People's Republic of Bangladesh
Ministry of Irrigation, Water Development and Flood Control

Flood Plan Coordination Organisation

Southwest Area Water Resources Management Project

United Nations Development Programme
(BGD/88/038)

Asian Development Bank
(TA No 1498-BAN)

FAP 4

FINAL REPORT

Volume 4

Coastal Studies

August 1993

Sir William Halcrow & Partners Ltd.

in association with
Danish Hydraulic Institute
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SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT (FAP-4)

VOLUME 4 - COASTAL STUDIES

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BIWTA	Bangladesh Inland Water Transport Authority
BWDB	Bangladesh Water Development Board
CEP	Coastal Embankment Project
CERP	Coastal Embankment Rehabilitation Project
CERP II	Second Coastal Embankment Rehabilitation Project
DHI	Danish Hydraulic Institute
EE	Executive Engineer
EPWAPDA	East Pakistan Water and Power Development Authority
FAO	Food and Agricultural Organisation
FAP	Flood Action Plan
FPCO	Flood Plan Coordination Organisation
GIS	Geographical Information System
GOB	Government of Bangladesh
GPS	Geographical Positioning System
Ha	Hectare
IECO	International Engineering Company Inco.
IPCC	Intergovernmental Panel on Climate Change
IRDSR	Integrated Resource Development and Sundarbans Reserve Project
KCERP	Khulna Coastal Embankment Rehabilitation Project
MIKE 11	One Dimensional River Modelling System
MIKE 21	Two Dimensional River Modelling System
MP	Member of Parliament
MPO	Master Plan Organisation
NAM	Rainfall Runoff Model
NE	Northeast
NEDECO	Netherlands Engineering Consultants
PWD	Public Works Datum
SC	Southcentral region
SPARRSO	Bangladesh Space Research Remote Sensing Organisation
SRP	Systems Rehabilitation Project
SW	Southwest region
SWA	Southwest Area comprising SC and SW
SWAM	Southwest Area Model
SWMC	Surface Water Modelling Centre
TOR	Terms of Reference
UNDP	United Nations Development Programme
WAPDA	Water and Power Development Authority.

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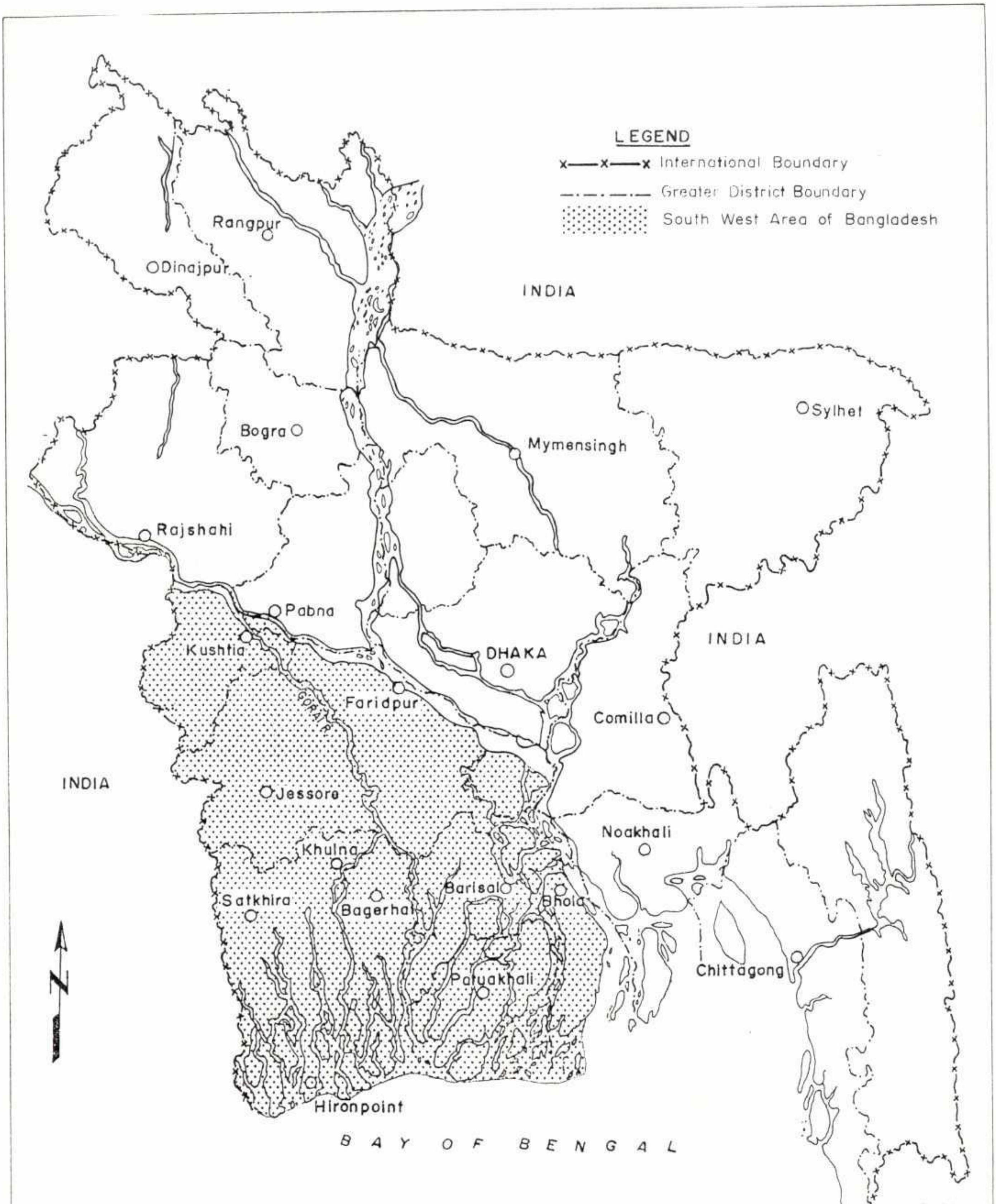
Figure 1.1



South West Area Location Map

1 INTRODUCTION

1.1 General Description

A large part of the Southwest area of Bangladesh is subject to tidal movement which can penetrate as far inland as 325 km in the dry season. For the purposes of this study the coastal region is taken to include all of this area which generally comprises of land poldered to improve both agricultural and fisheries production. In addition a large part of the area adjacent to the Bay of Bengal boundary is occupied by the Sundarbans, a mangrove forest area of both national and international significance.

Drainage congestion within the coastal embankment areas has been deteriorating over a period of many years and will continue to do so for some time to come in the absence of any further human intervention. At the same time the system will respond to external influences, particularly fresh water inflows which may change over time. The future planning of the region therefore requires a thorough understanding of the way in which the hydrodynamics and morphodynamics of the coastal area responds to both internal and external influences. These in turn have potential impacts on future land use, industrial development, a number of issues concerning environmental impact and the Area's navigation infrastructure including the county's second largest seaport at Mongla.

The location of the SW Area is shown in Figure 1.1.

1.2 Scope of this Report

The purpose of this report is to describe the wide ranging coastal studies carried out as part of the development of the regional water resources plan described in the Main Report. The coastal studies contribute to meeting the Terms of Reference in the following respects:

T.O.R. 1 (i) Review reports and data and produce a comprehensive understanding of the region;

T.O.R. 2 (i) Carryout additional survey;

T.O.R. 2 (ii) Apply SWMC models to the study area;

T.O.R. 2 (iii) Carryout morphological studies;

T.O.R. 2 (iv) Review past and ongoing projects;

T.O.R. 3 (i) Identify medium to long term management options. Priority areas include drainage improvement in the coastal embankment area (CEP);

T.O.R. 3 (ii) Examine the impact of selected options using mathematical models and other techniques.

Priority areas, or "burning issues" identified in the T.O.R 3(i) are as follows:

(i) flood control along the right bank of the Ganges and Padma Rivers;

(ii) drainage improvement in the CEP area; and

(iii) augmentation of the dry-season flows in the Gorai River.

The nature of the linkages between these issues, and the full effect of any proposed solutions, must be established to avoid wasted investment and counter productive side effects. For example drainage improvement in the CEP area may not be worthwhile unless dry season flows are augmented to prevent overall long term deterioration of the tidal rivers. On the other hand the construction of barriers across all the tidal rivers would produce a solution to the current CEP problem and produce a large fresh water reservoir which might reduce the area that would require augmentation from the Gorai.

1.3 Approach to the Coastal Studies

The processes within the coastal delta are highly complex due to the large number of interconnections between the various main and tributary rivers. The studies have used a variety of sources of information and analytical techniques coupled with corroborating evidence in order to enable projections to future possible scenarios to be made with some confidence. The studies described in this report include reviews of current and previous studies and projects, analysis of both new and historic survey data, analysis of satellite imagery and historic maps, hydrodynamic modelling, morphological modelling and regime analysis. Confirmation of findings has been sought through river surveys and field observations.

Site visits carried out by team members during the study have shown that the nature of drainage problems in the CEP area are varied and widespread. In some instances polders are not draining due to incorrectly located drainage outlets or inadequate maintenance of the sluice gates. In other cases the external rivers have silted up so that drainage is not possible regardless of the amount of sluice maintenance. In extreme cases, of which Beel Dakatia is the most notorious, local farmers have become so frustrated with the drainage congestion problems that they have made cuts through the polder embankments to try and improve drainage but generally without success.The coastal studies have sought to rational explanations for these observations.

Public opinion has been treated as a key element in the study process. This has been obtained from field visits, public meetings, reports from public authorities and questionnaires to district officers.On a general level it is known that the coastal issues which the public in the affected areas are particularly concerned about are drainage congestion, the conflicting requirements of shrimp and rice farmers, increasing saline intrusion and loss of grazing lands. (Appendix A gives a summary of the seminar held in Jessore, as part of the public consultation process).

There are a number of important linkages with the other studies that have been carried out as part of the development of the water resources strategy. The morphological studies carried out in the coastal region are also reported in Volume 3 to put them into context with the non-tidal rivers in the region and that volume includes a discussion of the interdependence and linkages between upland rivers and the coastal area.

Present day and future performance of the polder areas has been established and used as the basis for identifying areas in which action should be given priority. For each of those areas a number of options for dealing with the identified problems have been investigated and recommendations for preferred options made taking into account all of the interdependent issues involved. The result is a number of identified projects that can be implemented in a phased manner and for which preliminary capital costs have been identified and set against perceived benefits.

1.4 Other Studies11

1.4.1 FAP Studies

The Flood Action Plan contains a number of supporting studies to the main regional studies and use has been made of these related studies and findings where they have been relevant or impinge on the coastal studies. These include:

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FAP 5	South East Regional Study: Limited study of the Lower Meghna is described.
FAP 7	Cyclone Protection Project II has examined the feasibility and design of protection measures against cyclonic flooding.
FAP 9A	Secondary Towns Flood Protection: Detailed designs for bank protection and drainage of Khulna and environs into the upper end of the Pussur River system.
FAP 18	Topographic Mapping: Maps of the SPOT imagery for 1989 were provided through FPCO at a scale of 1:50,000. Maps of the boundary rivers for 1990 were also made available.
FAP 19	Geographic Information System: FAP 4 has worked closely with FAP 19 who processed two Landsat Images for FAP 4 and provided other imagery around the Gorai Mouth and for the Padma in 1993.
FAP 24	River Survey Programme: This project started too late to provide any data to FAP 4 though the surveys proposed will provide data for future studies.

1.4.2 Other Relevant Studies

Data and findings from a number of other studies were taken into account whenever relevant. When studies were ongoing discussions with study participants took place. These were as follows:

SWMC	The Surface Water Modelling Centre carried out the development and running of sediment transport models for the tidal zone which has assisted in verifying the regime analysis.
CERP II	The Second Coastal Rehabilitation Feasibility Study has used the concept of sustainable rivers to derive a strategy to drain Beel Dakatia, but no detailed analysis of the morphology of the system is given.
Mongla	Pussur-Sibsa study of alternative interventions at or near Mongla Port with a view to improving navigation depths along the approaches and in the vicinity of the port. Twelve different options were investigated.
SRP	The Systems Rehabilitation Project is ongoing and is considering various options for BWDB sub-projects which include a number of polders in the southwest region.
3rd Fisheries	The shrimp farming component of the study is investigaing ways of improving yields and developing shrimp farming in a number of polders in the southwest region.
IRDSRF	The Integrated Resource Development of the Sundarbans Reserved Forest provides for the conduct of mangrove system studies and the formulation of a strategy for an integrated plan to address all the needs of the region.

Other historic studies have been reviewed and are discussed in the relevant sections of the report.

2 METHODOLOGY

2.1 The Tools Available

The coastal studies have sought to produce an understanding of the current situation and predict future conditions with and without interventions. There have been a range of "tools" available for the purpose and it must not be assumed that one tool is sufficient on its own to deal with the technical complexity and large scale of the coastal and river delta systems. For example, although field surveys are essential for obtaining information on existing conditions they are, on their own, insufficient for predicting future conditions. On the other hand numerical models are only able to produce meaningful predictions of future conditions if the model realistically reproduces the existing situation as verified by field surveys.

The tools available which have been used for the coastal studies are as follows:

(i) Current and Previous Studies
(ii) Current and Historic survey data
(iii) Reports from BWDB Executive Engineers
(iv) Satellite imagery and Historic Maps
(v) Hydrodynamic modelling
(vi) Regime analysis using field survey and modelling results
(vii) Sediment Transport modelling results
(viii) Field visits and public meetings

The other factor which must be taken into account is an awareness that the coastal region is a complex dynamic system and the consequences of actions which disrupt the natural processes can have significant negative effects, in addition to the potential positive effects. The CEP is a particular example of a project where the state of knowledge at the time of inception was apparently not sufficient to predict both the beneficial and adverse consequences of the project. The adverse consequences have now materialised in the form of drainage congestion. In this situation interventions should be planned on a stage by stage basis with reliable monitoring of each stage constituting an essential part of the intervention package.

2.2 Current and Previous Studies and Projects

2.2.1 Current Studies

There are several current studies which relate to the coastal zone and where possible there has been liaison between those studies and FAP-4. FAP-4 has tried to avoid duplication of study effort and has made use where possible, of information received from these studies.

The studies in question are:

(i) Cyclone Protection Project II - FAP-7 (1992)

FAP-7 has examined the feasibility and design of protection measures against cyclonic flooding. Detailed designs have been produced for work to be implemented immediately under the Emergency programme and feasibility studies have been carried out for the 5 year Mid Term Programme for coastal embankment works. Areas examined in the South West Region were polders 5; 7/1; 7/2; 10-12; 14/1; 14/2; 15; 35/1; 40/2; 48 and 56/57 and of these it was concluded that polders 35/1; 40/2; 48 and 56/57 should be included in the Mid Term Programme. The works recommended are shown in Table 2.1

TABLE 2.1

Mid Term Cyclone Protection Work in SW Region

Polder No.	Chainage	Embankment Works		Protective Works		Structures (No.)		Total Financial Cost in Million Taka
		Resection (Km)	New Retired (Km)	Repair (Km)	New (Km)	New	Repair	
35/1 Sharankhola	1.6-4.1 6.3-8.1	2.5 1.8		1.8	2.5	1		57.5
40/2 Pathergata	10.0-15.0 & 18.5-23	9.5						59.9
48 Kalapara	26.0-35.0	9.0						14.1
56/57 Bhola	63.7-67.5 67.5-76.0 76.0-80.5 80.5-126	3.8 45.5	 8.5 4.5			1		317.4

Source: FAP-7 Main Report (May 1992)

It should be noted that resectioning means improvement of existing embankment in their present location whereas new embankments in retired alignments are proposed on eroding coasts.

The report points out that afforestation provides very efficient protection to embankments by dissipating wave energy and reducing the level of tidal surge and the rate of coastal erosion.

The report also contains measurements of surge heights from past cyclones and numerical modelling was carried out to reproduce these events. FAP-4 has extended the model work to demonstrate the propagation of tidal surge through the SW Region.

Except for surge propagation FAP-4 have not carried out any other work on cyclone protection.

(ii) Secondary Towns Integrated Flood Protection-FAP-9A (1992)

The study produced Integrated Plans for six towns of which Khulna was the only town in the Southwest Region. The impact of the proposed Khulna plan on the coastal studies for FAP-4 is primarily the location and size of the proposed outfall structures. It is proposed that the main outfall will be a new drainage channel running Southwest from Khulna into the Upper Solmari River. As originally conceived this proposal would have produced a conflict with the CERP II proposals and the FAP-4 strategy for the tidal rivers. FAP-9A have now proposed that the outfall will be located in the Lower Solmari River which is compatible with both CERP II and FAP-4 proposals.

(iii) Systems Rehabilitation Project

The study is ongoing and is studying various options for BWDB sub-projects in a number of polders, some of which lie within the southwest region. These sub-projects are related to internal irrigation and drainage options at feasibility level.

(iv) Third Fisheries Project (Shrimp Farming Component) (on going)

The project activities comprise development of shrimp farming infrastructure; upgrading embankment; construction of water supply and drainage channels and structures; and support services such as credit facilities and training for farmers. The first phase of the project involves CEP polders 5 and 23 and subsequent phases will involve polders 16, 18/19, 31, 32 and 33. The impact of the Regional strategy on these polders is discussed in Section 7.

(v) Second Coastal Rehabilitation Project Feasibility Study (CERP-II) (1992)

Haskoning Consultants have been appointed by the Government of Bangladesh to carry out a comprehensive feasibility study into methods for improving the drainage, flood control and land use of about 100,000 ha in Polders 24, 25, 27/1 and 28/1. This encompasses both the KCERP and CERP II project areas. Haskoning are required under their terms of reference to make maximum use of information and findings of other similar studies and projects including FAP4. Discussions have taken place between the FAP4 team and Haskoning concerning the relationship between the Regional Strategy and Haskoning's proposals. Haskoning completed their study in January 1992. The CERP-II Area covers approximately 100,600 ha and includes CEP polders 24, 25, 27 and 28 and the area of land north of polder 24 stretching almost to Jessore. The report concludes that Beel Dakatia and Polders 27 and 28 should be drained towards the Lower Solmari river which is considered to be a sustainable river. It is proposed that the remaining two thirds of the project area should drain via the Harihar, Hari and Upper Bhadra rivers after dredging in the Upper Bhadra. Haskoning consider that drainage can be sustained by regular dredging using mechanised dredging equipment. As a consequence of the tidal conditions at the mouth of the Hari and Upper Bhadra rivers it is considered by Haskoning that drainage improvement in this area will be modest and not perform as well as the areas draining into the Lower Solmari. The capital cost of the works is estimated at US$ 46 million.

(vi) Study of Pussur Sibsa River System (1992)

The study is a mathematical model study of the Pussur-Sibsa River System and Karnafuli Entrance to examine the navigational constraints of the rivers leading to Mongla and Chittagong. The objectives concerning Mongla Port are to determine the effect of proposed polder schemes on navigation in the Pussur and various ways of improving the navigation conditions at the port by closing some inter-connecting channels between the Pussur and Sibsa and increasing the tidal cubature by the tidal flooding of uneconomic polder areas. The study has included extensive field work to ensure good calibration of the model which is claimed to produce reliable results. Twelve alternative schemes are produced for improving navigation and it is recommended, in the report, that all twelve should be taken to pre-feasibility level before a preferred scheme can be identified. The relationship between these schemes and the Regional strategy is discussed in Section 7.

(vii) Integrated Resource Development of the Sundarbans Reserve Forest (1992-1996)

This study and trials is a jointly funded programme of the UNDP and GOB.

The project provides for the conduct of mangrove ecosystem studies and trials and the formulation of a strategy and an integrated plan for the sustainable multiple-use, conservation and management of the forest, terrestrial wildlife, and aquatic resources of the Sundarbans Reserved Forest compatible with the underlying ecological and environmental changes. It also aims at improving the technical capability of the national institutions operating in the forest area to ensure participation of disadvantaged social groups in exploiting forest resources and improving transport and communications services without disturbing the natural ecosystem and resource balance. This will lead to higher productivity and the identification of new investment opportunities and options. An equally important function of the project will be to enhance the environmental and protective role of the forests for coastal croplands and homesteads.

The main link between this study and the Regional Study will be the impact of the coastal embankment projects on siltation and tidal flows and the effect of changes in fresh water flow from the north on the salinity and sediment movement in the Delta.

2.2.2 Previous Studies and Projects

The present problems of channel siltations and polder drainage cannot be fully understood without an appreciation of the history of these problems. In particular a historical perspective is needed to avoid the trap of assigning current problems solely to recent interventions and thereby seeking a solution by merely modifying or reversing those recent interventions.

The reports and publications relevant to siltation and polder drainage and other coastal matters are given in a reference list at the end of this Section. A synopsis is given below of some of the key references:

(i) A Statistical Account of Bengal (1877)

The Statistical Account comprises twenty volumes of detailed information on all aspects of social and agricultural development in Bengal. Points of particular interest are comments on the settlement of land in the Khulna district and the methods of reclaiming the Sundarbans to produce land suitable for cultivation.

At that time the Sundarbans stretched from the Hoogley to the Meghna and inland approximately 130 km i.e. approximately 10 km north of Khulna. The central area in the Satkhira - Khulna region is described as low and swampy with the land half-cleared for cultivation, and the fields are surrounded by low embankments. The water is described as sweet and large volumes of silt are carried down the Jessore rivers, from the Ganges, between April and October, gradually raising the level of the land. The coastal fringe at the Bay of Bengal is described as thickly forested and it is noted that the forest acted as excellent protection against the cyclone and tidal surge of 1869 and prevented the areas to the north from being flooded. However there are also reports that "cyclone waves" have travelled up the Pussur and Haringhata causing extensive flooding. The coastal areas are reported as being higher than the inland area and this is thought to have been caused by the deposition of large volumes of silt and sand carried into the coastal inlets from the sea by wave and tide action. Evidence is also reported that at Khulna the land was once 6 meters lower than at present either due to settlement or an earthquake.

The natural river banks in the delta were higher than the surrounding lands which would remain flooded except for reclamation work. This work comprised closing the khals, or small channels which cross through the embankment, at high tide and re-opening them at low tide to allow drainage to occur. It was noted that the embanking operations had an effect on the tide and that tidal effects, reversal of flow, moved northwards over a period of twenty years to "a few miles" north of Narail on the Gorai in the dry season. That is, about 40 - 45 km north of Khulna.

This would have caused a similar saline intrusion but the Account makes no reference to this effect, instead reference is made to "vast plains" covered with rice and "stretching for miles". One exception is the "remarkable line of depression" which runs across the Jessore District immediately north of Khulna which is only partly drained and reclaimed. No mention is made of siltation of the channels and it is noted that shipping routes between the Eastern Districts and Calcutta have been virtually unchanged for a hundred years. Mention is made of the "Swatch of No Ground" and its origin is postulated as being caused by a meeting point of the two parts of the flood tide advancing up both sides of the Bay of Bengal. The result is a continuous erosion of the sea bed resulting in the steep slopes encountered in the weak sea bed materials (they are assumed to be weak).

It is clear from the Account that reclamation and development of low lying lands and the Sundarbans was being carried out on an enormous scale in the 19th century and no heed appears to have been taken of the effect that these large scale works might have on the estuarial regime.

(ii) History of the Rivers in the Gangetic Delta (1750-1918)

The History provides a detailed and authoritive account of the Ganges Delta. It differs from the Account in that it concentrates specifically on the rivers and demonstrates a clear understanding of the adverse consequences that can result from in-appropriate interference with natural estuarial processes. Its value was recognised by the East Pakistan Inland Water Transport Authority who instructed NEDECO to carry out the reprint in 1966 as part of their contract for the survey of the rivers of East Pakistan.

The History demonstrates that by the year 1900 there was a clear understanding of the link between reclamation of tidal spill areas and channel siltation. Extensive reclamation between the Hoogley and the Indian Border had created widespread channel siltation with consequent drainage and navigation problems. It was also noted that as more embankments were constructed so the high and low water levels rose in the adjacent channels. At Dhappa the river bed was silting up at a rate of 150mm/yr and the river was practically dry at low tide. It was recognized that by removing some of the embankments and thereby increasing the tidal storage area tidal scouring would improve. It was planned to carry this out step by step so that as one area of reservoir silted up a new reservoir could be opened and the silted-up reservoir turned over to agriculture with the benefit of improved ground level and drainage. The results of 12 months operation with a 2.5 sq km tidal spill reservoir were dramatic where accretion had been occurring at 150 mm/yr, erosion took place at up to 900 mm/yr. It was estimated that these operations would sustain the river for another 100 years. The effect of the reservoir is particularly dramatic because the river bed is described as "hard stiff blue clay". The effect would have been greater in the softer materials usually associated with silted channels. It was planned to introduce another similar reservoir following this initial success but the subsequent progress is not given.

The effect of increased tide levels, as a consequence of embankments, is dealt with in detail. It clearly points out that reclaimed land, which prior to reclamation may have been only 300 -600 mm below high water, can soon become 1-2 m below high water as the tide levels in the adjacent channels is forced to rise by embankment construction. What at first appeared easy land to reclaim soon became reclaimed land that was impossible to drain. It is reported that another effect of increased tide levels was that for a short period of time the increased depth improved navigation but this benefit is soon lost as channel siltation progressed.

The process is described of allowing the tidal to spill during the wet season and preventing it during the dry season. By this means the tidal spill tends to be dominated by sweet water. Silt laden tidal water is allowed to build up the land and the tidal flow in the wet season flushes out the channels. In areas where this practice is carried out people are reported to lead prosperous and healthy lives.

Information is provided on the waves created by cyclones but the only data relevant to the Southwest Region refer to the 1916 storm when tide levels increased by 600 mm at Khulna and 1200 mm at Barisal.

The History concludes by pointing out that the lessons learnt from the severe deterioration of the delta system adjacent to the Hoogley over the last 80 years must be applied to the development of the eastern areas. In particular it cites the essential role of the beels to the west of Khulna in maintaining the drainage and fertility of the higher land to the south, and the active life of the Pussur and Sibsa rivers.

The particular advantage of the History for future use is that it is able to transcend the existing political border between India and Bangladesh and demonstrate the gradual evolution of the delta from west to east thereby providing engineers in Bangladesh with the results of a unique full scale hydraulic model for planning future works.

(iii) Coastal Embankment Project (CEP) in Bangladesh (East Pakistan) (1960)

The CEP was an immense undertaking designed to prevent tidal flooding of vast areas of low lying land and thereby increase the agricultural yields. In the Southwest Region this involved a polder area of 860,000 Ha with 3700 km of embankment constructed from 114 million cubic meters of material. Most of this land had previously been under some form of cultivation following the construction of dwarf bunds along the river banks. After partition the landowners, known as Zaminders, left East Pakistan and the bunds fell into disrepair with subsequent loss in agricultural production. The CEP aimed to provide a substantial increase in food production by rebuilding the existing bunds and constructing new bunds. It was realised that the closing of channels envisaged in the CEP would cause a radical alteration of tidal currents, but it was concluded that although the consequences were "difficult to calculate" the discharges from the embankment areas would keep the outer channels "clear of silt".

With the benefit of hindsight it is now clear that this conclusion was incorrect for the Khulna and Satkhira Districts and ignored the warnings on the consequences of embankments in these areas provided in the History 40 years previously.

(iv) Coastal Embankment Project - Engineering and Economic Evaluation, Volume 1 (1969)

In 1962 WAPDA engaged Leeds hill - De Leuw as its special consultant to assist with the design, construction and maintenance of the Coastal Embankment Project (CEP). In 1969 they reported that an intensive engineering and economic review of the project had demonstrated the engineering soundness and economic profitability of the CEP concept as advanced in the original 1961 feasibility report.

The consultants collected large quantities of data which cover all the coastal regions of Bangladesh. As such this report forms a valuable base survey against which current conditions may be compared.

The main conclusions relevant to the current coastal studies were:

- the CEP will help reduce damage from cyclone wave surges on the edge of the cyclone but the embankments are not designed to resist the surge in the main path of the cyclone
- the CEP will not appreciably affect the pattern or degree of salinity incursion but reduction in fresh water flows from the Ganges will cause salinity to advance further inland (subsequently found to be at least partially incorrect)
- the CEP will have only a minor effect on sedimentation and erosion compared with the existing natural processes (subsequently found to be incorrect)
- the CEP will not cause any significant increases in water levels in confined river channels, increases are estimated to be less than 150 mm (subsequently found to be incorrect).

There is no evidence in the report that the Consultants carried out model studies, numerical or physical. There is also no reference made to the siltation and tide level changes known to have occurred in western parts of the Ganges Delta as a consequence of large scale polder construction. Recommendations are however made for a comprehensive programme of data collection and aerial photographing to allow monitoring of sedimentation changes due to the CEP.

(v) Delta Development Project (Phase I & II)

The Delta Development Project relates to the rehabilitation of certain selected polders in the deltaic zones of the Southwest Area under a joint programme of the Governments of Bangladesh and Netherlands. The initial study which was started in 1978 laid emphasis on delta development in the Southwest region, with three pilot polders in different salinity regimes. However, in 1981 the scope of this study was modified to suit integrated rural development and related to only one polder - Polder 22 in Paikgacha (semi-saline). The programme focussed on appropriate land and water management and on achieving greater participation of the landless and small farmers in the development work.

(vi) Southwest Regional Plan (IECO-1980)

The Regional Plan contains extensive measured data which is useful relative to the present coastal studies, in particular tidal and salinity data. The main content of the plan concerns augmentation of fresh water flows from the Ganges with the Ganges Barrage. The plan does not contain however any proposals for relieving drainage congestion in the CEP area.

(vii) Khulna Coastal Embankment Rehabilitation Project (KCERP) - Feasibility Report

In 1985 consultants were appointed to carry out a prefeasibility study, Phase-I, into the rehabilitation of 313,000 Ha of poldered land in the Khulna and Satkhira districts. Siltation of the river channels, especially at the out-falls, inadequate maintenance and ineffective irrigation had dramatically reduced the benefits of the polders and the aim of the study was to propose methods of rehabilitation and thereby increase rice production and improve the socio-economic condition of people in the Project Area. Following Phase-I the consultants proceeded with

Phase-II which involved detailed proposals of 31,900 Ha in the Khulna area and covered polders 25, 27/1, 27/2, 28/1 and 28/2.

(viii) Evaluation of the Khulna Coastal Embankment Rehabilitation Project (1990)

Following a rise of local opposition to the KCERP project a mission team of 6 experts, 3 expatriate and 3 Bangladeshi, was set up to evaluate the project.

The mission concluded that the design and execution of the project was flawed in several major aspects and implementation should cease whilst some radial changes were made.

The main flaws in the project were found to be:-

- the proposed outlet regulator, situated at the junction of the Hankura and Bhadra Rivers, is located in an area undergoing rapid siltation and the Bhadra River could be closed in 5-10 years.
- the project did not take sufficient account of the socio-economic needs of the community and did not achieve an acceptable balance between the requirement of rice farmers, fisheries and shrimp culture.
- the project did not appear to be formulated within a regional framework.

The main changes proposed were:

- the drainage outlet should be via the Gallamari River to the Pussur River system or alternatively via the Solmari River.
- the redesigned project should include specifications to enhance fisheries and encourage fish culture in the area.

Phase-II of the study included a detailed proposal for one dimensional numerical model studies of the Phase-I area. The arguments behind the proposal stressed the need for a comprehensive understanding of the river and tidal system before engineering works can be implemented. The study provides three detailed engineering proposals, without the benefit of model studies, and concludes that Alternative III is the best solution. This alternative involves closing the Hamkura river with sluice structure which discharges into the Baghra river.

Implementation of the KCERP proposals commenced in 1988 under the direction of a new consultant but were suspended in 1989.

(ix) CERP-II Mathematical Model (Phase II, June'91)

Following the completion of the KCERP study a further study, known as CERP-II, was proposed to cover a further 60,000 ha to the north and west of the KCERP area. It was also decided that a surface water simulation model should be set up to cover the tidal and non-tidal channel network in the KCERP - CERP-II area and to extend as far south as the Port of Mongla. The purpose of the model was to examine local and regional impacts of the rehabilitation on other proposed works. A pilot project was completed in 1988 and the Phase-I report was submitted in 1990. Phase-I defined the detailed model design and data collection for Phase-II which was completed in 1991. Meanwhile implementation of KCERP was suspended in 1989 following some doubts about its long term effectiveness and a new feasibility study of the KCERP - CERP II area was proposed.

The KCERP - CERP II model is a one dimensional hydrodynamic model based on the DHI MIKE 11 modelling system. The model has now been calibrated and is available for comparing the relative effects of possible interventions. it is stressed that the calibration will need periodic rechecking as siltation and other changes continue in the model area.

(x) Dredging of M.G. Canal (1972)

Between 1970 and 1972 the M.G. Canal was excavated to provide an all-year navigation route between the Pussur and Baleswar Rivers via the Monglanulla and Ghashiakhali rivers. This route is a considerable improvement over the previous dry season route which was via the Bay of Bengal. There have, however, been some adverse consequences due to salinity intrusion from the Pussur river penetrating into the Baleswar on the ebb tide. This consequence requires further investigation.

2.3 Current and Historic Survey Data

Although a large number of studies have been carried out in the Region there is a severe lack of reliable sequential survey data which will show the evolution of channels and rivers. The main source of existing survey information is SWMC who require data for calibration of the South West Area Model. To provide an indication of the changes occurring at selected locations an additional 77 cross sections were taken during the FAP-4 studies as shown on Figures 2.1 and 2.2. Great care was taken, by reference to the original field books and survey marks, to ensure that these new cross sections were taken at the same location as the previous sections. For each location the sections were plotted as shown in Appendix B and an assessment made of the river condition. The results of the assessment are given in Table 5.1. Latitude and longitude have been measured at each section location to enable future surveys to easily locate the same position. It is essential that surveys are repeated at regular intervals to monitor the existing river condition and the changes induced by future interventions.

2.4 Reports from BWDB Executive Engineers

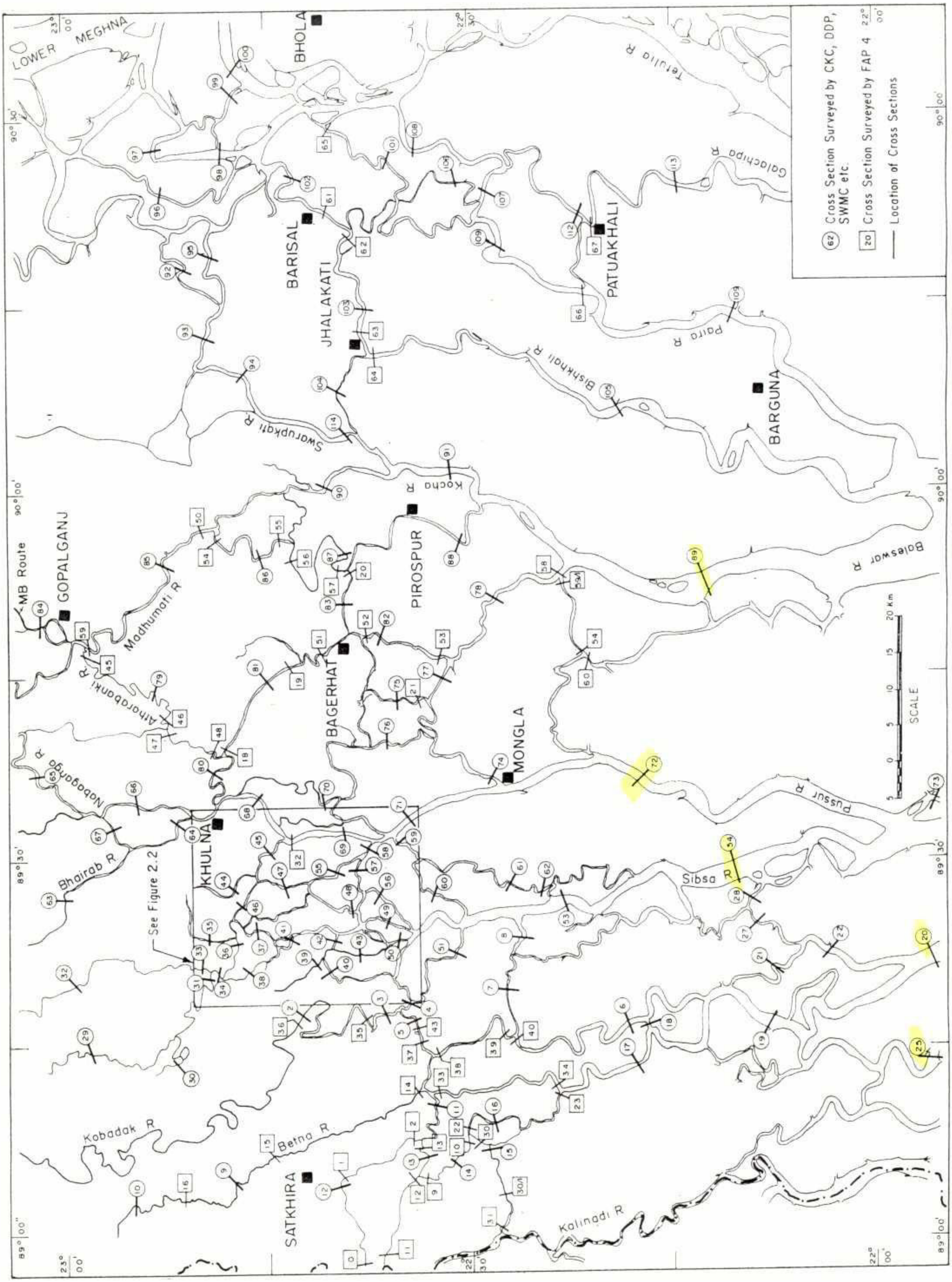
One of the most important tasks of the coastal studies is to assess the performance of the CEP polders. Many global comments have been made concerning drainage congestion but no overall evidence exists on the extent of this congestion and the consequential impact on the performance of the polders. To obtain field reports on the condition of the polders a questionnaire was sent to Executive Engineers in the CEP area. Table 2.2 shows the degree of success in obtaining information by this method. The information obtained was used, in conjunction with other data, to provide on assessment of the condition of rivers and polders as discussed in Section 6.

2.5 Satellite Imagery and Historic Maps

There are many reliable maps for the region dating back to the Rennell's Map of 1779. In addition satellite images are now available to complement current maps. By using the GIS it is possible to reference the maps and satellite images to the same grid system so that accurate appraisal can be made of the changes in coastal shape and river alignment.

The 1989 1:50,000 SPOT images have also been used for detailed visual examination to help determine the existing condition of rivers.

Figure 2.1



Location of Surveys

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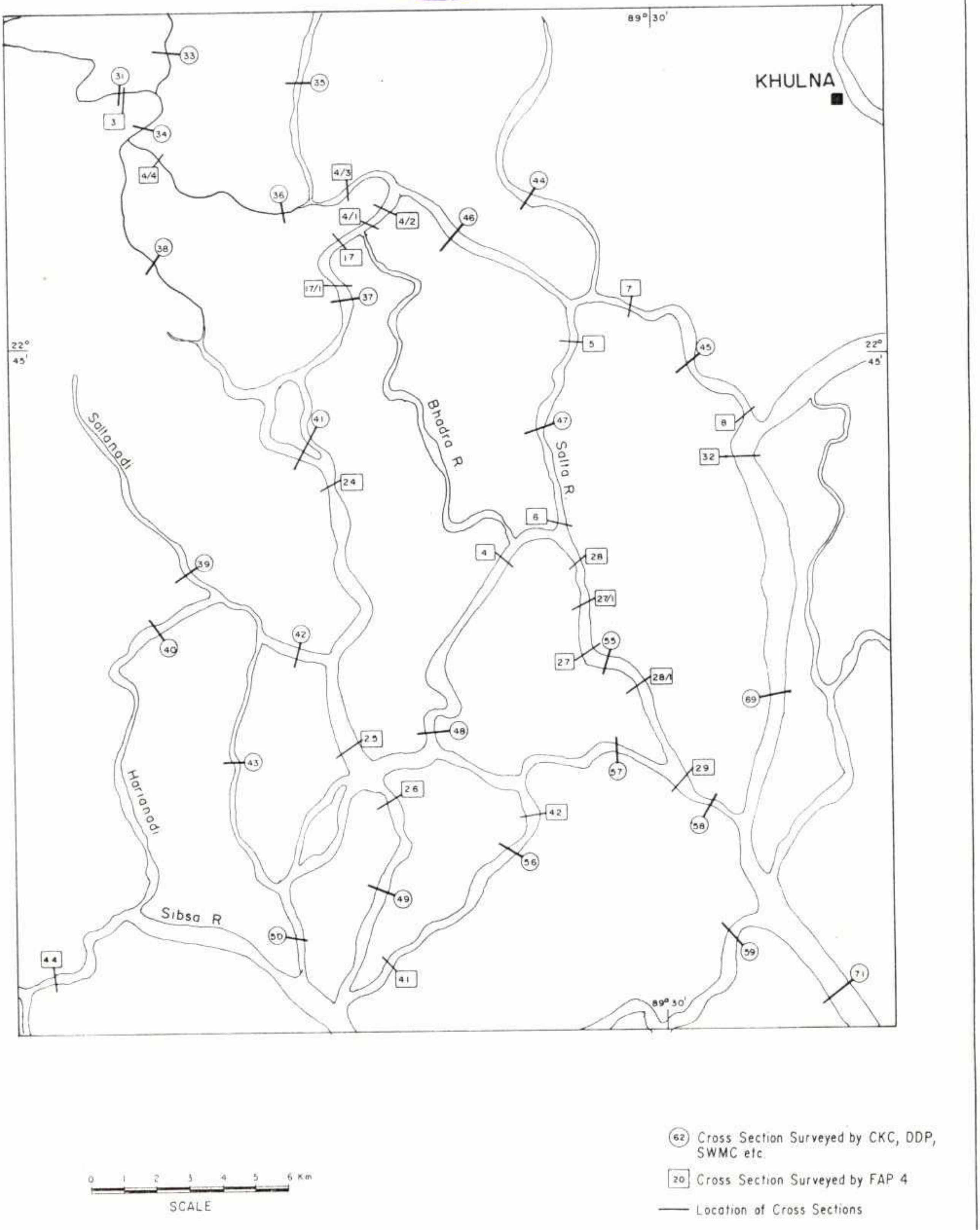
Figure 2.2



Location of Surveys

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TABLE 2.2

List of the Executive Engineers (EE) To Whom Questionnaires Were Sent

	Executive Engineer	Response
1.	EE, Khulna O & M Division-I, BWDB Boyra, Khulna	Reply Received
2.	EE, Khulna O & M Division-II, BWDB Kailaghat, Khulna	"
3.	EE, Bagerhat O & M Division, BWDB Bagerhat	"
4.	EE, Jessore O & M Division, BWDB, Karbala Road, Jessore	Not Received
5.	EE, Satkhira O & M Division-I, BWDB, Satkhira	Reply Received
6.	EE, Satkhira O & M Division-II, BWDB, Satkhira	"
7.	EE, Patuakhali O & M Division, BWDB, Patuakhali	"
8.	EE, Barguna O & M Division, BWDB, Barguna	"
9.	EE, Bhola WD Division-I, BWDB, Bhola	Not Received
10.	EE, Bhola WD Division-II, BWDB, Bhola	"

2.6 Hydrodynamic Modelling

The river models of the southwest and south central regions, as developed by the Surface Water Modelling Centre are based on the one dimensional river modelling system MIKE11. In addition significant developments were carried out by the modellers on the study team, particularly on the two dimensional model (MIKE21) of the Bay of Bengal which was used to provide improved downstream boundary conditions for saline intrusion studies.

A number of different models were used to investigate different aspects of the region and these are fully described in Volume 2. The South West Regional Model (SWRM) covered the western part of the study area including the Kobadak-Betna system and the Pussur-Sibsa system in the south and the inter-connections to the Ganges through the Gorai and the Arial Khan in the north. The South Central Regional Model (SCRM) covers all the rivers of the region connecting to the Padma and Lower Meghna. Saline intrusion was investigated using the South West Regional Salinity Model (SWRM-TD) and the GM-SALT model. The latter takes into account the fully tidal boundary conditions in the Bay of Bengal generated by the two dimensional model. Lastly the South West Area Model (SWAM) essentially combines the SWRM, SCRM and the western branches of the GM-SALT model and uses a coarser discretisation that has been checked for consistency with the relevant sub-models.

The models described have been used to improve the understanding of the interacting hydrodynamic processes of the region. They have provided key data that enabled an effective regime analysis to be carried out and to investigate the impacts of different augmentation and intervention scenarios. The impact of possible long term sea level rise on flooding and salinity intrusion has also been assessed through the models.

2.7 Morphological Modelling

The type of sediment transport model available for the project was based on the one dimensional hydrodynamic model and it therefore could only be used for prediction of bed level changes or to give an indication of areas of erosion or siltation. As the modelling is only one dimensional, it complements but does not replace the study of bank line movement and planform development described previously. A change in river sinuosity due to bank erosion could for example have a major impact on the river but would not be simulated in the model. The models are most suited for comparing the effects of different intervention strategies and could not be used for long term prediction of morphological changes.

The morphological behavior of the tidal delta area is particularly complex with many interlinked branches which develop and change continuously. It is unlikely that the simplified one dimensional models will be able to predict the long term opening up and silting of the smaller cross connecting channels due to the natural processes. However where there have been major interventions such as reducing spill areas by poldering, the models should be able to simulate the effects observed. It is unfortunate that there is only sparse historical data available for model calibration as major changes that are known to have occurred. As part of the Pussur Sibsa study the MIKE 11 sediment transport model has been successful in predicting the rate of siltation of a major reach, but in general terms the modelling techniques are novel and for detailed studies need further field verification.

There are three different types of model which it was hoped SWMC would make available to the study. Each of the models have particular suitability for different applications:

(i) Sand Transport Model (Non Cohesive Sediment Transport)

The movement of bed material is simulated using standard sediment transport formulae such as Engelund and Hanson or van Rijn. The cross section profile remains unchanged throughout the simulation. Small errors in cross section data can give large errors in sediment transport rates and it is therefore necessary to consider a number of sections in any reach. The sediment transport formulae are accurate only for sand size sediment and above. The grading of bed sediments can be modelled. This model was used to assess the qualitative condition of rivers, i.e. silting or active.

(ii) Cohesive Sediment Transport Model

The processes involved in the settling, deposition, resuspension and eventual consolidation of cohesive silt and clay size material are significantly different to those for sand size sediments for which the standard sediment transport formulae were developed. The data requirements for modelling and calibration are also much greater. This model had not been developed for situations other than single reaches and was therefore not available for the present coastal studies.

(iii) Morphological Sand Transport Model

This model is similar to the sand transport model but includes updating of the cross sections to take account of erosion or deposition. The model must therefore be run together with the hydrodynamic model and not at a later time as is possible for the other sediment transport models. The model may show rapid siltation or erosion of cross sections for which conveyance is greater or less than representative for the reach. This model had also not been sufficiently developed to be useful for the coastal studies.

2.8 Regime Analysis

The difficulty in modelling morphological processes lies in the fact that it is a constantly changing evolutionary process. The channel cross-section geometry, which has taken a considerable effort to obtain, can only be a snapshot in time so, in turn, the representation of sediment transport processes can only relate to that channel geometry unless a morphological model that makes progressive adjustments to that geometry is employed.

The tidal system within the project area is complex with many interconnecting channels and at present a suitable morphological model does not exist.

An alternative approach to detailed sediment transport modelling is to apply a regime model which although it does not represent the processes in any detail, it empirically relates the ideal tidal river cross-sections to some measure of the flow conditions. McDowell and O'Connor(1977) show that many estuaries which have unrestrained boundaries exhibit a strong correlation between the maximum tidal discharge on a mean spring tide and the channel cross-section so that

$$Q_m = A_m C(t_s/p)^{½}$$

where Q_m (m^3/s) is the maximum tidal discharge, A_m (m^2) the cross-sectional area at mean tide level, t_s an average cross-sectional shear stress which may vary between 0.35 and 0.5 kg/m^2, p is water density and C is a Chezy coefficient which can be approximated by

$$C = 30 + 5 \log(A_m) \; m^{½}/s$$

If however the river is in a state of transition it follows that a flow greater than Q_m will cause the cross section to erode until a new stable cross-section is created. Conversely a flow lower than Q_m will cause siltation. Whilst the conditions in the tidal rivers in the study area do not exactly match those for which this relationship is known to be valid, for example the Hooghly in India, it can be checked as a valid means of approach by comparison with field observations and data obtained from SPOT imagery. The hydrodynamic model can also be used to generate results for use in a regime type equation. The usefulness of this type of approach has been proven over many years. At a planning level it gives a simple analysis tool that can be applied over a wide area to identify areas for which further detailed study is required. The hydrodynamic model may then be run to give results that can quickly be analysed to give predictions of the effects of interventions for example.

The hydrodynamic model can be used to calculate Q_{max} at specified locations in the river system. The value of the cross-sectional area at mean tide level, A_m, can be approximated by Q_{max}/V_{max} and the corresponding value of Q_m determined. If the ratio $Q_{max} : Q_m$ is greater than unity this implies erosion and if less than unity the siltation is occurring. The manner in which this method has been used to predict the condition of the tidal rivers is discussed in Chapters 5, 6 and 8.

For the purposes of river classification the morphological process has been defined in Table 2.3.

Table 2.3

River Classification Related to Discharge Ratio

River Classification	Ratio $Q_{max} : Q_m$
Heavy Siltation	< 0.05
Moderate Siltation	0.36 - 0.70
Slow Siltation	0.71 - 0.95
Equilibrium	0.96 - 1.05
Slow Erosion	1.06 - 1.25
Moderate Erosion	1.26 - 1.50
Heavy Erosion	>1.51

The main value of this type of classification is as a means of comparing river conditions rather than the absolute conditions.

Results of the Regime Analysis and hydrodynamic modelling are given in Appendix C.

3 COASTAL AND DELTA FORMATION

3.1 Coastal Formation

The coastal zone of the Area forms the boundary between the flood plains of the Ganges, the Padma River and the Lower Meghna estuary and the Bay of Bengal. The form and development of the coast line is dominated by the development of the river systems. The river system morphology is described in Volume 3.

The combined sediment load of the rivers has created the largest submarine fan in the world which slopes almost uniformally southward for about 3000 km. The enormous quantities of sediment, approximately 2.4 billion tons per year (Coleman 1969, Khan 1978), carried into the sea by the river is distributed between the delta fan and the coastal areas. Discharge to the delta fan takes place through submarine canyons at the head of the bay. The "Swatch of No Ground" is the most remarkable of these canyons. The sediments are distributed along the length of the fan by a system of turbidity current channels which run mainly from north to south. The sediments have accumulated in places to a thickness of 15 km. The deposed sediment is called a turbite and its accumulation continues at the present time, but is now concentrated in the northern part of the fan. In 1975 shoaling was reported at the northern end of the "Swatch of No Ground" when a depth of 83m was measured at a location charted as 183m. This could be due to a positioning error during charting or measurement but it could also be indicative of changes in the pattern of coastal sedimentation.

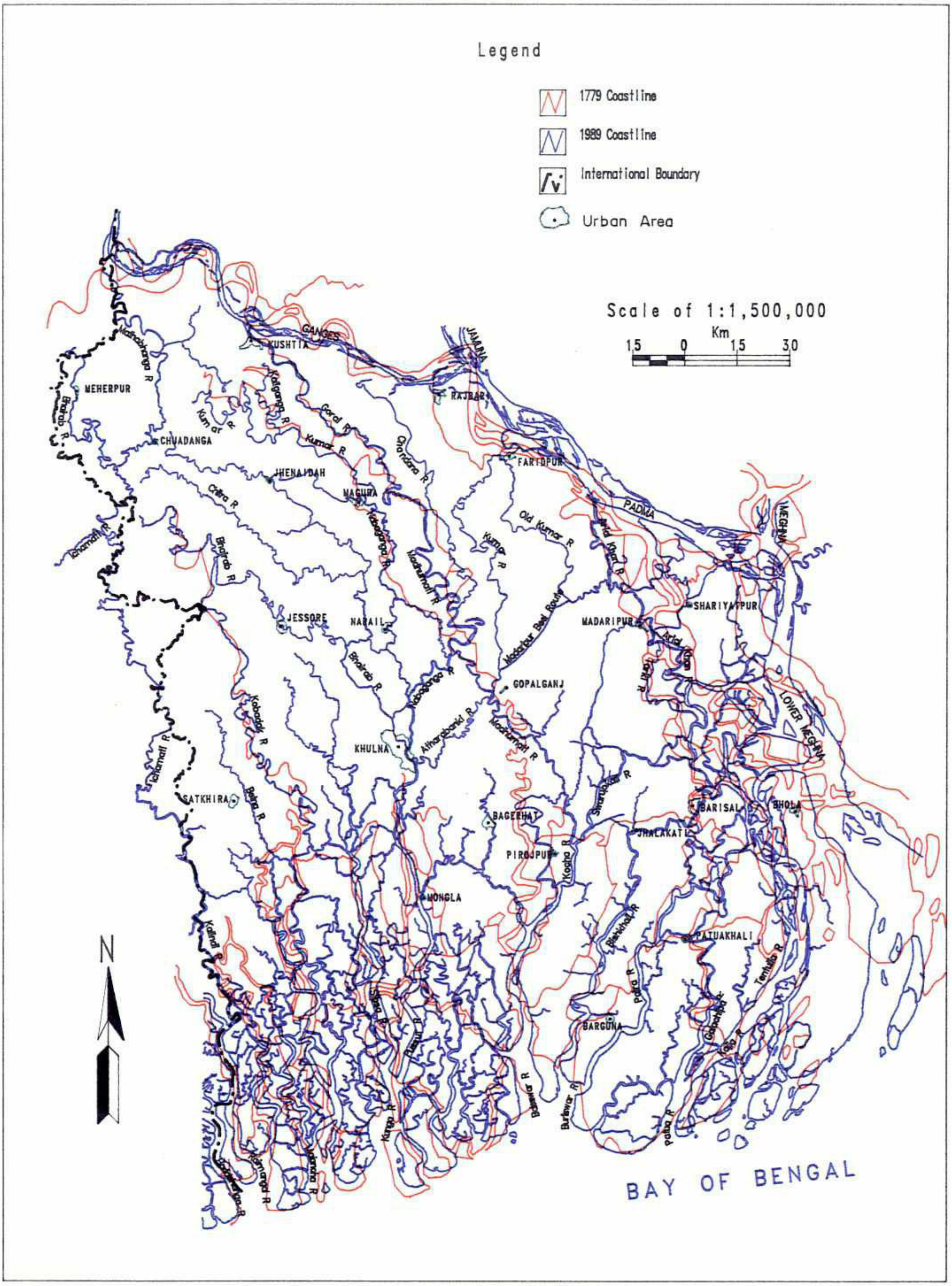
A review of historical charts has been carried out by a comparison between the coastal outline obtained from the 1989, 1:50,000 SPOT satellite images and selected charts dating back to Rennell's Map of 1779. The results are shown on Figure 3.1. The most notable points concerning coastal formation are:

- along the southern limit of the central part of the Southwest and South Central Regions the coastline has remained virtually unchanged over the last 200 years
- there have been some changes to the lateral channels linking the main north-south tidal rivers
- there have been marked changes in both size and position of the islands to the east of the Region in the mouth of the Meghna, principally to Bhola island.

3.2 Delta Formation

A probable explanation for the progressive formation of the coastal region of the delta is shown diagrammatically on Figure 3.2. When the rivers, Kumar, Nabaganga, Chitra, Bhairab and Kobadak were active distributaries of the Ganges, sediment laden water flowed into the sea in a south easterly direction. Under normal conditions sediment that reached the sea would be returned at high tide and be deposited over tidal spill areas. During the wet season the rivers would be carrying large volumes of material and would increase the height of their bed and banks. During the dry season the tide would break through the raised banks and deliver silt to the low lying areas, thereby causing a general increase in levels of the intervening lowlands. The old river bed would then silt up leaving raised ridges above the inter-channel lowlands. In this way a gradual raising and seaward progression of the delta was taking place.

Figure 3.1



Coast Line Changes (1779 & 1989)

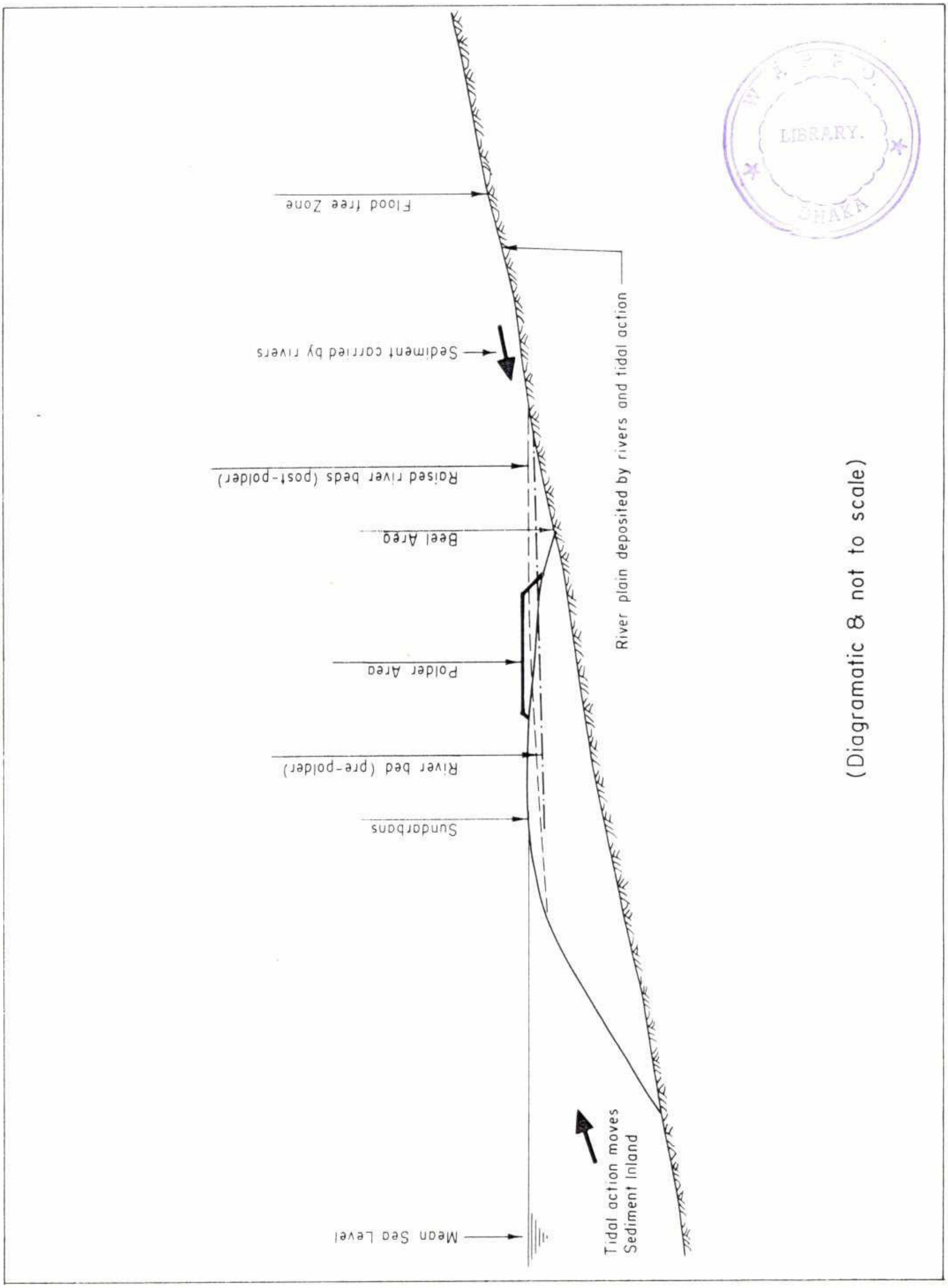
However, as the Ganges migrated eastwards, this situation changed, as the flow from the Ganges into these rivers first diminished and then ceased when their offtakes from the Ganges eventually closed. At this time there was probably insufficient sediment reaching the sea from the inland rivers to cause further seaward movement of the coast. Instead tidal action continued to move material inland, probably including material originating from the Meghna Estuary, thereby advancing the shore ridge landward and further raising the old river beds. In time sediment reaching the low lying junction between tidal and river deposits diminished and permanent low lying beel areas were created as shown schematically in Figure 3.2. As vegetation died off in these brackish areas the peat common to the beel areas was formed. The low lying coastal ridge where salt and fresh water meet provided the conditions necessary for extensive mangrove forests to grow.

The delta in the Southwest Region is now undergoing a period of transition from being an active deltaic system with large Ganges fresh water flows mixing with tidal incursions, to a system with much smaller local fresh water flows but similar tidal incursions. This transition involves the gradual siltation of tidal inlets until they reach a size which is in equilibrium with the reduced fresh water flows. The point at which the system will stabilise is not known but total decay of the delta is not likely to occur. Whether or not future regional developments should be planned in harmony with this gradual decay or planned to pre-empt the decay by large scale interventions is the fundamental question to be resolved in formulating a long term strategy for the delta as discussed in Chapter 7.

Initial cultivation commenced in the fertile river plain to the north of the beels but as the demand grew for more land, attention was focussed on protecting low-lying areas from tidal inundation by the construction of small scale bunds. The bunds were controlled so that areas were flooded during the dry season, when salinity was greatest, to enable shrimp and fish cultivation to be carried out and in the wet season the land was protected from tidal inflow so that rice could be grown. This system was largely managed by the zamindars (landlords) until Partition after which the system fell into disrepair and crop failures due to flooding or saline incursion became a frequent occurrence. To remedy this situation the former East Pakistan Water and Power Development Authority (EPWAPDA) embarked, in the early 1960s, on a huge programme of polder construction known as the Coastal Embankment Project (CEP). In addition to protecting land poldering limits or prevents the tidal spill over low lying lands and silt carried in on the tide is therefore deposited in the channels. Also in addition the funneling effect of the polders raises tidal levels and reduces the tidal volume entering the estuary. With the volume reduced there is less ebb tide flushing action to remove the sediment in the channels and these are gradually accreting. At the same time the natural raising of low lying lands has diminished. Gravity drainage of the beels and low lying polders is thus likely to become increasingly difficult.

The construction of the CEP has caused a major change to the transitional processes that were already taking place in the delta prior to 1960. The pre-1960 situation cannot now be recreated and future strategies must take account of the manner in which changes are now taking place. Chapters 5 and 6 propose methods for assessing present and future conditions to assist in the formulation of the long term strategy discussed in Chapter 7.

Figure 3.2



Southwest Area Delta Formation

4 COASTAL PROCESSES

4.1 Coastal Boundary

The coastal boundary of the Area comprises the extensive, flat, coastal and deltaic land of the Ganges Delta which is crossed by large tidal rivers discharging into the Bay of Bengal. The coastline is subjected to coastal processes which are :

- tides
- saline intrusion
- cyclones
- waves
- currents
- sea level rise due to global warming

As a consequence of the flat topography coastal processes have a major impact on the freshwater resources of the area. These impacts are :

(i) reversal of freshwater flows due to tidal action is experienced up to 225 km inland in the wet season and 325 km inland in the dry season as shown on Figure 4.1.

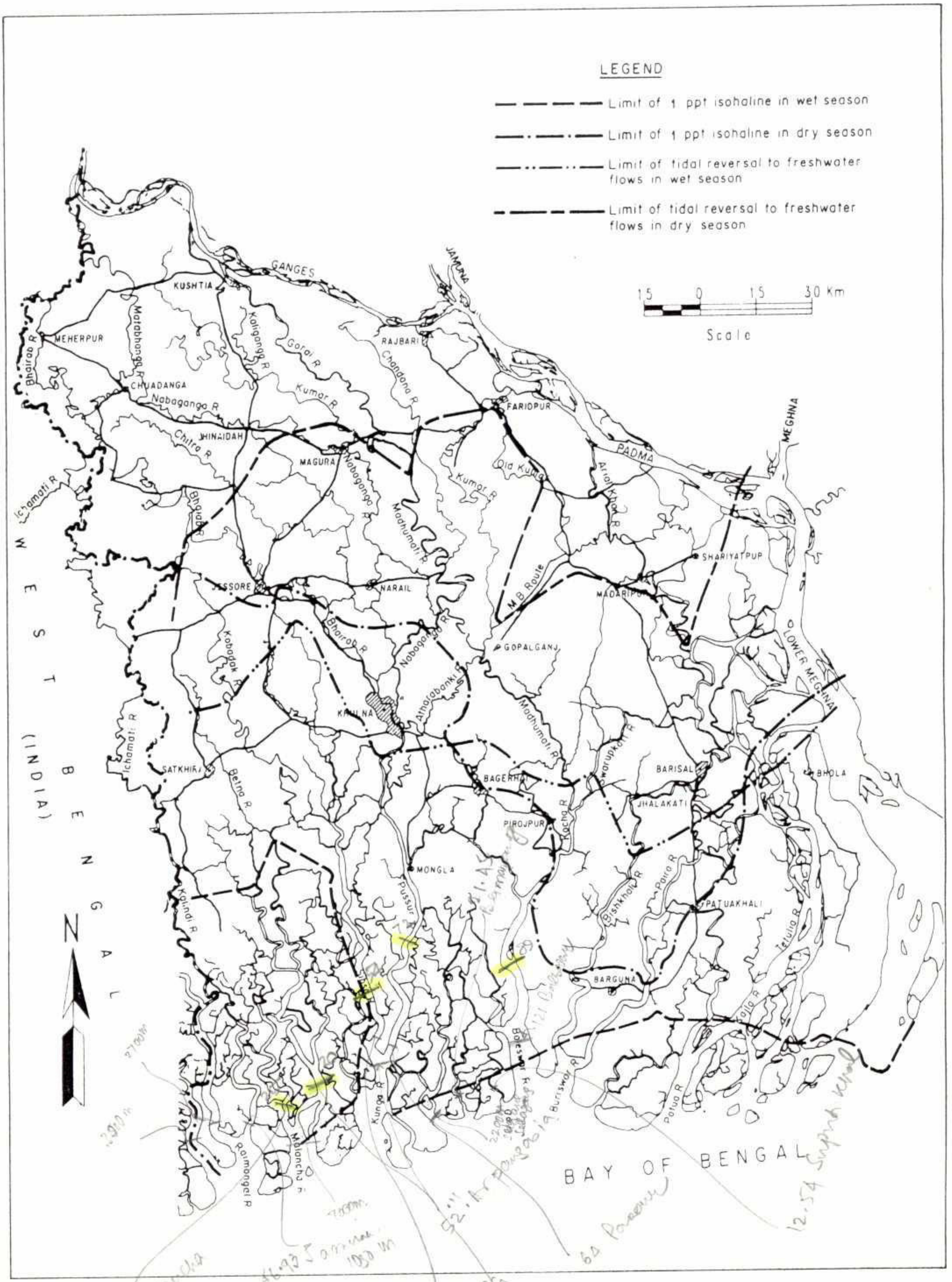
(ii) the average tidal range in the area varies from approximately 3.0 m on the coast at Hiron Point to 0.5 m 275 km inland. The time difference between high water at Hiron Point and high water at Narail is approximately 7 hours. In addition to daily tidal fluctuations there are half yearly variations in sea level of 600-800 mm in the northern part of the Bay of Bengal due to seasonal changes in salinity and atmospheric pressure.

(iii) a level of average saline intrusion likely to have an adverse effect on agriculture, 1 ppt (approximately 2000 mmhos), is experienced through 10% (4000 sq km) of the Area in the wet season and throughout 40% (16200 sq km) in the dry season as shown on Figure 4.1. In both seasons the extent of intrusion is greater in the southwest than the south central where intrusion is prevented by the fresh water flows entering the south central area from the Lower Meghna via the Arial Khan. In the southwest the 1 ppt isohaline is 75 km and 150 km inland in the wet and dry seasons respectively. In the south central the corresponding figures are 25 km and 45 km.

(iv) fine sediment and silt is transported by tidal currents into the Area. It is probable that the sediment originates from the Meghna discharge during the wet season and is carried westwards by near shore currents created by the NE monsoon in the period July to November. Course sediment and sand is carried into the Area by the freshwater rivers.

(v) cyclones originating in the Bay of Bengal can cause storm surges which have a devastating impact on the coastal region. Although the predominant passage of cyclones is to the east of the Meghna the Area coastal boundary has suffered from storm surge attack in the past. The main areas of vulnerability are the sea facing coastal embankment areas in the south-central and the lands adjacent to the main rivers. The Sundarbans forest dampens the impact of surges in the south west but surges have propagated up the main rivers. A surge value of 2.8 m above normal tide levels was recorded at Mongla in 1988. The measures required for protection against cyclones have been studied under the Cyclone Protection Project -II (FAP 7) and are not considered further in this study.

Figure 4. 1



Coastal Boundary

(vi) in addition to storm surges, storm waves impact on the coast. Sea facing coastal embankments are generally set back from the coast and waves break before reaching the embankment. However the effect of sea level rises due to surge or global warming may allow waves to propagate as far as the embankment.

(vii) currents in the coastal zone carry sediments to and from the tidal rivers and influence the shape of accretion and erosion of the coastal boundary. However, except for large scale accretion at the mouth of the Meghna, there have been no significant changes over the last two hundred years to the shape of the coastline.

(viii) sea level rise due to global warming coupled with land subsidence will cause changes to tidal, salinity and sedimentation patterns throughout the coastal boundary. Although these changes are unlikely to have a significant impact on management options during the period under study (25 years) improvements in monitoring will be required to evaluate these changes so that rational plans may be made for the long term.

4.2 Tides

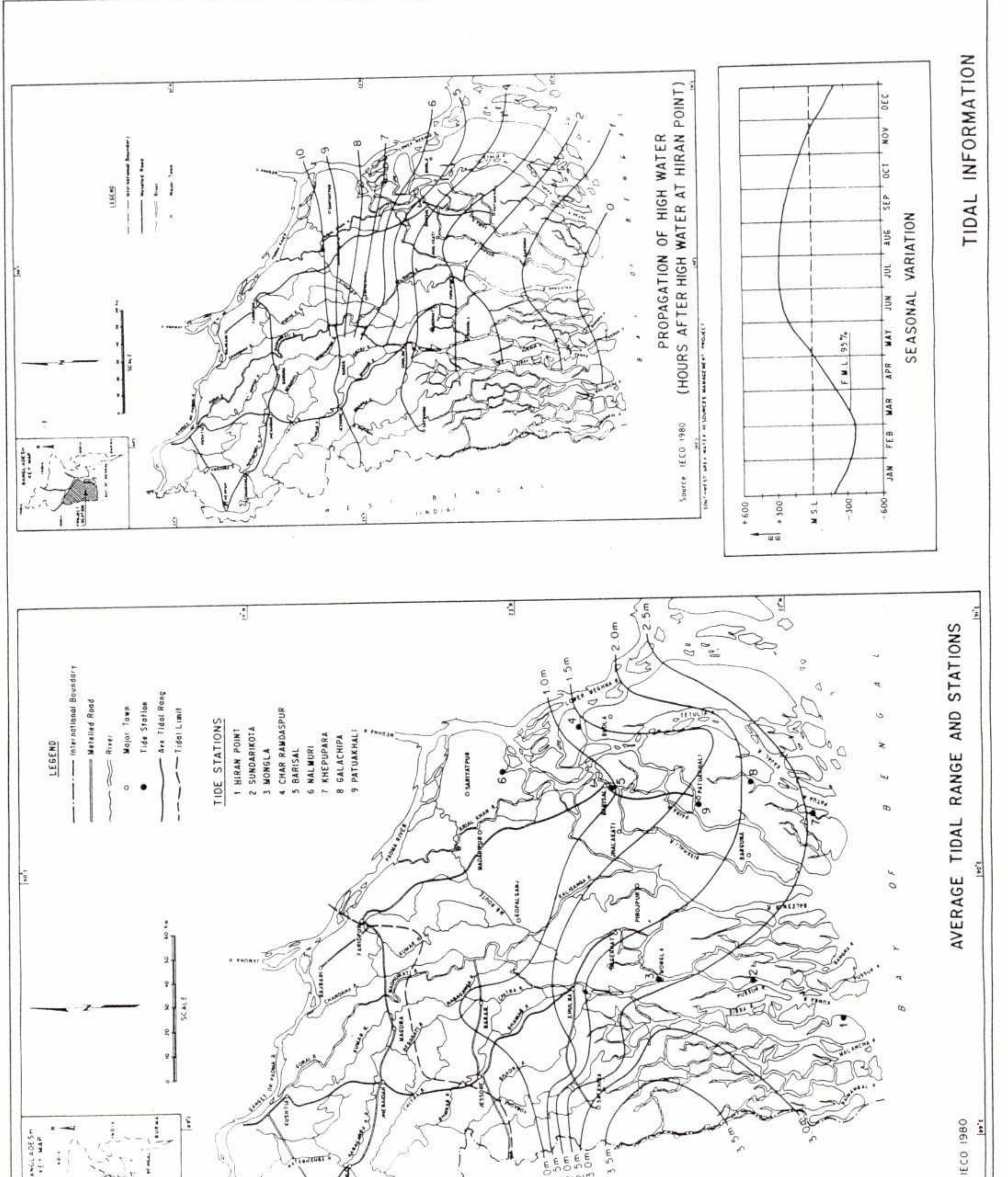
The tides in the Bay of Bengal are predominantly semi-diurnal, that is the tidal period is 12 hours 25 minutes. As shown on Figure 4.2 it takes approximately 10 hours for the tide to propagate through the study area. The predicted ranges of tides for 1992, based on the BIWTA tide tables, are shown in Table 4.1. This should be compared with the lines of average tidal range shown on Figure 4.2. It is important to note that in the inland part of the Area the difference between extreme high and low water given in Table 4.1 is much greater than the average tidal range shown on Figure 4.2. The mean water level of the rivers changes between wet and dry season thus the extreme high water is high in the wet season and extreme low water is low tide in the dry season. The critical levels for structure and drainage design should therefore be based on the figures given in Table 4.1 and not the co-tidal ranges.

As the tidal wave propagates inland it loses its symmetrical shape due to the different hydrodynamic characteristics of the rivers and cross channels so the flood and ebb tide characteristics are different. The simulated tidal conditions (D.H.I. 1992) for various locations in the Pussur - Sibsa river system are given in Tables 4.2 and 4.3. It should be noted that the increase in ebb discharge for August compared with May is due to the fresh water flows.

The overall picture in the dry season is that the system is flood dominated with peak discharges, and hence sediment transport, greater during flood than ebb. In the wet season the situation is less pronounced or reversed. Annually the dry season effects appear to exceed the wet season effects making the system a net importer of sediment but this important topic requires further verification with the aid of the sediment transport model.

The inland tidal condition is also subject to changes caused by major intervention in the river system. Simulations verified by historic measurements for Mongla (DHI 1992) show that the tidal range has increased and tidal discharge decreased following the large scale construction of polders under the Coastal Embankment Protection (CEP) scheme in the 1960s and 70s. These results are reproduced in Figure 4.3 and 4.4, but it should be noted that the results for the de-embankment condition are based on present day channel dimensions which will generally be different to those that originally existed.

Figure 4.2



Tidal Flow Information

TABLE 4.1

Tidal Levels and Tide Station Information

TIDAL LEVELS							
STATION	LAT	MLWS	MLWN	ML	MHWN	MHWS	HAT
Hiron Point	-0.256	0.225	0.905	1.700	2.495	3.175	3.656
Sundarikota	-0.553	0.036	0.636	1.829	3.022	3.694	4.211
Mongla	-0.212	0.284	0.968	1.946	2.924	3.608	4.104
Char Ramdaspur	-0.261	0.189	0.763	2.036	3.309	3.883	4.333
Barisal	+0.134	0.434	0.692	1.539	2.386	2.644	2.944
Nalmuri	+0.078	0.370	0.722	2.195	3.669	4.021	4.313
Galachipa	-0.159	0.283	0.937	1.764	2.592	3.245	3.689
Patuakhali	-0.143	0.242	0.740	1.575	2.409	2.907	3.293

STATION INFORMATION					
STATION	RIVER	LATITUDE	LONGITUDE	BENCH MARK HEIGHTS	
		NORTH	EAST	CD	PWD
Hiron Point	Pussur	21:48	89:28	3.784	
Sundari Kota	Pussur	22:07	89:36	3.369	
Mongla	Pussur	22:27	89:36	4.657	
Char Ramdaspur	Meghna	22:48	90:39	5.137	
Barisal	Barisal	22:41	90:22	3.365	2.946
Nalmuri	Meghna	23:06	90:26	4.186	3.962
Galachipa	Lohalia	22:10	90:24	5.119	4.404
Patuakhali	Laukati	22:22	90:19	3.785	2.889

LAT = Lowest Astronomical Tide
HAT = Highest Astronomical Tide
PWD = Public Works Datum
CD = Chart Datum
MLWS = Mean Low Water Spring
MHWS = Mean High Water Spring
MHWN = Mean High Water Neap
MLWN = Mean Low Water Neap
ML = Mean Level

Source: Bangladesh Tide Tables 1992 BIWTA.

TABLE 4.2

Hydrodynamic Simulation
Present Conditions Spring and Neap Tide, May 1990

Date : 11th May 1990 Tide : Spring

River	Location	Rising Tide (Flood Current)		Falling Tide (Ebb Current)		Water Level Range (m)
		Peak velocity (m/s)	Peak Discharge (m^3/s)	Peak velocity (m/s)	Peak Discharge (m^3/s)	
Sibsa	Easy Point	1.007	30347	0.964	26555	2.78
Pussur	Sundarikota	0.919	17485	0.959	15592	2.54
Mongla M.	Mongla	0.864	2244	0.696	1516	2.86
Pussur	Mongla	0.920	5956	0.860	5253	2.93
Chunkuri	--	0.597	1093	0.555	626	3.07
Old Pussur	--	0.976	2035	0.619	1447	3.09
Jhapjhapia	--	1.030	1349	1.290	1150	3.05
Kazibacha	--	0.574	2691	0.627	2250	2.86
Solmari	--	0.457	668	0.756	719	2.87
Sibsa	Malianala	1.424	18651	1.223	14984	3.32

Date : 17th May 1990 Tide : Neap

River	Location	Rising Tide (Flood Current)			Falling Tide (Ebb Current)		Water Level Range (m)
		Peak velocity (m/s)	Peak Discharge (m^3/s)	Total Volume (10^6 m^3)	Peak velocity (m/s)	Peak Discharge (m^3/s)	
Sibsa	Easy Point	0.795	23782	353.33	0.697	19362	2.00
Pussur	Sundarikota	0.749	13973	213.14	0.696	11423	1.82
Mongla M.	Mongla	0.716	1811	28.78	0.567	1197	2.38
Pussur	Mongla	0.770	4903	72.27	0.653	3830	2.42
Chunkuri	--	0.605	931	14.55	0.445	490	2.60
Old Pussur	--	0.742	1589	21.66	0.520	1147	2.62
Jhapjhapia	--	0.924	1196	19.47	0.964	883	2.60
Kazibacha	--	0.564	2489	37.78	0.458	1618	2.51
Solmari	--	0.504	665	11.20	0.571	549	2.52
Sibsa	Malianala	1.095	14577	216.34	0.913	11035	2.52

Source: DHI 1992

TABLE 4.3

Hydrodynamic Simulation
Present Conditions Spring and Neap Tide, August 1990

Date : 21st August 1990 Tide : Spring

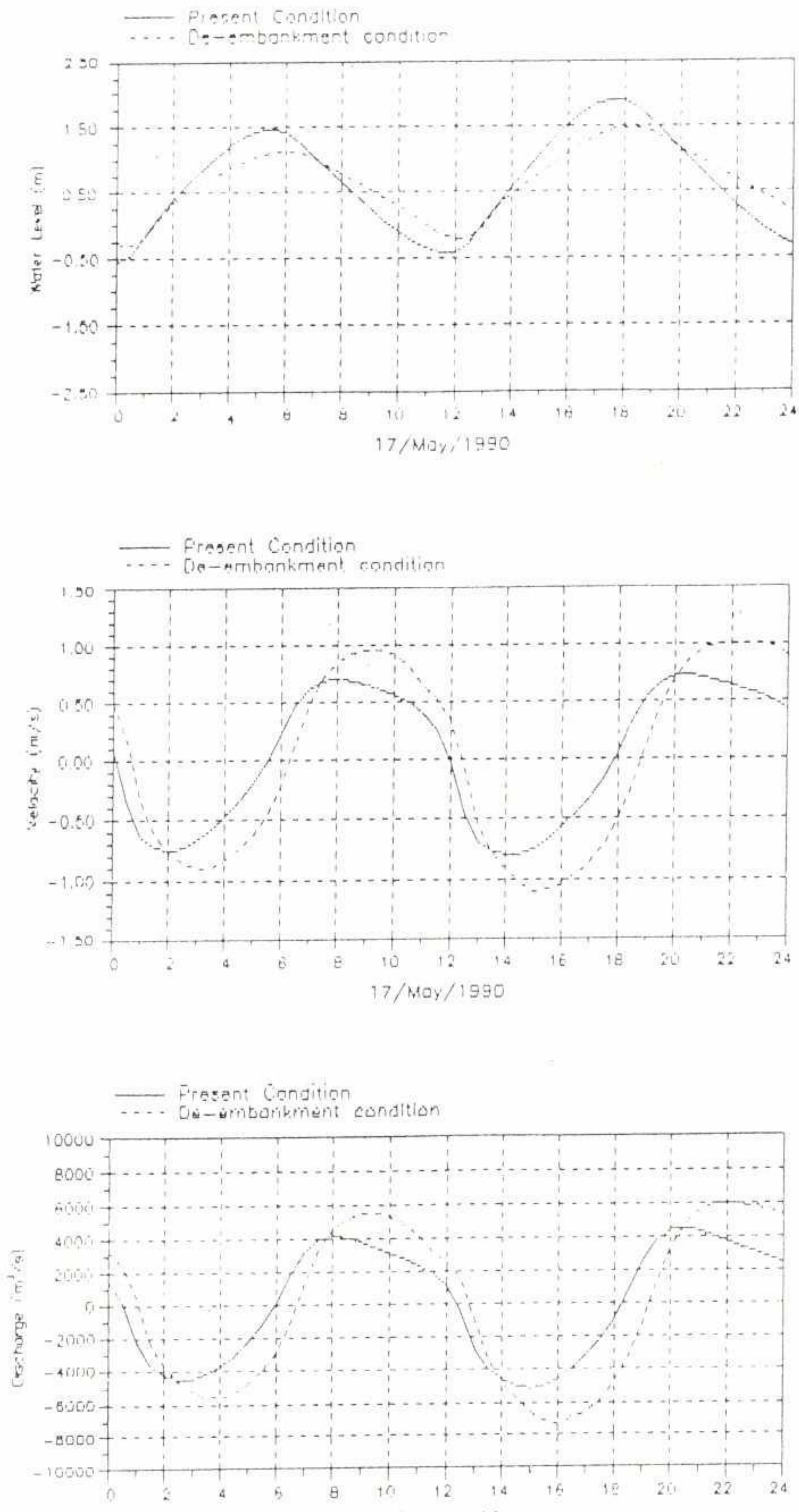
River	Location	Rising Tide (Flood Current)		Falling Tide (Ebb Current)		Water Level Range (m)
		Peak velocity (m/s)	Peak Discharge (m^3/s)	Peak velocity (m/s)	Peak Discharge (m^3/s)	
Sibsa	Easy Point	1.045	33023	1.134	32987	2.77
Pussur	Sundarikota	0.880	17954	1.026	18260	2.60
Mongla M.	Mongla	0.935	2765	0.765	1821	2.93
Pussur	Mongla	0.864	6226	1.073	7460	3.00
Chunkuri	--	0.502	838	0.756	999	3.04
Old Pussur	--	1.021	2496	0.651	1686	3.05
Jhapjhapia	--	0.382	580	1.517	1592	2.89
Kazibacha	--	0.067	355	0.960	4095	2.55
Solmari	--	0.008	15	0.975	1092	2.54
Sibsa	Malianala	1.520	21552	1.451	20260	3.36

Date : 30th August 1990 Tide : Neap

River	Location	Rising Tide (Flood Current)		Falling Tide (Ebb Current)		Water Level Range (m)
		Peak velocity (m/s)	Peak Discharge (m^3/s)	Peak velocity (m/s)	Peak Discharge (m^3/s)	
Sibsa	Easy Point	0.354	10440	0.545	15943	1.28
Pussur	Sundarikota	0.279	5104	0.561	10123	1.25
Mongla M.	Mongla	0.356	922	0.451	1006	1.62
Pussur	Mongla	0.204	1285	0.642	4143	1.66
Chunkuri	--	0.089	132	0.543	704	1.75
Old Pussur	--	0.341	784	0.411	987	1.77
Jhapjhapia	--	--	--	1.025	1116	1.70
Kazibacha	--	--	--	0.727	2946	1.54
Solmari	--	--	--	0.725	823	1.53
Sibsa	Malianala	0.475	6224	0.752	9898	1.75

Source: DHI 1992

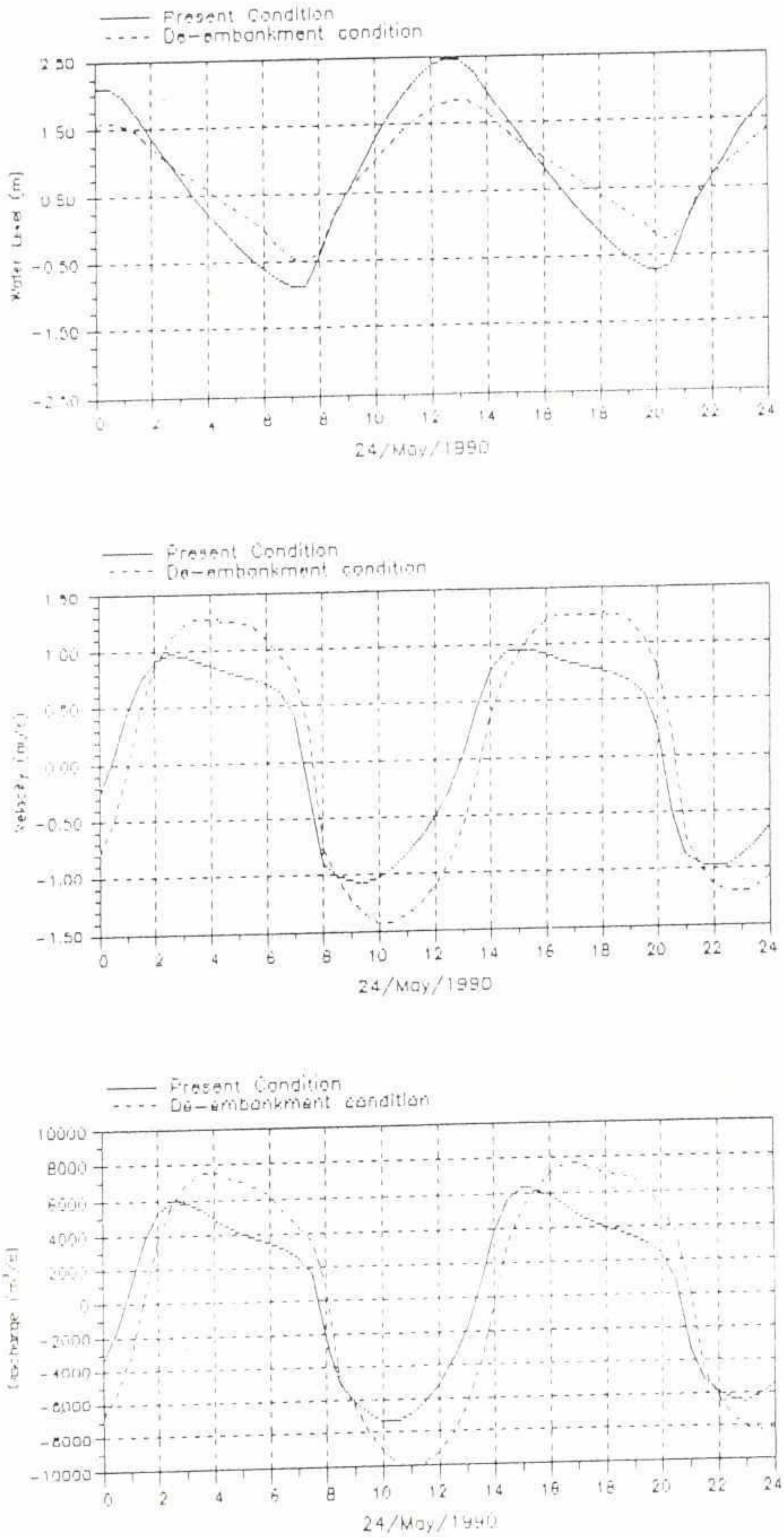
Figure 4.3



Source : DHI 1992

Comparison of Tidal Range, Velocities and Discharges
Neap Tide at Mongla

Figure 4.4



Source : DHI 1992

Comparison of Tidal Range, Velocities and Discharges
Spring Tide at Mongla

4.3 Tidal Characteristics of Rivers

The tidal wave propagates into the Area along the major tidal rivers. The speed of propagation in the rivers varies due to their different cross sectional area and in consequence water levels in adjacent rivers can differ. This results in flow from one river to another through the cross channels and rivers (cross rivers are particularly prevalent in the southwest). Where the tidal wave from one river meets the wave from another river there are tidal meeting points which are characterized by periods of low or stagnant flow and consequential siltation. Where there are no tidal meeting points the tidal flow is continuous and the conditions for siltation are less severe.

Notwithstanding the effect of cross channel flows the tidal wave propagates to the upstream limits discussed in Section 4.2 where tidal movement ceases and siltation is likely to occur. Unless freshwater flows are present at this upstream boundary siltation will continue until the estuary reaches equilibrium. Where fresh water flows exist the channel will tend to be flushed clear during the ebb tide but the success in clearing or sustaining the channel will depend on the relationship between the ebb discharge, freshwater plus tidal volume, and the channel cross section. Empirical regime relationships exist which relate the peak ebb discharge to the corresponding stable channel cross section at mean water level.

Following construction of the Coastal Embankment Project, the volume of tidal over-spill was greatly reduced with the result that the tidal ebb discharge became insufficient to sustain the pre polder channel cross section and siltation occurred. This situation has not occurred to such a large extent where freshwater flows or tidal circulation patterns are dominant.

Based on field observations in combination with the one dimensional hydrodynamic model it has been possible to determine the location of tidal meeting points and near stagnant flow. These are shown on Figure 4.5. The model results also provide peak ebb discharges and channel cross sections throughout the river system which may be used in the appropriate empirical regime relationship to assess whether or not the channel is stable, accreting or eroding. The results of this regime analysis are also shown on Figure 4.5 and are discussed in greater detail in Section 5.

The manner in which the tidal wave propagates through the major rivers is as follows:

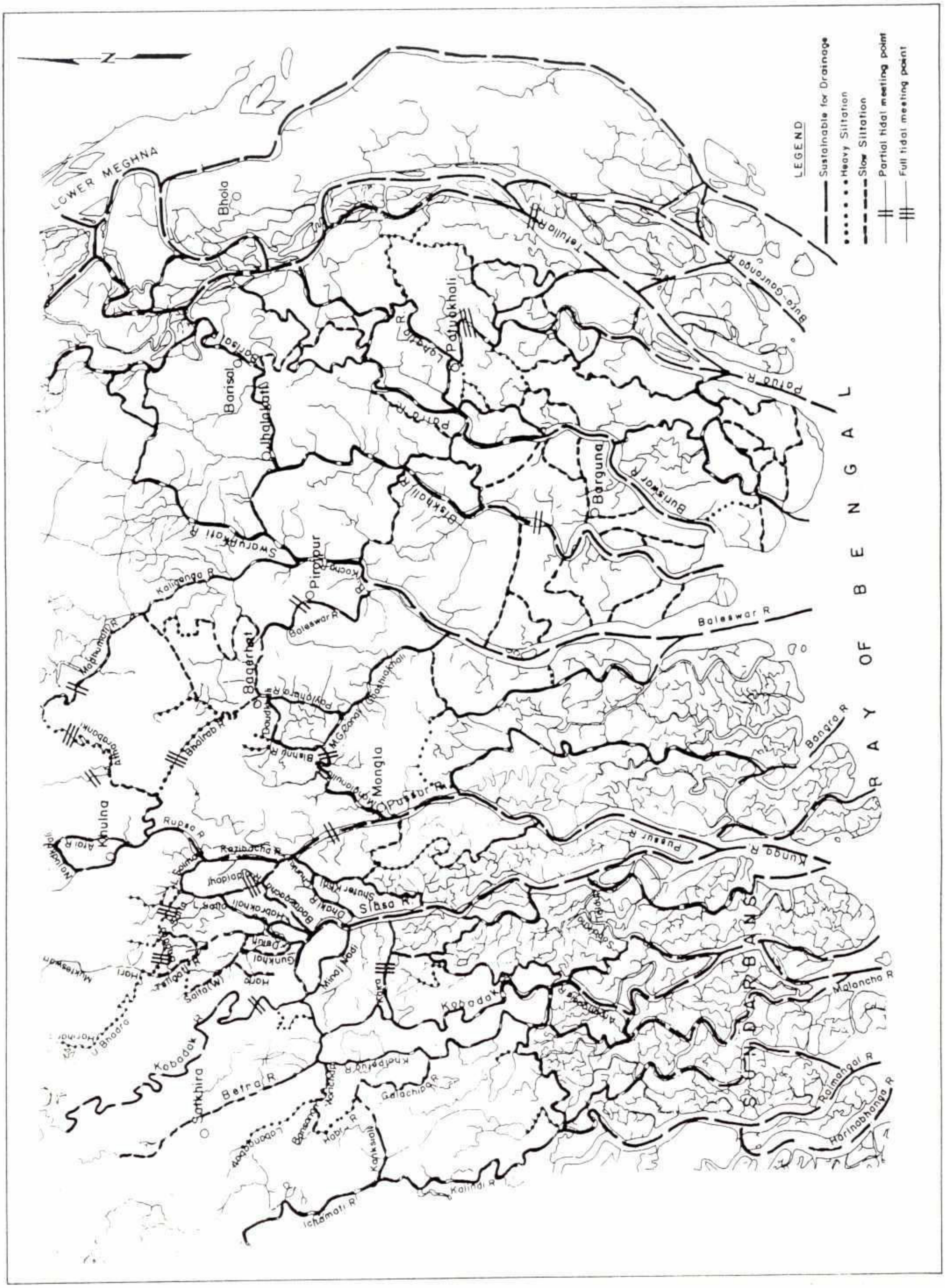
(i) Kobadak-Sibsa

The Malancha/Kobadak and Sibsa have the same tidal phase. These two rivers are exchanging flow through Koira, Minajnadi and Haria (upper stretch of Sibsa). Tide meeting is occurring in Koira and Haria and causing siltation to these channels. The tidal flow in the upper Kobadak is both the action of Sibsa via Minajnadi and L.Kobadak rivers. This phenomenon indicates that the Minajnadi is free from tide meeting. The Minajnadi is under the process of siltation which is the consequence of the deterioration in the U.Kobadak. The flood tide pushes the flow from Kobadak to Sibsa through Koira and reverses at the beginning of ebb tide. In the dry period, both for ebb and flood condition, the tidal meeting is for longer duration in the Koira river. Another linkage between Kobadak and Sibsa is the Sonakhal-Taldup river. Through this river,the flood movement is toward Sibsa and ebb direction towards Kobadak. This linkage is morphologically stable and sound.

(ii) Pussur-Sibsa

The Sibsa has earlier tide than the Pussur. The flow from Sibsa, at its upstream end, is diverted firstly toward Gengrail and later to L.Bhadra during flood tide. The

Figure 4.5



Tidal River Characteristics-Present Situation wide corridor of Gengrail allows the main sediment flux to move upward and create siltation in the upper reaches of its system. In the dry season, the flow in L.Bhadra combines with the flow from Kazibacha.

The Sibsa is linked with the Pussur through the Badurgacha, Dhaki-Chunkuri and Shuterkhali-Chunkuri rivers.

As the Sibsa has earlier tide, more prominent during wet season, the flow from Shuterkhali, Badurgacha together with the upland fresh flow create a "Flow Stagnation Zone" in the upper reach of Pussur. In the dry neap tidal period the Pussur at its upper reach has dampening in flow due to interchange of tide with its connecting channels. This phenomenon is causing siltation in the Pussur but the extent is not significant. All the connecting channels have south-west to north-east alignment which make them less prone to siltation and therefore these rivers such as the L.Bhadra and L.Solmari are relatively dynamic and stable.

(iii) Pussur-Baleswar

The exchange of flow between these rivers is mainly through the Monglanulla-M.G.Canal-Gashiakhali connection.

For a short while, during flood tide, the flow is from Baleswar to Pussur river. But the ebb tide drops much earlier in Baleswar which initiates flow from Pussur to this river. The net flow is toward Baleswar. The flow from Pussur and Baleswar through the connecting channel enters the loop of Poylahara, Bishnu and Daudkhali rivers and finally moves into the upper reaches of Poylahara where it fades and causes silting to this channel. The siltation is gradually propagating downward. It is important to note that the flow in the Poylahara is mainly dominated by the flow from Baleswar river.

(iv) Central region

The rivers in the central region are very active. Cross flow between the rivers is, however, small. The flow is mainly governed by the substantial fresh water flow originating from the Lower Meghna and tidal flow from downstream. The small internal channels are tending to silt up. Any change in the upstream conditions will drastically change the morphology of this area.

4.4 Salinity

4.4.1 Salinity Conditions in the Bay of Bengal

During monsoon large quantities of fresh water flows into the Bay, mainly through the Lower Meghna, rendering the water in the northern part of the Bay more or less brackish. Records on resulting salinity concentrations are available at a number of stations along the coast, but not much data are available on the salinities in the Bay. Two sets of salinity measurements in the Meghna estuary (the NE part of the Bay), one from the end of the dry season and one from the end of the wet season, by the Land Reclamation Project, are available, (see Figures 5.1.1 through to 5.1.4 in Volume 2). After the wet season, water is fresh (salinity below 1 ppt) out to at least the 20m contour of the Meghna estuary. Both in dry and wet season salinity is well mixed over the depth by the tidal movement and stratification is present.

In order to describe salinity over a larger part of the Bay, a simulation on salinity was performed using a two dimensional hydrodynamic model of the Bay. In this, typical discharges of fresh water from the rivers (as obtained from the one dimensional hydrodynamic modelling of the river System) was introduced in the Bay having a constant salinity of 33 ppt, and the resulting distribution of salinity was calculated taking into account dispersion and advection by the outflow and tidal movement derived from the hydrodynamic calculations of the model.

The calculations show that the salinity never reaches a steady state: during dry season the "plume" of fresh water decreases, but does not reach the level it would have reached if dry season flows continued for a longer time. Similarly, the distribution in wet season never reaches the state that would be reached if wet season flows persisted for a longer time. This means that the salinities in the Bay are governed by the total outflow of fresh water during wet and dry seasons, and not so much on the variation of outflows during each season. It also means that a change of total outflow into the Bay during a wet season will affect salinities during the following dry season and even the salinities in the following wet season.

4.4.2 Salinity Intrusion

Isohalines of simulated salinities for dry and wet seasons (April and August 1991) are presented in Figures 4.6 and 4.7 respectively. The general pattern of simulated salinity intrusion in the study area matches well with reported measurements. It should be noted that the salinities simulated by the SWAM model at the south east corner of the South Central Region in the Meghna estuary are not representative. This is due to the fact that the more saline estuaries of Meghna on the eastern side (eg. Hatia, and Sandwip channels) are not included in the model. The salinities in the Tentulia, the Lower Meghna and its distributaries are affected by circulation of more saline waters from the eastern part of the Meghna estuary. The isohalines in Figure 4.6 in this area have been drawn correlating the simulated results of GM-SALT [see Volume 2]. The low salinities in the South Central Region are clearly due to the large freshwater supplies from the Padma and the Lower Meghna rivers through the Arial Khan system in the northern part and through the numerous distributaries in the eastern part of the region.

High salinities in the southwest corner and along the Pussur-Sibsa system of the area are associated with the decreasing upstream freshwater flow as well as silting of the major channels. It is clear that any measure to be taken to alleviate the salinity problem in this area should consider augmenting the freshwater inflow during the dry season to the upper reaches of the Pussur-Sibsa system, specifically increasing the flow significantly near Khulna. Further details on salinity intrusion in the South west Region and the impacts of low flow augmentations are presented in Section 7 of Volume 3.

4.4.3 Historical Changes in Salinity Intrusion

Comparison of 1966 and 1991 isohaline for April shows that the 1 ppt boundary has moved northwards approximately 20 km in the Khulna Region. Modelling results discussed in Volume 3 show that augmentation of the present April Gorai flow by 100 cumec would be sufficient to return Khulna salinity to the 1966 levels. In the area to the east of Bagerhat the 1 ppt isohaline has moved eastwards probably as a consequence of dredging the M.G. canal connection in 1970. This cut provides a pathway for salt to migrate from the Pussur to Baleswar with potentially adverse effects on the fresh water dominated South Central Region.

4.5 Cyclones

Inundation of otherwise dry land is one of the damages caused by cyclone surges. The surge progresses as a tidal bore with high translational water velocities. A knowledge of the extent that the surge progresses into the Region is needed so that embankment design crest levels can be determined. The effect of the surge is very dependant on whether the cyclone occurrence coincides with low or high tide and damage is relatively greater for the autumn cyclones as these occur when the general water level in the Bay of Bengal is high (see Section 4.2).

There are few reliable measurements of cyclonic surges. Frequently the severity of the event prevents measurements or destroys the instruments.

The different cyclone tracks in the Bay of Bengal have been studied by FAP-7. The most severe cyclone for the Southwest Area, for which water level data along the coast line exists, was the one occurred in November 1988. The cyclone, which was classified as a severe cyclonic storm with a core of hurricane wind hit the coast around the Malancha river and resulted in large wind speeds and surges along the whole coast of the Southwest Area. Measurements of surge heights at Hiron Point and Mongla are shown on Figure 4.8.

This Cyclone was modelled by the two dimensional Bay of Bengal model as a part of the Cyclone Protection Project II (FAP-7). However, when comparing the simulated results with the measurements they appear to over estimate the height as well as the duration of the surge wave. This can be due to the initial estimate of the physical extension of the low pressure in the Bay. Water levels were recorded at Hiron Point and Mongla in the Southwest Region and at Ramdaspur and Patuakhali in the South Central Region as well as at Khal No. 10 in Chittagong. Measurements along the major parts of the coastline are non-existent. The model results of FAP-7 has been used to interpolate the measurements along the coast and thereby create boundaries for the SWAM model.

The cyclone surge has been over layered with the normal tide at the appropriate time and has been simulated by the SWAM model using the above boundary conditions at a time step of five minutes. The normal tidal water levels in the area have been deducted from the water levels generated by the Cyclone and the maximum differences, which describe the impact of the cyclonic surge, are shown in Figure 4.9.

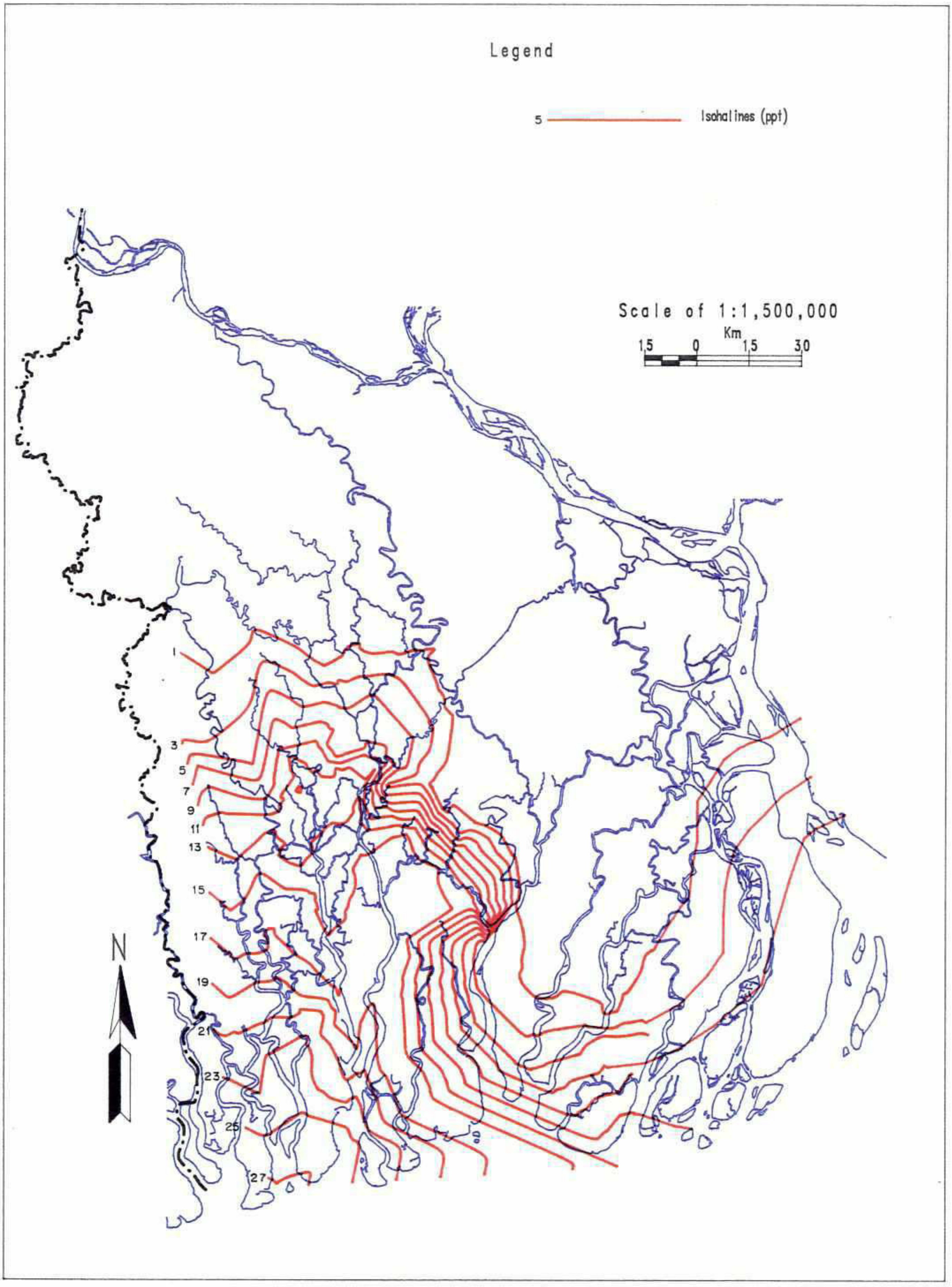
The results show limited attenuation of the surge through the lower part of the Southwest Area. eg. the maximum water level at Mongla is nearly the same as at Hiron Point which is consistent with the measurement. In the Meghna, however attenuation of the wave takes place.

Although these model results should be treated with caution they do represent the best available estimate of the impact of a major cyclone. The 1988 cyclone occurred at low tide but had it occurred at high tide the impact would have been much more severe. Typical design practice for embankments in the tidal zone is for the crest level to be at mean annual maximum water level (which excludes cyclonic surges) plus a free board of 0.9m. If the 1988 cyclone had coincided with a still water level equal to the mean annual maximum, Figure 4.9 indicates that the main poldered areas at risk would have been Satkhira, Bagerhat and the South Central area south of Barisal.

4.6 Waves

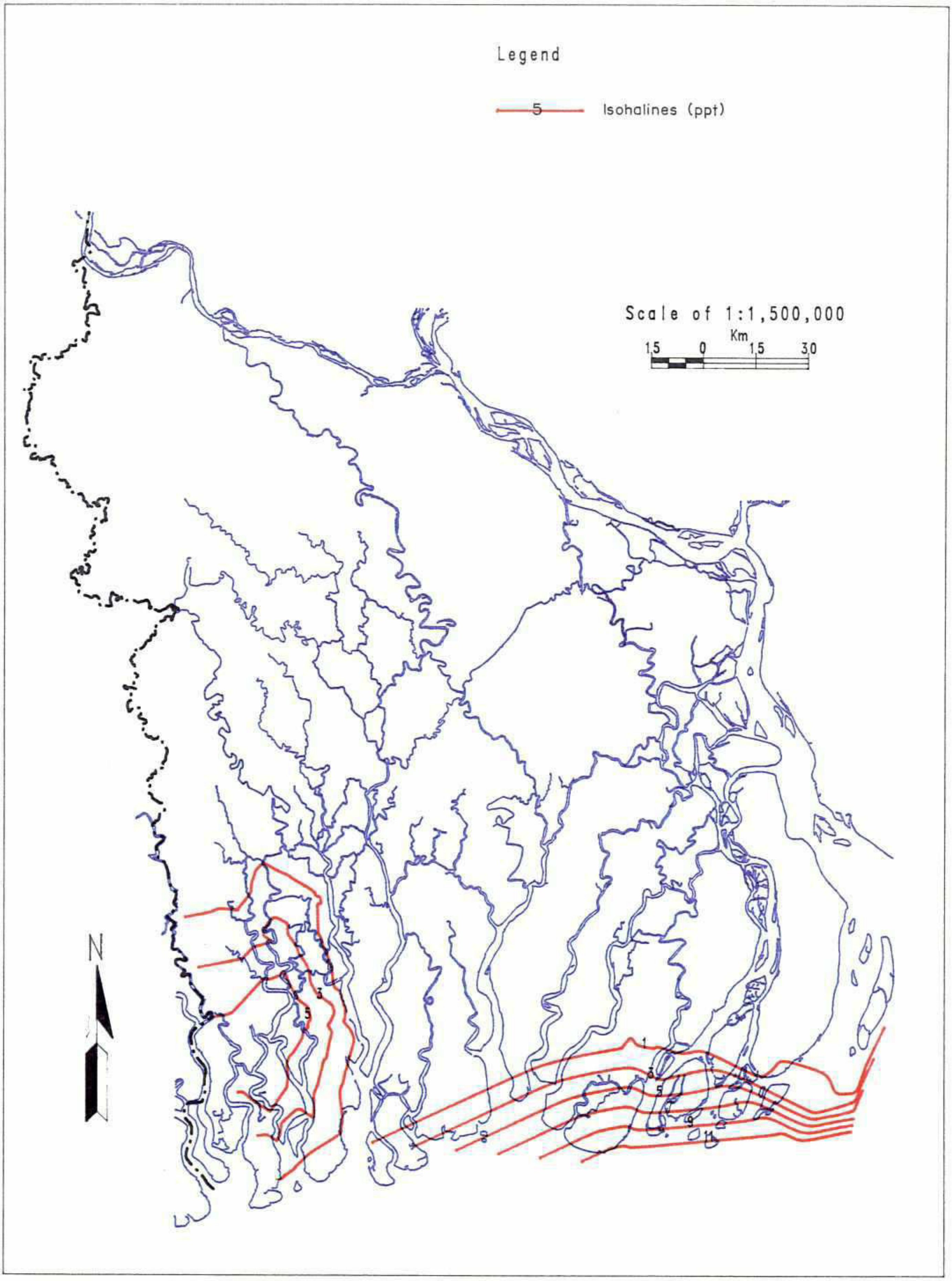
The embankments facing the open sea are exposed to storm waves in addition to extreme water levels. In the absence of long term measured records the FAP-7 study has derived wave heights for offshore and near shore conditions. The offshore waves are generated by travelling depressions and storms in the Bay of Bengal and the near shore waves are the result of offshore waves shoaling and breaking as they approach the shore over a 1:200 sea bed slope. The latter can only be approximate as they vary from location to location due to the effects of wave refraction. The results of the study are shown in the following Tables:

Figure 4.6



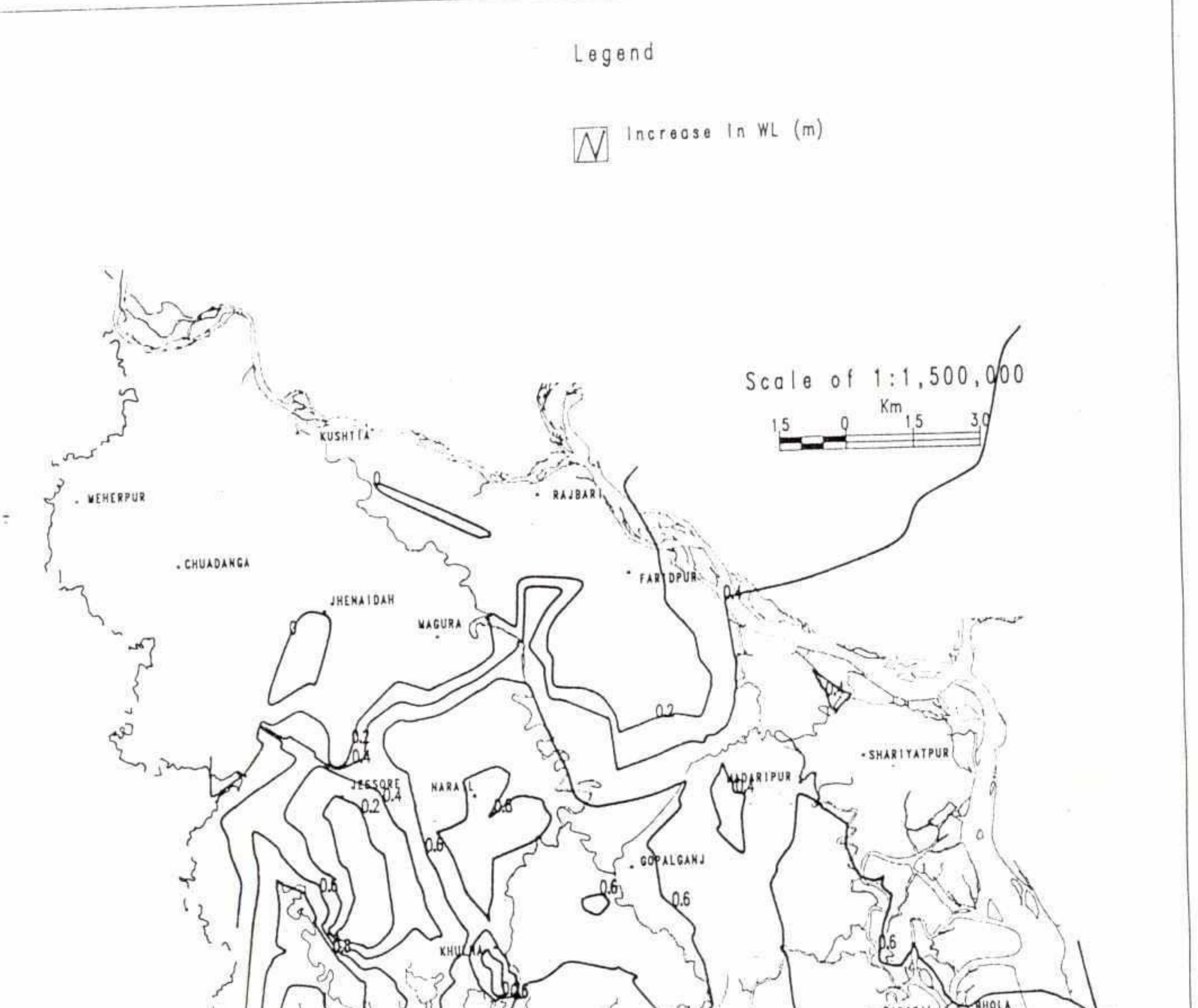
Simulated Dry Season Salinity (ppt)

Figure 4.7



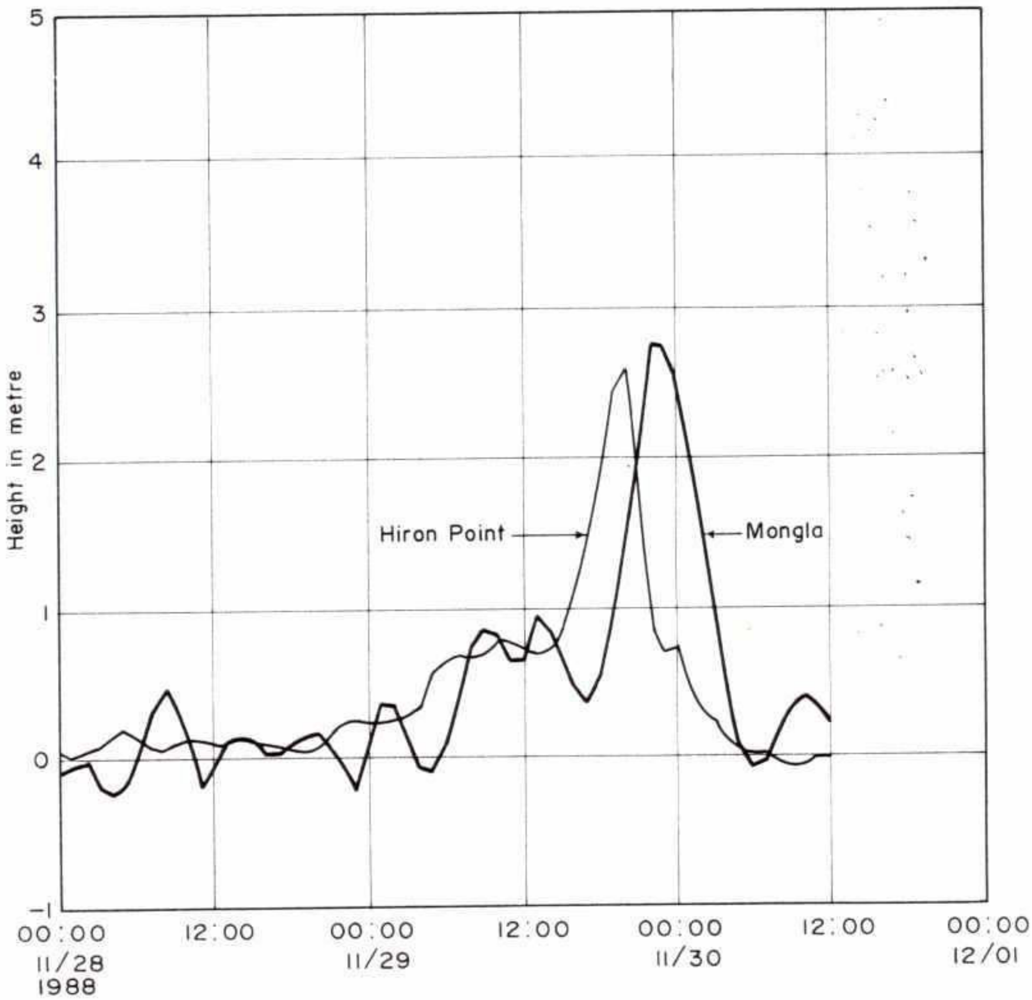
Simulated Wet Season Salinity(ppt)

Figure 4.8



Impact of Cyclone of November 1988

Figure 4.9



Plot of Surge Height for 1988 Cyclone

TABLE 4.4

Offshore Significant Wave Heights and Periods

Return Period (Years)	2.5	5	10	20	50	100
Offshore Significant Wave Height (m)	6.9	7.6	8.2	8.8	9.6	10.2
Offshore Significant Wave Period (s)	11.1	11.7	12.2	12.5	13.1	13.6

TABLE 4.5

Approximate Nearshore Significant Wave Heights and Periods

Water Depth (m)	1.0	2.0	3.0	4.0	5.0	6.0
Nearshore Significant Wave Height (m)	0.8	1.50	2.10	2.70	3.3	3.6
Nearshore Significant Wave Period (s)	7	8	8.5	9	9	9

4.7 Currents

Currents in the northern part of the Bay of Bengal comprise ocean currents which vary seasonally and tidal currents which vary daily.

