Government of the Republic of Indonesia

REPORT ON THE FEASIBILITY STUDY
FOR
THE MADIUN RIVER URGENT IMPROVEMENT PROJECT
(Main Report)

December 1980

Japan International Cooperation Agency
Tokyo

PREFACE

In response to the request of the Government of The Republic of Indonesia, the Japanese Government decided to conduct a survey on The Feasibility Study for the Madiun River Urgent Improvement Project and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to Indonesia a survey team headed by Mr. R. Nishikawa from March 20th to July 18th, 1980.

The team exchanged views with the officials concerned of the Government of Indonesia and conducted a field survey (in the Madiun River Project area). After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

December, 1980

Keisuke Arita
President
Japan International Cooperation Agency

SUMMARY

A. Background of The Study

The over-all improvement of the Madiun river with respect to the design flood discharge of the fourty years return period was formulated in 1974 as a component of the Master Plan of Solo River Basin Development. During the subsequent years, however, unprecedented floods occured three times in the Madiun river, namely in 1975, 1978 and 1979. The floods caused serious damages in the Madiun and its surroundings.

In view of the above experience, the Government of Indonesia requested the Government of Japan to undertake the feasibility study for the Madiun river urgent improvement project. The request was promptly complied by Japanese Government and it was agreed that Japan International Cooperation Agency (JICA) would dispatch a team of experts to carry out a study with the following understandings:

The scope of the feasibility study will focus on formulation of an optimum project plan for the urgent flood control of the Madiun city and its surrounding area upon conceptional review for overall flood control scheme of the entire Solo river system and identify the effects of the improvement to the downstream areas.

Further the objective area to be covered by the urgent improvement work was defined as the area subject to inundation along the Madiun river between the confluence of the Jerowan river and that of the Catur river.

In carrying out the study for the urgent improvement, consideration was paid to formulate the project to be a first stage improvement toward the over-all plan, so that the urgent works proposed may remain useful or at least harmless in planning and implementing the future stages of the improvement.

The study by the JICA team was started in March 1980 with a conceptual review of the over-all improvement plan which included following main components:

a) Construction of two dams in the upper Madiun reaches to control flood run-off.

b) Construction of a flood way with 500 meter wide to divert the run-off from the urban area of Madiun city.

c) Construction of continuous dikes along the river to confine the flood plain within the dikes.

d) Construction of Jipang dam in the main Solo river to absorb possible increase of the flood peak and to protect the Lower Solo river basin from flooding.

The result of the review had revieled some important elements which were considered relevant to subsequent project formulation, namely:

a) The proposed dams in the upstream may produce a flood control effect mainly in the upper reaches including the Ponorogo area but a limited effect to the Madiun area. Their construction may take several years.

b) Construction of the floodway may require some 350 ha of the semi-urban and rural land, acquisition of which may require considerable cost and time and may cause serious social problems.

c) Construction of continuous dikes to provide the main stream with a large flow section may also require a wide agricultural land to be purchased and may cause deterioration of the drainage condition in the basin of the tributaries.

d) Construction of Jipang dam may be realized after many years due to social, financial and other problems likely to be involved. In the absence of Jipang dam, the level of improvement of the Madiun river will be limited within a redsuced level.

In view of the above result and taking into account the objective of the urgent project, it was considered appropriate to set up a guideline to the project formulation as follows:

a) The return period of the design flood discharge may vary according to the present status of the area to be protected; however, it should be more than 5 years at any part of the project area.

b) The number of houses to be removed should be minimized to the extent as possible.

c) Increment of the flood water level as a consequence of the improvement work should be minimized or avoided wherever possible.

d) Intentional retardation of the flood run-off in the productive area should be avoided.

The field study was carried out within 4 months ending in July 1980 and further was undertaken by the team in the home country.

B. Conclusion

1. The dischharge of 1,200 cubic meters per second at the A. Yani gaging station was adopted as the design discharge considering that the floods of approximately the same magnitude have occurred twice in the recent five years. This design flood correspond to that of 17 years return period according to the Gumbel's method.

2. As to the basic method of improvement, heightenning of dykes, widenning of the river channel, dredging of the channel, shortcut and construction of by-pass channel were examined. However, it was considered that the heightenning of the dykes and shortcut works were most practical in the light of the nature of the project.

3. As to the treatment of the habitual inundation area along the left bank of the Jerowan river, two alternative ideas namely to protect the area by embankment and to leave the area unprotected were considered.

4. With due consideration of the conditions described above, following five alternative plans shown below were examined for the project:

Alternative	Jerowan inundation area	Shortcut
I-1	Without protection	None
I-2	"	Part-1 & Part-2
II-1	Protected by dyke	None
II-2	"	Part-1 & 2
II-3	"	Part-1,2,3,4, & 5

For each alternative plan, earth embanked dyke, wall type dyke, shortcut, groyne work, revetment of wet masonry, gate structure, bridge, siphone and irrigation canal and drainage facilities were designed.

5. The items and quantity of the right of way and compensation required were estimated as follows:

Alternative	Land to be purchased (ha)	Land to be hired (ha)	House to be relocated (pcs)
Alternative I-1	47	108	357
" I-2	72	41	454
" II-1	64	151	357
" II-2	88	93	454
" II-3	109	54	482

6. The construction cost of the project were estimated based on the following assumptions;

(1) The construction period is to be shorten as much as possible by means of the mechanized construction method in view of the urgency of the project.

(2) The construction work is to be carried out by contract base.

(3) The construction equipment, spare parts and steel product for the metal works are to be furnished by the Government to the contractors.

7. The financial and economic costs of the project for each alternative were estimated as follows:

(1 US$ = ¥240 = Rp.625.-)

Currency	Alternative				
	I-1	I-2	II-1	II-2	II-3
			Financial Cost		
Foreign (¥10^6)	3,063	2,580	3,689	3,200	3,200
(Equivalent US$$10^3$)	12,764	10,751	15,369	13,335	13,335
Domestic (Rp.10^6)	9,486	8,895	10,951	10,347	11,560
(Equivalent US$$10^3$)	15,178	14,233	17,522	16,555	18,496
Total (US$$10^3$)	27,942	24,984	32,891	29,890	31,831
			Economic Cost		
Foreign (¥10^6)	1,954	1,531	2,136	1,711	1,747
(Equivalent US$$10^3$)	8,140	6,379	8,899	7,130	7,281
Domestic (Rp.10^6)	7,427	7,072	8,593	8,230	9,195
(Equivalent US$$10^3$)	11,883	11,315	13,750	13,168	14,713
Total (US$$10^3$)	20,023	17,694	22,649	20,298	21,994

8. The annual benefit of the project for each alternative were estimated as the sum of the expectation of the damage mitigation in the residential and the farm areas.

Benefit	Alternative				
	I-1	I-2	II-1	II-2	II-3
(Million Rp.)	1,670	1,670	1,740	1,740	1,740
(Equivalent 1,000 US$)	(2,672)	(2,672)	(2,784)	(2,784)	(2,784)

9. The project life period was assumed 50 years, and all the benefit and costs were alloted in each year of the fifty years period. The alloted benefits and costs were discounted by several discount rates to obtain the present values for each alternative. The benefit-cost ratio and IRR were obtained from the present values and are summarized hereunder.

Alternative	Discount Rate in Percent 7	10	12	IRR
Alternative I-1	1.61	1.15	0.95	11.3
" I-2	1.81	1.28	1.05	12.6
" II-1	1.48	1.05	1.87	10.5
" II-2	1.64	1.16	0.96	11.5
" II-3	1.51	1.07	0.88	10.6

10. Each alternative shows a similar level of feasibility. In selecting the final alternative, however, alternatives in the "I" group were left out in view of the following considerations:

a) The Jerowan area has already been cultivated for food production and certain land improvement works are underway.

b) The net benefit of the project will be increased by including protective works for the Jerowan area.

c) More intensive land use of the area is foreseen in the near future.

Further, taking account the highest value of IRR and the least investment required among those in the "II" group, it was concluded that the alternative II-2 was the most appropriate one.

11. The principal work quantities required to the alternative II-2 are presented below.

Embankment of dykes	1,308,000 m^3
Excavation of shortcut	525,000 m^3
Wet masonry	44,000 m^2
Construction of bridge	3 sets
Modification of bridge	2 sets
Construction of gate structure	4 sets
Treatment of spoil bank	210,000 m^2
Land to be purchased	88 ha
Land to be hired	93 ha
House to be removed	454 pcs.

12. Implementation of the above works will require one and half years for the detail design and preparatory works, which will be followed by the construction works carried out within a two year period. Total period required for the completion of the project will therefore be four years.

13. Possible increase of the depth of inundation in the area along the Madiun river below the Jerowan river confluence as a effect of the implementation of the alternative II-2 was assessed. It was concluded that the estimated increase with respect to the design flood would be approximately 20 cm, which may cause an increase of a few percent of the present inundation area.

14. The inflow into the Solo river consequent to the occurance of the design flood at A. Yani under the present condition was estimated at 900 m^3/sec. Increment of the above inflow as the effect of the improvement works by the alternative II-2 was estimated to be 75 m^3/sec or approximately at the order of 8 percent value. This may correspond to a few percent of the discharge in the Lower Solo river.

15. Maximum possible degradation in the Madiun river as an effect of proposed short cut works was estimsted at 1.2 meters. Although the section of the degradation is confined within the immediate upstream of the shortcut channels, certain protection for the foot of the dike and other riparian structures will be needed.

C. Recommendation

1. It should be recognized that the present project is by no means ideal in the light of the general principle for planning the river improvement. Since any partial improvement in a river system cannot be free from causing deterioration of the flood situation in the downstream, it is preferable to take certain measures towards compensating such an effect wherever possible.

2. Practical measures for eliminating or minimizing the possible rise of the flood level in the downstream area of the Jerowan confluence due to the influence of protecting Jerowan area were not indicated in this report since the disadvantage to be caused by this effect was considered insignificant. It is advisable, however, to consider a certain improvement of that area as the priority scheme to be implemented immediately after the urgent project. Shortcut works will be the most preferable method of improvement in this connection.

3. Possible increment of the flood peak discharge in the Lower Solo river should be studied more in detail by using more accurate topographic map and other data relevant to the problem. In this connection, it will be of practical necessity to assess the compound effect of all the river works likely to be implemented in the reaches in the Upper Solo river basin including the Madiun river.

4. The design flood discharge of 1,200 m^3/sec at A. Yani should be considered as a criterion for formulating the project. In carrying out the detail design of the works and structures for the project, it will be necessary to provide more elaborate design criteria with careful examination of the construction sites.

5. As for the future stages of the Madiun river improvement with the view to increasing the safety or to cover more extensive area protected following measures will be worth while studying:

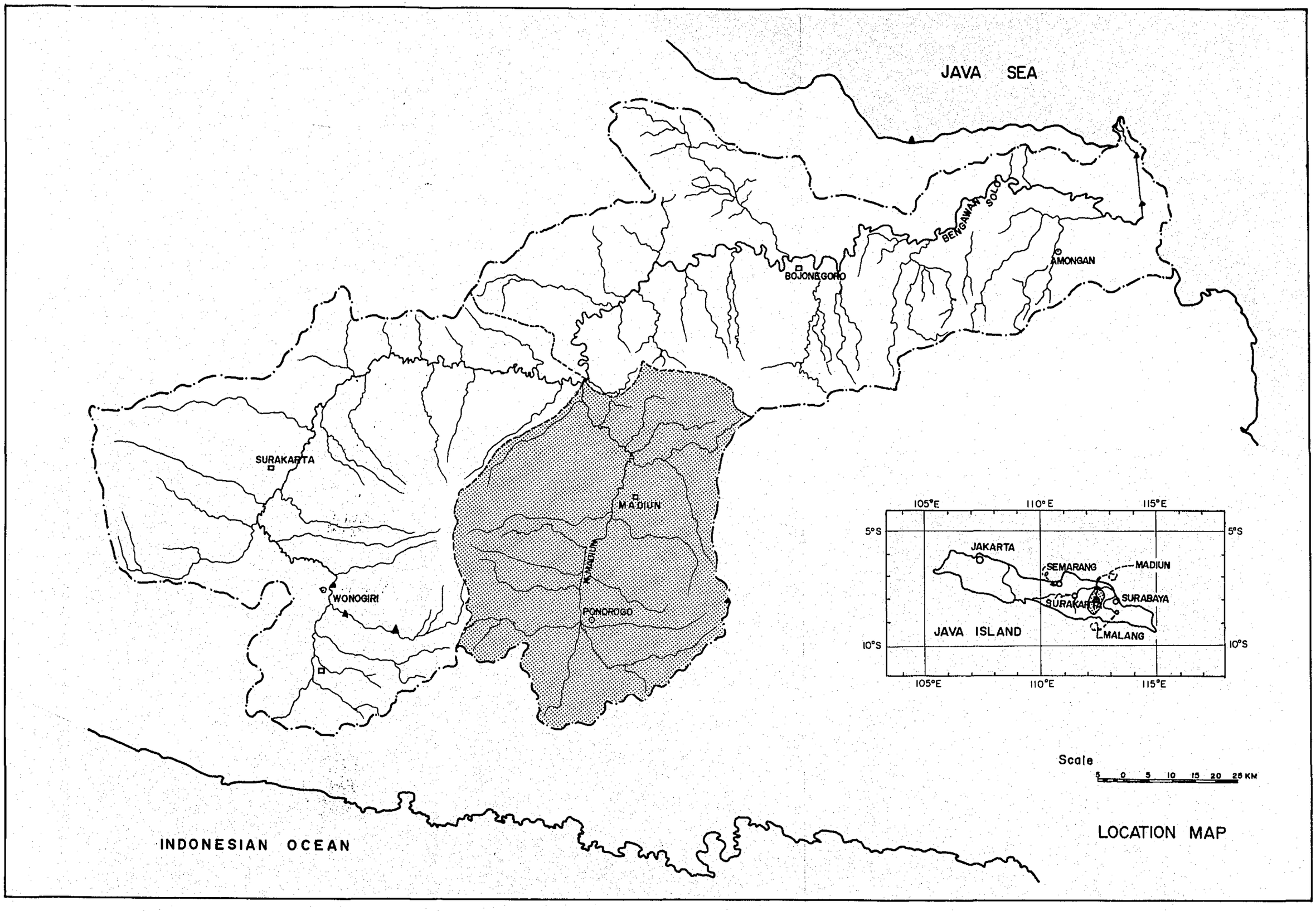
   a) Construction of Badegan dam and/or Bendo dam.
   b) More extensive shortcut works in the lower reaches of the Madiun river.
   c) Construction of the floodway with an adequate capacity.
   d) Diversion of the Gandong river to reduce the peak discharage of the flood runoff passing the urban area of Madiun city.
   e) Erosion control works in some tributary basins as necessary.
   f) Establishment of a flood forecasting and warning system.

6. Monitoring of the river bed variation should be carried out with respect to the following items:

a) Cross-sectional survey of the river bed at the end of each flood season in the upstream section of the short cut works and other strategic sections in the main river and selected tributaries.

b) Periodical sampling of bed material at selected sections in the river system and analysis of the sample obtained.

c) Observation of the sediment loads at a few sections along the main stream.



LOCATION MAP

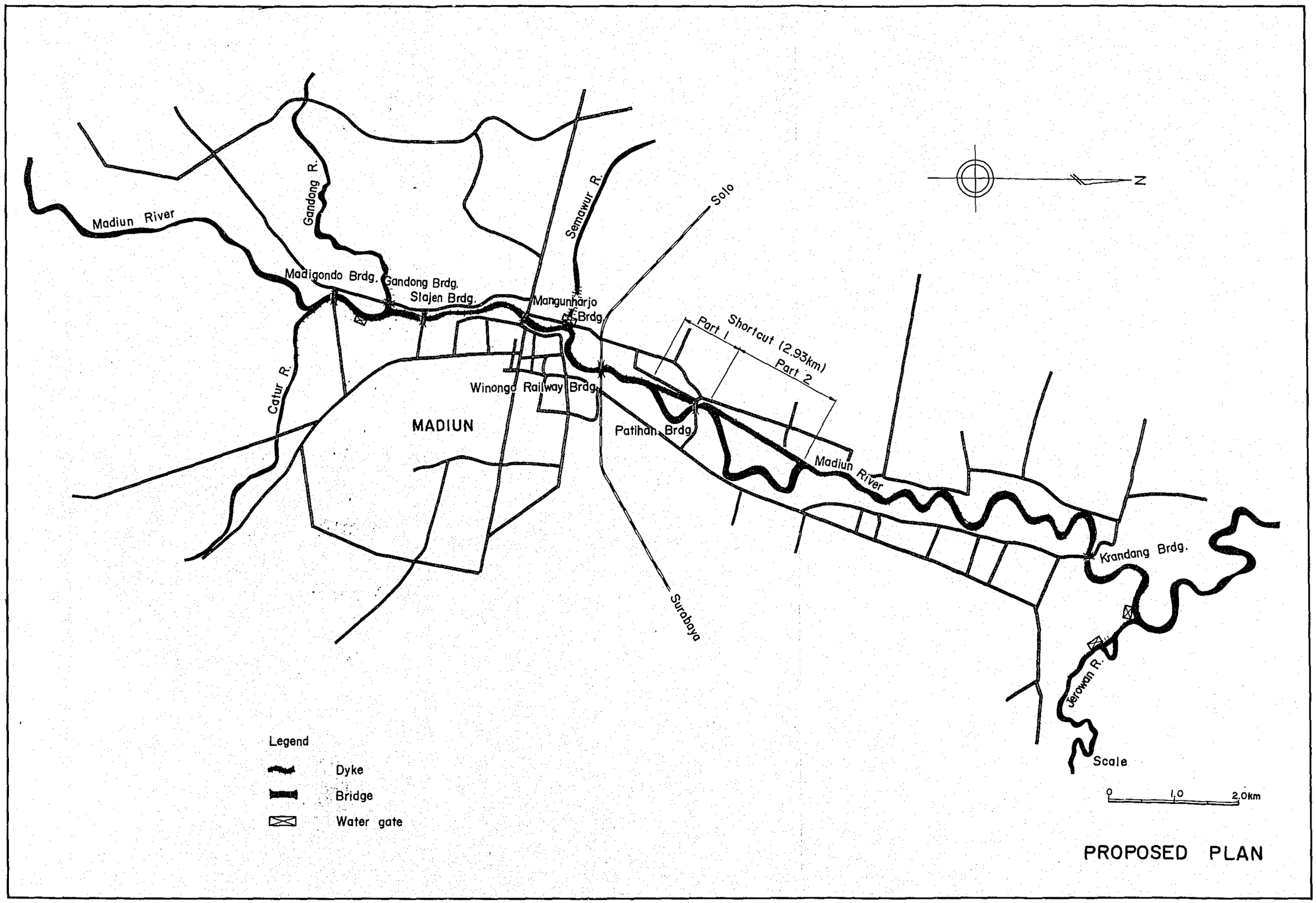

Madiun River
Gandong R.
Semawur R.
Solo
N
Madigondo Brdg.
Gandong Brdg.
Slajen Brdg.
Mangunharjo Brdg.
Part 1
Shortcut (2.93km)
Part 2
Catur R.
Winongo Railway Brdg.
MADIUN
Patihan Brdg.
Madiun River
Krandang Brdg.
Surabaya
Jerowan R.
Legend
Dyke
Bridge
Water gate
Scale
0
1.0
2.0km
PROPOSED PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY AND ABBREVIATIONS

1. Local Terms of Administration Areas and Organizations

BINA-MARGA	Agency for design and construction of road
Camat	Chief of township
Desa	Village or block
DGWRD	Directorate of General Water Resources Development
DPMA	Directorate of Hydraulic Engineering
Kabupaten	District or regency
Kecamatan	Subdistrict or township
Kotamadya	City
LPMA	Directorate of Hydraulic Engineering
P2AT	Proyek Pengairan Air Tanah (Authority for ground water development)
PBS	Proyek Bengawan Solo (Authority for the development of Solo river basin)
PG	Public Gura (Sugar refinery factory)
Propinsi	Province

2. Natural Features

Air	Water
Banjir	Flood
Gunung	Mountain
Hujan	Rainfall
Kali	River

3. Unit

cm	centimeter
cm^2	square centimeter
ha	hectar

km	kilometer
km^2	square kilometer
L.S.	Lump sum
m	meter
m^2	square meter
m^3	cubic meter
mm	milimeter
Pcs	Pices
Rp	Indonesian Rupiah
Sec.	Second

4. Miscellaneous

Alt.	Alternative
B	Width of channel, road and bridge
BM	Bench Mark
br. and brdg.	Bridge
El.	Elevation
Fig.	Figure
g	Acceleration of gravity
J.I.C.A and JICA	Japan International Corporation Agency
No.	Number
Nos.	Numbers
OECF	Overseas Economic Cooperation Fund
OMR	Operation Maintenance and Repair
OTCA	Overseas Technical Cooperation Agency
St.	Station

1. INTRODUCTION

1.1 The River Basin

The Madiun river basin in Java island at the west border of the East Java Province is located approximately between 7°15' and 8°10' south in latitude and between 111°10' and 111°45' east in longitude.

The river, the primal tributary of the Solo river, takes it's origin in the mountain area of the southern part of the basin.

The river flows to the north in the Madiun valley for about 100 km and meets the Solo river at Ngawi. It drains about 3,800 km^2 of the land and joins various tributaries before it comes to the confluence with the Solo river.

The land of the basin area is well reclaimed for agricultural use and has been reputed to be one of the most important granary area in the country.

The irrigation canals and drainages are extended all over the flat land. The flat low land have been used mainly for the paddy and the sugar cane plantations.

Maze and beans are cultivated in the hilly area but the small scale paddy field are also arranged in tier on the sloped hill sides.

The land has been fully developed in the last decade and more than 70 percent of the catchment area has been used for the agricultural production.

Accordingly the basin has become one of the most populated area in the country.

The population of the basin is culminated by the Madiun city which is located in the center of the Madiun river basin and nearly 200 thousands of people reside therein. The Ponorogo city with 50 thousands of population is the central town of the southern part of the catchment area and the Ngawi city is the center of the northern part.

Those urban area are the center of the regional government, the commercial center of the agricultural products and also the industrial center for the sugar refining and others.

Except the Ngawi city, all the towns discussed above have been subjected to the menace of the frequent flood.

The remarkable floods were experienced in 1966, 1968, 1972, and 1975 bringing heavy damages to the Ponorogo and the Madiun cities and the area along the river. The inundated area of about 6,000 ha and the suffered houses of 16,000 were reported as an average damage of these floods.

The major causes of the flood are considered to be the rainfall with high intensity in the developed and deforested land and the subsequent flash flow from the steep sloped tributaries.

It is supposed that it requires long period to change these socio-economic, hydrologic and topographic conditions in order to mitigate the flood magnitude. Consequently the river improvement is considered to be one of the most effective counter measure for the increasing flood damage in the Madiun river basin.

1.2 Project History

To cope with the conditions of the river, several studies were performed to mitigate the flood damages by the agencies concerned; The Overseas Technical Co-operation Agency, Japan carried out a comprehensive studies on the river improvement of the whole Solo river basin including the Madiun river in 1974 and a master plan was formulated.

In this plan, a floodway was proposed to protect the Madiun city from inundation, it will divert a part of flood runoff from the original channel. The master plan was subsequented by the preliminary study on the design of the floodway by the PBS. The study made by the PBS was taken over by the University of Gajah Mada who prepared a prefeasibility report on the floodway.

The construction of the Bendo and the Badegan dam were proposed in the master plan. An objective thereof is to mitigate the inundation around the Ponorogo city. Both dams were studied again by P2AT as the multipurpose dams.

Both floodway and dam plans were studied as the over-all plan which designs structures in a full scale and they require considerable amount of construction works. Consequently the economic feasibilities were supposed to be kept low.

No dykes were constructed along the Madiun river before 1974 except the small ones in the Madiun city. And the substantial part of the city was submerged by the inundation caused by floods in 1968, 1975 and others.

