A STUDY ON MORPHOLOGICAL BEHAVIOUR OF BRAHMAPUTRA - JAMUNA RIVER

BY

PROVATI MUKHERJEE

90283
26-9-96
লাইব্রেরী, ঢাকা

In partial fulfilment of the requirements for the Degree of Master of science in Engineering (Water Resources)

DEPARTMENT OF WATER RESOURCES ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DHAKA, BANGLADESH

OCTOBER, 1995

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF WATER RESOURCES ENGINEERING

We hereby recommend that the thesis presented by PROVATI MUKHERJEE entitled A STUDY ON MORPHOLOGICAL BEHAVIOUR OF BRAHMAPUTRA-JAMUNA RIVER be accepted as fulfilling this part of the requirements for the degree of master of science in Engineering (Water Resources)

90283
26-9-96
লাইব্রেরী, ঢাকা

Chairman of the Committee
(Supervisor)

(Dr. Abdul Hannan)

Member

(Dr. Ainun Nishat)

Member

(Mr. A.K.M. Shamsul Haque)

Member and Head of the Department

(Dr. M. Monowar Hossain)

#90283#

OCTOBER, 1995

CERTIFICATE

This is to certify that this thesis work has been done by me and neither this thesis nor any part thereof has been submitted elsewhere for the award of any degree or diploma.

Countersigned

(Dr. Abdul Hannan)
Supervisor

Signature

(Provati Mukherjee)
Candidate

ACKNOWLEDGEMENT

The author acknowledges her deepest gratitude and indebtedness to Dr. Abdul Hannan, Professor, Department of Water Resources Engineering for his kind supervision, encouragement and valuable guidence during the course of study and research work. It was a great previlege for the author to work with Dr. Abdul Hannan, whose constant guidence made it possible to conclude this work successfully.

The author is greatly indebted to other members of her thesis committee, Dr. Md. Monowar Hossain, Professor and Head of the Department of Water Resources Engineering, Dr. Ainun Nishat, Professor, Department of Water Resources Engineering and Engineer A.K.M. Shamsul Haque, Chief Engineer, Planning (General), Bangladesh Water Development Board for their kind encouragement, valuable comments and suggestions regarding the study.

The author wishes her warm gratitude to Engineer Malik Fida Abdullah Khan, Local Consultant, SWMC, Dhaka, for his kind and sincere help in computer works.

The author is idebted to all the officials of the Surface Water Hydrology-II, BWDB, Dhaka and to the officials of River Morphology and Research Circle, BWDB, Dhaka for their help and cooperation in collecting the required data and informations.

The author wishes to thank her husband, Engineer Shakti Shadhan Mukherjee for his sincere support, inspiration, and help during the entire period of this study.

Sincere appreciations are expressed to Mr. M. Mofser Ali, Mr. Abul Kalam Azad, Mr. Bahauddin Bhuiyan, Mr. A.M. Mannan Khan for their help and cooperation to prepare this project.

Finally, appreciations are expressed to all officials of the Technological Services Ltd. Consulting Farm, Dhaka for preparing tables, figures and bindings etc.

Author

ABSTRACT

The present study is related to the Morphological behaviour of Brahmaputra -Jamuna River within the territory of Bangladesh. The analysis has been carried out mainly based on cross-sectional data for 17 selected stations, namely J-17 to J-1 near Charnatua to Aricha for the years 1969-70,1976-77, 1977-78, 1978-79, 1981-82,1986-87, 1988-89 and 1990-91. The water level, discharge, width and depth data at station Bahadurabad for the years 1969-70, 1978-79 and 1981-82 were used for n value studies.

Study of variation of cross-sectional area with elevation from bottom to high water level shows that at first the area increases slowly, then increases very fast with faster increase of width with elevation. No systematic change in the variation of cross-sectional area, total width and effective width has been observed at any station over the years. In most of the stations cross-sectional area increased in certain years and decreased in other years. Similarly the total width and the effective width increased during certain periods and decreased during some other periods.

When the total widths corresponding to HWL of the river sections at different stations for the year 1969-70 are compared with the corresponding total widths for the year 1990-91 it is observed that the total width remained more or less same at station J-14; increased at stations J-17 to J-15, J-13 to J-11,

J-9 to J-7, J-3 and J-1; decreased at stations J-14, J-10, J-6 to J-4 and J-2.

Similarly a comparison of effective widths of the river sections at different stations for the years 1969-70 and 1990-91 show that the effective width increased at stations J-17 to J-15, J-13 to J-11, J-9 to J-07, J-3 and J-1; and decreased at stations J-14, J-10, J-6, to J-4 and J-2.

In general the changes in the effective width was more rapid than the changes in the total width. In most of the cases no similarity in the pattern of variation of total width and effective width has been observed.

From an over all comparison of mean bed levels of river sections at different stations for the years 1969-70 and 1990-91 it may be concluded that on an average the mean bed level fell down in the upper reaches and rose up in the lower reaches.

There has been shifting of right bank towards right at ten stations and towards left at seven stations. The left bank has shifted towards left at ten stations, towards right at five stations and remained more or less in the same positions at two stations.

The roughness co-efficient (Manning's n) values were found to lie between 0.0103 to 0.0339 and 0.019 to 0.037 in dry season and wet season respectively.

TABLE OF CONTENTS

		Page
ACKNOWLEDGEMENT		iv
ABSTRACT		vi
TABLE OF CONTENTS		viii
LIST OF FIGURES		xii
LIST OF TABLES		xvi
NOTATION AND ABBREVIATIONS		xvii
CHAPTER-I	**INTRODUCTION**	
1.1	General	1
1.2	Objectives of the study	4
CHAPTER-II	**REVIEW OF LITERATURE**	
2.1	Introduction	5
2.2	Channel Patterns	5
2.2.1	Straight Channel	7
2.2.2	Meandering Channel	10
2.2.3	Braided Channel	12
2.3	Variables Affecting River Behaviour	13
2.4	Channel Geometry	15
2.5	Factors Influencing River Geometry	18

		Page
2.6	Zones of Flow Convergence and Divergence for Braided	20
2.7	Review of Previous Studies	21
CHAPTER-III	**RIVER BRAHMAPUTRA-JAMUNA AND ITS CHARACTERISTICS**	
3.1	General	28
3.2	The Brahmaputra-Jamuna and its Drainage Basin	28
3.3	Tributaries and Distributaries of Brahmaputra-Jamuna River	34
3.4	Width and Depth of Brahmaputra-Jamuna River	35
3.5	Longitudinal Deformation of the Brahmaputra-Jamuna River	39
3.6	Channel Migration/Shifting	44
3.7	Change of Course of the Brahmaputra-Jamuna River	47
3.8	Reasons for the change of Course	50
3.9	Bank Erosion and Bankline Migration	50
3.10	Wandering of the Thalweg	56
3.11	Reasons for Channel Migration/Shifting	60
3.12	Formation and Movement of Sand Bars	61
3.13	Deposition and Erosion of the River Bed	63

		Page
3.14	Scour	63
3.15	Planform Characteristics	64
3.16	Cross-Section Characteristics	65
3.17	Bed Material	66
3.18	Resistance to Flow	66
3.19	Sediment Transport	67
CHAPTER-IV	**DATA COLLECTION AND METHODOLOGY**	
4.1	Introduction	70
4.2	Description of Selected Stations	73
4.3	Background of MIKE 11 Software	76
4.4	Methodology	77
4.5	Data Analysis	81
CHAPTER-V	**RESULTS AND DISCUSSION**	
5.1	Introduction	83
5.2	Cross-Sectional Area and Bed Level	83
5.3	Cross-Sectional Area Versus Distance	115
5.4	Velocity Vs. Roughness Co-efficient	154
CHAPTER-VI	**CONCLUSION AND RECOMMENDATIONS**	
6.1	Conclusions	507
6.2	Recommendations for further Study	512

Page

REFERENCES : 513

APPENDIX-A A_1-A_{18}

Location Statement of Monuments/R.C.C pillars along the cross section of the river Brahmaputra-Jamuna for the year 1981-82 at stations J-1 to J-17

APPENDIX-B B_1-B_{10}

Mean daily water level for the years 1969-70, 1978-79 and 1981-82

APPENDIX-C C_1-C_2

Bottom level of Brahmaputra - Jamuna river in meter for the years 1969-70 to 1990-91 at stations J-17 to J-1.

LIST OF FIGURES

Figure No.		Page No.
2.1	Typical River channel patterns (after Simons et al., 1975)	6
2.2	Channel classification based on pattern and type of sediment load, showing types of channel, their relative stability and some associated variables (After SCHUMM and MEYER, 1979)	8
2.3	Plan view and cross-section of a meandering stream (Simons, 1977)	11
2.4	Example of a Braided River (Khan, 1978)	14
2.5	Jamuna River Banklines - August, 1970 (ECI, 1970)	17
3.1	Bahadurabad, frequency curves for discharges (Hannan, 1993)	29
3.2	The Brahmaputra River Basin (Hannan, 1993)	31
3.3	Major river courses (Hannan, 1993)	33
3.4	Variation of water surface width along Brahmaputra River (CBJET, 1991)	36
3.5	Changes of channel width along the Brahmaputra River(1830 to 1988)(CBJET,1991)	38
3.6	Distribution of degradation and aggradation along the Brahmaputra River (CBJET, 1991)	41
3.7	Distribution of channel deposition and erosion along the Brahmaputra River(CBJET,1991)	43

Figure No.		Page No.
3.8	Development of a channel in the Jamuna River near Bahadurabad based on bathymetric survey by the river survey project (Barua, Klaassen and Mahmood, 1995)	46
3.9	Banklines-Jamuna River 1830-1963, (after Coleman)	49
3.10	Bankline migration in feet per year (Coleman, 1969)	51
3.11	Range of Thalweg shifting along the Brahmaputra River since 1830 (CBJET, 1991)	53
3.12	Location of cross-section of island/node sub-reaches used in morphological studies (Alam, Thorne, Russel, 1987)	54
3.13	Discharge hydrograph & corresponding movement of the Thalweg during a flood cycle (Coleman, 1969)	58
3.14	Plan view of changes in sand bar position before & after flood of 1952 on the Brahmaputra River Banklines obtained from aerial photographs (Coleman, 1969)	58
4.1	Standard BWDB Cross-sections in the main river system (FAP 24, Study Report-3, 1994)	71
4.2	Location of Cross-sections from Ganges-Jamuna confluence to Noonkhawa and water level and discharge gaging stations (Halder, 1989)	74
4.3	Definition sketch for raw data, X-Z coordinates and relative resistance (MIKE 11, Scientific Documentation)	78
5.1.a-5.17.b	Elevation Vs. Area Section J-17 to J-1	163 - 196
5.18.a-5.34.b	Area Vs. year for different level, Section J-17 to J-1	197 - 230

Figure No.		Page No.
5.35-5.51	Elevation for 5% & 10% of Total Area Vs. Year, Section J-17 to J-1	231 - 247
5.52.a-5.68.b	Area Vs. Distance, Section J-17 to J-1	248 - 281
5.69.a-5.85.h	Cross-section at, section J-17 to J-1 for the year 1969-70 to 1990-91	282 - 349
5.86-5.102	Width Vs. Year for section J-17 to J-1	350 - 366
5.103-5.119	Right Bankline, Left Bankline and Total Width	367 - 383
5.120-5.128	Velocity Vs. Roughness Co-efficient, Dry season	384 - 392
5.129-5.137	Velocity Vs. Roughness Co-efficient, Wet season	393 - 401
5.138	Cross-Sectional area Vs. Distance along the river	402
5.139	Bed level elevation Vs. Distance along the river	403
5.140	Total width Vs. Distance along the river	404
5.141	Effective width Vs. Distance along the river	405
5.142	Movement of the left bank during different periods from 1969-70 to 1990-91	406
5.143	Movement of the right bank during different periods from 1969-70 to 1990-91	407

LIST OF TABLES

Table No.		Page No.
3.1	Amounts of Degradation and Aggradation from J-2 to J-17 during the period of 1965-66 to 1988-89	40
3.2	Bank Erosion rates in Island and Nodal Reaches between 1953/1956 and 1988	57
3.3	Suspended coarse sediment balance according to the BWDB	68
3.4	Suspended fine sediment balance according to the BWDB	68
3.5	Total suspended sediment balance according to the BWDB	68
3.6	Coarse Suspended sediment balance according to FAP 24	69
3.7	Total Suspended sediment balance according to FAP 24	69
3.8	Annual suspended load for station Bahadurabad (1965-1988) (Unit $1x10^9$ tons)	69
3.9	Comparison of the annual sediment load (Unit $1x10^9$ tons)	69
4.1	Processed data for a cross-section	80
5.1-5.17	Elevation and corresponding area, Section J-17 to J-1	408 - 424

Table No.		Page No.
5.18-5.34	Area and Corresponding Elevation, Section J-17 to J-1	425 - 430
5.35.1-5.51.8	Distance and Corresponding area, Section J-17 to J-1	431 - 495
5.52-5.68	Right Bank reading, Left Bank reading, Total width, Effective width and last reading on the opposite bank, Section J-17 to J-1	496 - 504
5.69-5.70	Discharge, Width, Area, Velocity, Hydraulic Radius and Roughness Co-efficient	505 - 506

NOTATION AND ABBREVIATION

ASCE	American Society for Civil Engineers
BWDB	Bangladesh Water Development Board
BUET	Bangladesh University of Engineering and Technology
BIWTA	Bangladesh Inland Water Transport Authority
BCL	Bangladesh Consultants Limited
CBJET	China Bangladesh Joint Expert Team
Cm.	Centimeter
Ch.	Chainage
DHI	Danish Hydraulic Institute
ECI	Engineering Consultants International
FAP	Flood Action Plan
FEC	French Engineering Consortium
HD	Hydrodynamic
HWL	High Water Level
ISPAN	Irrigation Support for Asia and the Near east
JMBA	Jamuna Multipurpose Bridge Authority
JICA	Japan International Co-operative Agency
m/M	Meter
m^2/M^2	Square Meter
m/sec	Meter per Second
MPO	Master Plan Organization

NEDECO	Netherlands Engineering Consultants
PWD	Public Works Department
RRI	River Research Institute
RPT	Rendel Palmer & Tritton
RRI - LP - CNR - DELFT	
RRI	RHEIN-RUHR-ING-GES.MBH.DORTMUND/GERMANY
LP	PROF. DR. LACKNER & PARTNERS. BREMEN/GERMANY
CNR	COMPAGNIE NATIONALE DU RHONE. LYON/FRANCE
DELFT	DELFT HYDRAULICS. DELFT/NETHERLANDS.
SLW	Standard Low Water
UNDP	United Nation Development Programme

CHAPTER–1

INTRODUCTION

90283
26-9-96
লাইব্রেরী, ঢাকা

1.1 General

Bangladesh is a riverine deltaic country. Almost all the rivers that flow through Bangladesh are alluvial in nature. An alluvial river generally changes its position and shape continually as a consequence of hydraulic forces acting on its bed and banks and related geomorphological forces interacting with these hydraulic forces. These changes may be slow or rapid and may result from natural environmental changes or from changes caused by man's activities. When a river channel is modified locally, the change frequently causes changes in channel characteristics both upstream and downstream. The response of a river to man-induced changes often occurs in spite of attempts to control the response. However these responses can be better controlled if the man-made changes are planned and executed after proper study of river morphology.

Natural and man-induced in rivers frequently set in motion responses that can be propagated for long distances, and in spite of the complexity of these changes all alluvial rivers are governed by some basic forces. Successful river utilization and water resources development requires an understanding of these forces. It is necessary that river system design be based on competent knowledge of (1) geologic factors, including soil

conditions; (2) hydrologic factors, including possible changes in flow and runoff, and the hydrologic effects of changes in land use; (3) geomorphic characteristics of the stream, including the probable geometric alternations that will be activated by the changes that development will impose on the channel; (4) hydraulic characteristics such as depth, slope, velocity of streams and sediment tranport and the changes that may be expected in these characteristics in space and time; and (5) ecological/biological chanbges that will result from physical change and in turn will induce or modify physical changes.

To emphasize the inherent dynamic qualities of river channels, evidence will be cited to demonstrate that most alluvial rivers are not static in their natural state. Indeed, scientists concerned with the history of landforms, vegetation, and the past activities of man, rarely consider the landscape as unchanging. Rivers, glaciers, sand dunes, and seacoasts are highly susceptible to change with time. Over a relatively short period of time, perhaps a man's lifetime, the landscape may seem to be relatively stable. Nevertheless stability cannot be assumed.

Evidence demonstrates that river channels are continually changing position, shape, dimensions, and pattern. Some of the changes has been natural and some has been the consequence of river development work.

In alluvial river systems, it is the rule rather than the exception that floodplains, islands, and side channels will undergo modification and banks will erode, sediment will be deposited with time. Such changes may be very slow or dramatically rapid.

From ancient times to the present days, rivers have been playing a dominant role in human activities. For this reason, rivers have been constantly the subject for study by man. During monsoon, rivers carry huge dischage and heavy sediment composed of sedimentary rocks, clay, silt and fine sand which are supplied by the drainage basins. Therefore sediment along with water and hence waterflow cannot be seperated from the problems of erosion and deposition. These cause the rivers to be extremely unstable, change the corss-section both horizontally and vertically and also changes to geomorphic and other hydraulic characteristics.

The mighty rivers, the Ganges, the Jamuna and the Meghna and their distributaries and tributaries flowing through Bangladesh are heavily charged with sediment and major part of Bangladesh is formed from sediment deposited by them. These rivers have occupied and abandoned numerious river courses and drain one of the heaviest rainfall area of the world. From study of cross-sections of these rivers, it is seen that during lean period flow is confined only in the deepest channel of very sinuous nature. Cross-sectional study also shows that there are changes in cross-sectional area, slope, thalweg, bed level etc. throughout the year. Again these parameters changes from year to year due to

changes in water discharge and sediment load. Recognizing such changes in river characteristics and importance of having better knowledge about such river characteristics, the present study with the Jamuna river has been taken. The study is expected to give some idea about the morphological behaviour of the river Jamuna. The Jamuna river has been selected for the present study because of its large discharge and heavy sediment load which make the river extremely unstable. The importance of the Jamuna river in the context of Bangladesh is another factor of selecting the river for such morphological study.

1.2 Objectives of the Study

The objectives of the present study are :

i) To study the variation of cross-sectinal area with elevation at selected stations over the years and thereby to have some idea about bed level rise or fall.

ii) To study the movement of effective conveyance area across the width.

iii) To study the 'n' value variation with stage for the reach around Bahadurabad.

CHAPTER–2

RIVIEW OF LITERATURE

2.1 Introduction

Rivers are responsible for draining landmasses and carrying the water sediment to the ocean. In accomplishing this task the water forms and maintains a highly organized system of physical and hydraulic features. Details of interrelations in this organized system are highly complex, and it is difficult to visualize many of them simultaneously. Yet, these interrelationships constitute the distinctive characteristics of rivers, and some understanding of the basic types of rivers is necessary before complex relatinships can be understood.

2.2 Channel Patterns

The pattern of a river is defined as the appearance of a reach in a plan view. If the plan views of most of the major rivers are examined, they can be classified broadly into three major pattern, straight, meandering and braided (Leopold et al 1964). These types are shown diagramatically in figure 2.1. Although these three types represent the major divisions, it should be realized that a continuous gradation exists between one type and another. In any single river, therefore, it is common to find more than one type of pattern existing along its length.

Chital (1970) divided the channels into single and multithread with a transition pattern in between them. Single channels are futher subdivided into meandering, straight and

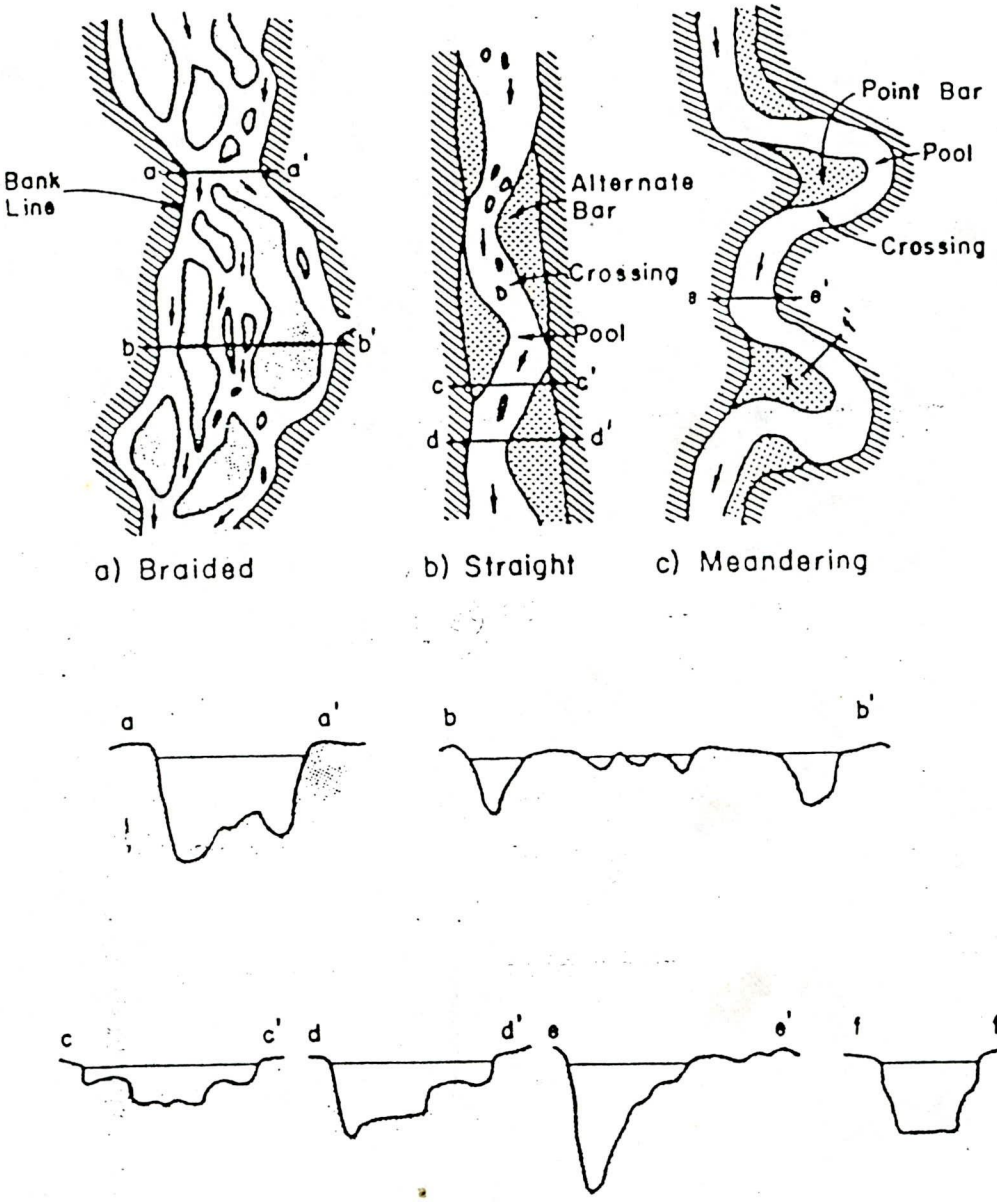


Figure. 2.1 Typical river channel patterns (after Simons et al., 1975).

transitional between them, and multiple channels are subdivided into braided channels in submontane regions and braiding channels in alluvial fan or deltas near the sea.

From the view point that rivers present a wide spectrum of intermediate form between braided and meandering type Kellerhals, Church and Bray (1970) proposed detail classification of river channels, islands and channel bars.

The various types of channels was classified based on pattern and type of sediment load with their relative stability by Schumm and Meyer (after Schumm, 1980). This is shown in figure 2.2. The channel pattern are discussed in the following articles.

2.2.1 Straight Channel

A straight channel can be defined as one that does not follow a sinuous course. Leopold and Wolman (1957) have pointed out that straight channels are rare in nature. Although a stream may have relatively straight banks, the thalweg, or path of greatest depths along the channel, is usually sinuous (figure 2.1(b). As a result, there is no simple distinction between straight and meandering channels. Straight channels with prismatic cross-section are not common in nature. It is only possible for artificial channel.

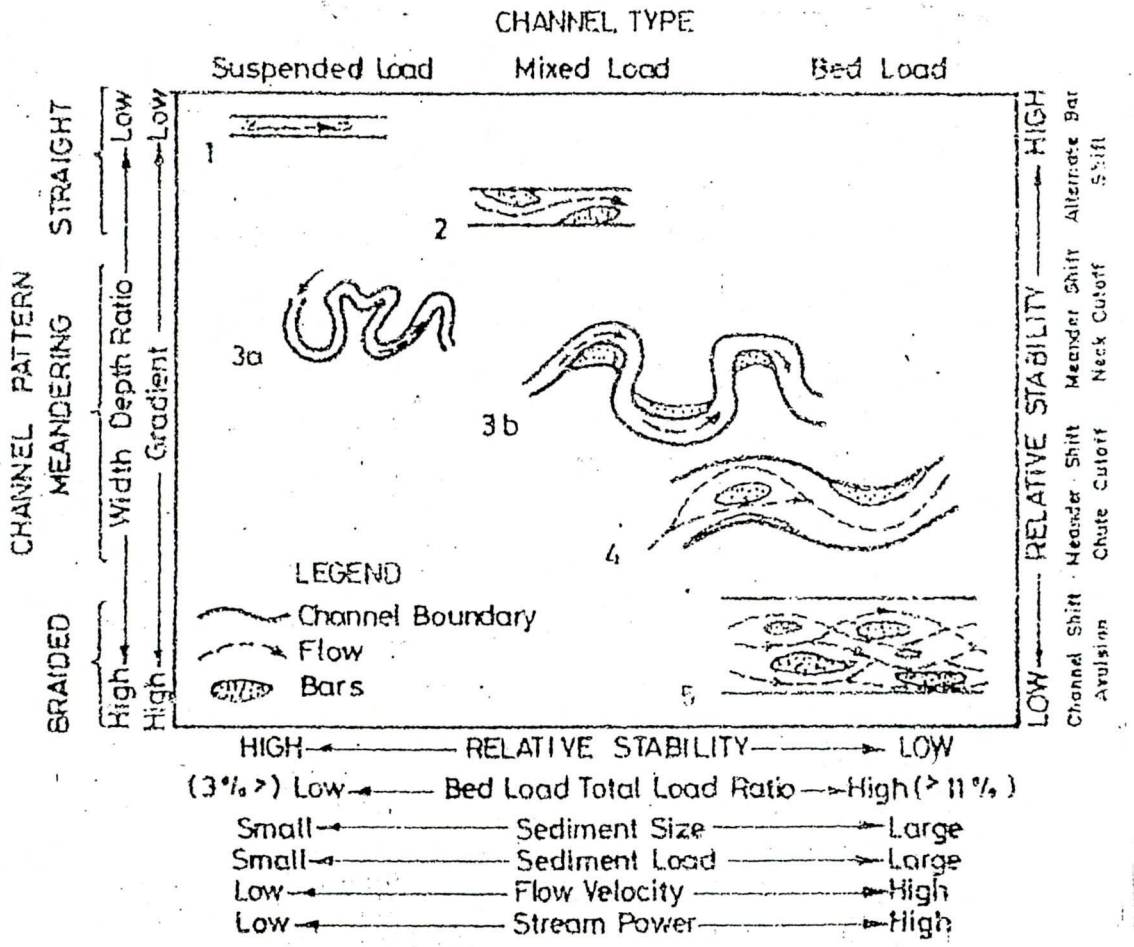


FIGURE. 2.2 CHANNEL CLASSIFICATION BASED ON PATTERN AND TYPE OF SEDIMENT LOAD, SHOWING TYPES OF CANNEL, THEIR RELATIVE STABILITY AND SOME ASSOCIATED VARIABLES.(AFTER SCHUMM AND MEYER, 1979)

The sinuosity of a river, the relation between thalweg length to down valley distance is most often used to distinguish between straight and meandering channels. Sinuosity varies from a value of unity to a value of three or more. Leopold, Wolman, and Miller (1964) took a sinuosity of 1.5 as the division between meandering and stragight channels. It should be noted that in a straight channel with a sinuous thalweg developed between alternate bars (figure 2.1(b) a sequence of shallow crossings and deep pools is established along the channels.

Reaches of a river that are relatively straight over a long distance are generally classed as unstable, as are divided flow reaches, and those in which bends are migrating rapidly. Long straight reaches can be created by natural or man-made cutoff of meander loops where long reaches of sinuous meandering channels with relatively flat slopes are converted to shorter reaches with much steeper slopes. Straight reaches can also be man induced by placing of contraction works such as dikes and revetment to reduce or control sinuosity. As noted, even where the channel is straight it is normal for the thalweg to wander back and forth from one bank to the other. Opposite the point of greatest depth there is usually a bar or accumulation of sediment along the bank, and these bars tend to alternate from one side of the channel to the other (figure 2.3). At low stages, then, the thalweg in a straight reach tends to meander within the high-water channel, forming short pools and relatively long and shallow crossing generally unsuitable for navigation. The alternate bars control channel pattern and, thus, their stability determines the stability of the reach.

If a river is dredged as a straight channel it can remain as such depending on the regime of the river, the erodibility of the banks, etc. Sometimes only part of a river is straight mostly a stretch of a few miles in between two meander bends.

2.2.2 Meandering Channel

A meandering channel is one that consists of alternating bends, giving an s-shape appearance to the plan view of the river (figure 2.1(c). More precisely Lane (1957) concluded that a meandering stream is one whose channel alignment consists principally of pronounced bends, the shape of which have not been determined predominantly by the varying nature of the terrain through which the channel passes. The meandering river consists of a series of deep pools in the bends and shallow crossings in the short straight reach connecting the bends. The thalweg flows from a pool through a crossing to the next pool forming the typical s-curve of a single meander loop.

Figure 2.3 shows the plan view and some cross-sections of a typical meandering stream. In this figure, one observe the position of the thalweg, the location of the point bars, alternate bars and the location of the pools and crossings. Note that in the crossing the channel is shallow compared to pools and the banks may be more subject to erosion.

As shown schematically in figure 2.3 the pools tend to be some what traingular in section with point bars located on the inside of the bend. In the crossing the channel tends to be more

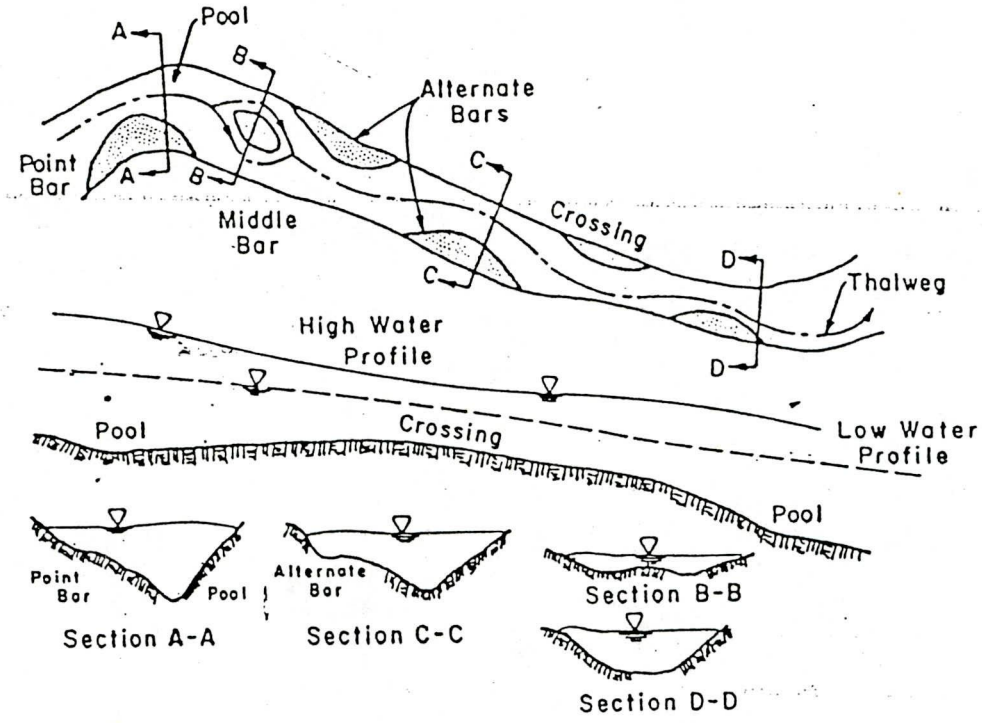


Figure. 2.3 Plan view and cross section of a meandering stream.(Simons,1977)

rectangular, widths are greater and depths are relatively shallow. At low flows the local slope in steeper and velocities are larger in the crossing than in the pool. At low stages the thalweg is located very close to the outside of the bend. At higher stages, the thalweg tends to straighten more specifically, the thalweg moves away from the outside of the the bend encroaching on the point bar to some degree.In the extreme case, the shifting of the current causes chute channels to develop across the point bar at high stages.

2.2.3 Braided Channel

A braided river is generally wide with poorly defined and unstable banks, and is characterized by a steep, shallow course with multiple channel divisions around alluvial islands (figure 2.1(a). Braiding was studied by Leopold and Wolman (1957) in a laboratory flume. They concluded that braiding is one of many patterns which can maintain quasiequilibrium among the variables of discharge, sediment load, and transporting ability. Lane (1957) concluded that, generally, the two primary causes that many be responsible for the braided condition are: (1) Overloading, that is the stream may be supplied with more sediment than it can carry resulting in deposition of part of the load, and (2) steep slopes, which produce a wide shallow channel where bars and islands form readily.

Either of these factors alone, or both in concert, could be responsible for a braided pattern. If the channel is overloaded with sediment, deposition occurs, the bed aggrades, and the slope

of the channel increases in an effort to maintain a graded condition. As the channel steepens, the velocity increases, multiple channels develop and cause the overall channel system to widen. The multiple channels, which form when bars of sediment accumulate within the main channel, are generally unstable and change position with both time and stage.

Another cause of braiding is easily eroded banks. If the banks are easily eroded, the streams widens at high flow and at low flow bars form which become stabilized, forming island. In general, then, a braided channel has a steep slope, a large bed-material load in comparison with its suspended load, and relatively small amounts of silts and clay in the bed and banks. The braided stream is difficult to work with in that it is unstable, changes its alignment rapidly, carries large quantities of sediment, is very wide and shallow even at flood flow and is in general unpredictable. The Brahmaputra (figure 2.4) is an example of a braided river.

2.3 Variables Affecting River Behaviour

Variables affecting alluvial river channels are numerous and interrelated. Their nature is such that, unlike rigid boundary hydraulic problems, it is not possible to isolate and study the role of any individual variable. According to Lane (1957), the Major factors affecting alluvial stream channel forms are:

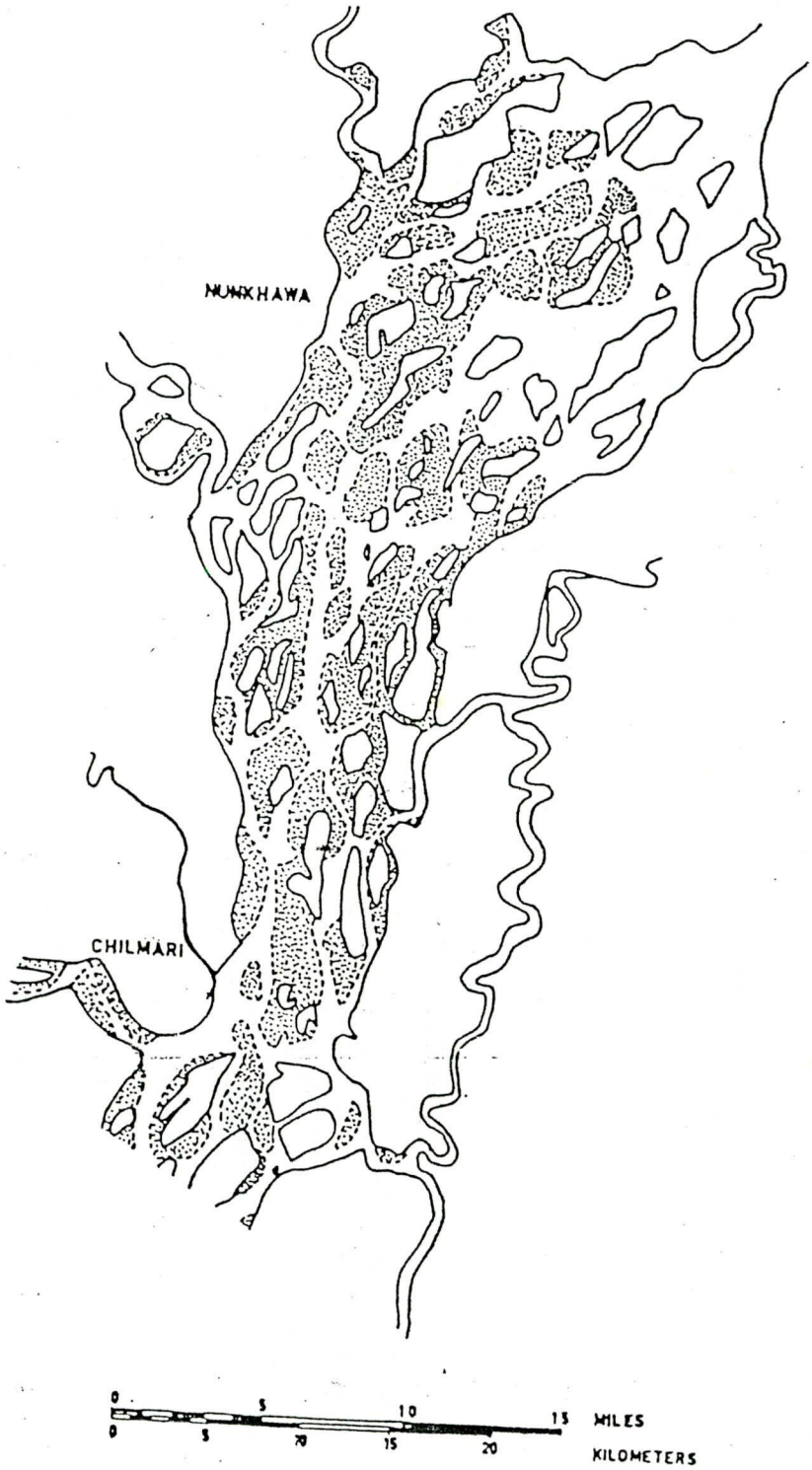


Fig. 2.4 Example of a braided river (Khan, 1978)

(1) Stream discharge (2) Sediment load (3) Longitudinal slope (4) Resistance of banks and bed to movement by flowing water (5) Vegetation (6) Temperature (7) Geology including types of sediment and (8) Works of man.

The fluvial processes involved are extremely complicated and the variables of importance are difficult to isolate. Many laboratory and field studies have been carried out in an attempt to establish relationships among these and other variables. The problem has been more amenable to an empirical solution than an analytical one.

In an analysis of flow in alluvial rivers, the flow field is complicated by the constantly changing discharge. Significant variables are, therefore, quite difficult to relate mathematically. It is normal to list measurable or computable variables which effectively describe the processes occuring and then to reduce the list by making simplifying assumptions and examining relative magnitudes of variables, striving toward an acceptable balance between accuracy and limitations of obtaining data. When this is done, the basic equations of fluid motion may be simplified (on the basis of valid assumptions) to describe the physical system.

2.4 Channel Geometry

The geometry and shape of an alluvial channel is the result of the interaction between water discharge, the quantity and characteristics of sediment discharge, composition of bed and

bank materials etc. The bed and banks of alluvial channels are mostly composed of non-cohesive granular materials. The erosion and subsequent transportation and deposition mainly results from the interaction of moving fluid and its loose boundary. Prolonged interaction tend to achieve the equilibrium or in regime status. A channel in regime exists in a state of dynamic equilibrium self adjusting its channel pattern, cross-sectional geometry, slope and bed form. These adjustments occur as the channels ability to transport sediment balances the available sediment load. Also, the geometry of meanders and braids and the characteristics of the river valleys and river flood plain play an important role in channel geometry.

The plan geometry of the Jamuna river near Serajgonj after 1970 flood is shown in figure 2.5. The outlines of the channels in the upper portion of the region of the map on figure 2.5 have been sketched (dashed line) in their approximate locations. The main channel of the Jamuna river in August 1970 is shown by the arrows on figure 2.5. No measurement were taken of channel flows in this region but studies of the elevations of the river bed and visual observations indicate that the main channel crosses from the left to the right bank just upstream of Serajgonj. Computations based on the sounded bed elevations by ECI (1970) showed that 60% of the flow was in the channel next to the right bank (section A-A on figure 2.5), 30% in the middle channel (section B-B) and 10% in the left bank channel (section C-C) in August 1970. Also, it is estimated that 75% of the total flow crossed section D-D.

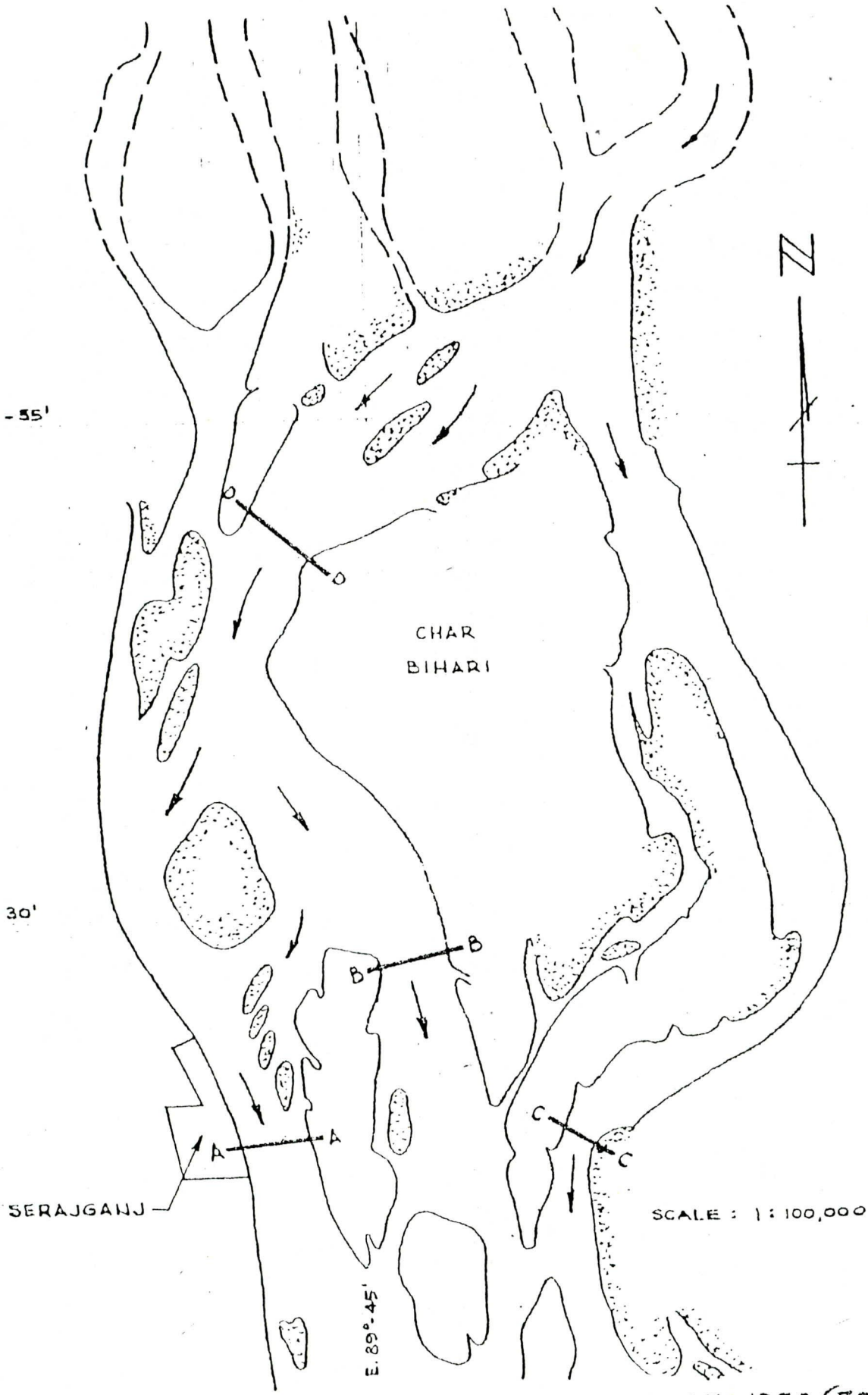


FIG2.5 JAMUNA RIVER BANK LINES – AUGUST 1970 (ECI, 1970,)

Visual observation indicate that most of the flow passed through the sharp bend on the left bank just upstream of the cross-over channel. Erosion along the outside of the bed on the left bank appears to be very severe.

The reason for the development of the erosion problem at Serajgonj during recent years is the bend on the left bank upstream of Serajgonj. The bend carries a large percentage of the total river flow and directs this flow across the river where it impinges on the highly erodible right bank.

The main channel of the Jamuna river will remain in its position shown on Figure 2.5 until the left bank bend has migrated downstream for enough to redevelop the left bank channel or until a large flood redistributes the islands and bars along this reach of the river. There is only minor changes of those bars near Serajgonj since 1970 as observed in September, 1985. It would appear that the immediate future right bank erosion will accelerate as the left bank bend moves downstream.

2.5 Factors Influencing River Geometry

The factors that govern the geometry and reoughness of an alluvial river are numerous and inter-related. Their nature is such that it is not possible to isolate and study the role of an individual variable. Thus,if one attempts to evaluate the effect of increasing channel depth on average velocity, additional related variables respond to changing depth. Similarly, not only will the velocity respond to change in depth, but also the form

of bed roughness, the position and shape of alternate, middle and point bars, the shape of cross-section, the magnitude of sediment discharge and so on. Consequently the study of the mechanics of flow in alluvial channels and the response of channel geometry has been the subject of study by many investigators at various time.

There are several variables which influence the geometry of alluvial rivers some of the important variables are (Simon 1971):

$V, D, S, \rho, \mu, g, d, \sigma, \rho_s, S_p, S_R, S_c, f_s, C_T$.

where,

V = Velocity

D = depth

S = Slope

ρ = density of water-sediment mixturte

μ = apparent dyanmic viscosity of the water sediment mixture

g = aceleration due to gravity

d = grain size of the bed materials

σ = measure of size distribution of bed materials

ρ_s = density of sediment

S_p = shape factor of the particles

S_R = shape factor of the reach of stream

S_c = shape factor of the cross-section of the stream

f_s = seepage force in the bed of the streams

C_T = concentration of the bed material discharge.

The role of the variables on resistance and bed form have been discussed by Simons and Richardsen (1962). Their importance on the geometry has also been partially explained by Simons (1971).

2.6 Zones of Flow Convergence and Divergence for Braided River

Braided rivers are characterized by having a number of alluvial channels with bars and islands between meeting and dividing again, and presenting from the air the intertwining effect of a braid (Lane 1957). The division and joining of channels are essential features of braided rivers and whilst the bars within these rivers have received attention from both geomorphologists and sedimentologists, the areas of flow convergence and divergence have not been incorporated into braided river depositional models. The flow dynamics and morphology of channel confluences have been studied by the researchers; Best and Roy 1991; and recent attention has highlighted the abundant confluences within braided rivers (Ashmore 1982, Ashmore & Parker 1983, Klaassen & Vermeer 1988). However, the link between flow convergence and the downstream division of flow has been neglected, despite the fact that this transition is the area which may be of fundamental importance to the development of braid bars (Ashworth et al. 1992). Although some depositional models of braided rivers are beginning to recognise and incorporate confluence scour and fill (Bristow et al, 1993), areas of flow divergence are less well understood and ignored in these models. In general, flow divergence is associated with flow deceleration and sediment deposition and, once deposition has been initiated, the sediment accumulation is

likely to promote further flow division, deposition and bar formation. Divergent flow may also impinge on the bank at an increased angle leading to bank erosion, channel widening and a local increase in available sediment, all of which are likely to lead to the development of a new braid bar. The deposits of diffluence areas may therefore form the foundations of braid bars but there are no known descriptions of these deposits and their internal structure. It is possible that some sedimentation may occur by vertical or even upstream accretion in the diffluence areas in braided rivers (Ashmore, 1982) and these must be manifested within the sedimentary record. Bed shear stress has been shown to increase in shallow flows over bar tops (Cheetham, 1979) where a coarse bed armour may form. In coarse-grained braided rivers the bar heads may be characterized by coarse-grained sediments that are imbricated or laminated (Bluck, 1979). There is a clear need for both an understanding of the fluid dynamics of the diffluence zone and how this may influence braid bar initiation and internal structure (Best and Bristow, 1993).

2.7 Review of Previous Studies

After devasting floods of 1954 and 1955 it was considered necessary to investigate and study the hydro-morphological aspects of the major rivers of the country and their tributaries and distributaries, in order to prepare comprehensive flood control plan to minimize flood hazards. Accordingly a scheme "Control over Brahmaputra for flood control (survey)" was prepared and then "Brahmaputra Circle with two field Divisions-Division-1, head quarter at Dhaka and Brahmaputra survey

division-11, with head quater at Mymensingh, initiated the hydro morphological data collection programme since October, 1964. Now the morphological data on the river Jamuna are collected by the morphology division of BWDB.

Over the past decades many studies on morpholgical changes of major rivers in and outside of Bangladesh have been made. According to Galay (1987), morphology is a result of the interaction of the hydraulics of flow (velocity, discharge roughness and shear), channel configuration at the reach and immediate upstream (width, depth shape, slope and pattern), load entering the reach (Caliber and amount), and bed and bank material. E. Mosselman, M. Huisink, E. Koomen and A.C. Seymonsleergen (1993), had studied on the morphological changes in large braided sand bed river.

According to Schumm (1977), the variable that significantly controls river morphology is the sediment load. Lacey (1930) concluded from an analysis of regime canal data that the wetted perimeter of a channel is directly dependent on discharge, but that the shape of the channel reflects the size of the sediment load. Coarse sediment load produces channels of high width/depth ratio, and fine sediment produces narrow and deep cross-section. Schumm and Khan (1972) have also stated the same opinion. Leopold and Maddock (1953) have dealt with this aspect in detail. Kouich Yamamoto (1994) had studied some morphologic and hydrologic characteristics of alluvial rivers in Japan. According to Professor dr. M. de.Vries (1993), the bed level to be chosen at

the toe of the bank protection is an important morphological problem. The design bed level is governed by four more or less independent morphological processes (i) Over all degradation of the rive is possible (ii) Seasonal degradation may be present (iii) constriction scour may be induced (iv) Local scour may be induced by groynes.

In recent years several studies on morphological changes of major rivers in Bangladesh have been made. Dad (1977) analysed the shifting pattern of the Ganges river based on the plan map of the banklines. According to Dad (1977), the shifting of thalweg is due to movement of sand bars, mid-islands and due to aggradation. Historical maps for banklines of the Ganges have been compiled by the water investigation directorate of BWDB for the year 1780, 1855 and 1868 for this reach (BWDB, 1978).

Bari (1978) has analysed the sediment data of the Ganges river at Kalikapur for the year 1970, 1972 and 1973. He concluded that Colby and Engelund-Hansen Formula yield a result which may be comparable with the measured values. He also developed rating curves for the Ganges at this station. Alam and Ahmed (1980) have also analysed the sediment data at the same station by using various transport equations for the period 1969 to 1972.

Galay (1980) and Chowdhury (1986) reported to have conducted some studies on the shifting character of the Ganges using historical maps. Master Plan Organization (MPO, 1984) analysed the cross-sectional data of the Ganges in details. Hossain (1989)

studied the erosion-deposition pattern, shifting characteristics and rate of change of cross-section and thalweg movement, including sediment transport of the Ganges. He found that the net deposition in the Ganges upto Brahmaputra Confluence was approximately 4.26×10^8 m^3 during 1967-68 to 1979-80 which corresponds to about 4.30 cm sediment deposition each year throughout the reach.

Das (1992) has studied on the variation of hydraulic geometry of the Ganges, interms of area, width, depth, discharge for all available years from 1967-68 to 1990-91 and developed relationships between area and width, width and hydraulic radius. Islam (1993) analysed the numerical simulation of bed level changes of the Ganges. Ashrafuzzaman (1992) studied on morphological aspects of the Arialkha and Kamrunnessa (1994) studied on geomorphic and sediment transport characteristics of the river Surma.

Analysis of the channel processes, sedimentation and hydraulic characteristics of the Jamuna has been done by Coleman (1969). Shahidullah (1978) studied the course of Brahmaputra-Jamuna which has changed radically over the years 1830-1963. The bank movement maps show that the river has a tendency to move towards the west. Khan H.R. (1975) analysed on roughness coefficient for some rivers in Bangladesh. Rahman (1978) had studied the erosional pattern of the river reach, its migrating tendency and direction of movement, formation and movement of sandbars and mid-channel Islands on its bed for the river Padma

from Ganges-Brahmaputra confluence near Chandpur. He produced some relationships between thalweg sinuosity with meander pattern.

According to the investigation on Jamuna river crossing by the Department of Water Resources Engineering, BUET (1985) the daily maximum rate of erosion is about 75 ft in the west bank and about 5 ft in the east bank. The studies were conducted only for a short period from May 23, 1969 to July 9, 1969. This period represents the early flood period in the Jamuna and during this period the net migration of the west bank was about 220 ft representing an average rate of shifting. Habibullah (1985) analysed the cross-sections of Jamuna and determined the bed level variation between the years 1965-66 to 1983-84 for the reach Aricha to Charnatua. He found that there is a trend of bed level rise in the upper reach and fall in the lower reach. The highest rise and fall occurred at stations J-12 and J-10 respectively. Hossain (1991) reanalysed the bed level variation of the Jamuna for the reach Aricha to Charnatua.

Sultana (1989) studied on critical review of data collection, processing, publication procedure and compared sediment load estimated by Yang and Hossain formulae for Jamuna river. She found that during October to December the daily maximum and the minimum sediment flow at Bahadurabad is 0.98 m tons and 0.14 m tons respectively. The total sediment flow for the year 1982 is found to be 244 million tons per year. Halder (1989) analysed on changes in river section characteristics of

Brahmaputra-Jamuna river at selected stations. Nahar (1991) developed a numerical model to calculate the change of bed level at different locations of Jamuna from Bahadurabad to Serajgonj. The China-Bangladesh Joint expert team (CBJET,1991) studied on Hydrological and river morphology of the Brahmaputra river in Bangladesh. According to CBJET study, most of the bankline shifted by 5-10 km toward the right except some local bankline shifting toward the left. The annual sediment load at Bahadurabad by MPO, FEC, Coleman and CBJET report are 387 x 10^6 tons, 431 x 10^6 tons, 607 x 10^6 tons and 499 x 10^6 tons respectively. The China Bangladesh Joint expert team (CBJET, 1991) studied the behaviour of the confluence of the Brahmaputra and the Ganges river.

Flood action Plan (1992) studied classification of river pattern, Jamuna fluvial processes morphological effects of development scenarios etc. Dilip K. Barua (1993) compiled the morphological processes in the Bangladesh river systems. Alam, Chowdhury and Rahman (1995) analysed on the changes in river section characteristics of the Brahmaputra-Jamuna river. Rahman (1995) studied on investigation of islands in the Brahmaputra river and finds that middle zone islands are some how larger than that of the upstream or downstream islands. Except the above studies, FAP24 survey project (1994) gives the following important studies which deal with the morphology of the Brahmaputra/Jamuna river.

River	Period	Consultancy Report
Brahmaputra River/Jamuna River	1967	Surveys of Inland waterways and ports, NEDECO.
	1968-1970	East-West Interconnector Project, Acres International
	1975	Jamuna (Brahmaputra) river crossing, Northwest Hydraulic consultants
	1974-1976	Feasibility study Jamuna Bridge, JICA
	1986,1987 1990	Jamuna Bridge Study, Phase I and II RPT, NEDECO
	1991	Flood control and river training project on the Brahmaputra river, China-Bangladesh Joint expert team.
	1993	FAP1, Brahmaputra river training studies, DHI
	1992	FAP 3.1, Charland study, Sogreah, Halcrow, Lahmeyer
	1993	FAP 21/22, Bank protection and River training project, RRI, CNR, DELFT Lackner & Partner.

CHAPTER 3

RIVER BRAHMAPUTRA–JAMUNA AND ITS CHARACTERISTICS

3.1 GENERAL

The Brahmaputra-Jamuna is one of the largest rivers in the world, ranking fifth in terms of discharge, eleventh interms of drainage area and third in terms of sediment discharge. The river is braided with meta-stable islands and nodal reaches, mobile sand bars, shifting anabranches and severe bank erosion. Its large dimensions make it difficult to understand its behaviour and morphological changes. Also because the river is highly mobile due to its fine sediments and the large floods it is experiencing almost every year, its platform is changing completely in a few years only. Fig. 3.1 shows that the discharge starts increasing in April and the first peak flood generally occurs in June-July and is characterized by a rapid rise, the peak flood of Jamuna is generally earlier than the one in the Ganges River (Hannan, 1993).

3.2 The Brahmaputra-Jamuna and its Drainage Basin

The Brahmaputra originates from the famous Manas Sarowar in chemayundang glacier as Tsangpo which flows eastward for about 1248 km (775 miles) in a constricted valley through Tibet. The river Tsangpo takes a sharp bend southward before meeting Dihang, enters Assam from the north and meets with the Dihang and Luhit some 48 km (30 miles) north-east of Dibrugarh. This combined flow assumes the name Brahmaputra and continues to flow through Assam towards south-east before entering Bangladesh from the north as

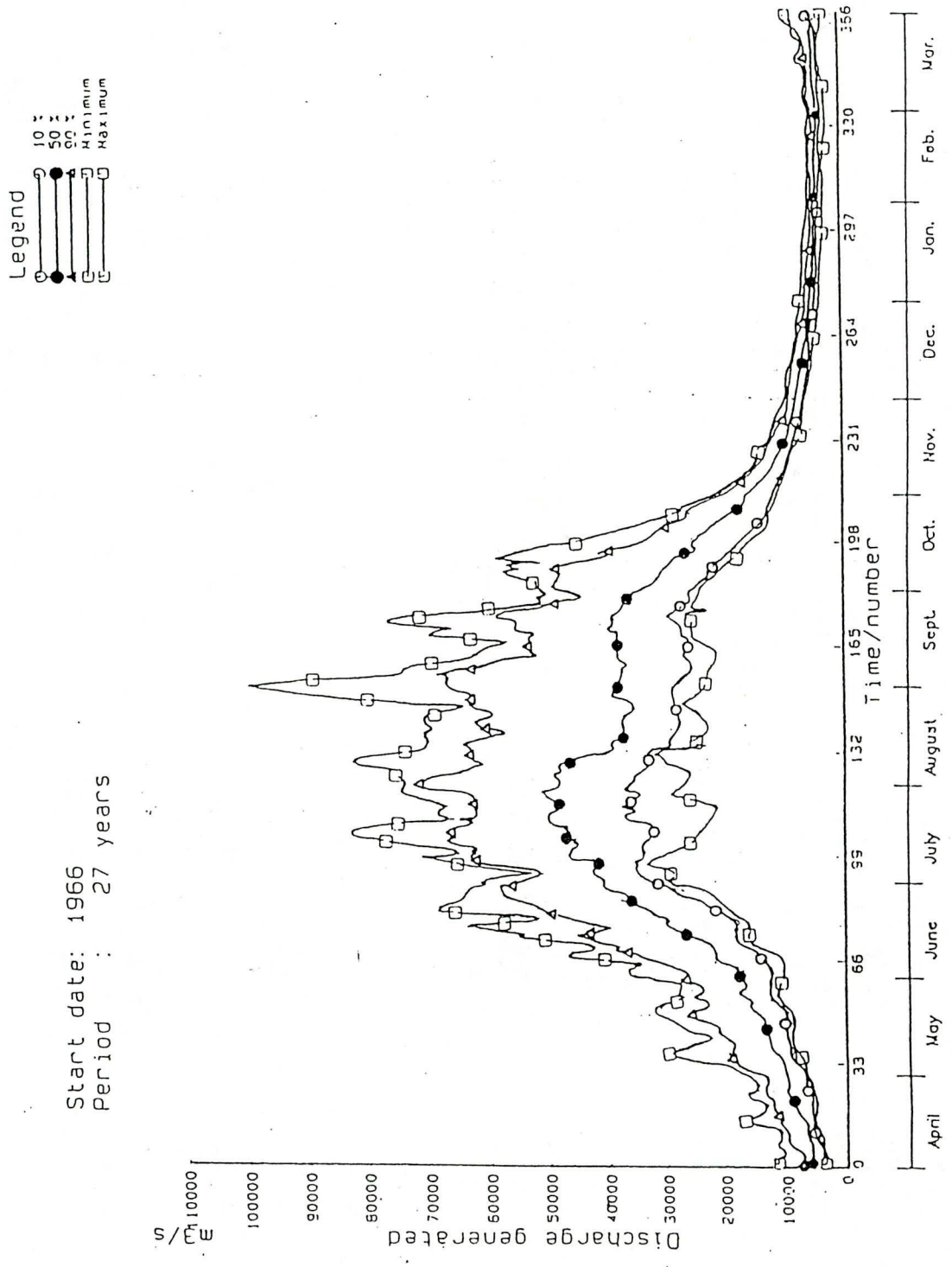


Figure 3.1 Bahadurabad, frequency curves for discharges (Hannan, 1993)

shown in figure 3.2.

Jamuna is the lowest part of the Brahmaputra river and it flows through Bangladesh. In Bangladesh the river flows south and takes on the flows of the Teesta just south of Chilmari and north of Hurasagar in between Porabari and Nagarbari and then joins the mighty Ganges near Goalundo. Within Bangladesh, the most important distributary is the Old Brahmaputra, the former course of the river over 200 years ago. Further downstream, another major distributary, the Dhaleswari leaves the left bank of the Brahmaputra just below Siragonj is shown in figure 3.3. Thus distributary has formed rather recently (between 1870 and 1920), but preliminary examination of aerial photographs does not seem to indicate that it is increasing significantly in size. The combined flow of the Brahmaputra and Ganges, with the name Padma flows south-east before meeting another big river-the Meghna at Chandpur. From Chandpur the combined flow, one of the largest in the world-only exceeded by the Amazon and Congo, flows southward with the name Meghna and falls into the Bay of Bengal.

The course of the river Brahmaputra is shown in figure 3.2. The total length of the Brahmaputra river from the source in the Himalaya to the Bay of Bengal is about 2900 km (1800 miles). The length of the alluvial reach between the India-Chinese border and the confluence with the Ganges river is about 1,100 km (683 miles). The length of the river in Bangladesh upto the confluence with the ganges River is abut 240 km (149 miles) (FAP24, 1994). According to Latif (1969), the total length of the Tsangpo-Brahmaputra-Jamuna river upto Goalundo is 2575 km (1600 miles).

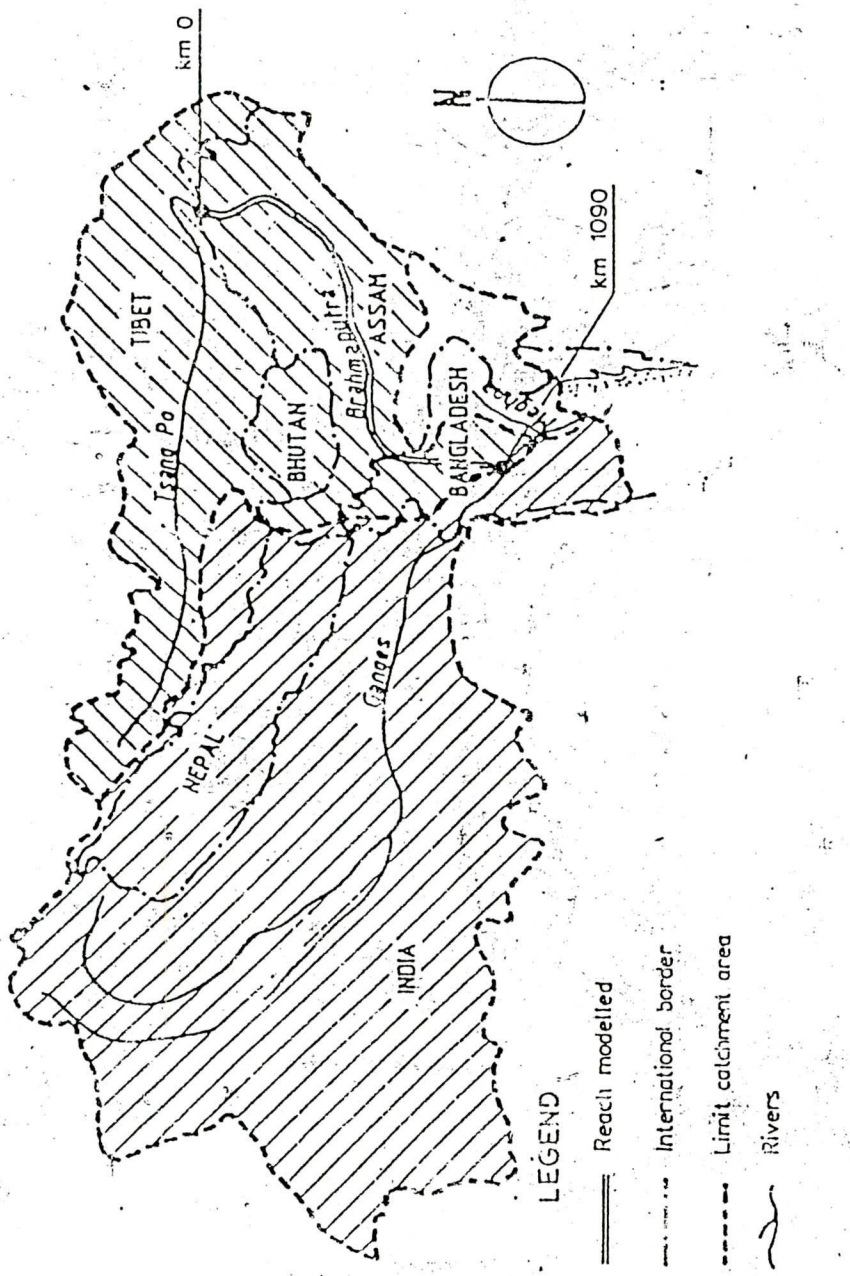


Fig.3.2 The Brahmaputra River Basin (Hannan, 1993)

The total drainage area down to Aricha is 5,80,455 sq.km (2,24,000 sq.miles) of which 2,92,819 sq.km (1,13,000 sq.miles) area is in Tibet, 2,40,992 sq.km (93,000 sq.miles) in India and only 46,644 sq.km (18,000 sq.miles) in Bangladesh (Rashid, 1977). Although the Brahmaputra has a much smaller total length and drainage area than other major rivers of the world, its discharge is one of the highest, only exceeded by the Amazon, Congo and Yangtze. The average discharge of the Jamuna river during flood is about 50,000 m^3/sec (Nazimuddin, 1988). Average annual discharge, based on the data of the period 1965-1984 at Bahadurabad is approximately 19,412 m^3/sec (6,85,000 cusecs) (Habibullah, 1987). The maximum and the minimum discharge recorded at Bahadurabad in between 1965 and 1984 are 91,100 m^3/sec (32,14,696 cusecs) in 1974-1975 and 2,860 m^3/sec (1,00,922 cusecs) in 1970-1971. It is estimated that the highest recorded discharge of the Jamuna at Bahadurabad during the flood of 1988 was of the order of 1,00,000 m^3/sec. The average water surface slope is approximately 7.6 cm per km for the upper reach of the Jamuna river and 6.5 cm per km for the lower reach (Hannan, 1993).

The valley slope of the river decreases in downstream direction. Near Bahddurabad it is about 8 cm per km, while near the confluence with the Ganges river it is about 6 cm per km. The bed material of the river is fine sand, with D_{50} varying between 0.22 mm at Chilmary and 0.165 mm near Aricha (Hannan, 1993).

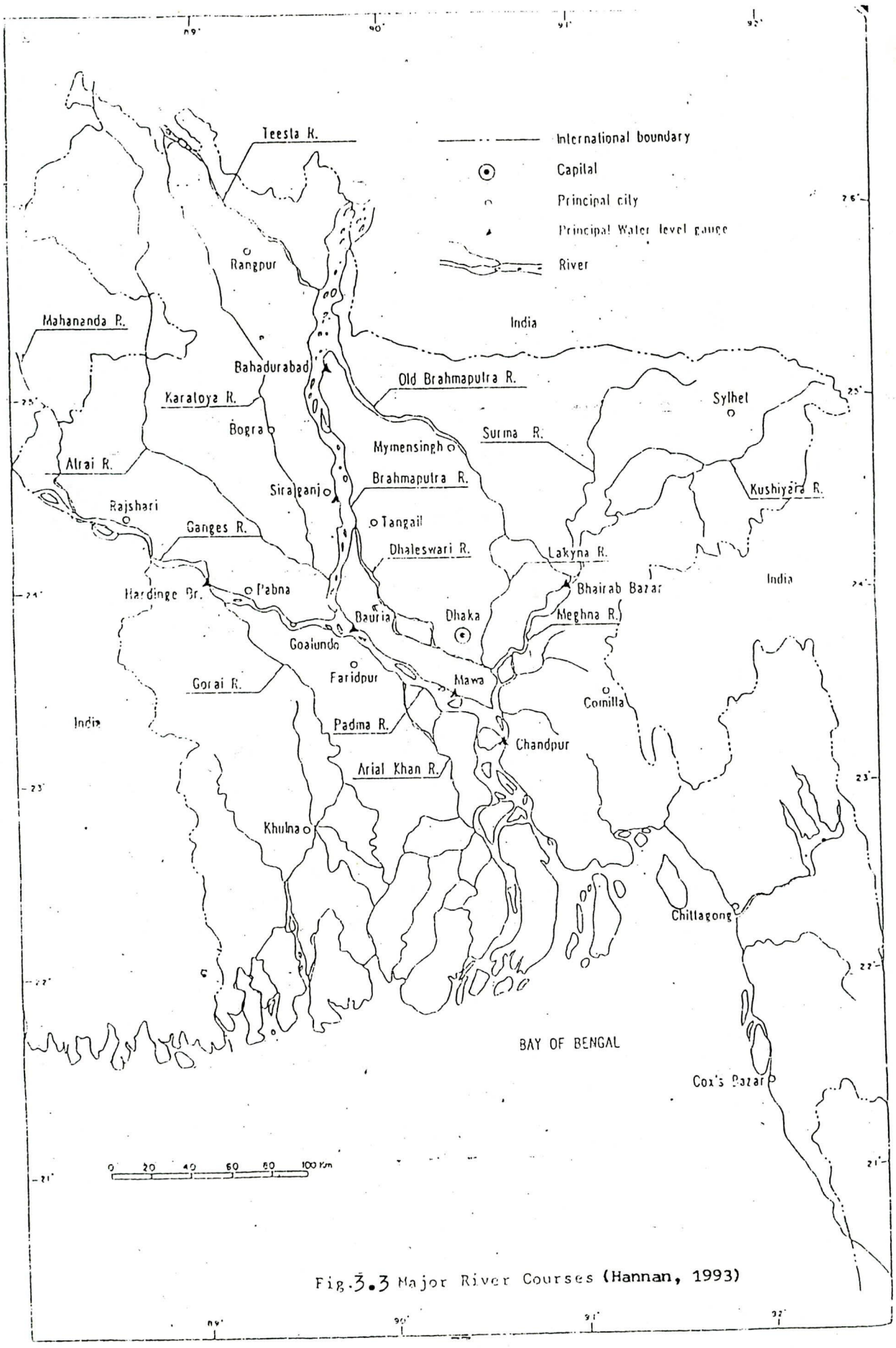


Fig.3.3 Major River Courses (Hannan, 1993)

3.3 Tributaries and Distributaries of Brahmaputra-Jamuna River

Major tributaries and distributaries of Brahmaputra-Jamuna river include two right-bank tributaries and two left-bank distributaries. The two major right-bank tributaries are the Teesta River and the Atrai-Gur River. The teesta River switched its course some two hundred years ago. It is a coarse sand bed braided river. In 1990, a 615 m long barrage was costructed on the river. Very limited information and data are available for these two rivers.

There are two major left-bank distributaries of the Brahmaputra-Jamuna River, they are the abandoned course of the Brahmaputra River (now known as Old Brahmaputra River) and the Dhaleswari River which was an old distributary of the Ganges River. Both of these rivers empty into the upper Meghna River, often through some small distributaries. According to historic perspectives, both the rivers appear to be loosing their conveyance functions.

The old Brahmaputra River appears to be going through a secular period of aggradation. The river at present reduced to a mere spill channel of the Brahmaputra-Jamuna River, active only during high river stage. Therefore, its hydrological regime is more like flashy than perennial. The annual average discharge of the river appears to be showing a decreasing trend, from being about 800m^3/s in 1964 to 500 m^3/s in 1991 (DELFT-DHI, 1994). The former discharge represents only 4% of the Jamuna River flow. The sinuosity of the upper reach of the river appears to be decreasing

from 1.6 in 1973 to 1.4 in 1989.In the lower reach, the sinuosity is some 1.3. Another interesting feature of this river is the development of the offtake during the past 20 years. Monitoring of satellite imageries revealed that the offtake was nearly closed during the 1973-82 period, became wider again during the 1983-89 period and nearly closed again from 1990. The offtake is affected by the overall westward migration of the Brahmaputra River. In the mean time, however, an interesting development occurred which is the capture of the Jinjiram River as its tributary.

At present the Dhaleswari River offtakes at two locations, the downstream offtake is more active than the upstream offtake. The upstream offtake is presently closed by the Jamuna Bridge construction activities. The annual average discharge of the Dhaleswari River reduced from about 1750 m^3/s in 1969 to 600 m^3/s in 1987 (DELFT-DHI, 1993). This range of discharge represents some 7% and 4% of the Jamuna river discharge. The sinuosity of the river is 1.6 in the upper reaches and 1.3 in the lower reachs. The bed slope of the river also reduces downstream,from being $6x\ 10^{-5}$ in the upper reaches to 3×10^{-3} in the lower reaches (Barua, Klaassen and Mahmood, 1995).

3.4 Width and Depth of the Brahmaputra-Jamuna River

The Brahmaputra-Jamuna is a wandering braided river with multi-branches and chars (bars and islands). From cross-sections analysis, it is seen that the cross-sections of the upper and middle reaches have many branches with different widths and depths,but the lower reach near Aricha is a transitional reach

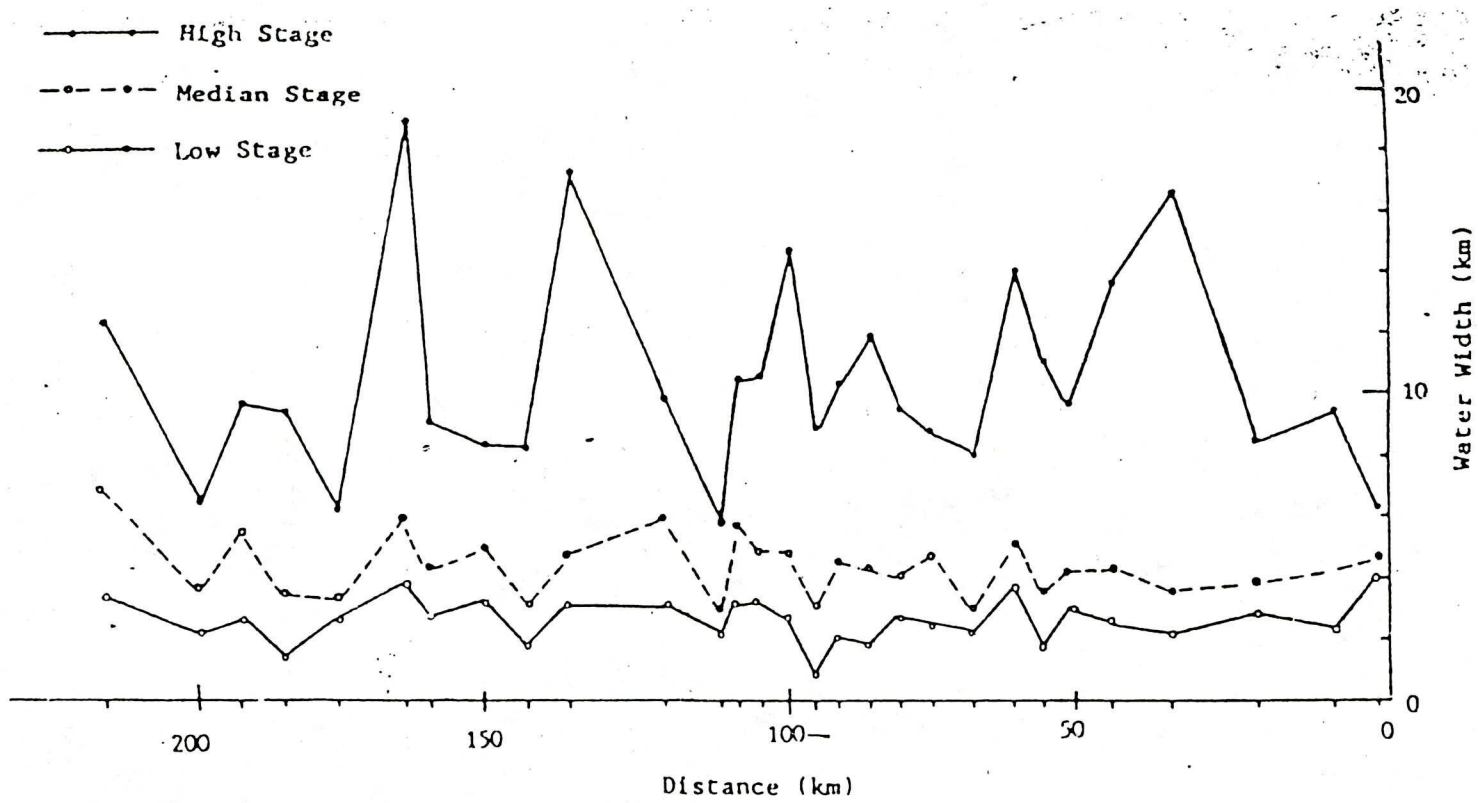


Figure3.4 Variation of Water Surface Width along Brahmaputra River (CBJET, 1991)

with a single channel cross-section. The widths corresponding to the high, medium and low water levels along the river are shown in figure 3.4, illustrating that the water width varies from 4 km to 5 km at the medium water level, from 2 km to 3 km at the low water level, from 8 km to 15 km at the high water level. It implies that the channel corresponding to the moderate and low discharge is relatively stable and smooth but at high discharge the channel along the river is not uniform (CBJET, 1991).

The average width of the Brahmaputra-Jamuna river was 6.2 km in 1830, 6.8 km in 1861 and increased to 9.9 km in 1944. Since then, the width of the river varies in the range of 9-10 km. It means that upto 1944, the developed width of the river is in line with the incoming discharge and sediment load (CBJET,1991).

The maximum width, reflecting the range of channel, along the river is shown in figure 3.5. Like other alluvial river, the Brahmaputra-Jamuna river in 1944-1988 had the wider channel in upstream reach and the narrower channel in downstream reach. The present minimum channel width in the reach downstream of J-8 (Ch. 149.50 km) is close to the historical minimum width which means that the channel width was stable in recent 100 years, thereby providing a reference for the design of stable cross-section in river rectification and channel stabilization (CBJET, 1991).

Again within Bangladesh, the channels vary considerably in width ranging from less than 2 km to 13 km. During low flow the channels shift back and forth between the main stream banks, which are often 6-13 km apart (Coleman, 1969).

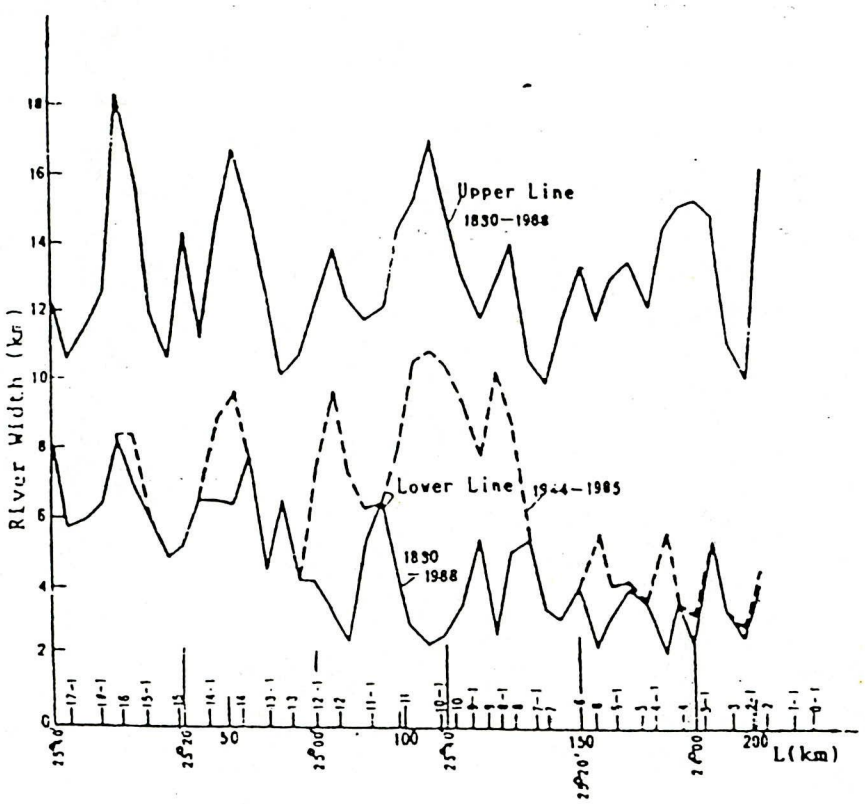


Figure 3.5 Changes of Channel Width along the Brahmaputra River (1830 to 1988) (CBJET, 1991)

Around Sirajgonj, the width of the river varies from 3 km to 18 km. Maximum channel depth is 40 m and mean channel depth is around 5m, although this varies with stage fluctuations which are around 7-8 m per annum (Bristow, 1987).

Buring rainy season, many islands (Chars) go under water. One braided portion is to the east of Kurigram Thana, where the four main channels and three islands are together 11 km in breadth. North of Sirajgonj, another braided stretch, 10 km in breadth. The greatest breadth of clear stretch is 6 km (Hossain, 1974). The maximum width during flood is more than 15 km (Nazimuddin, 1988).

It is a wide and shallow river. In dry season the navigation depth on shoal (riffle) is 1.75 m in the upstram reach and 2.5 m in downstream reach (CBJET, 1991).

3.5 Longitudinal Deformation of the Brahmaputra-Jamuna River

The phenomena of channel deformation are the consequences of the interaction of flow and channel boundary. The degradation and aggredation have complicated variations over time and space due to the frequent changes of flow and sediment carried and the non-unified sediment composition of channel bed. In order to meet the needs of planning and design of river training works, the channel degradation and the aggradation in a short period of time should be further studied. The former reflects the tendency of channel development and latter, for example, the channel deformation in monsoon season or in a flood indicates the range and rate of channel degradation and aggradation of the river. Sometimes the

local channel deformation, such as around the head of groyne and near the dike, should also need further investigation.

According to the experience in China, there are three approaches to study the longitudinal degradation and aggradation of channel, i.e. the method of sediment discharge, the method of water level and the method of cross-section (or topography). The method of sediment discharge is used to study the degradation and aggradation of the reach for a long or a short period according to the differences of sediment load between the upper and the lower stations for the same period. The method of water level is used to study the tendency of channel degradation and aggradation for long term according to the changes of water level at the same discharge. The changes of water level during a flood is also used to study the degradation and aggradation processes in the flood. In the method of cross-section, the measured cross-sections are directly used to calculate the amount of degradation or aggradation within the measuring duration. For the Brahmaputra River, due to the difficulties of sediment measurement; the degradation and aggradation cannot be determined accurately by the method of sediment discharge. So, the other two methods are used for determining the degradation and aggradation of the river.

Table 3.1 Amounts of Degradation and Aggradation from J-2 to J-17 during the period of 1965-1966 to 1988-89

Period	Total ($10^9 m^3$)	Main channel ($10^9 m^3$)	Char($10^9 m^3$)
1965-66 to 1980-81	-0.2780	-0.4804	+0.2024
1980-81 to 1988-89	+0.5020	+0.5968	-0.0948
1965-66 to 1988-89	+0.2240	+0.1164	+0.1076

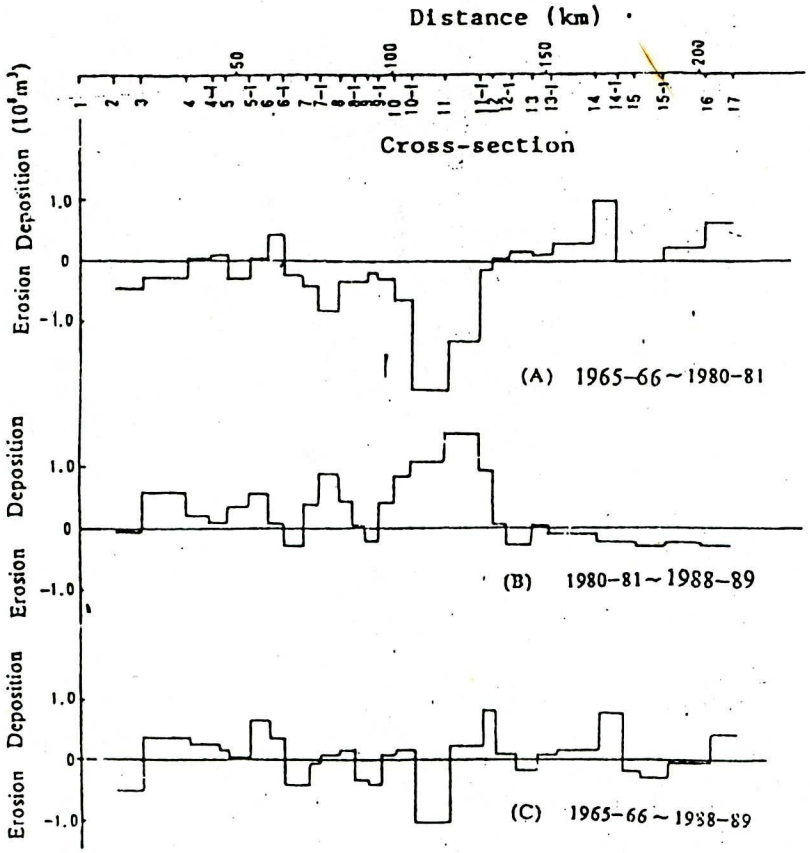


Figure 3.6 Distribution of Degradation and Aggradation along the Brahmaputra River (CBJET, 1991)

From table 3.1 it is seen that from 1965-66 to 1980-81, the river, including the main channel and the chars, suffered from erosion by $0.278 \times 10^9 m^3$, whereas in the period of 1980-81 to 1988-89 deposition occurred in the river by $0.502 \times 10^9 m^3$. Hence from 1965-66 to 1988-89, the river as a whole, was in aggradation of $0.224 \times 10^9 m^3$ and accordingly, in consideration of channel width 6 km, on an average the channel was raised by 0.25 m with an annual thickness of 1 cm. Therefore, the Brahmaputra River is practically in equilibrium having only a slight deposition.

Figure 3.6 shows the degradation and aggradation distributions along the river. It indicates that in the period of 1965-66 to 1980-81, the channel in the reach upstream of cross-section J-12 was in deposition while in the reach downstream of J-12-1(cross-section between J-12 and J-13) suffered from erosion. On the contrary, in the period from 1980-81 to 1988-89, the channel upstream of J-12 was eroded and the channel downstream of J-12-1 (cross-section in between J-12 and J-13) was deposited, but as a whole the channel was in the state of slight deposition.

After further analyzing the cross-sectional data with an interval of five years, an important phenomenon is found as shown in figure 3.7. In the period of 1976-77 to 1980-81, a successive channel deposition occurred in the reach upstream of J-12-1 (cross-section in between J-12 and J-13). In the period of 1980-81 to 1985-86, the front of the successive deposition shifted to J-6 and a new deposition was found in the reach upstream of J-14-1 (cross-section in between J-14 and J-15). This pehnomenon reflects the process of the movement of the large successive deposition from the upstream to the downstream reach.

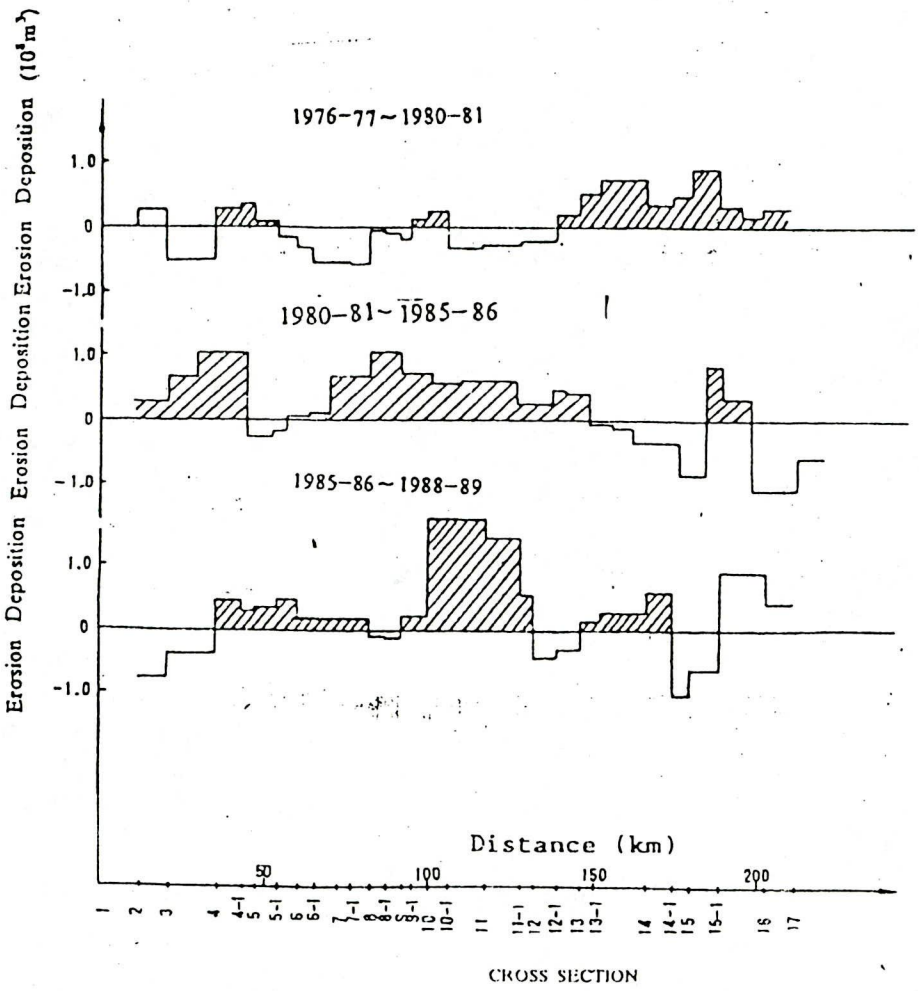


Figure 3.7 Distribution of Channel Deposition and Erosion along the Brahmaputra River (CBJET, 1991)

The deposition and erosion of the lower Brahmaputra River are affected by the various conditions in the upper reach. The literatures illustrated that the great Assam earthquake occurred in 1950 in upper Assam and the whole hill sides with earth and debris slipped into the river and made the river risen by 3 m at Dibrugarh in five years. From 1950 to 1957, the channel bed rose by 0.5-2.4 m in a reach of 168 km for the Brahmaputra River in India. The deposition in the upper Brahmaputra river was transported along the river course downstream to Bangladesh. After 1957, the deposition was transferred further downward. In Assam reach, India, the channel was eroded by $0.316 \times 10^9 m^3$, whereas the channel downstream of Bessamara was deposited by $1.1 \times 10^9 m^3$.

Subsequently, it can be inferred that the sediment previously deposited in the channel of the upper reach has been carried into the lower Brahmaputra River in Bangladesh since latter 1970s. As a result, the channel bed of the downstream reach had gradual deposition (CBJET, 1991).

3.6 Channel Migration/Shifting

The Brahmaputra-Jamuna is a large multi-thread braided channel, and during low flow the channel shifts back and forth between the main stream banks, which are often 6.50-13 km (4-8 miles) apart. The short term channel migration of the river is quite drastic, with rates of movement as high as 792 m (2600 ft) a year being common. Aerial photographs of the river show numerous channels, shoals, and islands, which indicate a river of low hydraulic efficiency and a heavy sediment load. The channels of

the river have a wide and shallow bed chocked with sand bars. Water flows in a number of branching and reuniting channels, with one or two often serving as major channels. The mid channel islands and sand banks shift rapidly with the ever-changing flow regimes, and in cosequence there is a day to day variation in channel configuration (Coleman, 1969).

Several-years map compilation by ISPAN (1993a) indicates that in about 158 years (1834-1992), the entire Bangladesh reach of the river migrated westward by bank erosion with an average rate of some 50 m per year. Apart from this secular westward migration, erosion occurs at different rates in different of channels (Bristow, 1987; Halcrow, 1993; Thorne et al., 1993; RRI-LP-CNR-DELFT, 1993). For example, Bristow (1987) showed that first order channels comprising the entire river width of some 10 km migrate at a rate of some 70 m/year. The next lower order channels having a maximum width of some 5 km migrate as high as 1000 m/year. Migration of third order channels is much erratic and occurs in response to local hydraulic conditions. The erosion is mostly concentrated at outer bank embayments. Satellite imagery interpretations by Klaassen and Masselink (1992) showed that bank-erosion in curved-channels occur at different rates ranging from 0 to 500 m with a maximum of some 1000 m/year. And they mostly occur perpendicular to the primary flow direction (in the east-west direction).

The rapidity of channel migration is further shown in figure 3.8. The migration and development of a deep-water second order channel near Bahadurabad obtained by bathymetric survey are shown

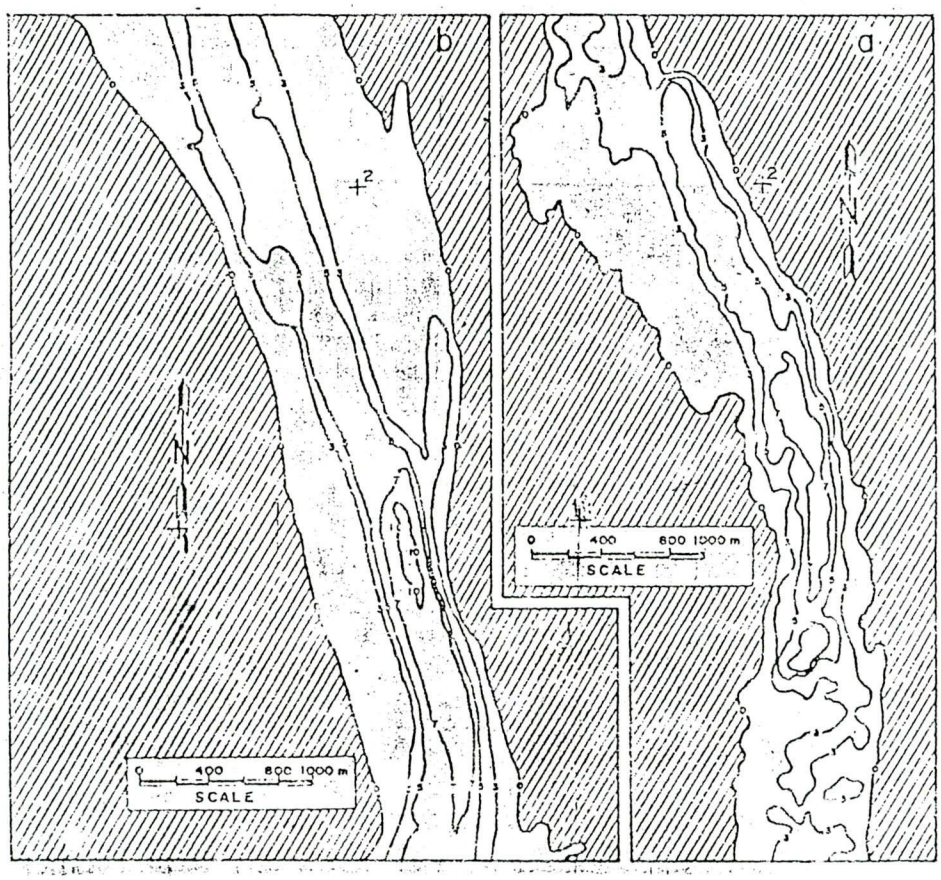


Figure 3.8 Development of a channel in the Jamuna River near Bahadurabad based on bathymetric survey by the River Survey Project. a. Surveyed in August-September 1993. b. Surveyed in November 1993. The contour lines (in meter, below) are referred to Standard Low Water (SLW) which is 12.03 m + PWD. PWD represents public Works Datum which is commonly used in Bangladesh. The Standard High Water at this station is 20.6 m + PWD. (Barua, Klaassen and Mahmood, 1995)

in about 2 months. At the fixed-point cross 1, the O-SLW line shifted westward by about 400 m. At the upper fixed-point cross 2, on the other hand, the O-SLW line migrated 520 m eastward. Similar comparisons can be made for all the contour lines which were rearranged and the channel became well-developed by November (BARUA, KLAASSEN, MAHMOOD, 1995). Lastly the analysis of the data from 1944 to 1988 indicates that the rate of channel shifting toward the right in recent 40 years was slower than that of 100 years ago and the channel appears to be in equilibrium.

3.7 Change of Course of the Brahmaputra-Jamuna

The river changed its course within Bangladesh drastically over the years. So did the Ganges using several sets of aerial photo-mosaics, Coleman (1969), investigated the changes of the river course in Bangladesh over hundreds of years. Without going into detail it can be said generally that over the centuries the Brahmaputra river system shifted south westward. The most recent remarkable change happened about 200 years ago when the Brahmaputra shifted to its present course abandoning the previous one through the Old Brahmaputra to its confluence with the Meghna river at Bhairab Bazar. There is little aggrement among the researchers about the exact time of this diversion. Accordig to most of them the diversion was gradual starting from 1787 and completing by around 1830 when it joined the ganges near Goalundo. In relation to this diversion, the year 1787 is specifically mentioned because one of the reasons of Brahmaputra's diversion is said to be the joining of Teesta with the Brahmaputra in that year when a severe flood changed its (Teesta's) original course.Before

this change the Teesta used to fall into the Ganges. Apparently, the Brahmaputra reinforced the combined flow in the Old Brahmaputra channel passing through the heart of Mymensingh and developed a new channel diverting in between Bahadurabad and Dewanganj more or less along the Jenai which is now called the Jamuna.

The recent findings of Morgan and Mointire (1959) should be mentioned in this connection. They made a geological reconnaissance of Bangladesh and West Bengal from November 1955 through April 1956 to determine the morphology of the deltaic complex of the Ganges, Brahmaputra and Meghna rivers and their distributaries. Study indicated that structural activity, primary faulting has significantly influenced quaternary geology. Changes in the course of the Ganges and Brahmaputra through Bengal during the last few hundred years was attributed to faulting and resultant tilting of fault blocks. These changes have caused the Ganges to abandon numerous western distributaries in favour of joining the Brahmaputra-Meghna system to the south-west.

The subsidence is also bed responsible for the large depression in the Brahmaputra basin. It is also a reasonable explanation that these depressions are signs of incomplete delta building process of the Brahmaputra when it changed to a new course (HALDER, 1989).

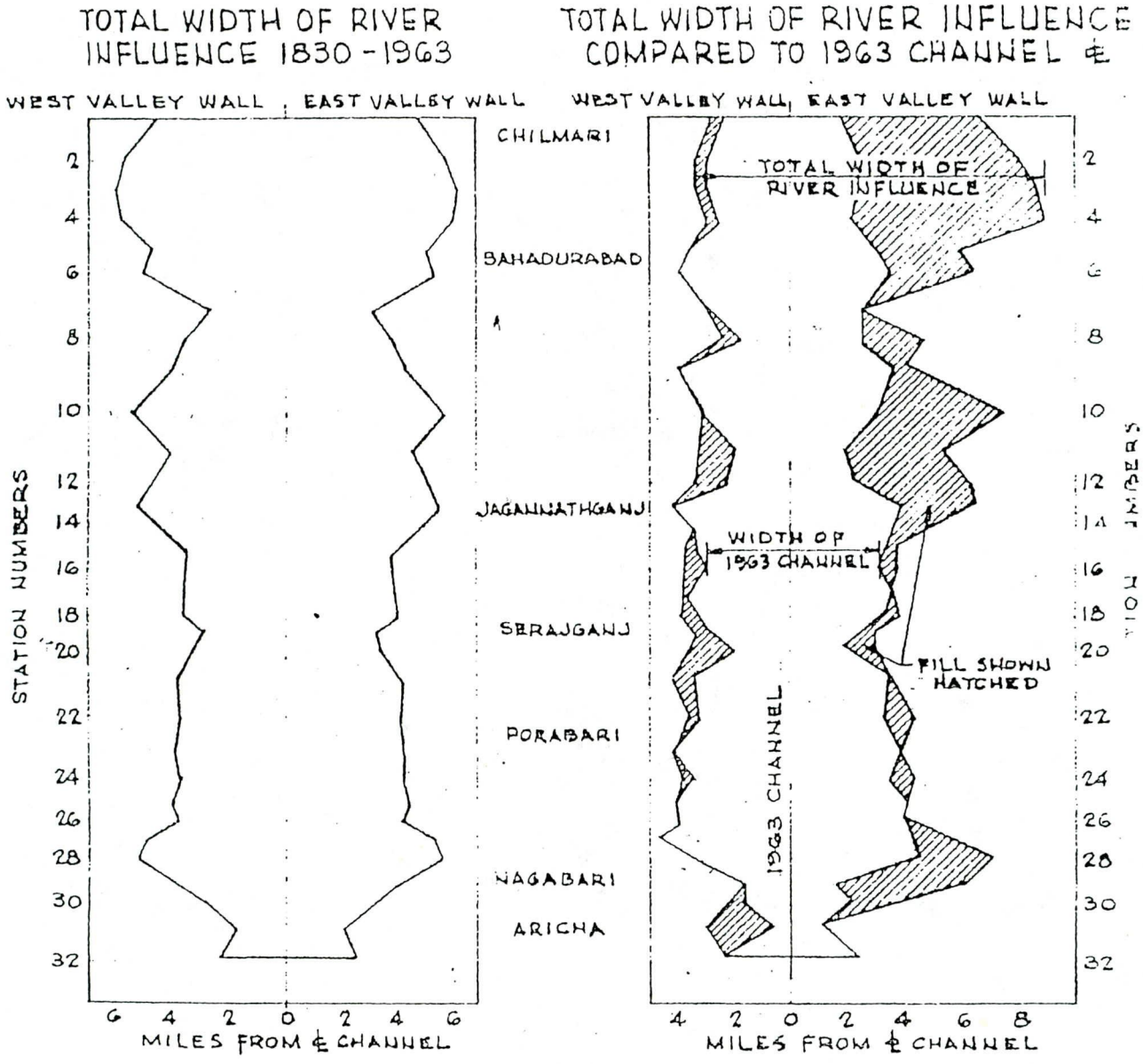


FIGURE. 3.9 BANKLINES - JAMUNA RIVER 1830 - 1963
(AFTER COLEMAN)

3.8 Reasons for the Change of Course

A major river can only change its course if there is an alternative route available to which it is as at least as attractive as its previus course. A new route must be available that has an equal or greater land slope over its length as a whole and which can be easily scoured to the necessary channel cross-sections. If the river undergoes an appreciable increase in discharge it may be forced to change its course to a more favourable route.

3.9 Bank Erosion and Bankline Migration

The history of the bankline configuration has been documented with maps dating back to 1830. Coleman (1969) had shown the total width of the river influence for the period 1830 to 1963 (figure 3.9). He also compared the 1963 Jamuna bankline positions with the total width of the river influence. The total width of influence of the river at any cross-section is the distance between the most westerly position and most easterly position of the river banks in the period of time being studied. The drawings made by Coleman (1969) are reproduced in figure 3.9. The greatest amount of fill has been on the left bank, indicating a channel migration of the river to the west.

Figure 3.10 shows the rates of migration in feet per year that have occurred on both banks for the two periods 1944-1952 and 1952-1963. In the diagram a receding or eroding bank is indicated by a negative sign before the rate, whereas a bank that is building out or receiving deposition is indicated by a positive

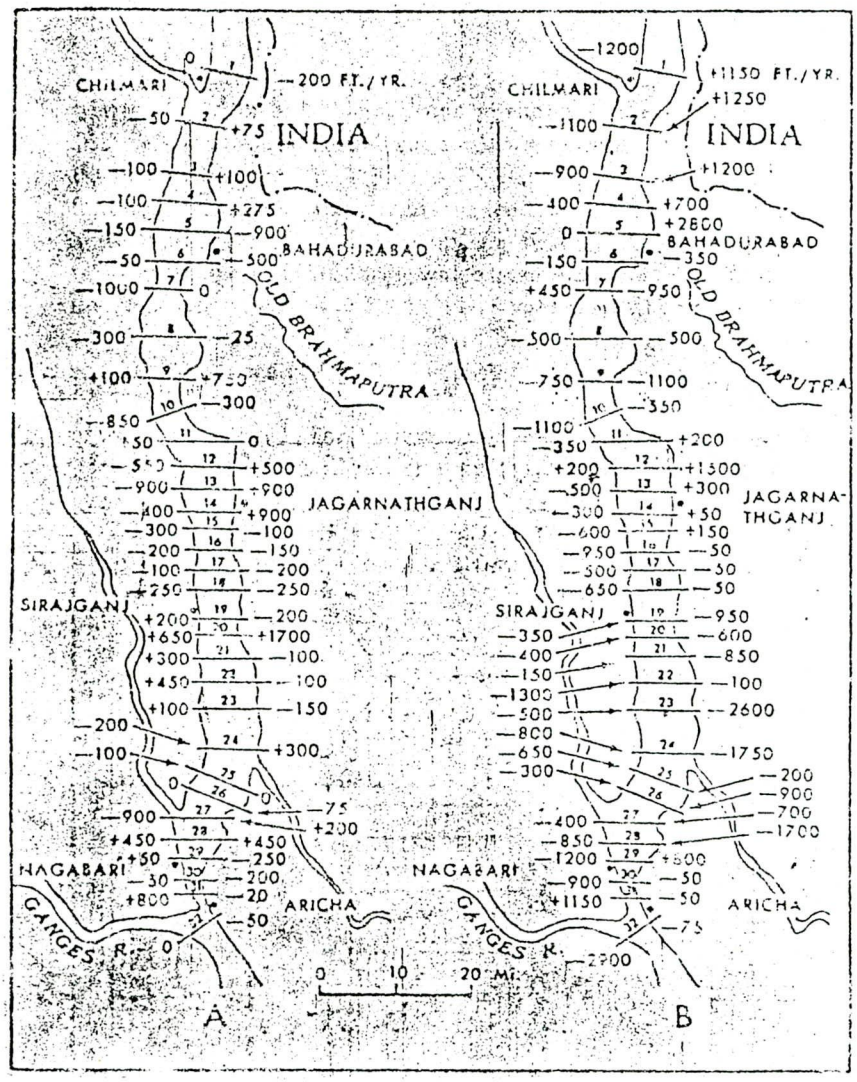


Figure.3.10 Rate of bankline migration if feet per year. Two periods of time are illustrated : A. 1962 - 1963; B. 1944 - 1952. A plus mark denotes deposition or buildout; a minus sign denotes erosion or retreat. (Coleman , 1969)

sign before the rate. During the period 1944-1952 the maximum rate of erosion was 792 m (2600 ft) per year (station 23) and the maximum amount of build out was 853 m (2800 ft) per year (station 5). In some areas, both banks of the river were retreating rapidly (station 10, 23, 24 and 28), whereas in another area both banks were building out or restricting (station 12) rapidly. At several stations (1,2,3,13 etc.) one bank is cutting and the other is building out at a similar rate. Thus within the period bankline migration was not predictable but, rather, it was erratic. It might be noted that a slightly higher number of stations on the right bank showed erosion than on the left bank (Coleman, 1969).

The shifting range of bankline is shown in figure 3.11. Most of the bankline shifted 5-10 km toward the right except some local bankline shifted toward the left (CBJET, 1991).

In figure 3.12, the study reach was divided into island and nodal reaches and point measurements of right and left bank erosion distance were made at 0.5 km intervals, with erosion being measured as a positive distance and accretion as a negative distance. Offset distances were divided by the interval in years to give a mean erosion rate. Map updates were made between 1951 and 1957 and the rates (listed in table 3.2) reflect the best estimate of the actual date of the last map update for a reach. The sample distributions of bank erosion were used to generate average values of bank erosion for such sub-reach. The overall average rates for islands, nodes and the whole study reach were found by weighting the averages for the sub-reaches according to their lengths. These data are listed at the foot of Table 3.2.

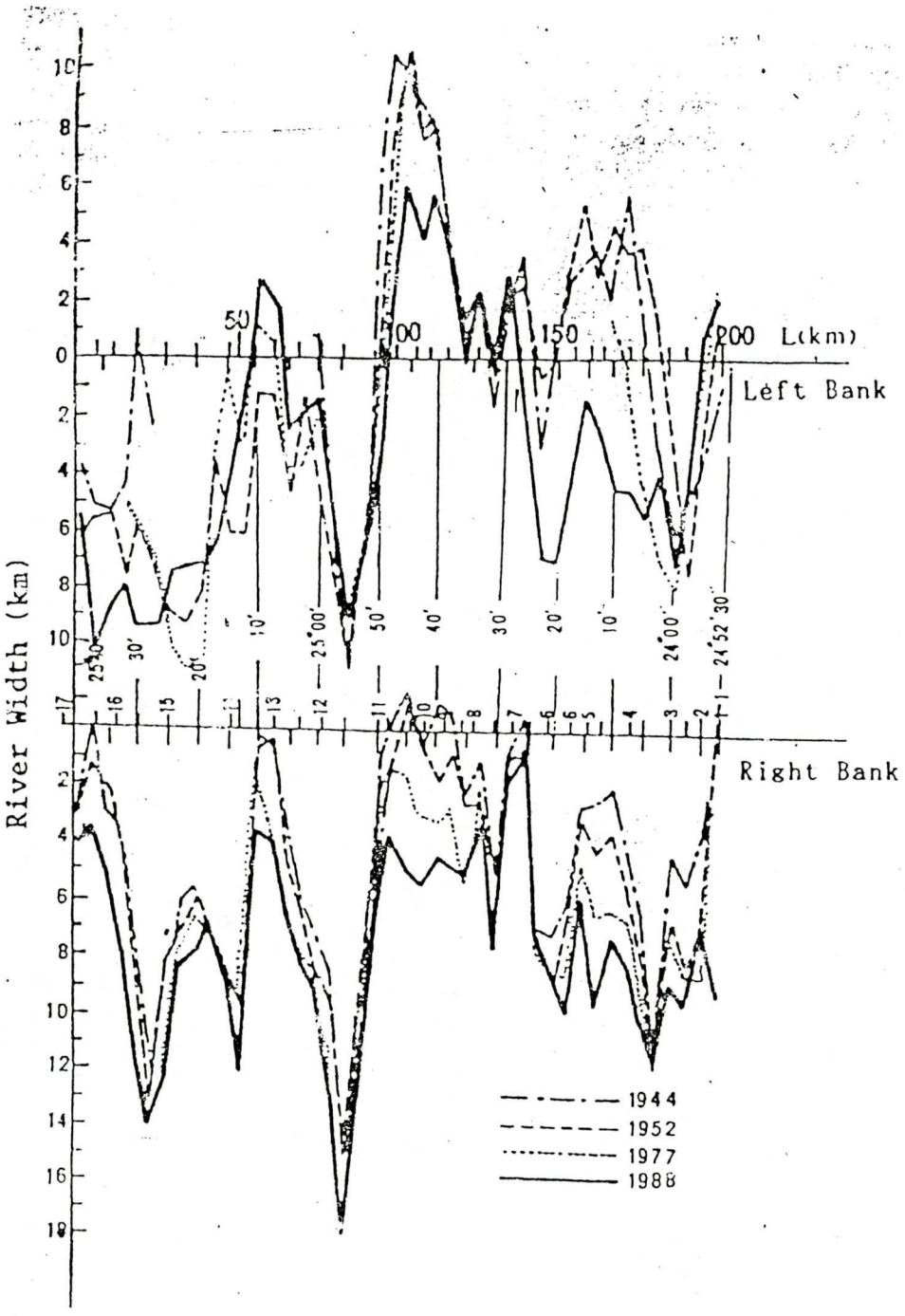


Figure. 3.11 Range of Thalweg Shifting along the Brahmaputra River since 1830 (CBJET, 1991)

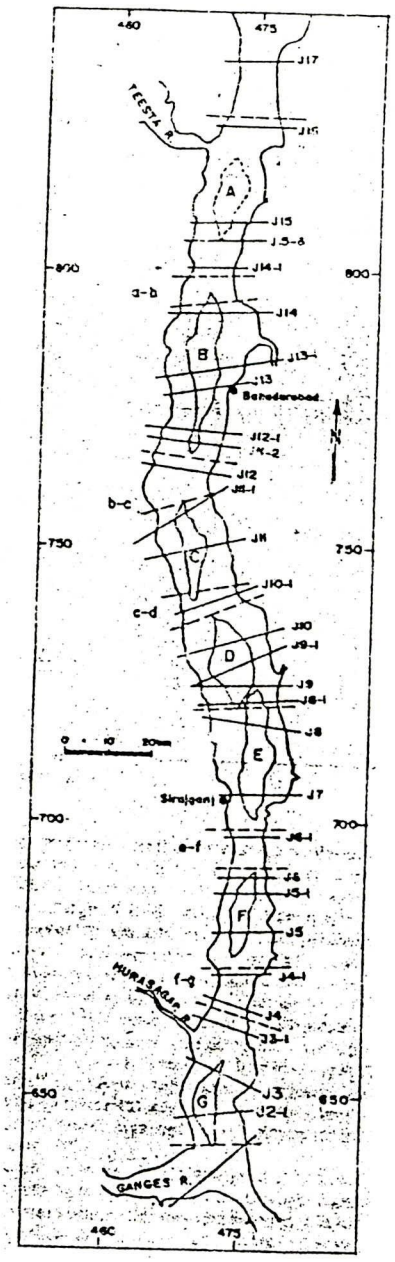


Figure. 3.12 Location of cross-section and island/node sub-reaches used in morphological studies (Alam, Thorne, Russel, 1987)

The results show that over the entire study reach bank erosion during the period was more severe on the right than the left bank. The average right bank erosion rate is 90 m per year, with individual sub-reach rates as high as double this figure. The left bank exhibits an overall small net accretion rate, although large scale erosion rates of over 90 m per year are also observed.

For the right bank, the island average erosion rate is nearly three times that for the nodes, while for the left bank island reaches show erosion at a relatively low rate. The data indicate that in island reaches the average width of the braided channel has increased markedly. Since erosion of both banks together produce a net widening rate of about 120 m per year. A medium term average erosion rate of nearly 40 m per year for the right bank together with an accretion rate of nearly 50 m per year on the left bank indicates a very dynamic form of stability that leads to channel shifting. The bankline movement figures for the nodes support the conclusion that the river has migrated wastward during the last three decades.

Island reach A showed moderate widening and westward shifting over the study period. Bank erosion is currently a problem in this reach and Kamarjani is a priority site for bank stabilization under FAP21/22. Node a/b was relatiely stable. Island reach B widened through retreat of both banks, while the next node (b/c), north of Sariakandi, was relatively stable, but with moderate westward migration.

Island reaches C and D migrated westwards and widened. Islands D and E are unusual in that they overlap with no clear node between them. This reach widened quite rapidly through net erosion of both banks. Island reach F has a right bank erosion rate approaching 200 m per year . Node f/g has migrated rapidly westward at constant width (Alam, Thorne, Russell, 1987).

The location of bank erosion along the Jamuna river is very difficult to predict over a longer period than a few years. From studies under FAP1 it was found that major bank erosion is related to the presence of large bend that have a life cycle of between 3 and 7 years. In fact these bends are the most stable phenomena in the Jamuna river. Bank erosion along these bends was studied on the basis of satellite images and preliminary results were presented by Klaassen and Masselink (1992) and Thorne (1983). They observed erosion rates along outer banks of major bends varying between 200 to 700 m (and exceptionally even to 1 km) in one year (Hannan, 1993).

3.10 Wandering of the Thalweg

In a river, as highly charged with sediment as the Brahmaputra, the bed configuration changes drastically under differing flow regimes. Deposition of sediment in one locality causes deepening by scour in another locality. Thus the thalweg tends to wander continuously from one position to another within the river bank lines. This is generally characterized by two distinct types of movements, a gradual and transverse movement and sudden shifts from one position to another. The graph in figure

Table 3.2 Bank Erosion rates in Island and Nodal reaches between 1953/1956 and 1988

Reach	Period	Length (km)	Average erosion rate Right bank (m/year)	Left bank (m/year)
Island A	1953-89	31	58.2	-18.8*
Node A/B	1953-89	5.5	-10.6	1.73
Island B	1953-89	25	59.2	65.6
Node B/C	1953-89	9.5	22.6	- 8.36
Island C	1953-89	16	94.0	-16.6
Node C/D	1953-89	5	86.7	106.9
Island D	1953-89	18	165	-11.1
Island E	1953-89	18	151.4	73.0
Node E/F	1953-89	20.5	9.4	-36.7
Island F	1953-89	18	198.5	-34.2
Node F/G	1953-89	11.5	109	-98.1
Averages:				
Island reaches		21	111.6	10.2
Node		10.4	39.2	-47.8
Study reach		178	90.4	-6.7

* Negative erosion rates indicate bank accretion

3.13 illustrates these two types of movement of the thalweg during one flood season at Sirajgonj. The upper graph shows a discharge curve while the lower graph indicates the magnitude of the movement of the thalweg from a stable reference point on the right bank. In May and June, during rising stage the amplitude of movement is rather large. On the order of 914 m (3,000 ft), but this movement is gradual, as it takes place over an entire month. During the peak of the flood, July through August, there is a relatively small amount of movement and the thalweg remains nearly constant in location. However, during the months of August and October, the falling stage, the thalweg moves in an irregular and sudden fashion. Within a few days the main current wanders back and forth to an extent of several thousand feet. The pattern is extremely irregular and the thalweg moves by fits and starts. From November through March, the low flow stage, very little movement

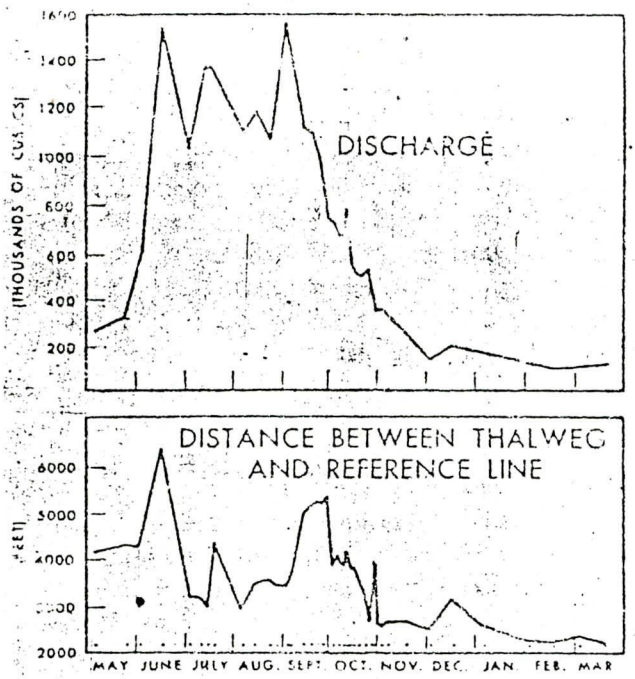


Figure. 3.13 Discharge hydrograph and corresponding movement of the thalweg during a flood cycle. Data from Sirajganj station. Small dots at bottom of the lower curve indicate actual dates measurements were taken.(Coleman, 1969)

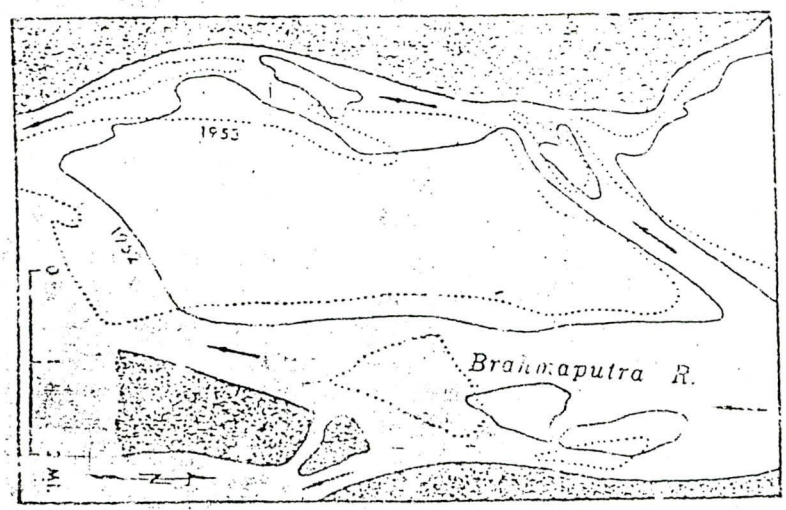


Figure. 3.14 Plan view of changes in sand bar position before and after flood of 1952 on the Brahmaputra River Banklines obtained from aerial photographs. Solid line shows the location of the sand bar during low river stage of 1952, whereas dotted line shows position of the same bar after passage of the flood 1952. (Coleman, 1969)

of the thalweg takes place.

In the low-water stage,prior to the passage of the flood, the river is subdivided into numerous small channels with one of these generally serving as the main channel and carrying a larger portion of the flow. This channel is commonly situated near one of the banks and is slightly curved, moving from one bank to the other. With the oneset of the flood, the initial reaction is for the river to seek a path with little curvature. As a result, the thalweg tends to move toward the inside portion of the curvature.The rise in flood stage, however, is quite rapid, and the river must widen and deepen to accomodate this large increase in discharge. The usual result is for the bank to be undercut, slumping then occurs and the migration of the thalweg in a transverse direction is initiated. This type of river shifting takes place gradually, usually over an entire month, but it may attain considerable amplitude.

The second type of shifting of the thalweg can be related to the movements of the sand bars and mid-channel islands. As flood water subside, an excess of sediment is carried as bed load in suspension, velocities diminish, causing this material to be deposited. Deposition of the material results in a corresponding change in local flow direction and the thalweg is in a state of constant movement. It is during this period that bed aggradation is the greatest and many new channels are formed, function for a short time, and are then abandoned. As the flood continues to subside, one of the channels becomes dominant and the rate of wandering of the thalweg diminishes. This is illustrated during the months of November through March in figure 3.13 (Coleman,1969).

3.11 Reasons for Channel Migration/Shifting

The characteristics and direction of flow are determined by various opposing factors within the stream; for instance;the oncoming load versus the sediment-carrying capacity of the flow, and the errosive resistance of the bank against the bank caving capacity of the flow (Chen, 1964). The existence and development of these various factors contribute to the shifting of the river channel. Probably the major controlling factor, however, is the amount of sediment and the inability of the river to transport it. Within the Brahmaputra-Jamuna river, the total amount of sediment provided by the catchment far exceeds the ability of the flow to carry the sediment. Thus there is a general aggradation of the channel bed which causes the channel to become wider and shallower. The aggradation constantly causes the main current to seek better gradients, new alignments and paths of least resistance. A new channel thus formed is at first narrow and deep; with time; however, it, too, will begin to aggrade, and the whole process is repeated. In this manner the river is in a state of constant migration, eroding and redepositing sediment of its own making as well as older deposits of previous channels.

Although the aggradation of the river bed is one of the major factors responsible for the wandering of a river course, it also creates conditions under which other factors manifest their influence. During low stage, the river width is excessive for the amount of water it must attain, and the channel forms complicated patterns of pools and riffles. Some areas receive excessive deposition, causing scour in an adjacent area.

Thus, the river spreads its sediments across the entire valley. Under such conditions the channel is able to remould freely its bed configuration, thus maintaining a cross-sectional area in keeping with flow regime. In addition, a number of factors, including the high susceptibility to erosion of the bed material, the large variability of the flow, and the abrupt rise and fall of the river stage, have a strong bearing in determining the migration patterns. Both rate and amplitude of channel shifting become larger when the above factors exist (Coleman, 1969).

3.12 Formation and Movement of Sand Bars

A braided channel is characterized by innumerable sand bars(Chars) and mid-channel islands which seperate the flow into several channels. Such a condition exists in the Brahmaputra chnnel. Oncoming load is greater than the sediment-carrying capacity of the flow and results in an aggrading channel bed characterized by such bars and islands.

The initial location and formation of the sand bars are determined during the flood; they are possibly the result of the formation of the two scour channels hagging each channel bank. The hydraulic conditions that cause this erosion and deposition are essentially unknown. However, the area of deposition in the central part of the channel is undoubtedly caused by sack-water conditions. During the flood this area receives deposition and bed is aggraded significantly. Since the flood water subside rapidly, there is not enough time for this material to erode, and hence it

is soon exposed as a shoal. After exposure and drying of the surface, wind activity modifies it slightly, piling sand into various types of aeolian.

During the next flood, the island is once more inundated. In some cases it is completely removed by erosion, but more commonly it suffers erosion on its upstream face and deposition on its downstream end. This generally causes the island to migrate in a downstream direction. Figure 3.14 is a plan view, as traced from areal photographs, of a single channel in the Brahmaputra south of Sirajgonj. The solid lines indicate the position of several sand bars as they existed during low water in 1952-1953. The dotted lines indicate the position of the sand bars after the 1953 flood. In every instance, the sand bars have moved downstream in varying degrees. The small bars along the east bank have migrated downstream 1524 m (5,000 ft) during a single flood. The large central bar has been eroded on the upstream end as well as along its eastern side, deposition having occurred on the downstream end, causing the island to migrate some 762m (2500 ft) downstream. In most cases the total area of the island remains approximately the same from one flood to another, and only its position and shape change. In some instances, however, whole islands disappear or new islands form that were not present the previous year. Thus, during flood the sediment is shifted as bed load, causing the islands to migrate. The large number of bedforms present on the surface of these islands when they are exposed indicates that sediment had moved as migratory dunes during flood.

3.13 Deposition and Erosion of the River Bed

The Brahmaputra-Jamuna is heavily charged with sediment, rates of erosion and deposition are quite high. The constant shifting of the thalweg adds to the magnitude and complexity of deposition and erosion patterns. During rising stage the velocity increases abruptly to a maximum, then fluctuates in response to differences in discharge. Scour depth, however, increase slowly and do not reach maximum as the same time as velocity. The greatest amount of scour occurs during the latter part of the flood, at which time the velocity declines sharply. Once the velocity diminishes, the maximum amount of deposition takes place. This generally occurs just before or during the falling stage. The river widens with the passage of the flood and suddenly diminishes during falling stage (Coleman,1969).

90283

3.14 Scour

Bank protection structures such as groynes, revetments and cross bars can induce local scour holes with a maximum depth of 20 to 30 m below the water level. For example, near the head of the Ranigram Groyne a deep local scour hole has developed. General scour is the lowering of the bed level owing to changes and developments in the catchment area (Alam, Chowdhury, Rahman, 1995). General scour may be influenced by the following factors.

- Construction of embankments, reducing the flood plain width and causing higher peak flows downstream,
- Increasing soil erosion in Nepal and possibly other parts of the catchment result in more sediment supply to the rivers contributing to the Brahmaputra/Jamuna discharge.

- Construction of dams will reduce the sediment load of the rivers downstream and also cause a general damping of seasonal water level fluctuation (not major floods).

In alluvial channel bends, the bed level in the outer bend is lower than in the inner bend. Consequently, the depth increases are going from the inner to the outer bend. The large depth in the outer bend, know as bend scour, was expected to give a considerable contribution to the maximum scour in the Jamuna River. In the Jamuna river confluene scour seems to be dominant over bend scour. Only local protrusions produce deeper scour holes. For the bridge piers confluence scour may be the major cotribution to the total scour (JMBA, 1988).

During the special hydrographic survey some measurements were done near the town protection of Sirajgonj and near Bhuapur along the Eastern bank of the Jamuna River. The results (deepest scour levels expressed in m + PWD) are listed below:

- Bhuapur 24-25 August 1987- 8.0 m
- Sirajgonj 3-19 September 1987-25.3 m
- Bhuapur 23-24 October 1987- 6.1 m

3.15 Planform Characteristics

The Jamuna River is a braiding stream with chars and deeper channels in between. The braiding character is most prominent in the upstream reaches, as observed on a number of satellite imageries taken during low flow conditions. The deep water channel

changes frequently and the banks are susceptible to heavy erosion and deposition, indicating a very unstable nature of the channel. However, the channel is maintaining the present course for quite a number of years (Sultana, 1989). Planform characteristics of braided streams can be divided into (i) characteristics of the network of channels and (ii) characteristics of the individual channels, Howard et al (1970) introduced a number of topological and geometrical indices for networks of braided channels. Their approach and definitions were used in the analysis of the Jamuna planform characteristics. Planform characteristics of individual channels relate to radii of curvature of bends in relation to channel widths,the total arc length of bends and channel directions (JMBA, 1988).

3.16 Cross-Section Characteristics

Cross-sectional characteristics of the Jamuna river were studied by Ullah (1987), and RPT/NEDECO/BCL(1989) on the basis of data available from Bangladesh Water Development Board (BWDB). They concluded that most of the cross-sections can be characterized as a flat sand bed with an elevation few metres below the annual flood level in which deep channels are curved. These channels are clearly composed of several smaller ones. Typical bend profiles seem to be present in the river. The following characteristics were determined by cross-section and year.

- total river width, defined as the width between the edges of the deeper channels.
- the number of main channels

- the combined width of channels
- the total wet area of the main channels below the mean annual flood level
- the maximum depth

The average depths were computed from the total wetted area and the combined widths of the main channels. Mean values for the different parameters were derived by averaging the data of the available years (Sultana, 1989).

3.17 Bed Material

Bed material characteristics of the Brahmaputra/Jamuna river were studied by Coleman (1969) throughout its length in Bangladesh and indicated an average grain size value of 0.172 mm. The Jamuna Bridge Appraisal Study found D_{50} value range between 0.235 to 0.165 mm from the upper to the lower reach. According to FAP1 study, the average size ranges between 0.15 to 0.17 mm. According to Hannan (1993), the bed material of the river is fine sand, with D_{50} varying between 0.22 mm at Chilmari and 0.165 mm near Aricha.

CBJET (1991) observed tht D_{50} value for the main channel has gradually decreased from 0.26 mm in the upper reach to 0.17 mm in the lower reach,which fairly relates to observations made by all other studies.

3.18 Resistance to Flow

Resistance to flow data of the Jamuna river has been analysed by Nazim (1985) and indicate generally low flow values. There are

indications that during floods, dunes are washed out and possibly even flat bed conditions may occur.

3.19 Sediment Transport

The Brahmaputra-Jamuna river is more heavily charged with sediment both in terms of quantity and calibre among many sediment carrying rivers of Bangladesh. It is quite difficult to have an accurate prediction of sediment distribution and yield in a braided river like the above river for all the periods, especially during monsoon due to the complex variation of sediment load with incoming flow. The suspended load measurement on the Brahmaputra-Jamuna river is taken at the two points, 0.2H and 0.8H along every measured vertical line. According to the field measured data in the monsoon season of 1990, the sediment concentrations corresponding to the relative depth, d/H, of 0.2, 0.6 and 0.8 are 0.52, 1.02, 1.32 kg/m^3 respectively, in which d is the depth of measured point and H is the depth of corresponding vertical line. It may be estimated that the amount of coarse sediment which could not be accounted for in the measurement may be higher than 10 percent. Meanwhile, according to the size distribution of bed material and hydraulic calculation, the bed load is nearby 10 percent of the suspended load (CBJET, 1991).

Coleman (1969) studied sedimentation of the Jamuna river based on suspended load measured at Bahadurabad during the period of 1958-1962. According to Latif (1969), the average yearly sediment transport is about 600 million tons. The measured monthly sediment transport rates in the Jamuna river vary between less than 1 million tons/month during low fow season and more than 250

million tons/month in the flood season (UNDP, 1986). Goswami (1985) reported suspended sediment load of about 402 million tons measured in the Jamuna river at Gouhati in Assam. Hossain (1990) stated that the total average sediment load transport in the Jamuna river at Bahadurabad is 650 million tons per year.

According to BWDB, the suspended coarse sediment transport for the period 1966-1969, suspended fine sediment transport for the period 1967-1969 and total suspended sediment transport for the period 1967-1969 are shown in Table 3.3,3.4 and 3.5 respectively (FAP24, 1994).

Table 3.3 Suspended coarse sediment balance according to the BWDB

Name of station	Suspended coarse sediment transport (million tons per year)			
	1966	1967	1968	1969
Bahadurabad	256	170	171	186

Table 3.4 Suspended fine sediment balance according to the BWDB

Name of station	Suspended fine sediment transport (million tons per year)		
	1967	1968	1969
Bahadurabad	405	355	235

Table 3.5 Total Suspended sediment balance according to BWDB

Name of station	Total suspended sediment transport (million tons per year)		
	1967	1968	1969
Bahadurabad	575	526	421

Hossain (1992) reported that the sediment transport through Jamuna river in the years 1982, 1983, 1984, 1986, 1987 and 1988 are 733, 754,747, 403, 815 and 840 milion tons per year respectively (FAP24, 1994). According to FAP24, the annual average suspended coarse sediment load for the period 1966-1989 are as shown in Table 3.6 and 3.7 respectively.

Table 3.6 Coarse suspended sediment balance according to FAP24

Name of station	Annual average (1966-1989) suspended coarse sediment load in million tons	
	(1966-1970)	(1976-1988)
Bahadurabad	202	96

Table 3.7 Total suspended sediment balance according to FAP24

Name of station	Annual average (1966-1989) suspended sediment load in million tons		
	Coarse (A)	Fine (B)	Total (A+B)
Bahadurabad	202	388	590

According to CBJET (1991), the annual suspended load for station Bahadurabad is shown in table 3.8

Table 3.8 Annual suspended load for station Bahadurabad (1965-1988) (Unit 1 x 10^9 tons)

Name of station	Year											
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Bahadurabad	.771	.510	.711	.704	.728	.737	.602	.471	.733	.451	.250	.370

Table 3.8 (To be continued)
Annual suspended load for station Bahadurabad (1965-1988) (Unit 1 x 10^9 tons)

Name of station	Year												Average in 24 years
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	
Bahadurabad	.480	.278	.362	.281	.252	.294	.236	.556	.420	.488	.706	.539	0.499

The comparison between the results of CBJET, MPO (BANGLADESH), FEC (France) and Coleman are given in table 3.9 (CBJET, 1991)

Table 3.9 Comparison of the annual sediment load (Unit 1 x 10^9 tons)

River	Station	MPO Report	FEC Report	Coleman Report	CBJET Report
Brahmaputra-Jamuna	Bahadurabad	0.387	0.431	0.607	0.499

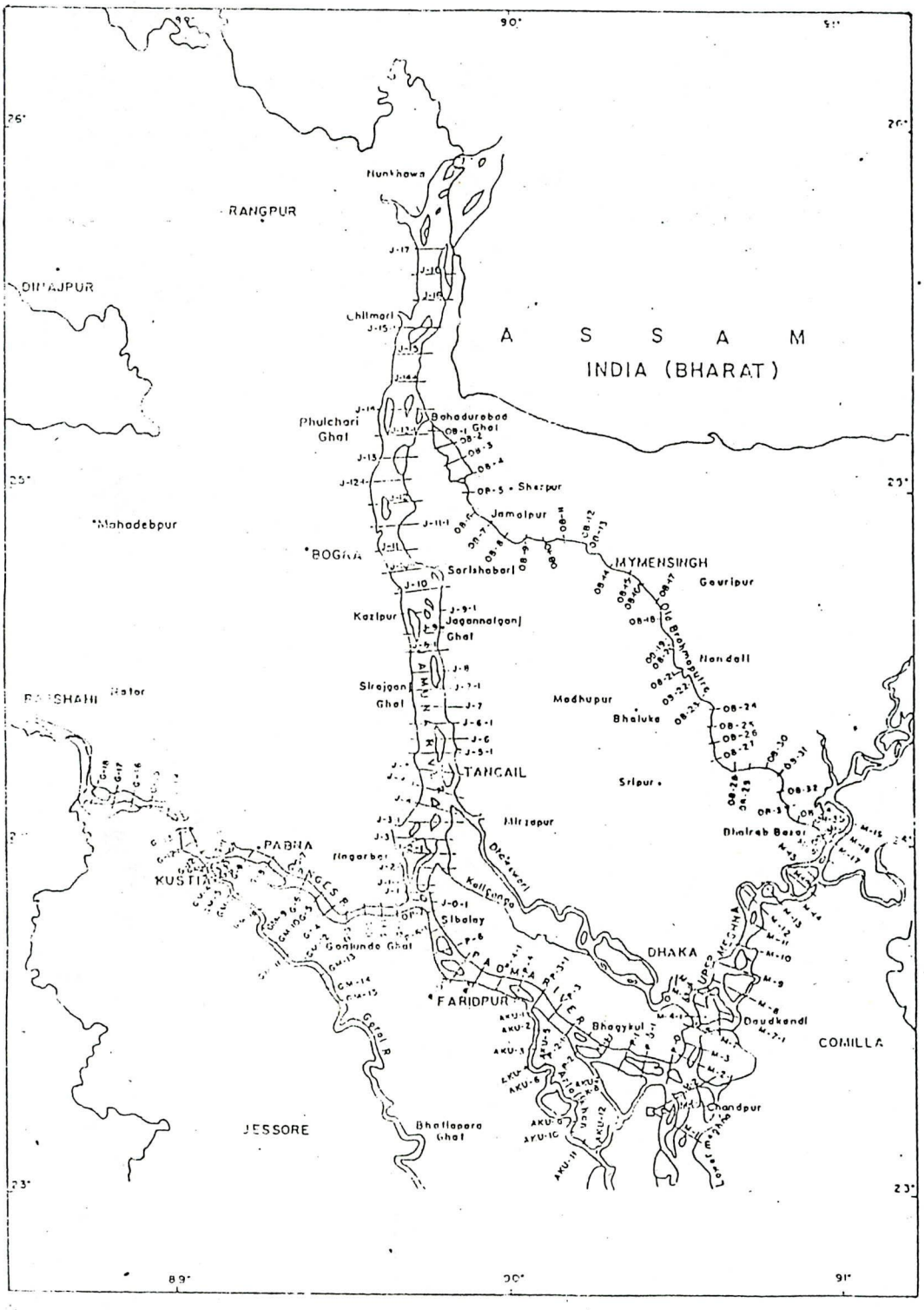
CHAPTER—4

DATA COLLECTION AND METHODOLOGY

4.1 Introduction

To study the morphological behaviour of Brahmaputra-Jamuna river, cross-sections at different stations covering the distance between Noonkhawa and Goalundo have been collected from river Morphology and Research Circle, BWDB, Dhaka and surface water Hydrology-II,BWDB, Dhaka. The main river system of Bangladesh is covered by a network of standard cross-sections which are surveyed by BWDB regularly. BIWTA makes irregular soundings of the deepest part of the channels of the main river system to inform the inland navigation on the available depth in navigation routes. In addition to these cross-section soundings are made for special purpose or according to special project requirements.

The BWDB established a river survey network covering all main, medium and minor rivers in the whole country during the past 25 years. This network comprises a total of 607 standard cross-sections at an interval of about 6436 m (4 miles). In total, 144 cross-sections are surveyed in the main rivers (figure 4.1). The cross-sections are measured during the dry season when the water level is below the level of the chars. The dry part of the cross-section is surveyed with a levelling instrument and a levelling staff, while the wet part of the cross-section is surveyed by an echo-sounder on a survey vessel. The positioning of the vessel along the transit line is determined by sextant or


RANGPUR
DINAJPUR
Nunkhawa
Chilmari
Phulchari Ghat
Bahadurabad Ghat
Sherpur
Jamalpur
Mahadebpur
BOGRA
Sariakandi
Sariakandi
Kazipur
Jagannathganj Ghat
Sirajganj Ghat
RAJSHAHI
Nator
TANGAIL
Madhupur
Bhaluka
Sripur
Mirzapur
Dhirasram
Dhaka
Dhaka
Dhaka

theodolite with respect to a known base line. The BWDB feels that for appropriate analysis of the morphological changes in the river system it is necessary to survey the cross-section also during the monsoon season and to densify the network with more standard cross-sections in future (Haque, 1993).

A cross-section is defined by two to three pillars or monuments at one bank and at least one pillar or monument at the other bank. In case high chars develop, in the cross-section it is necessary to define more temporary pillars at the char. The location of a pillar is fixed by a description of the plot of land it is placed, the location of that plot in the Mouza maps and by the geographic co-ordinates of the pillar. The direction of the cross-section is defined by the bearing, at an angle measured with respect to the magnetic north. In general, a cross-section is measured from the pillar (or the embankment) at one bank to the pillar (or the embankment) at the other bank. This means that not only the channel(s) and the chars are surveyed but often also a part of the flood plain. Preferably the cross-section is selected perpendicular to the river axis or the main flow direction in the river, but after sometime the river axis may have changed as part of the changes in the planform of the river and the angle between the cross-section and the river axis is no longer perpendicular. If the pillars are eroded it is necessary to place and define new pillars with a new bearing. This can result in minor shifts in the location of a cross-section.

4.2 Description of Selected Stations

BWDB collects data of the Brahmaputra-Jamuna river for a number of standard cross-sections designated as J-0-1 to J-17, starting from the confluence of the Jamuna river with the Ganges to Charantua. In this river, the oldest cross-sections were measured in 1964-1965 at an interval of about 8 miles for the study of a barrage near Bahadurabad. Cross-sectional data of the river have been collected since 1965-1966, at intervals of 4 miles. This interval was further reduced to about 1 mile since 1969-70. Initially these measurements were done every year, but they were interrupted in 1970 due to the independence war. In 1975-76 the soundings were taken up again, but these soundings were not performed regularly, and only in smaller stretches of the river.

For the present study the stations J-1 to J-17 are selected at an interval of about 8 miles (figure 4.2) and the data of 1969-70. 1976-77, 1977-78, 1978-79, 1981-82,1986-87, 1988-89 and 1990-91 have been analysed. The cross-sectional data for the period 1965-66 to 1968-69 were not used because the data are not available for all the stations. The cross-sections J-1 to J-3,J-5, J-6, and J-9 to J-13 are measured from left bank to right bank and the cross-sections J-4, J-7, J-8, J-14 to J-17 are measured from right bank to left bank by BWDB. In 1976-77 station J-12 and in 1978-79 station J-9 were not surveyed by BWDB. Data for the period 1979-80 and 1987-88 were not available. The cross-sectional data for the period 1985-86 and 1986-87 are same and the cross-sectional data for the period 1982-83 and 1984-85 could

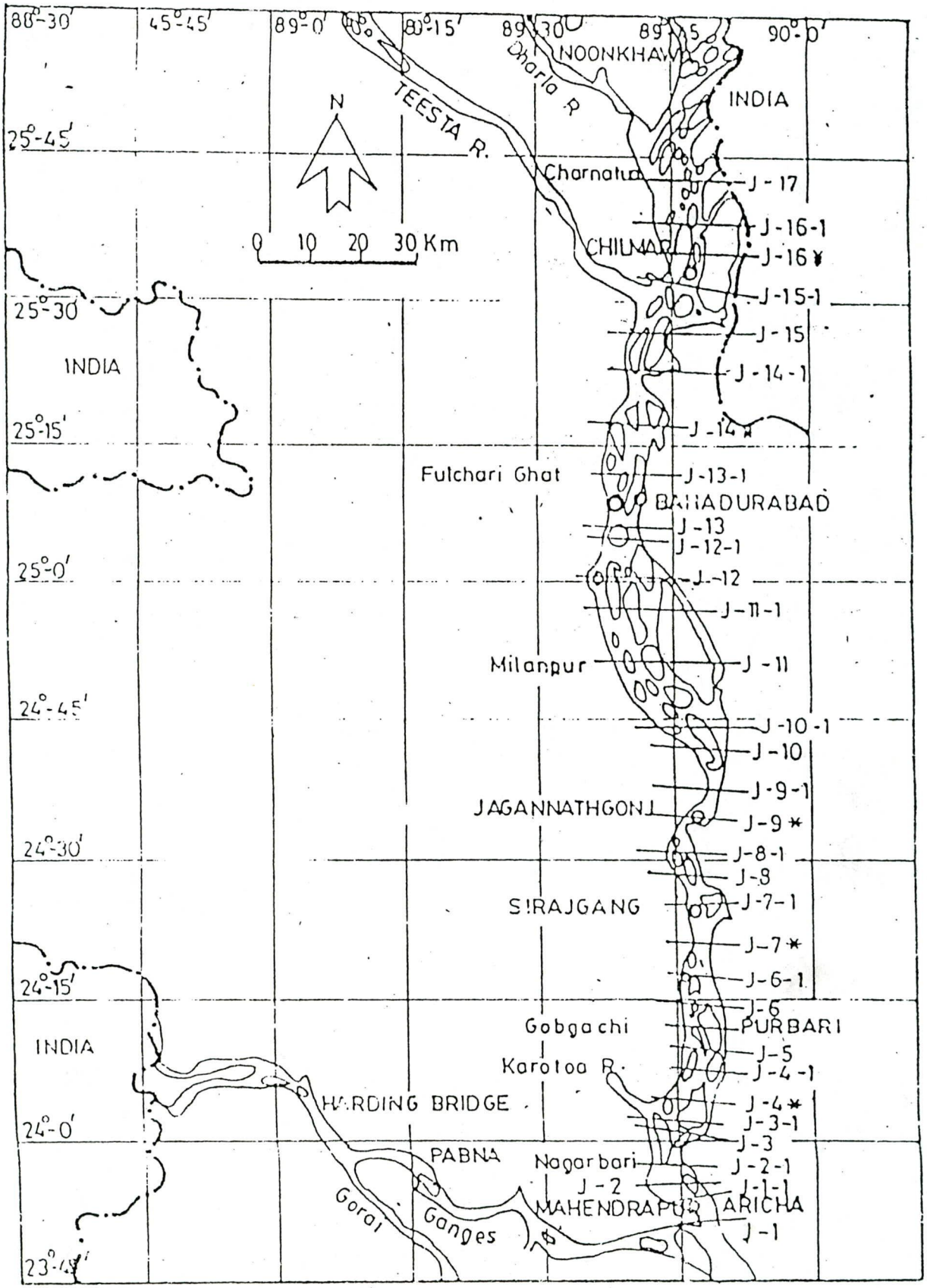


Figure. 4.2 LOCATION OF CROSS-SECTIONS FROM GANGES–JAMUNA CONFLUENCE TO NOONKHAWA AND WATER LEVEL AND DISCHARGE GAGING STATIONS (Halder, 1989)

not be collected as these data are reported to be missing. There are high, medium and low water level marks in the cross-section which are supplied from River Morphology, BWDB, Dhaka.The station from J-17 to J-1 with high water level are shown in figure 5.69.a to 5.85.h.

Water level data are collected at various stations along the river but discharge data are only recorded at Bahadurabad station. The location statement of the monuments or the RCC pillars along the cross-section of the river selected at J-1 to J-17 stations for the year 1981-82 are given in appendix - A.

For the third objective, the data are collected from surface water Hydrology-II, BWDB, Dhaka. Although for the first and second objective the data of the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are used, but for the third objective only the data of the years 1969-70, 1978-79 and 1981-82 for dry and monsoon season are used, which are supplied from surface water Hydrology-II, BWDB, Dhaka. All the eight years data which were used for the first and second objective but could not used for the third objective because data relating to discharge, velocity etc. were not available for all the years. In surface water Hydrology-II, BWDB, Dhaka data relating to discharge, area, velocity and water depth etc are available only for the three years out of previously mentioned eight years. The mean daily water level data were however available for all the years. The mean daily water level data for three years are given in Appendix-B. The distance between

Noonkhawa to Bahadurabad and Bahadurabad to Sirajgonj are taken as approximately 87 km. This information is also supplied from surface water Hydrology-II, BWDB, Dhaka.

4.3 Background of MIKE 11 Software

MIKE 11 is a software package developed at the Danish Hydrulic Institute (DHI) for the simulation of flows, sediment transport and water quality in estuaries, rivers, irrigation systems and similar water bodies.

MIKE 11 is doeveloped especially for application on micro-computers and is based on DHI's well known SYSTEM 11, which since its development in 1972 has been used in a large number of applications around the world.

MIKE 11 offers a unique and user-friendly tool for design, management and operation of river basins and channel networks.

MIKE 11 is an integrated software package which enables the user to simulate catchment runoff, river flow, sediment and pollutants transport. MIKE 11 consists of a number of modules which in principle operate independently. This gives a rational and user-friendly execution and enhances the flexibility of the package.

The MIKE 11 hydrodynamic module has been developed on basis of the well known SYSTEM 11 HD(Hydrodynamic module), and is an implicit, finite difference model for unsteady flow computation.

The model can describe subcritical as well as supercritical flow conditions through a numerical description which is altered according to the local flow conditions (in time and space).

Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation.

The formulations can be applied for looped networks and quasi two-dimensional flow simulation on flood plains.

The computational scheme is applicable for vertically homogeneous flow conditions extending from steep river flows to tidal ifluenced estuaries. The system has been used in numerous engineering studies around the world.

4.4 Methodology

The raw data comprises the coordinates (X_j, Z_j) of the bed level across the river branch and the relative resistance for each section (from X_{j-1}, Z_{j-1} to Z_j, Z_j). The relative resistance is default 1, indicating a constant value of the roughness across the section, see figure 4.3. The maximum number of X-Z coordinate sets which may be used to describe one cross-section is 300.

After the raw data have been entered, and an <esc> is made from the raw data menu, calculatins will take place in which the raw data are processed to a form which is used in the actual hydrodynamic calculations.

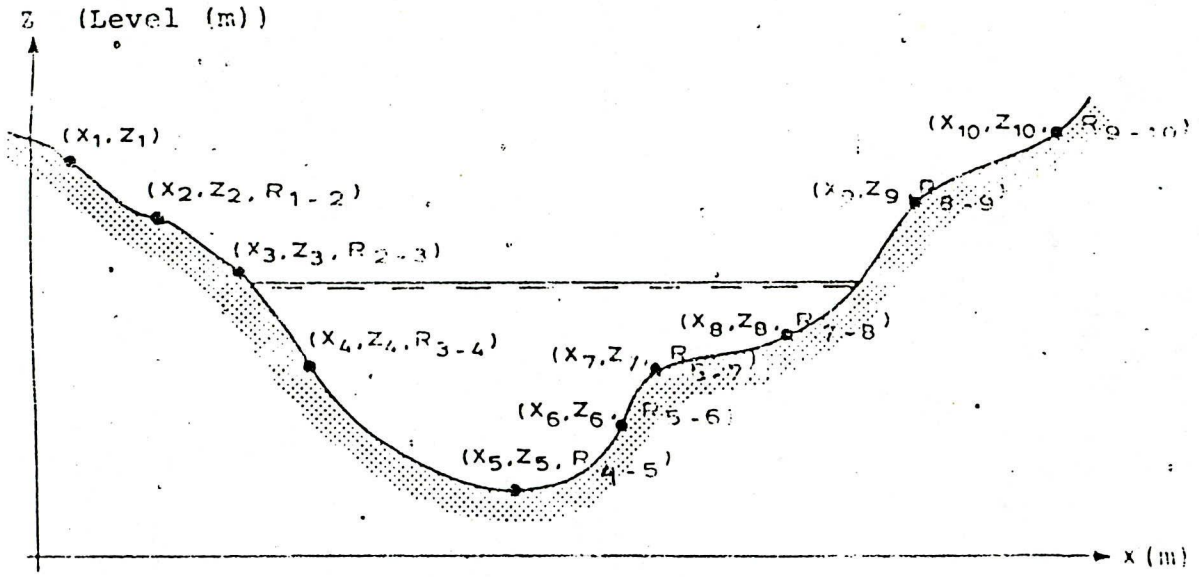


Figure 4.3 Definition sketch for raw data, x-z coordinates and relative resistance.(MIKE 11, Scientific documentation)

When processing the raw data we can specify a number of levels (maximum of 10 levels) at which the hydraulic parameters are to be computed. If we know in advance that the water level varies within a certain range, this can be used to determine the minimum and maximum levels for the table.

If no levels are specified, they will automatically be selected by the system, taking the variation of the area and the width into account. (The upper and lower bounds will be determined from the raw data input). If we enter only one level, it will be interpreted as the lowest value in the table and MIKE 11 will select several levels above this one. Entering two levels, these will be interpreted as the minimum and maximum for the table respectively. When selecting the water levels at which the hydraulic parameters are to be computed, it is important to ensure that non-linear variations of the hydraulic parameters will be described adequately. (This is achieved if automatic selection of levels is chosen).

The datum specified in the raw data will be added to all Z-X coordinates when calculating the processed data. In this way it is possible to correct for bench mark errors in the raw data.

The processed data consists of a table containing the hydraulic parameter variations with water level.

The hydraulic parameters are:

- cross-section area (m^2)
- width of water surface (m)

- hydraulic radius (resistance radius) (m)
- additional surface storage area (m^2)
- resistance coefficient.

Among these hydraulic parameters, we have used only cross-section area (m^2) and width of water surface (m).

Table 4.1 Processed data for a cross-section

RIVER CROSS SECTION — PROCESSED DATA

1 River name	2 Chainage	3	4 x-coor	5 y-coor	6	Pos flow dir
WEST-CHANNEL	9.000	1	0.500	4.350	0	

HYDRAULIC PARAMETERS: Number of levels : 9

Level (m)	Cross sec. area (m^2)	Hydraulic radius(m)	Width (m)	Add. fl. areas (m^2)	Resistance Factor
-3.00	0.00	0.00	0.00	0	1.00
-2.88	0.32	0.07	6.00	0	1.00
-2.10	11.94	0.72	18.75	0	1.00
-1.80	18.20	0.95	23.00	0	1.00
-1.00	40.20	1.53	32.00	0	1.00
-0.50	61.20	1.76	52.00	0	1.00
-0.25	82.51	1.62	118.50	0	1.00
0.00	120.45	1.42	185.00	0	1.00
3.00	690.45	3.73	195.00	0	1.00

<I> Insert row (before cursor) <D> Delete row <ESC> end and update
<'K'S> update < O > end WITHOUT update <F1> Help

MIKE 11 will compute most of the processed data after we have specified the raw data for a cross-section. Additional storage areas and resistance coefficients different from 1.0 must however be entered manually.

Calculation of the hydraulic parameters will only take place in the section between the right and left markers (see section figure 5.69.a to 5.85.h).

MIKE 11 has in-built facilities to process the hydraulic parameters from raw cross-section data at different levels. And also to facilitate us by defining cross-section width as per requirement. In this study, above two facilities are repeatedly used to process the cross-sectional area of that particular section for different level and defined width of that section. All graphs have taken by using HARVARD GRAPHIC Software.

4.5 Data Analysis

To study the morphological behaviour of the Brahmaputra-Jamuna river, eight years cross-sectional data are used. A powerful micro computer based MIKE11 engineering software (UNIX version) is used for this study to reveal the actual long term morphological behaviour of Brahmaputra-Jamuna river. This software is well proven tool for hydrological and hydrodynamic model calculation. Some in built facilities of this software is used to compute the cross-sectional area for different conditions.

For the first and second objective, the eight years cross-sectional data of 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are used. The high water levels which are supplied from River Morphology & Research Circle, BWDB, Dhaka are shown in the cross-sections (Fig. 5.69.a to 5.85.h).

For the first objective the areas are calculated based on data by 1 (one) meter interval from bottom level to high water level for every section. Elevation versus Areas are given in

Table 5.1 to 5.17. From Table 5.1 to 5.17 elevation versus area curves are drawn as shown in figure 5.1.a to 5.17.b. Elevations are found out with respect to 5% and 10% of the total area for every section for every year. These are given in Tables 5.18 to 5.34. From Table 5.18 to 5.34 elevation versus year curves are drawn (figure 5.35 to 5.51). From Table 5.1 to 5.17 area versus year curves are drawn for fixed elevation (Fig. 5.18.a to 5.34.b).

For the second objective, the areas are taken near about 500 m gap from left bank to right bank for J-1 to J-3, J-5, J-6, J-9 to J-13 sections and from right bank to left bank for J-4, J-7, J-8, J-14 to J-17 sections. Horizontal distance versus areas are given in tables 5.35.1 to 5.51.8. From tables 5.35.1 to 5.51.8 area versus distance curves are drawn (Figs. 5.52.a to 5.68.b). Total width and effective width are given in tables 5.52 to 5.68. From tables 5.52 to 5.68 width versus year curves are drawn (Fig. 5.86 to 5.102) and also from tables 5.52 to 5.68 year versus horizontal distance are drawn (Figs. 5.103 to 5.119).

For the third objective, Manning's formula $v = \frac{1}{n} R^{2/3} S^{1/2}$ or, $n = \frac{1}{V} R^{2/3} S^{1/2}$ is used to determine the roughness coefficient. Data relating to discharge, area and depth are collected from surface water Hydrology-II, BWDB, Dhaka. Based on these data n values were calculated are shown in table 5.69 to 5.70. From Tables 5.69 to 5.70 velocity versus roughness coefficient curves are drawn (Figs. 5.120 to 5.137).

CHAPTER–5

RESULT AND DISCUSSION

5.1 Introduction

The aim of the present study is to have some idea about the variation of cross-sectional area with elevation, the bed level rise or fall, the movement of effective conveyance area across the width, variation of total width and the effective width at the high water level for every section, the movement of bankline westward or eastward at sections J-17 to J-1 (Ch. 25.00 km to 230.75 km) for the river Jamuna during the period 1969-70 to 1990-91. Study of n value variation at high and low stages for the reach around Bahadurabad for the years 1969-70, 1977-78 and 1981-82 is also a part of the objectives of the present study.MIKE 11 programme has been extensively used for the study and most of the figures are drawn by using Harvard graphic software.

5.2 Cross-sectinal Area and Bed Level

Figures 5.1.a to 5.17.b and Tables 5.1 to 5.17 have been prepared to study the changes in cross-sectional area with elevation for river sections at different stations in different years. Eight cross-sectional profiles for the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 for each of the stations J-1 to J-8, J-10, J-11 and J-13 to J-17 have been available. The cross-sectional profiles for the years 1978-79 of J-9 station and for the year 1976-77 of J-12 station have not been available. Hence, for these two stations only

profiles of other seven years have been studied. For better understanding and presentation of data relating to eight cross-sectional profiles, two different plots are made taking five years of data in one plot and four years of data in another plot in which data of year 1981-82 is repeated. For other seven cross-sectional profiles, two different plots are also made taking four years of data in one plot and four years of data in another plot in which similarly data of one common year is repeated. The area-elevation curves show that the curves rise sharply with high gradients at lower elevation i.e. near the channel bottom and become flatter with increase of depth towards the top. This particular pattern of the profile is mainly because of nature of increase of width with elevation.

From figures 5.1.a to 5.1.b and Table 5.1 it is seen that the section J-17 (Ch.25.00 km), the cross-sectional area upto about 15.50 m elevation for the year 1969-70, 1977-78 and 1981-82 to 1990-91 are nearly same and is about 800 m^2, the cross-sectional area for the year 1976-77 is about 626.00 m^2 and for the year 1978-79 is about 2838.00 m^2. Above this elevation, it is observed that the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width. From figures 5.1.a to 5.1.b and table 5.1 it is also observed that at 23.65 m elevation, the cross-sectional area for the years 1969-70 and 1990-91 are almost same (near about 23000.00 m^2) and the cross-sectional area for the years 1976-77 and 1978-79 to 1988-89 are almost same (near about 32000.00 m^2). The cross-sectional area for the year 1977-78 is however more than cross-sectional area for all other years and this is about 38795.00 m^2.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the year 1969-70 and 1990-91 are nearly same. The effective width of river section in 1990-91 is however almost double the effective width in the year 1969-70. Besides this, it is observed that width in general has increased over the years.

From figures 5.18.a to 5.18.b and table 5.1 it is seen that upto elevation 17.5 m, the cross-sectional area for the year 1978-79 is more than the cross-sectional area for all other years 1969-70 to 1977-78 and 1981-82 to 1990-91. From these it can be remarked that in 1978-79, there was some erosion in bed level. From figure 5.35 and table 5.18 it is observed that lower elevation is required for the year 1978-79 for 5% of total cross-sectional area with respect to other years. This indicate also that there is erosion of bed level. But from figure 5.35 it is observed that the elevation for 10 % of total cross-sectional area in the year 1978-79 is more than the elevation for 5% of total cross-sectional area. From figure 5.35 it is also observed that bed erosion was limited only to lower elevations.

The changes of cross-sectional area in different years for same elevation are shown in figure 5.18.a. From figure 5.18.a it is seen that above 17.5 m elevation, the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years. From the same figure, it is observed that the river section in general increased in area from 1969-70 to 1977-78 and then decreased over the years and returned to the same cross-sectional area as it was in 1969-70.

From figures 5.18.a to 5.18.b and table 5.1 and above discussions, it may be concluded that through the cross-sectional area and bed level changed at different rates in different years, the total change during the period 1969-70 to 1990-91 is not significant.

From figures 5.2.a to 5.2.b and from table 5.2 it is seen that at section J-16 (Ch. 37.10 km) for 11.50 m elevation, the cross-sectional area for the years 1969-70 to 1977-78 are nearly equal to 0, the cross-sectional area for the years 1978-79 to 1981-82 and 1990-91 are 505.00 m^2, 933.00 m^2 and 299.00 m^2 respectively and the cross-sectional area for the years 1986-87 and 1988-89 are more or less same and equal to 1600 m^2. Above this elevation, it is observed that the area increases quite fast with increase of elevation and width. It is to be noted that the cross-sectional area increament in 1986-87 is more than all other years. From figure 5.2.a to 5.2.b and table 5.2 it is also seen that at 22.49 m elevation, the cross-sectional area for the years 1969-70 to 1981-82 and 1990-91 are nearly equal to 33500.00 m^2, the cross-sectional area for the years 1978-79 and 1988-89 are about 28500.00 m^2 and the cross-sectional area for the year 1986-87 is 38245.00 m^2 which is more than the area of any other year.

In general it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area in 1990-91 is almost same as that in 1969-70 although there has been some increase in width over the years.

From figures 5.19.a to 5.19.b and table 5.2 it is seen that upto elevation 11.50 m, the cross-sectional area increased during the period 1977-78 to 1988-89. This shows erosion in the channel bed i.e. lowering of bed level during that period. Figure also shows rise of bed level before and after that period. This is also evident from figure 5.36. From figure 5.36 it is also observed that there is no remarkable changes between the elevation for 5% and 10% of total area from 1969-70 to 1990-91 although there were changes during different periods.

From figure 5.19.a and table 5.2 it is seen that above 11.50 m elevation, the cross-sectional area decreased during certain periods and increased during certain periods.

From figures 5.19.a to 5.19.b table 5.2 and above discussion, it can be concluded that there has not been significant change in cross-sectional area and the bed level during the period 1969-70 to 1990-91 even though there were changes in cross-sectional area and bed level during different periods.

From figures 5.3.a to 5.3.b and table 5.3 it is seen that at section J-15 (Ch. 55.65 km) the cross-sectional area upto about 9.5 m elevation for the years 1969-70 to 1977-78 and 1986-87 are nearly equal to 0; the cross-sectional area for the years 1978-79 and 1990-91 are nearly equal to 600.00 m^2 and also the cross-sectional area for the years 1981-82 and 1988-89 are 217.00 m^2 and 1648.00 m^2 respectively. Above this elevation, it is observed

that the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width. From figures 5.3.a to 5.3.b and table 5.3 it is also observed that at 21.15 m elevation, the cross-sectional area for the year 1969-70 is 28626.00 m^2, the cross-sectional area for the years 1977-78 to 1986-87 are nearly equal to 36000.00 m^2; and the cross-sectional area for the years 1976-77 and 1988-89 are 45056.00 m^2 and 38382.00 m^2 respectively. The cross-sectional area for the year 1990-91 is 47989.0 m^2 which is more than the cross-sectional area of any other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1900-91. But the cross-sectional area for the year 1969-70 is less than the cross-sectional area for the year 1990-91 from bottom to top level. The effective width in general has increased over the year.

From figures 5.20.a to 5.20.b and table 5.3 it is seen that upto 10.5 m elevation, the cross-sectional area for the year 1988-89 is more than the cross-sectional area for any other years. From these it can be noted that in 1988-89 there was some erosion in bed level. From figure 5.37 and table 5.20 it is also observed that lower elevation is required for the year 1988-89 for 5% of total cross-sectional area with respect to other years. It indicates also that there is erosion of bed level in 1988-89. But from figure 5.37, it is observed that the elevation for 10% of total cross-sectional area in the year 1988-89 is more than the elevation for 5% of total cross-sectional area. From figure 5.37 it is also observed that bed erosion was limited only to lower elevation.

From figure 5.20.a and table 5.3, it is seen that above 10.5 m elevation the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years.

The changes of cross-sectional area in different years for same elevation are shown in figure 5.20.a. From figure 5.20.a it is observed that above 10.5 m elevation, the cross-sectional area for the year 1990-91 is more than the cross-sectional area of all other years. From the same figure, it is observed that the river section in general increased in area from 1969-70 to 1976-77, then decreased from 1976-77 to 1977-78, then remained more or less same from 1977-78 to 1986-87 and again increased from 1986-87 to 1990-91. From figure 5.20.a and above discussion it can be told that there was erosion in bed level i.e. bed level has been fall down in the year 1990-91 with respect to the year 1969-70 at section J-15 (Ch. 55.65 km).

From figure 5.4.a to 5.4.b and table 5.4 it is seen that at 10.5 m elevation of section J-14 (Ch.71.20 km), the cross-sectional area for the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 4322.00 m^2, 3931.00 m^2, 69.6 m^2, 1226.00 m^2, 581.00 m^2, 965.00 m^2, 1420.00 m^2 and 1791.00 m^2 respectively. Among these, the cross-sectional area for the year 1969-70 is more than any other year. Above this elevation, it is observed that the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width. From figure 5.4.a to 5.4.b and table 5.4 it is also observed that at 19.84 m elevation, the cross-sectional area for the years 1969-70

and 1990-91 are nearly equal to 52500.00 m^2, the cross-sectional area for the years 1976-77 and 1986-87 are nearly equal to 46500.00 m^2, the cross-sectional area for the years 1978-79 and 1988-89 are nearly equal to 40600.00 $m^2$and the cross-sectional area for the years 1977-78 and 1981-82 are 36810.00 m^2 and 44611.00 m^2 respectively.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the years 1969-70 and 1990-91 are almost same above 12.5 m elevation and more than the cross-sectional area of any other years. The effective width of the river section in 1969-70 is more than the effective width in 1990-91. Besides this, it is observed that the effective width has been decreased over the year.

From figure 5.21.a to 5.21.b and table 5.4 it is seen that upto 13.5 m elevation, the cross-sectional area for the year 1969-70 is more than any other years. From this, it can be remarked that in 1969-70, there was some erosion in bed level. From figure 5.38 and table 5.21 it is observed that lower elevation is required for the year 1969-70 for 5% of total cross-sectional area with respect to other years. This indicate also that there is erosion of bed level. But the elevation for 10% of total cross-sectional area is higher than the elevation for 5% of total cross-sectional area in the year 1969-70. From figure 5.38 it is observed that bed erosion is limited only to lower elevation.

The changes of cross-sectional area in different years for same elevation are shown in figure 5.21.a for section J-14 (Ch.71.20 km). From figure 5.21.a it is observed that above 13.5 m elevation, the cross-sectional area for the year 1990-91 is more than the cross-sectional area of any other year. From the same figure it is also observed that the cross-sectional area has increased during certain period and decreased during certain period. From figures 5.21.a to 5.21.b, table 5.4 and above discussion, it may be stated that the bed level has been rise up at section J-14 (Ch. 71.20 km) over the periods.

From figure 5.5.a to 5.5.b and table 5.5 it is seen that at 9.5 m elevation of section J-13 (Ch. 84.70 km), the cross-sectional area for the years 1969-70,1976-77, 1977-78, 1978-79,1981-82, 1986-87, 1988-89 and 1990-91 are 9.57 m^2, 1684.84 m^2, 3017.24 m^2, 783.70 m^2, 1460.94 m^2, 1816.86 m^2, 2197.00 m^2 and 2504.81 m^2 respectively. Among these, the cross-sectional area for the year 1977-78 is more than the cross-sectional area of any other year. Above this 9.5 m elevation, it is observed that the cross-sectional area increases rapidly with increase of elevation and width. From figure 5.5.a to 5.5.b and table 5.5 it is also observed that at 18.5 m elevation, the cross-sectional area for the years 1969-70 and 1986-87 are nearly equal to 34000.00 m^2; the cross-sectional area for the years 1976-77 and 1977-78 are nearly equal to 39590.00 m^2; the cross-sectional area for the years 1981-82 and 1988-89 are nearly equal to 28500.00 m^2 and the cross-sectional area for the years 1978-79 and 1990-91 are 37473.00 m^2 and 41811.00 m^2 respectively. Among these the

cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years.

In general it can be told that there are changes of cross-sectional areas in between 1969-70 and 1990-91. Besides this, the effective width has increased over the years.From figure 5.22.a to 5.22.b and table 5.5 it is seen that upto the elevation 13.5 m, the cross-sectional area for the years 1977-78 and 1990-91 are nearly same and this cross-sectional area is more than the cross-sectional areas for all other years. From these, it can be marked that there were some erosion in bed level in 1977-78 and 1990-91. From figure 5.39 and table 5.22 it is observed that lower elevation is required for the years 1977-78 and 1990-91 for 5% of total cross-sectional area with respect to all other years. Although lower elevation is also observed for 5% of total cross-sectional area in 1988-89 but in this case the area for 5% of total cross-sectional area is less than that of the 5% of total cross-sectional area in 1977-78 and 1990-91. These indicate also the erosion in bed level in the years 1977-78 and 1990-91. Figure 5.39 also indicate that there is no remarkable changes of elevation for 5% and 10% of total cross-sectional area in the year 1977-78 and 1990-91.

From figure 5.22.a and table 5.5 it is seen that above 13.5 m elevation, the cross-sectional area for the year 1990-91 is more than the cross-sectional areas for all other years. From the same figure it is also observed that above 13.5 m elevation, the cross-sectional area increased during certain period and

decreased during certain period. The changes of cross-sectional area of different years for same elevation are shown in figure 5.22.a. From figure 5.22.a and table 5.5 it can be told that there are erosion in bed level in the year 1990-91 with respect to the year 1969-70. From the above discussion we can say that there has been fall of bed level at section J-13 (Ch. 84.70 km).

From figure 5.6.a to 5.6.b and table 5.6 it is seen that at 9.5 m elevation of section J-12 (Ch. 100.50 km), the cross-sectional area for the years 1969-70, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 1428.00 m^2, 2479.00 m^2, 2646.00 m^2, 3450.00 m^2, 1990.00 m^2, 441.00 m^2 and 2819.00 m^2 respectively. Among these, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years. Above this elevation 9.5 m, it is observed that the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width. From figure 5.6.a to 5.6.b and table 5.6 it is also observed that at 17.37 m elevation, the cross-sectional area for the years 1969-70, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 30352.00 m^2, 42731.00 m^2, 47395.00 m^2, 37611.00 m^2, 34242.00 m^2, 34920.00 m^2 and 48305.00 m^2 respectively. Among these, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91. But the cross-sectional area in 1990-91 is more than the cross-sectional area

in 1969-70. Besides this, it is observed that the width has increased during certain period and decreased during certain period i.e. Overall width has increased over the periods.

From figure 5.23.a to 5.23.b and table 5.6 it is seen that upto elevation 9.5 m of section J-12 (Ch. 100.50 km), the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years. From this it can be told that there was some erosion in bed level in 1981-82. From figure 5.40 and table 5.23 it is observed that lower elevations are required for the year 1981-82 for 5% and 10% of total cross-sectional area with respect to all other years. This also indicate the erosion of bed level for the year 1981-82.

From figure 5.23.a and table 5.6 it is seen that above 9.5 m elevation, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. From the same figure it is observed that the cross-sectional area has increased from the year 1969-70, then decreased from the year 1978-79 and again increased from the year 1988-89. From figure 5.23.a and table 5.6 it is also observed that the cross-sectional area for the year 1990-91 is more than the cross-sectional area for the year 1969-70 from lower to higher elevation.

The changes of cross-sectional area in different years for same elevation are shown in figure 5.23.a. From figure 5.23.a to 5.23.b and table 5.6, it can be told that there are erosion in bed level for the year 1990-91 with respect to the year 1969-70.

From figure 5.23.a, table 5.6 and above discussion, it may be concluded that there has been fall of bed level at section J-12 (Ch. 100.50 km).

From figure 5.7.a to 5.7.b and table 5.7 it is seen that at 7.5 m elevation of section J-11 (Ch.117.75 km), the cross-sectional area for the years 1969.70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 140.00 m^2, 1597.00 m^2, 3153.00 m^2, 2084.00 m^2, 3304.00 m^2, 2184.00 m^2, 268.00 m^2 and 5078.00 m^2 respectively. Among these, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. Above this elevation, it is observed that the cross-sectional area increases with increase of elevation due to rapid increase of width. From figure 5.7.a to 5.7.b and table 5.7 it is also observed that at 16.25 m elevation, the cross-sectional area for the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89, and 1990-91 are 25690.00 m^2, 29413.00 m^2, 43958.00 m^2, 44760.00 m^2, 40723.00 m^2, 41497.00 m^2, 37470.00 m^2 and 50572.00 m^2 respectively. Among these, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. It may be mentioned here that the cross-sectional area for the year 1990-91 is double the cross-sectional area for the year 1969-70. In general, it can be told that there are changes of cross-sectional areas in between 1969-70 and 1990-91. But the effective width in 1990-91 is more than the effective width in 1969-70. Besides this, it is observed that the width in general has increased over the years.

From figure 5.24.a to 5.24.b and table 5.7 it is seen that upto elevation 7.5 m, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. From this, it can be marked that in 1990-91 there was some erosion in bed level. From figure 5.41 and table 5.24 it is observed that lower elevations are required for the year 1990-91 for 5% and 10% of total cross-sectional area with respect to all other years. This also indicate the erosion of bed level in 1990-91.

From figure 5.24.a and table 5.7 it is seen that upto 10.5 m elevation and above 12.5m elevation the cross-sectional area for the year 1990-91 is more than the corss-sectional area for all other years. From the same figure it is observed that the cross-sectional area has increased from the year 1969-70, then remained more or less same from 1977-78 to 1978-79, then decreased from 1978-79 and again increased from the year 1988-89. From figure 5.24.a and table 5.7 it is also observed that the cross-sectional area for the year 1990-91 is more than the cross-sectional area for the year 1969-70 from lower elevation to higher elevation. The changes of cross-sectional area in different years for same elevation are shown in figure 5.24.a. From figure 5.24.a and table 5.7 it can be told that there are erosion in bed level in 1990-91 with respect to the year 1969-70 for section J-11 (Ch.117.75 km). From the above figure and discussion, it may be concluded that the bed level falls down.

From figures 5.8.a to 5.8.b and table 5.8 it is seen that at 6.5 m elevation of section J-10 (Ch. 134.30 km), the cross-sectional area for the years 1969-70 and 1976-77 are nearly equal to 4450.00 m^2, the cross-sectional area for the years 1978-79 and 1990-91 are nearly equal to 1400.00 m^2 and the cross-sectional area for the years 1977-78, 1981-82, 1986-87 and 1988-89 are 2535.00 m^2, 2286.00 m^2, 1141.00 m^2 and 0 respectively. Among these, the cross-sectional area for the years 1969-70 and 1976-77 are more than the cross-sectional area for all other years. Above this 6.5 m elevation, the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width.

From figure 5.8.a to 5.8.b and table 5.8 it is observed the cross-sectional area at 15.12 m elevation for the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 44489.00 m^2, 61079.00 m^2, 55102.00 m^2, 49770.00 m^2, 46350.00 m^2, 37356.70 m^2, 35039.00 m^2 and 42769.00 m^2 respectively. Among these, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years.

In general it can be told that there are changes of cross-sectional area in between the year 1969-70 and 1990-91 but the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91. The effective width of river section in 1969-70 is more than the effective width in 1990-91. Besides this, it is observed that the effective width has decreased over the years.

Figures 5.25.a to 5.25.b, and table 5.8 show that upto 6.5 m elevation the cross-sectional area for the years 1969-70 and 1976-77 are more than the cross-sectional area for all other years. This indicates that there are erosion in bed level in 1969-70 and 1976-77. From figure 5.42 and table 5.25 it is observed that lower elevations are required for the years 1969-70 and 1976-77 for 5% and 10% of total cross-sectional areas with respect to other years. This also indicate the erosion of bed level in 1969-70 and 1976-77.

From figure 5.25.a and table 5.8 it is seen that above 6.5 m elevation, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years. This same figure and table show that above 6.5 m elevation, the cross-sectional area has increased from 1969-70, then decreased from 1976-77 and again increased from the year 1988-89. From the same figure and table, it may be mentioned that the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 from lower to higher elevation. The changes of cross-sectional area in different years for same elevation are shown in figure 5.25.a. From figure 5.25.a and above discussion, it may be concluded that bed level rises up at section J-10 (Ch. 134.30 km).

From figure 5.9.a to 5.9.b and table 5.9 it is seen that at 5.5 m elevation of section J-9 (Ch. 142.45 km), the cross-sectional area for the years 1969-70 and 1976-77 are nearly equal to 1100.00 m^2, the cross-sectional area for the years 1977-

78, 1981-82, 1986-87, 1988-89 and 1990-91 are 2006.00 m^2, 1635.00 m^2, 775.00 m^2, 609.00 m^2 and 4468.00 m^2 respectively. Among these, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. Above this elevation, it is observed that the cross-sectional area increases with increase of elevation and width. From figure 5.9.a to 5.9.b and table 5.9 it is seen that at 14.00 m elevation, the cross-sectional area for the years 1969-70, 1976-77, 1977-78, 1981-82, 1986-87, 188-89 and 1990-91 are 29571.00 m^2, 40008.00 m^2, 36824.00 m^2, 40469.00 m^2, 38957.00 m^2, 45736.00 m^2 and 41471.00 m^2 respectively. Among these the cross-sectional area for the year 1988-89 is more than the cross-sectional area for all other years.

In general, it may be mentioned that there are changes of cross-sectional area in between 1969-70 and 1990-91. But the cross-sectional area and effective width in 1990-91 are more than the cross-sectional area and effective width in 1969-70 at 14.00 m elevation of section J-9 (Ch. 142.45 km). Besides this, it is also observed that the effective width has increased over the year.

From figure 5.26.a to 5.26.b and table 5.9 it is seen that upto elevation 7.5 m, the cross-sectional area for the year 1990-91 is more than the cross-sectional area for all other years. It indicate that there was some erosion in bed level in 1990-91. From figure 5.43 and table 5.26 it is observed that lower elevations are required for the year 1990-91 for 5% and 10% of total cross-sectional area with respect to all other years. This also indicates the erosion of bed level in 1990-91.

Figures 5.26.a to 5.26.b and table 5.9 show that above 7.5 m elevation the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years upto the elevation 11.5 m. Above 11.5 m elevation the cross-sectional area for the year 1988-89 is more than the cross-sectional area for all other years upto the elevation 14.00 m. From the same figure and table, in general, it can be told that the cross-sectional area has increased during certain period and decreased during certain period. From figures 5.26.a to 5.26.b and table 5.9, it is seen that the cross-sectional area for the year 1990-91 is more than the cross-sectional area for the year 1969-70 from lower to higher elevation. The changes of cross-sectional area in different years for same elevation are shown in figure 5.26.a. From figures 5.26.a to 5.26.b, table 5.9 and the above discussion it may be concluded that the bed level falls down at section J-9 (Ch. 142.45 km).

From figures 5.10.a to 5.10.b and table 5.10 it is seen that at 4.5 m elevation of section J-8 (Ch. 149.50 km), the cross-sectional area for the years 1969-70 and 1981-82 are nearly equal to 4250.00 m^2; the cross-sectional area for the years 1986-87 and 1988-89 are nearly equal to 1800.00 m^2 and the cross-sectional area for the years 1976-77, 1977-78, 1978-79 and 1990-91 are 478.3 m^2, 1015.88 m^2, 2664.76 m^2 and 674.30 m^2 respectively. Among these, the cross-sectional area for the year 1969-70 and 1981-82 is more than the cross-sectional area for all other years. Above this elevation, the cross-sectional area increases with increase of elevation and width . From the same figures and table it is observed that at 13.23 m elevation, the

cross-sectional area for the years 1977-78 and 1990-91 are nearly equal to 40,000.00 m^2, the cross-sectional area for the years 1978-79 to 1988-89 are nearly equal to 33500.00 m^2 and the cross-sectional area for the years 1969-70 and 1976-77 are 28898.00 m^2 and 35586.20 m^2 respectively. Among these, the cross-sectional area for the years 1977-78 and 1990-91 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area and effective width at 13.23 m elevation for the year 1990-91 are more than the cross-sectional area and effective width for the year 1969-70. Besides this, it is also observed that the effective width has increased over the years.

From figure 5.27.a to 5.27.b and table 5.10 it is seen that upto the elevation 4.5 m, the cross-sectional area for the years 1969-70 and 1981-82 is more than the cross-sectional area for all other years. This indicate that there were some erosion in bed level in the year 1969-70 and 1981-82. Figure 5.44 and table 5.27 show that lower elevations are required for the years 1969-70 and 1981-82 for 5% and 10% of total cross-sectional area with respect to all other years. It also indicates the erosion of bed level in 1969-70 and 1981-82.

Figure 5.27.a to 5.27.b and table 5.10 show that above 4.5 m elevation, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years upto the elevation 9.5 m and above 9.5 m elevation the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years upto the elevation 13.23m.

From the same figures and table it is observed that the cross-sectional area at lower elevation for the year 1969-70 was more than the cross-sectional area for the year 1990-91 but at higher elevation the cross-sectional area for the year 1990-91 was more than the cross-sectional area for the year 1969-70. The changes, of cross-sectional area in different years for same elevation are shown in figure 5.27.a. From figure 5.27.a to 5.27.b, table 5.10 and the above discussions, it may be stated that the bed level rises up at section J-8 (Ch. 149.50 km).

From figure 5.11.a to 5.11.b and table 5.11 it is seen that at 1.5 m elevation of section J-7 (Ch. 162.35 km), the cross-sectional area for the years 1976-77, 1978-79 and 1988-89 are nearly equal to 450.00 m^2, the cross-sectional area for the years 1969-70, 1977-78, 1981-82, 1986-87 and 1990-91 are 2566.20 m^2, 150.88 m^2, 4015.14 m^2, 1811.24 m^2 and 0 respectively. Among these, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years. Above this elevation the cross-sectional area increases quite fast with increase of elevation due to rapid increase of width. The same figures and table show that at 12.5 m elevation, the cross-sectional area for the years 1969-70,1976-77 and 1977-78 are nearly equal to 30,000.00 m^2; the cross-sectional area for the years 1986-87 and 1990-91 are nearly equal to 28000.00 m^2; and the cross-sectional area for the years 1978-79, 1981-82 and 1988-89 are 40435.60 m^2, 67398.0 m^2 and 34752.10 m^2 respectively. Among these the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years.

In general it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the year 1990-91 is less than the cross-sectional area for the year 1969-70 from lower to higher elevation. The effective width in the year 1990-91 is more than the effective width in the year 1969-70. Besides this, it is observed that the effective width has increased over the years.

From figures 5.28.a to 5.28.b and table 5.11 it is seen that upto the elevation 1.5 m, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years. This indicate that there was some erosion in bed level in 1981-82. Figure 5.45 and table 5.28 show that lower elevations are required for the years 1969-70 and 1986-87 for 5% and 10% of total cross-sectional area with respect to all other years. But the area for 5% and 10% of total cross-sectional area for the year 1981-82 is more than the area for 5% and 10% of total cross-sectional area of all other years. If we compare the elevations for 5% and 10% of total cross-sectional area then the elevations for the year 1981-82 are lower than all other years. This also indicate the erosion of bed level in 1981-82.

Figs. 5.28.a to 5.28.b and table 5.11 show that above 1.5m elevation, the cross-sectional area for the year 1981-82 is more than the cross-sectional areas for all other years up to the elevation 12.5 m. From the same figures and table it is observed that the cross-sectional area has increased from the year 1969-70 and decreased from the year 1981-82. But the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 from lower to higher elevation. The changes of

cross-sectional area for different years for same elevations are shown in figure 5.28.a. From figures 5.28.a to 5.28.b and above discussion it may be concluded that the bed level rises up at section J-7 (Ch. 162.35 km).

From figure 5.12.a to 5.12.b and table 5.12 it is seen that at 0 elevation of section J-6 (Ch. 177.70 km), the cross-sectional area for the years 1976-77 and 1986-87 are nearly equal to 0, the cross-sectional area for the years 1977-78 and 1988-89 are nearly equal to 800.00 m^2 and the cross-sectional area for the years 1969-70, 1978-79, 1981-82 and 1990-91 are 1573.51 m^2, 2477.41 m^2, 3139.14m^2 and 357.60 m^2 respectively. Among these, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years. Above this elevation, the cross-sectional area increases quite fast with increase of elevation due rapid increase of width. The same figures and table show that at 11.70m elevation, the cross-sectional area for the years 1969-70 and 1986-87 are nearly equl to 30,000.00 m^2; the cross-sectional area for the years 1976-77 and 1977-78 are nearly equal to 26000.00 m^2; the cross-sectional area for the years 1978-79 and 1990-91 are nearly equal to 32,000.00 m^2, and the cross-sectional area for the years 1981-82 and 1988-89 are 42952.20 m^2 and 24207.20 m^2 respectively. Among these, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional areas in between 1969-70 and 1990-91 but the cross-sectional area for the year 1990-91 is less than the cross-sectional area for the year 1969-70 upto the elevation 3.5 m.

The cross-sectional area for the year 1990-91 is more than the cross-sectional area for the year 1969-70 above 3.5 m elevation. The effective width for the year 1990-91 is less than the effective width for the year 1969-70. Besides this, it is observed that the effective width has decreased over the years.

From figure 5.29.a to 5.29.b and table 5.12 it is seen that upto the elevation 0, the cross-sectional area for the year 1981-82 is more than the cross-sectional areas for all other years. This indicate that there was some erosion in bed level in 1981-82. Figure 5.46 and table 5.29 show that lower elevation is required for 5% for the year 1981-82 of total cross-sectional area with respect to all other years. Although the elevation for 10% of total cross-sectional area for the year 1978-79 is lower than that for the year 1981-82 but the area for 10% of total cross-sectional for the year 1981-82 is more than that of 1978-79. This also indicate the erosion of bed level in 1981-82.

Figure 5.29.a to 5.29.b and table 5.12 show that after 0 elevation the cross-sectional area for the year 1981-82 is also more than the cross-sectional area for all other years upto the elevation 11.70 m. From the same figures and table it is observed that the cross-sectional area has decreased from 1969-70 and 1981-82 and has increased from 1977-78 and 1988-89. The cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 upto the elevation 3.5 m and above 3.5 m elevation the cross-sectional area for the year 1969-70 is lower than the cross-sectional area for the year 1990-91. The changes of cross-sectional area in different years for same elevations are shown in figure 5.29.a. From figure 5.29.a to

to 5.29.b, Fig. 5.46, table 5.12 and above discussions, it may be concluded that the cross-sectional area and bed level changed at different rates in different years but the bed level rises up at this section J-6 (Ch. 177.20 km).

From figure 5.13.a to 5.13.b and table 5.13 it is observed that at 0 elevation of section J-5 (Ch. 188.20 km), the cross-sectional area for the years 1969-70, 1976-77, 1977-78, 1978-79, 1981-82 and 1988-89 are 1008.84 m^2, 1584.10 m^2, 4132.2 m^2, 3243.70 m^2, 570.26 m^2 and 179.81 m^2 respectively; the cross-sectional area for the years 1986-87 and 1990-91 are nearly equal to 0. Among these, the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years. Above this elevation, the cross-sectional area increases with increase of elevation and width.

From figures 5.13.a to 5.13.b and table 5.13 it is also observed that at 10.94 m elevation, the cross-sectional area for the year 1969-70, 1977-78 and 1978-79 are 28270.40 m^2, 50425.10 m^2 and 56075.90 m^2 respectively; the cross-sectional area for the years 1976-77 and 1990-91 are nearly equal to 37500.00 m^2 and the cross-sectional area for the years 1981-82 to 1988-89 are equal to 32500.00 m^2. Among these, the cross-sectional area for the year 1978-79 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91. But the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 upto the elevation 2.5 m and above 2.5 m elevation the cross-sectional area for the year 1969-70 is less than the cross-sectional area for the year 1990-91. The effective width in the year 1990-91 is less than the effective width in the year 1969-70.Besides this the effective width has decreased over the years.

Figures 5.30.a to 5.30.b and table 5.13 show that upto 0 elevation the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years. This indicate that there was some erosion in bed level. Figure 5.47 and table 5.30 show that lower elevations are required for the year 1977-78 for 5% and 10% of total cross-sectional area with respect to all other years. This indicates also the erosion in bed level in the year 1977-78.

From figure 5.30.a to 5.30.b and table 5.13 it is observed that above 0 elevation, the cross-sectional area for the year 1978-79 is more than the cross-sectional area for all other years. From the same figures and table it is observed that in general, the cross-sectional area has increased from 1969-70, then decreased from the year 1978-79 and again increased from the year 1988-89. The changes of cross-sectional area in different years for same elevation are shown in figure 5.30.a. From the above figures and table it may be mentioned that the cross-

sectional area for the year 1969-70 upto 2.5 m elevation is more than the cross-sectional area for the year 1990-91. From figure 5.30.a to 5.30.b, Fig. 5.47 and above discussions it can be told that there was deposition in bed level in the year 1990-91 with respect to the year 1969-70, i.e. there has been rise of bed level at section J-5 (Ch. 188.20 km).

From figures 5.14.a to 5.14.b and table 5.14 it is seen that at 0 elevation of section J-4 (Ch. 201.30 km), the cross-sectional area for the years 1977-78 and 1988-89 are nearly equal to 1840.00 m^2; the cross-sectional area for the years 1978-79 and 1990-91 are nearly equal to 97.00 m^2 and the cross-sectional area for the years 1969-70, 1976-77, 1981-82 and 1986-87 are 916.58 m^2, 3466.20 m^2, 2735.82 m^2 and 3194.23 m^2 respectively. Among these, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years. Above this 0 elevation, the cross-sectional area increases quite fast with increase of elevation and width. The same figures and table show that at 10.15m elevation the cross-sectional area for the year 1969-70 is 46194.60 m^2, the cross-sectional area for the years 1976-77 to 1978-79 and 1986-87 to 1988-89 are nearly equal to 28000.00 m^2 and the cross-sectional area for the years 1981-82 and 1990-91 are nearly equal to 35000.00 m^2. Among these, the cross-sectional area for the year 1969-70 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 from lower to higher elevation. The effective width of river section in 1969-70 is however double the effective width in the year 1990-91. Besides this it is observed that the effective width in general has decreased over the years.

Figure 5.31.a and table 5.14 show that upto 0 elevation, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years. This indicate that there was some erosion in bed level in 1976-77. From figure 5.48 and table 5.31, it is seen that lower elevations are required for 5% and 10% of total cross-sectional area for the year 1976-77 with respect to all other years. This also indicates the erosion of bed level in the year 1976-77. Figure 5.31.a and table 5.14 also show that there was erosion in bed level in 1981-82 and 1986-87.

From figure 5.31.a and table 5.14, it is observed that above 0 elevation, the cross-sectional area for the year 1981-82 is more than the cross-sectional area for all other years upto the elevation 8.5 m and above 8.5 m elevation, the cross-sectional area for the year 1969-70 is more than the cross-sectional area for all other years upto 10.15 m elevation. The same figure and table show that in general the cross-sectional area has decreased during certain period and increased during certain period. The

changes of cross-sectional area in different years for same elevation are shown in figure 5.31.a. From figures 5.31.a to 5.31.b and above discussions, it may be mentioned that there was deposition in bed level in the year 1990-91 with respect to the year 1969-70 i.e. there has been rise of bed level at section J-4 (Ch. 201.30 km).

From figures 5.15.a to 5.15.b and table 5.15 it is observed that at -1.5 m elevation of section J-3 (Ch. 213.20 km), the cross-sectional area for the years 1969-70, 1976-77 and 1990-91 are nearly equal to 300.00 m^2 and the cross-sectional area for the year 1977-78, 1978-79, 1981-82, 1986-87 and 1988-89 are 2356.7 m^2, 1209.107 m^2,595.20 m^2, 13.45 m^2 and 2228.07 m^2 respectively. Among these the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years. Above this -1.5 m elevation, the cross-sectional area increases quite fast with increase of elevation and width. The same figures and table show that at 9.39 m elevation the cross-sectional area for the years 1977-78 and 1988-89 are nearly equal to 51500.00 m^2 and the cross-sectional area for the years 1969-70, 1976-77,1978-79, 1981-82, 1986-87 and 1990-91 are 25868.30 m^2, 34347.50 m^2, 44427.90 m^2, 36694.80 m^2 , 32325.30 m^2 and 50886.70 m^2 respectively. Among these, the cross-sectional area for the years 1977-78 and 1988-89 are more than the cross-sectional area for all other years.

In general, it can be stated that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the year 1990-91 is more than the cross-sectional area for the year 1969-70 from lower to higher elevation. The effective width in the year 1990-91 is more than the effective width in the year 1969-70. Besides this, the effective width has increased over the years.