The ocean currents are largely generated by the monsoons. During the period January to March the ocean currents are generated by the SW monsoon and flow clockwise with the near shore current running eastwards at approximately 0.25 knots. During the period July to November the currents are generated by the NE monsoon and flow anticlockwise with the nearshore currents running westwards at 0.50 to 0.75 knots. This is also the period when sediment discharge from the Meghna is greatest. It is likely that this current carries material from the Meghna to the entrances of the tidal rivers to the west. The south-westerly direction of sedimentation on the island of Bhola would support this concept.

Tidal currents off the mouth of the Pussur River are predominantly north south. The values quoted on Admiralty Chart No. 859 for a point 36 km south of Hiron Point, are given in Table 4.6.

TABLE 4.6

Tidal Streams 36 km South of Hiron Point

Time relative to high water at Chittagong (hours)	Direction of current (degree N.)	Current (knots)	
		Spring Tide	Neap Tide
-6	343	1.5	0.6
-5	349	1.6	0.6
-4	359	1.5	0.6
-3	015	0.8	0.3
-2	102	0.5	0.2
-1	143	1.2	0.5
0	158	1.8	0.7
1	172	1.9	0.7
2	174	1.6	0.6
3	175	1.0	0.4
4	280	0.1	0.0
5	334	1.0	0.4
6	341	1.4	0.5

4.8 Sea Level Changes

4.8.1 Seasonal Sea Level Changes

In addition to tidal effects there are seasonal changes in water level in the northern part of the Bay of Bengal due to the onset of the monsoon wind field and changes in salinity due to increased fresh water flows. This results is a 600 mm increase in sea level from March to July as shown on Figure 4.2.

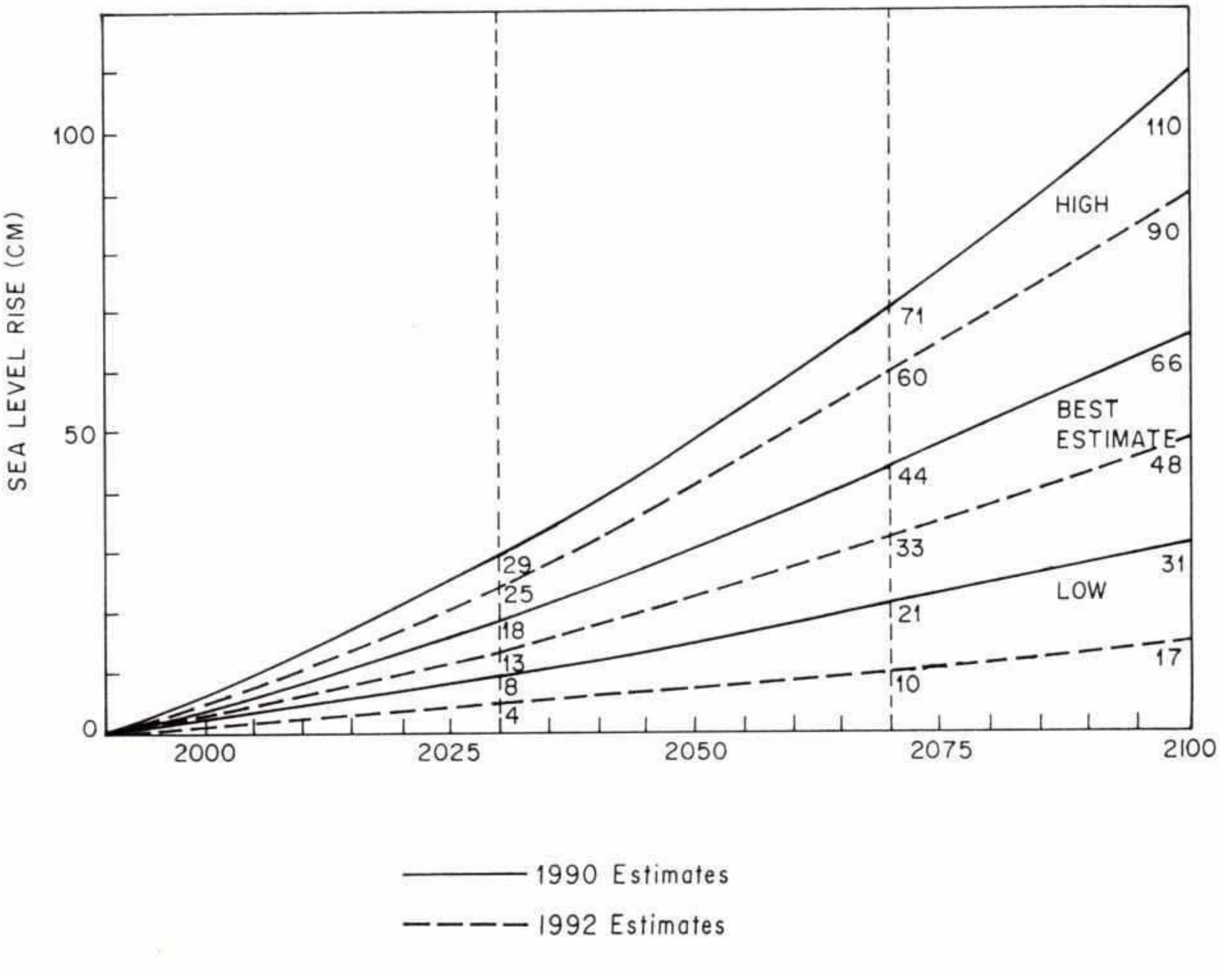
4.8.2 Long Term Sea Level Changes

The most authoritative reference on long term climate change is the final report of the Intergovernmental Panel on Climate Change which is sponsored jointly by the World Meteorological Organisation and the United Nations Environment Programme.

The report (IPCC 1990) includes an estimate of sea level rise based on "Business-as-Usual" which is reproduced in Figure 4.10. The figures given are global mean sea level rises. The local values may differ from the average. Although the figures are based on "Business-as-Usual" the imposition of stricter control over future green house gas concentrations will have little effect for 50 - 100 years. Sea level rise in the near future is largely a consequence of past conditions because of the lag effects introduced by the thermal inertia of the oceans.

An update of the report of the Intergovernmental Panel on Climate Change (IPCC), May 1992, includes a new set of greenhouse gas emissions scenarios. Changes in temperature and sea level are predicted to be less severe than those estimated previously by IPCC in 1990, but are still far beyond the limits of natural variability. The reason for this is that new factors have been included such as: the cooling effect due to sulphate aerosols; the potential cooling effect of ozone depletion; and uptake of carbon dioxide by the biosphere as carbon dioxide concentration levels increase, which leads to a lowering of predicted atmospheric concentration levels. The effect of these changes is also shown on Figure 4.9. It should be noted that the local values may differ from the average. Although these new rates are less than the predictions made by IPCC in 1990 the changes are still far greater than anything experienced over the last 5,000 years.

Figure 4.10



Source : Intergovernment Panel on Climate Change (IPCC)

Global Sea-level Rise, 1990—2100 for Policy Scenario Business as Usual (BAU)

4.8.3 Impact of Future Sea Level Rise

The Area will be affected by the combined impact of future sea level rises and land settlement. As discussed earlier the rate of settlement indicated in the Khulna area is between 1mm and 5m annually with rates of between 0.75mm and 1.4mm annually in the Sundarbans. The combined effects of sea-level rise (1992 values) and land subsidence (at Khulna) are given in Table 4.7.

TABLE 4.7

Values of Sea Level Rise and Land Subsidence

Year	2050			2100		
Estimate	High	Best	Low	High	Best	Low
Absolute Sea Level Rise (cm)	43	23	7	90	48	17
Subsidence (cm)	29	17	6	54	32	11
Relative Sea Level (cm)	72	40	13	144	80	28

In addition to the expected increased flooding, the trends in salinity intrusion need to be determined. A simplified simulation of the sea level rise scenario has been carried out for preliminary impact analysis. A general increase in the sea level of 35 cm has been assumed and incorporated in the coastal water level boundaries. The present channel geometry as represented in the SWAM model has been used for this case also.

The impact of the assumed sea level rise on flooding has been assessed by simulating the increased flooding during the peak flood time of August - September. Also, since a major part of the study area is tide affected, the increased flooding due to high tide under the sea level rise scenario is assessed during the dry season, ie. the month of April.

The extent of the impact of sea level rise in the study area as a whole is presented in Figures 4.11 and 4.12, which show the contours of increase in water level in April and August, respectively. During the dry season, the impact on high water level is seen to extend far upstream along the Gorai - Madhumati river as well as in the South Central Region. More than two thirds of the area will experience a 30 cm increase in water level during a high tide if the sea level will rise by 35 cm. The impact during the flood time is less extensive as can be seen in Figure 4.12.

Isohalines of maximum salinity simulated at the end of April 1991 are presented in Figure 4.13 for both the existing condition and the sea level rise scenario. The same salinity boundary conditions at the sea have been assumed for both the simulations. The only significant effect as seen from the simulations is an increase in salinity by 1 ppt north of Khulna near Mollahat. Hence, it can be concluded that the assumed sea level rise will move the saline front only marginally.

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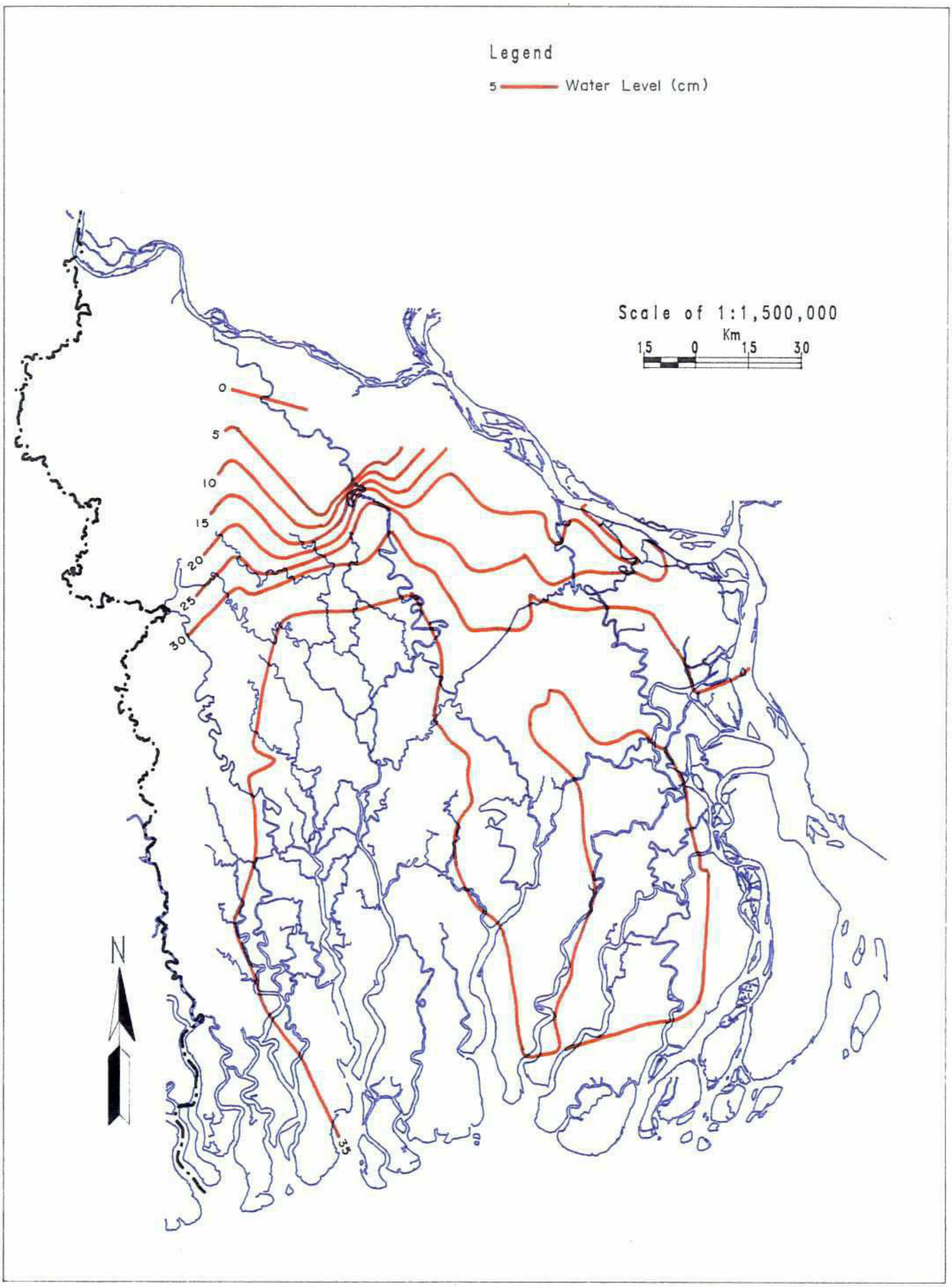
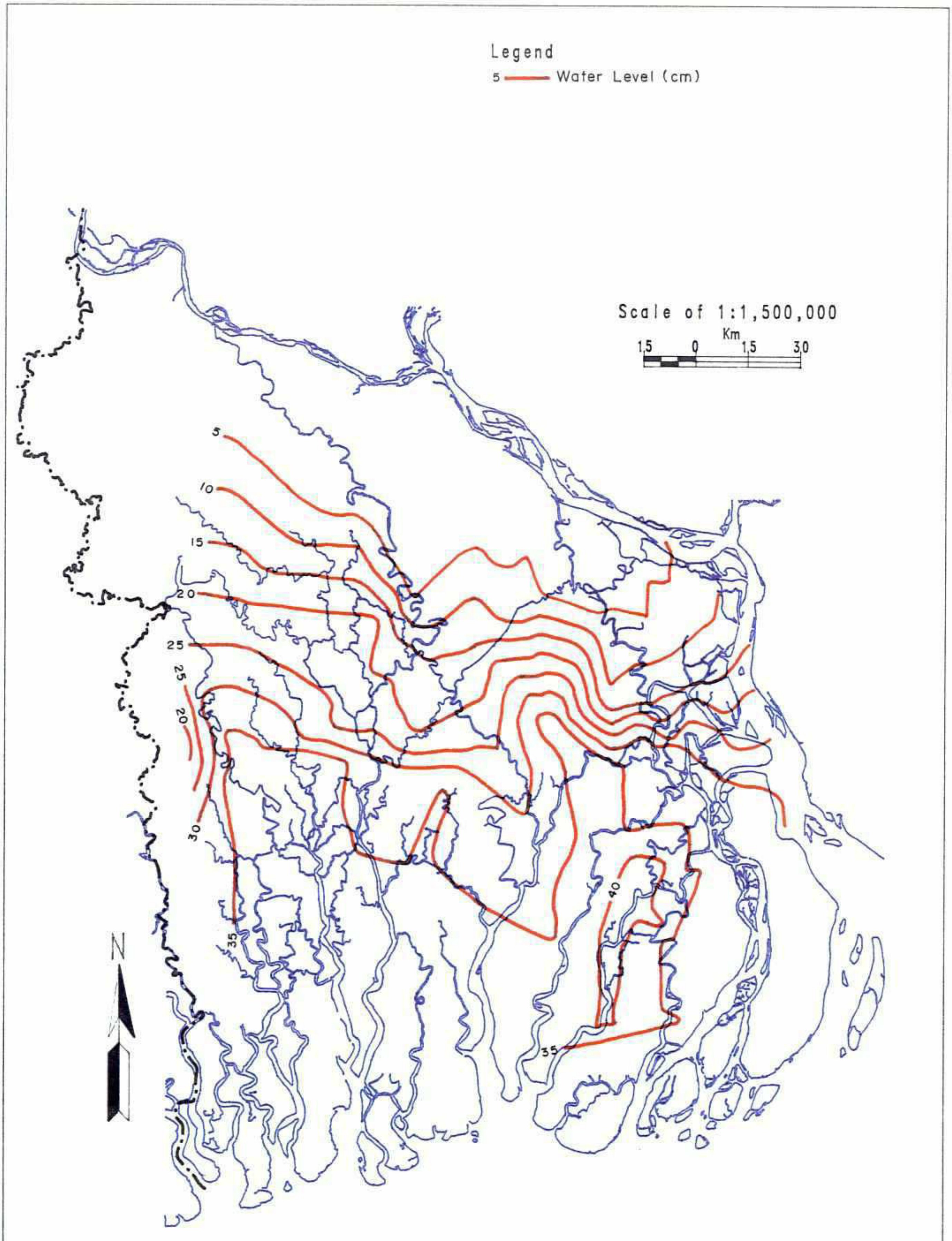
Figure 4.11



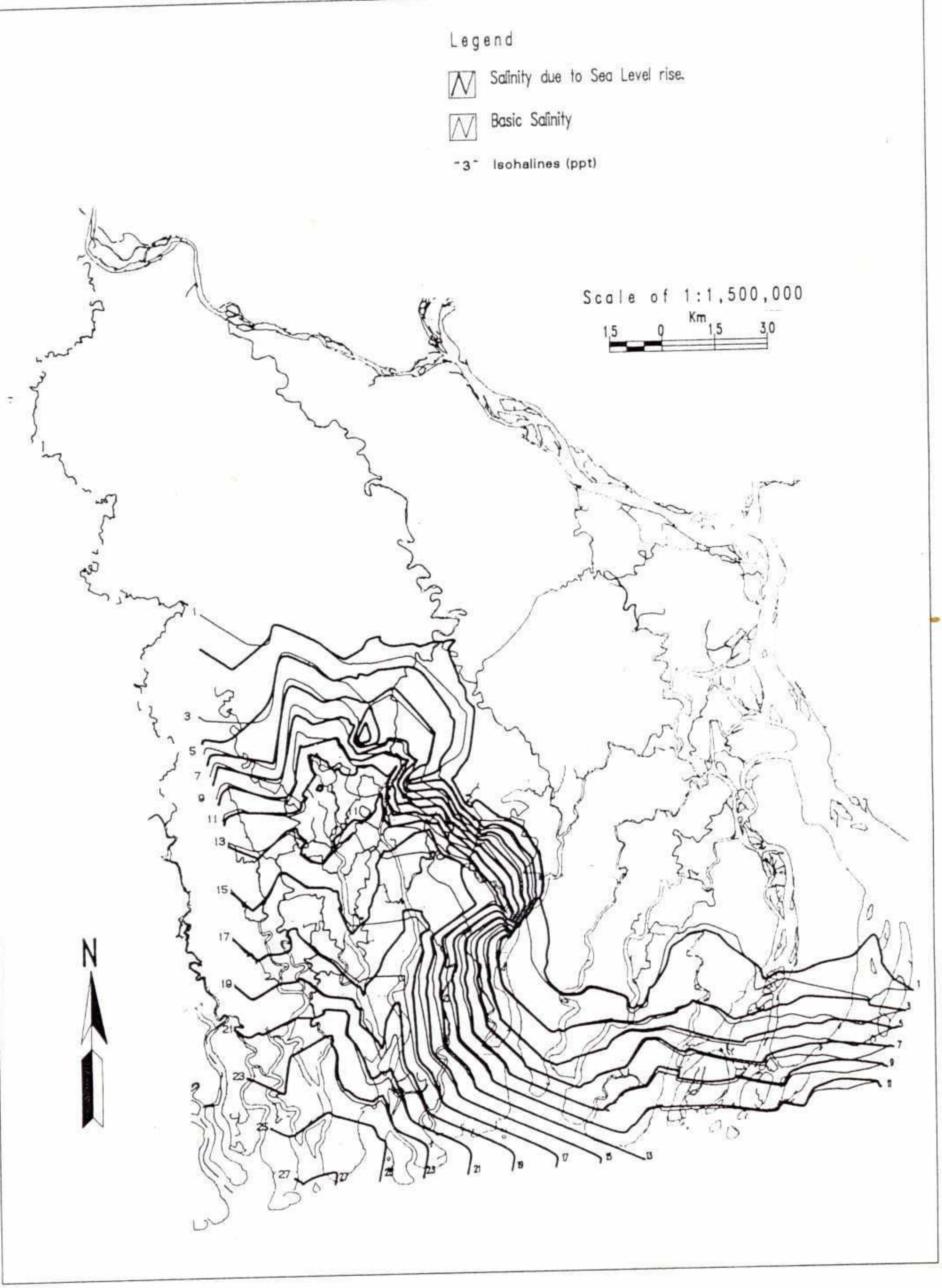
Increase in High Water Level due to 35 cm Sea Level Rise (April)

Figure 4.12



Increase in High Water Level due to 35 cm Sea Level Rise (August)

Figure 4.13



Impact of Sea Level Rise on Salinity Intrusion

5 PRESENT CONDITION OF TIDAL RIVERS

5.1 Regime Analysis

The methodology for the regime analysis has been explained in Section 2.8. Corroboration was sought through (a) comparing repeat survey cross-sections (see Appendix C) (b) analysis the output from the sediment transport modelling for comparative conditions and (c) reviewing historic maps and surveys obtained from BWDB offices and SPOT Image analysis. Thus all four methods provided a classification of the rivers with respect to their siltation and erosion trends. Table 5.1 shows the results of these analyses for rivers throughout the tidal area. The analyses were carried out for dry and wet season flows, using April'91 and August'91 data where the numerical models were used, and the end result takes account of seasonal variations. It can be seen that generally the regime analysis produces a result that can be substantiated by other methods. It is therefore realistic to use this "tool" for predicting the impact of interventions in the coastal area. In practice this is also the only tool available for future predictions until the morphological models are operational. The hydrodynamic model results and the analyses are tabulated in Appendix C.

The main points to note are as follows:

(i) Kobadak River

The Kobadak river is slowly deteriorating. Historical maps (1778) show the Kobadak connected via the U. Bhairab and Ichamati to the Ganges. The wide corridor near Morirchap reflects the past potential of the river. The present reduced fresh water flows come only from the local catchment area. Saline intrusion has increased but may now have stabilised. During dry season heavy siltation occurs and during the monsoon period siltation is reduced but not flushed out of the system.

(ii) Betna River

The Betna was a tributary of the Ichamati and Kobadak system but many of the past branches are now disconnected. The regime analysis indicates rapid siltation upstream and slow siltation in the lower reaches.

(iii) Lower Solmari River

The L. Solmari is a crucial river connecting the upper reaches of the Sibsa-Pussur system. Although slow siltation is indicated in the dry season the river can be considered as active or in equilibrium.

(iv) Pussur upstream of Mongla Port

The regime analysis clearly shows that the Pussur upstream of Mongla port is slowly silting. The siltation is acute in the dry period when the Pussur is dominated by tidal flows. The reason for siltation is a stagnation stretch of dampened flow created by the intersection of flows between the Sibsa and Pussur rivers.

(v) Other Rivers

The rivers Bishnu, M.G. Canal, Gashiakhali and Daudkhali are correctly shown as undergoing slow siltation but some of the channels in the Sundarban area do not appear to be correctly represented by the regime analysis.

TABLE 5.1

River Characteristics-Comparison of Regime Analysis with Alternative Methods of Analysis

X-section No.	River Name	Regime Analysis	Sediment Model	X-section Comparison	Maps & spot Image Analysis
1	KOBADAK U	Moderate siltation	Slow siltation	Slow siltation	Slow siltation
2	KOBADAK M	Slow siltation	Slow siltation	Slow siltation	Slow siltation
3	KARULLA	Erosion	Erosion		Equilibrium
4	CONNECTION	Slow siltation	Slow siltation		Equilibrium
5	KATAKHALI-K	Erosion	Erosion	Erosion	Equilibrium
6	KOBADAK L	Slow siltation	Equilibrium	Equilibrium	Equilibrium
7	KOIRA	Slow siltation	Slow siltation		Slow siltation
8	HADDA	Slow siltation	Slow siltation		Slow siltation
9	BETNA	Moderate siltation	Slow siltation	Slow siltation	Slow siltation
10	BETNA	Slow siltation	Equilibrium	Equilibrium	Slow siltation
11	MORIRCHAP	Equilibrium	Slow siltation		Slow siltation
12	LABANGABATI	Heavy siltation	Heavy siltation	Heavy siltation	Heavy siltation
13	BANSANA	Equilibrium	Heavy siltation	Slow siltation	Heavy siltation
14	HABRA	Heavy siltation	Heavy siltation	Heavy siltation	Heavy siltation
15	KANKSIALI	Heavy siltation	Erosion	Heavy siltation	Heavy siltation
16	GALGHASIA	Slow siltation	Moderate siltation	Slow siltation	Moderate siltation
17	KHOLPETUA	Slow siltation	Moderate siltation	Equilibrium	Slow siltation
18	LINK-KK	Equilibrium			Equilibrium
19	ARPANGASIA	Equilibrium			Equilibrium
20	ARPANGASIA	Equilibrium			Equilibrium
21	CHALKIGANG	Equilibrium			Equilibrium
22	BAL	Equilibrium			Equilibrium
23	BARAPANGA				Equilibrium
24	BETMARAGANG	Equilibrium			Equilibrium
25	MALANCHA	Equilibrium			Equilibrium
26	MALANCHA-E	Equilibrium			Equilibrium
27	SONAKHAL	Equilibrium	Erosion		Equilibrium
28	TALDUP	Equilibrium	Erosion		Equilibrium
29	HARIHAR	Heavy siltation	Heavy siltation		Heavy siltation
30	BURIBHADRA	Heavy siltation	Heavy siltation		Heavy siltation
31	U-BHADRA	Heavy siltation			Heavy siltation
32	MUKTESWARI	Heavy siltation	Moderate siltation		Heavy siltation
33	HARI	Heavy siltation	Erosion		Heavy siltation
34	M-BHADRA	Moderate siltation	Equilibrium	Slow siltation	Moderate siltation
35	HAMKURA	Moderate siltation	Slow siltation		Moderate siltation
36	BHADRA	Heavy siltation	Slow siltation		Moderate siltation
37	BHADRA	Moderate siltation	Erosion	Erosion	Moderate siltation
38	TELIGATI	Slow siltation	Erosion		Slow siltation
39	SALTA(W)	Slow siltation	Slow siltation		Slow siltation
40	HARIA	Slow siltation	Slow siltation	Slow siltation	Slow siltation
41	GHENGRAIL	Slow siltation	Slow siltation	Slow siltation	Slow siltation
42	BHANGARIA	Heavy siltation			Heavy siltation
43	GUNAKHALI	Slow siltation	Heavy siltation		Slow siltation
44	U-SOLMARI	Moderate siltation	Slow siltation		Moderate siltation
45	L-SOLMARI	Equilibrium	Erosion	Equilibrium	Equilibrium
46	SALTA	Moderate siltation	Erosion		Heavy siltation
47	L-SALTA	Equilibrium	Equilibrium	Equilibrium	Equilibrium
48	L-BHADRA	Equilibrium	Erosion	Slow siltation	Equilibrium
49	HABARKHALI	Equilibrium	Equilibrium	Equilibrium	Equilibrium
50	DELUTI	Erosion	Erosion		Equilibrium
51	MINAJNADI	Slow siltation	Slow siltation		Equilibrium
52	SIBSA	Slow siltation	Slow siltation		Equilibrium
53	SIBSA	Erosion	Erosion		Equilibrium
54	SIBSA	Erosion	Equilibrium		Equilibrium
55	JHAPJHAPIA	Heavy siltation	Heavy siltation	Heavy siltation	Heavy siltation
56	BADURGACHA	Erosion	Erosion	Equilibrium	Equilibrium
57	MANGA	Erosion	Slow siltation		Equilibrium
58	JHAPJH-MANGA	Heavy erosion	Erosion	Erosion	Equilibrium
59	CHUNKURI	Equilibrium	Equilibrium		Equilibrium
60	DHAKI	Erosion	Erosion		Equilibrium
61	SUTARKHALI	Equilibrium	Slow siltation		Equilibrium
62	SUTARKHALI	Equilibrium	Slow siltation		Equilibrium
63	BHAIRAB U	Moderate siltation			Heavy siltation
64	BHAIRAB U	Slow siltation	Equilibrium		Moderate siltation
65	NABAGANGA-M	Equilibrium			Equilibrium

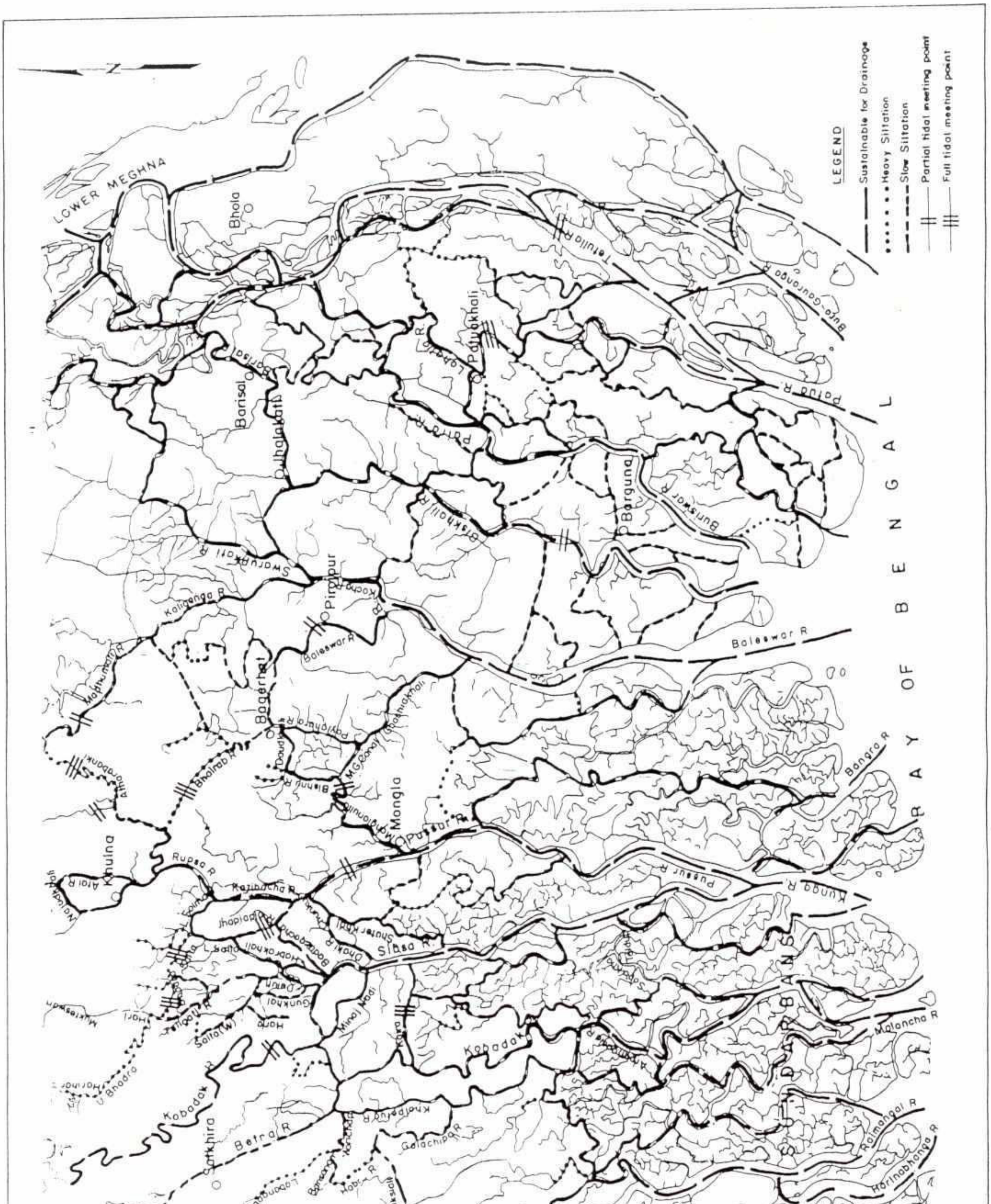
TABLE 5.1 (CONTINUED)

X-section No.	River Name	Regime Analysis	Sediment Model	X-section Comparison	Maps & spot Image Analysis
66	ATAI	Equilibrium			Equilibrium
67	NABAGANGA-M	Slow siltation	Low flow		Slow siltation
68	RUPSA	Erosion	Equilibrium		Equilibrium
69	KAZIBACHA	Equilibrium	Equilibrium	Equilibrium	Equilibrium
70	NALUANULLAH	Slow siltation			Equilibrium
71	PUSSUR	Slow siltation			Equilibrium
72	PUSSUR	Equilibrium	Equilibrium		Equilibrium
73	PUSSUR	Slow erosion	Equilibrium		Equilibrium
74	MONGLANULLA	Equilibrium	Slow siltation		Equilibrium
75	BISHNU	Slow siltation	Erosion		Slow siltation
76	DAUDKHALI	Slow siltation	Erosion		Slow siltation
77	M.G.CANAL	Slow siltation	Erosion		Equilibrium
78	GASHIAKHALI	Slow siltation	Erosion	Erosion	Equilibrium
79	ATHAROBANKI	Heavy siltation	Low flow	Equilibrium	Heavy siltation
80	ATHAROBANKI	Moderate siltation	Slow siltation	Equilibrium	Moderate siltation
81	BHAIRAB	Heavy siltation	Low flow		Heavy siltation
82	POYLAHARA	Heavy siltation	Heavy siltation	Slow siltation	Moderate siltation
83	BHAIRAB L	Slow siltation	Heavy siltation	Slow siltation	Moderate siltation
84	KUMAR	Moderate siltation			
85	MADHUMATI	Heavy siltation	Slow siltation	Slow siltation	Slow siltation
86	BALESWAR	Heavy siltation	Now flow	Heavy siltation	Heavy siltation
87	BALESWAR	Moderate siltation	Heavy siltation	Heavy siltation	Moderate siltation
88	BALESWAR	Slow siltation	Equilibrium	Equilibrium	Equilibrium
89	BALESWAR	Equilibrium	Equilibrium	Slow siltation	Equilibrium
90	KALIGANGA	Moderate siltation	Moderate siltation		Slow siltation
91	KOCHA	Erosion	Moderate siltation		Equilibrium
92	SHIKARPUR	Equilibrium			Slow siltation
93	UZIRPUR	Equilibrium			Equilibrium
94	SHANDHA	Equilibrium			Equilibrium
95	AMTALI	Equilibrium			Equilibrium
96	NAYABHANGANI	Equilibrium			Slow siltation
97	DHARMAGANJ	Slow siltation			Equilibrium
98	KALABADAR-1	Slow siltation			Equilibrium
99	KALABADAR-2	Equilibrium			Equilibrium
100	ILSHA				Equilibrium
101	RANGAMATIA	Slow siltation		Slow siltation	Slow siltation
102	KIRTONKHOLA	Slow siltation		Slow siltation	Equilibrium
103	KIRTONKHOLA	Equilibrium		Equilibrium	
104	KATAKHALI	Equilibrium			Slow siltation
105	BISHKHALI	Equilibrium		Equilibrium	Equilibrium
106	PANDAB-1	Slow siltation			Slow siltation
107	PANDAB-2	Erosion			
108	DHULIA	Equilibrium			Equilibrium
109	PAIRA	Equilibrium		Equilibrium	Equilibrium
110	BURISWAR	Equilibrium			Equilibrium
111	PATUAKHALI	Erosion			Equilibrium
112	LOHALIA	Slow siltation		Heavy siltation	Slow siltation
113	LOHALIA	Equilibrium			Equilibrium
114	SWARUPKATI	Erosion			Equilibrium

5.2 Flow Analysis

A sequential flow analysis has been carried out for the spring tide of 16th April'91 and neap tide of 7th April'91. The tidal meeting places are more evident during spring tide than neap tide. Stagnation zones are also predicted where the flow is dampened due to the interaction of flows from different directions. Both tidal meeting and stagnation places are detrimental factors causing siltation in the channel. Figure 5.1 illustrates the places and rivers of tidal meeting and wave dampened location. This analysis confirms the results of the regime analysis. The following are the rivers where tide meeting and stagnation take place:

Figure 5. 1



Tidal Meeting Place

60

(a) Tidal meeting
- Koira and Hudda rivers
- Salta
- Bhadra
- Haria, upstream end of Sibsa
- Jhapjhapia
- Bhairab at Bagerhat
- U. Atharobanki
- Lohalia near Patuakhali

(b) Stagnation places
- Kobadak
- Pussur, upstream of Mongla Port
- Pussur (for a short duration), downstream of Mongla Port
- Athorobanki
- Baleswar
- M.G. Canal (not very evident)
- L. Modhumati
- Bishkhali (not very pronounced)
- Tentulia (not very pronounced)

5.3 Map of River Classification

On the basis of the analysis discussed above Figure 5.1 has been prepared to show the present condition of tidal rivers. This figure is a key element in the understanding of the tidal delta morphology and forms the basis for estimating future developments with and without interventions.

5.4 Impact of the River Conditions on the CEP

5.4.1 Drainage Congestion

The performance of the polders in the CEP depends on many factors which include maintenance of the internal channels and sluices, the tidal characteristics of the rivers surrounding the polders and the degree of siltation in these rivers. Assuming the drainage in the polders has been correctly designed, deterioration, or "drainage congestion", in the surrounding rivers will prevent the polder functioning. Locations where the present rivers are causing severe problems with operation of the polders are as follows:

(i) Polders 1, 2, 3, 4 and 5

These polders in the Satkhira district cover a net area of approximately 100,000 ha. The drainage depends on the Ichamati and Kobadak-Kholpetua system. The CEP has completely diverted the drainage of these polders towards the Kholpetua system through the Labangabati, Barsana, Habra, and Morichap river which terminate in the polders and are now severely silted.

(ii) Polders 24, 25, 27/1, 27/2, 28/1 and 28/2

These polders in the Khulna district cover a net area of approximately 49,000 Ha and contain Beel Dakatia which is probably the best known example of drainage congestion. Construction of the CEP in the 1960s involved closure of the Bhadra by the construction of polder 29 and enclosing the tidal reservoir of Beel Dakatia with embankments. This completely changed the morphodynamics of this area. The major parts of the drainage was diverted into the Gengrail system through the Hamkura, Mukteswari-Hari, Harihar and the U. Bhadra rivers. All of these rivers are silting rapidly and unable to provide drainage routes for the polders.

(iii) Polder 36/1

This polder in the Bagerhat area covers a net area of approximately 32,000 ha and is surrounded by silting rivers, the Atharobanki, Madhumati Baleswar and Poylahara. Prior to the CEP the central part of the polder was a large tidal basin fed by a large number of tidal channels with the Chitra river dissecting the area. The Chitra is now largely silted-up but dredging works have recently commenced. The tidal basin has been cut off from regular tidal incursion and is no longer free draining.

5.4.2 CEP Polder Performance

Although drainage improvement in the CEP area is identified in the TOR as one of the three "burning issues" there are no comprehensive quantitative data on the extent of the problem. Similarly the consequences of the problem have not been quantified. There is a clear public demand for action because the CEP is not performing adequately and in places not at all.

To provide a method of estimating the extent that polder performance is related to drainage congestion an examination was made of all the outfall sluices in each polder. The area of sluices outfalling into each perimeter river was determined and the proportion of sluice area outfalling into silting rivers calculated.

In general the polder performance has been assessed as follows:

(i) a satisfactory condition exists when the drainage congestion affects less than 30% of the total area of outfall sluices;

(ii) a marginal condition exists when the area affected is between 30% and 60% of the total area; and

(iii) an unsatisfactory condition exists when the area affected is in excess of 60% of the gross area.

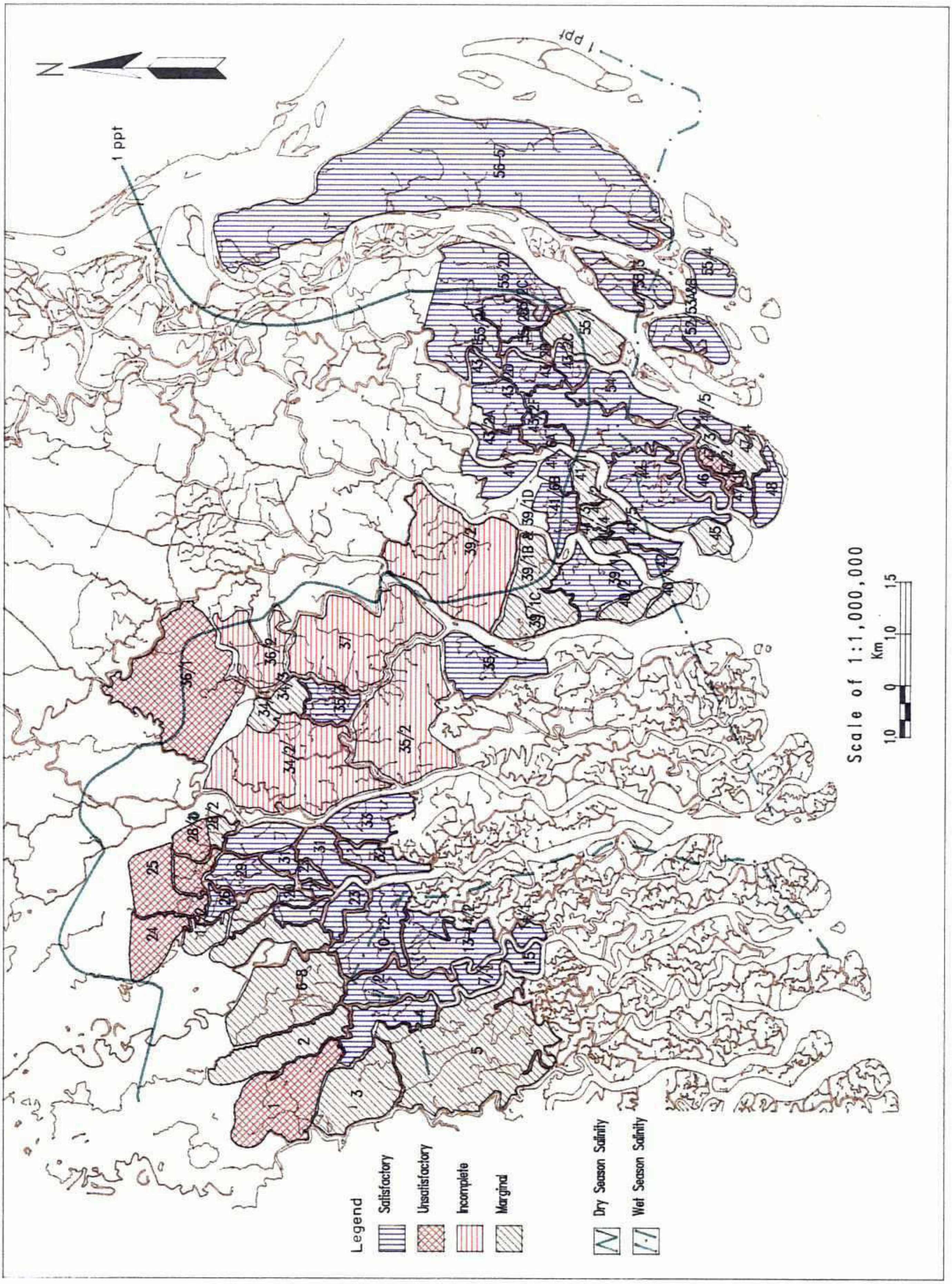
The choice of these percentages is subjective and relates primarily to polder drainage performance coupled with observations made during field visits and interviews with both BWDB personnel and the farmers themselves. The classifications could be reviewed when specific data on actual and potential crop yields are available. However, if the polder is failing to produce its potential crop yield there could be a number of factors involved and it would be necessary to separate problems caused by drainage congestion from other causes such as the conflicts that exist between shrimp and paddy farming. An indication of present land use in the polders is given in Table 5.2.

The appraisal was checked against field information supplied by the BWDB; the Consultants field visits; past reports, and SPOT imagery for 1989-90 and modified where necessary. The results are shown in Appendix D and Figure 5.2. The latter also shows the dry and wet season saline front contour which can be related to the land use data given in Table 5.2

5.4.3 The Effect of Present River Conditions on Mongla

The regime analysis shows that the upper reaches of the Pussur is in a state of slow siltation but the lower reaches are in equilibrium. The existence of a partial tidal meeting point upstream from Mongla Port is part of the reason for the siltation which occurs at the Port. This problem has recently been studied in detail (Pussur-Sibsa Study 1992) and relevance of the results to the FAP-4 strategy for the coastal zone is discussed in Section 8.

Figure 5.2



POLDER PERFORMANCE PRESENT SITUATION

TABLE 5.2

Present Land Use of Polders

Polder No.	Area		Present Land Use	
	Gross (Ha)	Net (Ha)	Rice	Shrimp
			% of the net area within the Polder	% of the net area within the Polder
1	28370	26420	50	50
2	12343	10000	75	25
3	18373	14698	50	50
4	10320	7200	75	25
5	55404	42045	75	25
6-8	25860	20688	85	15
7/1	3885	3108	80	20
7/2	10887	7600	75	25
10-12	17400	16200	60	40
13-14/2	14650	10400	60	40
14/1	2550	2000	60	40
15	3319	2520	50	50
16/1&16/2	10441	10120	80	20
17/1	5018	3808	60	40
17/2	3400	2611	70	30
18-19	3278	3238	60	40
20	2488	1620	50	50
21	1660	1620	50	50
22	1417	1134	60	40
23	4290	4050	60	40
24	28329	23720	50	-
25	19430	13620	-	-
26	2696	2157	90	10
27/1&27/2	4250	3249	70	10
28/1	5625	4269	50	-
28/2	2590	1966	50	-
29	8215	6235	85	15
30	6315	5668	80	20
31	10118	9920	80	20
32	10400	9700	80	20
33	10360	7862	76	-
34/1	2428	1942	60	-
34/3	3238	2590	64	-
35/1	14805	13396	80	-
35/3	6516	4945	76	10
36/1	40025	32020	60	10
39/1A	11750	9400	86	-
39/1B&1D	12541	10284	86	-
39/1C	4882	4003	86	-
39/2	41062	33260	83	-
40/1	2105	1747	77	-
40/2	3675	2834	77	-
41/1	3239	2632	81	-

TABLE 5.2 (continued)

Polder No.	Area		Present Land Use	
	Gross (Ha)	Net (Ha)	Rice	Shrimp
			% of the net area within the Polder	% of the net area within the Polder
41/2	2834	2308	81	-
41/3	810	729	90	-
41/4	1215	1012	83	-
41/5	2429	2024	83	-
41/6A	4024	2834	70	-
41/6B	6864	5560	70	-
41/7	6868	4858	70	-
42	2794	2291	82	-
43/1&43/1A	16223	12978	80	-
43/2A	4858	3239	67	-
43/2B	5466	5247	75	-
43/2C	2753	2146	78	-
43/2D	7500	6000	78	-
43/2E	1650	1350	82	-
43/2F	4060	3250	80	-
44	17530	14024	71	-
45	4089	3108	76	-
46	4049	2834	70	-
47/1	2065	1870	90	-
47/2	1020	850	83	10
47/3	2429	2105	87	10
47/4	3644	2632	72	10
47/5	1619	1457	89	10
48	5385	4861	90	10
52/53A&B	8029	6440	80	-
54	9315	7545	90	-
55/1	10800	7800	72	10
55/2A	13229	10715	90	-
55/2B	2632	2378	90	-
55/2C	6275	6024	90	-
55/2D	22224	18224	90	-
55/3	9847	7403	75	-
55/4	5142	4288	80	-
56-57	92074	74992	90	-
Total	781692	621977		

Source: Consultants' estimate based on data collected from the Department of Agricultural Extension and Department of Fishery and Thana statistics prepared by BBS (1991).

6 FUTURE "DO NOTHING" SITUATION

6.1 Future River Conditions

As discussed in Chapter 3 the tidal rivers are not in equilibrium and they are gradually silting up as the fresh water flows from the Ganges diminish. Historically this trend has been a natural process but recently the situation has been accelerated by inappropriate human interventions. The two main factors are the construction of the CEP in the 1960s and 1970s and the commissioning of the Farakka Barrage in 1975.

One of the reasons the CEP has not achieved sustainable success is that the project was not planned to work in harmony with the changing delta situation, with the result that many tidal channels were truncated by embankments and the tidal cubature was drastically reduced. Another possible reason is that reduced dry season flow in the Ganges and the Gorai, as a result of Farakka, has probably increased silt intrusion in the dry season. The key to planning future development and for establishing whether or not future interventions are needed or justified is a knowledge of what will happen in the future if no further works are carried out.

To estimate the future river condition information on current trends, as discussed in Chapter 5 has been supplemented by running the SWAM hydrodynamic model with a simulated "future" condition. This is a prediction of a future situation likely to occur if no interventions are done. Based on a regime analysis carried out on the output and field observations the river branches already silting or likely to silt up in the future have been identified. These 'dying' rivers are in this scenario blocked or isolated from the remaining network by the use of closed structures. The rainfall contribution to these branches is assumed stored in the dead branches, which is justifiable as it is small compared to the flow in the remaining 'live' branches. The model set-up is shown on Table 6.1 and Figure 6.1 (Scenario 6.4.1).

The results have been analysed by regime methods as described in Section 2.8 and the rivers classified as shown in Figure 6.2. This figure indicates which rivers are likely to be sustainable and hence the rivers into which future drainage in the CEP should be directed. These rivers should therefore be preserved and future projects in the Region should not be undertaken if they cause these rivers to deteriorate.

The main fault with this method is that the time scale of the changes can only be estimated and not accurately modelled. Based on the past rate of changes the transition from "present" to "future" conditions will take 10 - 30 years.

It should be noted that the "future" condition has been modelled with April and August 1991 conditions because good quality validation data on which boundary conditions must be based exists for those two periods.

6.2 Future Polder Conditions

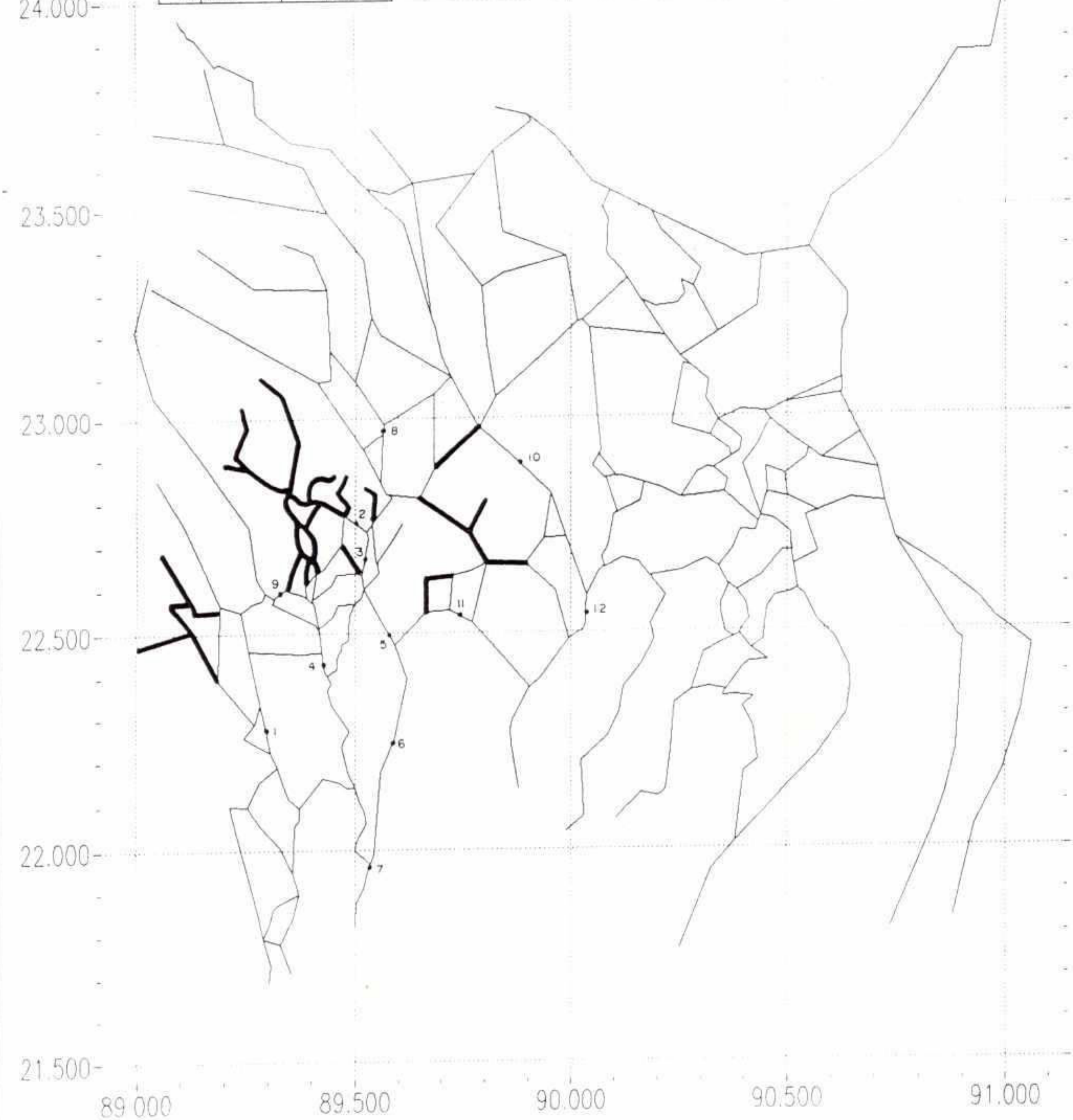
In the same way that present polder performance was determined the future performance has been estimated based on the future projected river condition, Table 6.2 shows the nature of changes in the polders and Figure 6.3 shows the predicted future performance of polders in the "do nothing situation" corresponding to the future river conditions shown on Figure 6.2.

It can be seen that the projected deterioration is extensive and demonstrates that perhaps the most important impact of drainage congestion, from a regional view point, is the progressive deterioration of areas that are currently satisfactory. It should also be noted

Figure 6.1

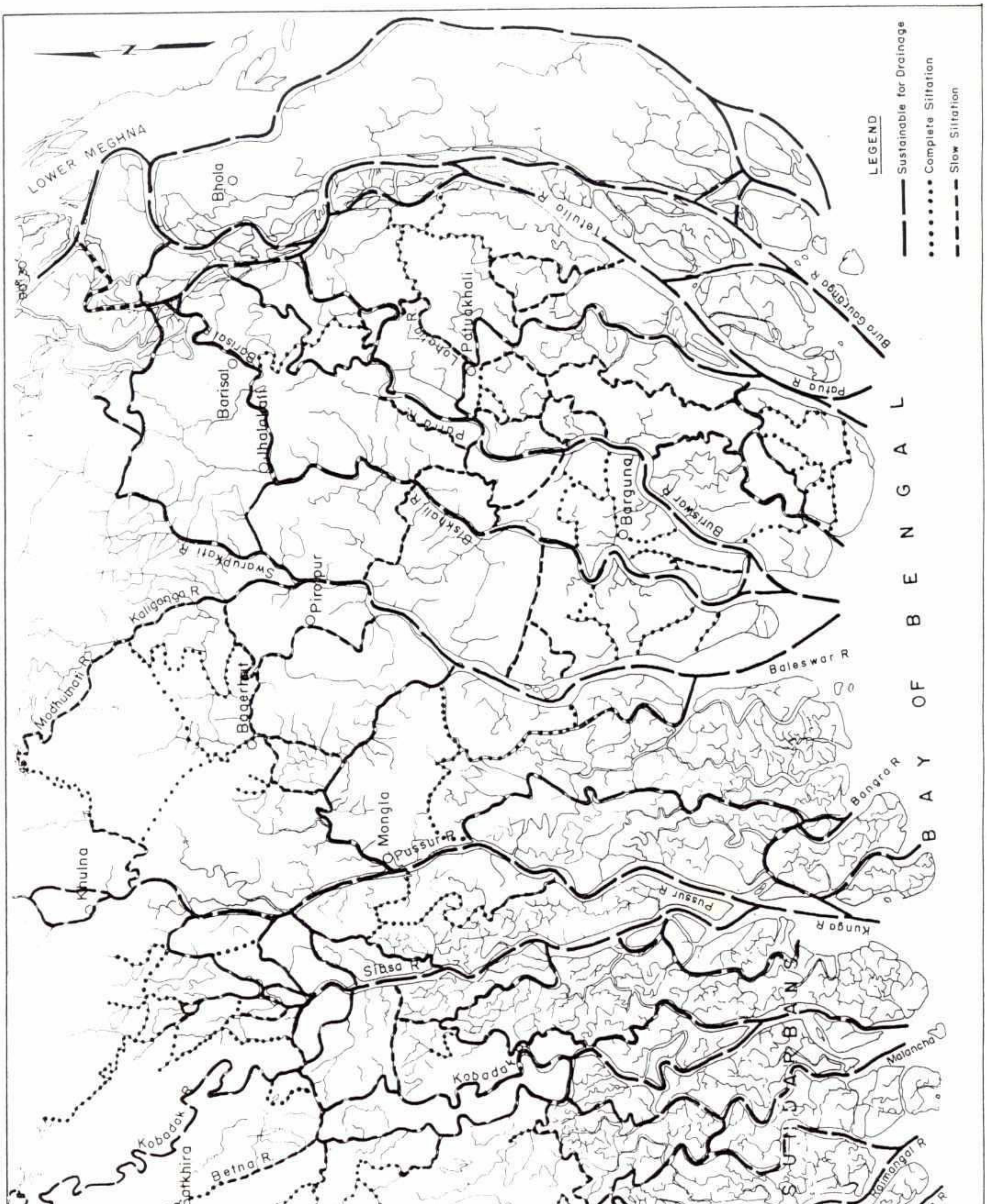
Selection Points

Sl. No.	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Pussur	12.626
6	Pussur	48.885
7	Pussur	81.335
8	Nabaganga_L	27.500
9	Haria	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000



Improvement of Polder Drainage. Scenario 6.4.1: Future Situation with Stable Rivers Only

Figure 6.2



Tidal River Characteristics – Future "Do Nothing" Situation that these projections do not include the possible impact of sea level rise due to global warming and land subsidence (see Section 4.8) which will tend to accelerate the rate of deterioration.

TABLE 6.1

'SWAM' Model Set-up for Future "Do Nothing" Situation

Scenario	River	Chain(1) (Km)	Chain(2) (Km)	Nature of Intervention				Remarks
				Closure	Dredging	Regulator	Surge Basin	
6.4.1	Morirchap	7.000	17.000	x				
	Labangabati	0.000	17.500	x				
	Bansana	0.000	6.000	x				
	Habra	0.000	12.500	x				
	Kanksiali	0.000	17.000	x				
	Galghasia	0.000	20.500	x				
	Harihar	0.000	39.500	x				
	Buribhadra	0.000	8.250	x				
	U. Bhadra	0.000	16.500	x				
	Mukteswari	0.000	40.000	x				
	Hari	0.000	14.000	x				
	M. Bhadra	16.500	19.000	x				
	Hamkura	0.000	14.000	x				
	U. Solmari	0.000	14.000	x				
	Salta	0.000	8.500	x				
	Ghengrail	8.000	21.000	x				
	Teligati	0.000	7.500	x				
	Jhapjhapia	0.000	9.500	x				
	Gunkhali	0.000	8.500	x				
	Haria	0.000	13.500	x				
	Salta(W)	0.000	25.000	x				
	Bhangaria	0.000	2.250	x				
	Bhadra	19.000	37.500	x				
	Bhairab	0.000	17.000	x				
	Bhairab L	0.000	10.500	x				
	Atharobanki	0.000	32.000	x				
	Hatia	0.000	12.000	x				
	Poylahara	0.000	20.000	x				
	Daudkhali	10.200	29.390	x				

TABLE 6.2

Polder Performance - Present and Future without Interventions

Polder No.	Polder Performance					
	Present			Future (Without Intervention)		
	Satisfactory	Marginal	Unsatisfactory	Satisfactory	Marginal	Unsatisfactory
1			•			•
2		•				•
3		•				•
4	•				•	
5		•			•	
6-8		•			•	
7/1	•			•		
7/2	•			•		
10-12	•			•		
13-14/2	•				•	
14/1	•			•		
15	•			•		
16/1&16/2		•				•
17/1		•				•
17/2		•				•
18-19	•				•	
20	•			•		
21	•			•		
22	•			•		
23	•			•		
24			•			•
25			•			•
26	•					•
27/1&27/2			•			•
28/1			•			•
28/2		•			•	
29	•			•		
30/1&30/2	•			•		
31/1&31/2	•			•		
32	•			•		
33	•			•		
34/1		•				•
34/3		•			•	
35/1	•				•	
35/3	•			•		
36/1			•			•
39/1A	•			•		
39/1C		•			•	
39/2	•				•	
40/1		•			•	
40/2		•				•
41/1		•				•

TABLE 6.2 (continued)

Polder No.	Polder Performance					
	Present Condition			Future Without Intervention		
	Satisfactory	Marginal	Unsatisfactory	Satisfactory	Marginal	Unsatisfactory
41/2		•				•
41/3		•				•
41/4		•				
41/5	•				•	•
41/6A	•					•
41/6B	•					
41/7	•			•		
42	•				•	
43/1&43/1A	•			•		
43/2A	•				•	
43/2B	•				•	
43/2C	•				•	
43/2D	•				•	
43/2E	•			•		
43/2F	•				•	
44	•			•		•
45		•				
46	•			•		•
47/1	•					•
47/2			•			•
47/3			•			
47/4		•			•	
47/5	•				•	
48	•				•	
52/53A&B	•				•	
54	•				•	•
55/1		•				
55/2A	•				•	
55/2B	•				•	
55/2C	•				•	
55/2D	•				•	
55/3	•				•	
55/4	•				•	
56-57	•			•		
% Total Number	62	27	11	28	38	34
% Total Net Area	59	24	17	33	38	29

Note: (i) Polder performance has been taken to be satisfactory where less than 30% of the drainage outfalls into silting rivers.

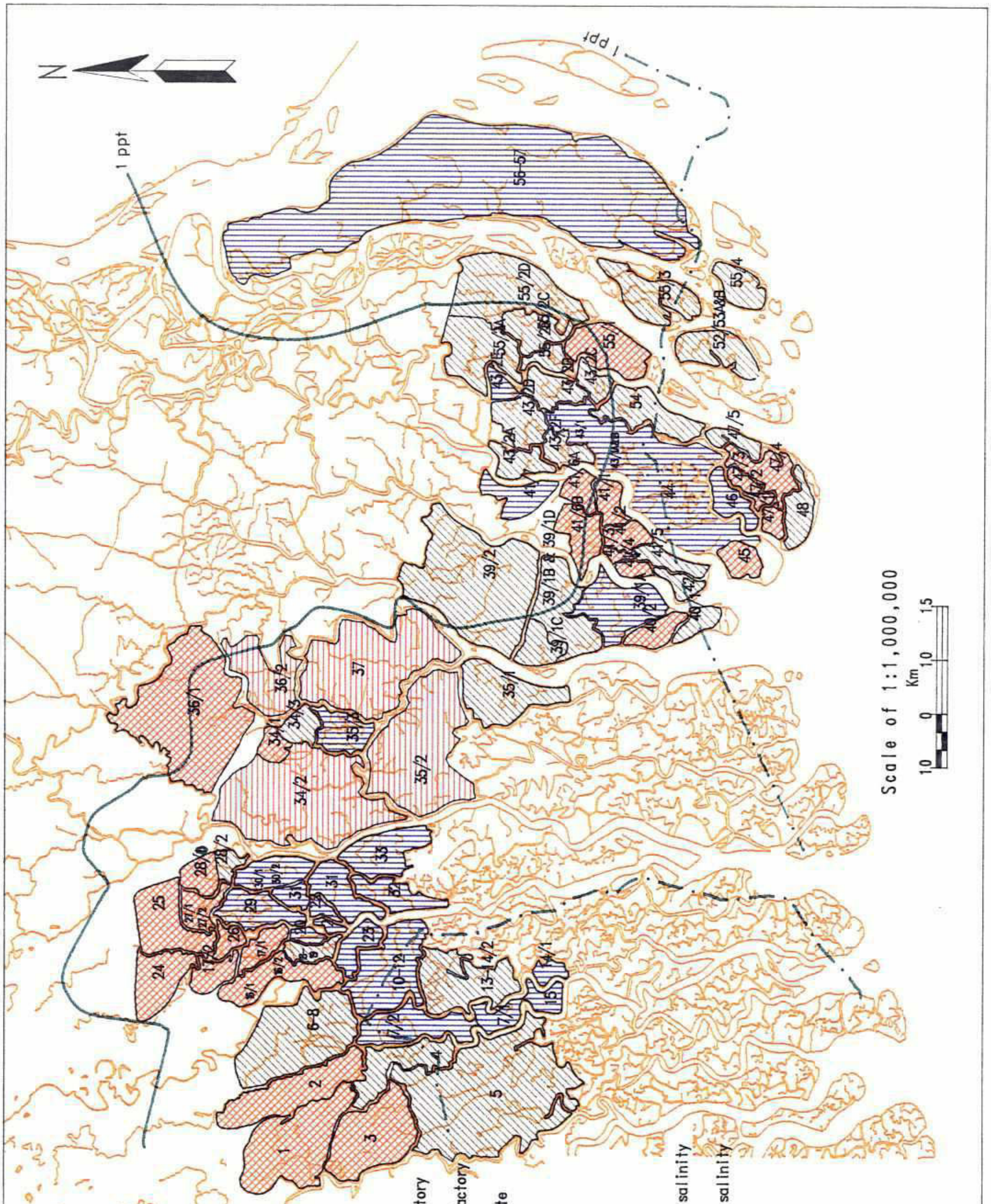
(ii) It has been considered marginal when the figure is between 31 and 60%.

(iii) It has been taken to be unsatisfactory when the figure is above 60%.

This table has been prepared on the basis of the information collected from the sources as mentioned below:

1. Field information as supplied by the different Executive Engineers of Bangladesh Water Development Board.
2. Spot Imageries of the year 1989-90.
3. Site visit by different experts particularly fishery, agriculture and coastal experts.
4. Past Reports.

Figure 6.3



POLDER PERFORMANCE FUTURE SITUATION

7 DRAINAGE IMPROVEMENTS IN THE COASTAL AREA

7.1 Long Term Coastal Strategy

The aim of the long term (15 years onwards) coastal strategy is to enable the Area to make the most beneficial use of the resources in the coastal zone. Drainage congestion is the major problem which currently prevents these benefits from being realised. Other problems are related to salinity intrusion during the dry season, the social conflicts that arise between shrimp and rice cultivation, internal water management within the polders and primary navigation including Mongla Port.

A number of options have been considered during the course of the study, some of which for various reasons were considered to be untenable. This sifting process reduced the number of options that were considered further to three and the positive and negative aspects of these on the "burning issues" and the Regional Plan were assessed and are summarised in the following paragraphs and tables.

Option 1 - No interventions in the coastal zone and allow the delta to progress to a new tidal equilibrium based on augmented Gorai flows and the existing tidal cubature. Whilst this does not involve any large capital investments it does not address the problems of a continuing deterioration and the full realisation of an even larger investment that has already been made. The population in some of the areas are already unhappy about the drainage capability of the polders and the pressures on these areas will increase with population growth. The possible change of land use to shrimp, fish culture and salt production, though possible is not a solution that is likely to be socially acceptable. Furthermore, these activities, although not dependent on freshwater flows, still require relatively frequent water exchange and thus good conveyance characteristics for the primary rivers around the polders. It is concluded that this option has more fundamental negative than positive aspects.

TABLE 7.1

Option 1 - No External Coastal Interventions

Positive	Negative
No large capital investments would make more funds available for operation, maintenance and improved farming and fishing training.	Social discontent because expectations of CEP have not been fulfilled.
	Loss of farming and homestead lands in unsustainable drainage.
Some poldered areas might be more productive if turned over exclusively to shrimp, fish culture and salt production all of which are valuable commodities.	Drainage congestion will become progressively worse and where land use can not be changed to suit congested condition pumping may be required.
Areas that cannot be drained could be used as freshwater reservoirs for industry, drinking water and irrigation.	Loss of some navigation routes
	Long term consequences are not known
	If Gorai flows are cut off conditions will become worse
In areas where tidal flooding is permitted ground levels will be raised naturally.	Increased risk and frequency of flooding in congested areas
	Exposure to cyclonic surge is unchanged
Time scale - immediate	Saline intrusion may increase in congested channels.

Option 2 - Intervene in the coastal zone to revitalise the CEP and prevent further deterioration. Interventions in the CEP area will direct drainage to sustainable rivers and future interventions should not cause these rivers to deteriorate. Interventions will be required progressively as the delta attains a new tidal equilibrium based on augmented Gorai flows and a tidal cubature which is modified by future interventions. The interventions will, however, be based on the premise that the Region will remain tidally dominated. In the longer term this option would allow realistic and sustainable planning of land use to increase farming and fisheries production to increase to meet some of the future needs of the population. It is anticipated that it would be a popular option, based on interviews with farmers, BWDB officers and MPs who represent the various areas in the region. The maintenance of selected rivers would maintain drainage conditions, aid navigation planning and assist in attempting to maintain the delicate ecological balance that exists within the Sundarbans forest. In order to maximise the benefits from this option the flows from the Gorai need to be maintained at least at their present levels to avoid deterioration of the future system. Interventions would proceed in a phased development allowing impacts to be monitored over time and, if necessary, schemes could be revised to meet changing needs and contitions. The perceived positive and negative aspects of this option are summarised in Table 7.2.

TABLE 7.2

Option 2 - Controlled Transition to Tidal Equilibrium

Positive	Negative
Socially acceptable because expectations of CEP will be fulfilled (partially at least)	Capital works interventions will be needed progressively until estuary stabilises which may take many decades.
Controlled interventions allows realistic and sustainable future planning of land-use	Medium to high Cost
Minimum impact on the ecological balance within the Sundarbans	If Gorai wet season flows are cut-off in the future system will deteriorate wasting investment made in the coastal areas
Selected channels will remain open thereby allowing long term navigation planning	Lacks the political attractions of a 'single solution' to drainage congestion problems.
Saline intrusion will be controlled at, or marginally better, than present day levels	
Development is in harmony with natural changes.	

Option 3 - Transform the Region into a non-tidal area by the introduction of major tidal barriers across all of the rivers that connect to the Bay of Bengal and control of the water quality and level throughout the Region to suit farming, fishing and industrial needs. This option constitutes a "brute force" approach the main attribute of which would be to control or eliminate saline intrusion. Large scale storage of fresh water would be provided, but this would only reduce the need for augmented fresh water flows to the upper areas of the region. Existing land use practices of shrimp farming in certain areas would no longer be possible and the Sundarbans mangrove forests would go into rapid deterioration. Implementation could be carried out in a phased manner, but during the intervening period the rivers in those areas not converted could silt up more rapidly due to the loss of tidal cubature through interconnections. These positive and negative aspects are summarised in TABLE 7.3

TABLE 7.3

Option 3 - Non Tidal Coastal Zone

Positive	Negative
Saline intrusion removed	Very High Cost for 30-50 years and full benefits will not be realised until all closures are complete
Large scale storage of fresh water in existing rivers will reduce dependence on future Gorai flows.	Benefit of tidal drainage systems will be lost.
Risk of cyclonic surge penetrating the Region is reduced.	Brackish water shrimp and fish farming will not be possible inside the non tidal zone
Major changes in land use will be offset by increased rice production due to elimination of saline water.	Navigation outside the region will be through lock gates.
Siltation in the non tidal zone from marine sources will be eliminated.	Large areas of standing water may create health hazards
	Heavy siltation downstream of the barriers
	Environmental damage and morphological impact cannot be reliably predicted with present day state of knowledge, but can be anticipated to be extensive

7.2 Preferred Long Term Strategy Option

The preferred strategy option is Option 2. The reasons for this choice are as follows:

- Option 2 recognises that the coastal zone is a changing environment and, to ensure sustainability, development should be in harmony with these changes

- It aims to obtain the maximum benefit from the CEP providing this is not in conflict with the requirement for sustainability

- Mongla Port and navigation in general will benefit from sustained river system

- Investment in interventions which follow this strategy will be complementary to investments in augmentation of fresh water flows

- It will allow small scale and immediate interventions to be carried out, and yield benefits in a short time scale, without relying on the future development of a large scale high cost project

- Impact of each intervention can be monitored and future interventions tailored to suit the results

- It will provide continual evolution of the polder system as the delta progresses towards stable tidal equilibrium

- The linkages between the long term coastal strategy and the Regional burning issues is shown diagrammatically on Figure 7.1.

The main uncertainty is the consequences of the Gorai becoming separated from the Ganges inflows and the negative impacts this would have on the coastal areas. This preference for Option 2 is strengthened further if commitments are made to sustain the Gorai mouth.

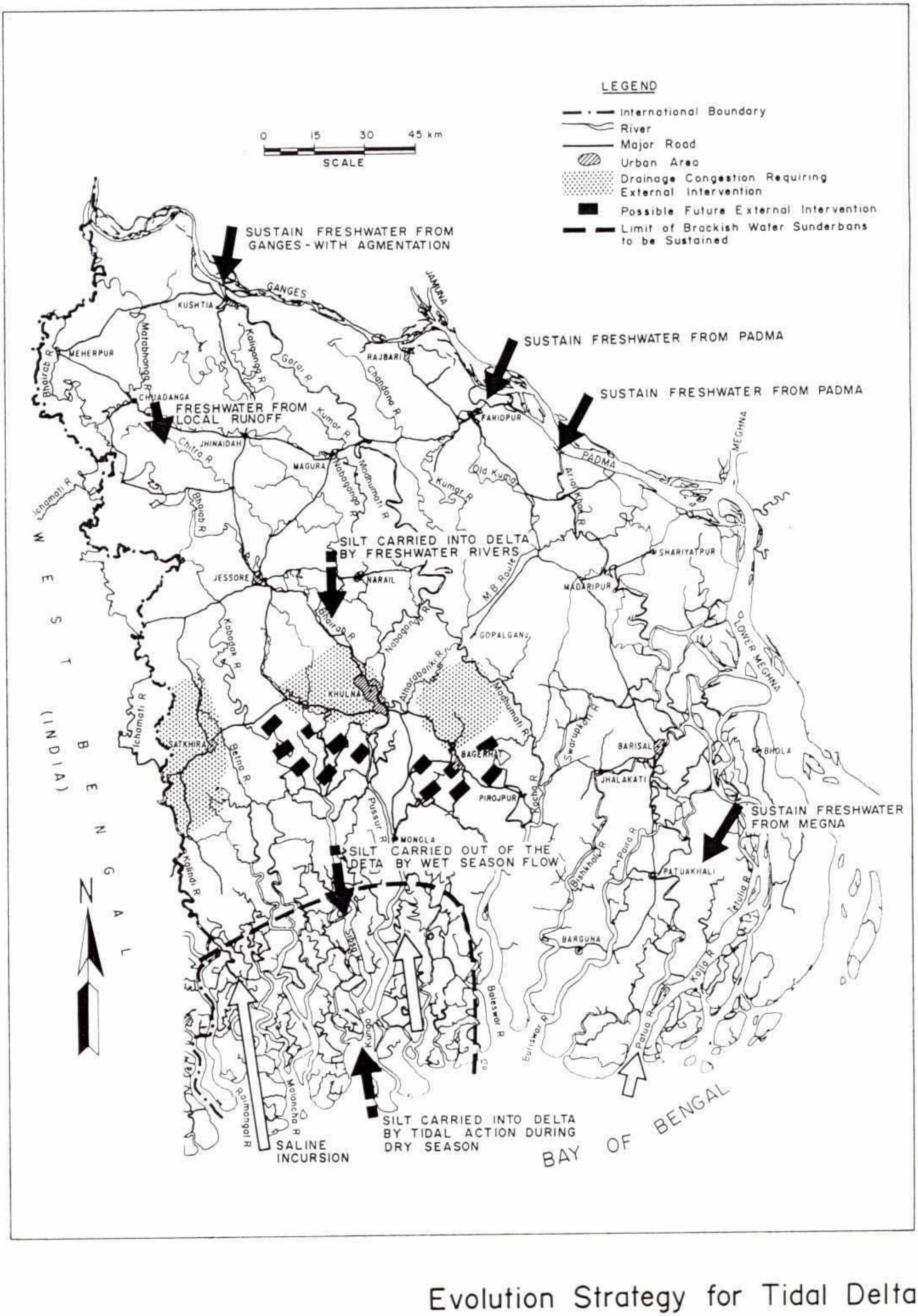
7.3 Near Term Coastal Strategy

There clearly must be strong links between the near term and long term strategies. The near term (0-15 years) strategy proposes ways to meet the current urgent requirements in the coastal zone in line with the long term strategy. The near term coastal strategy is primarily concerned with projects related to drainage congestion in the CEP area.

The key link is that near term projects and interventions must not interfere with the sustainable rivers identified in Section 6.3. This means that projects must be planned on a Regional basis so that adverse effects are not caused elsewhere as a consequence of the project.

Near term projects in the CEP which are likely to impact on, or improve, drainage congestion are summarised in Table 7.4.

Figure 7.1



Evolution Strategy for Tidal Delta

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TABLE 7.4

Near Term Projects in the CEP Area

Project	Purpose	Status
Satkhira - dredging in Labangabati; Morichap; Kanksiali & Gashiakhali	- to create tidal interchange between Ichamati and Kholpetua to assist drainage in Polders: 2, 3 and partially 4 & 5	Conceptual as part of the Regional strategy under FAP4
Khulna - CERP II proposals by Haskoning	- to drain Beel Dakatia, Polders 24; 25; 27/1; 27/2; 28/1; 28/2	Feasibility study completed January'93
Khulna - create a macro- polder comprising polders 17/1;26;18/19;20 & 29	- to provide sustainable drainage to polders 24 & 25 under CERP II proposals by creating a sustainable channel in the U.Bhadra & U.Salta Rivers - to eliminate siltation and control saline intrusion in Teligati; Gengrail; Salta(W); Gunkhati & Haria rivers - to prevent deterioration of polders 17/1; 26; 18/19; 20 and 29 due to drainage congestion.	Conceptual as part of the Regional strategy under FAP4
Khulna - Khulna town drainage outlet to L.Solmari as proposed by FAP 9A	to improve town drainage	Outline design stage completed under FAP 9A
Bagerhat - dredging in Chitra river in Polder 36/1 and augmentation of fresh water flows in the MB Route	to improve drainage in Polder 36/1 to improve drainage in 36/2; 34/3 & 35/3 by sustaining the Poylahara River	Conceptual as part of the Regional strategy under FAP-4

TABLE 7.4 (continued)

Near Term Projects in the CEP Area

Project	Purpose	Status
3rd Fisheries - Development of shrimp farming in polder 5; 23; 16;18/19; 31; 32 & 33	to improve shrimp farming	Study stage under 3rd Fisheries Project
Mongla Port - Pussur-Sibsa Study of alternative interventions at, or near, Mongla Port	to improve navigation at Mongla Port	Numerical Model studies under Danida have identified 12 options for pre-feasibility studies
Systems Rehabilitation Project - sub-projects in the Southwest	to study as sub-projects polders 4; 5; 7/1; 7/2; 13-14/2; 14/1; 15; 32; 34/3; 35/1; 35/3; 40/2; 48	Possible options to be studied under BWDB System Rehabilitation Project
CEP - Completion of polders 34/2; 35/2; 36/2; 37 & 39/2	to improve productivity of these polders	Conceptual as part of the Regional Strategy under FAP4
CEP - Internal intervention	to improve internal drainage of all polders shown on Table 8.6	Conceptual as part of the Regional Strategy under FAP4
M.G. Canal Salinity Control	to prevent salinity intrusion from Pussur to Baleswar River	Problem identified as a project requiring detailed study

Some of the projects described in Table 7.4 above were conceived before the FAP-4 study commenced. It is therefore important to check that the project proposals are compatible with the strategy and identify any conflicts. Table 7.5 summarises the outcome of this check.

TABLE 7.5

Compatibility between Near Term Projects and Strategy

Project	Compatibility
Satkhira - dredging	- Compatible with strategy of sustaining Kholpetua River. - Impact on salinity intrusion is subject to salinity levels in the Ichamati
Khulna - CERP II	- Drainage of Polders 27/1; 27/2; 28/1; 28/2 into the L. Solmari in compatible with strategy of sustaining this river. - Drainage of polders 24 & 25 into U.Bhadra is not compatible with strategy of only draining into sustainable rivers. Proposals to sustain U.Bhadra by dredging or macro-poldering to the south require further study.
Khulna - Macro polder	- Drainage of macro polder into Lower Salta; L. Bhadra; Deluti and Sibsa is compatible with strategy of sustaining these rivers. - Compatible with strategy of sustaining the Poylahara.
Bagerhat - dredging in Chitra river and MB Route	- Compatible with strategy of sustaining the Poylahara.
3rd Fisheries - Shrimp production in polders 5; 23; 16; 18/19; 31; 32 & 33	- Shrimp in polders 5; 23; 31; 32 & 33 is compatible with strategy - Shrimp in polders 16 & 18/19 may conflict with Khulna macro polder proposal
Mongla Port - 12 options (see Figures 7.2 to 7.9 for scheme options)	- Schemes 1, 5, 6, 8, 9, 10 & 12 are not compatible with strategy of sustaining the Pussur-Sibsa tidal river system and should not be persued further - Schemes 2 & 3 are compatible with the strategy and should be examined further - Scheme 4 is compatible with the strategy but conflicts with CERP II

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TABLE 7.5 (continued)

Compatibility between Near Term Projects and Strategy

Project	Compatibility
	- Scheme 7 conflicts with Regional strategy of augmenting dry season Gorai flow to 150 m^3/sec. The proposed 1000 m^3/sec exceeds the dry season Ganges flow and may not be feasible even with the Ganges Barrage. - Scheme 11 conflicts with the strategy of maximising the benefits of the CEP and should not be perused. A reduced scheme involving only polders 34/2 and 35/2 should be studied before these polders are completed
Systems Rehabilitation Project	- Compatible with strategy because polders to be studied are able to drain to sustainable rivers
CEP - Completion of polers 34/2; 35/2; 36/2, 37 & 39/2	- Compatible with strategy of drainage to sustainable rivers but impact of this large change in tidal cubature requires detailed study of the impact on these rivers and particularly the impact on navigation to Mongla
CEP - Internal intervention	- Compatible with strategy of maximising benefits of the CEP
MG Canal - Salinity control	- Control gate on the canal to limit ebb tide flows from Pussur to Baleswar would affect flows in Poylahara. If flows are improved such controls would be compatible with strategy. Conversely reduced flows would be incompatible.

The main area of incompatibility can be seen to be many of the schemes associated with attempting to improve navigation depths within the Pussur River upstream to Mongla Port. Some of these involve major interventions that would result in extremely large changes in the discharge characteristics of the regional rivers. Whilst these would be effective in increase in flows in the Pussur River itself it has been deduced from morphological modelling that the benefits with respect to improving navigation depths in the long term would not be realised for several decades and conditions would be worse in the intervening periods. It should also be noted that none of these schemes have been recommended for implementation.

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7.4 Application of Coastal Strategy to Drainage Improvement

The key to developing the coastal strategy has been to identify the sustainable rivers in conjunction with data and analyses relating to the present day and projected polder performance, linked to drainability. The following considerations underly the strategy:

- Rivers that are likely to silt-up and cannot feasibly be sustained will be converted into internal polder drains by combining adjacent polders and inserting drainage regulators where necessary.

- Future polder use will be linked to the river conditions that can be sustained by minimum intervention. Unless shown to be strategically essential, interventions will not be used to create major change, eg. attempts to convert the saline regions of the west to a fresh water zone will not be attempted.

- Polders have been classified according to their existing and predicted future performance. Further studies will be required to confirm prioritisation of interventions to obtain maximum financial and social benefit. Thus, interventions to prevent a 'good' polder going 'bad' may have priority over interventions to save a 'bad' polder.

- The selection of sustainable channels will also be linked to non-polder requirements such as navigation and forestry requirements to ensure the maximum overall benefit.

The steps involved in deciding where to carry out interventions have been as follows:

(i) Establish the existing polder performance

(ii) Establish the existing river characteristics

(iii) Predict the future river characteristics

(iv) Predict the future polder performance from (iii)

(v) Predict future polder drainability

(vi) Identify the link between (iii), (iv)/(v) and the Regional Plan

(vi) Propose interventions where (iv)/(v) is insufficient to achieve the requirements of the Regional Plan.

The technical complexity and large scale of the river system and the severe consequences of errors should not be under estimated. The existing data, reports and analytical framework that has been developed are described in Sections 2 through 7 of this report. These provide a matrix of information which has allowed the strategy to be devoped with some confidence. However, each scheme will need to be subject to pre-feasibility and full feasibility studies prior to implementation.

The information and decision tools that are now available, some as a result of this study are :

- Current and Previous Studies

- Current and Historic survey data

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- Reports from BWDB Executive Engineers
- Satellite imagery and Historic Maps
- Hydrodynamic modelling
- Regime analysis using field survey and modelling results
- Sediment Transport modelling results
- Drainage analysis for each individual polder
- Field visits and public meetings

It must be emphasised that modelling has not be used as a substitute for field visits and surveys. Extensive field data, both qualitative and quantitative has been used to check that model simulations are realistic. The main purpose of the models is to assist with prediction of future conditions with and without interventions. This is an essential requirement in formulating a coastal strategy and in this respect the models have been very useful.

7.5 Alternative Drainage Strategy

Drainage Ability of Polders

According to Table 6.2 presented in Section 6, four polders (CEP 24, 25, 28/1 and 47/3) have more than 80% of their ventage (vent area of drainage outfalls) on rivers that have silted up, thus drastically reducing the drainage disposal capacity of the relevant outfalls; possibly the present drainage disposal ability of these polders is mainly based on the less than 20% of the design ventage that is on relatively active rivers, and this could be considered as the currently available effective ventage. The Table also shows that further sets of 12 polders and 14 polders have 50% - 80% and 30% - 50% ventages respectively on silted up rivers.

The prediction of the present performance status of the polders viz-a-viz drainage disposal is an important aspect of the present study. Due to the limitation in the availability of some of the required data, the prediction has to be made on the basis of a preliminary drainage discharge (routing) analysis. The following data/information relating to each polder have been considered in this analysis/simulation:

(a) Identified active rivers;

(b) The currently available effective ventage;

(c) Area-elevation and storage curves for each polder based on available digital elevation of MPO;

(d) 10-days cumulative rainfall runoff time series for the period May-December relating to a rainfall time series in a particular year that corresponds to a 1 in 5 year return period event (through the NAM rainfall-runoff model);

(e) Time series of the 10-days mean water levels (high tide and low tide) of the associated river(s) for the same period as above (from the 1D hydrodynamic model Mike 11);

(f) Coefficients to reflect the sinusoidal tidal fluctuation of the associated river(s);

(g) Estimated sill level of the gates (based on the low tide level).

The simulation output for each polder is a time series giving the depths (F0, F1, etc) and the associated areas of inundation at 10-days interval. Considering that it is a 10-days time series, it is reasonable to assume that the inundation (depths/areas) results relate to, on an average, five days duration at each time step.

The simulation was repeated to assess the impacts if the following changes to the ventage and river stages were introduced one at a time:

- Increased ventage, in steps to the original design ventage (and even further if found necessary); and

- Lowered river stage levels.

  (Simulations were carried out incorporating the above two changes separately and jointly in order to assess the impact of any river dredging).

- Decreased ventage;

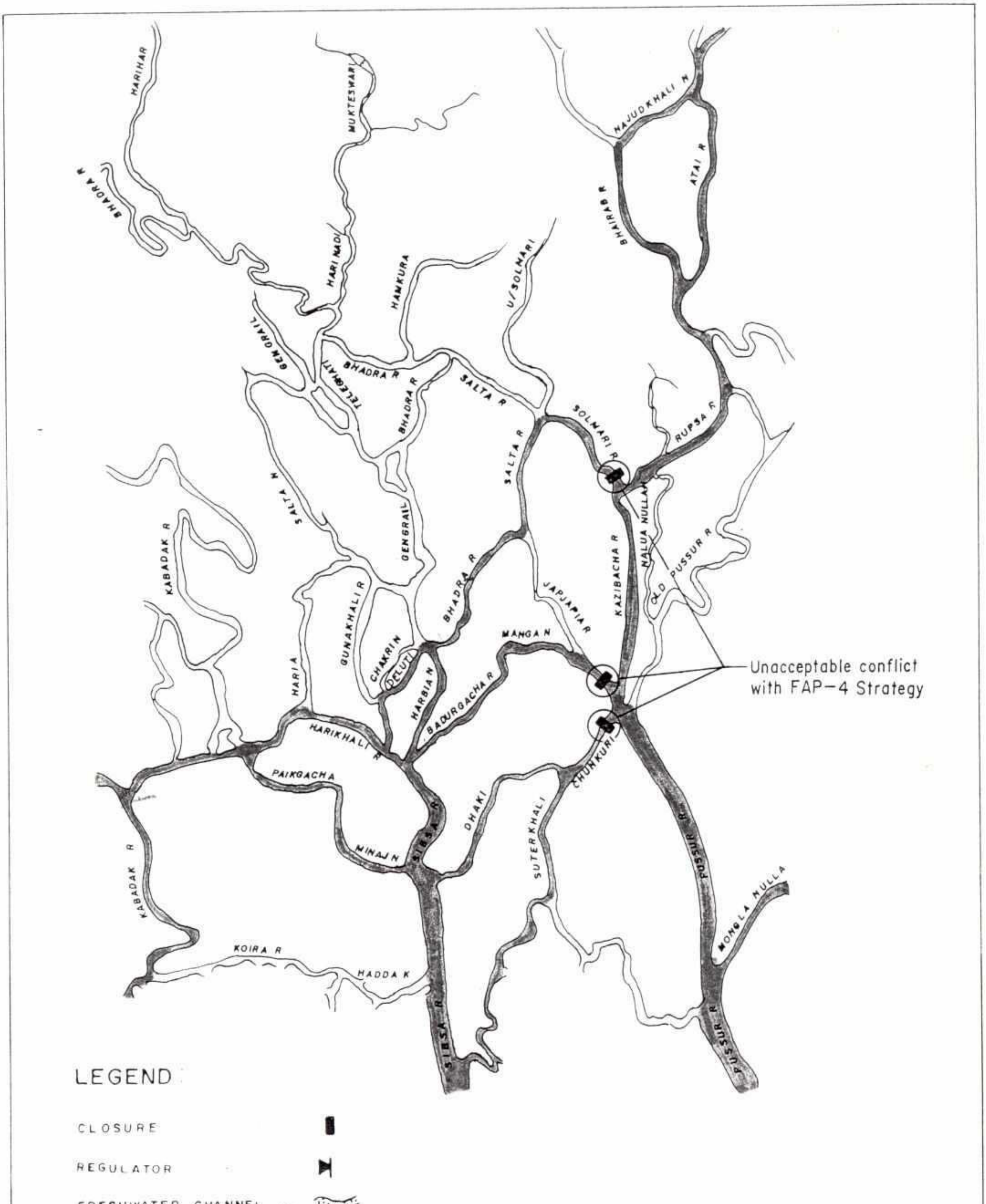
- Raised river stage levels.

  (Simulations were carried out separately and jointly as above to assess the impacts of further siltation in rivers and/or raise in sea levels).

An examination of the results shows that the prevailing drainage congestion in some polders, such as CEP 25, 28/1, 28/2 and 36/1, could not be eliminated by increasing the ventage or dredging the associated rivers. This is because predominant areas in these polders are fairly low lying compared with water levels in the associated rivers. An alternative option involving pumped drainage system may have to be incorporated to relieve congestion. However, further studies using additional data will be necessary before finally selecting the most appropriate and cost effective option.

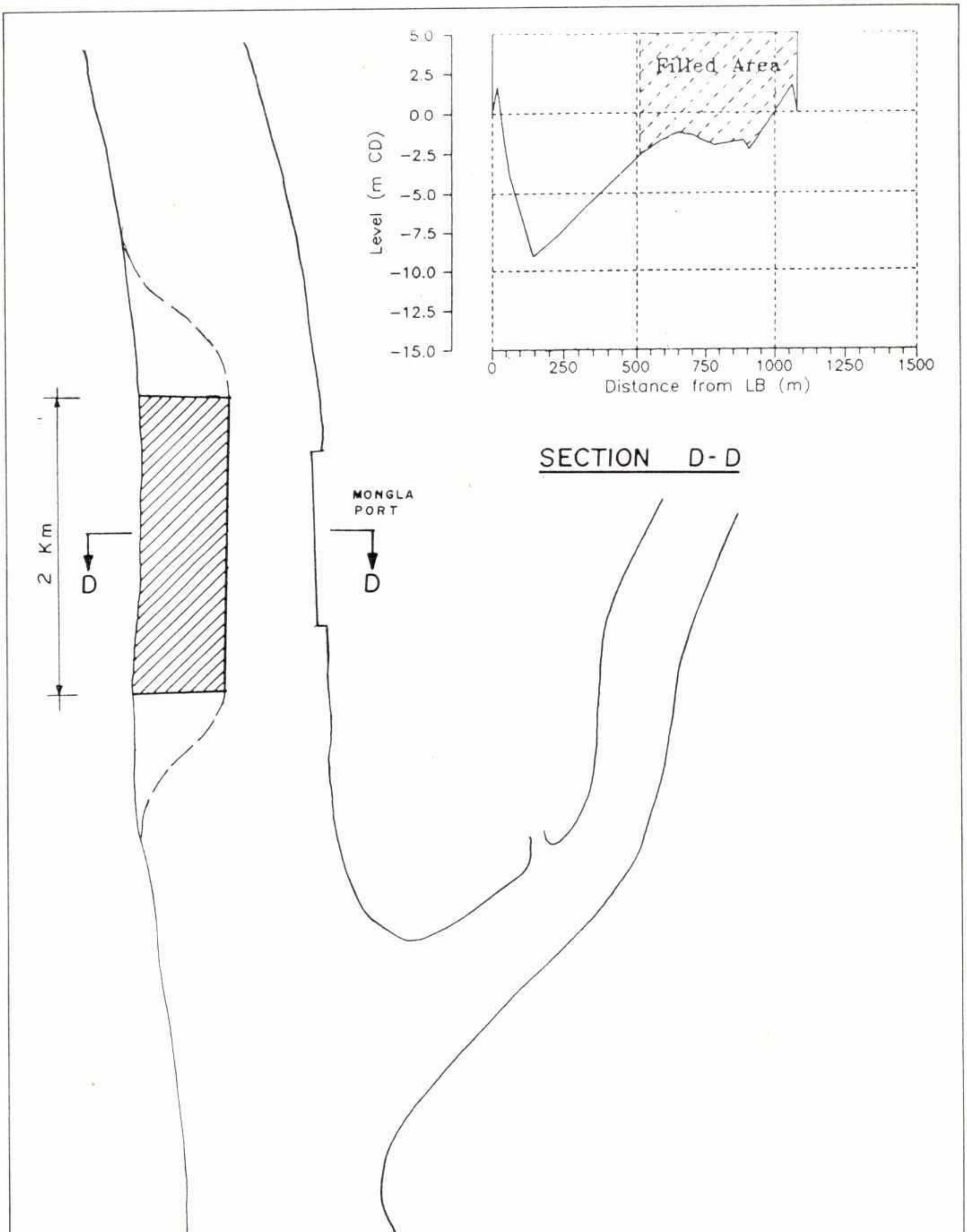
Results of the computer simulation analysis are given in Appendix E.

Figure 7.2



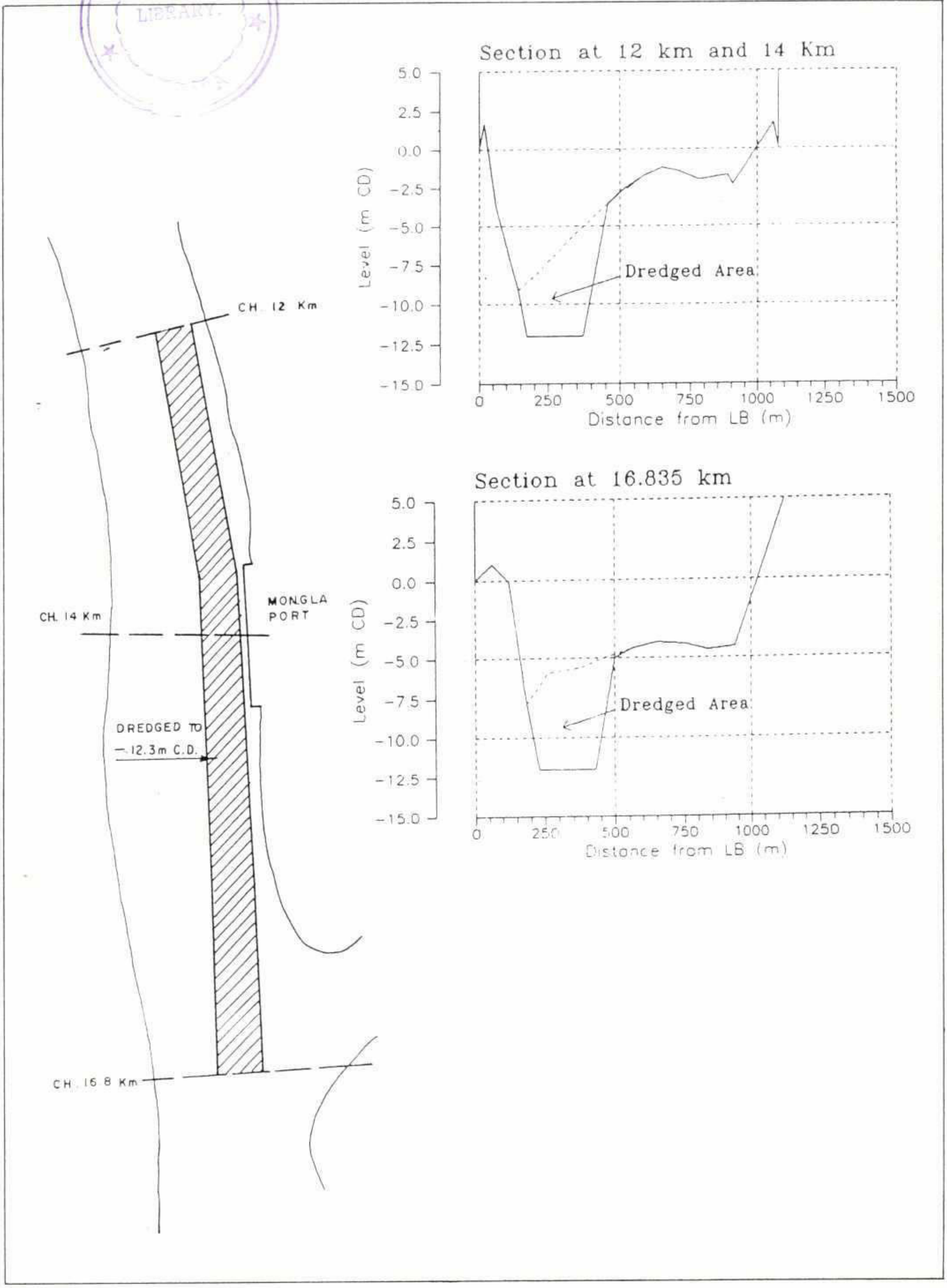
DHI Scheme 1
Closure of Pussur – Sibsa Connections

Figure 7.3



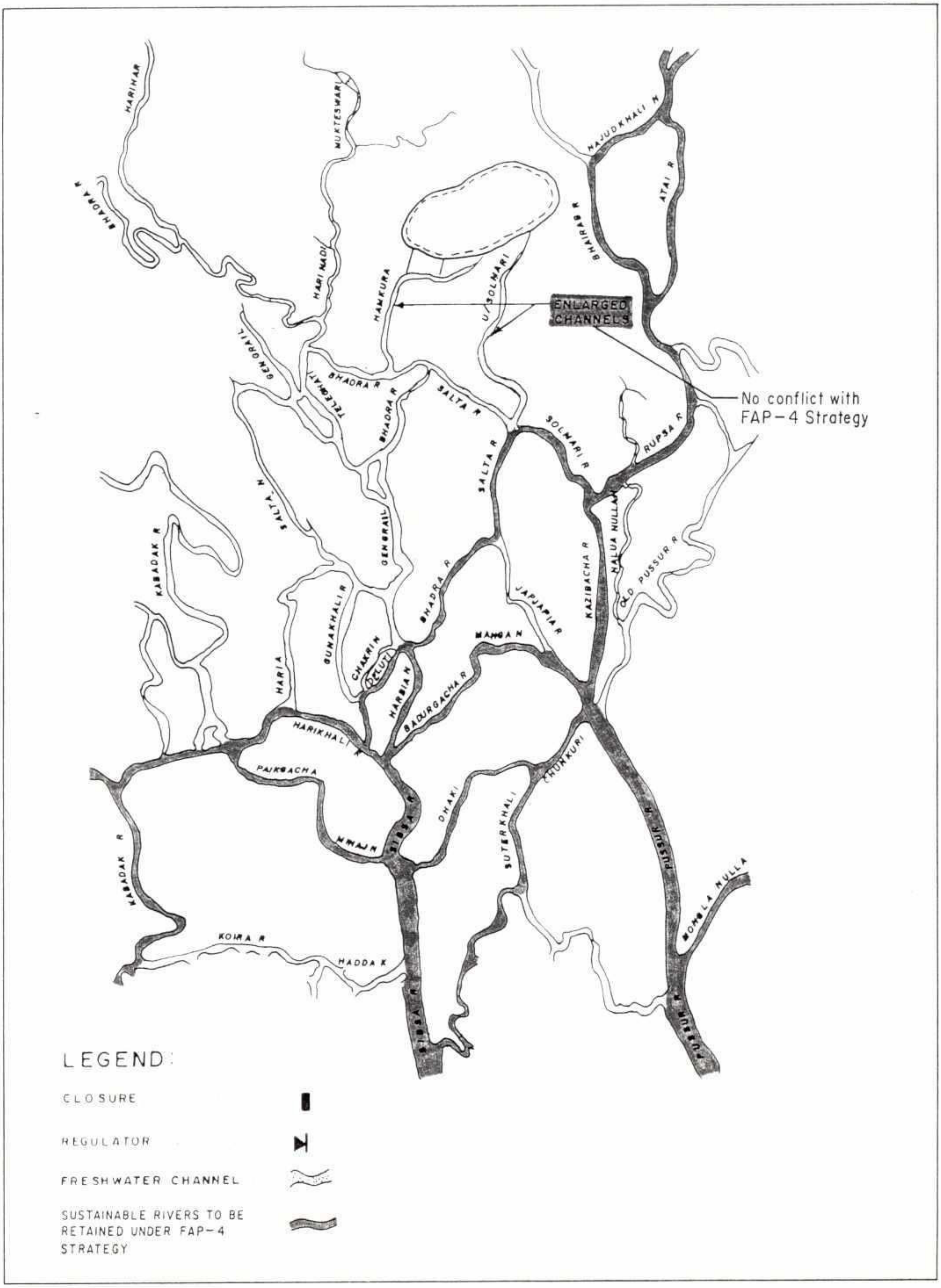
DHI Scheme 2
Constriction near Mongla Jetty

Figure 7.4



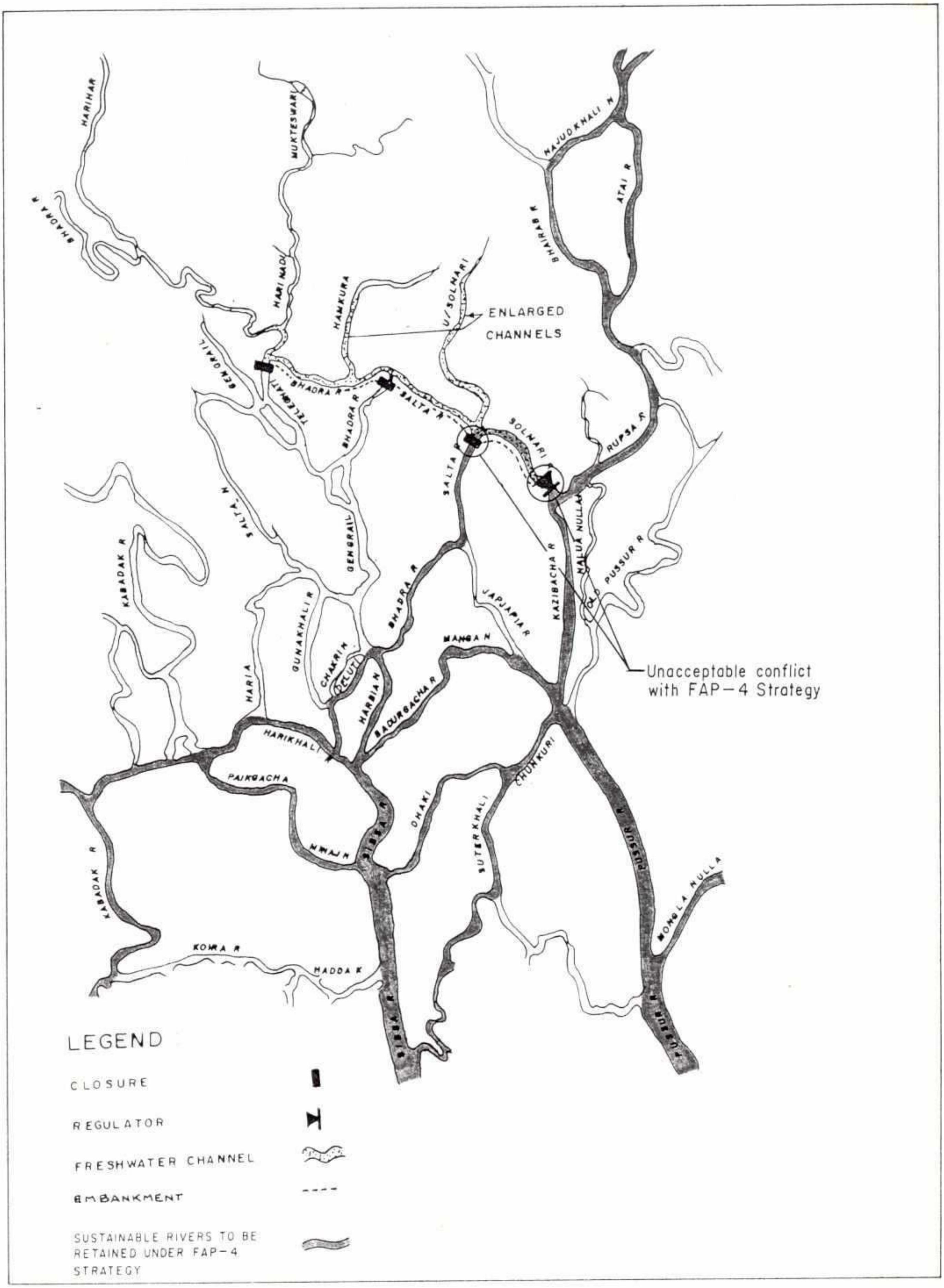
DHI Scheme 3
Dredging near Mongla Port

Figure 7.5



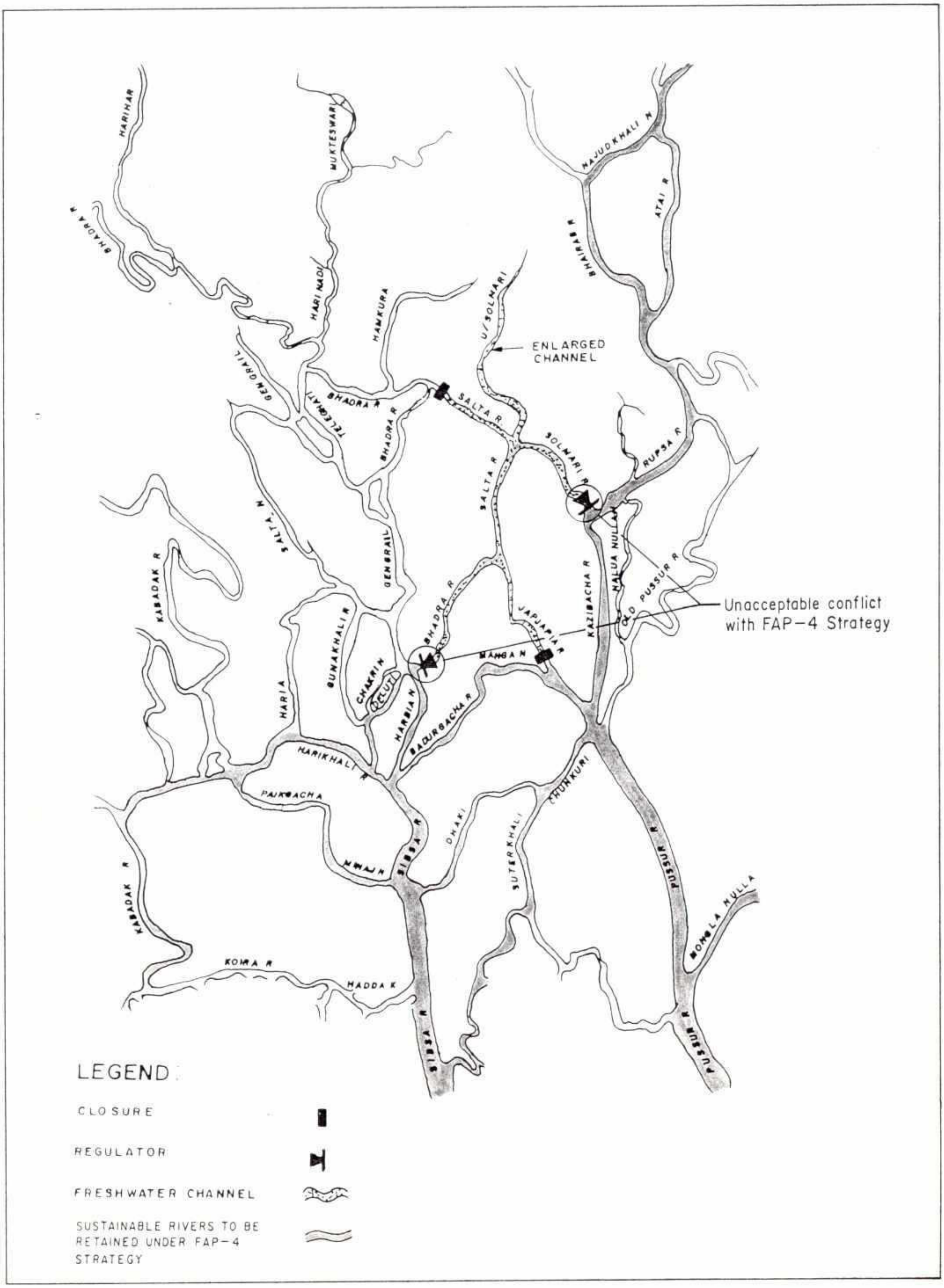
DHI Scheme 4
Surge Basin (Trunk Drainage via Solmari)

Figure 7.6



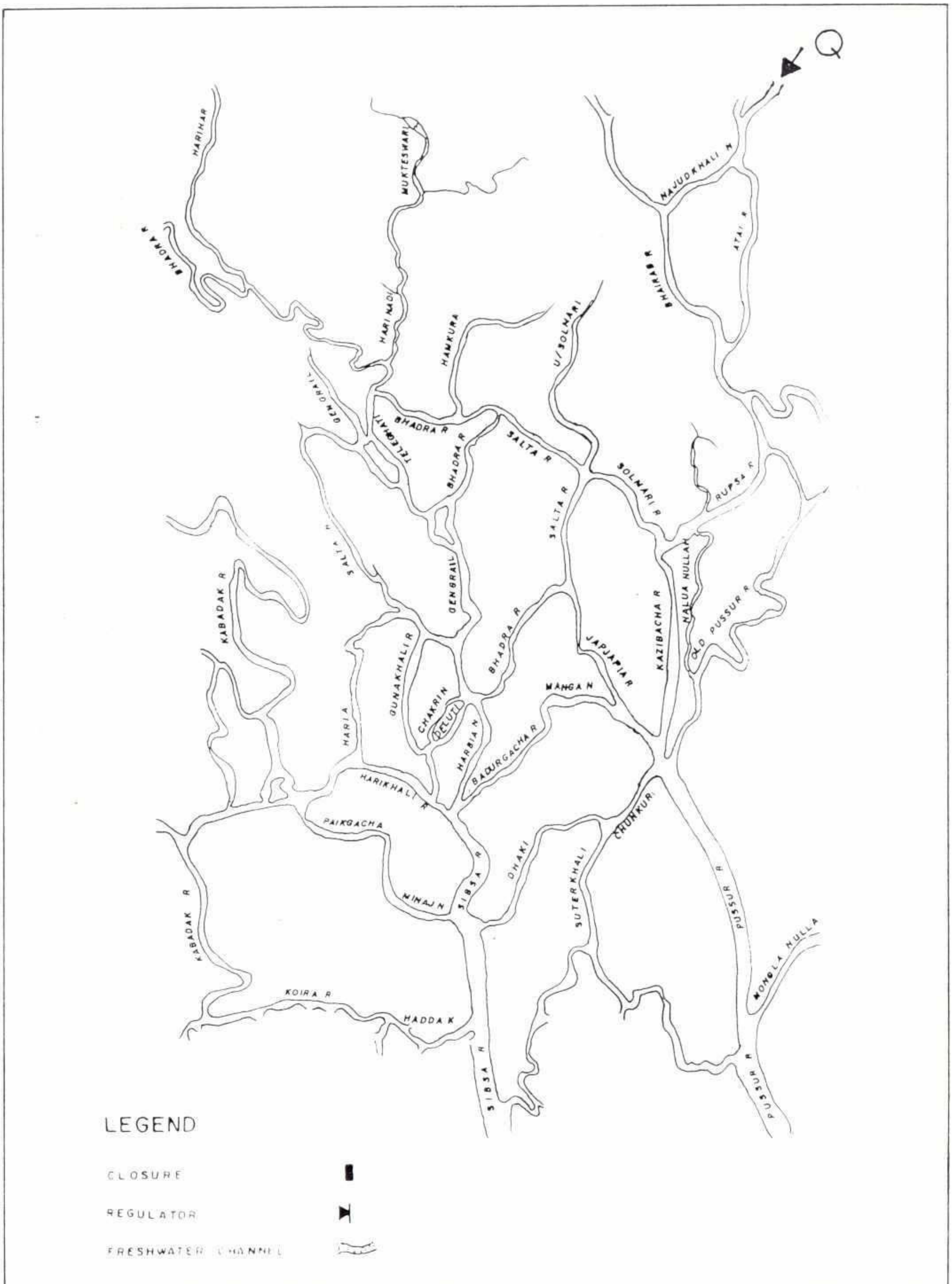
DHI Scheme 5
Empoldering (Bhadra + Salta + Solmari)

Figure 7.7



DHI Scheme 6
Extension of Freshwater Channels

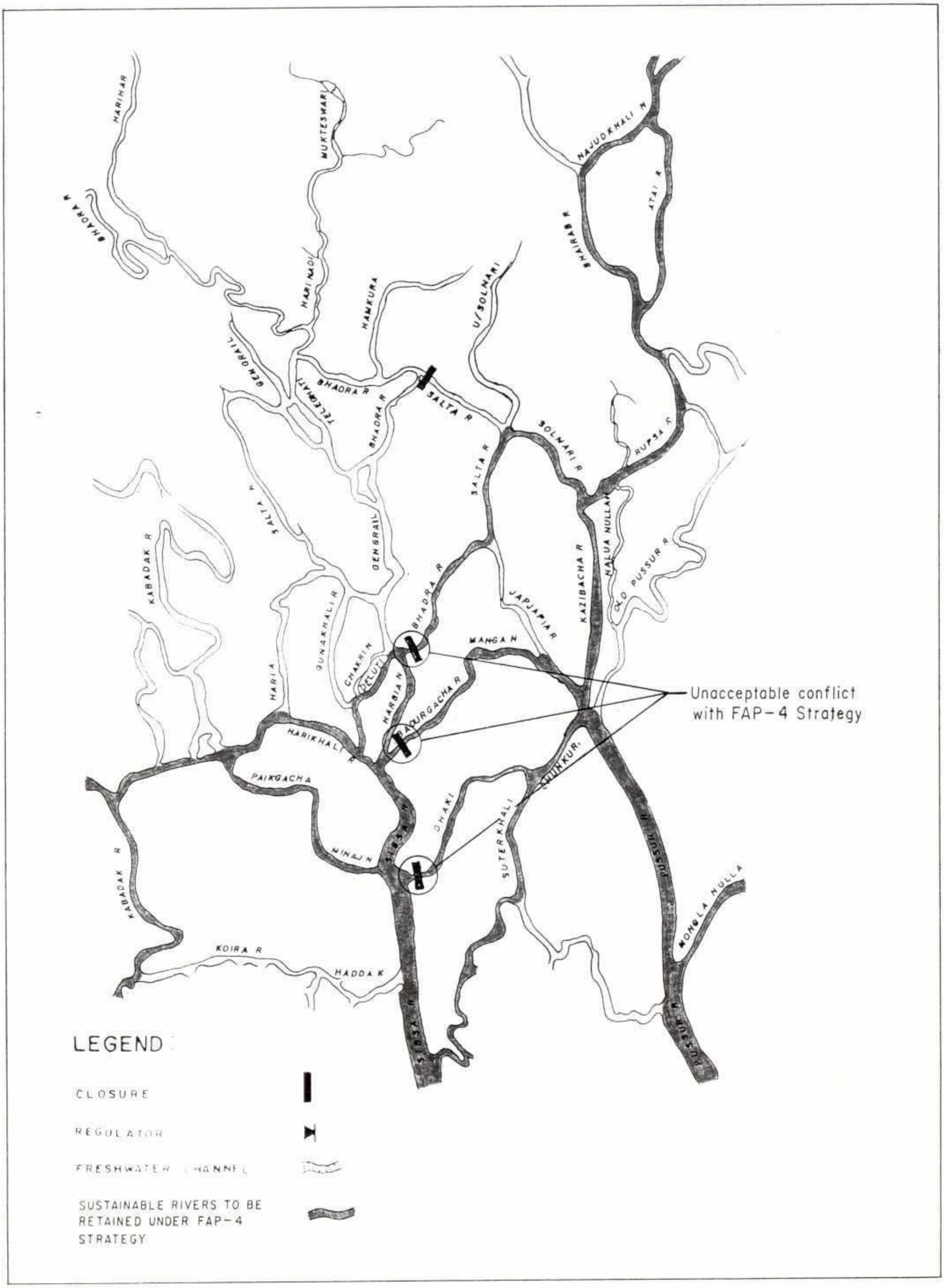
Figure 7.8



DHI Scheme 7

Increase of Freshwater Inflow during Dry Season ($Q = 1000 m^3/s$)

Figure 7.9



DHI Scheme 12
Closure of Salta, L. Bhadra, Badurgacha & Dhaki

8 RECOMMENDED INTERVENTIONS IN CEP AREA

8.1 Link between interventions and strategy

Interventions will be selected to revitalise the CEP and planned to be in harmony with the natural transitional processes of the delta.