Of these floods, the spilled water from the river channel a little downstream from the confluence with the Gandong river submerged almost all over the city and brought considerable damages.

After 1975, the PBS has engaged the river improvement in and upstream reach of the Madiun city by reconstructing and upraising of the dyke heights.

By the flood occurred on June 30, 1978, the dyke was over-topped at Patihan and was washed away to the bottom. The inundation caused by the flood brought damage to the northern suburbs of the Madiun city.

The floods occurred on April 30, and May 5, 1979 spilled out from the dyke at Patihan repeatedly. And the reconstructed dyke were again breached to the dyke foundation.

Reflecting the circumstances abovementioned, the Government of Indonesia decided to undertake the extensive remedies for flood damages in the Madiun river basin especially in the Madiun city and its surroundings. And the Madiun river urgent improvement project was taken up as the initial action.

The Government requested the technical cooperation from the Japanese Government to carry out the feasibility study on the project.

The Japanese Government then responded to the request sending a Contact Mission headed by Mr. K. Hagiwara to Indonesia. The Mission exchanged their view with the Government of Indonesia concerning the scope of work of the feasibility study. And both sides agreed on the SCOPE OF WORK FOR THE FEASIBILITY STUDY OF THE MADIUN RIVER URGENT IMPROVEMENT PROJECT attached hereto as ANNEX - 1.

Following the Contact Mission, the Japan International Cooperation Agency (JICA), responsible for the implementation of the technical cooperation programmes of the Government of Japan dispatched the feasibility study team consist of nine experts in Japan on March 20, 1980 to the site.

The study team executed the assigned work during the period from March 20 to July 18, 1980 and in concluding the field study the Interim Report was prepared in complying with the Scope of Work.

The study team continued the feasibility study after their coming back to Japan and prepared this report as the final conclusion of the study. The report were comprise with two volumes namely a main report and a supporting report. The major results of studies and conclusions were described in the Main Report whereas the details of survey and calculations were discussed in the Supporting Report.

1.3 Objective of Study

According to the Scope of Work main objective of the Feasibility Study of the Madiun River Urgent Improvement Project is given as follow;

"To fomulate an optimum project plan for urgent measures to mitigate the flood damage in Madiun city and its surroundings caused by the Madiun River and to assess its technical economic feasibilities."

"The area covered by the study includes the whole basin of the Madiun river, in which the length of the main stream is nearly 100 km and the catchment area is about 3,800 km^2. The objective area of the urgent flood mitigation will cover mainly Madiun city and its surroundings."

The study team prepared the Inception Report on the project a half month after the commencement of the study and submitted to the JICA.

Both Governments including study team held a meeting on the Inception Report on April 3, 1980 in Jakarta and discussed the basic concept of the study and the plan of operation for the scope of work. Both sides reached to an agreement as deseribed in INCEPTION REPORT ON THE FEASIBILITY STUDY OF THE MADIUN RIVER URGENT IMPROVEMENT PROJECT, April 1980.

In this meeting the meaning of the Madiun city and its surroundings was defined as the area downstream from the confluence with the Catur river and the upstream from the confluence with the Jerowan river.

1.4 Acknowledgement

Since the day the study team arrived in Indonesia and entered into operation, a hearty and most efficient cooperation were extended to the study team by the various offices. Thereby the team could achieve their assignment successfully and as scheduled. The extensive data and information were collected and were used in the study. The additional surveys were carried out with sufficient qualities and quantities by the Government of Indonesia as mentioned in the Scope of Work. The surveyed results were fully incorporated in the studies.

The discussion in the meetings held several times during the study period were efficient and useful for the study.

The names of such offices and the attendants to the respective meetings are listed in ANNEX - 2.

The team wish to take this opportunity to express our deep gratitude to these offices and people.

The team wish to present its special appreciation and gratitude to the PBS managed by Ir. Soeminto who take charge of seeing general care of team's activities, and the counterpart officials headed by Ir. Imam Hidayat who have provided day-to-day support of the team throughout the study period.

The team also wish to express its thanks for the guidance and collaboration extended by the Japanese Embassy in Jakarta, JICA Jakarta office, Advisory Comittee Members from JICA and Colombo Plan Experts in Jakarta and in Surakarta.

2. NATURAL CONDITION

2.1 Topography

2.1.1 General

The river basin is culminated by the mount Lawu, 3,265 meters in altitude in the west. The east of the basin is also flanked by the high mountains Dorowati, 2,362 meters and Wilis, 2,169 meters in altitudes. Wheras the flat area in the Madiun valley is around 50 meters in altitude.

The mountain area in the southern part of the basin is in the range of 200 to 500 meters in altitude and form a hilly topography.

The profile of the Madiun river has rather gentle slope ranging from 1 : 1,500 to 1 : 3,000. Most of the tributaries, however, have steep slopes; as steep as 1 to 200 even at their down reaches.

In the mountain area, the Madiun river joins with many tributaries. The Keyang, Anyar and Munkungan are the main tributaries in this area.

After the Madiun river comes into the flat area in the Madiun valley, the river joins with the Asin, Catur and Gandong river, which originate in the high mountains in the east and the west sides.

No remarkable tributary joins to the Madiun river in the downstream reach from the Gandong river until it come across the Jerowan river.

The Jerowan river has large catchment area of 453 km^2. The channel slope is as gentle as 1 to 1,500.

There is a low land in the right side of the Madiun river at the confluence with the Jerowan river. This low land forms a natural retarding area for the flood discharge from the Madiun river and the Jerowan river. The land has already been cultivated for food production and certain land improvement works are under way.

In the downstream area from the junction with the Jerowan the slope of the land become flat. The average river channel slope of the Madiun river is less than 1 to 3.000 in this portion. The channel capacity decrease to the range of 200 to 300 m^3/sec.

The river flow in this portion is influenced by the back water from the Solo river.

2.1.2 Survey

The PBS surveyed in the inundation area along the Madiun river from the confluence with the Catur river to the Solo river and the inundation map was prepared. The map was referred to estimate the assumed inundation.

The PROSIDA carried out air photo survey and prepared the photo map in a scale of 1 to 5,000. The map was used to survey the land use in the project area. Especially the houses to be compensated by the project were counted in the map preliminarily.

The PBS surveyed the Madiun river from Ponorogo to Ngawi prior to the study in 1979 and 1980. The map in a scale of 1 to 1,000 was prepared as a result of the survey. The major topographic data for the feasibility design were obtained by the cross sectional and longitudinal profiles of the surveyed map.

The datum of the bench mark elevation used to the survey was lower than the standard datum of levelling by one meter. Accordingly the elevation given in the map is one meter lower than ones in other map based on the standard datum of levelling. In this report, all the basis of the levelling were unified to the datum of levelling in the map in a scale of 1 to 1,000.

2.2 Soil and Geology

2.2.1 General

The Madiun river basin is classified in the three areas from the geological view point.

The geology of the southern mountain area is composed of tertiary marine deposits, such as limestone, sandstone, mudstone etc. The northern hilly land is also composed of tertiary and quarternary marine deposits.

The slopes of the mountain situated in the east and the west of the basin border are composed of quarternary volcanic products such as mud flow, pumice flow, tuff breccia, lava and so on.

The river deposit carried by the Madiun river covers the alluvium, pleistocene deposit in plain area of the Madiun valley.

The project area belongs to the third category; the river deposit of volcanic products covers the alluvium and pleistocene.

The general geologic condition in and around the project area are illustrated and shown in Fig. 2.1, 2.2 and 2.3.

2.2.2 Soil and geology

All the soils of foundations for the proposed structure sites are Brown Clay, Clay with Terrace Sand, Loose Sand and Dense Sand.

The number of the standard penetration test of the Dense Sand is more than 30 and the qc of Dutch cone penetration test is more than 100 kg/cm^2.

The concrete structure such as the gate structure is judged to be constructed without serious problem only if the surface soil is removed.

In each proposed construction site for bridge, the Dense Sand or gravel was found around ten meters under the original ground surface. And any special difficulty is unforeseeable to construct bridge at the sites concerning the foundation.

The soil cross section along the proposed shortcut and the proposed bridge sites are developed and shown in nine figures; from Fig. 2.4 to Fig. 2.12.

2.2.3 Materials

Soil tests were carried out on 60 samples for basic soil tests such as natural moisture content, specific gravity, atterberg limit and grain size analysis. Uniaxial and triaxial compression test were also performed.

The test materials were sampled mainly at the shortcut site.

The results of the test indicate that the soil belongs to Brown Clay, Clay, Terrace Sand, Loose Sand and Dense Sand. As for the grain size, Clay with more than 80 percent passing of 0.074 mm grain size were predominant. The natural moisture contents were almost in between 30 percent and 50 percent. The specific gravity were in between 2.4 and 2.6. The unit weight were in the range of 1.7 g/cm^3 and 2.0 g/cm^3.

The results of the grain size analysis are shown in Fig. 2.13. The basic soil property are exhibited in Fig. 2.14.

It is supposed that the soil is to be used for the material of the embankment. But sufficient compaction work may be required if the height of the embankment is more than three meters.

In and around the project area the river sand and gravel have been used as the fine and coarse aggregates of concrete. No special problems have arised from the usage of the river sand and gravel.

The sufficient volume of river sand is deposited in the river bed in the project area for the implementation of the project.

The river gravel are deposited in the Catur river and the Gandong river in the project area. The gravel borrowed from these river beds should be crushed to the proper size as can be seen in the PROSIDA's project sites now under construction.

The grain size of the natural river bed sand is shown in Fig. 2.15 together with the actually used coarse aggregate.

The locations of the river gravel deposit are shown in Fig. 2.16.

2.3 Hydrology

2.3.1 General

The climate in the river basin is tropical and is dominated by the tropical monsoon.

The north-west wind prevails in the period from November to April and brings wet season in the basin. The south-east is the dominant wind during the dry season from May to October.

The average annual rainfall is around 1,900 millimeters and almost eighty percent of it is concentrated in the wet season. However heavy rainfall have been experienced in the transition period from wet to dry season from time to time. And some remarkable floods were recorded in May or June.

The intensity of point rainfall is extremely high. It is not seldom that one day rainfall exceed 150 millimeters. Furthermore these heavy rainfall tends to concentrate around six hours in the afternoon to evening.

The rainfall is sporadic as is usual in the tropical zone. It is very seldom that the covering of a rain-cloud exceed ten square kilometers.

Rainfall of high intensity in the steep sloped mountain area become flood of high peak in a tributary. When these flood in tributary flush into the gently sloped Madiun river, the flood magnitude exceed the flow capacity of the river and inundation is to be caused. The river heavily meanders in the project area and the river channel reduced its flow capacity considerably and the flood from the Catur or the Gandong river brought flood of the Madiun river frequently.

The slope of the catchment area is comparatively steep in the project area and the upstream. The channel slope of the Madiun is 1 to 1,500 on an average and ones of tributaries are more than 1 to 200 at the minimum.

The channel slope of the Madiun river and its tributaries become 1 to 2,000 to 1 to 3,000 in the downstream reach from the project area.

There is a habitual inundation area in the upper reach of the Madiun river near the Ponorogo city. After Ponorogo, no special retarding area exist in the Madiun river until it come across the Jerowan river.

The banks of the Madiun river are kept natural in the upper and lower reaches. But the river channel is formed by dykes in most part of the project area.

The low land in the right side of the Madiun river at the confluence with the Jerowan river have been inundated frequently by the flood from the Madiun and the Jerowan rivers. The area forms a natural retarding basin.

The flow capacity of the Madiun river channel is as small as 200 to 300 cubic meters per second in the downstream reach from the confluence with the Jerowan river. The spilled water from the usual channel flows wide inundating vast flat land.

The specific discharge from the upper to middle reach of the Madiun river is estimated a little more than 0.4 cubic meters per second for ten-years flood and one from the lower reach around 0.2.

2.3.2 Probable flood

A certain number of hydrologic gaging stations have been established in the Bengawan Solo river basin as shown in Fig. 2.17.

The Sekayu, Dam Jati and A. Yani gaging stations are the most reliable ones in the Madiun river. The automatic recording type gage was installed in the Sekayu gaging station. The gaging station has been managed by the PBS since 1975. The ordinary staff gages were installed in the Dam Jati and the A. Yani gaging stations. Both stations have been maintained and operated by the local irrigation

offices. The location of the Dam Jati gaging station was sifted several times. The latest one was established in the same year of 1952 as the A. Yani gaging station. The hourly observation of the water level have been carried out in both gaging stations in flood period.

The A. Yani gaging station is located in the project area and the data recorded at the station was deemed to be the representative of the project area. The recorded maximum flood discharge of 1,200 cubic meters per second occurred twice at the A. Yani gaging station in April 19, 1975 and June 30, 1978. The annual maximum momentary peak discharge at the station were summarized in Table 2.1.

The probable flood in cubic meters per second were estimated at three gaging sites applying the Gumbel's method. The estimated results were as follows;

Site	Catchment area (km2)	Return period in year 2	10	20	50
Sekayu	1,056	320	385	405	445
Dam Jati	1,714	440	630	740	840
A. Yani	2,294	757	1,110	1,245	1,419

The probable discharge charts were developed and Fig. 2.18 shows the regression line for the A. Yani gaging station site.

The return period of the recorded maximum discharge at the A. Yani site was estimated 17 years. The regression line indicates that the peak discharge of more than 750 m^3/sec will occur every two years.

No record is available for the flood runoff in the tributaries so far. And the flood runoff from the tributaries were studied through the runoff from the remnant catchment areas, between the Sekayu and the Dam Jati gaging stations and the Dam Jati and A. Yani gaging stations. The studied results were given in Table 2.2.

2.3.3 Jerowan inundation area

The low land in the right side of the Madiun river at the confluence with the Jerowan river has acted as the natural retarding basin. The flood runoff from the Madiun and the Jerowan rivers flow into the low land and is stored once then flow out to the downstream reach. The water level and discharge in the up and downstream reaches have been influenced by the regulating effect of the area. The land have formed a natural retarding area though the area was cultivated well as a productive land.

No actual survey or observation have been performed to assess the effect of the area so far. And no hydrologic gaging station is established around the area. The effect was assessed by theoretical way in this study. The storage volume curve and the discharge rating curve of the retarding area were developed through the topographic data and hydraulic calculation.

The inflow and the corresponding outflow from the area were estimated as shown in Fig. 19, 20 and 21. If the peak discharge of 1,490 cubic meters per second flows into the area the discharge of 1,190 cubic meter per second will flow out. The peak discharge is to be reduced by 300 cubic meters per second by the regulating effect of the area.

2.3.4 Sediment load

The turbidness of the Madiun river is high as is the case of the river in Java island. The average annual sediment runoff of 1,600 cubic meters per square kilometers was estimated by the Madiun Ground Water Development Project (P2AT). The steep sloped, well developed land may produce the considerable amount of sediment and the flush flow of the tributary may transport the sediment to the Madiun river.

According to the river cross section surveyed at the old Mangunharjo bridge, the river bed elevation was increased by five to ten meters since 1890. The rising tendency ceased after 1975 and it is supposed that the present river bed is stable.

The same was seen at the A. Yani gaging station. The cross sectional survey has been carried out from time to time at the station site prior to carry out the discharge measurement. No significant river bed transformation was recorded since 1973. Consequently unique rating curve shows good fit to the discharge measurement data. And the river bed at the A. Yani gaging station has been considered to be stable.

The bed loads were estimated for each section applying Sato-Kikkawa-Ashida's formula. The average bed load for the discharge of 760 m^3/sec was 0.01 m^3/sec and no significant difference was found among sections. This implies that the inflow to a section from the upstream reach is almost same with the outflow to the downstream reach. It is considered that the ballanced inflow and outflow gives the river bed the appearance of the stability.

Table 2.1 Annual Maximum Water Level and Discharge
(A. Yani)

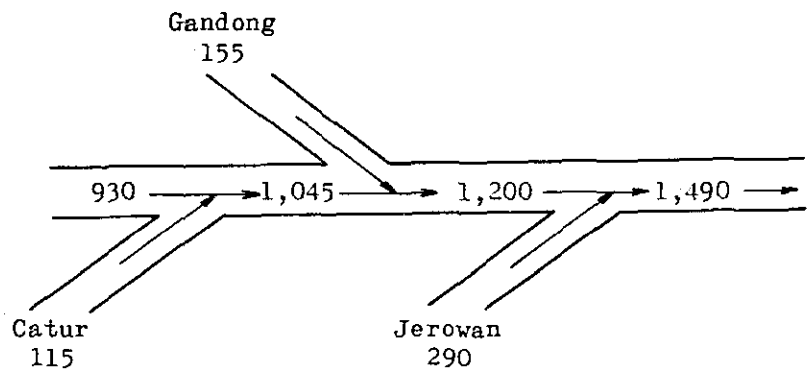
Date	Water Level (m)	Discharge (m^3/sec)
1) Jan 6, 1963	8.30	750
1) Mar 3, 1964	8.60	620
1) Apr 9, 1965	8.60	620
1) Mar 16, 1966	8.85	800
1) Jan 26, 1967	8.50	570
1) Mar 26, 1968	8.80	750
1) Apr 3, 1969	8.95	880
1) Feb 12, 1970	8.45	560
1) Mar 26, 1971	8.60	620
1) Mar 29, 1972	8.80	750
1) Mar 28, 1973	8.70	680
1) May 6, 1974	8.90	850
1) Apr 19, 1975	9.30	1,200
2) Dec 1, 1976	8.80	700
2) Jan 9, 1977	9.00	790
3) June 30,1978	9.50	1,200
3) May 5, 1979	9.25	1,010

Note 1) : Rating curve established by OTCA and LPMA was used.
2) : Rating curve established by PBS was used.
3) : Estimated by hydraulic calculation.

Table 2.2 Allocated Discharge

	Probable flood at A. Yani (m^3/sec)	Specific discharge ($m^3/sec/km^2$)	Local inflow Catur (m^3/sec)	Gandong & others (m^3/sec)	Jerowan (m^3/sec)
Catchment area (Km^2)	-	-	180	240	453
Return period					
17	1,200	0.64	115	155	290
10	1,110	0.59	105	140	270
5	969	0.52	95	125	235
2	757	0.40	70	95	180

Schematic Diagram
(A. Yani 1,200 m^3/sec)



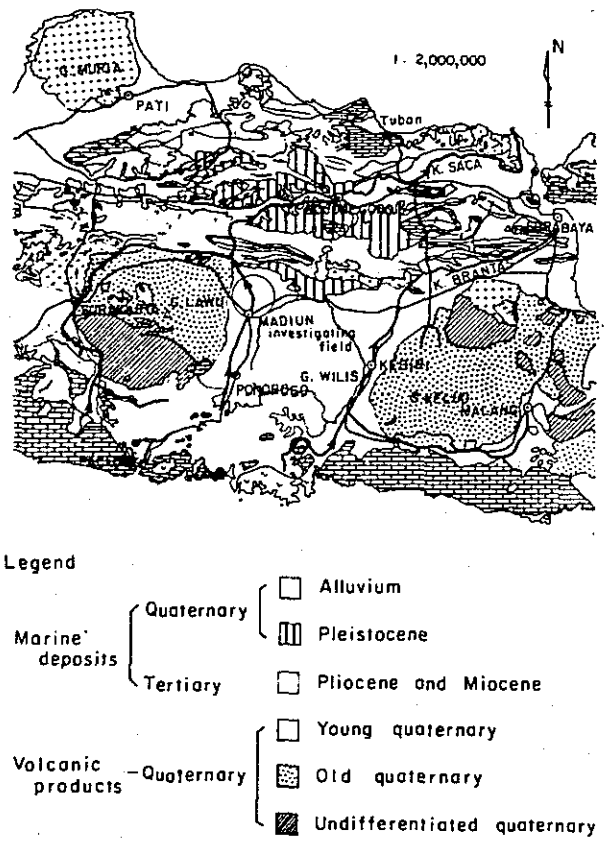


Fig. 2.1 GEOLOGICAL MAP OF EAST JAWA

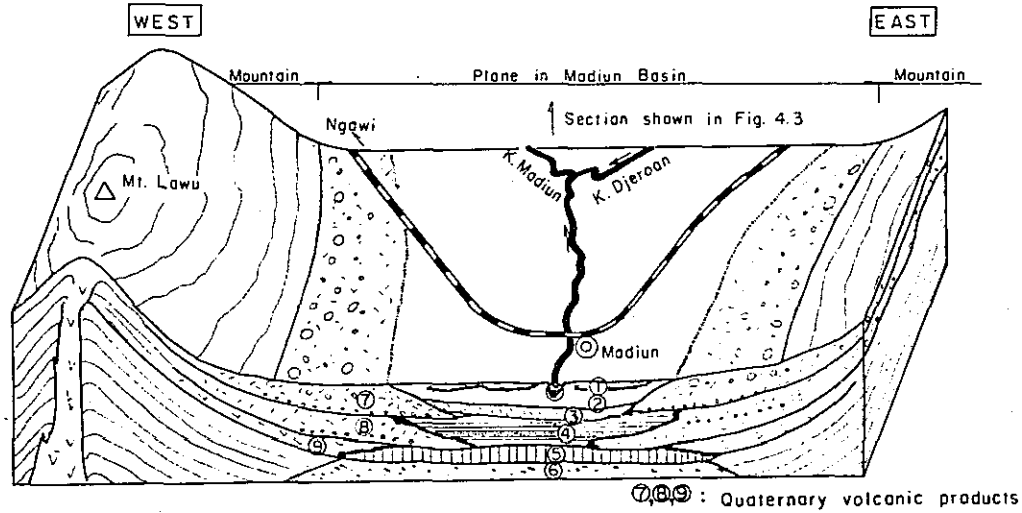


Fig. 2.2 SCHEMATIC BLOCK DIAGRAM OF GEOLOGY IN MADIUN BASIN

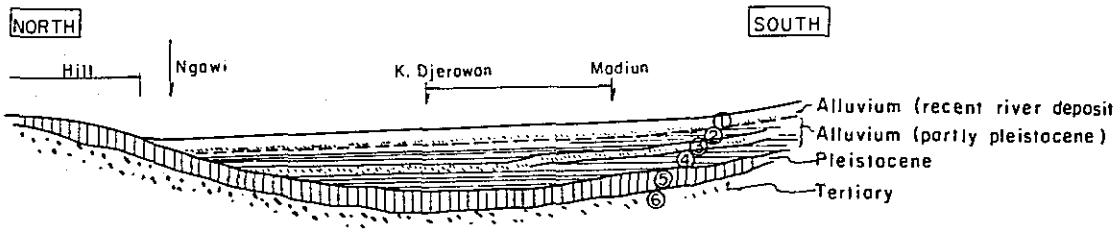


Fig. 2.3 SCHEMATIC SECTION OF MADIUN BASIN

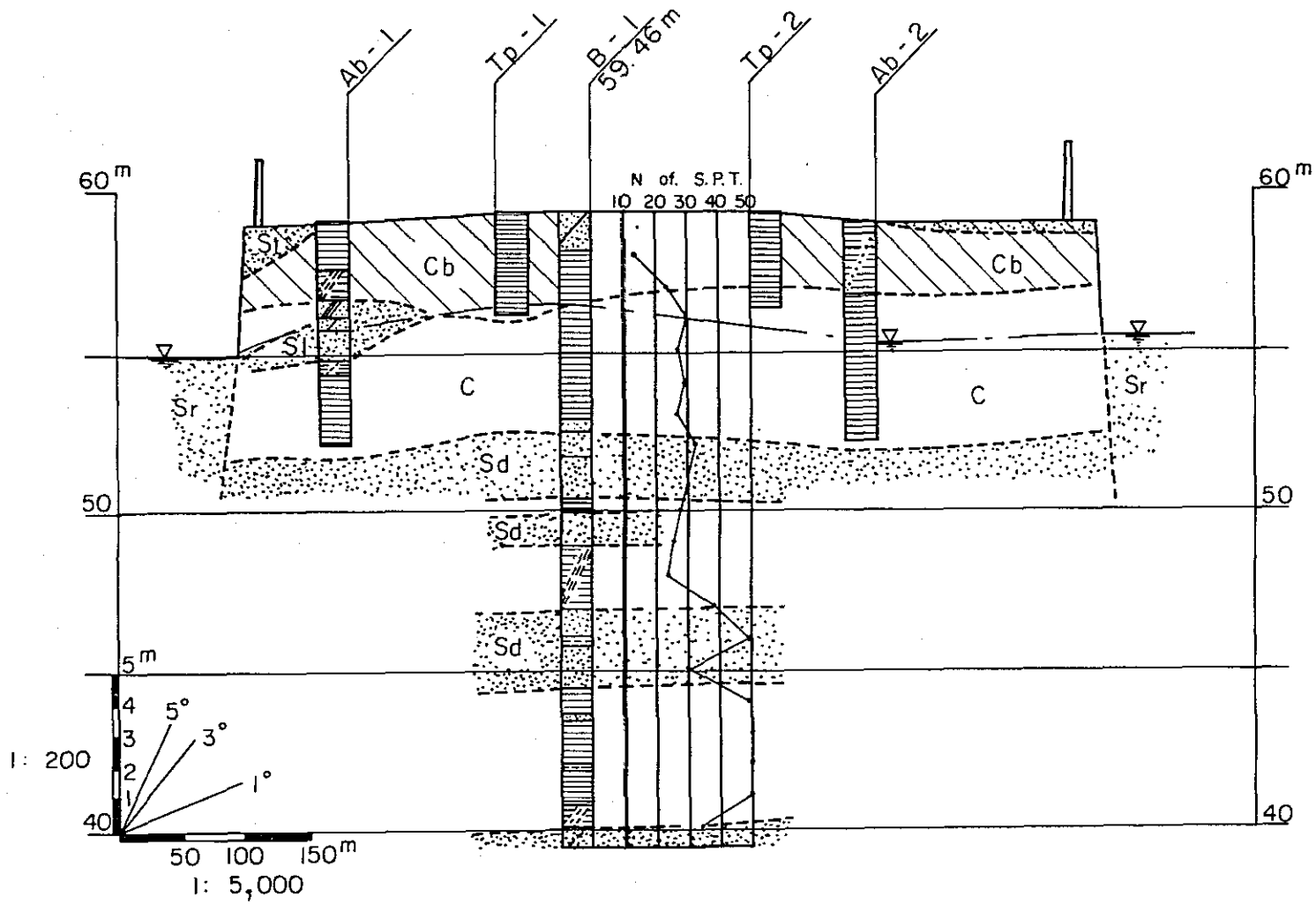


Fig. 2.4 SOIL CROSS SECTION ALONG THE PROPOSED SHORT CUT SITE (PART 1)

