DGIS

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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

M E S II
MEGHNA ESTUARY STUDY

TECHNICAL NOTE MES-045
Review Design and Implementation of
Nijhum Dwip Cross Dam

December 2000

DHV CONSULTANTS BV

in association with

DEVCON SULTANTS LTD
SURFACE WATER MODELLING CENTRE

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TABLE OF CONTENTS

LIST OF FUGURES

SUMMARY

For almost 20 years now the construction of a so-called cross dam, connecting South Hatia and Nijhum Dwip, has been under consideration. Although the morphological conditions change over the years and connecting channels in between islands and chars have a tendency to be filled up naturally, the Nijhum Dwip channel is not expected to close in the foreseeable future.

The dam would reduce the velocities in between these islands and as a result accretion in the channel would accelerate which eventually would result in new stable land for people who may have become landless as a result of erosion elsewhere in the estuary.

Although on many occasions it was stated, in the presence of potential donors, that the Government of Bangladesh had a keen interest in implementing the cross dam, so far the Government has not formulated a clear policy with regard to acceleration of accretion. So it may take some time, if not until natural closure occurs, before the channel between Nijhum Dwip will be ready for human habitation.

This note has been prepared in order to update the design and the cost estimate for the Nijhum Dwip cross dam presented in the Feasibility Report for Nijhum Dwip Integrated Development Project of of December 1998. The update takes into account the lessons learned during installation and monitoring of the Char Montaz Pilot Scheme as well as the Hanarchar Erosion Control Pilot Scheme and the trial section installed in the Nijhum Dwip channel itself.

The following major adjustments have been included in the update

1. Replacement of the steel A-frames with reinforced concrete frames and larger footings that will be more stable
2. Addition of a geotextile membrane to reduce leakage through the under water concrete block dam
3. Reinforcement of the geotextile screens and adjustment of the design of the suspension system for the screens
4. The Twin Hull Pontoon used for installation of Pilot Schemes during MES may be used for installation of the Nijhum Dwip cross dam. It is recommended to replace the hand-operated winches by electrically operated winches and control system.
5. The handling and anchoring of the THP has to be improved in order to ensure efficient and accurate installation of the various components of the dam.

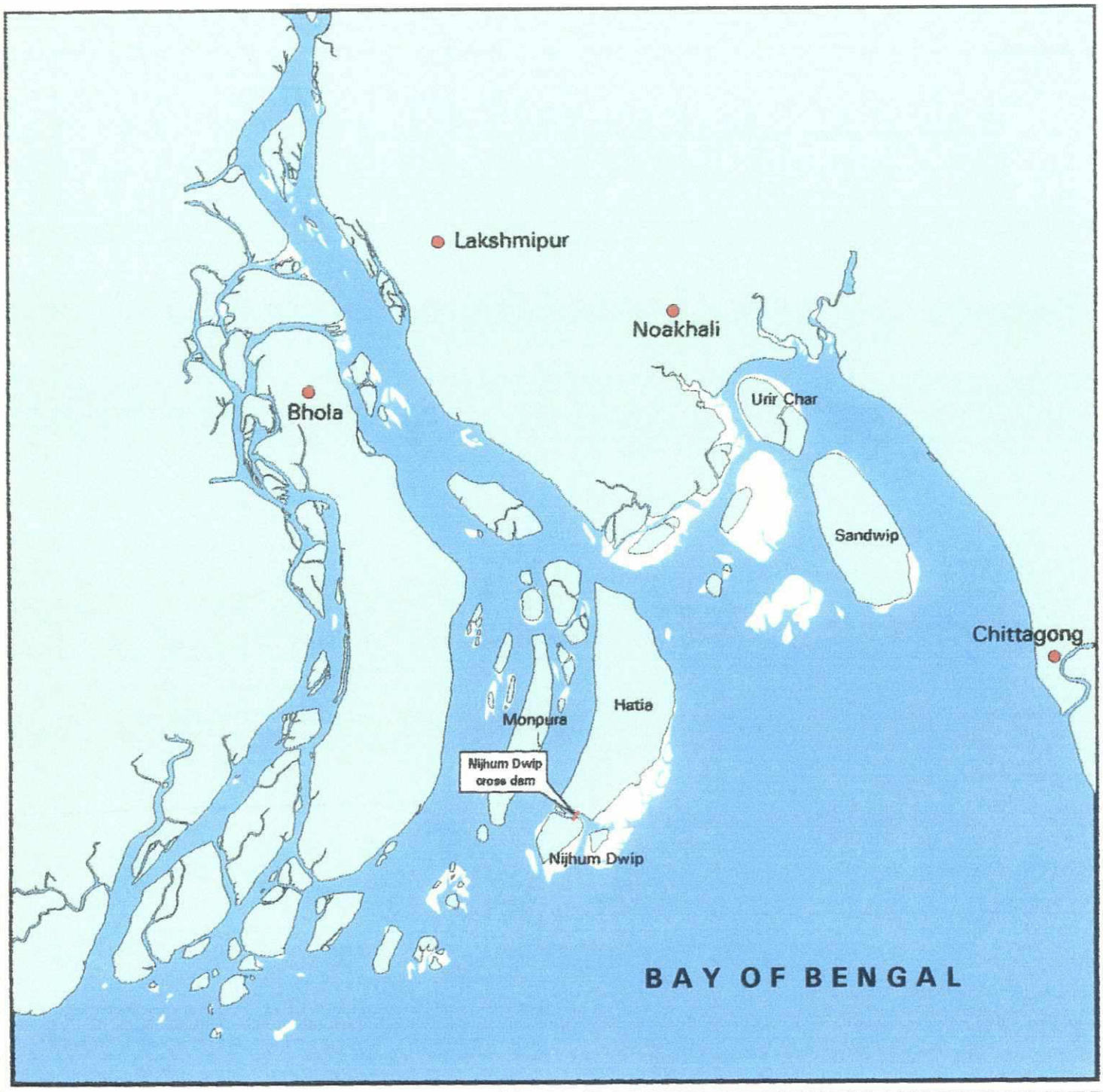
An essential condition for successful implementation of the cross dam is the timely completion of those parts of the works of which the installation is sensitive to wind and waves. These are the bed protection mattresses and the concrete frames. In view of the weather conditions in the second half of March and the time required for installation of these parts, the installation works at site should not start after 15 November.

A tentative time schedule for implementation of the works has been included in the note. After arranging the required funding for construction of the dam and approval of the design and tender documents, it will take 18 – 20 months to tender the works, evaluate tenders, award the contract, procure geotextiles and other materials from abroad and mobilise at site. The time required for installation and completion of the dam will be about 9 months.

The construction cost of the permeable cross dam and flanking earth dams is estimated at 162 million Taka or US$ 3,000,000. Additional funds will be required for adjustment of the THP and site supervision.

The cost of a cross dam built as per traditional design described in the Feasibility Report of LRP (1990) is estimated at 450 million Taka or US $ 8,300,000. Both estimates have been prepared for current unit rates.

Location of Nijhum Dwip permeable cross dam



Legend:

- Land of 2000
- Mudflat
- Water body

Meghna Estuary Study - II

MES II

10 0 40km

SCALE

Prepared by: GIS/RS/CAD Section of Meghna Estuary Study II

Note: Bankline were digitized from the Landsat TM imagery of January 2000

1. INTRODUCTION

The area South of Hatia and around Nijhum Dwip has been identified as having potential for acceleration of accretion as early as 1984 in Technical Report 20, prepared by the Land Reclamation Project (LRP).

At the end of LRP (1990) a feasibility report and a revised feasibilty report have been prepared for the South Hatia cross dams, one dam that connects Hatia with Nijhum Dwip and another dam that connects Hatia with Damar Char. The objective of the study was to consider the construction of the South Hatia cross dams as part of a comprehensive strategy for outer embankment development for South Hatia. However the project has not been given follow up because of low rates of return and for a number of other reasons.

Within the framework of preparing a Master Plan and a Development Plan for the Meghna Estuary, the South Hatia/Nijhum Dwip area has been identified as one of the three priority project areas. See the Feasibility Report for Integrated Development of Nijhum Dwip of December 1998.

Meanwhile under the Char Development and Settlement Project (CDSP II), the construction of a polder in South Hatia as well as implementation of limited infrastructure in Nijhum Dwip has been taken up to be followed by comprehensive development and settlement activities in these areas.

The cross dam construction, proposed in the MES Study, has not been included in the CDSP II project. As a result the Nijhum Dwip cross dam has become a stand-alone project which will never become attractive from an economic point of view since the bulk of the expenditures have to be made initially and benefits will only come many years after implementation.

However after the present policy (considering acceleration of accretion as a non-issue) in due course has been replaced by a more positive approach (prevailing in 1990) towards providing new land for the scores and an ever increasing number of landless people in Bangladesh who have nowhere else to go, implementation of measures that accelerate accretion may be consired once again. At that time other aspects will have to be taken into account besides tangible cost and benefits.

The objective of this technical note is to update MES feasibility report on Nijhum Dwip as far as the design of the cross dam, the implementation and the construction cost are concerned. This update is based on the results of the evaluation of the functionality and performance of the Char Montaz Pilot Project and a small trial section of a cross dam in the Nijhum Dwip channel itself.

Additional observations, surveys as well as hydrodynamic simulations of water levels and curents have been done in relation to the Nijhum Dwip cross dam. These have also been included in this report.

2. ADDITIONAL SURVEYS AND STUDIES DURING MES II

During the MES II project period additional water level recording, bathymetric surveys and float tracking has been done. Part of the results are given in this note.

Based on a fresh bathymatric survey of the Nijhum Dwip area a detailed computer model has been set up within the framework of the whole area update of the MIKE 21 two-dimensional hydrodynamic model of the Meghna Estuary. The results are given in the update report prepared by SWMC and ANNEX C.

2.1 Water levels

Water levels have been recorded near the proposed damsite until the end of 2000. The data have been stored in computer files and will be transferred to the national data base in due course.
Pressure transducers have been installed at the South-eastern tip of Hatia and the North-western end of Nijhum Dwip. Due to theft and instrument failure the record is not continuous, it covers the periods .....to ....., ...to ... and 22 November 2000 till 4 December 2000. The pressure transducer records have been reduced to PWD datum by recording water levels nearby these instruments. Samples of the tidal curves and head differences are shown in ANNEX A. These figures indicate the headdifferences at different waterlevels at South-east tip of Hatia. From this figure the maximum head differences after closure of the channel can be derived.

2.2 Bathymetric surveys

Detailed bathymetric surveys have been executed in June 2000 and November 2000. The results of these surveys are shown in ANNEX A. Compared to previous surveys it is found that the main channel east of the dam alignment is relatively stable while the channel west of the alignment has shifted to the north. In between the old main channel along the north coast of Nijhum Dwip and this new channel a char has been deposited in the past five years. This char has already been stabilised by vegetation.

The results of the surveys indicate that the alignment proposed in the study report of the Nijhum Dwip Integrated Development Project of 1997/1998 is not the most favourable at this time. Therefore shifting of the dam alignment is considered in Chapter 3.

2.3 Float tracking

The results of float tracking by GPS are presented in ANNX B to this note. These data provide information about the currents and flow pattern in the vicinity of the intially proposed alignment. This information is of particular interest for planning of the implementation methodology of the cross dam.

2.4 Condition of the channel bed

During the surveys the condition of the channel bed has been probed by a bamboo pole and bed samples have been inspected on the spot. Except close to the bank the channel bed consists of fine sands/silts that could not easily be penetrated with the pole. This confirms the results of geotechnical surveys under taken during LRP. Close to the banks a layer of recently soft muds was found. Under loading this layer will be compressed and unequal settelment of the structure has to be taken into account in the design of the dam.

2.5 Hydrodynamic simulations

The results of these simulations are presented in the update report prepared by SWMC. Some results have been included in ANNEX C of this note for clarification

3. REVISED DESIGN AND IMPLEMENTATION METHODOLOGY

The design presented in the feasibility study of Nijhum Dwip had not been tested under actual site conditions. Meanwhile a permeable cross dam of similar design has been in operation for almost two years, including two monsoon seasons and one cyclonic event, at Char Montaz. In addition river bank protection has been installed elsewhere using the same equipment and similar installation methodologies.

In the Nijhum Dwip channel a trial section of an improved version of the Char Montaz cross dam has been in place since April 2000. The main purpose of this trial section was to obtain data on the behaviour of the geotextile screens under actual site conditions in particular with waves generated by wind. Unfortunately due to delays in mobilising material and equipment, it was not possible to install the trial in the middle of the channel as planned but close to the shore. However valuable lessons were learnt about implementation under inclement weather and tide conditions prevailing at site after arrival of the equipment.

An improved design for the Nijhum Dwip cross dam is presented in Figures 3.1 and ANNEX D.

The following remarks are made on this design:

3.1 Final alignment of the cross dam

This can only be fixed after detailed bathymetric surveys show the most favourable alignment. However it Is expected that the final location of the dam will be close to the selected alignment based on the year 2000 bathymetry.

3.2 Bed protection

The bed protection mattresses have been widened to 30 m to cope with the increased head across the dam as well as with longer overtopping of the dam at high tide than at Char Montaz. This will induce more turbulence in the flow passing through the dam and result in increased scour power at both edges of the protective mattresses. The geobags and sharp edged cube-shape concrete blocks used in Char Montaz have been replaced by rounded concrete blocks cast in synthetic bags.

3.3 A-frames

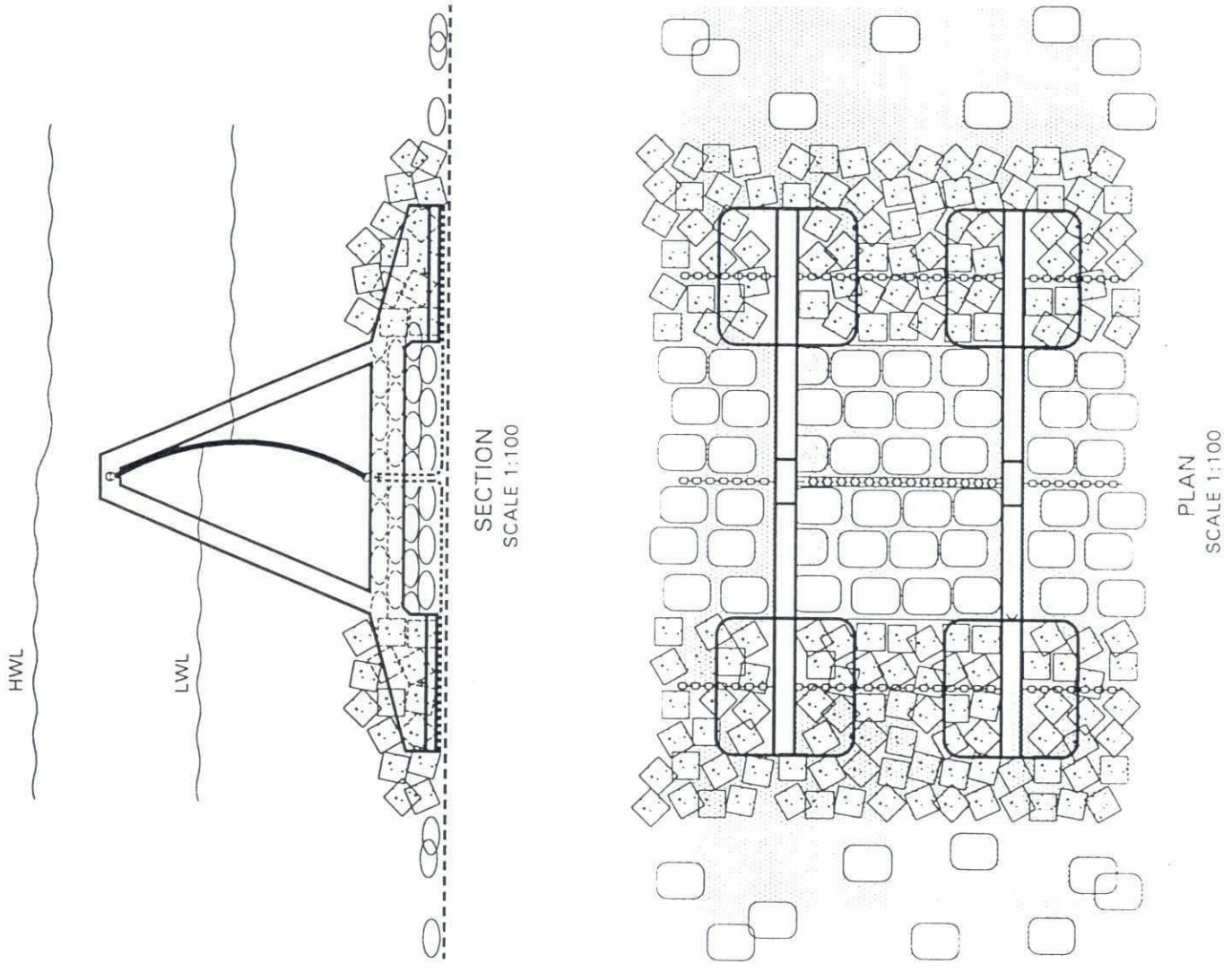
The GI pipe A-frames have been replaced by solid pre-cast reinforced concrete frames on raft footing with a weight of about 10,000 kg. The design change has been made because of apparent corrosion of the exposed steel works and the problems encountered with slipping connections in the A-frames at Char Montaz. It was also deemed necessary to increase the distance between the supporting frame of the geotextile screens to provide sufficent space for the footings. The c.o.c distance is now 3.3 m so that the width of the geotxtile screens is about 3.0 m.

3.4 Geotextile screens

The design of the geotextile screens has to be strengthened at several points. An improved design is indicated in ANNEX D. Where possible a stitching machine has to be used to ensure maximum strength of connections in the screens. The edges of the screens have been hemmed to reduce physical damage.

The clamping arrangement has to be adjusted in view of increased waterpressure/forces. The diameter of the GI pipes of the clamping arrangement has to be determined based on testing in a laboratory. The connection to the concrete frame also needs detailed review to ensure sufficient strength under all loading conditions. Conservation of the steel parts should be specified in detail.

Figure 3.1 Design Nijhum Dwip permeable cross dam



3.5 Rope used for fixing ballast

The local nylon ropes detoriorates relatively fast even under water. It is therefore essential that the specifications for synthetic rope, used for permanent fixing of ballast, include durabilty besides strength. If needed these materials have to be imported to meet the requirements

3.6 Remarks on implementation methodology:

- The existing Twin Hull Pontoon may be used for the installation of the bed protection and the pre-cast concrete frames. However the site conditions are such that radical changes are required. The results of float tracking as well as simulated velocities provide valuable information what to expect during installation activities. Figure 3.2 shows the position of the THP in the current during installation of bed mattresses and concrete frames

- During the installation of the trial section a Nijhum Dwip it became abundently clear that the anchoring system of the THP is not adequate. Heavier anchors as well as heavier winches will be required to keep the THP in position. In order to facilitate positioning of the THP in relatively strong currents, the existing hand operated winches should be replaced by an electric operating and control system

- Since the installation works have to start right after the post-monsoon rains, it has to be studied how to ensure that sufficient concrete frames and ballast bags are available when required according to the planning. It may be required to pre-cast at least part of these concrete elements elsewhere and arrange transport to site.

- Special measures like the use of frames will be required to lower the bed matresses and to keep them in position as long as the ballasting of the mattress is not sufficient. Bamboos attached to the mattress during installation should all be removed.

- The weight of the concrete frames will be much more than the weight of the steel A-frames. In order to be able to lower at least two concrete frames into position it will be required to replace the existing hand operated winches by electric driven winches and an easy control system

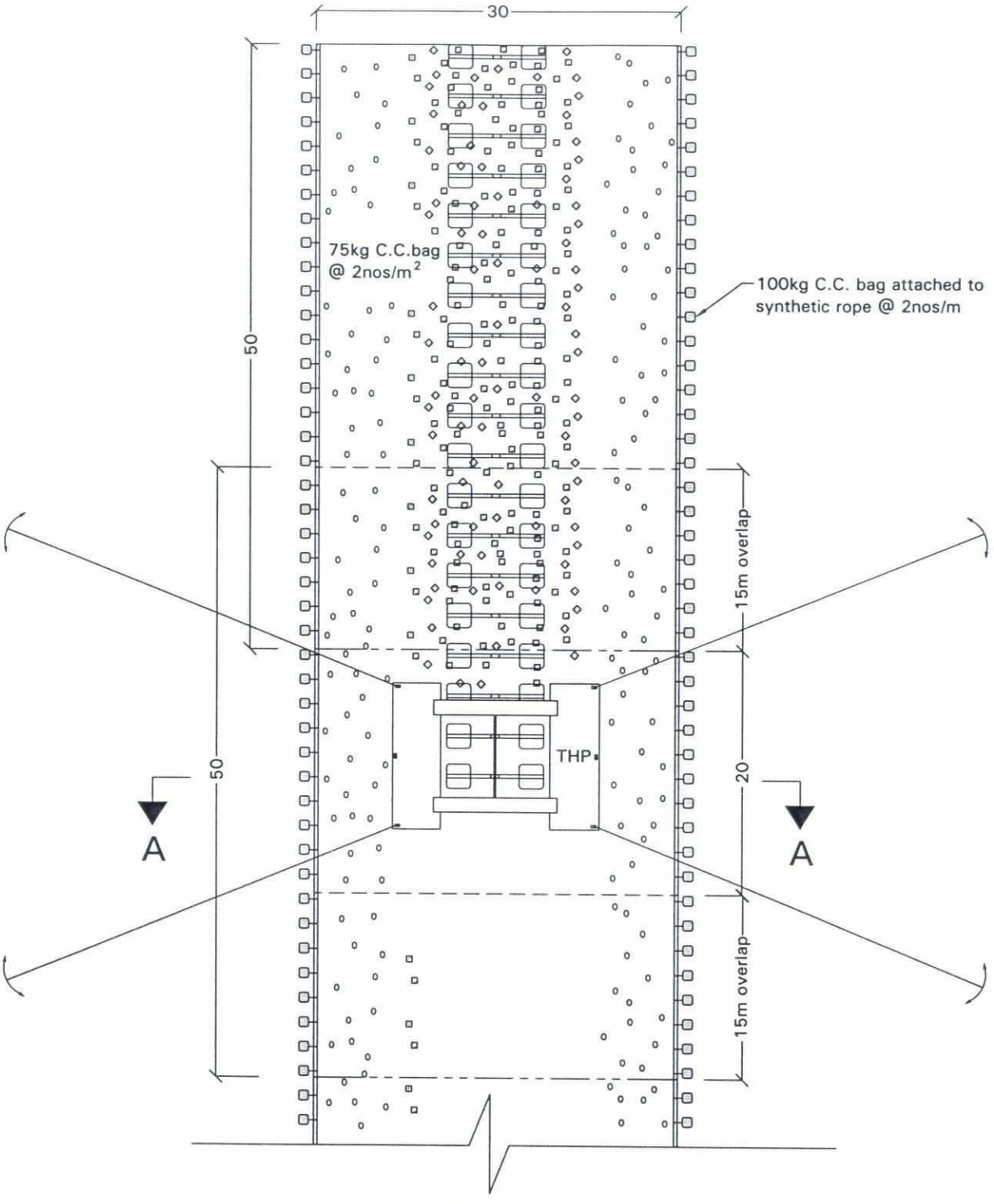
- Detailed procedures for ballasting and installation of concrete frames have to be prepared before the start of the work. In particular recording of the distribution of ballast blocks is essential to avoid weak spots in the bed protection.

- The number of divers employed at site has to be matched with the planned progress of the works, taking the fact that usually only limited time is available for under water works

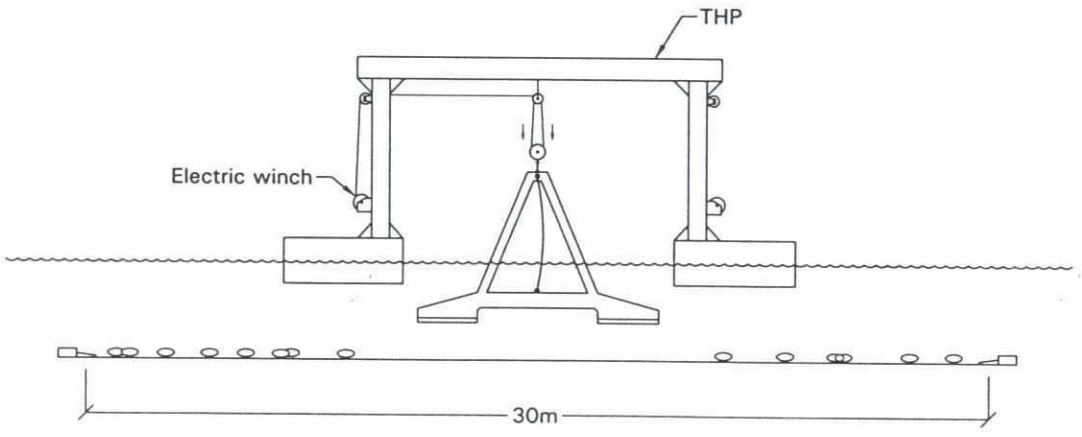
- In order to be able to work most efficiently it is essential that the divers are equipped with modern diving gear. Use of primitive diving equipment shall not be allowed.

- Working in two shifts as well as working at night time is deemed necessary to minimize the time required to install the bed protection mattresses. Delays may cause scour holes to develop where the currents will be increased over a long period of time due to contraction

Figure 3.2 THP during installation of concrete frames



PLAN
SCALE 1:500



SECTION A-A
SCALE 1:250

4. TIME SCHEDULE AND COST ESTIMATE FOR THE WORKS

An important lesson learned during execution of the two small scale pilot schemes is that proper timing is essential for accurate and fast exeution of the works. For various reasons in both cases the work at site was started in the second half of March. By that time strong South to South-easterly winds prevail hampering the movements and positioning of vessels as well as the positioning and lowering of the geotextile bed mattress in the currents. The pre-monsoon rains will also start at that time often accompanied by nor'westerns, very strong winds that may even damage equipment.

It is imperative to start the actual installation works in the second half of November to ensure a working period of about 3.5 months when the weather usually will be calm and quiet and installation works can continue unhampered by unpredictable rain and wind.

Another, albeit predictable, factor to be taken into account in the detailed planning the works are the tide and tidal currents. It is essential to make the best use of the tidal conditions for the installation of the bed mattresses and the concrete frames. This detailed planning has to be prepared as soon as the year of implementation is known.

Depending on the actual site conditions at the time of implementing the works 25 - 30 bed mattresses have to be lowered and ballasted. Although in theory two mattresses could be installed in 24 hours under neap tide conditions, in practice some days will be lost due unavoidable circumstances. Therefore it is assumed that it will take 6 weeks to install all bed mattresses.

About 300 concrete frames have to be installed to cover the length of the Nijhum Dwip cross dam. Installation of the frames will start after lowering of all the bed matresses because only one THP is available moreover during installation of the mattresses the reduction in the cross section should be kept at a minimum so no concrete frames should be placed before completion of the bed matttress installation.
Assuming efficient positioning of the THP and handling of the concrete frames, it may be possible to install 10 - 12 frames in 24 hours under neaptide conditions. However it is deemed prudent to assume that on average 5 frames can be installed in a day so that it will take 60 days to install all frames.
Initially only part of the under water dam of concrete blocks should be constructed to reduce the constriction of the channel and thus avoid an increase of velocities in the still open part of the channel as much as possible. It is advisable to install the frames first in the deeper part of the channel for the same reason.

The best time to lower and fix the screens of the cross dam is the neap tide condition. Sufficient divers and labour should be engaged to complete this work in two days.

The proposed time schedule for the works is presented in Figure 4.1. The total time required for the implementation of the works is 19 months, including tendering of the works and separate procurement of geotextile and new machinery for the THP from abroad. In case the contractor has to procure the geotextile and other materials from abroad the time need for implementation will be 30 months.

A cost estimate for the works is given in ANNEX D. The total cost of implementation wil be 162 million Taka or about 3 million US $.

The estimate of the cost of an earthen dam is 450 million Taka or 8,300,000 US$, see also ANNEX D.

TENTATIVE IMPLEMENTATION SCHEDULE NIJHUM DWIP CROSS DAM

Sl. No.	Description	YEAR 1												YEAR 2												YEAR 3					
		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06
	Preparetory works																														
1	Additional field investigations																														
2	Preparation of detailed designs and cost estimate																														
3	Approval of detailed design and cost estimate																														
4	Preparation of tender documents																														
5	Approval of tender documents																														
	Tendering of the works																														
1	Prequalifications of contractors																														
2	Preparation of tenders by pre-qualified contractors																														
3	Evaluation of tender documents																														
4	Award of tender																														
	Construction of the works																														
1	Mobilisation																														
2	Manufacturing of bed mattresses																														
3	Manufacturing of sreens																														
4	Pre-casting of reinforced concrete frames																														
5	Construction of earth dam in parallel channel																														
6	Construction of connnecting dikes																														
7	Installation of bed protection matresses and partial ballasting																														
8	Installation of concrete frames, including partial ballasting																														
9	Completion of ballasting bed mattresses																														
10	Installation of screens																														
11	Completion of the works and demobilisation																														
	Procurement and shipment																														
1	Procurement and shipment of geotextile for bed mattresses																														
2	Procurement, shipment and installation of winches etc. on THP																														

Figure 4.1 Implementation schedule Nijhum Dwipl cross dam

5 SURVEYS AND INVESTIGATIONS BEFORE IMPLEMENTATION

Although in the course of time a lot of data have been collected already, there is a need to continue data collection because of the continued morphological changes and the limited data on currents during the full tidal cycle.
Below some suggestions are given regarding future surveys and investigations that will be required to ensure an adequate data base for the detailed design and implementation procedures for cross dam construction.