As discussed in Section 5, polder drainage deterioration is a combination of "internal" and "external" factors. Internal factors relate to channels and sluices in the polder and external factors relate to the condition of the external rivers.

Table 8.1 shows the polders which will require revitalising and the type of intervention required. As discussed in Section 7 drainage will be directed towards sustainable rivers and where external interventions are proposed the necessary steps will be taken to ensure that these rivers remain sustainable. Table 8.1 also shows the nearest sustainable river adjacent to each polder. These rivers are also shown on Figure 8.1. It is essential that interventions in the CEP or elsewhere do not interfere with these rivers.

Table 8.1 is essentially a schedule of necessary projects in the CEP. Obviously they cannot all be carried out at once and as order of priority is required.

8.2 Prioritising Interventions

For the purposes of initial prioritisation it is assumed that internal and external interventions are carried out as separate exercises. External interventions are considered as major projects and internal interventions are considered as operation and maintenance projects.

A number of options for interventions to relieve drainage in the CEP have been considered in the areas where external interventions are urgently required. These are Satkhira, Khulna and Bagerhat. An outline of the problem and possible solutions is discussed below:

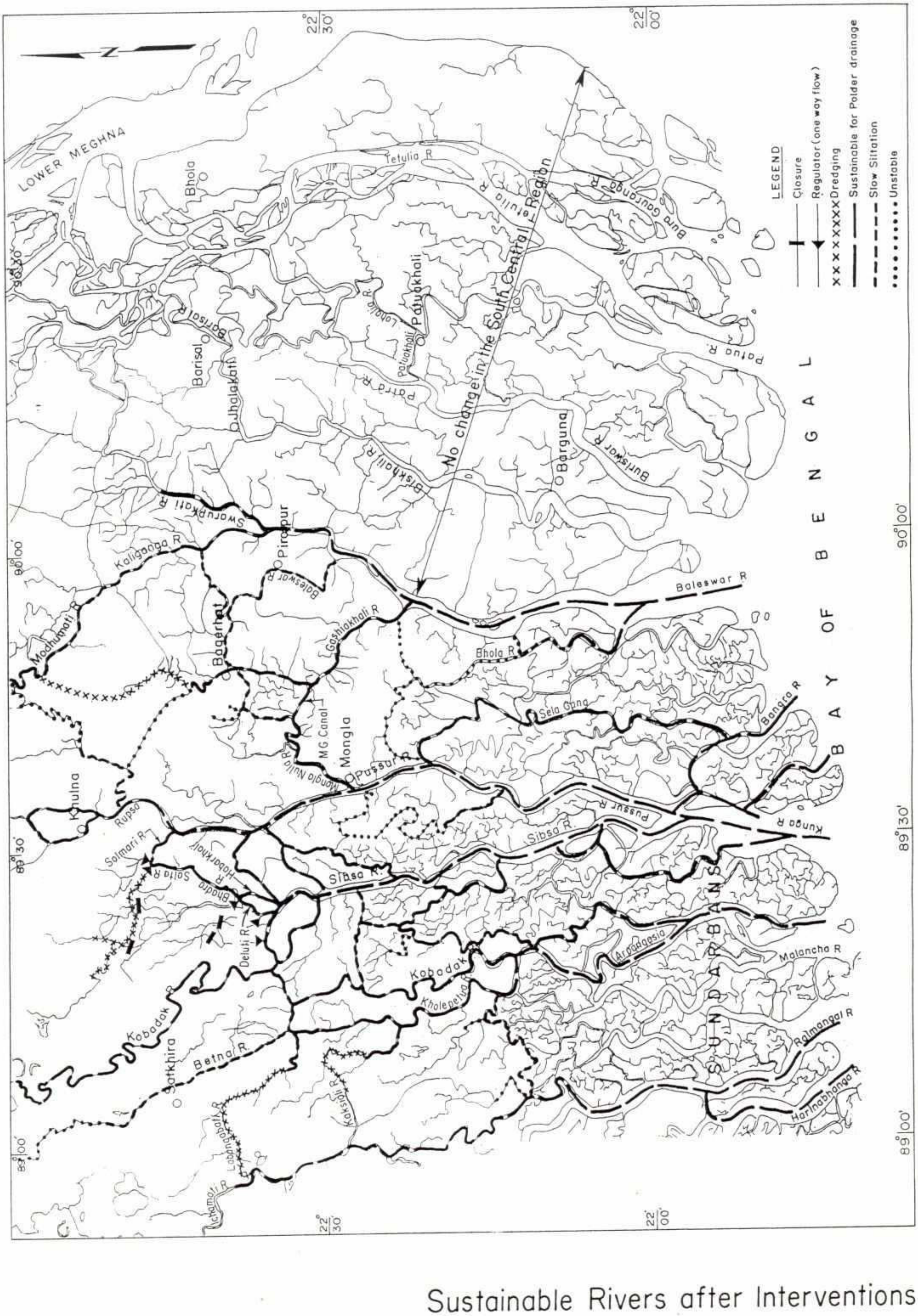
(i) Satkhira

The problem in this area is that the 'lateral' rivers: Labangabati; Morichap; Sapmara; Habra; Kanksiali and Galghasia are partially or totally silted. Polders 1,2 and 3 and to a lesser extent polders 4 and 5, do not have drainage access to sustainable rivers and hence polder performance is deteriorating. Active tidal rivers in the area are the Ichamati and the Kholpetua which run north-south and the aim of the external interventions is to make use of them. Two possible options, as shown on Figure 8.2, have been considered:

Option 1 - carry out dredging in the Labangabati; Morichap; Kanksiali and Gunakhali to create a tidal interchange between the Ichamati and Kholpetua. Existing information indicates that there is a significant head difference between these rivers which would help create sustainable lateral rivers;

Option 2 - remove the embankment in places and use the existing beel and flooded areas to act as a tidal surge basin with dredging to improve the channel cross-sections linking the basin with the Kholpetua. The anticipated benefit would be improved tidal flushing in the Kholpetua system.

Figure 8.1



Sustainable Rivers after Interventions

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(ii) Khulna

The problem in this area is that the tidal siltation, which has caused severe drainage congestion to polders 24, 25, 27/1, 27/2, 28/1 and 28/2, is progressively spreading southwards and will cause congestion in polders 16/1, 16/2, 17/1, 17/2, 18-19 and 26. The main rivers which are deteriorating are the Sreenadi/Hari Hamkura, Upper Solmari, Telighati, Middle Bhadra, Upper Salta, Gengrail and Salta West. The sustainable river systems, which could be used to prevent this deterioration, are the Kobadak-Lower Haria - Sibsa system and the Sibsa-Deluti-Lower Bhadra - Lower Solmari - Rupsa system. Three options as shown on Figure 8.2 have been considered for realigning drainage towards these systems:

Option 1 - improve the freshwater flow in the Sreenadi/Hari - Telighati - Gengrail system by diverting flow from the Nabaganga via the Majudkhali and a new canal to the Mukteshwari thereby creating a new sustainable north - south system;

Option 2 - create a macro polder by closing the Telighati and Middle Bhadra, dredging the Middle Bhadra and Upper Salta to create a sustainable lateral river and installing regulators on the upper Solmari, Upper Salta, Gengrail, Gunkhali and Haria to prevent silt re-entering the rivers adjacent to the congested polders listed above;

Option 3 - removing the embankment in places and use the two existing flooded areas in polders 24 and 25 as a tidal surge basin to create improved tidal flushing in the rivers to the south.

(iii) Bagerhat

The problem in this area is that the rivers surrounding polders 36/1, 34/1 and 34/3 are either heavily silted, as is the case with the Atharabanki, Lower Madhumati and Bhairab or deteriorating as is the case with the Duadkhali and Poylahara, thereby creating drainage congestion in the external sluices. In addition, the central part of polder 36/1 is lacking an active drainage canal. Two options, as shown on Figure 8.2 have been considered:

Option 1 - creating an active north-south river through polder 36/1 by dredging the Poylahara and reopening the Chitra river northwards to meet the Madhumati. The aim is to provide a drainage channel through the centre of the polder and to provide additional freshwater flushing to sustain the Poylahara.

Option 2 - use the existing flooded area in polder 36/1 as a tidal surge basin to improve tidal flushing in the Poylahara.

The model results of these options have been evaluated by comparison of the 'before' and 'after' situations in water level, discharge volumes, regime analysis and polder drainability, details of which are provided in Section 5.

TABLE 8.1

Schedule of Interventions

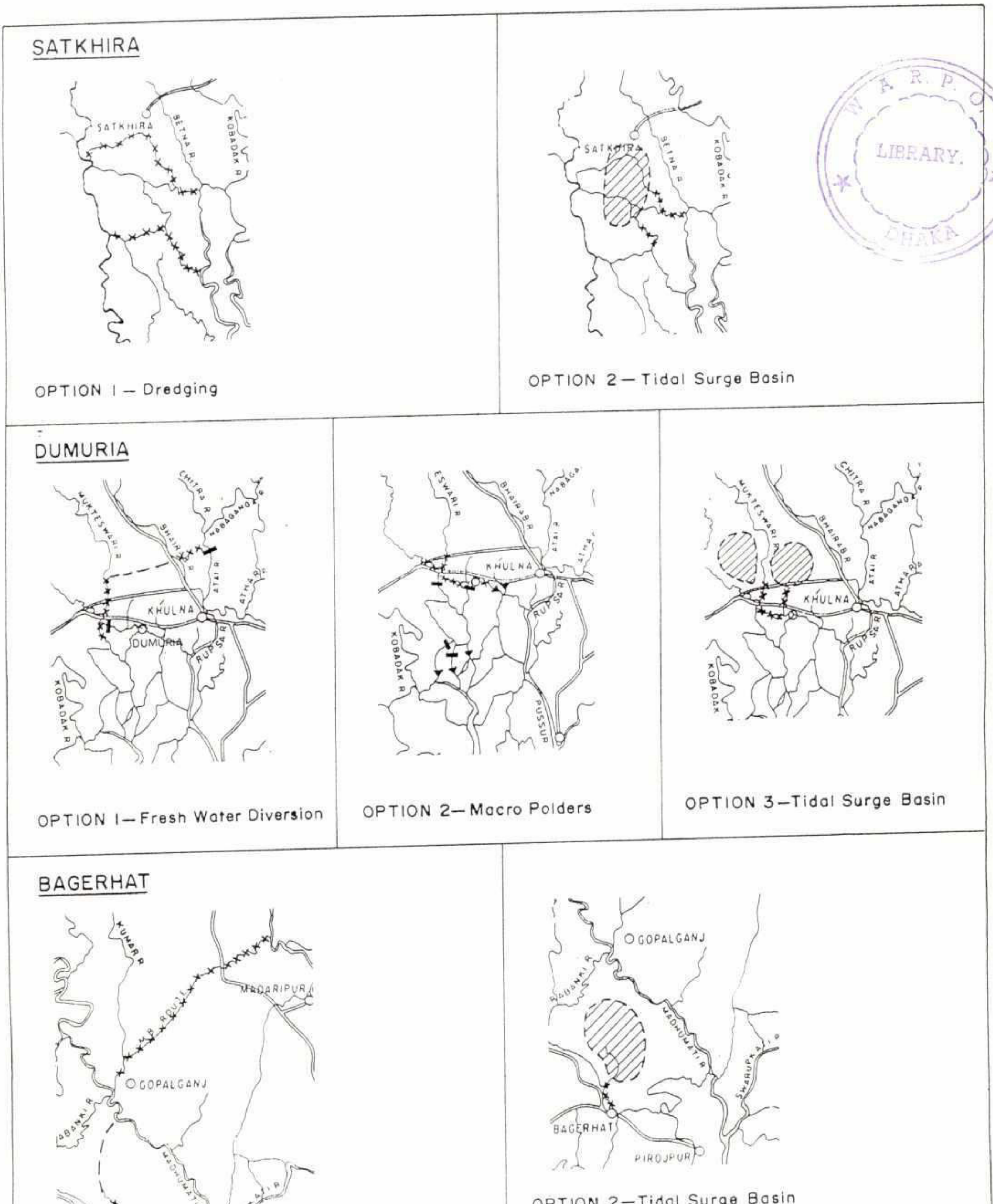
Polder No.	Area	Present Land Use		Change in Polder Performance		Intervention required	Adjacent Sustainable Rivers
	Net (Ha)	Rice	Shrimp				
		% of the net area within the Polder	% of the net area within the Polder	Present	Future		
1	26420	50	50	us	us	A + B	Kholpetua, Kobadak & Ichamati
2	10000	75	25	M	us	A + B	
3	14698	50	50	M	us	A + B	
4	7200	75	25	S	M	B	
5	42045	75	25	M	M	B	
6-8	20688	85	15	M	M	B	
7/1	3108	80	20	S	S	none	
7/2	7600	75	25	S	S	none	
10-12	16200	60	40	S	S	none	
13-14/2	10400	60	40	S	M	B	
14/1	2000	60	40	S	S	none	
15	2520	50	50	S	S	none	
16/1&16/2	10120	80	20	M	us	A + B	Sibsa, Deluti, Habarkhali, Bhadra, L. Salta, L. Solmari & Rupsa
17/1	3808	60	40	M	us	A + B	
17/2	2611	70	30	M	us	A + B	
18-19	3238	60	40	S	M	B	
20	1620	50	50	S	S	none	
21	1620	50	50	S	S	none	
22	1134	60	40	S	S	none	
23	4050	60	40	S	S	none	
24	23720	50	-	us	us	A + B	
25	13620	-	-	us	us	A + B	
26	2157	90	10	S	us	A + B	
27/1&27/2	3249	70	10	us	us	A + B	
28/1	4269	50	-	us	us	A + B	
28/2	1966	50	-	M	M	A + B	
29	6235	85	15	S	S	none	
30	5668	80	20	S	S	none	
31	9920	80	20	S	S	none	
32	9700	80	20	S	S	none	
33	7862	76	-	S	S	none	
34/1	1942	60	-	M	us	A + B	Swarupkati, Baleswar, Mongla, Nulla, Gashikhali, Rupsa & Pussur
34/3	2590	64	-	M	M	A + B	
35/1	13396	80	-	S	M	A + B	
35/3	4945	76	10	S	S	none	
36/1	32020	60	10	us	us	A + B	
39/1A	9400	86	-	S	S	none	Baleswar, Bishkhali, Buriswar, Patuakhali, Tentulia & Lohalia
39/1B&1D	10284	86	-	M	M	B	
39/1C	4003	86	-	S	M	B	
39/2	33260	83	-	M	M	B	
40/1	1747	77	-	M	us	B	
40/2	2834	77	-	M	us	B	
41/1	2632	81	-				

Note : A = external intervention to ensure adjacent rivers remain sustainable
B = internal improvement in polders drainage system

TABLE 8.1 (continued)

Polder No.	Net (Ha)	Present Land Use: Rice — % of the net area within the Polder	Present Land Use: Shrimp — % of the net area within the Polder	Change in Polder Performance: Present	Change in Polder Performance: Future	Intervention Required	Adjacent Sustainable Rivers
41/2	2308	81	-	M	US	B	
41/3	729	90	-	M	US	B	
41/4	1012	83	-	M	US	B	
41/5	2024	83	-	M	US	B	
41/6A	2834	70	-	S	US	B	
41/6B	5560	70	-	S	US	B	
41/7	4858	70	-	S	M	B	
42	2291	82	-	S	M	B	
43/1&43/1A	12978	80	-	S	M	B	
43/2A	3239	67	-	S	M	B	
43/2B	5247	75	-	S	M	B	
43/2C	2146	78	-	S	M	B	
43/2D	6000	78	-	S	M	B	
43/2E	1350	82	-	S	M	B	Baleswar
43/2F	3250	80	-	S	M	B	Bishkhali
44	14024	71	-	M	US	B	Buriswar
45	3108	76	-	M	US	B	Patuakhali
46	2834	70	-	M	US	B	Tentulia
47/1	1870	90	-	S	US	B	Lohalia
47/2	850	83	10	US	US	B	
47/3	2105	87	10	US	US	B	
47/4	2632	72	10	M	US	B	
47/5	1457	89	10	S	M	B	
48	4861	90	10	S	M	B	
52/53A&B	6440	80	-	S	M	B	
54	7545	90	-	S	M	B	
55/1	7800	72	10	M	US	B	
55/2A	10715	90	-	S	M	B	
55/2B	2378	90	-	S	M	B	
55/2C	6024	90	-	S	M	B	
55/2D	18224	90	-	S	M	B	
55/3	7403	75	-	S	M	B	
55/4	4288	80	-	S	M	B	
56-57	74992	90	-	S	S	none	
	621977						

Figure 8.2



External Interventions in C.E.P. Polders

8.3 Modelling of Interventions

8.3.1 Model Scenarios

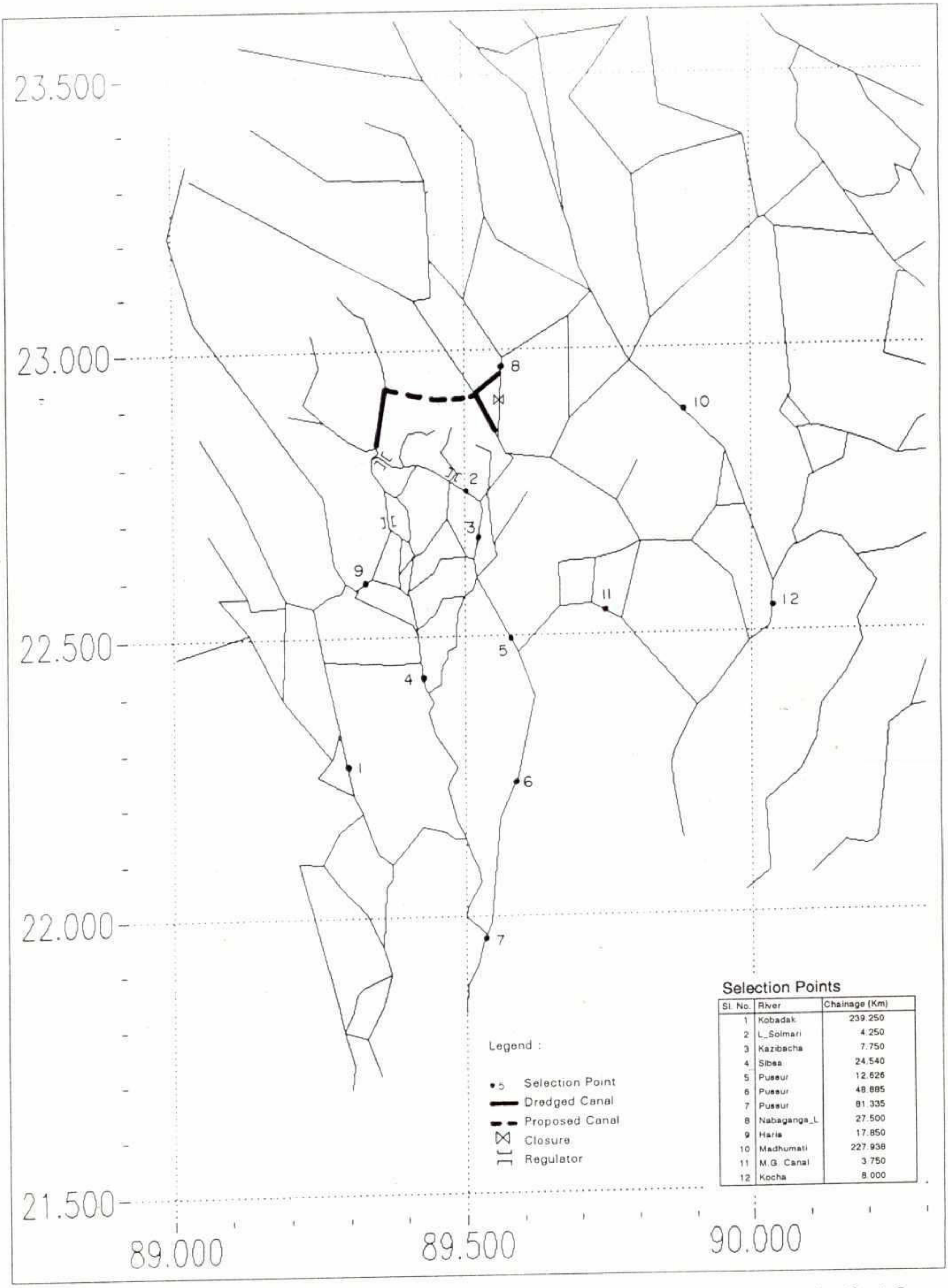
Further to the modelling of the present and future "do nothing" situations a total of nine different scenarios have been tested by the SWAM model for April and August 1991 representing dry and wet season conditions respectively. The main purpose of the tests is to provide information that may be compared with the present day and "do nothing" conditions. As described in Section 5.1 the regime analysis of the model results has been used for making this comparison. A short description of each scenario is given below and shown on Figures 8.3 to 8.9. Table 8.2 shows the interventions that have been made. For ease of reference the scenario numbers are the same as those used in Volume 2-Hydraulic Studies.

TABLE 8.2

'SWAM' Model Setup for Interventions in the CEP Area

Scenario	River	Chainage (km)		Nature of Intervention				Remarks
				Closure	Dredging	Regular	Surge Basin	
6.4.2	Conn-Hari	0.000	17.000		x			Proposed link canal
	Hari	0.000	14.000		x			
	Majudkhali	0.000	8.500		x			
	Bhairab U	123.000	137.000		x			
	Atai	3.000	17.000	x				
	U.Solmari	13.000				x		
	Bhadra	19.500				x		
	Salta(W)	23.200				x		
6.4.3	Galghasia	0.000	20.500		x			Connection of Kanksiali and Labangabati with Ichamati river
	Kanksiali	0.000	17.000		x			
	Morirchap	7.000	17.000		x			
	Labangabati	0.000	32.500		x			
6.4.4	Teligati	0.000	7.500	x				
	Bhadra	19.000	28.500		x			
	Bhadra	28.500	37.500	x				
	Haria	0.000	13.500	x		x		
	Salta	0.000	8.500		x	x		
	Gunkhali	0.000	8.500	x		x		
	Ghengrail	20.500				x		
	U.Solmari	13.500				x		
6.4.5	Bhadra	28.500	37.500					
	Haria	0.000	13.500			x		
	Gunkhali	0.000	8.500			x		
	Ghengrail	20.500				x		-
	U.Solmari	13.500				x		
6.4.6	Labangabati	17.500					160.0km²	Polder 1&2
	Galghasia	0.000	20.500		x		120.0km²	Polder 3&4 at 0.0 Km
	Hari	0.000	14.000		x		92.5km²	Polder 24 at 0.0 Km
	Hamkura	2.900	5.400		x		92.5km²	Polder 25 at 0.0 Km
	Bhadra	19.000	28.500		x			
	Poylahara	0.000	7.000		x		290.0km²	Polder 36 at 0.0 Km
	Old Pussur	21.525					115.0km²	Polder 34/2
6.4.7	Kumar-1	0.000	20.500		x			
	Atharobanki	0.000	32.000		x			
	Bhairab	0.000	17.000		x			
6.4.8	Kumar-1	0.000	20.500		x			Link canal connecting Poylahara and Madhumati
	Poylahara	0.000	7.000		x			
	Chitra	0.000	22.000		x			
	Atharobanki	0.000	32.000		x			

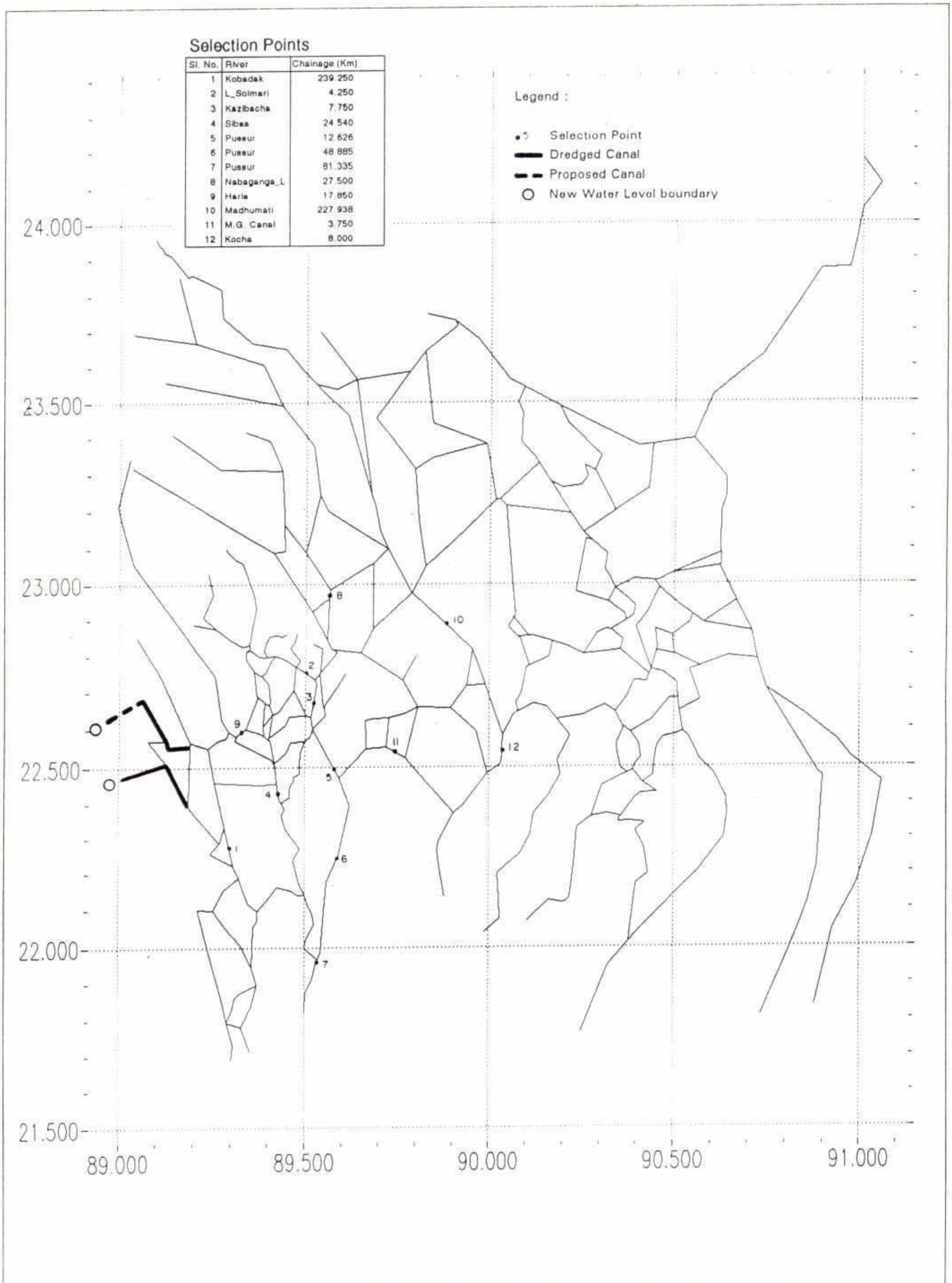
Figure 8.3



Sl. No.	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Pussur	12.626
6	Pussur	48.885
7	Pussur	81.335
8	Nabaganga_L	27.500
9	Haria	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000

Improvement of Polder Drainage. Scenario 6.4.2: Diversion of Water from Nabaganga to Hari

Figure 8.4



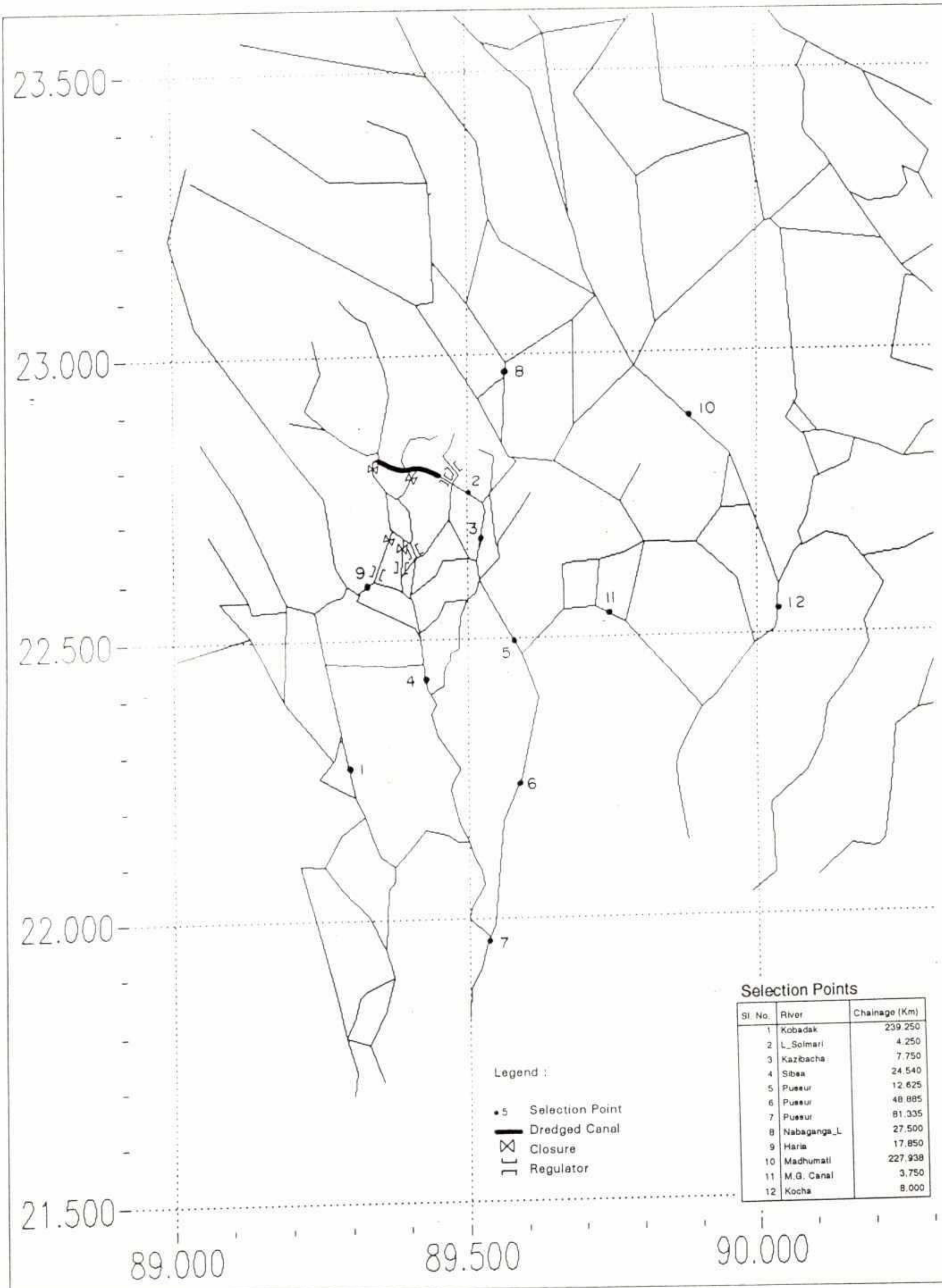
Selection Points

Sl. No.	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Pussur	12.626
6	Pussur	48.885
7	Pussur	81.335
8	Nabaganga_L	27.500
9	Harla	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000

Improvement of Polder drainage. Scenario 6.4.3 :
Connection of Kanksiali and Labangabati with Ichamati

L01

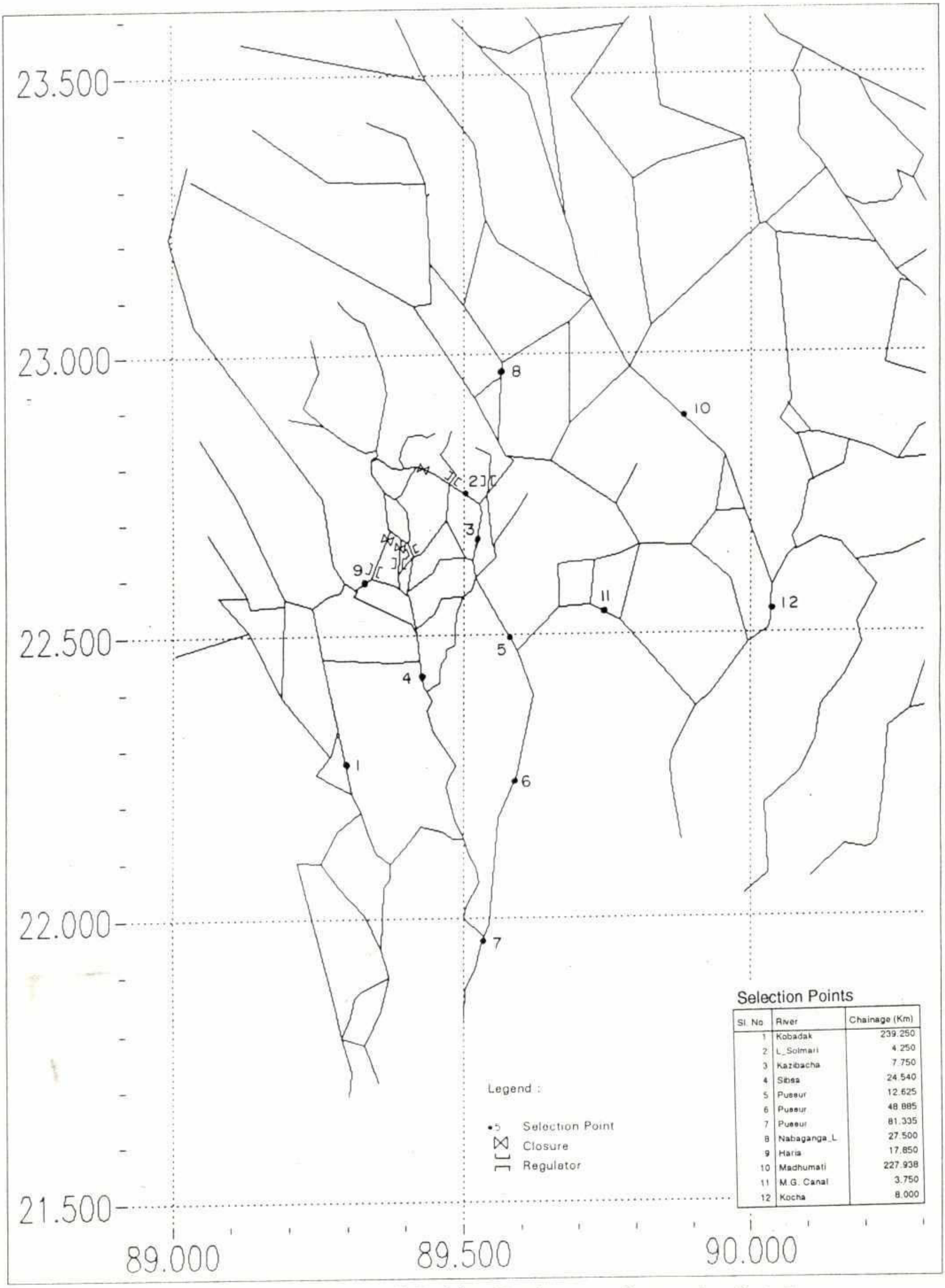
Figure 8.5



Sl. No.	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Pussur	12.625
6	Pussur	48.885
7	Pussur	81.335
8	Nabaganga_L	27.500
9	Haria	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000

Improvement of Polder Drainage. Scenario 6.4.4. Repositioning of Drainage Outlets of the Polders 24 and 25

Figure 8.6

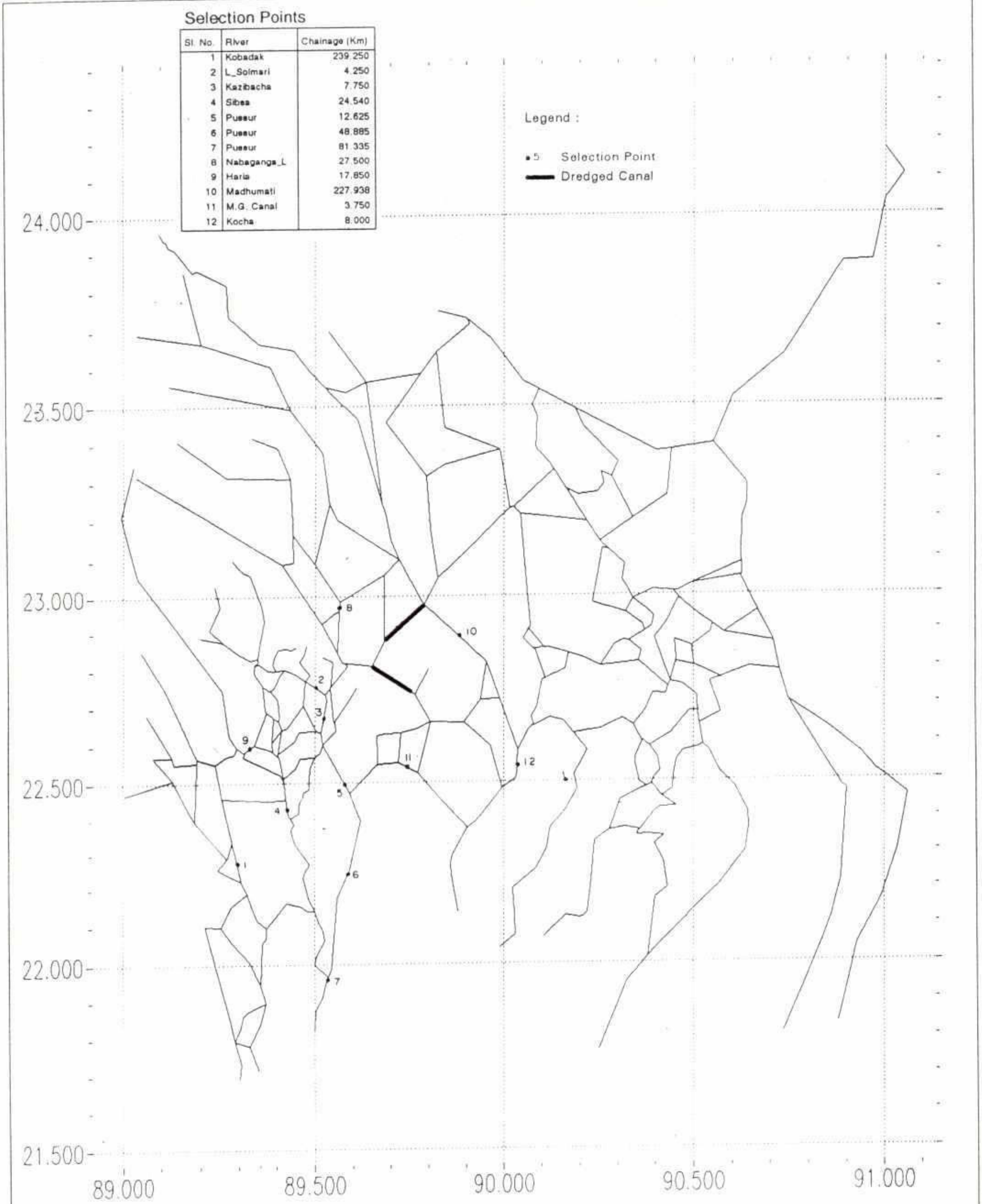


Selection Points

Sl. No	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Puseur	12.625
6	Puseur	48.885
7	Puseur	81.335
8	Nabaganga_L	27.500
9	Haria	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000

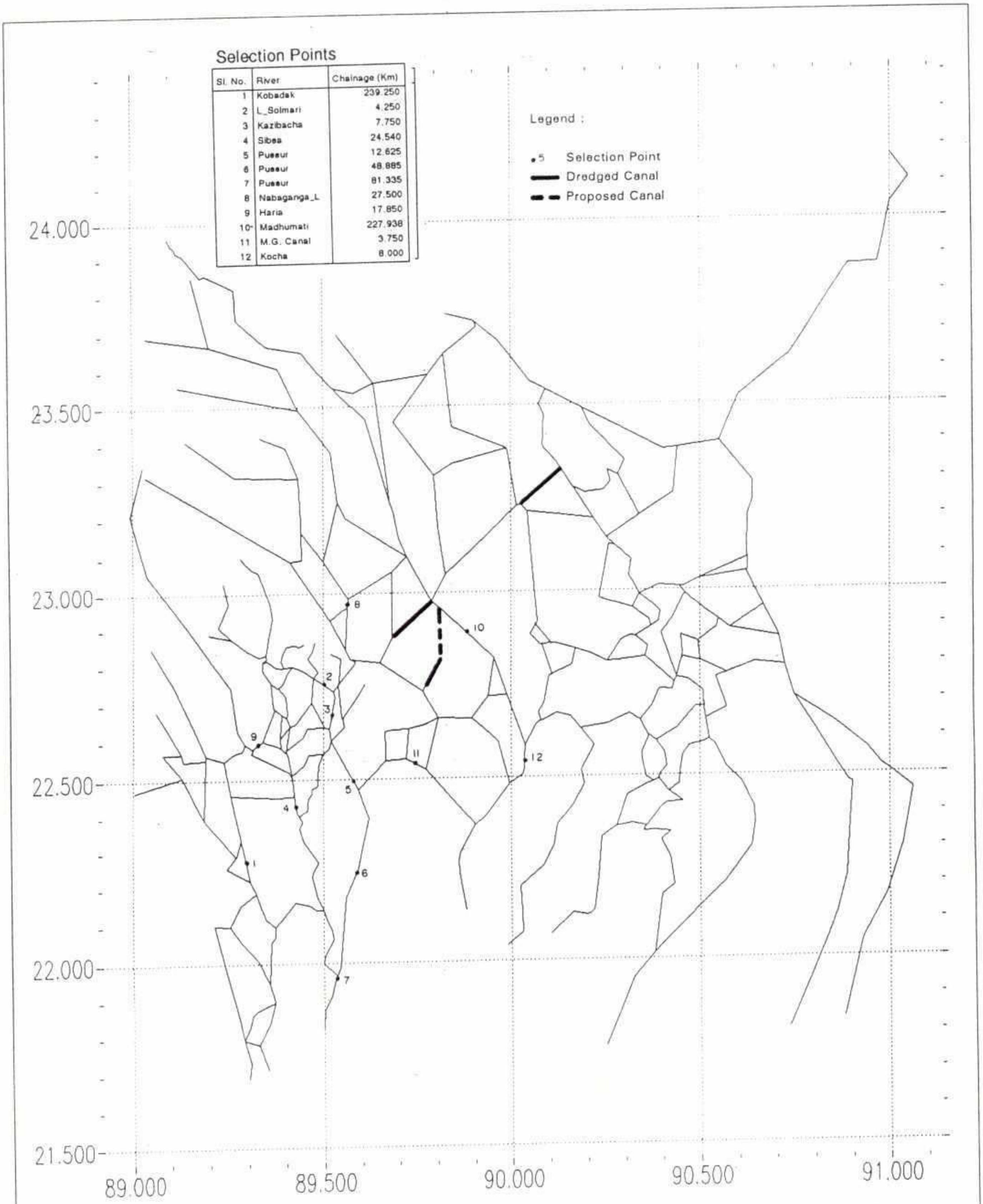
Improvement of Polder Drainage. Scenario 6.4.5: Macro Poldarization with Drainage Outlets Into Living Rivers Only

Figure 8.8



Improvement of Polder Drainage. Scenario 6.4.7: Reopening of the Atharobanki, Bhairab and Poylahara Rivers

Figure 8.9



Selection Points

Sl. No.	River	Chainage (Km)
1	Kobadak	239.250
2	L_Solmari	4.250
3	Kazibacha	7.750
4	Sibsa	24.540
5	Pussur	12.625
6	Pussur	48.885
7	Pussur	81.335
8	Nabaganga_L	27.500
9	Haria	17.850
10	Madhumati	227.938
11	M.G. Canal	3.750
12	Kocha	8.000

Improvement of Polder Drainage. Scenario 6.4.8: Opening of the Chitra Channel in Polder 36 to Madhumati

Scenario 6.4.2 Diversion of Water from the Nabaganga to Mukteswari

The objective of this scenario, is to test the effects on the hydraulic conditions in the western parts of the polder area if fresh water is diverted from the Nabaganga River via a new canal across Beel Dakatia into the Hari river.

The Atai river is closed by structures, to facilitate diversion of water through the new canal and to counter balance this intervention the Bhairab_U and Majudkhali branches are excavated. Strategic dredging is also assumed in Hari (see Figure 8.3).

Scenario 6.4.3 Connection of Kanksiali and Labangabati with the Ichamati River

The rivers Galgasia, Kanksiali, Morirchap and Labangabati is assumed dredged to create a connection to the Ichamati river on the Border to India. The Ichamati has a very high tidal range in this reach and is supposed capable of providing enough tidal motion to keep the dredged channels open, and hereby improve the drainage capability of the surrounding drainage congested polders. Observed water levels as collected by BWDB in the Stations Bansana and Sakara is used as boundary conditions in the Ichamati river (see Figure 8.4).

Scenario 6.4.4 Repositioning of Drainage Outlets of Polders 24 and 25

This scenario is of one of the suggested options for improving the draining the polders 24 and 25 into dredged reaches of Bhadra and U_Salta. Additional regulators are introduced enabling the polders s 17/1&2, 18, 19 20 and 26 to drain directly into highly dynamic channels, which are unlikely to silt up (see Figure 8.5).

Scenario 6.4.5 Macro Polderization with Drainage Outlets into Living Rivers Only

This is an alternative to the above scenario 6.4.4 and considers macro polderization by closure of U_Salta and draining of the polders 24,17/1,17/2,18,19,20 & 29 directly into highly dynamic channels (see Figure 8.6).

Scenario 6.4.6 Introduction of Tidal Surge Basins in Existing Drainage Congested Areas

The effects of introduction of surge basins in drainage congested areas to increase the tidal volume flowing into the polder area and the effects from this on the velocities and stability of the channels is tested in this scheme. Surge basins are inserted in the polders 1,2,3,4,24,25,34/2 and 36 (see Figure 8.7).

Scenario 6.4.7 Reopening of the Atharobanki, Bhairab and Poylahara Rivers

This scenario tests the effects of reopening the Atharobanki and dredging the Bhairab and Poylahara Rivers, which has been suggested for improvement of the drainage congestion in polder 36 (see Figure 8.8).

Scenario 6.4.8 Opening of the Chitra Channel in Polder 36 to Madhumati

The drainage congestion in polder 36 might also be alleviated by opening the internal Chitra channel toward the Madhumati. This scenario tests the effects of this intervention (see Figure 8.9).

Scenario 6.4.9 Combination of Preferred Options

The most promising interventions for each area are tested simultaneously to obtain the Regional impact. Scenario 6.4.3 is combined with 6.4.5 and 6.4.8.

Scenario 6.4.10 Diversion of Water from the Nabaganga to Hari

This scenario is the same as 6.4.9 except that a barrier is introduced downstream of the Chitra connection with the Modhumati to try and improve flow in the Chitra.

8.3.2 Model Results

The model results are as follows:

Scenario 6.4.2 Diversion of Water from the Nabaganga to Hari

In April the assumed connection between Majudkhali and Hari introduces a small North going net flow in hari, but a large (283 m^3/s) South going flow in August where the water levels in Nabaganga are high. The intervention leads to a small reduction in the inflow through the Nabaganga, and also has an impact on the net flow in Pussur and Sibsa.

In Nabaganga 20-40% and 40-70% decreases in maximum velocities and tidal range respectively are found. In the wet season this velocity reduction pushes around 20% more water down into the lower reaches of Madhumati and into the Baleswar system.

Scenario 6.4.3 Connection of Kanksiali and Labangabati with the Ichamati River

The opening to Ichamati introduces significant East-going net flows in the Dredged channels which proceed southward through Galgasia Kholpetua and Kobadak. The intervention generates small increases in the flow from the Kobadak into the Sibsa system through the connection at Paikgacha and Koira river. Although these increments are found to be only around 2 m^3/s (12%) at each location in the dry season the effects will influence negatively the salinity conditions in the area West of Paikgacha. Hence this impact will be studied by salinity simulation.

The maximum velocities in the rivers Morirchap, Habra, Galgasia, Kholpetua and Labangabati will increase significantly, whereas in Haria at Paikgacha they will generally decrease during flood and increase slightly during ebb. The velocities at more distant locations will not change much. The simulated effects on the tidal range are a significant rise in the branches close to the intervention and negligible changes in the rest of the system.

Evaluating the above findings it should be emphasized, that boundary data applied in Basantapur and Sakara are observed data as collected by BWDB, which has not been quality checked by FAP4. They might be of dubious quality, which in turn will affect the quality of the results. Hence if it is decided to proceed any further with examination of this option the data could be checked for consistency and salinity data form the Ichamati river should be collected.

Scenario 6.4.4 Repositioning of the Drainage Outlets of Polders 24 and 25

The results outside the empoldered areas show increases in the flow velocities in Lower Solmari and Haria of up to 77%, but reduction in the velocities in the upper reaches of Pussur and Sibsa (0-25%). In the rest of the area the changes are insignificant. Furthermore a part of the Sibsa net flow is shifted to Pussur and Kobadak, whereas the effects in the rest of the investigated channels are negligible.

Scenario 6.4.5 Macro Polderization with Drainage Outlets into Living Rivers Only

The scenario is very similar to the above one, therefore the model also give nearly identical results in the regional rivers. Compared to the above scenario the drainage outlet of polder

24 has been changed to lower Gengrail close to Habarkhali. This change of course increases the net flows in the Habarkhali river slightly during the wet season. The max. velocities in this river, however, are the same in the two scenarios.

Scenario 6.4.6 Introduction of Tidal Surge Basins in Existing Drainage Congested Areas

The results for the twelve key locations show that except for two locations, namely Mongla and L_solmari the maximum velocities during flood and ebb decreases.

Hence introduction of surge basins, although having a positive effect on the rivers close to the basins, may aggravate the siltation situation at locations remote to the interventions.

Scenario 6.4.7 Reopening of the Atharobanki, Bhairab and Poylahara Rivers

The effect on the dry season net flows in the systems are decreases in the upper reaches of Pussur and Sibsa in the orders of 40% and 10% respectively and an augmentation in the Bhairab of 20 m^3/s. The effects on the velocities are amplification in the dredged reaches and the directly connected reaches eg. in Madhumati. In other areas the influence is negligible.

Scenario 6.4.8 Opening of the Chitra Channel in Polder 36 to Madhumati

This scenario increases the South going net flow in the Chitra and Poylahara channels by 18 and 208 m3/s in the dry sand wet seasons respectively. The changes in net flow pattern will be a small decrease in the Nabaganga and in the upper reaches of Pussur and Sibsa. The intervention has very small impacts on the max velocities in the rivers except in the dredged reaches.

8.3.3 Analysis of Model Results

The model results of these options have been evaluated by comparison of the 'before' and 'after' situations in water level, discharge volumes, regime analysis and polder drainability, details of which are provided in Volume 2.

The results are summarised as follows:

(i) Satkhira

Dredging in the Labangabati, Morichap, Kanksiali and Gunakhali is shown to have a significant impact on the net flows in these rivers - in excess of a ten times increase in dry season flows and doubling in wet season flows. Regime analysis of the results show that these rivers are transformed from dying to active, sustainable rivers with further improvement to the Kholpetua system. These changes would create improved drainage in polders 1, 2, 3, 4 and 5. However, it must be pointed out that field data in this area is of low quality and further data to improve model boundary conditions will be required if it is decided to proceed further with this option.

Utilizing the existing flooded areas as tidal surge basins results in an improvement in flow characteristics in the rivers close to the surge basin, but a redistribution of flows are shown in the short term at locations further away. This could result in initial siltation at these locations which should gradually migrate downstream.

Analyses of the drainability of polders in the area indicate that polders 1,2 and 3 in particular would benefit from improved ventage at the sluice outlets.

(ii) Khulna

Diversion of freshwater flow from the Nabaganga to the Mukteshwari does not provide sufficient flow in the dry season to prevent the Mukteshwari from silting. Although the wet season flow is greatly increased, it is considered that the dry season effects will dominate.

The creation of macro polders causes significant increases in maximum flow in the Lower Solmari and Habarkhali. The additional flow in the Habarkhali creates a slight backwater effect on the Sibsa flood tide thereby forcing additional flow westwards to the Kobadak and eastwards to the Pussur through the lateral rivers. This effect is, however, considered to be short term until the Lower Bhadra cross-section has increased sufficiently to accommodate the increased flow, when flow patterns will return to the existing stable condition.

The tidal surge basin option demonstrated similar effects to those observed at Satkhira with improved tidal flushing adjacent to the polder but potential siltation further south, which will migrate downstream.

Analyses of polder drainability show that polders 24, 25, 28/1 and 28/2 are particularly difficult to drain by gravitational means. Increases in ventage do not indicate significant improvements in the highest flood area classifications (F3 and F2). However, improvements in the lower categories (from F2 to F1) would be possible. This situation arises because the land in this area is particularly low. If these area are incorporated into a macro polders some improvements will be effected. If these improvements were insufficient to justify the investment pumped drainage may be considered as a possible alternative. This would need to be established as a result of more detailed studies.

(iii) Bagerhat

Dredging of the Chitra - Poylahara was only found to create a sustainable channel when this was combined with increased flow from the Madaripur Beel Route (MBR). The necessary increase was created by dredging the Kumar River and MBR. Even with this additional flow, the dry season period is likely to show some siltation, however, the improved wet season flows are likely to dominate. In order to control flows through the Chitra within the polder control structures would be required at both the northern and southern boundaries. The southern control would prevent saline intrusion during the dry season and the northern control would regulate flooding and flushing during the wet season.

As in Satkhira and Dumuria, utilising the flooded area as a tidal surge basin appears to provide only localised benefit with potential siltation further south.

Analyses of polder drainability indicate that polder 36/1 has particularly poor gravity drainage characteristics due to the tidal characteristics surrounding the polder. Increases in ventage do not appear to effect significant improvement in the distribution of flood area classifications and only changes some F3 category to F2. Therefore in this case pumped drainage should be considered as a possible viable alternative to be investigated at the pre-feasibility stage.

Based on the above analysis the preferred options for external interventions are:

Satkhira	-	Option 1, dredging
Khulna	-	Option 2, macro polders
Bagerhat	-	Option 1, dredging

It should be noted that the Bagerhat option is the least robust of the three. There are a number of difficulties in providing freshwater flows to the area and a very high degree of control would be required to provide adequate drainage even with the scheme in place. It will also be noted in Section 9.2 that the initial capital cost are estimated to be extremely high when compared to other areas and this must be considered together with the potentially high costs associated with maintaining adequate discharge through maintenance dredging in the Madaripur Beel Route.

The results of carrying out regime analysis of the river system with these three options combined is shown in Table 8.3 where the influence on the rivers throughout the coastal region can be seen. Figure 8.10 shows the corresponding river characteristic and should be compared with Figure 6.2 which shows the future "do nothing" situation. It can be seen that the proposed interventions do not cause deterioration of the sustainable rivers.

The primary components of the preferred options are shown schematically on Figures 8.11 to 8.13.

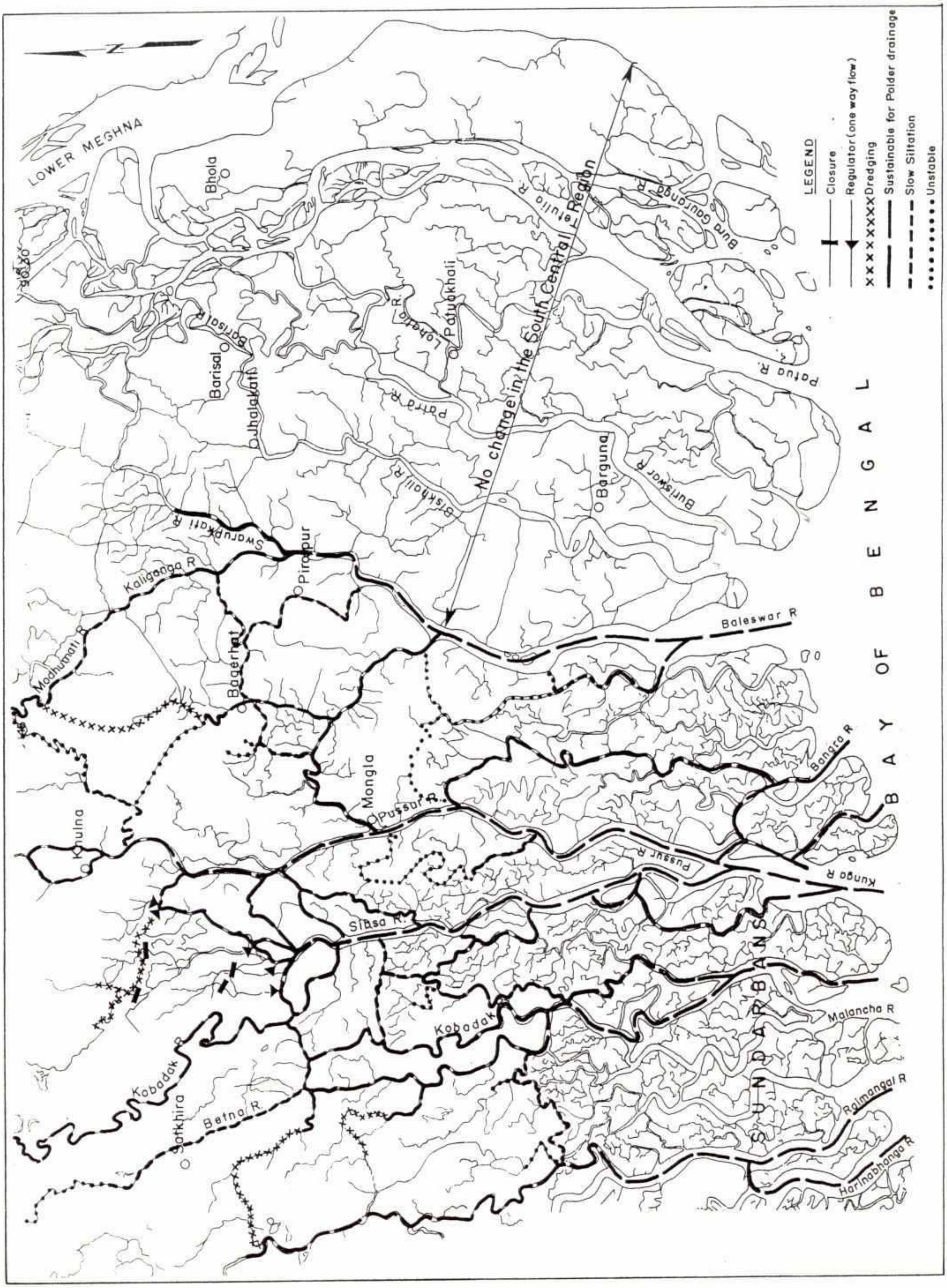
8.3.4 Drainage Improvements in the CEP, South Central Region

Most of the emphasis in this study has been placed on the Southwest Region due to the significantly greater problems that exist, not only due to drainage congestion, but also saline intrusion. Conditions in the South Central Region are rather more favourable due to the fresh water inflows from the Padma River and Lower Meghna Estuary which provide good flushing characteristics for the rivers coupled with less saline conditions, even in the dry season.

The regime analysis has shown the main rivers to be sustainable in the region and the primary cause of siltation of the interconnecting rivers. In some cases these channels were originally internal, but the polders have split up e.g.polder 41.

The studies have concluded that sufficient drainage improvements can be effected through improved internal drainage and water management without having to resort to external interventions. This would include re-combining polders in accordance with their original design.

Figure 8.10



Tidal River Characteristics After Interventions

TABLE 8.3

River Characteristics-Comparison of Regime Analysis with Alternative Methods of Analysis

X-section No.	River Name	Regime Analysis	
		Before	After
1	KOBADAK U	Moderate siltation	Moderate siltation
2	KOBADAK M	Slow siltation	Slow siltation
3	KARULLA	Erosion	Slow erosion
4	CONNECTION	Slow siltation	Slow siltation
5	KATAKHALI-K	Erosion	Equilibrium
6	KOBADAK L	Slow siltation	Slow siltation
7	KOIRA	Slow siltation	Slow siltation
8	HADDA	Slow siltation	Slow siltation
9	BETNA	Moderate siltation	Moderate siltation
10	BETNA	Slow siltation	Slow siltation
11	MORIRCHAP	Equilibrium	Slow erosion
12	LABANGABATI	Heavy siltation	Improvement in net flow dredged channel
13	BANSANA	Equilibrium	Moderate siltation
14	HABRA	Heavy siltation	Heavy siltation
15	KANKSIALI	Heavy siltation	Equilibrium-increase in net flow
16	GALGHASIA	Slow siltation	Equilibrium
17	KHOLPETUA	Slow siltation	Slow siltation
18	LINK-KK	Equilibrium	Slow siltation
19	ARPANGASIA	Equilibrium	Equilibrium
20	ARPANGASIA	Equilibrium	Equilibrium
21	CHALKIGANG	Equilibrium	Equilibrium
22	BAL	Equilibrium	Equilibrium
23	BARAPANGA		-
24	BETMARAGANG	Equilibrium	Equilibrium
25	MALANCHA	Equilibrium	Equilibrium
26	MALANCHA-E	Equilibrium	Equilibrium
27	SONAKHAL	Equilibrium	Equilibrium
28	TALDUP	Equilibrium	Equilibrium
29	HARIHAR	Heavy siltation	-
30	BURIBHADRA	Heavy siltation	-
31	U-BHADRA	Heavy siltation	-
32	MUKTESWARI	Heavy siltation	-
33	HARI	Heavy siltation	-
34	M-BHADRA	Moderate siltation	-
35	HAMKURA	Moderate siltation	-
36	BHADRA	Heavy siltation	-
37	BHADRA	Moderate siltation	-
38	TELIGATI	Slow siltation	-
39	SALTA(W)	Slow siltation	-
40	HARIA	Slow siltation	-
41	GHENGRAIL	Slow siltation	-
42	BHANGARIA	Heavy siltation	-
43	GUNAKHALI	Slow siltation	-
44	U-SOLMARI	Moderate siltation	-
45	L-SOLMARI	Equilibrium	Slow erosion
46	SALTA	Moderate siltation	-
47	L-SALTA	Equilibrium	Slow erosion
48	L-BHADRA	Equilibrium	Slow erosion
49	HABARKHALI	Equilibrium	Siltation } Temporary
50	DELUTI	Erosion	Siltation
51	MINAJNADI	Slow siltation	Slow siltation
52	SIBSA	Slow siltation	Slow siltation
53	SIBSA	Erosion	Erosion
54	SIBSA	Erosion	Erosion
55	JHAPJHAPIA	Heavy siltation	-
56	BADURGACHA	Erosion	Slow erosion
57	MANGA	Erosion	Erosion
58	JHAPJH-MANGA	Heavy erosion	Heavy erosion
59	CHUNKURI	Equilibrium	Slow erosion
60	DHAKI	Erosion	Slow erosion
61	SUTARKHALI	Equilibrium	Slow erosion
62	SUTARKHALI	Equilibrium	Slow erosion
63	BHAIRAB U	Moderate siltation	-
64	BHAIRAB U	Slow siltation	-
65	NABAGANGA-M	Equilibrium	-

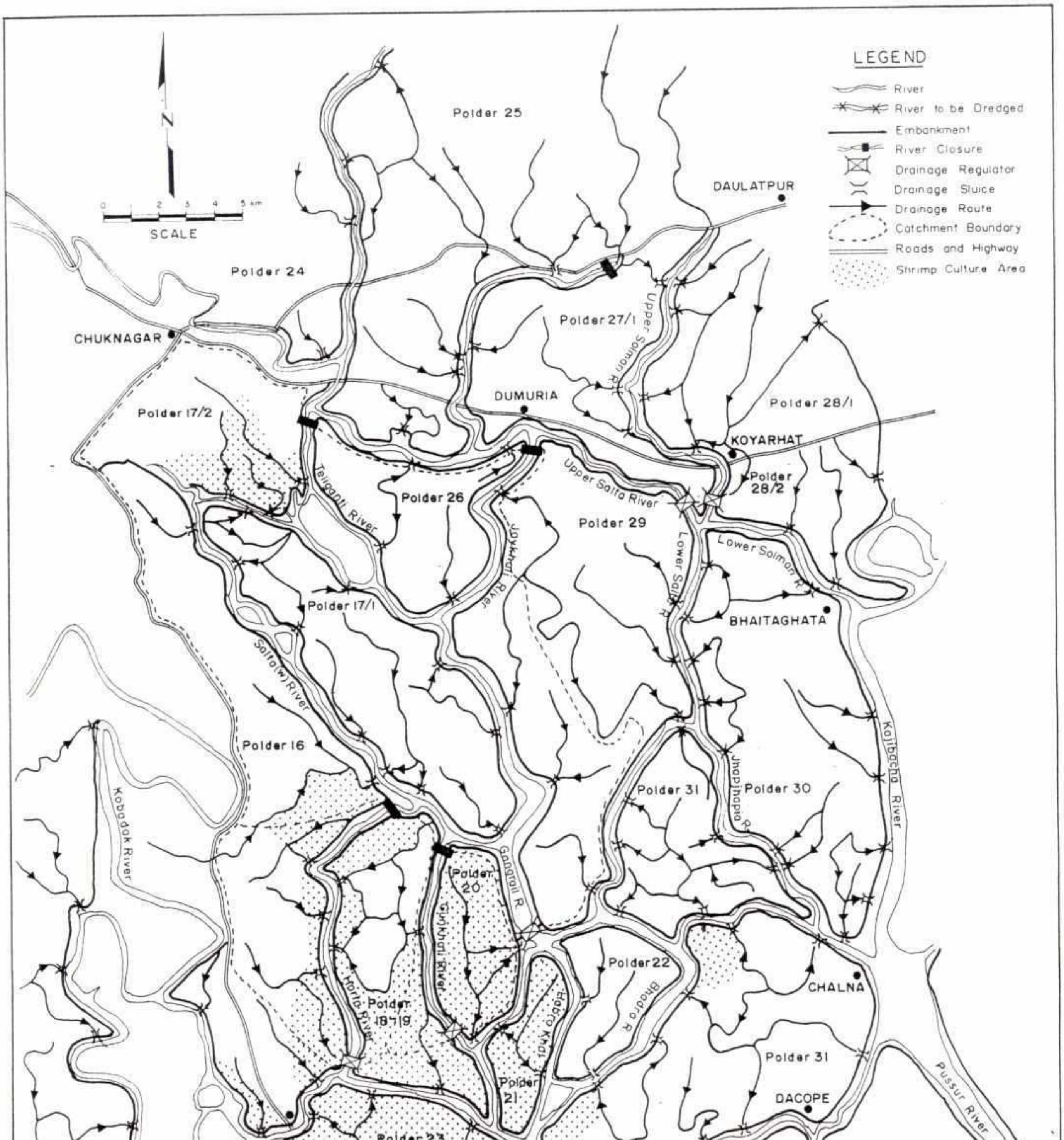
TABLE 8.3 (continued)

X-section No.	River Name	Regime Analysis	
		Before	After
66	ATAI	Equilibrium	Equilibrium
67	NABAGANGA-M	Slow siltation	Slow siltation
68	RUPSA	Erosion	Erosion
69	KAZIBACHA	Equilibrium	Erosion
70	NALUANULLAH	Slow siltation	Slow siltation
71	PUSSUR	Slow siltation	Slow siltation
72	PUSSUR	Equilibrium	Equilibrium
73	PUSSUR	Slow erosion	Slow erosion
74	MONGLANULLA	Equilibrium	Equilibrium
75	BISHNU	Slow siltation	Slow siltation
76	DAUDKHALI	Slow siltation	Slow siltation
77	M.G.CANAL	Slow siltation	Slow siltation
78	GASHIAKHALI	Slow siltation	Slow siltation
79	ATHAROBANKI	Heavy siltation	Heavy siltation
80	ATHAROBANKI	Moderate siltation	Moderate siltation
81	BHAIRAB	Heavy siltation	Heavy siltation
82	POYLAHARA	Heavy siltation	New flow has increased-dredged section
83	BHAIRAB L	Slow siltation	Moderate siltation
84	KUMAR	Moderate siltation	-
85	MADHUMATI	Heavy siltation	Slow siltation
86	BALESWAR	Heavy siltation	-
87	BALESWAR	Moderate siltation	-
88	BALESWAR	Slow siltation	-
89	BALESWAR	Equilibrium	-
90	KALIGANGA	Moderate siltation	Slow siltation
91	KOCHA	Erosion	-
92	SHIKARPUR	Equilibrium	-
93	UZIRPUR	Equilibrium	-
94	SHANDHA	Equilibrium	-
95	AMTALI	Equilibrium	-
96	NAYABHANGANI	Equilibrium	-
97	DHARMAGANJ	Slow siltation	-
98	KALABADAR-1	Slow siltation	-
99	KALABADAR-2	Equilibrium	-
100	ILSHA		-
101	RANGAMATIA	Slow siltation	-
102	KIRTONKHOLA	Slow siltation	-
103	KIRTONKHOLA	Equilibrium	-
104	KATAKHALI	Equilibrium	-
105	BISHKHALI	Equilibrium	-
106	PANDAB-1	Slow siltation	-
107	PANDAB-2	Erosion	-
108	DHULIA	Equilibrium	-
109	PAIRA	Equilibrium	-
110	BURISWAR	Equilibrium	-
111	PATUAKHALI	Erosion	-
112	LOHALIA	Slow siltation	-
113	LOHALIA	Equilibrium	-
114	SWARUPKATI	Erosion	-

Note: 'After' situation is scenario 6.4.9 which comprises Satkhira dredging, Khulna macro polder and Bagerhat dredging.

'-' indicates 'no change'

Figure 8.11



Khulna Area: Drainage Conditions after Interventions

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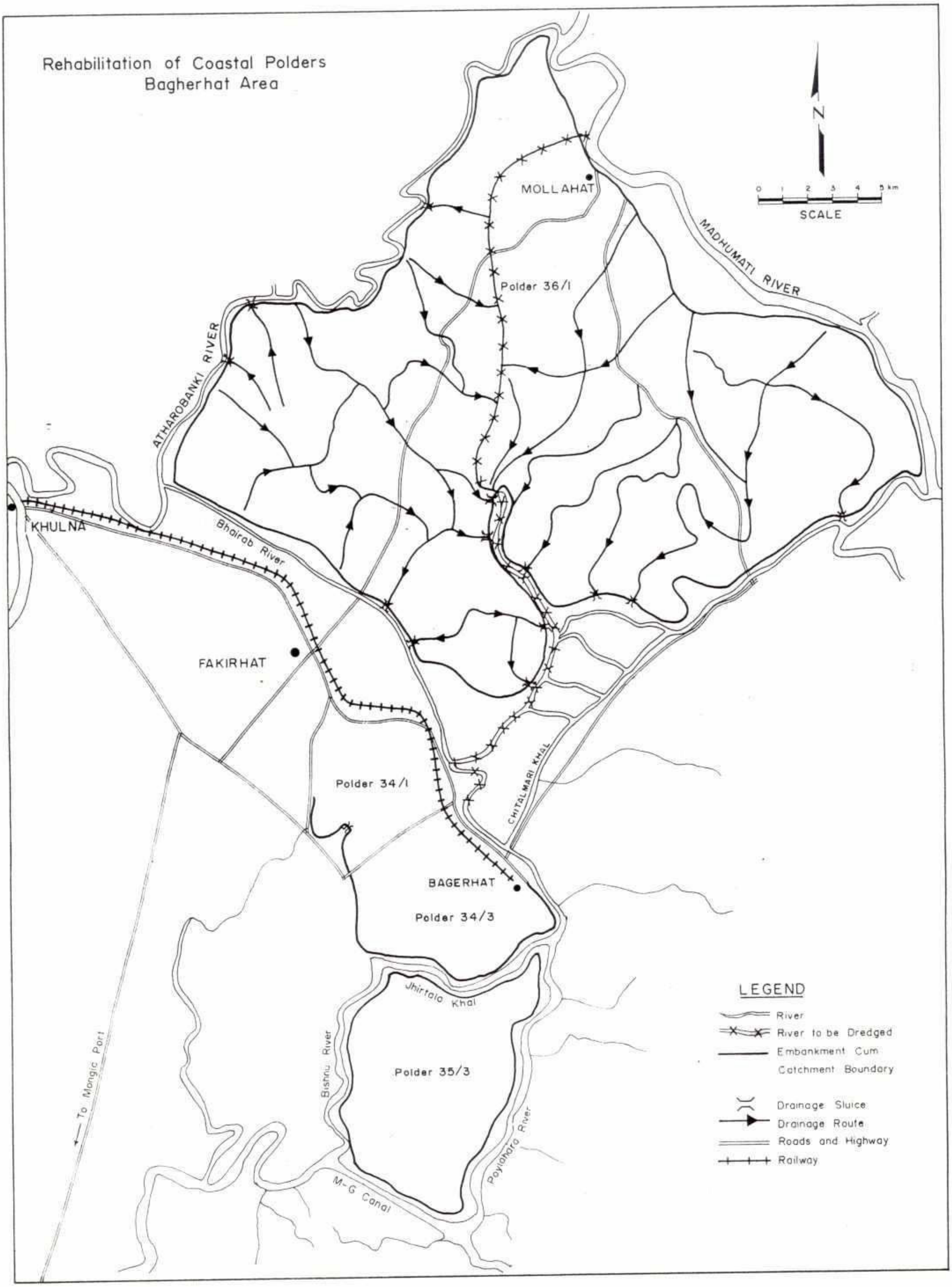
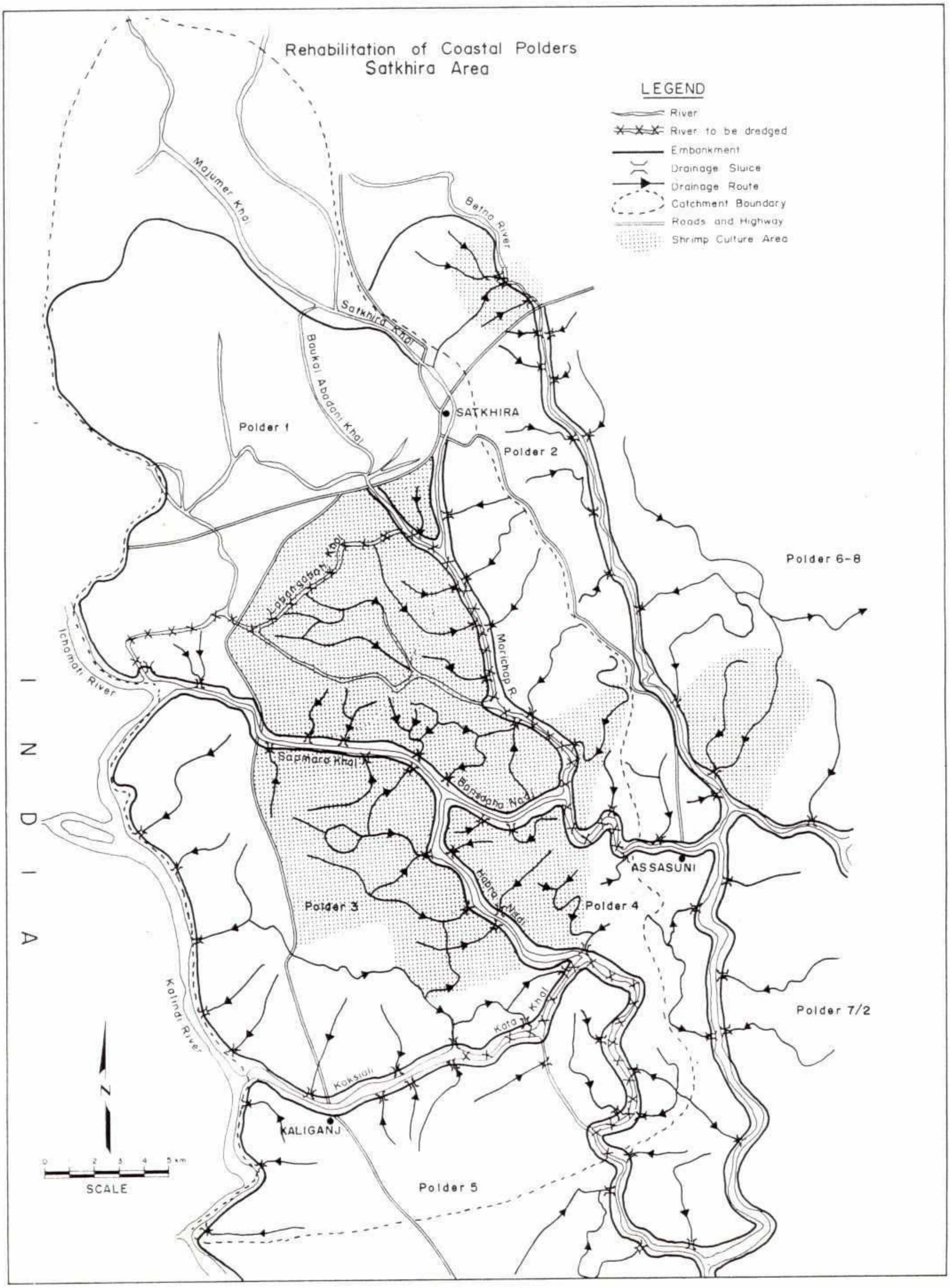
Figure 8.12



Bagerhat Area: Drainage Conditions after Interventions

Figure 8. 13



Satkhira Area: Drainage Conditions after Interventions

9 IMPLEMENTATION PROGRAMME AND COST

9.1 Programme

Figure 9.1 shows a preliminary near term programme for interventions in the coastal zone. As discussed in Section 8 the most pressing need is for relief of drainage congestion in the CEP area, activities (1) to (18) but this must proceed in parallel with other activities (19) to (24).

The proposed internal and external interventions to improve the drainage condition of polders in the CEP area. The year given when work should commence is generally related to the present and future predicted conditions of the polders, see Figures 5.2 and 6.3 respectively, as shown on the following Table 9.1

TABLE 9.1

Preliminary Intervention Programme

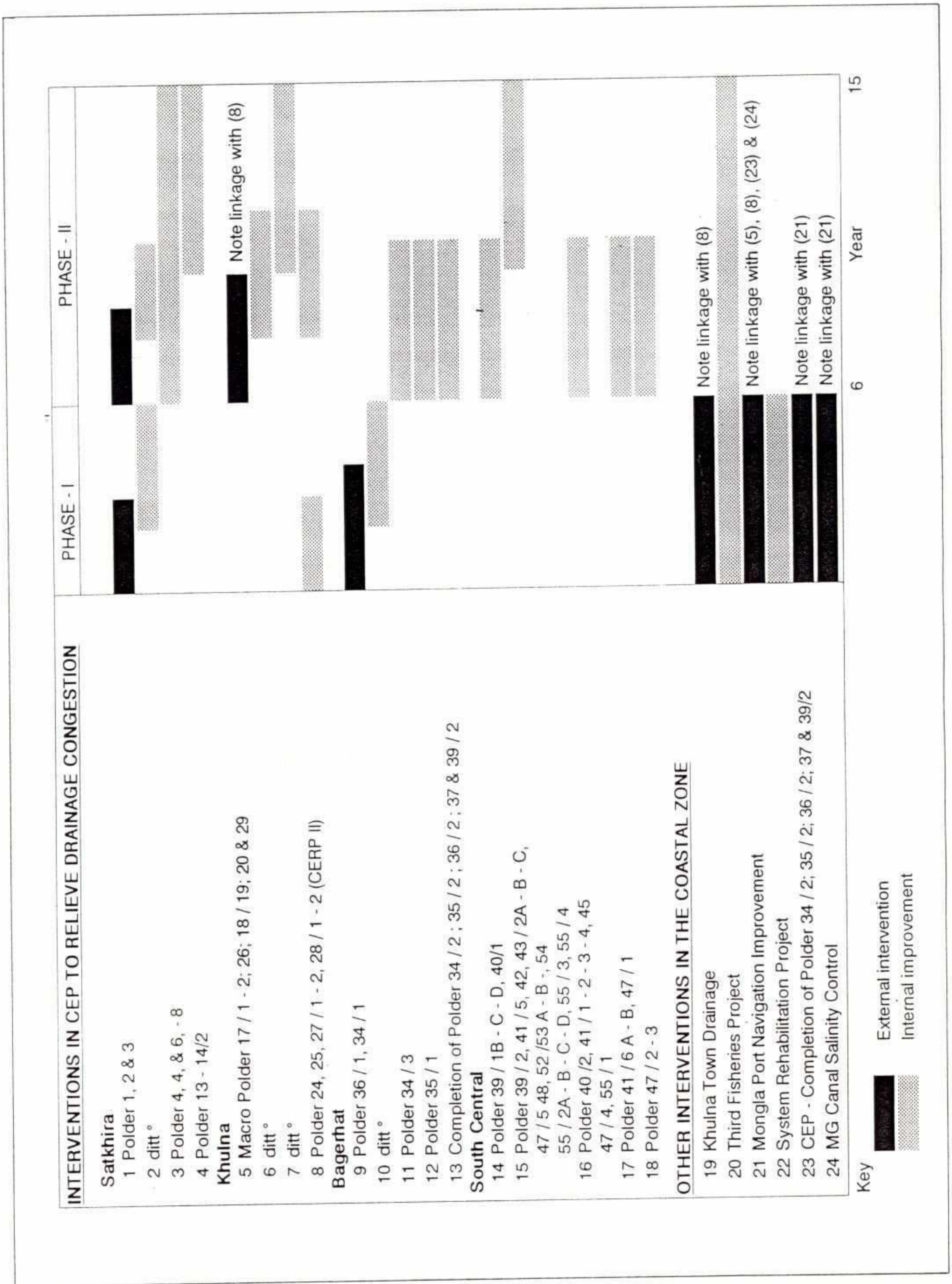
Polder Condition		Commence Intervention(yr)
Present	Future	
Satisfactory	Marginal	10
Marginal	Unsatisfactory	5
Unsatisfactory	Unsatisfactory	1

The exceptions are where both external and internal interventions are required, for example Satkhira, when it would not be worthwhile completing the internal intervention ahead of the necessary external intervention.

9.2 Costs

Indicative capital costs for carrying out the interventions discussed in this chapter are given in Table 9.2. The costs cover the interventions needed to improve the polder systems identified in the Table and do not include routine maintenance in these or other polders.

Figure 9.1



Preliminary Near Term Intervention Programme in the Coastal Zone

TABLE 9.2

Capital Cost of Interventions

Location	Net Area (Ha)	Intervention Cost (M.Taka)			Unit Cost (Tk/net ha)
		External	Internal	Total	
Satkhira (1,2,3,4,5,6-8)	121000	1200	1210	2410	19900
Satkhira (13-14/2)	20500	0	154	154	7500
Khulna (CERP II & macro polder)	112000	273	1106 (incl.CERPII)	1379	12300
Bagerhat (36/1,34/1,34/3)	36600	878	366	1244	34000
Bagerhat (35/1)	79000	0	948	948	12000
South Central	179000	0	895	895	5000
Totals	548100	2351	4679	7030	
Average Unit Cost = Tk 12,800/net ha					

Note: assumed unit rates:

external improvement
- dredging - 65 Tk/m^3
- closures - 2.0 to 4.6 M Tk depending on size
- regulators- 8.5 to 48.0 M Tk depending on size

internal improvement
- Satkhira - 10000 Tk/net ha
- Paikgacha - 7500 Tk/net ha
- Dumuria - 5000 to 12000 Tk/net ha
- Bagerhat - 10000 Tk/net ha
- Rampal - 12000 Tk/net ha
- South Central- 5000 Tk/net ha

completion of polders 34/2; 35/2; 36/2; 37 & 39/2 not included.

10 PILOT PROJECT PROPOSALS

10.1 Introduction

As discussed above, different solutions have been proposed for different areas of the CEP, to relieve drainage congestion. Clearly the interventions proposed are over a long period and the investment required is large. Before committing to this large investment, it is essential to have confirmation that the interventions proposed in one area of the CEP do not adversely impact on other areas. It is therefore recommended that Pilot Projects are initially taken up to 'test' the interventions proposed and monitor the results before embarking on a full scale investment in the CEP. As the solutions suggested for the polders in the SC Region are relatively less complex and consist mainly of internal improvement to the drainage and water management, these can go ahead as shown in Figure 9.1.

Before any pilot projects are taken up detailed feasibility studies need to be completed. For the Bagerhat Pilot Project, because of the estimated high cost of the scheme, it is proposed a pre-feasibility study is undertaken before further studies are carried out.

Details of these Pilot Projects are given in the following sections:

10.2 Satkhira

The project that has been identified involves dredging in the Labangabati, Morichap, Kanksiali and Gunakhali rivers which according to the modelling results will result in quite significant improvements in river discharges in the region. It has been concluded that this will be sufficient to sustain the rivers without the need for large maintenance commitments. Drainability calculations for the polders in the area indicate that quality of land would benefit from improved ventage. Much of the area is used for shrimp farming and this requires good flushing characteristics for maintaining adequate water quality. However, this aspect would not require the same degree of tide level variation as would be required for drainage of agricultural crops. Thus, there needs to be balance that matches the use and that provides benefits commensurate with the investment. These aspects should all be addressed in a detail feasibility study for the proposed intervention scheme.

10.3 Khulna

CERP II has proposed four alternative solutions for the drainage congestion in Polder 24, 25, 27/1-2 and 28/1-2. Alternative IV is considered to be compatible with FAP-4 strategy. However, the preferred alternative (Alternative III) addresses only a part of the area (Polder 25) and therefore does not fully represent the future 'with project' situation. Had the CERP II Alternative IV had been adopted then this would have been used as a pilot project to study the impact of amalgamating polders on areas lying to the south.

The pilot project proposed would lead towards a macro polder with a sub-area of the full scheme as it is finally envisaged. The polders to be combined would be Polders 26, 17/1, 17/2, 16/1, 16/2 (part), an area of about 16,500 ha. These polders are just south of the CERP II area and it is proposed to use this as a 'pilot' project for the ultimate strategy of amalgamating most of the polders in the area. An initial survey indicates that most of the area is under rice cultivation and there is no significant shrimp cultivations.

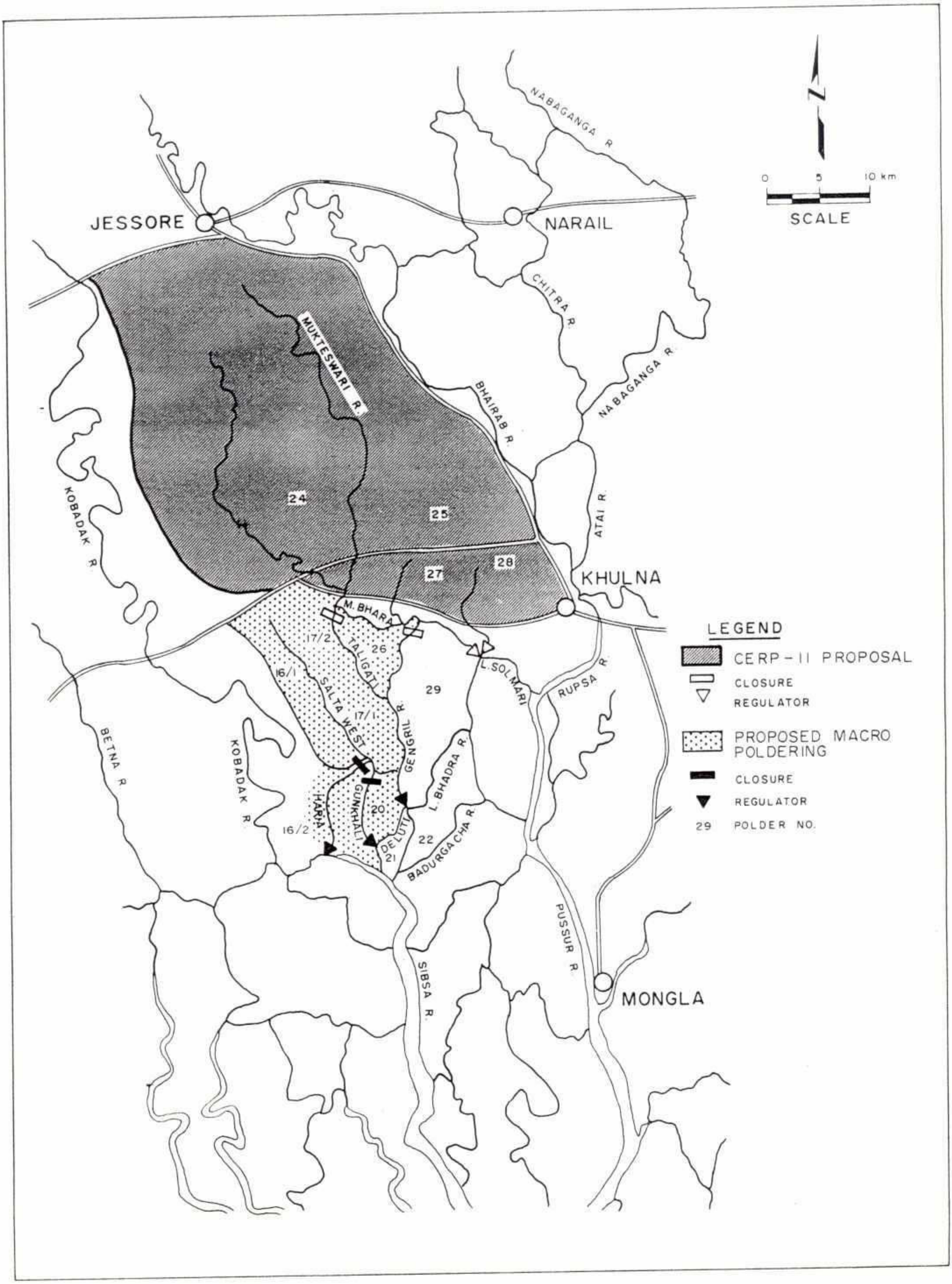
The proposed works would involve construction of regulators and closure of the Telighati and Bhadra Rivers in addition to closing the Gunkhali and Haria Rivers as shown in Figure 10.1. In addition, internal rehabilitation of existing drainage channels and structures including relocating structures where necessary for efficient drainage would be carried out.

The investment would mitigate the agricultural production losses related to drainage congestion and raise water management efficiency. The incremental crop production due to the project would result in decline of water related crop losses, and changes in cropping pattern, cropping intensity and production practices. The change in cropping pattern is envisaged to be largely to higher yielding varieties and the increase in cropping intensity should be at least 40%. The project is considered to have sufficient technical, economic and social justification identified at this stage to proceed to full feasibility study. This would assess the technical and economic feasibility of the scheme together with the social and environmental impacts.

10.4 Bagerhat

The project as identified involves the dredging of the river through the centre of polder 36/1 combined with capital and maintenance dredging of the MB Route. There are very large tidal variations around the polder and all but the northern boundary river has silted. It has been pointed out that regulators would be required at both ends of the central river. The river dredging would by now have been completed by BWDB if it had not been for a land dispute. Although investigations at the present level of detail indicate that the project is technically feasible, the overall benefits may not be that large and the estimated costs are exceptionally high to the extent that pumped drainage might be a viable alternative. It is therefore proposed that this scheme should be subject to a pre-feasibility study in order to identify these issues rather more definitively before proceeding further.

Figure 10.1



Pilot Study Proposal – Macro-Poldering

11 IMPACT OF INTERVENTIONS

11.1 Environmental

The recommended strategy would intervene in the coastal zone to revitalise the Coastal Embankment Project (CEP) area and prevent further deterioration. Interventions would be required progressively as the delta attains a new equilibrium based on augmented flows from the upstream strategies. The strategy presumes that the Southwest Area will remain tidally dominated.

Positive impacts of the strategy would include the achievement of some of the original aims of the CEP programme, and allow realistic future planning of future land use. Open channels may permit long-term strategies for navigation.

The strategy is essentially long-term and would be spread over the period of delta stabilisation (say 50-100 years). This time scale is too long to define major impacts without detailed data collection and modelling.

Consideration of impacts centres on the three development works proposed, and on some of the other projects that are on-going in the coastal zone.

All three projects (as recommended) would open up channels which would drain to the Sundarbans. The impact of these flows need to be assessed with particular reference to:

- changes in rates of sedimentation
- possible impact of changes in water quality due to upstream irrigated agriculture.

The impacts of the options considered for each project are discussed below.

Satkhira

The option for dredging brings with it problems of spoil disposal. Fisheries are unlikely to be greatly affected in this instance, and indeed may be improved in the post-project situation with the opening and stabilising of channels under natural flows. Some navigation improvement may also be expected.

The development of a tidal basin will bring no navigational improvements, although a reservoir fishery may be developed (though limited to estuarine species). Care must be taken to ensure that sea-marsh plant species do not become established in the tidal basin. Weed growths may reduce basin volumes by increased sedimentation; and reduce fishing potential by denial of access. Some species may encourage greater numbers of insect disease vectors.

Environmental considerations are thus in line with the recommendation to adopt the dredging option.

Bagerhat

The impacts for this project are similar to those discussed for Satkhira. In this instance there might be a greater benefit brought about by access to the MB Canal, providing a shorter journey time through the Arial Khan to the Padma (in the dredging option).

Dumuria

The recommended macro-polder option is the most disruptive in terms of works. Closure of channels may lead to artisanal and commercial navigation disruption. There is a high level of operational complexity required by the number of regulators and channels. The area includes the present artisanal shrimp/rice project, and areas ear-marked for future such development. Given the need to ensure maximum income generation in this part of the region, potential impacts on shrimp culture will need careful assessment at feasibility level.

Mitigation

For all three projects (as recommended) an EIA at feasibility stage should be included which should address the changes in rates of sedimentation, possible changes in water quality, examination of the shrimp larvae fishery etc.

The macro-polder proposal at Dumuria will require additional investigations in the EIA at feasibility stage. This is to ensure that potential negative impacts on navigation, artisanal incomes, and shrimp culture are fully taken into account.

It is recommended that full public participation of the beneficiaries at feasibility study stage to determine the social impacts and their views taken into account in the final design.

The environmental impacts are discussed more fully in Volume 9 - Impact Studies, along with other interventions in the Region.

11.2 Social

Interventions in the CEP area will cause significant social impacts.

Reduction of drainage congestion will improve condition for both rice and shrimp farmers providing both groups work together. Elimination of some flooded land may reduce capture fish yields.

Creation of macro polders may create areas of potential conflict with shrimp cultivation in polders 16 and 18-19 and this will require further study in conjunction with the 3rd fisheries project.

Navigation in the major rivers will be sustained with resulting benefits in long term transport planning Navigation by country boat will be affected in the proposed macro polder area. Transfer from internal to external river may require a lock gate or simple transfer system depending on the traffic. In some cases, e.g. U. Salta on internal river will be created where there is currently a fully silted tidal river thereby improving country boat navigation.

12 CONCLUSIONS AND RECOMMENDATIONS

- Drainage congestion in the CEP area should be resolved as part of an overall long term coastal strategy.

- The long term strategy is based on the premise that the coastal zone will remain as a tidal delta.

- Sustainability of the tidal delta depends on sustained wet season flows in the Gorai and sustained non saline dry season fresh water flows from the Arial Khan and Meghna.

- Sustainable rivers have been identified by analysis of field measurements and model results and modelling techniques with regime analysis has been used to predict the impact of proposed interventions.

- The near term intervention programme proposes that present drainage congestion problems are tackled by dredging at Satkhira, implementation of CERP II and amalgamating certain Polders at Khulna, dredging at Bagerhat and completion of unfinished polders in the Mongla, Bagerhat and Khulna areas (subject to resolution of potentially adverse consequences on navigation at Mongla and siltation in other rivers that must be sustained).

- Drainage congestion in the South Central Region is largely due to internal drainage problems and this can be resolved by improved internal drainage and water management.

- Social and Environmental impacts of any intervention proposed need to be assessed by undertaking a full Social and Environmental Impact Assessment Study.

- The performance of each intervention will require monitoring and subsequent intervention design will depend on the nature of the monitoring results.

- The timing of the proposed macro polder at Khulna will depend on the performance of CERP II.

- The quality of land produced by intervention in the low lying beel areas of Satkhira, Khulna and Bagerhat requires further investigation before the conceptional design of interventions proceeds further.

- In certain areas pumped drainage may be cost-effective and this needs to be studied further.

- The proposed long term strategy involves a new approach to evaluating interventions in the coastal zone. Identification of sustainable rivers has not previously been attempted on a Regional scale and even proposals as recent as 1989 (Pussur-Sibsa study) are considering blocking these essential rivers.

- A programme of data collection should be initiated so that future studies could be based on reliable and up-to-date database.

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Appendices

Appendix A

Summary of Seminar

APPENDIX 2

REGIONAL SEMINAR ON

SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT

(FLOOD ACTION PLAN : FAP-4)

As part of the programme for people's participation in the planning of development projects, a one day seminar was held in Jessore on 15th January 1993 where the different water resources management options for the Southwest Area were discussed. The discussion focussed on the various regional and local issues, the people's needs and the scope of the interventions suggested by the Consultants to overcome the issues and satisfy the needs.

The Chief Engineer, FPCO and some members of the Consultants' team (Team Leader, Deputy Team Leader, Irrigation and Drainage Engineer and Coastal Engineer) presented the results of the FAP-4 studies and the development options to the meeting.

Various representatives of the people, including Ministers (Minister for Agriculture, Irrigation, Water Development and Flood Control and the Minister for Foreign Affairs), Members of Parliament and Members of Local Governments who represent different areas within the Southwest Region, and the Mayor of Khulna City Corporation participated in the discussion.

The salient points of the discussion are given hereunder.

In addition to the formal seminar, numerous informal meetings, interviews and discussions were held by the Team members, with interested groups including farmers, fishermen, women groups, landless and these are described in Volume 9 - Impact Studies.

1. <u>S.M. Mustafizur Rahman, MP</u>, Bagerhat-2 & Hon'ble Minister, Foreign Affairs:

- Augmentation of Gorai river flow (dry season) along with increase of Ganges flow (dry season) needs, immediate action.
- Problem of Drainage Congestion in Beel Dakatia should be solved on emergency basis.
- All actions required on national basis.

2. <u>Salahuddin Yousuf, MP</u>, Khulna-5

- Diversion of Ganges water at Farakka created serious salinity and siltation problems in Khulna & adjoining areas - need immediate solution.
- Problem of drainage congestion in Beel Dakatia to be solved on urgent basis. Solmari river and Hamkura river should be dredged.

3. <u>SK. Ansar Ali, MP</u>, Satkhira-1

- Drainage congestion in Dantbhanga Beel (between Tala and Kalaroa thana in Satkhira Dist) to be removed by re-excavating existing khals of excavating new ones.
- Drainage congestion in Kadar Beel (between Tala & Dumuria thana) to be removed.
- Construction of Ganges Barrage should be taken up immediately.
- Shrimp culture and paddy cultivation together is difficult due to salinity problem.
- All policy should be taken on national basis under one cell comprising all concerned ministers.

4. <u>Abdur Rouf Chowdhury, MP</u>, Kushtia-2

- Serious problems created in the operation of G-K Project due to shortage of Ganges water in dry season.
- Augmentation of Gorai river flow along with Ganges flow (dry season) is essentially and immediately needed.
- Ganges Barrage should be constructed immediately.
- Other Smaller rivers of the area to be re-excavated to remove drainage congestion.

5. <u>Dr. Mozammel Hossain, MP</u>, Bagerhat-1

- CEP Polders 37, 36/2 & 35/2 should be implemented immediately. No Paddy cultivation in the area is possible now due to salinity.
- Heavy siltation observed at Mongla Port area.
- Augmentation of Gorai river flow (dry season) and construction of Ganges Barrage is immediately needed.

6. <u>Mufti Mowlana A. Sattar, MP</u>, Bagerhat-4

- Excavation of Mongla-Ghashiakhali (MG) khal created problem by increasing salinity in new area.
- CEP Polders 37 & 35/2 should be implemented immediately.
- Mara Balleswar river should be re-excavated.

7. <u>Abdur Rouf Mia, MP</u>, Faridpur-1

- Defects in the construction of Regulators in Chandana-Barashia Project should be rectified.

8. <u>Dhirendra Nath Saha, MP</u>, Narail-1

- Ganges Barrage Project should be implemented.
- Augmentation of Gorai river flow (during dry season) needed.
- Dredging of Gorai, Nabaganga & Atharabanki rivers needed.

9. <u>Moulana Md. Sakhawat Hossain, MP</u>, Jessore-6

- Monitoring of Project implementation is essential.
- Drainage congestion created after construction Gangrail closure (south of CEP Polder 24) should be removed.

10. <u>SK. Tayabur Rahman, Mayor</u>, Khulna City Corporation

- Problem of salinity and siltation near Khulna and surrounding areas should be solved.

11. <u>Mansur Ahmed, MP</u>, Satkhira-4

- Problem of drainage congestion (in Polder) areas should be solved.
- Ganges Barrage Project should be implemented.
- Augmentation of Gorai river flow during dry season is essentially needed.

12. <u>Khan Tipu Sultan, MP</u>, Jessore-5

- Drainage congestion in Bhabadaha area (north of CEP Polders 24 & 25) should be removed.
- Ganges Barrage Project should be implemented.
- Agreement between Bangladesh & India should be made for acceptable dry season flow of the Ganges in Bangladesh.

13. <u>Shah Hadiuzzaman, MP</u>, Jessore-4

- Problem of drainage congestion in Bhabadaha area should be removed.

14 <u>Abdul Khaleque Talukder, MP</u>, Bagerhat-3

- Problems of drainage congestion and salinity in Bagerhat area should be solved.
- CEP Polders No. 34/2, 35/2 and 37 should be implemented immediately.
- Excavation of Mongla-Ghashiakhali (MG) khal created problem by increasing salinity in Bagerhat area.
- Ganges Barrage Project should be implemented.
- Augmentation of Gorai river flow during dry season is essentially needed.

15. <u>Kazi Shamsur Rahman, MP</u>, Satkhira-2

- Public participation in implementation of projects is essentially needed.
- Serious adverse effect in Bangladesh due to withdrawal of Ganges water at Farakka.

16. <u>Shah Md. Ruhul Quddus, MP</u>, Khulna-6

- Adverse effect in Bangladesh due to withdrawal of Ganges water at Farakka.
- Problem of river bank erosion in some areas around Khulna, Paikgachha needs solution.
- GW should be made available for irrigation through DTW.
- Shrimp Projects should be registered under appropriate laws.

17. <u>Moulana Habibur Rahman, MP</u>, Chuadanga-2

- Irrigation facilities should be extended in Chuadanga area.
- Upper Mathabhanga river should be re-excavated.

18. <u>A.M. Riasat Ali, MP</u>, Satkhira-3

- Adverse effect in Bangladesh due to withdrawal of Ganges water at Farakka.
- Problem of serious salinity and drainage congestion in Satkhira area.
- Problem of river bank erosion is some rivers in Satkhira.

19. <u>Maj. Gen.(Rtd) M. Majid-ul Haq, MP</u>, Magura-1 & Hon'ble Minister, Irrigation, WD & FC and Agriculture

- Management of water resources in the area is of vital importance for development.
- Problems of the area should be solved jointly by all as a national issue.
- Government determined to solve the problems created by Farakka withdrawal with all available resources.
- Peoples participation is of vital importance in formulating and implementing projects.