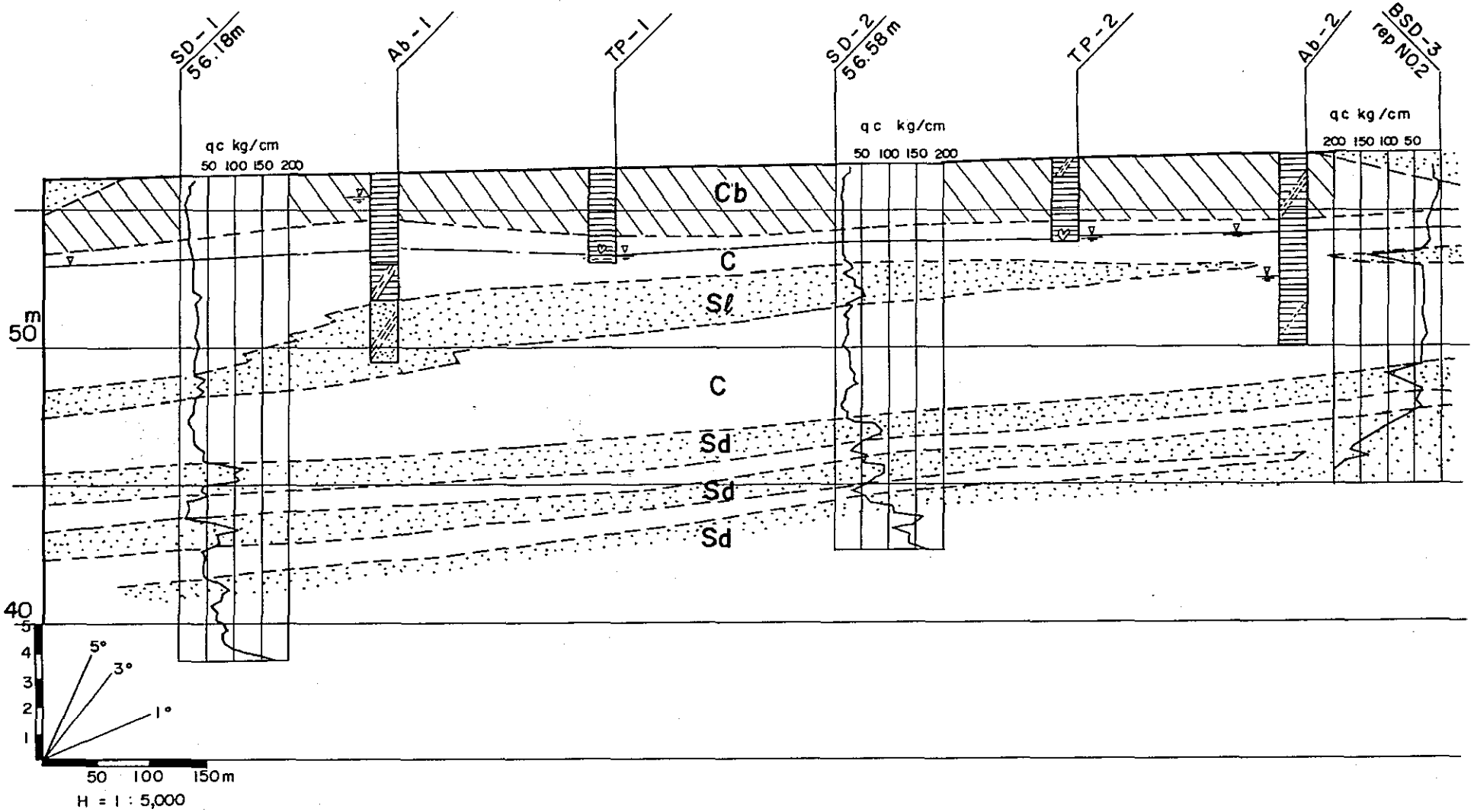


Fig. 2.5 SOIL CROSS SECTION ALONG THE PROPOSED SHORT CUT IN PART 2.

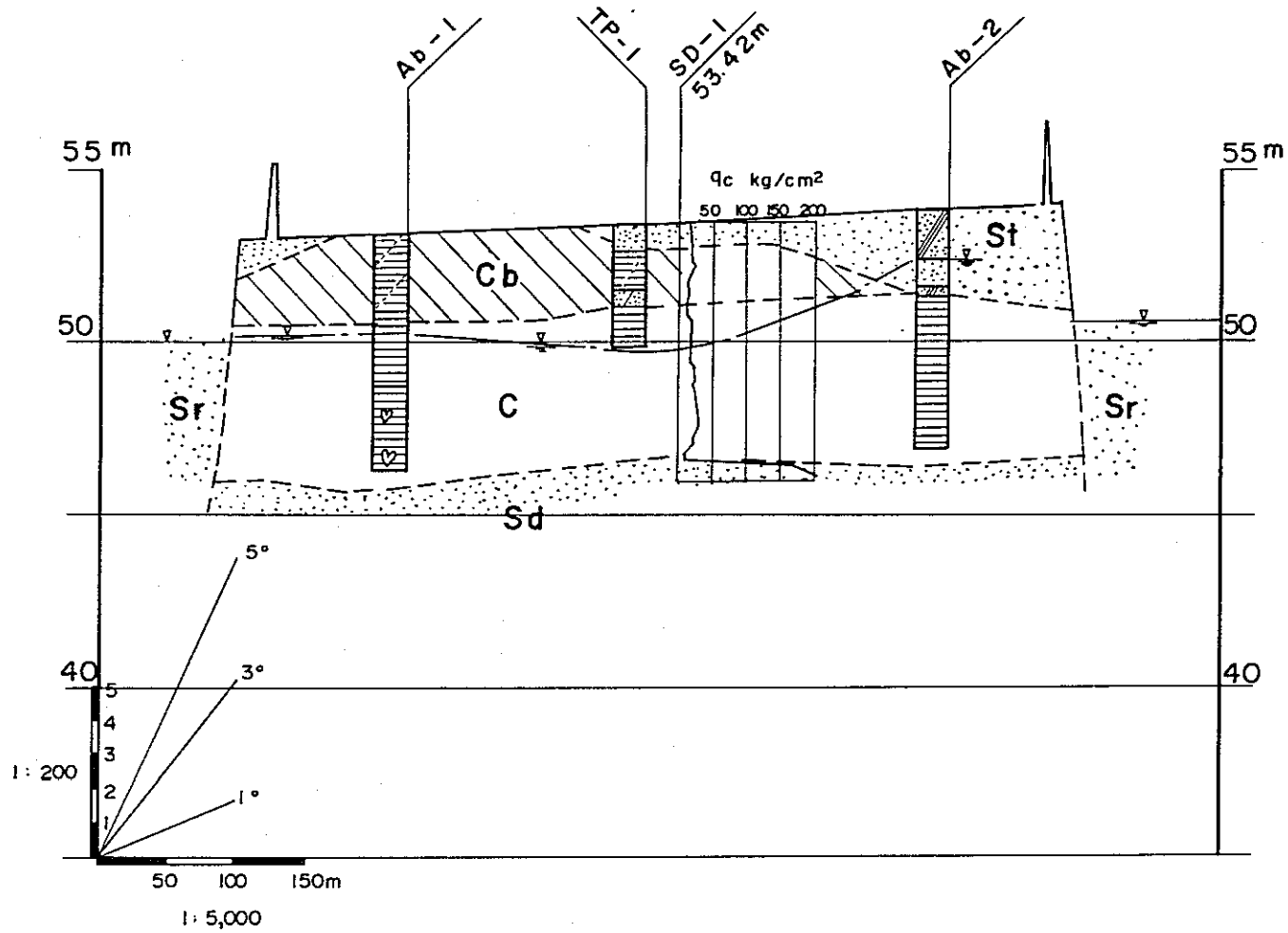


Fig. 2.6 SOIL CROSS SECTION ALONG THE PROPOSED SHORT CUT IN PART 3.

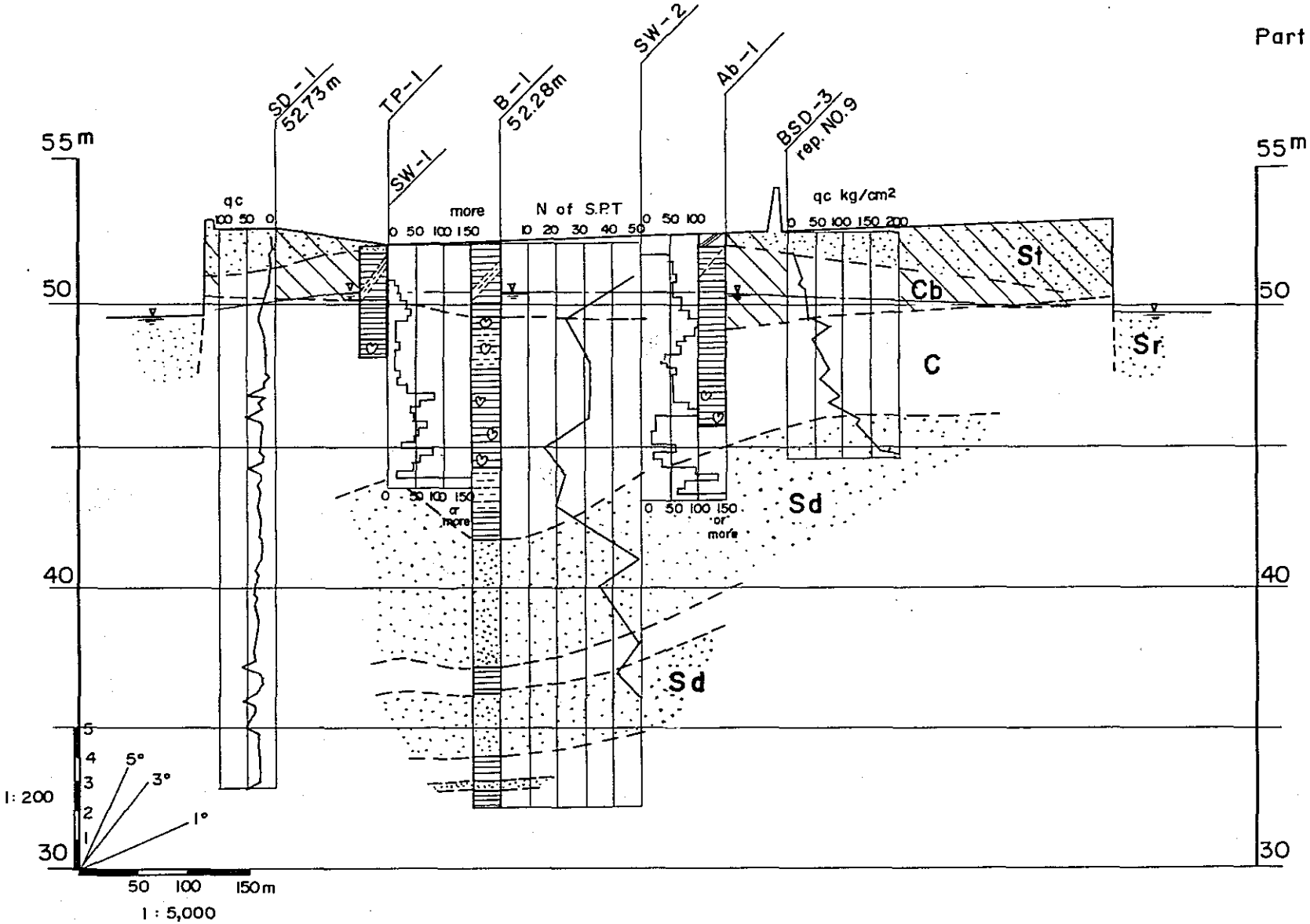


Fig. 2.7 SOIL CROSS SECTION ALONG THE PROPOSED SHORT CUT IN PART 4

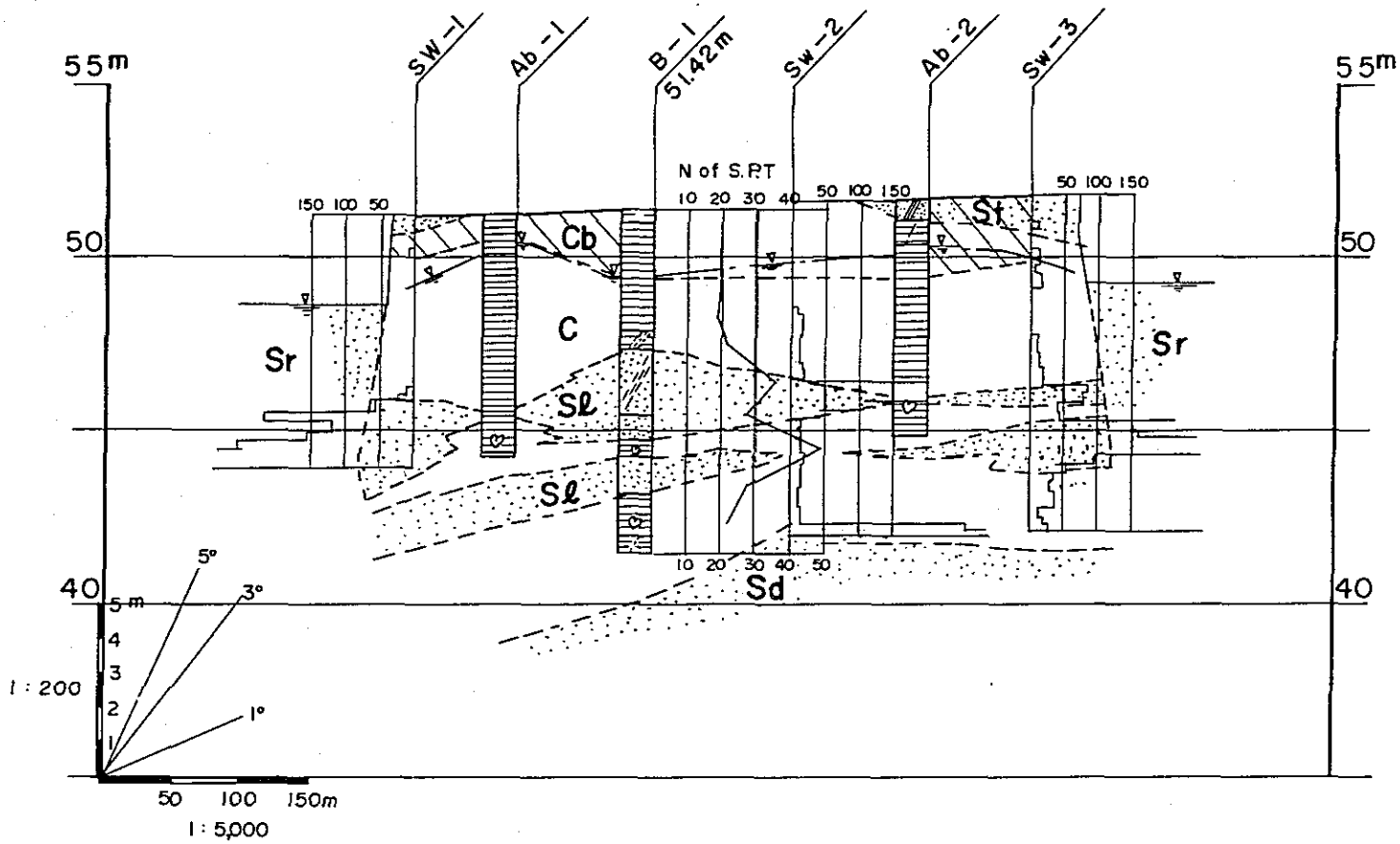


Fig. 2.8 SOIL CROSS SECTION ALONG THE PROPOSED SHORT CUT IN PART 5.

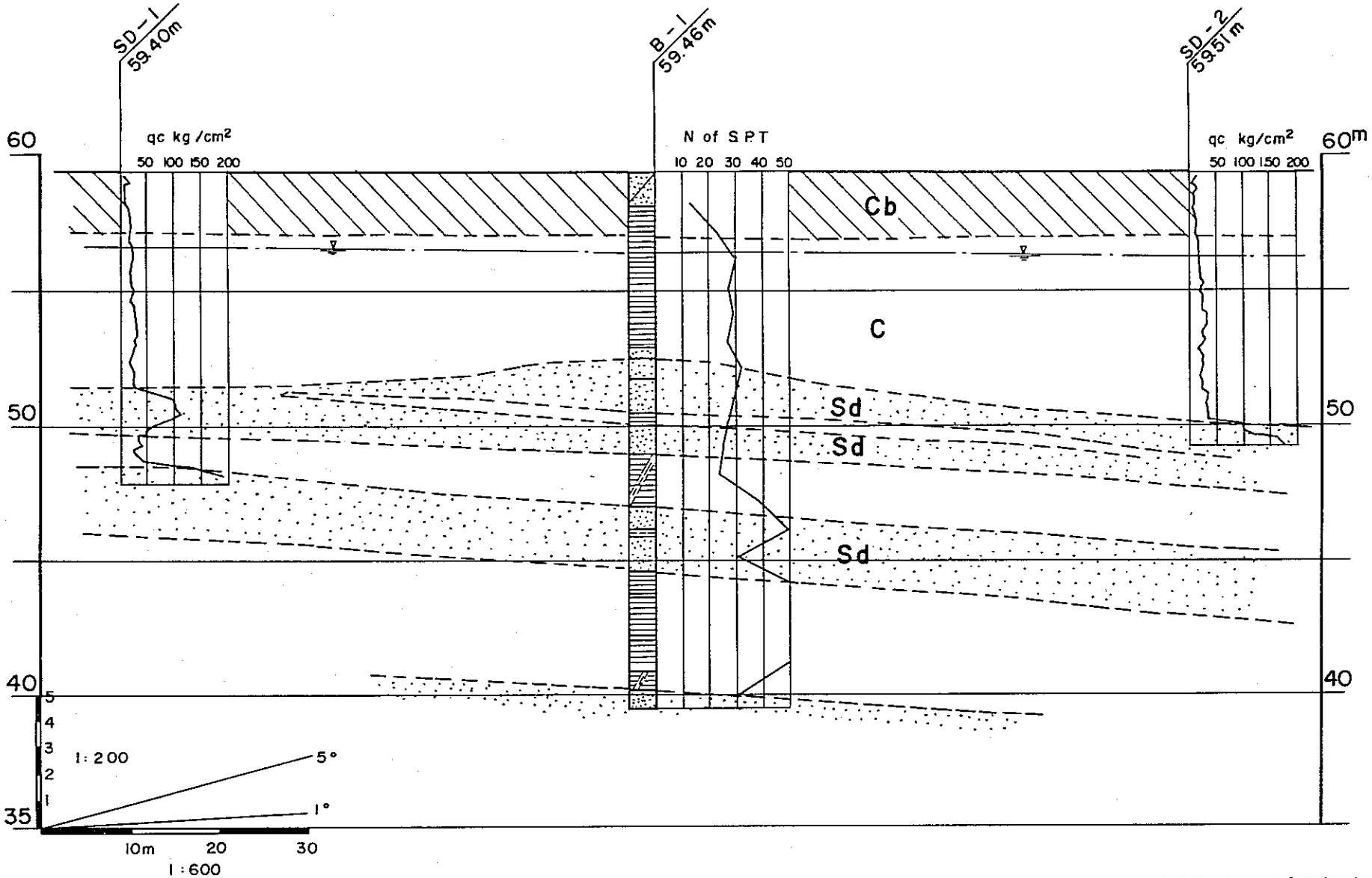


Fig. 2.9 SOIL CROSS SECTION ALONG THE PROPOSED NEW PATIHAN BRIDGE IN PART I.

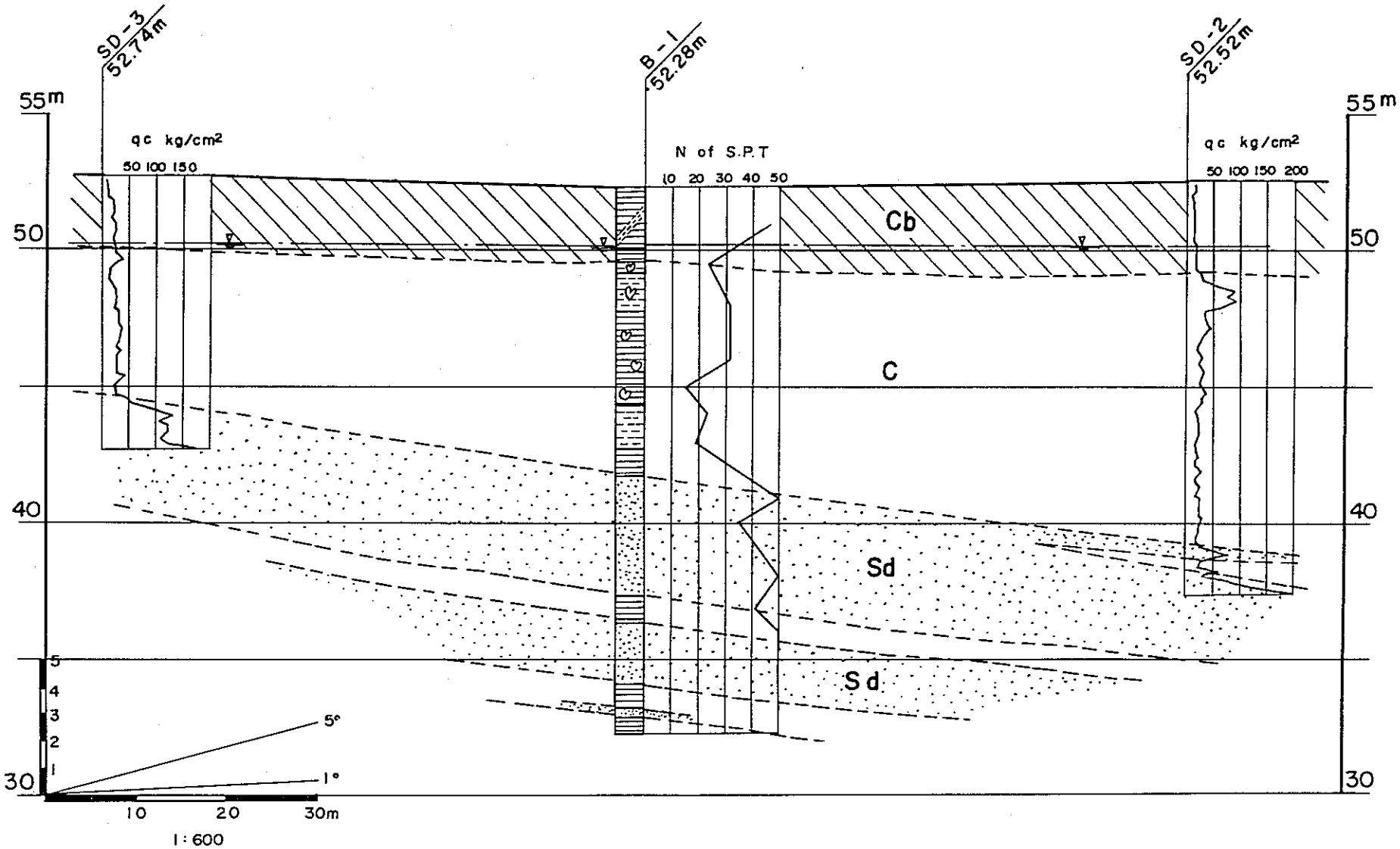


Fig. 2. 10 SOIL CROSS SECTION ALONG THE PROPOSED NEW KRAMDANG BRIDGE IN PART 4.