5.1 Reference station

At present the nearest reference benchmark is located on top of the cyclone shelter at the Nijhum Dwip market. To facilitate future surveys and positioning during surveys a new reference bench mark has to be established near the future cross dam.

5.2 Waterlevel recording

Water level recording should be continued near the dam site. The existing trial section offers a stable structure to install a pressure transducer at a low level. Reading of the gauge should also be continued to obtain independent records from pressure tranducer records.
In addition pressure transducers should be installed at both ends of the Nijhum Dwip channel in order to determine the phase difference of the tides at these locations. These phase differences will determine the head differences at the cross dam.

5.3 Float tracking and ADCP measurements

Float tracking and ADCP measurements will provide important information about velocities that have to be expected during installation of the cross dam. With ADCP measurements the results of float tracking can be calibrated.

5.4 Geotechnical investigations

It is recommended to perform Dutch Cone Penetration Tests with a simple hand operated apparatus in the alignment of the cross dam in order to obtain an indication of the soil conditions. This will be required for the stability analysis of the concrete frames. The spacing of the tests should be 50 m – 100 m depending on the variability of the sub-soils.

5.5 Sediment and salinity measurements

It is deemed advisable to prepare an improved estimate of the rate of accretion after closure so that the impact in the course of time can be estimated more accurately.
Since the concentration and size of the sediment in the water as well as the salinity of the water will determine the rate of accretion, it is advisable to establish routine sampling at selected locations. Since after closure the source of the sediment will come from the main channel in the West and the open water to the East samples should be collected from that location also.

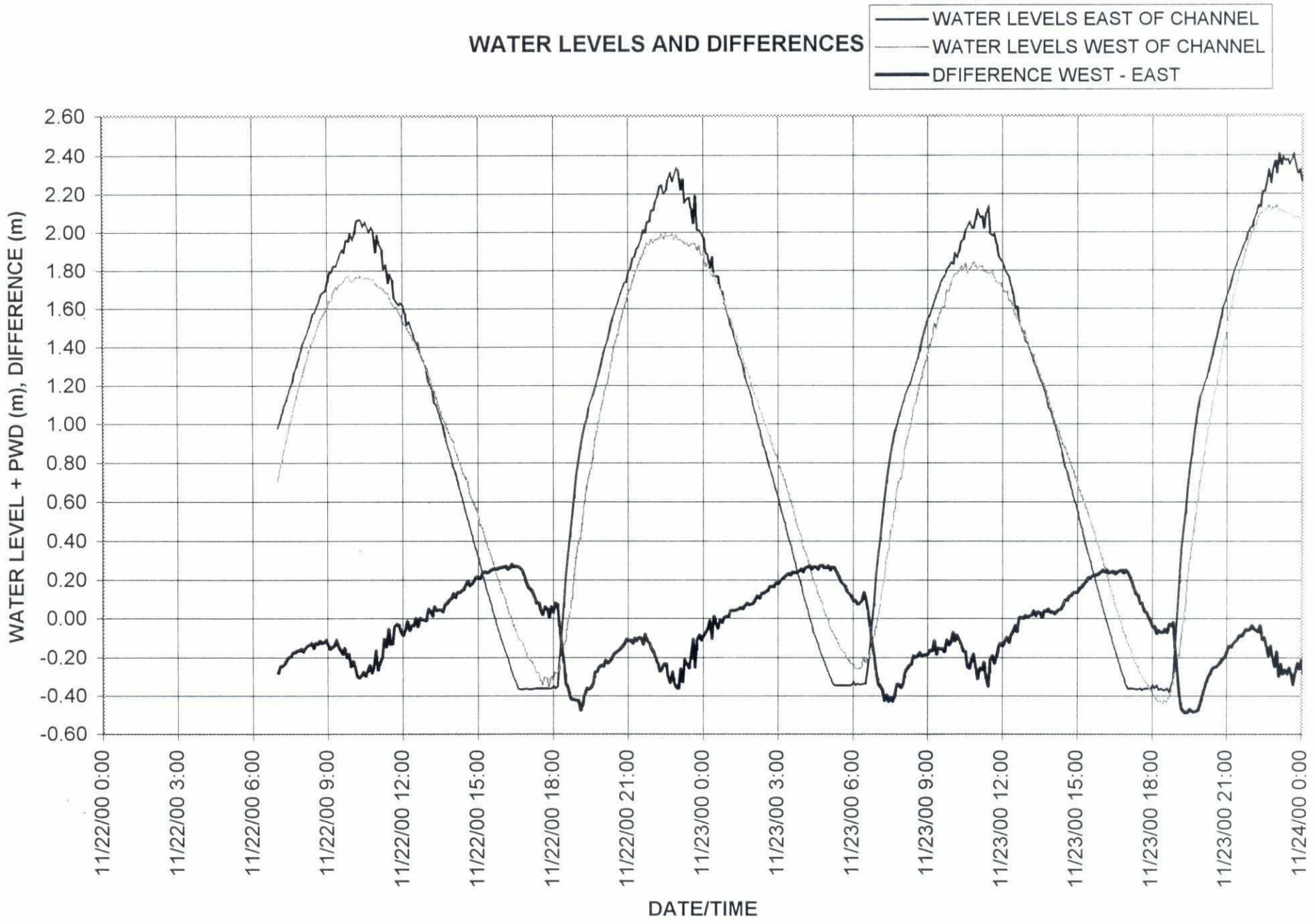
5.6 Water level and velocity simulations

The existing hydrodynamic model shall be used to simulate water levels and velocities after closure. Since the cross dam will be permeable and the permeability may be adjusted to some extent, the optimum permeability may be determined by simulation of the changing flow velocities and flow pattern as accretion continues to change the hydraulic conditions on both side of the cross dam.

ANNEX A

DESIGN AND IMPLEMENTATION
NIJHUM DWIP PERMEABLE CROSS DAM

BATHYMETRIC MAPS
MEASURED WATER LEVELS


WATER LEVELS AND DIFFERENCES
WATER LEVELS EAST OF CHANNEL
WATER LEVELS WEST OF CHANNEL
DFIFERENCE WEST - EAST
WATER LEVEL + PWD (m), DIFFERENCE (m)
2.60
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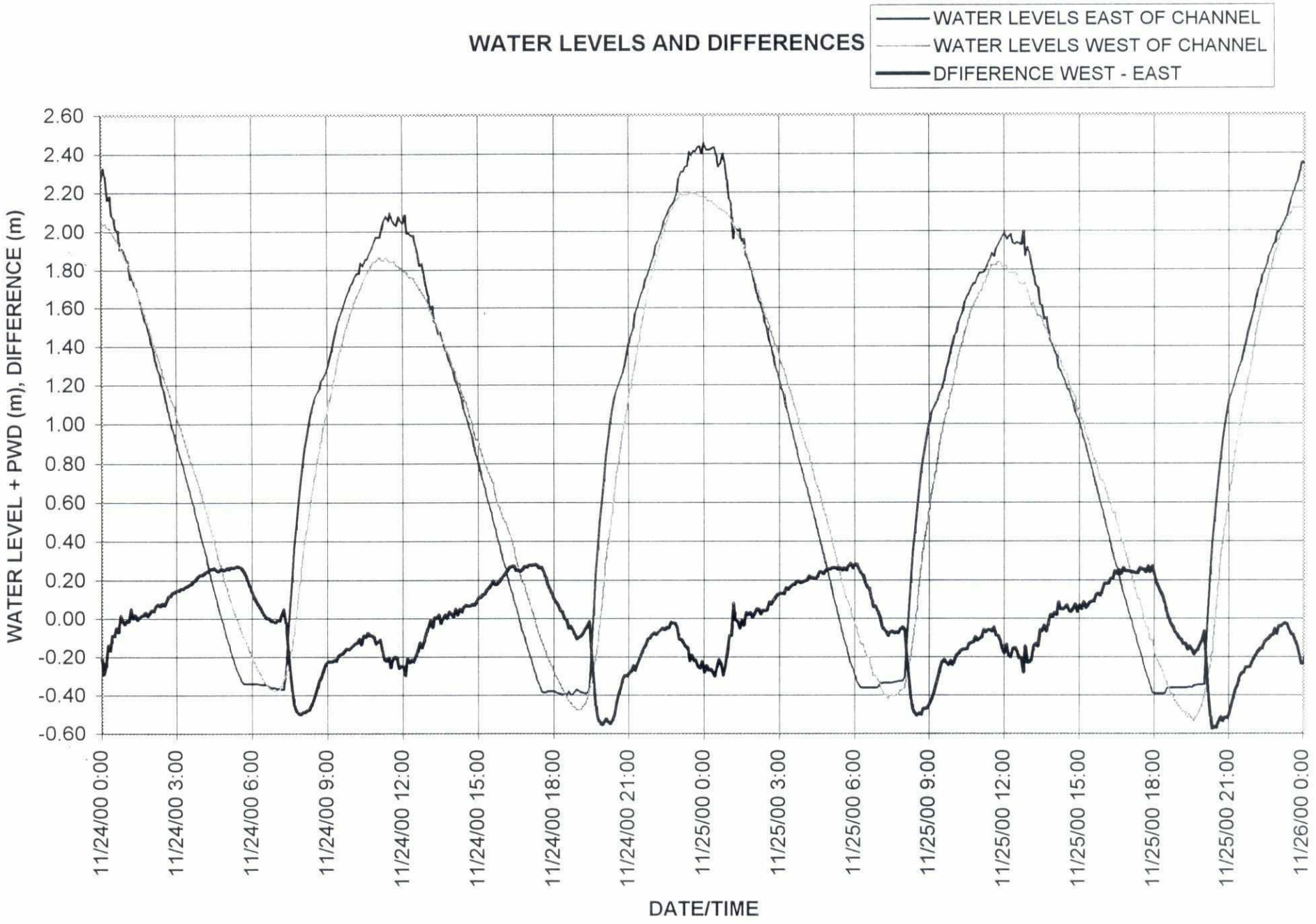
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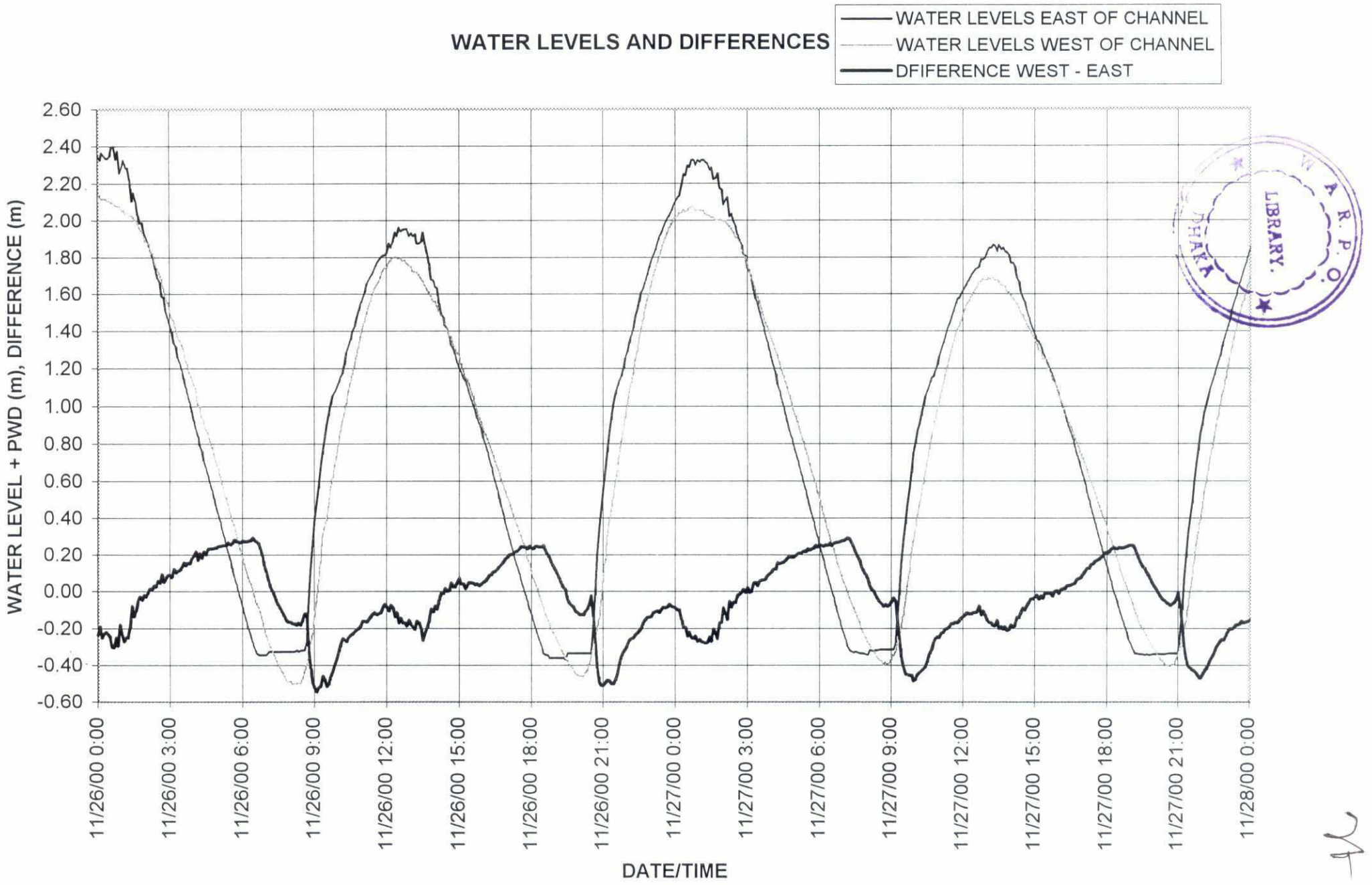

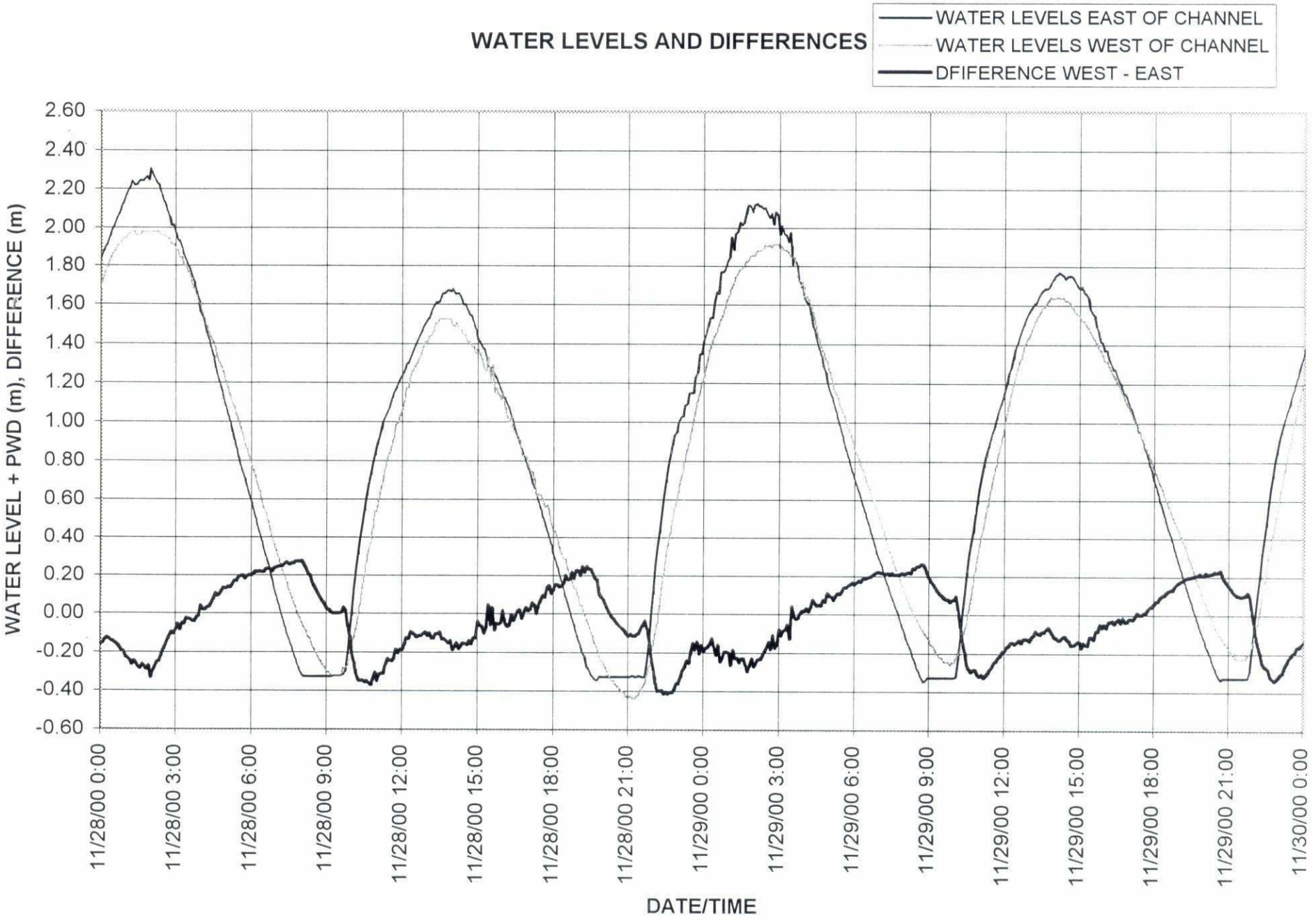
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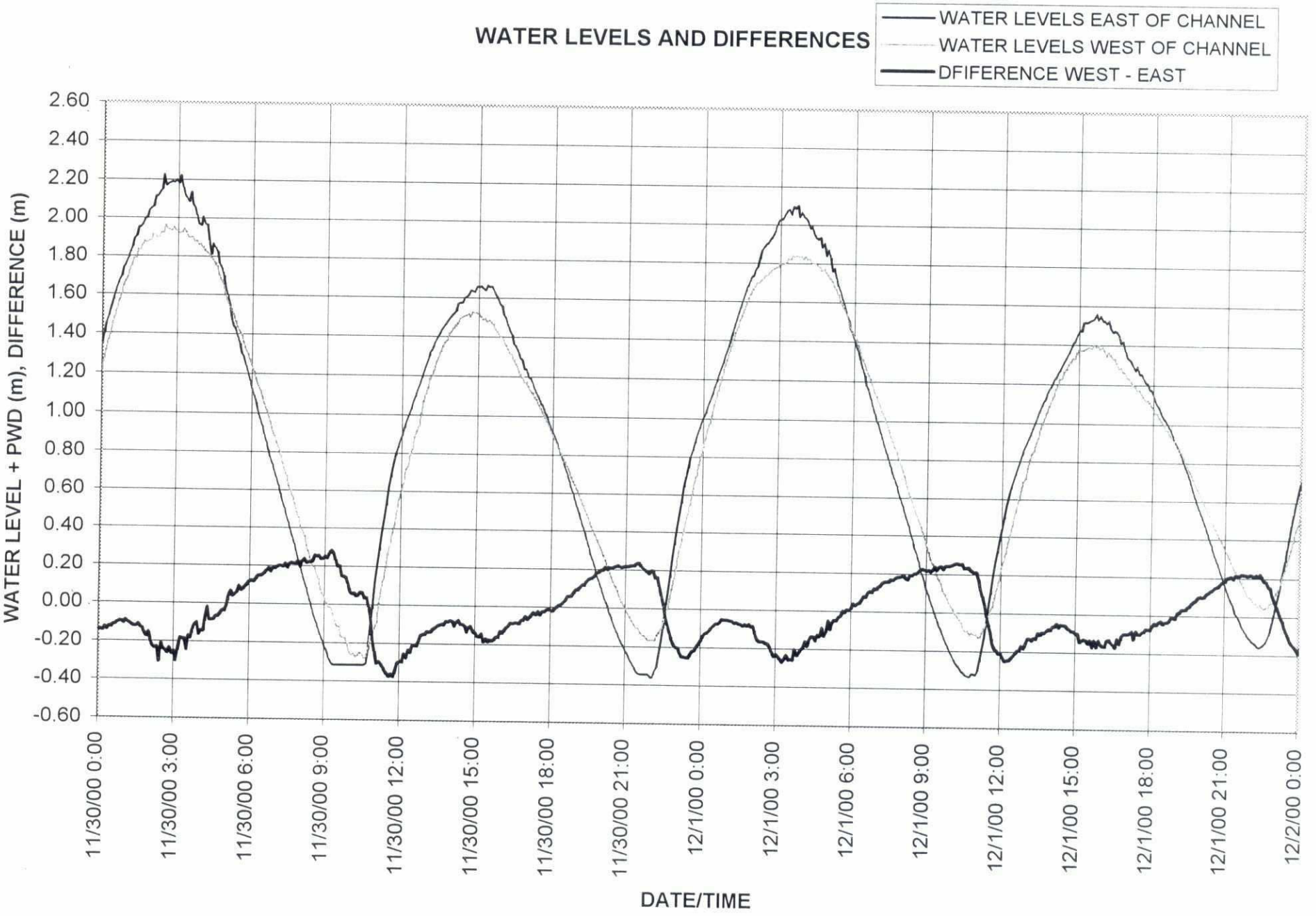
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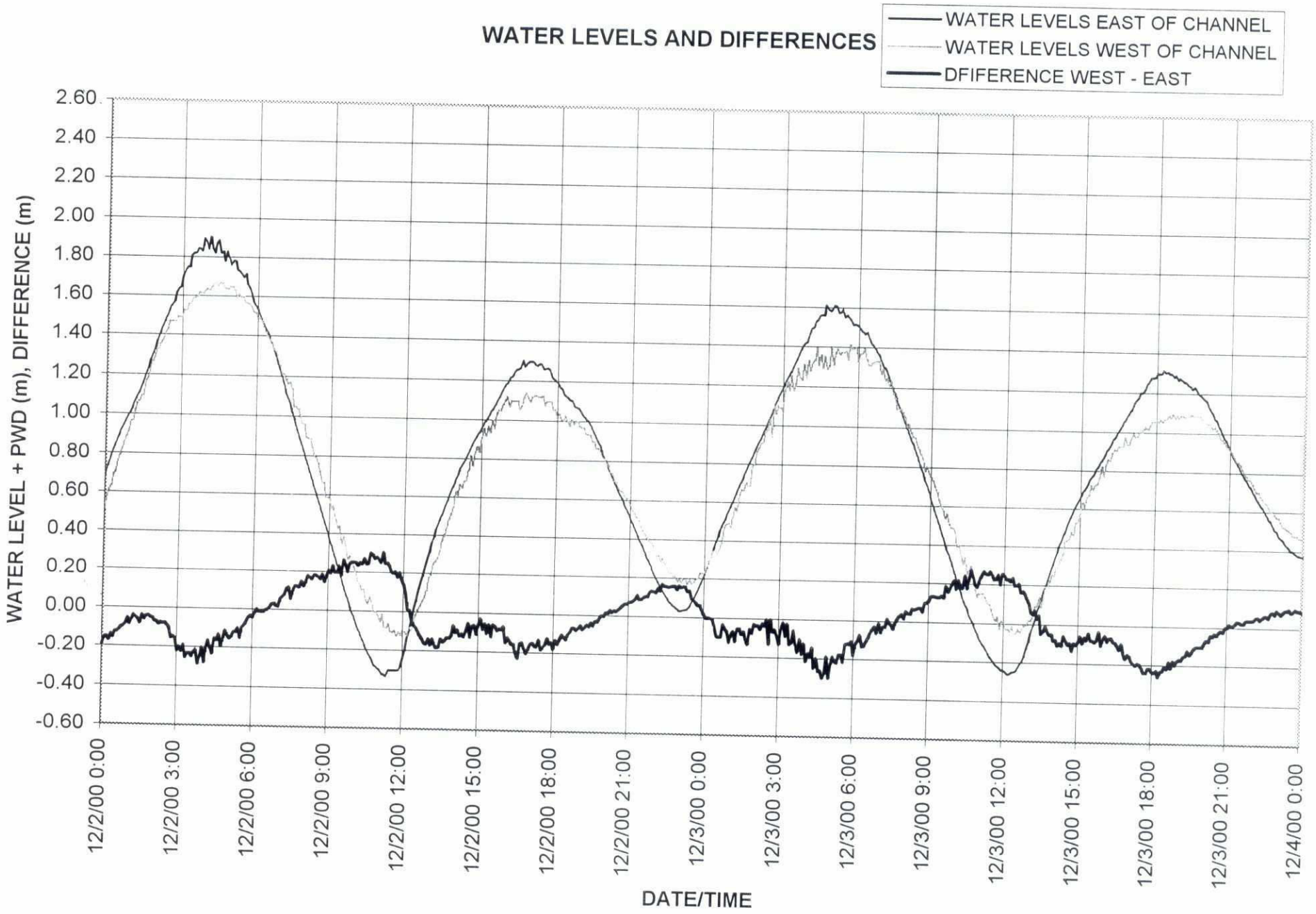
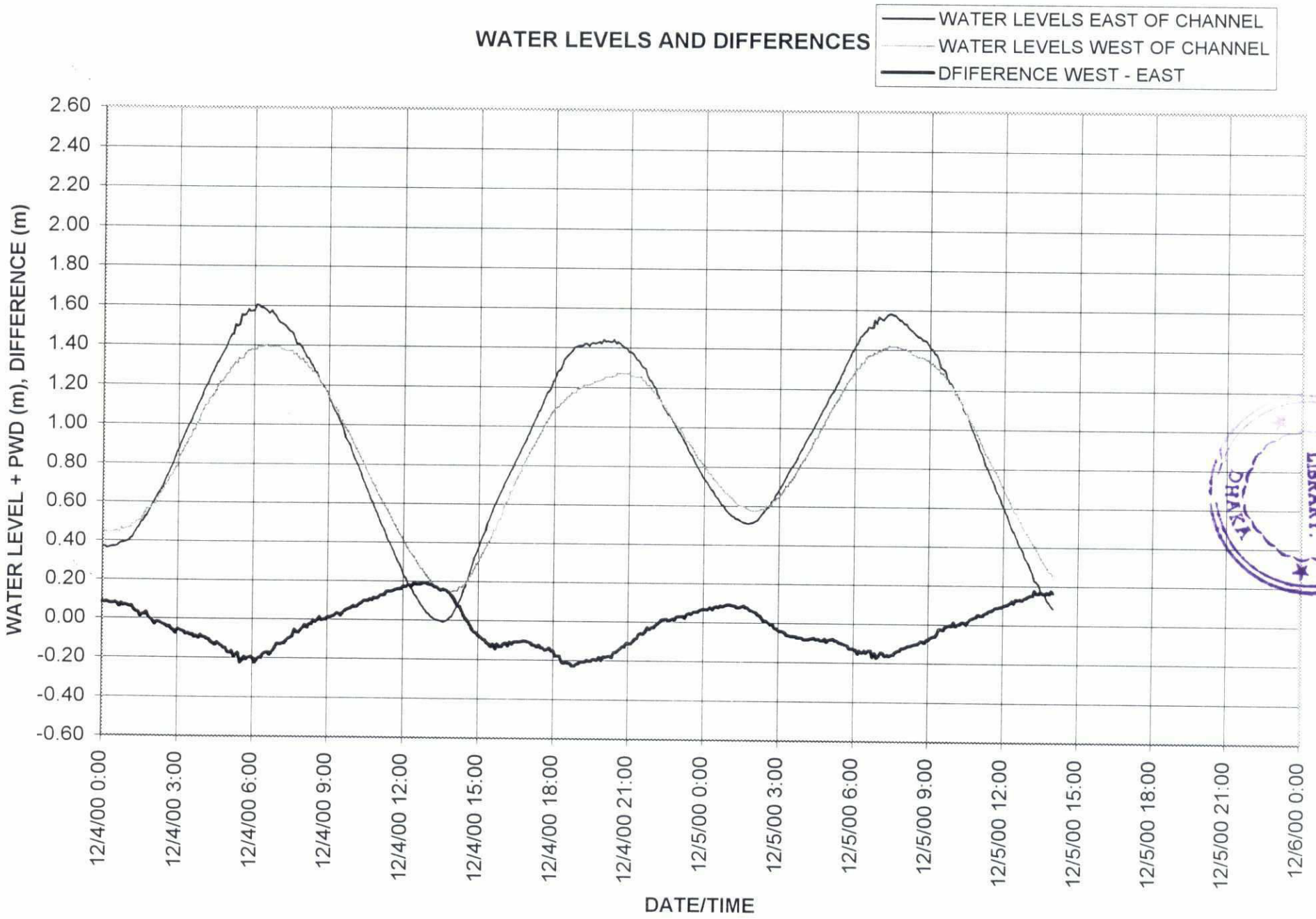
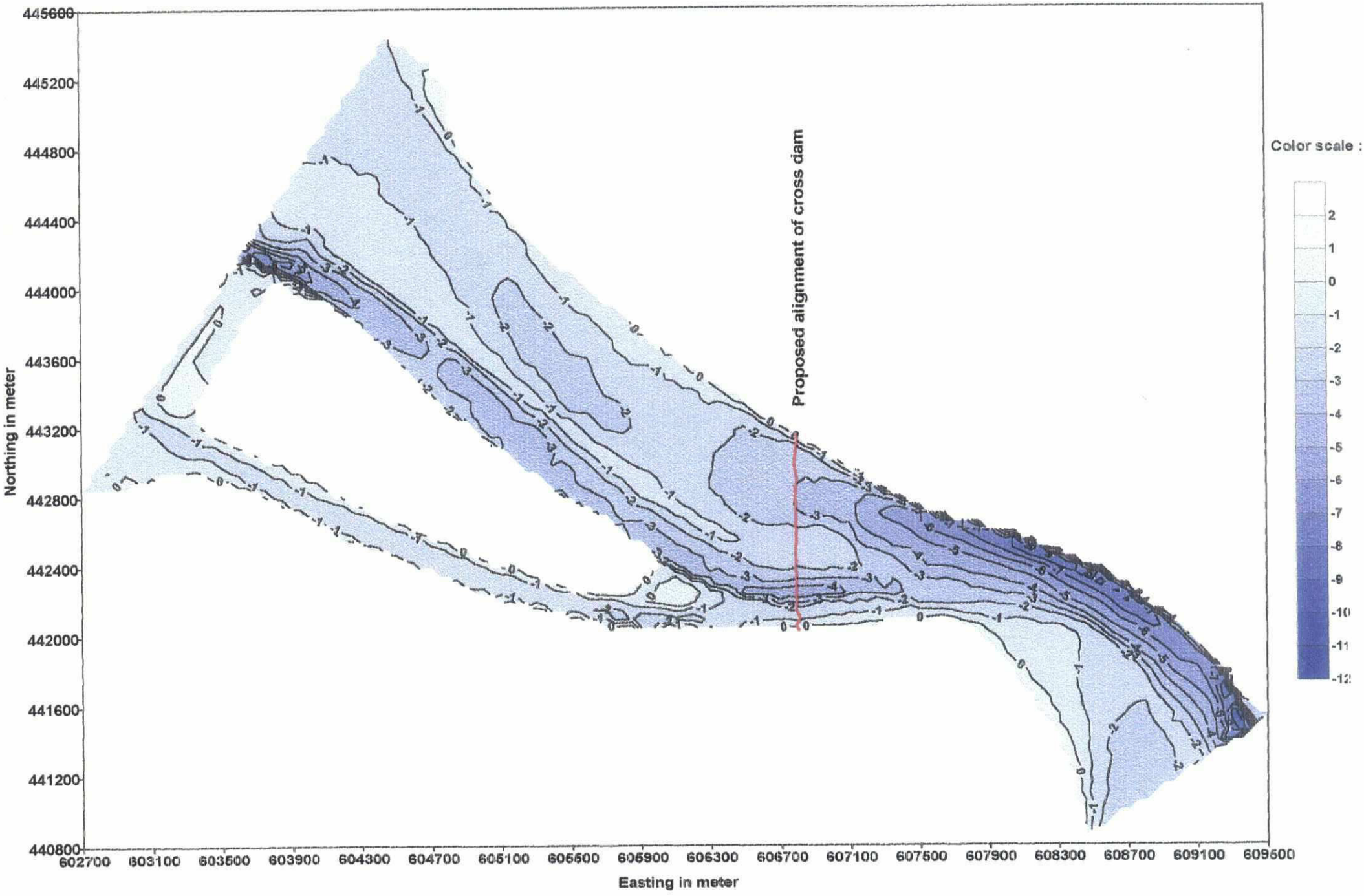
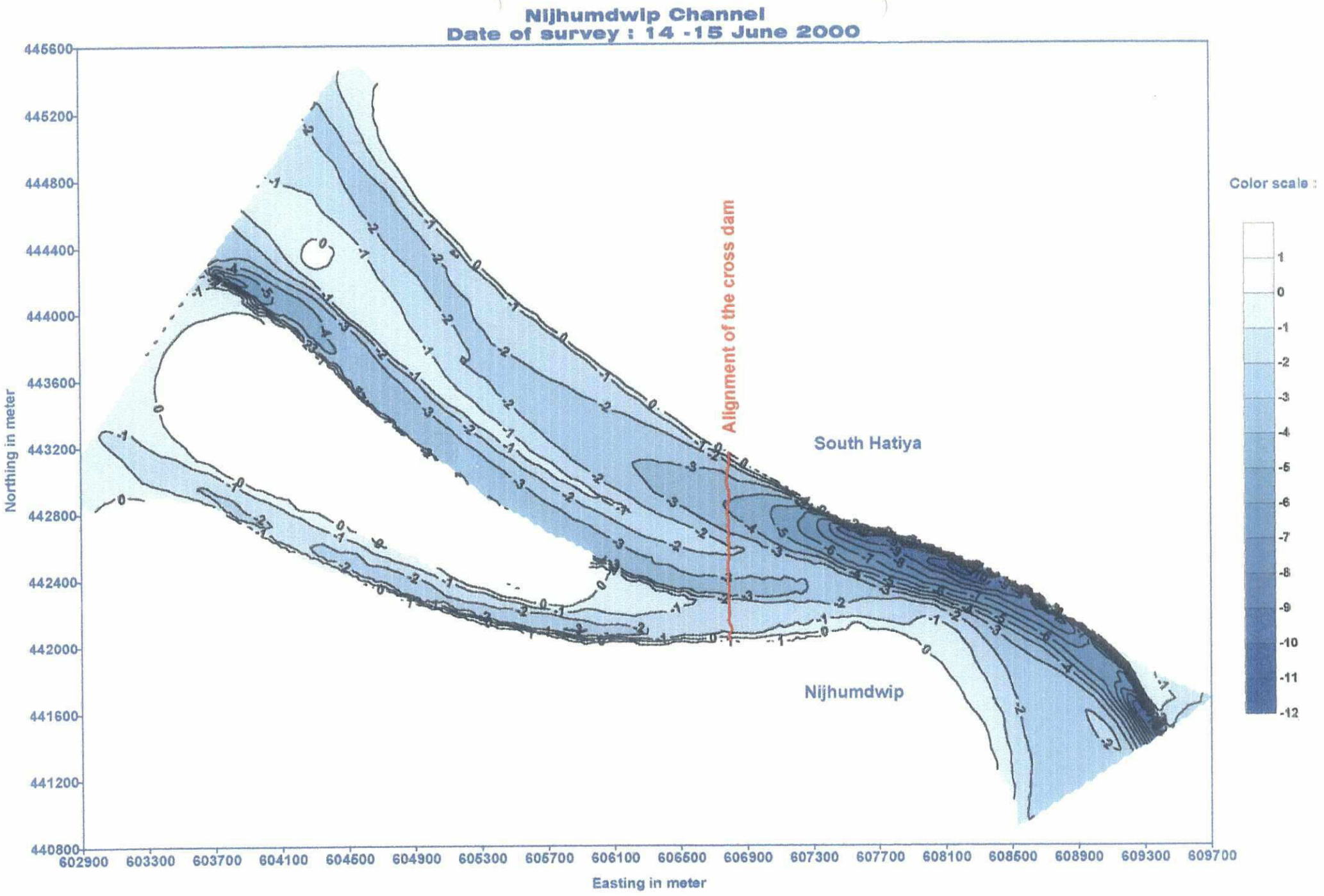
DATE/TIME

