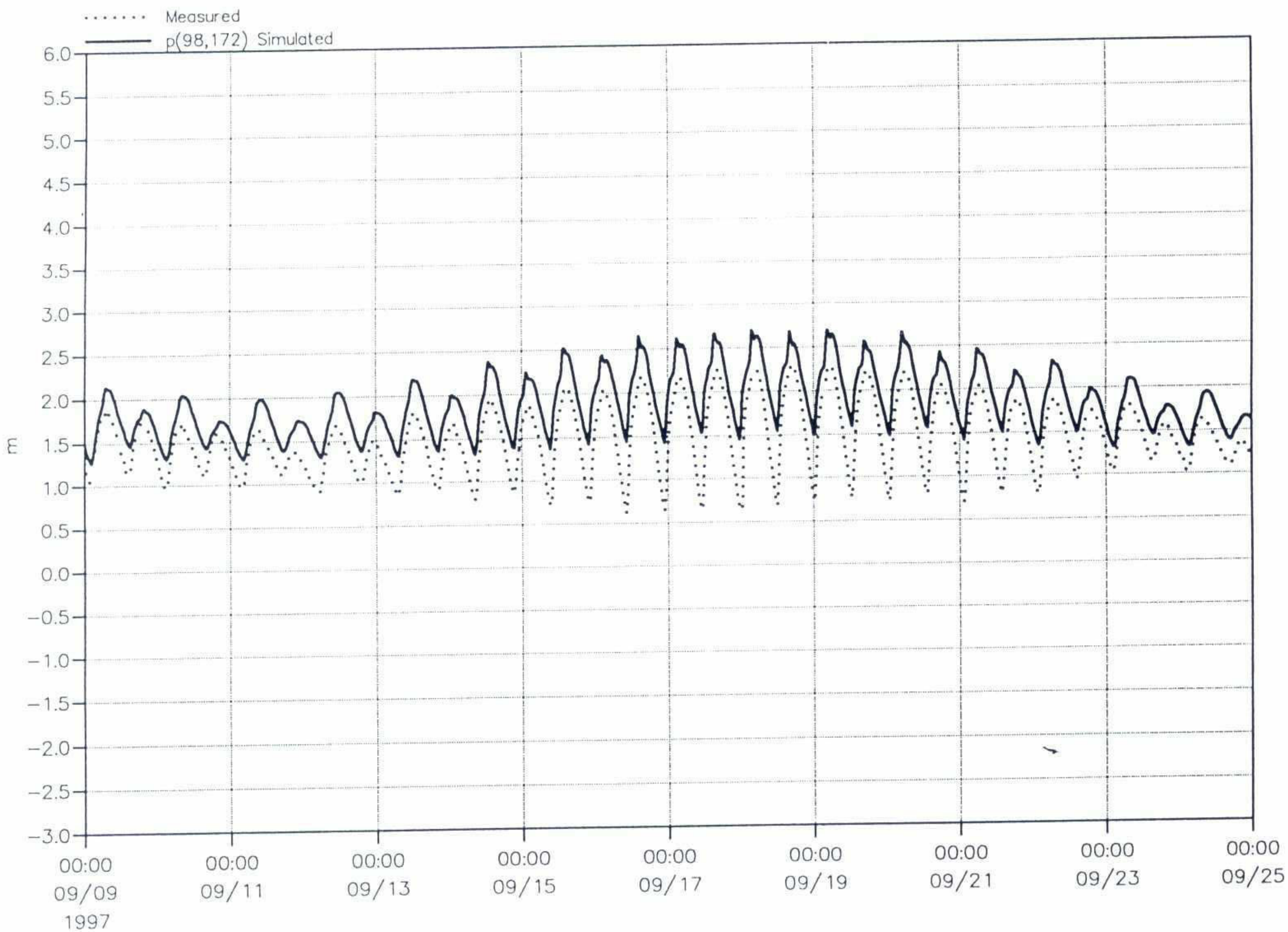
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Dasmunia (PWD) Monsoon Season 1997	Drawing no. 4.33
Scale:	Init: p5011		



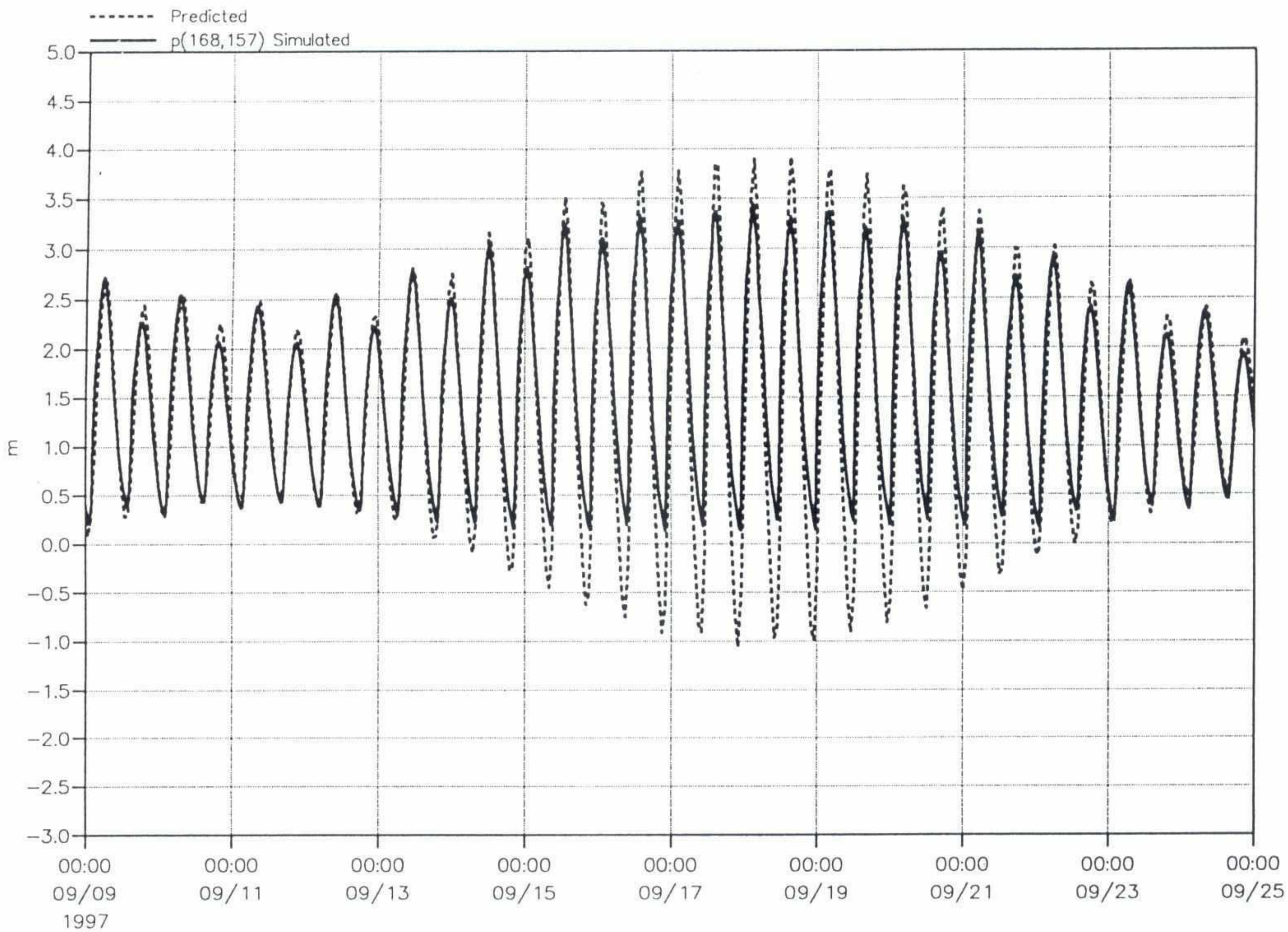
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Daulatkhan (PWD), BWDB Monsoon Season 1997
Scale:	Init: p5011	Drawing no. 4.34



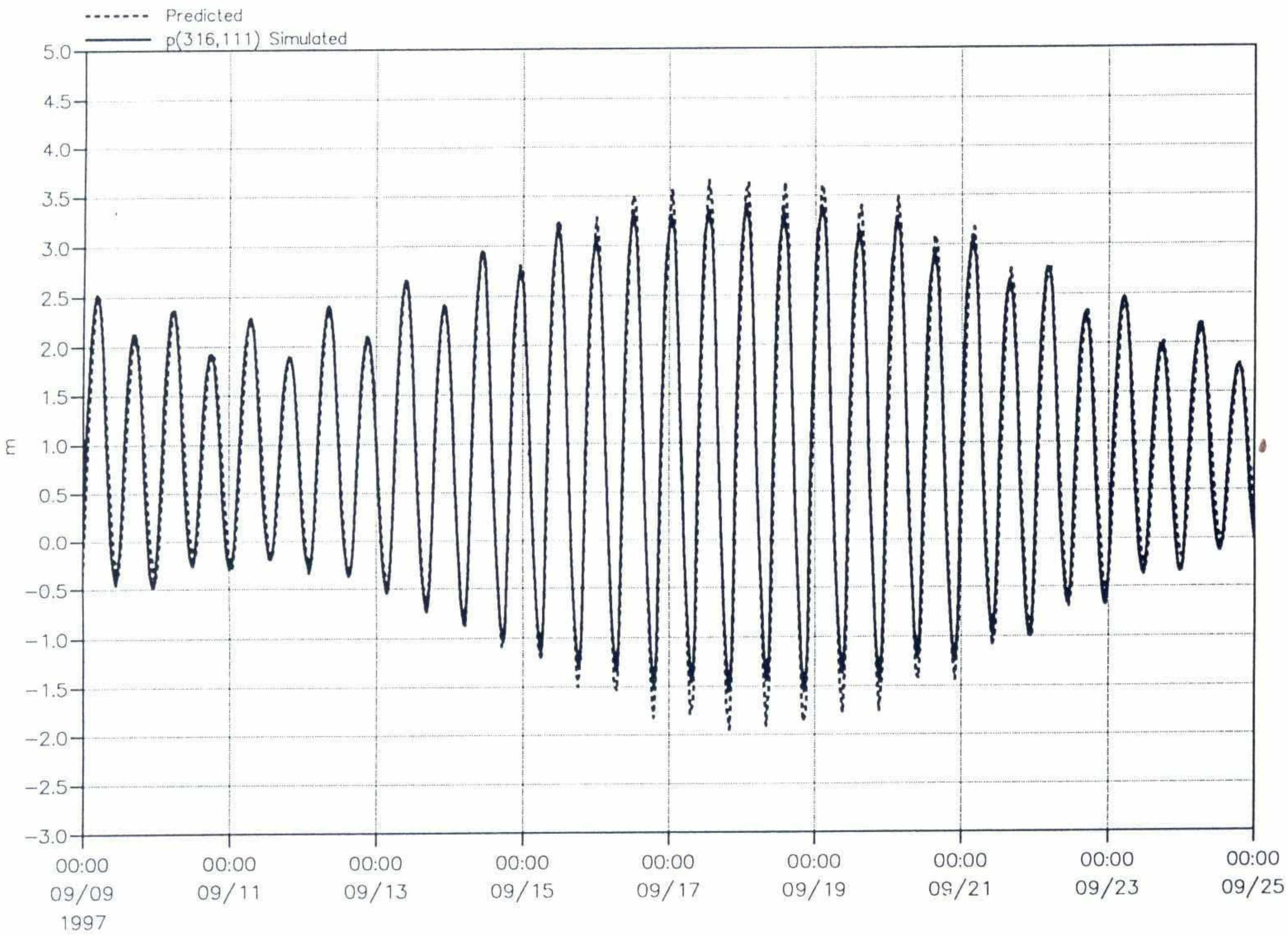
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and predicted water level at Dhulasar (PWD) Monsoon Season 1997	Drawing no. 4.35	
Scale:	Init: p5011			



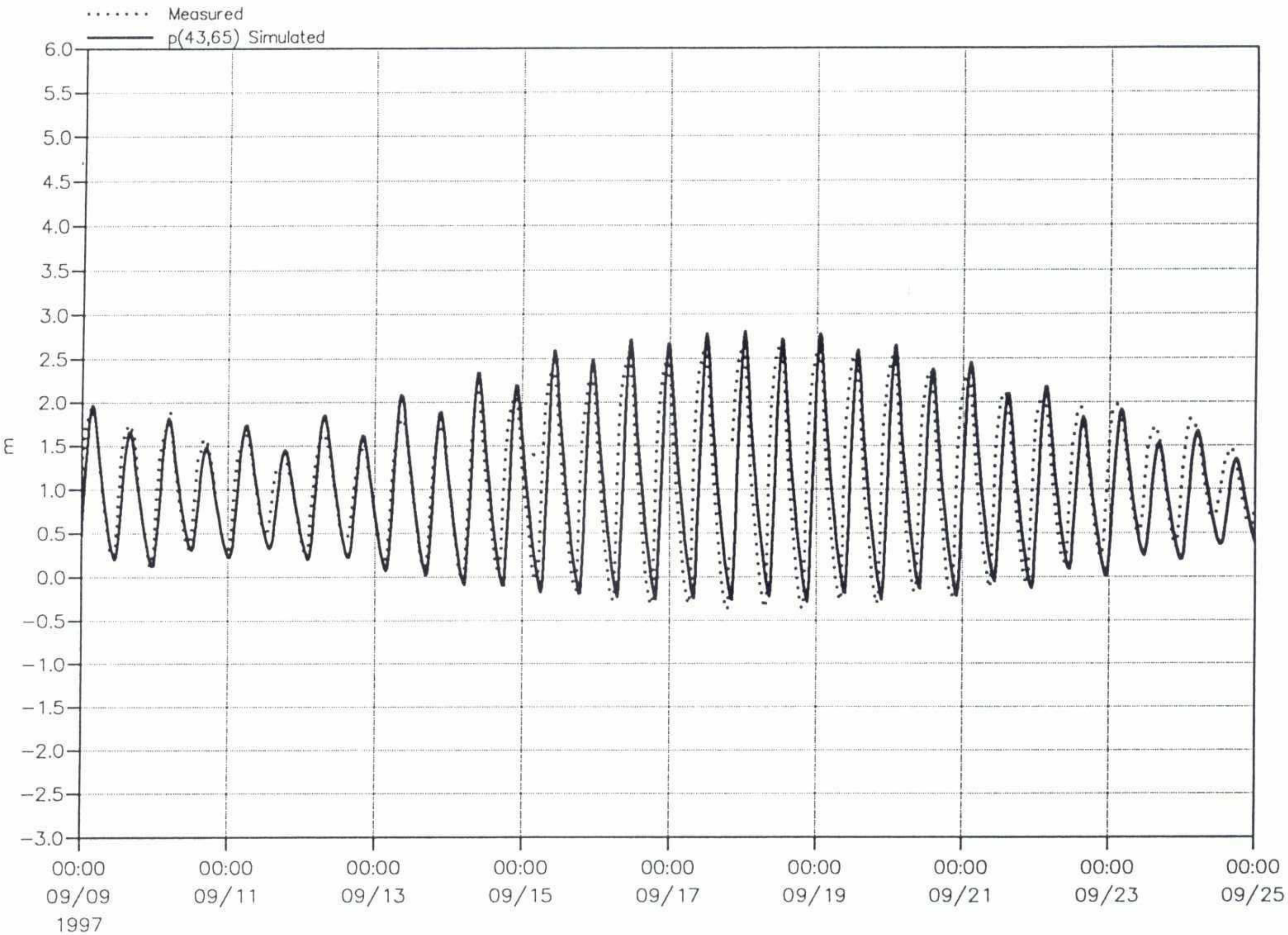
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and simulated water level at Dhulia (PWD) Monsoon Season 1997	Drawing no. 4.36
Scale:	Init: p5011		



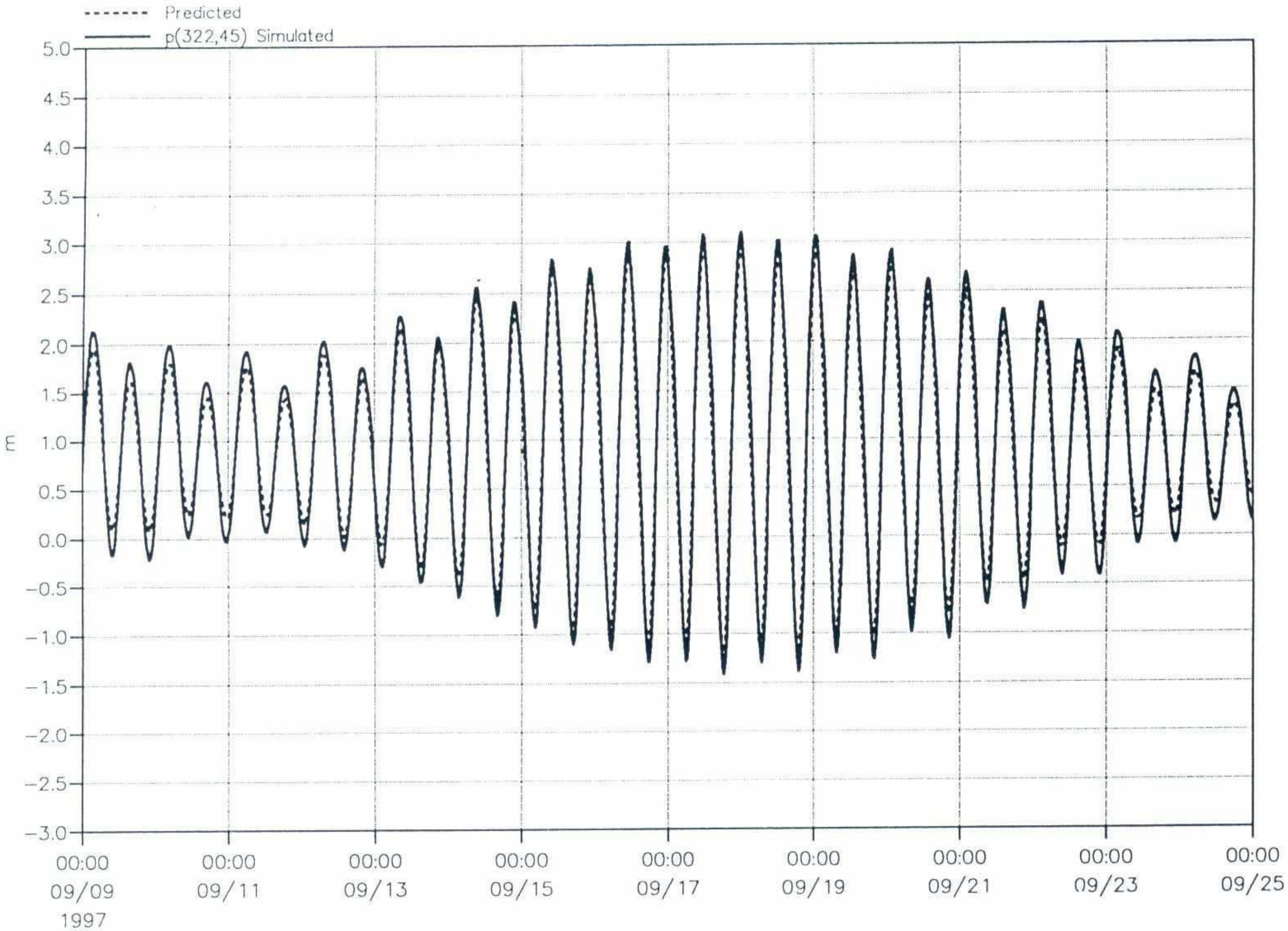
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and predicted water level at Hatia Bar (PWD) Monsoon Season 1997	Drawing no. 4.37
Scale:	Init: p5011		



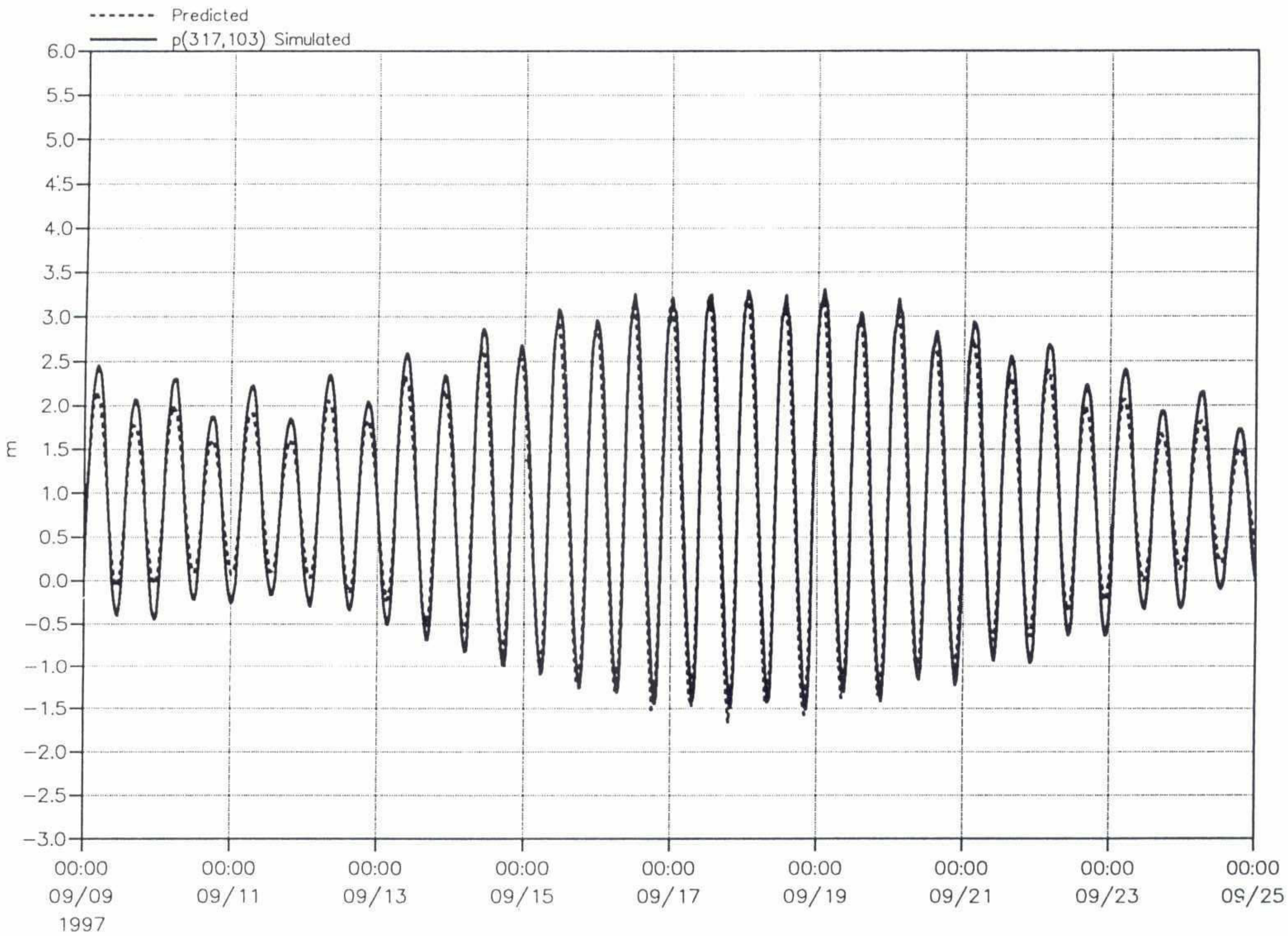
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Khal No. 18 (PWD) Monsoon season 1997	Drawing no. 4.38
Scale:	Init: p5011		



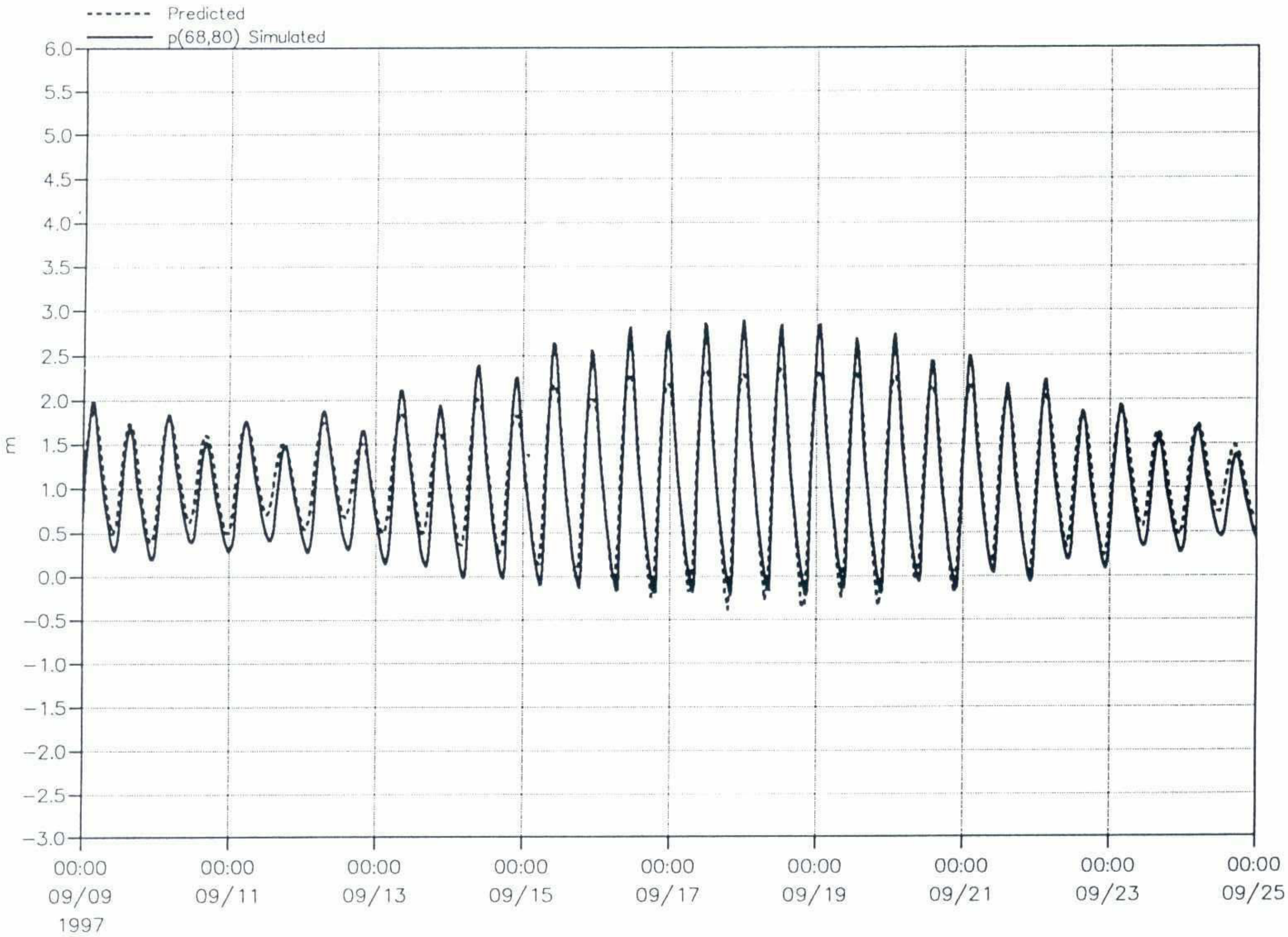
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Khepupara (PWD) Monsoon Season 1997	Drawing no. 4.39
Scale:	Init: p5011		



SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and predicted water level at Kutubdia Island (PWD) Monsoon Season 1997	Drawing no. 4.40	
Scale:	Init: p5011			

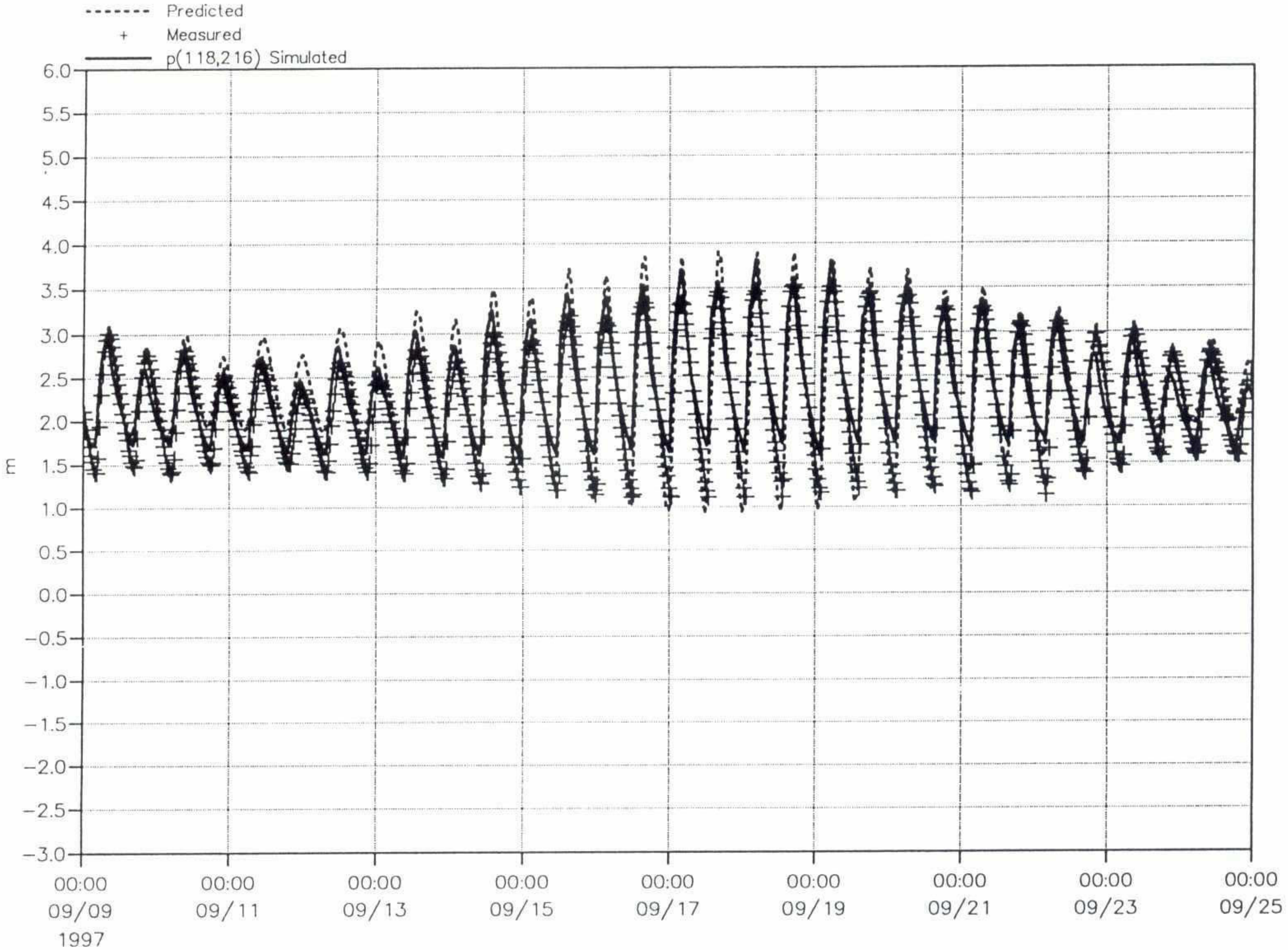


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and predicted water level at Normans Point (PWD) Monsoon Season 1997	Drawing no. 4.41
Scale:	Init: p5011		

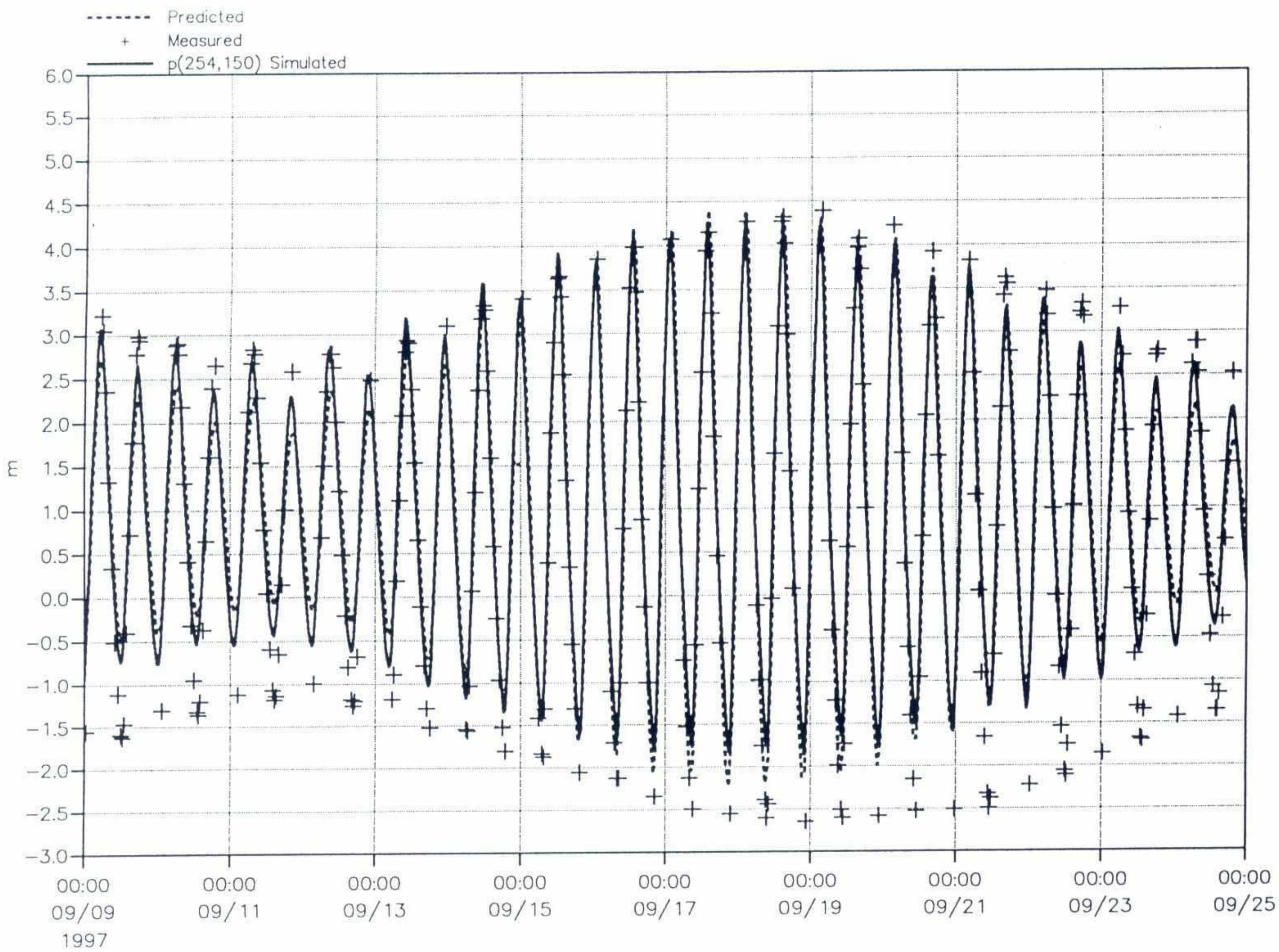


SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Rabnabad Channel (PWD) Monsoon Season 1997	Drawing no. 4.42
Scale:	Init: p5011		

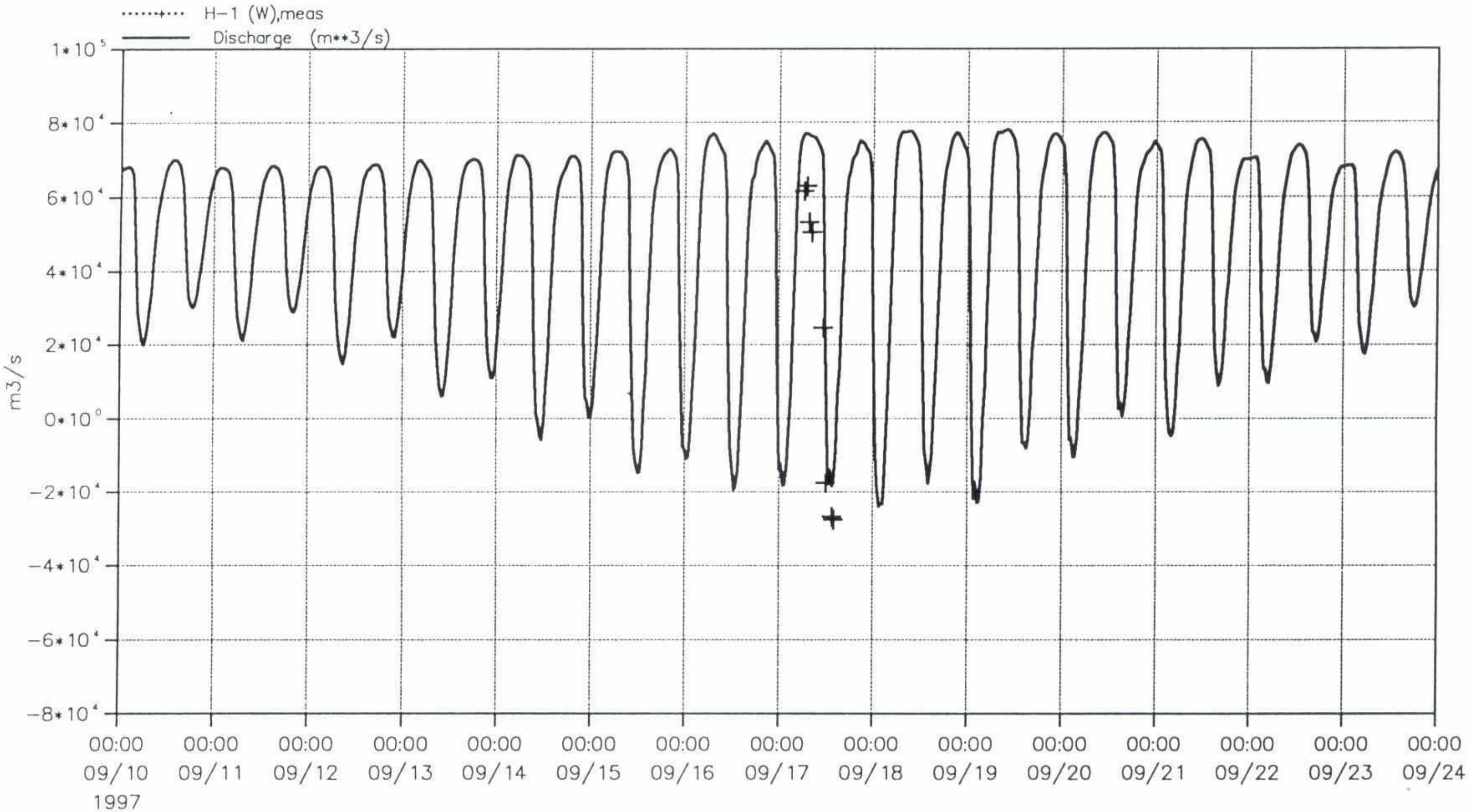
Mon97 sim0997A
meas0997 Ram0997C
tide0997 4507dN



SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Scale:	Date: Sun May 31 1998 / Init: p5011	Measured, simulated and predicted wated level at Ramdaspur (PWD) Monsoon Season 1997 — Drawing no. 4.43



SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File: / Date: Sun May 31 1998	Measured, simulated and predicted water level at Sandwip (PWD) Monsoon Season 1997	Drawing no. 4.44	
Scale: / Init: p5011			



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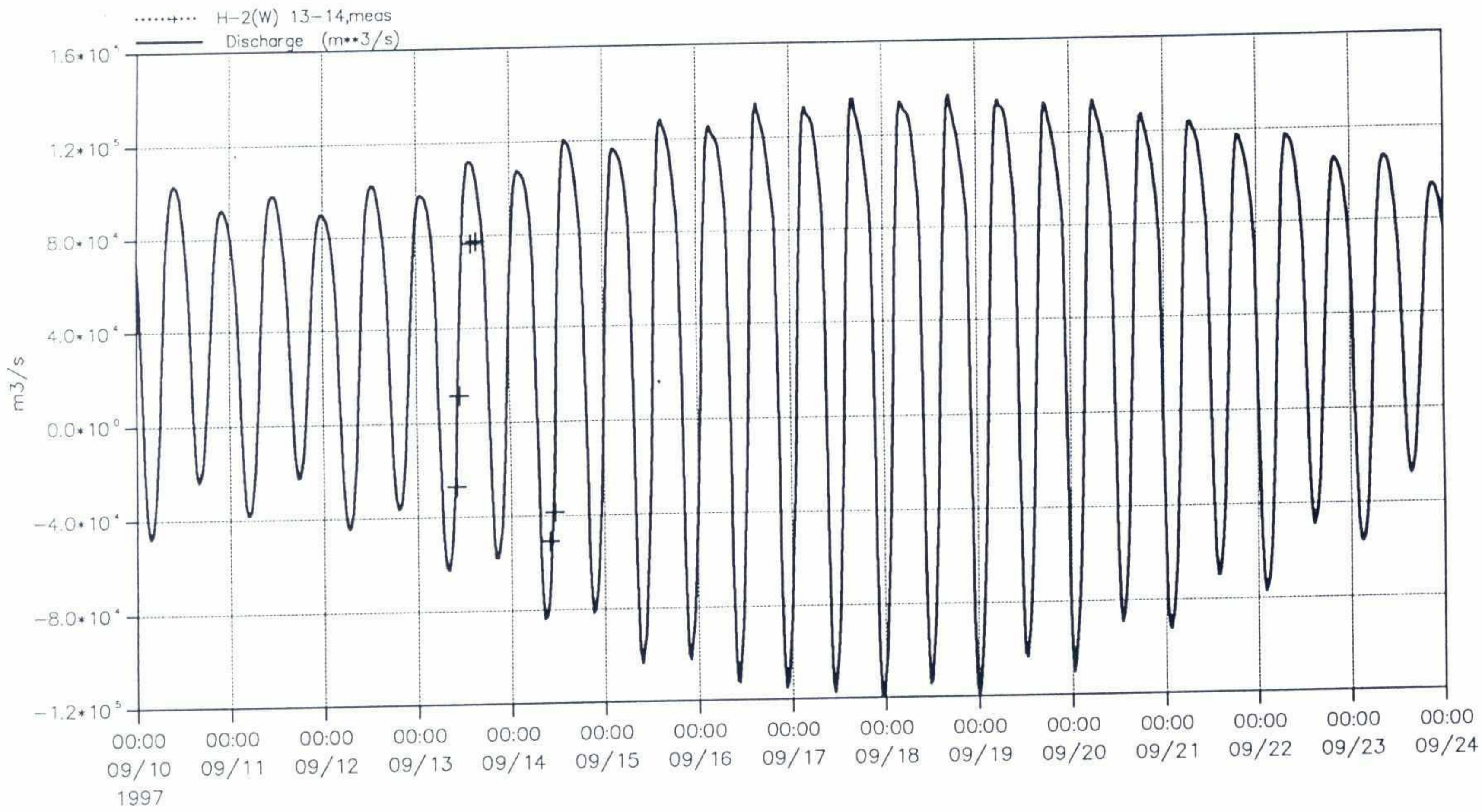
File:	Date: Mon Apr 27 1998	H-1 (West) Bhola to Char Gazaria 17 September 1997	Drawing no. 4.45
Scale:	Init: p5011		



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Apr 27 1998	H-2 (New West) Bhola to Manpura 13-14 September 1997	Drawing no. 4.46
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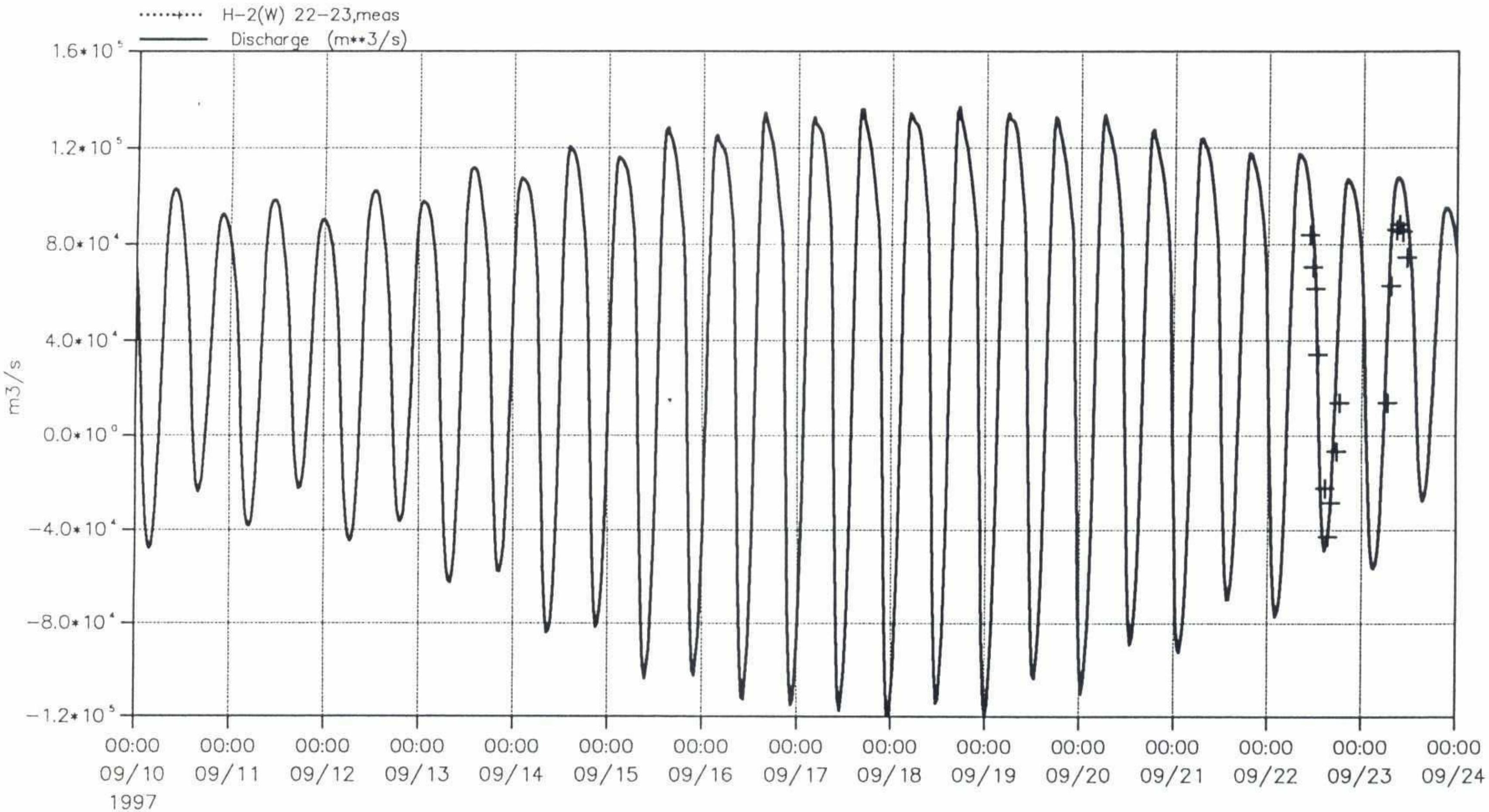

SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Apr 27 1998	H-2 (New West) Bhola to Manpura 22-23 September 1997	Drawing no. 4.47
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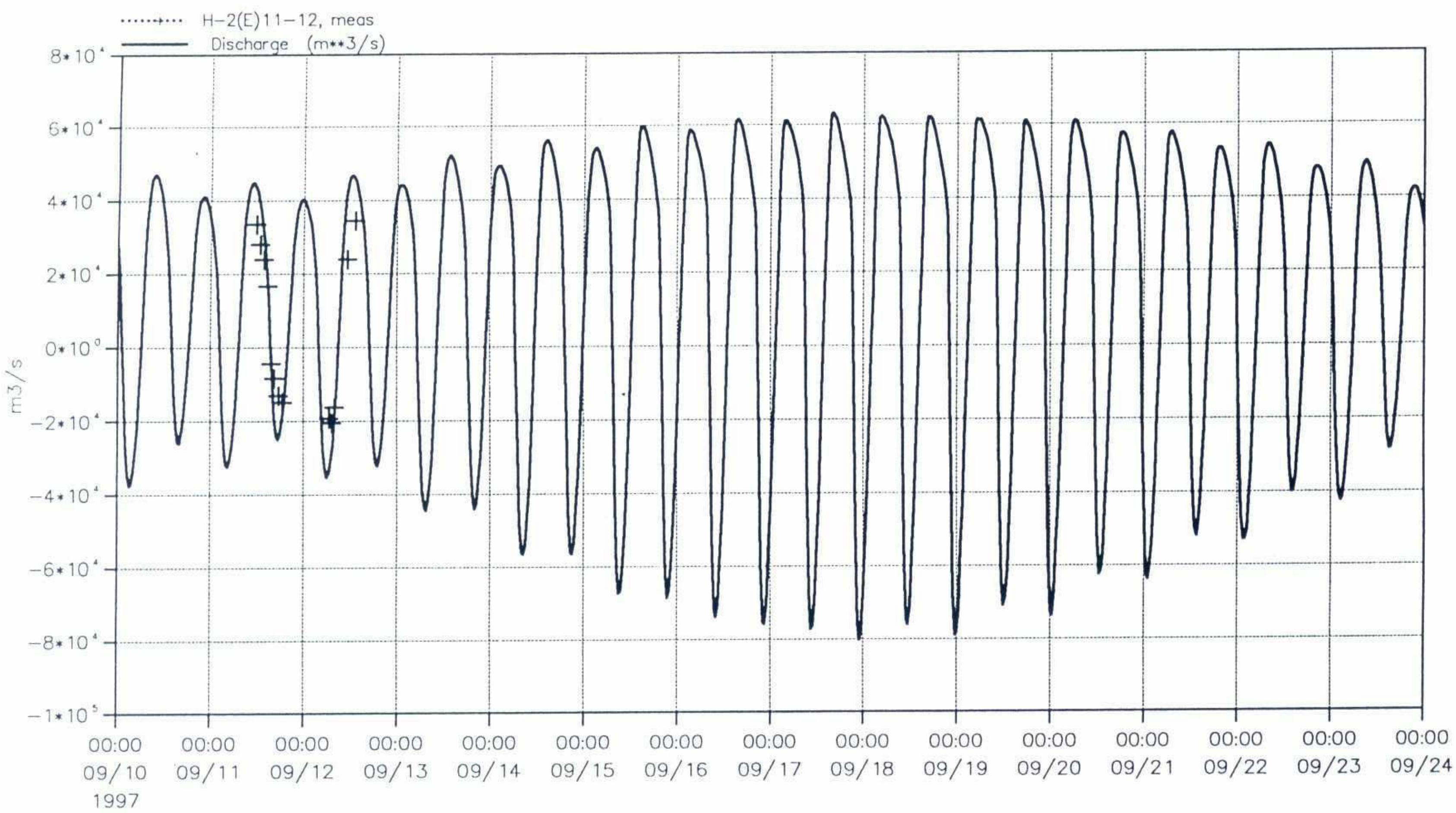
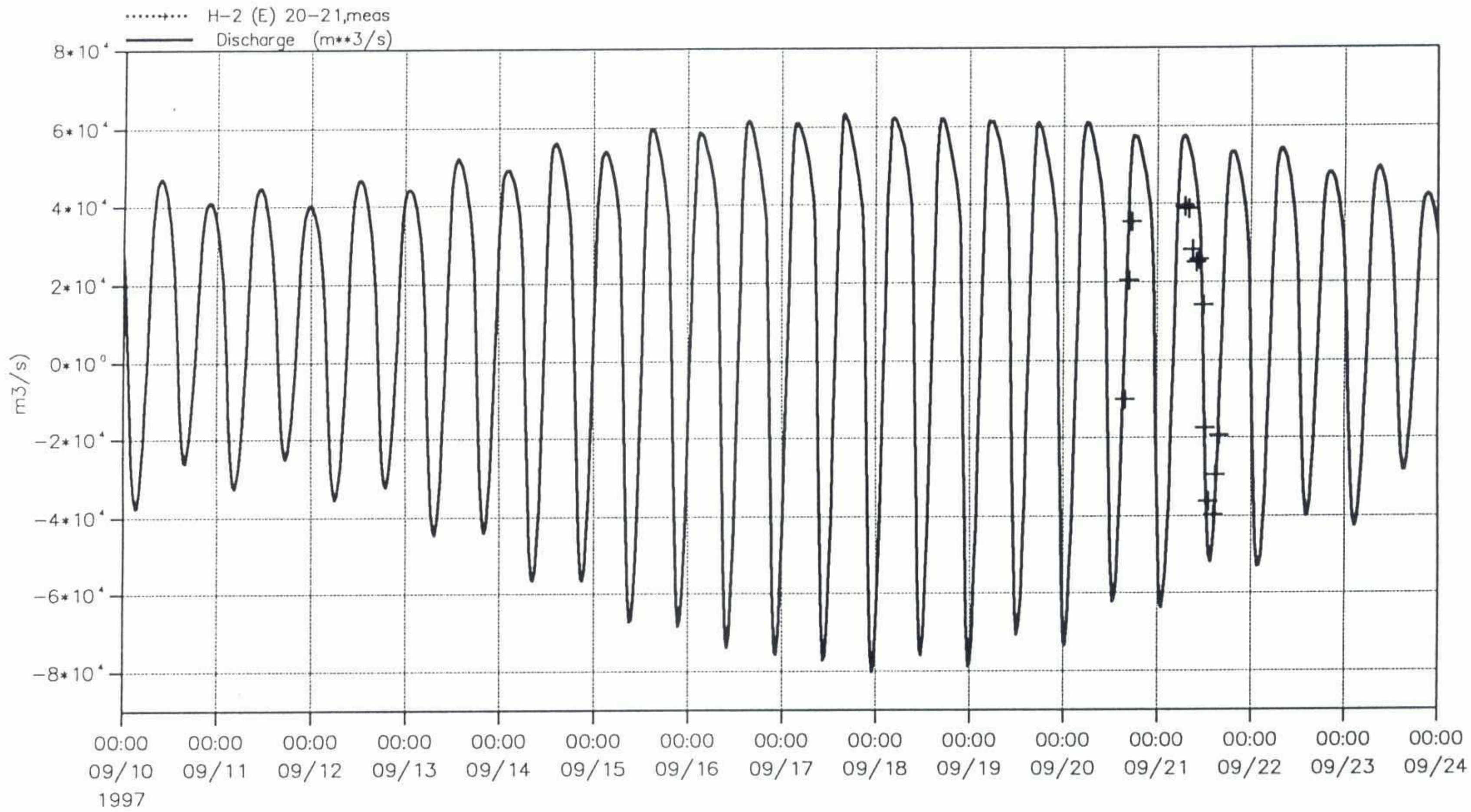
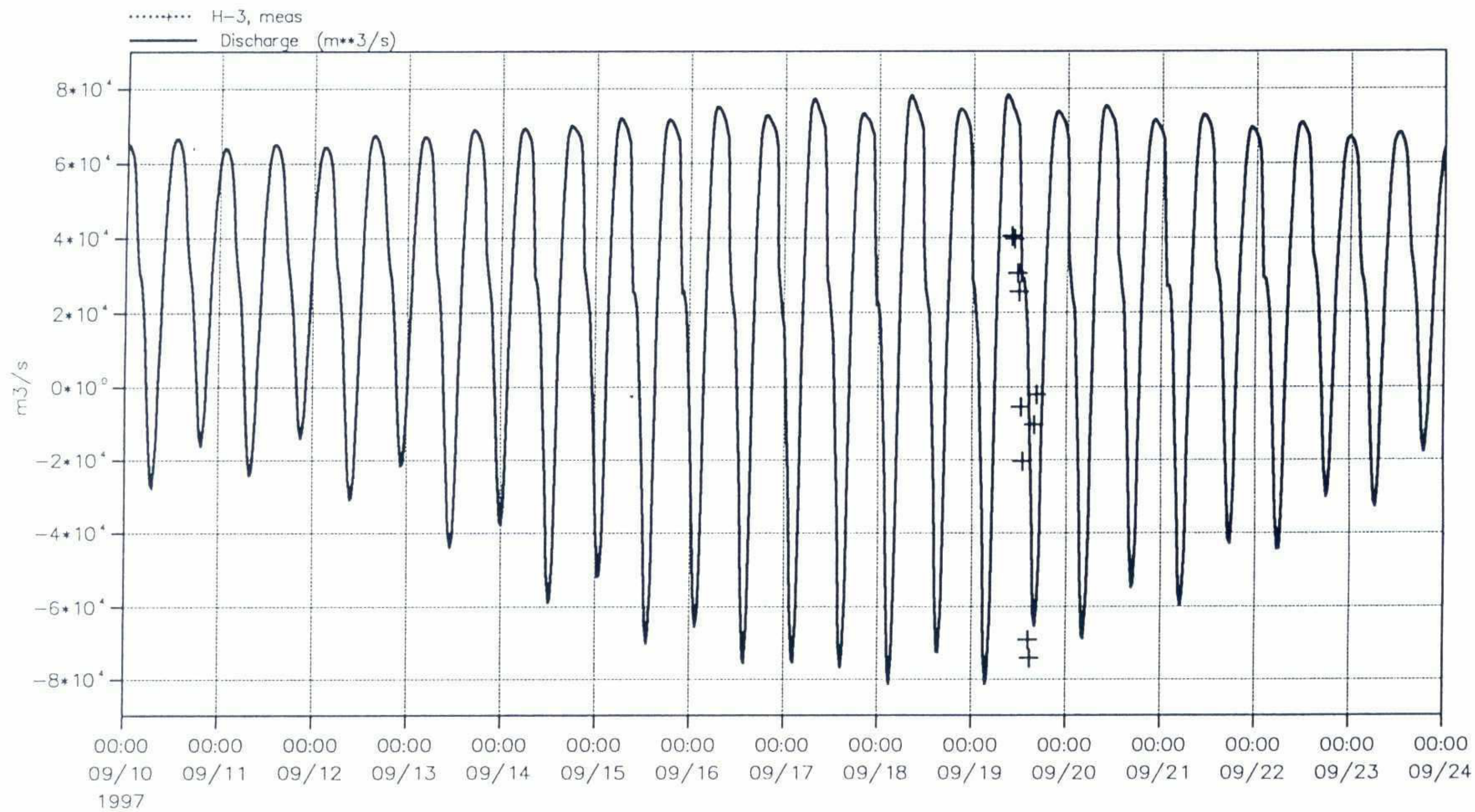