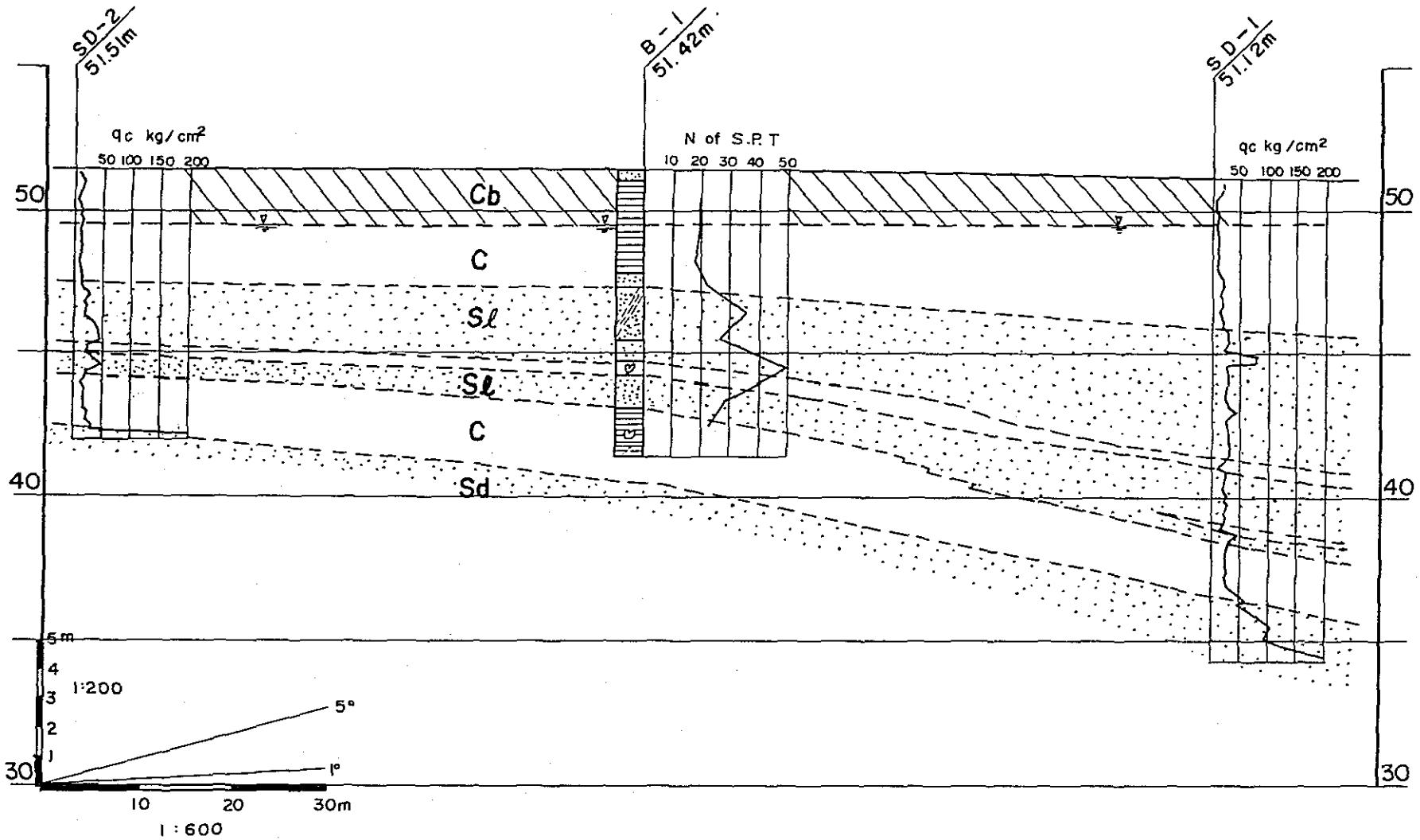


Fig. 2.11 SOIL CROSS SECTION IN PART 5.

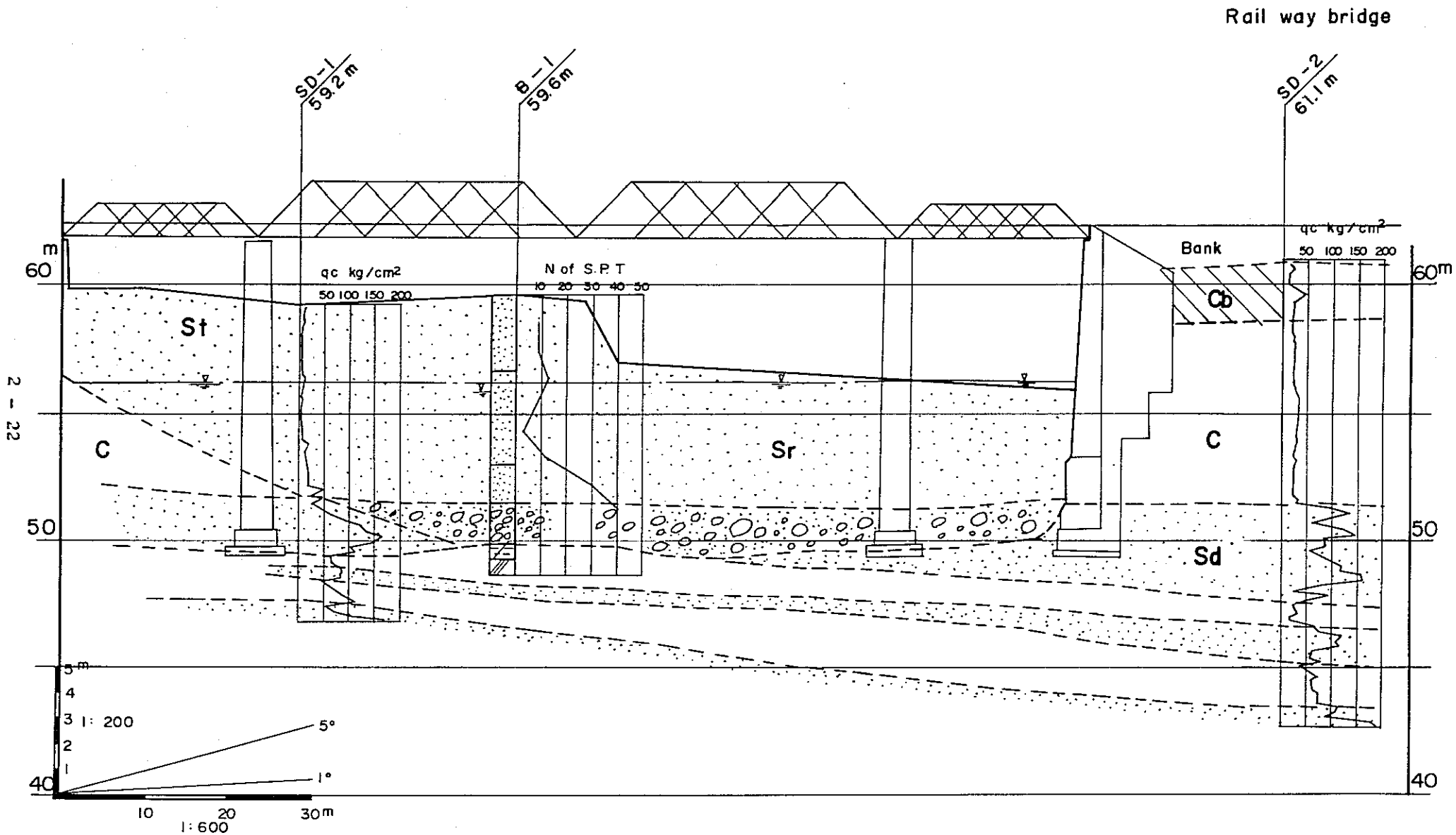


Fig. 2.12 SOIL CROSS SECTION ALONG EXISTING NATIONAL RAILWAY BRIDGE

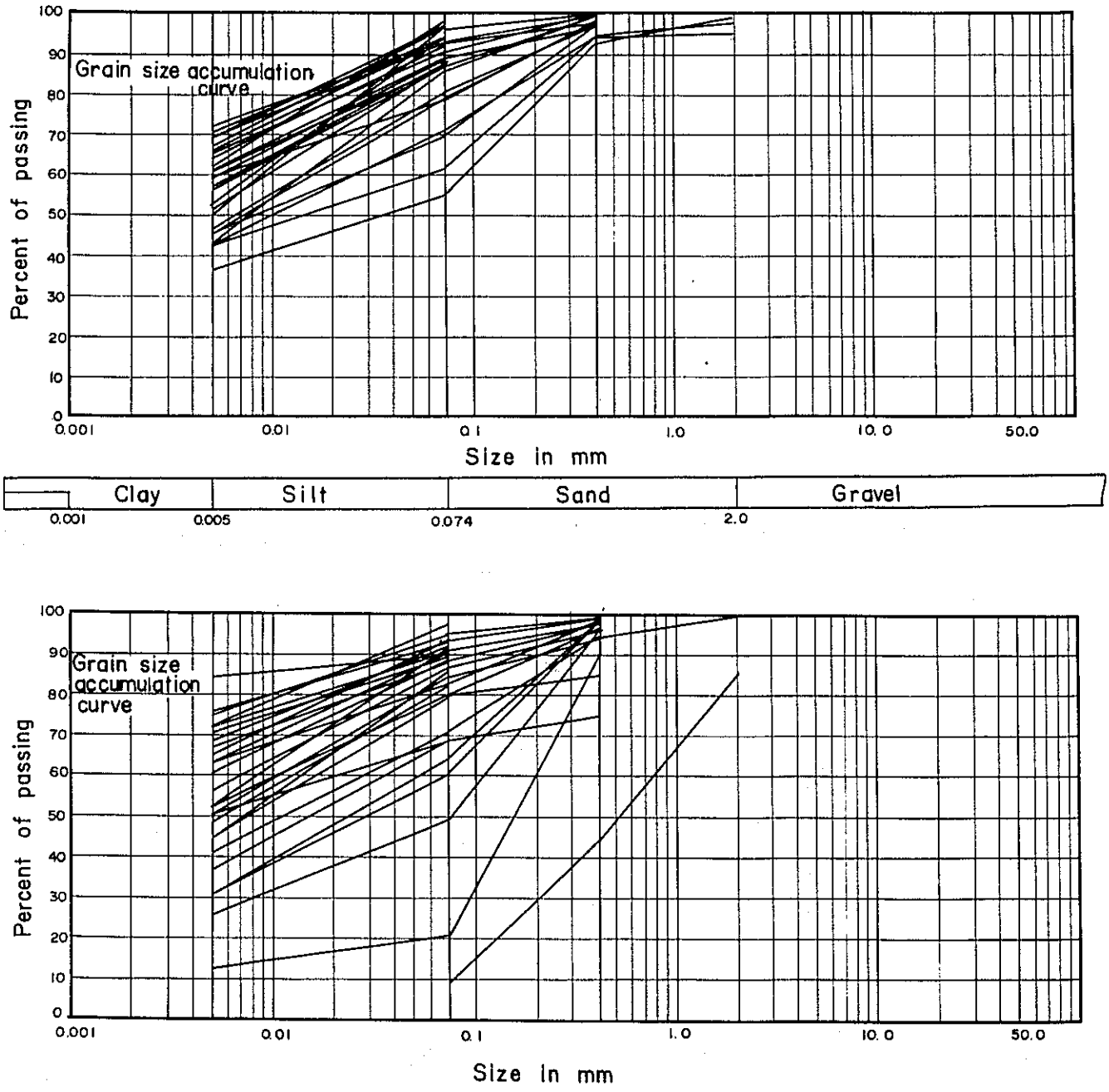


Fig. 2.13 GRAIN SIZE OF SOIL

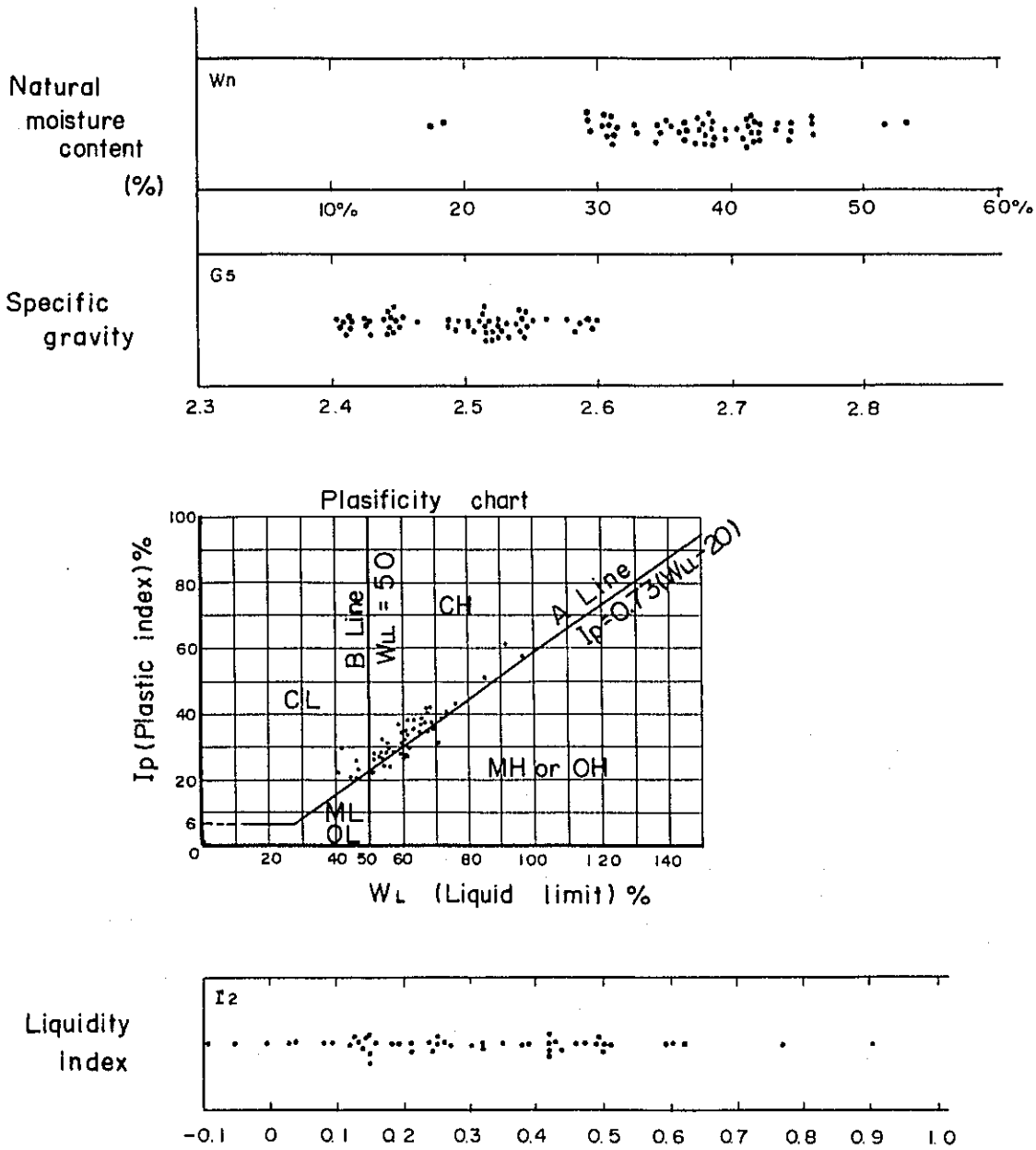
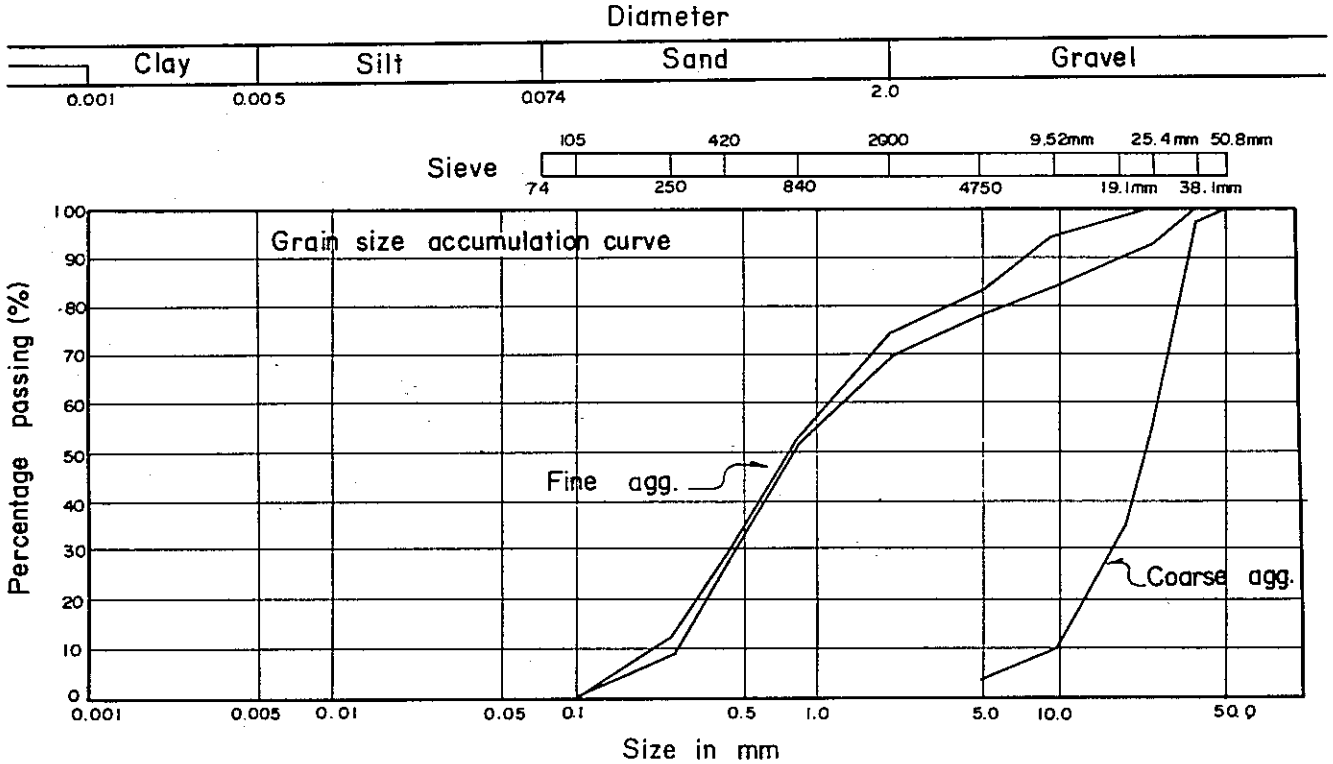
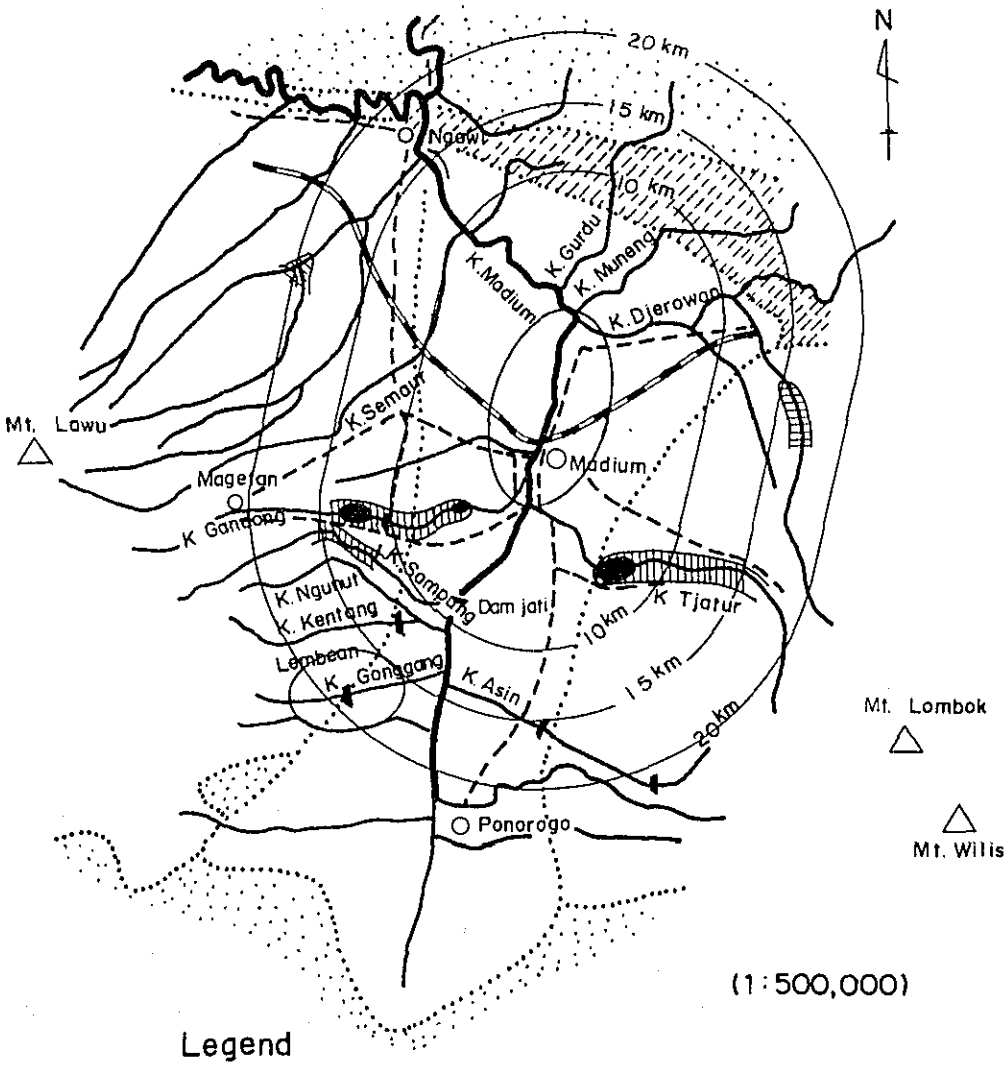


Fig. 2.14 BASIC SOIL PPOPERTY



Note : — Natural river bed sand used for concret aggregate
— Coarse aggregate mode by manual crushing

Fig. 2.15 GRAIN SIZE OF CONCRETE AGGREGATE.