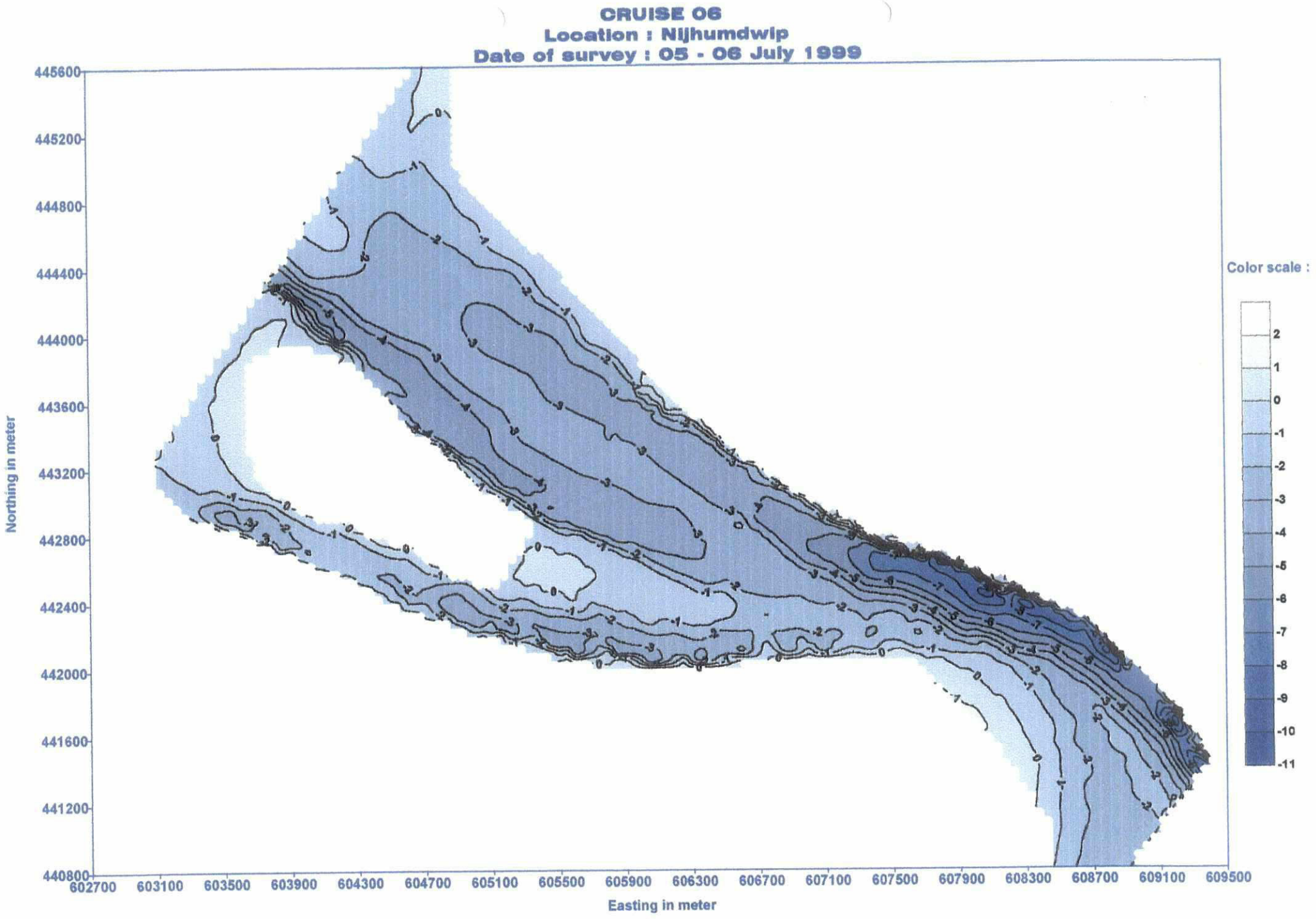

WATER LEVELS AND DIFFERENCES
WATER LEVELS EAST OF CHANNEL
WATER LEVELS WEST OF CHANNEL
DFIFERENCE WEST - EAST
WATER LEVEL + PWD (m), DIFFERENCE (m)
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
12/2/00 0:00
12/2/00 3:00
12/2/00 6:00
12/2/00 9:00
12/2/00 12:00
12/2/00 15:00
12/2/00 18:00
12/2/00 21:00
12/3/00 0:00
12/3/00 3:00
12/3/00 6:00
12/3/00 9:00
12/3/00 12:00
12/3/00 15:00
12/3/00 18:00
12/3/00 21:00
12/4/00 0:00
DATE/TIME

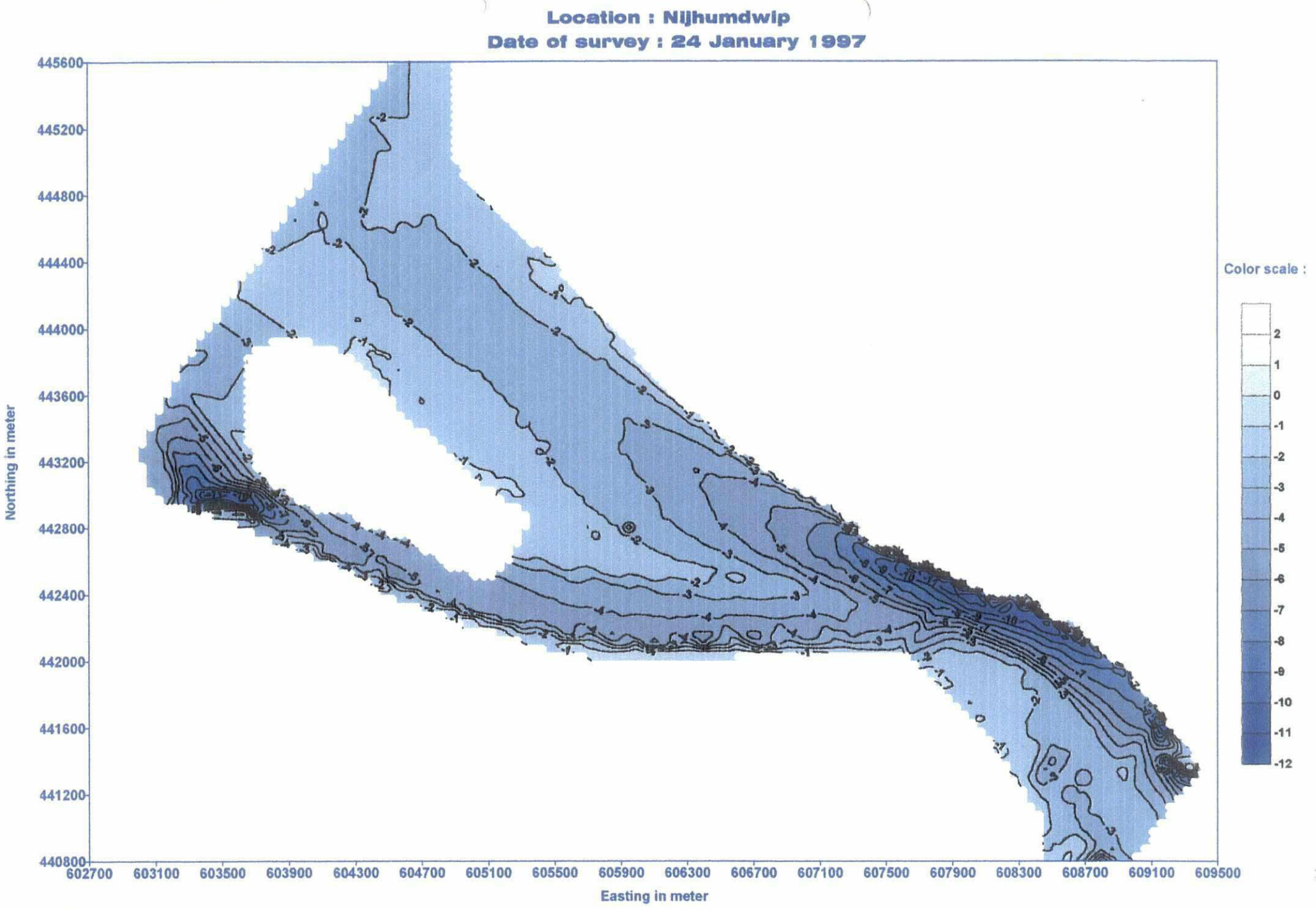


CRUISE 2000/13
Location : Nijhumdwip
Date of survey : 21 - 22 November 2000




Nijhumdwip Channel
Date of survey : 14 -15 June 2000
Alignment of the cross dam
South Hatiya
Nijhumdwip
Color scale :
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
Northing in meter
445600
445200
444800
444400
444000
443600
443200
442800
442400
442000
441600
441200
440800
Easting in meter
602900
603300
603700
604100
604500
604900
605300
605700
606100
606500
606900
607300
607700
608100
608500
608900
609300
609700


CRUISE 06
Location : Nijhumdwip
Date of survey : 05 - 06 July 1999
Color scale :
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
Northing in meter
445600
445200
444800
444400
444000
443600
443200
442800
442400
442000
441600
441200
440800
Easting in meter
602700
603100
603500
603900
604300
604700
605100
605500
605900
606300
606700
607100
607500
607900
608300
608700
609100
609500

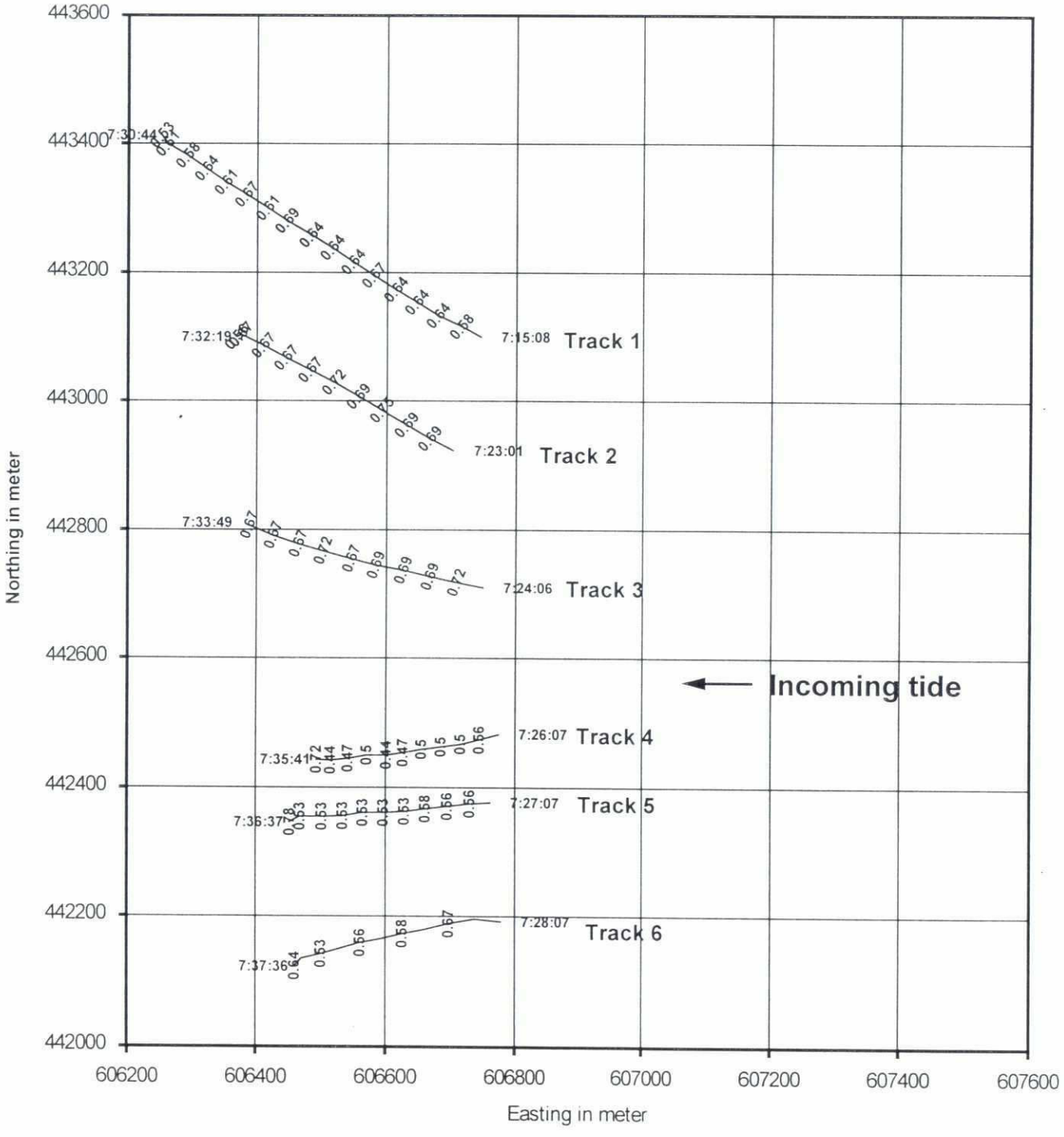

Location : Nijhumdwip
Date of survey : 24 January 1997
Northing in meter
445600
445200
444800
444400
444000
443600
443200
442800
442400
442000
441600
441200
440800
Easting in meter
602700
603100
603500
603900
604300
604700
605100
605500
605900
606300
606700
607100
607500
607900
608300
608700
609100
609500
Color scale :
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12

ANNEX B

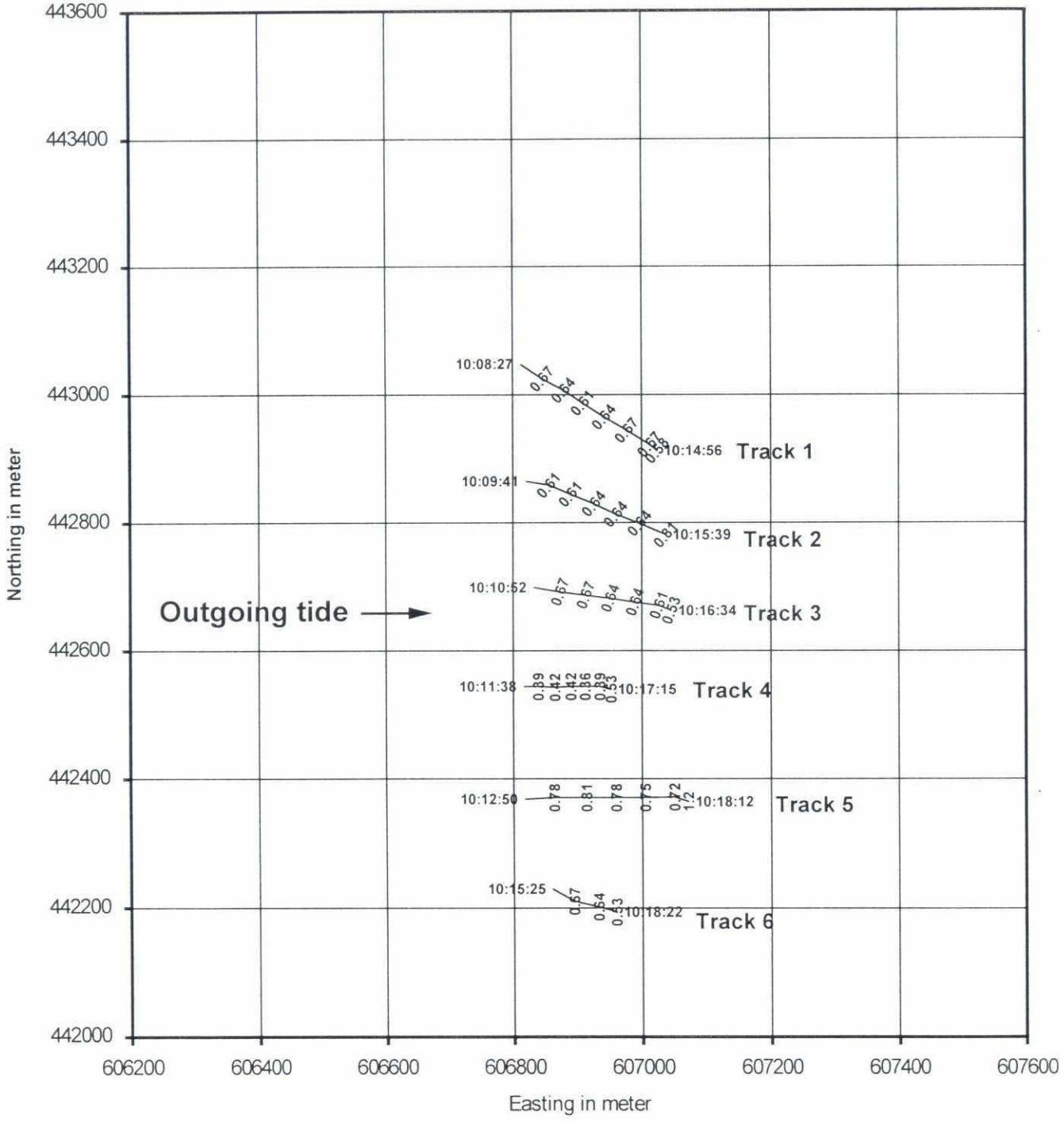
DESIGN AND IMPLEMENTATION
NIJHUM DWIP PERMEABLE CROSS DAM

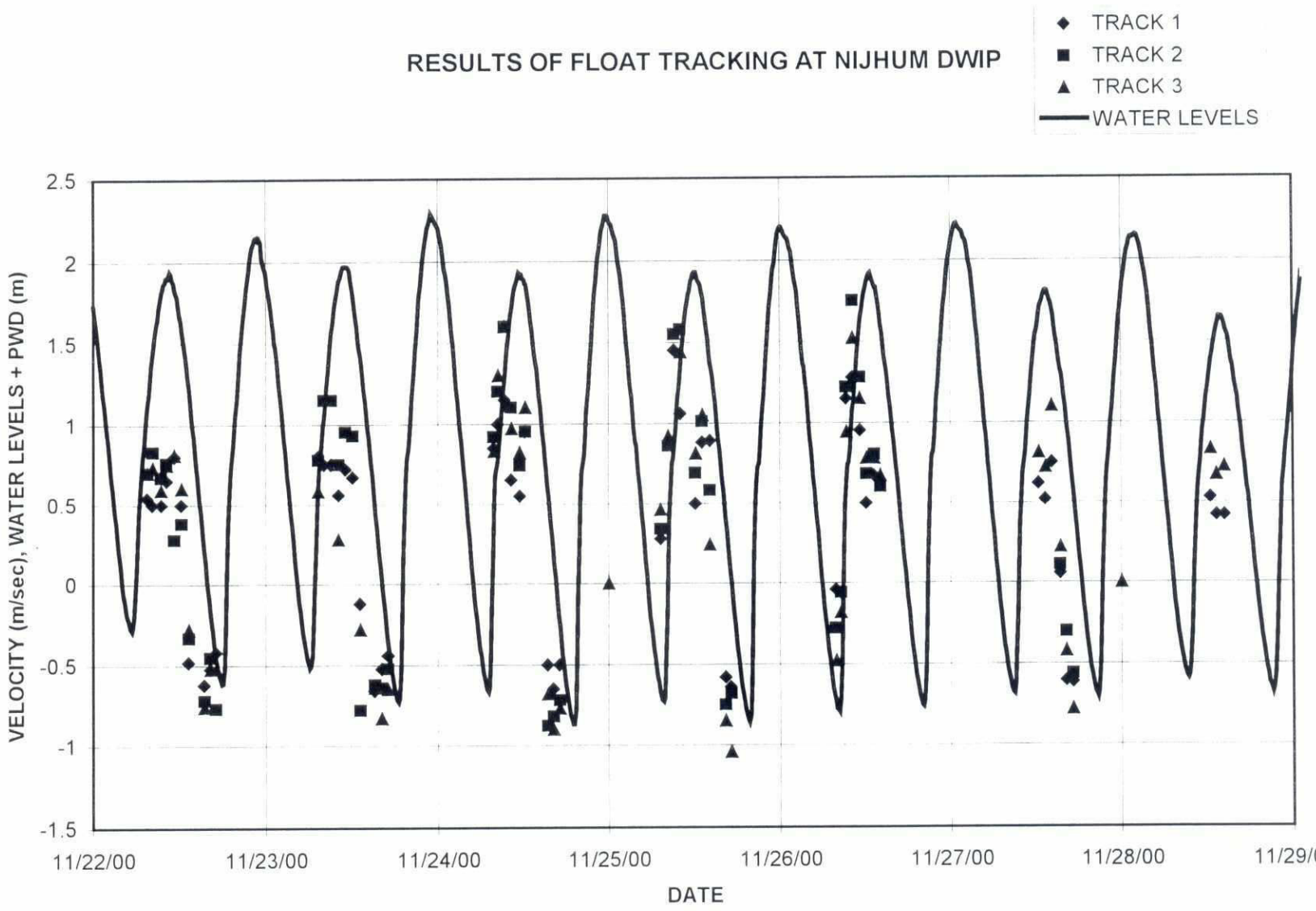
RESULTS OF FLOAT TRACKING

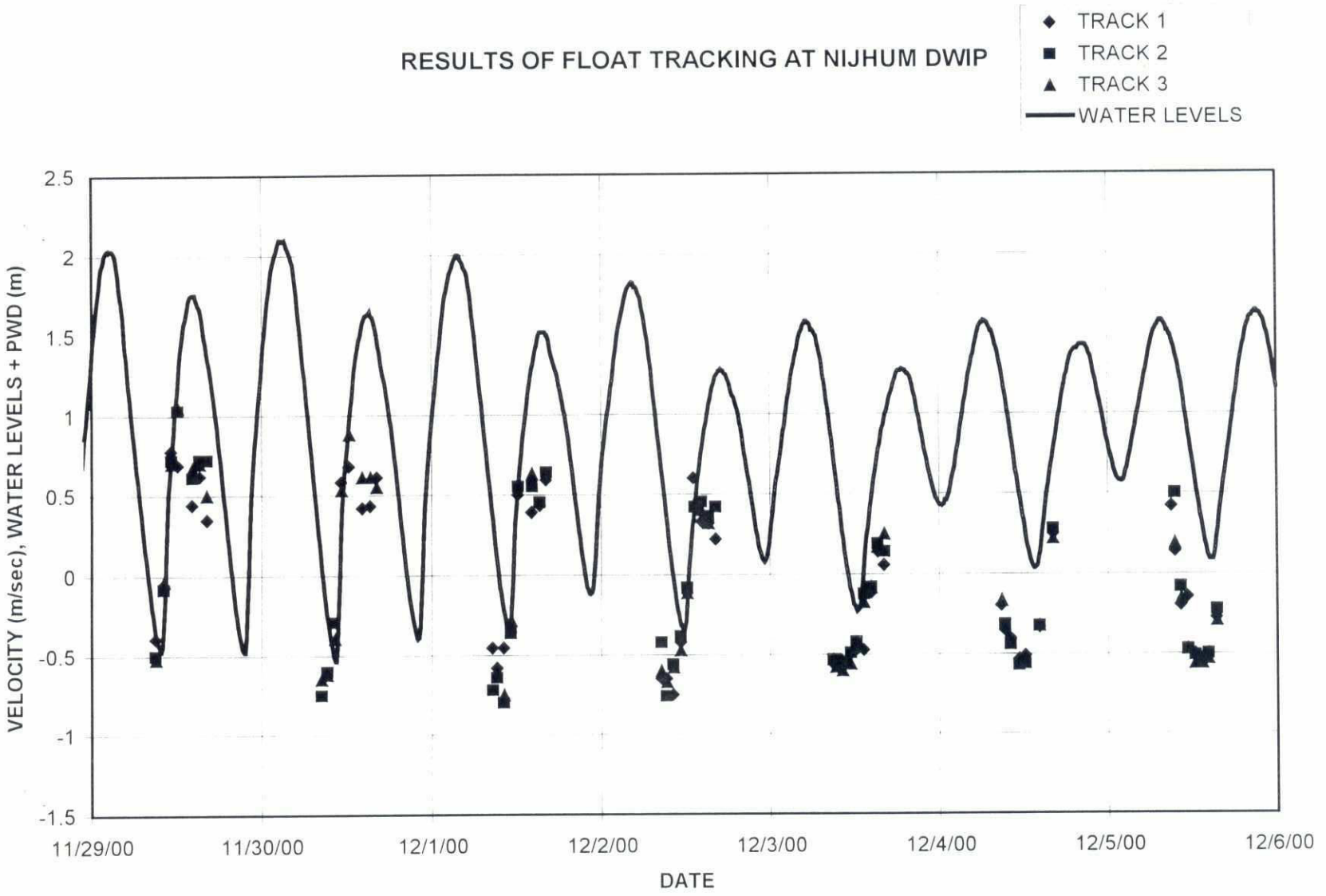
Float Tracking at Nijhum Dwip
22 November 2000
Velocity in m/sec