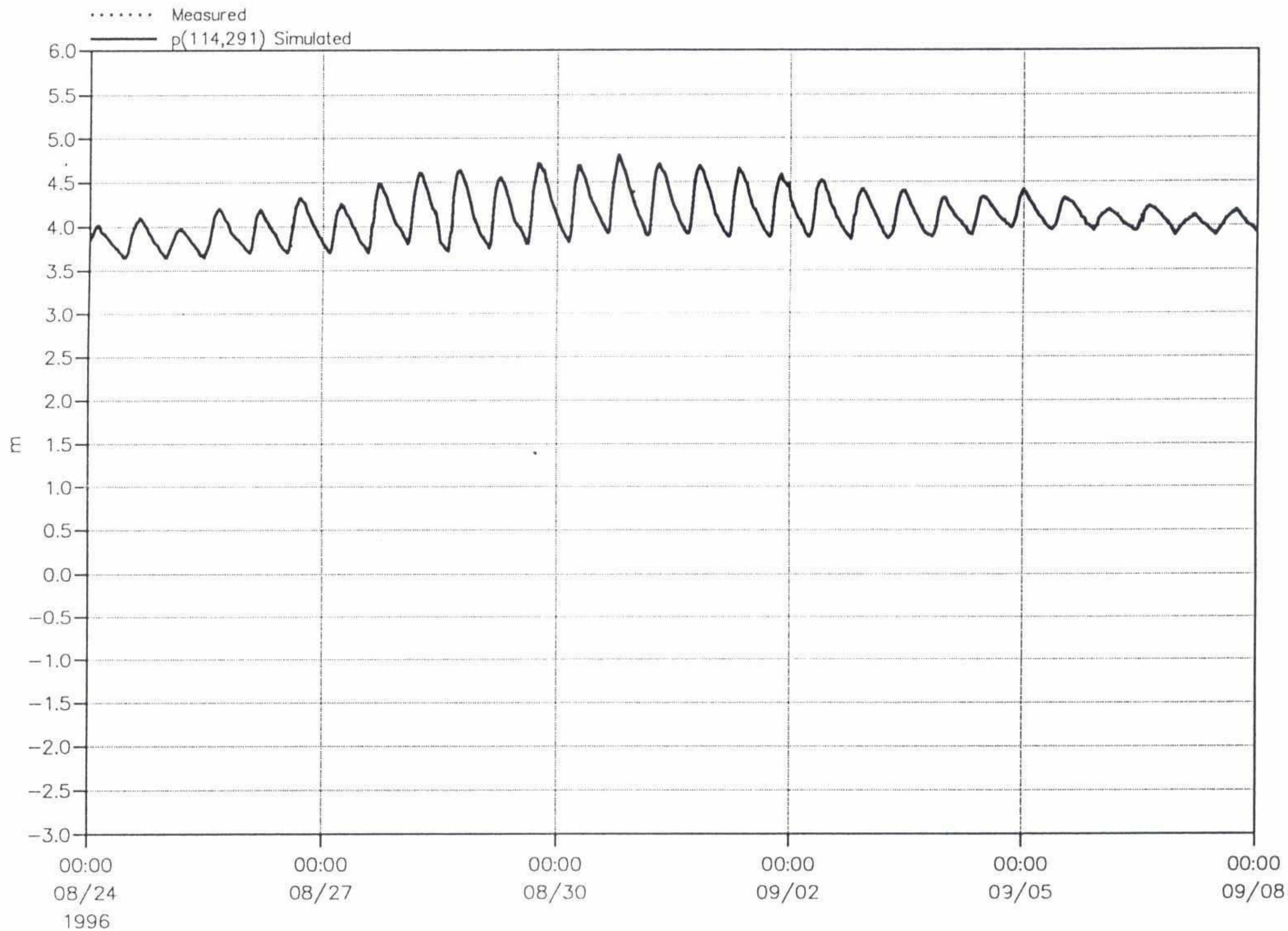
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Apr 27 1998	H-2 (New East) Monpura to Jahajmara 11-12 September 1997	Drawing no. 4.48
Scale:	Init: p5011		



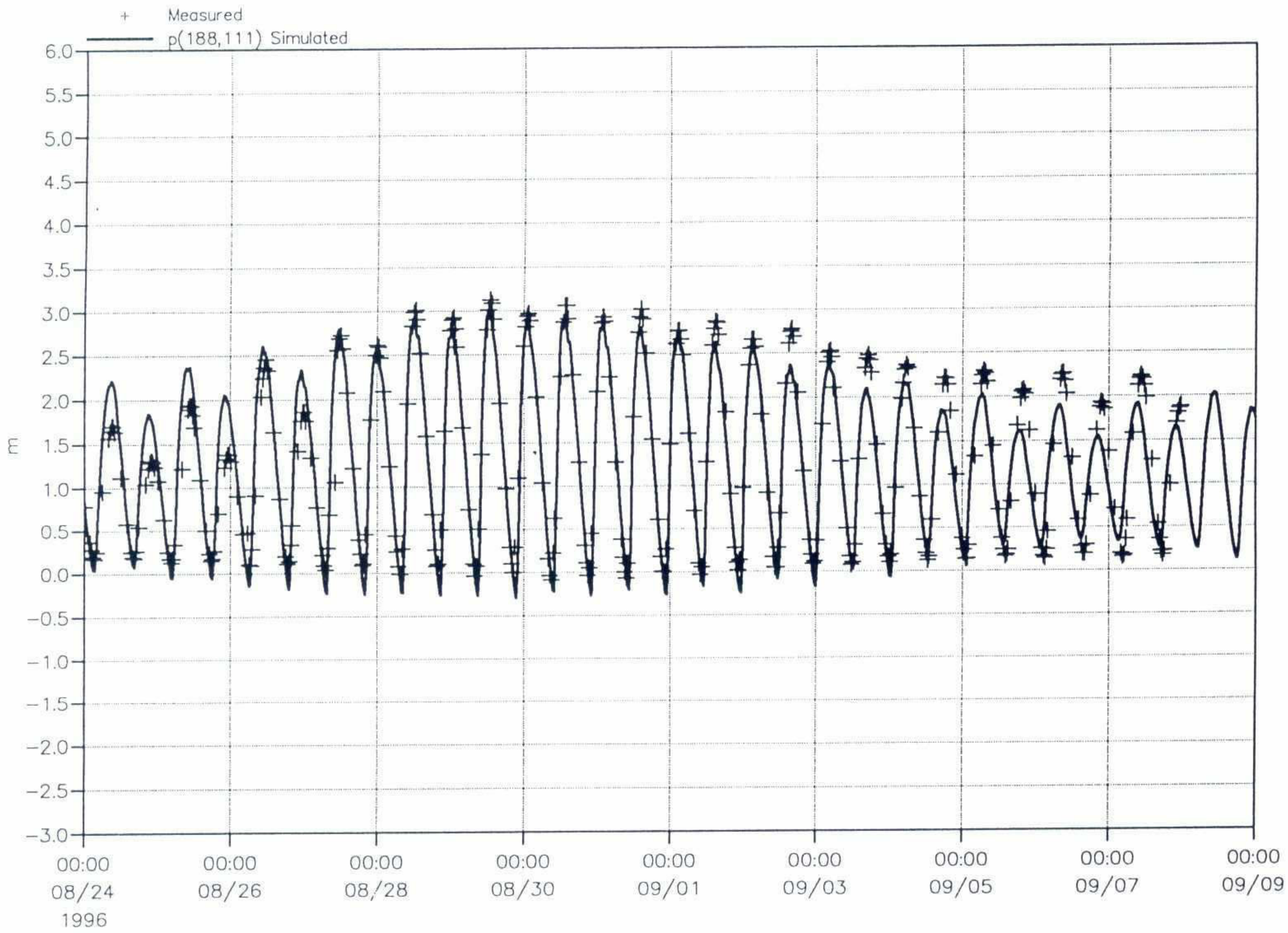
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Scale:	Date: Mon Apr 27 1998 / Init: p5011	H-2 (New East) Monpura to Jahajmara 20-21 September 1997 — Drawing no. 4.49



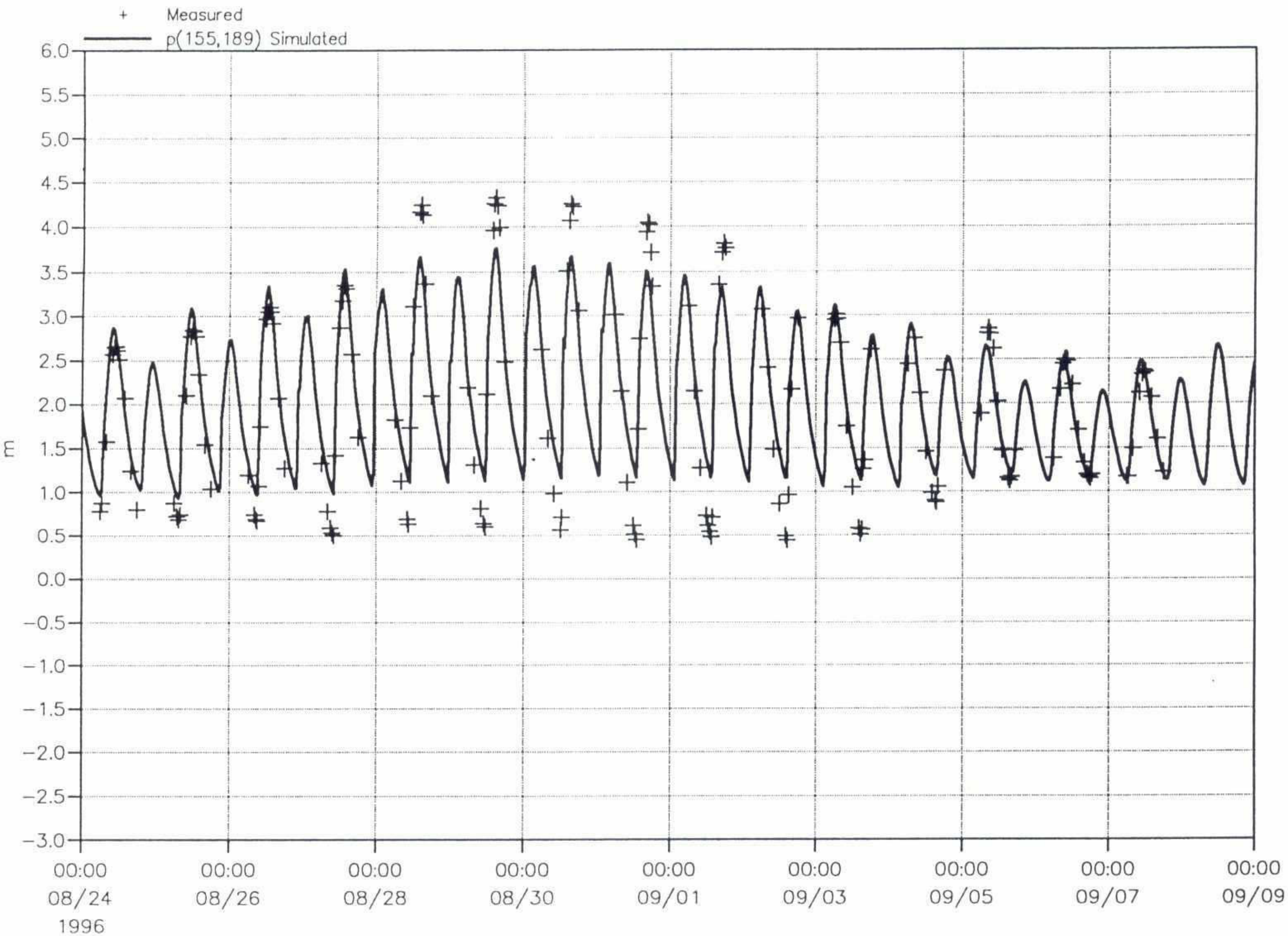
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Apr 27 1998	H-3 Hatia to Noakhali Coast 19 September 1997	Drawing no. 4.50
Scale:	Init: p5011		



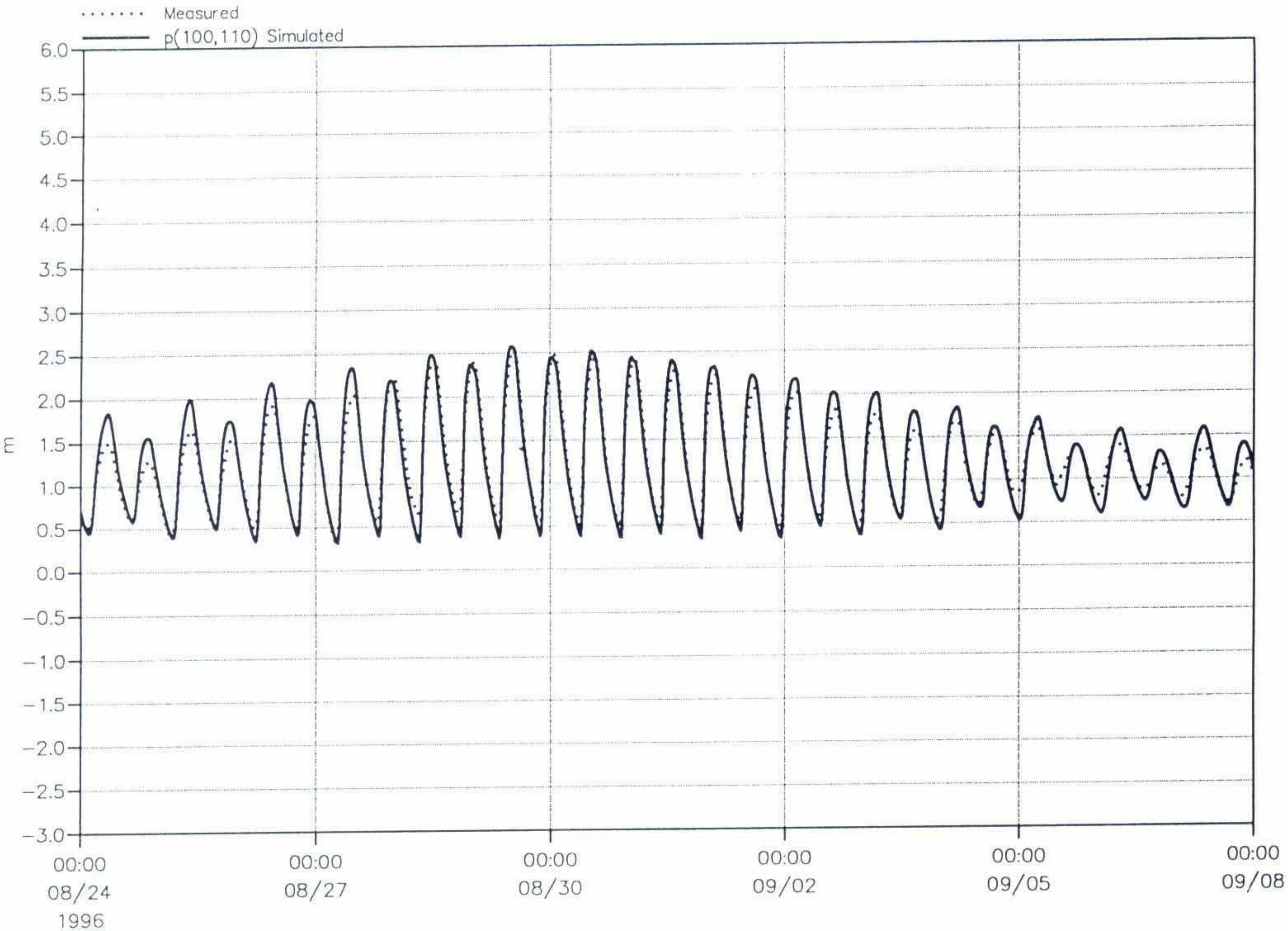
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chandpur (PWD) Monsoon Season 1996	Drawing no. 4.51
Scale:	Init: p5011		



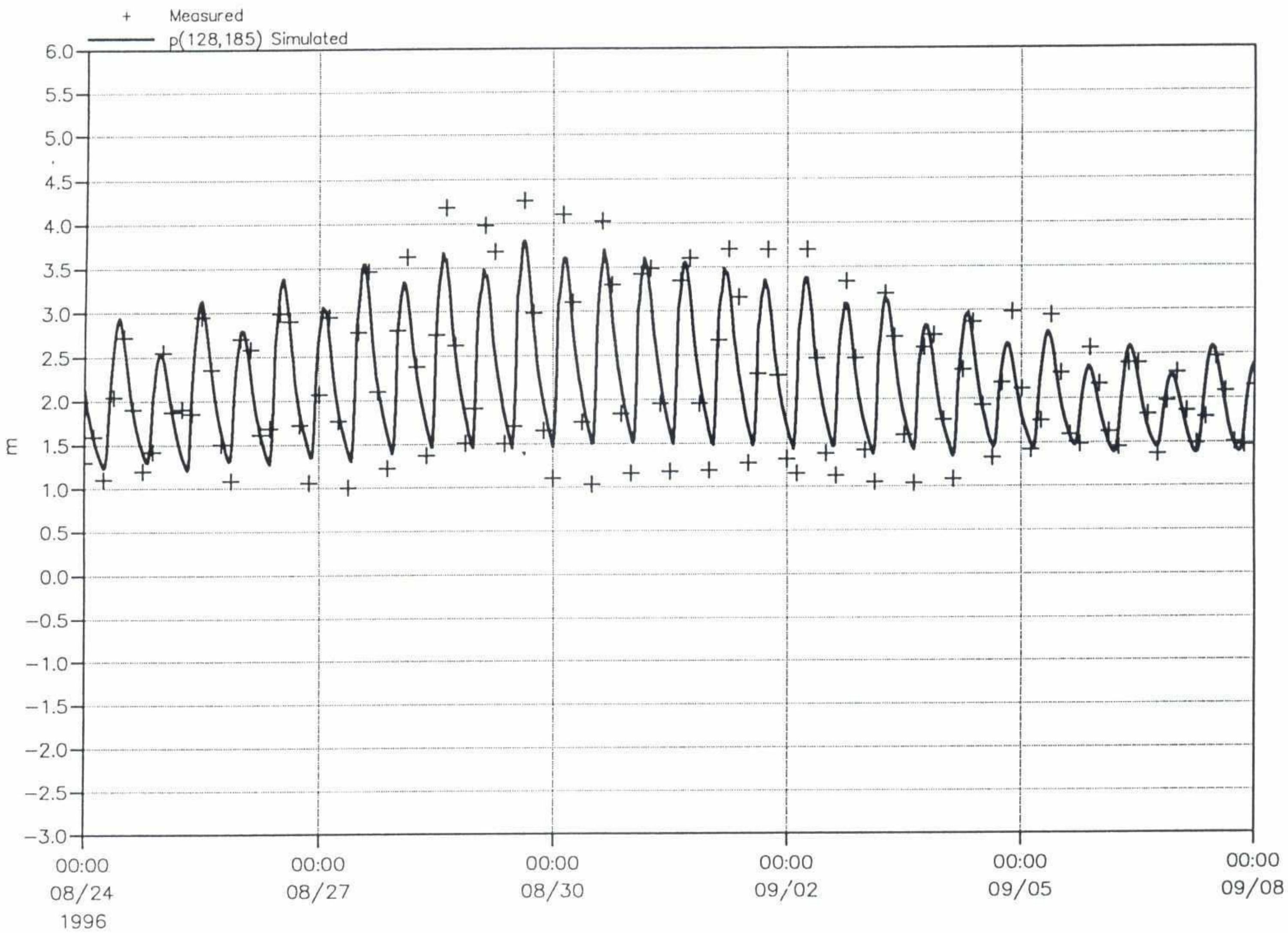
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Char Chenga (PWD) Monsoon Season 1996	Drawing no. 4.52
Scale:	Init: p5011		



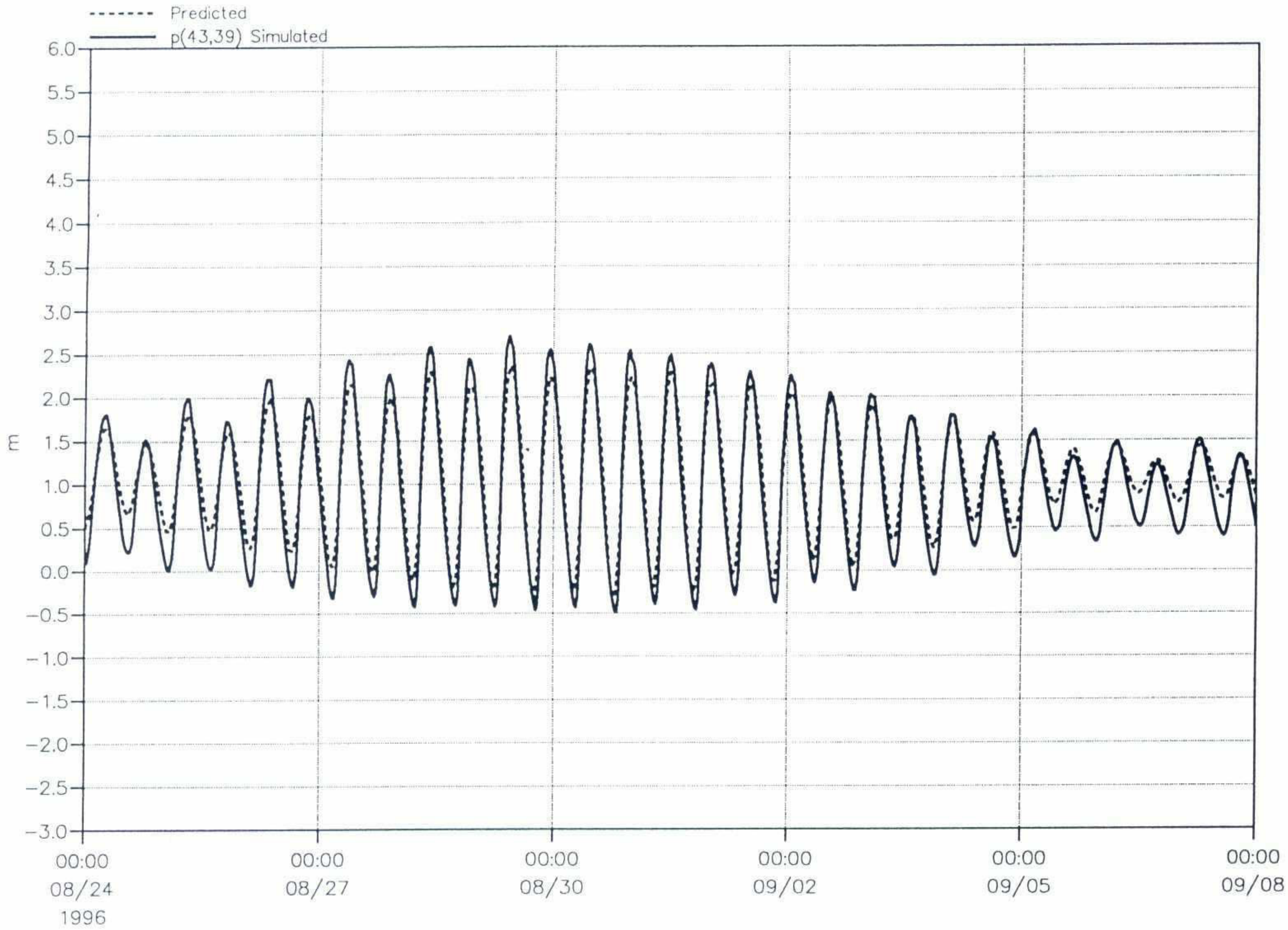
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chitalkhali (PWD) Monsoon Season 1996	Drawing no. 4.53
Scale:	Init: p5011		



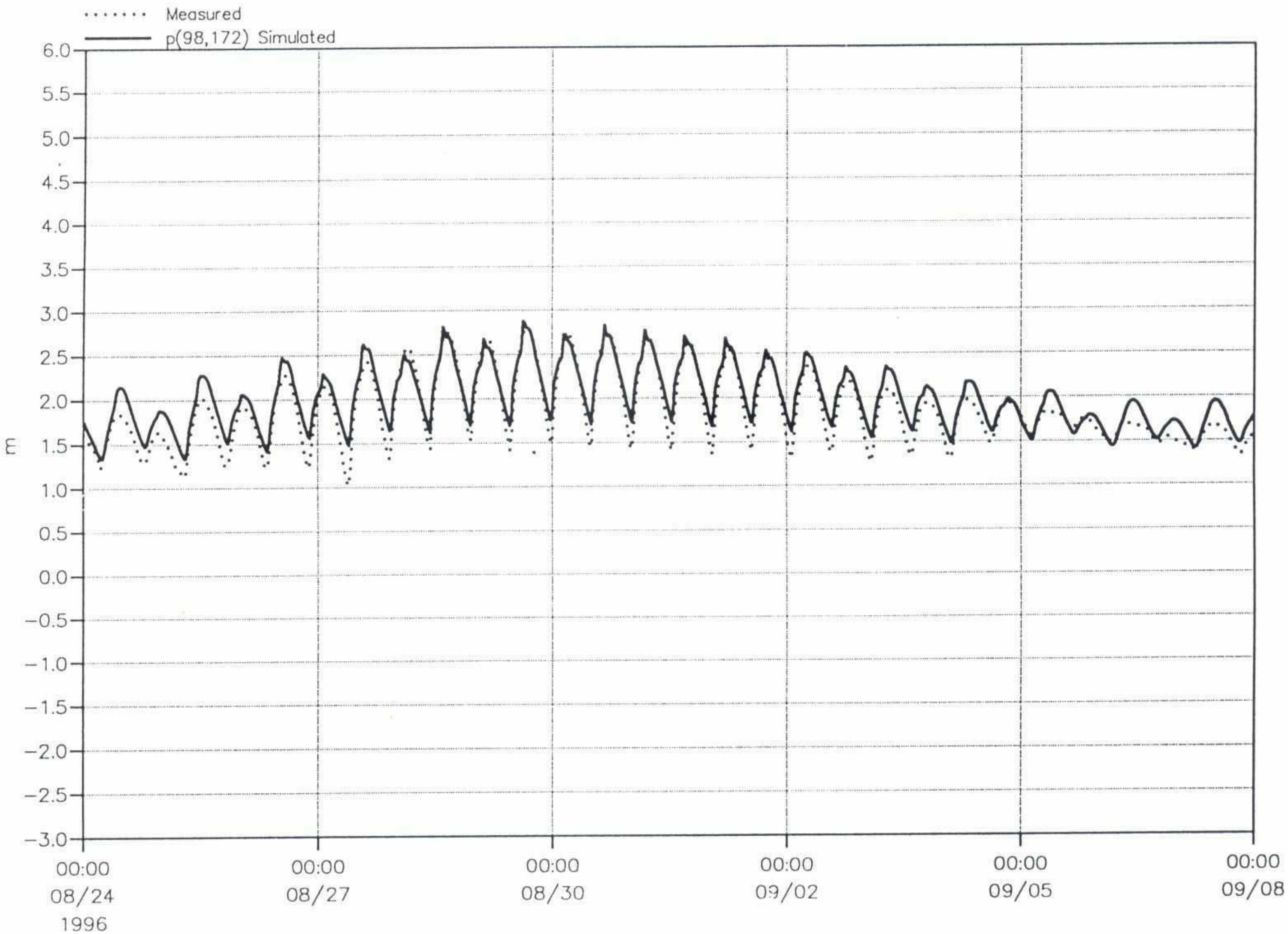
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Date: Sun May 31 1998	Measured and simulated water level at Dasmunia (PWD) Monsoon Season 1996	Drawing no. 4.54
Scale: / Init: p5011		



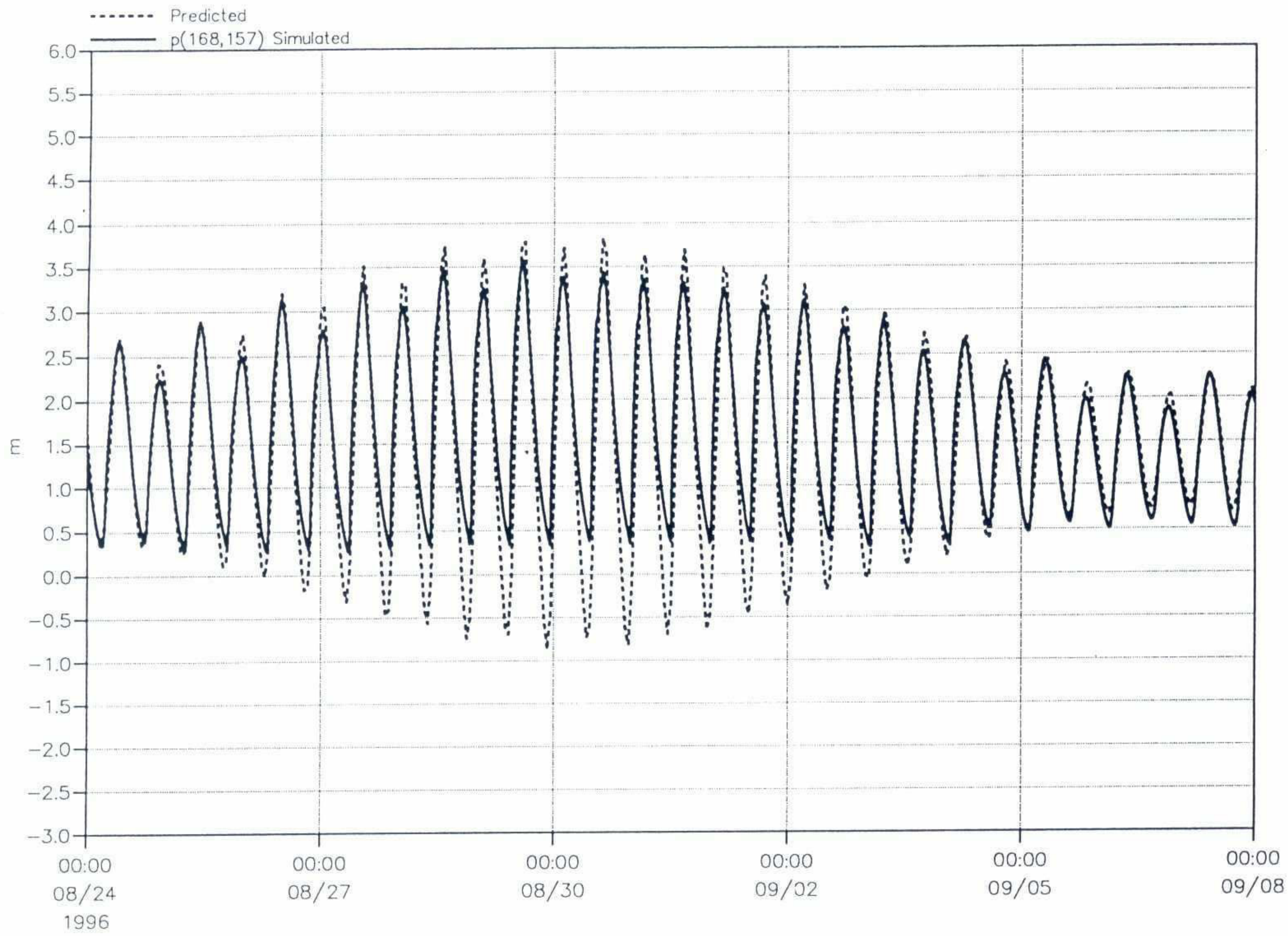
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Date: Sun May 31 1998	Measured and simulated water level at Daulatkhan (PWD), BWDB Monsoon Season 1996	Drawing no. 4.55
Scale: / Init: p5011		



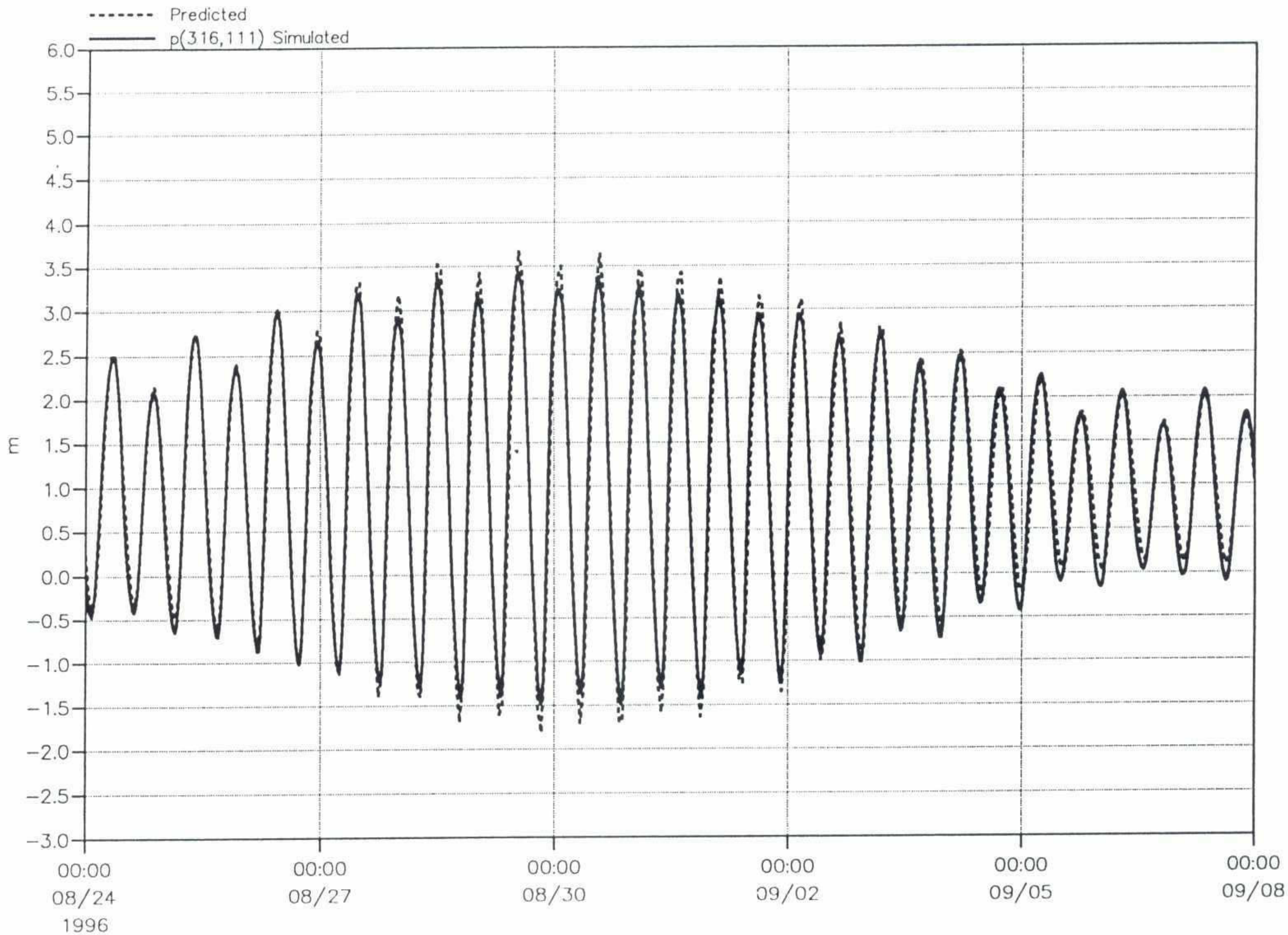
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Date: Sun May 31 1998	Measured and predicted water level at Dhulasar (PWD) Monsoon Season 1996	Drawing no. 4.56
Scale: / Init: p5011		



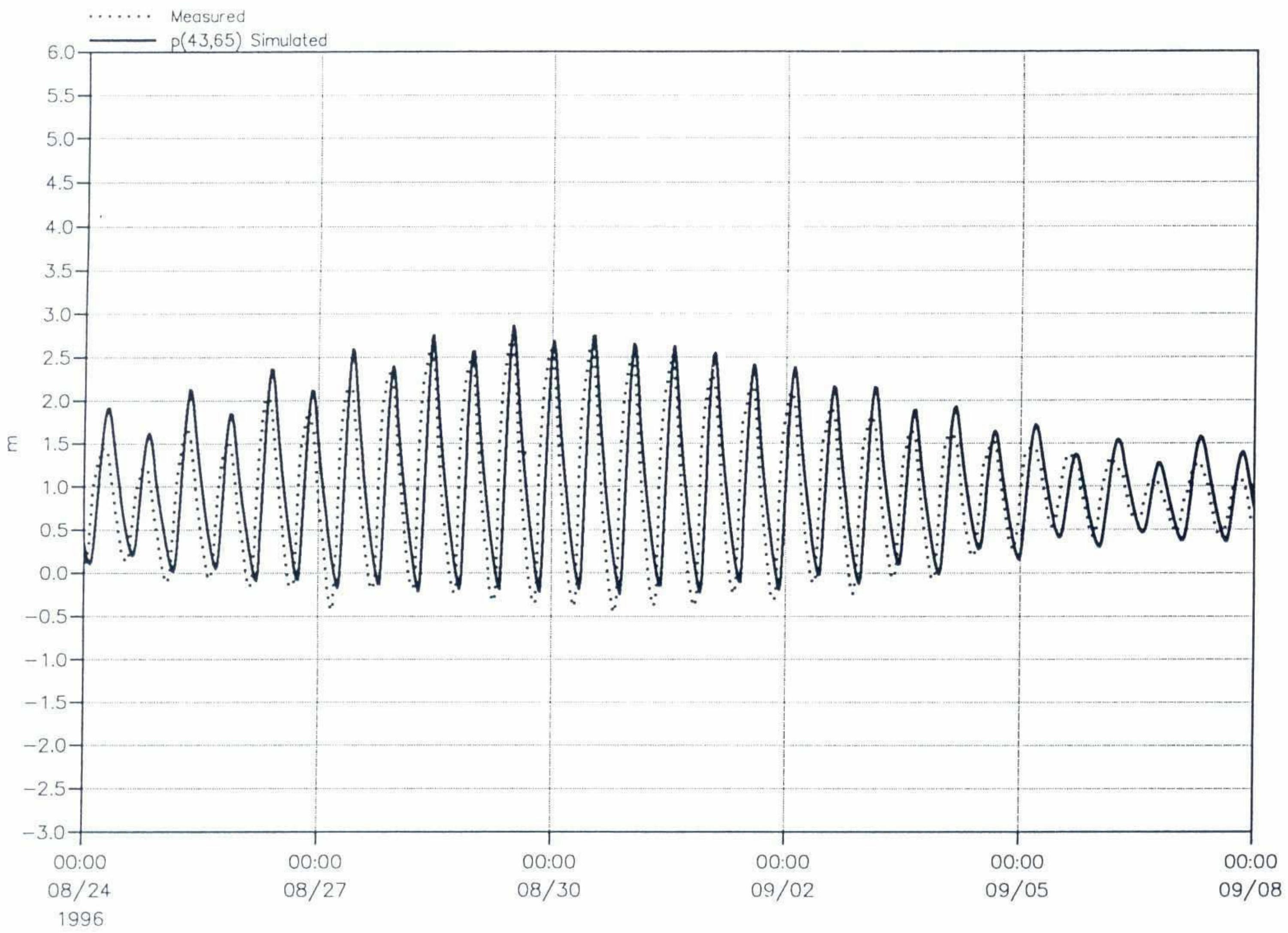
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Dhulia (PWD) Monsoon Season 1996	Drawing no. 4.57
Scale:	Init: p5011		



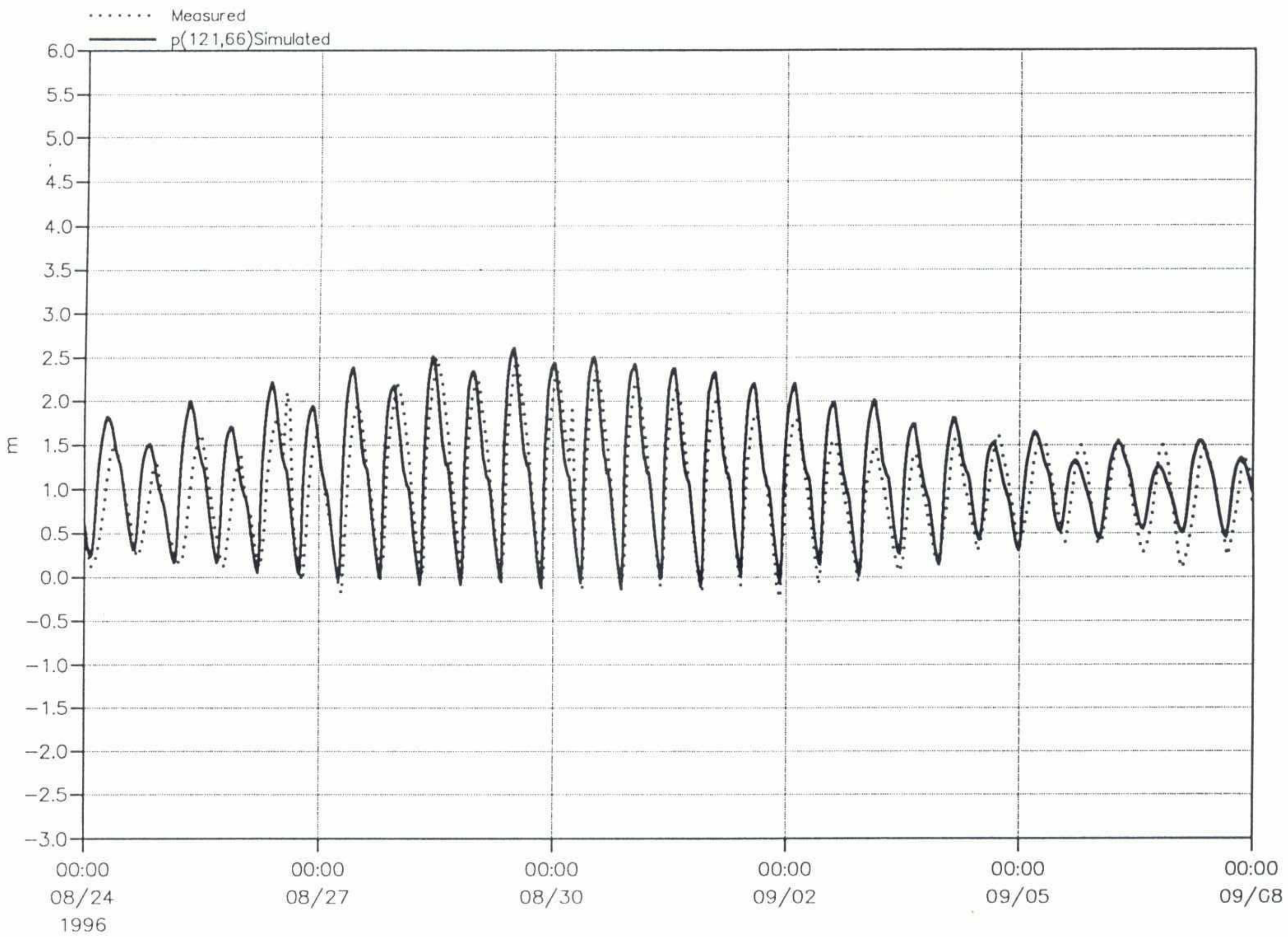
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and predicted water level at Hatia Bar (PWD) Monsoon Season 1996	Drawing no. 4.58	
Scale:	Init: p5011			



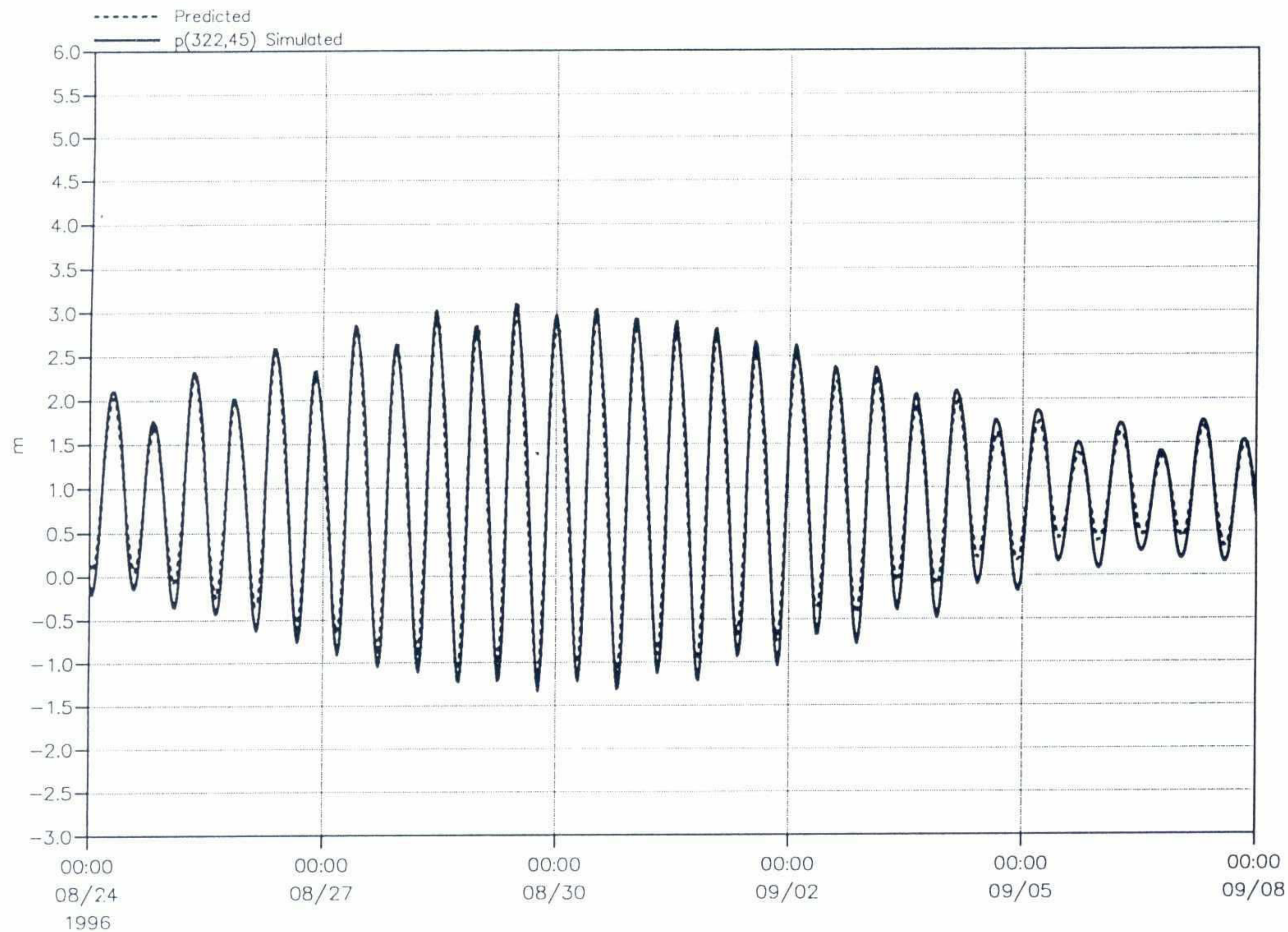
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Khal No. 18 (PWD) Monsoon Season 1996	Drawing no. 4.59
Scale:	Init: p5011		



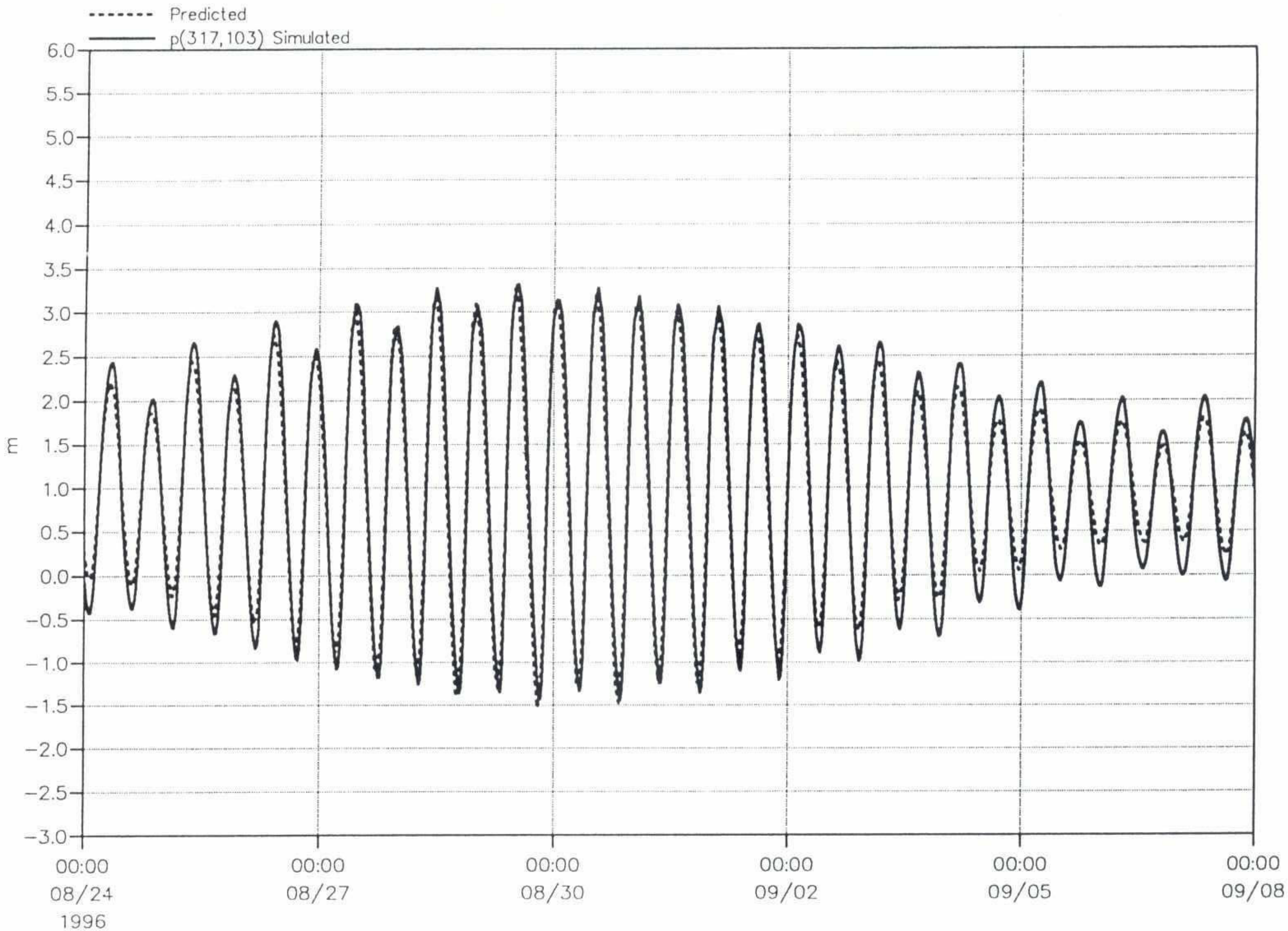
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Khepupara (PWD) Monsoon Season 1996	Drawing no. 4.60
Scale:	Init: p5011		