Figure 5.32.a to 5.32.b and table 5.15 show that upto -1.5 m elevation, the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years. This indicates that there was erosion in bed level in the year 1977-78. From figure 5.49 and table 5.32 it is seen that lower elevations are required for 5% and 10% of total area for the year 1977-78 with respect to all other years. This also indicates the erosion in bed level for the year 1977-78. From figures 5.32.a and table 5.15 it may be mentioned that there was erosion in bed level in the year 1988-89.

From figure 5.32.a and table 5.15 it is observed that above -1.5 m elevation, the cross-sectional area for the year 1977-78 is more than the cross-sectional area for all other years up to the elevation 8.50 m. The same figures and table show that the cross-sectional area has increased from 1969-70 to 1977-78, then decreased from 1977-78 to 1986-87 and again increased from the year 1986-87 to 1990-91. The changes of cross-sectional area in different years for same elevation are shown in figure 5.32.a. Figures 5.32.a to 5.32.b, Fig. 5.49, table 5.15 and above

discussions, it may be concluded that the bed level rises up at station J-3 (Ch.213.20 km).

From figures 5.16.a to 5.16.b and table 5.16 it is seen that at 1.5 m elevation of section J-2 (Ch. 223.20 km), the cross-sectional area for the years 1969-70,1976-77, 1977-78, 1978-79, 1981-82,1986-87,1988-89 and 1990-91 are 7248.97 m^2, 6682.00 m^2, 5426.00 m^2, 5780.00 m^2, 6122.00 m^2, 1772.00 m^2, 6274.00 m^2 and 3875.00 m^2 respectively. Among these, the cross-sectional area for the year 1969-70 is more than the cross-sectional area for all other years. Above this elevation, the cross-sectional area increases with increase of elevation and width. The same figures and table show that at 8.66 m elevation, the cross-sectional area for the years 1977-78 and 1990-91 are nearly equal to 34470.00 m^2, the cross-sectional area for the years 1969-70, 1976-77, 1978-79, 1981-82, 1986-87,1988-89 are 28501.00 m^2, 52151.00 m^2, 41352.00 m^2, 36868.00 m^2, 35849.00 m^2 and 30228.50 m^2 respectively. Among these, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional areas in between 1969-70 and 1990-91 but the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 upto elevation 2.5 m and above 2.5 m elevation, the cross-sectional area for the year 1969-70 is less than the cross-sectional area for the year 1990-91. The effective width in the year 1969-70 is more than the

effective width in the year 1990-91. Besides this, it is observed that the effective width has decreased over the years.

Figures 5.33.a to 5.33.b and table 5.16 show that upto 1.5 m elevation, the cross-sectional area for the year 1969-70 is more than the cross-sectional area for all other years. This indicate that there was erosion in bed level in the year 1969-70. From figure 5.50 and table 5.33, it is seen that lower elevations are required for 5% and 10% of total cross-sectional area for the year 1969-70. This also indicate the erosion in bed level in the year 1969-70.

From figures 5.33.a to 5.33.b and table 5.16 it is also observed that above 1.5 m elevation, the cross-sectional area for the year 1976-77 is more than the cross-sectional area for all other years upto elevation 8.66 m. The same figures show that the cross-sectional area has increased from the year 1969-70 to 1976-77, then decreased during certain periods and increased during certain period above 1.5 m elevation. The changes of cross-sectional area in different years are shown in figure 5.33.a. Figure 5.33.a and table 5.16 show that the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 upto the elevation 1.5 m. From figures 5.33.a to 5.33.b, Fig. 5.50 and above discussions, it may be concluded that there has been rise of bed level at section J-2 (Ch. 223.20 km).

From figure 5.17.a to 5.17.b and table 5.17 it is seen that at -1.5 m elevation of section J-1 (Ch. 230.75 km), the cross-sectional area for the years 1976-77 and 1977-78 are nearly equal to 4700.00 m^2, the cross-sectional area for the years 1969-70, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 3140.64 m^2, 2741.26 m^2, 2133.32 m^2, 3245.71 m^2, 4524.30 m^2 and 182.83 m^2 respectively. Among these, the cross-sectional area for the years 1976-77 and 1977-78 is more than the cross-sectional area for all other years. After this -1.5 m elevation, the cross-sectional area increases with increase of elevation and width. The same figures and table show that at 8.17 m elevation the cross-sectional area for the years 1969-70, 1876-77, 1977-78, 1978-79, 1981-82, 1986-87, 1988-89 and 1990-91 are 36342.60 m^2, 36940.90 m^2, 40159.20 m^2, 43706.2 m^2, 42291.20 m^2, 39280.00 m^2, 67419.10 m^2 and 33822.20 m^2 respectively. Among these, the cross-sectional area for the year 1988-89 is more than the cross-sectional area for all other years.

In general, it can be told that there are changes of cross-sectional area in between 1969-70 and 1990-91 but the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 from lower to higher elevation. The effective width in the year 1969-70 is less than the effective width in the year 1990-91. Besides this, the effective width has increased over the years.

Figures 5.34.a to 5.34.b and table 5.17 show that upto -1.5 m elevation, the cross-sectional area for the years 1976-77 and 1977-78 are more than the cross-sectional area for all other years. This indicate that there were erosion in bed level in 1976-77 and 1977-78. From figure 5.51 and table 5.34 it is observed that lower elevations are required for 5% and 10% of total cross-sectional area for the years 1976-77 and 1977-78. This also indicate the erosion in bed level in the years 1976-77 and 1977-78.

From figures 5.34.a to 5.34.b and table 5.17 it is observed that above -1.5 m elevation, the cross-sectional area for the year 1988-89 is more than the cross-sectional area for all other years. The same figures and table show that the cross-sectional area has increased from the year 1969-70 to 1988-89 and decreased from the year 1988-89 to 1990-91 above -1.5 m elevation. The changes of cross-sectional area in different years for same elevation are shown in figure 5.34.a. Figures 5.34.a to 5.34.b and table 5.17 show that the cross-sectional area for the year 1969-70 is more than the cross-sectional area for the year 1990-91 from lower to higher elevation. From the same figures and above discussion, it can be told that there has been rise of bed level at section J-1 (Ch. 230.75 km).

5.3 Cross-sectional area versus distance

Figures 5.52.a to 5.68.b show the conveyance area across the width for river sections at stations J-17 to J-1 for the years 1969-70, 1976-77, 1977-78, 1978-79,1981-82, 1986-87, 1988-89 and

1990-91. Figures 5.69.a to 5.85.h show the cross-sections of all the 17 stations for different years. It has already been mentioned that for each station except J-12 and J-9 eight years of data were available and for station J-12 and J-9 seven years of data were available. Even though plotting of area versus distance across the width for all the years for each station in a single figure will give better opportunity to compare shifting of conveyance area across the width, it was decided to show the variation in two figures keeping one year data common in both the figures for better presentation.

Figures 5.52.a to 5.52.b and tables 5.35.1 to 5.35.8 show how the cross-sectional area upto 23.65 m elevation of the section J-17 (Ch. 25.00 km) for different years vary across the width from right to left bank. The cross-sectional area for the years 1969-70 and 1990-91 were almost same but less than the cross-sectional area for all other years. The cross-sectional area for the years 1976-77, 1978-79,1981-82, 1986-87 and 1988-89 were more of less same. The cross-sectional area for the year 1977-78 was however maximum. From the same figures and tables it is also observed that the cross-sectional area for the years 1969-70 and 1990-91 were almost same. The total width of the section for the year 1990-91 was however greater than the total width for the year 1969-70.

From figures 5.69.a to 5.69.h, it is observed that the channel section at station J-17 (Ch. 25.00 km) had two or three relatively wide and deep channels in the years 1969-70, 1977-78,

1981-82 and 1990-91. In other years the channel section had one or two relatively deeper but narrower chanels along with a number of relatively wide and shallow channels. It is also observed that the channel section configuration changes very fast from one year to another due to rapid changes in the channel and char pattern as a result of active erosion and deposition activity. On the whole it may be stated that the channel section is very unstable so far as position of channels, deeper or shallower, and location of chars.

Figure 5.86 and table 5.52 show that the total width increased during the period 1969-70 to 1976-77, then remained more or less same from the year 1976-77 to 1978-79 and decreased during the period 1978-79 to 1981-82. The total width then increased rapidly from 1981-82 to 1988-89, then decreased quite rapidly from 1988-89 to 1990-91. In a word, it can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.86 and table 5.52 also show the effective width has increased rapidly during the period 1969-70 to 1977-78, then decreased from the year 1977-78 to 1981-82, then again increased rapidly during the period 1981-82 to 1986-87 and again decreased from the year 1986-87 to 1990-91. Variation of total width and effective width as shown in figure 5.86 shows that effective width changes much more rapidly than the total width. This is because of the fact that changes in total width is due to erosion or deposition along the bankline only. But the changes in

effective width is also due to erosion and deposition of chars which changes their width quite rapidly.

It is also to be noted that during all the time when total width were increased the effectie width also increased. But during period 1986-87 to 1988-89 the total width increased very fast but the effective width decreased during that period.

Figure 5.103 and table 5.52 show the movement of right bank towards right or left and left bank towards left or right at station J-17 (Ch.25.00 km) for different years. From the same figure and table, it is observed that the right bank remained almost in the same position during the period 1969-70 to 1977-78,then moved towards left from 1977-78 to 1981-82, then moved towards right from 1981-82 to 1986-87 and again moved towards right from 1986-87 to 1990-91.

Figure 5.103 and table 5.52 also show that the left bank has moved towards left during the period 1969-70 to 1976-77 and remained more or less in the same position during the period 1976-77 to 1978-89, then moved towards right in the year 1981-82 and then moved towards left during the period 1981-82 to 1988-89 and then again moved to the right in 1990-91. Considering the total period from 1969-70 to 1990-91 it is also observed that the right bank moved towards left by 852.00 m and the left bank moved towards left by 2250.00 m.

Figures 5.53.a to 5.53.b and tables 5.36.1 to 5.36.8 show how the cross-sectional area upto 22.49 m elevation of the section J-16 (Ch. 37.10 km) for different years vary across the width from right to left bank. The cross-sectional area in the years 1978-79 and 1988-89 were more or less same but less than the cross-sectional area for all other years and the cross-sectional area for the years 1969-70 to 1977-78, 1981-82 and 1990-91 were more or less same except the cross-sectional area for the year 1986-87 when the cross-sectional area was more than all other years. From the same figures and tables it is observed that the cross-sectional area for the years 1969-70 and 1990-91 were almost same. The total width of the section for the year 1990-91 was however greater than the total width for the year 1969-70.

From figures 5.70.a to 5.70.h it is observed that the channel section at station J-16 (Ch. 37.10 km) had three or four relatively narrower and deeper channels in the years 1969-70 to 1981-82. In other years the channel section had one or two relatively wide and deep channels with a number of relatively narrow and shallow channels along with a number of char in between. The causes of changes in channel and char pattern are same as explained at station J-17(Ch. 25.00 km).

Figure 5.87 and table 5.53 show that the total width increased during the period 1969-70 to 1977-78, then remained more or less same during the period 1976-77 to 1988-89 and increased rapidly from the period 1988-89 to 1990-91. Considering

the entire period from 1969-70 to 1990-91 it is found that the total width has increased during the period 1969-70 to 1990-91 but not always the same rate. It is to be noted that the effective width was minimum in the years 1978-79 and 1988-89 and cross-sectional area was also minimum.

Figure 5.87 and table 5.53 also show that the effective width has increased during the period 1969-70 to 1976-77, then decreased from the year 1976-77 to 1978-79, then again increased during the period 1978-79 to 1981-82, then again decreased from the year 1981-82 to 1988-89 and then again increased during the period 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.87 shows that effective width changed much more rapidly than the total width. This is because of the fact that changes in total width is due to erosion or deposition along the bankline only. But the changes in effective width is mainly because of erosion and deposition of chars which changes their width quite rapidly due to erosion and deposition.

Figure 5.104 and table 5.53 show the movement of right bank towards right or left and left bank towards left or right at station J-16 (Ch. 37.10 km) for different years. From the same figure and table it is observed that the right bank has moved towards left from 1969-70 to 1976-77 but remained almost in the same position from 1976-77 to 1977-78, then moved towards right in the year 1978-79, then again moved towards left from 1978-79 to 1981-82 and again moved towards right from 1981-82 to 1990-91.

Figure 5.104 and table 5.53 also show that left bank has moved towards left from 1969-70 to 1976-77 and remained almost in the same position from 1976-77 to 1977-78, then moved towards right from 1977-78 to 1978-79, then moved towards left from 1978-79 to 1981-82 and remained more or less in the same position from 1981-82 to 1986-87, then again moved towards right from 1986-87 to 1988-89 and also again moved towards left from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the right bank moved towards right by 600.00 m and left bank moved towards left by 1503.00 m.

Figures 5.54.a to 5.54.b and tables 5.37.1 to 5.37.8 show how the cross-sectional area upto 21.15 m elevation of the section J-15 (Ch. 55.65 km) for different years vary across the width from right to the left bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional area for all other years and the cross-sectional area for the years 1977-78 to 1988-89 were more or less same except the cross-sectional area for the years 1976-77 and 1990-91. The cross-sectional area for the years 1976-77 and 1990-91 were more or less same and more than the cross-sectional area for all other years. From the same figures and tables it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was greater than the total width for the year 1969-70.

From figures 5.71.a to 5.71.h it is observed that the channel section at station J-15 (Ch. 55.65 km) had two or three relatively wide and deep channels in the years 1969-70 to 1986-87. In other years the channel section had one or two relatively deep but narrow channels with a number of relatively wide and shallow channels along with a number of chars in between. The causes of changes in channel and char pattern are same as mentioned before.

Figure 5.88 and table 5.54 show that the total width increased during the period 1969-70 to 1976-77, but remained almost same from the year 1976-77 to 1977-78. The total width however increased from 1977-78 to 1981-82, then remained more or less same during the period 1981-82 to 1986-87 and increased from the year 1986-87 to 1990-91. Considering the entire period from 1969-70 to 1990-91 it is found that the total width has increased during the mentioned but not always at the same rate.

Figure 5.88 and table 5.54 also show that the effective width has increased during the period 1969-70 to 1978-79, then decreased from the year 1978-79 to 1981-82, then again increased from 1981-82 to 1986-87, then remained more or less same during the period 1986-87 to 1988-89 and again increased from the year 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.88 shows that effective width changes much more rapdily than the total width. The cause of changes in total width and effective width is same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.105 and table 5.54 show the movement of right bank towards right or left and left bank towards left or right at station J-15 (Ch. 55.65 km) for different years. From the same figure and table it is observed that the right bank has remained more or less in the same position from 1969-70 to 1986-87, then moved towards right from 1986-87 to 1990-91. Figure 5.105 and table 5.54 also show that the left bank has moved towards left from 1969-70 to 1976-77 and remained more or less in the same position from 1976-77 to 1978-79, then again moved towards left from 1978-79 to 1981-82 and remained more or less in the same position from 1981-82 to 1986-87 and again moved towards left from 1986-87 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the right bank moved towards right by 587.00 m and the left bank moved towards left by 41.00 m during that period.

Figures 5.55.a to 5.55.b and tables 5.38.1 to 5.38.8 show how the cross-sectional area upto 19.84 m elevation of the section J-14(Ch.71.20 km) for different years vary across the width from right to left bank. The cross-sectional area for the year 1977-78 was less than the cross-sectional area for all other years. The cross-sectional area for the year 1976-77 and 1981-82 to 1986-87 were more or less same; the cross-sectional area for the years 1978-79 and 1988-89 were more or less same and the cross-sectional area for the years 1969-70 and 1990-91 were more or less same when the cross-sectional area were more than all other years.

From figures 5.72.a to 5.72.h it is observed that the channel section had one, two, three or four relatively deep but narrow channels along with a number of relatively wide and shallow channels with a number of chars in between.The causes of changes in channel and char pattern are same as mentioned previously (section J-17).

Figure 5.89 and table 5.55 show that the total width has decreased during the period 1969-70 to 1976-77, then remained more or less same from 1976-77 to 1981-82. The total width however decreased from 1981-82 to 1986-87 and remained almost same from 1986-87 to 1988-89 and again decreased from 1988-89 to 1990-91. In a word, it can be stated that the total width has remained more or less same during the period 1969-70 to 1990-91.

Figure 5.89 and table 5.55 also show that the effective width has decreased rapidly during the period 1969-70 to 1977-78, then increased from the year 1977-78 to 1978-79, then again decreased from 1978-79 to 1981-82, then again increased during the period 1981-82 to 1986-87,then again decreased rapidly from 1986-87 to 1988-89 and also again increased quite rapidly during the period 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.89 shows that effective width changes much more rapidly than the total width. The cause of changes in total width and effective width is same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.106 and table 5.55 show the movement of right bank towards right or left and left bank towards left or right at station J-14 (Ch. 71.20 km) for different years. From the same figure and table it is observed that the right bank has moved towards left from 169-70 to 1976-77, then remained almost in the same position from 1976-77 to 1986-87 m, then moved towards left in the year 1988-89 and then moved towards right from 1988-89 to 1990-91. Figure 5.106 and table 5.55 also show that the left bank has moved towards right from 1969-70 to 1976-77, then remained more or less in the same position from 1976-77 to 1981-82, then moved towards left from 1981-82 to 1988-89 and again moved towards right from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the right bank moved towards left by 291.00 m and the left bank moved towards left by 120.00 m during that period.

Figures 5.56.a to 5.56.b and tables 5.39.1 to 5.39.8 show how the cross-sectional area upto 18.50 m elevation of the section J-13 (Ch. 84.70 km) for different years vary across the width from left to right bank. The cross-sectional area for the years 1981-82 and 1988-89 were more or less same but less than the cross-sectional area for all other years and the cross-sectional area for the years 1969-70 and 1988-89 were more or less same. The cross-sectional area for the years 1976-77 to 1978-79 were more or less same but greater than the cross-sectional area for all other years. From the same figures and tables it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the

year 1990-91. The total width of the section for the year 1990-91 was more than the total width for the year 1969-70.

From figures 5.73.a to 5.73.h, it is observed that the channel section at station J-13 (Ch. 84.70 km) had three or four relatively wide and shallow channels in the years 1969-70 to 1981-82. In other years the channel section had one relatively deep but narrow channels along with a number of relatively wide and shallow channels with a number of chars in between. The causes of changes in channel and char pattern are same as expected previously (J-17,Ch. 25.00 km).

Figure 5.90 and table 5.56 show that the total width increased during the period 1969-70 to 1990-91 but not always at the same rate. Figure 5.90 and table 5.56 also show that the effective width has decreased during the period 1969-70 to 1976-77, then increased from 1976-77 to 1978-79, then again decreased rapidly from the year 1978-79 to 1988-89, and also again increased quite rapidly during the period 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.90 shows that effective width changes much more rapidly than the total width. The cause of changes in total width and effective is same as mentioned at station J-17 (Ch. 25.00 km). It is to be noted that the effective width was minimum in the year 1988-89.

Figure 5.107 and table 5.56 show the movement of left bank towards left or right and right bank towards right or left at station J-13 (Ch. 84.70 km) for different years. From the same figure and table it is observed that the left bank has moved towards left from 1969-70 to 1990-91 and the right bank moved towards right from 1969-70 to 1976-77 and remained more or less in the same position from 1976-77 to 1990-91. Conisdering the total period from 1969-70 to 1990-91, it is observed that the left bank moved towards left by 1450.00 m and the right bank moved towards right by 663.00 m during that period.

Figures 5.57.a to 5.57.b and tables 5.40.1 to 5.40.7 show how the cross-sectional area upto 17.37 m elevation of the section J-12 (Ch. 100.50 km) for different years vary across the width from left to right bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional area for all other years and the cross-sectional area for the years 1986-87 and 1988-89 were more or less same. The cross-sectional area for the years 1978-79 and 1990-91 were more or less same when the cross-sectional area was more than all other years. From the same figures and tables it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was more than the total width for the year 1969-70.

From figures 5.74.a to 5.74.g, it is observed that the channel section at station J-12 (Ch. 100.50 km) had three or four relatively deep but narrow channels in the year 1977-78 to 1978-

79 and 1988-89. In other years the channel section had one or two relatively wide and deep channels along with a number of relatively narrow and shallow channels with a number of chars in between. The causes of changes in channel and char pattern are as mentioned before.

Figure 5.91 and table 5.57 show that the total width increased rapidly during the period 1969-70 to 1977-78, then decreased rapidly from the year 1977-78 to 1981-82. The total width however remained almost same from 1981-82 to 1986-87, then increased from 1986-87 to 1988-89 and decreased from 1988-89 to 1990-91.It can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.91 and table 5.57 also show that the effective width has increased rapidly during the period 1969-70 to 1978-79, then decreased rapidly from the year 1978-79 to 1986-87, then again increased quite rapidly from 1986-87 to 1988-89 and again decreased during the period 1988-89 to 1990-91. Variation of total width and effetive width as shown in figure 5.91 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km). It may be mentioned here that the effective width was minimum in the year 1986-87.

Figure 5.108 and table 5.57 show the movement of left bank towards left or right and right bank towards right or left at station J-12 (Ch. 100.50 km) for different years. From the same figure and table it is observed that the left bank has moved towards left from 1969-70 to 1977-78, then moved towards right from 1977-78 to 1981-82, and then remained almost in the same position from 1981-82 to 1990-91. Figure 5.108 and table 5.57 also show that the right bank has moved toward right from 1969-70 to 1977-78, then remained almost in the same position from 1977-78 to 1978-79, then moved towards left from 1978-79 to 1981-82 and remained in the same position from 1981-82 to 1986-87, then moved towards right from 1986-87 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the left bank moved towards right by 298.00 m and the right bank moved towards right by 2260.00 m during the period.

Figures 5.58.a to 5.58.b and tables 5.41.1 to 5.41.8 show how the cross-sectional area upto 16.25 m elevation of the section J-11 (Ch. 117.75 km) for different years vary across the width from left to right bank. The cross-sectional area for the years 1969-70 and 1976-77 were more or less same but less than the cross-sectional area for all other years. The cross-sectional area for the years 1977-78 to 1978-79 were more or less same, the cross-sectional area for the years 1981-82 to 1988-89 were more or less same except the cross-sectional area for the year 1990-91 when the cross-sectional area was more than all other years. From the same figures and table it is observed that the cross-

sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was greater than the total width for the year 1969-70.

From figures 5.75.a to 5.75.h it is observed that in the years 1969-70 to 1990-91 the channel section at station J-11(Ch. 117.75 km) had two or three relatively wide and deep channels along with a number of shallow but narrow channels with a number of chars in between. The causes of changes in channel and char pattern are same explained before.

Figure 5.92 and table 5.58 show that the total width has decreased during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1978-79. The total width however decreased from the year 1978-79 to 1981-82, then increased during the period 1981-82 to 1990-91. In a word, it can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.92 and table 5.58 also show that the effective width has decreased during the period 1969-70 to 1876-77, then increased from the year 1976-77 to 1990-91. Variation of total width and effective width as shown in figure 5.92 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width is same as mentioned before.

Figure 5.109 and table 5.58 show the movement of left bank towards left or right and right bank towards right or left at station J-11 (Ch. 117.76 km) for different years. From the same figure and table, it is observed that the left bank has moved towards right from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1978-79, then again moved towards right from 1978-79 to 1981-82 and again moved towards left from 1981-82 to 1990-91. Figure 5.109 and table 5.58 also show that the right bank has remained more or less in the same position from 1969-70 to 1986-87, then moved towards right from 1986-87 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the left bank moved towards left by 93.00 m and the right bank moved towards right by 1774 m during that period.

Figures 5.59.a to 5.59.b and tables 5.42.1 to 5.42.8 show how the cross-sectional area upto 15.12 m elevation of the section J-10 (Ch.134.30 km) for different years vary across the width from left to right bank. The cross-sectional area for the years 1986-87 and 1988-89 were more or less same but less than the cross-sectional area for all other years; the cross-sectional area for the year 1969-70 was more than the cross-sectional area for the year 1990-91; the cross-sectional area for the years 1978-79 to 1981-82 were more or less same and the cross-sectional area for the years 1976-77 to 1977-78 were more or less same when the cross-sectional area were more than all other years. From the same figures and tables it is observed that the cross-sectional area for the year 1969-70 was greater than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was less than the total width for the year 1969-70.

From figures 5.76.a to 5.76.h it is observed that the channel section at station J-10 (Ch. 134.30 km) had one or two relatively wide and deep chanels along with a number of relatively shallow but narrow channels with a number of chars in between in the years 1969-70 to 1986-87. In other years the channel section had three or four relatively deep but narrow channels along with a number of relatively wide and shallow channels with a number of chars in between. The causes of changes in channel and char pattern are same as mentioned before.

Figure 5.93 and table 5.59 show that the total width has decreased during the period 1969-70 to 1976-77, then decreased rapidly from 1976-77 to 1981-82, then increased from 1981-82 to 1986-87. The total width however decreased from 1986-87 to 1988-89, then increased during the period 1988-89 to 1990-91. It can be stated that the total width has decreased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.93 and table 5.59 also show that the effective width has increased during the period 1969-70 to 1976-77, then decreased rapidly from the year 1976-77 to 1981-82, then increased again during the period 1981-82 to 1986-87, then again decreased from the year 1986-87 to 1988-89 and again increased during the period 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.93 shows that there is a similarity in pattern of variation of total width and effective width. It is to be mentioned here that the effective width of the section was minimum in the year 1988-89.

Figure 5.110 and table 5.59 show the movement of left bank towards left or right and right bank towards right or left at station J-10 (Ch. 134.30 km) for different years. From the same figure and table it is observed that the left bank has moved towards right from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1978-79, then again moved towards right from 1978-79 to 1981-82, then again moved towards left from 1981-82 to 1986-87, then remained almost in the same position from 1986-87 to 1988-89 and also again moved towards right from 1988-89 to 1990-91. Figure 5.110 and table 5.59 also show that the right bank remained more or less in the same position from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1881-82, then moved towards right from 1981-82 to 1986-87, then again moved towards left from 1986-87 to 1988-89 and again moved towards right from 1988-89 to 1990-91.Considering the total period from 1969-70 to 1990-91 it is observed that the left bank moved towards left by 817.00 m and the right bank moved towards left by 5026.00 m during that period.

Figures 5.60.a to 5.60.b and table 5.43.1 to 5.43.7 show how the cross-sectional area upto 14.00 m elevation of the section J-9 (Ch. 142.45 km) for different years vary across the width from left to right bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional are for all other years and the cross-sectional area for the years 1976-77 to 1986-87 and 1990-91 were more or less same except the cross-sectional area for the year 1988-89 when the cross-sectional area was more than all other years. From the same figures and tables it is observed

that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was more than that of the year 1969-70.

From figures 5.77.a to 5.77.g it is observed that the channel section at station J-9 (Ch. 142.45 km) had one or two relatively wide and deep channels with two or three relatively deep but narrow channels in the years 1976-77 to 1981-82. In other years the channel section had one or two relatively wide and deep channels along with a number of shallow but narrow channels with a number of chars in between. The causes of changes in channel and char pattern are same as explained for station J-17.

Figure 5.94 and table 5.60 show that the total width has decreased during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1977-78. The total width however decreased from 1977-78 to 1981-82, then increased from 1981-82 to 1990-91. It may be mentioned that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.94 and table 5.60 also show that the effective width has increased rapidly during the period 1969-70 to 1976-77, then decreased rapidly from the year 1976-77 to 1981-82, then increased again during the period 1981-82 to 1988-89, and again decreased from the year 1988-89 to 1990-91. Variation of total

width and effective width as shown in figure 5.94 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width is same as mentioned at station J-17 (Ch. 25.00 km). It may be noted that the effective width was minimum in the year 1969-70.

Figure 5.111 and table 5.60 show the movement of left bank towards left or right and right bank towards right or left at station J-9 (Ch. 142.45 km) for different years. From the same figure and table it is observed that the left bank has moved towards right from 1969-70 to 1977-78, then moved towards left from 1977-78 to 1981-82, then again moved towards right from 1981-82 to 1986-87, then again moved towards left from 1986-87 to 1988-89 and remained almost in the same position from 1988-89 to 1990-91. Figure 5.111 and table 5.60 also show that the right bank has moved towards left from 1969-70 to 1976-77, then moved towards right from 1976-77 to 1977-78 and then again moved towards right from 1977-78 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the left bank moved toward right by 414.00 m and the right bank moved towardd right by 890.00 m during that period.

Figures 5.61.a to 5.61.b and tables 5.44.1 to 5.44.8 show how the cross-sectional area upto 13.23 m elevation of the section J-8 (Ch. 149.50 km) for different years vary across the width from right bank to left bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional area for all other years and the cross-sectional area for the years 1976-77

and 1978-79 to 1988-89 were more or less same except the cross-sectional area for the years 1977-78 and 1990-91. The cross-sectional area for the years 1977-78 and 1990-91 were more or less same and more than the cross-sectional area for all other years. From the same figures and tables, it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was more than that of the year 1969-70.

From figures 5.78.a to 5.78.h it is observed that the channel section at station J-8 (Ch. 149.50 km) had two relatively wide and deep channels with a big char in between in the years 1976-77 to 1981-82 . In other years the channel section had one or two relatively wide and deep channels along with a number of relatively shallow but narrow channels with a number of chars in between. The causes of changes in channel and char pattern are same as mentioned previously at station J-17.

Figure 5.95 and table 5.61 show that the total width has increased during the period 1969-70 to 1977-78, then decreased from the year 1977-78 to 1978-79. The total width however remained more or less same from 1978-79 to 1981-82, then increased from 1981-82 to 1986-87, then decreased from 1986-87 to 1988-89 and again increased rapidly from 1988-89 to 1990-91. In a word, it can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.95 and table 5.61 also show that the effective width has increased during the period 1969-70 to 1977-78, then decreased from the year 1977-78 to 1978-79, then again increased from the period 1978-79 to 1986-87, then again decreased during the period 1986-87 to 1988-89, and again increased from the year 1988-89 to 1990-91. Variation of total width and effetive width as shown in figure 5.95 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.112 and table 5.61 show the movement of right bank towards right for left and left bank towards left or right. From the same figure and table it is observed that the right bank has moved towards right from 1969-70 to 1977-78, then remained more or less in the same position from 1977-78 to 1981-82, then again moved towards right from 1981-82 to 1986-87, then moved towards left from 1986-87 to 1988-89 and then again moved towards right from 1988-89 to 1990-91. Figure 5.112 and table 5.61 also show that the left bank has moved towrds right from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1977-78, then again moved towards right from 1977-78 to 1981-82, then again moved towards left from 1981-82 to 1986-87, then again moved towards right from 1986-87 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the right bank moved towards right by 2528.00 m and the left bank moved towards left by 1822,00 m during that period.

Figures 5.62.a to 5.62.b and tables 5.45.1 to 5.45.8 show how the cross-sectional area upto 12.50 m elevation of the section J-7 (Ch. 162.35 km) for different years vary across the width from right bank to left bank. The cross-sectional area for the years 1969-70 to 1977-78, 1986-87 and 1990-91 were more or less same but less than the cross-sectional area for all other years and the cross-sectional area for the years 1978-79 and 1988-89 were more or less same except the cross-sectional area for the year 1981-82 when the cross-sectional area was more than all other years. From the same figures and tables, it is observed that the cross-sectional area for the year 1969-70 was more than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was more than the total width for the year 1969-70.

From figures 5.79.a to 5.79.h, it is observed that the channel section at station J-7 (Ch. 162.35 km) had one deep but narrow channel with one wide and deep channel in the year 1981-82. In other years the channel section had one or two relatively deep but narrow channels along with a number of relatively wide and shallow channels with a number of chars in between. The causes of changes in channel and char pattern are same as described for station J-17.

Figure 5.96 and table 5.62 show that the total width has increased rapidy during the period 1969-70 to 1976-77, then decreased from the year 1976-77 to 1978-79. The total width

however increased from 1978-79 to 1981-82, then decreased from 1981-82 to 1986-87 and again increased during the period 1986-87 to 1990-91. It can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.96 and table 5.62 also show that the effective width has increased rapidly during the period 1969-70 to 1981-82, then decreased from the year 1981-82 to 1986-87, then again increased during the period 1986-87 to 1988-89 and again decreased from the year 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.96 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km). Besides these, the effective width was minimum in the year 1969-70.

Figure 5.113 and table 5.62 show the movement of right bank towards right or left and left bank towards left or right at station J-7 (Ch. 162.35 km) for different years. From the same figure and table it is observed that the right bank has moved towards right from 1969-70 to 1976-77, then remained in the same position from 1976-77 to 1977-78, then moved towards left from 1977-78 to 1978-79, then again moved towards right from 1978-79 to 1981-82, then again moved towards left from 1981-82 to 1988-89 and then also moved towards right from 1988-89 to 1990-91. Figure 5.113 and table 5.62 also show that the left bank has moved towards left from 1969-70 to 1976-77 and remained more or less in

the same position from 1976-77 to 1981-82, then again moved towards left from 1981-82 to 1986-87 and remained more or less in the same position from 1986-87 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the right bank moved towards right by 813.00 m and the left bank moved towards left by 4807.00 m during that period.

Figures 5.63.a to 5.63.b and tables 5.46.1 to 5.46.8 show how the cross-sectional area upto 11.70 m elevation of the section J-6 (Ch. 177.70 km) for different years vary across the width from left bank to right bank. The cross-sectional area for the years 1976-77 to 1977-78 and 1988-89 were more or less same but less than the cross-sectional area for all other years and also the cross-sectional area for the years 1969-70, 1978-79, 1986-87 and 1990-91 were more or less same except the cross-sectional area for the year 1981-82 when the cross-sectional area was more than all other years. From the same figures and tables, it is observed that the cross-sectional area for the years 1969-70 and 1990-91 were more or less same. The total width of the section for the year 1990-91 was less than the total width for the year 1969-70.

From figures 5.80.a to 5.80.h it is observed that the channel section at station J-6 (Ch. 177.70 km) had one relatively wide and deep channel along with a number of relatively shallow but narrow channels with a number of chars in between in the years 1969-70 to 1990-91. The causes of changes in channel and char pattern are same as given at station J-17 (Ch. 25.00 km).

Figure 5.97 and table 5.63 show that the total width has decreased during the period 1969-70 to 1977-78, then increased from the period 1977-78 to 1978-79. The total width however decreased from 1978-79 to 1981-82, then increased from 1981-82 to 1986-87, then decreased again from 1986-87 to 1988-89 and again increased from 1988-89 to 1990-91. In summary it can be stated that the total width has decreased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.97 and table 5.63 also show that the effective width has decreased rapidly during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1977-78, then again decreased from 1977-78 to 1978-79, then again increased from 1978-79 to 1981-82, then also again decreased from 1981-82 to 1988-89 and again increased from 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.97 shows that effective width changes much more rapidly than the total width. This figure also shows that the total width and effective width were almost same in the year 1981-82. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.114 and table 5.63 show the movement of left bank towards left or right and right bank towards right or left at station J-6 (Ch. 177.70 km) for different years. From the same figure, it is observed that the left bank has moved towards right from 1969-70 to 1977-78, then moved towards left from 1977-78 to 1978-79 and came to the 0 position that was in 1969-70,

then again moved towards right from 1978-79 to 1981-82, then again moved towards left from 1981-82 to 1986-87 and then also again moved towards right from 1986-87 to 1990-91. Figure 5.114 and table 5.63 also show that the right bank has moved towards left from 1969-70 to 1977-78 and remained more or less in the same position from 1977-78 to 1978-79, then again moved towards left from 1978-79 to 1981-82, then again moved towards right from 1981-82 to 1986-87, then also again moved towards left from 1986-87 to 1988-89 and also again moved towards right from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the left bank has moved towards right by 470.00 m and the right bank moved towards left by 3932.00 m during that period.

Figures 5.64.a to 5.64.b and tables 5.47.1 to 5.47.8 show how the cross-sectional area upto 10.94 m elevation of the section J-5 (Ch. 188.20 km) for different years vary across the width from left bank to right bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional for all other years, the cross-sectional area for the years 1981-82 to 1988-89 were more or less same and also the cross-sectional area for the years 1976-77 and 1990-91 were more or les same except the cross-sectional area for the years 1977-78 to 1978-79. The cross-sectional area for the years 1977-78 to 1978-79 were more or less same when the cross-sectional area was more than the cross-sectinal area for all other years. From the same figures and tables, it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-

91. The total width of the section for the year 1990-91 was however less than the total width for the year 1969-70.

From figures 5.81.a to 5.81.h it is observed that the channel section at station J-5 (Ch. 188.20 km) had one relatively wide and deep channels along with a number of relatively shallow but narrow channels with a number of chars in between in the years 1969-70 and 1977-78 to 1981-82. In other years the channel section had one relatively wide and deep channel along with one relatively deep but narrow channel with a number of relatively shallow but narrow channels also with a number of chars in between.

Figure 5.98 and table 5.64 show that the total width has decreased during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1977-78. The total width however decreased from 1977-78 to 1981-82, then increased from 1981-82 to 1986-87, then again decreased from 1986-87 to 1988-89 and remained almost same from 1988-89 to 1990-91. In a word, it can be stated that the total width has decreased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.98 and table 5.64 also show that the effective width has decreased rapidly during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1981-82, then again decreased rapidly during the period 1981-82 to 1988-89 and again increased from the year 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.98 shows that

effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 m).

Figure 5.115 and table 5.64 show the movement of left bank towards left or right and right bank towards right or left at station J-5 (Ch. 188.20 km) for different years. From the same figure and table, it is observed that the left bank has moved towards left from 1969-70 to 1976-77 and remained almost in the same position from 1976-77 to 1978-79, then moved towards right from 1978-79 to 1981-82, then again moved towards left from 1981-82 to 1986-87, then again moved towards right from 1986-87 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Figure 5.115 and table 5.64 also show that the right bank has moved towards left from 1969-70 to 1976-77, then moved towards right from 1976-77 to 1977-78, then remained more or less in the same position from 1977-78 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the left bank has moved towards left by 498.00 m and the right bank moved towards left by 2626.00 m during that period.

Figures 5.65.a to 5.65.b and tables 5.48.1 to 5.48.8 show how the cross-sectional area upto 10.15 m elevation of the section J-4 (Ch. 201.30 km) for different years vary across the width from right bank to left bank. The cross-sectional area for the years 1976-77 to 1978-79 and 1986-87 to 1988-89 were more or less same but less than the cross-sectional area for all other

years and the cross-sectional area for the years 1981-82 and 1990-91 were more or less same except the cross-sectional area for the year 1969-70 when the cross-sectional area was more than all other years. From the same figures and tables it is observed that the cross-sectional area for the year 1969-70 was more than the cross-sectional area for the year 1990-91. However, the total width of the section for the year 1990-91 was less than the total width for the year 1969-70.

From figures 5.82.a to 5.82.h, it is observed that the channel section had one relatively wide and deep channel along with one relatively deep but narrow channel with a char in between in the year 1976-77 to 1981-82 and 1988-89. In other years the channel section had one relatively wide and deep chanel along with a number of shallow but narrow channels with a number of chars in between. The causes of changes in channel and char pattern are same as mentioned before.

Figure 5.99 and table 5.65 show that the total width has decreased rapidly during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1986-87 and again decreased during the period 1986-87 to 1990-91. It can be stated that the total width has decreased during the period 1969-70 to 1990-91 but not always in the same rate.

Figure 5.99 and table 5.65 also show that the effective width has decreased rapidly during the period 1969-70 to 1976-77, then increased from the year 1976-77 to 1977-78, then remained

more or less same from 1977-78 to 1978-79, then again increased from 1978-79 to 1986-87, then again decreased from 1986-87 to 1988-89 and also again increased from 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.99 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch.25.00 km).

Figure 5.116 and table 5.65 show the movement of right bank towards right or left and left bank towards left or right at station J-4 (Ch. 210.30 km) for different years. The same figure and table also show that the right bank has moved towards left from 1969-70 to 1976-77, then remained in the same position from 1976-77 to 1981-82, then moved towards right and came to the 0 position that was in 1969-70, then again moved towards left from 1986-87 to 1988-89 and remained almost in the same position from 1988-89 to 1990-91. From figure 5.116 and table 5.65 it is observed that the left bank has moved towards right from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1988-89 and again moved towards right from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the right bank has moved towards right by 513.00 m and the left bank moved towards right by 8845.00 m during that period.

Figures 5.66.a to 5.66.b and tables 5.49.1 to 5.49.8 show how the cross-sectional area upto 9.39 m elevation of the section J-3 (Ch.213.20 km) for different years vary across the width from

left bank to right bank. The cross-sectional area for the year 1969-70 was less than the cross-sectional area for all other years and the cross-sectional area for the years 1976-77 and 1981-82 to 1986-87 were more or les same. Also the cross-sectional area for the years 1977-78 and 1988-89 to 1990-91 were more or less same when the cross-sectional area was more than all other years. The cross-sectional area for the year 1978-79 was in between the medium and maximum cross-sectional area. From the same figures and table it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was more than the total width for the year 1969-70.

From figures 5.83.a to 5.83.h it is observed that the channel section at station J-3 (Ch. 213.20 km) had one or two relatively wide and deep channels in the years 1969-70 to 1976-77 and 1981-82 to 1988-89. The channel section had two relatively wide and deep channels along with one deep but narrow channel with one char in between in the year 1990-91.In other years the channel section had one wide and deep channel along with two or three relatively shallow but narrow channels. The causes of changes in channel and char pattern are same as explained at section J-17 (Ch. 25.00 km).

Figure 5.100 and table 5.66 show that the total width has increased during the period 1969-70 to 1978-79 but remained more or les same from the year 1978-79 to 1986-87. The total width

however increased rapidly during the period 1986-87 to 1988-89 and remained almost same from the year 1988-89 to 1990-91. In a word, it can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.100 and table 5.66 also show that the effective width has increased during the period 1969-70 to 1977-78, then decreased from the year 1977-78 to 1986-87, then again increased rapidly during the period 1986-87 to 1988-89 and again decreased from the year 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.100 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.117 and table 5.66 show the movement of left bank towards left or right and right bank towards right or left at station J-3 (Ch. 213.20 km) for different years. From the same figure and table, it is observed that the left bank has remained at 0 position from 1969-70 to 1990-91 except the year 1988-89 when the left bank moved towards right by 123.00 m. Figure 5.117 and table 5.66 also show that the right bank has moved towards right from 1969-70 to 1976-77, then remained more or less in the same position from 1976-77 to 1986-87, then again moved towards right from 1986-87 to 1988-89 and remained more or less in the same position from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91, it is observed that the left bank remained unchange and the right bank moved towards right by 4855.00 m during that period.

Figure 5.67.a to 5.67.b and tables 5.50.1 to 5.50.8 show how the cross-sectional area upto 8.66 m elevation of the section J-2 (Ch. 223.20 km) for different years vary across the width from left to right bank. The cross-sectional area for the years 1969-70 and 1988-89 were more or less same but less than the cross-sectional area for all other years and the cross-sectional area for the years 1977-78 ,1981-82 to 1986-87 and 1990-91 were more or less same. The cross-sectional area for the year 1976-77 was more than the cross-sectional area for all other years and the cross-sectional area for the year 1978-79 was in between the medium and maximum cross-sectional area. From the same figures and tables, it is observed that the cross-sectional area for the year 1969-70 was less than the cross-sectional area for the year 1990-91. The total width of the section for the year 1990-91 was however less than the width for the year 1969-70.

From figures 5.84.a to 5.84.h it is observed that the channel section at station J-2 (Ch. 223.20 km) had one or two relatively wide and deep channel in the years 1969-70 to 1976-77,1981-82 and 1988-89 to 1990-91. In other years the channel section had two or three relatively wide and deep channels along with a number of relatively shallow but narrow channels with a number of chars in between. The causes of changes in channel and char pattern are same as mentioned before.

Figure 5.101 and table 5.67 show that the total width has increased during the period 1969-70 to 1976-77, then decreased from the year 1976-77 to 1977-78. The total width however remained almost same from 1977-78 to 1981-82, then decreased rapidly from 1981-82 to 1988-89 and increased from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91 it may be stated that the total width has decreased during that period but not always in the same rate.

Figure 5.101 and table 5.67 also show that the effective width has remained more or less same during the period 1969-70 to 1976-77, then decreased from the year 1976-77 to 1977-78, then increased during the period 1977-78 to 1981-82 and remained more or less same from 1981-82 to 1986-87, then again decreased rapidly during the period 1986-87 to 1988-89 and also again decreased during the period 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.101 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width are same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.118 and table 5.67 show the movement of left bank towards left or right and right bank towrds right or left at station J-2 (Ch. 223.20 km) for different years. From the same figure and table, it is observed that the left bank has remained almost in the 0 position from 1969-70 to 1988-89 and then moved towards right in the year 1990-91. Figure 5.118 and table 5.67 also show that the right bank has moved towrds right

from 1969-70 to 1976-77, then moved towards left from 1976-77 to 1977-78, then remained more or less in the same position from 1977-78 to 1986-87, then again moved towards left from 1986-87 to 1988-89 and again moved towards right from 1988-89 to 1990-91. Considering the total period from 1969-70 to 1990-91 it is observed that the left bank moved towards right by 432.00 m and the right bank moved towards left by 1850.00 m during that period.

Figures 5.68.a to 5.68.b and tables 5.51.1 to 5.51.8 show how the cross-sectional area upto 8.17 m elevation of the section J-1 (Ch. 230.75 km) for different years vary across the width from left to right bank. The cross-sectional area for the year 1990-91 was less than the cross-sectional area for all other years but the cross-sectional area for the years 1969-70 and 1976-77 were more or less same and also the cross-sectional area for the years 1977-78 to 1986-87 were more or less same except the cross-sectional area for the year 1988-89 when the cross-sectional area was more than the cross-sectional area for all other years. From the same figures and tables, it is observed that the cross-sectional area for the year 1969-70 was more than the cross-sectional for the year 1990-91. The total width of the section for the year 1990-91 however more than the total width for the year 1969-70.

From figures 5.85.a to 5.85.h, it is observed that the channel section at station J-1(Ch.230.75 km) had one relatively very wide and deep channel in the years 1969-70 and 1978-79 to

1990-91. In other years the channel section had two or three relatively wide and deep channel with one or two chars in between. It is also observed that the channel section changes very fast from one year to another due to rapid changes in the channel and char pattern as a result of active erosion and deposition activity. On the whole it may be stated that the channel section is very unstable so far as position of channels, deeper or shallower and location of chars.

Figure 5.102 and table 5.68 show that the total width has increased during the period 1969-70 to 1981-82, then decreased from the year 1981-82 to 1986-87. The total width however increased from 1986-87 to 1988-89, then decreased from 1988-89 to 1990-91. In a word, it can be stated that the total width has increased during the period 1969-70 to 1990-91 but not always at the same rate.

Figure 5.102 and table 5.68 also show that the effective width has increased during the year 1969-70 to 1976-77, then decreased from the period 1976-77 to 1977-78 and again increased during the year 1977-78 to 1978-79. The effective width remained almost same from 1978-79 to 1981-82, then decreased from 1981-82 to 1986-87, then increased from 1986-87 to 1988-89 and again decreased from 1988-89 to 1990-91. Variation of total width and effective width as shown in figure 5.102 shows that effective width changes much more rapidly than the total width. The causes of changes in total width and effective width is same as mentioned at station J-17 (Ch. 25.00 km).

Figure 5.119 and table 5.68 show the movement of left bank towards left or right and right bank towards right or left at station J-1 (Ch. 230.75 km) for different years. From the same figure and table it is observed that the left bank remained more or less in the same position from 1969-70 to 1977-78, then moved towards left from 1977-78 to 1981-82, then moved towards right from 1981-82 to 1986-87 and remained almost in the same position from 1986-87 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Figure 5.119 and table 5.68 also show that the right bank has moved towards right from 1969-70 to 1976-77, then remained more or less in the same position from 1976-77 to 1981-82, then moved towards left from 1981-82 to 1986-87, then again moved towards right from 1986-87 to 1988-89 and again moved towards left from 1988-89 to 1990-91. Considering the total period rom 1969-70 to 1990-91, it is observed that the left bank has moved towards left by 425.00 m and the right bank moved towards right by 1163.00 m during that period.

From figures 5.86 to 5.102, figures 5.103 to 5.119 and tables 5.52 to 5.68 which are based on data shown in tables 5.52 to 5.68, it is observed that the total width has increased at stations J-17 to J-15, J-13 to J-11, J-9 to J-7, J-3 and J-1; remained more or less same only at station J-14; decreased at station J-10, J-6 to J-4 and J-2. The total width, effective width, the movement of left bank towards left or right and the right bank towards right or left are clearly shown in figure 5.103 to 5.119.

From the above figures and tables it is also observed that the effective width has increased at stations J-17 to J-15, J-13 to J-11, J-9 to J-7, J-3 and J-1; and decreased at stations J-14, J-10, J-6 to J-4 and J-2.

5.4 Velocity vs. Roughness Coefficient:

Figures 5.120 to 5.128, figures 5.129 to 5.137 and tables 5.69 to 5.70 show the roughness coefficient with respect to mean velocity. For calculating roughness coefficient, three different slopes were considered (1) the upstream slope, (2) the downstream slope and (3) the average slope. Upstream slope is the slope between Noonkhawa to Bahadurabad; downstream slope is the slope between Bahadurabad to Sirajgonj and average slope indicats the slope of average of upstream and downstream slopes. Data were analysed on the basis of dry season and wet season. Data for the period December to mid May were used for dry season flow and data for September to October were used for wet season flow condition.

In dry season, it is observed that there are two channels for Fulchari channel such as Fulchari channel and fulchari channel-1. In wet season there are four channels for Fulchari channel such as Fulchari channel, Fulchari channel-1, Fulchari channel-2 and Fulchari channel-3. Because of limitation of data relating to roughness coefficient has been limited only to Fulchari channel and Fulchari channel-1 although the roughness coefficient for other channels have been determined.

It is observed that in dry season there are five channels in Bahadurabad channel such as Bahadurabad channel-1, Bahadurabad channel-2, Bahadurabad channel-3, Bahadurabad channel-4 and Bahadurabad channel-5. In wet season there are six channel in Bahadurabad channel such as Bahadurabad channel-1, Bahadurabad channel-2, Bahadurabad channel-3, Bahadurabad channel-4, Bahadurabad channel-5 and Bahadurabad channel-6. Among these, only the first four channels have been considered for discussion relating to roughness coefficient.

Data were also analysed for all channels taken together both for dry and wet seasons. But this method does not properly reflect the channel roughness. This procedure was followed just to have some overall idea about n values.

From figure 5.120 and table 5.69 it is observed that for dry season the roughness coefficient for Fulchari channel are generally in between 0.0337 to 0.0124 when velocities are in between 0.499 to 0.8864 m/sec.

From figure 5.123 and table 5.70, it is observed that for dry season the roughness coefficient for Bahadurabad channel-1 are generally in between 0.0269 to 0.0224 when velocities are 0.8371 to 1.3031 m/sec; the roughness coefficient for Bahadurabad channel-2 are generally in between 0.0337 to 0.0123 when velocities are in between 0.6970 to 0.9225 m/sec; the roughness coefficient for Bahadurabad channel-3 are in between 0.02305 to 0.02565 when velocities are in between 0.9823 to 0.9223 m/sec; and the roughness coefficients for Bhadurabad channel-4 are in

between 0.0137 to 0.0103 when velocities are in between 0.7039 to 0.7459 m/sec.

From figure 5.126 and table 5.70 it is observed that for dry season the roughness coefficient for all channels taken together are generally in between 0.0277 to 0.0225 when velocities are in between 0.6476 to 1.0623 m/sec.

From figure 5.129 and table 5.69 it is observed that for wet season the roughness coefficient for Fulchari channel are in between 0.0331 to 0.0257 when velocities are 0.8729 to 1.2801 m/sec.

From figure 5.132 and table 5.70, it is observed that for wet season the roughness coefficient for Bahadurabad channel-1 are in between 0.037 to 0.022 when velocities are 0.7989 to 1.5596 m/sec; the roughness coefficient for Bahadurabad channel-2 are in between 0.0272 to 0.019 when velocities are 0.8990 to 1.2948 m/sec; the roughness coefficient for Bahadurabad chanel-3 are in between 0.0202 to 0.0284 when velocities are 0.8560 to 1.1033 m/sec; the roughness coefficient for Bahadurabad channel-4 are in between 0.0257 to 0.0202 when velocities are 0.3387 to 0.664 m/sec.

From figure 5.135 and table 5.70 it is seen that for wet season the roughness coefficient for all channels taken together are generally in between 0.0238 to 0.0236 when velocities are in between 1.1438 to 1.1551 m/sec.

The variation of n value (Roughness coefficient) remains more or les same for all the three conditions of slopes. For this reason the downstream and average slope related figures are not discussed.

Fig. 5.138 shows the changes in cross-sectional area corresponding to high water level at different stations (J-17 to J-1 i.e, ch. 25.00 km to 230.75 km) along the river in different years. The firm line and the dash line show the trends in variation of the cross-sectional area along the length of the river for the year 1969-70 and 1990-91 respectively. From Fig. 5.138 and tables 5.1 to 5.17, it is observed that in most of the years there has not been much changes in cross-sectional area at stations J-16 and J-7. In all other stations there have been, however, a large variation in cross-sectional area from time to time during the period 1969-70 to 1990-91.

If the cross-sectional areas for the years 1969-70 and 1990-91 are compared, it is observed that the cross-sectional area has remained almost same at stations J-17 and J-16; remained more or less same at stations J-14, J-10, J-7, J-6 and J-1. There have been however, a large changes in cross-sectional area in all other stations.

Fig.5.139 shows the changes in assumed bed level at elevation corresponding to 5% of total cross-sectional area from channel bottom for different years and different stations (J-17 to J-1 i.e. Ch. 25.00 km to 230.75 km). The firm line in this figure gives some idea about this assumed bed level for the year 1969-70 for all the stations along the river and the dash line gives similar idea for this bed level along the river for the year 1990-91. From figure 5.139 and tables 5.18 to 5.34 it is

observed that only at stations J-17 and J-12, this bed level remained more or less at same elevation in most of the years. In all other stations, there has been a large variation in this bed level elevation in different years. It may therefore be stated that the bed level has remained more or less at same elevation only for stations J-17 and J-12 over the years.

If the bed level elevations for the years 1969-70 and 1990-91 are compared, it is observed that the bed level has remained almost same at station J-17; remained more or less same at stations J-16 and J-12; fell down at stations J-15, J-13, J-11 and J-9; rose up at stations J-14, J-10 and J-8 to J-1. The maximum lowering (4.33m) and rise up (6.17m) occured at statins J-11 and J-7 respectively. In general, it may be concluded that the bed level fell down in the upper reaches (Stations J-17 to J-9) and rose up in the lower reaches (Stations J-8 to J-1) in the year 1990-91 with that of the year 1969-70.

Fig. 5.140 shows the changes in total width at high water level at different stations (J-17 to J-1 i.e. ch.25.00 km to 230.75 km) during different periods along the river. The firm line and the dash line show the variation of total width along the length of the river for the years 1969-70 and 1990-91 respectively. From the above figure and tables 5.52 to 5.68 it is observed that there has been changes in total width in all stations during different periods; such changes in total width have been, however, relatively small only at station J-14 and relatively large at stations J-15, J-12, J-10, J-8, J-7, J-6, J-4 and J-3.

When the total width of river sections at various stations is compared between the year 1969-70 and 1990-91 it observed that the total width has increased at most of the stations except J-14, J-10, J-6, J-5, J-4 and J-2 where the total width has decreased. Here it may be mentioned that the change in total width at J-14 and J-9 however, has been small.

From the above observations it is clear that from the consideration of total width at different stations only station J-14 shows relatively stable condition. Figs. 7.1.e and 7.1.f, however, show that there have been some shifting of bankline at station J-14. This indicates that the river section at J-14 is not stable even though the total width shows relatively less changes.

Fig. 5.141 shows how the effective width at different stations (J-17 to J-1 i.e ch. 25.00 km to Ch. 230.75 km) changed during different periods. The firm line and the dash line in the figure indicates the variation of effective width along the length of the river for the year 1969-70 and 1990-91 respectively. From the plotted points in the above figure and tables 5.52 to 5.68 it is observed that the effective width has remained more or less same at station J-15 during most of the time over the period 1976-77 to 1990-91. In other stations, there has been a large variation of effective width during different periods from 1969-70 to 1990-91.

From the firm line and the dash line in figure 5.141 it is observed that during the period 1969-70 to 1990-91, there has been large change in effective width at each station along the length of the river except J-12 where the effective width has remained more or less same. From figures 5.140 and 5.141 it is also observed that the changes of effective width is much more than the changes in total width. This is because of the fact that an increase or decrease of effective width is generally due to erosion or deposition of chars and bank which changes in total width is only due to erosion or deposition of bank only.

Figure 5.142 shows the left bank position of river Jamuna at different stations in different years with respect to the bank position in those stations in the year 1969-70. The points above the straight line indicate erosion and the points below the straight line indicate accretion at different stations (J-17 to J-1 i.e. Ch. 25.00 km to 230.75 km) to the bank line position in the year 1969-70 along the length of the river. From Fig. 5.142 and tables 5.52 to 5.68, it is observed that the left bank remained almost in the same position at station J-3 only, more or less in the same position at stations J-12, J-9, J-6,J-2 and J-1 in most of the years. Stations J-17, J-16, J-15, J-13, J-10, J-7 and J-5 show mostly erosion even though there was accretion time to time. Stations J-11, J-8 and J-4 show mostly accretion with time to time some erosion and station J-14 had both erosion and accretion but more or less of equal extent from 1969-70 to 1990-91.

If we compare the bank positions at different stations for the year 1969-70 and 1990-91, it is observed that there has been accretion in the range of 200 m to 300 m at stations J-12, J-9, J-6 and J-2. At station J-4 however the accretion has been upto about 8845.0 m.

From the same figure it is also observed that there has been bank erosion within a range of about 100 m to 2250 m along bank-line at stations J-17, J-16, J-14, J-13, J-11, J-10, J-8, J-5 and J-1. At stations J-15 and J-7 the erosion was quite severe and was about 4100.00 m and 4800.00 m respectively. At station J-3 there has been however, neither erosion nor accretion.

Fig. 5.143 shows the right bank position of river Jamuna at different stations in different years with respect to the bank position in those stations in the year 1969-70. The points above the straight line indicate accretion and the points below the straight line indicate erosion at different stations (J-17 to J-1 i.e. Ch. 25.000 km to 230.75 km) with respect to the bank line position in the year 1969-70 along the length of the river. From figure 5.143 and tables 5.52 to 5.68, it is observed that the right bank remained more or less in the same position at stations J-15, J-14, J-13, J-11, J-8, J-6 and J-4 in most of the years. Stations J-12, J-3 and J-1 show mostly erosion even though there was accretion time to time; the stations J-17, J-10, J-9, J-5 and J-2 show mostly accretion with time to time some erosion; stations J-16 and J-7 show both erosion and accretion but more or less of equal extent.

If we compare the bank positions at different stations for the years 1969-70 and 1990-91, it is observed that there has been accretion in the range of 300 m to 900 m at stations J-17, J-14 and J-4; accretion in the range of 1800 m to 3900 m at stations J-6, J-5 and J-2. At station J-10 however the accretion has been upto a distance 5026.00 m. There has been erosion in the right bank for other stations varying from 500 m to 2500 m.

Bank erosion and accretion for all stations are also observed from figures 5.103 to 5.119. These figures show that bank erosion or accretion does not follow any systematic trend with time. Such characteristics are expected from a braided river like Jamuna. This is because the flow velocity and direction not only depends on discharge and cross-section but also on char size, shape and its pattern of growth and decay and thus the char development pattern plays a very important role in bank erosion and causes bank erosion to occur not following any systematic pattern.

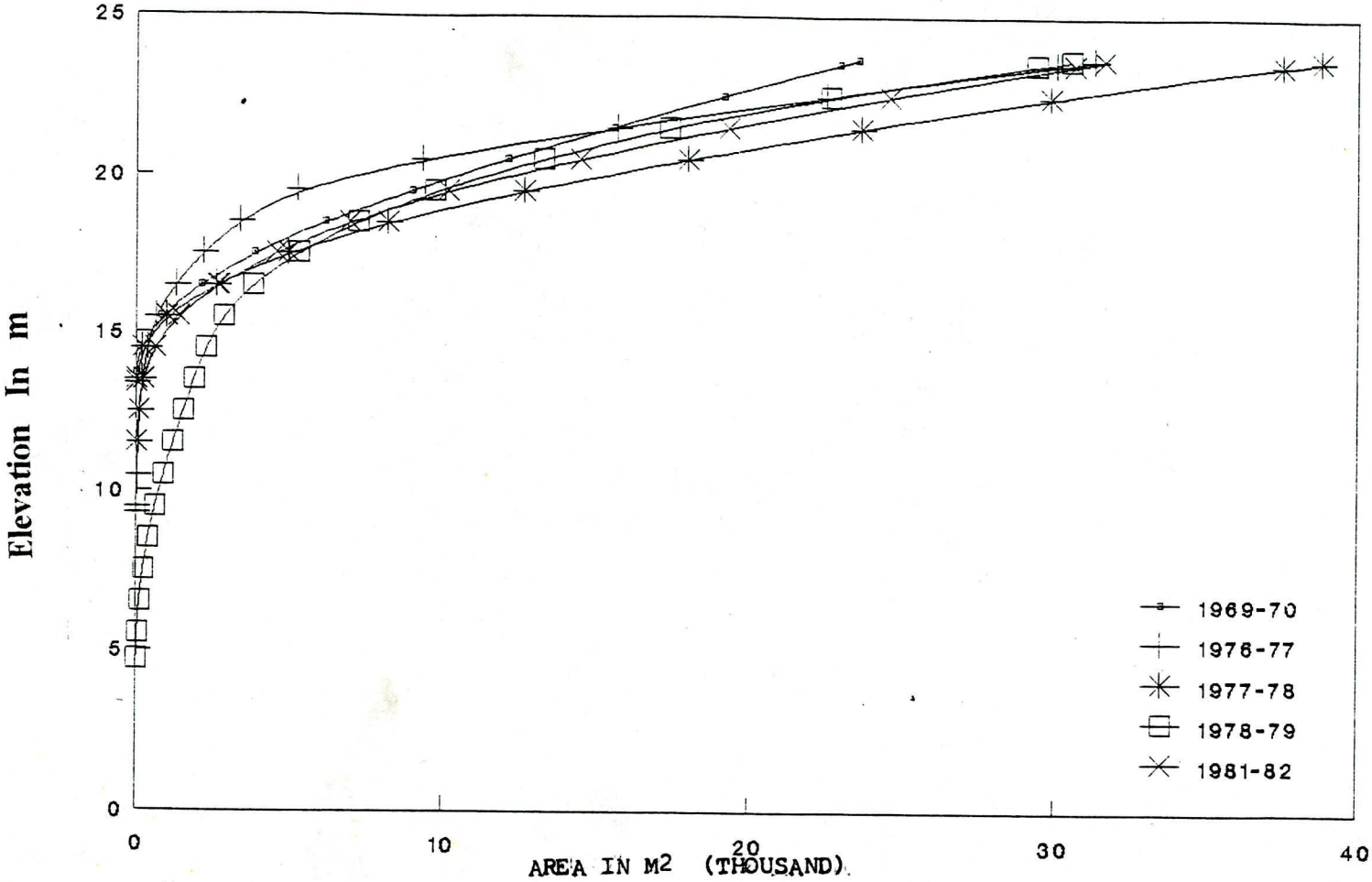


Figure 5.1.a Elevation Vs Area, Section J-17 (Ch. 25.00 Km.)

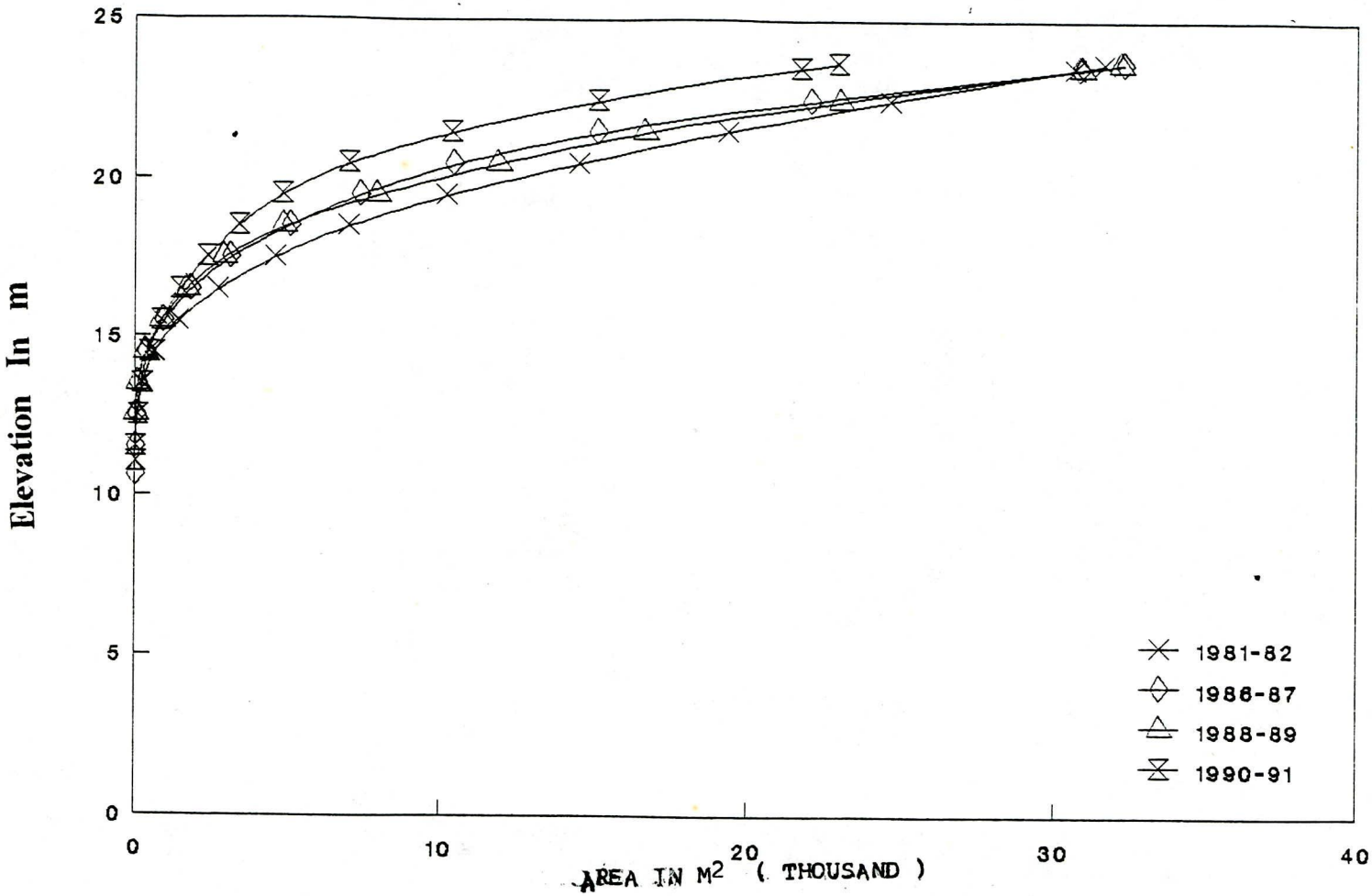


Figure 5.1.b Elevation Vs Area , Section J-17 (Ch. 25.00 Km.)

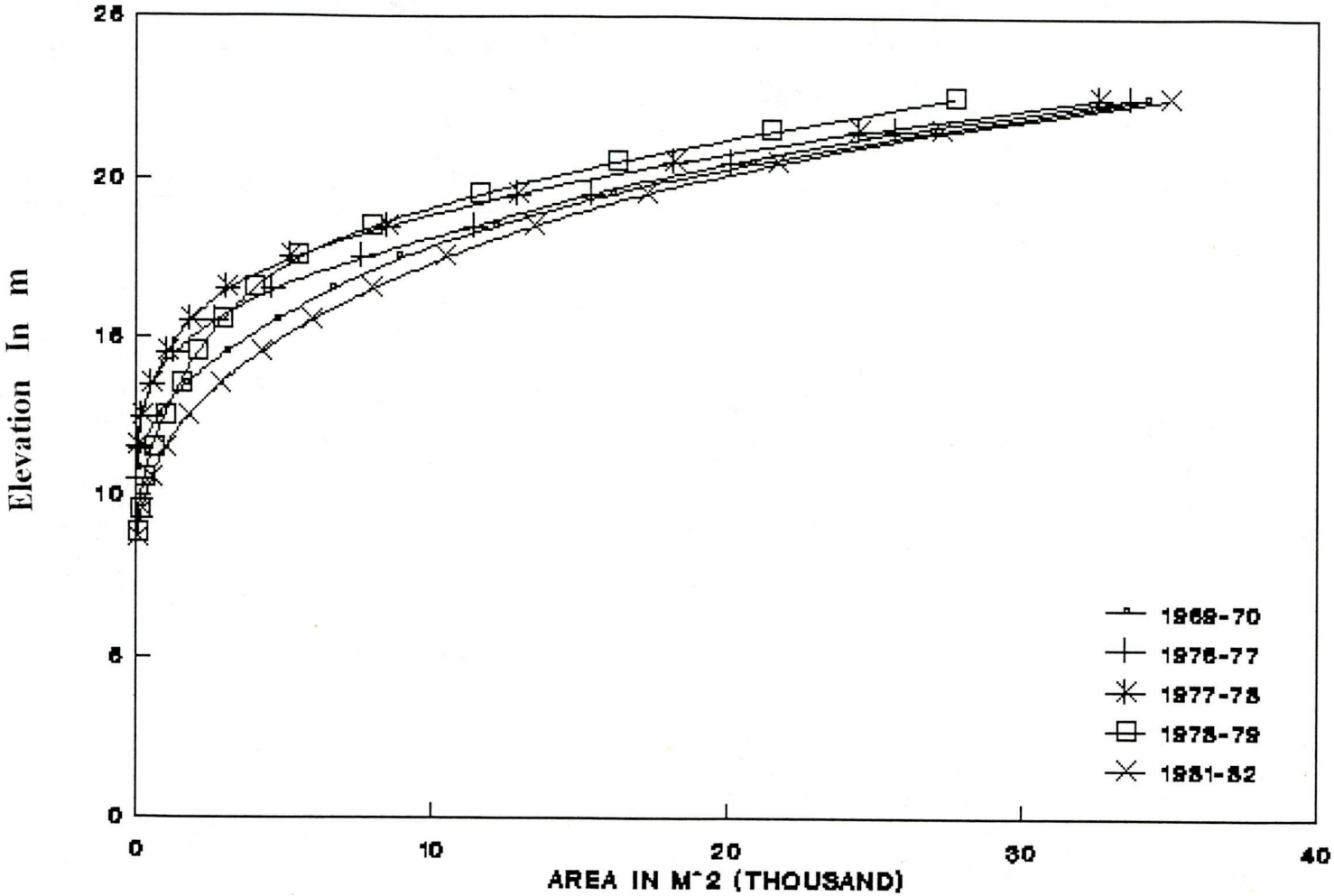


Figure 5.2.a Elevation Vs Area , Section J-16 (Ch. 37.10 Km.)

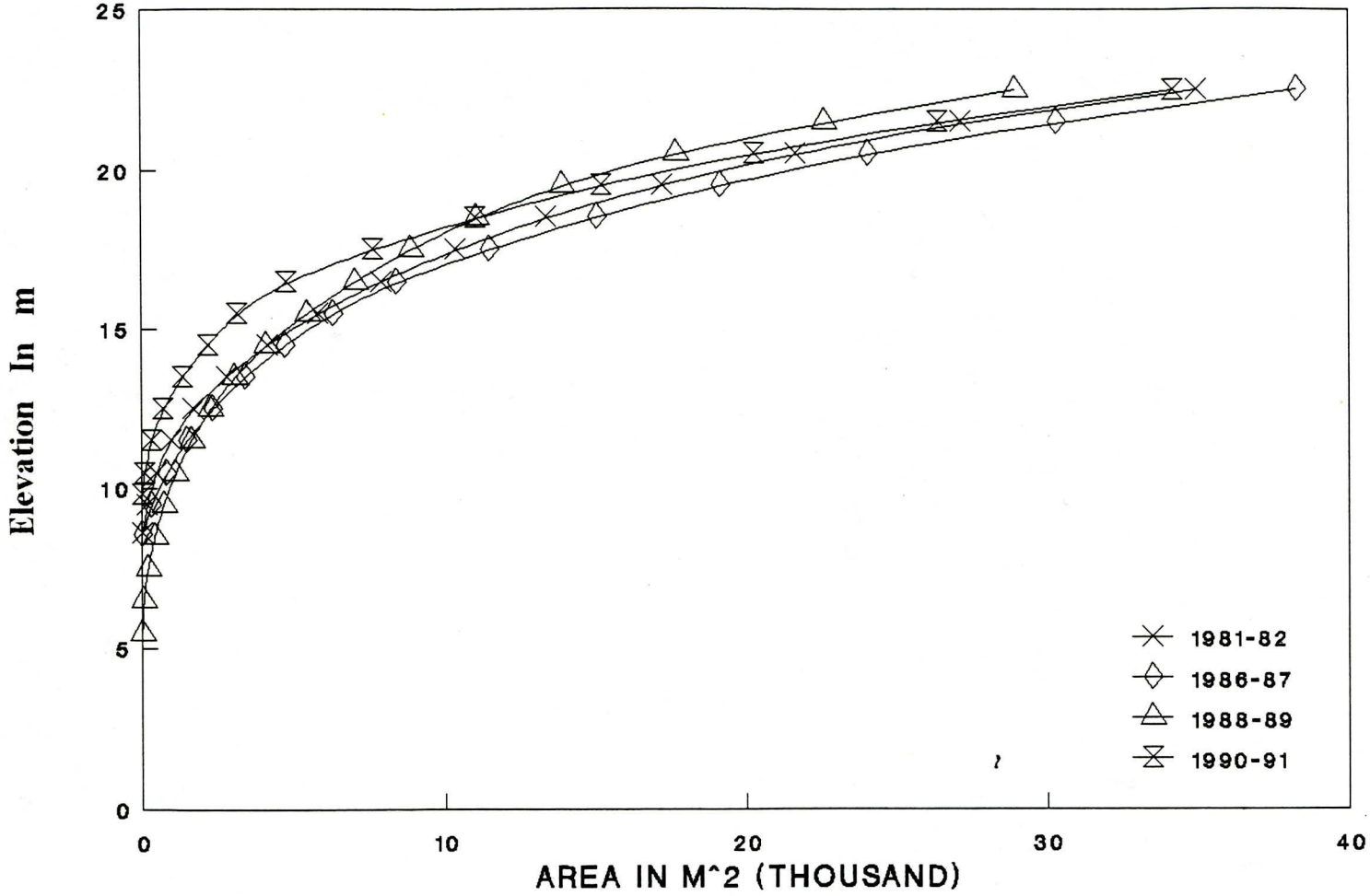


Figure 5.2.b Elevation Vs Area, Section J-16 (Ch. 37.10 Km.)

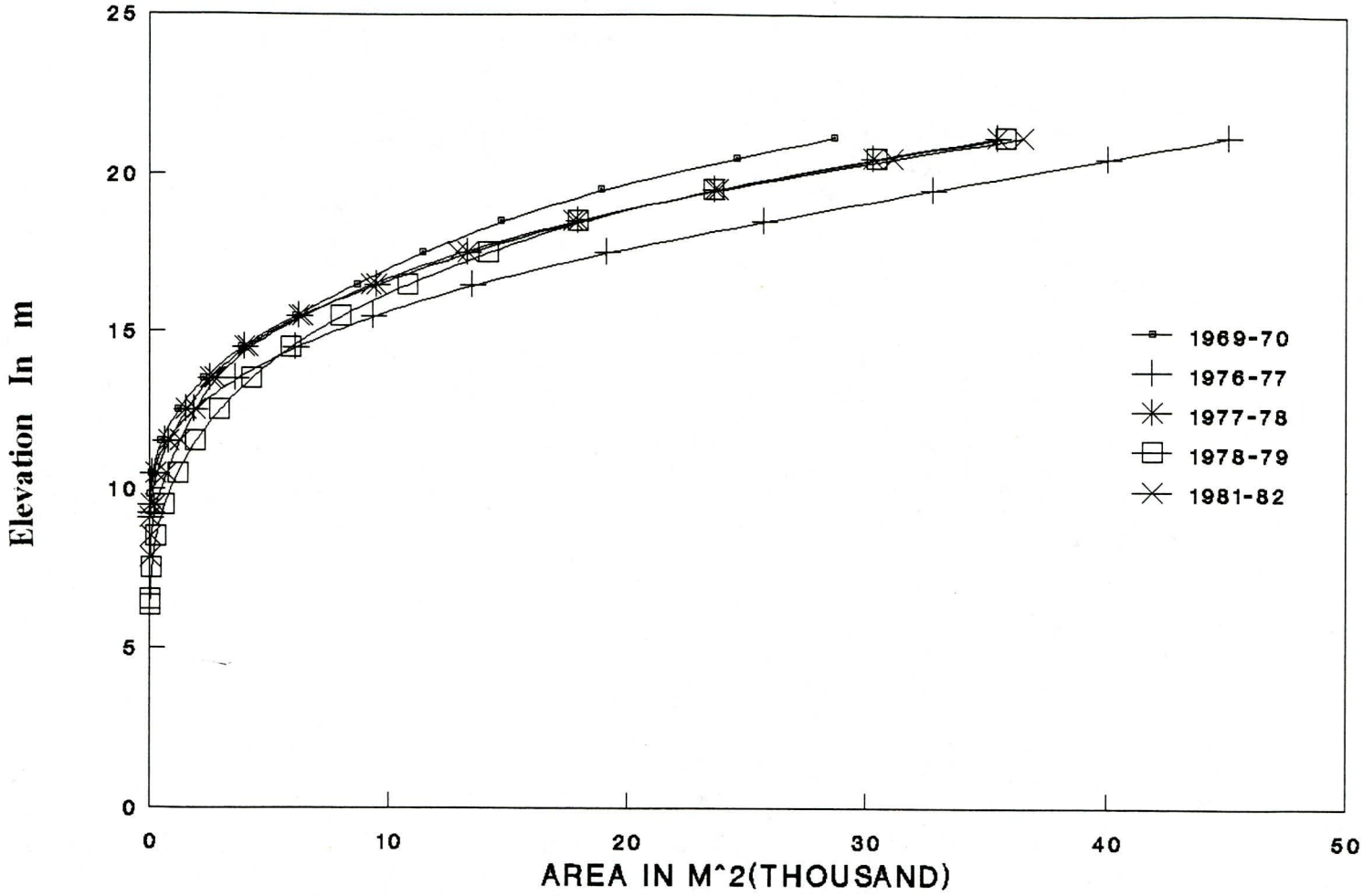


Figure 5.3.a Elevation Vs Area , Section J-15 (Ch. 55.65 Km.)

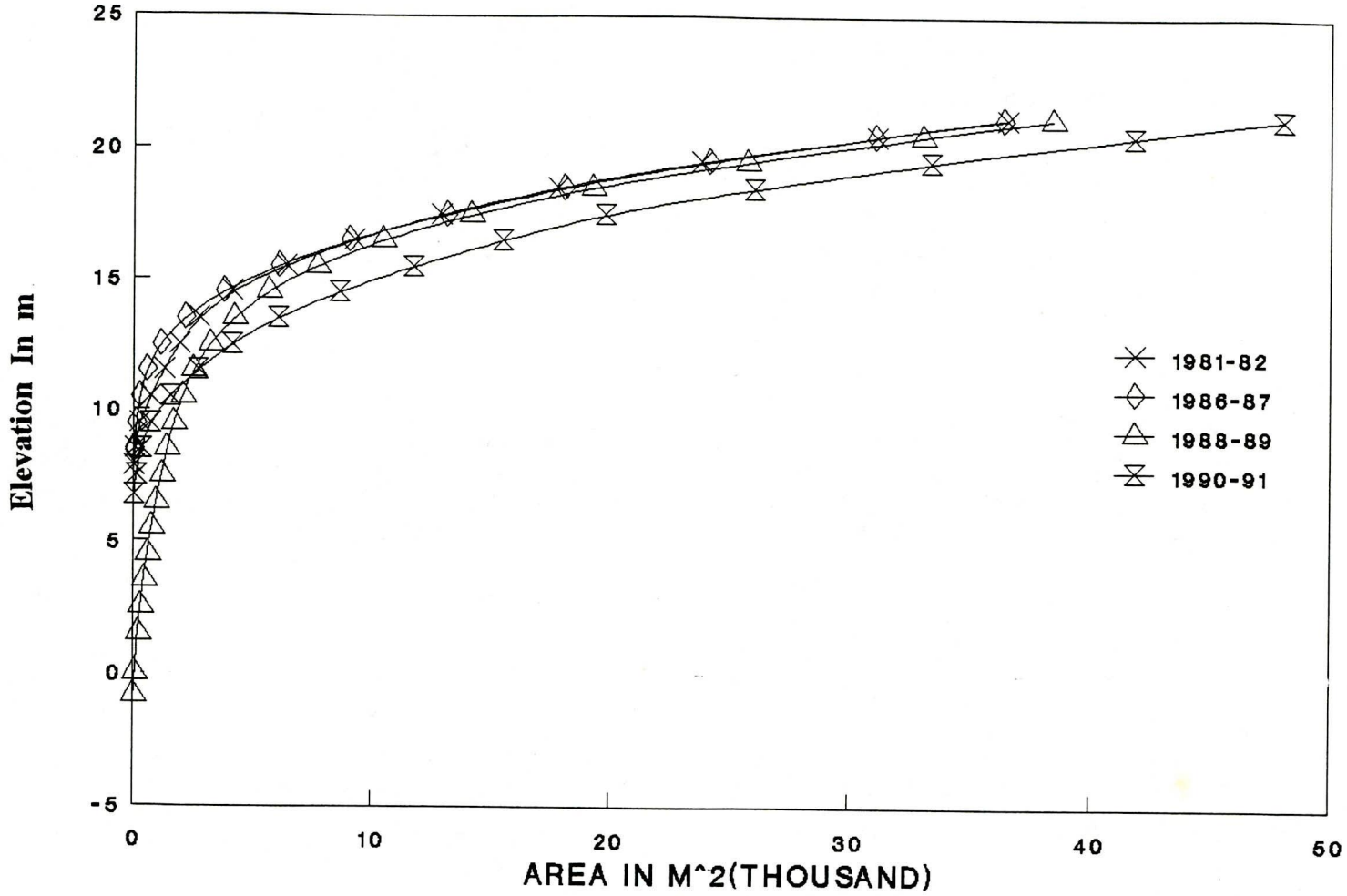


Figure 5.3.b Elevation Vs Area , Section J-15 (Ch. 55.65 Km.)

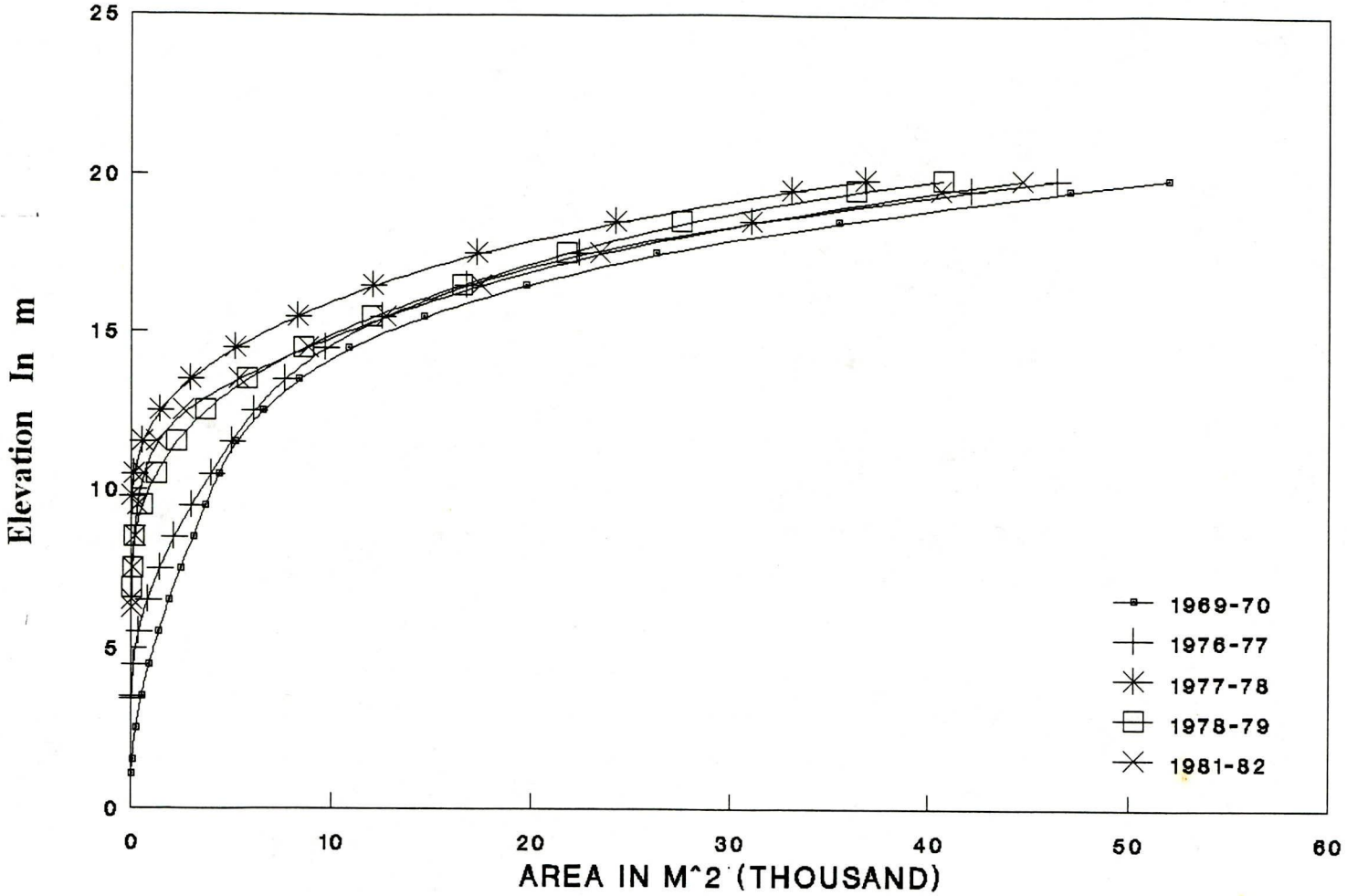


Figure 5.4.a Elevation Vs Area, Section J-14 (Ch. 71.20 Km.)

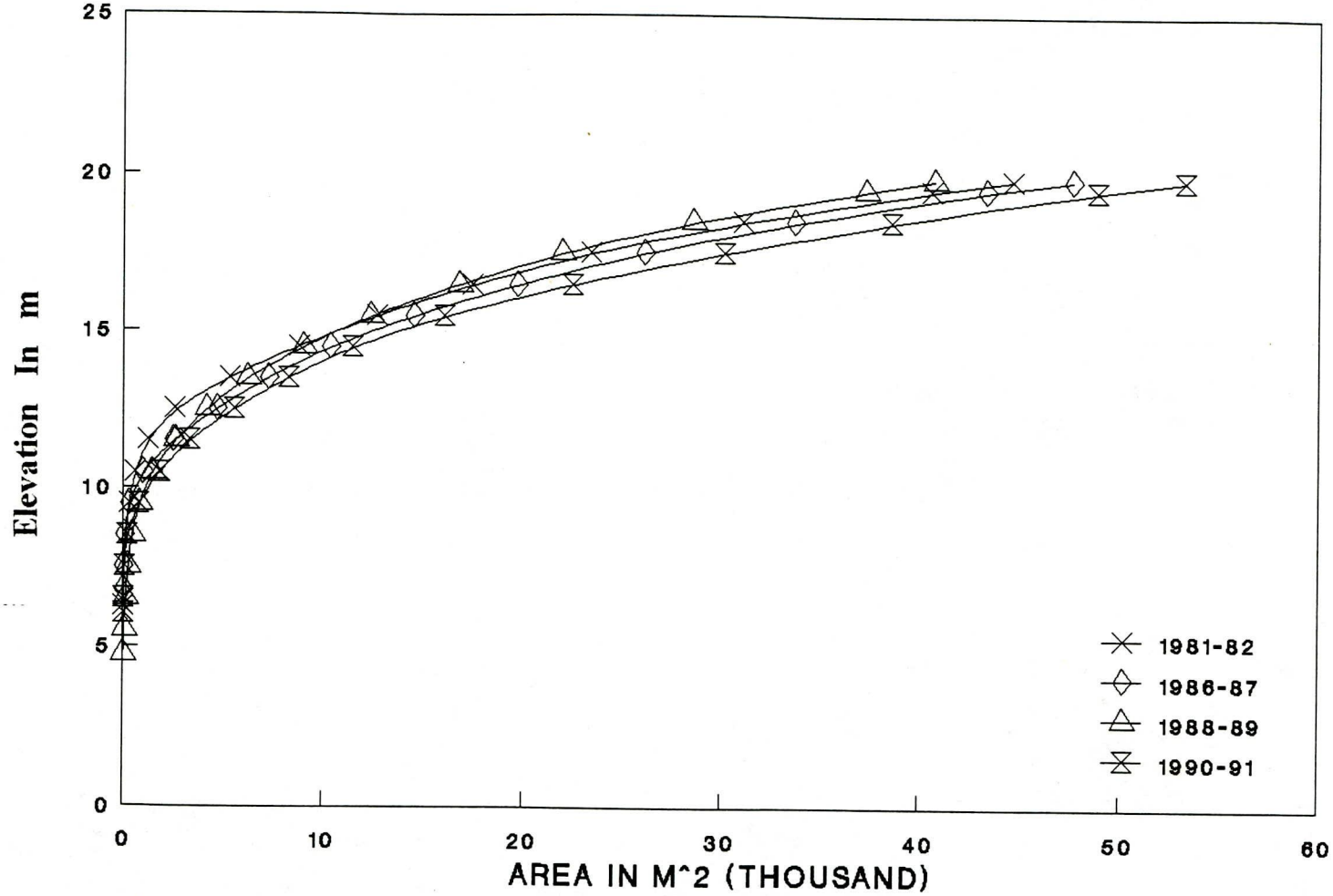


Figure 5.4.b Elevation Vs Area , Section J-14 (Ch. 71.20 Km.)

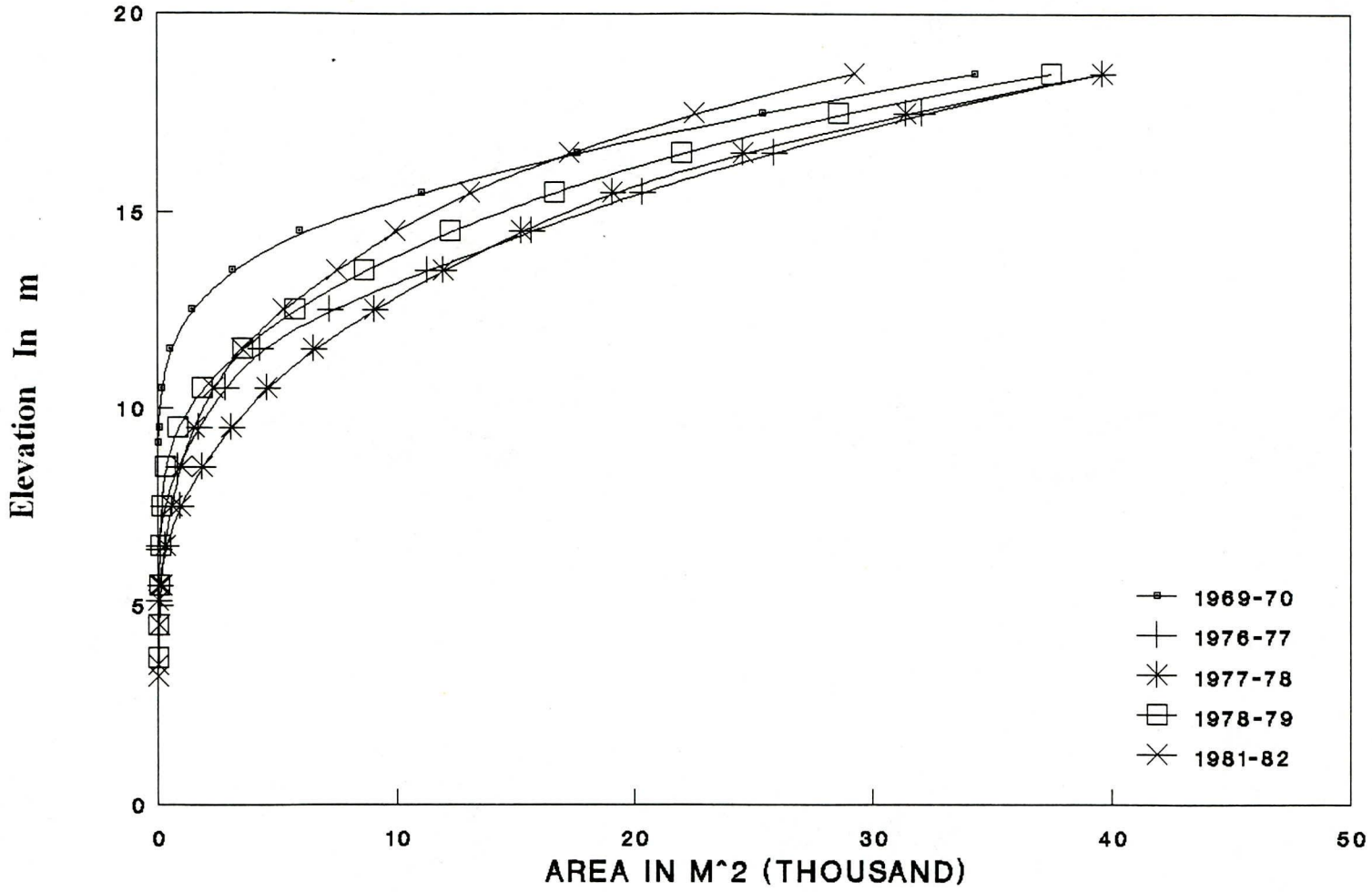


Figure 5.5.a Elevation Vs Area , Section J-13 (Ch. 84.70 Km.)

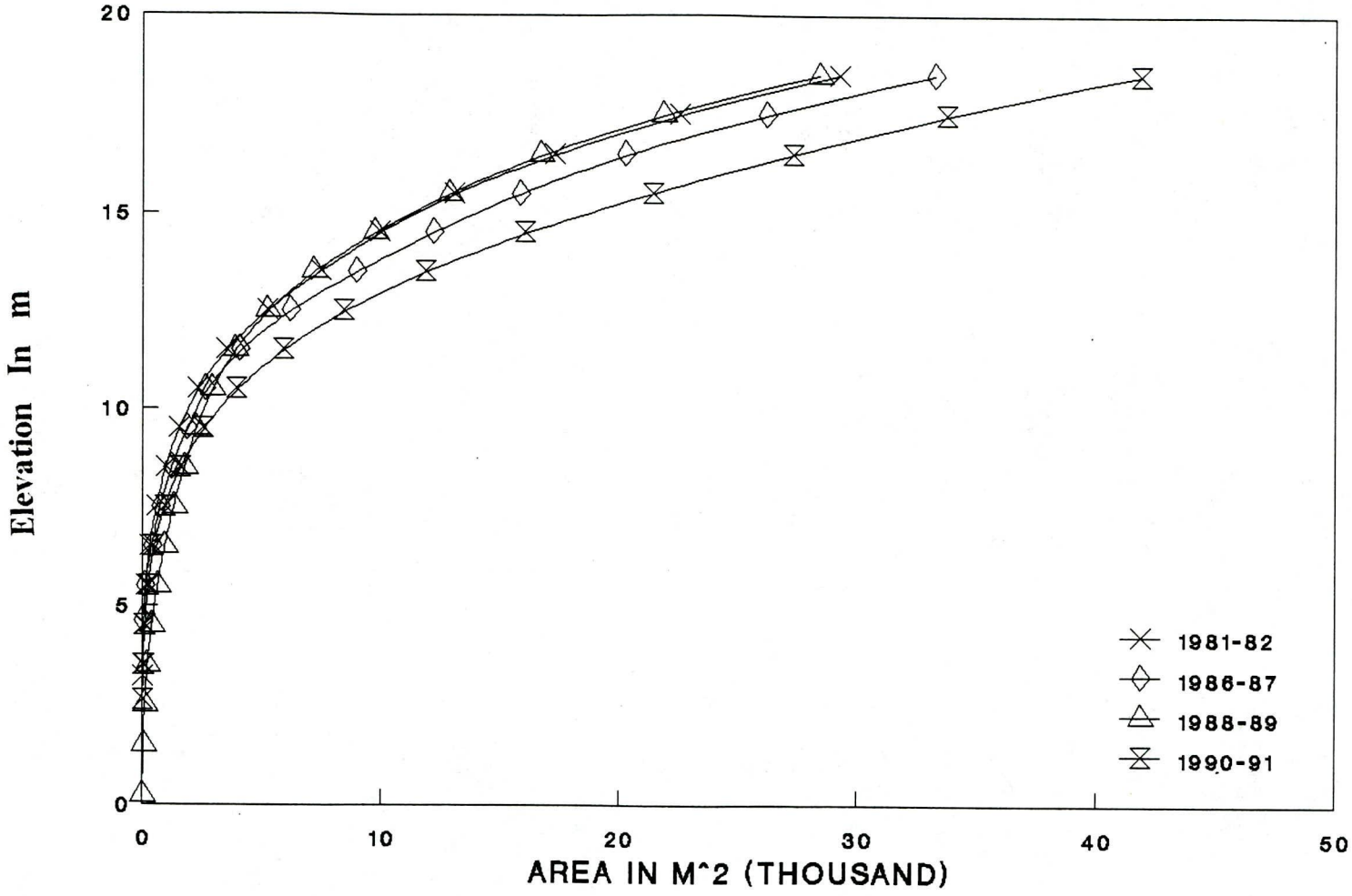


Figure 5.5.b Elevation Vs Area , Section J-13 (Ch. 84.70 Km.)

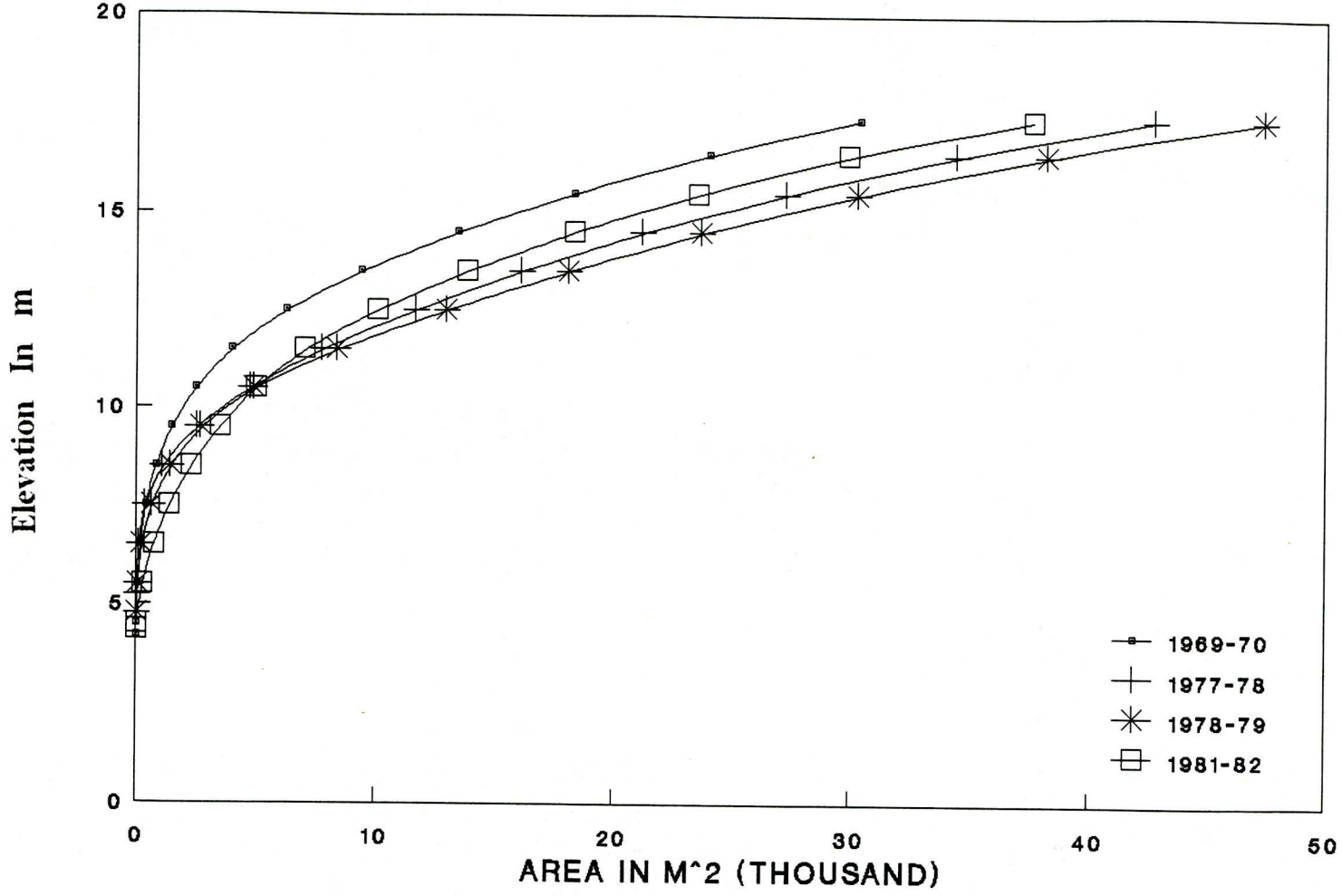


Figure 5.6.a Elevation Vs Area, Section J-12 (Ch. 100.50 Km.)

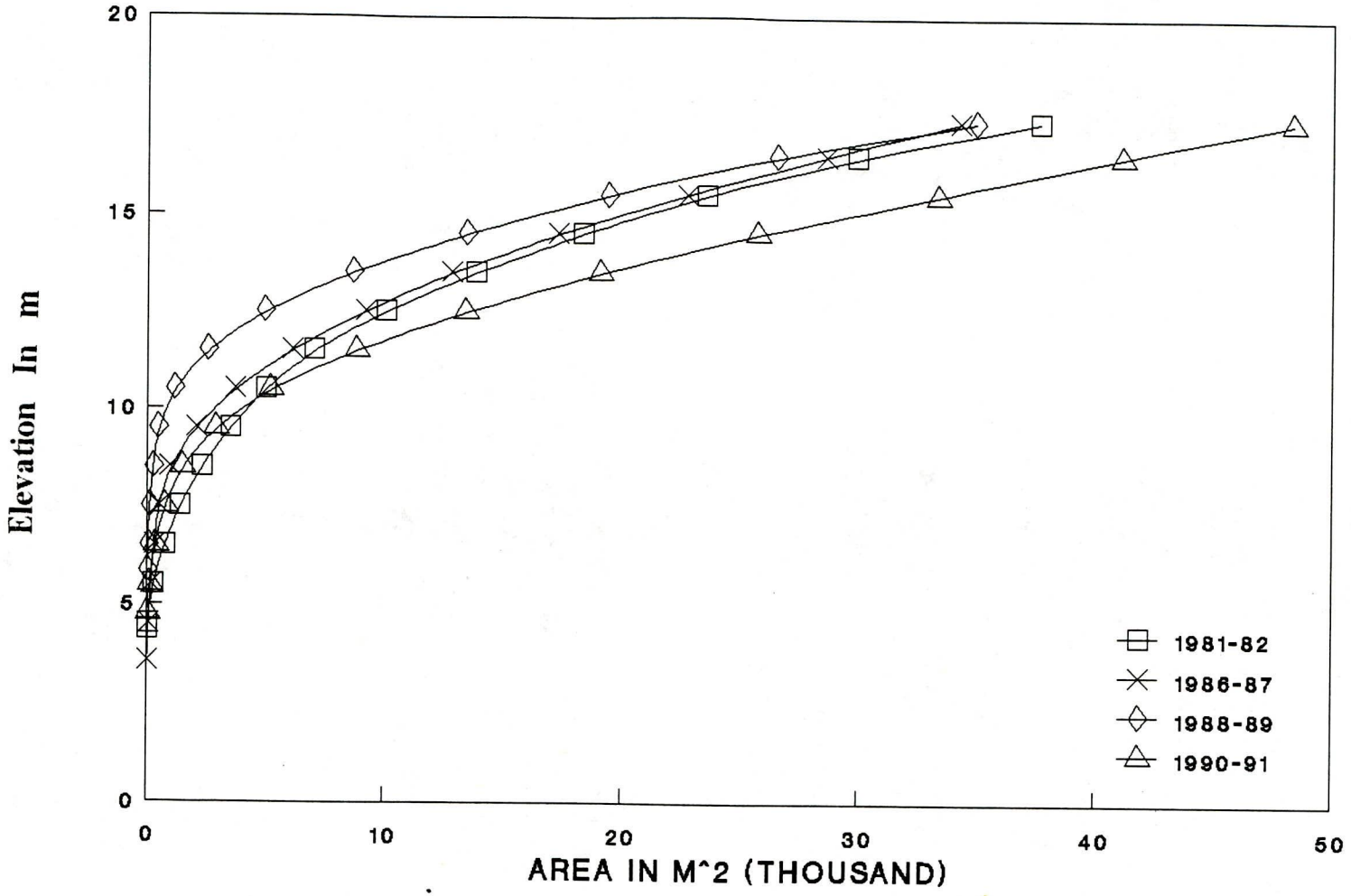


Figure 5.6.b Elevation Vs Area , Section J-12 (Ch. 100.50 Km.)

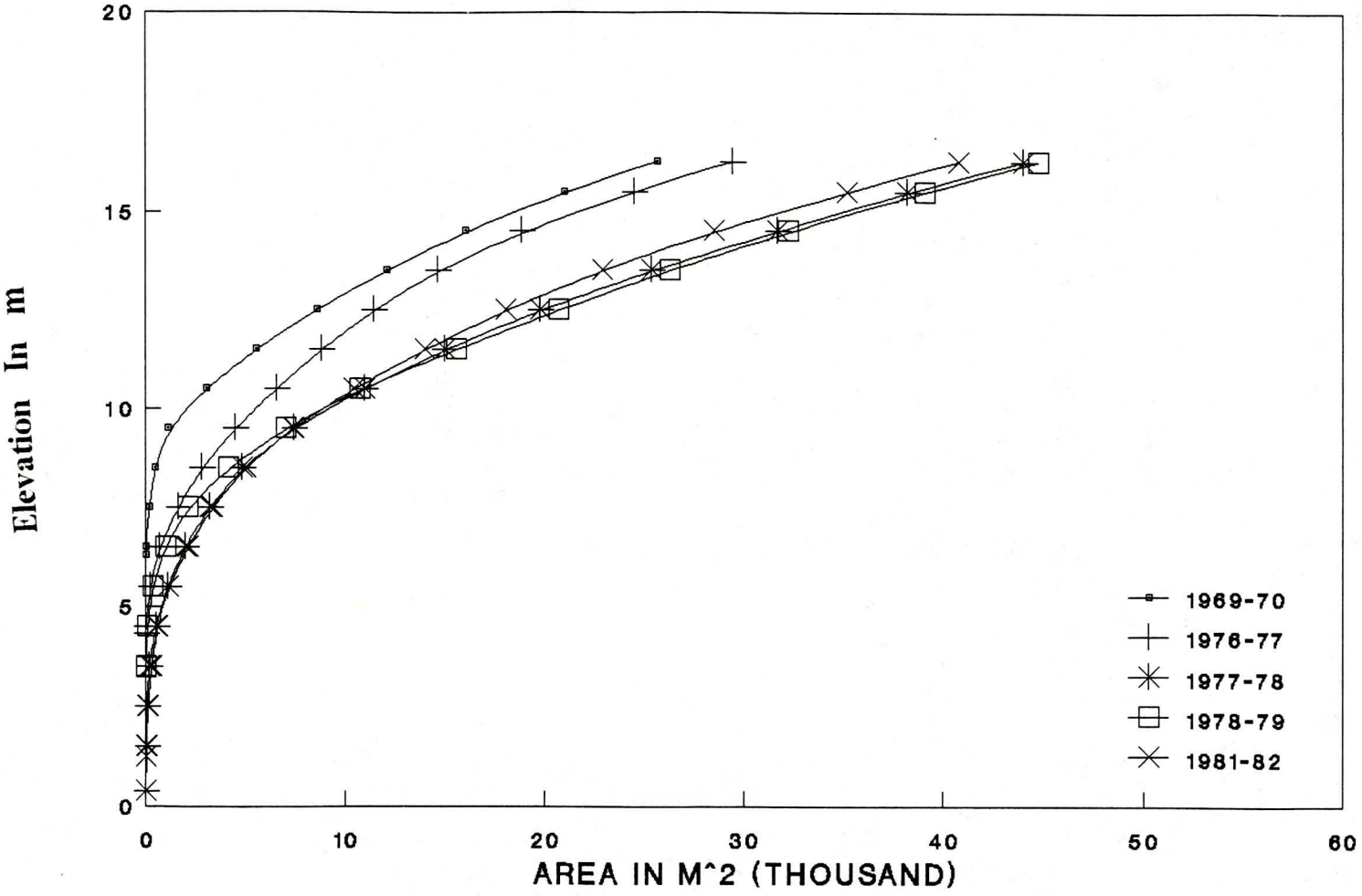


Figure 5.7.a Elevation Vs Area , Section J-11 (Ch. 117.75 Km.)

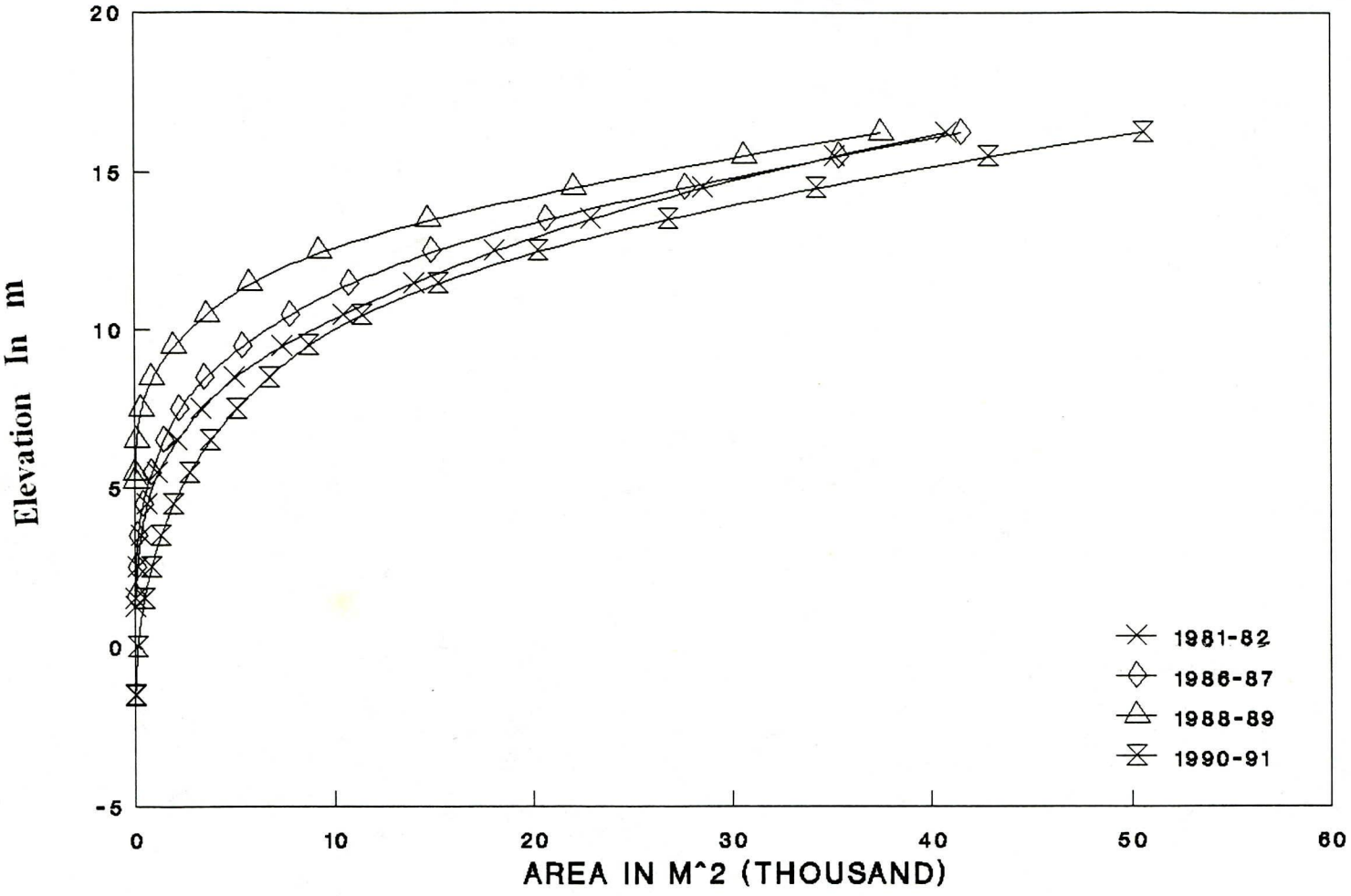


Figure 5.7.b Elevation Vs Area , Section J-11 (Ch. 117.75 Km.)

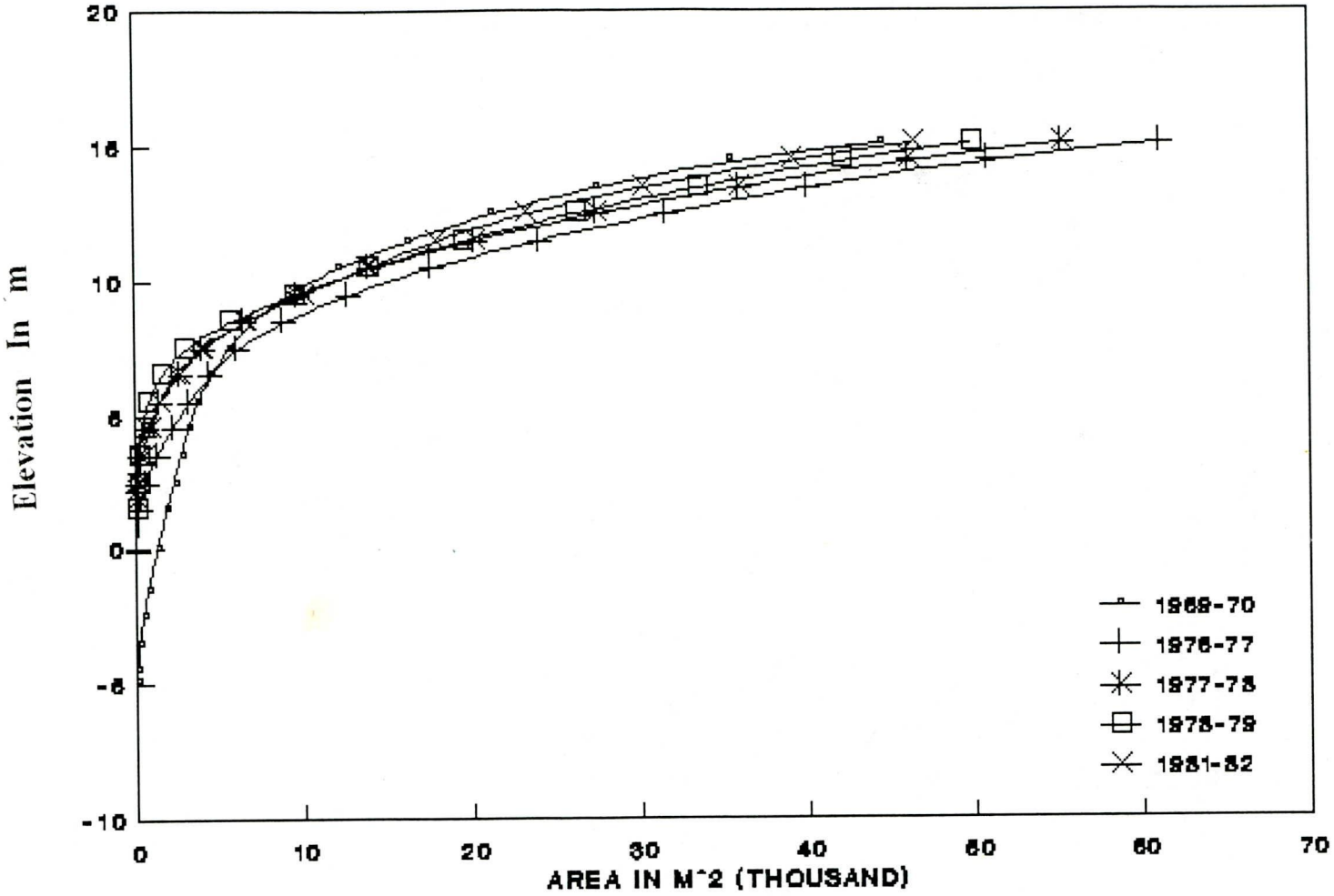


Figure 5.8.a Elevation Vs Area , Section J-10 (Ch. 134.30 Km.)

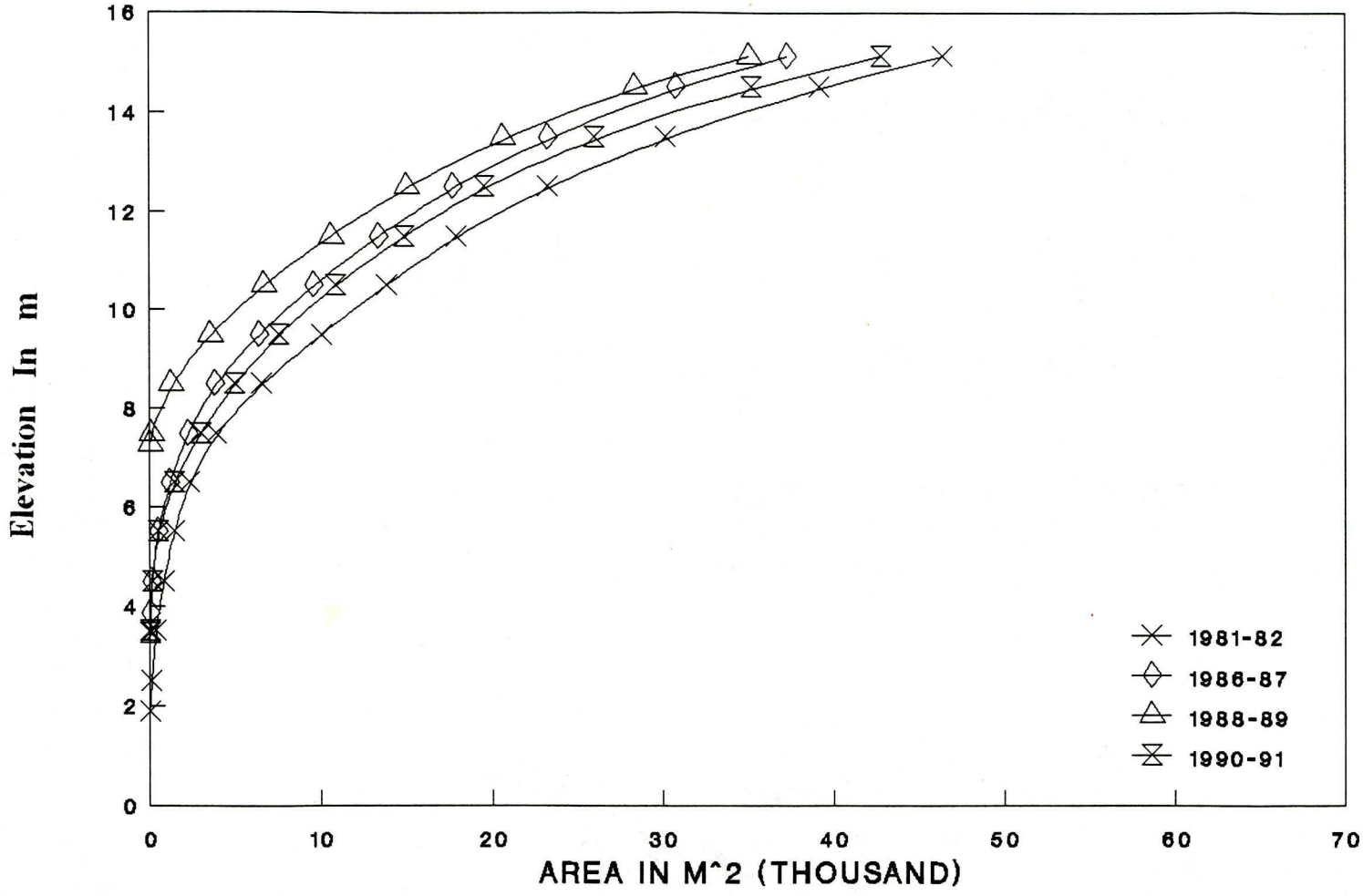


Figure 5.8.b Elevation Vs Area , Section J-10 (Ch. 134.30 Km.)

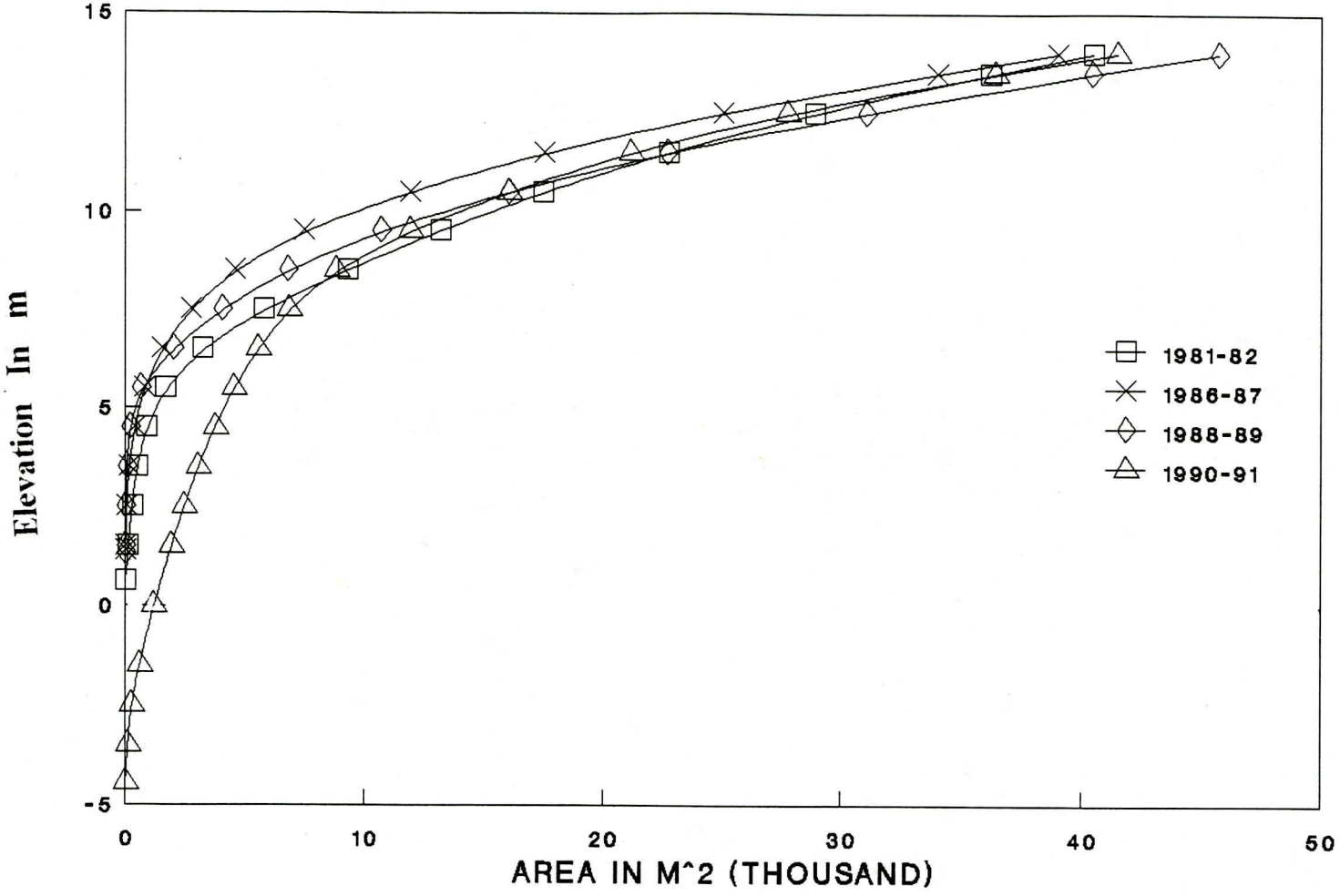


Figure 5.9.a Elevation Vs Area , Section J-9 (Ch. 142.45 Km.)

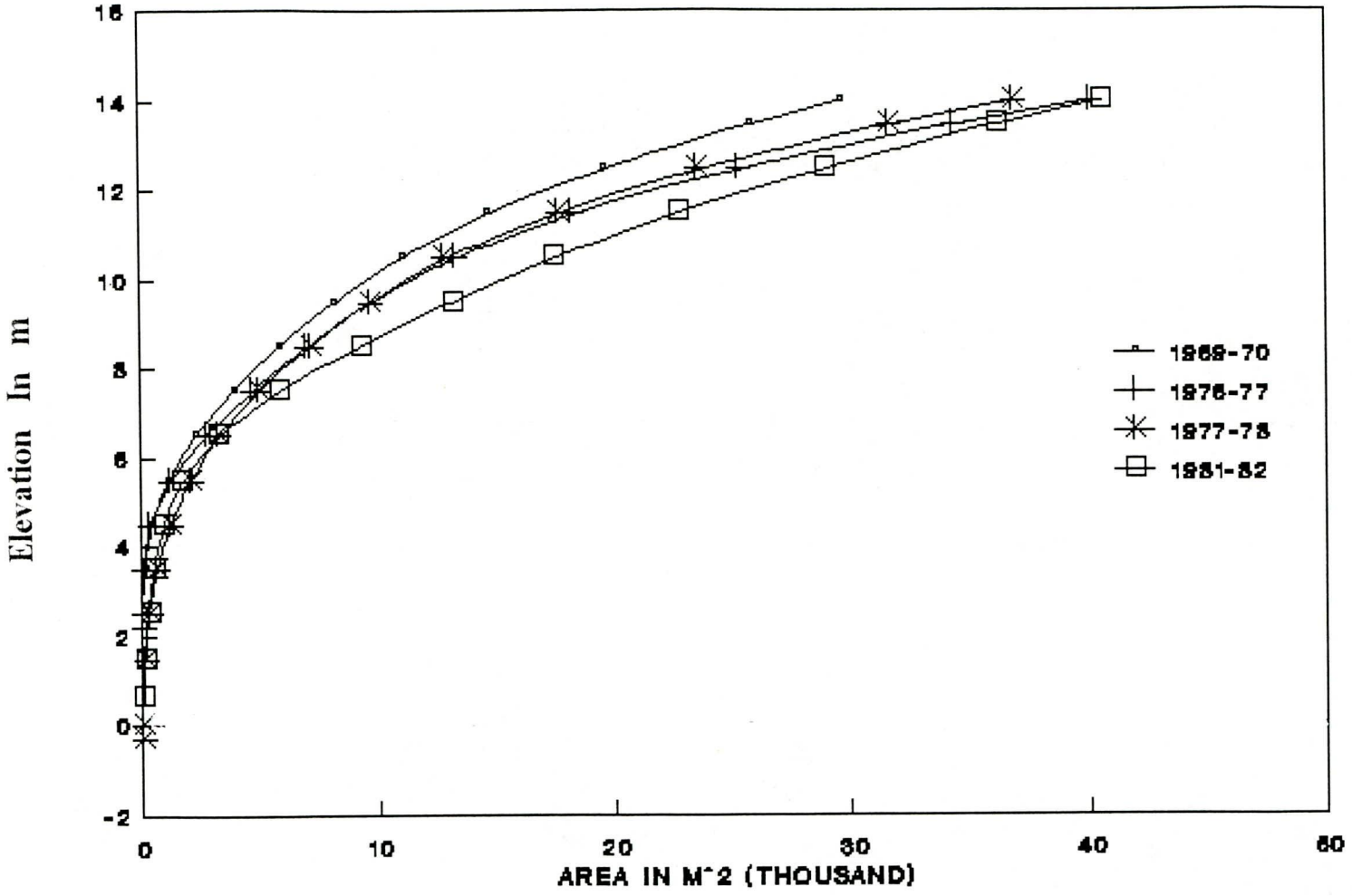


Figure 5.9.b Elevation Vs Area , Section J-9 (Ch. 142.45 Km.)

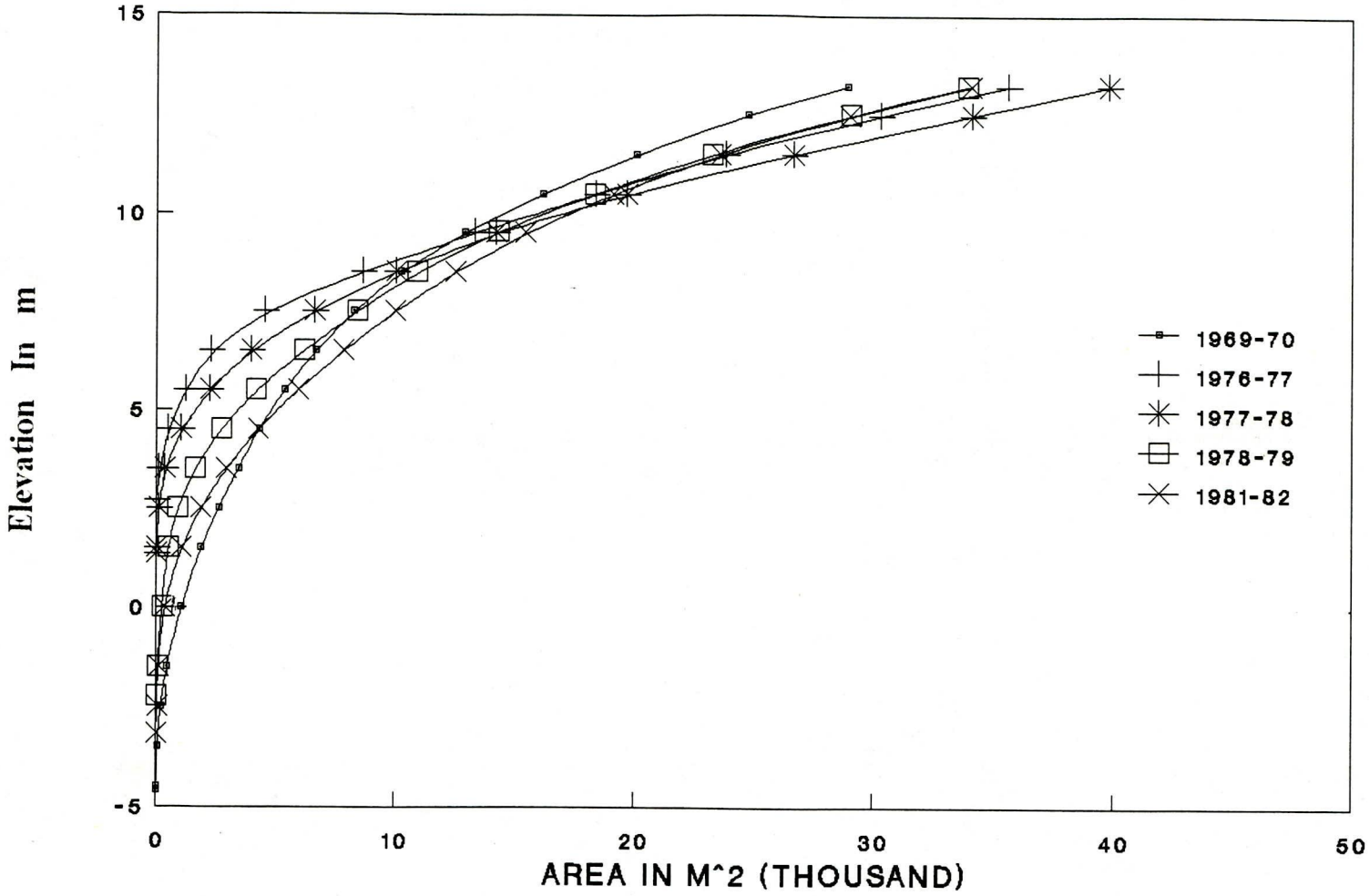


Figure 5.10.a Elevation Vs Area , Section J-8 (Ch. 149.50 Km.)

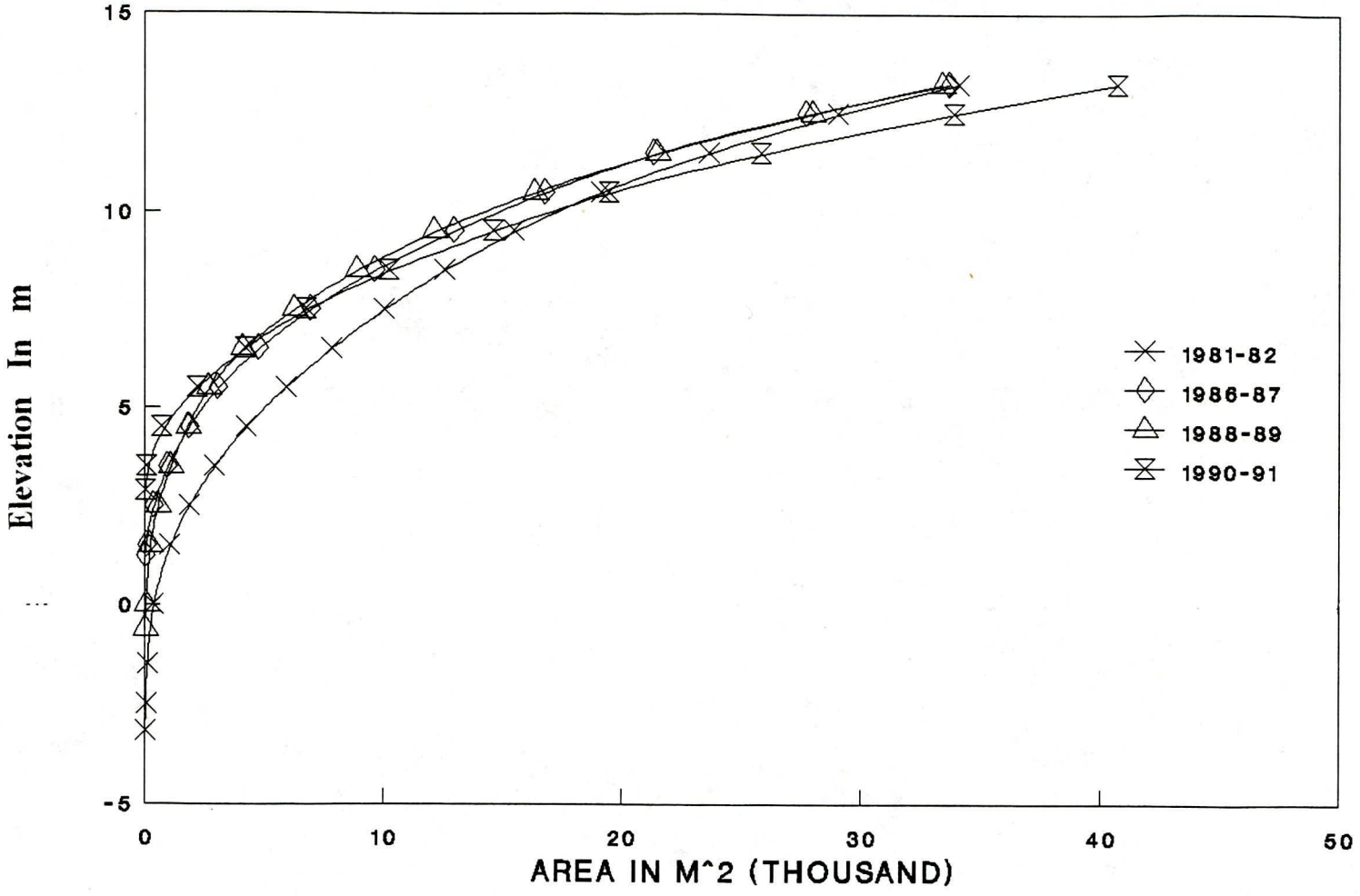


Figure 5.10.b Elevation Vs Area , Section J-8 (Ch. 149.50 Km.)

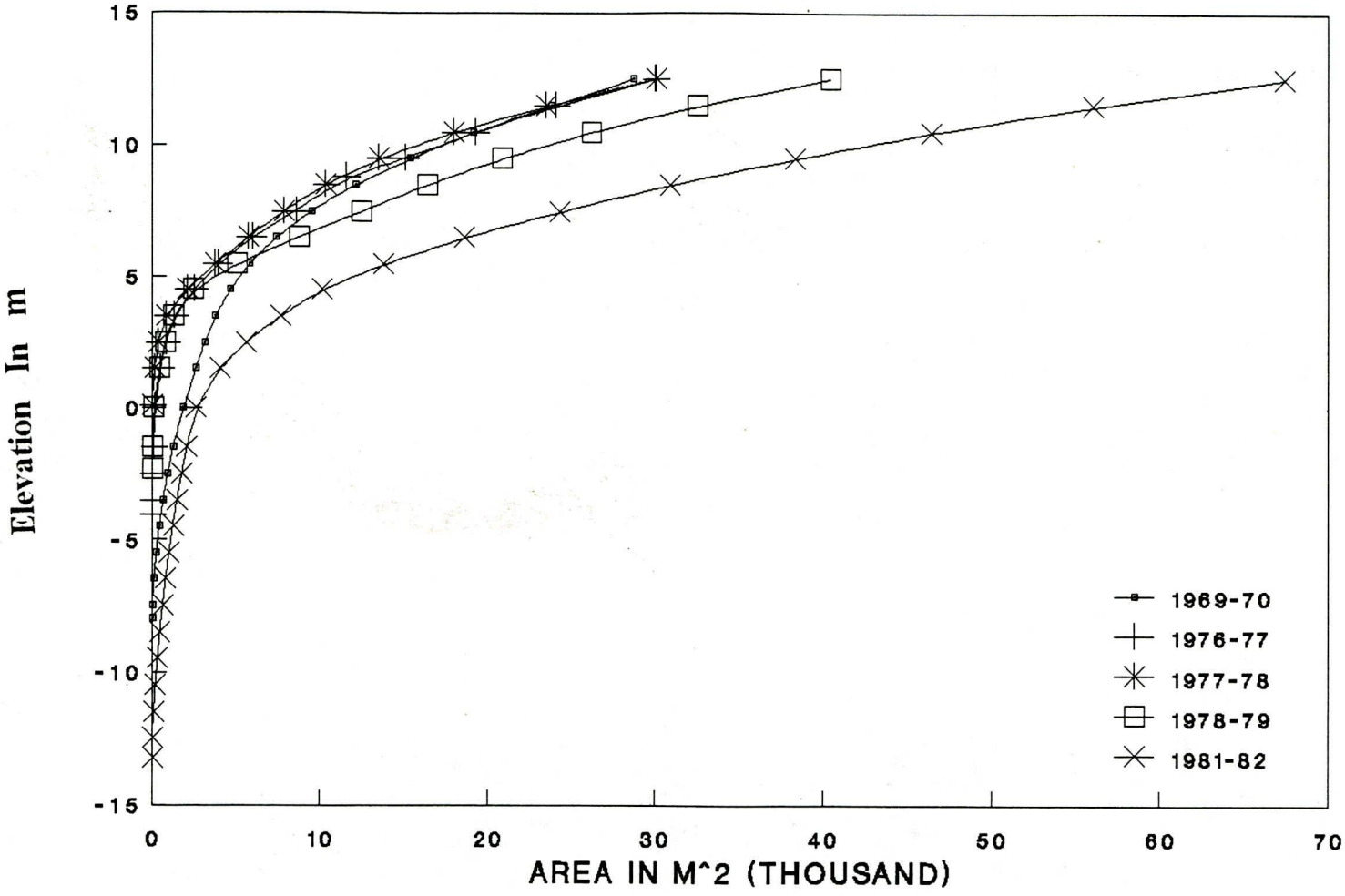


Figure 5.11.a Elevation Vs Area, Section J-7 (Ch. 162.35 Km.)

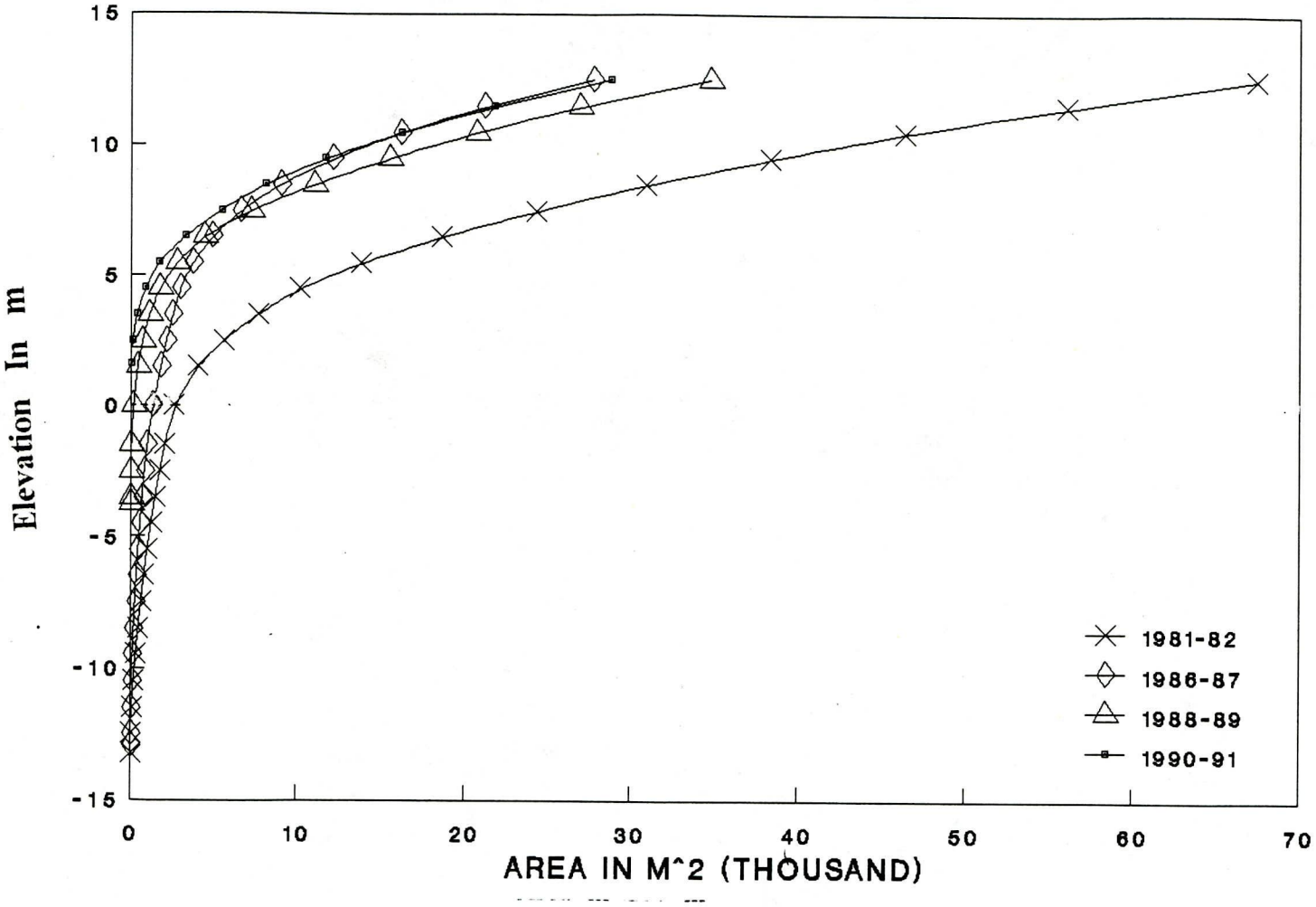


Figure 5.11.b Elevation Vs Area , Section J-7 (Ch. 162.35 Km.)

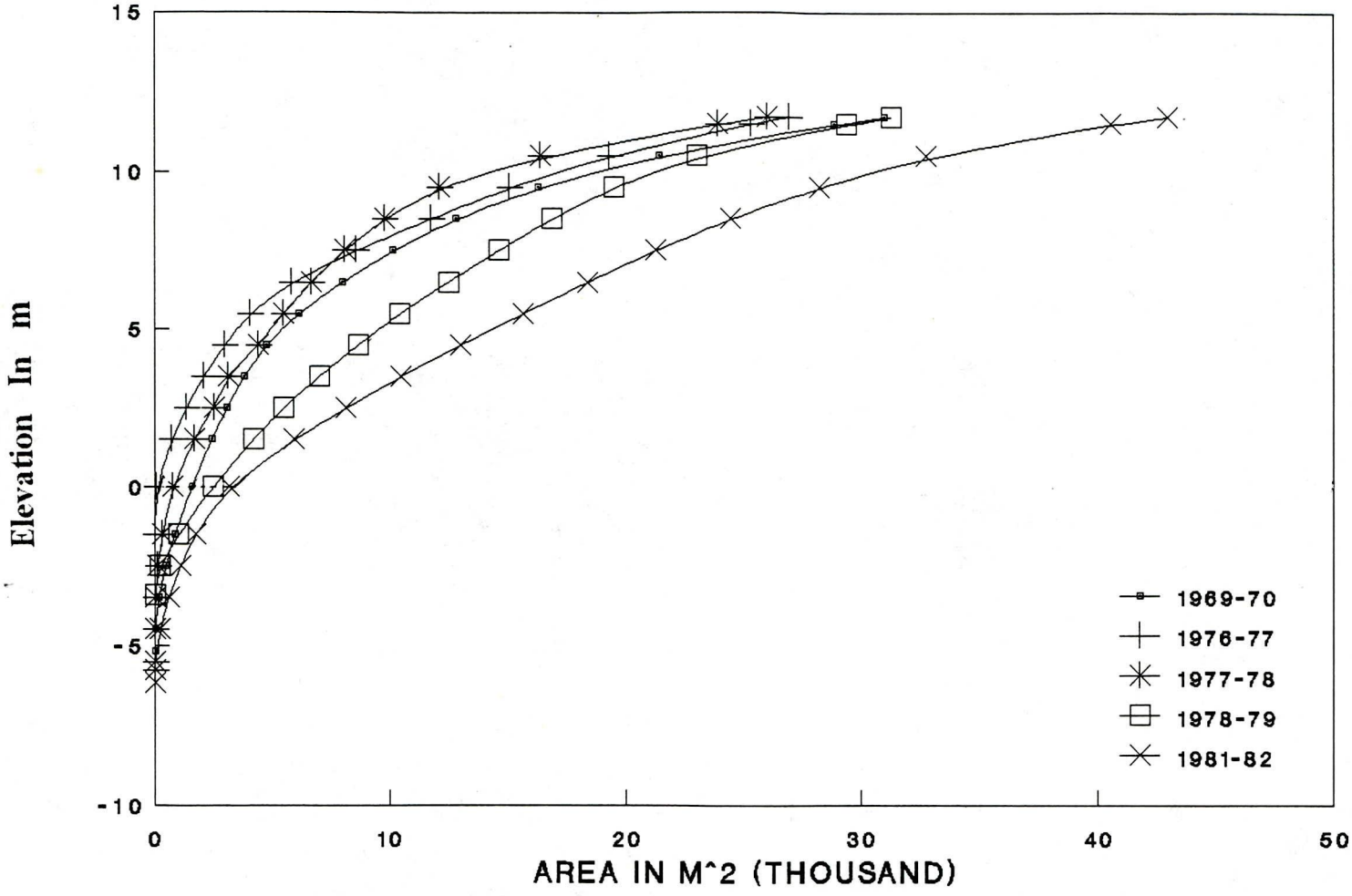


Figure 5.12.a Elevation Vs Area , Section J-6 (Ch. 177.70 Km.)

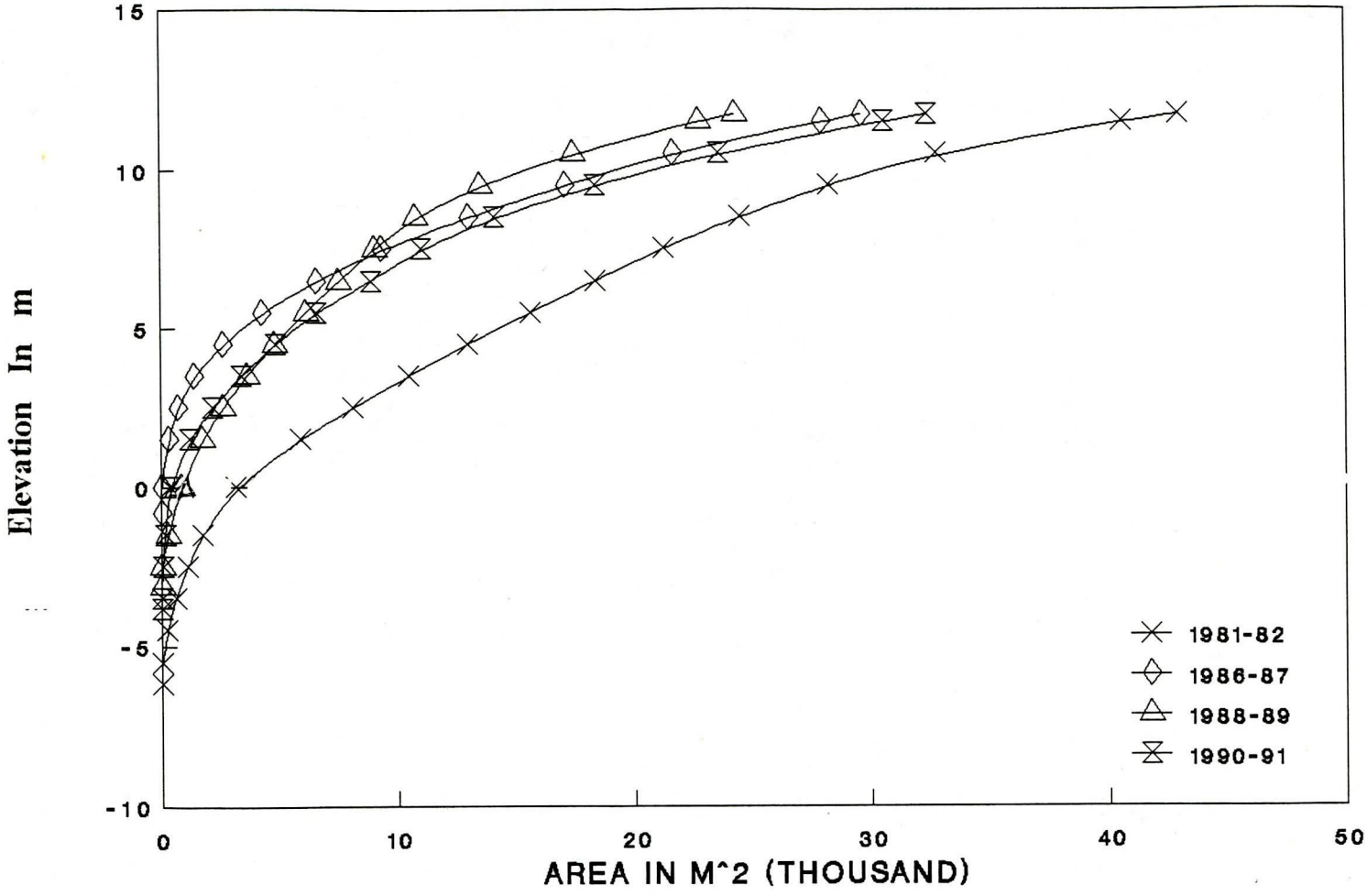


Figure 5.12.b Elevation Vs Area , Section J-6 (Ch. 177.70 Km.)

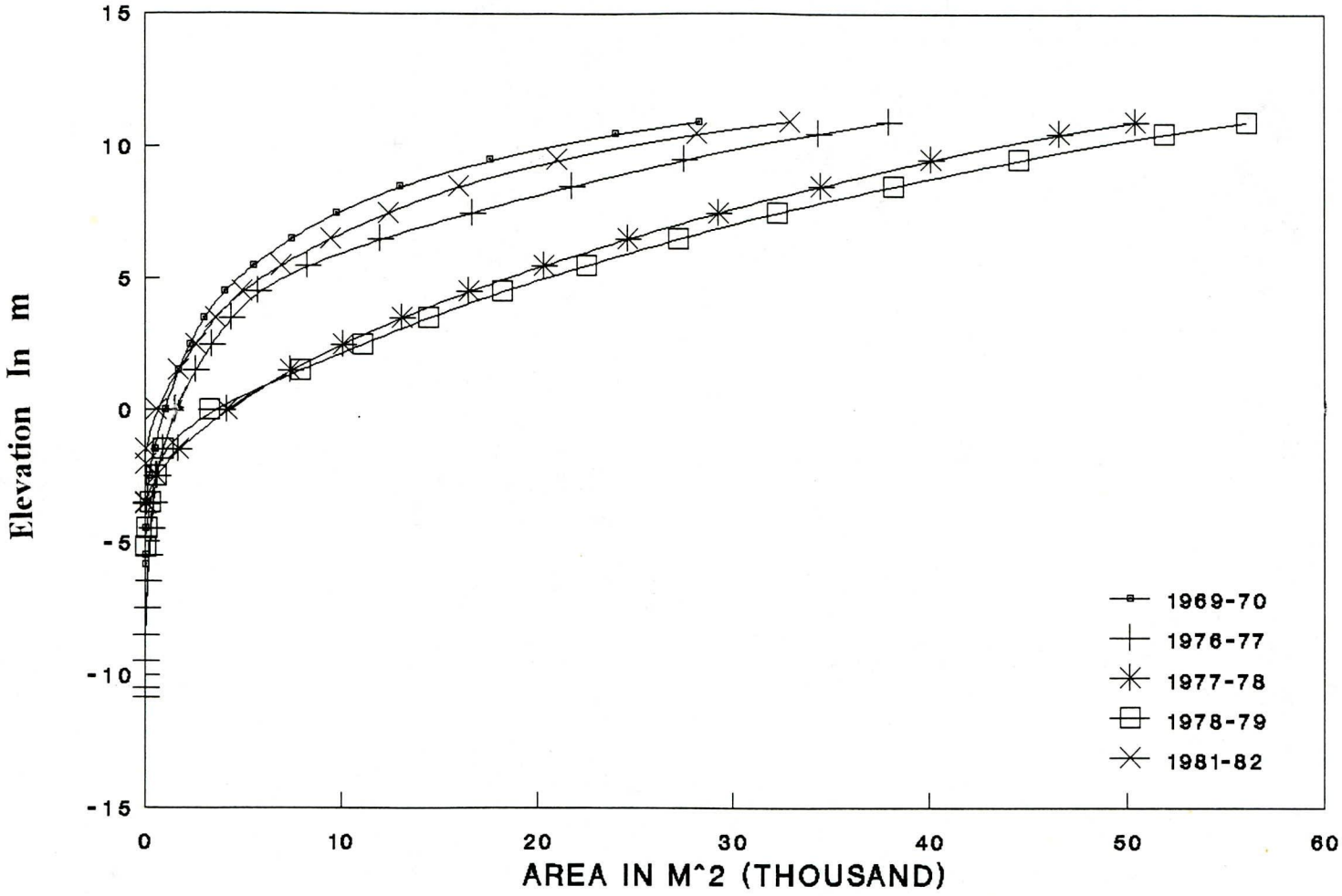


Figure 5.13. a Elevation Vs Area , Section J-5 (Ch. 188.20 Km.)

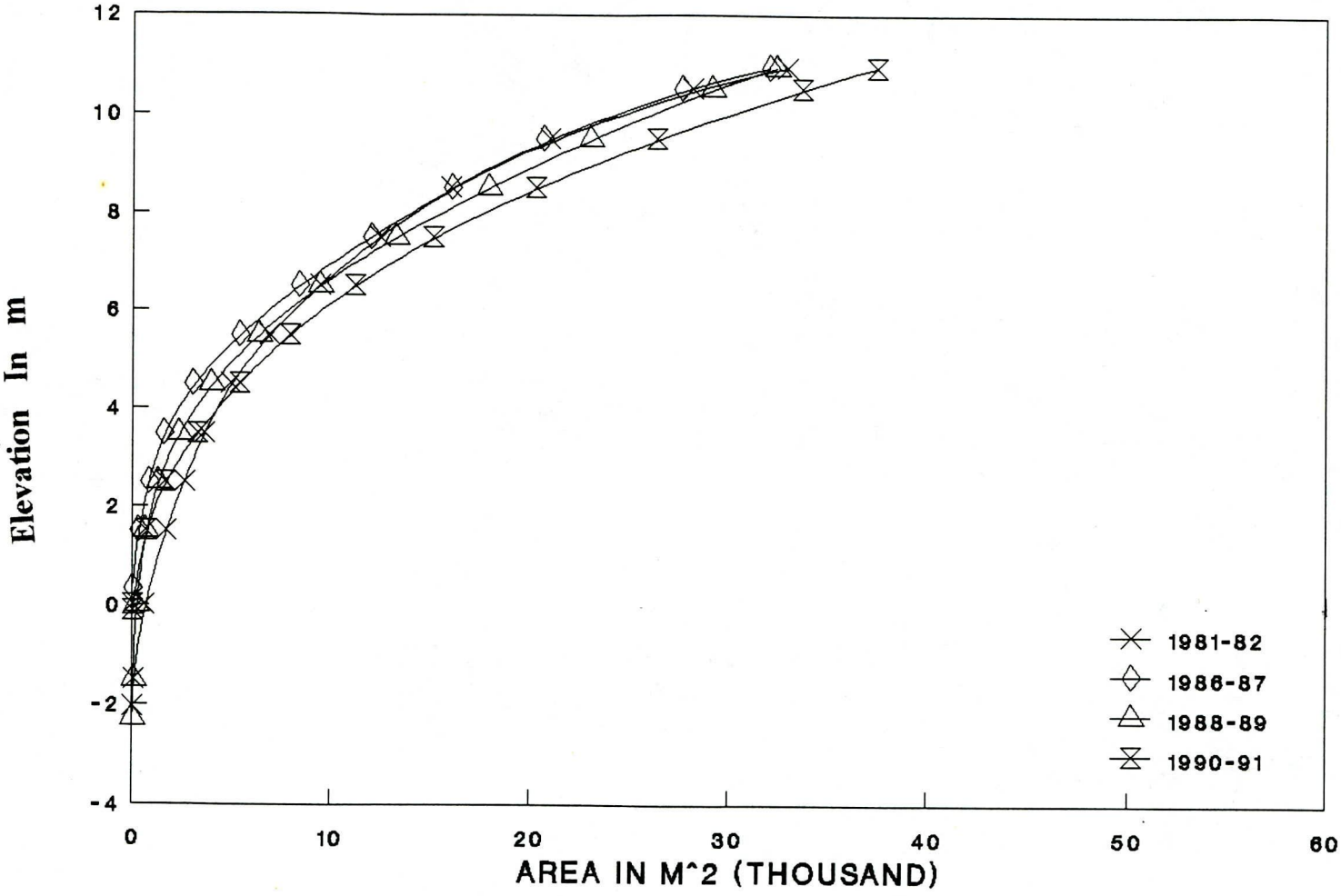


Figure 5.13.b Elevation Vs Area, Section J-5 (Ch. 188.20 Km.)

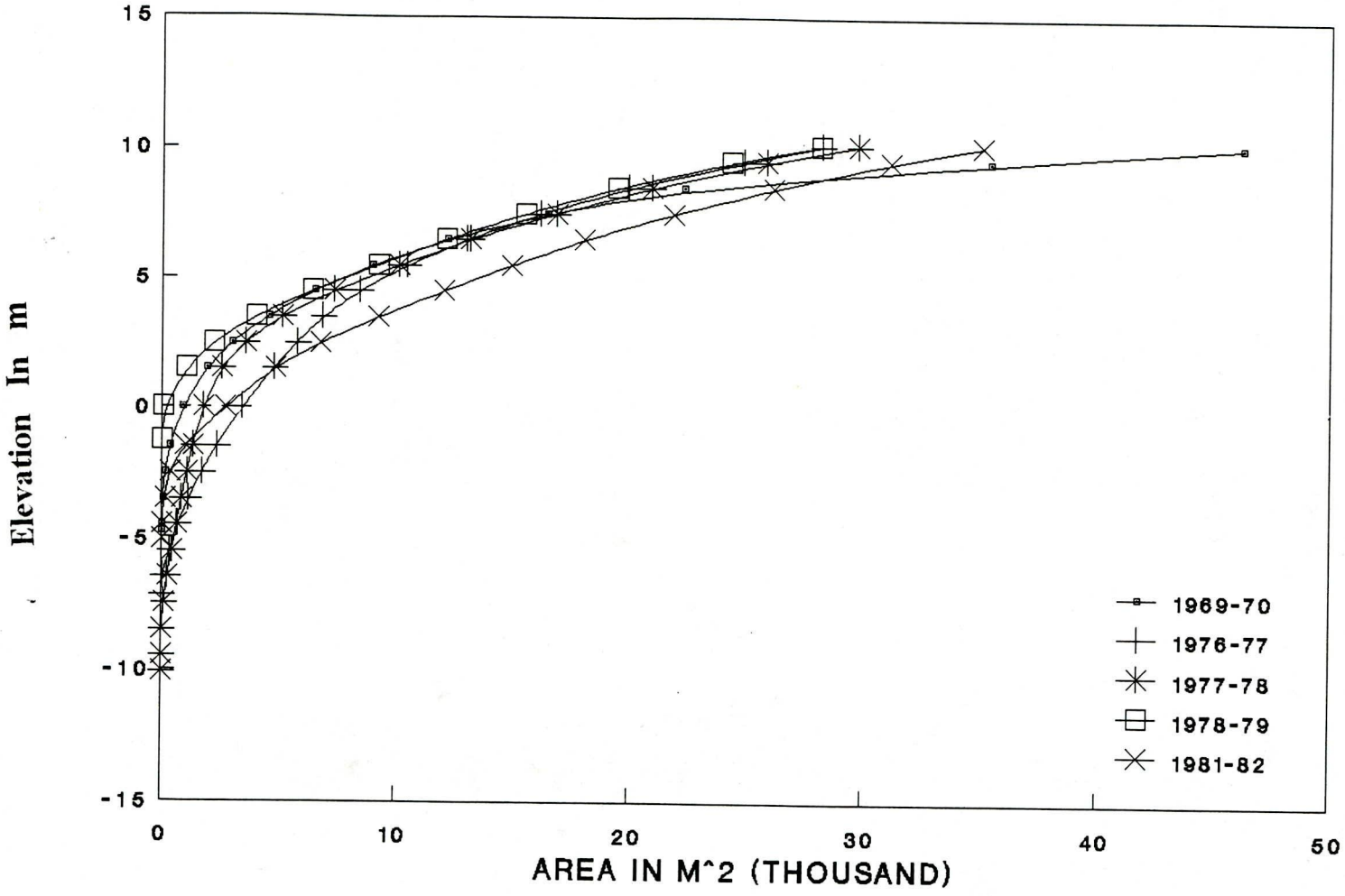


Figure 5.14. a Elevation Vs Area , Section J-4 (Ch. 201.30 Km.)

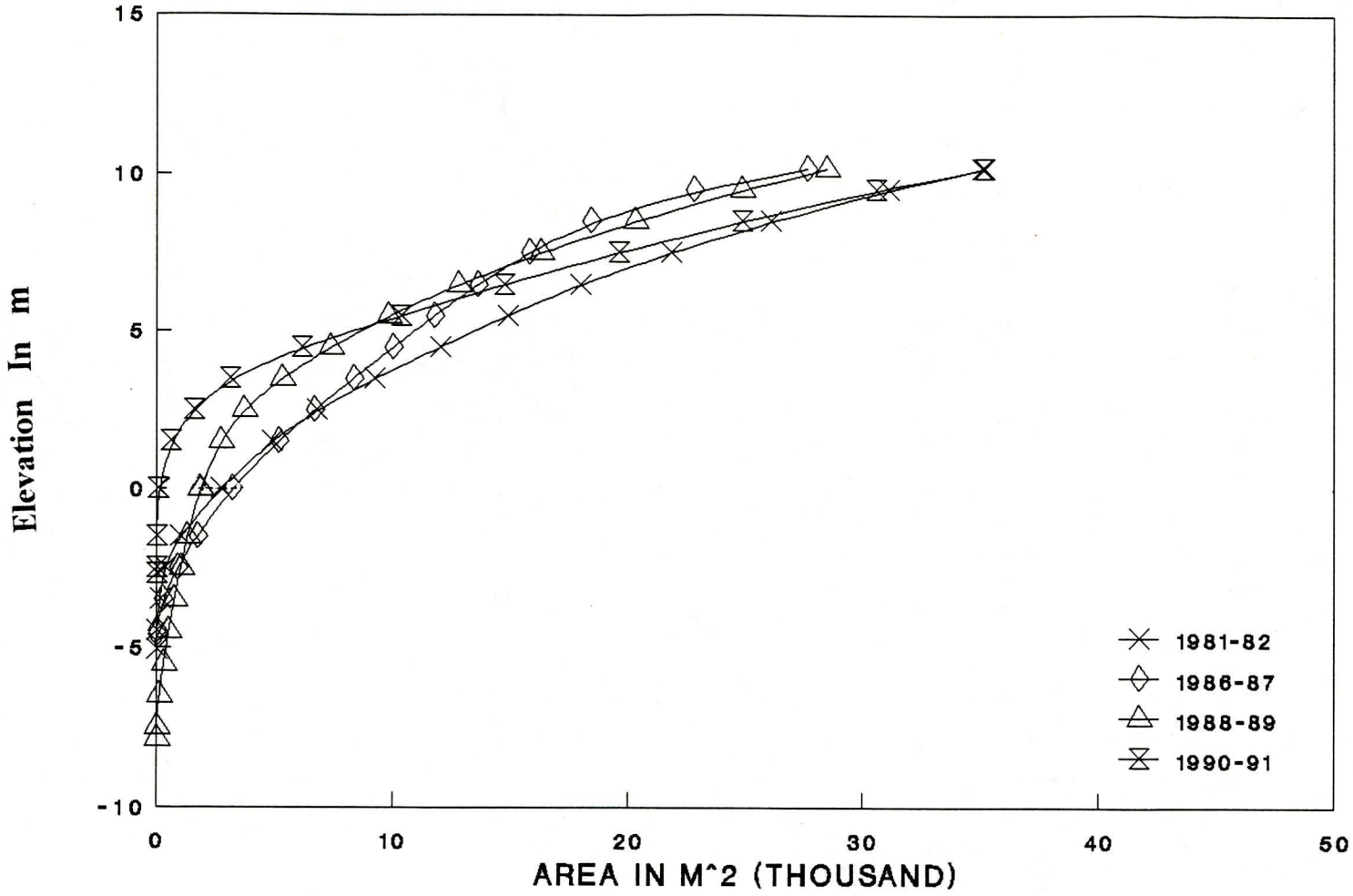


Figure 5.14.b Elevation Vs Area , Section J-4 (Ch. 201.30 Km.)

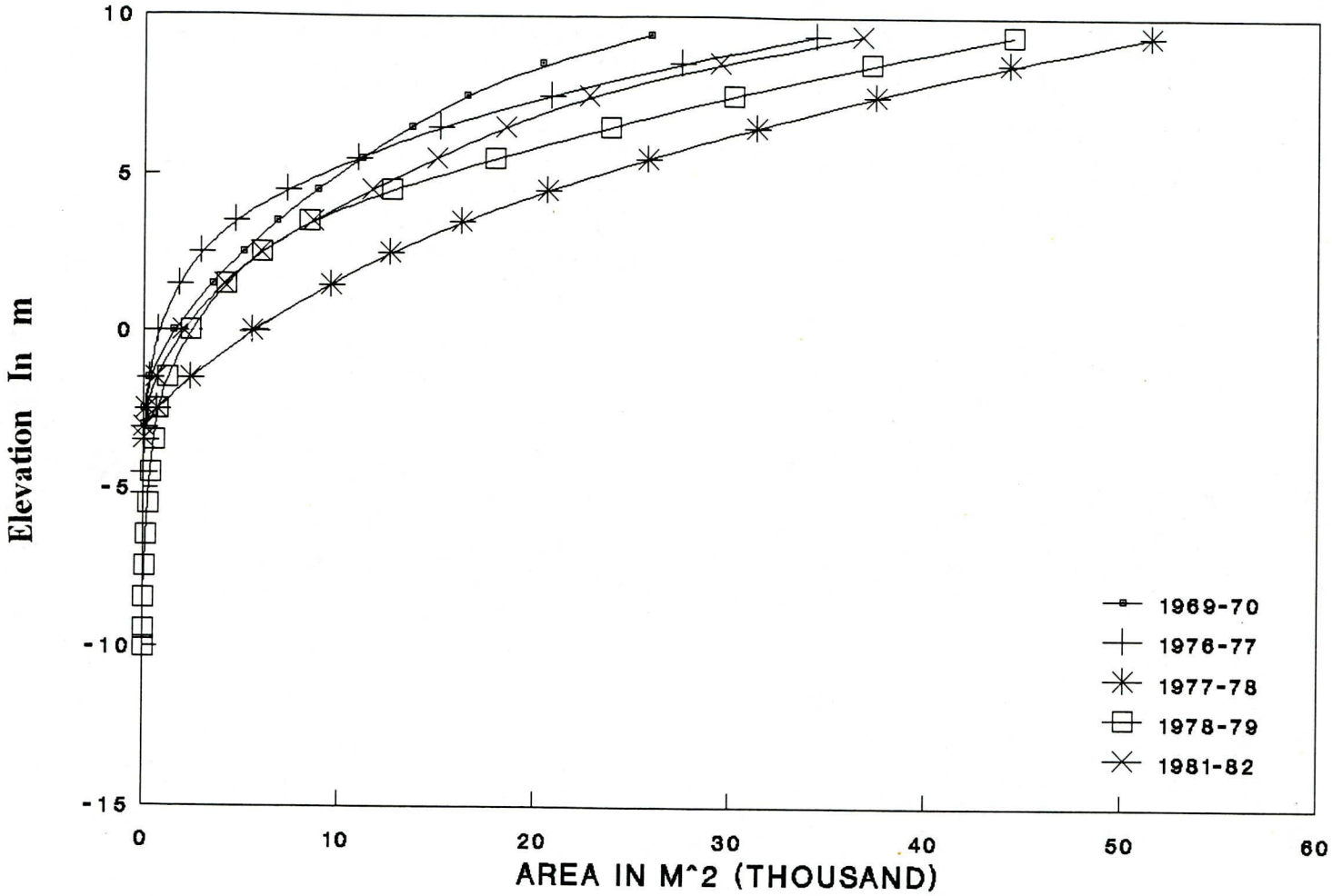


Figure 5.15. à Elevation Vs Area , Section J-3 (Ch. 213.20 Km.)

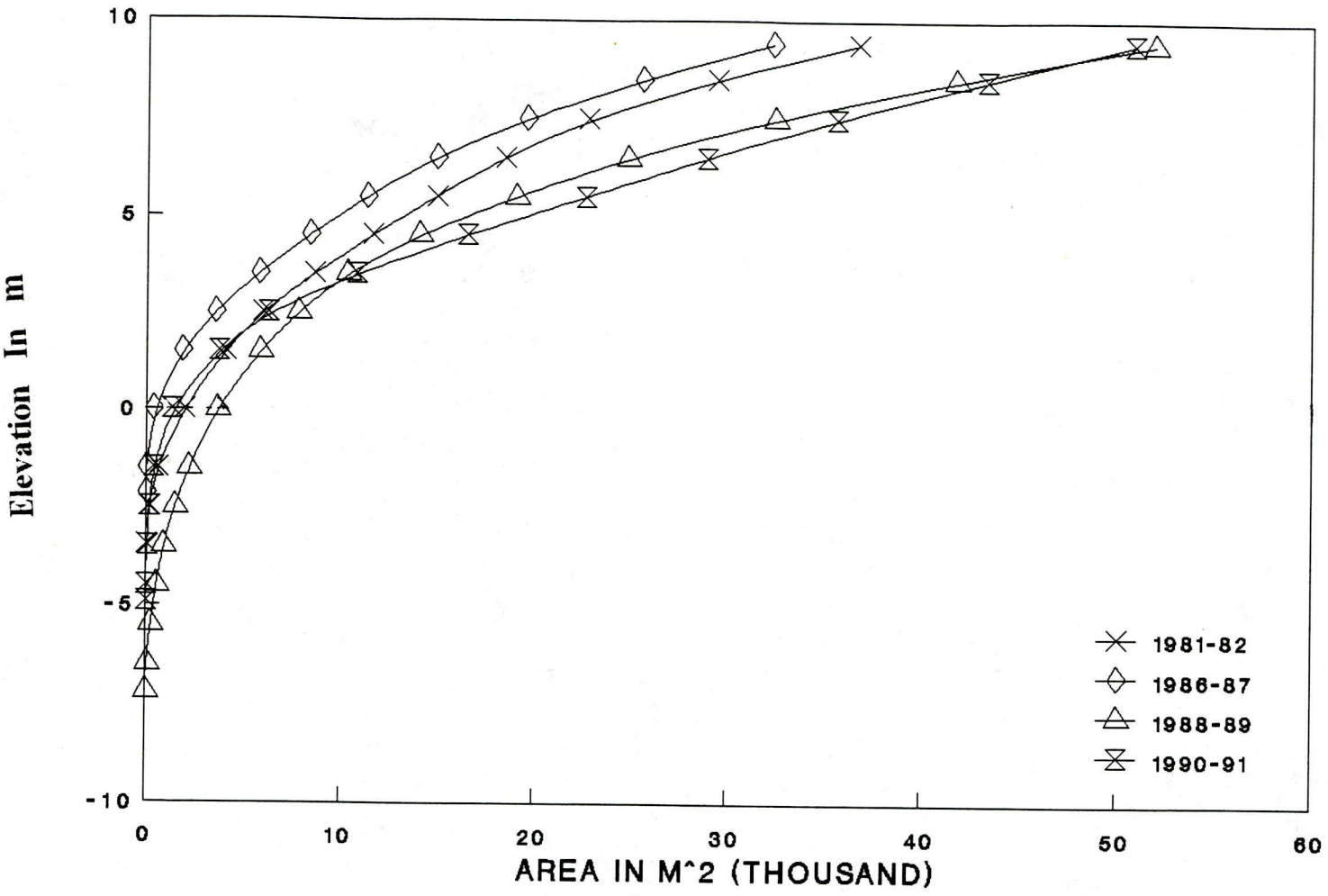


Figure 5.15.b Elevation Vs Area , Section J-3 (Ch. 213.20 Km.)

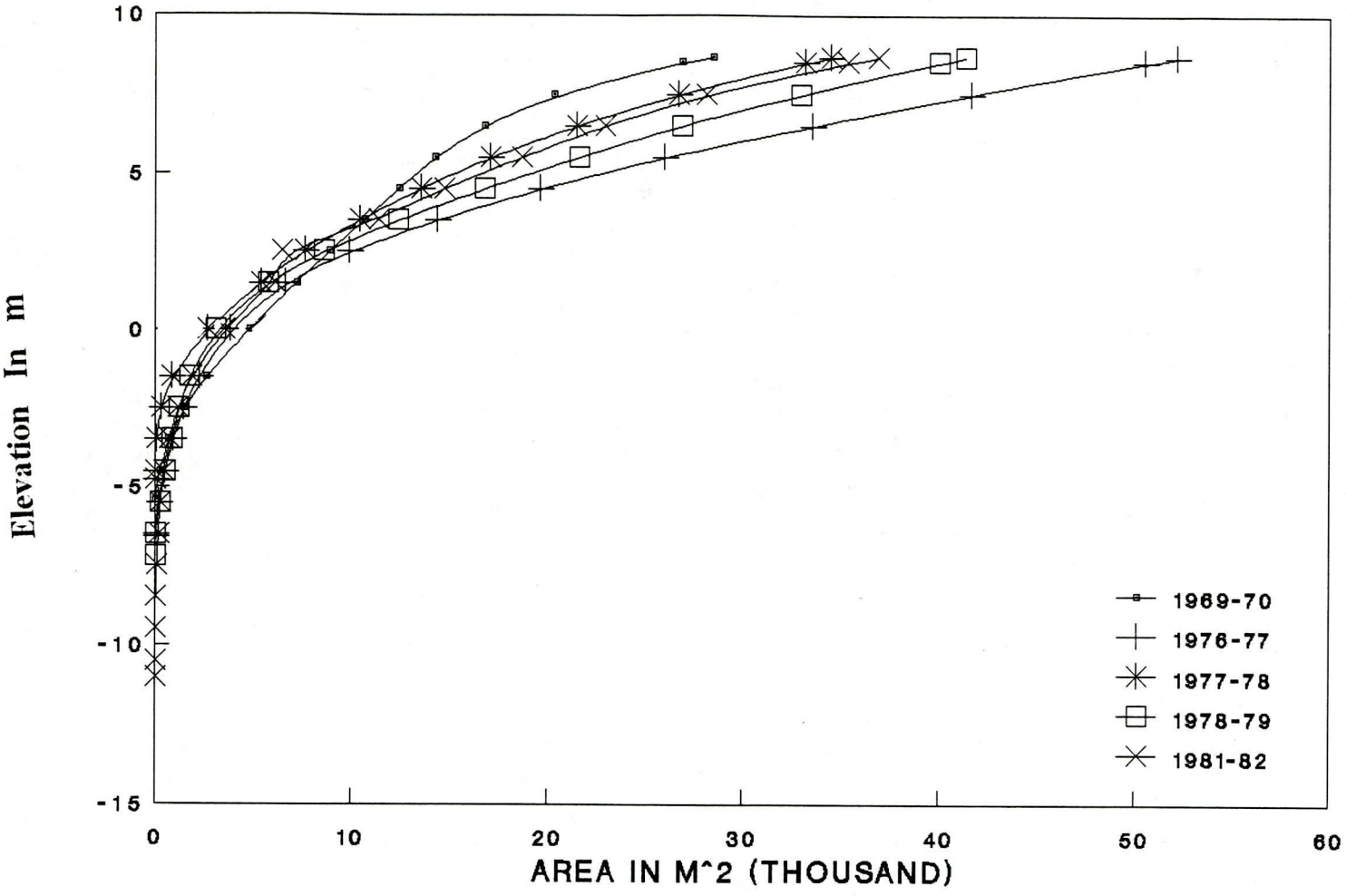


Figure 5.16.a Elevation Vs Area , Section J-2 (Ch. 223.20 Km.)

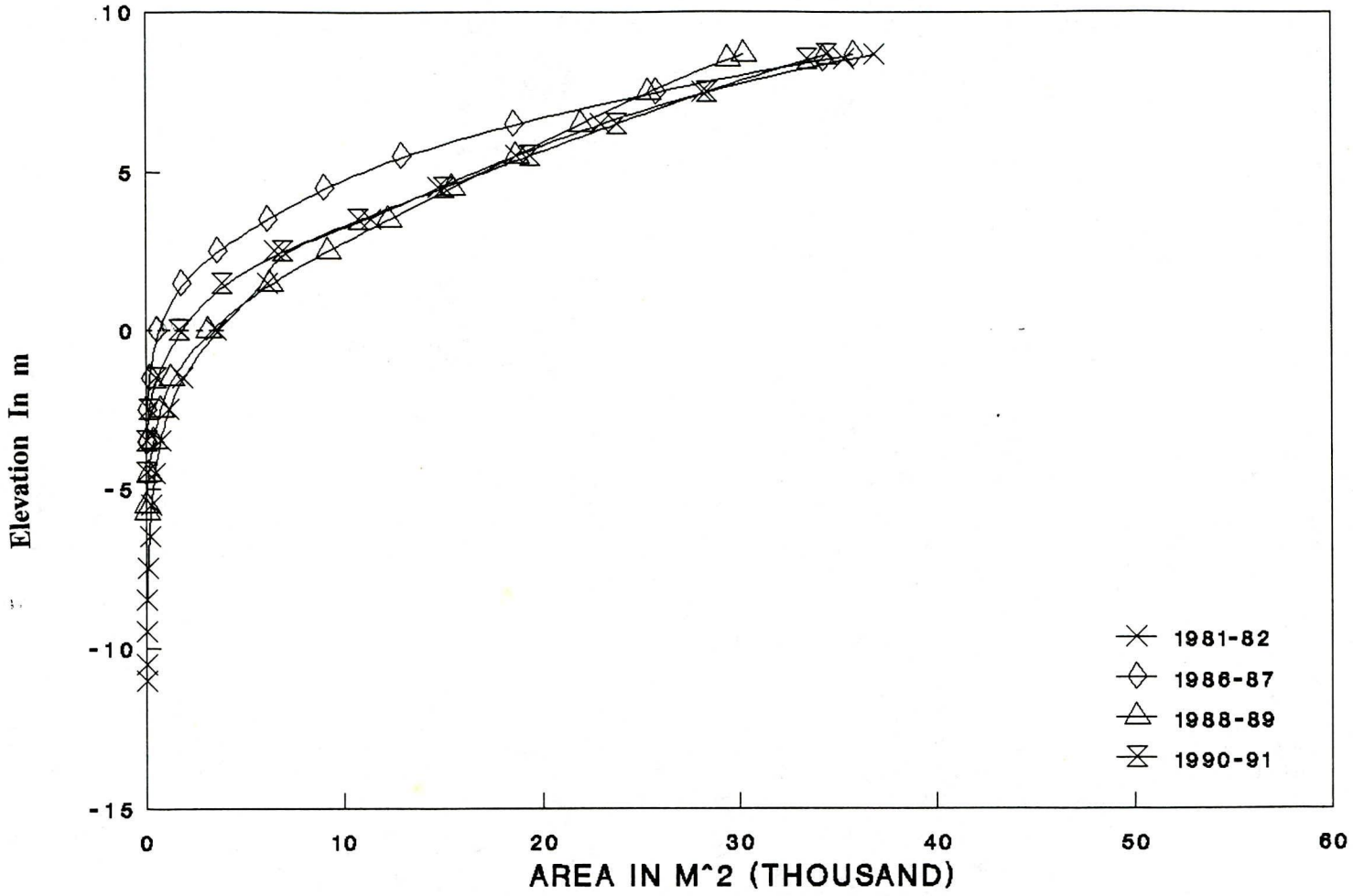


Figure 5.16.b Elevation Vs Area , Section J-2 (Ch. 223.20 Km.)

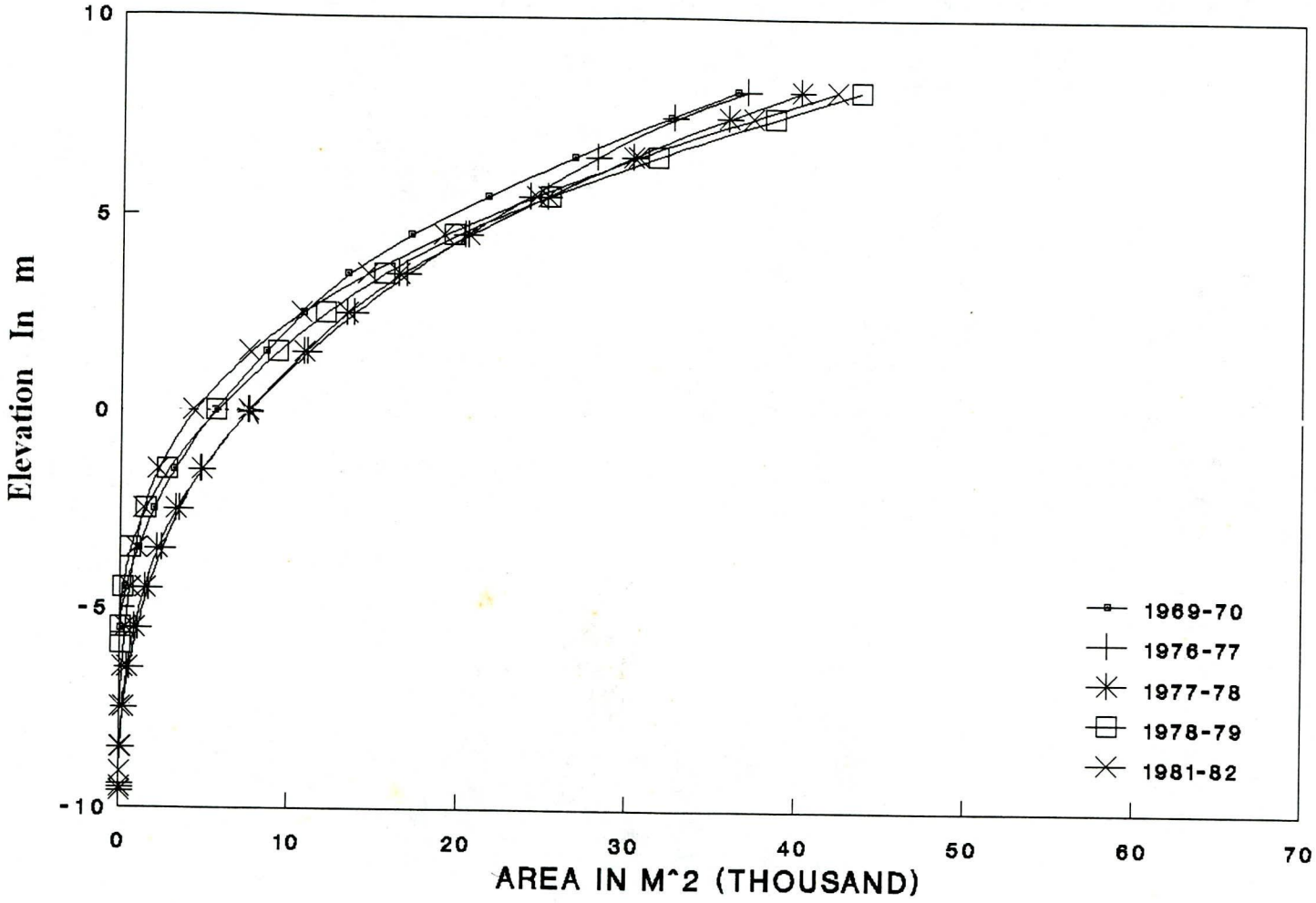


Figure 5.17.a Elevation Vs Area , Section J-1 (Ch. 230.75 Km.)

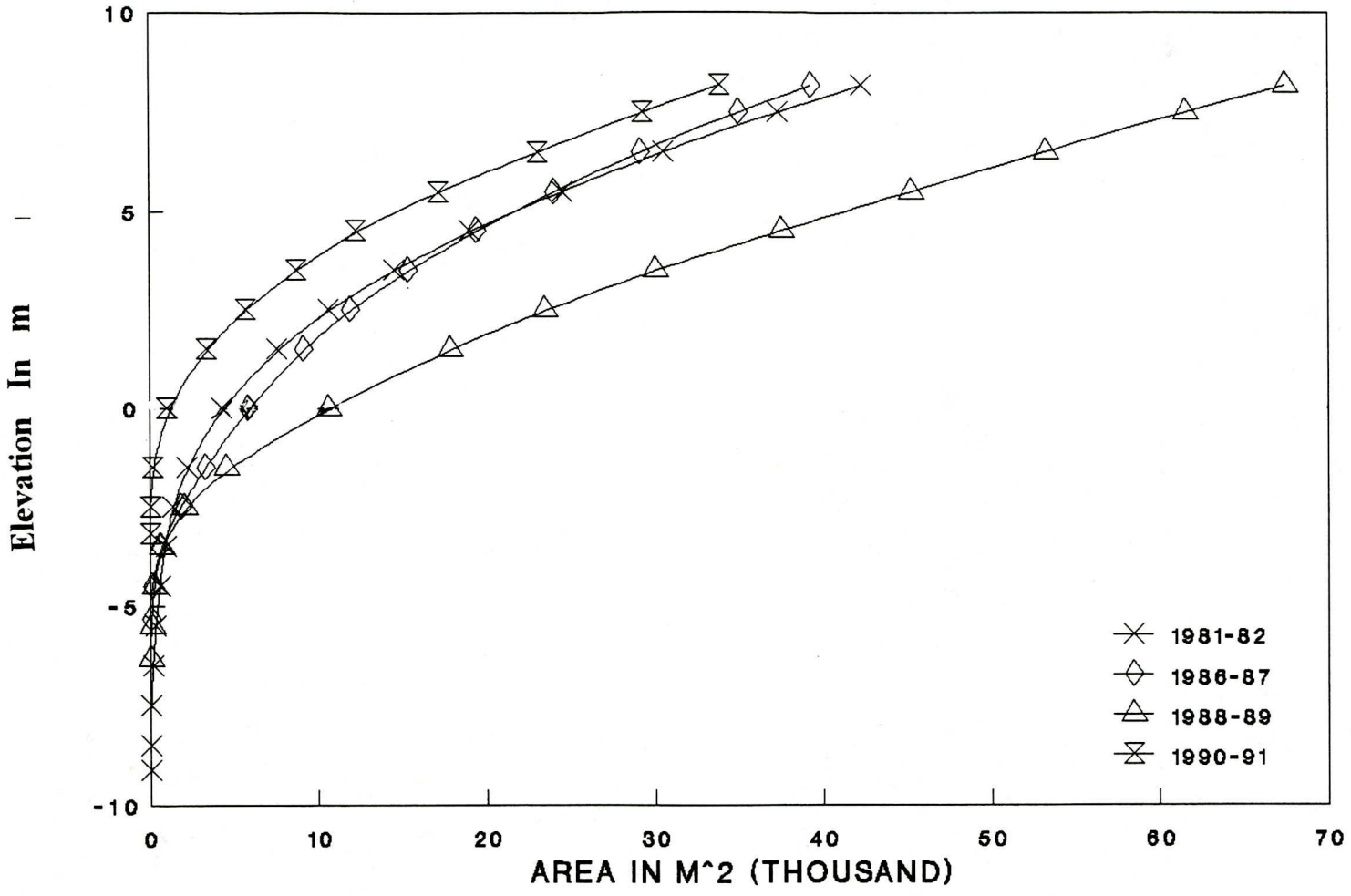


Figure 5.17.b Elelvation Vs Area , Section J-1 (Ch. 230.75 Km.)