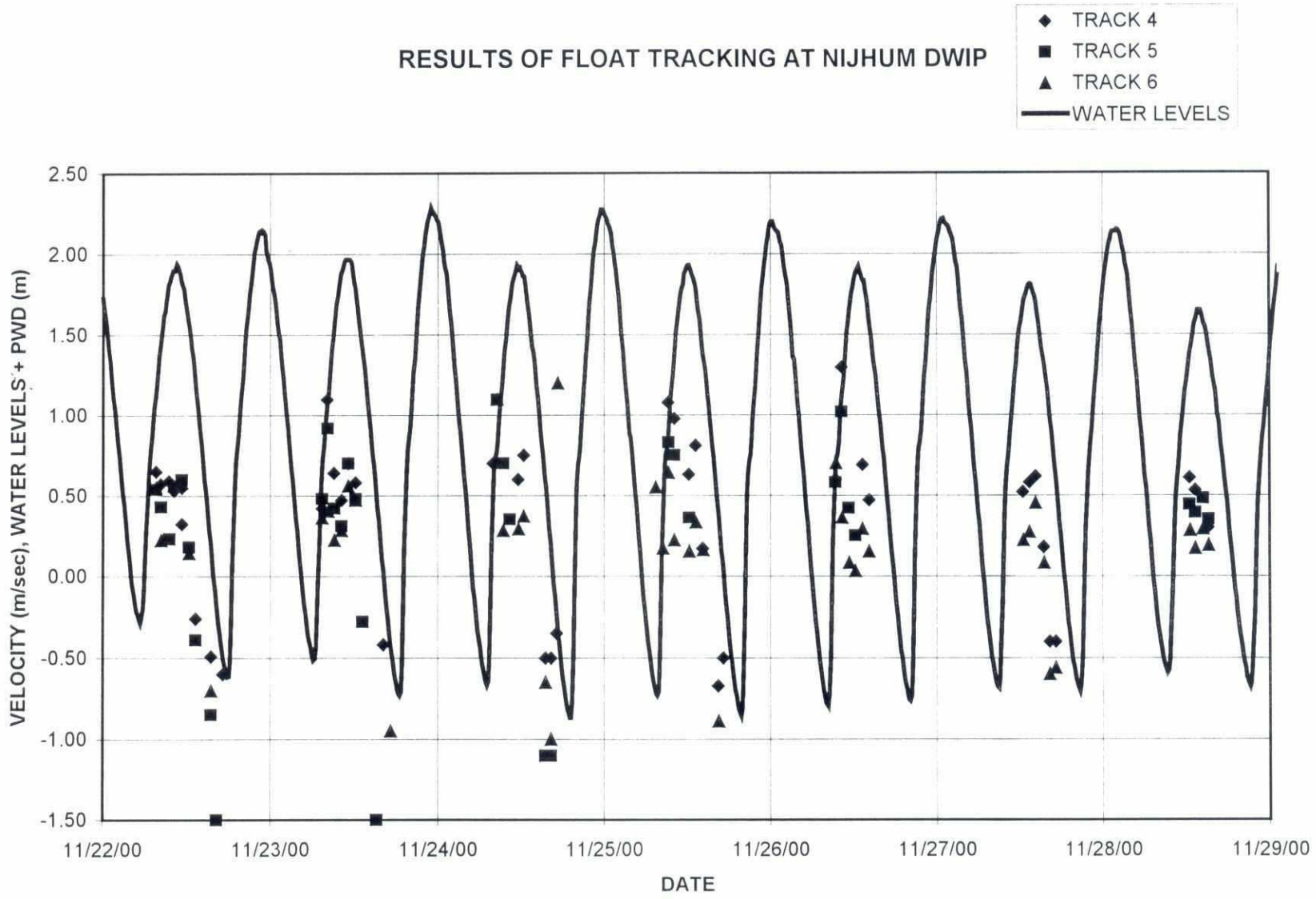
Float Tracking at Nijhum Dwip
03 December 2000
Velocity in m/sec



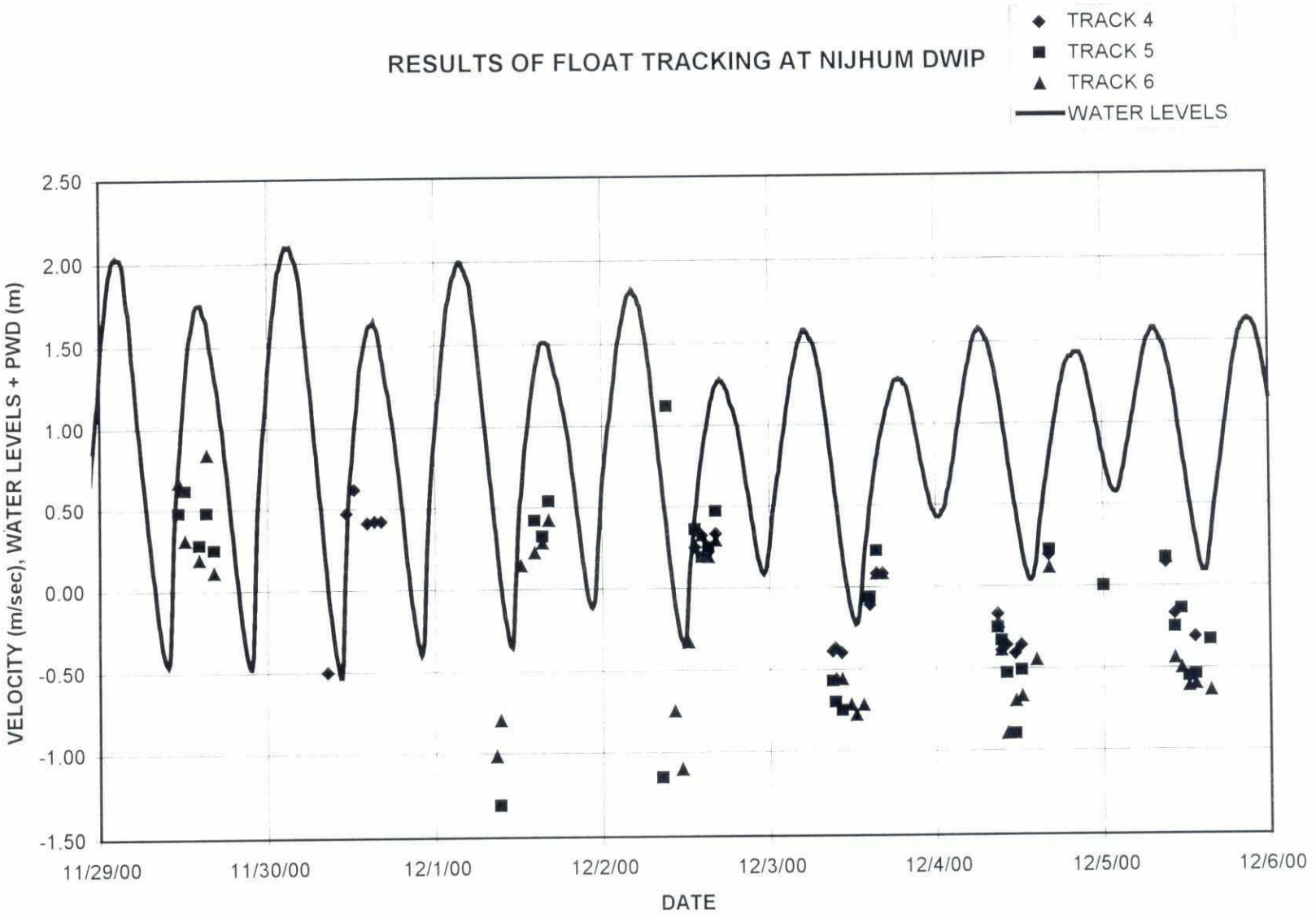



RESULTS OF FLOAT TRACKING AT NIJHUM DWIP
TRACK 1
TRACK 2
TRACK 3
WATER LEVELS
VELOCITY (m/sec), WATER LEVELS + PWD (m)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
11/29/00
11/30/00
12/1/00
12/2/00
12/3/00
12/4/00
12/5/00
12/6/00
DATE

RESULTS OF FLOAT TRACKING AT NIJHUM DWIP



RESULTS OF FLOAT TRACKING AT NIJHUM DWIP

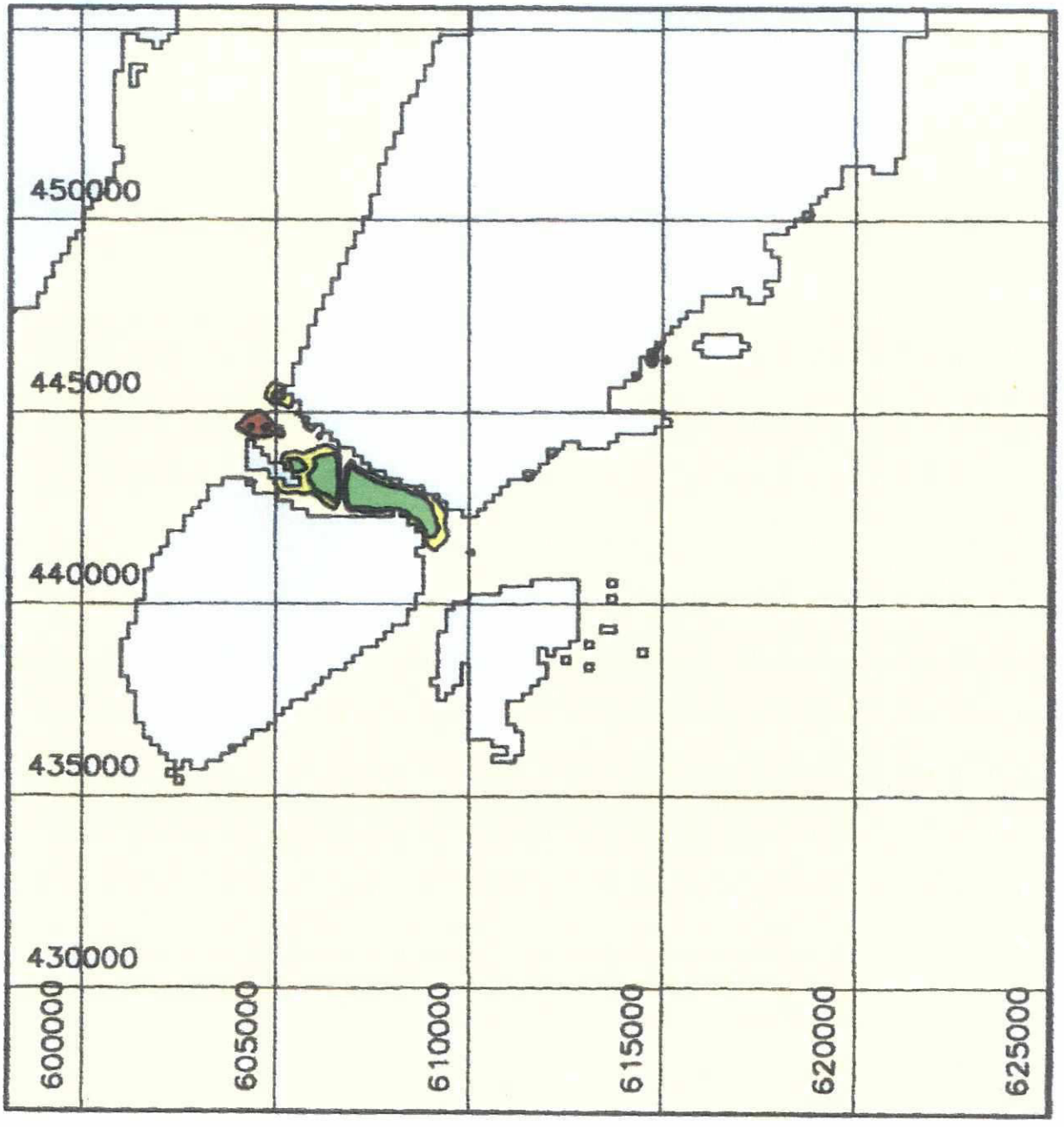


ANNEX C

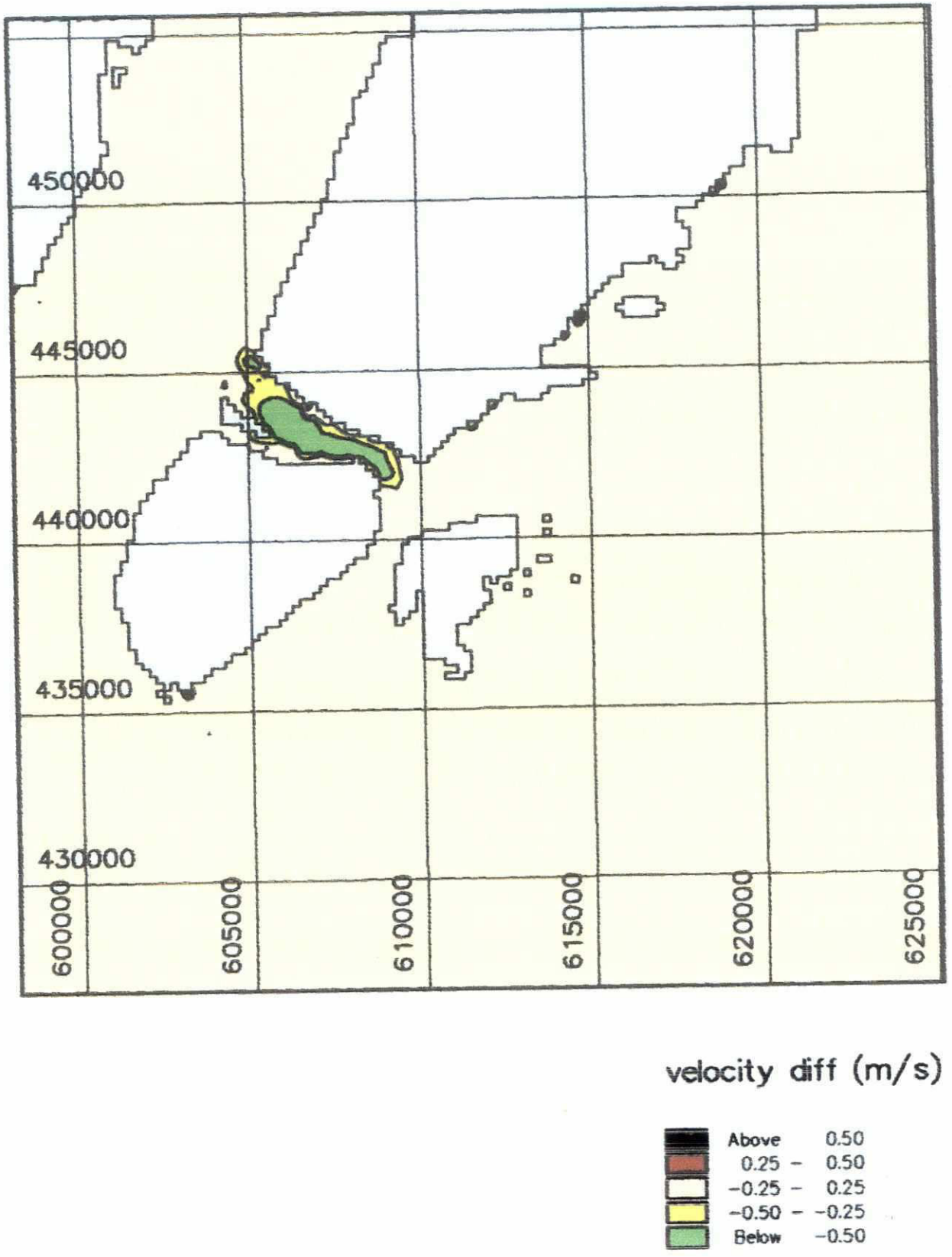
DESIGN AND IMPLEMENTATION
NIJHUM DWIP PERMEABLE CROSS DAM

RESULTS COMPUTER SIMULATIONS
WATER LEVELS
HEAD DIFFERENCES
WATER LEVEL DIFFERENCES

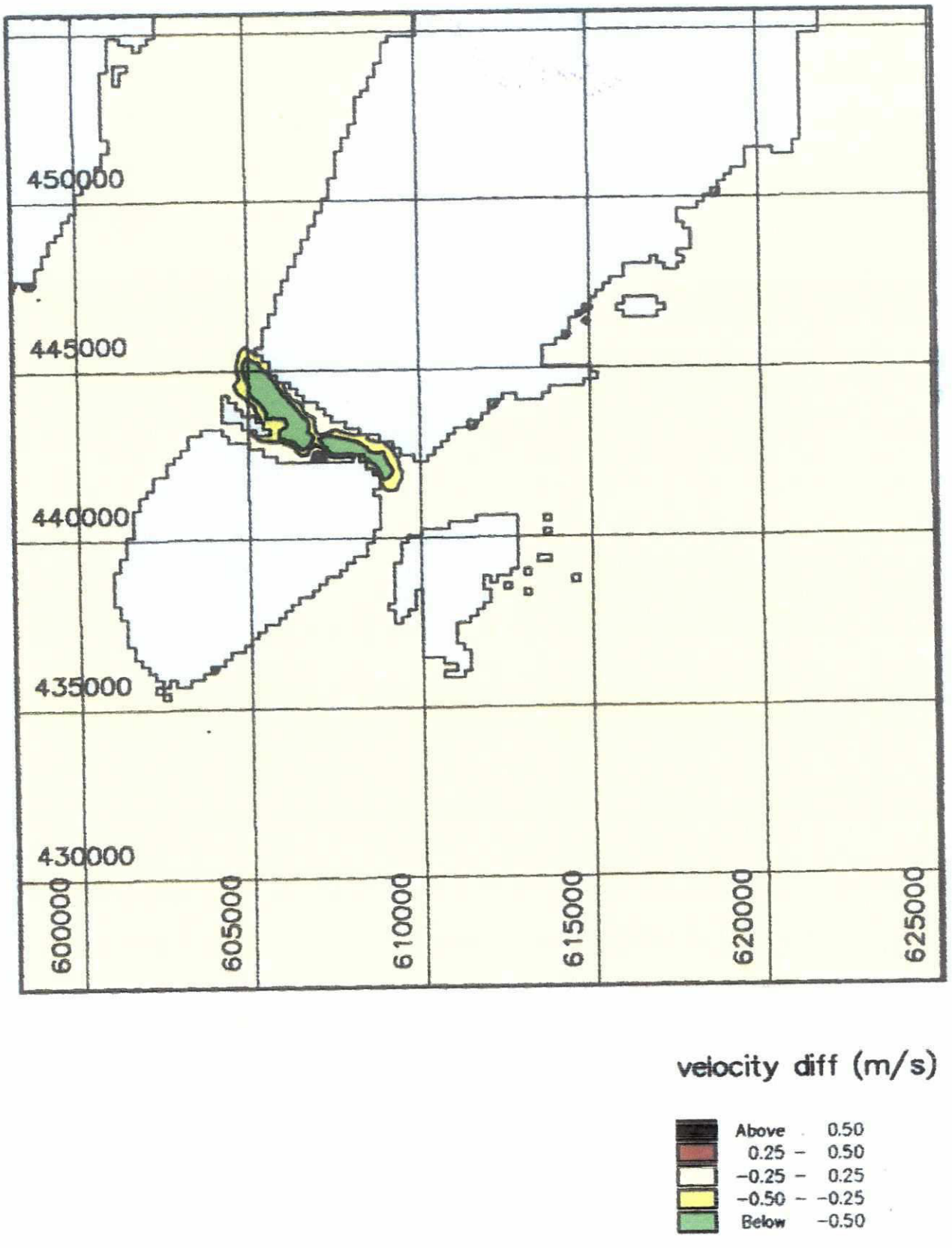
Impact on maximum velocities of impermeable cross dam at Nijhum Dwip