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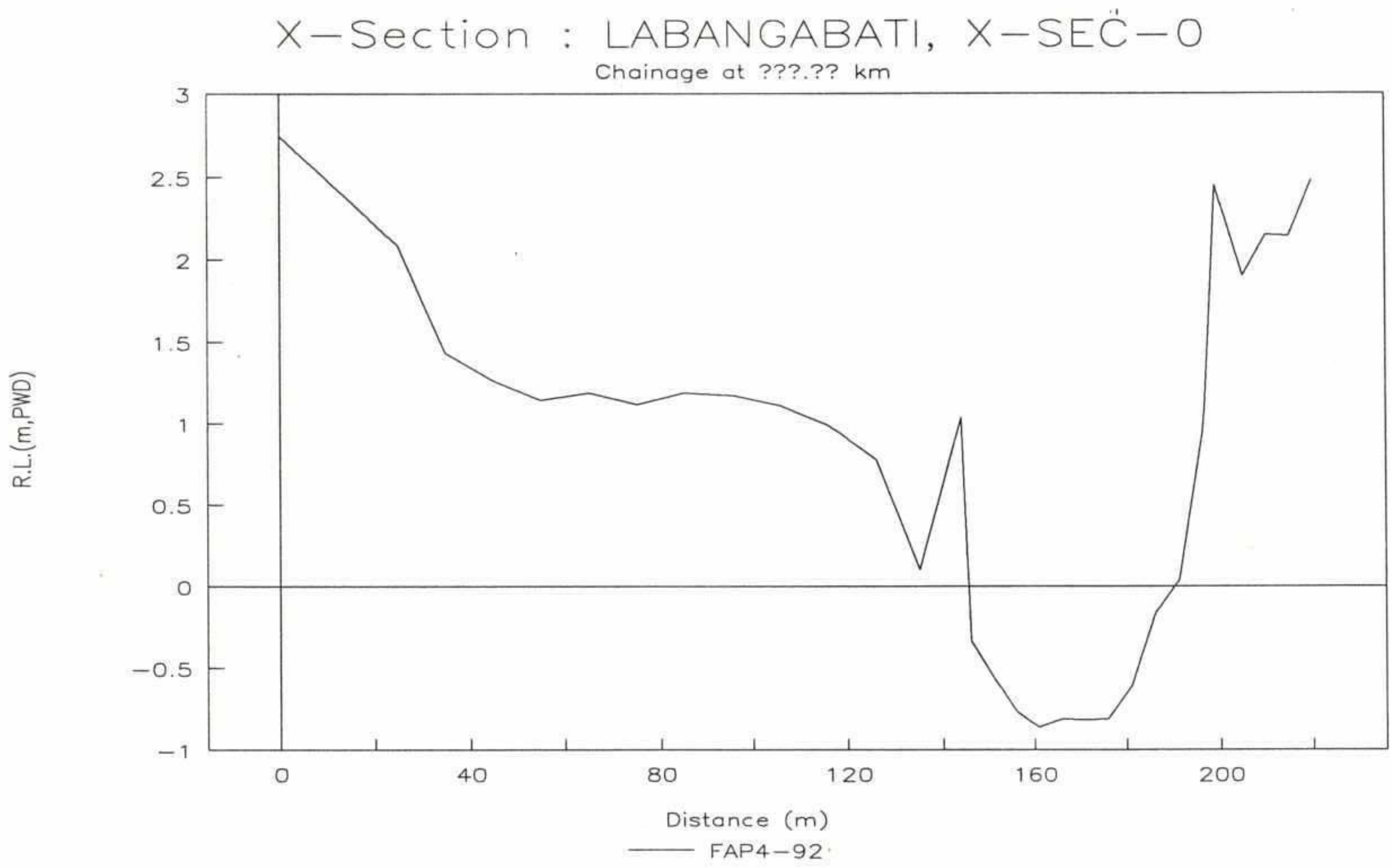
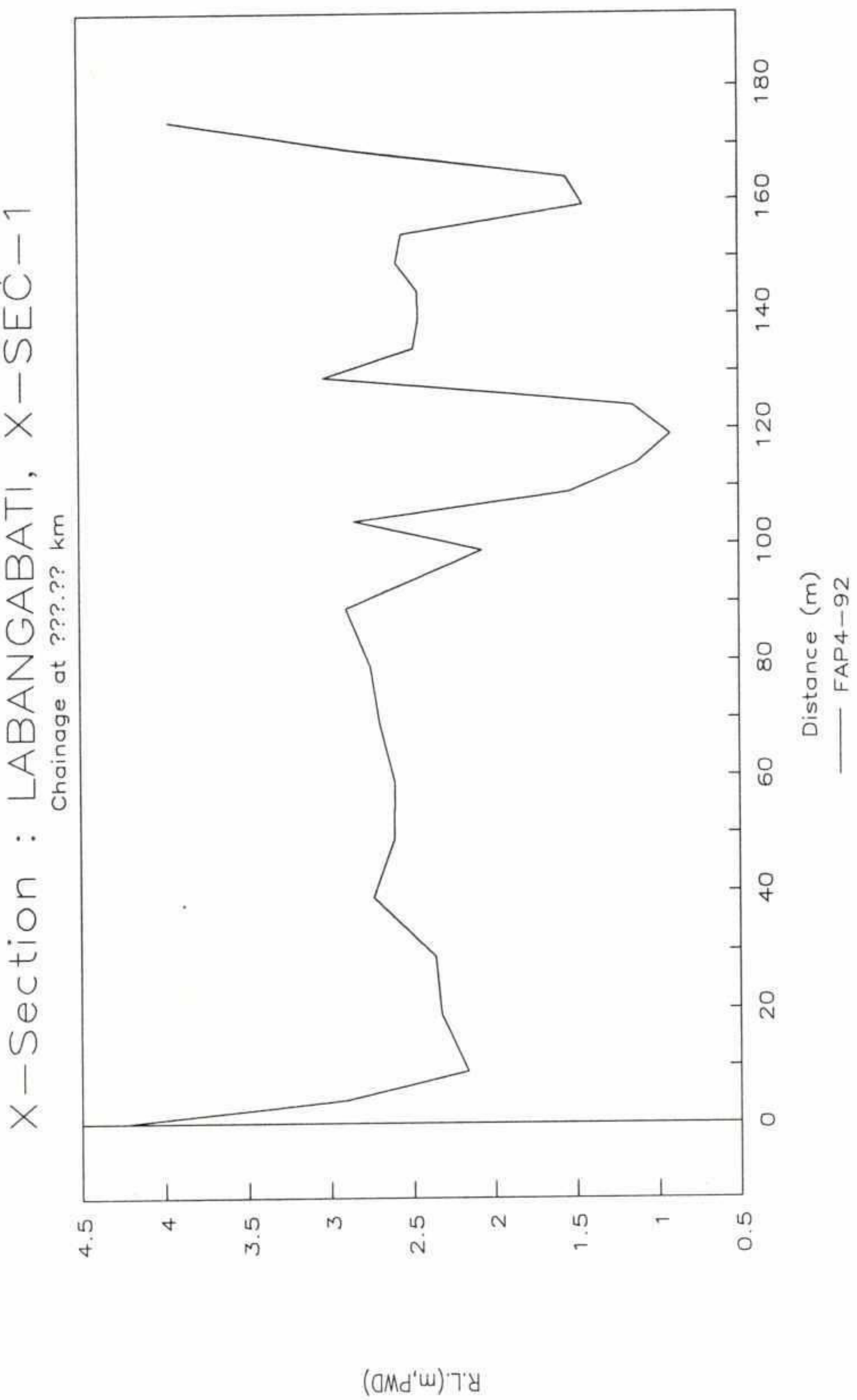
Appendix B

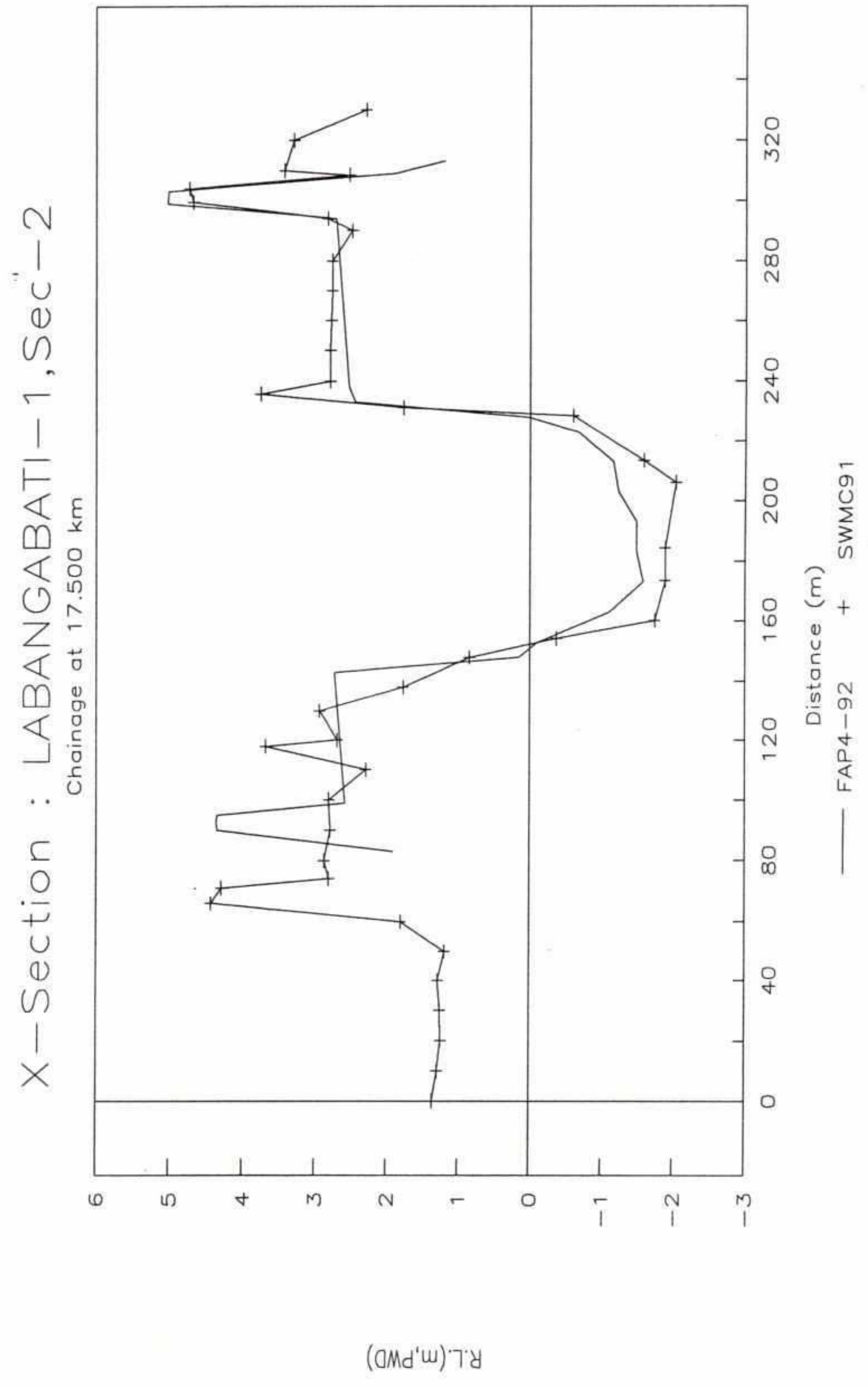
Typical Cross Sections of Rivers

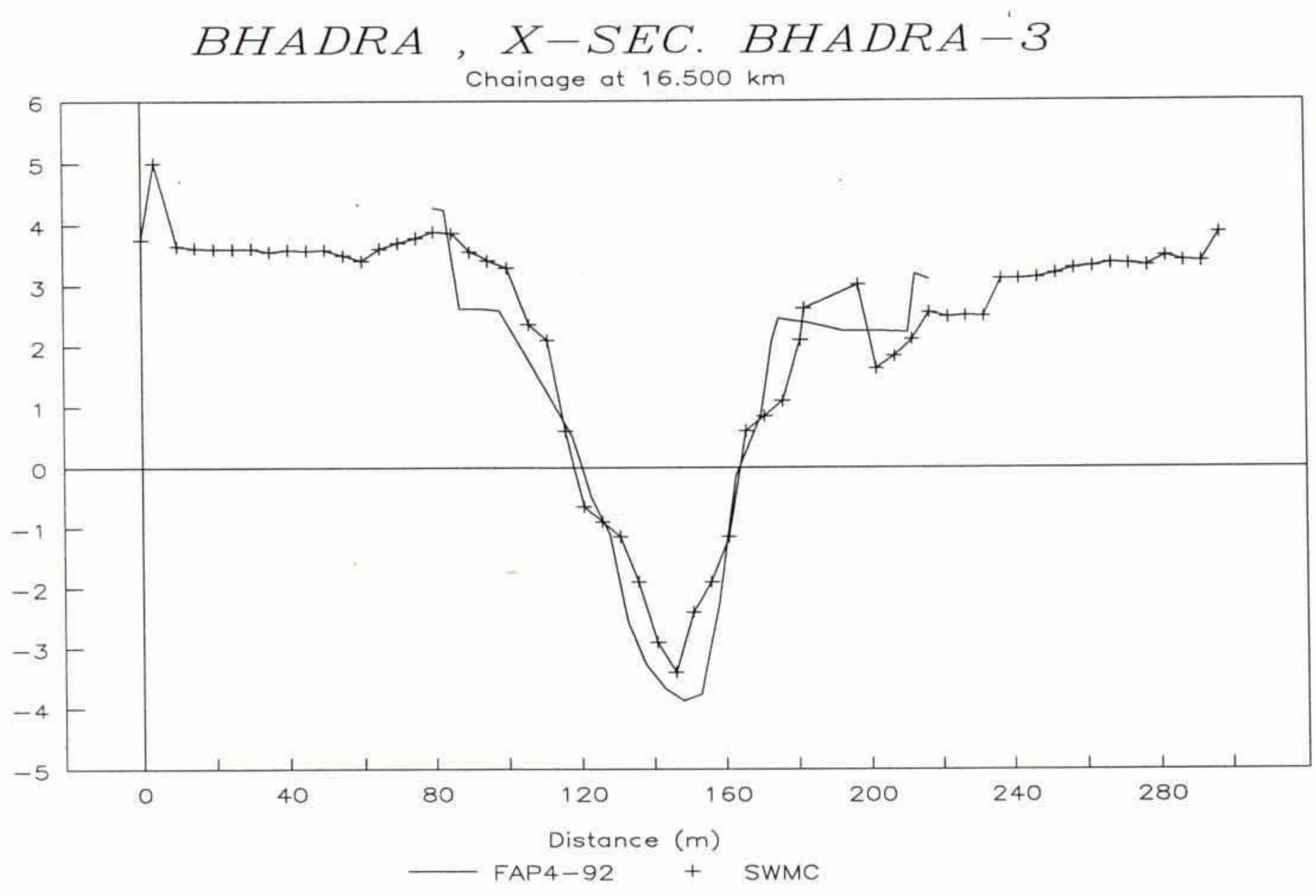
TYPICAL X-SECTIONS

Name of River	X-section Code	X-section NO	Total No
Labangabati	LABA-1 & two others	2, 0, 1	3
Bhadra		3,4,4/1,4/2,4/3,4/4	6
Salta		5,6	2
L.Solmary		7,8	2
Habra	HAB-1, HAB-2	9, 10	2
Sapmata	SAP-1 & another one	11 '12	2
Bansana	BAN-1	13	1
Betna	BET-3, BET-4, BET-5	14,15, 16	3
Joykhali		17, 17/1	2
Galgasia	GAL-1, GAL-2	22, 23	2
Gengrail		24, 25	2
Habarkhali		26	1
Jhapjapia		27,27/1,28,28/1,29	5
Kanksiali	KANK-1,KANK-2,KANK-3	30/1, 30, 31	3
Kholpetua	KHOL-1, KHOL-2	33,34	2
Kabadak	KBD-4,KBD-5,KBD-8,KBD-9,KBD-10,KBD-11	36,35,37,38,39,40	6
Badurgacha		41'42	2
Katakhalikhal	KATK-1	43	1
Haria	HARI-1	44	1
Kirtonkhola	KIR-1,KIR-3,KIR-4	61'62'63	3
Rangamatia	RANG-1	65	1
Bishkhali		64	1
Paira	PAIRA-1	66	1
Lohalia	LOHA-1	67	1
Kazibacha		32	1
Gashiakhali	GASH-3	58	1
BG Canal	BGC-1, BGC-2	59, 59/1	2
Bhola R	BHOL-4	60	1
Madhumati	MADH-3, MADH-4	49, 50	2
Baleswar	BALE-1,BALE-2,BALE-3,BALE-5	54,55,56,57	4
Kumarkhali	KKHL-3	21	1
Poylahara	POY-1, POY-2	52, 53	2
Bhairab	BHAI-7,BHAI-8,BHAI-10,BHAI-13	18,19,51,20	4
Atharobanki	ATHA-1,ATHA-2,ATHA-3,ATHA-4	45,46,47,48	4
Total			77

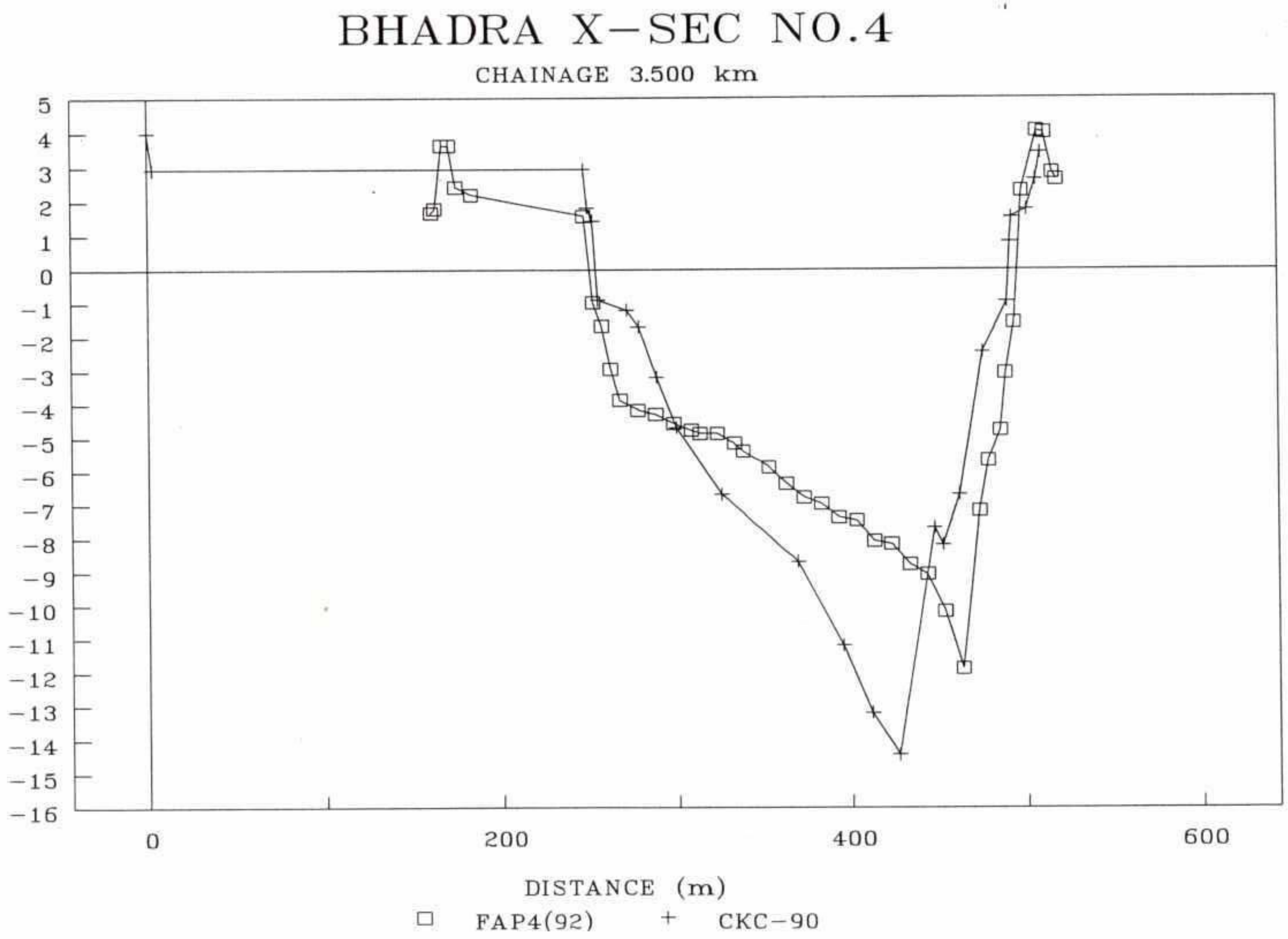

X-Section : LABANGABATI, X-SEC-0
Chainage at ???.?? km
R.L.(m,PWD)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
40
80
120
160
200
Distance (m)
FAP4-92


X–Section : LABANGABATI, X–SEC–1
Chainage at ???.?? km
Distance (m)
R.L.(m,PWD)
FAP4–92
0
20
40
60
80
100
120
140
160
180
0.5
1
1.5
2
2.5
3
3.5
4
4.5


X-Section : LABANGABATI-1, Sec-2
Chainage at 17.500 km
Distance (m)
— FAP4-92 + SWMC91
R.L.(m,PWD)
0 40 80 120 160 200 240 280 320
6 5 4 3 2 1 0 -1 -2 -3

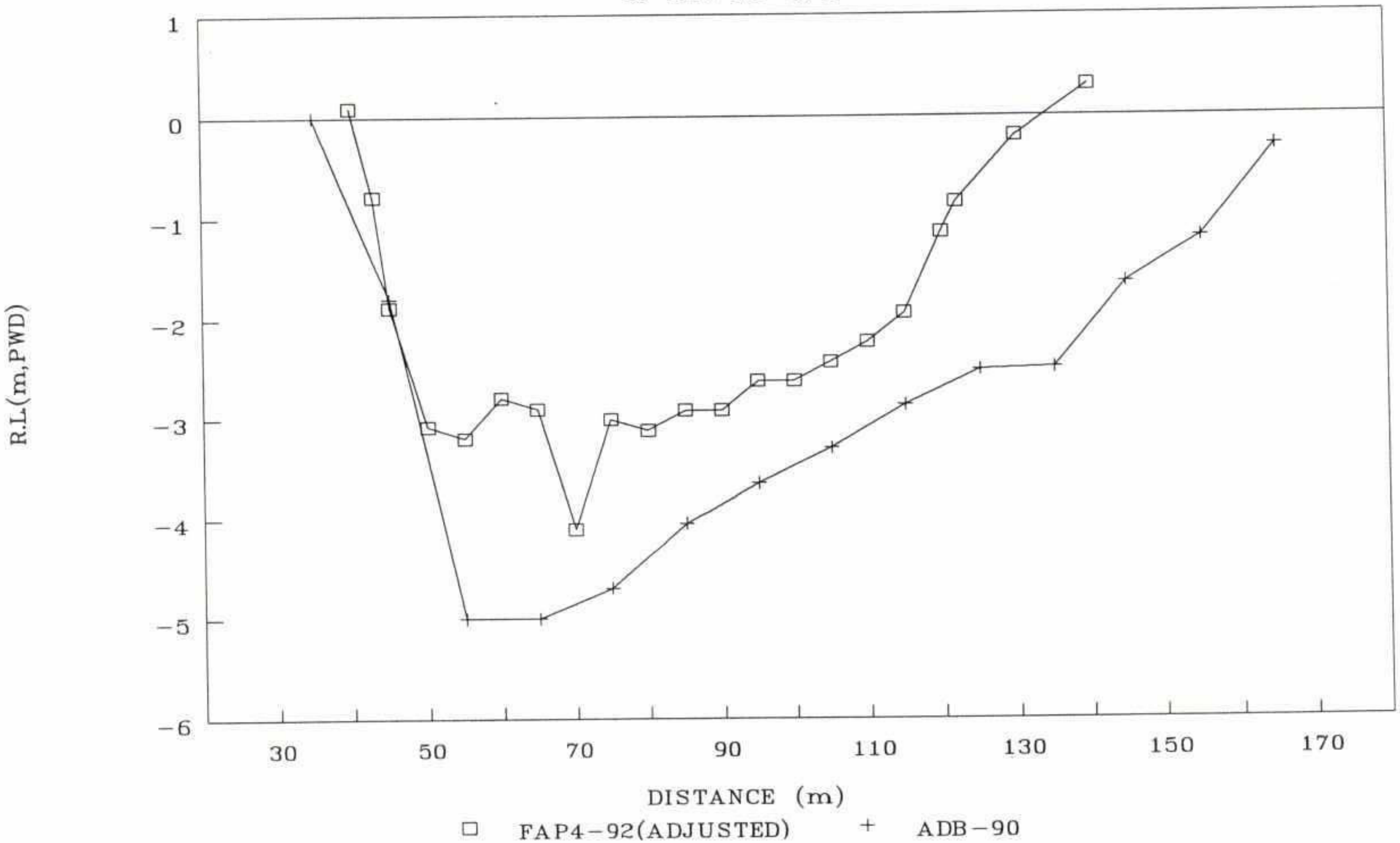

BHADRA , X-SEC. BHADRA-3
Chainage at 16.500 km
R.L.(m,pwd)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
0
40
80
120
160
200
240
280
Distance (m)
FAP4-92
+ SWMC

137


BHADRA X-SEC NO.4
CHAINAGE 3.500 km
R.L.(m,PWD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
-16
0
200
400
600
DISTANCE (m)
FAP4(92)
CKC-90

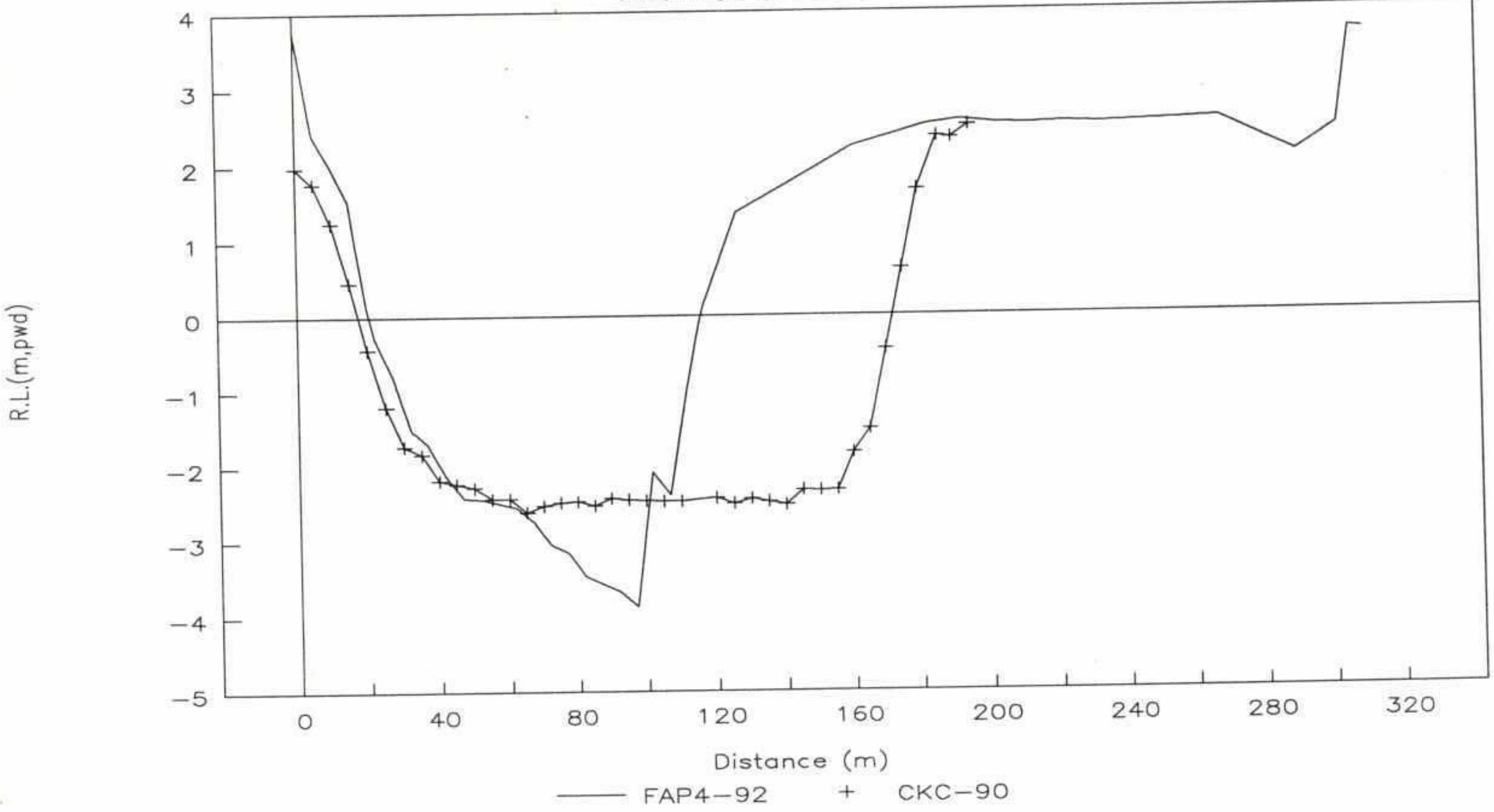
BHADRA

X-SEC NO-4/1

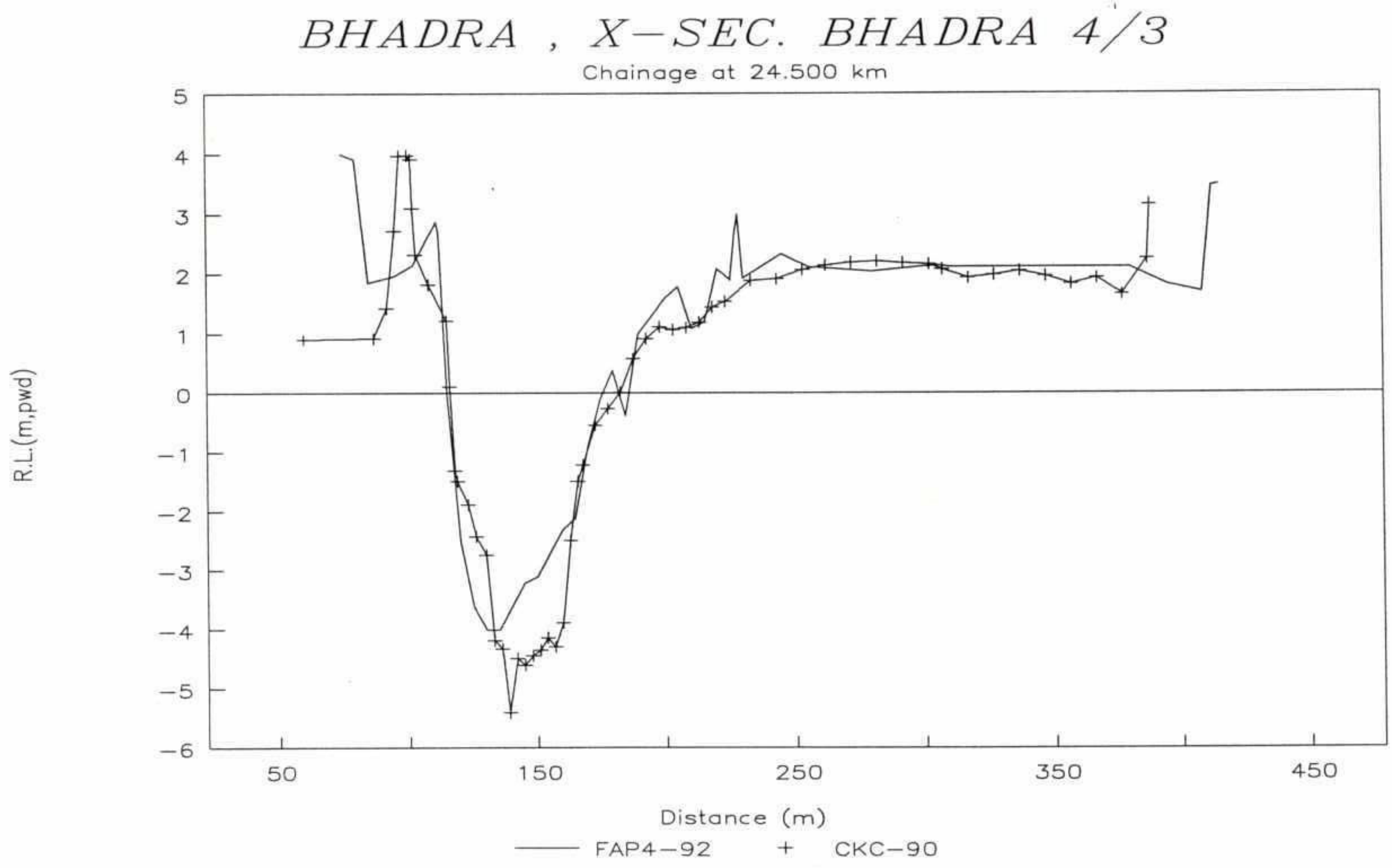


BHADRA , X−SEC. BHADRA 4/2

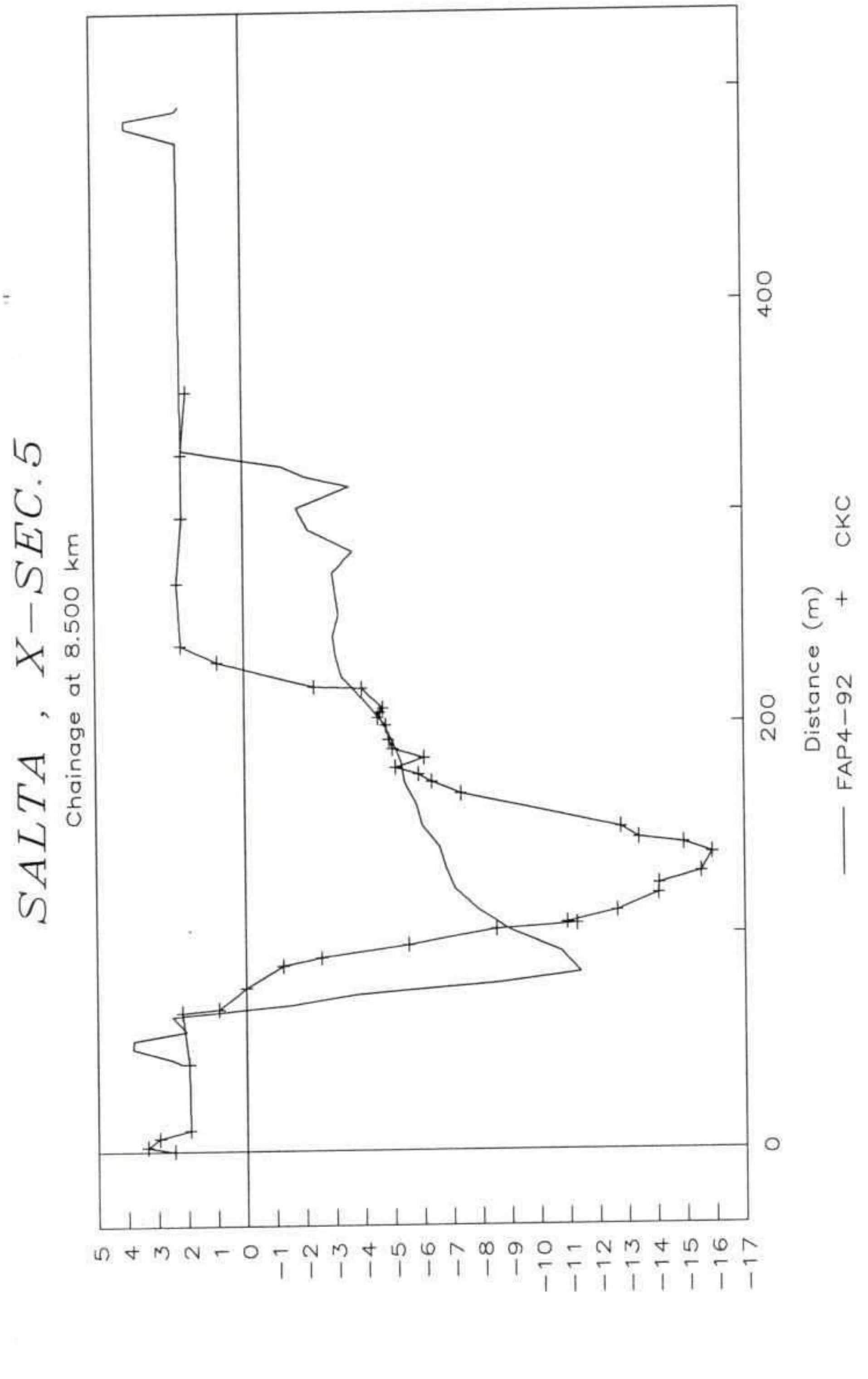
Chainage at 25.100 km

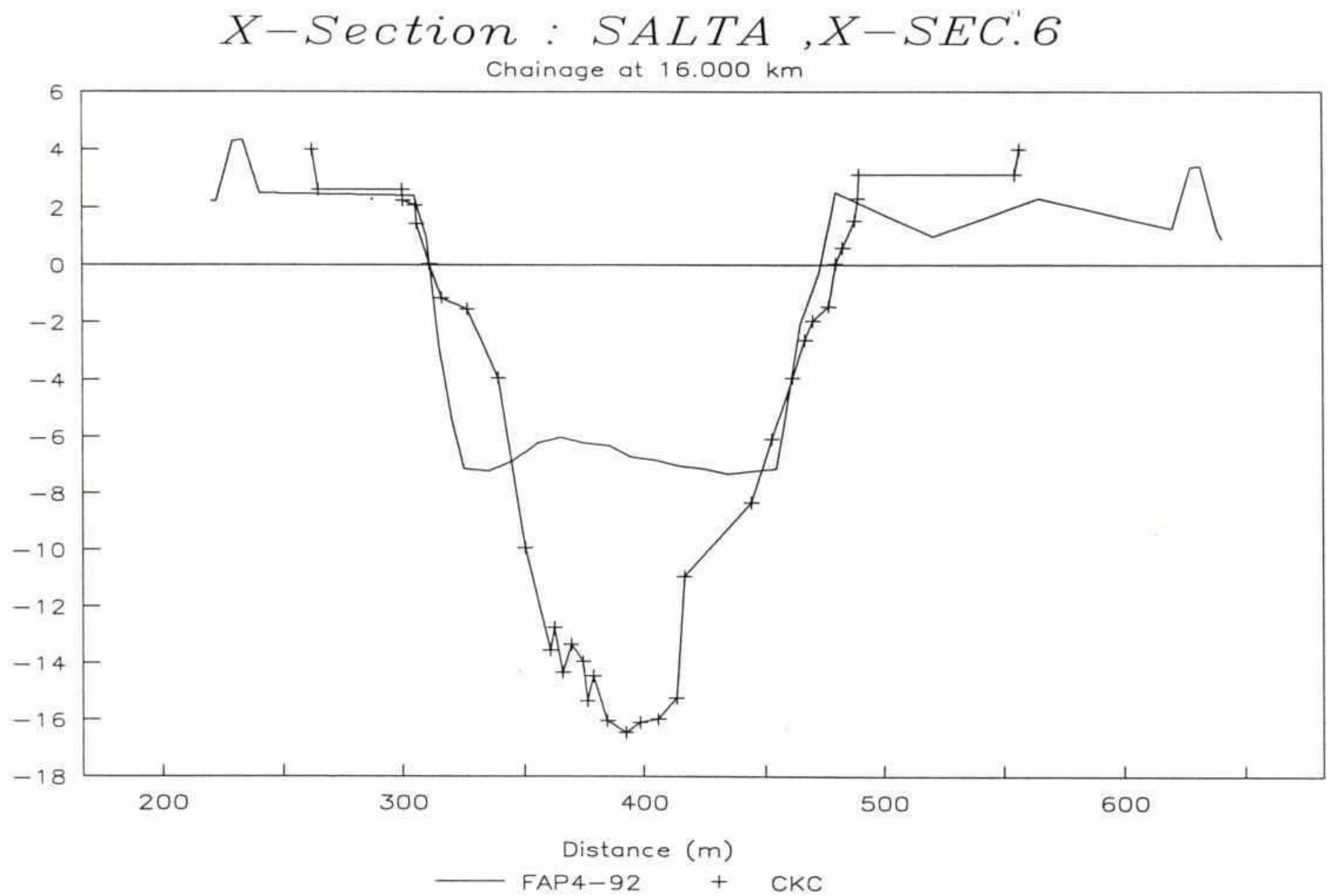


140


BHADRA , X–SEC. BHADRA 4/3
Chainage at 24.500 km
R.L.(m,pwd)
5
4
3
2
1
0
−1
−2
−3
−4
−5
−6
50
150
250
350
450
Distance (m)
FAP4–92
+ CKC–90

141

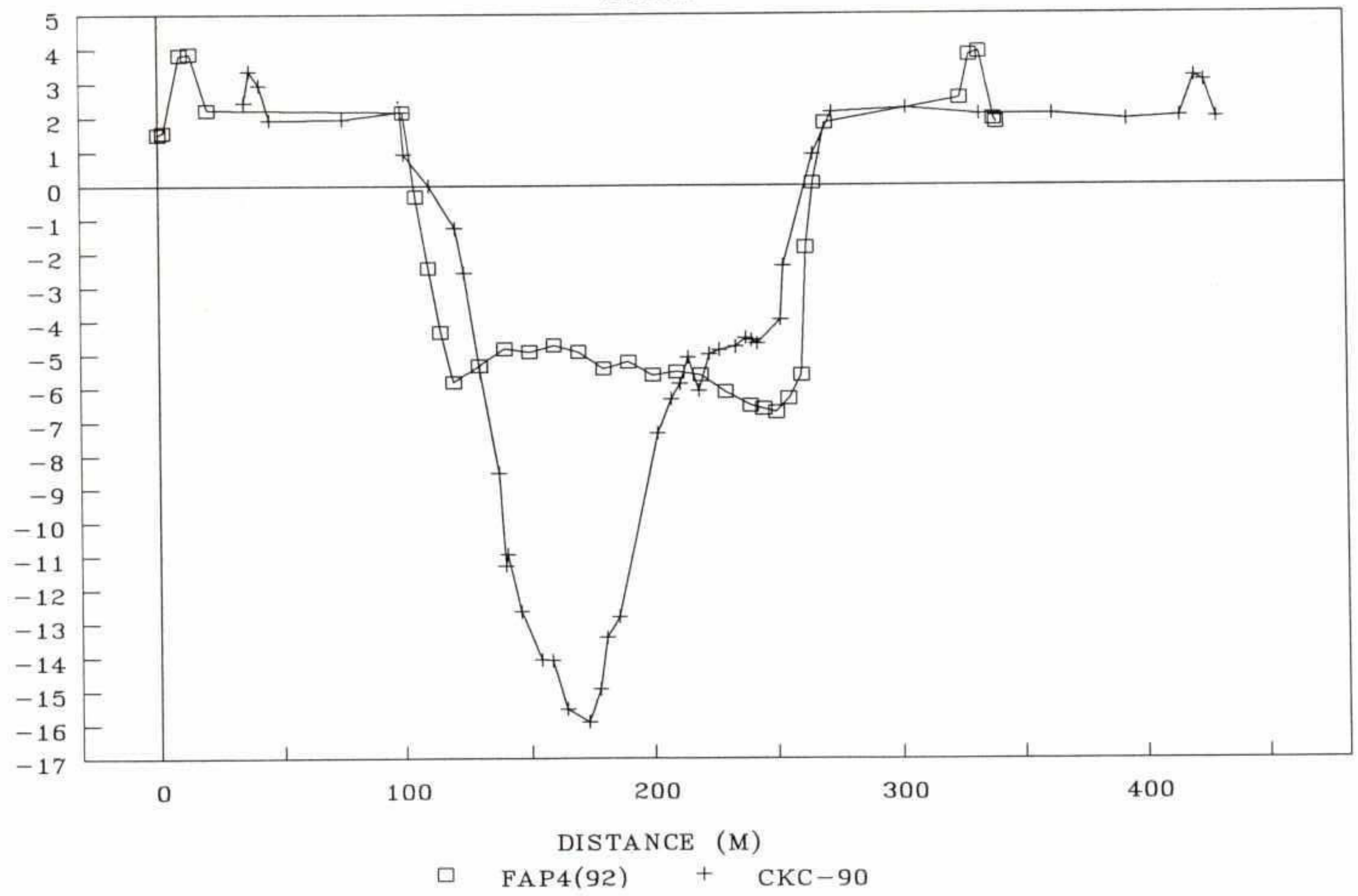

SALTA , X–SEC.5
Chainage at 8.500 km
R.L.(m,pwd)
5
4
3
2
1
0
–1
–2
–3
–4
–5
–6
–7
–8
–9
–10
–11
–12
–13
–14
–15
–16
–17
0
200
400
Distance (m)
FAP4–92
+ CKC



X-Section : SALTA ,X-SEC.6
Chainage at 16.000 km
R.L.(m,PWD)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
200
300
400
500
600
Distance (m)
FAP4-92
+ CKC

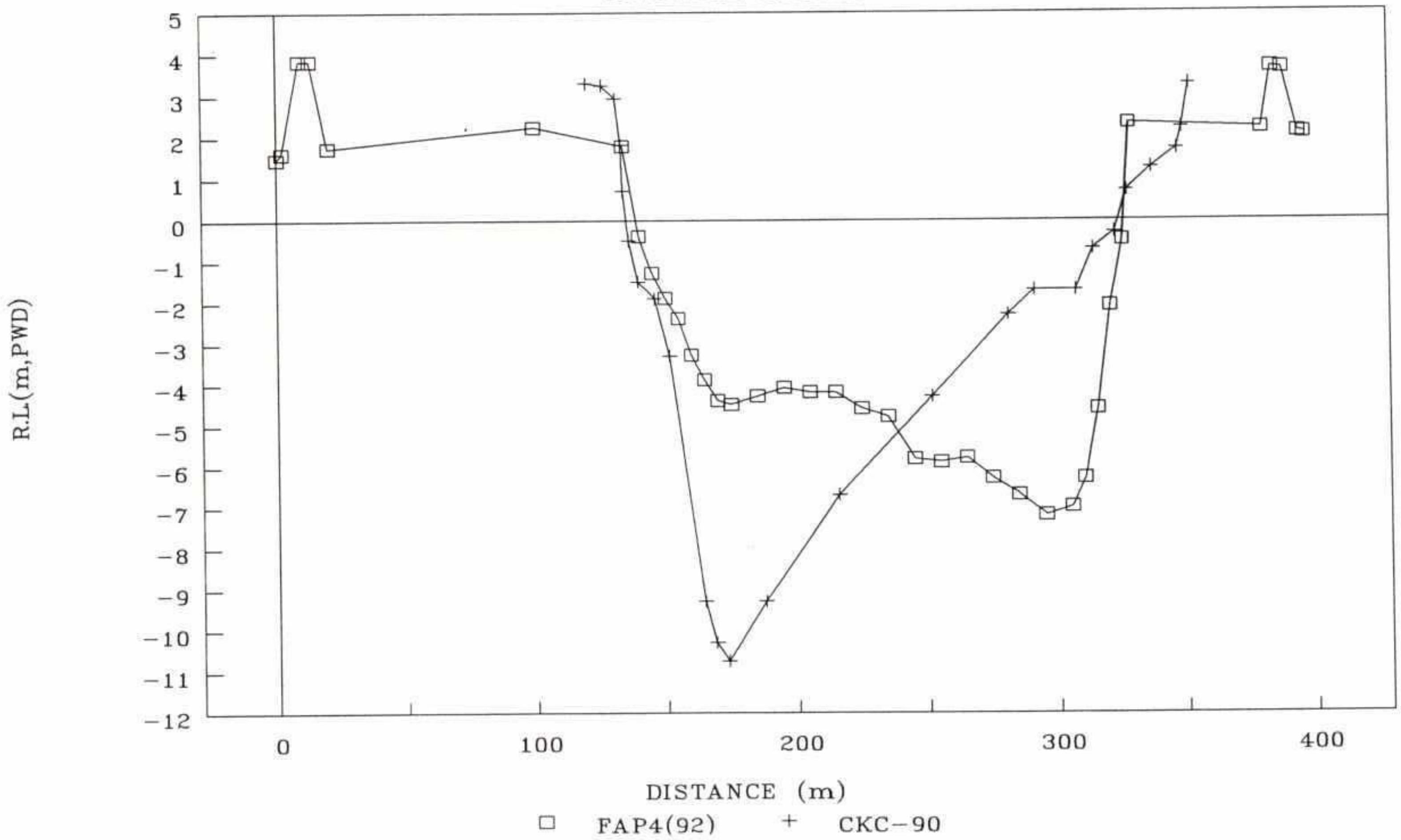
L.SOLMARI X-SEC.NO-7

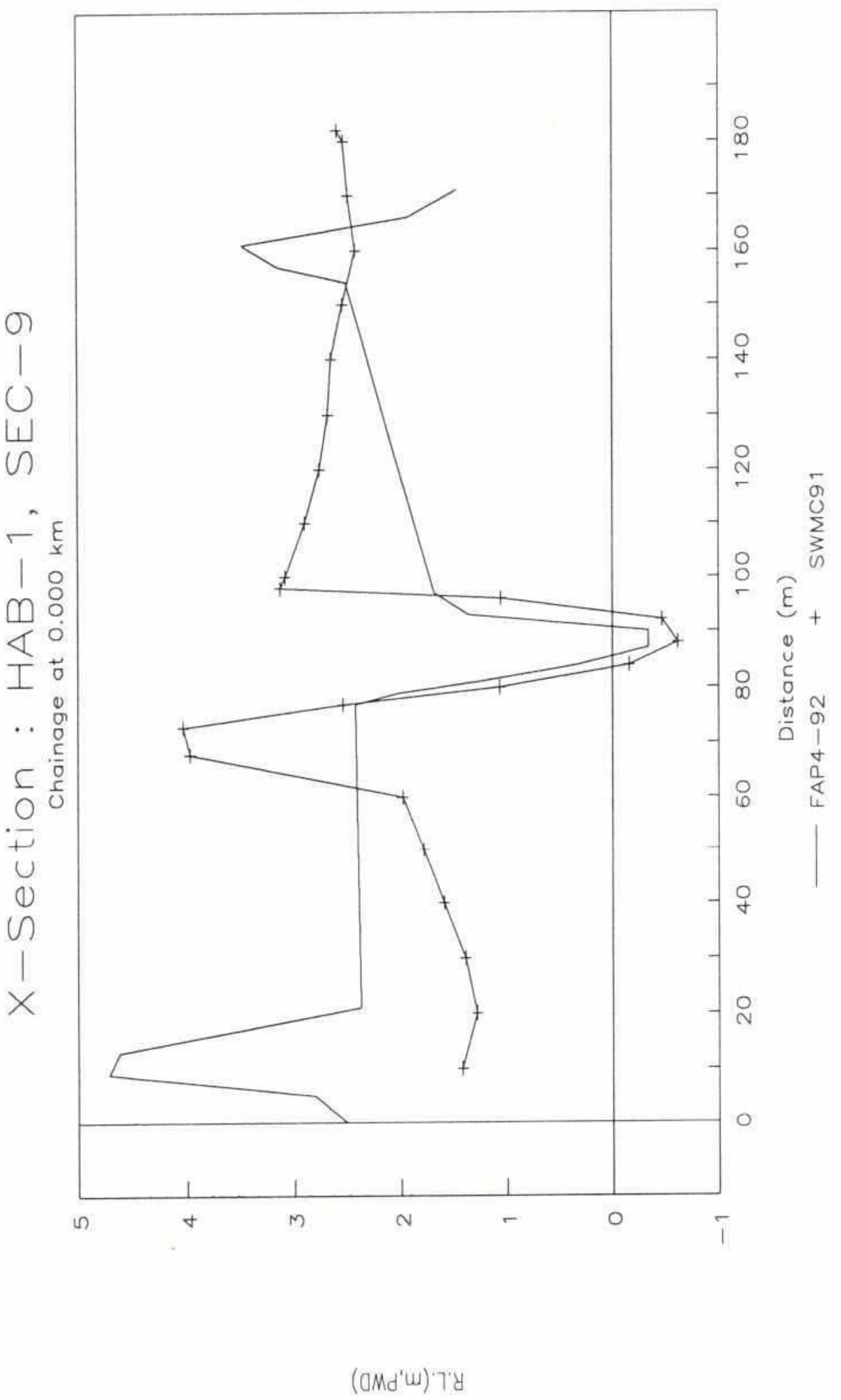
0.00KM



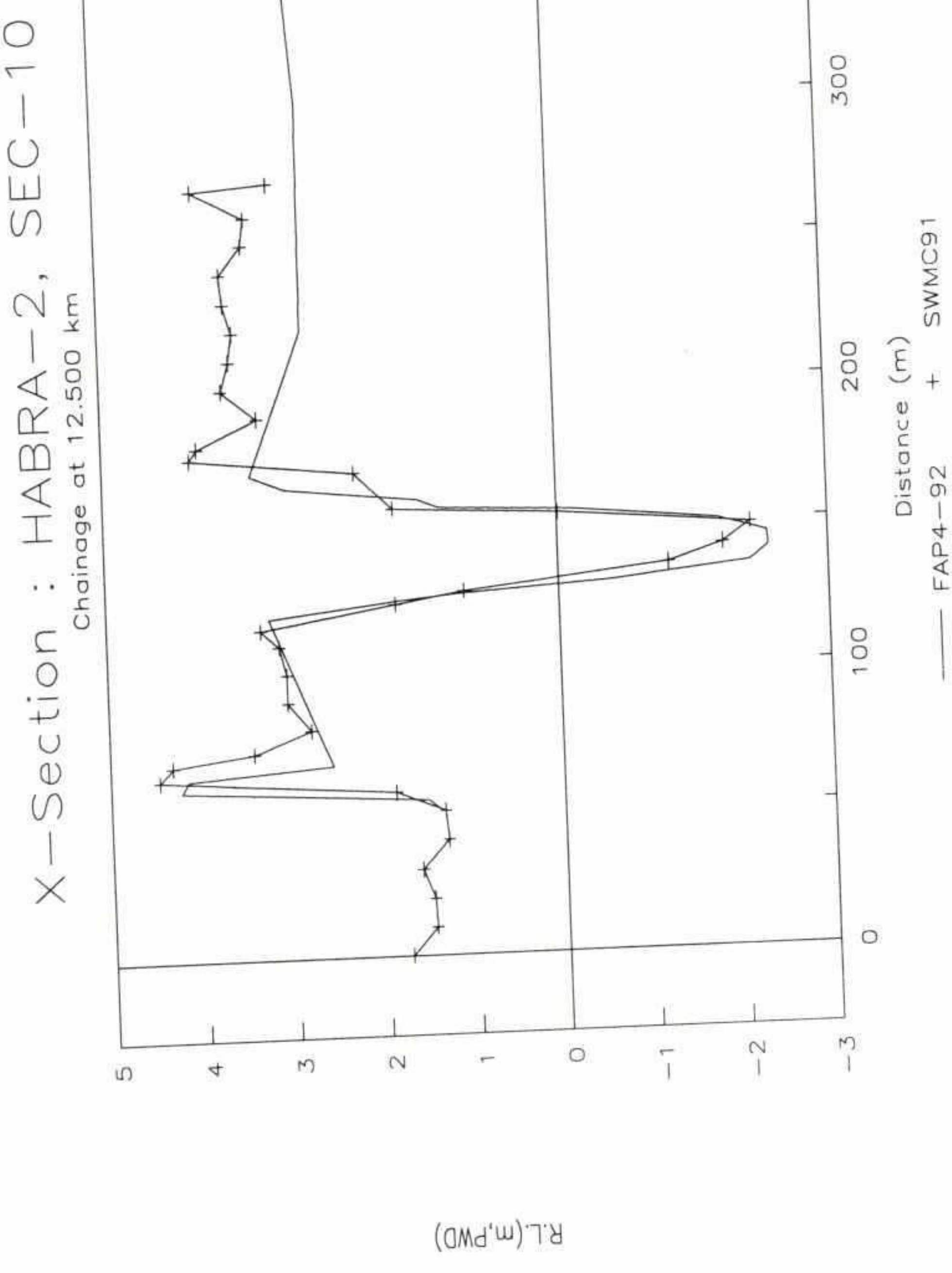
SOLMARI X-SEC NO-8

CHAINAGE 8.500KM

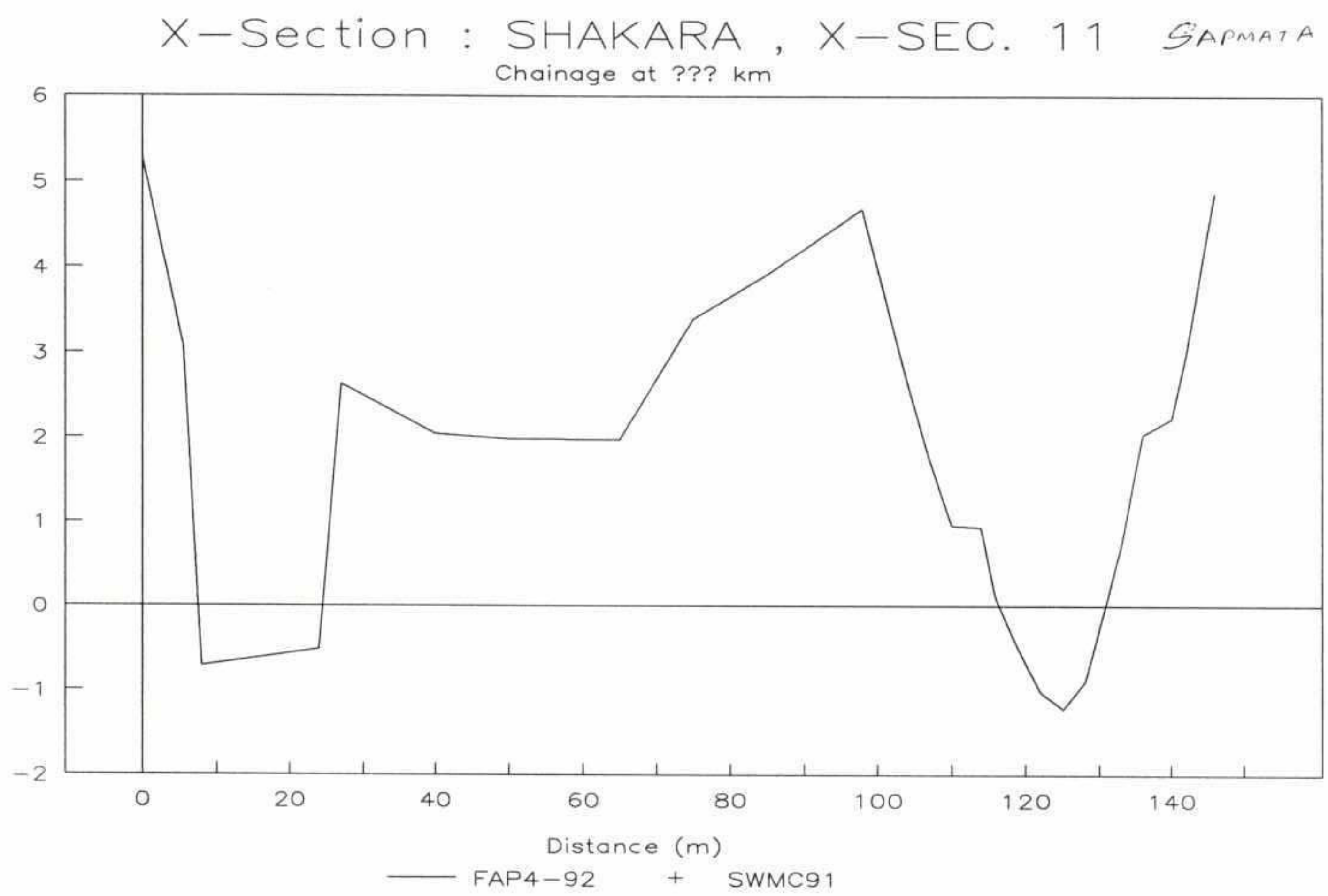


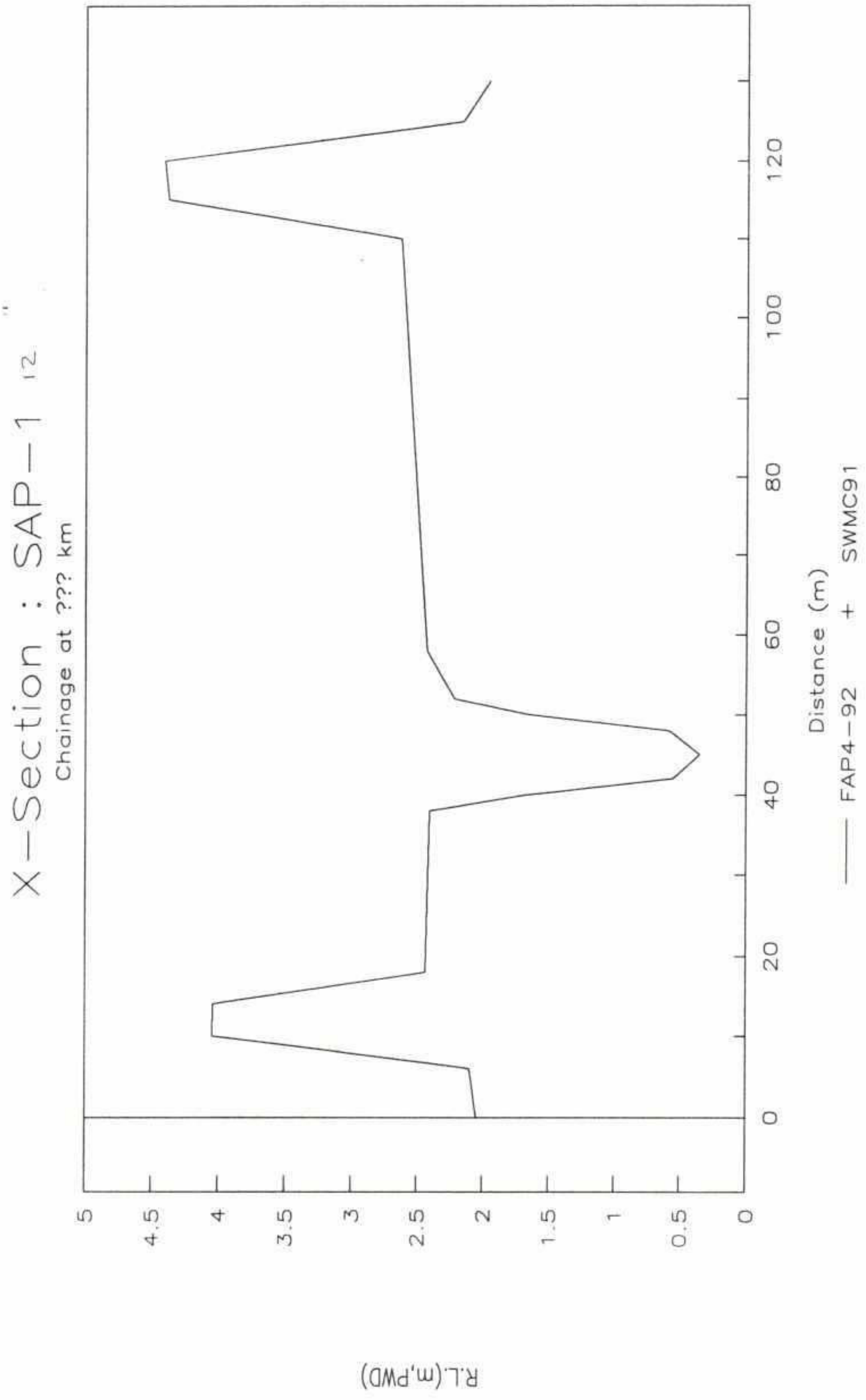

X-Section : HAB-1, SEC-9
Chainage at 0.000 km
Distance (m)
R.L.(m,PWD)
FAP4-92
SWMC91

147

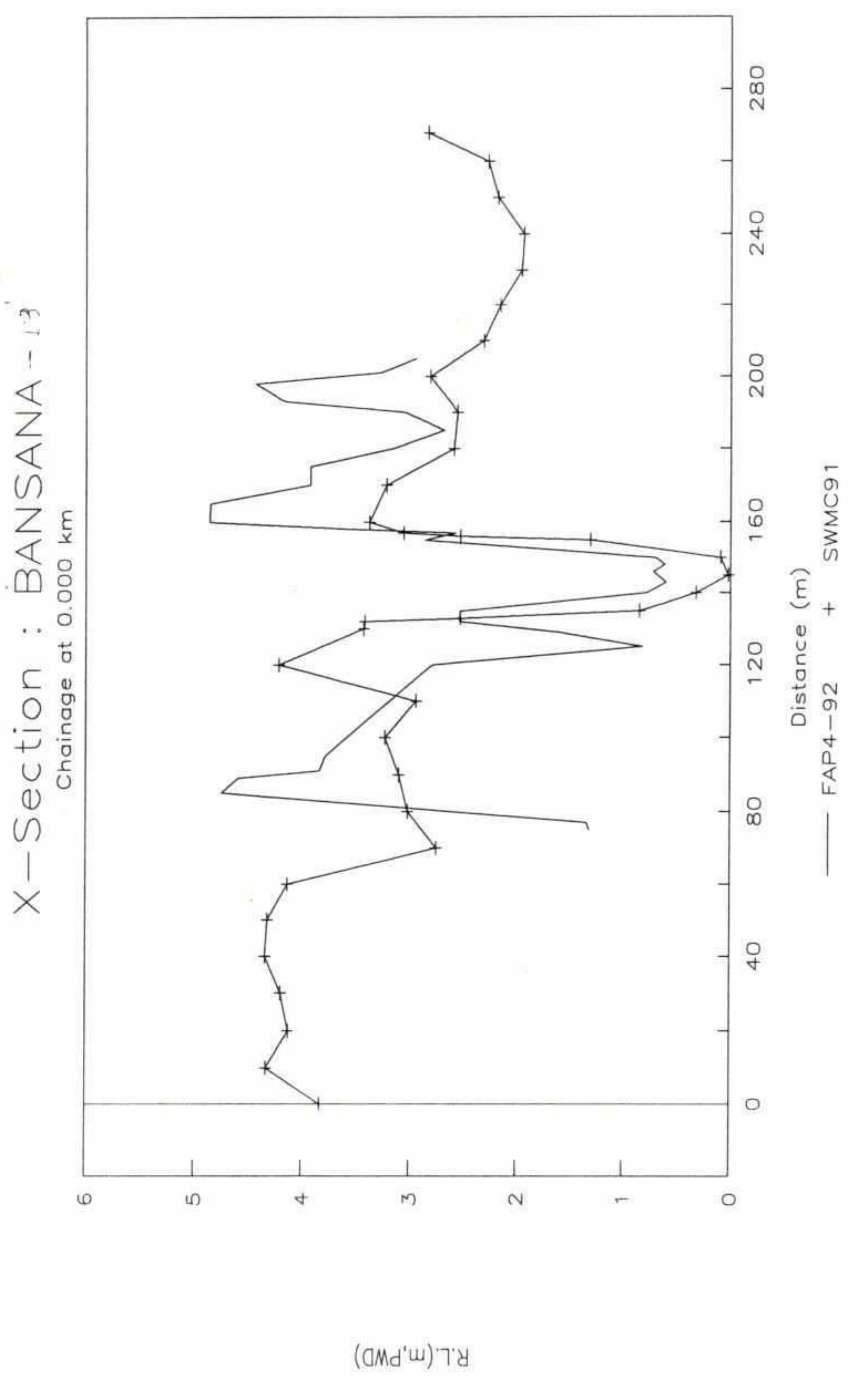


X-Section : HABRA-2, SEC-10
Chainage at 12.500 km
R.L.(m,PWD)
5
4
3
2
1
0
-1
-2
-3
0
100
200
300
400
Distance (m)
— FAP4-92 + SWMC91


X—Section : SHAKARA , X—SEC. 11
SAPMATA
Chainage at ??? km
R.L.(m,PWD)
6
5
4
3
2
1
0
−1
−2
0
20
40
60
80
100
120
140
Distance (m)
FAP4—92
+ SWMC91

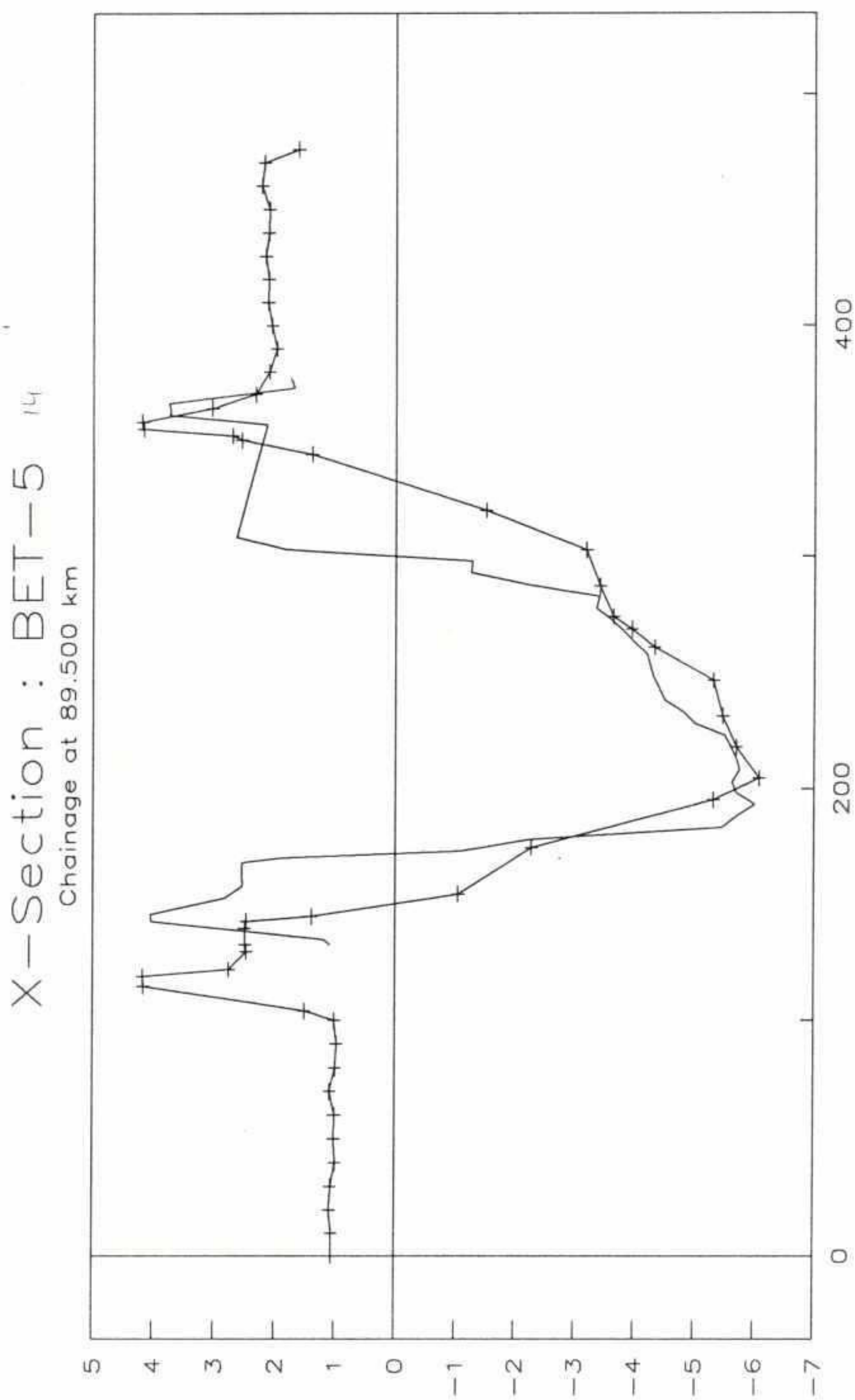

X-Section : SAP-1 12
Chainage at ??? km
R.L.(m,PWD)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
20
40
60
80
100
120
Distance (m)
—— FAP4-92 + SWMC91

150



X-Section : BANSANA - 13
Chainage at 0.000 km
R.L.(m,PWD)
0
1
2
3
4
5
6
0
40
80
120
160
200
240
280
Distance (m)
FAP4-92
+ SWMC91

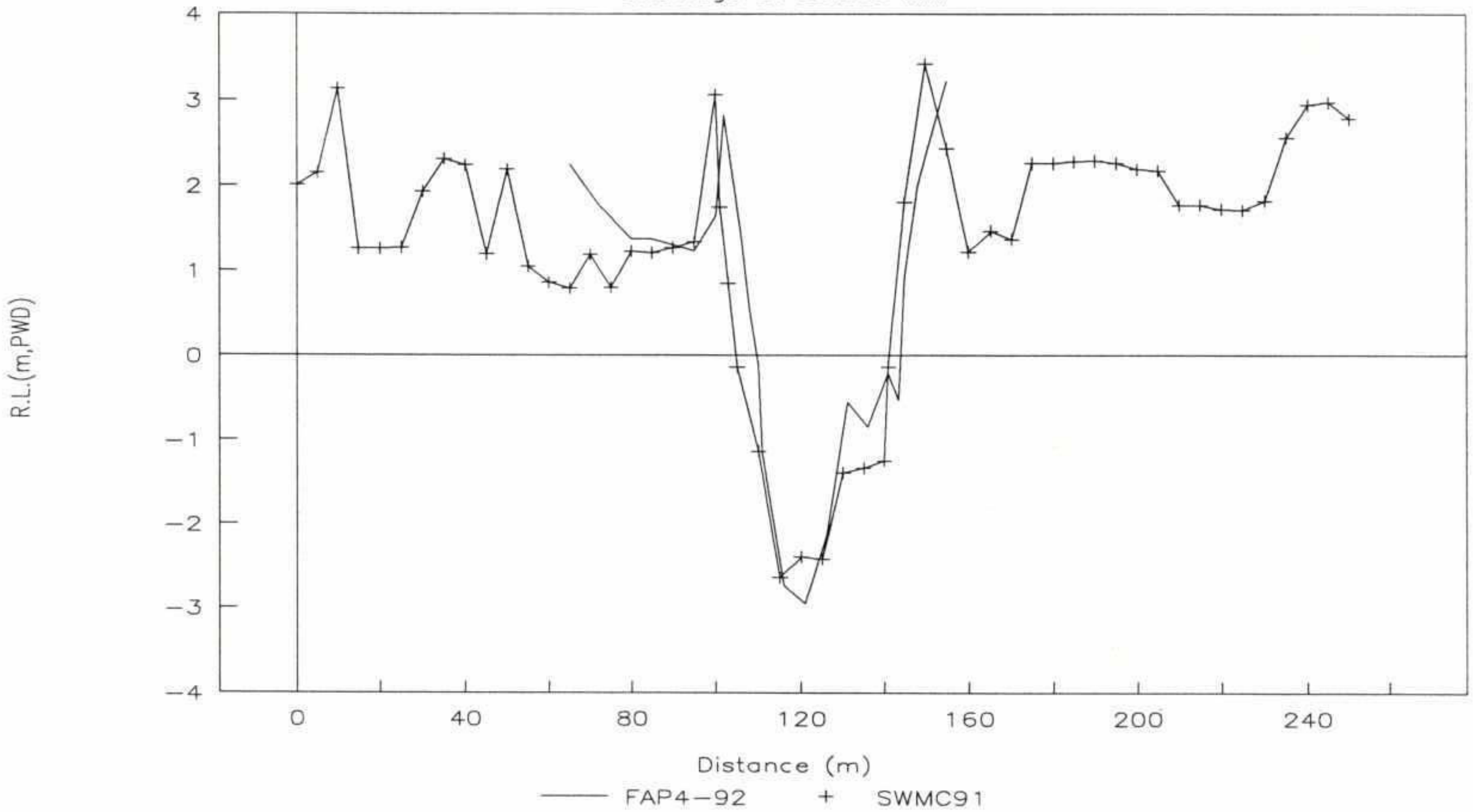
151



X-Section : BET-5
Chainage at 89.500 km
R.L.(m,PWD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
200
400
Distance (m)
FAP4-92
+ SWMC91

X-Section : BET-4 15

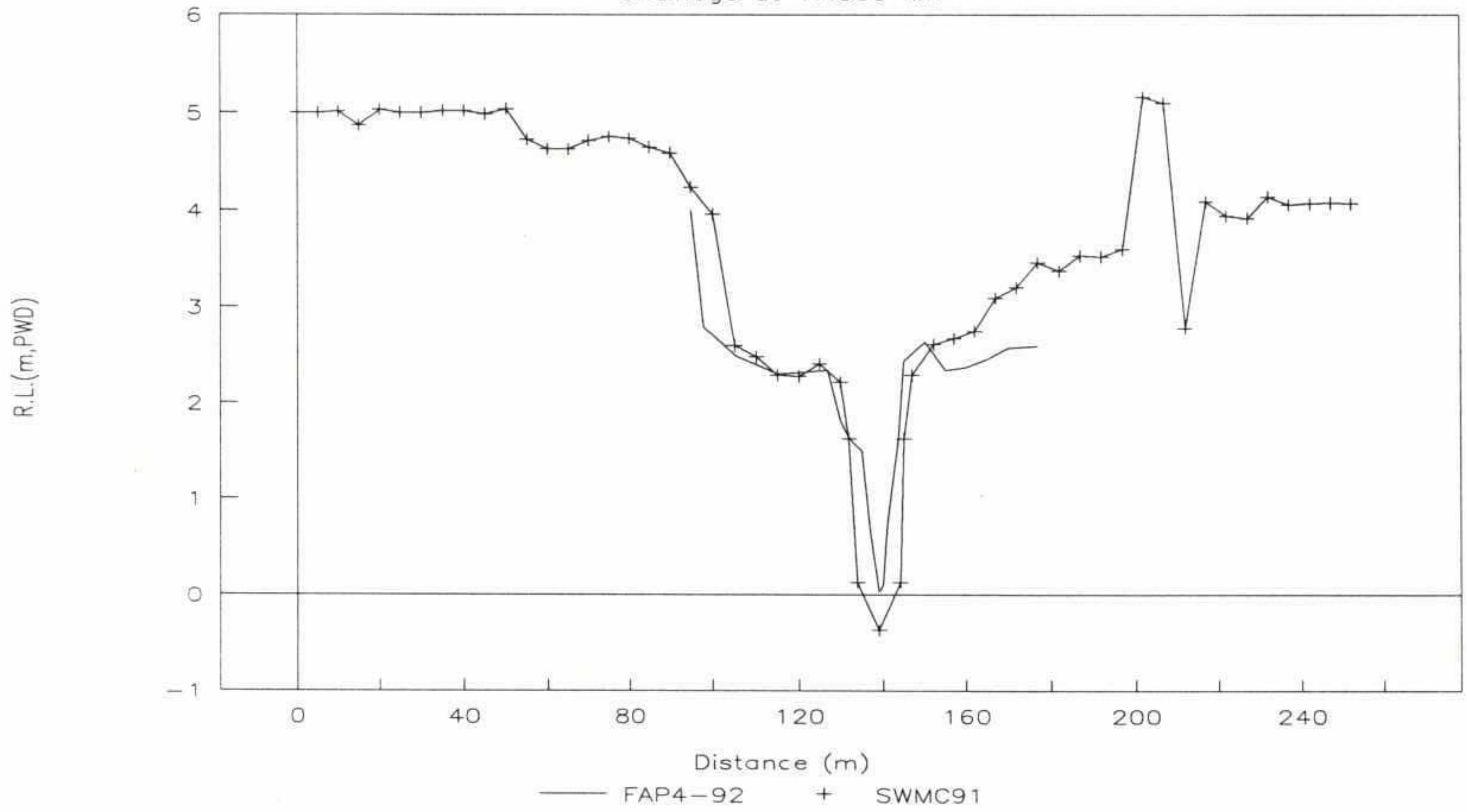
Chainage at 65.000 km



152

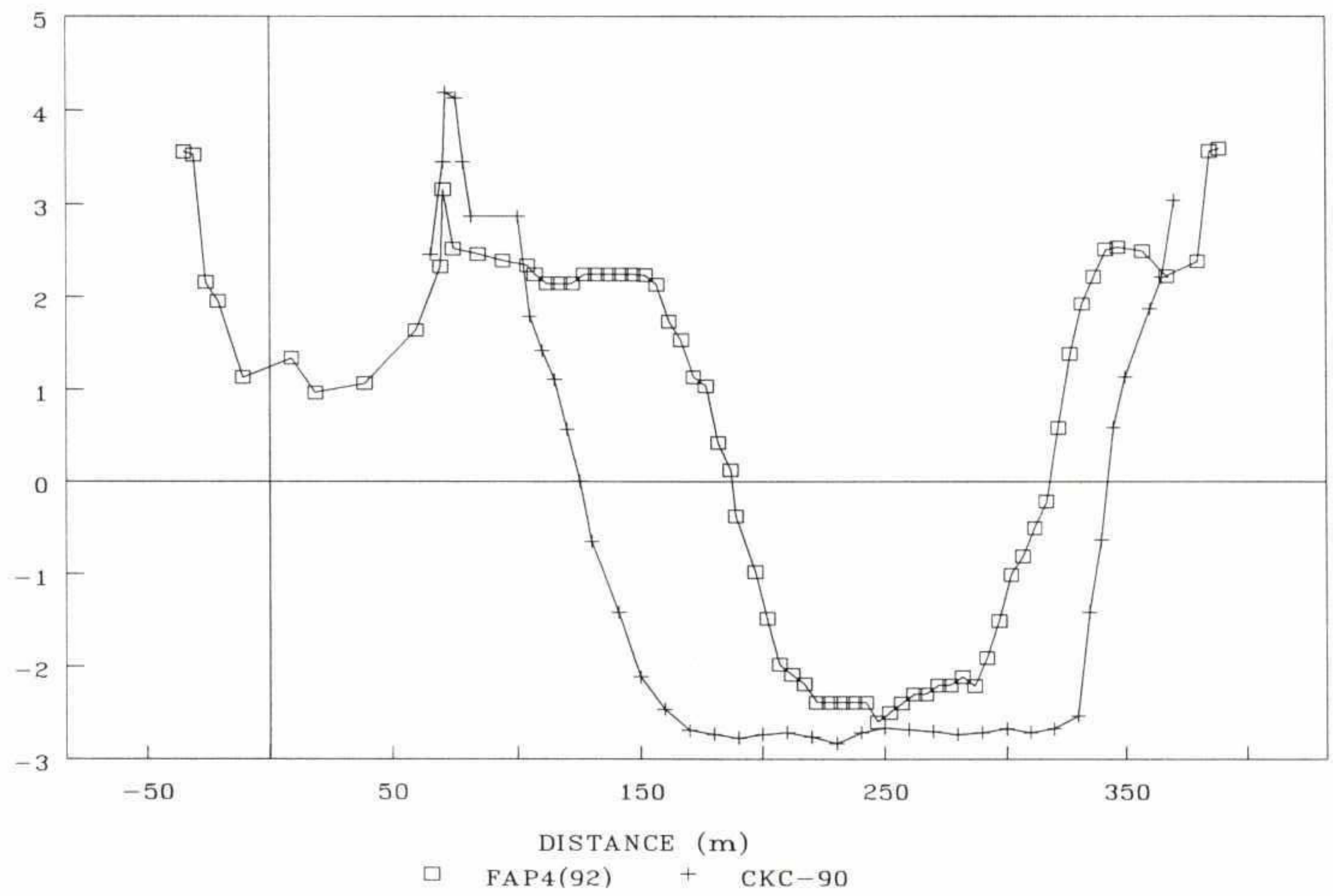
X-Section : BET-3

Chainage at 47.000 km

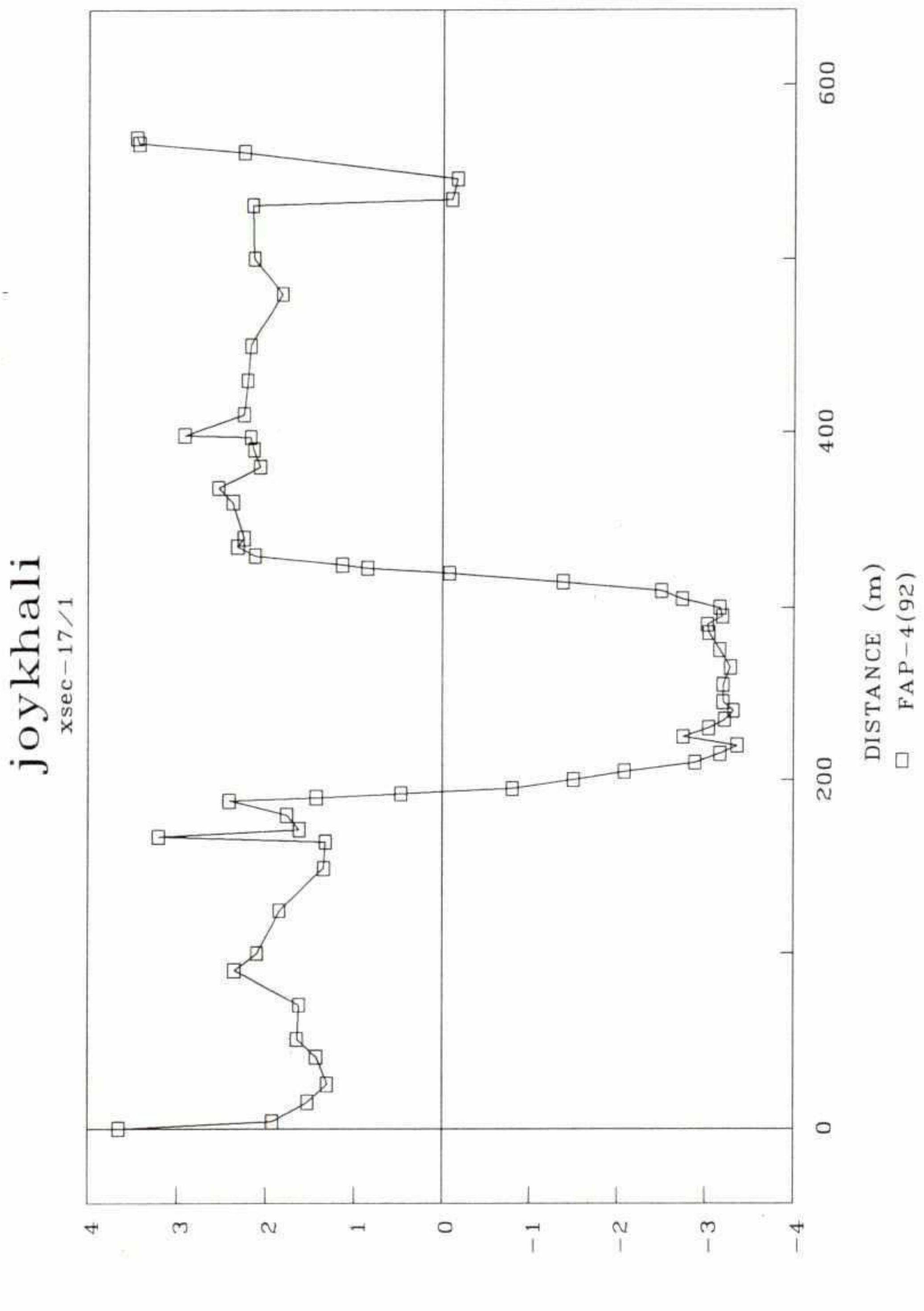


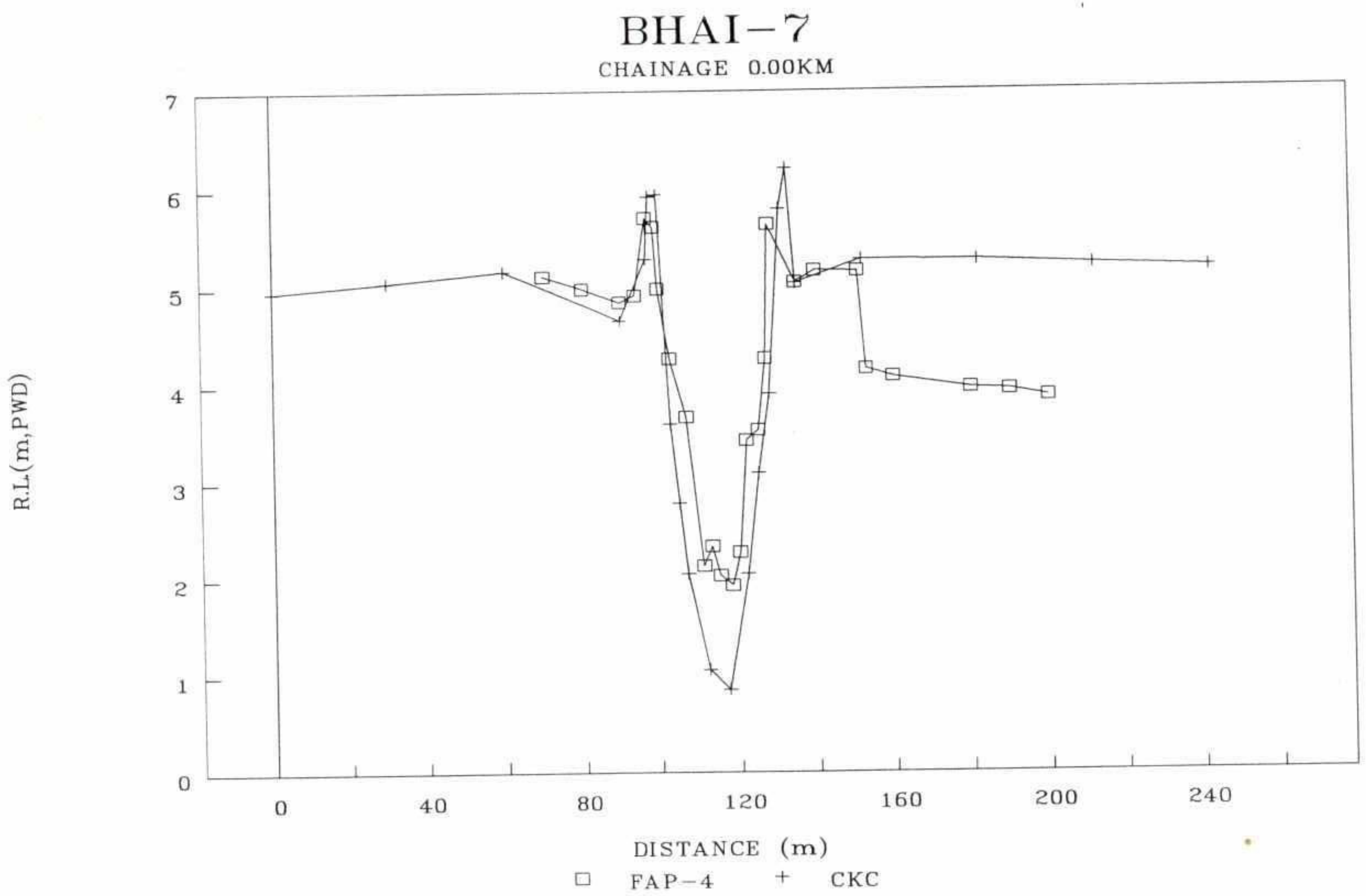
253

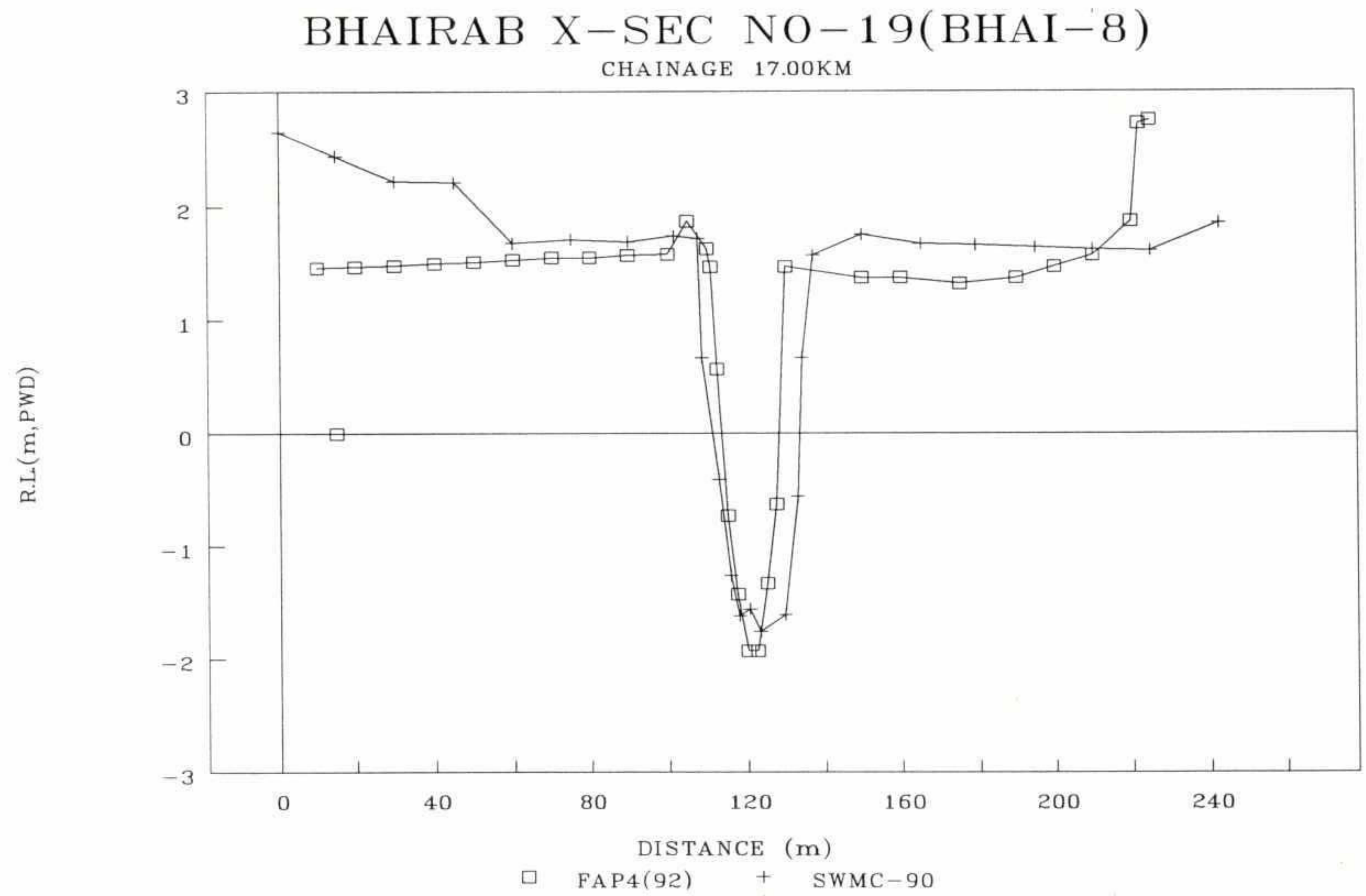
JOYKHALI X-SEC NO-17



254

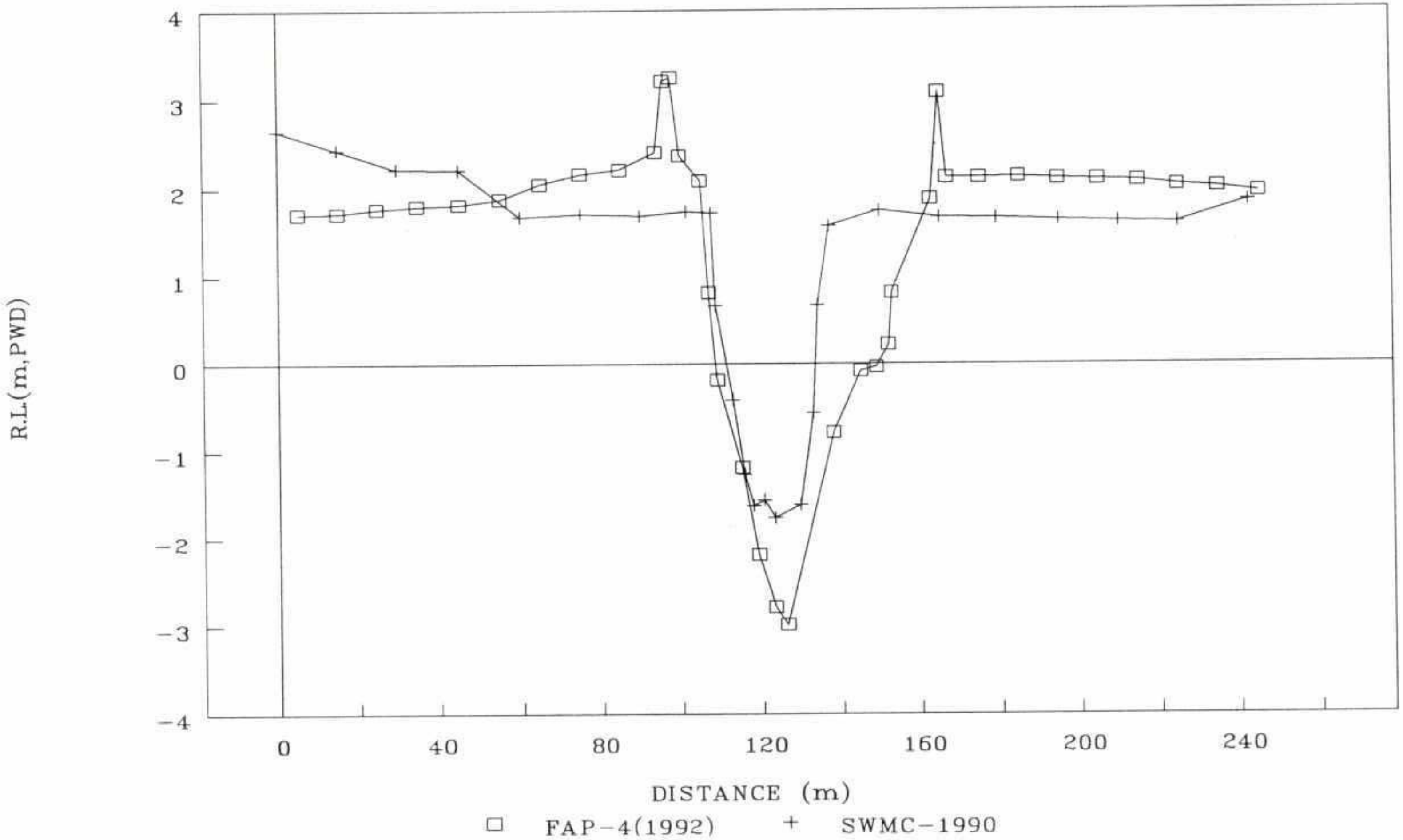

joykhali
xsec-17/1
DISTANCE (m)
FAP-4(92)
R.L.(m,PWD)
0
200
400
600
4
3
2
1
0
-1
-2
-3
-4


BHAI-7
CHAINAGE 0.00KM
R.L(m,PWD)
0
1
2
3
4
5
6
7
0
40
80
120
160
200
240
DISTANCE (m)
FAP-4
CKC

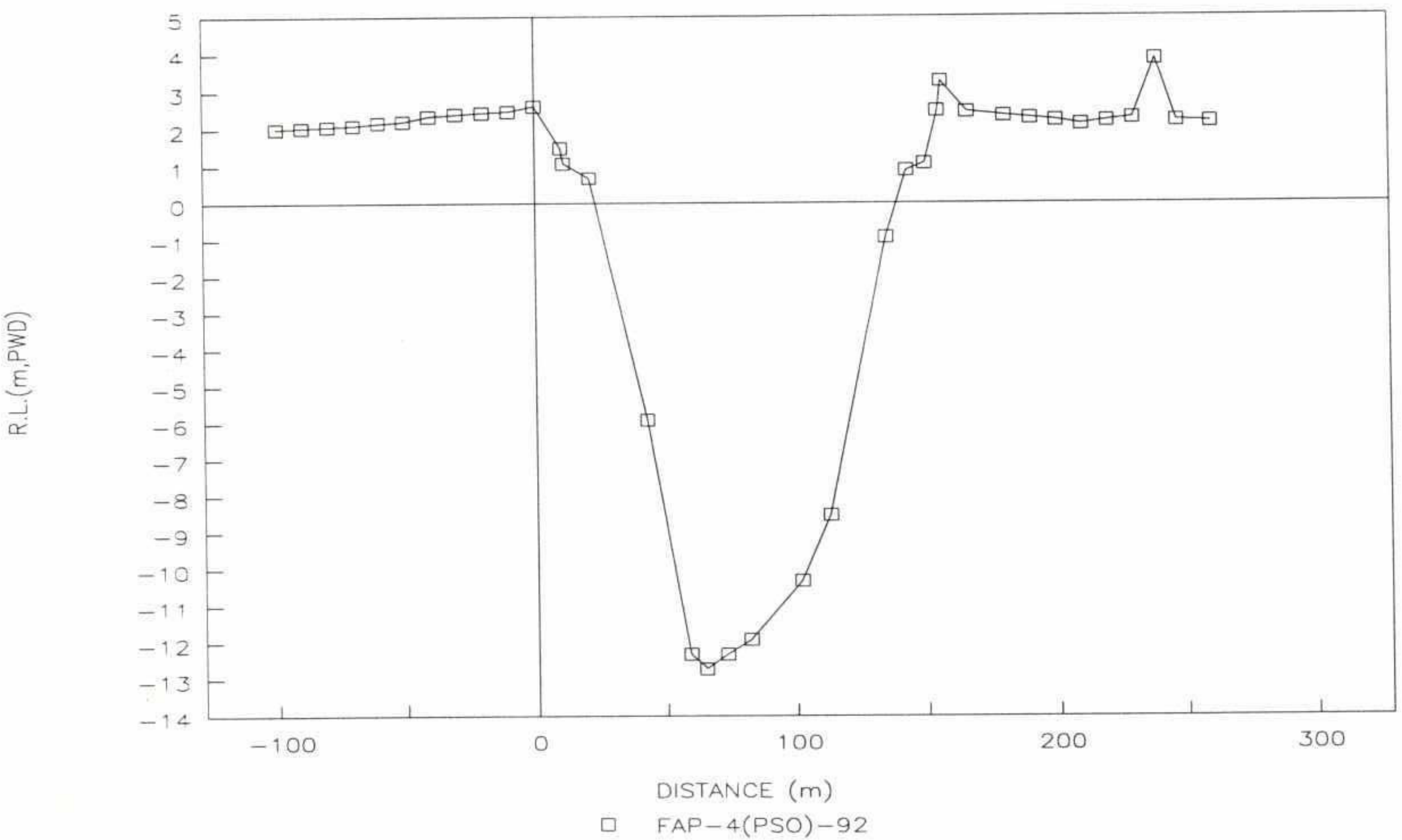

BHAIRAB X−SEC NO−19(BHAI−8)
CHAINAGE 17.00KM
R.L.(m,PWD)
3
2
1
0
−1
−2
−3
0
40
80
120
160
200
240
DISTANCE (m)
□ FAP4(92) + SWMC−90

BHAIRAB (XSECE NO–20/BHAI–13)

CHAINAGE 17.000KM

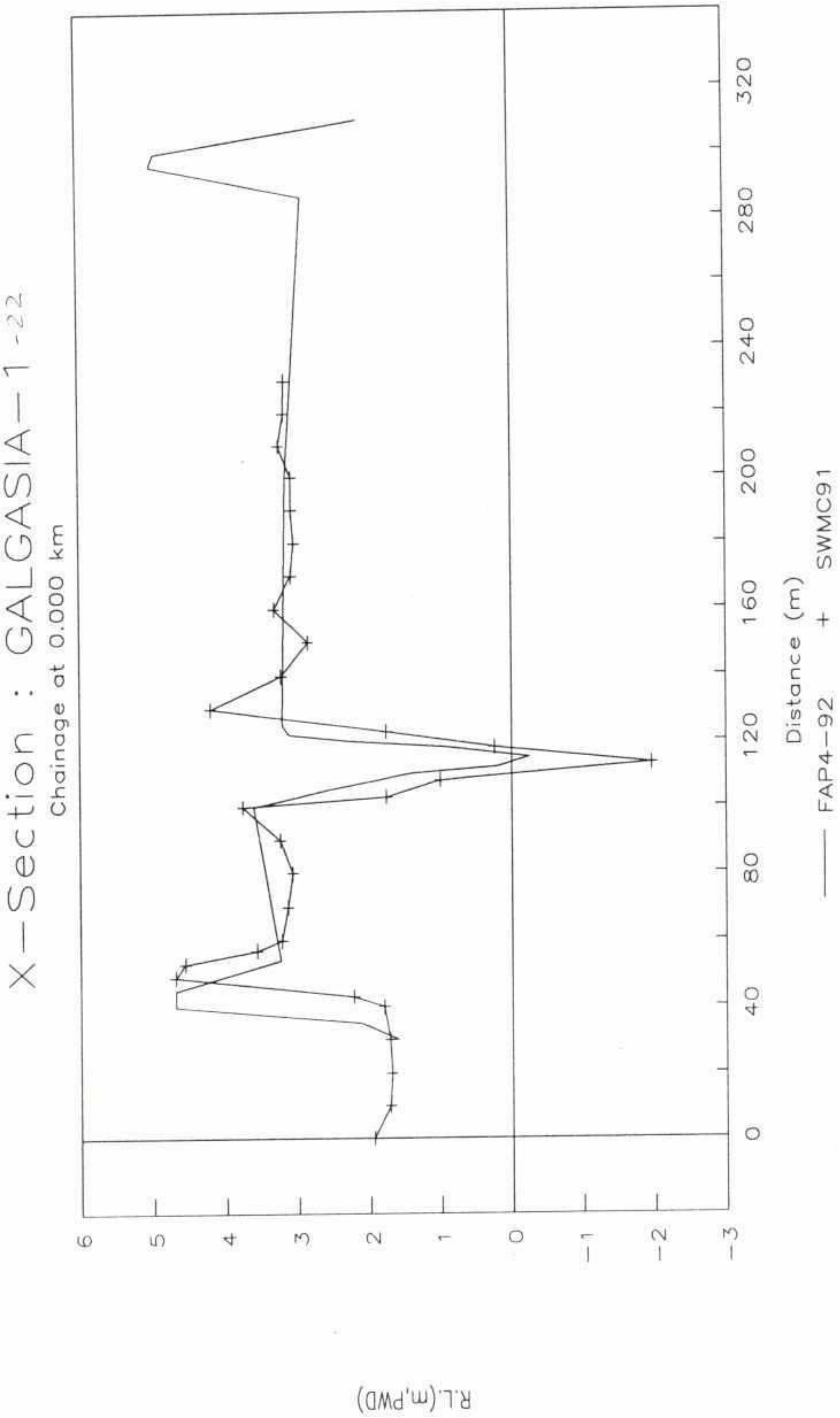


KUMARKHALI X-SEC NO.21(KKHL-3)



159

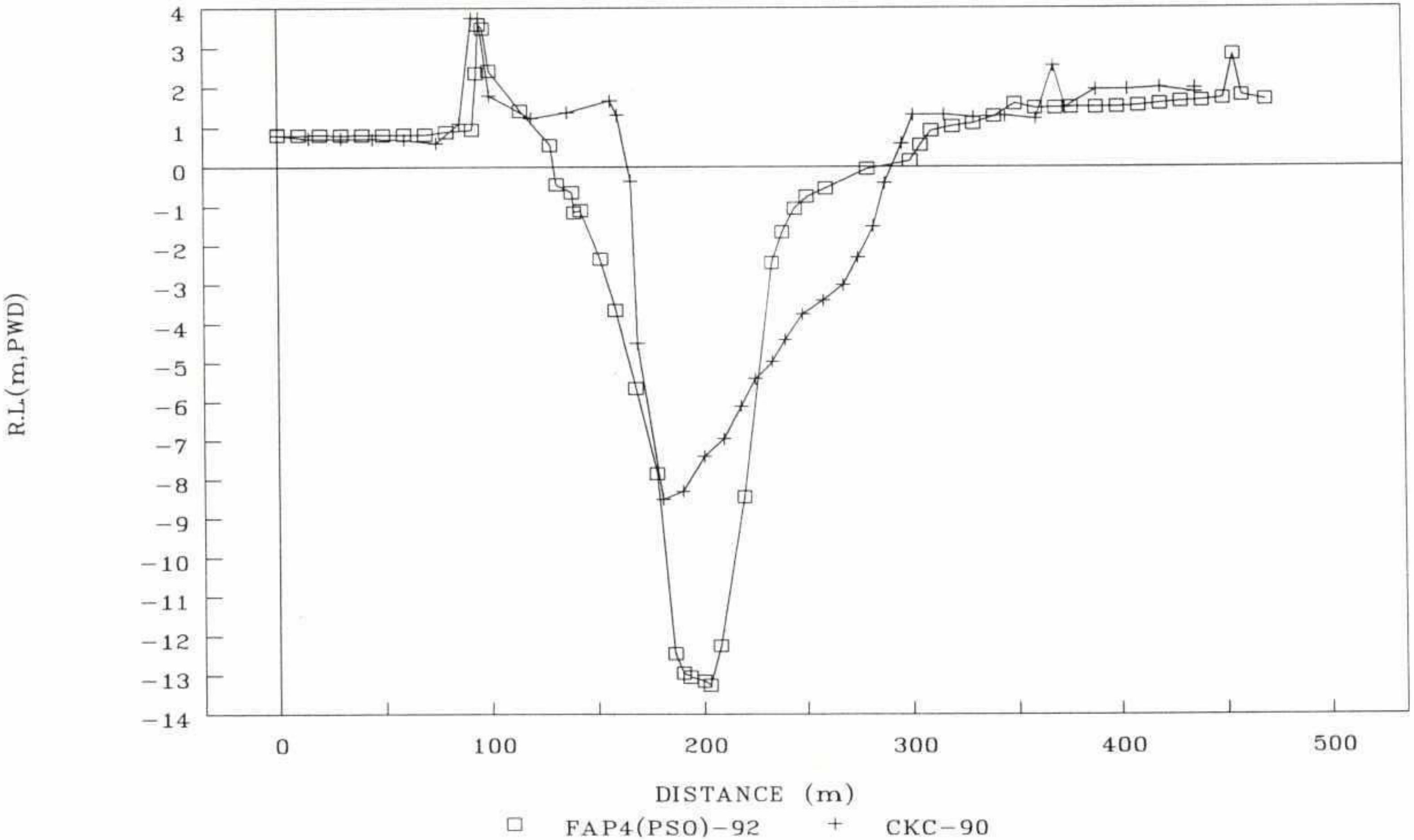
160

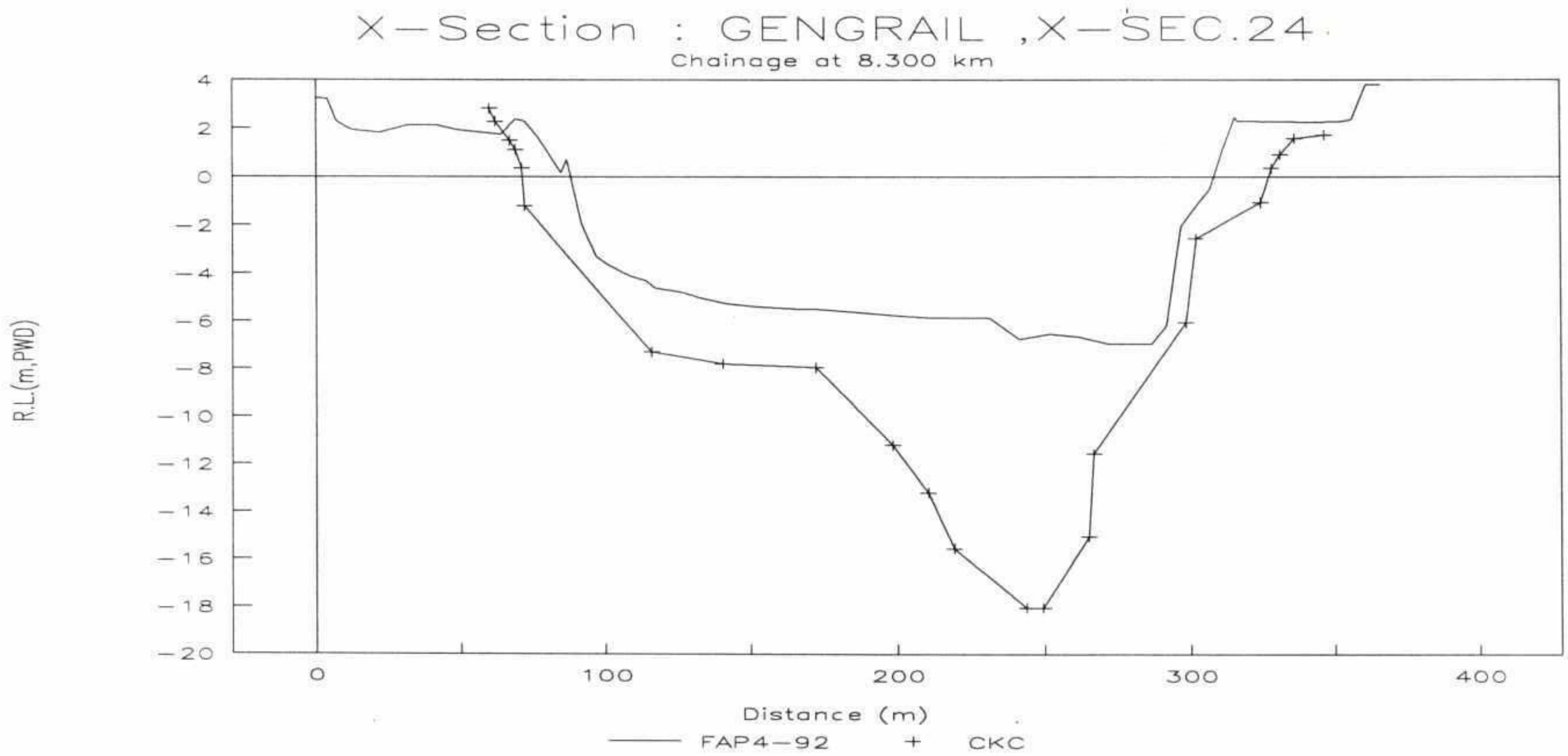


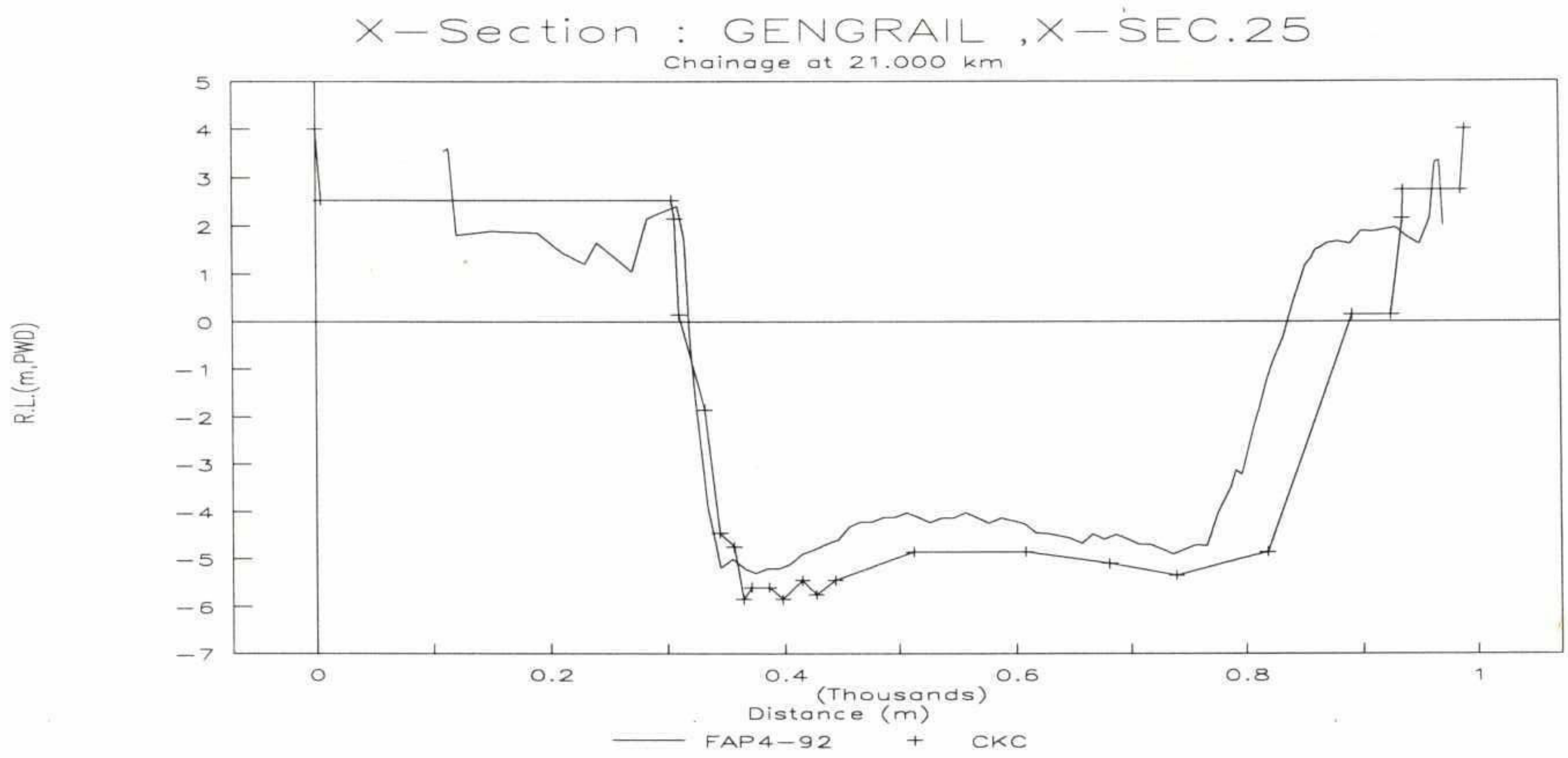
X-Section : GALGASIA-1 -22
Chainage at 0.000 km
R.L.(m,PWD)
6
5
4
3
2
1
0
-1
-2
-3
0
40
80
120
160
200
240
280
320
Distance (m)
FAP4-92
+ SWMC91