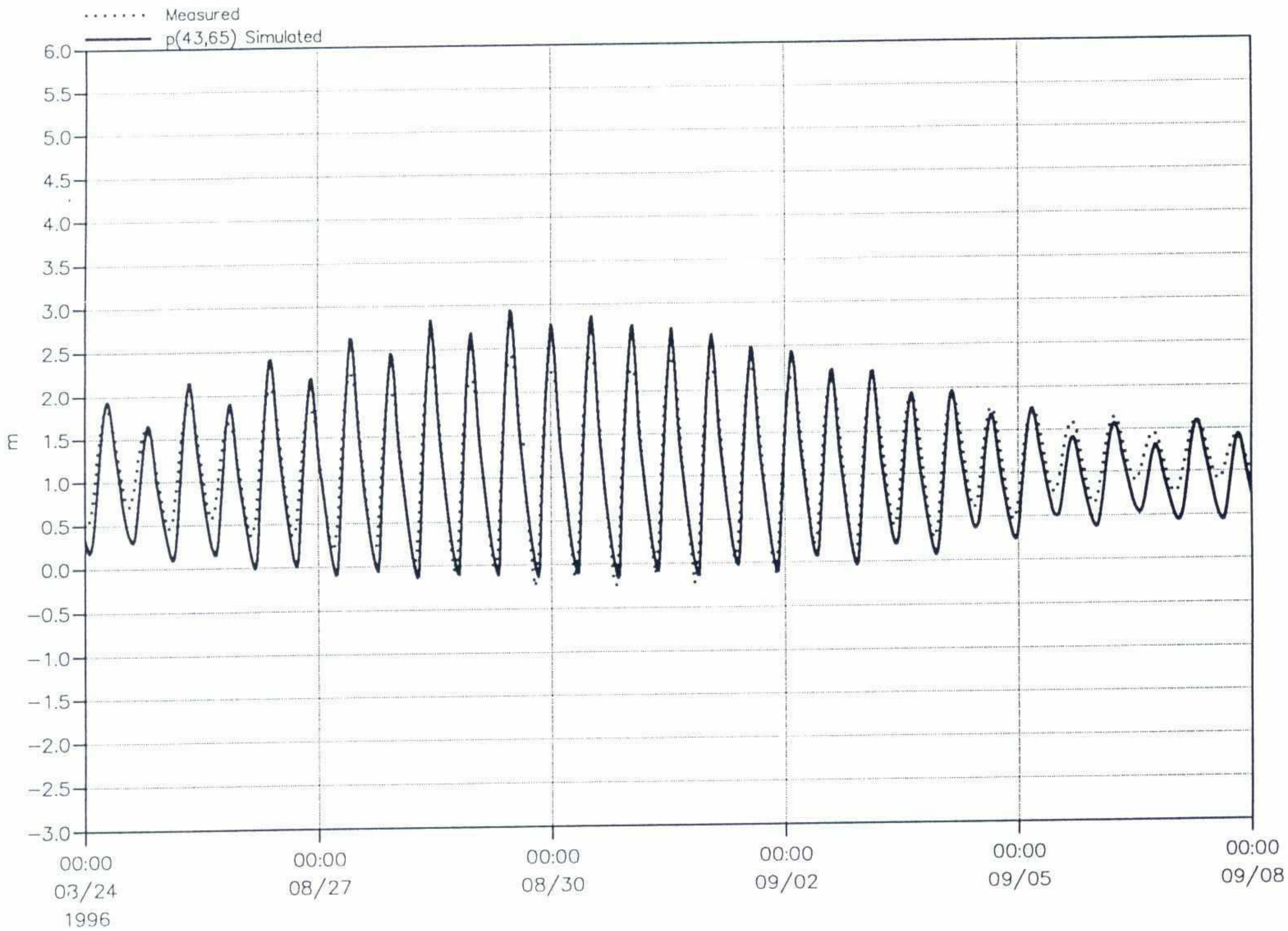
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Sun May 31 1998	Measured and simulated water level at Kochopia (PWD) Monsoon Season 1996	Drawing no. 4.61
Scale:	Init: p5011		



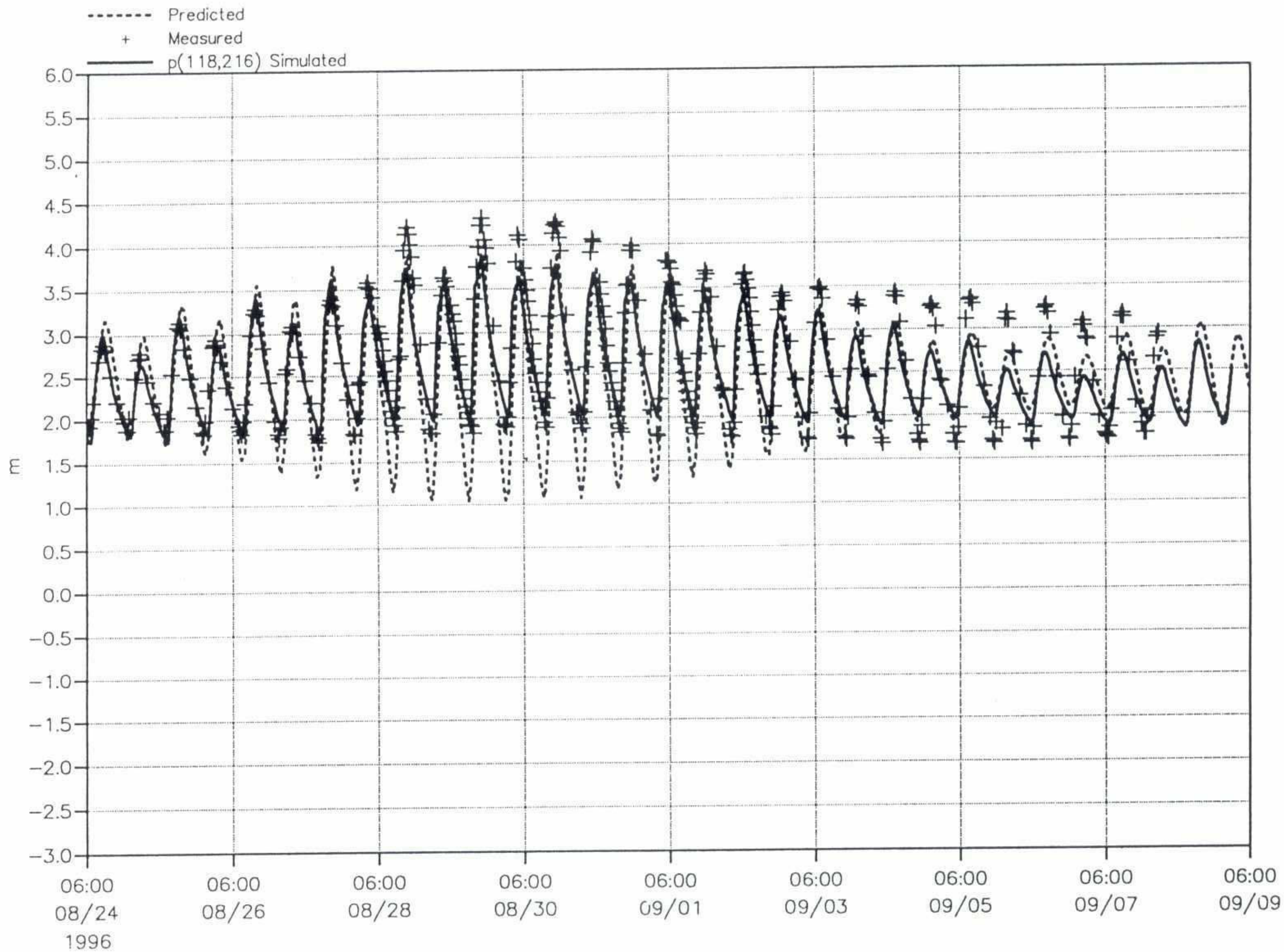
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Sun May 31 1998	Measured and predicted water level at Kutubdia Island (PWD) Monsoon Season 1996	Drawing no. 4.62	
Scale:	Init: p5011			



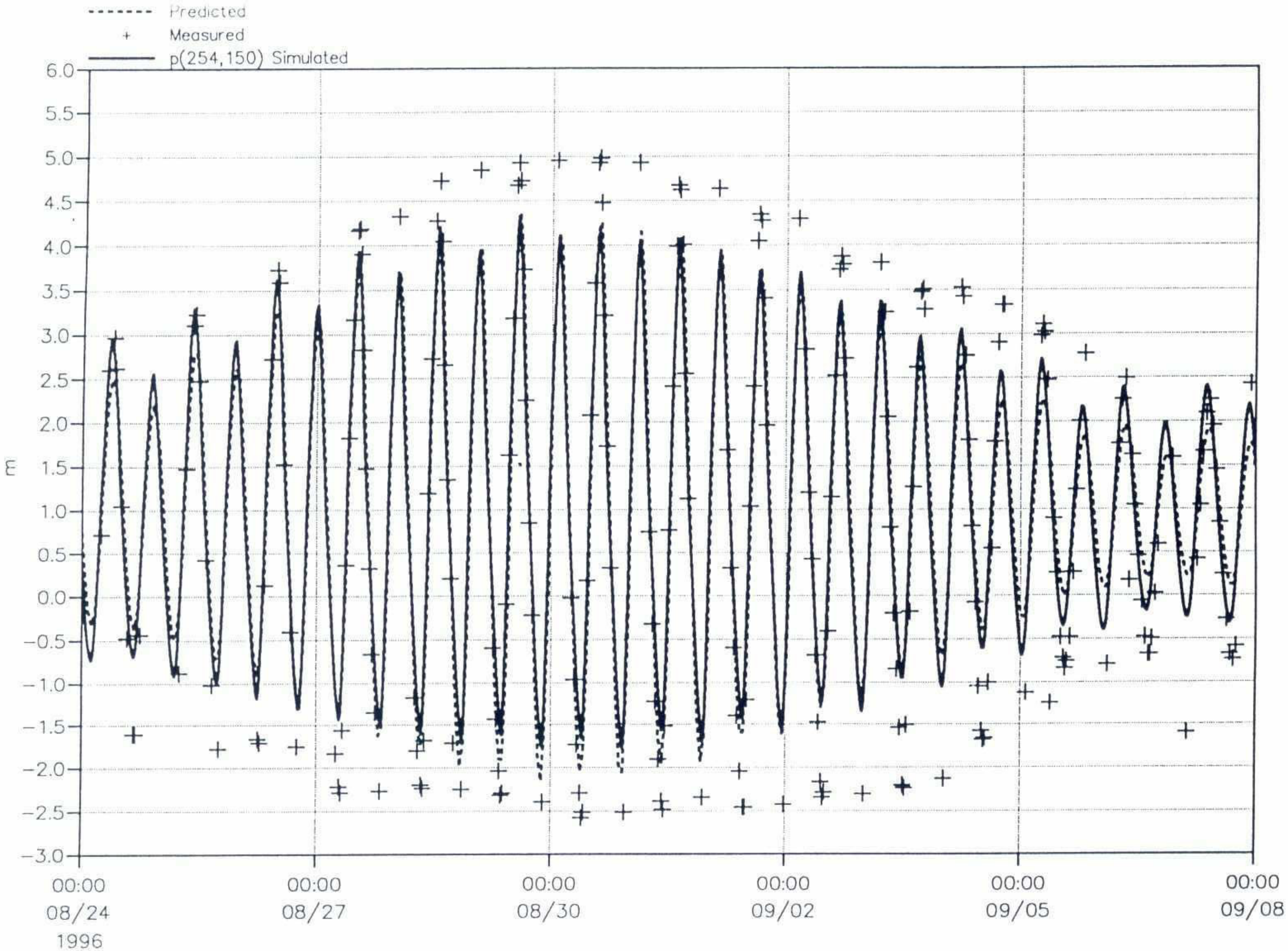
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and predicted water level at Normans Point (PWD) Monsoon Season 1996	Drawing no. 4.63
Scale:	Init: p5011		



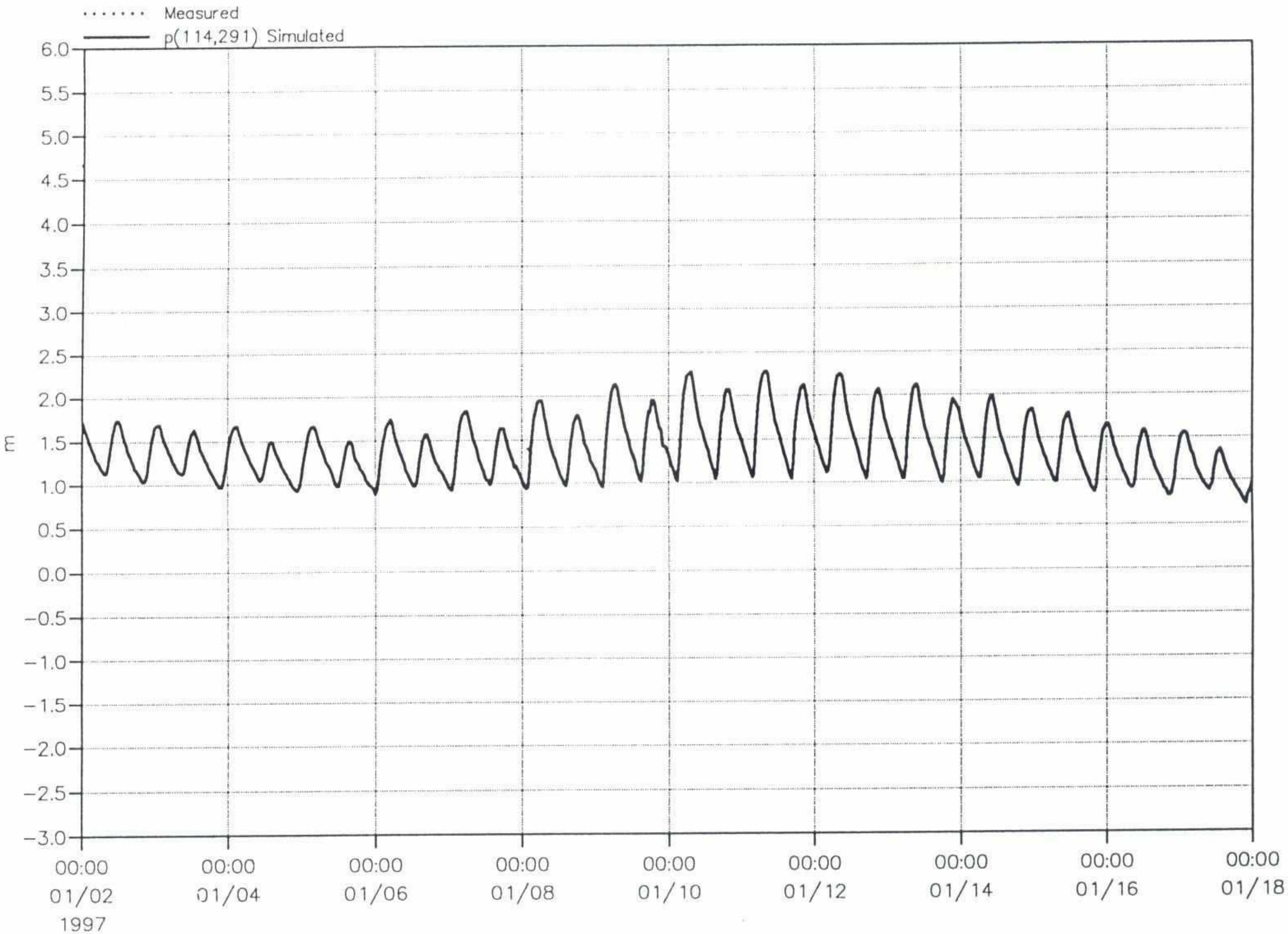
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured and simulated water level at Rabnabad Channel (PWD) Monsoon Season 1996	Drawing no. 4.64
Scale:	Init: p5011		



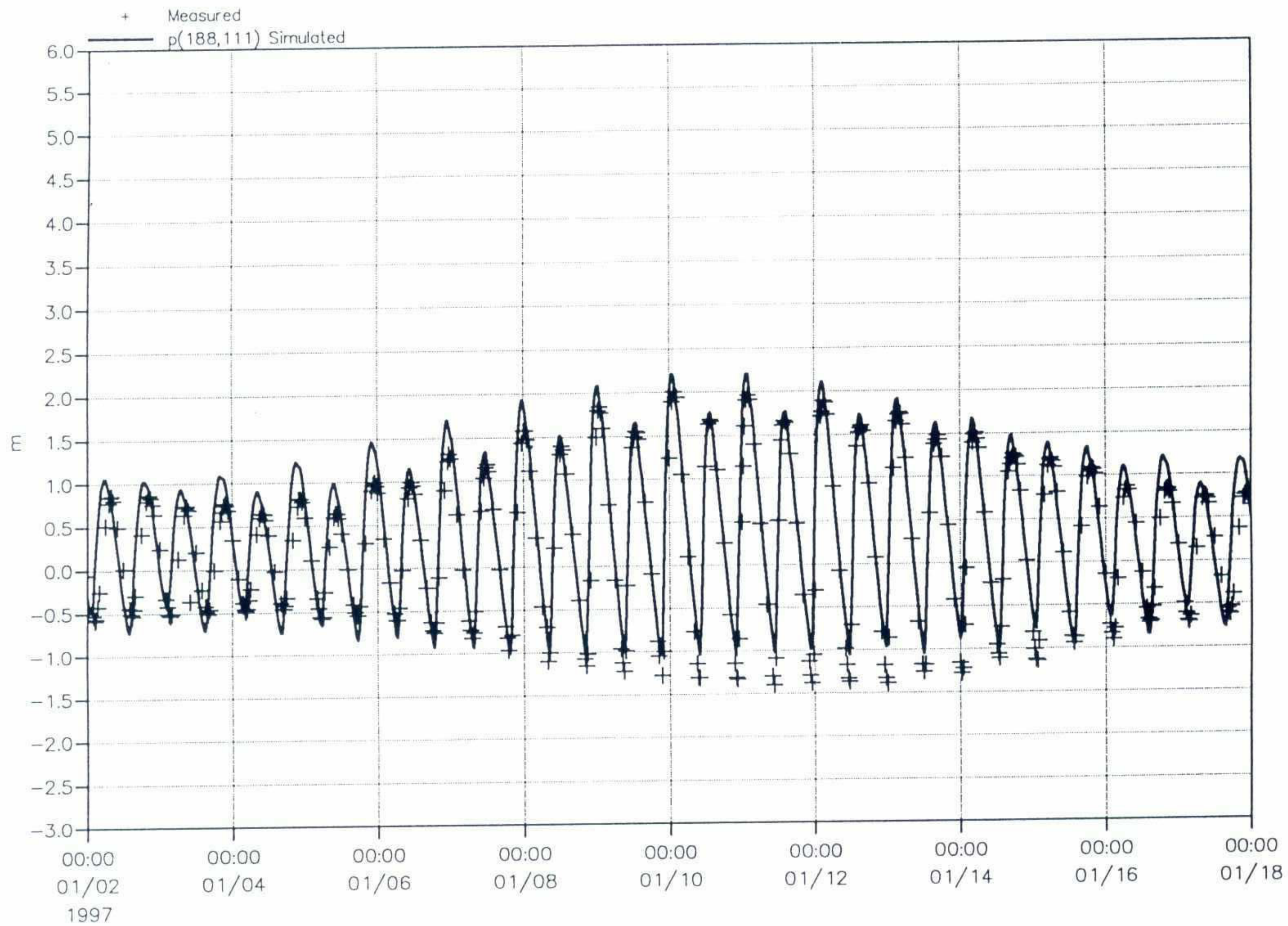
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured, simulated and predicted water level at Ramdaspur Monsoon Season 1996	Drawing no. 4.65
Scale:	Init: p5011		



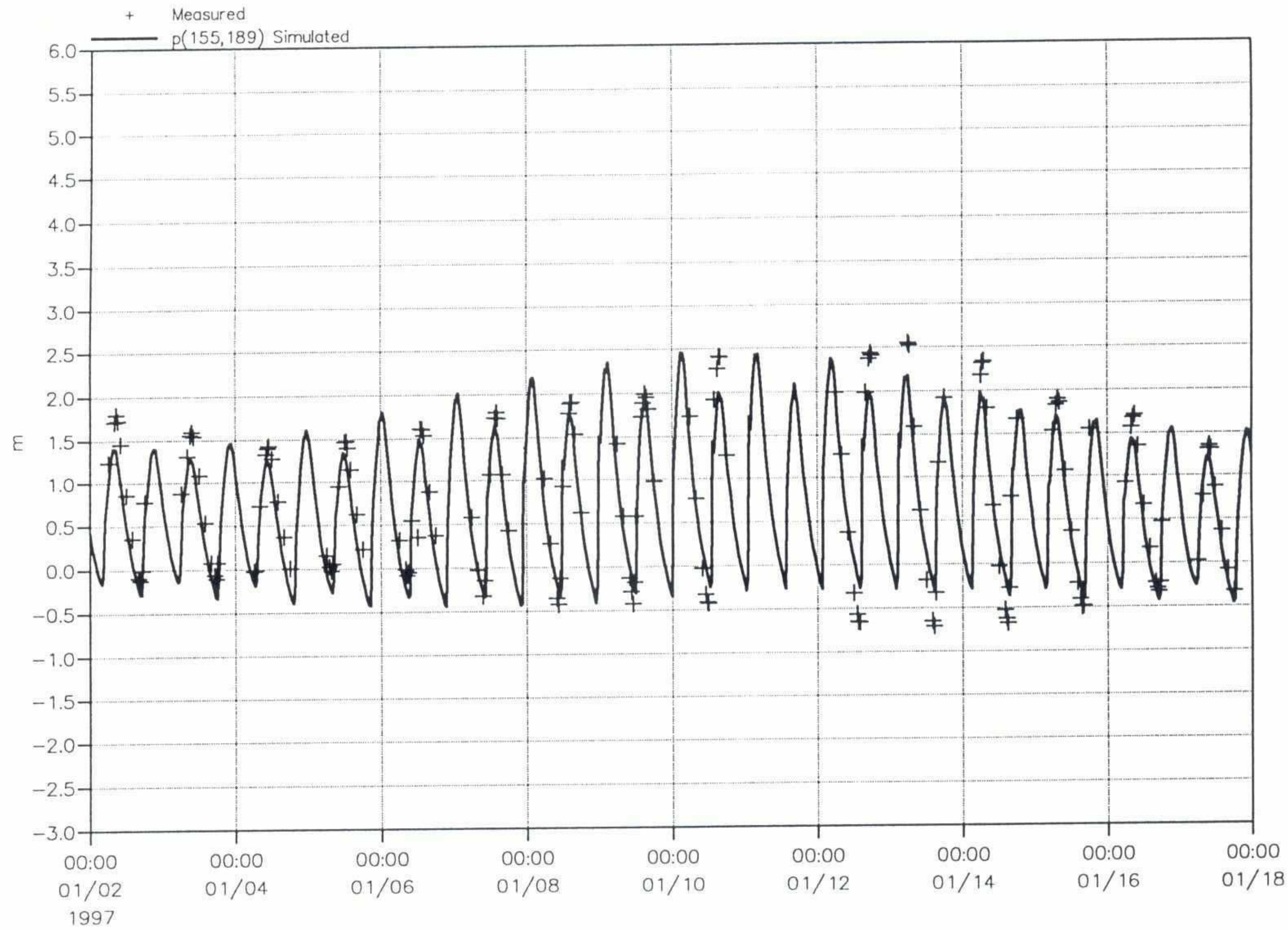
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Sun May 31 1998	Measured, simulated and predicted water level at Sandwip (PWD) Monsoon Season 1996	Drawing no. 4.66
Scale:	Init: p5011		



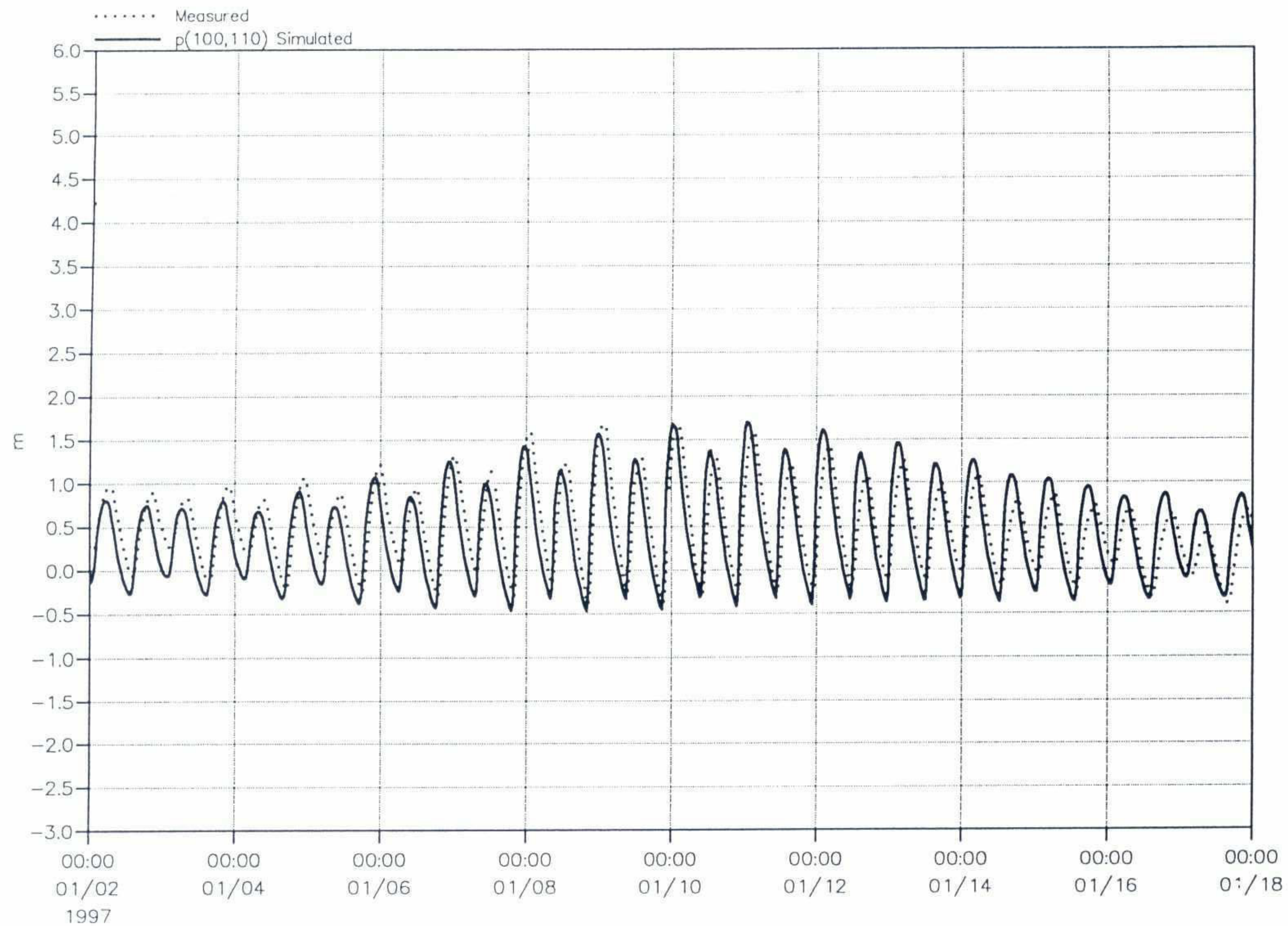
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chandpur (PWD) Dry Season 1997	Drawing no. 4.67
Scale:	Init: p5011		



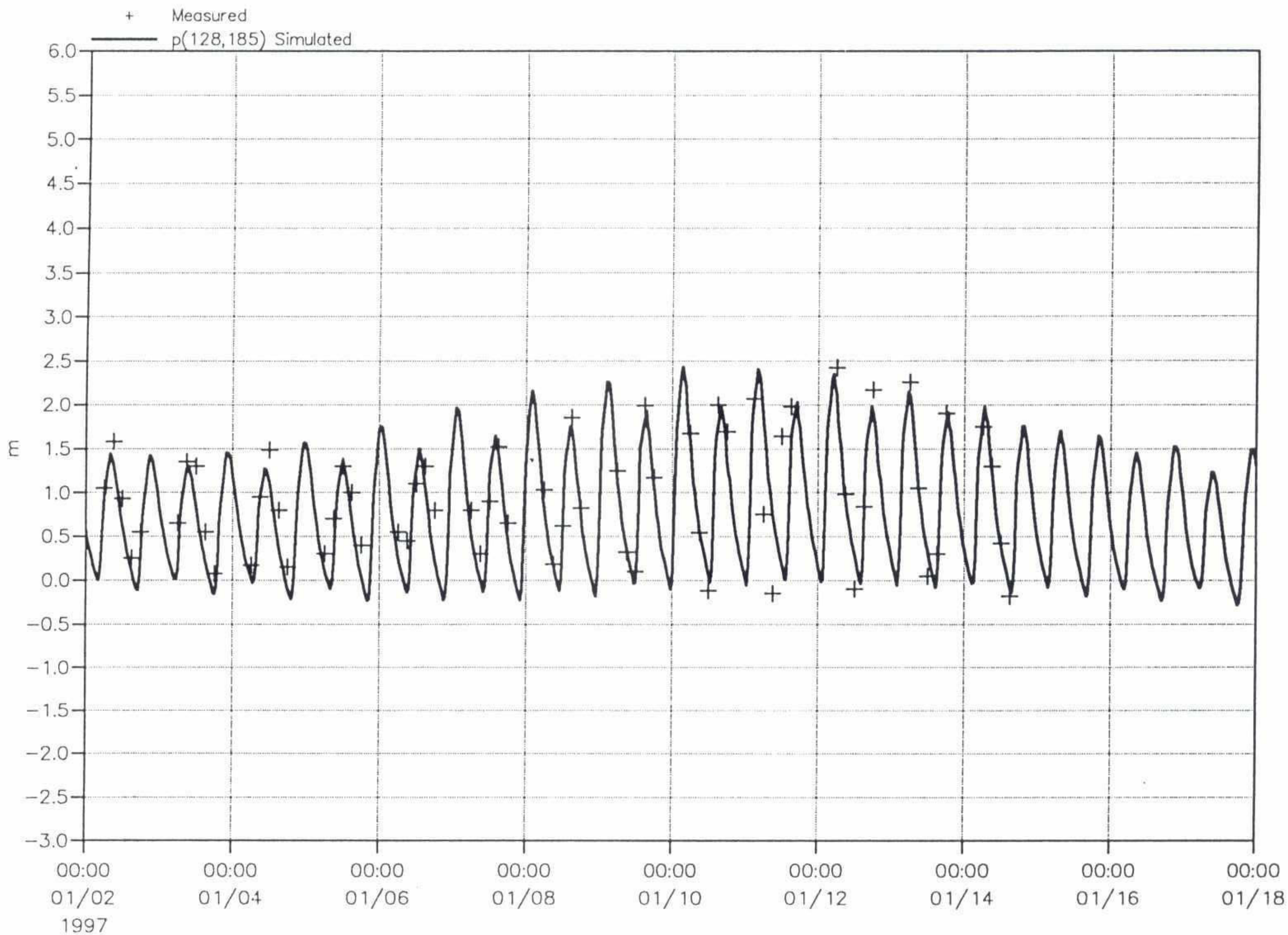
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD		MIKE 21
		Project: MEGHNA ESTUARY STUDY		
File:	Date: Wed May 13 1998	Measured and simulated water level at Char Chenga (PWD) Dry period Validation, 1997	Drawing no. 4.68	
Scale:	Init: p5011			



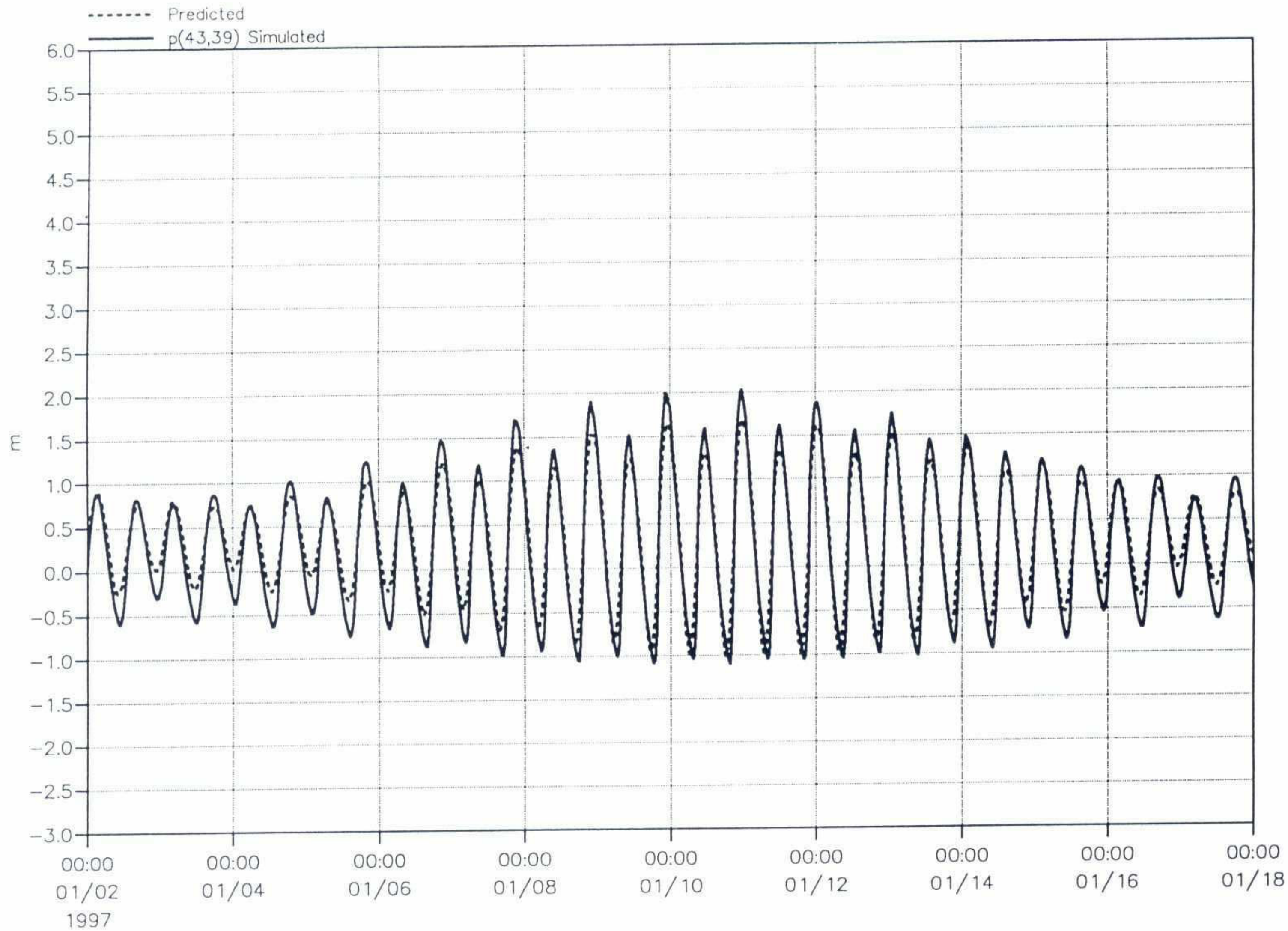
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and simulated water level at Chitalkhali (PWD) Dry Season 1997	Drawing no. 4.69
Scale:	Init: p5011		



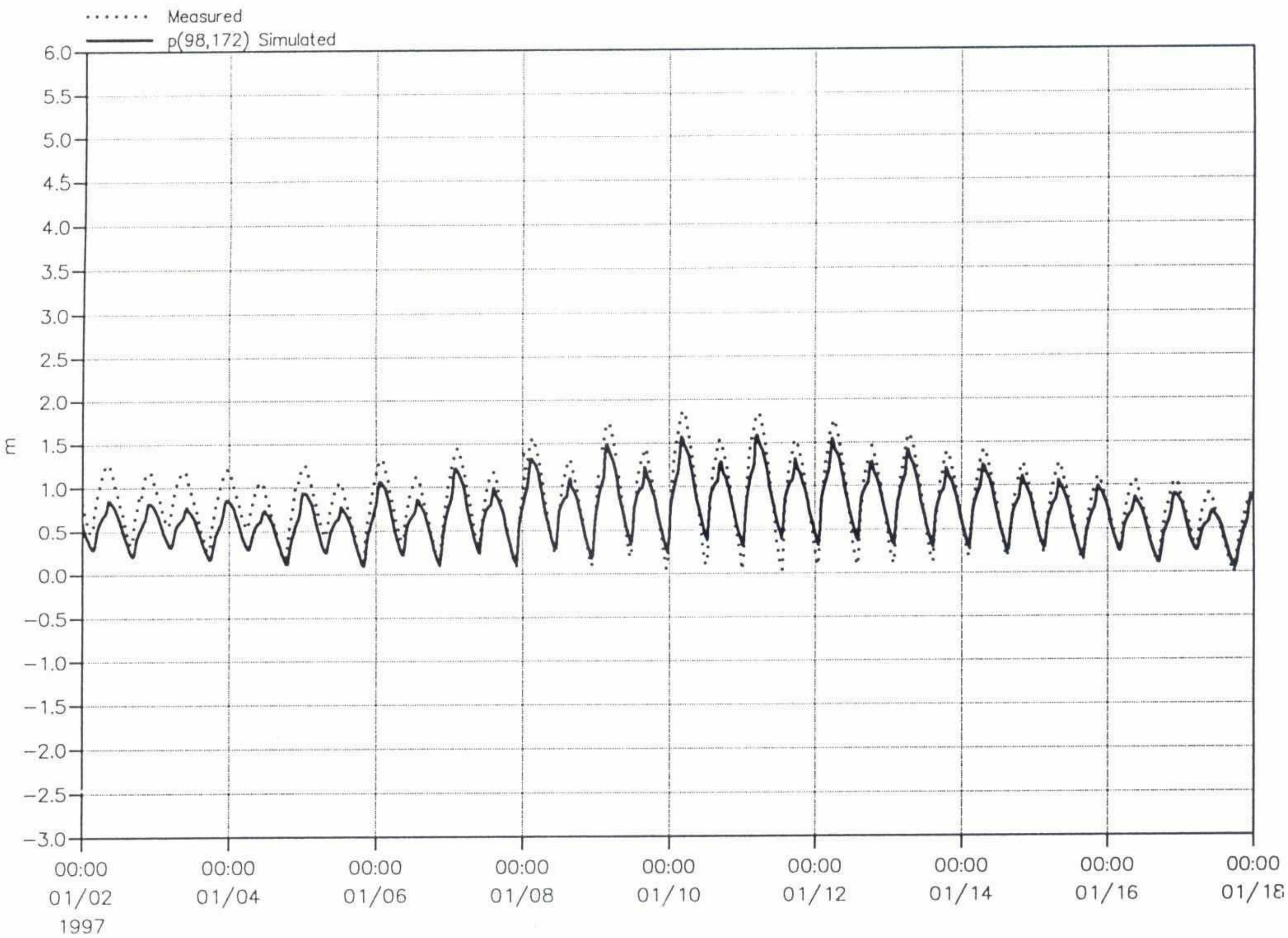
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and simulated water level at Dasmunia (PWD) Dry Season 1997	Drawing no. 4.70
Scale:	Init: p5011		



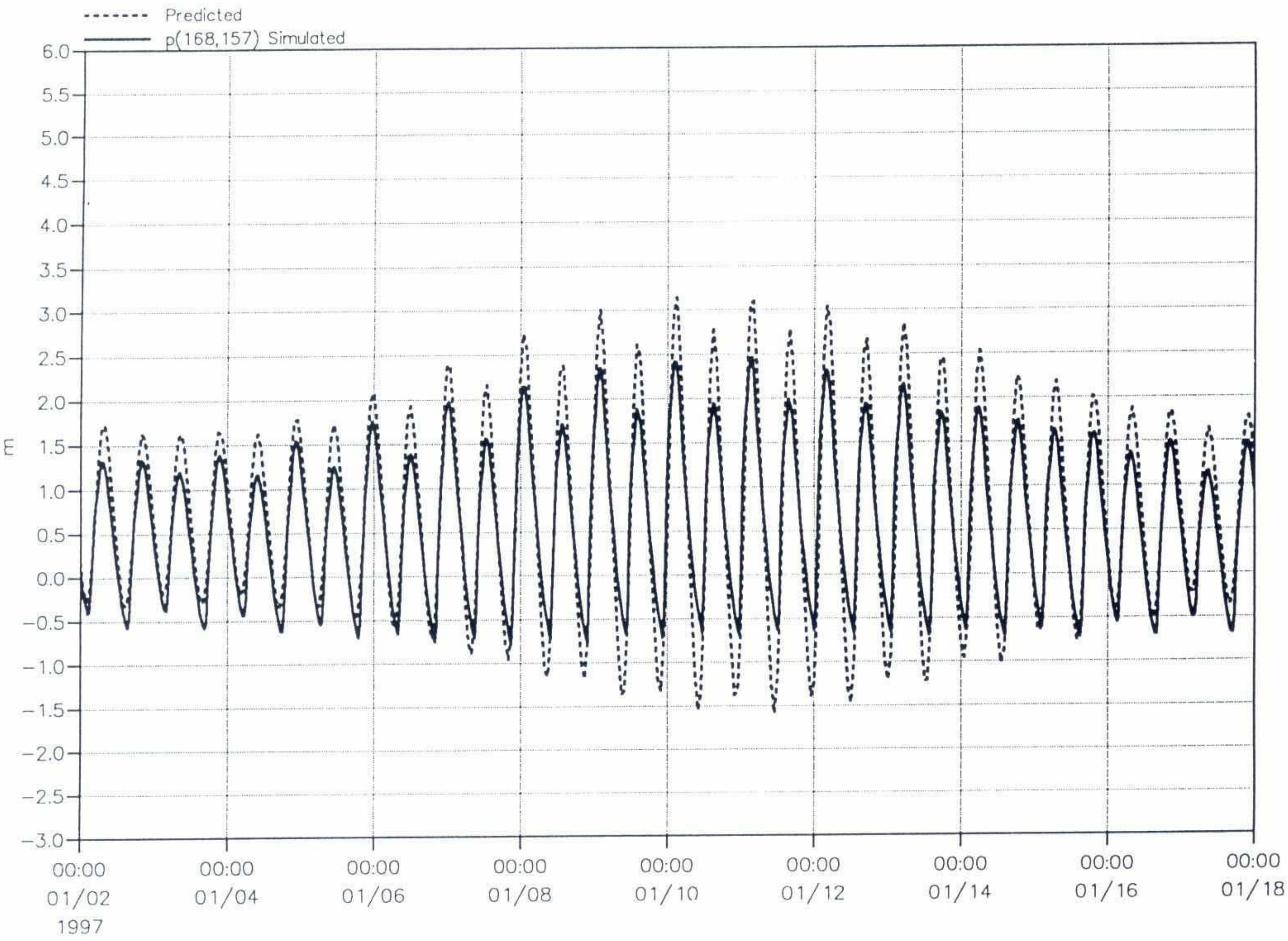
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and simulated water level at Daulatkhan (PWD), BWDB Dry Season 1997	Drawing no. 4.71
Scale:	Init: p5011		



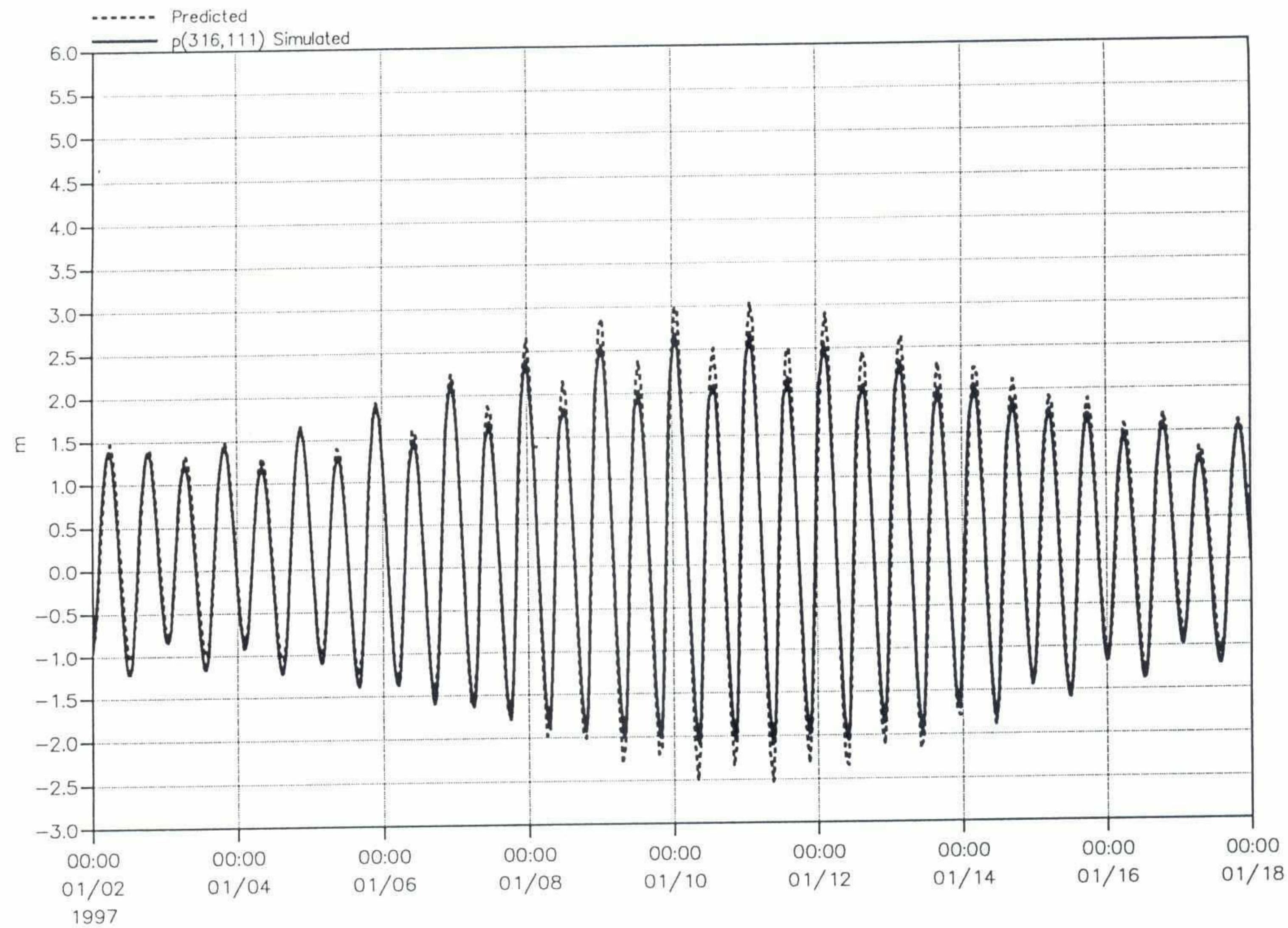
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and predicted water level at Dhulasar (PWD) Dry Season 1997	Drawing no. 4.72
Scale:	Init: p5011		