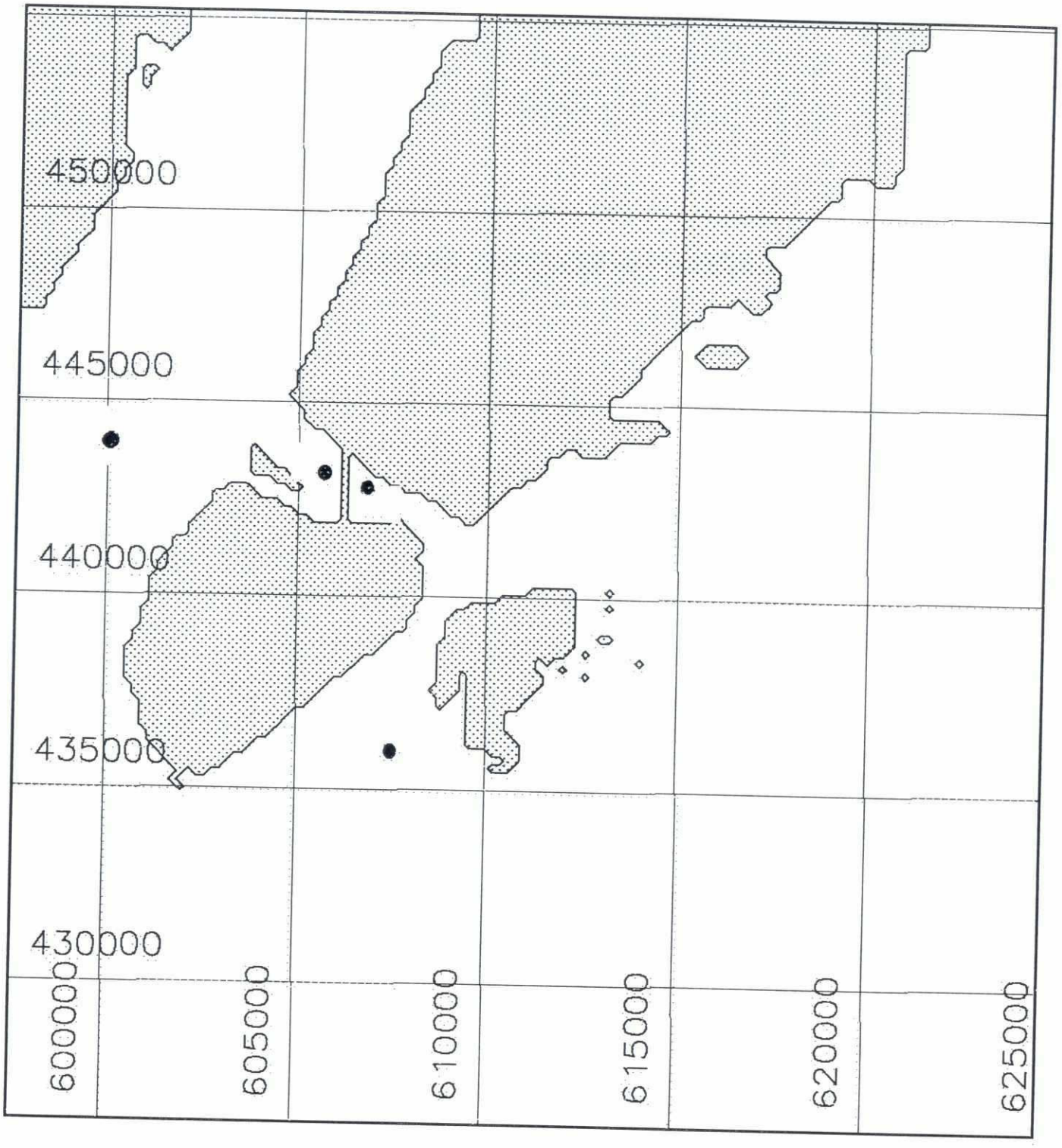


Impact on maximum velocities of 10% permeable cross dam at Nijhum Dwip

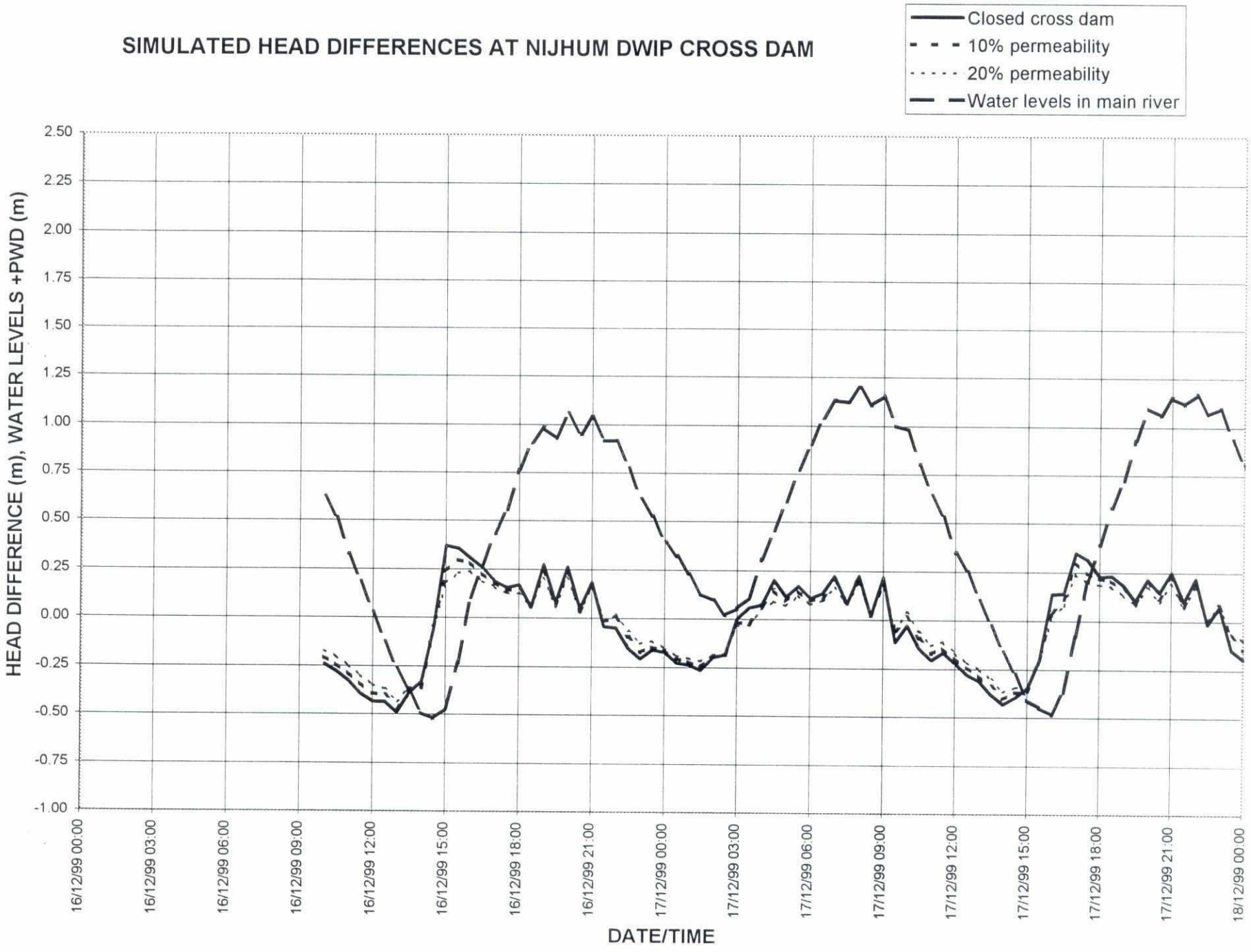


Impact on maximum velocities of 20% permeable cross dam at Nijhum Dwip

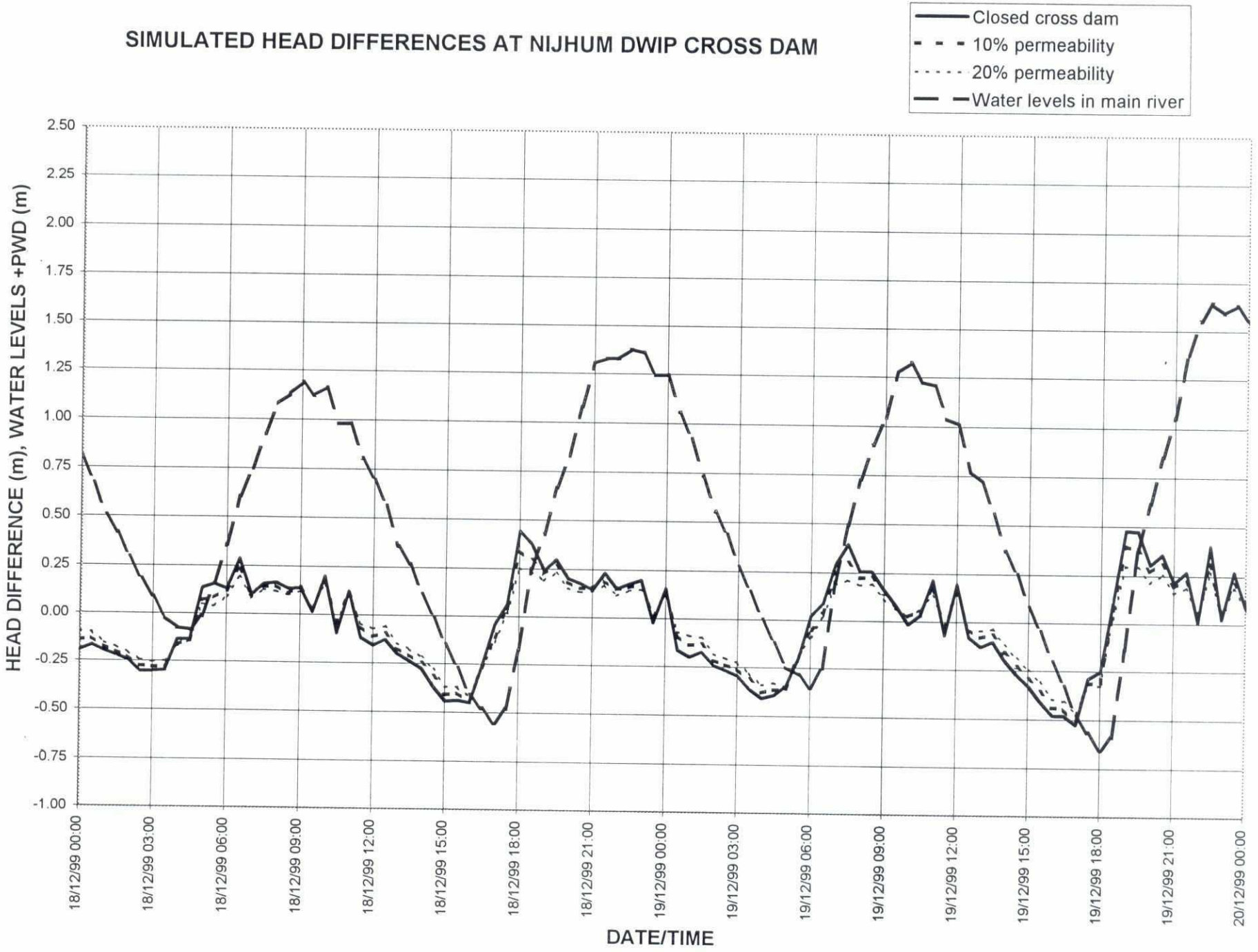




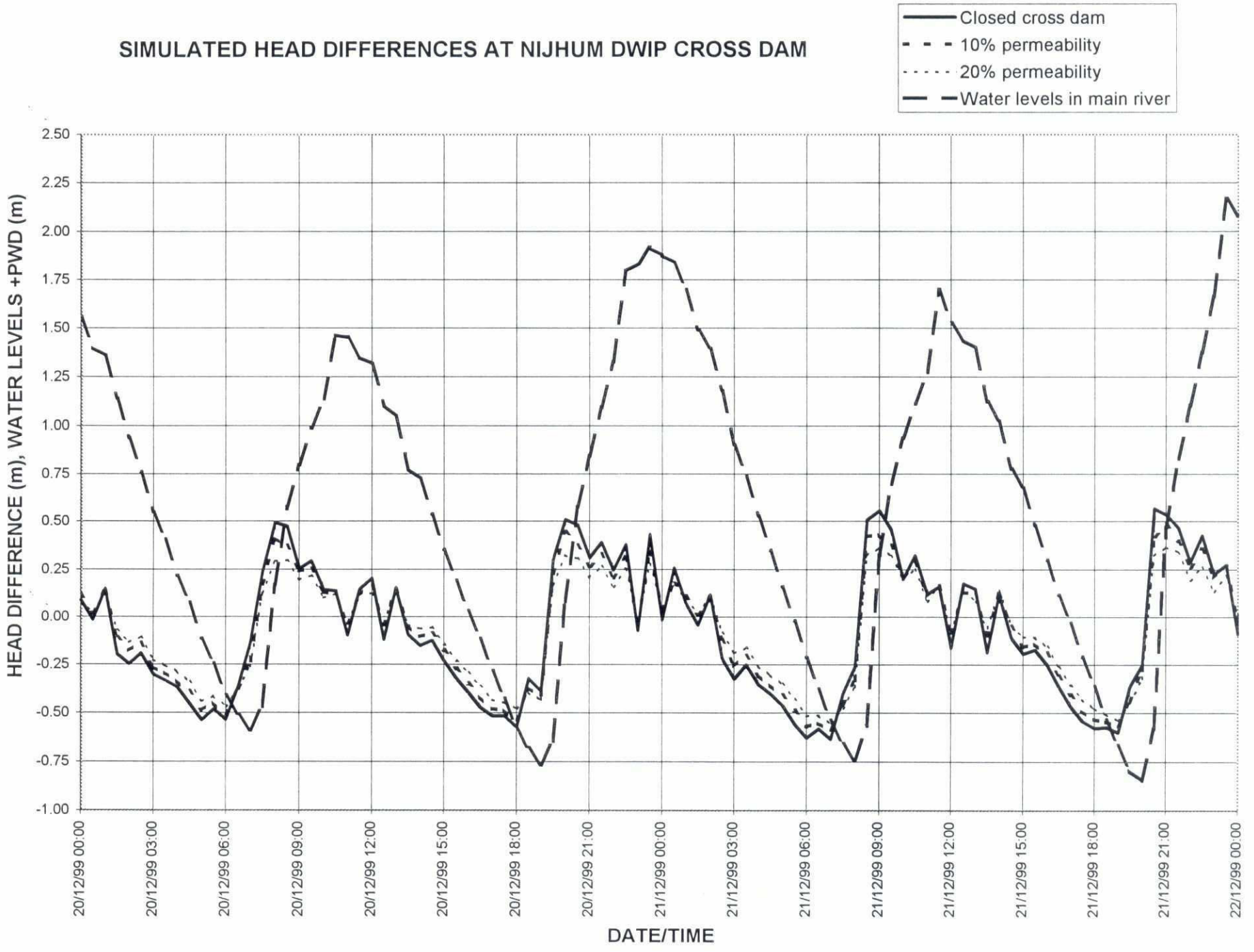
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM



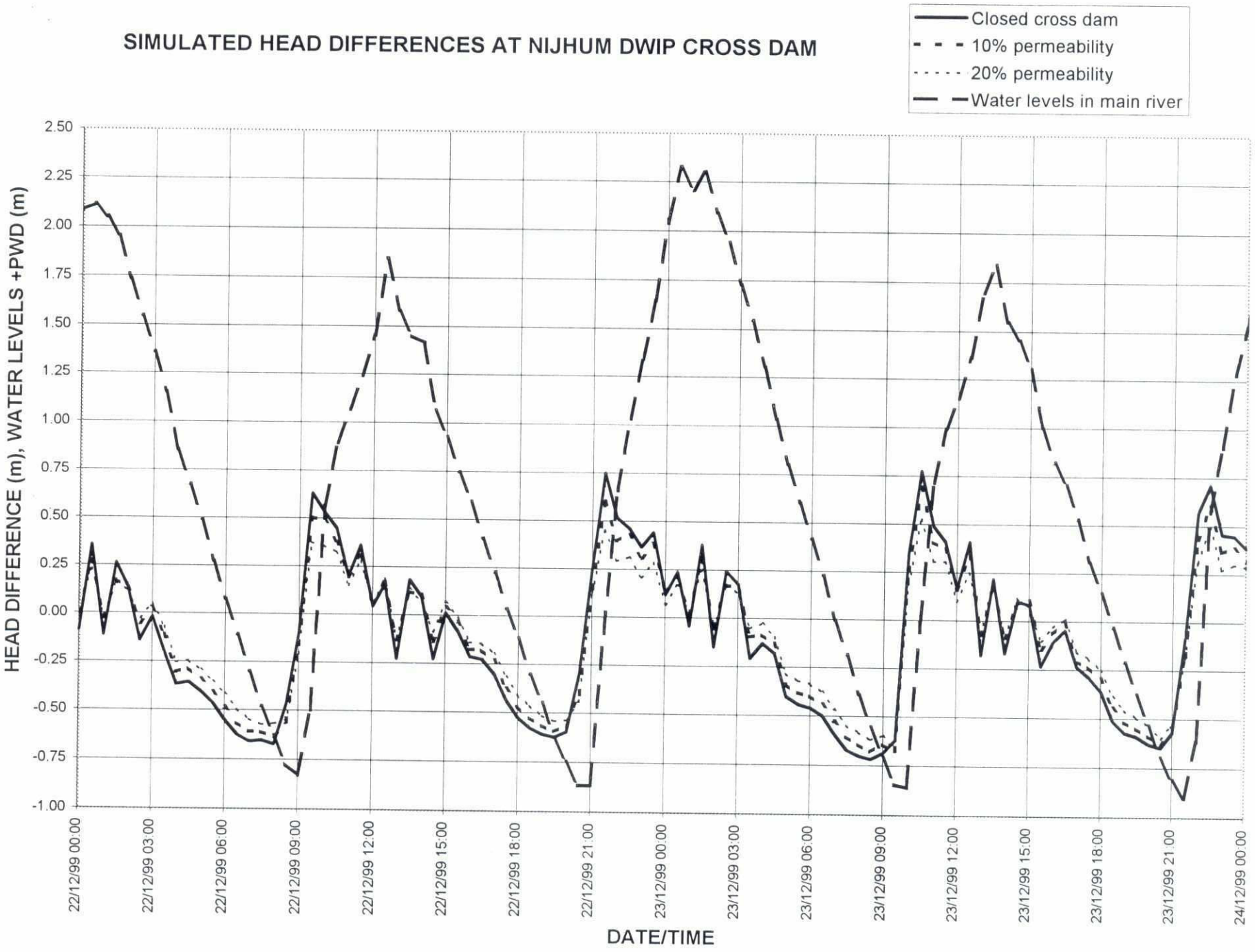
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM



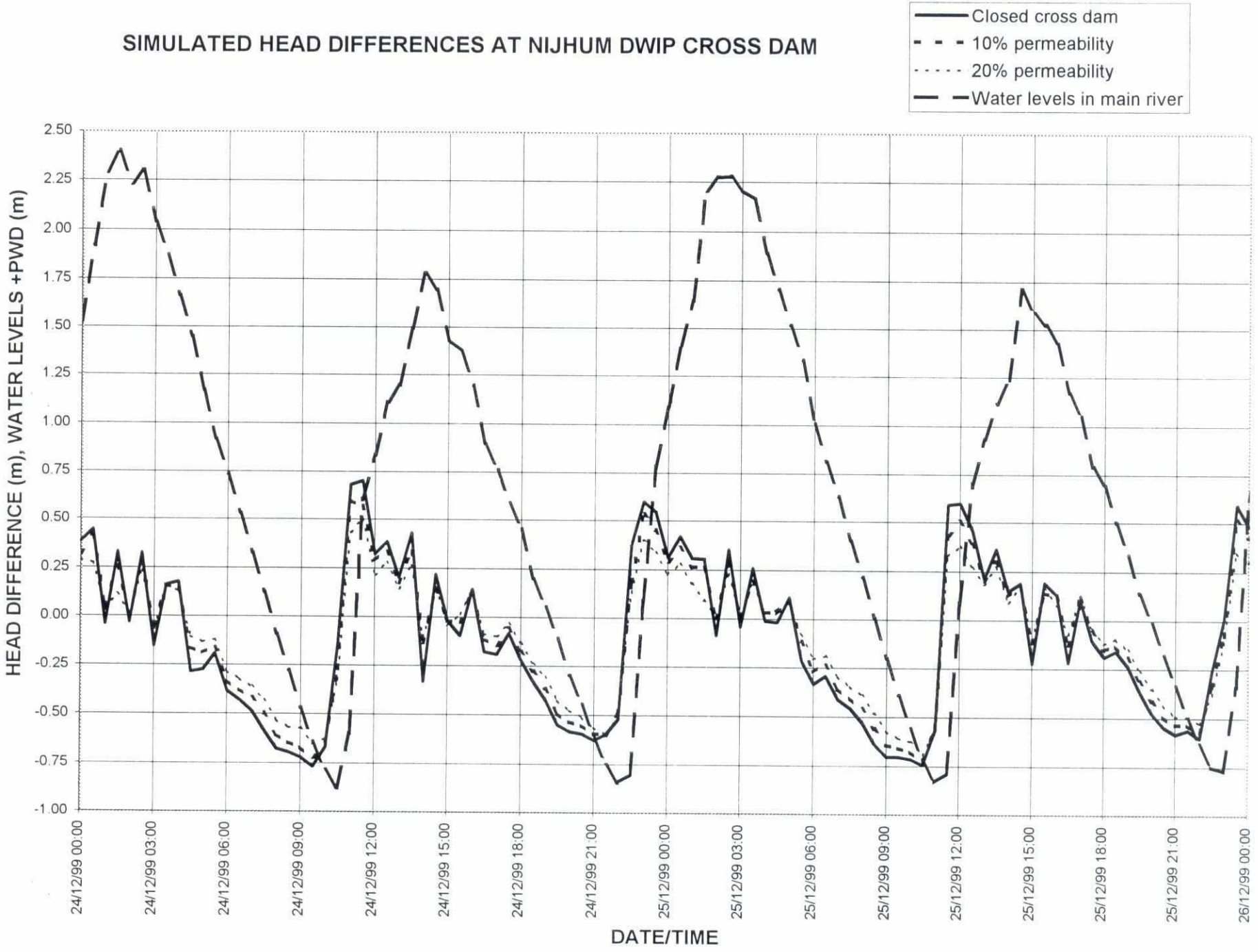
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM



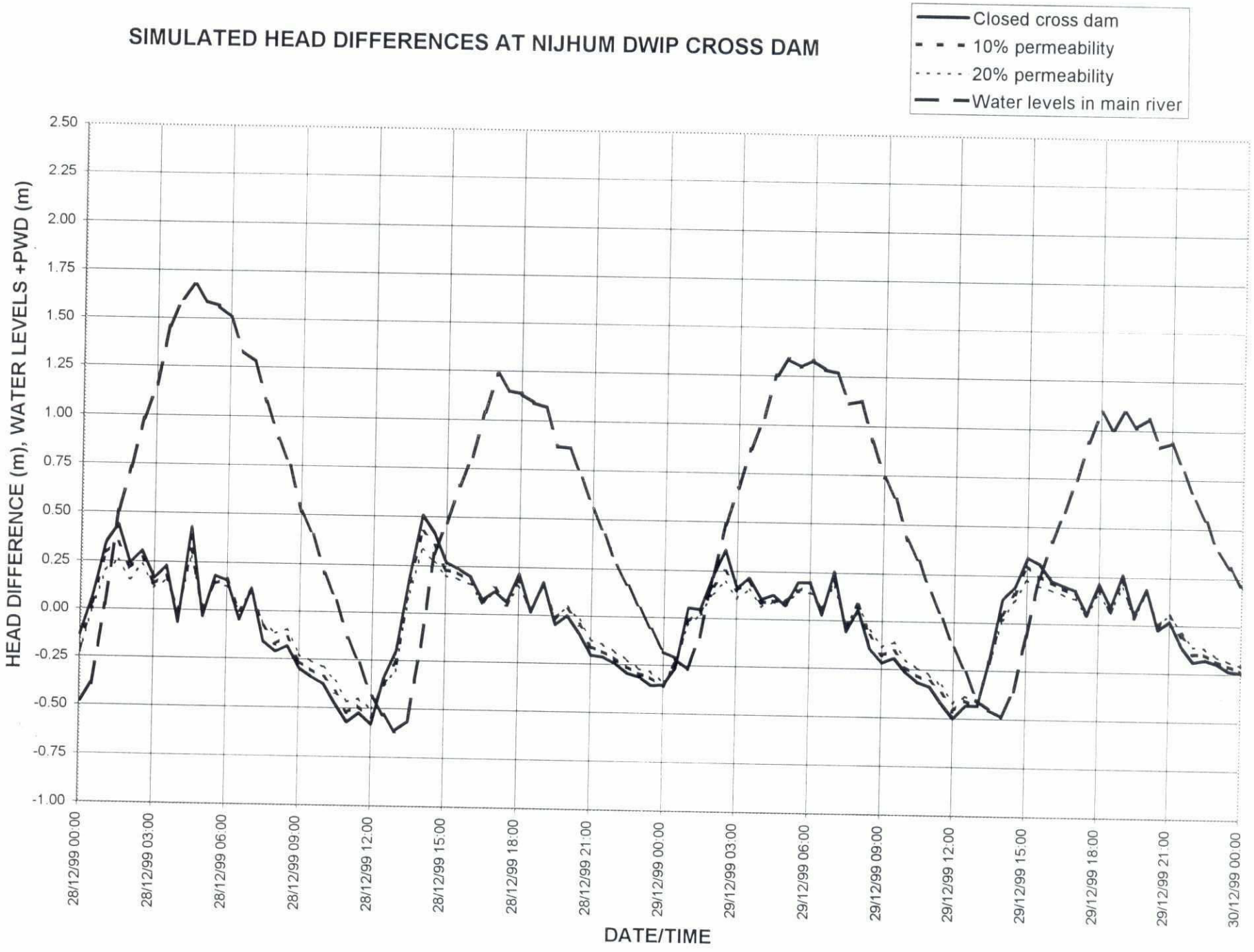
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM



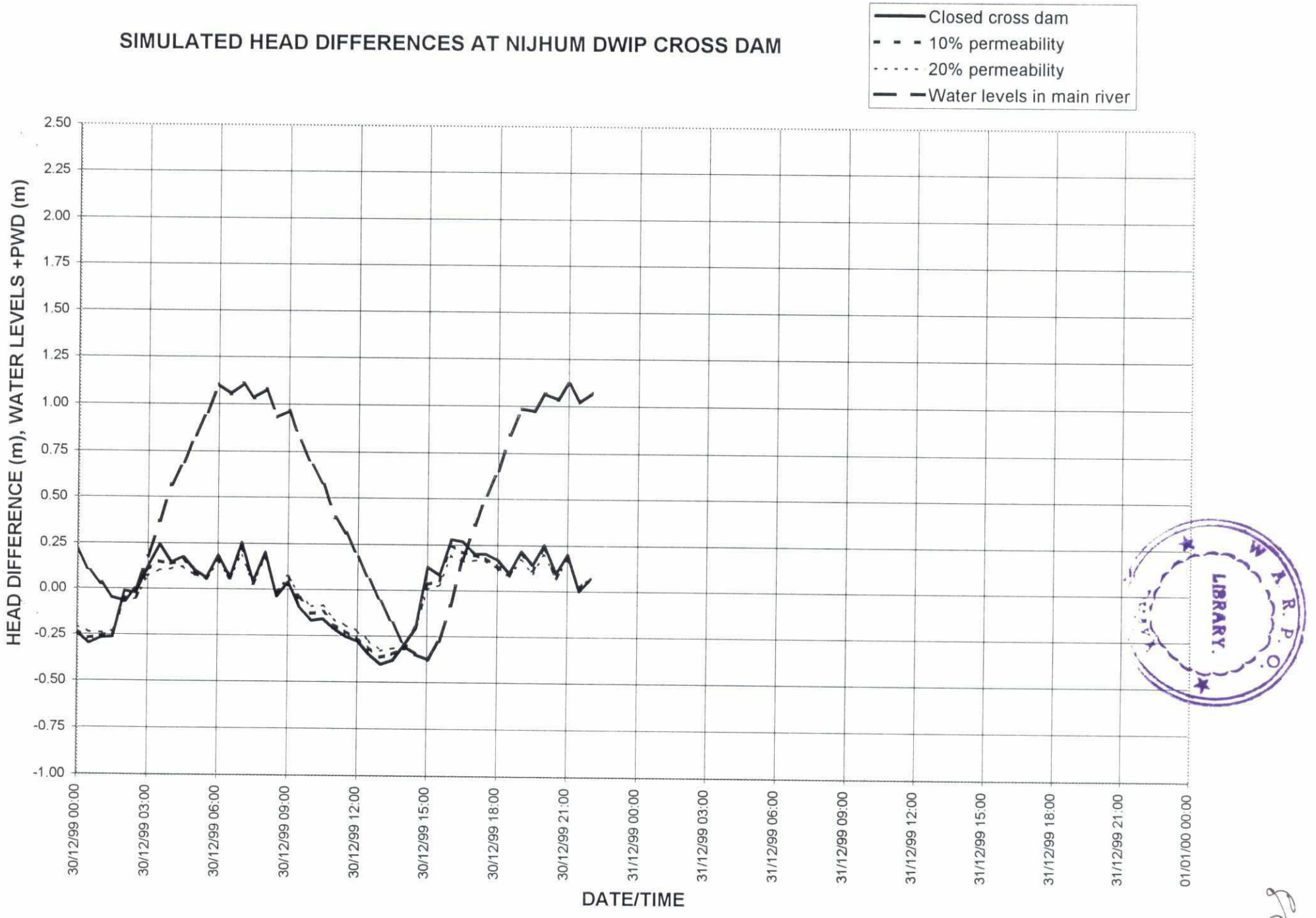
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM

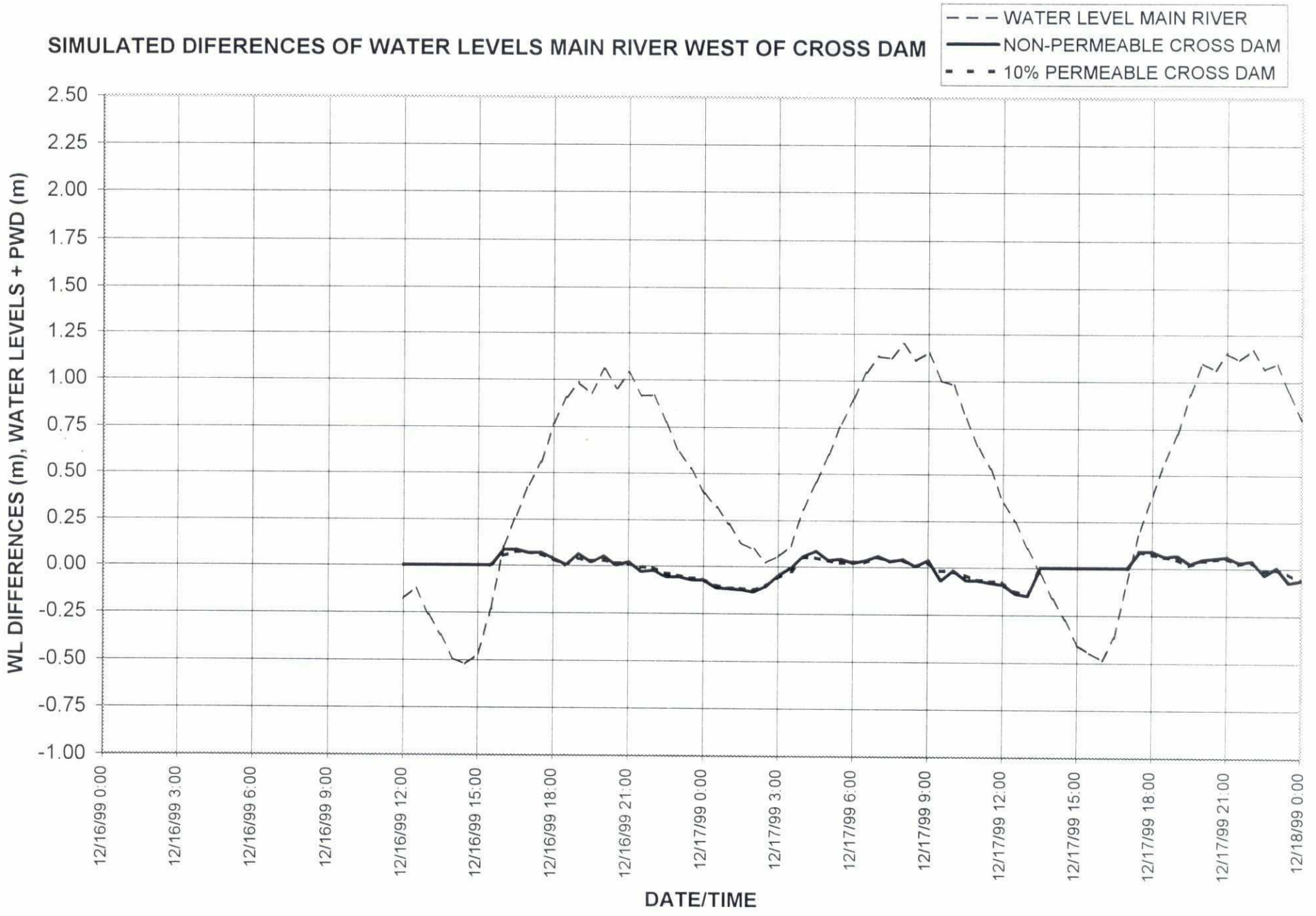


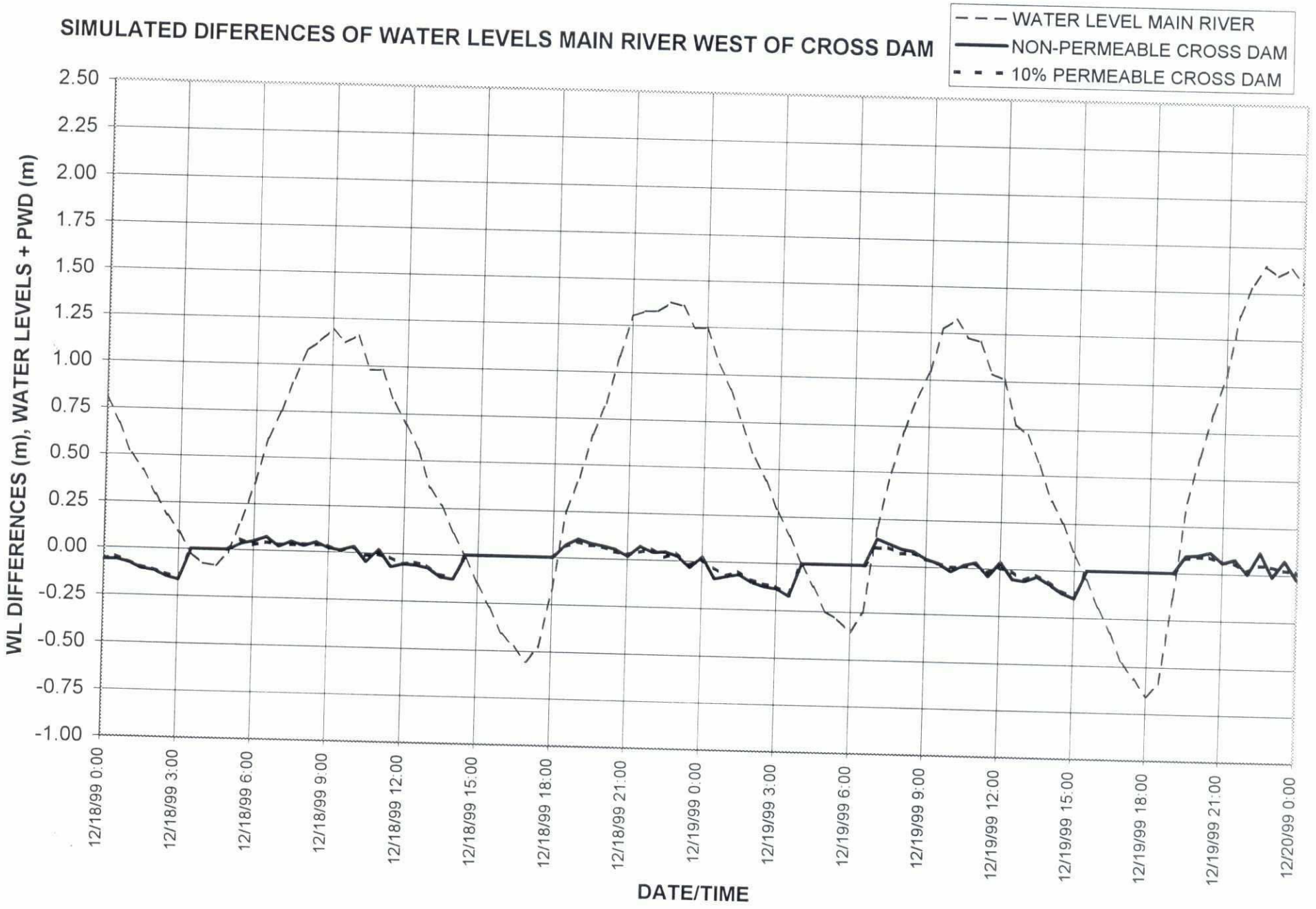
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM