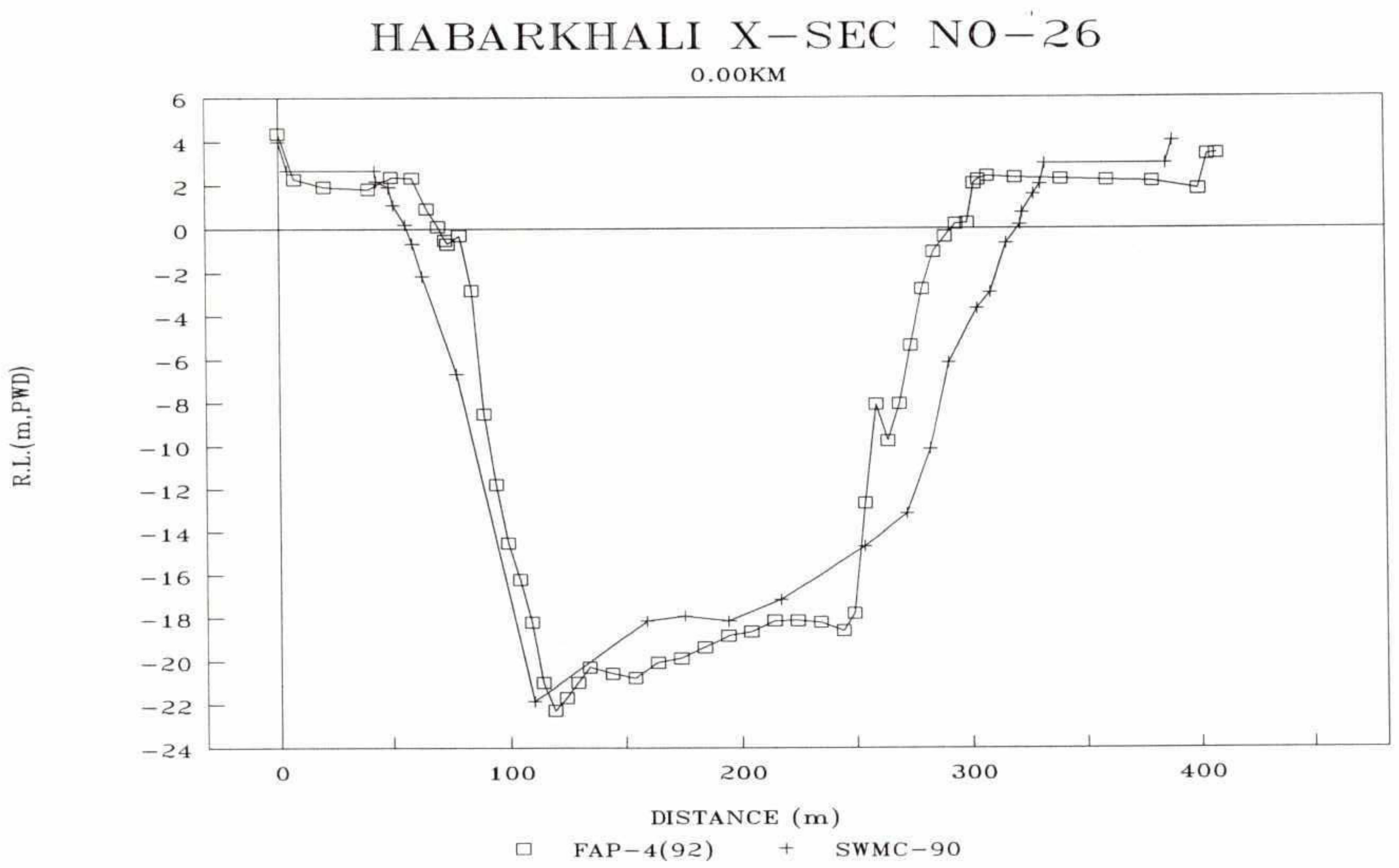
GALGHASIA X-SEC NO.23(GAL'-2)

20.50KM




X—Section : GENGRAIL ,X—SEC.24
Chainage at 8.300 km
R.L.(m,PWD)
4
2
0
−2
−4
−6
−8
−10
−12
−14
−16
−18
−20
0
100
200
300
400
Distance (m)
FAP4—92
+ CKC

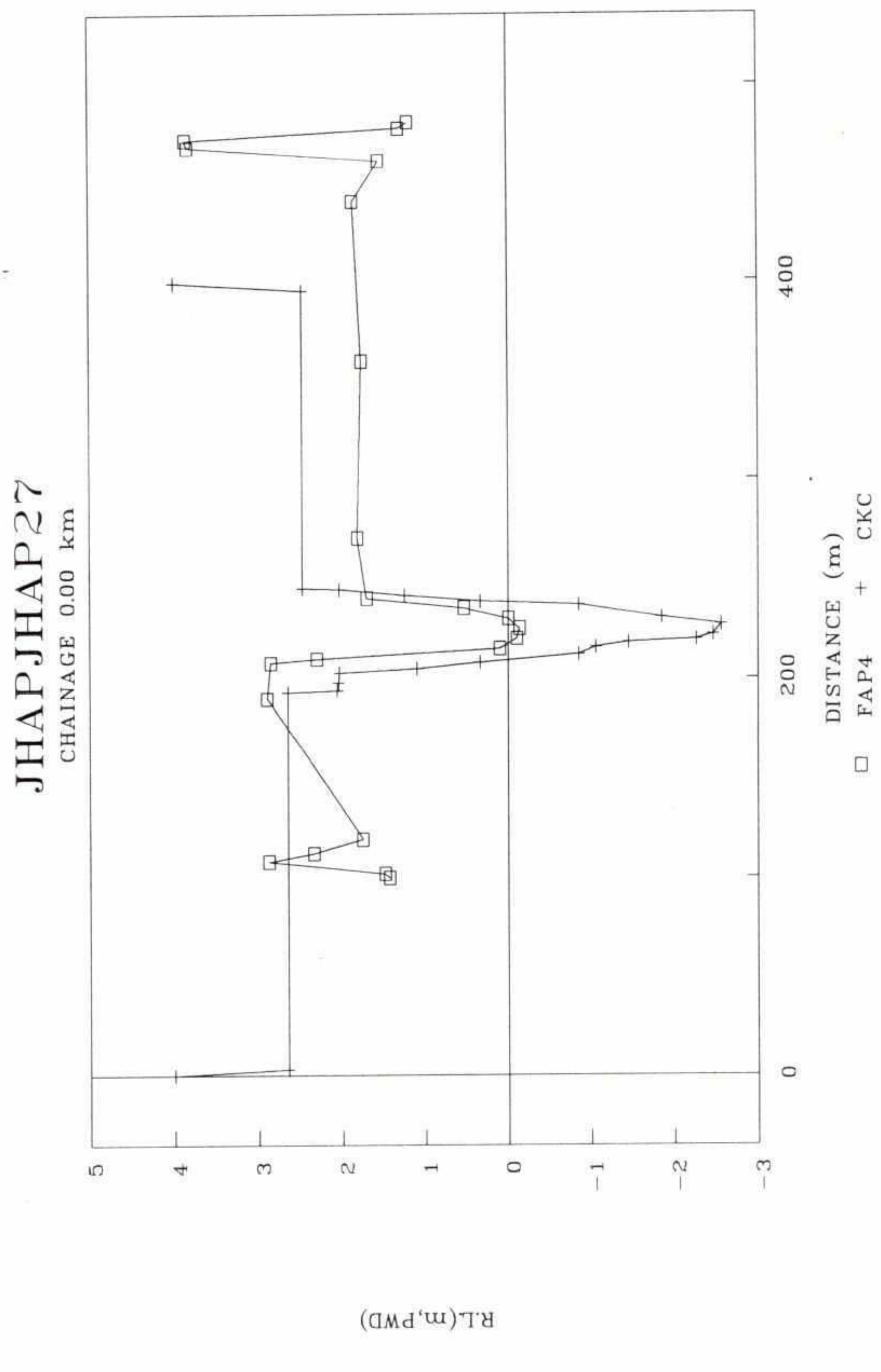

X—Section : GENGRAIL ,X—SEC.25
Chainage at 21.000 km
R.L.(m,PWD)
5
4
3
2
1
0
−1
−2
−3
−4
−5
−6
−7
0
0.2
0.4
0.6
0.8
1
(Thousands)
Distance (m)
FAP4—92
+ CKC



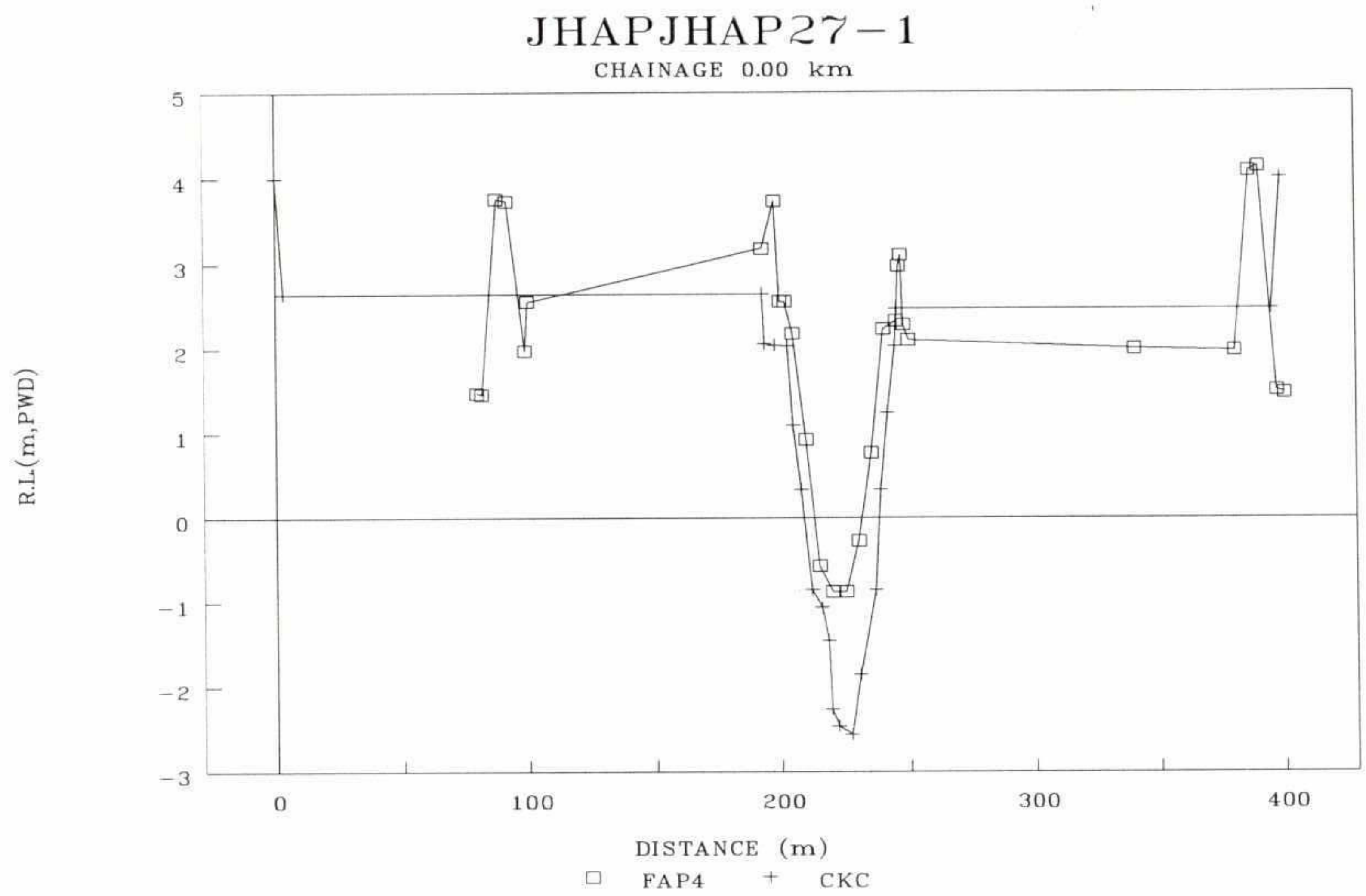
HABARKHALI X-SEC NO-26
0.00KM
R.L.(m,PWD)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
0
100
200
300
400
DISTANCE (m)
FAP-4(92)
SWMC-90

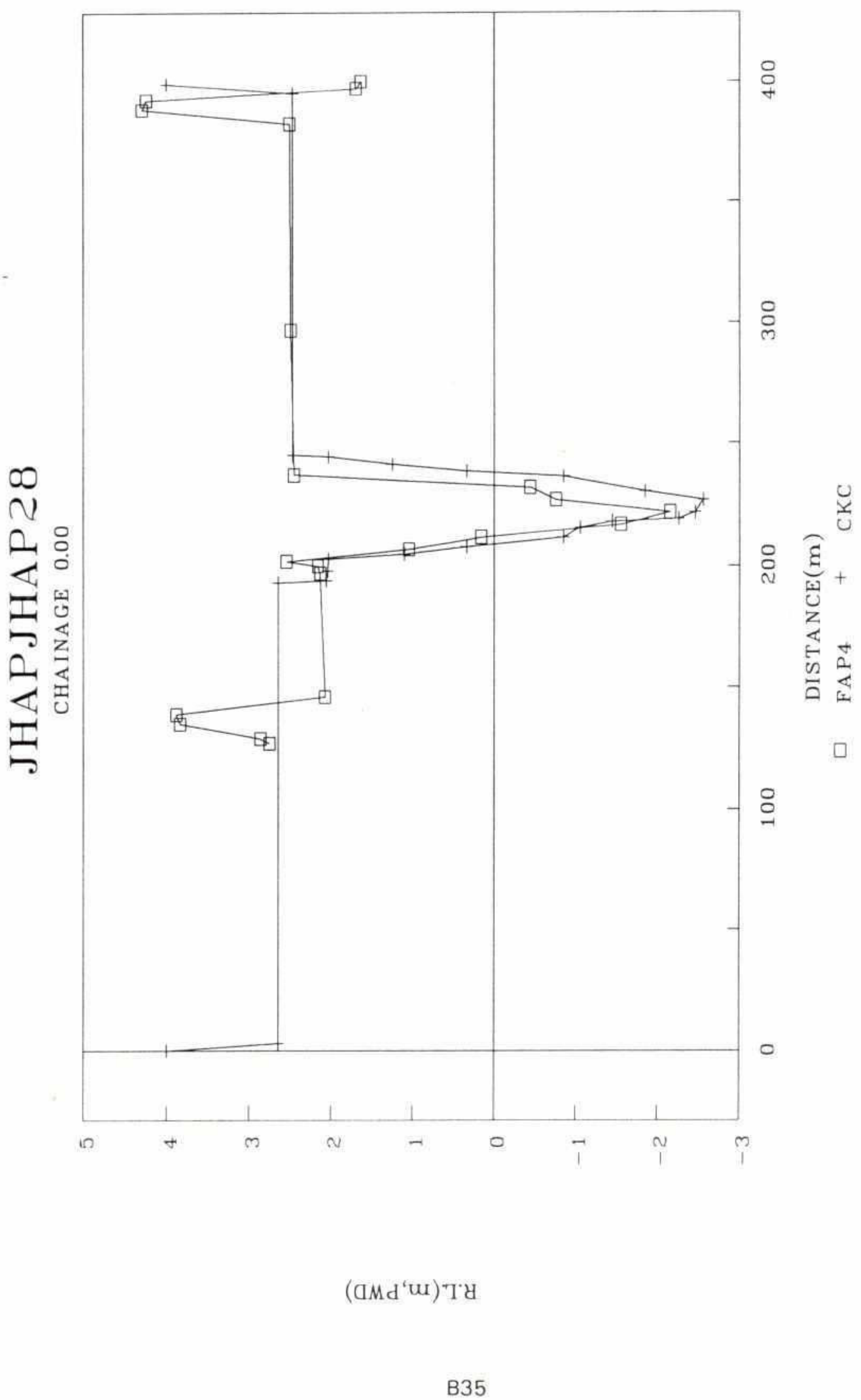
264

165



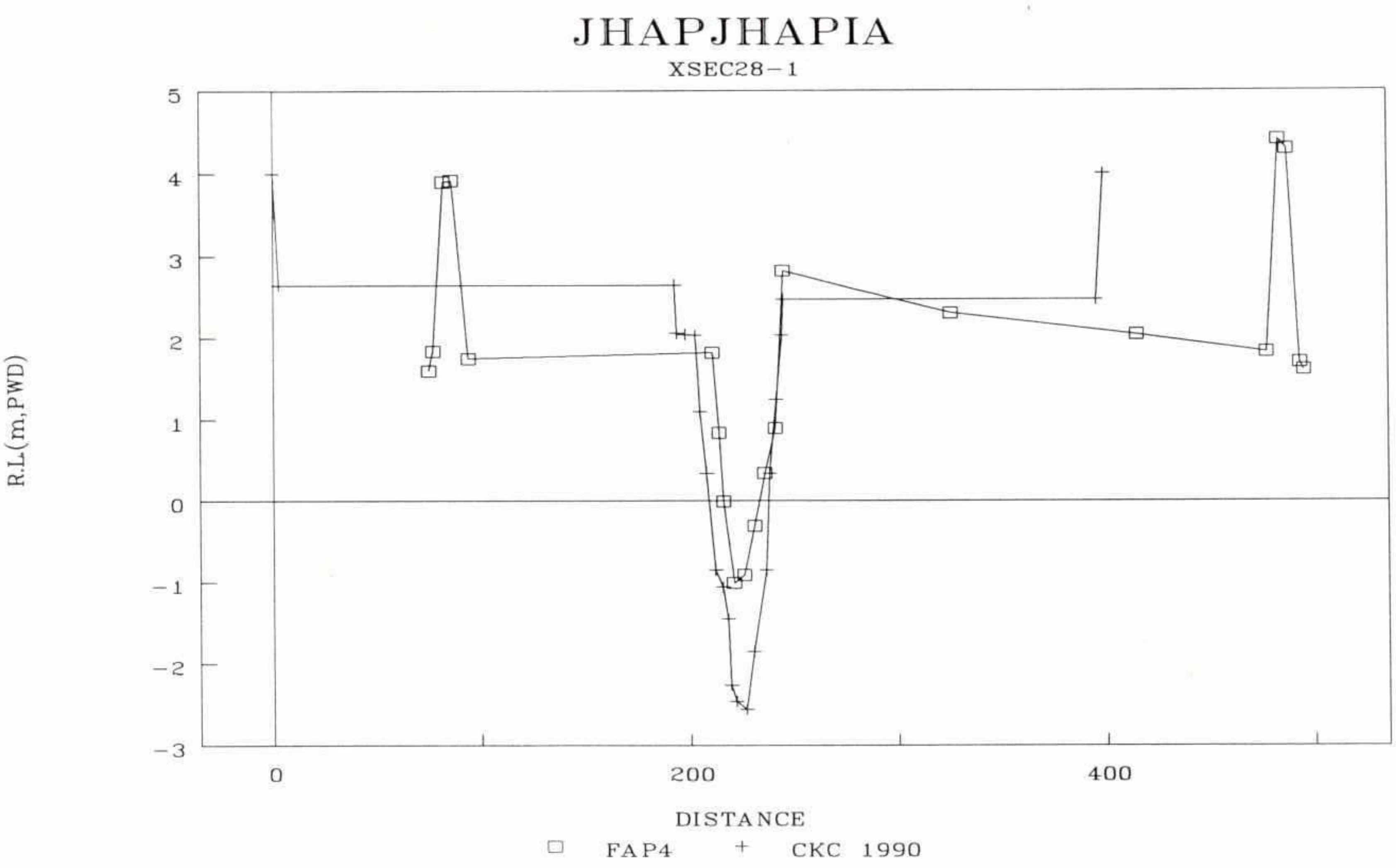
JHAPJHAP27
CHAINAGE 0.00 km
R.L.(m,PWD)
DISTANCE (m)
□ FAP4 + CKC
5
4
3
2
1
0
-1
-2
-3
0
200
400


JHAPJHAP27−1
CHAINAGE 0.00 km
R.L.(m,PWD)
5
4
3
2
1
0
−1
−2
−3
0
100
200
300
400
DISTANCE (m)
FAP4
CKC



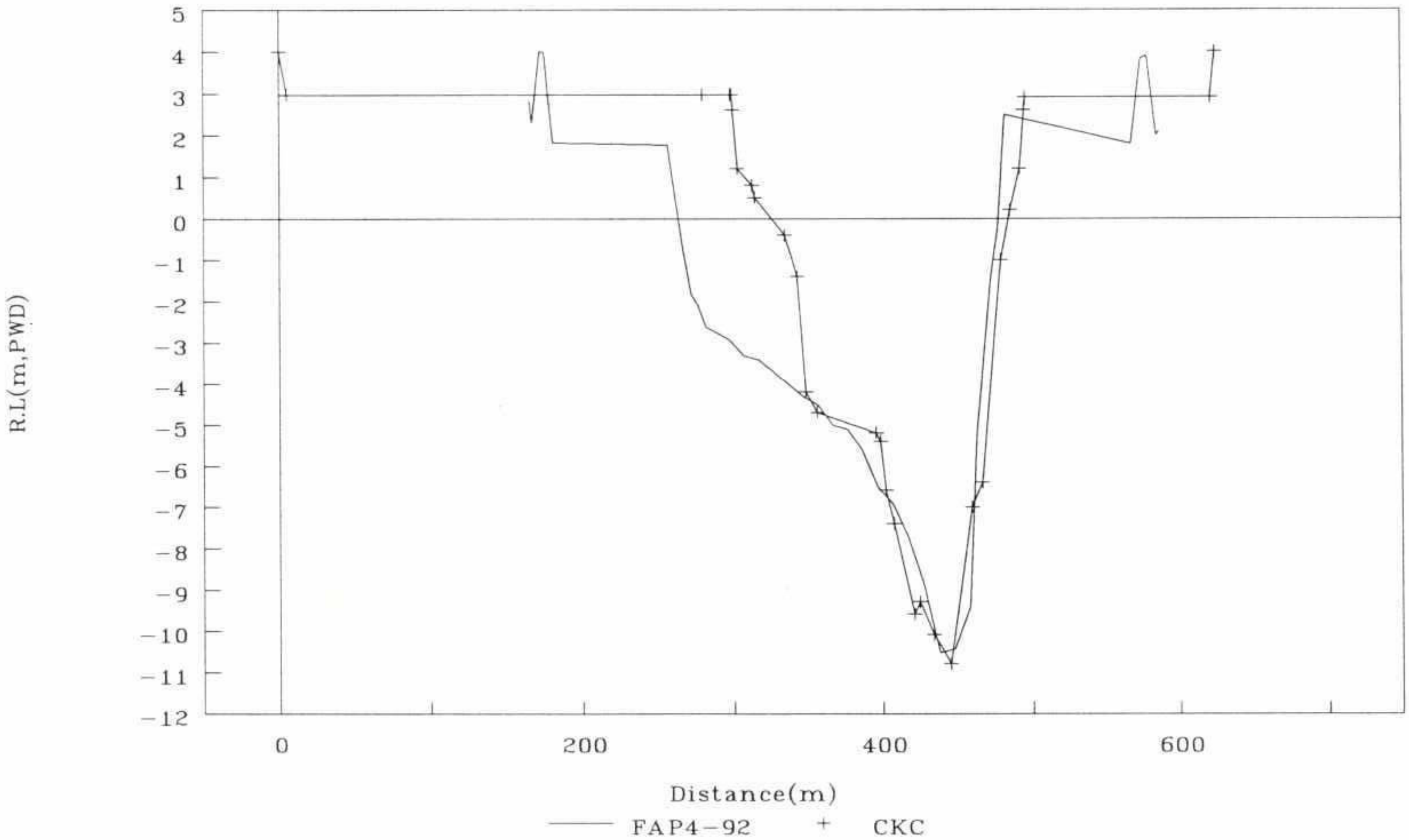
JHAPJHAP28
CHAINAGE 0.00
DISTANCE(m)
R.L.(m,PWD)
□ FAP4 + CKC
0
100
200
300
400
5
4
3
2
1
0
−1
−2
−3

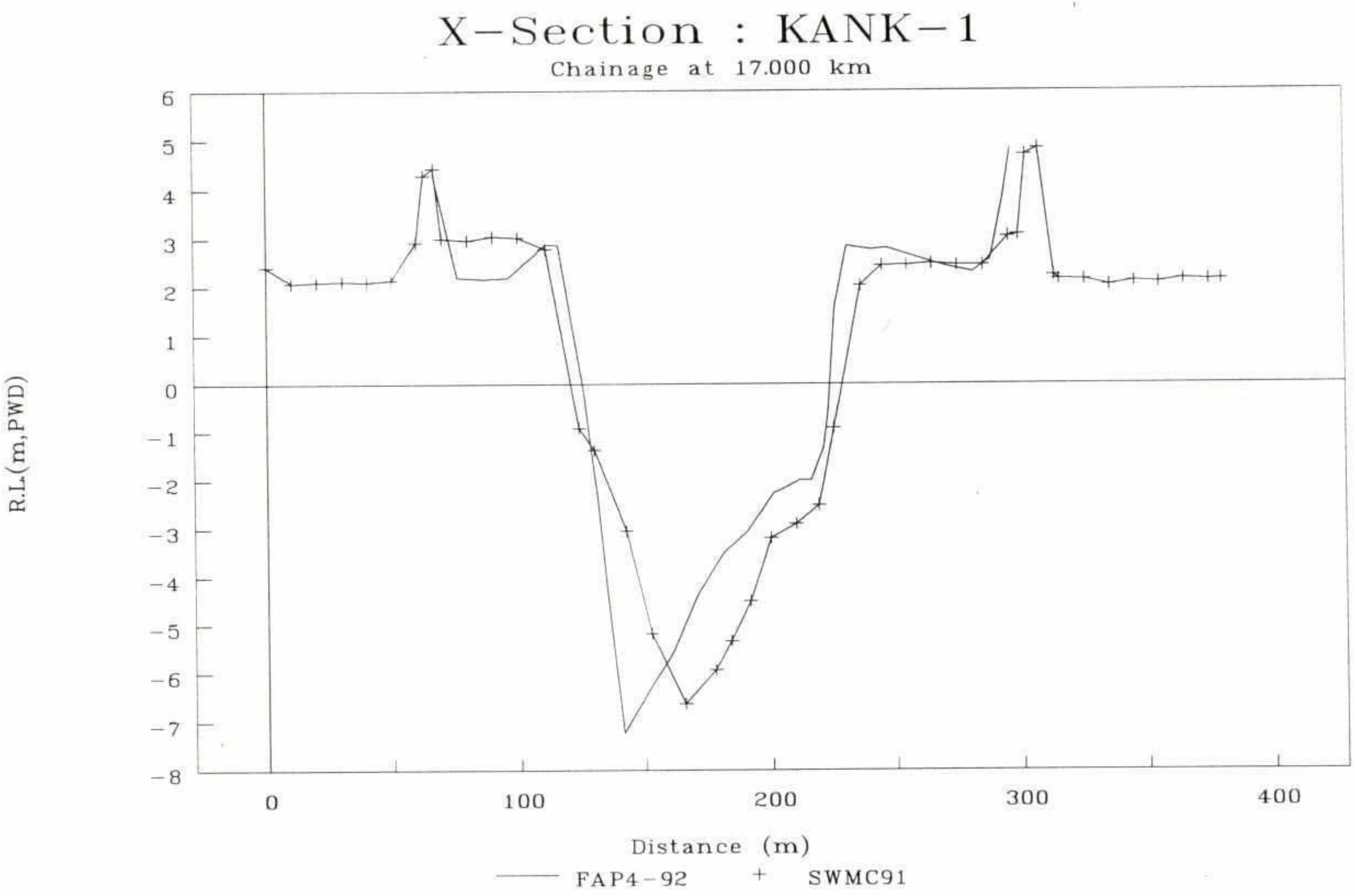
167


JHAPJHAPIA
XSEC28-1
R.L.(m,PWD)
5
4
3
2
1
0
-1
-2
-3
0
200
400
DISTANCE
FAP4
+ CKC 1990

JHAPJA29

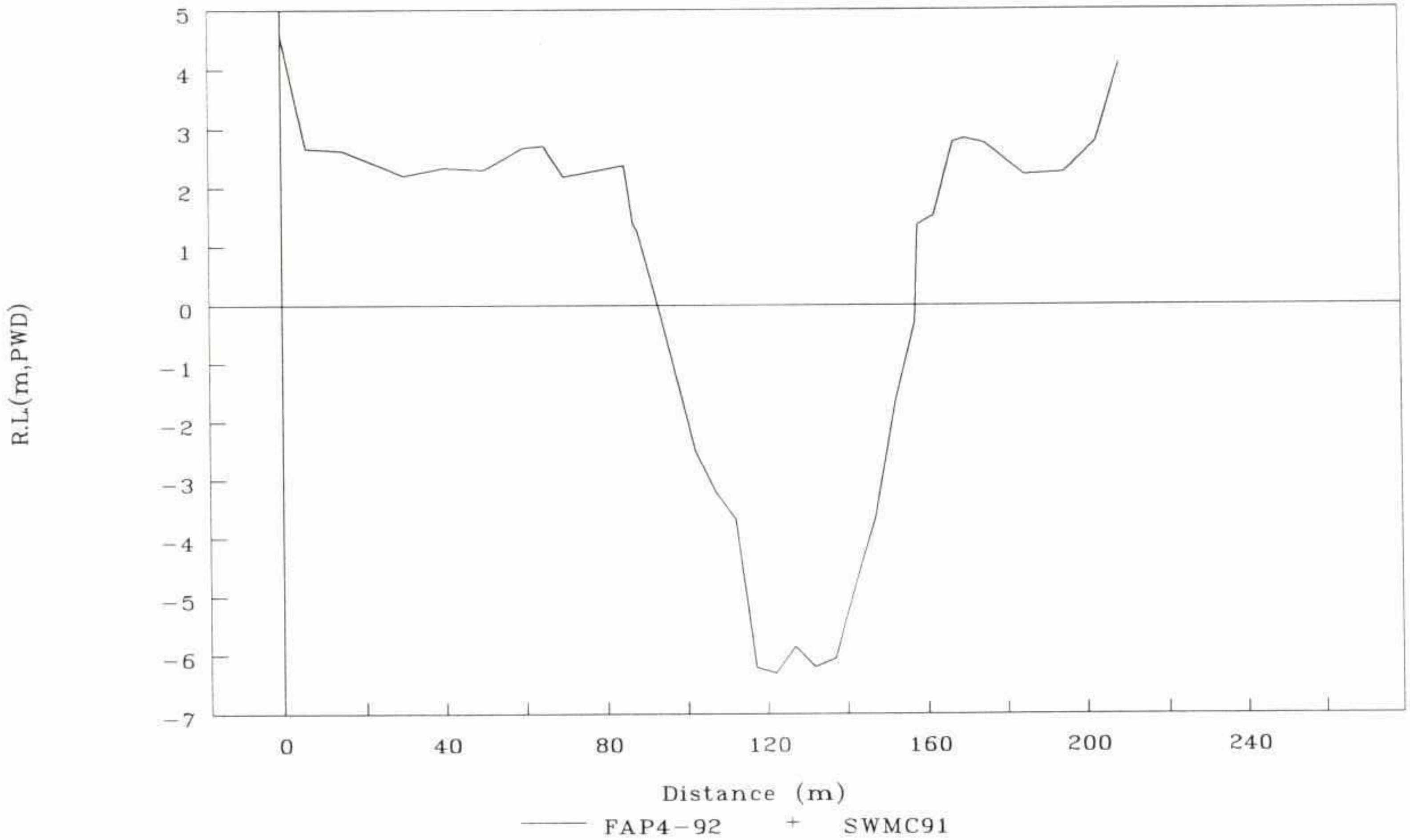
CHAINAGE 0.00km




X-Section : KANK-1
Chainage at 17.000 km
R.L.(m,PWD)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
100
200
300
400
Distance (m)
FAP4-92
SWMC91

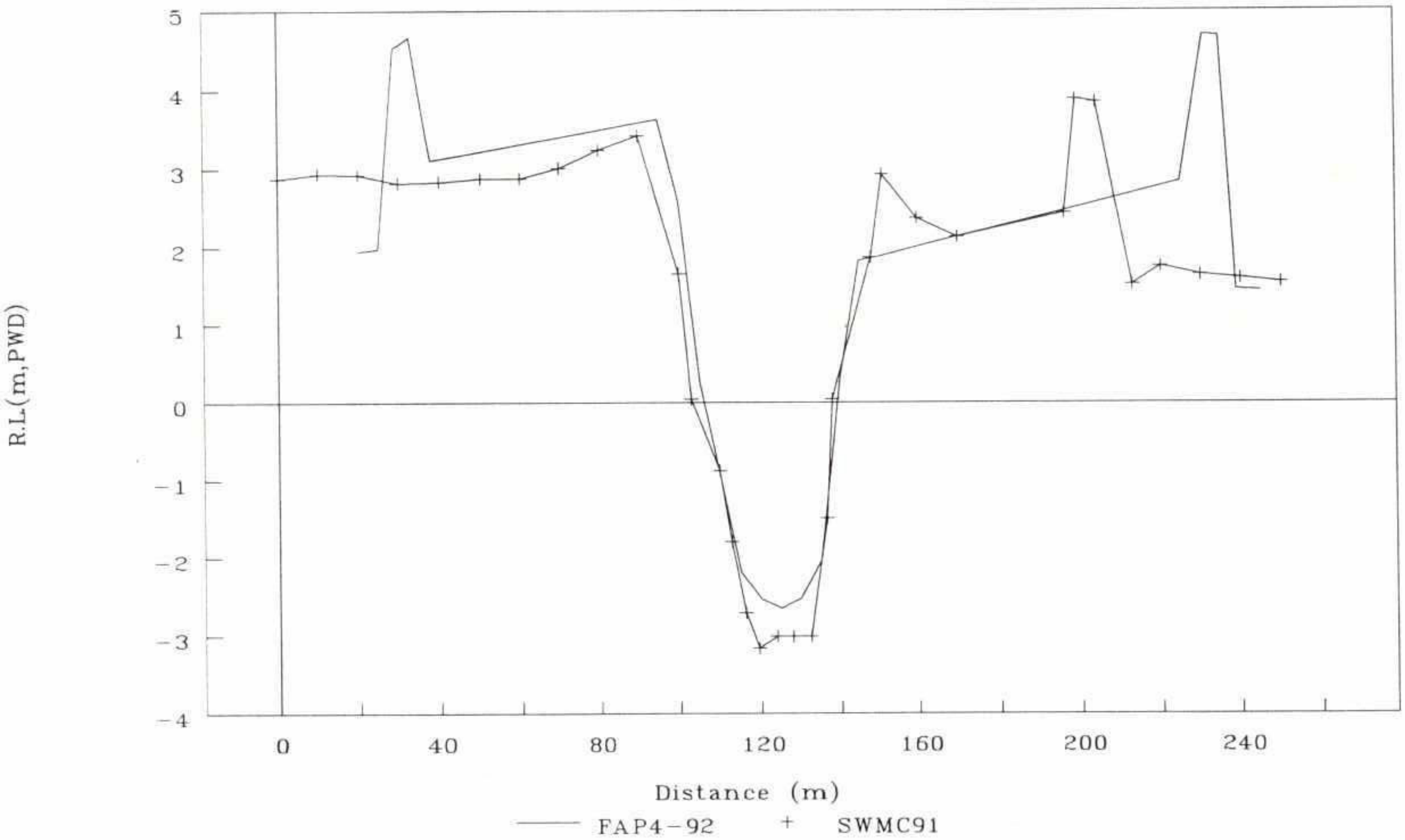
X-Section : KANK-3

Chainage at ??? km



X-Section : KANK-2

Chainage at 0.000 km



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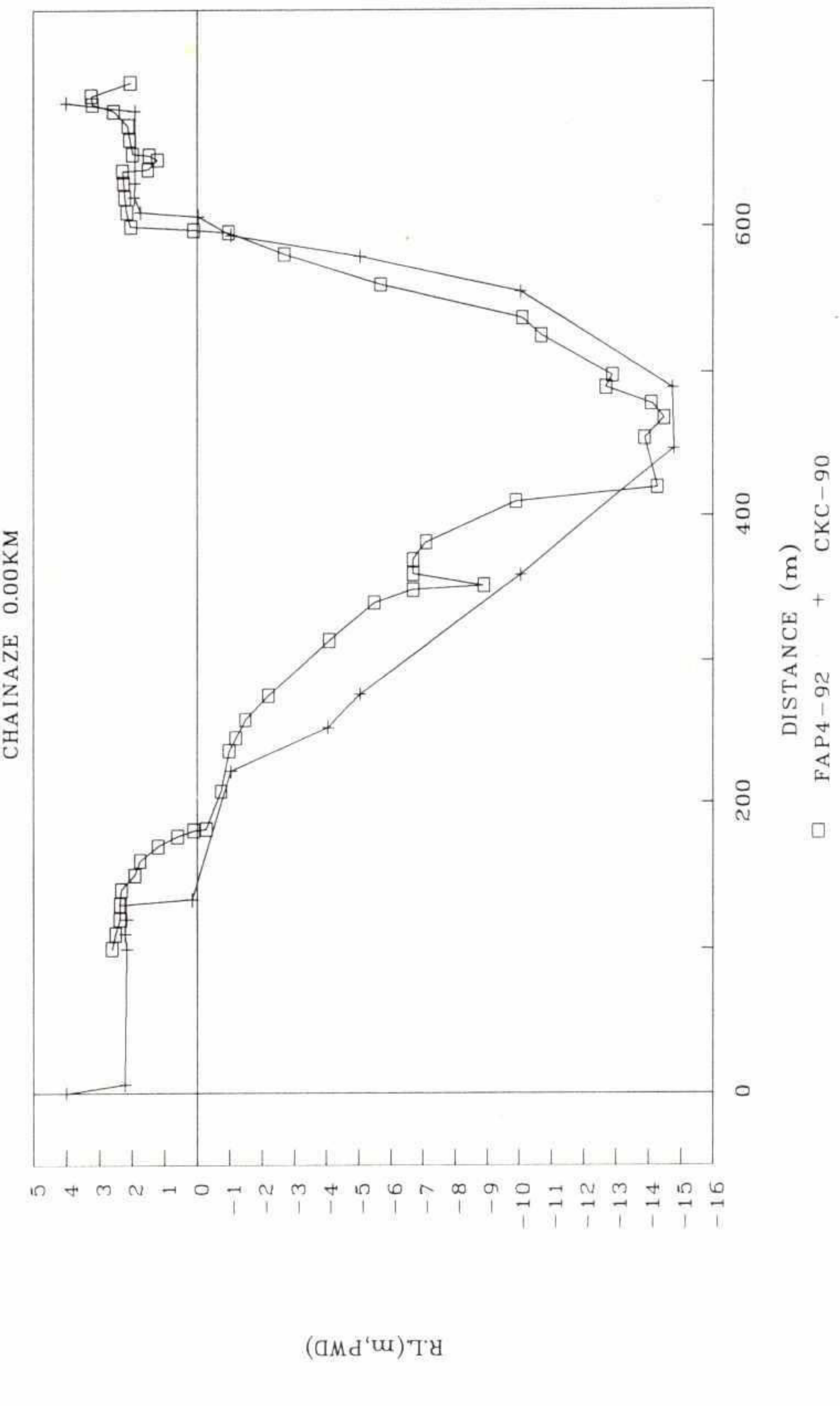
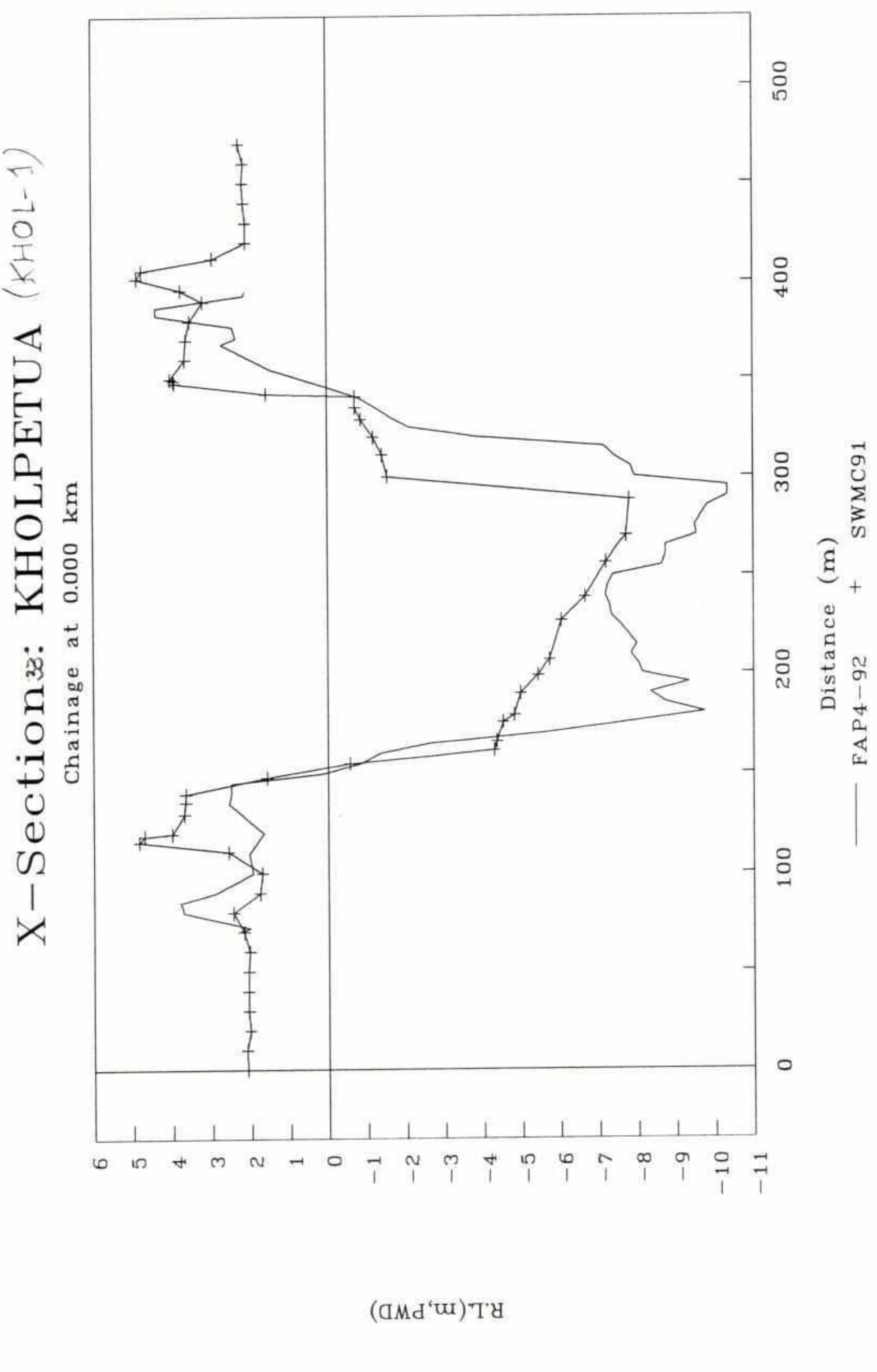
KAZI-32

CHAINAZE 0.00KM

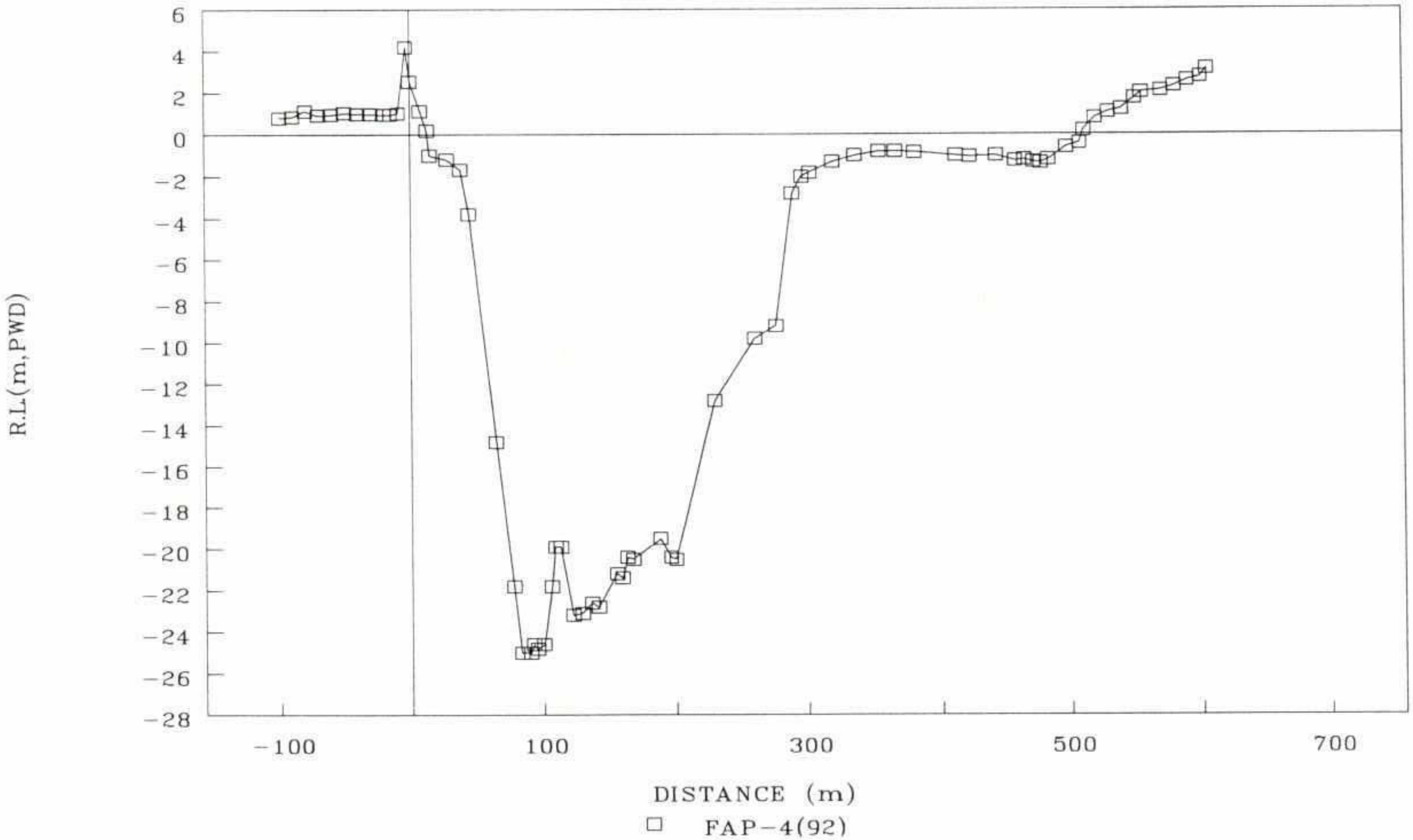


174


X-Section: KHOLPETUA (KHOL-1)
Chainage at 0.000 km
R.L.(m,PWD)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
0
100
200
300
400
500
Distance (m)
FAP4-92
+ SWMC91

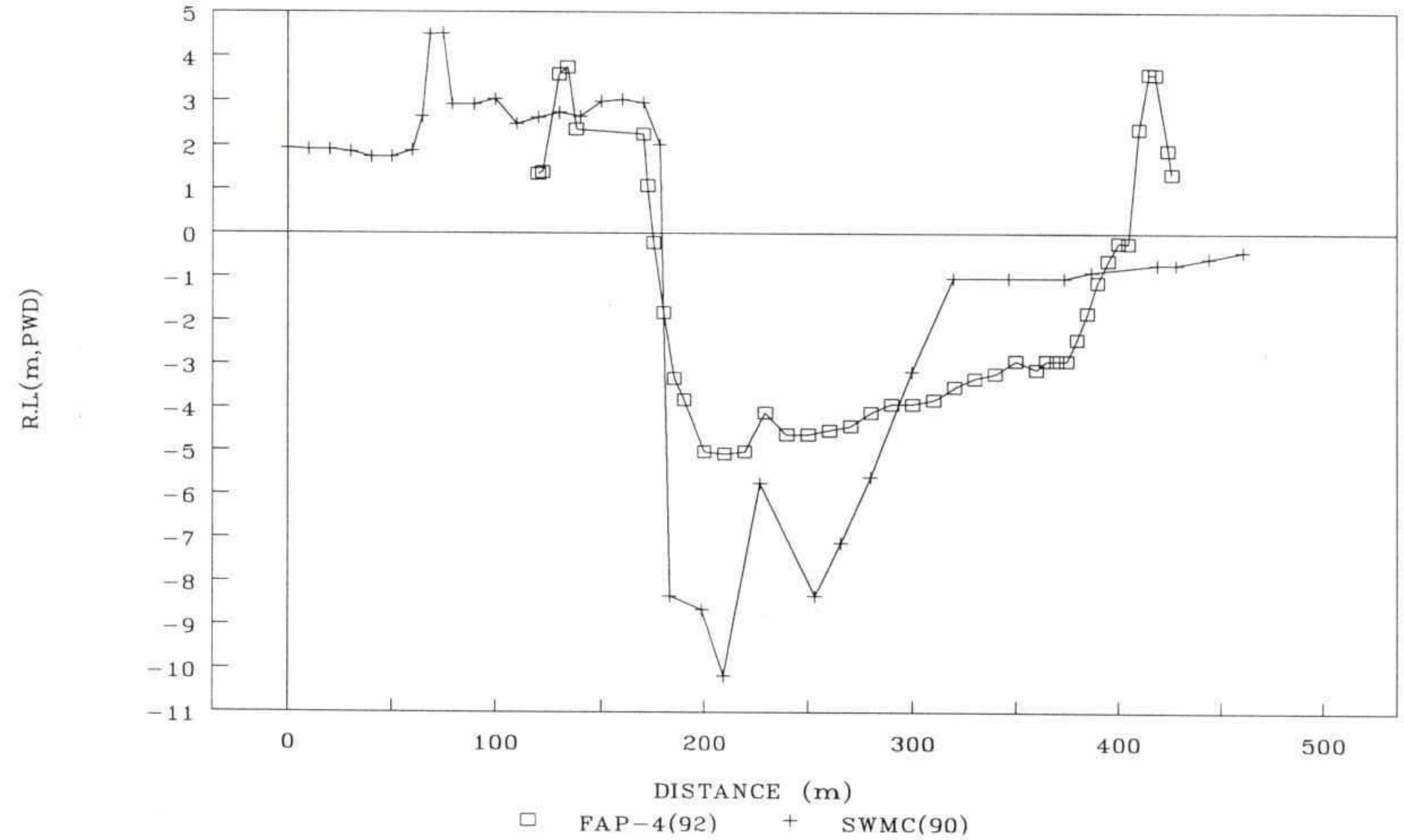
KHOLPETUA X-SEC NO.34(KHOL-2)

??KM



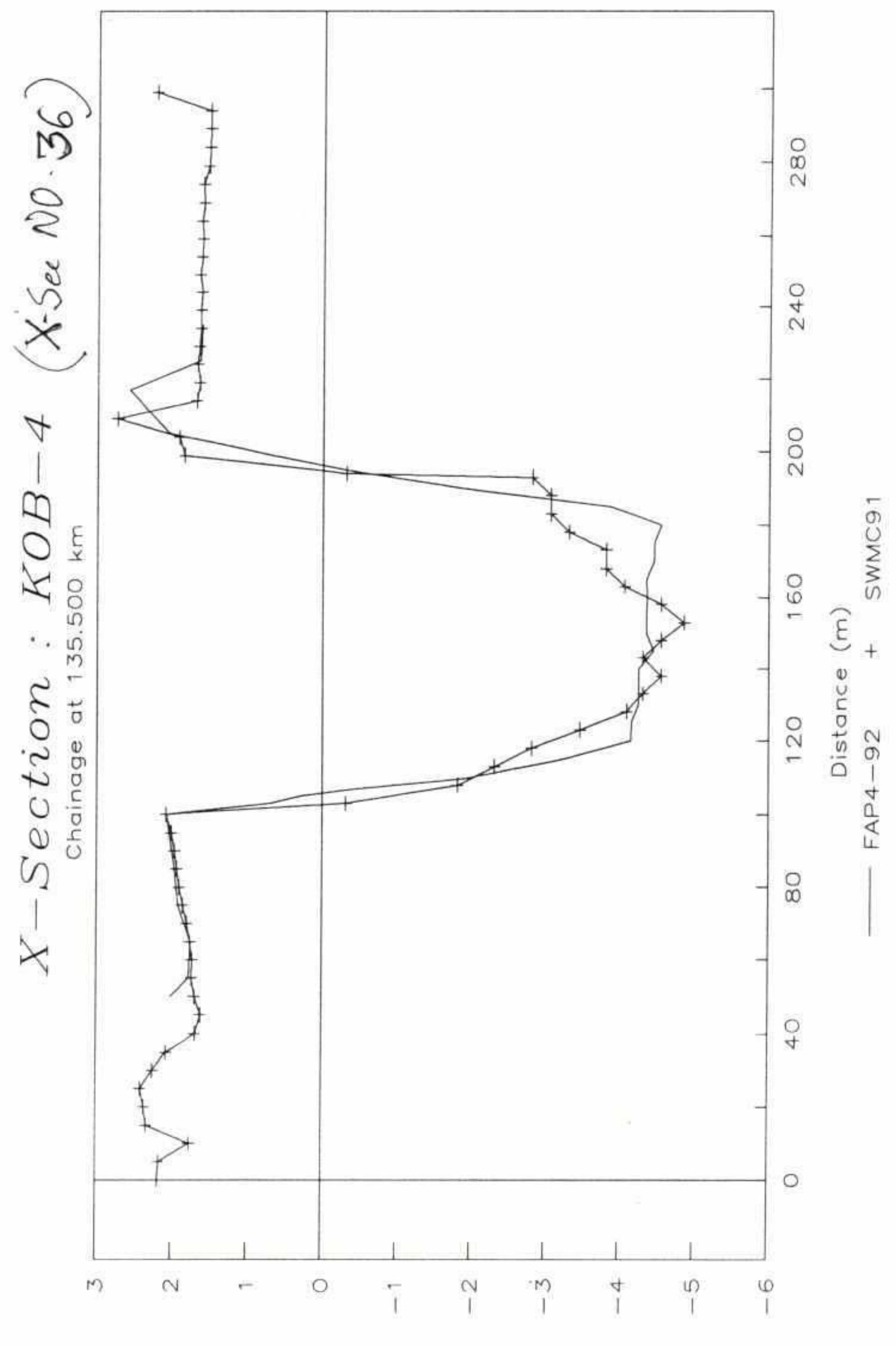
KOBADAK X-SEC NO-35(KBD-5)

CHAINAGE 166.5KM



176

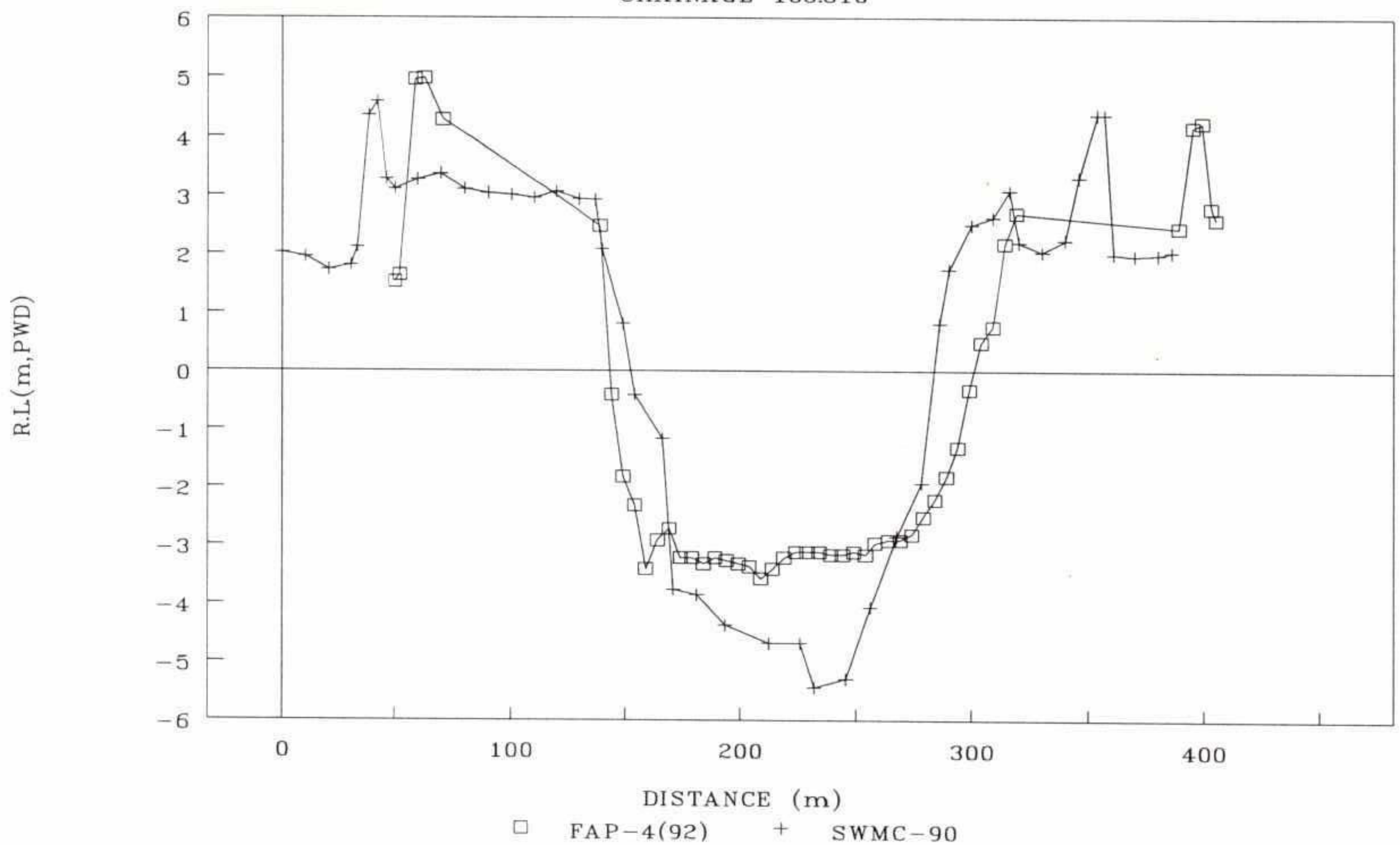
177



X-Section : KOB-4 (X-Sec NO. 36)
Chainage at 135.500 km
R.L.(m,PWD)
3 2 1 0 -1 -2 -3 -4 -5 -6
0 40 80 120 160 200 240 280
Distance (m)
FAP4-92 + SWMC91

KOBDAK X-SEC NO.37(KBD-8)

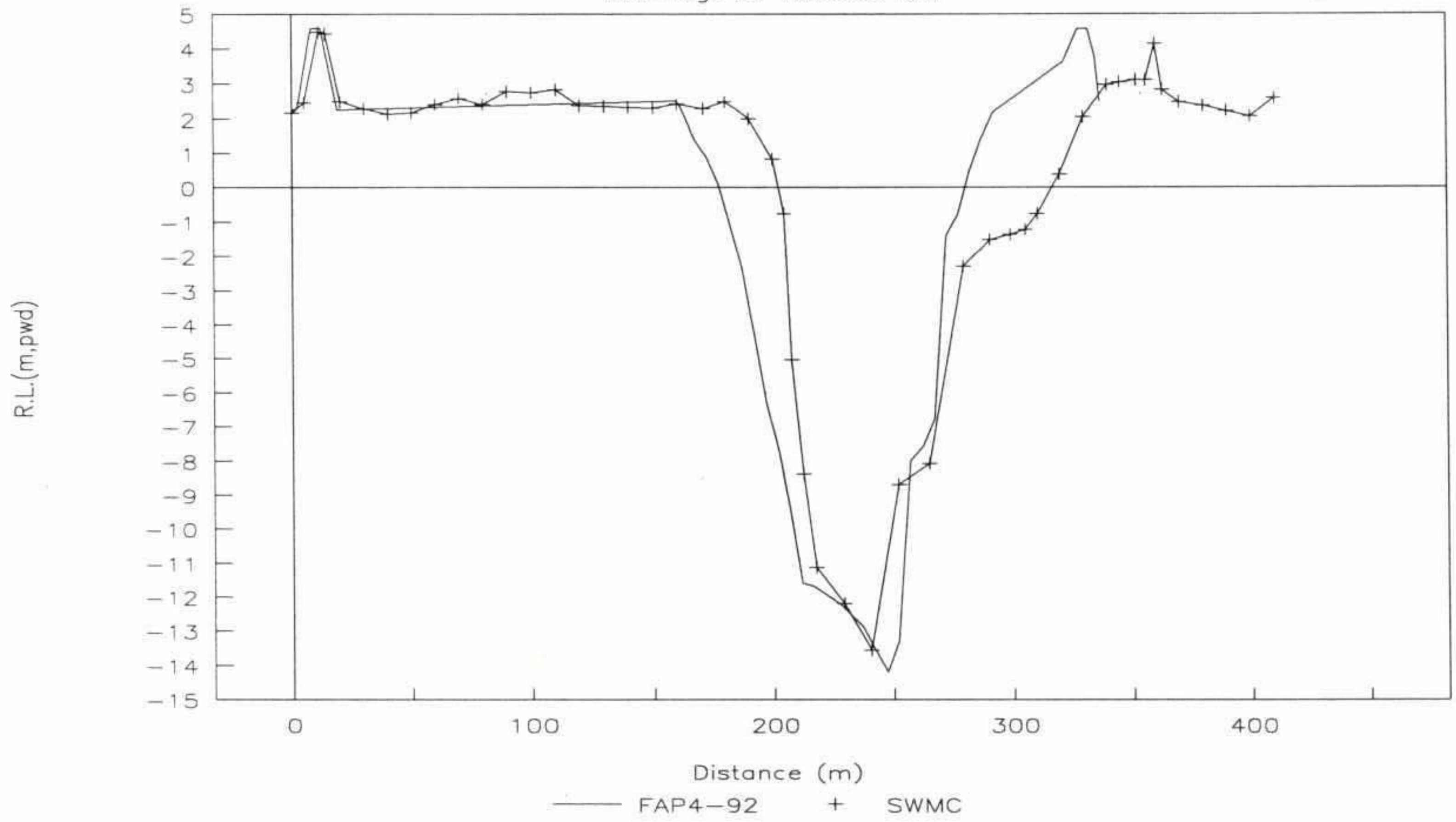
CHAINAGE 185.510



178

KOBADAK , X–SEC. KOBADAK–9 (39)

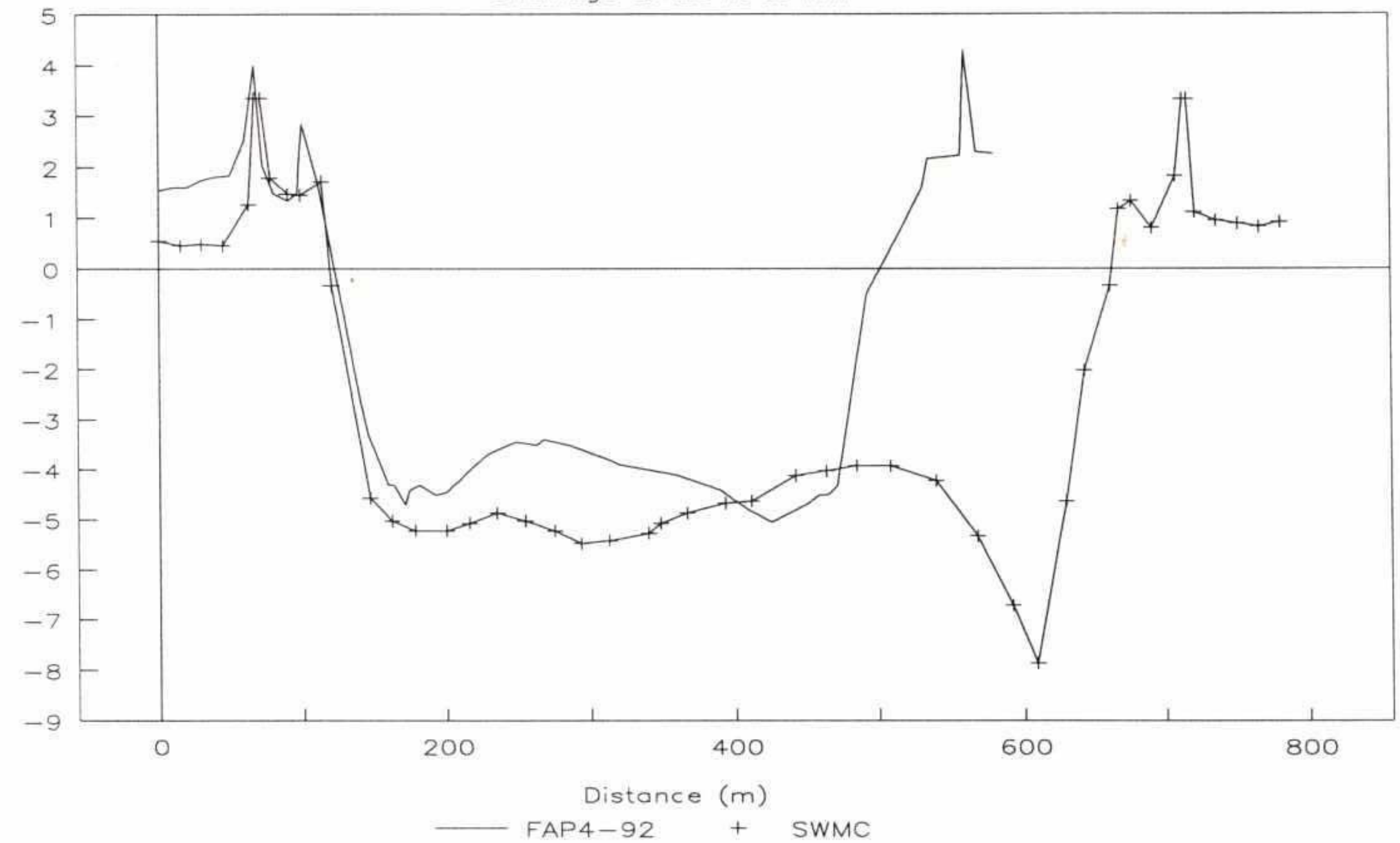
Chainage at 189.500 km



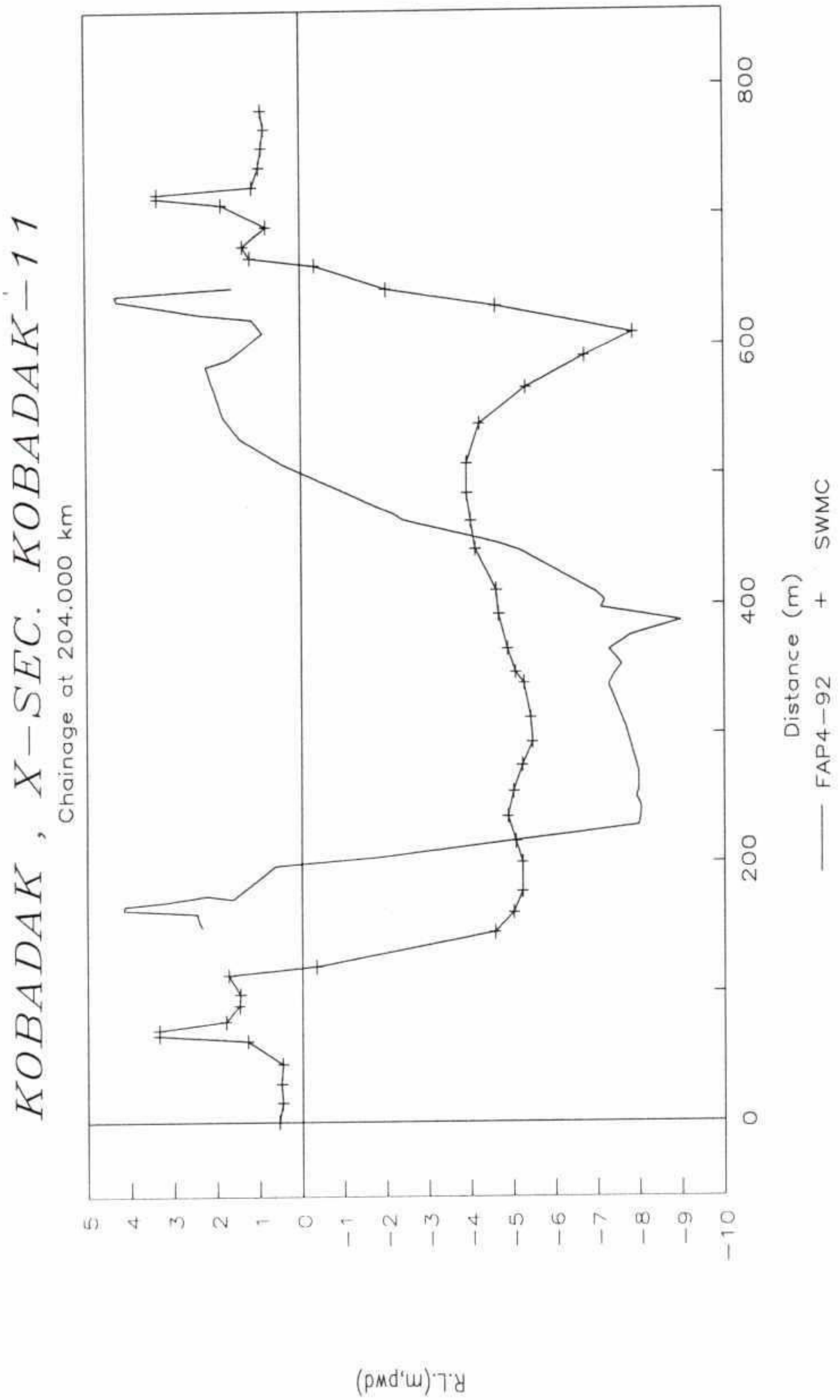
179

KOBADAK , X−SEC. KOBADAK−10

Chainage at 204.000 km

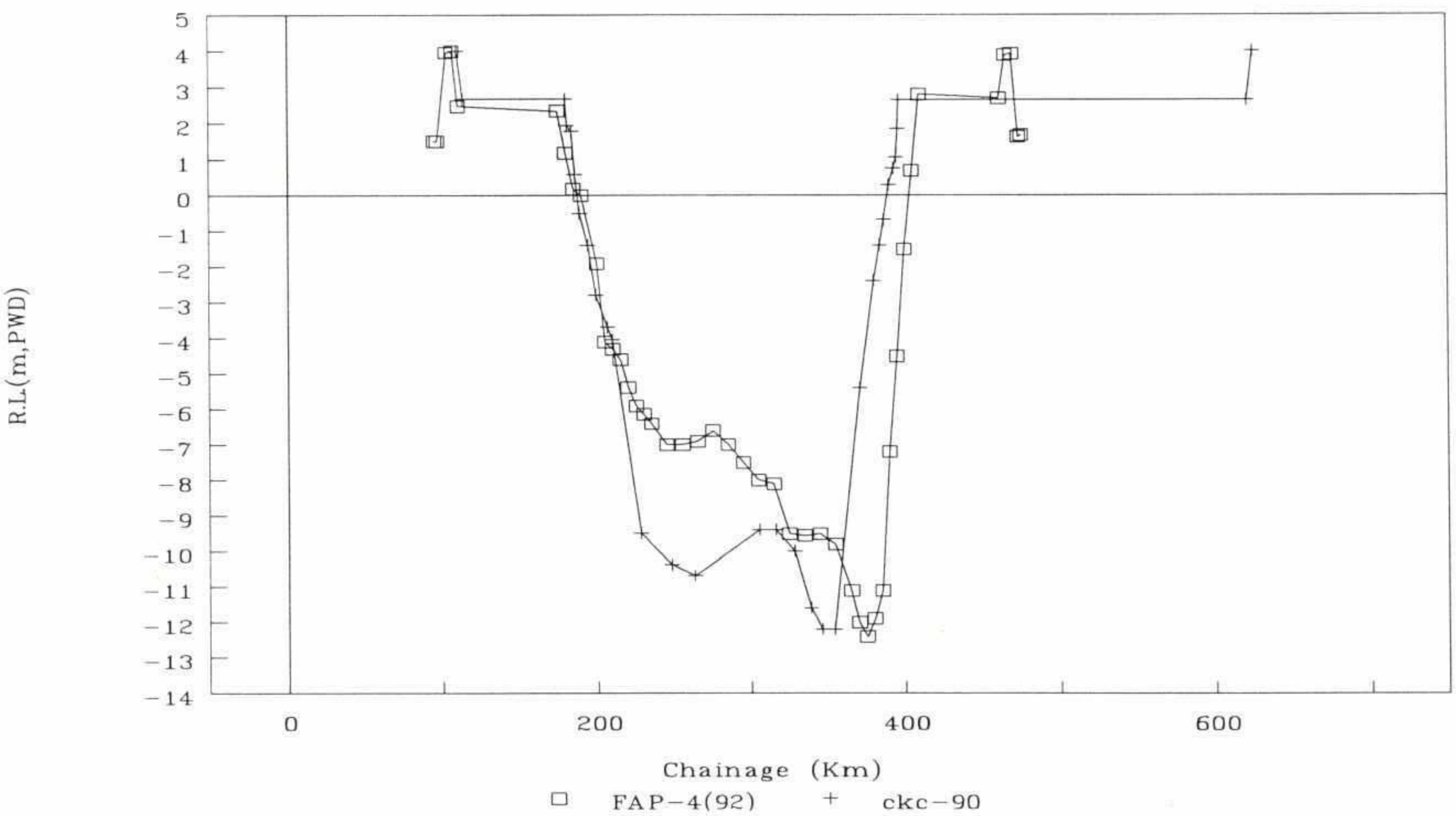


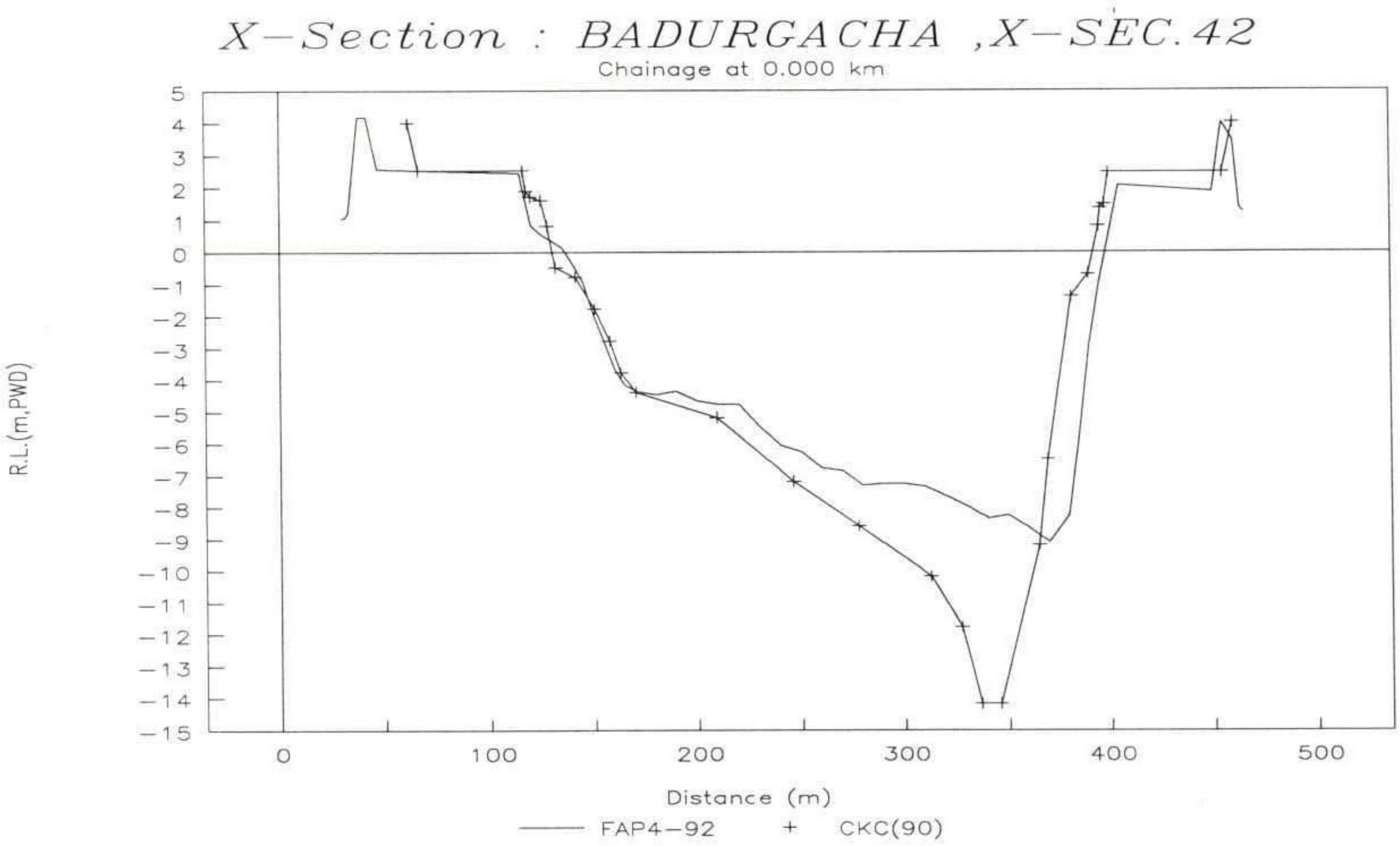
180



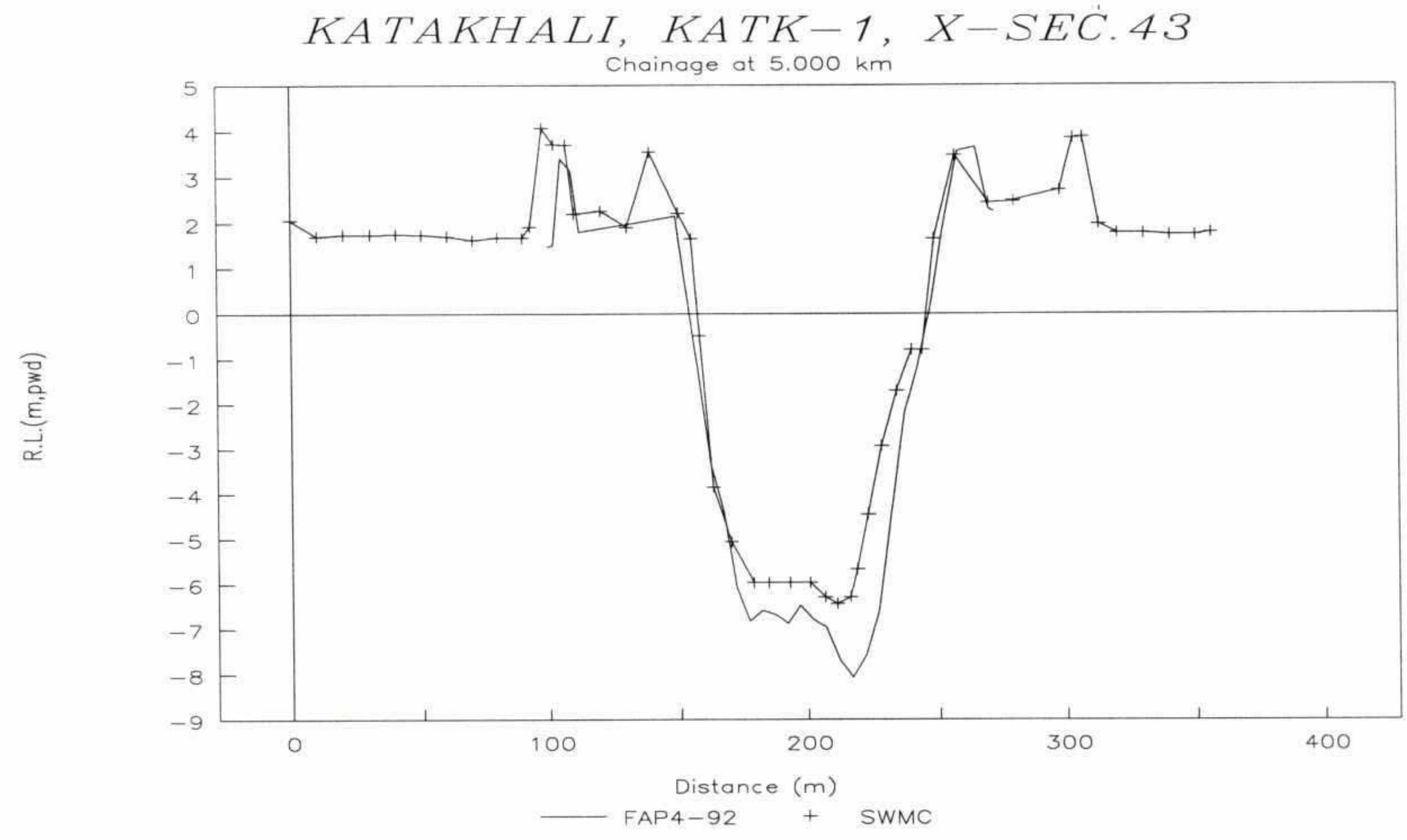
KOBADAK , X-SEC. KOBADAK-11
Chainage at 204.000 km
R.L.(m,pwd)
Distance (m)
— FAP4-92 + SWMC
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0
200
400
600
800

BADURGACHA X-Sec No-41

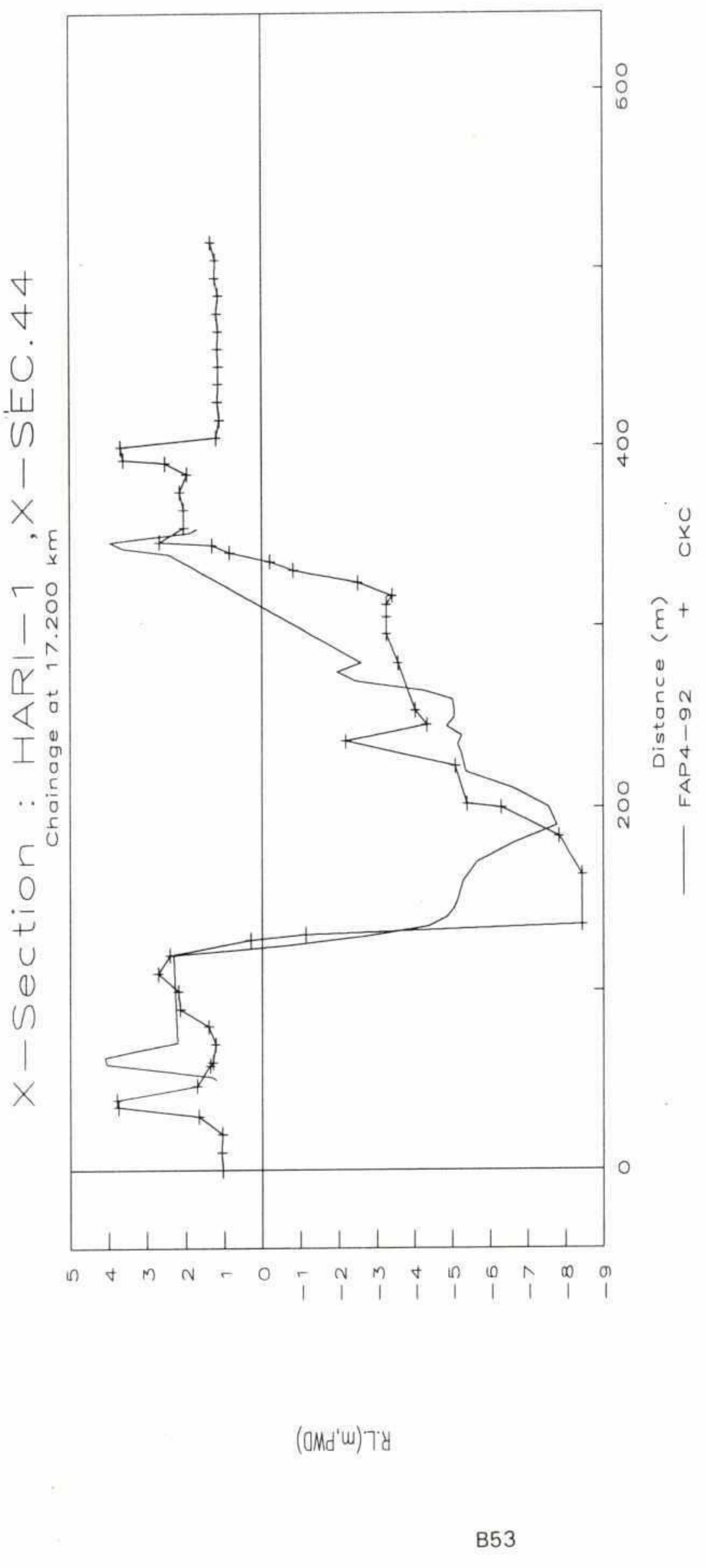


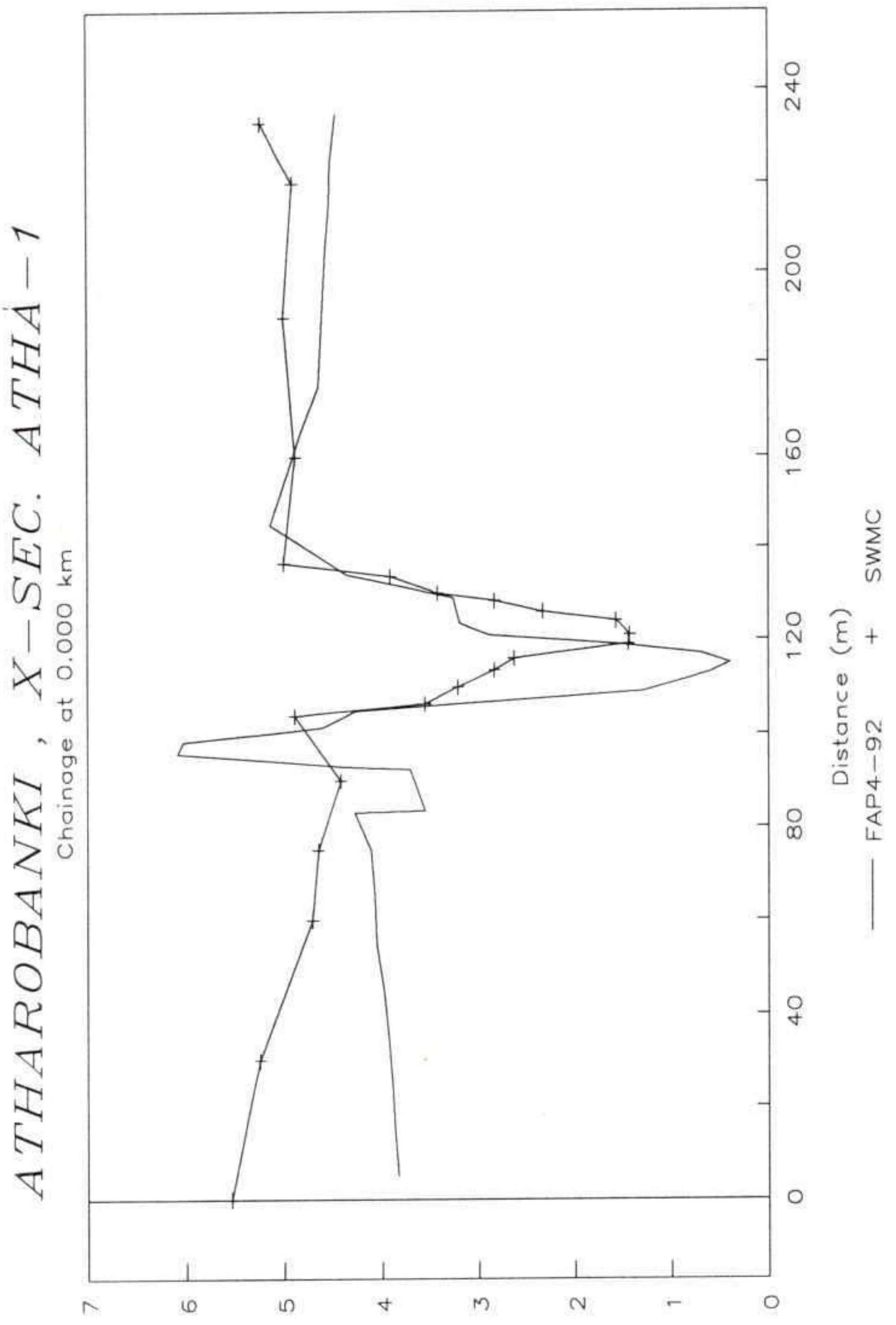

X–Section : BADURGACHA ,X–SEC.42
Chainage at 0.000 km
R.L.(m,PWD)
5
4
3
2
1
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
−10
−11
−12
−13
−14
−15
0
100
200
300
400
500
Distance (m)
FAP4–92
+ CKC(90)

183


KATAKHALI, KATK−1, X−SEC.43
Chainage at 5.000 km
R.L.(m,pwd)
5
4
3
2
1
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
0
100
200
300
400
Distance (m)
FAP4−92
+ SWMC

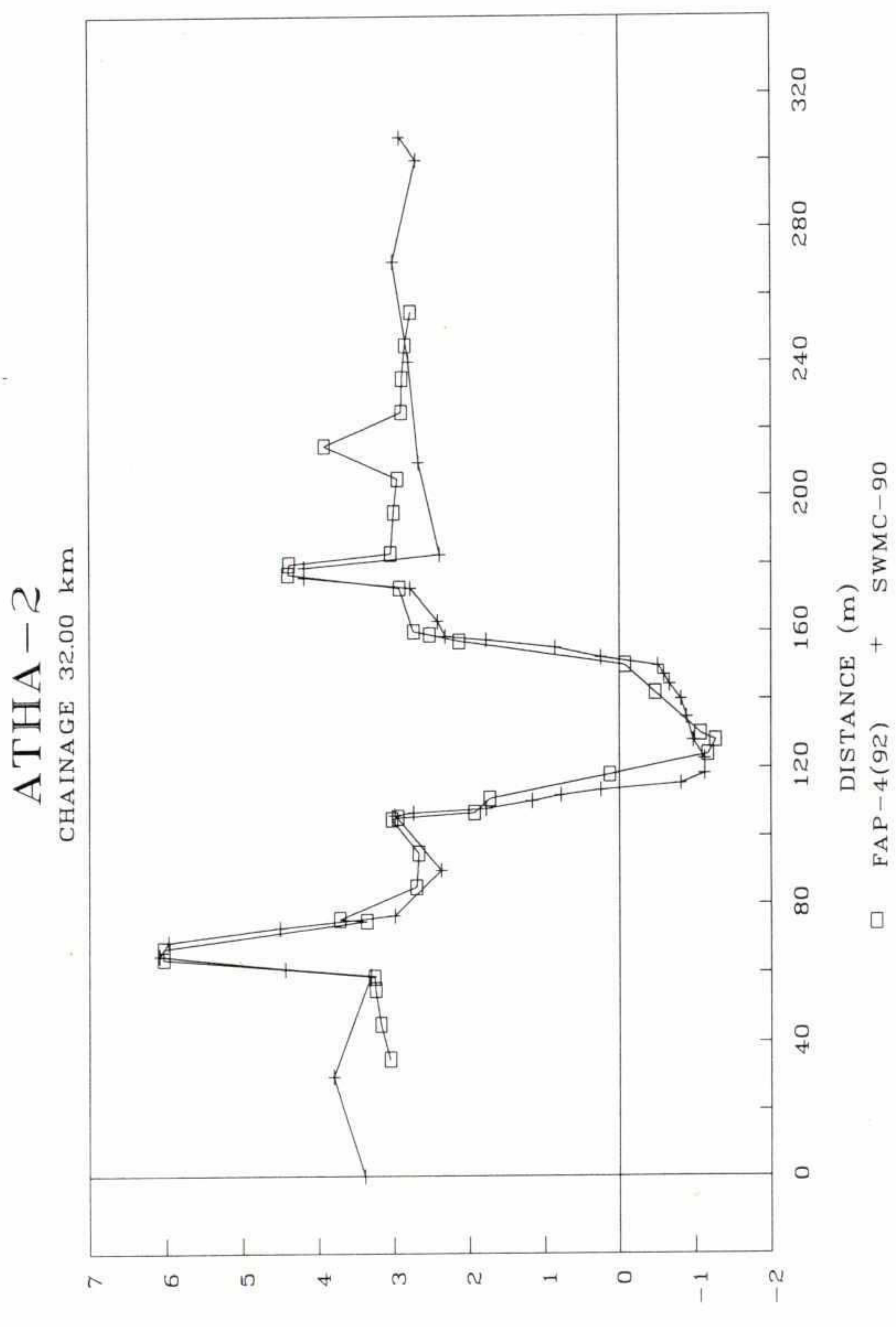
184


X-Section : HARI-1 ,X-SEC.44
Chainage at 17.200 km
R.L.(m,PWD)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0
200
400
600
Distance (m)
FAP4-92
+ CKC



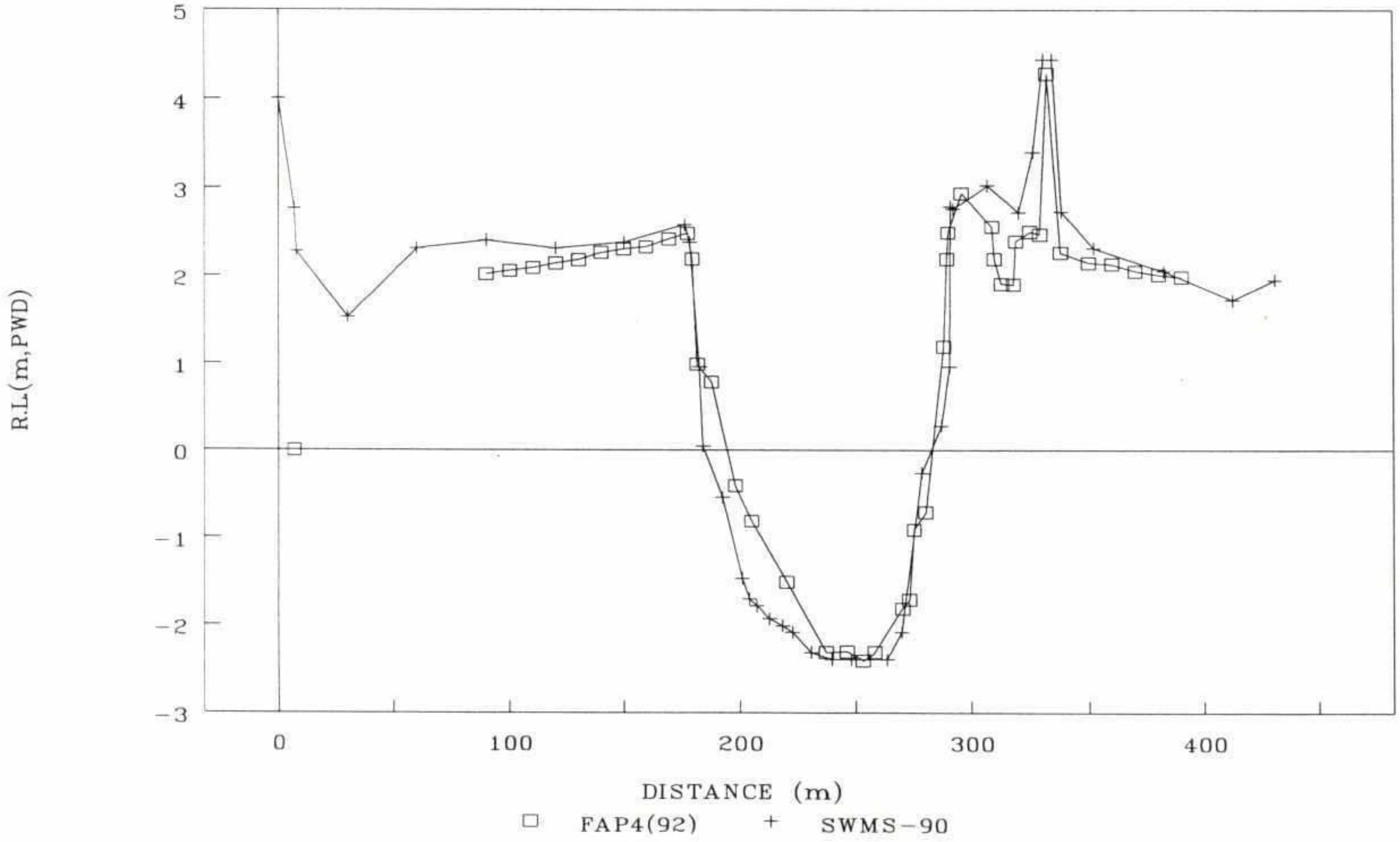
ATHAROBANKI , X−SEC. ATHA−1
Chainage at 0.000 km
R.L.(m,pwd)
0
1
2
3
4
5
6
7
0
40
80
120
160
200
240
Distance (m)
FAP4−92
+ SWMC

L87

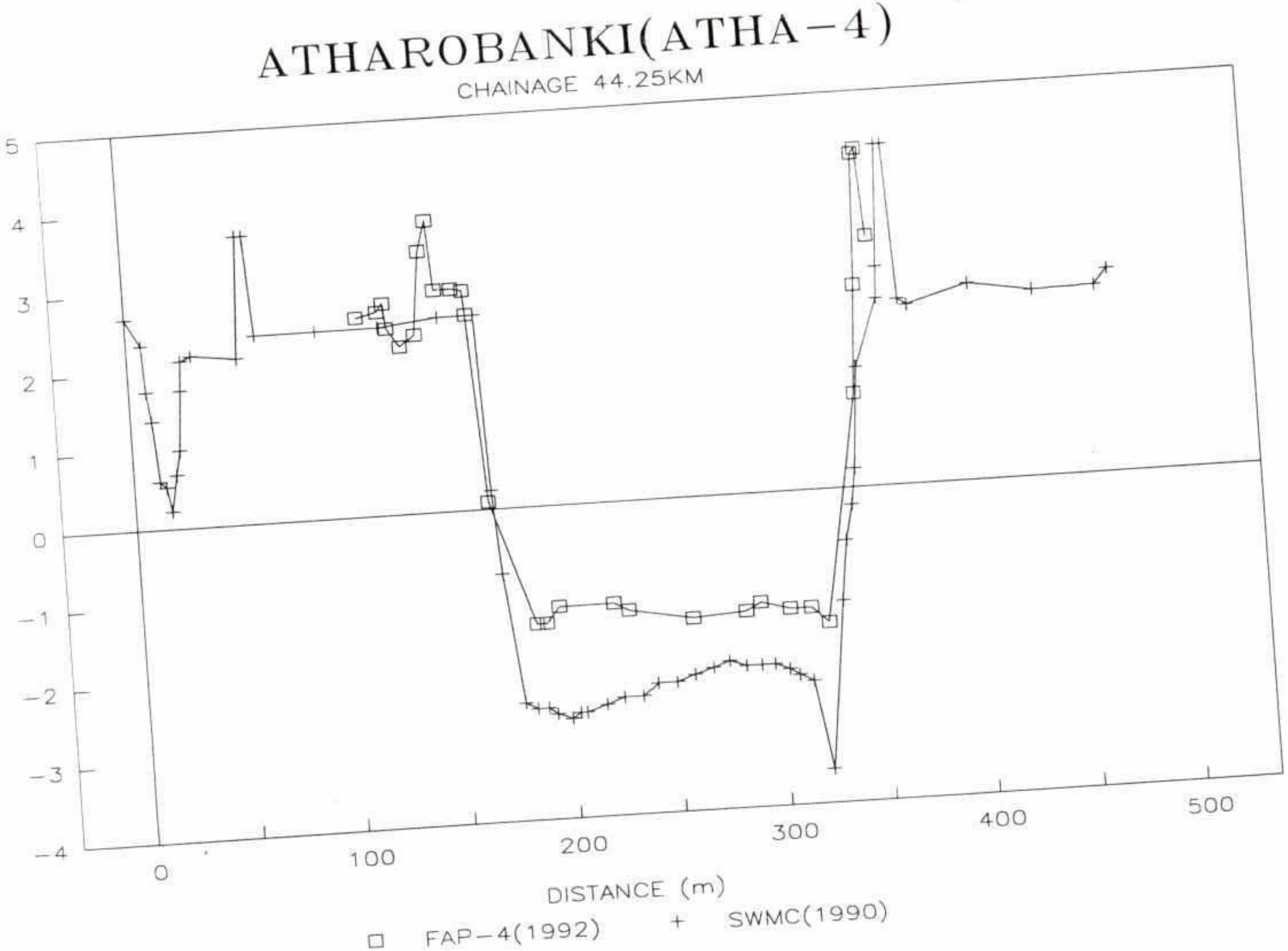

ATHA-2
CHAINAGE 32.00 km
R.L.(m,PWD)
DISTANCE (m)
□ FAP-4(92) + SWMC-90
7
6
5
4
3
2
1
0
-1
-2
0
40
80
120
160
200
240
280
320

ATHAROBANKI X-SEC NO.47(ATHA-3)

CHAINAGE 32.010

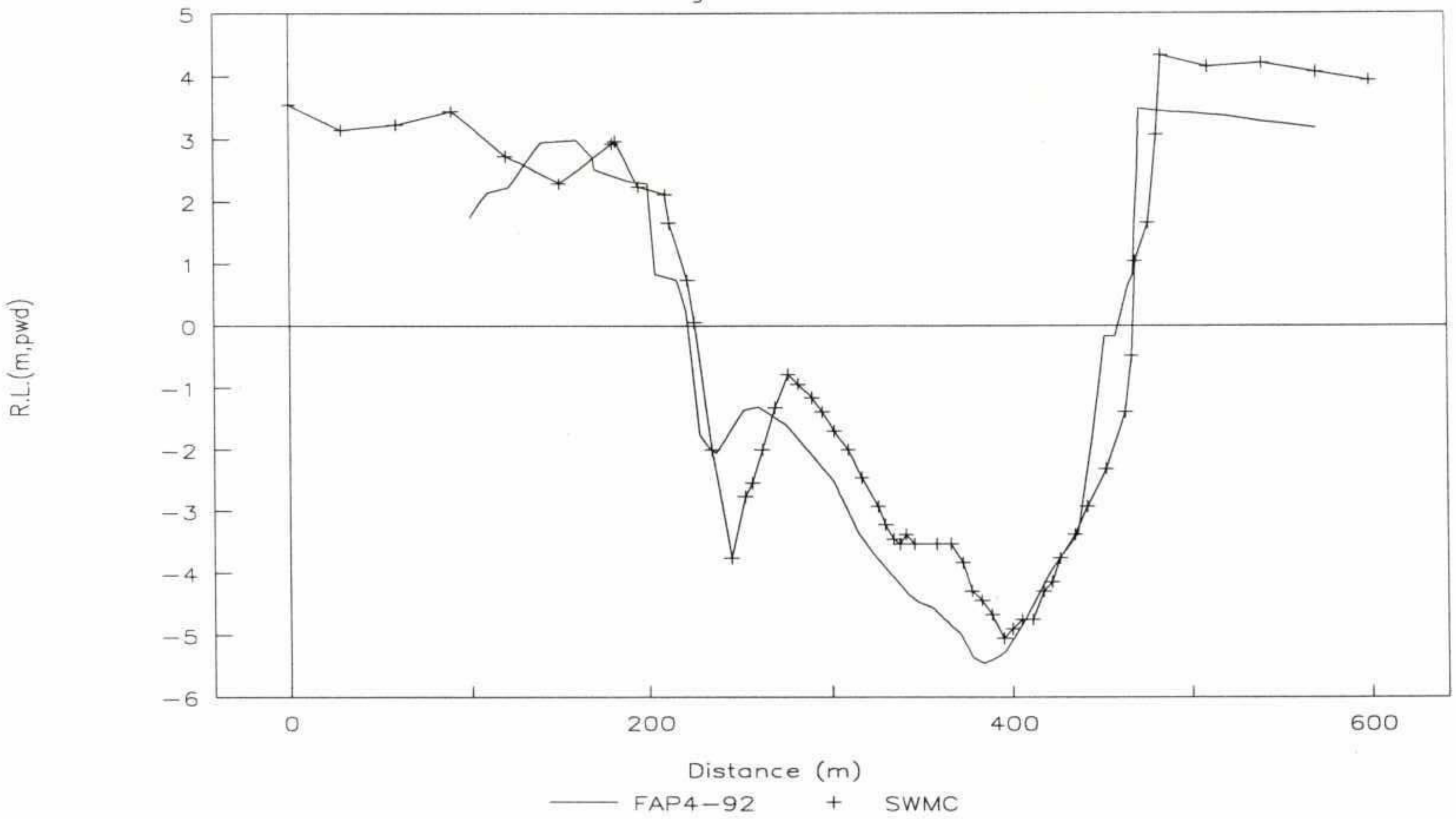


387


ATHAROBANKI(ATHA−4)
CHAINAGE 44.25KM
R.L.(m,PWD)
5
4
3
2
1
0
−1
−2
−3
−4
0
100
200
300
400
500
DISTANCE (m)
□ FAP−4(1992) + SWMC(1990)

MADHUMATI , X-SEC. MADH-3

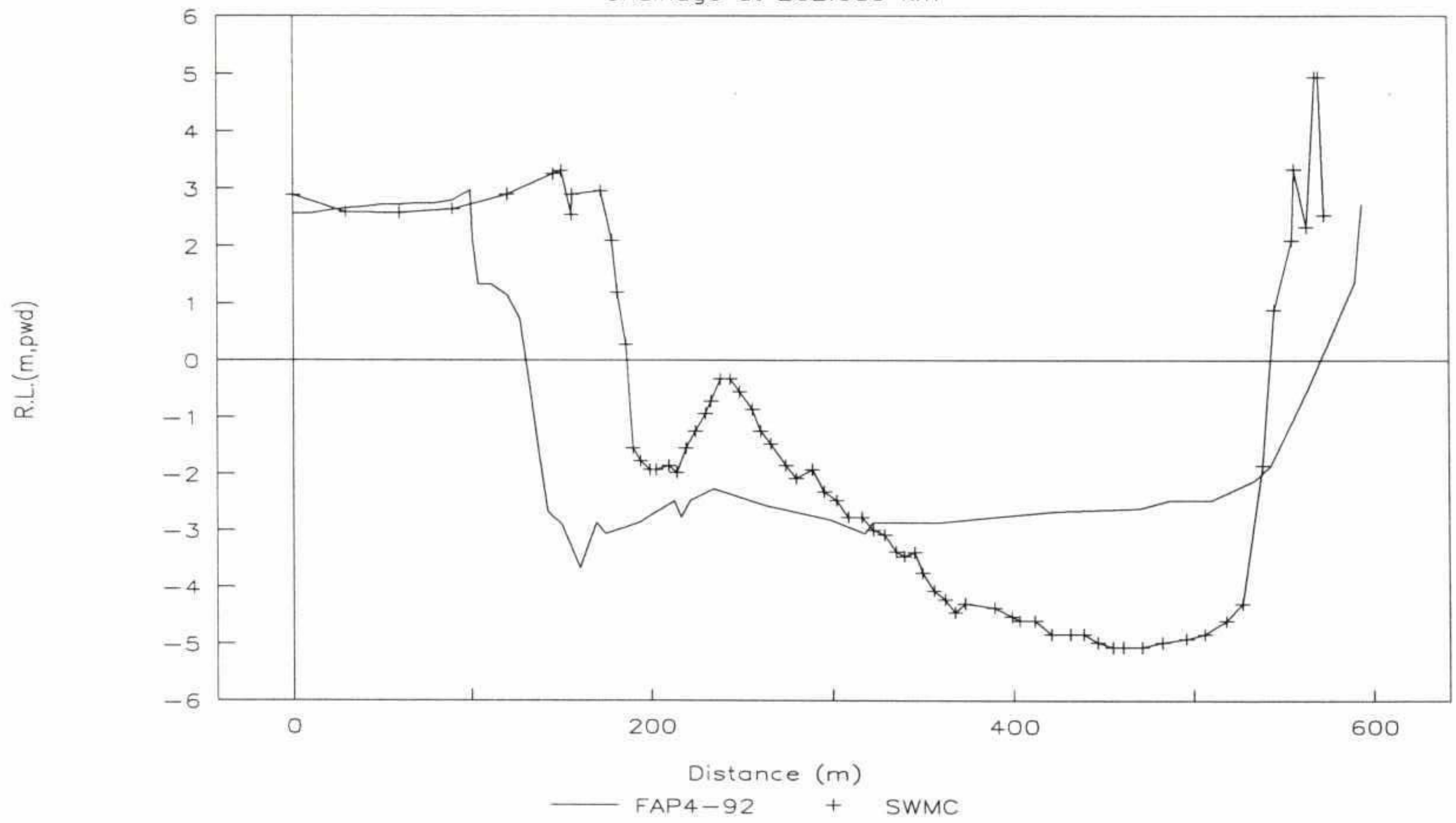
Chainage at 207.500 km



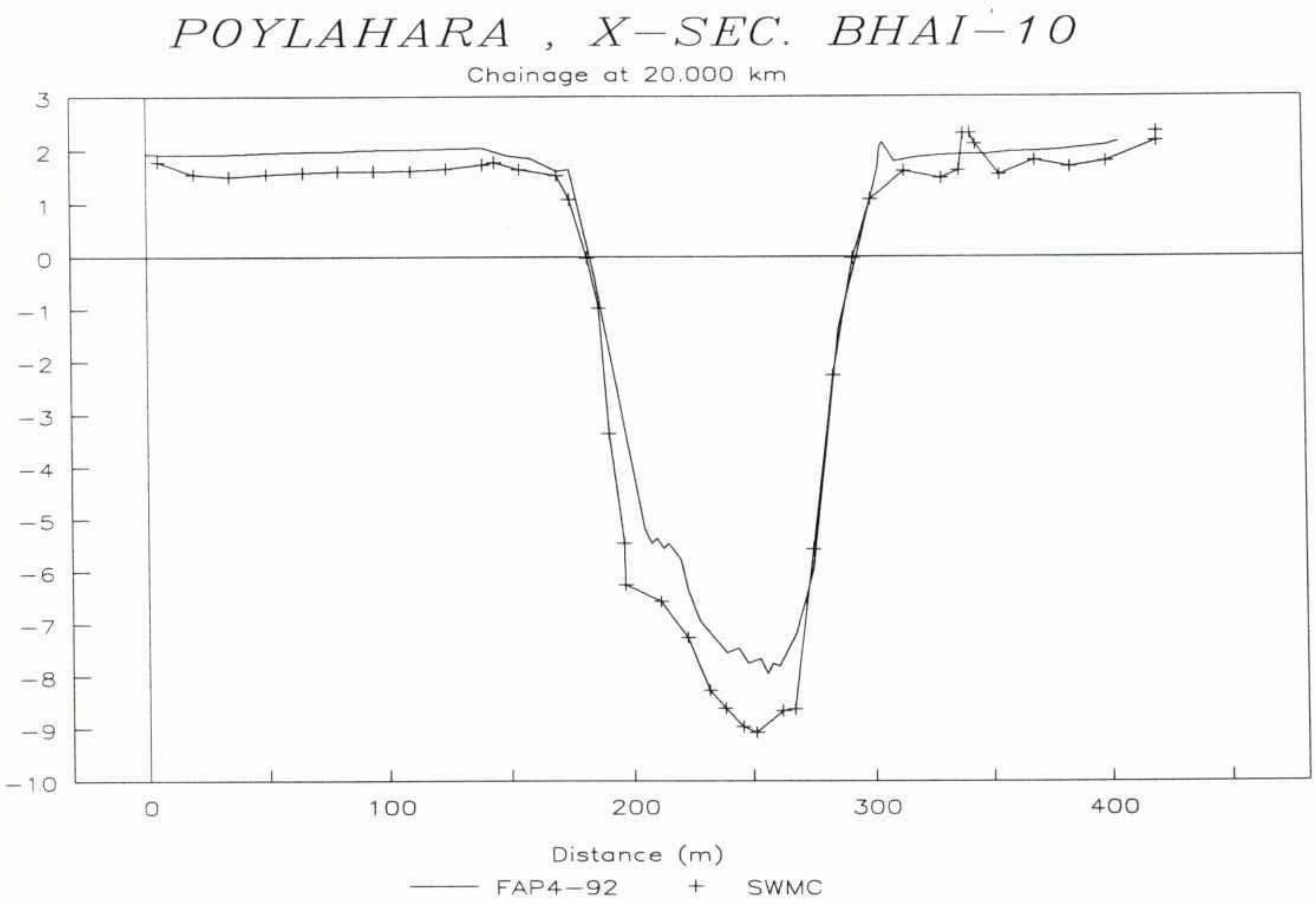
B58

MADHUMATI , X-SEC. MADH'-4

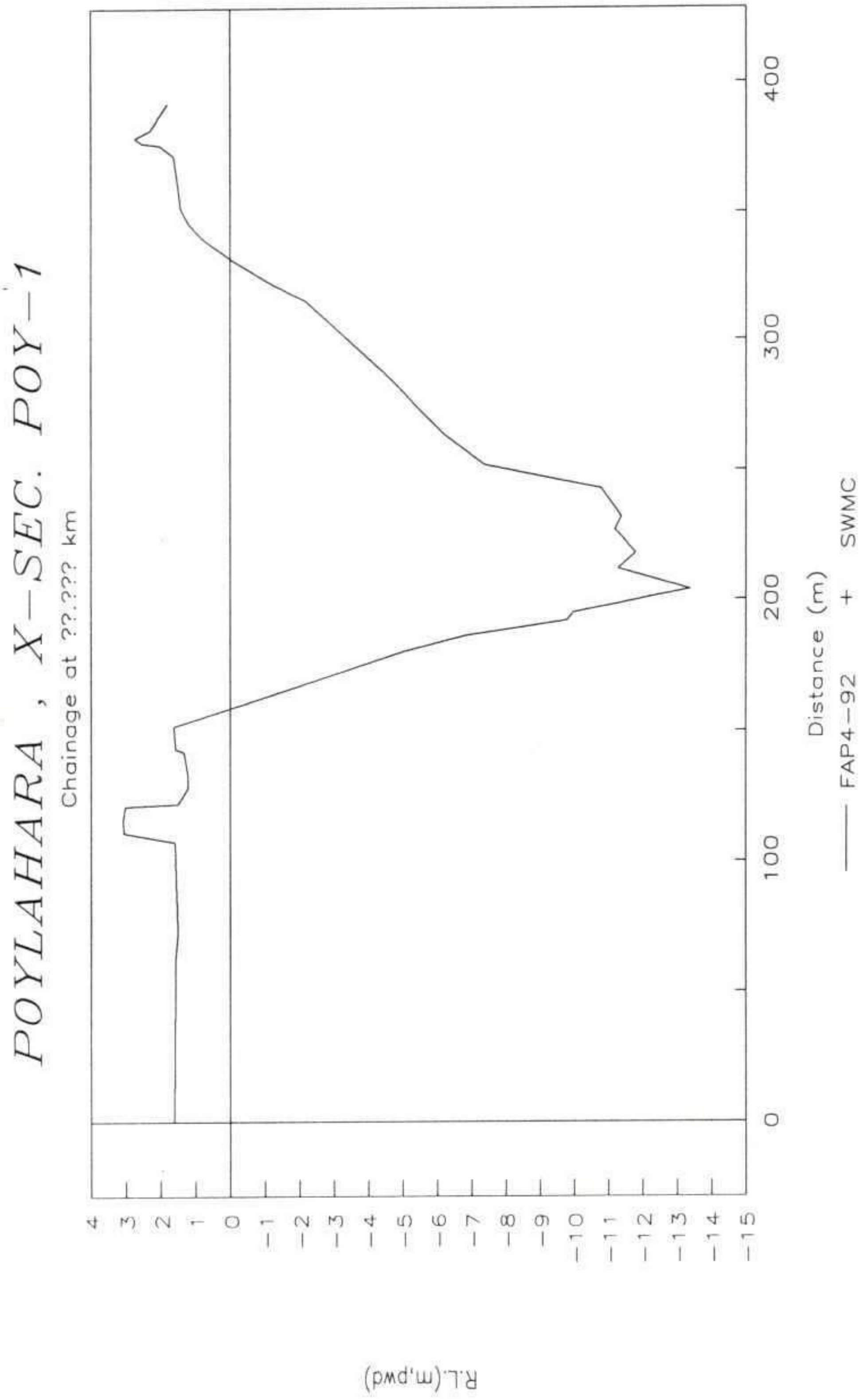
Chainage at 262.000 km

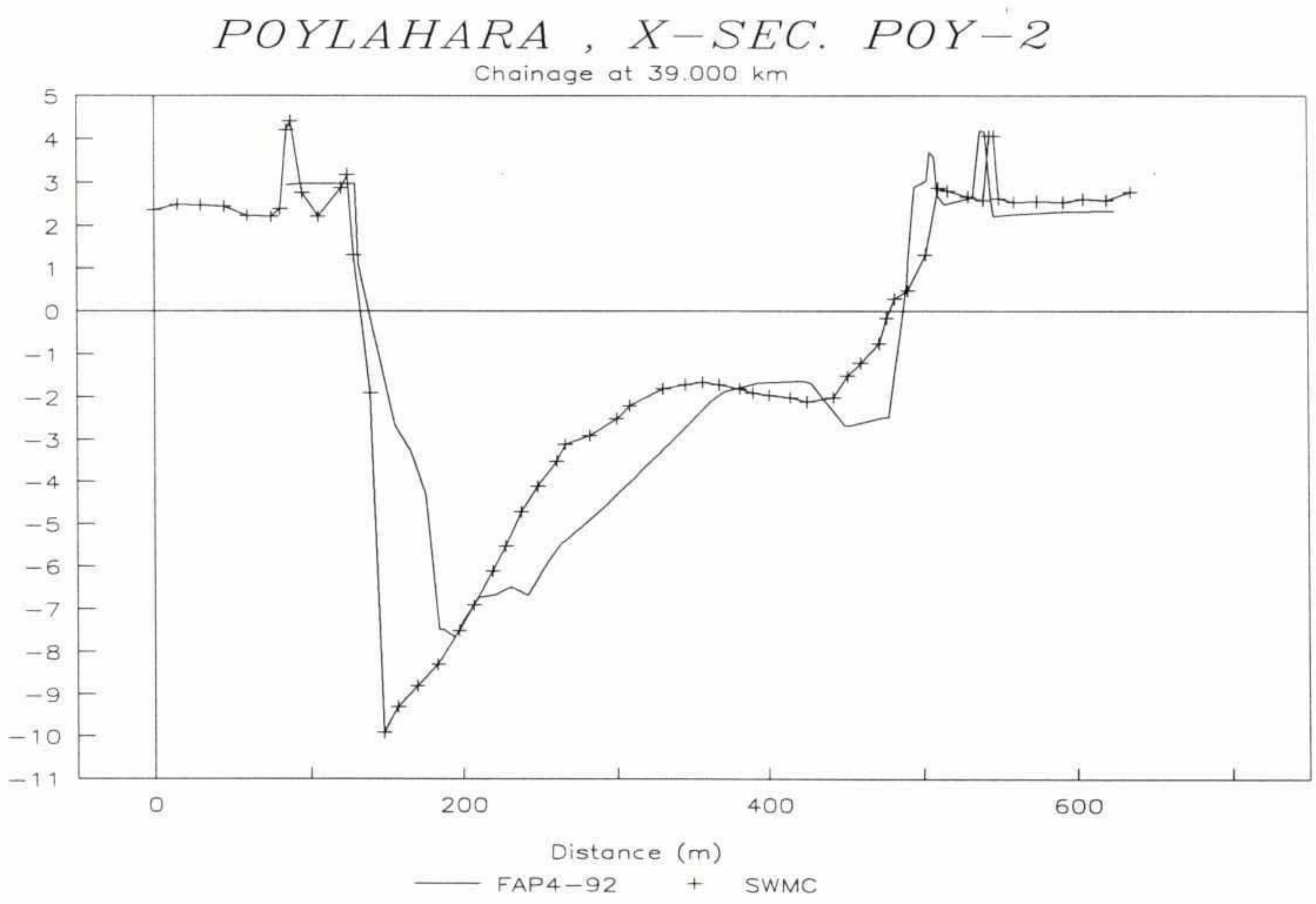


161


POYLAHARA , X–SEC. BHAI–10
Chainage at 20.000 km
R.L.(m,pwd)
3
2
1
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
−10
0
100
200
300
400
Distance (m)
FAP4−92
SWMC