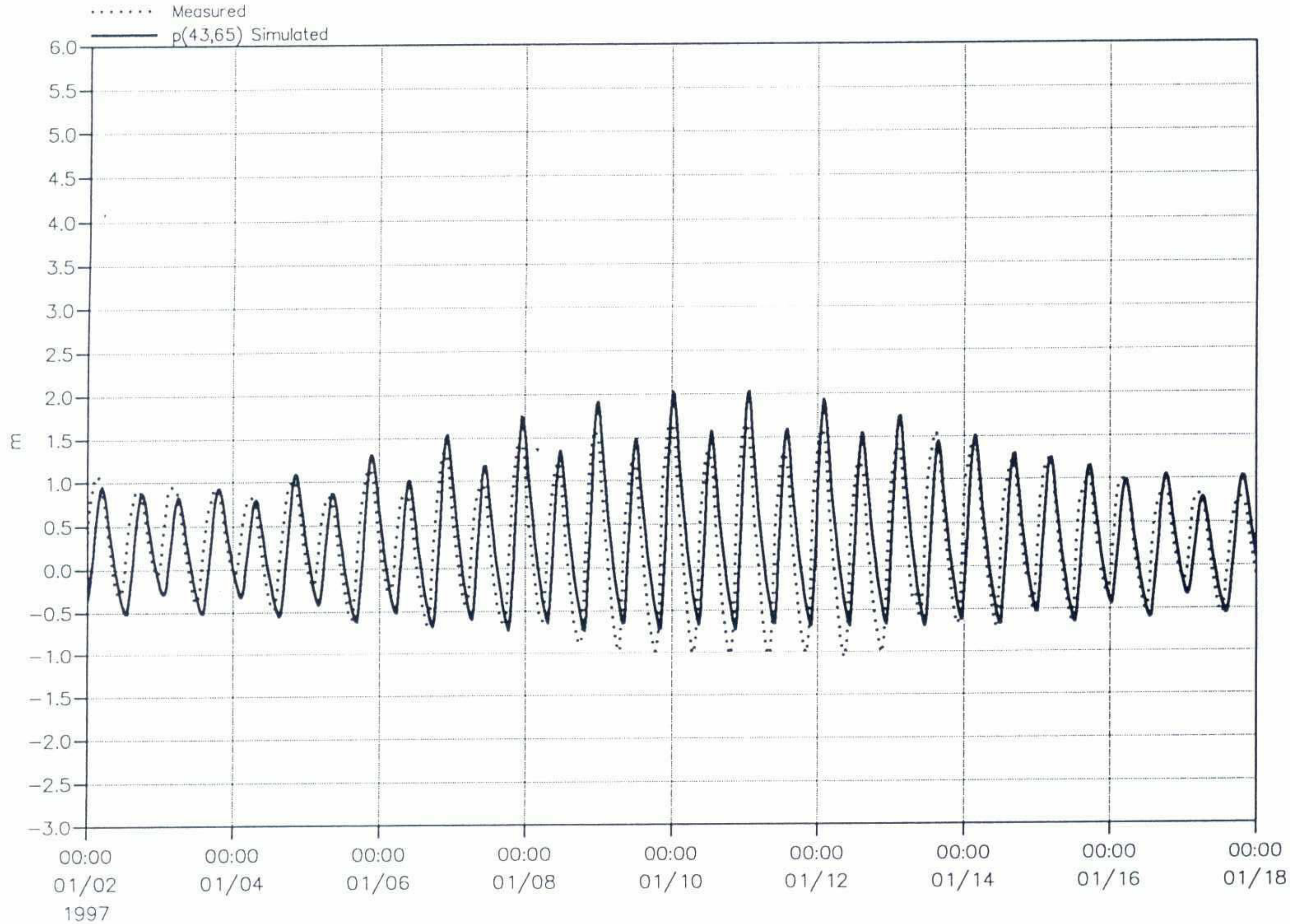
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and simulated water level at Dhulia (PWD) Dry Season 1997	Drawing no. 4.73
Scale:	Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and predicted water level at Hatia Bar (PWD) Dry Season 1997	Drawing no. 4.74
Scale:	Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and predicted water level at Khal No. 18 (PWD) Dry Season 1997	Drawing no. 4.75
Scale:	Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
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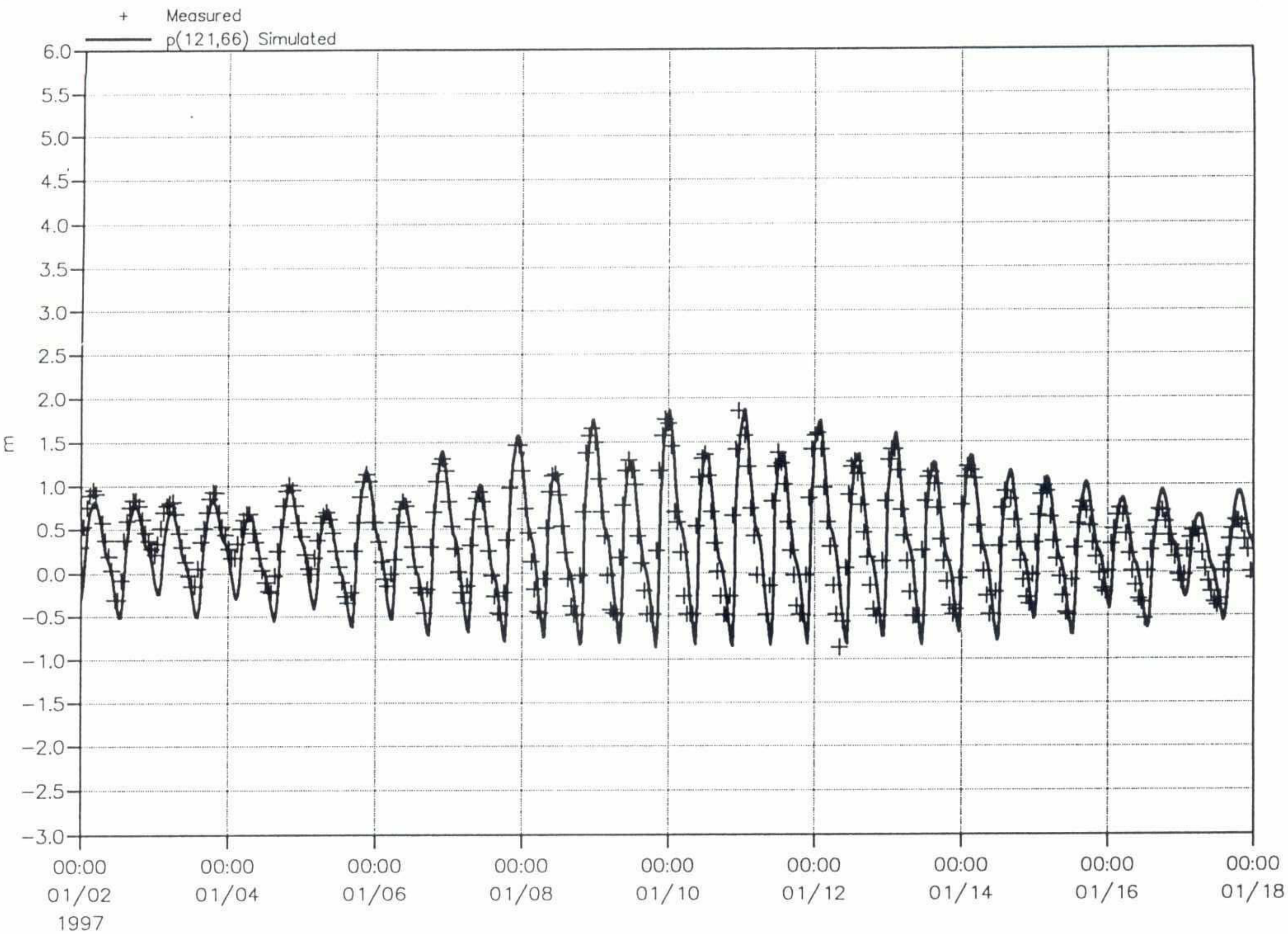
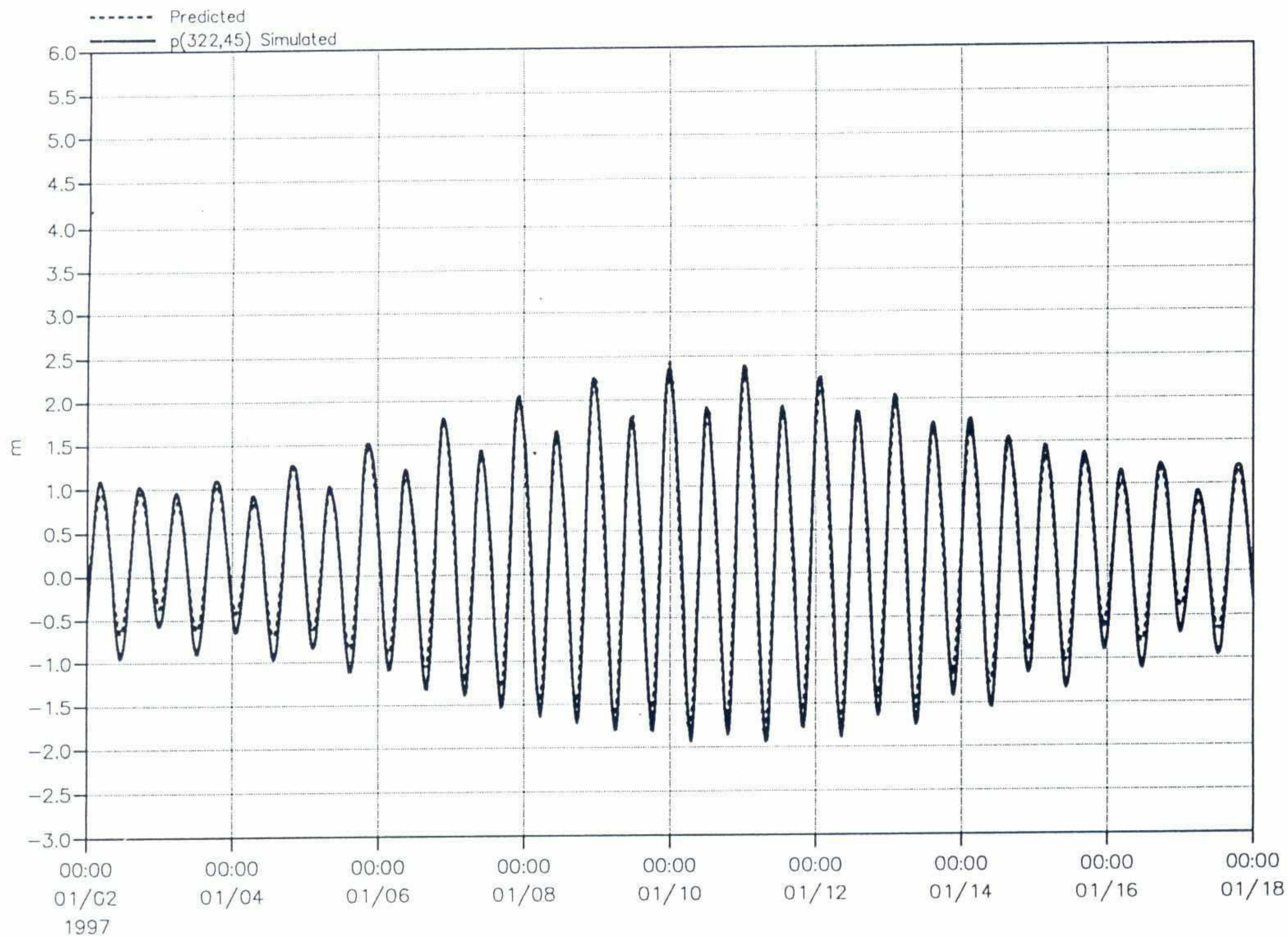
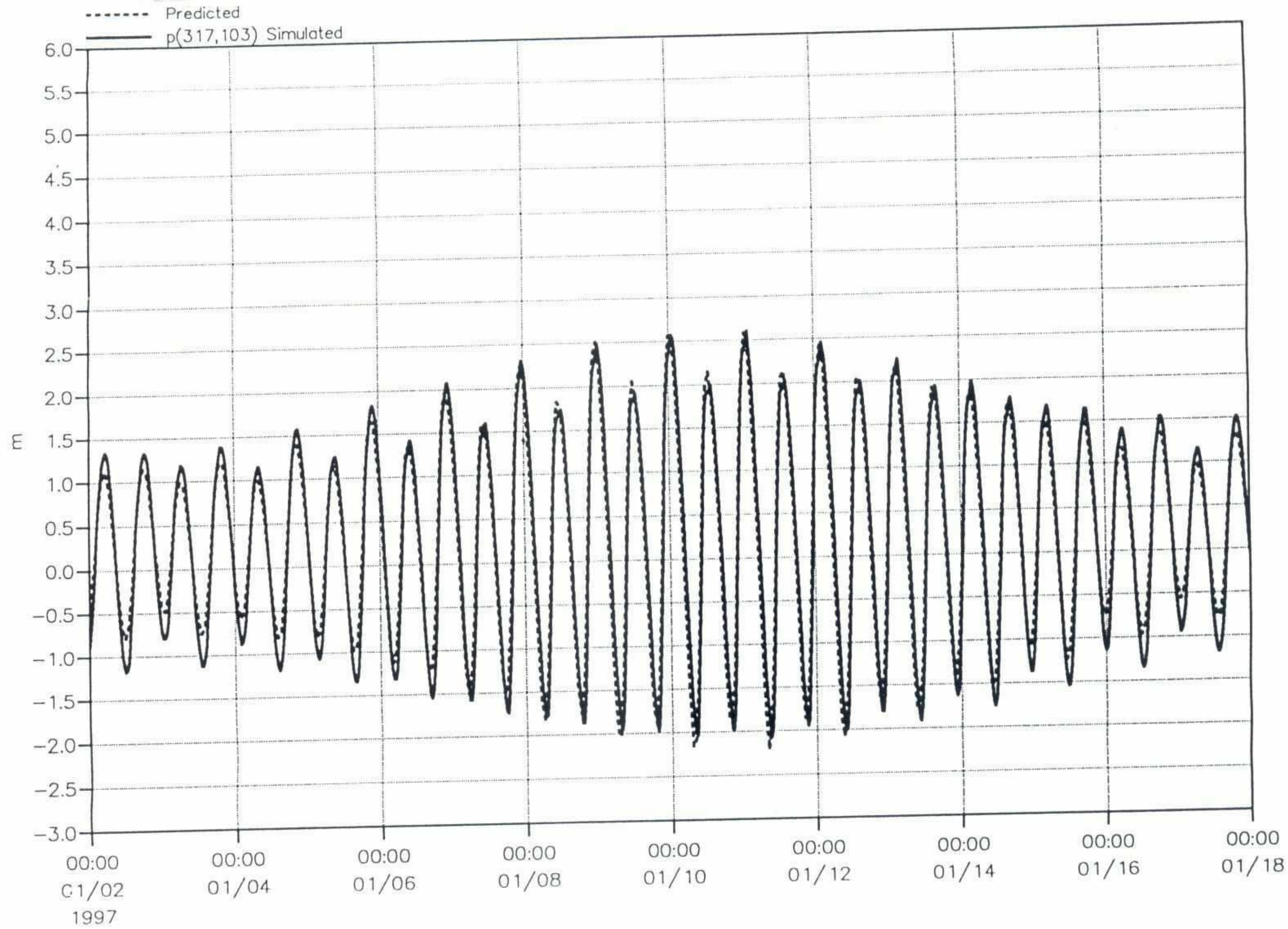
Scale:	Init: p5011		



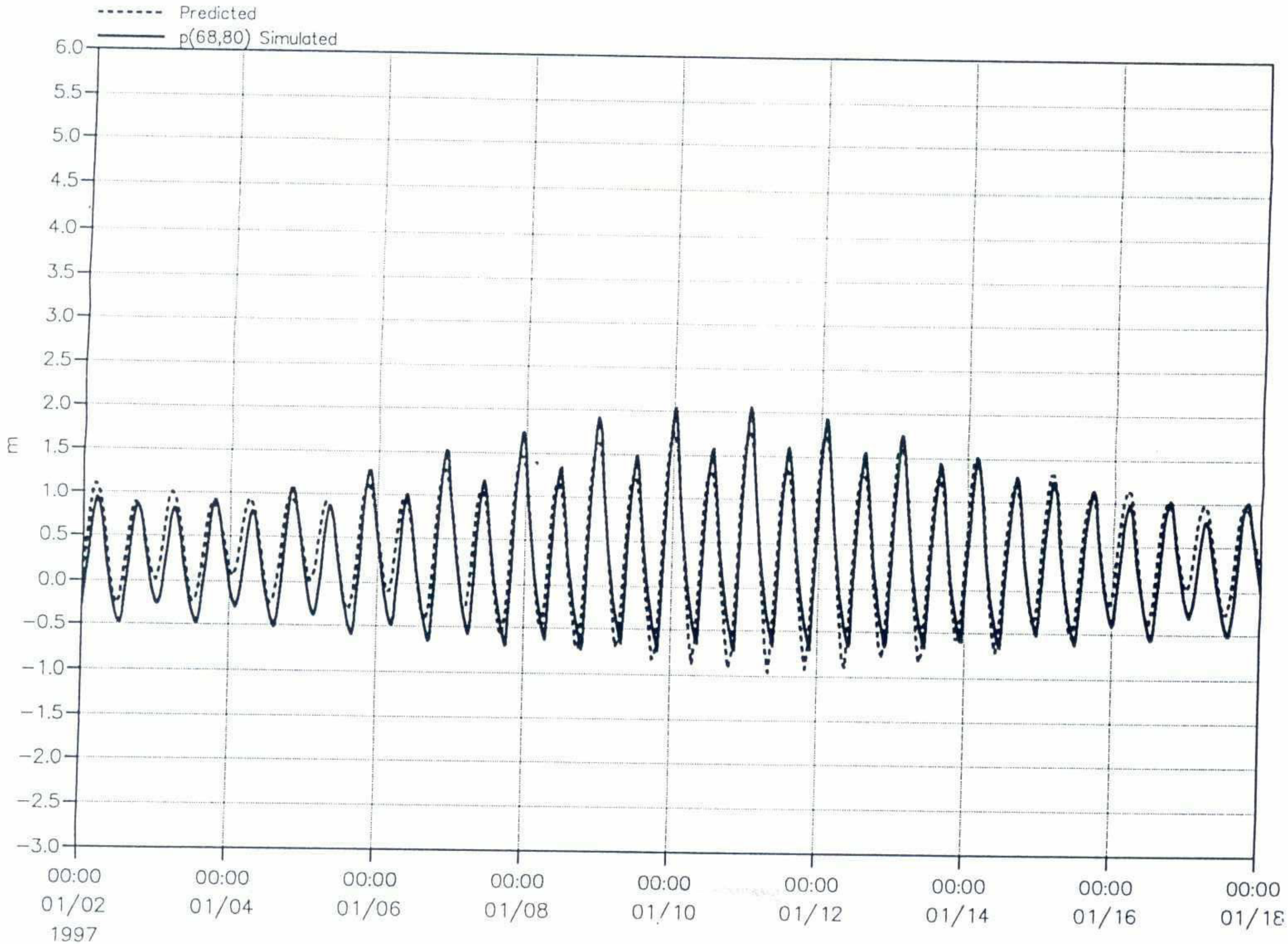
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD Project: MEGHNA ESTUARY STUDY	MIKE 21
File:	Date: Sun May 31 1998	Measured and simulated water level at Kochopia (PWD)) Dry Season 1997	Drawing no. 4.77
Scale:	Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Sun May 31 1998	Measured and predicted water level at Kutubdia Island (PWD) Dry Season 1997	Drawing no. 4.78
Scale:	Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD Project: MEGHNA ESTUARY STUDY	MIKE 21
File:	Date: Sun May 31 1998	Measured and predicted water level at Normans Point (PWD) Dry Season 1997	Drawing no. 4.79
Scale:	Init: p5011		

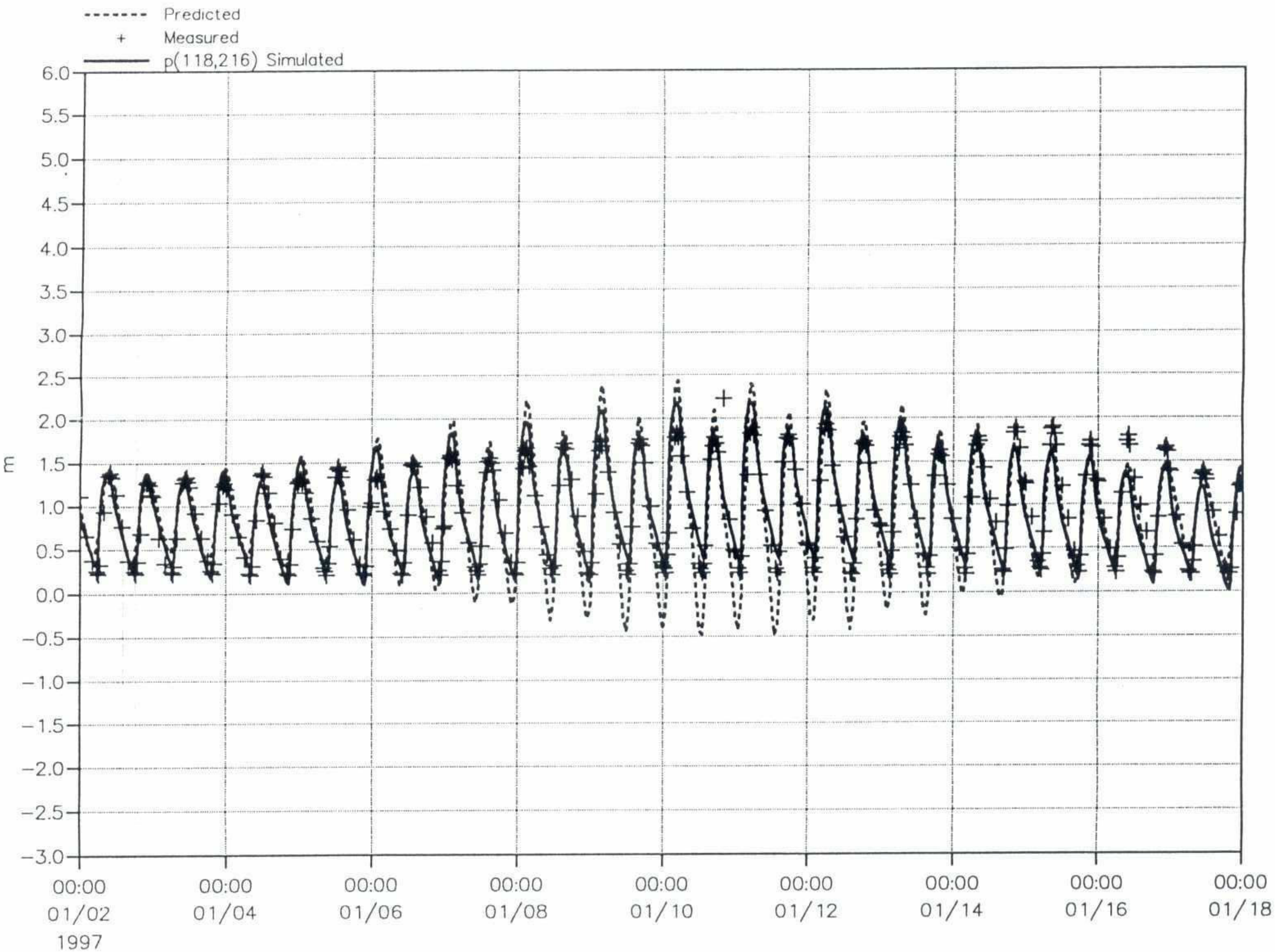


SWMC	Client: BANGLADESH WATER DEVELOPMENT BOARD
	Project: MEGHNA ESTUARY STUDY
File:	Date: Sun May 31 1998
Scale:	Init: p5011

Measured and predicted water level at Rabnabad Channel (PWD) Dry season 1997

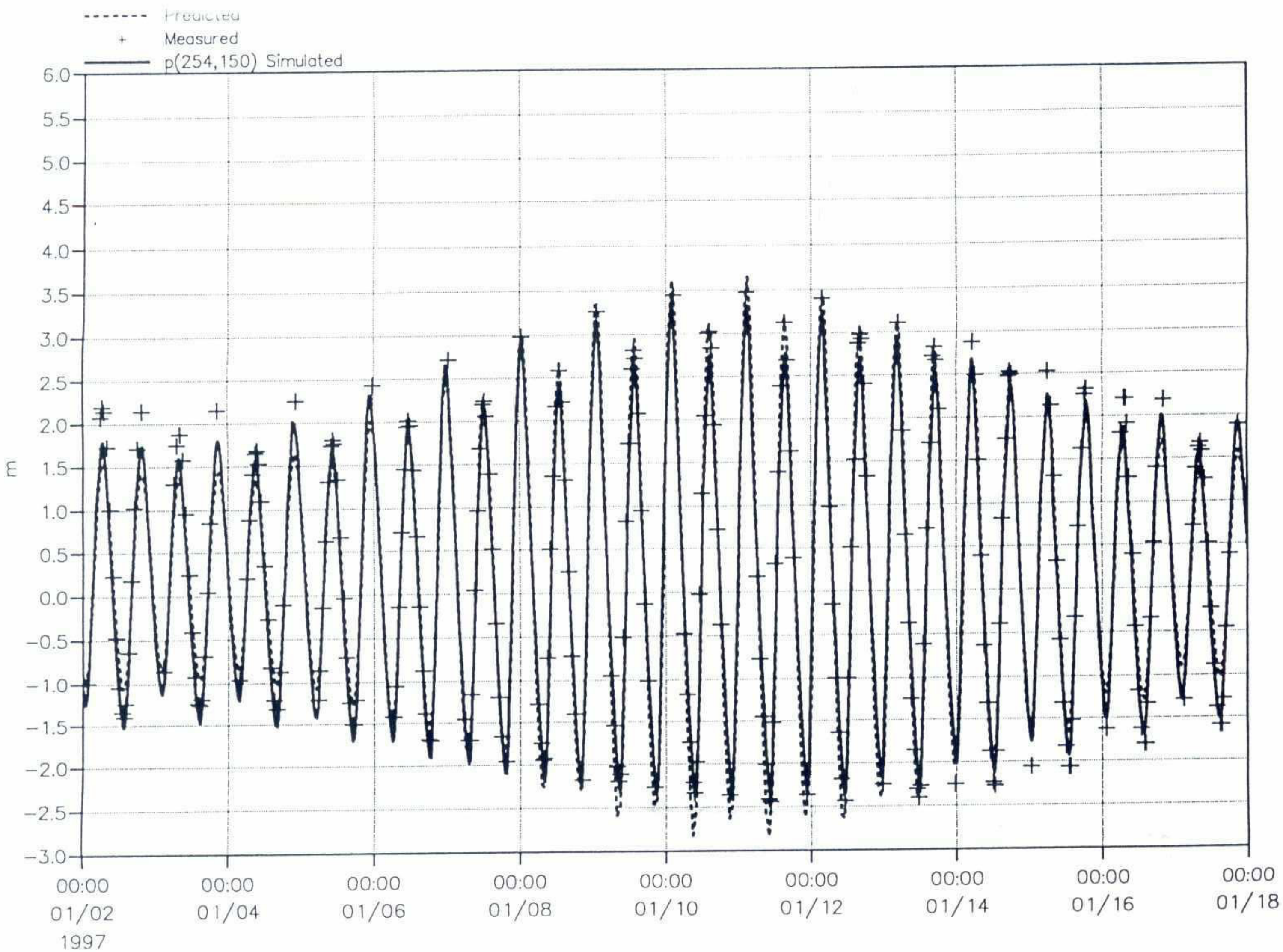
Drawing no. 4.80

MIKE 21

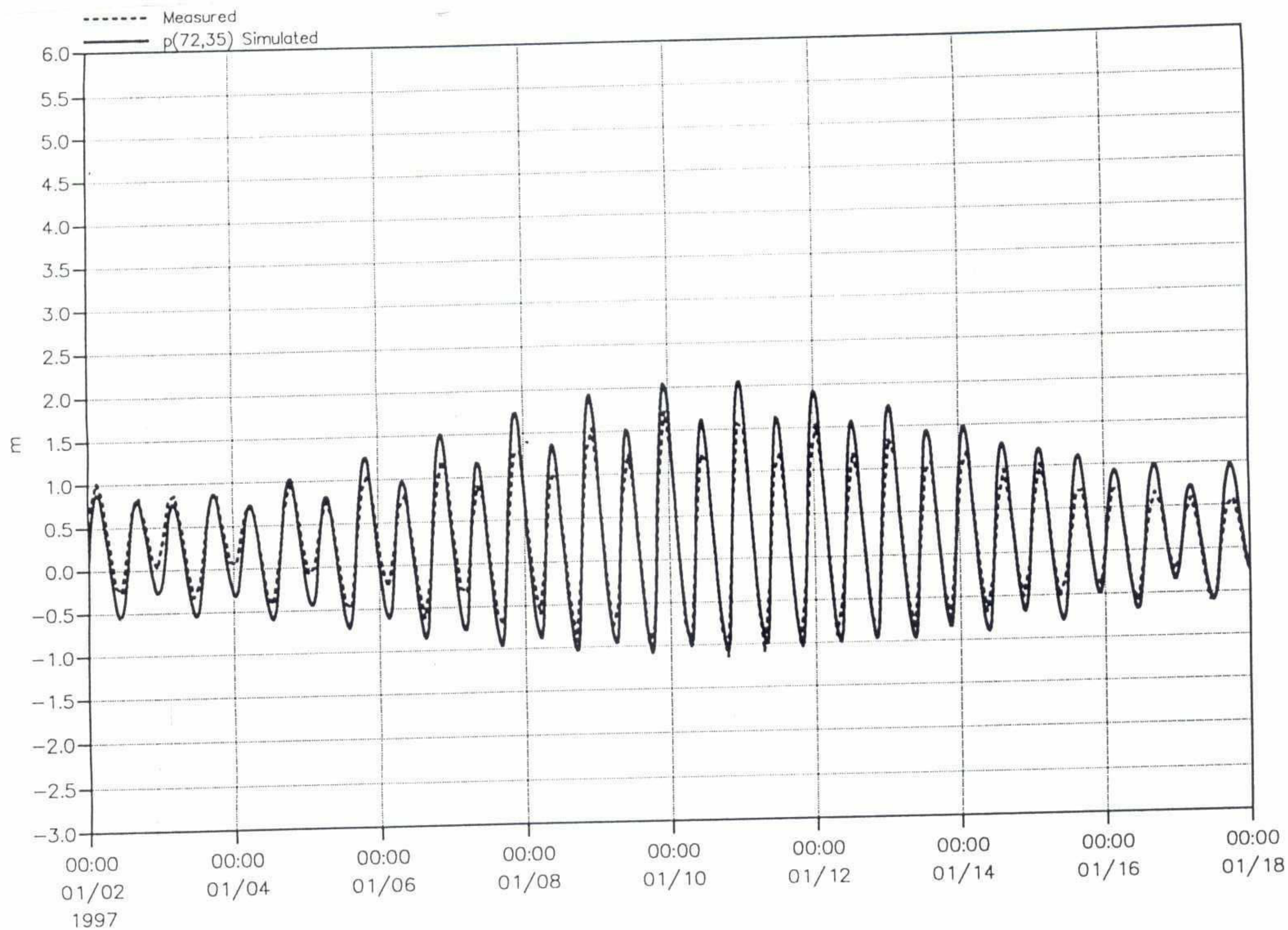


SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD		MIKE 21
		Project: MEGHNA ESTUARY STUDY		
File:	Date: Sun May 31 1998	Measured, simulated and predicted wated level at Ramdaspur (PWD) Dry Season 1997	Drawing no. 4.81	
Scale:	Init: p5011			

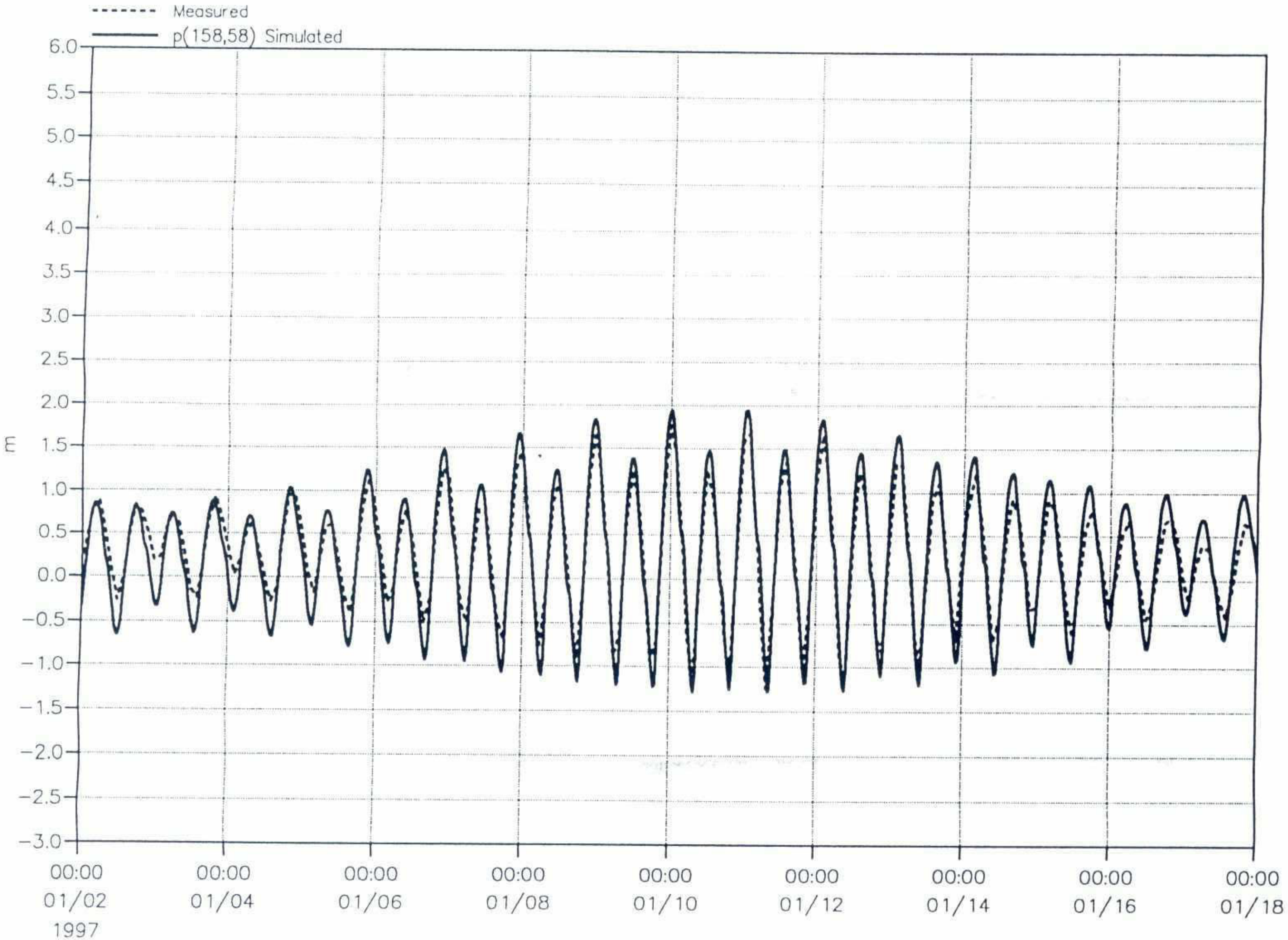
206



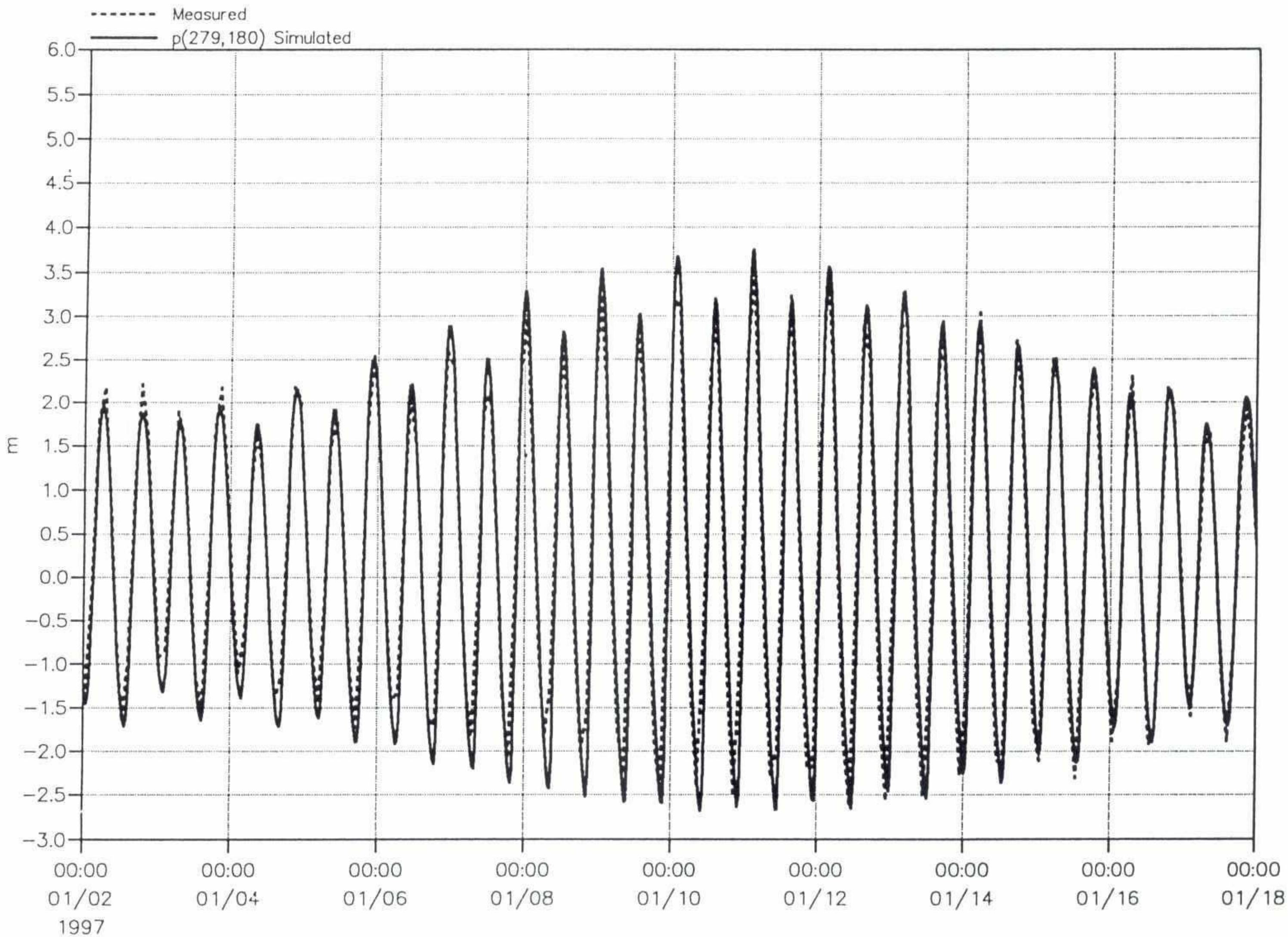
SWMC	Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
	Project: MEGHNA ESTUARY STUDY	
File: / Date: Sun May 31 1998	Measured, simulated and predicted water level at Sandwip (PWD) Dry Season 1997	Drawing no. 4.82
Scale: / Init: p5011		



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Mon Jun 1 1998	Measured and predicted water level at MES 1 (PWD) Dry Season 1997	Drawing no. 4.83
Scale:	Init: p5011		

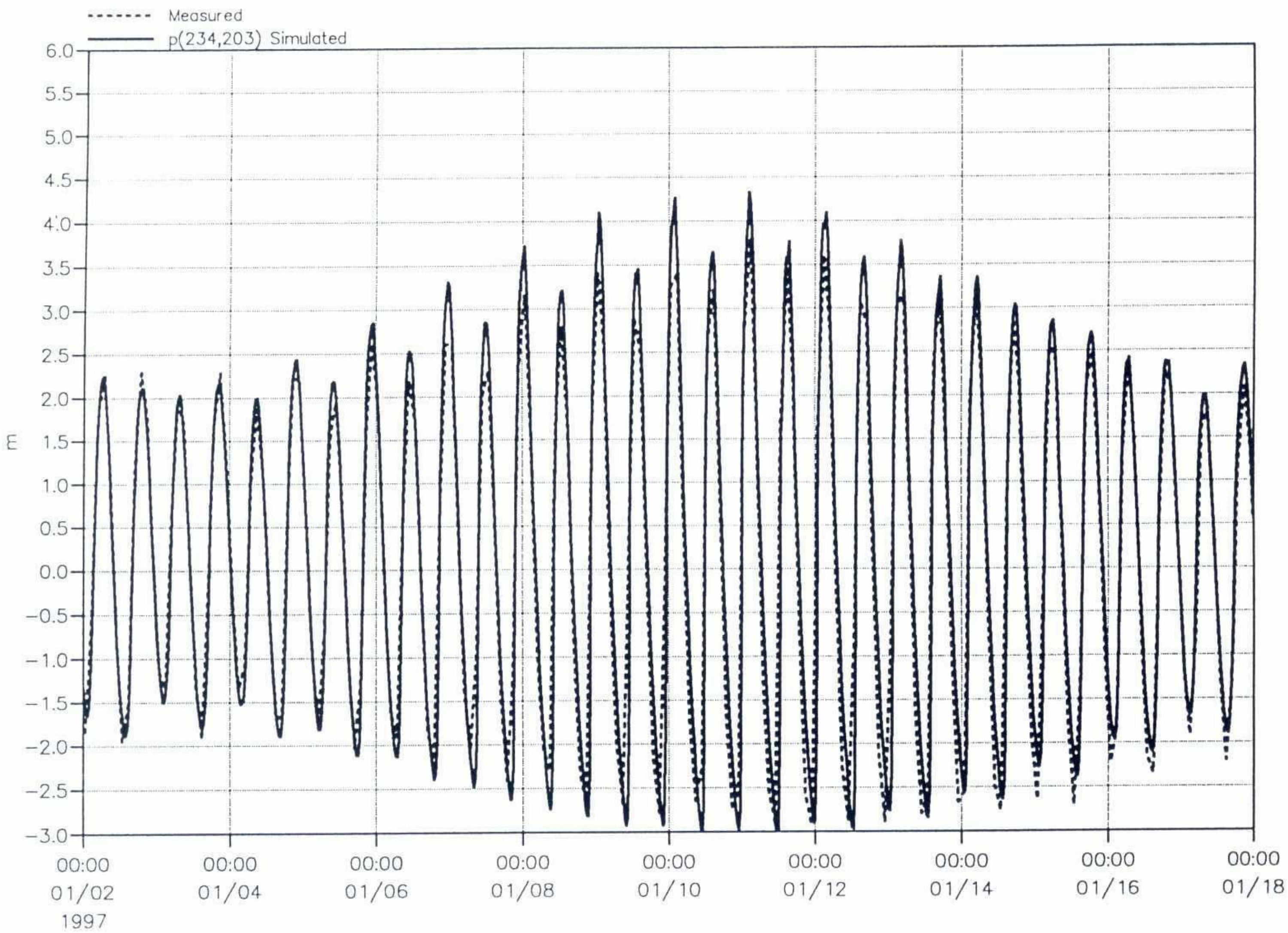


SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Mon Jun 1 1998	Measured and predicted water level at MES 2 (PWD) Dry Season 1997	Drawing no. 4.84
Scale:	Init: p5011		

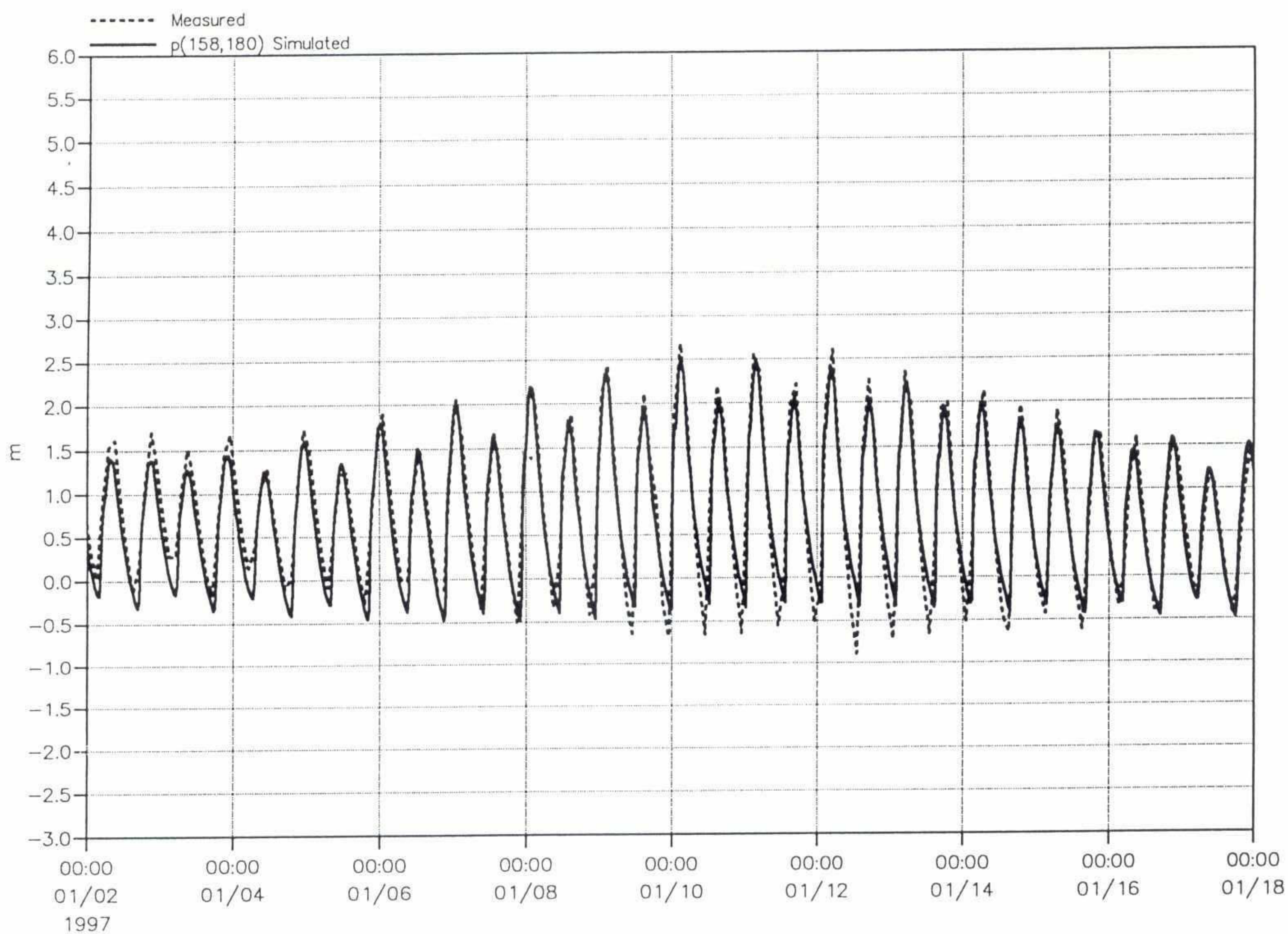


SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD Project: MEGHNA ESTUARY STUDY	MIKE 21
File:	Date: Mon Jun 1 1998	Measured and predicted water level at MES 4 (PWD) Dry Season 1997	Drawing no. 4.85
Scale:	Init: p5011		

207

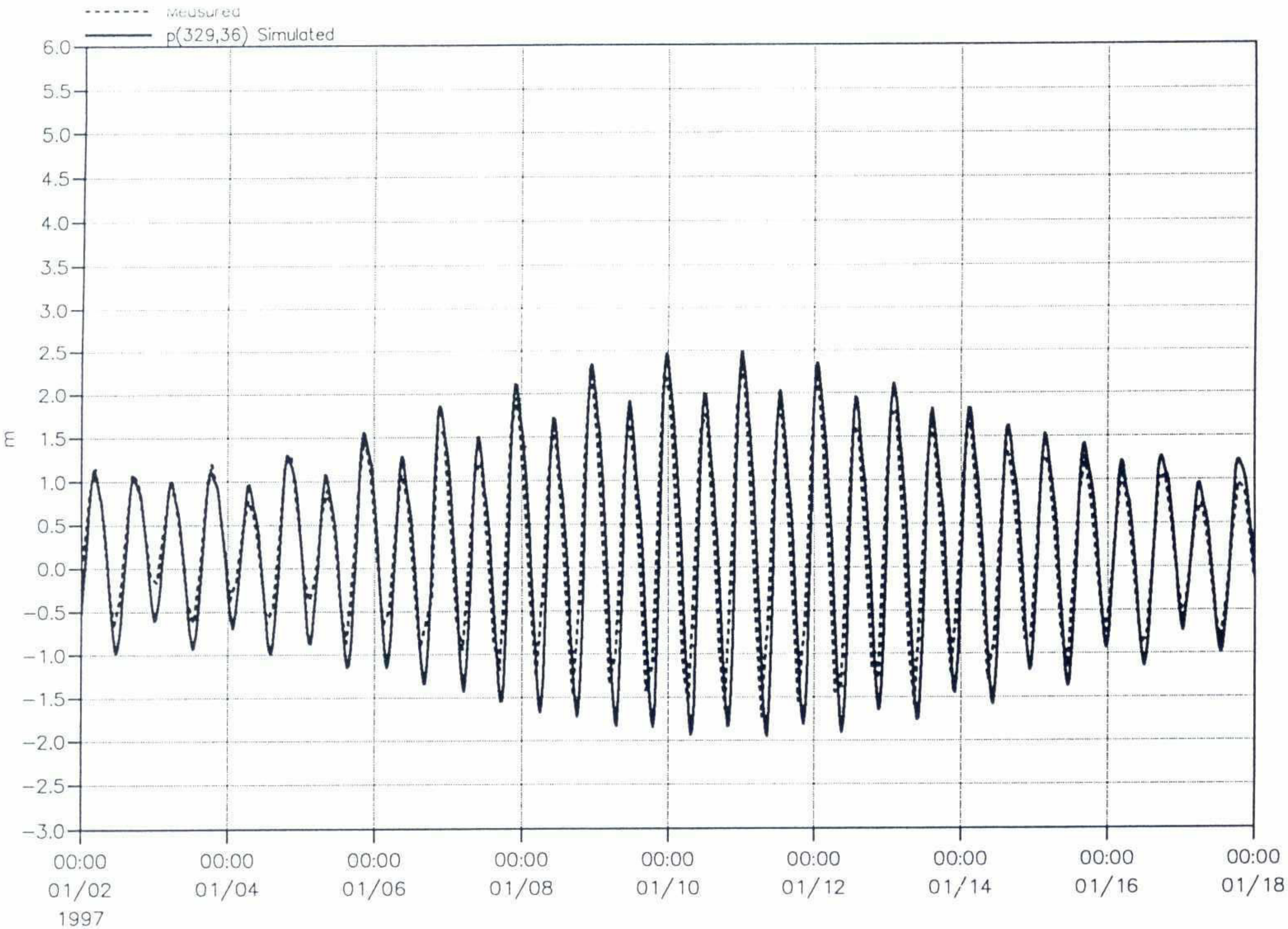


SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Mon Jun 1 1998	Measured and predicted water level at MES 5 (PWD) Dry Season 1997	Drawing no. 4.86
Scale:	Init: p5011		



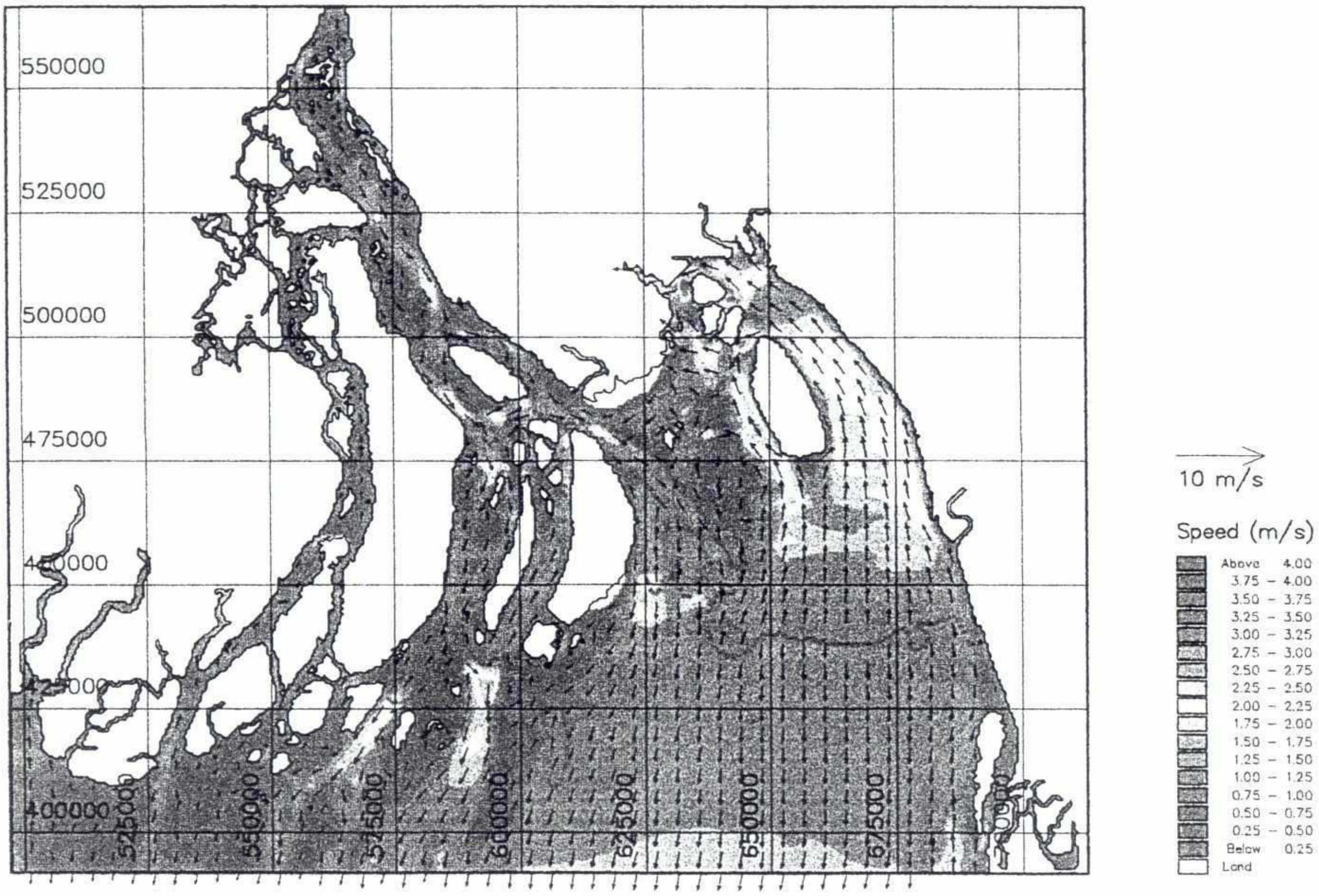
SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Mon Jun 1 1998	Measured and predicted water level at MES 6 (PWD) Dry Season 1997	Drawing no. 4.87
Scale:	Init: p5011		

I20



SWMC		Client: BANGLADESH WATER DEVELOPMENT BOARD	MIKE 21
		Project: MEGHNA ESTUARY STUDY	
File:	Date: Mon Jun 1 1998	Measured and predicted water level at SE (PWD) Dry Season 1997	Drawing no. 4.88
Scale:	Init: p5011		

221

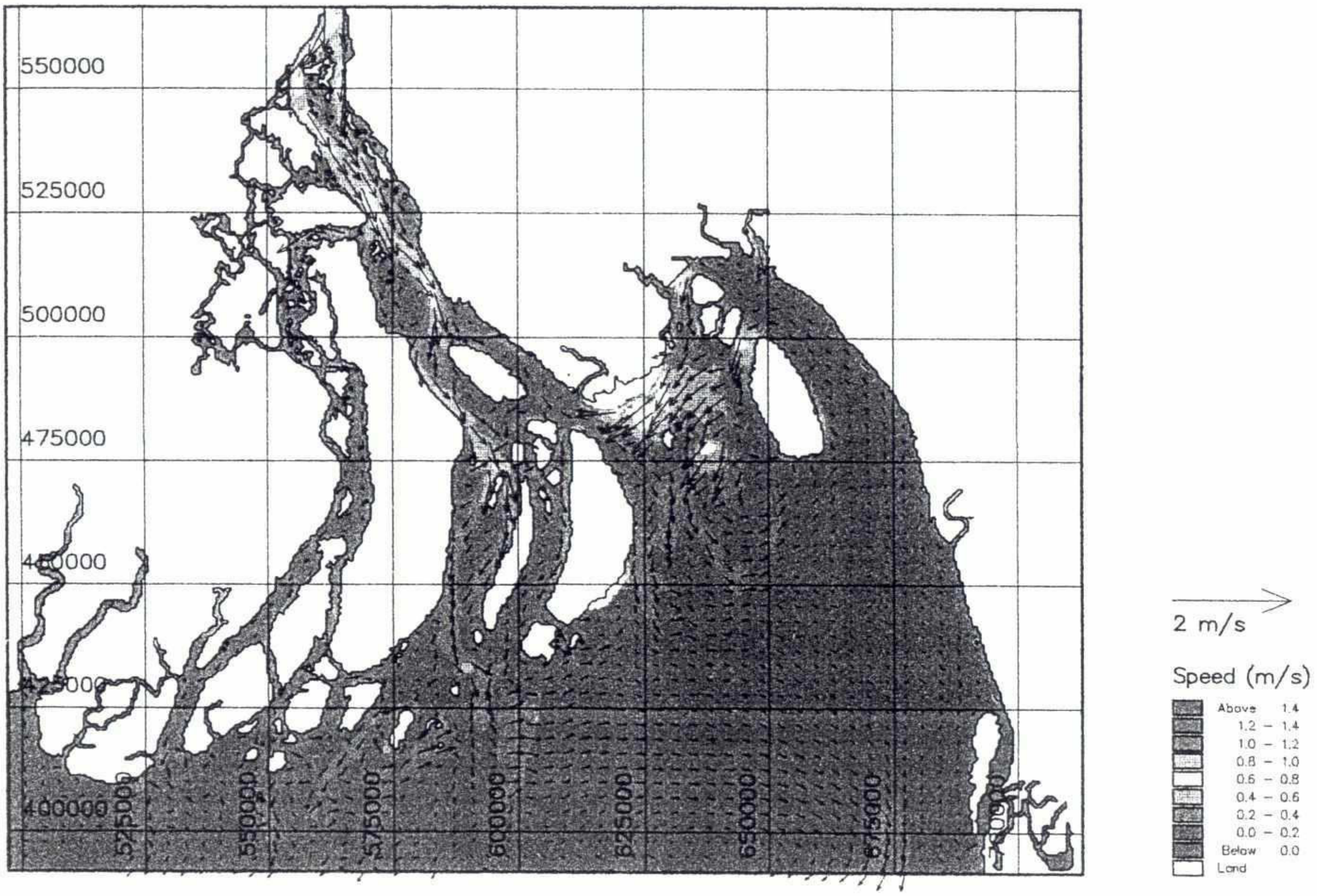


SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	
Scale: 1:1500000	Init: p5011	