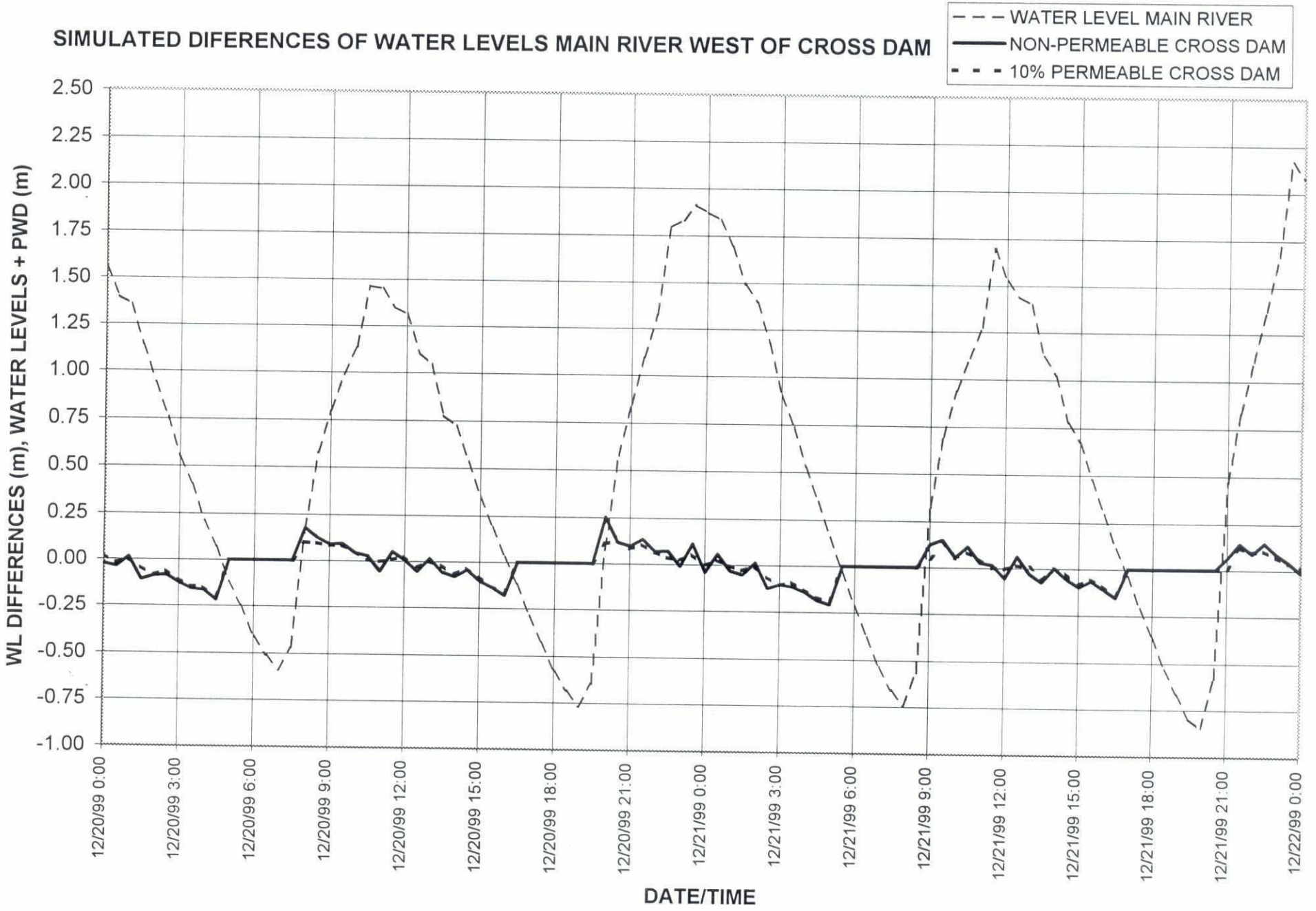


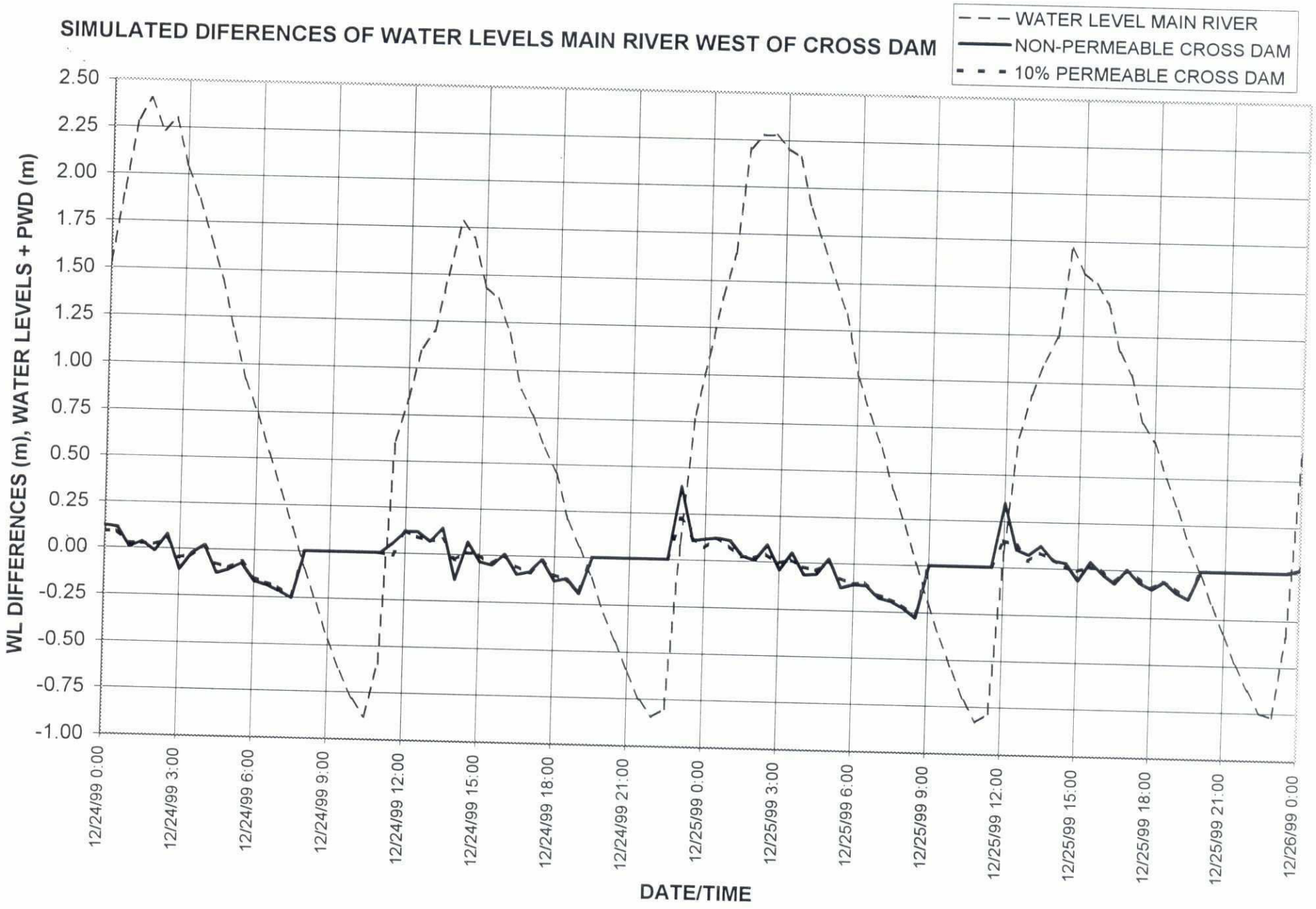
SIMULATED HEAD DIFFERENCES AT NIJHUM DWIP CROSS DAM

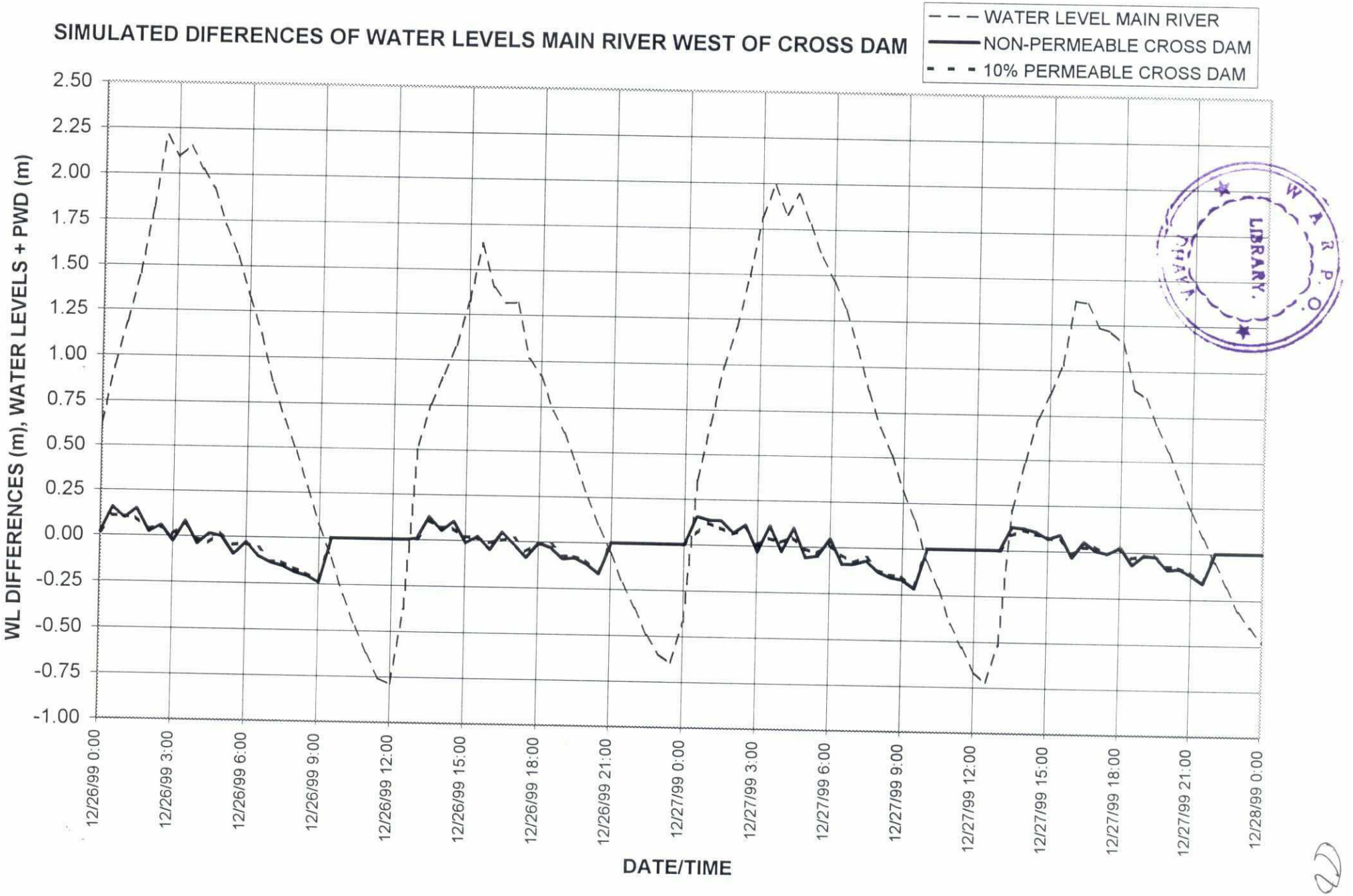


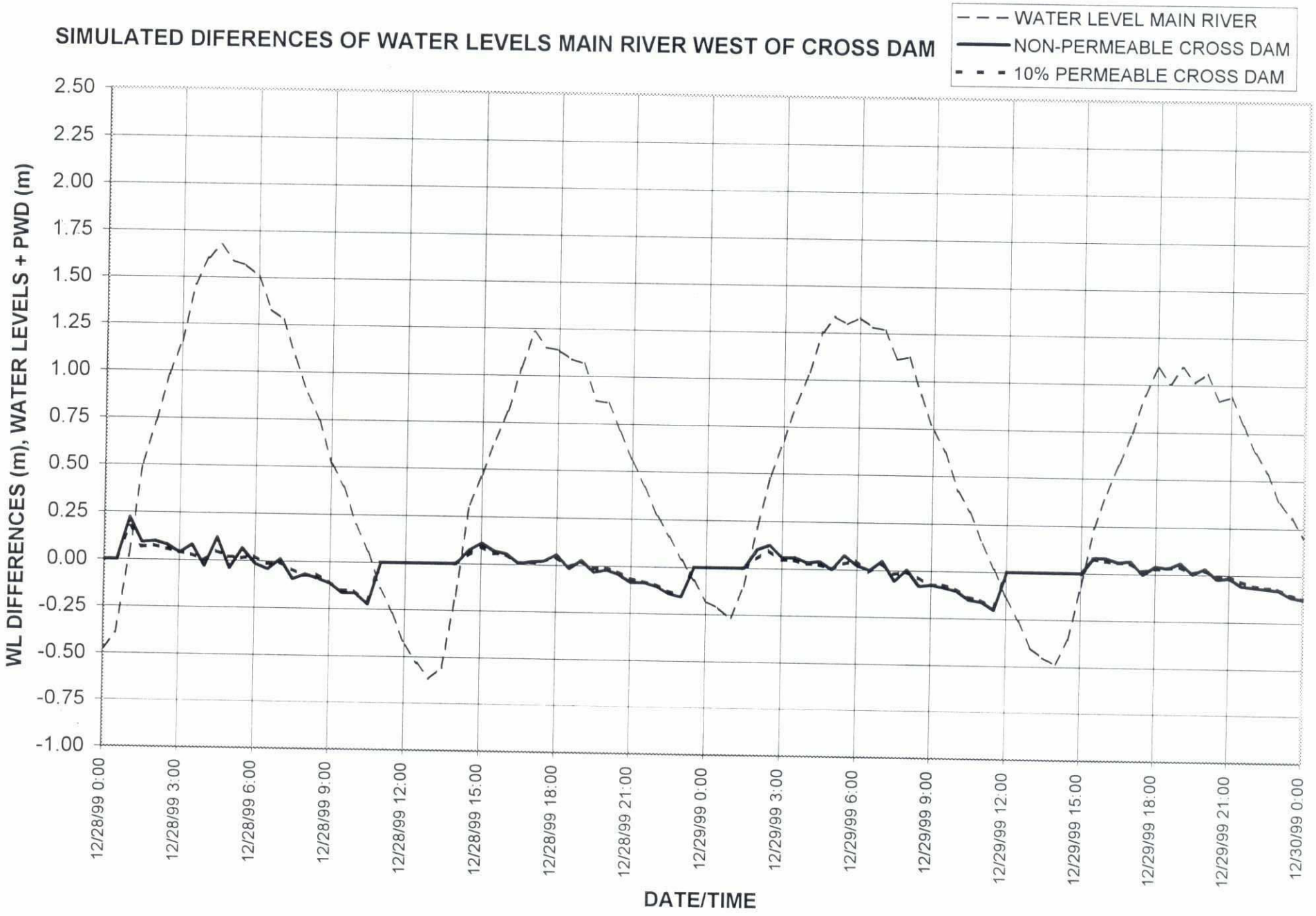

SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/16/99 0:00
12/16/99 3:00
12/16/99 6:00
12/16/99 9:00
12/16/99 12:00
12/16/99 15:00
12/16/99 18:00
12/16/99 21:00
12/17/99 0:00
12/17/99 3:00
12/17/99 6:00
12/17/99 9:00
12/17/99 12:00
12/17/99 15:00
12/17/99 18:00
12/17/99 21:00
12/18/99 0:00
DATE/TIME


SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/18/99 0:00
12/18/99 3:00
12/18/99 6:00
12/18/99 9:00
12/18/99 12:00
12/18/99 15:00
12/18/99 18:00
12/18/99 21:00
12/19/99 0:00
12/19/99 3:00
12/19/99 6:00
12/19/99 9:00
12/19/99 12:00
12/19/99 15:00
12/19/99 18:00
12/19/99 21:00
12/20/99 0:00
DATE/TIME

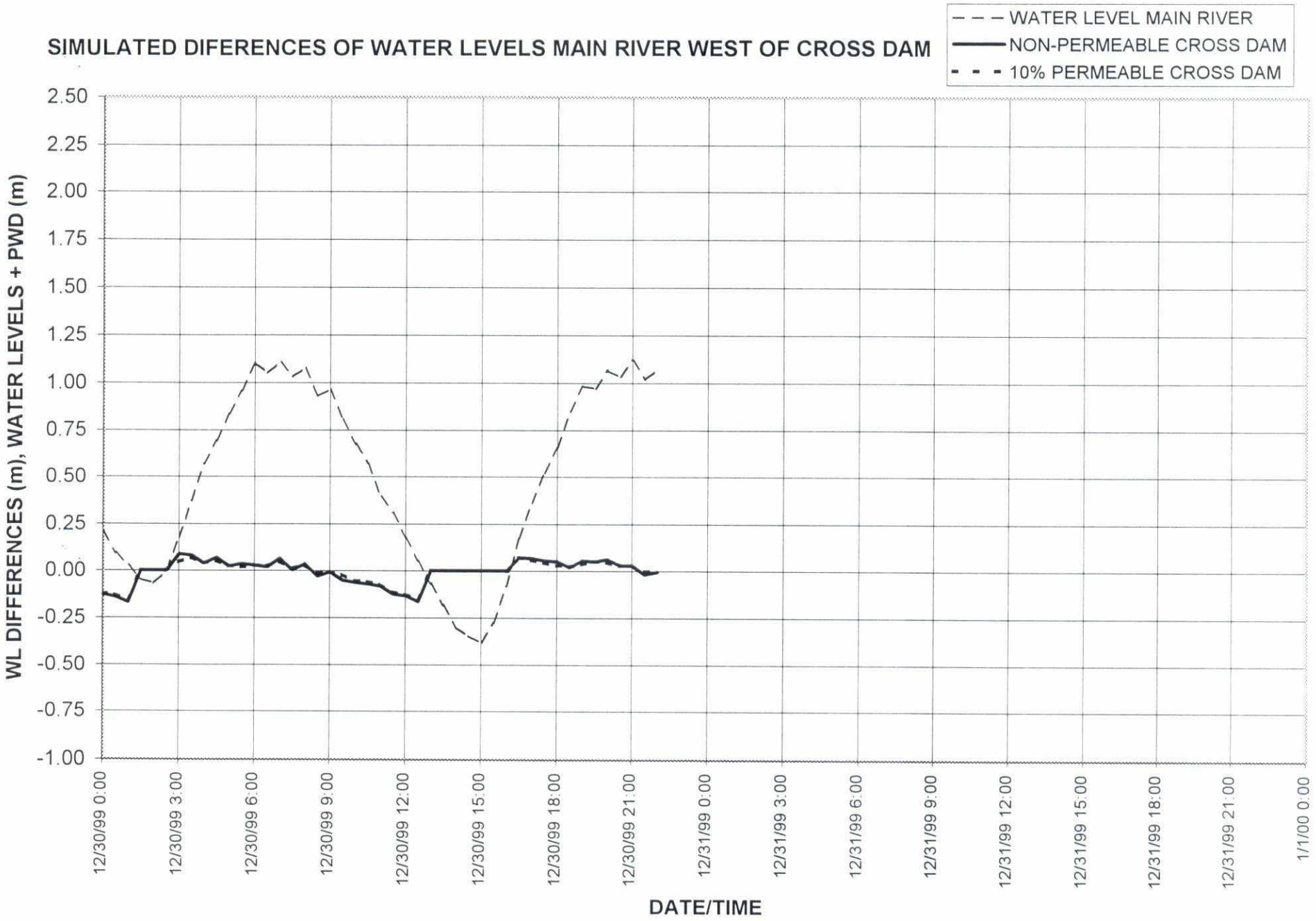

SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/20/99 0:00
12/20/99 3:00
12/20/99 6:00
12/20/99 9:00
12/20/99 12:00
12/20/99 15:00
12/20/99 18:00
12/20/99 21:00
12/21/99 0:00
12/21/99 3:00
12/21/99 6:00
12/21/99 9:00
12/21/99 12:00
12/21/99 15:00
12/21/99 18:00
12/21/99 21:00
12/22/99 0:00
DATE/TIME


SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/24/99 0:00
12/24/99 3:00
12/24/99 6:00
12/24/99 9:00
12/24/99 12:00
12/24/99 15:00
12/24/99 18:00
12/24/99 21:00
12/25/99 0:00
12/25/99 3:00
12/25/99 6:00
12/25/99 9:00
12/25/99 12:00
12/25/99 15:00
12/25/99 18:00
12/25/99 21:00
12/26/99 0:00
DATE/TIME

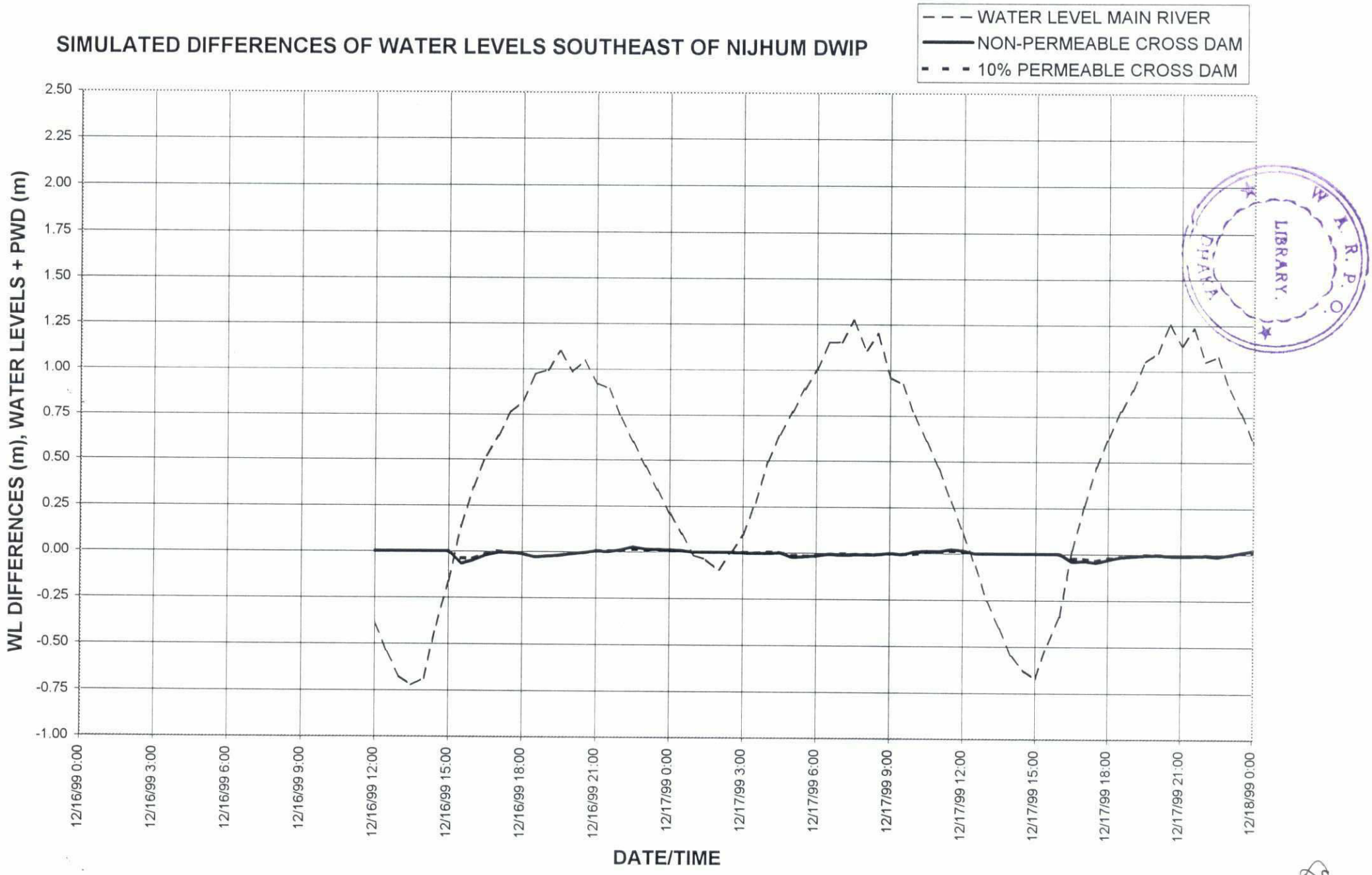


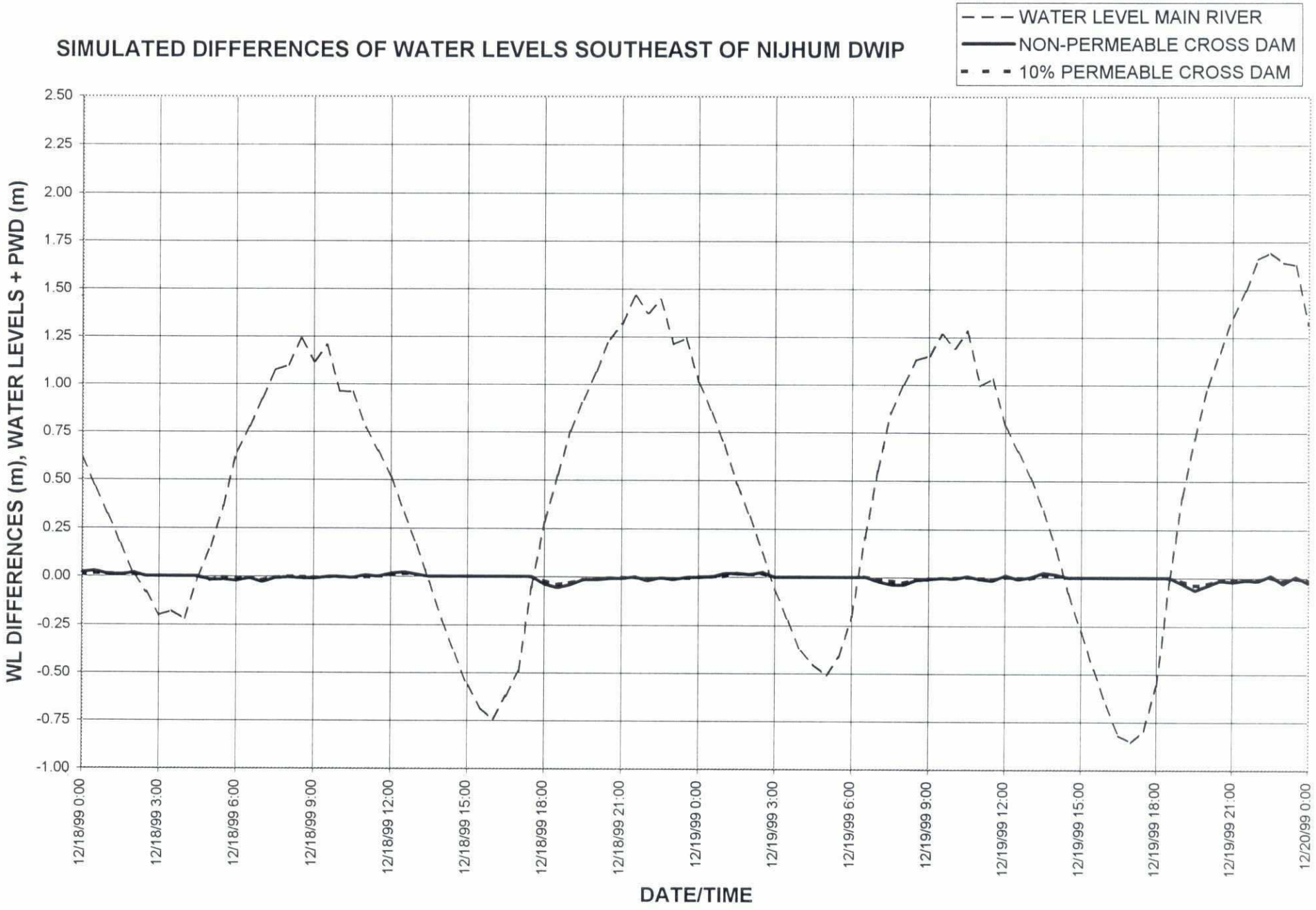

SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/28/99 0:00
12/28/99 3:00
12/28/99 6:00
12/28/99 9:00
12/28/99 12:00
12/28/99 15:00
12/28/99 18:00
12/28/99 21:00
12/29/99 0:00
12/29/99 3:00
12/29/99 6:00
12/29/99 9:00
12/29/99 12:00
12/29/99 15:00
12/29/99 18:00
12/29/99 21:00
12/30/99 0:00
DATE/TIME