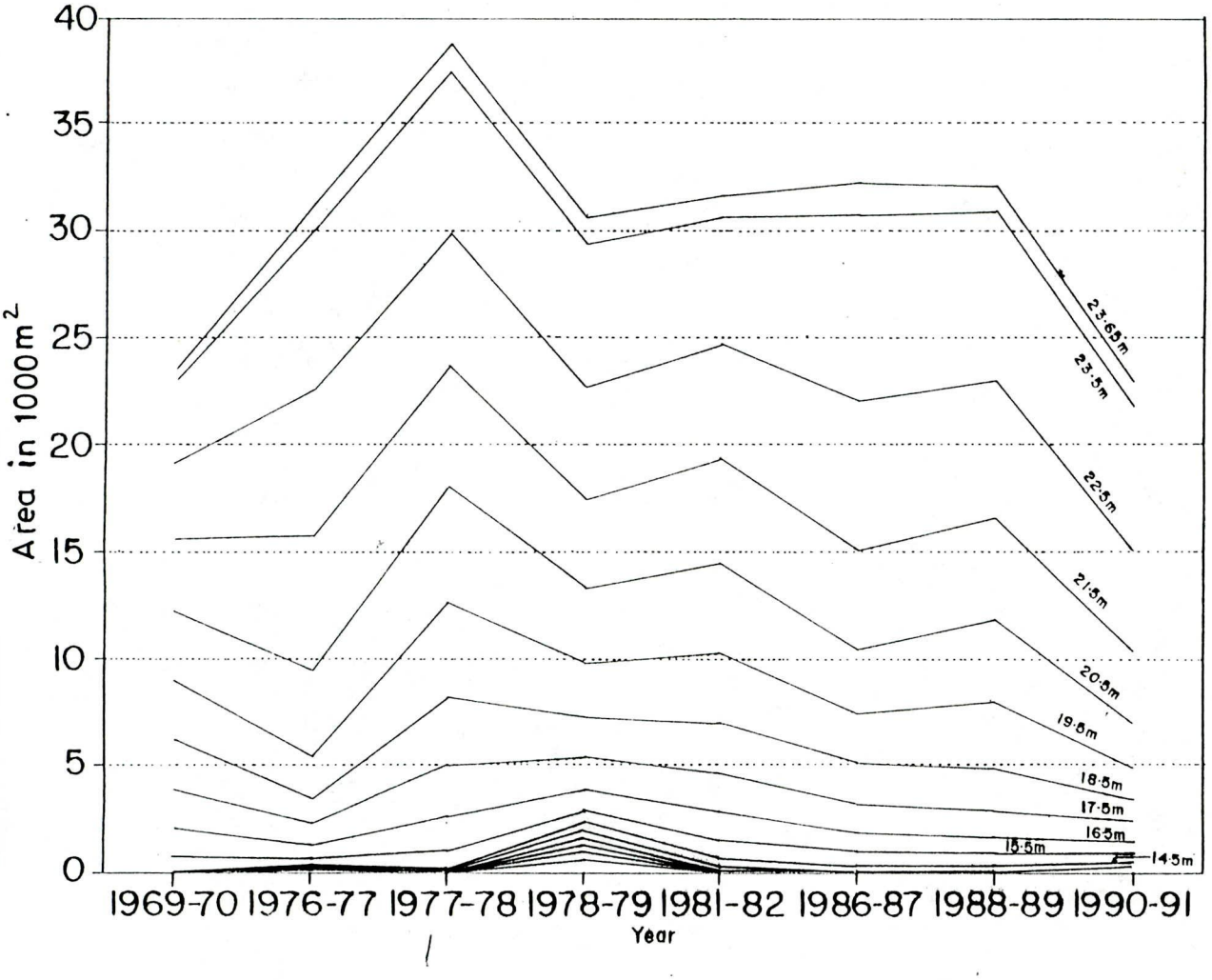


Figure 5.18.a Area upto different elevations Vs. Year (Ch. : 25.00 Km) Sec. J-17

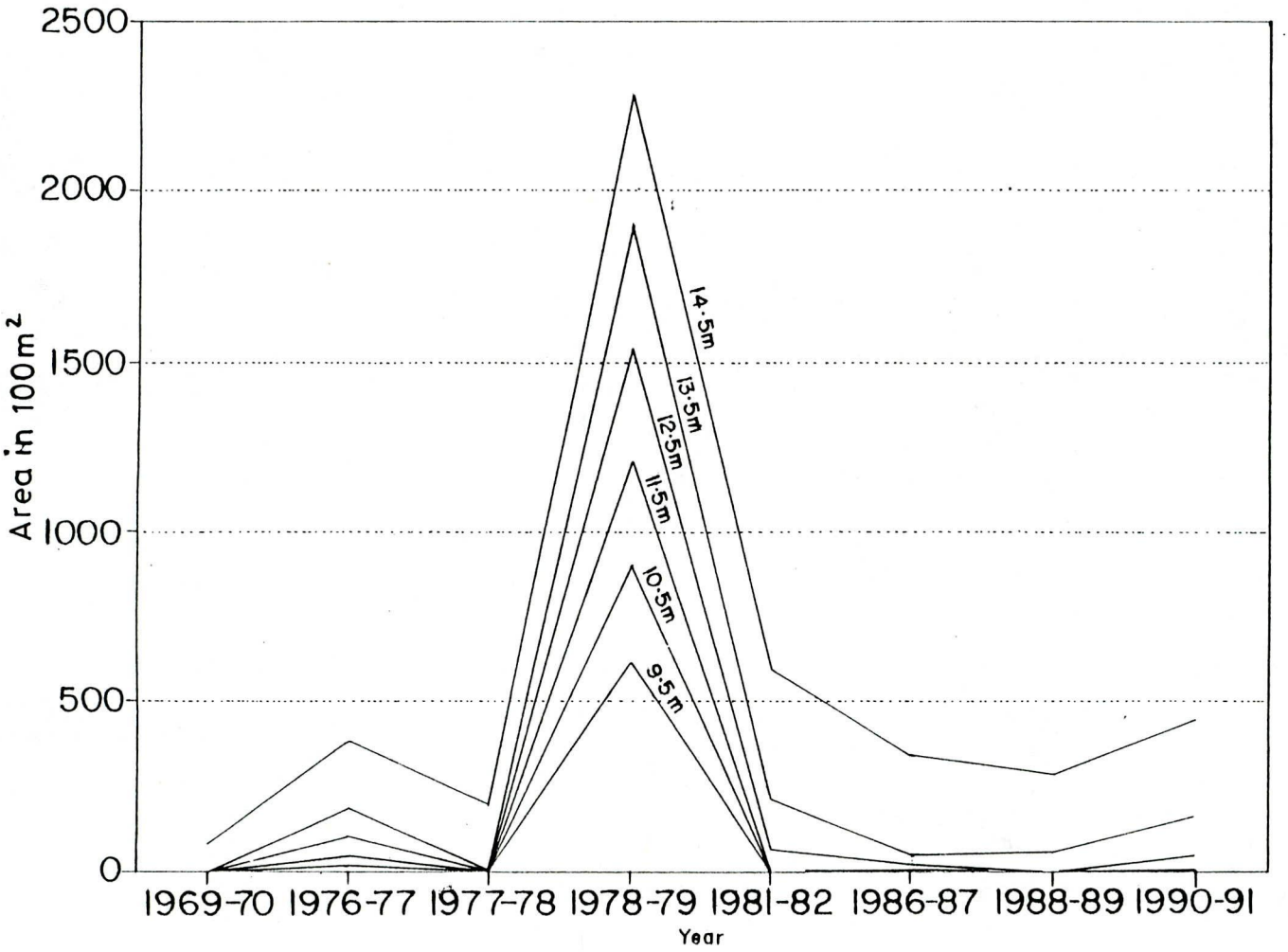


Figure 5.18.b Area upto different elevations Vs. Year (Ch. : 25.00 Km) Sec. J-17

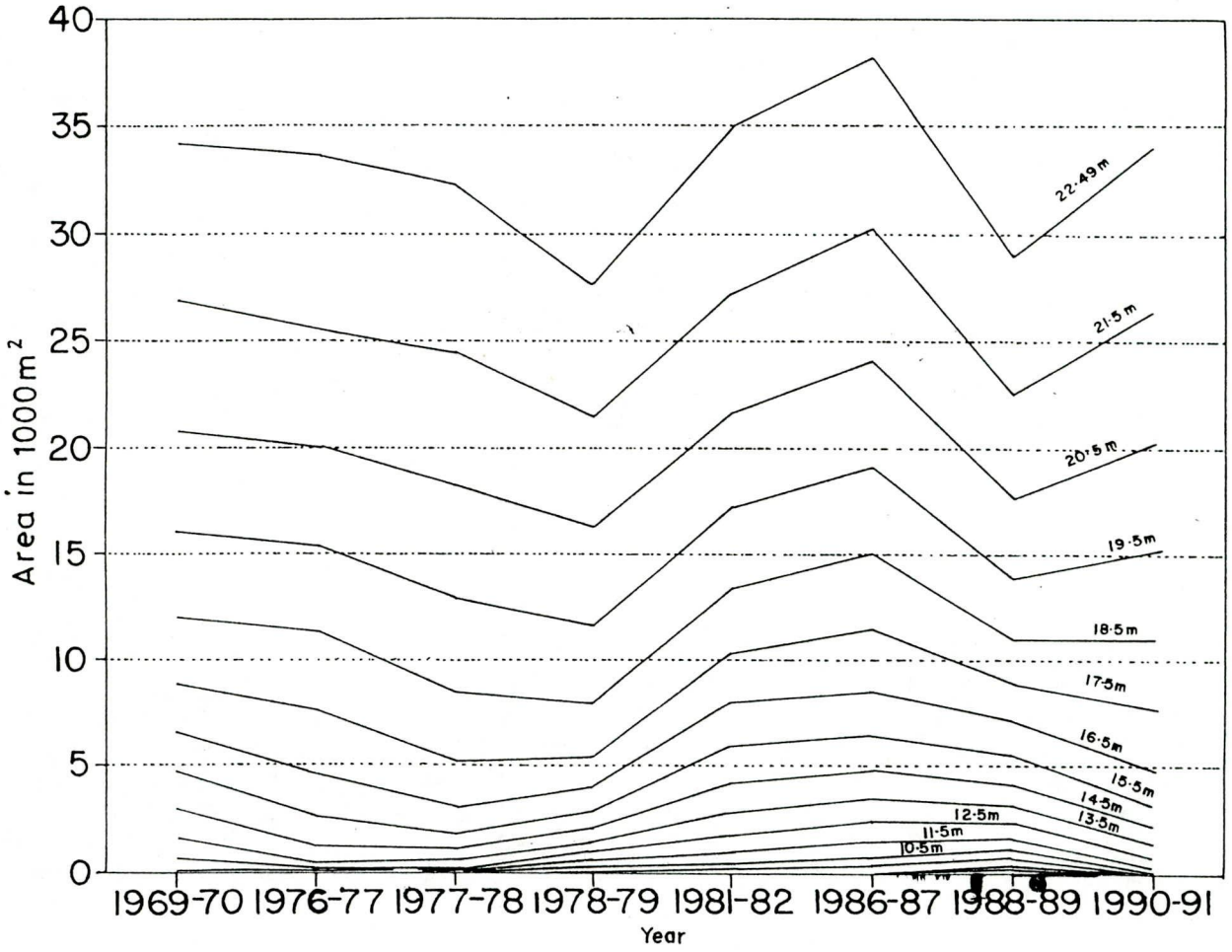


Figure 5.19.a Area upto different elevations Vs. Year (Ch. : 37.10 Km) Sec. J-16

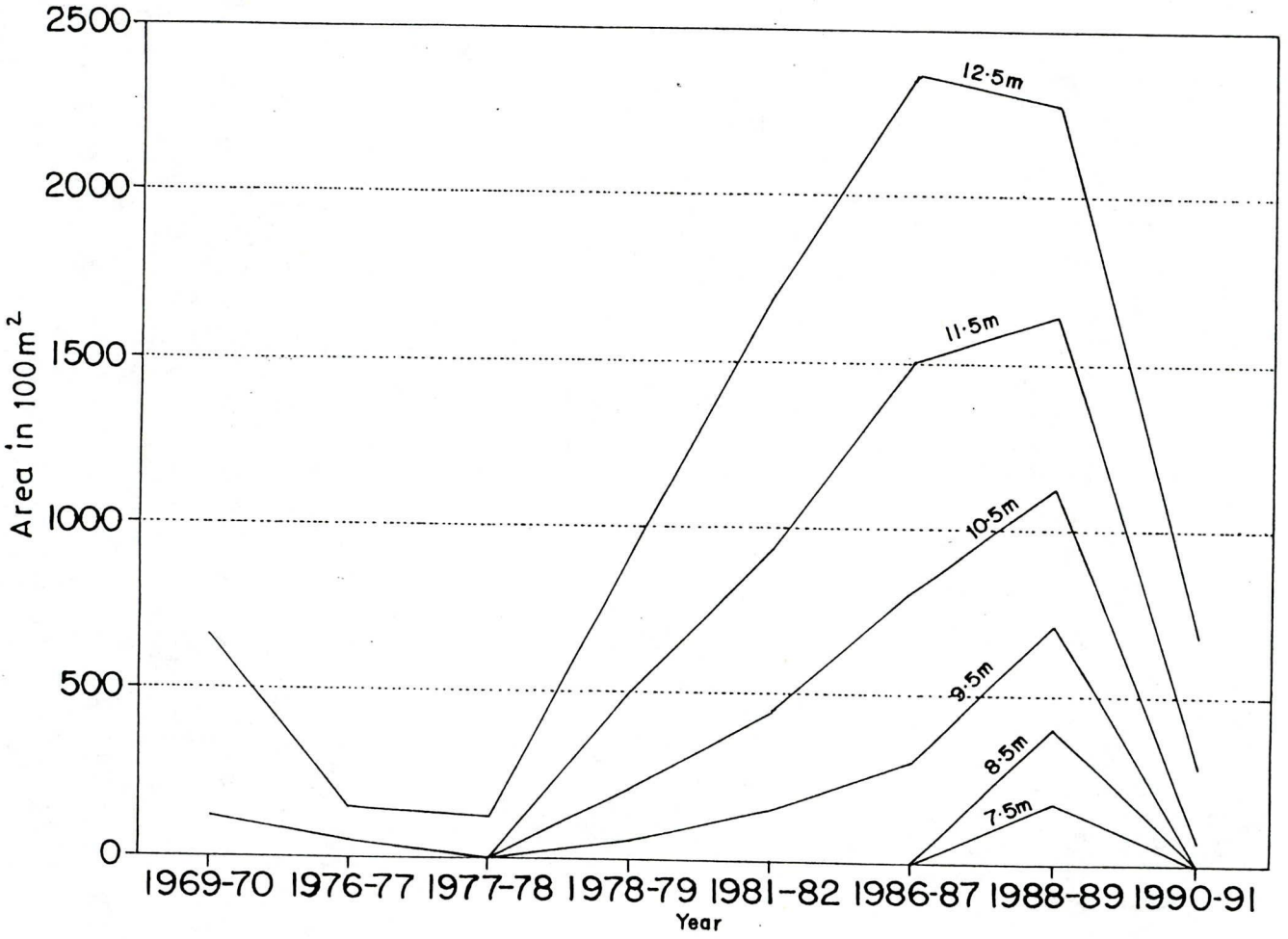


Figure 5.19.b Area upto different elevations Vs. Year (Ch. : 37.10 Km) Sec. J-16

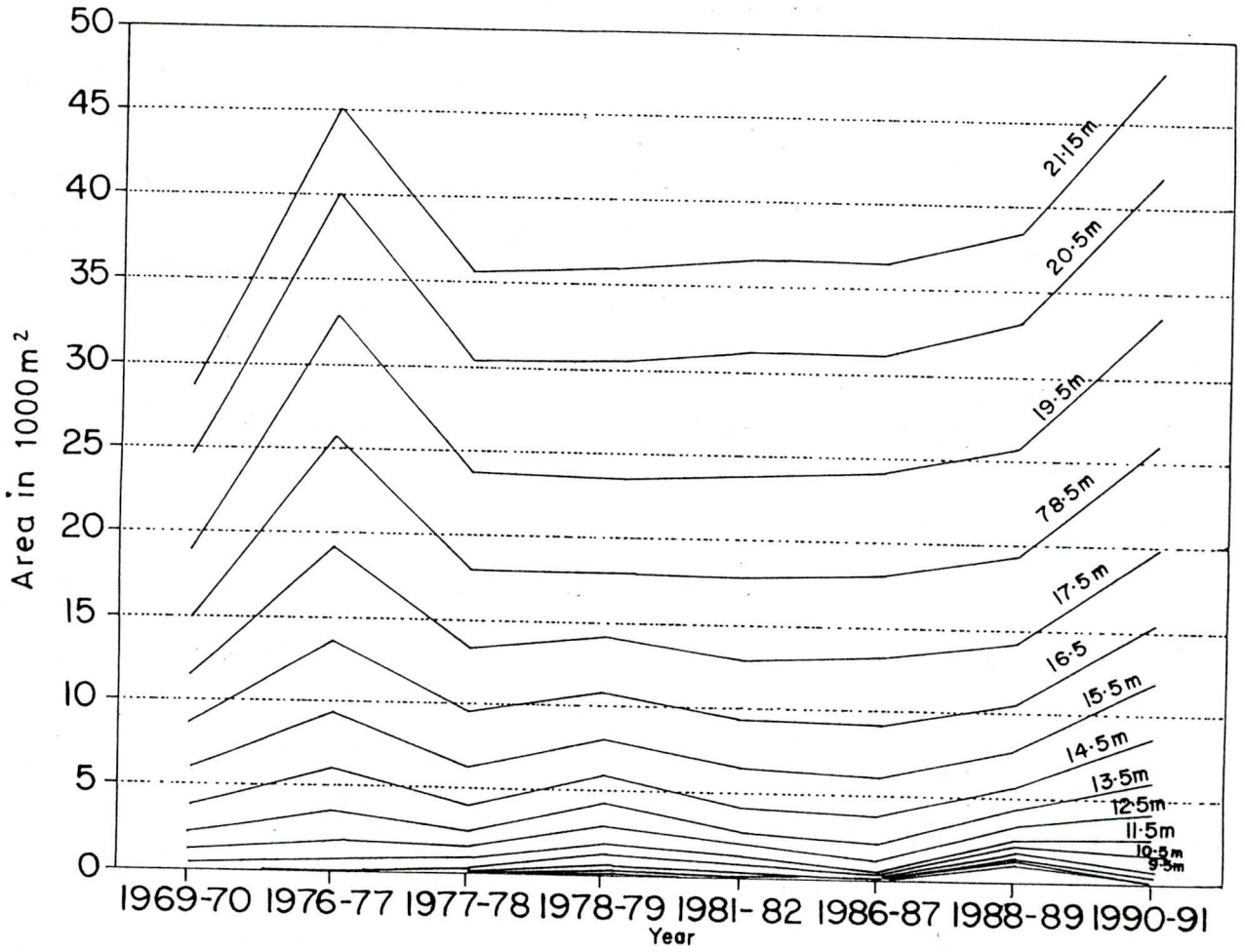


Figure 5.20.a Area upto different elevations Vs. Year (Ch. : 55.65 Km) Sec. J-15

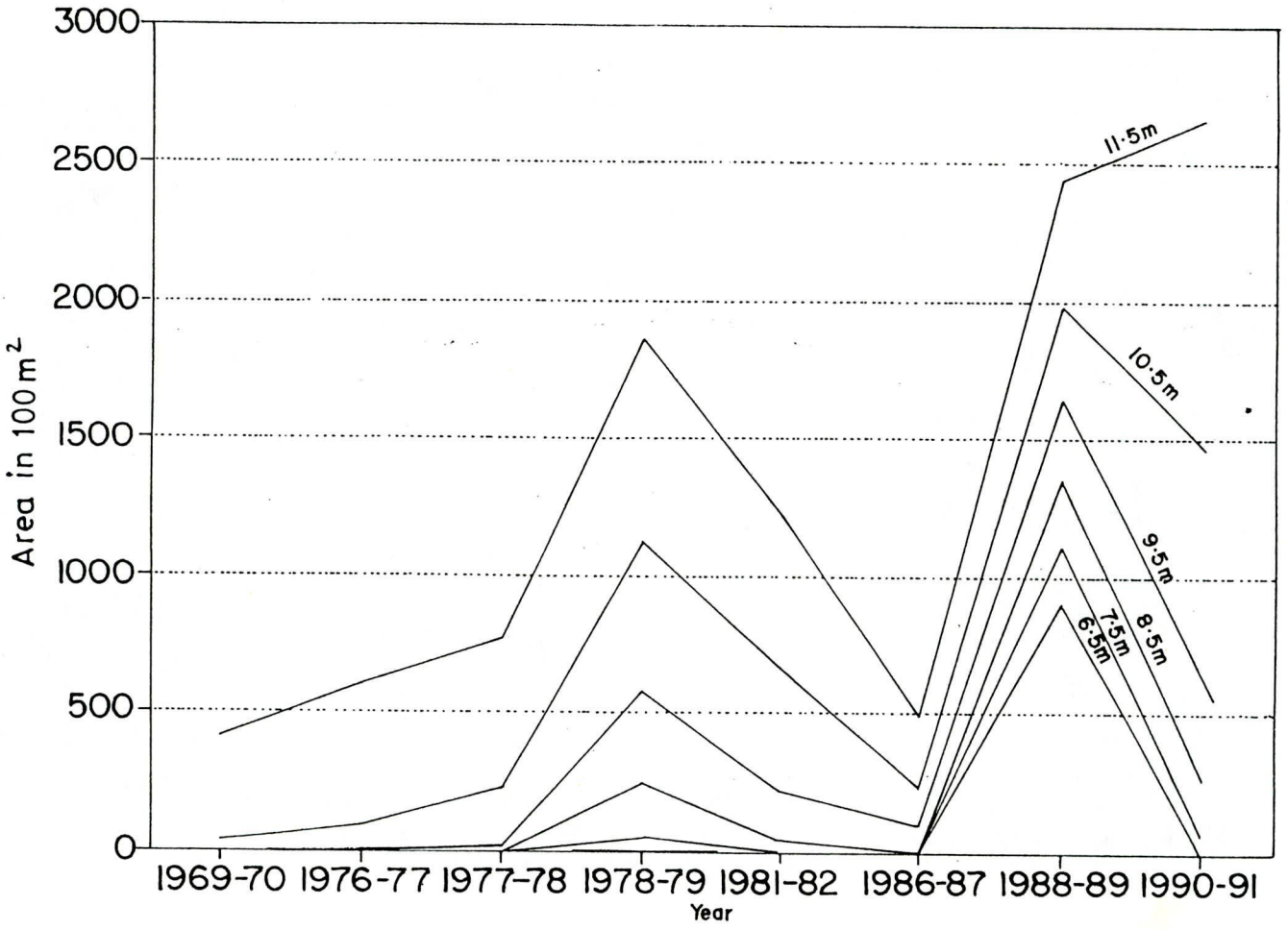


Figure 5.20.b Area upto different elevations Vs. Year (Ch. : 55.65 Km) Sec. J-15

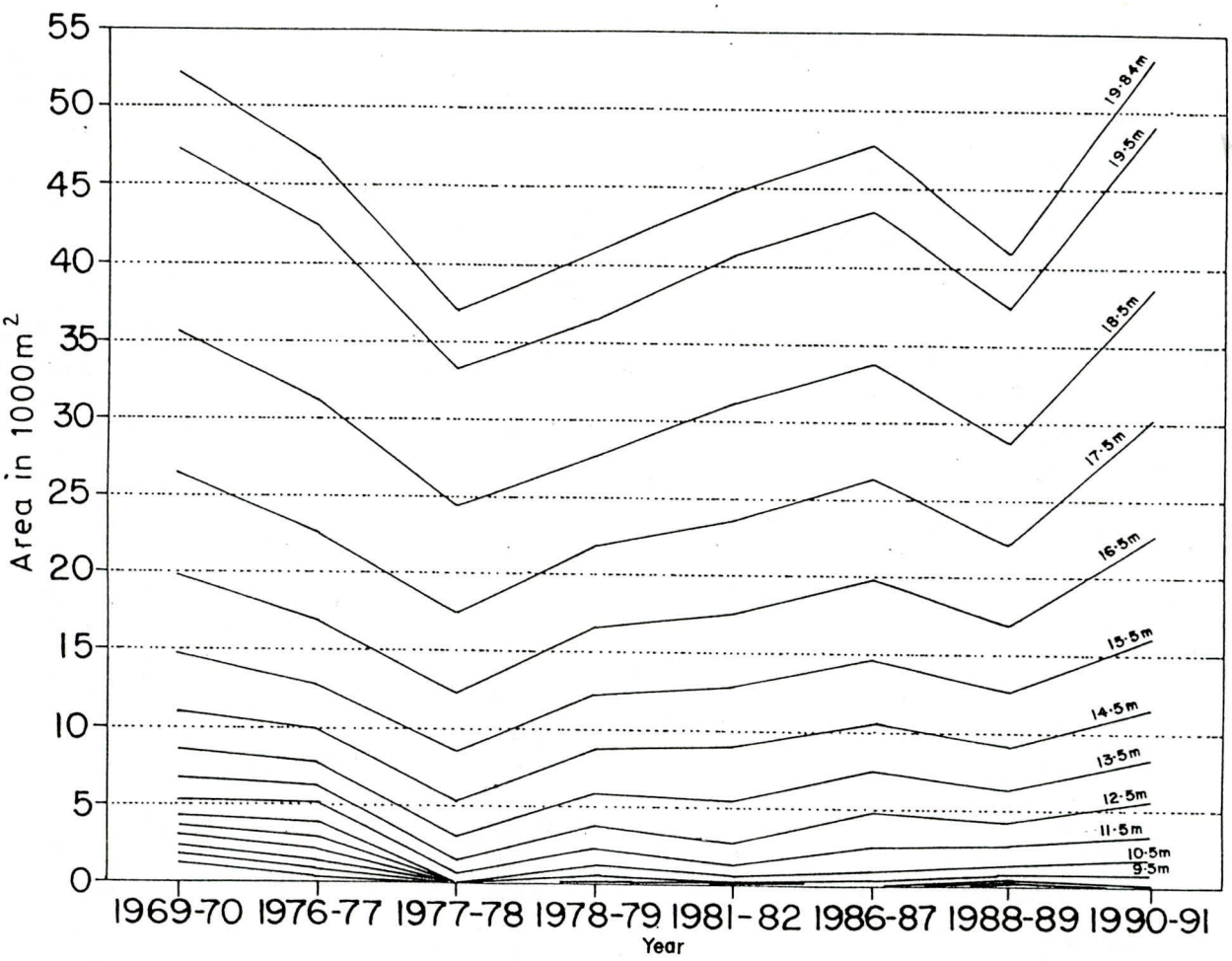


Figure 5.21.a Area upto different elevations Vs. Year (Ch. : 71.20 Km) Sec. J-14

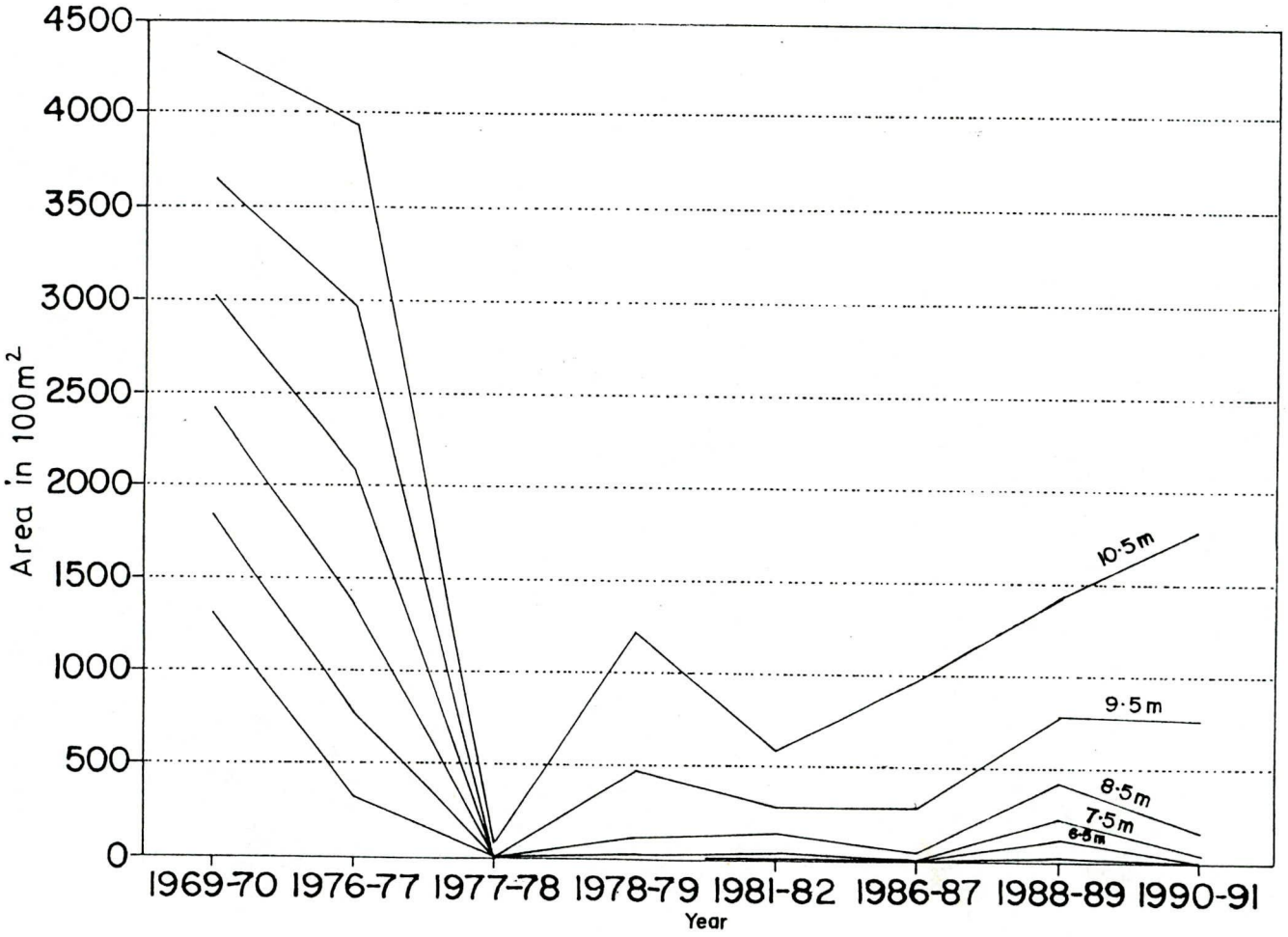


Figure 5.21.b Area upto different elevations Vs. Year (Ch. : 71.20 Km) Sec. J-14

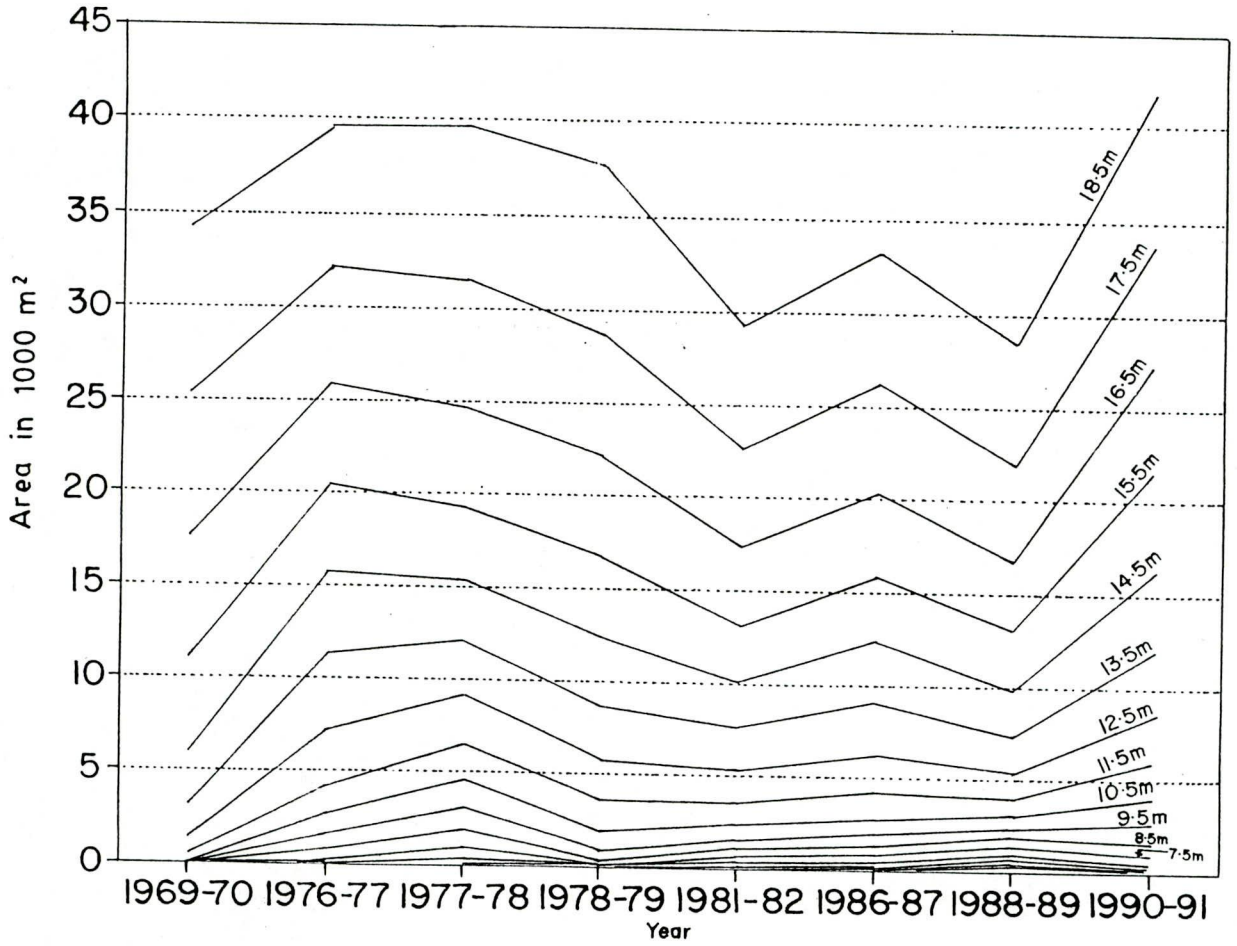


Figure 5.22.a Area upto different elevations Vs. Year (Ch. : 84.70 Km) Sec. J-13

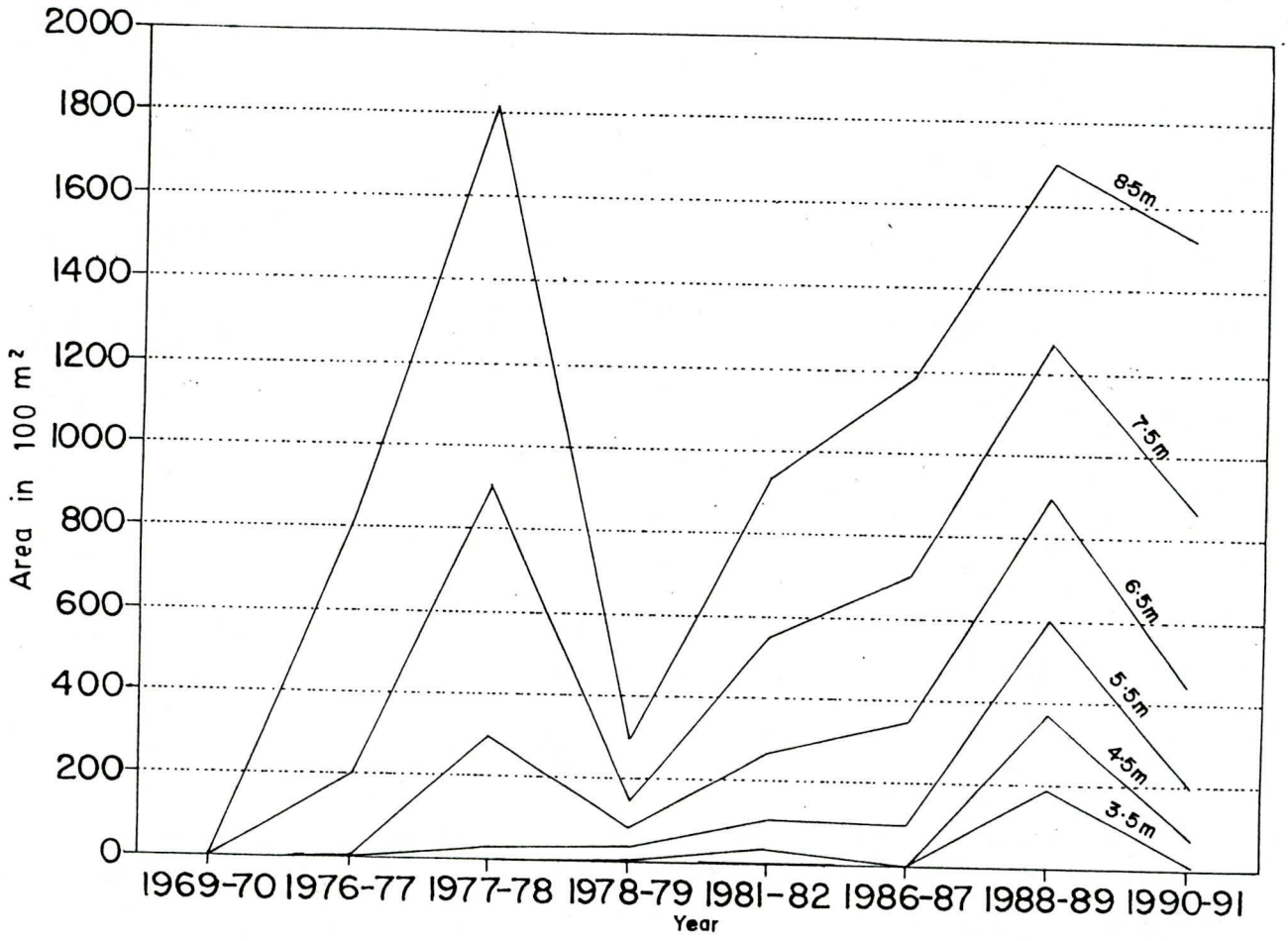


Figure 5.22.b Area upto different elevations Vs. Year (Ch. : 84.70 Km) Sec. J-13

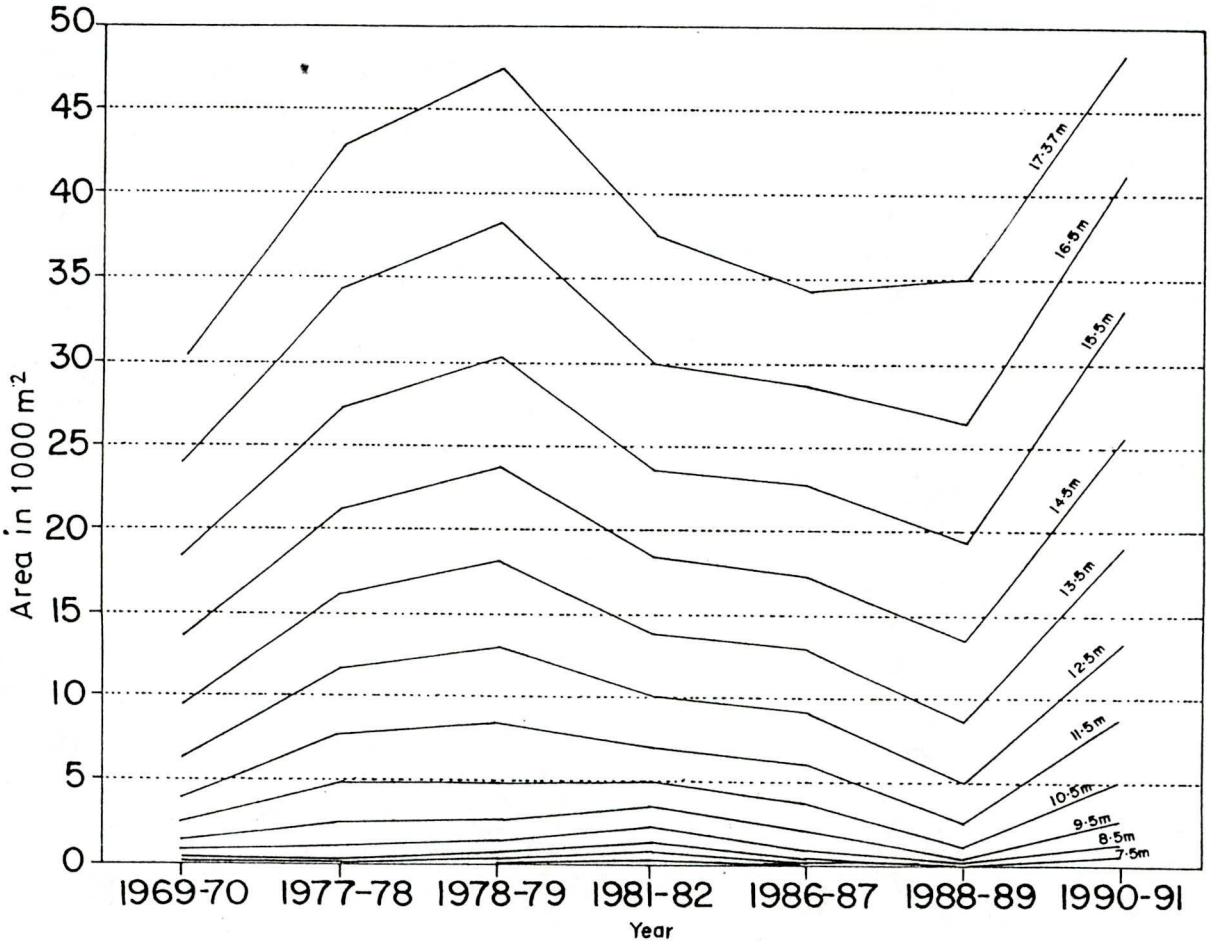


Figure 5.23.a Area upto different elevations Vs. Year (Ch. : 100.50 Km) Sec. J-12

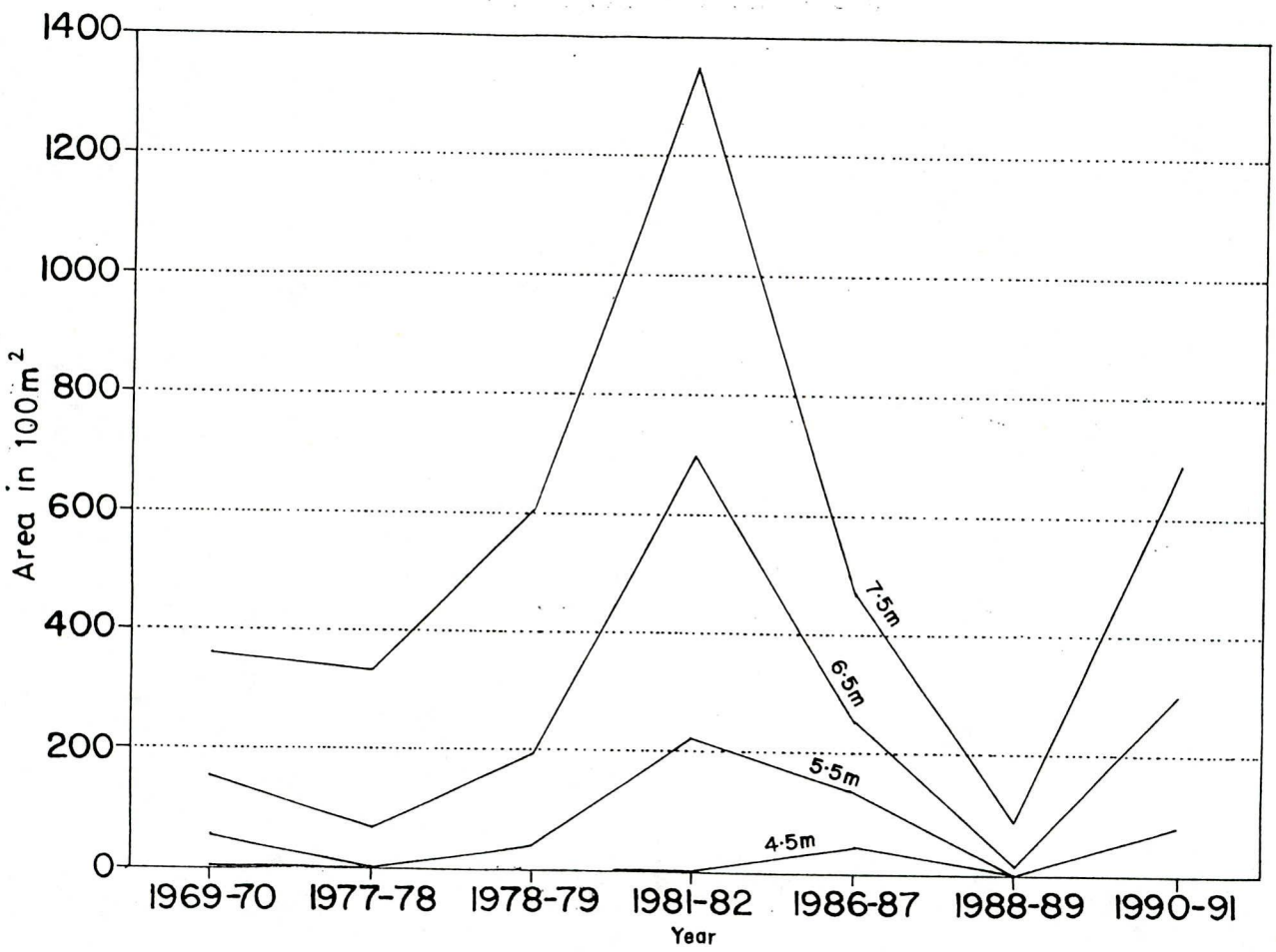


Figure 5.23.b Area upto different elevations Vs. Year (Ch. : 100.50 Km) Sec. J-12

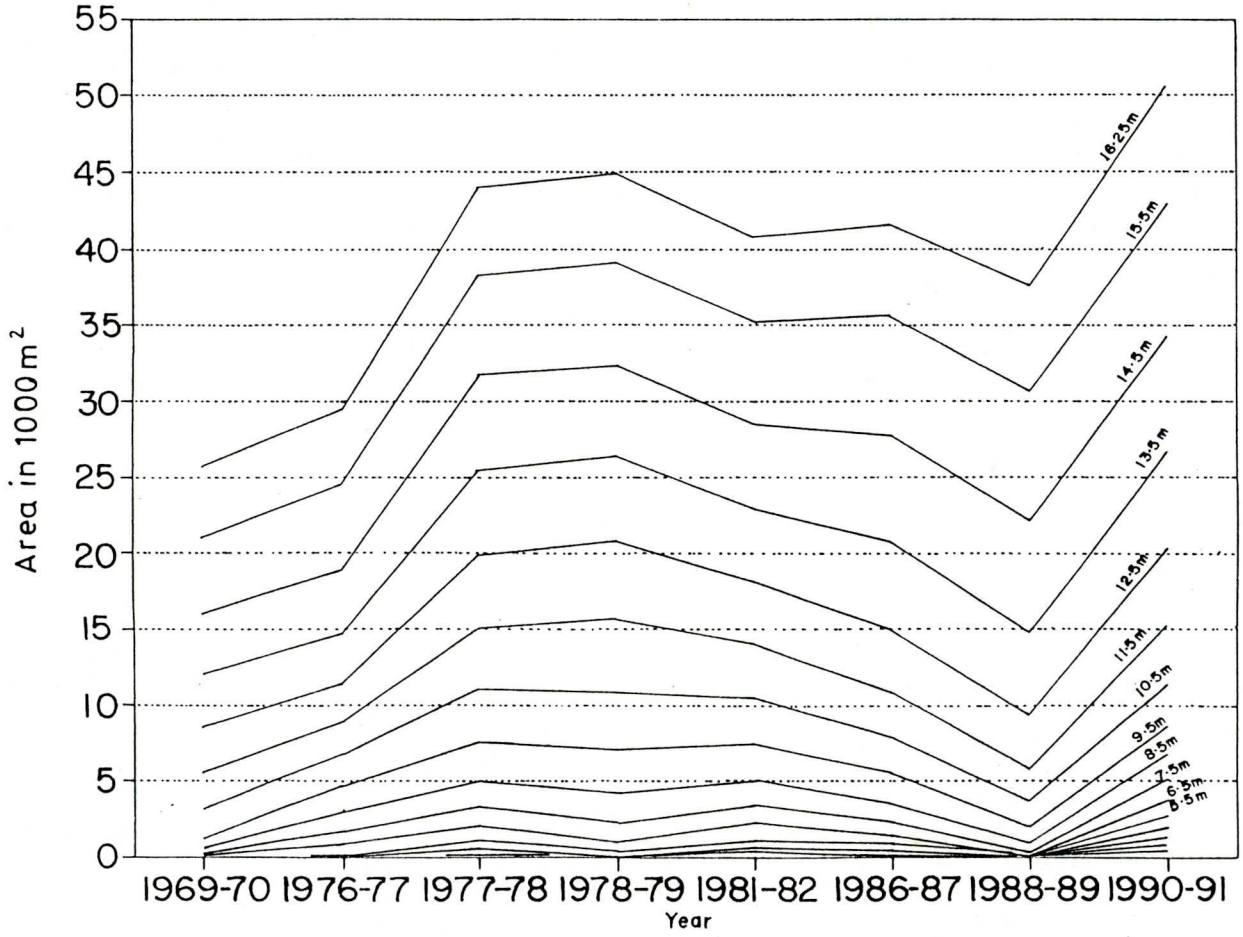


Figure 5.24.a Area upto different elevations Vs. Year (Ch. : 117.75 Km) Sec. J-11

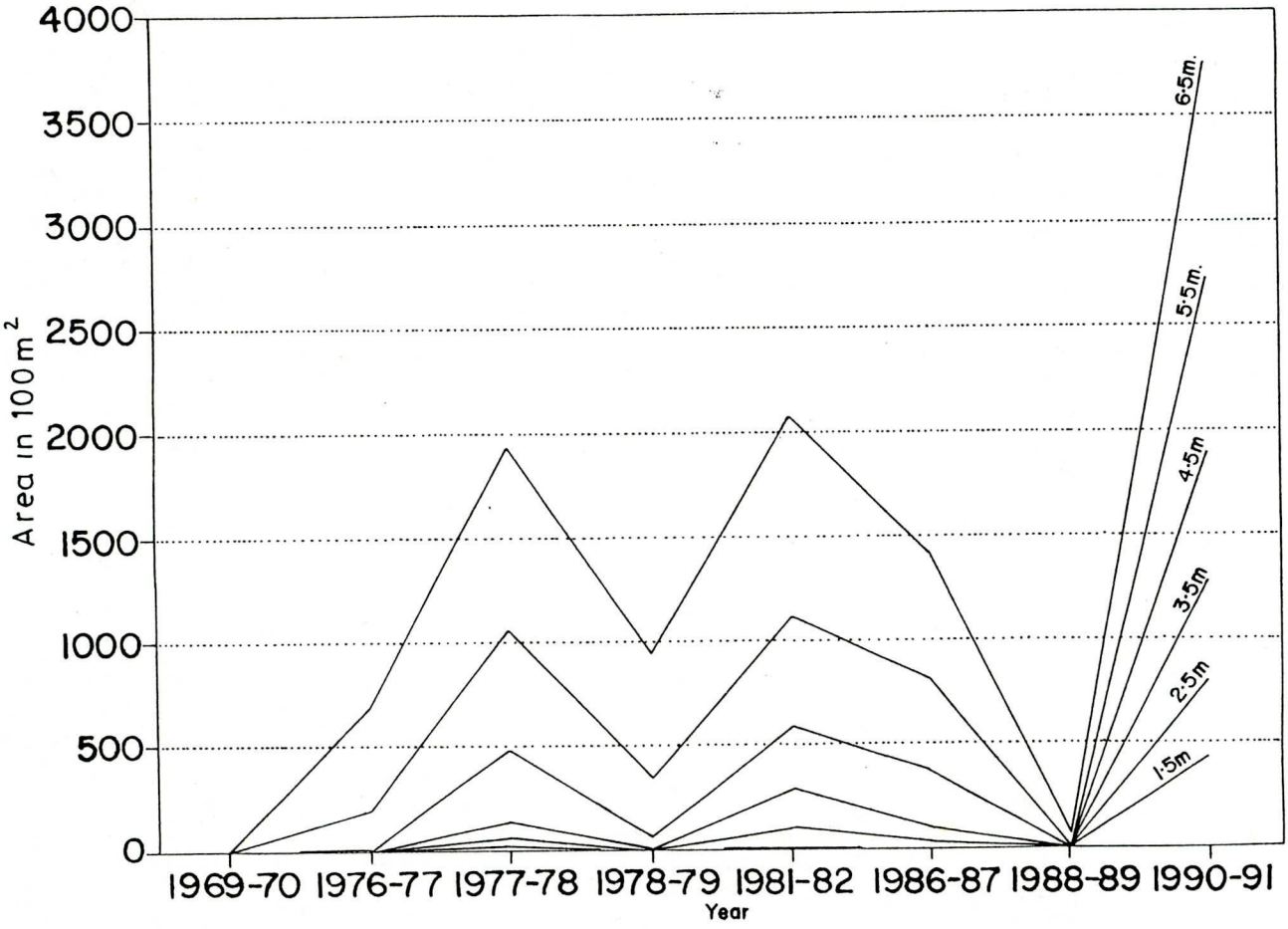


Figure 5.24.b Area upto different elevations Vs. Year (Ch. : 117.75 Km) Sec. J-11

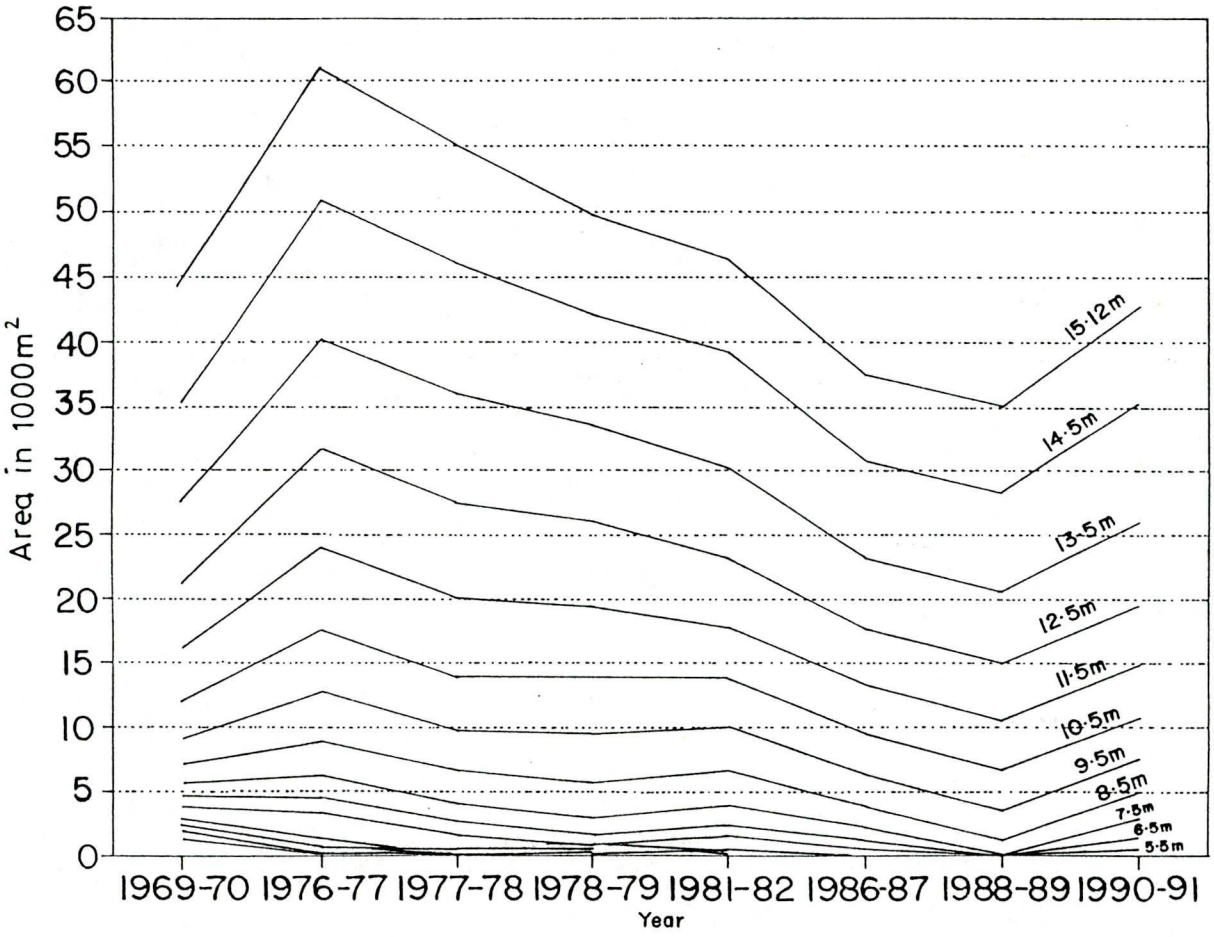


Figure 5.25.a Area upto different elevations Vs. Year (Ch. : 134.30 Km) Sec. J-10

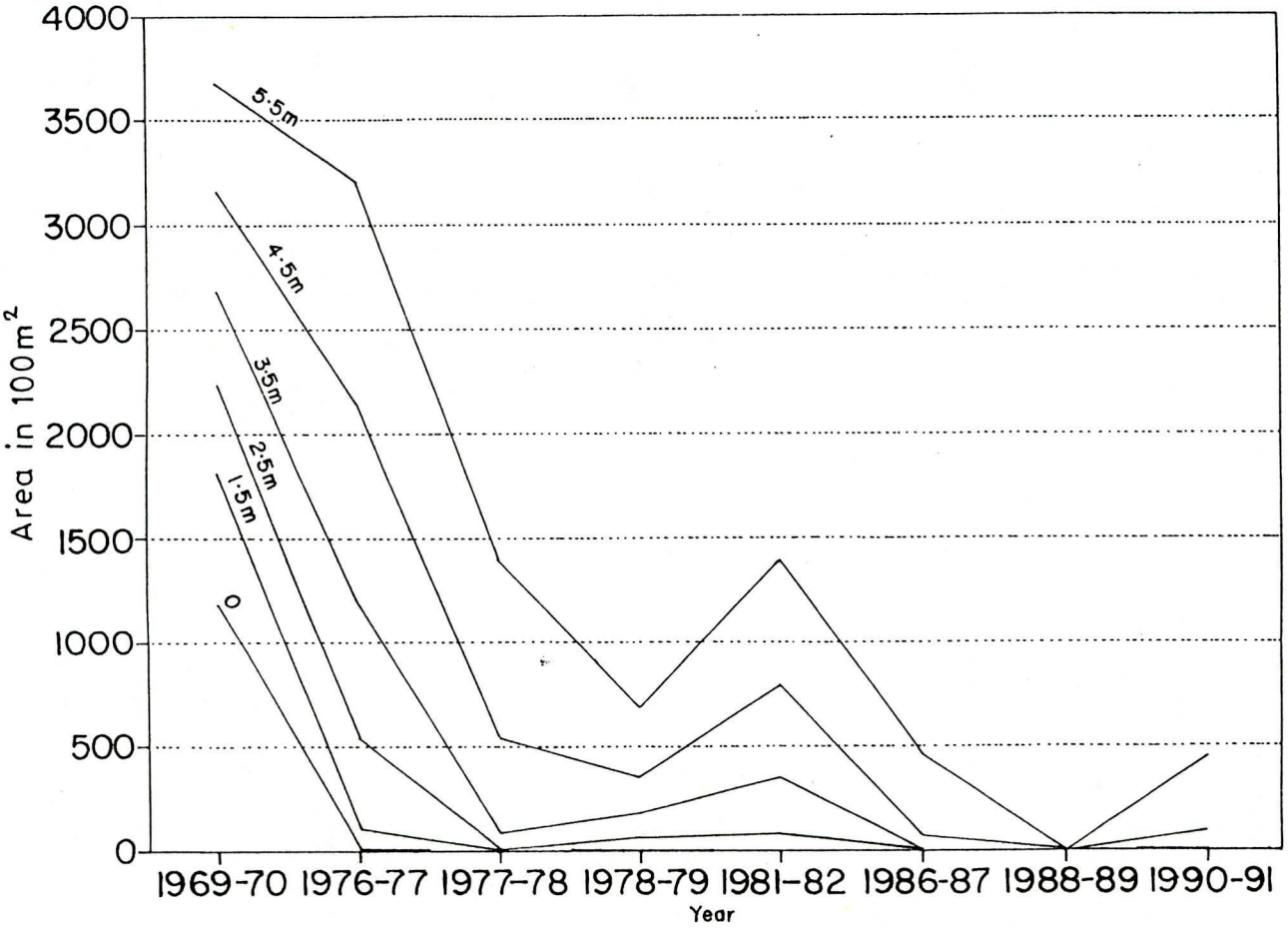


Figure 5.25.b Area upto different elevations Vs. Year (Ch. : 134.30 Km) Sec. J-10

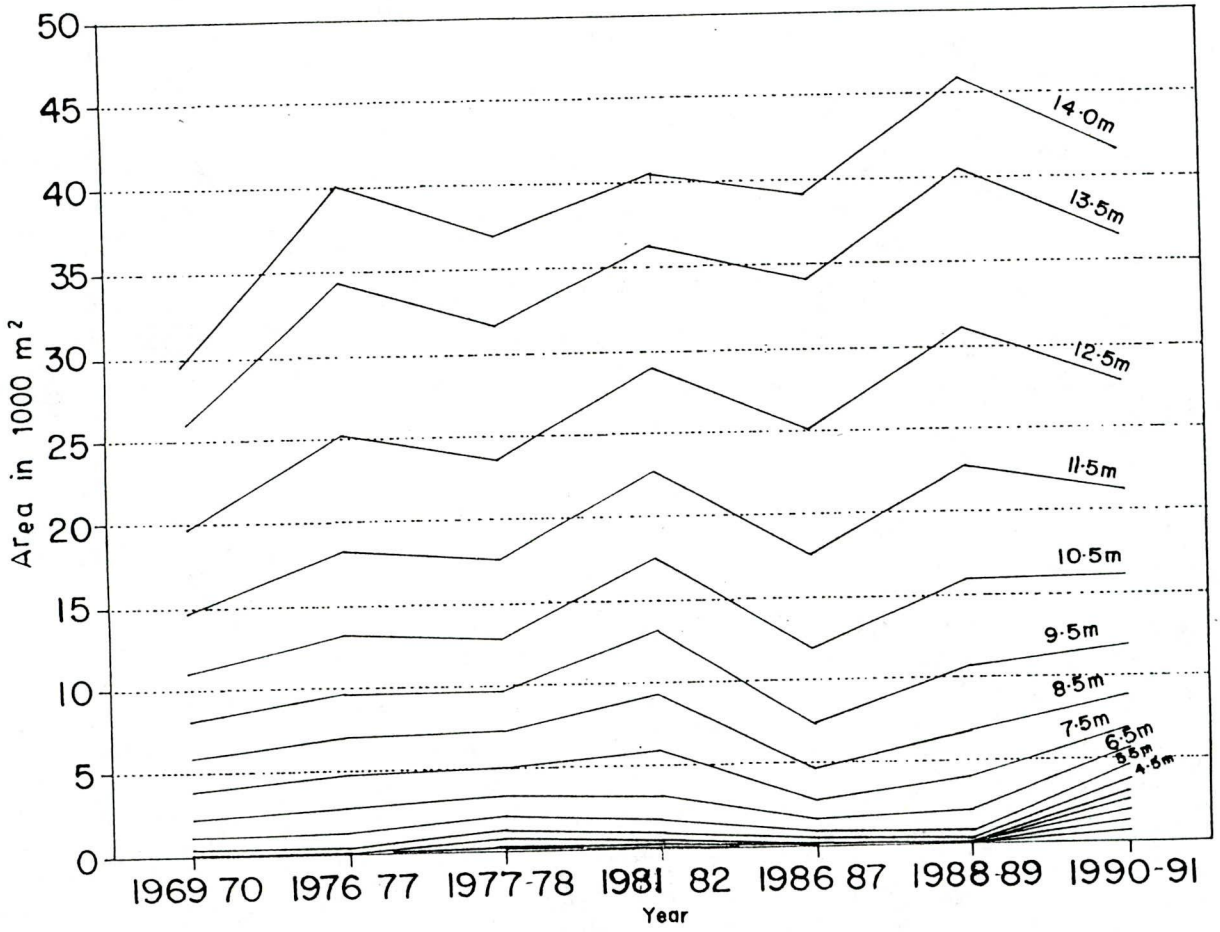


Figure 5.26.a Area upto different elevations Vs. Year (Ch. : 142.45 Km) Sec. J - 9

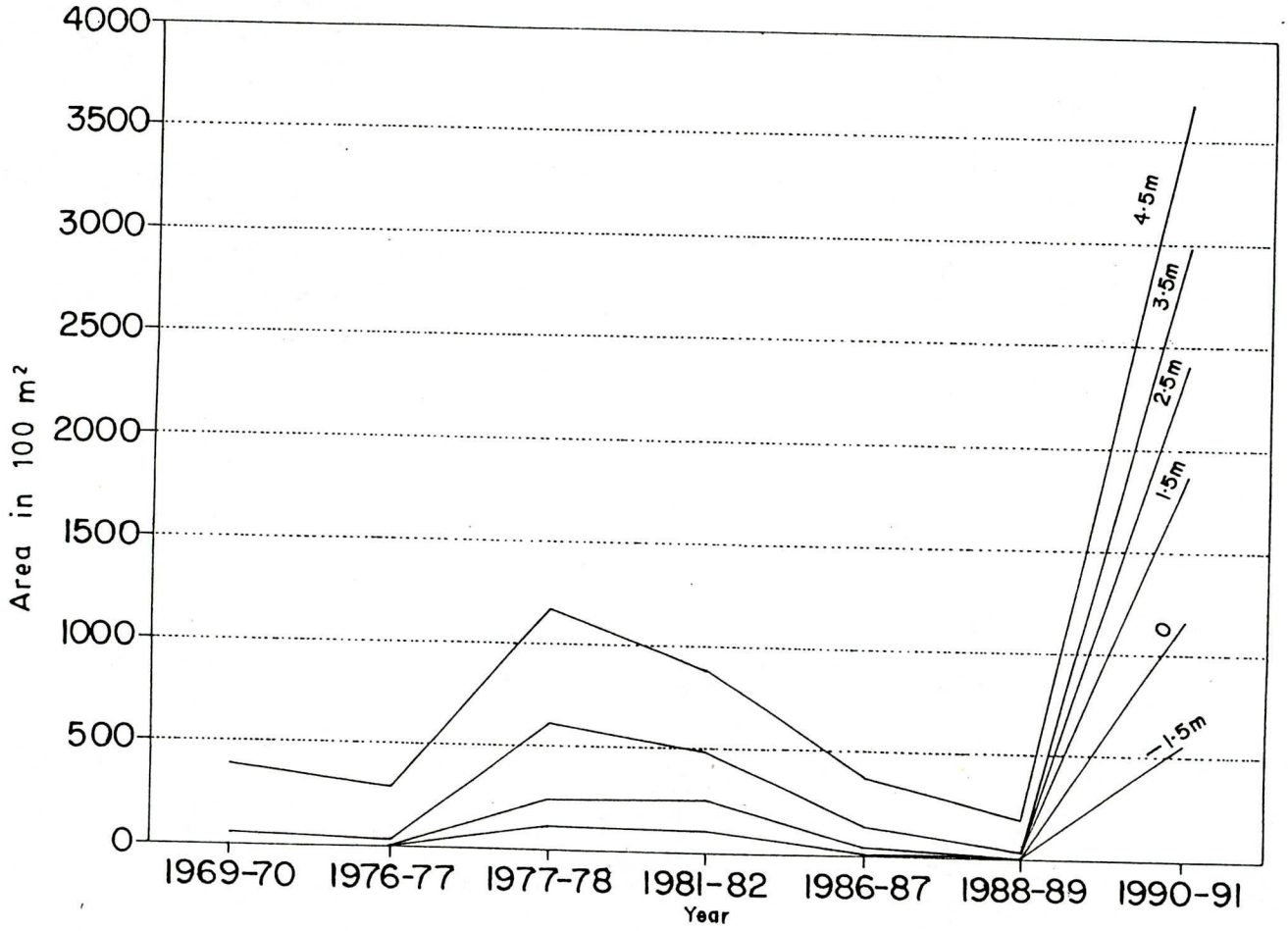


Figure 5.26.b Area upto different elevations Vs. Year (Ch. : 142.45 Km) Sec. J - 9

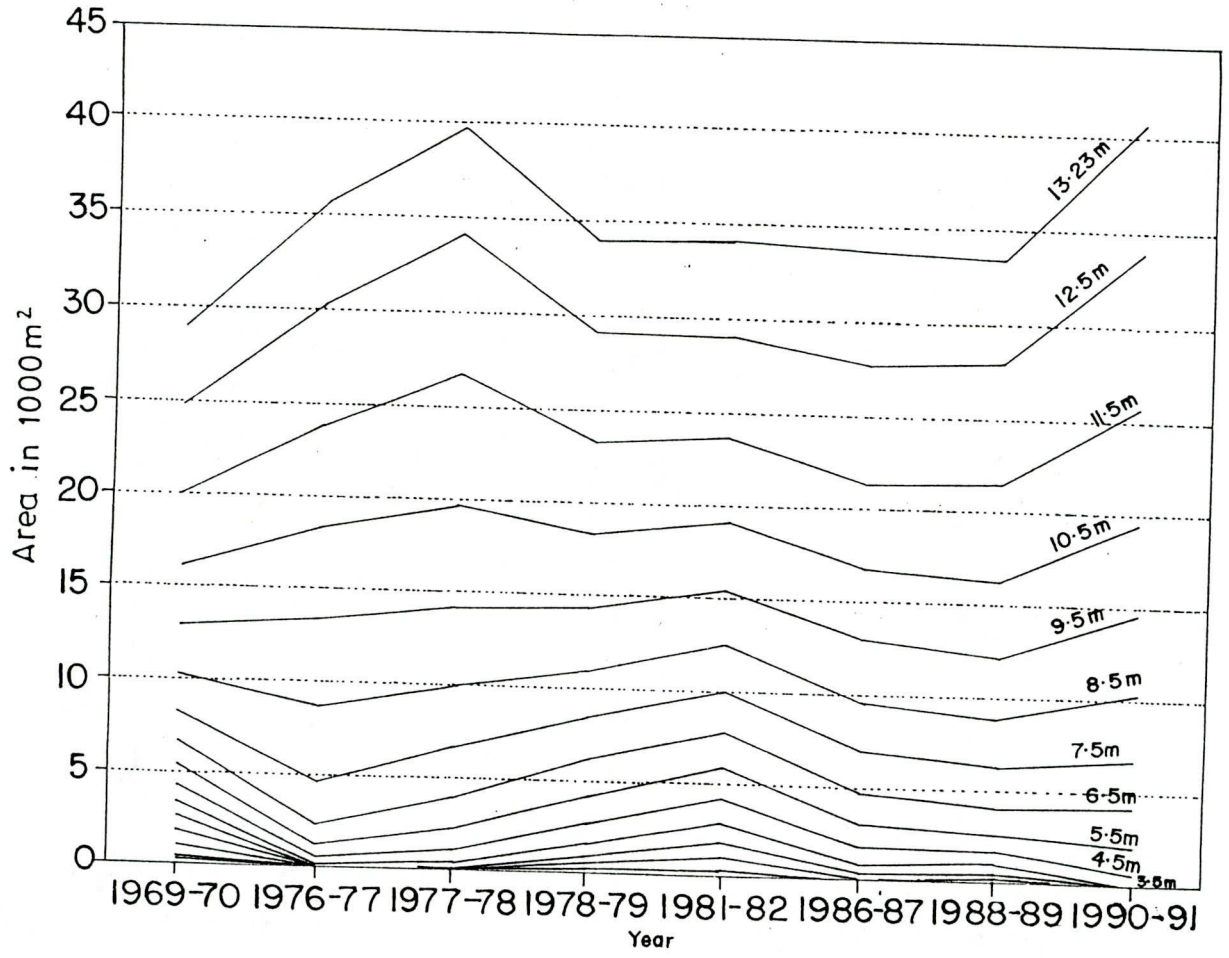


Figure 5.27.a Area upto different elevations Vs. Year (Ch. : 149.50 Km) Sec. J - 8

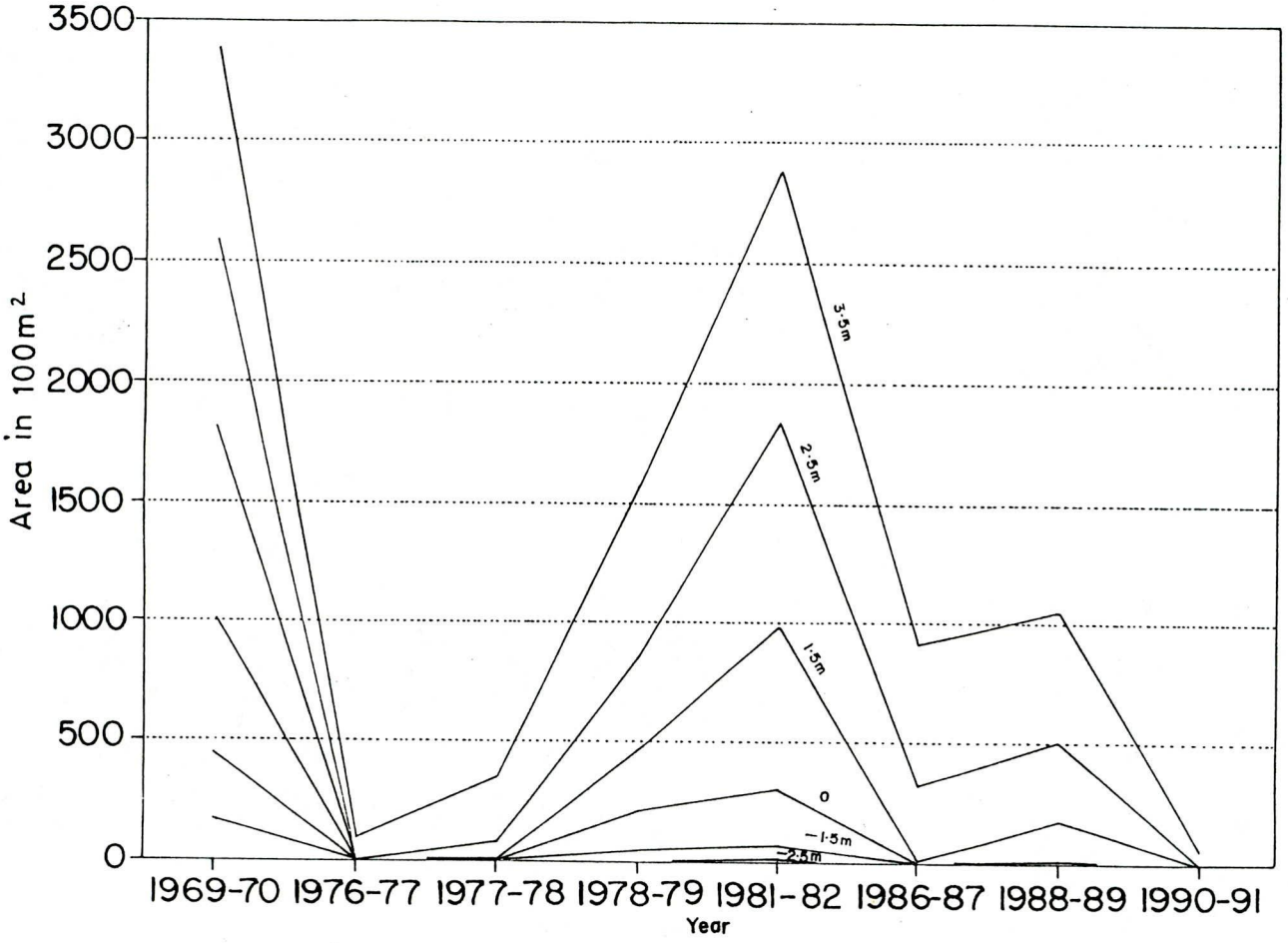


Figure 5.27.b Area upto different elevations Vs. Year (Ch. : 149.50 Km) Sec. J - 8

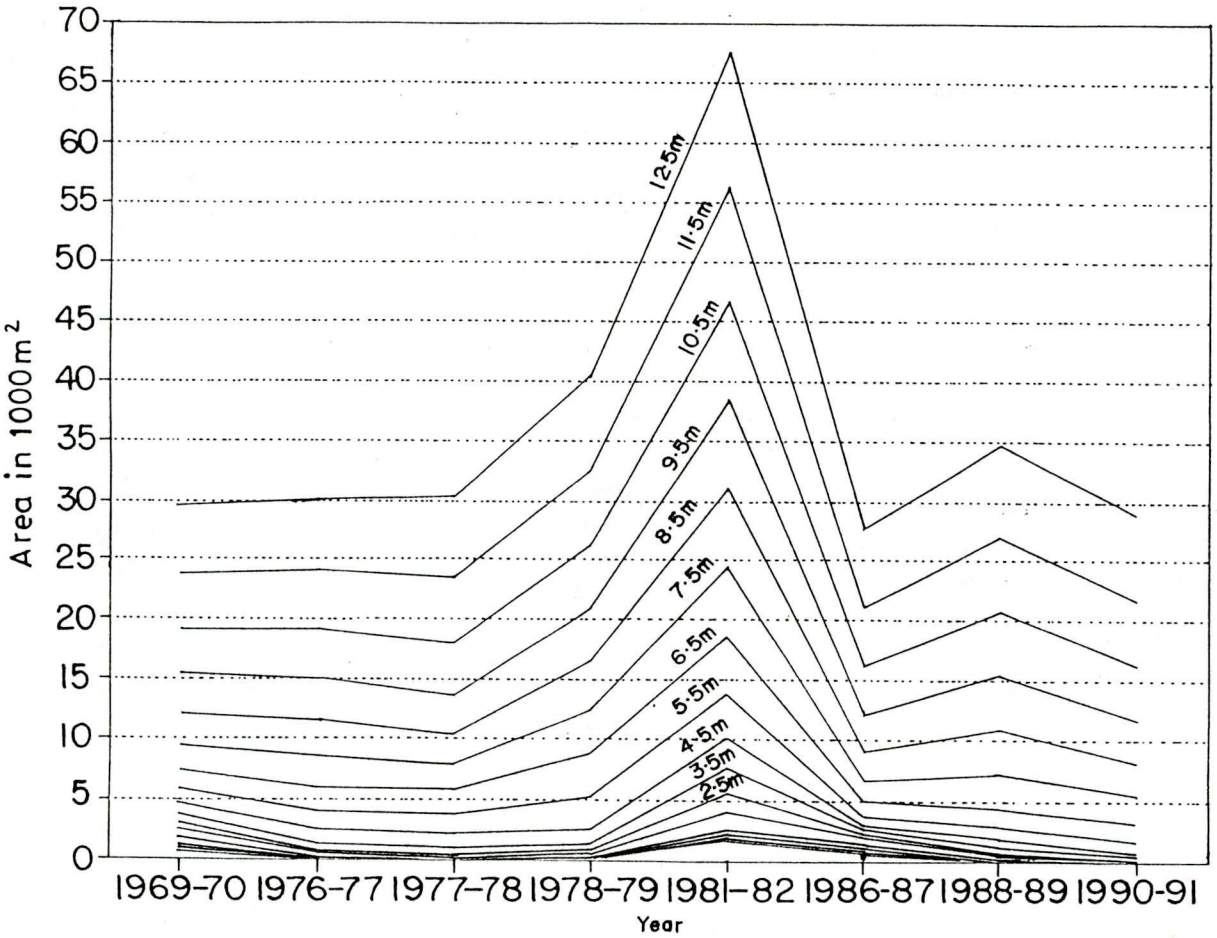


Figure 5.28.a Area upto different elevations Vs. Year (Ch. : 162.35 Km) Sec. J - 7

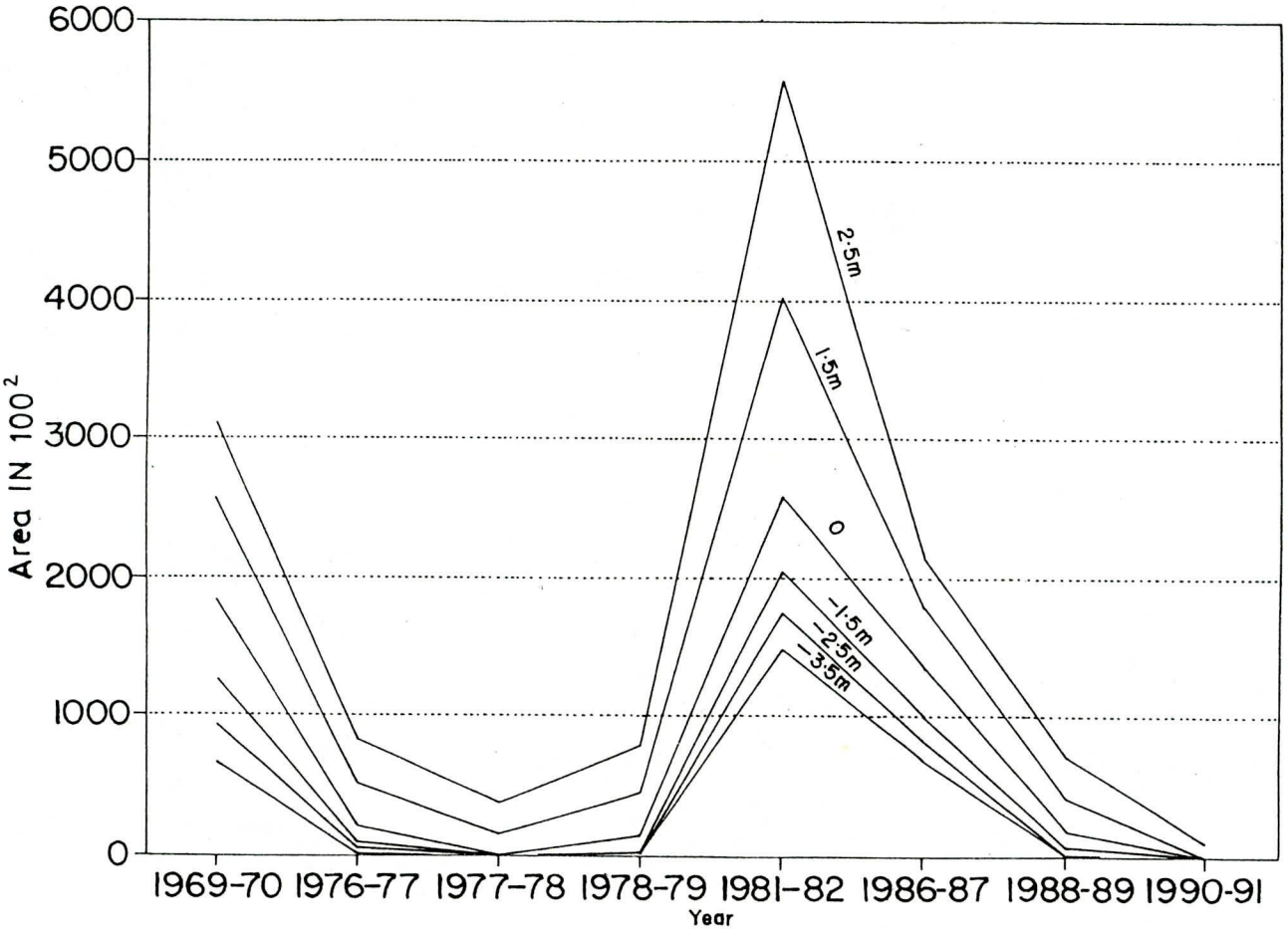


Figure 5.28.b Area upto different elevations Vs. Year (Ch. : 162.35 Km) Sec. J - 7

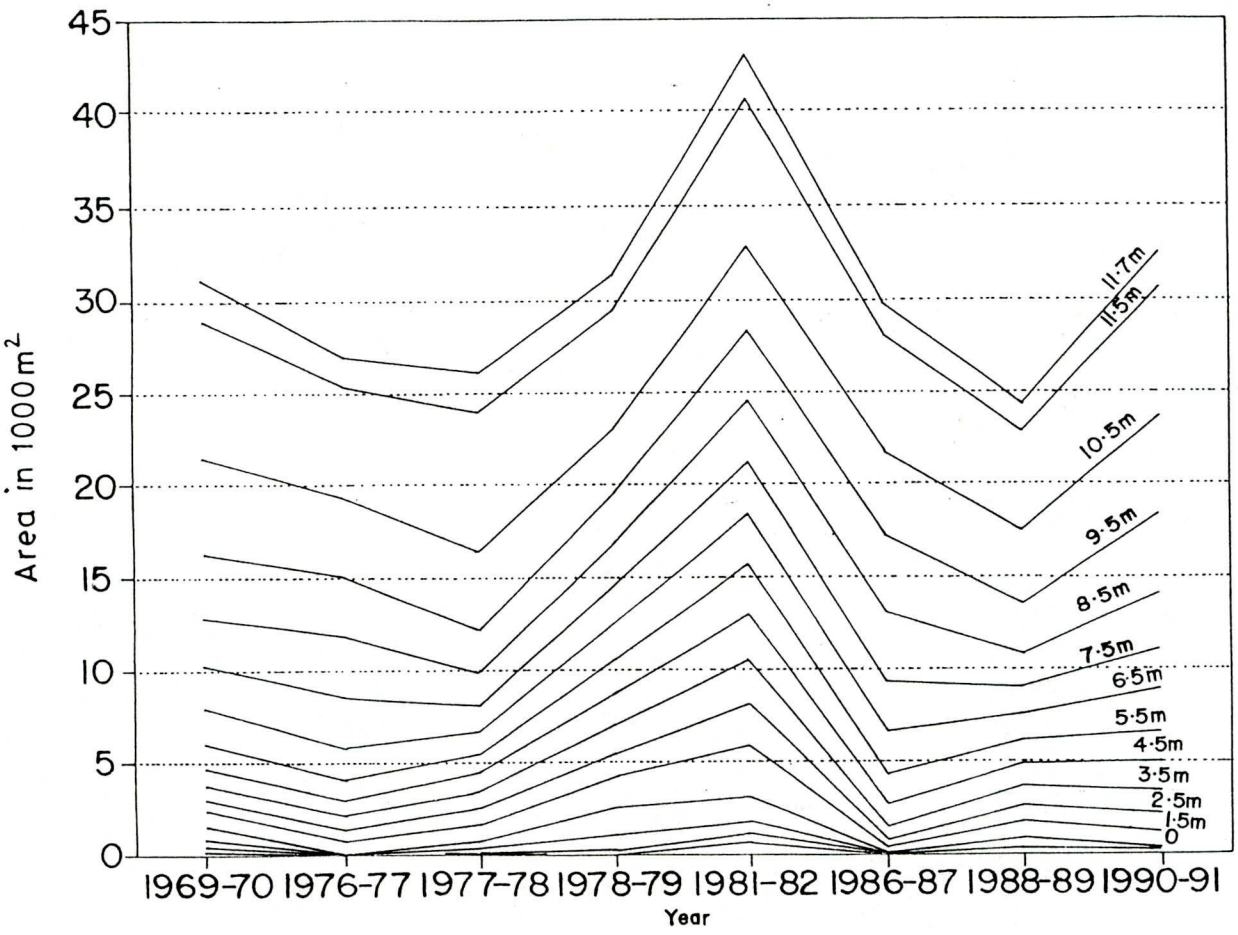


Figure 5.29.a Area upto different elevations Vs. Year (Ch. : 177.20 Km) Sec. J - 6

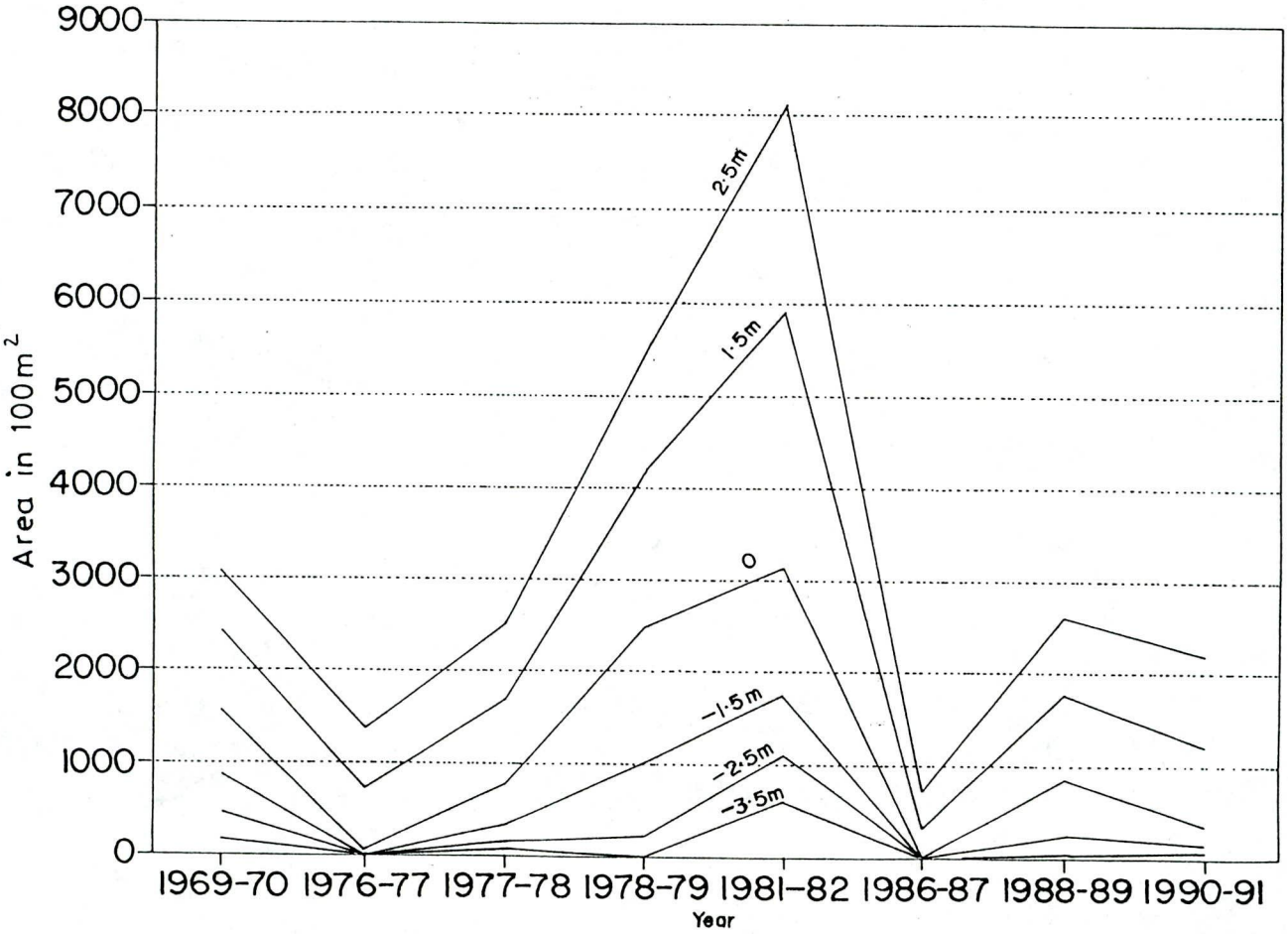


Figure 5.29.b Area upto different elevations Vs. Year (Ch. : 177.20 Km) Sec. J - 6

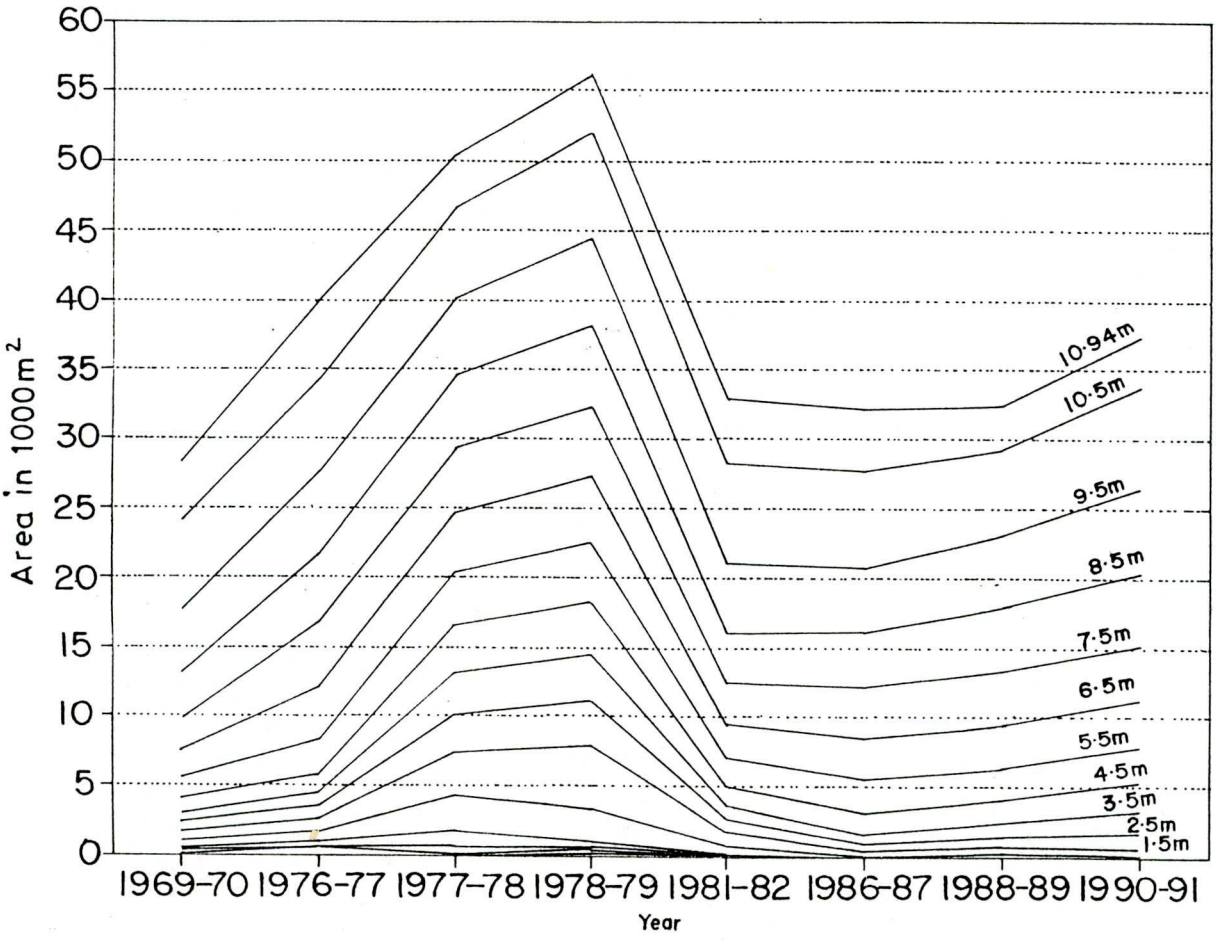


Figure 5.30.a Area upto different elevations Vs. Year (Ch. : 188.20 Km) Sec. J - 5

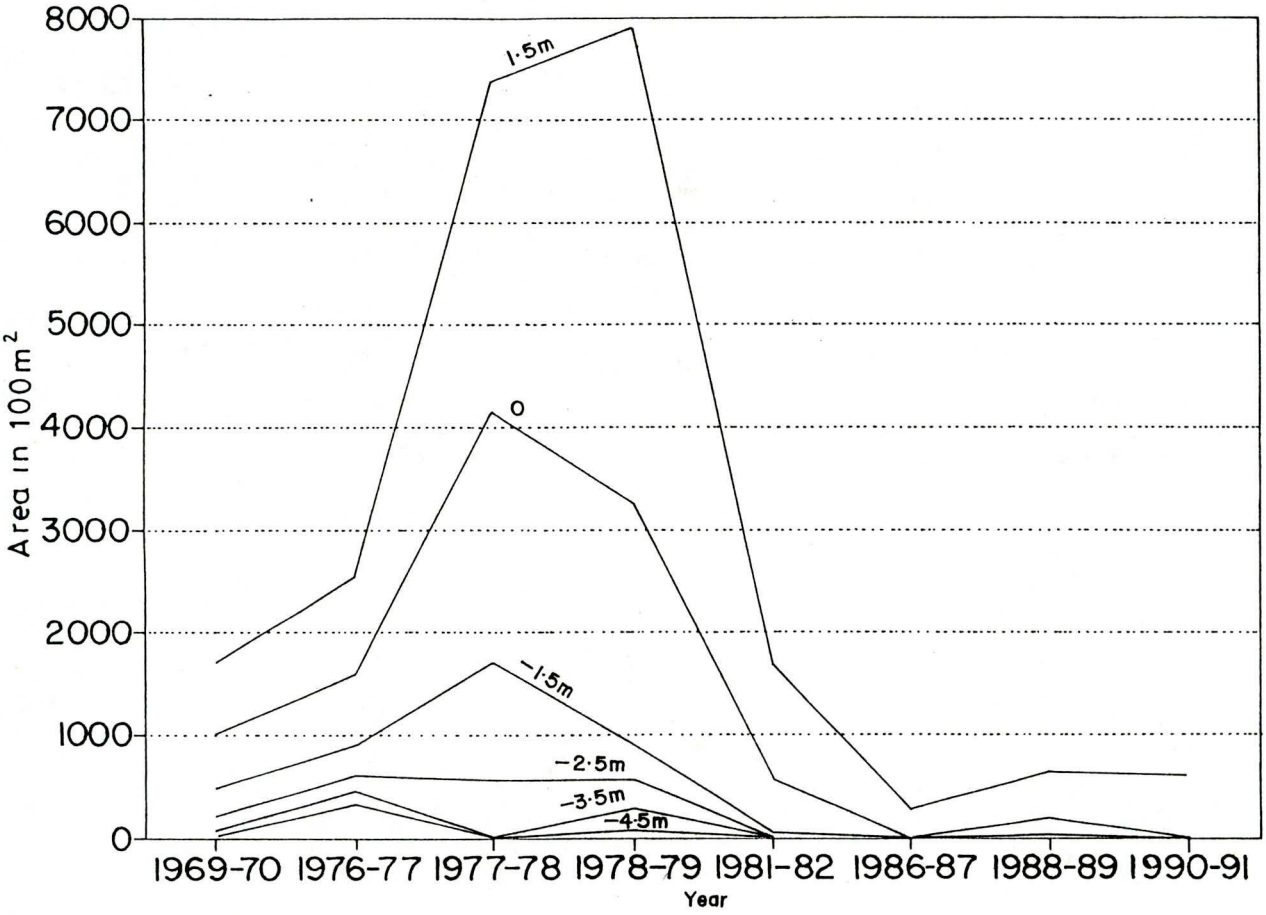


Figure 5.30.b Area upto different elevations Vs. Year (Ch. : 188.20 Km) Sec. J - 5

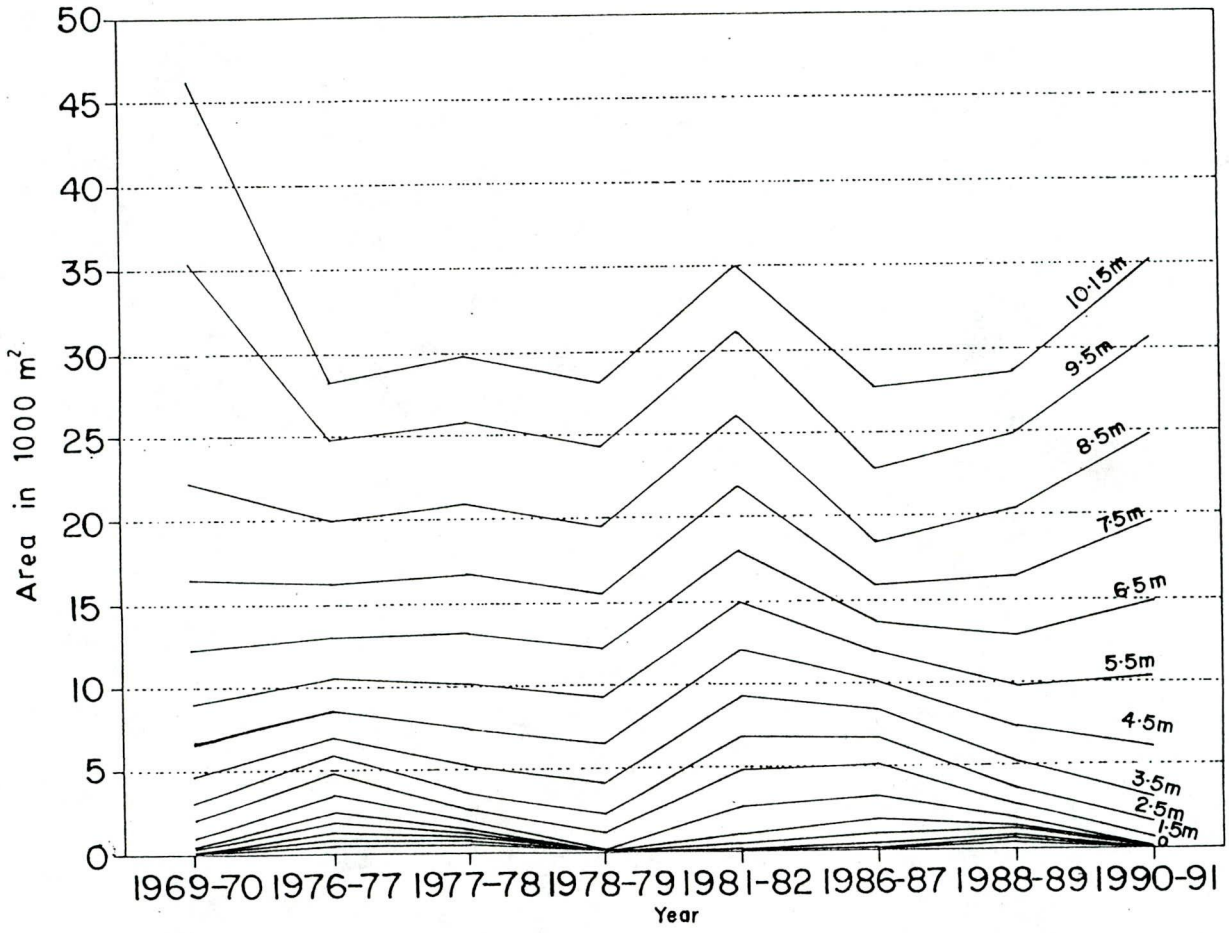


Figure 5.31.a Area upto different elevations Vs. Year (Ch. : 201.30 Km) Sec. J - 4

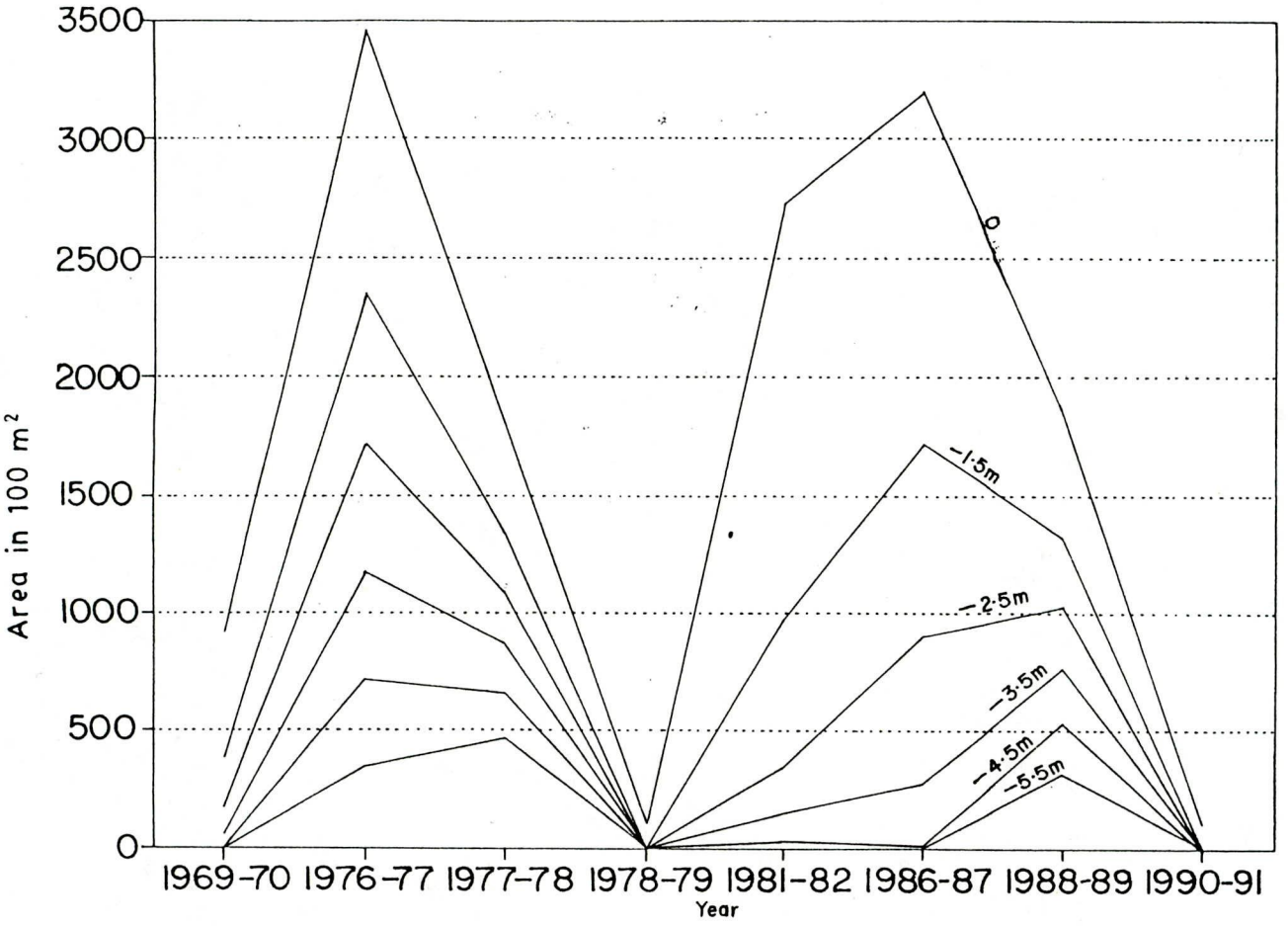


Figure 5.31.b Area upto different elevations Vs. Year (Ch. : 201.30 Km) Sec. J - 4

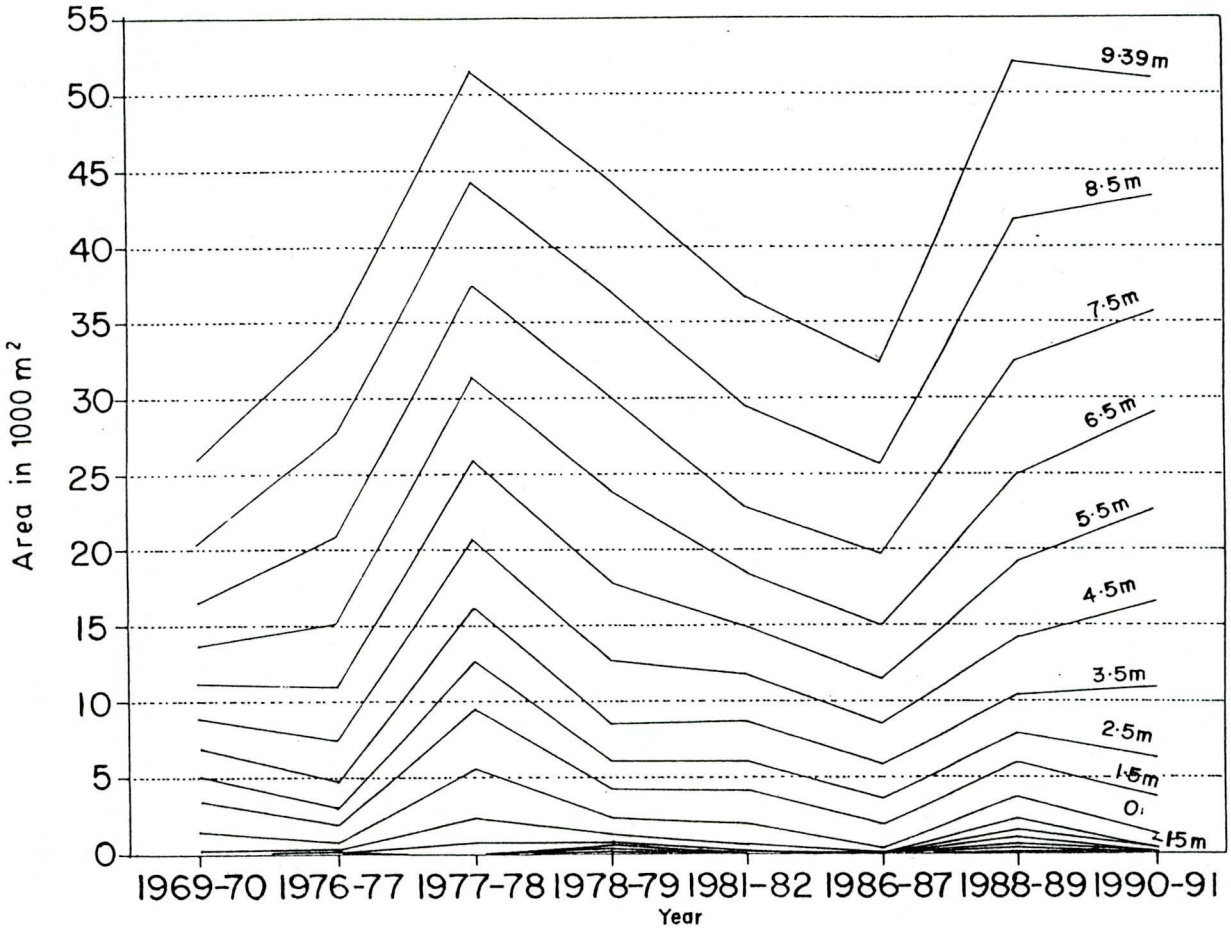


Figure 5.32.a Area upto different elevations Vs. Year (Ch. : 213.20 Km) Sec. J - 3

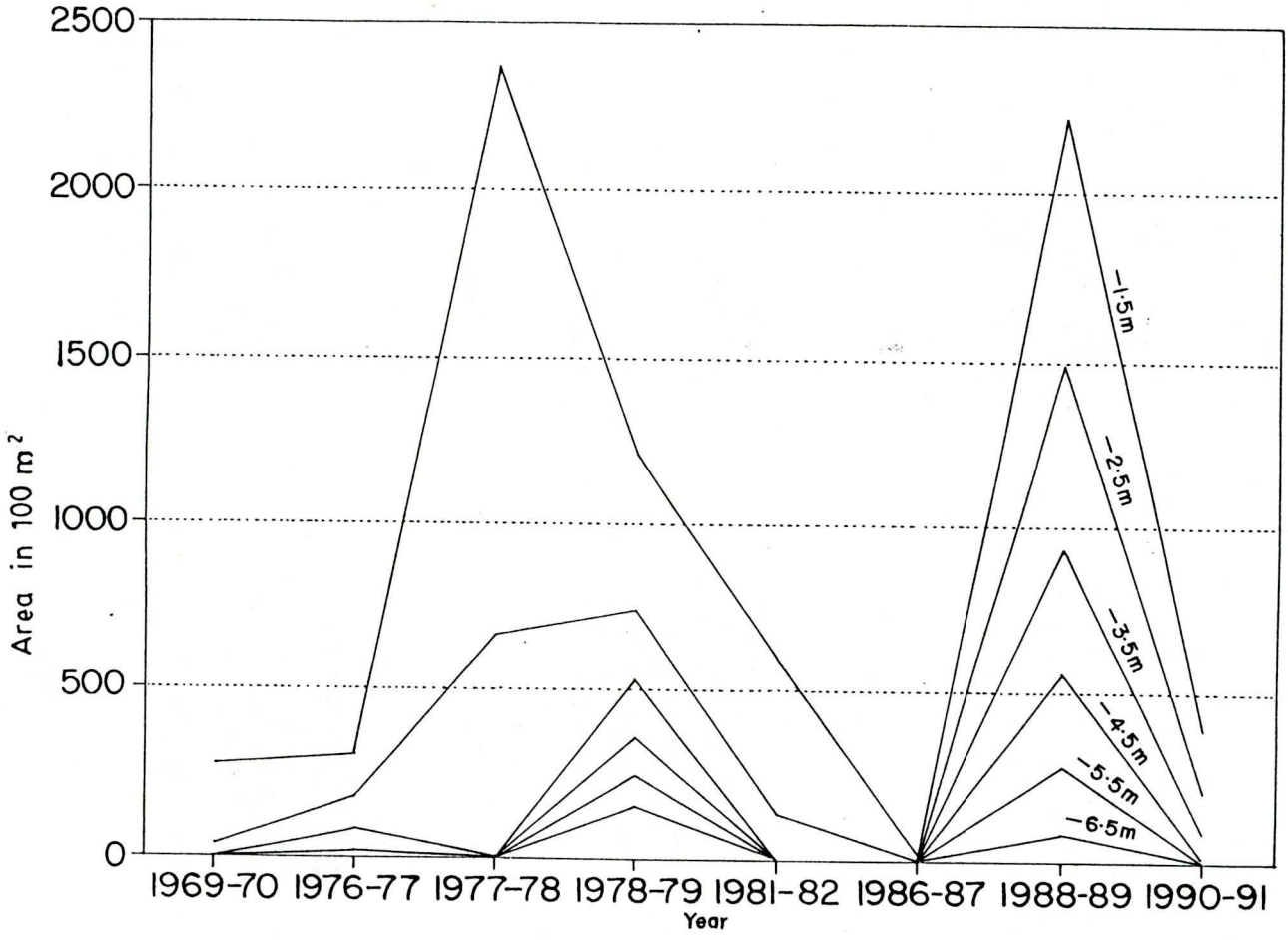


Figure 5.32.b Area upto different elevations Vs. Year (Ch. : 213.20 Km) Sec. J - 3

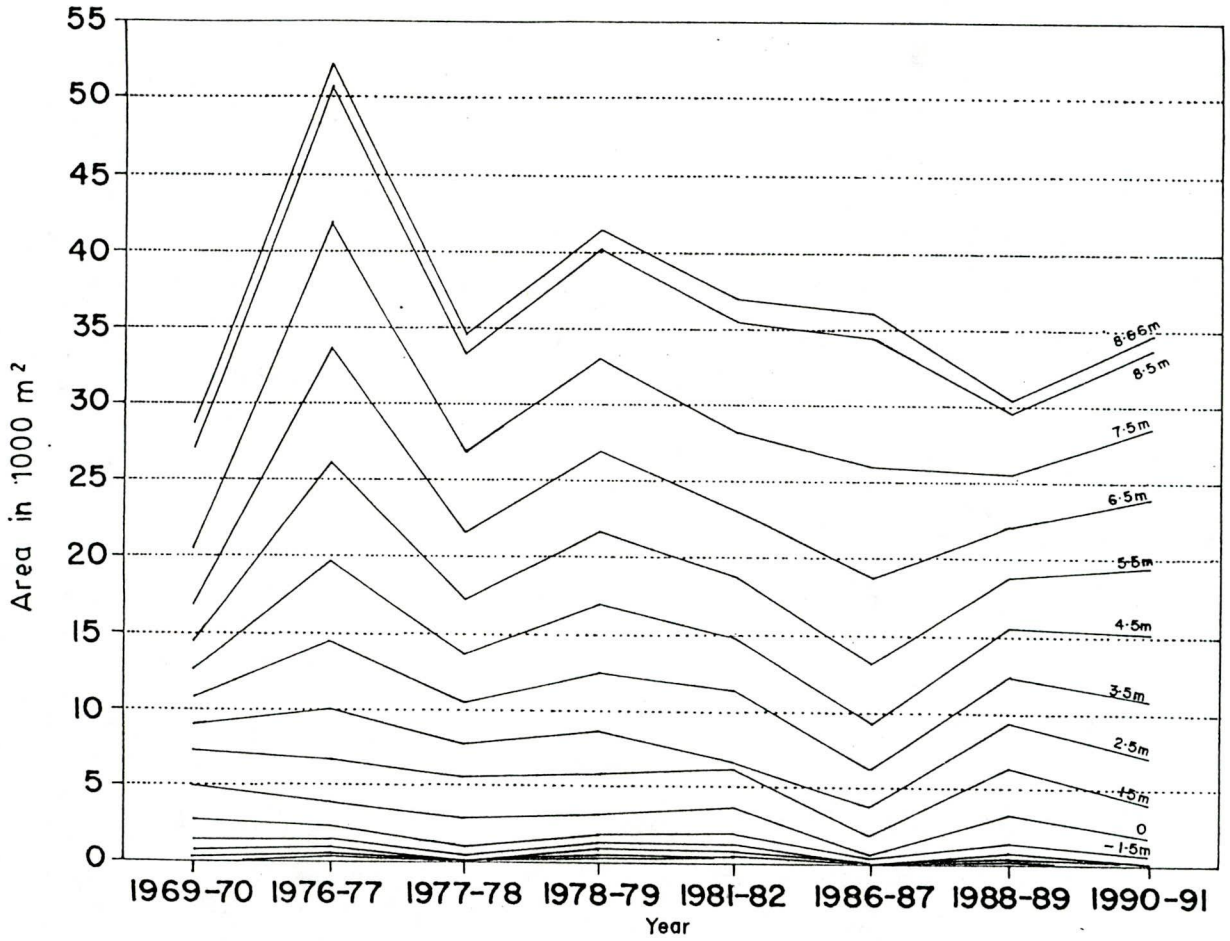


Figure 5.33.a Area upto different elevations Vs. Year (Ch. : 223.20 Km) Sec. J - 2

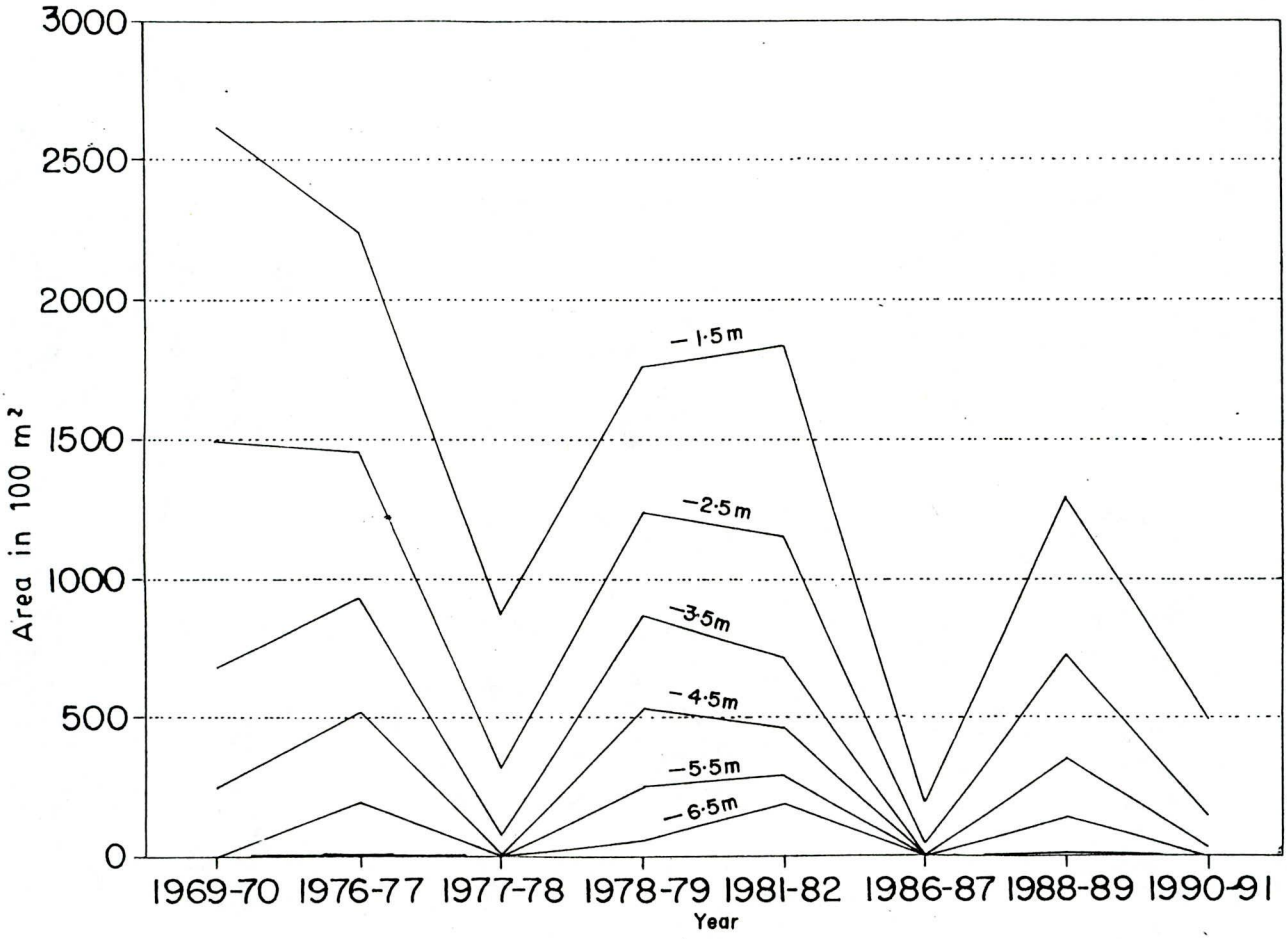


Figure 5.33.b Area upto different elevations Vs. Year (Ch. : 223..20 Km) Sec. J - 2

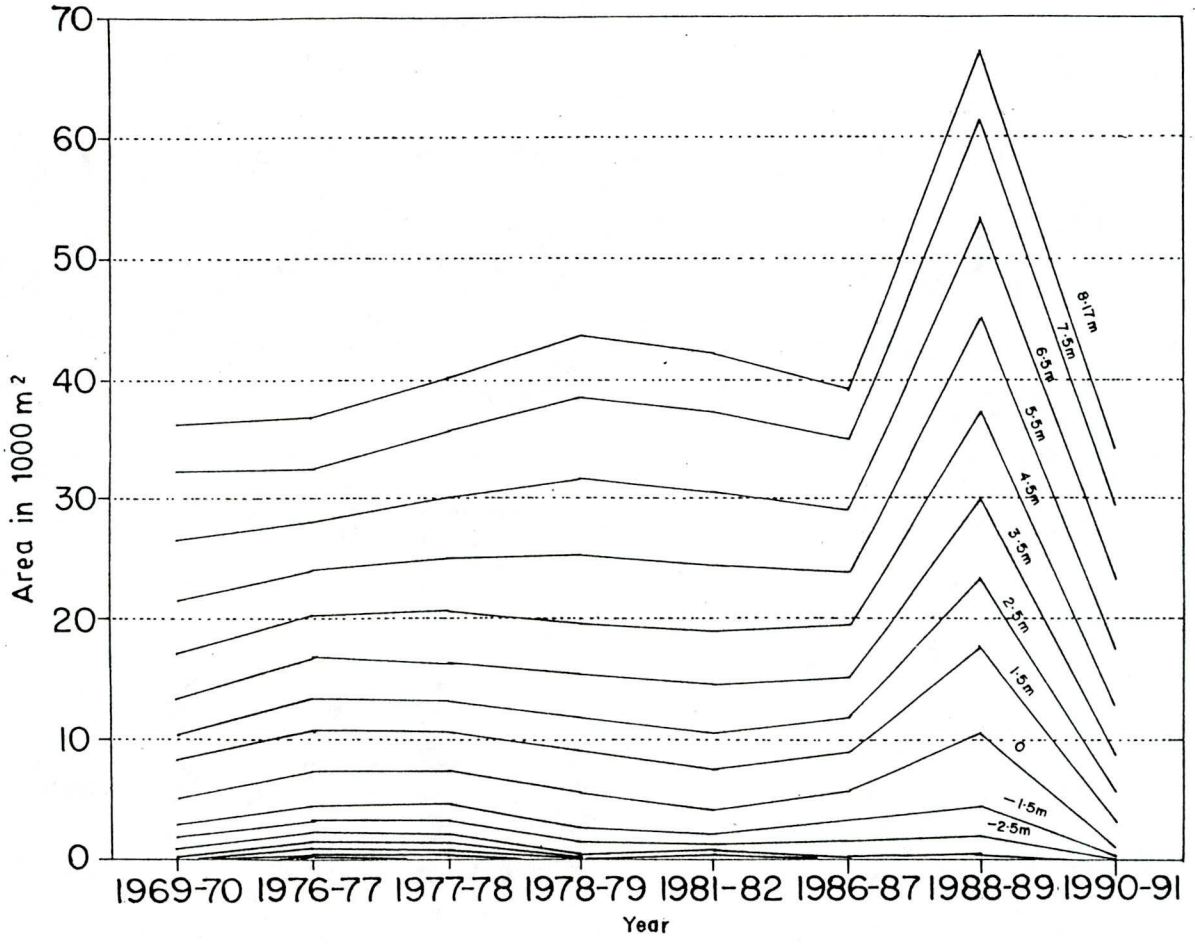


Figure 5.34.a Area upto different elevations Vs. Year (Ch. : 230.75 Km) Sec. J - 1

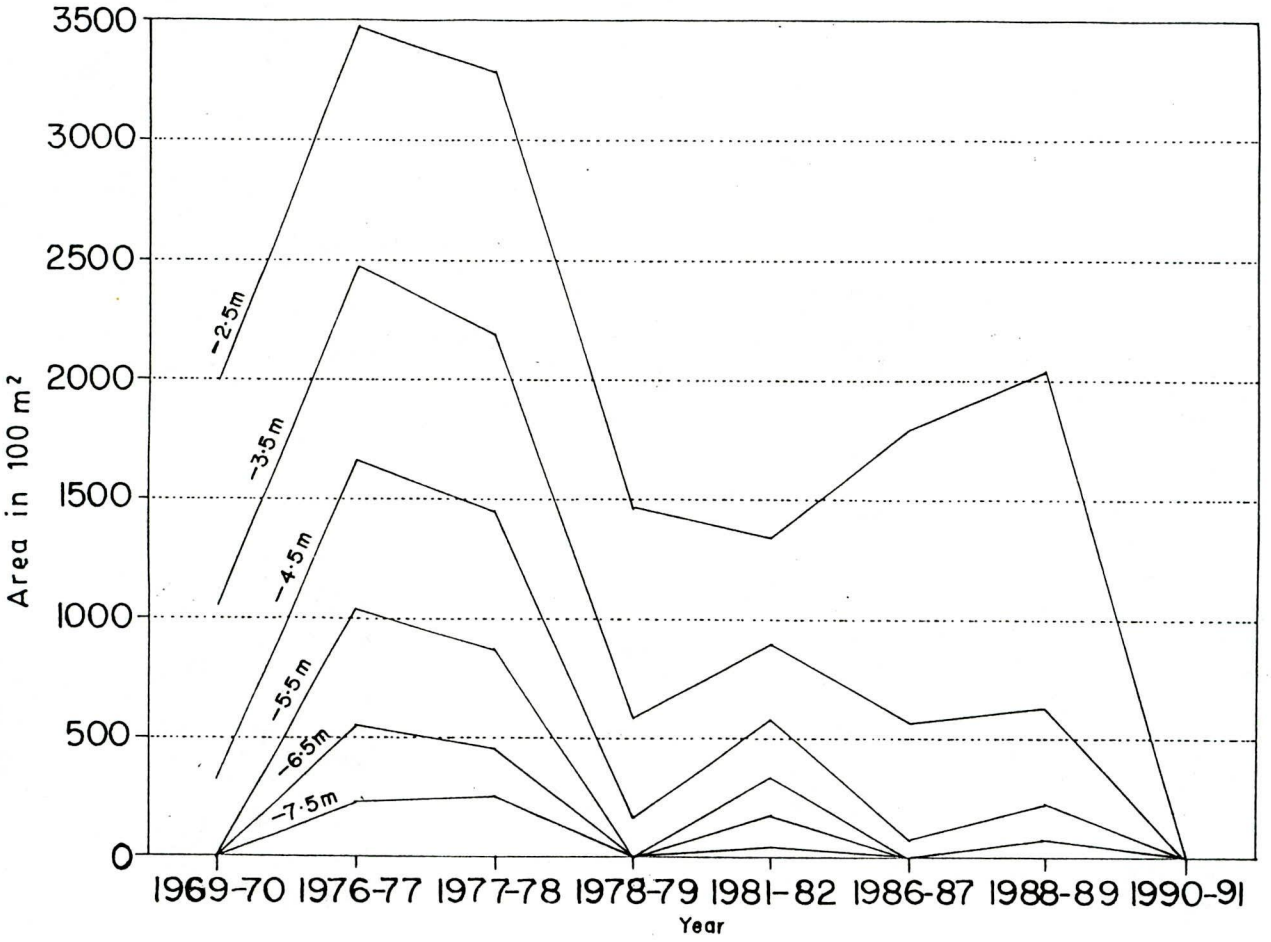


Figure 5.34.b Area upto different elevations Vs. Year (Ch. : 230.75 Km) Sec. J - 1

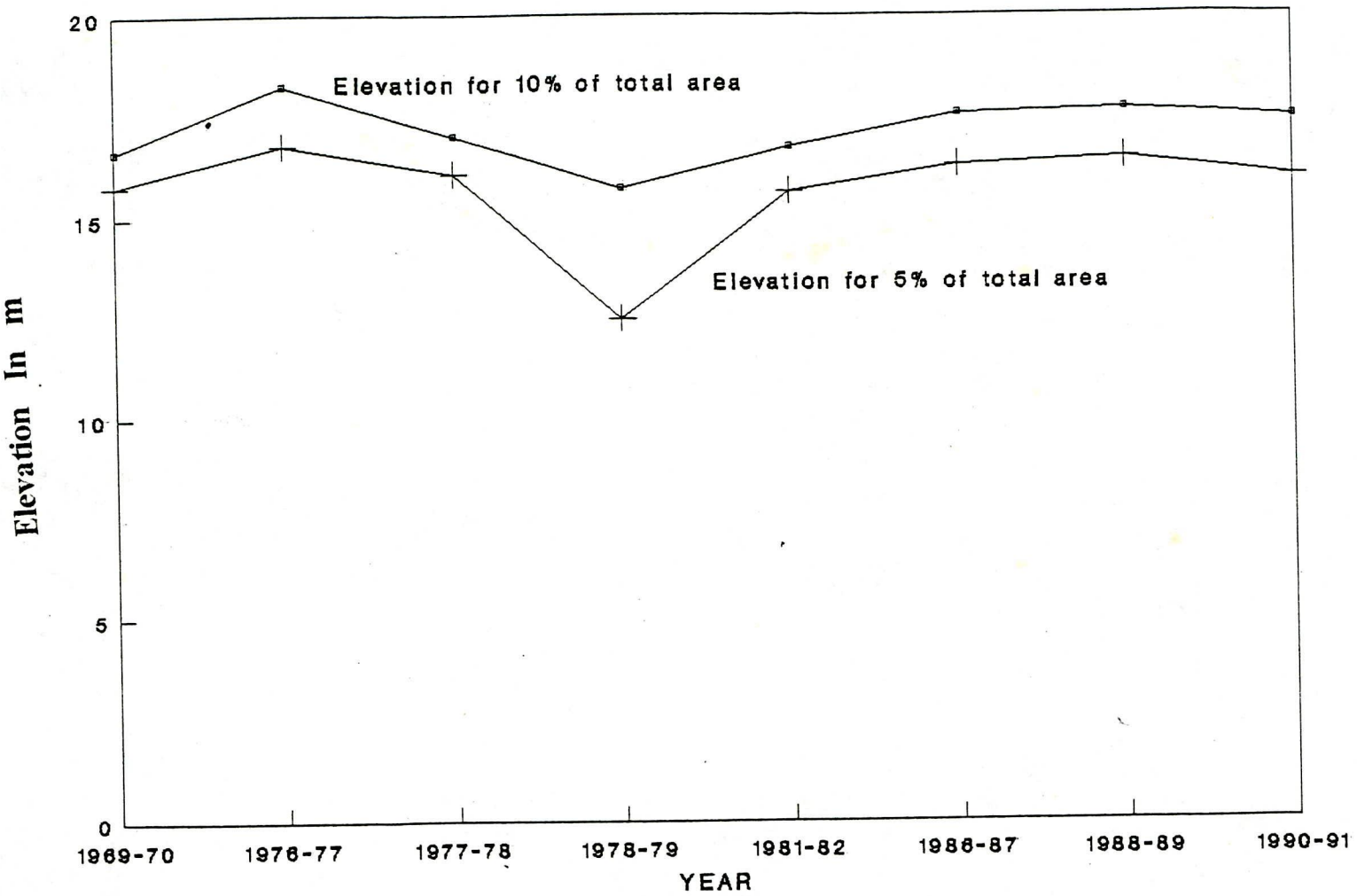


Fig.5.35 Elevation for 5% & 10% of Total Area Vs Year , Section J-17 (Ch. 25.00 Km.)

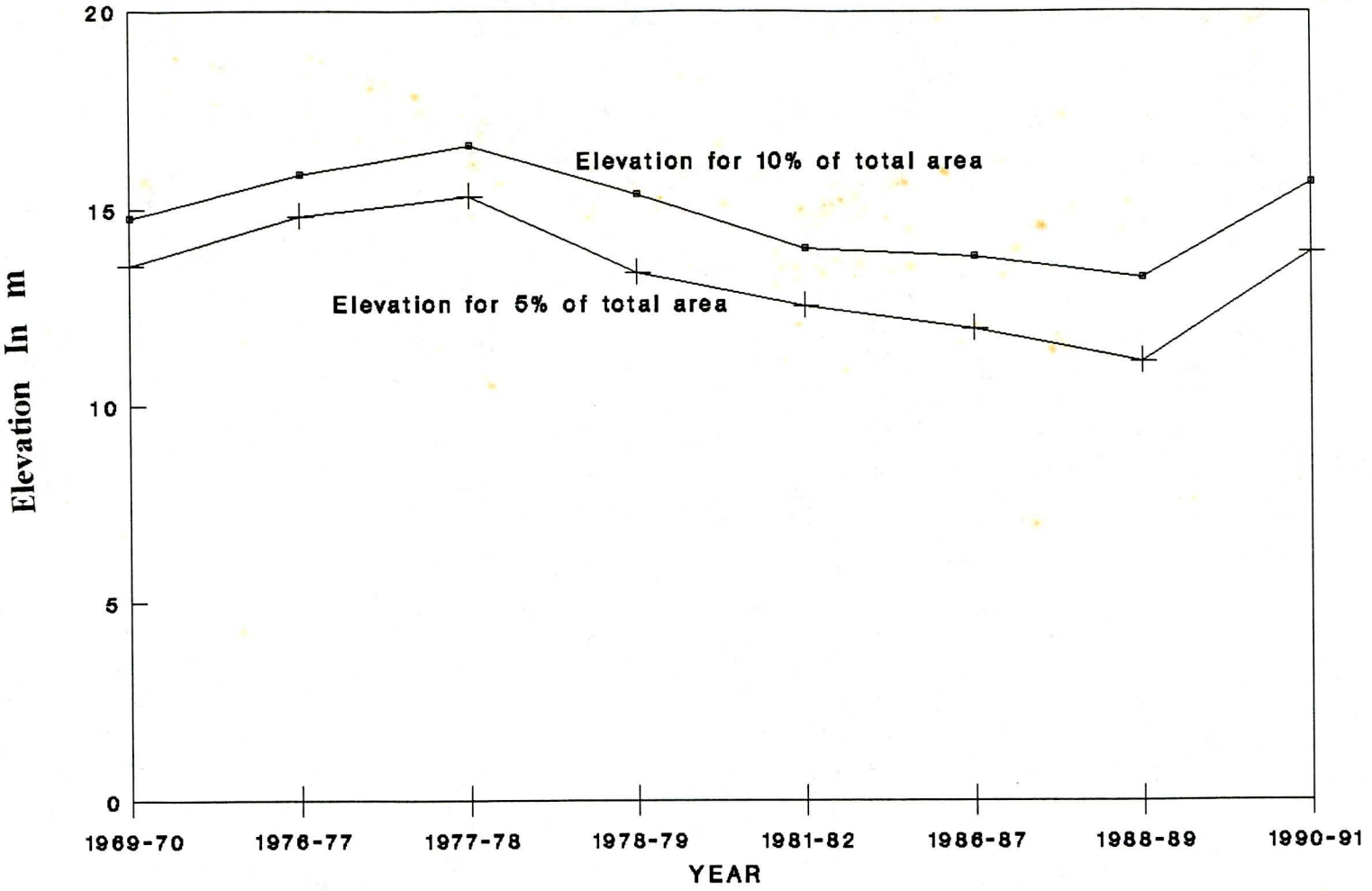


Fig.5.36 Elevation for 5% & 10% of Total Area Vs Year , Section J-16 (Ch. 37.10 Km.)

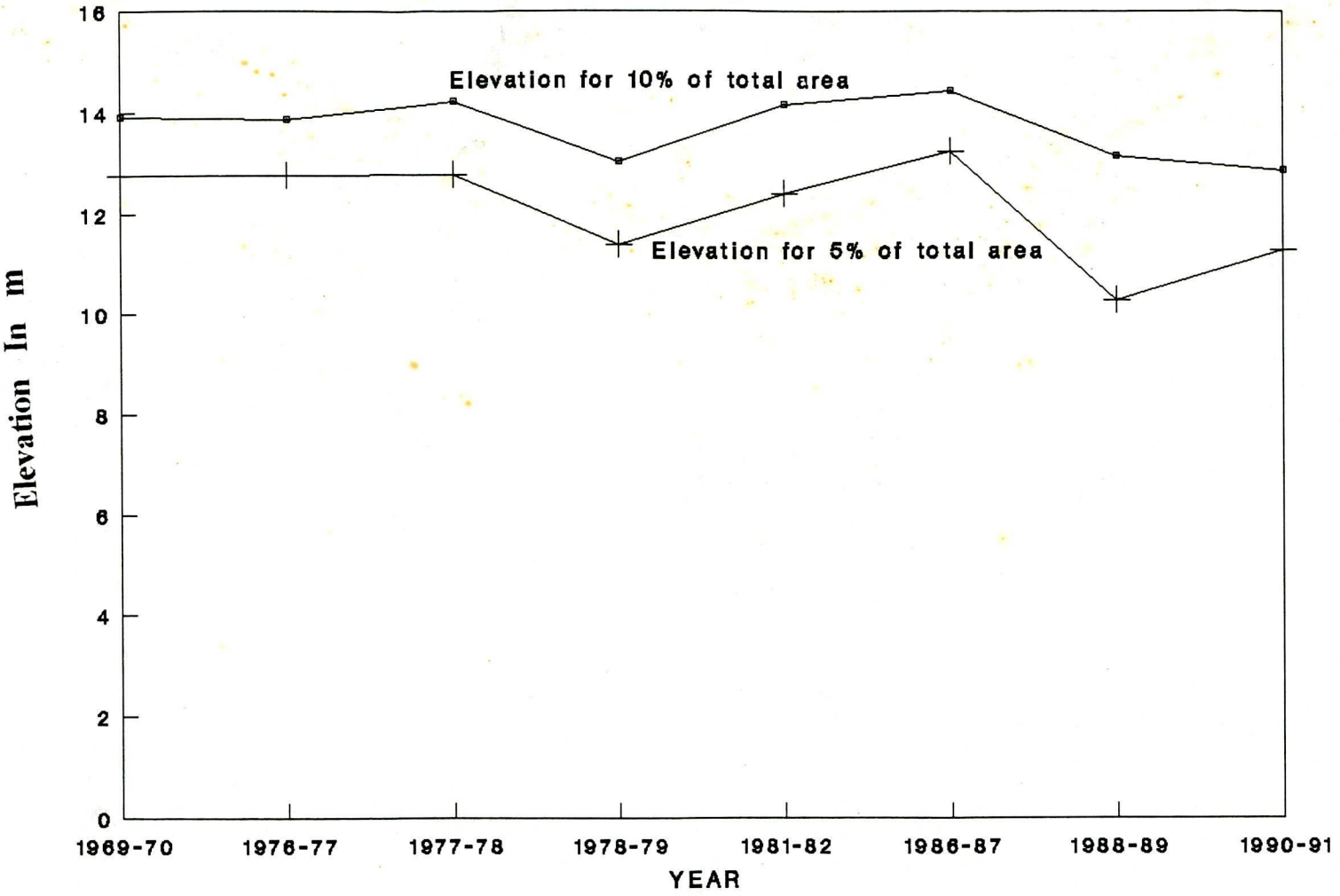


Fig. 5.37 Elevation for 5% & 10% of Total Area Vs Year , Section J-15 (Ch. 55.65 Km.)

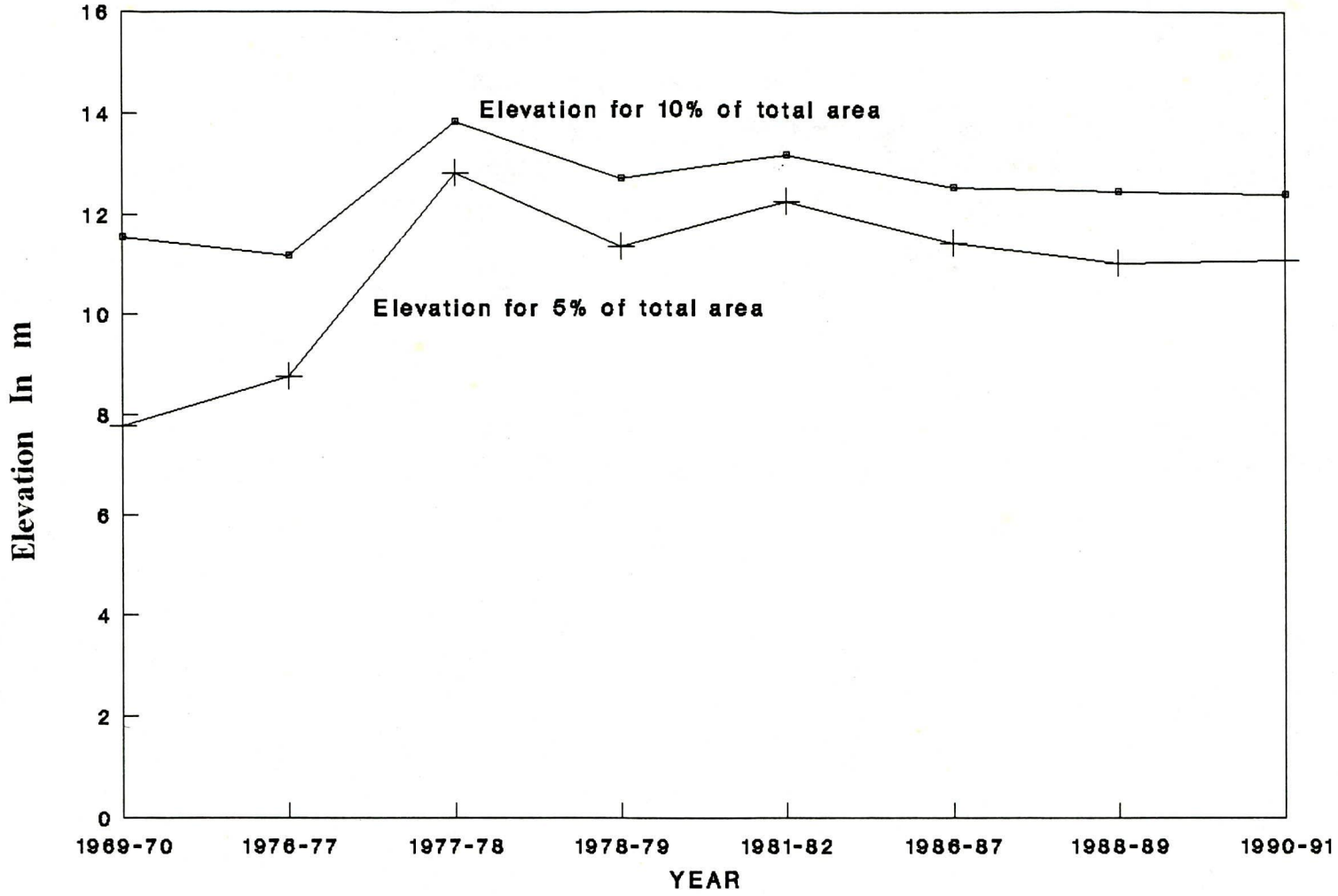


Fig. 5.38 Elevation for 5% & 10% of Total Area Vs Year , Section J-14 (Ch. 71.20 Km.)

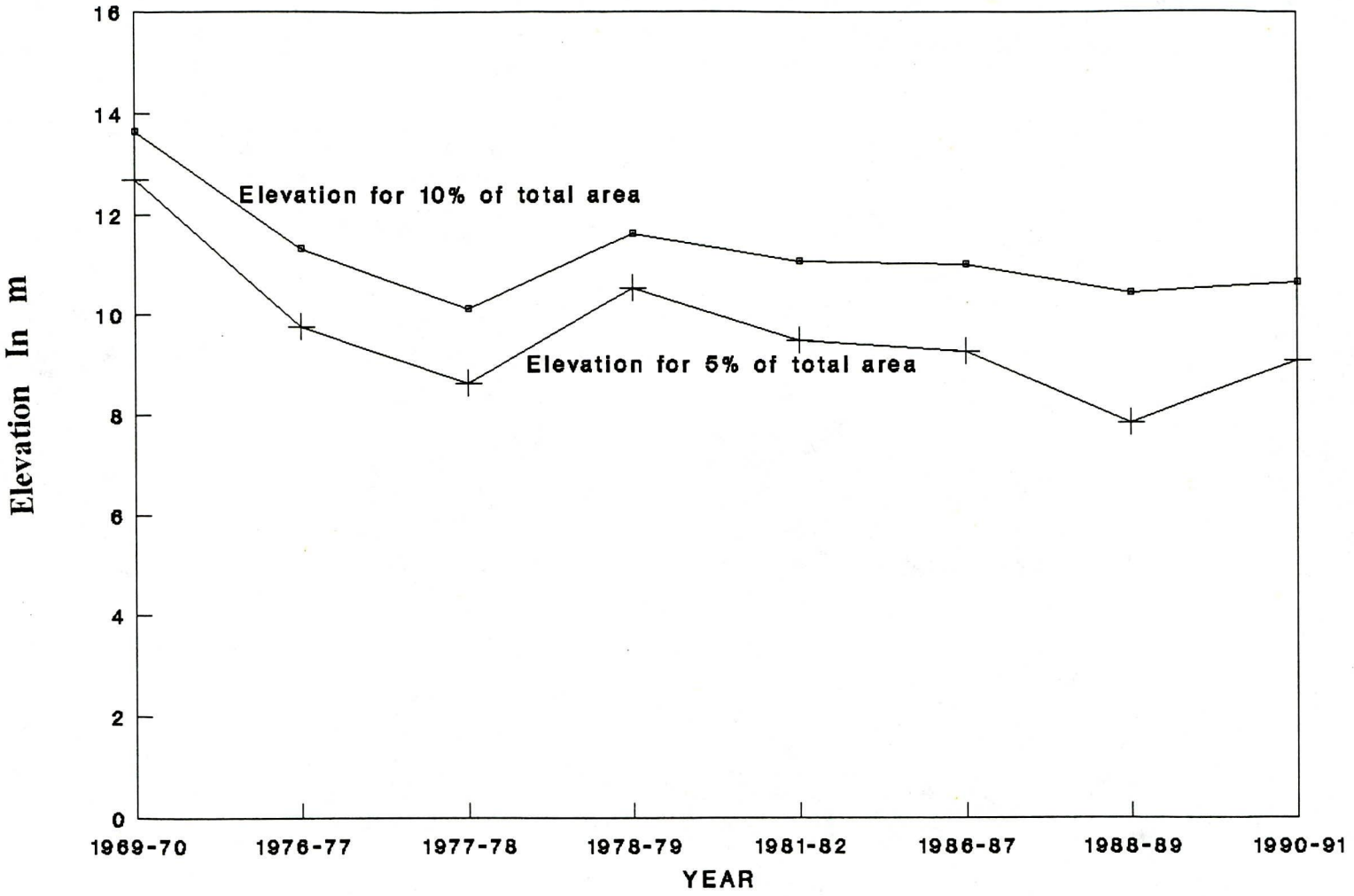


Fig.5.39 Elevation for 5% & 10% of Total Area Vs Year , Section J-13 (Ch. 84.70 Km.)

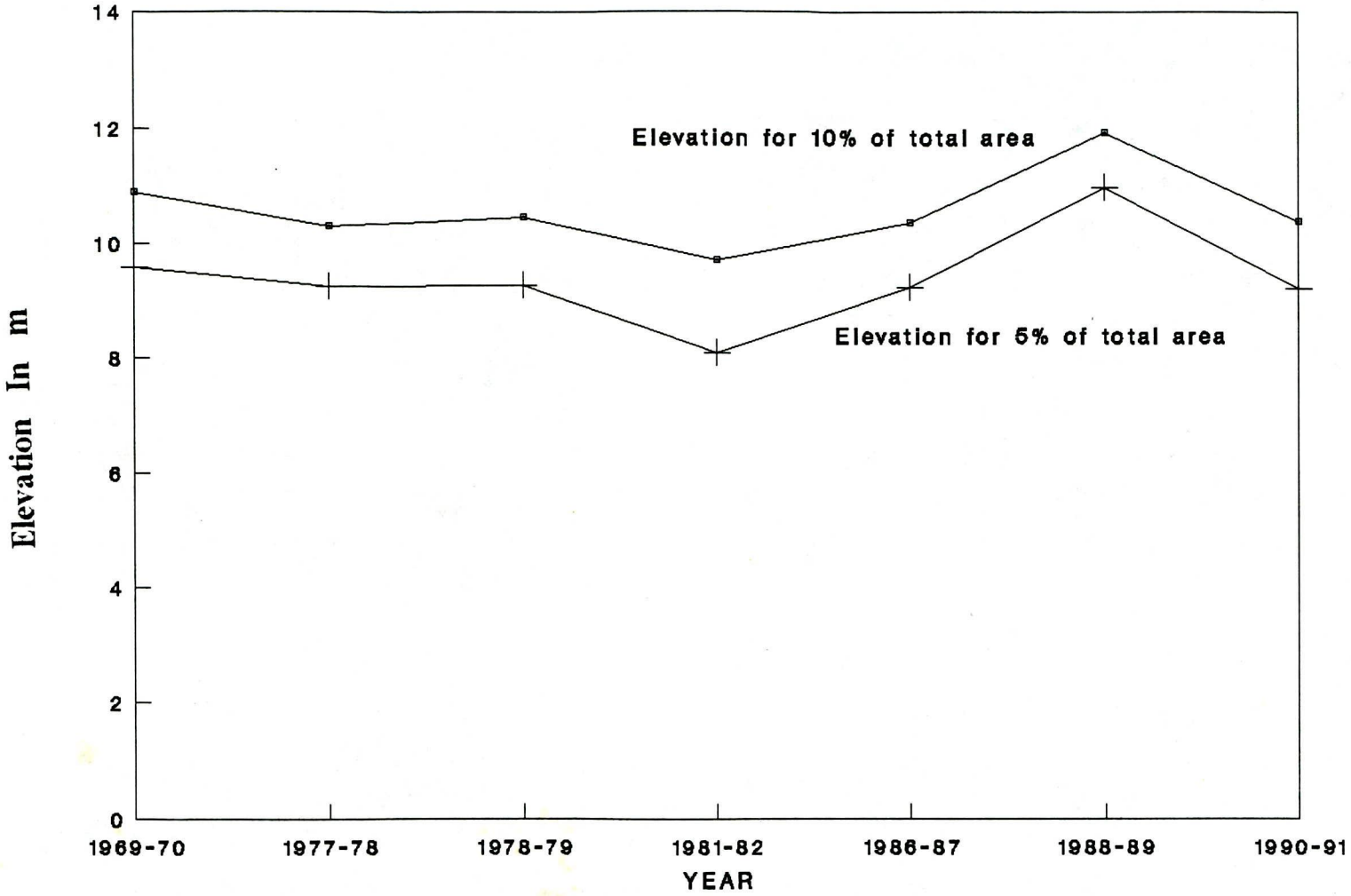


Fig. 5.40 Elevation for 5% & 10% of Total Area Vs Year , Section J-12 (Ch. 100.50 Km.)

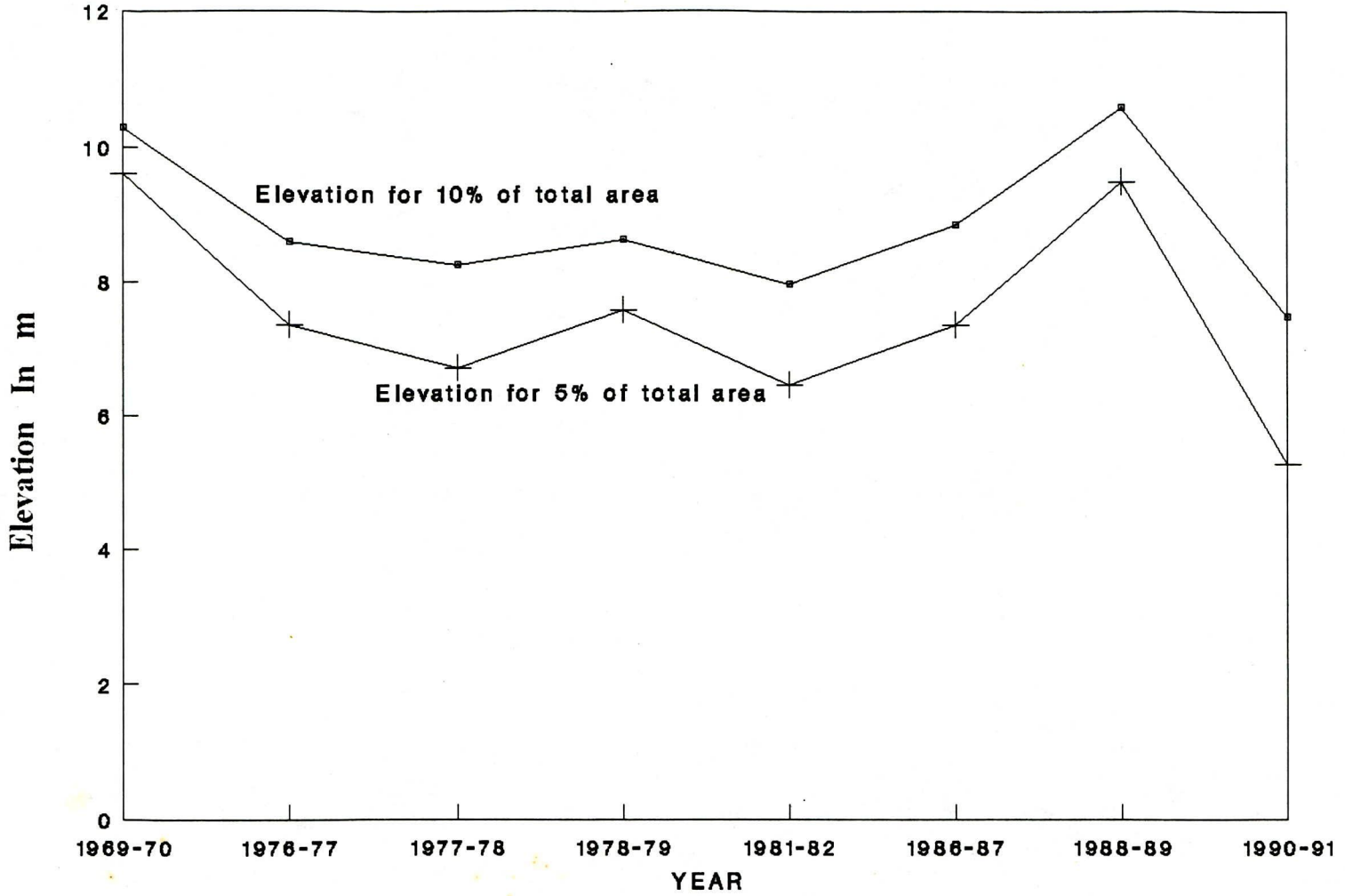


Fig.5.41 Elevation for 5% & 10% of Total Area Vs Year , Section J-11 (Ch. 117.75 Km.)

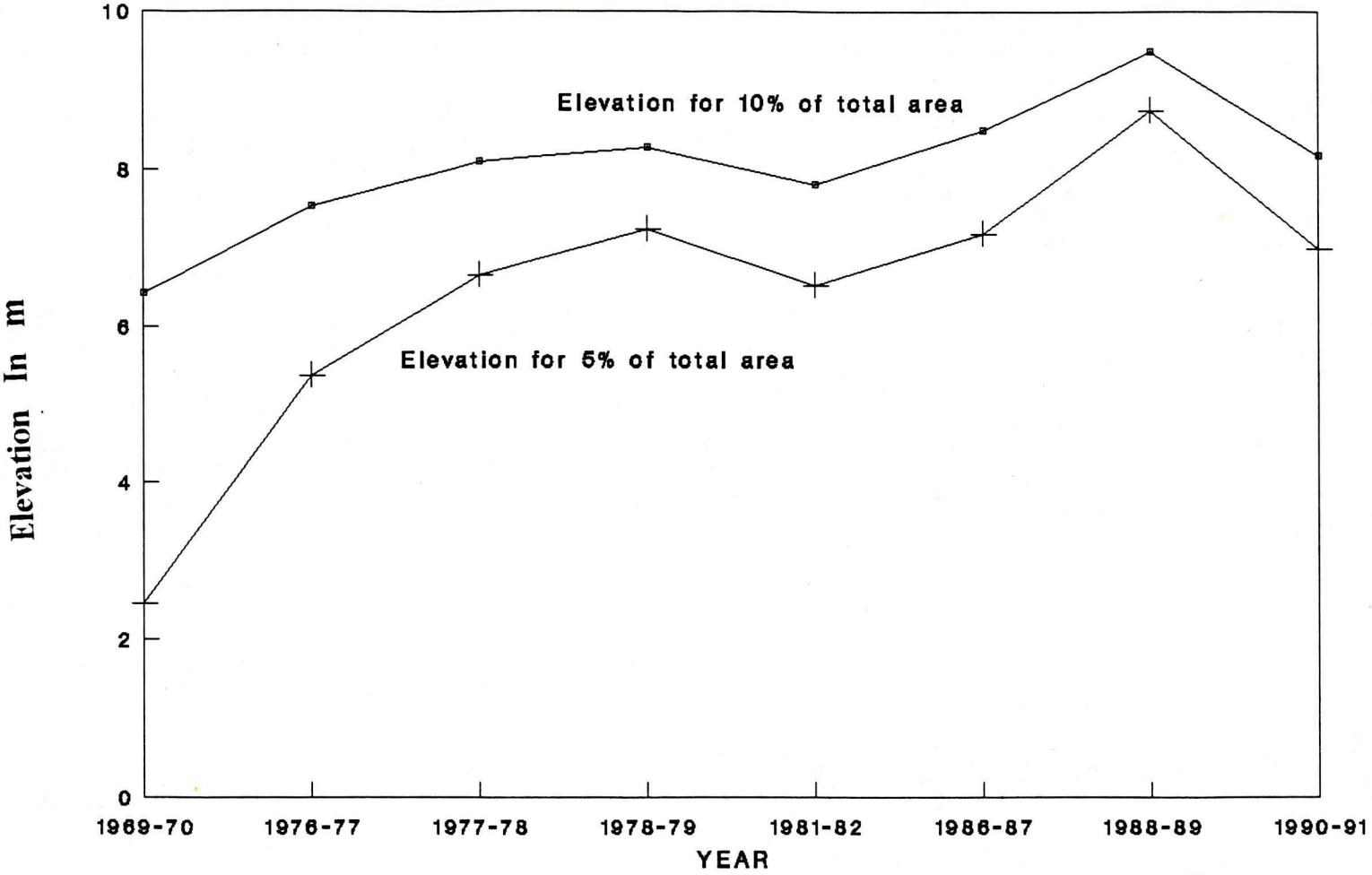


Fig. 5.42 Elevation for 5% & 10% of Total Area Vs Year , Section J-10 (Ch. 134.30 Km.)

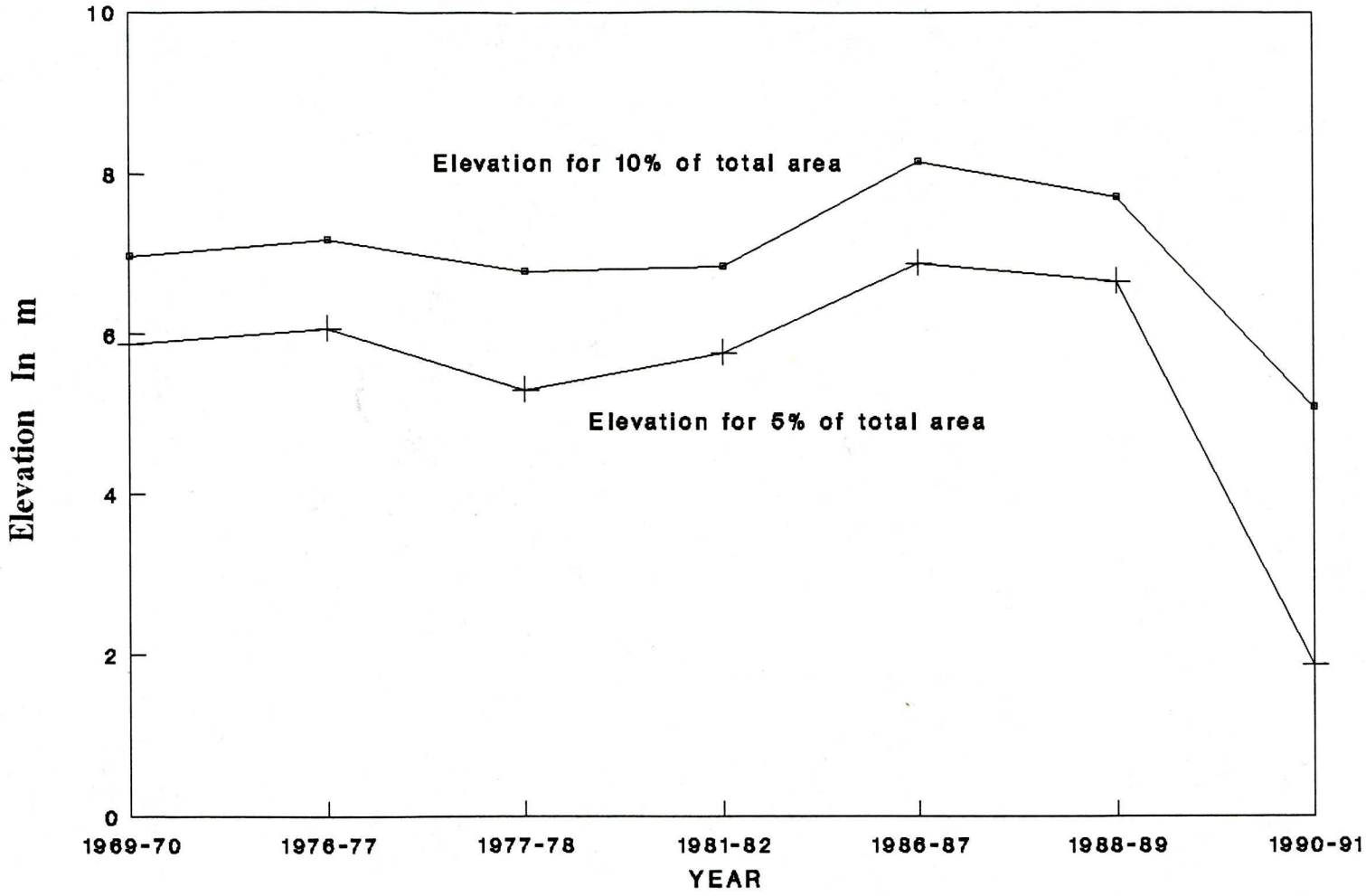


Fig. 5.43 Elevation for 5% & 10% of Total Area Vs Year , Section J-9 (Ch. 142.45 Km.)

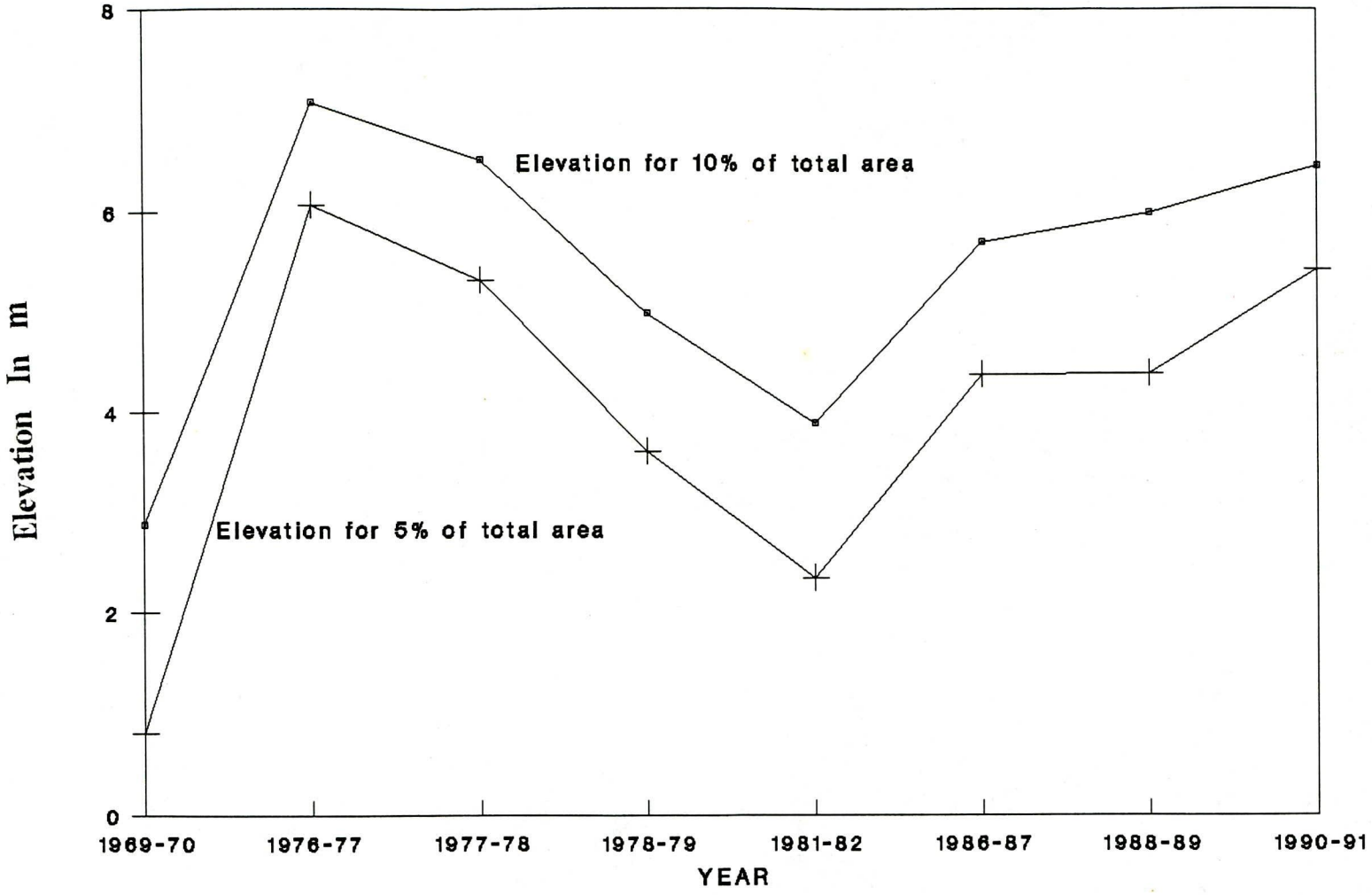


Fig. 5.44 Elevation for 5% & 10% of Total Area Vs Year , Section J-8 (Ch. 149.50 Km.)

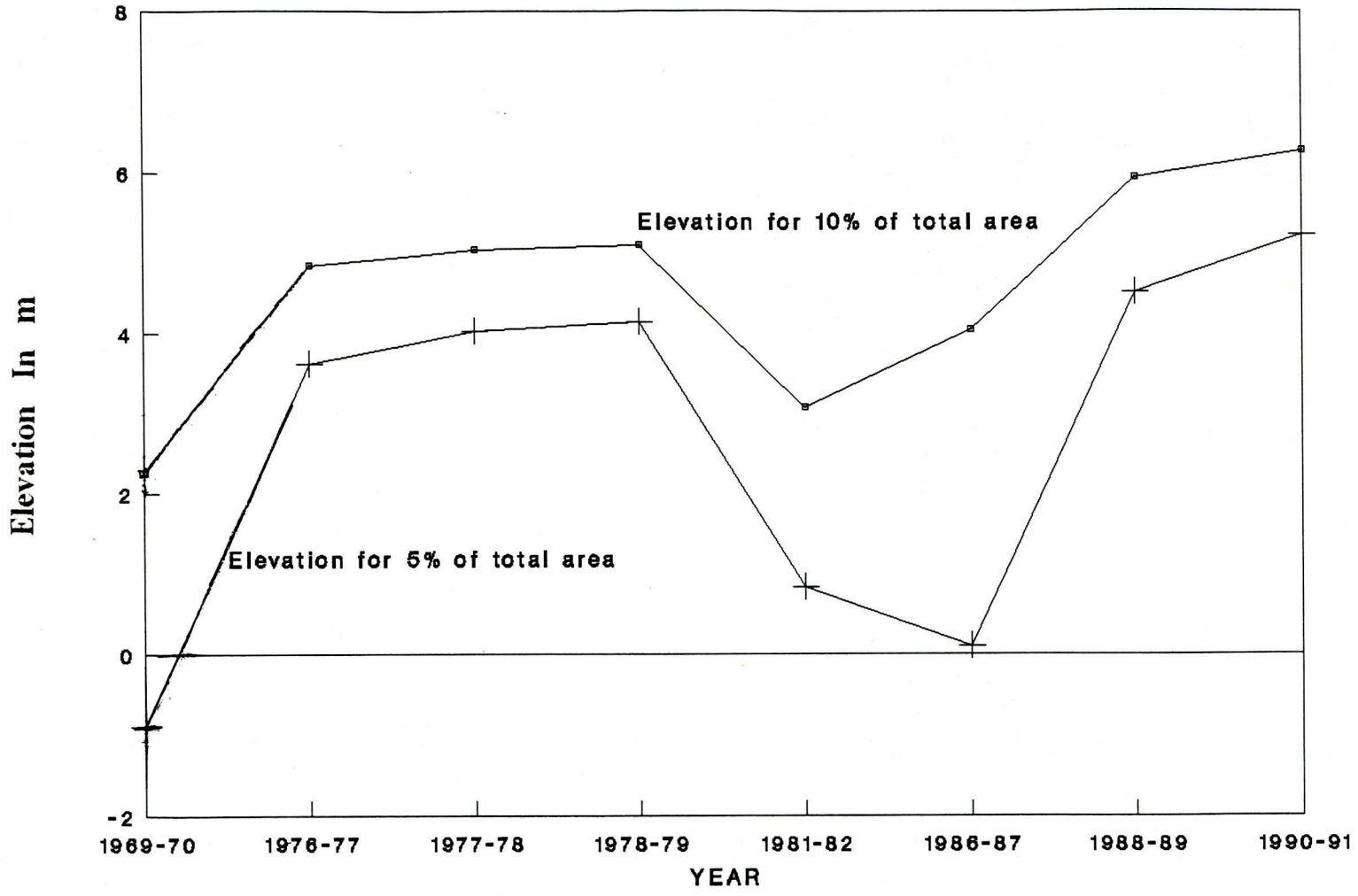


Fig.5.45 Elevation for 5% & 10% of Total Area Vs Year , Section J-7 (Ch. 162.35 Km.)

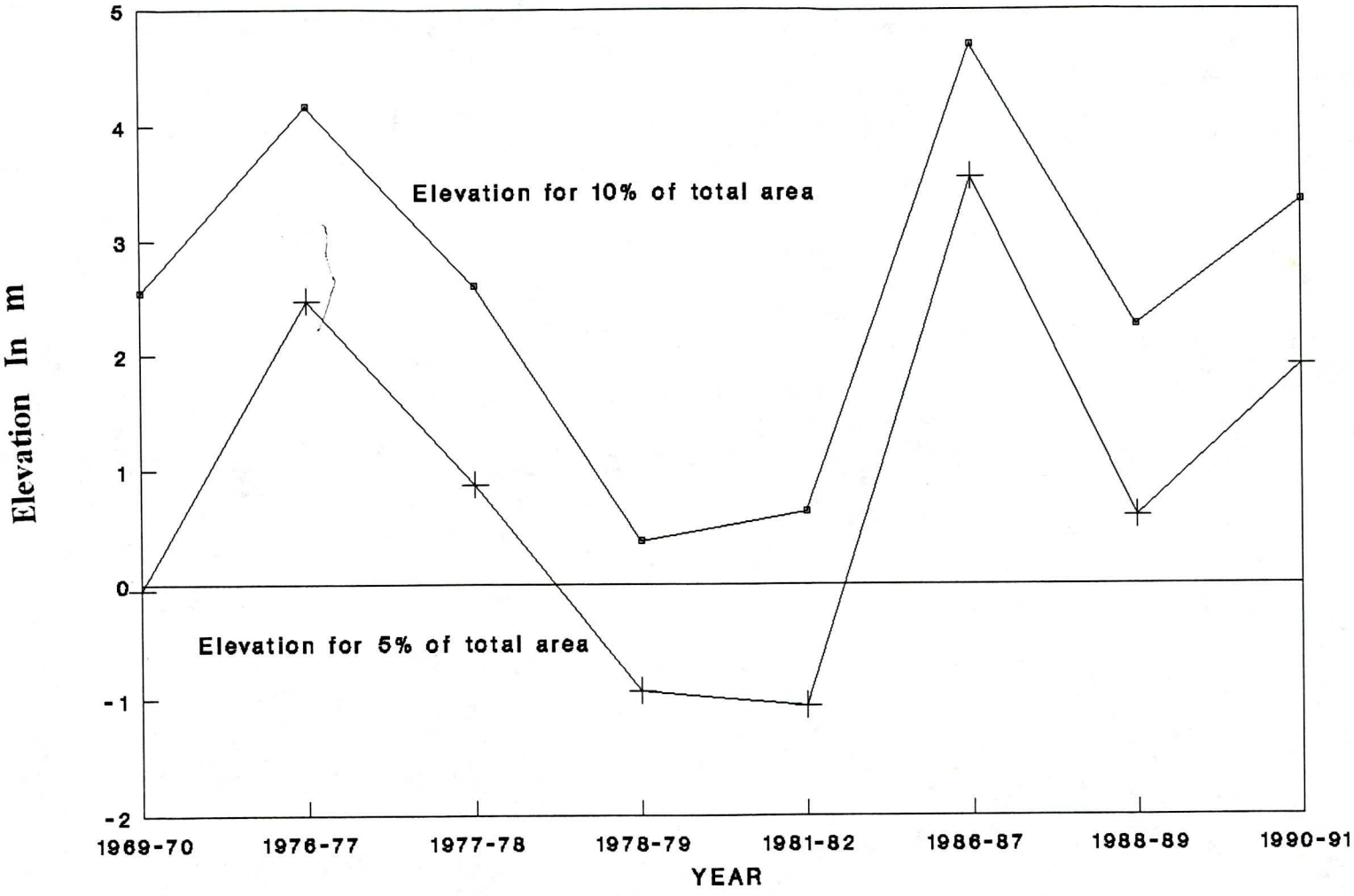


Fig. 5.46 Elevation for 5% & 10% of Total Area Vs Year , Section J-6 (Ch. 177.70 Km.)

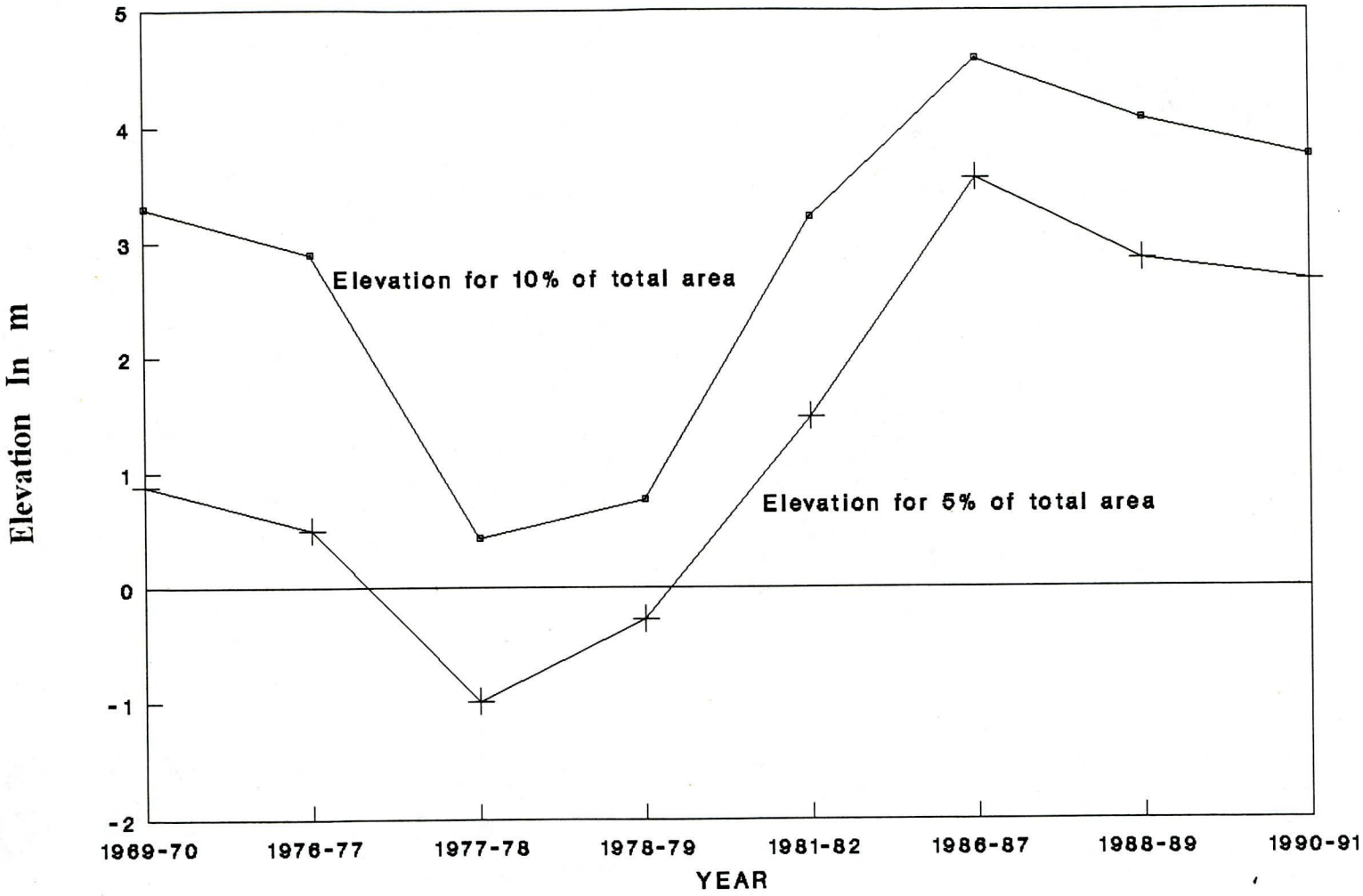


Fig. 5.47 Elevation for 5% & 10% of Total Area Vs Year , Section J-5 (Ch. 188.20 Km.)

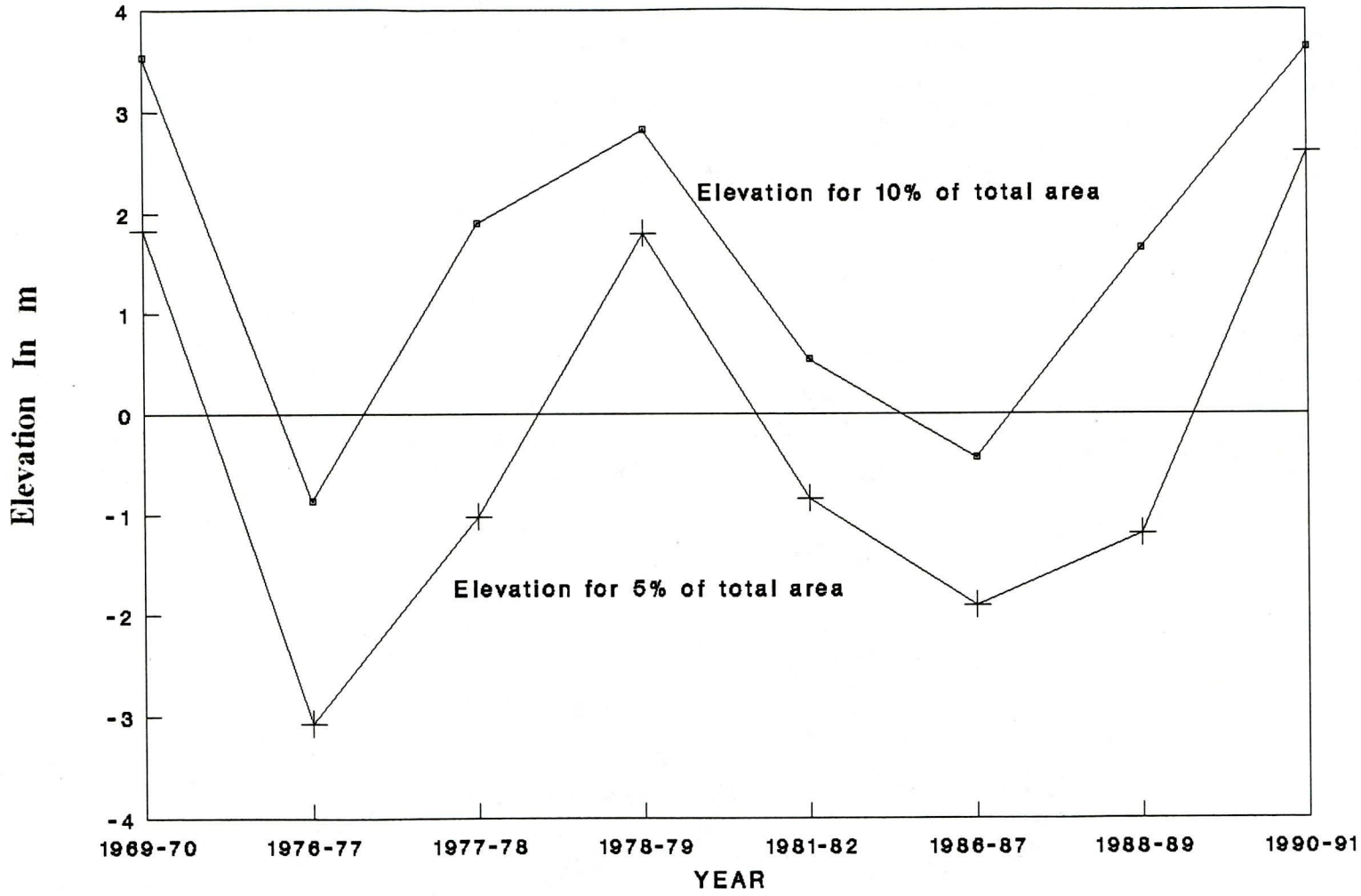


Fig. 5.48 Elevation for 5% & 10% of Total Area Vs Year , Section J-4 (Ch. 201.30 Km.)

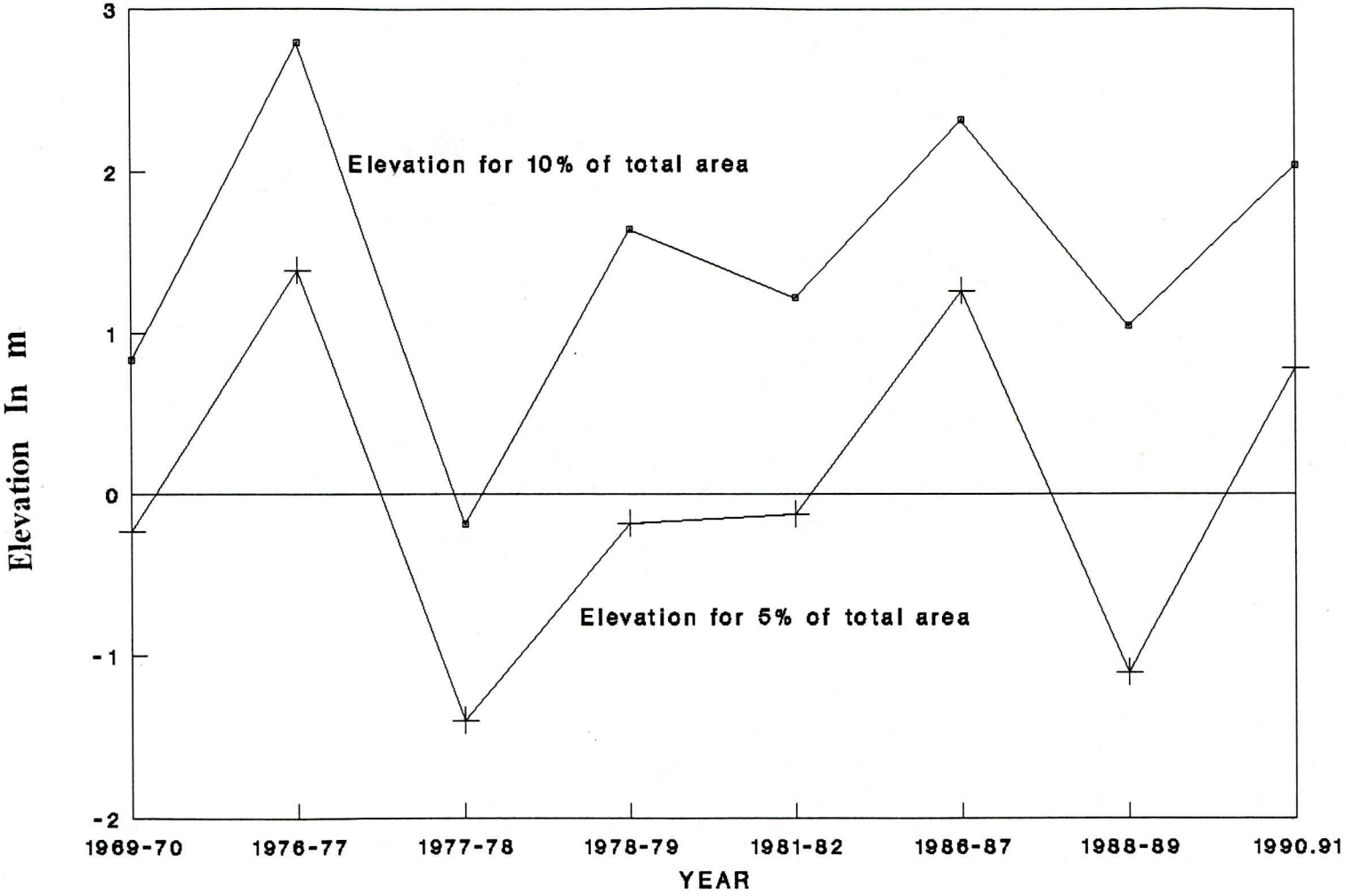


Fig. 5.49 Elevation for 5% & 10% of Total Area Vs Year , Section J-3 (Ch. 213.20 Km.)

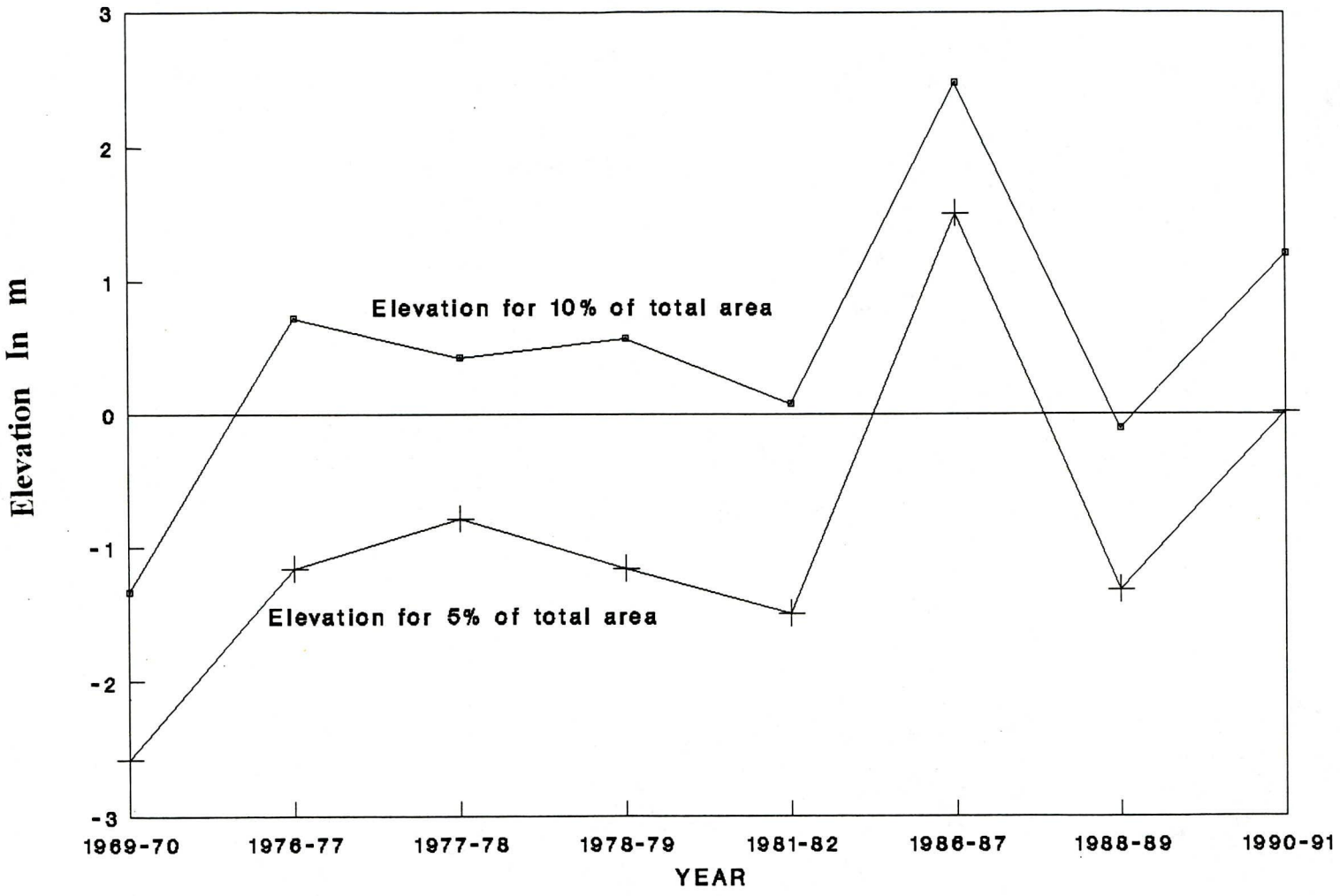


Fig. 5.50 Elevation for 5% & 10% of Total Area Vs Year , Section J-2 (Ch. 223.20 Km.)

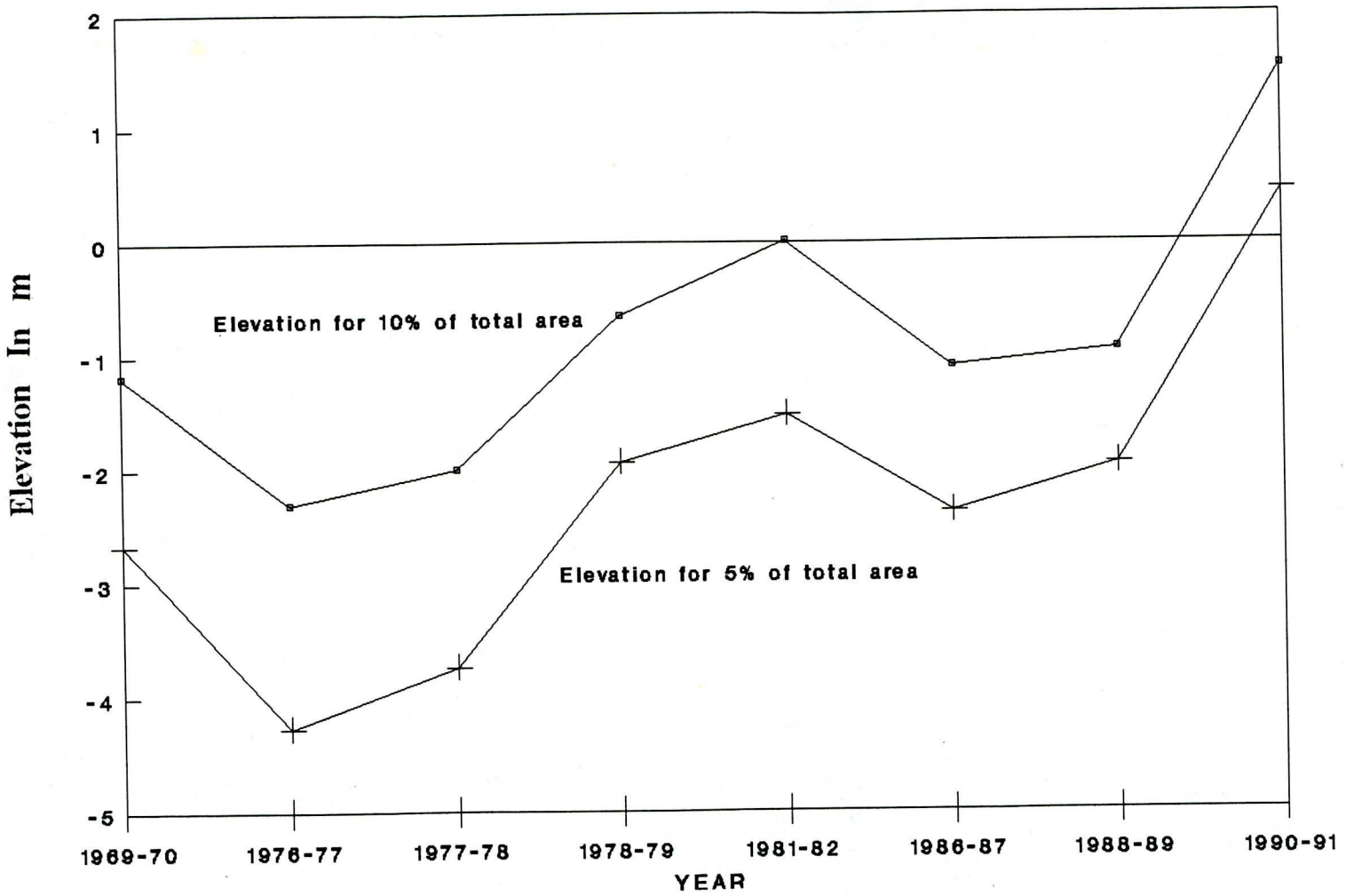


Fig. 5.51 Elevation for 5% & 10% of Total Area Vs Year , Section J-1 (Ch. 230.75 Km.)