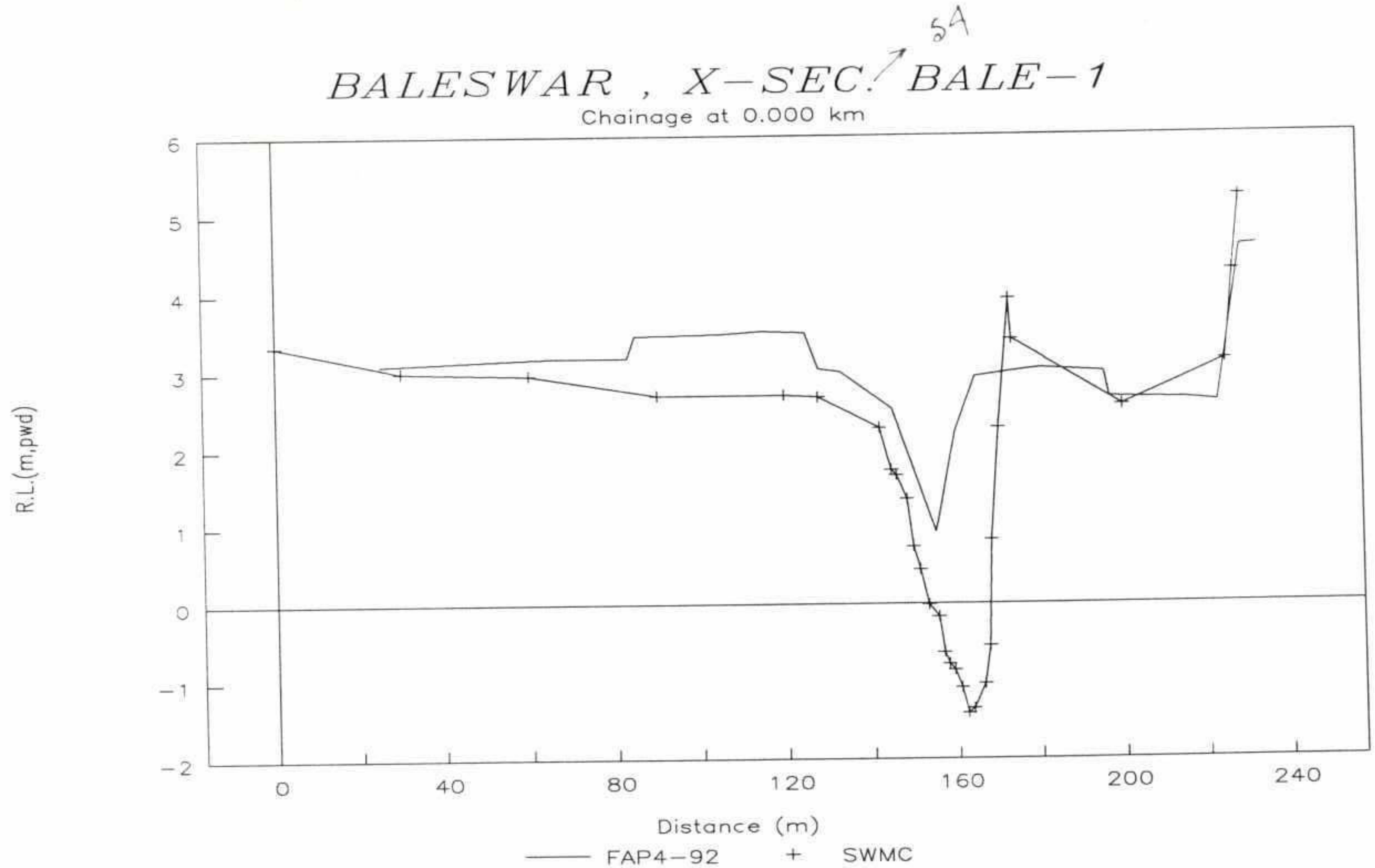
193


POYLAHARA , X-SEC. POY-1
Chainage at ??.??? km
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
R.L.(m,pwd)
0
100
200
300
400
Distance (m)
FAP4-92 + SWMC


POYLAHARA , X-SEC. POY-2
Chainage at 39.000 km
R.L.(m,pwd)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
0
200
400
600
Distance (m)
FAP4-92
+ SWMC

BALESWAR , X-SEC. BALE-1

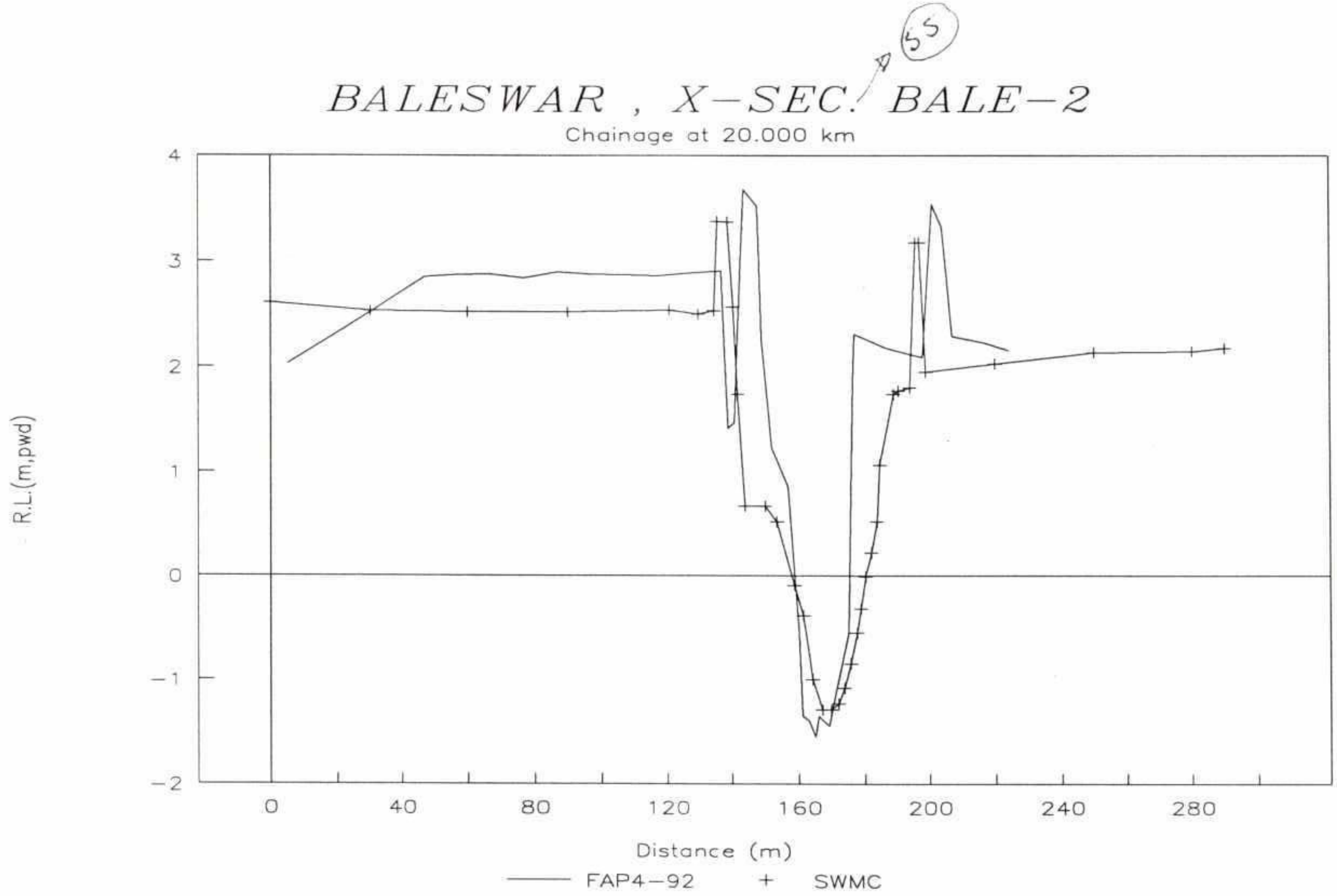
Chainage at 0.000 km



195

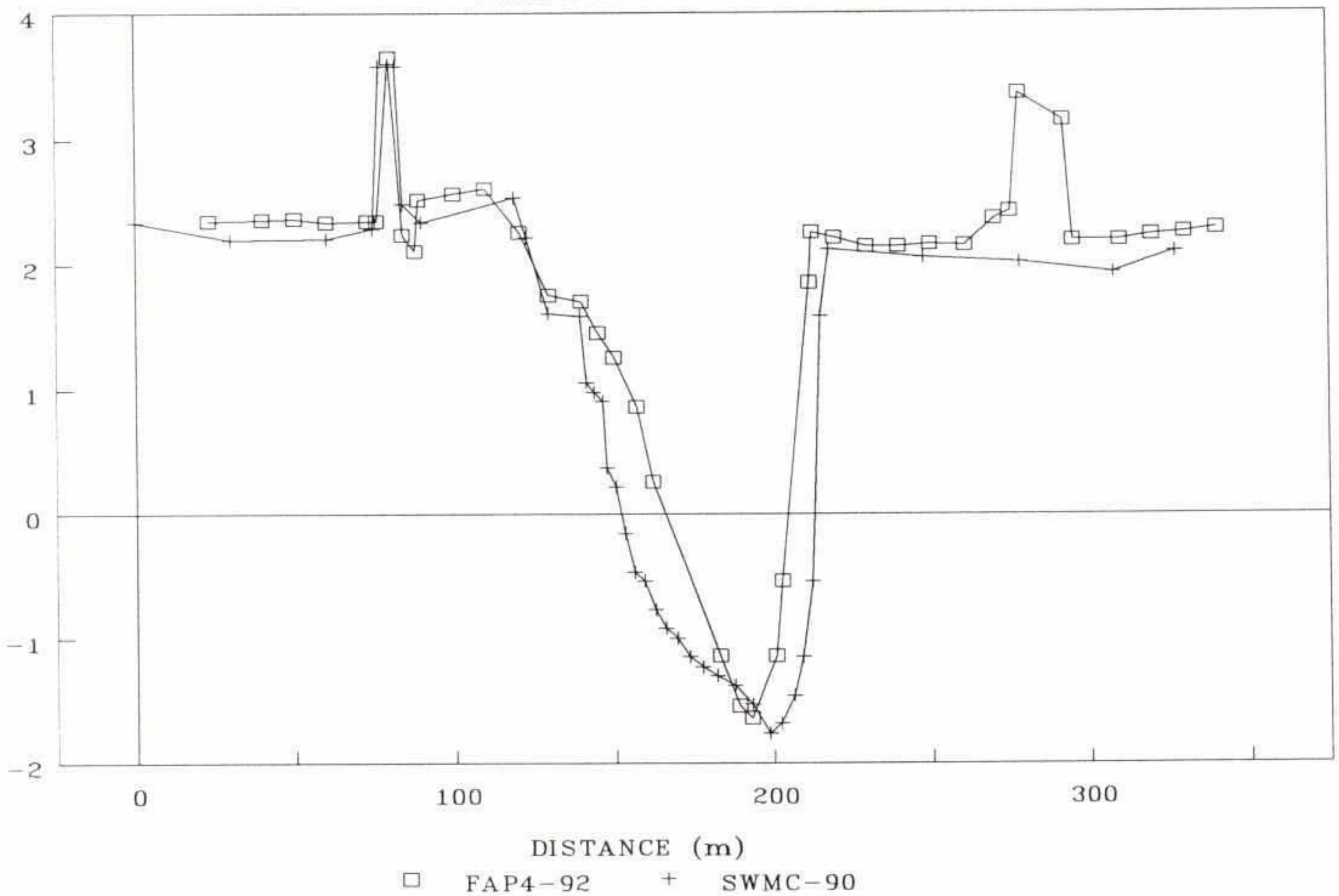
BALESWAR , X–SEC. BALE–2

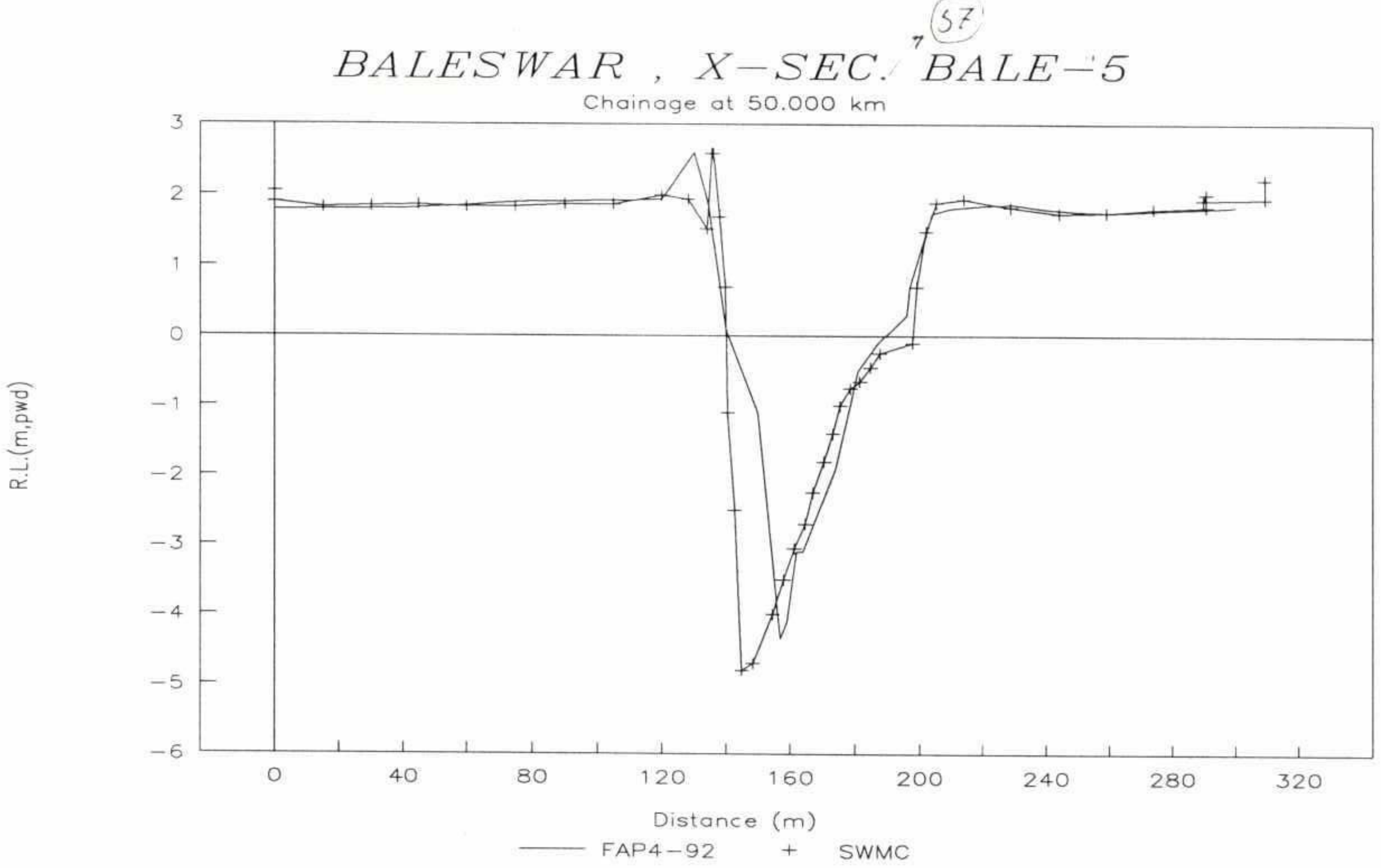
Chainage at 20.000 km



BALE-3(XSEC-NO.56)

CHAINAGE 20.010 KM



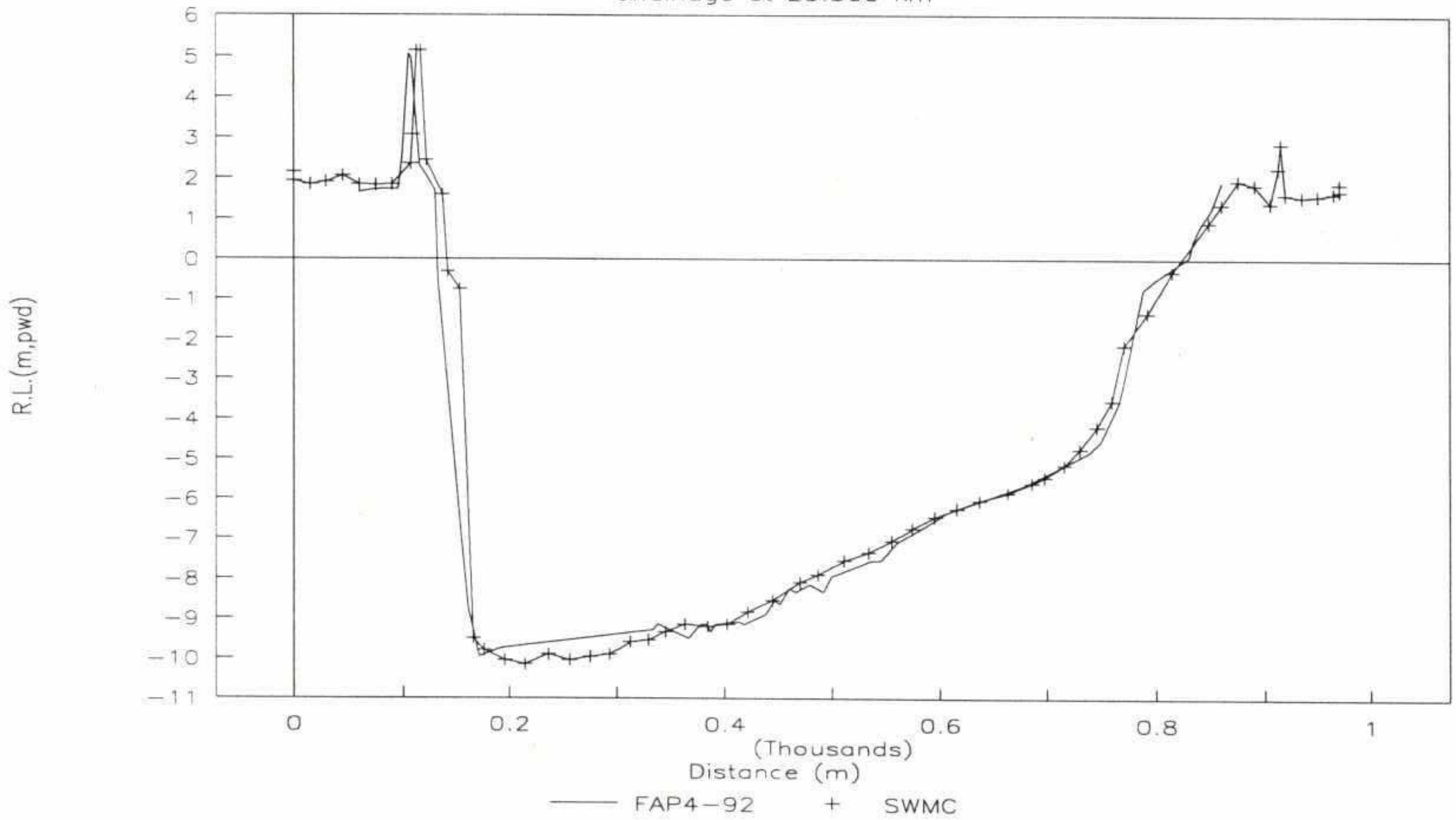


BALESWAR , X-SEC. BALE-5
57
Chainage at 50.000 km
R.L.(m,pwd)
3
2
1
0
-1
-2
-3
-4
-5
-6
0
40
80
120
160
200
240
280
320
Distance (m)
FAP4-92
+ SWMC

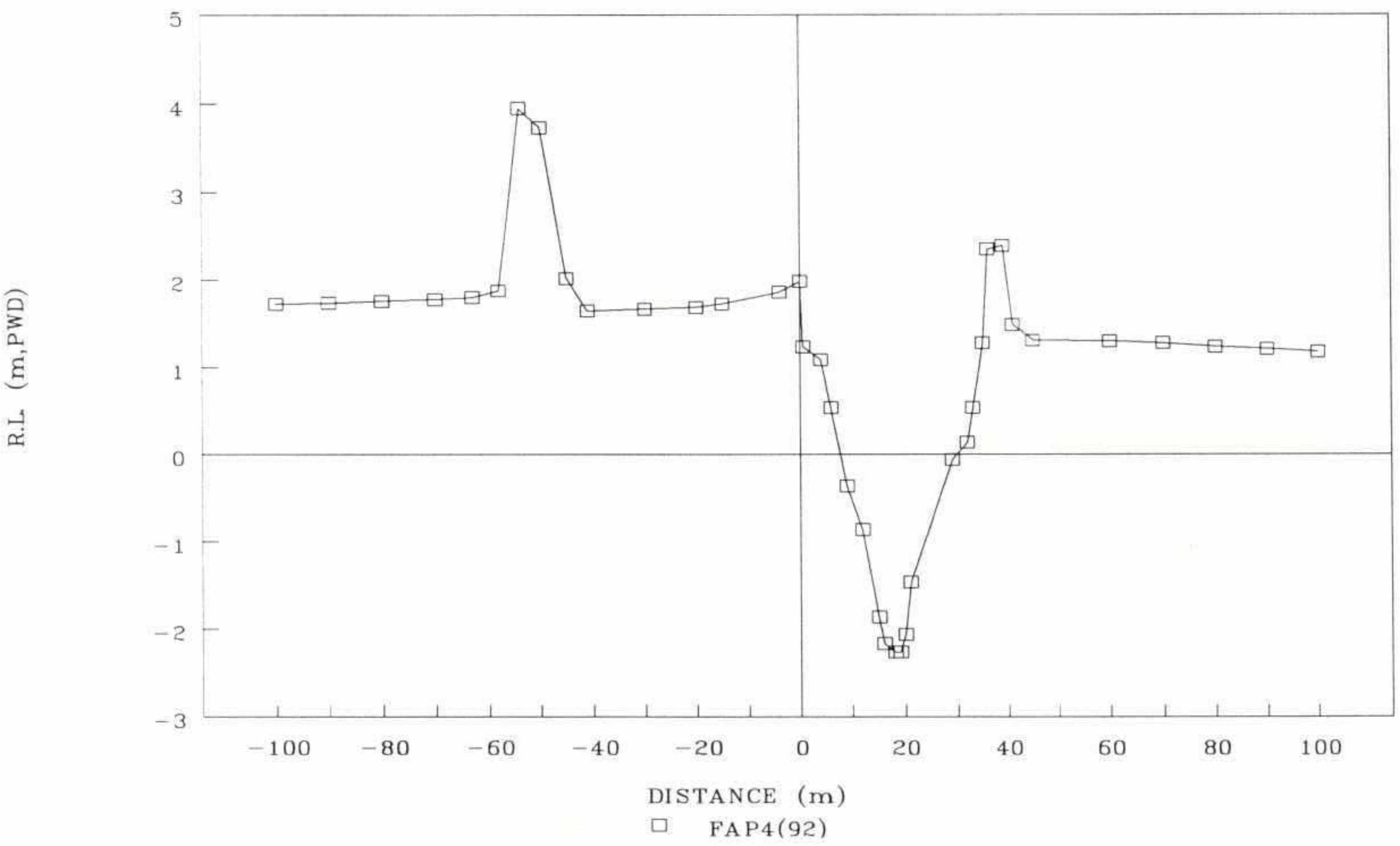
198

GHASIAKHALI , X–SEC. GHAS'–3 (58)

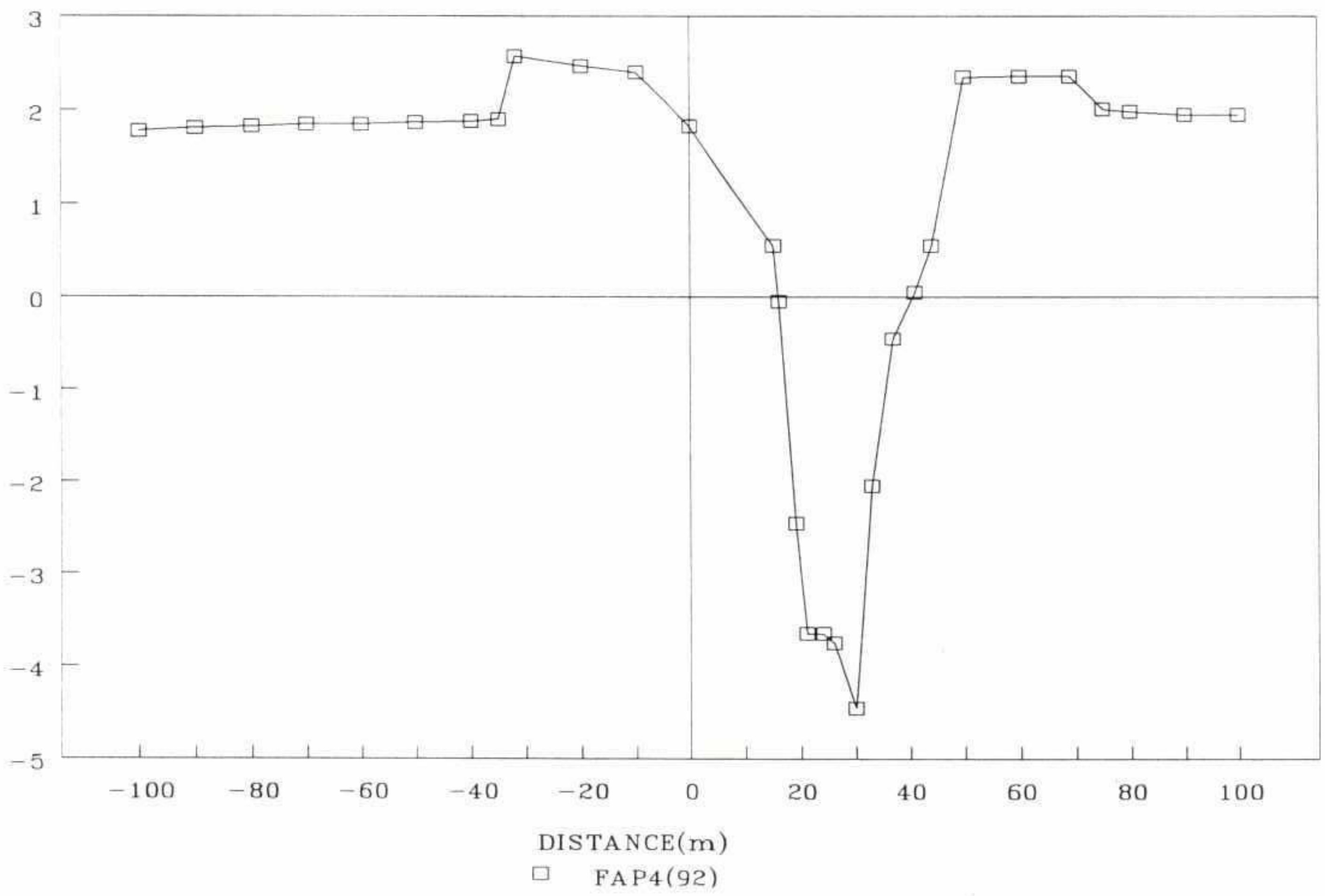
Chainage at 23.500 km



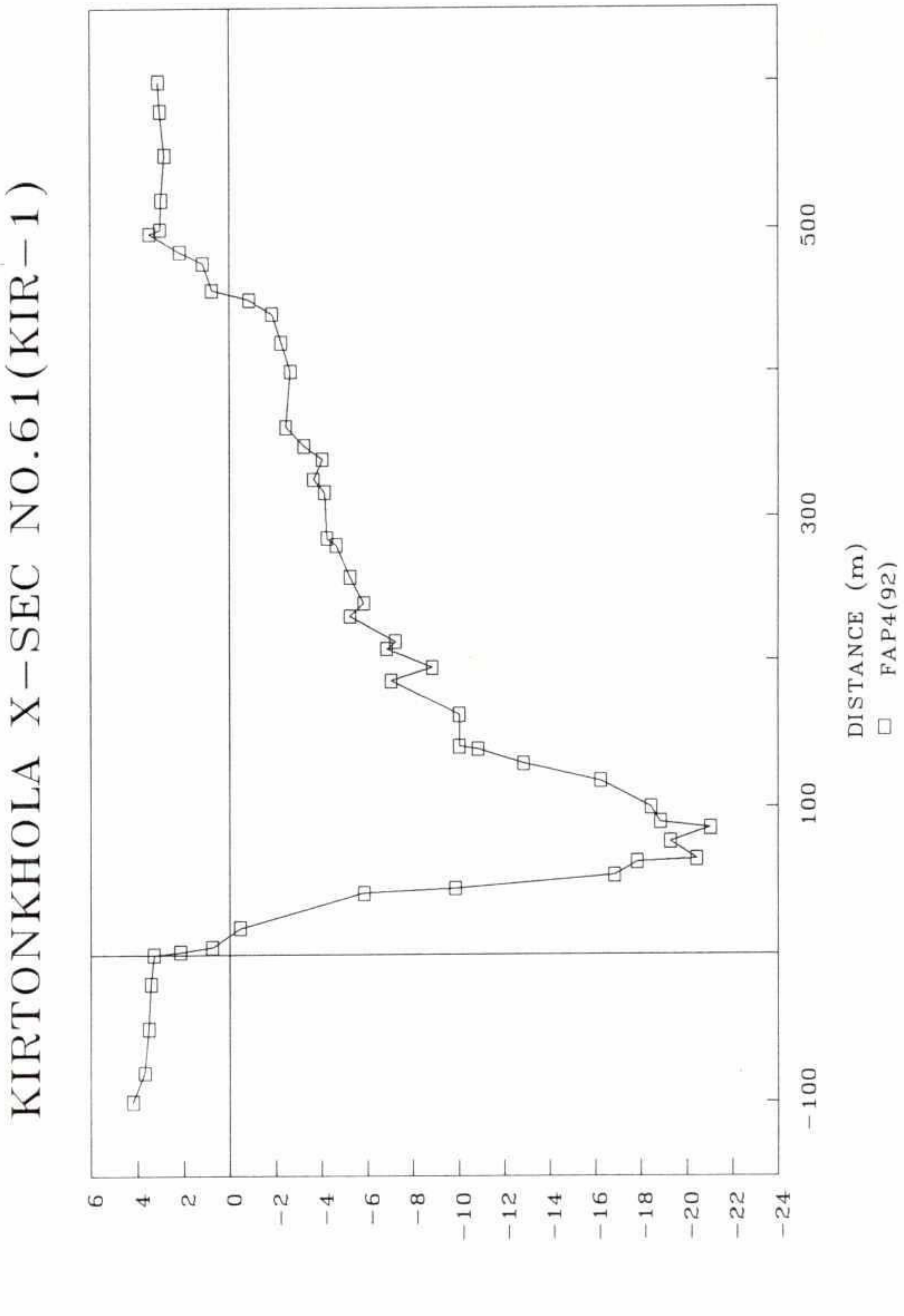
BG CANAL (BHOLA) X-SEC NO.59(BGC-1)



BG CANAL(BHOLA) X-SEC NO.59/1(BGC-2)

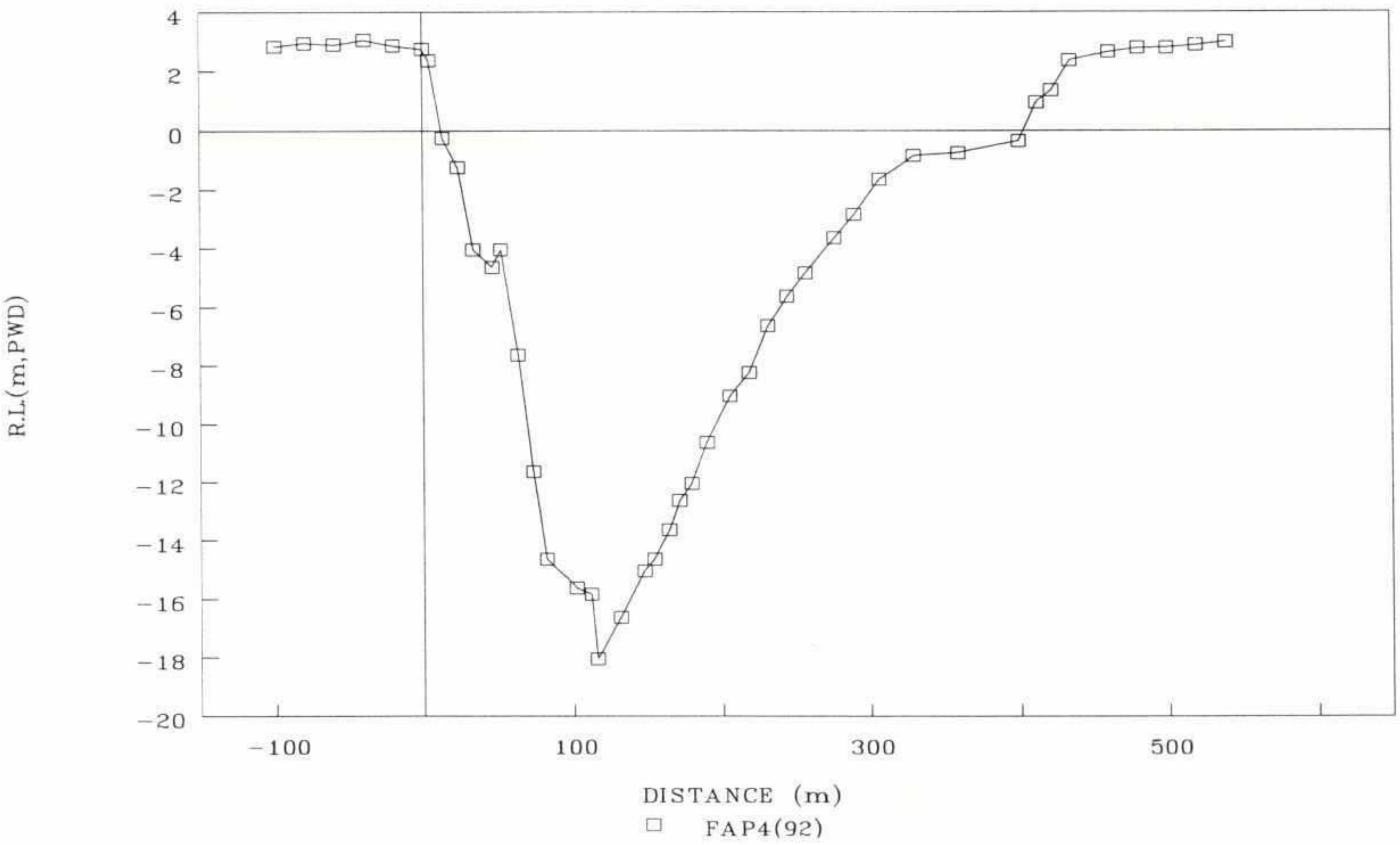


202

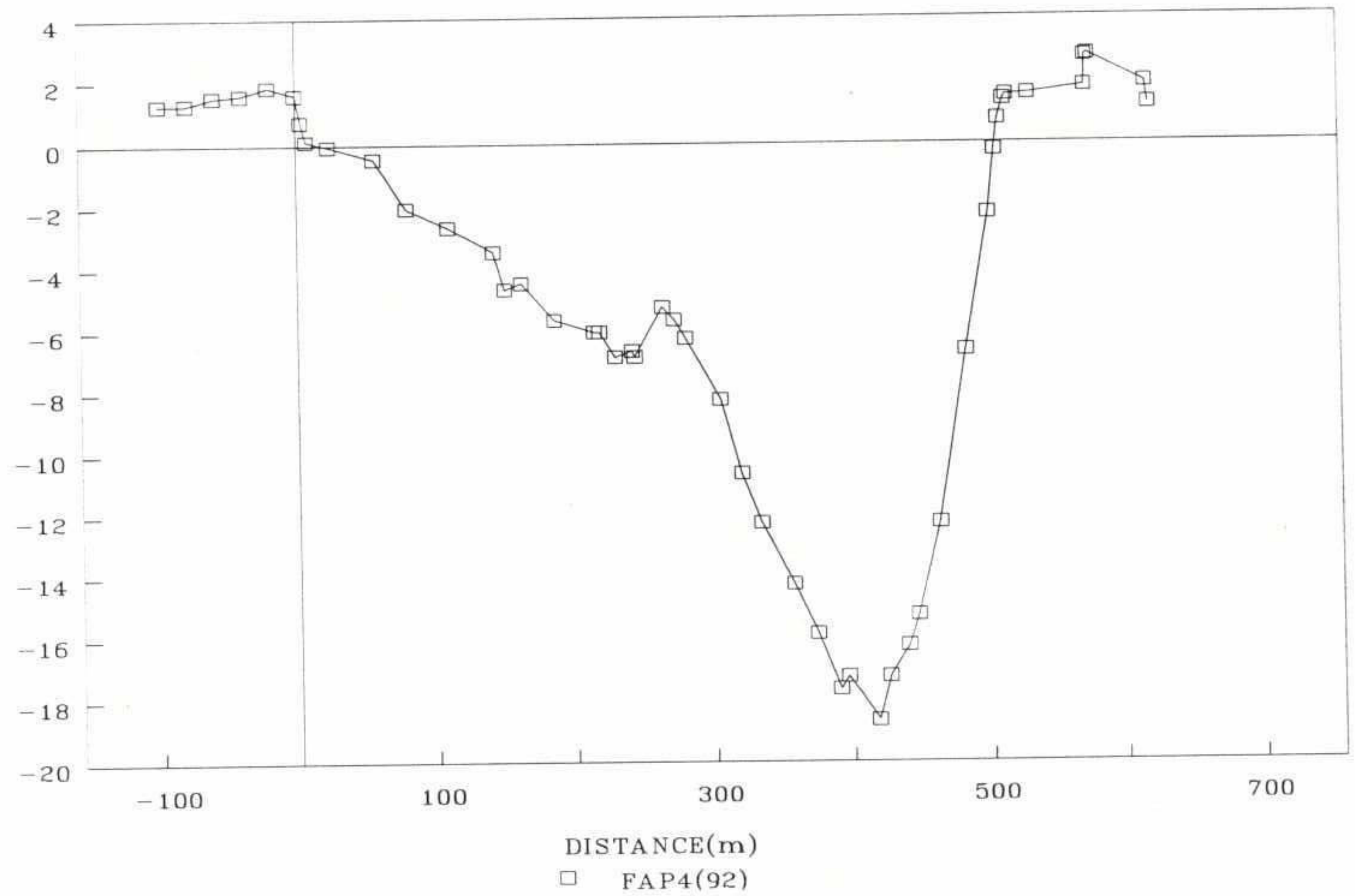


KIRTONKHOLA X-SEC NO.61(KIR-1)
R.L.(m,PWD)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-100
100
300
500
DISTANCE (m)
FAP4(92)

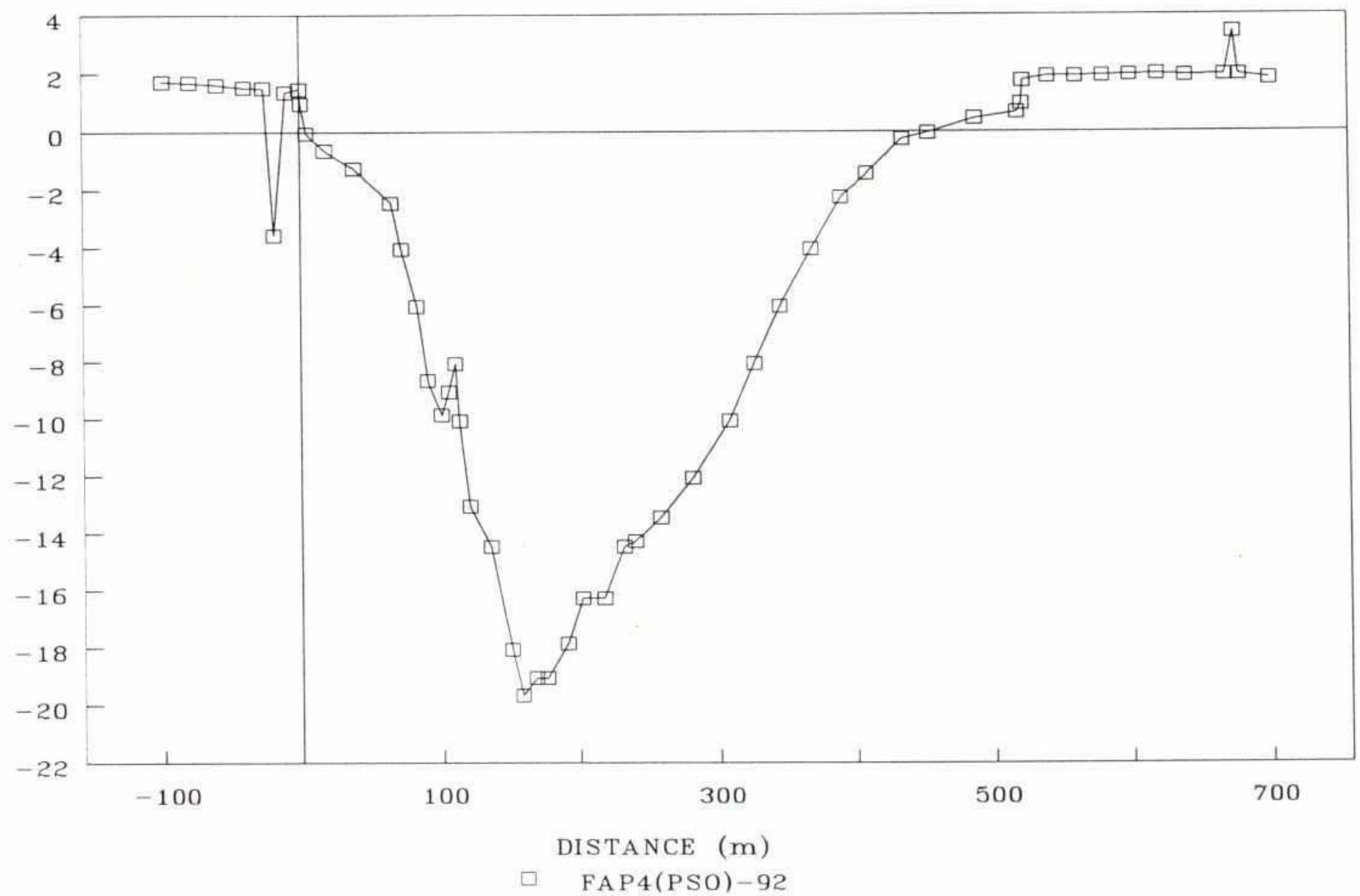
KIRTONKHOLA X-SEC NO.62(KIR'-3)

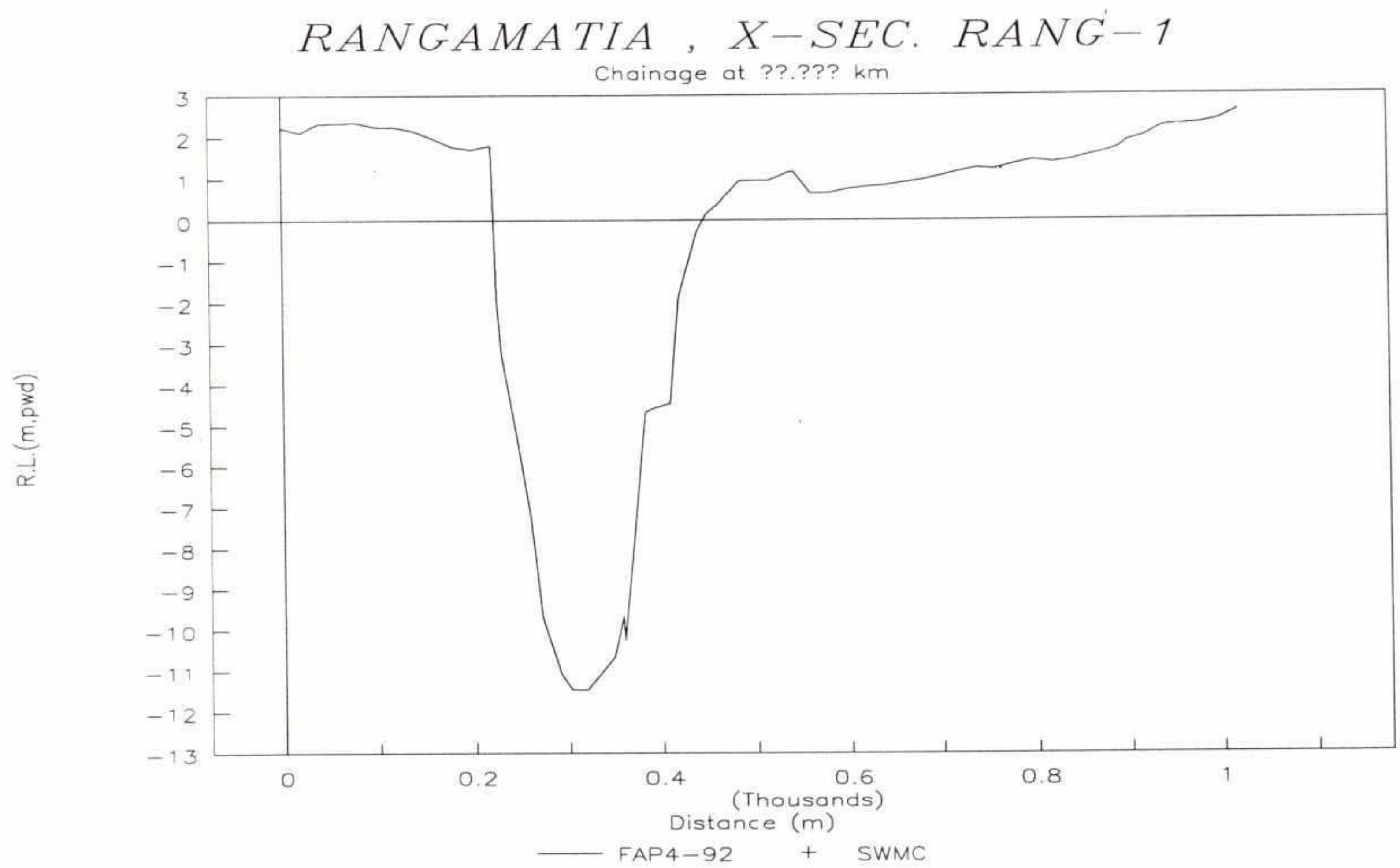


KIRTONKHOLA X-SEC NO-63(KIR-4)



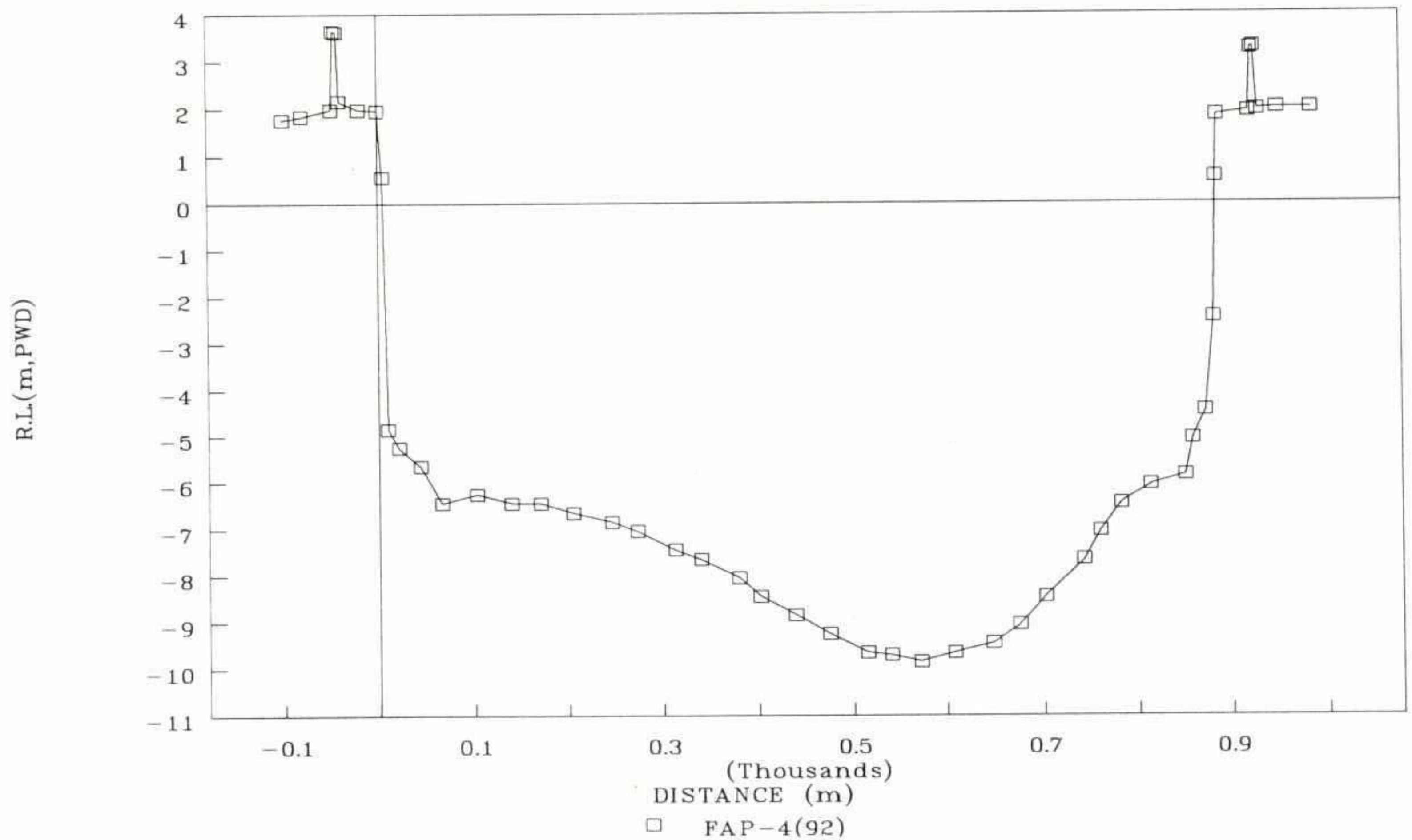
BISHKHALI X-SEC NO 64





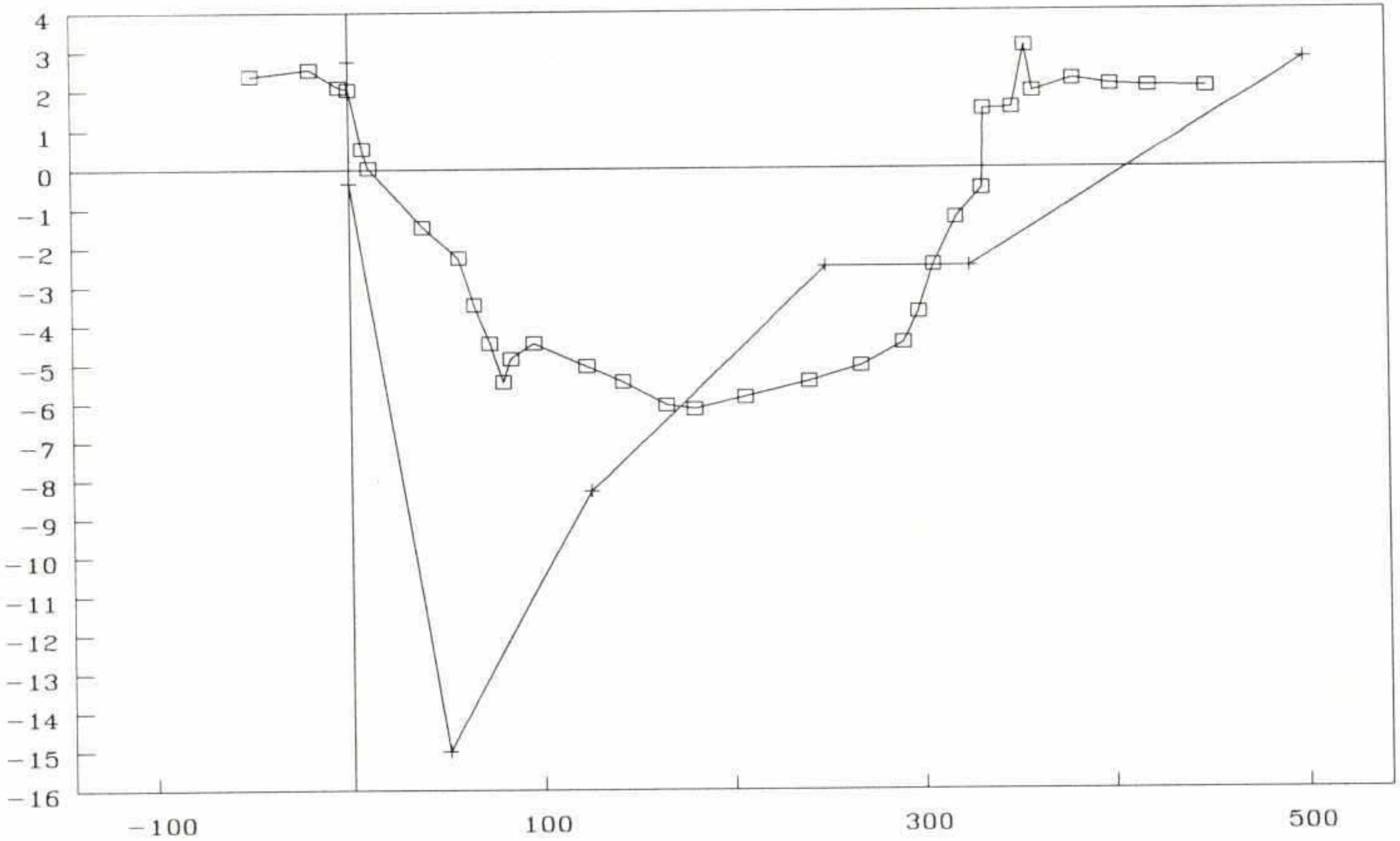
RANGAMATIA , X-SEC. RANG-1
Chainage at ??.??? km
R.L.(m,pwd)
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
0
0.2
0.4
0.6
0.8
1
(Thousands)
Distance (m)
FAP4-92
+
SWMC

PAIRA-1


R.L.(m,PWD)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-0.1
0.1
0.3
0.5
0.7
0.9
(Thousands)
DISTANCE (m)
FAP-4(92)

LOHALIA(LOHA−1)

CHAINAGE 46.5KM



Appendix C

Results of Regime Analysis
and
Hydrodynamic Model Analyses

2l0

LIST OF TABLES

Table C 1

Regime Analysis for the Month of April and August ,1991

(Representative)

Sl. No.	River Name	Chainage (km.)	April Qmax (Cumec)	April Velocity (m/s)	April Area (m2)	April Ratio(Fmor) (Qmax/Qt)	August Qmax (Cumec)	August Velocity (m/s)	August Area (m2)	August Ratio(Fmor) (Qmax/Qt)
1	KOBADAK	13.875	1	0.04	26	0.05	22	0.19	116	0.22
2	KOBADAK	129.000	-337	-0.69	492	0.75	-487	-0.76	641	0.82
3	KARULLA	2.500	-1111	-1.15	966	1.22	-1208	-1.07	1125	1.13
4	CONNECTION	2.500	-590	-0.55	1070	0.58	-948	-0.77	1234	0.80
5	KATAKHALI-K	1.250	-635	-0.98	646	1.06	894	1.45	618	1.57
6	KOBADAK	219.752	-4788	-0.91	5266	0.89	-5143	-0.87	5903	0.85
7	KOIRA	6.000	356	0.34	1036	0.36	-641	-0.8	801	0.86
8	HADDA	3.000	293	0.8	364	0.90	-443	-0.86	515	0.94
9	BETNA	41.125	-10	-0.37	28	0.46	25	0.47	52	0.59
10	BETNA	60.500	-125	-0.77	163	0.89	-132	-0.64	208	0.73
11	MORIRCHAP	8.750	326	0.91	359	1.01	401	0.82	490	0.90
12	LABANGABATI	13.125	-178	-0.58	306	0.65	-220	-0.57	388	0.63
13	BANSANA	3.000	-17	-0.97	18	1.24	-33	-1.26	26	1.63
14	HABRA	6.250	-25	-0.34	74	0.41	-27	-0.27	98	0.33
15	KANKSIALI	4.250	147	0.53	278	0.60	173	0.49	356	0.54
16	GALGHASIA	5.125	-252	-0.81	311	0.91	-312	-1	311	1.13
17	KHOLPETUA	36.002	-6212	-0.71	8800	0.68	-6577	-0.69	9554	0.66
18	LINK-KK	0.500	-303	-1.15	262	1.31	-361	-1.06	342	1.18
19	ARPANGASIA	12.250	-14397	-0.9	15917	0.84	-15030	-0.86	17446	0.80
20	ARPANGASIA	42.750	-31212	-0.93	33657	0.84	-31762	-0.89	35824	0.80
21	CHALKI GANG	8.750	-7862	-0.83	9459	0.79	-7980	-0.8	9968	0.76
22	BAL	4.750	-12954	-1.09	11883	1.03	-13103	-1.04	12642	0.98
23	BARAPANGA	6.125	2977	0.43	6891	0.42	-3487	-0.48	7213	0.47
24	BETMARAGANG	2.250	-32218	-0.95	33814	0.86	-32048	-0.92	35007	0.83
25	MALANCHA	24.000	-10248	-0.68	14999	0.64	-10318	-0.65	15835	0.61
26	MALANCHA-E	2.500	-14576	-0.72	20300	0.66	-14316	-0.66	21714	0.61
27	SONA KHAL	2.250	-3714	-0.96	3865	0.95	4845	1.17	4150	1.16
28	TALDUP	18.000	3421	0.85	4046	0.84	-4655	-1.03	4523	1.02
29	HARIHAR	24.250	-3	-0.12	24	0.16	8	0.16	52	0.19
30	BURIBHADRA	4.125	3	0.09	28	0.14	6	0.06	109	0.07
31	U_BHADRA	15.565	-77	-0.21	365	0.23	57	0.53	108	0.63
32	MUKTESWARI	25.000	-10	-0.04	225	0.05	-20	-0.05	369	0.06
33	HARI	11.000	-79	-0.38	206	0.44	-88	-0.36	242	0.41
34	M_BHADRA	18.250	-193	-0.44	439	0.48	254	0.8	315	0.90
35	HAMKURA	9.450	-60	-0.38	158	0.44	72	0.6	119	0.71
36	BHADRA	24.150	-158	-0.24	649	0.26	-170	-0.32	531	0.35
37	BHADRA	34.100	-908	-0.7	1302	0.73	-1089	-0.82	1333	0.85
38	TELIGATI	1.150	-279	-0.6	467	0.66	361	0.99	364	1.10
39	SALTA(W)	23.200	-425	-0.68	628	0.73	566	0.88	646	0.95
40	HARIA	15.350	471	0.38	1250	0.39	-686	-0.72	957	0.76
41	GHENGRAIL	10.150	-1758	-0.65	2707	0.66	2430	0.85	2872	0.85
42	BHANGARIA	1.125	8	0.12	62	0.16	10	0.17	58	0.21
43	GUNKHALI	4.250	551	0.77	719	0.82	965	1.25	775	1.33
44	U_SOLMARI	8.700	42	0.35	123	0.40	75	0.61	123	0.72
45	L_SOLMARI	4.250	933	0.65	1438	0.67	-1289	-0.99	1297	1.04
46	SALTA	1.750	32	0.29	111	0.34	54	0.38	141	0.45
47	L_SALTA	12.250	-1295	-0.76	1707	0.78	1613	1.01	1602	1.04
48	L_BHADRA	11.400	-2125	-0.78	2736	0.78	2579	1.15	2252	1.17

Table C 1 (continued)

Regime Analysis for the Month of April and August ,1991

(Representative)

Sl. No.	River Name	Chainage (km.)	April Qmax (Cumec)	April Velocity (m/s)	April Area (m2)	April Ratio(Fmor) (Qmax/Qt)	August Qmax (Cumec)	August Velocity (m/s)	August Area (m2)	August Ratio(Fmor) (Qmax/Qt)
49	HABARKHALI	4.125	-4212	-1.06	3977	1.05	4678	1.09	4278	1.08
50	DELUTI	8.000	2704	0.92	2929	0.93	4286	1.33	3213	1.34
51	MINAJNADI	12.75	-1046	-0.67	1552	0.70	1316	0.69	1904	0.71
52	SIBSA	6.438	3783	0.58	6486	0.57	6405	0.87	7372	0.84
53	SIBSA	29.520	-23023	-1.14	20120	1.06	29530	1.42	20778	1.31
54	SIBSA	55.414	-30359	-1.02	29624	0.93	37969	1.4	27105	1.28
55	JHAPJHAPIA	4.750	10	0.09	110	0.11	29	0.08	354	0.09
56	BADURGACHA	1.950	-2444	-1.05	2336	1.06	2685	1.4	1919	1.44
57	MANGA	3.000	-2281	-1.09	2097	1.11	2512	1.41	1777	1.46
58	JHAPJH-MANGA	1.250	-2132	-1.47	1448	1.53	2360	1.88	1253	1.97
59	CHUNKURI	1.650	1658	0.91	1816	0.94	1946	1.19	1637	1.23
60	DHAKI	10.250	1512	0.95	1597	0.98	1783	1.04	1708	1.08
61	SUTARKHALI	18.160	-1448	-0.81	1790	0.83	2058	1.13	1821	1.16
62	SUTARKHALI	26.050	-1997	-0.94	2127	0.96	2797	1.17	2383	1.19
63	BHAIRAB U	108.000	-158	-0.38	412	0.42	-326	-0.5	646	0.55
64	BHAIRAB U	130.000	-503	-0.59	851	0.63	636	0.73	873	0.78
65	NABAGANGA_M	12.875	-2005	-0.84	2379	0.86	4233	1.61	2624	1.63
66	ATAI	10.250	-2643	-1.28	2063	1.31	4341	2.08	2088	2.12
67	MAJUDKHALI	4.250	-165	-0.38	431	0.42	431	0.75	573	0.82
68	RUPSA	7.922	-4100	-0.96	4277	0.95	5784	1.57	3695	1.56
69	KAZIBACHA	7.750	-4122	-0.96	4297	0.95	5466	1.37	4004	1.35
70	NALUA NULLAH	11.032	-503	-0.51	989	0.54	747	0.74	1013	0.78
71	PUSSUR	4.209	-3984	-0.57	6984	0.55	5075	0.87	5826	0.85
72	PUSSUR	39.015	-14565	-0.86	16861	0.80	20165	1.34	15020	1.26
73	PUSSUR	84.585	-64991	-1.14	56905	1.01	79115	1.51	52465	1.34
74	MONGLA NULLA	12.550	-2698	-0.91	2960	0.92	-3131	-0.9	3478	0.90
75	BISHNU	5.000	-468	-0.47	1006	0.49	-527	-0.4	1320	0.42
76	DAUDKHALI	21.035	-527	-0.52	1006	0.55	-546	-0.52	1059	0.54
77	M.G.CANAL	3.750	-1112	-0.59	1872	0.61	-1716	-0.81	2117	0.83
78	GASHIAKHALI	22.250	-3882	-0.62	6238	0.61	-4788	-0.73	6587	0.71
79	ATHAROBANKI	16.000	-1	-0.06	26	0.05	-8	-0.09	88	0.11
80	ATHAROBANKI	51.250	-421	-0.54	783	0.58	-528	-0.43	1225	0.45
81	BHAIRAB	12.750	-10	-0.16	64	0.19	11	0.09	120	0.11
82	POYLAHARA	24.750	267	0.16	1664	0.17	261	0.16	1640	0.16
83	BHAIRAB L	5.250	106	0.47	225	0.54	171	0.62	275	0.70
84	KUMAR	112.105	72	0.1	734	0.11	431	0.4	1072	0.42
85	MADHUMATI	227.938	163	0.15	1086	0.16	629	0.4	1570	0.41
86	BALESWAR	15.000	-2	-0.04	41	0.06	5	0.07	74	0.08
87	BALESWAR	42.502	-43	-0.21	202	0.24	-56	-0.18	303	0.21
88	BALESWAR	68.625	-777	-0.62	1258	0.65	-1210	-0.62	1947	0.64
89	BALESWAR	110.250	-19986	-0.93	21512	0.86	20698	1.11	18601	1.03
90	KALIGANGA	17.450	-536	-0.35	1551	0.36	790	0.44	1807	0.45
91	KOCHA	8.000	8763	0.87	10106	0.83	15662	1.56	10049	1.48
92	SHIKARPUR	8.750	1653	0.88	1886	0.90	2042	0.94	2163	0.96
93	UZIRPUR	6.750	4455	1.04	4292	1.03	5412	1.04	5203	1.02
94	SHANDHA	7.250	4602	1.18	3894	1.17	7230	1.33	5422	1.30
95	AMTALI	5.250	2649	0.91	2920	0.91	2973	0.96	3106	0.96
96	NAYABHANGANI	13.500	731	0.43	1690	0.45	1855	0.91	2036	0.93

Table C 1 (continued)

Regime Analysis for the Month of April and August ,1991

(Representative)

Sl. No.	River Name	Chainage (km.)	April Qmax (Cumec)	April Velocity (m/s)	April Area (m2)	April Ratio(Fmor) (Qmax/Qt)	August Qmax (Cumec)	August Velocity (m/s)	August Area (m2)	August Ratio(Fmor) (Qmax/Qt)
97	DHARMAGANJ	13.625	-1796	-0.36	4943	0.36	3490	0.68	5116	0.67
98	KALABADAR-1	12.750	1975	0.46	4323	0.45	3486	0.64	5445	0.63
99	KALABADAR-2	4.250	-2384	-0.88	2720	0.88	-4733	-1.22	3874	1.21
100	ILSHA	12.250	6672	0.77	8689	0.74	13606	1.17	11607	1.11
101	RANGAMATIA	18.750	1205	0.85	1414	0.89	1265	0.8	1575	0.83
102	KIRTONKHOLA	4.500	3176	0.89	3588	0.88	3670	0.85	4301	0.84
103	KIRTONKHOLA	31.500	4609	1.08	4269	1.07	5103	1.14	4483	1.12
104	KATAKHALI	8.375	528	0.84	628	0.91	660	0.94	701	1.01
105	BISHKHALI	42.500	-8918	-0.84	10671	0.79	10986	1.21	9062	1.16
106	PANDAB-1	12.062	593	0.5	1186	0.52	765	0.77	993	0.82
107	PANDAB-2	1.500	3794	1.3	2916	1.31	4839	1.48	3269	1.48
108	DHULIA	7.625	-3733	-0.9	4130	0.90	4516	0.93	4863	0.91
109	PAIRA	8.088	6135	0.93	6580	0.90	9563	1.25	7662	1.20
110	BURISWAR	24.000	-14697	-0.94	15617	0.88	21407	1.44	14845	1.35
111	PATUAKHALI	9.000	2089	1.07	1946	1.10	3176	1.5	2120	1.53
112	LOHALIA	21.312	1284	0.73	1753	0.75	2043	0.53	3878	0.52
113	LOHALIA	48.250	2145	0.76	2820	0.77	-3158	-0.9	3506	0.90
114	SWARUPKATI	15.750	-7059	-0.82	8579	0.79	14729	1.66	8886	1.59

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Table C 2
Morphological behavior of the rivers
(Regime analyais)

Sl. No.	River Name	Chainage (km.)	Morphology		Morphological Process
			Dry	Wet	
1	KOBADAK	0.00-100	HS	MS	Unstable
2	KOBADAK	100-163	MS	SS	Slow siltation
3	KARULLA		SE	SE	Erosive
4	CONNECTION		MS	SS	Slow siltation
5	KATAKHALI-K		SE	HE	Erosive
6	KOBADAK	163-240	SS	SS	Slow siltation, may be considered stable
7	KOIRA		MS	SS	Slow siltation
8	HADDA		SS	SS	Slow siltation, may be considered stable
9	BETNA	0.00-55	HS-MS	MS	Moderate siltation
10	BETNA	55-94	SS	SS	Slow siltation, may be considered stable
11	MORIRCHAP		E	SS	Stable
12	LABANGABATI		HS-MS	HS-MS	Unstable
13	BANSANA		SE	HE	Stable. Probably Bansana drains to Morirchar
14	HABRA		MS	MS	Unstable, artificially controlled
15	KANKSIALI		MS	MS	Unstable, may presence of closure
16	GALGHASIA		MS-SS	SE	Slow siltation, may be considered stable
17	KHOLPETUA		MS-SS	MS-SS	Slow siltation
18	LINK-KK		SE	SE	Stable
19	ARPANGASIA	0.00-13	SS	SS	Model is not well calibrated for this area, may be considered stable
20	ARPANGASIA	13-43	SS	SS	"Do"
21	CHALKI GANG		SS	SS	"Do"
22	BAL		E	E	Stable
23	BARAPANGA		MS	MS	Representative x-section may not included in the model
24	BETMARAGANG		SS	SS	Do", slow siltation, may be considered stable
25	MALANCHA		MS	MS	"Do"
26	MALANCHA-E		MS	MS	"Do"
27	SONA KHAL		E	SE	Stable
28	TALDUP		SS	E	Stable
29	HARIHAR		HS	HS	Very Unstable
30	BURIBHADRA		HS	HS	Very Unstable
31	U_BHADRA		HS	MS	Unstable
32	MUKTESWARI		HS	HS	Very Unstable
33	HARI		MS	MS	Unstable
34	M_BHADRA		MS	SS	Unstable
35	HAMKURA		HS-MS	MS	Unstable
36	BHADRA	0.00-25	HS	HS-MS	Very Unstable
37	BHADRA	25-37	MS-SS	SS	Unstable
38	TELIGATI		MS-SS	E	Representative x-section may not included in the model, silting
39	SALTA(W)		MS-SS	MS-E	"Do"
40	HARIA		MS	MS-SS	"Do"
41	GHENGRAIL		MS	SS	Slowly silting
42	BHANGARIA		HS	HS	Unstable
43	GUNKHALI		SS	SE	Representative x-section may not included in the model, silting

Table C 2 (continued)

Morphological behavior of the rivers

(Regime analyais)

Sl. No.	River Name	Chainage (km.)	Morphology Dry	Morphology Wet	Morphological Process
44	U_SOLMARI		HS-MS	SS	Unstable
45	L_SOLMARI		SS	E	Very slow siltation, may be stable
46	SALTA		MS	MS	Unstable
47	L_SALTA		SS	E	Stable
48	L_BHADRA		SS	E-SE	Stable
49	HABARKHALI		E	SE	Stable
50	DELUTI		SS-E	SE	Erosive river
51	MINAJNADI		MS	SS	Slow siltation
52	SIBSA	0.00-6.5	MS	SS	Slow siltation
53	SIBSA	6.5-50	E-SE	SE	Erosive river
54	SIBSA	50-82	SS-E	SE	Stable
55	JHAPJHAPIA		HS	HS	Very Unstable
56	BADURGACHA		E	SE	Erosive
57	MANGA		E	SE	Erosive
58	JHAPJH-MANGA		ME	HE	Very erosive
59	CHUNKURI		SS	E	Stable
60	DHAKI		E	SE	Erosive
61	SUTARKHALI	0.00-20	SS	SE	May be considered stable
62	SUTARKHALI	20-28	E	SE	Stable
63	BHAIRAB U	86-123	MS	MS	Silting
64	BHAIRAB U	123-137	MS	SS	Slow siltation
65	NABAGANGA_M		SS	SE	Stable, Lower part
66	ATAI		SE	HE	Stable
67	MAJUDKHALI		MS	SS	Silting
68	RUPSA		SS	SE-HE	Erosive
69	KAZIBACHA		MS-SS	SE	Stable
70	NALUA NULLAH		MS	SS	Slow siltation
71	PUSSUR	0.00-17	MS	SS-E	Slow siltation, stagnation length due to flow from Sibsa
72	PUSSUR	17-48	SS	SE	Stable
73	PUSSUR	48-95	SS-E	SE-ME	Slow erosion
74	MONGLA NULLA		SS-E	SS	May be considered stable
75	BISHNU		MS	MS	Slow siltation
76	DAUDKHALI		MS	MS	Slow siltation
77	M.G.CANAL		MS	MS	Slow siltation
78	GASHIAKHALI		MS	MS-SS	Slow siltation
79	ATHAROBANKI	0.00-32	HS	HS	Unstable
80	ATHAROBANKI	32-58	HS-MS	MS	Silting, Unstable
81	BHAIRAB	0.00-17	HS	HS	Unstable
82	POYLAHARA	0.00-20	HS	HS	Unstable
83	BHAIRAB L	0.00-11	MS	SS	Slow siltation
84	KUMAR		HS	MS	Unstable (lower part)
85	MADHUMATI	207-262	hS	MS	Unstable
86	BALESWAR	0.00-20	HS	HS	Unstable
87	BALESWAR	20-50	MS	MS	Unstable
88	BALESWAR	50-82	MS	MS	Slow siltation
89	BALESWAR	82-123	SS	E	Stable
90	KALIGANGA		MS	MS	Unstable

Table C 2 (continued)

Morphological behavior of the rivers

(Regime analyais)

Sl. No.	River Name	Chainage (km.)	Morphology		Morphological Process
			Dry	Wet	
91	KOCHA		SS	ME	Erosive
92	SHIKARPUR		SS	E	Stable
93	UZIRPUR		E	E	Stable
94	SHANDHA		SE	SE	Stable
95	AMTALI		E	E	Stable
96	NAYABHANGANI		MS	E	Slow siltation, May be considerd stable
97	DHARMAGANJ		MS	MS	Slow siltation
98	KALABADAR-1	0.00-18	MS	SS	Slow siltation
99	KALABADAR-2	0.00-09	SS	SE	Stable
100	ILSHA		SS	SE	May be considered stable
101	RANGAMATIA		SS	SS	Slow siltation
102	KIRTONKHOLA	0.00-22	SS	SS	Slow siltation
103	KIRTONKHOLA	22-39	E	SE	Stable
104	KATAKHALI		SS	E	May be considered stable
105	BISHKHALI		SS	SE	Stable
106	PANDAB-1		MS	SS	Slow siltation
107	PANDAB-2		SE	ME	Erosive
108	DHULIA		SS	SS-E	May be considered stable
109	PAIRA		SS	SE	Stable
110	BURISWAR		SS	ME	Stable
111	PATUAKHALI		SE	HE	Erosive
112	LOHALIA	0.00-30	SS	MS	Slow siltation
113	LOHALIA	30-84	SS	SS	Slow siltation, may be considered stable
114	SWARUPKATI		SS	HE	erosive

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Table C 3
Hydraulic Impact Analysis of Scenario 1

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Maximum (Ebb) Inc. (%)	Maximum (Ebb) Velocity (m/s)	Maximum (Ebb) Inc. (%)	Maximum (Flood) Flow (Cumec)	Maximum (Flood) Inc. (%)	Maximum (Flood) Velocity (m/s)	Maximum (Flood) Inc. (%)	Net Flow Flow (Cumec)	Net Flow Inc. (%)	Tidal Range Range (m)	Tidal Range Inc. (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	7000	4%	0.861	3%	-7844	1%	-0.932	1%	-120	-14%	3.54	2%
2	L_SOLMARI	4.250	1209	30%	0.975	42%	-1077	40%	-0.835	7%	-93	9%	3.51	2%
3	KAZIBACHA	7.750	2485	1%	0.911	2%	-4083	-1%	-0.994	-1%	-58	23%	3.25	3%
4	SIBSA	24.540	14741	-12%	1.079	-11%	-17488	-9%	-1.196	-8%	40	-42%	3.98	6%
5	PUSSUR	12.626	4304	-8%	0.753	-8%	-5888	-3%	-0.809	-6%	-112	-13%	3.56	6%
6	PUSSUR	48.885	16419	5%	1.18	3%	-17683	2%	-1.143	2%	-374	9%	3.24	3%
7	PUSSUR	81.335	58169	2%	1.336	1%	-64863	2%	-1.356	3%	-267	77%	3.03	1%
8	NABAGANGA_L	27.500	1823	2%	0.511	2%	-2714	2%	-0.695	2%	51	-6%	1.93	2%
9	HARIA	17.850	567	62%	0.386	63%	-408	14%	-0.415	14%	2	-120%	4.15	5%
10	MADHUMATI	227.938	163	1%	0.154	1%	-146	0%	-0.135	0%	46	5%	0.40	1%
11	M.G.CANAL	3.750	761	-11%	0.464	-7%	-1354	1%	-0.719	0%	-127	-7%	2.74	7%
12	KOCHA	8.000	8782	0%	0.916	0%	-7845	1%	-0.742	1%	1293	-1%	2.30	1%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2107	-3%	0.265	-4%	-2072	-2%	-0.264	-3%	95	-2%	1.03	0%
2	L_SOLMARI	4.250	471	5%	0.379	6%	-458	2%	-0.422	0%	-26	117%	1.32	-5%
3	KAZIBACHA	7.750	1419	-2%	0.477	-1%	-1509	-1%	-0.418	-2%	64	10%	1.28	-2%
4	SIBSA	24.540	5090	-18%	0.371	-18%	-4923	-18%	-0.34	-19%	268	-10%	1.27	-1%
5	PUSSUR	12.626	1478	-7%	0.297	-5%	-1533	-7%	-0.264	-9%	107	-4%	1.28	0%
6	PUSSUR	48.885	5715	-5%	0.412	-5%	-5591	-5%	-0.385	-5%	300	3%	1.05	0%
7	PUSSUR	81.335	18973	-6%	0.42	-6%	-17981	-6%	-0.389	-5%	1067	0%	0.84	1%
8	NABAGANGA_L	27.500	1202	-1%	0.339	-1%	-1302	-1%	-0.349	-1%	37	12%	0.90	-1%
9	HARIA	17.850	139	2%	0.109	1%	-143	6%	-0.136	3%	-13	-13%	1.35	-4%
10	MADHUMATI	227.938	101	1%	0.103	0%	-95	-1%	-0.094	-1%	19	0%	0.28	1%
11	M.G.CANAL	3.750	387	-14%	0.246	-10%	-514	-11%	-0.291	-11%	-14	-33%	0.89	-2%
12	KOCHA	8.000	4184	1%	0.453	1%	-2739	1%	-0.277	1%	647	0%	0.79	1%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7434	3%	0.885	2%	-8313	1%	-0.937	1%	109	28%	3.49	0%
2	L_SOLMARI	4.250	1136	102%	0.701	85%	-1494	17%	-1.13	7%	-533	-10%	3.19	0%
3	KAZIBACHA	7.750	5317	-2%	1.422	0%	-544	-43%	-0.109	-47%	2859	2%	2.78	0%
4	SIBSA	24.540	26600	1%	1.647	5%	-17353	-10%	-1.115	-9%	1519	-18%	3.91	0%
5	PUSSUR	12.626	7963	-1%	1.154	-2%	-4401	-19%	-0.63	-12%	2080	12%	3.46	0%
6	PUSSUR	48.885	24658	3%	1.578	2%	-22467	2%	-1.194	2%	1880	12%	3.09	0%
7	PUSSUR	81.335	79781	3%	1.767	2%	-70870	3%	-1:362	2%	3659	-4%	2.99	0%
8	NABAGANGA_L	27.500	4447	1%	1.086	1%	1762	-0%	0.411	-1%	3498	0%	1.03	0%
9	HARIA	17.850	619	-13%	0.413	1%	-719	27%	-0.562	32%	77	40%	3.94	0%
10	MADHUMATI	227.938	558	1%	0.362	0%	477	0%	0.309	0%	525	1%	0.12	0%
11	M.G.CANAL	3.750	1072	4%	0.549	4%	-1668	-3%	-0.833	-2%	-286	2%	2.20	0%
12	KOCHA	8.000	15683	0%	1.663	0%	-10006	0%	-0.926	0%	4634	-0%	1.99	0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2372	-2%	0.283	-3%	-2943	-2%	-0.348	-2%	-14	56%	1.28	1%
2	L_SOLMARI	4.250	-143	-27%	-0.114	-22%	-1001	3%	-0.82	2%	-692	2%	1.41	-4%
3	KAZIBACHA	7.750	3854	-1%	1.123	-0%	1896	4%	0.482	3%	3078	-0%	1.24	-2%
4	SIBSA	24.540	7311	-14%	0.501	-14%	-4659	-24%	-0.313	-24%	1737	-2%	1.52	-2%
5	PUSSUR	12.626	3574	-6%	0.618	-3%	66	-116%	0.014	-125%	2080	2%	1.51	2%
6	PUSSUR	48.885	8747	-1%	0.579	-2%	-5699	1%	-0.367	1%	2067	-0%	1.24	2%
7	PUSSUR	81.335	25483	-3%	0.539	-4%	-19921	-4%	-0.418	-4%	3577	-2%	0.97	0%
8	NABAGANGA_L	27.500	4166	0%	1.032	0%	3462	1%	0.846	0%	3882	0%	0.29	-3%
9	HARIA	17.850	209	-13%	0.15	-11%	-176	1%	-0.167	4%	19	27%	1.65	-2%
10	MADHUMATI	227.938	631	0%	0.402	0%	602	0%	0.38	0%	615	0%	0.05	0%
11	M.G.CANAL	3.750	522	-7%	0.292	-6%	-663	-7%	-0.346	-7%	96	2%	1.01	1%
12	KOCHA	8.000	9427	0%	0.952	0%	-2649	2%	-0.252	2%	4486	-0%	0.93	2%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow Net Flow (Cumec)	April 1991 Net Flow Inc (%)	April 1991 Regime Ratio Regime Ratio	April 1991 Regime Ratio Inc (%)	August 1991 Net Flow Net Flow (Cumec)	August 1991 Net Flow Inc (%)	August 1991 Regime Ratio Regime Ratio	August 1991 Regime Ratio Inc (%)
1	KOBADAK	239.250	-35	-24%	-0.81	0%	43	27%	-0.86	0%
2	L_SOLMARI	4.250	-49	29%	0.96	43%	-579	-5%	-1.16	12%
3	KAZIBACHA	7.750	6	-57%	-0.92	-3%	2942	1%	1.35	0%
4	SIBSA	24.540	89	-11%	-1.03	-7%	1611	-11%	1.38	-3%
5	PUSSUR	12.626	26	-26%	-0.70	-4%	2081	8%	1.11	-2%
6	PUSSUR	48.885	-48	71%	-0.90	1%	1938	7%	1.46	3%
7	PUSSUR	81.335	230	-16%	-1.15	1%	3602	-3%	1.53	2%
8	NABAGANGA_L	27.500	52	-2%	-0.64	-2%	3623	0%	1.12	1%
9	HARIA	17.850	-5	-64%	0.34	-187%	41	37%	-0.54	-316%
10	MADHUMATI	227.938	30	0%	0.16	0%	557	0%	0.42	0%
11	M.G.CANAL	3.750	-69	-9%	-0.72	6%	-135	2%	-0.85	2%
12	KOCHA	8.000	937	-1%	0.83	0%	4557	0%	1.49	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 2

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Maximum (Ebb) Inc. (%)	Maximum (Ebb) Velocity (m/s)	Maximum (Ebb) Inc. (%)	Maximum (Flood) Flow (Cumec)	Maximum (Flood) Inc. (%)	Maximum (Flood) Velocity (m/s)	Maximum (Flood) Inc. (%)	Net Flow Flow (Cumec)	Net Flow Inc. (%)	Tidal Range Range (m)	Tidal Range Inc. (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6722	0%	0.833	0%	-7785	0%	-0.925	0%	-140	1%	3.46	0%
2	L_SOLMARI	4.250	1007	8%	0.762	11%	-876	14%	-0.759	-2%	-81	-5%	3.56	3%
3	KAZIBACHA	7.750	2434	-1%	0.833	-7%	-4065	-1%	-1.043	4%	70	49%	3.33	6%
4	SIBSA	24.540	16537	-1%	1.201	-1%	-19151	-0%	-1.301	-0%	52	-25%	3.76	0%
5	PUSSUR	12.626	4939	6%	0.854	5%	-6320	4%	-0.899	4%	-126	-2%	3.37	0%
6	PUSSUR	48.885	15883	1%	1.153	1%	-17548	1%	-1.124	1%	-354	3%	3.16	-0%
7	PUSSUR	81.335	56855	0%	1.321	0%	-63506	0%	-1.321	0%	-177	17%	2.99	0%
8	NABAGANGA_L	27.500	1084	-39%	0.297	-41%	-1660	-38%	-0.435	-36%	40	-26%	0.99	-48%
9	HARIA	17.850	380	9%	0.255	8%	-356	-1%	-0.363	-1%	-7	-30%	3.97	0%
10	MADHUMATI	227.938	161	-1%	0.152	-1%	-145	-1%	-0.135	0%	43	-2%	0.39	0%
11	M.G.CANAL	3.750	862	1%	0.507	1%	-1366	1%	-0.727	1%	-137	1%	2.55	-0%
12	KOCHA	8.000	8753	-0%	0.913	-0%	-7756	-0%	-0.735	-0%	1307	-0%	2.28	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2182	0%	0.276	0%	-2120	0%	-0.272	0%	95	-2%	1.03	0%
2	L_SOLMARI	4.250	421	-6%	0.332	-8%	-431	-4%	-0.401	-5%	-18	50%	1.43	4%
3	KAZIBACHA	7.750	1361	-6%	0.453	-6%	-1347	-12%	-0.373	-12%	70	21%	1.39	7%
4	SIBSA	24.540	6251	1%	0.454	1%	-6084	1%	-0.424	1%	295	-1%	1.29	1%
5	PUSSUR	12.626	1667	5%	0.325	4%	-1766	7%	-0.320	10%	114	3%	1.30	2%
6	PUSSUR	48.885	6207	3%	0.450	3%	-6038	3%	-0.416	3%	288	-1%	1.05	0%
7	PUSSUR	81.335	20448	1%	0.452	2%	-19281	1%	-0.416	1%	1061	-0%	0.83	0%
8	NABAGANGA_L	27.500	778	-36%	0.218	-36%	-876	-33%	-0.236	-33%	52	58%	0.55	-40%
9	HARIA	17.850	141	3%	0.109	1%	-136	1%	-0.134	2%	-14	-7%	1.41	1%
10	MADHUMATI	227.938	100	0%	0.102	-1%	-96	0%	-0.095	0%	19	0%	0.28	0%
11	M.G.CANAL	3.750	461	2%	0.280	2%	-592	3%	-0.339	3%	-22	5%	0.91	0%
12	KOCHA	8.000	4163	0%	0.450	0%	-2707	-0%	-0.274	0%	644	-1%	0.78	0%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7242	0%	0.866	0%	-8213	0%	-0.925	0%	88	4%	3.42	-2%
2	L_SOLMARI	4.250	933	66%	0.590	56%	-1287	1%	-1.011	-4%	-522	-12%	3.31	4%
3	KAZIBACHA	7.750	5335	-2%	1.315	-7%	-1740	83%	-0.381	85%	2432	-13%	2.94	6%
4	SIBSA	24.540	26458	1%	1.581	1%	-19183	-1%	-1.223	-1%	1855	1%	3.72	-5%
5	PUSSUR	12.626	8034	0%	1.179	1%	-5764	6%	-0.759	6%	1673	-10%	3.34	-3%
6	PUSSUR	48.885	23969	0%	1.545	0%	-22280	1%	-1.188	1%	1502	-10%	3.02	-2%
7	PUSSUR	81.335	77610	-0%	1.727	0%	-69194	0%	-1.340	0%	3629	-5%	2.96	-1%
8	NABAGANGA_L	27.500	3658	-17%	0.850	-21%	2398	36%	0.555	34%	3188	-9%	0.38	-63%
9	HARIA	17.850	700	-2%	0.405	-2%	-579	2%	-0.438	3%	63	14%	3.78	-4%
10	MADHUMATI	227.938	641	16%	0.398	10%	578	22%	0.358	16%	611	17%	0.10	-18%
11	M.G.CANAL	3.750	1048	2%	0.537	2%	-1731	1%	-0.859	1%	-272	-3%	2.15	-3%
12	KOCHA	8.000	15724	0%	1.661	0%	-9944	-0%	-0.920	-0%	4695	1%	1.98	-0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2423	-0%	0.292	-0%	-2987	-0%	-0.354	-0%	-8	-11%	1.26	-0%
2	L_SOLMARI	4.250	11	-106%	-0.004	-97%	-907	-7%	-0.754	-7%	-596	-13%	1.53	4%
3	KAZIBACHA	7.750	3594	-8%	1.053	-7%	1402	-23%	0.368	-22%	2767	-10%	1.35	8%
4	SIBSA	24.540	8433	-1%	0.579	-1%	-5892	-4%	-0.395	-3%	1843	4%	1.53	-1%
5	PUSSUR	12.626	3642	-4%	0.613	-4%	-660	56%	-0.103	81%	1866	-9%	1.51	2%
6	PUSSUR	48.885	8876	0%	0.589	0%	-5899	5%	-0.378	4%	1894	-9%	1.23	1%
7	PUSSUR	81.335	26254	-0%	0.563	-0%	-20867	0%	-0.437	0%	3499	-4%	0.97	0%
8	NABAGANGA_L	27.500	3722	-11%	0.869	-16%	3430	-0%	0.799	-5%	3592	-7%	0.09	-70%
9	HARIA	17.850	231	-4%	0.162	-4%	-172	-2%	-0.157	-2%	17	13%	1.67	-1%
10	MADHUMATI	227.938	753	20%	0.448	12%	728	21%	0.430	13%	739	21%	0.04	-29%
11	M.G.CANAL	3.750	563	0%	0.310	0%	-724	2%	-0.378	1%	100	6%	0.99	-1%
12	KOCHA	8.000	9532	1%	0.959	1%	-2539	-2%	-0.241	-2%	4622	3%	0.91	-1%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	April 1991 Net Flow: Inc (%)	April 1991 Regime Ratio: Regime Ratio	April 1991 Regime Ratio: Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	August 1991 Net Flow: Inc. (%)	August 1991 Regime Ratio: Regime Ratio	August 1991 Regime Ratio: Inc. (%)
1	KOBADAK	239.250	-47	2%	-0.81	0%	35	3%	-0.86	0%
2	L_SOLMARI	4.250	-39	3%	0.68	2%	-533	-12%	-1.03	-1%
3	KAZIBACHA	7.750	2	-86%	-0.94	-1%	2581	-11%	1.26	-7%
4	SIBSA	24.540	90	-10%	-1.10	-1%	1846	2%	1.42	0%
5	PUSSUR	12.626	33	-6%	-0.76	4%	1750	-9%	1.13	0%
6	PUSSUR	48.885	-35	25%	-0.90	1%	1647	-9%	1.43	1%
7	PUSSUR	81.335	260	-6%	-1.14	0%	3548	-4%	1.50	0%
8	NABAGANGA_L	27.500	49	-8%	-0.39	-40%	3333	-8%	0.88	-21%
9	HARIA	17.850	-12	-14%	0.25	-164%	35	17%	0.37	48%
10	MADHUMATI	227.938	29	-3%	0.16	0%	659	19%	0.46	10%
11	M.G.CANAL	3.750	-78	3%	-0.70	3%	-125	-5%	-0.83	0%
12	KOCHA	8.000	943	-0%	0.82	-1%	4604	2%	1.50	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 2

(c) Near Field Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc (%)	Velocit (m/s)	Inc (%)	Maximum (Flood) Flow (Cumec)	Inc (%)	Velocity (m/s)	Inc (%)	Net Flow Flow (Cumec)	Inc (%)	Tidal Range Range (m)	Inc (%)
Spring Tide (April 1991)														
1	HARI	7.650	202	708%	0.221	-47%	-262	337%	-0.332	-43%	-3	50%	1.517	-35%
2	GHENGRAIL	7.850	399	-28%	0.32	-11%	-577	9%	-0.308	-0%	-3	-127%	4.109	-2%
3	NABAGANGA_L	27.500	1084	-39%	0.297	-41%	-1660	-38%	-0.435	-36%	40	-26%	0.993	-48%
4	MAJUDKHALI	1.500	1139	4456%	0.77	1122%	-1719	955%	-1.018	172%	40	-156%	1.043	-45%
5	HARIA	13.100	400	-8%	0.64	-8%	-474	0%	-1.043	-1%	-8	-43%	4.036	0%
6	BHADRA	26.800	297	6%	0.417	5%	-369	5%	-0.456	-7%	2	-140%	4.001	-2%
7	BHAIRAB U	130.000	1505	543%	1.088	243%	-2527	402%	-1.329	87%	47	-169%	1.418	-26%
Neap Tide (April 1991)														
1	HARI	7.650	88	487%	0.124	-61%	-117	800%	-0.154	-11%	3	-50%	0.81	-34%
2	GHENGRAIL	7.850	208	16%	0.159	28%	-235	53%	-0.149	41%	8	-58%	1.517	-0%
3	NABAGANGA_L	27.500	778	-36%	0.218	-36%	-876	-33%	-0.236	-33%	52	58%	0.549	-40%
4	MAJUDKHALI	1.500	819	27200%	0.575	-9683%	-907	1295%	-0.582	233%	51	-238%	0.556	-39%
5	HARIA	13.100	97	-4%	0.229	-1%	-102	-7%	-0.258	-3%	3	0%	1.429	1%
6	BHADRA	26.800	80	3%	0.137	0%	-75	-5%	-0.138	-5%	4	0%	1.586	-0%
7	BHAIRAB U	130.000	1024	823%	0.721	290%	-1158	424%	-0.693	112%	49	-236%	0.689	-23%
Spring Tide (August 1991)														
1	HARI	7.650	368	636%	0.393	-33%	-72	26%	-0.049	-87%	256	3100%	1.137	-50%
2	GHENGRAIL	7.850	841	4%	0.574	11%	-312	-52%	-0.157	-55%	275	540%	3.942	-3%
3	NABAGANGA_L	27.500	3658	-17%	0.85	-21%	2398	36%	0.555	34%	3188	-9%	0.378	-64%
4	MAJUDKHALI	1.500	3770	924%	1.775	167%	2065	1004%	0.942	178%	3165	984%	0.441	-58%
5	HARIA	13.100	754	-2%	1.17	-5%	-570	0%	-1.008	-1%	-3	-75%	3.926	0%
6	BHADRA	26.800	461	7%	0.607	6%	-484	9%	-0.509	2%	6	200%	3.834	-2%
7	BHAIRAB U	130.000	4023	554%	2.125	201%	1124	-585%	0.499	-331%	3038	751%	0.903	-18%
Neap Tide (August 1991)														
1	HARI	7.650	348	1143%	0.383	-18%	272	-6900%	0.294	-800%	318	1667%	0.301	-77%
2	GHENGRAIL	7.850	474	91%	0.35	122%	173	-171%	0.102	-168%	340	900%	1.807	-2%
3	NABAGANGA_L	27.500	3722	-11%	0.869	-16%	3430	-0%	0.799	-5%	3592	-7%	0.089	-70%
4	MAJUDKHALI	1.500	3763	1020%	1.786	167%	3399	1123%	1.601	174%	3602	1081%	0.096	-68%
5	HARIA	13.100	117	-5%	0.222	-5%	-165	-6%	-0.334	-5%	-3	-40%	1.692	-1%
6	BHADRA	26.800	124	5%	0.171	2%	-142	4%	-0.208	5%	3	0%	1.848	-3%
7	BHAIRAB U	130.000	3773	729%	2	257%	3025	837%	1.493	306%	3468	761%	0.239	-14%

(d) Near Field Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	Inc (%)	April 1991 Regime Ratio: Regime Ratio	Inc (%)	August 1991 Net Flow: Net Flow (Cumec)	Inc (%)	August 1991 Regime Ratio: Regime Ratio	Inc (%)
1	HARI	7.650	-3	-400%	-0.34	-52%	283	2258%	0.44	-192%
2	GHENGRAIL	7.850	0	-100%	-0.30	-183%	305	663%	0.59	14%
3	NABAGANGA_L	27.500	49	-8%	-0.39	-40%	3333	-8%	0.88	-21%
4	MAJUDKHALI	1.500	50	-188%	-1.02	162%	3332	1018%	1.90	141%
5	HARIA	13.100	-3	-50%	-0.93	-5%	-2	-75%	1.01	-6%
6	BHADRA	26.800	1	-200%	-0.41	-9%	5	150%	-0.47	2%
7	BHAIRAB U	130.000	55	-200%	-1.27	102%	3201	749%	2.24	187%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 3

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc (%)	Velocity (m/s)	Inc (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc (%)	Net Flow Flow (Cumec)	Inc (%)	Tidal Range Range (m)	Inc (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6553	-3%	0.817	-2%	-7767	-0%	-0.921	-0%	105	-25%	3.41	-2%
2	L_SOLMARI	4.250	932	-0%	0.684	-0%	-767	-0%	-0.776	-0%	-85	0%	3.45	-0%
3	KAZIBACHA	7.750	2451	-0%	0.896	-0%	-4121	0%	-1.005	0%	-49	4%	3.16	-0%
4	SIBSA	24.540	16780	0%	1.219	0%	-19234	0%	-1.304	0%	72	4%	3.74	-0%
5	PUSSUR	12.626	4651	-0%	0.812	-0%	-6094	0%	-0.862	0%	-133	4%	3.36	-0%
6	PUSSUR	48.885	15665	-0%	1.140	-0%	-17392	0%	-1.118	0%	-349	2%	3.16	0%
7	PUSSUR	81.335	56716	-0%	1.319	-0%	-63381	-0%	-1.319	-0%	-133	-12%	2.99	0%
8	NABAGANGA_L	27.500	1778	-0%	0.499	-0%	-2665	-0%	-0.681	0%	52	-4%	1.90	-0%
9	HARIA	17.850	376	7%	0.248	5%	-372	4%	-0.377	3%	-11	10%	3.94	-1%
10	MADHUMATI	227.938	161	-1%	0.153	0%	-146	0%	-0.136	1%	43	-2%	0.39	0%
11	M.G.CANAL	3.750	853	-0%	0.499	-0%	-1345	-0%	-0.719	0%	135	-1%	2.56	0%
12	KOCHA	8.000	8753	-0%	0.913	-0%	-7760	-0%	-0.736	0%	1306	-1%	2.28	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2365	9%	0.297	8%	-2225	5%	-0.277	2%	107	10%	1.05	2%
2	L_SOLMARI	4.250	453	1%	0.361	1%	-452	0%	-0.423	0%	-10	-17%	1.39	1%
3	KAZIBACHA	7.750	1445	-0%	0.484	0%	-1538	1%	-0.430	1%	50	-14%	1.31	1%
4	SIBSA	24.540	6279	1%	0.455	1%	-6100	1%	-0.425	1%	291	-2%	1.29	1%
5	PUSSUR	12.626	1595	1%	0.314	0%	-1671	1%	-0.296	2%	105	-5%	1.28	0%
6	PUSSUR	48.885	6053	1%	0.437	1%	-5899	1%	-0.406	1%	283	-3%	1.05	0%
7	PUSSUR	81.335	20435	1%	0.451	1%	-19319	1%	-0.416	1%	1063	-0%	0.84	0%
8	NABAGANGA_L	27.500	1211	-0%	0.341	0%	-1318	1%	-0.356	1%	25	-24%	0.92	0%
9	HARIA	17.850	125	-9%	0.097	-10%	-141	4%	-0.136	3%	-17	13%	1.42	1%
10	MADHUMATI	227.938	100	0%	0.102	-1%	-96	0%	-0.095	0%	18	-5%	0.28	0%
11	M.G.CANAL	3.750	454	1%	0.276	1%	-577	0%	-0.330	1%	-20	-5%	0.91	0%
12	KOCHA	8.000	4161	0%	0.450	0%	-2711	0%	-0.274	0%	643	-1%	0.78	0%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7180	-1%	0.865	-0%	-8156	-1%	-0.920	-1%	130	53%	3.36	-4%
2	L_SOLMARI	4.250	558	-1%	0.374	-1%	-1277	0%	-1.051	-0%	-596	1%	3.17	-1%
3	KAZIBACHA	7.750	5418	-0%	1.416	-0%	-951	0%	-0.206	0%	2794	0%	2.74	-1%
4	SIBSA	24.540	26295	0%	1.566	-0%	-19302	0%	-1.230	-0%	1855	1%	3.69	-6%
5	PUSSUR	12.626	8024	-0%	1.172	-0%	-5441	0%	-0.718	0%	1843	-1%	3.33	-4%
6	PUSSUR	48.885	23935	-0%	1.541	-0%	-22049	0%	-1.173	0%	1666	-0%	3.03	-2%
7	PUSSUR	81.335	77570	-0%	1.724	-0%	-68827	-0%	-1.334	-0%	3831	1%	2.95	-1%
8	NABAGANGA_L	27.500	4410	0%	1.077	0%	1768	0%	0.414	0%	3493	0%	1.04	1%
9	HARIA	17.850	680	-5%	0.390	-5%	-581	3%	-0.437	3%	56	2%	3.77	-4%
10	MADHUMATI	227.938	557	0%	0.362	0%	478	1%	0.310	1%	524	0%	0.12	-2%
11	M.G.CANAL	3.750	1028	0%	0.527	0%	-1714	-0%	-0.852	-0%	-280	-0%	2.15	-2%
12	KOCHA	8.000	15665	0%	1.660	0%	-9966	0%	-0.923	0%	4639	0%	1.98	-0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2622	8%	0.314	7%	-3074	3%	-0.367	3%	-1	-89%	1.27	1%
2	L_SOLMARI	4.250	-198	2%	-0.147	1%	-976	0%	-0.809	0%	-681	0%	1.48	0%
3	KAZIBACHA	7.750	3891	0%	1.129	0%	1823	-0%	0.469	0%	3089	0%	1.26	0%
4	SIBSA	24.540	8617	1%	0.591	1%	-6182	1%	-0.414	1%	1786	0%	1.55	1%
5	PUSSUR	12.626	3801	0%	0.642	0%	-445	6%	-0.060	5%	2051	0%	1.48	0%
6	PUSSUR	48.885	8856	0%	0.589	0%	-5655	0%	-0.363	0%	2073	0%	1.22	0%
7	PUSSUR	81.335	26574	1%	0.569	1%	-20989	1%	-0.439	1%	3642	0%	0.97	0%
8	NABAGANGA_L	27.500	4167	0%	1.033	0%	3443	0%	0.842	-0%	3882	0%	0.30	0%
9	HARIA	17.850	229	5%	0.160	5%	-182	4%	-0.167	4%	13	13%	1.70	1%
10	MADHUMATI	227.938	630	0%	0.401	0%	601	0%	0.380	0%	614	0%	0.05	0%
11	M.G.CANAL	3.750	563	0%	0.311	0%	-716	0%	-0.374	0%	93	-1%	1.00	-0%
12	KOCHA	8.000	9423	0%	0.949	0%	-2600	-0%	-0.247	0%	4496	0%	0.92	-0%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	April 1991 Regime Ratio: Regime Ratio	Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	August 1991 Regime Ratio: Regime Ratio	Inc (%)
1	KOBADAK	239.250	-19	-59%	-0.81	0%	66	94%	-0.85	-1%
2	L_SOLMARI	4.250	-38	0%	0.67	0%	-610	0%	-1.04	0%
3	KAZIBACHA	7.750	9	36%	0.95	0%	2912	0%	1.35	0%
4	SIBSA	24.540	100	0%	1.11	0%	1816	1%	1.42	0%
5	PUSSUR	12.626	29	-17%	-0.73	0%	1927	-0%	1.13	0%
6	PUSSUR	48.885	-34	21%	-0.89	0%	1814	-0%	1.42	0%
7	PUSSUR	81.335	283	3%	-1.14	0%	3712	1%	1.50	0%
8	NABAGANGA_L	27.500	48	-9%	-0.65	0%	3620	0%	1.11	0%
9	HARIA	17.850	-15	7%	0.21	-154%	29	-3%	0.23	-8%
10	MADHUMATI	227.938	29	-3%	0.16	0%	557	0%	0.42	0%
11	M.G.CANAL	3.750	-76	0%	-0.68	0%	-131	-1%	-0.83	0%
12	KOCHA	8.000	942	-0%	0.82	-1%	4566	1%	1.48	0%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 3

(c) Near Field Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc (%)	Velocit (m/s)	Inc. (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Net Flow Flow (Cumec)	Inc (%)	Tidal Range Range (m)	Inc. (%)
Spring Tide (April 1991)														
1	MORIRCHAP	13.750	583	116%	0.832	-4%	-651	264%	-0.891	21%	-73	508%	3.697	38%
2	LABANGABATI	7.500	649	1125%	1.106	485%	-325	416%	-0.667	188%	69	6800%	4.66	153%
3	BANSANA	3.000	13	-425%	0.431	-292%	-21	31%	-0.69	-32%	-3	-70%	2.739	232%
4	HABRA	6.250	24	-580%	0.449	-599%	-50	100%	-0.642	61%	-2	-80%	4.031	394%
5	GALGHASIA	15.375	589	158%	1.074	148%	-547	63%	-0.966	120%	80	-767%	3.924	0%
6	KHOLPETUA	5.250	1452	37%	0.794	32%	-1537	21%	-0.82	18%	29	-1067%	4.037	-4%
7	KHOLPETUA	36.002	5987	4%	0.711	5%	-6355	2%	-0.751	-1%	71	-225%	3.753	-3%
Neap Tide (April 1991)														
1	MORIRCHAP	13.750	250	184%	0.477	15%	-267	256%	-0.469	16%	-35	775%	1.504	42%
2	LABANGABATI	7.500	247	1076%	0.552	500%	-154	711%	-0.445	368%	40	3900%	2.16	129%
3	BANSANA	3.000	2	-300%	0.097	-229%	-4	33%	-0.359	-31%	-1	0%	1.383	224%
4	HABRA	6.250	8	700%	0.253	1388%	-13	86%	-0.307	79%	-1	0%	1.783	335%
5	GALGHASIA	15.375	270	291%	0.567	254%	-213	97%	-0.57	159%	51	5000%	1.545	21%
6	KHOLPETUA	5.250	618	30%	0.37	29%	-616	30%	-0.36	33%	26	86%	1.381	6%
-7	KHOLPETUA	36.002	2260	22%	0.281	23%	-2081	14%	-0.262	12%	140	75%	1.232	4%
Spring Tide (August 1991)														
1	MORIRCHAP	13.750	637	102%	0.84	-4%	-760	212%	-0.949	12%	-95	171%	3.817	42%
2	LABANGABATI	7.500	647	627%	1.114	400%	-342	339%	-0.652	179%	71	7000%	4.43	116%
3	BANSANA	3.000	-2	-86%	-0.11	-62%	-26	-21%	-1.028	-20%	-11	-50%	2.426	187%
4	HABRA	6.250	29	93%	0.572	289%	-49	89%	-0.571	88%	3	-138%	4.101	463%
5	GALGHASIA	15.375	712	139%	1.128	123%	-528	46%	-0.944	125%	119	644%	3.933	3%
6	KHOLPETUA	5.250	1707	32%	0.85	22%	-1604	24%	-0.839	23%	130	24%	4.072	-2%
7	KHOLPETUA	36.002	6435	5%	0.721	5%	-6808	4%	-0.76	2%	291	82%	3.781	-2%
Neap Tide (August 1991)														
1	MORIRCHAP	13.750	259	112%	0.446	-8%	-240	112%	-0.356	-30%	-28	65%	1.812	39%
2	LABANGABATI	7.500	296	957%	0.595	507%	-158	427%	-0.423	223%	24	2300%	2.34	97%
3	BANSANA	3.000	-1	-75%	-0.046	-69%	-6	-46%	-0.803	1%	-4	-43%	0.99	263%
4	HABRA	6.250	15	114%	0.392	211%	-11	-1200%	-0.197	-804%	7	75%	1.738	561%
5	GALGHASIA	15.375	245	148%	0.479	144%	-181	217%	-0.392	227%	51	122%	1.681	9%
6	KHOLPETUA	5.250	707	20%	0.383	18%	-806	29%	-0.435	31%	22	-4%	1.665	5%
7	KHOLPETUA	36.002	2374	9%	0.278	9%	-2882	12%	-0.343	13%	42	163%	1.506	3%

(d) Near Field Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991				August 1991			
			Net Flow		Regime Ratio		Net Flow		Regime Ratio	
			Net Flow (Cumec)	Inc. (%)	Regime Ratio	Inc. (%)	Net Flow (Cumec)	Inc. (%)	Regime Ratio	Inc (%)
1	MORIRCHAP	13.750	-60	757%	-0.94	-204%	-67	148%	-0.99	-214%
2	LABANGABATI	7.500	57	5600%	0.84	-520%	49	4800%	1.04	420%
3	BANSANA	3.000	-2	-67%	-0.72	-44%	-9	-44%	-0.47	-71%
4	HABRA	6.250	-2	-67%	-0.51	24%	4	-233%	-0.44	38%
5	GALGHASIA	15.375	64	-1014%	1.35	-475%	100	456%	1.33	-460%
6	KHOLPETUA	5.250	24	-2500%	-0.71	16%	77	20%	0.87	28%
7	KHOLPETUA	36.002	88	-1357%	-0.66	-3%	187	106%	-0.70	6%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 4