Max velocities for
Spring Tide, Dry Season 1996
Existing situation

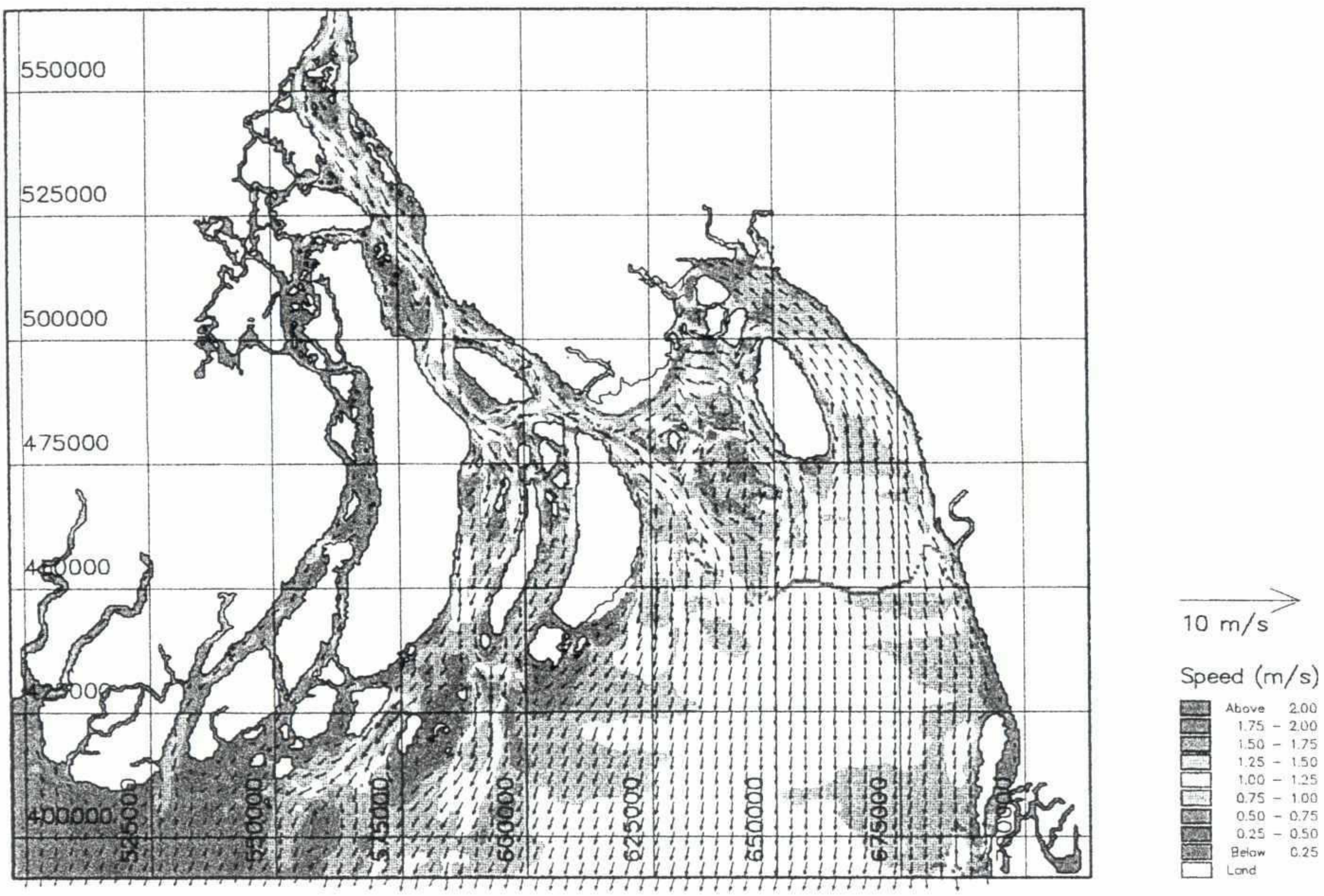
Drawing no. 5.1

222

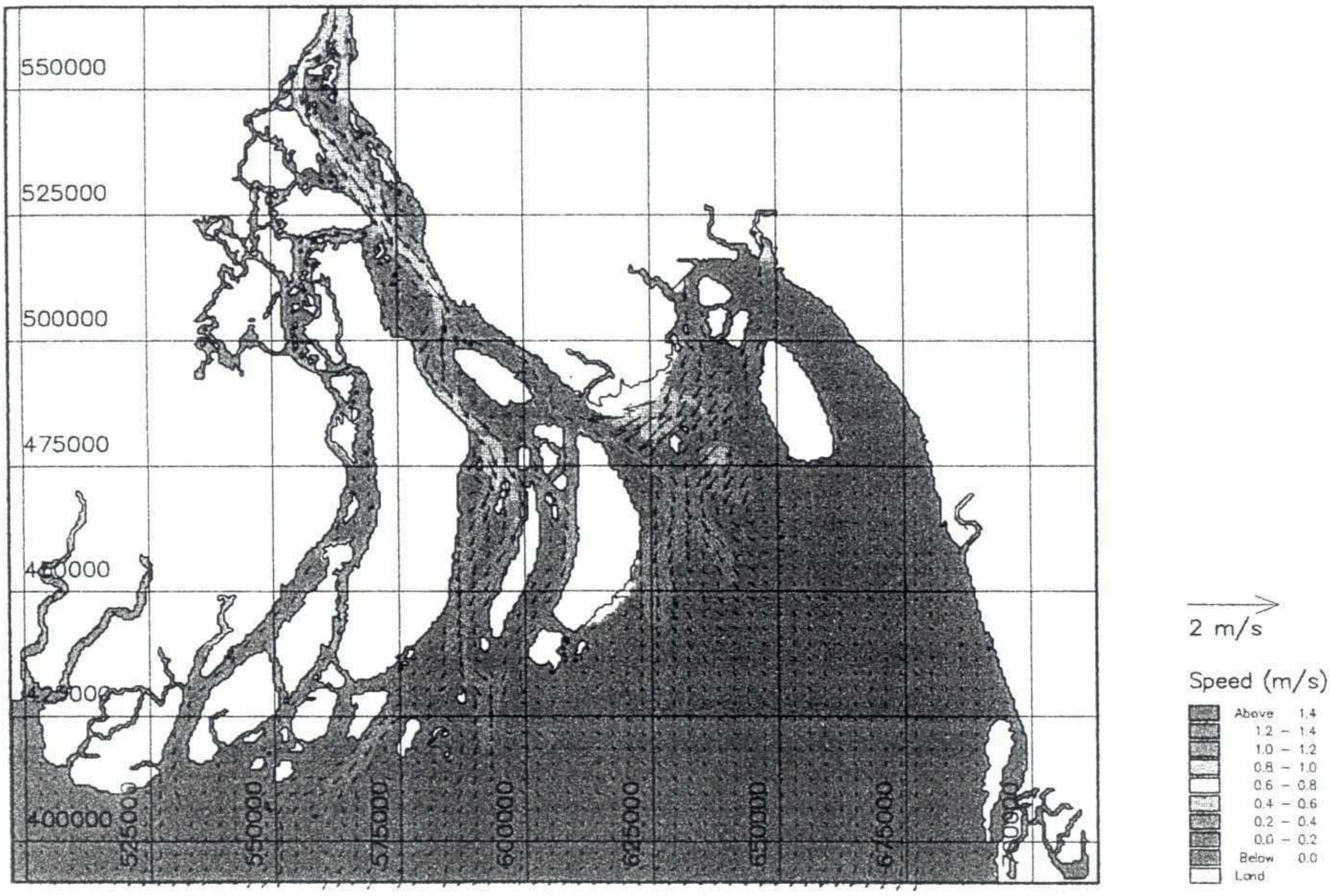


SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 Existing situation	Drawing no. 5.2
Scale: 1:1500000	Init: p5011		

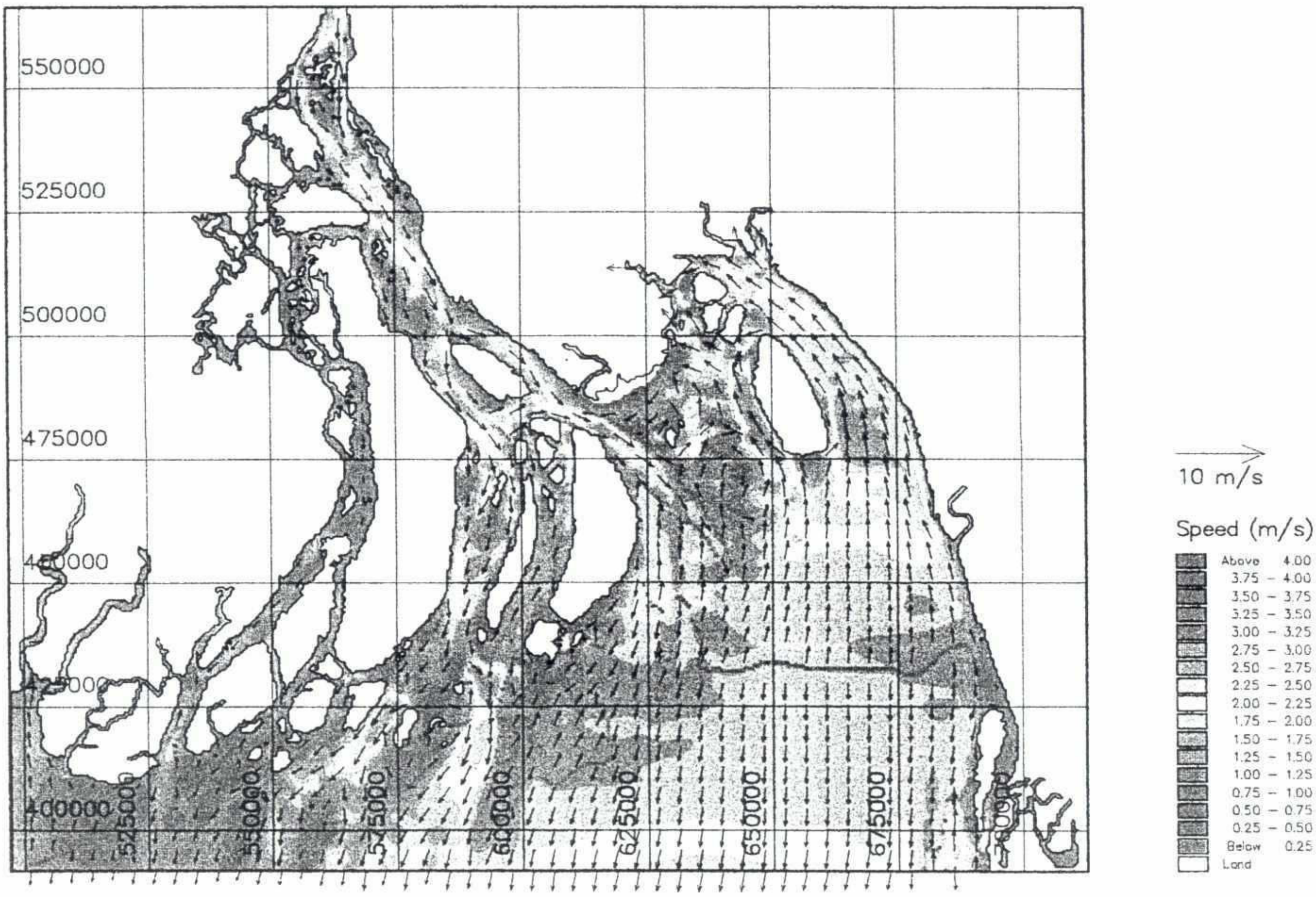
226



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File: / Date: Mon Jun 8 1998 Scale: 1:1500000 / Init: p5011	Max velocities for Neap Tide, Dry Season 1996 Existing situation	Drawing no. 5.3	

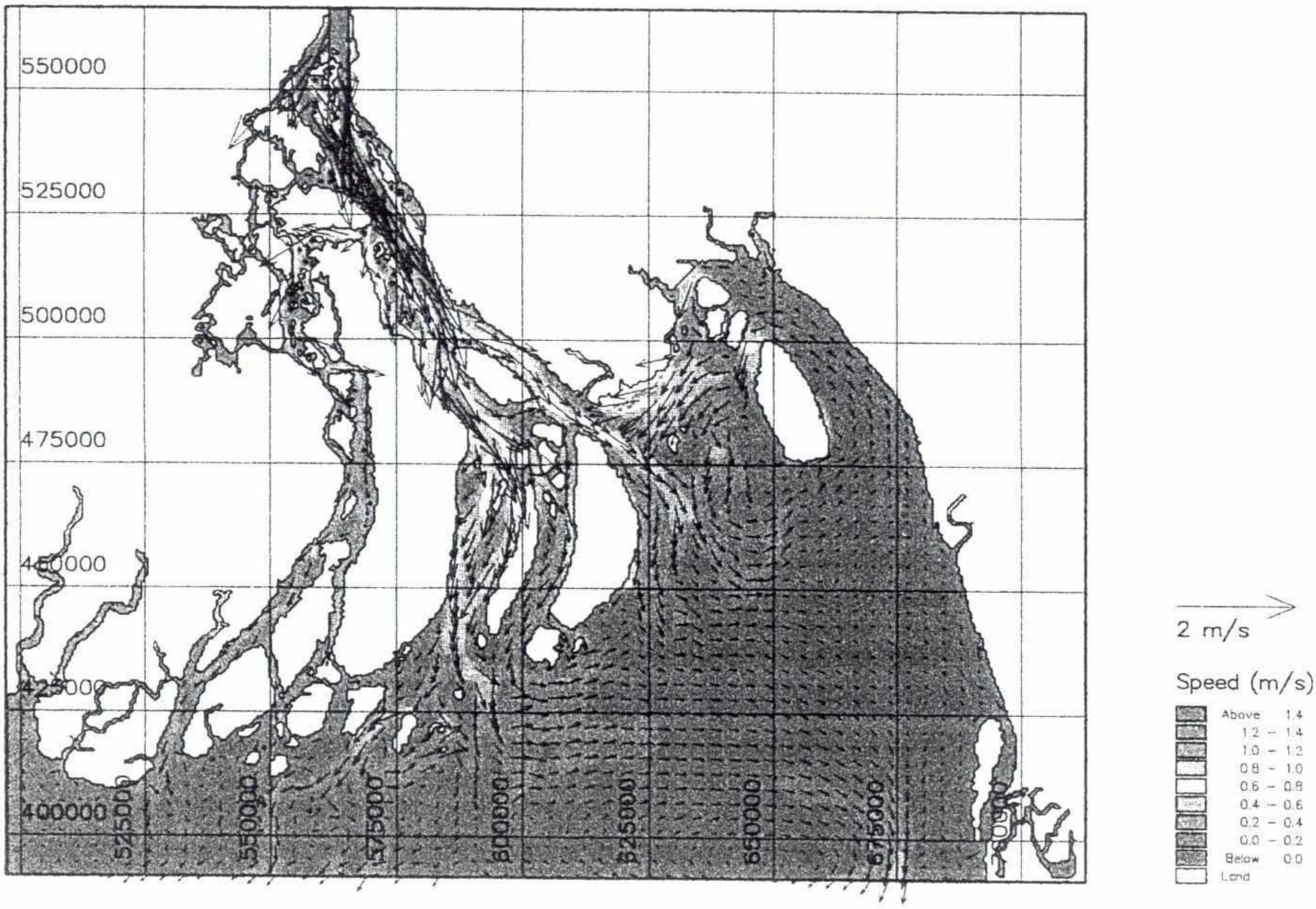


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Neap Tide, Dry Season 1996 Existing situation	Drawing no. 5.4	
Scale: 1:1500000	Init: p5011			



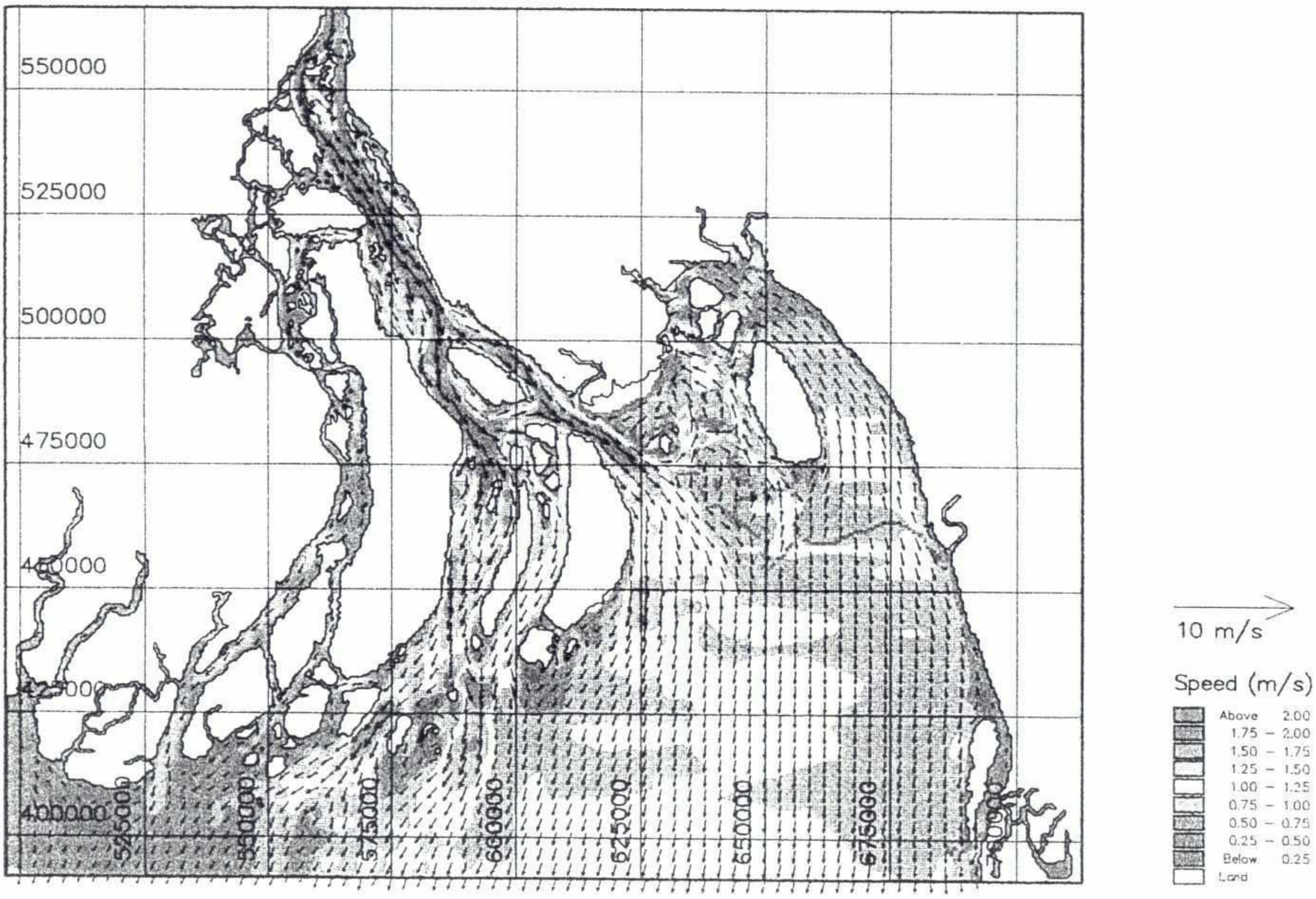
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Monsoon Season 1997 Existing situation	Drawing no. 5.5	
Scale: 1:1500000	Init: p5011			

224



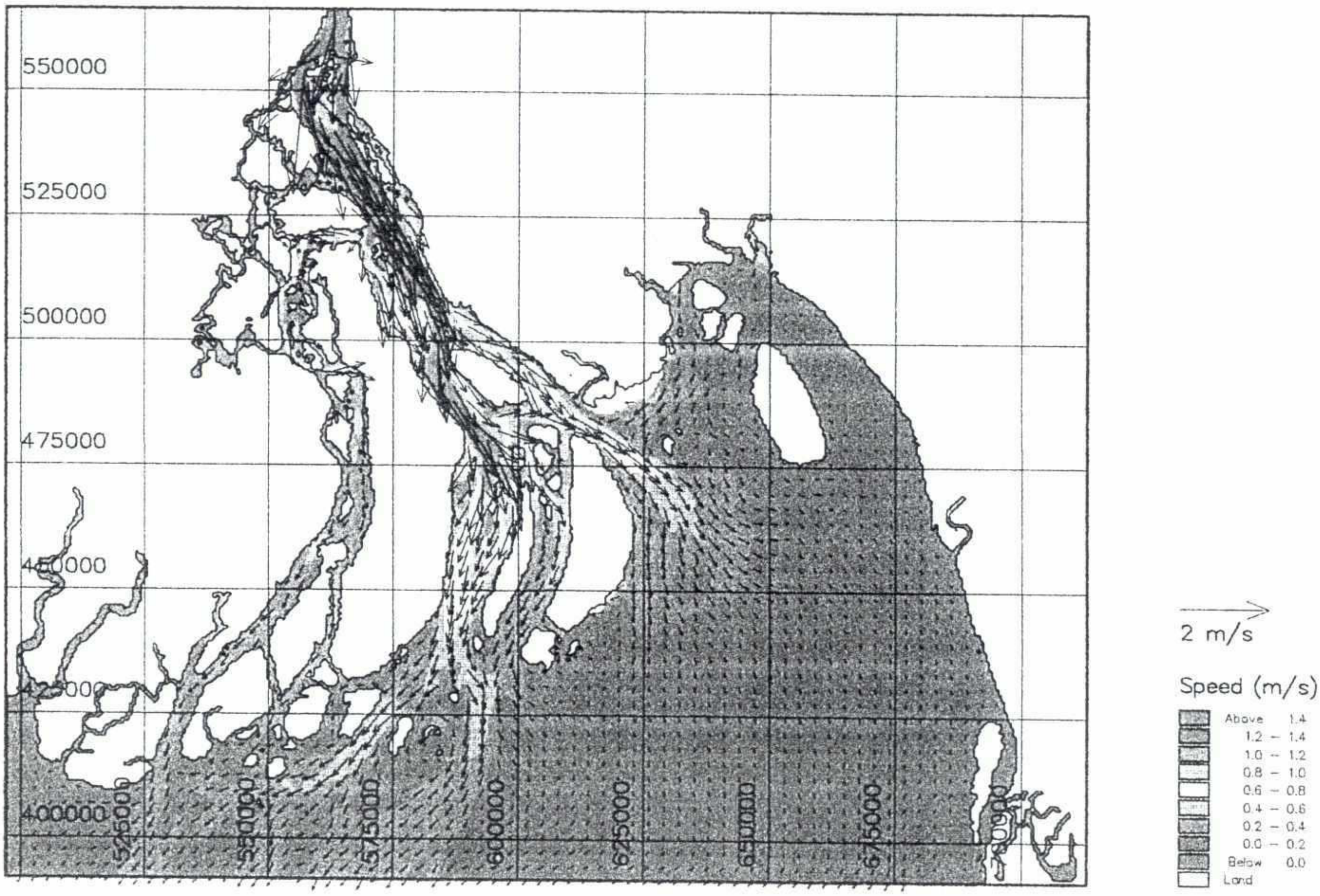
SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Monsoon Season 1997 Existing situation	Drawing no. 5.6
Scale: 1:1500000	Init: p5011		

227

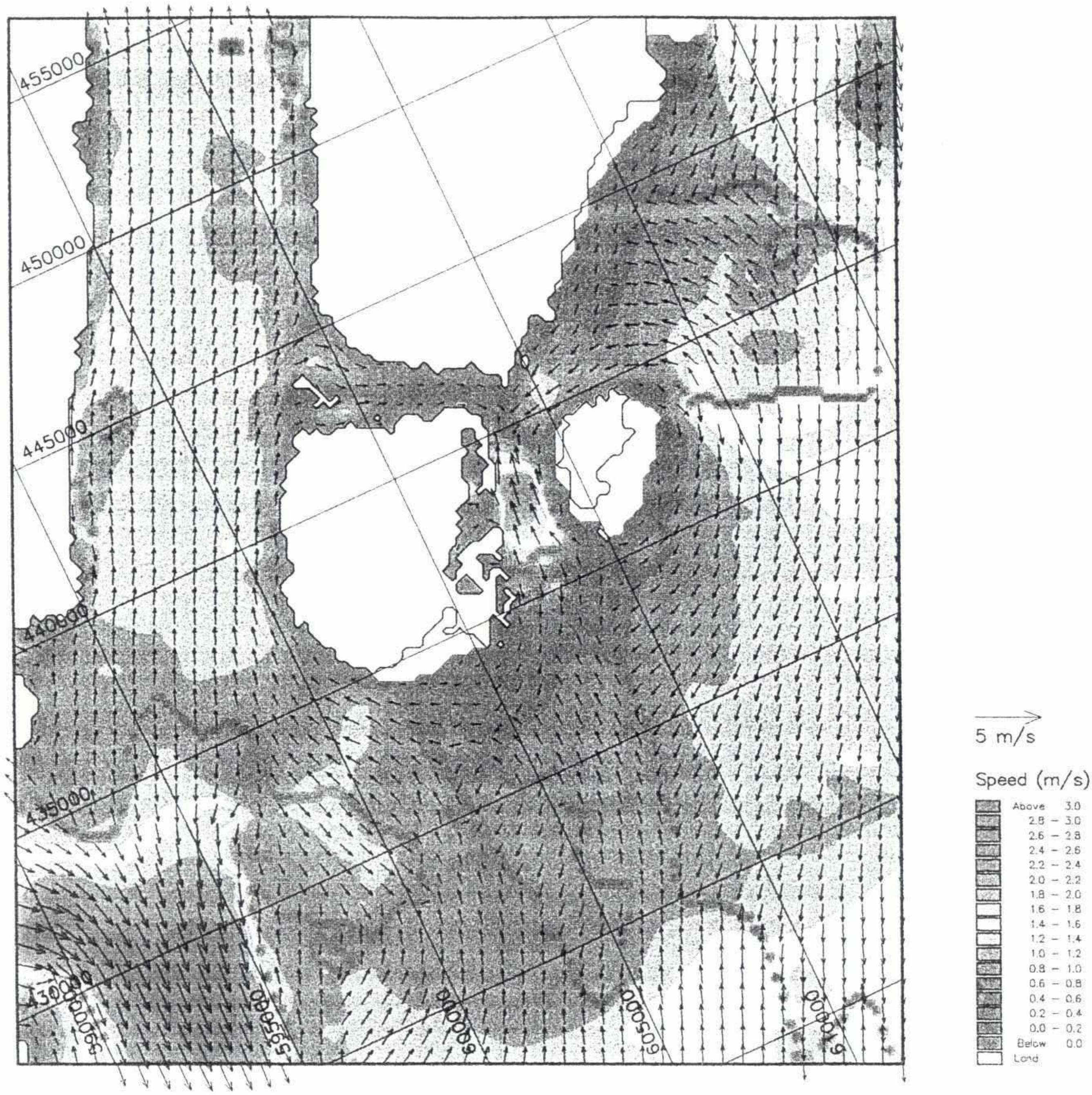


SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Max velocities for Neap Tide, Monsoon Season 1997 Existing situation	Drawing no. 5.7
Scale: 1:1500000	Init: p5011		

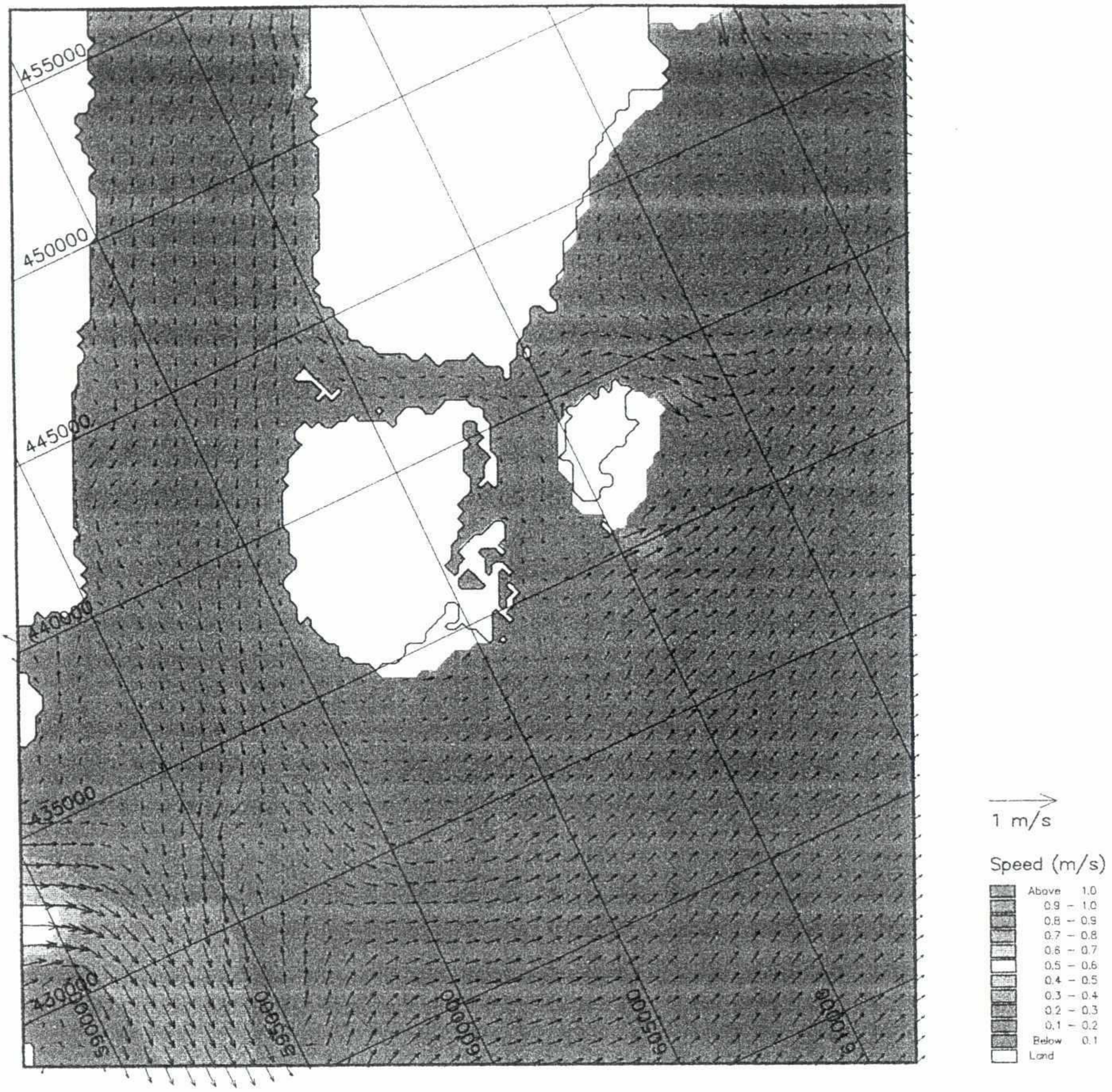
227



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File: / Date: Mon Jun 8 1998 Scale: 1:1500000 / Init: p5011	Net flow for Neap Tide, Monsoon Season 1997 Existing situation	Drawing no. 5.8	



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 Existing situation	Drawing no. 5.9
Scale: 1:185000	Init: p5011		



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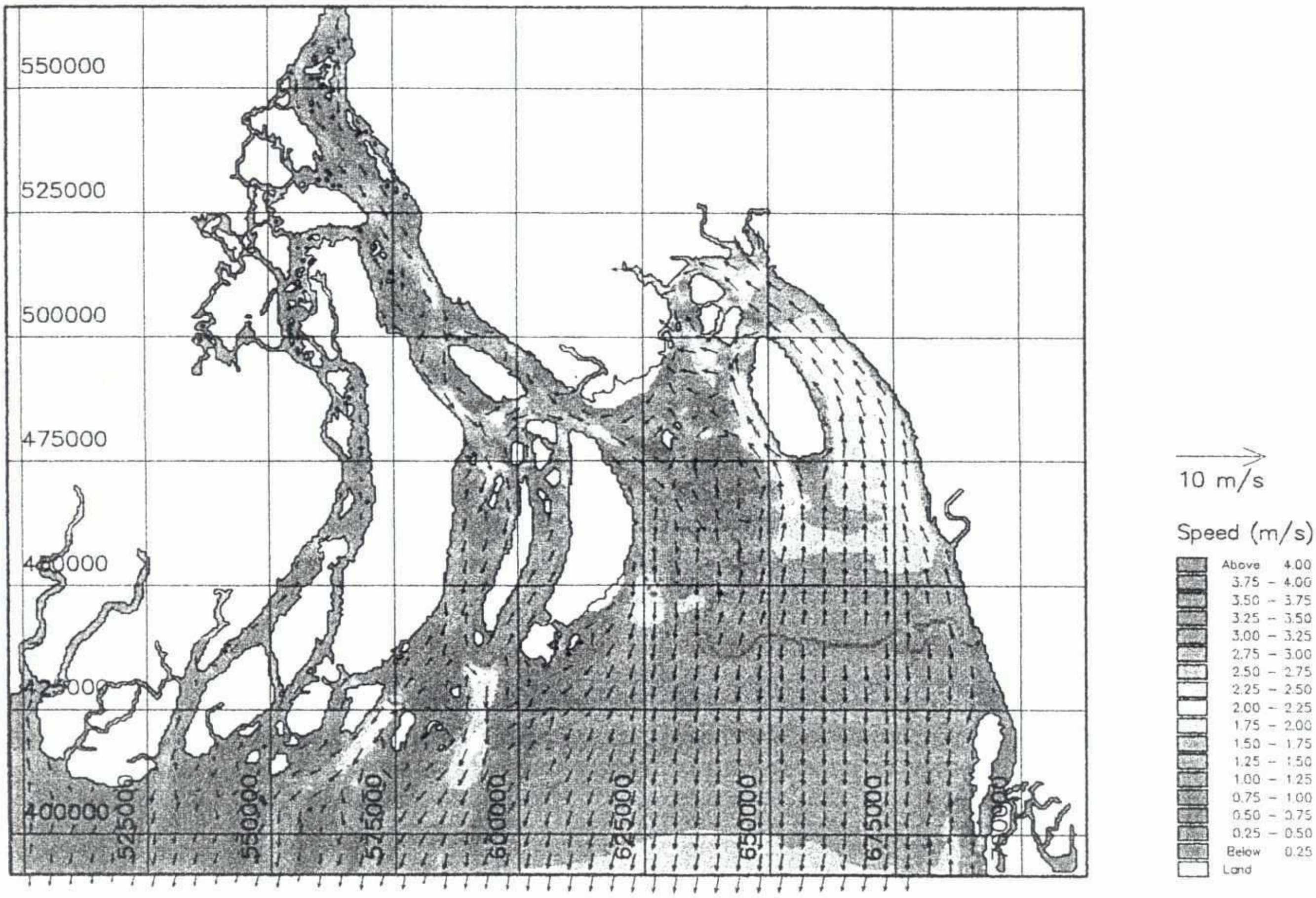
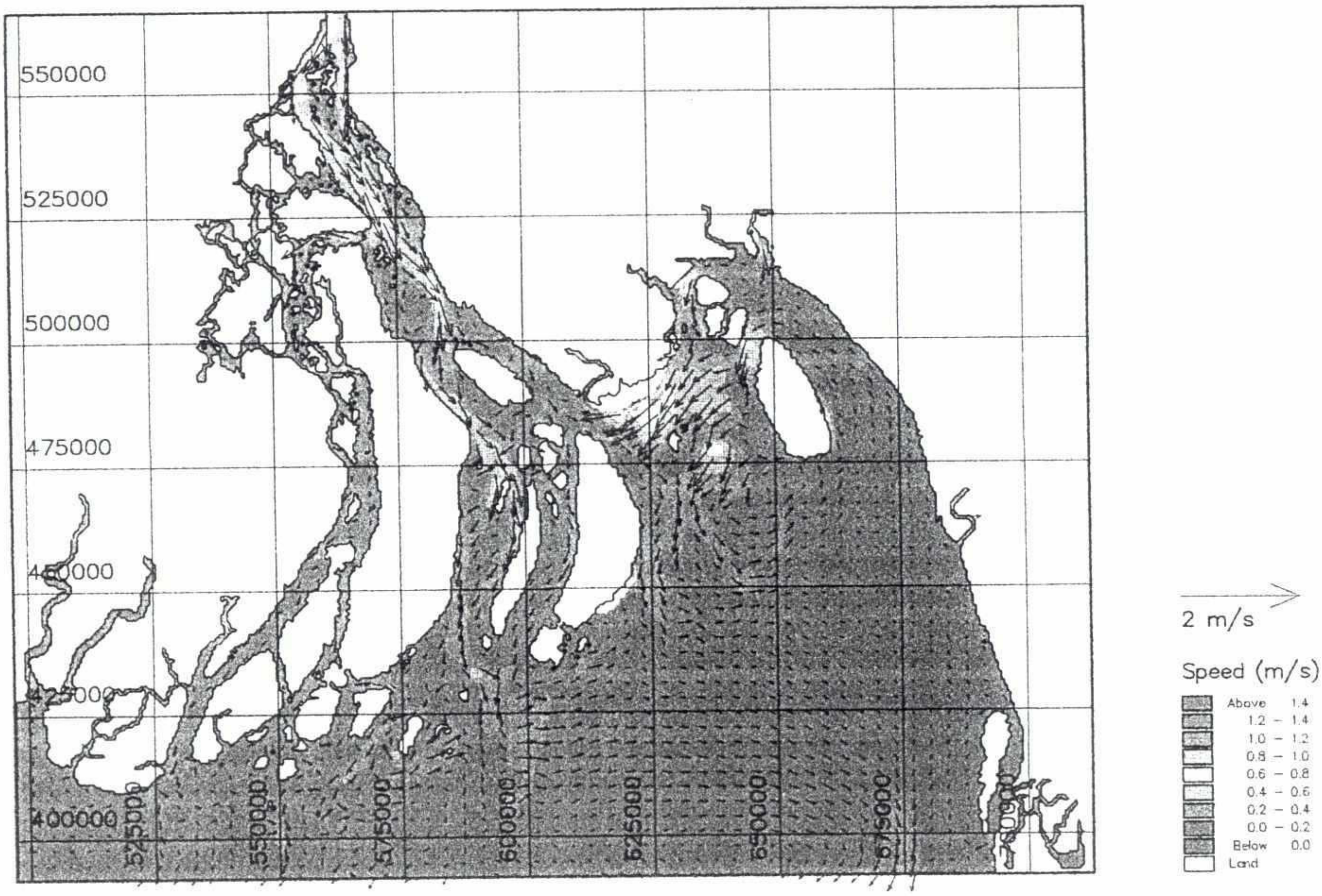
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 Existing situation	Drawing no. 5.10
Scale: 1:185000	Init: p5011		

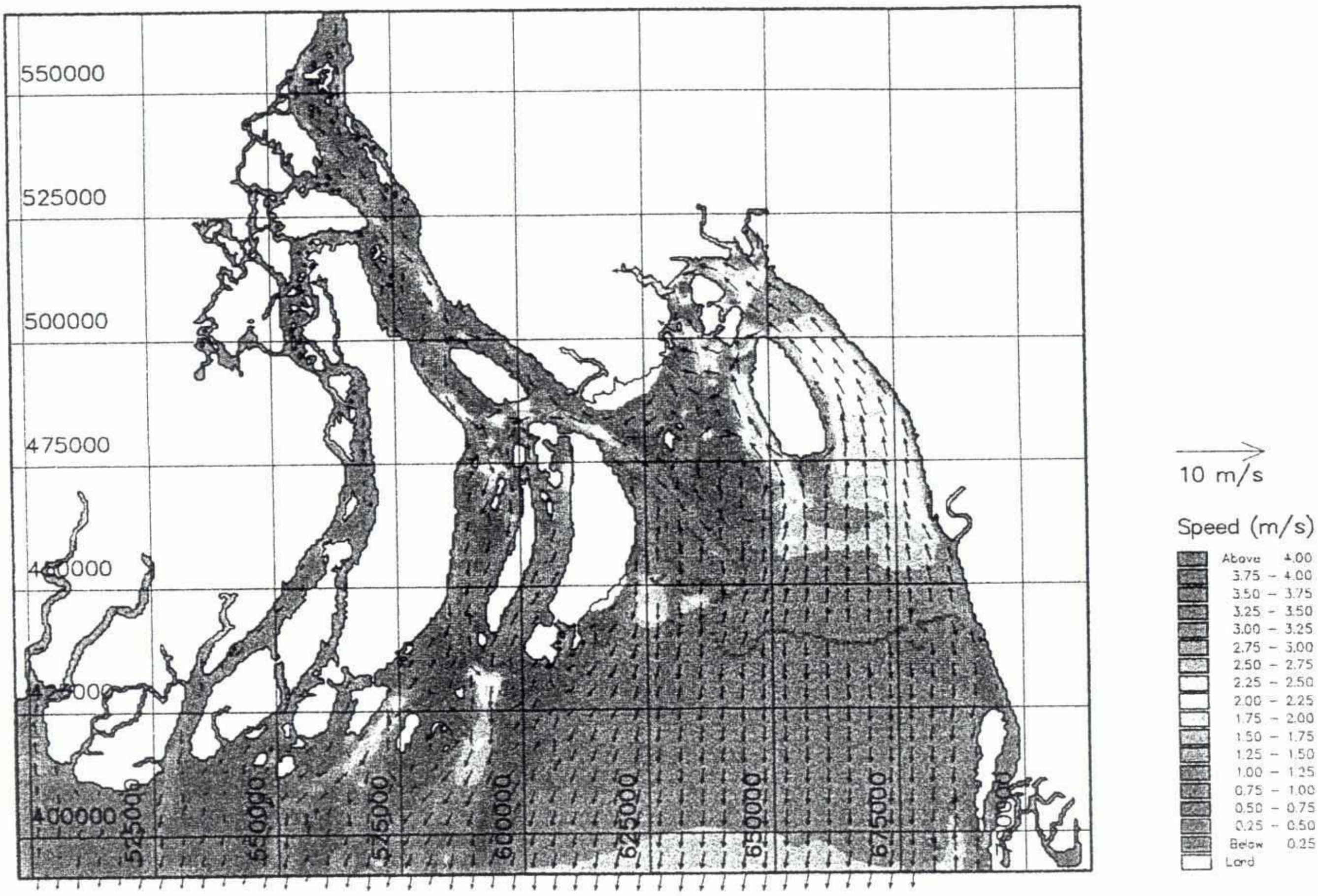


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.1	
Scale: 1:1500000	Init: p5011			



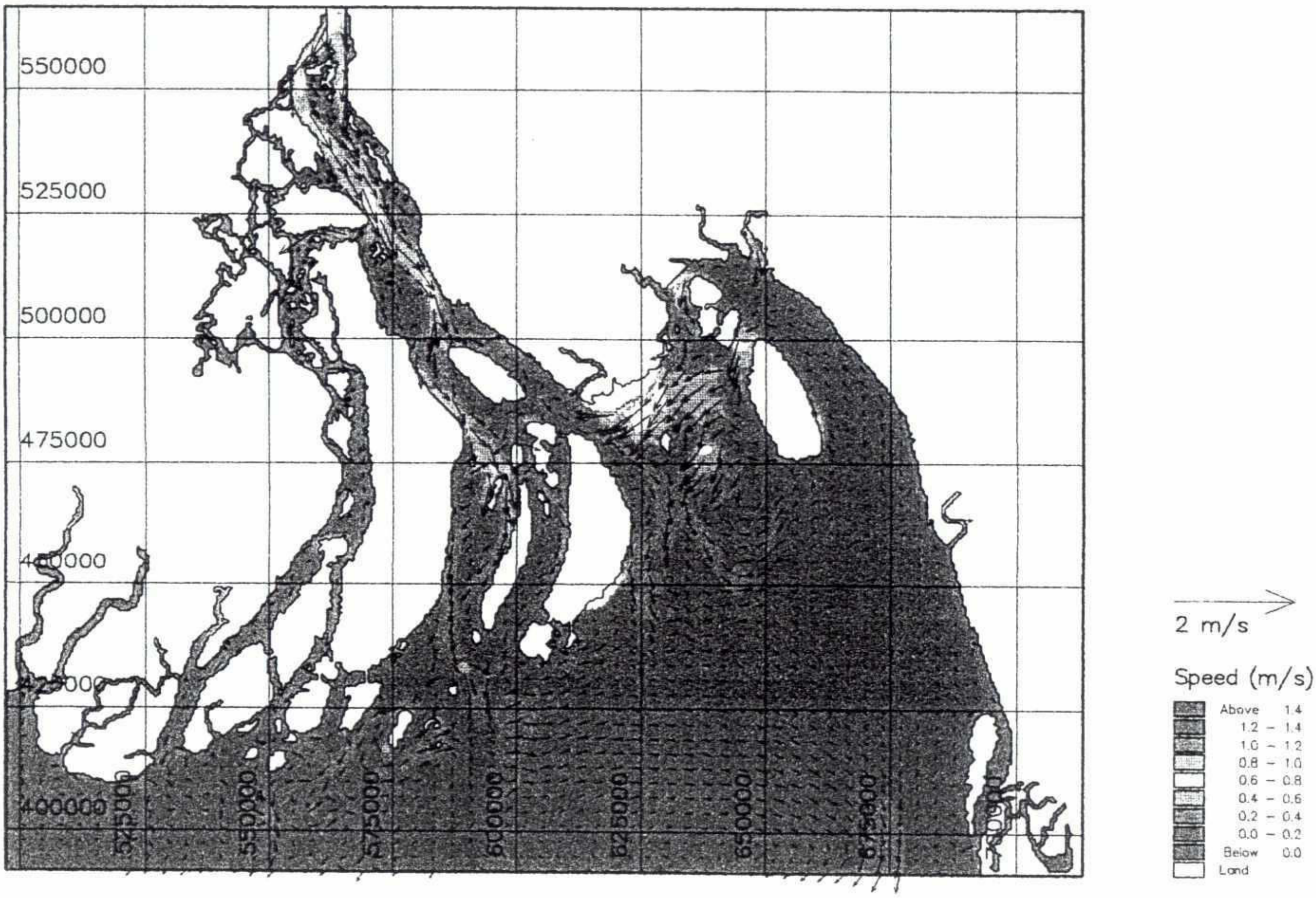
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.2
Scale: 1:1500000	Init: p5011		

226



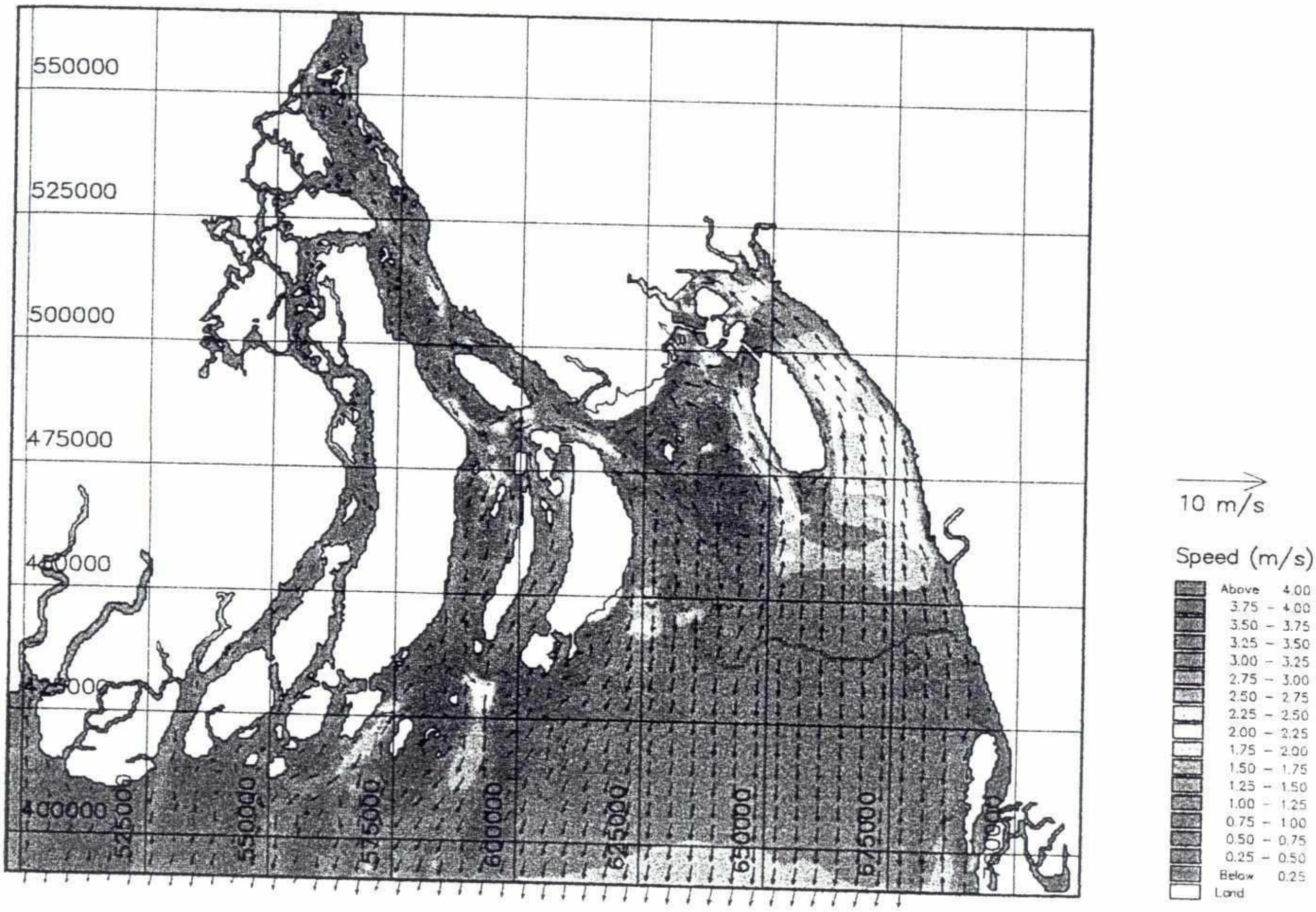
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 All intervention Schemes, excl. 8	Drawing no. 6.3	
Scale: 1:1500000	Init: p5011			

228



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 All intervention Schemes, excl. 8	Drawing no. 6.4
Scale: 1:1500000	Init: p5011		

22



SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 All intervention Schemes	Drawing no. 6.5	
Scale: 1:1500000	Init: p5011			