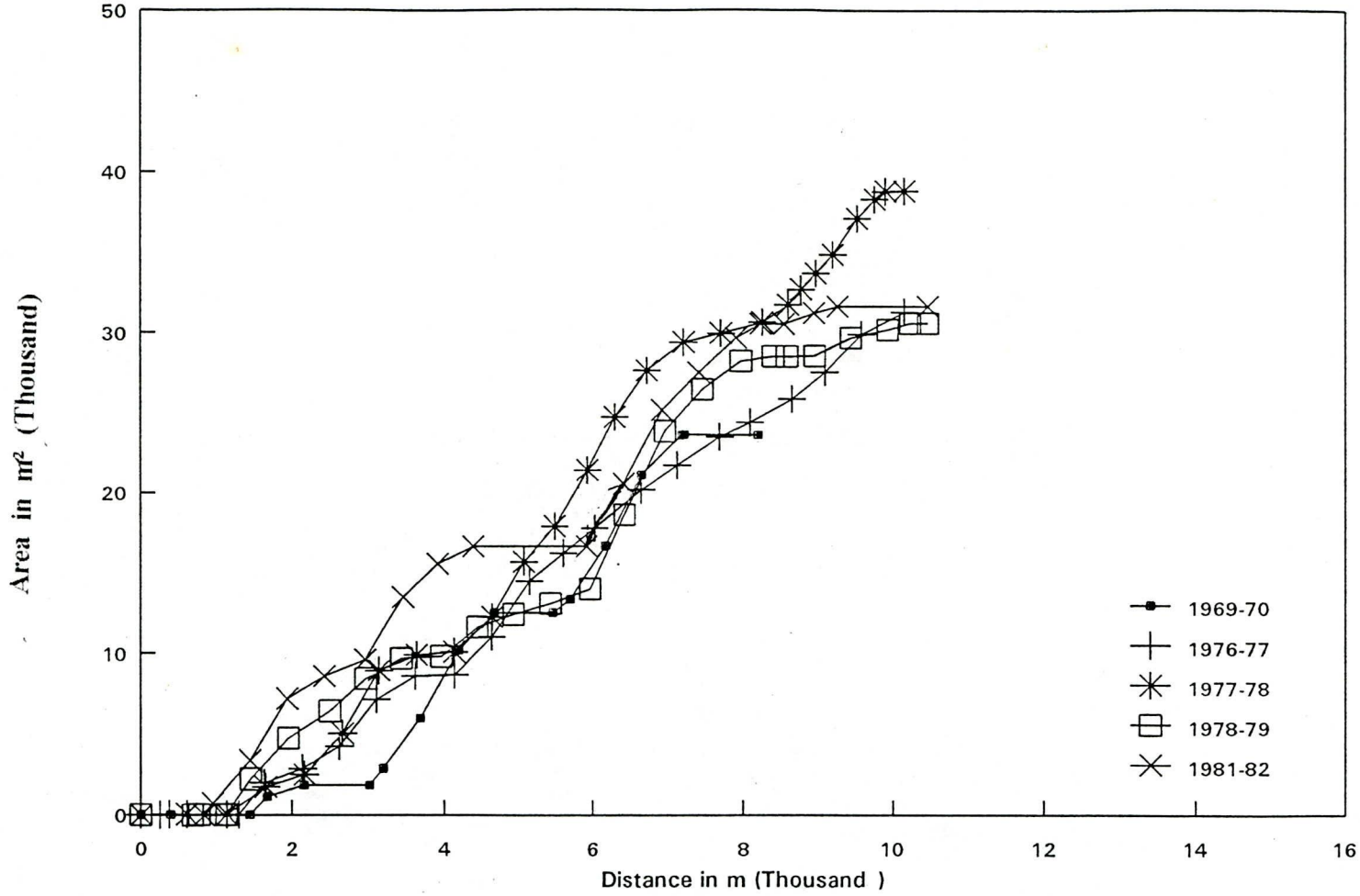


Figure 5.52.a Area Vs. Distance across the width (Ch.: 25.00 Km.) Sec. J - 17

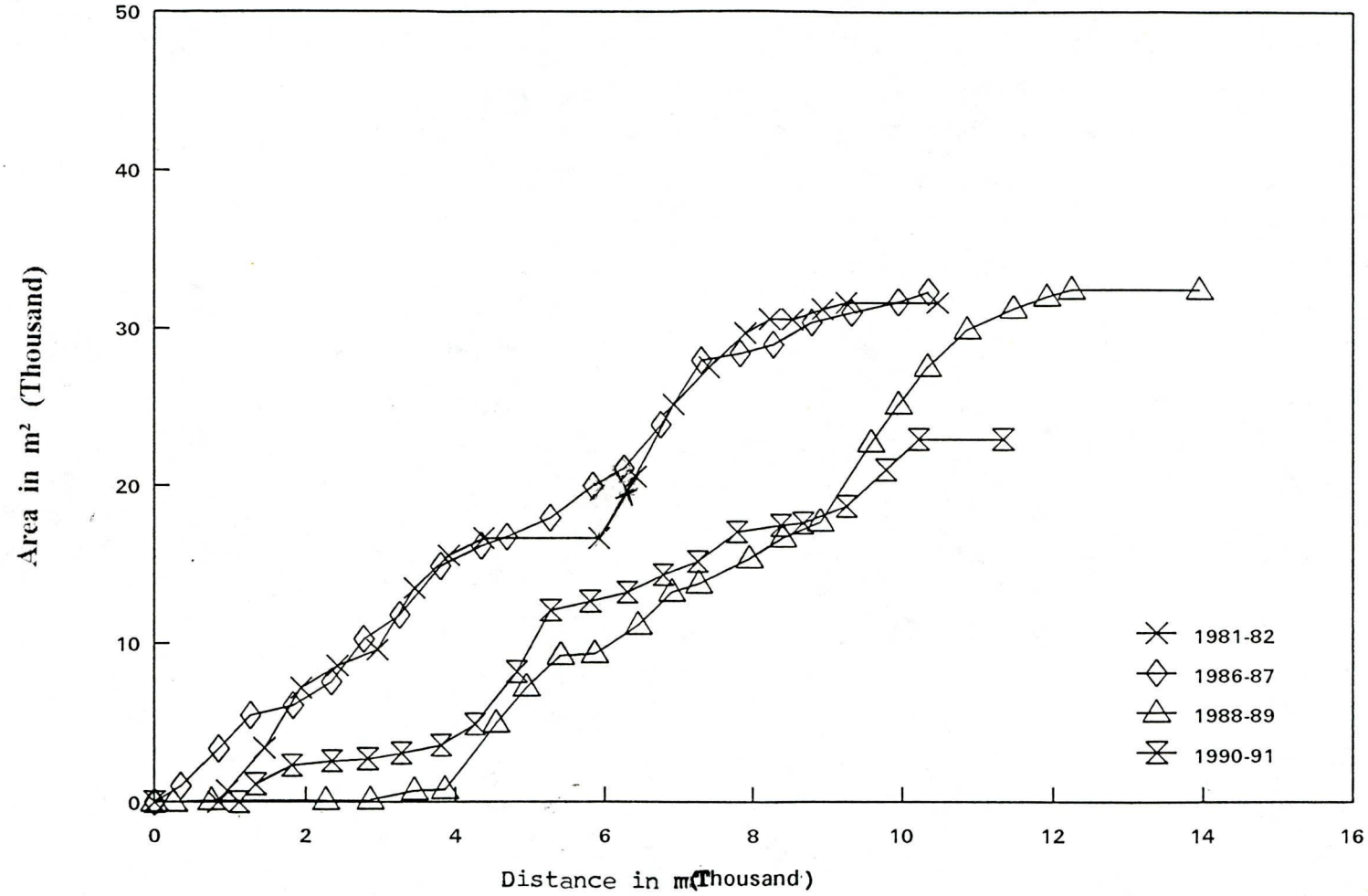


Figure 5.52.b Area Vs. Distance across the width (Ch.: 25.00 Km.) Sec. J - 17

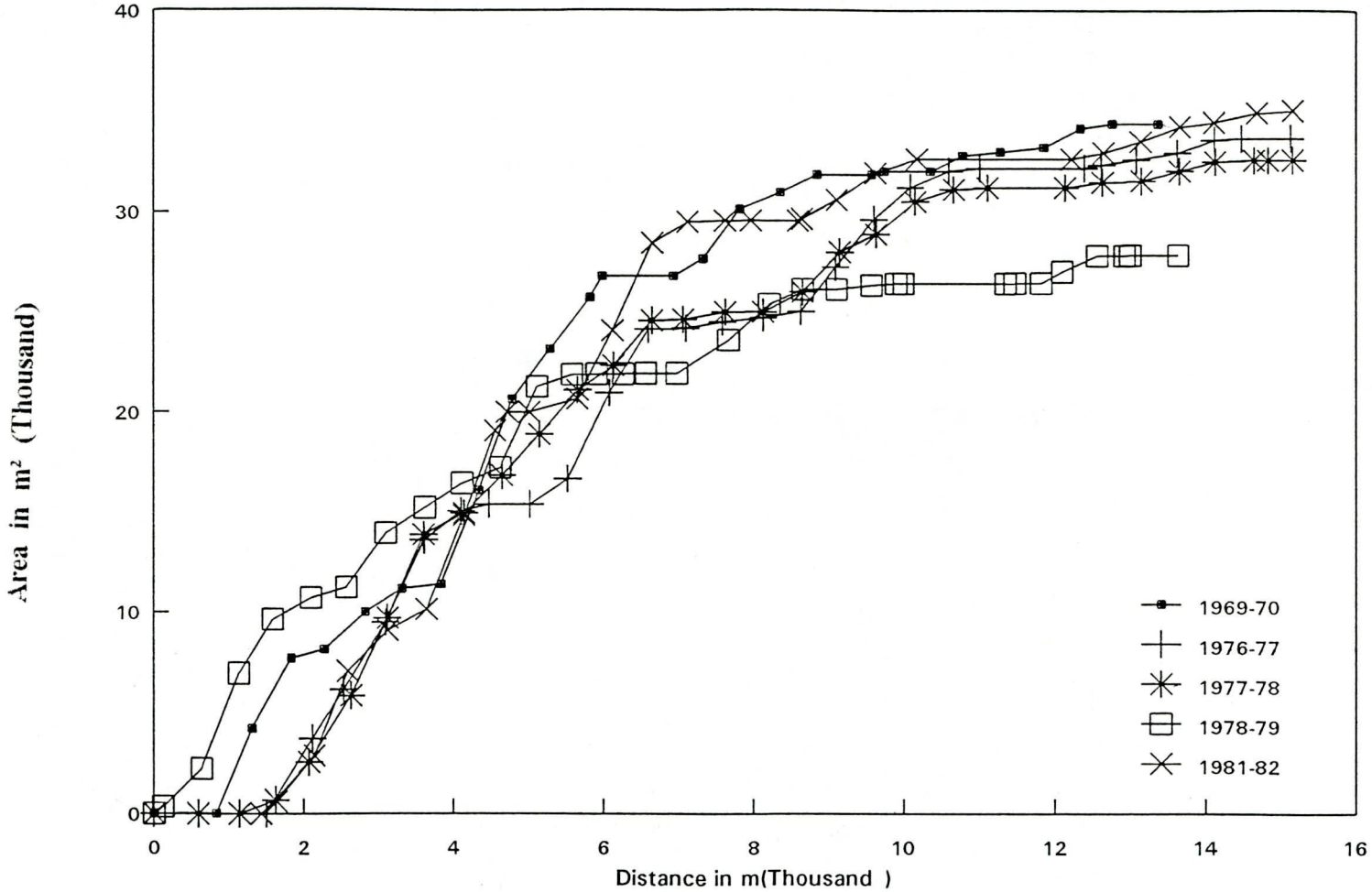


Figure 5.53.a Area Vs. Distance across the width (Ch.: 37.10 Km.) Sec. J - 16

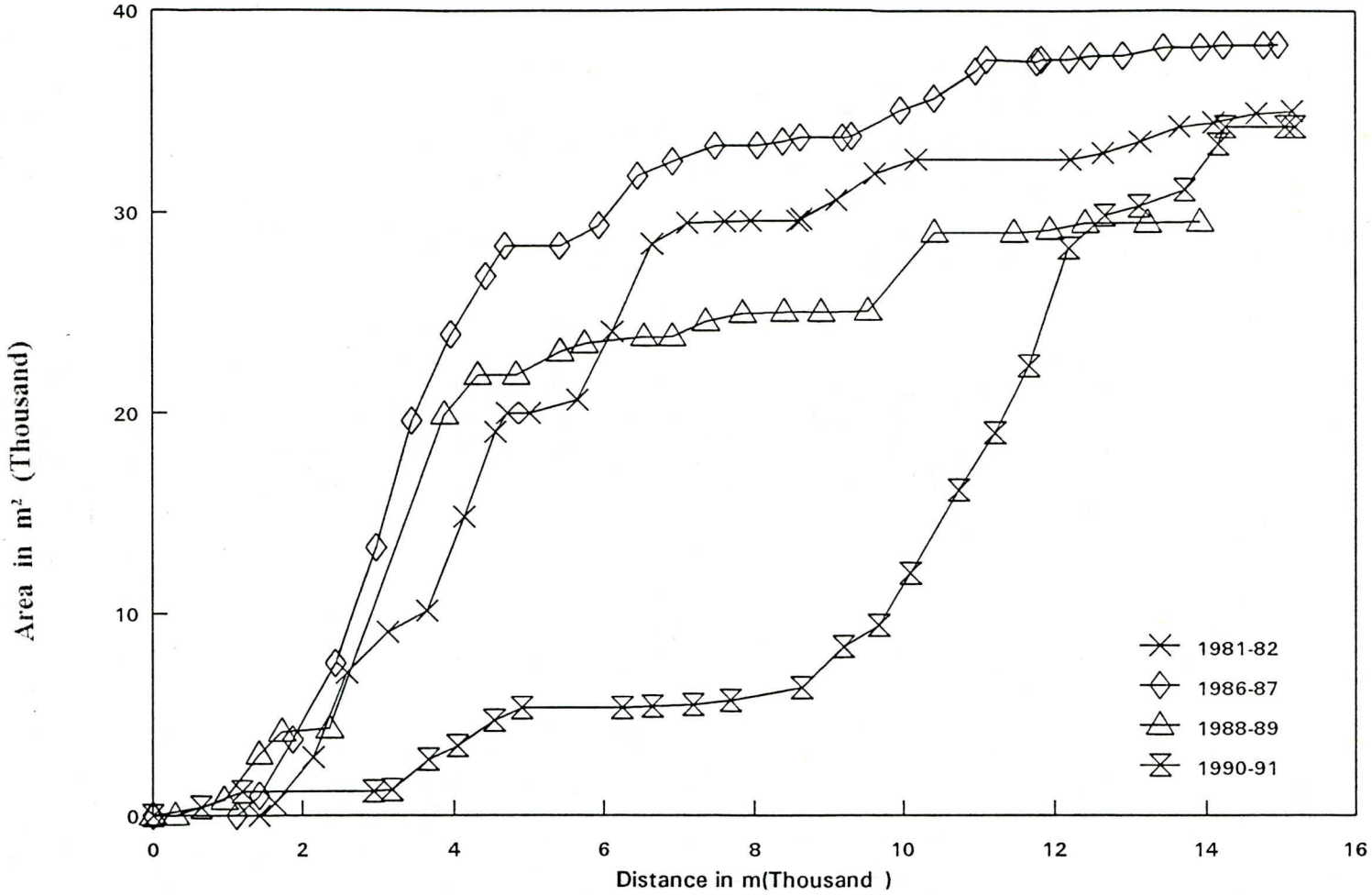


Figure 5.53.b Area Vs. Distance across the width (Ch.: 37.10 Km.) Sec. J - 16

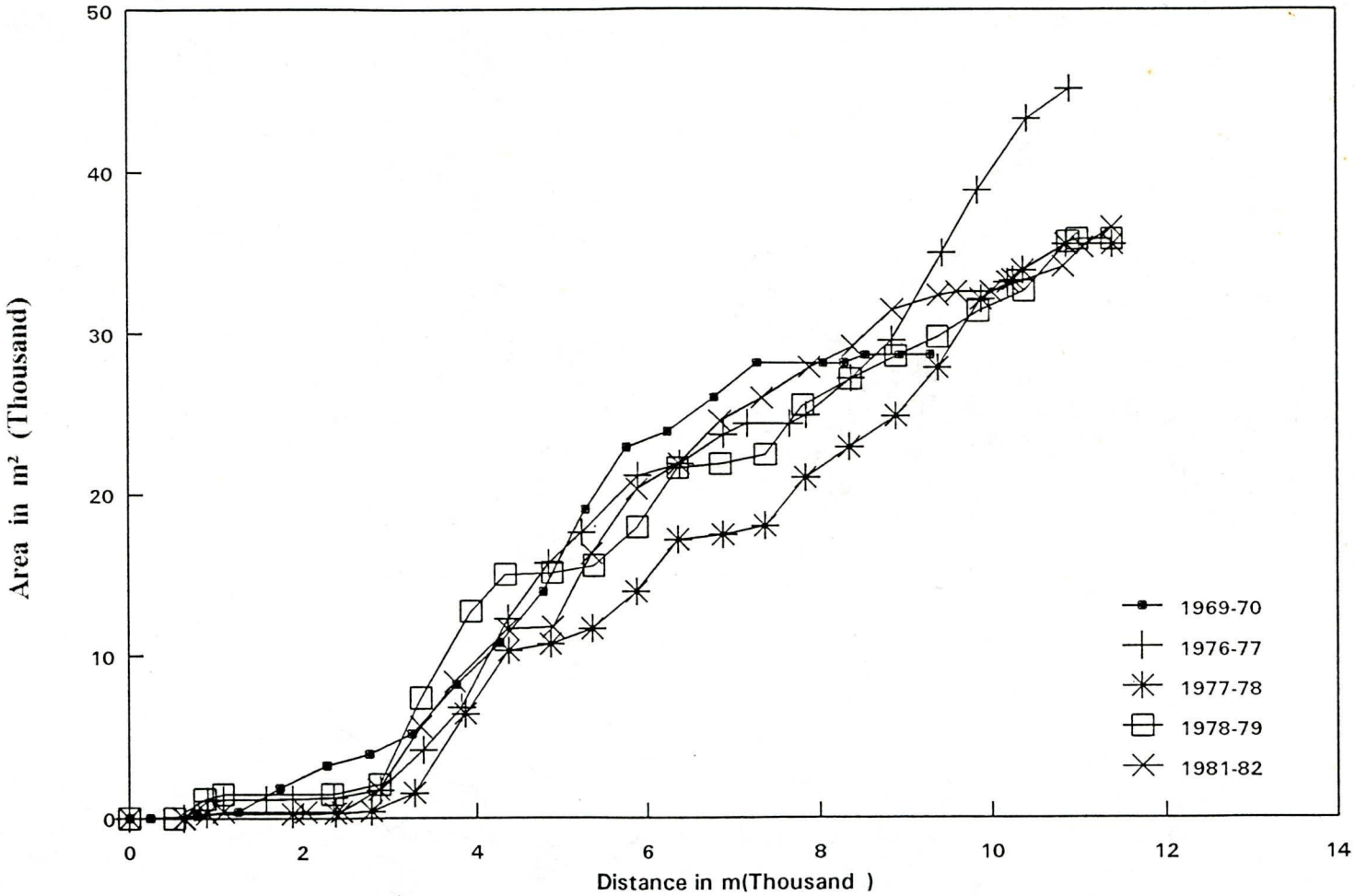


Figure 5.54.a Area Vs. Distance across the width (Ch.: 55.65 Km.) Sec. J - 15

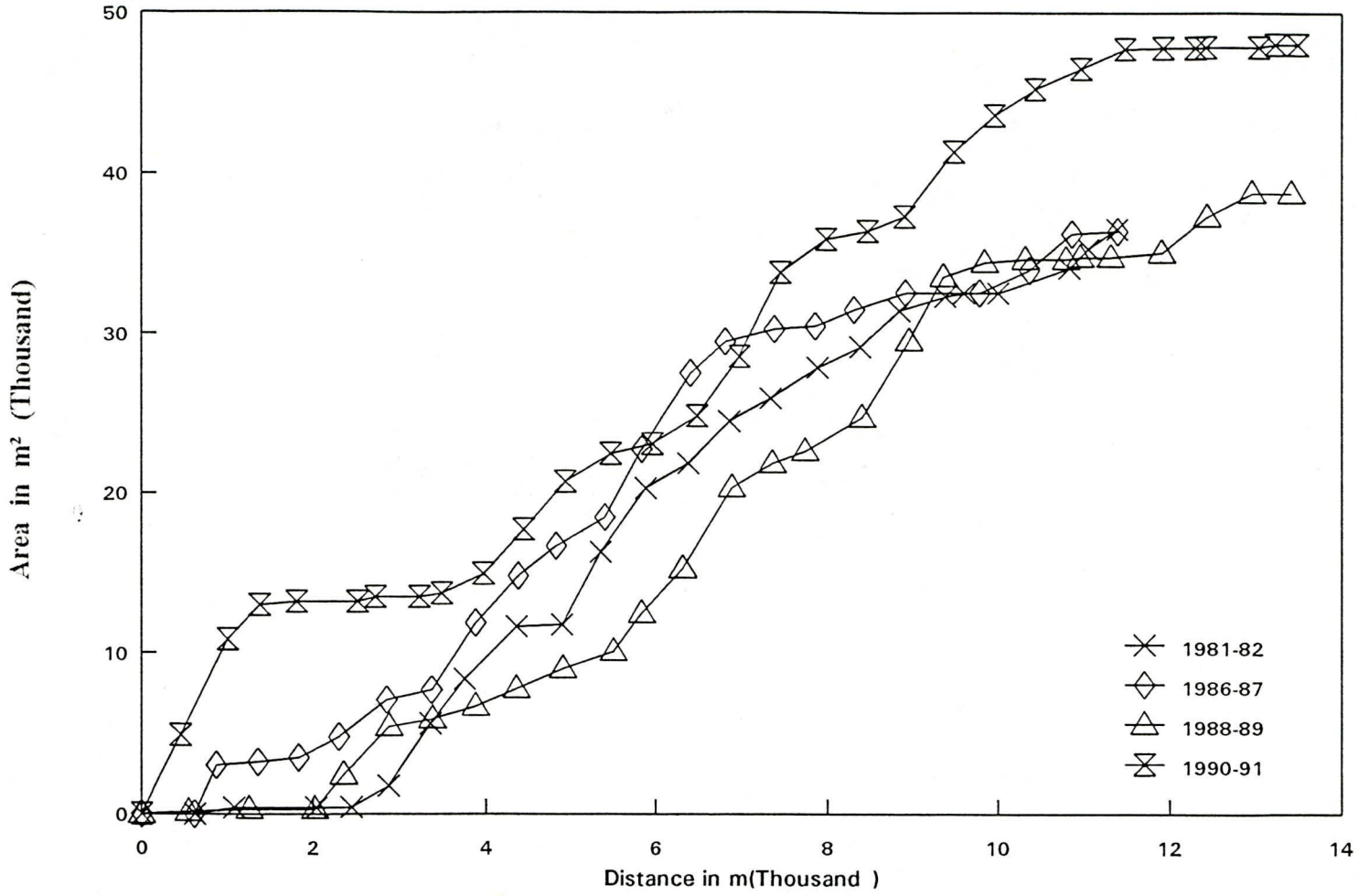


Figure 5.54.b Area Vs. Distance across the width (Ch.: 55.65 Km.) Sec. J - 15

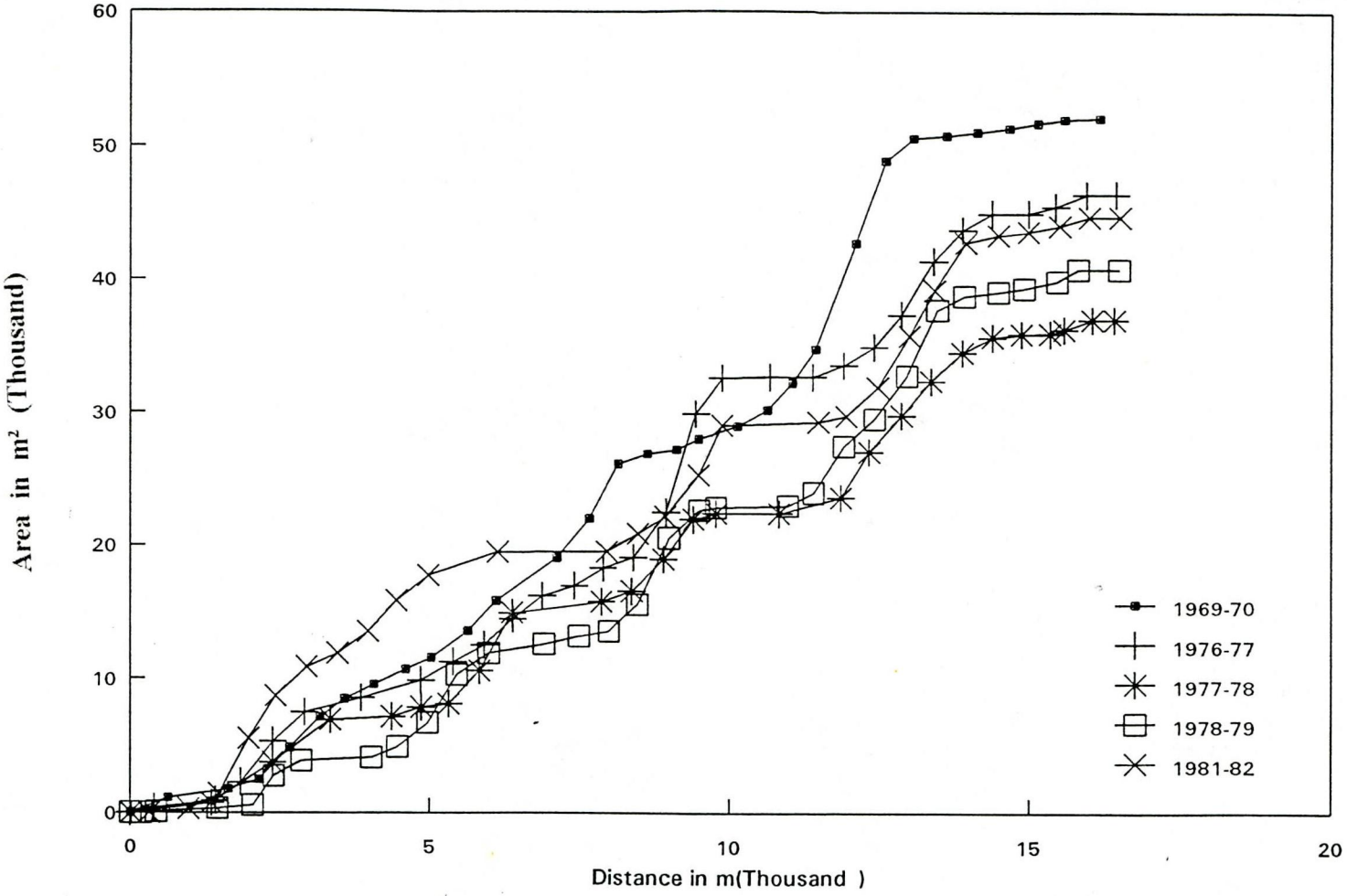


Figure 5.55.a Area Vs. Distance across the width (Ch.: 71.20 Km.) Sec. J - 14

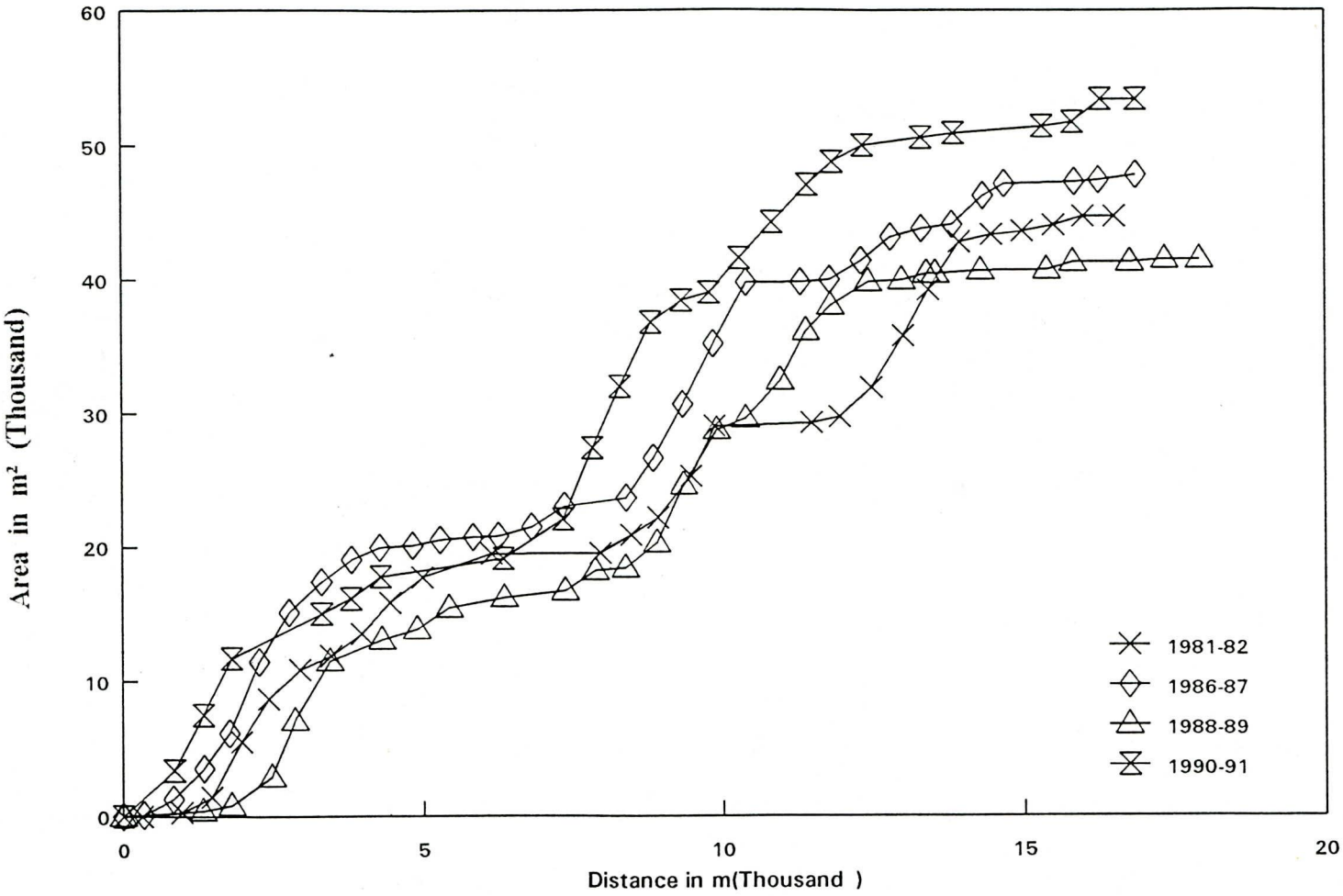


Figure 5.55.b Area Vs. Distance across the width (Ch.: 71.20 Km.) Sec. J - 14

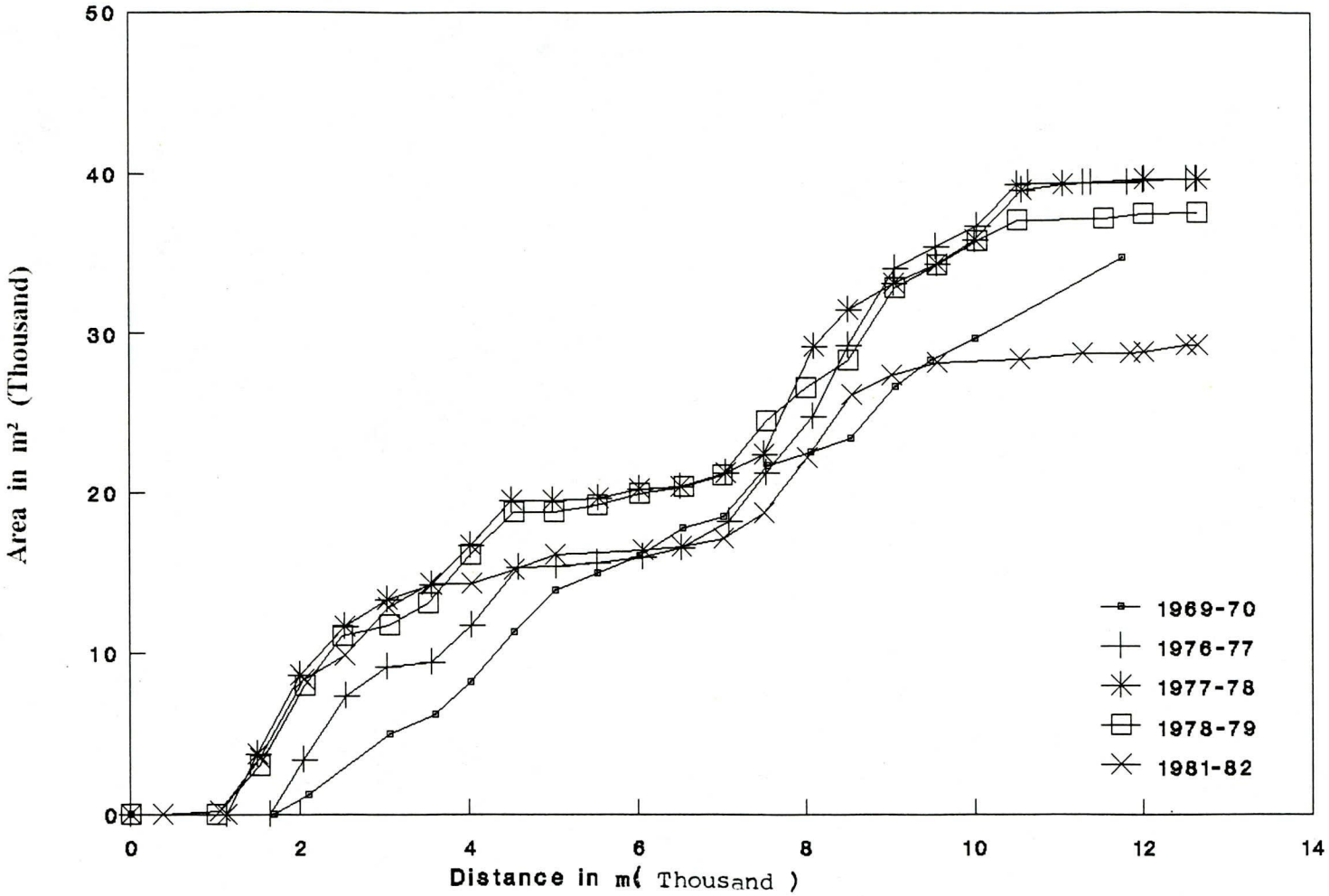


Figure 5.56.a Area Vs. Distance across the width (Ch.: 84.70 Km.) Sec. J - 13

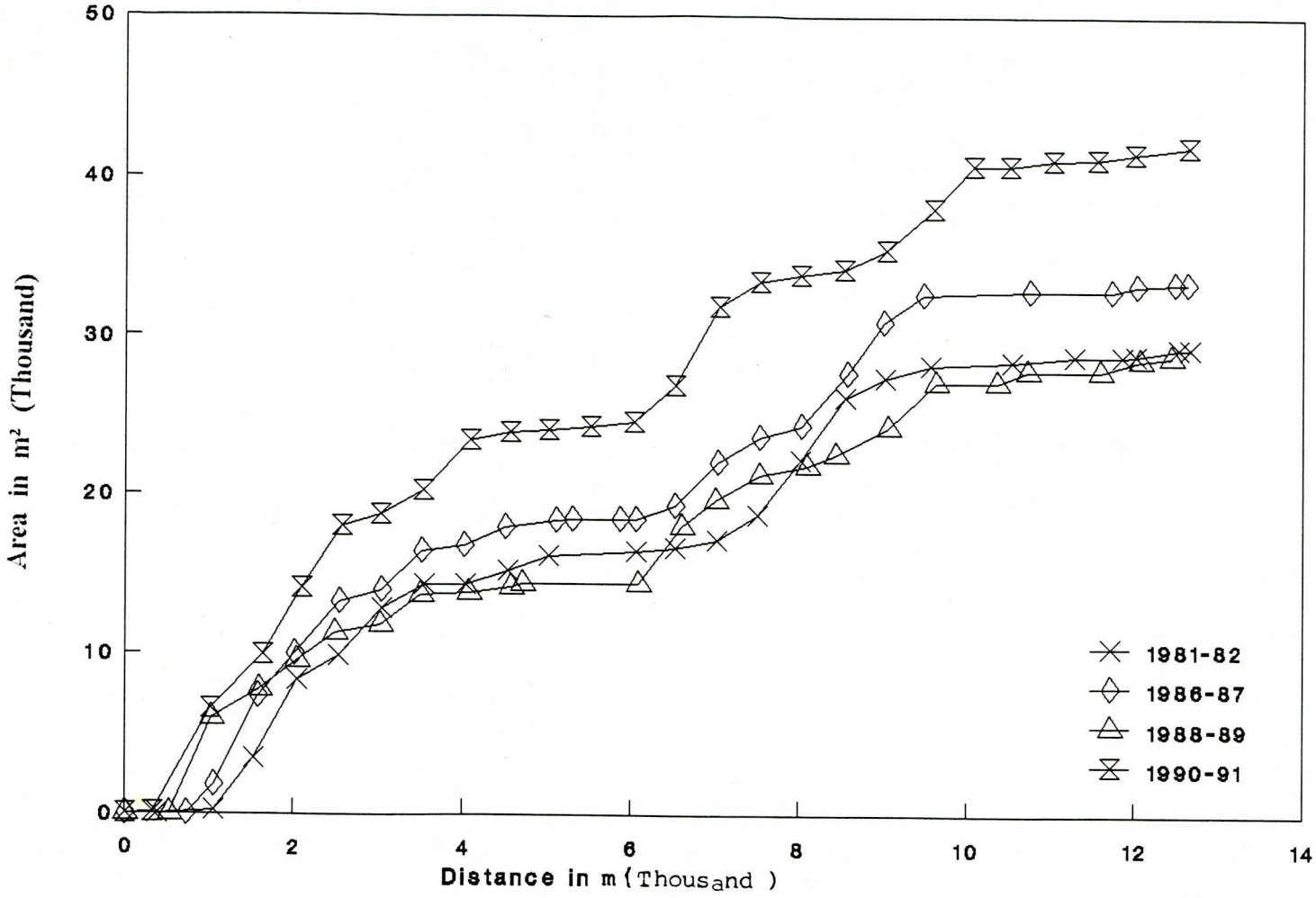


Figure 5.56.b Area Vs. Distance across the width (Ch.: 84.70 Km.) Sec. J - 13

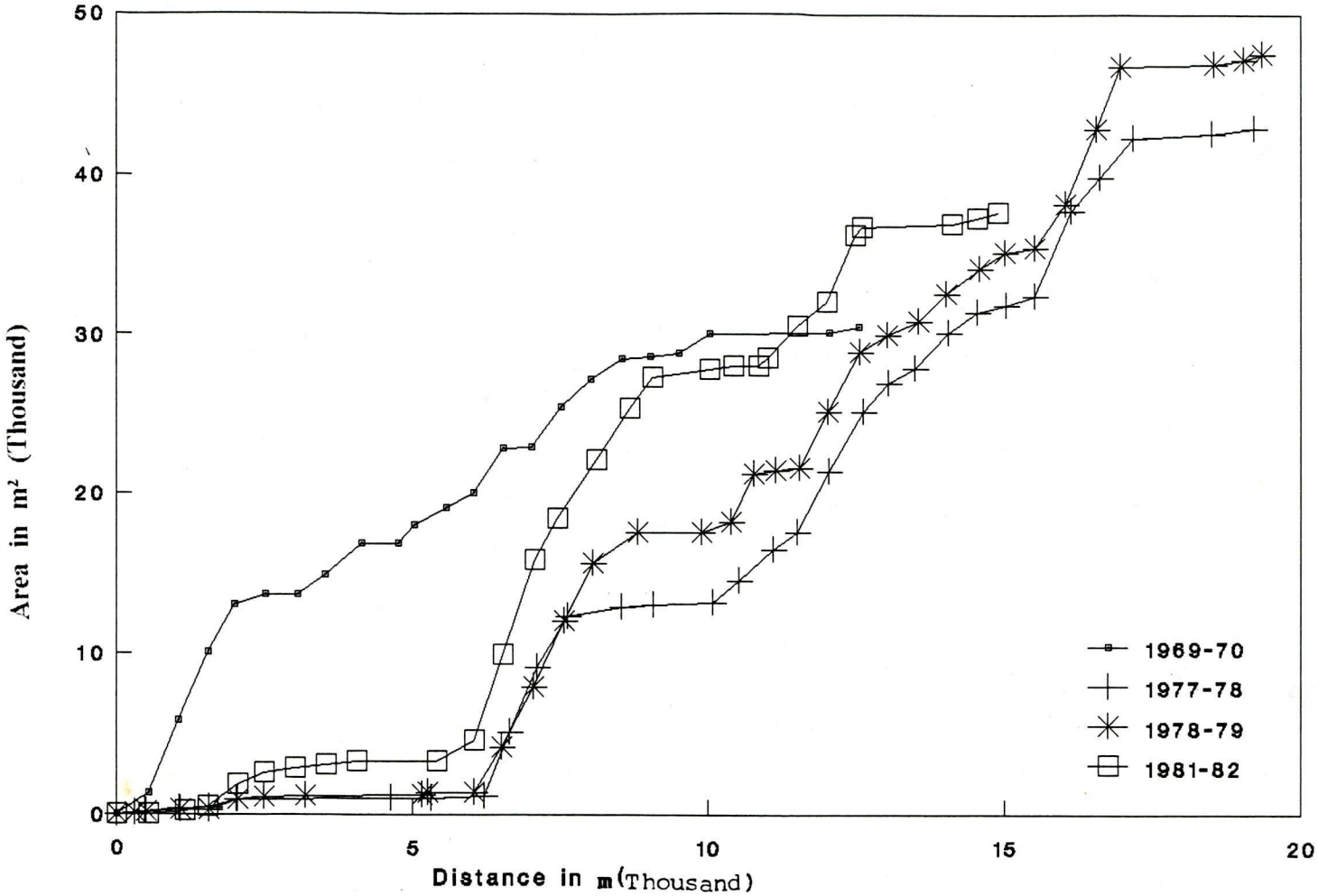


Figure 5.57.a Area Vs. Distance across the width (Ch.: 100.50 Km.) Sec. J - 12

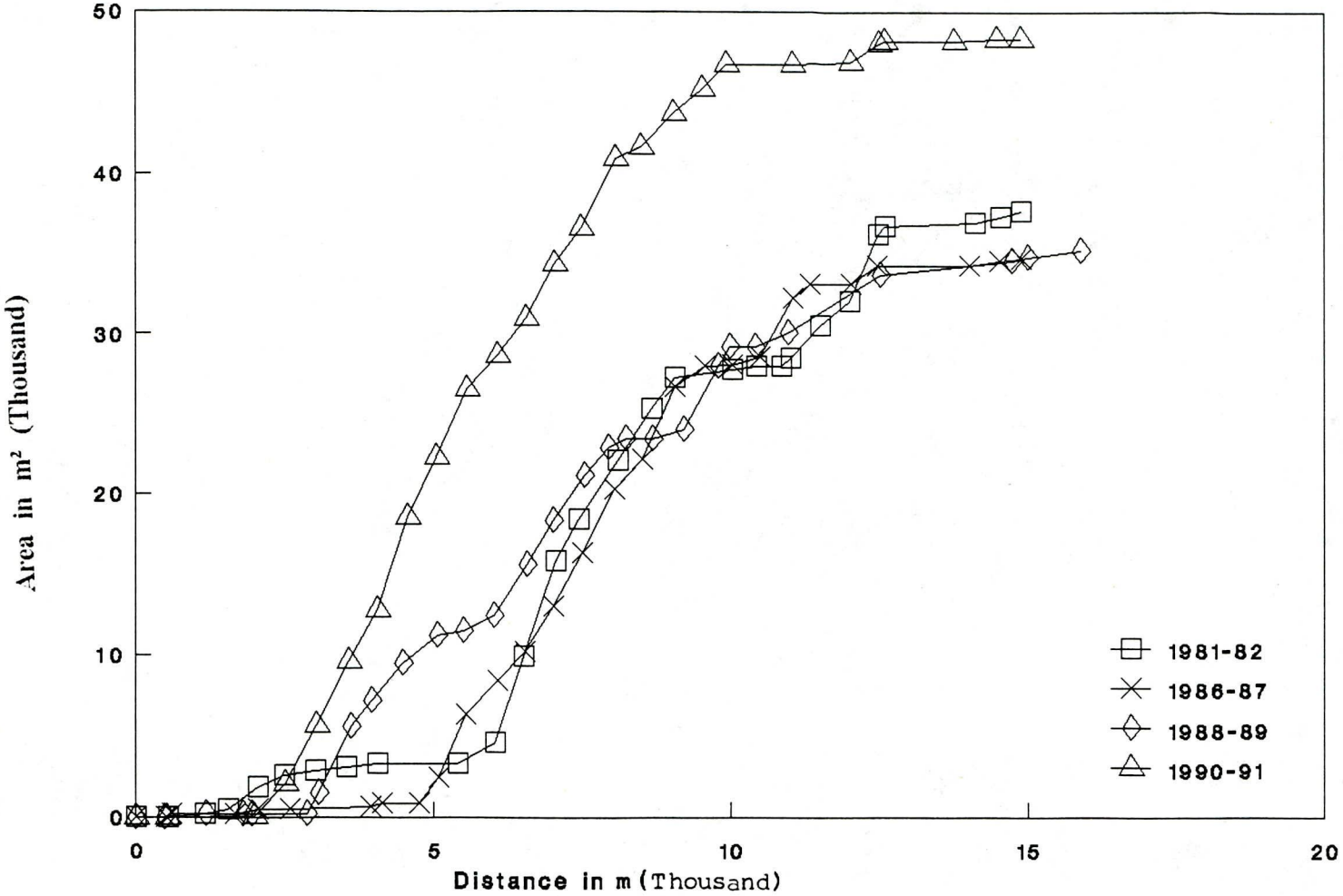


Figure 5.57.b Area Vs. Distance across the width (Ch.: 100.50 Km.) Sec. J - 12

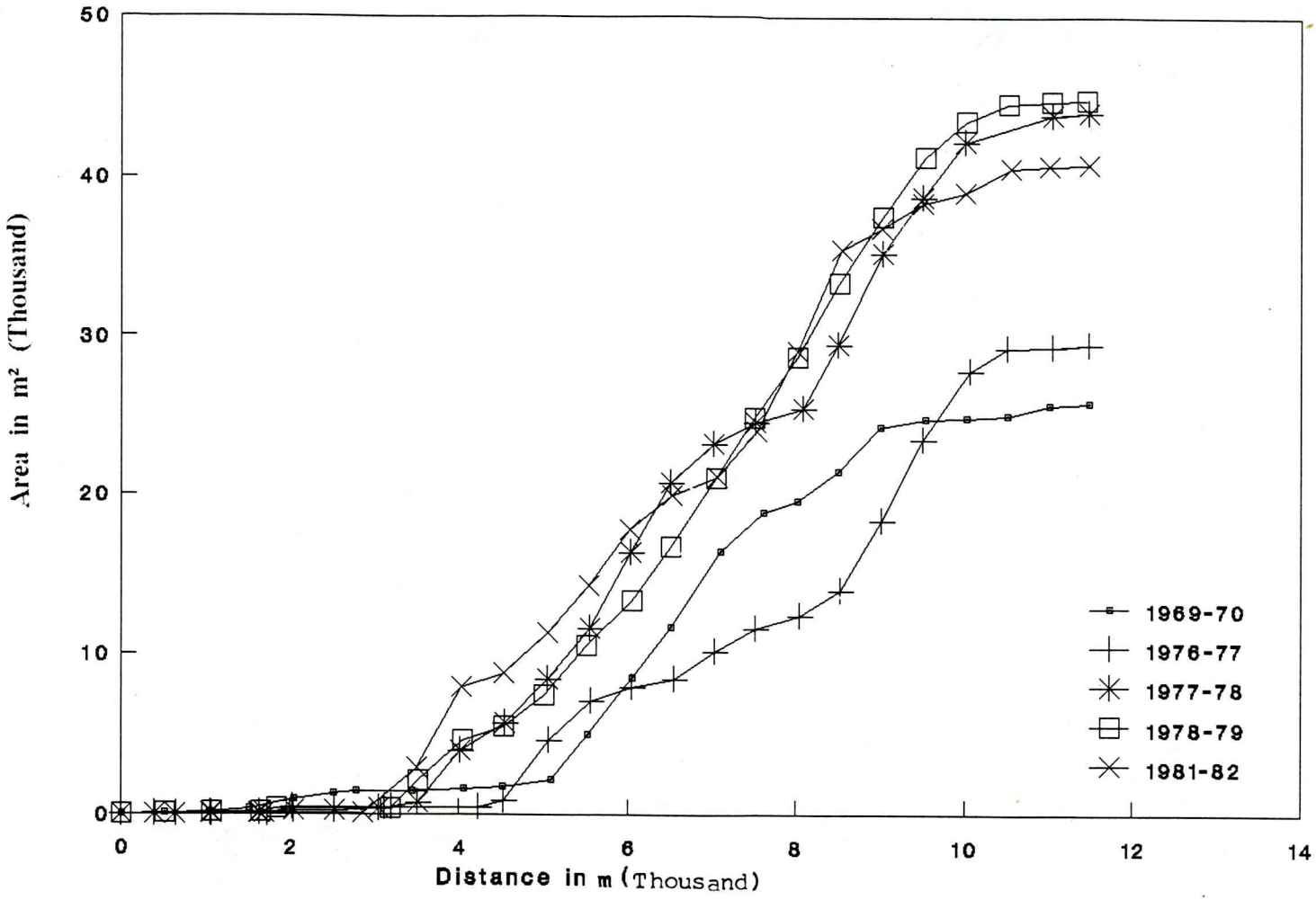


Figure 5.58.a Area Vs. Distance across the width (Ch.: 117.75 Km.) Sec. J - 11

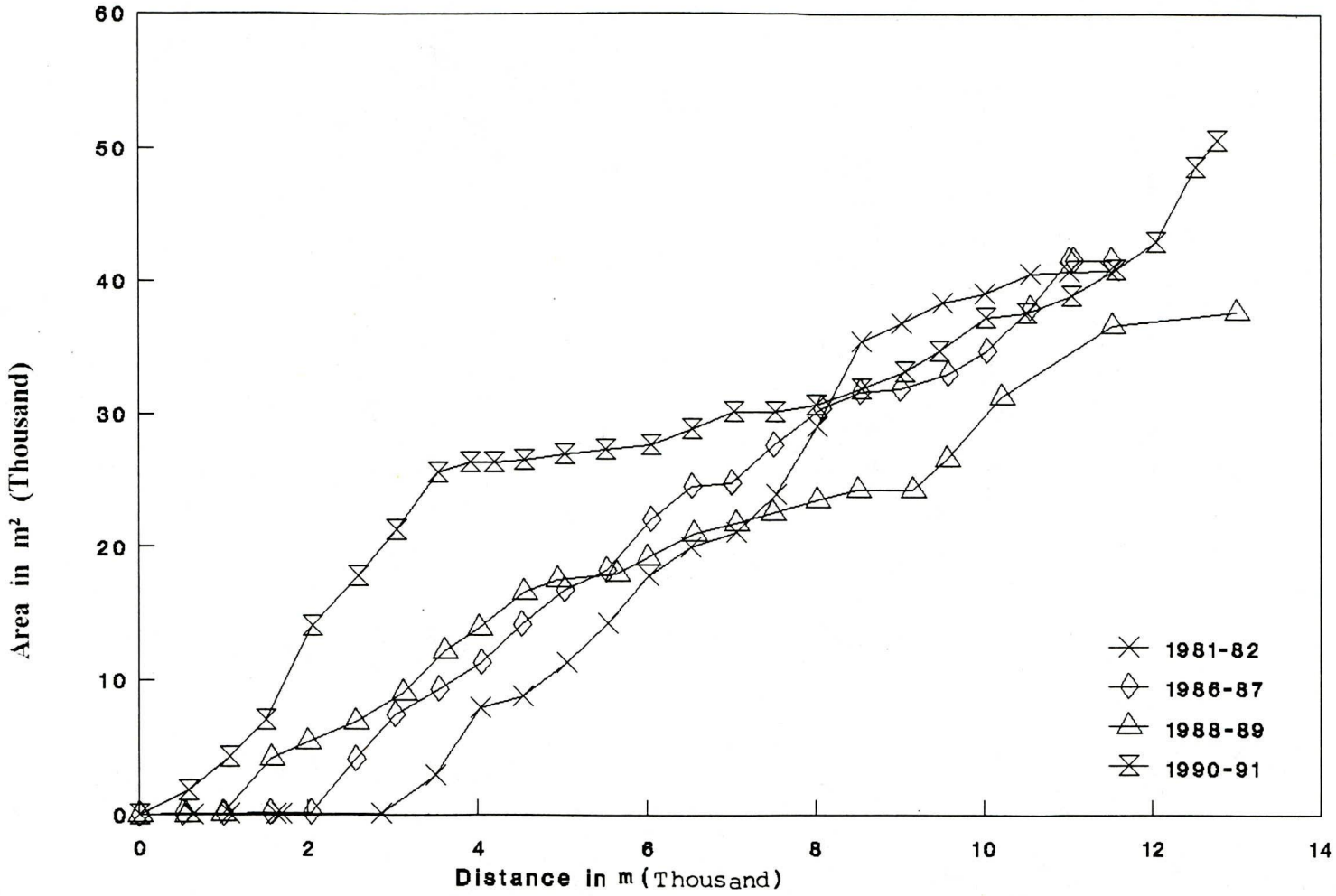


Figure 5.58.b Area Vs. Distance across the width (Ch.: 117.75 Km.) Sec. J - 11

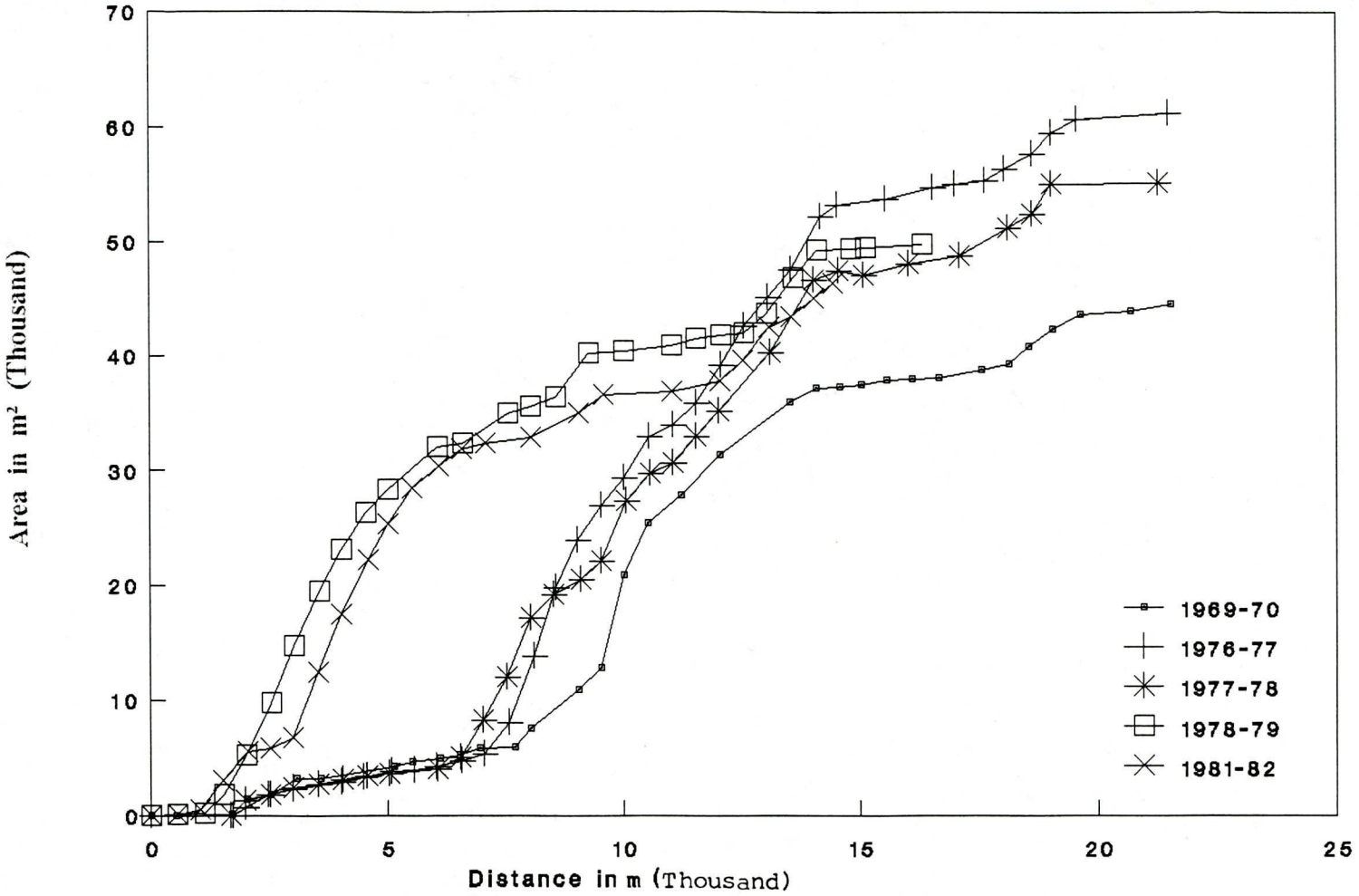


Figure 5.59.a Area Vs. Distance across the width (Ch.: 134.30 Km.) Sec. J - 10

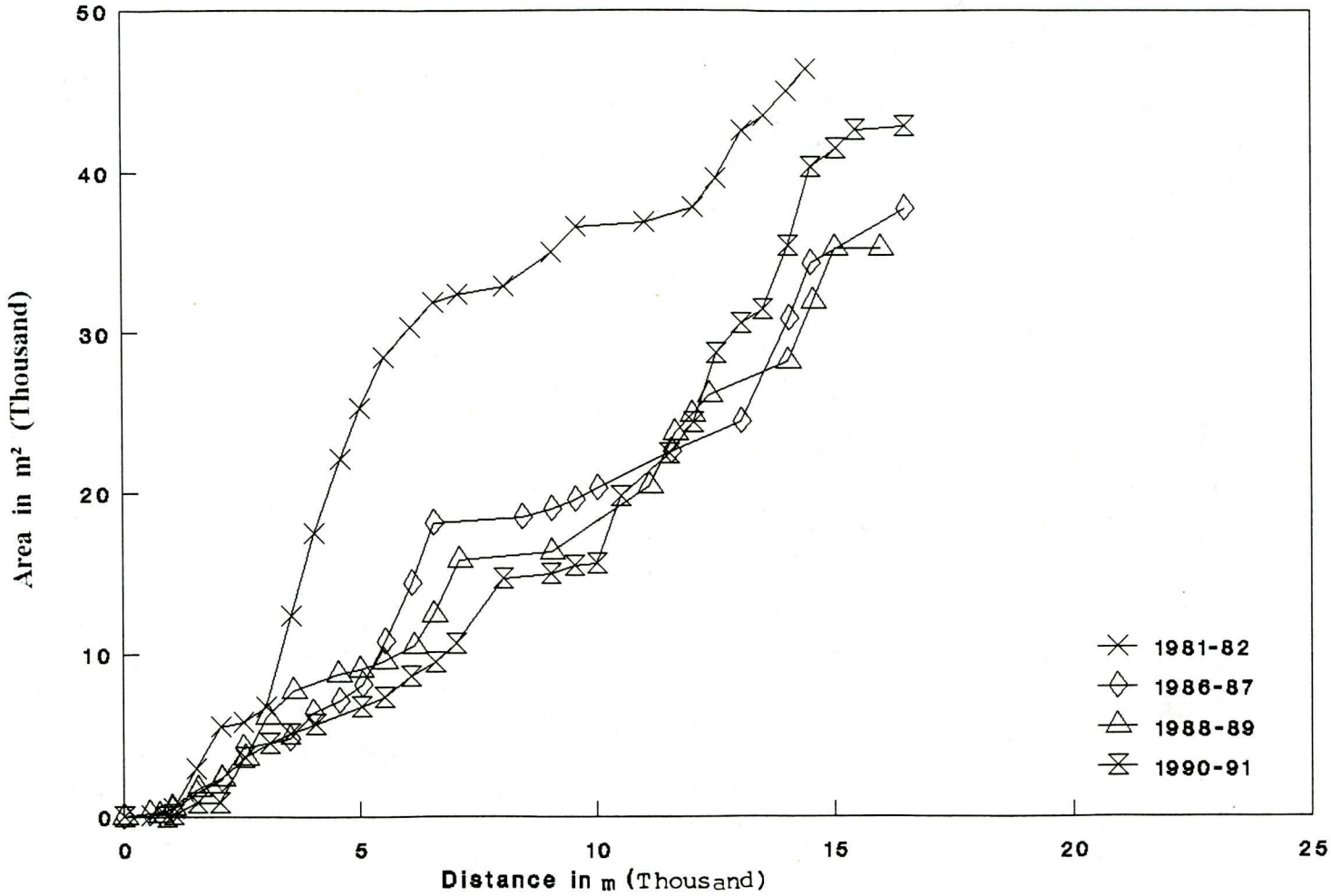


Figure 5.59.b Area Vs. Distance across the width (Ch.: 134.30 Km.) Sec. J - 10

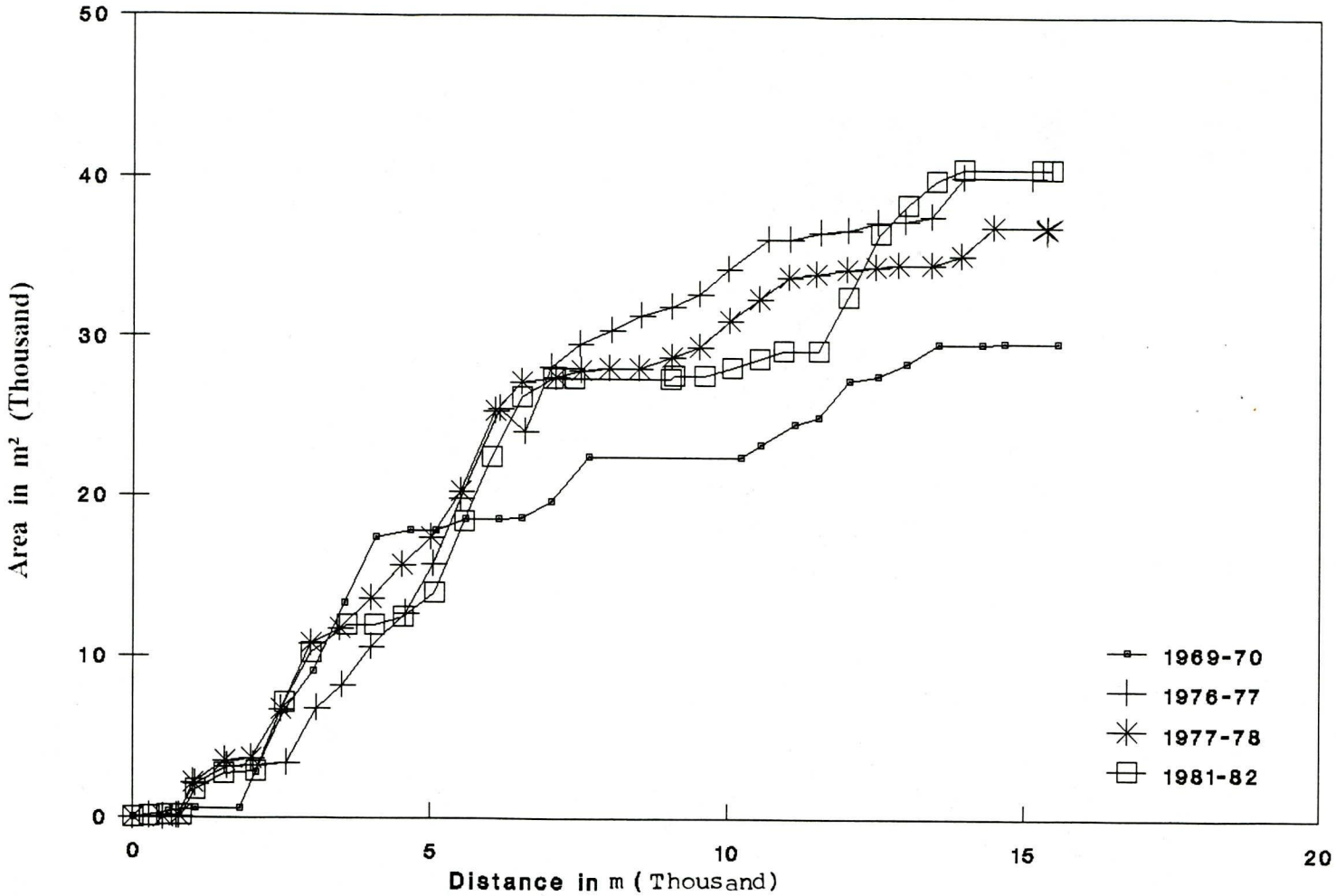


Figure 5.60.a Area Vs. Distance across the width (Ch.: 142.45 Km.) Sec. J - 9

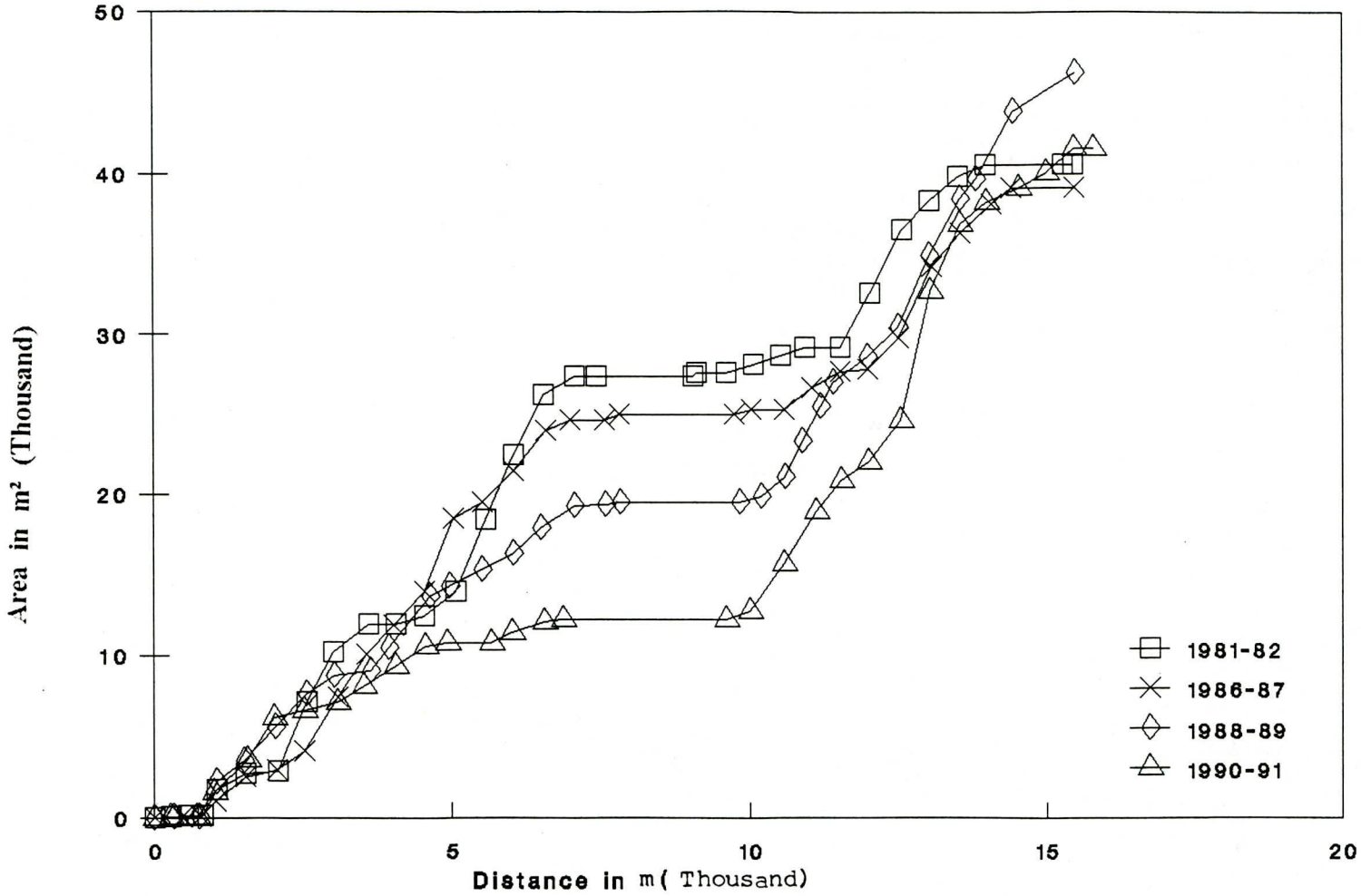


Figure 5.60.b Area Vs. Distance across the width (Ch.: 142.45 Km.) Sec. J - 9

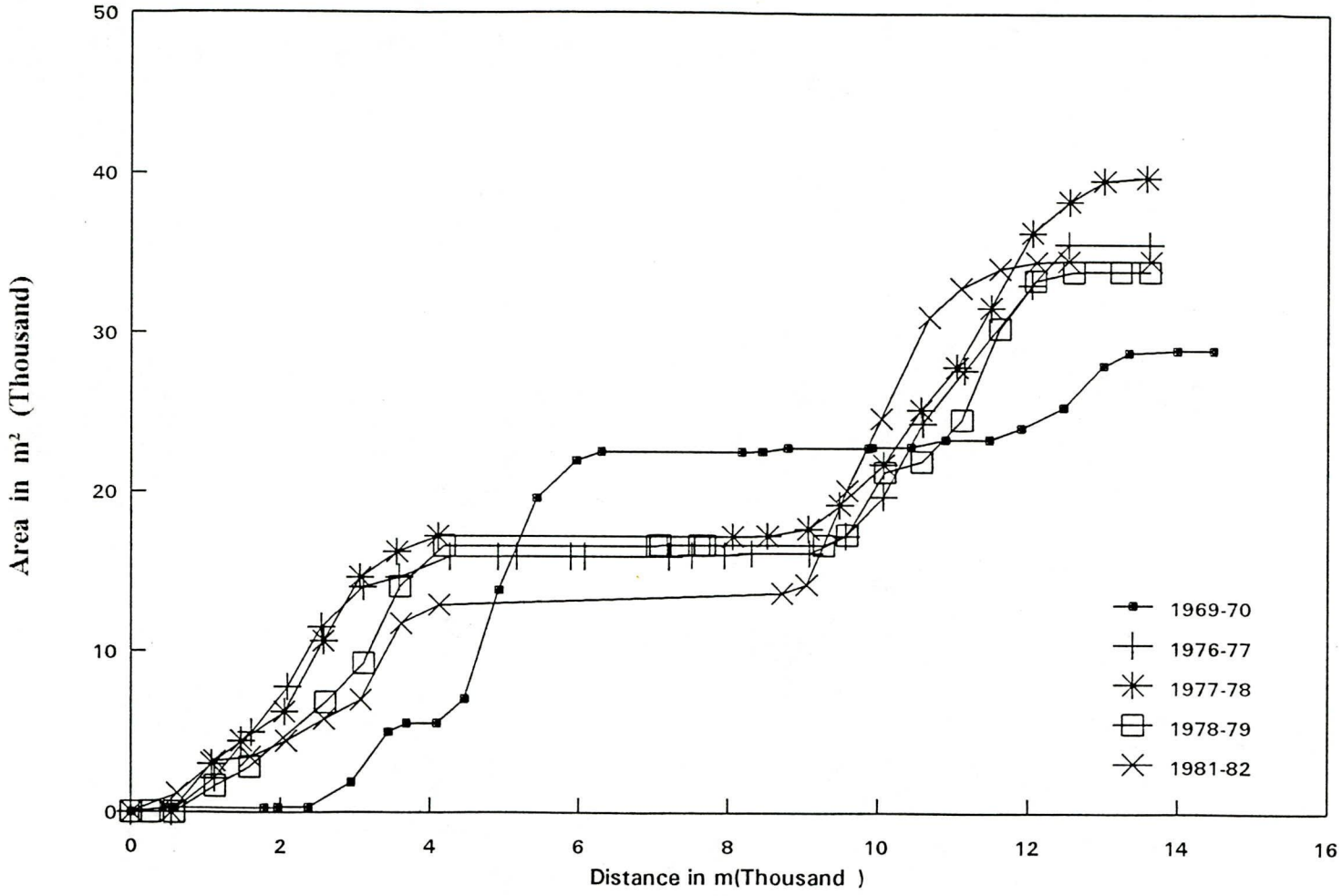


Figure 5.61.a Area Vs. Distance across the width (Ch.: 149.50 Km.) Sec. J - 8

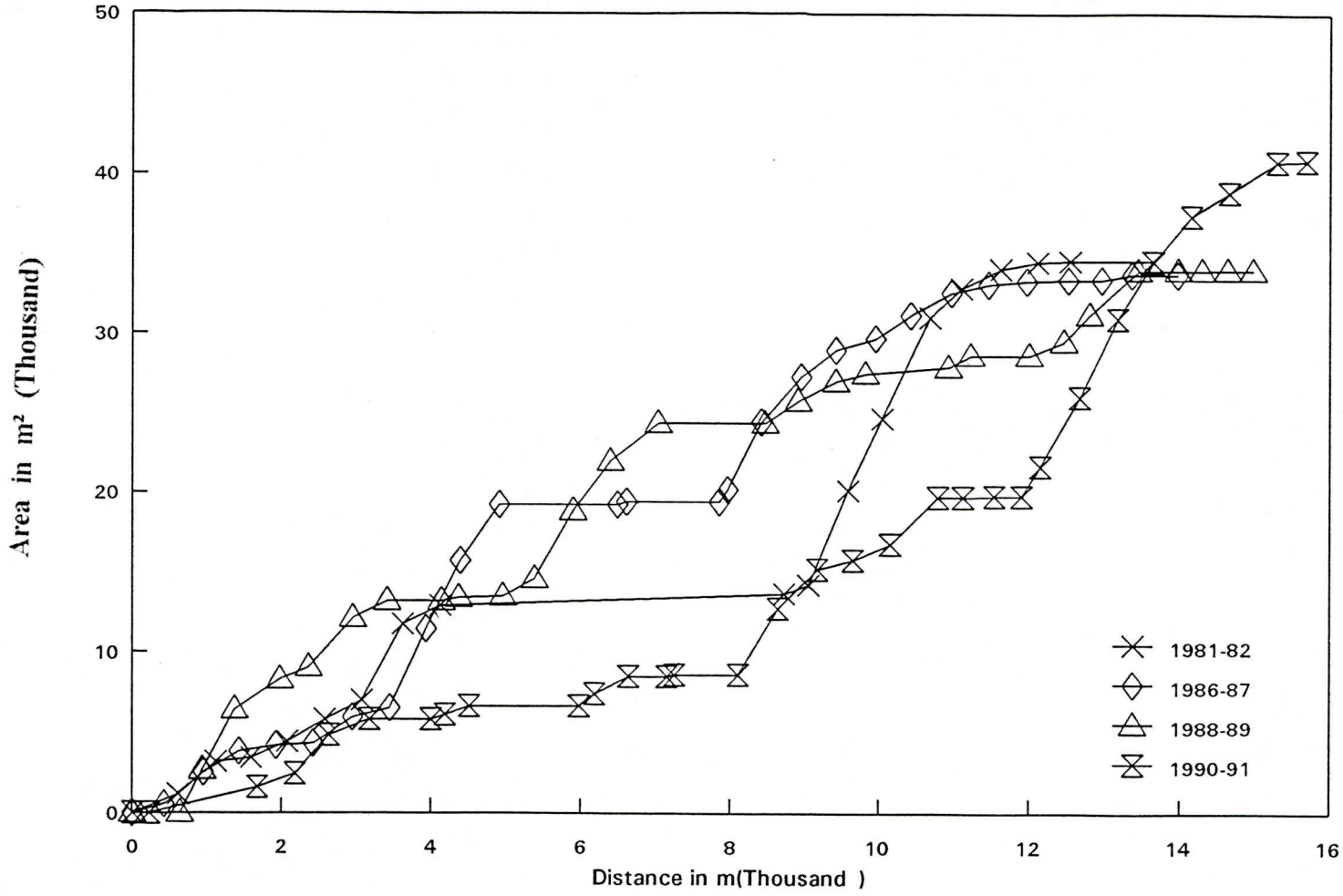


Figure 5.61.b Area Vs. Distance across the width (Ch.: 149.50 Km.) Sec. J - 8

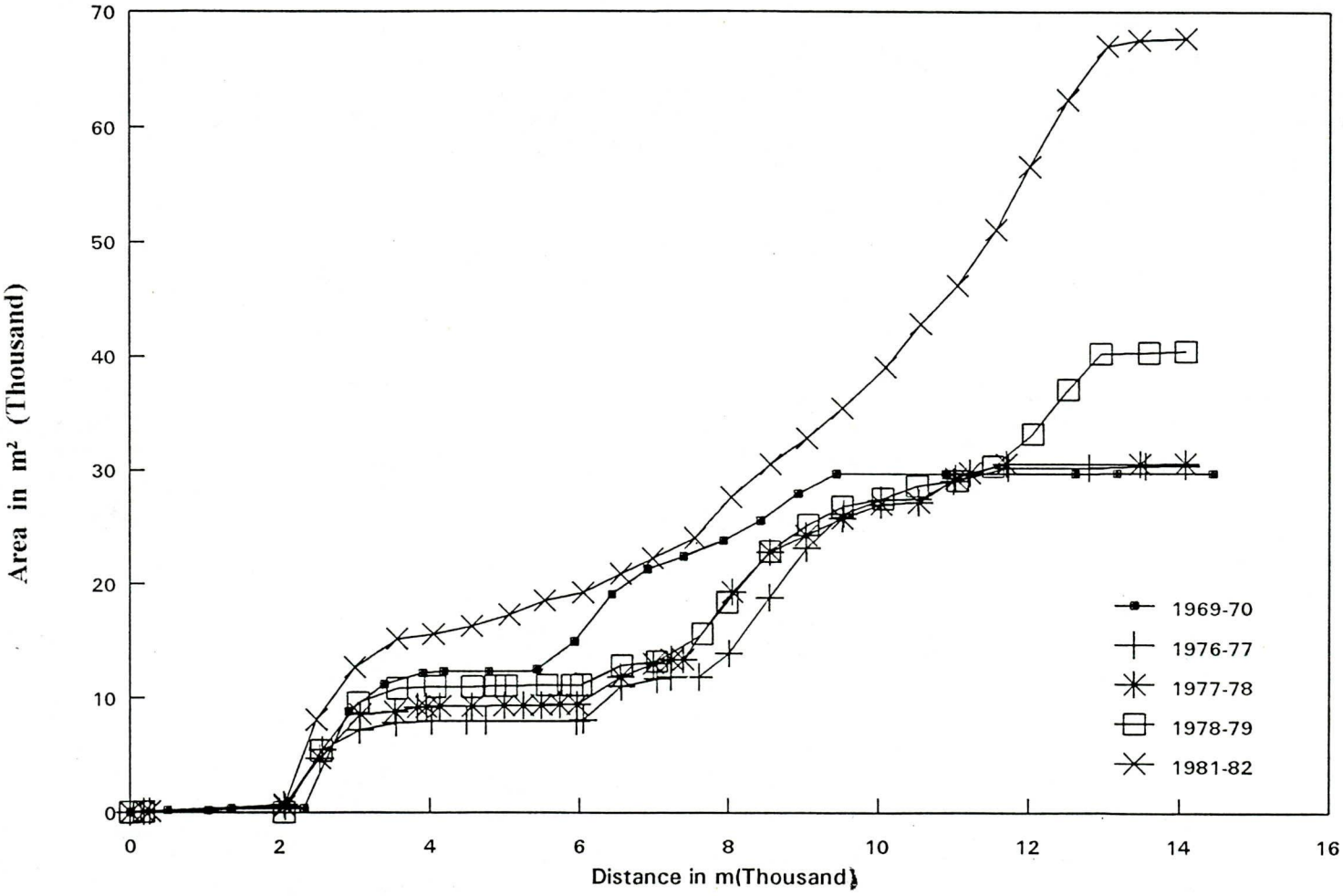


Figure 5.62.a Area Vs. Distance across the width (Ch.: 162.35 Km.) Sec. J - 7

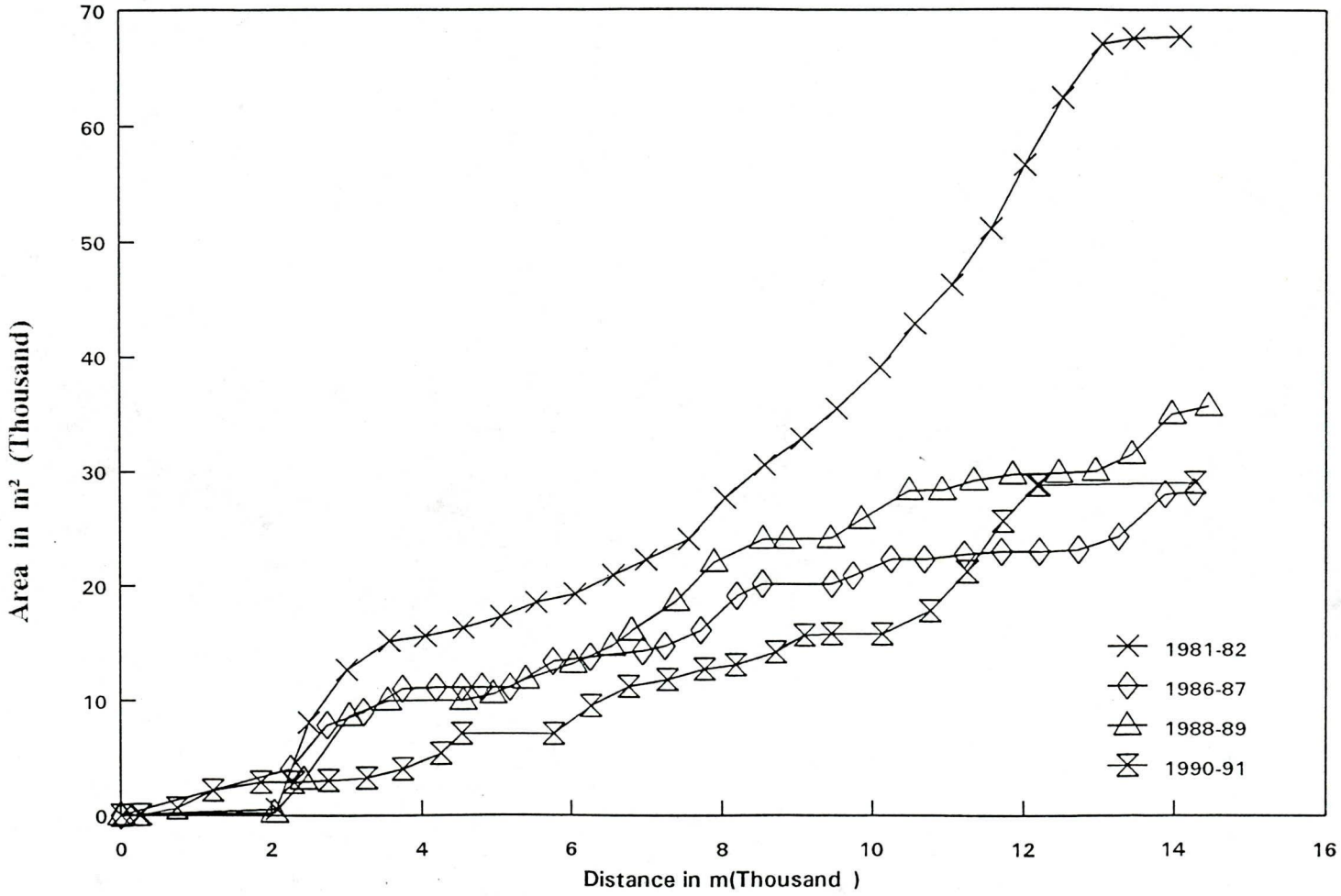


Figure 5.62.b Area Vs. Distance across the width (Ch.: 162.35 Km.) Sec. J - 7

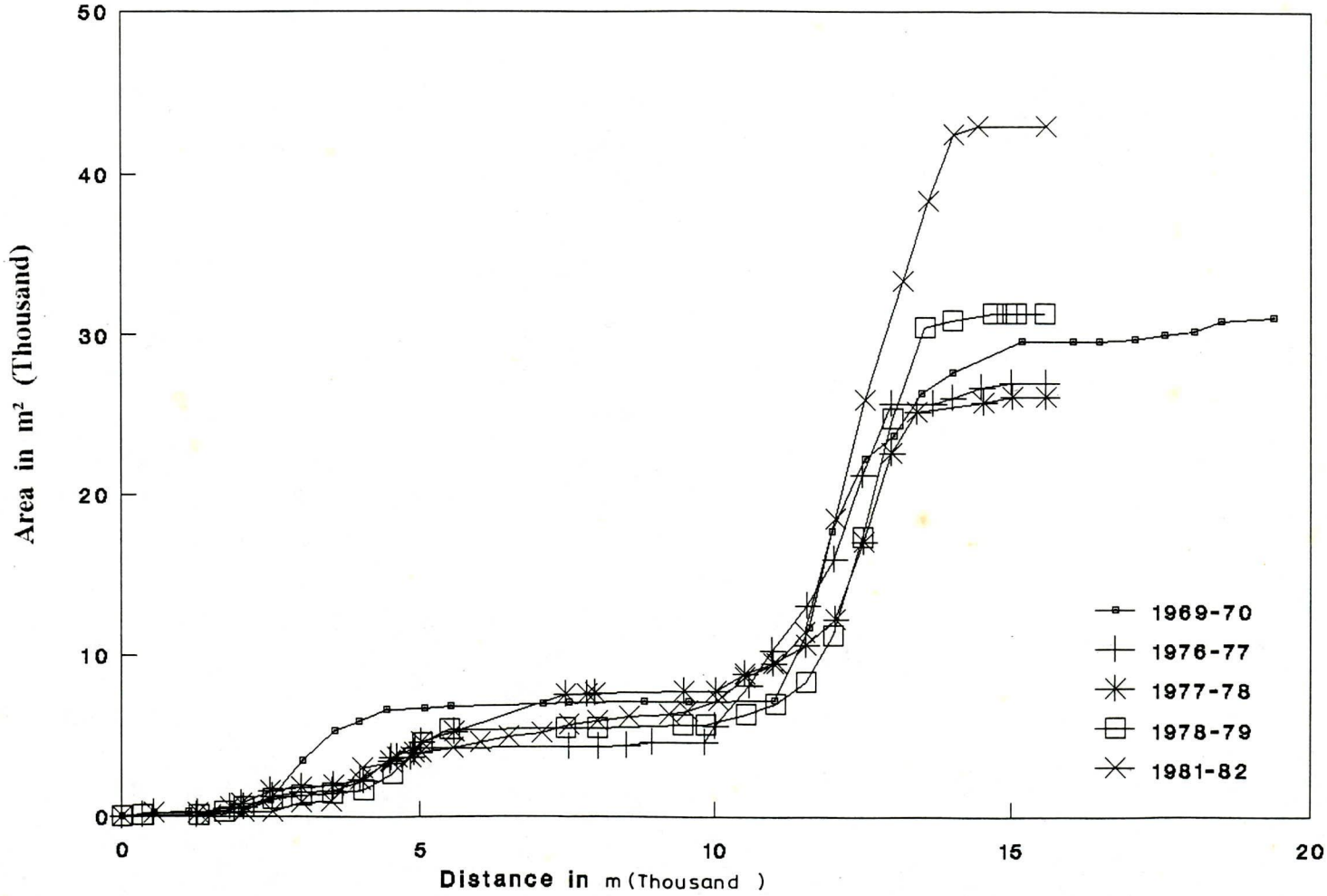


Figure 5.63.a Area Vs. Distance across the width (Ch.: 177.70 Km.) Sec. J - 6

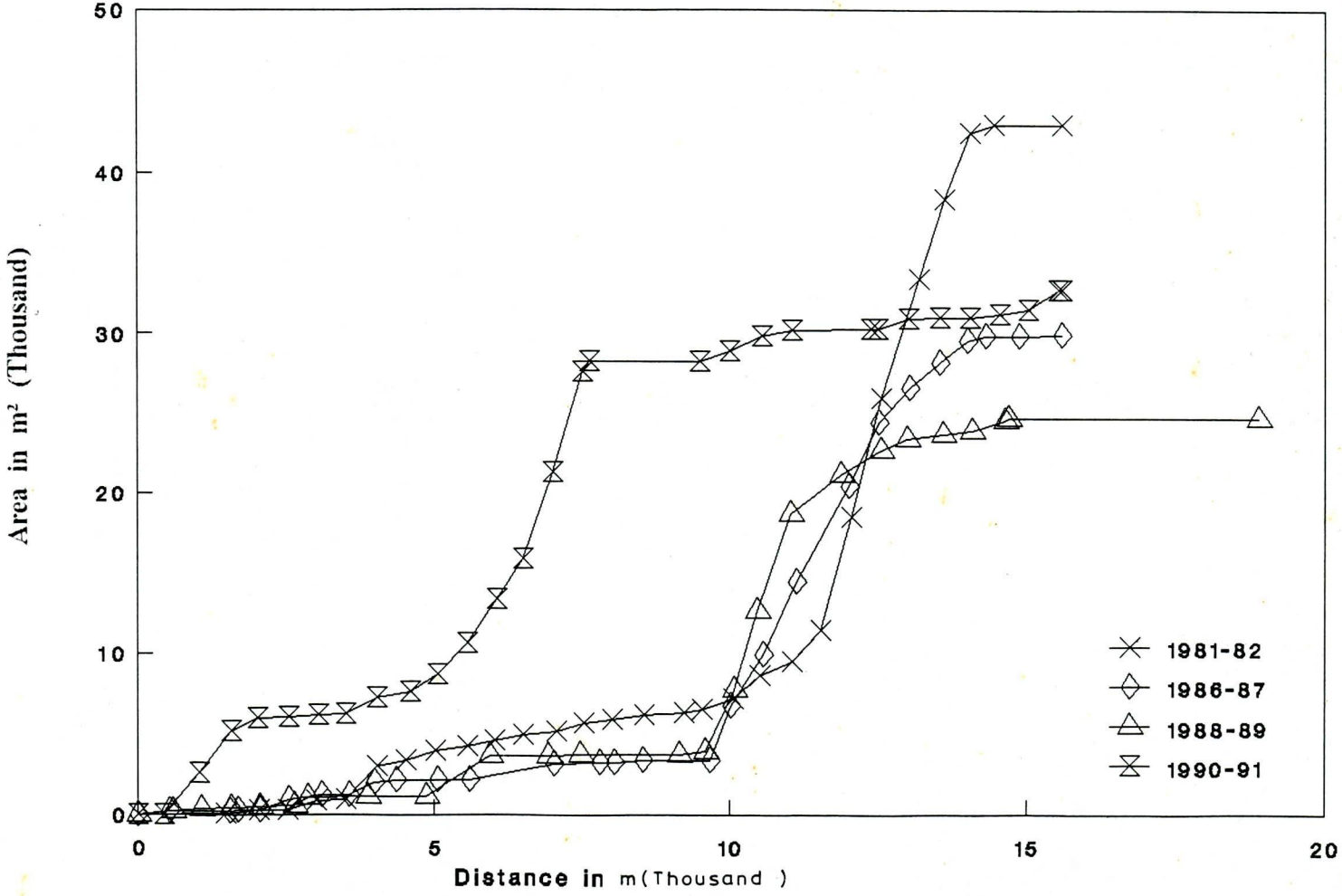


Figure 5.63.b Area Vs. Distance across the width (Ch.: 177.70 Km.) Sec. J - 6

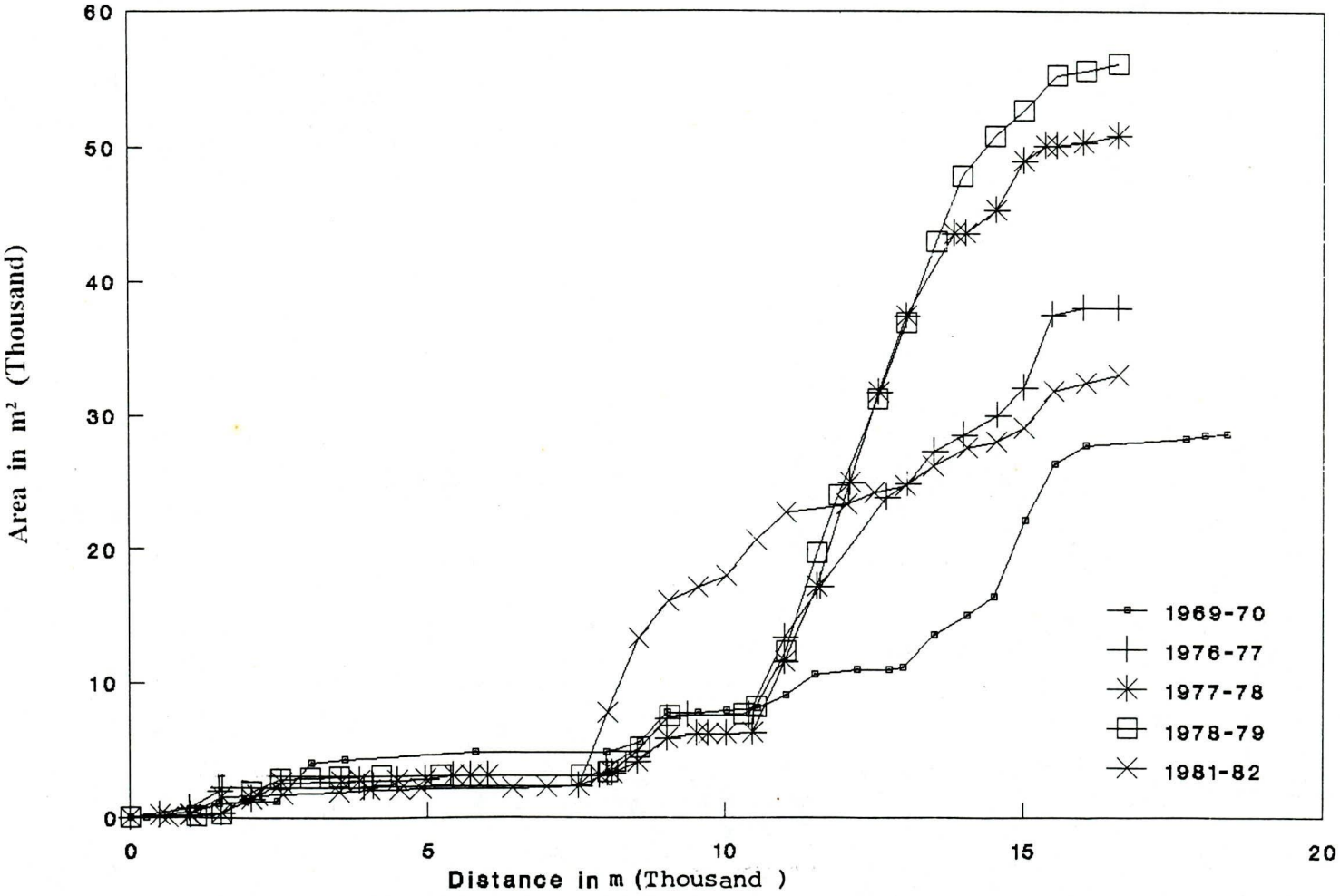


Figure 5.64.a Area Vs. Distance across the width (Ch.: 188.20 Km.) Sec. J - 5

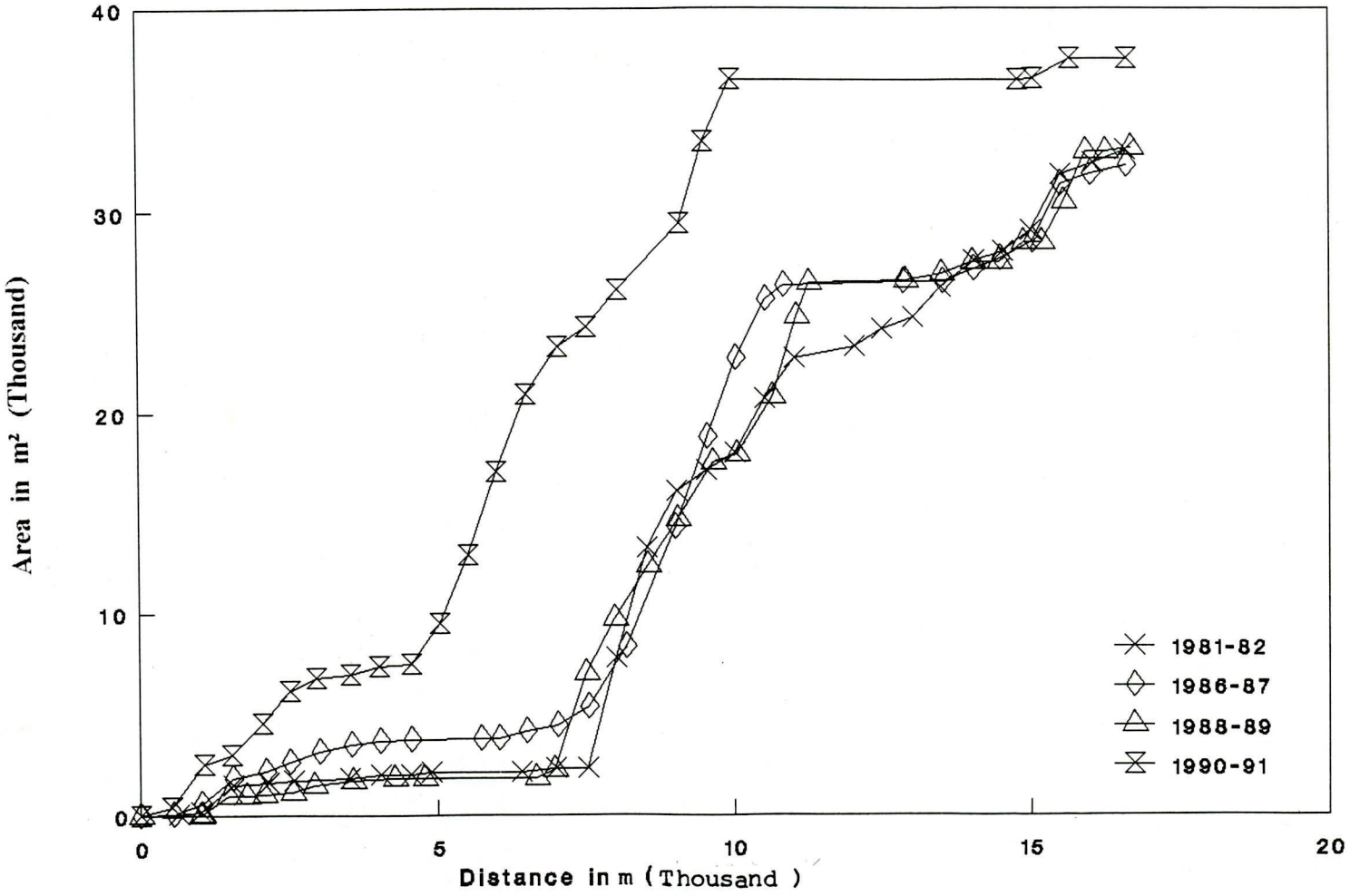


Figure 5.64.b Area Vs. Distance across the width (Ch.: 188.20 Km.) Sec. J - 5

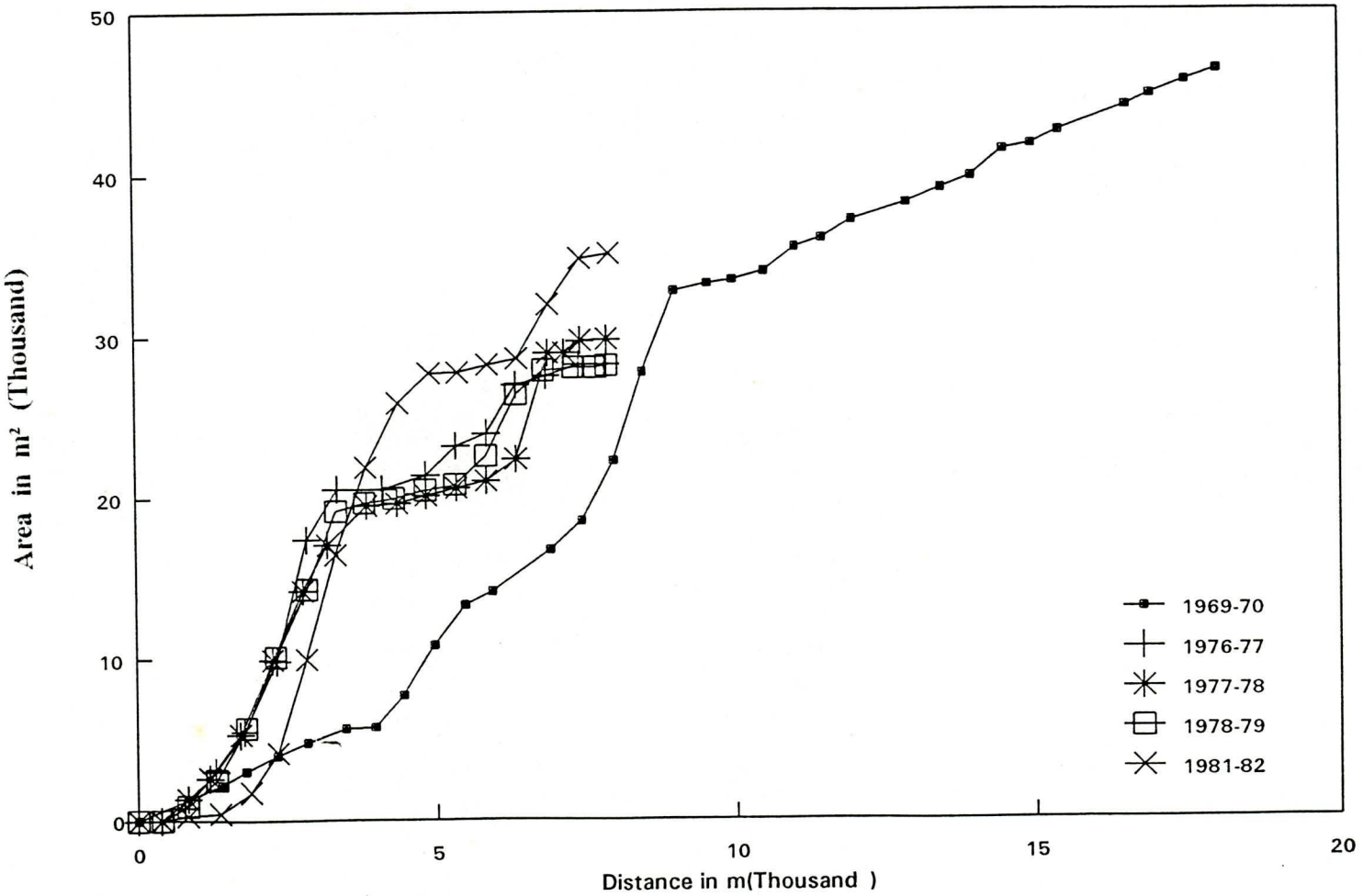


Figure 5.65.a Area Vs. Distance across the width (Ch.: 201.30 Km.) Sec. J - 4

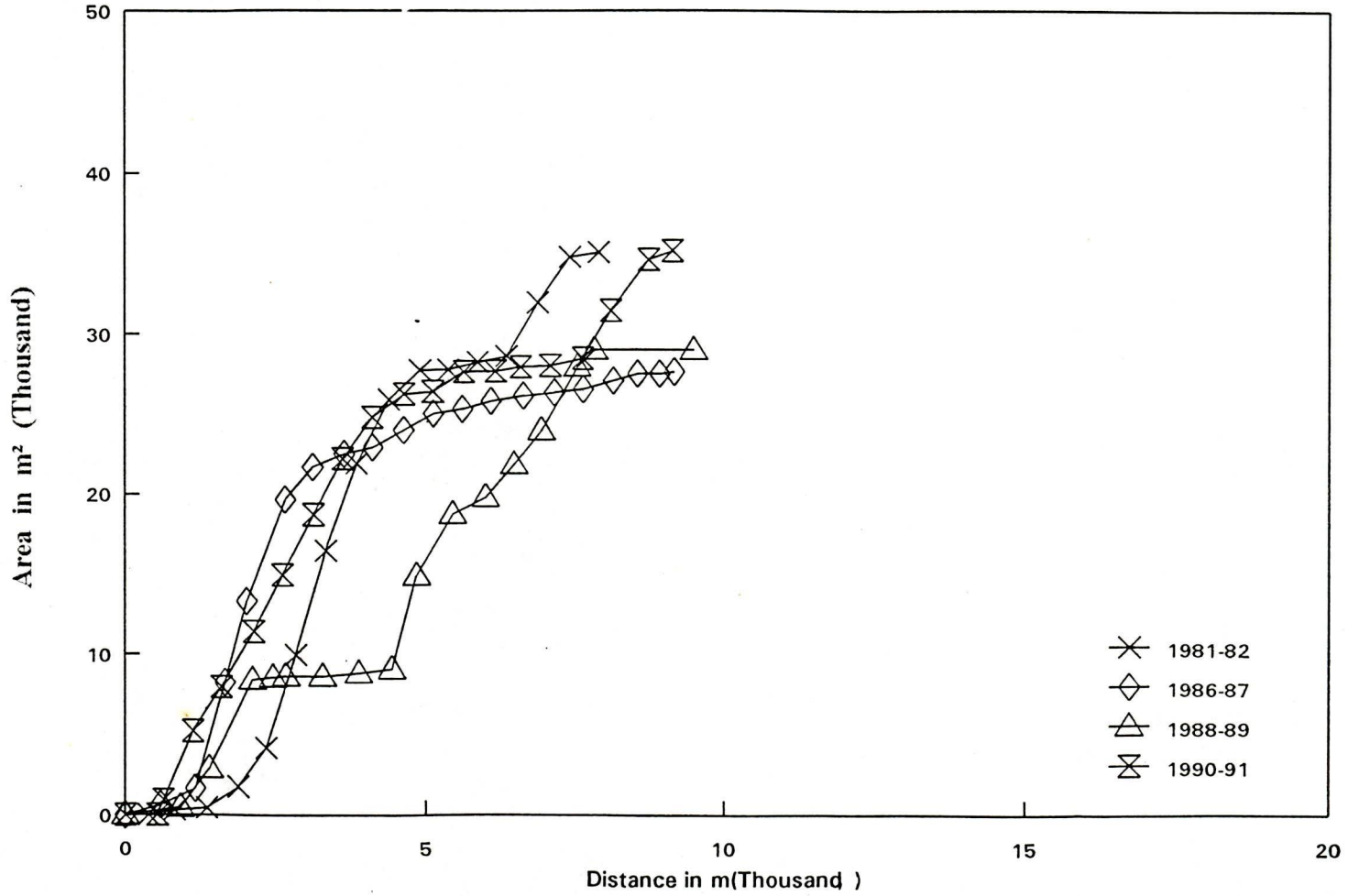


Figure 5.65.b Area Vs. Distance across the width (Ch.: 201.30 Km.) Sec. J - 4

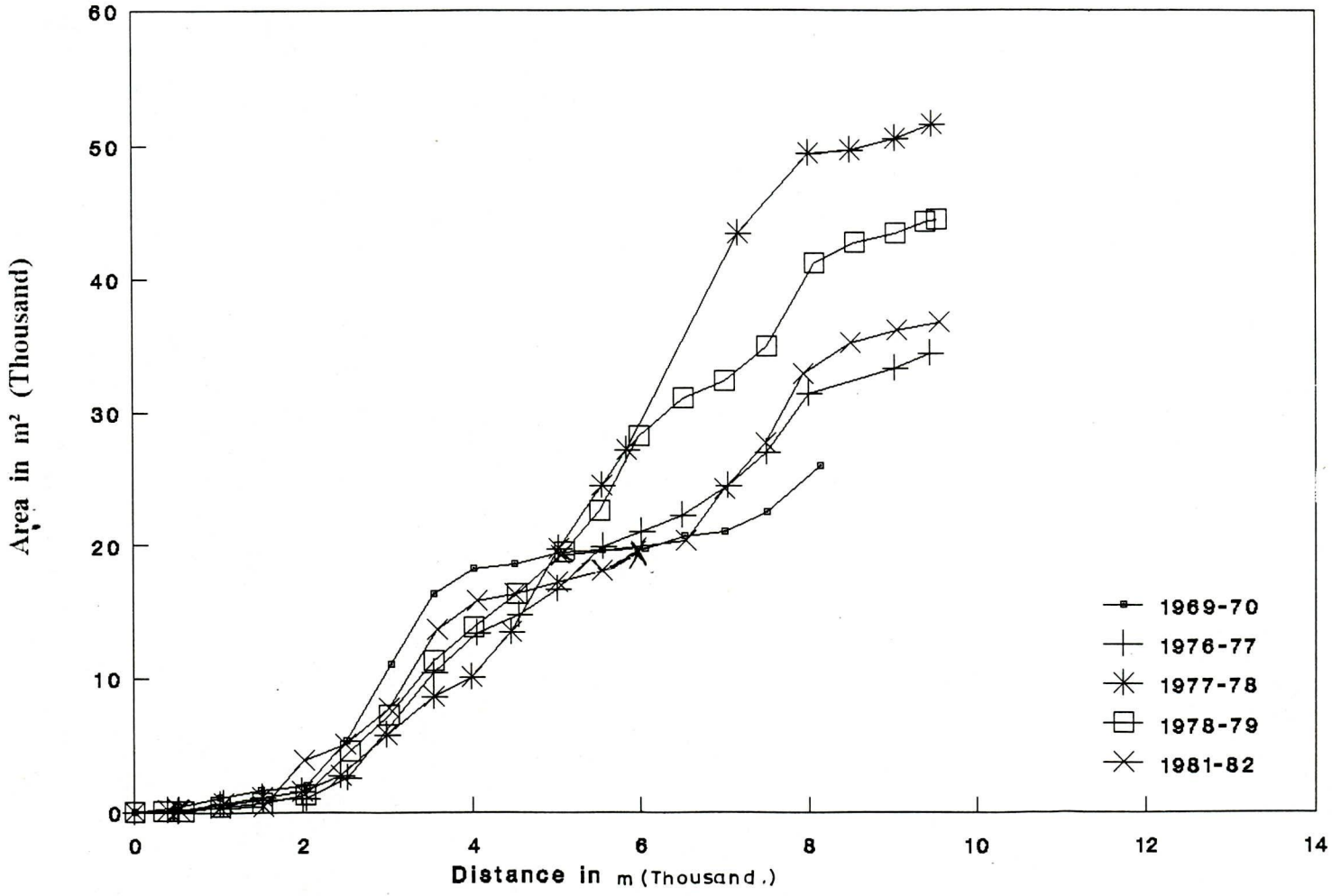


Figure 5.66.a Area Vs. Distance across the width (Ch.: 213.20 Km.) Sec. J - 3

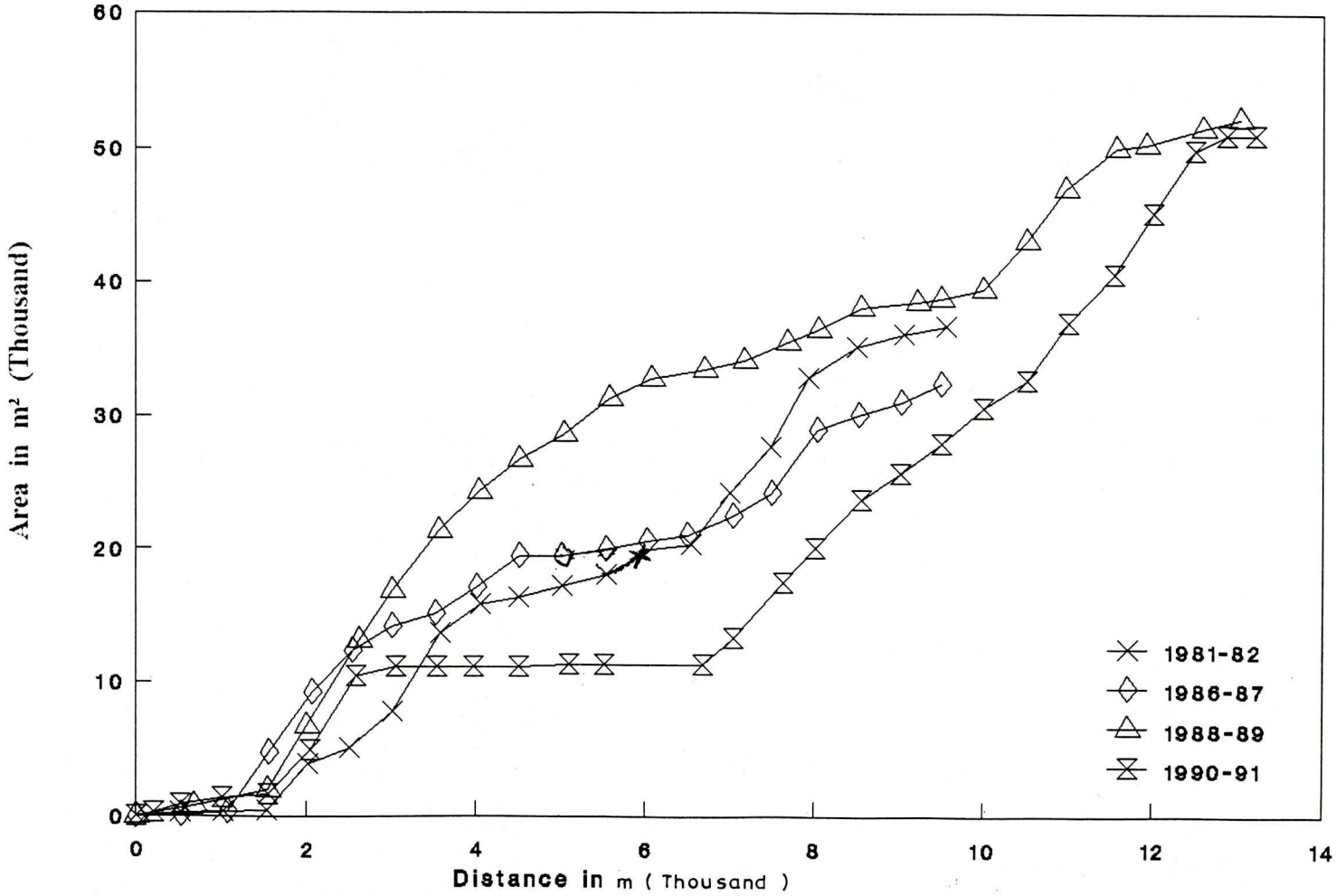


Figure 5.66.b Area Vs. Distance across the width (Ch.: 213.20 Km.) Sec. J - 3

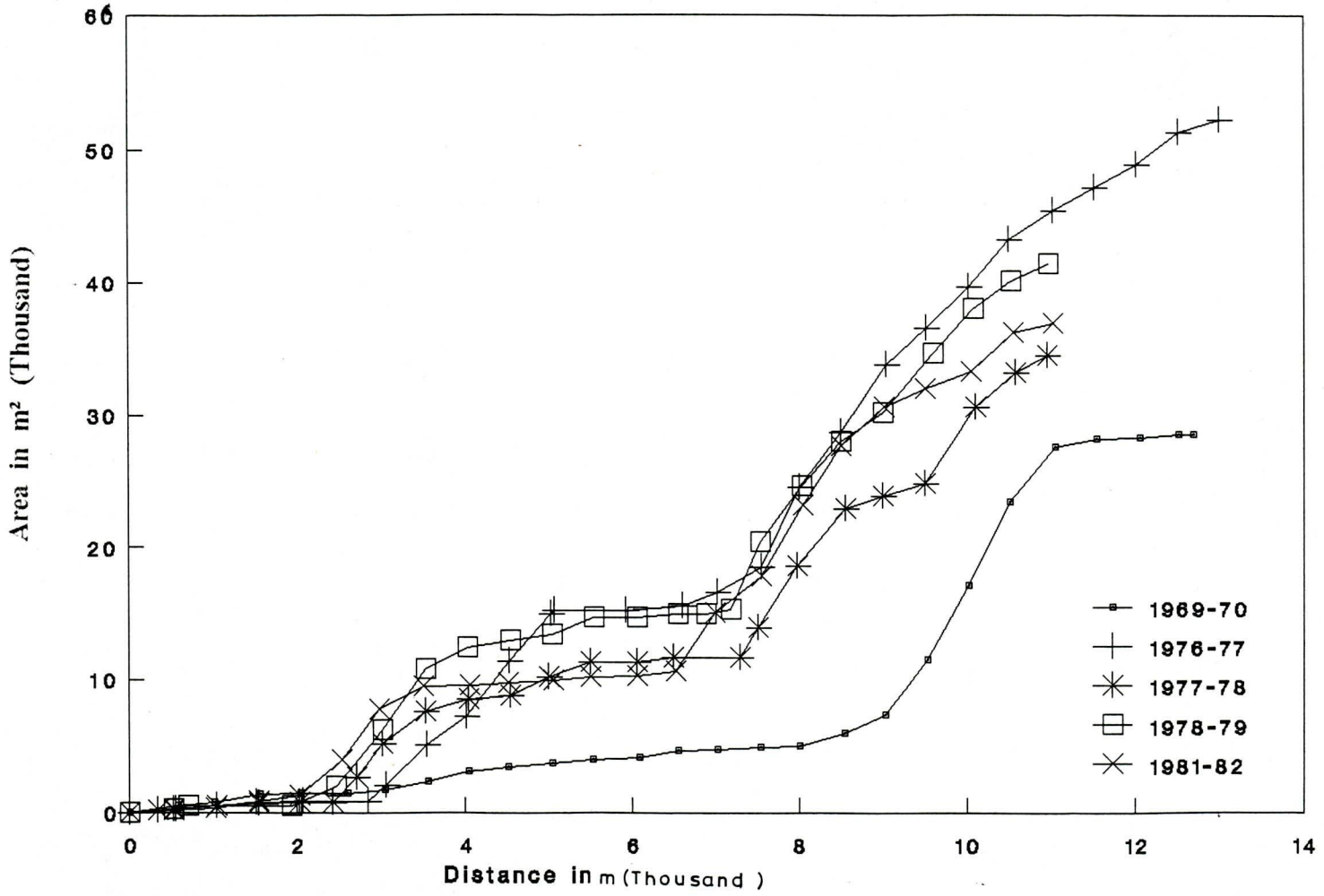


Figure 5.67.a Area Vs. Distance across the width (Ch.: 223.20 Km.) Sec. J - 2

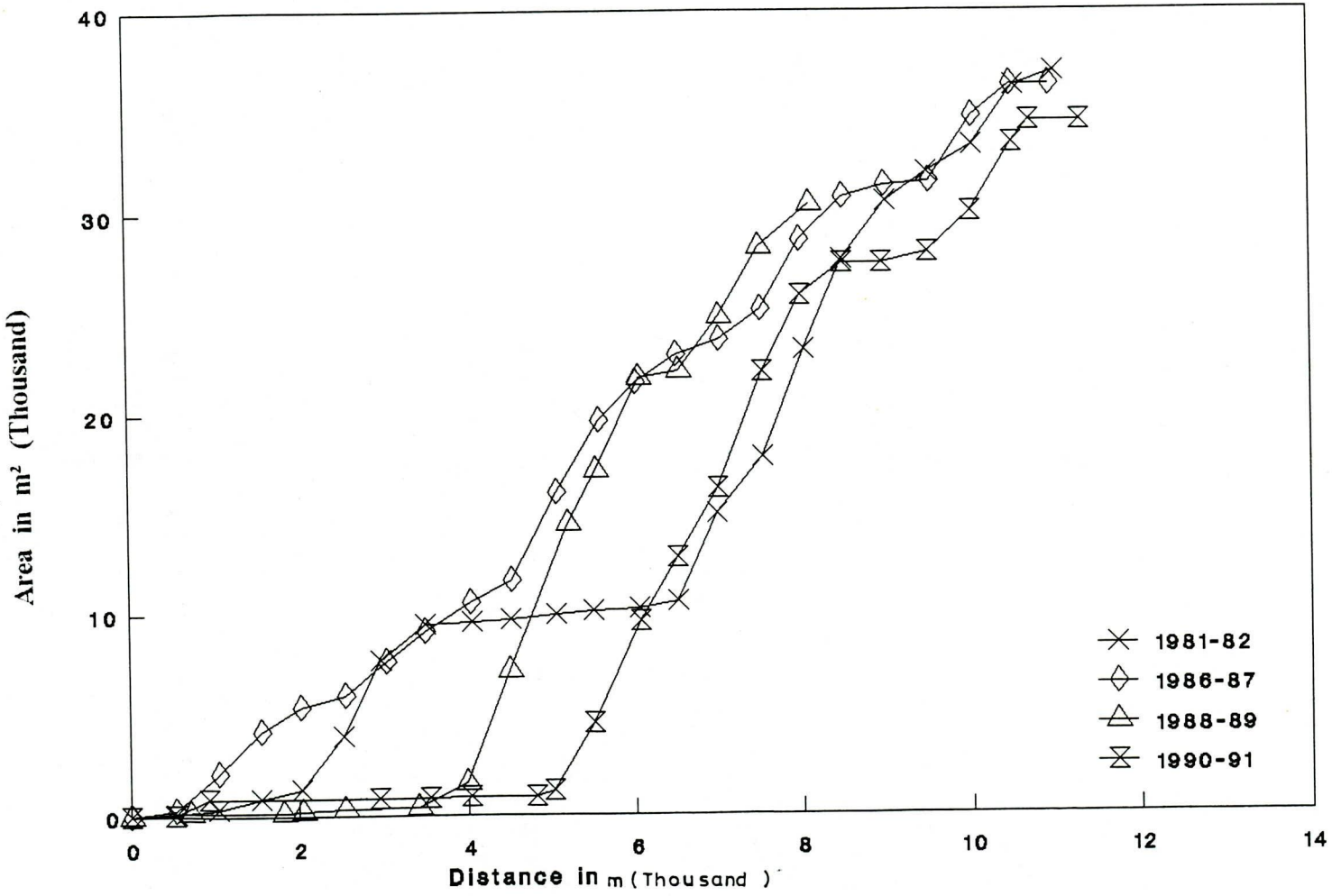


Figure 5.67.b Area Vs. Distance across the width (Ch.: 223.20 Km.) Sec. J - 2

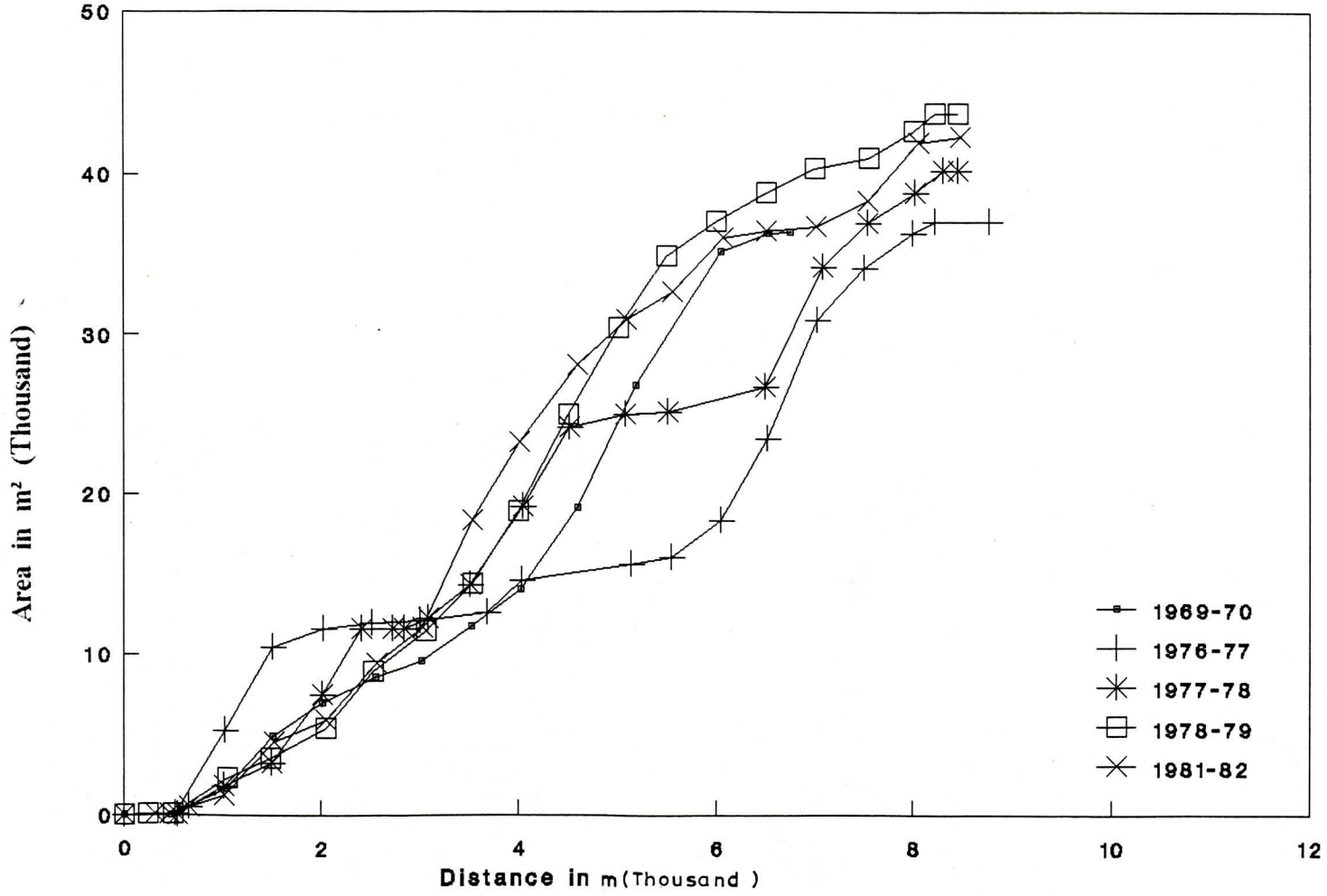


Figure 5.68.a Area Vs. Distance across the width (Ch.: 230.75 Km.) Sec. J - 1

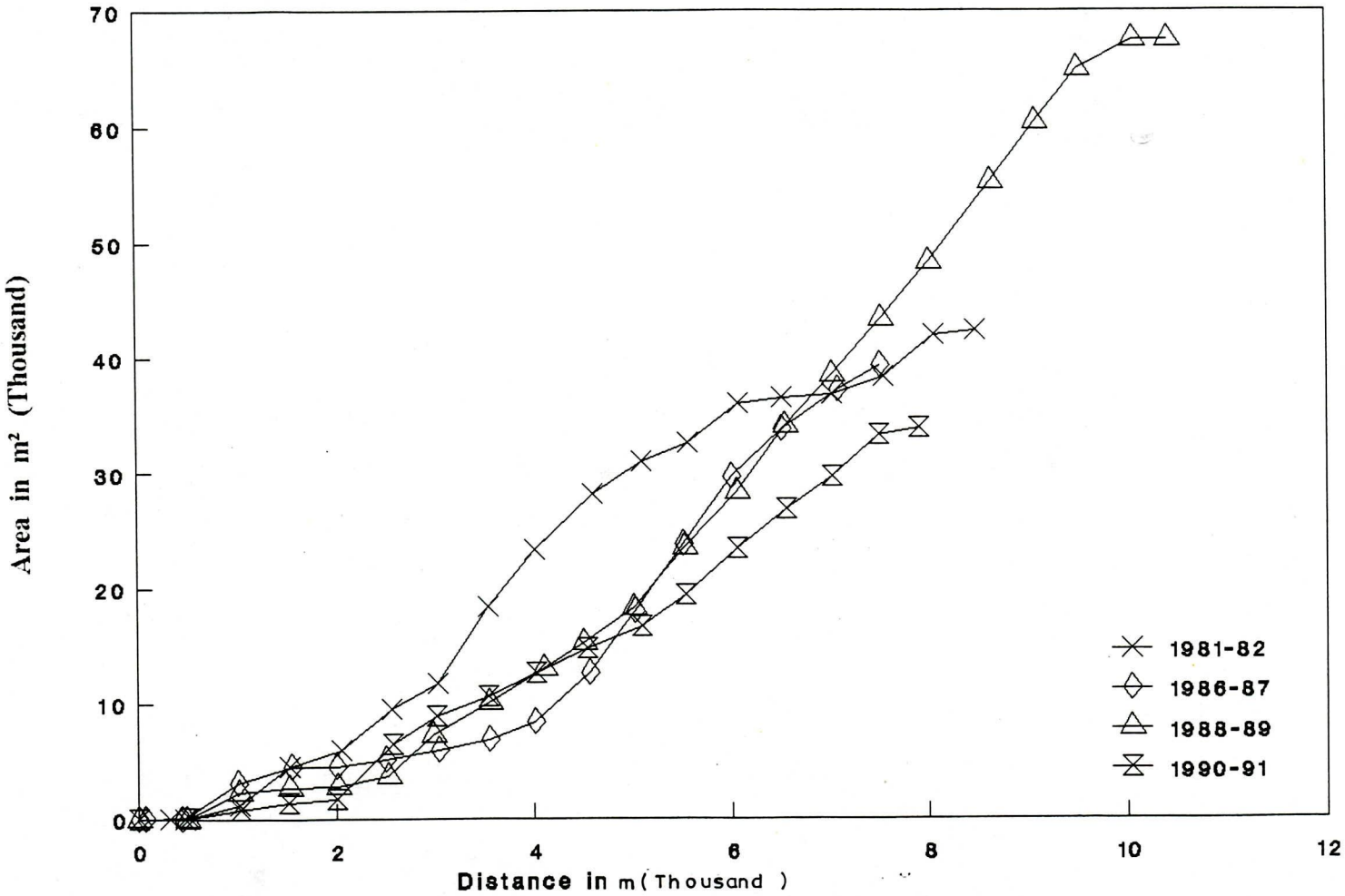


Figure 5.68.b Area Vs. Distance across the width (Ch.: 230.75Km.) Sec. J - 1

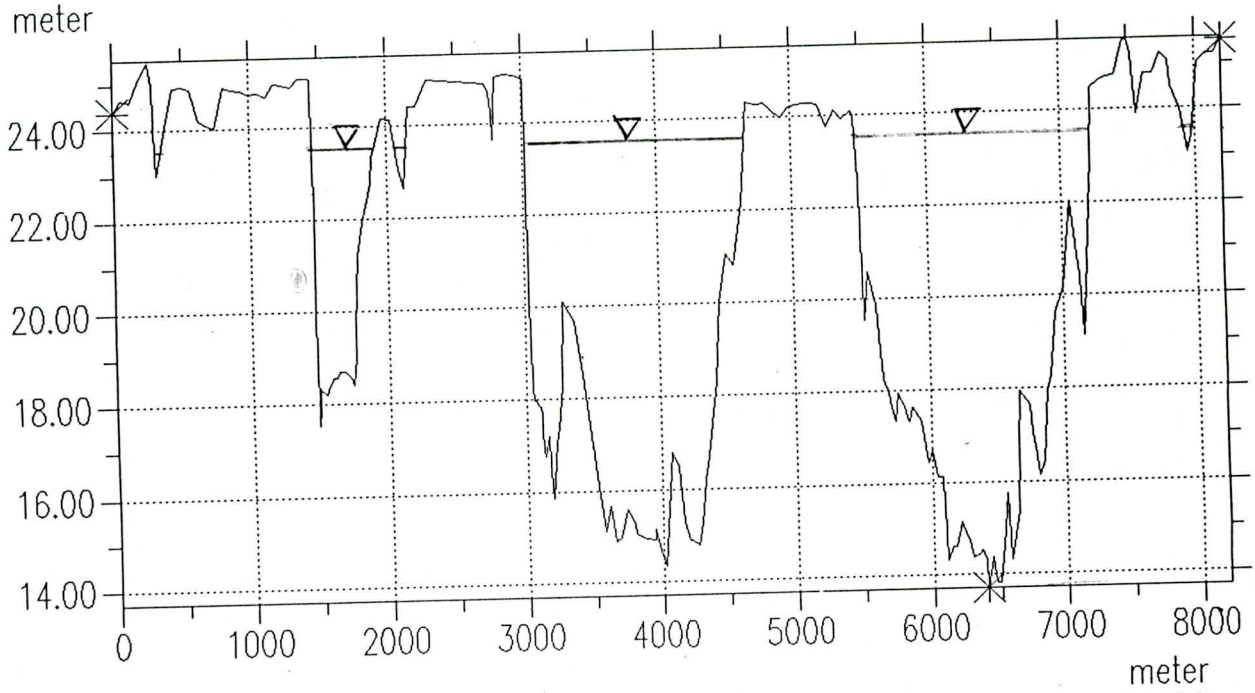


Fig.5.69.a Cross-section at Chainage 25·000Km, J-17, 1969-70

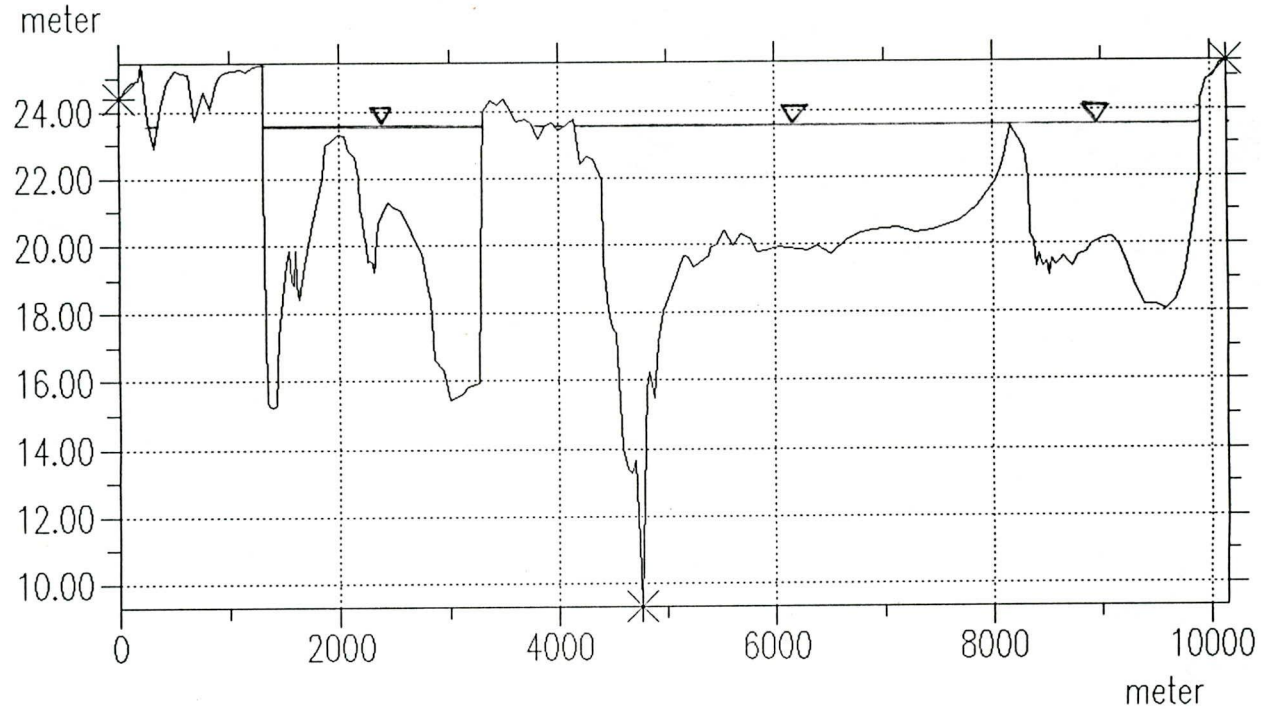


Figure 5.69.b Cross-section at Chainage 25.000Km, J-17, 1976-77

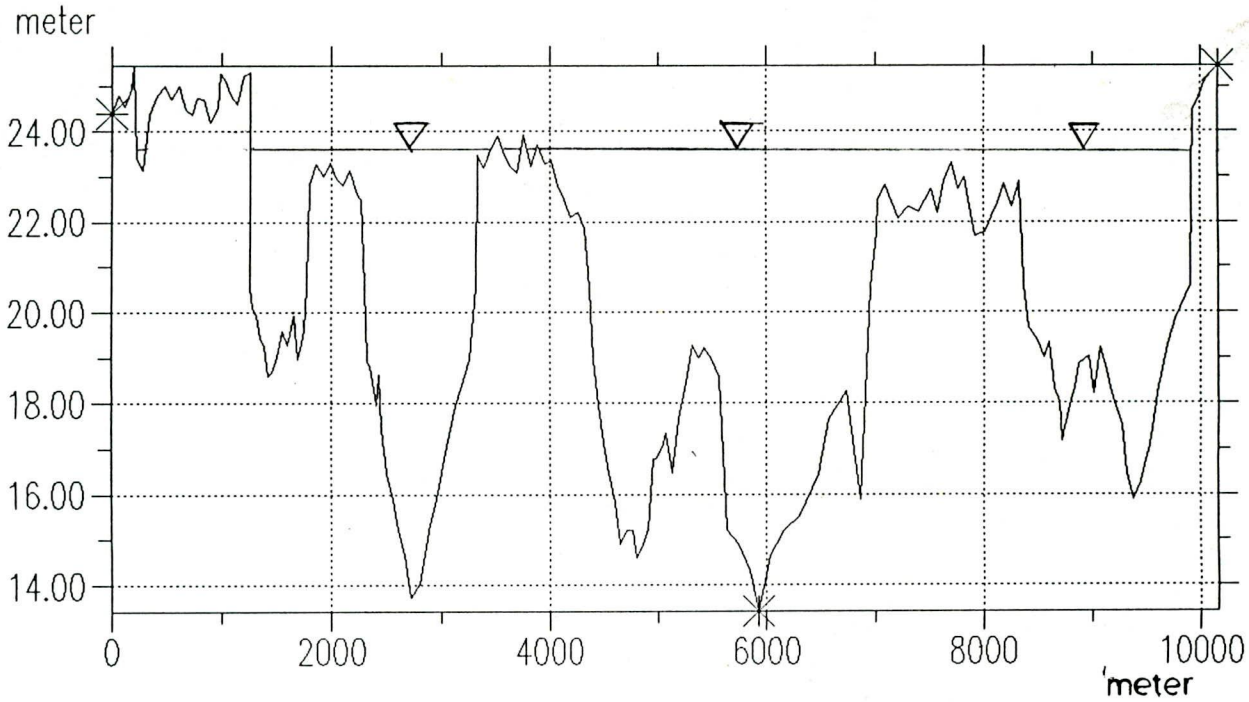


Figure 5.69.c Cross-section at Chainage 25.000Km, J-17, 1977-78

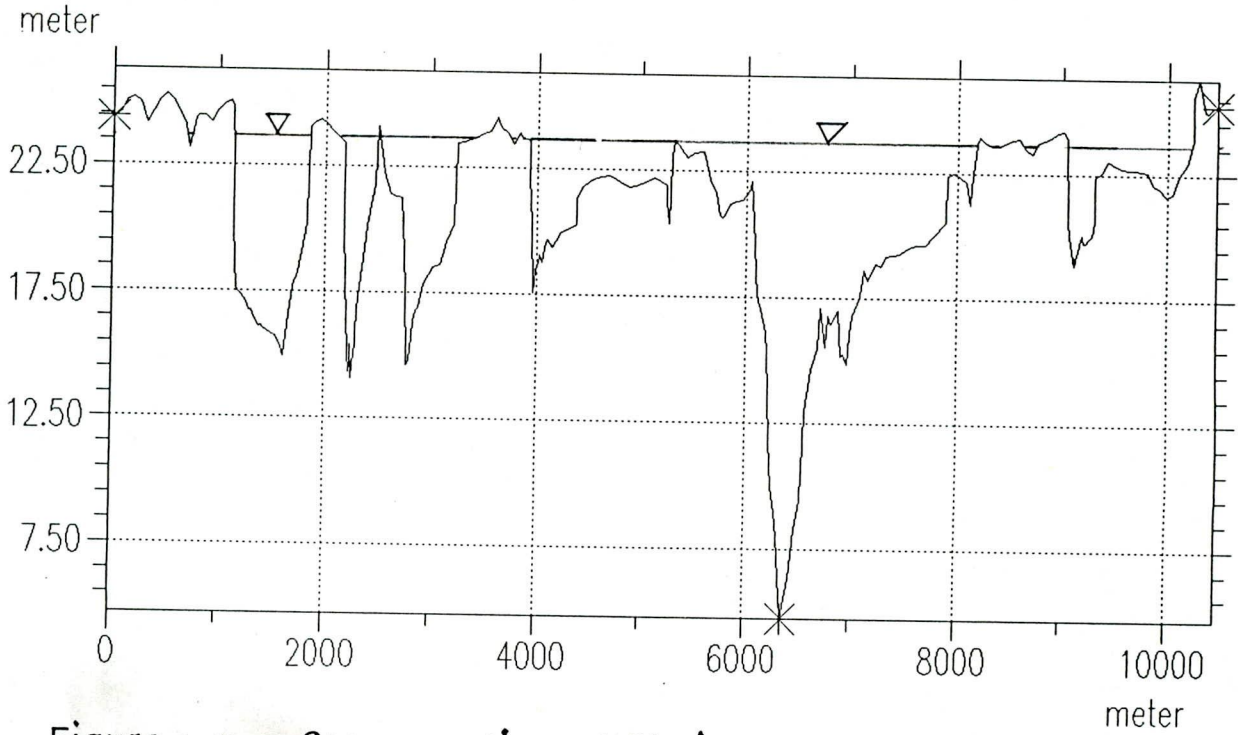


Figure 5.69.d Cross-section at Chainage 25..000Km, J-17, 1978-79

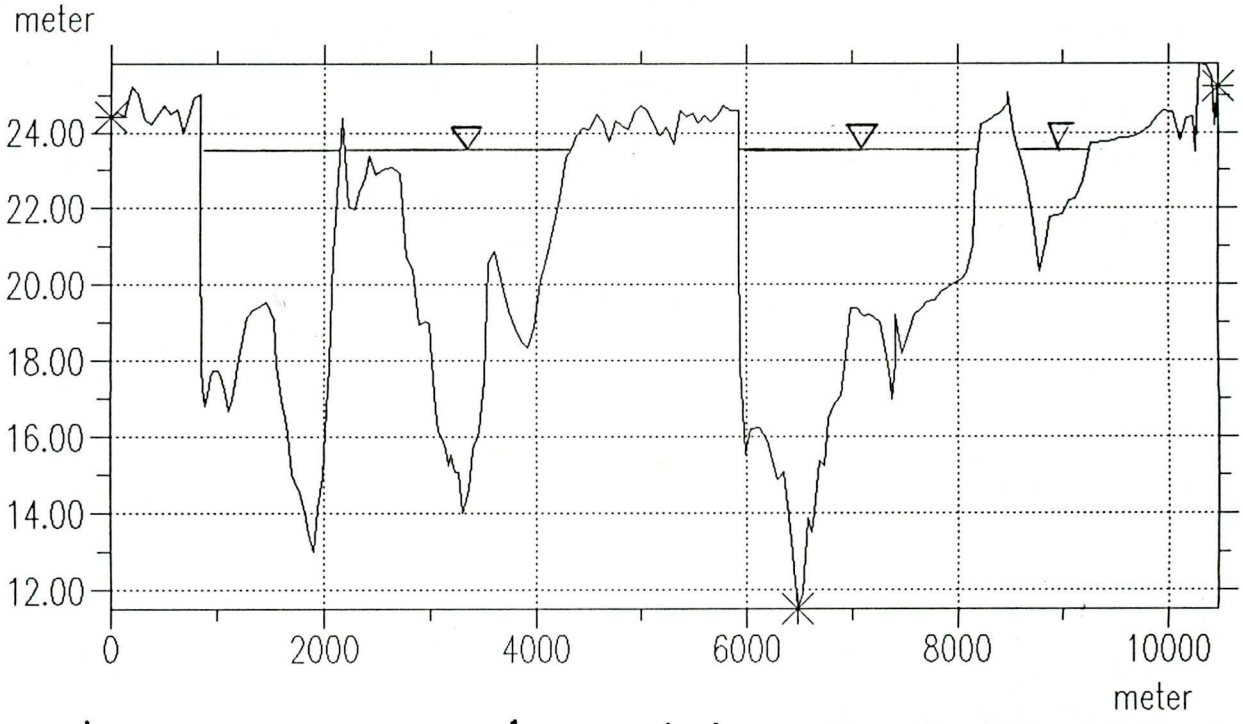


Figure 5.69.e Cross-section at Chainage 25.000Km, J-17, 1981-82

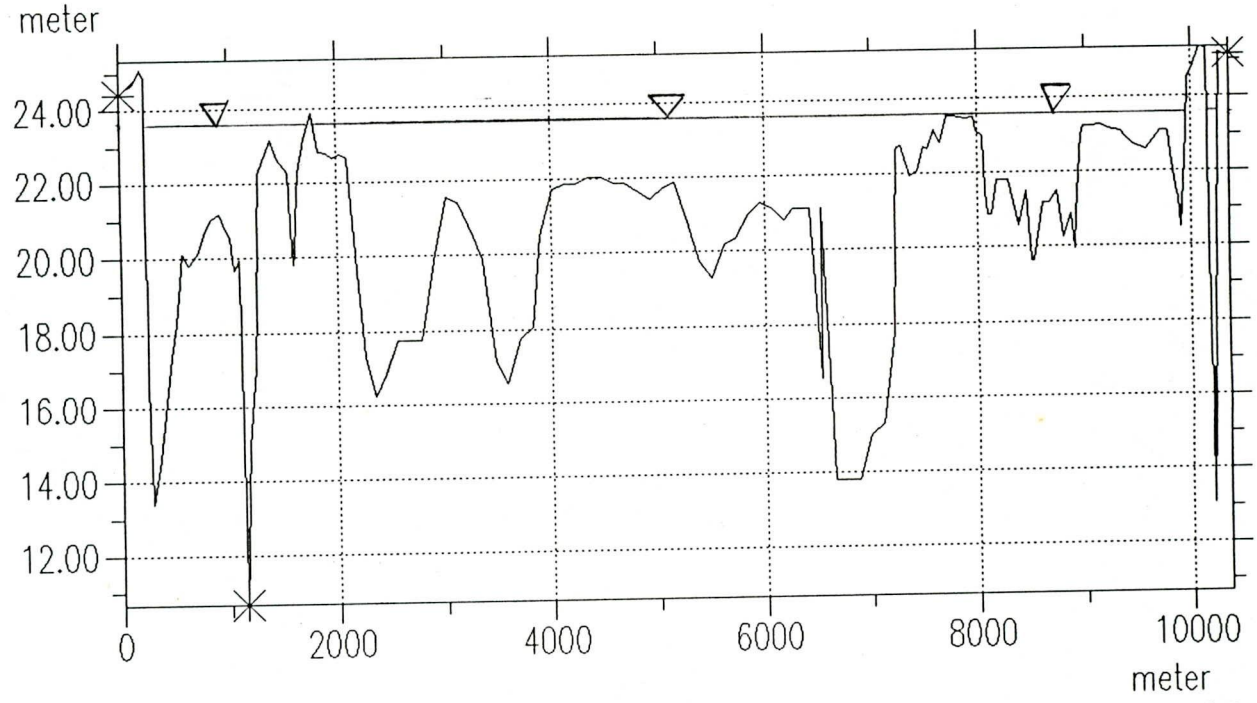


Figure 5.69.f Cross-section at Chainage 25.000Km, J-17, 1986-87

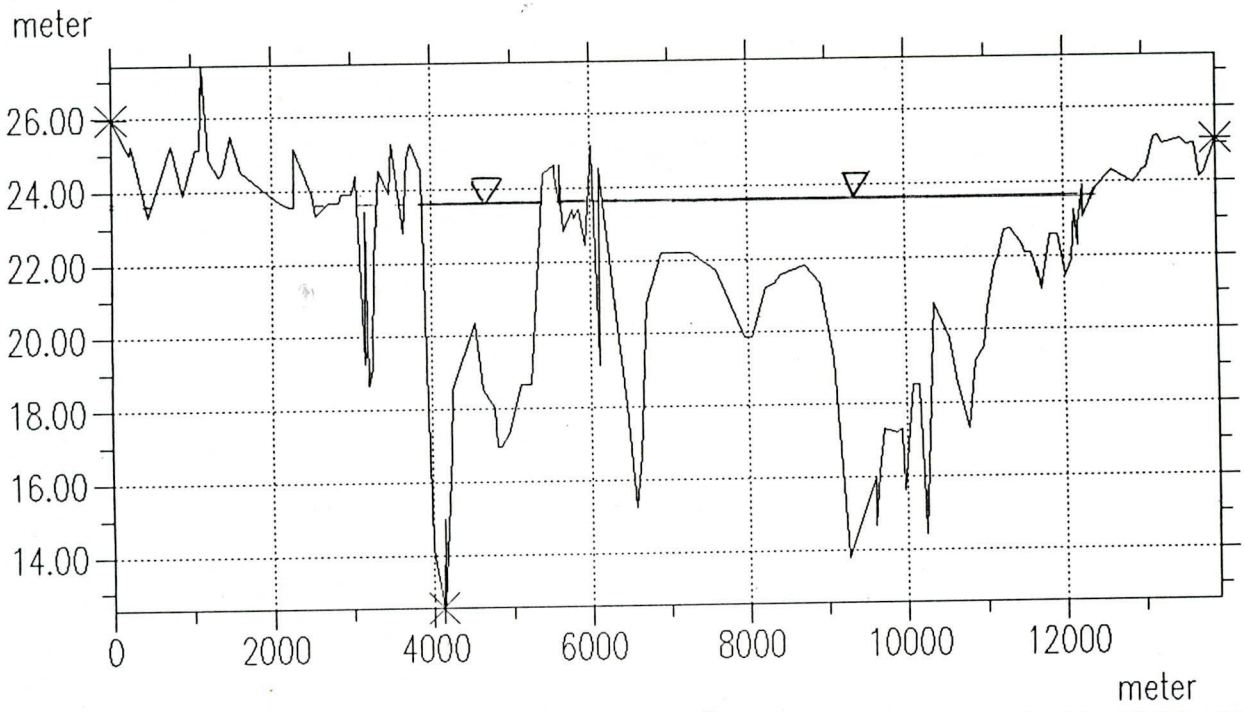


Figure 5.69.g Cross-section at Chainage 25.000Km, J-17, 1988-89

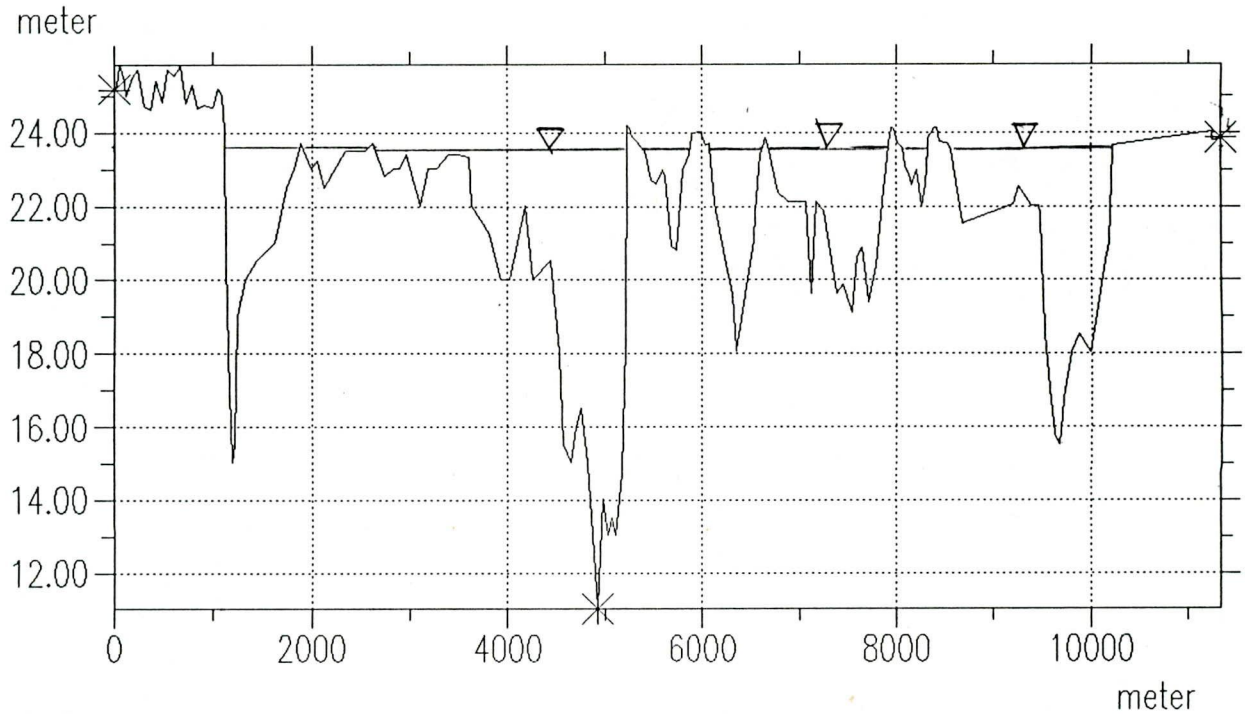


Figure 5.69.h. Cross-section at Chainage 25.000Km, J-17, 1990-91

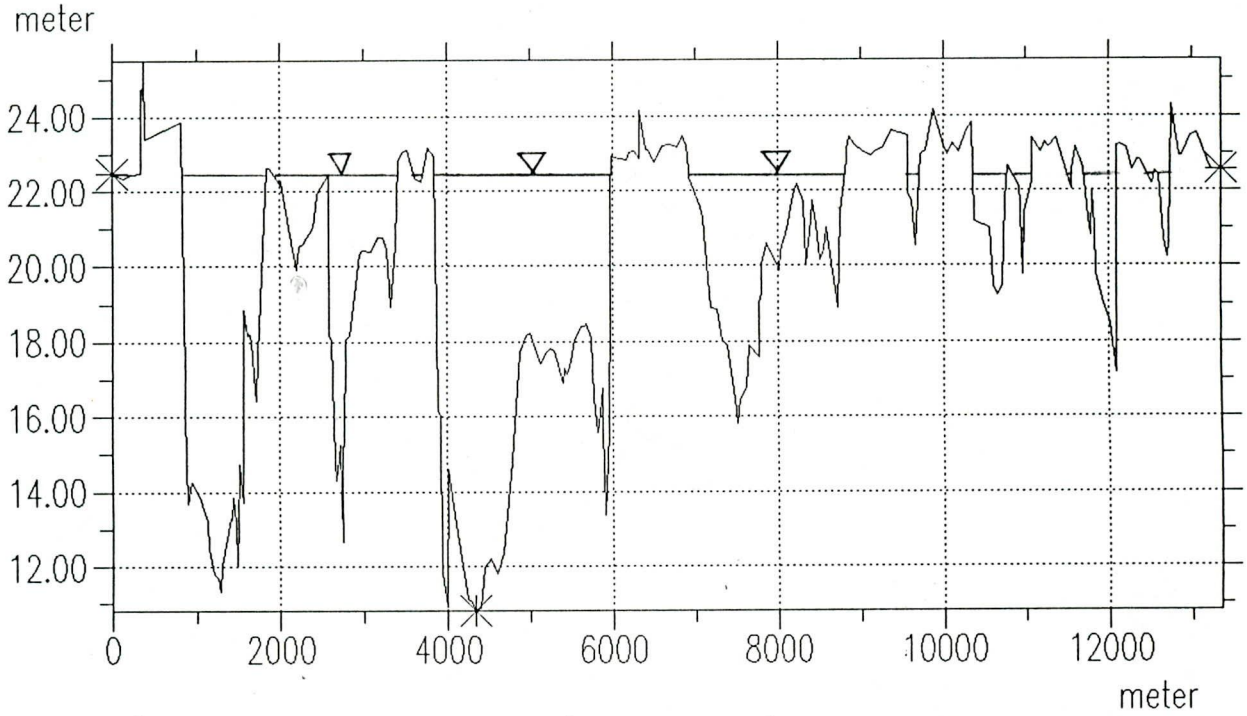


Figure 5.70.a Cross-section at Chainage 37.100 Km, J-16, 1969-70.

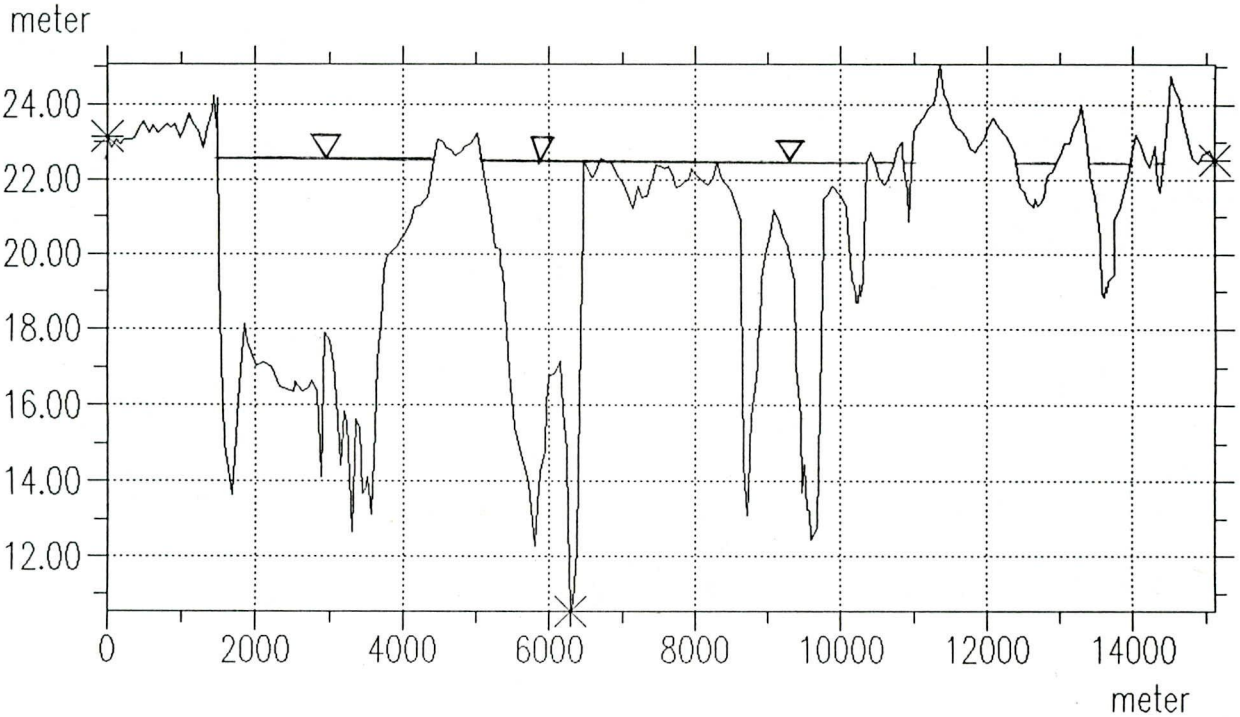


Figure 5.70.b Cross-section at Chainage 37.100 Km, J-16, 1976-77

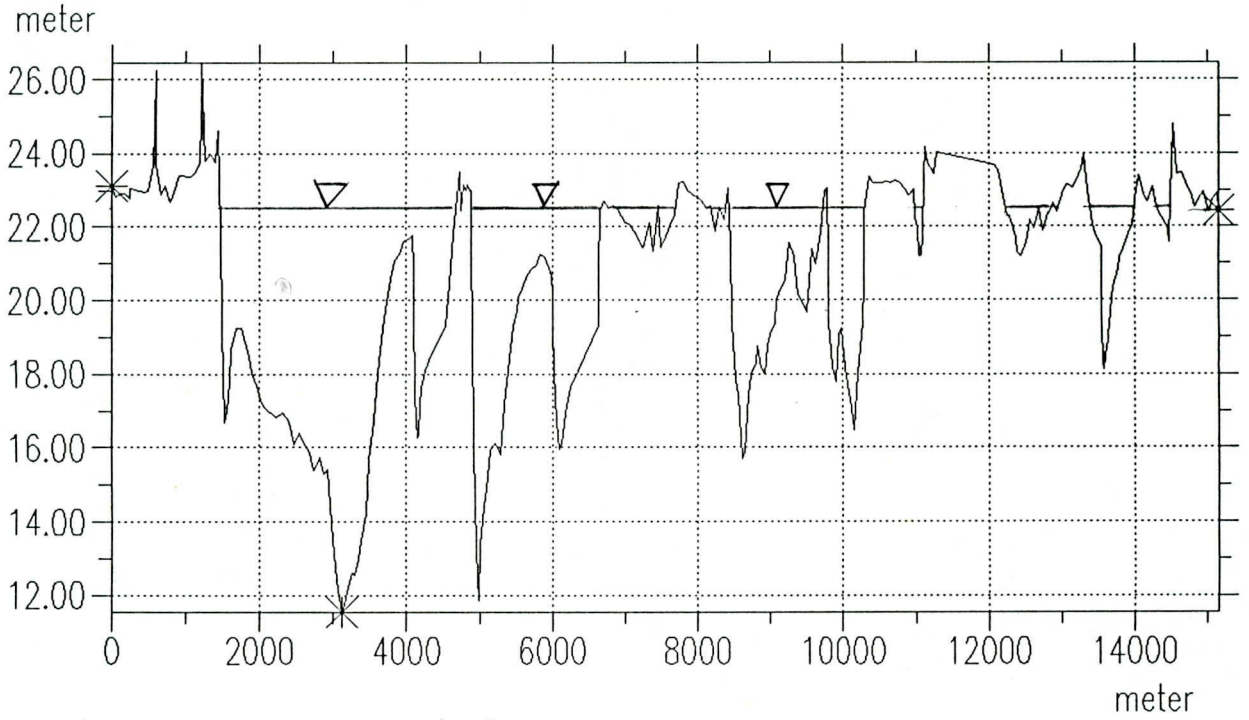


Figure 5.70.c Cross-section at Chainage 37·100Km, J-16, 1977-78·

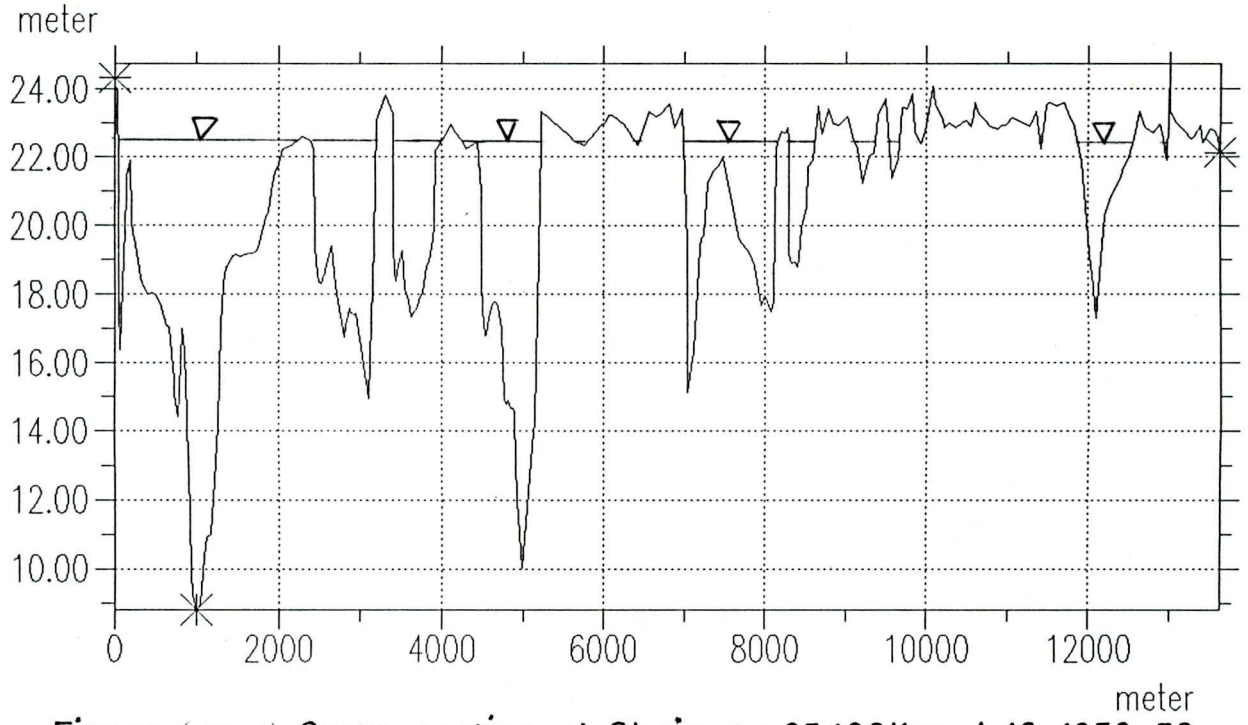


Figure 5.70.d Cross-section at Chainage 37·100Km, J-16, 1978-79 .