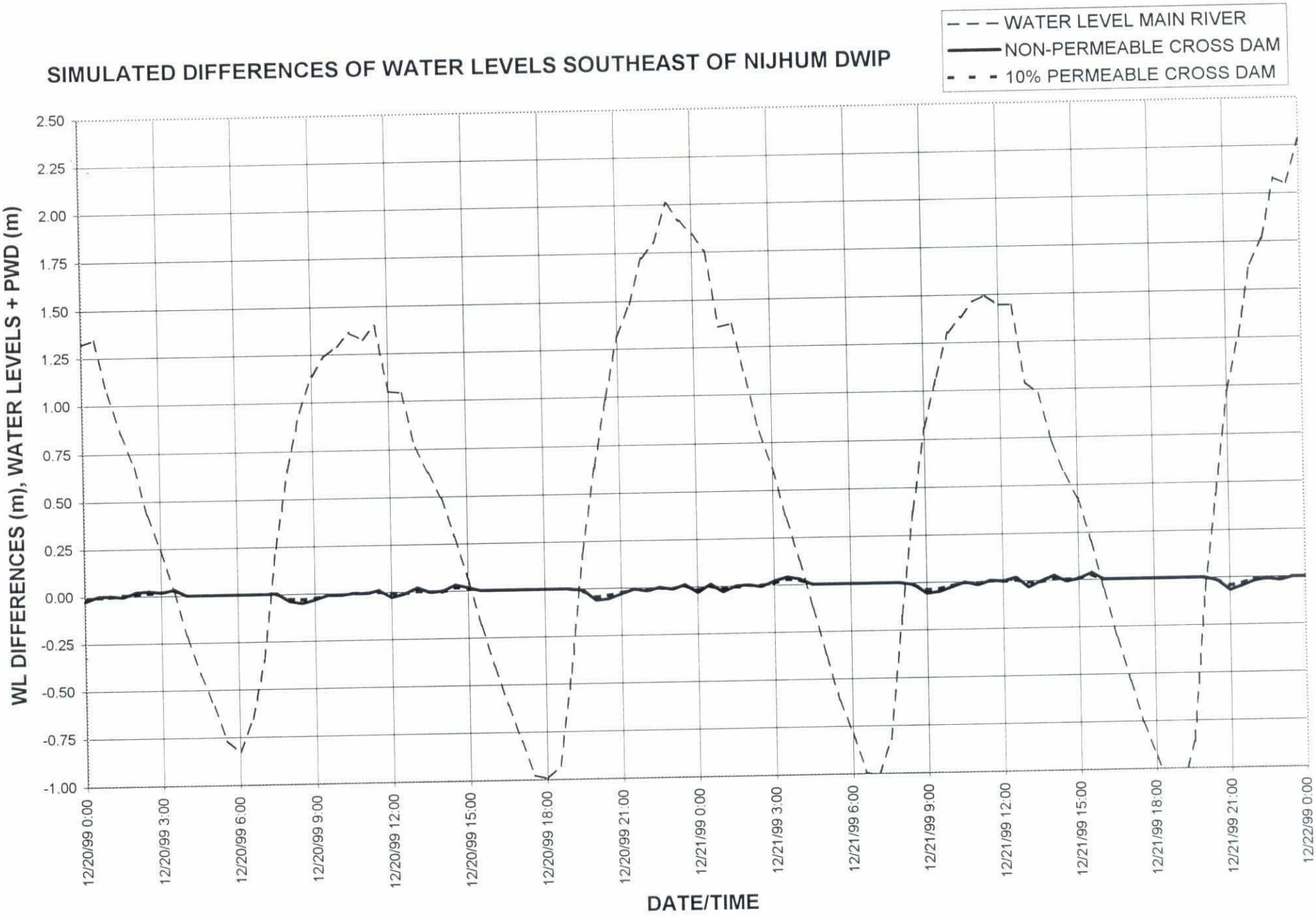
e2

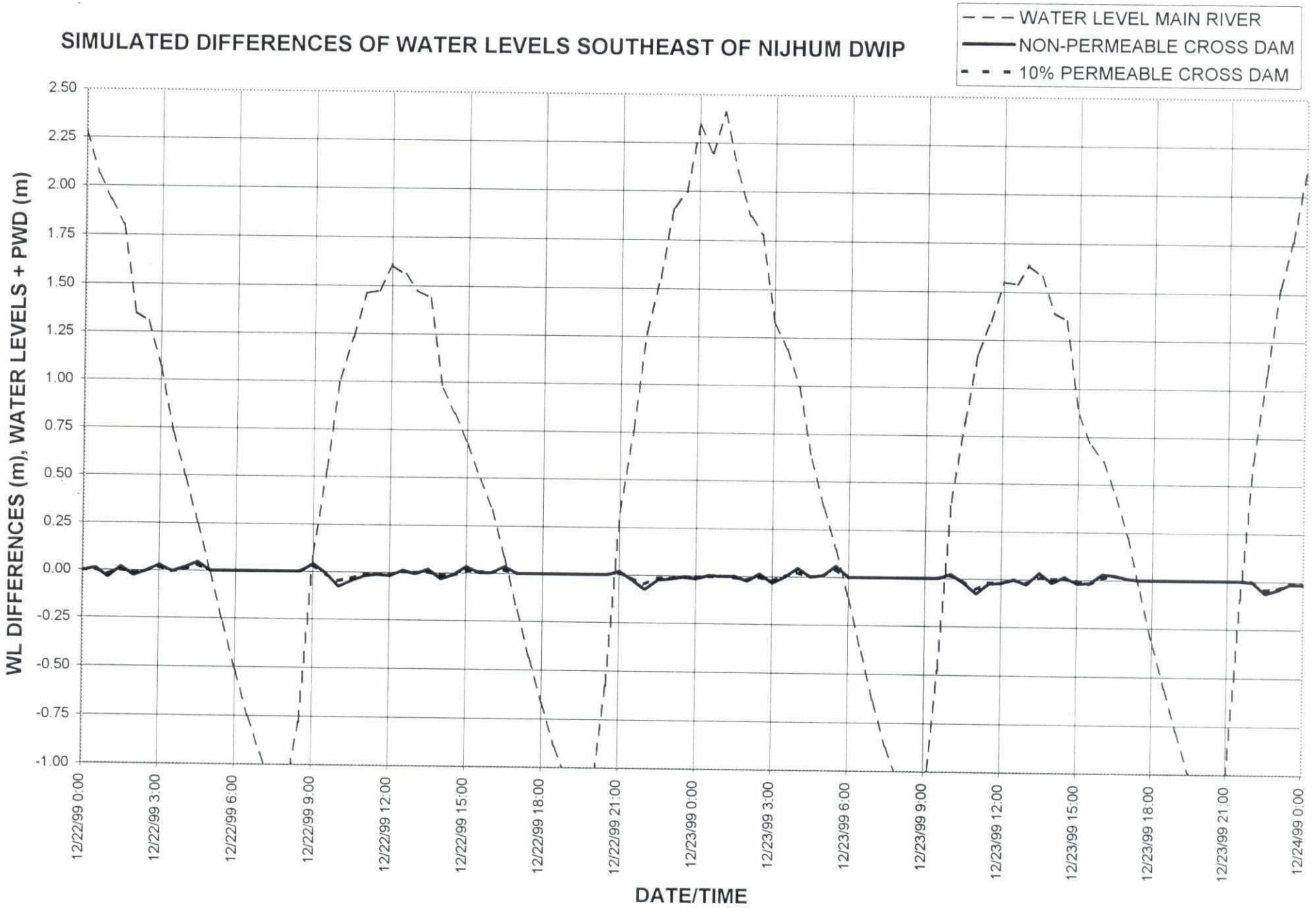

SIMULATED DIFERENCES OF WATER LEVELS MAIN RIVER WEST OF CROSS DAM
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/30/99 0:00
12/30/99 3:00
12/30/99 6:00
12/30/99 9:00
12/30/99 12:00
12/30/99 15:00
12/30/99 18:00
12/30/99 21:00
12/31/99 0:00
12/31/99 3:00
12/31/99 6:00
12/31/99 9:00
12/31/99 12:00
12/31/99 15:00
12/31/99 18:00
12/31/99 21:00
1/1/00 0:00
DATE/TIME

SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP




SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/18/99 0:00
12/18/99 3:00
12/18/99 6:00
12/18/99 9:00
12/18/99 12:00
12/18/99 15:00
12/18/99 18:00
12/18/99 21:00
12/19/99 0:00
12/19/99 3:00
12/19/99 6:00
12/19/99 9:00
12/19/99 12:00
12/19/99 15:00
12/19/99 18:00
12/19/99 21:00
12/20/99 0:00
DATE/TIME


SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/20/99 0:00
12/20/99 3:00
12/20/99 6:00
12/20/99 9:00
12/20/99 12:00
12/20/99 15:00
12/20/99 18:00
12/20/99 21:00
12/21/99 0:00
12/21/99 3:00
12/21/99 6:00
12/21/99 9:00
12/21/99 12:00
12/21/99 15:00
12/21/99 18:00
12/21/99 21:00
12/22/99 0:00
DATE/TIME


SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/22/99 0:00
12/22/99 3:00
12/22/99 6:00
12/22/99 9:00
12/22/99 12:00
12/22/99 15:00
12/22/99 18:00
12/22/99 21:00
12/23/99 0:00
12/23/99 3:00
12/23/99 6:00
12/23/99 9:00
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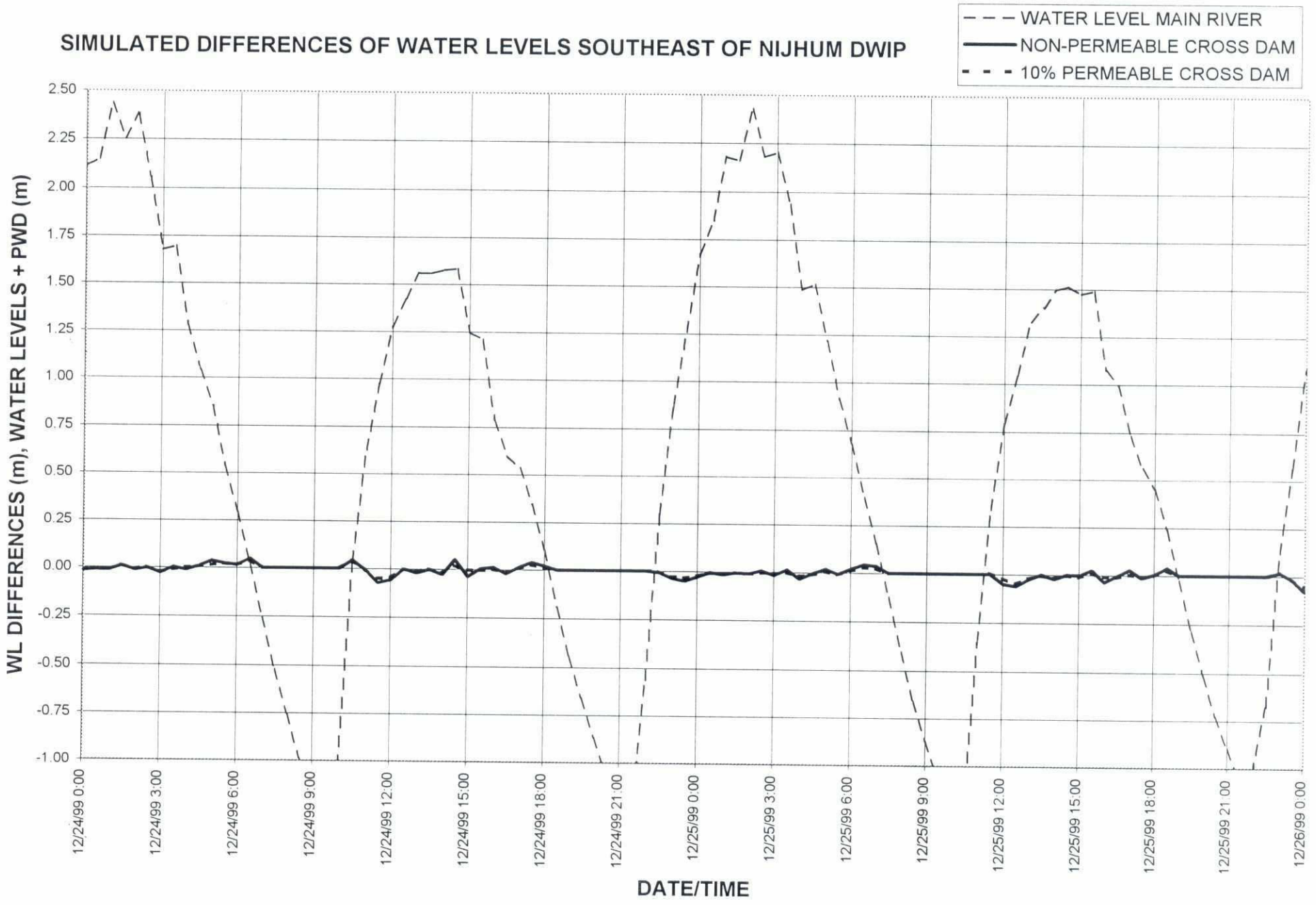
DATE/TIME


SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/24/99 0:00
12/24/99 3:00
12/24/99 6:00
12/24/99 9:00
12/24/99 12:00
12/24/99 15:00
12/24/99 18:00
12/24/99 21:00
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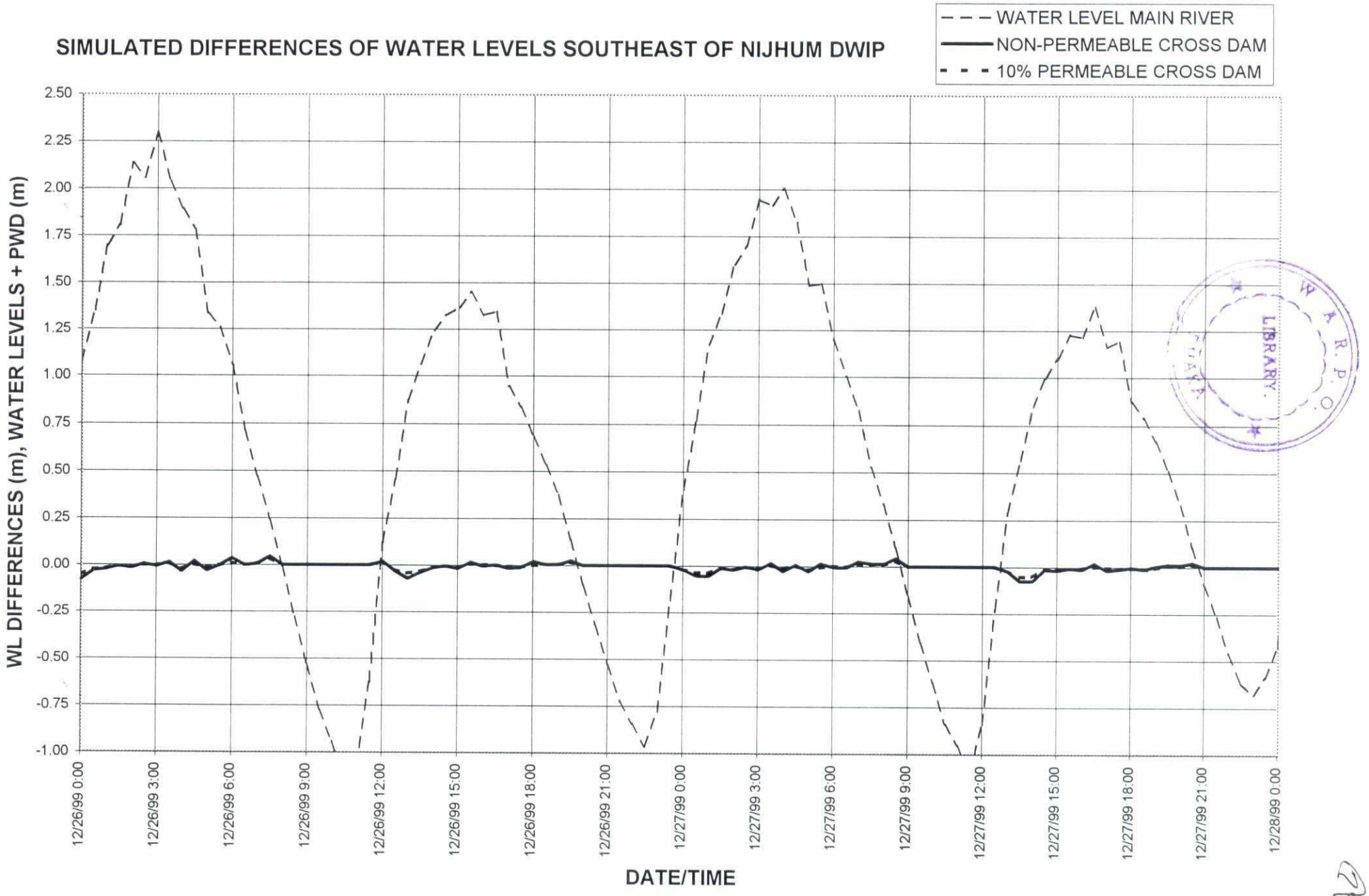
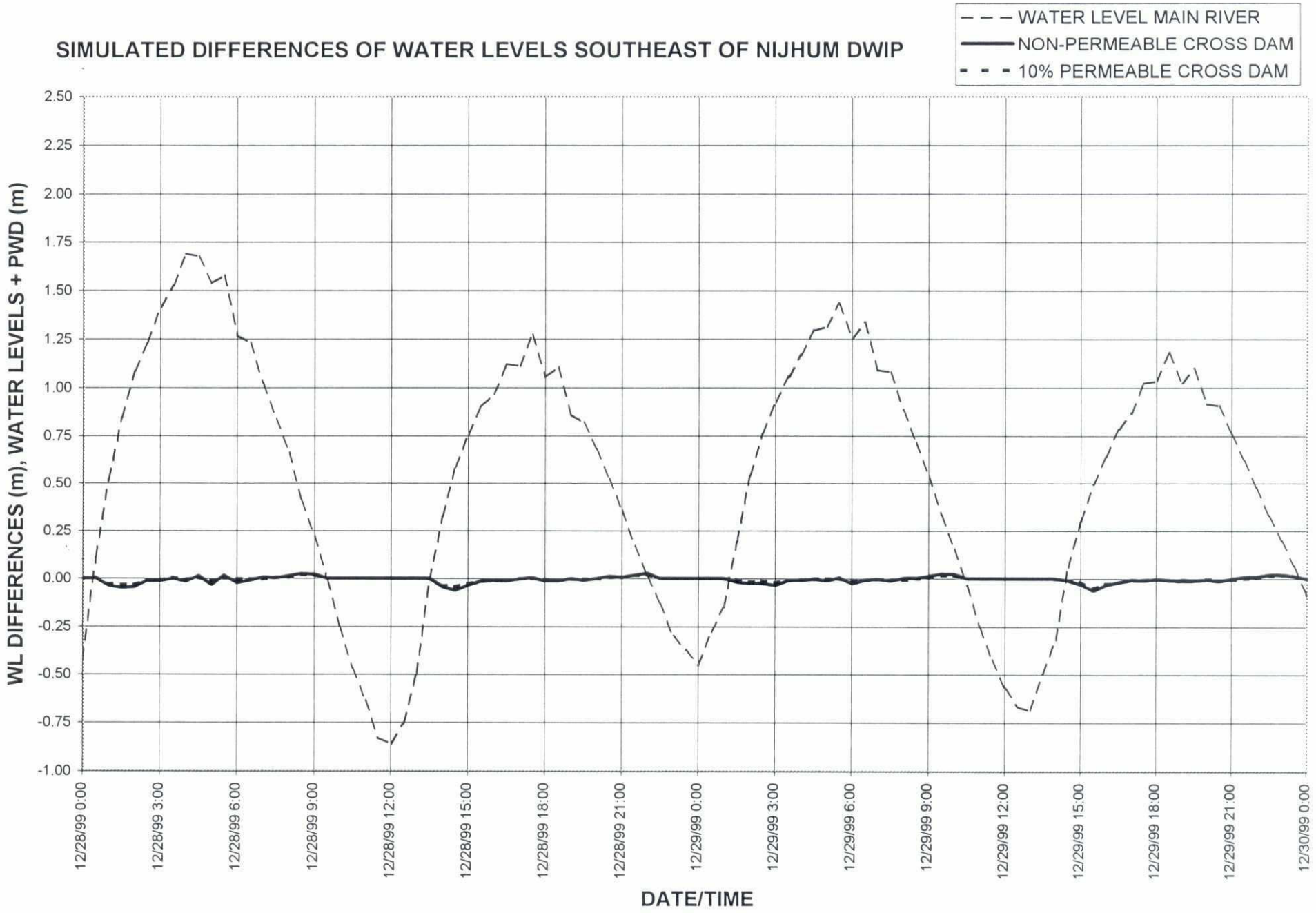
12/25/99 9:00
12/25/99 12:00
12/25/99 15:00
12/25/99 18:00
12/25/99 21:00
12/26/99 0:00
DATE/TIME

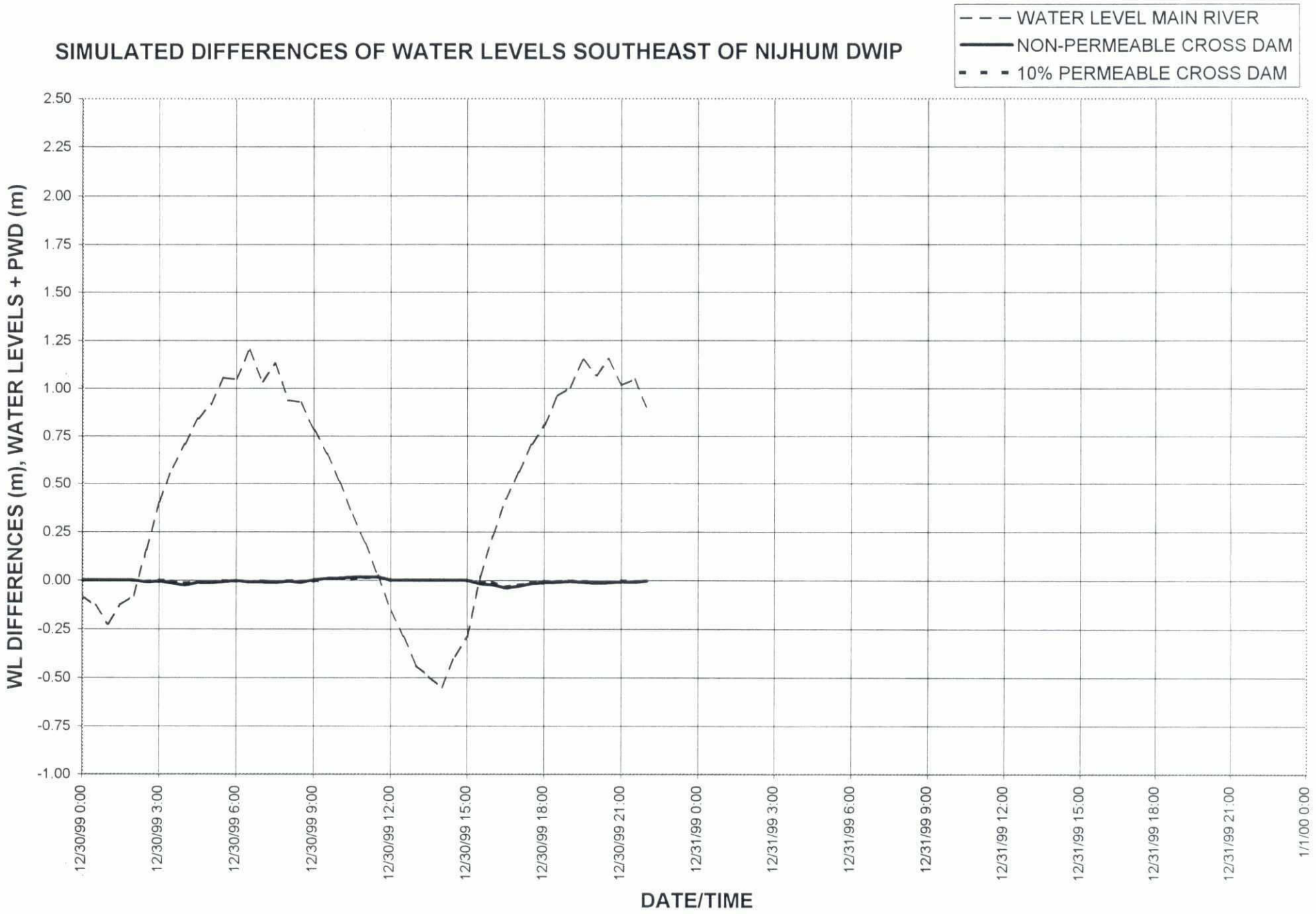
62

SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP



SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP

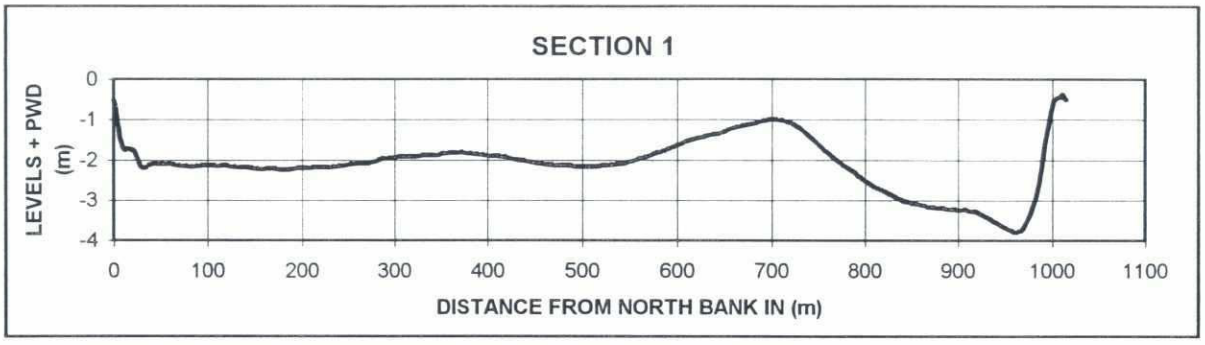


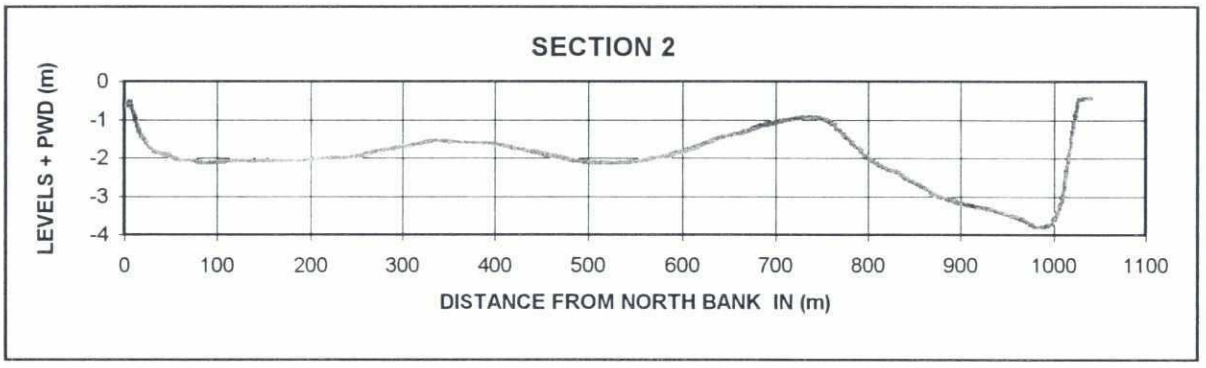

SIMULATED DIFFERENCES OF WATER LEVELS SOUTHEAST OF NIJHUM DWIP
WATER LEVEL MAIN RIVER
NON-PERMEABLE CROSS DAM
10% PERMEABLE CROSS DAM
WL DIFFERENCES (m), WATER LEVELS + PWD (m)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
12/30/99 0:00
12/30/99 3:00
12/30/99 6:00
12/30/99 9:00
12/30/99 12:00
12/30/99 15:00
12/30/99 18:00
12/30/99 21:00
12/31/99 0:00
12/31/99 3:00
12/31/99 6:00
12/31/99 9:00
12/31/99 12:00
12/31/99 15:00
12/31/99 18:00
12/31/99 21:00
1/1/00 0:00
DATE/TIME