Legend

- Project area
- Existing gravels along the river usable as concrete coarse aggregate
- Existing quarry site for coarse aggregate
- Existing check dam

Geology

- Alluviam
- Pleistocene
- Tertiary
- Quaternary volcanic products

Fig. 2. 16 LOCATION MAP OF RIVER GRAVEL DEPOSIT

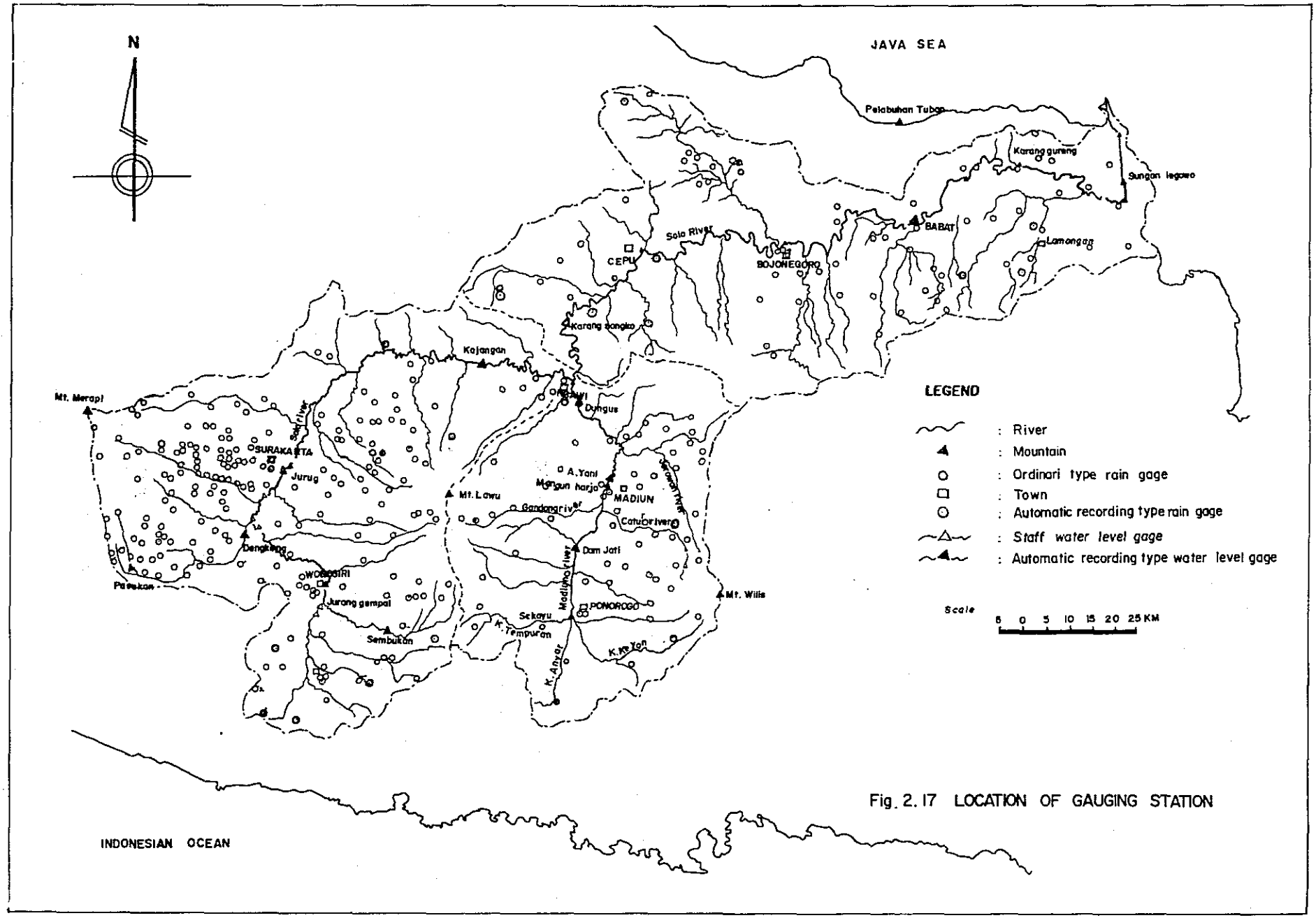


Fig. 2.17 LOCATION OF GAUGING STATION

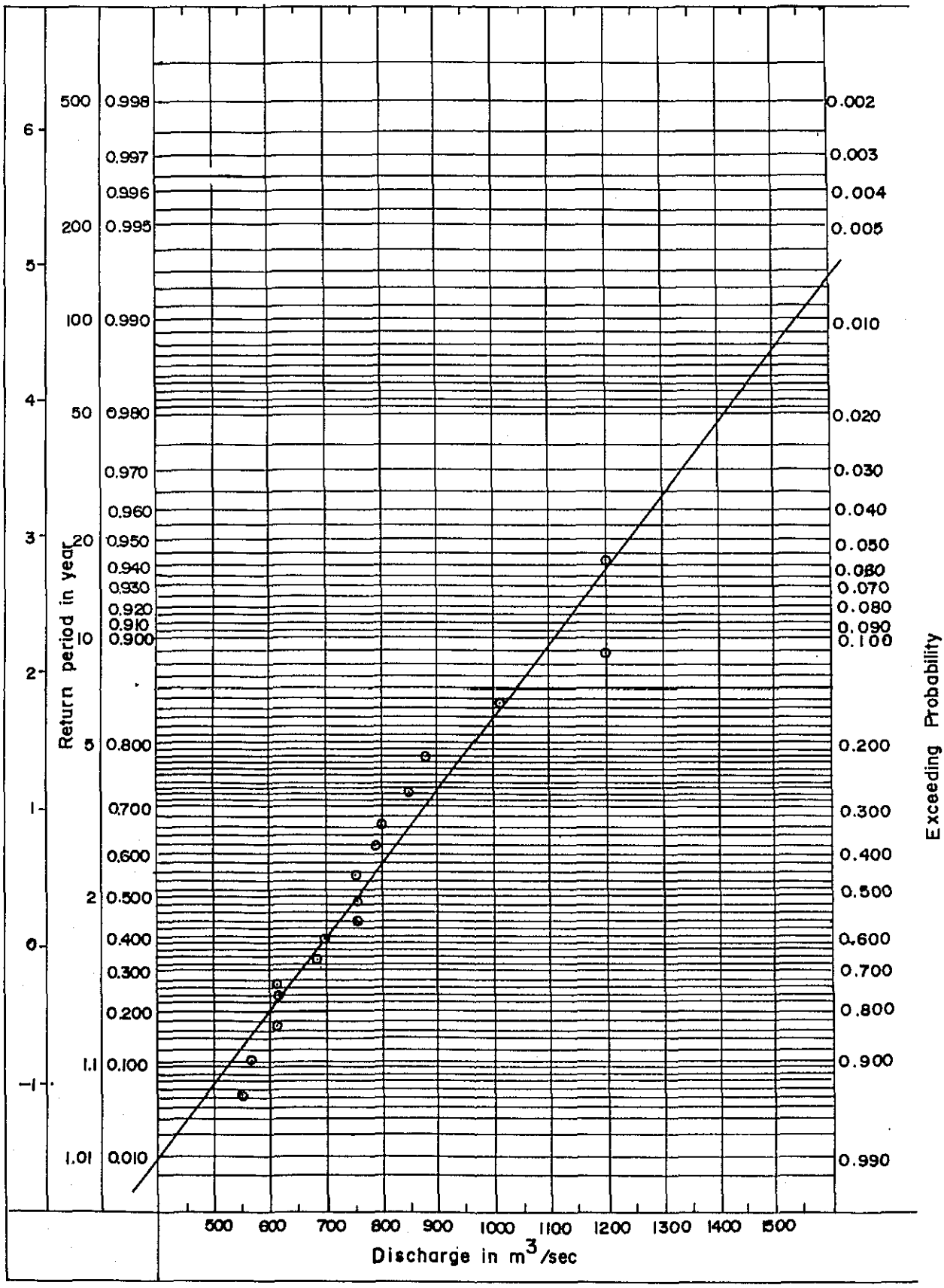


Fig. 2.18 PROBABLE PEAK DISCHARGE

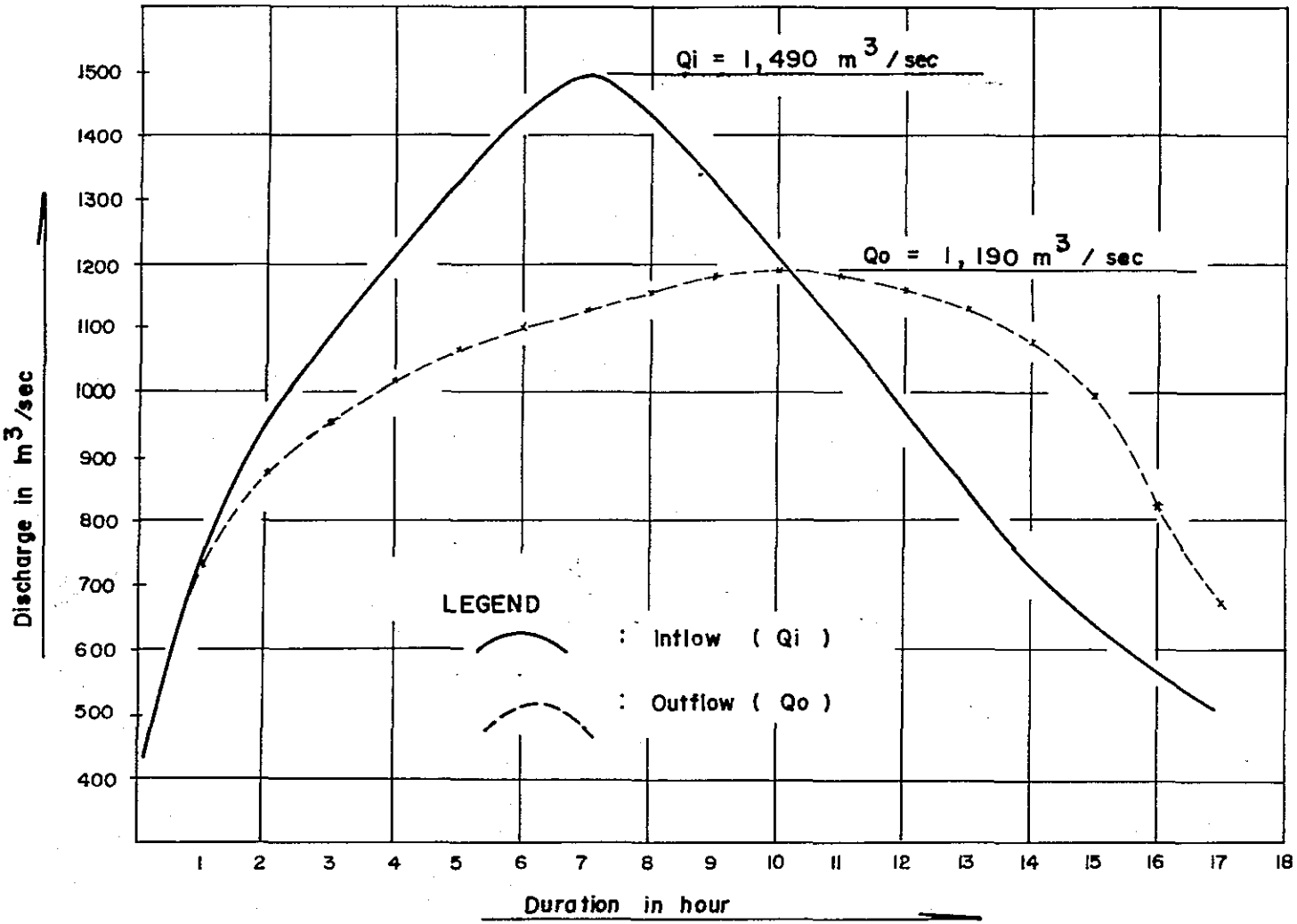


Fig.2.19 INFLOW AND OUTFLOW FROM JEROWAN INUNDATION AREA

(17 — Year return period)

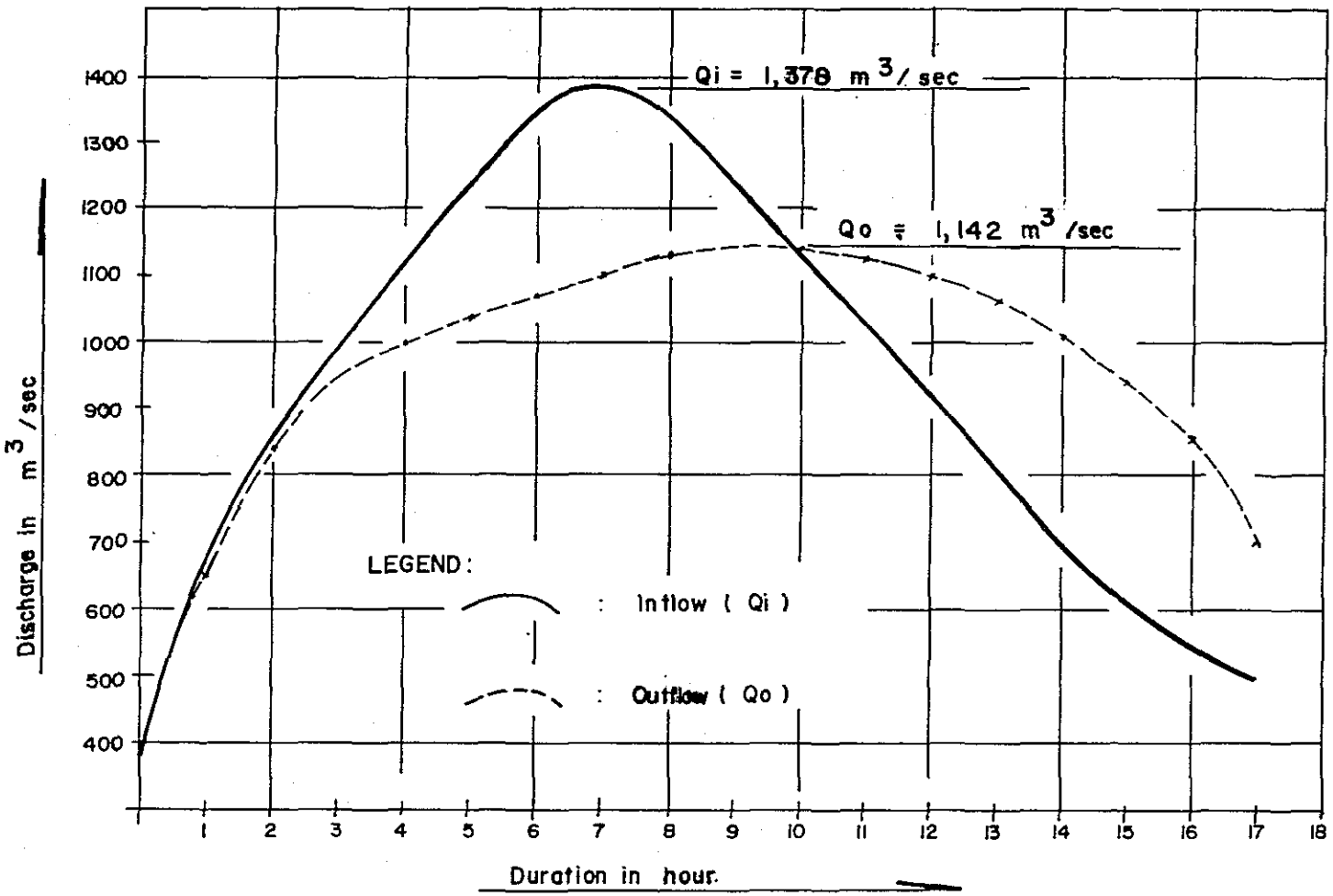


Fig .2.20 INFLOW AND OUTFOW FROM JEROWAN INUNDATION AREA

(10 — Year return period)

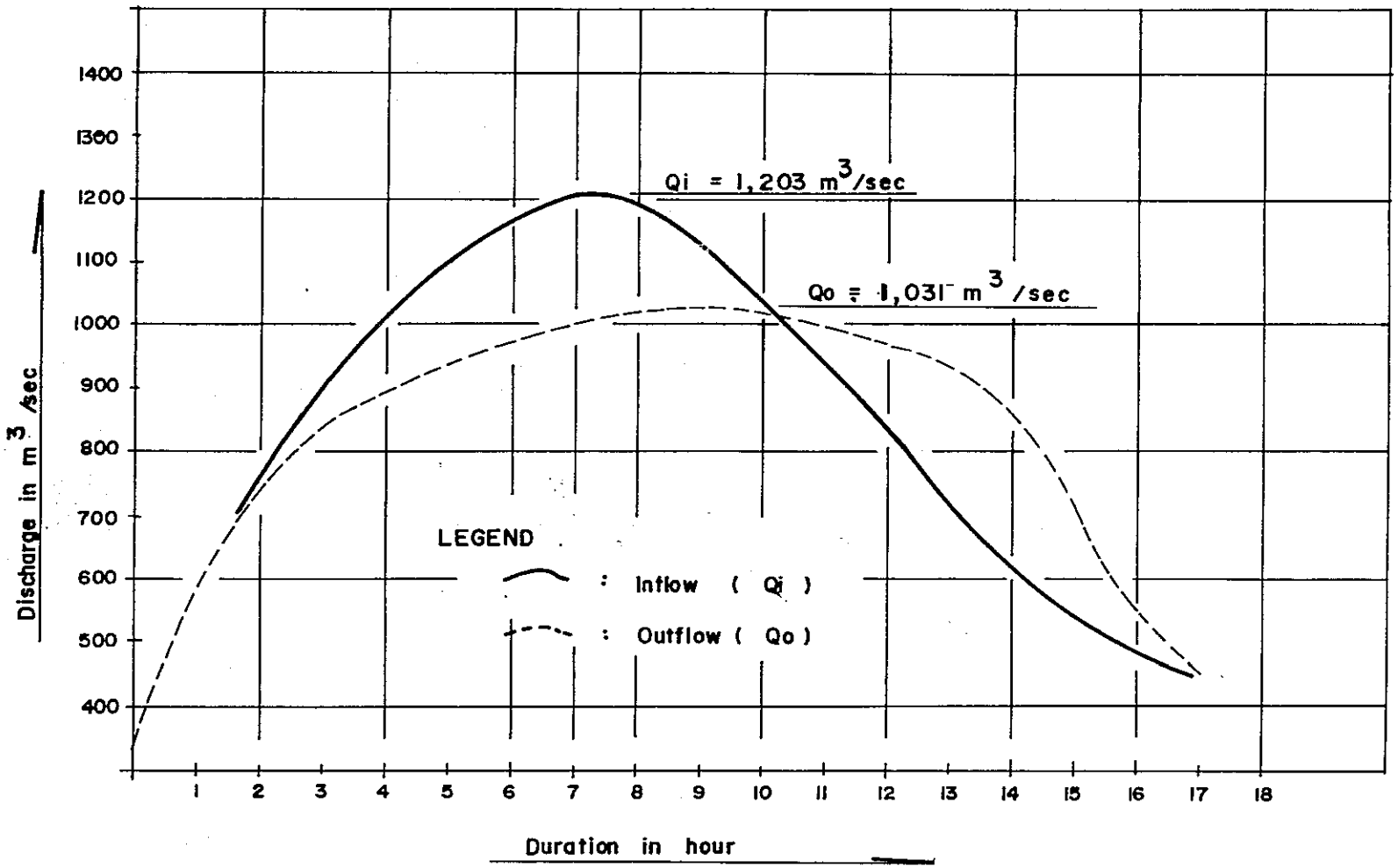


Fig. 2.21 INFLOW AND OUTFLOW FROM JEROWAN INUNDATION AREA

(5 — Year return period)

3. PRESENT RIVER CONDITION

3.1 River Course

3.1.1 Alignment

The existing course of the Madiun river meanders considerably as can be seen in Fig. 3.1. The present river length between the junctions with the Catur river and with the Jerowan river is about 20 km never the less the linear distance between both junctions is only 14 km.

There are many disadvantages in the meandering river from the hydraulic viewpoint. For instance a bend at the meandering portion disturbes the flow which run straight ahead. The turbulance cause the slow down of flow velocity and accordingly cause the deposition of sediment carried by flood. Most of the narrow flow area in the bending portion are the consequent of the sedimentation. As the result of this, flood water level are raised higher easily. Furthermore, it causes dangerous conditions by flow water and sometime floating log crash into the dyke surrounding the bend.

According to the experimental data in Japan it is desirable to make the meandering ratio of river course, R/B (R: radius of curvature in meter and B: Cross section width in meter), in the range of 10 to 20 and the angle of bend more than 60 degrees and the ratio of meandering should be made more than 3 in order to avoid the disadvantages mentioned above.

3.1.2 Longitudinal profile

Based on the surveyed results conducted in 1979 and 1980, the longitudinal slope of main reaches of Madiun river are as follows:

Dam Jati	- Junction with Catur river	1/1,000
Junction with Catur	- Jerowan river	1/1,800
Junction with Jerowan	- Ngawi	1/1,800
		1/3,500

Fig. 3.2 shows the longitudinal profile of the river channel between the junctions with the Catur and the Jerowan rivers.

Usually the bed-load carried by flood is tend to deposit at the upstream of bridge. But there are no remarkable tendency of sedimentation at the upstream of each bridge in this river.

3.1.3 Cross sectional profile

The flood water channel width, the distance between the both dykes, and low-water channel at several sites in the proposed reach are shown in Fig. 3.3. Most of the sections are as wide as 120 m in flood water channel and 80 m in low-water channel.

In Japan there are standard relations between design flood and river channel width as follows;

Design Discharge	River width
500 m^3/sec	60 - 80 m
1,000	90 - 120
2,000	160 - 220

The relation are to be used to the river channel planning as one of the reference taking longitudinal, alignment and land utilization along the proposed river into consideration. Comparing with this reference standards, most of the proposed reach have sufficient width assuming the flood magnitude of around 1,000 m^3/sec.

However, more than half of the land in the flood-channel are the property of the private people. It is used as a residential quater and aggricultural land for sugar cane and rice field.

Recently PBS has constructed the new dykes by heightenning and displacing backward the existing dyke.

Still now-a-days the old dyke are kept remained to protect the personal proparty situated between the old dyke and new-one and also to protect the new dyke from the impact of the flow water at the meandering portion. The old dyke should be removed in the improvement plan.

From the hydraulic viewpoint, the present condition of the flood channel is considered undesirable because the agricultural products, houses and other structures in the flood channel become the obstacles to flow and dead water zones are formed therein.

3.1.4 Tributaries and drainages

In the project area, four major tributaries join to the Madiun river.

The conditions of these tributaries are mentioned below;

Tributaries	Catchment Area (km 2)	Length of main course	Remarks
Catur river	180	35	No dyke
Gandong river	138	25	No dyke
Semawur river	48	17	Existing dyke
Jerowan river	453	45	No dyke

Except Semawur river, no dyke was constructed along the remaining three. The dykes were provided in the both sides of Semawur river to protect the crowded people in the Madiun city and its surroundings from the flood from Madiun river and Semawur river.

Several main channels are laid out on the both sides of Madiun river. The right side main channels meet Jerowan river and the left side ones join Ngelang river. Almost all the project area and it's surroundings are drained by these main channels.

The small remained area are drained by various small channels which meet Madiun river directly through sluices.

There are three pumping station for the area which are difficult to drain by sluice. The drainage pump with the capacity of 0.7 m^3/sec is provided in the A. Yani station.

The station has the drainage area of 144 ha and it is now under construction to extend the pumping capacity to 4 m^3/sec from 0.7 m^3/sec.

3.1.5 Flow capacity

The coefficient of roughness of the river channel was estimated through the non-uniform calculation method. The calculated water level with coefficient of 0.03 showed the best fit to the recorded water level as shown in Fig. 3.4 and 3.5.