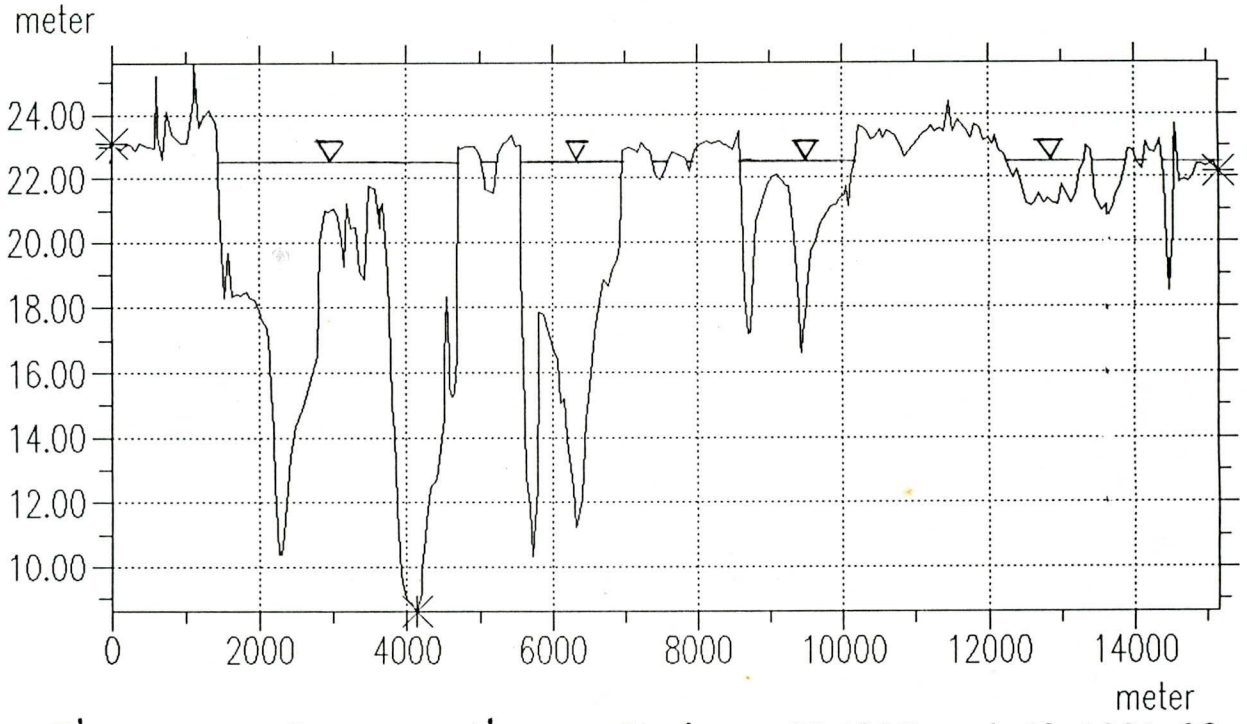


Figure 5.70.e Cross-section at Chainage 37.100Km, J-16, 1981-82

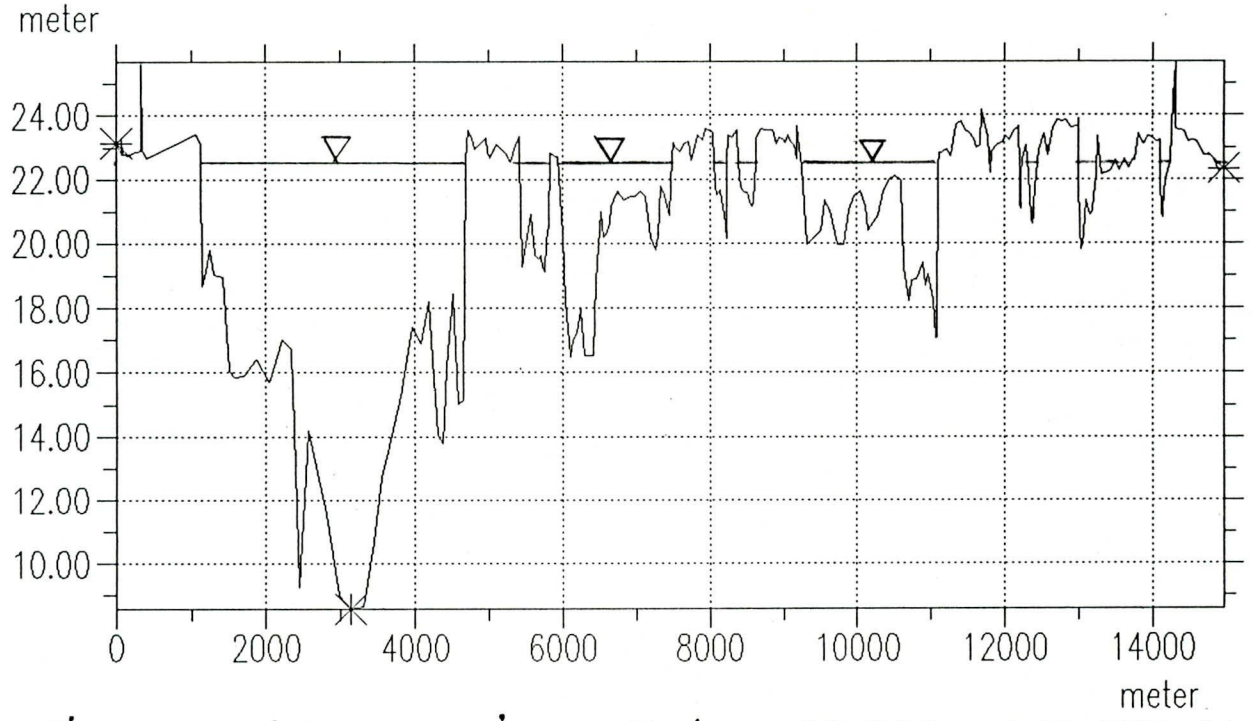


Figure 5.70.f Cross-section at Chainage 37.100Km, J-16, 1986-87

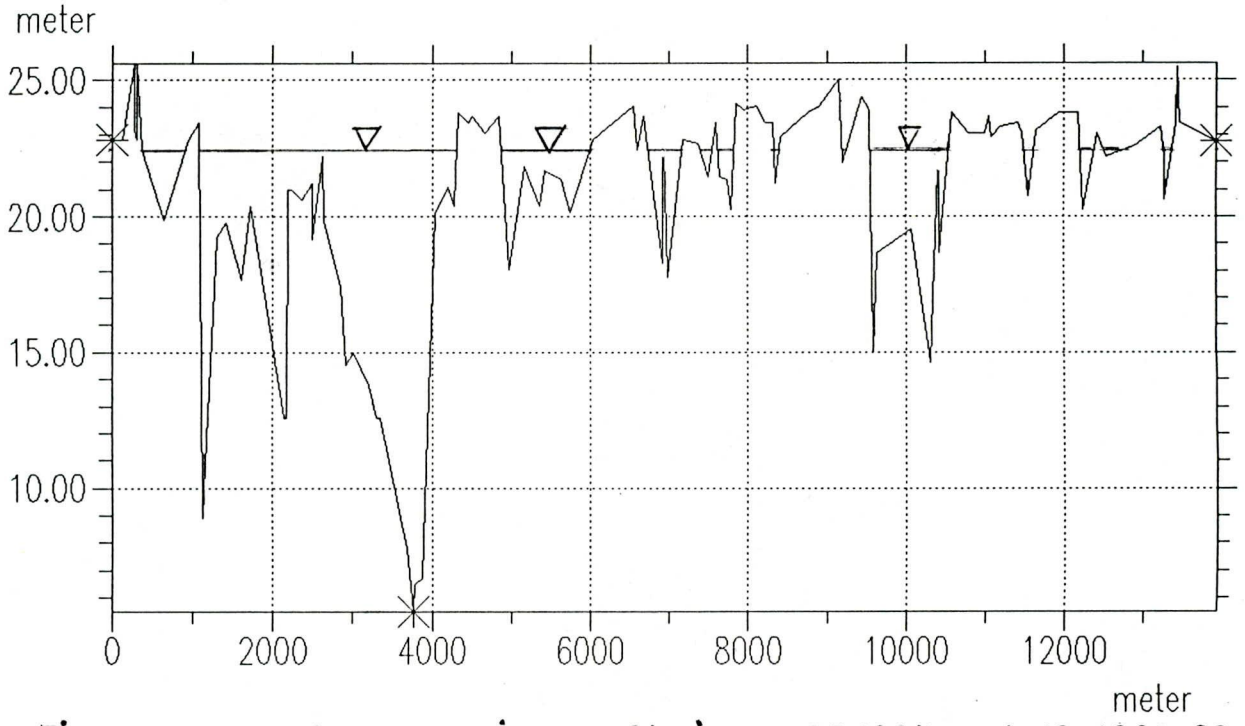


Figure 5.70.g Cross-section at Chainage 37·100Km, J-16, 1988-89

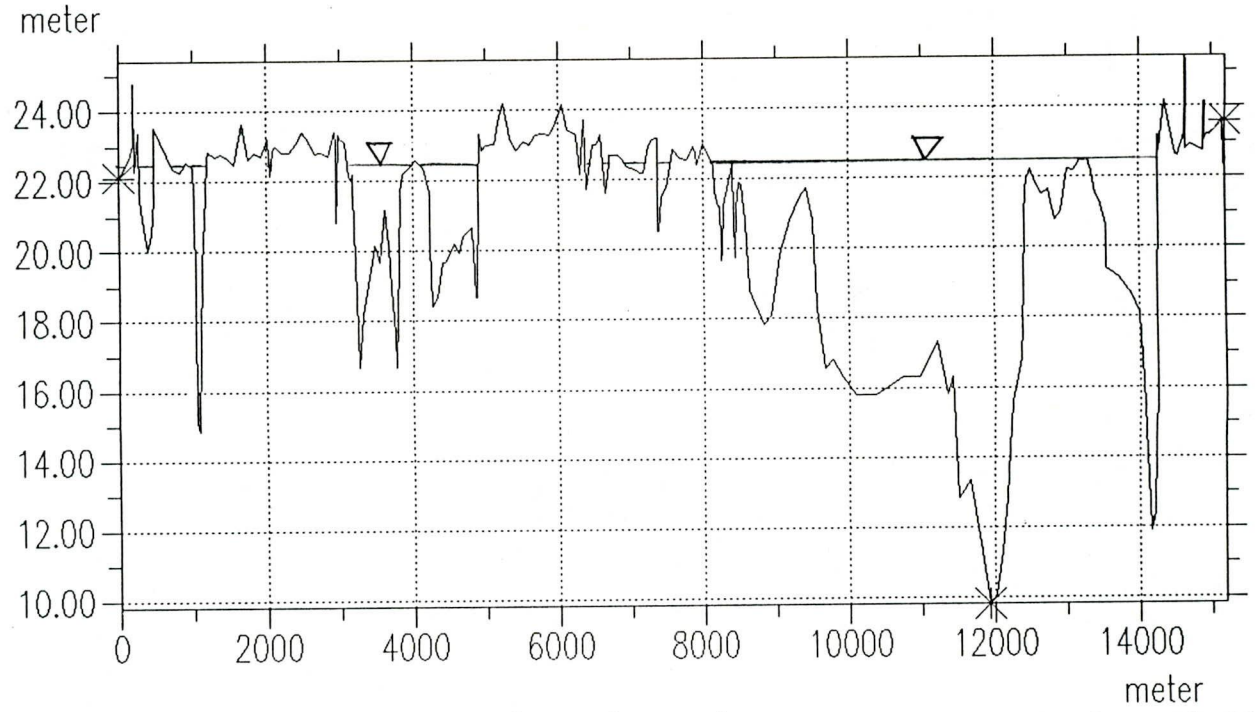


Figure 5.70.h Cross-section at Chainage 37.100Km, J-16, 1990-91

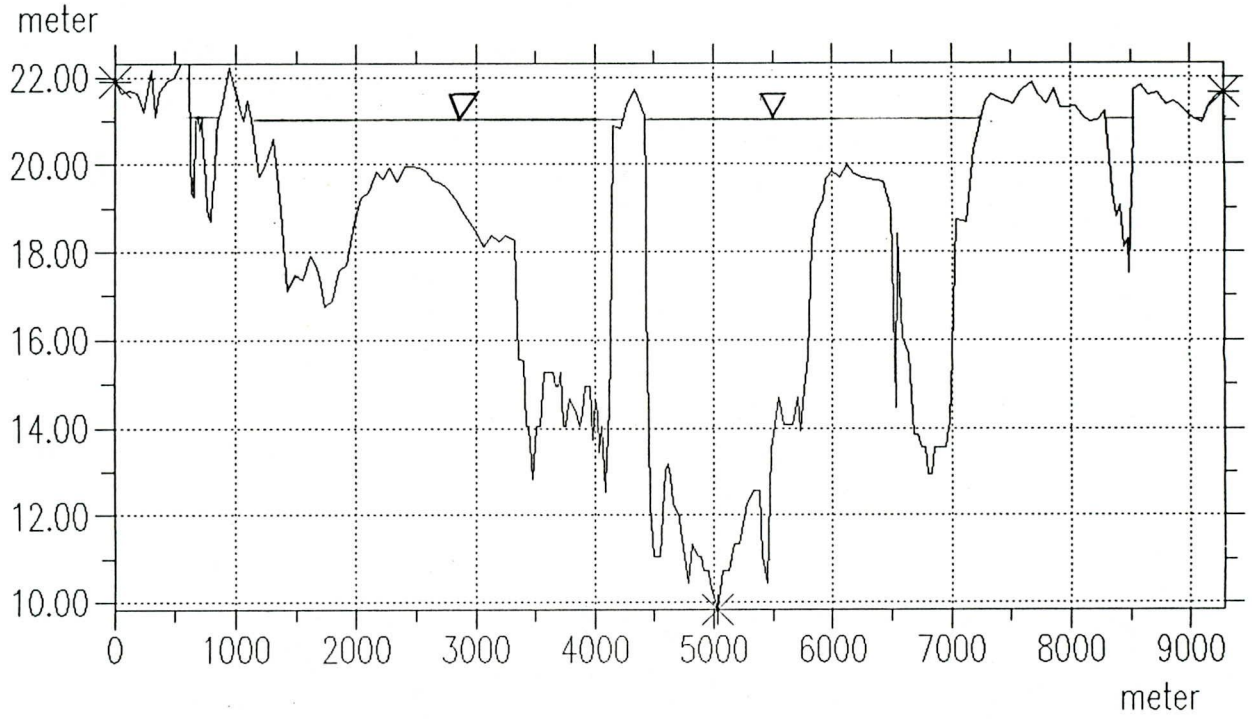


Figure 5.71.a Cross-section at Chainage 55·650 Km, J-15, 1969-70

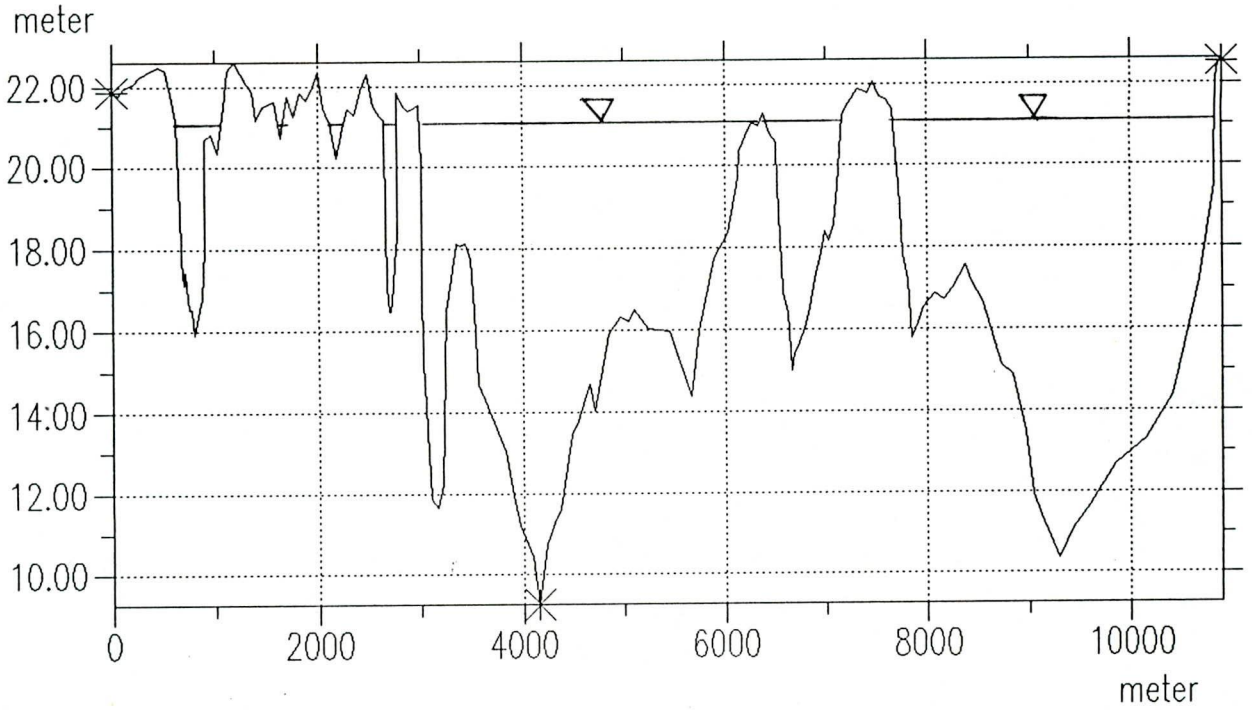


Figure 5.71.b Cross-section at Chainage 55·650 Km, J-15, 1976-77

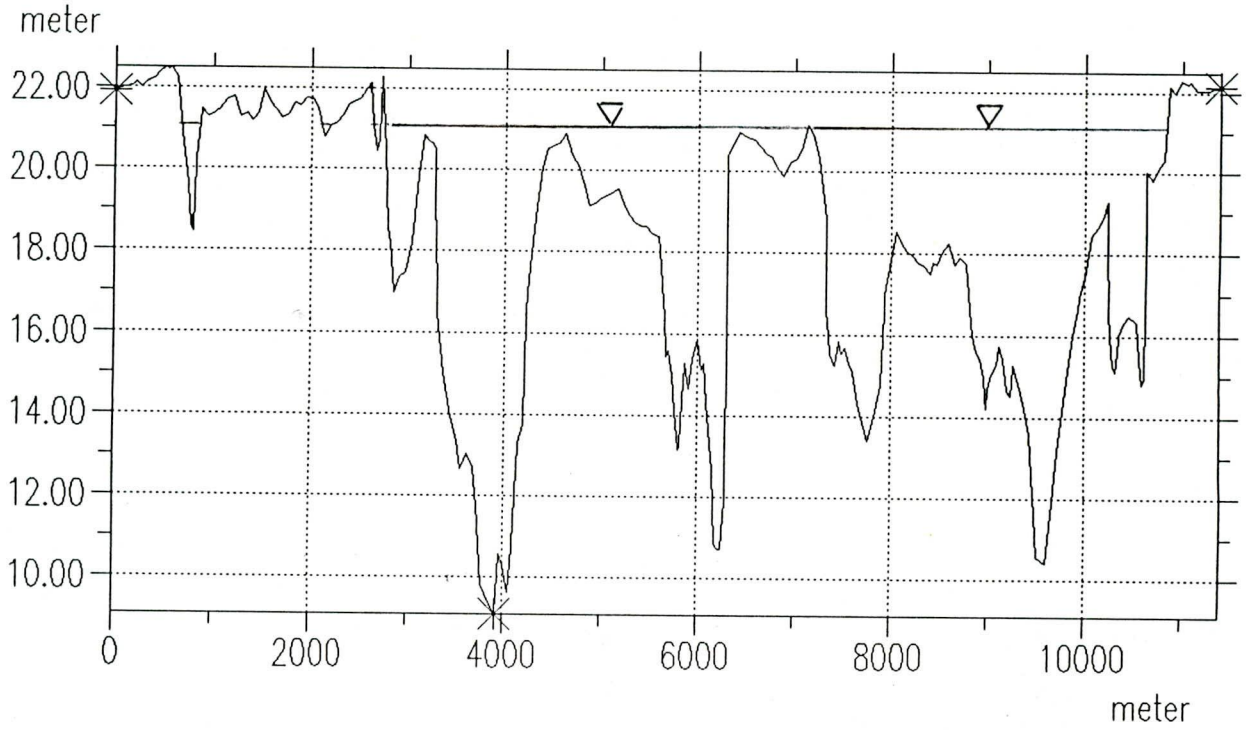


Figure 5.71.c Cross-section at Chainage 55·650 Km. J-15. 1977-78

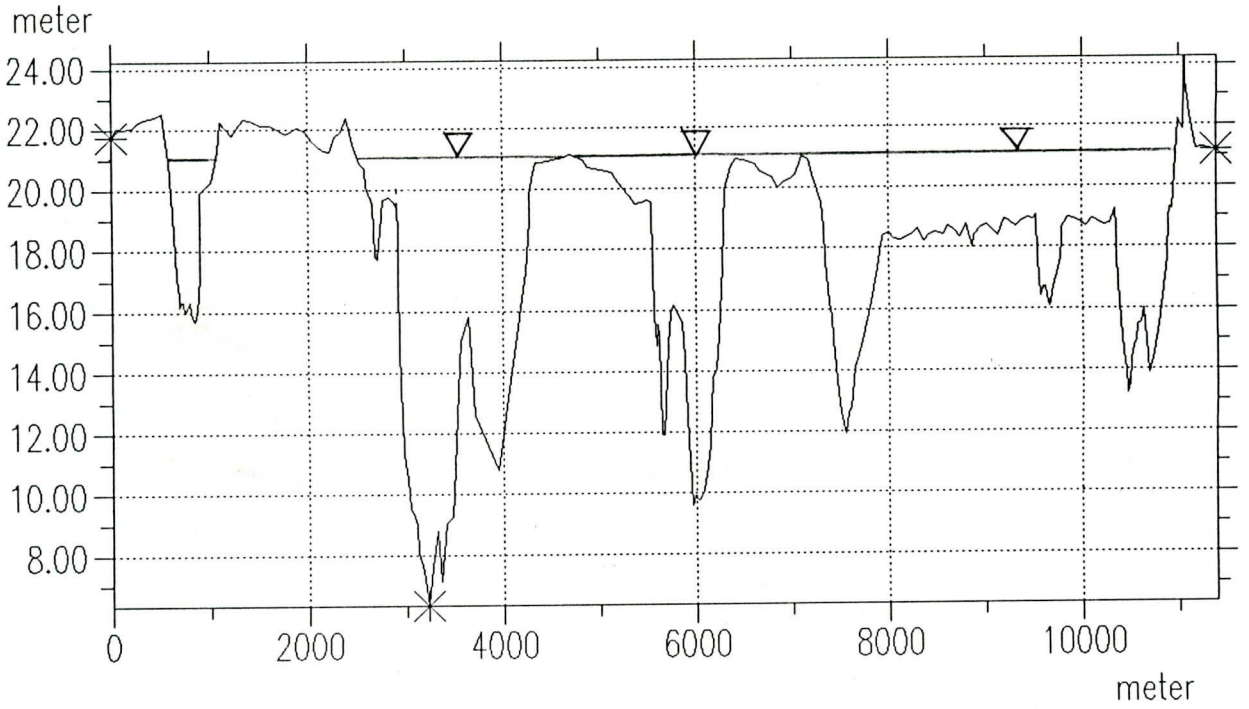


Figure 5.71.d Cross-section at Chainage 55·650 Km J-15 1978-79

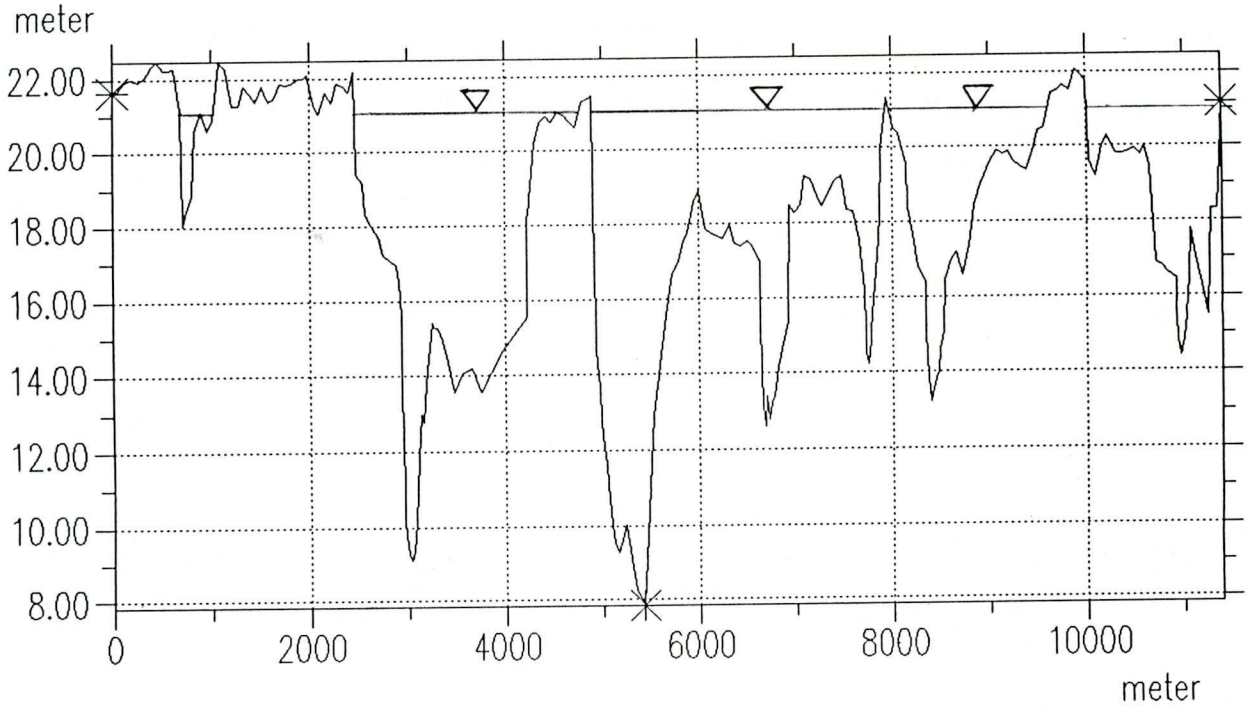


Figure 5.71.e Cross-section at Chainage 55·650 Km J-15 1981-82

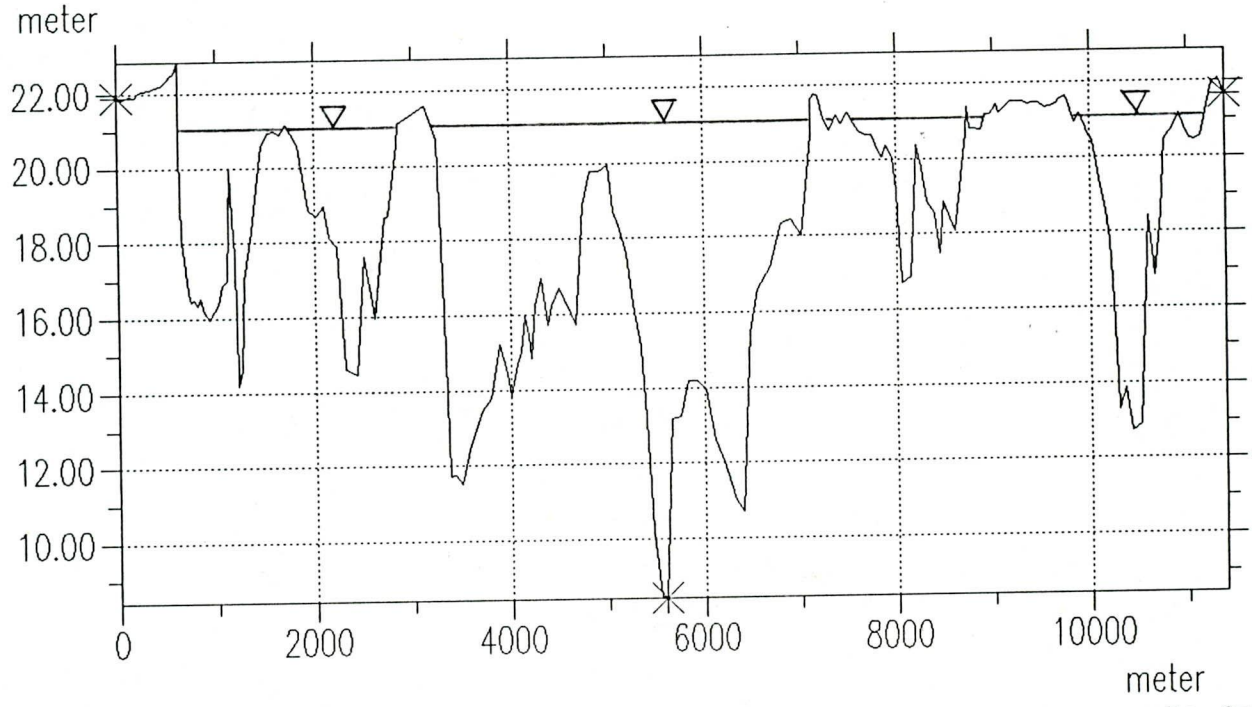


Figure 5.71.f Cross-section at Chainage 55·650 Km J-15· 1986-87

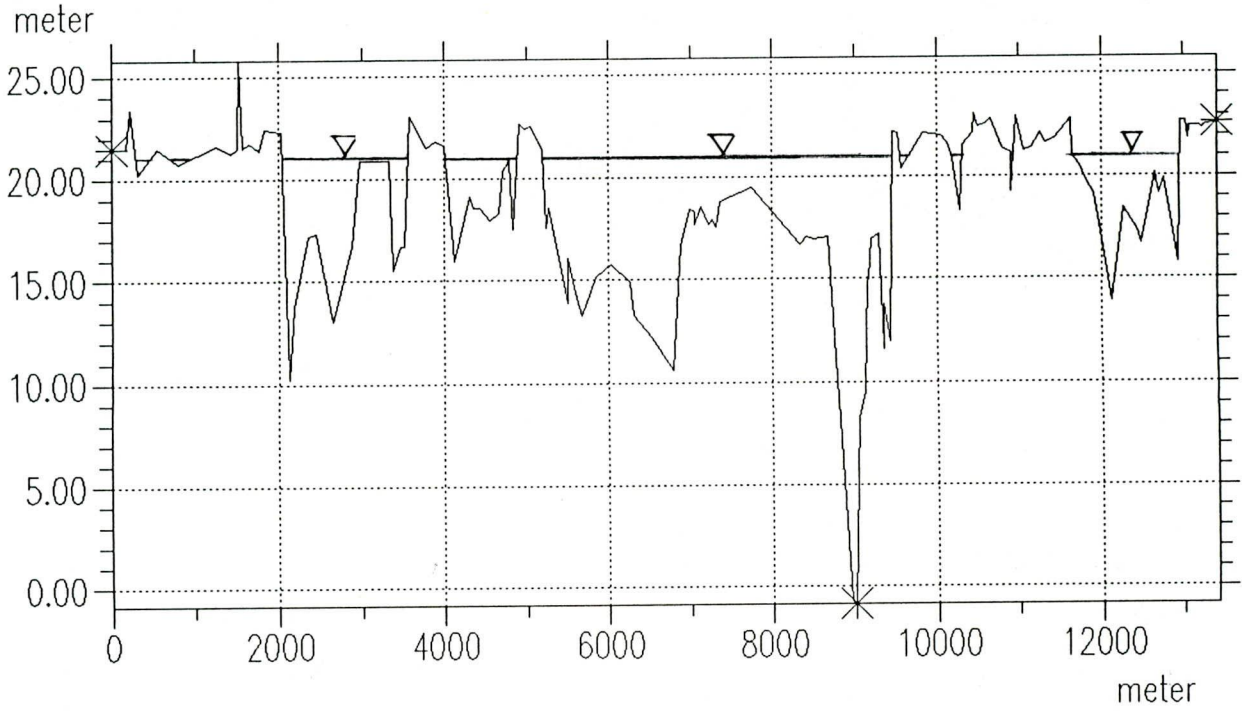


Figure 5.71.g Cross-section at Chainage 55.650 Km J-15 1988-89

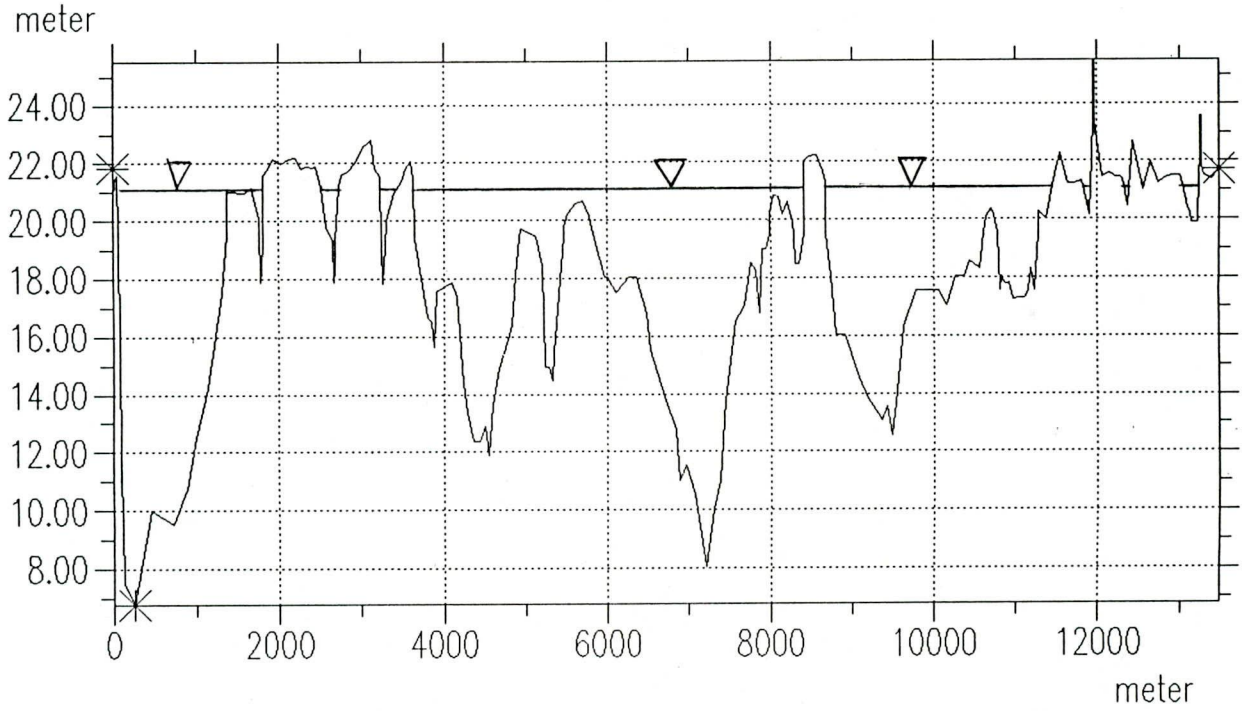


Figure 5.71.h Cross-section at Chainage 55.650 Km. J-15. 1990-91

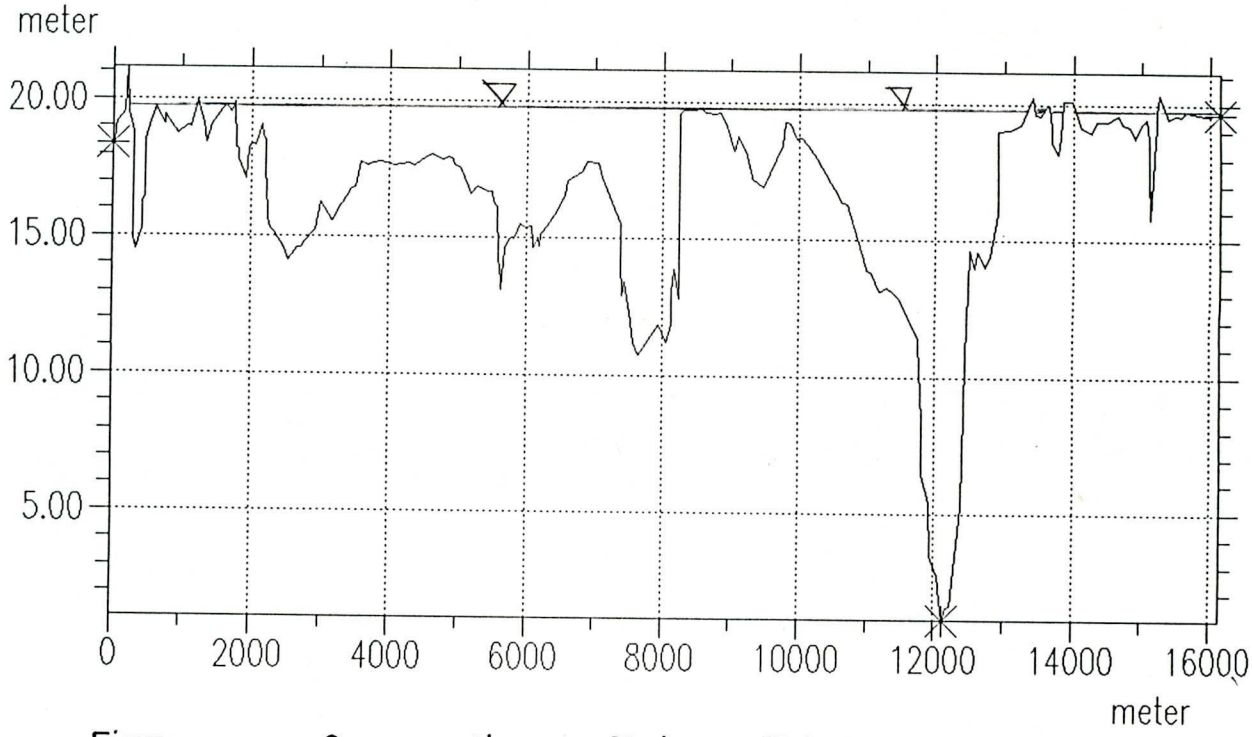


Figure 5.72.a Cross-section at Chainage 71·200 Km, J-14, 1969-70

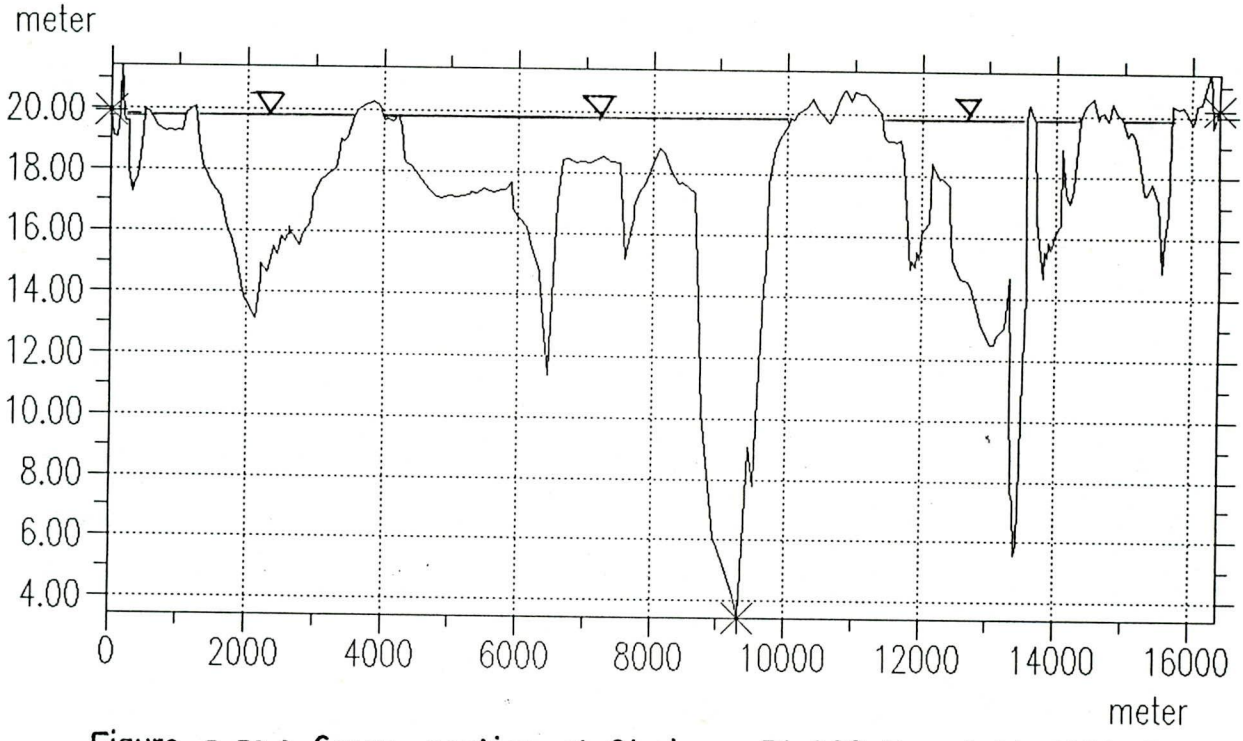


Figure 5.72.b Cross-section at Chainage 71·200 Km, J-14, 1976-77

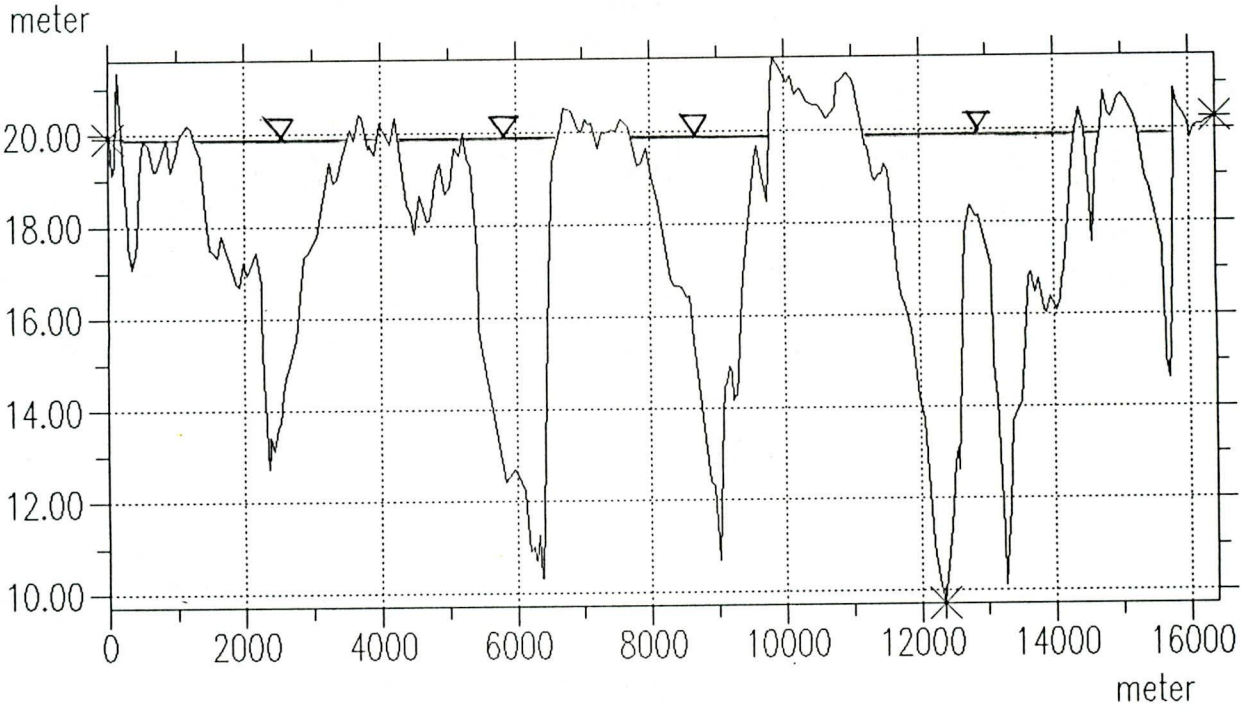


Figure 5.72.c Cross-section at Chainage 71·200 Km. J-14. 1977-78

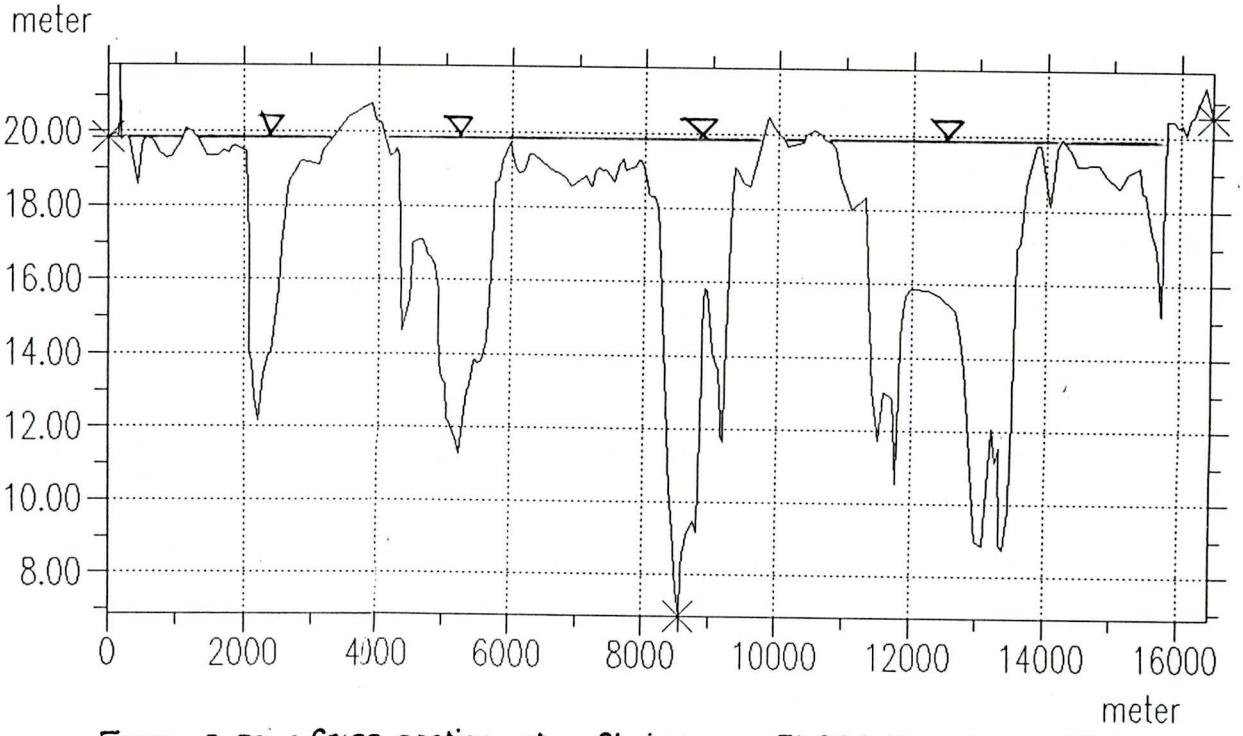


Figure 5.72.d Cross-section at Chainage 71·200 Km J-14. 1978-79

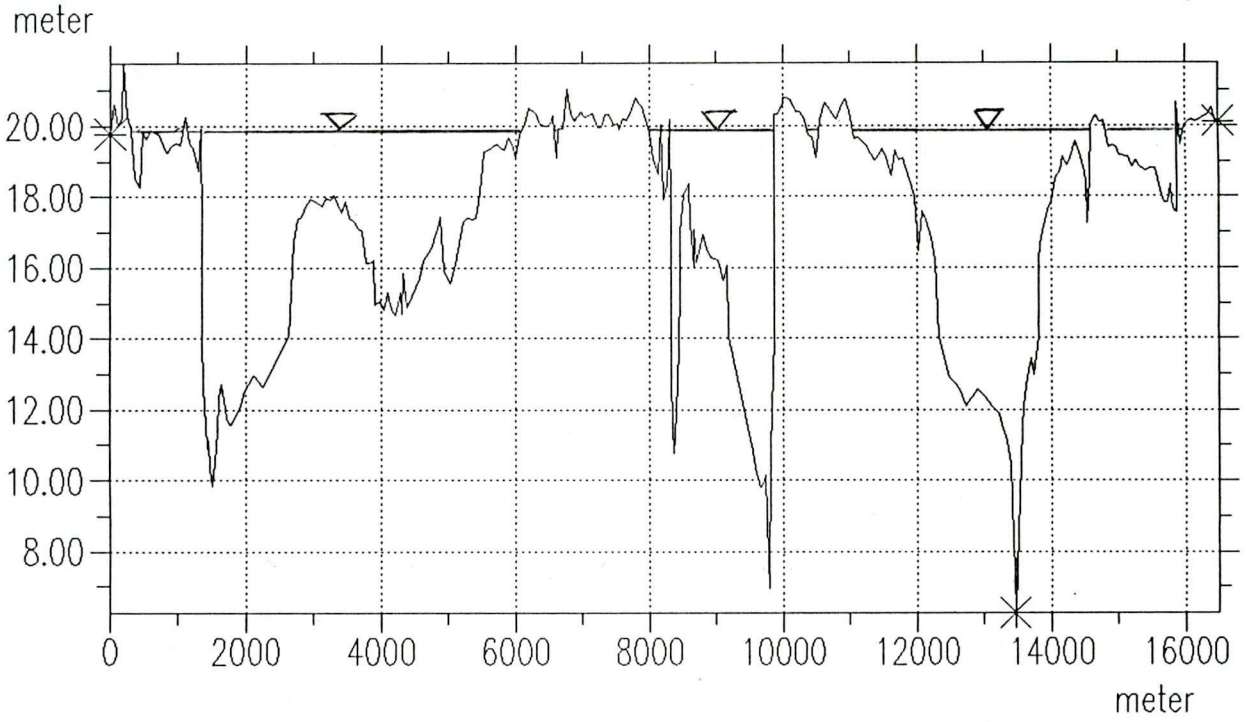


Figure 5.72.e Cross-section at Chainage 71.200 Km J-14. 1981-82

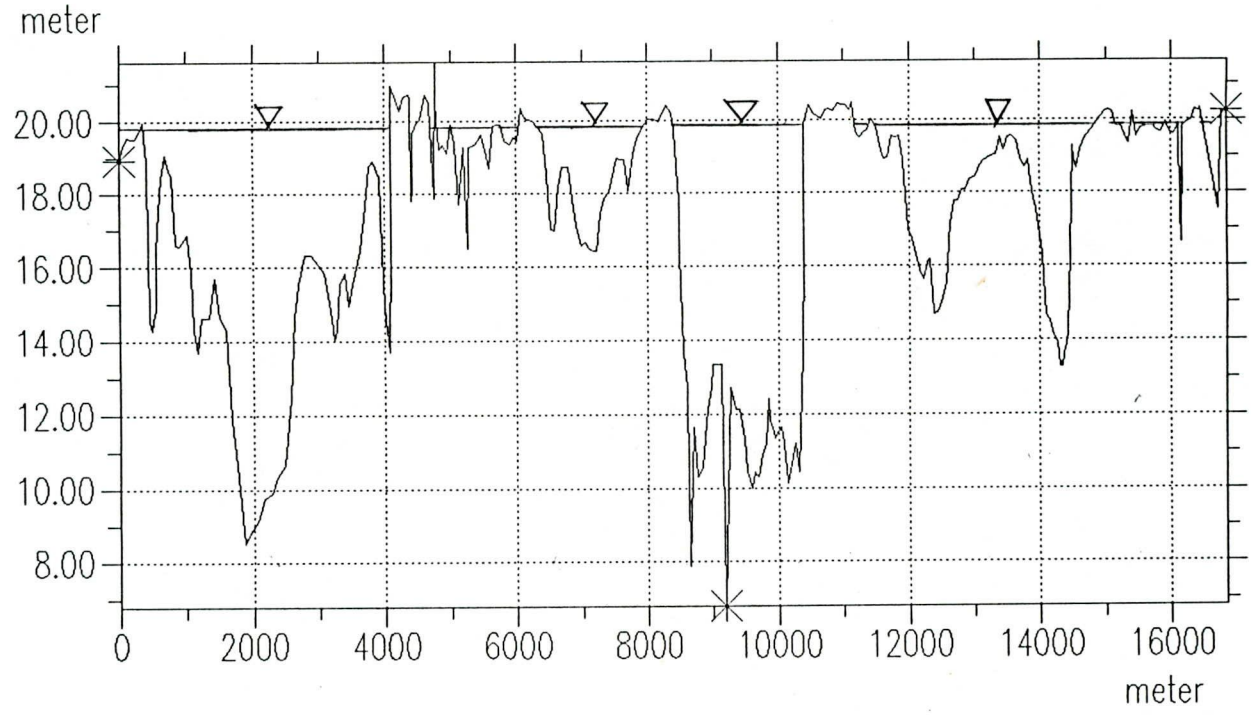


Figure 5.72.f Cross-section at Chainage 71.200 Km J-14. 1986-87

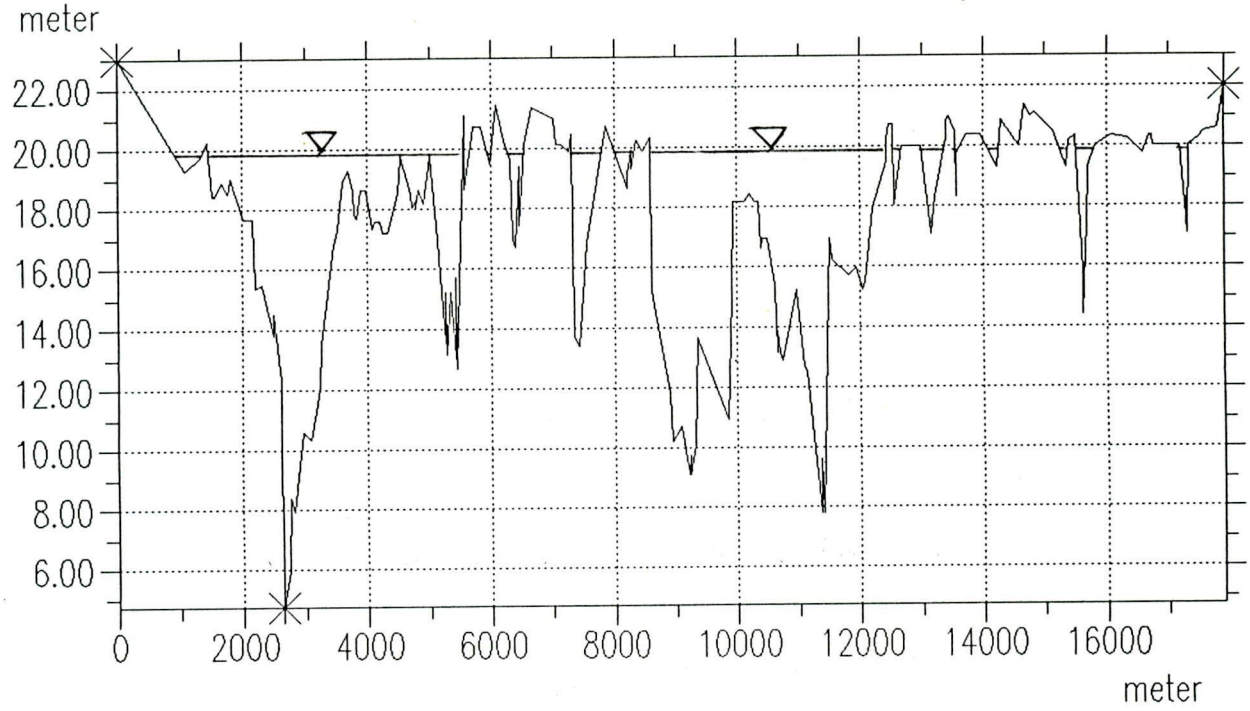


Figure 5.72.g Cross-section at Chainage 71·200 Km J-14. 1988-89

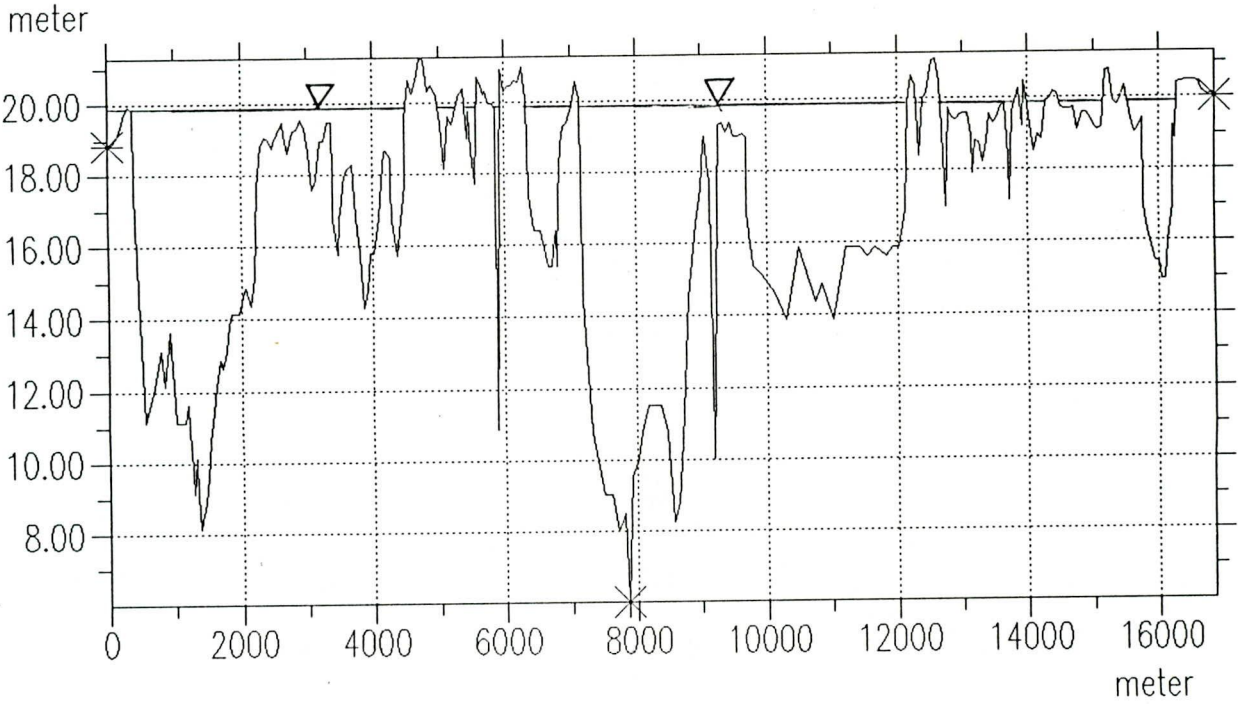


Figure 5.72.h Cross-section at Chainage 71·200 Km. J - 14. 1990-91

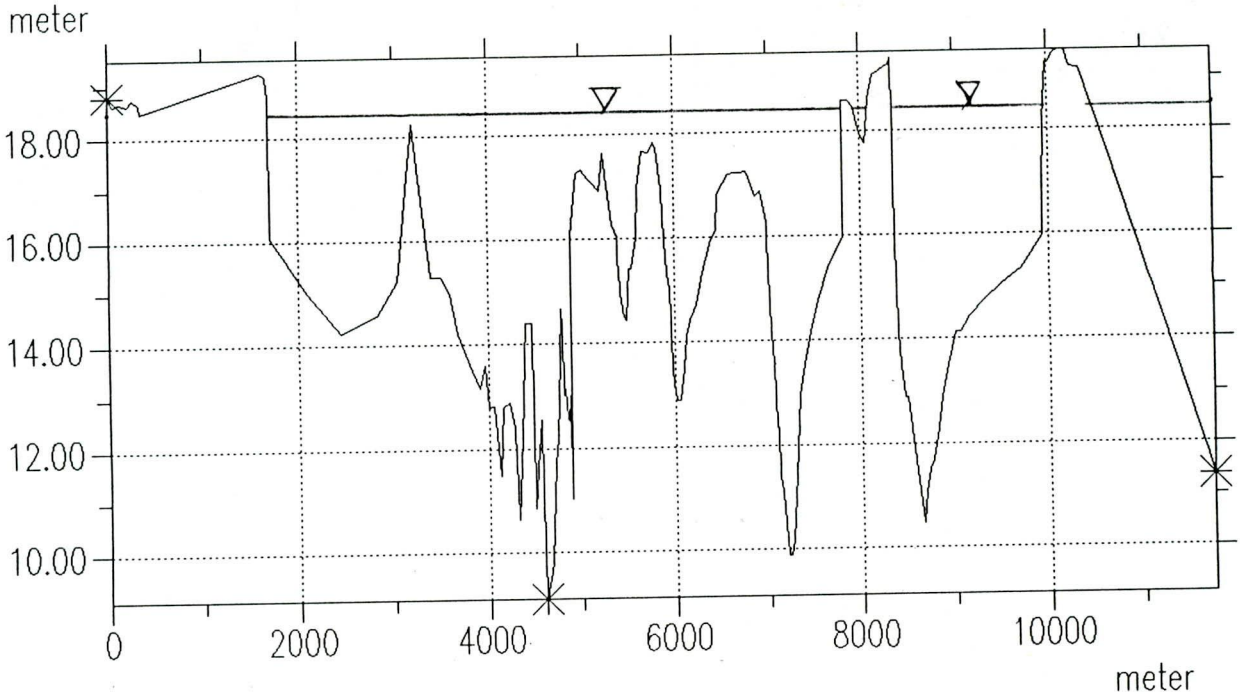


Figure 5.73.a Cross-section at Chainage 84·700 Km, J-13, 1969-70

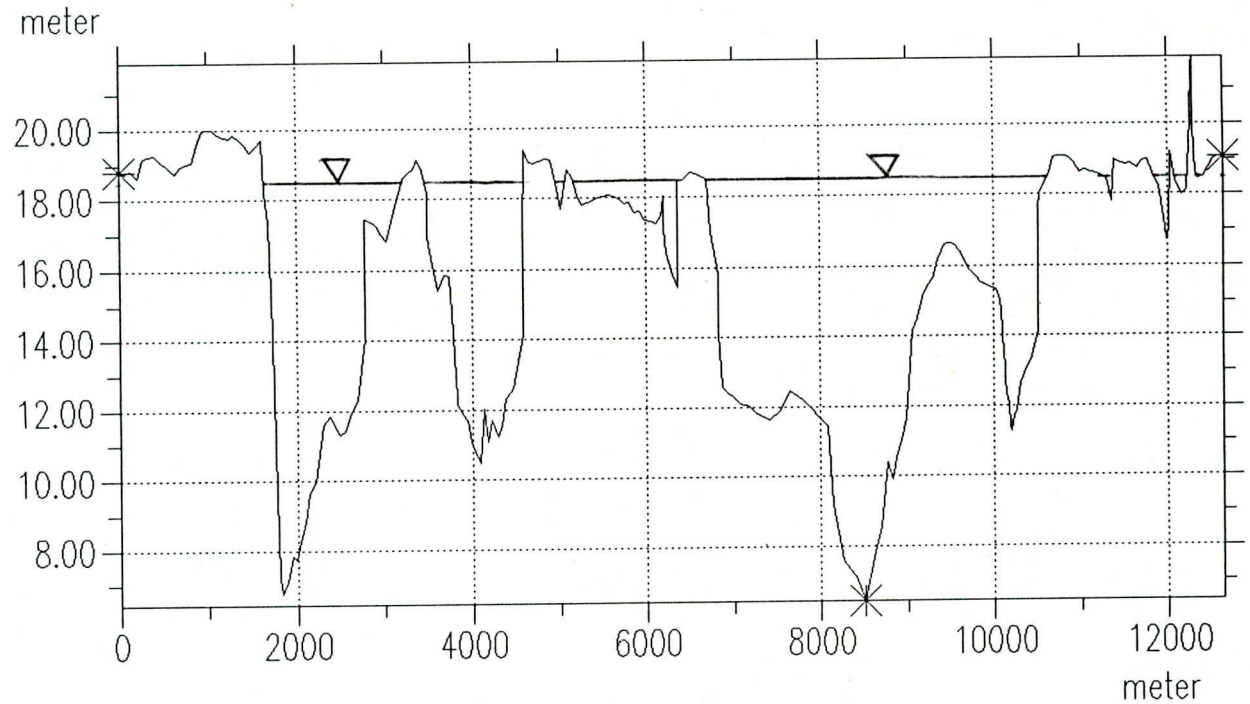


Figure 5.73.b Cross-section at Chainage 84·700 Km, J-13, 1976-77

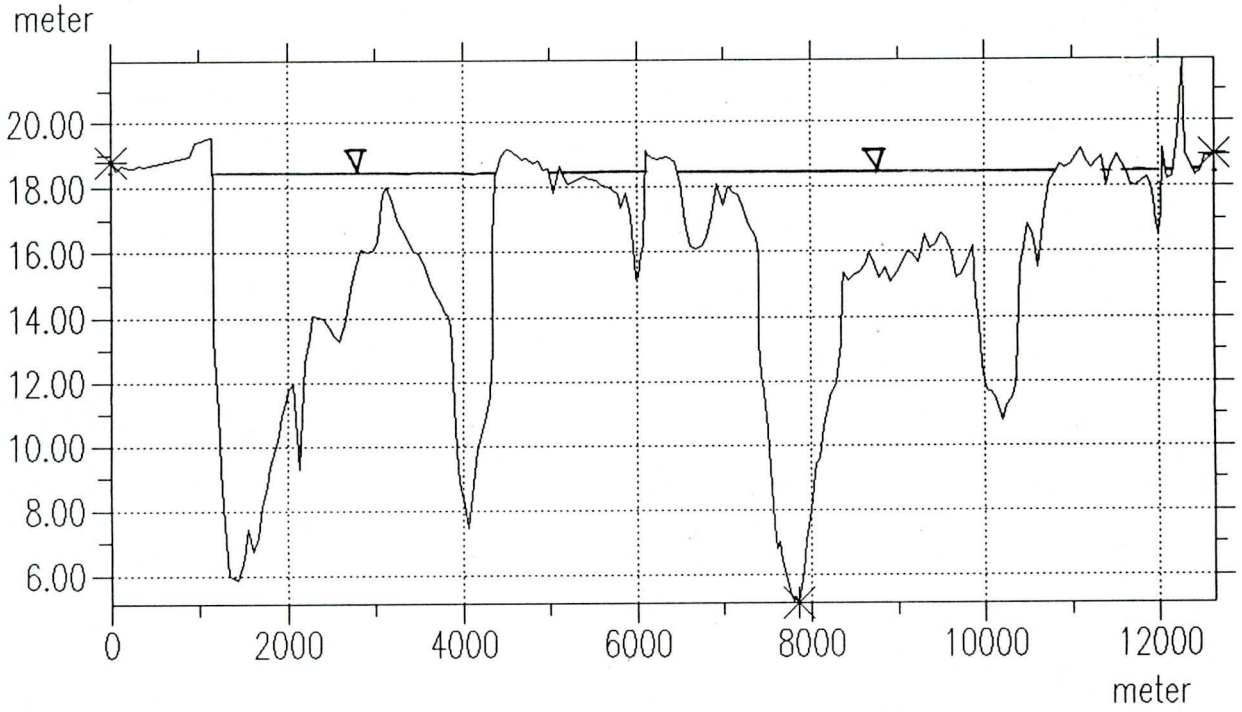


Figure 5.73.c Cross-section at Chainage 84·700 Km , J-13 , 1977-78

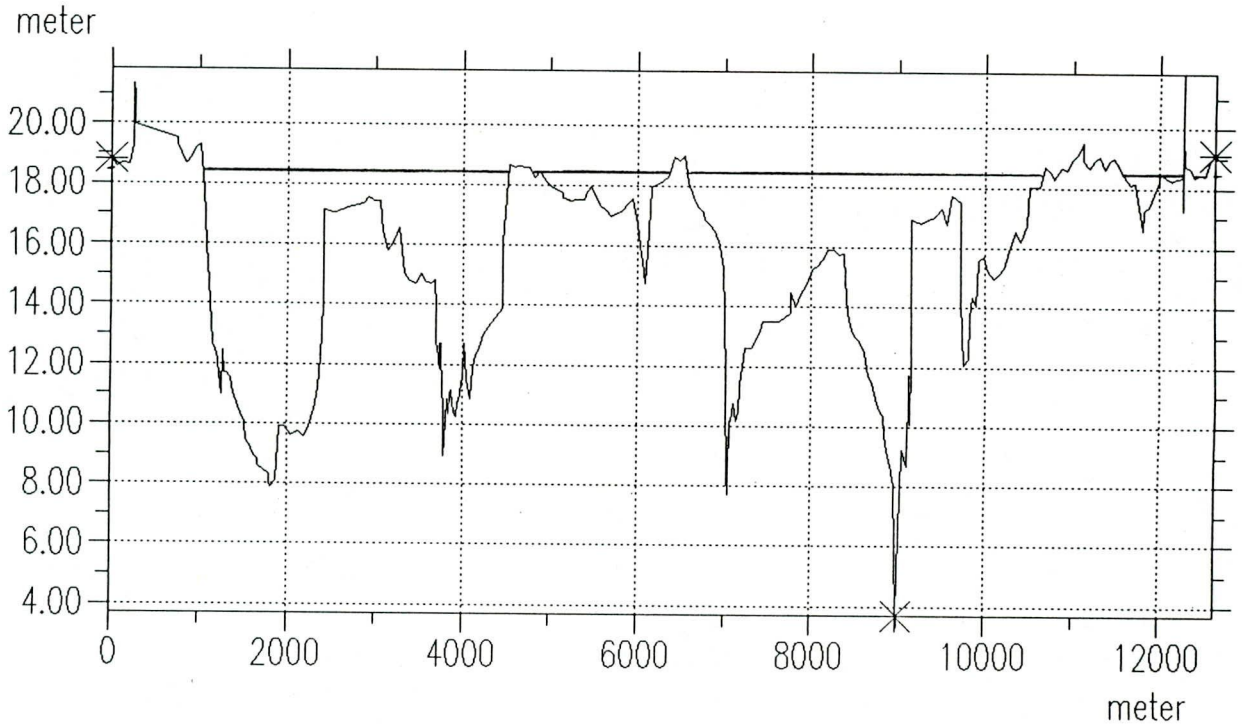


Figure 5.73.d Cross-section at Chainage 84·700 Km , J-13 , 1978-79

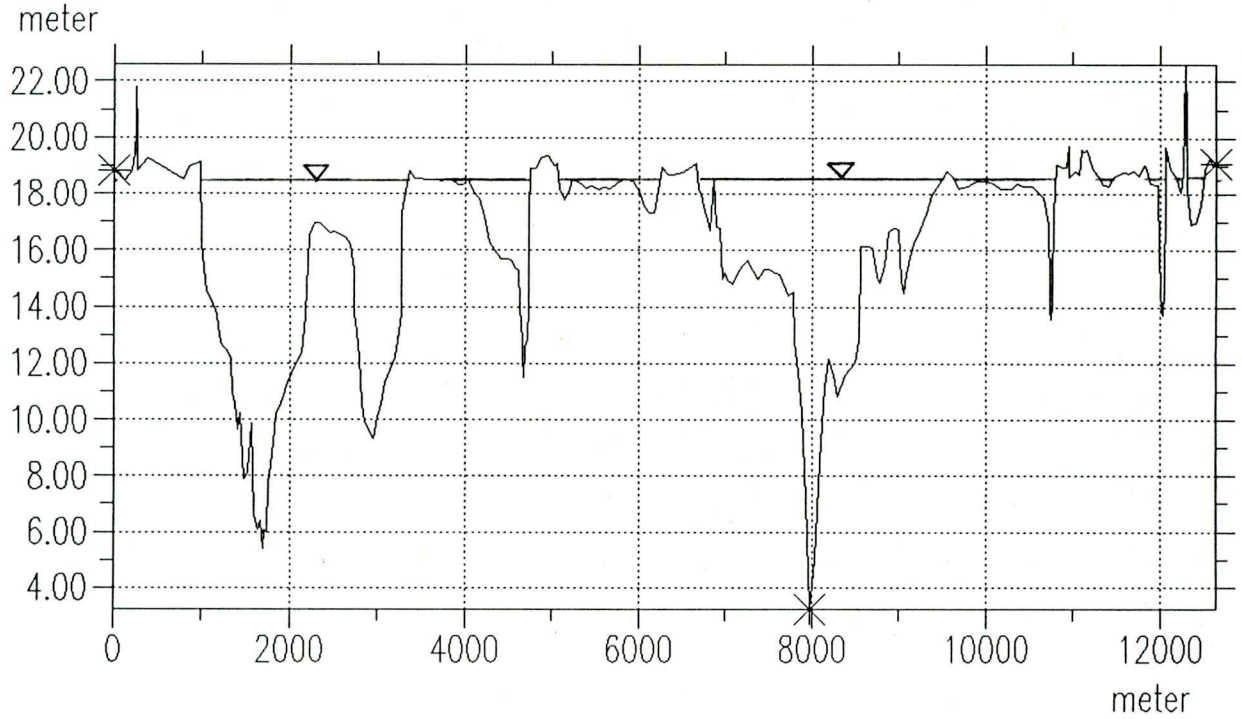


Figure 5.73.e Cross-section at Chainage 84·700 Km, J-13, 1981-82

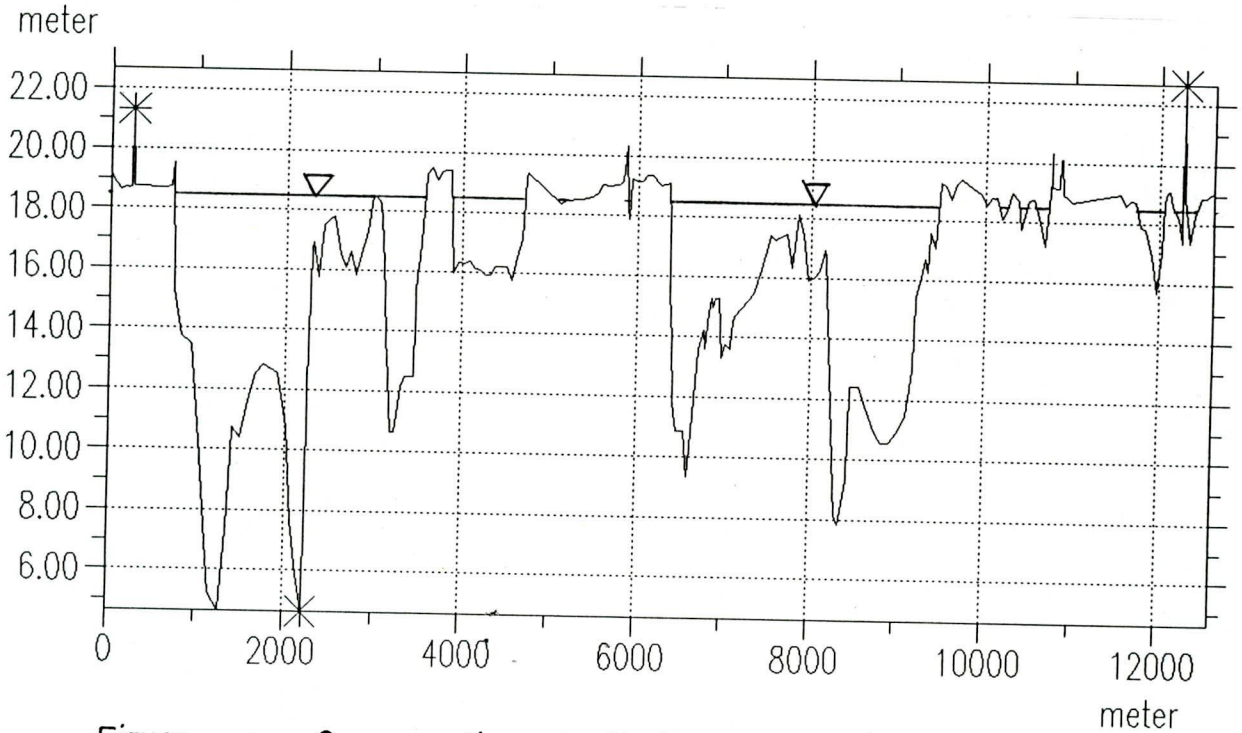


Figure 5.73.f Cross-section at Chainage 84·700 Km, J-13, 1986-87

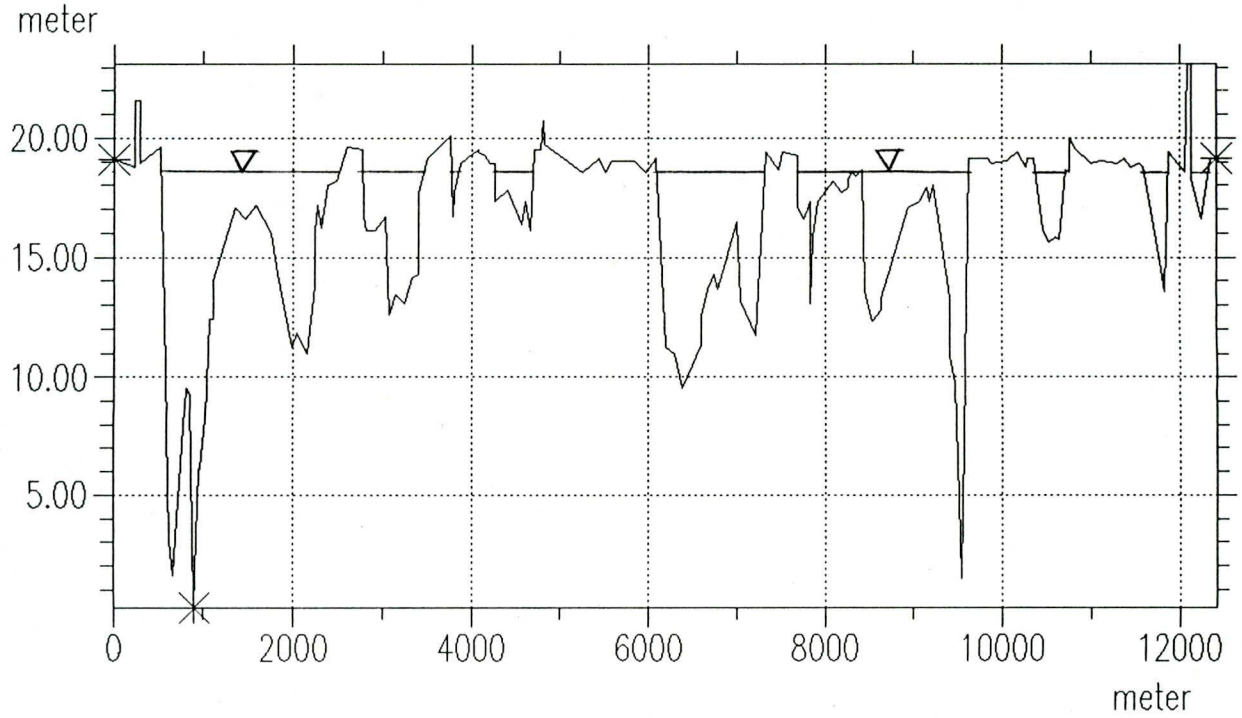


Figure 5.73.g Cross-section at Chainage 84·700 Km , J-13, 1988-89

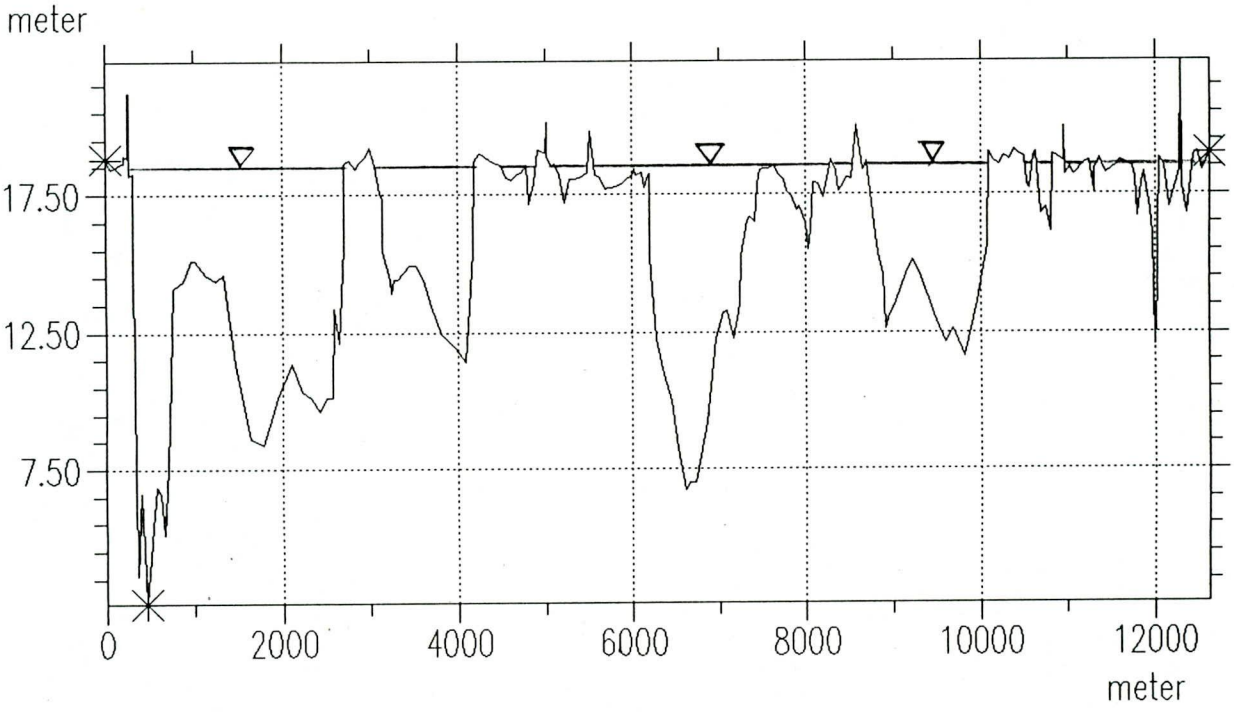


Figure 5.73.h Cross-section at Chainage 84·700 Km , J-13 , 1990-91

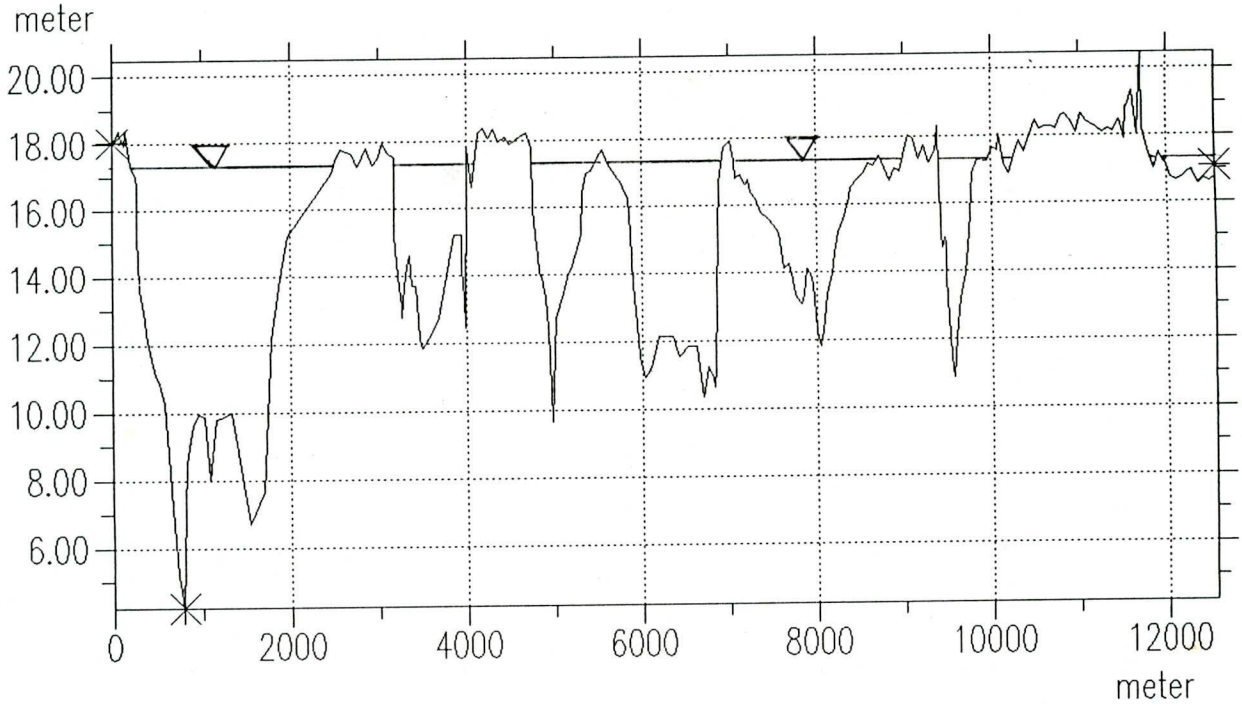


Figure 5.74.a Cross-section at Chainage 100·500 Km , J-12 , 1969-70

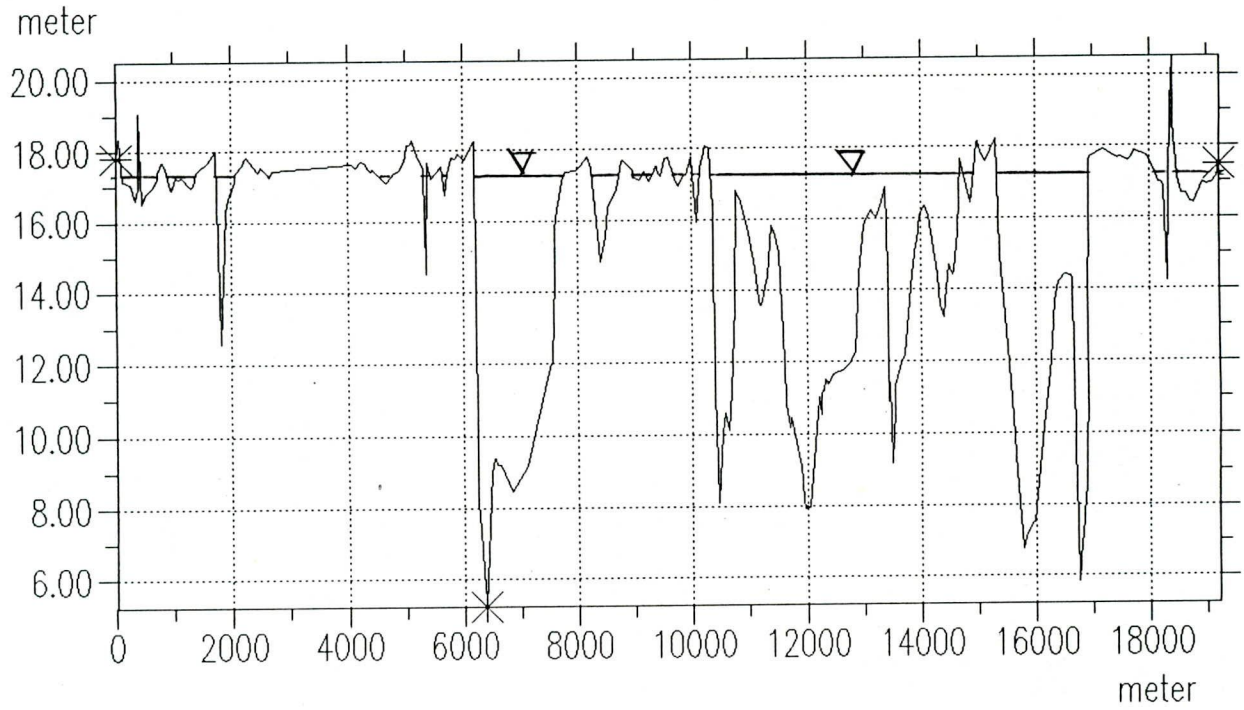


Figure 5.74.b Cross-section at Chainage 100·500 Km , J-12 , 1977-78

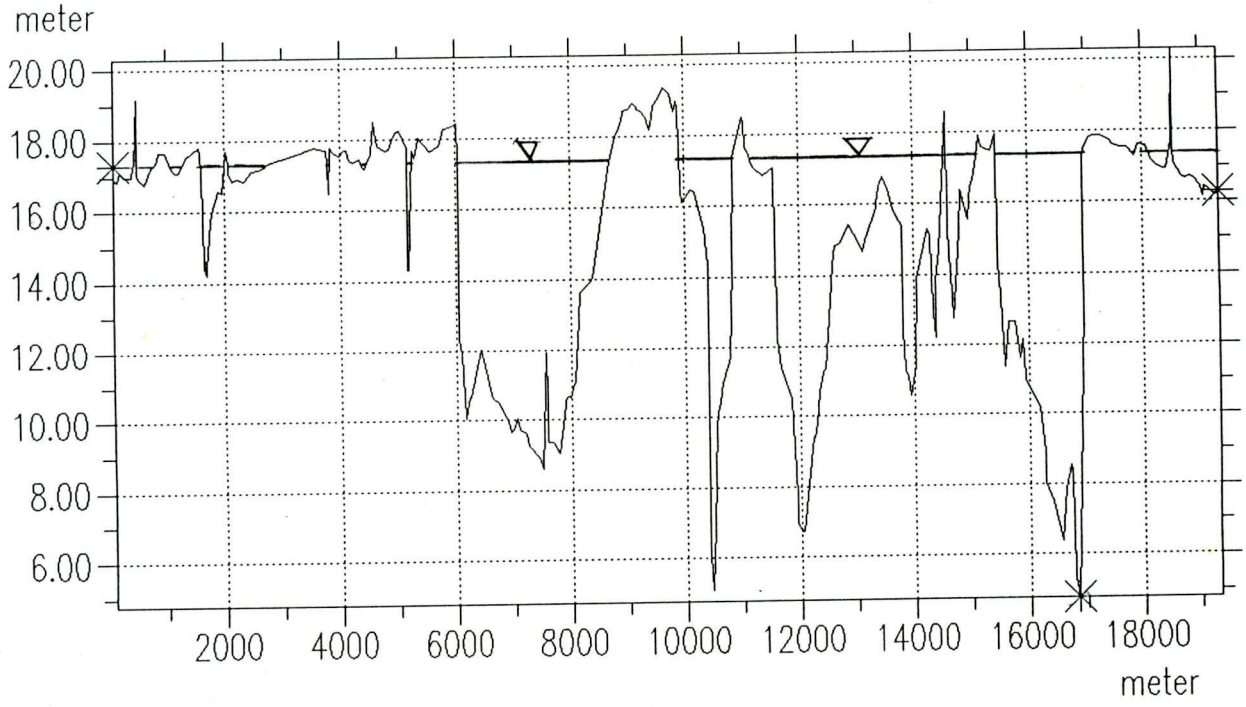


Figure 5.74.c Cross-section at Chainage 100·500 Km , J-12 , 1978-79

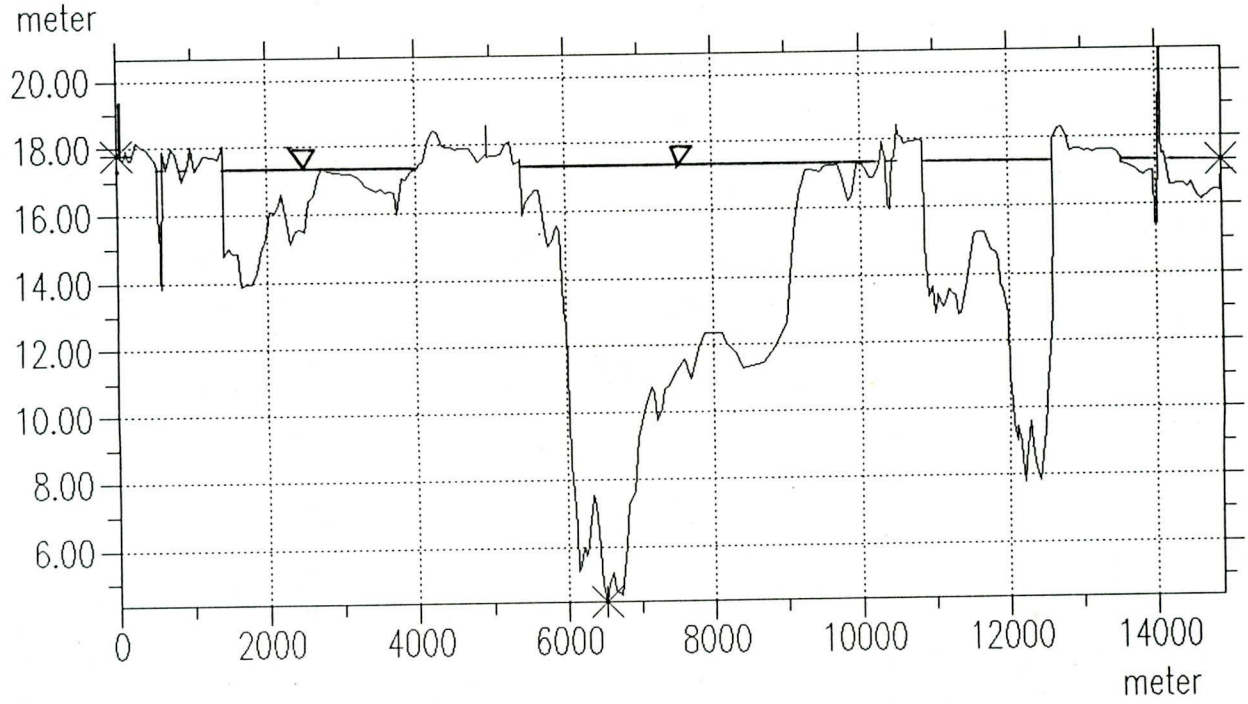


Figure 5.74.d Cross-section at Chainage 100·500Km , J-12 , 1981-82

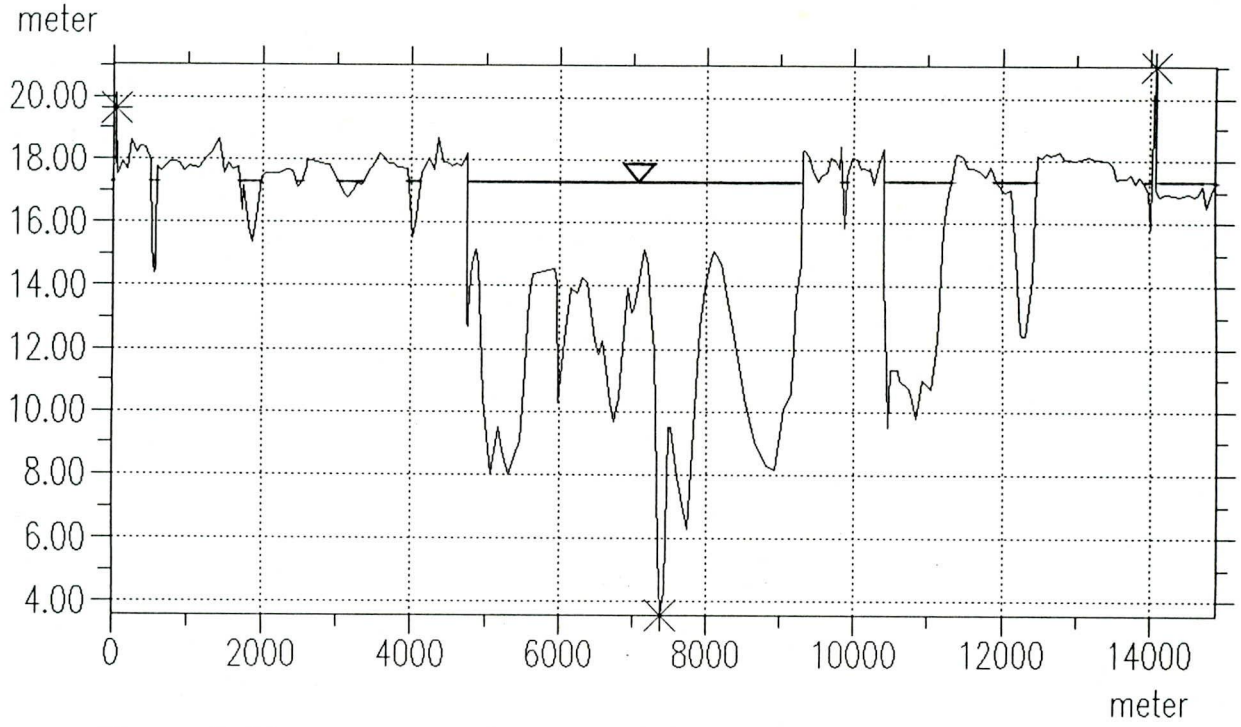


Figure 5.74.e Cross-section at Chainage 100·500 Km, J-12, 1986-87

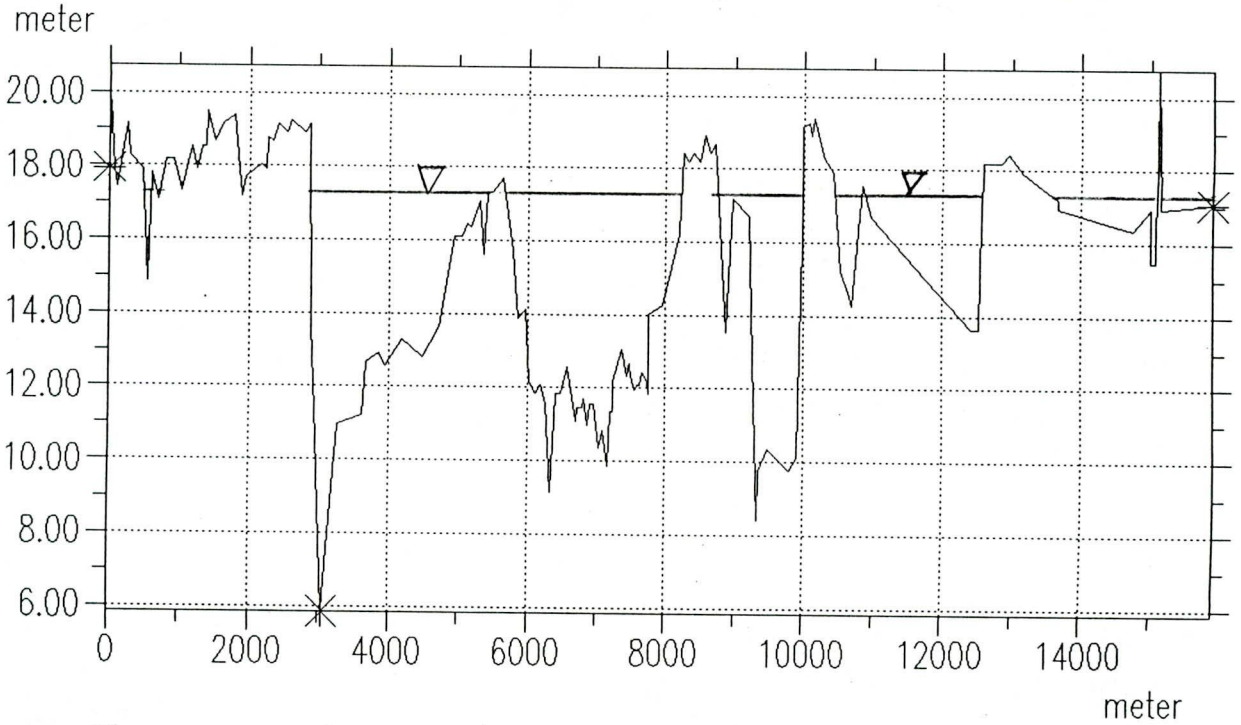


Figure 5.74.f Cross-section at Chainage 100·500 Km, J-12, 1988-89

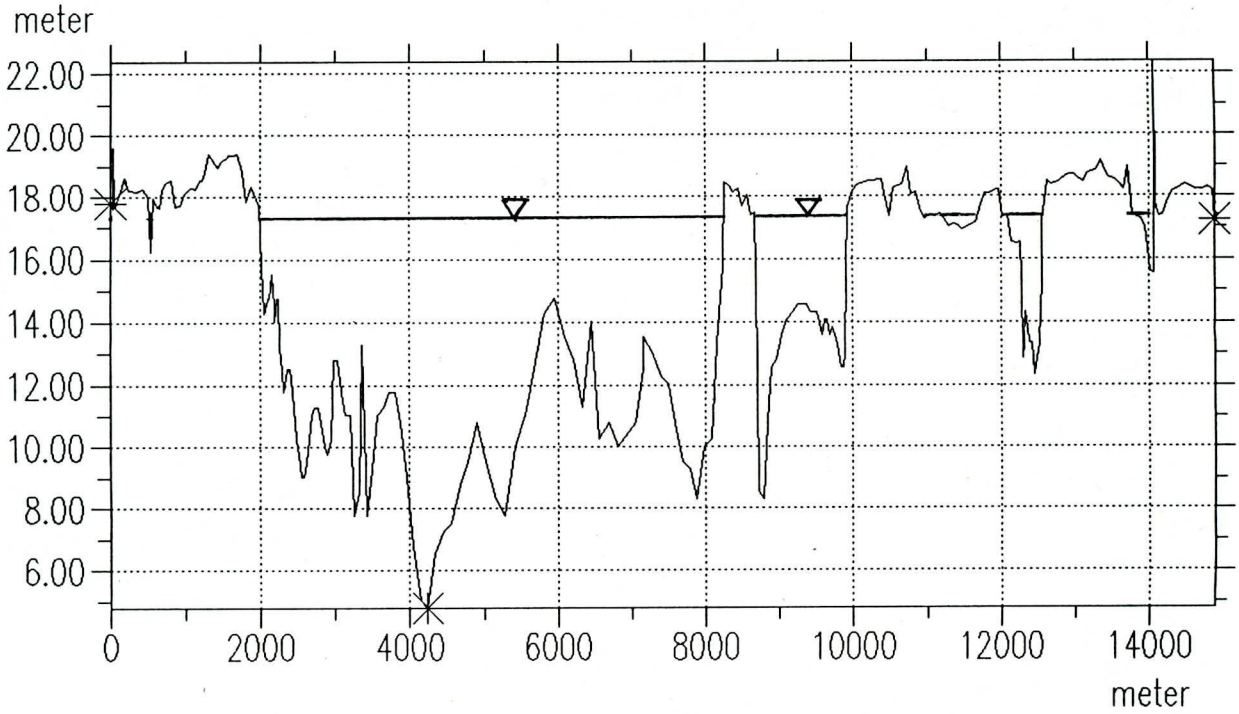


Figure 5.74g Cross-section at Chainage 100·500 Km, J-12, 1990-91

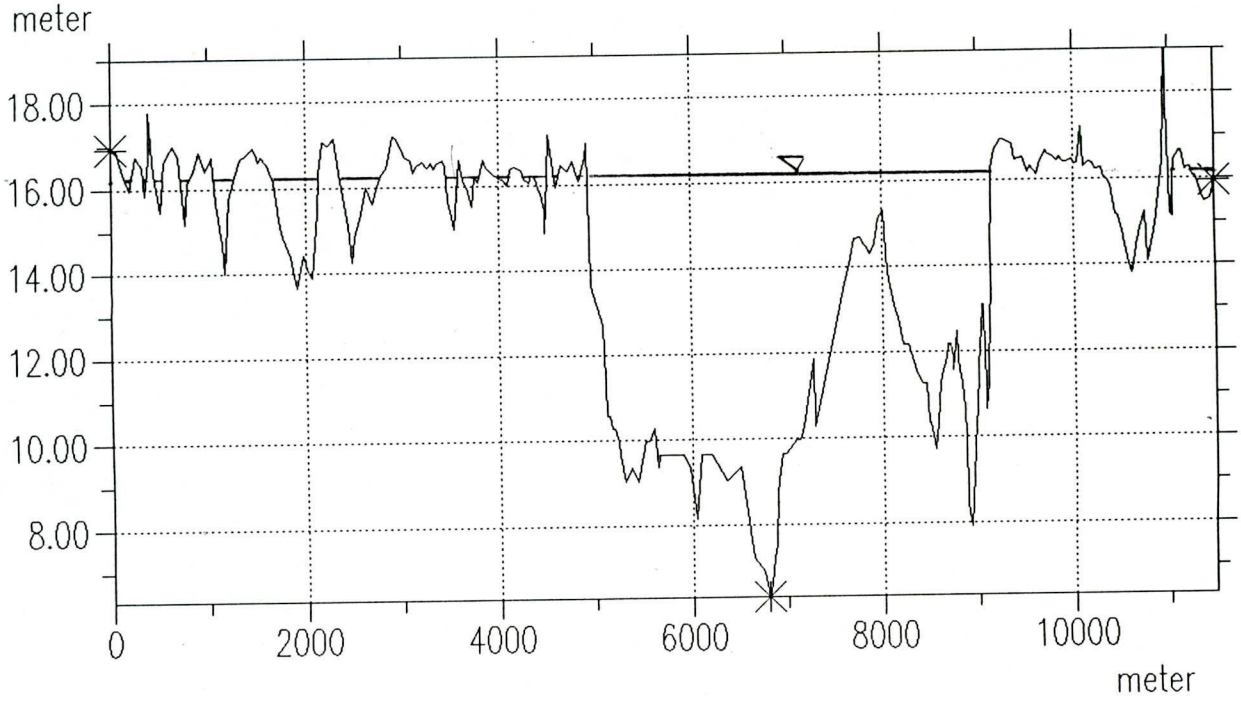


Figure 5.75.a Cross-section at Chainage 117·750 Km, J-11, 1969-70

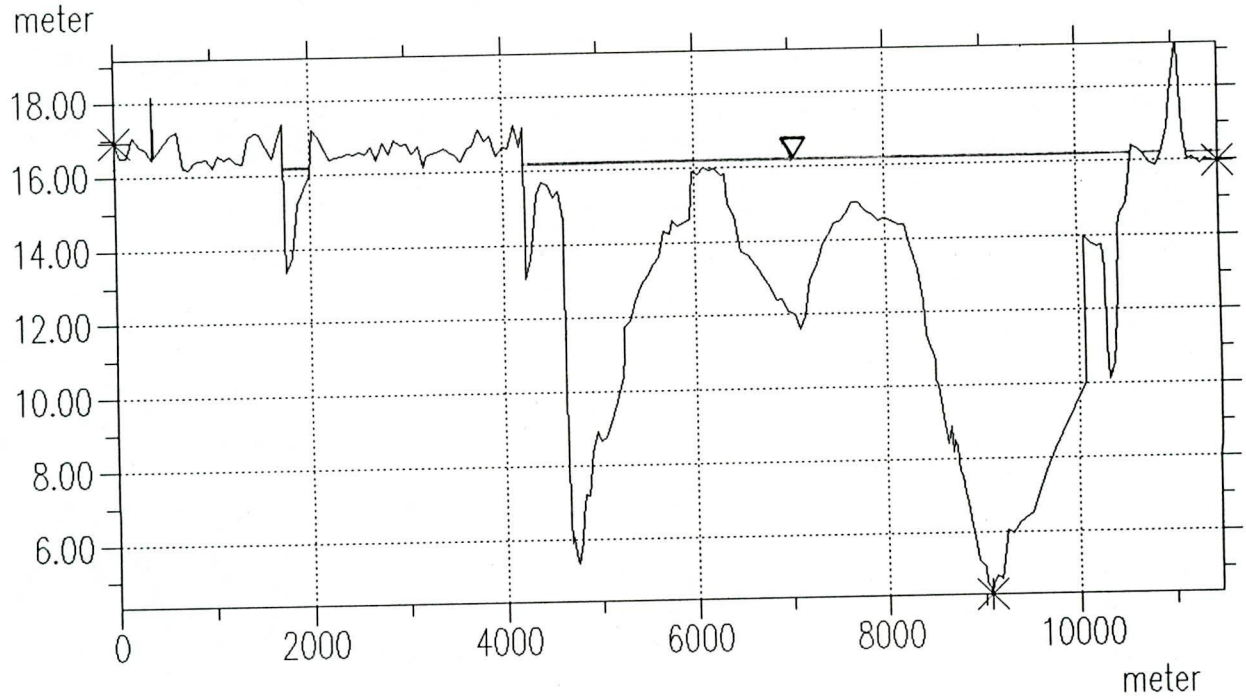


Figure 5.75.b Cross-section at Chainage 117·50 Km, J-11, 1976-77

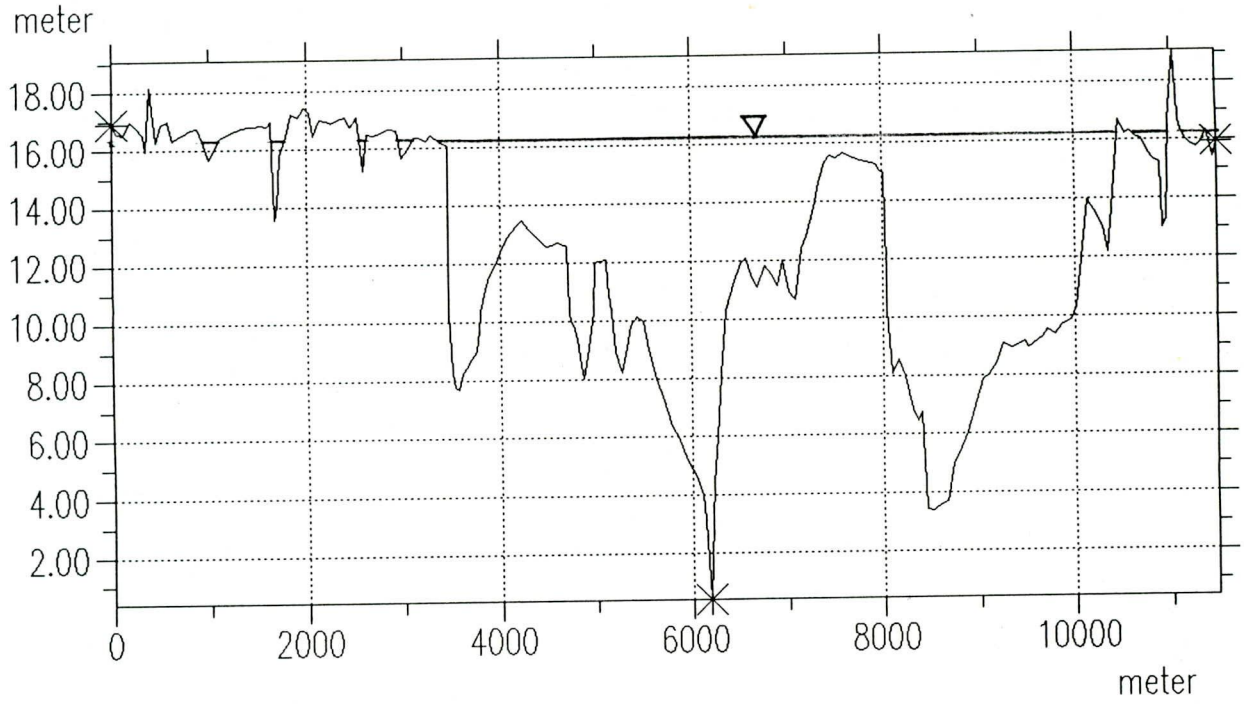


Figure 5.75.c Cross-section at Chainage 117·750 Km, J-11, 1977-78

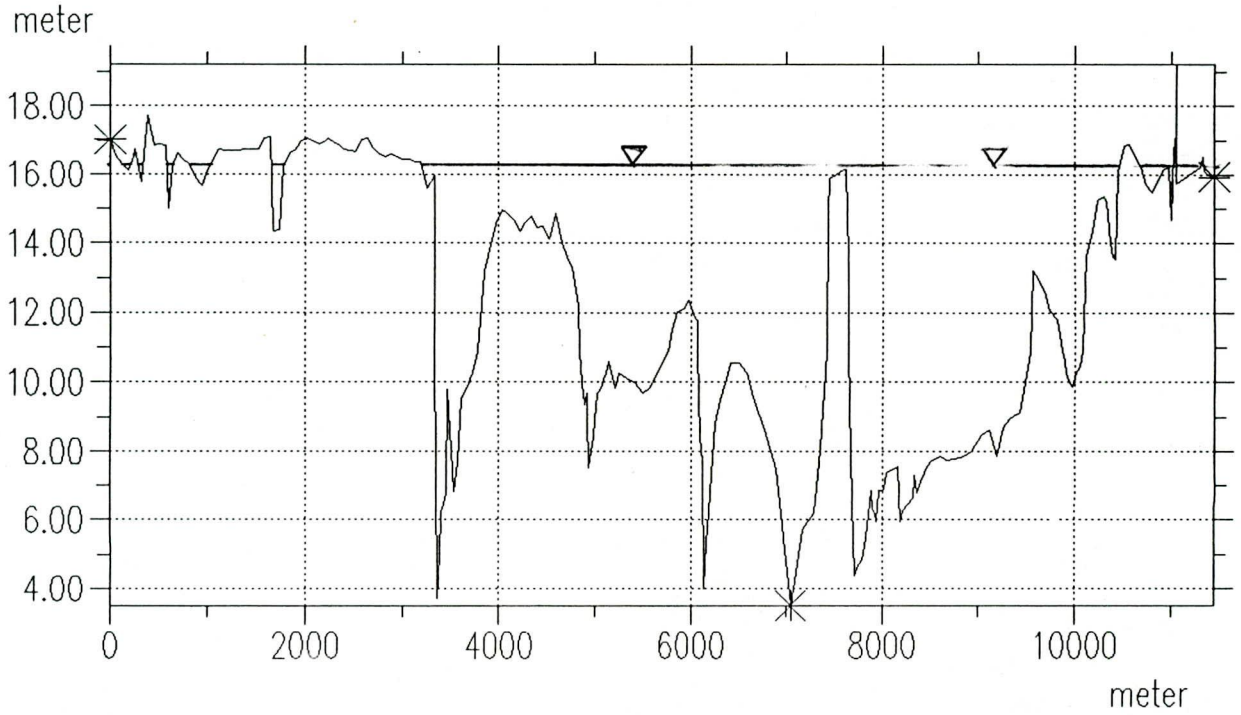


Figure 5.75.d Cross-section at Chainage 117·750 Km, J-11, 1978-79

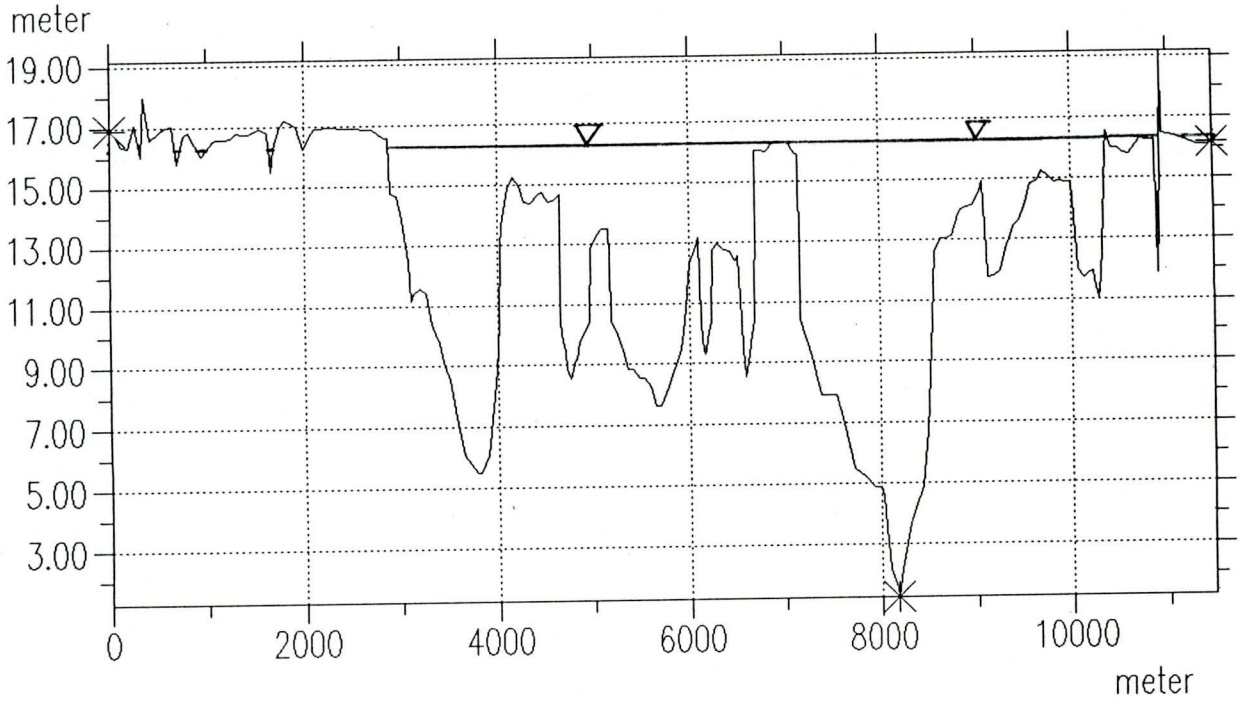


Figure 5.75.e Cross-section at Chainage 117·750 Km, J-11, 1981-82

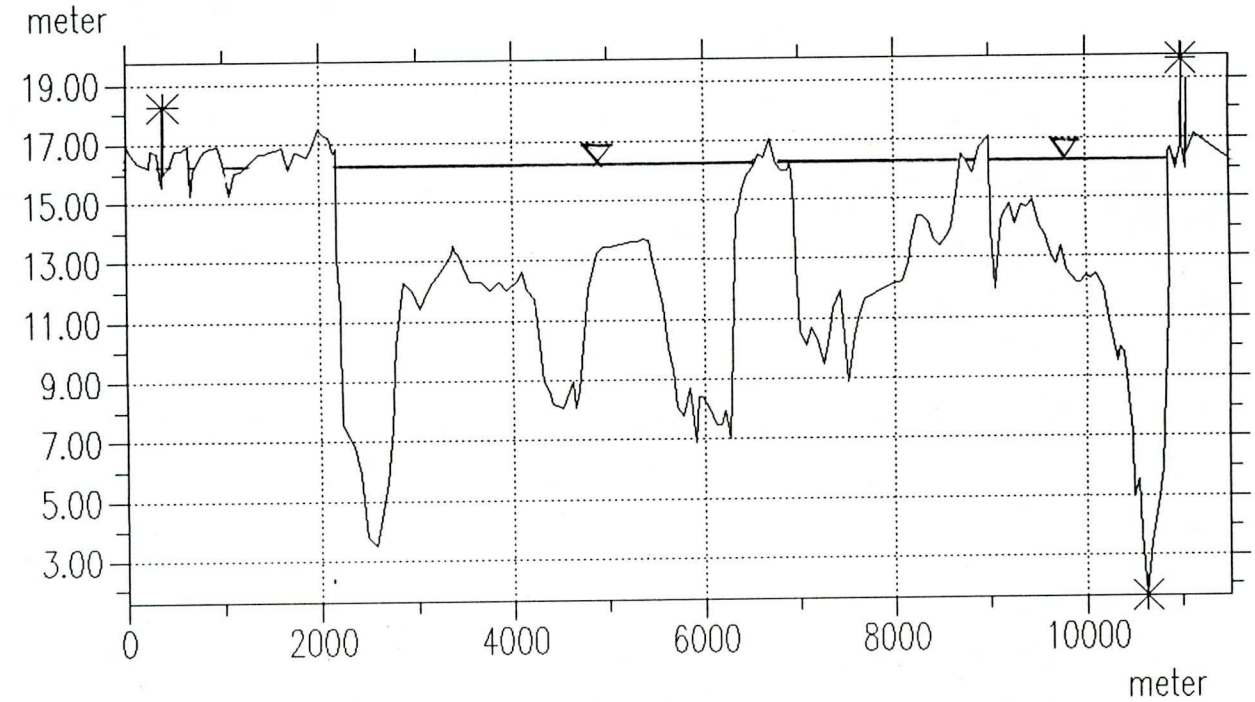


Figure 5.75.f Cross-section at Chainage 117·750 Km, J-11, 1986-87

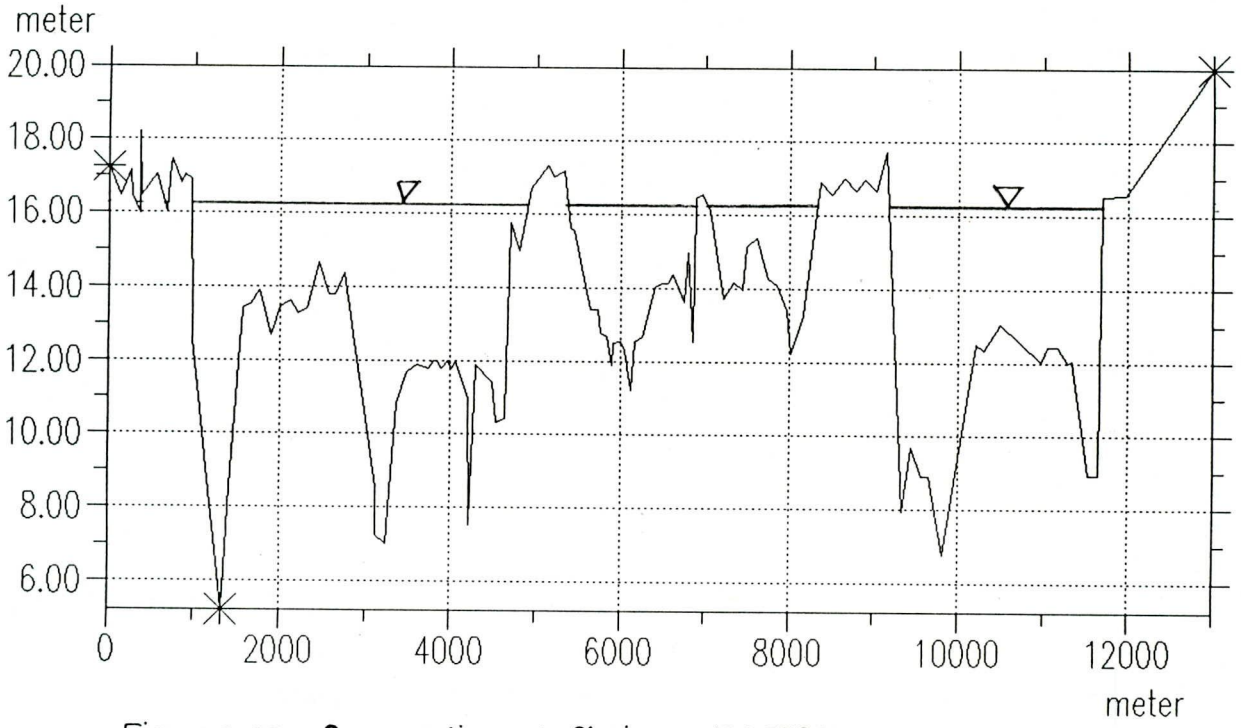


Figure 5.75.g Cross-section at Chainage 134.750 Km, J-11, 1988-89

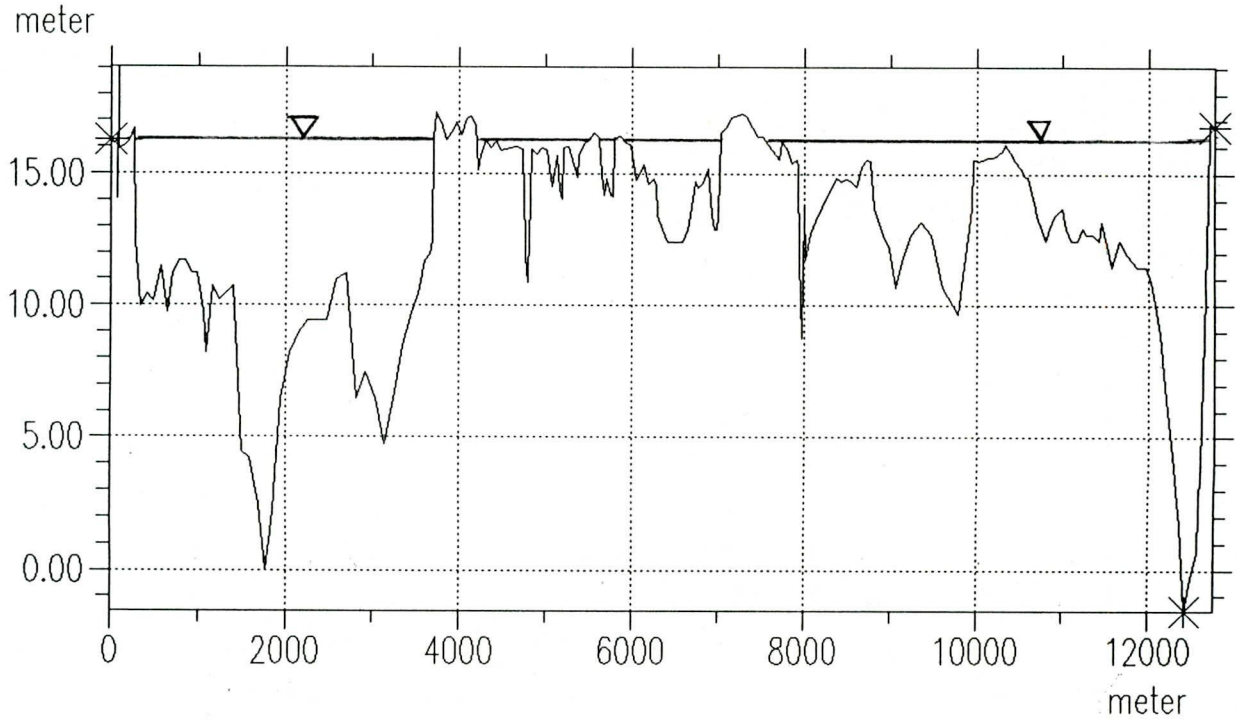


Figure 5.75.h Cross-section at Chainage 117.750 Km, J-11, 1990-91

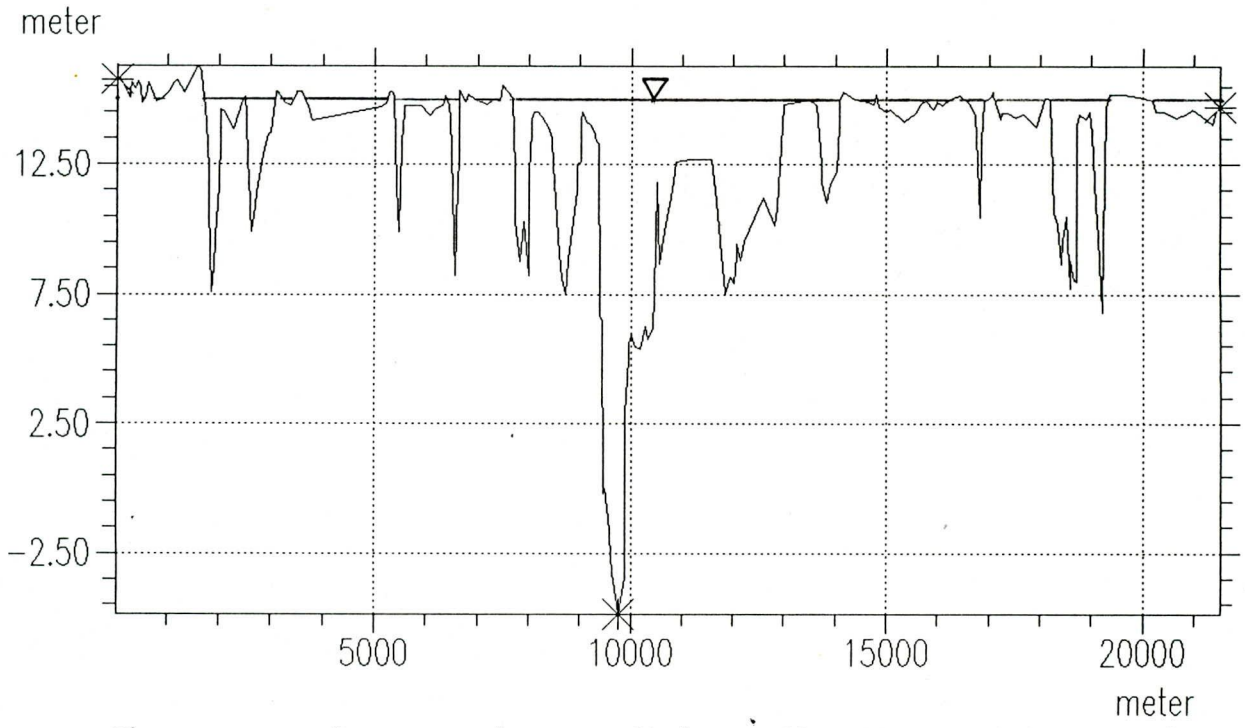


Figure 5.76.a Cross-section at Chainage 134·300 Km , J-10 , 1969-70

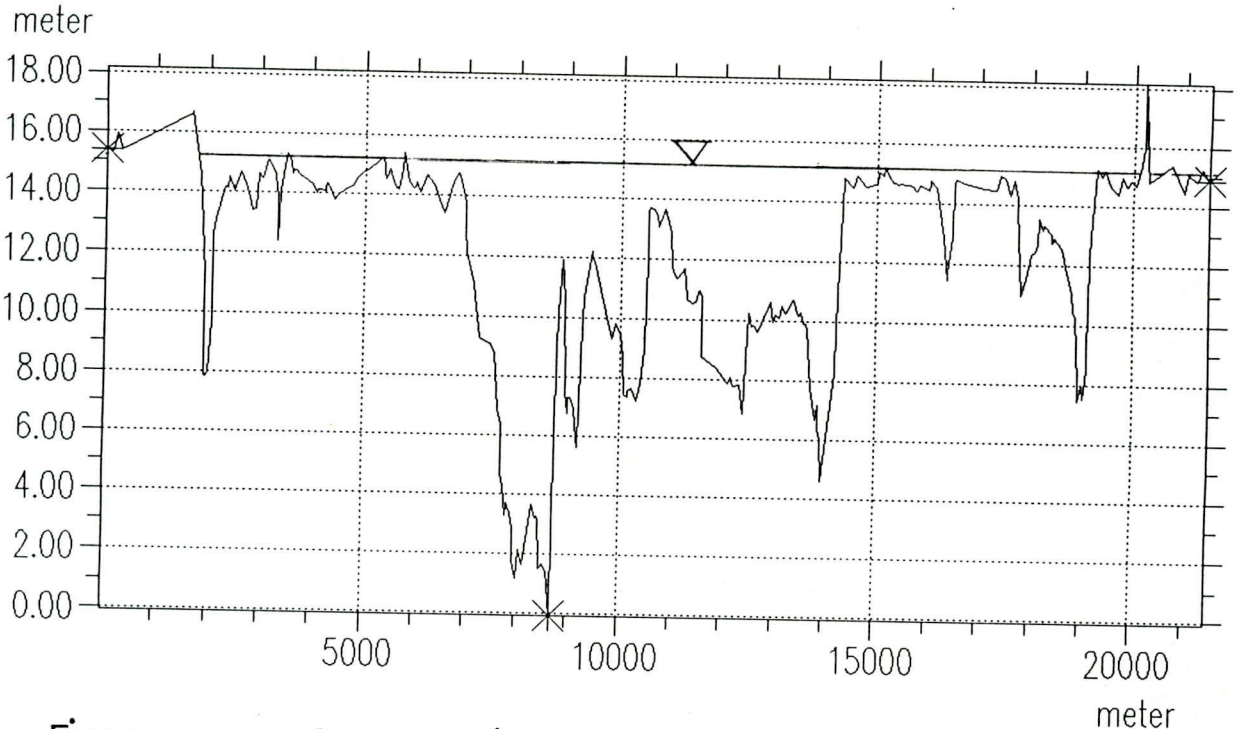


Figure 5.76.b Cross-section at Chainage 134·300Km, J-10, 1976-77

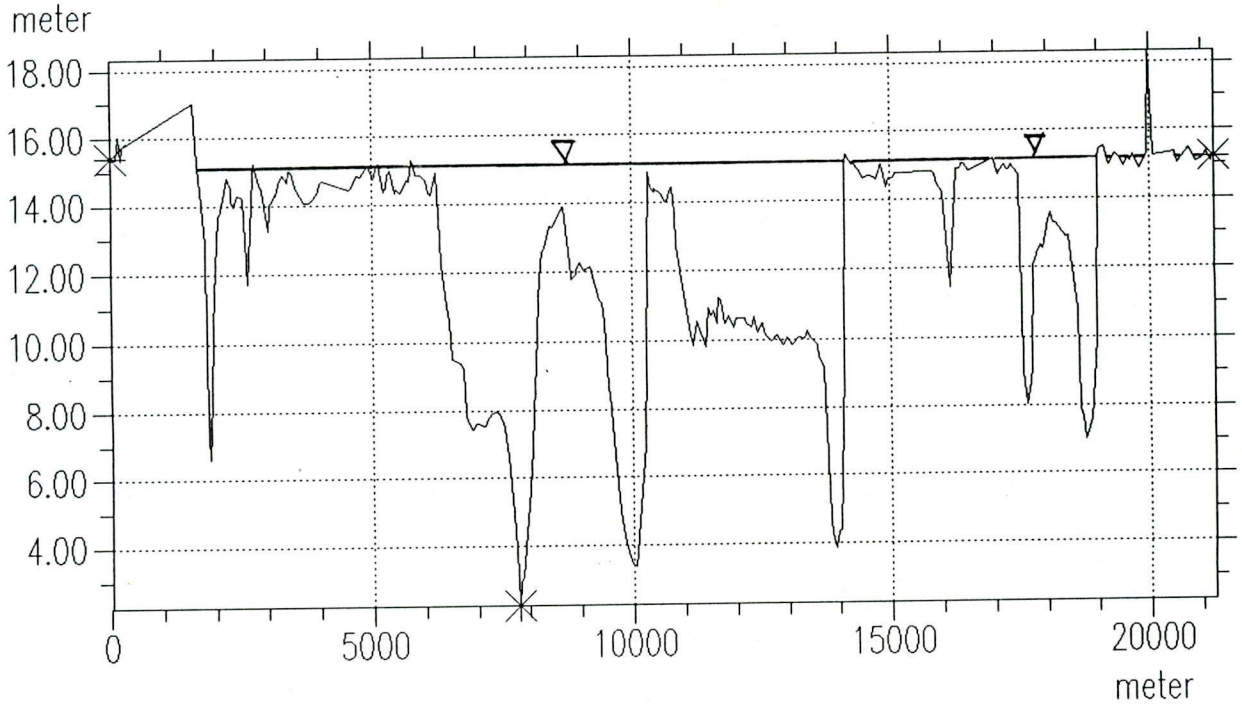


Figure 5.76.c Cross-section at Chainage 134·300 Km, J-10 1977-78

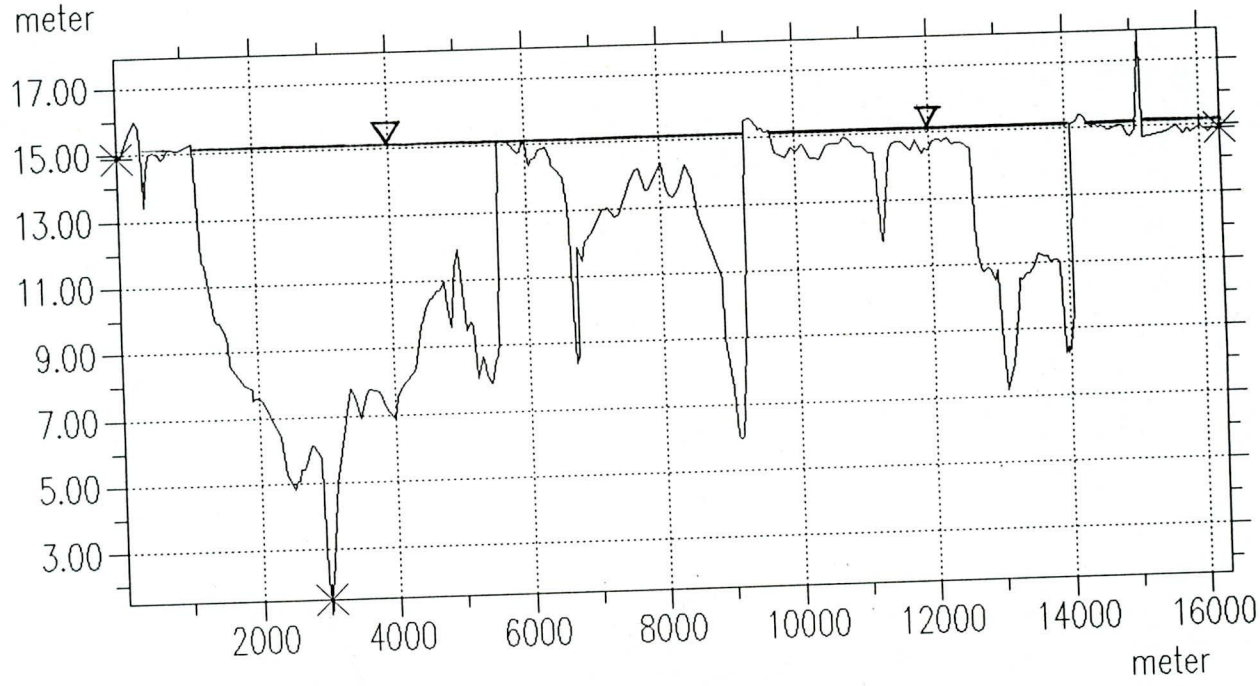


Figure 5.76.d Cross-section at Chainage 134·300 Km, J-11, 1978-79

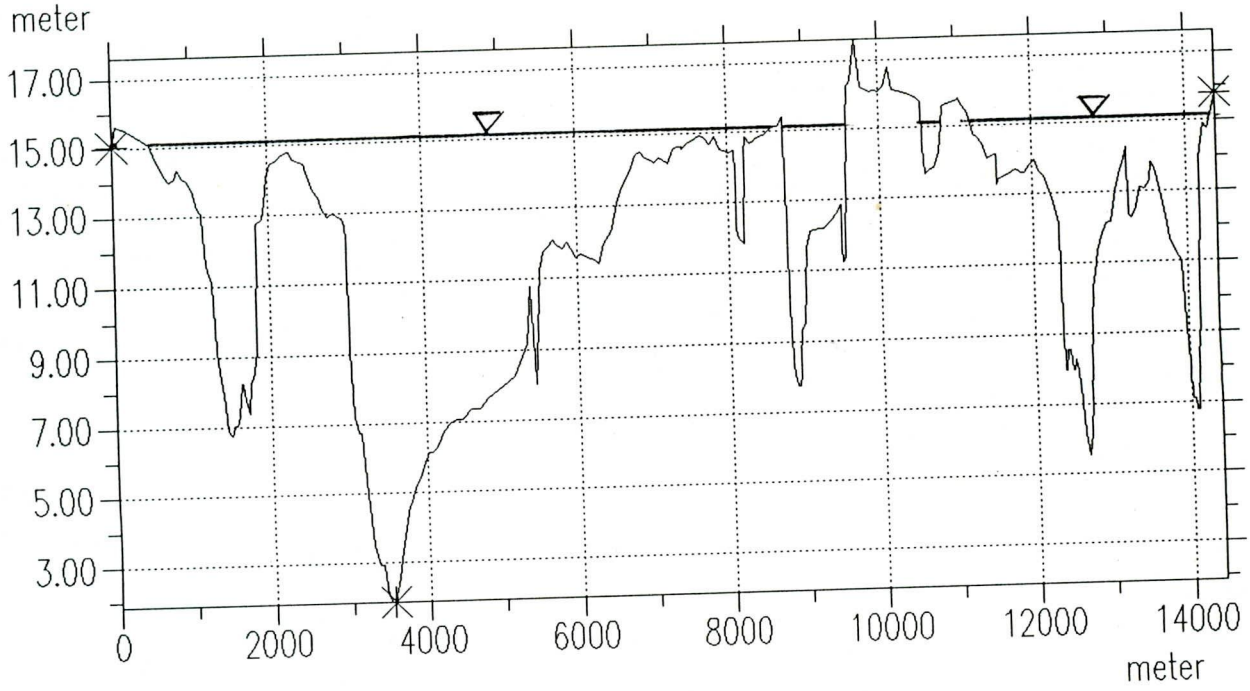


Figure 5.76.e Cross-section at Chainage 134.300 Km, J-10, 1981-82

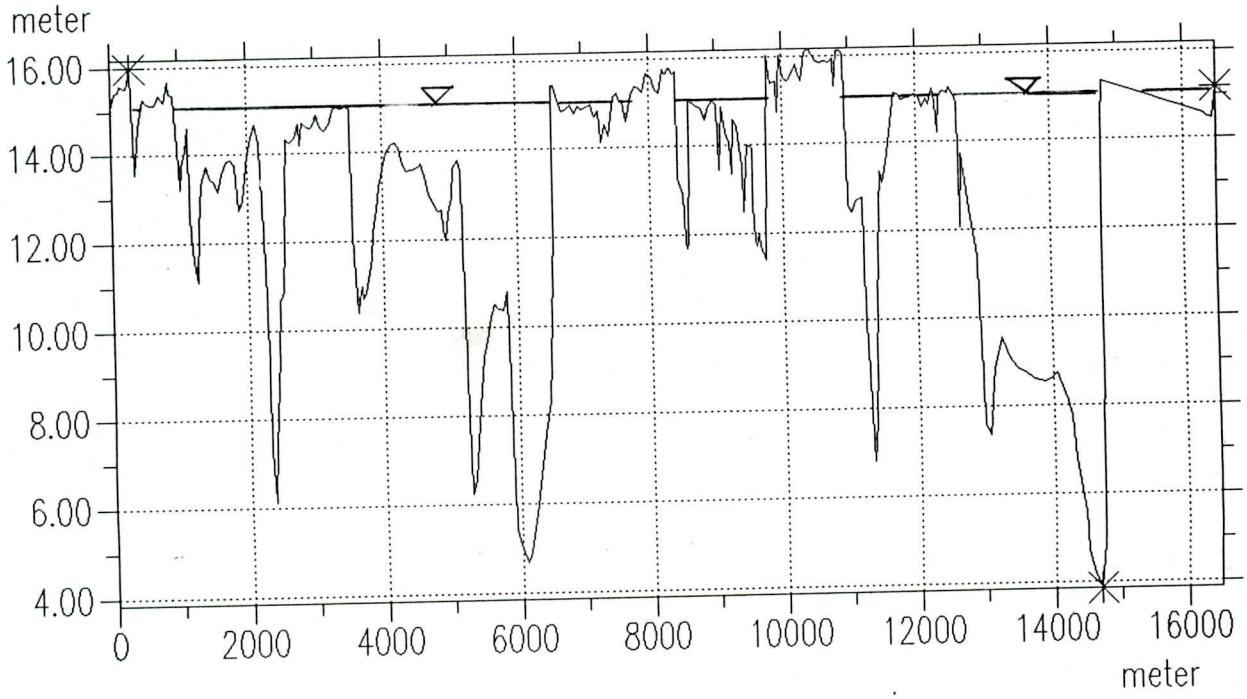


Figure 5.76.f Cross-section at Chainage 134.300 Km, J-10, 1986-87

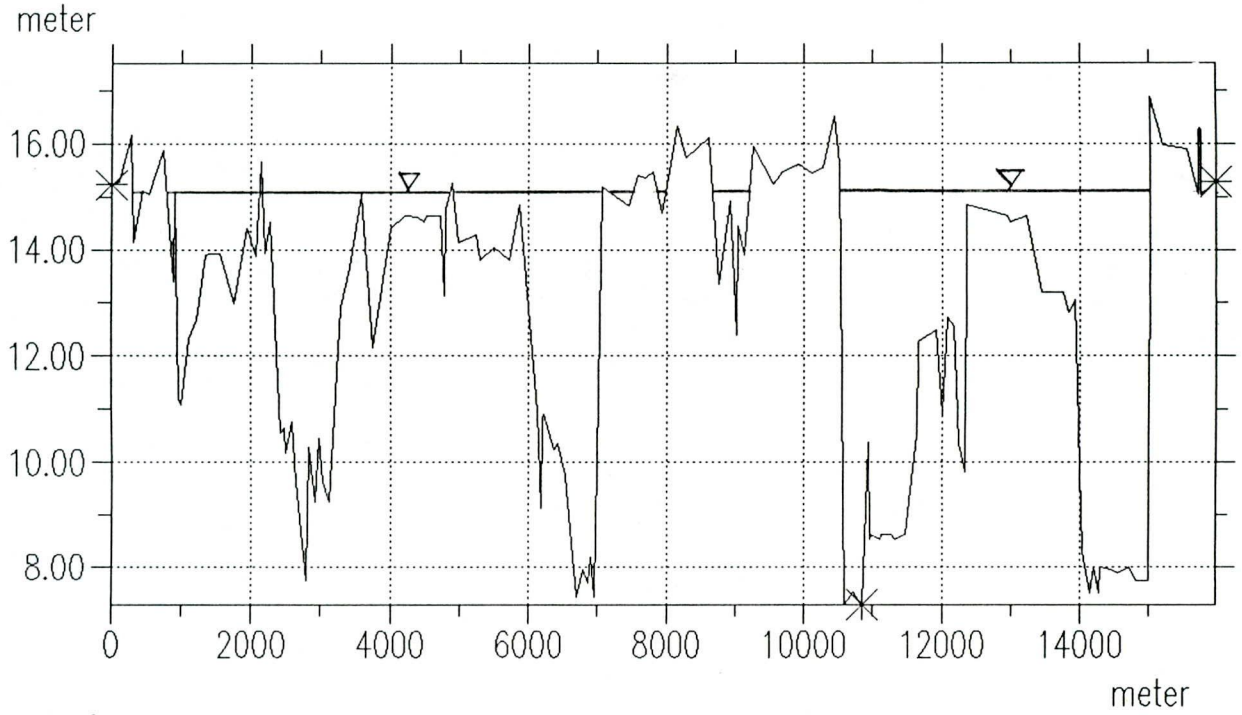


Figure 5.76.g Cross-section at Chainage 134·300Km, J-10, 1988-89

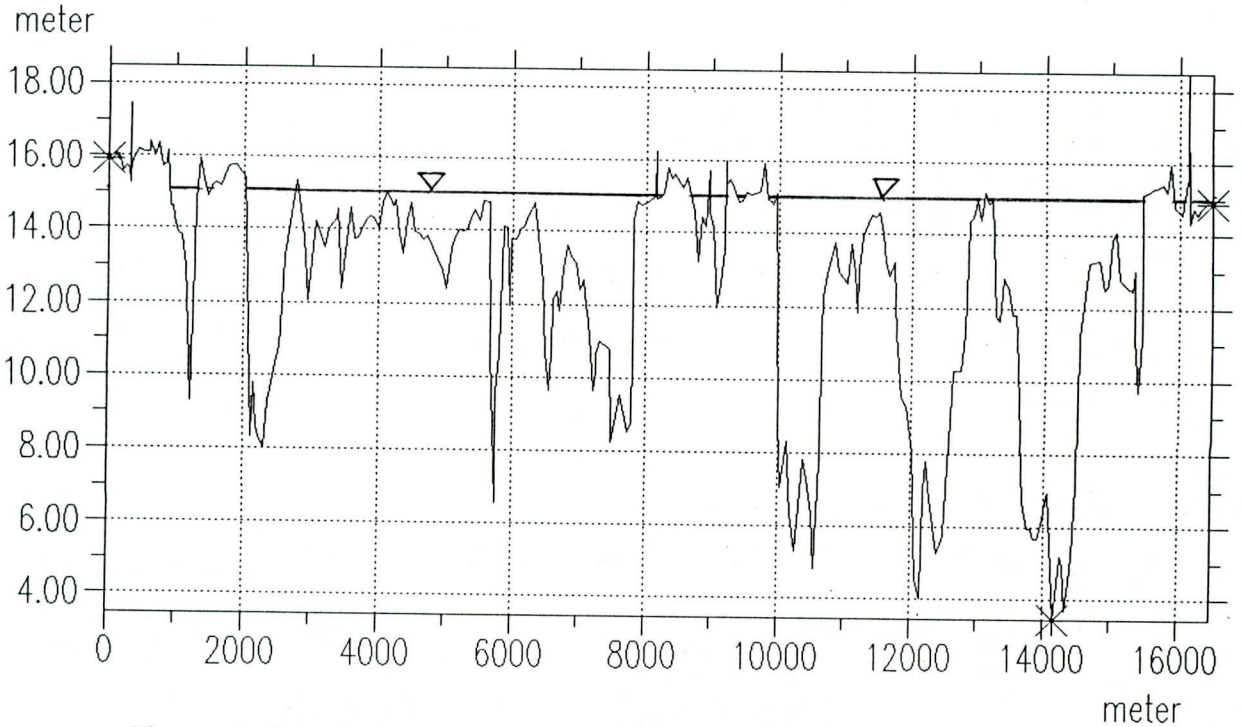


Figure 5.76.h Cross-section at Chainage 134·300 Km, J-10, 1990-91

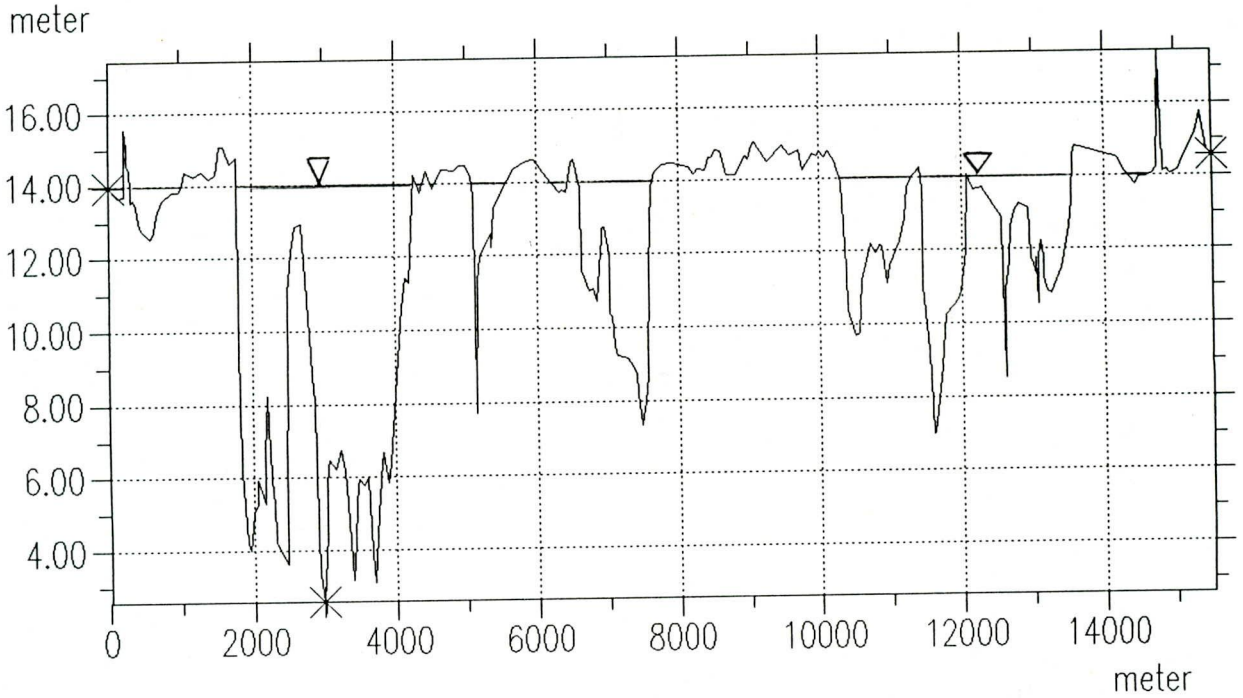


Figure 5.77.a Cross-section at Chainage 142·450 Km, J-9, 1969-70

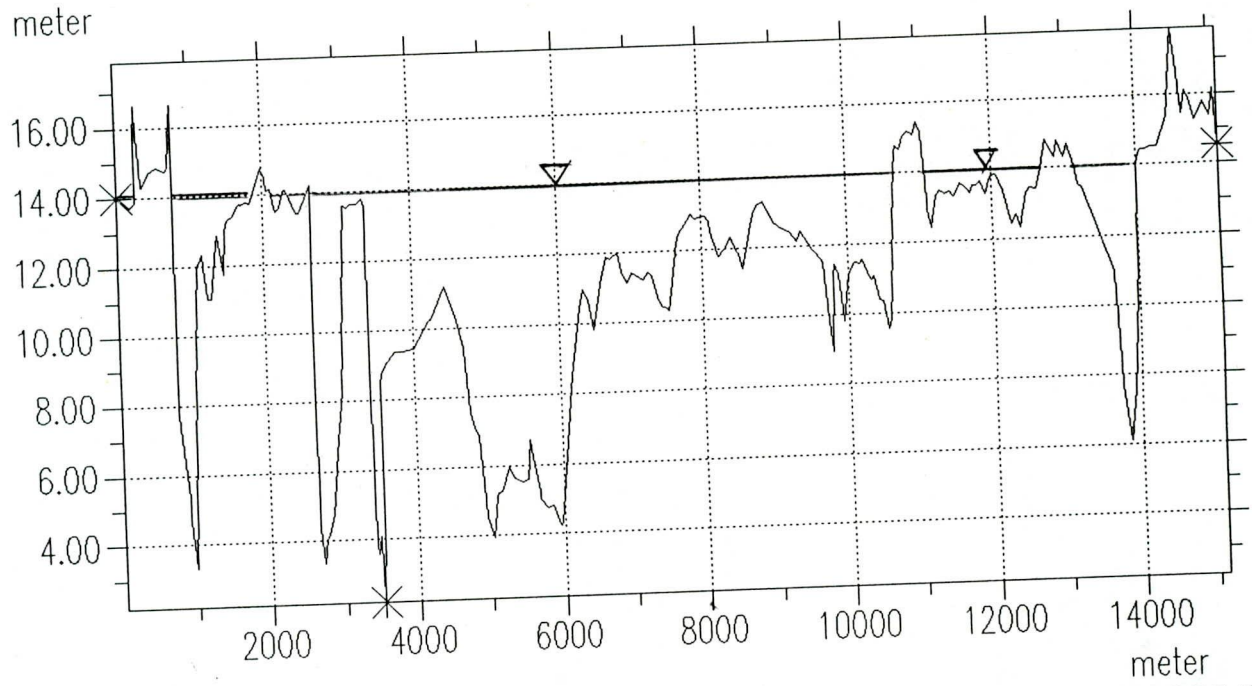


Figure 5.77.b Cross-section at Chainage 142·450 Km, J-9, 1976-77

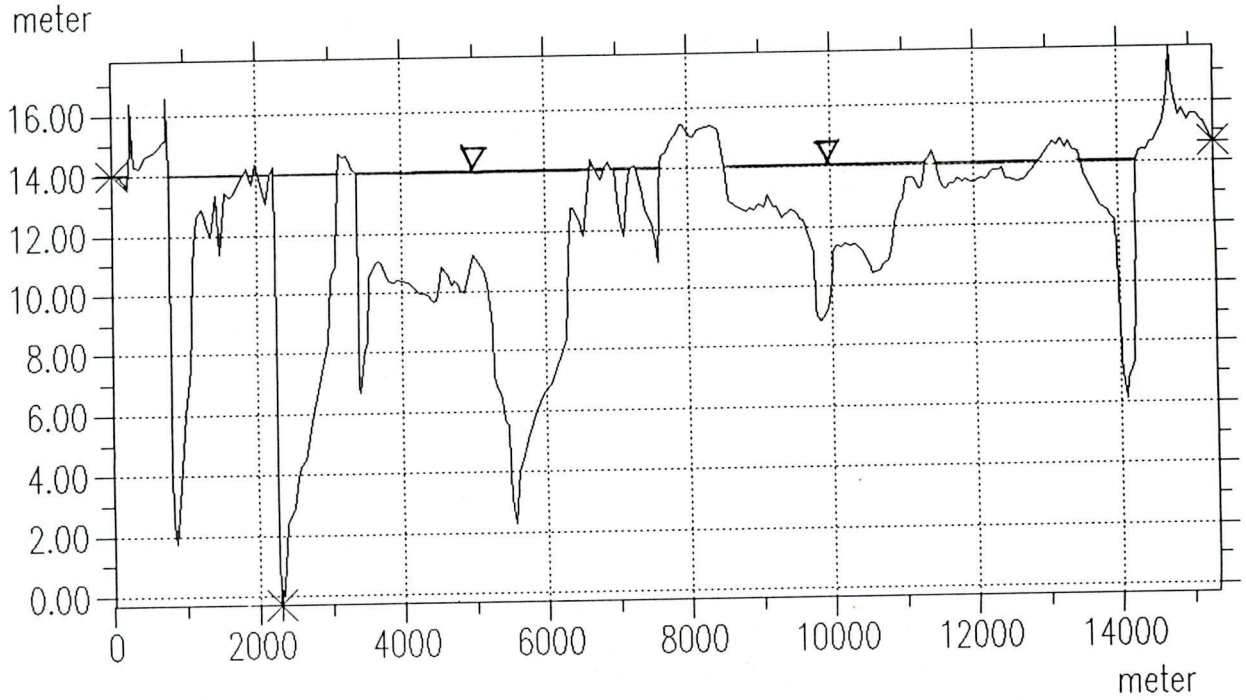


Figure 5.77.c Cross-section at Chainage 142·450 Km, J-9, 1977-78

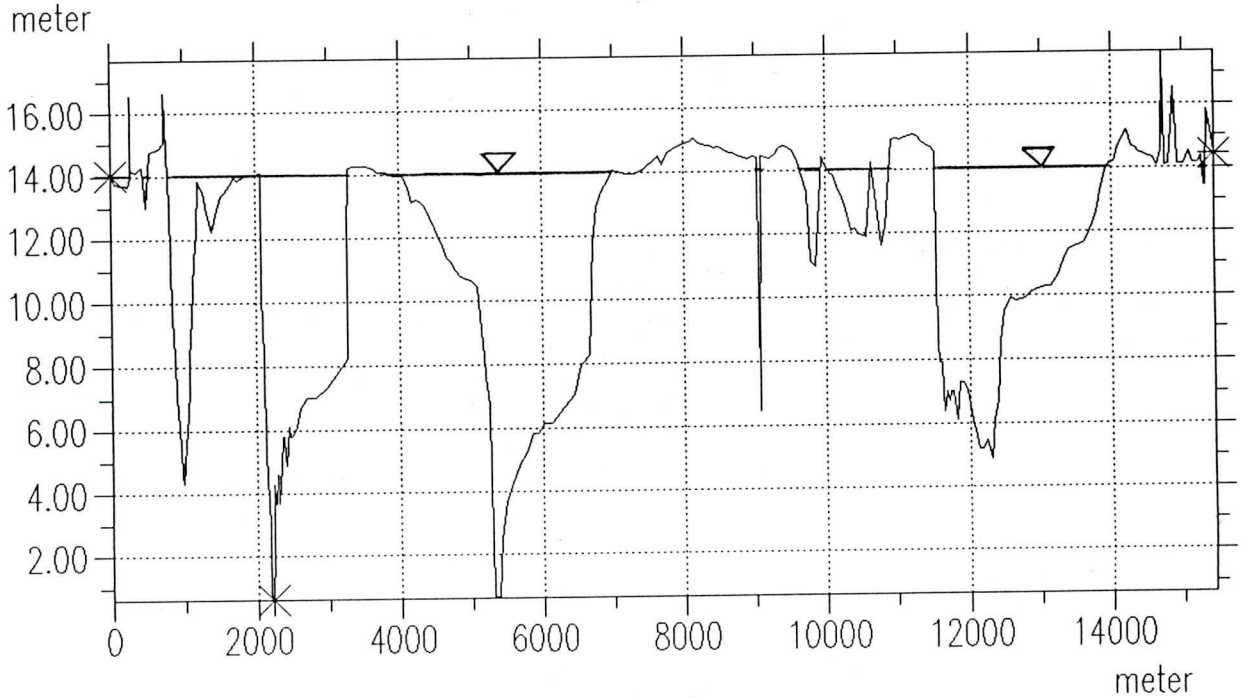


Figure 5.77.d Cross-section at Chainage 142·450 Km, J-9, 1981-82

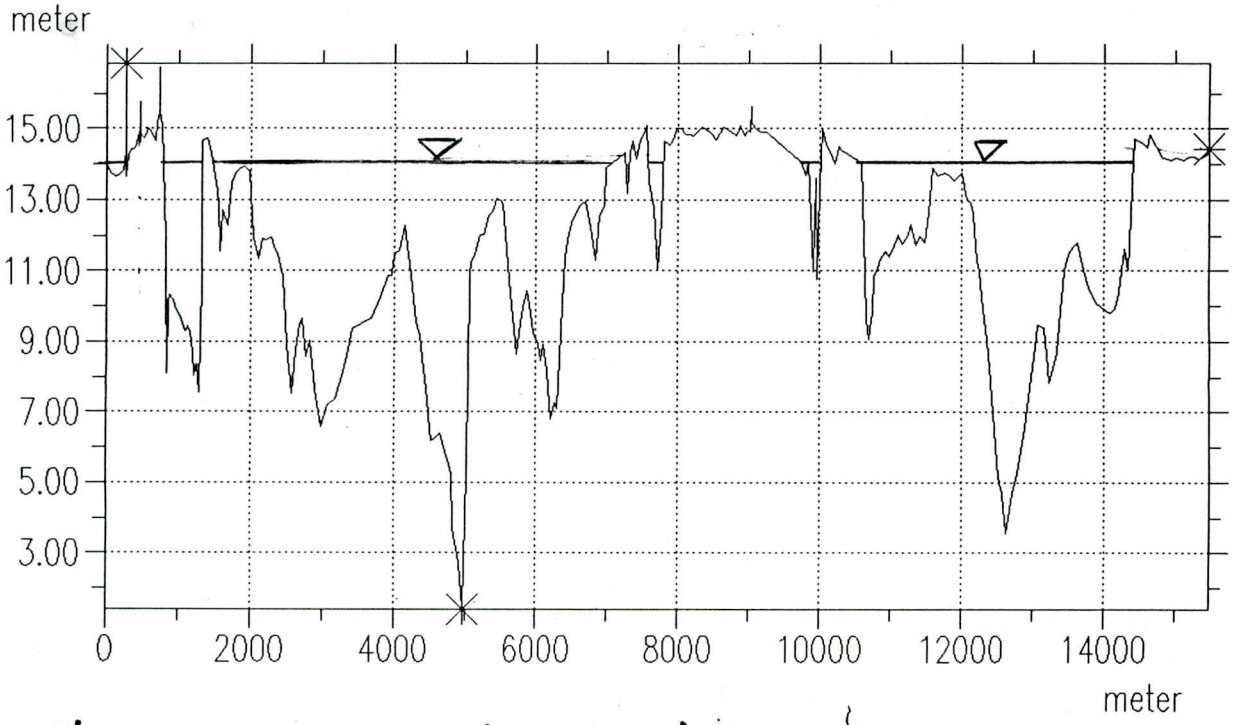


Figure 5.77.e Cross-section at Chainage 142·450 Km, J-9, 1986-87

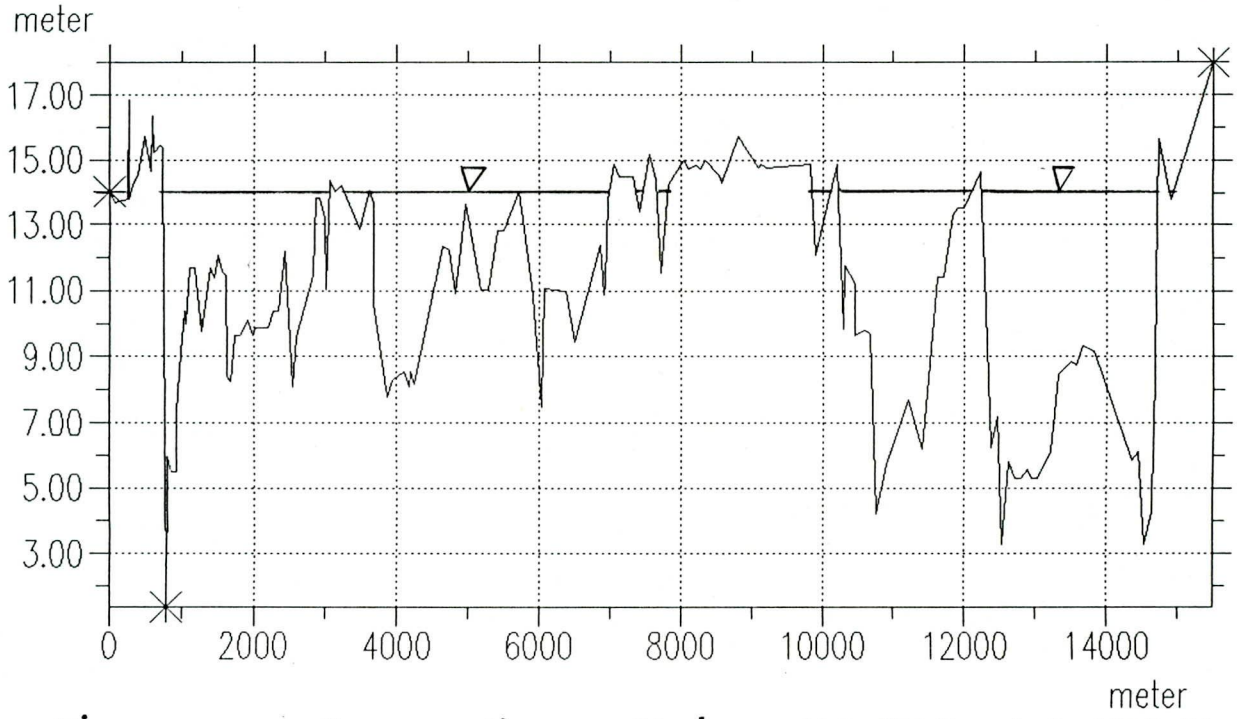


Figure 5.77.f Cross-section at Chainage 142·450 Km, J-9, 1988-89

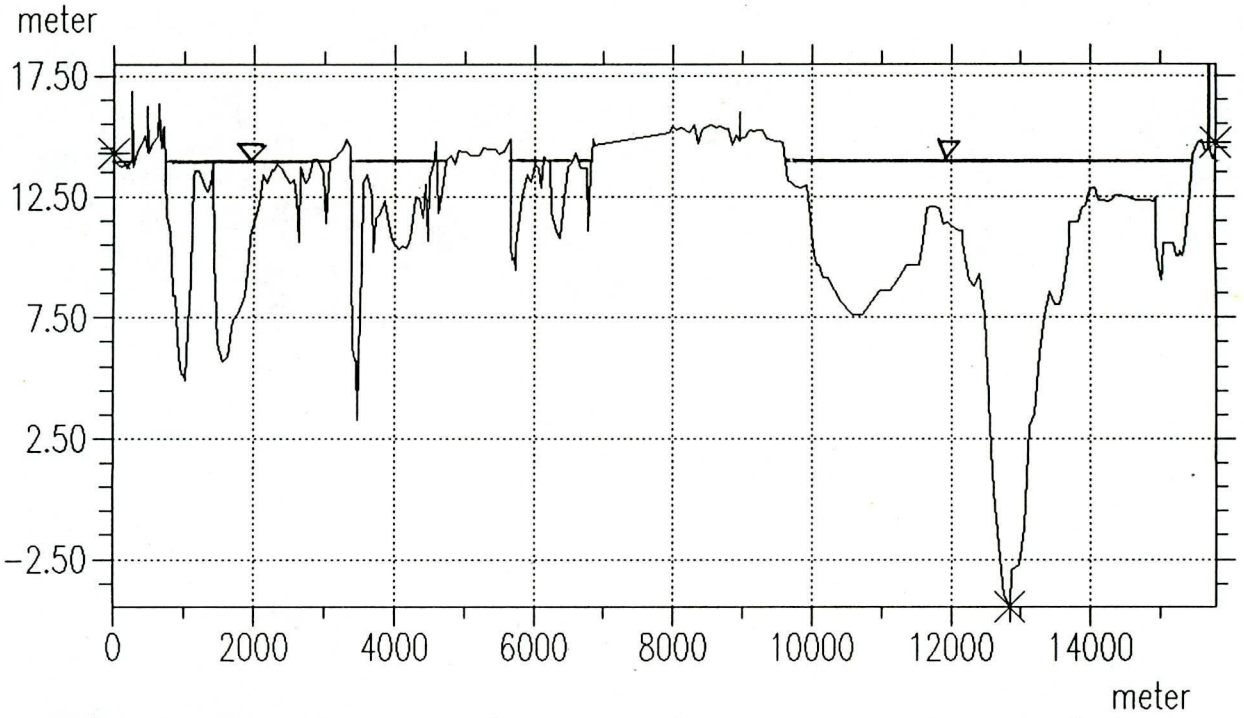


Figure 5.77.g Cross-section at Chainage 142·450 Km, J-9, 1990-91

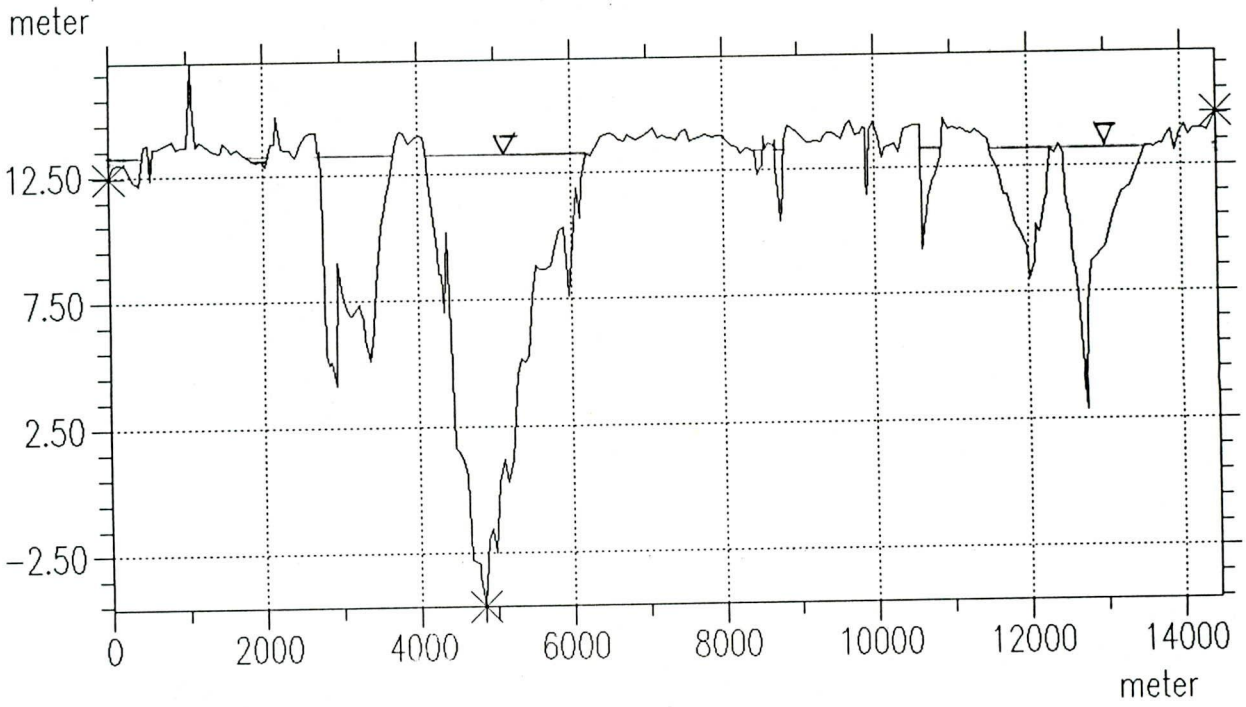


Figure 5.78.a Cross-section at Chainage 149.500 Km, J-8, 1969-70

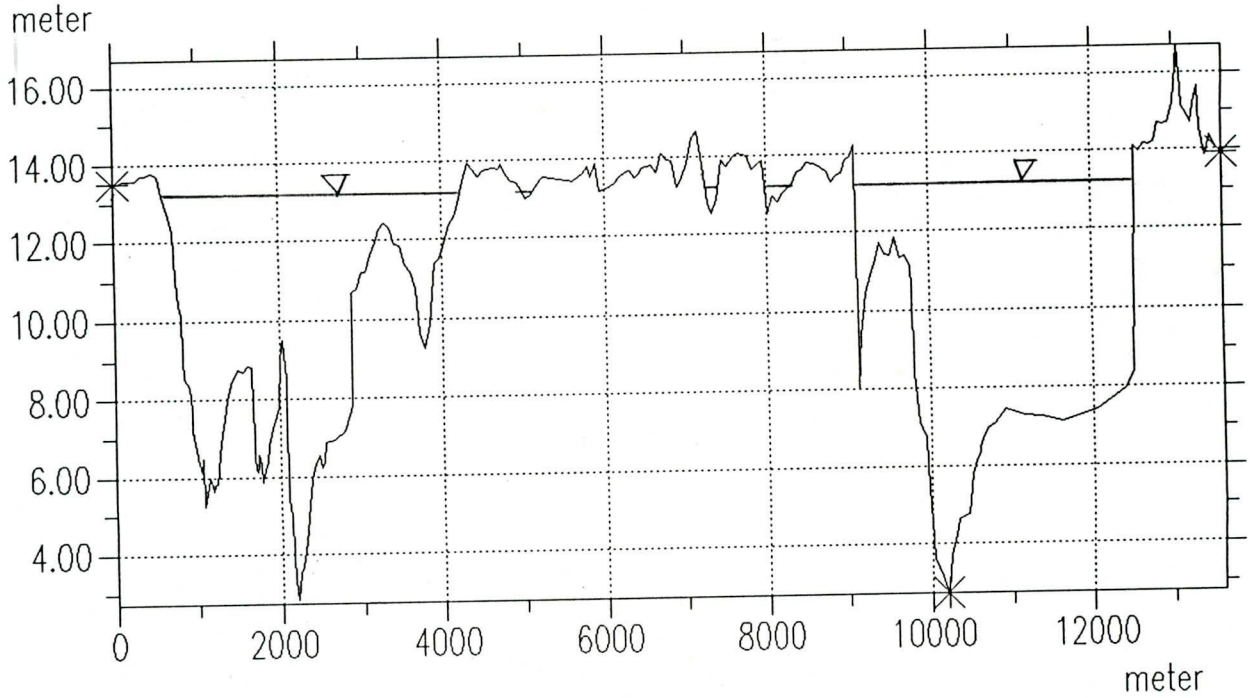


Figure 5.78.b Cross-section at Chainage 149.500 Km, J-8, 1976-77

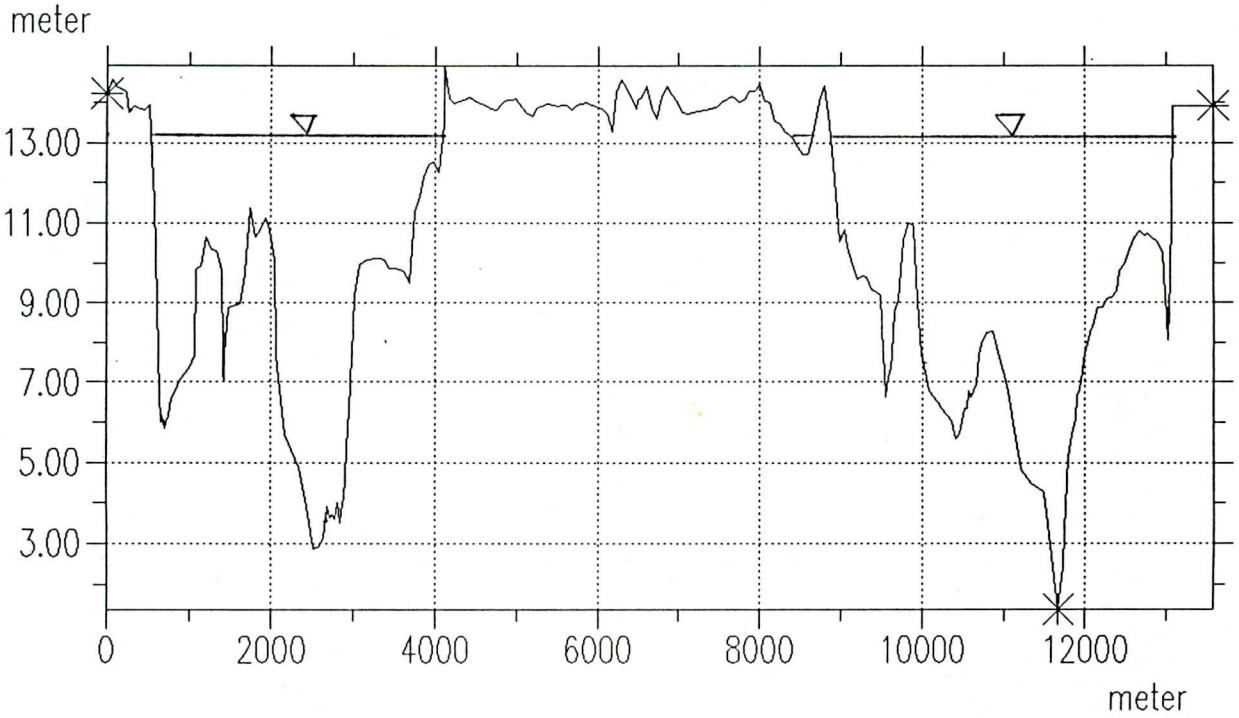


Figure 5.78.c Cross-section at Chainage 149.500 Km , J-8 , 1977-78

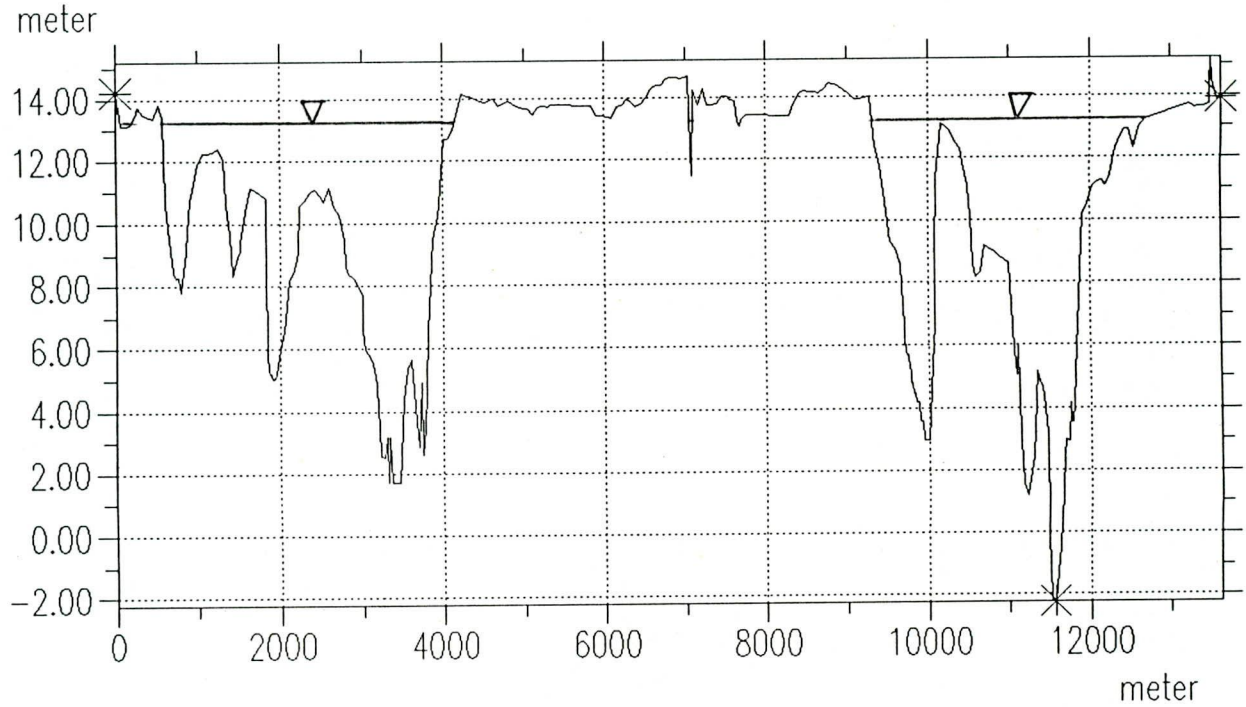


Figure 5.78.d Cross-section at Chainage 149.500 Km , J-8 , 1978-79

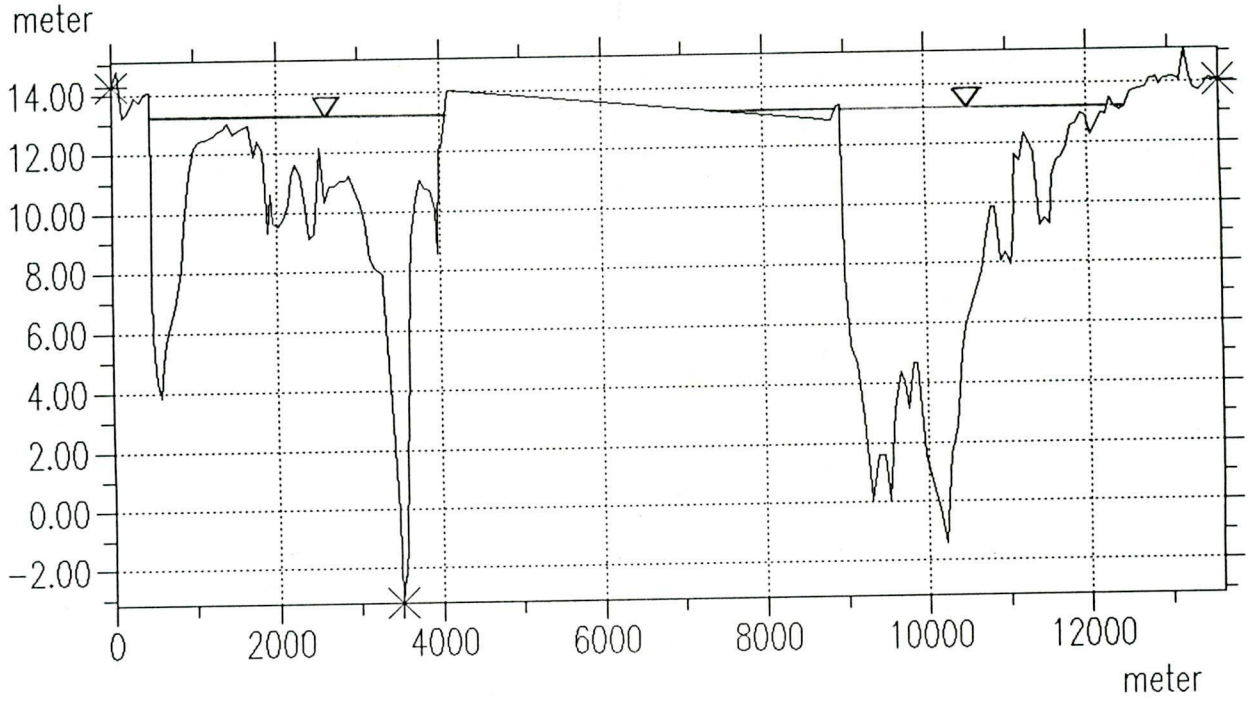


Figure 5.78.e Cross-section at Chainage 149.500Km, J-8, 1981-82

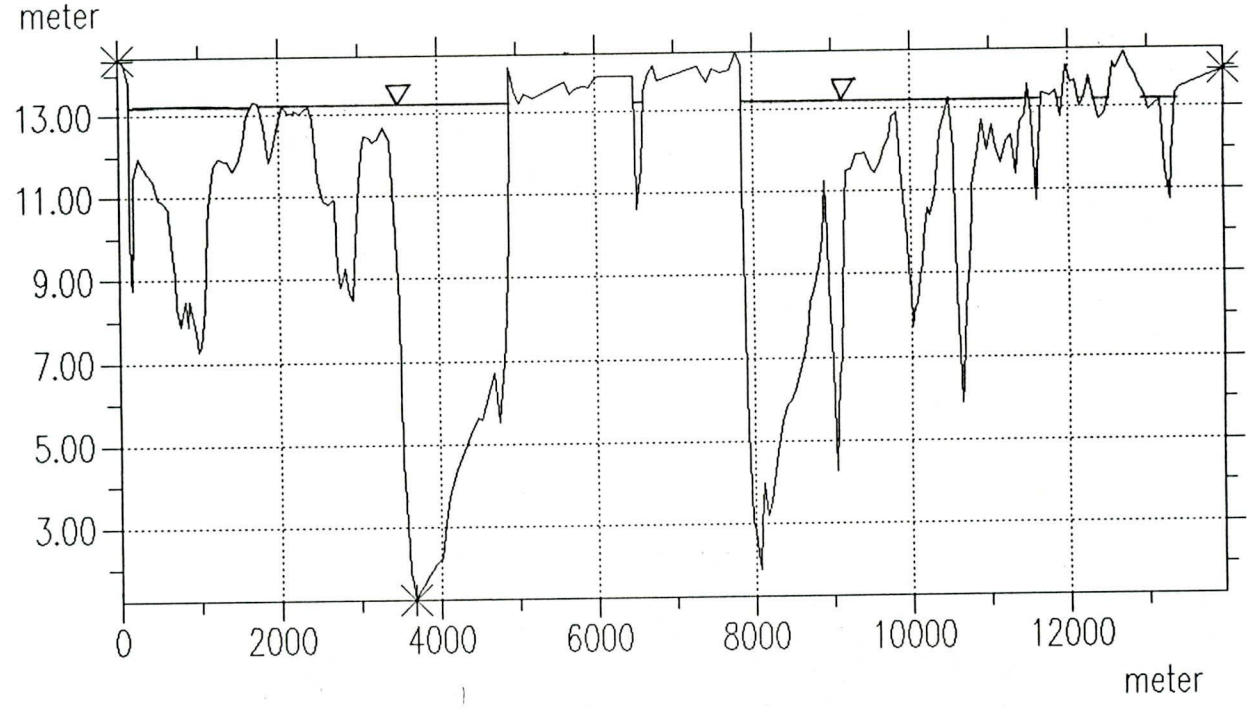


Figure 5.78.f Cross-section Chainage 149.500Km, J-8, 1986-87

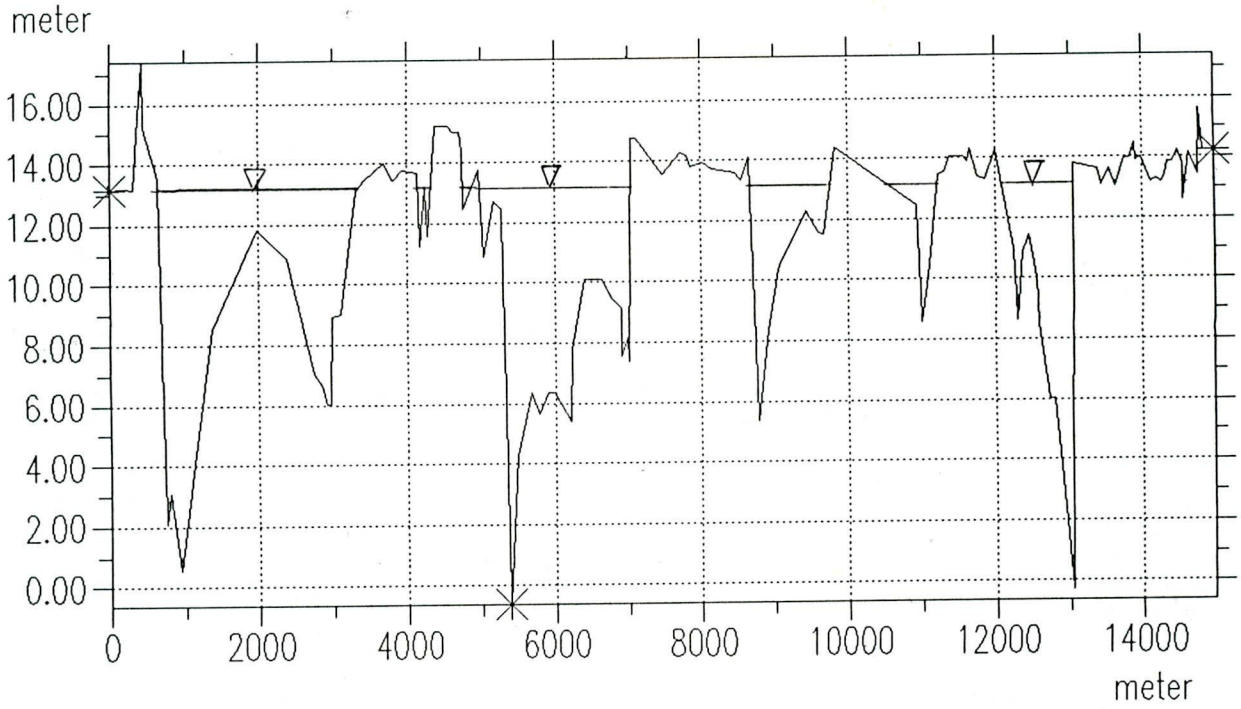


Figure 5.78.g Cross-section at Chainage 149.500Km, J-8, 1988-89

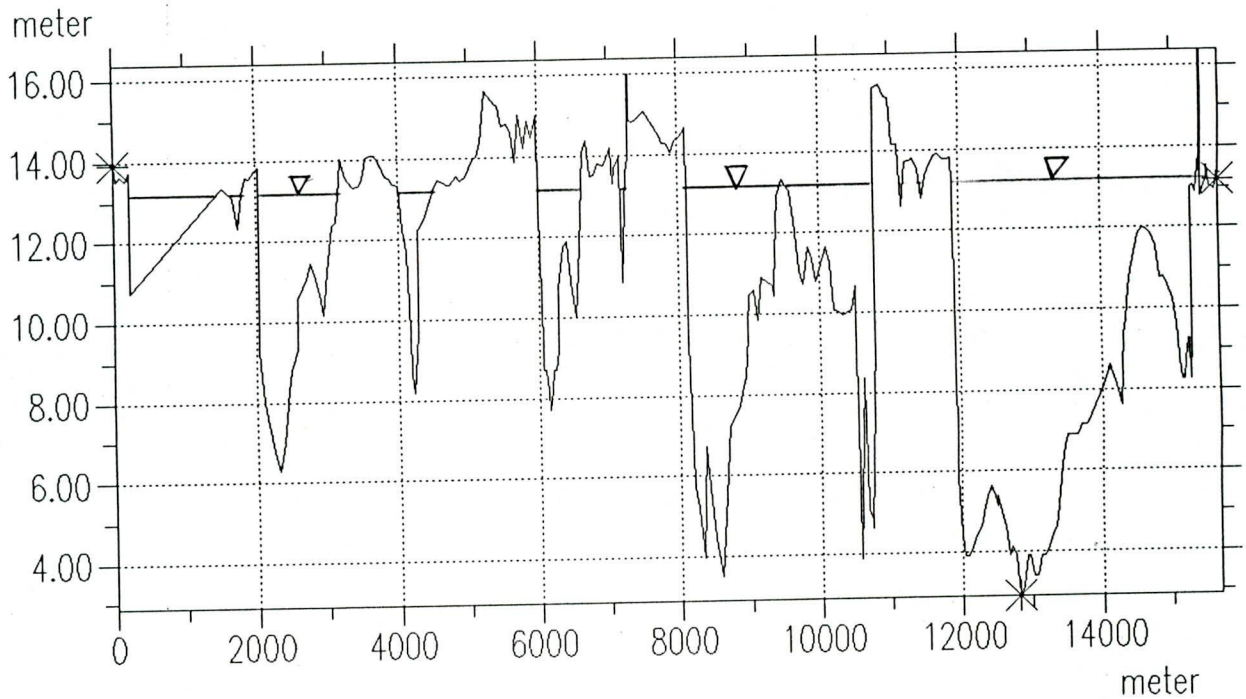


Figure 5.78.h Cross-section at Chainage 149.500Km, J-8, 1990-91