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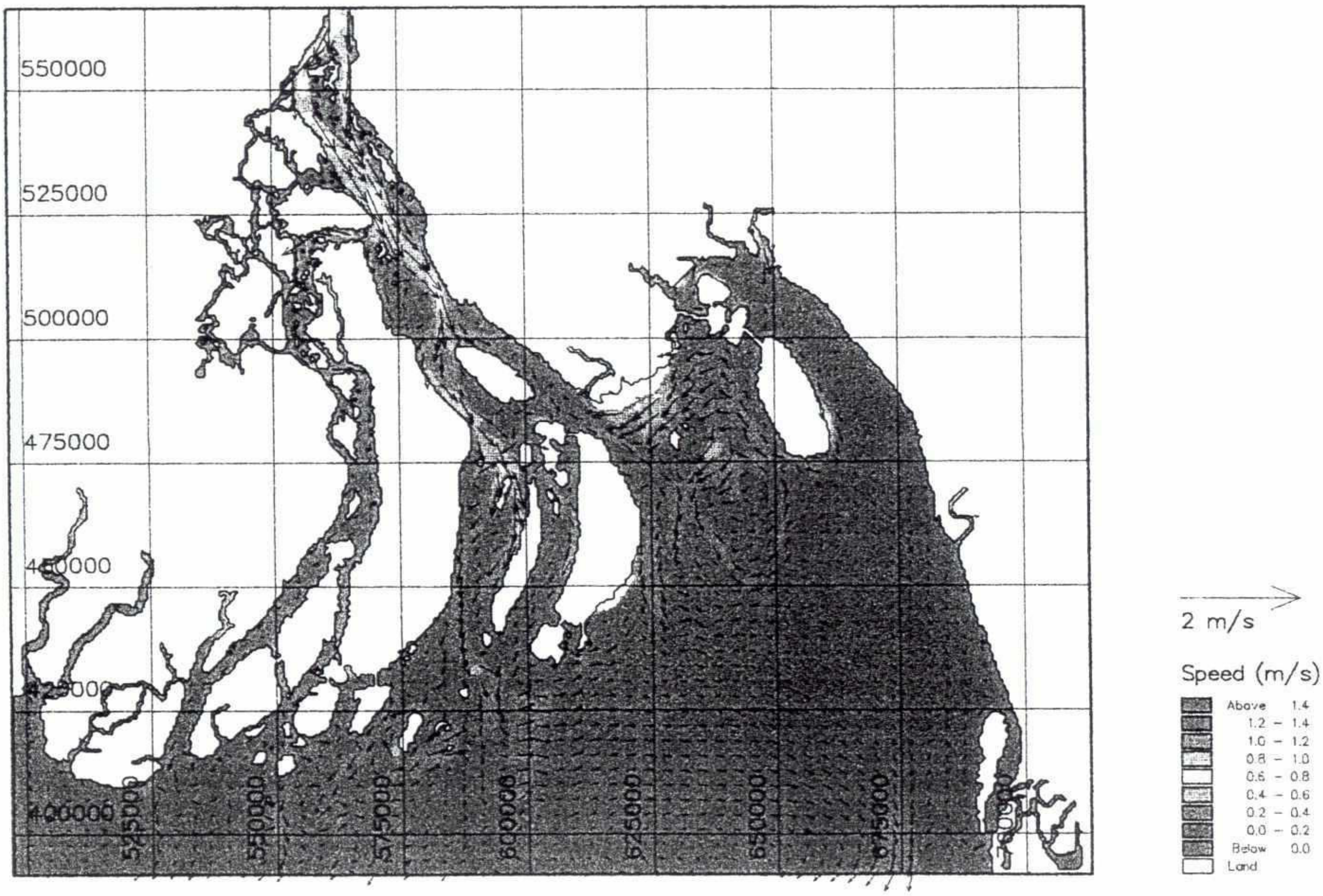
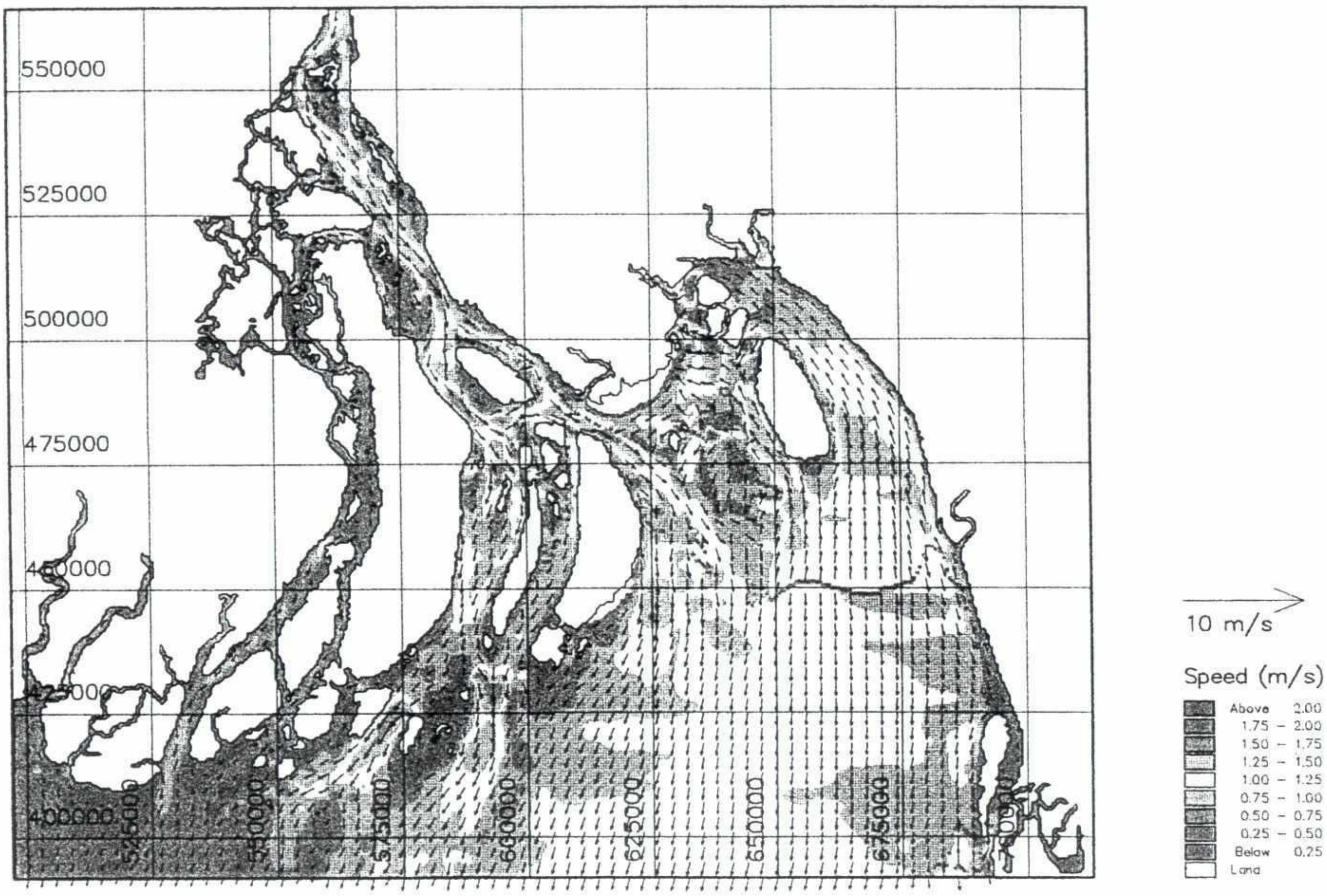
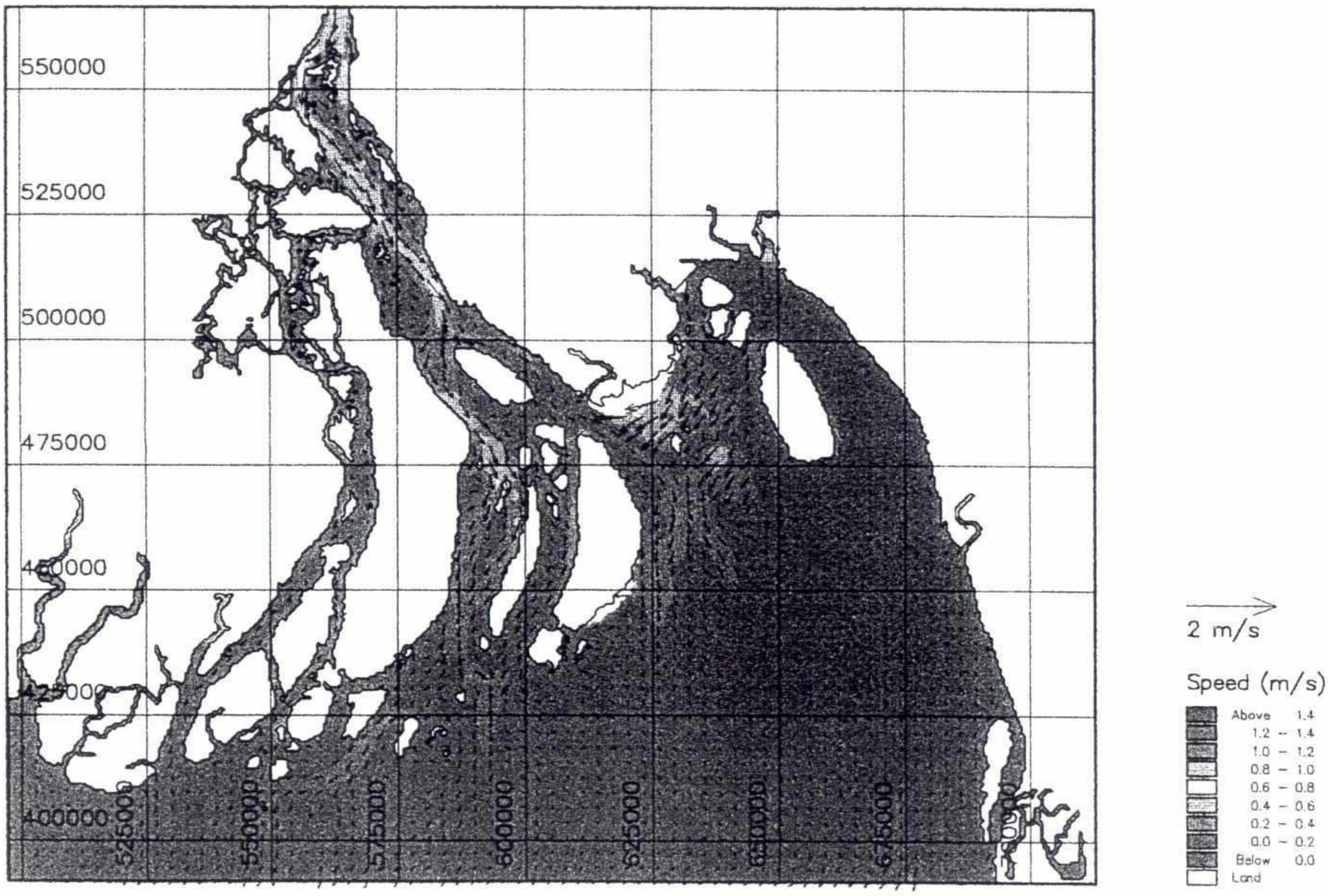


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 All intervention Schemes	Drawing no. 6.6	
Scale: 1:1500000	Init: p5011			



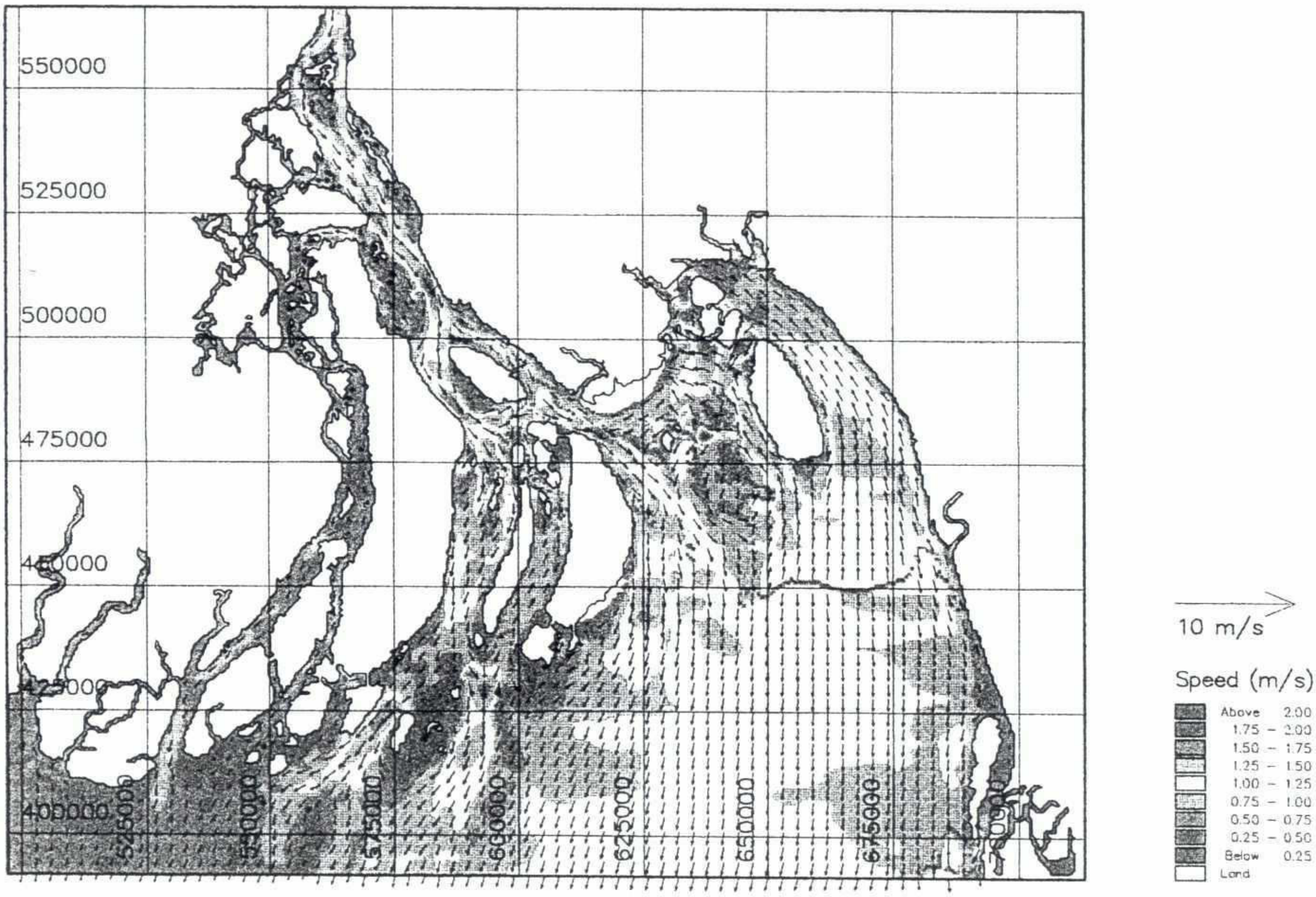
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Neap Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.7
Scale: 1:1500000	Init: p5011		

228



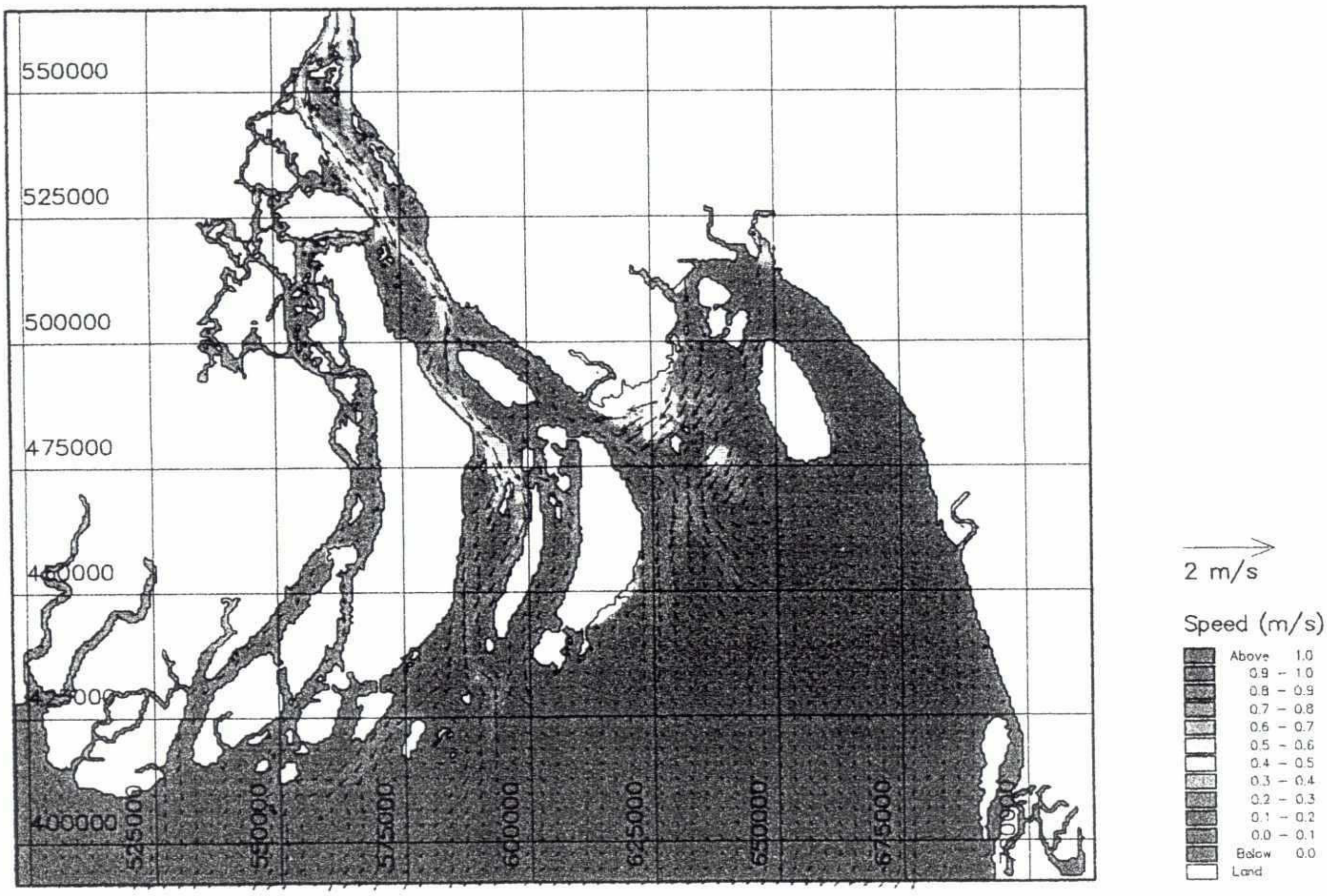
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Neap Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.8
Scale: 1:1500000	Init: p5011		

22 D



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Max velocities for Neap Tide, Dry Season 1996 All intervention Schemes, excl. 8	Drawing no. 6.9
Scale: 1:1500000	Init: p5011		

260



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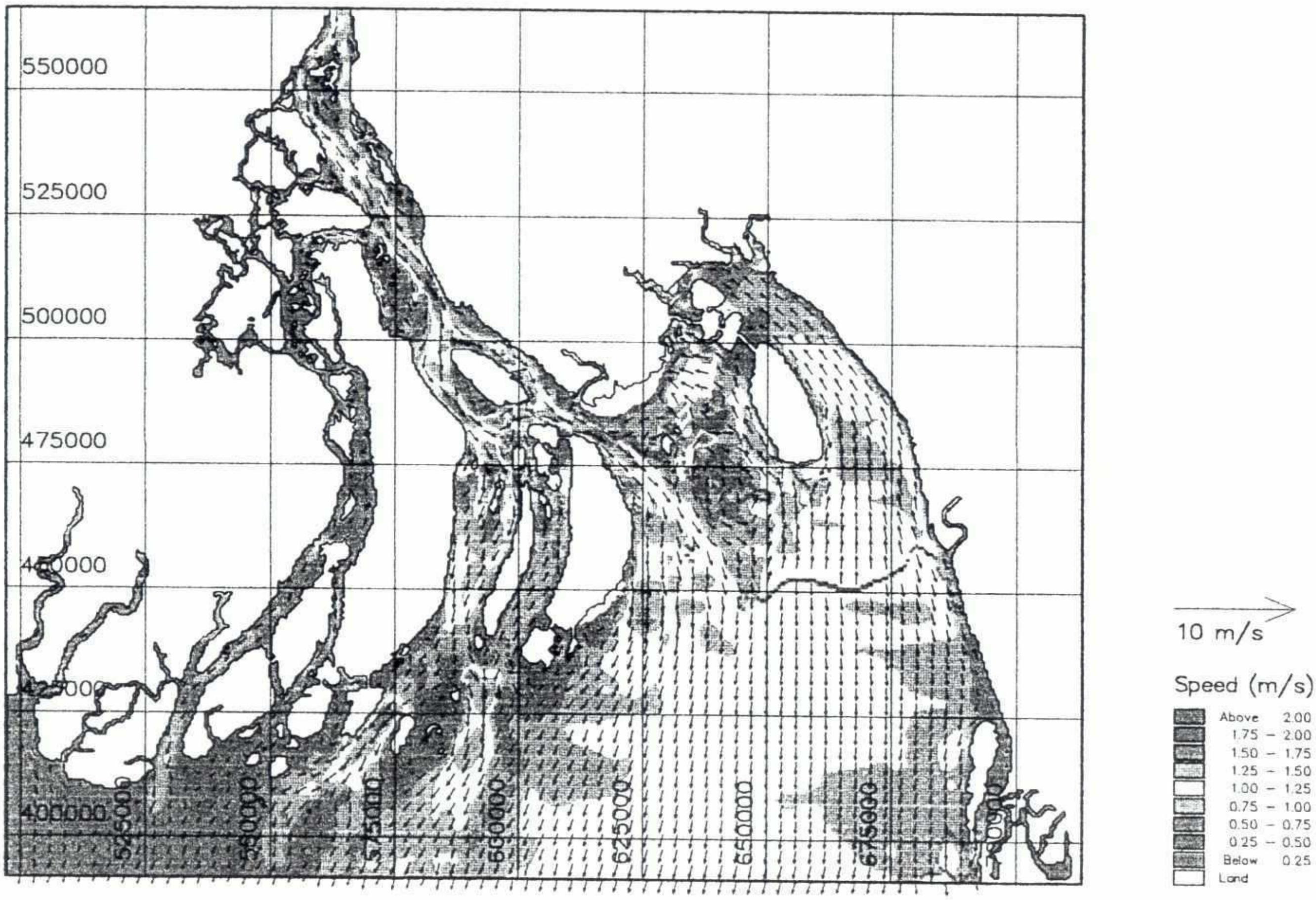
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Net flow for Neap Tide, Dry Season 1996 All intervention Schemes, excl. 8	Drawing no. 6.10
Scale: 1:1500000	Init: p5011		

262



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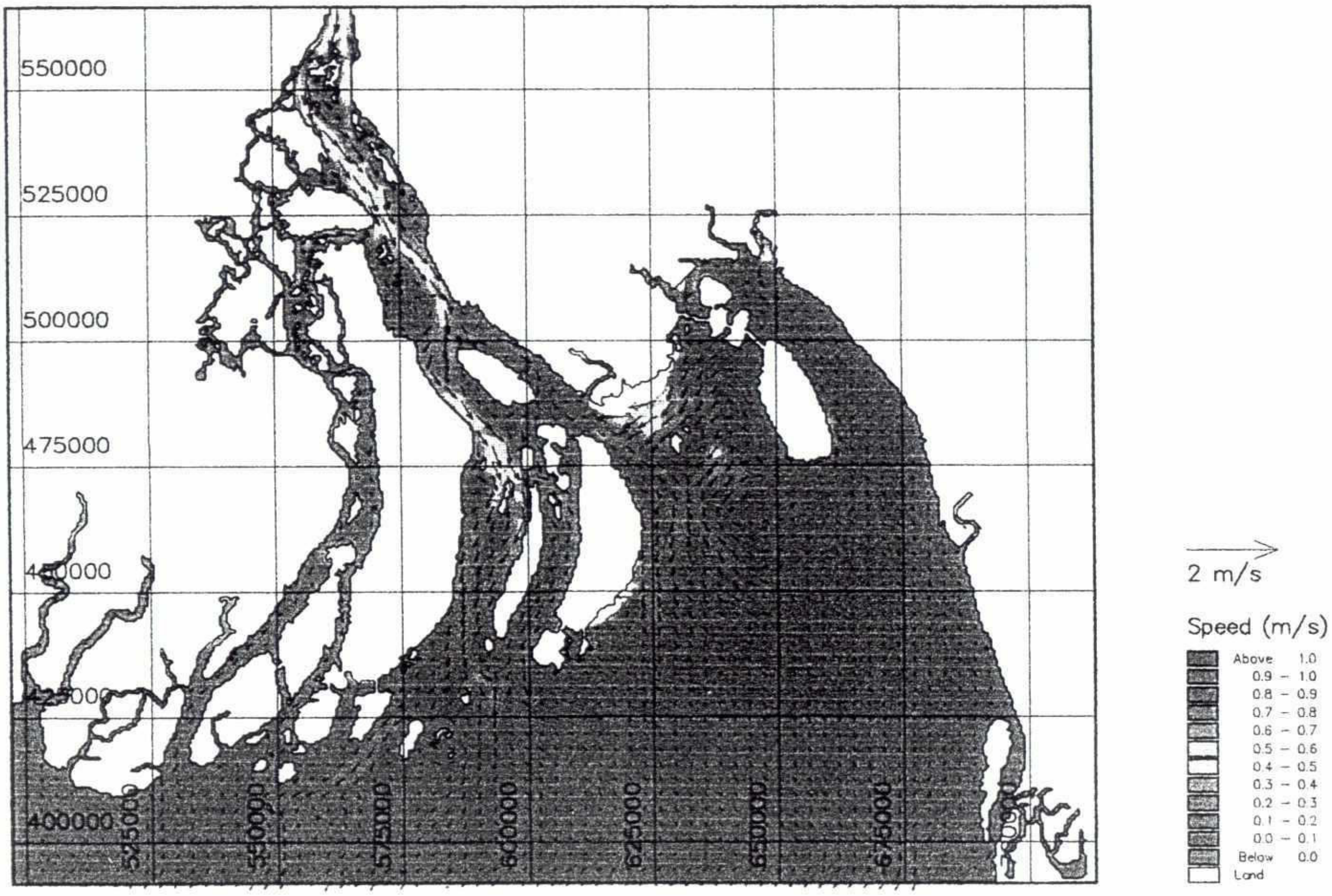
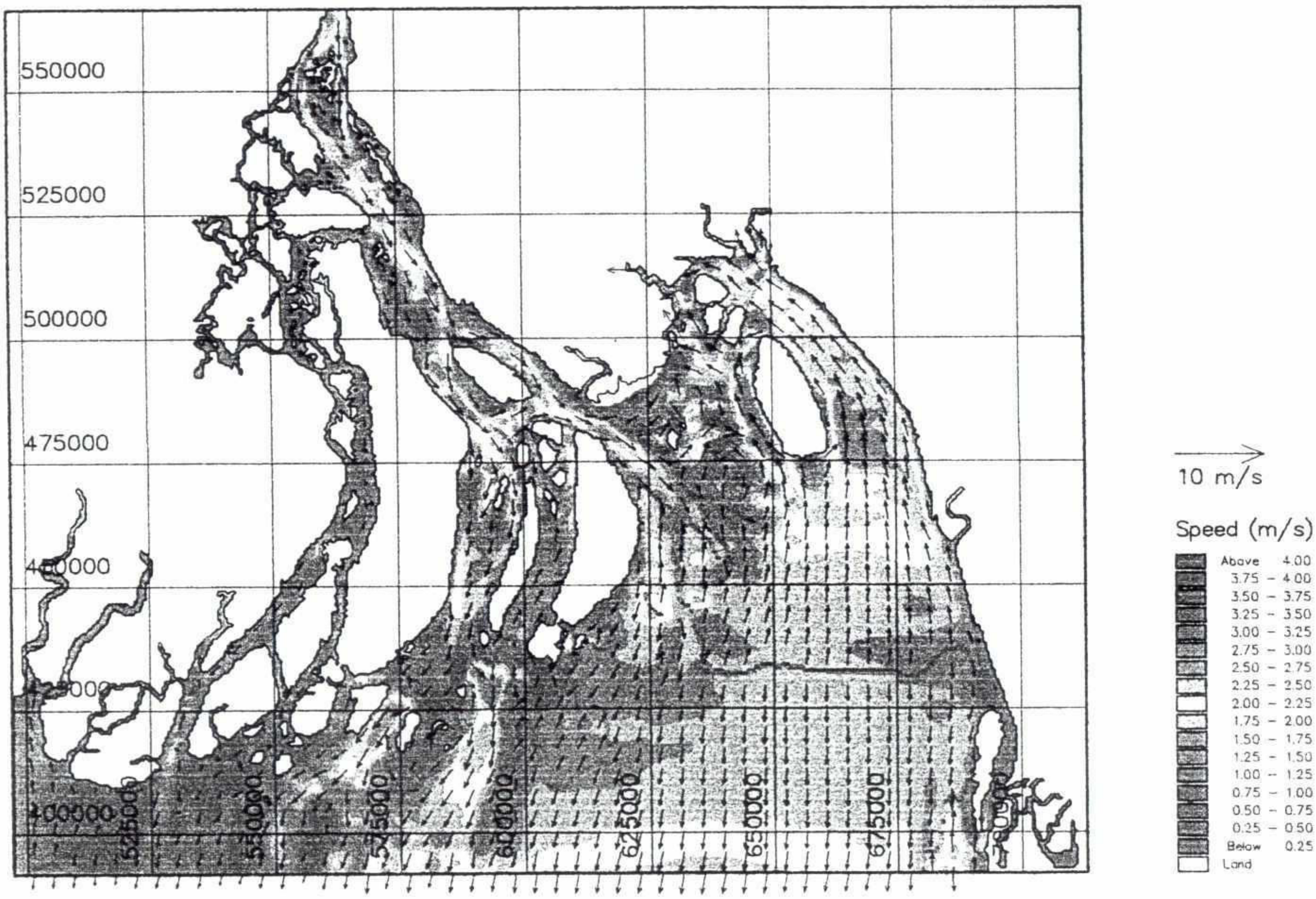
File:	Date: Mon Jun 8 1998	Max velocities for Neap Tide, Dry Season 1996 All intervention Schemes	Drawing no. 6.11
Scale: 1:1500000	Init: p5011		

262



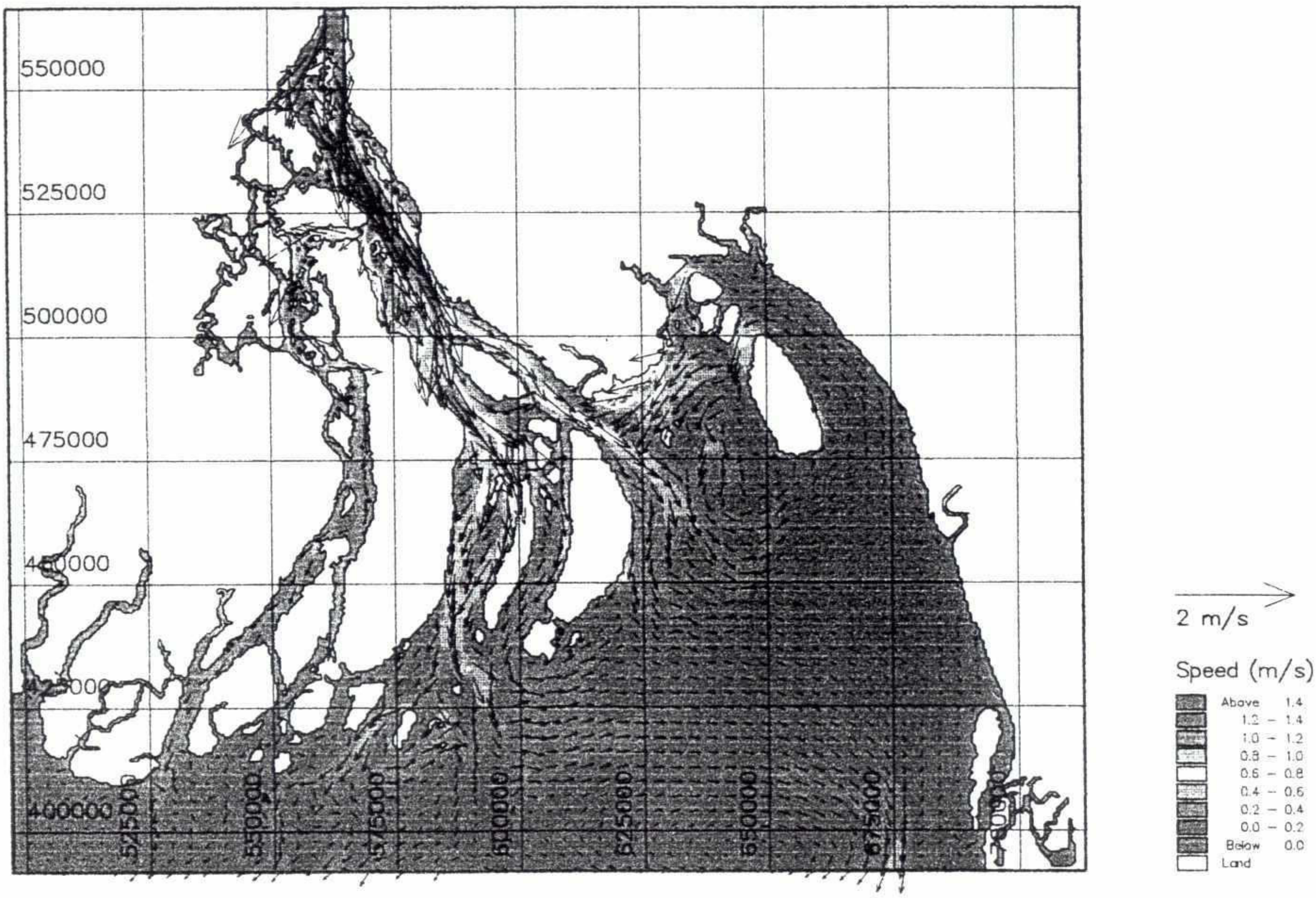
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Neap Tide, Dry Season 1996 All intervention Schemes	Drawing no. 6.12
Scale: 1:1500000	Init: p5011		

2006



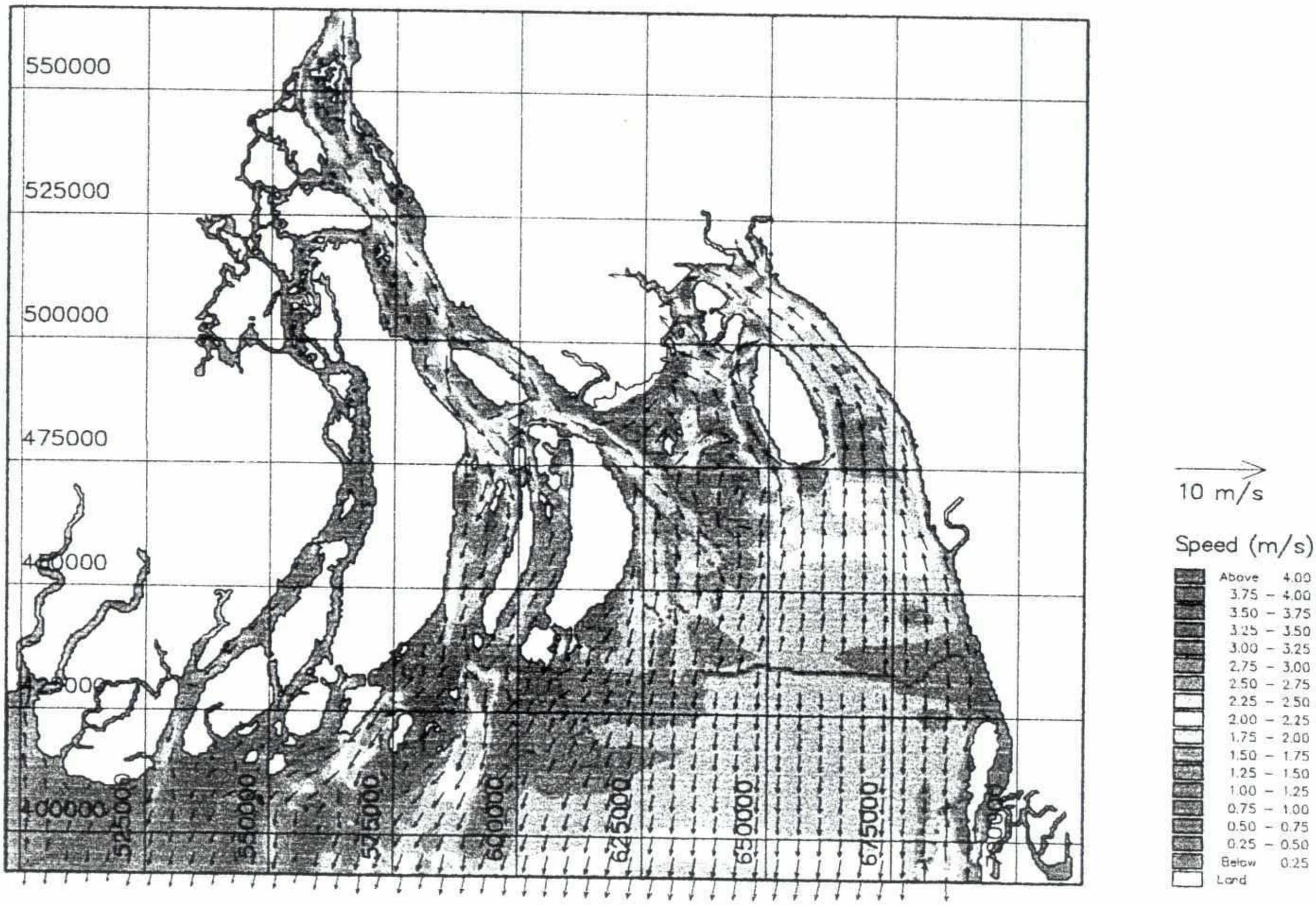
SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Monsoon 1997 Intervention Schemes 1 and 3	Drawing no. 6.13
Scale: 1:1500000	Init: p5011		

208



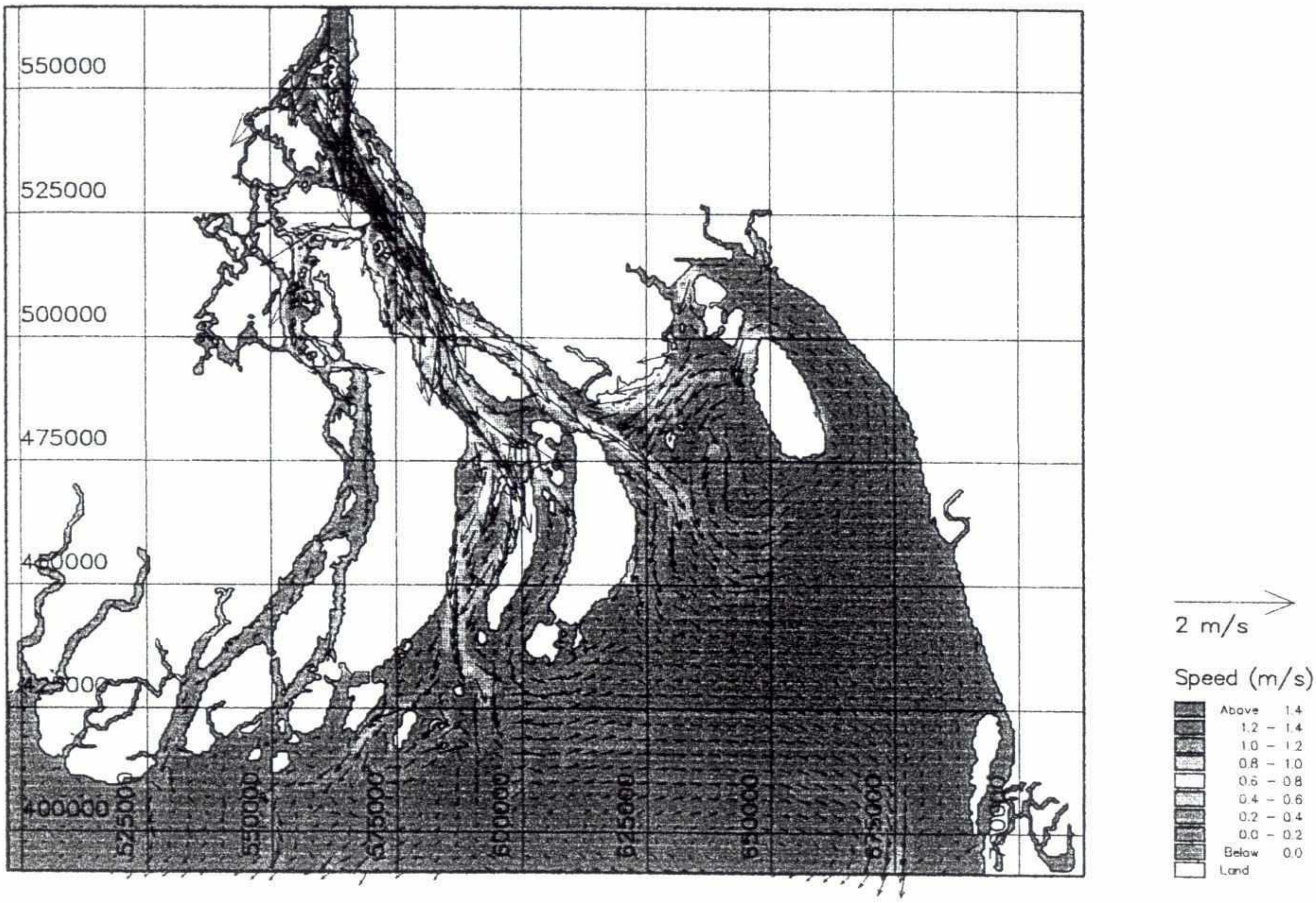
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Monsoon Season 1997 Intervention Schemes 1 and 3	Drawing no. 6.14	
Scale: 1:1500000	Init: p5011			

26a



SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File: / Date: Mon Jun 8 1998	Max velocities for	Drawing no.	
Scale: 1:1500000 / Init: p5011	Spring Tide, Monsoon 1997 All intervention Schemes, excl. 8	6.15	

263



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
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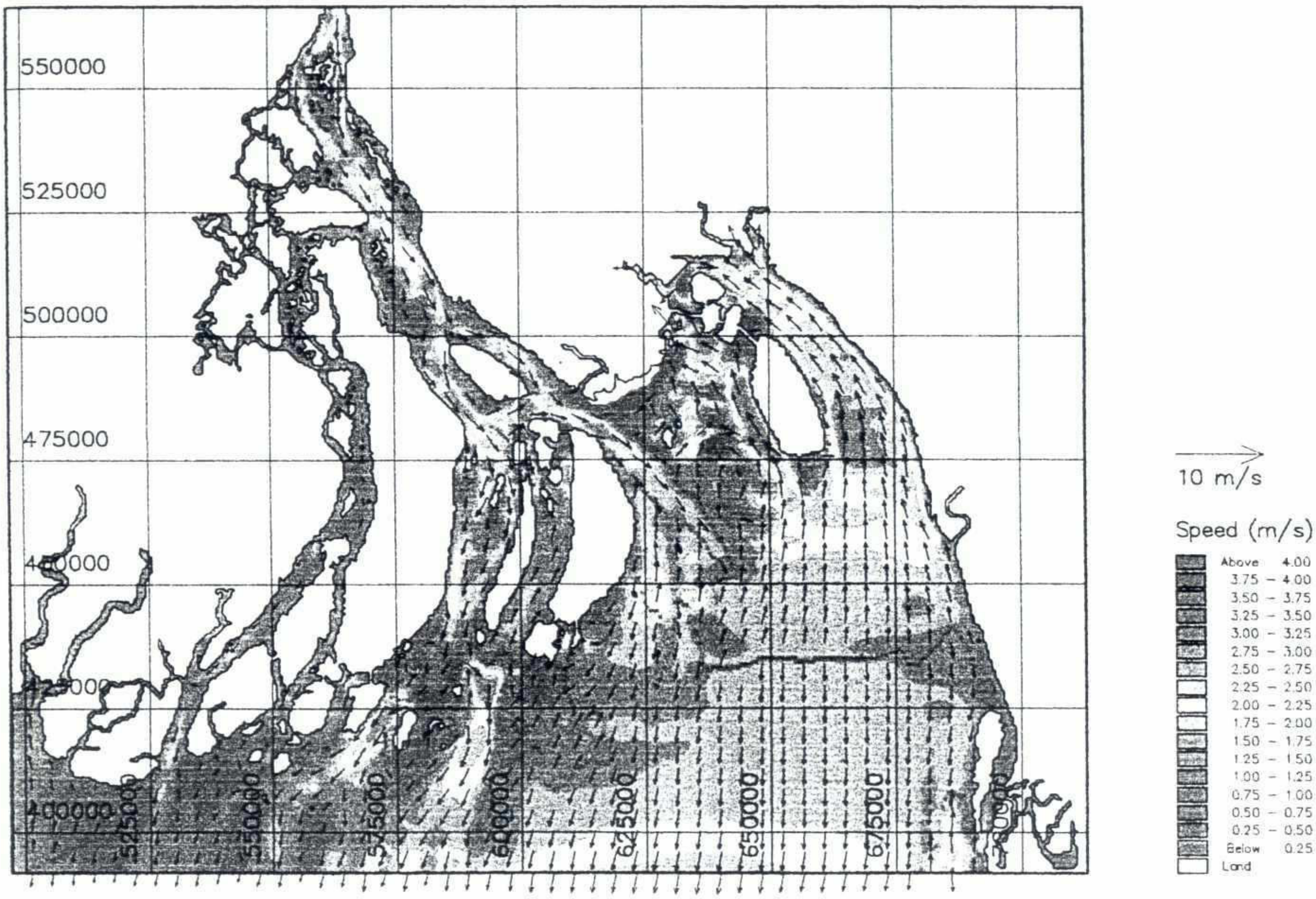
237



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File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Monsoon 1997 All intervention Schemes	Drawing no. 6.17
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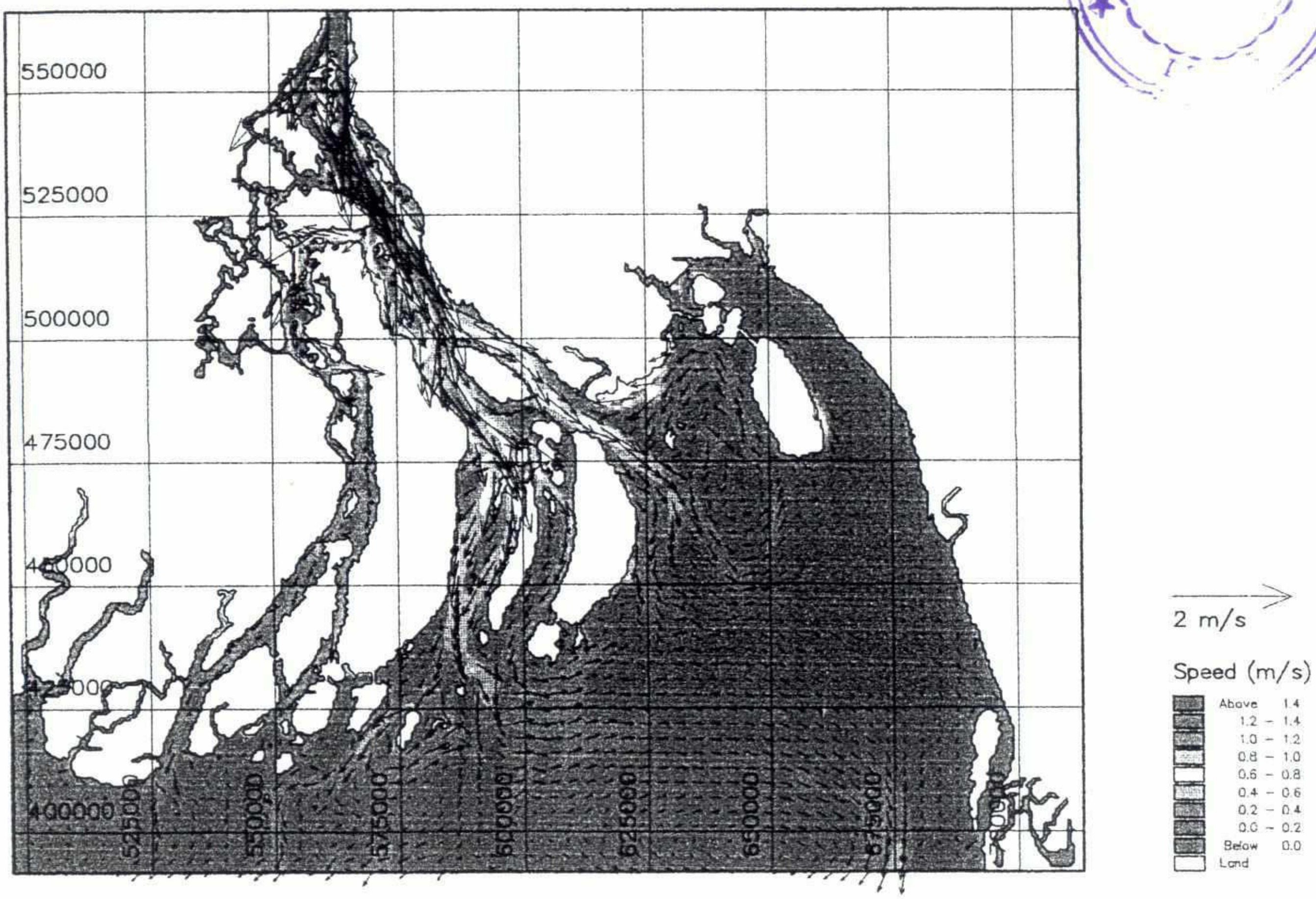
267



SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Monsoon Season 1997 All intervention Schemes	Drawing no. 6.18	
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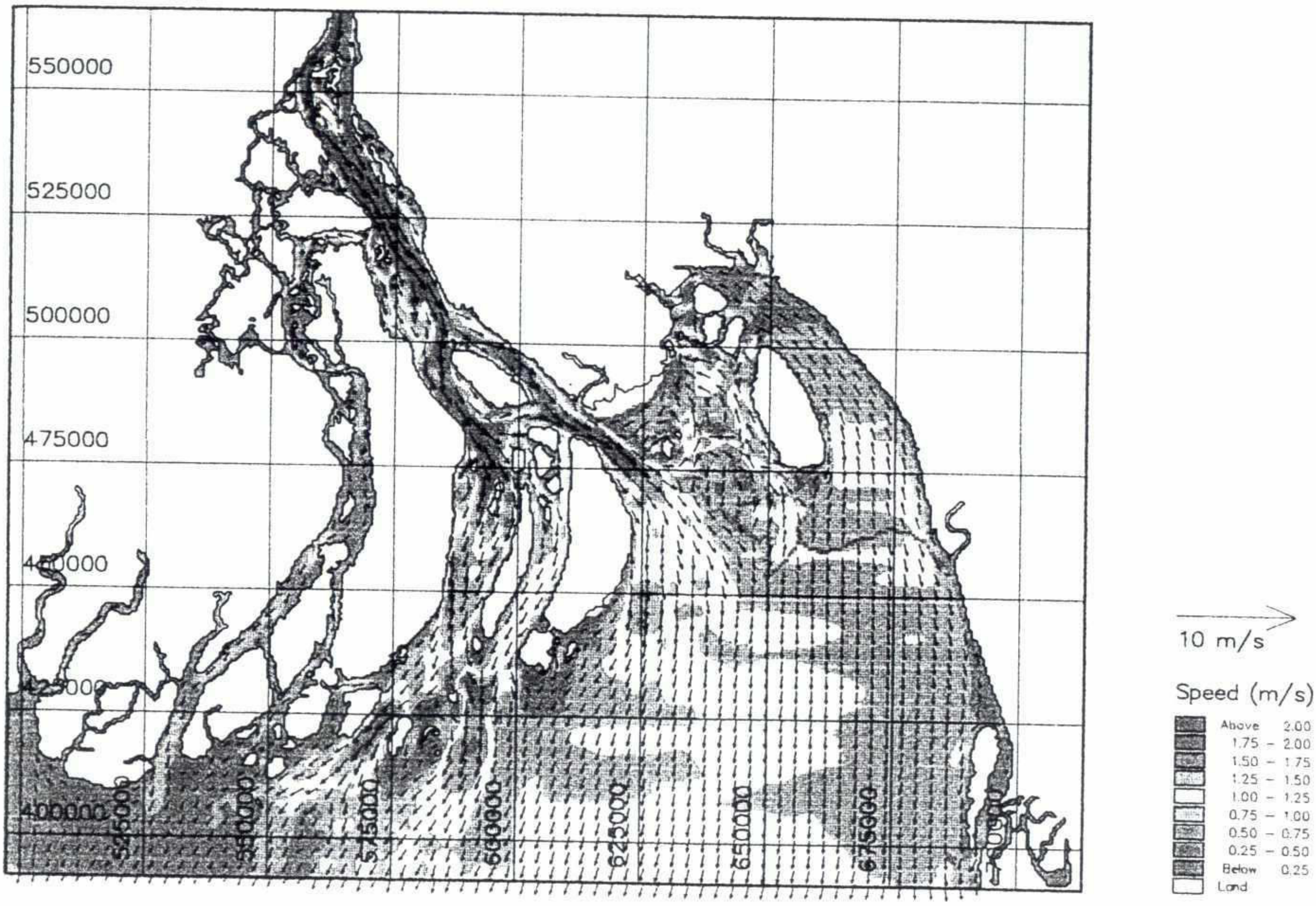

SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
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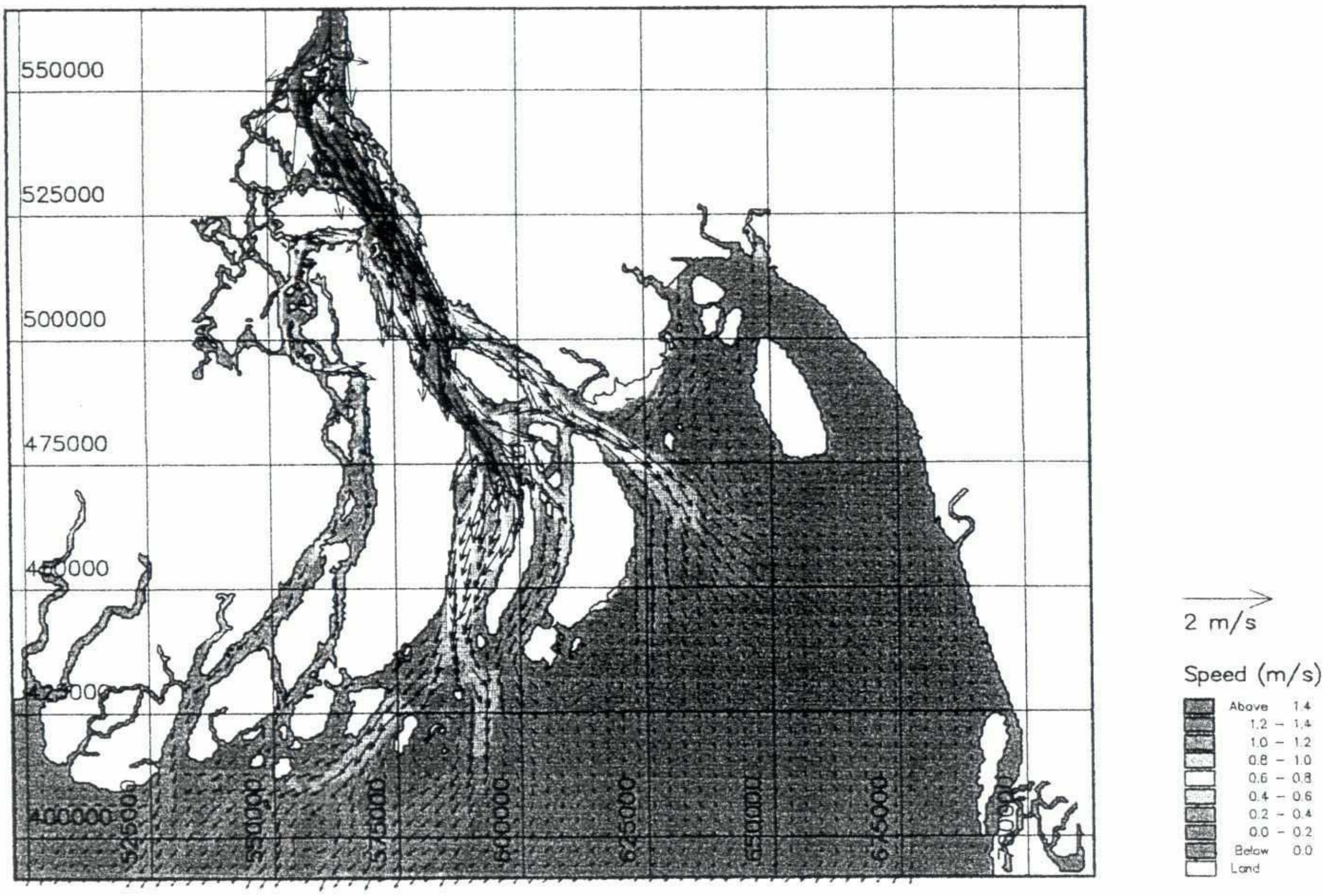
Scale: 1:1500000	Init: p5011			