Thus 0.03 was adopted as the basic coefficient of roughness throughout the study.

The water levels for several discharge were obtained by non-uniform flow-method with roughness coefficient of 0.030 and shown in Fig. 3.6.

Based on the water-levels shown in Fig. 3.6 the flow capacity in the respective reach were estimated. In this estimation a free board of 1 meter was adopted applying the river engineering standard of Japan.

According to the result of estimation, the flow capacity of lower reach is about 200 m^3/sec, middle reach is 600 to 700 m^3/sec and upper reach is 400 to 500 m^3/sec.

3.2 Inundation

Along the Madiun river, flood water inundate some sides of the river;

The Tempuran, Anyar and Keyang rivers join at the almost same place just upstream from the Ponorogo city. From time to time heavy rainfall have been received simultaneously in the basins of two or three tributaries mentioned above. The similar topographic conditions of the tributaries have given the similar time of concentration and the floods from the tributaries have arrived in the Madiun river almost at the same time frequently. In this manner, the accumulated peak runoff have spilled out from the river channel and have caused inundation in the Ponorogo area.

The river channel alignment meander in the portion a little up and downstream of the Madiun city and the flow capacity of the river channel is decreased.

The high flow from the upper reach tends to be raised its stage and to spill out from both sides of the river. The inundation in the Madiun city have been amplified when the flash flow from the Catur and/or the Gandong river come into the Madiun river synchronously. The typical case was experienced in the flood occurred in 1978.

There is a flood plane in the right side of the Madiun river just upstream from the confluence with the Jerowan river. The river channel slope of the Jerowan river is as gentle as 1 to 2,000 in the around ten kilometers reach from the confluence and the high water in the Madiun river flows up the Jerowan river as the back water.

The local flow of the Jerowan and the back water from the Madiun river flow into the flood plane and are stored therein.

After the confluence with the Jerowan river the Madiun river flows in the flat plane untill it reaches about 10 km upstream from the confluence with the Solo river. The spilled water from the river channel soaks vast land especially in the left side of the river.

The river channel run through rather high land in the last ten kilometers. The river channel become narrow and the river banks form a small cliff. All the inundated water are concentrated in the river channel in this portion and flow into the Solo river.

The river channel slope of the Madiun river becomes more gentle, 1 to 3,000, after it joins the Jerowan river. The back water from the Solo river influences the flow conditions of the Madiun river for some ten kilometers.

Applying the data recorded before 1972, the average annual inundation area of 6,500 ha was estimated in the Madiun river basin in the study on the master plan of the Solo River Basin Development. The inundation area of around 3,000 ha in the Madiun city and its surroundings was reported for the flood occurred in 1975.

The inundation area in the river basin is illustrated in Fig. 3.7.

3.3 Existing Structures

3.3.1 D y k e

The dykes have been constructed by the PBS since 1975 on the both river banks of the up and downstream from the Madiun city. All of the dykes are located in the objective area. In the rural area the earth embanked dykes were constructed. The parapet wall were provided as the dyke in the urban area because houses are crowded in this area and only the narrow lands are remained for the construction of dykes.

Most of the earth embanked dykes have steep slope of 1 to 1, sometime 1 to 0.75 for both river and land sides.

The height of the dykes are in the range of 3 to 5 meters from the original ground line. The dyke of 7 meters high is constructed in a middle portion of the river. In this case the revetment of wet masonry is provided on the river side of the slope to protect it.

The revetment of the wet masonry and sodding are the most common slope protection works. The former is applied in the bending portion of the river course.

The width of the crest is in the range of 2 to 3 meters. The berms are provided to the dykes which was raised from the original dykes by the additional embankment.

The excavated silty clay were used for the embankment. Most of the material were borrowed from the high water channel and it is supposed that the silt contents is rather high.

The substantial earth works were carried out by man-power even the compaction work with some dump truck for the transportation. No. heavy equipment have been used yet for the dyke construction.

The constructed dykes were well maintained and the breached portions were rehabilitated completely. No displacement is found in the foundations of the dykes. No land slide have occurred in the slope of the dykes. Some crack were found in the surface of the slope. The crack are considered to be caused by shrinkage due to low moisture content in the embanked earth.

The dykes were breached twice near Patihan in 1978 and 1979. The report on the flood commented that the dyke was breached by the overtopping of the flood water.

The parapet wall of gravity type were constructed in the urban area. The wall are constructed by wet masonry. The crest width is around 50 centimeters and the river side slope is 1 to 0.4 and the land side perpendicular.

L-shaped retaining walls are provided as dykes in the center of the town. The wall is made of brick or reinforced concrete. The width of the crest thereof are 25 centimeters and the height of walls are less than 3 meters, 2.5 meters on an average.

The walls are maintained well. The principal features of the existing dykes are given in Table 3.1.

3.3.2 Groyne

The river course is heavily meandering in the project area and the erosion of the river bank are consequent. To cope with the tendency of the river, the PBS has constructed and maintained the groyne works on the concave side of the river banks in the bending portions.

Gabions or concrete piles were used for the groyne.

Gabions were tied and laid for around 30 meters to the center of the river from the bank. The height of the gabion type groyne works are around 3 meters.

The effect of the groyne works are explicit because silting of the sediment are conspicuous in their bank side and the toes of the dykes were protected from scouring. However, the foundations of some groynes were scoured in their river side and groynes are twisted.

In some part, concrete piles were driven in to the river bed in a certain intervals as the groyne works. The height of the pile is around 5 meters from the river bed. Most of the case, the height of the piles are more or less equivalent to the flood water levels.

The effects of this type are also conspicuous.

No maintenance work have been carried out so far.

The location of the existing dykes were shown in Fig. 3.8.

3.3.3 Revetment

Revetments are provided on the surface of the dykes in the bending portions. All the revetment works are of wet masonry.

The masonry revetment are extended from the river bed to the high water level, sometime to the crest of the dykes.

The gabion mats fixed by wooden pile are provided in the toe of the some revetment to protect the toes of the revetment works and dykes.

Most of the dykes have the slope of 1 to 1 in case they are protected by the revetments.

Sand and soil were used as the backfill to the revetment work.

Bamboo pipes are arranged as the drain pipe.

Cracks were observed in some revetment due to the subsidence of the dykes.

The location of the existig revetment works are shown in Fig. 3.8.

3.3.4 Shortcut

The shortcut works were carried out in the downstream portion from the confluence with the Jerowan river and in the Jerowan river.

The cross section of the shortcut channel is single trapezoid section. The slopes of both banks are designed 1 to 2.

The river bed slopes were formed the straight lines which connect the original river bed of the up and downstretches.

No distinctive scoring or silting in the river bed could be seen in the up and down stretch of the shortcut.

The location of the shortcut works are shown in Fig. 3.8.

3.3.5 Pumping facilities

There are four pumping stations in the project area to drain land side water of the Madiun city. The pumped water are discharged directly to the Madiun river through pipe.

The pipe run through the dyke of concrete wall at the A. Yani pumping station. No harmfull effects of the vibration of the pipe on the concrete wall were traced.

The locations of the existing pumping stations are shown in Fig. 3.8.

3.3.6 Bridges

Many bridges and culvert were constructed in the project area. Among the existing bridges, following seven bridges were considered to be substantial with regard to the economic and technical feasibility of the project. And the investigations were concentrated on them. The seven bridges are the Madigondo, the Gandong, the Srajen, the Mangunharjo, the Winongo, the Patihan and the Krandang bridge. The principal features of the bridges are given in Table 3.1.

The heavy densities were recorded in traffic of the Mangunharjo and the Winongo bridges. And it is supposed if the traffic thereof are suspended, the serious problems may arise in and around the Madiun city. The traffic densities are shown in Table 3.2.

Except the Patihan bridge, most of the bridges have the average span length of more than 30 meters. The span length of the Patihan bridge is around 16 meters and considered insufficient supposing the conditions of the river flow.

Some element of the Patihan bridge and the Krandang bridge were decayed and rehabilitations are necessary sooner or later.

Besides two bridges mentioned above, remainings are in sound conditions in both super and substructures.

The locations of the said bridges are shown in Fig. 3.8.

3.4 Non-Structural Flood Protecting Measures

The operations of the flood defensive team are the unique non-structural counter measure for the increasing flood damage in the basin.

The flood defensive teams are organized under the command of the government chief of the province.

The majour activities of the flood defensive teams are;

i) to observe the water levels at the certain gaging stations and to transmit the information to the appropriate sectors,
ii) to transmit the warning to the habitants,
iii) to prepare and stock the materials to embank to protect the dyke from over-topping and
iv) to embank the materials in the required places.

In the works described above, the PBS and the irrigation office of the province act as the core of the teams for the technical aspects.

The works are carried out in accordance with the information from the water level gaging stations. The water level of 8.0 meter at the A. Yani gaging station is decided as the critical water level for the Madiun city and the team commence their works if the critical water level is acknowledged.

The communication between the observer of the gages and the local irrigation offices or the PBS office are made by the public telephone line or manual messenger. Both method take usually rather long period.

Sand filled bags are stocked in the rainy season in the specific cottage built along the dykes in a certain interval. Bags are to be embanked on dyke by the member of the defensive team in case the flood water level is forcasted to exceed the crest elevation of the dyke. The protection activities, however, tend to be behind time due to the difficulty of the communication.

The dykes so designed as to have the same elevation with the frequent flood water level might be the other reason which makes the flood protecting activities ineffective. If the dykes have appropriate freeboard against the flood of the frequent magnitudes the activities may become more effective ones.

Table 3.1 (1) Existing River Structures

Kind of Structure	N o t e s
- Dykes	dykes without revetment L = 22.6 km, h = 5 m dykes with revetment L = 3.1 km, h = 6 to 7 m parapet wall L = 1.9 km, h = 2.5 to 3 m
- Bridges	
MADIGONDO BR.	rail way br. for sugar factory, W = single track, L = 82 m, 3 spans, I-beam girder br., truss br.
GANDONG BR.	road way, BINA - MARGA loading calss A, W = 9 m, L = 41 m, truss br., single span, R.C. pile foundation
SLAJEN BR.	rail way br. for sugar factory, W = single track, L = 82 m, 2 - spans, truss br.
MANGUHARDJO BR.	road way, BINA - MARGA loading class A, W = 10 m, L = 107 m, 3 - spans, T - shaped prestressed concrete girder br., open caisson foundation
WINONGO BR.	rail way br. for National Rail Way, W = single track, L = 123 m, 4 - spans, truss br., direct foundation
PATIHAN BR.	rail way br. for sugar factory, W = single track, L = 98 m, 6 - spans, I-beam girder br.

Table 3.1 (2) Existing River Structures

Kind of Structure	N o t e s
KRANDANG BR.	road way br. W = 4.5 m, L = 80 m, 3 - spans, I-beam girder br., truss br.
- Pump Facilities (with water gate)	
TAMAN PANCASILA	Q = 13.7 m^3/min, A = 55 ha
A. YANI	Q = 18.3 m^3/min, A = 144 ha (new pumping facilities with capacity Q = 4 m^3/sec are under construction)
BETENG	Q = 2.1 m^3/min, A = 7 ha
MADIUN LOR	Q = 3.0 m^3/min, A = 7 ha
- Groyne	made of gabion matress made of reinforced concrete piles
- Short cut	natural short cut artificial short cut

Table 3.2 Traffic Density on Bridge

- WINONGO BRIDGE (National Rail Way) as of May, 1980.

  traffic volume = 33 trains/day

  maximum interval of train traffic = 2.5 hours

  * These numbers were counted by using the traffic schedule diagram.

- MANGUNHARJO BRIDGE (road way) Apr., 20th, 1980

Kind of vehicle	heavy vehicle	light vehicle	others
Volume / day	1,870	3,223	7,503

* heavy vehicle ; trailer trucks, trucks, buses, etc.
* light vehicle ; micro tracks, passenger cars, etc.
* others ; motor bicycles, bicycles, persons on foot, etc.

- Bridge of sugar factory as of 1979

Name month	MADIGONDO	SLAJEN	PATIHAN
Jan.	2 @ 4	2 @ 62	2 @ 17
Feb.	" 4	" 58	" 17
Mar.	" 3	" 62	" 17
Apr.	" 3	" 60	" 17
May.	" 8	" 124	" 17
Jun.	" 10	" 150	" 420
Jul.	" 11	" 186	" 420
Aug.	" 12	" 186	" 420
Sept.	" 8	" 150	" 420
Oct.	" 8	" 62	" 17
Nov.	" 5	" 60	" 17
Dec.	" 5	" 62	" 17

* unit ; trains/month
* In case of PATIHAN BRIDGE, it is supposed that one train consists of 30 trolleies.
* MADIGONDO BR. is used mainly for transportation of sugar and sub-materials.