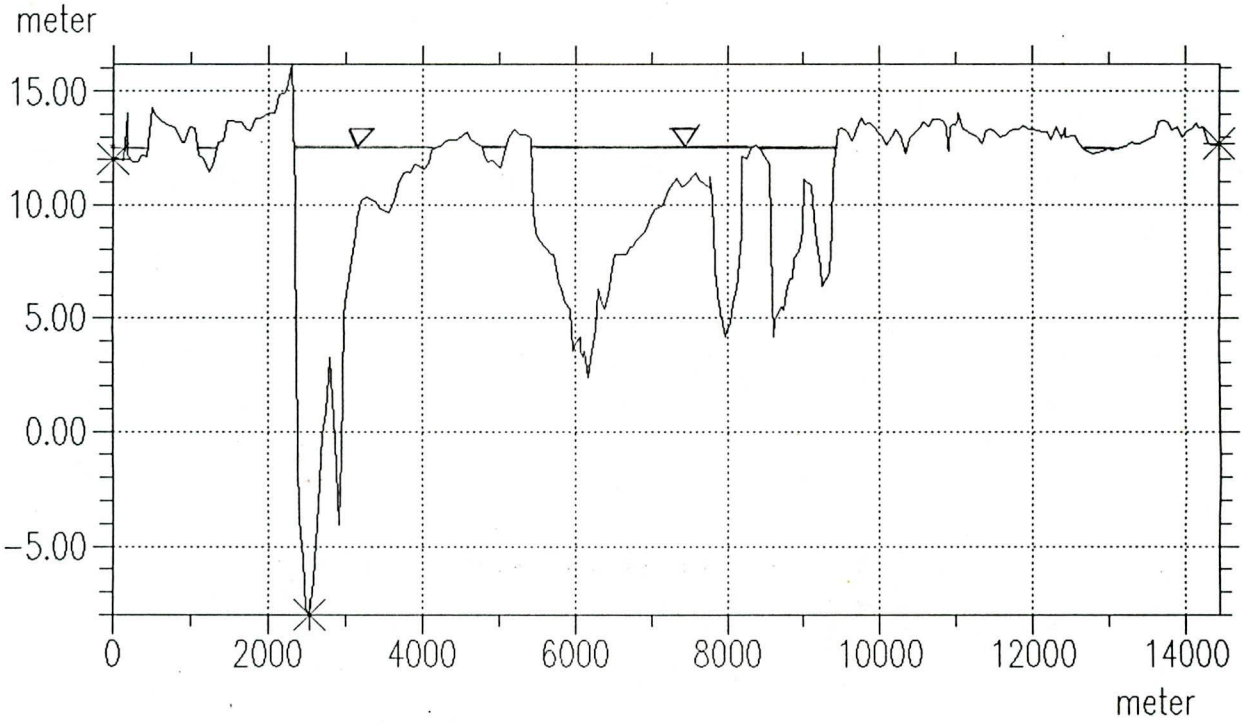


Figure 5.79.a Cross-section at Chainage 162·350 Km, J-7, 1969-70

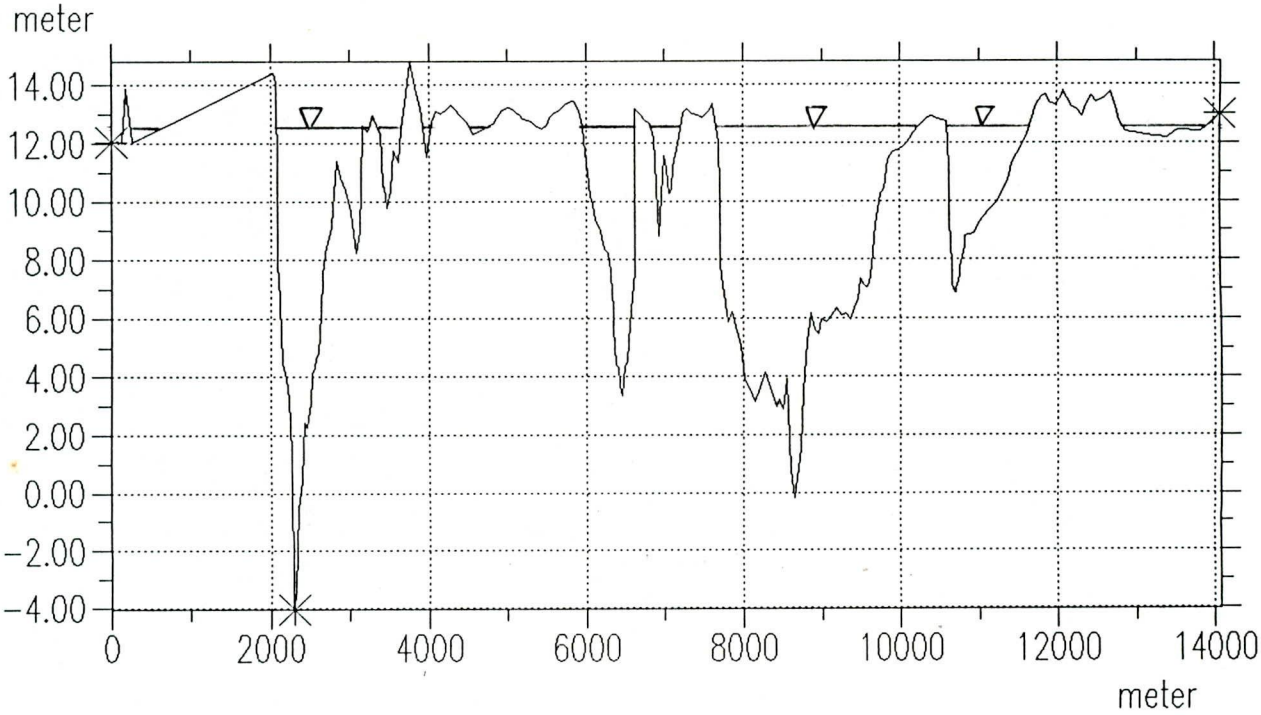


Figure 5.79.b Cross-section at Chainage 162·350 Km, J-7, 1976-77

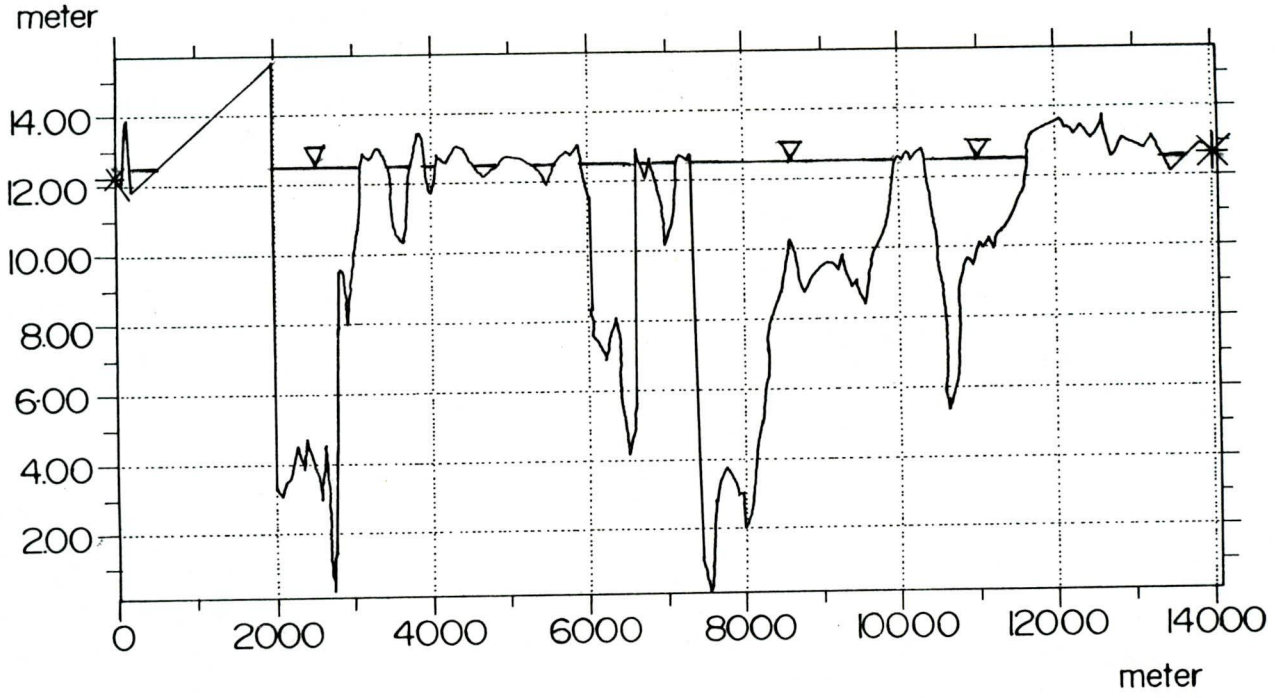


Figure 5.79.c Cross-section at Chainage 162.350 Km , J-7, 1977-78

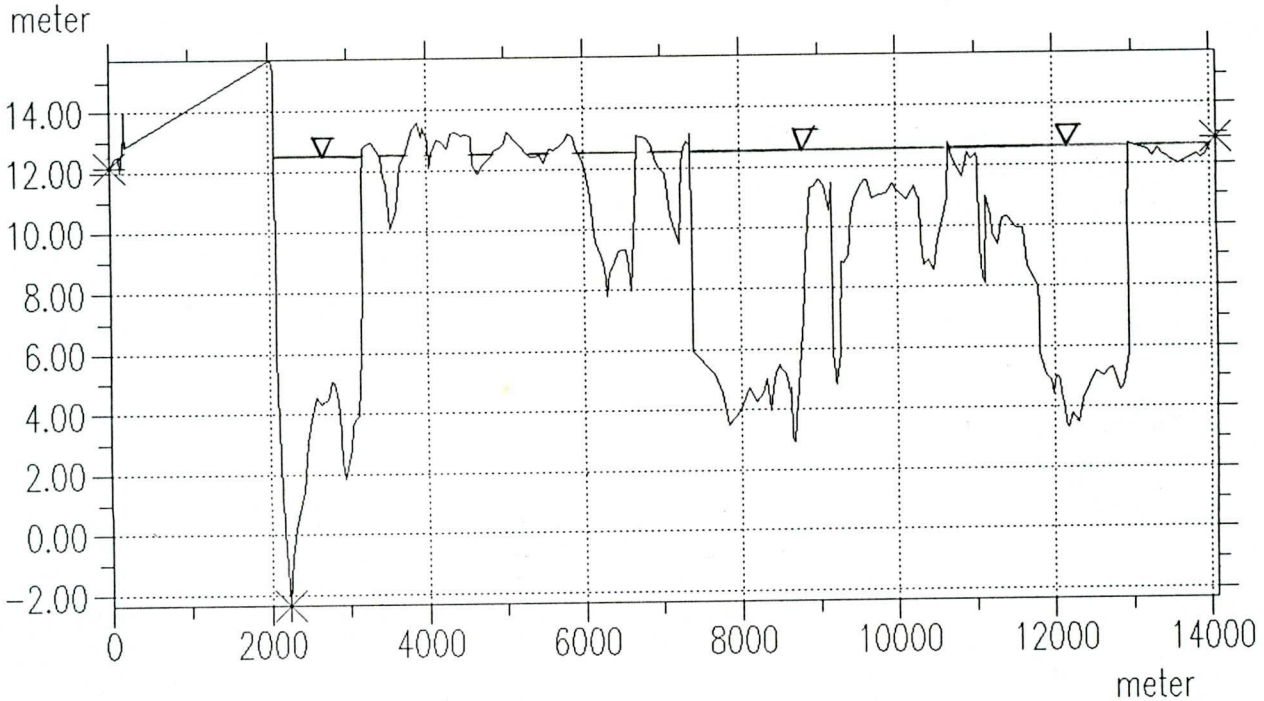


Figure 5.79.d Cross-section at Chainage 162.350 Km , J-7, 1978-79

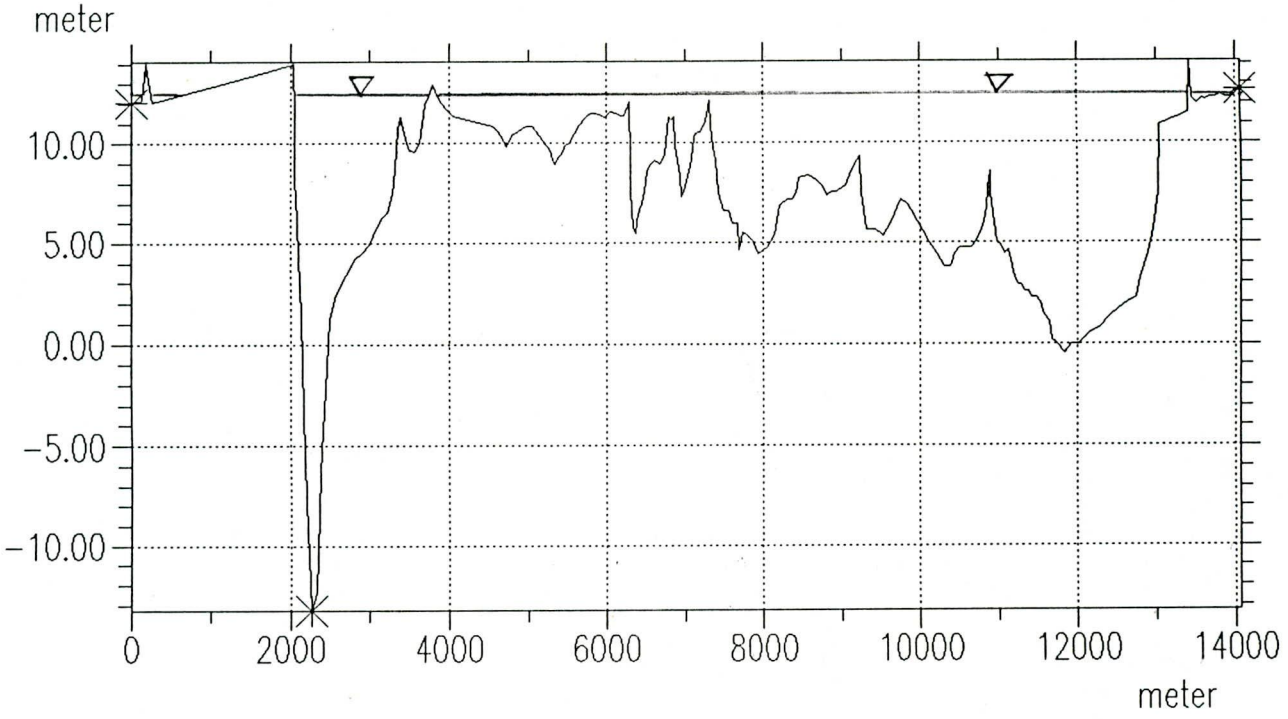


Figure 5.79.e Cross section at Chainage 162.350 Km , J-7, 1981-82

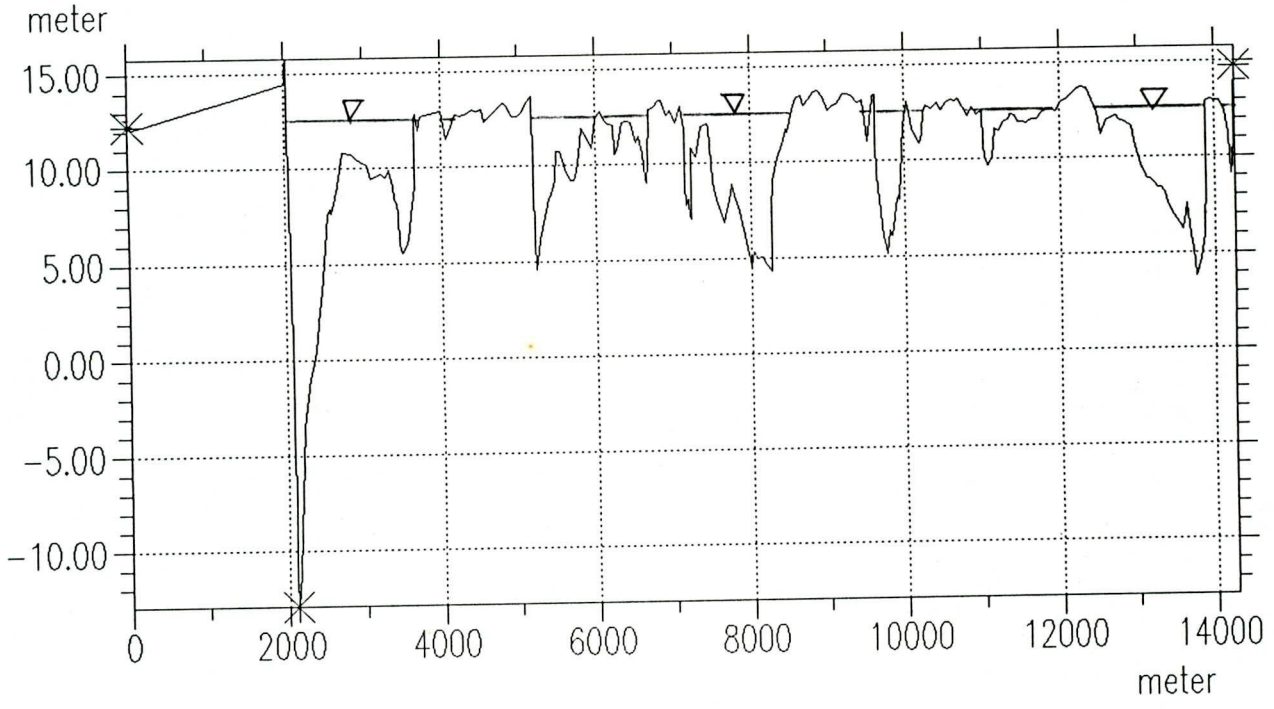


Figure 5.79.f Cross-section at Chainage 162.350 Km , J-7, 1986-87

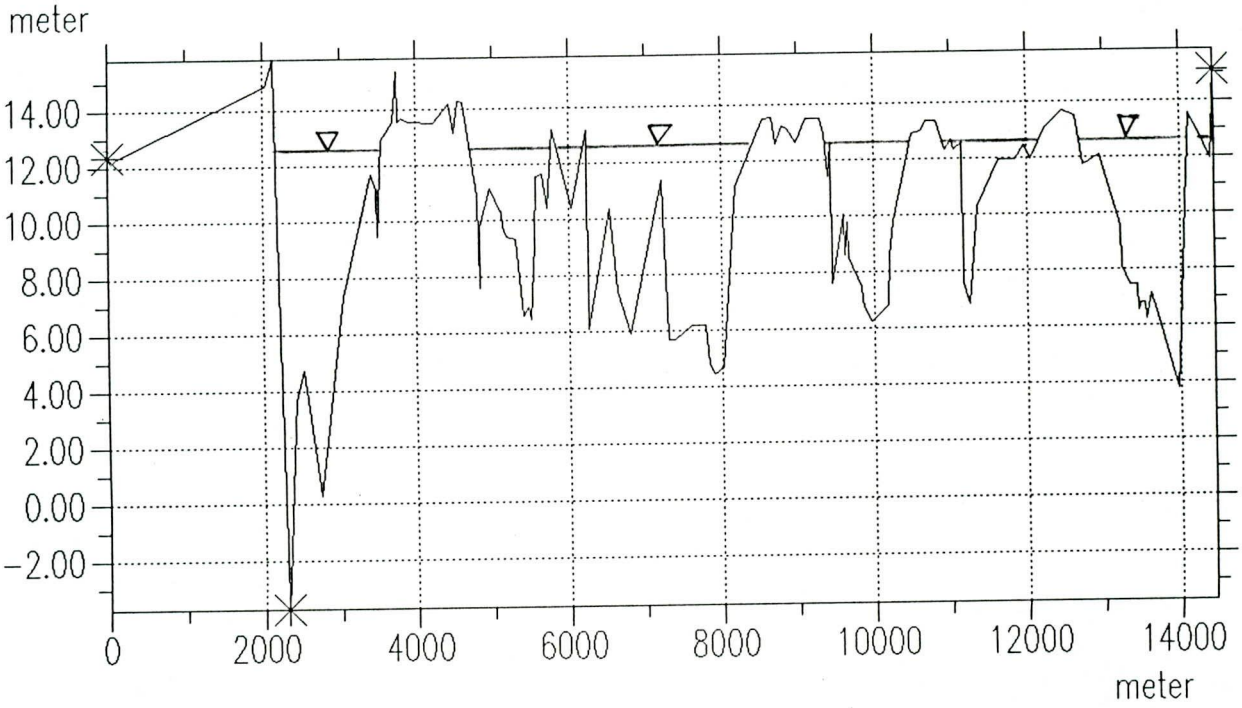


Figure 5.79.g Cross-section at Chainage 162.350 Km, J-7, 1988-89

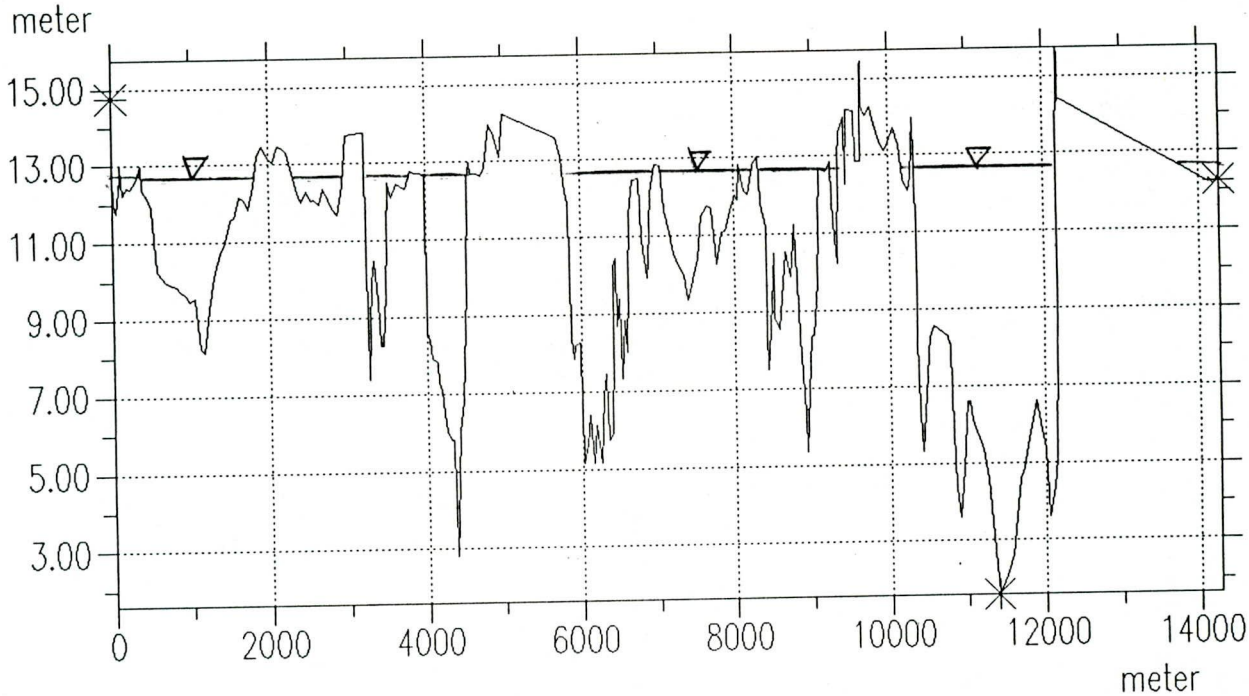


Figure 5.79.h Cross-section at Chainage 162.350 Km, J-7, 1990-90

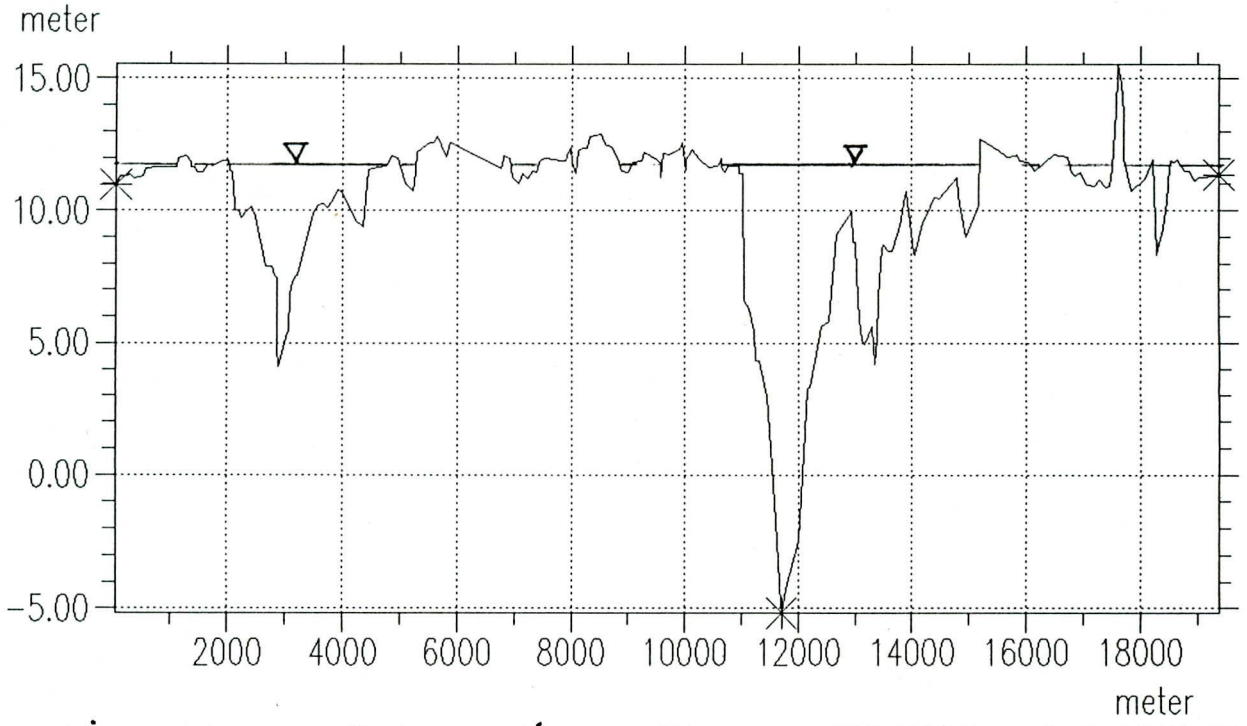


Figure 5.80.a Cross-section at Chainage 177·700 Km, J-6, 1969-70

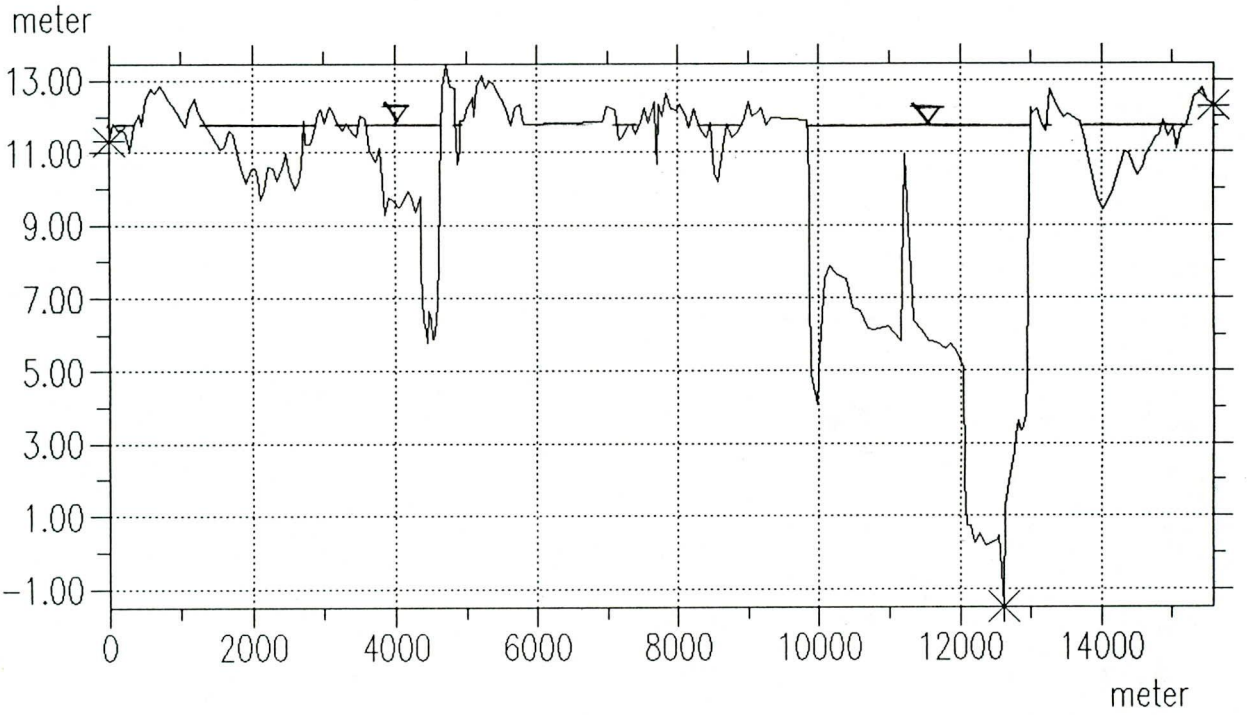


Figure 5.80.b Cross-section at Chainage 177·700 Km, J-6, 1976-77

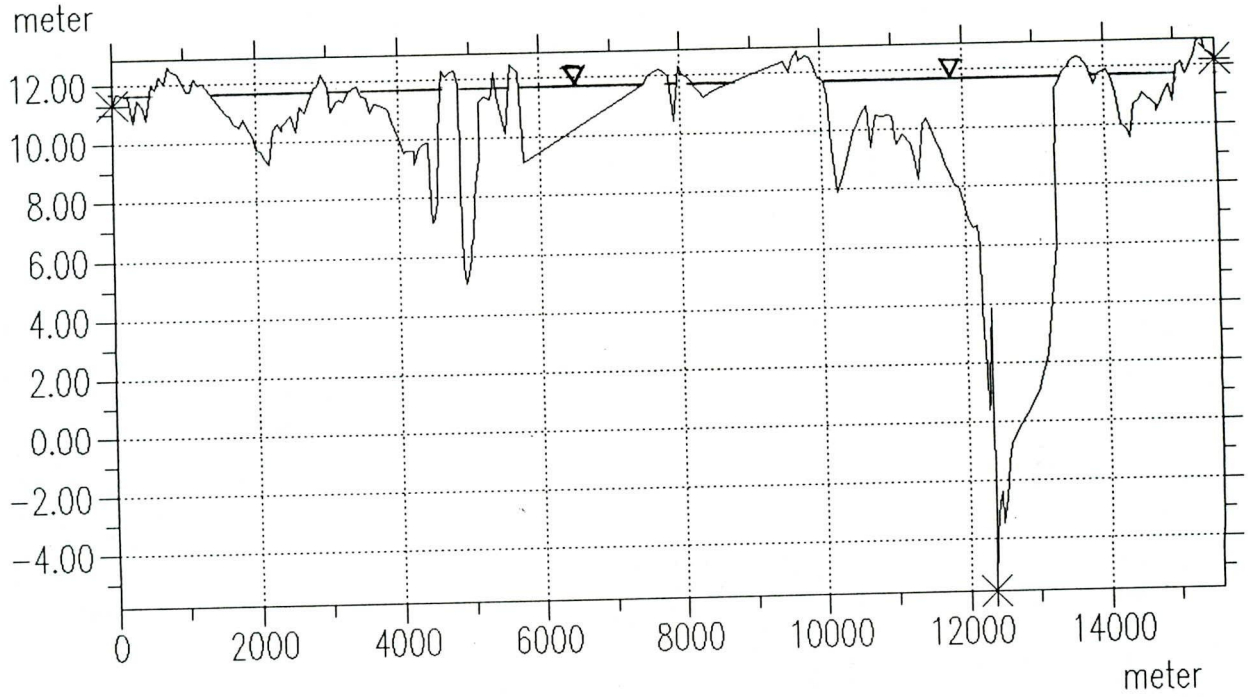


Figure 5.80.c Cross-section at Chainage 177·700Km, J-6, 1977-78

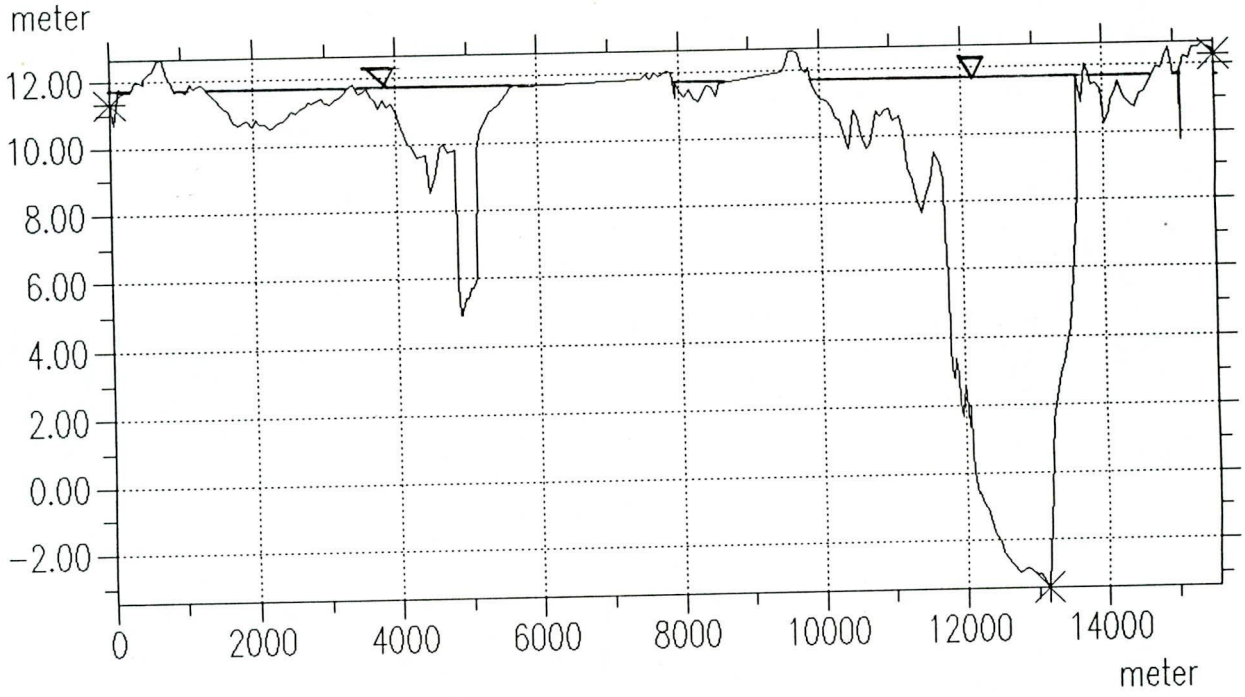


Figure 5.80.d Cross-section at Chainage 177·700Km, J-6, 1978-79

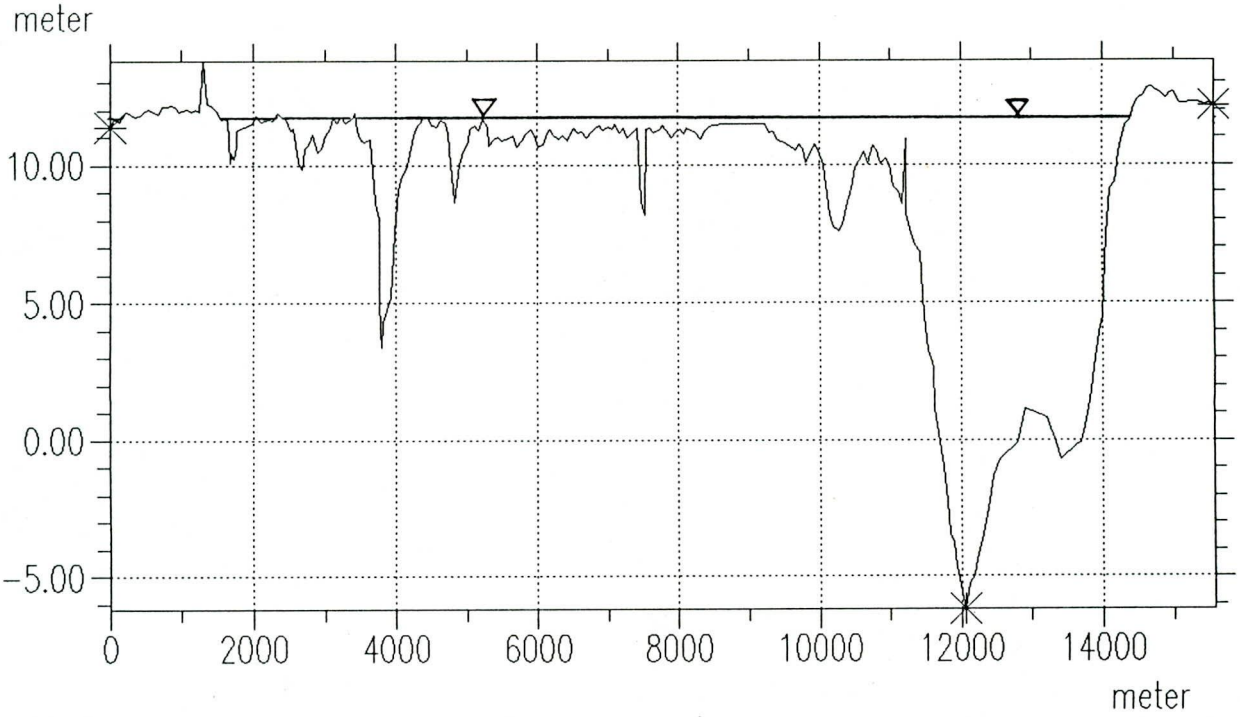


Figure 5.80.e Cross-section at Chainage 177·700 Km, J-6, 1981-82

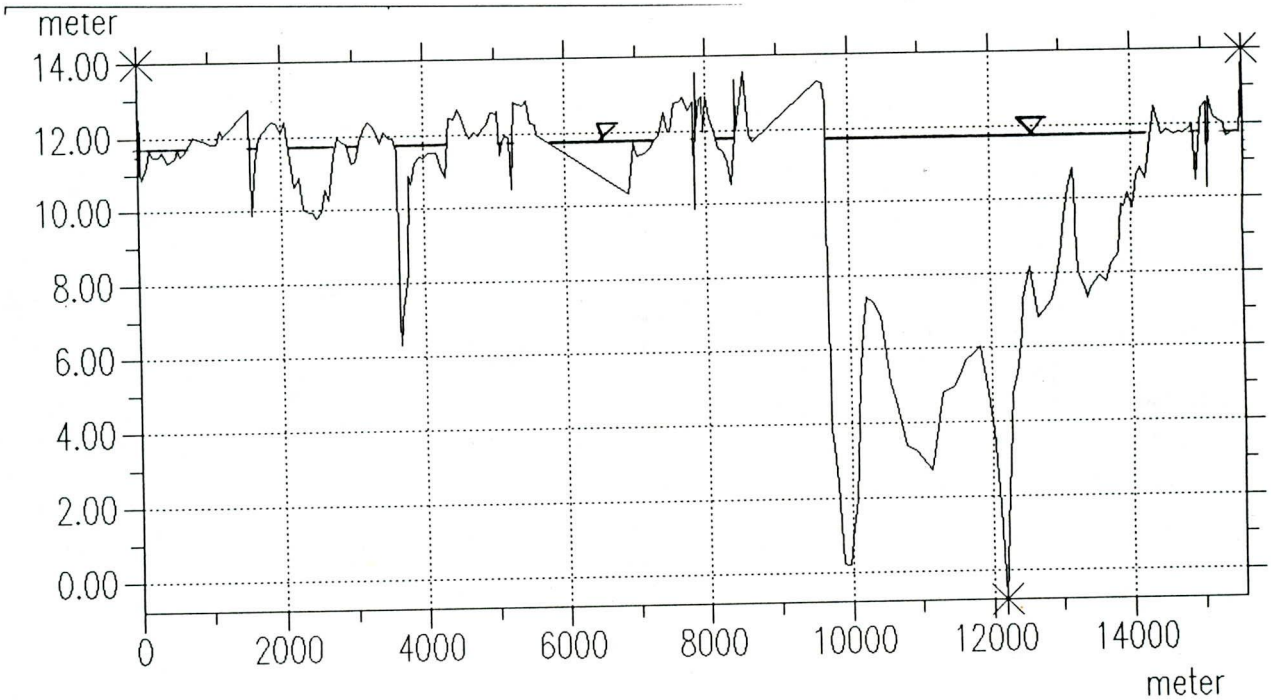


Figure 5.80.f Cross-section at Chainage 177·700 Km, J-6, 1986-87

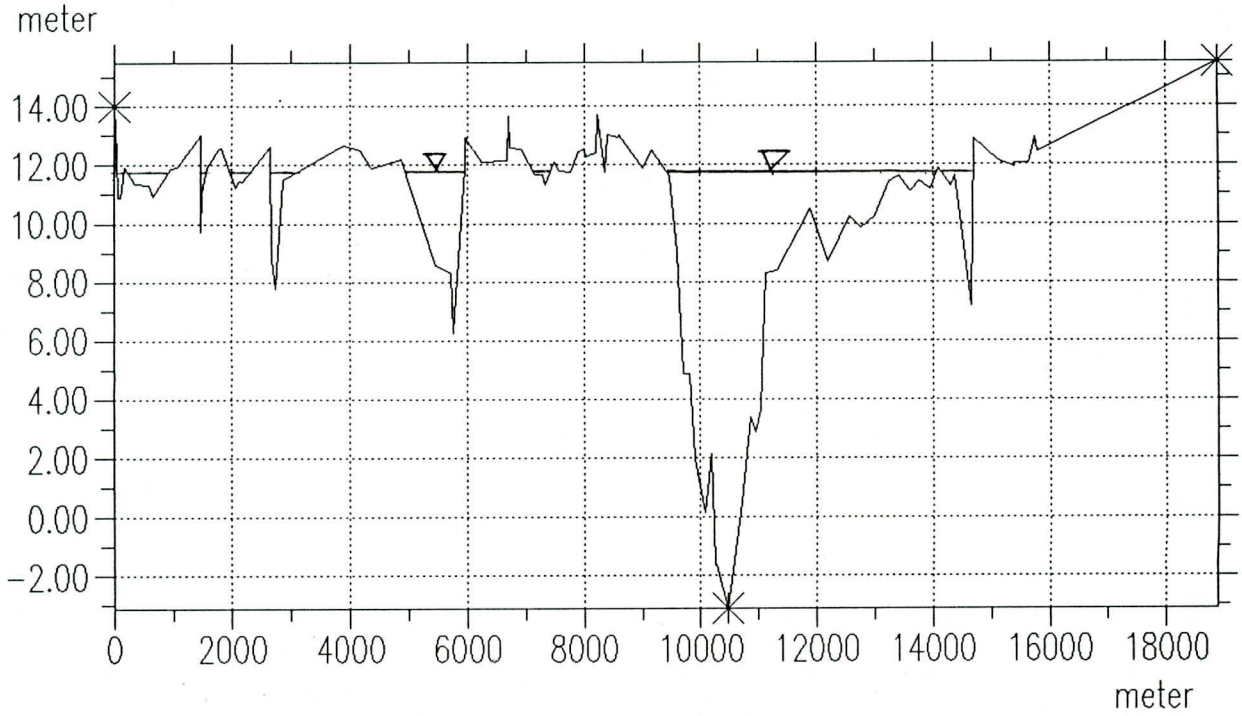


Figure 5.80.g Cross-section at Chainage 177·700 Km, J-6, 1988-89

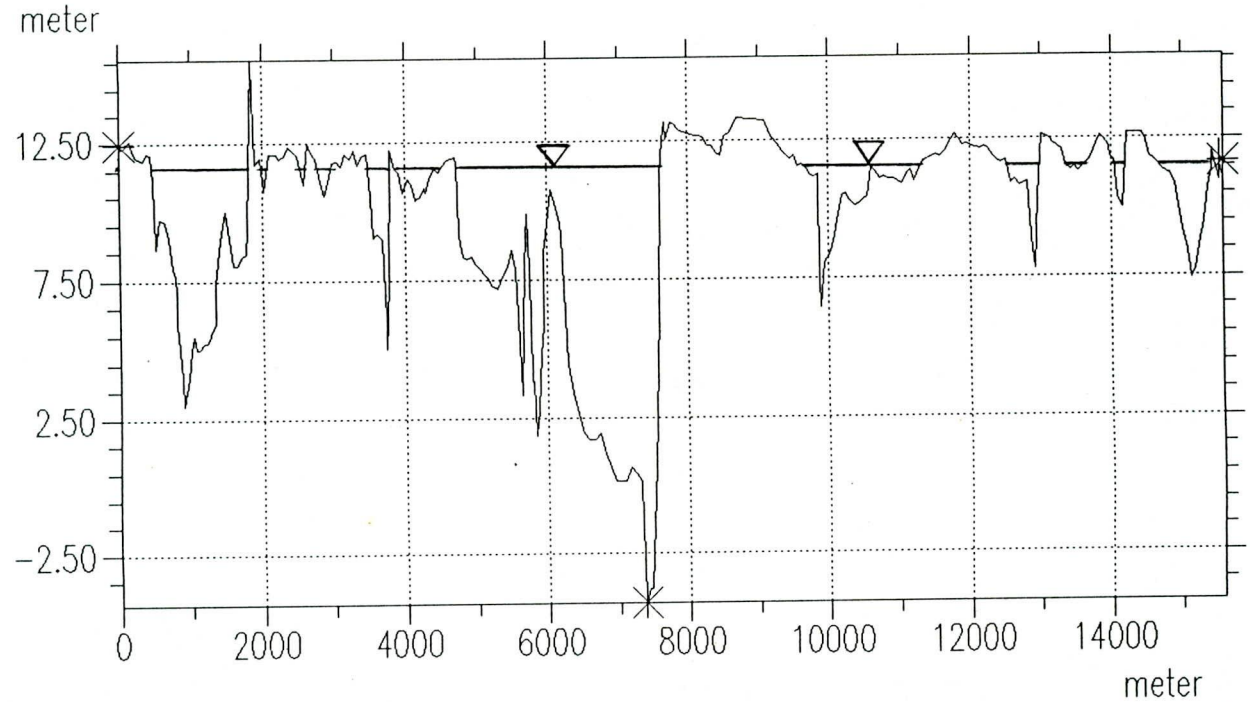


Figure 5.80.h Cross-section at Chainage 177·700 Km, J-6, 1990-91

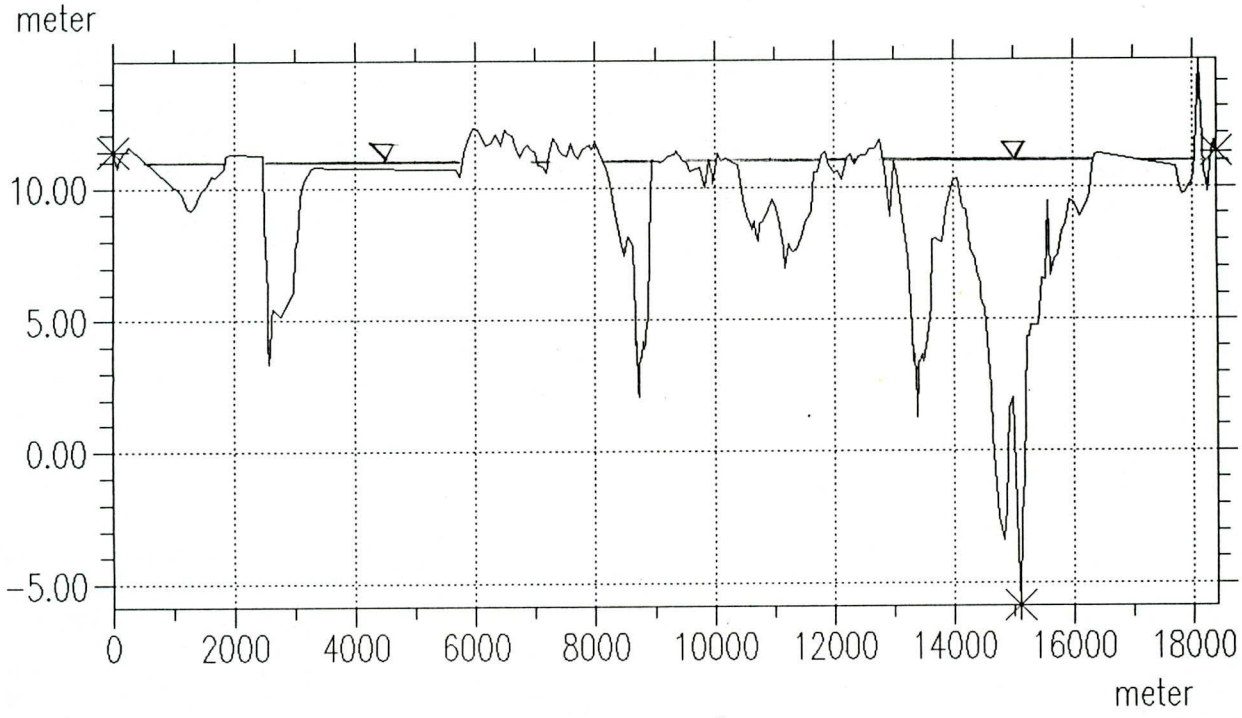


Figure 5.81.a Cross-section at Chainage 188·200 Km, J-5, 1969-70

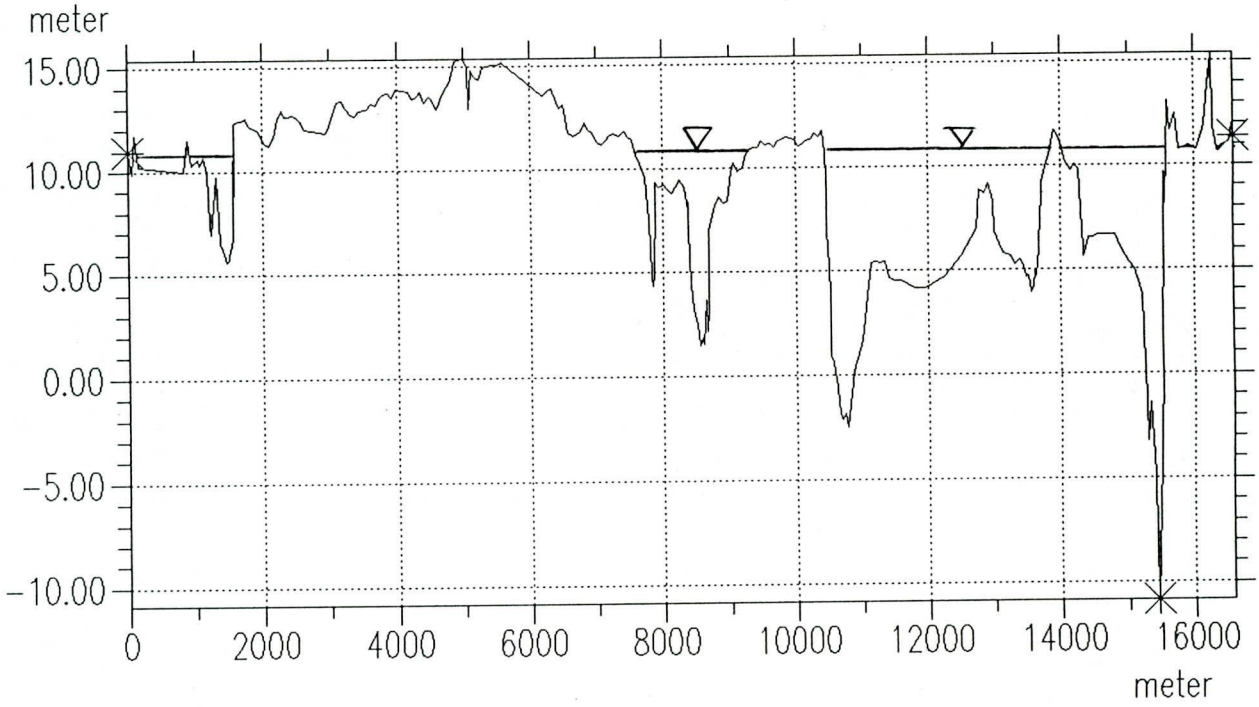


Figure 5.81.b Cross-section at Chainage 188·200Km, J-5, 1976-77

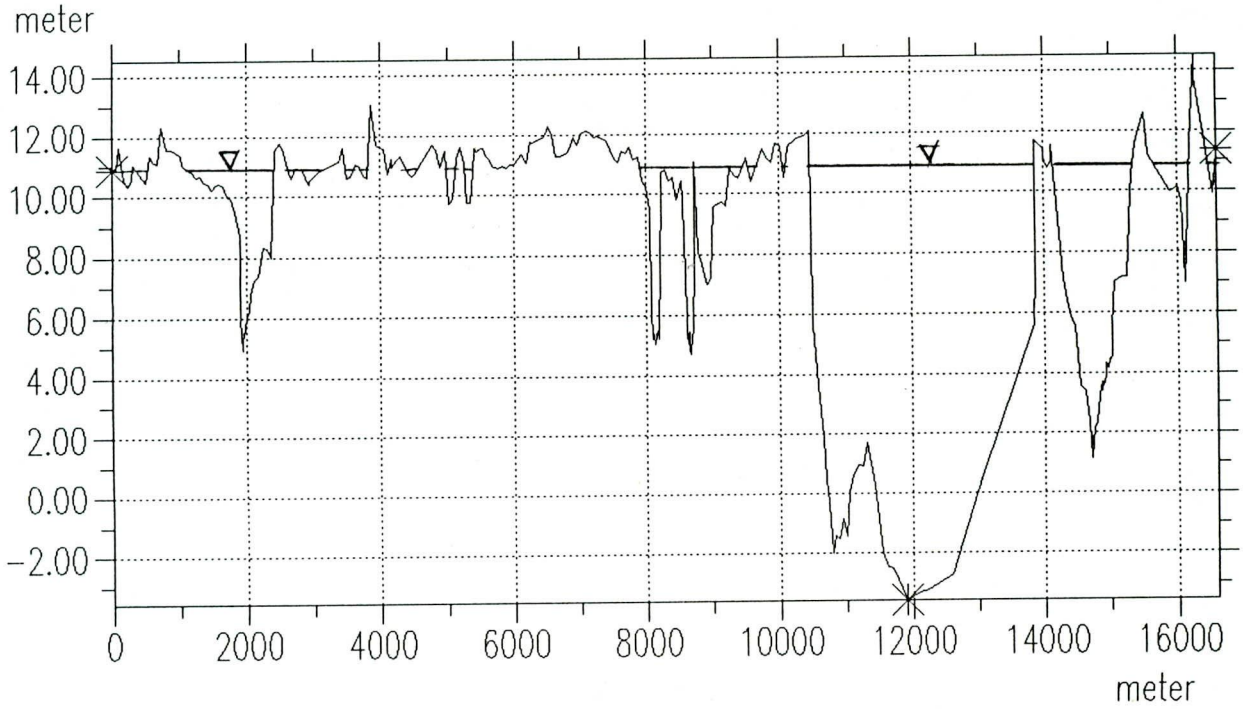


Figure 5.81.c Cross-section at Chainage 188·200Km, J-5, 1977-78

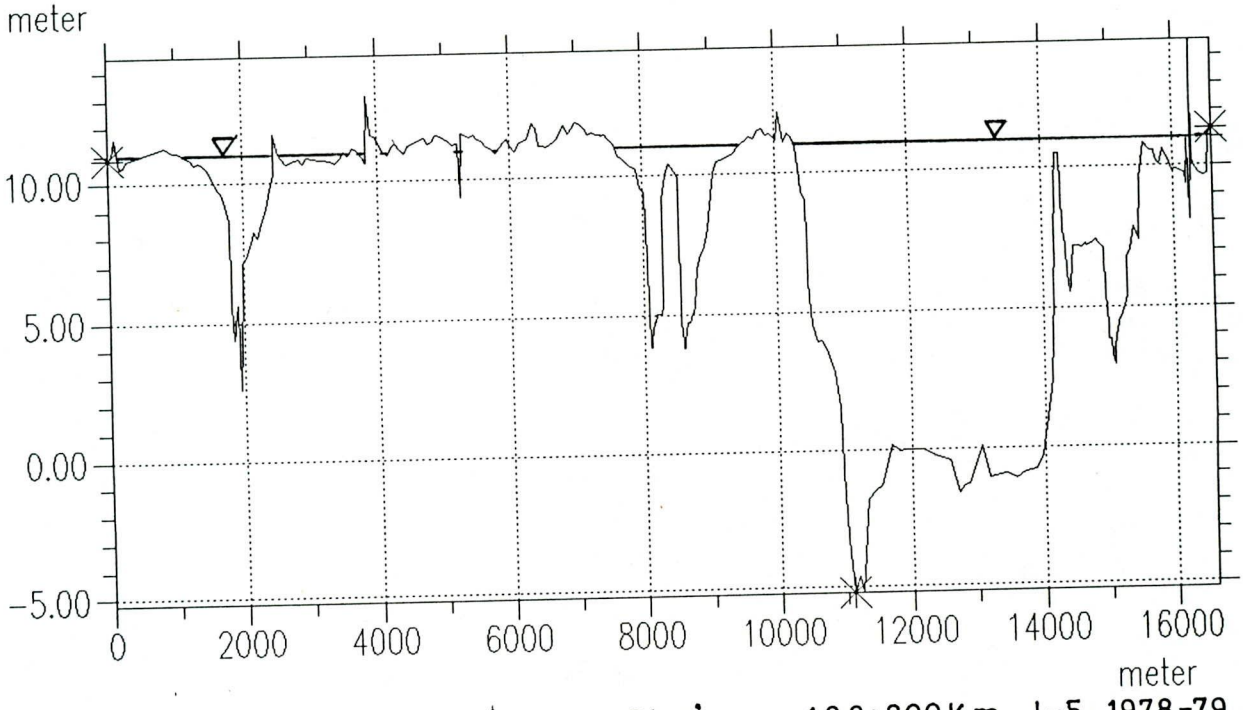


Figure 5.81.d Cross-section at Chainage 188·200Km, J-5, 1978-79

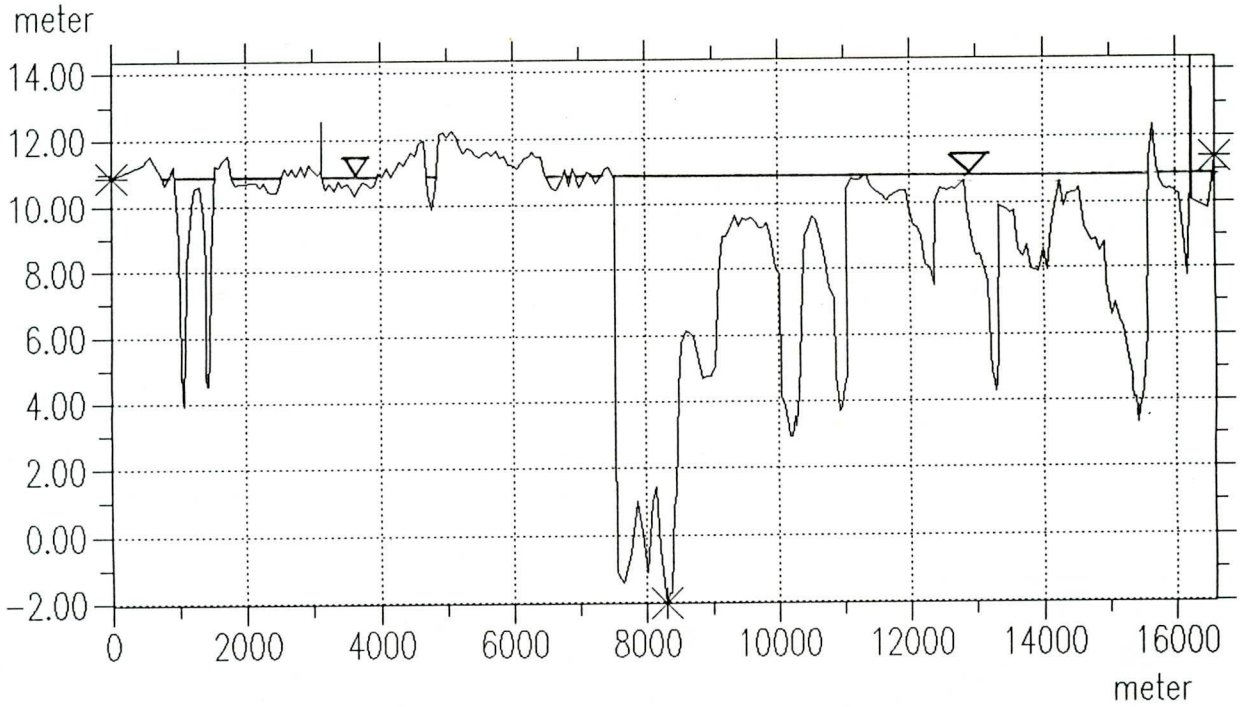


Figure 5.81.e Cross-section at Chainage 188·200Km, J-5, 1981-82

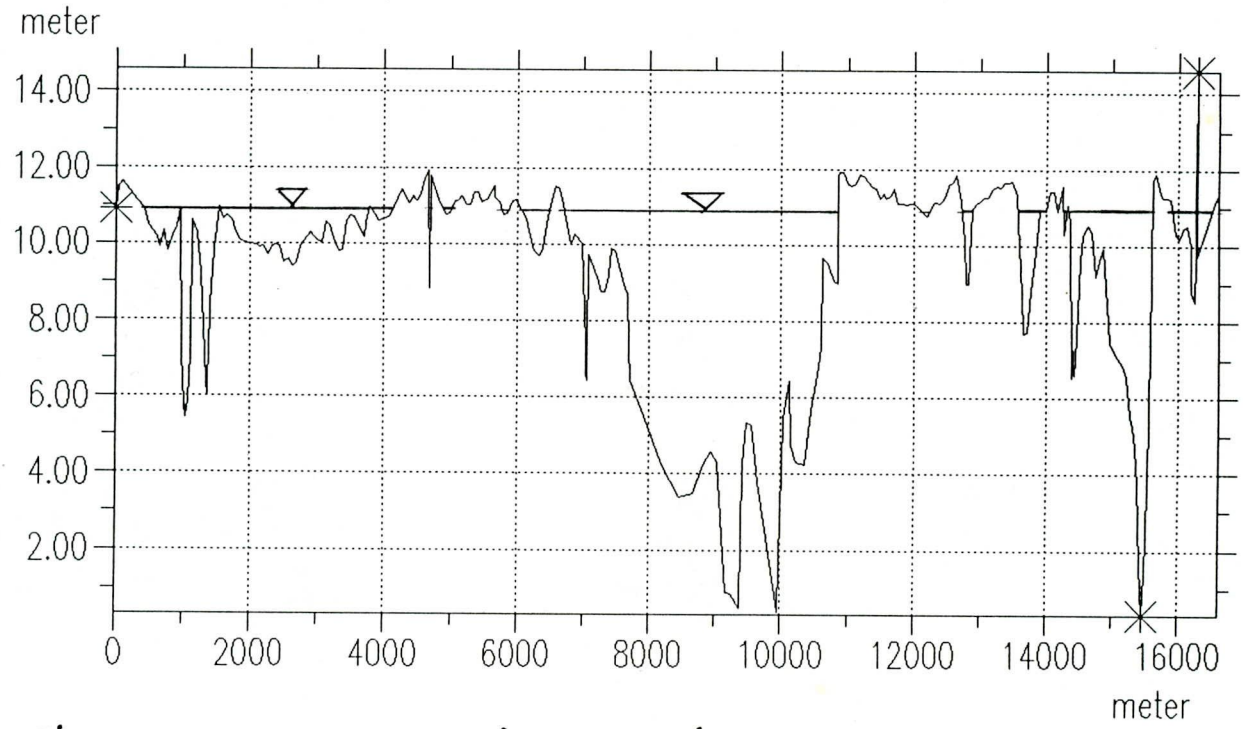


Figure 5.81.f Cross-section at Chainage 188·200Km, J-5, 1986-87

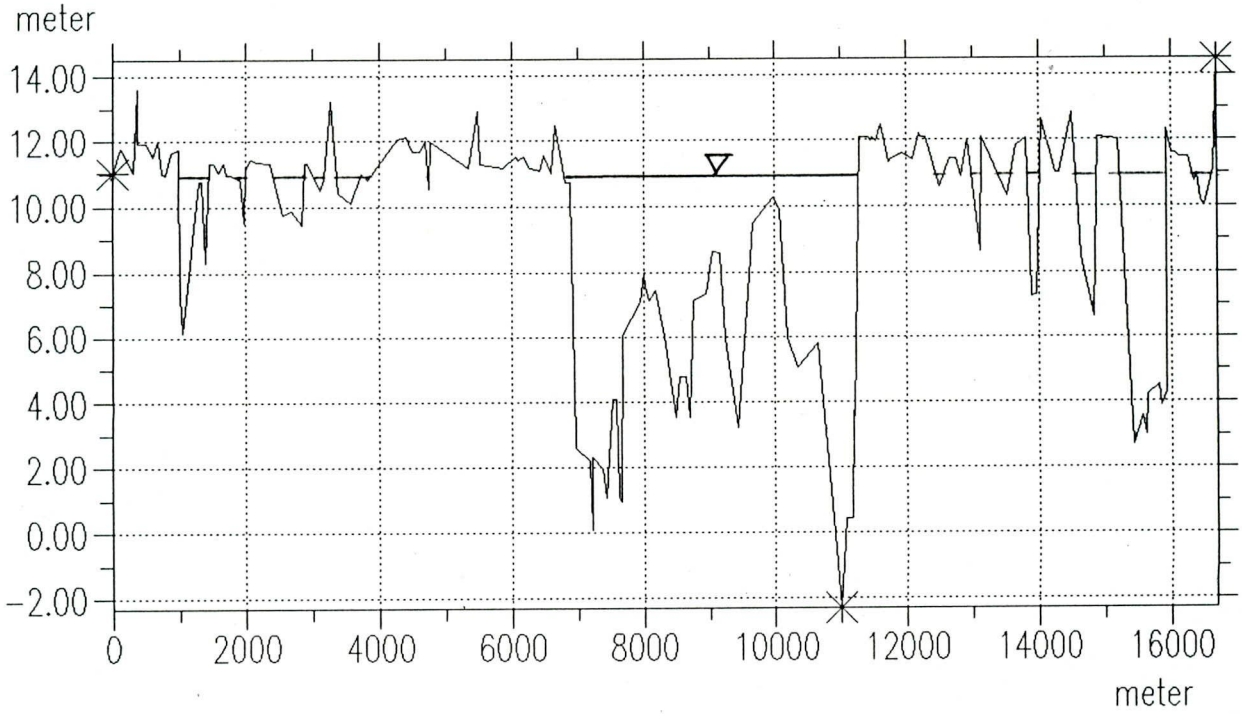


Figure 5.81.g Cross-section at Chainage 188·200Km, J-5, 1988-89

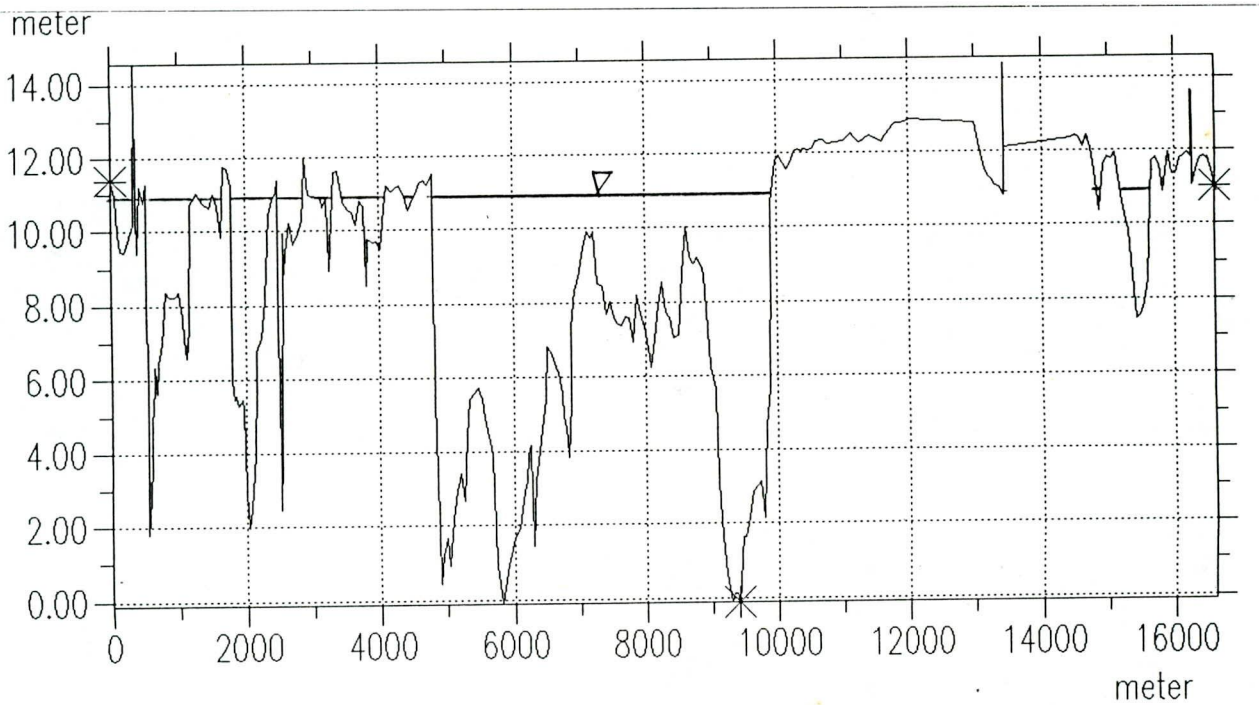


Figure 5.81.h Cross-section at Chainage 188·200Km, J-5, 1990-91

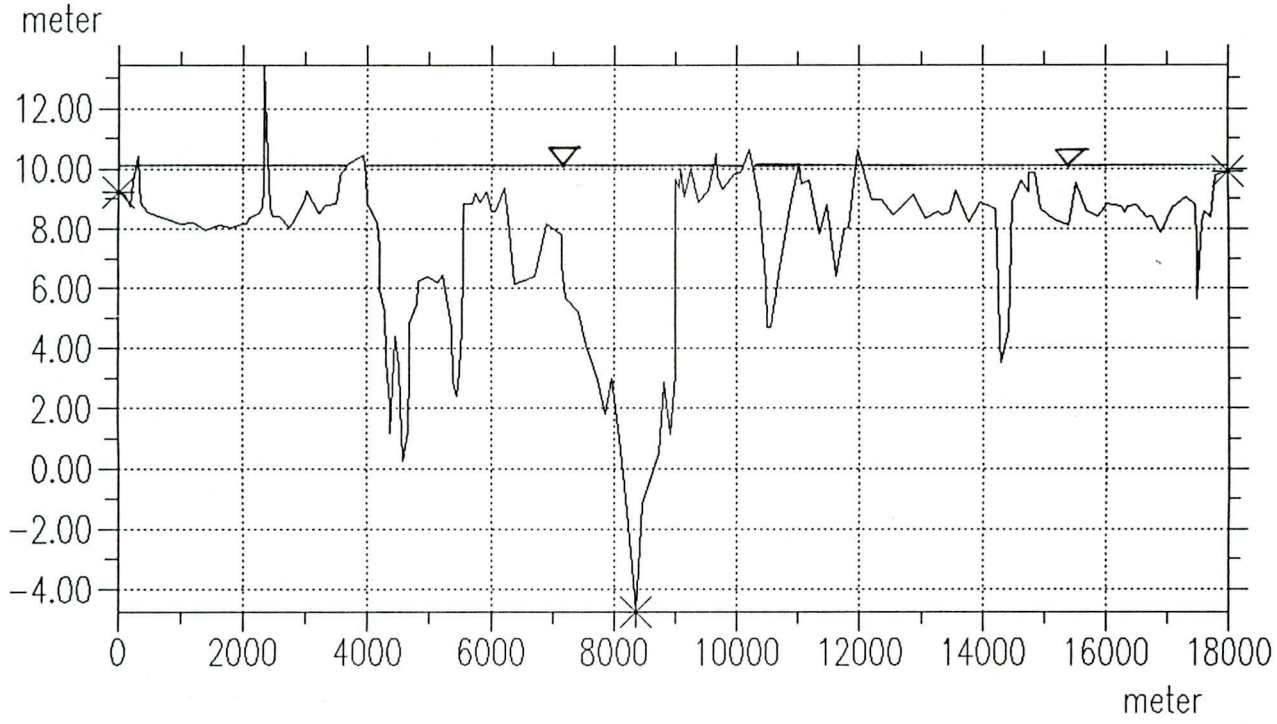


Figure 5.82.a Cross-section at Chainage 201·300Km, J-4, 1969-70

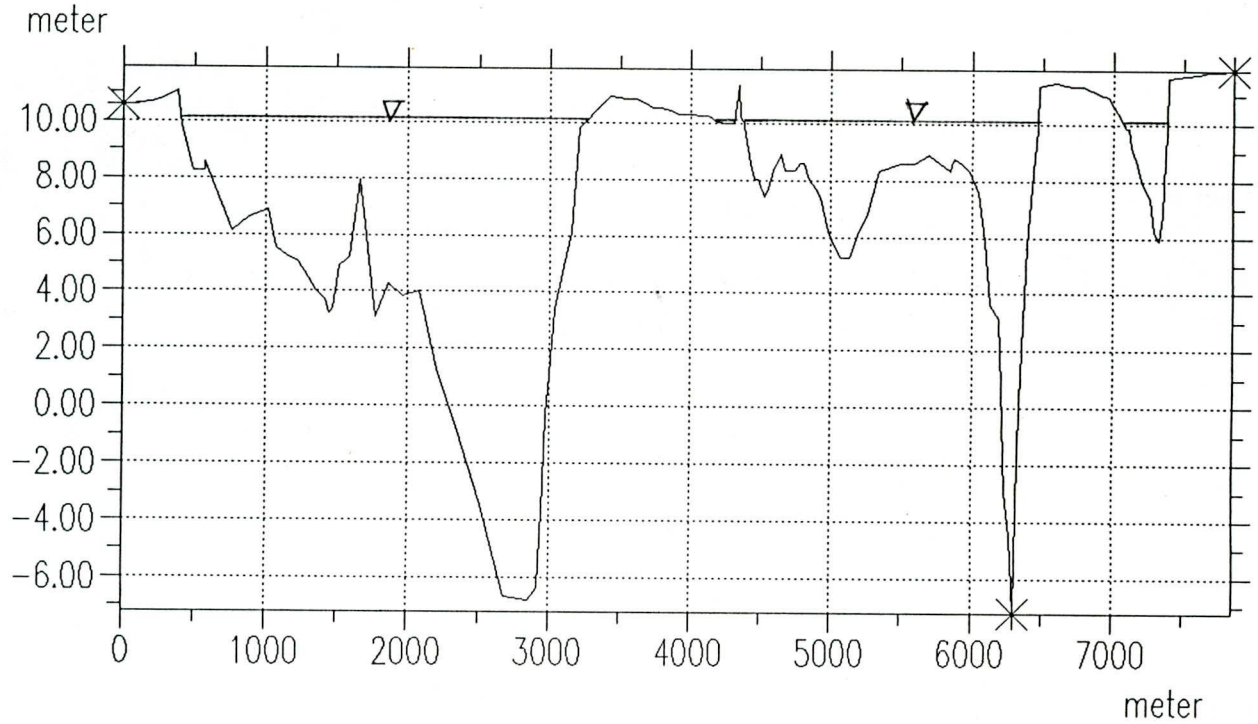


Figure 5.82.b Cross-section at Chainage 201·300Km, J-4 1976-77

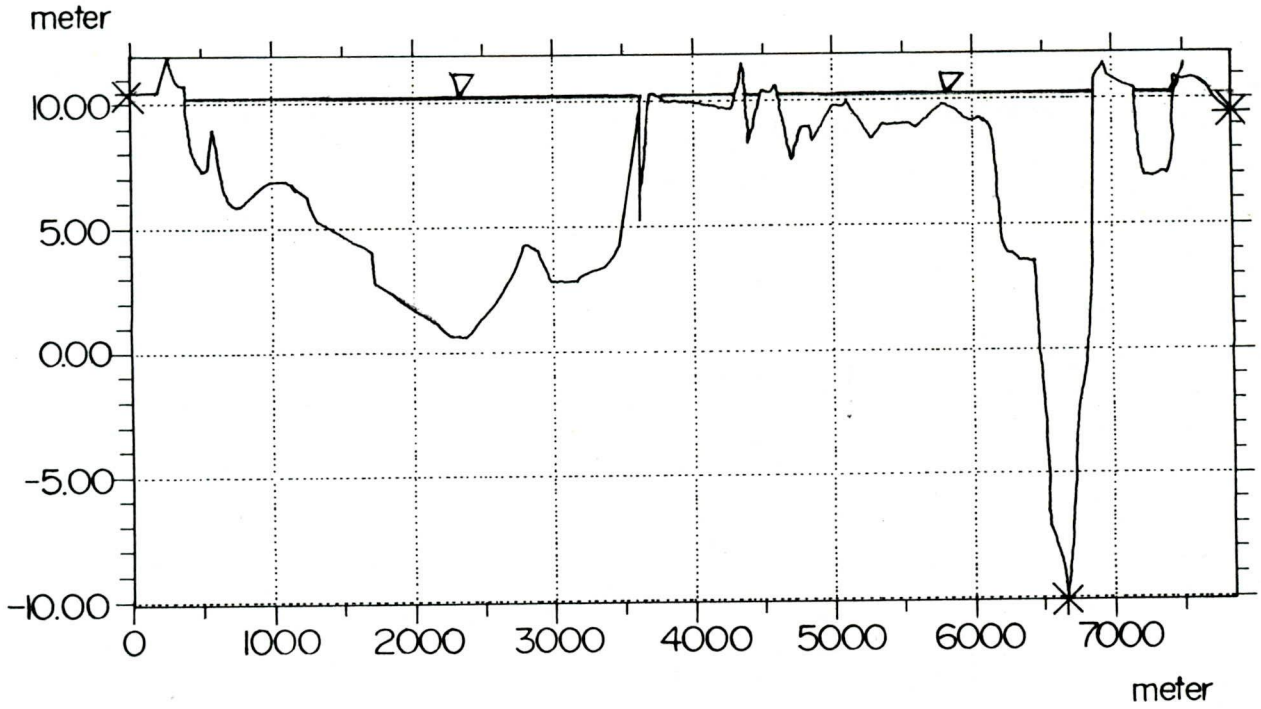


Figure 5.82.c Cross-section at Chainage 201·300 Km, J-4, 1977-78

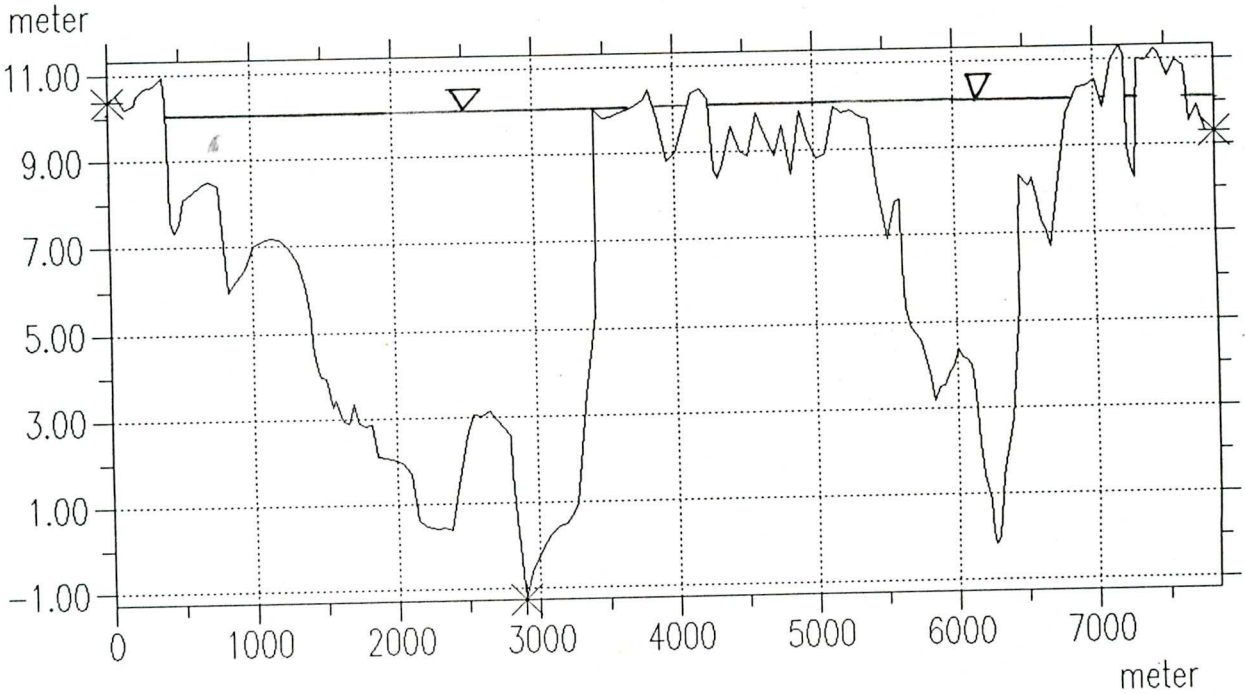


Figure 5.82.d Cross-section at Chainage 201·300 Km, J-4, 1978-79

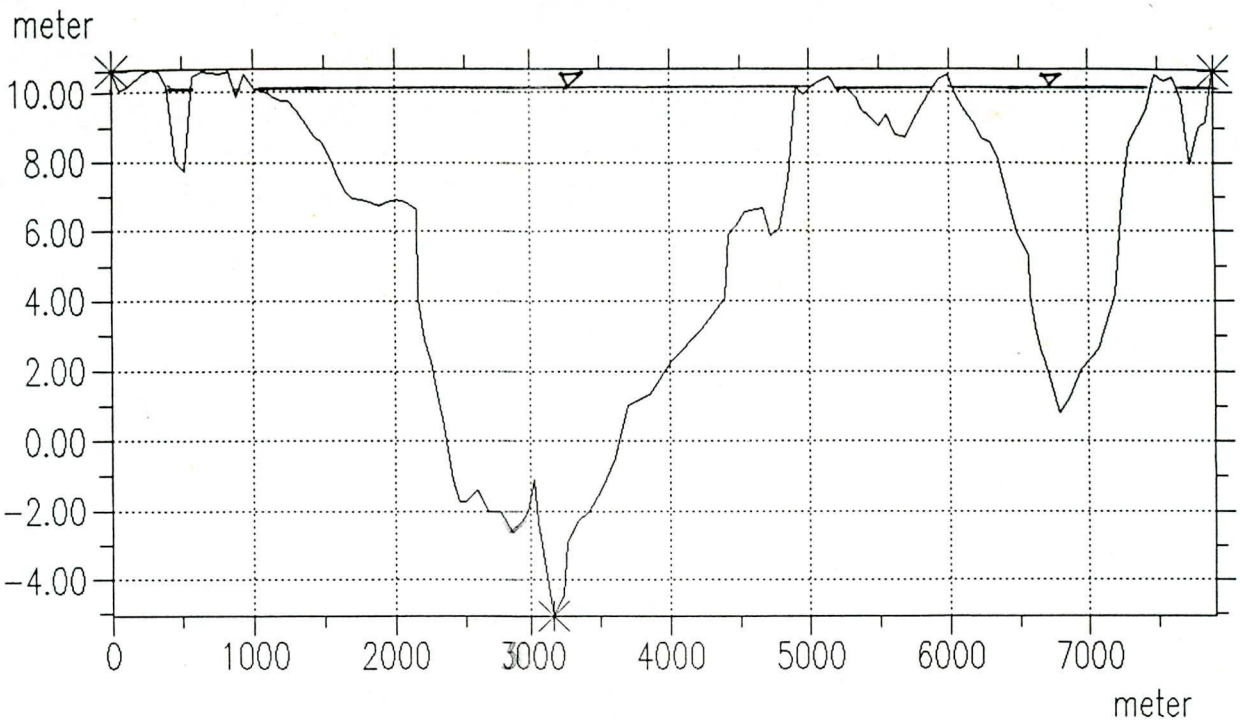


Figure 5.82.e Cross-section at Chainage 201·300 Km, J-4, 1981-82

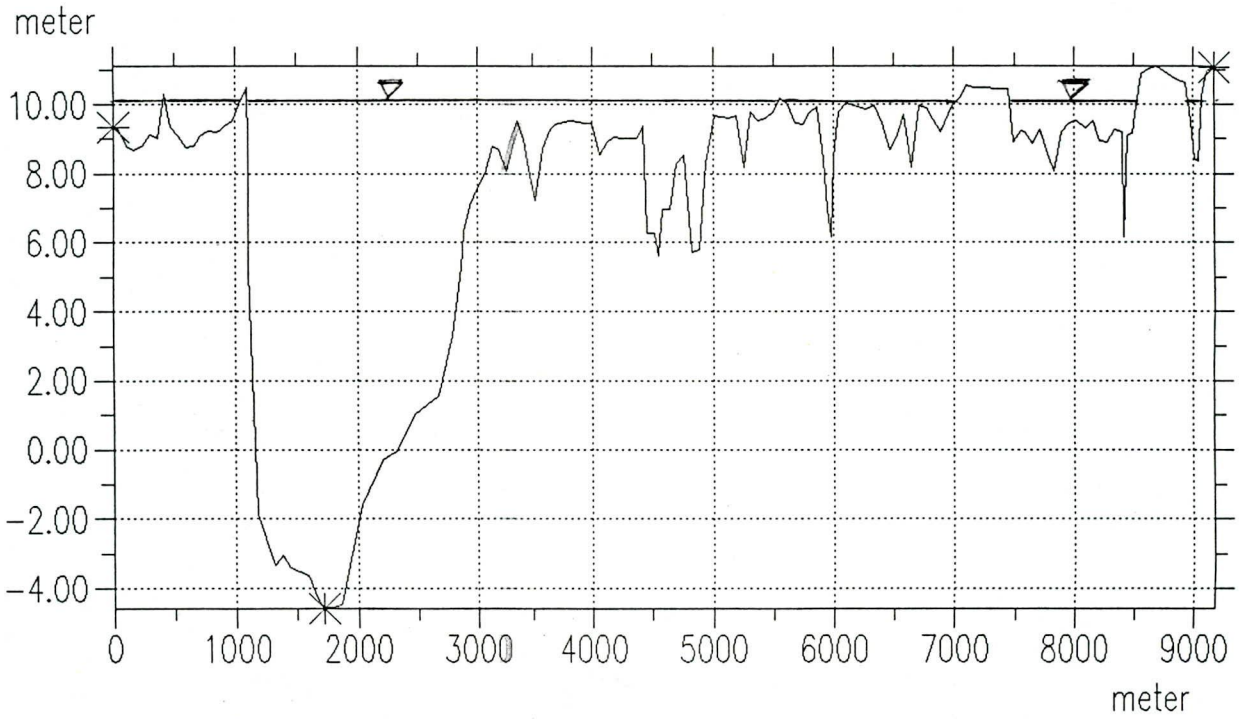


Figure 5.82.f Cross-section at Chainage 201·300 Km, J-4, 1986-87

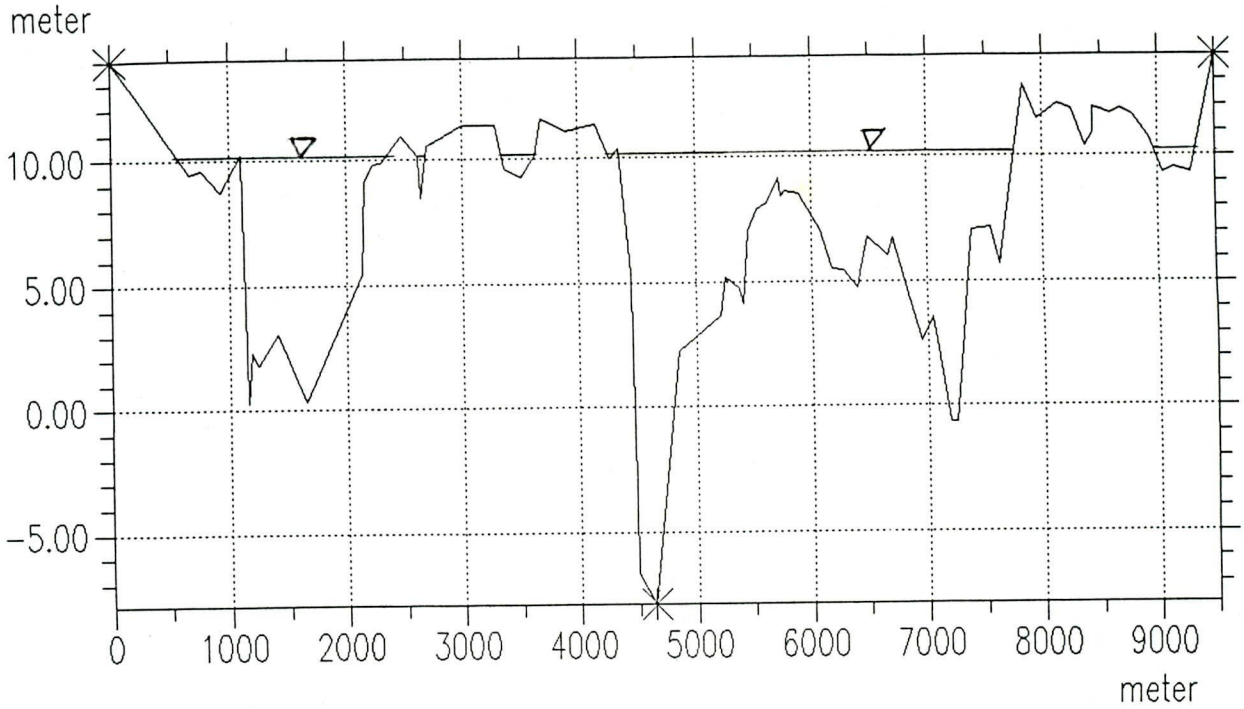


Figure 5.82.g Cross-section at Chainage 201·300Km, J-4, 1988-89

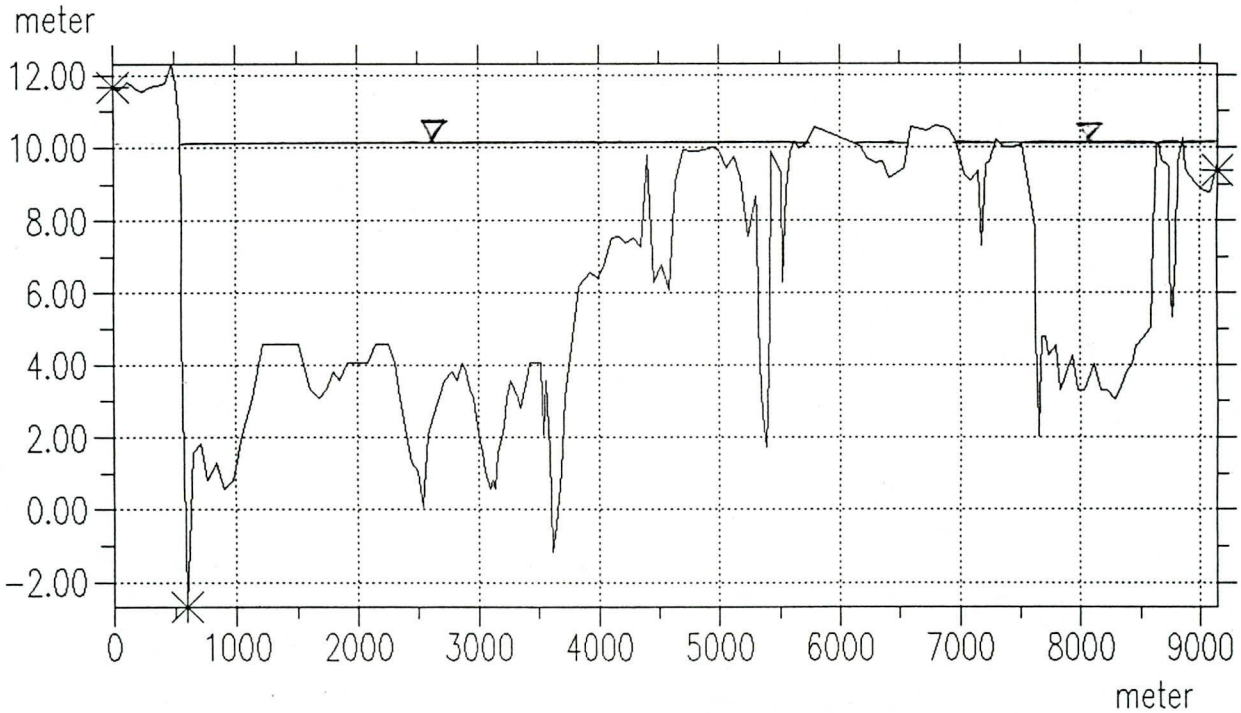


Figure 5.82.h Cross-section at Chainage 201·300Km, J-4, 1990-91

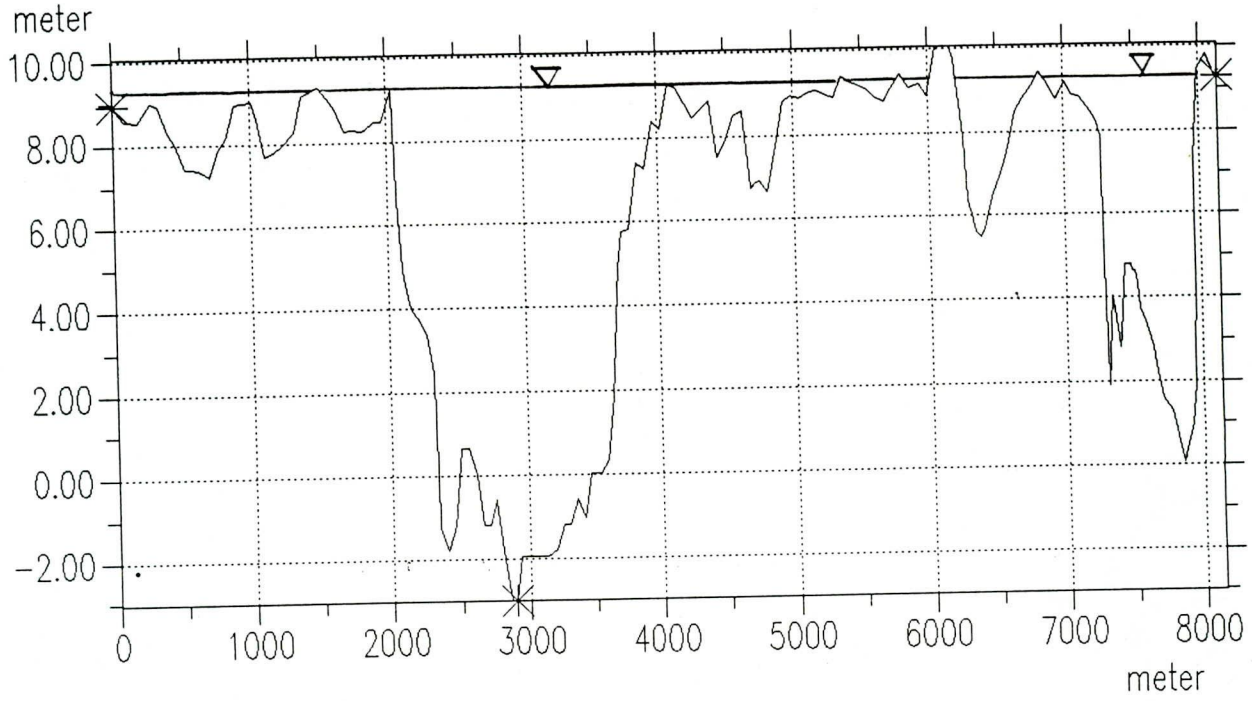


Figure 5.83.a Cross-section at Chainage 213·200 Km. J-3. 1969-70

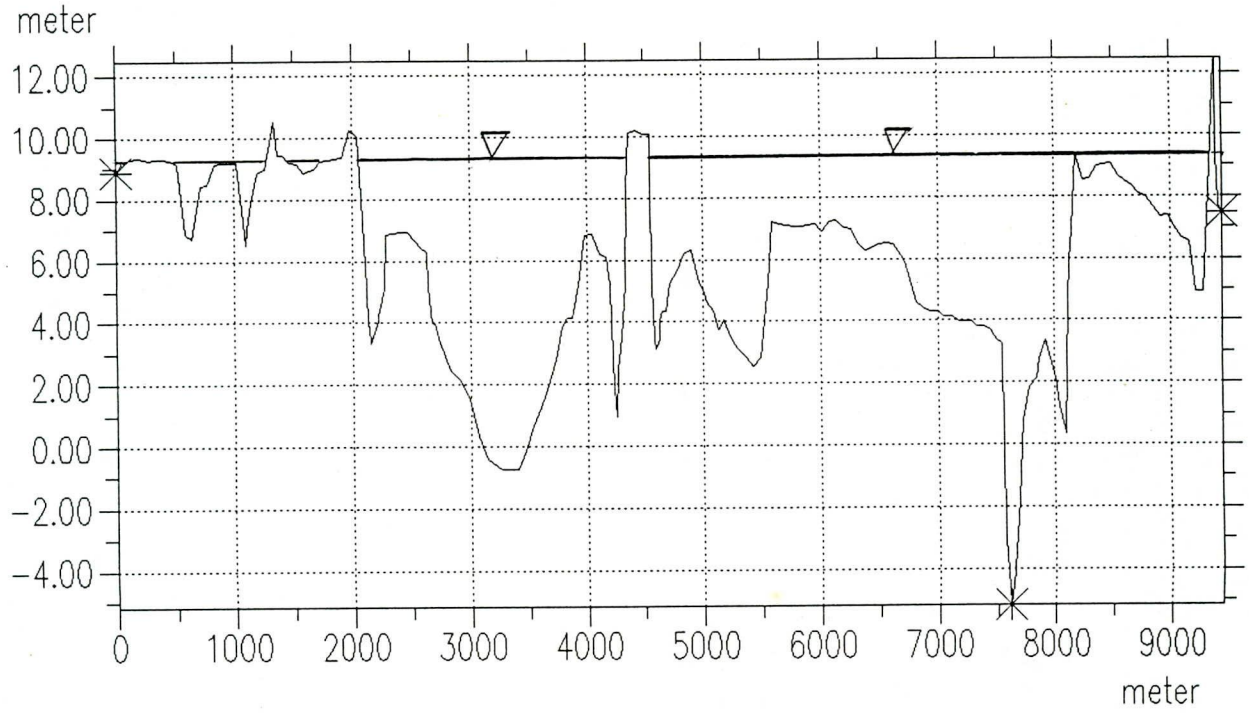


Figure 5.83.b Cross-section at Chainage 213·200 Km, J-3, 1976-77

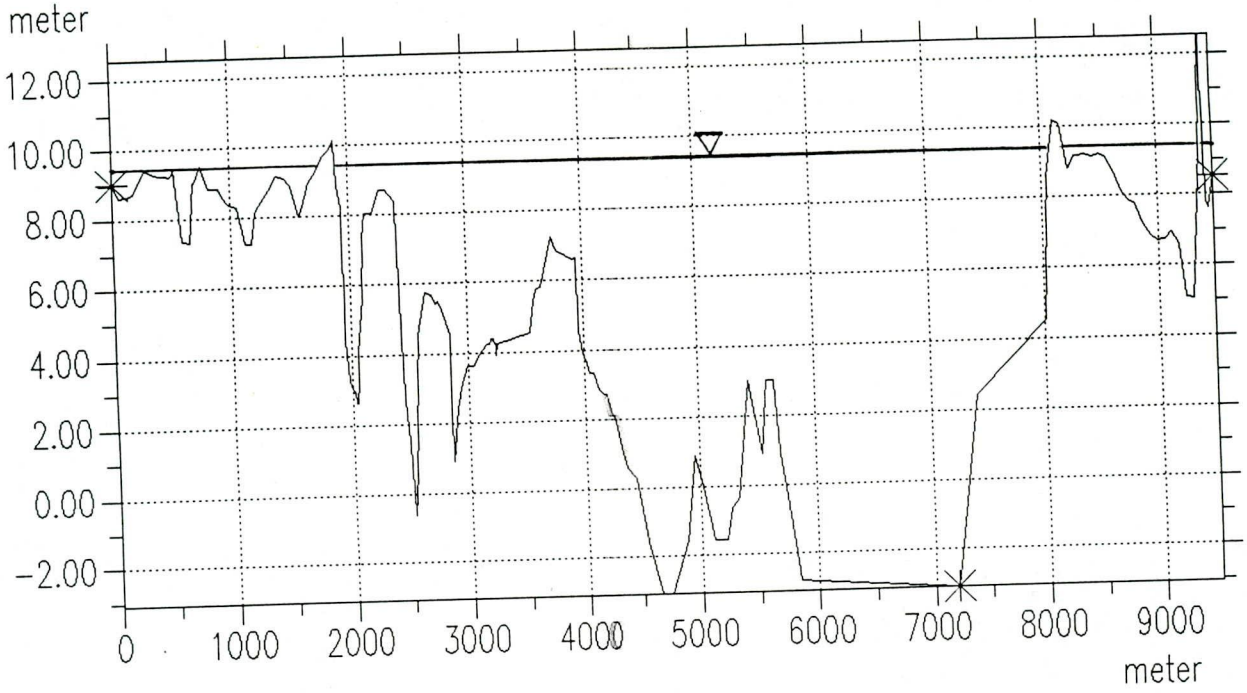


Figure 5.83.C Cross-section at Chainage 213·200 Km. J-3· 1977-78

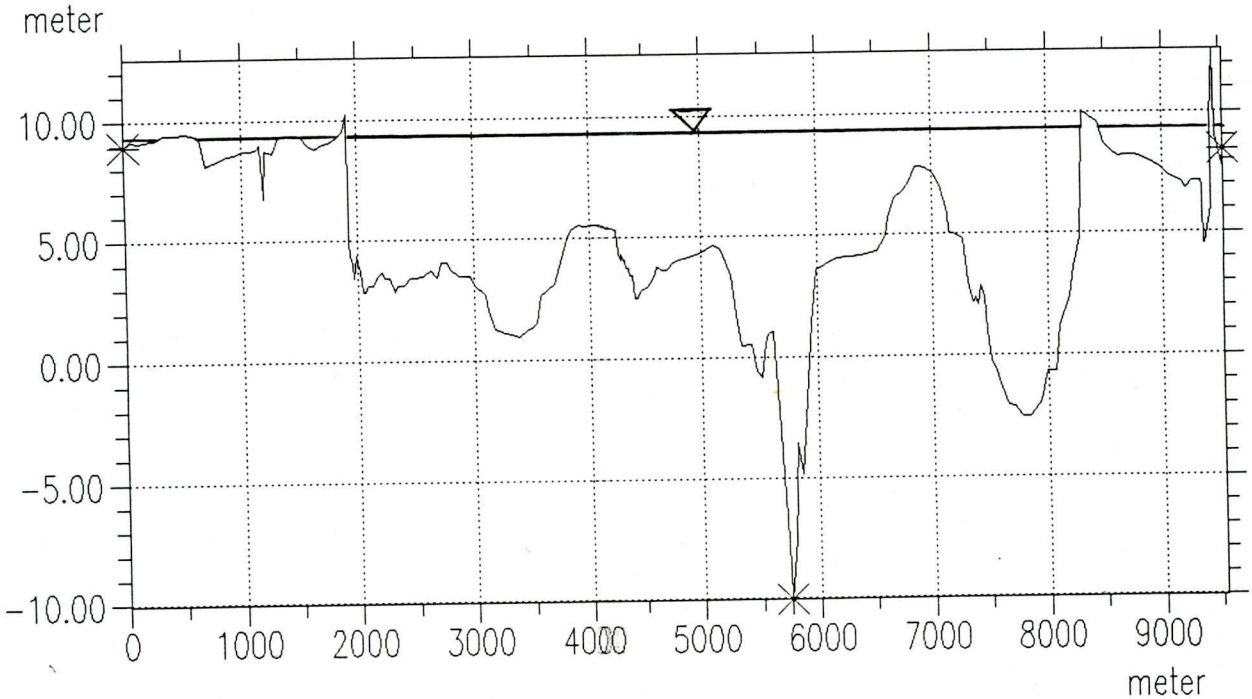


Figure 5.83.d Cross-section at Chainage 213·200 Km, J-3, 1978-79

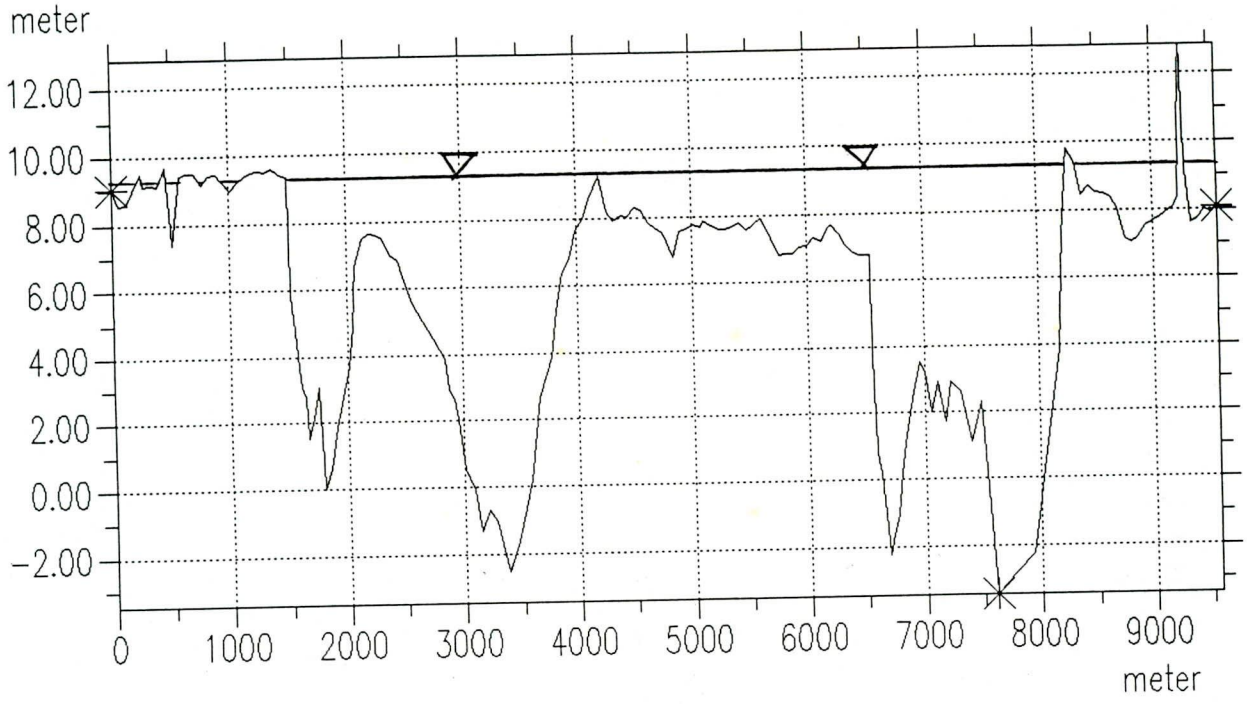


Figure 5.83.e Cross-section at Chainage 213.200 Km. J-3. 1981-82

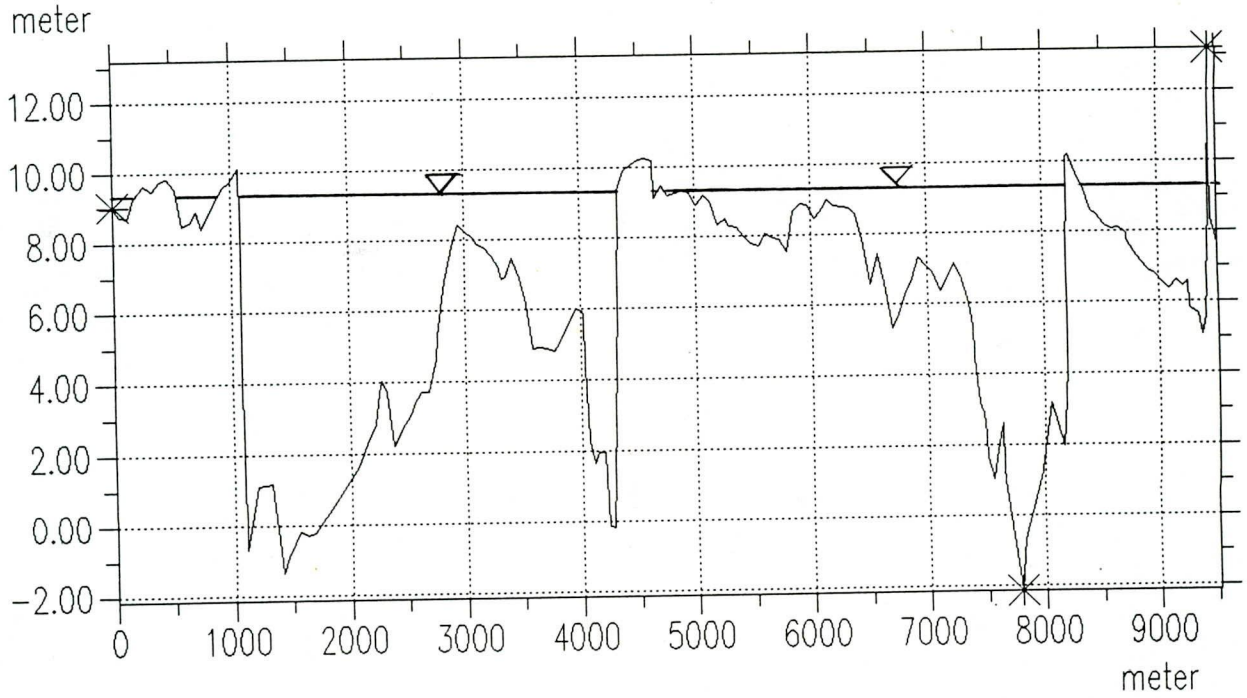


Figure 5.83.f Cross-section at Chainage 213.200Km, J-3, 1986-87

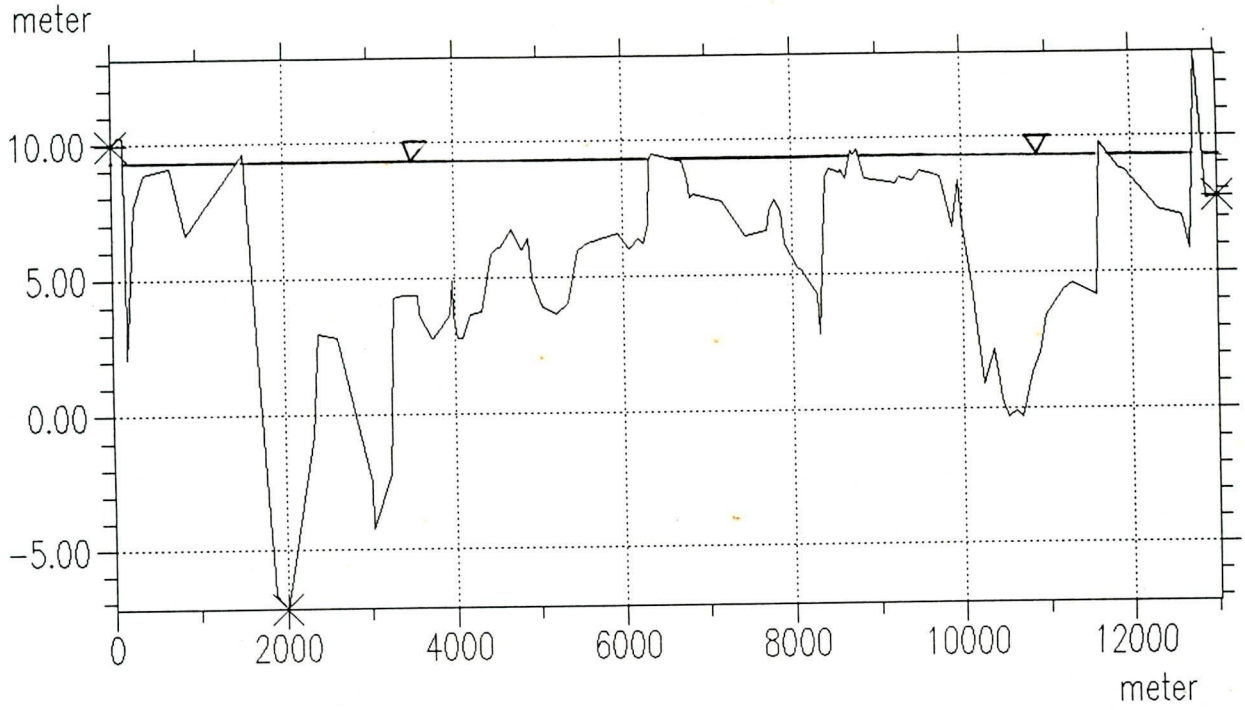


Figure 5.83.g Cross-section at Chainage 213·200 Km, J-3, 1988-89

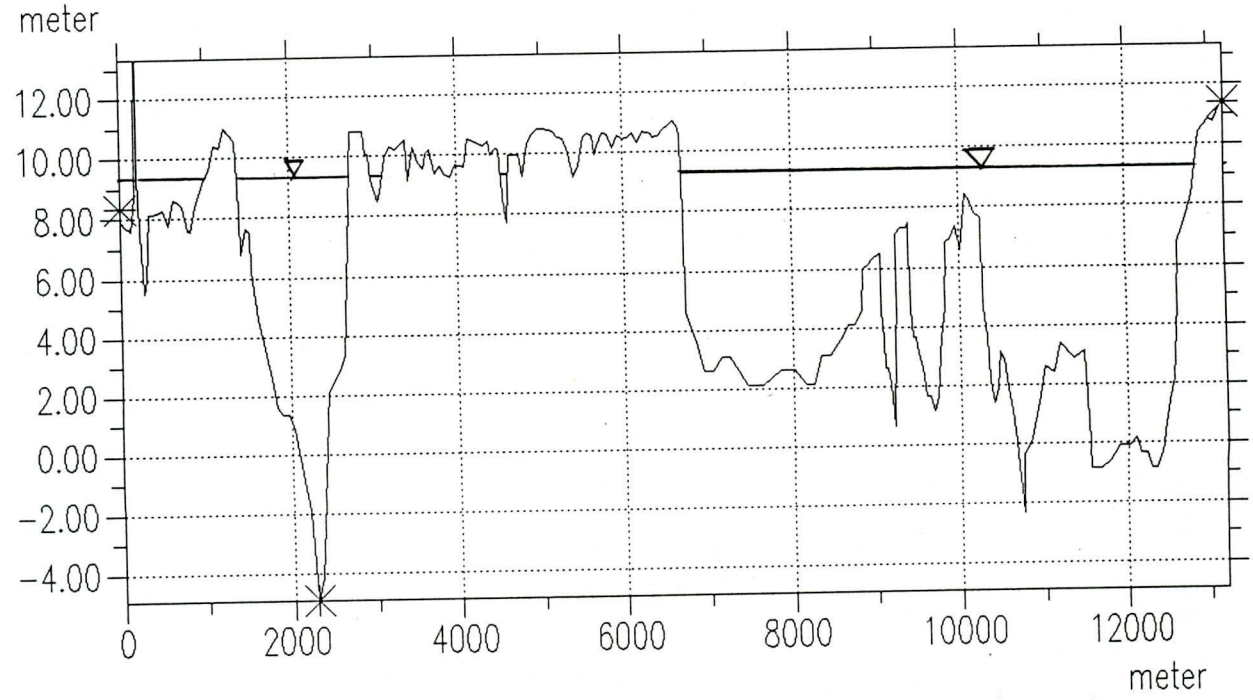


Figure 5.83.h Cross-section at Chainage 213·200Km , J-3 , 1990-91

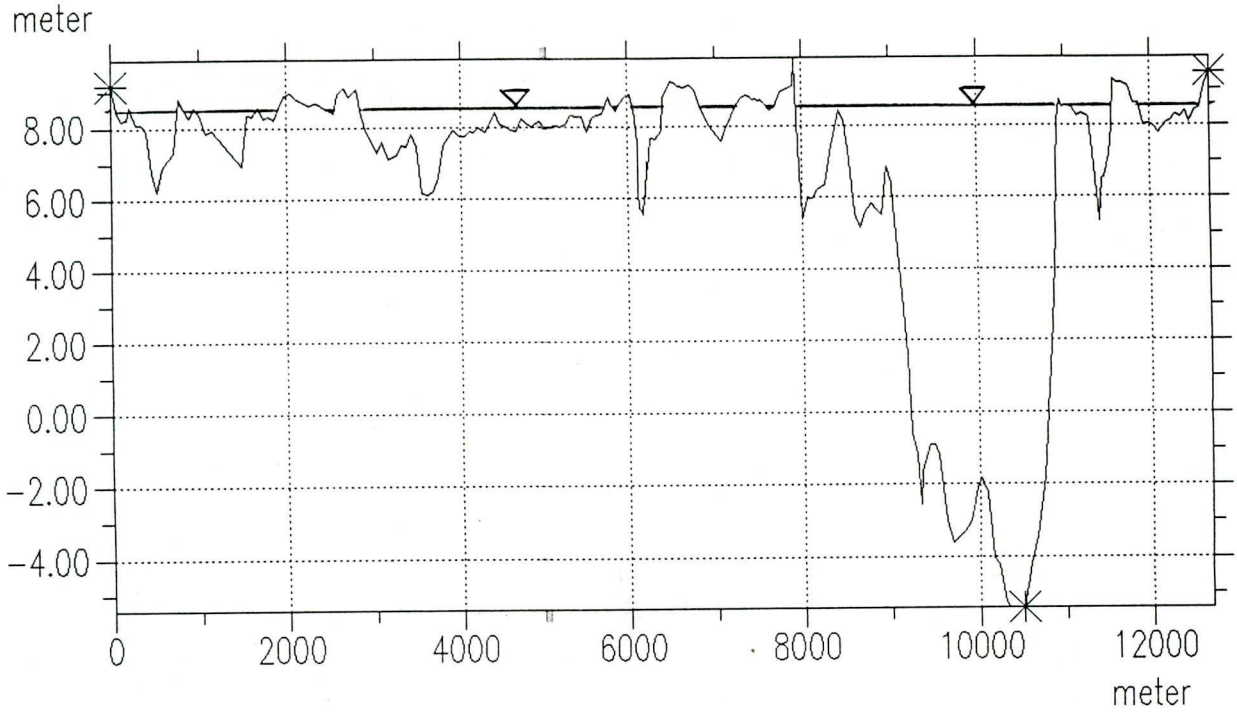


Figure 5.84.a Cross-section at Chainage 223·200 Km. J-2. 1969-70

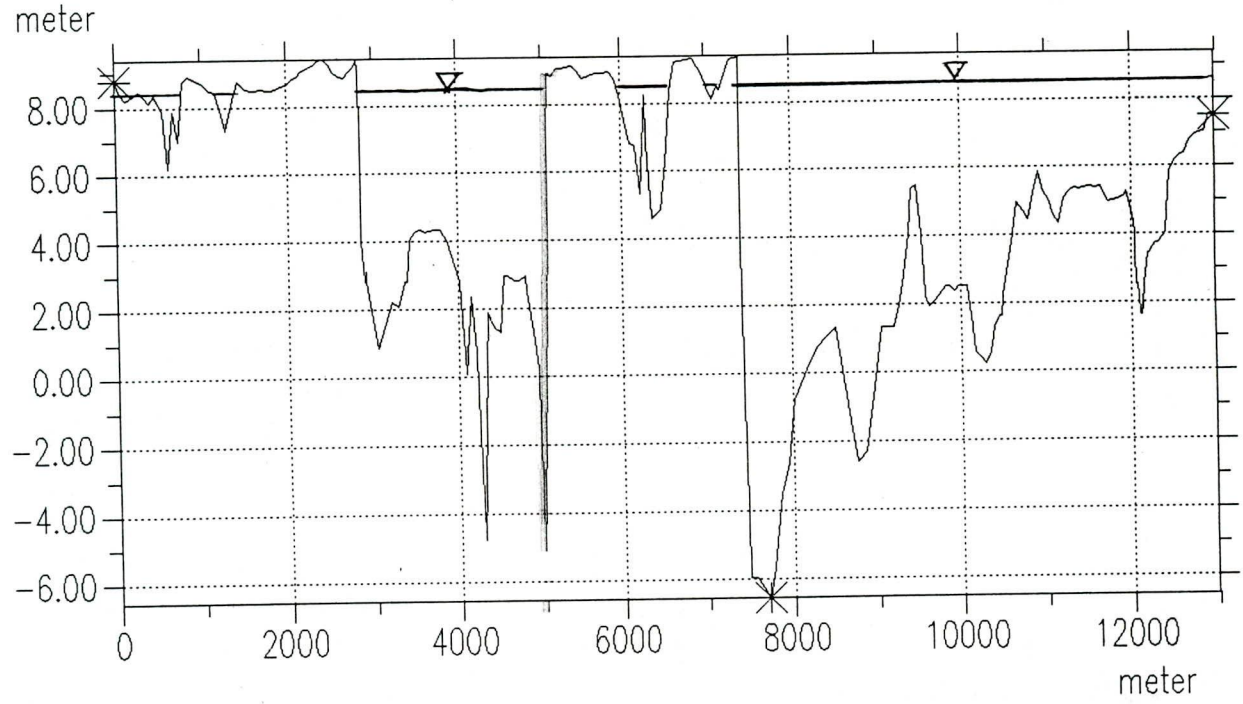


Figure 5.84.b Cross-section at Chainage 223·200 Km. J-2. 1976-77

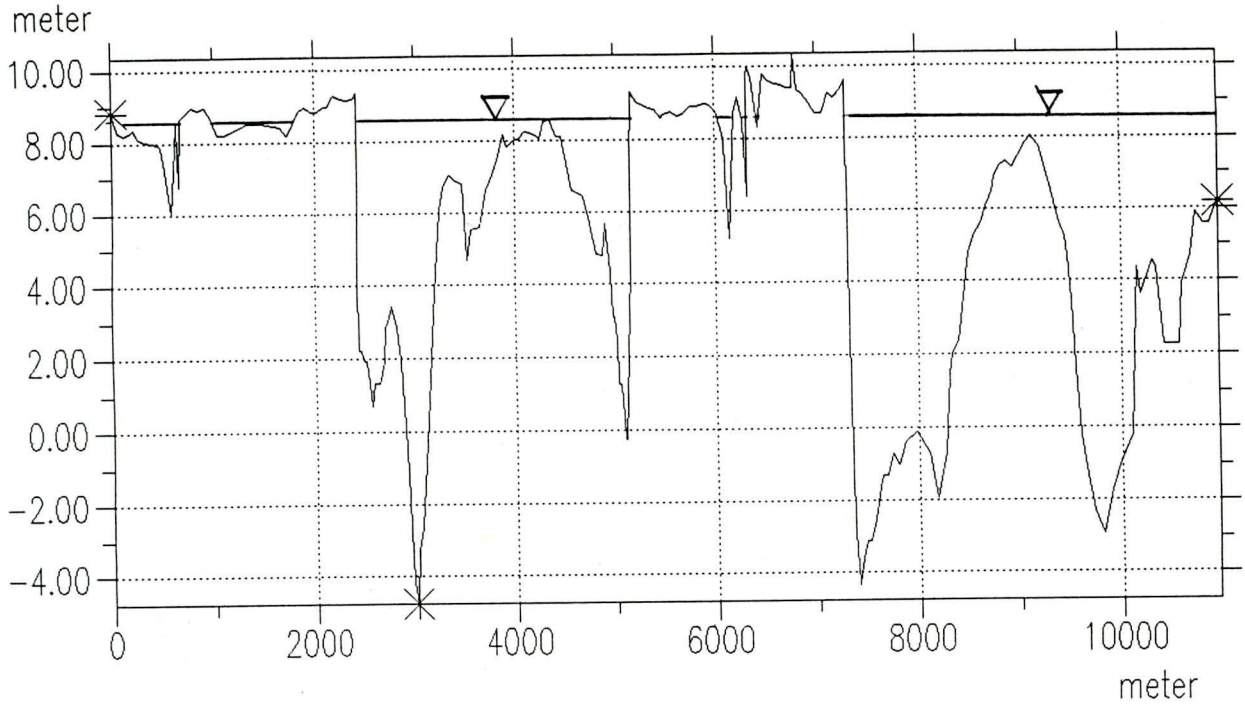


Figure 5.84.c Cross-section at Chainage 223.200 Km. J-2. 1977-78

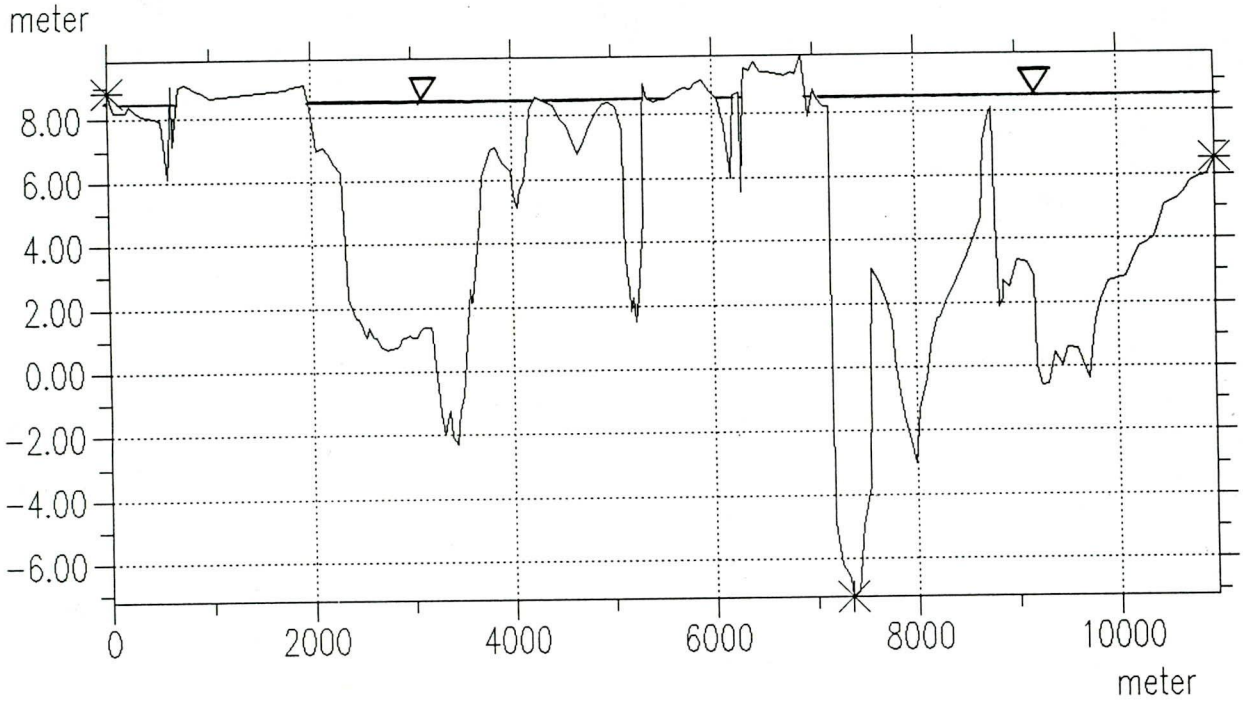


Figure 5.84.d Cross-section at Chainage 223.200 Km. J-2. 1978-79

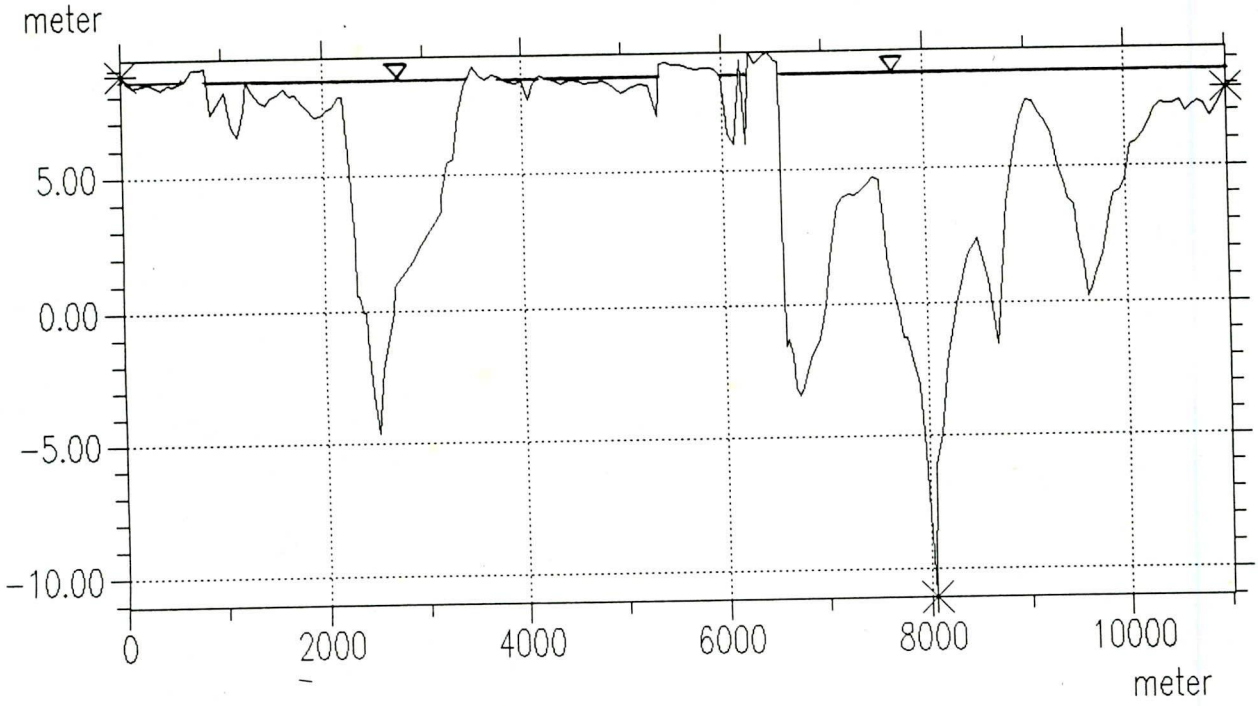


Figure 5.84.e Cross-section at Chainage 223.200 Km. J-2. 1981-82

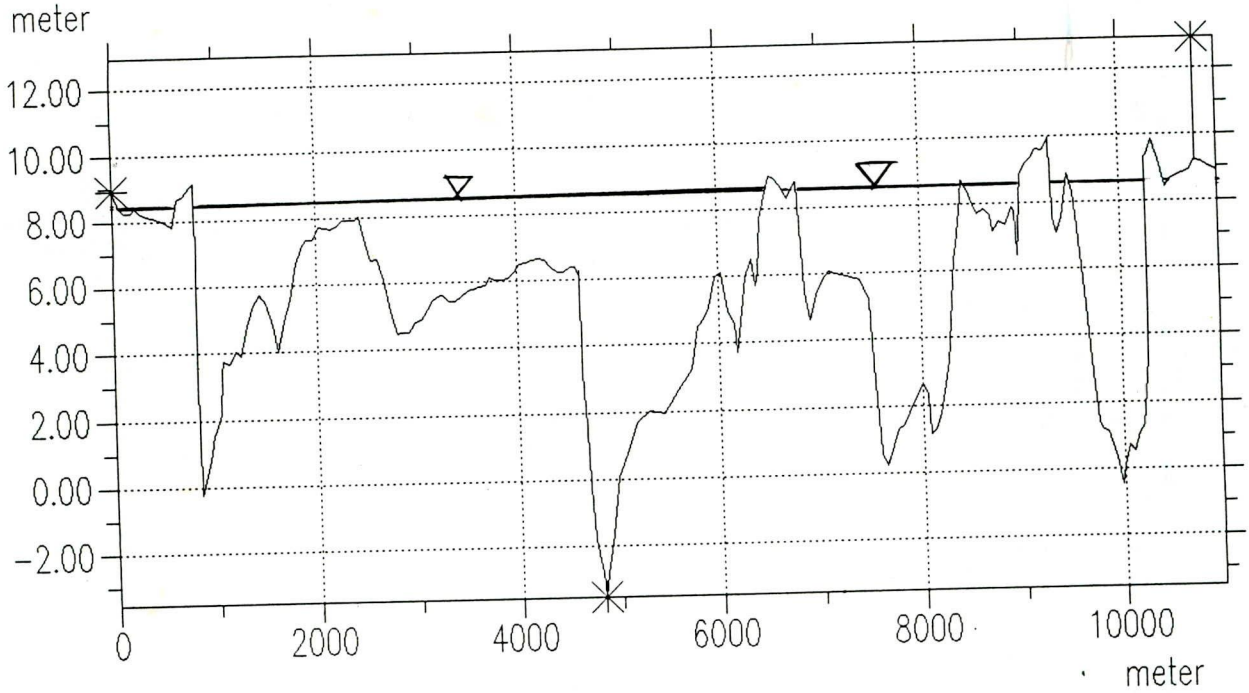


Figure 5.84.f Cross-section at Chainage 223.200 Km, J-2, 1986-87

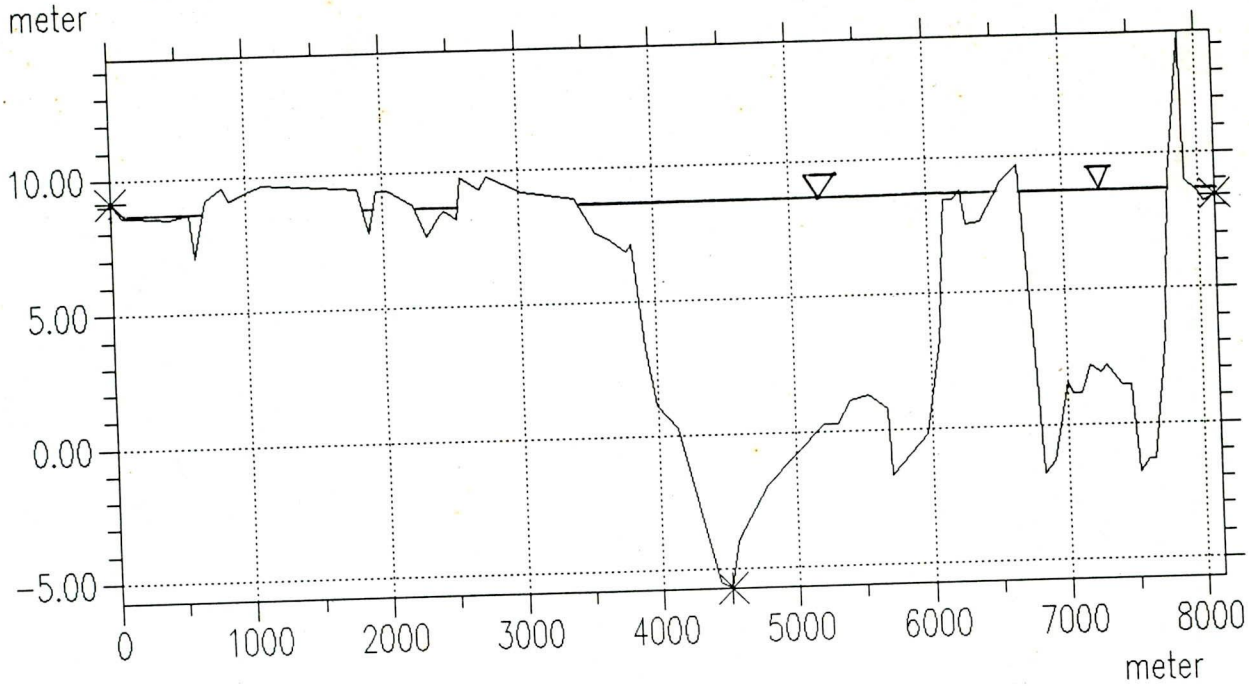


Figure 5.84.g · Cross-section at Chainage 223.200Km , J-2 , 1988-89

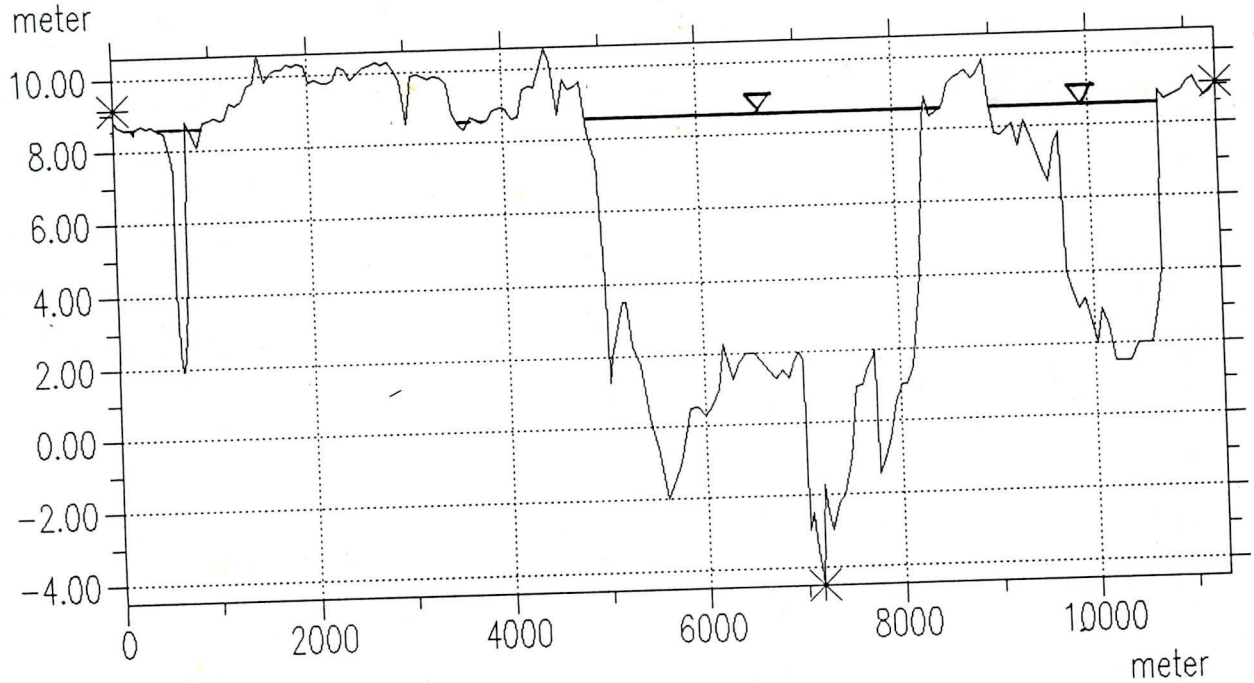


Figure 5.84.h Cross-section at Chainage 223.200Km, J-2 , 1990-91

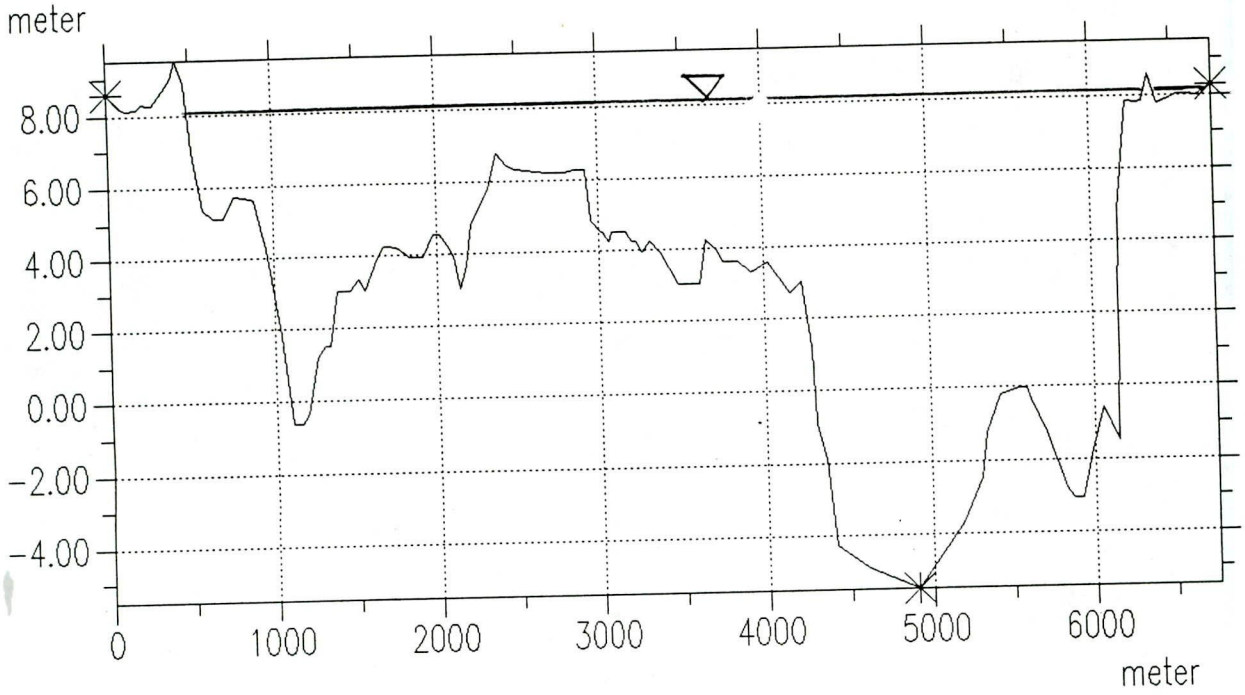


Figure 5.85.a Cross-section at Chainage 230·750 Km, J-1, 1969-70

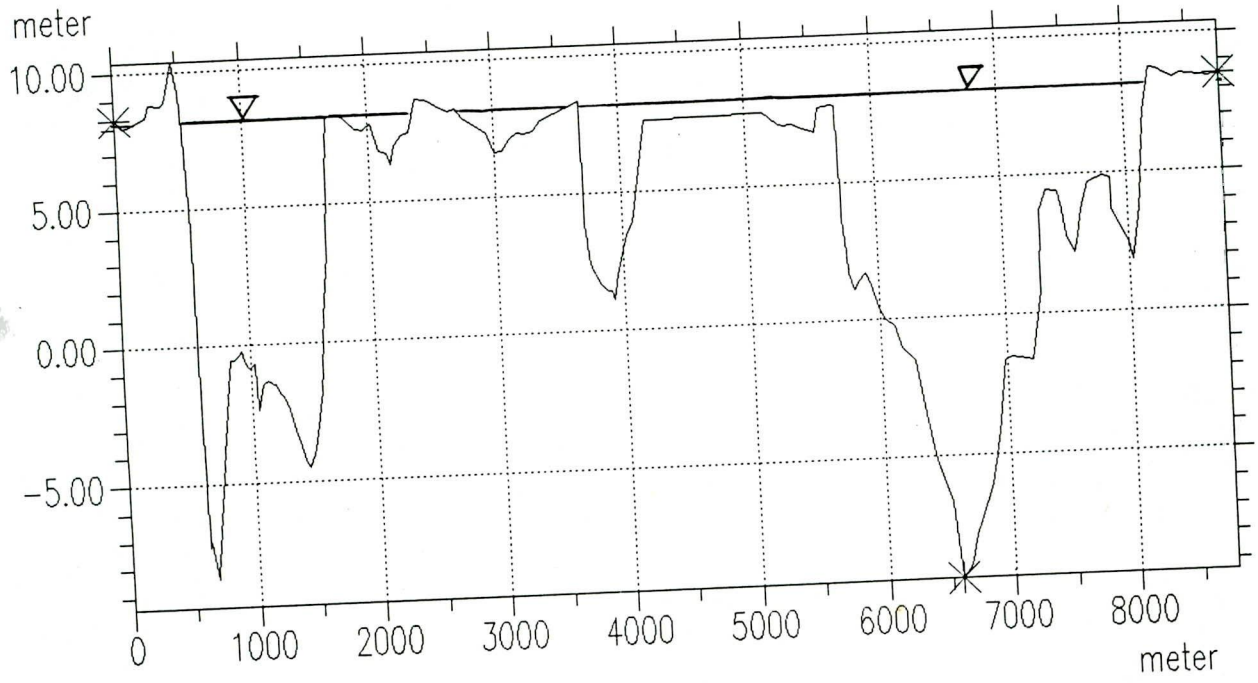


Figure 5.85.b Cross-section at Chainage 230·750 Km. J-1.1976-77

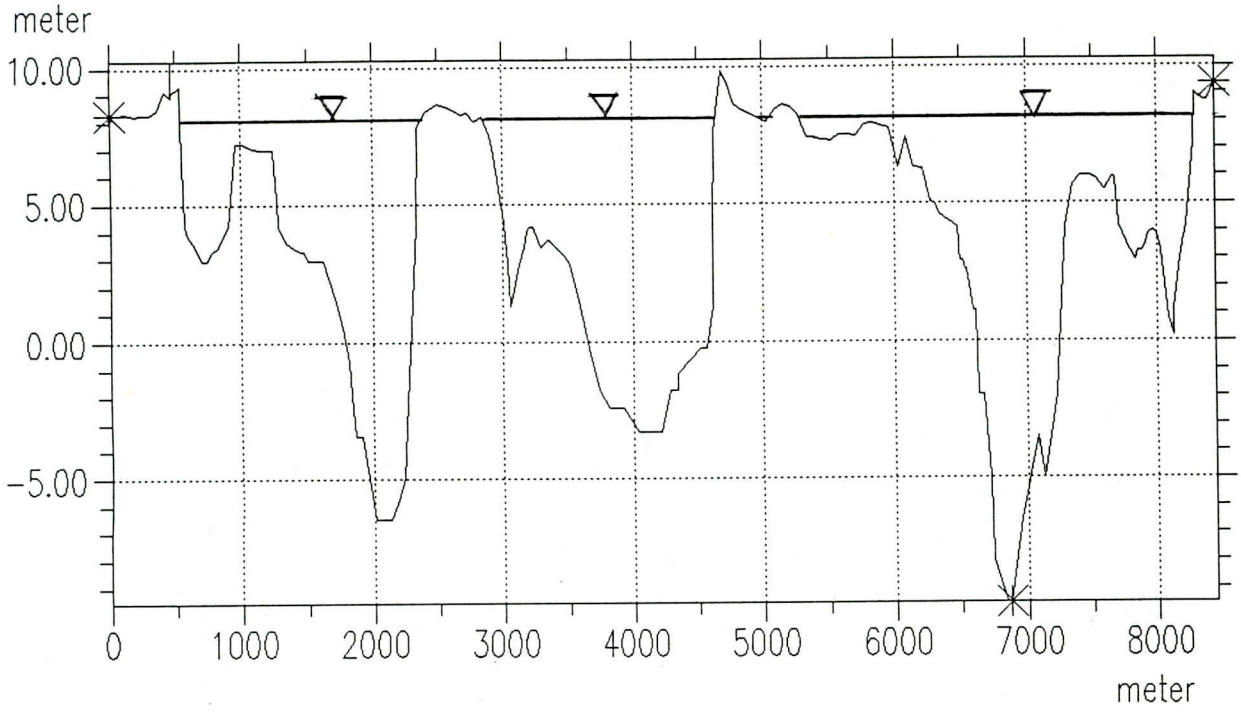


Figure 5.85.c Cross-section at Chainage 230·750 Km, J-1, 1977-78

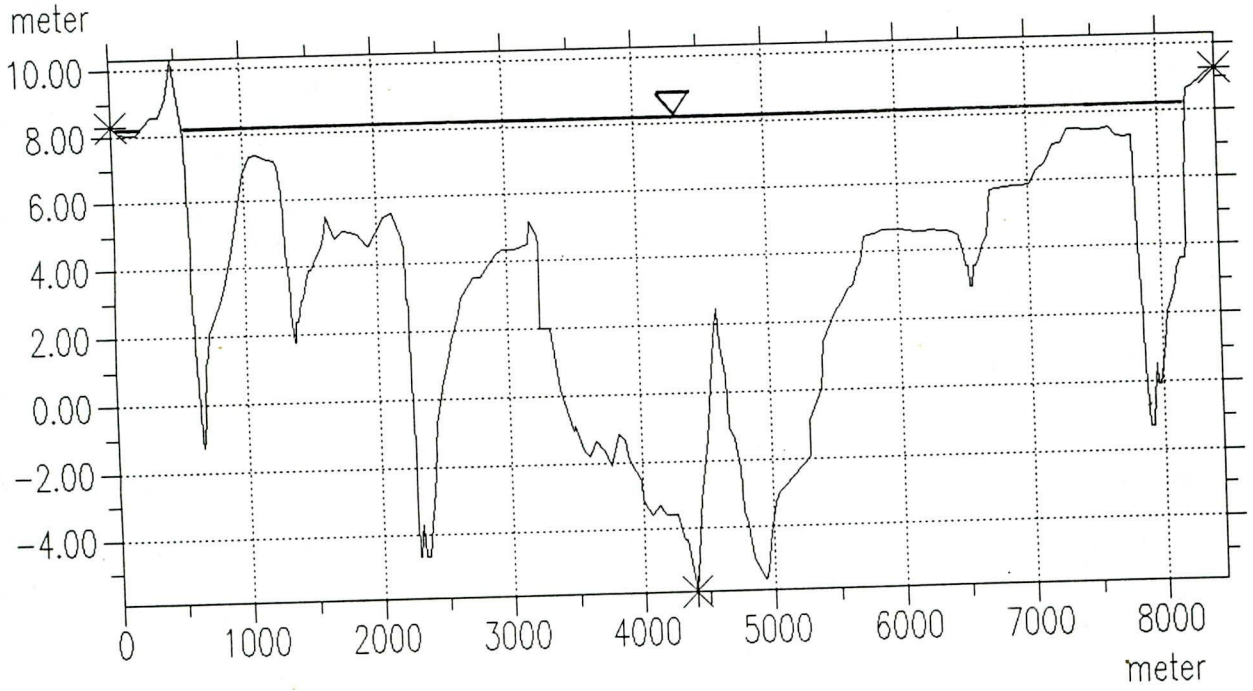


Figure 5.85.d Cross-section at Chainage 230·750 Km. J-1. 1978-79

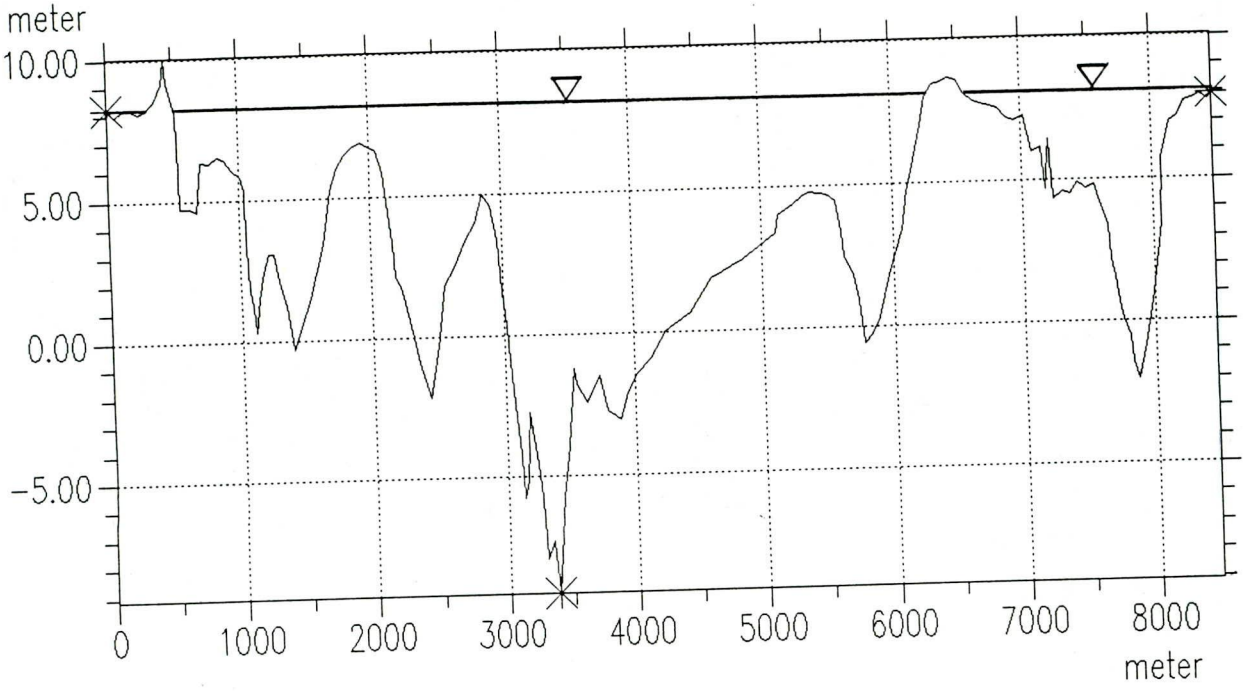


Figure 5.85.e Cross-section at Chainage 230·750Km, J-1, 1981-82

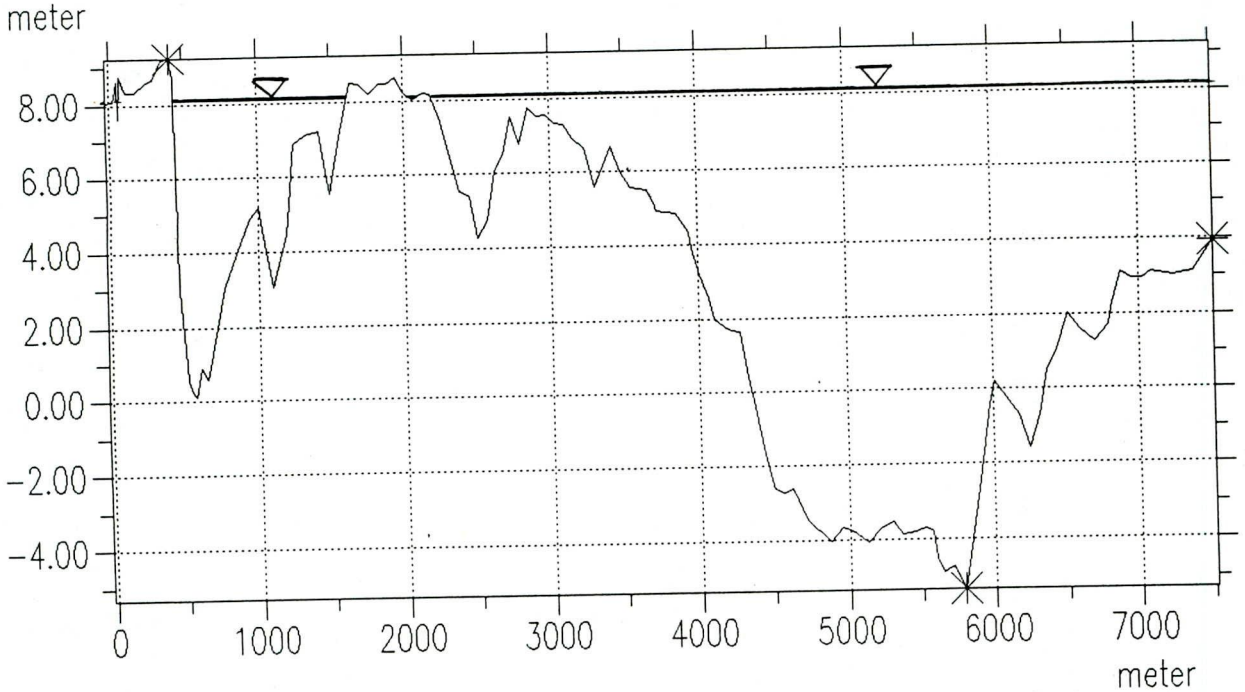


Figure 5.85.f Cross-section at Chainage 230·75Km, J-1, 1986-87

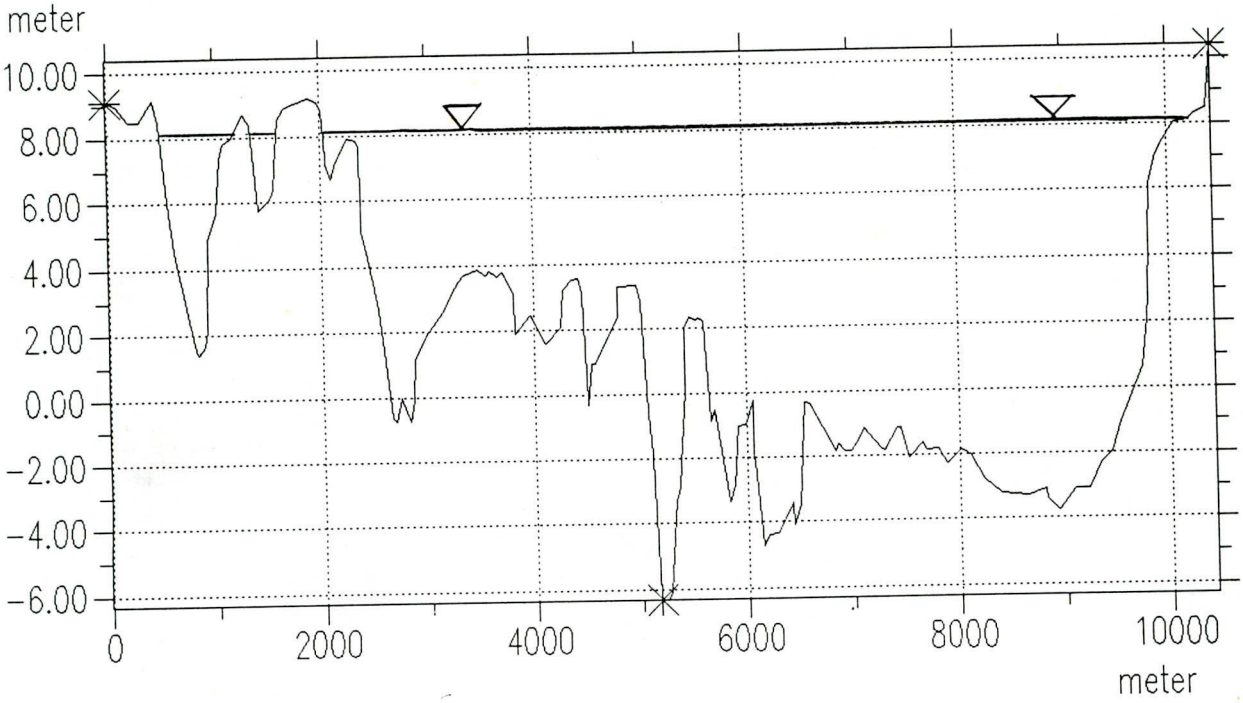


Figure 5.85.g Cross-section at Chainage 230·75 Km, J-1, 1988-89

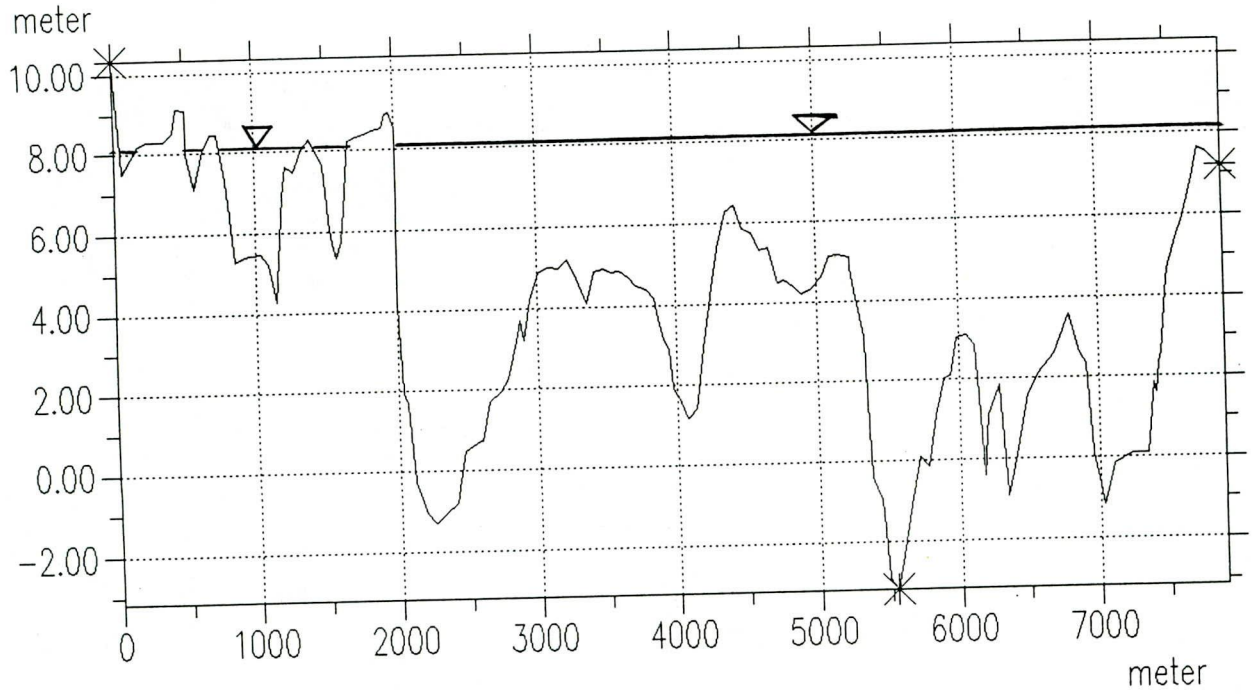


Figure 5.85.h Cross-section at Chainage 230·75 Km, J-1, 1990-91

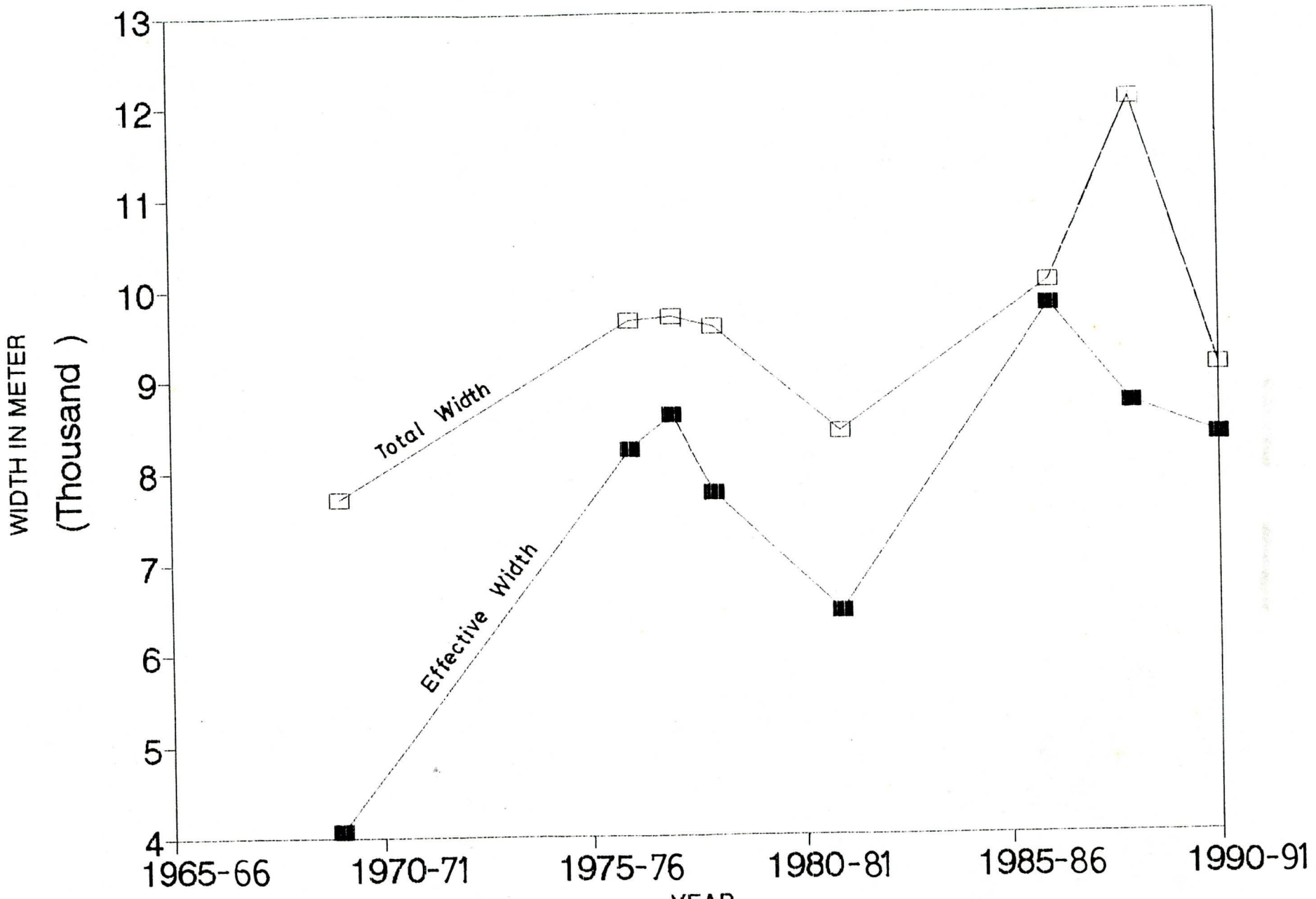


Figure 5.86 Width Vs Year For Section J-17 (Ch, 25·00 Km)

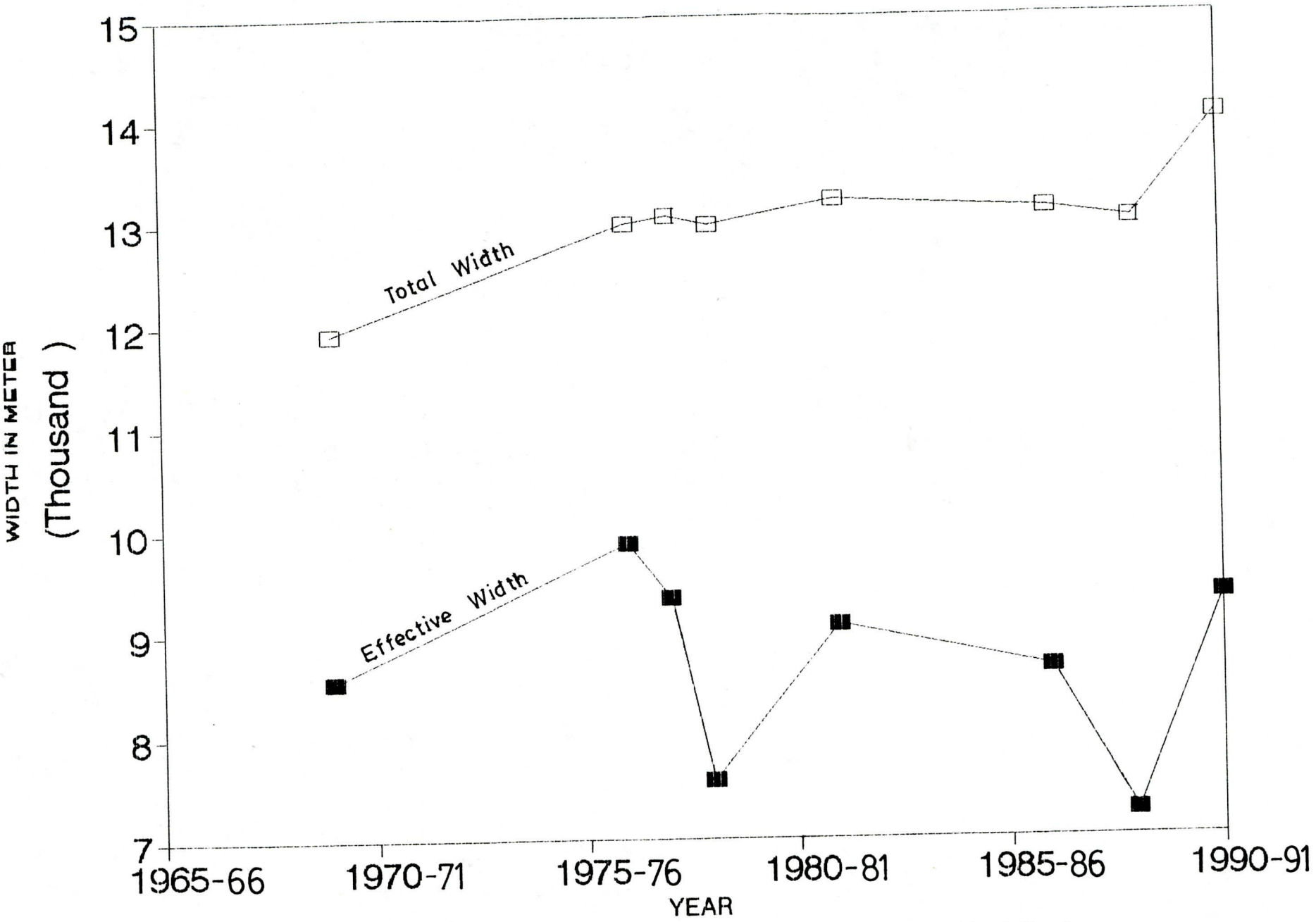


Figure. 5.87 Width Vs Year For Section J-16 (Ch. 37.10 Km)

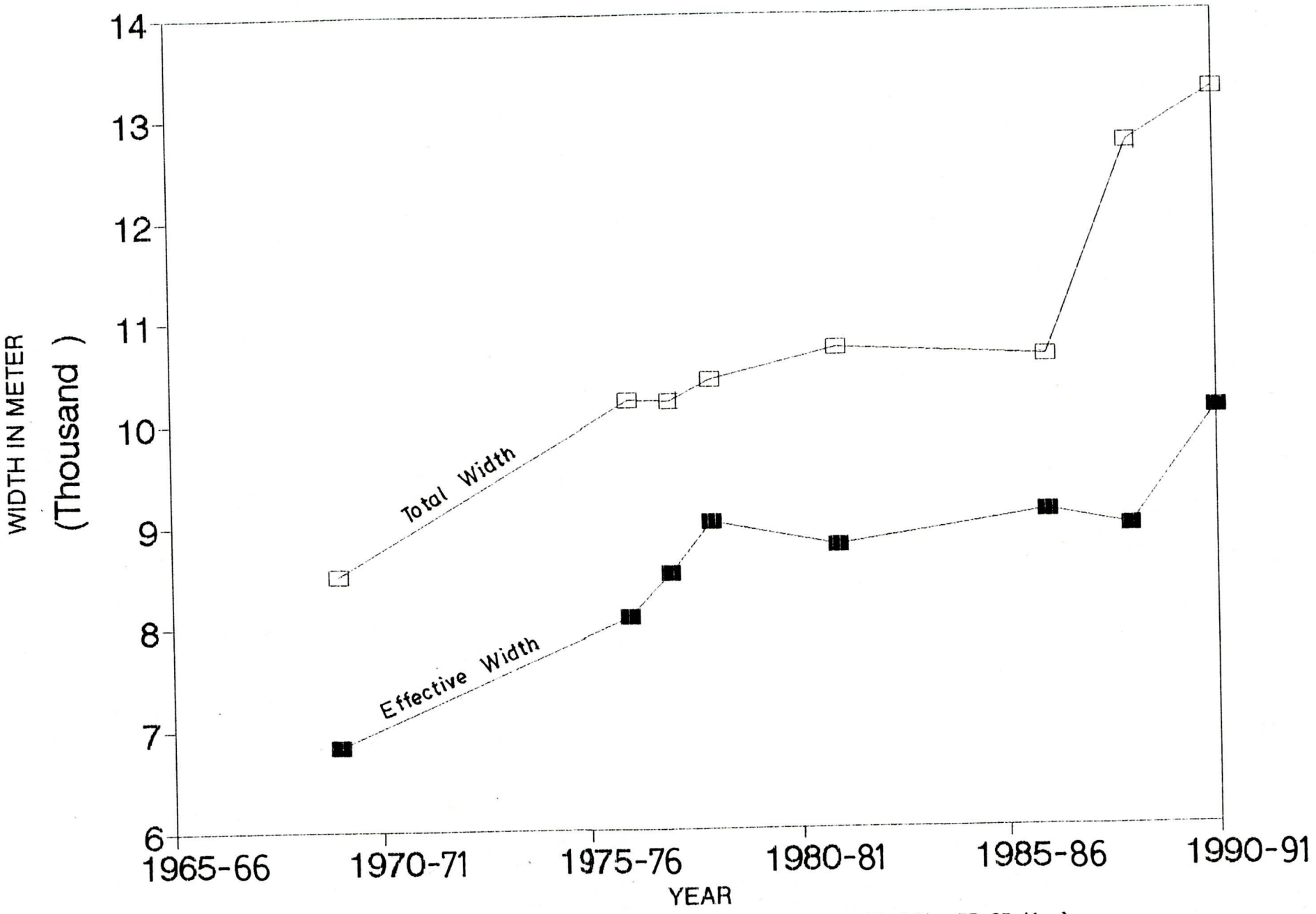


Figure.5.88 Width Vs Year For Section J-15 (Ch. 55-65 Km)

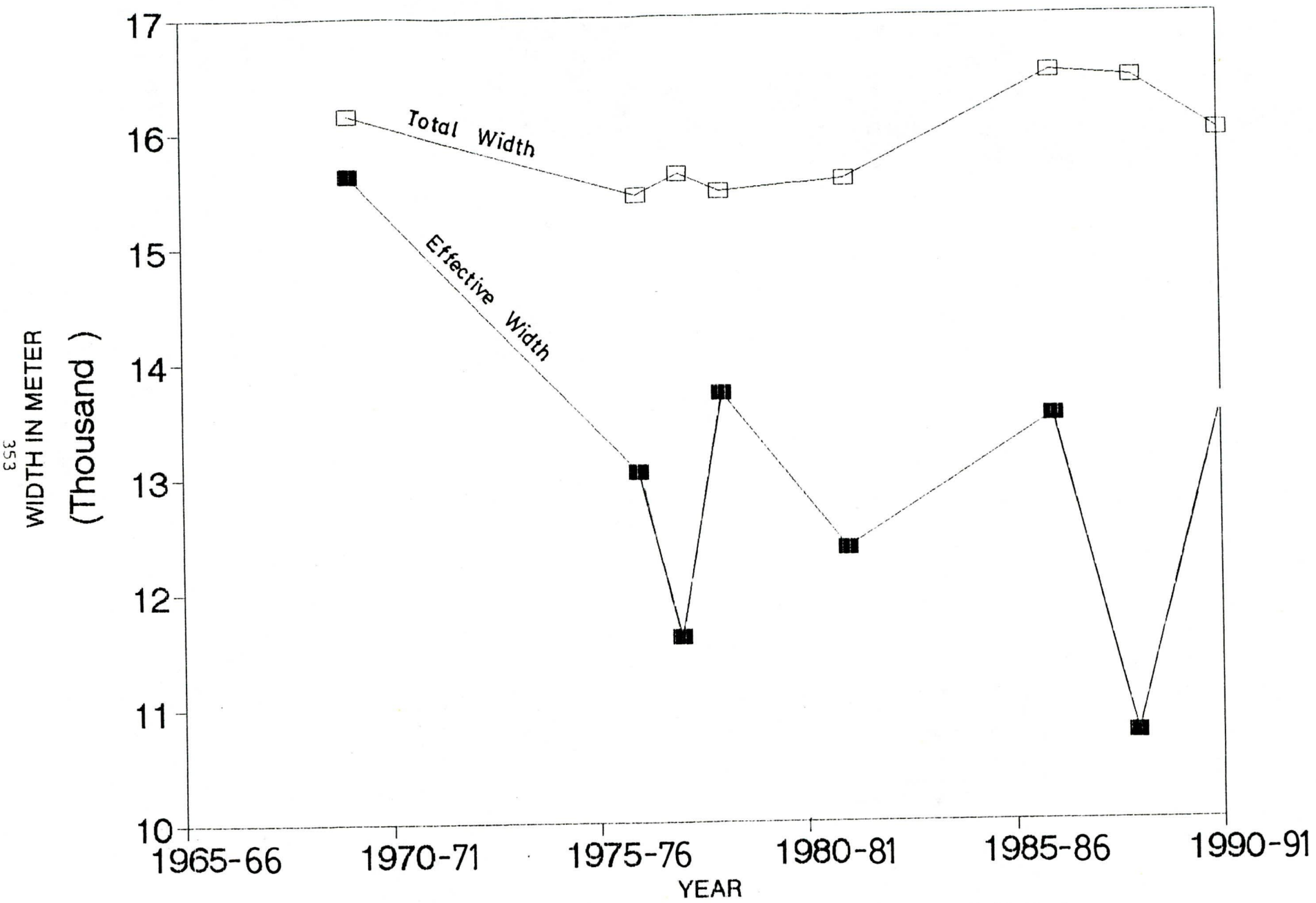


Figure. 5.89 Width Vs Year For Section J-14 (Ch. 71·20 Km)

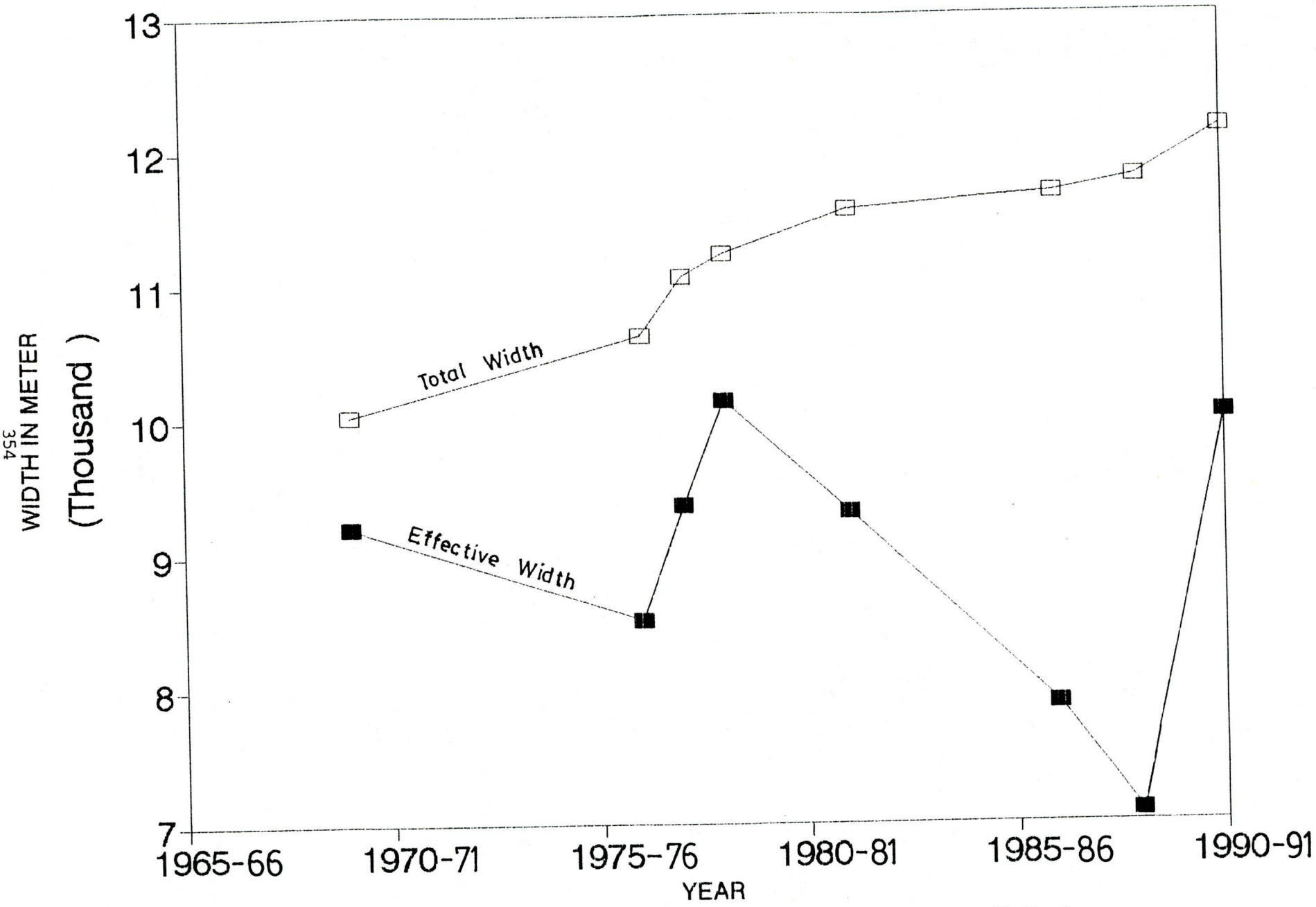


Figure. 5.90 Width Vs Year For Section J-13 (Ch. 84·70 Km)

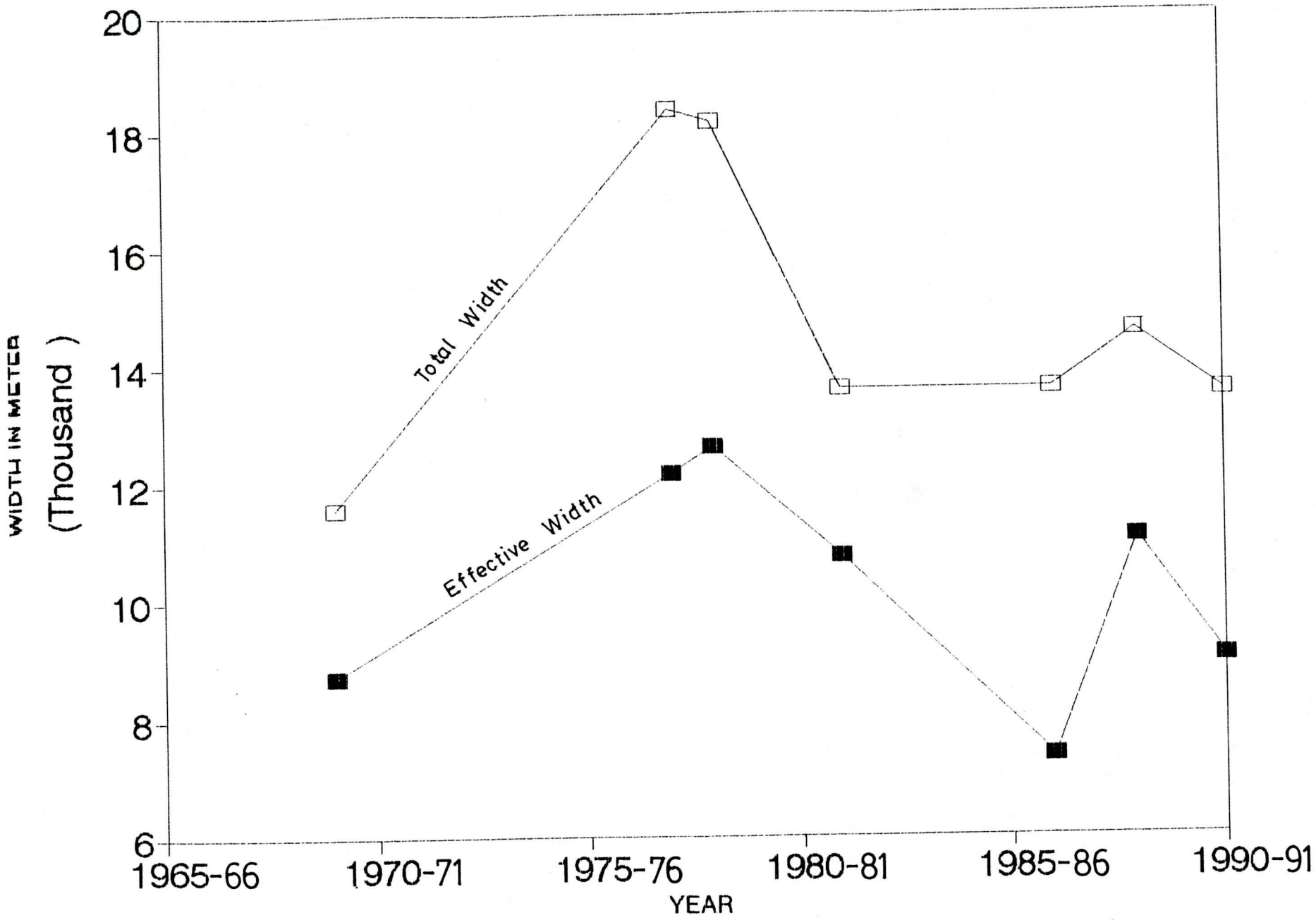


Figure. 5.91 Width Vs Year For Section J-12 (Ch. 100·50 Km)

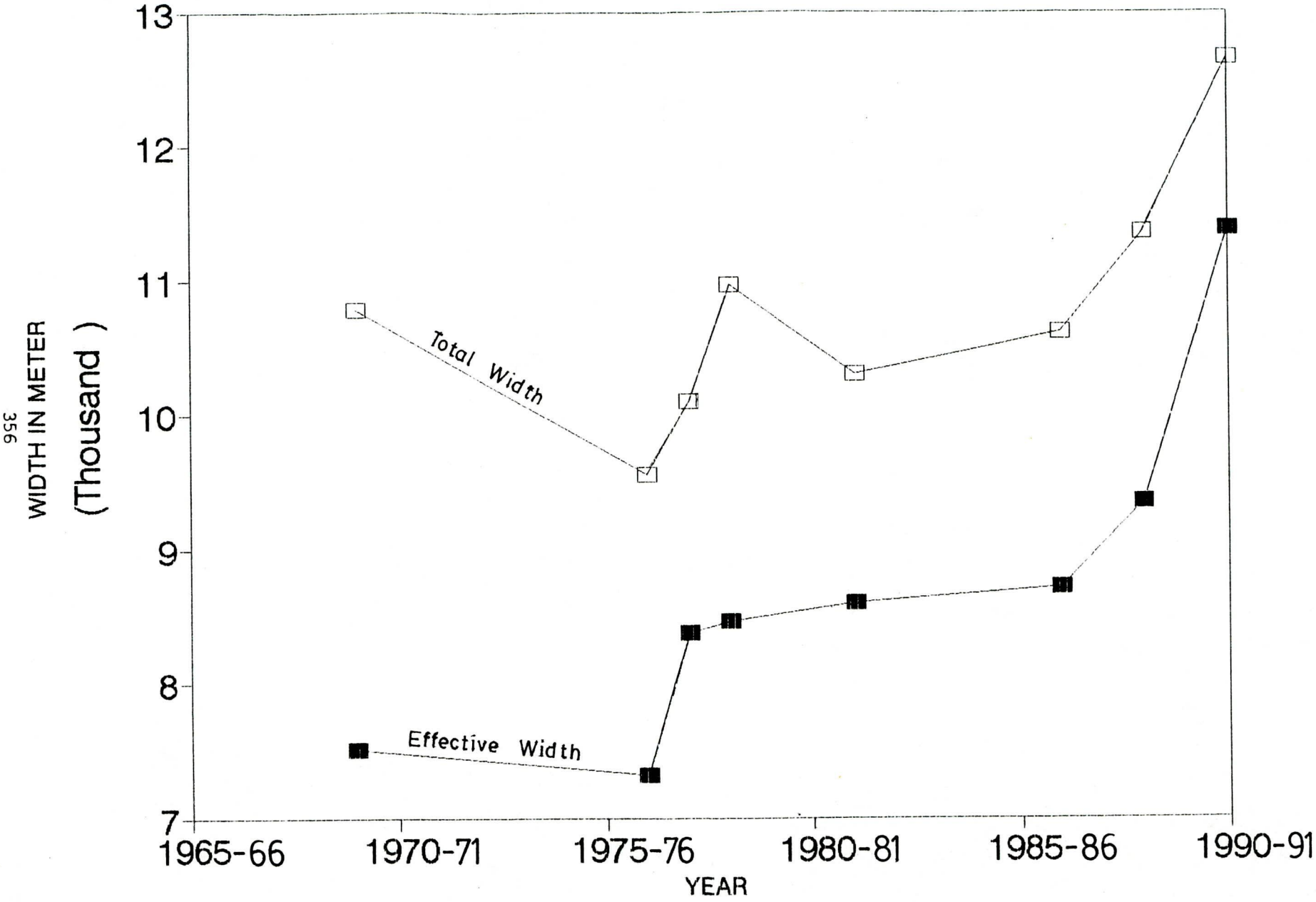


Figure. 5.92 Width Vs Year For Section J-11 (Ch. 117·75 Km)

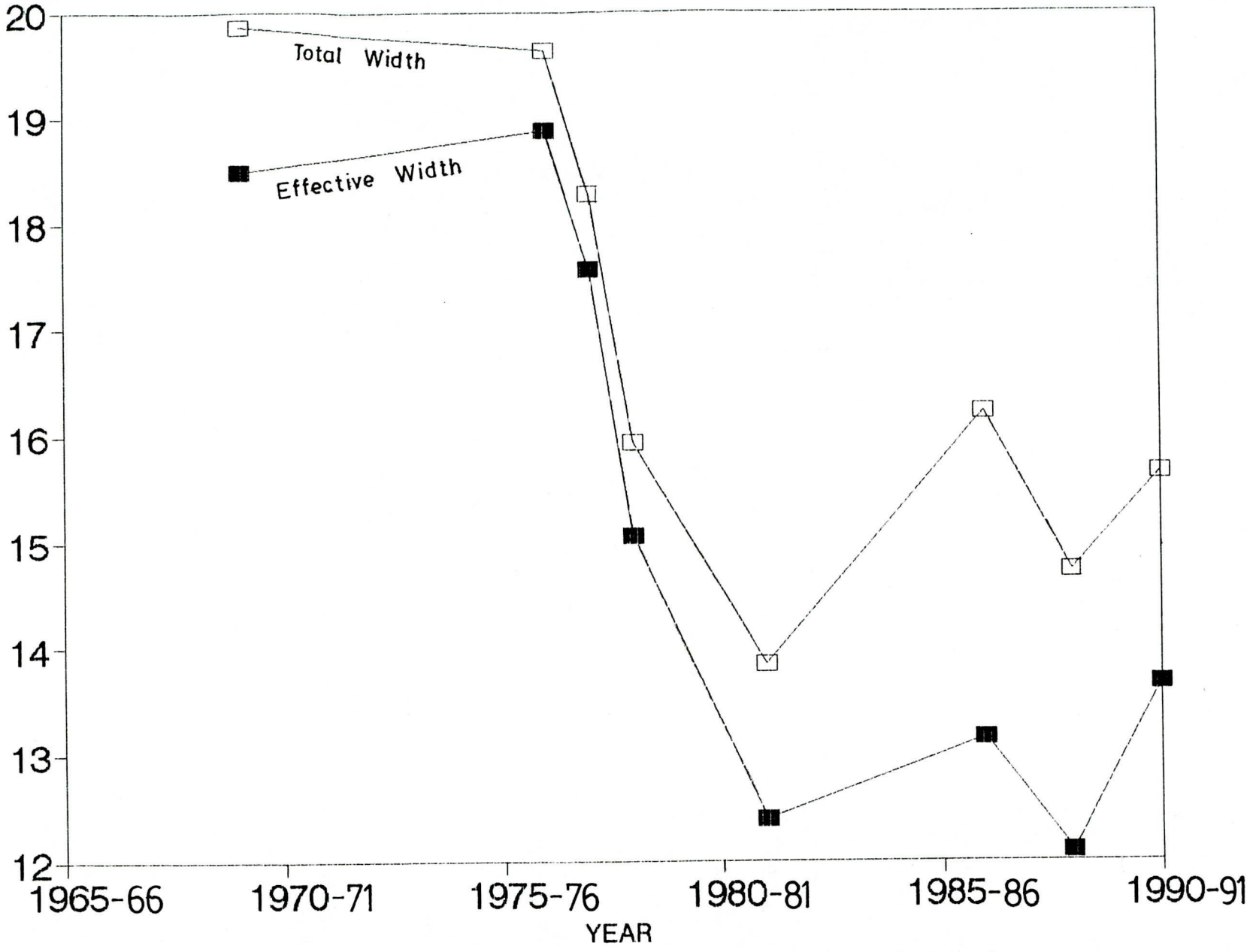


Figure. 5.93 Width Vs Year For Section J-10 (Ch. 134·30 Km)

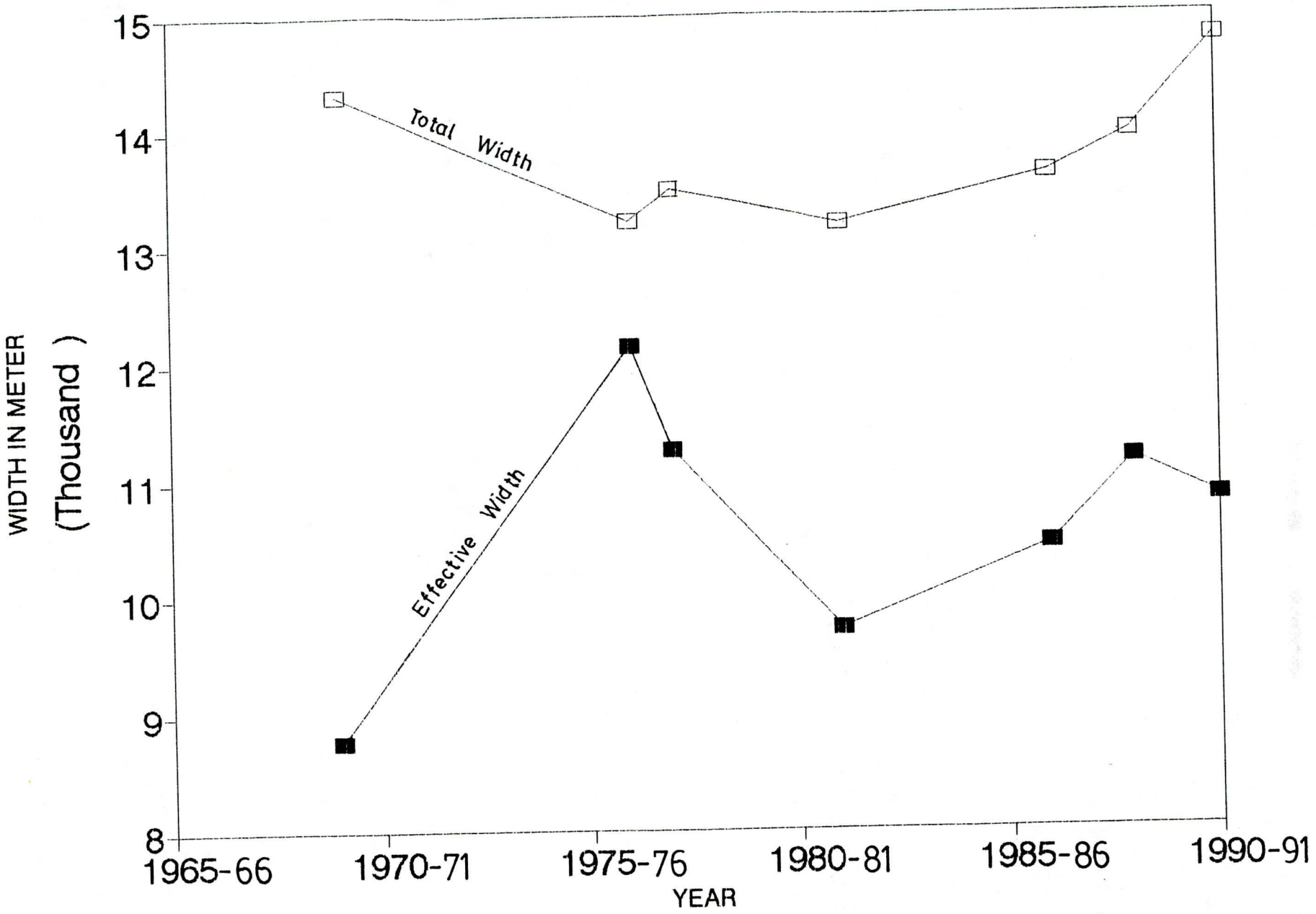


Figure. 5.94 Width Vs Year For Section J-9 (Ch. 142·45 Km)

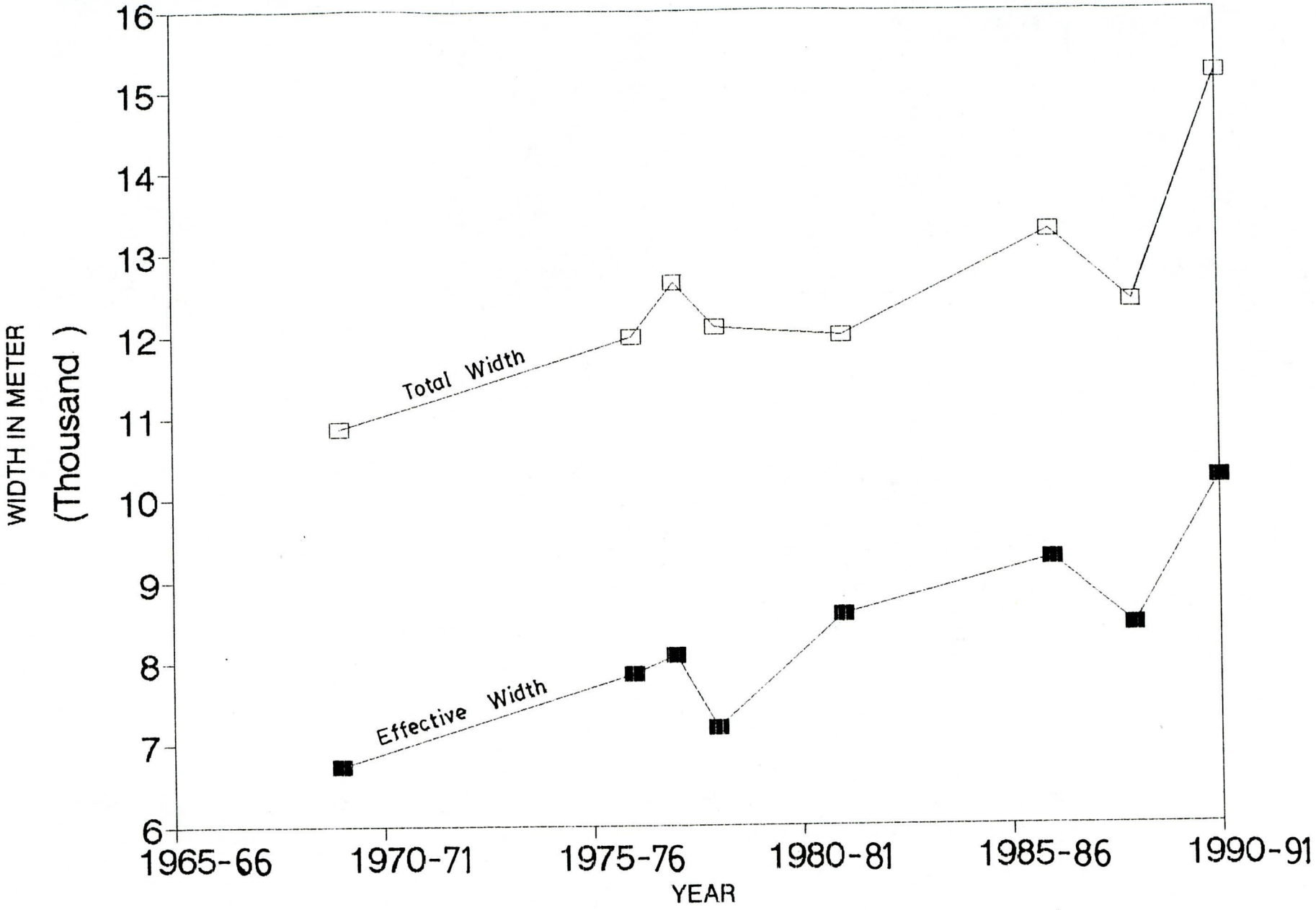


Figure. 5.95 Width Vs Year For Section J-8 (Ch. 149·50 Km)

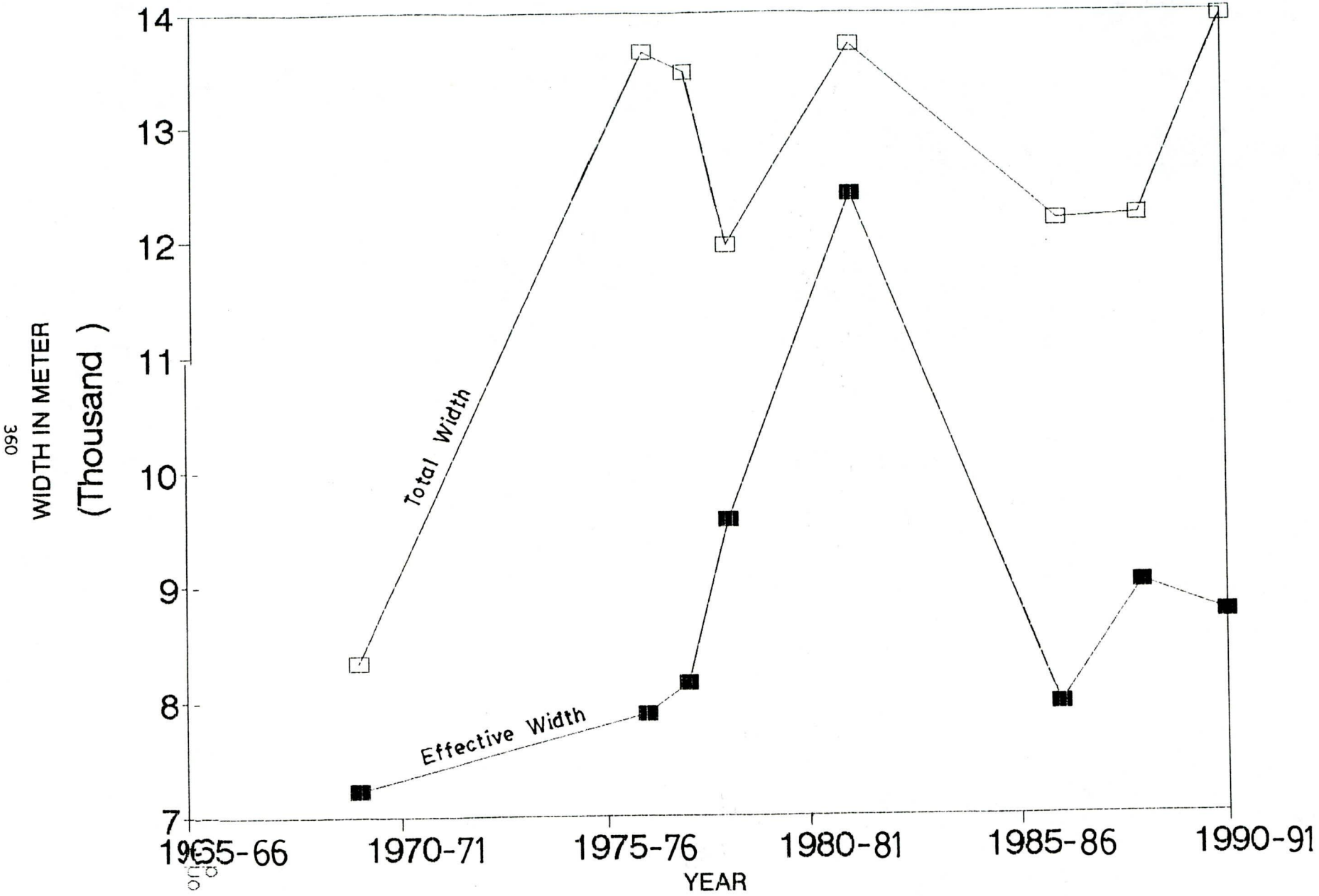


Figure. 5.96 Width Vs Year For Section J-7 (Ch. 162·35 Km.)