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Maximum (Ebb) Inc. (%)	Maximum (Ebb) Velocity (m/s)	Maximum (Ebb) Inc. (%)	Maximum (Flood) Flow (Cumec)	Maximum (Flood) Inc. (%)	Maximum (Flood) Velocity (m/s)	Maximum (Flood) Inc. (%)	Net Flow Flow (Cumec)	Net Flow Inc. (%)	Tidal Range Range (m)	Tidal Range Inc. (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6784	1%	0.837	1%	-7791	0%	-0.926	0%	-114	-18%	3.50	1%
2	L_SOLMARI	4.250	1160	24%	0.939	37%	-1036	35%	-0.824	6%	-86	1%	3.44	-1%
3	KAZIBACHA	7.750	2442	-1%	0.896	-0%	-4019	-3%	-0.981	-2%	-50	6%	3.19	1%
4	SIBSA	24.540	14706	-12%	1.077	-12%	-17527	-9%	-1.198	-8%	14	-80%	3.96	6%
5	PUSSUR	12.626	4219	-10%	0.742	-9%	-5655	-7%	-0.802	-7%	-94	-27%	3.47	3%
6	PUSSUR	48.885	16058	2%	1.162	2%	-17579	1%	-1.124	1%	-347	1%	3.22	2%
7	PUSSUR	81.335	57375	1%	1.319	-0%	-64484	2%	-1.347	2%	262	74%	3.03	1%
8	NABAGANGA_L	27.500	1805	1%	0.506	1%	-2677	0%	-0.687	1%	49	-9%	1.90	0%
9	HARIA	17.850	561	60%	0.380	60%	-412	15%	-0.416	14%	6	-160%	4.12	4%
10	MADHUMATI	227.938	162	0%	0.153	0%	-146	0%	-0.135	0%	44	0%	0.40	1%
11	M.G.CANAL	3.750	847	-1%	0.495	-1%	-1373	2%	-0.735	2%	-148	9%	2.58	1%
12	KOCHA	8.000	8742	-0%	0.912	-0%	-7763	0%	-0.736	0%	1304	-1%	2.28	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2129	-2%	0.269	-3%	-2092	-1%	-0.268	-2%	95	-2%	1.03	-0%
2	L_SOLMARI	4.250	476	6%	0.385	7%	-453	0%	-0.418	-1%	-21	75%	1.31	-5%
3	KAZIBACHA	7.750	1405	-3%	0.471	-3%	-1484	-3%	-0.414	-3%	56	-3%	1.26	-3%
4	SIBSA	24.540	5141	-17%	0.375	-17%	-5021	-17%	-0.346	-18%	255	-14%	1.26	-2%
5	PUSSUR	12.626	1405	-11%	0.283	-10%	-1444	-12%	-0.249	-14%	102	-8%	1.26	-1%
6	PUSSUR	48.885	5769	-4%	0.419	-4%	-5675	-3%	-0.389	-4%	293	1%	1.05	-0%
7	PUSSUR	81.335	18918	-6%	0.420	-6%	-18051	-6%	-0.390	-5%	1044	-2%	0.84	0%
8	NABAGANGA_L	27.500	1188	-2%	0.336	-2%	-1301	-1%	-0.348	-2%	28	-15%	0.89	-3%
9	HARIA	17.850	143	4%	0.112	4%	-145	7%	-0.138	5%	-13	-13%	1.35	-4%
10	MADHUMATI	227.938	100	0%	0.102	-1%	-96	0%	-0.095	0%	18	-5%	0.28	0%
11	M.G.CANAL	3.750	433	-4%	0.260	-5%	-555	-4%	-0.313	-5%	-18	-14%	0.90	-1%
12	KOCHA	8.000	4164	0%	0.450	0%	-2719	0%	-0.275	0%	643	-1%	0.78	0%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7251	0%	0.867	0%	-8261	1%	-0.930	1%	117	38%	3.46	-1%
2	L_SOLMARI	4.250	1136	102%	0.670	77%	-1486	16%	-1.111	6%	-520	-12%	3.07	-4%
3	KAZIBACHA	7.750	5336	-2%	1.425	1%	-571	-40%	-0.121	-41%	2865	3%	2.75	-1%
4	SIBSA	24.540	26668	1%	1.636	4%	-17188	-11%	-1.103	-10%	1562	-15%	3.91	-0%
5	PUSSUR	12.626	7994	-1%	1.153	-2%	-4419	-19%	-0.646	-10%	2088	13%	3.43	-1%
6	PUSSUR	48.885	24455	2%	1.567	2%	-22295	1%	-1.184	1%	1887	13%	3.09	0%
7	PUSSUR	81.335	79394	2%	1.758	2%	-70595	2%	-1.356	2%	3710	-3%	2.99	0%
8	NABAGANGA_L	27.500	4434	1%	1.080	0%	1773	1%	0.414	0%	3489	-0%	1.03	1%
9	HARIA	17.850	623	-13%	0.418	2%	-718	27%	-0.565	33%	82	49%	3.90	-1%
10	MADHUMATI	227.938	556	0%	0.361	0%	477	0%	0.309	0%	523	0%	0.12	0%
11	M.G.CANAL	3.750	1020	-1%	0.525	-0%	-1725	1%	-0.857	1%	-303	8%	2.17	-1%
12	KOCHA	8.000	15667	0%	1.659	-0%	-9969	0%	-0.923	0%	4634	-0%	1.98	-0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2363	-3%	0.283	-3%	-2943	-2%	-0.347	-2%	-4	-56%	1.27	1%
2	L_SOLMARI	4.250	-155	-21%	-0.121	-17%	-956	-2%	-0.756	-6%	-680	-0%	1.34	-9%
3	KAZIBACHA	7.750	3875	-0%	1.129	0%	1909	4%	0.487	4%	3089	0%	1.20	-4%
4	SIBSA	24.540	7257	-15%	0.498	-15%	-4569	-25%	-0.306	-25%	1763	-1%	1.50	-2%
5	PUSSUR	12.626	3537	-7%	0.610	-5%	72	-117%	0.014	-125%	2085	2%	1.48	-0%
6	PUSSUR	48.885	8596	-3%	0.570	-3%	-5471	-3%	-0.351	-3%	2115	2%	1.23	1%
7	PUSSUR	81.335	25196	-4%	0.534	-5%	-19515	-6%	-0.410	-6%	3648	0%	0.97	0%
8	NABAGANGA_L	27.500	4157	-0%	1.030	-0%	3470	1%	0.848	1%	3882	0%	0.28	-4%
9	HARIA	17.850	214	-11%	0.155	-8%	-176	1%	-0.168	5%	19	27%	1.63	-3%
10	MADHUMATI	227.938	630	0%	0.401	0%	601	0%	0.380	0%	614	0%	0.05	0%
11	M.G.CANAL	3.750	539	-4%	0.297	-4%	-683	-4%	-0.351	-6%	100	6%	1.01	1%
12	KOCHA	8.000	9421	0%	0.951	0%	-2628	1%	-0.250	1%	4501	0%	0.92	0%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	April 1991 Net Flow: Inc (%)	April 1991 Regime Ratio: Regime Ratio	April 1991 Regime Ratio: Inc (%)	August 1991 Net Flow: Net Flow (Cumec)	August 1991 Net Flow: Inc (%)	August 1991 Regime Ratio: Regime Ratio	August 1991 Regime Ratio: Inc (%)
1	KOBADAK	239.250	-32	-30%	-0.81	0%	52	53%	-0.86	0%
2	L_SOLMARI	4.250	-42	11%	0.77	15%	-565	-7%	-1.16	12%
3	KAZIBACHA	7.750	9	-36%	-0.91	-4%	2949	1%	1.35	0%
4	SIBSA	24.540	70	-30%	-1.03	-7%	1645	-9%	1.38	-3%
5	PUSSUR	12.626	39	11%	-0.66	-10%	2087	8%	1.12	-1%
6	PUSSUR	48.885	-33	18%	-0.90	1%	1956	8%	1.44	1%
7	PUSSUR	81.335	223	-19%	-1.15	1%	3655	-1%	1.52	1%
8	NABAGANGA_L	27.500	48	-9%	-0.63	-3%	3619	0%	1.11	0%
9	HARIA	17.850	-3	-79%	0.35	-190%	44	47%	-0.54	-316%
10	MADHUMATI	227.938	29	-3%	0.16	0%	556	0%	0.42	0%
11	M.G.CANAL	3.750	-82	8%	-0.69	2%	-143	8%	-0.83	0%
12	KOCHA	8.000	941	-1%	0.82	-1%	4540	0%	1.49	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 4

(c) Near Field Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc. (%)	Velocit (m/s)	Inc. (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Net Flow Flow (Cumec)	Inc. (%)	Tidal Range Range (m)	Inc. (%)
Spring Tide (April 1991)														
1	L_SOLMARI	4.250	1160	24%	0.939	37%	-1036	35%	-0.824	6%	-86	1%	3.437	-1%
2	DELUTI	2.500	981	-46%	0.458	-44%	-652	-46%	-0.28	-49%	186	-39%	4.16	4%
3	SIBSA	5.212	970	-10%	0.295	-14%	-1270	-13%	-0.39	-12%	-13	30%	4.143	5%
4	L_BHADRA	9.650	1817	8%	1.017	12%	-2228	13%	-0.946	9%	74	1%	3.859	2%
5	HABARKHALI	4.125	1492	-52%	0.414	-49%	-2148	-49%	-0.532	-52%	-121	-53%	4.125	5%
6	HARIA	15.350	684	45%	0.735	39%	-512	14%	-0.788	13%	8	-189%	4.171	4%
Neap Tide (April 1991)														
1	L_SOLMARI	4.250	476	6%	0.385	7%	-453	0%	-0.418	-1%	-21	75%	1.307	-5%
2	DELUTI	2.500	356	-42%	0.172	-42%	-265	-36%	-0.119	-37%	66	-47%	1.344	-6%
3	SIBSA	5.212	324	-20%	0.102	-20%	-296	-19%	-0.09	-17%	22	-19%	1.337	-5%
4	L_BHADRA	9.650	736	2%	0.41	1%	-773	3%	-0.379	4%	39	22%	1.334	-6%
5	HABARKHALI	4.125	605	-46%	0.164	-46%	-715	-45%	-0.186	-46%	-15	-42%	1.331	-4%
6	HARIA	15.350	169	18%	0.191	20%	-181	7%	-0.25	6%	-15	-12%	1.347	-5%
Spring Tide (August 1991)														
1	L_SOLMARI	4.250	1136	102%	0.67	77%	-1486	16%	-1.111	6%	-520	-12%	3.072	-3%
2	DELUTI	2.500	1486	-43%	0.664	-42%	-539	-58%	-0.215	-59%	388	-33%	4.044	3%
3	SIBSA	5.212	1871	-6%	0.528	-6%	-1575	-8%	-0.46	-3%	-73	18%	4.026	4%
4	L_BHADRA	9.650	2634	11%	1.311	11%	-1805	11%	-0.715	12%	564	-7%	3.637	1%
5	HABARKHALI	4.125	2719	-42%	0.665	-44%	-1878	-57%	-0.461	-58%	199	126%	4.006	4%
6	HARIA	15.350	821	31%	0.764	61%	-849	24%	-1.006	31%	81	50%	4.047	4%
Neap Tide (August 1991)														
1	L_SOLMARI	4.250	-155	-21%	-0.121	-17%	-956	-2%	-0.756	-6%	-680	-0%	1.337	-9%
2	DELUTI	2.500	548	-40%	0.262	-36%	-74	-81%	-0.032	-81%	282	-17%	1.624	-5%
3	SIBSA	5.212	357	-17%	0.107	-21%	-428	-20%	-0.127	-17%	-25	0%	1.612	-4%
4	L_BHADRA	9.650	1321	1%	0.722	2%	-201	-17%	-0.09	-16%	704	4%	1.55	-7%
5	HABARKHALI	4.125	985	-40%	0.259	-39%	-347	-74%	-0.089	-74%	414	19%	1.601	-4%
6	HARIA	15.350	255	2%	0.272	11%	-203	-3%	-0.286	1%	21	31%	1.627	-4%

(d) Near Field Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	April 1991 Regime Ratio: Regime Ratio	Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	August 1991 Regime Ratio: Regime Ratio	Inc. (%)
1	L_SOLMARI	4.250	-42	11%	0.77	15%	-565	-7%	-1.16	12%
2	DELUTI	2.500	130	-42%	0.46	-43%	334	-29%	0.64	-40%
3	SIBSA	5.212	3	-57%	-0.37	-12%	-41	11%	0.44	-10%
4	L_BHADRA	9.650	47	18%	-0.84	14%	605	-1%	1.30	11%
5	HABARKHALI	4.125	-82	-52%	-0.50	-52%	282	50%	0.59	-45%
6	HARIA	15.350	-3	-79%	0.57	46%	44	47%	-0.99	30%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 5

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Net Flow Flow (Cumec)	Inc. (%)	Tidal Range Range (m)	Inc. (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6784	1%	0.837	1%	-7791	0%	-0.926	0%	-114	-18%	3.50	1%
2	L_SOLMARI	4.250	1176	26%	0.949	39%	-1044	36%	-0.826	6%	-87	2%	3.47	0%
3	KAZIBACHA	7.750	2439	-1%	0.896	-0%	-4015	-3%	-0.980	-3%	-52	11%	3.20	1%
4	SIBSA	24.540	14702	-12%	1.077	-12%	-17551	-9%	-1.200	-8%	12	-83%	3.96	6%
5	PUSSUR	12.626	4216	-10%	0.742	-9%	-5651	-7%	-0.803	-7%	-94	-27%	3.47	3%
6	PUSSUR	48.885	16059	2%	1.162	2%	-17576	1%	-1.124	1%	-348	1%	3.22	2%
7	PUSSUR	81.335	57383	1%	1.319	-0%	-64449	2%	-1.347	2%	-263	74%	3.03	1%
8	NABAGANGA_L	27.500	1806	1%	0.506	1%	-2676	0%	-0.687	1%	49	-9%	1.90	0%
9	HARIA	17.850	561	60%	0.381	61%	-412	15%	-0.416	14%	6	-160%	4.12	4%
10	MADHUMATI	227.938	162	0%	0.153	0%	-146	0%	-0.135	0%	44	0%	0.40	1%
11	M.G.CANAL	3.750	847	-1%	0.495	-1%	-1374	2%	-0.735	2%	-148	9%	2.58	1%
12	KOCHA	8.000	8742	-0%	0.912	-0%	-7764	0%	-0.736	0%	1304	-1%	2.28	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2129	-2%	0.269	-3%	-2092	-1%	-0.268	-2%	96	-1%	1.03	-0%
2	L_SOLMARI	4.250	477	6%	0.386	8%	-454	1%	-0.420	-1%	-21	75%	1.31	-5%
3	KAZIBACHA	7.750	1405	-3%	0.471	-3%	-1482	-3%	-0.413	-3%	56	-3%	1.26	-3%
4	SIBSA	24.540	5137	-17%	0.375	-17%	-5015	-17%	-0.346	-18%	255	-14%	1.26	-2%
5	PUSSUR	12.626	1403	-11%	0.283	-10%	-1441	-13%	-0.249	-14%	102	-8%	1.26	-1%
6	PUSSUR	48.885	5787	-4%	0.419	-4%	-5673	-3%	-0.388	-4%	293	1%	1.05	-0%
7	PUSSUR	81.335	18914	-6%	0.420	-6%	-18046	-6%	-0.390	-5%	1045	-2%	0.84	0%
8	NABAGANGA_L	27.500	1188	-2%	0.336	-2%	-1300	-1%	-0.348	-2%	26	15%	0.89	-3%
9	HARIA	17.850	143	4%	0.113	5%	-145	7%	-0.138	5%	-13	-13%	1.35	-4%
10	MADHUMATI	227.938	100	0%	0.102	-1%	-96	0%	-0.095	0%	18	-5%	0.28	0%
11	M.G.CANAL	3.750	432	-4%	0.260	-5%	-555	-4%	-0.313	-5%	-18	-14%	0.90	-1%
12	KOCHA	8.000	4164	0%	0.450	0%	-2719	0%	-0.275	0%	643	-1%	0.78	0%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7247	0%	0.867	0%	-8264	1%	-0.930	1%	116	37%	3.46	-1%
2	L_SOLMARI	4.250	1123	100%	0.698	84%	-1492	17%	-1.115	6%	-534	-10%	3.16	-1%
3	KAZIBACHA	7.750	5328	-2%	1.415	-0%	-587	-38%	-0.123	-40%	2852	2%	2.76	-1%
4	SIBSA	24.540	26657	1%	1.633	4%	-17249	-11%	-1.109	-10%	1581	-14%	3.89	-1%
5	PUSSUR	12.626	7994	-1%	1.153	-2%	-4466	+18%	-0.652	-9%	2075	12%	3.43	-1%
6	PUSSUR	48.885	24431	2%	1.566	2%	-22303	1%	-1.185	1%	1874	12%	3.09	0%
7	PUSSUR	81.335	79351	2%	1.757	2%	-70379	2%	-1.352	1%	3714	-2%	2.99	0%
8	NABAGANGA_L	27.500	4434	1%	1.081	0%	1772	0%	0.414	0%	3490	0%	1.04	1%
9	HARIA	17.850	623	-13%	0.418	2%	-718	27%	-0.565	33%	81	47%	3.88	-1%
10	MADHUMATI	227.938	555	0%	0.361	0%	477	0%	0.309	0%	523	0%	0.12	1%
11	M.G.CANAL	3.750	1021	-1%	0.526	-0%	-1725	1%	-0.857	1%	-302	8%	2.17	-1%
12	KOCHA	8.000	15667	0%	1.659	-0%	-9969	0%	-0.923	0%	4634	-0%	1.98	-0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2367	-3%	0.284	-3%	-2941	-2%	-0.346	-3%	-5	-44%	1.27	0%
2	L_SOLMARI	4.250	-180	-8%	-0.137	-8%	-983	1%	-0.804	-1%	-690	1%	1.40	-5%
3	KAZIBACHA	7.750	3849	-1%	1.119	-1%	1892	3%	0.484	3%	3079	-0%	1.22	-3%
4	SIBSA	24.540	7281	-15%	0.500	-15%	-4553	-25%	-0.305	-25%	1766	-1%	1.49	-3%
5	PUSSUR	12.626	3546	-6%	0.609	-5%	14	-103%	0.004	-107%	2077	1%	1.48	-0%
6	PUSSUR	48.885	8623	-3%	0.572	-3%	-5449	-3%	-0.350	-3%	2105	2%	1.23	1%
7	PUSSUR	81.335	25227	-4%	0.535	-5%	-19522	-6%	-0.412	-6%	3642	0%	0.97	0%
8	NABAGANGA_L	27.500	4160	-0%	1.031	-0%	3467	1%	0.848	1%	3882	0%	0.28	-4%
9	HARIA	17.850	218	-10%	0.154	-9%	-167	-5%	-0.162	1%	19	27%	1.61	-4%
10	MADHUMATI	227.938	629	0%	0.401	0%	601	0%	0.380	0%	613	0%	0.05	0%
11	M.G.CANAL	3.750	539	-4%	0.297	-4%	-687	-4%	-0.354	-5%	100	6%	1.01	1%
12	KOCHA	8.000	9422	0%	0.951	0%	-2626	1%	-0.250	1%	4501	0%	0.92	0%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow (Cumec)	Inc. (%)	April 1991 Regime Ratio	Inc. (%)	August 1991 Net Flow (Cumec)	Inc. (%)	August 1991 Regime Ratio	Inc. (%)
1	KOBADAK	239.250	-32	-30%	-0.81	0%	51	50%	-0.86	0%
2	L_SOLMARI	4.250	-43	13%	0.93	39%	-579	-5%	-1.16	12%
3	KAZIBACHA	7.750	8	-43%	-0.91	-4%	2937	1%	1.35	0%
4	SIBSA	24.540	71	-29%	-1.03	-7%	1658	-8%	1.38	-3%
5	PUSSUR	12.626	39	11%	-0.66	-10%	2076	8%	1.11	-2%
6	PUSSUR	48.885	-34	21%	-0.90	1%	1945	7%	1.44	1%
7	PUSSUR	81.335	223	-19%	-1.15	1%	3657	-1%	1.52	1%
8	NABAGANGA_L	27.500	48	-9%	-0.63	-3%	3619	0%	1.11	0%
9	HARIA	17.850	-3	-79%	0.35	-190%	43	43%	-0.54	-316%
10	MADHUMATI	227.938	29	-3%	0.16	0%	556	0%	0.42	0%
11	M.G.CANAL	3.750	-82	8%	-0.69	2%	-143	8%	-0.83	0%
12	KOCHA	8.000	941	-1%	0.82	-1%	4540	0%	1.49	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 5

(c) Near Field Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Maximum (Ebb) Inc. (%)	Maximum (Ebb) Velocit (m/s)	Maximum (Ebb) Inc. (%)	Maximum (Flood) Flow (Cumec)	Maximum (Flood) Inc. (%)	Maximum (Flood) Velocity (m/s)	Maximum (Flood) Inc. (%)	Net Flow Flow (Cumec)	Net Flow Inc. (%)	Tidal Range Range (m)	Tidal Range Inc. (%)
Spring Tide (April 1991)														
1	L_SOLMARI	4.250	1176	26%	0.949	39%	-1044	36%	-0.826	6%	-87	2%	3.471	0%
2	DELUTI	2.500	979	-46%	0.457	-44%	-646	-47%	-0.281	-49%	186	-39%	4.153	4%
3	SIBSA	5.212	971	-10%	0.295	-14%	-1274	-13%	-0.39	-12%	-13	30%	4.139	5%
4	L_BHADRA	9.650	1810	8%	1.014	11%	-2223	12%	-0.937	8%	71	-3%	3.859	2%
5	HABARKHALI	4.125	1488	-52%	0.413	-49%	-2135	-49%	-0.529	-52%	-121	-53%	4.121	5%
6	HARIA	15.350	684	45%	0.736	39%	-512	14%	-0.788	13%	8	-189%	4.168	4%
Neap Tide (April 1991)														
1	L_SOLMARI	4.250	477	6%	0.386	8%	-454	1%	-0.42	-1%	-21	75%	1.306	-5%
2	DELUTI	2.500	355	-43%	0.171	-42%	-264	-36%	-0.119	-37%	66	-47%	1.344	-6%
3	SIBSA	5.212	324	-20%	0.102	-20%	-296	-19%	-0.09	-17%	22	-19%	1.337	-5%
4	L_BHADRA	9.650	733	2%	0.409	0%	-770	3%	-0.378	3%	40	25%	1.334	-6%
5	HABARKHALI	4.125	604	-46%	0.164	-46%	-713	-45%	-0.186	-46%	-15	-42%	1.331	-4%
6	HARIA	15.350	169	18%	0.191	20%	-181	7%	-0.25	6%	-15	-12%	1.347	-5%
Spring Tide (August 1991)														
1	L_SOLMARI	4.250	1123	100%	0.698	84%	-1492	17%	-1.115	6%	-534	-10%	3.162	-0%
2	DELUTI	2.500	1485	-43%	0.663	-42%	-546	-57%	-0.223	-57%	391	-32%	4.034	3%
3	SIBSA	5.212	1870	-6%	0.528	-6%	-1576	-8%	-0.46	-3%	-72	16%	4.005	4%
4	L_BHADRA	9.650	2627	10%	1.307	11%	-1789	10%	-0.707	11%	543	-10%	3.674	2%
5	HABARKHALI	4.125	2718	-42%	0.664	-44%	-1887	-57%	-0.464	-58%	214	143%	3.984	4%
6	HARIA	15.350	820	31%	0.764	61%	-849	24%	-1.005	31%	81	50%	4.018	4%
Neap Tide (August 1991)														
1	L_SOLMARI	4.250	-180	-8%	-0.137	-6%	-983	1%	-0.804	-1%	-690	1%	1.401	-5%
2	DELUTI	2.500	630	-31%	0.303	-26%	-85	-78%	-0.036	-78%	282	-17%	1.619	-5%
3	SIBSA	5.212	357	-17%	0.107	-21%	-419	-21%	-0.124	-19%	-24	-4%	1.601	-5%
4	L_BHADRA	9.650	1302	-1%	0.68	-4%	-231	-5%	-0.102	-5%	686	2%	1.573	-6%
5	HABARKHALI	4.125	1093	-33%	0.296	-30%	-362	-73%	-0.092	-73%	415	20%	1.591	-4%
6	HARIA	15.350	250	0%	0.266	9%	-199	-5%	-0.276	-2%	20	25%	1.613	-5%

(d) Near Field Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	April 1991 Net Flow: Inc. (%)	April 1991 Regime Ratio: Regime Ratio	April 1991 Regime Ratio: Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	August 1991 Net Flow: Inc. (%)	August 1991 Regime Ratio: Regime Ratio	August 1991 Regime Ratio: Inc. (%)
1	L_SOLMARI	4.250	-43	13%	0.93	39%	-579	-5%	-1.16	12%
2	DELUTI	2.500	130	-42%	0.46	-43%	337	-28%	0.64	-40%
3	SIBSA	5.212	3	-57%	-0.37	-12%	-40	8%	0.44	-10%
4	L_BHADRA	9.650	44	10%	-0.84	14%	584	-5%	1.30	11%
5	HABARKHALI	4.125	-81	-53%	-0.50	-52%	294	56%	0.58	-46%
6	HARIA	15.350	-3	-79%	0.57	46%	43	43%	-0.99	30%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 6

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Net Flow Flow (Cumec)	Inc (%)	Tidal Range Range (m)	Inc (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6645	-1%	0.824	-1%	-7751	-0%	-0.920	-1%	-159	14%	3.47	0%
2	L_SOLMARI	4.250	1116	20%	0.810	18%	-924	20%	-0.902	16%	-63	-26%	3.02	-13%
3	KAZIBACHA	7.750	2220	-10%	0.766	-15%	-3884	-6%	-0.968	-4%	-46	-2%	2.47	-22%
4	SIBSA	24.540	15299	-9%	1.121	-8%	-18289	-5%	-1.240	-5%	-1	-101%	3.73	-1%
5	PUSSUR	12.626	3981	-15%	0.871	7%	-6370	5%	-0.905	5%	-123	-4%	3.10	-8%
6	PUSSUR	48.885	14063	-10%	1.040	-9%	-16339	-6%	-1.038	-7%	-333	-3%	3.17	0%
7	PUSSUR	81.335	54487	-4%	1.260	-5%	-61991	-2%	-1.292	-2%	-234	55%	3.01	1%
8	NABAGANGA_L	27.500	1496	-16%	0.418	-16%	-2267	-15%	-0.589	-14%	51	-6%	1.57	-17%
9	HARIA	17.850	379	8%	0.258	9%	-356	-1%	-0.366	0%	-10	0%	3.89	-2%
10	MADHUMATI	227.938	159	-2%	0.151	-1%	-146	0%	-0.137	2%	40	-9%	0.39	0%
11	M.G.CANAL	3.750	779	-9%	0.441	-12%	-1236	-8%	-0.670	-7%	-112	-18%	2.57	0%
12	KOCHA	8.000	8766	0%	0.915	0%	-7778	0%	-0.737	0%	1301	-1%	2.29	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2036	-7%	0.258	-7%	-1984	-6%	-0.256	-6%	97	0%	0.99	-4%
2	L_SOLMARI	4.250	551	22%	0.447	25%	-557	24%	-0.508	20%	6	-150%	1.10	-20%
3	KAZIBACHA	7.750	1276	-12%	0.415	-14%	-1417	-7%	-0.404	-5%	21	-64%	0.94	-27%
4	SIBSA	24.540	5430	-13%	0.397	-12%	-5552	-8%	-0.383	-9%	257	-14%	1.16	-10%
5	PUSSUR	12.626	2185	38%	0.441	41%	-2093	27%	-0.360	24%	52	-53%	1.07	-16%
6	PUSSUR	48.885	5125	-15%	0.376	-14%	-5514	-6%	-0.376	-7%	254	-13%	0.96	-8%
7	PUSSUR	81.335	17474	-13%	0.387	-13%	-16667	-13%	-0.359	-13%	982	-8%	0.81	-3%
8	NABAGANGA_L	27.500	984	-19%	0.277	-19%	-1107	-15%	-0.299	-16%	21	-36%	0.71	-22%
9	HARIA	17.850	89	-35%	0.071	-34%	-97	-28%	-0.094	-29%	-24	60%	1.25	-11%
10	MADHUMATI	227.938	99	-1%	0.101	-2%	-96	0%	-0.095	0%	16	-16%	0.28	0%
11	M.G.CANAL	3.750	398	-12%	0.239	-13%	-476	-17%	-0.271	-17%	13	-162%	0.87	-4%
12	KOCHA	8.000	4151	-0%	0.448	-0%	-2699	-0%	-0.273	-0%	645	-0%	0.77	-1%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7079	-2%	0.849	-2%	-8161	-1%	-0.916	-1%	50	-41%	3.44	-2%
2	L_SOLMARI	4.250	691	23%	0.443	17%	-1451	14%	-1.183	13%	-526	-11%	2.70	-16%
3	KAZIBACHA	7.750	5505	2%	1.352	-5%	-132	-86%	-0.026	-87%	2944	5%	2.07	-26%
4	SIBSA	24.540	24175	-8%	1.488	-5%	-18109	-6%	-1.152	-6%	1716	-7%	3.70	-6%
5	PUSSUR	12.626	6446	-20%	1.152	-2%	-5811	7%	-0.610	-15%	1924	4%	3.03	-12%
6	PUSSUR	48.885	21908	-9%	1.426	-8%	-20413	-8%	-1.071	-9%	1766	6%	3.12	1%
7	PUSSUR	81.335	73164	-6%	1.634	-5%	-67288	-2%	-1.296	-3%	3710	-3%	2.97	-1%
8	NABAGANGA_L	27.500	4261	-3%	1.036	-4%	2163	23%	0.520	26%	3534	1%	0.80	-22%
9	HARIA	17.850	590	-17%	0.348	-15%	-531	-6%	-0.423	-1%	58	6%	3.70	-6%
10	MADHUMATI	227.938	602	9%	0.380	5%	541	14%	0.340	10%	576	10%	0.09	-27%
11	M.G.CANAL	3.750	931	-9%	0.479	-9%	-1612	-6%	-0.805	-6%	-247	-12%	2.20	0%
12	KOCHA	8.000	15788	1%	1.670	1%	-9961	-0%	-0.922	-0%	4700	1%	1.99	0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2191	-10%	0.263	-10%	-2781	-7%	-0.329	-7%	18	-300%	1.23	-3%
2	L_SOLMARI	4.250	-35	-82%	-0.036	-75%	-1048	7%	-0.854	6%	-689	1%	1.14	-23%
3	KAZIBACHA	7.750	3651	-6%	1.020	-10%	2293	25%	0.585	25%	3109	1%	0.86	-32%
4	SIBSA	24.540	7025	-18%	0.496	-15%	-4540	-26%	-0.302	-26%	1985	12%	1.38	-11%
5	PUSSUR	12.626	3857	2%	0.707	11%	-303	-28%	-0.044	-23%	2140	4%	1.20	-19%
6	PUSSUR	48.885	6815	-23%	0.471	-20%	-3841	-32%	-0.248	-32%	2317	12%	1.12	-9%
7	PUSSUR	81.335	21130	-20%	0.451	-20%	-16852	-19%	-0.353	-19%	4097	13%	0.95	-2%
8	NABAGANGA_L	27.500	4069	-2%	1.006	-3%	3589	4%	0.879	4%	3885	0%	0.19	-34%
9	HARIA	17.850	183	24%	0.132	22%	135	-23%	0.125	-22%	9	-40%	1.47	-13%
10	MADHUMATI	227.938	640	2%	0.405	1%	610	2%	0.383	1%	623	2%	0.05	-2%
11	M.G.CANAL	3.750	478	-15%	0.264	-15%	-484	-32%	-0.244	-35%	173	84%	0.98	-2%
12	KOCHA	8.000	9379	-1%	0.949	0%	-2573	-1%	-0.245	-1%	4499	0%	0.92	0%

(b) Net Flow and Regime Ratio Statistics

Sl. No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	April 1991 Regime Ratio: Regime Ratio	Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	Inc (%)	August 1991 Regime Ratio: Regime Ratio	Inc. (%)
1	KOBADAK	239.250	-56	22%	-0.80	-1%	40	18%	-0.85	-1%
2	L_SOLMARI	4.250	-22	-42%	0.79	18%	-593	-3%	-1.22	17%
3	KAZIBACHA	7.750	9	-36%	-0.93	-2%	3072	6%	1.33	-2%
4	SIBSA	24.540	68	-32%	-1.12	1%	1920	6%	1.35	-5%
5	PUSSUR	12.626	38	9%	-0.83	14%	2058	7%	0.99	-12%
6	PUSSUR	48.885	-3	-89%	-0.89	0%	2051	13%	1.31	-8%
7	PUSSUR	81.335	249	-10%	-1.11	-3%	4110	11%	1.45	-3%
8	NABAGANGA_L	27.500	47	-11%	-0.55	-15%	3706	2%	1.07	-4%
9	HARIA	17.850	-17	21%	0.25	-164%	30	0%	0.29	16%
10	MADHUMATI	227.938	27	-10%	0.16	0%	600	8%	0.42	0%
11	M.G.CANAL	3.750	-51	-33%	-0.67	-2%	-94	-29%	-0.81	-2%
12	KOCHA	8.000	941	-1%	0.83	0%	4617	2%	1.50	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 7

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc (%)	Velocity (m/s)	Inc. (%)	Maximum (Flood) Flow (Cumec)	Inc. (%)	Velocity (m/s)	Inc. (%)	Net Flow Flow (Cumec)	Inc. (%)	Tidal Range Range (m)	Inc. (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6645	-1%	0.824	-1%	-7751	-0%	-0.920	1%	-159	14%	3.47	0%
2	L_SOLMARI	4.250	1116	20%	0.810	18%	-924	20%	-0.902	16%	63	26%	1.02	13%
3	KAZIBACHA	7.750	2220	-10%	0.766	-15%	-3884	-6%	-0.968	4%	-46	-2%	2.47	22%
4	SIBSA	24.540	15299	-9%	1.121	-8%	-18289	-5%	-1.240	-5%	-1	-101%	3.73	-1%
5	PUSSUR	12.626	3981	-15%	0.871	7%	-6370	5%	-0.905	5%	-123	-4%	3.10	-8%
6	PUSSUR	48.885	14063	-10%	1.040	-9%	-16339	-6%	-1.038	-7%	-333	-3%	3.17	0%
7	PUSSUR	81.335	54487	-4%	1.260	-5%	-61991	-2%	-1.292	-2%	-234	55%	3.01	1%
8	NABAGANGA_L	27.500	1496	-16%	0.418	-16%	-2267	-15%	-0.589	-14%	51	-6%	1.57	-17%
9	HARIA	17.850	379	8%	0.258	9%	-356	-1%	-0.366	0%	-10	0%	3.89	-2%
10	MADHUMATI	227.938	159	-2%	0.151	-1%	-146	0%	-0.137	2%	40	-9%	0.39	0%
11	M.G.CANAL	3.750	779	-9%	0.441	-12%	-1236	-8%	-0.670	-7%	-112	-18%	2.57	0%
12	KOCHA	8.000	8766	0%	0.915	0%	-7778	0%	-0.737	0%	1301	-1%	2.29	0%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2036	-7%	0.258	-7%	-1984	-6%	-0.256	-6%	97	0%	0.99	-4%
2	L_SOLMARI	4.250	551	22%	0.447	25%	-557	24%	-0.508	20%	6	-150%	1.10	-20%
3	KAZIBACHA	7.750	1276	-12%	0.415	-14%	-1417	-7%	-0.404	-5%	21	-64%	0.94	-27%
4	SIBSA	24.540	5430	-13%	0.397	-12%	-5552	-8%	-0.383	-9%	257	-14%	1.16	-10%
5	PUSSUR	12.626	2185	38%	0.441	41%	-2093	27%	-0.360	24%	52	-53%	1.07	-16%
6	PUSSUR	48.885	5125	-15%	0.376	-14%	-5514	-6%	-0.376	-7%	254	-13%	0.96	-8%
7	PUSSUR	81.335	17474	-13%	0.387	-13%	-16667	-13%	-0.359	-13%	982	-8%	0.81	-3%
8	NABAGANGA_L	27.500	984	-19%	0.277	-19%	-1107	-15%	-0.299	-16%	21	-36%	0.71	-22%
9	HARIA	17.850	89	-35%	0.071	-34%	-97	-28%	-0.094	-29%	-24	60%	1.25	-11%
10	MADHUMATI	227.938	99	-1%	0.101	-2%	-96	0%	-0.095	0%	16	-16%	0.28	0%
11	M.G.CANAL	3.750	398	-12%	0.239	-13%	-476	-17%	-0.271	-17%	13	-162%	0.87	-4%
12	KOCHA	8.000	4151	-0%	0.448	-0%	-2699	-0%	-0.273	-0%	645	-0%	0.77	-1%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7079	-2%	0.849	-2%	-8161	-1%	-0.916	-1%	50	-41%	3.44	-2%
2	L_SOLMARI	4.250	691	23%	0.443	17%	-1451	14%	-1.183	13%	-526	-11%	2.70	-16%
3	KAZIBACHA	7.750	5505	2%	1.352	-5%	-132	-86%	-0.026	-87%	2944	5%	2.07	-26%
4	SIBSA	24.540	24175	-8%	1.488	-5%	-18109	-6%	-1.152	-6%	1716	-7%	3.70	-6%
5	PUSSUR	12.626	6446	-20%	1.152	-2%	-5811	7%	-0.610	-15%	1924	4%	3.03	-12%
6	PUSSUR	48.885	21908	-9%	1.426	-8%	-20413	-8%	-1.071	-9%	1766	6%	3.12	1%
7	PUSSUR	81.335	73164	-6%	1.634	-5%	-67288	-2%	-1.296	-3%	3710	-3%	2.97	-1%
8	NABAGANGA_L	27.500	4261	-3%	1.036	-4%	2163	23%	0.520	26%	3534	1%	0.80	-22%
9	HARIA	17.850	590	-17%	0.348	-15%	-531	-6%	-0.423	-1%	58	6%	3.70	-6%
10	MADHUMATI	227.938	602	9%	0.380	5%	541	14%	0.340	10%	576	10%	0.09	-27%
11	M.G.CANAL	3.750	931	-9%	0.479	-9%	-1612	-6%	-0.805	-6%	-247	-12%	2.20	0%
12	KOCHA	8.000	15788	1%	1.670	1%	-9961	-0%	-0.922	-0%	4700	1%	1.99	0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2191	-10%	0.263	-10%	-2781	-7%	-0.329	-7%	18	-300%	1.23	-3%
2	L_SOLMARI	4.250	-35	-82%	-0.036	-75%	-1048	7%	-0.854	6%	-689	1%	1.14	-23%
3	KAZIBACHA	7.750	3651	-6%	1.020	-10%	2293	25%	0.585	25%	3109	1%	0.86	-32%
4	SIBSA	24.540	7025	-18%	0.496	-15%	-4540	-26%	-0.302	-26%	1985	12%	1.38	-11%
5	PUSSUR	12.626	3857	2%	0.707	11%	-303	-28%	-0.044	-23%	2140	4%	1.20	-19%
6	PUSSUR	48.885	6815	-23%	0.471	-20%	-3841	-32%	-0.248	-32%	2317	12%	1.12	-9%
7	PUSSUR	81.335	21130	-20%	0.451	-20%	-16852	-19%	-0.353	-19%	4097	13%	0.95	-2%
8	NABAGANGA_L	27.500	4069	-2%	1.006	-3%	3589	4%	0.879	4%	3885	0%	0.19	-34%
9	HARIA	17.850	183	-24%	0.132	-22%	-135	-23%	-0.125	-22%	9	-40%	1.47	-13%
10	MADHUMATI	227.938	640	2%	0.405	1%	610	2%	0.383	1%	623	2%	0.05	-2%
11	M.G.CANAL	3.750	478	-15%	0.264	-15%	-484	-32%	-0.244	-35%	173	84%	0.98	-2%
12	KOCHA	8.000	9379	-1%	0.949	0%	-2573	-1%	-0.245	-1%	4499	0%	0.92	0%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	Regime Ratio: Regime Ratio	Inc. (%)	August 1991 Net Flow: Net Flow (Cumec)	Inc. (%)	Regime Ratio: Regime Ratio	Inc. (%)
1	KOBADAK	239.250	-48	4%	-0.81	0%	35	3%	-0.86	0%
2	L_SOLMARI	4.250	-37	-3%	0.68	2%	-606	-0%	-1.04	0%
3	KAZIBACHA	7.750	3	-79%	-0.95	0%	2892	-1%	1.38	2%
4	SIBSA	24.540	90	-10%	-1.11	0%	1808	0%	1.42	0%
5	PUSSUR	12.626	22	-37%	-0.73	0%	1906	-1%	1.12	-1%
6	PUSSUR	48.885	-31	11%	-0.89	0%	1854	2%	1.42	0%
7	PUSSUR	81.335	261	-5%	-1.14	0%	3732	1%	1.5	0%
8	NABAGANGA_L	27.500	48	-9%	-0.64	-2%	3602	-1%	1.1	-1%
9	HARIA	17.850	-14	0%	-0.39	0%	30	0%	0.25	0%
10	MADHUMATI	227.938	63	110%	0.2	25%	608	10%	0.42	0%
11	M.G.CANAL	3.750	-79	4%	-0.68	0%	-158	20%	-0.85	2%
12	KOCHA	8.000	958	1%	0.83	0%	4523	-0%	1.49	1%

Table C 3 (Continued)
Hydraulic Impact Analysis of Scenario 8

(a) Flow and Velocity Statistics

Sl No	River	Chainage (Km)	Maximum (Ebb) Flow (Cumec)	Inc (%)	Velocity (m/s)	Inc (%)	Maximum (Flood) Flow (Cumec)	Inc (%)	Velocity (m/s)	Inc (%)	Net Flow Flow (Cumec)	Inc (%)	Tidal Range Range (m)	Inc (%)
Spring Tide (April 1991)														
1	KOBADAK	239.250	6717	-7%	0.833	-4%	-7786	-5%	-0.925	0%	-140	-265%	3.459	-1%
2	L_SOLMARI	4.250	933	66%	0.683	80%	-772	-40%	-0.78	-26%	-87	-85%	3.455	8%
3	KAZIBACHA	7.750	2470	-55%	0.902	-36%	-4132	335%	-1.006	388%	-42	-101%	3.152	13%
4	SIBSA	24.540	16765	-36%	1.218	-22%	-19218	-1%	-1.304	6%	73	-96%	3.748	-4%
5	PUSSUR	12.626	4650	-42%	0.812	-31%	-6109	12%	-0.861	20%	-129	-107%	3.361	-3%
6	PUSSUR	48.885	15683	-35%	1.141	-26%	-17370	-21%	-1.118	-5%	-337	-120%	3.166	3%
7	PUSSUR	81.335	56865	-27%	1.321	-24%	-63464	-8%	-1.321	-1%	-141	-104%	2.991	0%
8	NABAGANGA_L	27.500	1772	-60%	0.498	-54%	-2644	-250%	-0.676	-264%	58	-98%	1.895	85%
9	HARIA	17.850	351	-51%	0.238	-42%	-359	-37%	-0.366	-14%	-10	-118%	3.959	1%
10	MADHUMATI	227.938	147	-74%	0.167	-54%	-41	-109%	0.014	-96%	72	-86%	0.529	334%
11	M.G.CANAL	3.750	865	-16%	0.505	-4%	-1351	-21%	-0.73	-14%	-135	-52%	2.508	14%
12	KOCHA	8.000	8773	-44%	0.915	-45%	-7796	-22%	-0.739	-20%	1315	-72%	2.276	14%
Neap Tide (April 1991)														
1	KOBADAK	239.250	2177	-10%	0.276	-6%	-2117	-29%	-0.272	-23%	95	-1156%	1.032	-18%
2	L_SOLMARI	4.250	449	-330%	0.358	-345%	-450	-54%	-0.422	-48%	-12	-98%	1.377	-7%
3	KAZIBACHA	7.750	1448	-63%	0.485	-57%	-1529	-184%	-0.428	-191%	58	-98%	1.294	3%
4	SIBSA	24.540	6178	-28%	0.448	-24%	-6008	-2%	-0.418	2%	294	-84%	1.283	-17%
5	PUSSUR	12.626	1588	-58%	0.312	-51%	-1657	293%	-0.293	414%	108	-95%	1.27	-14%
6	PUSSUR	48.885	5970	-33%	0.432	-27%	-5831	3%	-0.4	11%	294	-86%	1.048	-14%
7	PUSSUR	81.335	20105	-24%	0.444	-21%	-19077	-8%	-0.41	-6%	1064	-71%	0.834	-14%
8	NABAGANGA_L	27.500	1202	-71%	0.338	-67%	-1294	-138%	-0.35	-142%	33	-99%	0.911	210%
9	HARIA	17.850	137	-43%	0.107	-37%	-135	-23%	-0.132	-18%	-15	-200%	1.399	-17%
10	MADHUMATI	227.938	66	-90%	0.089	-78%	-1	-100%	-0.029	-108%	37	-94%	0.387	659%
11	M.G.CANAL	3.750	422	-25%	0.257	-17%	-545	-24%	-0.311	-17%	-21	-122%	0.887	-12%
12	KOCHA	8.000	4179	-56%	0.452	-52%	-2715	4%	-0.275	11%	650	-86%	0.776	-15%
Spring Tide (August 1991)														
1	KOBADAK	239.250	7245	0%	0.866	0%	-8210	0%	-0.925	0%	86	1%	3.423	-2%
2	L_SOLMARI	4.250	555	-1%	0.371	-2%	-1289	1%	-1.057	1%	-595	0%	3.153	-1%
3	KAZIBACHA	7.750	5423	0%	1.425	1%	-919	-3%	-0.198	-4%	2797	0%	2.719	-2%
4	SIBSA	24.540	26292	-0%	1.57	0%	-19285	-0%	-1.229	-0%	1857	1%	3.7	-6%
5	PUSSUR	12.626	8004	-0%	1.169	-0%	-5441	0%	-0.72	0%	1836	-1%	3.323	-4%
6	PUSSUR	48.885	23939	0%	1.541	-0%	-21987	-0%	-1.168	-0%	1727	3%	3.029	-2%
7	PUSSUR	81.335	77733	0%	1.727	0%	-68842	-0%	-1.333	-0%	3871	2%	2.954	-1%
8	NABAGANGA_L	27.500	4351	-1%	1.061	-2%	1739	-2%	0.406	-2%	3443	-1%	1.067	4%
9	HARIA	17.850	710	-0%	0.409	-1%	-568	0%	-0.427	0%	56	2%	3.772	-4%
10	MADHUMATI	227.938	621	12%	0.378	5%	405	-15%	0.262	-15%	487	-7%	0.266	118%
11	M.G.CANAL	3.750	1025	-0%	0.526	-0%	-1728	1%	-0.853	0%	-294	5%	2.084	-5%
12	KOCHA	8.000	15603	-0%	1.655	-0%	-10009	0%	-0.927	0%	4579	-1%	1.981	-0%
Neap Tide (August 1991)														
1	KOBADAK	239.250	2435	0%	0.293	0%	-2995	0%	-0.355	0%	-7	-22%	1.265	0%
2	L_SOLMARI	4.250	-225	15%	-0.168	15%	-988	1%	-0.817	1%	-698	3%	1.469	-0%
3	KAZIBACHA	7.750	3935	1%	1.14	1%	1892	3%	0.484	3%	3147	2%	1.244	-1%
4	SIBSA	24.540	8553	0%	0.588	0%	-6041	-1%	-0.405	-1%	1836	3%	1.543	0%
5	PUSSUR	12.626	3756	-1%	0.642	0%	-426	1%	-0.057	0%	2070	1%	1.476	-0%
6	PUSSUR	48.885	8936	1%	0.593	1%	-5500	-3%	-0.353	-3%	2200	6%	1.223	0%
7	PUSSUR	81.335	26458	1%	0.568	1%	-20663	-1%	-0.433	-1%	3813	5%	0.965	0%
8	NABAGANGA_L	27.500	4127	-1%	1.023	-1%	3414	-1%	0.835	-1%	3846	-1%	0.297	1%
9	HARIA	17.850	246	2%	0.172	2%	-175	0%	-0.16	0%	16	7%	1.686	0%
10	MADHUMATI	227.938	529	-16%	0.35	-13%	488	-19%	0.338	-11%	504	-18%	0.109	114%
11	M.G.CANAL	3.750	515	-8%	0.287	-7%	-745	5%	-0.381	2%	55	-42%	1.023	2%
12	KOCHA	8.000	9267	-2%	0.934	-2%	-2656	2%	-0.252	2%	4333	-4%	0.916	-0%

(b) Net Flow and Regime Ratio Statistics

Sl No	River	Chainage (Km)	April 1991 Net Flow (Cumec)	Inc (%)	Regime Ratio	Inc (%)	August 1991 Net Flow (Cumec)	Inc (%)	Regime Ratio	Inc (%)
1	KOBADAK	239.25	-48	-241%	-0.81	-6%	36	6%	-0.86	0%
2	L_SOLMARI	4.25	-40	-93%	0.67	-164%	-616	1%	-1.04	0%
3	KAZIBACHA	7.75	15	-100%	-0.95	-170%	2935	1%	1.39	3%
4	SIBSA	24.54	97	-95%	-1.11	-178%	1836	2%	1.42	0%
5	PUSSUR	12.626	30	-98%	-0.73	-165%	1932	0%	1.13	0%
6	PUSSUR	48.885	-26	-101%	-0.89	-163%	1897	4%	1.42	0%
7	PUSSUR	81.335	272	-93%	-1.14	-176%	3803	3%	1.50	0%
8	NABAGANGA_L	27.5	52	-99%	-0.64	-158%	3577	-1%	1.10	-1%
9	HARIA	17.85	-13	-143%	-0.39	-256%	31	3%	0.25	0%
10	MADHUMATI	227.938	50	-91%	0.14	-67%	488	-12%	0.41	-2%
11	M.G.CANAL	3.75	-75	-43%	-0.67	-19%	-157	19%	-0.86	4%
12	KOCHA	8	948	-79%	0.83	-44%	4432	-2%	1.48	0%

Table C 4

Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
TALDUP	18.000	3421	261	0.85	4046	0.84	3654	268	0.88	4129	0.88	3653	267	0.88	4129	0.88
TALDUP	20.000	3024	260	0.67	4514	0.66	3261	268	0.74	4433	0.73	3260	266	0.74	4433	0.73
KOBADAK	4.625	1	1	0.07	14	0.09	1	1	0.07	15	0.10	1	1	0.07	15	0.10
KOBADAK	13.875	1	1	0.04	26	0.05	1	1	0.05			1	1	0.05		
KOBADAK	25.000	2	1	0.03	56	0.03	2	1	0.03			2	1	0.03		
KOBADAK	38.000	3	1	0.04	85	0.04	3	1	0.04			3	1	0.04		
KOBADAK	51.000	-9	1	-0.07	138	-0.08	-9	1	-0.07	143	-0.08	-9	1	-0.07	143	-0.08
KOBADAK	64.000	-29	1	-0.11	255	-0.13	-30	1	-0.12	242	-0.14	-30	1	-0.12	242	-0.14
KOBADAK	77.000	-77	1	-0.19	395	-0.22	-79	1	-0.19	411	-0.21	-79	1	-0.19	411	-0.21
KOBADAK	90.000	-132	1	-0.28	476	-0.30	-137	1	-0.27	498	-0.30	-137	1	-0.27	498	-0.30
KOBADAK	103.000	-199	1	-0.4	493	-0.44	-203	1	-0.39	515	-0.43	-203	1	-0.39	515	-0.43
KOBADAK	116.000	-265	1	-0.52	508	-0.57	-272	1	-0.57	478	-0.62	-272	1	-0.57	478	-0.62
KOBADAK	129.000	-337	1	-0.69	492	-0.75	-351	1	-0.69	512	-0.75	-351	1	-0.69	512	-0.75
KOBADAK	140.667	-426	1	-0.59	718	-0.64	-440	1	-0.58	753	-0.63	-440	1	-0.58	753	-0.63
KOBADAK	151.000	-609	1	-0.54	1127	-0.57	-620	1	-0.52	1199	-0.54	-620	1	-0.52	1199	-0.54
KOBADAK	161.333	-874	1	-0.58	1519	-0.60	-897	1	-0.63	1432	-0.65	-897	1	-0.63	1432	-0.65
KARULLA	2.500	-1111	2	-1.15	966	-1.22	-1132	1	-1.23	923	-1.30	-1132	1	-1.23	923	-1.30
CONNECTION	2.500	-590	9	-0.55	1070	-0.58	-793	2	-0.75	1060	-0.79	-793	1	-0.75	1060	-0.79
KATAKHALI-K	1.250	-635	-8	-0.98	646	-1.06	-482	0	-0.73	660	-0.79	-482	0	-0.73	661	-0.79
KATAKHALI-K	3.750	-661	-8	-0.99	664	-1.07	-499	0	-0.77	647	-0.83	-498	0	-0.77	647	-0.83
KOBADAK	187.505	-720	-8	-0.74	974	-0.78	-547	0	-0.53	1040	-0.56	-547	0	-0.53	1040	-0.56
KOBADAK	196.750	-1424	2	-0.56	2552	-0.57	-1483	33	-0.59	2527	-0.59	-1482	33	-0.59	2527	-0.59
KOBADAK	209.258	-3448	-33	-0.93	3712	-0.92	-3397	8	-0.9	3763	-0.90	-3397	8	-0.9	3763	-0.90
KOBADAK	219.752	-4788	-33	-0.91	5266	-0.89	-4774	8	-0.9	5298	-0.88	-4774	8	-0.9	5299	-0.88
KOBADAK	229.750	-6457	-45	-0.89	7232	-0.86	-6445	0	-0.89	7251	-0.86	-6445	1	-0.89	7251	-0.86
KOBADAK	239.250	-7786	-46	-0.85	9175	-0.81	-7769	-1	-0.84	9195	-0.81	-7769	0	-0.84	9195	-0.81
KOIRA	6.000	356	36	0.34	1036	0.36	167	25	0.24	703	0.26	167	25	0.24	703	0.26
HADDA	3.000	293	36	0.8	364	0.89	247	25	0.77	323	0.86	247	25	0.76	323	0.86
BETNA	5.875	2	1	0.07	24	0.10	2	1	0.08	23	0.10	2	1	0.08	23	0.10
BETNA	17.625	-3	1	-0.13	23	-0.17	-3	1	-0.13	23	-0.17	-3	1	-0.13	23	-0.17
BETNA	29.375	-5	1	-0.21	24	-0.28	-5	1	-0.21	25	-0.27	-5	1	-0.21	25	-0.27
BETNA	41.125	-10	1	-0.37	28	-0.47	-11	1	-0.39	27	-0.50	-11	1	-0.39	27	-0.50
BETNA	51.500	-27	1	-0.27	99	-0.32	-26	1	-0.29	88	-0.35	-26	1	-0.29	88	-0.35
BETNA	60.500	-125	1	-0.77	163	-0.89	-124	1	-0.67	185	-0.77	-124	1	-0.67	185	-0.77
BETNA	71.125	-202	1	-0.44	463	-0.48	-195	1	-0.45	438	-0.49	-195	1	-0.45	438	-0.49
BETNA	83.375	-647	1	-0.7	919	-0.75	-607	1	-0.62	982	-0.65	-607	1	-0.62	982	-0.65
BETNA	90.500	-830	-8	-0.84	986	-0.89	-588	-32	-0.63	930	-0.67	-588	-32	-0.63	930	-0.67
MORIRCHAP	2.500	422	-10	0.44	969	0.46	-690	-33	-0.81	847	-0.87	-690	-33	-0.81	847	-0.87
MORIRCHAP	8.750	326	-7	0.91	359	1.01	-810	-55	-1.24	652	-1.34	-810	-55	-1.24	652	-1.34

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage	BASE					SCENARIO : 9					SCENARIO : 10				
	(Km)	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio
MORIRCHAP	13.750	270	-7	0.81	335	0.90	-669	-55	-0.87	769	-0.93	-669	-55	-0.87	769	-0.93
LABANGABATI	4.375	-63	1	-0.18	359	-0.20	659	55	1	658	1.08	659	55	1	658	1.08
LABANGABATI	13.125	-178	1	-0.58	306	-0.65	352	55	0.6	583	0.66	352	55	0.6	583	0.66
LABANGABATI	25.000						425	54	0.74	574	0.80	425	54	0.74	574	0.80
BANSANA	3.000	-17	-6	-0.97	18	-1.28	18	0	0.31	58	0.38	18	0	0.31	58	0.38
HABRA	6.250	-25	-6	-0.34	74	-0.41	-51	0	-0.43	119	-0.51	-51	0	-0.43	119	-0.51
KANKSIALI	4.250	147	1	0.53	278	0.60	-518	-62	-0.73	705	-0.79	-518	-62	-0.73	705	-0.79
KANKSIALI	12.750	71	1	0.12	600	0.13	-839	-62	-1.1	761	-1.18	-839	-62	-1.1	761	-1.18
GALGHASIA	5.125	-252	-7	-0.81	311	-0.91	557	63	0.92	607	1.00	557	63	0.92	607	1.00
GALGHASIA	15.375	-336	-7	-0.34	980	-0.36	646	63	1.24	521	1.35	646	63	1.24	521	1.35
KHOLPETUA	5.250	-1274	-1	-0.6	2131	-0.61	-1516	23	-0.68	2214	-0.70	-1516	23	-0.68	2214	-0.70
KHOLPETUA	15.750	-2273	-1	-0.68	3344	-0.68	-2395	23	-0.6	3968	-0.60	-2395	23	-0.6	3968	-0.60
KHOLPETUA	26.008	-4265	-7	-0.67	6372	-0.65	-4643	86	-0.68	6863	-0.66	-4644	86	-0.68	6863	-0.66
KHOLPETUA	36.002	-6212	-7	-0.71	8800	-0.68	-6377	86	-0.69	9229	-0.66	-6377	86	-0.69	9229	-0.66
KHOLPETUA	43.500	-7392	5	-0.71	10359	-0.68	-7414	93	-0.73	10187	-0.69	-7414	93	-0.73	10187	-0.69
KHOLPETUA	50.750	-8751	5	-1.02	8593	-0.98	-8738	93	-1.03	8481	-0.99	-8738	93	-1.03	8481	-0.99
LINK-KK	0.500	-303	-12	-1.15	262	-1.31	-343	-7	-1.35	255	-1.53	-343	-7	-1.35	255	-1.53
ARPANGASIA	1.750	-18510	-42	-1.26	14655	-1.18	-18466	91	-1.27	14581	-1.19	-18466	91	-1.27	14581	-1.19
ARPANGASIA	6.000	-12509	-199	-0.77	16282	-0.72	-12475	-132	-0.77	16293	-0.71	-12474	-131	-0.77	16293	-0.71
ARPANGASIA	12.250	-14397	-200	-0.9	15917	-0.84	-14348	-133	-0.9	15919	-0.84	-14347	-133	-0.9	15919	-0.84
ARPANGASIA	21.880	-9829	-188	-0.71	13762	-0.67	-9831	-160	-0.71	13800	-0.67	-9831	-160	-0.71	13800	-0.67
ARPANGASIA	30.125	-11946	-191	-0.73	16399	-0.68	-11908	-162	-0.73	16409	-0.68	-11908	-162	-0.73	16409	-0.68
ARPANGASIA	35.995	-13666	-193	-0.85	16006	-0.80	-13651	-165	-0.85	16055	-0.79	-13651	-164	-0.85	16055	-0.79
ARPANGASIA	42.750	-31212	-306	-0.93	33657	-0.84	-31046	-220	-0.92	33657	-0.83	-31045	-219	-0.92	33657	-0.83
CHALKI GANG	2.500	-7335	156	-0.97	7537	-0.94	-7241	221	-0.97	7455	-0.94	-7242	221	-0.97	7455	-0.94
CHALKI GANG	8.750	-7862	155	-0.83	9459	-0.79	-7765	221	-0.83	9358	-0.79	-7765	221	-0.83	9358	-0.79
CHALKI GANG	14.500	-8325	155	-0.8	10380	-0.76	-8233	221	-0.8	10278	-0.76	-8234	220	-0.8	10278	-0.76
BAL	1.875	-12430	-107	-0.99	12569	-0.93	-12381	-49	-0.98	12607	-0.93	-12380	-48	-0.98	12607	-0.93
BAL	4.750	-12954	-107	-1.09	11883	-1.03	-12902	-49	-1.08	11911	-1.02	-12902	-48	-1.08	11911	-1.02
BAL	11.125	-13962	-108	-1.04	13454	-0.98	-13906	-50	-1.03	13471	-0.97	-13906	-49	-1.03	13471	-0.97
SONA KHAL	2.250	-3714	-261	-0.96	3865	-0.95	-3947	-268	-1	3941	-0.99	-3946	-267	-1	3941	-0.99
SONA KHAL	7.250	-4093	-261	-0.8	5148	-0.78	-4319	-268	-0.82	5238	-0.81	-4318	-267	-0.82	5238	-0.81
BARAPANGA	2.500	2375	-193	0.33	7206	0.32	2401	-191	0.33	7259	0.32	2401	-191	0.33	7260	0.32
BARAPANGA	6.125	2977	-194	0.43	6891	0.42	3006	-192	0.43	6932	0.42	3006	-192	0.43	6932	0.42
BARAPANGA	8.625	-3361	-195	-0.44	7686	-0.42	-3375	-192	-0.44	7723	-0.42	-3375	-192	-0.44	7723	-0.42
BARAPANGA	10.750	-3864	-195	-0.46	8326	-0.45	-3878	-193	-0.46	8358	-0.45	-3878	-193	-0.46	8358	-0.45
BETMARAGANG	2.250	-32218	-118	-0.95	33814	-0.86	-32058	-34	-0.95	33828	-0.86	-32057	-33	-0.95	33828	-0.86
BETMARAGANG	8.000	-33425	-120	-0.93	35847	-0.84	-33260	-36	-0.93	35864	-0.84	-33259	-35	-0.93	35864	-0.84
MALANCHA	2.000	-7351	-15	-0.8	9190	-0.76	-7322	24	-0.75	9829	-0.71	-7322	24	-0.74	9829	-0.71

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
MALANCHA	10.667	-8306	-16	-0.72	11464	-0.69	-8265	23	-0.72	11457	-0.68	-8265	23	-0.72	11457	-0.68
MALANCHA	24.000	-10248	-18	-0.68	14999	-0.64	-10185	20	-0.68	14991	-0.64	-10184	21	-0.68	14991	-0.64
MALANCHA	37.333	-12588	-22	-0.65	19352	-0.60	-12522	17	-0.65	19365	-0.60	-12522	17	-0.65	19365	-0.60
MALANCHA	46.750	-14334	-25	-0.58	24826	-0.53	-14263	14	-0.57	24849	-0.53	-14263	14	-0.57	24849	-0.53
MALANCHA	53.255	-6581	-152	-0.38	17486	-0.35	-6550	-140	-0.37	17509	-0.35	-6550	-140	-0.37	17509	-0.35
MALANCHA	60.000	-9457	-157	-0.6	15826	-0.56	-9453	-145	-0.6	15859	-0.56	-9453	-145	-0.6	15859	-0.56
MALANCHA-E	2.500	-14576	-74	-0.72	20300	-0.66	-14537	-46	-0.71	20339	-0.66	-14537	-45	-0.71	20339	-0.66
MALANCHA-E	9.050	-54524	-205	-0.61	89994	-0.53	-54321	-93	-0.6	90099	-0.52	-54320	-91	-0.6	90099	-0.52
HARIHAR	4.500	2	1	0.05	31	0.07	1	1	0.05			1	1	0.05		
HARIHAR	13.500	2	1	0.08	30	0.10	1	1	0.05	22	0.07	1	1	0.05	22	0.07
HARIHAR	20.750	-3	1	-0.1	26	-0.13	1	1	0.06	20	0.08	1	1	0.06	20	0.08
HARIHAR	24.250	-3	1	-0.12	24	-0.16	1	1	0.07	18	0.09	1	1	0.07	18	0.09
HARIHAR	29.000	-3	1	-0.13	27	-0.16	1	1	0.06	21	0.08	1	1	0.06	21	0.08
HARIHAR	36.250	-4	1	-0.09	40	-0.12	1	1	0.04			1	1	0.04		
BURIBHADRA	4.125	3	1	0.09	28	0.12	1	1	0.06	18	0.08	1	1	0.06	18	0.08
U_BHADRA	5.255	-7	2	-0.16	43	-0.20	2	2	0.1	23	0.13	2	2	0.1	23	0.13
U_BHADRA	12.570	-27	2	-0.38	71	-0.46	2	2	0.31	8	0.43	2	2	0.31	8	0.43
U_BHADRA	15.565	-77	2	-0.21	365	-0.24	2	2	0.96	3	1.43	2	2	0.93	3	1.37
MUKTESWARI	5.000	2	1	0.01	410	0.01	1	1	0			1	1	0		
MUKTESWARI	13.000	-5	1	-0.01	390	-0.01	1	1	0			1	1	0		
MUKTESWARI	18.000	-6	1	-0.02	280	-0.02	1	1	0.01			1	1	0.01		
MUKTESWARI	25.000	-10	1	-0.04	225	-0.05	1	1	0.04			1	1	0.04		
MUKTESWARI	35.000	-33	1	-0.34	97	-0.41	1	1	0.07	19	0.09	1	1	0.07	20	0.08
HARI	3.650	-54	1	-0.47	114	-0.56	1	1	0.07	21	0.09	2	1	0.09	17	0.12
HARI	7.650	-64	1	-0.6	108	-0.71	3	1	0.15	19	0.20	3	1	0.15	20	0.20
HARI	11.000	-79	1	-0.38	206	-0.44	4	1	0.14	31	0.18	5	1	0.14	32	0.18
M_BHADRA	17.000	-182	3	-0.42	430	-0.47	17	3	0.14	120	0.17	18	3	0.14	122	0.17
M_BHADRA	18.250	-193	3	-0.44	439	-0.48	21	3	0.18	119	0.21	22	3	0.18	122	0.21
HAMKURA	1.000	-9	1	-0.07	131	-0.08	1	1	0.03			1	1	0.03		
HAMKURA	2.250	-19	1	-0.19	100	-0.23	1	1	0.04			1	1	0.04		
HAMKURA	2.700	-23	1	-0.34	68	-0.42	1	1	0.07	14	0.09	1	1	0.07	14	0.09
HAMKURA	4.150	-29	1	-0.54	54	-0.66	1	1	0.2	5	0.28	1	1	0.2	5	0.29
HAMKURA	6.700	40	1	0.44	90	0.53	1	1	0.09	13	0.12	1	1	0.09	13	0.12
HAMKURA	9.450	-60	1	-0.38	158	-0.44	3	1	0.11	32	0.14	4	1	0.11	33	0.14
HAMKURA	12.450	-110	1	-0.49	222	-0.56	12	1	0.15	76	0.18	12	1	0.15	79	0.19
U_SOLMARI	1.700	-10	1	-0.16	65	-0.19	1	1	0.19	5	0.27	1	1	0.19	5	0.27
U_SOLMARI	4.400	-19	1	-0.24	78	-0.29	1	1	0.09	16	0.12	1	1	0.09	16	0.12
U_SOLMARI	8.700	42	1	0.35	123	0.41	10	1	0.12	81	0.14	12	1	0.1	116	0.12
U_SOLMARI	13.000	111	1	0.4	276	0.45	33	1	0.67	49	0.83	32	1	0.4	79	0.48

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
L_SOLMARI	4.250	933	-38	0.65	1438	0.67	1157	-44	0.74	1558	0.77	1155	-46	0.74	1560	0.77
SALTA	1.750	32	1	0.29	111	0.35	205	4	0.32	643	0.34	211	4	0.32	652	0.35
SALTA	6.000	8	1	0.15	50	0.19	489	4	0.41	1188	0.43	500	4	0.42	1203	0.44
RUPSA	2.097	-3360	56	-1.21	2776	-1.22	-3375	59	-1.17	2882	-1.18	-3360	72	-1.17	2883	-1.17
RUPSA	4.596	-3397	56	-0.79	4325	-0.78	-3416	60	-0.83	4109	-0.82	-3398	72	-0.83	4107	-0.82
RUPSA	5.000	-3402	56	-0.82	4129	-0.82	-3428	60	-0.87	3924	-0.87	-3410	72	-0.87	3922	-0.86
RUPSA	5.172	-4001	46	-1.07	3739	-1.06	-4029	49	-1.05	3830	-1.05	-4012	62	-1.05	3832	-1.04
RUPSA	7.922	-4100	46	-0.96	4277	-0.95	-4110	49	-0.94	4381	-0.93	-4093	62	-0.93	4383	-0.92
RUPSA	11.500	-4298	46	-0.9	4761	-0.89	-4283	49	-0.95	4494	-0.94	-4262	62	-0.95	4493	-0.94
RUPSA	13.750	-4413	46	-0.92	4792	-0.91	-4415	49	-0.98	4501	-0.97	-4393	62	-0.98	4500	-0.96
RUPSA	16.200	-4210	52	-0.91	4630	-0.90	-4257	59	-0.88	4810	-0.87	-4235	71	-0.88	4809	-0.87
GHENGRAIL	6.450	493	13	0.93	530	1.02	16	1	0.11	151	0.13	16	1	0.11	151	0.13
GHENGRAIL	7.850	557	13	0.35	1586	0.36	25	1	0.01			25	1	0.01		
GHENGRAIL	8.150	-1617	11	-0.55	2917	-0.56	89	1	0.02			88	1	0.02		
GHENGRAIL	10.150	-1758	12	-0.65	2707	-0.66	111	1	0.02			111	1	0.02		
GHENGRAIL	14.750	-2170	12	-0.6	3620	-0.60	157	1	0.01			155	1	0.01		
GHENGRAIL	18.150	-2680	12	-0.7	3836	-0.69	182	1	0.01			181	1	0.01		
GHENGRAIL	19.900	-2959	12	-0.93	3174	-0.93	212	1	0.1	2094	0.10	210	1	0.1	2091	0.10
KAZIBACHA	1.750	-3659	14	-0.75	4880	-0.74	-3581	15	-0.72	4962	-0.71	-3561	25	-0.72	4960	-0.71
KAZIBACHA	7.750	-4122	14	-0.96	4297	-0.95	-4006	15	-0.92	4371	-0.91	-3986	25	-0.91	4371	-0.90
KAZIBACHA	13.500	-2638	29	-0.73	3619	-0.73	-2430	36	-0.7	3496	-0.69	-2417	43	-0.69	3494	-0.69
DELUTI	2.500	1814	223	0.79	2283	0.81	979	132	0.45	2190	0.46	979	133	0.45	2191	0.46
DELUTI	6.250	2604	222	1.01	2583	1.02	1173	132	0.46	2542	0.47	1174	133	0.46	2543	0.47
DELUTI	8.000	2704	222	0.92	2929	0.93	1277	132	0.44	2889	0.44	1277	133	0.44	2890	0.45
SIBSA	0.450	-1026	7	-0.53	1942	-0.54	-829	4	-0.31	2655	-0.32	-829	4	-0.31	2655	-0.32
SIBSA	2.850	-1304	7	-0.46	2812	-0.47	-1087	4	-0.4	2723	-0.40	-1088	4	-0.4	2725	-0.40
SIBSA	5.212	-1466	7	-0.42	3480	-0.42	-1278	4	-0.37	3476	-0.37	-1279	4	-0.37	3476	-0.37
SIBSA	6.438	3783	229	0.58	6486	0.57	-2454	136	-0.36	6740	-0.35	-2454	137	-0.36	6744	-0.35
SIBSA	7.575	-10739	45	-1.01	10663	-0.96	-7936	34	-0.72	11077	-0.68	-7932	39	-0.72	11078	-0.68
SIBSA	11.950	-11519	45	-0.85	13540	-0.80	-8684	34	-0.61	14141	-0.58	-8679	39	-0.61	14142	-0.58
SIBSA	16.395	-16206	65	-1.04	15512	-0.98	-13823	54	-0.91	15179	-0.85	-13816	61	-0.91	15180	-0.85
SIBSA	19.352	-17295	65	-1.17	14812	-1.09	-15120	54	-1.04	14530	-0.98	-15112	61	-1.04	14531	-0.97
SIBSA	24.540	-19227	100	-1.19	16111	-1.11	-17530	78	-1.11	15844	-1.03	-17522	85	-1.11	15846	-1.03
SIBSA	27.728	-20202	100	-1.13	17925	-1.05	-18693	78	-1	18785	-0.92	-18686	84	-0.99	18787	-0.92
SIBSA	28.395	-20493	100	-1.09	18777	-1.01	-19011	77	-0.96	19726	-0.89	-19004	84	-0.96	19728	-0.89
SIBSA	29.520	-23023	72	-1.14	20120	-1.06	-21729	44	-1.04	20983	-0.96	-21722	51	-1.04	20984	-0.96
SIBSA	31.528	-23506	72	-1.08	21766	-0.99	-22247	44	-0.98	22628	-0.90	-22239	51	-0.98	22630	-0.90
SIBSA	33.638	-24213	71	-1.09	22300	-1.00	-23102	43	-1.07	21661	-0.98	-23097	51	-1.07	21663	-0.98
SIBSA	36.138	-25034	71	-1.22	20522	-1.13	-24129	43	-1.2	20029	-1.11	-24124	50	-1.2	20031	-1.11

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
SIBSA	41.390	-25884	71	-1.17	22199	-1.07	-25193	43	-1.16	21784	-1.07	-25188	50	-1.16	21785	-1.07
SIBSA	46.765	-26986	70	-0.92	29275	-0.84	-26509	42	-0.93	28590	-0.84	-26503	49	-0.93	28591	-0.84
SIBSA	49.046	-28018	69	-0.9	31270	-0.81	-27710	41	-0.91	30460	-0.83	-27704	48	-0.91	30462	-0.83
SIBSA	51.914	-28853	68	-0.98	29576	-0.89	-28668	40	-1	28746	-0.91	-28662	48	-1	28747	-0.91
SIBSA	55.414	-30359	67	-1.02	29624	-0.93	-30350	39	-1.06	28589	-0.97	-30343	46	-1.06	28590	-0.97
SIBSA	58.252	-31515	66	-0.98	32263	-0.89	-31667	38	-1.02	31193	-0.92	-31661	45	-1.01	31194	-0.92
SIBSA	60.252	-29545	325	-0.85	34859	-0.77	-29745	305	-0.89	33597	-0.80	-29740	311	-0.89	33597	-0.80
SIBSA	62.302	-30167	324	-0.96	31523	-0.87	-30452	304	-1	30349	-0.91	-30447	310	-1	30349	-0.91
SIBSA	65.652	-30987	323	-0.97	31899	-0.88	-31393	303	-1.02	30693	-0.93	-31387	309	-1.02	30693	-0.93
SIBSA	68.902	-31972	322	-0.95	33636	-0.86	-32458	302	-0.94	34464	-0.85	-32452	308	-0.94	34464	-0.85
SIBSA	72.652	-32963	321	-0.95	34530	-0.86	-33504	300	-0.95	35347	-0.86	-33497	307	-0.95	35346	-0.86
SIBSA	75.798	-33804	320	-0.96	35313	-0.86	-34380	299	-0.95	36119	-0.86	-34374	305	-0.95	36119	-0.86
SIBSA	77.986	-34382	319	-0.95	36224	-0.86	-34981	298	-0.94	37036	-0.85	-34974	305	-0.94	37036	-0.85
SIBSA	81.961	-36000	316	-0.97	37283	-0.87	-36653	296	-0.96	38069	-0.87	-36647	302	-0.96	38069	-0.87
PUSSUR	4.209	-3984	33	-0.57	6984	-0.55	-3340	40	-0.47	7139	-0.45	-3324	45	-0.46	7150	-0.45
PUSSUR	12.626	-6090	35	-0.76	8035	-0.73	-5652	40	-0.69	8172	-0.66	-5639	45	-0.69	8176	-0.66
PUSSUR	21.587	-10882	-26	-1.02	10670	-0.97	-10783	-24	-0.98	10951	-0.93	-10770	-9	-0.98	10961	-0.93
PUSSUR	30.565	-12788	-26	-0.85	15001	-0.80	-12847	-25	-0.84	15299	-0.79	-12836	-10	-0.84	15308	-0.78
PUSSUR	39.015	-14565	-27	-0.86	16861	-0.80	-14627	-26	-0.86	16963	-0.80	-14613	-11	-0.86	16965	-0.80
PUSSUR	48.885	-17398	-28	-0.96	18115	-0.89	-17566	-27	-0.97	18161	-0.90	-17553	-12	-0.97	18162	-0.90
PUSSUR	60.262	-21054	-31	-1.12	18826	-1.04	-21421	-30	-1.02	21096	-0.94	-21410	-15	-1.01	21099	-0.94
PUSSUR	71.728	-24658	-35	-1.09	22557	-1.01	-25154	-34	-1.11	22634	-1.02	-25144	-19	-1.11	22636	-1.02
PUSSUR	78.835	-26977	-39	-0.81	33490	-0.73	-27475	-38	-0.82	33503	-0.74	-27465	-23	-0.82	33504	-0.74
PUSSUR	81.335	-63468	275	-1.28	49450	-1.14	-64393	255	-1.29	49981	-1.15	-64374	276	-1.29	49979	-1.15
PUSSUR	84.585	-64991	272	-1.14	56905	-1.01	-65942	252	-1.15	57478	-1.02	-65923	273	-1.15	57477	-1.02
PUSSUR	88.960	-67536	267	-1.01	66942	-0.89	-68518	247	-1.01	67570	-0.89	-68499	268	-1.01	67569	-0.89
PUSSUR	94.710	-74871	252	-0.94	79252	-0.83	-75909	233	-0.95	79906	-0.83	-75889	254	-0.95	79905	-0.83
ATAI	10.250	-2643	110	-1.28	2063	-1.31	-2669	113	-1.26	2113	-1.29	-2657	125	-1.26	2114	-1.28
NABAGANGA_L	27.500	-2667	53	-0.65	4087	-0.65	-2666	56	-0.64	4191	-0.63	-2653	69	-0.63	4199	-0.63
MAJUDKHALI	0.500	-164	-57	-0.35	471	-0.38	-168	-57	-0.34	491	-0.37	-165	-56	-0.34	489	-0.37
MAJUDKHALI	1.500	-163	-57	-0.36	456	-0.39	-166	-57	-0.35	474	-0.38	-164	-56	-0.35	473	-0.38
MAJUDKHALI	4.250	-165	-57	-0.38	431	-0.42	-165	-57	-0.37	442	-0.41	-164	-56	-0.37	444	-0.41
NABAGANGA_M	4.250	-1650	37	-0.81	2028	-0.83	-1669	42	-0.8	2076	-0.82	-1660	54	-0.8	2077	-0.82
NABAGANGA_M	12.875	-2005	49	-0.84	2379	-0.86	-2024	53	-0.83	2430	-0.85	-2007	65	-0.83	2431	-0.84
NABAGANGA_M	21.625	-2149	49	-0.86	2487	-0.88	-2150	53	-0.85	2540	-0.86	-2136	65	-0.84	2546	-0.85
KATAKHALI-SW	6.750	169	-11	0.59	287	0.66	174	-11	0.57	304	0.64	175	-11	0.57	306	0.64
KATAKHALI-SW	20.250	99	-11	0.31	317	0.35	100	-11	0.36	275	0.41	100	-11	0.36	276	0.41
TELIGATI	1.150	-279	6	-0.6	467	-0.66	0	0				0	1			
TELIGATI	4.900	-342	6	-0.79	433	-0.87	7	0	0.02			7	0	0.02		

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
CHUNKURI	1.650	1658	-5	0.91	1816	0.94	1811	-9	0.98	1849	1.01	1812	-6	0.98	1848	1.01
CHUNKURI	4.650	1731	-4	0.69	2522	0.70	1895	-9	0.73	2581	0.74	1896	-6	0.73	2580	0.74
DHAKI	2.250	1253	23	1.02	1223	1.07	-1352	24	-0.97	1393	-1.01	-1350	25	-0.97	1393	-1.01
DHAKI	6.500	1395	23	1.17	1196	1.22	1506	24	1.29	1170	1.35	1507	25	1.29	1170	1.35
DHAKI	10.250	1512	23	0.95	1597	0.98	1634	24	1.06	1548	1.09	1635	25	1.06	1548	1.09
DHAKI	13.000	1711	23	0.91	1875	0.94	-1858	24	-0.72	2573	-0.73	-1857	25	-0.72	2575	-0.73
SUTARKHALI	2.000	-702	-27	-0.71	984	-0.76	-786	-32	-0.85	926	-0.90	-785	-32	-0.85	926	-0.90
SUTARKHALI	6.150	-817	-27	-0.79	1038	-0.83	-927	-32	-0.78	1183	-0.82	-925	-32	-0.78	1182	-0.82
SUTARKHALI	8.800	-902	-27	-0.79	1149	-0.83	-1003	-32	-0.77	1304	-0.80	-1001	-32	-0.77	1304	-0.80
SUTARKHALI	11.235	-960	-27	-0.64	1493	-0.67	-1050	-32	-0.68	1553	-0.70	-1050	-32	-0.68	1553	-0.70
SUTARKHALI	14.200	-1193	-27	-0.72	1647	-0.75	-1284	-33	-0.77	1674	-0.79	-1284	-32	-0.77	1674	-0.79
SUTARKHALI	16.290	-1304	-27	-0.75	1746	-0.77	-1403	-33	-0.79	1769	-0.82	-1403	-32	-0.79	1769	-0.82
SUTARKHALI	18.160	-1448	-27	-0.81	1790	-0.83	-1555	-33	-0.86	1814	-0.88	-1554	-32	-0.86	1814	-0.88
SUTARKHALI	19.720	-1541	-27	-0.78	1969	-0.80	-1657	-33	-0.83	1996	-0.85	-1656	-32	-0.83	1996	-0.85
SUTARKHALI	21.385	-1648	-27	-0.76	2166	-0.78	-1773	-33	-0.81	2192	-0.82	-1773	-32	-0.81	2192	-0.82
SUTARKHALI	23.300	-1761	-27	-1.07	1649	-1.10	-1868	-33	-0.98	1912	-1.00	-1867	-32	-0.98	1912	-1.00
SUTARKHALI	26.050	-1997	-27	-0.94	2127	-0.96	-2124	-33	-0.99	2150	-1.01	-2124	-32	-0.99	2150	-1.01
SUTARKHALI	27.900	-2111	-27	-0.84	2526	-0.85	-2257	-33	-0.88	2556	-0.89	-2256	-32	-0.88	-2556	-0.89
L_SALTA	12.250	-1295	40	-0.76	1707	-0.78	-1460	49	-0.86	1698	-0.89	-1458	51	-0.86	1698	-0.89
L_BHADRA	4.250	-1697	40	-0.8	2111	-0.82	-1920	49	-0.85	2267	-0.86	-1918	51	-0.85	2268	-0.86
L_BHADRA	9.650	-1980	40	-0.73	2697	-0.74	-2225	49	-0.83	2674	-0.84	-2224	51	-0.83	2675	-0.84
L_BHADRA	11.400	-2125	40	-0.78	2736	-0.78	-2356	49	-0.78	3027	-0.78	-2354	51	-0.78	3028	-0.78
JHAPJHAPIA	4.750	10	1	0.09	110	0.11	-14	1	-0.09	155	-0.10	-14	1	-0.09	154	-0.10
MANGA	3.000	-2281	-13	-1.09	2097	-1.11	-2659	-20	-1.3	2040	-1.33	-2656	-16	-1.3	2040	-1.33
MANGA	6.150	-2356	-13	-0.92	2561	-0.93	-2736	-20	-1.04	2642	-1.05	-2733	-16	-1.03	2643	-1.05
JHAPJH-MANGA	1.250	-2132	-15	-1.47	1448	-1.53	-2536	-21	-1.79	1414	-1.87	-2533	-17	-1.79	1415	-1.86
HABARKHALI	4.125	-4212	-171	-1.06	3977	-1.05	-2146	-83	-0.51	4213	-0.50	-2144	-81	-0.51	4212	-0.50
BADURGACHA	1.950	-2444	-13	-1.05	2336	-1.06	-2813	-20	-1.16	2424	-1.18	-2809	-16	-1.16	2424	-1.18
BADURGACHA	6.700	-2673	-13	-1.24	2156	-1.26	-3081	-20	-1.41	2182	-1.44	-3079	-16	-1.41	2184	-1.44
GUNKHALI	0.500						0	0				0	0			
GUNKHALI	4.250	551	-1	0.77	719	0.82	0	0				0	0			
HARIA	0.500	-51	-7	-0.53	96	-0.63	0	0				0	0			
HARIA	6.850	-112	-7	-0.23	487	-0.25	0	0				0	0			
HARIA	13.100	-547	-6	-0.9	607	-0.98	0	0				0	0			
HARIA	15.350	471	-14	0.38	1250	0.39	694	-4	0.56	1235	0.59	694	-4	0.56	1235	0.59
HARIA	17.850	-358	-14	-0.37	982	-0.39	577	-4	0.35	1640	0.36	577	-4	0.35	1640	0.36
MINAJNADI	4.250	-495	-4	-0.33	1497	-0.34	-522	-3	-0.36	1441	-0.38	-522	-3	-0.36	1442	-0.38
MINAJNADI	12.750	-1046	-4	-0.67	1552	-0.70	-1134	-2	-0.69	1639	-0.72	-1135	-2	-0.69	1639	-0.72
SALTA(W)	5.750	-63	-7	-0.46	137	-0.54	0	0				0	0			

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
SALTA(W)	17.250	-224	-7	-0.37	608	-0.40	0	0				0	0			
SALTA(W)	23.200	-425	-7	-0.68	628	-0.73	0	0				0	0			
SALTA(W)	23.400	-398	-1	-0.65	611	-0.71	0	0				0	0			
SALTA(W)	23.600	-402	-1	-0.66	606	-0.72	0	0				0	0			
SALTA(W)	24.400	421	-1	0.75	562	0.81	0	0				0	0			
BHANGARIA	1.125	8	0	0.12	62	0.15	0	0				0	0			
BHADRA	19.500	63	-2	0.11	597	0.12	28	3	0.12	243	0.13	29	3	0.12	247	0.13
BHADRA	20.625	-50	-2	-0.09	556	-0.10	33	3	0.15	212	0.18	34	3	0.16	215	0.18
BHADRA	22.375	-125	-2	-0.44	282	-0.50	42	3	0.18	226	0.21	43	3	0.19	228	0.21
BHADRA	24.150	-158	-2	-0.24	649	-0.26	50	3	0.21	240	0.24	52	3	0.24	216	0.28
BHADRA	24.950	-172	-2	-0.25	683	-0.27	58	3	0.26	227	0.29	60	3	0.26	231	0.30
BHADRA	25.100	-175	-2	-0.18	975	-0.19	60	3	0.26	230	0.30	62	3	0.26	234	0.30
BHADRA	26.800	-355	-1	-0.42	835	-0.45	100	4	0.37	269	0.42	103	4	0.38	274	0.42
BHADRA	29.600	-612	-2	-0.61	994	-0.65	0	0				0	0			
BHADRA	31.350	-776	-2	-0.77	1014	-0.81	-17	0	-0.01			-17	0	-0.01		
BHADRA	34.100	-908	-2	-0.7	1302	-0.73	-37	0	0			-37	0	0		
BHADRA	36.850	-1062	-2	-0.74	1426	-0.77	56	0	0.03			55	0	0.03		
MADHUMATI	88.500	38	35	0.14	267	0.16	38	35	0.15	258	0.17	38	35	0.15	259	0.17
MADHUMATI	101.500	41	35	0.14	291	0.16	41	35	0.14	289	0.16	41	35	0.14	290	0.16
MADHUMATI	114.917	50	35	0.13	373	0.15	50	35	0.14	371	0.15	51	35	0.14	374	0.15
MADHUMATI	128.750	87	35	0.12	737	0.13	85	35	0.12	726	0.13	85	35	0.12	731	0.13
MADHUMATI	142.583	186	36	0.15	1275	0.15	184	34	0.15	1243	0.15	185	34	0.15	1242	0.16
MADHUMATI	153.250	-710	38	-0.39	1840	-0.40	-719	35	-0.38	1881	-0.39	-724	35	-0.38	1890	-0.39
MADHUMATI	161.750	-801	38	-0.26	3108	-0.26	-810	34	-0.25	3188	-0.25	-814	34	-0.25	3201	-0.25
MADHUMATI	174.000	-1299	38	-0.44	2959	-0.44	-1307	34	-0.43	3048	-0.43	-1308	34	-0.43	3058	-0.43
MADHUMATI	182.000	155	1	0.15	1068	0.15	156	-8	0.14	1112	0.15	-168	-20	-0.15	1108	-0.16
MADHUMATI	188.125	77	1	0.3	253	0.34	79	-8	0.27	297	0.30	-79	-20	-0.25	319	-0.28
MADHUMATI	199.375	31	1	0.12	260	0.13	34	-8	0.1	332	0.11	-50	-21	-0.15	332	-0.17
MADHUMATI	205.700	66	30	0.32	203	0.37	114	70	0.44	259	0.50	73	42	0.2	372	0.22
MADHUMATI	206.700	68	30	0.19	363	0.21	116	70	0.29	402	0.32	74	42	0.13	555	0.14
MADHUMATI	207.250	71	30	0.1	714	0.11	119	71	0.16	736	0.17	74	42	0.08	889	0.09
MADHUMATI	211.250						138	70	0.14	1008	0.14	80	42	0.07	1112	0.08
MADHUMATI	216.000											13		0.01		
MADHUMATI	214.312	106	30	0.11	982	0.11	157	58	0.15	1073	0.15	0				
MADHUMATI	227.938	163	30	0.15	1086	0.16	220	58	0.19	1186	0.19	-95		-0.09	1031	-0.10
MADHUMATI	241.562	227	30	0.18	1240	0.19	276	58	0.21	1311	0.22	-207		-0.19	1110	-0.20
MADHUMATI	255.188	-309	30	-0.21	1465	-0.22	316	58	0.23	1388	0.24	-316		-0.23	1390	-0.24
DAUDKHALI	2.838	-399	12	-0.2	1971	-0.21	-418	16	-0.19	2154	-0.20	-404	34	-0.18	2234	-0.18
DAUDKHALI	7.938	-518	12	-0.26	1981	-0.27	-510	16	-0.26	1952	-0.27	-497	34	-0.25	1975	-0.26

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Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
DAUDKHALI	10.202	-331	11	-0.14	2435	-0.14	-343	14	-0.14	2452	-0.14	-337	23	-0.14	2475	-0.14
DAUDKHALI	12.886	-412	11	-0.3	1361	-0.32	-406	14	-0.28	1442	-0.29	-398	23	-0.27	1451	-0.28
DAUDKHALI	16.909	-440	12	-0.48	909	-0.51	-433	14	-0.48	908	-0.51	-422	23	-0.46	908	-0.49
DAUDKHALI	21.035	-527	12	-0.52	1006	-0.55	-520	14	-0.52	1008	-0.55	-510	23	-0.5	1012	-0.53
DAUDKHALI	26.605	-577	12	-0.38	1527	-0.39	-567	14	-0.37	1529	-0.38	-559	23	-0.36	1535	-0.38
KUMARKHALI	5.125	-1112	-75	-0.59	1872	-0.61	-1163	-79	-0.61	1911	-0.62	-1160	-78	-0.6	1920	-0.62
M.G.CANAL	3.750	-1347	-76	-0.67	2019	-0.68	-1384	-82	-0.67	2052	-0.69	-1396	-90	-0.68	2059	-0.69
BISHNU	5.000	-468	1	-0.47	1006	-0.49	-463	3	-0.45	1025	-0.48	-457	11	-0.44	1036	-0.47
MONGLA NULLA	5.425	-2039	-62	-0.75	2732	-0.75	-2094	-64	-0.76	2772	-0.76	-2088	-54	-0.75	2776	-0.76
MONGLA NULLA	12.550	-2698	-62	-0.91	2960	-0.92	-2728	-64	-0.93	2924	-0.94	-2718	-54	-0.93	2921	-0.94
NALUA NULLAH	5.406	-381	-4	-0.39	976	-0.41	-381	-8	-0.39	981	-0.41	-379	-7	-0.39	982	-0.41
NALUA NULLAH	11.032	-503	-4	-0.51	989	-0.54	-508	-8	-0.51	1002	-0.54	-507	-7	-0.51	1003	-0.53
OLD PUSSUR	2.938	-95	1	-0.16	609	-0.17	-97	1	-0.17	579	-0.18	-98	1	-0.17	579	-0.18
OLD PUSSUR	13.700	-494	1	-0.5	990	-0.53	-527	1	-0.5	1060	-0.52	-529	1	-0.5	1063	-0.52
OLD PUSSUR	22.012	-1296	2	-0.74	1759	-0.76	-1390	2	-0.74	1870	-0.76	-1393	2	-0.74	1872	-0.76
OLD PUSSUR	23.512	-1821	-2	-0.75	2425	-0.76	-1892	-6	-0.75	2512	-0.76	-1894	-5	-0.75	2515	-0.76
OLD PUSSUR	27.262	-2175	-2	-0.86	2532	-0.87	-2286	-6	-0.87	2630	-0.88	-2289	-5	-0.87	2632	-0.88
POYLAHARA	5.000	-26	1	-0.02	1143	-0.02	-98	12	-0.13	737	-0.14	99	41	0.18	545	0.20
POYLAHARA	8.500						-125	12	-0.15	807	-0.17	113	41	0.18	627	0.20
POYLAHARA	15.000	185	1	0.15	1202	0.16	-178	12	-0.2	901	-0.21	148	40	0.2	722	0.22
POYLAHARA	24.750	267	4	0.16	1664	0.17	255	9	0.16	1619	0.16	287	17	0.17	1687	0.18
POYLAHARA	34.250	534	4	0.21	2503	0.22	-521	9	-0.25	2081	-0.26	-539	17	-0.25	2118	-0.26
LINKTOPOYLAH	5.500						53	12	0.11	481	0.12	95	41	0.17	576	0.18
LINKTOPOYLAH	16.500						-59	12	-0.12	482	-0.13	93	41	0.18	507	0.20
GASHIAKHALI	5.250	2167	81	0.56	3855	0.56	2209	92	0.57	3855	0.57	2225	107	0.58	3846	0.57
GASHIAKHALI	15.750	-3086	82	-0.61	5054	-0.60	-3089	92	-0.61	5054	-0.60	-3080	107	-0.61	5056	-0.60
GASHIAKHALI	22.250	-3882	82	-0.62	6238	-0.61	-3885	92	-0.62	6238	-0.61	-3874	107	-0.62	6235	-0.60
BHAIRAB	4.250	15	0	0.36	42	0.45	19	0	0.46	42	0.57	14	-1	0.29	49	0.36
BHAIRAB	12.750	-10	0	-0.16	64	-0.19	10	0	0.12	87	0.14	-11	-1	-0.15	75	-0.18
BHAIRAB L	5.250	106	-15	0.47	225	0.54	112	-14	0.42	264	0.48	110	-10	0.48	231	0.54
ATHAROBANKI	5.333	-1	0	-0.08	7	-0.11		0				1	0			
ATHAROBANKI	16.000	-1	0	-0.06	26	-0.07	-1	0	-0.05	28	-0.06	-2	0	-0.04		
ATHAROBANKI	26.667	-16	0	-0.15	109	-0.18	-19	0	-0.16	117	-0.19	-20	0	-0.16	124	-0.19
ATHAROBANKI	38.130	126	-11	0.14	900	0.15	118	-11	0.14	854	0.15	116	-11	0.14	845	0.15
ATHAROBANKI	51.250	-421	-11	-0.54	783	-0.58	-432	-11	-0.54	808	-0.57	-432	-10	-0.53	810	-0.57
BALESWAR	5.000	-4	0	-0.07	60	-0.08	5	0	0.08	65	0.09	-4	0	-0.07	60	-0.08
BALESWAR	15.000	-2	0	-0.04	41	-0.05	-2	0	-0.04			-2	0	-0.04		
BALESWAR	20.005	-22	-3	-0.18	120	-0.21	25	-2	0.16	152	0.19	-23	-4	-0.2	116	-0.23
BALESWAR	27.508	-12	-3	-0.08	153	-0.09	-12	-2	-0.08	152	-0.09	-13	-4	-0.09	146	-0.11

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
BALESWAR	42.502	-43	-3	-0.21	202	-0.24	-44	-2	-0.24	181	-0.28	-46	-4	-0.25	182	-0.29
BALESWAR	50.005	-186	-17	-1.1	169	-1.28	-156	-16	-1.01	154	-1.18	-157	-14	-0.99	158	-1.15
BALESWAR	57.005	-254	-17	-0.45	559	-0.49	-201	-16	-0.35	569	-0.38	-200	-14	-0.35	573	-0.38
BALESWAR	68.625	-777	-17	-0.62	1258	-0.65	-778	-15	-0.62	1258	-0.65	-774	-13	-0.61	1258	-0.64
BALESWAR	77.875	-1379	-17	-0.53	2588	-0.54	-1381	-15	-0.53	2583	-0.54	-1373	-13	-0.53	2587	-0.54
BALESWAR	82.505	55486	930	-0.85	-65423	0.00	10309	940	1.15	8970	1.10	10206	899	1.14	8951	1.09
BALESWAR	87.755	10914	930	0.69	15918	0.64	10950	941	0.69	15947	0.64	10855	899	0.68	15900	0.64
BALESWAR	95.625	11840	931	0.7	17001	0.65	11868	941	0.7	17013	0.65	11779	900	0.69	16985	0.65
BALESWAR	103.625	-17294	1013	-0.85	20286	-0.79	-17285	1033	-0.85	20288	-0.79	-17305	1007	-0.85	20279	-0.79
BALESWAR	110.250	-19986	1012	-0.93	21512	-0.86	-19980	1032	-0.93	21515	-0.86	-19998	1006	-0.93	21507	-0.86
BALESWAR	113.375	-21453	1011	-0.89	24094	-0.82	-21447	1031	-0.89	24098	-0.82	-21466	1005	-0.89	24090	-0.82
BALESWAR	120.375	-25490	1008	-0.88	28999	-0.80	-25483	1028	-0.88	29002	-0.80	-25504	1002	-0.88	28998	-0.80
KALIGANGA1	5.000	-36	-2	-0.11	326	-0.12	43	-2	0.12	367	0.13	-37	-3	-0.11	323	-0.13
KALIGANGA	6.550	-402	30	-0.26	1535	-0.27	387	58	0.28	1366	0.30	-431	0	-0.28	1528	-0.29
KALIGANGA	17.450	-536	32	-0.35	1551	-0.36	-507	60	-0.32	1600	-0.33	-560	4	-0.36	1541	-0.38
KALIGANGA	26.150	-707	33	-0.37	1896	-0.38	-669	60	-0.39	1724	-0.40	-777	4	-0.4	1954	-0.41
KOCHA	1.600	-7761	946	-0.76	10211	-0.72	7776	954	0.86	9008	0.83	-7754	911	-0.76	10186	-0.72
KOCHA	4.800	8269	946	0.98	8470	0.94	8284	954	0.98	8476	0.94	8186	911	0.97	8451	0.93
KOCHA	8.000	8763	946	0.87	10106	0.83	8777	954	0.87	10107	0.83	8680	911	0.86	10088	0.82
KOCHA	12.300	9320	946	0.61	15204	0.57	9333	955	0.61	15200	0.57	9236	912	0.61	15180	0.57
HATIA	2.700	3	1	0.01	235	0.02	2	1	0.01			2	1	0.01		
HATIA	7.700	20	1	0.09	228	0.10	18	1	0.07	252	0.08	18	1	0.07	252	0.08
HATIA	11.000	23	1	1.15	20	1.51	22	1	1.21	18	1.59	22	1	1.21	18	1.59
BEGABATI	54.200	1	1	0.02	62	0.02	1	1	0.02			1	1	0.02		
BEGABATI	67.200	1	1	0.03	52	0.03	1	1	0.02			1	1	0.02		
AFRAKHAL	4.875	-36	2	-0.25	144	-0.30	-37	2	-0.25	150	-0.29	-37	2	-0.25	150	-0.29
AFRAKHAL	14.625	-57	2	-0.25	228	-0.28	-58	2	-0.25	236	-0.28	-58	2	-0.25	237	-0.28
AFRAKHAL	20.750	-71	2	-0.26	273	-0.29	-72	2	-0.26	282	-0.29	-73	2	-0.26	283	-0.29
AFRAKHAL	25.255	-65	2	-0.25	266	-0.28	-66	1	-0.24	275	-0.27	-66	1	-0.24	275	-0.27
AFRAKHAL	32.255	-80	2	-0.23	348	-0.26	-82	1	-0.23	358	-0.25	-82	1	-0.23	359	-0.25
BHAIRAB U	6.642	2	1	0.04	50	0.05	2	1	0.04			2	1	0.04		
BHAIRAB U	19.926	3	1	0.06	49	0.08	3	1	0.06	48	0.08	3	1	0.06	48	0.08
BHAIRAB U	33.211	3	1	0.07	48	0.09	3	1	0.07	48	0.09	3	1	0.07	48	0.09
BHAIRAB U	46.495	4	1	0.09	47	0.11	4	1	0.09	46	0.11	4	1	0.09	47	0.11
BHAIRAB U	59.779	5	1	0.1	47	0.13	5	1	0.11	46	0.14	5	1	0.11	46	0.14
BHAIRAB U	73.064	-7	1	-0.15	49	-0.18	-7	1	-0.14	51	-0.18	-7	1	-0.14	52	-0.18
BHAIRAB U	86.348	-12	1	-0.23	54	-0.28	-12	1	-0.22	56	-0.27	-12	1	-0.22	56	-0.27
BHAIRAB U	98.000	-121	3	-0.31	389	-0.34	-123	2	-0.31	400	-0.34	-123	2	-0.31	401	-0.34
BHAIRAB U	108.000	-158	3	-0.38	412	-0.42	-160	2	-0.38	425	-0.42	-161	2	-0.38	426	-0.42

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Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
BHAIRAB U	118.000	-218	3	-0.47	462	-0.52	-221	2	-0.5	442	-0.55	-221	2	-0.5	443	-0.55
BHAIRAB U	130.000	-503	-55	-0.59	851	-0.63	-510	-54	-0.58	883	-0.62	-509	-53	-0.58	884	-0.61
GOBRAKHAL	4.500	-22	0	-0.37	59	-0.45	-22	0	-0.35	62	-0.43	-22	0	-0.39	57	-0.49
KUMARK	28.250	1	1	0.04	23	0.06	1	1	0.05			1	1	0.05		
KUMARK	40.750	1	1	0.05	20	0.07	1	1	0.05	21	0.07	1	1	0.05	21	0.07
KUMARK	53.250	1	1	0.06	18	0.07	1	1	0.06	19	0.08	1	1	0.06	19	0.08
KUMARK	65.750	1	1	0.03	31	0.04	1	1	0.04			1	1	0.04		
KUMARK	78.758	2	2	0.04	52	0.05	2	2	0.04			2	2	0.04		
KUMARK	92.252	2	2	0.04	48	0.05	2	2	0.04			2	2	0.04		
KUMARK	103.250	2	2	0.02	130	0.02	2	2	0.01			2	2	0.01		
KUMARK	111.750	2	2	0.01	308	0.01	2	2	0.01			2	2	0.01		
KALIGANGA U	11.167	1	1	0.13	8	0.17	1	1	0.13	8	0.18	1	1	0.13	8	0.18
KALIGANGA U	23.500	1	1	0.15	7	0.21	1	1	0.16	7	0.22	1	1	0.16	7	0.22
KALIGANGA U	35.833	1	1	0.04	27	0.05	1	1				1	1			
CHITRA	55.233	1	1	0.2	5	0.28	1	1	0.2	5	0.28	1	1	0.2	5	0.28
CHITRA	65.700	1	1	0.2	5	0.28	1	1	0.19	5	0.27	1	1	0.19	5	0.27
CHITRA	76.167	1	1	0.18	6	0.25	1	1	0.19	6	0.26	1	1	0.18	6	0.26
CHITRA	88.050	-3	1	-0.07	41	-0.09	-3	1	-0.06	44	-0.08	-3	1	-0.07	45	-0.08
CHITRA	101.350	-15	1	-0.16	95	-0.19	-15	1	-0.16	96	-0.19	-15	1	-0.16	97	-0.19
CHITRA	125.750	-221	3	-0.36	609	-0.39	-228	3	-0.36	637	-0.39	-229	3	-0.36	639	-0.39
CHITRA	137.250	-286	3	-0.56	508	-0.62	-291	3	-0.59	490	-0.65	-291	3	-0.59	491	-0.65
CHITRA	147.258	-366	4	-0.72	510	-0.79	-372	3	-0.71	525	-0.77	-372	3	-0.71	526	-0.77
CHITRA	155.752	-421	4	-0.67	623	-0.73	-429	3	-0.67	643	-0.72	-430	3	-0.67	643	-0.72
NABAGANGA_U	49.000	1	1	0.04	23	0.06	1	1	0.04			1	1	0.04		
NABAGANGA_U	63.000	1	1	0.05	22	0.06	1	1	0.05			1	1	0.05		
NABAGANGA_U	77.000	1	1	0.05	21	0.06	1	1	0.05			1	1	0.05		
NABAGANGA_U	91.000	1	1	0.05	18	0.07	1	1	0.06	18	0.07	1	1	0.06	18	0.07
NABAGANGA_U	104.258	3	3	0.04	72	0.05	3	3	0.04			3	3	0.04		
NABAGANGA_U	116.752	3	3	0.09	35	0.11	3	3	0.08	34	0.10	3	3	0.08	34	0.10
NABAGANGA_U	128.250	-17	3	-0.08	214	-0.09	-22	3	-0.11	197	-0.13	-18	3	-0.1	179	-0.12
NABAGANGA_U	138.750	-99	3	-0.25	389	-0.28	-97	3	-0.25	393	-0.27	-98	3	-0.23	424	-0.25
NABAGANGA_U	147.005	29	0	0.18	157	0.21	32	0	0.16	199	0.19	32	0	0.16	198	0.19
NABAGANGA_U	157.000	9	0	0.1	89	0.12	9	0	0.09	93	0.11	9	0	0.1	85	0.12
NABAGANGA_U	171.000	-25	0	-0.19	135	-0.22	-25	0	-0.2	128	-0.23	-26	0	-0.2	128	-0.23
CHANDANA	32.250	1	1	0.23	5	0.32	1	1	0.22	5	0.32	1	1	0.22	5	0.32
CHANDANA	45.950	1	1	0.44	3	0.64	1	1	0.44	3	0.64	1	1	0.44	3	0.64
KUMAR	8.995	1	1	0.01	76	0.02	2	1	0.02			2	1	0.02		
KUMAR	14.200	1	1	0.02	52	0.02	1	1	0.03			2	1	0.03		
KUMAR	25.275	1	0	0.01	49	0.01	0	0				0	0			

Table C 4 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
KUMAR	37.025	0	0	0.01	46	0.01	0	0				0	0			
KUMAR	48.608	0	0	0.01	39	0.01	0	0				0	0			
KUMAR	60.025	0	0	0.01	29	0.01	0	0				-1	0			
KUMAR	71.442	0	0	-0.01	40	-0.01	-1	0				-1	0	-0.03		
KUMAR	83.580	-5	1	-0.04	132	-0.04	-5	1	-0.04			-9	0	-0.06	149	-0.07
KUMAR	94.650	-7	1	-0.07	113	-0.08	-8	1	-0.07	125	-0.08	-13	0	-0.09	143	-0.11
KUMAR	103.950	-11	1	-0.06	206	-0.06	-12	1	-0.05	223	-0.06	-23	0	-0.09	241	-0.11
KUMAR	112.105	72	28	0.1	734	0.11	136	79	0.18	775	0.19	115	63	0.14	819	0.15
KUMARF1	6.525	1	0	0.07	9	0.10	1	1	0.1	11	0.13	1	1	0.12	12	0.16
KUMARF1	19.575	-1	0	-0.1	11	-0.13	1	1	0.14	8	0.19	1	1	0.17	9	0.23
KUMAR NADI	6.250	1	1	0.01	82	0.02	2	1	0.02			2	1	0.01		
KUMAR NADI	18.750	1	1	0.01	53	0.02	2	1	0.02			1	1	0.02		
KUMAR NADI	30.262	1	1	0.02	33	0.03	1	1	0.03			1	0	0.02		
KUMAR NADI	40.788	1	0	0.04	23	0.05	1	1	0.04			-2	0	-0.04		
SITALAKHYA	6.200	2	1	0.02	87	0.03	1	1	0.01			1	1			
SITALAKHYA	18.600	2	1	0.02	85	0.02	1	1				1	0			
SITALAKHYA	30.100	1	1	0.02	74	0.02	1	1				1	0	0.01		
SITALAKHYA	40.700	1	1	0.02	68	0.02	1	0	0.02			-2	0	-0.02		
SITALAKHYA	51.858	-1	0	-0.01	43	-0.02	-2	-1	-0.04			-3	-1	-0.04		
SITALAKHYA	63.552	-2	0	-0.03	87	-0.03	-4	-1	-0.03			-4	-1	-0.03		
KUMAR-CONN	2.000	3	2	0.28	12	0.38	3	2	0.23	12	0.31	3	2	0.21	13	0.28
MBR	7.500	53	28	0.14	368	0.16	125	79	0.3	417	0.33	106	64	0.24	436	0.27
MBR	22.500	59	28	0.11	526	0.12	127	78	0.23	558	0.25	108	64	0.19	581	0.20
BARASIA_ARBT	6.375	-118	2	-0.06	1904	-0.06	-117	2	-0.06	1854	-0.06	-118	2	-0.07	1756	-0.07
BARASIA_ARBT	19.125	-250	2	-0.15	1708	-0.15	-251	1	-0.15	1643	-0.16	-253	1	-0.15	1652	-0.16
BARASIA_ARBT	31.875	-333	2	-0.2	1667	-0.21	-336	1	-0.2	1680	-0.21	-339	1	-0.2	1690	-0.21
BARASIA_ARBT	44.625	-423	2	-0.25	1674	-0.26	-430	1	-0.25	1720	-0.26	-433	1	-0.25	1730	-0.26
GORAI	1.250	35	35	0.07	508	0.08	35	35	0.07	508	0.08	35	35	0.07	508	0.08
GORAI	3.000	35	35	0.16	218	0.19	35	35	0.16	218	0.19	35	35	0.16	218	0.19
GORAI	4.250	35	35	0.35	99	0.42	35	35	0.35	99	0.42	35	35	0.35	99	0.42
GORAI	6.000	35	35	0.06	545	0.07	35	35	0.06	545	0.07	35	35	0.06	545	0.07
GORAI	10.000	35	35	0.05	695	0.05	35	35	0.05	695	0.05	35	35	0.05	695	0.05
GORAI	14.250	35	35	0.1	362	0.11	35	35	0.1	362	0.11	35	35	0.1	362	0.11
GORAI	20.500	35	35	0.11	308	0.13	35	35	0.11	308	0.13	35	35	0.11	308	0.13
GORAI	28.125	35	35	0.13	274	0.15	35	35	0.13	274	0.15	35	35	0.13	274	0.15
GORAI	33.375	35	35	0.09	415	0.09	35	35	0.09	413	0.09	35	35	0.09	413	0.09
GORAI	39.250	35	35	0.04	869	0.04	35	35	0.04			35	35	0.04		
GORAI	45.750	36	35	0.02	1511	0.02	36	35	0.02			36	35	0.02		
GORAI	52.000	36	35	0.03	1432	0.03	36	35	0.03			36	35	0.03		

Table C 4 (Continued)

Comparison of Hydraulic Parameters and Regime Ratio for April 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
GORAI	58.000	36	35	0.05	776	0.05	36	35	0.05			36	35	0.05		
GORAI	64.125	37	35	0.06	596	0.07	37	35	0.06	595	0.07	37	35	0.06	596	0.07
GORAI	70.375	37	35	0.05	750	0.05	37	35	0.05			37	35	0.05		
GORAI	76.500	37	35	0.07	567	0.07	37	35	0.07	566	0.07	37	35	0.07	567	0.07
GORAI	80.750	38	35	0.14	259	0.16	37	35	0.14	258	0.16	38	35	0.14	259	0.16

Table C 5

Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
TALDUP	18.000	-4655	-1	-1.03	4523	-1.02	-4764	-2	-1.08	4392	-1.07	-4808	-27	-1.1	4379	-1.08
TALDUP	20.000	-4486	-2	-0.93	4811	-0.92	-4557	-2	-0.93	4889	-0.92	-4604	-28	-0.94	4875	-0.93
KOBADAK	140.667	-583	31	-0.68	853	-0.73	-577	31	-0.67	862	-0.71	-577	31	-0.67	862	-0.71
KOBADAK	151.000	-729	31	-0.57	1281	-0.59	-709	31	-0.55	1292	-0.57	-709	31	-0.55	1292	-0.57
KOBADAK	161.333	-972	30	-0.6	1628	-0.62	-947	30	-0.56	1677	-0.58	-945	30	-0.56	1677	-0.58
KARULLA	2.500	-1208	29	-1.07	1125	-1.13	-1194	29	-1.11	1075	-1.17	-1192	29	-1.11	1076	-1.17
CONNECTION	2.500	-948	-25	-0.77	1234	-0.80	-928	-40	-0.79	1178	-0.83	-937	-44	-0.79	1184	-0.83
KATAKHALI-K	1.250	894	53	1.45	618	1.57	836	69	1.31	640	1.41	843	73	1.32	640	1.42
KATAKHALI-K	3.750	925	53	1.62	570	1.77	871	68	1.47	592	1.60	877	73	1.48	592	1.61
KOBADAK	187.505	976	54	1.23	794	1.31	925	69	1.12	828	1.19	929	74	1.13	826	1.20
KOBADAK	196.750	-1703	56	-0.57	2993	-0.57	-1792	91	-0.6	2974	-0.61	-1790	94	-0.6	2976	-0.60
KOBADAK	209.258	-3770	49	-0.91	4160	-0.90	3684	92	1.08	3421	1.08	3690	99	1.08	3421	1.08
KOBADAK	219.752	-5143	47	-0.87	5903	-0.85	-5105	90	-0.86	5966	-0.83	-5103	97	-0.85	5969	-0.83
KOBADAK	229.750	-6865	36	-0.86	7973	-0.83	-6854	87	-0.85	8023	-0.82	-6853	94	-0.85	8026	-0.82
KOBADAK	239.250	-8210	34	-0.9	9162	-0.86	-8213	85	-0.89	9189	-0.85	-8212	91	-0.89	9190	-0.85
KOIRA	6.000	-641	3	-0.8	801	-0.86	-652	-5	-0.79	826	-0.84	-657	-9	-0.8	823	-0.85
HADDA	3.000	-443	3	-0.86	515	-0.94	-440	-6	-0.87	505	-0.96	-444	-10	-0.9	494	-0.99
BETNA	5.875	6	5	0.07	83	0.09	6	5	0.07	84	0.09	6	5	0.07	84	0.09
BETNA	17.625	11	9	0.13	81	0.16	11	9	0.13	81	0.16	11	9	0.13	81	0.16
BETNA	29.375	17	14	0.23	73	0.28	17	14	0.23	74	0.28	17	14	0.23	74	0.28
BETNA	41.125	25	20	0.47	52	0.58	25	20	0.47	53	0.58	25	20	0.47	53	0.58
BETNA	51.500	56	24	0.38	147	0.44	53	24	0.38	139	0.45	53	24	0.38	139	0.45
BETNA	60.500	-132	28	-0.64	208	-0.73	-130	28	-0.54	240	-0.62	-130	28	-0.54	240	-0.61
BETNA	71.125	-218	32	-0.36	612	-0.39	-215	32	-0.39	554	-0.42	-215	32	-0.39	555	-0.42
BETNA	83.375	-624	35	-0.63	992	-0.67	-600	35	-0.63	948	-0.67	-601	35	-0.63	948	-0.67
BETNA	90.500	-843	38	-0.68	1246	-0.71	-538	17	-0.48	1114	-0.51	-538	19	-0.48	1116	-0.51
MORIRCHAP	2.500	474	2	0.46	1029	0.49	731	-18	0.76	959	0.81	735	-16	0.77	960	0.81
MORIRCHAP	8.750	401	-27	0.82	490	0.90	-938	-59	-1.22	769	-1.31	-938	-58	-1.22	769	-1.31