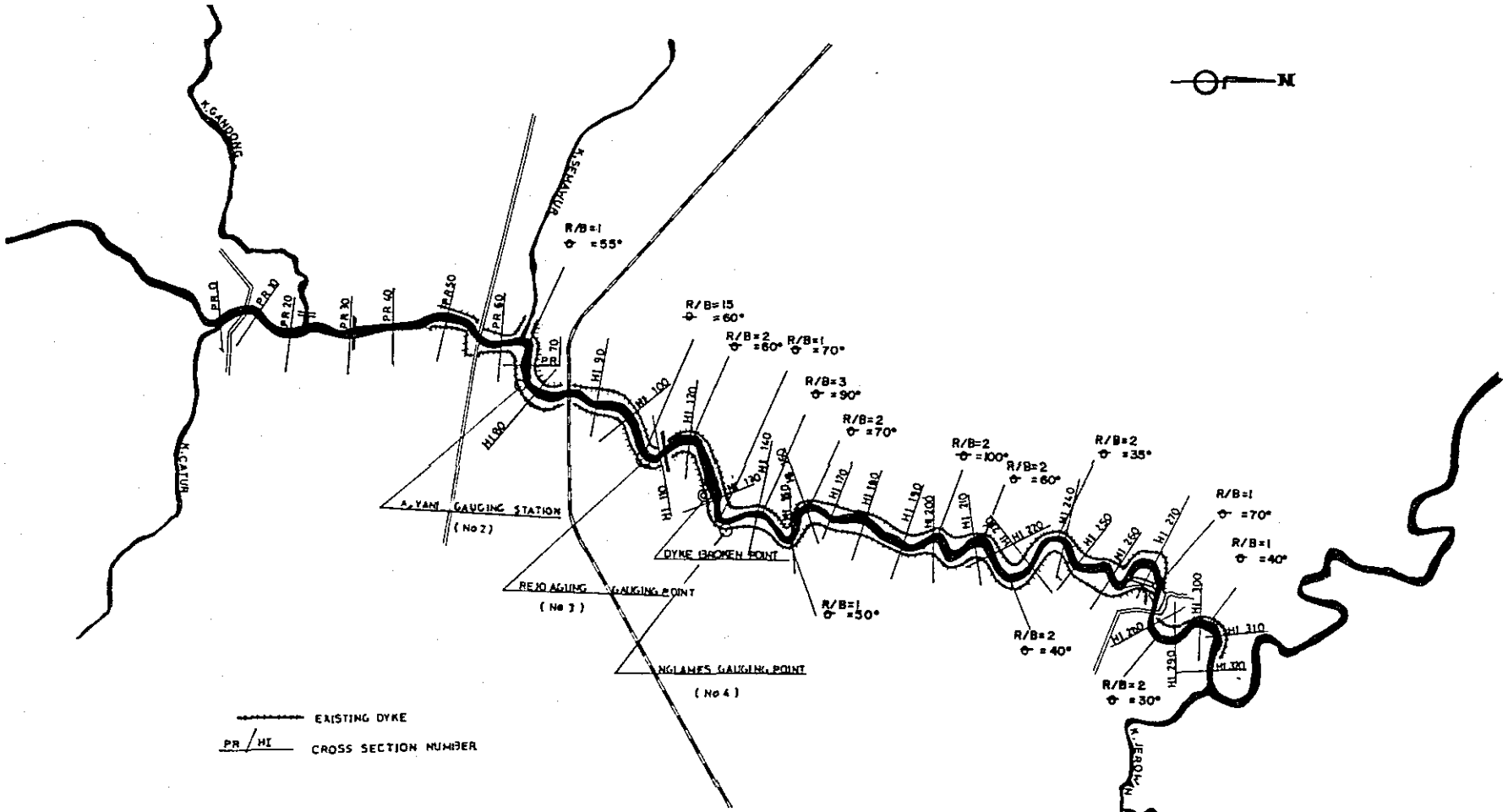


Fig.3.1 ALIGNMENT OF MADIUN RIVER

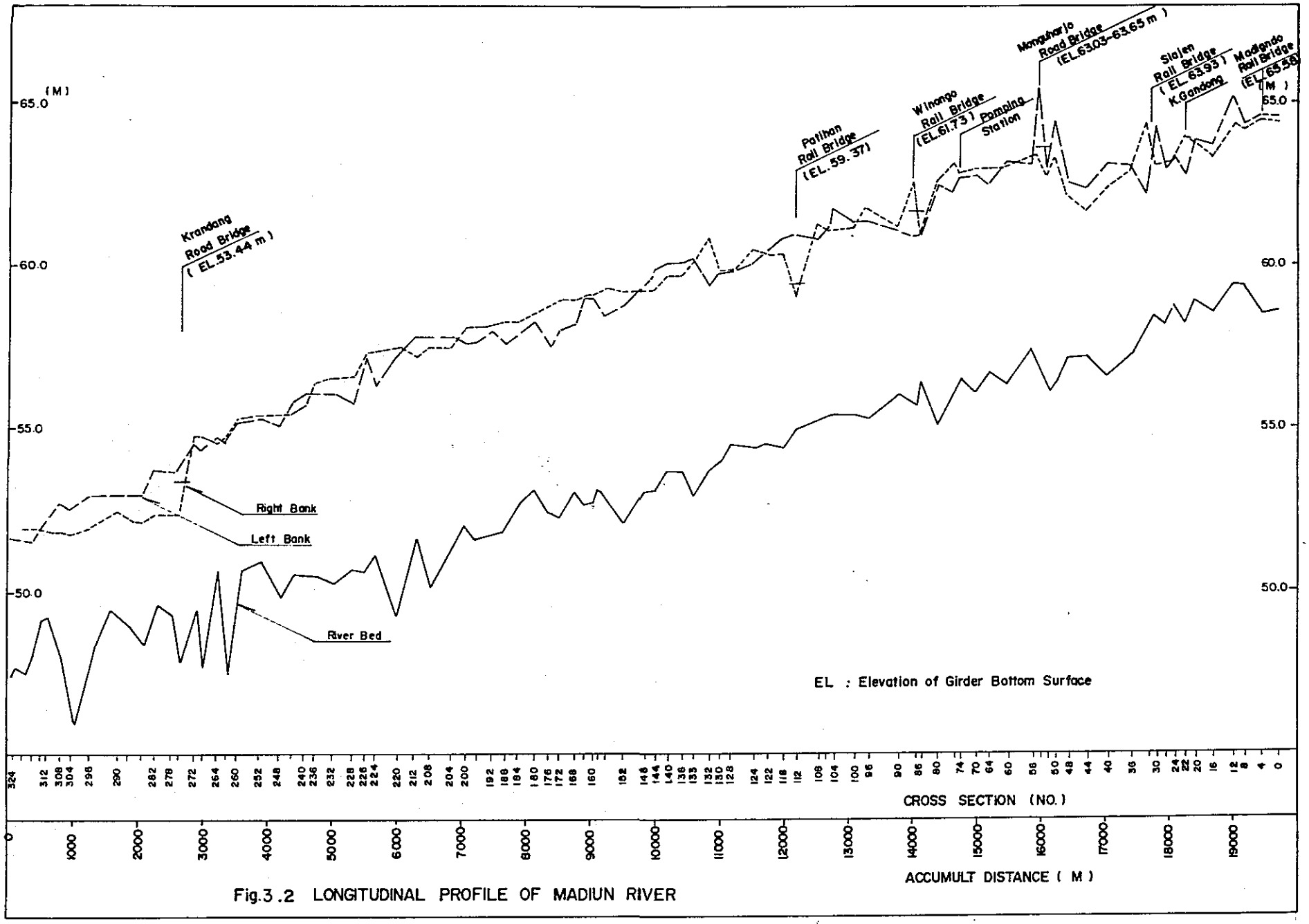


Fig.3.2 LONGITUDINAL PROFILE OF MADIUN RIVER

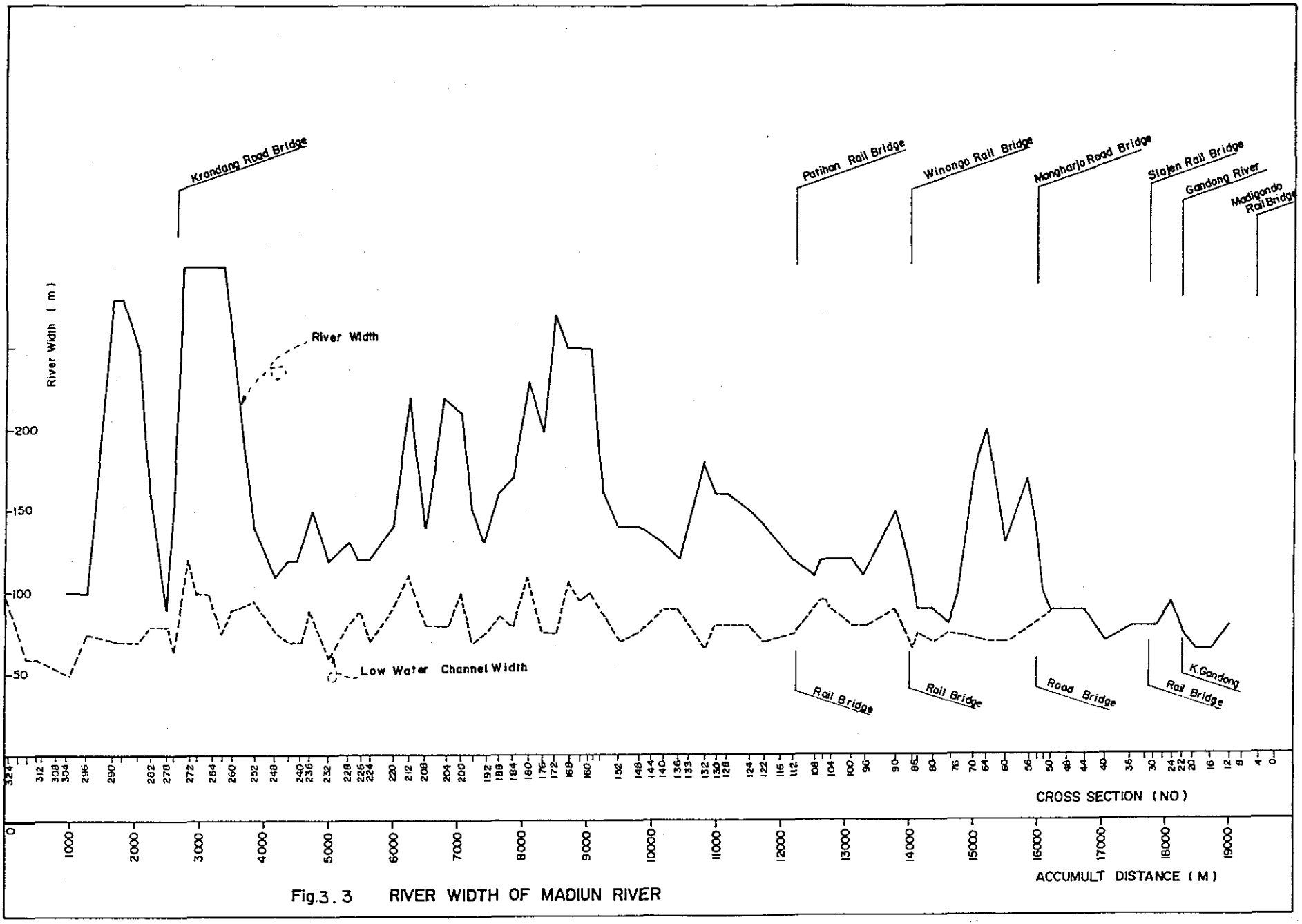


Fig.3.3 RIVER WIDTH OF MADIUN RIVER

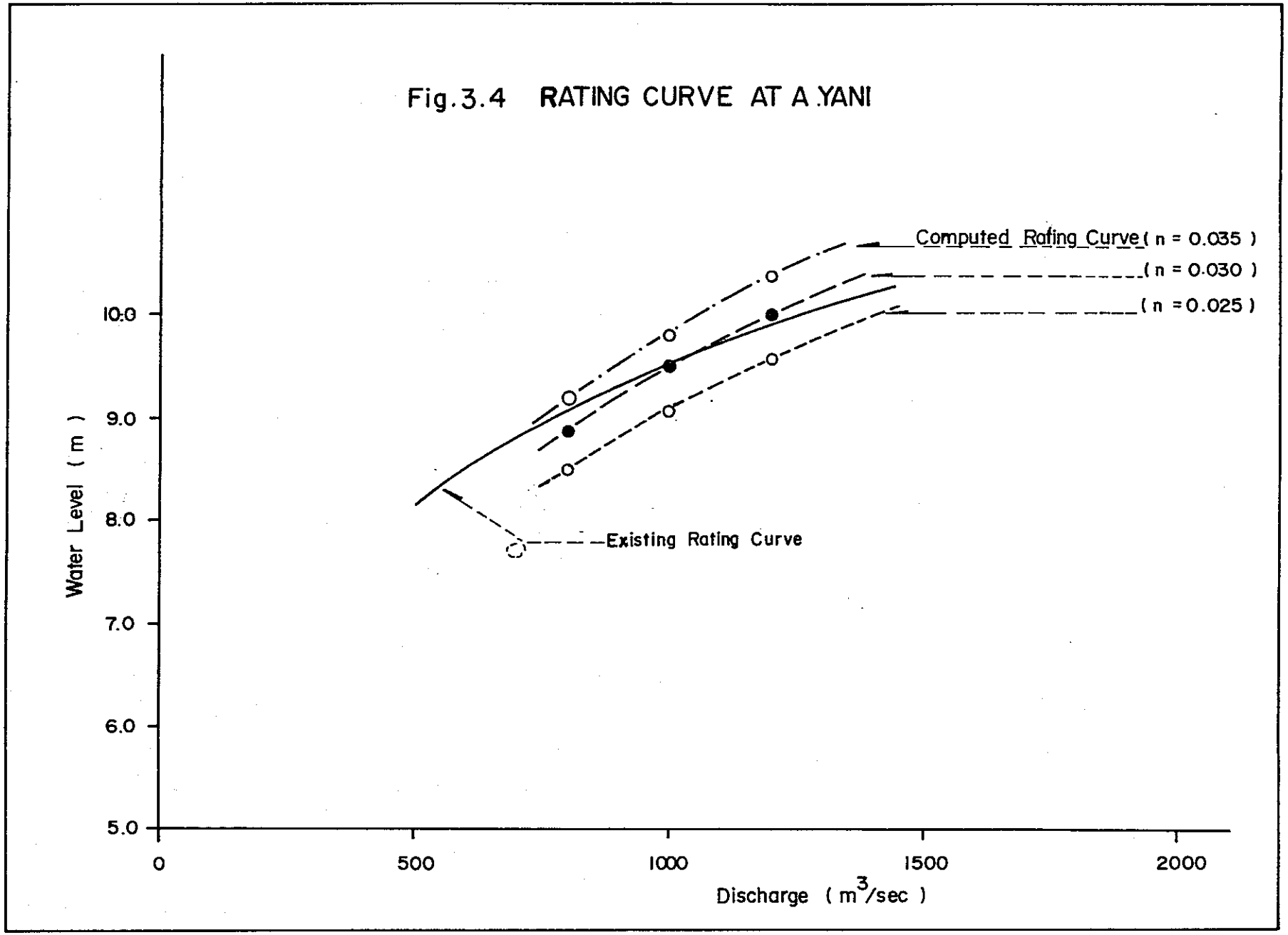


Fig.3.4 RATING CURVE AT A.YANI
Computed Rating Curve (n = 0.035)
(n = 0.030)
(n = 0.025)
Existing Rating Curve
Water Level (m)
10.0
9.0
8.0
7.0
6.0
5.0
0
500
1000
1500
2000
Discharge (m3/sec)

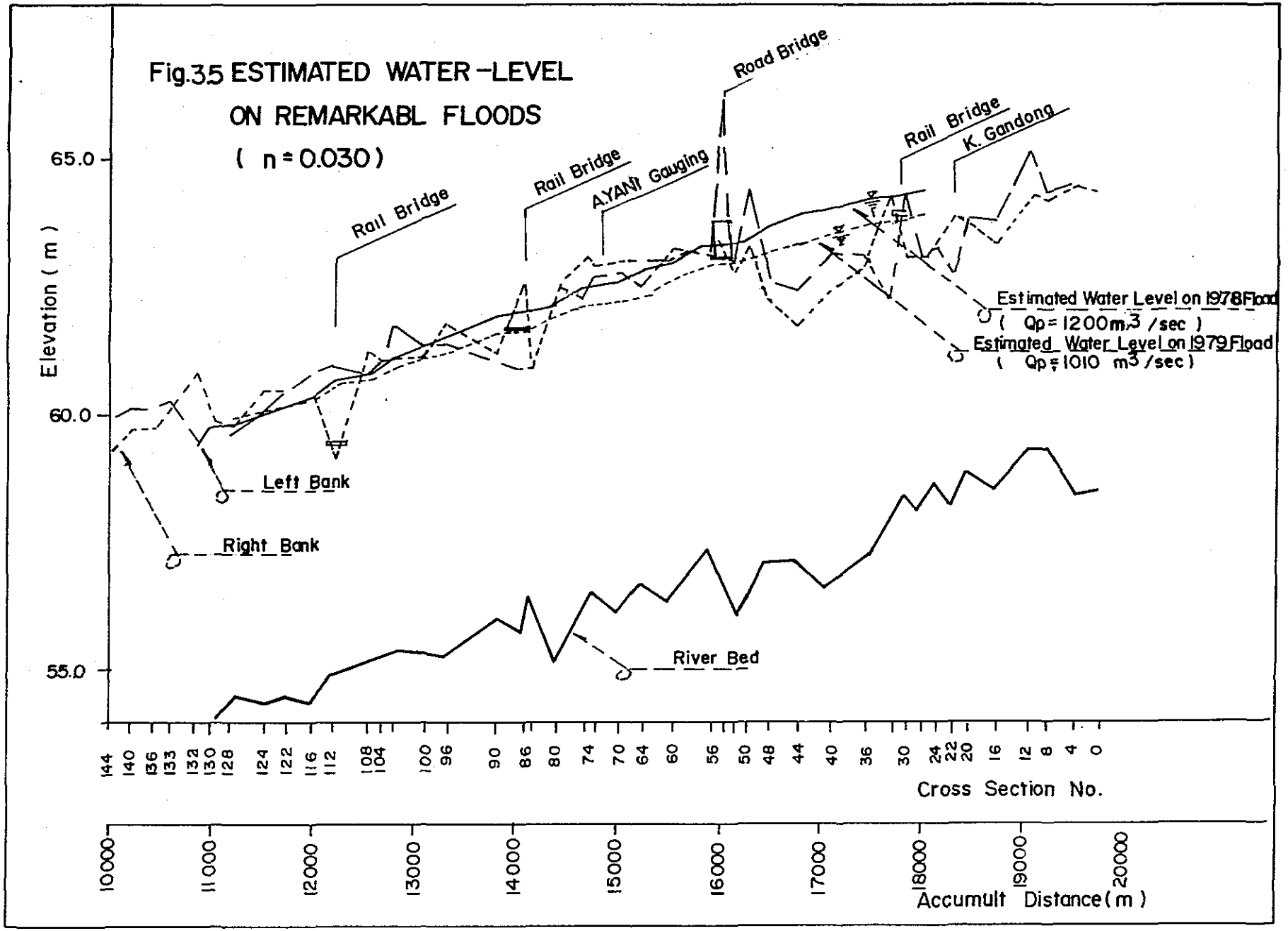


Fig.35 ESTIMATED WATER-LEVEL
ON REMARKABL FLOODS
(n = 0.030)
Road Bridge
Rail Bridge
Rail Bridge
A.YANI Gauging
Rail Bridge
K. Gandong
Estimated Water Level on 1978 Flood
(Qp = 1200 m3 /sec)
Estimated Water Level on 1979 Flood
(Qp = 1010 m3 /sec)
Left Bank
Right Bank
River Bed
Elevation (m)
65.0
60.0
55.0
144 140 136 133 132 130 128 124 122 116 112 108 104 100 96 90 86 80 74 70 64 60 56 50 48 44 40 36 30 24 22 20 16 12 8 4 0
Cross Section No.
10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000
Accumult Distance (m)

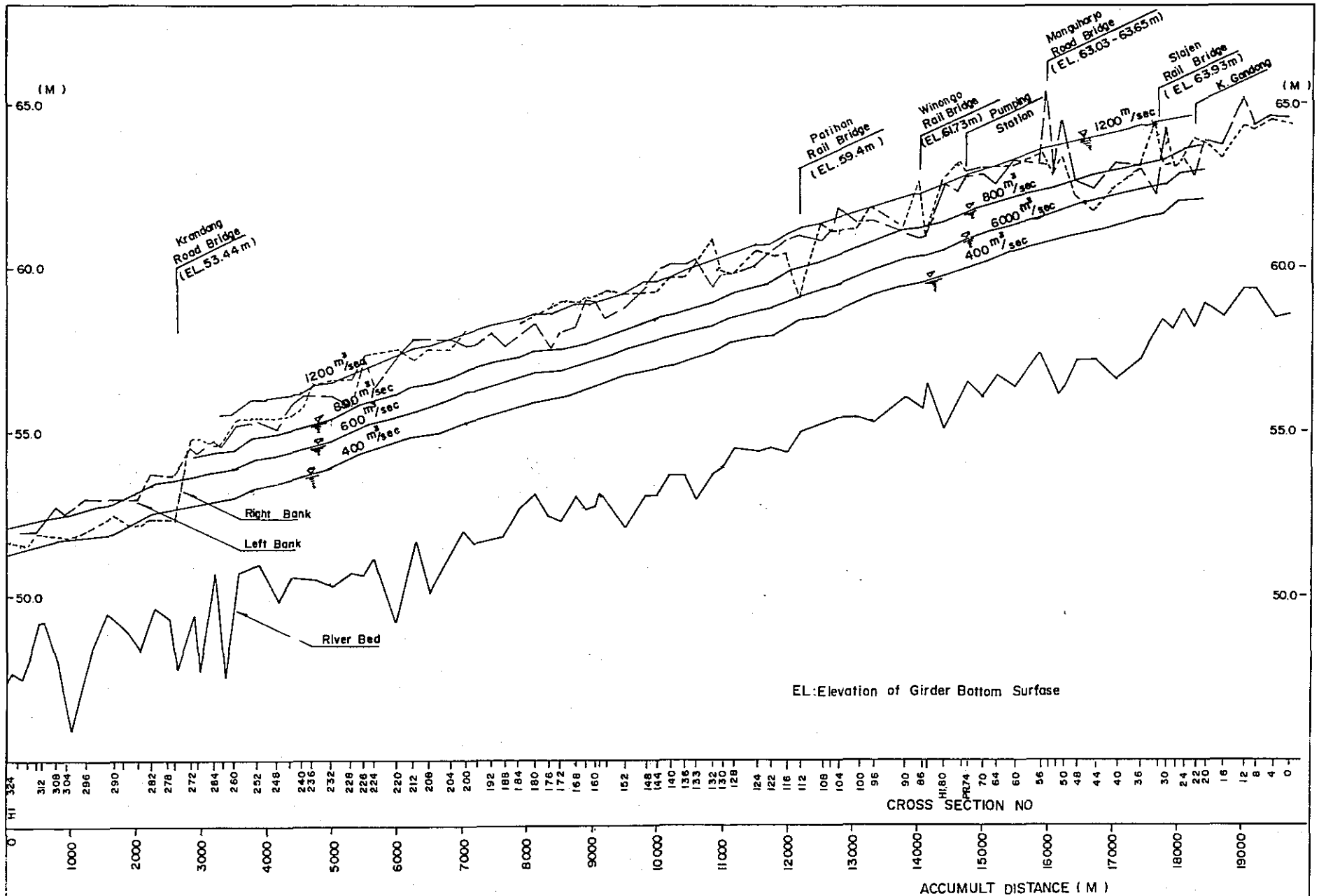


FIG.3.6 FLOW CAPACITY OF EXISTING RIVER CHANNEL

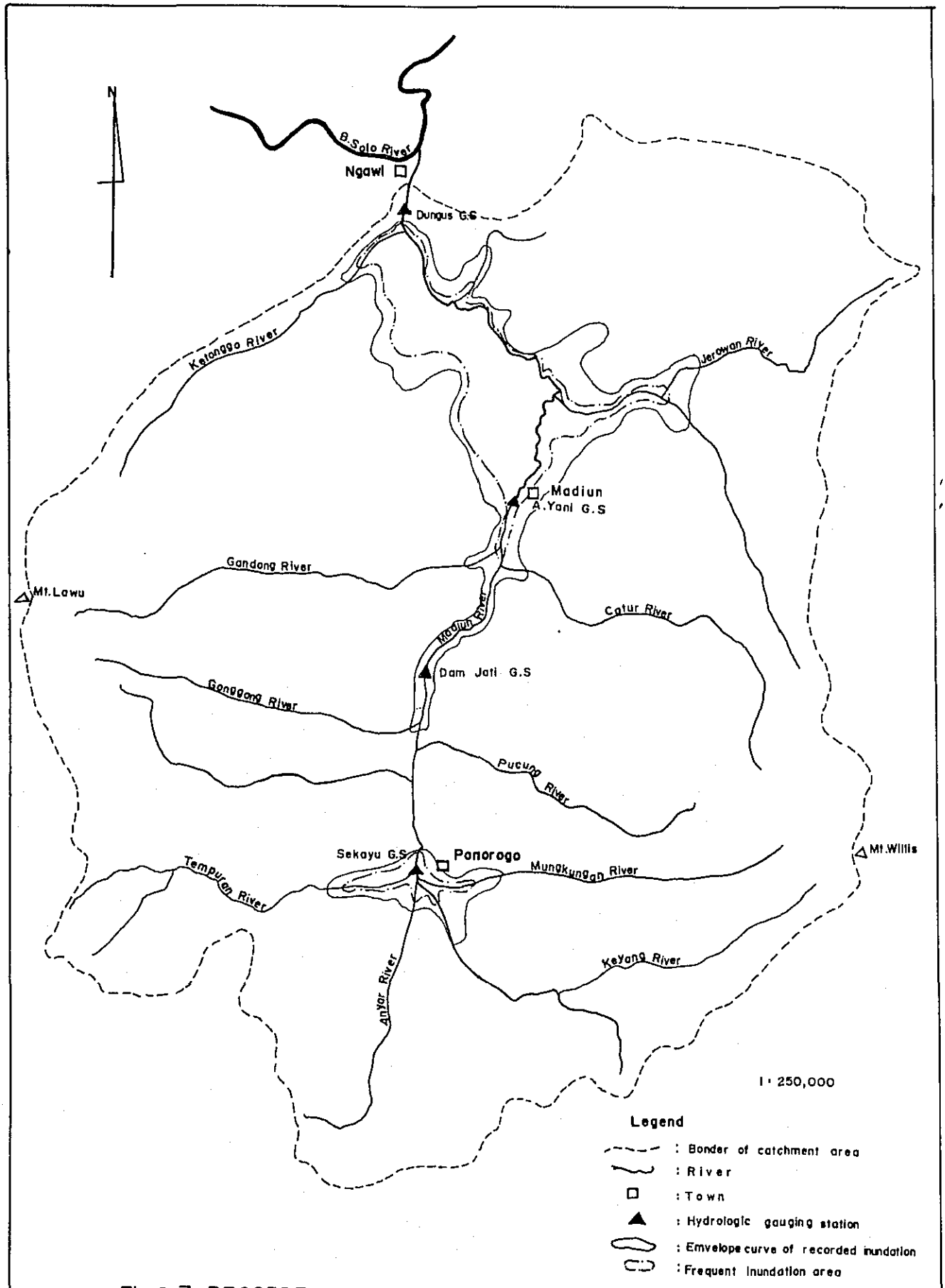


Fig.3.7 RECORDED INUNDATION AREA

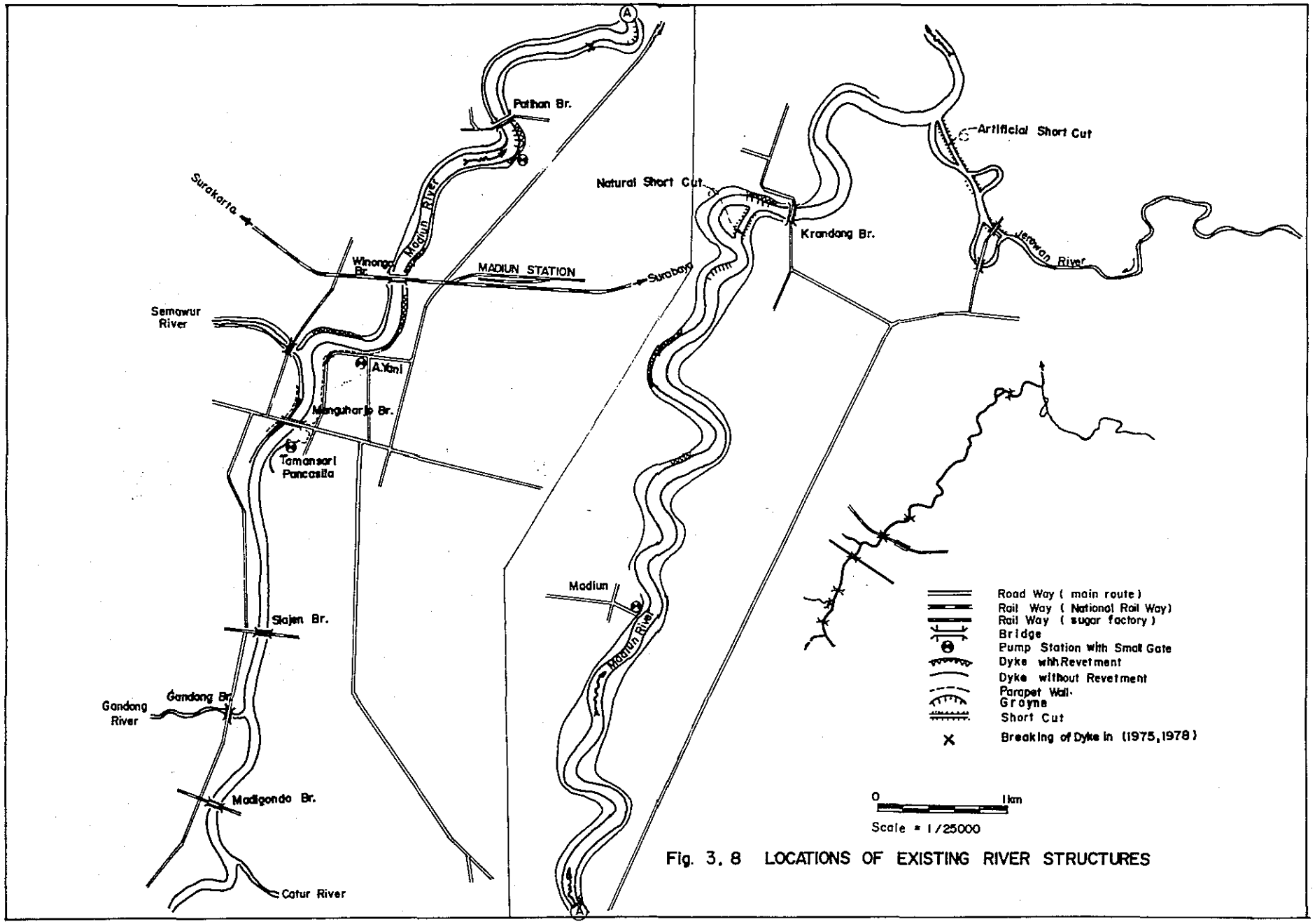


Fig. 3. 8 LOCATIONS OF EXISTING RIVER STRUCTURES

4. RIVER IMPROVEMENT PLAN

4.1 Basic Concept

As mentioned before, the objective of the urgent improvement project is to mitigate the flood damage in the Madiun city and its surrounding by means of the partial river improvement. And it was supposed that an over-all improvement plan would be initiated subsequent to this project. In this respect, it was recognized that the works of this urgent project should be so planned as to function well in the future stage of the improvement.

The conceptional review was performed on the following components of the over-all plan formulated by the OTCA, Japan in 1974;

a) Construction of two dams in the upper Madiun reaches to control flood run-off.

b) Construction of a flood way with 500 meter wide to divert the run-off from the urban area of Madiun city.

c) Construction of continuous dikes along the river to confine the flood plain within the dikes.

d) Construction of Jipang dam in the main Solo river to absorb possible increase of the flood peak and to protect the Lower Solo river basin from flooding.

The results of the review were summarized as follows;

a) The proposed dams in the upstream may produce a flood control effect mainly in the upper reaches including the Ponorogo area but a limited effect to the Madiun area. Their construction may take several years.

b) Construction of the floodway may require some 350 ha of the semi-urban and rural land, acquisition of which may require considerable cost and time and may cause serious social problems.

c) Construction of continuous dikes to provide the main stream with a large flow section may also require a wide agricultural land to be purchased and may cause deterioration of the drainage condition in the basin of the tributaries.

d) Construction of Jipang dam may be realized after many years due to social, financial and other problems likely to be involved in its implementation. In the absence of Jipang dam, the improvement of the Madiun river will be limited within a reduced level.

In view of the above results following basic concepts were taken account in the planning of the urgent project;

a) The return period of the design flood discharge may vary according to the present status of the area to be protected; however, it should be more than 5 years at any part of the project area.

b) The number of houses to be removed should be minimized to the extent as possible.

c) Increment of the flood water level as a consequence of the improvement work should be minimized or avoided wherever possible.

d) Intentional retardation of the flood run-off in the productive area should be avoided.

4.2 Design Discharge

It is generally considered that the optimum scale of design discharge is obtained inherently by the socio-economic and the technical conditions of the project area. The essential socio-economic conditions are the population, the situation of industry, property, the sensibilities of the habitants against the flood damage and the economic and financial feasibilities. The technical conditions are topography, geology, hydrology such as the characteristics of rainfall and runoff, the situation of river and so on.

The design discharge for the existing river improvement plans may supposed to have been formulated with due regard to the conditions mentioned above. Accordingly the existing design discharge were considered to imply the comprehensive standard for the decision making from both administrative and technical aspects.

The respective design flood for the urgent river improvement of the Bengawan Solo and Krung Aceh are 1500 and 1300 cubic meters per second. The design flood are interpreted 0.45 and 0.73 cubic meters per second per square kilometers in the terms of specific discharge as shown Table 4.1.

The specific discharge of around 0.5 cubic meters per second per square kilometer may be proposed as the design discharge for the Madiun river urgent improvement project taking the catchment areas into consideration.

In like manner, it is proposed that the return period of the design discharge for the project should be adopted in the range of ten to twenty years in accordance with the urgency of the project and the status of the project area.

The discharge not less than the second recorded maximum has been adopted as the design discharge for the urgent river improvement plan in many country if the records of around twenty years or more are

available. This become a kind of customary guideline for the river planning in Japan.

According to the hydrologic records in the project area, the flood of 1,200 cubic meters per second occurred twice in the recent five years. These floods are the first and the second maximum discharges in seventeen years recording period since 1963.

The said second maximum discharge of 1,200 cubic meters per second is equivalent to the specific discharge of 0.52 cubic meters per second and to the probable flood with seventeen years reccurrence intervals according to hydrologic analysis.