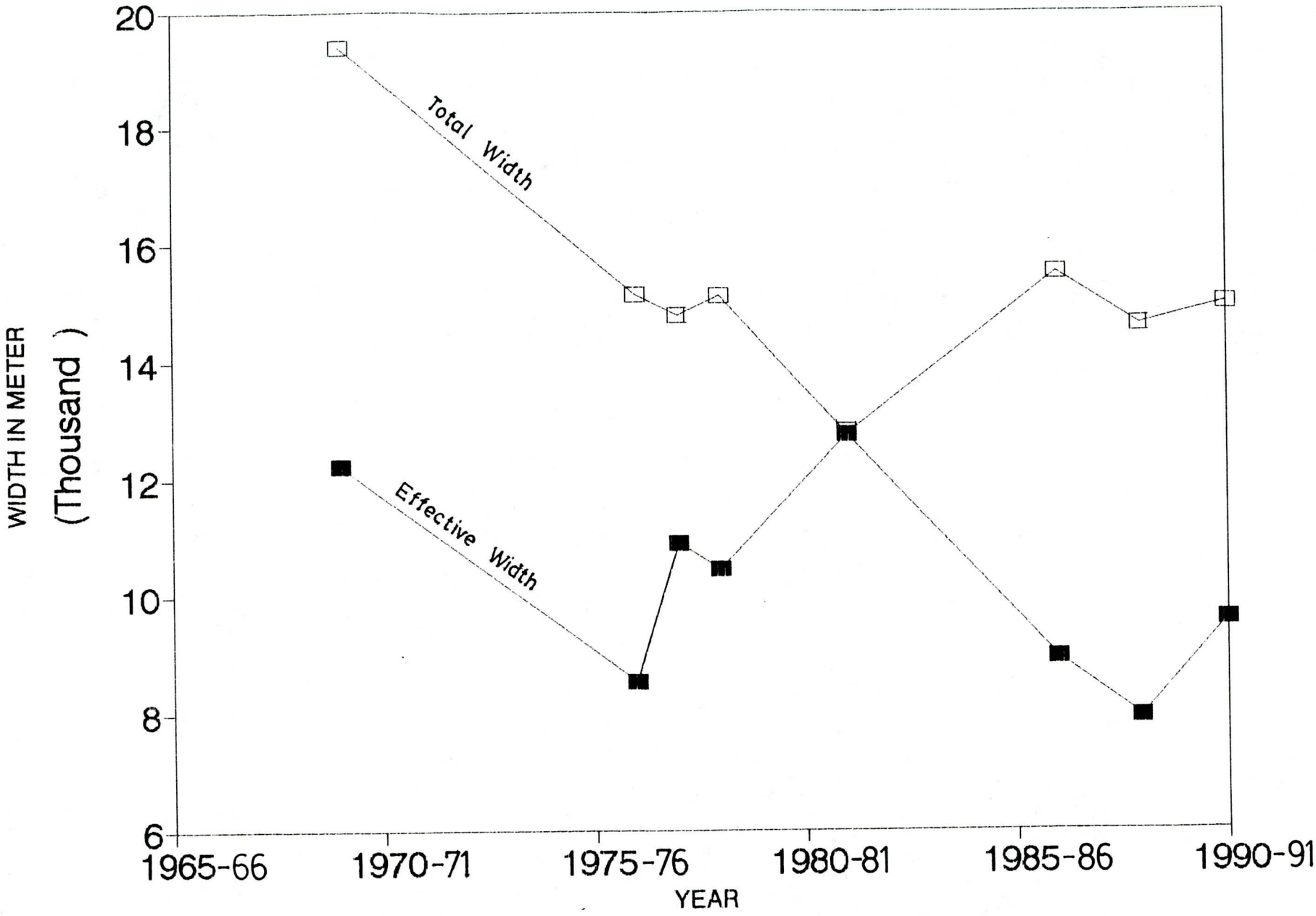


Figure. 5.97 Width Vs Year For Section J-6 (Ch. 177·70 Km)

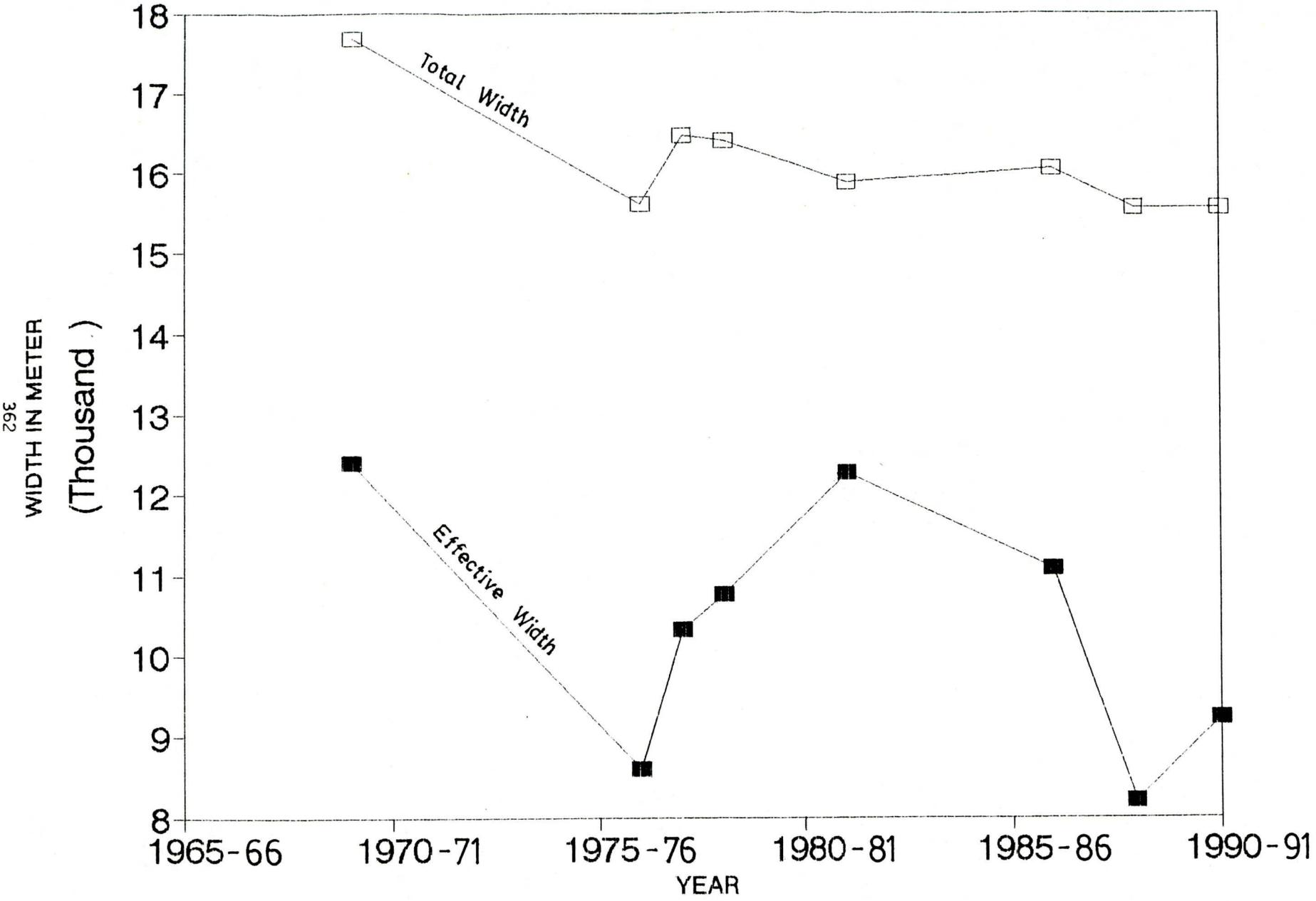


Figure. 5.98 Width Vs Year For Section J-5 (Ch. 188·20 Km)

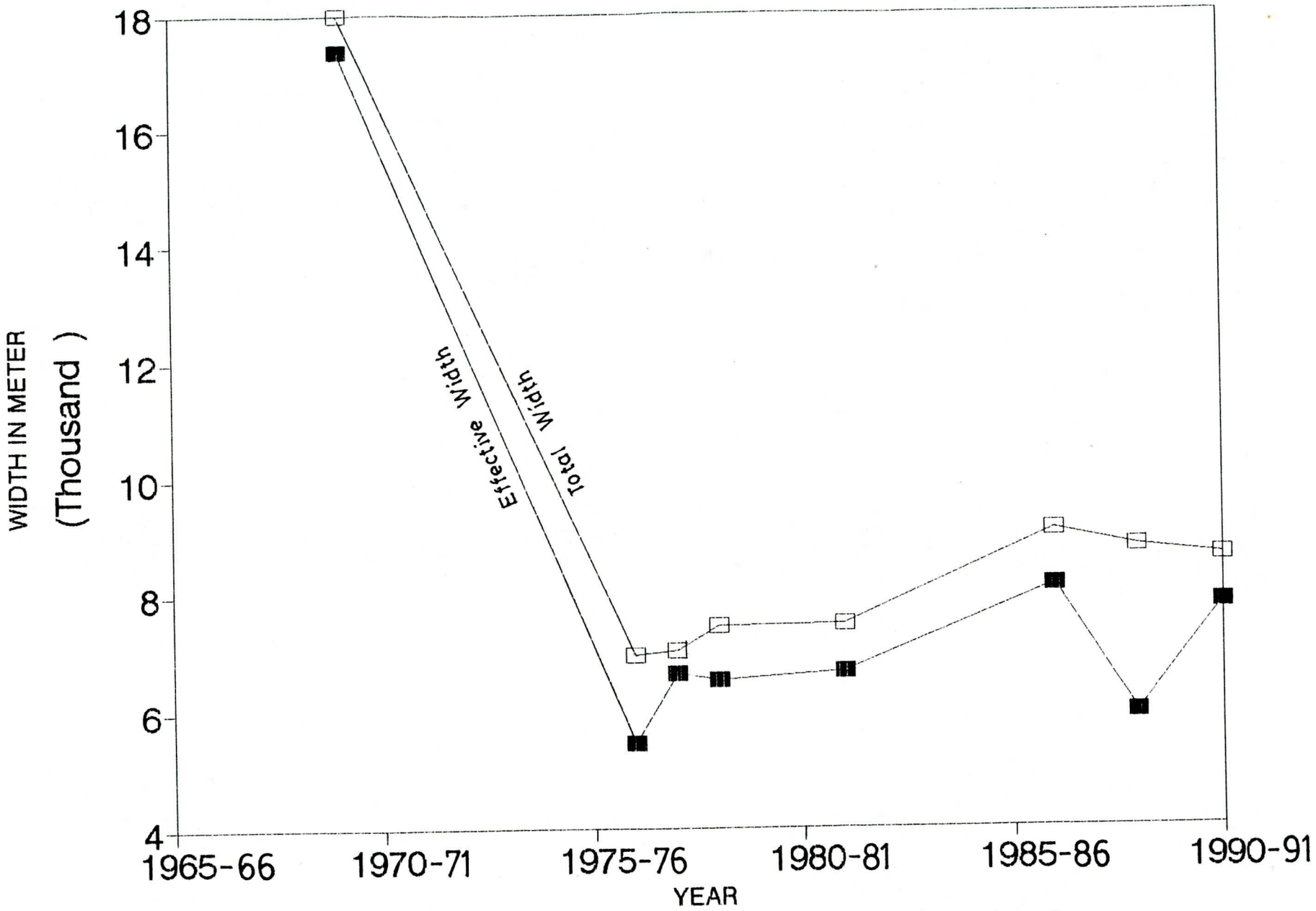


Figure. 5.99 Width Vs Year For Section J-4 (Ch. 201·30 Km)

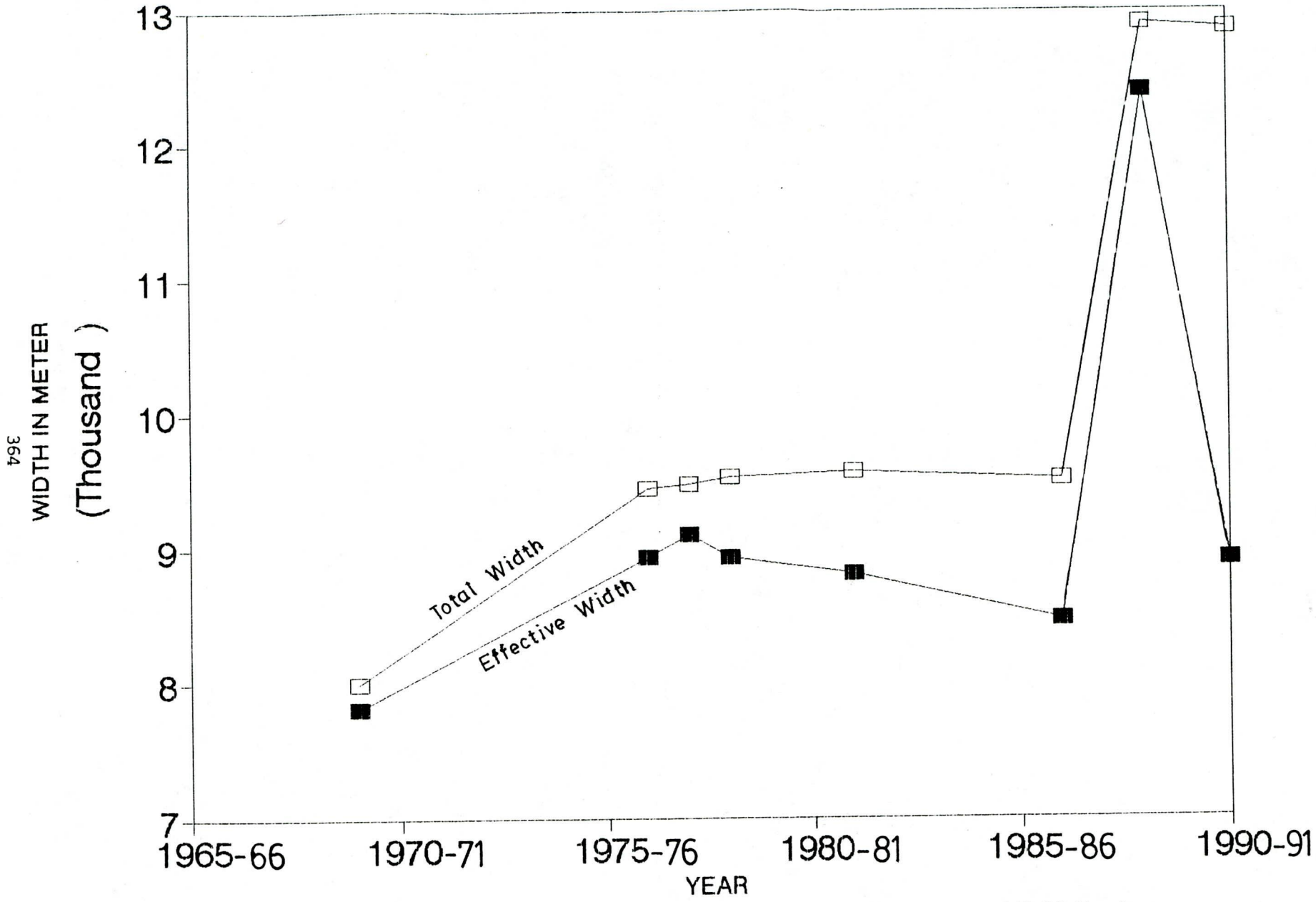


Figure. 5.100 Width Vs Year For Section J-3 (Ch. 213·20 Km)

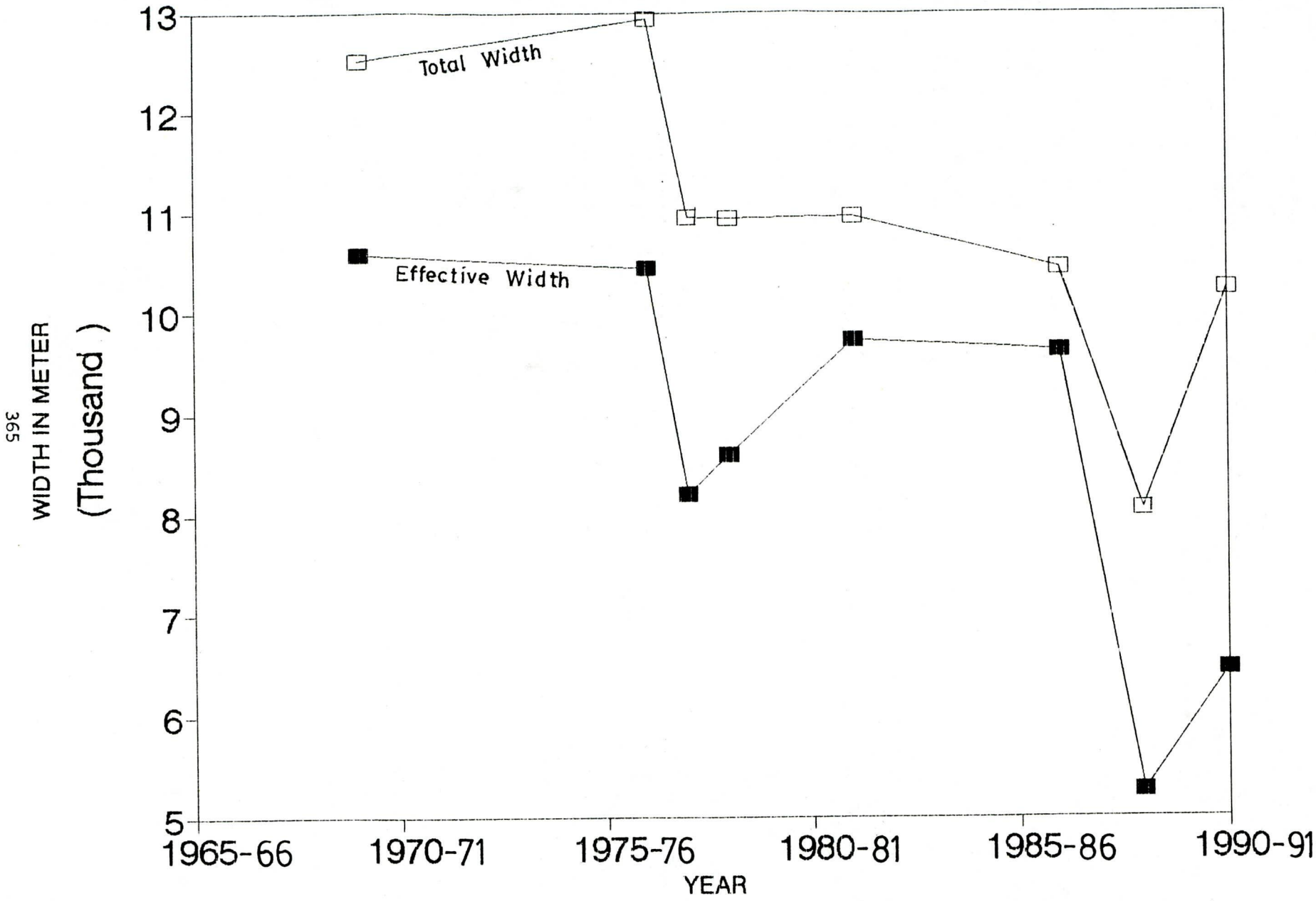


Figure 5.101 Width Vs Year For Section J-2 (Ch. 223·20 Km)

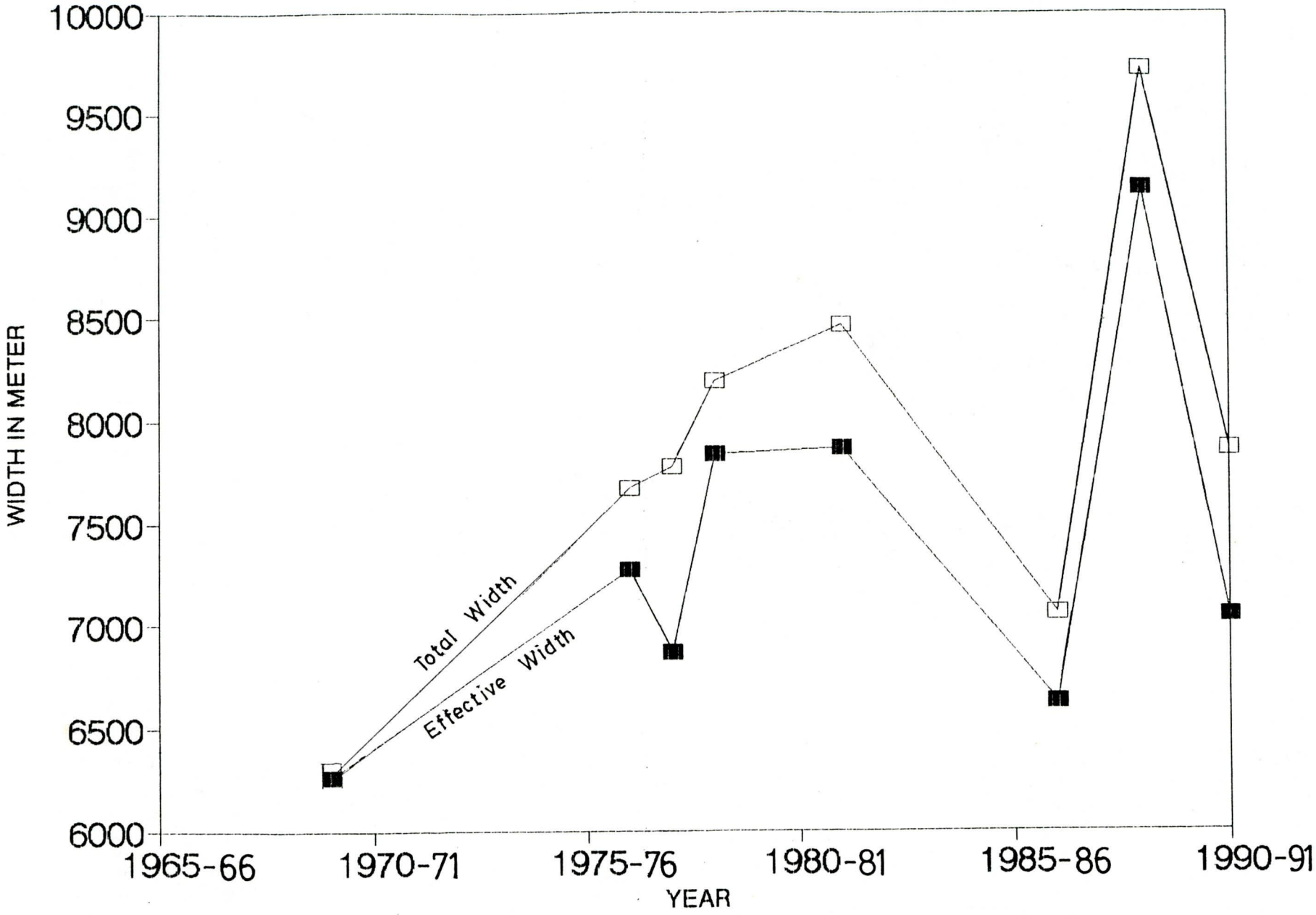


Figure. 5.102 Width Vs Year For Section J-1 (Ch. 230·75 Km)

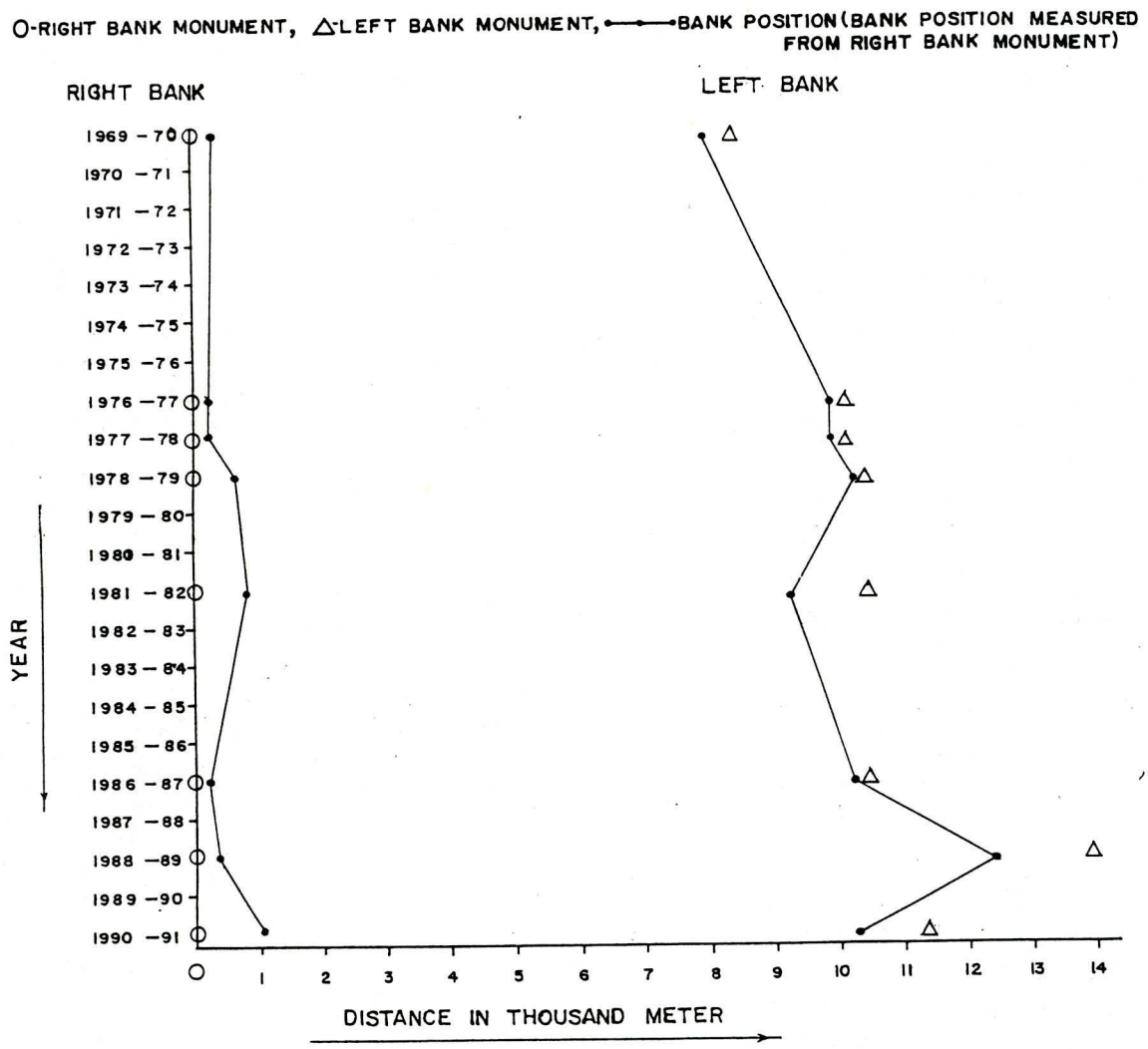


FIG: 5·103 BANK POSITION IN DIFFERENT YEARS (STATION J-17, CH. 25·00 Km)

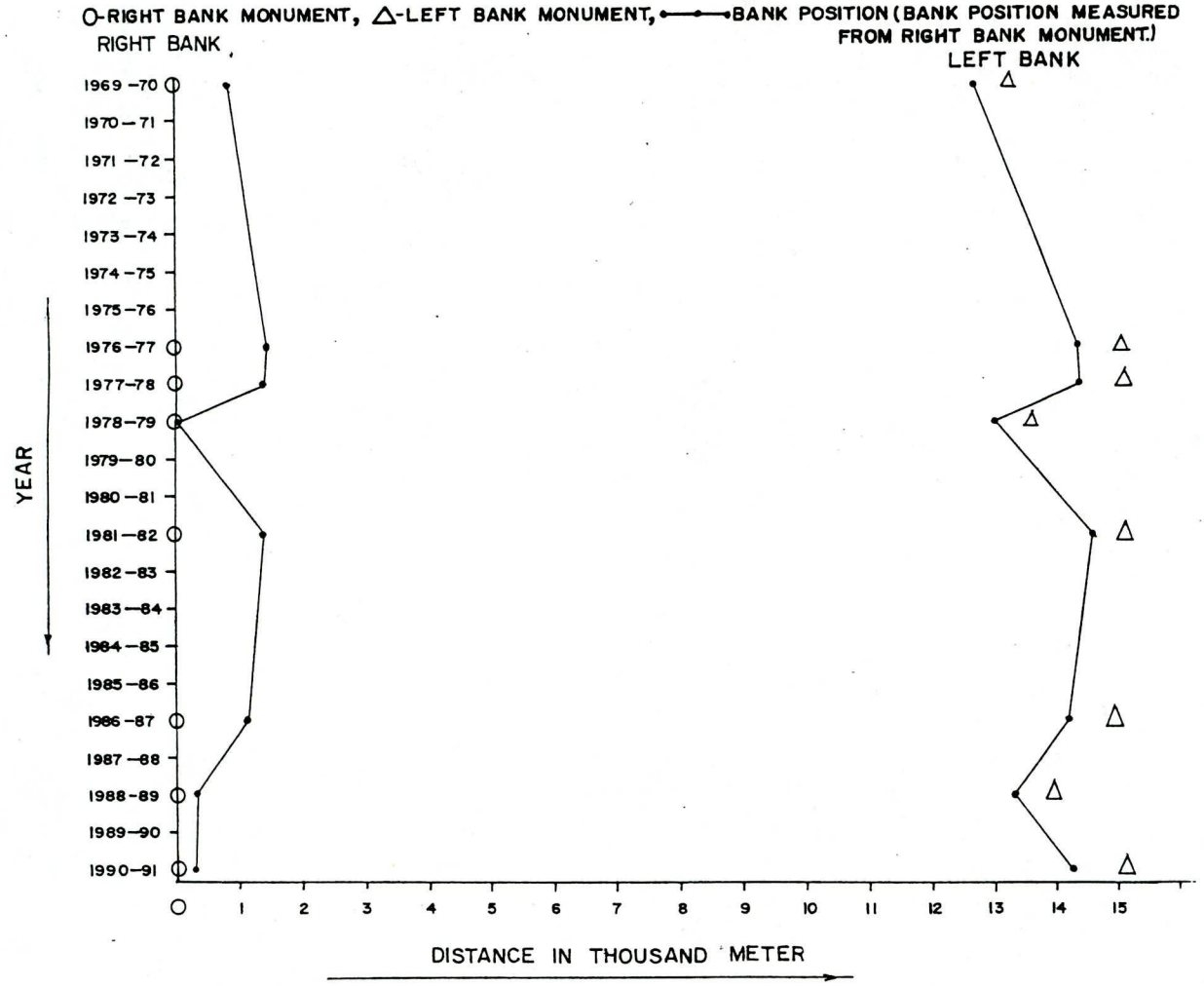


FIG. 5·104 BANK POSITION IN DIFFERENT YEARS.(STATION J-16, CH. 37·10Km)

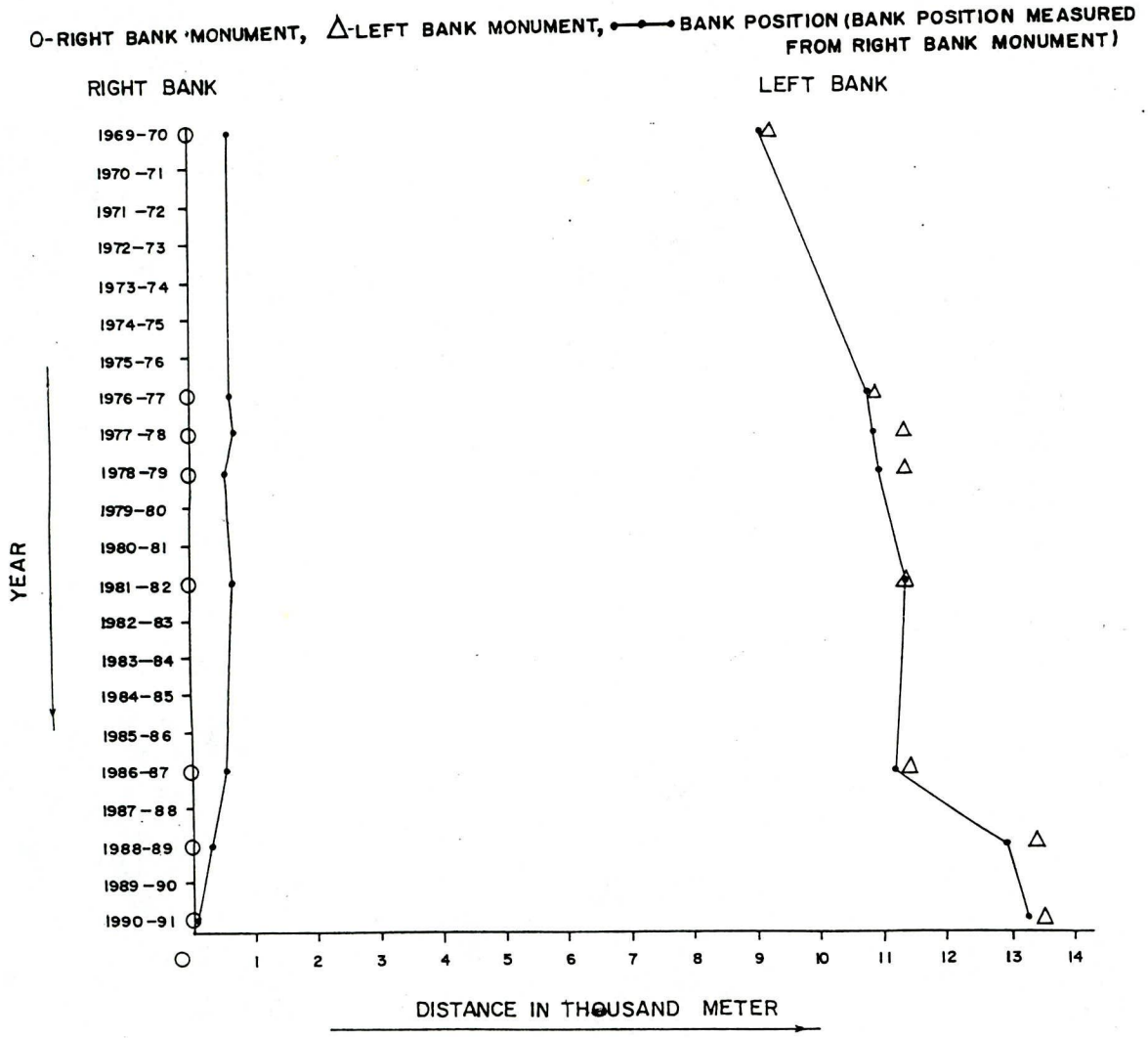


FIG.5·105 BANK POSITION IN DIFFERENT YEARS.(STATION J-15, CH. 55·65 Km)

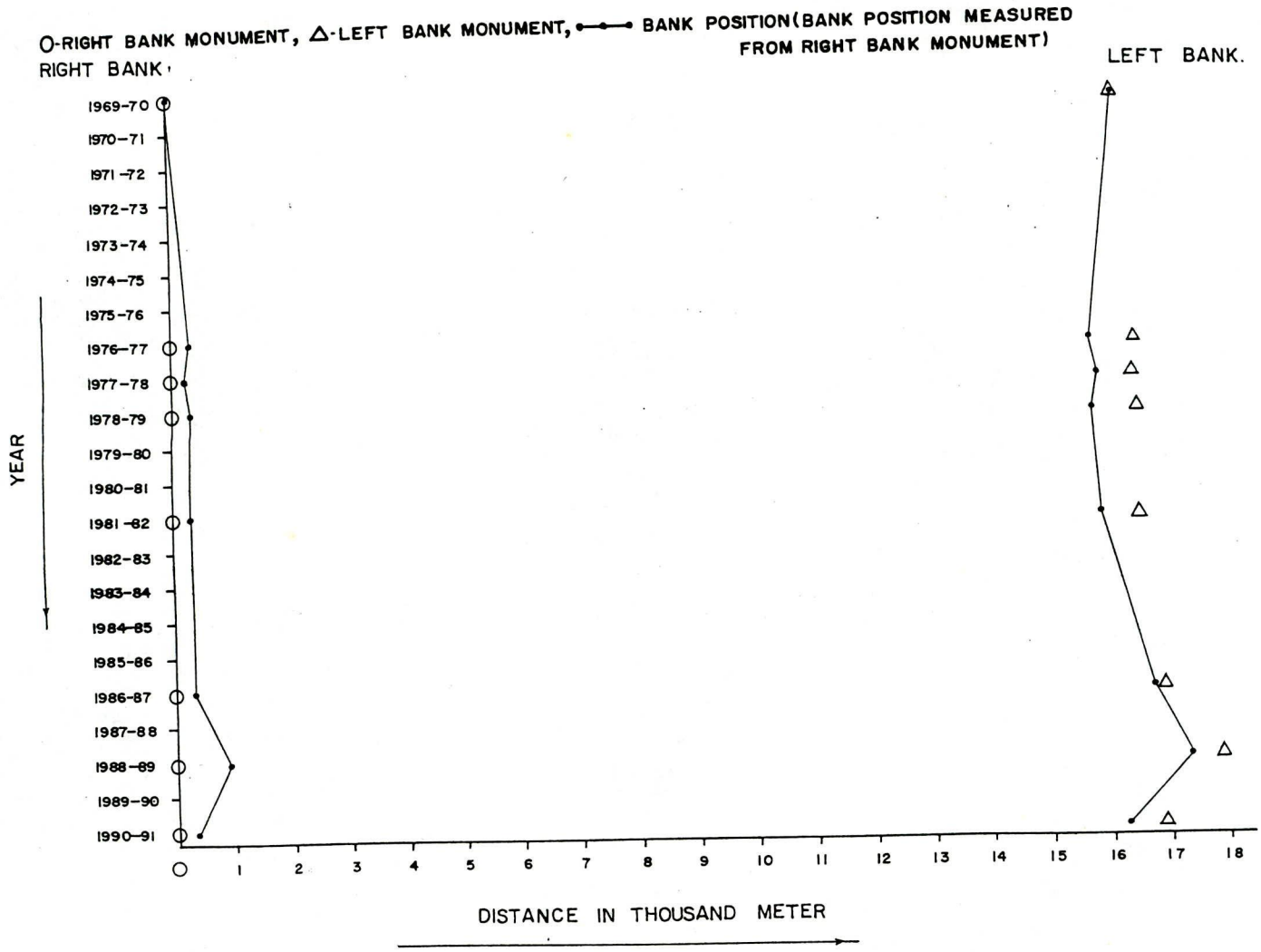


FIG: 5·106 BANK POSITION IN DIFFERENT YEARS.(STATION J-14, CH.71·20 Km)

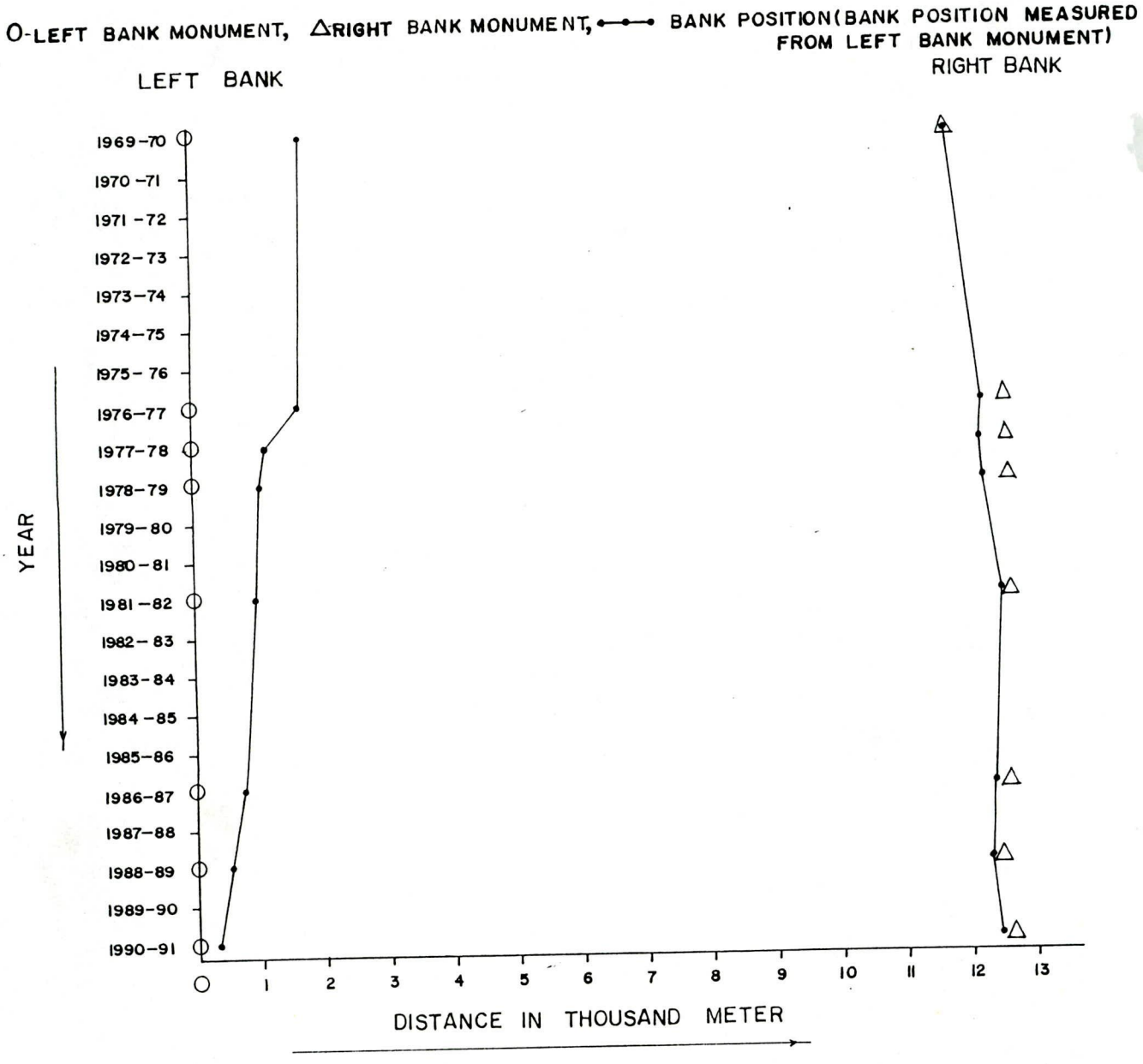


FIG: 5·107 BANK POSITION IN DIFFERENT YEARS.(STATION J-13,CH.84·70Km)

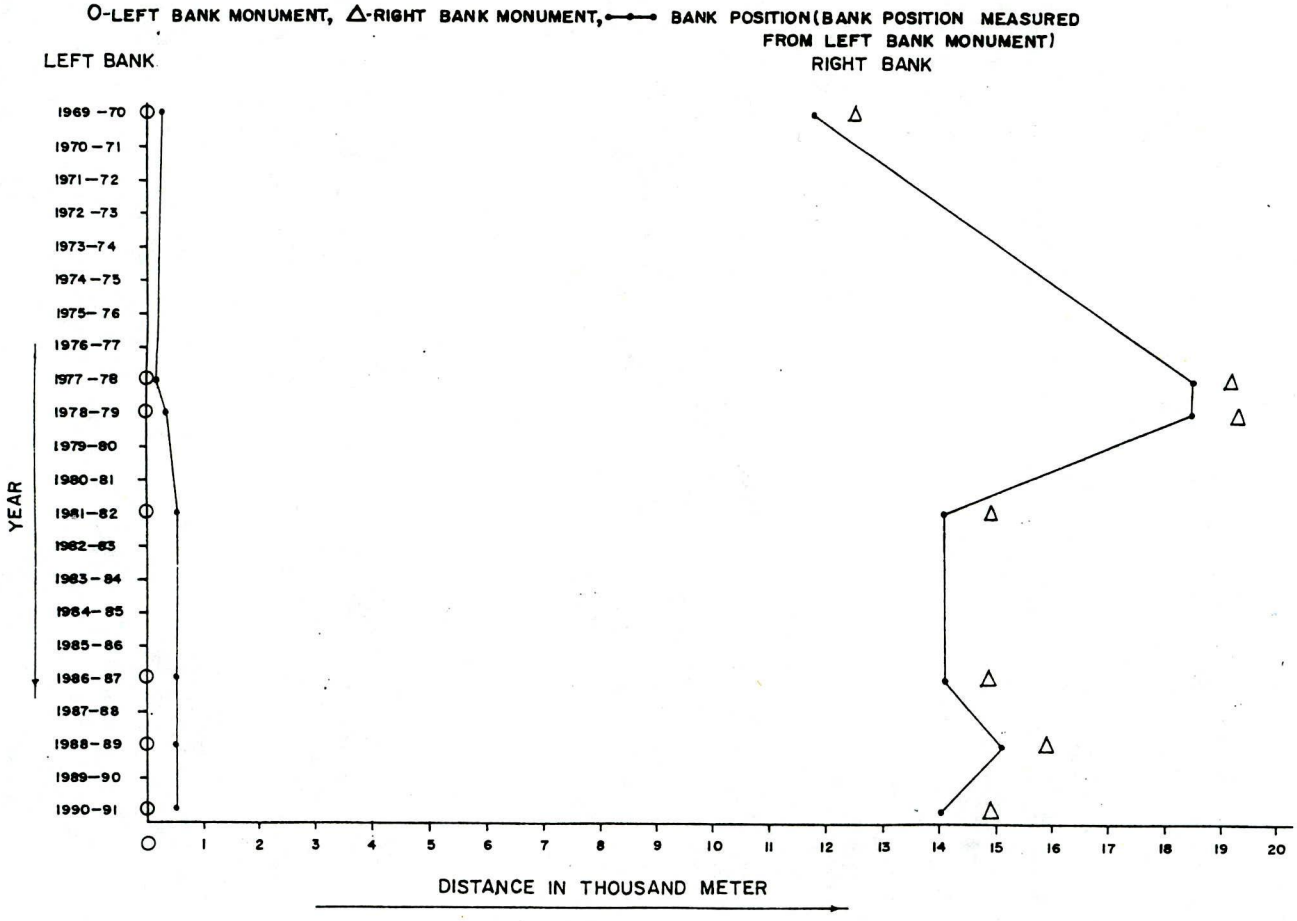


FIG:5·108 BANK POSITION IN DIFFERENT YEARS(STATION J-12,CH.100·50 Km)

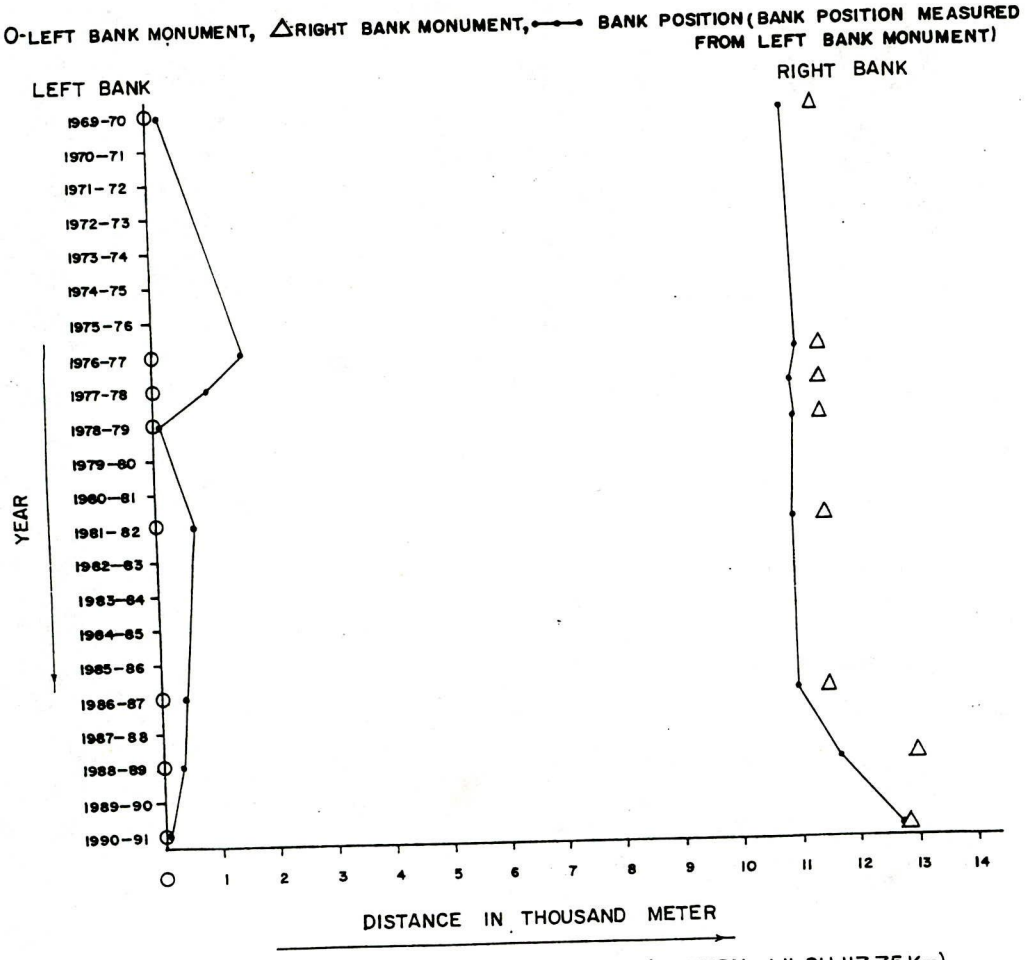


FIG: 5·109 BANK POSITION IN DIFFERENT YEARS(STATION J-11, CH.117·75 Km)

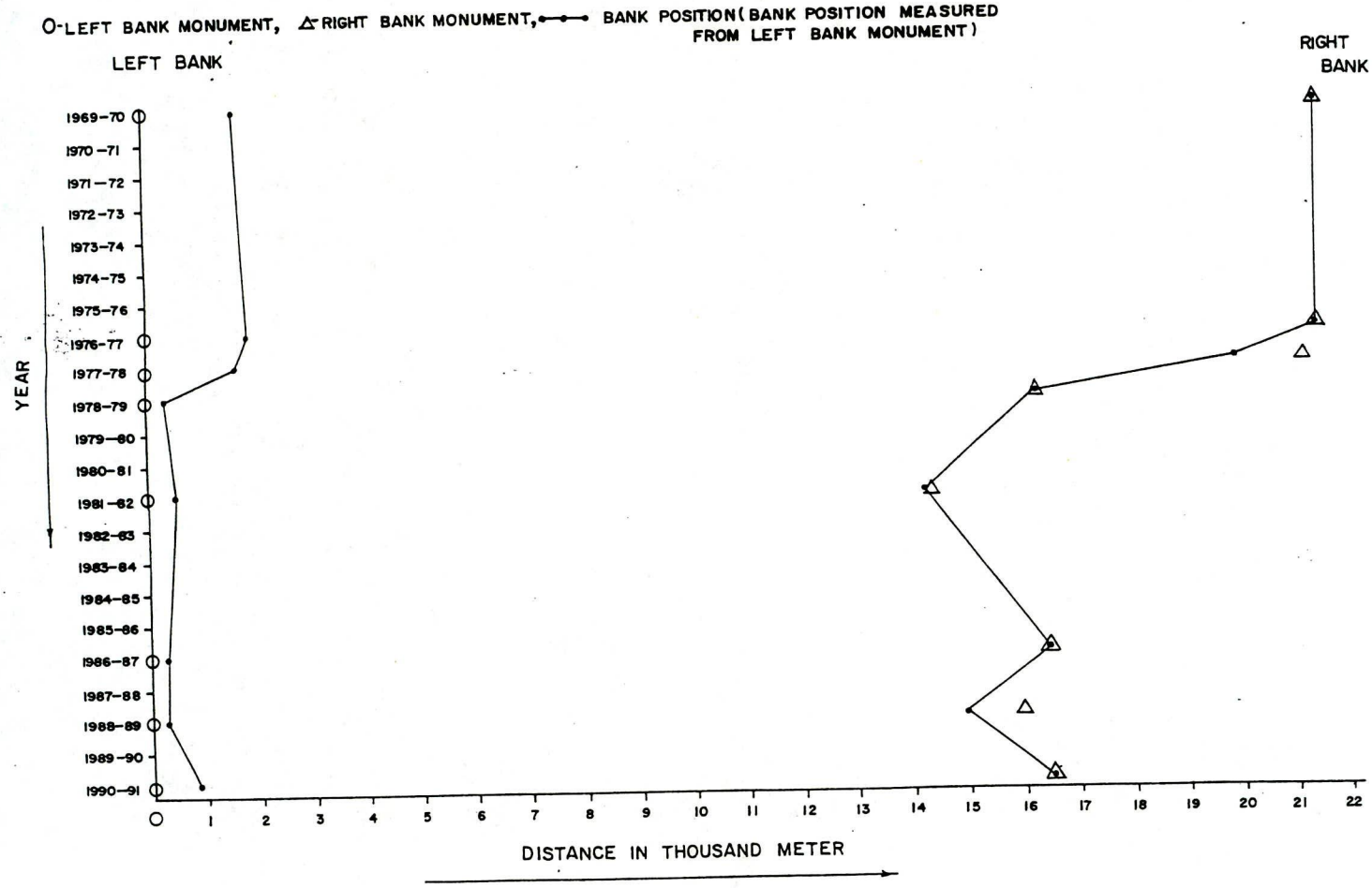


FIG: 5·110 BANK POSITION IN DIFFERENT YEARS (STATION J-10, CH. 134·30 Km)

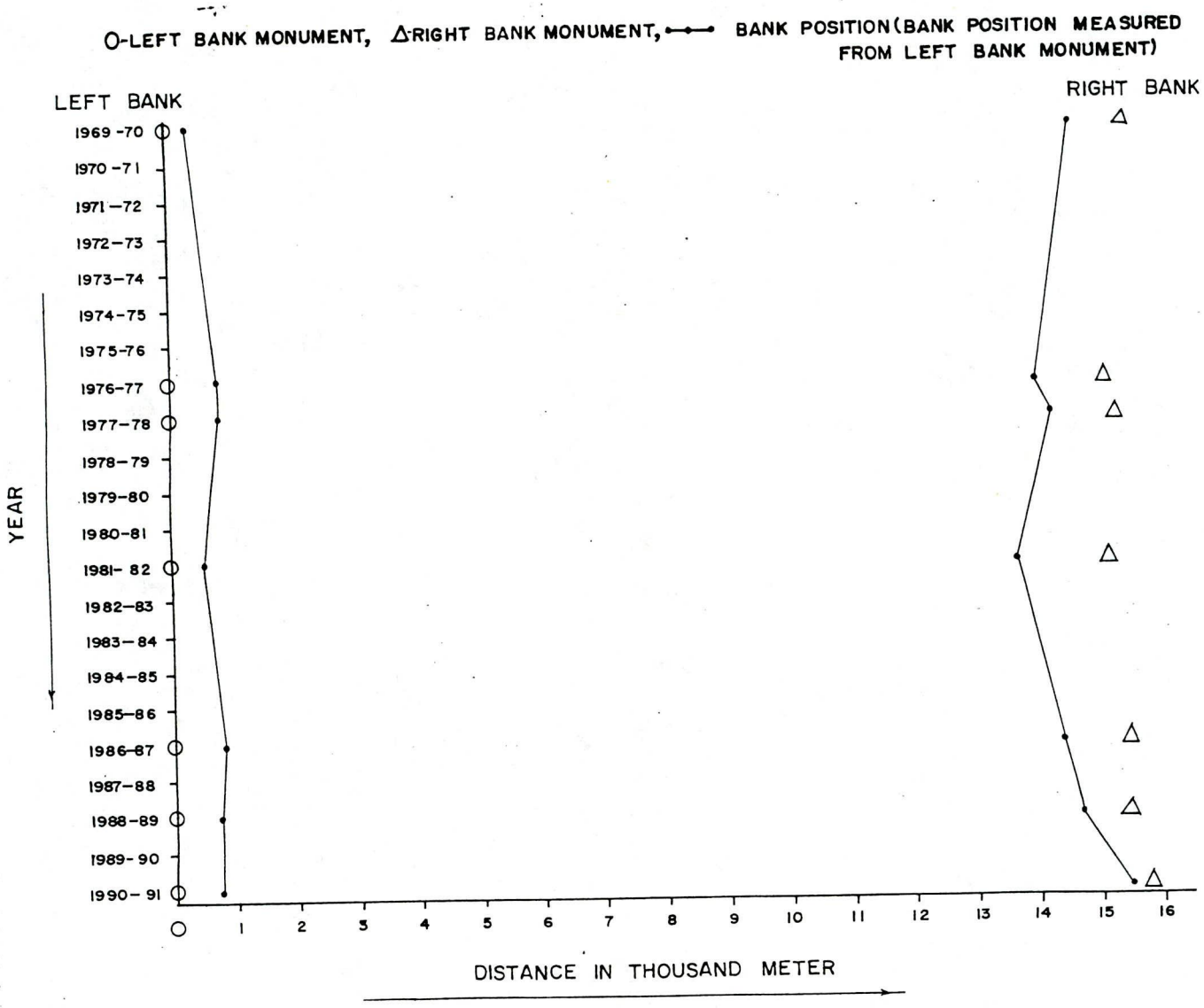


FIG. 5·111 BANK POSITION IN DIFFERENT YEARS.(STATION J-9, CH.142·45 Km)

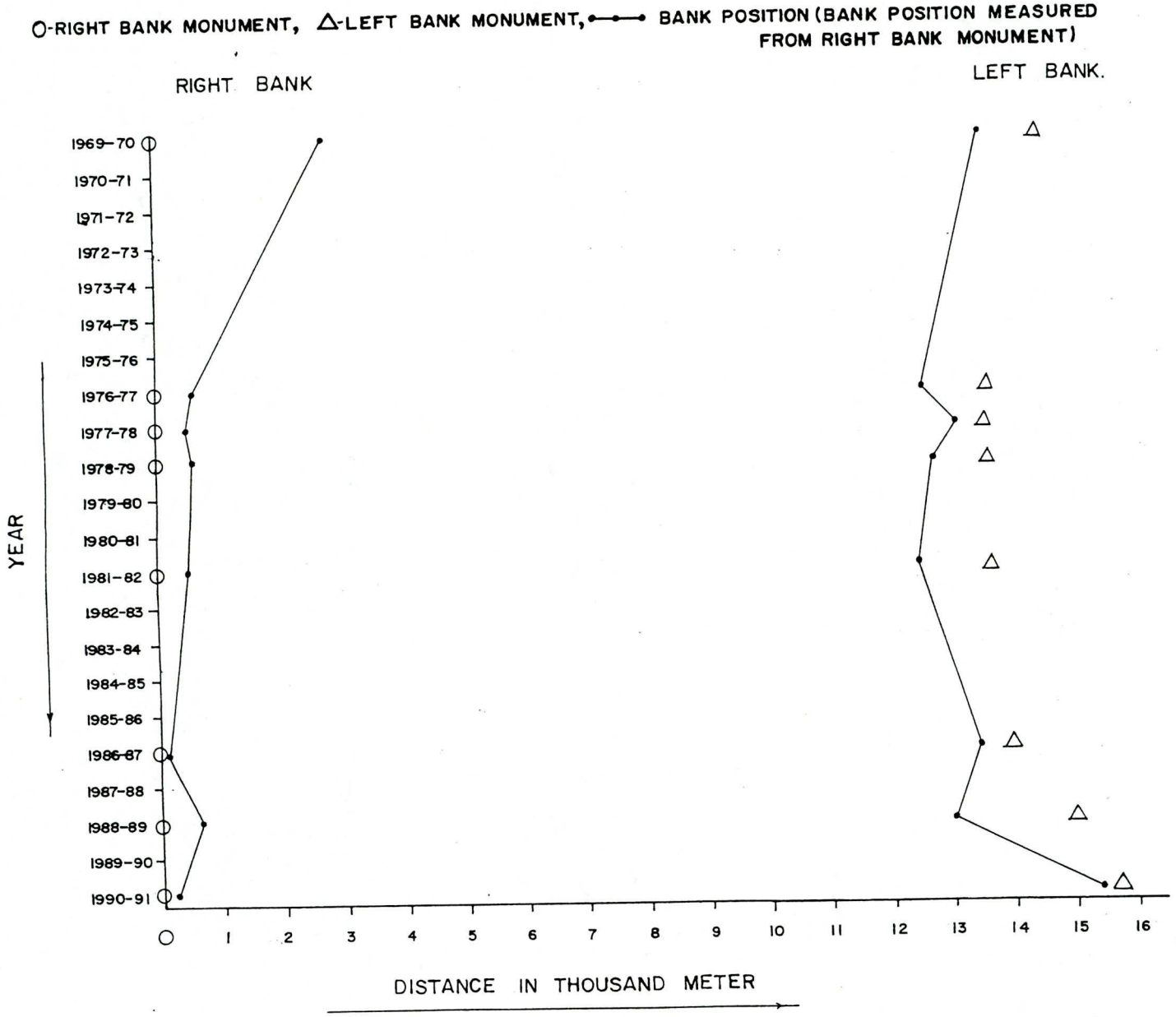


FIG: 5·112 BANK POSITION IN DIFFERENT YEARS(STATION J-8, CH. 149·50 Km)

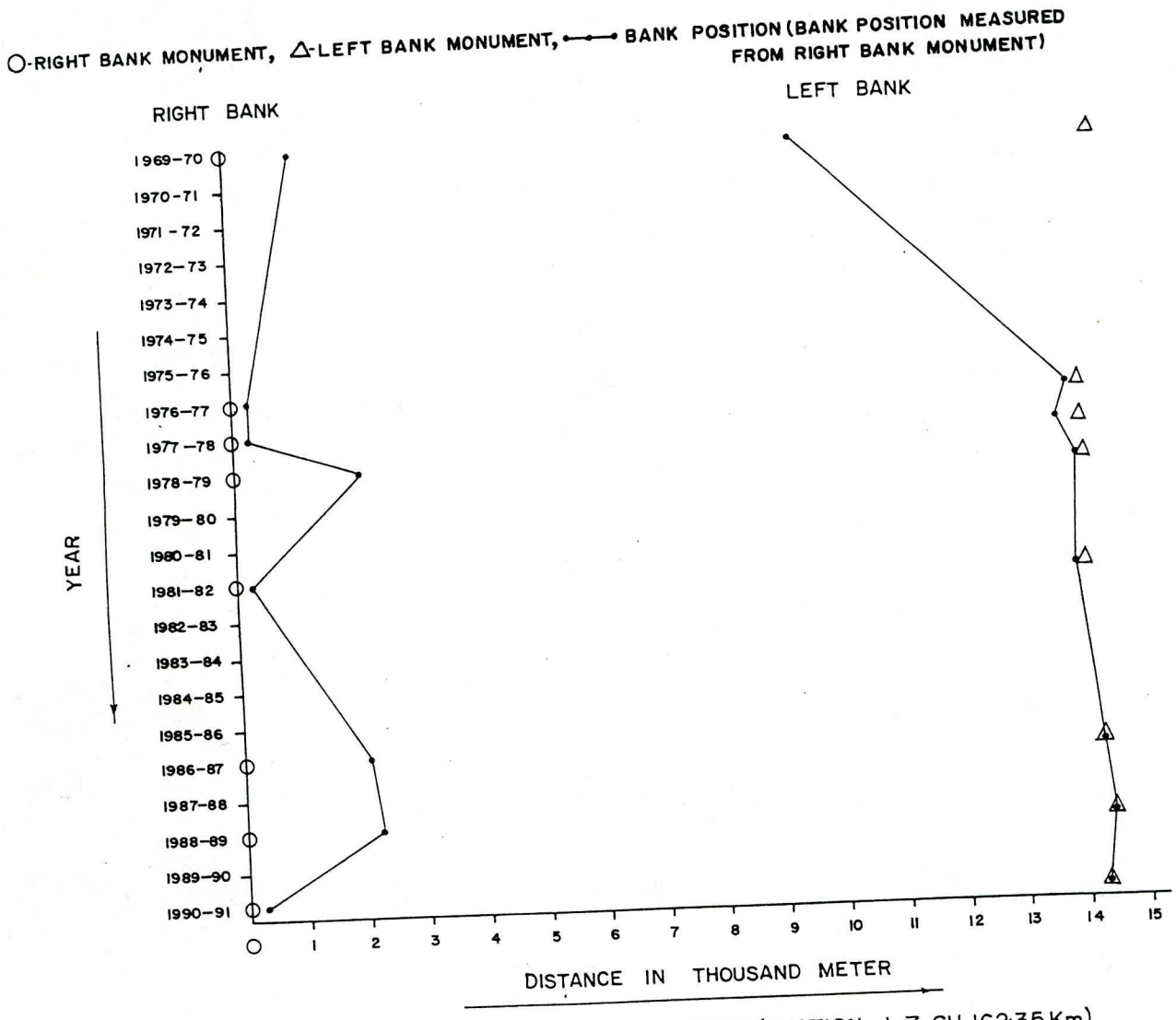


FIG: 5·113 BANK POSITION IN DIFFERENT YEARS (STATION J-7, CH. 162·35 Km)

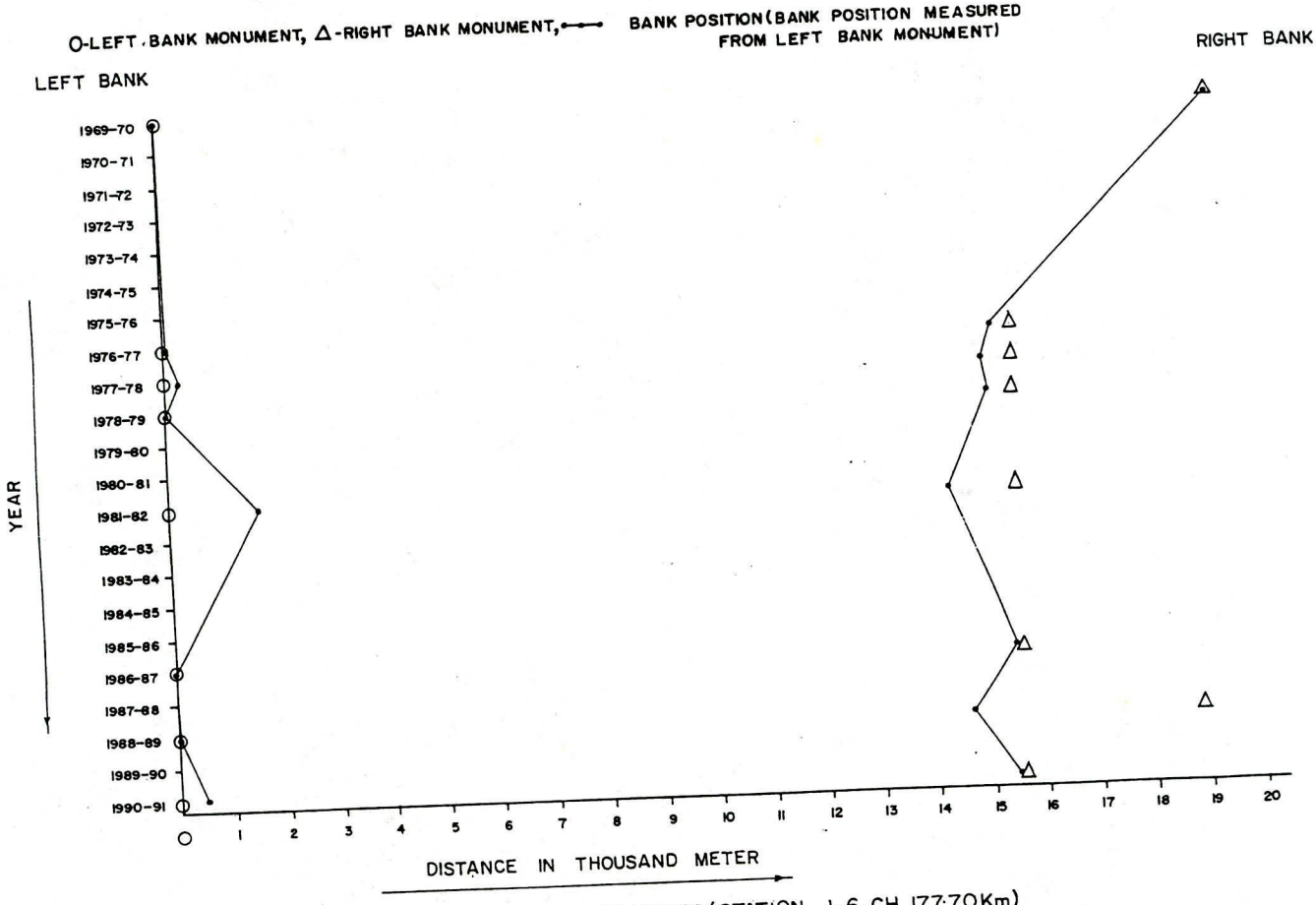


FIG: 5·114 BANK POSITION IN DIFFERENT YEARS.(STATION J-6, CH. 177·70Km)

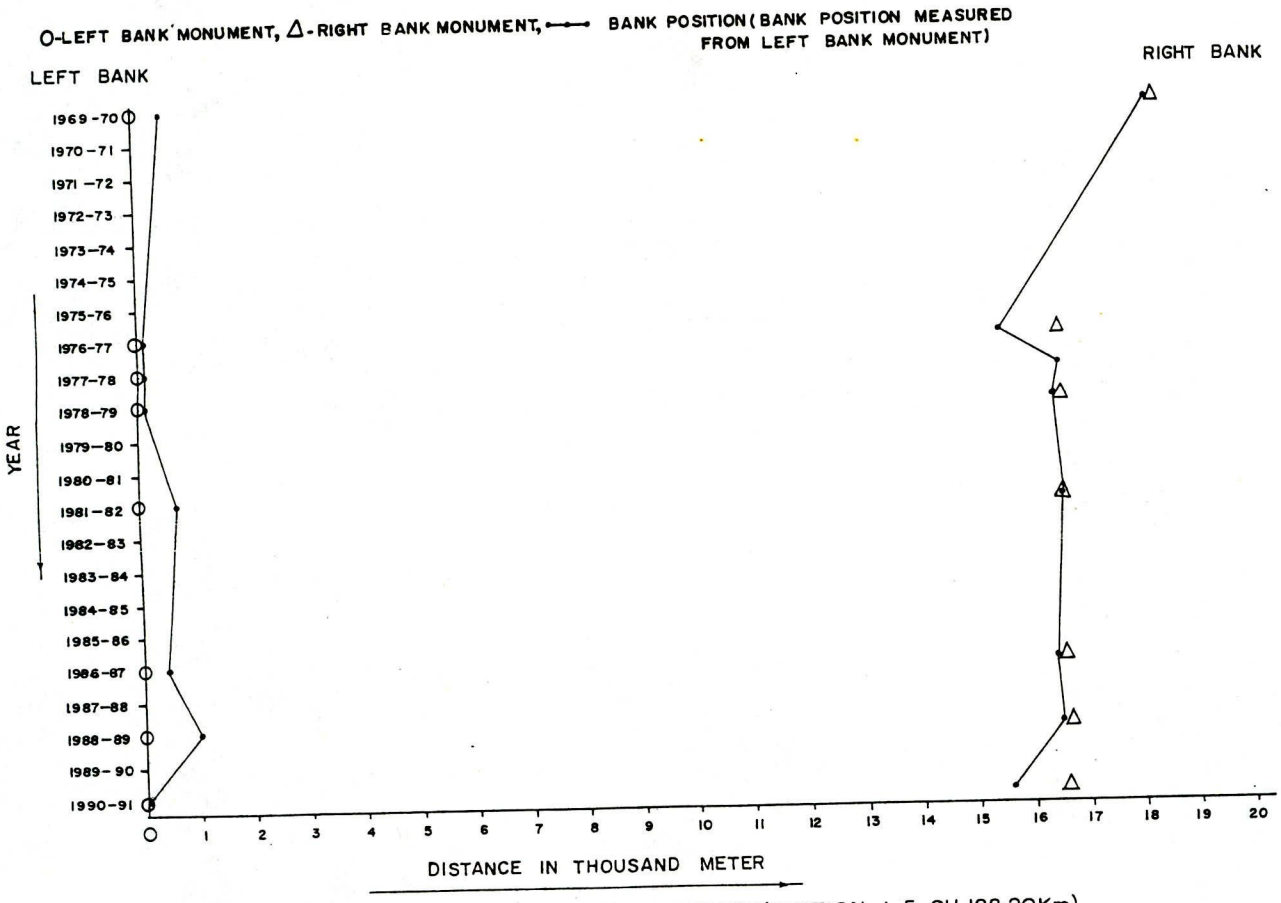


FIG: 5·115 BANK POSITION IN DIFFERENT YEARS.(STATION J-5, CH.188·20Km)

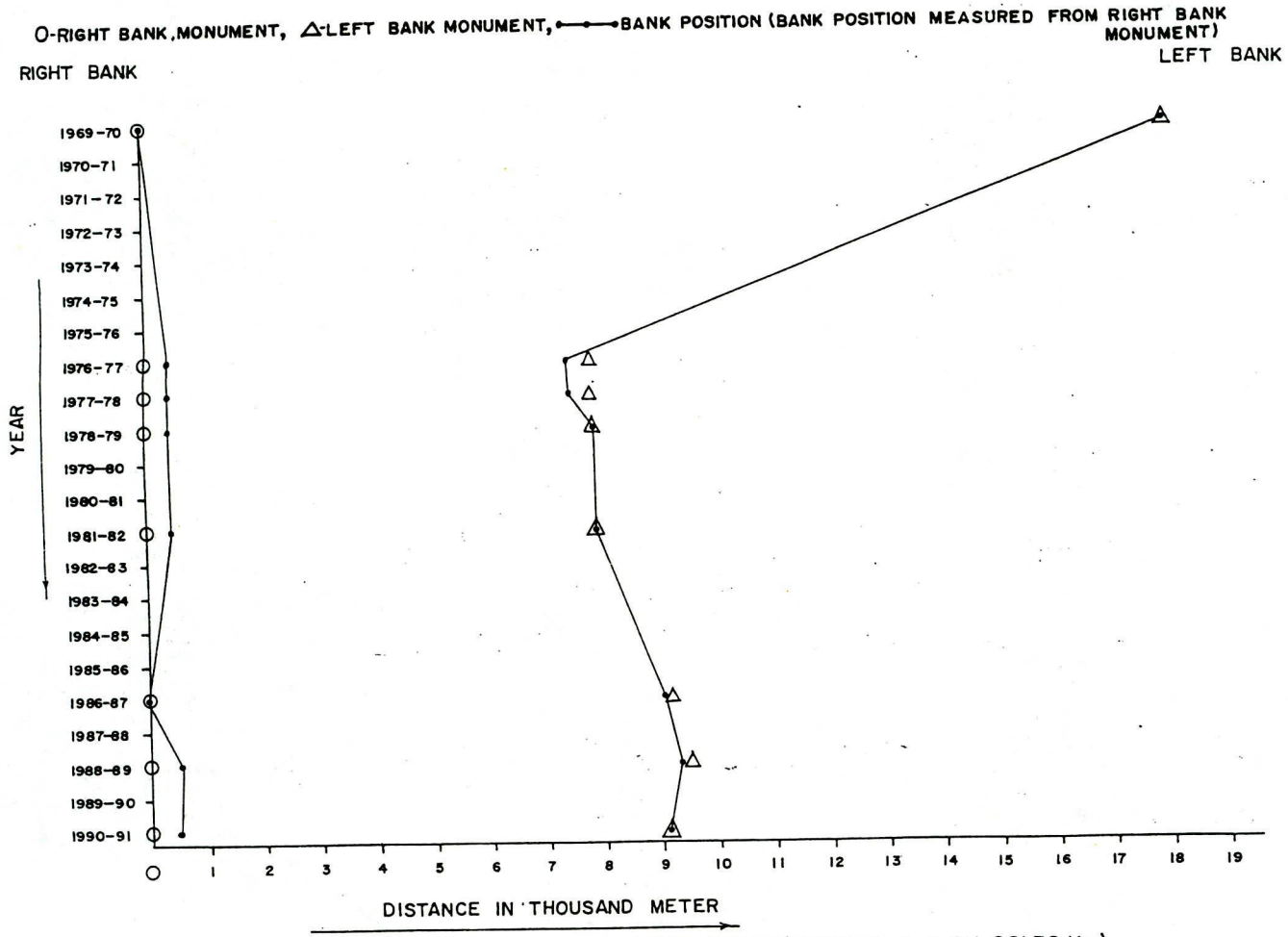


FIG: 5·116 BANK POSITION IN DIFFERENT YEARS(STATION J—4, CH. 201·30 Km)

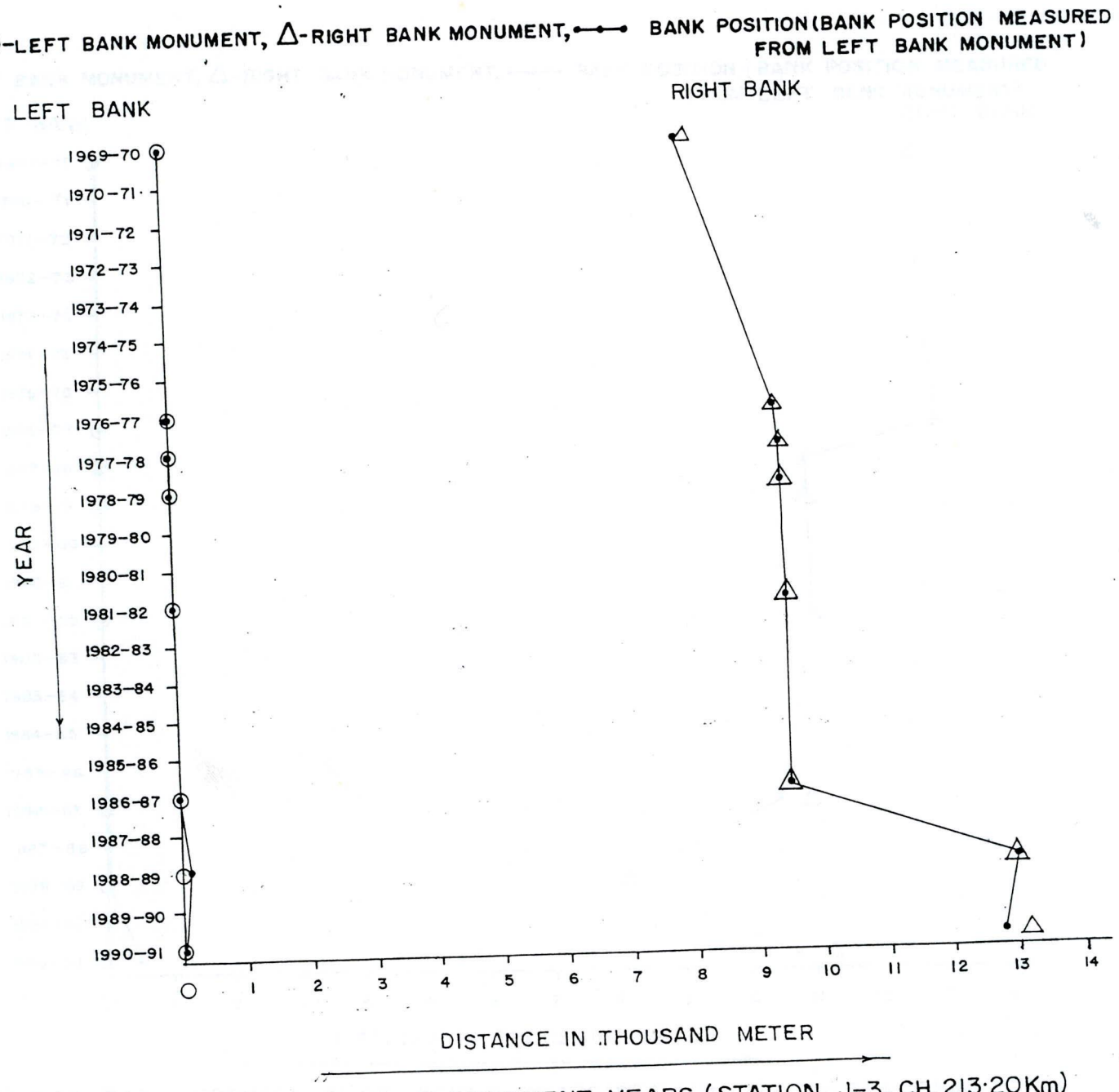


FIG: 5·117 BANK POSITION IN DIFFERENT YEARS. (STATION J-3, CH. 213·20Km)

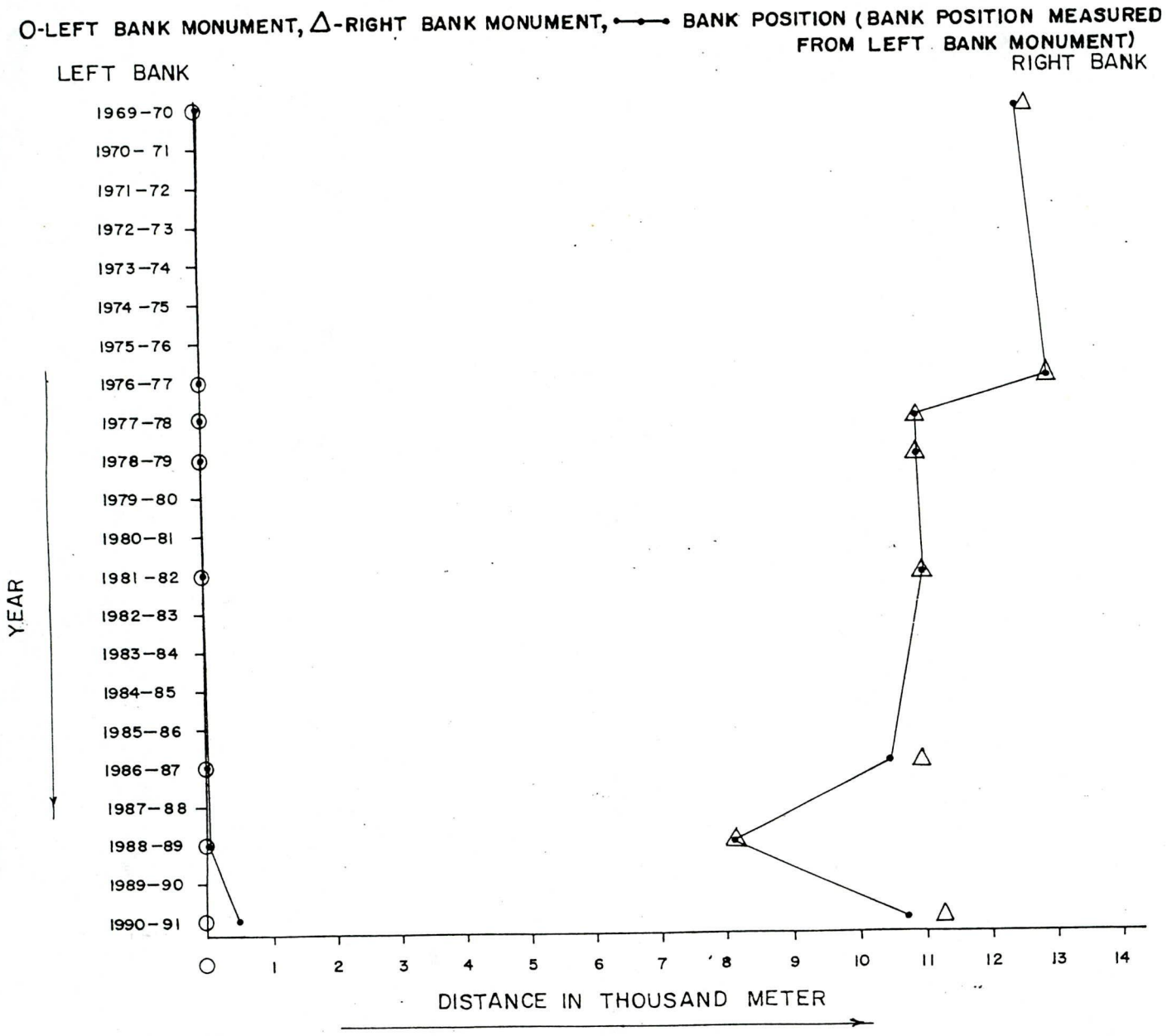


FIG: 5·118 BANK POSITION IN DIFFERENT YEARS (STATION J-2, CH. 223·20 Km)

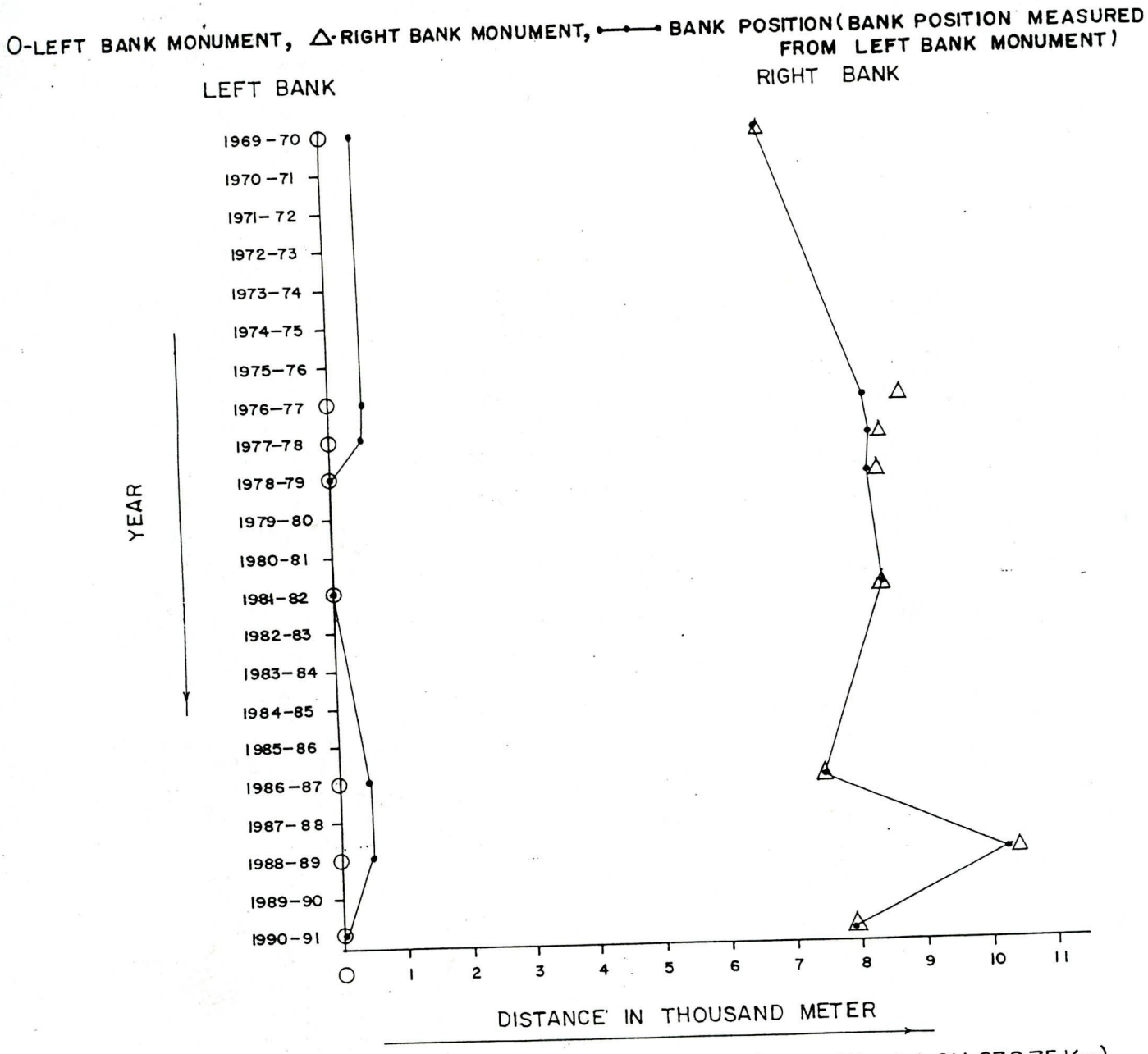


FIG: 5·119 BANK POSITION IN DIFFERENT YEARS (STATION J-1, CH. 230·75 Km)

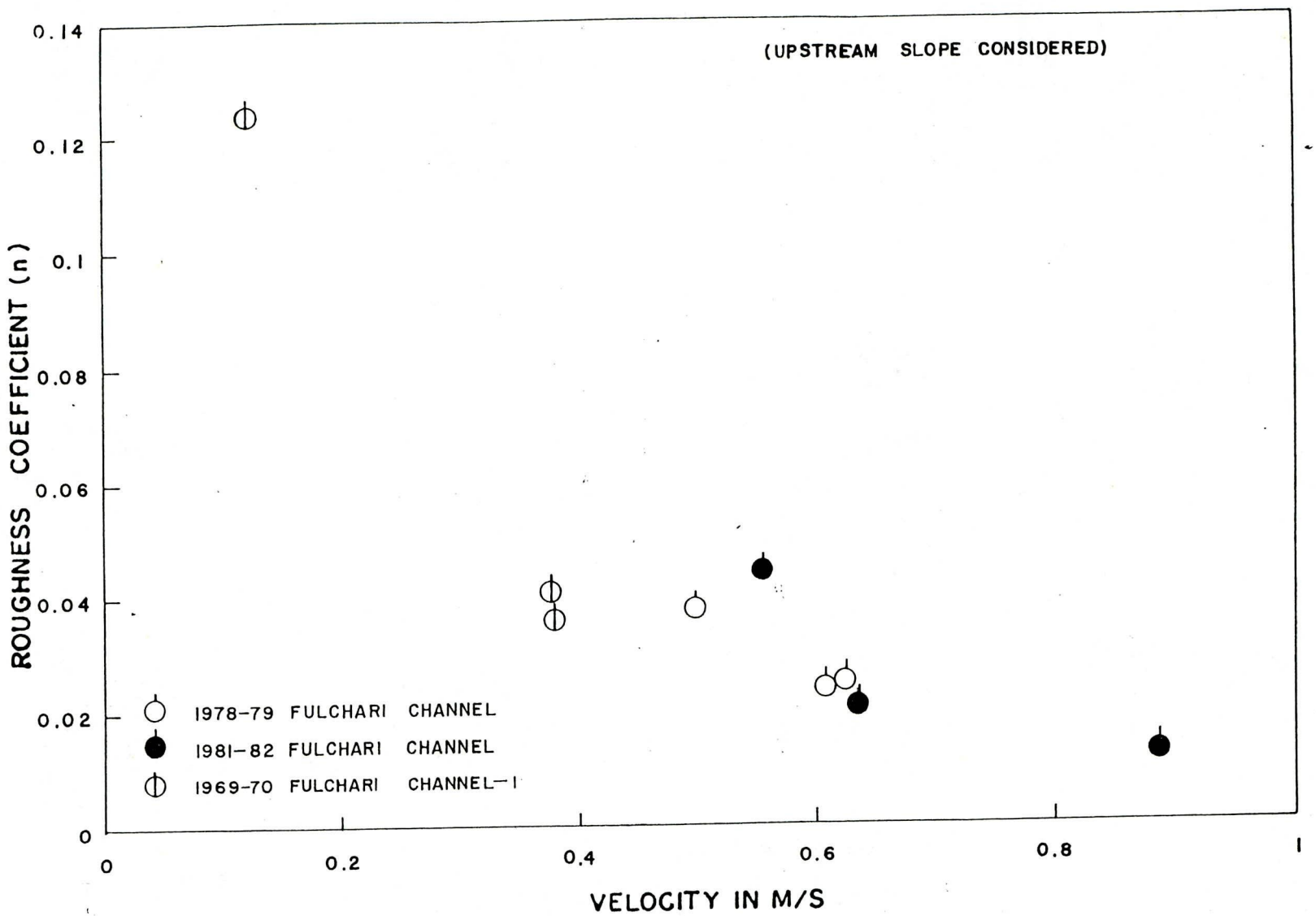


FIG:5·120 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON.

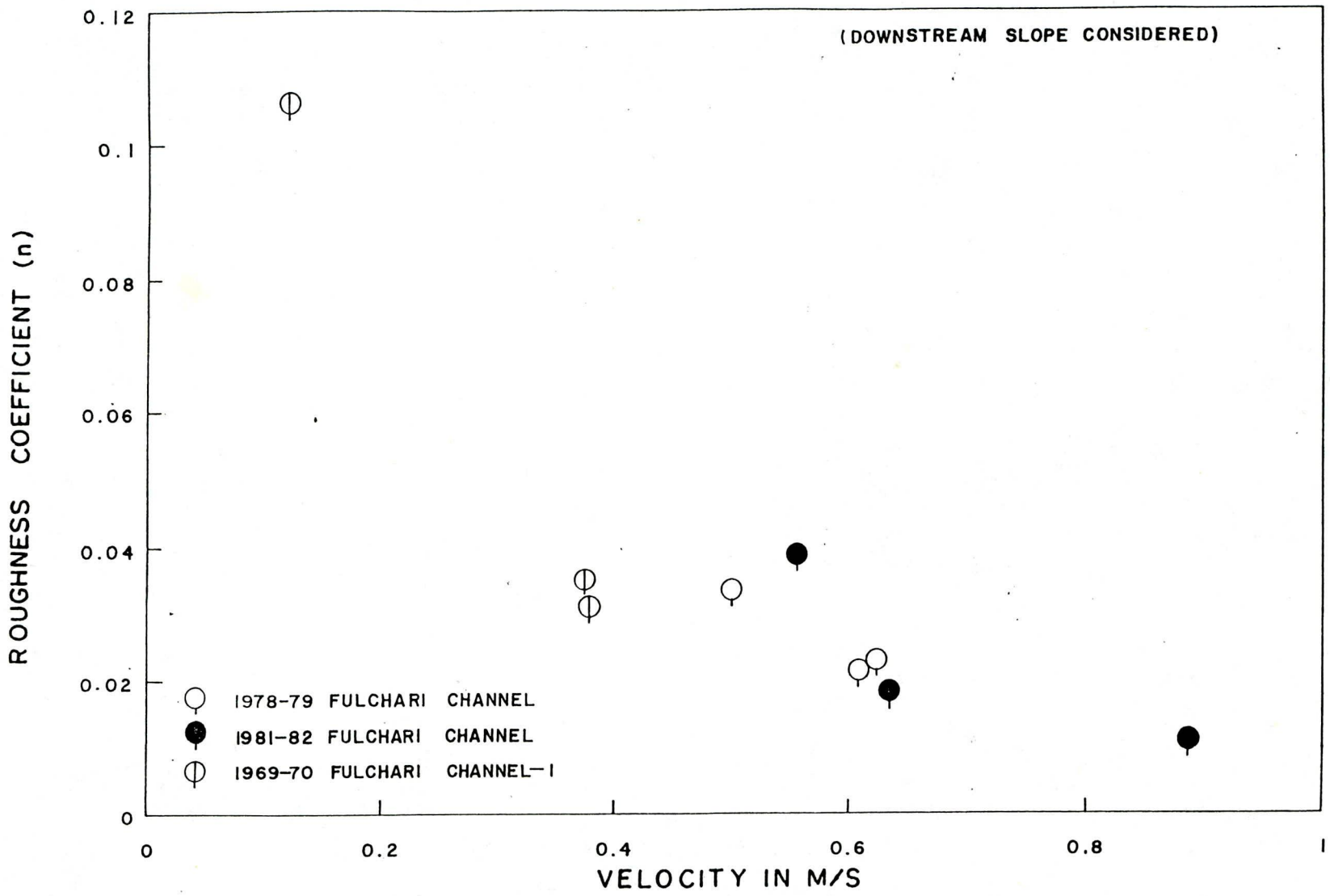


FIG:5·121 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON.

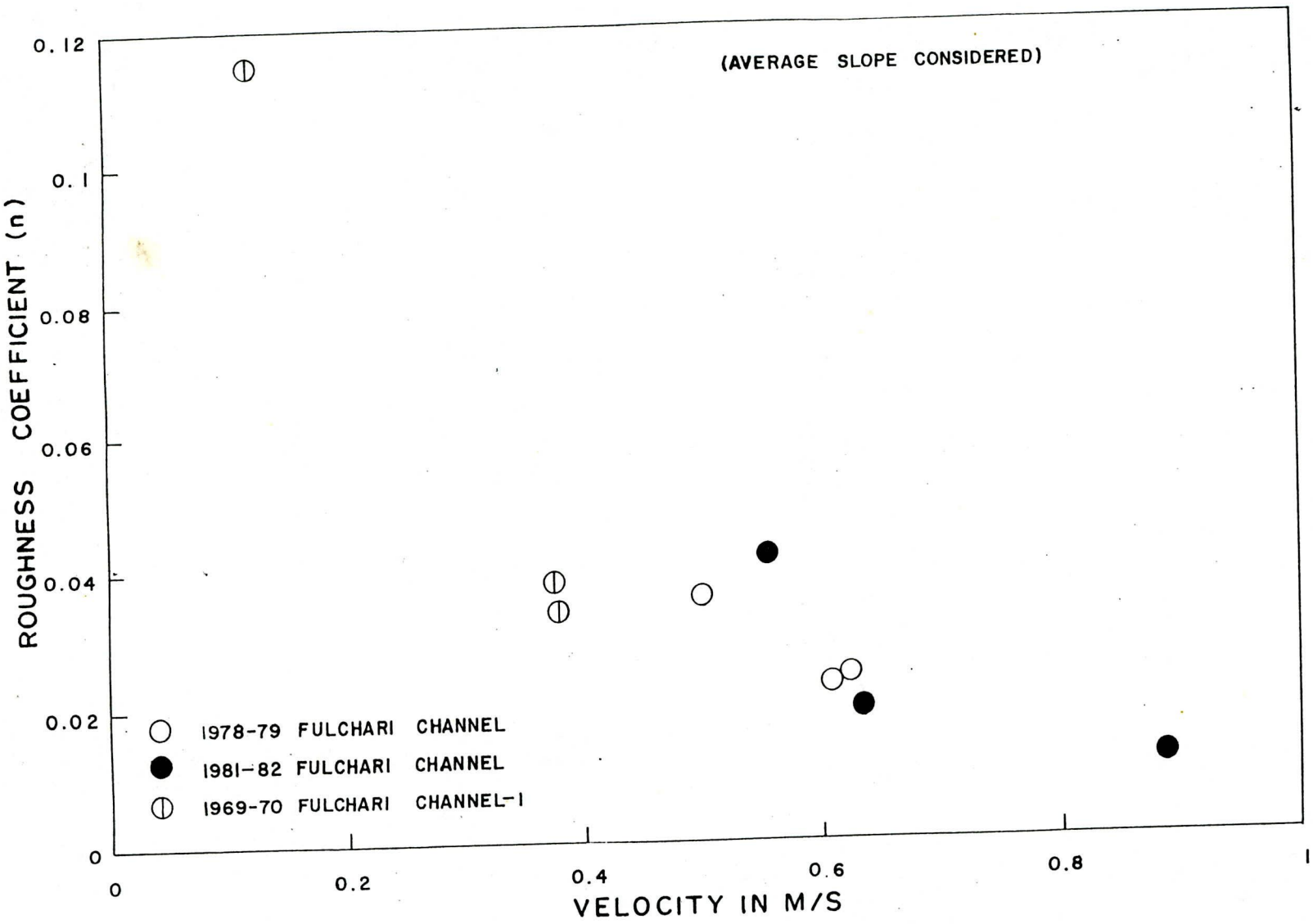


FIG:5·122 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON

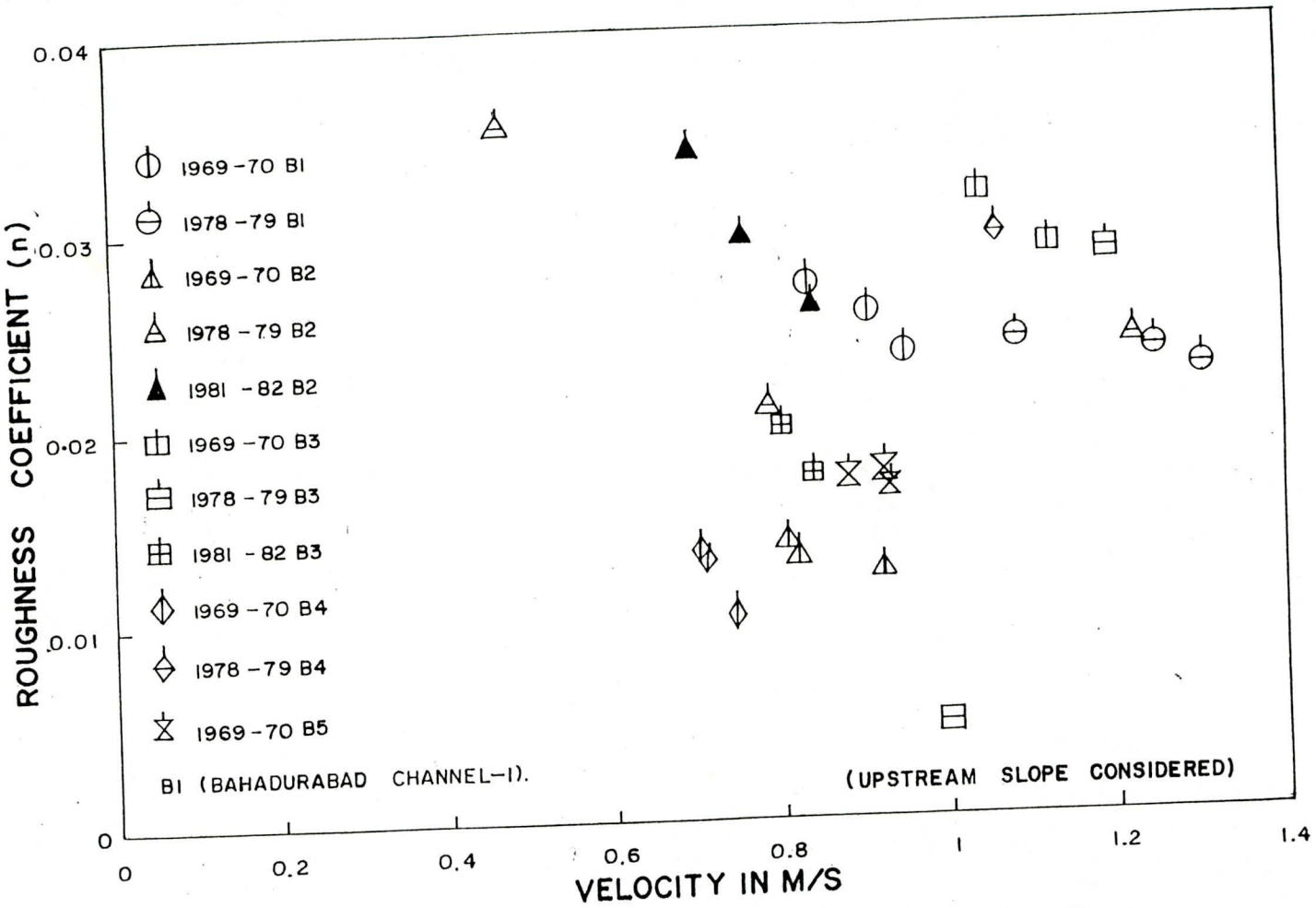


FIG:5·123 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON.

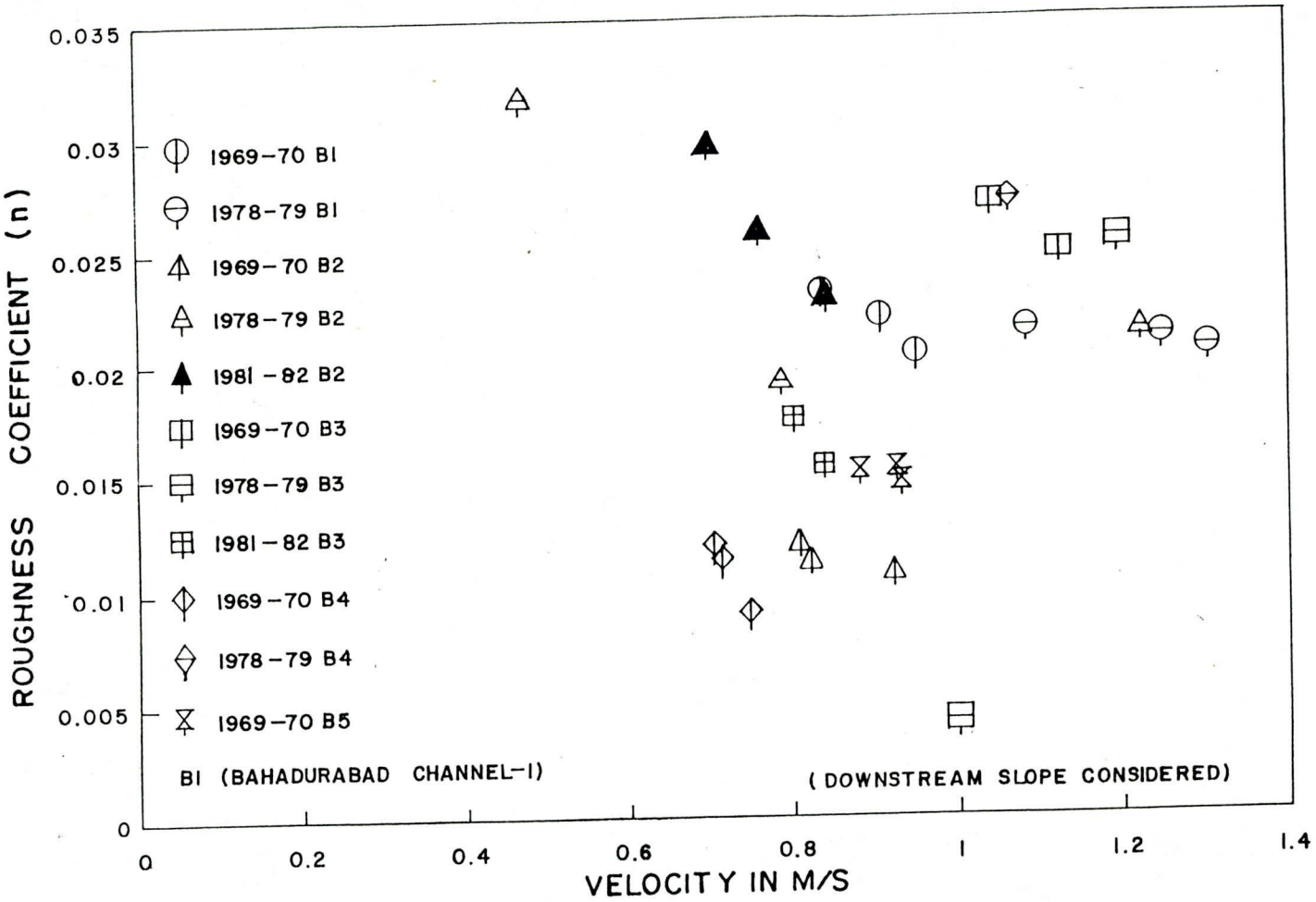


FIG:5·124 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON.

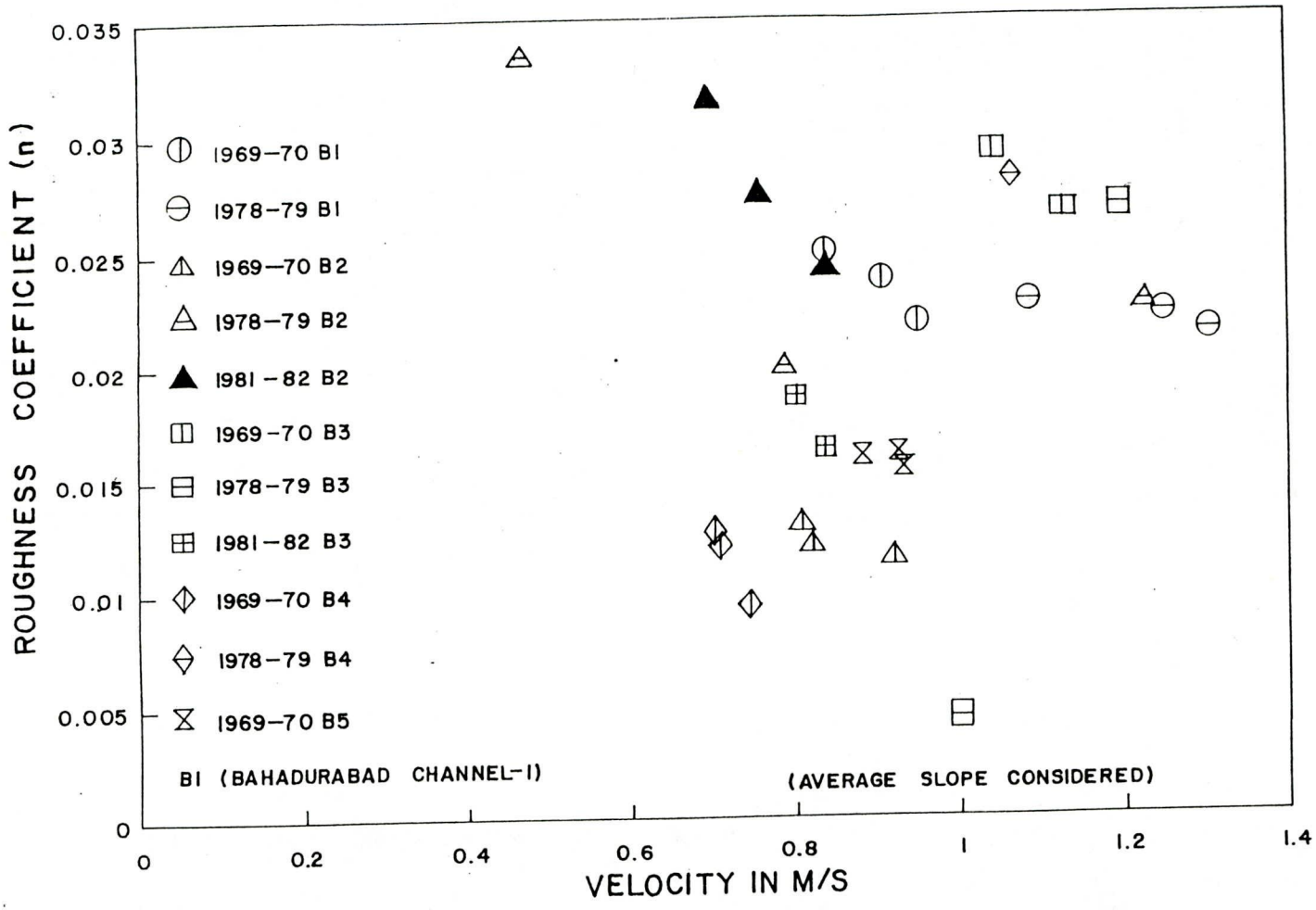


FIG:5·125 VELOCITY VS ROUGHNESS COEFFICIENT

DRY SEASON

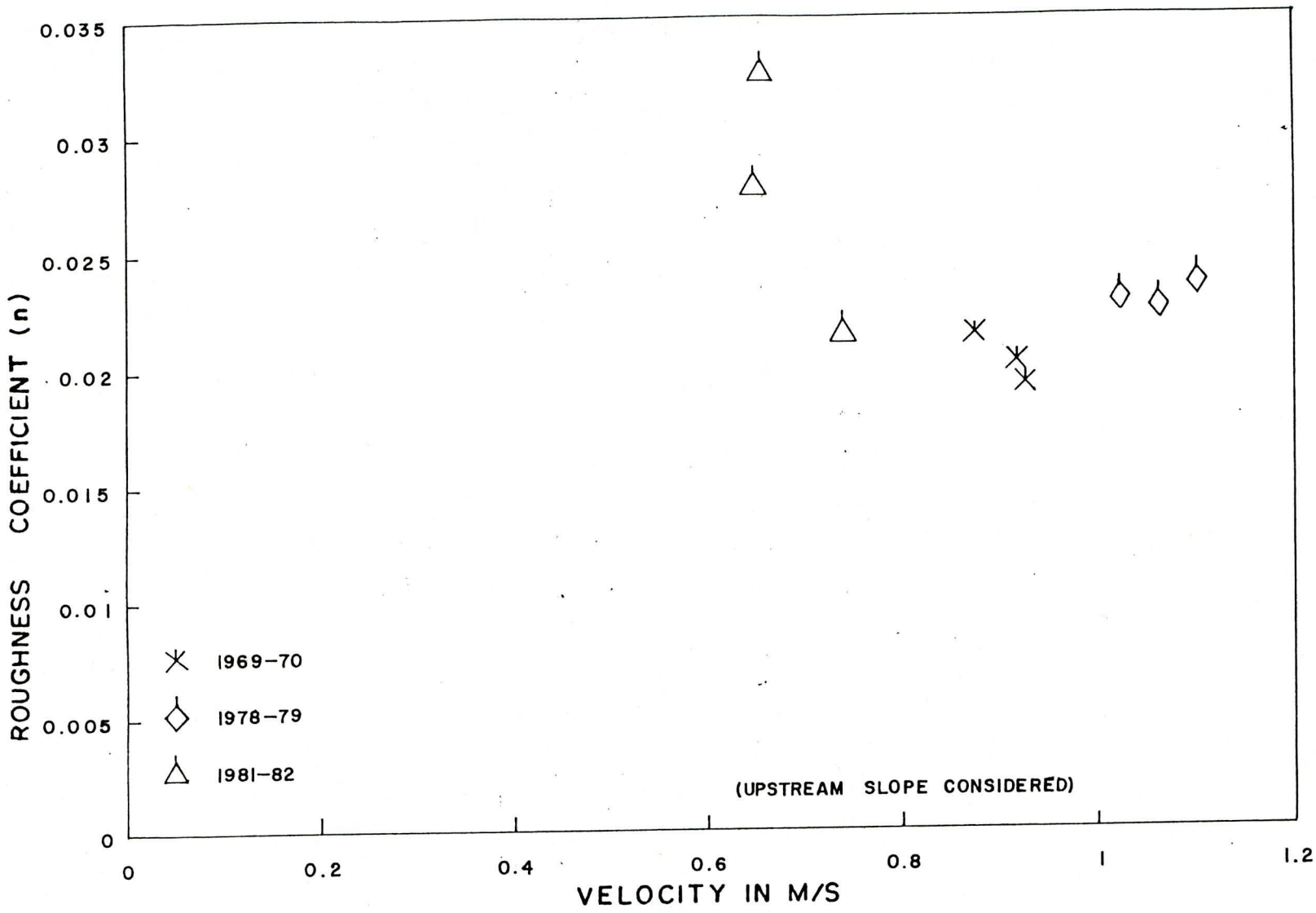


FIG: 5·126 VELOCITY VS ROUGHNESS COEFFICIENT
DRY SEASON (ALL CHANNELS TAKEN TOGETHER)

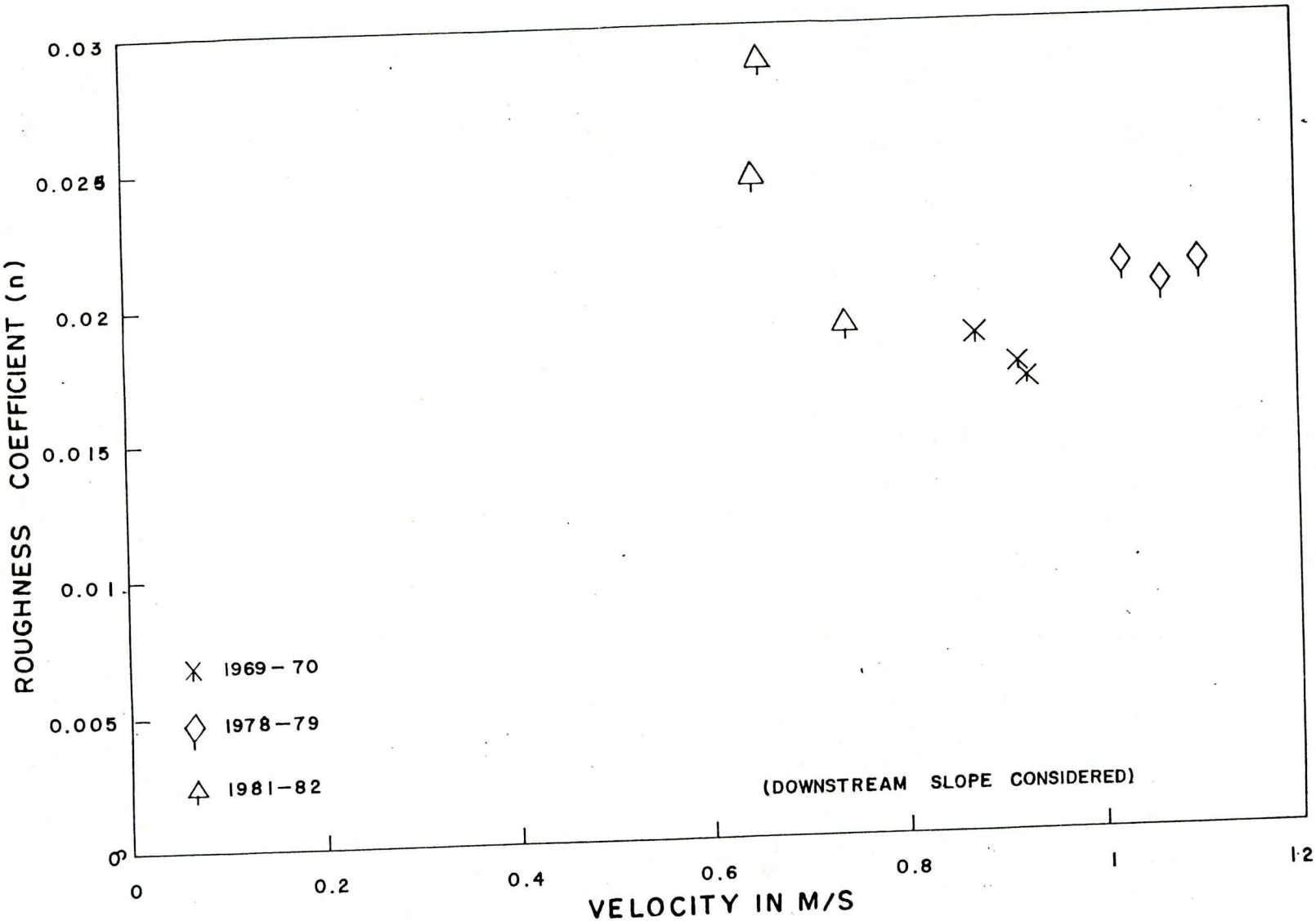


FIG:5·127 VELOCITY VS ROUGHNESS COEFFICIENT.
DRY SEASON (ALL CHANNELS TAKEN TOGETHER)

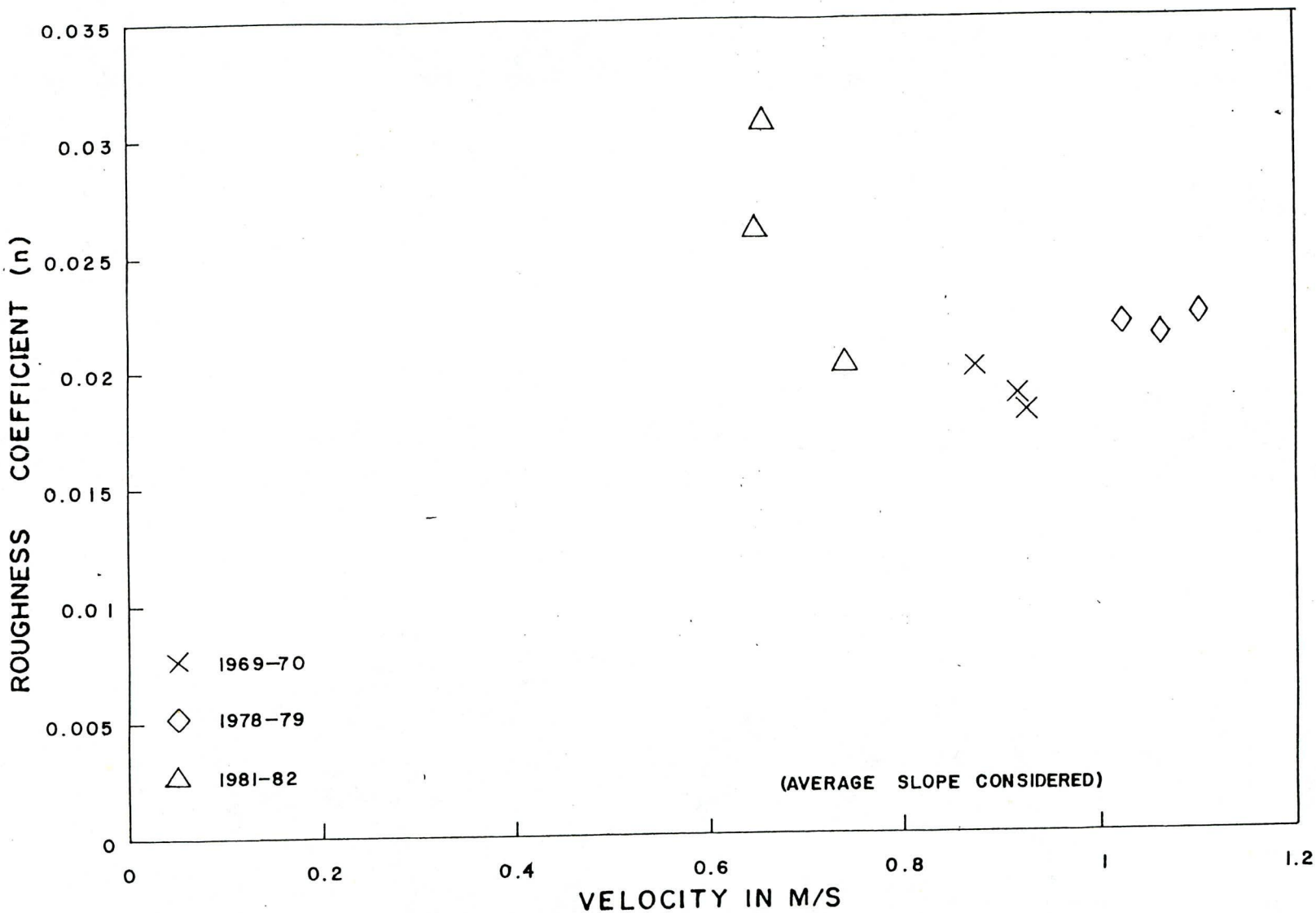


FIG: 5·128 VELOCITY VS ROUGHNESS COEFFICIENT.
DRY SEASON (ALL CHANNELS TAKEN TOGETHER)

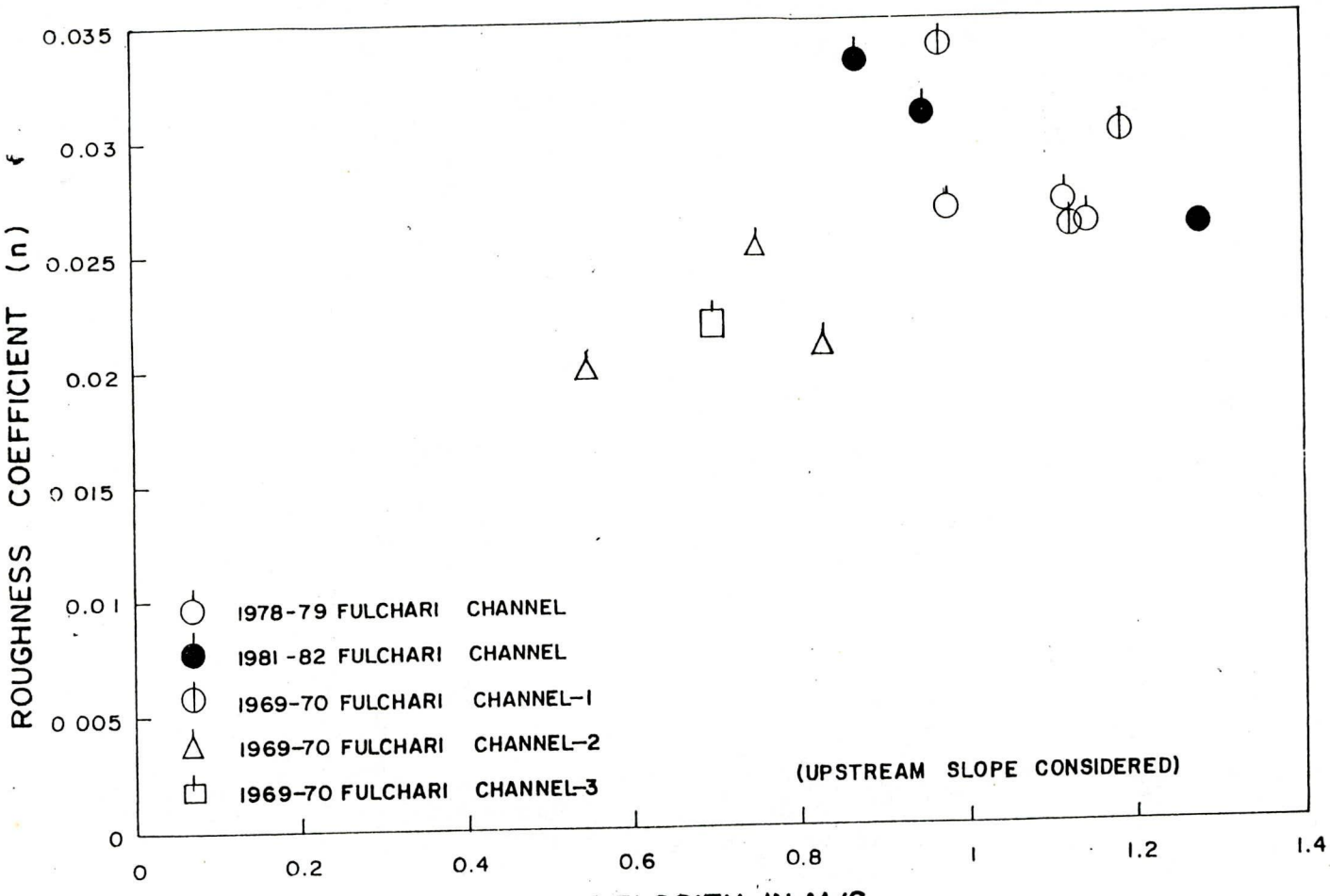


FIG:5·129 VELOCITY VS ROUGHNESS COEFFICIENT
WET SEASON.

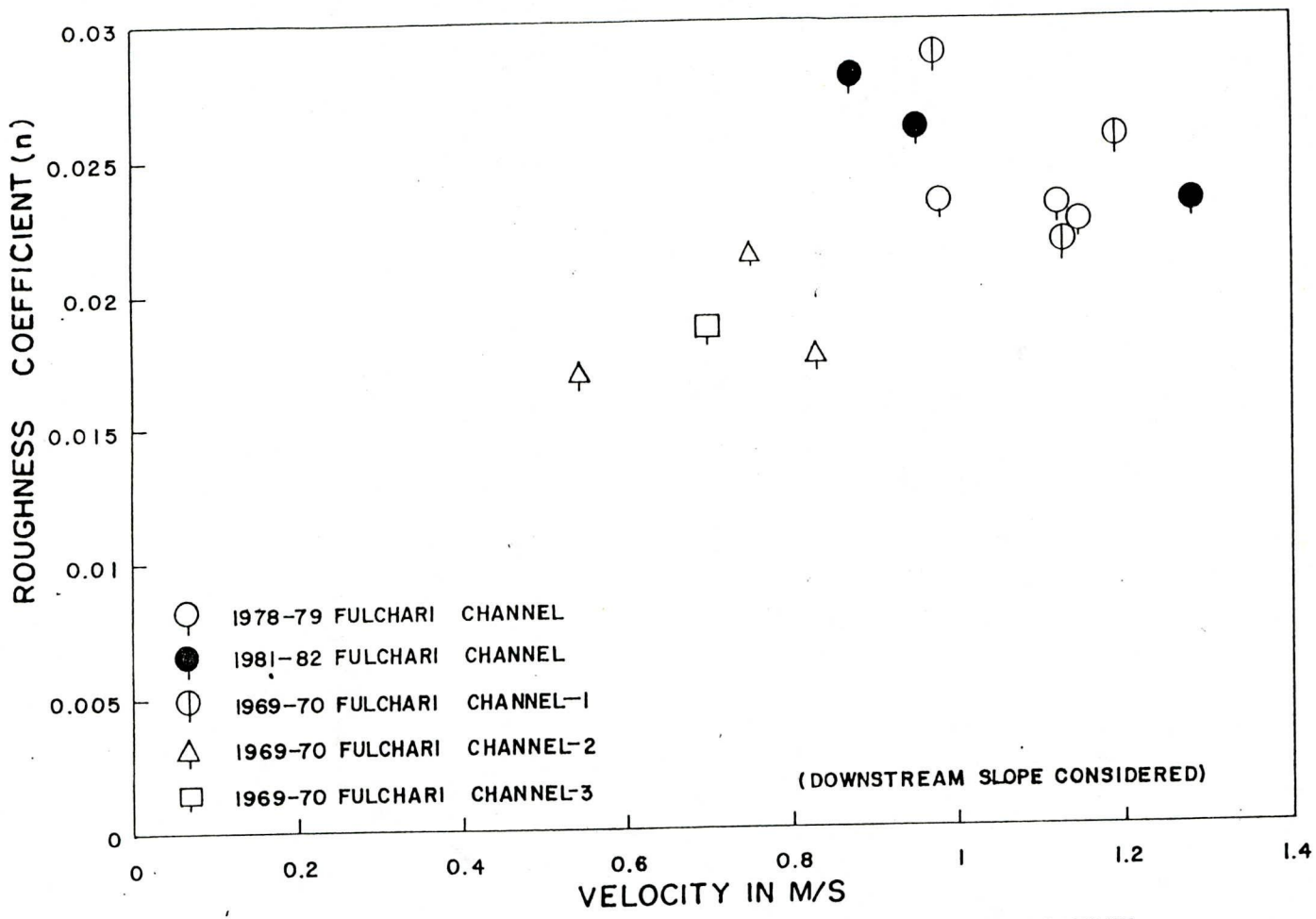


FIG:5·130 VELOCITY VS ROUGHNESS COEFFICIENT
WET SEASON

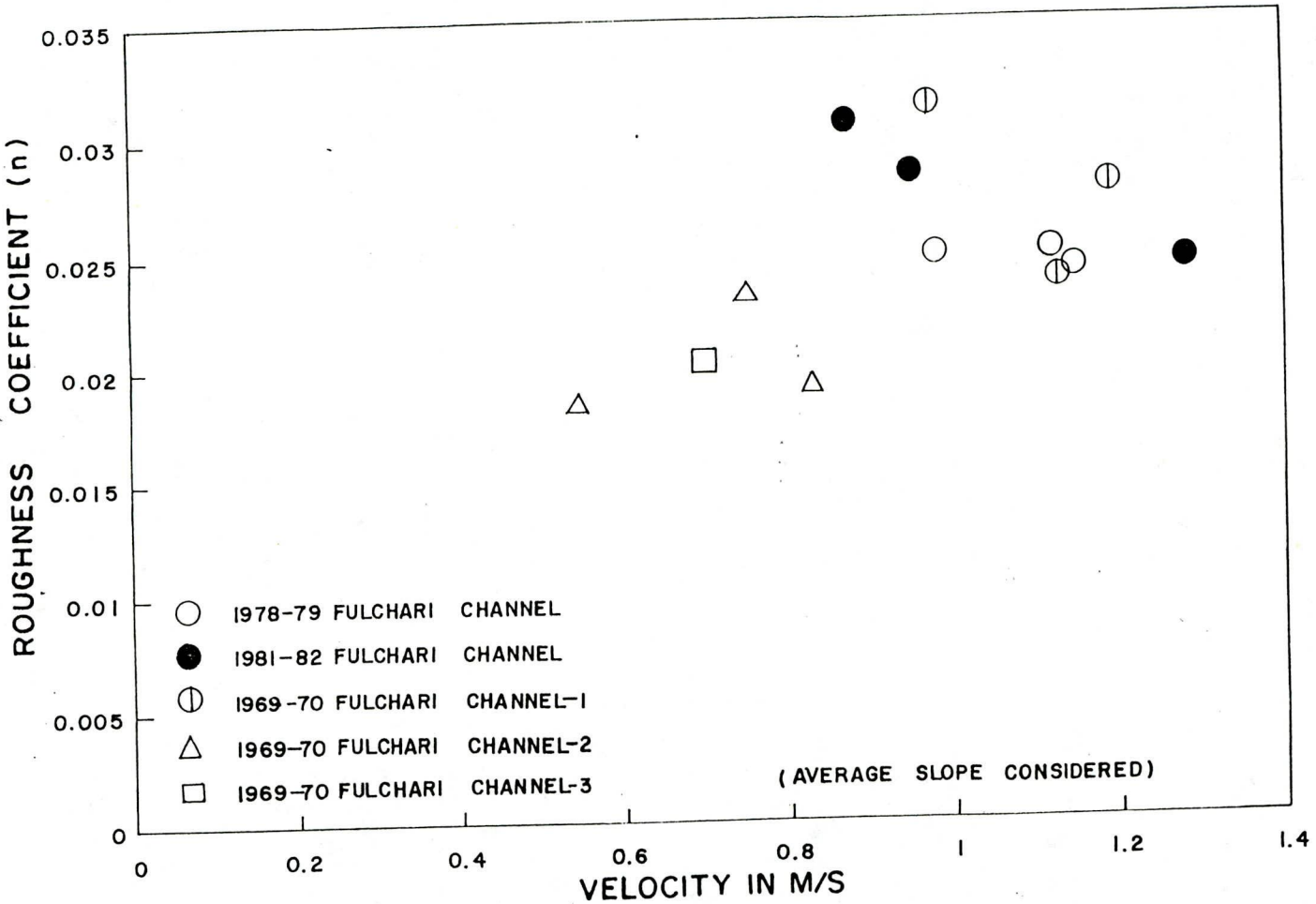


FIG:5·131 VELOCITY VS ROUGHNESS COEFFICIENT
WET SEASON.

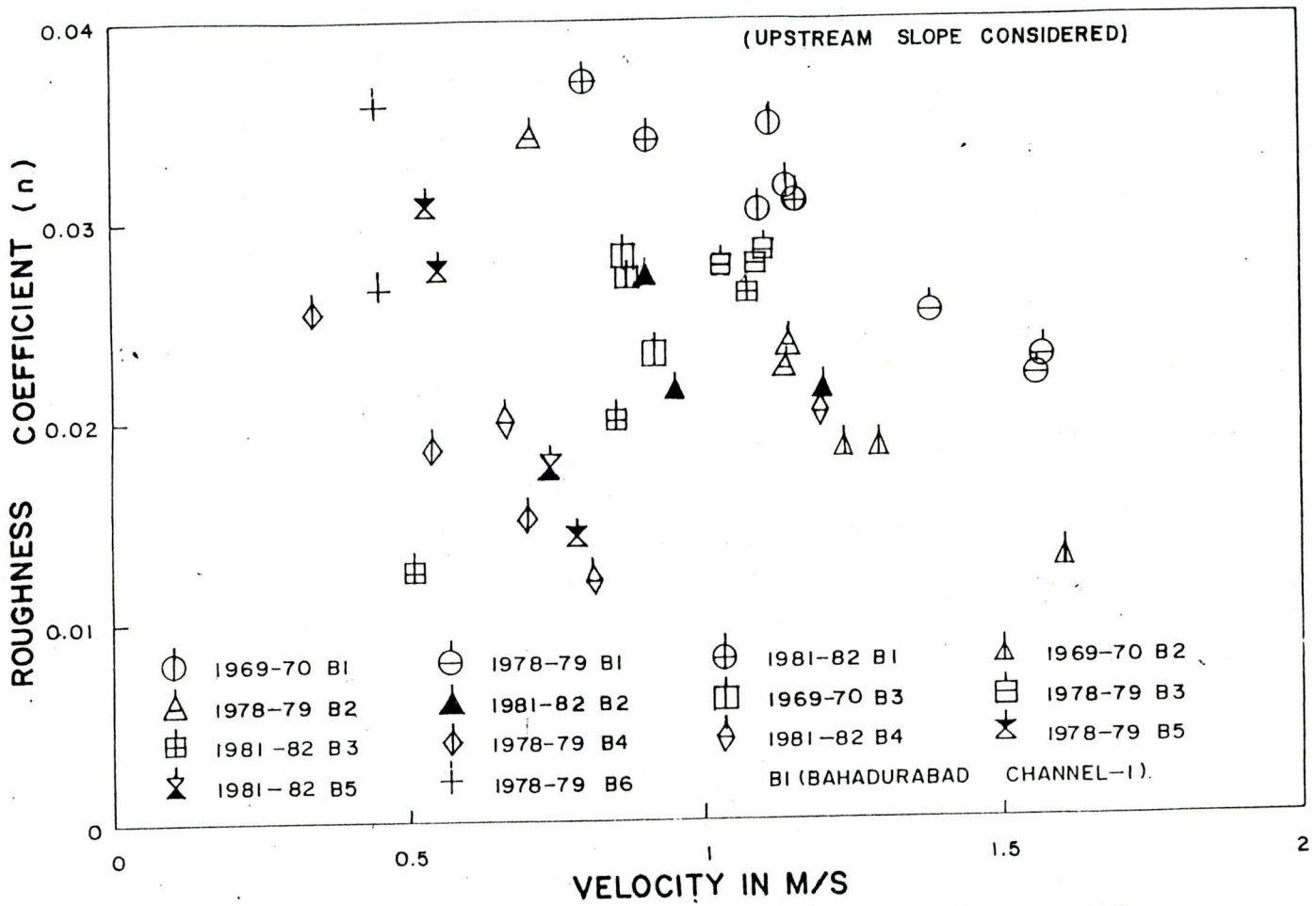


FIG:5·132 VELOCITY VS ROUGHNESS COEFFICIENT WET SEASON.

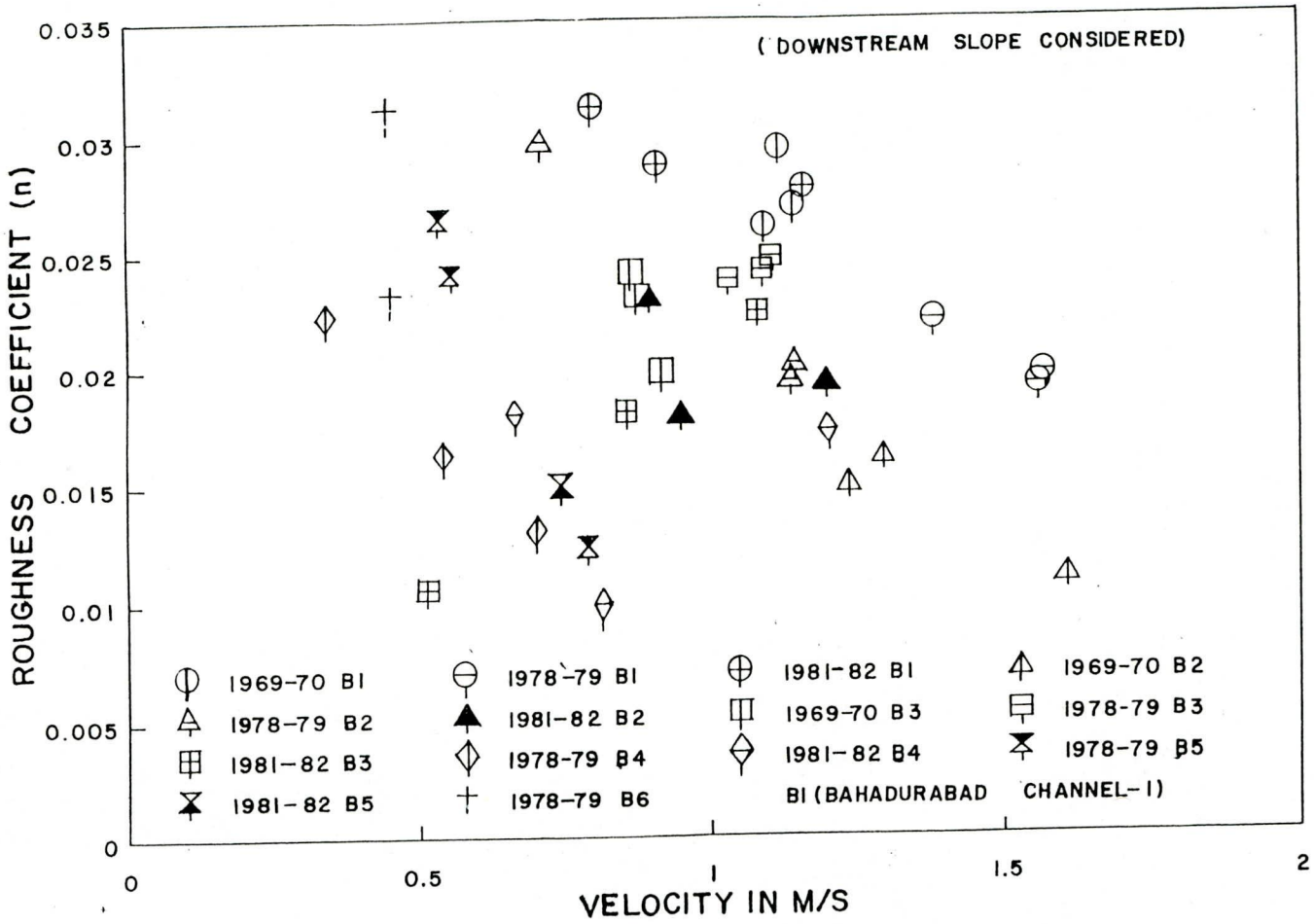


FIG:5·133 VELOCITY VS ROUGHNESS COEFFICIENT

WET SEASON

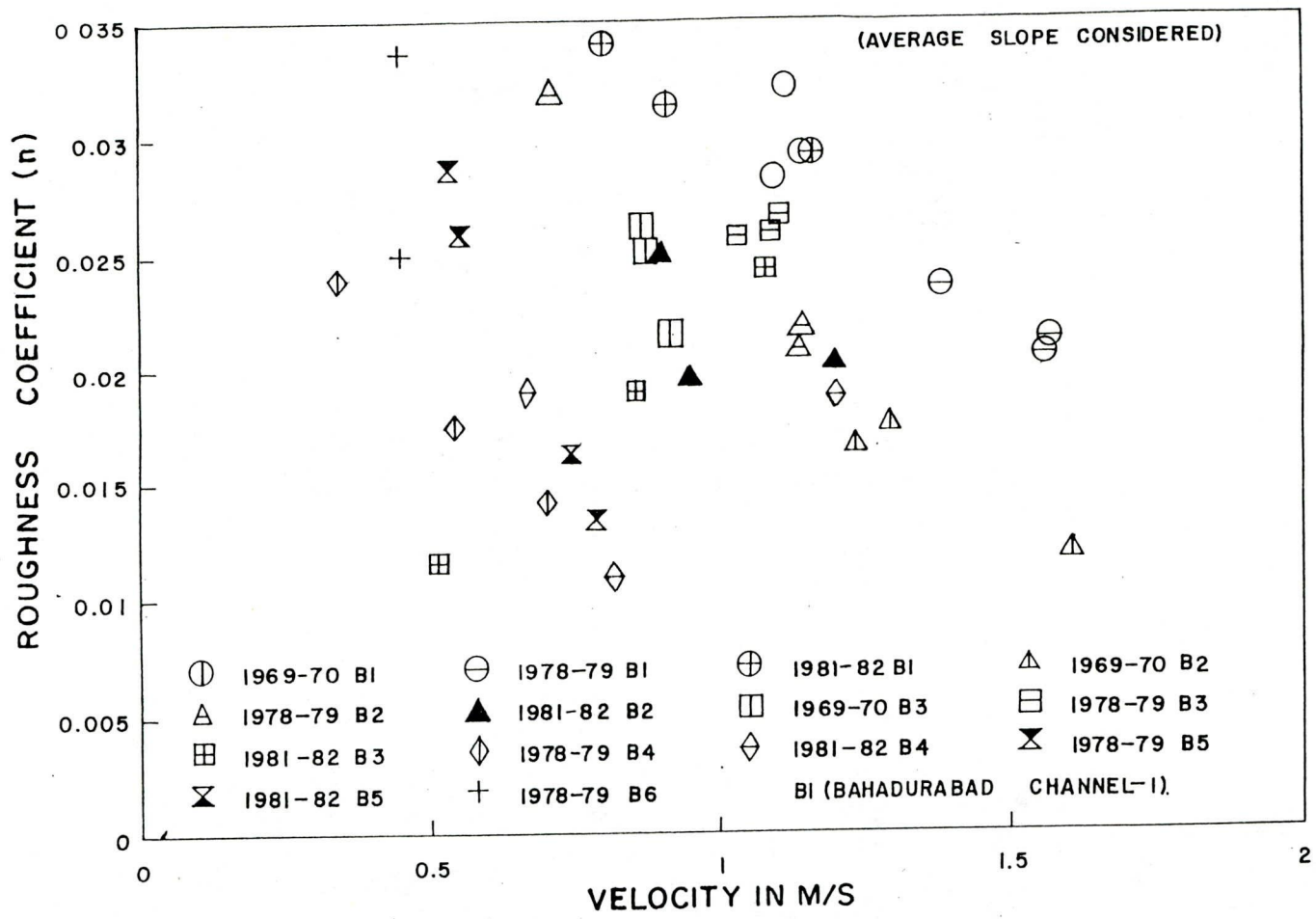


FIG:5·134 VELOCITY VS ROUGHNESS COEFFICIENT
WET SEASON

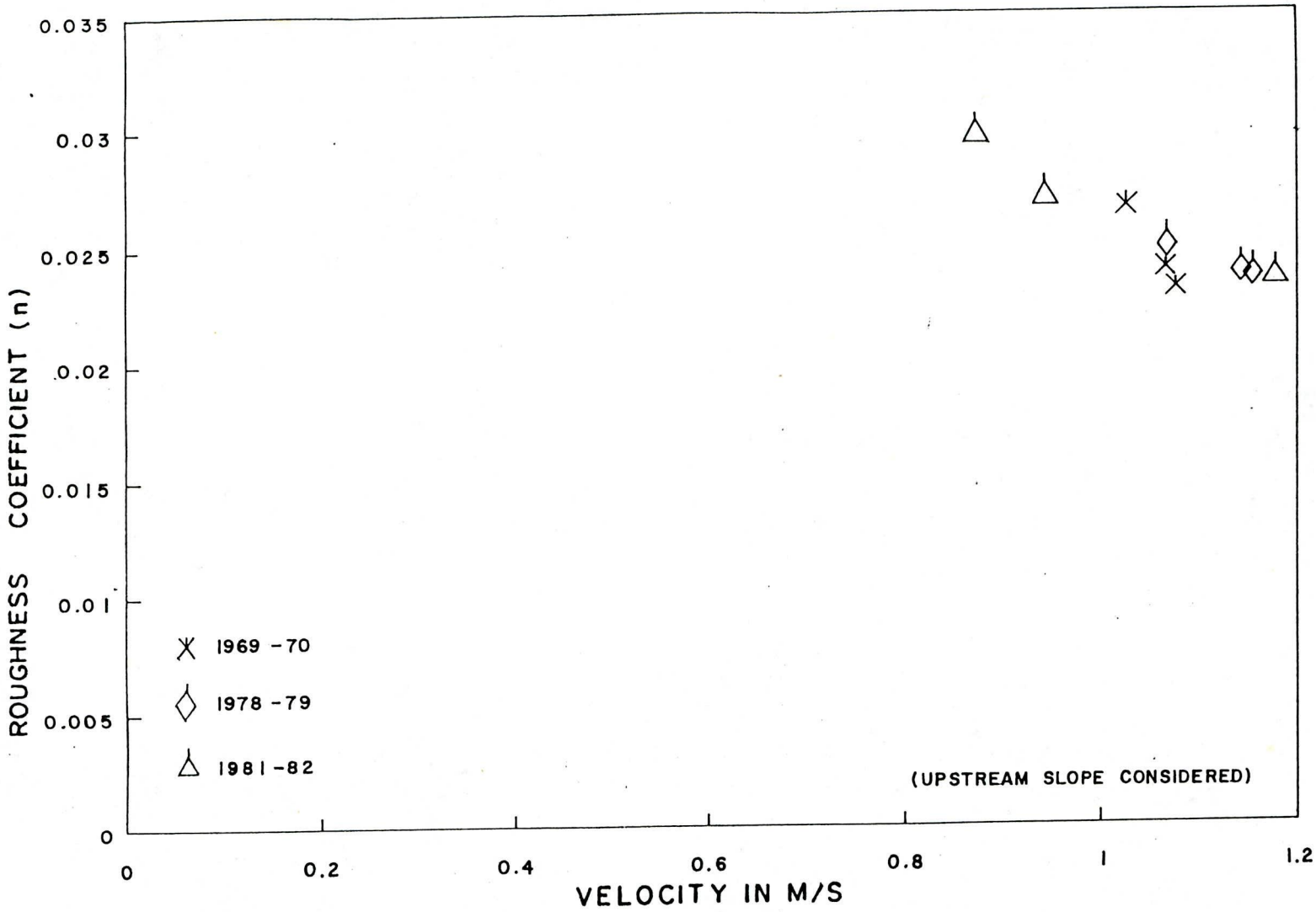


FIG.5-135 VELOCITY VS ROUGHNESS COEFFICIENT.
WET SEASON (ALL CHANNELS TAKEN TOGETHER)

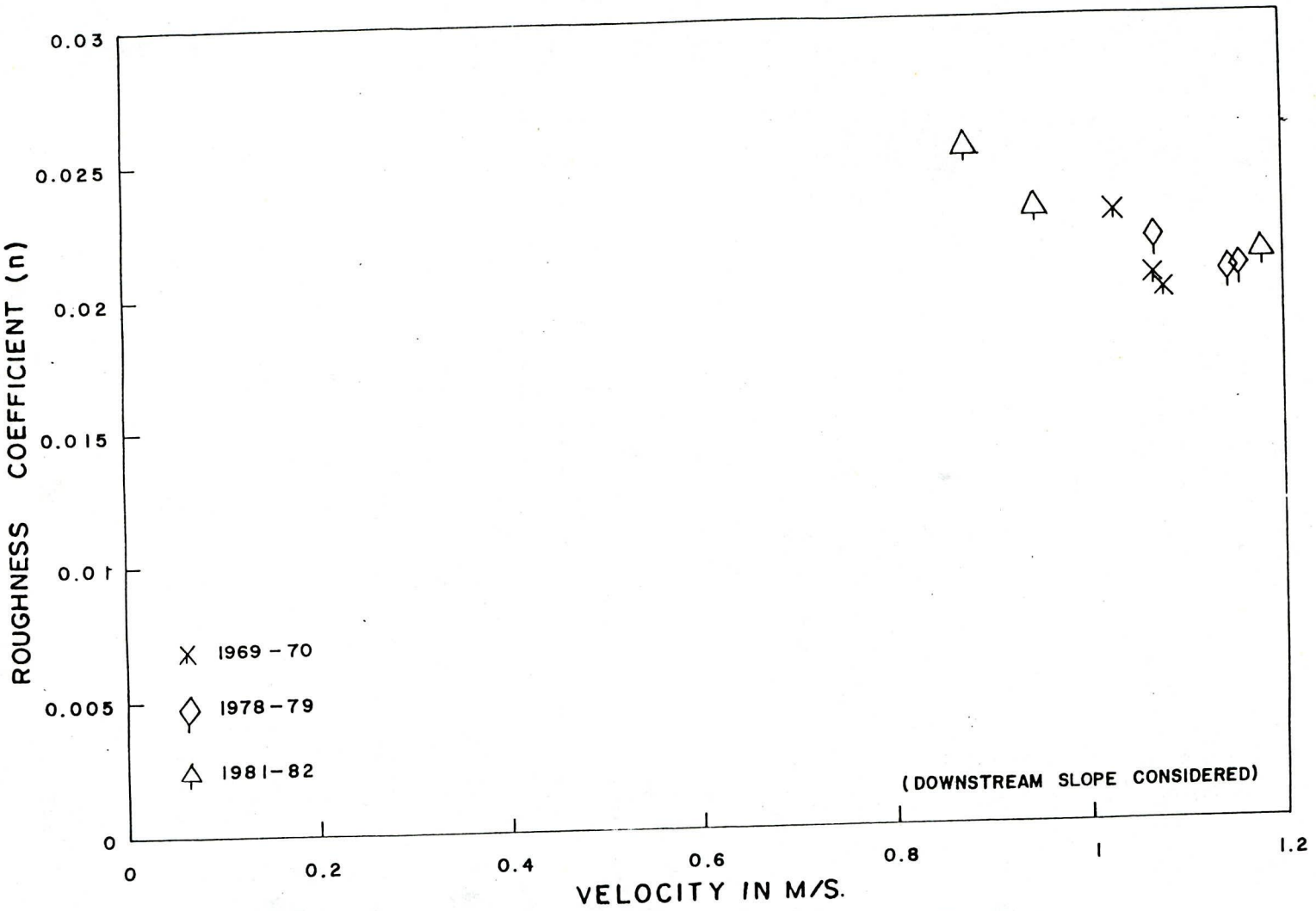


FIG:5·136 VELOCITY VS ROUGHNESS COEFFICIENT
WET SEASON (ALL CHANNELS TAKEN TOGETHER)

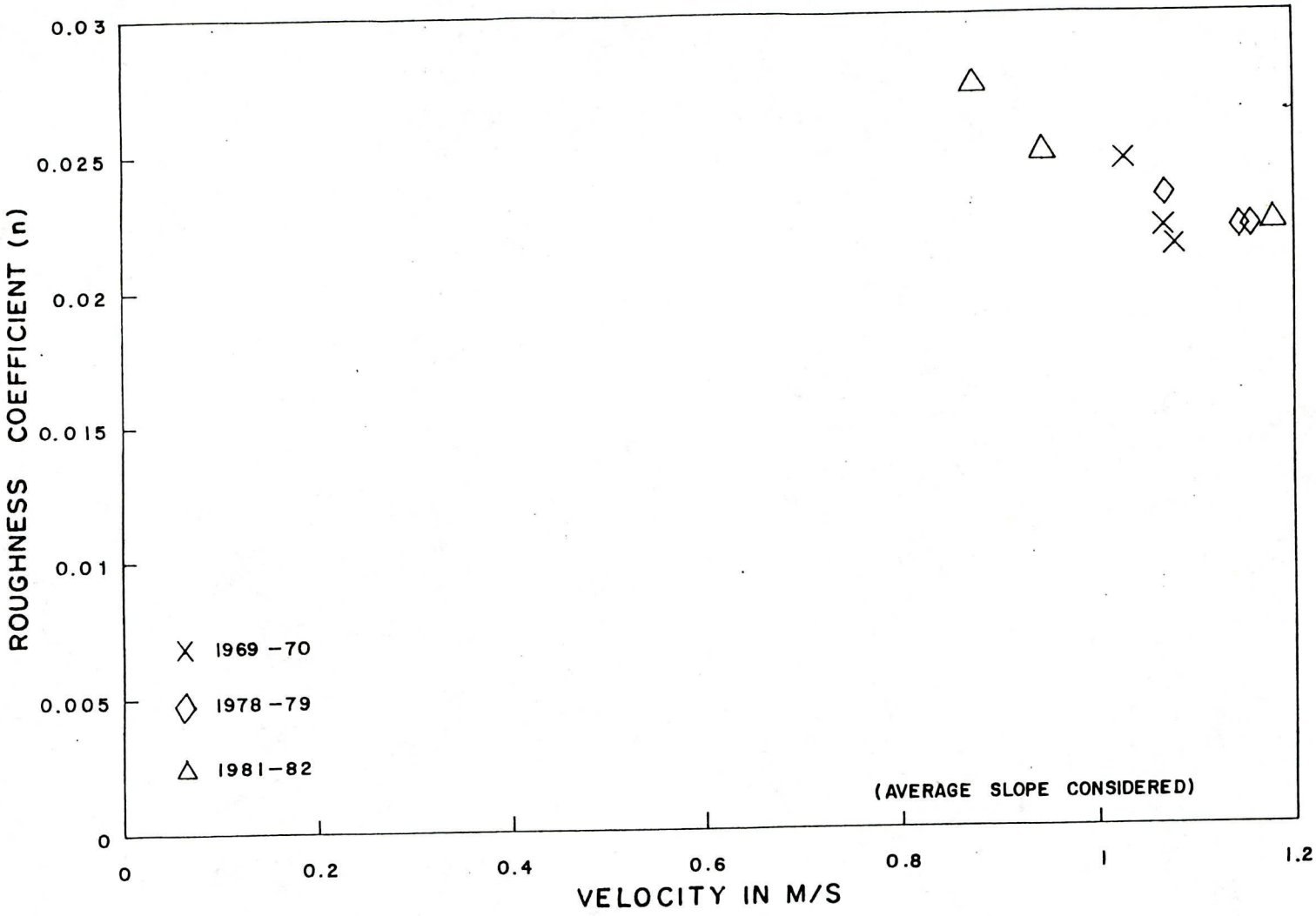


FIG:5·137 VELOCITY VS ROUGHNESS COEFFICIENT.
WET SEASON (ALL CHANNELS TAKEN TOGETHER)

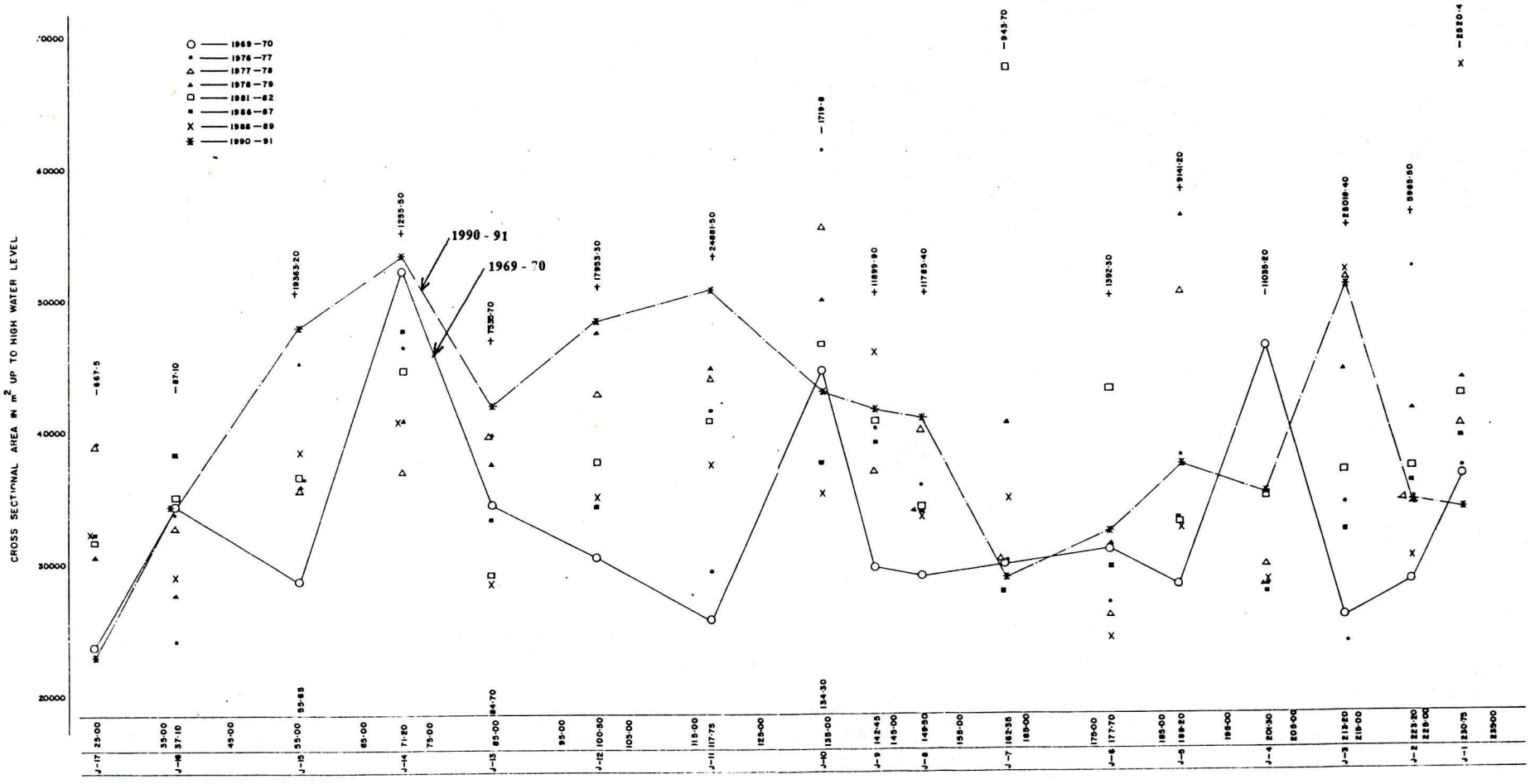


FIG : 5.138 CROSS SECTIONAL AREA VS DISTANCE ALONG THE RIVER

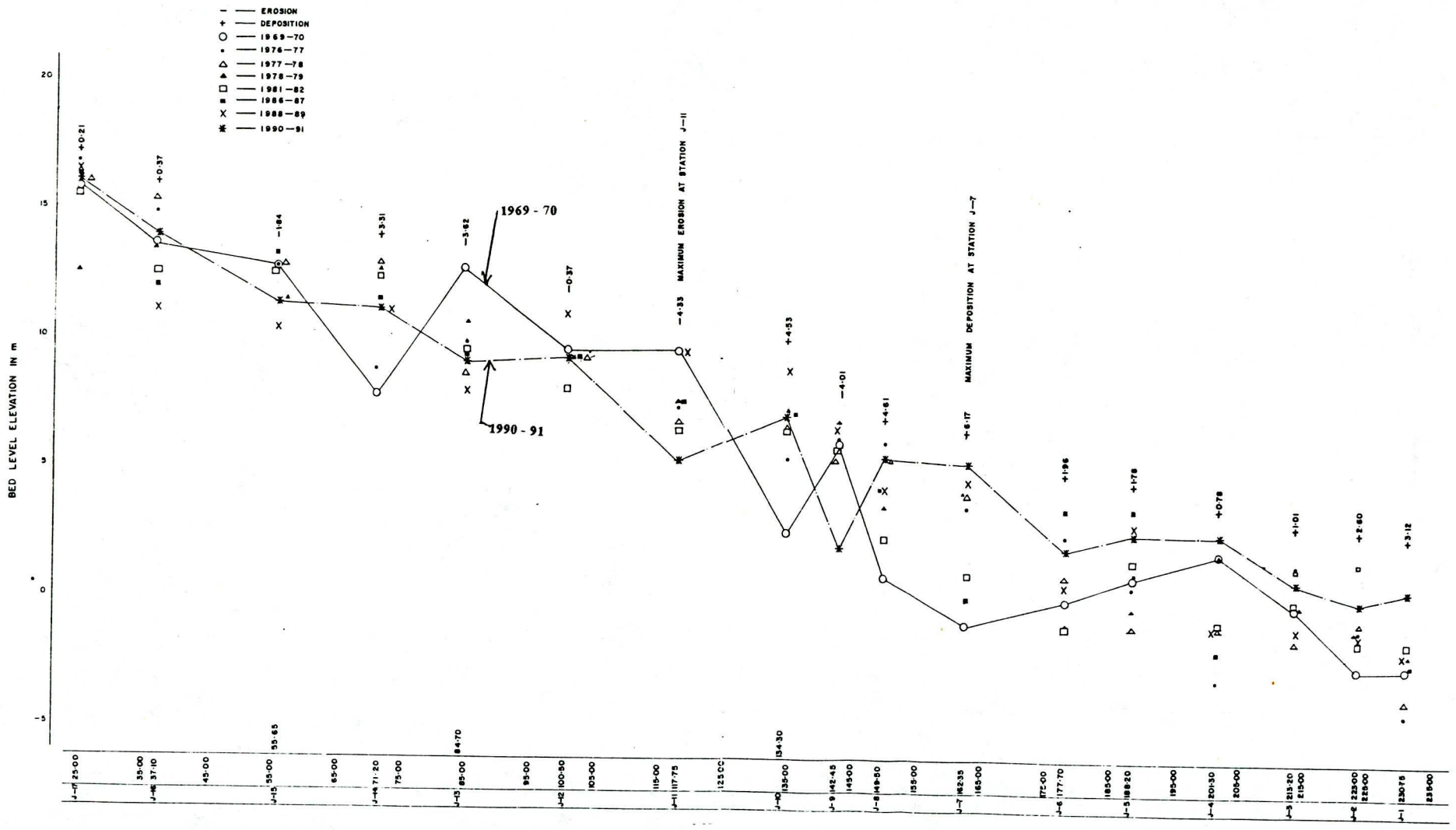


FIG : 5.139 BED LEVEL ELEVATION VS DISTANCE ALONG THE RIVER

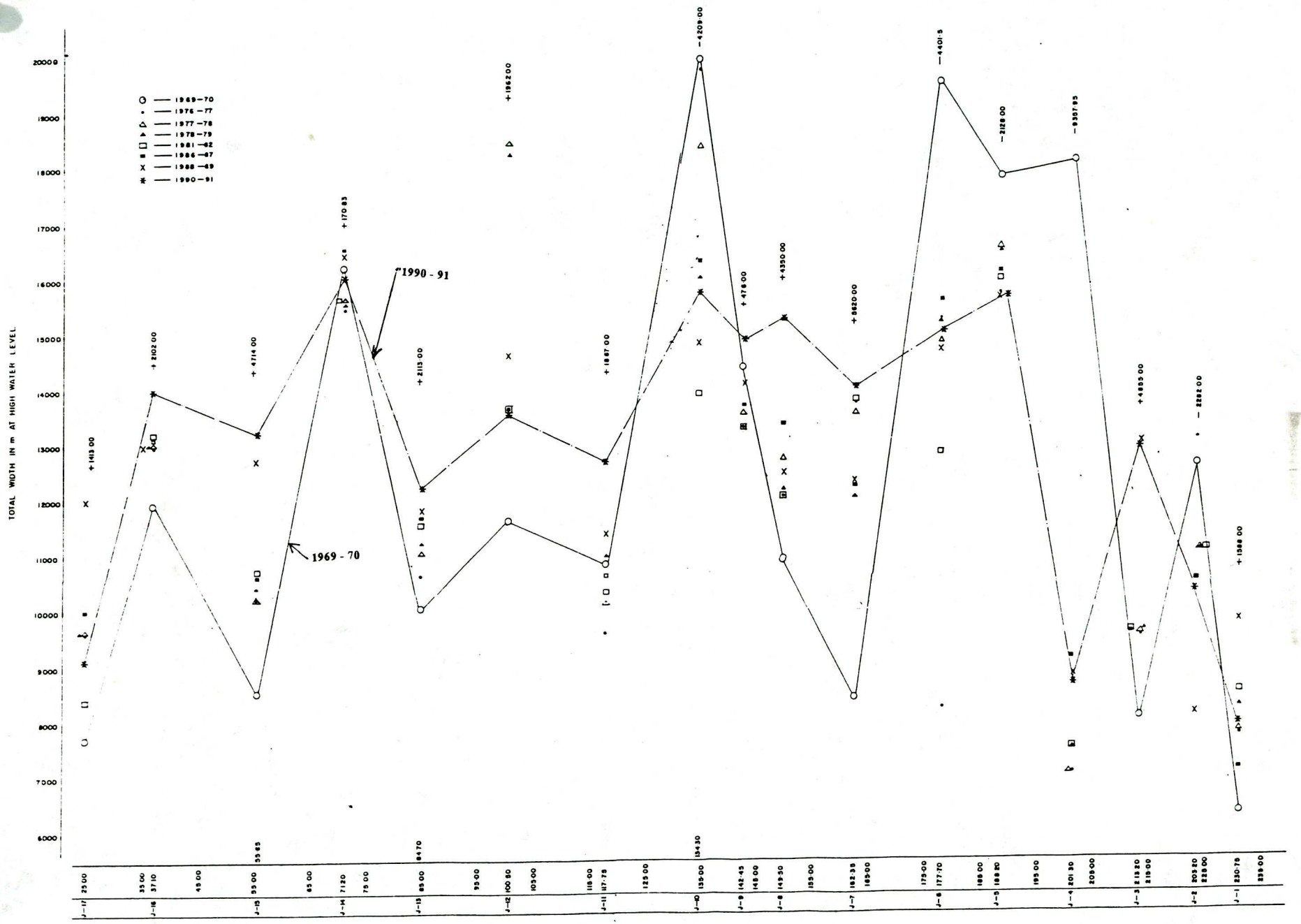


FIG : 5.140 TOTAL WIDTH VS DISTANCE ALONG THE RIVER

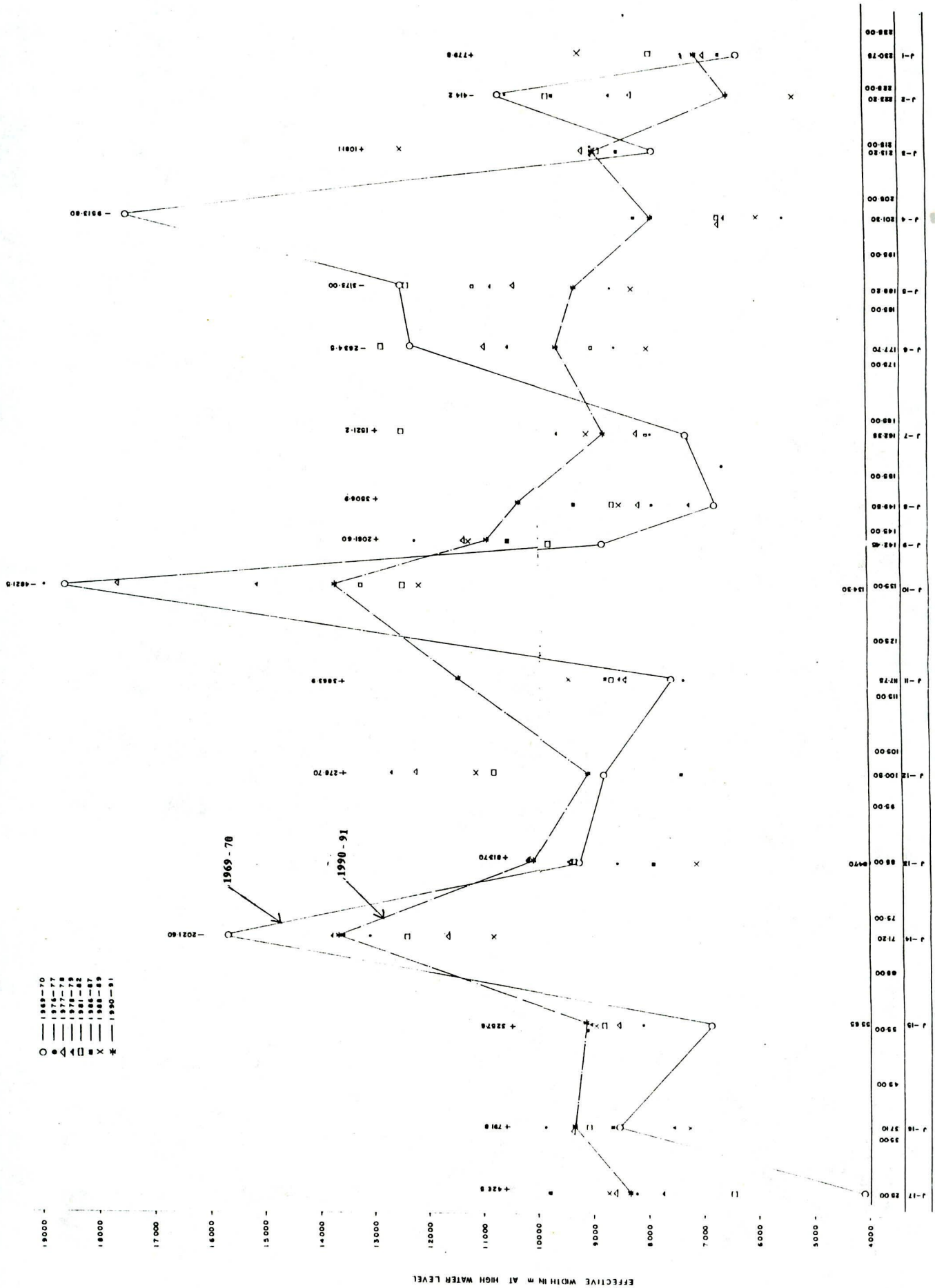


FIG : 5.141 EFFECTIVE WIDTH VS DISTANCE ALONG THE RIVER

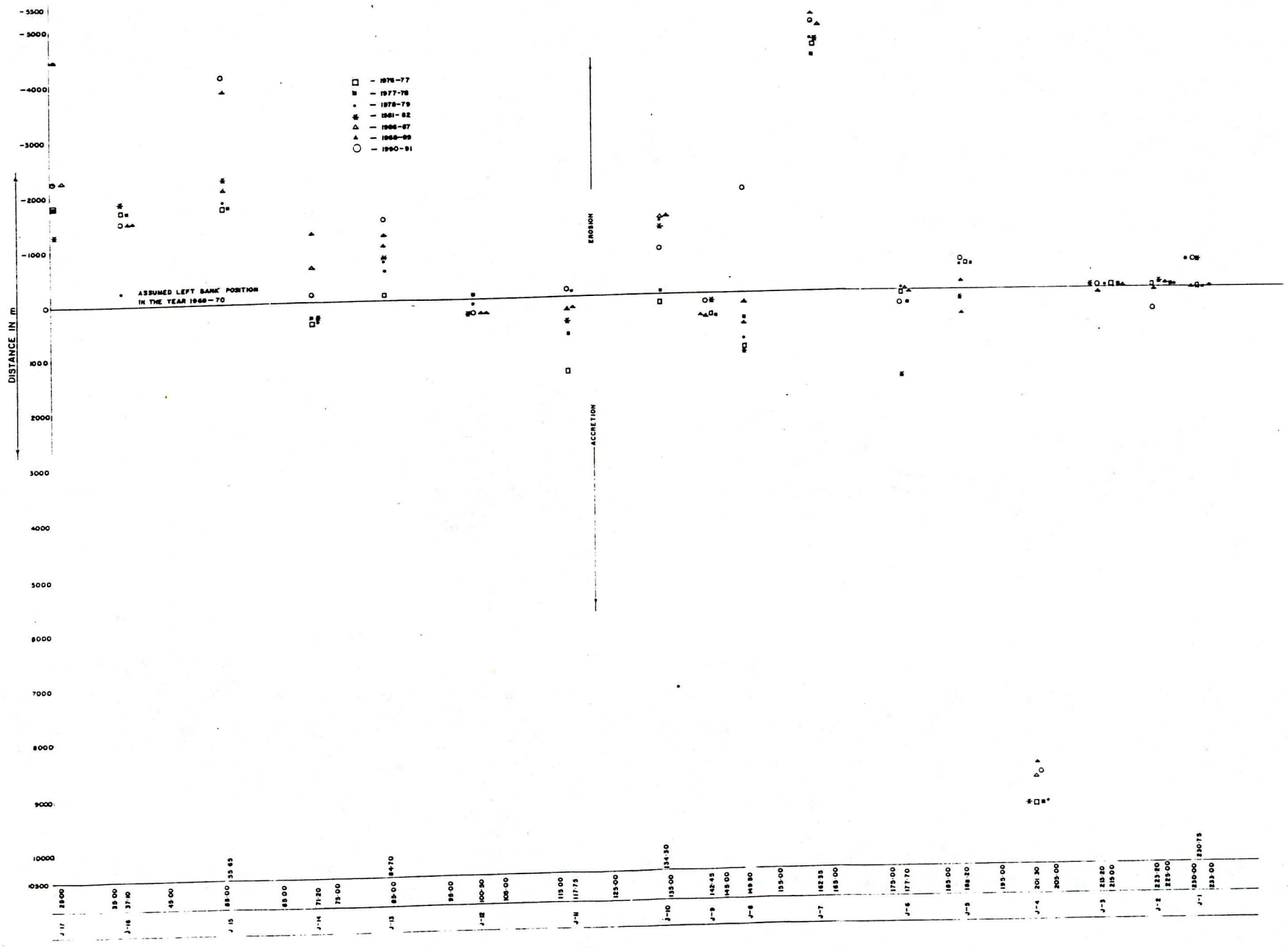


FIG : 5.142 MOVEMENT OF THE LEFT BANK DURING DIFFERENT PERIODS FROM 1969-70 TO 1990-91

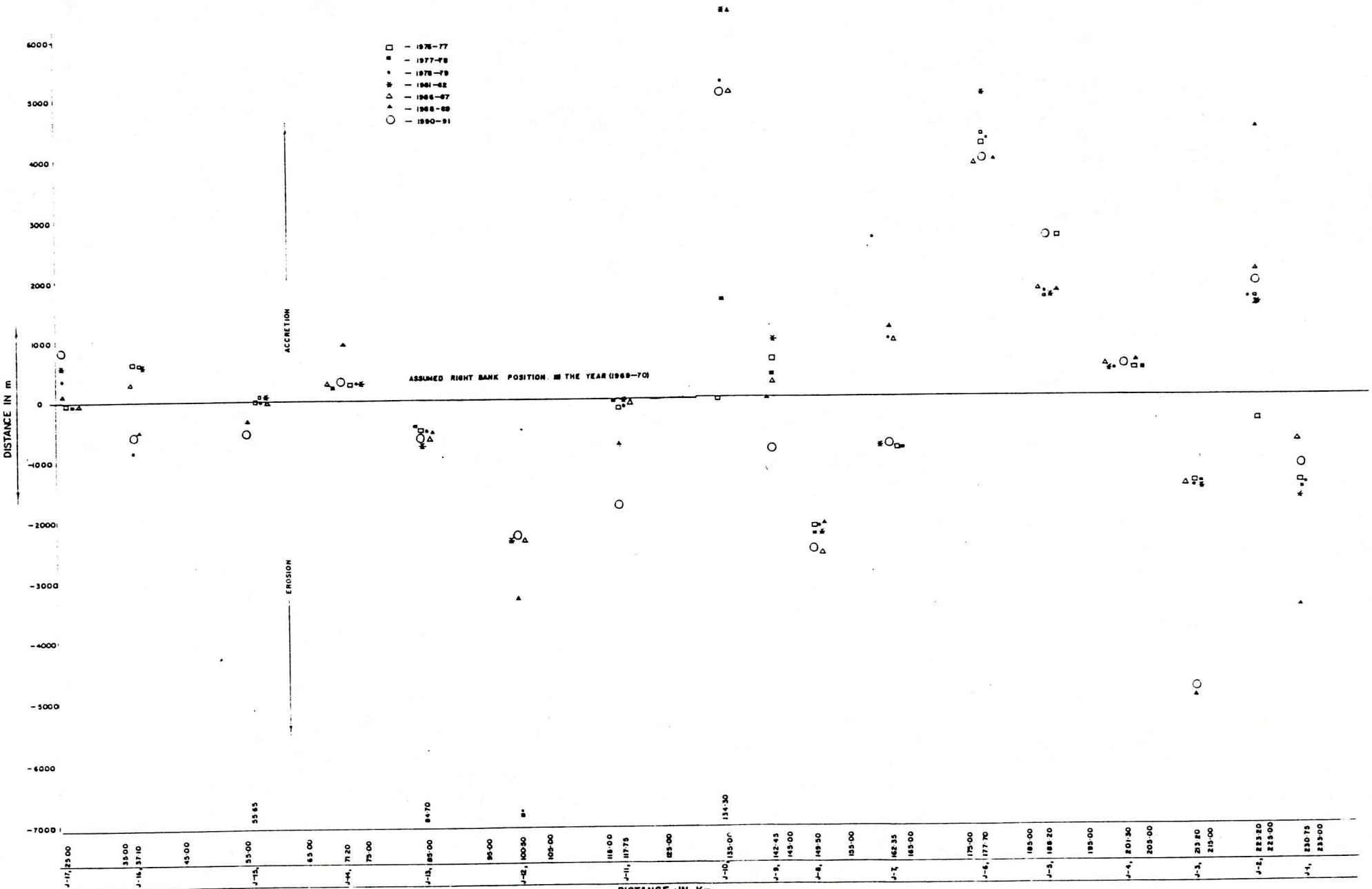


FIG:5·143. MOVEMENT OF THE RIGHT BANK DURING DIFFERENT PERIODS FROM 1969–70 TO 1990–91

Table 5.1 : Elevation and corresponding area , Section J-17 (Ch.25 km)

Elevation (m)	Year 1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
4.71				0				
5.5				17.954				
6.5				91.926				
7.5				213.286				
8.5		0		379.182				
9.5		0.35		609.338				
10.5		13.71		893.096		0		0
11.5		46.49		1203.389	0	4.4		5.01
12.5		99.86	0	1536.426	63.49	20.87	0	47.64
13.5	0	182.71	0.70	1889.753	209.37	50.84	51.70	161.93
14.5	78.33	378.24	190.0	2280.40	588.44	335.15	286.98	445.79
15.5	816.99	626.48	998.60	2835.10	1372.81	929.24	842.97	824.06
16.5	2121.97	1286.14	2606.5	3806.60	2698.48	1791.41	1636.95	1475.22
17.5	3865.97	2203.76	4989.90	5310.2	4570.07	3109.97	2878.47	2333.79
18.5	6175.43	3395.90	8222.40	7236.0	6982.96	5073.37	4862.50	3380.41
19.5	8977.10	5293.20	12620.90	9741.70	10159.30	7377.65	7928.96	4820.52
20.5	12086.09	9345.50	18017.60	13251.9	14444.18	10382.0	11832.37	6970.50
21.5	15508.56	15678.00	23737.50	17375.4	19311.90	15058.5	16597.03	10305.20
22.5	19150.73	22573.20	29879.60	22661.8	24633.80	22045.9	23034.6	15042.50
23.5	22994.40	30062.90	37514.60	29410.5	30628.50	30782.0	30886.0	21709.40
23.65	23601.20	31279.40	38795.20	30537.0	31589.90	32246.4	32164.7	22933.70
Effective width in m at elevation 23.65 m	4073.60	8224.60	8601.30	7751.50	6448.50	9791.10	8711.0	8338.00

Table 5.2 : Elevation and corresponding area, Section J-16 (Ch.37.10 km)

Elevation (m)	Year 1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
5.49								
5.5							0	
6.5							27.98	
7.5							186.23	
8.5				0	0	0	405.60	
9.5				58.98	152.44	299.32	712.67	0
10.5	0	0		213.54	448.39	817.21	1125.11	69.72
11.5	117.14	47.33	0	505.20	933.13	1505.14	1644.64	298.85
12.5	664.12	145.12	116.78	923.70	1701.11	2362.70	2271.25	689.42
13.5	1621.98	453.67	488.59	1433.30	2803.38	3417.97	3097.26	1342.28
14.5	2986.88	1221.38	1036.23	2036.54	4153.83	4748.10	4114.10	2192.41
15.5	4679.61	2602.27	1743.73	2855.80	5836.77	6327.84	5464.7	3146.94
16.5	6569.55	4533.28	3012.36	3929.97	7901.49	8416.69	7064.7	4760.90
17.5	8840.10	7609.11	5205.99	5377.77	10351.20	11453.82	8874.0	7644.47
18.5	12030.40	11351.05	8387.99	7881.60	13378.40	15062.70	11025.6	11015.74
19.5	16099.12	15412.00	12843.61	11530.00	17220.60	19173.20	13899.7	15210.4
20.5	20817.10	20080.80	18183.86	16208.70	21669.30	24119.00	17683.0	20280.6
21.5	26946.10	25646.50	24450.80	21436.60	27213.70	30325.70	22626.0	26430.7
22.49	34223.50	33626.90	32589.1	27703.0	34932.30	38245.30	28984.1	34136.4
Effective width in m at elevation 22.49 m	8543.10	9874.70	9342.5	7569.30	9073.40	8660.90	7242.8	9334.80

Table 5.3 : Elevation and corresponding area, Section J-15 (Ch.55.65 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-0.85							0	
0							43.64	
1.5							162.99	
2.5							269.17	
3.5							396.64	
4.5							545.41	
5.5				0			715.46	
6.5				1.11			906.81	0
7.5				56.02	0	0	1119.45	63.41
8.5		0	0	249.04	40.13	4.05	1354.55	282.27
9.5	0	3.80	19.53	584.19	216.70	95.06	1647.65	663.22
10.5	37.00	93.93	231.34	1128.58	670.43	239.69	1989.82	1476.96
11.5	417.33	608.81	776.07	1867.62	1233.48	495.38	2444.97	2658.01
12.5	1156.40	1800.42	1498.84	2886.95	1887.47	1085.42	3183.64	4109.72
13.5	2199.34	3581.03	2477.23	4223.20	2705.53	2093.69	4206.6	6021.80
14.5	3801.60	6057.44	3961.34	5853.53	4109.93	3752.90	5637.9	8570.77
15.5	6053.03	9289.10	6213.71	7951.20	6374.86	6086.78	7647.7	11688.69
16.5	8613.71	13466.36	9476.74	10735.00	9186.18	9017.04	10406.00	15374.9
17.5	11364.99	19120.18	13252.06	14124.0	12814.60	13088.8	14115.1	19762.2
18.5	14687.91	25700.50	17894.20	17918.4	17709.80	18003.4	19213.4	25965.3
19.5	18863.90	32766.90	23613.30	23576.70	23751.80	24098.6	25665.6	33385.4
20.5	24505.80	40030.90	30261.20	30416.0	31097.10	31035.8	33027.0	41777.4
21.15	28626.00	45056.00	35448.60	35773.8	36501.60	36373.6	38382.5	47989.2
Effective width in m at elevation 21.15 m	6829.60	8084.10	8510.10	9006.0	8774.80	9097.20	8940.5	10087.2

Table 5.4 : Elevation and corresponding area , Section J-14 (Ch.71.20 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
1.07	0							
1.5	17.35							
2.5	184.82	0						
3.5	472.13	0.38						
4.5	871.32	71.96					0	
5.5	1317.70	310.22			0		23.09	0
6.5	1846.09	771.42		0	1.15	0	116.03	4.41
7.5	2430.08	1362.58		18.46	36.10	6.04	229.64	41.93
8.5	3030.20	2089.10		111.07	133.78	39.81	423.49	168.40
9.5	3658.00	2964.68	0	473.18	281.33	285.32	781.40	757.93
10.5	4322.90	3931.08	68.6	1225.8	581.26	965.07	1420.45	1791.09
11.5	5141.10	4959.77	515.1	2167.78	1210.41	2480.34	2594.86	3276.38
12.5	6522.80	6081.90	1354.4	3621.85	2552.78	4671.64	4150.79	5541.25
13.5	8351.30	7606.90	2894.1	5733.12	5287.93	7268.69	6249.04	8277.12
14.5	10839.00	9688.00	5137.1	8586.81	8777.17	10386.82	9043.30	11486.59
15.5	14574.50	12530.50	8244.1	12002.76	12696.20	14507.81	12410.70	16021.30
16.5	19679.30	16760.90	12057.1	16501.30	17448.60	19681.80	16776.10	22461.00
17.5	26269.00	22375.00	17235.0	21708.0	23408.50	26153.40	21977.10	30122.50
18.5	35451.70	31041.60	24200.7	27529.20	31079.10	33667.40	28556.60	38528.20
19.5	47022.20	42088.20	33091.5	36346.30	40563.90	43347.10	37239.90	48829.90
19.84	52011.50	46342.00	36810.2	40682.10	44611.10	47610.40	40724.20	53267.00
Effective width in m at elevation 19.84 m	15624.60	13036.6	11605.10	13716.0	12368.0	13513.20	10751.50	13603.0

Table 5.5 : Elevation and corresponding area, Section J-13 (Ch.84.70 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
0.24							0	
1.5							10.60	
2.5					0		62.816	0
3.5				0	1.61		189.46	15.82
4.5			0	6.48	33.56	0	370.95	79.38
5.5		0	24.26	32.35	105.32	98.90	603.35	207.62
6.5		0.572	296.54	77.98	264.40	349.06	896.96	438.07
7.5		198.344	900.05	143.36	551.88	699.92	1266.54	879.03
8.5	0	811.28	1818.04	293.41	933.67	1177.03	1700.52	1521.26
9.5	9.57	1684.84	3017.24	783.70	1460.94	1816.86	2197.00	2504.81
10.5	133.90	2772.89	4541.53	1821.26	2264.28	2610.69	2876.57	3914.48
11.5	484.10	4232.46	6469.78	3494.11	3437.31	4064.40	3850.60	5883.50
12.5	1367.80	7144.97	9033.51	5695.31	5188.60	6147.14	5216.20	8388.40
13.5	3071.60	11228.24	11893.83	8563.90	7422.10	8942.51	7121.30	11804.40
14.5	5857.60	15658.97	15224.00	12216.50	9900.80	12162.10	9694.80	15970.00
15.5	10995.10	20343.00	19090.10	16589.00	13006.10	15768.40	12833.00	21392.10
16.5	17553.00	25816.40	24524.90	21950.70	17226.30	20243.10	16657.50	27299.20
17.5	25348.20	32057.20	31411.20	28547.30	22506.10	26177.40	21830.70	33709.80
18.5	34275.30	39595.10	39590.60	374773.20	29201.80	33244.50	28378.60	41811.00
Effective width in m at elevation 18.5 m	9202.30	8511.40	9362.60	10131.00	9308.10	7886.30	7076.90	10016.00

Table 5.6 : Elevation and corresponding area, Section J-12 (Ch.100.50 km)

Elevation (m)	Year						
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
3.57	0				0	0		
4.5	2.64		0	0	1.79	41.38		0
5.5	53.99		1.16	40.78	221.70	135.60	0	80.22
6.5	152.38		66.29	190.81	696.32	254.73	13.23	304.24
7.5	362.29		332.38	602.77	1343.94	469.83	85.24	684.86
8.5	791.41		1033.28	1398.78	2254.99	896.44	220.02	1417.78
9.5	1428.48		2478.77	2645.82	3449.63	1990.40	440.56	2819.18
10.5	2465.86		4731.96	4846.08	4973.66	3646.75	1080.95	5136.76
11.5	3936.77		7709.50	8348.07	6976.77	6085.01	2494.40	8769.72
12.5	6222.00		11629.45	12924.82	10019.56	9144.75	4921.44	13375.53
13.5	9356.80		16074.36	18050.97	13796.40	12795.40	8615.76	19040.16
14.5	13417.50		21163.80	23668.50	18271.80	17221.30	13406.48	25710.30
15.5	18299.00		27243.90	30264.30	23516.40	22677.30	19355.60	33300.40
16.5	23988.60		34373.20	38213.00	29915.00	28563.20	26493.00	41110.60
17.37	30352.20		42731.70	47395.20	37611.20	34241.80	34919.90	48305.50
Effective width in m at elevation 17.37 m	8734.40		12159.10	12635.20	10746.40	7360.60	11058.20	9013.10

Table 5.7 : Elevation and corresponding area, Section J-11 (Ch.117.75 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-1.56								0
-1.5								0.13
0			0		0			86.45
1.5			16.29		2.84	0		426.35
2.5			58.86	0	92.78	22.85		796.04
3.5		0	135.68	0.02	286.24	100.78		1279.89
4.5		2.65	484.90	60.7	583.19	363.13	0	1896.71
5.5	0	187.09	1058.96	341.5	1110.65	800.90	2.8	2721.40
6.5	2.70	684.54	1935.59	938.6	2085.71	1414.58	58.6	3744.27
7.5	140.8	1597.30	3153.08	2084.2	3304.60	2184.05	268.57	5078.28
8.5	451.40	2788.69	4802.05	4122.0	4939.90	3477.49	817.92	6704.50
9.5	1100.30	4456.04	7381.48	6968.4	7317.53	5396.84	1889.88	8649.30
10.5	2979.4	6527.66	10914.20	10718.44	10405.9	7766.87	3545.32	11345.50
11.5	5484.4	8815.67	14945.50	15522.0	13928.2	10729.3	5721.71	15170.10
12.5	8546.7	11404.38	19743.70	20694.9	18028.9	14811.3	9184.08	20197.00
13.5	12034.10	14618.10	25403.70	26272.4	22872.9	20622.5	14676.39	26765.60
14.5	15972.9	18846.00	31666.10	32230.6	28478.3	27656.30	22036.80	34259.40
15.5	20967.9	24487.70	38206.20	39048.6	35188.6	35381.2	30616.20	42851.40
16.25	25690.5	29413.40	43958.70	44760.1	40723.5	41497.9	37470.60	50572.00
Effective width in m at elevation 16.25 m	7513.00	7318.50	8375.6	8465.6	8600.00	8711.60	9350.50	11376.90

Table 5.8 : Elevation and corresponding area, Section J-10 (Ch.134.30 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-4.88	0							
-4.5	10.59							
-3.5	139.82							
-2.5	382.70							
-1.5	663.10	0						
0.0	1181.63	0.27		0				
1.5	1816.76	96.97	0	0.02	0			
2.5	2240.89	533.48	2.25	57.75	78.03			0
3.5	2683.11	1174.67	79.78	177.79	345.73	0		0.06
4.5	3156.12	2129.61	529.58	348.61	784.02	66.58		93.36
5.5	3665.90	3196.68	1389.68	677.93	1386.55	454.78		454.79
6.5	4514.90	4405.38	2535.07	1487.74	2286.57	1141.49	0	1386.53
7.5	5570.00	6029.19	4002.42	2862.72	3837.57	2203.21	26.6	2925.65
8.5	6947.70	8806.31	6492.63	5597.08	6499.34	3753.15	1181.5	4935.55
9.5	9007.10	12616.40	9589.45	9421.28	9973.81	6336.41	3517.7	7510.63
10.5	11991.20	17542.20	13869.28	13865.60	13763.29	9526.94	6589.5	10766.89
11.5	16155.70	23956.90	20137.90	19509.30	17814.00	13291.90	10501.5	14783.42
12.5	21173.60	31565.10	27399.50	26141.30	23189.00	17659.96	14948.2	19463.20
13.5	27469.50	40128.30	35937.00	33535.00	30138.50	23188.50	20561.1	25915.70
14.5	35374.20	50749.20	46043.00	42111.40	39142.30	30770.10	28299.8	35145.10
15.12	44489.40	61079.10	55102.30	49770.7	46350.00	37356.70	35039.5	42769.6
Effective width in m at elevation 15.12 m	18484.20	18870.30	17557.4	15048.5	12379.30	13157.70	12089.4	13662.70

Table 5.9 : Elevation and corresponding area , Section J-9 (Ch.142.45 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-4.46								0
-3.5								64.79
-2.5								237.60
-1.5			0					557.89
0			4.14		0	0	0	1164.45
1.5		0	112.14		99.63	0.33	0.11	1878.98
2.5	0	1.35	244.77		253.81	33.44	5.60	2409.27
3.5	50.62	26.51	604.24		476.30	134.39	23.68	2995.82
4.5	384.60	281.45	1166.55		865.52	364.13	178.96	3685.47
5.5	1041.00	1120.79	2005.79		1635.40	774.71	608.90	4468.16
6.5	2188.35	2668.66	3175.73		3150.23	1482.92	1951.28	5511.60
7.5	3836.09	4665.99	4913.35		5752.83	2668.20	4000.82	6792.25
8.5	5774.66	6996.98	7120.79		9249.71	4538.88	6723.14	8768.42
9.5	8105.90	9633.34	9633.30		13101.78	7405.25	10648.48	11879.9
10.5	10973.50	13198.12	12750.20		17443.00	11864.70	15951.00	15962.9
11.5	14609.74	18170.90	17550.00		22686.30	17481.0	22658.00	21111.0
12.5	19512.78	25190.50	23513.90		28890.20	24998.0	31033.10	27705.4
13.5	25746.60	34298.60	31586.70		36171.10	33991.1	40436.60	36372.1
14.00	29570.9	40008.20	36824.30		40469.00	38956.8	45736.10	41470.8
Effective width in m at elevation 14.00 m	8760.9	12152.2	11250.30		9720.20	10440.10	11171.90	10822.5

Table 5.10 : Elevation and corresponding area, Section J-8 (Ch.149.50 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-4.59	0							
-4.5	0.28							
-3.5	40.83				0			
-2.50	168.40			0	9.6			
-1.5	439.26			42.61	70.13		0	
0	1011.91		0	212.10	304.28	0	7.16	
1.5	1817.42		1.33	464.23	981.10	11.91	176.47	
2.5	2587.16	0	78.00	853.78	1836.20	323.47	506.08	0
3.5	3395.90	91.0	342.74	1574.29	2885.80	911.44	1052.25	49.7
4.5	4260.58	478.3	1015.88	2664.76	4222.15	1801.89	1751.57	674.3
5.5	5326.80	1169.7	2198.50	4158.95	5907.26	3032.58	2633.66	2143.3
6.5	6668.00	2254.6	3932.54	6161.35	7818.27	4766.26	4089.58	4170.2
7.5	8255.00	4505.0	6585.61	8401.26	9992.60	6955.08	6268.82	6748.6
8.5	10221.70	8631.3	10018.71	10903.10	12498.20	9577.84	8868.53	10199.8
9.5	12858.20	13331.6	14167.64	14290.3	15414.00	12900.11	12069.80	14519.9
10.5	16125.00	18350.6	19666.80	18283.5	19045.20	16724.10	16246.60	19411.0
11.5	20048.20	23812.8	26654.10	23215.8	23552.2	21276.30	21436.40	25754.2
12.5	24731.00	30291.1	34079.80	29023.0	28973.0	27638.40	27913.20	33855.8
13.23	28898.00	35586.2	39802.70	33896.00	34039.7	33656.80	33373.40	40683.4
Effective width in m at elevation 13.23 m	6723.50	7861.4	8084.0	7192.3	8565.7	9255.70	8428.30	10230.4

Table 5.11 : Elevation and corresponding area, Section J-7 (Ch.162.35 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-13.26					0	0		
-12.5					23.17	2.633		
-11.5					102.851	29.123		
-10.5					204.163	78.441		
-9.5					326.440	136.801		
-8.5	0				469.681	203.403		
-7.5	22.42				633.652	278.248		
-6.5	116.47				814.162	361.909		
-5.5	252.96				1012.401	459.017		
-4.5	431.50	0			1235.07	568.823	0	
-3.5	659.72	9.42			1482.47	689.03	0.72	
-2.5	939.62	42.87		0	1754.61	829.04	19.32	
-1.5	1268.78	91.93		16.19	2050.46	1002.81	63.03	
0	1851.83	201.09	0	136.84	2575.75	1355.13	175.72	
1.5	2566.20	513.94	150.88	449.58	4015.14	1811.24	414.44	0
2.5	3111.60	832.10	370.83	785.25	5562.26	2154.95	715.98	94.73
3.5	3763.20	1360.02	850.23	1290.39	7626.94	2530.78	1133.05	365.02
4.5	4631.60	2476.18	2066.21	2439.03	10135.11	2967.24	1726.00	832.93
5.5	5774.60	3955.33	3754.48	5074.03	13745.78	3716.42	2771.62	1658.45
6.5	7391.00	5970.80	5715.40	8729.52	18555.67	4931.69	4396.60	3239.05
7.5	9470.00	8589.20	7865.09	12480.54	24272.20	6648.70	7253.30	5436.72
8.5	12116.70	11574.20	10347.06	16337.0	30922.2	9024.4	11009.90	8084.82
9.5	15350.50	15065.10	13488.49	20810.4	38278.6	12136.0	15438.00	11651.47
10.5	19126.60	19210.6	17935.30	26140.8	46419.5	16142.9	20674.50	16162.50
11.5	23742.60	24028.5	23422.50	32513.8	55980.4	21123.8	26944.90	21730.70
12.5	29707.80	30001.2	30038.70	40435.6	67398.0	27729.7	34752.10	28764.10
Effective width in m at elevation 12.50 m	7221.40	7887.9	8149.6	9576.5	12400.2	7960.3	9009.30	8742.6

Table 5.12 : Elevation and corresponding area, Section J-6 (Ch.177.70 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-6.19			0		0			
-5.5	0		0.65		37.36			
-4.5	27.81		15.23		238.42			0
-3.5	177.35		49.24	0	594.17		0	13.75
-2.5	471.05		146.64	209.28	1110.36		37.83	76.53
-1.5	866.61	0	339.59	1004.69	1730.62	0	260.42	166.42
0	1573.51	57.77	765.53	2477.41	3139.14	14.83	852.85	357.60
1.5	2420.10	714.90	1677.78	4180.10	5904.08	321.77	1764.73	1210.46
2.5	3062.11	1359.06	2498.25	5453.97	8125.65	715.99	2624.18	2199.14
3.5	3787.15	2087.52	3414.44	6965.72	10457.90	1413.26	3640.74	3412.85
4.5	4734.04	2985.34	4400.60	8642.76	12944.00	2629.68	4832.36	4863.44
5.5	6090.60	4018.10	5453.0	10420.62	15597.90	4308.11	6138.66	6575.45
6.5	7983.00	5818.78	6647.9	12445.36	18354.50	6595.73	7534.72	8885.90
7.5	10138.70	8557.96	8063.3	14555.6	21220.60	9336.21	9030.10	10992.6
8.5	12747.00	11734.81	9781.00	16815.7	24439.40	12998.87	10771.80	14101.1
9.5	16245.20	15029.20	12060.7	19463.8	28192.0	17078.70	13488.60	18366.8
10.5	21366.70	19253.00	16322.2	23006.7	32761.7	21611.40	17430.20	23550.6
11.50	28826.40	25310.60	23891.7	29388.7	40531.9	27886.40	22724.00	30530.9
11.70	30975.30	26896.80	25962.4	31280.0	42952.2	29590.40	24207.20	32367.6
Effective width in m at elevation 11.70 m	12221.20	8525.2	10902.8	10465.2	12747.9	8942.0	7921.40	9586.7

Table 5.13 : Elevation and corresponding area, Section J-5 (Ch.188.20 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-10.87		0						
-10.5		1.096						
-9.5		15.029						
-8.5		44.977						
-7.5		90.941						
-6.5	0	152.919						
-5.5	1.89	230.912		0				
-4.50	25.91	325.631	0	68.21				
-3.5	77.57	443.277	1.3	281.23				
-2.5	212.59	592.273	551.8	555.99	0		0	
-1.5	471.14	883.60	1690.8	900.55	34.17		21.40	0
0	1008.84	1584.10	4132.2	3243.70	570.26	0	179.81	3.8
1.5	1697.70	2547.2	7378.7	7886.93	1661.16	267.1	636.61	598.1
2.5	2275.43	3401.6	10067.3	11098.66	2579.15	786.2	1243.13	1604.1
3.5	2966.06	4410.1	13066.0	14445.14	3569.26	1526.5	2310.32	3230.0
4.5	4010.00	5720.3	16480.5	18165.06	4914.37	3005.6	3942.67	5348.50
5.5	5475.40	8252.5	20295.9	22486.7	6907.55	5386.2	6329.64	7918.10
6.5	7442.40	11966.1	24593.4	27189.5	9428.69	8409.3	9409.79	11165.3
7.5	9752.80	16664.1	29270.9	32264.6	12381.13	11977.9	13200.73	15041.6
8.5	12985.40	21711.4	34503.2	38165.5	15933.70	15980.2	17843.20	20215.0
9.5	17555.70	27497.8	40078.7	44454.6	20927.50	20609.1	22996.70	26348.7
10.5	23951.10	34362.0	46553.1	51890.3	28142.10	27644.0	29126.60	33689.1
19.94	28270.40	37941.0	50425.1	56075.9	32915.50	32045.0	32411.90	37411.6
Effective width in m at elevation 19.94 m	12403.10	8598.8	10330.9	10767.8	12292.2	11078.2	8192.60	9230.10

Table 5.14 : Elevation and corresponding area, Section J-4 (Ch.201.30 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-10.12			0					
-9.5			5.311					
-8.5			36.522				0	
-7.50		0	126.835				9.89	
-6.5		54.54	286.762				129.49	
-5.5	0	347.84	466.265		0	0	316.70	
-4.5	2.49	719.90	659.136		24.99	7.42	529.32	
-3.5	55.14	1174.75	865.374		148.76	273.98	767.33	0
-2.5	178.45	1720.51	1085.379		345.32	905.30	1030.73	0.28
-1.5	378.17	2353.67	1338.339	0	981.51	1717.61	1319.52	11.86
0	916.58	3466.20	1805.8	96.62	2735.82	3194.23	1841.98	97.61
1.5	1959.03	4802.04	2559.8	1067.54	4853.35	5144.04	2703.80	618.74
2.5	3002.96	5802.47	3589.5	2246.44	6800.05	6705.16	3681.60	1584.48
3.5	4562.23	6903.60	5154.2	4032.48	9241.60	8342.32	5292.20	3130.43
4.5	6548.03	8459.60	7384.0	6447.54	12021.68	10038.02	7382.10	6154.43
5.5	8989.00	10468.20	10121.4	9213.05	14904.20	11783.10	9843.50	10374.05
6.5	12196.40	13009.60	13156.5	12130.65	17991.20	13656.60	12834.70	14773.55
7.5	16443.50	16156.90	16804.5	15480.99	21798.60	15833.00	16361.90	19596.00
8.5	22269.30	19904.00	20912.4	19433.05	26088.30	18431.20	20313.10	24865.60
9.5	35396.40	24806.30	25766.9	24260.10	31118.10	22807.0	24837.80	30612.40
10.15	46194.60	28190.80	29736.9	28127.0	35030.40	27634.5	28477.70	35159.40
Effective width in m at elevation 10.15 m	17342.20	5461.30	6661.9	6521.6	6664.60	8142.60	5947.10	7828.40

Table 5.15 : Elevation and corresponding area, Section J-3 (Ch.213.20 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-10.04				0				
-9.5				3.713				
-8.5				30.202				
-7.5				82.165			0	
-6.5				156.145			75.18	
-5.5		0		248.66			282.49	0
-4.5		14.79		362.594			560.65	7.33
-3.5	0	78.05	0	530.448	0		937.72	80.78
-2.5	30.07	178.21	664.3	741.342	131.79	0	1489.65	205.66
-1.5	270.30	301.03	2356.7	1209.107	595.20	13.45	2228.07	393.96
0	1478.94	724.56	5555.4	2358.4	1949.46	353.35	3662.23	1296.46
1.5	3472.54	1795.39	9526.0	4189.3	4062.04	1860.34	5856.68	3705.24
2.5	5070.63	2927.69	12571.4	5999.5	5991.40	3538.79	7784.54	6273.43
3.5	6818.02	4645.80	16217.6	8454.4	8596.60	5775.86	10288.20	10811.50
4.5	8852.52	7317.65	20619.9	12595.2	11620.74	8402.68	13992.70	16480.52
5.5	11099.20	10917.50	25765.0	17913.9	14902.62	11341.20	19005.40	22591.80
6.5	13580.85	15086.10	31310.2	23859.5	18419.52	14895.48	24767.70	28880.60
7.5	16437.70	20757.30	37425.5	30144.7	22693.70	19574.79	32401.20	35614.0
8.5	20289.20	27478.20	44225.6	37169.7	29432.40	25520.50	41694.90	43291.30
9.39	25868.30	34347.50	51466.8	44427.9	36694.80	32325.30	51917.80	50886.70
Effective width in m at elevation 9.39 m	7814.30	8928.0	9100.8	8928.9	8809.3	8462.5	12383.30	8895.4

Table 5.16 : Elevation and corresponding area, Section J-2 (Ch.223.20 km)

Elevation (m)	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
-11.04					0			
-10.5					2.681			
-9.5					21.808			
-8.5					59.326			
-7.5		0		0	115.236			
-6.5		0.99		55.78	189.537		0	
-5.5	0	191.27	0	252.75	292.991		9.15	
-4.5	242.95	517.69	2.2	527.36	461.629	0	140.29	0
-3.5	676.95	926.31	72.36	862.76	714.187	0.02	359.00	29.47
-2.5	1490.57	1457.58	319.34	1233.92	1148.95	45.05	727.48	145.75
-1.5	2618.77	2239.95	871.84	1762.22	1842.60	195.52	1287.20	505.63
0	4828.11	3858.04	2675.97	3110.74	3556.00	559.80	3158.07	1692.58
1.5	7248.97	6682.32	5426.03	5780.03	6121.80	1771.71	6273.83	3874.72
2.5	8926.36	9919.72	7690.26	8637.65	6518.00	3615.64	9172.62	6893.34
3.5	10656.07	14375.60	10428.01	12389.5	11350.80	6124.77	12279.05	10752.16
4.5	12432.95	19586.90	13521.81	16803.30	14709.60	9037.24	15451.80	15020.10
5.5	14278.80	26012.20	17093.10	21575.10	18636.50	12890.19	18679.70	19372.62
6.5	16764.80	33533.00	21471.80	26867.70	22937.20	18557.70	21962.70	23776.30
7.5	20294.80	41620.40	26717.90	32940.40	28112.40	25765.50	25386.50	28340.30
8.5	26878.70	50508.30	33186.50	40003.10	35347.70	34328.20	29429.80	33504.7
8.66	28501.10	52151.10	34473.80	41351.5	36868.10	35849.40	30227.50	34466.6
Effective width in m at elevation 8.66 m	10598.60	10450.4	8198.7	8593.10	9743.7	9623.80	5259.70	6456.6

Table 5.18 Area and Corresponding Elevation, Section J-17, (Ch. 25.00 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2360.12	3127.94	3879.52	3053.70	3158.99	3224.64	3216.47	2293.37
Elevation (m)	16.64	18.27	17.03	15.72	16.75	17.56	17.67	17.45
5% of Total Area (m^2)	1180.06	1563.97	1939.76	1526.85	1579.495	1612.32	1608.235	1146.685
Elevation (m)	15.78	16.80	16.08	12.47	15.65	16.29	16.46	15.99

Table 5.19 Area and Corresponding Elevation, Section J-16, (Ch. 37.10 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	3422.35	3362.69	3248.91	2770.30	3493.23	3824.53	2898.41	3413.64
Elevation (m)	14.76	15.89	16.61	15.39	14.01	13.80	13.26	15.66
5% of Total Area (m^2)	1711.175	1681.345	1624.45	1385.15	1746.615	1912.265	1449.205	1706.82
Elevation (m)	13.56	14.83	15.33	13.40	12.54	11.97	11.12	13.93

Table 5.20 Area and Corresponding Elevation, Section J-15, (Ch. 55.65 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2862.60	4505.60	3544.86	3577.38	3650.16	3637.36	3838.25	4798.92
Elevation (m)	13.91	13.87	14.22	13.02	14.17	14.43	13.14	12.86
5% of Total Area (m^2)	1431.30	2252.80	1772.43	1788.69	1825.08	1818.68	1919.125	2399.46
Elevation (m)	12.76	12.75	12.78	11.39	12.40	13.23	10.29	11.28

Table 5.21 Area and Corresponding Elevation, Section J-14, (Ch. 71.20 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	5201.15	4634.20	3681.02	4068.21	4461.11	4761.04	4072.42	5326.70
Elevation (m)	11.54	11.18	13.85	12.71	13.20	12.53	12.45	12.40
5% of Total Area (m^2)	2600.575	2317.10	1840.51	2034.105	2230.555	2380.52	2036.21	2663.35
Elevation (m)	7.78	8.76	12.82	11.36	12.26	11.43	11.02	11.09

Table 5.22 Area and Corresponding Elevation, Section J-13, (Ch. 84.70 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	3427.53	3959.51	3959.06	3747.32	2920.18	3324.45	2837.86	4181.10
Elevation (m)	13.63	11.31	10.12	11.62	11.06	10.99	10.44	10.64
5% of Total Area (m^2)	1713.765	1979.755	1979.53	1873.66	1460.09	1662.225	1418.93	2090.55
Elevation (m)	12.70	9.77	8.63	10.53	9.50	9.26	7.85	9.08

Table 5.23 Area and Corresponding Elevation, Section J-12, (Ch. 100.50 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	3035.22	—	4273.17	4739.52	3761.12	3424.18	3491.99	4830.55
Elevation (m)	10.89		10.30	10.45	9.70	10.36	11.91	10.37
5% of Total Area (m^2)	1517.61	—	2136.585	2369.76	1880.56	1712.09	1745.995	2415.275
Elevation (m)	9.58		9.26	9.28	8.09	9.24	10.97	9.21

Table 5.24 Area and Corresponding Elevation, Section J-11, (Ch. 117.75 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2569.05	2941.34	4395.87	4476.01	4072.35	4149.79	3747.06	5057.20
Elevation (m)	10.28	8.59	8.25	8.62	7.97	8.85	10.59	7.48
5% of Total Area (m^2)	1284.525	1470.67	2197.935	2238.005	2036.175	2074.895	1873.53	2528.60
Elevation (m)	9.60	7.36	6.72	7.57	6.45	7.36	9.48	5.27

Table 5.25 Area and Corresponding Elevation, Section J-10, (Ch. 134.30 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	4448.94	6107.91	5510.23	4977.07	4635.00	3735.67	3503.95	4276.96
Elevation (m)	6.42	7.53	8.10	8.27	7.80	8.49	9.49	8.17
5% of Total Area (m^2)	2224.47	3053.955	2755.115	2488.535	2317.50	1867.835	1751.975	2138.48
Elevation (m)	2.46	5.37	6.65	7.23	6.52	7.18	8.74	6.99

Table 5.26 Area and Corresponding Elevation, Section J-9, (Ch. 142.45 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2957.09	4000.82	3682.43	—	4046.90	3895.68	4573.61	4147.08
Elevation (m)	6.97	7.17	6.79		6.84	8.16	7.71	5.09
5% of Total Area (m^2)	1478.54	2000.41	1841.215	—	2023.45	1947.84	2286.805	2073.54
Elevation (m)	5.88	6.07	5.30		5.76	6.89	6.66	1.87

Table 5.27 Area and Corresponding Elevation, Section J-8, (Ch. 149.50 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2889.80	3558.62	3980.27	3389.60	3403.97	3365.68	3337.34	4068.34
Elevation (m)	2.87	7.08	6.52	4.98	3.89	5.69	5.98	6.45
5% of Total Area (m^2)	1444.90	1779.31	1990.135	1694.80	1701.985	1682.84	1668.67	2034.17
Elevation (m)	0.81	6.06	5.32	3.61	2.34	4.37	4.38	5.42

Table 5.28 Area and Corresponding Elevation, Section J-7, (Ch. 162.35 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2970.78	3000.12	3003.87	4043.56	6739.80	2772.97	3475.21	2876.41
Elevation (m)	2.24	4.85	5.05	5.10	3.07	4.05	5.93	6.27
5% of Total Area (m^2)	1485.39	1500.06	1501.935	2021.78	3369.90	1386.485	1737.605	1438.205
Elevation (m)	-0.94	3.62	4.03	4.14	0.83	0.10	4.51	5.23

Table 5.29 Area and Corresponding Elevation, Section J-6, (Ch. 177.20 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	3097.53	2689.68	2596.24	3128.00	4295.22	2959.04	2420.72	3236.76
Elevation (m)	2.55	4.17	2.61	0.38	0.63	4.70	2.26	3.35
5% of Total Area (m^2)	1548.765	1344.84	1298.12	1564.00	2147.61	1479.52	1210.36	1618.38
Elevation (m)	-0.05	2.48	0.87	-0.93	-1.06	3.55	0.59	1.91

Table 5.30 Area and Corresponding Elevation, Section J-5, (Ch. 188.20 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2827.04	3794.10	5042.51	5607.59	3291.55	3204.50	3241.19	3741.16
Elevation (m)	3.30	2.89	0.42	0.76	3.22	4.58	4.07	3.74
5% of Total Area (m^2)	1413.52	1897.05	2521.255	2803.795	1645.775	1602.25	1620.595	1870.58
Elevation (m)	0.88	0.49	-0.99	-0.28	1.48	3.55	2.85	2.66

Table 5.31 Area and Corresponding Elevation, Section J-4, (Ch. 201.30 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	4619.46	2819.08	2973.69	2812.70	3503.04	2763.45	2847.77	3515.94
Elevation (m)	3.53	-0.87	1.90	2.82	0.54	-0.44	1.65	3.63
5% of Total Area (m^2)	2309.73	1409.54	1486.845	1406.35	1751.52	1381.725	1423.885	1757.97
Elevation (m)	1.83	-3.07	-1.02	1.79	-0.84	-1.91	-1.20	2.61

Table 5.32 Area and Corresponding Elevation, Section J-3, (Ch. 213.20 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2586.83	3434.75	5146.68	4442.79	3669.48	3232.53	5191.78	5088.67
Elevation (m)	0.83	2.79	-0.19	1.64	1.22	2.32	1.04	2.04
5% of Total Area (m^2)	1293.415	1717.375	2573.34	2221.395	1834.74	1616.265	2595.89	2544.335
Elevation (m)	-0.23	1.39	-1.40	-0.18	-0.13	1.26	-1.11	0.78

Table 5.33 Area and Corresponding Elevation, Section J-2, (Ch. 223.20 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	2850.11	5215.11	3447.38	4135.15	3686.81	3584.94	3022.75	3446.66
Elevation (m)	1.34	0.72	0.42	0.57	0.08	2.48	-0.11	1.20
5% of Total Area (m^2)	1425.055	2607.555	1723.69	2067.575	1843.405	1792.47	1511.375	1723.33
Elevation (m)	-2.58	-1.16	-0.79	-1.16	-1.50	1.51	-1.32	0.02

Table 5.34 Area and Corresponding Elevation, Section J-1, (Ch. 230.75 Km.)