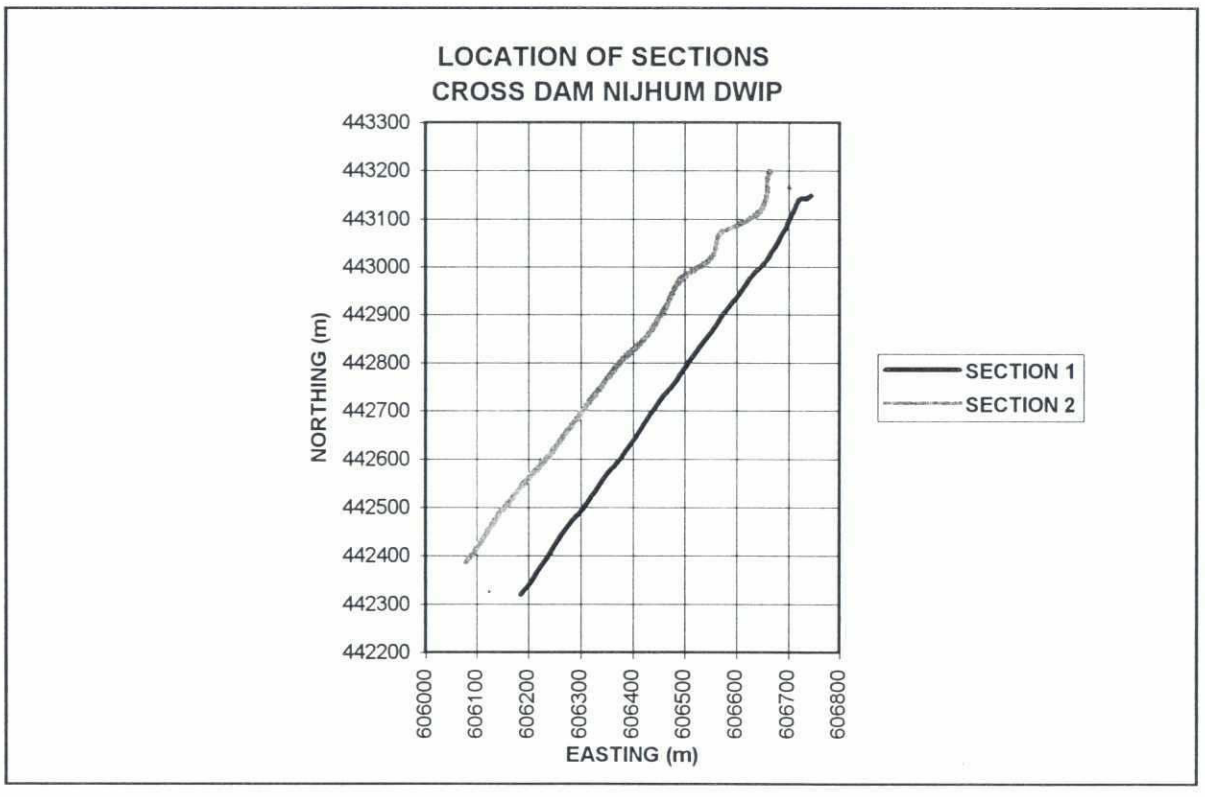
ANNEX D

DESIGN AND IMPLEMENTATION
NIJHUM DWIP PERMEABLE CROSS DAM

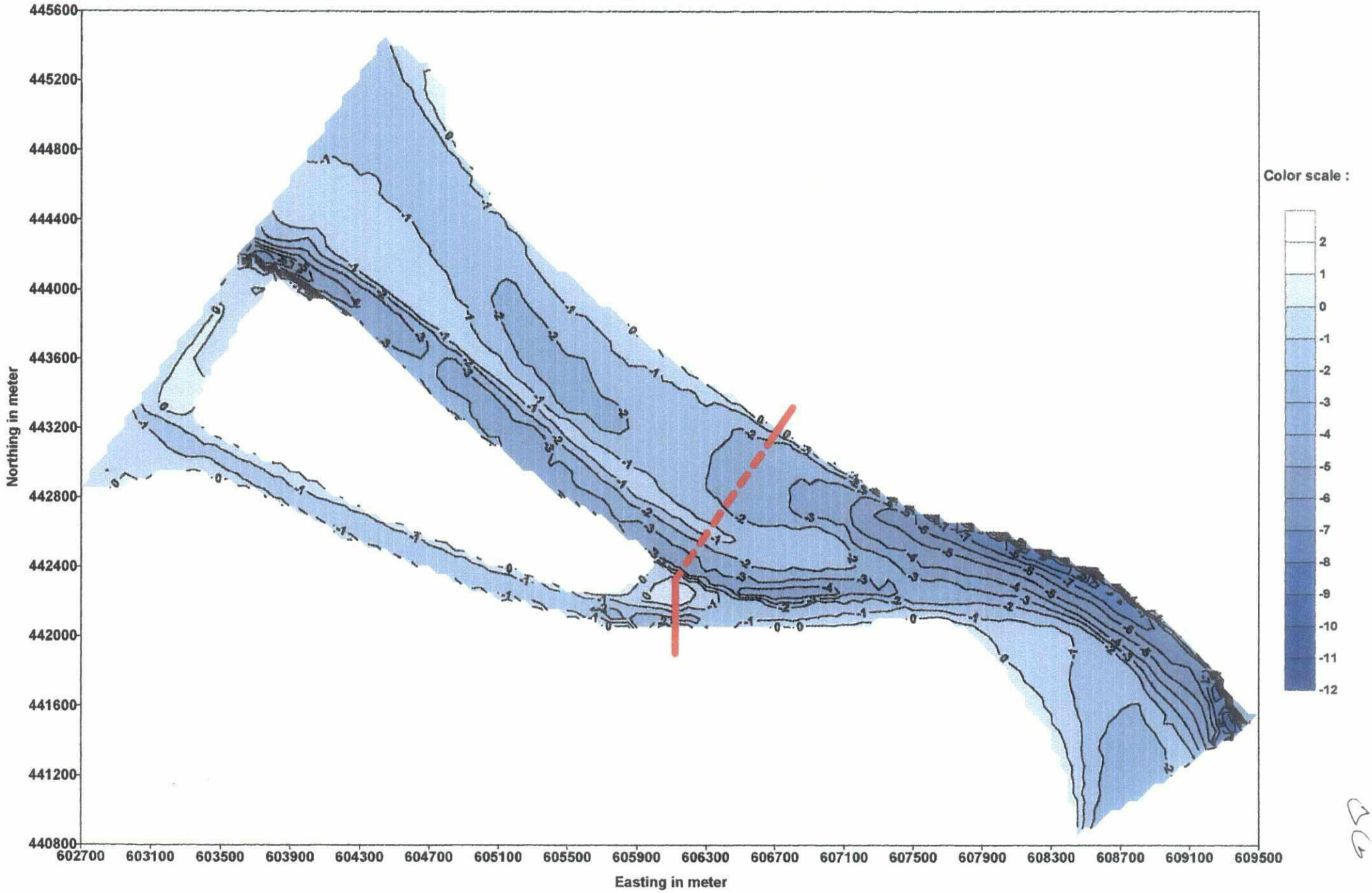
REVISED PRELIMINARY DESIGN AND COST ESTIMATE


SECTION 1
LEVELS + PWD (m)
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000
1100
DISTANCE FROM NORTH BANK IN (m)

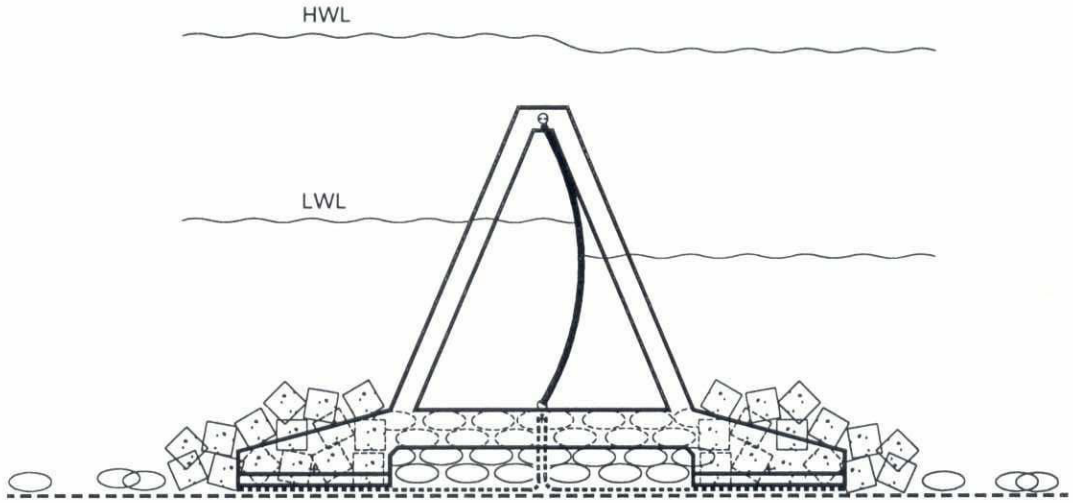

SECTION 2
LEVELS + PWD (m)
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000
1100
DISTANCE FROM NORTH BANK IN (m)


LOCATION OF SECTIONS
CROSS DAM NIJHUM DWIP
NORTHING (m)
443300
443200
443100
443000
442900
442800
442700
442600
442500
442400
442300
442200
606000
606100
606200
606300
606400
606500
606600
606700
606800
EASTING (m)
SECTION 1
SECTION 2

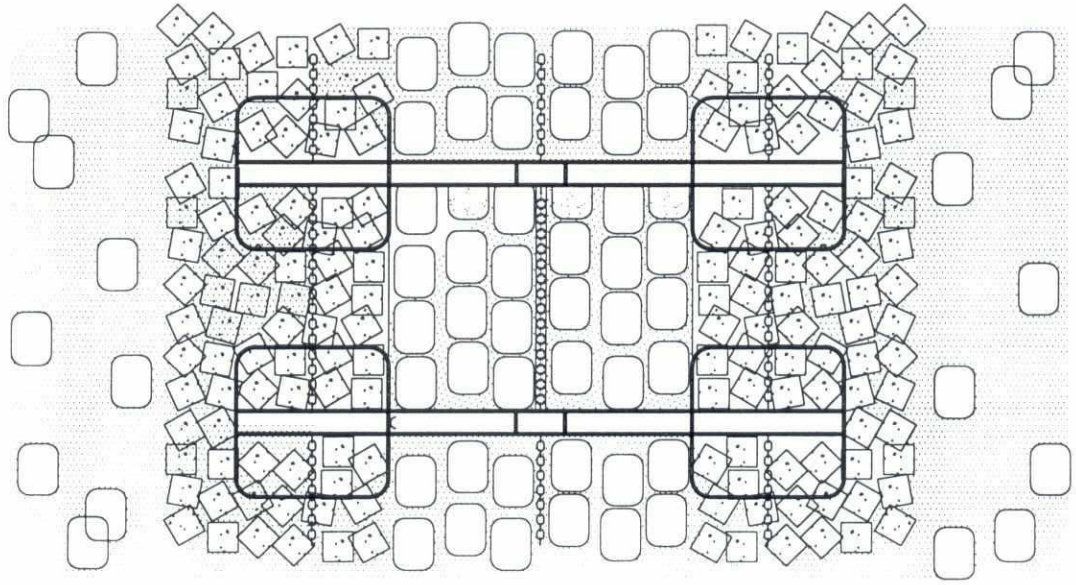
Location of revised alignment of cross dam at Nijhumdwip



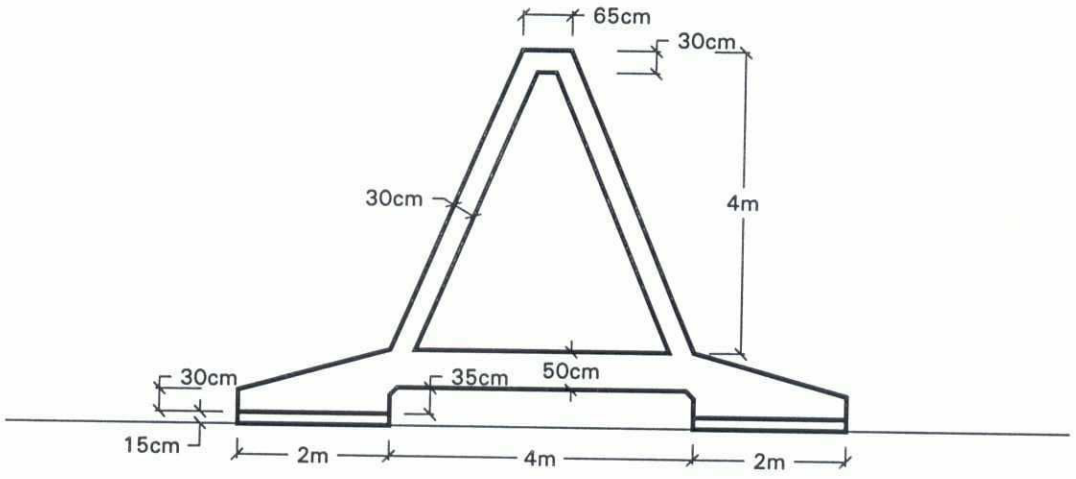
MODEL OF NIJHUM DWIP PERMEABLE CROSS DAM



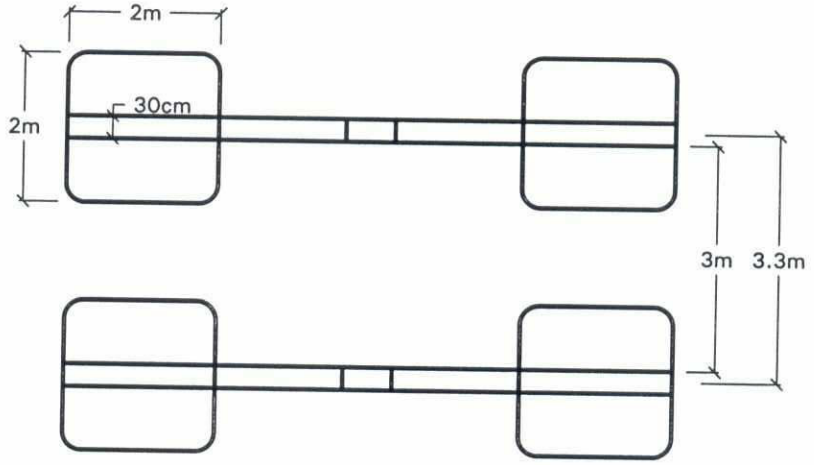
SECTION
SCALE 1:100



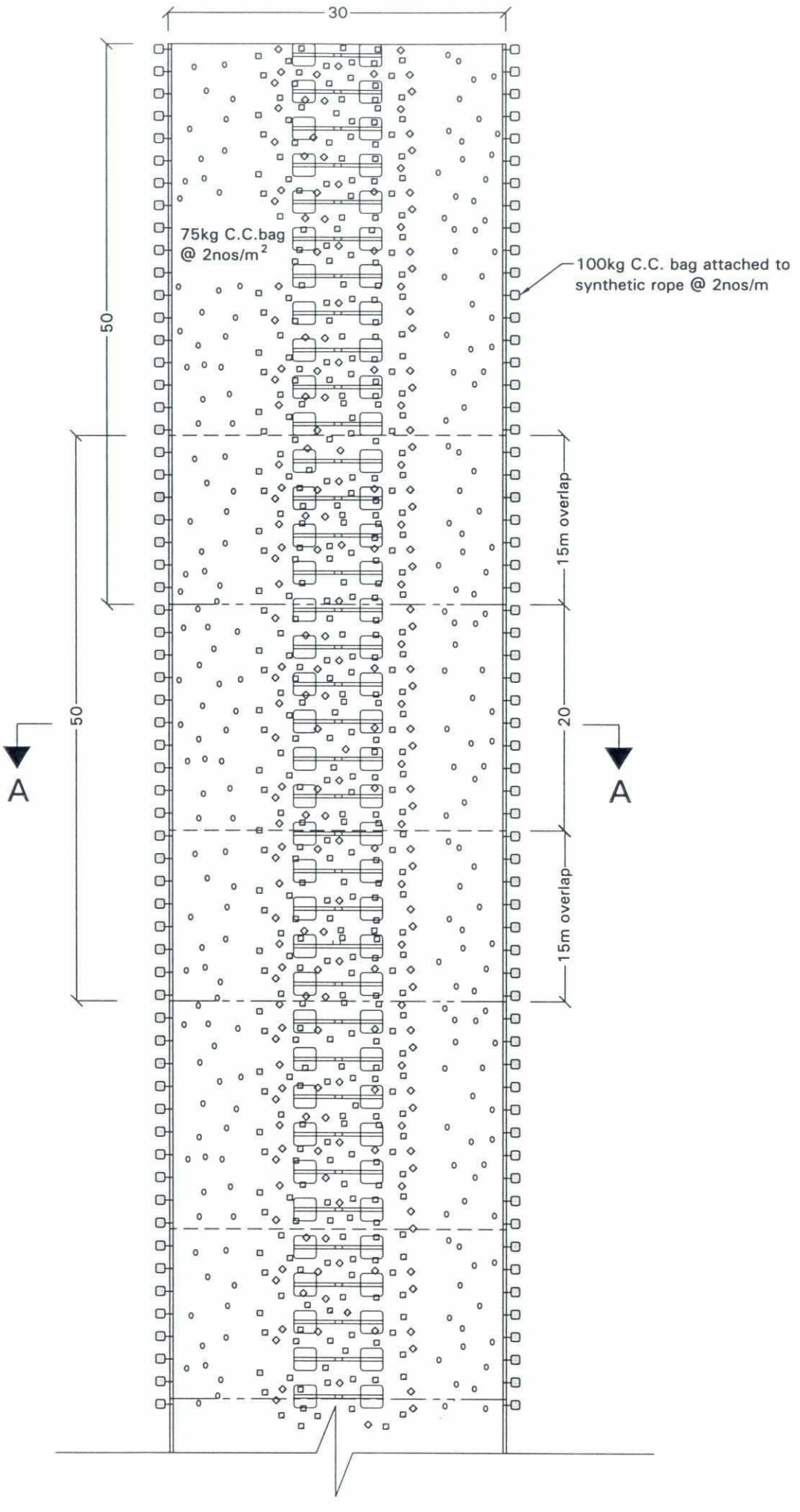
PLAN
SCALE 1:100



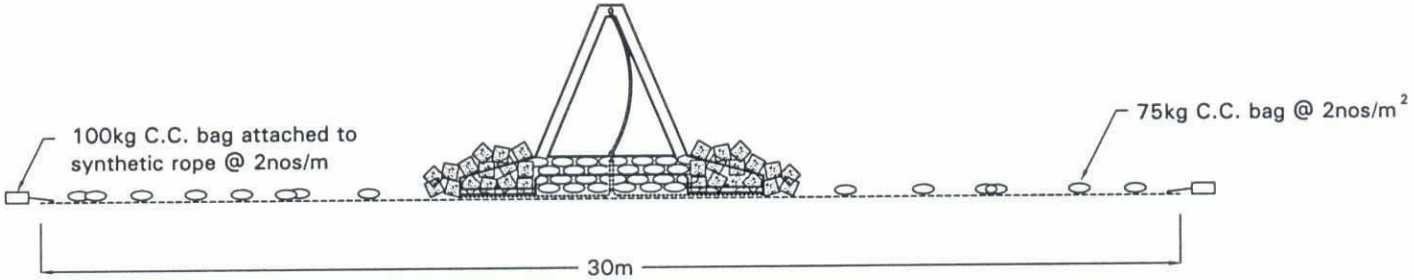
SECTION
SCALE 1:100



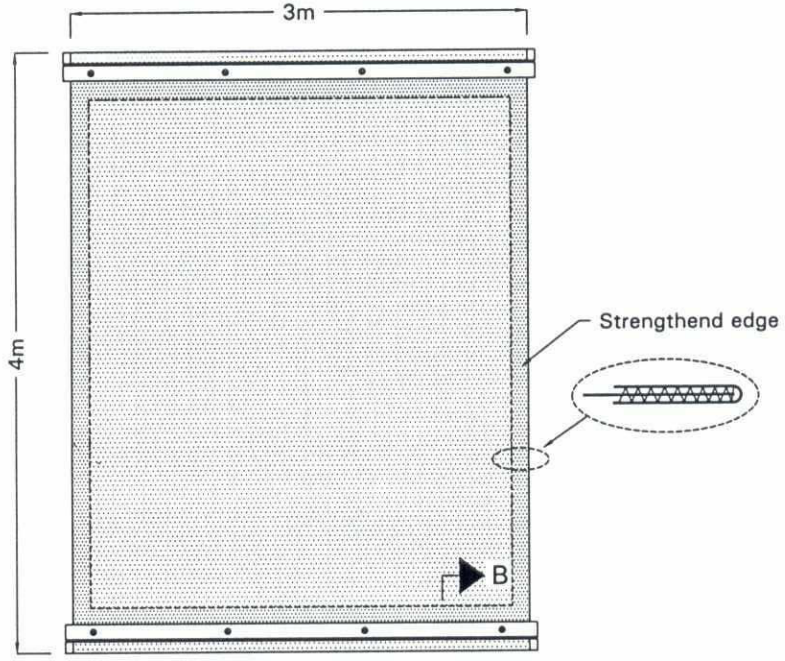
PLAN
SCALE 1:100



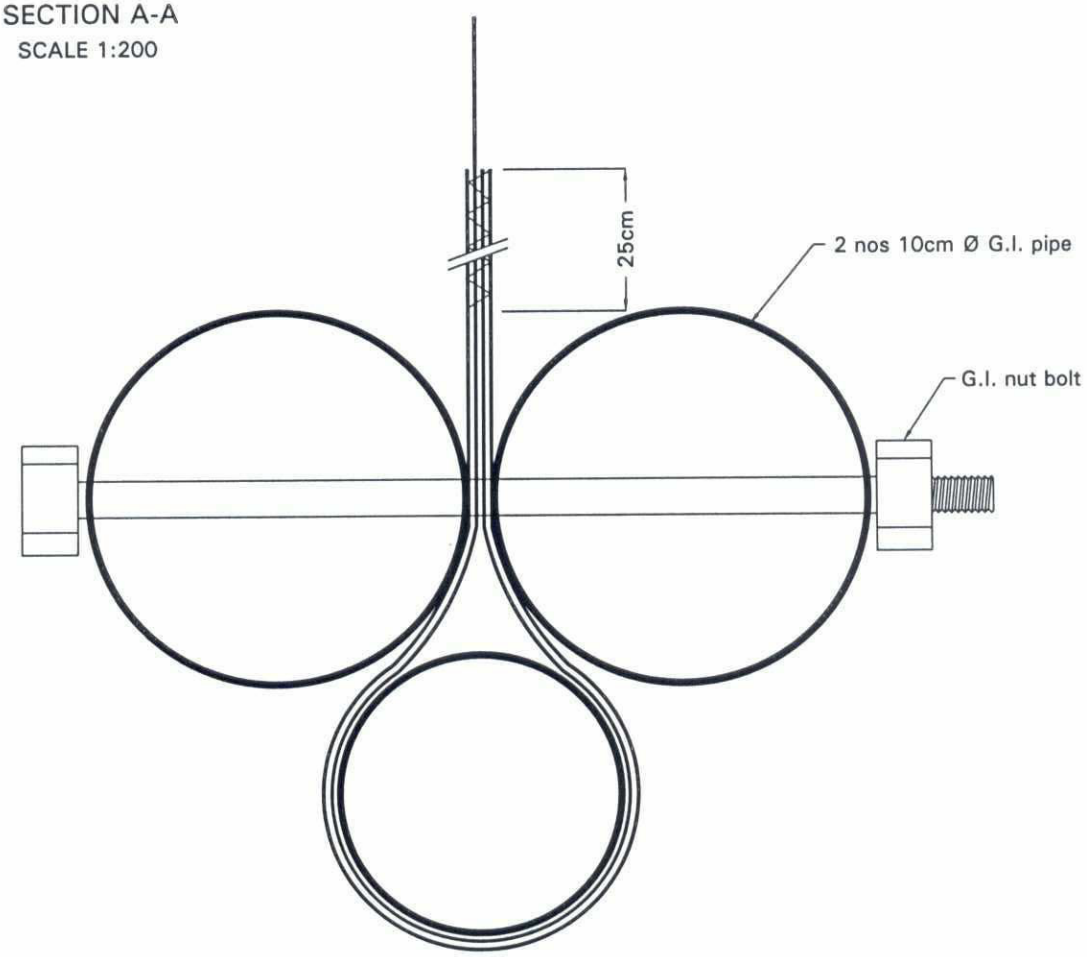
PLAN
SCALE 1:500



SECTION A-A
SCALE 1:200



VERTICAL SCREEN
CROSS DAM
SCALE 1:50



SECTION B-B
SCALE 1:2

NIJHUM DWIP CROSS DAM
Cost Estimate

Length of Permeable Dam 1000 metre with single screen
Length of Earthen Dam 300m
Length of Flanking/Connecting embankment 400 metre

Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
A.	**FOREIGN MATERIALS**				
1.	Propex 6284 + RIG EDY 300.1 Bed Mattress	m^2	91	70,000	6,370,000
2.	Propex 6288 + RIG EDY 300.1 Bed Mattress	m^2	115	47,000	5,405,000
3.	Propex 6288 for screen	m^2	78	8,000	624,000
4.	Synthetic rope	Kg	1,120	500	560,000
5.	Sewing yarn	Kg	1,120	850	952,000
6.	Trasport cost of Geotextile	L.S			500,000
	Sub-total*				**14,411,000**
B.	**MOBILISATION / DEMOBILISATION**				
7	Mobilisation / demobilisation	L.S.			2,500,000
	Sub-total				**2,500,000**
C.	**SUPPLY**				
	Manufacturing and Supply				
8.	R.C.C anchor frame	No.	30,240	305	9,223,200
9.	C.C. blocks / slabs (1:3:6)				
	a) 40 x 40 x 40cm	No.	225	100,000	22,500,000
	b) 50 x 50 x 12.5cm	No.	110	46,000	5,060,000
10.	C.C. Blocks inside synthetic bags (75 Kg)	No.	160	300,000	48,000,000
11.	C.C. Blocks inside synthetic bags (100 Kg)	No.	210	4,000	840,000
12.	Steel Chain	m	150	5,000	750,000
	Sub-total				**85,623,200**
	Supply				
13.	Shil Borak bamboo (6.25 - 7.5cm dia)	No.	200	1,500	300,000
14.	PVC pipe (22mm dia, 6mm thick)	m	100	1,830	183,000
15.	Steel anchor (13 -15 kg)	No.	1,000	240	240,000
	Sub-total				**723,000**
D.	**LABOUR**				
	Geo-textile works				
16.	Manufacturing bed mattress 50m x 30m	No.	60,000	70	4,200,000
17.	Installation of bed mattress including initial ballasting by 800 nos. C.C. Blocks inside sythetic bag	No.	75,000	60	4,500,000
18.	Manufacturing vertical screen including supply of top and bottom G.I. pipes, hardwares etc.	No.	20,000	305	6,100,000
19.	Installation vertical screen including supply of all hardwares	No.	3,000	305	915,000
20.	Placing C.C. blocks (100 kg) under water & tying by divers	No.	30	4,000	120,000
	Sub-total				**11,635,000**

Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
	Dumping / Placing C.C. Block / Slab				
21.	Dumping C.C. Block				
	a) 40 x 40 x 40cm	No.	25	100,000	2,500,000
	b) C.C. blocks inside synthetic bags	No.	15	210,000	3,150,000
22.	Dumping C.C. Blocks inside synthetic bags & tying through divers	No.	28	70,000	1,960,000
23.	Placing C.C slab including preparation of slope (50 x 50 x 12.5cm)	No.	15	46,000	690,000
	Sub-total				**8,300,000**
	Installation				
24.	Anchor profiles under water	No.	25,000	305	7,625,000
	Sub-total				**7,625,000**
E.	**PROVISIONAL ITEMS**				
25.	Provisional items:				
	a) Manpower	P.S.			500,000
	b) Equipment	P.S.			500,000
	Sub-total				**1,000,000**
F.	**EARTHWORKS**				
26.	Earthwork for Flanking embkt./ Earthen dam				
	a) Earthwork in fill	m^3	70	22,500	1,575,000
	b) Supply and dump earthfilled gunny bags	nos.	50	252,000	12,600,000
	c) Turfing	m^2	5	3,000	15,000
	Sub-total				**14,190,000**
G.	**MISCELLANEOUS**				
27.	Supply & drive 6" dia bullah upto required depth	No.	2,000	200	400,000
28.	Transportation of geotextile materials from Dhaka to site	L.S.			500,000
	Sub-total				**900,000**
	Total				**146,907,200**
	Add: 10% Contingency				**14,690,720**
	Grand Total				**161,597,920**

** Local Taxes not included.*

NIJHUM DWIP EARTHEN CROSS DAM
Cost Estimate

Length of Earthen Dam 1000 metre
Length of Flanking/Connecting embankment 300 metre

Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
A.	**FOREIGN MATERIALS**				
1.	Propex 6288 + RIG EDY 300.1 Bed Mattress	m^2	115	150,000	17,250,000
2.	Sewing yarn	Kg	1,120	400	448,000
3.	Trasport cost of Geotextile	L.S			500,000
	Sub-total*				**18,198,000**
B.	**MOBILISATION / DEMOBILISATION**				
4	Mobilisation / demobilisation	L.S.			5,000,000
	Sub-total				**5,000,000**
C.	**SUPPLY**				
	Manufacturing and Supply				
5.	C.C. slabs (1:3:6) 50 x 50 x 12.5cm	No.	110	100,000	11,000,000
	Sub-total				**11,000,000**
	Supply				
6.	Shil Borak bamboo (6.25 - 7.5cm dia)	No.	200	5,000	1,000,000
	Sub-total				**1,000,000**
D.	**LABOUR**				
	Geo-textile works				
7.	Manufacturing bed mattress				
	a) 50m x 50m	No.	100,000	24	2,400,000
	b) 60m x 50m	No.	120,000	19	2,280,000
	c) 15m x 50m	No.	20,000	36	720,000
8.	Installation of bed mattress under water				
	a) 50m x 50m	No.	120,000	24	2,880,000
	b) 60m x 50m	No.	130,000	19	2,470,000
	Sub-total				**10,750,000**
	Placing C.C. Slab				
9.	Placing C.C slab (50 x 50 x 12.5cm) including preparation of slope	No.	15	100,000	1,500,000
	Sub-total				**1,500,000**
F.	**EARTHWORKS**				
10.	Earthwork for Flanking embkt./ Earthen dam				
	a) Earthwork in fill	m^3	70	12,000	840,000
	b) Supply and dump earthfilled gunny bags	nos.	50	7,200,000	360,000,000
	c) Turfing	m^2	5	3,000	15,000
	Sub-total				**360,855,000**

Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
G.	MISCELLANEOUS				
11.	Supply & drive 6" dia bullah upto required depth	No.	2,000	200	400,000
12.	Transportation of geotextile materials from Dhaka to site	L.S.			800,000
Sub-total					**1,200,000**
Total					**409,503,000**
Add: 10% Contingency					**40,950,300**
Grand Total					**450,453,300**

** Local Taxes not included.*