2 87



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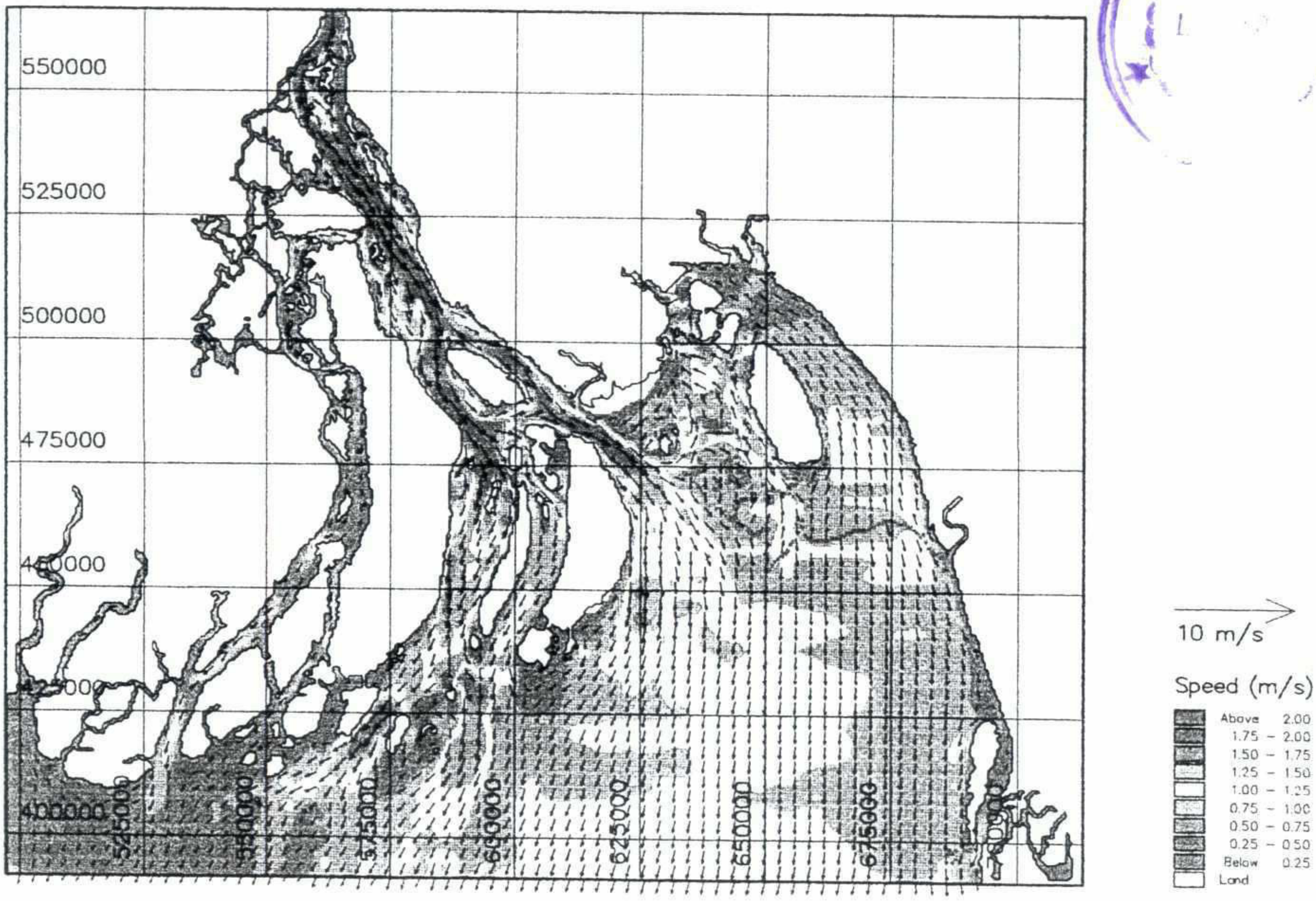
Scale: 1:1500000	Init: p5011		

282



SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
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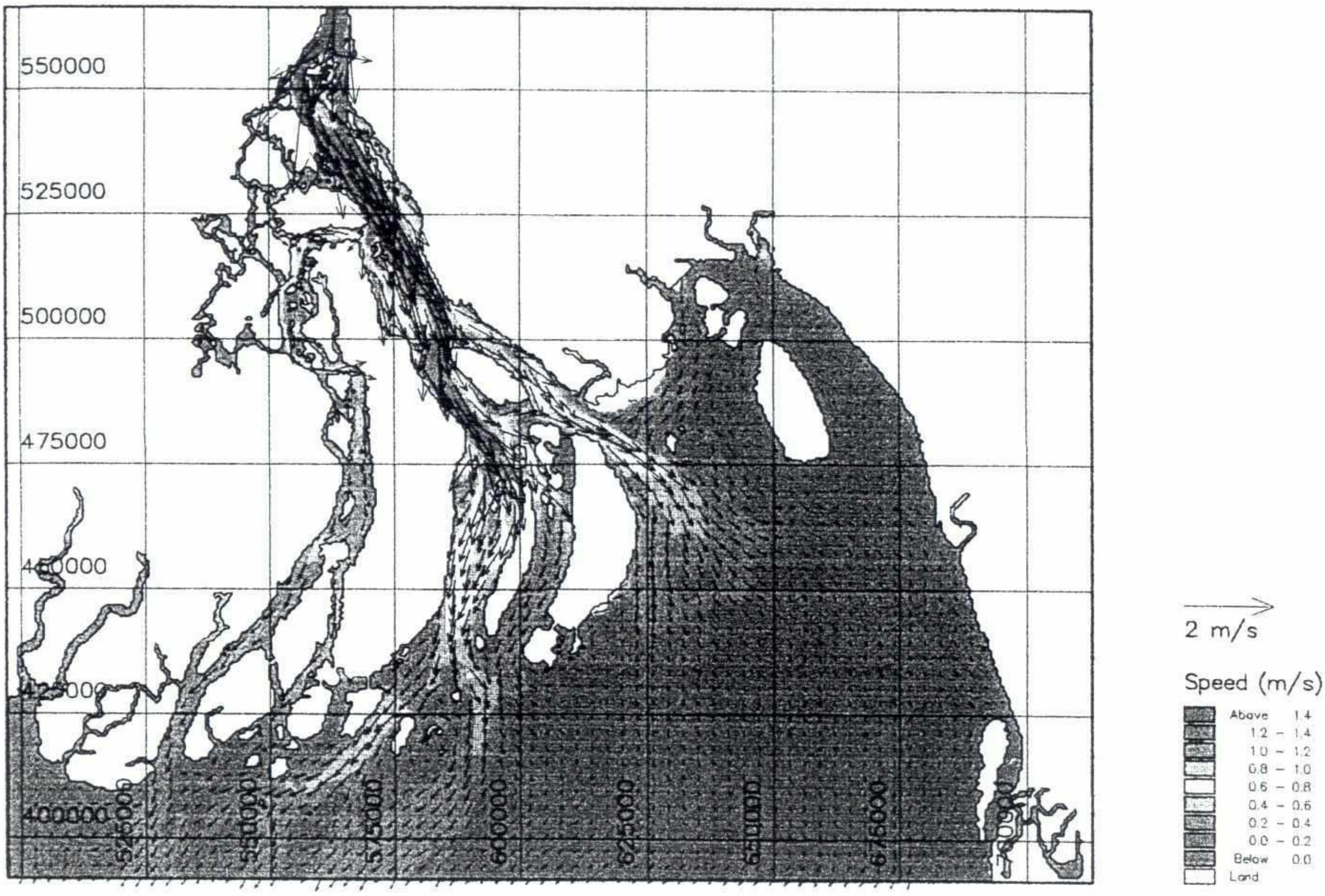
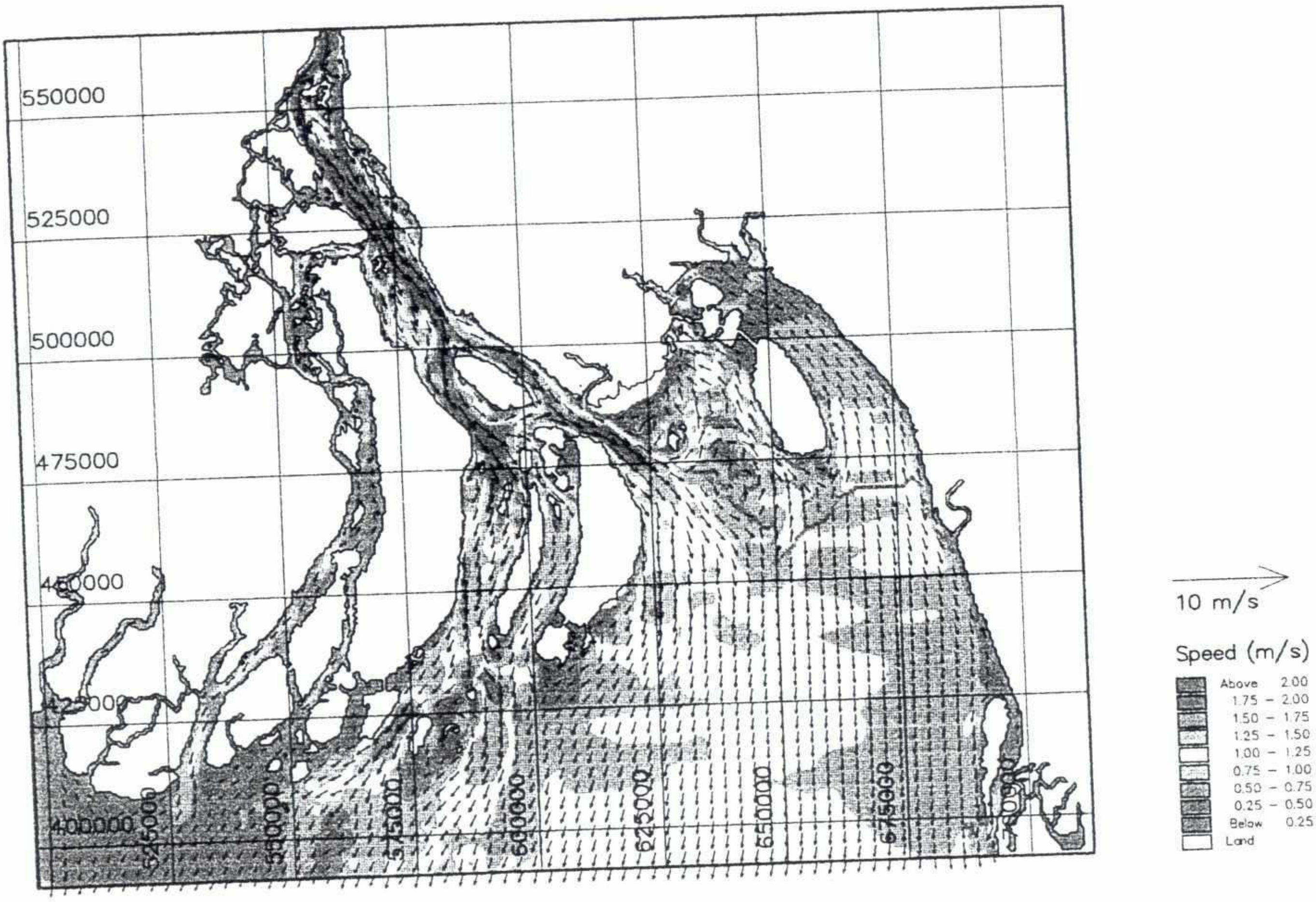
Scale: 1:1500000	Init: p5011			

281



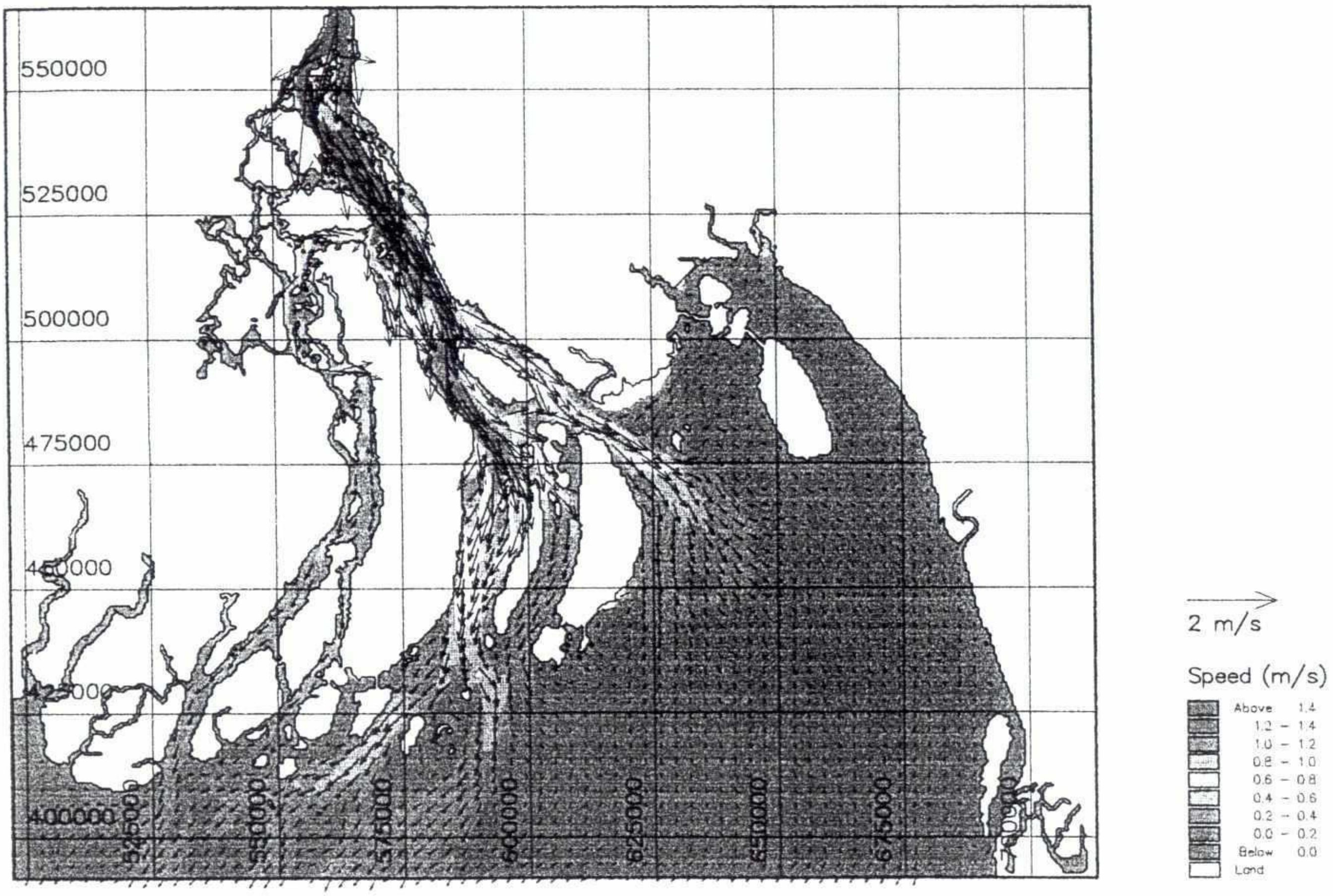
SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Net flow for Neap Tide, Monsoon Season 1997 All intervention Schemes, excl. 8	Drawing no. 6.22
Scale: 1:1500000	Init: p5011		

286



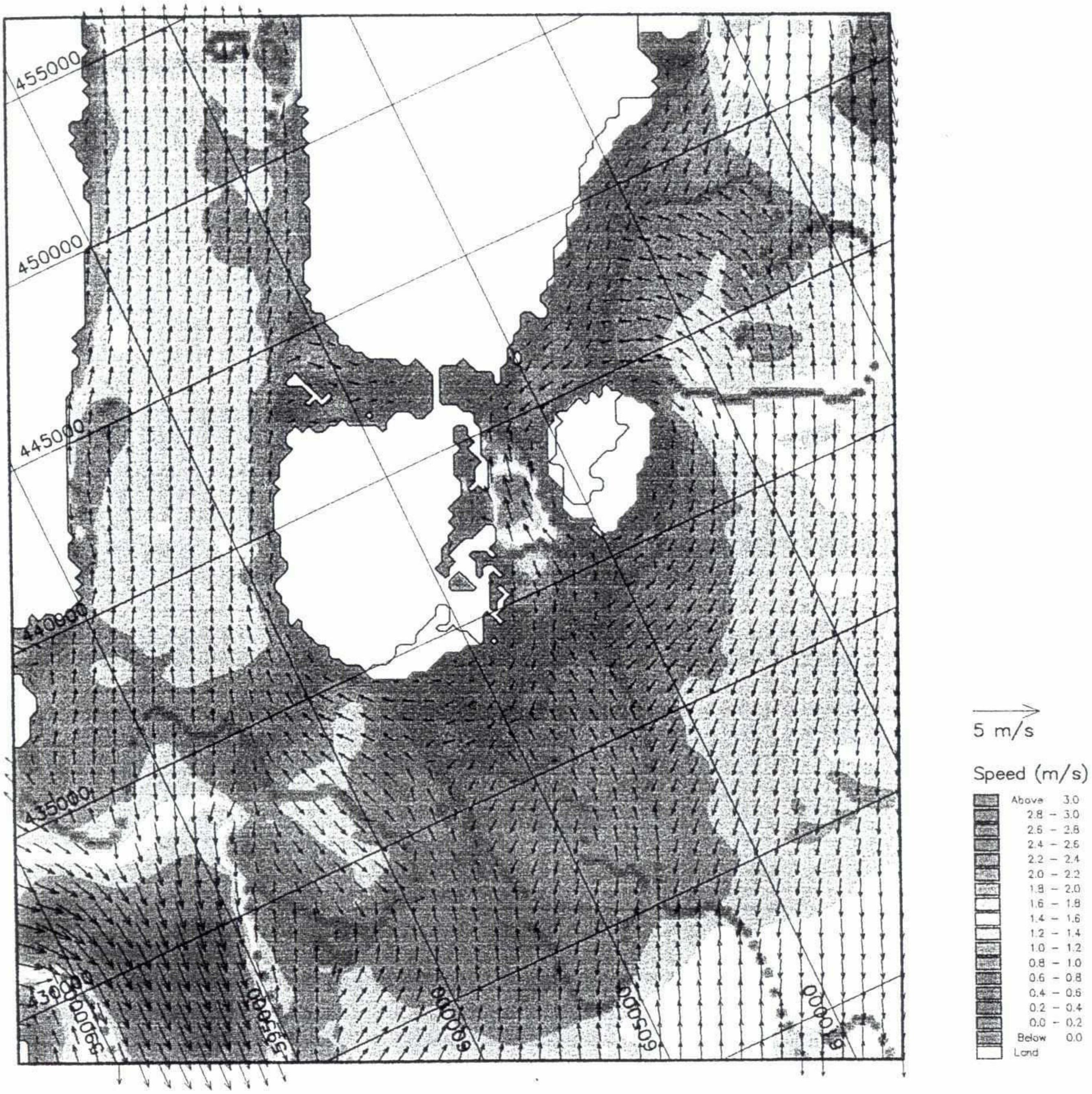
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Max velocities for Neap Tide, Monsoon Season 1997 All intervention Schemes	Drawing no. 6.23
Scale: 1:1500000	Init: p5011		

288



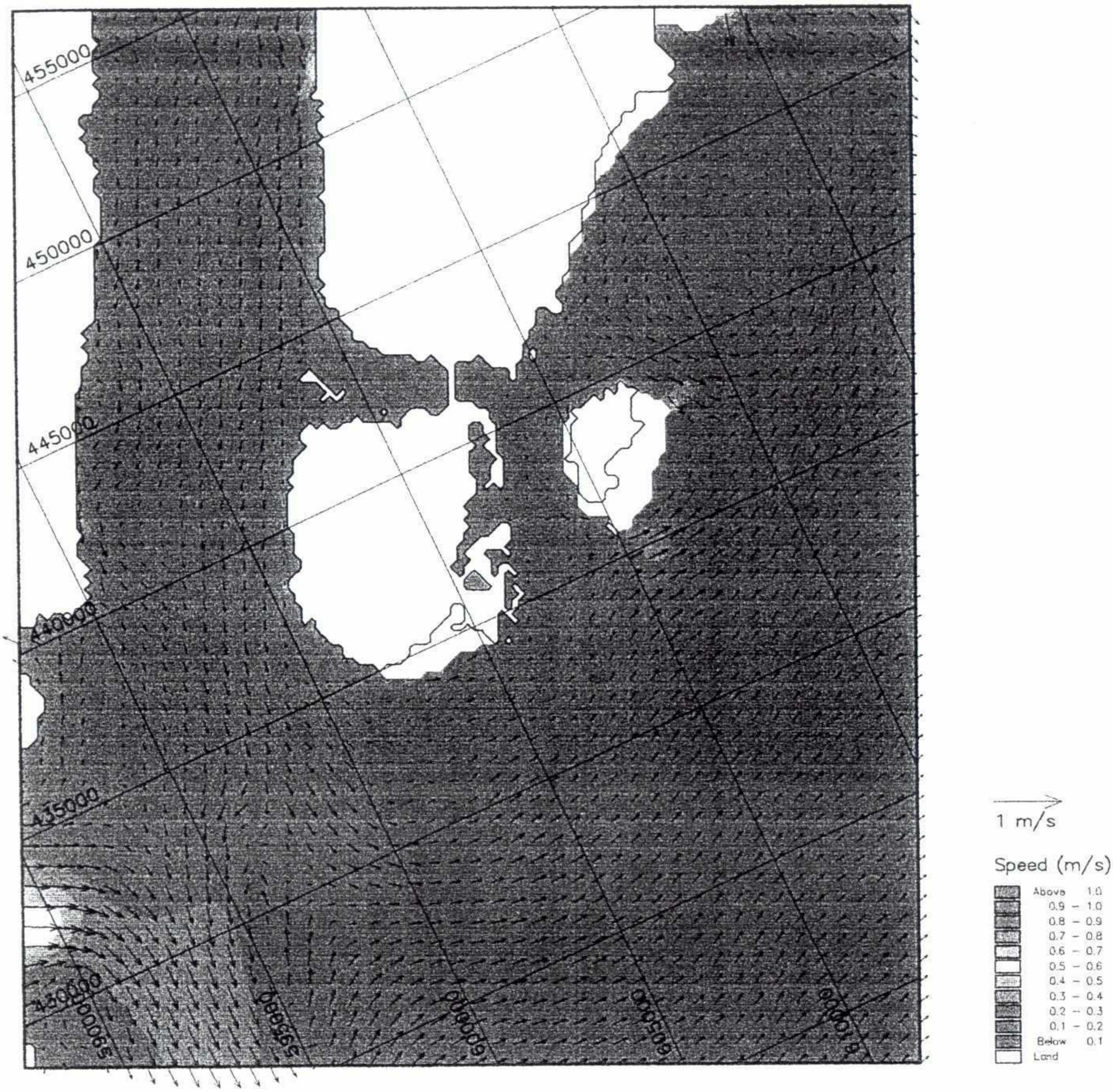
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Scale: 1:1500000	Date: Mon Jun 8 1998 / Init: p5011	Net flow for Neap Tide, Monsoon Season 1997 All intervention Schemes	Drawing no. 6.24

288



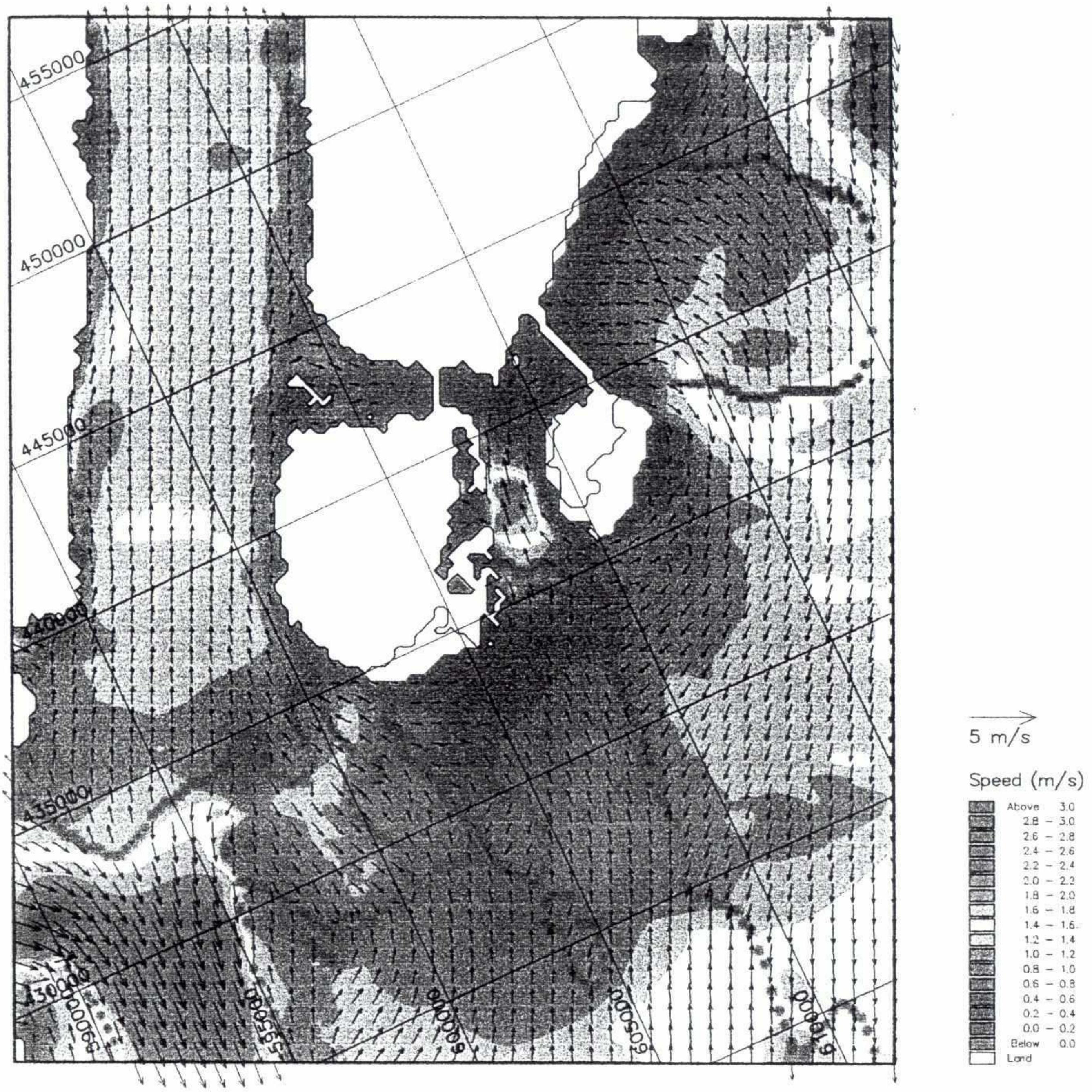
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.25	
Scale: 1:185000	Init: p5011			

283



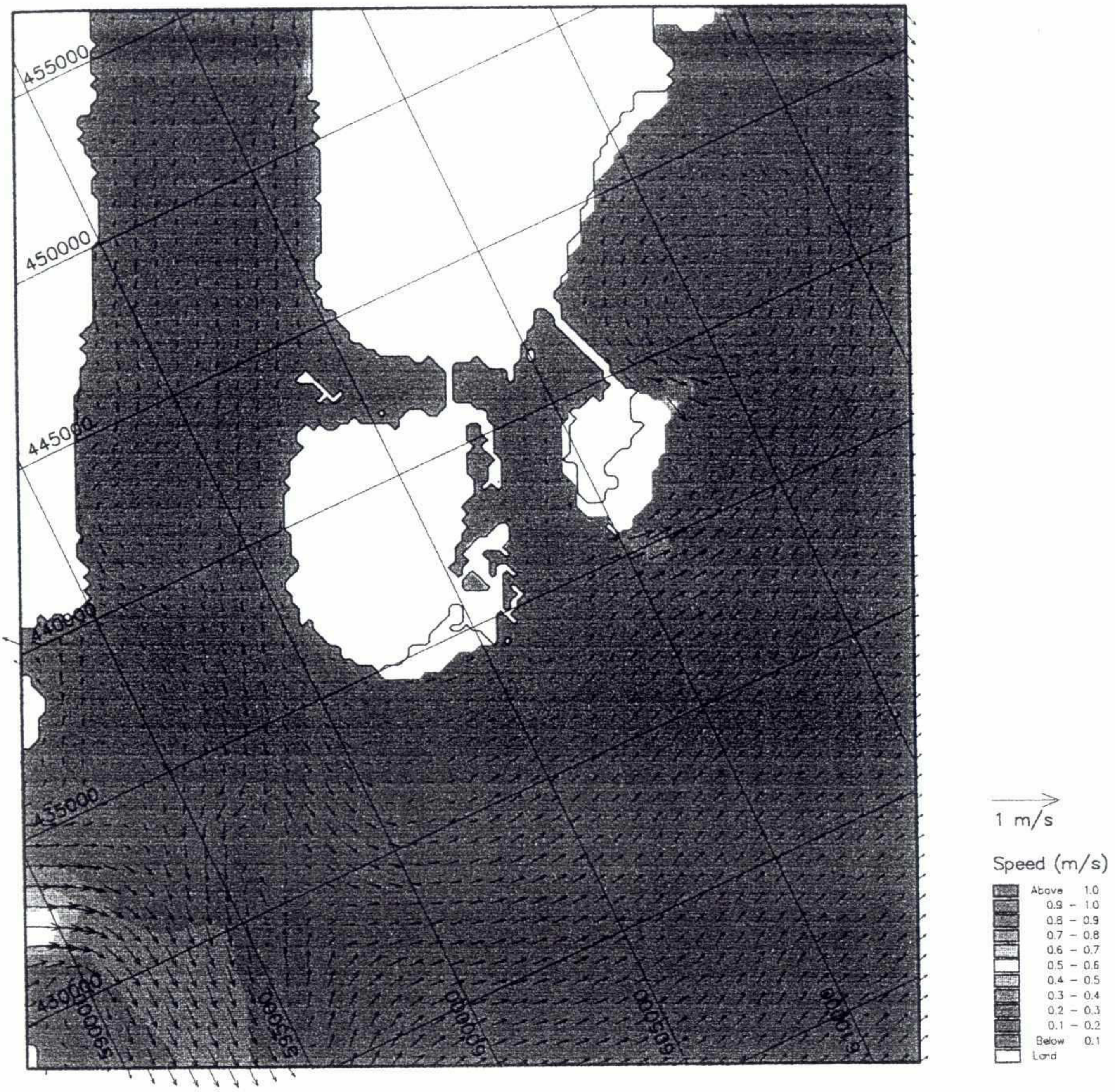
SWMC	Client: Bangladesh Water Development Board		MIKE 21
	Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Net flow for Spring Tide, Dry Season 1996 Intervention Schemes 1 and 3	Drawing no. 6.26
Scale: 1:185000	Init: p5011		

289



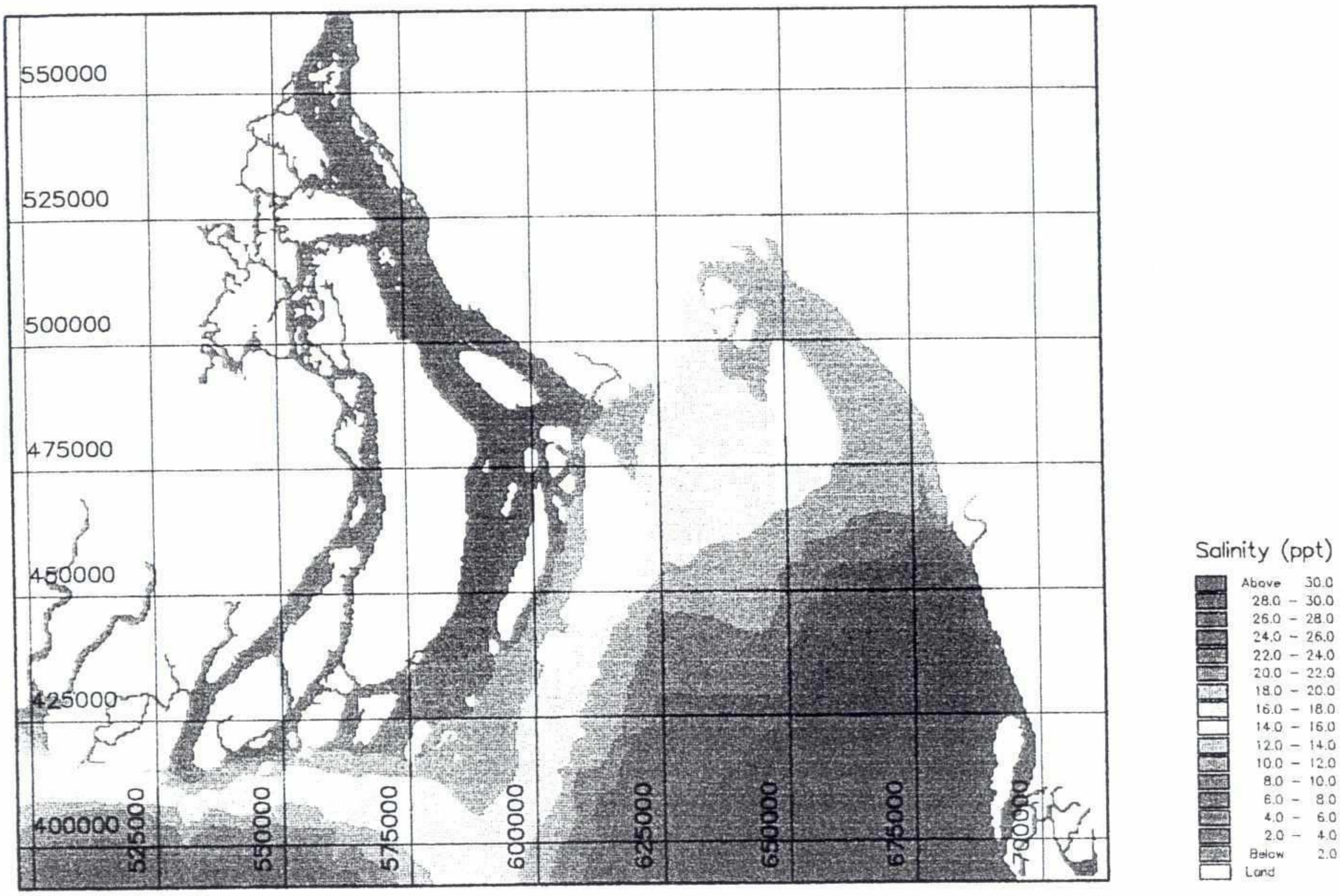
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Max velocities for Spring Tide, Dry Season 1996 All interventions Schemes	Drawing no. 6.27	
Scale: 1:185000	Init: p5011			

287

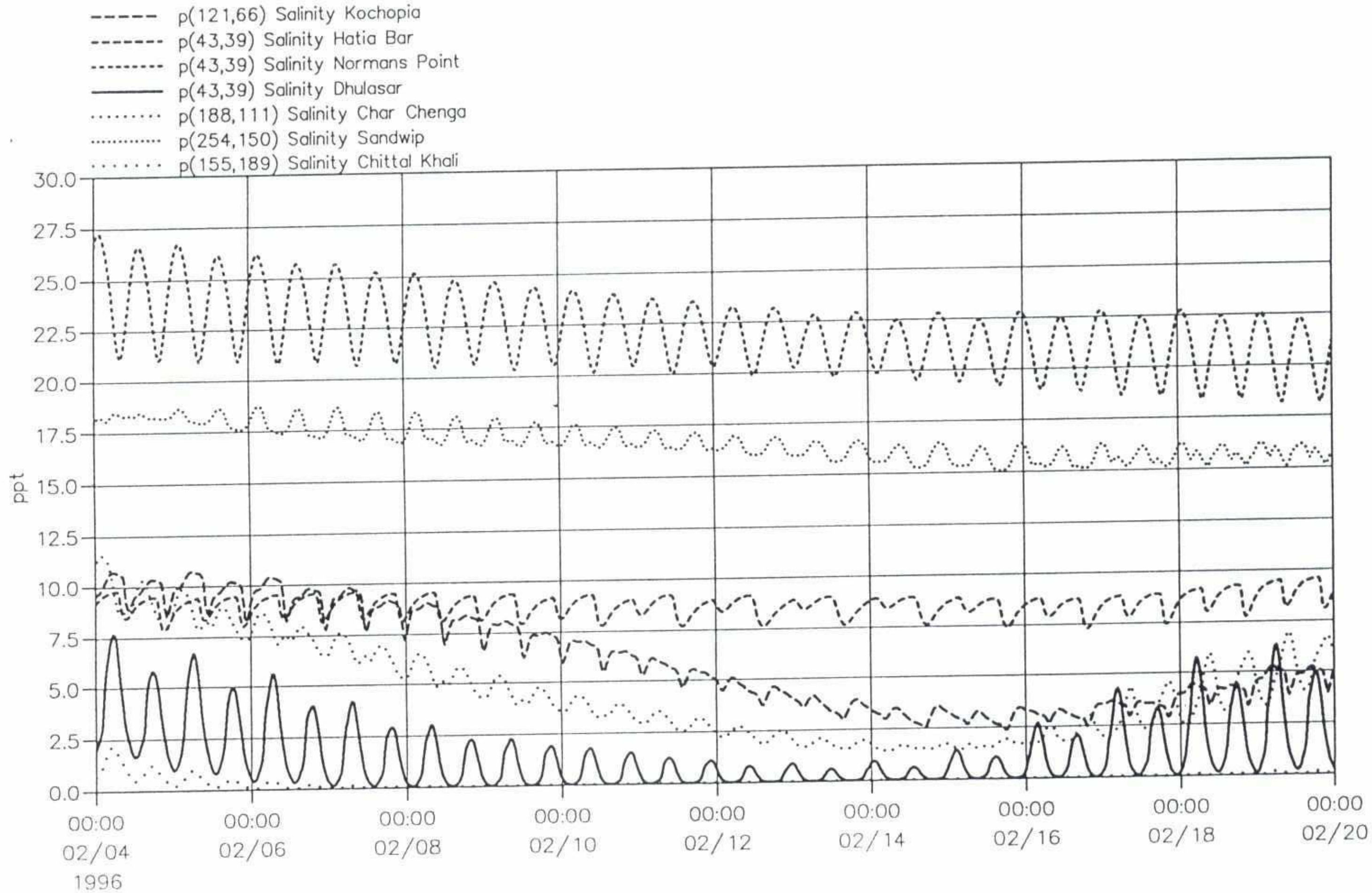


SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File: / Date: Mon Jun 8 1998 Scale: 1:185000 / Init: p5011	Net flow for Spring Tide, Dry Season 1996 All interventions Schemes	Drawing no. 6.28

2 8 7



SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	LRP salinity data 0.5 m below surface	Drawing no. 7.1
Scale: 1:1500000	Init: p5011	1986/03/21 - 1986/03/28	



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Salinity, Dry season 1996	Drawing no. 7.2
Scale:	Init: p5011		

200

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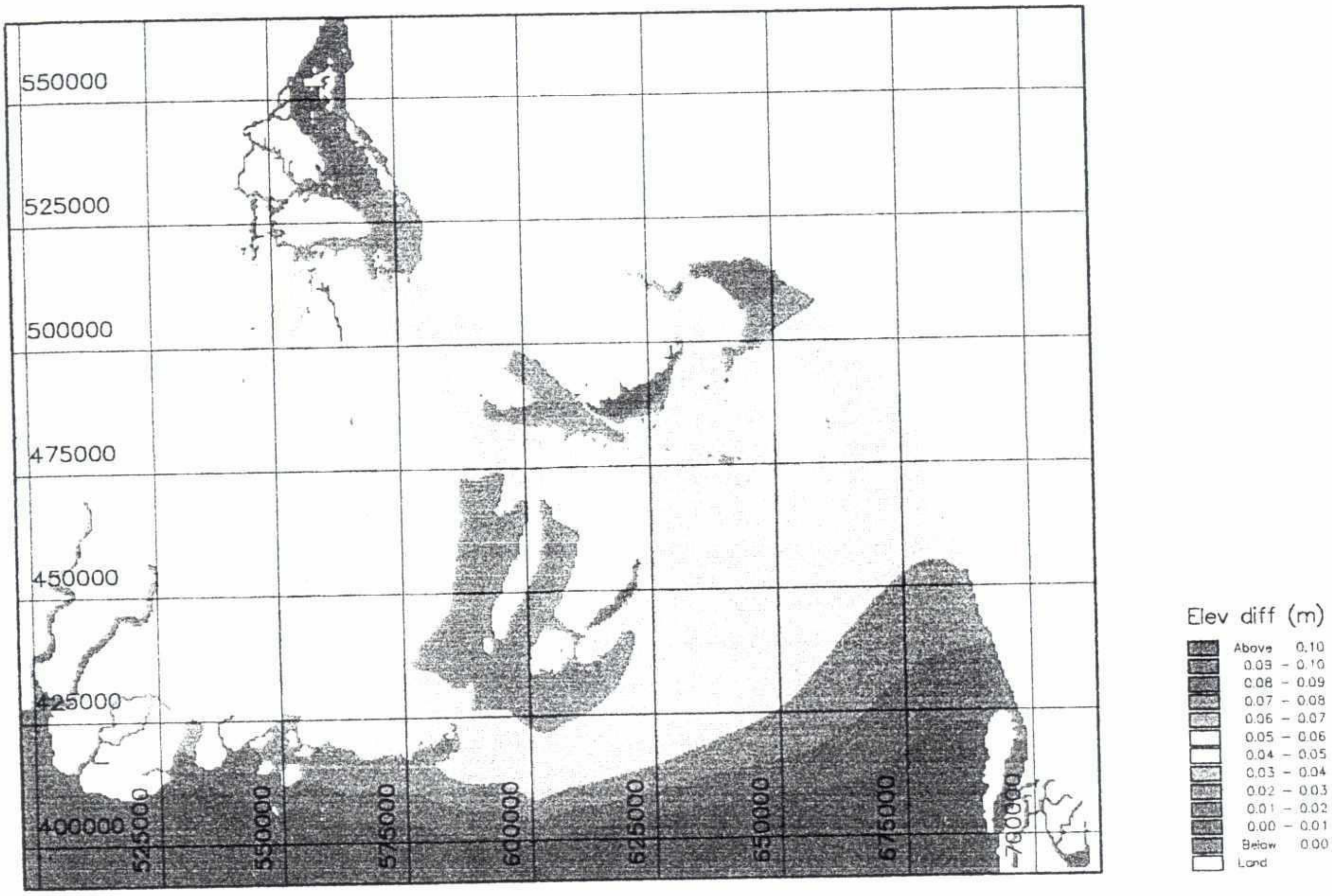
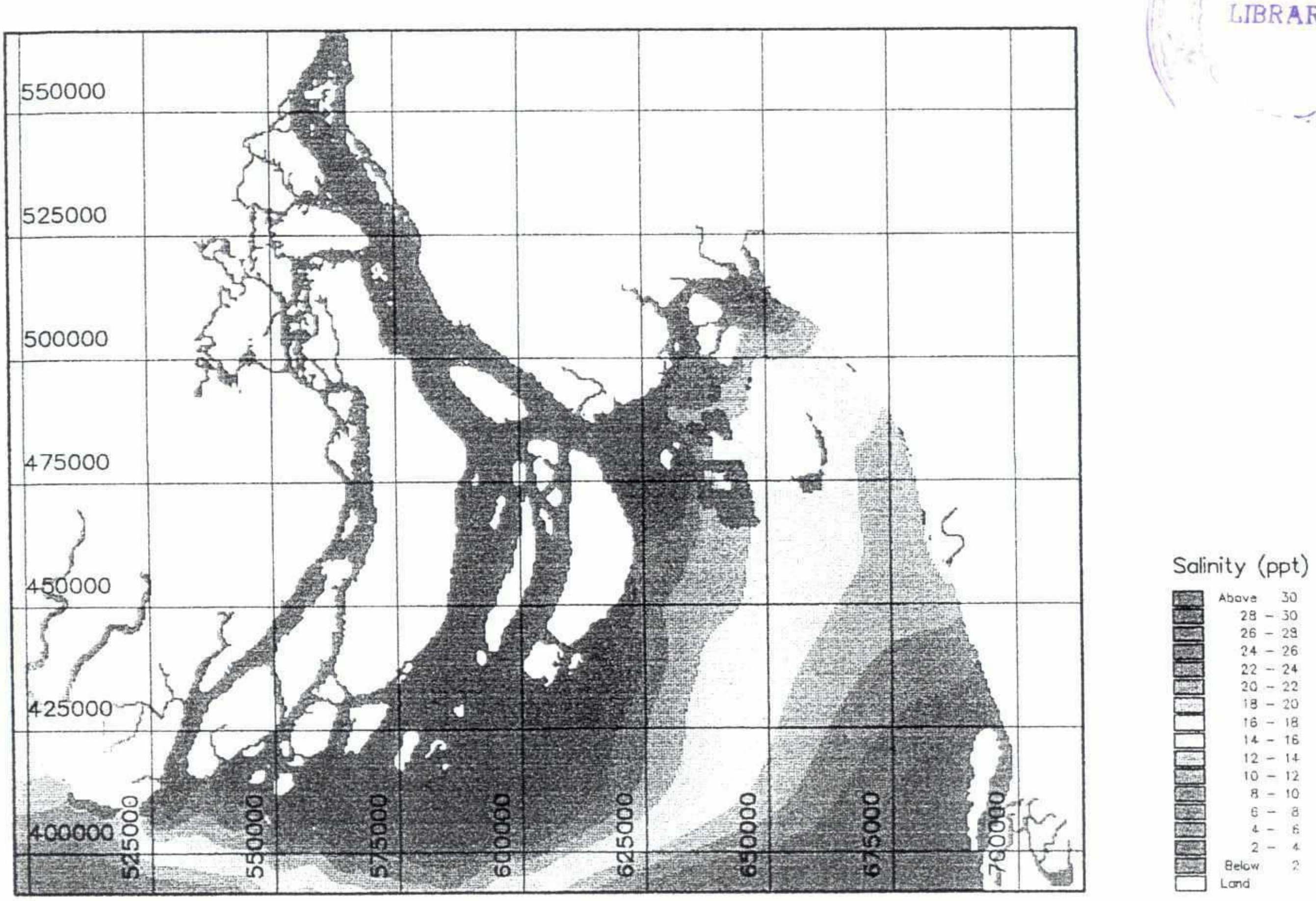


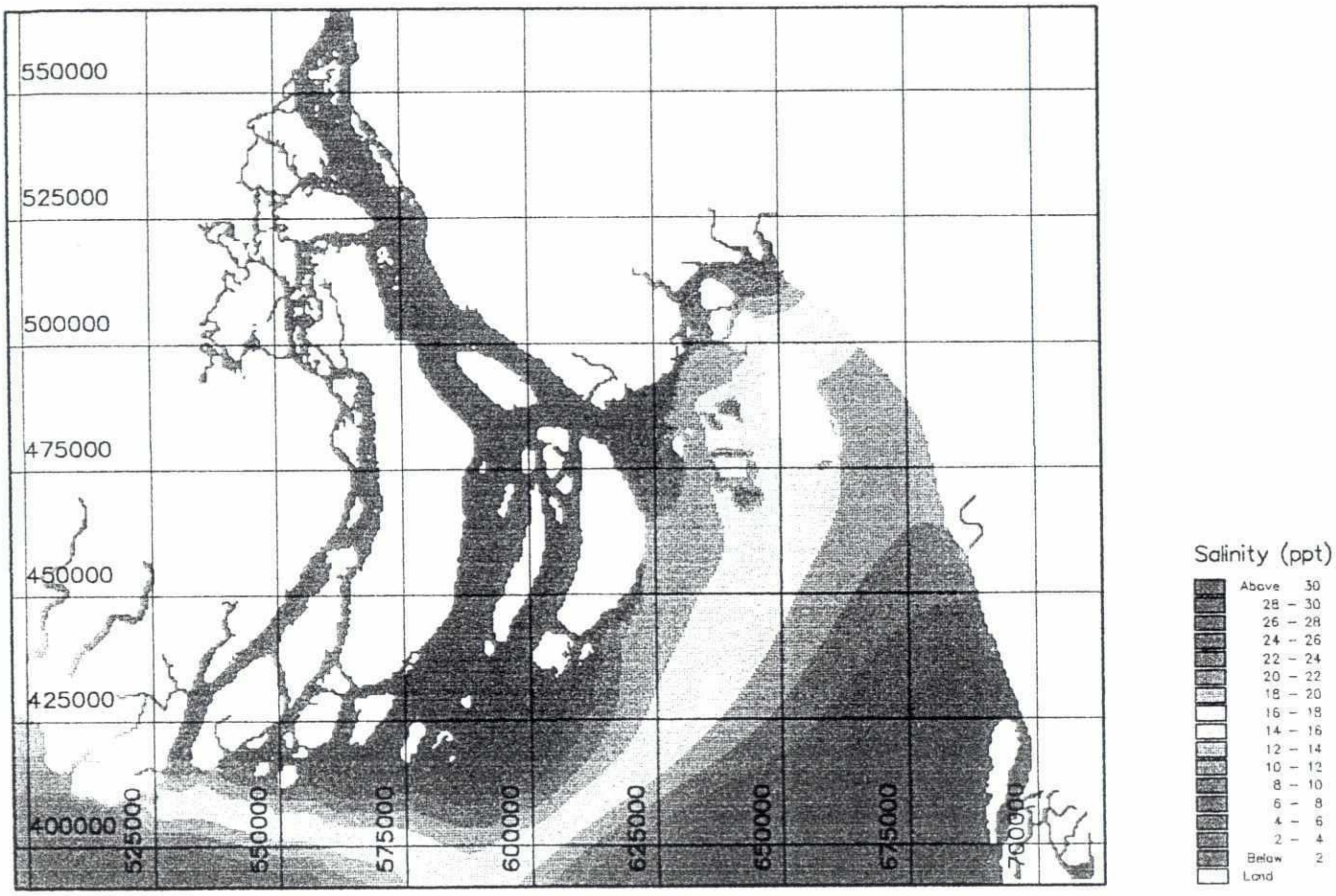
SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Difference in mean elevations incl – excl the effect of salinity	Drawing no. 7.3
Scale: 1:1500000	Init: p5011		

202



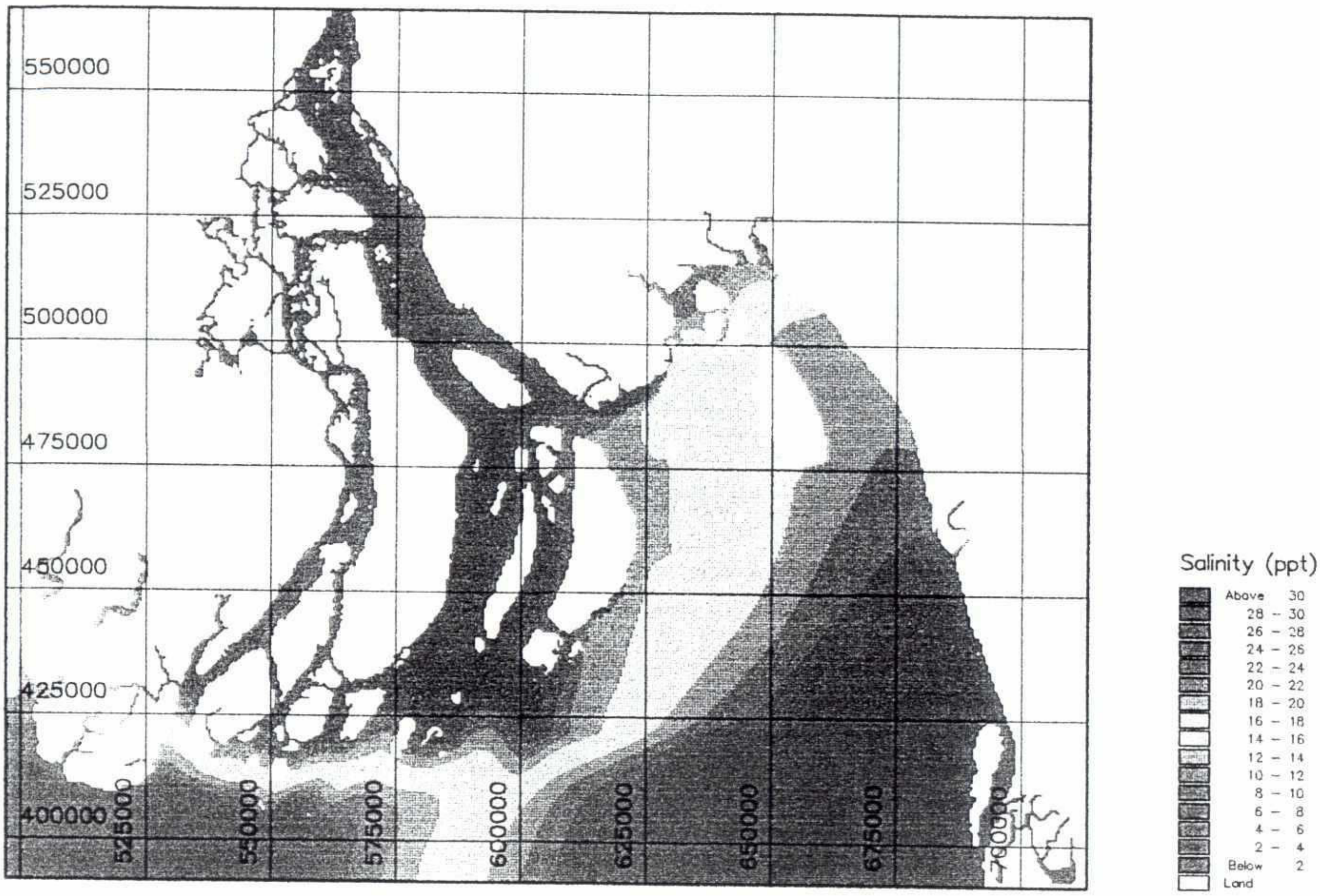
SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Scale: 1:1500000	Date: Mon Jun 8 1998 / Init: p5011	Minimum salinities Dry season 1996 Existing situation	Drawing no. 7.4