Area and Elevation	Year							
	1969-70	1976-77	1977-78	1978-79	1981-82	1986-87	1988-89	1990-91
10% of Total Area (m^2)	3634.26	3694.09	4015.92	4370.62	4229.12	3928.00	6741.91	3382.22
Elevation (m)	-1.18	-2.31	-2.00	-0.65	0.01	-1.10	-0.95	1.53
5% of Total Area (m^2)	1817.13	1847.045	2007.96	2185.31	2114.56	1964.00	3370.955	1691.11
Elevation (m)	-2.67	-4.27	-3.74	-1.94	-1.52	-2.38	-1.96	0.45

Table 5.35.1, 5.35.2 and 5.35.3

Distance and corresponding area, J-17 (Ch. 25.00 km)

Year 1969-70		Year 1976-77		Year 1977-78	
Distance (m)	Area (m)	Distance (m)	Area (m)	Distance (m)	Area (m)
0	0	0	0	0	0
397.17	28.20	257.56	0	607.47	41.50
1445.36	28.20	379.48	45.70	1142.39	41.50
1671.22	1130.10	1300.28	45.70	1652.93	1731.80
2155.85	1844.80	1632.81	1988.90	2164.99	2504.20
3011.42	1844.80	2139.09	2870.10	2661.21	5041.60
3195.83	2880.00	2621.58	4262.80	3137.00	8943.90
3686.25	5988.75	3105.30	7147.90	3637.79	9900.70
4192.22	10213.95	3620.41	8602.70	4133.09	10103.00
4670.15	12533.30	4138.27	8662.50	4642.10	12255.40
5458.36	12533.30	4636.01	11025.90	5072.18	15683.80
5689.40	13355.36	5147.77	14481.36	5487.92	17900.00
6169.15	16683.82	5604.05	16233.10	5929.27	21450.47
6658.36	21091.87	6027.42	17778.75	6299.30	24713.22
7193.89	23592.56	6657.74	20159.91	6730.29	27613.00
7224.37	23625.20	7134.45	21720.92	7214.92	29378.68
8197.90	23625.20	7693.15	23500.41	7709.00	29961.67
		8092.74	24406.28	8253.98	30656.58
		8650.22	25864.66	8597.19	31764.07
		9087.31	27539.12	8767.27	32717.26
		9581.08	29904.55	8965.39	33719.93
		10158.07	31301.10	9194.90	34867.13
				9522.56	37130.12
				9759.70	38315.98
				9905.09	38814.67
				10158.98	38829.10

Table 5.35.4, 5.35.5 and 5.35.6

Distance and corresponding area, J-17 (Ch. 25.00 km)

Year 1978-79		Year 1981-82		Year 1986-87	
Distance (m)	Area (m)	Distance (m)	Area (m)	Distance (m)	Area (m)
0	0	0	0	0	0
684.28	0	839.72	0	344.51	1005.00
775.72	22.40	953.11	698.30	846.90	3346.00
1132.33	22.40	1452.07	3381.80	1265.24	5458.80
1459.08	2215.50	1939.14	7191.00	1836.89	6087.20
1953.77	4738.70	2423.16	8601.40	2345.43	7576.30
2496.92	6433.80	2955.95	9603.60	2778.05	10293.70
2963.57	8433.20	3455.52	13493.44	3260.06	11810.10
3432.35	9685.90	3917.59	15563.03	3810.37	14899.41
3965.75	9806.60	4383.94	16644.85	4350.30	16165.16
4443.68	11636.64	5921.65	16644.85	4693.90	16749.93
4929.84	12424.52	5942.38	16704.64	5272.87	17942.04
5428.79	13088.34	6419.39	20553.68	5843.60	19980.24
5965.85	13995.50	6929.32	25138.04	6266.77	21078.38
6432.80	18608.80	7414.26	27505.62	6760.67	23859.50
6970.17	23828.68	7904.68	29669.48	7310.06	27951.62
7465.47	26458.49	8228.08	30565.01	7835.98	28385.73
7972.04	28237.17	8538.67	30565.01	8281.10	28951.07
8398.76	28532.82	8941.31	31240.93	8800.00	30388.59
8583.17	28533.44	9261.35	31643.34	9336.89	31022.43
8952.01	28562.70	10472.01	31647.00	9957.32	31700.52
9438.13	29683.33			10353.66	32346.30
9932.21	30195.57				
10237.01	30597.00				
10471.71	30597.00				

Table 5.35.7 and 5.35.8

Distance and corresponding area, J-17 (Ch. 25.00 km)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m)	Distance (m)	Area (m)
0	0	0	0
250.00	0	1112.00	0
750.13	99.60	1331.20	1117.40
2273.01	99.60	1816.20	2292.90
2864.18	150.00	2351.50	2576.60
3455.06	715.70	2825.00	2720.80
3864.35	793.00	3277.00	3075.92
4546.32	4945.20	3811.00	3566.09
4955.32	7235.60	4259.00	4889.03
5410.15	9218.30	4826.00	8194.82
5865.84	9327.60	5277.00	12085.05
6455.87	11156.70	5800.00	12642.80
6910.41	13244.55	6307.00	13222.72
7274.16	13775.63	6787.42	14329.36
7956.12	15360.32	7256.81	15177.08
8410.67	16688.51	7789.76	17053.22
8910.76	17685.52	8328.20	17490.25
9592.72	22735.64	8675.63	17625.03
9956.47	25174.56	9261.93	18687.41
10342.85	27570.26	9787.22	21021.08
10865.56	29952.14	10221.90	22960.80
11479.36	31272.49	11337.00	22960.80
11922.73	32016.81		
12252.40	32467.80		
13957.16	32467.80		

Table 5.36.1, 5.36.2 and 5.36.3

Distance and corresponding area, J-16 (Ch.37.10 km)

Year 1969-70		Year 1976-77		Year 1977-78	
Distance (m)	Area (m)	Distance (m)	Area (m)	Distance (m)	Area (m)
823.57	24.0	1493.82	0	586.74	0
1301.19	4216.70	2118.66	3724.80	1136.60	0
1830.63	7700.80	2534.41	6152.40	1619.71	669.00
2274.42	8155.40	3097.07	9489.40	2073.25	2545.30
2827.63	10010.20	3612.79	13577.70	2635.91	5837.90
3319.27	11165.50	4100.47	15025.71	4139.79	14925.02
3835.60	11379.60	4476.90	15364.08	4649.11	16798.01
4337.91	16070.54	5019.45	15364.08	5147.16	18863.11
4783.53	20629.44	5519.62	16623.68	5651.30	21072.63
5286.15	23133.31	6072.23	20934.66	6125.87	22293.96
5813.45	25700.25	6595.87	24111.73	6646.16	24538.52
5978.90	26768.47	7091.78	24151.60	7059.47	24582.90
6931.15	26768.47	7580.07	24472.24	7620.30	24973.65
7323.43	27630.70	8124.14	24709.68	8121.70	24998.34
7809.58	30124.08	8624.93	25039.07	8647.79	26014.77
8347.25	30975.07	9088.53	27253.87	9147.05	27997.89
8837.08	31856.41	9598.15	29626.71	9629.55	28891.69
9569.19	31856.41	10085.83	31219.93	10151.36	30507.42
9732.57	32017.17	10597.59	32035.36	10662.82	31115.12
10353.45	32017.17	11004.50	32181.34	11104.78	31204.346
19778.95	32805.54	12385.15	32181.34	12128.60	31204.346
11272.72	32992.32	12609.88	32345.80	12626.04	31478.498
11847.88	33213.33	13069.82	32609.95	13137.79	31550.324
12328.24	34153.11	13612.98	32949.63	13647.42	32045.371
12749.48	34394.40	14112.24	33594.60	14120.77	32513.194
13351.76	34394.40	14468.25	33664.71	14639.24	32579.564
		15128.14	33668.60	14825.78	32579.564
				15154.35	32586.300

Table 5.36.4, 5.36.5 and 5.36.6

Distance and corresponding area, J-16 (Ch. 37.10 km)

Year 1978-79		Year 1981-82		Year 1986-87	
Distance (m)	Area (m)	Distance (m)	Area (m)	Distance (m)	Area (m)
0	0	0	0	0	0
121.89	340.10	1426.77	0	1125.61	0
628.93	2225.80	1637.08	609.20	1428.96	978.60
1127.89	6949.20	2145.18	2860.50	1874.09	3750.70
1579.93	9630.78	2591.10	7062.00	2440.24	7533.90
2098.34	10702.68	3127.25	9074.80	2977.13	13293.30
2568.89	11236.12	3645.41	10130.80	3444.51	19607.30
3101.77	13935.35	4141.02	14798.20	3964.33	23919.76
3622.31	15199.73	4557.06	19043.35	4430.79	26835.11
4115.90	16416.24	4715.56	19977.79	4686.89	28332.56
4625.83	17196.26	5012.44	19977.79	5414.94	28332.56
5112.38	21250.01	5645.51	20638.69	5940.85	29350.69
5581.17	21852.64	6114.59	24044.11	6457.62	31803.88
5903.10	21874.97	6649.82	28409.32	6921.34	32523.20
6256.39	21874.97	7114.34	29456.23	7484.76	33297.57
6559.06	21899.18	7614.51	29533.61	8051.52	33297.57
6976.11	21899.18	7957.41	29550.68	8388.42	33489.52
7663.10	23568.06	8582.25	29550.68	8623.17	33698.53
8204.67	25385.35	8643.21	29652.64	9188.72	33698.53
8651.96	26135.88	9100.41	30602.70	9311.28	33784.41
9102.28	26135.88	9624.67	31924.90	9967.68	35075.37
9569.35	26337.57	10173.31	32639.05	10417.07	35663.98
9896.71	26415.95	12209.98	32639.05	10964.63	37019.07
9991.53	26421.63	12636.70	32945.68	11112.20	37596.47
11344.69	26421.63	13128.04	33511.28	11772.26	37596.47
11466.06	26438.01	13649.25	34245.13	11833.23	37605.31
11812.74	26438.01	14103.10	34476.34	12196.04	37605.31
12089.62	27007.92	14676.73	34918.81	12470.43	37775.55
12556.03	27819.42	15154.96	35032.90	12900.92	37775.55
12918.80	27819.42			13437.50	38176.38
12989.30	27844.55			13936.28	38204.74
13628.62	27853.6			14239.33	38305.55
				14778.66	38305.55
				14970.73	38327.8

Table 5.36.7 and 5.36.8

Distance and corresponding area, J-16 (Ch. 37.10 km)

Year 1988-89	
Distance (m)	Area (m)
0	0
303.83	0
958.02	775.70
1425.55	3015.00
1729.09	4125.30
2360.03	7298.00
3878.91	19925.50
4322.88	21892.53
4836.93	21892.53
5421.63	23047.83
5748.15	23456.90
6544.53	23789.37
6916.38	23793.52
7360.35	24551.70
7851.14	24956.34
8412.01	25016.26
8902.79	25016.26
9533.72	25092.02
10421.38	28994.56
11473.02	28994.56
11940.26	29138.36
12407.50	29471.44
13225.38	29471.11
13926.38	29536.40

Year 1990-91	
Distance (m)	Area (m)
0	0
645.00	400.50
1195.00	1176.80
2945.00	1189.00
3181.65	1261.60
3664.30	2753.30
4046.45	3423.70
4636.90	4672.50
4908.00	5299.00
6242.00	5299.00
6644.14	5380.30
7184.14	5464.20
7680.64	5671.20
8634.90	6307.00
9195.98	8329.70
9672.90	9386.60
10096.90	11971.40
10733.55	16125.46
11217.30	18983.40
11662.30	22352.40
12185.85	28218.34
12662.78	29861.43
13112.78	30308.73
13719.80	31117.71
14164.05	33398.51
14262.40	34254.13
15062.00	34254.13
15195.00	34257.00

Table 5.37.1 & 5.37.2

Distance and Corresponding Area, J-15 (Ch. 55.65 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
243.84	0	624.23	0
777.25	163.00	898.55	1071.00
1250.90	408.50	1081.43	1154.80
1738.58	1852.40	1581.91	1154.80
2279.60	3250.50	1886.71	1182.30
2767.28	3925.90	2359.15	1256.00
3254.96	5165.20	2891.03	1713.30
3767.94	8189.30	3387.55	4187.90
4272.99	10798.61	3830.12	6803.70
4778.65	13953.23	4367.78	12270.30
5274.26	19036.49	4846.02	15701.41
5762.72	22870.90	5232.20	17598.30
6242.00	23862.15	5894.53	21107.70
6781.80	25977.94	6388.61	21841.80
7278.93	28126.419	6891.53	23667.80
8042.45	28126.419	7165.85	24367.40
8286.29	28152.022	7653.53	24367.40
8530.13	28632.23	7844.03	24887.80
8924.85	28632.23	8366.76	27182.33
9286.65	28651.50	8839.20	29556.14
		9424.72	34977.16
		9841.08	38851.47
		10408.62	43257.049
		10901.17	45104.30

Table 5.37.3& 5.37.4

Distance and Corresponding Area, J-15 (Ch. 55.65 Km.)

Year 1977-78			Year 1978-79	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
0	0		0	0
630.63	0		516.94	0
888.49	285.60		867.16	1188.00
1887.32	286.40		1080.21	1474.20
2380.79	314.40		2341.78	1474.20
2792.27	410.70		2887.98	2072.90
3284.22	1537.50		3359.20	7381.20
3874.01	6399.70		3942.59	12738.20
4376.93	10305.30		4338.22	15006.00
4868.27	10710.50		4886.86	15115.10
5355.95	11653.10		5374.54	15537.90
5873.19	13929.30		5887.21	17924.92
6364.53	17145.61		6362.09	21586.41
6886.04	17452.78		6857.39	21841.42
7372.50	18009.89		7375.25	22426.98
7840.07	21000.28		7812.33	25500.57
8346.34	22904.36		8362.19	27146.40
8884.31	24830.32		8885.83	28549.46
9371.69	27820.99		9372.60	29747.50
9881.62	32095.32		9849.61	31343.44
10189.16	33126.03		10376.92	32597.69
10248.90	33264.19		10885.63	35653.409
10360.15	33874.52		10992.61	35807.664
10864.29	35489.40		11391.60	35807.80
11392.81	35489.40			

Table 5.37.5 & 5.37.6

Distance and Corresponding Area, J-15 (Ch. 55.65 Km.)

Year 1981-82		Year 1986-87	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
622.71	0	619.82	0
1081.74	402.10	873.48	3040.40
2036.37	402.10	1361.59	3224.10
2449.37	409.40	1837.50	3495.90
2876.09	1725.50	2304.88	4787.90
3358.90	5596.80	2856.10	7074.10
3752.39	8387.50	3375.00	7699.10
4358.03	11639.00	3881.40	11881.80
4894.48	11759.70	4382.93	14806.60
5346.50	16286.10	4828.05	16663.37
5880.81	20289.71	5398.17	18465.34
6373.37	21848.52	5837.80	22734.28
6851.90	24502.86	6400.91	27518.55
7338.97	25950.01	6807.93	29502.17
7884.52	27866.50	7382.62	30294.65
8386.27	29151.01	7859.45	30473.40
8841.94	31436.39	8317.68	31504.55
9379.61	32318.67	8920.12	32564.28
9595.52	32537.24	9782.01	32564.28
9995.61	32537.24	10362.50	33990.47
10828.63	34097.94	10859.76	36259.415
11051.44	35322.67	11398.17	36409.20
11389.77	36556.50		

Table 5.37.7 & 5.37.8

Distance and Corresponding Area, J-15 (Ch. 55.65 Km.)

Year 1988-89			Year 1990-91	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
0	0	**	0	0
548.11	151.70	**	453.71	4905.50
1262.82	301.80	**	1001.79	10865.60
2024.94	301.80	**	1379.73	13001.00
2358.73	2422.00	**	1811.28	13207.60
2882.83	5426.30	**	2515.38	13207.60
3382.91	5901.50	**	2722.38	13499.00
3883.29	6677.70	**	3231.38	13499.00
4359.66	7781.40	**	3485.38	13712.50
4907.77	9030.60	**	3971.17	14948.80
5503.31	10105.10	**	4444.42	17707.40
5836.80	12453.00	**	4932.38	20713.70
6313.17	15274.20	**	5465.33	22455.10
6884.99	20347.64	**	5959.96	23072.40
7361.36	21861.93	**	6475.87	24825.00
7742.57	22626.26	**	6969.65	28558.17
8409.55	24744.37	**	7450.16	33825.33
8957.65	29542.18	**	7983.88	35912.34
9362.59	33569.25	**	8475.23	36411.53
9838.96	34471.10	**	8904.96	37335.73
10315.62	34666.50	**	9479.02	41373.11
10792.00	34666.50	**	9954.64	43642.12
10958.59	34780.53	**	10430.18	45280.96
11316.09	34780.53	**	10965.50	46540.076
11911.62	35059.61	**	11480.10	47765.89
12435.72	37314.696	**	11928.20	47825.985
12959.81	38782.40	**	12305.00	47825.985
13412.47	38782.40	**	12425.00	47868.585
		**	13037.00	47882.755
		**	13230.50	48061.40
		**	13487.00	48061.40
		**		

Table 5.38.1 & 5.38.2

Distance and Corresponding Area, J-14 (Ch. 71.20 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
624.84	1129.10	397.15	373.90
1634.64	1780.00	1413.91	921.60
2142.44	2478.10	1842.58	2262.70
2666.69	4843.10	2388.29	5317.30
3176.93	7143.40	2921.60	7493.60
3588.71	8523.20	3858.68	8566.50
4073.95	9570.40	4861.53	9847.50
4604.00	10688.40	5394.88	11244.70
5032.25	11546.50	5912.39	12508.40
5634.53	13546.70	6385.53	14465.50
6110.02	15835.50	6867.60	16184.90
7104.58	19055.80	7399.39	16950.10
7648.04	22000.70	7883.19	18278.90
8134.75	26110.60	8386.18	19071.20
8616.08	26859.60	8930.61	22492.40
9103.15	27170.80	9433.07	29884.12
9475.92	27981.50	9878.23	32572.30
10130.03	28943.70	10673.52	32641.37
10632.03	30156.60	11397.48	32641.37
11052.36	32195.51	11918.08	33537.80
11444.63	34748.40	12425.14	34906.25
12122.50	42718.25	12882.68	37339.51
12614.15	48906.70	13413.46	41384.84
13076.13	50601.427	13888.21	43721.84
13615.72	50793.181	14367.66	44966.387
14117.42	51051.613	14980.52	44966.387
14653.56	51344.584	15422.12	45483.587
15131.49	51723.073	15932.44	46375.653
15571.31	52000.641	16425.25	46391.20
16149.83	52094.50		

Table 5.38.3 & 5.38.4

Distance and Corresponding Area, J-14 (Ch. 71.20 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
1349.08	734.10	188.03	0.20
2380.65	3745.90	433.76	83.10
3348.29	6930.40	1456.34	333.30
4373.61	7155.00	2046.77	552.10
4864.15	7853.50	2399.72	2741.70
5320.65	8099.30	2866.46	3878.30
5834.18	10580.80	4034.15	4135.60
6377.15	14916.20	4469.56	4913.10
7853.78	15745.40	4975.89	6692.50
8361.40	16528.60	5459.15	10275.90
8887.54	18930.94	5981.98	11885.30
9386.23	21934.88	6895.68	12576.90
9773.60	22369.68	7479.52	13175.60
10831.92	22369.88	7979.24	13553.40
11868.46	23549.37	8452.60	15538.80
12343.92	26985.53	8980.36	20529.50
12883.50	29747.74	9486.69	22584.54
13371.67	32341.68	9767.08	22804.48
13880.93	34503.02	10974.36	22940.03
14378.46	35649.965	11411.41	23926.43
14857.57	35869.342	11919.39	27430.69
15333.73	35910.114	12432.31	29500.78
15565.71	36236.849	12971.62	32735.22
16031.54	36969.18	13473.02	37709.22
16401.20	36970.20	13916.65	38758.87
		14472.49	39051.298
		14904.60	39333.747
		15452.14	39856.173
		15795.20	40761.30
		16479.66	40761.30

Table 5.38.5 & 5.38.6

Distance and Corresponding Area, J-14 (Ch. 71.20 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
0	0	**	0	0
313.64	2.10	**	348.48	111.80
968.65	282.70	**	836.28	1292.90
1475.84	1428.30	**	1348.48	3547.10
1977.24	5524.70	**	1776.22	6160.30
2429.26	8686.10	**	2278.96	11466.30
2954.12	10864.10	**	2779.27	15127.80
3469.54	11894.10	**	3317.07	17421.60
3977.64	13541.00	**	3814.94	19069.80
4452.52	15826.40	**	4281.71	19946.60
4978.91	17713.70	**	4824.09	20092.80
6128.00	19479.40	**	5281.40	20517.80
7944.31	19511.60	**	5829.27	20719.90
8462.77	20849.30	**	6249.70	20801.60
8915.40	22137.00	**	6798.48	21485.70
9476.23	25238.72	**	7347.26	23034.20
9873.08	28986.34	**	8379.57	23630.70
11490.35	29254.19	**	8838.72	26606.10
11957.00	29696.05	**	9338.72	30632.32
12486.44	31877.60	**	9852.44	35165.68
13013.13	35757.75	**	10403.35	39756.91
13427.05	39198.13	**	11310.98	39792.89
13941.55	42789.25	**	11798.78	39972.76
14476.17	43341.825	**	12320.12	41377.48
14971.47	43578.906	**	12807.93	43145.17
15490.85	44031.694	**	13322.87	43773.44
15975.48	44684.70	**	13823.17	44076.31
16494.56	44684.70	**	14335.37	46220.861
		**	14682.93	47114.806
		**	15838.42	47258.145
		**	16240.24	47393.527
		**	16853.35	47783.40
		**		

Table 5.38.7 & 5.38.8

Distance and Corresponding Area, J-14 (Ch. 71.20 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
1329.92	396.40	850	3408.70
1811.80	806.80	1334	7515.90
2486.49	2926.20	1811	11721.30
2872.11	7107.00	3316	15026.10
3450.55	11511.60	3800	16150.70
4318.05	13080.80	4293	17767.20
4896.49	13860.60	6327	19111.60
5425.12	15448.60	7321	22050.80
6342.41	16215.60	7815	37368.90
7354.45	16725.60	8279	31949.00
7860.62	18221.80	8799	36743.14
8366.48	18391.00	9316	38395.58
8896.64	20268.80	9780	38990.81
9354.53	24597.08	10287	41571.17
9908.98	28720.90	10832	44242.17
10390.85	29584.66	11421	47052.99
10969.29	32436.56	11838	48764.78
11402.88	36144.28	12344	49969.33
11812.80	38046.82	13314	50544.63
12439.21	39800.299	13846	50868.21
12993.35	39930.376	15299	51382.70
13402.96	40417.685	15809	51704.93
13547.80	40417.685	16272	53404.00
14294.76	40647.432	16851	53404.00
15379.36	40717.348		
15812.96	41274.031		
16752.72	41289.212		
17331.16	41489.40		
17909.59	41489.40		

Table 5.39.1& 5.39.2

Distance and Corresponding Area, J-13 (Ch. 84.70 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
1681.89	0	1643.48	0
2086.97	1171.622	2033.32	3336.32
3048.00	4952.85	2543.03	7335.11
3593.29	6206.92	3025.14	9110.92
4009.95	8178.46	3550.92	9391.92
4532.38	11287.28	4033.42	11736.14
5015.18	13919.32	4584.19	15342.31
5517.79	14965.28	5028.29	15391.13
6018.28	16019.32	5512.31	15598.18
6525.46	17769.44	6051.80	15985.58
7018.32	18531.42	6512.36	16523.43
7538.62	21644.4	7079.89	18233.40
8052.82	22514.6	7533.44	21244.3
8527.69	23419.2	8085.73	24805.9
9055.61	26631.4	8506.05	29240.1
9482.94	28280.8	9056.22	34079.2
10008.11	29696.1	9542.68	35443.4
11751.26	34745.6	10030.36	36750.6
		10504.02	39329.7
		10641.79	39382.3
		11296.80	39382.3
		11388.24	39417.0
		11822.58	39417.0
		12008.51	39565.4
		12519.66	39640.0
		12636.09	39640.0

Table 5.39.3 & 5.39.4

Distance and Corresponding Area, J-13 (Ch. 84.70 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
1134.77	0	1014.07	0
1502.36	3730.28	1522.78	2969.74
2002.84	8599.59	2045.82	7953.28
2531.06	11622.12	2500.27	11078.92
3023.92	13295.97	3048.91	11740.69
3558.84	14213.09	3516.17	13090.77
4019.09	16724.01	4013.30	16131.92
4494.58	19535.14	4521.40	18767.38
4982.26	19535.14	5004.51	18826.21
5531.21	19688.11	5519.62	19253.81
6018.89	20203.20	6028.64	19924.62
6498.64	20394.80	6545.58	20363.80
7047.28	21246.40	7004.91	21064.10
7506.61	22396.20	7524.90	24450.30
8099.45	29194.80	8010.45	26606.60
8501.48	31478.00	8510.32	28270.20
9051.65	33156.10	9054.08	32826.70
9559.14	34367.90	9558.83	34292.20
10007.80	35902.30	10034.32	35818.50
10557.36	38944.50	10506.76	37067.00
11042.90	39305.10	11532.72	37149.90
12026.49	39594.60	12003.94	37454.20
12639.75	39646.60	12638.53	37513.10

Table 5.39.5& 5.39.6

Distance and Corresponding Area, J-13 (Ch. 84.70 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
377.04	4.27	**	724.09	0
1054.61	210.985	**	1053.05	1753.651
1528.57	3402.04	**	1575.91	7307.59
2042.16	8375.24	**	2009.15	9987.19
2519.78	9861.04	**	2544.51	13223.61
3044.04	12787.01	**	3035.37	13984.72
3540.25	14325.32	**	3510.37	16406.52
4030.37	14350.06	**	4015.85	16791.14
4528.41	15219.10	**	4503.66	17951.52
5018.23	16158.72	**	5114.63	18391.28
6057.29	16416.16	**	5297.56	18399.35
6510.83	16605.97	**	5872.87	18399.35
7020.76	17148.27	**	6051.52	18413.29
7502.35	18726.57	**	6522.26	19318.46
8023.86	22187.90	**	7032.32	22066.70
8539.89	26138.20	**	7536.59	23647.80
9023.91	27386.10	**	8035.98	24354.60
9553.04	28180.60	**	8567.07	27634.30
10528.71	28365.00	**	9010.98	30920.50
11284.00	28720.90	**	9482.32	32661.10
11846.05	28745.30	**	10753.05	32842.50
12005.46	28829.50	**	11718.90	32842.50
12512.04	29272.30	**	12023.78	33230.90
12642.19	29272.30	**	12469.51	33384.80
		**	12620.43	33384.80
		**		

Table 5.39.7& 5.39.8

Distance and Corresponding Area, J-13 (Ch. 84.7_ Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
520.55	0	318	66.10
1017.55	5973.97	1015	6504.43
1585.21	7732.89	1635	9937.98
2034.80	9577.92	2097	14099.16
2484.40	11262.44	2571	18010.90
3028.79	11830.38	3020	18720.62
3501.94	13709.86	3520	20236.30
4069.90	13791.13	4085	23411.50
4566.60	14161.86	4551	23918.20
4708.81	14383.71	5015	24083.20
6080.85	14383.71	5516	24274.40
6601.70	18017.53	6026	24533.50
7003.89	19669.62	6516	26842.40
7524.44	21250.30	7040	31859.40
8092.40	21837.00	7534	33440.40
8542.00	22539.00	8018	33865.10
9062.55	24277.30	8525	34242.60
9630.50	27069.20	9034	35459.40
10363.92	27069.20	9594	38017.80
10718.71	27794.40	10076	40718.30
11594.35	27794.40	10508	40735.60
12067.49	28499.70	11024	41073.80
12422.57	28716.40	11549	41153.20
		12000	41469.70
		12632	41951.80

Table 5.40.1 & 5.40.2

Distance and Corresponding Area, J-12 (Ch. 100.50 Km.)

Year 1969-70		Year 1977-78	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
527.91	1281.259	467.99	137.627
1022.97	5851.92	1050.10	302.352
1538.02	10066.06	1557.04	379.328
1978.46	13024.34	2030.30	939.767
2514.90	13651.06	4624.00	978.169
3048.91	13663.25	5316.63	1011.256
3510.24	14891.84	6211.99	1167.908
4129.74	16876.19	6646.96	5124.62
4746.96	16876.19	7113.27	9105.89
5025.85	18027.56	7632.41	12307.74
5552.54	19069.73	8538.18	12853.65
6027.12	19987.90	9085.39	13015.51
6530.04	22803.30	10082.54	13183.48
7013.14	22904.30	10530.75	14511.55
7516.37	25419.80	11109.41	16453.95
8010.14	27122.70	11517.11	17577.22
8539.28	28418.30	12045.64	21383.60
9026.96	28561.10	12624.42	25136.10
9501.53	28809.30	13047.88	26914.40
10019.39	30003.50	13505.35	27895.10
12051.18	30105.00	14059.75	30074.60
12555.63	30435.40	14548.29	31389.40
		15033.62	31818.70
		15518.95	32385.90
		16130.30	37771.40
		16618.58	39805.30
		17175.54	42295.80
		18489.59	42546.60
		19211.18	42963.80

Table 5.40.3& 5.40.4

Distance and Corresponding Area, J-12 (Ch. 100.50 Km.)

Year 1978-79		Year 1981-82	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
300.29	81.338	539.80	0
500.70	130.85	1160.68	168.366
1073.45	246.532	1537.11	482.077
1552.13	296.653	2036.98	1885.37
2032.77	904.525	2495.70	2605.18
2479.34	1086.817	3014.78	2827.04
3183.09	1135.326	3523.79	3050.19
5151.36	1183.813	4045.61	3324.54
5246.28	1356.799	5408.98	3324.54
6035.04	1356.799	6034.74	4567.54
6502.51	4128.35	6520.59	9908.30
7040.94	7900.04	7074.71	15819.79
7563.12	12036.00	7458.15	18448.90
8046.45	15631.36	8110.42	22074.70
8802.90	17575.67	8675.22	25334.30
9896.00	17575.67	9059.88	27300.70
10395.26	18228.13	10014.51	27832.10
10778.28	21224.60	10436.66	27997.40
11140.14	21447.80	10852.10	27997.40
11554.63	21603.90	11004.50	28526.80
12043.44	25116.50	11506.50	30527.10
12568.67	28886.10	12019.79	32084.10
13038.54	29972.90	12505.33	36227.60
13566.89	30843.40	12604.09	36723.00
14015.25	32549.70	14114.68	36961.70
14580.81	34122.40	14545.36	37284.90
15004.21	35146.20	14888.87	37644.70
15518.74	35422.30		
16030.86	38203.20		
16558.66	42870.00		
16968.28	46734.60		
18533.94	46871.60		
19022.78	47195.10		
19331.94	47537.00		

Table 5.40.5& 5.40.6

Distance and Corresponding Area, J-12 (Ch. 100.50 Km.)

Year 1986-87		Year 1988-89	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
503.96	0	481.88	0
585.06	177.32	1180.86	191.147
1664.02	177.32	1783.28	191.147
2035.06	492.220	1952.10	206.341
2583.84	514.173	2867.58	206.341
3942.07	629.418	3060.39	1509.458
4132.62	820.002	3614.83	5571.48
4746.34	820.002	3952.18	7174.98
5076.83	2452.72	4482.34	9496.85
5535.06	6354.28	5060.77	11190.17
6075.61	8386.59	5494.37	11518.68
6543.90	10245.19	6024.53	12431.99
7027.74	13000.74	6578.97	15646.07
7515.85	16312.52	7036.86	18354.51
8046.95	20300.00	7541.81	21163.80
8516.46	22161.30	7952.33	22909.40
9057.01	26723.10	8241.71	23450.70
9567.07	28000.20	8699.60	23450.70
10027.80	28069.70	9205.46	24070.10
10493.29	28621.50	9783.90	28031.50
11051.22	32291.30	9976.70	29235.90
11329.27	33099.50	10410.60	29235.90
12033.54	33126.40	10964.75	30075.20
12479.27	34259.60	12530.92	33687.80
14024.39	34319.50	14748.10	34609.60
14533.54	34565.30	15013.18	34801.80
14894.51	34728.40	15904.98	35240.70

Table 5.40.7

Distance and Corresponding Area, J-12 (Ch. 100.50 Km.)

Year 1990-91		Year 19__-__	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
506	0		
1989	40.88		
2509	2092.17		
3032	5649.36		
3570	9626.04		
4047	12808.72		
4562	18565.94		
5033	22308.20		
5551	26583.10		
6082	28662.60		
6563	31000.80		
7052	34391.50		
7499	36579.80		
8077	40935.30		
8501	41617.10		
9033	43747.90		
9518	45233.20		
9930	46748.10		
11053	46757.60		
12025	46908.30		
12517	48041.20		
12620	48174.30		
13774	48174.30		
14496	48358.20		
14893	48361.00		

Table 5.41.1 & 5.41.2

Distance and Corresponding Area, J-11 (Ch.117.75 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
512.67	56.115	639.78	0
1030.83	124.542	1066.50	12.192
1515.77	320.620	1724.56	12.192
2033.93	937.23	2029.36	415.911
2504.85	1259.748	3126.64	415.911
2779.17	1427.693	3206.19	420.684
3445.76	1427.693	4223.61	420.684
4060.24	1584.342	4528.41	828.864
4514.09	1677.380	5049.93	4579.07
5078.58	2129.32	5558.94	7044.93
5516.58	4950.79	6039.31	7888.15
6046.01	8475.49	6445.28	8405.62
6505.96	11661.93	7033.56	10108.17
7093.31	16386.43	7520.64	11577.78
7613.60	18882.84	8038.80	12378.10
8022.95	19577.48	8529.52	13976.17
8500.87	21492.00	9017.51	18333.46
9000.13	24244.30	9503.36	23504.70
9530.18	24808.00	10056.57	27832.20
10017.86	24815.80	10505.85	29247.00
10505.54	24954.90	11044.43	29348.40
11010.90	25641.00	11478.77	29440.80
11475.72	25801.20		

Table 5.41.3 & 5.41.4

Distance and Corresponding Area, J-11 (Ch.117.75 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
388.62	9.67	510.24	38.21
1053.08	52.341	1059.48	142.80
1636.78	60.266	1638.91	142.80
2033.02	231.106	1836.42	330.29
2520.70	231.106	3187.29	330.29
3052.88	330.528	3515.56	2090.94
3508.55	682.194	4034.33	4625.10
4009.34	3909.61	4531.16	5449.63
4545.79	5677.13	5005.12	7412.37
5041.09	8420.75	5499.81	10492.33
5537.30	11556.23	6046.32	13310.06
6032.30	16349.82	6506.57	16675.16
6505.04	20770.00	7045.45	21030.40
7020.15	23192.50	7504.48	24854.10
7519.42	24544.40	8015.02	28657.30
8086.65	25409.50	8522.51	33329.70
8505.75	29441.90	9029.40	37560.80
9027.87	35192.20	9535.67	41282.70
9504.58	38786.60	10013.90	43479.80
10008.72	42191.30	10514.99	44573.70
11048.39	43902.90	11035.59	44726.80
11480.60	44034.80	11454.08	44818.50

Table 5.41.5& 5.41.6

Distance and Corresponding Area, J-11 (Ch.117.75 Km.)

Year 1981-82		**	Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
633.07	9.144	**	511.28	30.323
1059.79	51.816	**	1000.91	67.977
1624.28	51.816	**	1549.70	154.567
1685.24	74.676	**	2042.99	162.494
2862.07	74.676	**	2567.38	4086.95
3495.14	2883.62	**	3030.18	7448.30
4023.97	7914.45	**	3543.60	9314.19
4532.38	8777.56	**	4045.73	11345.26
5035.30	11304.91	**	4513.72	14167.70
5533.64	14225.94	**	5008.84	16791.86
6012.18	17789.79	**	5517.99	18224.32
6515.10	19916.66	**	6040.24	22060.30
7057.03	21063.40	**	6522.56	24538.30
7534.35	23967.10	**	7006.71	24830.60
8018.98	29056.20	**	7501.83	27684.80
8539.28	35462.00	**	8071.04	30393.20
9023.91	36823.80	**	8535.67	31590.40
9511.28	38419.50	**	9006.40	31886.20
10000.49	39079.00	**	9567.38	33035.20
10543.03	40540.20	**	10038.11	34723.00
11009.38	40731.20	**	10543.29	37919.60
11478.16	40779.00	**	11001.22	41570.80
		**	11060.98	41577.90
		**	11503.35	41577.90

Table 5.41.7 & 5.41.8

Distance and Corresponding Area, J-11 (Ch.117.75 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
552.31	13.237	575.00	1750.425
984.55	79.388	1068.00	4310.39
1560.88	4176.22	1501.00	7196.72
1993.12	5420.59	2050.00	14084.68
2569.45	6867.48	2588.00	17766.69
3121.76	9066.52	3034.00	21232.00
3602.03	12167.96	3529.00	25609.60
4010.27	13940.56	3908.00	26378.80
4538.57	16613.53	4185.00	26378.80
4934.78	17571.35	4545.00	26491.40
5643.18	17967.80	5010.00	26949.30
6003.39	19212.44	5500.00	27337.60
6555.70	21000.80	6040.00	27668.20
7059.99	21735.20	6529.00	28874.90
7492.23	22527.10	7028.00	30120.80
8020.53	23524.10	7521.00	30120.80
8500.80	24311.20	8008.00	30688.10
9149.16	24311.20	8546.00	31927.40
9557.39	26655.50	9058.00	33183.40
10205.76	31308.40	9470.00	34768.10
11526.51	36666.00	10024.00	37286.30
13000.00	37719.20	10504.00	37564.80
		11040.00	38933.40
		11569.00	40871.40
		12031.00	42972.90
		12506.00	48571.30
		12761.00	50602.90

Table 5.42.1& 5.42.2

Distance and Corresponding Area, J-10 (Ch. 134.30 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
518.77	13.296	1733.61	0
1706.88	60.056	2000.65	705.90
2021.13	1388.240	2475.68	1765.73
2524.05	1739.261	3019.17	2302.33
3095.85	3177.16	4034.06	2868.17
3596.03	3246.12	4473.12	3331.66
5118.51	4210.51	5066.20	3789.50
5505.30	4660.08	5552.54	3909.33
6074.97	4961.77	6007.73	4208.25
6500.16	5187.29	6540.61	4702.78
6932.98	5810.07	7032.19	5300.16
7681.87	5906.82	7548.49	8015.70
8004.96	7559.20	8074.30	13748.27
9020.86	10890.90	8552.69	19782.33
9510.37	12805.65	9003.85	23929.10
10004.45	20894.30	9498.57	26899.90
10508.28	25376.80	10004.24	29360.00
11190.73	27862.40	10520.84	33005.10
12021.31	31336.40	11034.83	33962.60
13484.05	35947.20	11519.25	35914.80
14041.83	37196.70	12045.60	39220.70
14560.60	37321.80	12519.42	42608.30
15011.70	37460.70	13025.26	45179.80
15558.52	37865.70	13522.33	47552.80
16083.08	38042.90	14137.84	52264.10
16632.94	38118.60	14519.15	53294.00
17533.32	38871.00	15513.01	53709.00
18112.44	39334.80	16517.29	54805.80
18521.78	40816.40	16965.69	55017.30
19022.26	42341.20	17599.18	55352.30
19605.35	43637.60	18015.63	56355.20
20668.49	43954.10	18601.43	57653.30
21525.89	44577.20	19001.41	59529.00
		19546.37	60710.60
		21478.34	61212.20

Table 5.42.3& 5.42.4

Distance and Corresponding Area, J-10 (Ch. 134.30 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
1676.22	0	548.00	102.33
2003.15	1268.82	1129.07	142.32
2524.48	1801.70	1541.80	1819.28
3010.54	2395.89	2029.51	5227.09
3533.24	2698.09	2542.92	9791.58
4042.84	3135.28	3024.68	14725.79
4568.53	3429.67	3563.69	19484.96
5024.23	3560.30	4037.11	23124.00
6038.70	3961.20	4535.15	26317.40
6519.82	5057.03	4984.91	28316.30
7008.30	8285.72	5505.60	31509.30
7508.40	11961.35	6042.29	32016.00
8011.33	17128.52	6556.58	32324.90
8505.81	19093.18	7010.22	33919.00
9073.41	20433.40	7527.22	35029.00
9521.56	22121.40	8017.70	35622.90
10043.46	27277.20	8536.66	36388.90
10554.98	29735.80	9252.20	40237.20
11021.87	30606.00	10002.04	40440.70
11518.06	32995.70	11004.53	40929.50
12007.54	35158.30	11508.55	41557.10
13074.37	40359.00	12038.29	41834.10
14014.70	46733.60	12526.55	42035.10
14546.37	47509.40	13001.79	43757.00
15057.06	47733.80	13559.42	46850.70
16006.72	48103.40	14084.78	49357.90
17074.47	48826.40	14797.52	49407.70
18079.70	51190.10	15103.88	49474.20
18604.87	52467.10	16295.16	49805.7
19014.61	55098.30		
21244.83	55192.10		

Table 5.42.5 & 5.42.6

Distance and Corresponding Area, J-10 (Ch. 134.30 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
551.69	24.61	**	533.54	216.718
1021.08	471.45	**	1007.62	381.408
1518.51	2951.35	**	1509.45	1407.122
2036.06	5520.00	**	2058.23	2279.69
2519.48	5790.48	**	2516.46	4208.14
3001.06	6737.85	**	3000.00	4634.20
3537.81	12393.67	**	3524.39	4781.74
4013.91	17471.01	**	4009.45	6381.25
4573.83	22133.40	**	4558.23	7084.61
4992.32	25280.40	**	5030.79	8146.04
5502.25	28469.70	**		
6054.24	30293.20	**	5525.91	10755.97
6541.92	31889.40	**	6075.00	14377.00
7039.66	32411.00	**	6529.57	18147.54
8019.59	32914.10	**	7000.91	18248.51
8601.76	33425.10	**	8403.66	18486.16
9014.76	34987.90	**	9024.08	19015.15
9564.62	36581.20	**	9542.07	19594.86
11011.81	36867.90	**	10025.00	20314.20
11520.83	37100.4	**	10917.68	20314.20
12023.75	37837.90	**	11554.27	22593.10
12516.31	39642.1	**	12504.88	22804.30
13068.60	42601.60	**	13046.34	24478.50
13519.71	43499.20	**	13596.95	27879.90
14000.99	45048.80	**	14058.23	30878.40
14405.76	46369.60	**	14502.74	34373.30
		**	16501.83	37750.40

Table 5.42.7& 5.42.8

Distance and Corresponding Area, J-10 (Ch. 134.30 Km.)

Year 1988-89			Year 1990-91	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
734.54	93.51	**	888	0
1002.70	524.61	**	1028	98.90
1562.34	1675.84	**	1535	850.665
2075.35	2390.32	**	2029	850.665
2588.35	3681.31	**	2543	3661.26
3031.41	6206.34	**	3076	4508.48
3591.06	7764.55	**	3518	5111.26
4010.79	8487.19	**	4058	5648.86
4523.80	8774.01	**	4542	5990.42
4990.17	9025.26	**	5022	6789.32
5503.17	9560.88	**	5502	7353.32
6132.77	10511.00	**	6054	8640.58
6529.19	12417.89	**	6552	9480.18
7065.15	15812.57	**	7008	10669.33
8622.02	15933.13	**	7548	12986.97
9024.28	16359.55	**	7989	14655.06
10516.66	16559.03	**	8548	14709.03
11099.62	20441.30	**	9009	15006.24
11635.95	23785.40	**	9507	15472.40
12009.05	24894.80	**	10000	15638.42
12358.82	26147.60	**	10511	19791.21
12988.43	26394.80	**	11029	21813.60
13454.80	26802.80	**	11509	22470.60
14037.76	28250.70	**	12031	24405.30
14550.77	31965.30	**	12502	28719.40
15017.14	35277.60	**	13033	30645.40
15973.20	35295.30	**	13503	31491.20
		**	14020	35434.10
		**	14521	40330.30
		**	15052	41476.60
		**	15454	42664.10
		**	16500	42877.70
		**		

Table 5.43.1& 5.43.2

Distance and Corresponding Area, J-9 (Ch. 142.45 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
596.19	332.209	266.21	34.17
1044.85	548.124	773.95	34.17
1782.78	548.124	1030.01	2070.72
2058.01	2759.06	1574.44	3137.85
2546.60	6621.98	2019.27	3232.81
3033.37	9079.01	2585.67	3342.43
3543.30	13305.30	3077.99	6737.75
4077.92	17424.07	3516.97	8177.98
4653.38	17877.40	3996.96	10556.76
5067.60	17877.40	4582.49	12675.27
5579.06	18565.72	5027.83	15789.93
5953.96	18565.72	5507.71	19900.63
6139.89	18565.72	6166.47	25469.20
6522.72	18623.79	6583.89	27027.40
7021.37	19623.27	7022.65	28075.40
7662.06	22445.60	7520.39	29566.30
10212.06	22445.60	8044.28	30377.00
10547.30	23271.10	8556.86	31336.90
11124.59	24578.00	9052.93	31941.70
11522.05	25011.60	9518.57	32728.70
12047.52	27308.30	10003.23	34263.20
12544.96	27575.90	10679.89	36195.50
13028.68	28365.80	11052.44	36195.50
13557.20	29623.30	11561.67	36569.10
14289.63	29623.30	12035.49	36769.60
14659.05	29655.20	12529.11	37233.10
15552.55	29655.20	13002.68	37296.90
		13448.14	37583.60
		13987.97	40078.50
		15126.37	40078.50

Table 5.43.3 & 5.43.4

Distance and Corresponding Area, J-9 (Ch. 142.45 Km.)

Year 1977-78		Year 1981-82	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
504.54	33.273	270.66	65.764
775.26	33.273	544.98	123.841
1001.57	2135.53	804.67	123.841
1547.68	3507.61	1029.92	1679.22
1978.21	3657.06	1519.43	2746.02
2485.16	6667.68	2068.98	2830.10
2995.24	10808.42	2546.91	7111.58
3475.18	11758.83	2990.70	10231.26
3986.78	13601.97	3582.92	11964.48
4509.39	15673.67	4055.36	11973.54
4989.42	17388.92	4543.04	12464.57
5500.91	20306.30	5051.45	13956.38
6072.68	25327.40	5554.37	18448.51
6521.20	27129.10	6020.10	22484.20
7097.69	27472.50	6528.21	26207.40
7526.49	27844.60	7056.42	27356.30
8020.81	28027.60	7422.18	27369.10
8508.58	28027.60	9029.40	27369.10
9059.84	28709.60	9090.36	27599.20
9525.70	29356.80	9591.45	27599.20
10015.91	31069.80	10058.40	28067.70
10518.16	32444.30	10524.74	28661.80
11028.94	33807.20	10924.95	29185.60
11500.13	33970.20	11534.55	29185.60
12012.26	34272.70	12035.33	32577.90
12498.11	34457.30	12575.44	36516.80
12876.92	34610.80	13032.64	38341.00
13453.81	34610.80	13520.62	39873.40
13937.56	35137.30	13977.82	40532.40
14496.14	36919.20	15273.22	40532.40
15339.21	36919.20	15450.31	40558.70

Table 5.43.5 & 5.43.6

Distance and Corresponding Area, J-9 (Ch. 142.45 Km.)

Year 1986-87		Year 1988-89	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
461.28	82.85	324.67	68.644
768.29	82.85	742.10	68.644
1026.52	965.245	1043.58	2178.72
1514.94	2488.74	1507.39	3532.35
2044.82	2907.45	2017.58	5599.16
2509.45	4112.60	2550.96	7598.23
3074.70	7398.76	3014.77	8791.84
3550.00	10075.88	3617.72	9085.44
4020.43	11847.38	3942.40	10505.91
4532.62	13926.99	4638.11	13670.81
5025.61	18484.50	4962.78	14293.94
5506.71	19509.26	5496.17	15341.12
6020.12	21486.00	6029.55	16355.74
6559.45	23995.60	6493.36	17908.24
6973.17	24613.00	7049.93	19268.58
7554.27	24651.00	7560.12	19340.42
7798.78	25002.40	7815.22	19539.27
9732.01	25002.40	9832.80	19539.27
10022.26	25289.40	10203.85	19895.48
10584.45	25289.40	10598.09	21107.20
11041.77	26646.80	10899.56	23318.70
11529.57	27637.70	11201.04	25515.00
12003.66	27810.40	11409.76	26987.50
12519.82	29772.60	11989.52	18589.00
13075.61	34210.60	12522.90	30470.90
13560.67	36332.70	13033.10	34945.60
14078.05	38090.40	13566.48	38460.50
14402.13	39095.50	13821.57	39693.40
15479.88	39095.50	14447.72	43899.50
		15500.00	46244.10

Table 5.43.7

Distance and Corresponding Area, J-9 (Ch. 142.45 Km.)

Year 1990-91		**	Year 19-	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
255	43.20	**		
329	51.87	**		
715	51.87	**		
1002	1528.86	**		
1562	3590.78	**		
2003	6209.76	**		
2505	6612.94	**		
3075	7082.44	**		
3507	8103.58	**		
4047	9379.72	**		
4557	10581.08	**		
4914	10764.82	**		
5655	10764.82	**		
6009	11448.90	**		
6539	12091.80	**		
6849	12239.70	**		
9589	12239.70	**		
10005	12713.50	**		
10577	15692.02	**		
11129	18940.26	**		
11547	20888.90	**		
12017	22067.30	**		
12545	24625.80	**		
13049	32686.20	**		
13556	36883.00	**		
14005	38253.60	**		
14545	39081.60	**		
15014	40028.80	**		
15480	41547.10	**		
15803	41547.10	**		

Table 5.44.1 & 5.44.2

Distance and Corresponding Area, J-8 (Ch. 149.50 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
451.41	243.10	531.27	0
573.33	269.90	1109.47	2110.20
1779.42	269.90	1607.21	4959.80
1962.30	298.90	2094.59	7790.00
2374.39	328.50	2552.70	11552.80
2950.16	1858.00	3109.87	14038.10
3448.20	5001.90	3597.55	14668.40
3691.74	5518.60	4268.72	15954.94
4091.94	5518.60	4917.95	15954.94
4460.14	7054.00	5162.40	15979.33
4926.79	13866.52	5889.78	15979.33
5430.01	19627.13	6072.84	15985.43
5961.58	21990.10	7211.87	15985.43
6298.69	22539.35	7516.67	16073.82
8183.58	22539.35	7954.98	16073.82
8457.90	22562.51	8320.74	16181.72
8800.80	22800.66	9088.53	16181.72
9871.86	22800.66	9576.21	17281.43
9919.41	22853.88	10074.86	19761.36
10437.57	22878.26	10595.76	24367.86
10894.16	23349.95	11146.23	27703.11
11477.85	23349.95	12042.34	33069.24
11901.22	24075.72	12533.99	35625.40
12463.88	25381.20	13612.98	35625.40
13002.46	28009.227		
13340.79	28821.357		
13988.91	28982.10		
14470.68	28982.10		

Table 5.44.3 & 5.44.4

Distance and Corresponding Area, J-8 (Ch. 149.50 Km.)

Year 1977-78			Year 1978-79	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
0	0	**	0	0
530.35	0	**	243.84	14.00
1070.76	3028.40	**	572.20	14.00
1470.36	4428.10	**	1120.14	1645.10
2053.44	6228.70	**	1581.91	2818.30
2581.96	10667.50	**	2604.21	6842.30
3069.34	14658.30	**	3117.49	9269.10
3564.03	16255.40	**	3606.70	14076.82
4109.31	17226.30	**	4189.78	16638.29
8064.09	17226.30	**	7048.50	16638.29
8528.00	17269.40	**	7094.22	16680.35
9076.64	17714.10	**	7611.16	16680.35
9494.22	19224.70	**	7687.36	16685.76
10076.69	21765.26	**	9283.29	16685.76
10571.68	25220.52	**	9591.14	17360.12
11048.70	27908.55	**	10095.59	21298.84
11500.41	31637.41	**	10583.27	21965.13
12050.88	36343.08	**	11113.62	24589.48
12542.82	38314.571	**	11619.89	30341.01
13012.83	39629.667	**	12092.64	33343.256
13577.01	39820.70	**	12603.78	33912.128
		**	13233.50	33931.30
		**	13622.43	33931.30
		**		

Table 5.44.5 & 5.44.6

Distance and Corresponding Area, J-8 (Ch. 149.50 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
0	0	**	0	0
610.21	1155.10	**	426.83	548.40
1114.65	3186.40	**	947.87	2531.60
1591.67	3435.30	**	1424.70	3837.00
2079.35	4422.60	**	1930.18	4189.00
2586.23	5787.60	**	2429.88	4309.20
3077.87	6997.00	**	2957.62	5937.50
3620.41	11763.80	**	3451.83	6520.10
4123.33	12903.70	**	3937.20	11457.00
8726.73	13663.30	**	4392.38	15741.06
9053.78	14218.30	**	4914.63	19246.33
9589.31	20144.20	**	6494.21	19246.33
10045.29	24676.68	**	6616.77	19439.34
10679.28	31045.85	**	7855.18	19439.34
11099.90	32880.391	**	7966.16	20199.00
11618.05	34086.18	**	8419.82	24446.73
12105.74	34519.606	**	8958.54	27314.92
12532.46	34589.10	**	9428.35	28984.42
13635.23	34589.10	**	9958.23	29715.14
		**	10427.74	31182.21
		**	10968.29	32584.225
		**	11456.10	33110.451
		**	11967.38	33322.695
		**	12512.20	33398.90
		**	12957.93	33398.90
		**	13362.80	33717.70
		**	13970.73	33717.70
		**		

Table 5.44.7 & 5.44.8

Distance and Corresponding Area, J-8 (Ch. 149.50 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
637.40	0	224	0
933.34	2688.60	1675	1617.10
1365.87	6440.80	2181	2439.70
1980.51	8315.50	2640	4824.30
2367.49	9046.90	3180	5815.00
2959.38	12136.50	4000	5815.00
3414.66	13211.30	4188	6108.10
4143.13	13211.30	4512	6652.40
4370.77	13420.70	5977	6652.40
4962.64	13510.80	6178	7392.30
5383.78	14617.01	6637	8496.20
5895.98	18869.69	7150	8496.20
6396.80	21998.23	7250	8615.70
7034.20	24379.56	8103	8615.70
8468.37	24379.56	8639	12740.30
8912.27	25767.96	9172	15188.80
9424.47	27005.82	9651	15773.20
9822.84	27483.87	10151	16766.20
10926.92	27908.94	10786	19740.80
11222.86	28647.20	11120	19740.80
11996.85	28647.20	11530	19804.40
12452.14	29513.62	11893	19804.40
12793.61	31196.16	12139	21677.00
13442.39	33949.00	12660	26023.51
13977.35	33974.098	13171	30934.86
14296.06	33983.66	13646	34542.91
14637.52	34015.10	14153	37383.61
14978.99	34015.10	14657	38871.985
		15293	40790.32
		15690	40869.90

Table 5.45.1 & 5.45.2

Distance and Corresponding Area, J-7 (Ch. 162.35 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
498.96	202.10	264.26	91.40
1047.60	202.10	2075.69	497.30
1352.40	361.30	2573.12	5476.90
2329.28	361.30	3064.73	7200.90
2917.85	8827.70	3550.92	7804.20
3394.56	11198.90	4027.63	7952.90
3906.62	12182.23	4487.88	7952.90
4180.94	12339.96	4746.96	7978.30
4783.53	12339.96	5958.54	7978.30
5920.69	12402.30	6049.98	8085.60
5426.66	12501.57	6566.92	11004.20
5933.24	14964.87	7052.77	11662.47
6437.68	19096.76	7231.38	11850.09
6918.66	21292.21	7610.55	11850.09
7404.51	22419.42	8014.72	13914.39
7936.99	23813.33	8557.26	18801.32
8435.95	25592.74	9053.17	23152.81
8938.87	27955.971	9543.29	26173.34
9451.24	29706.65	10040.11	27405.56
10897.21	29706.65	10532.67	27471.41
10912.45	29722.34	11006.94	29056.032
12615.37	29722.34	11734.19	30252.25
13164.01	29783.30	12798.25	30252.25
14444.17	29783.30	13542.57	30401.996
		14077.49	30430.0

Table 5.45.3 & 5.45.4

Distance and Corresponding Area, J-7 (Ch. 162.35 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
186.54	64.30	182.88	30.80
2065.02	709.30	2064.72	30.80
2538.68	4724.90	2558.49	5400.70
3075.43	8568.80	3046.17	9593.90
3537.51	8793.40	3568.29	10834.50
3844.14	9198.30	4073.35	10996.40
3953.87	9198.30	4563.16	10996.40
4136.86	9275.10	4867.96	11081.60
4563.47	9275.10	5019.45	11081.60
4990.19	9343.40	5565.34	11117.40
5246.22	9343.40	5900.62	11117.40
5490.06	9366.60	6022.54	11139.70
5733.90	9427.70	6572.71	12841.30
5965.24	9427.70	7045.15	13210.60
6557.47	11846.30	7658.71	15627.00
7001.56	12998.32	7991.86	18413.40
7245.40	13366.22	8563.66	22875.63
7399.93	13366.22	9071.76	25209.15
8057.69	19310.14	9531.40	26797.27
8567.32	22812.27	10066.93	27502.80
9046.46	24284.93	10524.13	28639.25
9530.79	25774.24	11063.02	29108.24
10044.68	26993.06	11534.85	30361.37
10547.30	27182.36	12057.58	33229.19
11034.06	29320.718	12524.54	37127.85
11224.26	29791.67	12951.87	40272.91
11707.06	30586.876	13587.98	40368.465
13743.07	30586.876	14079.02	40492.0
14075.36	30648.90		

Table 5.45.5 & 5.45.6

Distance and Corresponding Area, J-7 (Ch. 162.35 Km.)

Year 1981-82		Year 1986-87	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
265.79	77.30	2251.83	4061.70
2067.46	535.10	2744.21	7889.60
2492.04	8088.40	3226.83	9007.03
3005.94	12673.90	3744.21	11020.88
3565.55	15163.60	4193.60	11108.68
4051.40	15590.70	4532.93	11108.68
4555.85	16294.50	4805.79	11135.97
5057.24	17287.50	5181.10	11135.97
5529.68	18540.30	5755.79	13374.13
6047.84	19246.80	6251.22	13747.83
6558.38	20898.40	6947.73	14286.46
6995.16	22253.60	7239.02	14733.04
7554.77	24042.00	7720.43	16081.13
8046.42	27626.00	8200.61	19085.19
8571.28	30531.80	8541.77	20142.02
9058.96	32825.70	9463.42	20142.02
9531.10	35451.20	9747.56	20863.44
10103.51	39053.30	10251.83	22284.88
10569.55	42854.80	10694.82	22284.88
11058.75	46223.80	11221.04	22719.19
11570.51	51133.20	11708.84	22964.46
12014.30	56621.37	12207.32	22986.03
12510.52	62419.33	12724.09	23143.96
13032.33	67065.984	13260.98	24282.24
13452.96	67571.618	13881.10	27981.714
14072.01	67725.70	14263.42	28182.70

Table 5.45.7 & 5.45.8

Distance and Corresponding Area, J-7 (Ch. 162.35 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
2040.46	234.40	242	54.20
2429.12	3138.20	744	631.60
3036.40	8674.50	1224	2182.30
3546.51	9983.40	1857	2887.80
4555.33	9983.40	2293	2887.80
4955.41	10542.20	2754	3045.40
5392.65	11832.10	3267	3283.10
6024.22	13185.80	3747	4046.50
6534.34	14696.60	4259	5355.90
6801.54	16044.86	4533	7086.30
7384.53	18604.68	5760	7086.30
7894.64	22031.40	6256	9486.07
8550.51	24040.69	6761	11190.18
8866.29	24040.69	7271	11781.02
9449.28	24117.88	7763	12705.86
9862.23	25803.02	8183	13072.88
10493.80	28315.59	8717	14183.48
10931.04	28328.95	9093	15659.40
11344.00	29183.52	9462	15783.04
11854.11	29719.13	10130	15783.04
12461.39	29835.60	10770	17805.02
12947.21	30004.18	11257	21219.83
13433.04	31485.82	11722	25635.46
13967.45	35010.746	12169	28780.00
14453.27	35706.90	12202	28780.00
		14271	29037.60

Table 5.46.1 & 5.46.2

Distance and Corresponding Area, J-6 (Ch. 177.70 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
542.85	211.941	349.61	69.565
1107.95	247.616	1251.20	69.565
1571.55	282.222	2042.46	566.313
2001.01	292.548	2531.36	1207.698
2478.33	972.916	3017.22	1515.005
3028.19	3466.75	3522.57	1550.953
3573.17	5327.87	4052.01	2198.47
3978.25	5855.53	4519.88	3656.55
4443.07	6623.26	4916.12	4227.16
5080.10	6680.97	7527.04	4275.93
5516.58	6819.24	8037.58	4299.40
7077.46	6943.68	8516.11	4363.39
7524.60	7064.74	8942.83	4566.69
8804.15	7080.70	9823.70	4566.69
9568.28	7124.72	10012.68	5586.73
11016.39	7178.04	10585.70	8133.79
11604.96	11716.22	10977.68	10272.54
11993.27	17693.26	11560.45	13110.23
12547.40	22279.80	12037.47	16010.37
13038.73	23684.30	12508.08	21244.80
13498.98	26346.80	13004.29	25675.80
14030.86	27668.60	13700.76	25683.60
15189.40	29591.50	14019.89	26068.10
16033.09	29591.50	14512.14	26736.20
16483.28	29620.20	15005.91	26979.70
17077.03	29732.40	15588.69	27023.60
17571.11	30029.20		
18090.49	30272.90		
18517.51	30888.70		
19386.50	31136.90		

Table 5.46.3 & 5.46.4

Distance and Corresponding Area, J-6 (Ch. 177.70 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
539.19	180.354	349.61	79.292
1270.41	180.354	1285.95	86.211
1818.44	531.617	1715.11	258.180
2001.32	784.296	2036.98	581.415
2495.09	1565.558	2533.19	1076.854
3002.89	1773.299	3014.78	1311.126
3543.30	1905.52	3527.45	1419.14
4002.94	2260.88	4054.14	1658.994
4503.72	3446.26	4529.63	2638.41
4617.72	3690.60	5029.50	4500.46
4837.79	3690.60	5498.59	5381.24
4907.28	3930.31	7474.61	5441.97
5013.96	4589.21	8021.42	5467.60
5575.10	5269.98	9457.33	5659.77
7470.34	7530.97	9842.60	5659.77
7839.46	7530.97	10526.27	6297.73
7972.96	7615.06	11029.91	6979.87
9477.15	7782.82	11544.91	8365.53
10020.00	7782.82	12022.23	11246.53
10510.72	8868.60	12509.60	17358.38
10998.40	9508.71	13020.14	24776.60
11553.75	10658.83	13552.02	30455.70
12045.09	12222.65	14017.45	30904.40
12526.98	17066.62	14695.32	31332.70
12997.59	22641.80	14939.16	31332.70
13417.60	25241.10	15093.70	31357.10
14545.06	25800.60	15577.72	31357.10
15037.31	26166.30		
15587.17	26166.30		

Table 5.46.5 & 5.46.6

Distance and Corresponding Area, J-6 (Ch. 177.70 Km.)

Year 1981-82		Year 1986-87	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
1482.55	18.99	532.62	169.942
2040.33	257.73	1553.66	193.417
2523.13	298.63	1698.48	291.892
3017.52	814.11	2064.33	291.892
3511.30	926.36	2553.96	939.330
4033.11	2975.67	3106.40	1222.356
4507.99	3397.60	3569.21	1222.356
5017.01	3937.08	4001.52	1971.37
5559.55	4240.66	4360.67	2107.48
6021.32	4579.14	5050.61	2107.48
6509.00	4923.11	5590.55	2154.42
7060.69	5182.66	7024.39	3132.72
7530.08	5660.22	7808.94	3189.49
8021.12	5903.38	8052.74	3230.72
8549.94	6161.10	8538.72	3362.12
9225.08	6315.20	9678.66	3381.72
9536.89	6530.58	10032.93	6779.90
10056.57	7154.35	10569.51	9908.09
10510.42	8642.04	11131.71	14501.02
11052.96	9471.60	12015.24	20437.80
11530.58	11475.68	12519.21	24435.80
12052.10	18491.62	13047.56	26590.00
12546.48	25960.00	13543.29	28124.00
13199.67	33350.00	14013.72	29509.90
13617.55	38319.70	14318.60	29787.40
14048.84	42410.70	14864.94	29787.40
14450.26	42971.40	15584.15	29896.90
15581.99	42971.40		

Table 5.46.7 & 5.46.8

Distance and Corresponding Area, J-6 (Ch. 177.70 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
582.99	175.144	441	0
1068.82	334.008	1029	2557.34
1578.93	393.702	1584	5199.66
2064.75	449.572	2023	5994.56
2647.75	553.541	2543	6032.96
2866.36	1056.364	3043	6210.91
3886.59	1158.387	3518	6252.66
4858.24	1158.387	4028	7249.23
5951.35	3686.82	4588	7602.03
6923.80	3686.82	5051	8665.68
7481.69	3736.13	5551	10660.98
9157.79	3736.13	6056	13369.48
9595.03	3916.98	6502	15903.01
10080.85	7774.77	7017	21299.40
10469.51	12692.77	7520	27608.10
11028.21	18724.53	7635	28224.50
11878.41	21200.30	9501	28224.50
12558.56	22681.20	10004	28901.30
12995.80	23402.60	10544	29852.60
13603.08	23711.70	11044	30151.40
14088.90	23885.20	12384	30282.50
14647.60	24569.60	12504	30287.30
14696.18	24680.10	13014	30906.00
18887.85	24680.10	13544	30967.80
		14044	31000.20
		14550	31184.50
		15020	31505.10
		15535	32685.00
		15589	32707.10

Table 5.47.1 & 5.47.2

Distance and Corresponding Area, J-5 (Ch. 188.20 Km.)

Year 1969-70			Year 1976-77	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
263.35	12.192	**	1003.10	698.664
1141.17	508.16	**	1504.19	2004.09
1506.93	1025.101	**	1568.20	2268.34
1936.09	1194.368	**	3932.53	2268.34
2471.32	1194.368	**	4084.93	2271.39
3044.95	4073.85	**	7533.44	2271.39
3609.44	4334.04	**	8005.27	3266.72
5800.65	4820.09	**	8509.41	4927.92
7986.06	4853.80	**	9026.65	7355.52
8546.59	5636.07	**	9371.99	7562.01
9013.85	7718.20	**	10412.58	7562.01
9533.23	7720.16	**	11002.67	13399.90
10027.92	7893.05	**	11601.60	17145.10
10540.29	8069.96	**	12724.79	23889.30
11027.97	9098.51	**	13074.09	24883.50
11521.44	10570.82	**	13517.27	27320.50
12222.48	10982.07	**	14014.40	28504.90
12771.12	10982.07	**	14556.33	29955.90
13008.86	11157.58	**	15016.28	32082.20
13523.06	13530.43	**	15502.13	37515.20
14057.68	15067.05	**	16023.34	38020.60
14503.60	16408.34	**	16596.36	38047.80
15035.48	22149.50	**		
15533.22	26321.30	**		
16051.38	27696.30	**		
17710.71	28248.40	**		
18015.51	28523.00	**		
18397.73	28616.20	**		
		**		

Table 5.47.3 & 5.47.4

Distance and Corresponding Area, J-5 (Ch. 188.20 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
495.60	116.88	1104.90	72.66
1016.51	131.206	1540.76	193.44
1539.85	288.677	2043.38	1913.51
2033.32	1335.934	2524.96	2860.56
2552.40	2527.08	3024.84	2947.62
3555.49	2675.24	3506.42	3027.11
3862.73	2722.86	4222.70	3046.43
4498.54	2763.62	5219.40	3046.43
4960.32	2797.70	5280.36	3094.29
5416.30	3051.47	7563.31	3095.99
5704.94	3051.47	8011.36	3380.51
6002.43	3056.78	8145.48	4088.32
7874.20	3056.78	8551.16	5190.12
8084.82	3287.84	9057.13	7503.81
8523.43	4132.58	10319.00	7652.07
9019.64	5837.18	10524.15	8220.28
9513.42	6176.51	11021.26	12383.95
9706.97	6223.61	11543.69	19735.09
10017.86	6223.61	11927.13	24019.00
10466.53	6249.21	12574.52	31208.40
11006.33	11523.65	13048.49	36868.60
11546.13	17202.39	13564.21	42978.80
12104.83	24983.20	13976.60	47832.20
12589.76	31754.90	14534.39	50756.30
13063.12	37432.80	15000.12	52643.00
13857.43	43587.40	15563.39	55284.90
14050.06	43592.30	16045.28	55588.80
14538.66	45311.60	16595.14	56138.40
15005.00	48934.90		
15379.29	50028.60		
15562.17	50028.60		
16008.71	50294.40		
16600.02	50802.80		

Table5.47.5 & 5.47.6

Distance and Corresponding Area, J-5 (Ch. 188.20 Km.)

Year 1981-82		**	Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
637.64	13.643	**	554.58	54.283
1005.84	129.665	**	1016.47	531.626
1533.14	1493.075	**	1538.11	1807.733
2142.74	1578.981	**	2096.95	2166.98
2570.38	1727.990	**	2504.27	2606.82
3501.24	1849.754	**	3016.47	3164.54
4034.64	2012.56	**	3555.49	3529.14
4529.94	2018.96	**	4032.01	3695.48
4889.60	2139.70	**	4550.92	3727.41
6413.60	2139.70	**	5737.20	3784.52
6995.77	2262.61	**	6042.08	3804.64
7523.38	2315.95	**	6510.67	4107.52
8014.72	7795.40	**	7036.28	4411.14
8534.40	13257.30	**	7551.53	5339.15
9044.64	16090.63	**	8188.42	8371.37
9532.32	17090.68	**	9025.31	14288.40
10016.64	17987.26	**	9558.84	18763.12
10519.56	20683.70	**	10038.72	22712.80
11029.80	22699.00	**	10541.47	25634.80
12050.88	23296.20	**	10859.76	26308.90
12508.08	24162.80	**	12887.20	26505.00
13047.27	24736.70	**	13550.61	26505.00
13510.56	26196.30	**	14056.71	27147.10
14059.20	27531.30	**	14514.64	27662.10
14551.15	28015.40	**	15042.08	28513.30
15015.36	29057.70	**	15508.23	31340.90
15504.57	31807.50	**	16007.01	31861.30
16048.63	32383.30	**	16606.10	32286.60
16592.09	33015.70	**		
		**		

Table 5.47.7 & 5.47.8

Distance and Corresponding Area, J-5 (Ch. 188.20 Km.)

Year 1988-89		**	Year 1990-91	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
997.30	0	**	524	367.89
1009.47	22.028	**	1057	2534.72
1459.48	952.147	**	1513	2982.10
1775.69	952.147	**	2038	4563.69
2067.59	1017.943	**	2509	6165.64
2554.08	1133.724	**	2945	6789.33
2918.95	1510.635	**	3531	6943.02
3575.72	1734.059	**	4011	7366.16
4256.81	1834.76	**	4551	7459.02
4767.62	1850.084	**	5035	9471.44
6664.94	1850.084	**	5530	12891.95
6969.00	2245.56	**	6005	17061.20
7516.31	7044.67	**	6501	20909.20
8002.80	9706.59	**	7055	23288.90
8550.10	12385.39	**	7524	24281.90
9048.75	14684.42	**	8054	26122.00
9656.87	17485.27	**	9098	29365.00
10070.39	17909.37	**	9501	33444.00
10654.69	20811.60	**	9970	36492.70
11067.69	24802.90	**	14802	36497.20
12916.36	26544.60	**	15042	36532.00
13524.47	26924.20	**	15658	37530.70
14035.30	27498.00	**	16616	37530.70
14497.46	27498.00	**		
14886.66	28444.50	**		
15202.88	28444.50	**		
15567.75	30489.60	**		
15933.82	32994.90	**		
16264.64	32994.90	**		
16700.00	33147.80	**		
		**		
		**		

Table 5.48.1 & 5.48.2

Distance and Corresponding Area, J-4 (Ch. 201.30 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
1401.16	2214.40	381.30	0
1807.16	3064.70	765.05	782.60
2341.47	4011.40	1297.23	3039.30
2853.23	4808.10	1783.71	5514.30
3487.82	5662.90	2348.18	9857.94
3983.43	5759.80	2856.89	17422.22
4455.26	7731.20	3365.30	20554.78
4967.63	10828.90	4127.30	20554.78
5480.61	13323.10	4845.10	21414.25
5928.66	14175.50	5342.23	23221.25
6903.11	16747.20	5848.81	23997.01
7425.54	18518.00	6339.23	26993.48
7966.56	22241.10	6842.76	27545.59
8454.24	27740.10	7391.70	28223.20
8991.84	32782.37	7852.56	28223.20
9547.86	33238.09		
9964.21	33458.36		
10490.24	33993.69		
11013.64	35480.84		
11465.95	36032.33		
11968.88	37138.77		
12882.98	38176.64		
13457.83	39076.39		
13958.31	39796.09		
14489.58	41445.52		
14946.31	41770.78		
15403.07	42592.77		
16499.74	44125.03		
16894.76	44820.951		
17470.14	45661.741		
17992.95	46338.40		

Table 5.48.3 & 5.48.4

Distance and Corresponding Area, J-4 (Ch. 201.30 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
381.30	0	398.37	0
826.01	1328.40	825.09	893.10
1198.47	2615.90	1314.60	2529.10
1719.07	5317.40	1825.45	5736.04
2272.28	9928.49	2325.93	10113.43
2786.48	14225.03	2854.15	14321.56
3204.97	17100.02	3351.89	19194.01
3860.29	19529.45	3825.24	19701.91
4368.39	19671.28	4312.92	19983.09
4847.54	20154.51	4837.79	20489.88
5351.68	20613.45	5325.47	20819.37
5839.36	21050.23	5835.70	22591.99
6340.14	22380.19	6345.02	26409.96
6872.71	28947.02	6799.48	27894.948
7148.78	28947.02	7306.36	28048.465
7423.10	29706.258	7641.64	28048.465
7860.79	29775.80	7858.05	28172.20

501 - 562

Table 5.48.5 & 5.48.6

Distance and Corresponding Area, J-4 (Ch. 201.30 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
0	0	**	0	0
387.40	5.50	**	595.42	613.70
820.83	282.80	**	1178.35	1649.50
1369.47	447.40	**	1669.81	8241.79
1888.54	1748.90	**	2032.92	13321.82
2351.84	4173.60	**	2672.86	19662.87
2843.17	9971.60	**	3125.00	21705.51
3336.65	16473.53	**	3646.34	22520.18
3851.45	21909.87	**	4121.03	22925.27
4390.95	25914.35	**	4638.72	24007.48
4909.11	27757.54	**	5132.62	25049.30
5375.45	27805.45	**	5620.42	25337.56
5870.45	28257.86	**	6100.61	25830.66
6359.65	28630.02	**	6646.64	26168.122
6881.16	31960.81	**	7165.55	26374.878
7421.88	34789.668	**	7652.74	26570.759
7909.56	35081.40	**	8156.40	27107.108
		**	8569.20	27539.416
		**	8935.06	27539.416
		**	9178.35	27668.50
		**		

Table 5.48.7 & 5.48.8

Distance and Corresponding Area, J-4 (Ch. 201.30 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
0	0	0	0
926.17	461.60	540	0
1407.85	2881.50	643	924.90
2136.36	8402.70	1134	5209.50
2467.53	8568.80	1607	7971.10
2684.29	8634.90	2147	11419.10
3286.38	8634.90	2621	14941.80
3888.48	8821.30	3135	18716.88
4442.40	9070.38	3618	22221.39
4851.83	14914.13	4112	24806.36
5453.92	18759.21	4643	26256.34
6007.85	19809.04	5122	26424.28
6489.53	21858.27	5637	27670.53
6947.12	23986.67	6174	27702.64
7549.22	27955.922	6597	27956.22
7838.21	29029.30	7094	28042.92
9500.00	29029.30	7639	28476.13
		8112	31461.76
		8748	34636.01
		9148	35188.10

Table 5.49.1 & 5.49.2

Distance and Corresponding Area, J-3 (Ch. 213.20 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
516.03	441.869	515.42	71.049
1003.71	1110.296	1012.24	572.834
1501.14	1580.752	1527.35	912.524
2033.32	1995.338	2037.89	1010.854
2506.68	5355.36	2527.10	2607.92
3037.64	11007.93	3535.07	10477.16
3539.95	16289.05	4048.66	13415.18
4019.09	18228.69	4550.05	14791.84
4502.20	18612.27	5010.61	16698.22
5050.84	19414.81	5551.32	19865.20
5545.53	19565.26	6014.31	20963.50
6052.41	19727.92	6501.99	22232.00
6524.85	20646.70	7050.02	24472.00
7005.22	20988.70	7500.52	26941.70
7502.96	22443.40	8006.79	31368.20
8143.95	25894.10	9035.49	33314.80
		9445.45	34377.40

Table 5.49.3 & 5.49.4

Distance and Corresponding Area, J-3 (Ch. 213.20 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
393.50	157.64	332.54	73.55
518.46	174.48	576.38	73.55
1053.69	645.80	1008.58	404.09
1514.86	1108.66	1511.50	640.92
1987.60	1531.03	2017.47	1296.22
2448.15	2725.65	2555.14	4577.50
2983.99	5779.24	3012.03	7202.78
3534.77	8638.92	3534.77	11302.56
3984.35	10052.78	4014.83	13771.36
4458.92	13500.37	4527.50	16335.11
5027.98	19731.79	5092.90	19397.59
5537.91	24476.80	5514.75	22514.00
5842.71	27112.50	5991.76	28176.90
7164.32	43388.20	6518.76	30988.40
8010.75	49379.10	7007.66	32308.30
8498.43	49585.60	7505.09	34890.60
9047.07	50464.40	8069.58	41117.70
9476.23	51508.90	8559.09	42698.70
		9046.77	43358.90
		9402.78	44298.40
		9531.71	44442.20

Table 5.49.5 & 5.49.6

Distance and Corresponding Area, J-3 (Ch. 213.20 Km.)

Year 1981-82			Year 1986-87	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
515.42	236.169	**	525.30	95.927
1005.23	333.10	**	1069.21	322.476
1519.73	414.37	**	1551.22	4692.80
2014.12	3884.72	**	2063.41	9270.15
2502.41	5072.77	**	2533.84	12384.86
3009.29	7777.83	**	3009.45	14128.66
3575.30	13677.34	**	3524.39	15139.61
4051.40	15810.01	**	4012.20	17141.45
4505.86	16288.84	**	4510.67	19400.37
5018.53	17185.44	**	5013.72	19458.68
5536.69	18063.11	**	5544.21	19962.53
6056.68	19203.44	**	6032.01	20539.50
6538.87	20285.80	**	6505.49	20973.30
7007.66	24219.20	**	7044.21	22483.10
7490.76	27659.20	**	7506.40	24190.40
7933.03	32803.20	**	8046.95	28944.00
8510.93	35184.40	**	8533.84	30094.20
9055.00	36089.20	**	9027.44	31048.20
9565.54	36740.60	**	9512.20	32426.90

Table 5.49.7 & 5.49.8

Distance and Corresponding Area, J-3 (Ch. 213.20 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
677.13	757.921	194	266.625
1544.34	1990.84	512	816.218
1995.76	6712.33	1002	1342.918
2613.49	13126.13	1535	1622.788
3017.40	16840.08	2032	4878.16
3563.86	21375.90	2582	10409.03
4039.04	24246.70	3057	11093.69
4514.22	26739.00	3537	11145.29
5036.92	28600.10	3974	11157.29
5583.37	31241.40	4496	11157.29
6082.31	32756.70	5096	11272.64
6700.05	33490.00	5516	11284.64
7175.23	34146.40	6675	11284.64
7697.93	35521.10	7044	13306.95
8054.32	36502.60	7645	17405.73
8553.25	38102.40	8020	19999.48
9218.51	38582.10	8565	23630.30
9503.62	38833.70	9024	25659.80
10002.55	39488.40	9504	27917.00
10525.25	43164.90	10009	30624.70
10976.68	47017.60	10521	32688.40
11570.65	50085.20	11009	36952.70
11927.04	50326.80	11553	40609.80
12592.29	51488.60	12014	45175.40
13019.95	52246.50	12501	49847.20
		12858	51004.90
		13200	51004.90

Table-5.50.1 & 5.50.2

Distance and Corresponding Area, J-2 (Ch. 223.20 Km.)

Year 1969-70			Year 1976-77	
Distance (m)	Area (m^2)	**	Distance (m)	Area (m^2)
579.73	487.217	**	546.20	196.43
1006.45	763.975	**	1030.83	516.47
1545.03	1338.113	**	1515.16	727.609
2032.71	1453.937	**	2063.80	805.33
2588.36	1487.891	**	2834.64	805.33
3039.16	1664.066	**	3048.00	2064.81
3555.19	2340.86	**	3541.17	5053.27
4042.87	3104.69	**	4013.00	7245.76
4518.96	3408.86	**	4526.28	11352.05
5036.52	3725.51	**	5024.63	14904.70
5524.20	3996.47	**	5069.13	15161.09
6079.54	4113.51	**	5922.57	15161.09
6545.58	4623.77	**	6593.13	16539.84
7012.23	4720.56	**	7019.54	16555.99
7530.39	4882.10	**	7550.51	18491.71
8007.71	5029.68	**	8008.32	24563.40
8541.11	5979.69	**	8507.88	28661.60
9030.31	7355.60	**	9046.46	33834.80
9532.32	11441.98	**	9522.87	36580.90
10024.26	17093.25	**	10018.78	39675.80
10509.20	23402.60	**	10487.86	43189.70
11045.04	27583.40	**	11025.53	45364.10
11532.72	28143.90	**	11513.21	47110.60
12047.52	28288.60	**	12010.64	48855.60
12508.99	28533.20	**	12507.16	51299.00
12687.00	28553.90	**	12992.10	52181.60
		**		

Table 5.50.3 & 5.50.4

Distance and Corresponding Area, J-2 (Ch. 223.20 Km.)

Year 1977-78		Year 1978-79	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
335.89	135.383	518.77	242.984
518.77	274.524	701.65	452.457
1036.93	529.566	1934.26	452.457
1532.53	658.137	2462.17	1963.083
2026.31	731.047	3015.08	6196.53
2419.50	731.047	3528.67	10803.46
2703.88	2683.52	4020.62	12406.85
3008.07	5205.37	4544.87	12958.07
3526.54	7620.75	5036.21	12420.77
4045.31	8518.32	5538.22	14699.26
4534.81	8766.82	6056.99	14714.45
4997.50	10214.93	6545.88	14941.36
5499.51	11328.23	6885.13	14941.36
6016.75	11330.06	7178.34	15272.55
6485.53	11631.92	7527.98	20383.90
7285.33	11631.92	8031.48	24654.10
7508.14	13939.68	8502.70	28012.60
7980.58	18549.70	9005.32	30159.80
8552.99	22899.90	9594.19	34671.50
9003.18	23810.40	10074.55	38032.50
9500.62	24758.40	10521.39	40107.00
10102.66	30607.00	10963.35	41398.30
10570.16	33174.40		
10960.30	34516.50		

Table 5.50.5 & 5.50.6

Distance and Corresponding Area, J-2 (Ch. 223.20 Km.)

Year 1981-82		Year 1986-87	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
518.17	123.148	518.90	244.119
1025.04	309.355	1042.99	2101.62
1543.20	837.878	1555.18	4205.62
2030.88	1312.147	2026.52	5422.55
2518.87	3962.59	2552.74	5962.98
2965.70	7726.20	3040.55	7641.34
3504.59	9511.35	3505.49	9149.33
4053.23	9606.14	4035.06	10569.20
4510.43	9722.27	4532.93	11685.35
5059.07	9935.02	5068.29	16090.31
5507.74	10158.61	5588.41	19636.07
6056.38	10238.46	6030.49	21559.50
6521.50	10612.44	6518.29	22907.20
6992.42	15000.51	7030.79	23680.70
7542.89	17774.36	7529.27	25172.70
8048.85	23136.50	8010.37	28648.80
8509.71	27642.40	8515.85	30783.90
9021.17	30551.40	9003.66	31331.50
9504.58	31998.50	9529.27	31538.30
10051.39	33312.80	10043.60	34782.60
10543.03	36246.50	10510.67	36317.00
11015.47	36928.30	10968.60	36335.30

Table 5.50.7 & 5.50.8

Distance and Corresponding Area, J-2 (Ch. 223.20 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
696.13	147.63	514	27.90
1809.73	147.63	917	847.365
2036.00	209.588	2941	847.365
2540.51	354.603	3540	857.565
3410.73	362.446	4030	894.165
3984.96	1582.965	4800	896.565
4507.00	7205.41	5009	1167.215
5202.91	14509.13	5508	4544.58
5537.50	17153.59	6064	9622.76
6072.92	21754.90	6511	12773.10
6542.78	22135.90	7003	16243.98
7030.19	24818.40	7545	22073.40
7517.37	28314.40	8003	25850.10
8121.86	30415.60	8500	27513.50
		8969	27513.50
		9509	27985.70
		10017	30013.30
		10527	33429.90
		10717	34506.50
		11313	34506.50

Table 5.51.1 & 5.51.2

Distance and Corresponding Area, J-1 (Ch. 230.75 Km.)

Year 1969-70		Year 1976-77	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
470.31	0	512.67	15.85
1037.54	1667.175	1029.92	5231.12
1513.33	4913.52	1512.11	10399.70
2012.59	7005.78	2020.12	11577.75
2550.87	8563.76	2507.89	11934.22
3014.78	9583.75	3002.28	12116.79
3521.66	11693.57	3688.38	12580.04
4024.58	14023.99	4036.47	14631.14
4605.22	19142.29	5145.33	15650.65
5190.13	26801.30	5552.24	16052.58
6051.19	35166.10	6148.45	18341.88
6541.01	36338.30	6519.06	23468.50
6754.37	36364.30	7038.14	30907.70
		7507.22	34136.10
		8001.30	36309.10
		8214.97	36992.90
		8767.27	36992.90

Table 5.51.3 & 5.51.4

Distance and Corresponding Area, J-1 (Ch. 230.75 Km.)

Year 1977-78			Year 1978-79	
Distance (m)	Area (m^2)		Distance (m)	Area (m^2)
536.14	0		243.84	17.678
661.72	467.809		498.04	17.678
1019.25	1802.929		1047.90	2255.12
1504.49	3201.58		1496.57	3535.79
2010.16	7479.88		2054.05	5383.26
2407.31	11566.73		2525.88	8929.00
2719.12	11566.73		3056.84	11425.14
2841.04	11577.09		3535.98	14358.30
3083.97	12266.45		4000.50	18959.63
3510.38	14291.44		4504.64	24984.80
4039.51	19237.41		5020.36	30374.80
4522.01	24161.90		5500.73	34832.40
5089.55	24964.00		6007.91	37007.20
5520.84	25144.10		6509.31	38831.00
6499.56	26744.80		7007.35	40369.30
7086.90	34177.80		7555.99	40965.50
7540.45	36937.80		8004.35	42649.30
8025.99	38849.10		8214.36	43714.00
8294.83	40188.80		8449.06	43714.00
8447.23	40188.80			

Table 5.51.5 & 5.51.6

Distance and Corresponding Area, J-1 (Ch. 230.75 Km.)

Year 1981-82		Year 1986-87	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
304.80	19.507	67.78	7.736
461.47	19.507	437.47	7.736
1013.76	1180.171	1001.01	3106.20
1530.40	4507.53	1554.70	4490.85
2044.90	5913.49	2004.68	4536.72
2553.31	9418.28	2501.68	5156.03
3019.35	11683.69	3037.62	5952.25
3529.58	18330.82	3548.00	6823.89
4006.29	23283.10	4013.75	8372.22
4603.09	28090.40	4562.07	12586.86
5102.35	30897.40	5024.15	17964.00
5564.43	32601.10	5514.69	23822.60
6076.49	36003.70	6005.41	29609.20
6513.58	36450.30	6513.53	33794.00
7021.07	36751.50	7086.47	37198.60
7543.80	38313.40	7509.98	39303.20
8051.60	41925.00		
8466.73	42304.40		

Table 5.51.7 & 5.51.8

Distance and Corresponding Area, J-1 (Ch. 230.75 Km.)

Year 1988-89		Year 1990-91	
Distance (m)	Area (m^2)	Distance (m)	Area (m^2)
484.97	0	510	55.80
1015.96	2271.49	1030	773.10
1521.33	2725.62	1514	1391.21
2016.61	2821.19	2001	1691.855
2527.32	3716.36	2570	6386.12
2981.08	7190.58	3015	8840.08
3545.25	10015.72	3535	10577.42
4103.87	12995.80	4016	12604.88
4504.53	15248.97	4542	14692.46
5014.42	18276.90	5094	16588.08
5526.49	23532.50	5538	19357.22
6057.30	28276.20	6061	23333.80
6544.03	34045.50	6559	26831.60
7021.52	38565.30	7027	29683.10
7518.71	43368.90	7500	33227.80
8010.52	48331.70	7900	33854.60
8638.50	55237.40		
9086.22	60398.70		
9513.89	64930.30		
10072.78	67440.40		
10418.05	67453.20		

Table 5.52 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-17 (Ch. 25.00 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	282.00	7987.00	7705.00	4073.00	8197.90
1976-77	262.00	9896.00	9634.00	8224.60	10158.07
1977-78	218.00	9897.00	9679.00	8601.30	10158.98
1978-79	677.00	10246.00	9569.00	7751.50	10471.71
1981-82	848.00	9253.00	8405.00	6448.50	10472.01
1986-87	222.00	10256.00	10034.00	9791.10	10353.66
1988-89	385.00	12417.00	12032.00	8711.00	13957.16
1990-91	1124.00	10242.00	9118.00	8338.00	11337.00

Table 5.53 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-16 (Ch. 37.10 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	860.00	12779.00	11919.00	8543.10	13351.76
1976-77	1500.00	14476.00	12976.00	9874.70	15128.14
1977-78	1457.00	14504.00	13047.00	9342.50	15154.35
1978-79	47.00	13018.00	12971.00	7569.30	13628.62
1981-82	1431.00	14635.00	13204.00	9073.40	15154.96
1986-87	1157.00	14264.00	13107.00	8660.90	14970.30
1988-89	360.00	13350.00	12990.00	7242.80	13926.38
1990-91	261.00	14282.00	14021.00	9334.80	15195.00

Table 5.54 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-15 (Ch. 55.65 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	622.00	9127.00	8505.00	6829.60	9286.65
1976-77	636.00	10845.00	10209.00	8084.10	10901.17
1977-78	688.00	10882.00	10194.00	8510.10	11392.81
1978-79	589.00	10999.00	10410.00	9006.00	11391.60
1981-82	684.00	11389.77	10706.00	8774.80	11389.77
1986-87	588.00	11202.00	10614.00	9097.20	11398.17
1988-89	289.00	12996.00	12707.00	8940.50	13412.47
1990-91	35.00	13254.00	13219.00	10087.20	13487.00

Table 5.55 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-14 (Ch. 71.20 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	0	16149.83	16149.83	15624.60	16149.83
1976-77	282.00	15720.00	15438.00	13036.60	16425.25
1977-78	212.00	15836.00	15624.00	11605.10	16401.20
1978-79	284.00	15769.00	15485.00	13716.00	16479.66
1981-82	283.00	15858.00	15575.00	12368.00	16494.56
1986-87	291.00	16781.00	16490.00	13513.20	16853.35
1988-89	926.00	17369.00	16443.00	10751.50	17909.59
1990-91	291.00	16270.00	15979.00	13603.00	16851.00

Table 5.56 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-13 (Ch. 84.70 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	1722.00	11751.00	10029.00	9202.30	11751.26
1976-77	1634.00	12255.00	10621.00	8511.40	12636.09
1977-78	1144.00	12204.00	11060.00	9362.60	12639.75
1978-79	1035.00	12257.00	11222.00	10131.00	12638.53
1981-82	981.00	12533.00	11552.00	9308.10	12642.19
1986-87	740.00	12403.00	11663.00	7886.30	12620.43
1988-89	535.00	12315.00	11780.00	7076.90	12422.57
1990-91	272.00	12414.00	12142.00	10016.00	12632.00

Table 5.57 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-12 (Ch. 100.50 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	216.00	11798.00	11582.00	8734.40	12555.63
1976-77	--	--	--	--	--
1977-78	166.00	18549.00	18383.00	12159.10	19211.18
1978-79	333.00	18499.00	18166.00	12635.20	19331.94
1981-82	513.00	14119.00	13604.00	10746.40	14888.87
1986-87	514.00	14124.00	13610.00	7360.60	14894.51
1988-89	494.00	15082.00	14588.00	11058.20	15904.98
1990-91	514.00	14058.00	13544.00	9013.10	14893.00

Table 5.58 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-11 (Ch. 117.75 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	148.00	10932.00	10784.00	7513.00	11475.72
1976-77	1534.00	11083.00	9549.00	7318.50	11478.77
1977-78	891.00	10986.00	10095.00	8375.60	11480.60
1978-79	99.00	11059.00	10960.00	8465.60	11454.08
1981-82	643.00	10944.00	10301.00	8600.00	11478.16
1986-87	397.00	11008.00	10611.00	8711.60	11503.35
1988-89	359.00	11711.00	11352.00	9350.50	13000.00
1990-91	55.00	12706.00	12651.00	11376.90	12761.00

Table 5.59 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-10 (Ch. 134.30 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	1670.00	21525.89	19856.00	18484.20	21525.89
1976-77	1852.00	21478.34	19626.34	18870.30	21478.34
1977-78	1648.00	19926.00	18278.00	17557.40	21244.83
1978-79	365.00	16295.16	15930.16	15048.50	16295.16
1981-82	497.00	14344.00	13847.00	12379.30	14405.76
1986-87	285.00	16501.83	16216.83	13157.70	16501.83
1988-89	275.00	15009.00	14734.00	12089.40	15973.20
1990-91	853.00	16500.00	15647.00	13662.70	16500.00

Table 5.60 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-9 (Ch. 142.45 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	335.00	14641.00	14306.00	8760.90	15552.55
1976-77	782.00	14005.00	13223.00	12152.20	15126.37
1977-78	793.00	14281.00	13488.00	11250.30	15339.21
1978-79	--	--	--	--	--
1981-82	522.00	13714.00	13192.00	9720.20	15150.31
1986-87	801.00	14412.00	13611.00	10440.10	15479.88
1988-89	735.00	14698.00	13963.00	11171.90	15500.00
1990-91	749.00	15531.00	14782.00	10822.50	15803.00

Table 5.61 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-8 (Ch. 149.50 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	2744.00	13597.00	10853.00	6723.00	14470.68
1976-77	587.00	12557.00	11970.00	7861.40	13612.98
1977-78	468.00	13109.00	12641.00	8084.00	13577.01
1978-79	587.00	12683.00	12096.00	7192.30	13622.43
1981-82	470.00	12460.00	11990.00	8565.70	13635.23
1986-87	145.00	13417.00	13272.00	9255.70	13970.73
1988-89	646.00	13042.00	12396.00	8428.30	14978.99
1990-91	216.00	15419.00	15203.00	10230.40	15690.00

Table 5.62 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-7 (Ch. 162.35 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	1121.00	9464.00	8343.00	7221.40	14444.17
1976-77	243.00	13895.00	13652.00	7887.90	14077.49
1977-78	243.00	13711.00	13468.00	8149.60	14075.36
1978-79	2063.00	14018.00	11955.00	9576.50	14079.02
1981-82	243.00	13951.00	13708.00	12400.20	14072.01
1986-87	2090.00	14263.42	12173.42	7960.30	14263.42
1988-89	2243.00	14453.27	12210.27	9009.30	14453.27
1990-91	308.00	14271.00	13963.00	8742.60	14271.00

Table 5.63 — Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-6 (Ch. 177.70 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	0	19386.50	19386.50	12221.20	19386.50
1976-77	54.00	15212.00	15158.00	8525.20	15588.69
1977-78	269.00	15050.00	14781.00	10902.80	15587.17
1978-79	0	15130.00	15130.00	10465.20	15577.72
1981-82	1612.00	14373.00	12761.00	12747.90	15581.99
1986-87	0	15517.00	15517.00	8942.00	15584.15
1988-89	33.00	14654.00	14621.00	7921.40	18887.85
1990-91	470.00	15455.00	14985.00	9586.70	15589.00

Table 5.64

Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-5 (Ch. 188.20 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	555.00	18239.00	17684.00	12403.10	18397.73
1976-77	140.00	15595.00	15455.00	8598.80	16596.36
1977-78	143.00	16600.02	16457.00	10330.90	16600.02
1978-79	143.00	16524.00	16381.00	10767.80	16595.14
1981-82	715.00	16592.09	15877.09	12292.20	16592.09
1986-87	429.00	16463.00	16034.00	11078.20	16606.10
1988-89	1008.00	16556.00	15548.00	8192.60	16700.00
1990-91	57.00	15613.00	15556.00	9230.10	16616.00

Table 5.65

Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-4 (Ch. 201.30 Km.)

Year	Right Bank Reading (m)	Left Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	0	17992.95	17992.95	17342.20	17992.95
1976-77	405.00	7380.00	6975.00	5461.30	7852.56
1977-78	407.00	7454.00	7047.00	6661.90	7860.79
1978-79	406.00	7858.05	7452.00	6521.60	7858.05
1981-82	409.00	7896.00	7487.00	6664.60	7909.56
1986-87	0	9083.00	9083.00	8142.60	9178.35
1988-89	541.00	9336.00	8795.00	5947.10	9500.00
1990-91	513.00	9148.00	8635.00	7828.40	9148.00

Table 5.66 Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-3 (Ch. 213.20 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	0	8004.00	8004.00	7814.30	8143.95
1976-77	0	9445.45	9445.45	8928.00	9445.45
1977-78	0	9476.23	9476.23	9100.80	9476.23
1978-79	0	9531.71	9531.71	8928.90	9531.71
1981-82	0	9565.54	9565.54	8809.30	9565.54
1986-87	0	9512.20	9512.20	8462.50	9512.20
1988-89	123.00	13019.95	12896.95	12383.30	13019.95
1990-91	0	12859.00	12859.00	8895.40	13200.00

Table 5.67 Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-2 (Ch. 223.20 Km.)

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	55.00	12578.00	12523.00	10598.60	12687.00
1976-77	56.00	12992.10	12936.10	10450.40	12992.10
1977-78	0	10960.30	10960.30	8198.70	10960.30
1978-79	28.00	10963.35	10935.35	8593.10	10963.35
1981-82	48.00	11015.47	10967.47	9743.70	11015.47
1986-87	47.00	10496.00	10449.00	9623.80	10968.60
1988-89	70.00	8121.86	8051.86	5259.70	8121.86
1990-91	487.00	10728.00	10241.00	6456.60	11313.00

Table 5.68 **Right Bank Reading, Left Bank Reading, Total Width, Effective Width and Last Reading on the Opposite Bank, Section J-1 (Ch. 230.75 Km.)**

Year	Left Bank Reading (m)	Right Bank Reading (m)	Total Width (m)	Effective Width (m)	Last Reading on the Opposite Bank (m)
1969-70	466.00	6737.00	6271.00	6263.20	6754.37
1976-77	529.00	8200.00	7671.00	7276.00	8767.27
1977-78	524.00	8302.00	7778.00	6871.40	8447.23
1978-79	36.00	8231.00	8195.00	7840.40	8449.06
1981-82	0	8466.73	8466.73	7865.90	8466.73
1986-87	453.00	7509.98	7056.98	6626.10	7509.98
1988-89	494.00	10212.00	9718.00	9134.20	10418.05
1990-91	41.00	7900.00	7859.00	7043.00	7900.00

Table 5.69 Discharge, Width, Area, Velocity, Hydraulic Radius and Roughness Co-efficient.

Date	Fulchari channel								Fulchari channel-1								Fulchari channel-2								Fulchari channel-3							
	W	R	Q	A	V	V/S/n	D/S/n	AV/n	W	R	Q	A	V	V/S/n	D/S/n	AV/n	W	R	Q	A	V	V/S/n	D/S/n	AV/n	W	R	Q	A	V	V/S/n	D/S/n	AV/n
17-3-70									180	1.8944	41	341	.1202	.1237	.1063	.115																
24-3-70									200	1.675	127	335	.3791	.0360	.0311	.0335																
31-3-70									190	1.9894	142	378	.3756	.0409	.0352	.0380																
17-4-78	198	2.6717	264	529	.4990	.0577	.0334	.0355																								
1-5-78	1041	1.8559	1174	1932	.6076	.0237	.0213	.0225																								
15-5-78	1034	2.1199	1367	2192	.6236	.0249	.0228	.0238																								
7-12-81	1195	1.6117	1222	1926	.6345	.0205	.018	.0192																								
23-12-81	1357	1.2586	1514	1708	.8864	.0124	.0110	.0117																								
12-1-82	635	4.0755	1438	2588	.5556	.0441	.0388	.0414																								
16-9-69									640	7.4203	5706	4749	1.1902	.0299	.0257	.0278	480	1.25	327	600	.545	.0198	.0170	.0184	910	2.0835	1323	1896	.6977	.0217	.0186	.0201
23-9-69									580	6.7034	3780	3888	.9722	.0338	.0288	.0313	550	2.900	1196	1595	.7498	.025	.024	.0252								
30-9-69									570	5.5403	3556	3158	1.1260	.0257	.0218	.0237	530	2.5452	1120	1349	.8302	.0207	.0176	.0191								
18-9-78	1195	5.8393	7811	6978	1.1193	.0268	.0231	.0249																								
25-9-78	1195	5.7029	7815	6815	1.1467	.0258	.0225	.0241																								
2-10-78	1183	4.6973	5442	5557	.9793	.0265	.0232	.0248																								
15-9-81	1488	6.8501	13049	10193	1.2801	.0257	.0232	.0244																								
29-9-81	1471	5.4167	7578	7968	.9510	.0307	.0260	.0283																								
12-10-81	1271	5.3450	5928	6791	.8729	.0331	.0280	.0305																								

Table 5.70 Discharge, Width, Area, Velocity, Hydraulic Radius and Roughness Co-efficer

Date	Bahadurabad channel-1								Bahadurabad channel-2								Bahadurabad channel-3								Bahadurabad channel-4							
	W	R	Q	A	V	$\frac{V}{N}$	$\frac{R^{2/3}}{N}$	$\frac{AV}{N}$	W	R	Q	A	V	$\frac{V}{N}$	$\frac{R^{2/3}}{N}$	$\frac{AV}{N}$	W	R	Q	A	V	$\frac{V}{N}$	$\frac{R^{2/3}}{N}$	$\frac{AV}{N}$	W	R	Q	A	V	$\frac{V}{N}$	$\frac{R^{2/3}}{N}$	$\frac{AV}{N}$
17-3-70	720	3.6949	2414	2660	.9075	.0255	.0219	.0257	320	1.2515	334	413	.8087	.0159	.0119	.0129	300	611	2064	1833	1.126	.0288	.0249	.0269	530	.7056	279	374	.7459	.0103	.0038	
24-3-70	725	3.4924	2406	2532	.9502	.0234	.0203	.0218	345	1.2724	405	439	.9225	.0123	.0106	.0114									555	.9981	390	554	.7039	.0137	.0118	
31-3-70	730	3.5328	2459	2579	.8371	.0269	.0231	.025	360	1.15	340	414	.8212	.013	.0111	.0120	325	6.2246	2410	2023	1.045	.0315	.0271	.0293	545	.9449	367	515	.7126	.0131	.0112	
17-4-78	532	4.3890	2532	2335	1.0843	.0241	.024	.0227	559	5.2561	3580	2927	1.223	.0241	.0213	.0227																
1-5-78	514	5.3696	3441	2760	1.2478	.0234	.0210	.0222	145	2.2827	155	331	.4682	.0353	.0317	.0335	635	6.6788	5069	4241	1.1952	.0283	.0259	.0268								
15-5-78	532	5.4943	3809	2923	1.3031	.0224	.0205	.0214	150	2.32	274	348	.7873	.0209	.0191	.020	69	.3478	24	24	1.00	.0046	.0042	.0044	716	.61675	4698	4416	1.0638	.0297	.0242	
7-12-81									586	3.8873	1588	2278	.6970	.0337	.0296	.036	389	2.1641	571	712	.8016	.0198	.0174	.0186								
23-12-81									576	3.4618	1677	1994	.8410	.0258	.0228	.0245	329	1.9023	525	626	.8389	.0173	.0153	.0163								
12-1-82									547	3.5553	1458	1923	.7581	.0293	.0258	.0275															
16-9-69	1380	6.7637	10213	9534	1.0941	.0304	.0261	.0282	1380	5.3449	7415	4616	1.6069	.0429	.0311	.0512	2380	4.2463	8743	10092	.8663	.0231	.0241	.0261								
23-9-69	1040	7.7288	9171	8038	1.1409	.0316	.0270	.0295	820	4.3451	4614	3553	1.2949	.019	.0162	.0176	1920	4.1072	8387	7886	.8733	.0221	.0231	.0251								
30-9-69	830	8.5569	7920	7102	1.1151	.0347	.0295	.0321	1150	3.3839	5533	4478	1.2355	.0165	.015	.0167	1870	3.5016	6001	6548	.9164	.0232	.0196	.0215								
18-9-78	1015	7.6423	12153	7757	1.5667	.0229	.0197	.0213	520	4.9153	2920	2556	1.1424	.0234	.0202	.0218	1857	5.4011	10344	10030	1.0313	.0276	.0238	.0252	193	1.2487	169	241	.7012	.0153	.0152	
25-9-78	1015	7.1162	11265	7223	1.5596	.0220	.0192	.0206	525	4.5381	2703	2382	1.1347	.0224	.0195	.0209	1560	6.2175	10701	9699	1.1035	.0284	.0248	.0266	68	.9117	21	62	.3387	.0257	.0225	
2-10-78	1011	7.2917	10190	7372	1.3822	.0252	.022	.0236	504	4.8565	1491	2110	.7068	.0340	.0298	.0319	1560	5.8839	10003	9179	1.0897	.0277	.0242	.0259	136	1.1544	85	167	.5414	.0188	.0165	
15-9-81	1345	7.7397	12070	10410	1.1594	.0308	.0278	.0293	2705	4.7674	5481	12896	.4249	.0215	.0194	.0204	154	2.6168	345	403	.8560	.0202	.0183	.0192	1096	1.3974	1313	1970	.6664	.0202	.0183	
29-9-81	1364	5.8651	7257	8000	.9071	.034	.0288	.0314	2092	3.448	6262	6579	.9518	.0214	.0181	.0197	470	5.2978	2693	2490	1.0815	.0266	.0226	.0246	103	1.0485	88	108	.8148	.012	.0101	
12-10-81	1345	5.5286	5941	7436	.7989	.037	.0313	.0341	1043	4.1792	3919	4359	.8990	.0272	.0231	.0251	435	.5724	128	249	.514	.0126	.0107	.0116	409	4.2483	2088	1738	1.2015	.0220	.0175	

Bahadurabad channel – 5								Bahadurabad channel – 6								All channels taken together								Noorkhwah to Bahadurabad S	Bahadurabad to Sirajgonj S	AV. S
W	R	Q	A	V	V/S	D/S	AV	W	R	Q	A	V	V/S	D/S	AV	W	R	Q	A	V	V/S	D/S	AV			
360	2.0527	689	739	.9323	.0168	.0145	.0156									2420	2.6289	5821	6360	.9152	.0202	.0173	.0187	9.44×10^{-5}	6.98×10^{-5}	8.21×10^{-5}
345	1.9884	606	686	.8833	.0173	.0150	.0161									2489	2.5076	5753	6219	.9250	.0193	.0167	.018	9.40×10^{-5}	7.03×10^{-5}	8.22×10^{-5}
360	2.1833	728	786	.9262	.0176	.0151	.0163									2510	2.6673	5846	6695	.8731	.0214	.0184	.0199	9.47×10^{-5}	6.99×10^{-5}	8.23×10^{-5}
																1389	4.3248	6376	5791	1.1010	.0235	.0209	.0222	9.55×10^{-5}	7.52×10^{-5}	8.54×10^{-5}
																2335	3.9674	9342	9264	1.0083	.0225	.0202	.0213	9.14×10^{-5}	7.37×10^{-5}	8.26×10^{-5}
																2568	3.9085	10263	10036	1.0226	.0228	.0209	.0218	8.86×10^{-5}	7.42×10^{-5}	8.14×10^{-5}
																3168	2.6016	5338	8242	.6476	.0277	.0244	.0260	9.04×10^{-5}	6.97×10^{-5}	8.00×10^{-5}
																3238	2.1692	5199	7024	.7401	.0214	.0189	.0201	8.99×10^{-5}	7.03×10^{-5}	8.01×10^{-5}
																2145	3.3244	4680	7131	.6562	.0326	.0287	.0306	9.26×10^{-5}	7.16×10^{-5}	8.21×10^{-5}
																7170	4.3884	35729	31322	1.0768	.0231	.0198	.024	8.67×10^{-5}	6.39×10^{-5}	7.53×10^{-5}
																4910	5.0855	25648	24979	1.0271	.0266	.0227	.0246	8.54×10^{-5}	6.23×10^{-5}	7.39×10^{-5}
																4950	4.5725	24180	22635	1.0660	.0239	.0203	.0221	8.57×10^{-5}	6.20×10^{-5}	7.39×10^{-5}
1273	2.4108	1640	3069	.5343	.0311	.0268	.0289									6055	5.0604	35057	30634	1.1438	.0258	.0220	.0239	8.59×10^{-5}	6.37×10^{-5}	7.48×10^{-5}
136	1.3455	144	183	.7868	.0145	.0125	.0134	1540	2.3164	1390	3.04	.4478	.0362	.0316	.0339	5938	5.0479	34039	29463	1.1551	.0236	.0206	.0221	8.6×10^{-5}	6.57×10^{-5}	7.59×10^{-5}
954	2.159	1137	2055	.5532	.0274	.0244	.0260	130	1.5	85	195	.4512	.0262	.0235	.0252	5478	4.9623	28456	26625	1.0689	.0249	.0218	.0233	8.59×10^{-5}	6.60×10^{-5}	7.60×10^{-5}
																6788	5.2849	42258	35834	1.1780	.0235	.0212	.0223	8.37×10^{-5}	6.82×10^{-5}	7.60×10^{-5}
269	1.0205	329	444	.7409	.0178	.0151	.0164									5769	4.4559	24206	25589	.9453	.0270	.0229	.0249	9.00×10^{-5}	6.48×10^{-5}	7.74×10^{-5}
																4503	4.5658	18404	20573	.8751	.0297	.0252	.0274	8.94×10^{-5}	6.43×10^{-5}	7.69×10^{-5}

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

From the present study based on cross-sectional and hydraulic data for stations J-17 (Ch. 25.00 km) to J-1 (Ch. 230.75 km) of the river Brahmaputra-Jamuna, it has been apparent that there has not been any systematic change in cross-sectional and hydraulic parameters during the period 1969-70 to 1990-91. The analysis has shown mostly unsystematic character in the variation of different parameters and the following conclusions are drawn:

1. Study of variation of cross-sectional area upto high water level at different stations over the years from 1969-70 to 1990-91 shows that in most of the years there have not been much changes in cross-sectional area at stations J-16 and J-7. In all other stations there has been, however, a large variation in cross-sectional area from time to time during that period.

   From a comparison of the cross-sectional area at different stations for the year 1969-70 with the corresponding cross-sectional area for the year 1990-91, it is observed that the cross-sectional area has remained almost same at stations J-17 and J-16 and changed very little at stations J-14, J-10, J-7, J-6 and J-1. There have been, however, large changes in cross-sectional areas at all other stations.

2. The study of variation of cross-sectional area with elevation shows that at first the area increases slowly with elevation, then increases quite fast with elevation indicating the influence of faster increase of width with elevation.

3. From the analysis of bed level data at different stations for the period 1969-70 to 1990-91, it is observed that only at stations J-17 and J-12 the bed level remained more or less at the same elevation in most of the years. At all other stations there have been, however, a large variation in bed level elevation in different years. It may, therefore, be stated that the bed level has remained more or less same only at stations J-17 and J-12 over the years.

From a comparison of the bed level elevations at different stations for the years 1969-70 and 1990-91, it is observed that the bed level has remained almost same at station J-17; remained more or less same at stations J-16 and J-12; fell down at stations J-15, J-13, J-11 and J-9; rose up at stations J-14, J-10 and J-8 to J-1. The maximum lowering (4.33m) and rise up (6.17 m) occurred at stations J-11 and J-7 respectively. On an average it may be generalised that the bed level fell down in the upper reaches (stations J-17 to J-9) and rose up in the lower reaches (stations J-8 to J-1) in the year 1990-91 as compared with that of the year 1969-70.

4. From an analysis of cross-sectional width at bank level elevation it is observed that there have been changes in total width in all stations from time to time during the period 1969-70 to 1990-91; such changes in total width have, however, been relatively small only at station J-14 and relatively large at stations J-15, J-12, J-10, J-8, J-7,J-6, J-4 and J-3.

When the total width of river sections at various stations is compared between the years 1969-70 and 1990-91 it is observed that the total width has increased at most of the stations except J-14, J-10, J-6, J-5, J-4 and J-2 where the total width has decreased. Here, it may be mentioned that the change in total width at J-14 and J-9, however, has been small. From the consideration of changes in total width at different stations it may be stated that only station J-14 shows relatively stable condition. But figures 7.1.e and 7.1.f show that there have been however some shifting of bank-lines at station J-14. This, therefore, indicates that the river section J-14 is not really a stable section even though the total width shows relatively less changes.

5. The effective width has remained more or less same only at station J-15 during most of the time over the period 1976-77 to 1990-91. At all other stations, there has been a large variation of effective width during different periods from 1969-70 to 1990-91.

A comparison of effective width at each station between the years 1969-70 and 1990-91 shows that there have been large changes in the effective width during this period at each of the stations along the length of the river except J-12 where the effective width was more or less same in the years 1969-70 and 1990-91 even though there was variation in all other years.

6. The changes in effective width have always been more than the changes in total width and no similarity has been observed in the pattern of variation of total width and effective width of the river section at any station.

7. The left bank-line remained almost in the same position at station J-3 only, more or less in the same position at stations J-12, J-9, J-6, J-2 and J-1 in most of the years from 1969-70 to 1990-91.Stations J-17, J-16, J-15, J-13,J-10, J-7 and J-5 were subjected mostly to erosion even though there was some accretion from time to time. Stations J-11, J-8 and J-4 had mostly bank accretion with time to time some erosion and station J-14 had both erosion and accretion but more or less of equal extent from 1969-70 to 1990-91.

A comparison of the left bank-line position at different stations between the years 1969-70 and 1990-91 shows that there has been accretion in the range of 200 m to 300 m along bank-line at stations J-12, J-9, J-6 and J-2. At station J-4, however, the accretion has been upto about 8845.0 m. There has been erosion in the range of 100 m to

2250.0 m along bank-line at stations J-17, J-16, J-14, J-13, J-11, J-10, J-8, J-5 and J-1. At stations J-15 and J-7 the erosion was quite severe and was about 4100.00 m and 4800.00 m respectively. At station J-3 there has been however, neither erosion nor accretion.

8. The right bank line remained more or less in the same position at stations J-15, J-14, J-13, J-11, J-8, J-6 and J-4 in most of the years during the period 1969-70 to 1990-91. Stations J-12, J-3 and J-1 show mostly erosion even though there was some accretion from time to time; the stations J-17, J-10, J-9, J-5 and J-2 show mostly accretion with time to time some erosion; stations J-16 and J-7 show both erosion and accretion but more or less of equal extent.

A comparison of the right bank line position at different stations between the years 1969-70 and 1990-91 shows that there has been accretion in the range of 300 m to 900 m at stations J-17, J-14 and J-4; accretion in the range of 1800 m to 3900 m at stations J-6, J-5 and J-2. At station J-10 the accretion has been as much as 5026.00 m. At all other stations, however, there have been erosion varying from 500 m to 2500 m.

9. The roughness co-efficient (Manning's n) in dry seasons has been estimated to be in between 0.0124 to 0.0337 for Fulchari Channel and 0.0103 to 0.0269 for Bahadurabad channel.

10. The roughness co-efficient (Manning's n) in wet seasons has been estimated to be in between 0.0257 to 0.0331 for Fluchari Channel and in between 0.019 to 0.037 for Bahadurabad channel.

6.2 Recommendations for further study:

To have a better idea on the changes in river section charactristics and other related parameters of Brahmaputra-Jamuna river the following suggestions are made for further study and to facilitate future studies:

1. Cross-sectional data covering shorter time interval and closer distance should be studied. The data should cover both the dry and flood seasons.

2. The discharge and water level data should be measured at more stations all over the year to facilitate better under standing of morphological processes.

3. The sediment transport phenomena of the river should be included in all future studies as far as possible.

4. The bed and bank material characteristics should be considered.

REFERENCES:

1. Alam, M.K. and Hossain, M.M. (1988), Sediment Transport in the River Jamuna, Journal of IEB, Vol.16, No.2, pp.17-20.

2. Ahmed, M.N. (1989), Study of Some Bank Protection works in Bangladesh, M.Sc. Engineering Thesis, Department of Water Resources Engineering, BUET, Dhaka.

3. Ashmore, P.E. (1982), Laboratory Modelling of gravel braided stream Morphology, Earth Surface Processes, 7, pp. 201-225.

4. Ashmore, P.E. and Parker.G (1983), Confluence Scour in Coarse Braided Streams, Water Resources Research, 19, pp. 392-402.

5. Best J.L. and Bristow, C.S. (edited) (1993), Braided Rivers: Geological Society, Special Publication, No. 75, The Geological Society, London.

6. Bristow, C.S. (1987), Brahmaputra River: Channel migration and Deposition, the Society of Paleontologists and Minerologists, pp.63-74.

7. Barua, D.K., Klaassen,G.J. and Mahmood, S. (1995), On the Adaptation and Equilibrium of Bangladesh Rivers, 6th International Symposium on River Sedimentation, New Delhi, India.

8. Barua, D.K. (1994), On the Environmental Controls of Bangladesh river Systems, Asia Pacific Journal on Environment and Development, Bangladesh Unnayan Parishad (BUP), Vol.1, No.1, pp. 81-98.

9. Bari, M.F. (1978), Applicability of Sediment Transport Formulas for the Ganges and the Jamuna, M.Sc. Engineering Thesis, Department of Water Resources Engineering, BUET, Dhaka.

10. Bluck, B.J. (1979), Structure of Coarse Grained Braided Alluvium, Transactions of the Royal Society of Edinburgh, 70, pp. 29-46.

11. Coleman, J.M. (1969), Brahmaputra River: Channel Processes and Sedimentation, ELSEVIER PUBLISHING Company, P.O. Box 211-335, Jan Van Galenstraat, Amsterdam, The Netherlands.

12. Chitale, S.V. (1970), River Channel Patterns, Journal Hydrology Division, ASCE, Vol. 96, No. HY1, pp. 201-221.

13. Cheetham, G.H. (1979), Flow Competance in Relation to Channel form and Braiding Geological Society of America Bulletin, 90, pp. 877-886.

14. CBJET (China-Bangladesh Joint Expert Team), (1991), Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh, Vol. 1: Analysis of Hydrology and River Morphology of the Brahmaputra River.

15. DELFT/DHI (1993), Morphological Processes in the Bangladesh River System a Compilation of Papers, River Survey Project, FAP24.

16. DELFT/DHI (1994), Morphological Studies Phase 1, Available Data and Characteristics. River Survey Project, FAP24, Study Report 3.

17. Dad, M.M. (1977), Study on River Course Shifting Pattern in Bangladesh, M.Sc. Engineering Thesis, Department of Water Resources Engineering, BUET, Dhaka.

18. Das, S.K. (1992), Study on Hydraulic Geometry of the Ganges, M. Engineering Project, Department of Water Resources Engg., BUET, Dhaka.

19. FAP (1992), FAP-3: North Central Regional Study, Preliminary Supporting Report, Water Resources II. A, Hydrometeorology II.1, River and Drainage System II.2, River Morphology II.3, Ground Water II.4, (Draft), Desh Upadesh Ltd and BETs Ltd.

20. Flood Plan Co-ordination Organization, Ministry of Irrigation (1993), PROGRAMME, International Workshop on Morphological Behaviour of the Major Rivers in Bangladesh, Dhaka.

21. French, R.H. (1986), Open Chanel Hydraulics, McGraw-Hill, Book Company, New York.

22. Goswami, D.C. (1985), Brahmaputra River Assam, India; Physiography, Basin Denundation and Channel Aggradation, Water Research, Vol. 21, No.7, pp. 959-978.

23. Galay, V.J. (1987), River Morphology: the Channel, Lecture Notes on Small Scale Water Control Structures, Northwest Hydraulic Consultants Ltd., Canada, Consulting Education Centre, AIT, Bangkok, Thailand.

24. Galay, V.J. (1980), River Channel Shifting on Large Rivers of Banghladesh Proceedings of International Symposium on River Sedimentation, Chinese Society of Hydraulic Engineering, Vol.I.

25. Halcrow (1993), Master Plan Report, Vol. 1, Main Report, Sir william Halcrow and Partners, Government of the People's Republic of Banglaesh.

26. Hannan, A. (1993), Major Rivers of Bangladesh and their Characteristics, Professor, Department of Water Resources Engineering, BUET, Dhaka In: FPCO, Ministry of Irrigation (ed), PROGRAMME, International Workshop on Morphological Behaviour of the Major rivers in Bangladesh, Dhaka.

27. Hossain, M.M. (1989), Geomorphic Characteristics of the Padma upto Brahmaputra Confluence, Final Report, R02/89, IFCDR, BUET, July.

28. Halder, S.K. (1989), Study on Changes in River-Section Characteristics of Brahmaputra-Jamuna at selected Stations. M. Engineering Project, Department of Water Resources Engineering, BUET, Dhaka.

29. ISPAN (1993), the Dynamic Physical and Human Environmental of Riverine Charlands: Brahmaputra-Jamuna.

30. Khan, H.R.(1978), Sediment Discharge and Channel Patterns, Internaitonal Conference on Water Resources Engineering, Bangkok, Thailand.

31. Klaassen, G.J.and Vermeer, K.(1988), Channel Characteristics of the Braiding Jamuna River, Bangladesh International Conference on River Regime, Wallingford, England.

32. Klaassen, G.J. and Masselink, G. (1992), Planform Changes of a Braided River with Fine Sand as Bed and Bank Material, Proc. 5th International Symposium River Sedimentation, Karlsruhe, Germany, pp. 459-471.

33. Kamrunnessa (1994), A Study on Geometric and Sediment Transport Characteristics of Surma, M. Engineering Project, Department of Water Resources Engineering, BUET, Dhaka.

34. Latif, A. (1969), Investigation of Brahmaputra River, Journal of the Hydraulics Division, ASCE, September, pp. 1687-1698.

35. Leopold, L. and wolman, G. (1957), River Channel Patterns: Braided, Meandering and Straight, U.S. Geol. Survey, Prof. Paper 282-B.

36. Leopold, L.B., Wolman, M.G. and Miller, V.P. (1964), Fluvial Processes in Geomorphology, Freeman and Company, Sanfrancisco, California, U.S.A.

37. Lane, E.W. (1957), A Study of the Shape of Channels Formed by Natural Streams Flowing in Erodible Material, M.R.D. Sediment Series No. 9, U.S. Army Engineers Division, Missiouri River, Groups of Engineers, Omaha, Nebraska.

38. Mosselman, E., M. Huisink, E.Koomen and A.C. Seymonsbergen (1993), Morphological Changes in a Large Braided Sand Bed River, Proc. Third Intern, Geomorphology Conf., Hamilton, Canada.

39. MIKE-11, Scientific Documentation, VERSION 3.01, A Mirco-computer Based Modelling Systems for River and Channel, Danish Hydraulic Institute, 1993.

40. Nahar, Q. (1991), A Numerical Approach to Study Erosion-Deposition in a River Reach, M.Sc. Engieering Thesis, Department of Water Resources Engineering, BUET, Dhaka.

41. RPT/NEDECO/BCL (1989), Jamuna Bridge Project, Design Report, Vol. II.

42 Rashid, H.E. (1977), Geography of Bangladesh, University Press Limited, Bangladesh.

43. Rahman, K.S. (1978), A study on the erosion of the Padma, M.Sc. Engineering Thesis, Department of Water Resources Engineering, BUET, Dhaka.

44. Simons, D.B. and Senturk,F. (1977), Sediment Transport Technology, Water Resopurces Publications Fort Collins, Colorado, 80522, U.S.A., pp.24-72.

45. Schiereck, G.J.(1993), Bed and Bank Protection, Workshop on River Engineering, Bangladesh, Dhaka.

46. Sultana, N. (1989), Critical Review of Sediment Transport Studies of Jamuna River, M. Engineering Project, Department of Water Resources Engineering,BUET, Dhaka.

47. Shahidullah, M., (1978), Morphological Features of Major Rivers of Bangladesh, Deputy Director, river MOrpholgy, Research and Training, BWDB, Dhaka.

48. Schumm, S.A. and Khan.H.R.(1972), Experimental Study of Channel Patterns, Geol. Soc. Am. Bull., Vol. 83, pp.1755-1770.

49. Thorne, C.R., Russel, A.P.G. and Alam, M.K. (1993), Planform Pattern and channel Evolution of the Brahmaputra River, Bangladesh, IN: Best J.L and Bristow, C.S. (ed), Braided rivers, geol. Soc. special Publ. 75, pp. 257-276.

50. Ullah, M.H. (1987), Computer Modelling of River Channel Changes in Alluvial Condition, First Interm Report: Analytical Study of Channel Changes of the Brahmaputra, R02/87, Institute of Flood Control and Drainage Research, BUET, Dhaka.

51. Vries, M. de. (1993), River Engineering, Lecture Notes F10, Delft University on Technology, Faculty of Civil Engieering, Workshop on River Engineering, Dhaka, Bangladesh, January.

52. Wajed, A. (1991), Bangladesher Nadimala.

53. Yamamoto.K. (1979), Some Morphologic and Hydrologic Characteristics of Alluvial Rivers in Japan, Public Works Research Institute, Ministry of Construction, Japan.

APPENDIX - A

Location Statement of Monuments/R.C.C pillars along the cross section of the river Brahmaputra-Jamuna for the year 1981-82 at stations J-1 to J-17

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. : J#1 L Bearing :250-00-00 (Mon. 1-3)
Dominant Level :

High : 26.80 Ft. PWD
Median : 16.40 Ft. PWD
Low : 10.10 Ft. PWD

	LB	RB
1	2	3
	Land	Land
i	Monument No. 1 :Placed on the land of Babu Tepu Sarker,S/O Late Bhagaban Sarker, Vill-Dakhin Teota , P.S-Sibalaya , Dist-Manikgonj.	
	Reduced Level :	
	Top : 28.20 Ft. PWD	
	Ground : 26.99 Ft. PWD	
i	i) Monument No. 2 :Placed on the land of Mr.Md.Matiur Rahman S/O Late Entaz Ali , Vill-Teota. P.S-Sibalaya , Dist-Manikgonj.	
	Reduced Level :	
	Top : 28.80 Ft. PWD	
	Ground : 27.89 Ft. PWD	
	Distance from Monument No.1 :1190 Ft.	
ii	ii) Bamboo Peg : Right Bank.	
	Location :	
	Reduced Level :	
	Top : 25.96 Ft. PWD	
	Ground :	
	Distance from Monument No.1 :27778 Ft.	

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#2 L
Dominant Level :

Bearing :216-06-00
(Mon. 1-3)

High : 28.40 Ft. PWD
Median : 17.20 Ft. PWD
Low : 10.90 Ft. PWD

LB RB

1	2	3
	Land	Land
i)	Monument No. 1 Location : Placed on the land of Mr.Nawab Ali SK. S/O Late Siddique Ali Master ,Vill-Bagutia, Dist-Manikgonj.	
	Reduced Level :	
	Top : 30.00 Ft. PWD	
	Ground : 29.00 Ft. PWD	
ii)	Monument No. 2 Location : Placed on the land of Mr. Nawser Ali ,S/O Mr.Danu SK.,Vill-Bagutia,Dist-Manikgonj.	
	Reduced Level :	
	Top : 28.12 Ft. PWD	
	Ground : 27.68 Ft. PWD	
	Distance from Monument No.1 : 702 Ft.	
iii)	Bamboo Peg :	
	Location :	
	Reduced Level :	
	Top : 25.90 Ft. PWD	
	Ground : 25.78 Ft. PWD	
	Distance from Monument No.1 : 36140 Ft.	

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :JH3 L
Dominant Level :

Bearing :290-32-00
(Mon. 1-3)

High : 30.80 Ft. PWD
Median : 19.20 Ft. PWD
Low : 12.80 Ft. PWD

LB RB

2 Land

3 Land

Monument No. 1 :Placed on the land of Mr.Rajab Ali Munshi,
Location :S/O Late Rahatullah, Vill-Char Gobindapur, Dist-Manikgonj.

Reduced Level :
Top :30.10 Ft. PWD
Ground :29.65 Ft. PWD

Monument No. 2 :
Location :

Reduced Level :
Top :
Ground :

Distance from Monument No.1 :

Bamboo peg :Right Bank.
Location :

Reduced Level :
Top :26.64 Ft. PWD
Ground :26.48 Ft. PWD

Distance from Monument No.1 :31383 Ft.

A4

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#4 R Bearing :110-00-00
Dominant Level : (Mon. 1-3)

High :33.30 Ft. PWD
Median :22.10 Ft. PWD
low :15.30 Ft. PWD

RB LB

2	3
Land	Land

Monument No. 1 :Placed on the land of Mr.Thanda Mia, S/O
Location :Late Kismet Bepari, Vill-Sreepur,
P.S-Shahjadpur, Dist-Pabna.
Reduced Level :
Top :35.30 Ft. PWD
Ground :34,88 Ft. PWD

Monument No. 2 :Placed on the land of Mr.Dhapader Sarker,
Location :S/O Mr.Zalu Sarker,Vill-Sanatain,
P.S-Shahjadpur, Dist-Pabna.
Reduced Level :
Top :34.81 Ft. PWD
Ground :34.52 Ft. PWD

Distance from Monument No.1 :698 Ft.

Bamboo Peg :
Location :

Reduced Level :
Top :34.96 Ft. PWD
Ground :

Distance from Monument No.1 :25950 Ft.

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :JM5 L Bearing :270-00-00
Dominant Level : (Mon. 1-3)

High :35.90 Ft. PWD
Median :25.00 Ft. PWD
Low :17.90 Ft. PWD

LB RB

2	3
Land	Land

Monument No. 1 :Placed on the land of Mr.Korban Ali,S/O Late
Location :Abbas, Vill-Fatehpur, Dist-Tangail.

Reduced Level :
Top :36.18 Ft. PWD
Ground :35.68 Ft. PWD

Monument No. 2 :Placed on the land of Haji Belayet Hossain
Location :Sareng ,Vill-Fatehpur,Dist-Tangail.

Reduced Level :
Top :38.23 Ft. PWD
Ground :37.73 Ft. PWD

Distance from Monument No.1 :355 Ft.

Monument No. 3 :Placed on the land of Mr. Md.Sanaullah, S/O
Location :Late Haji Bendu Sarker ,Vill-Gamarki,
P.O-Betil, Dist-Pabna.

Reduced Level :
Top :38.22 Ft. PWD
Ground :37.28 Ft. PWD

Distance from Monument No.1 :54436 Ft.

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :JH6 L
Dominant Level :

Bearing :270-00-00
(Mon. 1-3)

High :38.40 Ft. PWD
Median :27.90 Ft. PWD
Low :20.50 Ft. PWD

LB RB

2 Land

3 Land

i) Monument No. 1 :Placed on the land of Mr.Mahtab, S/O Late
Location :Harmuj Ali, Vill-Jogipal, Dist-Tangail.

Reduced Level :
Top :38.13 Ft. PWD
Ground :37.26 Ft. PWD

ii) Monument No. 2 :Placed on the land of Mr.Sikander Ali Mondal
Location :S/O Mr.Karim Mondal, Vill-Jogipal,
Dist-Tangail.

Reduced Level :
Top :39.18 Ft. PWD
Ground :38.36 Ft. PWD

Distance from Monument No.1 :547 Ft.

iii) Monument No. 3 :Placed on the land of Mr.Md.Khoda Box, S/O
Location :Late Mr.Afsar Mondal, Vill-Thakurpara,
P.O-Rajapur, Dist-Pabna.

Reduced Level :
Top :40.82 Ft. PWD
Ground :39.84 Ft. PWD

Distance from Monument No.1 :51122 Ft.

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#7 R Bearing :90-00-00
Dominant Level : (Mon. 1-3)

High :41.00 Ft. PWD
Median :30.80 Ft. PWD
Low :23.00 Ft. PWD

RB		LB
2		3
Land		Land
i) Monument No. 1	:Placed on the land of Mr. Afzal Khan, S/O Late Abdul Khan, Vill-Natun Bangabari, P.S-Sirajgonj, Dist-Sirajgonj.	
Location		
Reduced Level	:	
Top	:40.56 Ft. PWD	
Ground	:39.46 Ft. PWD	
ii) Monument No. 2	:Placed on the land of Mr.Jamaruddin Talukder	
Location	:Vill-Natun Bangabari, P.S-Sirajgonj, Dist-Sirajgonj.	
Reduced Level	:	
Top	:40.38 Ft. PWD	
Ground	:40.11 Ft. PWD	
	Distance from Monument No.1 :451 Ft.	
iii) Monument No. 3	:Placed on the land of Mr.Nazibar Mondal,	
Location	:S/O Late Kazem Mondal, Vill & P.O-Bagabari, Dist-Tangail.	
Reduced Level	:	
Top	:42.78 Ft. PWD	
Ground	:41.45 Ft. PWD	
	Distance from Monument No.1 :46160 Ft.	

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#8 R
Dominant Level :

Bearing :100-00-00
(Mon. 1-3)

High :43.40 Ft. PWD
Median :33.60 Ft. PWD
Low :25.50 Ft. PWd

RB LB

1	2	3
	Land	Land
i)	Monument No. 1 :Placed on the land of Mr.Md.Sobahan Malliek,	
	Location :S/O Mr.Sikander Malliek, Vill-Mesra, P.S & Dist-Sirajgonj.	
	Reduced Level :	
	Top :47.17 Ft. PWD	
	Ground :46.81 Ft. PWD	
ii)	Monument No. 2 :Placed on the land of Mr.Arfan Ali KKhan,	
	Location :S/O Mr.Sujabad Ali Khan ,Vill-Mesra, P.S & Dist-Sirajgonj.	
	Reduced Level :	
	Top :45.60 Ft. PWD	
	Ground :	
	Distance from Monument No.1 :915 Ft.	
iii)	Monument No. 3 :Placed on the land of Mr.md.Chandu Talukder	
	Location :S/O Mr.Haji Moinuddin Talukder, Vill-Nolin, P.O-Hemnagar, Dist-Tangail.	
	Reduced Level :	
	Top :46.60 Ft. PWD	
	Ground :46.00 Ft. PWD	
	Distance from Monument No.1 :44735 Ft.	

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. : J#9 L Bearing :270-00-00
Dominant Level : (Mon. 1-3)

High : 45.90 Ft. PWD
Median : 36.40 Ft. PWD
Low : 27.90 Ft. PWD

LB RB

1	2	3
	Land	Land
i)	Monument No. 1 : Location	Placed on the land of Mrs.Abeda Khatun W/O Mr.Ahsan Ali, Vill-Kawamara,P.S-Sarisabari Dist-jamalpur.
	Reduced Level :	
	Top	46.97 Ft. PWD
	Ground	46.01 Ft. PWD
ii)	R.C.C.Pillar-2 : Location	Placed on the land of Mr.Kalu Talukder, S/O Late Nawab Ali Talukder, Vill-Sathall, P.S-Sarisabari, Dist-Jamalpur.
	Reduced Level :	
	Top	45.36 Ft. PWD
	Ground	44.98 Ft. PWD
	Distance from Monument No.1	602 Ft.
iii)	Monument No. 3 : Location	Placed on the land of Mr. Md. Ismail Sheikh S/O Late Ofat SK. Vill-Khodbandi, P.S-Kazipur, Dist-Sirajgonj.
	Reduced Level :	
	Top	48.26 Ft. PWD
	Ground	47.25 Ft. PWD
	Distance from Monument No.1	50690 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :JH10 L
Dominant Level :

Bearing :255-00-00
(Mon. 1-3)

High :49.60 Ft. PWD
Median :39.90 Ft. PWD
Low :31.60 Ft. PWD

LB RB

4 5 3
Land Land

i) Monument No. 4 :Placed on the land of Md. Moin Ali S/O Late
Location :Zahed Ali Vill-Tekuria, P.S-Sarisabari,
Dist-Jamalpur.

Reduced Level :
Top :49.98 Ft. PWD
Ground :49.38 Ft. PWD

ii) Monument No. 5 :Placed on the land of Mr.Nur Mohammed S/O
Location :late Zamur Mondal, Vill-Char Sarisabari,
P.S-Sarisabari, Dist-Jamalpur.

Reduced Level :
Top :51.35 Ft. PWD
Ground :51.00 Ft. PWD

Distance from Monument No.1 :440 Ft.

iii) Monument No. 3 :Placed at dakuria Bazar, P.S-Kazipur,
Location :Dist-Pabna.

Reduced Level :
Top :52.08 Ft. PWD
Ground :51.67 Ft. PWD

Distance from Monument No.1 :47263 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#1|L
Dominant Level :

Bearing :235-00-00
(Mon. 1-3)

High :53.30 Ft. PWD
Median :43.50 Ft. PWD
Low :35.30 ft. PWD

LB RB

1	2	3
	Land	Land
(i)	Monument No. 1 :Placed on the land of Mr.Chaita Akond S/O Location :Late dainullah Akond, Vill-Sukuagari, P.S-Modergonj, Dist-jamalpur. Reduced Level : Top :56.50 Ft. PWD Ground :55.50 Ft. PWD	
(ii)	Monument No. 2 :Placed on the land of Md. Ana Sarker & Mr. Location :Alimuddin sarker, Vill-Sukuagari, P.S-Modirgonj, Dist-Jamalpur. Reduced Level : Top :56.07 Ft. PWD Ground : Distance from Monument No.1 :842 Ft.	
(iii)	Monument No. 3 :Placed on the land of Md. Ismail saha, S/O Location :Late moazzem saha, Vill & P.O-Chandanbaisha, Dist-Bogra. Reduced Level : Top :53.40 Ft. PWD Ground :52.95 Ft. PWD Distance from Monument No.1 :37658 Ft.	

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#12 L Bearing :278-00-00
Dominant Level : (Mon. 1-3)

High :57.00 Ft. PWD
Median :47.00 Ft. PWD
Low :39.00 Ft. PWD

LB RB

4 5 3
Land Land

i) Monument No. 4 :Placed on the land of Mr. Gendu Mondal, S/O
Location :Late Hossain Mondal, Vill-Chargobindi, P.S-Islampur, Dist-Jamalpur.
Reduced Level :
Top :58.89 Ft. PWD
Ground :58.36 Ft. PWD

ii) Monument No. 5 :Placed on the land of Mr. Hanifa Kamar, S/O
Location :mr. Barkat Kamar, Vill-Kazla, P.S-Islampur, Dist-Jamalpur.
Reduced Level :
Top :59.39 Ft. PWD
Ground :58.78 FT. PWD

Distance from Monument No.1 :428 Ft.

iii) Monument No. 3 :Placed on the land of Mr. Rabindra Nath
Location :Sarker, S/O Late Sukumar Sarker,Vill-West Tekania, P.S-Sariakandi, Dist-Bogra.
Reduced Level :
Top :57.75 Ft. PWD
Ground :56.74 Ft. PWD

Distance from Monument No.1 :48848 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#13 L Bearing :260-00-00
Dominant Level : (Mon. 1-3)

High :60.70 Ft. PWD
Median :50.50 Ft. PWD
Low :42.70 Ft. PWD

LB RB

1	2	3
	Land	Land

i) Monument No. 1 :Placed on the land of Mr.Nazrul Islam master
Location :S/O late Nawabulla Pandit,Vill-Noapara, P.O-Kulkandi, Dist-Jamalpur.
Reduced Level :
Top :62.69 Ft. PWD
Ground :61.75 Ft. PWD

ii) Monument No. 2 :Placed on the land of Mr.Rahimuddin S/O Late
Location :Kismat SK.,Vill-Noapara, P.O-Kulkandi, Dist-Jamalpur.
Reduced Level :
Top :62.09 Ft. PWD
Ground :61.79 Ft. PWD

Distance from Monument No.1 :667 Ft.

iii) Monument No. 3 :Placed on the land of Mr. Eakub Ali,S/O Late
Location :Ejahar Ali Akond, Vill & P.S-Saghalla, Dist-Rangpur.
Reduced Level :
Top :63.57 Ft. PWD
Ground :62.62 Ft. PWD

Distance from Monument No.1 :41477 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :JH14 R
Bearing :89-00-00
Dominant Level :
(Mon. 1-3)

High :65.10 Ft. PWD
Median :54.90 Ft. PWD
Low :47.10 Ft. PWD

RB LB

1 2

Land Land

i) R.C.C.Pillar-1 :Placed on the land border of Mr.Abul Kashem
Location :S/O Late Azizuddin Bepari and Mr. Sayan Bepari,S/O Late Umed Ali Bepari, Vill-Ratan -Pur, P.O-Syedpur, Dist-Rangpur.

Reduced Level :
Top :65.42 Ft. PWD
Ground :64.86 Ft. PWD

ii) Monument No. 2 :
Location :

Reduced Level :
Top :
Ground :

Distance from Monument No.1 :

iii) R.C.C.Pillar-2 :Placed on the land of Mr.Rafiuddin ,S/O Late
Location :Khaizuddin, Vill-Jalurchar, P.S-Dewangonj, Dist-Jamalpur.

Reduced Level :
Top :66.32 Ft. PWD
Ground :66.01 Ft. PWD

Distance from Monument No.1 :54116 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#15 R
Dominant Level :

Bearing :89-00-00
(Mon. 1-3)

High :69.40 Ft. PWD
Median :59.30 Ft. PWD
Low :51.40 Ft. PWD

RB LB

1	2	4
	Land	Land
i)	R.C.C.Pillar-1 Location	:Placed on the land of Mr. Baset Akond, S/O :Mr. Kismat Akond, Vill-Dakhin Sripur, P.S-Gaibanda, Dist-Rangpur.
	Reduced Level :	
	Top	:71.89 Ft. PWD
	Ground	:71.04 Ft. PWD
ii)	R.C.C.Pillar-2 Location	:Placed on the land of Mrs. Sonaban Bibi, W/O :Mr. Baset Sarker, Vill-Dakhin Sripur, P.S-Gaibanda, Dist-Rangpur.
	Reduced Level :	
	Top	:72.63 Ft. PWD
	Ground	:72.08 Ft. PWD
	Distance from Monument No.1	:686 Ft.
iii)	Monument No. 4 Location	:Placed on the land border of Mr. Abu Bakar :Soddique, S/O Late Moslem Mia & Mr. Ansar-Uddin, Vill-Sanyashikandi, P.S-Rajitpur, Dist-Rangpur.
	Reduced Level :	
	Top	:69.93 Ft. PWD
	Ground	:69.45 Ft. PWD
	Distance from Monument No.1	:37368 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. :J#16 R Bearing :89-00-00
Dominant Level : (Mon. 1-3)

High :73.80 Ft. PWD
Median :63.70 Ft. PWD
Low :55.80 Ft. PWD

RB LB

4 5 3
Land Land

i) Monument No. 4 :Placed on the land of Mr. Badsa Mia,S/O Late
Location :Helaluddin Mondal, Vill-Kharkharia, P.S-Chilmari, Dist-Rangpur.
Reduced Level :
Top :76.37 Ft. PWD
Ground :75.87 Ft. PWD

ii) Monument No. 5 :Placed on the land of Mr. Mozahar Ali, S/O
Location :Late Rahimuddin Khondaker, Vill-Kharkharia, P.S-Chilmari, Dist-Rangpur.
Reduced Level :
Top :76.16 Ft. PWD
Ground :75.67 Ft. PWD

Distance from Monument No.1 :825 Ft.

iii) Monument No. 3 :Placed on the land border of Mr.Abdul Khaleque S/O late Haji Abdul Awal,& Abdus Samad S/O Late Sirajuddin, Vill-Bandarban, P.S-Rowmari, Dist-Rangpur.
Location :
Reduced Level :
Top :73.41 Ft. PWD
Ground :72.75 Ft. PWD

Distance from Monument No.1 :49721 Ft.

****

BANGLADESH WATER DEVELOPMENT BOARD
Morphological Survey
Directorate of Surface Water Hydrology
DHAKA

Location Statement of Monuments/RCC Pillars along the Cross-section of the river Brahmaputra-Jamuna

Cross-section No. : JH17 R
Dominant Level :

Bearing : 89-00-00
(Mon. 1-3)

High : 77.60 Ft. PWD
Median : 68.10 Ft. PWD
Low : 60.70 Ft. PWD

RB LB

4	5	3
Land		Land

i) Monument No. 4 : Placed on the land of Belu Babu, S/O late
Location : Raju Babu, Vill-Bagua, P.O-Begumganj, Dist-Rangpur.
Reduced Level :
Top : 80.57 Ft. PWD
Ground : 80.07 Ft. PWD

ii) Monument No. 5 : Placed on the land of Mr. Belu babu, S/O Late
Location : Raju Babu, Vill-Bagua, P.O-Begumganj, Dist-Rangpur.
Reduced Level :
Top : 83.00 Ft. PWD
Ground : 82.77 Ft. PWD

Distance from Monument No.1 : 649 Ft.

iii) Monument No. 3 : Placed on the land of Asgar Dewan, S/O Late
Location : Basel Dewan, Vill-Khewarchar, P.O-Gandaraiga Dist-Rangpur.
Reduced Level :
Top : 83.37 Ft. PWD
Ground : 82.79 Ft. PWD

Distance from Monument No.1 : 34357 Ft.

****

APPENDIX - B

Mean daily water level for the years
1969-70, 1978-79 and 1981-82

BANGLADESH WATER DEVELOPMENT BOARD
SURFACE WATER HYDROLOGY
DHAKA

Date :01-12-1995

Mean Daily Water Level Metre/PWD

Station: 45 Noonkhawa River: 22 Brahmaputra-Jamuna Year: 1969-70

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	22.000	23.080	24.125	26.320	26.345	26.580	24.750	22.830	22.020	21.530	21.440	21.495
2	21.960	22.950	24.005	26.260	26.230	26.600	24.610	22.785	22.005	21.520	21.425	21.590
3	21.935	22.890	23.910	26.160	26.150	26.695	24.475	22.745	21.970	21.505	21.425	21.655
4	21.930	22.815	23.815	26.105	26.045	26.655	24.315	22.690	21.960	21.510	21.425	21.710
5	21.930	22.740	23.760	26.120	25.955	26.580	24.215	22.630	21.940	21.505	21.425	21.740
6	21.955	22.700	23.880	26.250	25.945	26.565	24.200	22.565	21.925	21.500	21.425	21.745
7	21.960	22.700	23.950	26.360	25.925	26.580	24.165	22.520	21.895	21.475	21.420	21.760
8	21.970	22.730	24.170	26.480	25.955	26.530	24.110	22.500	21.880	21.475	21.405	21.715
9	21.970	22.785	24.305	26.585	25.995	26.420	23.970	22.455	21.870	21.475	21.380	21.715
10	21.940	22.790	24.490	26.655	26.030	26.380	23.895	22.435	21.870	21.475	21.380	21.775
11	21.925	22.740	24.805	26.775	26.010	26.380	23.875	22.420	21.855	21.455	21.380	21.795
12	21.915	22.690	25.185	26.885	25.945	26.350	23.805	22.410	21.840	21.455	21.380	21.795
13	21.945	22.630	25.505	27.030	25.860	26.305	23.760	22.385	21.825	21.440	21.365	21.795
14	21.985	22.670	25.860	27.080	25.815	26.265	23.700	22.350	21.810	21.440	21.365	21.775
15	21.990	22.645	26.075	27.090	25.830	26.165	23.660	22.350	21.810	21.420	21.350	21.755
16	22.020	22.685	26.115	27.170	25.800	26.090	23.635	22.325	21.785	21.410	21.350	21.740
17	22.050	22.720	26.075	27.310	25.945	26.010	23.635	22.320	21.760	21.425	21.350	21.760
18	22.100	22.870	26.045	27.425	26.030	25.945	23.575	22.290	21.740	21.425	21.350	21.815
19	22.130	23.025	25.980	27.380	26.205	25.840	23.495	22.280	21.730	21.425	21.350	21.850
20	22.170	23.210	25.855	27.385	26.265	25.714	23.440	22.265	21.725	21.410	21.360	21.880
21	22.220	23.330	25.735	27.510	26.350	25.535	23.370	22.245	21.710	21.410	21.365	21.915
22	22.280	23.665	25.650	27.580	26.440	25.370	23.310	22.235	21.685	21.410	21.380	21.970
23	22.340	24.025	25.740	27.565	26.525	25.235	23.270	22.220	21.670	21.405	21.380	21.990
24	22.425	24.425	25.970	27.490	26.565	25.100	23.210	22.205	21.670	21.395	21.395	22.005
25	22.540	24.580	26.230	27.350	26.580	24.945	23.150	22.185	21.670	21.395	21.395	22.030
26	22.645	24.620	26.550	27.195	26.565	24.900	23.105	22.130	21.655	21.410	21.410	22.030
27	22.700	24.745	26.695	27.045	26.595	24.980	23.080	22.090	21.655	21.410	21.425	21.985
28	23.060	24.650	26.695	26.915	26.610	25.040	23.035	22.080	21.625	21.410	21.440	21.970
29	23.180	24.460	26.570	26.820	26.530	24.930	22.990	22.060	21.580	21.425	---	21.985
30	23.235	24.305	26.410	26.655	26.495	24.850	22.930	22.045	21.560	21.425	---	21.970
31	---	24.230	---	26.495	26.515	---	22.875	---	21.535	21.425	---	22.005

Ten Daily Averages

Av1	21.955	22.818	24.041	26.330	26.058	26.559	24.271	22.616	21.934	21.497	21.415	21.690
Av2	22.023	22.789	25.750	27.153	25.971	26.106	23.658	22.340	21.788	21.431	21.360	21.796
Av3	22.663	24.276	26.225	27.147	26.525	25.089	23.120	22.150	21.638	21.411	21.399	21.987

Monthly Means & Extremes

Max	23.235	24.745	26.695	27.580	26.610	26.695	24.750	22.830	22.020	21.530	21.440	22.030
Mean	22.214	23.326	25.339	26.885	26.195	25.918	23.665	22.368	21.782	21.445	21.391	21.830
Min	21.915	22.630	23.760	26.105	25.800	24.850	22.875	22.045	21.535	21.395	21.350	21.495

Annual Max.= 27.580 Date: 22/ 7/1969 Annual Min.= 21.350 Date: 15/ 2/1970

Annual Average = 23.543

BANGLADESH WATER DEVELOPMENT BOARD
SURFACE WATER HYDROLOGY

Date :01-21-1995

DHAKA

Mean Daily Water Level Metre/PWD

Station: 45 Noonkhawa River: 22 Brahmaputra-Jamuna Year: 1978-79

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	21.802	22.769	24.018	27.045	26.472	25.055	25.451	23.012	22.311	21.610	21.214	21.016
2	21.854	22.723	24.027	26.807	26.603	25.070	25.420	22.967	22.296	21.610	21.199	21.016
3	21.915	22.808	24.149	26.685	26.700	25.070	25.329	22.936	22.296	21.595	21.199	21.031
4	21.930	22.839	24.363	26.609	26.649	25.018	25.146	22.875	22.296	21.565	21.184	21.046
5	21.961	22.793	24.293	26.579	26.594	25.009	24.963	22.845	22.235	21.549	21.184	21.077
6	21.994	22.747	24.155	26.694	26.546	25.033	24.896	22.784	22.174	21.534	21.184	21.107
7	22.022	22.692	24.049	26.679	26.579	25.109	24.750	22.753	22.144	21.519	21.184	21.092
8	21.985	22.686	24.073	26.649	26.609	25.146	24.613	22.723	22.128	21.504	21.168	21.056
9	22.000	22.677	24.201	26.633	26.624	25.176	24.521	22.708	22.113	21.488	21.168	21.031
10	22.037	22.686	24.317	26.579	26.640	25.292	24.445	22.692	22.098	21.473	21.153	21.001
11	22.098	22.738	24.485	26.396	26.609	25.405	24.430	22.662	22.083	21.458	21.153	20.985
12	22.144	22.781	24.914	26.152	26.640	25.557	24.414	22.616	22.068	21.443	21.138	20.970
13	22.174	22.747	25.170	25.954	26.685	25.725	24.399	22.586	22.052	21.412	21.138	20.970
14	22.220	22.732	25.262	25.810	26.685	25.801	24.384	22.586	22.037	21.397	21.123	20.985
15	22.235	22.769	25.298	25.860	26.670	25.786	24.384	22.570	22.022	21.382	21.123	21.001
16	22.250	22.860	25.673	26.298	26.579	25.740	24.430	22.540	22.007	21.382	21.107	21.016
17	22.266	22.875	25.902	26.533	26.518	25.695	24.445	22.479	21.991	21.366	21.092	21.031
18	22.296	22.936	25.847	26.548	26.435	25.740	24.338	22.449	21.946	21.351	21.092	21.138
19	22.321	23.006	25.634	26.685	26.396	25.817	24.216	22.433	21.900	21.351	21.123	21.290
20	22.342	23.128	25.542	26.853	26.350	26.091	24.094	22.418	21.839	21.336	21.107	21.284
21	22.351	23.302	25.460	26.908	26.213	26.091	23.982	22.418	21.778	21.321	21.077	21.208
22	22.357	23.454	25.390	26.786	26.076	25.954	23.966	22.403	21.763	21.321	21.077	21.153
23	22.372	23.492	25.695	26.618	25.969	25.817	23.723	22.372	21.732	21.306	21.062	21.123
24	22.388	24.018	26.015	26.542	25.893	25.695	23.668	22.357	21.732	21.290	21.046	21.092
25	22.442	24.491	26.076	26.411	25.841	25.679	23.576	22.342	21.687	21.290	21.046	21.107
26	22.525	24.591	26.640	26.335	25.801	25.664	23.515	22.342	21.687	21.275	21.031	21.160
27	22.580	24.500	27.066	26.380	25.786	25.634	23.424	22.342	21.671	21.260	21.031	21.229
28	22.616	24.439	27.341	26.502	25.710	25.603	23.302	22.327	21.671	21.260	21.031	21.275
29	22.686	24.369	27.411	26.487	25.481	25.588	23.180	22.327	21.656	21.260	---	21.306
30	22.753	24.247	27.243	26.441	25.277	25.527	23.165	22.311	21.641	21.245	---	21.321
31	---	24.073	---	26.405	25.176	---	23.089	---	21.626	21.229	---	21.321

Ten Daily Averages

Av1	21.950	22.742	24.165	26.696	26.602	25.098	24.953	22.830	22.209	21.545	21.184	21.047
Av2	22.235	22.857	25.373	26.309	26.557	25.736	24.353	22.534	21.995	21.388	21.120	21.067
Av3	22.507	24.107	26.434	26.529	25.748	25.725	23.499	22.354	21.695	21.278	21.050	21.209

Monthly Means & Extremes

Max	22.753	24.591	27.411	27.045	26.700	26.091	25.451	23.012	22.311	21.610	21.214	21.321
Mean	22.231	23.283	25.324	26.512	26.284	25.520	24.244	22.573	21.957	21.399	21.123	21.111
Min	21.802	22.677	24.018	25.810	25.176	25.009	23.089	22.311	21.626	21.229	21.031	20.970

Annual Max.= 27.411 Date: 29/ 6/1978 Annual Min.= 20.970 Date: 12/ 3/1979

Annual Average = 23.476

BANGLADESH WATER DEVELOPMENT BOARD
SURFACE WATER HYDROLOGY
DHAKA

Date :01-21-1995

Mean Daily Water Level Metre/PWD

Station: 45 Noonkhawa River: 22 Brahmaputra-Jamuna Year: 1981-82

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	22.138	22.860	23.912	26.746	26.908	26.594	25.132	23.393	21.985	21.610	21.290	21.290
2	22.153	22.951	24.140	26.999	26.883	26.580	25.132	23.378	21.961	21.604	21.275	21.290
3	22.153	22.945	24.393	27.045	26.816	26.557	25.039	23.372	21.939	21.565	21.275	21.290
4	22.128	22.900	24.667	27.075	26.725	26.557	25.176	23.271	21.900	21.565	21.275	21.275
5	22.113	22.875	24.613	27.295	26.594	26.572	25.368	23.119	21.878	21.565	21.275	21.269
6	22.144	22.854	24.515	27.280	26.487	26.578	25.475	23.058	21.869	21.549	21.275	21.260
7	22.189	22.845	24.424	27.280	26.466	26.557	25.481	22.997	21.863	21.543	21.275	21.260
8	22.220	22.860	24.286	27.219	26.450	26.518	25.359	22.899	21.854	21.528	21.275	21.244
9	22.259	22.906	24.201	27.112	26.274	26.441	25.170	22.829	21.848	21.519	21.275	21.244
10	22.275	22.967	24.171	26.929	26.121	26.289	25.085	22.778	21.839	21.504	21.275	21.244
11	22.397	23.006	24.155	26.670	26.024	26.140	24.871	22.732	21.824	21.482	21.275	21.275
12	22.647	23.021	24.134	26.450	26.008	26.100	24.667	22.732	21.808	21.472	21.275	21.284
13	22.778	23.052	24.103	26.329	26.076	26.182	24.545	22.753	21.833	21.473	21.290	21.290
14	22.793	23.104	24.103	26.320	26.167	26.197	24.469	22.747	21.839	21.467	21.290	21.305
15	22.753	23.317	24.186	26.410	26.222	26.191	24.393	22.692	21.839	21.458	21.290	21.305
16	22.732	23.424	24.186	26.624	26.207	26.167	24.317	22.586	21.833	21.458	21.290	21.305
17	22.701	23.591	24.271	26.883	26.167	26.137	24.186	22.488	21.824	21.443	21.290	21.321
18	22.647	23.820	24.332	27.020	26.121	26.106	24.034	22.397	21.824	21.436	21.275	21.321
19	22.625	23.866	24.399	27.097	26.267	26.060	24.033	22.327	21.808	21.421	21.275	21.336
20	22.656	23.790	24.439	27.127	26.390	25.999	23.966	22.235	21.802	21.406	21.260	21.397
21	22.640	23.707	24.460	27.097	26.496	25.938	23.836	22.174	21.787	21.397	21.260	21.412
22	22.631	23.698	24.500	26.984	26.557	25.847	23.835	22.138	21.772	21.397	21.244	21.412
23	22.662	23.774	24.552	26.847	26.618	25.664	23.774	22.113	21.732	21.382	21.230	21.412
24	22.784	23.783	24.613	26.923	26.685	25.551	23.713	22.092	21.717	21.382	21.230	21.427
25	22.906	23.707	24.673	26.999	26.740	25.496	23.652	22.067	21.721	21.382	21.230	21.443
26	22.967	23.677	24.719	26.816	26.777	25.435	23.591	22.052	21.702	21.360	21.230	21.458
27	22.951	23.631	24.856	26.624	26.601	25.384	23.561	22.037	21.686	21.345	21.238	21.504
28	22.915	23.616	25.323	26.740	26.761	25.358	23.515	22.022	21.680	21.330	21.267	21.565
29	22.900	23.698	25.786	26.807	26.664	25.323	23.463	22.018	21.665	21.315	--	21.595
30	22.875	23.805	26.228	26.853	26.633	25.262	23.433	22.092	21.635	21.305	--	21.625
31	--	23.860	--	26.853	26.609	--	23.409	--	21.620	21.305	--	21.632

Ten Daily Averages

Av1	22.177	22.896	24.332	27.068	26.572	26.525	25.242	23.109	21.894	21.555	21.277	21.267
Av2	22.673	23.399	24.231	26.693	26.165	26.128	24.348	22.569	21.823	21.452	21.281	21.314
Av3	22.823	23.723	24.971	26.868	26.649	25.526	23.617	22.081	21.702	21.355	21.241	21.499

Monthly Means & Extremes

Max	22.967	23.866	26.228	27.295	26.908	26.594	25.481	23.393	21.985	21.610	21.290	21.632
Mean	22.550	23.352	24.511	26.896	26.460	26.060	24.377	22.586	21.803	21.451	21.268	21.364
Min	22.113	22.845	23.912	26.320	26.008	25.262	23.409	22.018	21.620	21.305	21.230	21.244

Annual Max.= 27.295 Date: 5/ 7/1981 Annual Min.= 21.230 Date: 23/ 2/1982

Annual Average = 23.572

BANGLADESH WATER DEVELOPMENT BOARD
SURFACE WATER HYDROLOGY
DHAKA

Date :01-12-1995

Mean Daily Water Level Metre/PWD

Station: 46_9L Bahadurabad (Transit River: 22 Brahmaputra-Jamuna Year: 1969-70

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	14.065	15.440	16.580	18.745	18.835	18.975	17.265	15.410	14.320	13.555	13.300	13.225
2	14.030	15.285	16.475	18.715	18.685	19.000	17.160	15.350	14.290	13.540	13.295	13.285
3	13.980	15.170	16.390	18.680	18.610	19.050	17.095	15.290	14.255	13.525	13.285	13.410
4	13.950	15.100	16.280	18.575	18.545	19.120	17.000	15.225	14.225	13.510	13.270	13.500
5	13.945	15.025	16.205	18.575	18.455	19.035	16.930	15.155	14.195	13.495	13.270	13.560
6	13.960	14.965	16.225	18.655	18.405	18.990	16.855	15.205	14.165	13.470	13.285	13.605
7	13.985	14.910	16.375	18.800	18.395	18.990	16.795	15.040	14.135	13.450	13.285	13.620
8	14.010	14.905	16.495	18.895	18.380	18.980	16.695	14.980	14.105	13.430	13.275	13.620
9	14.020	14.920	16.640	19.050	18.395	18.890	16.610	14.940	14.075	13.420	13.265	13.605
10	14.020	14.940	16.840	19.165	18.440	18.795	16.520	14.900	14.040	13.385	13.240	13.605
11	13.985	14.960	17.115	19.200	18.470	18.765	16.460	14.875	14.015	13.375	13.225	13.630
12	13.955	14.960	17.440	19.300	18.450	18.750	16.415	14.865	13.990	13.360	13.210	13.650
13	13.955	14.890	17.785	19.400	18.395	18.720	16.350	14.830	13.970	13.375	13.195	13.650
14	13.995	14.820	18.160	19.415	18.350	18.670	16.285	14.765	13.955	13.375	13.175	13.635
15	14.020	14.805	18.480	19.440	18.350	18.600	16.220	14.705	13.935	13.375	13.150	13.610
16	14.035	14.800	18.615	19.490	18.350	18.545	16.200	14.695	13.910	13.360	13.150	13.585
17	14.075	14.800	18.632	19.600	18.350	18.500	16.190	14.670	13.875	13.360	13.135	13.540
18	14.125	14.835	18.600	19.705	18.455	18.410	16.170	14.650	13.860	13.345	13.135	13.515
19	14.140	14.955	18.530	19.705	18.790	18.335	16.125	14.625	13.830	13.335	13.135	13.515
20	14.195	15.200	18.395	19.690	18.855	18.240	16.035	14.600	13.805	13.315	13.150	13.545
21	14.290	15.305	18.225	19.750	18.845	18.100	15.945	14.600	13.800	13.315	13.135	13.620
22	14.395	15.470	18.105	19.840	18.895	17.935	15.875	14.585	13.775	13.315	13.135	13.730
23	14.415	15.835	18.090	19.825	18.950	17.800	15.820	14.585	13.775	13.300	13.135	13.805
24	14.480	16.310	18.225	19.780	19.045	18.685	15.760	14.555	13.755	13.300	13.150	13.820
25	14.615	16.610	18.470	19.675	19.065	17.525	15.700	14.515	13.740	13.285	13.150	13.820
26	14.765	16.855	18.745	19.560	19.065	17.415	15.660	14.485	13.710	13.270	13.150	13.840
27	14.850	16.975	18.975	19.445	19.045	17.410	15.655	14.440	13.675	13.290	13.160	13.840
28	14.950	16.970	18.035	19.340	19.050	17.505	15.615	14.410	13.650	13.315	13.190	13.815
29	15.240	16.945	18.980	19.230	19.025	17.495	15.580	14.380	13.630	13.315	---	13.785
30	15.455	16.825	18.865	19.105	18.975	17.390	15.515	14.350	13.605	13.300	---	13.760
31	---	16.705	---	18.990	18.980	---	15.455	---	13.580	13.300	---	13.760
						Ten Daily Averages						
Av1	13.997	15.066	16.451	18.786	18.515	18.983	16.893	15.150	14.181	13.478	13.277	13.504
Av2	14.048	14.903	18.175	19.495	18.482	18.554	16.245	14.728	13.915	13.358	13.166	13.588
Av3	14.746	16.437	18.472	19.504	18.995	17.726	15.689	14.491	13.700	13.300	13.151	13.781
						Monthly Means & Extremes						
Max	15.455	16.975	18.980	19.840	19.065	19.120	17.265	15.410	14.320	13.555	13.300	13.840
Mean	14.263	15.500	17.699	19.269	18.674	18.421	16.257	14.769	13.924	13.376	13.201	13.629
Min	13.945	14.800	16.205	18.575	18.350	17.390	15.455	14.350	13.580	13.270	13.135	13.225

Annual Max.= 19.840 Date: 22/ 7/1969 Annual Min.= 13.135 Date: 17/ 2/1970

Annual Average = 15.765

BANGLADESH WATER DEVELOPMENT BOARD

SURFACE WATER HYDROLOGY

DHAKA

Date :01-21-1995

Mean Daily Water Level Metre/PWD

Station: 46.9L Bahadurabad (Transit River: 22 Brahmaputra-Jamuna Year: 1978-79

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	13.105	14.815	16.590	19.410	18.600	17.350	18.030	15.595	14.720	13.835	13.335	13.075
2	13.135	14.815	16.605	19.200	18.710	17.290	17.945	15.530	14.705	13.835	13.320	13.080
3	13.175	14.860	16.705	19.020	18.835	17.280	17.860	15.445	14.705	13.805	13.320	13.150
4	13.220	14.965	16.840	18.830	18.945	17.295	17.785	15.375	14.690	13.775	13.305	13.175
5	13.265	15.050	16.955	18.790	18.910	17.280	17.645	15.335	14.690	13.760	13.290	13.165
6	13.305	15.020	16.840	18.910	18.895	17.325	17.555	15.290	14.645	13.745	13.290	13.180
7	13.375	14.980	16.750	18.920	18.895	17.435	17.480	15.230	14.585	13.710	13.265	13.165
8	13.450	14.965	16.820	18.895	18.895	17.555	17.375	15.230	14.530	13.680	13.260	13.150
9	13.525	14.975	16.850	18.895	18.905	17.640	17.265	15.245	14.485	13.650	13.265	13.135
10	13.625	14.980	16.900	18.880	18.935	17.745	17.160	15.275	14.415	13.625	13.290	13.095
11	13.700	14.995	17.095	18.730	18.945	17.920	17.075	15.290	14.385	13.600	13.290	13.075
12	13.730	15.025	17.420	18.440	18.920	18.075	17.040	15.230	14.340	13.565	13.290	13.045
13	13.755	15.035	17.755	18.320	18.895	18.210	16.990	15.195	14.325	13.555	13.290	13.030
14	13.820	15.050	17.965	18.180	18.865	18.395	17.015	15.095	14.310	13.550	13.275	13.015
15	13.875	15.055	18.030	18.120	18.790	18.470	17.045	15.055	14.295	13.535	13.275	13.015
16	13.915	15.140	18.220	18.440	18.745	18.410	17.075	15.015	14.280	13.540	13.250	13.015
17	13.930	15.210	18.480	18.755	18.695	18.350	17.120	14.970	14.250	13.540	13.230	13.045
18	13.930	15.250	18.515	18.715	18.575	18.270	17.090	14.925	14.180	13.500	13.220	13.120
19	13.930	15.265	18.320	18.700	18.455	18.255	16.960	14.865	14.140	13.480	13.180	13.245
20	13.955	15.295	18.165	18.650	18.455	18.380	16.770	14.845	14.125	13.470	13.165	13.260
21	14.015	15.385	18.105	19.080	18.410	18.515	16.625	14.815	14.110	13.455	13.165	13.260
22	14.095	15.650	18.045	19.135	18.365	18.485	16.520	14.780	14.105	13.440	13.140	13.260
23	14.135	15.925	18.150	19.020	18.270	18.380	16.435	14.800	14.080	13.425	13.120	13.245
24	14.250	16.260	18.455	18.860	18.150	18.250	16.345	14.805	14.040	13.425	13.120	13.245
25	14.340	16.735	18.695	18.710	18.045	18.185	16.260	14.815	13.990	13.410	13.120	13.245
26	14.415	17.040	18.945	18.590	17.965	18.235	16.200	14.815	13.965	13.400	13.105	13.245
27	14.615	17.060	19.265	18.590	17.915	18.340	16.140	14.780	13.945	13.380	13.105	13.230
28	14.835	16.960	19.515	18.585	17.815	18.335	16.010	14.765	13.920	13.370	13.090	13.215
29	14.875	16.915	19.630	18.615	17.725	18.225	15.885	14.750	13.875	13.350	--	13.230
30	14.870	16.885	19.570	18.610	17.585	18.135	15.780	14.735	13.870	13.335	--	13.238
31	--	16.740	--	18.585	17.505	--	15.695	--	13.855	13.335	--	13.265
						Ten Daily Averages						
Av1	13.318	14.943	16.786	18.975	18.853	17.420	17.610	15.355	14.617	13.742	13.294	13.137
Av2	13.854	15.132	17.997	18.525	18.734	18.274	17.018	15.049	14.263	13.534	13.247	13.087
Av3	14.445	16.505	18.838	18.762	17.977	18.309	16.172	14.786	13.978	13.393	13.121	13.243
						Monthly Means & Extremes						
Max	14.875	17.060	19.630	19.410	18.945	18.515	18.030	15.595	14.720	13.835	13.335	13.265
Mean	13.872	15.558	17.873	18.754	18.504	18.001	16.909	15.063	14.276	13.551	13.228	13.158
Min	13.105	14.815	16.590	18.120	17.505	17.280	15.695	14.735	13.855	13.335	13.090	13.015

Annual Max.= 19.630 Date: 29/ 6/1978 Annual Min.= 13.015 Date: 14/ 3/1979

Annual Average = 15.744

BANGLADESH WATER DEVELOPMENT BOARD

SURFACE WATER HYDROLOGY

DHAKA

Date :01-21-1995

Mean Daily Water Level Metre/PWD

Station: 46.9L Bahadurabad (Transit. River: 22 Brahmaputra-Jamuna Year: 1981-82

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	14.055	14.815	16.200	18.730	19.185	19.210	17.480	15.275	14.125	13.620	13.185	13.115
2	14.095	14.920	16.360	19.115	19.230	19.145	17.365	15.260	14.115	13.595	13.160	13.135
3	14.065	14.995	16.595	19.285	19.225	19.055	17.160	15.260	14.095	13.570	13.140	13.150
4	14.010	14.970	16.915	19.295	19.240	19.020	17.255	15.250	14.065	13.555	13.140	13.135
5	13.980	14.910	17.040	19.325	19.225	18.980	17.425	15.195	14.035	13.540	13.140	13.120
6	13.960	14.820	16.960	19.460	19.110	18.930	17.540	15.150	14.015	13.515	13.130	13.105
7	13.980	14.780	16.785	19.400	18.995	18.870	17.575	15.085	13.995	13.495	13.120	13.100
8	14.005	14.815	16.650	19.430	18.880	18.805	17.525	15.025	13.975	13.485	13.120	13.085
9	14.065	14.880	16.490	19.315	18.810	18.765	17.360	14.970	13.955	13.460	13.130	13.070
10	14.165	14.935	16.460	19.170	18.645	18.675	17.175	14.930	13.925	13.440	13.140	13.070
11	14.270	14.965	16.480	18.990	18.520	18.775	17.005	14.895	13.920	13.425	13.140	13.070
12	14.455	14.965	16.615	18.730	18.460	18.760	16.885	14.900	13.900	13.420	13.140	13.085
13	14.650	15.150	16.670	18.560	18.500	18.760	16.765	14.925	13.930	13.405	13.130	13.105
14	14.780	15.270	16.625	18.490	18.560	18.880	16.640	14.905	13.940	13.390	13.140	13.120
15	14.760	15.370	16.510	18.425	18.625	18.910	16.525	14.840	13.965	13.390	13.150	13.130
16	14.665	15.470	16.435	18.575	18.675	18.890	16.430	14.765	13.970	13.380	13.160	13.140
17	14.585	15.640	16.415	18.850	18.660	18.865	16.310	14.710	13.980	13.370	13.145	13.140
18	14.525	15.825	16.415	19.080	18.570	18.865	16.230	14.660	13.985	13.355	13.115	13.150
19	14.510	15.985	16.570	19.210	18.590	18.825	16.125	14.610	13.960	13.340	13.090	13.155
20	14.540	15.955	16.665	19.295	18.655	18.775	16.000	14.575	13.965	13.330	13.090	13.175
21	14.495	15.835	16.725	19.300	18.720	18.715	15.880	14.495	13.960	13.320	13.080	13.205
22	14.370	15.790	16.815	19.195	18.820	18.630	15.820	14.460	13.960	13.310	13.070	13.230
23	14.370	15.775	16.905	19.110	18.965	18.530	15.740	14.430	13.910	13.300	13.060	13.220
24	14.560	15.825	16.970	19.040	19.055	18.350	15.670	14.360	13.850	13.290	13.060	13.220
25	14.705	15.795	17.045	18.975	19.140	18.105	15.605	14.325	13.810	13.275	13.050	13.225
26	14.775	15.710	17.145	18.920	19.200	17.920	15.530	14.295	13.770	13.260	13.040	13.225
27	14.795	15.650	17.195	18.935	19.195	17.790	15.470	14.265	13.735	13.245	13.070	13.285
28	14.850	15.650	17.390	18.965	19.140	17.935	15.420	14.240	13.705	13.120	13.090	13.345
29	14.830	15.680	17.880	19.065	19.085	17.485	15.370	14.200	13.675	13.215	--	13.400
30	14.830	15.795	18.305	19.125	19.085	17.465	15.330	14.160	13.660	13.200	--	13.425
31	--	15.970	--	19.155	19.125	--	15.305	--	13.645	13.190	--	13.445

Ten Daily Averages

Av1	14.038	14.894	16.646	19.261	19.055	18.946	17.386	15.140	14.030	13.528	13.141	13.109
Av2	14.571	15.462	16.540	18.821	18.562	18.831	16.492	14.779	13.952	13.381	13.130	13.127
Av3	14.603	15.770	17.238	19.071	19.048	18.093	15.558	14.323	13.791	13.248	13.065	13.293

Monthly Means & Extremes

Max	14.995	15.985	18.305	19.480	19.240	19.210	17.575	15.275	14.125	13.620	13.185	13.445
Mean	14.404	15.385	16.808	19.051	18.900	18.623	16.449	14.747	13.920	13.381	13.115	13.180
Min	13.870	14.780	16.200	18.425	18.460	17.465	15.305	14.160	13.645	13.120	13.040	13.070

Annual Max.= 19.480 Date: 7/ 7/1981 Annual Min.= 13.040 Date: 26/ 2/1982

Annual Average = 15.679

BANGLADESH WATER DEVELOPMENT BOARD
SURFACE WATER HYDROLOGY

Date :02-06-1995

DHAKA

Mean Daily Water Level Metre/PWD

Station: 49 Serajganj River: 22 Brahmaputra-Jamuna Year: 1969-70

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	7.725	9.420	10.930	12.790	13.065	13.400	11.885	9.420	8.360	7.695	7.290	7.125
2	7.725	9.430	10.840	12.715	12.970	13.400	11.745	9.345	8.330	7.680	7.290	7.150
3	7.715	9.280	10.760	12.650	12.865	13.430	11.630	9.270	8.300	7.665	7.290	7.225
4	7.615	9.165	10.685	12.600	12.805	13.500	11.540	9.200	8.285	7.650	7.275	7.325
5	7.565	9.050	10.610	12.530	12.745	13.485	11.435	9.155	8.290	7.630	7.275	7.445
6	7.555	8.960	10.565	12.560	12.650	13.445	11.350	9.115	8.290	7.605	7.275	7.505
7	7.555	8.870	10.595	12.620	12.635	13.400	11.250	9.100	8.290	7.590	7.275	7.530
8	7.555	8.835	10.745	12.750	12.635	13.400	11.150	9.100	8.285	7.555	7.275	7.535
9	7.570	8.825	10.900	12.820	12.660	13.355	11.050	9.085	8.255	7.520	7.275	7.535
10	7.645	8.870	11.075	12.950	12.705	13.275	10.930	9.040	8.225	7.505	7.260	7.535
11	7.670	8.925	11.325	13.000	12.720	13.200	10.830	9.005	8.195	7.490	7.245	7.535
12	7.665	8.950	11.735	13.065	12.730	13.185	10.760	8.980	8.185	7.475	7.225	7.535
13	7.615	8.905	11.905	13.165	12.715	13.150	10.710	8.950	8.145	7.460	7.200	7.550
14	7.570	8.810	12.210	13.240	12.715	13.095	10.625	8.910	8.130	7.445	7.185	7.550
15	7.625	8.735	12.470	13.300	12.695	13.040	10.545	8.870	8.085	7.425	7.160	7.545
16	7.645	8.715	12.635	13.355	12.695	12.985	10.470	8.770	8.055	7.410	7.155	7.500
17	7.700	8.705	12.680	13.455	12.745	12.925	10.425	8.710	8.030	7.395	7.160	7.470
18	7.700	8.715	12.665	13.580	12.845	12.860	10.380	8.680	8.010	7.380	7.125	7.440
19	7.800	8.780	12.645	13.635	12.995	12.805	10.335	8.650	7.985	7.365	7.115	7.415
20	7.830	8.905	12.560	13.640	13.230	12.750	10.260	8.625	7.965	7.350	7.110	7.415
21	7.985	9.170	12.440	13.690	13.245	12.665	10.150	8.590	7.935	7.360	7.095	7.445
22	8.060	9.315	12.300	13.750	13.260	12.515	10.055	8.580	7.905	7.350	7.080	7.535
23	8.135	9.545	12.195	13.810	13.305	12.375	9.985	8.580	7.895	7.335	7.080	7.630
24	8.195	10.120	12.240	13.820	13.360	12.270	9.900	8.440	7.895	7.320	7.095	7.705
25	8.255	10.655	12.400	13.765	13.400	12.150	9.850	8.545	7.870	7.305	7.095	7.720
26	8.350	10.980	12.615	13.665	13.415	12.055	9.785	8.595	7.820	7.305	7.095	7.735
27	8.570	11.175	12.835	13.575	13.415	11.995	9.725	8.565	7.810	7.305	7.110	7.750
28	8.715	11.235	12.965	13.385	13.415	12.020	9.680	8.535	7.800	7.305	7.110	7.750
29	8.850	11.220	12.985	13.165	13.410	12.050	9.635	8.405	7.780	7.305	--	7.715
30	9.225	11.145	12.925	13.285	13.400	11.995	9.545	8.375	7.750	7.290	--	7.685
31	--	11.005	--	13.185	13.385	--	9.480	--	7.720	7.290	--	7.675

Ten Daily Averages

Av1	7.623	9.071	10.771	12.699	12.774	13.409	11.397	9.183	8.291	7.610	7.278	7.391
Av2	7.682	8.815	12.283	13.344	12.809	13.000	10.534	8.815	8.079	7.420	7.168	7.496
Av3	8.434	10.507	12.590	13.554	13.365	12.209	9.799	8.521	7.835	7.315	7.095	7.668

Monthly Means & Extremes

Max	9.225	11.235	12.985	13.820	13.415	13.500	11.885	9.420	8.360	7.695	7.290	7.750
Mean	7.913	9.498	11.881	13.210	12.995	12.873	10.551	8.840	8.060	7.444	7.186	7.523
Min	7.555	8.705	10.565	12.530	12.635	11.995	9.480	8.375	7.720	7.290	7.080	7.125

Annual Max.= 13.820 Date: 24/ 7/1969 Annual Min.= 7.080 Date: 22/ 2/1970

Annual Average = 9.847

BANGLADESH WATER DEVELOPMENT BOARD

SURFACE WATER HYDROLOGY

DHAKA

Date :02-06-1995

Mean Daily Water Level Metre/PWD

Station: 49 Serajganj River: 22 Brahmaputra-Jamuna Year: 1978-79

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	8.570	8.405	10.485	13.455	12.875	11.995	12.315	9.250	8.115	7.050	6.445	6.180
2	8.590	8.395	10.395	13.215	12.930	11.950	12.205	9.175	8.085	7.020	6.445	6.170
3	8.620	8.335	10.425	12.940	13.305	11.900	12.140	9.085	8.060	6.995	6.425	6.170
4	8.670	8.395	10.525	12.755	13.365	11.855	12.070	9.020	8.100	6.980	6.410	6.195
5	8.680	8.565	10.715	12.695	13.395	11.855	11.915	8.960	8.120	6.945	6.385	6.270
6	8.745	8.575	10.690	12.740	13.380	11.870	11.720	8.930	8.115	6.930	6.385	6.280
7	8.775	8.530	10.570	12.830	13.330	11.915	11.575	8.870	8.040	6.895	6.385	6.280
8	8.810	8.490	10.515	12.875	13.320	12.025	11.460	8.810	7.955	6.880	6.380	6.255
9	8.935	8.490	10.650	12.860	13.330	12.130	11.355	8.795	7.880	6.850	6.370	6.240
10	7.080	8.490	10.635	12.840	13.380	12.250	11.215	8.840	7.800	6.820	6.380	6.195
11	7.180	8.530	10.730	12.770	13.410	12.375	11.125	8.865	7.555	6.805	6.385	6.170
12	7.225	8.560	10.955	12.635	13.410	12.535	11.080	8.855	7.705	6.775	6.395	6.150
13	7.195	8.565	11.355	12.465	13.395	12.605	11.035	8.780	7.660	6.750	6.400	6.140
14	7.230	8.595	11.635	12.315	13.405	12.680	11.010	8.715	7.615	6.745	6.400	6.140
15	7.270	8.595	11.765	12.220	13.395	12.800	10.990	8.625	7.565	6.715	6.395	6.125
16	7.370	8.625	11.840	12.360	13.405	12.830	10.970	8.565	7.535	6.700	6.380	6.140
17	7.385	8.745	12.065	12.635	13.335	12.795	10.995	8.520	7.505	6.685	6.350	6.150
18	7.390	8.835	12.215	12.875	13.290	12.725	11.020	8.465	7.460	6.655	6.325	6.185
19	7.360	8.880	12.130	12.855	13.260	12.665	10.940	8.410	7.430	6.640	6.310	6.250
20	7.360	8.930	11.980	12.965	13.180	12.690	10.760	8.350	7.385	6.610	6.305	6.340
21	7.375	8.990	11.900	13.135	13.160	12.830	10.560	8.315	7.355	6.590	6.270	6.415
22	7.435	9.190	11.885	13.245	13.145	12.870	10.345	8.290	7.325	6.585	6.240	6.430
23	7.480	9.435	11.885	13.235	13.085	12.765	10.165	8.305	7.295	6.560	6.225	6.395
24	7.575	9.770	12.085	13.180	12.985	12.605	10.060	8.285	7.265	6.555	6.215	6.365
25	7.680	10.165	12.450	13.045	12.845	12.465	9.980	8.240	7.240	6.530	6.210	6.340
26	7.795	10.685	12.635	12.955	12.735	12.435	9.905	8.215	7.215	6.505	6.200	6.325
27	7.895	10.850	12.940	12.895	12.665	12.495	9.800	8.215	7.185	6.505	6.200	6.325
28	8.075	10.820	13.275	12.900	12.555	12.555	9.675	8.230	7.155	6.490	6.200	6.325
29	8.240	10.760	13.455	12.895	12.430	12.555	9.570	8.215	7.125	6.475	--	6.365
30	8.410	10.730	13.515	12.925	12.270	12.465	9.480	8.170	7.110	6.475	--	6.415
31	--	10.620	--	12.900	12.130	--	9.355	--	7.080	6.460	--	6.475

Ten Daily Averages

Av1	8.749	8.467	10.566	12.921	13.261	11.975	11.797	8.974	8.027	6.937	6.401	6.224
Av2	7.797	8.686	11.667	12.610	13.349	12.670	10.993	8.615	7.542	6.708	6.365	6.179
Av3	7.801	10.183	12.603	13.028	12.728	12.604	9.900	8.248	7.214	6.521	6.270	6.380

Monthly Means & Extremes

Max	8.410	10.850	13.515	13.455	13.410	12.870	12.315	9.250	8.120	7.050	6.445	6.475
Mean	7.782	9.147	11.612	12.858	13.100	12.416	10.864	8.612	7.582	6.715	6.336	6.265
Min	6.570	8.335	10.395	12.220	12.130	11.855	9.355	8.170	7.080	6.460	6.200	6.125

Annual Max = 13.515 Date: 30/ 6/1978 Annual Min.= 6.125 Date: 15/ 3/1979

Annual Average = 9.418

BANGLADESH WATER DEVELOPMENT BOARD

SURFACE WATER HYDROLOGY

Date :02-06-1995

DHAKA

Mean Daily Water Level Metre/PWD

Station: 49 Serajganj River: 22 Brahmaputra-Jamuna Year: 1981-82

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	99.990	99.990	10.300	13.010	13.330	13.300	11.750	9.400	8.140	7.450	6.900	6.740
2	99.990	99.990	10.550	13.290	13.370	13.320	11.700	9.370	8.110	7.430	6.890	6.780
3	99.990	99.990	10.760	13.410	13.410	13.240	11.580	9.360	8.070	7.400	6.860	6.800
4	99.990	99.990	11.080	13.520	13.410	13.170	11.520	9.360	8.030	7.370	6.860	6.800
5	99.990	99.990	11.360	13.590	13.440	13.140	11.610	9.350	7.990	7.340	6.860	6.800
6	99.990	99.990	11.460	13.720	13.410	13.130	11.770	9.270	7.960	7.320	6.840	6.800
7	99.990	99.990	11.380	13.860	13.350	13.050	11.910	9.190	7.930	7.310	6.830	6.790
8	99.990	99.990	11.230	13.870	13.290	12.960	11.920	9.120	7.890	7.280	6.810	6.760
9	99.990	99.990	11.080	13.840	13.190	12.900	11.800	9.070	7.860	7.250	6.800	6.730
10	99.990	99.990	10.960	13.680	13.070	12.870	11.630	9.010	7.850	7.240	6.830	6.710
11	99.990	99.990	10.900	13.400	12.950	12.860	11.460	8.950	7.890	7.220	6.810	6.710
12	99.990	99.990	10.960	13.090	12.880	12.830	11.290	8.930	7.850	7.190	6.810	6.710
13	99.990	99.990	11.080	12.920	12.870	12.840	11.160	8.930	7.800	7.160	6.830	6.710
14	99.990	99.990	11.130	12.840	12.900	12.870	11.020	8.960	7.770	7.160	6.830	6.740
15	99.990	99.990	11.060	12.820	12.970	12.980	10.910	8.920	7.810	7.150	6.830	6.770
16	99.990	99.990	10.980	12.840	13.030	13.020	10.790	8.830	7.830	7.130	6.830	6.800
17	99.990	99.990	10.930	13.050	13.040	12.980	10.680	8.770	7.820	7.120	6.830	6.800
18	99.990	99.990	10.930	13.200	12.970	12.970	10.580	8.710	7.800	7.100	6.820	6.780
19	99.990	99.990	11.020	13.340	12.910	12.970	10.450	8.640	7.800	7.070	6.800	6.780
20	99.990	99.990	11.090	13.410	12.940	12.920	10.350	8.590	7.800	7.040	6.780	6.780
21	99.990	99.990	11.200	13.410	13.000	12.840	10.240	8.540	7.800	7.030	6.770	6.800
22	99.990	99.990	11.310	13.380	13.040	12.760	10.120	8.490	7.830	7.030	6.750	6.850
23	99.990	99.990	11.370	13.290	13.140	12.680	10.030	8.440	7.790	7.010	6.740	6.860
24	99.990	99.990	11.460	13.220	13.200	12.560	9.940	8.400	7.730	6.980	6.740	6.860
25	99.990	99.990	11.550	13.110	13.250	12.380	9.830	8.350	7.680	6.970	6.720	6.860
26	99.990	99.990	11.610	13.090	13.270	12.230	9.750	8.320	7.640	6.950	6.710	6.860
27	99.990	99.990	11.660	13.090	13.290	12.100	9.680	8.290	7.580	6.920	6.710	6.880
28	99.990	99.990	11.770	13.110	13.300	11.980	9.620	8.250	7.560	6.900	6.720	6.930
29	99.990	99.990	12.130	13.170	13.300	11.850	9.540	8.200	7.530	6.890	--	6.990
30	99.990	99.990	12.610	13.310	13.230	11.770	9.500	8.170	7.500	6.920	--	7.070
31	--	99.990	--	13.350	13.230	--	9.430	--	7.460	6.910	--	7.110

Ten Daily Averages

Av1	99.990	99.990	11.020	13.580	13.330	13.110	11.720	9.250	7.980	7.340	6.850	6.770
Av2	99.990	99.990	11.010	13.090	12.950	12.920	10.870	8.820	7.820	7.130	6.820	6.760
Av3	99.990	99.990	11.670	13.230	13.200	12.320	9.790	8.350	7.650	6.960	6.730	6.920

Monthly Means & Extremes

Max	99.990	99.990	12.741	13.869	13.442	13.320	11.933	9.403	8.138	7.452	6.904	7.117
Mean	99.990	99.990	11.230	13.300	13.160	12.780	10.760	8.810	7.810	7.140	6.800	6.820
Min	99.990	99.990	10.226	12.817	12.863	11.765	9.418	8.153	7.452	6.889	6.706	6.706

Annual Max.= 13.869 Date: 7/ 7/1981 Annual Min.= 6.706 Date: 26/ 2/1982

Annual Average = 9.880

APPENDIX - C

Bottom level of Brahmaputra - Jamuna river in meter for the years 1969-70 to 1990-91 at stations J-17 to J-1.

SECTION/ STATION	CHAINAGE IN Km.	BOTTOM LEVEL OF BRAHMAPUTRA–JAMUNA RIVER IN METRE.								HIGH WATER LEVEL/FIXED ELEVATION IN METRE.
		1969–70	1976–77	1977–78	1978–79	1981–82	1986–87	1988–89	1990–91	
J –17	25.000	13.69	9.31	13.41	4.71	11.50	10.65	12.56	11.02	23.65
J –16	37.100	10.81	10.53	11.54	8.81	8.62	8.58	5.49	9.82	22.49
J –15	55.650	9.82	9.24	9.09	6.33	7.84	8.41	–0.85	6.76	21.15
J –14	71.200	1.07	3.42	9.79	6.87	6.26	6.78	4.75	6.02	19.84
J –13	84.700	9.11	6.43	5.13	3.69	3.22	4.62	0.24	2.61	18.50
J –12	100.500	4.22	—	5.24	4.78	4.36	3.57	5.85	4.78	17.37
J –11	117.750	6.31	4.32	0.39	3.48	1.24	1.59	5.22	– 1.56	16.25
J –10	134.300	4.88	–0.09	2.24	1.48	1.87	3.85	7.28	3.46	15.12
J – 9	142.450	2.58	2.19	–0.30	—	0.62	1.39	1.34	44.46	14.00
J – 8	149.500	–4.59	2.72	1.35	–2.24	–3.18	1.24	–0.62	2.88	13.23
J –7	162.350	–8.00	–4.05	0.12	–2.33	–13.26	–12.93	–3.74	1.60	12.50
J –6	177.700	–5.17	–1.51	–5.76	–3.43	–6.19	–0.79	–3.12	–3.81	11.70
J– 5	188.200	–5.87	–10.87	–3.55	–5.21	–2.05	0.32	–2.29	–0.12	10.94
J –4	201.300	–4.77	–7.21	–10.12	–1.26	–5.06	–4.59	–7.88	–2.68	10.15
J –3	213.200	–3.02	–5.16	–3.08	–10.04	–3.46	–2.15	–7.22	–4.90	9.39
J –2	223.200	–5·44	–6.58	–4.77	–7.19	–11.04	–3.52	–6.72	–4.48	8.66
J – 1	230.750	–5.52	–9.41	–9.58	–5.90	–9.11	–5.32	–6.31	–3.16	8.17

90283
26/9/96
লাইব্রেরী, ঢাকা