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Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
KHOLPETUA	15.750	-4589	78	-0.62	7361	-0.60	2548	89	0.68	3752	0.68	2548	90	0.68	3751	0.68
KHOLPETUA	26.008	-6577	96	-0.69	9554	-0.66	-5033	188	-0.7	7156	-0.68	-5034	189	-0.7	7158	-0.68
KHOLPETUA	36.002	-7678	91	-0.74	10425	-0.70	-6865	184	-0.73	9344	-0.70	-6867	185	-0.73	9345	-0.70
KHOLPETUA	43.500	-9054	97	-1.04	8693	-1.00	-7908	181	-0.72	10944	-0.69	-7911	182	-0.72	10947	-0.69
KHOLPETUA	50.750	-361	95	-1.06	342	-1.18	-9207	179	-1	9226	-0.95	-9210	180	-1	9228	-0.95
LINK-KK	0.500	-19331	-9	-1.31	14705	-1.23	-404	-1	-1.24	326	-1.39	-405	-1	-1.24	326	-1.39
ARPANGASIA	1.750	-13130	124	-0.8	16397	-0.75	-19423	259	-1.33	14627	-1.24	-19425	267	-1.33	14629	-1.24
ARPANGASIA	6.000	-15030	-16	-0.86	17446	-0.80	-13208	55	-0.81	16403	-0.75	-13199	68	-0.8	16402	-0.75
ARPANGASIA	12.250	-10291	-21	-0.69	14832	-0.65	-15103	50	-0.87	17456	-0.80	-15095	62	-0.86	17456	-0.80
ARPANGASIA	21.880	-12321	-124	-0.69	17734	-0.65	-10358	-93	-0.7	14871	-0.65	-10356	-88	-0.7	14870	-0.65
CHALKI GANG	2.500	-7980	136	-0.8	9968	-0.76	-7484	201	-0.94	7944	-0.91	-7496	196	-0.94	7948	-0.91
CHALKI GANG	8.750	-8407	135	-0.77	10961	-0.73	-7983	199	-0.81	9828	-0.77	-7994	194	-0.81	9833	-0.77
CHALKI GANG	14.500	-12607	133	-0.95	13283	-0.89	-8423	198	-0.78	10824	-0.74	-8434	193	-0.78	10829	-0.74
BAL	1.875	-13103	131	-1.04	12642	-0.98	12648	196	1.03	12232	0.98	12675	217	1.04	12223	0.98
BAL	4.750	-14056	130	-0.98	14387	-0.92	-13123	195	-1.03	12700	-0.97	-13105	215	-1.03	12700	-0.97
BAL	11.125	4845	128	1.17	4150	1.16	-14074	193	-0.98	14432	-0.91	-14056	213	-0.97	14433	-0.91
SONA KHAL	2.250	5095	0	0.94	5416	0.92	4935	1	1.25	3952	1.24	4977	26	1.26	3937	1.25
SONA KHAL	7.250	-2731	0	-0.34	8004	-0.33	5184	0	1	5193	0.98	5225	26	1.01	5173	0.99
BARAPANGA	2.500	-3487	-210	-0.48	7213	-0.47	-2757	-206	-0.34	8073	-0.33	-2758	-205	-0.34	8071	-0.33
BARAPANGA	6.125	-3925	-212	-0.46	8458	-0.45	-3521	-207	-0.48	7268	-0.47	-3521	-207	-0.48	7266	-0.47
MALANCHA	2.000	-8382	96	-0.69	12135	-0.65	-7529	136	-0.77	9754	-0.74	-7523	143	-0.77	9754	-0.74
MALANCHA	10.667	-10318	93	-0.65	15835	-0.61	-8410	133	-0.69	12141	-0.65	-8405	141	-0.69	12142	-0.65
HARIHAR	4.500	6	2	0.09	61	0.12	2	2	0.04			2	2	0.04		
HARIHAR	13.500	7	3	0.13	57	0.16	4	3	0.07	51	0.09	4	3	0.07	51	0.09
HARIHAR	20.750	8	5	0.16	52	0.20	5	5	0.11	48	0.14	5	5	0.11	48	0.14
HARIHAR	24.250	10	5	0.2	49	0.25	6	5	0.14	44	0.17	6	5	0.14	44	0.17
HARIHAR	29.000	11	6	0.21	56	0.25	7	6	0.17	42	0.21	7	6	0.17	42	0.21
HARIHAR	36.250	6	7	0.06	109	0.07	8	7	0.17	50	0.21	8	7	0.17	50	0.21
BURIBHADRA	4.125	15	1	0.29	53	0.36	1	1	0.03			1	1	0.03		
U_BHADRA	5.255	-30	10	-0.24	124	-0.29	12	10	0.26	44	0.33	12	10	0.26	44	0.33
U_BHADRA	12.570	57	11	0.53	108	0.63	13	11	0.59	22	0.77	13	11	0.59	22	0.77
U_BHADRA	15.565	5	12	0.01	568	0.01	14	12	0.4	36	0.50	14	12	0.34	42	0.42
MUKTESWARI	5.000	-10	2	-0.02	506	-0.02	2	2	0.01			2	2	0.01		
MUKTESWARI	13.000	-12	4	-0.03	447	-0.03	4	4	0.01			5	4	0.01		
MUKTESWARI	18.000	-20	5	-0.05	369	-0.06	6	5	0.02			6	5	0.02		
MUKTESWARI	25.000	-34	7	-0.4	85	-0.48	8	7	0.03			8	7	0.04		
MUKTESWARI	35.000	-49	10	-0.34	142	-0.40	11	9	0.13	84	0.15	11	9	0.13	84	0.16
HARI	3.650	-58	12	-0.41	142	-0.48	13	11	0.24	55	0.29	14	11	0.26	53	0.32
HARI	7.650	-88	12	-0.36	242	-0.41	18	12	0.3	58	0.37	18	12	0.31	57	0.39

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
HARI	11.000	235	13	0.71	329	0.80	22	13	0.24	94	0.28	23	12	0.25	89	0.31
M_BHADRA	17.000	254	26	0.8	315	0.90	55	26	0.27	203	0.31	56	26	0.27	204	0.31
M_BHADRA	18.250	-9	26	-0.03	335	-0.03	62	26	0.3	207	0.34	63	26	0.31	206	0.35
HAMKURA	1.000	-21	1	-0.09	250	-0.10	2	1	0.03			2	1	0.03		
HAMKURA	2.250	-26	1	-0.15	174	-0.17	2	1	0.06	34	0.08	2	1	0.06	35	0.08
HAMKURA	2.700	-56	2	-0.51	111	-0.60	2	2	0.1	22	0.13	2	2	0.1	23	0.13
HAMKURA	4.150	-68	2	-0.65	105	-0.77	3	2	0.17	16	0.23	3	2	0.17	17	0.23
HAMKURA	6.700	72	2	0.6	119	0.71	5	2	0.17	30	0.21	5	2	0.16	32	0.21
HAMKURA	9.450	-122	3	-0.44	277	-0.50	13	3	0.19	69	0.23	13	3	0.19	70	0.23
HAMKURA	12.450	23	3	0.32	71	0.39	33	3	0.21	153	0.25	33	3	0.21	155	0.24
U_SOLMARI	1.700	33	1	0.53	61	0.65	-7	1	-0.15	46	-0.19	-5	1	-0.11	47	-0.13
U_SOLMARI	4.400	75	2	0.61	123	0.72	-16	2	-0.26	61	-0.31	-11	2	-0.2	53	-0.25
U_SOLMARI	8.700	-233	3	-0.53	439	-0.59	-35	3	-0.3	117	-0.35	-26	3	-0.21	125	-0.24
U_SOLMARI	13.000	-1289	4	-0.99	1297	-1.04	191	4	0.17	1121	0.18	107	4	0.11	955	0.12
L_SOLMARI	4.250	54	-608	0.38	141	0.45	-1488	-576	-1.11	1343	-1.16	-1523	-643	-1.12	1360	-1.17
SALTA	1.750	19	-1	0.21	91	0.25	397	33	0.44	899	0.47	394	33	0.43	913	0.46
SALTA	6.000	5102	0	2.11	2424	2.14	886	34	0.51	1735	0.53	882	34	0.51	1725	0.53
RUPSA	2.097	5169	3699	1.4	3691	1.39	5150	3750	2.13	2422	2.16	5395	4172	2.22	2434	2.25
RUPSA	4.596	5179	3699	1.48	3497	1.48	5216	3750	1.41	3689	1.41	5453	4172	1.47	3702	1.47
RUPSA	5.000	5712	3699	1.72	3325	1.72	5226	3750	1.5	3495	1.49	5462	4172	1.56	3508	1.55
RUPSA	5.172	5784	3821	1.57	3695	1.56	5754	3875	1.73	3322	1.73	6025	4320	1.7	3539	1.70
RUPSA	7.922	5946	3821	1.51	3932	1.50	5837	3876	1.57	3715	1.56	6160	4320	1.55	3985	1.53
RUPSA	11.500	6101	3821	1.48	4117	1.47	6063	3876	1.44	4217	1.42	6419	4321	1.5	4288	1.48
RUPSA	13.750	5788	3821	1.36	4260	1.34	6232	3876	1.52	4111	1.50	6587	4320	1.57	4183	1.56
RUPSA	16.200	702	3519	1.26	559	1.37	5936	3565	1.4	4254	1.38	6253	3967	1.45	4325	1.43
GHENGRAIL	6.450	811	40	0.5	1617	0.52	58	7	0.12	467	0.14	88	8	0.51	173	0.59
GHENGRAIL	7.850	2207	40	0.78	2825	0.79	74	7	0.03			139	7	0.11	1271	0.11
GHENGRAIL	8.150	2430	44	0.85	2872	0.85	216	9	0.03			548	9	0.06	9392	0.06
GHENGRAIL	10.150	2907	45	0.77	3765	0.77	254	9	0.04			699	9	0.04		
GHENGRAIL	14.750	3474	45	0.86	4049	0.85	322	10	0.03			976	11	0.26	3748	0.26
GHENGRAIL	18.150	3746	46	1.05	3569	1.05	394	11	0.12	3419	0.12	1811	11	0.27	6694	0.26
GHENGRAIL	19.900	4908	46	1.07	4597	1.05	450	12	0.24	1906	0.24	2469	12	0.3	8198	0.29
KAZIBACHA	1.750	5466	2912	1.37	4004	1.35	4804	2989	1.06	4530	1.05	5070	3325	1.11	4583	1.09
KAZIBACHA	7.750	3768	2912	1.29	2910	1.30	5398	2989	1.36	3957	1.35	5673	3324	1.41	4023	1.40
KAZIBACHA	13.500	2625	2164	1.06	2478	1.07	3512	2298	1.23	2849	1.24	3672	2546	1.14	3223	1.14
DELUTI	2.500	4077	470	1.47	2782	1.48	1488	341	0.63	2368	0.64	1492	362	0.63	2351	0.64
DELUTI	6.250	4286	475	1.33	3213	1.34	2013	341	0.65	3092	0.65	2017	363	0.66	3064	0.66
DELUTI	8.000	1455	475	0.68	2142	0.69	2279	341	0.62	3673	0.62	2286	363	0.63	3644	0.63
SIBSA	0.450	1839	-37	0.58	3169	0.58	1155	-41	0.58	1983	0.60	1147	-45	0.58	1965	0.60

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
SIBSA	2.850	1988	−37	0.5	4014	0.49	1643	−40	0.52	3171	0.52	1648	−45	0.52	3158	0.52
SIBSA	5.212	6405	−37	0.87	7372	0.84	1862	−40	0.45	4144	0.44	1867	−44	0.45	4117	0.45
SIBSA	6.438	14588	439	1.4	10454	1.33	4323	301	0.53	8194	0.51	4337	318	0.53	8132	0.51
SIBSA	7.575	15877	1377	1.2	13280	1.12	11234	1279	1.01	11126	0.96	11335	1430	1.02	11081	0.97
SIBSA	11.950	20831	1376	1.37	15239	1.28	12916	1278	0.9	14350	0.84	13043	1429	0.91	14306	0.86
SIBSA	16.395	23279	1795	1.54	15163	1.44	19596	1676	1.25	15700	1.17	19699	1864	1.22	16207	1.13
SIBSA	19.352	26307	1793	1.52	17262	1.42	22612	1674	1.43	15789	1.34	22650	1862	1.44	15688	1.35
SIBSA	24.540	26349	1807	1.38	19142	1.27	26801	1682	1.53	17483	1.43	27273	1866	1.5	18237	1.39
SIBSA	27.728	26394	1808	1.34	19714	1.24	28590	1683	1.4	20487	1.29	29050	1867	1.41	20565	1.30
SIBSA	28.395	29530	1808	1.42	20778	1.31	28844	1683	1.36	21206	1.25	29356	1867	1.38	21331	1.27
SIBSA	29.520	30863	1964	1.35	22812	1.24	32254	1830	1.45	22229	1.34	32815	2032	1.47	22360	1.35
SIBSA	31.528	31422	1965	1.36	23022	1.25	32449	1832	1.42	22859	1.31	32585	2034	1.44	22662	1.32
SIBSA	33.638	31977	1964	1.58	20291	1.46	34084	1832	1.43	23791	1.31	34494	2034	1.45	23783	1.33
SIBSA	36.138	32605	1962	1.47	22187	1.35	34949	1831	1.66	21017	1.53	35166	2033	1.68	20916	1.55
SIBSA	41.390	33846	1961	1.19	28484	1.08	34079	1832	1.5	22659	1.38	34431	2034	1.52	22647	1.40
SIBSA	46.765	35309	1957	1.17	30213	1.06	35373	1829	1.22	29050	1.11	35735	2032	1.23	29056	1.12
SIBSA	49.046	36404	1954	1.29	28194	1.18	37034	1826	1.2	30885	1.09	37384	2029	1.21	30883	1.10
SIBSA	51.914	37969	1951	1.4	27105	1.28	38252	1824	1.33	28852	1.21	38588	2026	1.34	28839	1.22
SIBSA	55.414	39137	1946	1.34	29302	1.22	39804	1819	1.44	27648	1.31	40115	2021	1.45	27630	1.32
SIBSA	58.252	35460	1942	1.13	31326	1.03	40859	1815	1.37	29765	1.25	41148	2017	1.38	29725	1.26
SIBSA	60.252	36359	1938	1.25	28978	1.14	36990	1810	1.17	31674	1.06	37207	1987	1.18	31616	1.07
SIBSA	62.302	37590	1935	1.29	29190	1.17	37606	1807	1.27	29611	1.16	37930	1984	1.28	29625	1.16
SIBSA	65.652	38961	1932	1.18	32896	1.07	38849	1805	1.31	29763	1.19	39175	1982	1.32	29766	1.20
SIBSA	68.902	40278	1928	1.19	33783	1.08	40176	1801	1.2	33432	1.09	40502	1978	1.21	33422	1.10
SIBSA	72.652	41327	1925	1.2	34324	1.09	41435	1797	1.21	34228	1.09	41759	1974	1.22	34205	1.10
SIBSA	75.798	42026	1922	1.22	34354	1.11	42436	1794	1.22	34706	1.10	42759	1971	1.23	34678	1.11
SIBSA	77.986	43860	1920	1.28	34179	1.16	43102	1792	1.24	34689	1.12	43425	1969	1.25	34660	1.13
SIBSA	81.961	5075	1914	0.87	5826	0.85	44853	1785	1.3	34420	1.18	45175	1962	1.31	34389	1.19
PUSSUR	4.209	8035	1933	1.17	6879	1.13	4967	2101	0.84	5940	0.81	5189	2337	0.86	6011	0.84
PUSSUR	12.626	13319	1932	1.43	9329	1.36	7986	2100	1.15	6947	1.11	8162	2336	1.17	6988	1.13
PUSSUR	21.587	16660	1847	1.38	12103	1.30	13355	2049	1.43	9317	1.37	13531	2291	1.45	9328	1.39
PUSSUR	30.565	20165	1838	1.34	15020	1.26	16718	2040	1.38	12085	1.31	16912	2282	1.4	12091	1.32
PUSSUR	39.015	23950	1828	1.52	15749	1.42	20423	2029	1.36	15049	1.27	20688	2272	1.37	15073	1.28
PUSSUR	48.885	27084	1817	1.63	16661	1.51	24504	2018	1.55	15829	1.45	24853	2261	1.56	15888	1.46
PUSSUR	60.262	−30734	1807	−1.3	23710	−1.19	28288	2008	1.67	16958	1.55	28823	2250	1.69	17067	1.57
PUSSUR	71.728	−33011	1795	−0.9	36605	−0.81	−31129	1994	−1.31	23825	−1.20	31471	2237	1.77	17737	1.65
PUSSUR	78.835	77663	1787	1.68	46169	1.50	−33470	1987	−0.95	35356	−0.85	33660	2230	1.2	27991	1.10
PUSSUR	81.335	79115	3694	1.51	52465	1.34	79396	3765	1.71	46543	1.52	80052	4185	1.72	46543	1.54
PUSSUR	84.585	81422	3689	1.44	56495	1.28	80809	3760	1.53	52880	1.36	81463	4179	1.54	52880	1.37

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Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE Qmax (m³/s)	BASE Qavg (m³/s)	BASE Vmax (m/s)	BASE Area (m²)	BASE Ratio	SCENARIO : 9 Qmax (m³/s)	SCENARIO : 9 Qavg (m³/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m²)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m³/s)	SCENARIO : 10 Qavg (m³/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m²)	SCENARIO : 10 Ratio
PUSSUR	88.960	87637	3680	1.39	62869	1.23	83114	3751	1.46	56959	1.29	83773	4170	1.47	56968	1.30
PUSSUR	94.710	4341	3656	2.08	2088	2.12	89442	3727	1.41	63503	1.24	90127	4146	1.42	63530	1.25
ATAI	10.250	4618	3322	1.12	4121	1.11	4379	3364	2.09	2092	2.14	4626	3715	2.19	2113	2.24
NABAGANGA_L	27.500	408	3619	0.74	551	0.81	4661	3669	1.13	4128	1.12	4988	4080	1.2	4160	1.19
MAJUDKHALI	0.500	412	298	0.72	569	0.79	413	305	0.74	556	0.81	468	365	0.83	562	0.91
MAJUDKHALI	1.500	431	298	0.75	573	0.82	418	305	0.73	570	0.80	469	365	0.82	575	0.89
MAJUDKHALI	4.250	4287	297	1.82	2351	1.85	436	305	0.76	574	0.83	483	365	0.84	577	0.91
NABAGANGA_M	4.250	4233	3637	1.61	2624	1.63	4332	3689	1.83	2363	1.86	4769	4123	1.97	2420	2.00
NABAGANGA_M	12.875	4263	3522	1.64	2595	1.66	4273	3573	1.62	2635	1.64	4677	3991	1.74	2684	1.76
NABAGANGA_M	21.625	257	3521	0.65	397	0.72	4304	3572	1.65	2604	1.67	4697	3991	1.78	2645	1.80
KATAKHALI-SW	6.750	181	116	0.47	383	0.52	253	117	0.66	385	0.73	244	132	0.63	389	0.70
KATAKHALI-SW	20.250	361	119	0.99	364	1.10	180	121	0.46	388	0.52	181	136	0.47	387	0.52
TELIGATI	1.150	430	29	1.29	334	1.44	0	0				0	0			
TELIGATI	4.900	1946	30	1.19	1637	1.23	21	1	0.06	372	0.06	34	1	0.13	257	0.15
CHUNKURI	1.650	2060	569	0.87	2380	0.88	2034	541	1.26	1620	1.30	2070	597	1.28	1620	1.32
CHUNKURI	4.650	1489	569	1.25	1188	1.32	2149	541	0.92	2343	0.93	2185	597	0.92	2362	0.94
DHAKI	2.250	1612	417	1.35	1190	1.42	1589	399	1.37	1156	1.44	1609	436	1.43	1126	1.50
DHAKI	6.500	1783	418	1.04	1708	1.08	1731	400	1.5	1153	1.58	1751	437	1.51	1156	1.59
DHAKI	10.250	2172	419	0.94	2315	0.95	1935	401	1.2	1616	1.24	1957	438	1.21	1622	1.25
DHAKI	13.000	773	419	1	776	1.07	2355	401	1.08	2174	1.10	2381	438	1.09	2181	1.11
SUTARKHALI	2.000	980	153	1.14	858	1.22	-813	143	-0.75	1086	-0.79	-811	162	-0.74	1100	-0.78
SUTARKHALI	6.150	1212	154	1.32	920	1.40	-1050	144	-0.86	1215	-0.91	-1049	162	-0.86	1225	-0.90
SUTARKHALI	8.800	1357	154	0.97	1398	1.01	1221	144	1.35	906	1.43	1238	163	1.36	913	1.44
SUTARKHALI	11.235	1728	154	1.02	1694	1.05	1381	145	0.96	1432	1.00	1395	163	0.97	1433	1.01
SUTARKHALI	14.200	1886	155	1.04	1811	1.07	1767	145	1.08	1632	1.12	1771	163	1.09	1623	1.13
SUTARKHALI	16.290	2058	155	1.13	1821	1.16	1941	145	1.11	1743	1.15	1946	164	1.12	1732	1.16
SUTARKHALI	18.160	2184	155	1.08	2018	1.11	2134	145	1.22	1749	1.26	2143	164	1.23	1740	1.27
SUTARKHALI	19.720	2309	155	1.04	2230	1.06	2281	145	1.17	1942	1.20	2293	164	1.19	1933	1.22
SUTARKHALI	21.385	2416	156	1.36	1783	1.40	2431	146	1.13	2156	1.15	2450	164	1.14	2151	1.16
SUTARKHALI	23.300	2797	156	1.17	2383	1.19	2549	146	1.4	1821	1.44	2576	165	1.41	1822	1.45
SUTARKHALI	26.050	3046	156	1.08	2811	1.09	2888	146	1.26	2297	1.28	2886	165	1.26	2283	1.29
SUTARKHALI	27.900	1613	156	1.01	1602	1.04	3184	146	1.11	2860	1.12	3185	165	1.12	2840	1.13
L_SALTA	12.250	2007	613	1.04	1927	1.07	1797	615	1.15	1567	1.19	1807	681	1.15	1567	1.19
L_BHADRA	4.250	2379	613	1.14	2084	1.17	2199	616	1.14	1924	1.17	2235	682	1.16	1928	1.19
L_BHADRA	9.650	2579	613	1.15	2252	1.17	2632	616	1.27	2072	1.30	2672	683	1.29	2074	1.32
L_BHADRA	11.400	29	613	0.08	354	0.09	2916	616	1.33	2195	1.35	2938	683	1.34	2189	1.37
JHAPJHAPIA	4.750	2512	1	1.41	1777	1.46	23	0	0.07	342	0.07	-25	0	-0.07	381	-0.07
MANGA	3.000	2597	750	1.13	2297	1.15	2776	692	1.55	1788	1.60	2823	779	1.58	1790	1.62
MANGA	6.150	2360	751	1.88	1253	1.97	2861	692	1.23	2316	1.26	2907	779	1.25	2321	1.27

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio
JHAPJH-MANGA	1.250	4678	748	1.09	4278	1.08	2619	690	2.09	1254	2.19	2661	778	2.11	1259	2.21
HABARKHALI	4.125	2685	188	1.4	1919	1.44	2712	287	0.59	4591	0.58	2728	332	0.6	4546	0.59
BADURGACHA	1.950	2913	751	1.63	1788	1.68	2971	692	1.54	1934	1.58	3017	780	1.56	1940	1.59
BADURGACHA	6.700	965	751	1.25	775	1.33	3289	692	1.79	1835	1.84	3337	780	1.81	1840	1.86
GUNKHALI	0.500	-176		-0.93	189	-1.07	0	0				0	0			
GUNKHALI	4.250	-173	5	-0.2	853	-0.22	0	0				26	0	-0.05		
HARIA	0.500	772	-10	1	772	1.07	0	0				0	0			
HARIA	6.850	-686	-9	-0.72	957	-0.76	8	1	0.03			8	1	0.03		
HARIA	13.100	713	-8	0.25	2848	0.25	87	2	0.08	1123	0.08	291	2	0.28	1051	0.29
HARIA	15.350	-571	30	-0.38	1509	-0.39	-863	43	-0.94	917	-1.00	-872	47	-0.95	922	-1.00
HARIA	17.850	1316	30	0.69	1904	0.71	-730	43	-0.53	1376	-0.55	-739	48	-0.53	1389	-0.55
MINAJNADI	4.250	-100	5	-0.55	182	-0.63	-584	2	-0.37	1561	-0.39	-586	2	-0.37	1566	-0.39
MINAJNADI	12.750	-261	3	-0.46	570	-0.50	1395	1	0.79	1774	0.81	1401	1	0.79	1773	0.81
SALTA(W)	5.750	566	-8	0.88	646	0.95	-13	-4	-0.23	56	-0.29	-11	-4	-0.27	39	-0.34
SALTA(W)	17.250	715	-6	1.07	671	1.15	-7	-1	-0.02			-5	-2	-0.02		
SALTA(W)	23.200	716	-5	1.1	653	1.18	-1	0	0			-1	0			
SALTA(W)	23.400	720	5	1.18	610	1.28	-1	0	0			-1	0			
SALTA(W)	23.600	10	5	0.17	58	0.20	-1	0				-1	0			
SALTA(W)	24.400	81	5	0.18	451	0.20	0	0				0	0			
BHANGARIA	1.125	-42	0	-0.16	262	-0.18	0	0				0	0			
BHADRA	19.500	-164	-2	-0.46	356	-0.51	73	27	0.23	324	0.25	74	27	0.22	331	0.25
BHADRA	20.625	-170	-2	-0.32	531	-0.35	82	27	0.25	330	0.28	83	27	0.25	337	0.27
BHADRA	22.375	-213	-2	-0.4	533	-0.44	96	27	0.28	348	0.31	97	27	0.27	356	0.30
BHADRA	24.150	-224	-2	-0.31	730	-0.33	113	27	0.34	333	0.38	113	27	0.33	337	0.37
BHADRA	24.950	-444	-2	-0.44	1018	-0.46	128	28	0.36	356	0.40	127	28	0.35	359	0.39
BHADRA	25.100	-722	-1	-0.65	1114	-0.68	131	28	0.36	360	0.40	130	28	0.36	363	0.40
BHADRA	26.800	-908	2	-0.77	1172	-0.81	215	32	0.51	420	0.57	214	32	0.5	425	0.56
BHADRA	29.600	-1089	3	-0.82	1333	-0.85	0	0				0	0			
BHADRA	31.350	-1310	4	-0.77	1695	-0.80	36	0	0.03			-94	0	0.03		
BHADRA	34.100	3742	4	1.3	2868	1.31	88	1	0.04			214	1	0.17	1229	0.18
BHADRA	36.850	3744	4	1.23	3037	1.24	128	1	0.04			361	1	0.09	4078	0.09
MADHUMATI	88.500	3747	3425	1.18	3179	1.18	3743	3426	1.3	2869	1.31	3744	3426	1.3	2869	1.31
MADHUMATI	101.500	3750	3425	1.13	3318	1.13	3745	3425	1.23	3037	1.24	3746	3426	1.23	3037	1.24
MADHUMATI	114.917	3760	3425	1.07	3527	1.06	3747	3426	1.18	3180	1.18	3748	3426	1.18	3182	1.18
MADHUMATI	128.750	4419	3426	1.17	3772	1.17	3750	3426	1.13	3319	1.13	3751	3427	1.13	3330	1.13
MADHUMATI	142.583	4438	3427	0.81	5460	0.80	3762	3428	1.07	3530	1.06	3761	3428	1.06	3561	1.05
MADHUMATI	153.250	4485	3900	0.95	4701	0.94	4421	3905	1.17	3778	1.16	4407	3907	1.15	3828	1.14
MADHUMATI	161.750	469	3900	0.28	1695	0.29	4438	3905	0.81	5463	0.79	4421	3907	0.8	5538	0.78
MADHUMATI	174.000	425	3897	0.52	822	0.55	4483	3902	0.95	4719	0.94	4464	3904	0.93	4823	0.91

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio
MADHUMATI	182.000	398	240	0.48	838	0.51	434	192	0.26	1696	0.26	-368	-244	-0.24	1567	-0.24
MADHUMATI	188.125	616	242	0.77	806	0.82	396	193	0.47	840	0.50	-363	-243	-0.44	832	-0.47
MADHUMATI	199.375	616	244	0.64	969	0.67	366	196	0.41	889	0.44	-358	-240	-0.36	1002	-0.38
MADHUMATI	205.700	615	548	0.48	1288	0.50	784	696	0.9	869	0.96	263	204	0.24	1079	0.26
MADHUMATI	206.700	614	548	0.42	1467	0.44	784	696	0.76	1026	0.81	260	204	0.2	1278	0.21
MADHUMATI	207.250	629	551	0.4	1570	0.42	782	698	0.58	1346	0.61	248	198	0.15	1664	0.15
MADHUMATI	211.250	651		0.39	1689	0.40	779	699	0.52	1501	0.54	230	199	0.13	1827	0.13
MADHUMATI	216.000	678		0.37	1846	0.38			0.41	1565	0.43	10		0		
MADHUMATI	220.875	-629	552	-0.28	2220	-0.29	646	587	0.4	1670	0.41	0				
MADHUMATI	232.625	-714	555	-0.33	2147	-0.34	662	589	0.39	1774	0.40	-115		-0.08	1516	-0.08
MADHUMATI	244.375	-427	558	-0.16	2673	-0.16	686	592	0.38	1883	0.39	-284		-0.2	1439	-0.21
MADHUMATI	255.188	-471	561	-0.3	1564	-0.31	715	595	-0.27	2306	-0.27	-374		-0.22	1720	-0.22
DAUDKHALI	2.838	-484	8	-0.49	981	-0.52	-612	76	-0.31	2212	-0.32	-581	121	-0.25	2311	-0.26
DAUDKHALI	7.938	-546	12	-0.52	1059	-0.54	-695	80	-0.16	2631	-0.16	-648	125	-0.28	2287	-0.29
DAUDKHALI	10.202	-582	-1	-0.35	1680	-0.36	-419	33	-0.29	1608	-0.30	-412	53	-0.15	2811	-0.15
DAUDKHALI	12.886	-1444	1	-0.7	2058	-0.72	-466	35	-0.48	998	-0.51	-449	55	-0.28	1607	-0.29
DAUDKHALI	16.909	-1716	4	-0.81	2117	-0.83	-477	38	-0.5	1078	-0.53	-457	58	-0.45	1023	-0.47
DAUDKHALI	21.035	-527	8	-0.4	1320	-0.42	-537	41	-0.32	1754	-0.33	-522	61	-0.48	1087	-0.51
DAUDKHALI	26.605	-2053	12	-0.72	2836	-0.73	-569	46	-0.69	2121	-0.71	-556	66	-0.31	1767	-0.32
KUMARKHALI	5.125	-3131	-105	-0.9	3478	-0.90	-1466	-103	-0.86	2043	-0.88	-1475	-117	-0.68	2153	-0.70
M.G.CANAL	3.750	635	-132	0.81	781	0.87	-1764	-165	-0.37	1387	-0.39	-1807	-204	-0.88	2056	-0.90
BISHNU	5.000	747	18	0.74	1013	0.78	-515	53	-0.65	3368	-0.65	-498	78	-0.42	1187	-0.44
MONGLA NULLA	5.425	-125	-85	-0.15	811	-0.17	-2176	-50	-0.98	3406	-0.98	-2202	-44	-0.62	3552	-0.62
MONGLA NULLA	12.550	-715	-81	-0.53	1350	-0.55	-3339	-46	0.8	778	0.85	-3352	-40	-0.92	3634	-0.92
NALUA NULLAH	5.406	-1787	309	-0.67	2655	-0.68	619	317	0.73	1006	0.77	648	360	0.82	790	0.88
NALUA NULLAH	11.032	-2183	308	-0.65	3357	-0.65	734	317	-0.15	852	-0.16	759	360	0.75	1018	0.79
POYLAHARA	3.500	2654		0.68	3924	0.67	153	114	0.23	731	0.25	227	201	0.28	814	0.30
POYLAHARA	5.000	-3858	3	-0.66	5888	-0.64	167	116	0.3	824	0.32	233	203	0.29	793	0.32
POYLAHARA	15.000	-4788	10	-0.73	6587	-0.71	244	120	0.18	1796	0.18	301	206	0.35	854	0.38
POYLAHARA	24.750	13	15	0.24	53	0.29	317	45	-0.3	2010	-0.30	-290	67	-0.15	1895	-0.16
POYLAHARA	34.250	11	18	0.09	120	0.11	-595	49	0.22	664	0.23	-587	71	-0.27	2182	-0.27
LINKTOPOYLAH	5.500	171		0.62	275	0.70	144	113	0.22	660	0.24	225	200	0.28	804	0.30
LINKTOPOYLAH	16.500	-5		-0.1	45	-0.13	148	113	0.69	3920	0.69	225	199	0.28	800	0.30
GASHIAKHALI	5.250	-8	157	-0.09	88	-0.11	2716	221	-0.65	5901	-0.63	2770	282	0.71	3910	0.70
GASHIAKHALI	15.750	-29	162	-0.12	232	-0.14	-3841	226	-0.72	6589	-0.70	-3790	287	-0.65	5789	-0.64
GASHIAKHALI	22.250	183	165	0.3	608	0.33	-4773	229	0.32	78	0.39	-4841	290	-0.71	6859	-0.68
BHAIRAB	4.250	-528	2	-0.43	1225	-0.45	25	1	-0.1	145	-0.12	14	0	0.19	73	0.24
BHAIRAB	12.750	5	2	0.08	60	0.10	-15	1	0.67	285	0.75	-14	0	-0.11	126	-0.13
BHAIRAB L	5.250	5	-7	0.07	74	0.09	190	4	-0.09	47	-0.11	204	22	0.7	294	0.78

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
ATHAROBANKI	5.333	31	-2	0.16	189	0.19	-4	-1	-0.09	91	-0.10	8	6	0.14	56	0.17
ATHAROBANKI	16.000	19	-1	0.1	178	0.12	-8	0	-0.12	230	-0.14	10	7	0.1	102	0.11
ATHAROBANKI	26.667	-56	0	-0.18	303	-0.21	-28	1	0.3	607	0.33	-25	8	-0.11	231	-0.12
ATHAROBANKI	38.130	-230	122	-0.95	242	-1.08	184	125	-0.47	1166	-0.49	203	147	0.32	628	0.35
ATHAROBANKI	51.250	-319	121	-0.45	706	-0.49	-545	125	0.09	60	0.10	-541	148	-0.45	1205	-0.47
BALESWAR	5.000	-1210	3	-0.62	1947	-0.64	5	3	0.07	76	0.09	4	-1	0.05	82	0.06
BALESWAR	15.000	-2169	3	-0.68	3192	-0.68	6	3	0.16	182	0.18	-3	-1	-0.05		
BALESWAR	20.005	16452	8	1.72	9574	1.64	29	8	0.11	180	0.12	26	-7	0.11	234	0.13
BALESWAR	27.508	16451	8	1.04	15835	0.97	19	7	-0.19	291	-0.22	-22	-7	-0.11	199	-0.13
BALESWAR	42.502	16760	8	1	16843	0.93	-57	7	-1.05	214	-1.20	-64	-7	-0.23	275	-0.26
BALESWAR	50.005	19768	1	1.08	18297	1.00	-225	12	-0.46	734	-0.50	-225	15	-1.07	211	-1.22
BALESWAR	57.005	20698	1	1.11	18601	1.03	-338	11	-0.62	1936	-0.64	-336	15	-0.46	732	-0.49
BALESWAR	68.625	21243	0	1.07	19866	0.99	-1202	10	-0.68	3189	-0.68	-1161	14	-0.6	1945	-0.61
BALESWAR	77.875	22866	-1	1.1	20714	1.02	-2161	10	1.72	9557	1.64	-2089	14	-0.65	3199	-0.65
BALESWAR	82.505	43	4534	0.1	427	0.11	16455	4555	1.04	15804	0.97	16229	4065	1.67	9741	1.59
BALESWAR	87.755	717	4532	0.38	1864	0.40	16439	4554	1	16842	0.93	16223	4063	1.02	15902	0.95
BALESWAR	95.625	790	4528	0.44	1807	0.45	16759	4550	1.08	18299	1.00	16305	4059	0.97	16813	0.90
BALESWAR	103.625	887	4689	0.52	1701	0.54	19801	4775	1.11	18603	1.03	19406	4345	1.06	18233	0.99
BALESWAR	110.250	15301	4683	1.66	9220	1.59	20732	4769	1.07	19866	0.99	20372	4339	1.1	18593	1.02
BALESWAR	113.375	15445	4679	1.78	8659	1.71	21275	4766	1.11	20711	1.02	20912	4336	1.05	19856	0.97
BALESWAR	120.375	15662	4667	1.56	10049	1.48	22901	4754	0.1	410	0.11	22483	4324	1.09	20686	1.00
KALIGANGA1	5.000	15966	5	1.05	15265	0.98	41	4	0.4	1886	0.41	46	-6	0.1	469	0.11
KALIGANGA	6.550	6	559	0.03	219	0.03	750	592	0.45	1820	0.46	-447	16	-0.25	1812	-0.25
KALIGANGA	17.450	39	553	0.14	276	0.16	821	587	0.54	1702	0.56	-663	22	-0.29	2274	-0.30
KALIGANGA	26.150	48	553	1.51	32	1.92	916	587	1.66	9225	1.59	-872	22	-0.36	2400	-0.37
KOCHA	1.600	11	4538	0.06	188	0.07	15312	4549	1.79	8654	1.71	15041	4055	1.58	9492	1.51
KOCHA	4.800	24	4538	0.15	158	0.18	15467	4548	1.56	10038	1.49	14956	4054	1.85	8082	1.78
KOCHA	8.000	99	4537	0.35	285	0.39	15666	4548	1.05	15235	0.98	15308	4054	1.49	10271	1.42
KOCHA	12.300	117	4536	0.33	359	0.36	15961	4547	0.03			15685	4053	1	15642	0.94
BHAIRAB U	86.348	25	7	0.24	103	0.29	-88	8	-0.46	577	-0.50	-87	7	-0.33	265	-0.37
BHAIRAB U	98.000	27	77	0.27	99	0.33	-267	79	-0.48	654	-0.52	-254	89	-0.43	589	-0.47
BHAIRAB U	108.000	30	78	0.29	101	0.35	-315	79	-0.52	688	-0.56	-292	90	-0.44	663	-0.48
BHAIRAB U	118.000	38	79	0.15	252	0.17	-359	80	0.73	880	0.78	-333	90	-0.5	665	-0.54
BHAIRAB U	130.000	44	377	0.16	277	0.18	646	386	-0.47	125	-0.56	688	456	0.77	894	0.82
GOBRAKHAL	4.500	48	-17	0.13	377	0.14	-59	-18	0.21	108	0.25	-64	-29	-0.49	129	-0.58
KUMARK	103.250	25	37	0.37	68	0.45	48	37	0.09	562	0.10	48	37	0.13	380	0.14
KUMARK	111.750	32	39	0.23	138	0.27	51	39	0.16	12	0.22	51	39	0.09	564	0.10
KALIGANGA U	11.167	60	2	0.22	280	0.24	2	2	0.07	52	0.09	2	2	0.16	12	0.22
KALIGANGA U	23.500	295	3	0.34	878	0.36	4	3	0.03			4	3	0.07	52	0.09

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Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage	BASE					SCENARIO 9					SCENARIO : 10				
	(Km)	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio	Qmax (m³/s)	Qavg (m³/s)	Vmax (m/s)	Area (m²)	Ratio
KALIGANGA U	35.833	332	4	0.51	652	0.55	5	4	0.46	41	0.58	5	4	0.03		
CHITRA	147.258	83	97	0.36	234	0.40	-404	96	-0.51	863	-0.55	-370	89	-0.51	721	-0.55
CHITRA	155.752	100	98	0.35	289	0.39	-443	97	0.09	107	0.10	-401	90	-0.5	803	-0.53
NABAGANGA_U	49.000	150	8	0.23	652	0.25	9	8	0.18	110	0.21	9	8	0.09	107	0.10
NABAGANGA_U	63.000	-56	16	-0.22	256	-0.25	20	16	0.25	95	0.29	20	16	0.18	110	0.21
NABAGANGA_U	77.000	-34	19	-0.24	138	-0.29	23	19	0.37	73	0.45	23	19	0.25	95	0.29
NABAGANGA_U	91.000	-46	21	-0.29	156	-0.34	27	21	0.2	392	0.22	27	21	0.37	73	0.45
NABAGANGA_U	104.258	4	66	0.13	27	0.17	76	66	0.36	234	0.41	77	66	0.19	394	0.22
NABAGANGA_U	116.752	9	71	0.16	55	0.20	83	71	0.35	290	0.39	83	71	0.35	239	0.40
NABAGANGA_U	128.250	24	76	0.1	251	0.11	101	76	0.24	643	0.25	101	76	0.34	301	0.38
NABAGANGA_U	138.750	24	80	0.13	183	0.15	152	80	-0.22	259	-0.25	152	80	0.23	651	0.25
NABAGANGA_U	147.005	29	-28	0.16	183	0.18	-58	-29	-0.25	139	-0.29	-64	-33	-0.25	261	-0.28
NABAGANGA_U	157.000	29	-26	0.16	183	0.18	-35	-26	-0.28	162	-0.32	-42	-30	-0.3	143	-0.35
NABAGANGA_U	171.000	29	-22	0.17	177	0.19	-45	-23	0.13	27	0.17	-48	-27	-0.26	183	-0.30
KUMAR	103.950	24	58	0.15	167	0.17	71	64	0.61	1117	0.64	66	58	0.12	562	0.13
KUMAR	112.105	97	302	0.24	398	0.27	677	499	-0.09	89	-0.11	582	443	0.46	1256	0.48
KUMAR NADI	30.262	49	23	0.2	252	0.22	31	29	0.16	193	0.18	29	26	0.13	227	0.15
KUMAR NADI	40.788	120	23	0.76	158	0.88	31	29	0.23	405	0.25	29	26	0.13	229	0.14
KUMAR-CONN	2.000	4273	105	0.48	8915	0.46	118	103	0.82	706	0.89	118	103	0.74	158	0.86
MBR	7.500	4273	320	1.19	3576	1.19	582	545	0.72	815	0.76	502	483	0.67	753	0.71
MBR	22.500	4273	322	1.35	3172	1.35	583	547	0.14	4045	0.14	503	485	0.54	926	0.58
GORAI	64.125		3864				4272	3864	1.3	3274	1.31	4272	3864	1.11	3865	1.10
GORAI	70.375		3863				4272	3863	1.43	2980	1.44	4272	3863	1.3	3275	1.31
GORAI	76.500		3862				4272	3862	1.29	2893	1.30	4272	3862	1.43	2980	1.44
GORAI	80.750		3401				3724	3401				3725	3402	1.29	2893	1.30
AFRAKHAL	4.875	-36	2	-0.25	144	-0.30	-37	2	-0.25	150	-0.29	-37	2	-0.25	150	-0.29
AFRAKHAL	14.625	-57	2	-0.25	228	-0.28	-58	2	-0.25	236	-0.28	-58	2	-0.25	237	-0.28
AFRAKHAL	20.750	-71	2	-0.26	273	-0.29	-72	2	-0.26	282	-0.29	-73	2	-0.26	283	-0.29
AFRAKHAL	25.255	-65	2	-0.25	266	-0.28	-66	1	-0.24	275	-0.27	-66	1	-0.24	275	-0.27
AFRAKHAL	32.255	-80	2	-0.23	348	-0.26	-82	1	-0.23	358	-0.25	-82	1	-0.23	359	-0.25
BHAIRAB U	6.642	2	1	0.04	50	0.05	2	1	0.04			2	1	0.04		
BHAIRAB U	19.926	3	1	0.06	49	0.08	3	1	0.06	48	0.08	3	1	0.06	48	0.08
BHAIRAB U	33.211	3	1	0.07	48	0.09	3	1	0.07	48	0.09	3	1	0.07	48	0.09
BHAIRAB U	46.495	4	1	0.09	47	0.11	4	1	0.09	46	0.11	4	1	0.09	47	0.11
BHAIRAB U	59.779	5	1	0.1	47	0.13	5	1	0.11	46	0.14	5	1	0.11	46	0.14
BHAIRAB U	73.064	-7	1	-0.15	49	-0.18	-7	1	-0.14	51	-0.18	-7	1	-0.14	52	-0.18
BHAIRAB U	86.348	-12	1	-0.23	54	-0.28	-12	1	-0.22	56	-0.27	-12	1	-0.22	56	-0.27
BHAIRAB U	98.000	-121	3	-0.31	389	-0.34	-123	2	-0.31	400	-0.34	-123	2	-0.31	401	-0.34
BHAIRAB U	108.000	-158	3	-0.38	412	-0.42	-160	2	-0.38	425	-0.42	-161	2	-0.38	426	-0.42

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage	BASE					SCENARIO : 9					SCENARIO 10				
	(Km)	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
BHAIRAB U	118.000	-218	3	-0.47	462	-0.52	-221	2	-0.5	442	-0.55	-221	2	-0.5	443	-0.55
BHAIRAB U	130.000	-503	-55	-0.59	851	-0.63	-510	-54	-0.58	883	-0.62	-509	-53	-0.58	884	-0.61
GOBRAKHAL	4.500	-22	0	-0.37	59	-0.45	-22	0	-0.35	62	-0.43	-22	0	-0.39	57	-0.49
KUMARK	28.250	1	1	0.04	23	0.06	1	1	0.05			1	1	0.05		
KUMARK	40.750	1	1	0.05	20	0.07	1	1	0.05	21	0.07	1	1	0.05	21	0.07
KUMARK	53.250	1	1	0.06	18	0.07	1	1	0.06	19	0.08	1	1	0.06	19	0.08
KUMARK	65.750	1	1	0.03	31	0.04	1	1	0.04			1	1	0.04		
KUMARK	78.758	2	2	0.04	52	0.05	2	2	0.04			2	2	0.04		
KUMARK	92.252	2	2	0.04	48	0.05	2	2	0.04			2	2	0.04		
KUMARK	103.250	2	2	0.02	130	0.02	2	2	0.01			2	2	0.01		
KUMARK	111.750	2	2	0.01	308	0.01	2	2	0.01			2	2	0.01		
KALIGANGA U	11.167	1	1	0.13	8	0.17	1	1	0.13	8	0.18	1	1	0.13	8	0.18
KALIGANGA U	23.500	1	1	0.15	7	0.21	1	1	0.16	7	0.22	1	1	0.16	7	0.22
KALIGANGA U	35.833	1	1	0.04	27	0.05	1	1				1	1			
CHITRA	55.233	1	1	0.2	5	0.28	1	1	0.2	5	0.28	1	1	0.2	5	0.28
CHITRA	65.700	1	1	0.2	5	0.28	1	1	0.19	5	0.27	1	1	0.19	5	0.27
CHITRA	76.167	1	1	0.18	6	0.25	1	1	0.19	6	0.26	1	1	0.18	6	0.26
CHITRA	88.050	-3	1	-0.07	41	-0.09	-3	1	-0.06	44	-0.08	-3	1	-0.07	45	-0.08
CHITRA	101.350	-15	1	-0.16	95	-0.19	-15	1	-0.16	96	-0.19	-15	1	-0.16	97	-0.19
CHITRA	125.750	-221	3	-0.36	609	-0.39	-228	3	-0.36	637	-0.39	-229	3	-0.36	639	-0.39
CHITRA	137.250	-286	3	-0.56	508	-0.62	-291	3	-0.59	490	-0.65	-291	3	-0.59	491	-0.65
CHITRA	147.258	-366	4	-0.72	510	-0.79	-372	3	-0.71	525	-0.77	-372	3	-0.71	526	-0.77
CHITRA	155.752	-421	4	-0.67	623	-0.73	-429	3	-0.67	643	-0.72	-430	3	-0.67	643	-0.72
NABAGANGA_U	49.000	1	1	0.04	23	0.06	1	1	0.04			1	1	0.04		
NABAGANGA_U	63.000	1	1	0.05	22	0.06	1	1	0.05			1	1	0.05		
NABAGANGA_U	77.000	1	1	0.05	21	0.06	1	1	0.05			1	1	0.05		
NABAGANGA_U	91.000	1	1	0.05	18	0.07	1	1	0.06	18	0.07	1	1	0.06	18	0.07
NABAGANGA_U	104.258	3	3	0.04	72	0.05	3	3	0.04			3	3	0.04		
NABAGANGA_U	116.752	3	3	0.09	35	0.11	3	3	0.08	34	0.10	3	3	0.08	34	0.10
NABAGANGA_U	128.250	-17	3	-0.08	214	-0.09	-22	3	-0.11	197	-0.13	-18	3	-0.1	179	-0.12
NABAGANGA_U	138.750	-99	3	-0.25	389	-0.28	-97	3	-0.25	393	-0.27	-98	3	-0.23	424	-0.25
NABAGANGA_U	147.005	29	0	0.18	157	0.21	32	0	0.16	199	0.19	32	0	0.16	198	0.19
NABAGANGA_U	157.000	9	0	0.1	89	0.12	9	0	0.09	93	0.11	9	0	0.1	85	0.12
NABAGANGA_U	171.000	-25	0	-0.19	135	-0.22	-25	0	-0.2	128	-0.23	-26	0	-0.2	128	-0.23
CHANDANA	32.250	1	1	0.23	5	0.32	1	1	0.22	5	0.32	1	1	0.22	5	0.32
CHANDANA	45.950	1	1	0.44	3	0.64	1	1	0.44	3	0.64	1	1	0.44	3	0.64
KUMAR	8.995	1	1	0.01	76	0.02	2	1	0.02			2	1	0.02		
KUMAR	14.200	1	1	0.02	52	0.02	1	1	0.03			2	1	0.03		
KUMAR	25.275	1	0	0.01	49	0.01	0	0				0	0			

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE					SCENARIO : 9					SCENARIO : 10				
		Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio	Qmax (m^3/s)	Qavg (m^3/s)	Vmax (m/s)	Area (m^2)	Ratio
GORAI	58.000	36	35	0.05	776	0.05	36	35	0.05			36	35	0.05		
GORAI	64.125	37	35	0.06	596	0.07	37	35	0.06	595	0.07	37	35	0.06	596	0.07
GORAI	70.375	37	35	0.05	750	0.05	37	35	0.05			37	35	0.05		
GORAI	76.500	37	35	0.07	567	0.07	37	35	0.07	566	0.07	37	35	0.07	567	0.07
GORAI	80.750	38	35	0.14	259	0.16	37	35	0.14	258	0.16	38	35	0.14	259	0.16

Table C 5 (Continued)
Comparison of Hydraulic Parameters and Regime Ratio for August 1991

River	Chainage (Km)	BASE Qmax (m^3/s)	BASE Qavg (m^3/s)	BASE Vmax (m/s)	BASE Area (m^2)	BASE Ratio	SCENARIO : 9 Qmax (m^3/s)	SCENARIO : 9 Qavg (m^3/s)	SCENARIO : 9 Vmax (m/s)	SCENARIO : 9 Area (m^2)	SCENARIO : 9 Ratio	SCENARIO : 10 Qmax (m^3/s)	SCENARIO : 10 Qavg (m^3/s)	SCENARIO : 10 Vmax (m/s)	SCENARIO : 10 Area (m^2)	SCENARIO : 10 Ratio
KUMAR	37.025	0	0	0.01	46	0.01	0	0				0	0			
KUMAR	48.608	0	0	0.01	39	0.01	0	0				0	0			
KUMAR	60.025	0	0	0.01	29	0.01	0	0				-1	0			
KUMAR	71.442	0	0	-0.01	40	-0.01	-1	0				-1	0	-0.03		
KUMAR	83.580	-5	1	-0.04	132	-0.04	-5	1	-0.04			-9	0	-0.06	149	-0.07
KUMAR	94.650	-7	1	-0.07	113	-0.08	-8	1	-0.07	125	-0.08	-13	0	-0.09	143	-0.11
KUMAR	103.950	-11	1	-0.06	206	-0.06	-12	1	-0.05	223	-0.06	-23	0	-0.09	241	-0.11
KUMAR	112.105	72	28	0.1	734	0.11	136	79	0.18	775	0.19	115	63	0.14	819	0.15
KUMARF1	6.525	1	0	0.07	9	0.10	1	1	0.1	11	0.13	1	1	0.12	12	0.16
KUMARF1	19.575	-1	0	-0.1	11	-0.13	1	1	0.14	8	0.19	1	1	0.17	9	0.23
KUMAR NADI	6.250	1	1	0.01	82	0.02	2	1	0.02			2	1	0.01		
KUMAR NADI	18.750	1	1	0.01	53	0.02	2	1	0.02			1	1	0.02		
KUMAR NADI	30.262	1	1	0.02	33	0.03	1	1	0.03			1	0	0.02		
KUMAR NADI	40.788	1	0	0.04	23	0.05	1	1	0.04			-2	0	-0.04		
SITALAKHYA	6.200	2	1	0.02	87	0.03	1	1	0.01			1	1			
SITALAKHYA	18.600	2	1	0.02	85	0.02	1	1				1	0			
SITALAKHYA	30.100	1	1	0.02	74	0.02	1	1				1	0	0.01		
SITALAKHYA	40.700	1	1	0.02	68	0.02	1	0	0.02			-2	0	-0.02		
SITALAKHYA	51.858	-1	0	-0.01	43	-0.02	-2	-1	-0.04			-3	-1	-0.04		
SITALAKHYA	63.552	-2	0	-0.03	87	-0.03	-4	-1	-0.03			-4	-1	-0.03		
KUMAR-CONN	2.000	3	2	0.28	12	0.38	3	2	0.23	12	0.31	3	2	0.21	13	0.28
MBR	7.500	53	28	0.14	368	0.16	125	79	0.3	417	0.33	106	64	0.24	436	0.27
MBR	22.500	59	28	0.11	526	0.12	127	78	0.23	558	0.25	108	64	0.19	581	0.20
BARASIA_ARBT	6.375	-118	2	-0.06	1904	-0.06	-117	2	-0.06	1854	-0.06	-118	2	-0.07	1756	-0.07
BARASIA_ARBT	19.125	-250	2	-0.15	1708	-0.15	-251	1	-0.15	1643	-0.16	-253	1	-0.15	1652	-0.16
BARASIA_ARBT	31.875	-333	2	-0.2	1667	-0.21	-336	1	-0.2	1680	-0.21	-339	1	-0.2	1690	-0.21
BARASIA_ARBT	44.625	-423	2	-0.25	1674	-0.26	-430	1	-0.25	1720	-0.26	-433	1	-0.25	1730	-0.26
GORAI	1.250	35	35	0.07	508	0.08	35	35	0.07	508	0.08	35	35	0.07	508	0.08
GORAI	3.000	35	35	0.16	218	0.19	35	35	0.16	218	0.19	35	35	0.16	218	0.19
GORAI	4.250	35	35	0.35	99	0.42	35	35	0.35	99	0.42	35	35	0.35	99	0.42
GORAI	6.000	35	35	0.06	545	0.07	35	35	0.06	545	0.07	35	35	0.06	545	0.07
GORAI	10.000	35	35	0.05	695	0.05	35	35	0.05	695	0.05	35	35	0.05	695	0.05
GORAI	14.250	35	35	0.1	362	0.11	35	35	0.1	362	0.11	35	35	0.1	362	0.11
GORAI	20.500	35	35	0.11	308	0.13	35	35	0.11	308	0.13	35	35	0.11	308	0.13
GORAI	28.125	35	35	0.13	274	0.15	35	35	0.13	274	0.15	35	35	0.13	274	0.15
GORAI	33.375	35	35	0.09	415	0.09	35	35	0.09	413	0.09	35	35	0.09	413	0.09
GORAI	39.250	35	35	0.04	869	0.04	35	35	0.04			35	35	0.04		
GORAI	45.750	36	35	0.02	1511	0.02	36	35	0.02			36	35	0.02		
GORAI	52.000	36	35	0.03	1432	0.03	36	35	0.03			36	35	0.03		

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Appendix D

Polder Performance - Present Condition

APPENDIX D

Polder Performance - Present Situation

Polder No	External River for Polder Drainage	Area of Polder Drainage Outlets into rivers (% polder total)	Area of drainage outlet into silting rivers (% polder total)	Classification of Polder Drainage
1	(E) Morichap (Si)	59	62	US
	(S) Sapmara Khal/ Barsdah Nadi (Si)	4		
	(W) Ichamati (A)	37		
2	(E) Betna (Si)	6	49	M
	(E) Betna (A)	32		
	(S) Morichap (A)	19		
	(W) Morichap (S)	43		
3	(N) Sapmara Khal/ Barsdah Nadi (Si)	6	49	M
	(E) Habra Nadi (Si)	29		
	(S) Kaksiali (A)	26		
	(S) Kaksiali (Si)	14		
	(W) Ichamati (A)	25		
4	(N) Barsdah (Si)	2	20	S
	(N) Morichap (A)	3		
	(E) Kholpetua (A)	60		
	(S) e(w) Habra Nadi/ Guntia-Khali/Galgasia (Si)	18		
	ditto (A)	17		
5	(N) Kaksiali/Katakhal (Si)	7	32	M
	ditto (A)	13		
	(E) Galachipa/Kholpetua (Si)	12		
	ditto (A)	23		
	(S) Chunkuri Khal/Chunas (Si)	13		
	ditto (A)	23		
	(W) Kalindi (A)	9		
6-8	(E) Kobadak (Si)	28	34	M
	ditto (A)	28		
	(S) Morichap (A)	7		
	(W) Betna (Si)	6		
	ditto (A)	31		
7/1	(E) Kobadak (A)	41	0	S
	(W) Kholpetua (A)	59		
7/2	(N) Morichap (A)	8	0	S
	(E) Kobadak (A)	27		
	(W) Kholpetua (A)	65		
10-12	(N) Katakhal/Karulia (A)	37	0	S
	(E) Sibsa (A)	26		
	(S) Kogra (A)	11		
	(W) Kobadak (A)	26		
13-14/2	(N) Koyra/Bariakhali (A)	41	0	S
	(E) Sakbaria (A)	23		
	(W) Kobadak (A)	36		
14/1	(E) Sakbaria (A)	52	0	S
	(W) Kobadak (A)	48		

15	(E) Kobadak (A) (W) Kholpetua (A)	25 75	0	S
16/1 & 16/2	(E) Salta, Haria (Si ditto (A) (S) Sibsa (A)	57 28 15	57	M
17/1	(N) Taltala (Si) (E) Gangrail (A) (W) Salta (Si) (W) Salta (A)	10 39 27 24	37	M
17/2	(E) Teligati (Si) (S) Taltala (A)	46 54	46	M
18-19	(N)(W) Haria Nadi (Si) (E) Gunkhali (A) (S) Sibsa (A)	26 19 55	26	S
20 & 20/1	(E) Gengrail, Deluti (A) (W) Gunkhali (A)	76 24	0	S
21	(E) Habar Khali (A) (W) Deluti (A)	50 50	0	S
22	(E) Bhadra, Badurgacha (A) (W) Habrakhali (A)	50 50	0	S
23	(N) Sibsa (A) (S) Karulia, Miraj (A)	50 50	0	S
24	(E) Hari Nadi, Srinadi (Si) (S) Middle Bhadra (A)	90 10	90	US
25	(S) Middle Bhadra (A) (S) Hankura (Si) (W) Hari Nadi, Srinadi (Si)	9 79 12	91	US
26	(N)(E) Middle Bhadra (A) (S)(W) Teligati (A)	50 50	0	S
27/1 & 27/2	(N) Hankura (Si) (E) Upper Solmari (Si) ditto (A) (S) Salta (Si) ditto (A) (W) Hankura (A)	29 28 4 8 2 29	65	US
28/1	(W) Upper Solmari (Si)	100	100	US
28/2	(E) Hatia (Si) (S) Lower Solmari (A) (W) Upper Solmari (Si)	23 54 23	46	M

29	(E) Lower Salta, Middle Bhadra (A)	49	25	S
	(W) Joykali Nadi, Gangrail (A)	51		
30/1 &	(N) Lower Solmari (A)	6		
30/2	(E) Kazibacha (A)	45		
	(W) Lower Salta (A)	24		
	(W) Jhapjhapia (Si)	25		
31	(E) Jhapjhapia (Si)	18	18	S
	(E) Dhaki Nadi (A)	30		
	(W) Lower Bhadra,Badurgacha, Sibsa (A)	52		
32	(E) Lower Bhadra, Shuterkhali (A)	27	0	S
	(W) Dhaki, Sibsa (A)	73		
33	(E) Pussur (A)	47	27	S
	(S) Dhangai Khal (Si)	27		
	(W) Lower Bhadra, Chunkuri (A)	26		
34/1	(S) Bhutramari Khal (Si)	50	50	M
	ditto (A)	50		
34/3	(S) Jhistala Khal (Si)	50	50	M
	(A)	50		
35/1	(N) Sannashi Khal (Si)	12	12	S
	(E) Baleswar (A)	56		
	(W) Bhola (A)	32		
35/3	(E) Poylahara (A)	67	0	S
	(W) Bishnu Nadi (A)	33		
36/1	(E) Alaipur, Madhumati (Si)	59	63	US
	ditto (A)	30		
	(W) Atharabanki, Bhairab (Si)	4		
	ditto (A)	7		
39/1A	(E) Bishkhali (A)	47	25	S
	(S) Katakhali (Si)	25		
	(W) Baleswar (A)	28		
39/1B &	(N) Matbari Khal (Si)	38	38	M
39/1D	(E) Bishkhali (A)	62		
39/1C	(N) Matbari Khal (Si)	38	38	M
	(W) Baleswar (A)	62		
39/2	(W) Sialkakati Nadi, Jangalia Nadi (A)	20	21	S
	(E) Bishkhali (A)	42		
	(S) Matbari (Si)	21		
	(W) Kacha, Baleswar (A)	17		

40/1	(N) Lathimara Khal (Si) (E) Bishkhali (A)	55 45	55	M
40/2	(N) Katakhal (Si) ditto (A) (S) Lathimara Khal (Si) (W) Baleswar (A)	35 34 6 25	41	M
41/1	(N) Khagdon (Si) ditto (A) (S)(E) Buriswar (A) (W) Barguna Khal (Si)	18 18 29 36	54	M
41/2	(N) Khagdon (A) (E) Barguna (Si) (S) Buriswar (A) (W) Local Khal (Si) ditto (A)	20 40 20 10 10	50	M
41/3	(N) Bishkhali (A) (E) Local Khal (Si) ditto (A) (W) Local Khal (Si) ditto (A)	33 17 16 17 16	34	M
41/4	(E) Local Khal (Si) ditto (A)	50 50	50	M
41/5	(N) Local Khal (Si) ditto (A) (E) Buriswar (A) (W) Nah Don Khal (A)	12 12 32 44	12	S
41/6A	(N) Ayla (A) (E) Buriswar (A) (S) Khagdon (Si) ditto (A) (W) Khagdou (Si) ditto (A)	33 17 17 17 8 8	25	S
41/6B	(N) Galachipa Khal (Si) (E) Khagdon (Si) ditto (A) (S) Khagdon (Si) ditto (A) (W) Bishkhali (A)	20 10 10 20 20 20	50	M
41/7	(E) Bighai (A)	100	0	S
42	(N)(W) Bishkhali (A) (E) Nah Dou Khal (A)	29 71	0	S

43/1, 43/1A & 43/1B	(N) Kukna (Si) ditto (A) (E) Dhankhali Dou (A) (S) Nilganj (A) (W) Tiakhali (Si) (W) Tiakhali, Buriswar (A)	5 9 33 12 16 25	21	S
43/2A	(N)(W) Bighai (A) (S)(E) Local Khal (A)	46 54	0	S
43/2B	(E) Galachipa (A) (S)(W) Local Khal (A)	63 37	0	S
43/2C	(E) Galachipa (A) (W) Local Khal (A)	20 80	0	S
43/2D	(N)(E)(S)(W) Local Khals (A)	100	0	S
43/2E	(N)(E) Galachipa (A)	100	0	S
43/2F	(E) Local Khal (A) (W) Buriswar (A)	50 50	0	S
44	(N) Buriswar (A) (E) Nilganj (A) (W) Bagi Don Khal (Si)	39 43 18	18	S
45	(N)(W) Haringhata (A) (E) Bagi Dou (Si) (S) Harin Bharani (Si) ditto (A)	31 31 19 19	40	M
46	(N)(W) Nilganj (A) (S)(E) Sonatala (A)	57 43	0	S
47/1	(N) Sonatala (A) (E) Local Khals (Si) ditto (A) (S) Khaprabhanga (A)	16 28 28 28	28	S
47/2	(E) Tegachia Khal (A) (S) Local Khal (Si)	36 64	64	US
47/3	(E) Local Khals (Si) (W) Sonatala Dou (A)	88 12	88	US
47/4	(N) Nilganj (A) (E) Tiakhali Dou, Baliatali (A) (S) Chapli Khal (A) (W) Local Khals (Si)	12 34 5 49	49	M
47/5	(E) Patna (A) (W) Tiakhali Dou (A)	28 72	0	S
48	(N) Khaprabhanga (A)	100	0	S

52/53 A & B	(E) Bura Gauranga (A) (W) Dane Chisia (A)	25 75	0	S
54	(E) Patna (A) (W) Dhankhali Dou, Tiakhali Dou (A)	21 79	0	S
55/1	(N) Gopalshi Dou (A) (S) Agunmukha (Si) ditto (A) (W) Galachipa (A)	22 34 34 10	34	M
55/2A	(N) Kanakdah Nala, Surjamani Khal, Kalaia Nadi (A) (E)(S) Local Khals (A) (W) Galachipa (A)	19 79 2	0	S
55/2B	(S) Local Khal (A)	100	0	S
55/2C	(E) Gopaldi Dou (A) (N)(S)(W) Local Khal (A)	63 37	0	S
55/2D	(N) Kalaia (A) (E) Tentulia (A) (W) Gopaldi Dou (A)	2 67 31	0	S
55/3	(E) Buraganranga (A) (W) Kajal (A)	76 24	0	S
55/4	(N)(W) Buraganranga (A) (S)(E) Bay of Bengal (A)	9 91	0	S
56/57	(N) Ilisa (E) Lower Meghna,Shahbazpur Channel (A) (S) Bay of Bengal (A) (W) Tentulia, Buraganranga (A)	4 20 27 49	0	S

Notes: (i) (N)(E)(S) & (W) refer to polder boundary, north, east, south and west
(ii) (Si) = silting river
(iii) (A) = active or only slowly silting river
(iv) S,M, US refer to polder condition as satisfactory, marginal and unsatisfactory.

Source: BWDB Inventory of polder systems and Consultant's analysis.

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Appendix E

Results of Simulation on Drainability of Polders

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Table No.

Table E 1

Inundation Areas (km2) of Different Depths for Selected Ventages

Scenario 1 : Existing River Stage Levels

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP1	284	42.9 15.2%	62.1 22.0%	144.0 51.0%	33.3 11.8%	84.3 29.8%	84.9 30.1%	95.0 33.7%	18.2 6.4%	100.2 35.5%	101.0 35.8%	81.1 28.7%	0.0 0.0%	121.5 43.1%	113.2 40.1%	47.6 16.8%	0.0 0.0%	138.2 48.9%	107.8 38.2%	36.3 12.9%	0.0 0.0%
CEP2	123	23.9 19.6%	19.2 15.8%	63.3 52.1%	15.2 12.5%	38.7 31.8%	26.9 22.2%	56.0 46.1%	0.0 0.0%	46.5 38.3%	40.0 32.9%	35.1 28.9%	0.0 0.0%	60.9 50.1%	53.7 44.1%	7.0 5.7%	0.0 0.0%	74.4 61.2%	47.2 38.8%	0.0 0.0%	0.0 0.0%
CEP3	184	9.7 5.4%	55.0 30.7%	99.9 55.8%	14.6 8.1%	44.0 24.6%	74.0 41.3%	57.9 32.3%	3.1 1.7%	71.3 39.8%	68.0 37.9%	39.9 22.3%	0.0 0.0%	105.6 59.0%	60.6 33.8%	12.9 7.2%	0.0 0.0%	122.7 68.5%	48.5 27.1%	7.9 4.4%	0.0 0.0%
CEP4	103	4.8 4.7%	9.4 9.1%	89.0 86.2%	0.0 0.0%	13.3 12.9%	83.8 81.2%	6.1 5.9%	0.0 0.0%	35.7 34.6%	67.5 65.4%	0.0 0.0%	0.0 0.0%	83.5 80.9%	19.7 19.1%	0.0 0.0%	0.0 0.0%	86.7 84.0%	16.5 16.0%	0.0 0.0%	0.0 0.0%
CEP5	554	32.1 6.0%	157.3 29.3%	307.5 57.2%	40.5 7.5%	157.2 29.2%	219.1 40.8%	161.1 30.0%	0.0 0.0%	258.4 48.1%	210.0 39.1%	69.0 12.8%	0.0 0.0%	387.4 72.1%	130.5 24.3%	19.5 3.6%	0.0 0.0%	490.0 91.2%	47.4 8.8%	0.0 0.0%	0.0 0.0%
CEP6-8	259	23.2 9.0%	30.6 11.8%	204.8 79.2%	0.0 0.0%	58.9 22.8%	193.8 75.0%	5.8 2.2%	0.0 0.0%	105.6 40.8%	153.0 59.2%	0.0 0.0%	0.0 0.0%	241.5 93.4%	17.1 6.6%	0.0 0.0%	0.0 0.0%	250.9 97.0%	7.7 3.0%	0.0 0.0%	0.0 0.0%
CEP13-14	147	0.0 0.0%	75.2 51.4%	71.3 48.6%	0.0 0.0%	100.7 68.7%	45.8 31.3%	0.0 0.0%	0.0 0.0%	146.5 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	146.5 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	146.5 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP16/1&2	104	25.1 24.0%	23.6 22.6%	46.4 44.4%	9.3 8.9%	47.3 45.3%	20.1 19.2%	37.1 35.5%	0.0 0.0%	56.5 54.1%	31.7 30.3%	16.3 15.6%	0.0 0.0%	72.9 69.8%	31.5 30.2%	0.0 0.0%	0.0 0.0%	101.0 96.7%	3.4 3.3%	0.0 0.0%	0.0 0.0%
CEP17/1	50	0.0 0.0%	23.3 46.4%	26.9 53.6%	0.0 0.0%	24.1 48.0%	26.1 52.0%	0.0 0.0%	0.0 0.0%	33.2 66.2%	16.9 33.8%	0.0 0.0%	0.0 0.0%	37.9 75.6%	12.2 24.4%	0.0 0.0%	0.0 0.0%	38.1 75.9%	12.1 24.1%	0.0 0.0%	0.0 0.0%
CEP17-2	34	10.3 30.4%	11.1 32.7%	3.0 8.9%	9.5 28.0%	24.3 71.5%	1.4 4.0%	8.3 24.5%	0.0 0.0%	24.5 72.1%	7.3 21.6%	2.1 6.3%	0.0 0.0%	28.1 82.6%	5.9 17.4%	0.0 0.0%	0.0 0.0%	26.4 82.6%	7.6 17.4%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res8 wk1

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Table E 1
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP18-19	33	0.0 0.0%	15.5 47.4%	17.3 52.6%	0.0 0.0%	17.3 52.7%	15.5 47.3%	0.0 0.0%	0.0 0.0%	19.6 59.8%	13.2 40.2%	0.0 0.0%	0.0 0.0%	32.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	32.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP24	283	31.9 11.3%	55.2 19.5%	164.2 57.9%	32.0 11.3%	47.4 16.7%	63.1 22.3%	152.1 53.7%	20.7 7.3%	56.6 20.0%	72.7 25.6%	154.0 54.4%	0.0 0.0%	74.8 26.4%	91.5 32.3%	117.1 41.3%	0.0 0.0%	89.3 31.5%	104.7 36.9%	89.4 31.5%	0.0 0.0%
CEP25	194	4.1 2.1%	50.0 25.7%	140.2 72.2%	0.0 0.0%	4.9 2.5%	54.5 28.0%	135.0 69.5%	0.0 0.0%	5.2 2.7%	55.6 28.6%	133.4 68.7%	0.0 0.0%	5.9 3.0%	57.1 29.4%	131.2 67.6%	0.0 0.0%	6.4 3.3%	58.1 29.9%	129.8 66.8%	0.0 0.0%
CEP26	27	0.0 0.1%	7.0 25.9%	20.0 74.1%	0.0 0.0%	13.9 51.5%	13.1 48.5%	0.0 0.0%	0.0 0.0%	21.4 79.4%	5.6 20.6%	0.0 0.0%	0.0 0.0%	23.9 88.6%	3.1 11.4%	0.0 0.0%	0.0 0.0%	23.9 88.8%	3.0 11.2%	0.0 0.0%	0.0 0.0%
CEP27-1&2	43	0.0 0.0%	6.9 16.2%	35.6 83.8%	0.0 0.0%	3.7 8.7%	30.5 71.7%	8.3 19.5%	0.0 0.0%	13.6 31.9%	23.0 54.1%	6.0 14.0%	0.0 0.0%	32.6 76.8%	9.9 23.2%	0.0 0.0%	0.0 0.0%	36.5 85.9%	6.0 14.1%	0.0 0.0%	0.0 0.0%
CEP28-1&2	56	0.0 0.0%	11.1 19.8%	38.7 68.8%	6.4 11.4%	0.0 0.1%	32.1 57.1%	24.1 42.8%	0.0 0.0%	0.1 0.2%	38.0 67.5%	18.2 32.3%	0.0 0.0%	0.2 0.4%	41.4 73.6%	14.6 26.0%	0.0 0.0%	1.2 2.2%	41.8 74.4%	13.2 23.5%	0.0 0.0%
CEP34-1	24	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	8.6 35.3%	15.7 64.7%	0.0 0.0%	0.0 0.0%	12.6 51.8%	11.7 48.2%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP34-3	32	0.0 0.0%	0.0 0.0%	21.3 65.7%	11.1 34.3%	11.0 33.8%	10.3 31.7%	11.2 34.5%	0.0 0.0%	19.8 61.1%	6.4 19.8%	6.2 19.0%	0.0 0.0%	27.9 86.1%	4.5 13.9%	0.0 0.0%	0.0 0.0%	28.3 87.4%	4.1 12.6%	0.0 0.0%	0.0 0.0%
CEP35-1	148	0.0 0.0%	0.0 0.0%	0.0 0.0%	56.0 100.0%	16.3 29.1%	9.5 17.0%	19.8 35.3%	10.4 18.6%	35.5 63.4%	10.0 17.8%	10.5 18.8%	0.0 0.0%	43.9 78.4%	4.2 7.5%	7.9 14.1%	0.0 0.0%	43.9 78.4%	4.2 7.5%	7.9 14.1%	0.0 0.0%
CEP36-1	400	88.7 24.0%	98.7 26.7%	31.8 8.6%	150.3 40.7%	132.7 35.9%	75.5 20.4%	24.7 6.7%	136.5 37.0%	150.8 40.8%	62.5 16.9%	39.4 10.7%	116.8 31.6%	184.5 49.9%	32.8 8.9%	106.0 28.7%	46.2 12.5%	206.0 55.8%	11.6 3.1%	146.7 39.7%	5.2 1.4%
CEP39-1B&D	125	2.2 1.8%	32.9 26.2%	90.3 72.0%	0.0 0.0%	31.9 25.4%	93.5 74.6%	0.0 0.0%	0.0 0.0%	80.4 64.1%	45.0 35.9%	0.0 0.0%	0.0 0.0%	121.1 96.6%	4.3 3.4%	0.0 0.0%	0.0 0.0%	121.1 96.6%	4.3 3.4%	0.0 0.0%	0.0 0.0%
CEP39-1C	49	0.8 1.7%	23.2 47.5%	24.8 50.8%	0.0 0.0%	26.1 53.5%	22.7 46.5%	0.0 0.0%	0.0 0.0%	27.6 56.5%	21.3 43.5%	0.0 0.0%	0.0 0.0%	48.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	48.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)

Source : Consultants Simulation

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Table E 1
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP40-1	21	0.1 0.6%	0.6 2.7%	9.2 43.7%	11.2 53.0%	1.8 8.6%	8.0 37.9%	11.3 53.6%	0.0 0.0%	5.7 27.2%	15.3 72.8%	0.0 0.0%	0.0 0.0%	21.1 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	21.1 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP40-2	37	0.0 0.0%	0.5 1.5%	27.1 73.7%	9.1 24.8%	17.0 46.2%	19.8 53.8%	0.0 0.0%	0.0 0.0%	35.1 95.4%	1.7 4.6%	0.0 0.0%	0.0 0.0%	35.1 95.4%	1.7 4.6%	0.0 0.0%	0.0 0.0%	35.1 95.4%	1.7 4.6%	0.0 0.0%	0.0 0.0%
CEP41-1	32	0.0 0.0%	0.0 0.0%	17.9 55.3%	14.5 44.7%	16.1 49.6%	16.3 50.4%	0.0 0.0%	0.0 0.0%	31.7 98.0%	0.6 2.0%	0.0 0.0%	0.0 0.0%	31.7 98.0%	0.6 2.0%	0.0 0.0%	0.0 0.0%	31.7 98.0%	0.6 2.0%	0.0 0.0%	0.0 0.0%
CEP41-2	28	0.0 0.0%	0.0 0.0%	16.0 56.4%	12.3 43.6%	0.0 0.0%	18.4 65.0%	9.9 35.0%	0.0 0.0%	13.0 46.0%	15.3 54.0%	0.0 0.0%	0.0 0.0%	28.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	28.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP41-3	8	0.0 0.0%	0.0 0.0%	5.9 72.6%	2.2 27.4%	5.1 62.9%	3.0 37.1%	0.0 0.0%	0.0 0.0%	8.1 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	8.1 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	8.1 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP41-4	12	0.0 0.0%	0.0 0.0%	10.5 86.2%	1.7 13.8%	8.2 67.6%	3.9 32.4%	0.0 0.0%	0.0 0.0%	11.6 95.6%	0.5 4.4%	0.0 0.0%	0.0 0.0%	11.6 95.6%	0.5 4.4%	0.0 0.0%	0.0 0.0%	11.6 95.6%	0.5 4.4%	0.0 0.0%	0.0 0.0%
CEP41-5	24	0.0 0.0%	0.0 0.0%	15.3 62.8%	9.0 37.2%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP41-6A	40	0.0 0.0%	0.0 0.0%	24.3 60.4%	15.9 39.6%	13.5 33.5%	20.2 50.2%	6.6 16.3%	0.0 0.0%	25.4 63.1%	14.8 36.9%	0.0 0.0%	0.0 0.0%	37.5 93.2%	2.7 6.8%	0.0 0.0%	0.0 0.0%	37.5 93.2%	2.7 6.8%	0.0 0.0%	0.0 0.0%
CEP41-6B	69	0.0 0.0%	0.0 0.0%	47.5 69.2%	21.1 30.8%	0.2 0.2%	41.4 60.3%	27.1 39.4%	0.0 0.0%	9.2 13.4%	59.1 86.0%	0.4 0.6%	0.0 0.0%	65.3 95.1%	3.3 4.9%	0.0 0.0%	0.0 0.0%	65.8 95.9%	2.8 4.1%	0.0 0.0%	0.0 0.0%
CEP42	28	0.0 0.0%	0.0 0.0%	23.0 82.5%	4.9 17.5%	26.7 95.7%	1.2 4.3%	0.0 0.0%	0.0 0.0%	26.7 95.7%	1.2 4.3%	0.0 0.0%	0.0 0.0%	26.7 95.7%	1.2 4.3%	0.0 0.0%	0.0 0.0%	26.7 95.7%	1.2 4.3%	0.0 0.0%	0.0 0.0%
CEP43-2A	49	0.0 0.0%	0.0 0.0%	25.0 51.5%	23.5 48.5%	27.9 57.3%	20.7 42.7%	0.0 0.0%	0.0 0.0%	41.6 85.6%	7.0 14.4%	0.0 0.0%	0.0 0.0%	41.6 85.6%	7.0 14.4%	0.0 0.0%	0.0 0.0%	41.6 85.6%	7.0 14.4%	0.0 0.0%	0.0 0.0%
CEP43-2B	55	0.0 0.0%	0.0 0.0%	0.0 0.0%	54.6 100.0%	0.0 0.0%	5.3 9.8%	49.3 90.2%	0.0 0.0%	0.0 0.0%	45.4 83.1%	9.2 16.9%	0.0 0.0%	23.6 43.2%	31.0 56.8%	0.0 0.0%	0.0 0.0%	45.2 82.7%	9.4 17.3%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res8.wk1

Table E 1
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP43-2C	28	0.0 0.0%	0.0 0.0%	0.0 0.0%	27.5 100.0%	0.0 0.0%	15.3 55.5%	12.2 44.5%	0.0 0.0%	2.0 7.2%	25.5 92.8%	0.0 0.0%	0.0 0.0%	27.5 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	27.5 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP45	41	0.0 0.0%	0.0 0.0%	11.9 29.0%	29.0 71.0%	0.0 0.0%	2.6 6.3%	29.7 72.6%	8.6 21.1%	0.0 0.0%	16.0 39.2%	24.9 60.8%	0.0 0.0%	11.8 28.8%	17.2 42.1%	11.9 29.0%	0.0 0.0%	22.6 55.2%	18.3 44.8%	0.0 0.0%	0.0 0.0%
CEP47-1	21	0.0 0.0%	0.0 0.0%	0.0 0.0%	9.7 100.0%	6.0 62.5%	3.2 33.6%	0.4 3.9%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%
CEP47-2	10	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	5.6 54.8%	4.6 45.2%	0.0 0.0%	1.9 18.6%	8.3 81.4%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP47-3	24	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.3 1.2%	24.0 98.8%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%
CEP47-4	36	0.0 0.0%	0.0 0.0%	1.4 3.8%	35.1 96.2%	13.4 36.9%	23.0 63.1%	0.0 0.0%	0.0 0.0%	32.5 89.2%	3.9 10.8%	0.0 0.0%	0.0 0.0%	34.8 95.5%	1.6 4.5%	0.0 0.0%	0.0 0.0%	34.8 95.5%	1.6 4.5%	0.0 0.0%	0.0 0.0%
CEP47-5	16	0.0 0.0%	0.0 0.0%	0.5 3.3%	15.6 96.7%	13.3 82.2%	2.9 17.8%	0.0 0.0%	0.0 0.0%	16.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	16.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	16.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP48	54	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.6 100.0%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%
CEP52-53A&B	80	0.0 0.0%	0.0 0.0%	0.0 0.0%	80.3 100.0%	0.8 1.0%	70.3 87.6%	9.2 11.5%	0.0 0.0%	59.5 74.1%	20.8 25.9%	0.0 0.0%	0.0 0.0%	68.3 85.1%	12.0 14.9%	0.0 0.0%	0.0 0.0%	68.3 85.1%	12.0 14.9%	0.0 0.0%	0.0 0.0%
CEP54	93	0.0 0.0%	0.0 0.0%	4.0 4.3%	89.1 95.7%	0.0 0.0%	93.2 100.0%	0.0 0.0%	0.0 0.0%	51.2 54.9%	42.0 45.1%	0.0 0.0%	0.0 0.0%	93.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	93.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP55-1	108	0.0 0.0%	0.0 0.0%	3.5 3.3%	104.5 96.7%	1.5 1.4%	91.5 84.7%	15.0 13.9%	0.0 0.0%	24.4 22.6%	83.6 77.4%	0.0 0.0%	0.0 0.0%	100.5 93.1%	7.5 6.9%	0.0 0.0%	0.0 0.0%	100.5 93.1%	7.5 6.9%	0.0 0.0%	0.0 0.0%
CEP55-2A	132	0.0 0.0%	0.0 0.0%	0.0 0.0%	132.3 100.0%	8.9 6.7%	109.0 82.4%	14.4 10.9%	0.0 0.0%	74.4 56.3%	57.9 43.7%	0.0 0.0%	0.0 0.0%	103.3 78.1%	29.0 21.9%	0.0 0.0%	0.0 0.0%	103.3 78.1%	29.0 21.9%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)

Source : Consultants Simulation

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Table E 1
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP55-2B	26	0.0	0.0	0.0	26.3	7.5	18.9	0.0	0.0	15.3	11.0	0.0	0.0	19.4	6.9	0.0	0.0	19.4	6.9	0.0	0.0
		0.0%	0.0%	0.0%	100.0%	28.4%	71.6%	0.0%	0.0%	58.1%	41.9%	0.0%	0.0%	73.9%	26.1%	0.0%	0.0%	73.9%	26.1%	0.0%	0.0%
CEP55-2C	63	0.0	0.0	3.9	58.8	14.8	48.0	0.0	0.0	33.3	29.4	0.0	0.0	48.1	14.7	0.0	0.0	48.1	14.7	0.0	0.0
		0.0%	0.0%	6.2%	93.8%	23.6%	76.4%	0.0%	0.0%	53.1%	46.9%	0.0%	0.0%	76.6%	23.4%	0.0%	0.0%	76.6%	23.4%	0.0%	0.0%
CEP55-2D	222	0.0	0.0	17.0	205.3	38.6	152.5	31.1	0.0	114.6	107.6	0.0	0.0	179.8	42.4	0.0	0.0	179.8	42.4	0.0	0.0
		0.0%	0.0%	7.6%	92.4%	17.4%	68.6%	14.0%	0.0%	51.6%	48.4%	0.0%	0.0%	80.9%	19.1%	0.0%	0.0%	80.9%	19.1%	0.0%	0.0%
CEP55-3	98	0.0	0.0	4.9	93.6	2.9	66.9	28.7	0.0	42.0	56.4	0.0	0.0	81.9	16.5	0.0	0.0	81.9	16.5	0.0	0.0
		0.0%	0.0%	5.0%	95.0%	2.9%	67.9%	29.2%	0.0%	42.7%	57.3%	0.0%	0.0%	83.2%	16.8%	0.0%	0.0%	83.2%	16.8%	0.0%	0.0%
CEP55-4	51	0.0	0.0	0.1	51.4	0.0	47.1	4.3	0.0	19.6	31.8	0.0	0.0	47.4	4.0	0.0	0.0	47.4	4.0	0.0	0.0
		0.0%	0.0%	0.1%	99.9%	0.1%	91.6%	8.3%	0.0%	38.1%	61.9%	0.0%	0.0%	92.2%	7.8%	0.0%	0.0%	92.2%	7.8%	0.0%	0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)

Source : Consultants Simulation

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Table E 2

Inundation Areas (km2) of Different Depths for Selected Ventages

Scenario 2 : River Levels Lowered by 200 mm

Polder Ref	Polder Area (km2)	No Ventage F0	No Ventage F1	No Ventage F2	No Ventage F3	Ventage 30% F0	Ventage 30% F1	Ventage 30% F2	Ventage 30% F3	Ventage 50% F0	Ventage 50% F1	Ventage 50% F2	Ventage 50% F3	Ventage 100% F0	Ventage 100% F1	Ventage 100% F2	Ventage 100% F3	Ventage 150% F0	Ventage 150% F1	Ventage 150% F2	Ventage 150% F3
CEP1	284	42.9	62.1	144.0	33.3	92.2	93.3	96.8	0.0	111.8	107.9	62.6	0.0	156.6	96.9	28.8	0.0	191.0	69.5	21.8	0.0
		15.2%	22.0%	51.0%	11.8%	32.7%	33.0%	34.3%	0.0%	39.6%	38.2%	22.2%	0.0%	55.5%	34.3%	10.2%	0.0%	67.7%	24.6%	7.7%	0.0%
CEP2	123	23.9	19.2	63.3	15.2	41.5	29.9	50.2	0.0	51.9	45.7	24.0	0.0	73.0	48.5	0.0	0.0	97.1	24.5	0.0	0.0
		19.6%	15.8%	52.1%	12.5%	34.1%	24.6%	41.3%	0.0%	42.7%	37.6%	19.7%	0.0%	60.1%	39.9%	0.0%	0.0%	79.9%	20.1%	0.0%	0.0%
CEP3	184	9.7	55.0	99.9	14.6	49.9	75.2	52.1	2.0	84.4	67.7	27.0	0.0	122.4	48.8	7.9	0.0	151.3	24.1	3.7	0.0
		5.4%	30.7%	55.8%	8.1%	27.9%	42.0%	29.1%	1.1%	47.1%	37.8%	15.1%	0.0%	68.3%	27.2%	4.4%	0.0%	84.5%	13.4%	2.1%	0.0%
CEP4	103	4.8	9.4	89.0	0.0	21.5	81.7	0.0	0.0	58.5	44.7	0.0	0.0	93.0	10.2	0.0	0.0	94.7	8.5	0.0	0.0
		4.7%	9.1%	86.2%	0.0%	20.9%	79.1%	0.0%	0.0%	56.7%	43.3%	0.0%	0.0%	90.2%	9.8%	0.0%	0.0%	91.8%	8.2%	0.0%	0.0%
CEP5	554	32.1	157.3	307.5	40.5	177.5	212.3	147.6	0.0	277.8	201.9	57.8	0.0	429.6	92.5	15.4	0.0	497.1	40.3	0.0	0.0
		6.0%	29.3%	57.2%	7.5%	33.0%	39.5%	27.5%	0.0%	51.7%	37.6%	10.7%	0.0%	79.9%	17.2%	2.9%	0.0%	92.5%	7.5%	0.0%	0.0%
CEP6-8	259	23.2	30.6	204.8	0.0	67.6	186.8	4.2	0.0	137.0	121.6	0.0	0.0	250.9	7.7	0.0	0.0	250.9	7.7	0.0	0.0
		9.0%	11.8%	79.2%	0.0%	26.1%	72.2%	1.6%	0.0%	53.0%	47.0%	0.0%	0.0%	97.0%	3.0%	0.0%	0.0%	97.0%	3.0%	0.0%	0.0%
CEP16/1&2	104	25.1	23.6	46.4	9.3	48.8	19.6	35.9	0.0	58.2	35.6	10.6	0.0	79.4	25.0	0.0	0.0	101.1	3.3	0.0	0.0
		24.0%	22.6%	44.4%	8.9%	46.8%	18.8%	34.4%	0.0%	55.7%	34.1%	10.2%	0.0%	76.0%	24.0%	0.0%	0.0%	96.8%	3.2%	0.0%	0.0%
CEP17/1	50	0.0	23.3	26.9	0.0	27.1	23.0	0.0	0.0	50.2	0.0	0.0	0.0	50.2	0.0	0.0	0.0	50.2	0.0	0.0	0.0
		0.0%	46.4%	53.6%	0.0%	54.1%	45.9%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP17-2	34	10.3	11.1	3.0	9.5	24.5	3.2	6.3	0.0	25.8	8.2	0.0	0.0	31.1	2.9	0.0	0.0	31.1	2.9	0.0	0.0
		30.4%	32.7%	8.9%	28.0%	71.9%	9.6%	18.5%	0.0%	75.8%	24.2%	0.0%	0.0%	91.5%	8.5%	0.0%	0.0%	91.5%	8.5%	0.0%	0.0%
CEP18-19	33	0.0	15.5	17.3	0.0	17.7	15.1	0.0	0.0	32.8	0.0	0.0	0.0	32.8	0.0	0.0	0.0	32.8	0.0	0.0	0.0
		0.0%	47.4%	52.6%	0.0%	53.9%	46.1%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP26	27	0.0	7.0	20.0	0.0	23.0	3.9	0.0	0.0	27.0	0.0	0.0	0.0	27.0	0.0	0.0	0.0	27.0	0.0	0.0	0.0
		0.1%	25.9%	74.1%	0.0%	85.5%	14.5%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP27-1&2	43	0.0	6.9	35.6	0.0	5.5	29.8	7.3	0.0	18.4	18.5	5.7	0.0	34.7	7.8	0.0	0.0	36.5	6.0	0.0	0.0
		0.0%	16.2%	83.8%	0.0%	12.9%	70.0%	17.1%	0.0%	43.2%	43.4%	13.3%	0.0%	81.7%	18.3%	0.0%	0.0%	85.9%	14.1%	0.0%	0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)

Source : Consultants Simulation

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Table E 3

Inundation Areas (km2) of Different Depths for Selected Ventages

Scenario 3 : River Levels Raised by 200 mm

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP1	284	42.9 15.2%	62.1 22.0%	144.0 51.0%	33.3 11.8%	76.1 27.0%	75.6 26.8%	111.5 39.5%	19.2 6.8%	89.6 31.7%	90.5 32.1%	102.2 36.2%	0.0 0.0%	103.7 36.7%	102.9 36.4%	75.7 26.8%	0.0 0.0%	108.5 38.4%	105.5 37.4%	68.2 24.2%	0.0 0.0%
CEP2	123	23.9 19.6%	19.2 15.8%	63.3 52.1%	15.2 12.5%	36.6 30.1%	24.9 20.5%	60.1 49.4%	0.0 0.0%	42.8 35.2%	32.5 26.7%	46.3 38.1%	0.0 0.0%	53.9 44.3%	46.5 38.2%	21.2 17.5%	0.0 0.0%	59.5 48.9%	53.3 43.8%	8.8 7.2%	0.0 0.0%
CEP3	184	9.7 5.4%	55.0 30.7%	99.9 55.8%	14.6 8.1%	38.1 21.3%	73.5 41.0%	63.2 35.3%	4.3 2.4%	54.3 30.3%	73.8 41.2%	51.0 28.5%	0.0 0.0%	88.0 49.1%	66.5 37.1%	24.6 13.7%	0.0 0.0%	100.6 56.1%	62.3 34.8%	16.3 9.1%	0.0 0.0%
CEP4	103	4.8 4.7%	9.4 9.1%	89.0 86.2%	0.0 0.0%	8.8 8.5%	84.6 82.0%	9.8 9.5%	0.0 0.0%	19.2 18.6%	84.0 81.4%	0.0 0.0%	0.0 0.0%	52.1 50.5%	51.1 49.5%	0.0 0.0%	0.0 0.0%	58.4 56.6%	44.8 43.4%	0.0 0.0%	0.0 0.0%
CEP5	554	32.1 6.0%	157.3 29.3%	307.5 57.2%	40.5 7.5%	142.9 26.6%	222.7 41.4%	162.4 30.2%	9.4 1.8%	239.6 44.6%	215.0 40.0%	82.8 15.4%	0.0 0.0%	356.4 66.3%	155.9 29.0%	25.1 4.7%	0.0 0.0%	461.3 85.8%	62.7 11.7%	13.4 2.5%	0.0 0.0%
CEP6-8	259	23.2 9.0%	30.6 11.8%	204.8 79.2%	0.0 0.0%	51.5 19.9%	193.1 74.7%	14.0 5.4%	0.0 0.0%	76.5 29.6%	178.9 69.2%	3.1 1.2%	0.0 0.0%	186.6 72.2%	72.0 27.8%	0.0 0.0%	0.0 0.0%	229.8 88.9%	28.8 11.1%	0.0 0.0%	0.0 0.0%
CEP13-14	147	0.0 0.0%	75.2 51.4%	71.3 48.6%	0.0 0.0%	88.8 60.6%	57.7 39.4%	0.0 0.0%	0.0 0.0%	120.9 82.5%	25.6 17.5%	0.0 0.0%	0.0 0.0%	103.6 70.7%	42.9 29.3%	0.0 0.0%	0.0 0.0%	103.6 70.7%	42.9 29.3%	0.0 0.0%	0.0 0.0%
CEP16/1&2	104	25.1 24.0%	23.6 22.6%	46.4 44.4%	9.3 8.9%	45.6 43.6%	20.5 19.6%	38.3 36.7%	0.0 0.0%	54.9 52.6%	26.8 25.7%	22.7 21.7%	0.0 0.0%	68.5 65.6%	35.9 34.4%	0.0 0.0%	0.0 0.0%	92.9 89.0%	11.5 11.0%	0.0 0.0%	0.0 0.0%
CEP17/1	50	0.0 0.0%	23.3 46.4%	26.9 53.6%	0.0 0.0%	23.4 46.7%	26.8 53.3%	0.0 0.0%	0.0 0.0%	25.2 50.1%	25.0 49.9%	0.0 0.0%	0.0 0.0%	26.8 53.4%	23.4 46.6%	0.0 0.0%	0.0 0.0%	28.3 56.4%	21.9 43.6%	0.0 0.0%	0.0 0.0%
CEP17-2	34	10.3 30.4%	11.1 32.7%	3.0 8.9%	9.5 28.0%	24.0 70.6%	0.6 1.8%	9.4 27.6%	0.0 0.0%	24.5 72.0%	4.7 13.8%	4.8 14.2%	0.0 0.0%	25.4 74.6%	8.6 25.4%	0.0 0.0%	0.0 0.0%	24.9 73.4%	9.1 26.6%	0.0 0.0%	0.0 0.0%
CEP18-19	33	0.0 0.0%	15.5 47.4%	17.3 52.6%	0.0 0.0%	14.8 45.2%	18.0 54.8%	0.0 0.0%	0.0 0.0%	17.9 54.7%	14.8 45.3%	0.0 0.0%	0.0 0.0%	32.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	32.8 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res7.wk1

Table E 3
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP24	283	31.9	55.2	164.2	32.0	44.6	61.4	153.9	23.4	52.6	67.1	163.6	0.0	66.1	84.8	132.3	0.0	78.7	93.7	110.9	0.0
		11.3%	19.5%	57.9%	11.3%	15.7%	21.7%	54.3%	8.2%	18.6%	23.7%	57.7%	0.0%	23.3%	29.9%	46.7%	0.0%	27.8%	33.1%	39.1%	0.0%
CEP25	194	4.1	50.0	140.2	0.0	4.7	53.6	136.0	0.0	4.8	54.3	135.1	0.0	5.0	55.2	134.1	0.0	5.0	55.2	134.1	0.0
		2.1%	25.7%	72.2%	0.0%	2.4%	27.6%	70.0%	0.0%	2.5%	28.0%	69.5%	0.0%	2.6%	28.4%	69.0%	0.0%	2.6%	28.4%	69.0%	0.0%
CEP26	27	0.0	7.0	20.0	0.0	4.2	22.8	0.0	0.0	8.7	18.3	0.0	0.0	11.1	15.8	0.0	0.0	9.6	17.3	0.0	0.0
		0.1%	25.9%	74.1%	0.0%	15.4%	84.6%	0.0%	0.0%	32.3%	67.7%	0.0%	0.0%	41.3%	58.7%	0.0%	0.0%	35.8%	64.2%	0.0%	0.0%
CEP27-1&2	43	0.0	6.9	35.6	0.0	2.8	30.4	9.3	0.0	8.0	28.5	6.0	0.0	29.7	12.8	0.0	0.0	33.8	8.7	0.0	0.0
		0.0%	16.2%	83.8%	0.0%	6.6%	71.4%	21.9%	0.0%	18.9%	66.9%	14.2%	0.0%	69.9%	30.1%	0.0%	0.0%	79.6%	20.4%	0.0%	0.0%
CEP28-1&2	56	0.0	11.1	38.7	6.4	0.0	20.7	35.5	0.0	0.0	26.3	30.0	0.0	0.0	31.6	24.6	0.0	0.1	33.4	22.8	0.0
		0.0%	19.8%	68.8%	11.4%	0.0%	36.8%	63.1%	0.0%	0.0%	46.7%	53.3%	0.0%	0.1%	56.2%	43.7%	0.0%	0.1%	59.3%	40.6%	0.0%
CEP34-1	24	0.0	0.0	24.3	0.0	3.4	20.9	0.0	0.0	10.6	13.6	0.0	0.0	24.3	0.0	0.0	0.0	24.3	0.0	0.0	0.0
		0.0%	0.0%	100.0%	0.0%	13.9%	86.1%	0.0%	0.0%	43.8%	56.2%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP34-3	32	0.0	0.0	21.3	11.1	7.1	14.1	11.2	0.0	18.6	4.9	8.9	0.0	22.9	9.4	0.0	0.0	27.0	5.4	0.0	0.0
		0.0%	0.0%	65.7%	34.3%	21.9%	43.5%	34.6%	0.0%	57.4%	15.0%	27.5%	0.0%	70.8%	29.2%	0.0%	0.0%	83.4%	16.6%	0.0%	0.0%
CEP35-1	148	0.0	0.0	0.0	56.0	14.4	8.3	22.5	10.7	30.1	15.1	10.8	0.0	40.9	6.3	8.8	0.0	40.9	6.3	8.8	0.0
		0.0%	0.0%	0.0%	100.0%	25.8%	14.9%	40.2%	19.1%	53.8%	26.9%	19.3%	0.0%	73.0%	11.3%	15.7%	0.0%	73.0%	11.3%	15.7%	0.0%
CEP36-1	400	88.7	98.7	31.8	150.3	130.5	77.1	23.5	138.4	147.3	65.2	35.0	122.0	178.1	38.9	91.7	60.8	200.7	16.8	137.3	14.7
		24.0%	26.7%	8.6%	40.7%	35.3%	20.9%	6.4%	37.5%	39.9%	17.6%	9.5%	33.0%	48.2%	10.5%	24.8%	16.5%	54.3%	4.5%	37.2%	4.0%
CEP39-1B&D	125	2.2	32.9	90.3	0.0	24.4	101.0	0.0	0.0	66.1	59.3	0.0	0.0	118.6	6.8	0.0	0.0	118.6	6.8	0.0	0.0
		1.8%	26.2%	72.0%	0.0%	19.4%	80.6%	0.0%	0.0%	52.7%	47.3%	0.0%	0.0%	94.6%	5.4%	0.0%	0.0%	94.6%	5.4%	0.0%	0.0%
CEP39-1C	49	0.8	23.2	24.8	0.0	24.7	24.1	0.0	0.0	27.5	21.3	0.0	0.0	48.8	0.0	0.0	0.0	48.8	0.0	0.0	0.0
		1.7%	47.5%	50.8%	0.0%	50.6%	49.4%	0.0%	0.0%	56.4%	43.6%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP40-1	21	0.1	0.6	9.2	11.2	1.5	7.9	11.6	0.0	5.0	16.1	0.0	0.0	10.1	11.0	0.0	0.0	21.1	0.0	0.0	0.0
		0.6%	2.7%	43.7%	53.0%	7.0%	37.7%	55.3%	0.0%	23.6%	76.4%	0.0%	0.0%	47.8%	52.2%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res7.wk1

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Table E 3
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP40-2	37	0.0	0.5	27.1	9.1	11.4	25.4	0.0	0.0	34.9	1.9	0.0	0.0	35.1	1.7	0.0	0.0	35.1	1.7	0.0	0.0
		0.0%	1.5%	73.7%	24.8%	30.9%	69.1%	0.0%	0.0%	94.9%	5.1%	0.0%	0.0%	95.4%	4.6%	0.0%	0.0%	95.4%	4.6%	0.0%	0.0%
CEP41-1	32	0.0	0.0	17.9	14.5	12.7	19.7	0.0	0.0	28.4	4.0	0.0	0.0	31.7	0.6	0.0	0.0	31.7	0.6	0.0	0.0
		0.0%	0.0%	55.3%	44.7%	39.1%	60.9%	0.0%	0.0%	87.6%	12.4%	0.0%	0.0%	98.0%	2.0%	0.0%	0.0%	98.0%	2.0%	0.0%	0.0%
CEP41-2	28	0.0	0.0	16.0	12.3	0.0	16.6	11.7	0.0	8.0	20.3	0.0	0.0	28.3	0.0	0.0	0.0	28.3	0.0	0.0	0.0
		0.0%	0.0%	56.4%	43.6%	0.0%	58.6%	41.4%	0.0%	28.4%	71.6%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP41-3	8	0.0	0.0	5.9	2.2	4.2	3.9	0.0	0.0	8.1	0.0	0.0	0.0	8.1	0.0	0.0	0.0	8.1	0.0	0.0	0.0
		0.0%	0.0%	72.6%	27.4%	51.4%	48.6%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP41-4	12	0.0	0.0	10.5	1.7	5.9	6.2	0.0	0.0	11.6	0.5	0.0	0.0	11.6	0.5	0.0	0.0	11.6	0.5	0.0	0.0
		0.0%	0.0%	86.2%	13.8%	48.9%	51.1%	0.0%	0.0%	95.6%	4.4%	0.0%	0.0%	95.6%	4.4%	0.0%	0.0%	95.6%	4.4%	0.0%	0.0%
CEP41-5	24	0.0	0.0	15.3	9.0	24.3	0.0	0.0	0.0	24.3	0.0	0.0	0.0	24.3	0.0	0.0	0.0	24.3	0.0	0.0	0.0
		0.0%	0.0%	62.8%	37.2%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
CEP41-6A	40	0.0	0.0	24.3	15.9	11.5	18.3	10.5	0.0	24.4	15.9	0.0	0.0	37.5	2.7	0.0	0.0	37.5	2.7	0.0	0.0
		0.0%	0.0%	60.4%	39.6%	28.6%	45.4%	26.0%	0.0%	60.6%	39.4%	0.0%	0.0%	93.2%	6.8%	0.0%	0.0%	93.2%	6.8%	0.0%	0.0%
CEP41-6B	69	0.0	0.0	47.5	21.1	0.1	35.6	33.0	0.0	5.2	61.5	2.0	0.0	55.7	13.0	0.0	0.0	65.8	2.8	0.0	0.0
		0.0%	0.0%	69.2%	30.8%	0.1%	51.9%	48.0%	0.0%	7.5%	89.5%	2.9%	0.0%	81.1%	18.9%	0.0%	0.0%	95.9%	4.1%	0.0%	0.0%
CEP42	28	0.0	0.0	23.0	4.9	26.7	1.2	0.0	0.0	26.7	1.2	0.0	0.0	26.7	1.2	0.0	0.0	26.7	1.2	0.0	0.0
		0.0%	0.0%	82.5%	17.5%	95.7%	4.3%	0.0%	0.0%	95.7%	4.3%	0.0%	0.0%	95.7%	4.3%	0.0%	0.0%	95.7%	4.3%	0.0%	0.0%
CEP43-2A	49	0.0	0.0	25.0	23.5	26.6	21.9	0.0	0.0	37.1	11.4	0.0	0.0	37.1	11.4	0.0	0.0	37.1	11.4	0.0	0.0
		0.0%	0.0%	51.5%	48.5%	54.8%	45.2%	0.0%	0.0%	76.4%	23.6%	0.0%	0.0%	76.4%	23.6%	0.0%	0.0%	76.4%	23.6%	0.0%	0.0%
CEP43-2B	55	0.0	0.0	0.0	54.6	0.0	0.6	54.1	0.0	0.0	24.1	30.5	0.0	1.5	52.0	1.1	0.0	9.8	44.8	0.0	0.0
		0.0%	0.0%	0.0%	100.0%	0.0%	1.1%	98.9%	0.0%	0.0%	44.2%	55.8%	0.0%	2.7%	95.2%	2.1%	0.0%	18.0%	82.0%	0.0%	0.0%
CEP43-2C	28	0.0	0.0	0.0	27.5	0.0	11.3	16.3	0.0	0.0	27.5	0.0	0.0	15.0	12.5	0.0	0.0	16.6	11.0	0.0	0.0
		0.0%	0.0%	0.0%	100.0%	0.0%	40.9%	59.1%	0.0%	0.0%	100.0%	0.0%	0.0%	54.4%	45.6%	0.0%	0.0%	60.2%	39.8%	0.0%	0.0%
CEP45	41	0.0	0.0	11.9	29.0	0.0	1.8	29.0	10.1	0.0	14.1	26.8	0.0	9.0	17.2	14.7	0.0	21.7	19.2	0.0	0.0
		0.0%	0.0%	29.0%	71.0%	0.0%	4.4%	71.0%	24.6%	0.0%	34.4%	65.6%	0.0%	21.9%	42.2%	35.9%	0.0%	53.0%	47.0%	0.0%	0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res7.wk1

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Table E 3
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP47-1	21	0.0 0.0%	0.0 0.0%	0.0 0.0%	9.7 100.0%	5.0 51.7%	4.0 41.6%	0.6 6.7%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%	7.1 73.5%	2.4 24.4%	0.2 2.1%	0.0 0.0%
CEP47-2	10	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	5.5 53.9%	4.7 46.1%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.2 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%
CEP47-3	24	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%	24.3 100.0%	0.0 0.0%	0.0 0.0%
CEP47-4	36	0.0 0.0%	0.0 0.0%	1.4 3.8%	35.1 96.2%	7.0 19.1%	29.5 80.9%	0.0 0.0%	0.0 0.0%	26.0 71.3%	10.5 28.7%	0.0 0.0%	0.0 0.0%	34.8 95.5%	1.6 4.5%	0.0 0.0%	0.0 0.0%	34.8 95.5%	1.6 4.5%	0.0 0.0%	0.0 0.0%
CEP47-5	16	0.0 0.0%	0.0 0.0%	0.5 3.3%	15.6 96.7%	7.5 46.6%	8.6 53.4%	0.0 0.0%	0.0 0.0%	7.6 46.7%	8.6 53.3%	0.0 0.0%	0.0 0.0%	8.0 49.5%	8.2 50.5%	0.0 0.0%	0.0 0.0%	8.0 49.5%	8.2 50.5%	0.0 0.0%	0.0 0.0%
CEP48	54	0.0 0.0%	0.0 0.0%	0.0 0.0%	10.6 100.0%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%	6.4 60.5%	2.0 19.4%	0.9 8.8%	1.2 11.4%
CEP52-53A&B	80	0.0 0.0%	0.0 0.0%	0.0 0.0%	80.3 100.0%	0.0 0.0%	67.5 84.1%	12.8 15.9%	0.0 0.0%	39.3 48.9%	41.0 51.1%	0.0 0.0%	0.0 0.0%	68.3 85.1%	12.0 14.9%	0.0 0.0%	0.0 0.0%	68.3 85.1%	12.0 14.9%	0.0 0.0%	0.0 0.0%
CEP54	93	0.0 0.0%	0.0 0.0%	4.0 4.3%	89.1 95.7%	0.0 0.0%	62.5 67.1%	30.7 32.9%	0.0 0.0%	23.7 25.4%	69.5 74.6%	0.0 0.0%	0.0 0.0%	52.5 56.4%	40.7 43.6%	0.0 0.0%	0.0 0.0%	52.3 56.2%	40.8 43.8%	0.0 0.0%	0.0 0.0%
CEP55-1	108	0.0 0.0%	0.0 0.0%	3.5 3.3%	104.5 96.7%	0.0 0.0%	51.9 48.1%	56.1 51.9%	0.0 0.0%	8.7 8.1%	98.7 91.4%	0.6 0.6%	0.0 0.0%	51.9 48.1%	56.1 51.9%	0.0 0.0%	0.0 0.0%	77.6 71.9%	30.4 28.1%	0.0 0.0%	0.0 0.0%
CEP55-2A	132	0.0 0.0%	0.0 0.0%	0.0 0.0%	132.3 100.0%	0.0 0.0%	79.6 60.2%	52.7 39.8%	0.0 0.0%	51.4 38.9%	80.9 61.1%	0.0 0.0%	0.0 0.0%	74.7 56.4%	57.6 43.6%	0.0 0.0%	0.0 0.0%	74.6 56.4%	57.7 43.6%	0.0 0.0%	0.0 0.0%
CEP55-2B	26	0.0 0.0%	0.0 0.0%	0.0 0.0%	26.3 100.0%	0.5 1.8%	17.9 68.1%	7.9 30.2%	0.0 0.0%	14.2 54.0%	12.1 46.0%	0.0 0.0%	0.0 0.0%	16.0 61.0%	10.3 39.0%	0.0 0.0%	0.0 0.0%	15.2 57.7%	11.1 42.3%	0.0 0.0%	0.0 0.0%
CEP55-2C	63	0.0 0.0%	0.0 0.0%	3.9 6.2%	58.8 93.8%	1.7 2.8%	33.8 53.9%	27.2 43.3%	0.0 0.0%	24.0 38.2%	38.8 61.8%	0.0 0.0%	0.0 0.0%	30.3 48.3%	32.5 51.7%	0.0 0.0%	0.0 0.0%	30.3 48.3%	32.5 51.7%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)   Source : Consultants Simulation   c:\ junaid \ res7.wk1

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Table E 3
(contd.)

Polder Ref	Polder Area (km2)	No Ventage				Ventage 30%				Ventage 50%				Ventage 100%				Ventage 150%			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
CEP55-2D	222	0.0 0.0%	0.0 0.0%	17.0 7.6%	205.3 92.4%	12.5 5.6%	119.1 53.6%	90.7 40.8%	0.0 0.0%	95.5 43.0%	126.7 57.0%	0.0 0.0%	0.0 0.0%	114.1 51.3%	108.2 48.7%	0.0 0.0%	0.0 0.0%	113.8 51.2%	108.4 48.8%	0.0 0.0%	0.0 0.0%
CEP55-3	98	0.0 0.0%	0.0 0.0%	4.9 5.0%	93.6 95.0%	0.8 0.8%	53.0 53.8%	44.8 45.5%	0.0 0.0%	17.3 17.5%	72.0 73.1%	9.2 9.4%	0.0 0.0%	59.0 59.9%	39.5 40.1%	0.0 0.0%	0.0 0.0%	65.1 66.2%	33.3 33.8%	0.0 0.0%	0.0 0.0%
CEP55-4	51	0.0 0.0%	0.0 0.0%	0.1 0.1%	51.4 99.9%	0.0 0.0%	33.5 65.2%	17.9 34.8%	0.0 0.0%	3.6 6.9%	47.9 93.1%	0.0 0.0%	0.0 0.0%	42.8 83.3%	8.6 16.7%	0.0 0.0%	0.0 0.0%	47.4 92.2%	4.0 7.8%	0.0 0.0%	0.0 0.0%

Note : 100% Ventage relates to presently effectively available gate opening in each polder (Consultants Estimate)

Source : Consultants Simulation

c:\ junaid \ res7.wk1