2 ♂

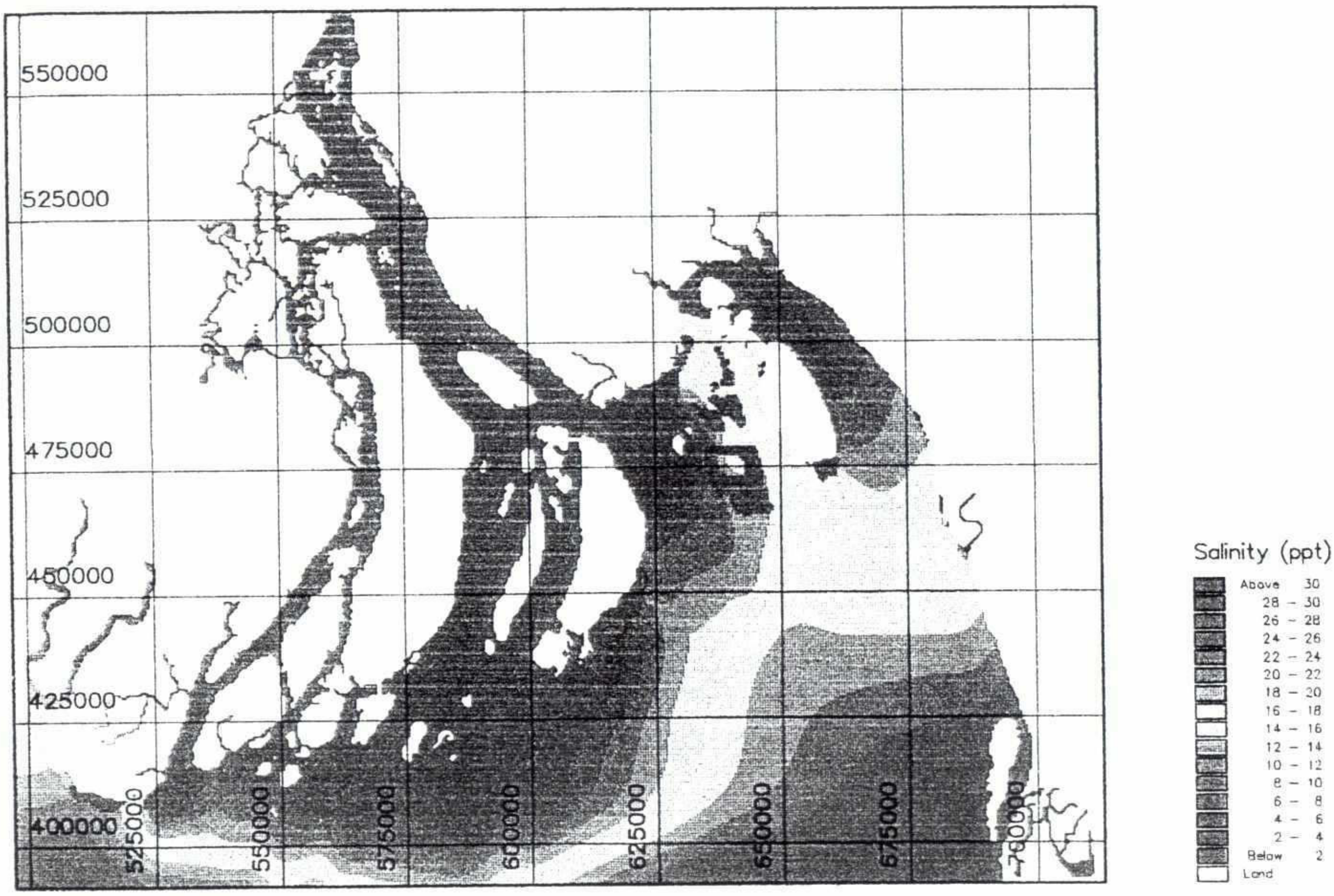


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Mean salinities (ppt)	Drawing no. 7.5	
Scale: 1:1500000	Init: p5011	Dry season 1996 Existing situation		

208

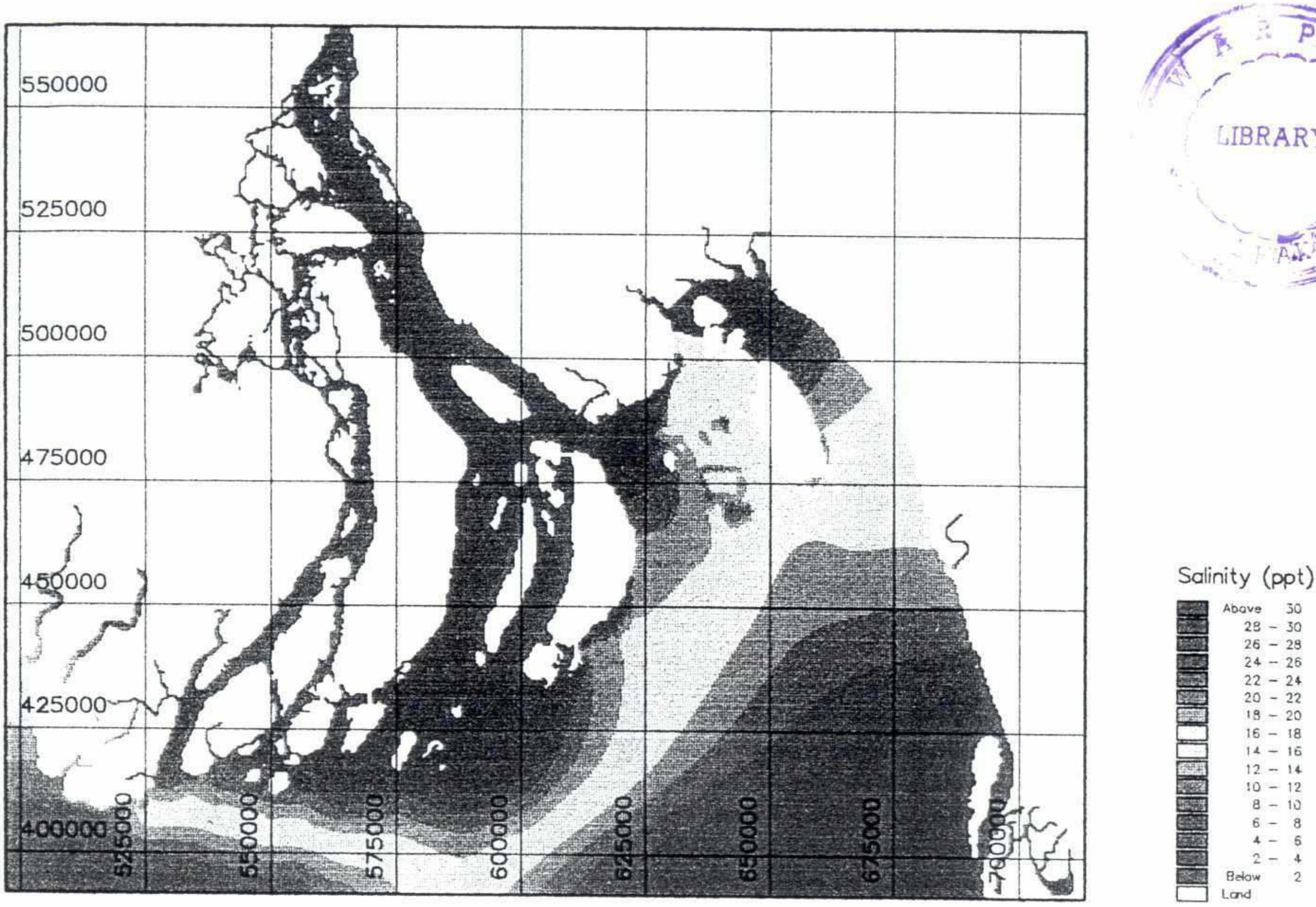


SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Maximum salinities (ppt) Dry period 1996 Existing situation	Drawing no. 7.6
Scale: 1:1500000	Init: p5011		



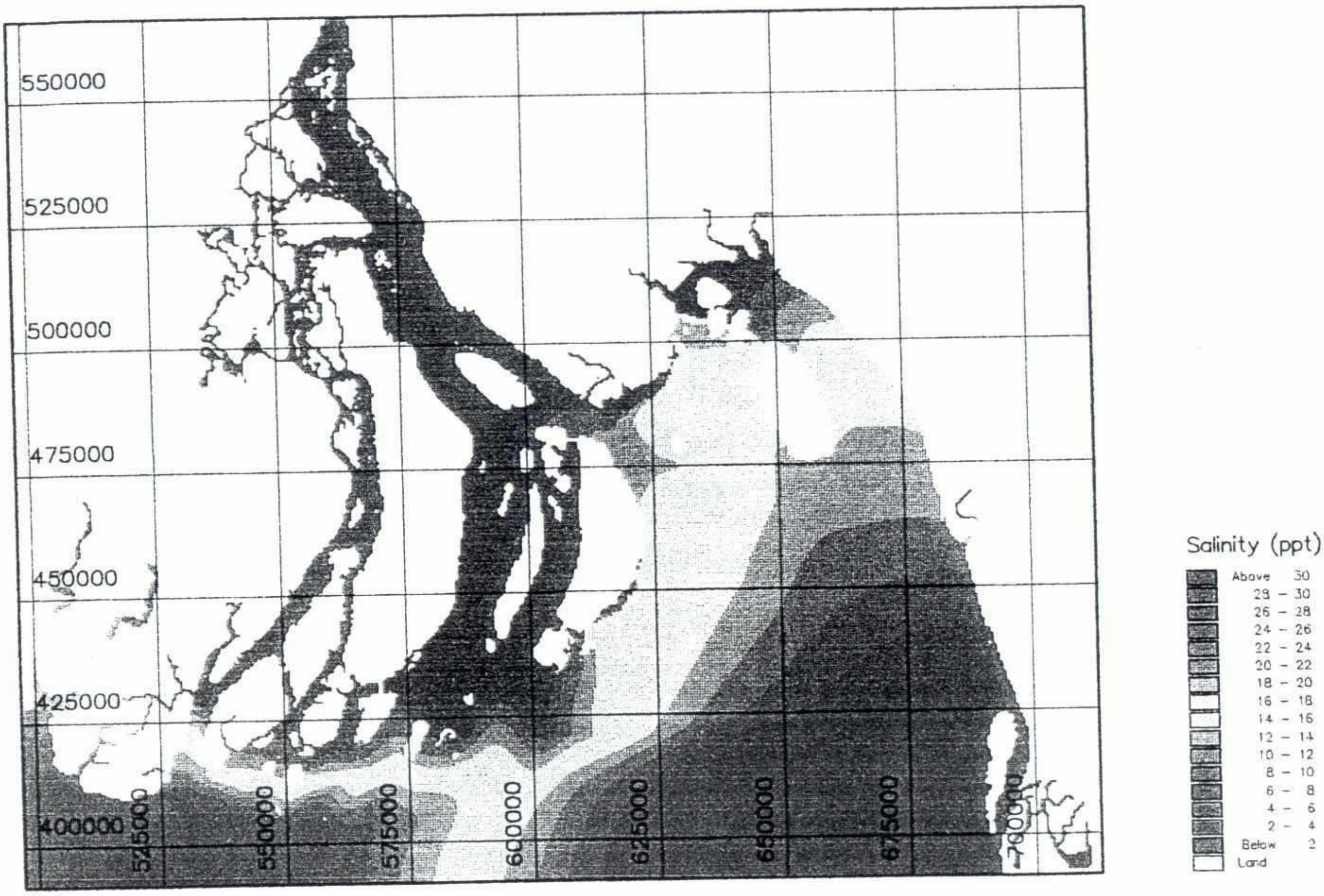
SWMC	Client: Bangladesh Water Development Board Project: Meghna Estuary Study		MIKE 21
File:	Date: Mon Jun 8 1998	Minimum salinities (ppt) Dry period 1996 Including all interventions	Drawing no. 7.7
Scale: 1:1500000	Init: p5011		

289



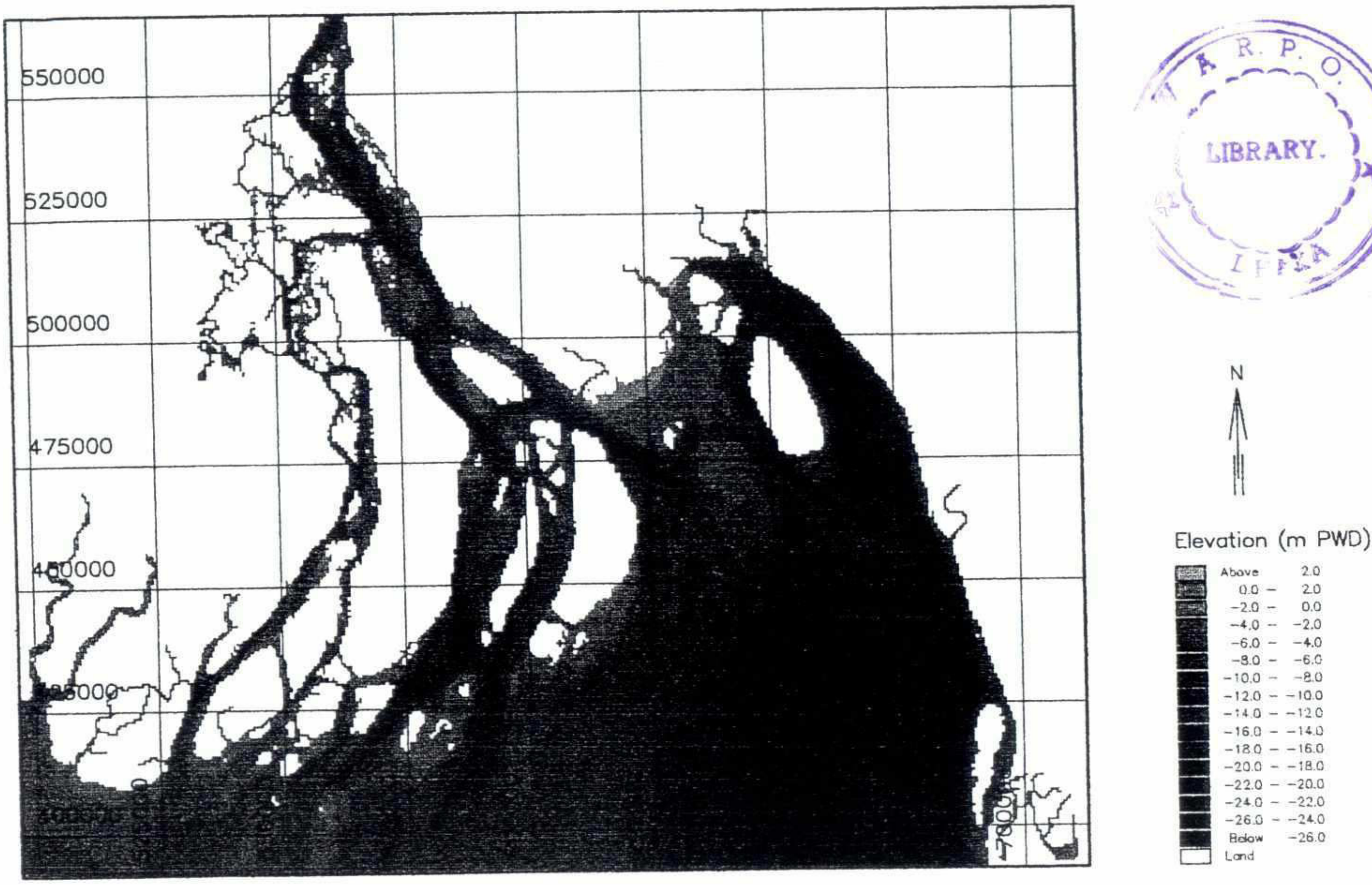
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Mean salinities (ppt)	Drawing no.	
Scale: 1:1500000	Init: p5011	Dry period 1996 Including all interventions	7.8	

209



SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Maximum salinities (ppt) Dry period 1996 Including all interventions	Drawing no. 7.9
Scale: 1:1500000	Init: p5011		

207



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Model bathymetry for wind-wave model Meghna Estuary Model	Drawing no. 8.1
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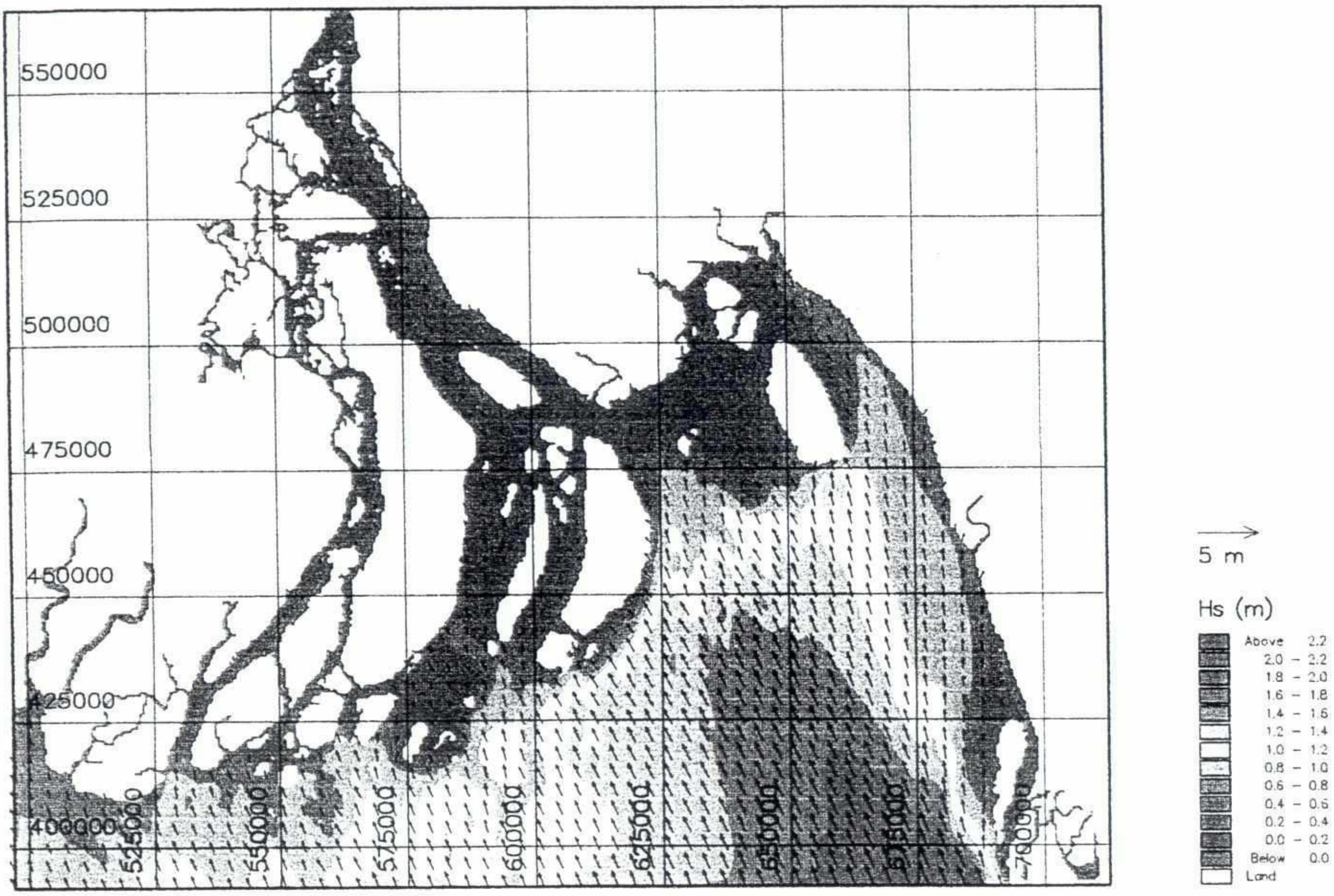
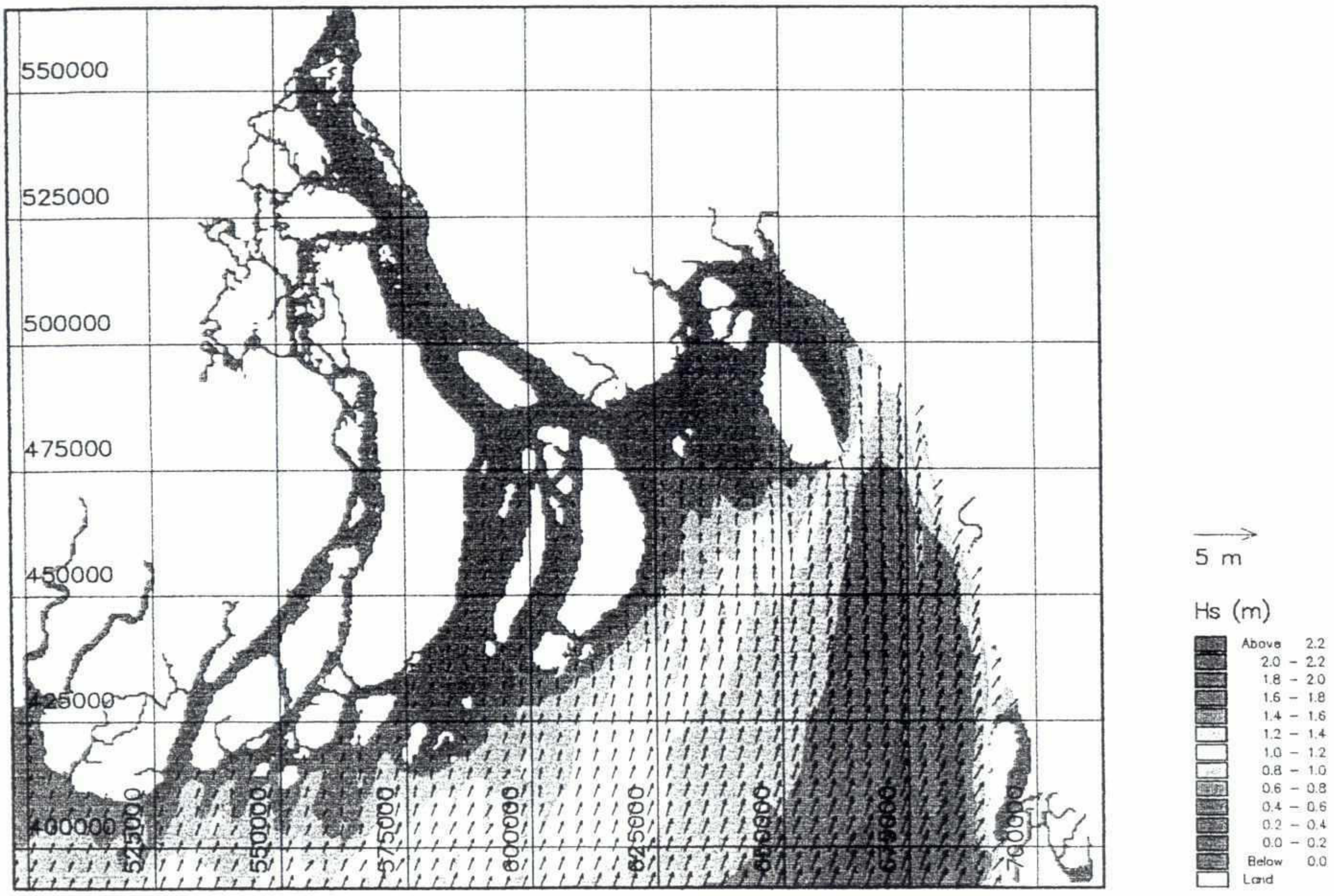
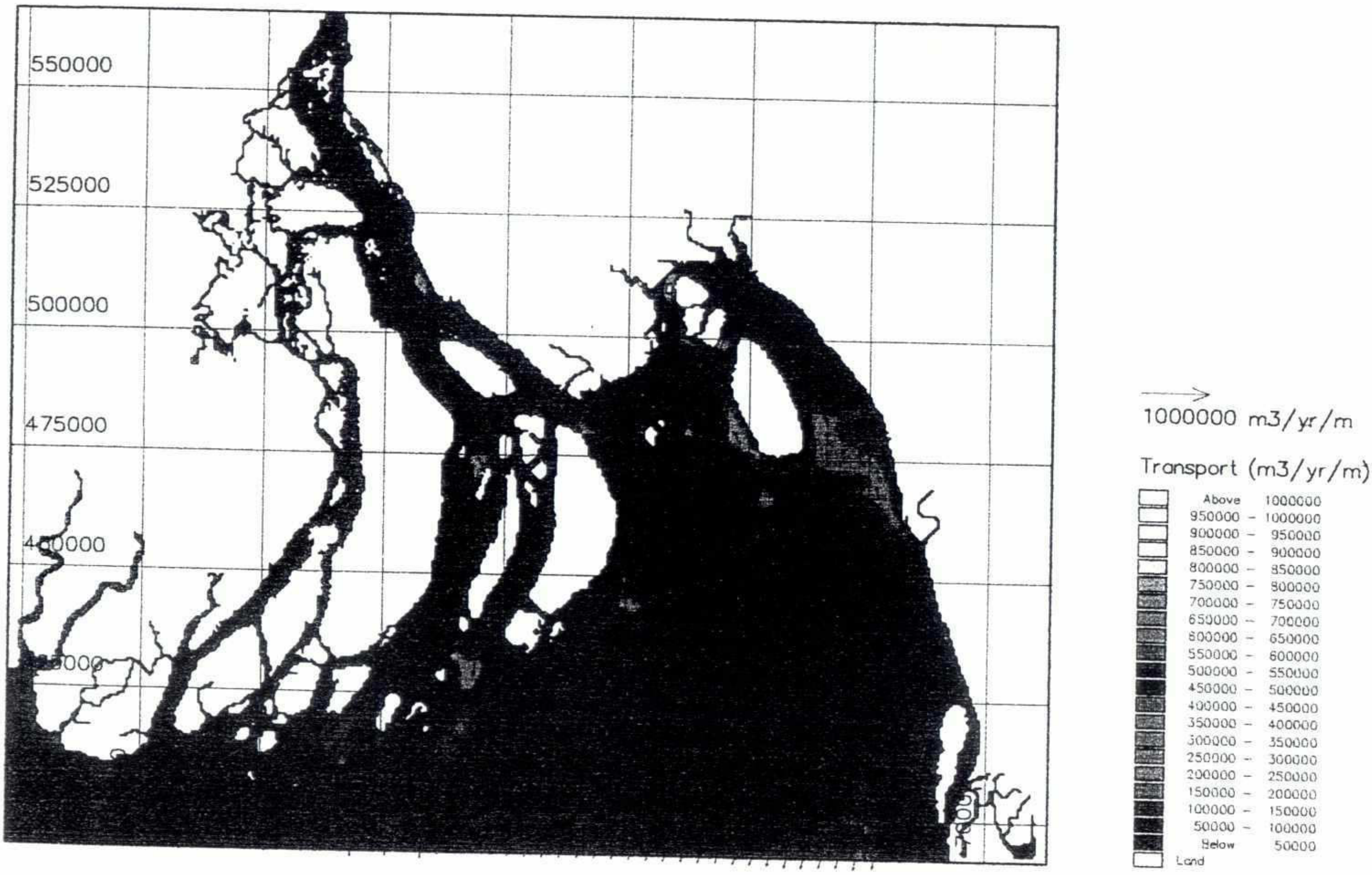


SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File: .	Date: Mon Jun 8 1998	Waves from SSE, wind 8 m/s	Drawing no. 8.2
Scale: 1:1500000	Init: p5011		

290

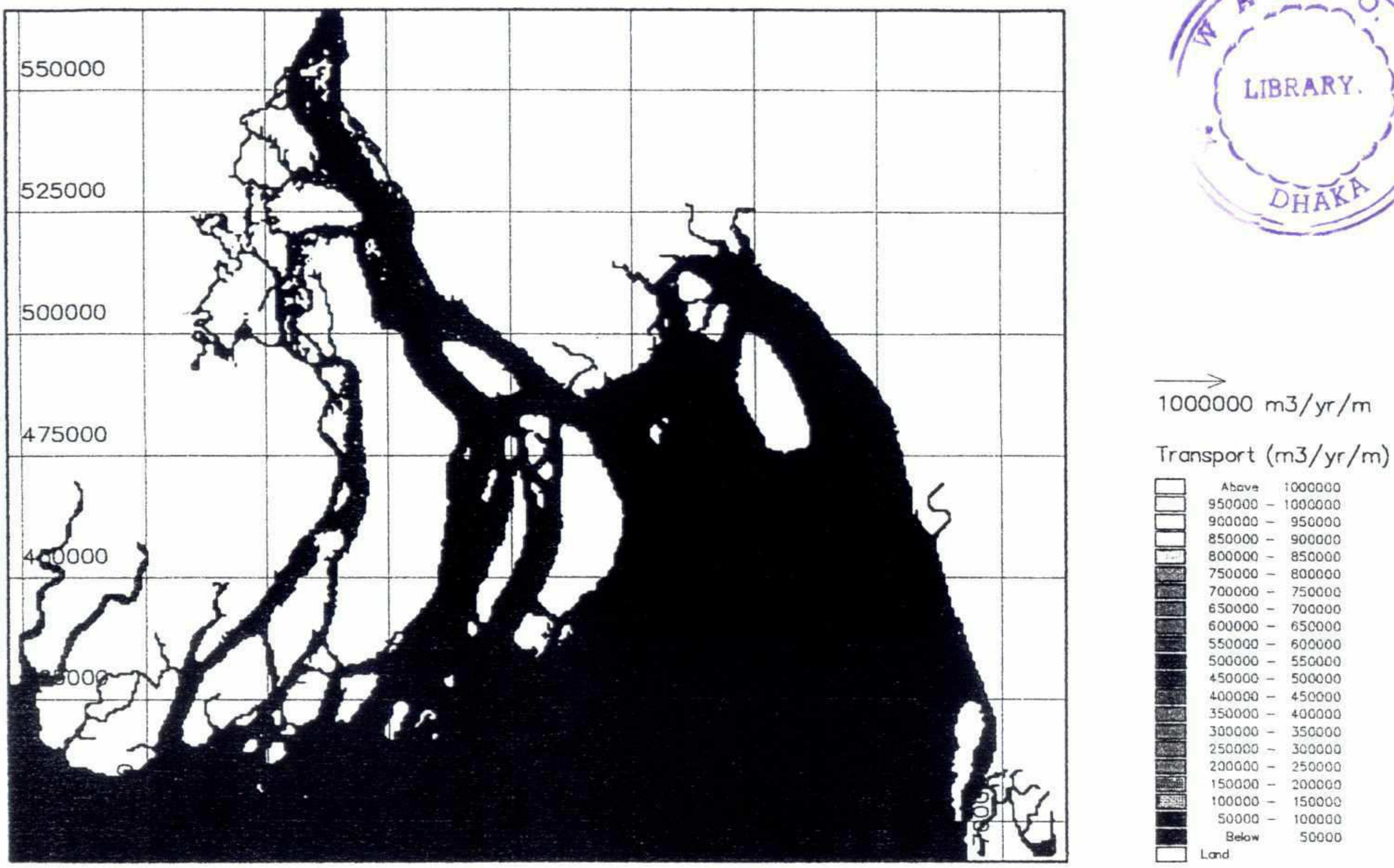


SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Waves from SSW, wind 8 m/s	Drawing no. 8.3	
Scale: 1:1500000	Init: p5011			



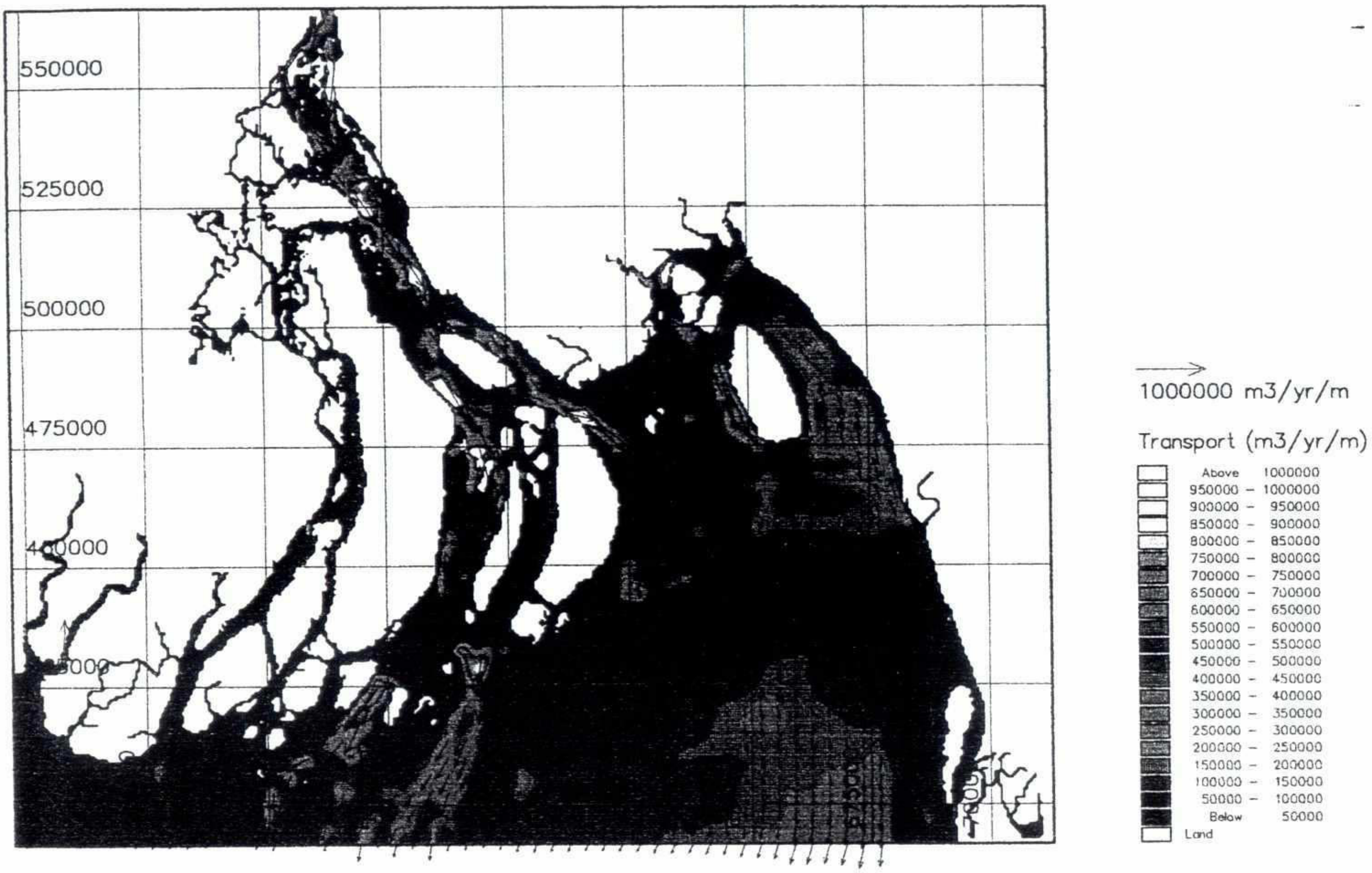
SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Sediment transport rates	Drawing no.
Scale: 1:1500000	Init: p5011	Dry season 1997, Spring tide No waves	9.1

272



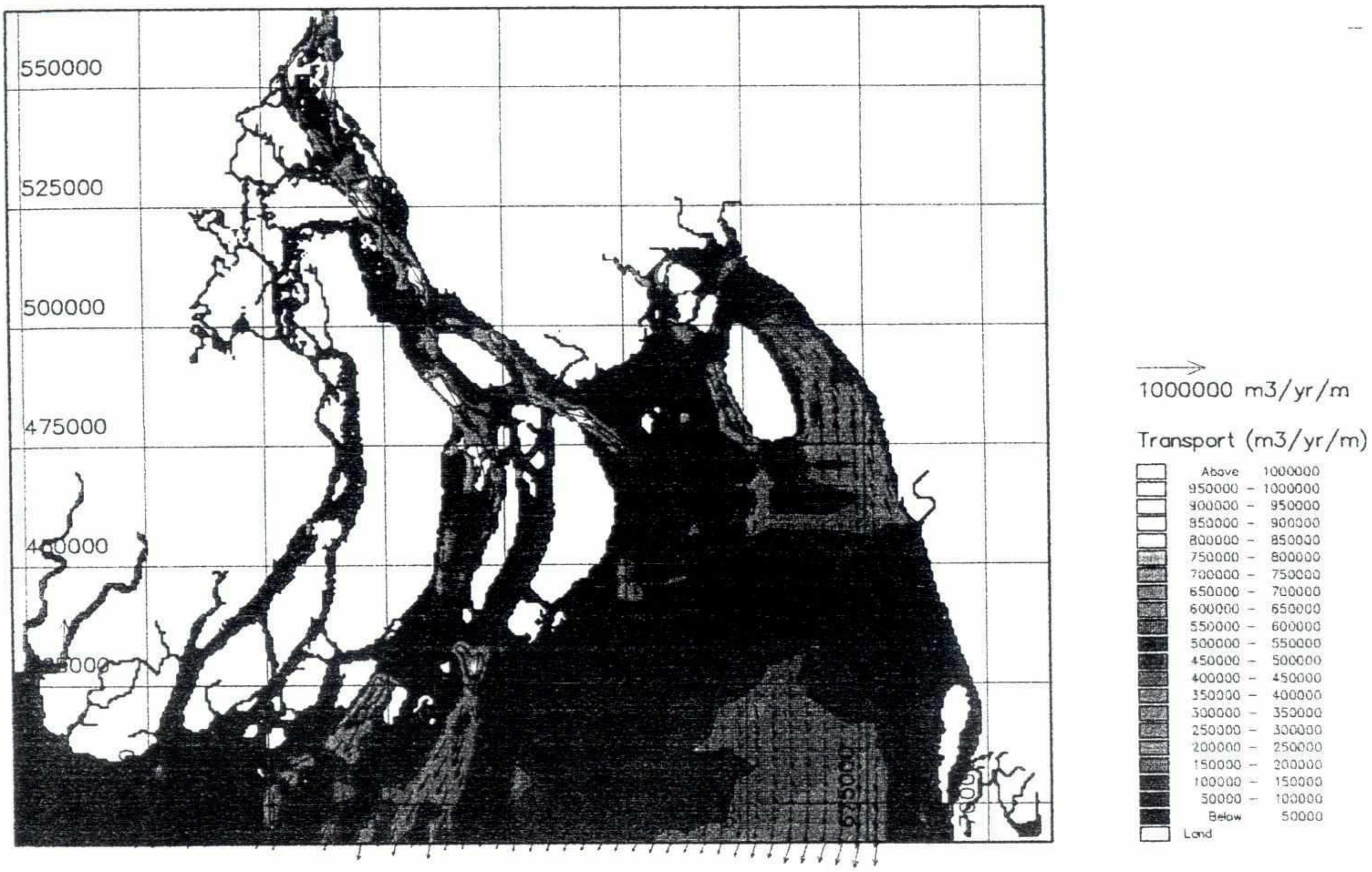
SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Sediment transport rates Dry season 1997, Neap tide No waves	Drawing no. 9.2	
Scale: 1:1500000	Init: p5011			

266



SWMC		Client: Bangladesh Water Development Board		MIKE 21
		Project: Meghna Estuary Study		
File:	Date: Mon Jun 8 1998	Sediment transport rates Monsoon 1997, Spring tide Waves corr. to wind of 8 m/s from SSE	Drawing no. 9.3	
Scale: 1:1500000	Init: p5011			

208



SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	

File:	Date: Mon Jun 8 1998	Sediment transport rates	Drawing no.
Scale: 1:1500000	Init: p5011	Monsoon 1997, Spring tide Waves corr. to wind of 8 m/s from SSW	9.4

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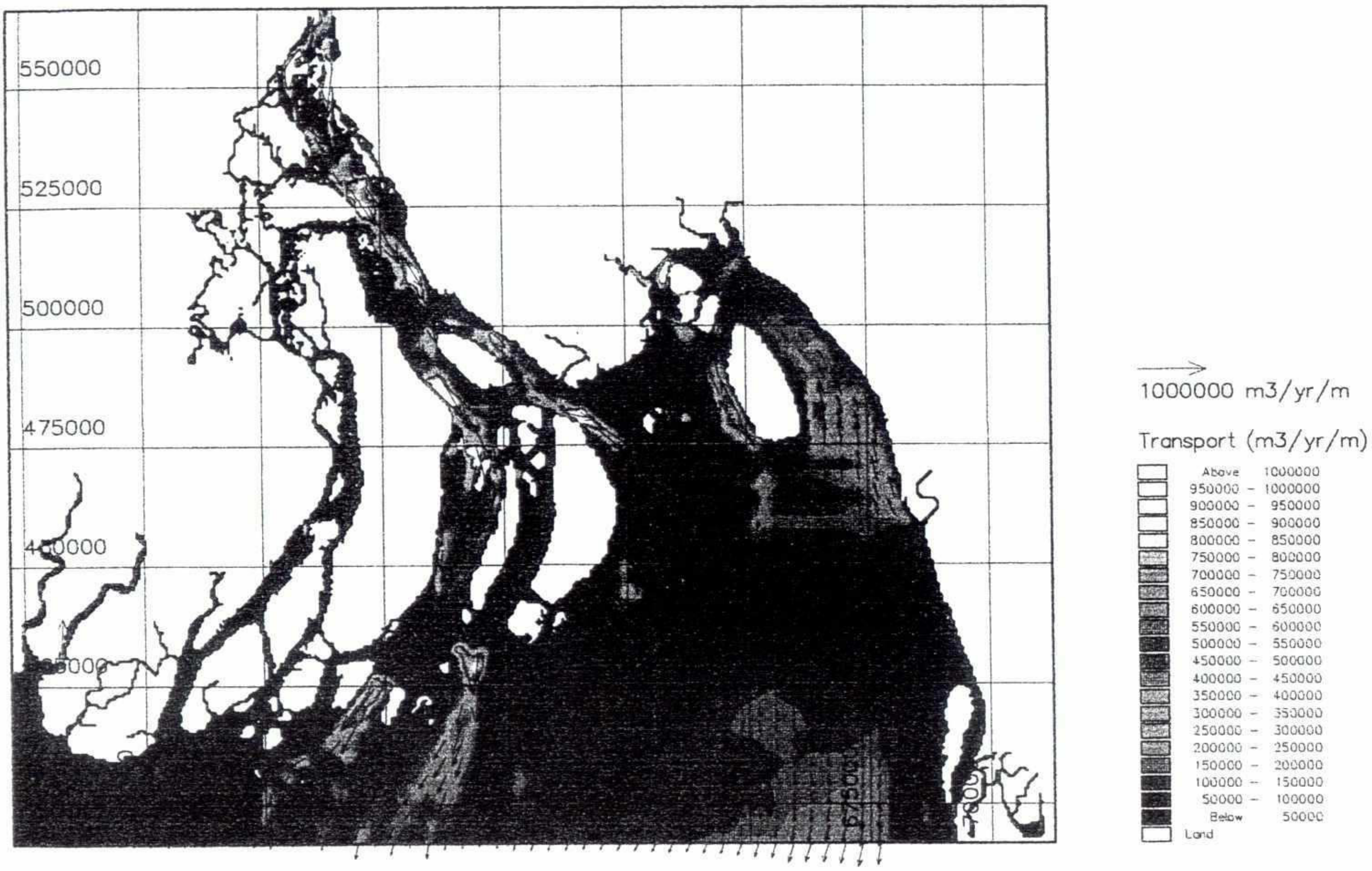
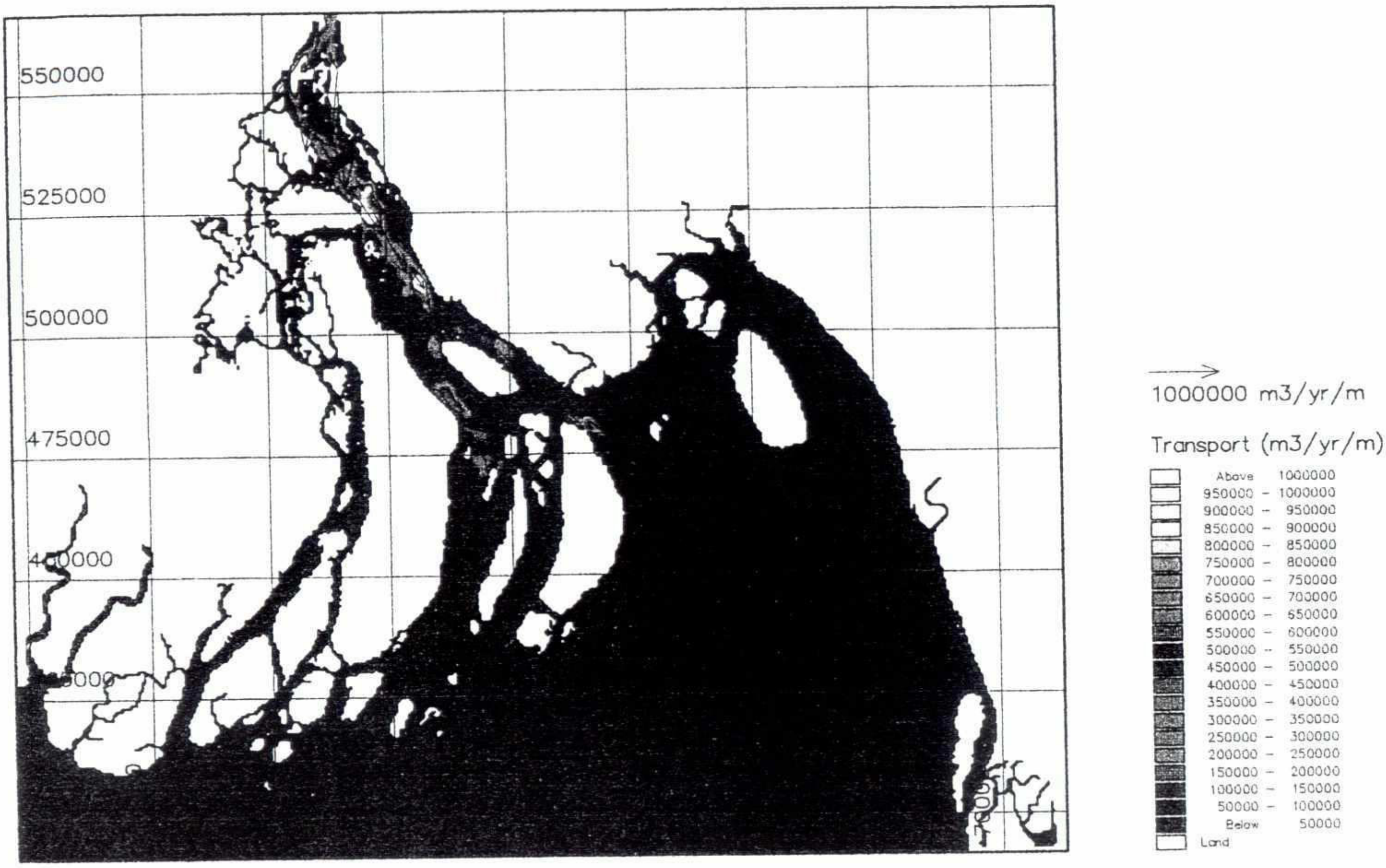


SWMC	Client: Bangladesh Water Development Board	MIKE 21
	Project: Meghna Estuary Study	
File: / Date: Mon Jun 8 1998	Sediment transport rates	Drawing no.
Scale: 1:1500000 / Init: p5011	Monsoon 1997, Spring tide No waves	9.5

264



SWMC

Client: Bangladesh Water Development Board

Project: Meghna Estuary Study

MIKE 21

File:

Date: Mon Jun 8 1998

Scale: 1:1500000

Init: p5011

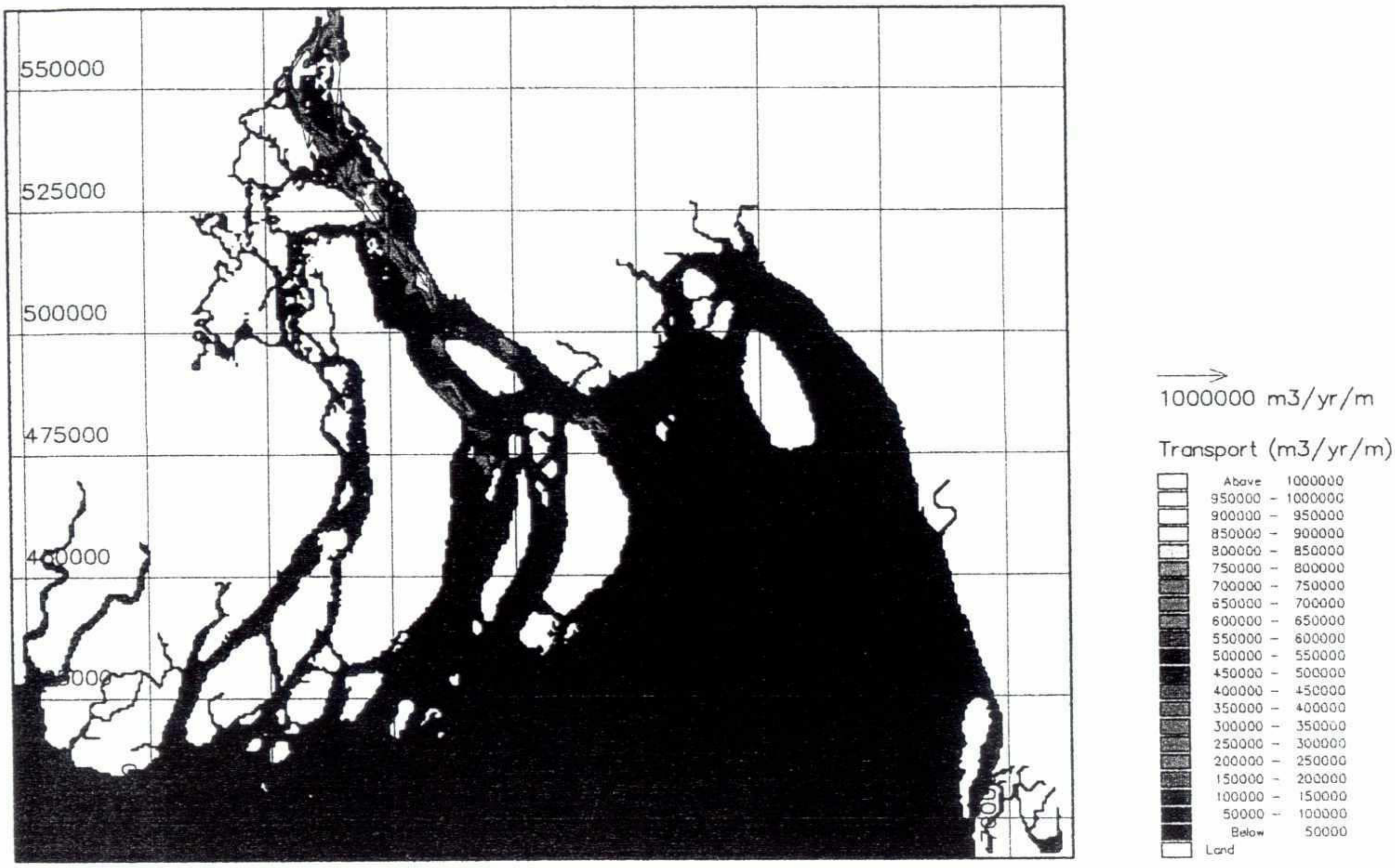
Sediment transport rates

Monsoon 1997, Neap tide

Waves corr. to wind of 8 m/s from SSE

Drawing no. 9.6

267



SWMC		Client: Bangladesh Water Development Board Project: Meghna Estuary Study	MIKE 21
File:	Date: Mon Jun 8 1998	Sediment transport rates Monsoon 1997, Neap tide Waves corr. to wind of 8 m/s from SSW	Drawing no. 9.7
Scale: 1:1500000	Init: p5011		

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SWMC		Client: Bangladesh Water Development Board	MIKE 21
		Project: Meghna Estuary Study	
File:	Date: Mon Jun 8 1998	Sediment transport rates Monsoon 1997, Neap tide No waves	Drawing no. 9.8
Scale: 1:1500000	Init: p5011		