In addition, there are some specific conditions to be considered to adopt the design discharge in this project.

As described before, the land use mode along the river is extremely high and no spare land can be obtained for the backward displacement of the dyke. Accordingly the plan should be formulated on the basis of the present river width.

The bankful capacity of the present river, with existing dykes but without free board is approximated 1,000 to 1,200 cubic meters per second over the project area. However the stability of the dykes need to be enforced as mentioned before. The reinforcement of dykes are indispensable matter in the improvement plan to avoid the damage caused by the dyke breach.

The modification and relocation of the existing bridges are one of the most serious work for the river improvement. As discussed later flood of 1,200 cubic meters per second is the maximum discharge which can flow with certain clearance under the Mangunhajo and the Winongo railway bridges without any modification.

Based on the considerations described above it is supposed that the design discharge of 1,200 cubic meters per second is the most appropriate one.

The runoff exceed the said design discharge should be diverted by the floodway or other conceivable measures in the full plan. When the full plan is implemented the said design discharge shares a part of the design flood for the full plan in the Madiun city and its surroundings.

4.3 Alternatives

4.3.1 Adopted measures

According to the master plan, the flood in Ponorogo area is to be mitigated by the regulating dams and river improvement. Whereas the flood in Madiun area is to be diverted by a floodway. The full plan will be formulated based on the said master plan. The urgent plan was studied under the condition that the urgent plan should be an effective element of the full plan when it is realized.

The average flow capacity of the existing channel of the proposed reach is around 700 m^3/sec according to the result of the study mentioned before.

The design discharge of 1,200 m^3/sec was adopted as also described before. It is supposed that the said design flood can be discharged safely in the channel by improvement of dyke by raising up of 1 meter.

In this respect the measures which require large scale construction works and periods such as flood way and flood control dam were eliminated from the alternatives for the urgent flood control.

The measures of dredging on the limitted reach and of dyke backward displacement were also disregarded because of the difficulty in the land acquisition to execute.

On the other hand, heightening of the existing dyke is to reinforce it at the same time and is considered to be favourable measure.

From the hydraulic viewpoint, the short-cut is preferable to adopt in order to decrease the water level at the heavy meandering portion and to reduce the damage to the structures caused by the inpact of the water flow and other floating articles.

With due regard to the conditions described above, the heightenning of dyke and short-cut were adopted for the Madiun river urgent improvement.

D y k e

The procedure to reinforce and raise up dyke is to be mentioned in detail in the next chapter.

In order to protect the project area from flood, it is necessary to construct new dykes on the both sides along the upstream reach from the Manguhardjo Bridge on the Madiun river where no dyke were provided yet. The right side of the Catur river and the left side of the Gandong river are also to be provided with new dykes.

For the dyke-less reach on right side of the Madiun river at the upstream from the junction with the Jerowan river, two alternatives were considered with regard to the land use in this area.

One alternative is to use the area as a natural retarding basin. The retarding area is expected to decreases water level on upper and lower reach by its regulating effect. It is also expected to absorve the influence of the river channel improvement to the downstream area from the confluence with the Jerowan river.

The other one is to use the area as an agricultural land constructing the dyke along the left bank of the Jerowan river as well as the dyke less reach at the Madiun river to protect the area from flood taking account of the future high productivity of this area.

Short - cut

The locations of the short-cut sites were proposed taking characteristic of the river, land-use condition of surroundings of the river and the river structural condition into account.

The short-cut of part 1 and part 2 sites were proposed as the counter alternatives of the bridge heightennings of the Winongo railway

bridge and the Manguharjo road bridge. It is supposed that the heightenning of the bridges are quite difficult because of their dense traffics and the relocations are not economical because of the required magnitude of construction works.

Furthermore, in order to discharge a flood safely and to reduce high water-level including the upper reach, the meandering alignments of middle and lower reaches in the project area are to be improved by short-cut of part 3, 4 and 5.

4.3.2 Alternative plans

The alternative plans to be studied were formulated by the combinations of dyke embankment including heightenning and the shortcut works.

The alternatives are classified into two groupes. One is the cases that the existing dykes are to be heightenned and new dykes are to be constructed along the proposed reach except the lower reach, just upstream of junction with Jerowan river on the right side of the river (Alt. I).

The other is the cases that the existing dykes are to be heightenned and the new dykes are to be constructed along the whole project area including the left side of Jerowan river (Alt. II).

The each alternative, is assorted into two categories. One is the river improvement only by dyke embankment without any shortcut works. Alt. I-1 and Alt. II-1 are belong to this category. The other is the river improvement by the dyke embankment with the shortcut works Alt. I-2, Alt. II-2 and Alt. II-3 belong to this category.

The shortcut works of Alt. I-2 and Alt. II-2 are planned at the sites of part 1 and 2. Whereas ones of Alt. II-3 are planned in the sites of part 3, 4 and 5 including part 1 and 2. Each alternatives are shown in Fig. 4.1.1 to 4.1.5.

Design high water level

The design high water levels on each proposed alternatives were brought based on the results of non-uniform flow calculation.

The obtained design high water levels are shown in Fig. 4.2.1 to 4.2.3.

In the alternative I-1 and II-1, the bottom surface of the girder of all bridges are submerged by the design discharge. And the modification work or relocation are necessary in these alternatives. In the alternative I-2, II-2 and II-3, there are clearances of 0.6 m for the Manguharjo bridge and 0.2 m for the Winongo railway bridge.

The design high water level for the tributaries were also obtained based on the results of non-uniform flow calculation for such as the Catur river, the Gandong river and the Jerowan river. The allocated flood discharge mentioned in 2.3 for the tributaries were used for the calculation.

The design high water level of such tributaries are shown in Fig. 4.3.1 to 4.3.3.

4.3.3 Drainage system

The drainage system was designed to drain the land-side water and to protect the land from the back water of the Madiun river. The studies for the design were conducted in accordance with the said alternatives, taking the drainage area, and it's geographic and hydrologic conditions into consideration.

In the right side of the Madiun river just downstream of the junction with the Catur river, the sluices are to be constructed and a water gate is to be provided at the river mouth of the Semawur river.

At the upstream of the junction with the Jerowan river a sluice is to be provided for the drainage of the low land which is an inundation area. A water gate is to be constructed at the downstream of the

Jerowan river for the alternative II-1, -2 and -3. The land-side water from the major part of the project area on the right side of the Madiun is to be concentrated to this drainage gate through various channels.

The existing sluices in the both sides of the Madiun river will be kept their functions after the implementation of the project. The location of the proposed water gates and sluices are shown in Fig. 4.4.

The capacities of the proposed water gates and sluices were decided taking the area, expected runoff from the drainage area and existing drainage channel conditions as well as the land use of drainage area into account.

The capacities and dimensions of each water gate and sluice structures are shown in Table 4.2.

4.4 Basic Design

4.4.1 Alignment and section

The river channel alignment is to be designed as smooth as possible with due regard to the conditions of land utilization along the river, existing river channel and the riparian structures and the costs of river improvement work.

For each alternative plan the conceivable alignment were proposed reflecting the conditions mentioned above.

The existing river alignment is adopted to the improved river channel as the alternative I-1 and II-1.

The existing alignment is improved by short-cut at part 1 and part 2 as the alternative I-2 and II-2. The short-cut in five portion at part 1 to part 5 is proposed in the alternative II-3.

The short-cut alignment of part 1 to part 5 are mentioned in 4.3.3.

Cross section was also designed with due considerations to the same conditions as the alignment.

In all alternative plans the existing cross section of the river were adopted except for the short-cut reaches after the studies on the conditions mentioned above.

The elevation of dyke was designed to afford the free-board for the design high water level.

In Japan the free-board is designed refering the standard classified in accordance with the design discharge.

Refering the said standard, the free-board for the upper reach was decided 1 meter, because the surroundings of the middle and upper reaches are developed land.

For the lower reaches, the free-board of 0.8 meters was applied based on the land-utilization of it's surroundings.

For the tributaries of the Catur river, Gandong river and Jerowan river, the free-board was decided 0.6 meters.

The elevation of dyke crest is shown in Fig. 4.2.1 to 4.2.3 and Fig. 4.3.1 to 4.3.3.

The typical cross sections of the Madiun river were illustrated and shown in Fig. 4.5.1 and Fig. 4.5.2. And ones of the tributaries were shown in the figures from Fig. 4.6.1 to Fig. 4.6.4.

4.4.2 D y k e

As descrived before, the freeboard of the dykes were designed reflecting the design flood of 1,200 m^3/sec. And the freeboard of one meter were provided to the dykes in the urban area. The dykes of the tributaries were so designed as to have freeboard of 0.6 meters.

The earth embanked type dyke was designed as the standard. The wall type or the gravity type dykes were designed if the sites were crowded with houses and the difficulties are foreseen in procurement of the land for the embanked dykes.

The wall type dykes are also to be provided if the raising up of the existing walls are possible.

The designed new embanked dyke has the following features; The width of the crest, 4 meters. The slope of the dyke, 1 to 2 for both sides. The homogenious embankment of silty clay.

The stability of the slope were estimated to be 1.1 in case the rapid draw down was assumed.

The typical sections of the designed dykes are shown in Fig. 4.12 and Fig. 4.13. And the proposed sites are shown in Fig. 4.8, 4.9, 4.10 and 4.11.

4.4.3 Shortcut

Short-cut works were designed for the five sites in the proposed reach. The alignment of short-cut in each part were decided under the conditions that crowded area should be avoided from the proposed route and short-cut channel should connect to the existing channel smoothly.

The slopes of the each short-cut section were given with straight line which tie the riverbed elevation of the existing channel at the upmost and the lowest point of the each short-cut reach. At the same time, the attention was paid not to be too steep in order to protect the short-cut and it's adjacent reaches from scoring caused by high velocity comparing with one of the existing channel.

The whole channel width of the short-cut sections was determined to be 120 meters refering the existing channel.

The cross section for low-water-channel was decided to be able to confine the normal discharge of 530 m^3/sec, with 1.2 years return period. The channel width is to be 80 meters which is almost the same with the average of the existing channel and the depth of the section is to be 3 meters.

The proposed cross section for short-cut was confirmed through hydraulic study that the channel had sufficient width to decrease the water level to some extent for the design discharge.

And discharge velocity in the short-cut channel is proved not to have significant difference from one of the existing channels.

The cross sections at relevant sites are shown in Fig. 4.7.1 and 4.7.2. And the slopes of shortcut were summarized in Table 4.3.

4.4.4 Gate and sluice way

Various tributaries and drainage canals join the Madiun river in the project area. The land in both sides of these tributaries and canals are subject to the back water of the Madiun river to some extent.

The gate structures are to be provided to protect such land mentioned above from the back water. Gate were designed for the tributaries of rather large catchment area and sluice way were designed mainly for the small drainage canals.

The roller gates operated by electric power and the slide gates of manual operation were designed to provide in these structures taking the dimensions of the gates and the operation into consideration.

All of the designed gate leaves and accessories are made of metal and the reinforced concrete structures were designed for the pier, the abutment and others.

The dimensions of the gates were decided to afford the same areas with the present river channels.

The wing walls and an apron are provided to protect the river banks and the foundation of the structure.

According to the geologic survey in the gate structure sites, the N-values of the soils are more than 15 and the permeabilities are in order of 10^{-5}. And the structures are designed to construct without special foundation treatment.

4.4.5 Revetment

The revetment works were designed to protect the embankment and other soil surfaces in the following portions:

i) The concave side of the bending river portion.
ii) The river side of a dyke if the slope is steeper than 1:2 and the height thereof is more than 2 meters.
iii) The up and downstream portions of the riparian structures.
iv) The joint of the river channel and the shortcut.

The wall of wet masonry are to be applied as the revetment work.

The materials to be used for the backfill are cobble and base concrete.

The revetment is designed to cover the lower part of the slope from the high water level. The upper part thereof are to be protected by sodding.

Gabion metresses are to be provided in the toe of the revetment. And the gabions are to be fixed by the wooden piles.

The bamboo pipe are to be embeded in a proper intervals in the wall as the drain pipe.

According to the studied results applying the several method's for sediment transport analysis, the river bed at the upstream from the shortcut is to be scoured to some extent. And the revetment work was designed to extend certain meters under the present river bed in accordance with the estimated scouring depth.

The locations of the proposed revetment sites and the typical sections of the designed revetment are illustrated in Fig. 4.8, 4.9, 4.10 and 4.11 and Fig. 4.14.

4.4.6 Groyne works

The existing dykes have been scoured from place to place. To protect the dykes from scouring, groynes have been constructed. The effect of the groyne is under study so far but it is proved experimentaly to be effective by the silting of the sediment.

In this design, the concrete pile type groyne was adopted.

The standard for the design were decided tentatively reflecting the experimental information as follows:

length	:	10% of the river channel
interval of groyne	:	140 to 180% of the length
height of groyne	:	3% to 10% of the interval
numbers of pile	:	6

The proposed locations of the groyne works are shown in Fig. 4.8, 4.9, 4.10 and 4.11. The typical arrangement is shown in Fig. 4.15.

4.4.7 Bridge

The clearances of the existing bridges were estimated against the design discharge and are shown in Table 4.4. Analysing the obtained clearances, the necessary works were identified for each alternative river improvement plans. The necessary works are summarized in Table 4.5.

The necessary works are the relocation of the existing bridges or the rehabilitation by raising up at the present location.

The design for both works were performed with due regard to the standards established by the authorities concerned such as BINA MARGA and the National Railway.

The design for each bridge is as follows:

Slajen bridge (Railway bridge for sugar factory)

The single lane was enlarged in its width to 2.75 meters.

The length of 126 meters is consisted by four spans. The span length is designed to be 31.5 meters.

The designed load is defined by the weight of the locomotive and train with freight, sugar cane. The weight of the locomotive is 18 tons and the train with freight 2 ton per meter.

The maximum longitudinal slope of 1% was adopted.

The plate girder was adopted as the super structure in order to decrease the altitude of the bridge.

The reinforced concrete piers are to be supported by the steel piles on the well cemented aluvial sand.

Gandong bridge (Road bridge)

The bridge is to be raised up its altitude by 2.1 meters by hydraulic jack.

The reinforced concrete plates are to be removed before the jacking up is executed. The dead load is expected to decrease to around 80 tons from 300 tons by this removal.

Other major works are to construct the saddles for the hydraulic jacks and the construction of the approach road.

The old road which was used before the bridge was constructed may be used as the relocation road.

Madigondo bridge (Railway bridge for sugar factory)

The bridge is to be raised up its altitude by 1.4 meters by hydraulic jacks.

The dead load is estimated to be 50 tons.

The constructions for the raise up of the abutments are necessary beside the construction of the saddles for the jacks.

The bridge is supposed to be able to raise by the hydraulic jack. However, no detailed information on the structure is available and further investigations and analysis are required in the detail design stage.

The freight transported therewith are products of the factory and they amount to 1,800 ton per day at the peak. And the existing road is available with sufficient capacity. Accordingly, no relocation road was designed.

Krandang bridge (Road bridge)

The present effective width of 4.5 meters was enlarged to 6 meters to afford two lanes because the growth of traffic is expected.

The length of 120 meters is consisted by three spans. The span length is designed to be 40 meters.

The load for the second class bridge by BINA MARGA was adopted as the design load.

The composit metal girder bridge was adopted as the superstructure.

The concrete piers with olliptical sections are to be supported by the direct foundation and the concrete piles.

The designed bridges were illustrated in Fig. 4.16, 4.17, 4.18, 4.19 and 4.20.

4.4.8 Irrigation structure and drainage

By shortcut works, the land of around 43 ha located between the existing river channel and the proposed shortcut channel are to be isolated from the water source and the drainage canal system.

The box-culvert type siphone is designed to convey the water to the isolated land across the proposed shortcut channel.

The box-culvert the dimensions thereof is 1 meter by 1 meter was designed assuming the discharge of 1.5 m^3/sec. The length of 150 meters was assumed to the work quantity calculation.

Drainage canals were designed to integrate the existing drainage system in the said isolated area. The canals are to be extended to the existing river channel.

The future development plans for the irrigation canals and drainage canals in and around the shortcut sites are not definite yet and the further studies are required in the detail design stage.

The typical section of siphon was shown in Fig. 4.21.

Table 4.1 Design Discharge for River Improvement in Java

No.	Name of River	Catchment Area (Km^2)	Ultimate Plan Design Flood (m^3/sec)	Ultimate Plan Specific Discharge ($m^3/sec/Km^2$)	Urgent Plan Design Flood (m^3/sec)	Urgent Plan Specific Discharge ($m^3/sec/Km^2$)
1.	Sungai Cimanuk	3,006	1,440	0.48		
2.	Kali Serang	937	900	0.96		
3.	Sungai Citandui	3,680	1,900	0.52		
4.	Kali Pemali	1,228	1,300	1.06		
5.	Sungai Cipanas	220	385	1.75		
6.	Bengawan Solo	3,320	2,000	0.60	1,500	0.45
7.	Kali Brantas	10,000	1,500	0.15		
Sumatra						
	Sungai Krung Aceh	1,775	-	-	1,300	0.73
Kali Madiun		2,294	2,300	1.00	1,200	0.52

Table 4.2 Water Gate and Sluice

Number	Location	Type	Drainage Area	Size	Remarks
WG 1	Right side of upper reach	Sluice	3 km^2	1.75^m x 1.75^m	
WG 2	River mouth of Semawur river	Water gate	48 km^2	15^m (W) x 3^m (H)	
WG 3	Right side of lower reach	Sluice	9 km^2	2.25^m x 2.25^m	
WG 4	Left side of Jerowan river	Water gate	98 km^2	14^m (W) x 4^m (H)	

Table 4.3 Slope of Short Cut

Number	Section	Distance	Slope	Remarks
Part 1 and Part 2	HI 96 to HI 168	2.93 km	1/1200	For Alternative I-2, II-2 & II-3
Part 3	HI 210 to HI 240	1.01 km	1/1450	For Alternative II-3
Part 4 and Part 5	HI 252 to HI 324	2.19 km	1/1450	For Alternative II-3

Table 4.4 Clearance under the Bottom Surface of Girder to High Water Level

Name of Bridge	Elevation of Girder Bottom (m)	High Water Level (m)					Clearance (m)				
		Alternative					Alternative				
		I-1	I-2	II-1	II-2	II-3	I-1	I-2	II-1	II-2	II-3
MADIGONDO	65.58	65.99	65.99	65.99	65.99	65.92	-0.41	-0.41	-0.41	-0.41	-0.34
GANDONG	63.78	64.89	64.88	64.89	64.88	64.77	-1.11	-1.10	-1.11	-1.10	-0.99
SLAJEN	63.93	64.61	64.52	64.61	64.52	64.40	-0.68	-0.59	-0.68	-0.59	-0.47
MANGUHARDJO	63.03 s 63.65	63.49	63.09	63.49	63.09	62.95	-0.46 s +0.16	-0.06 s +0.56	-0.46 s +0.16	-0.06 s +0.56	+0.08 s +0.70
WINONGO	61.73	62.27	61.53	62.27	61.53	61.38	-0.54	+0.20	-0.54	+0.20	+0.35
PATIHAN	59.37	61.10	60.46	61.10	60.46	60.33	-1.73	-	-1.73	-	-
KRANDANG	53.44	54.19	54.19	55.47	55.47	54.85	-0.75	-0.75	-2.03	-2.03	-

Table 4.5 Necessary Works for the Bridges

Jerowan area	no dyke		protection dyke		
Short cut	none	Part 1,2	none	Part 1,2	Part 1-5
Alternative	I - 1	I - 2	II - 1	II - 2	II - 3
MADIGONDO BR.	↑1.41	↑1.41	↑ 1.41	↑1.41	↑1.34
GANDONG BR.	↑2.11	↑2.10	↑ 2.11	↑2.10	↑1.99
SLAJEN BR.	x	x	x	x	x
MANGU HARDJO BR.	x	0	x	0	0
WINONGO BR.	x	0	x	0	0
PATIHAN BR.	x	new	x	new	new
KRANDANG BR.	x	x	x	x	new

Notes

↑ *.** ; heightening work (*.** m or more)

x ; relocation work near the existing bridge

0 ; no work

new ; new bridge across the short cut portion (no work for the existing bridge)

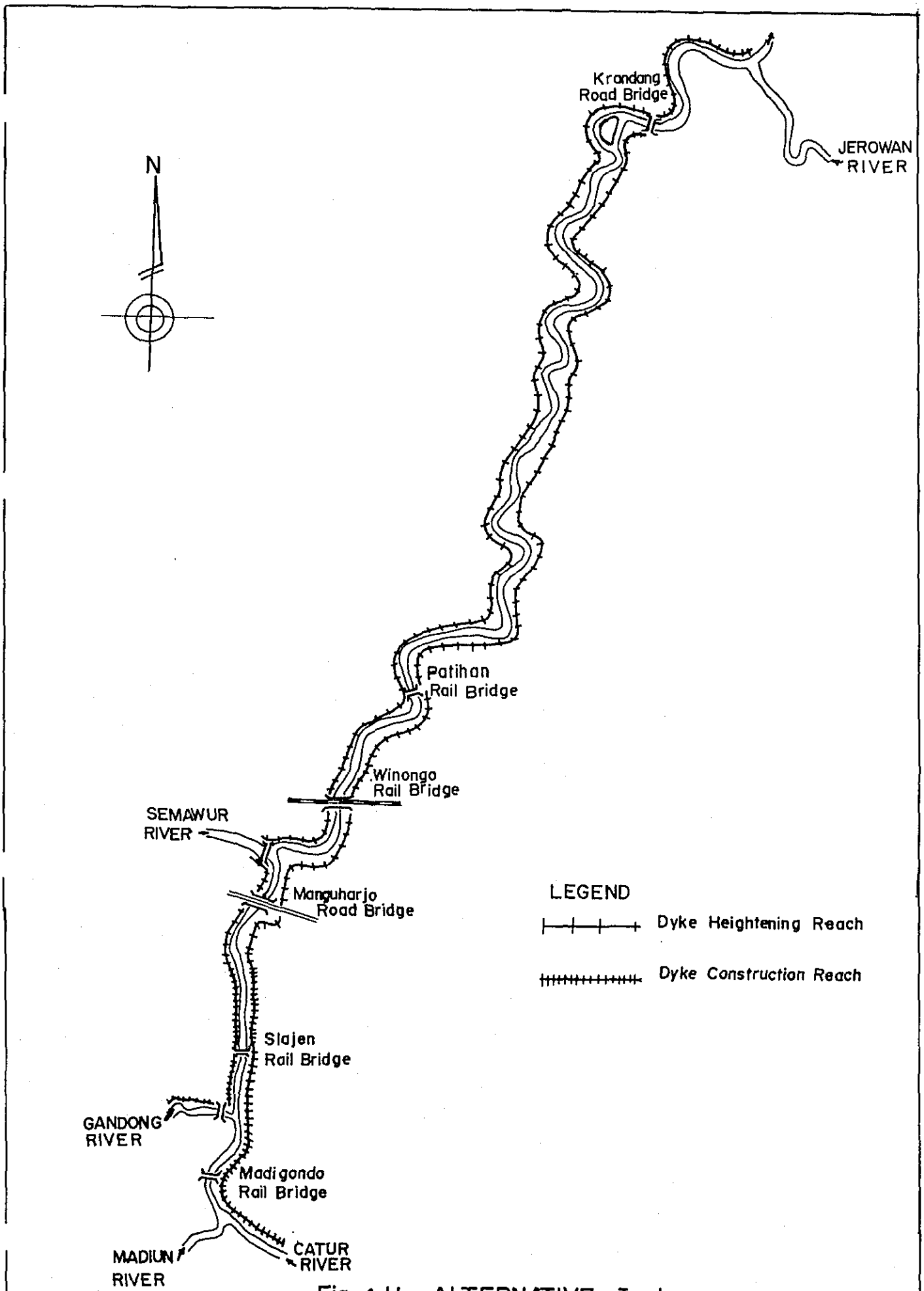


Fig .4.1.1 ALTERNATIVE I-1.

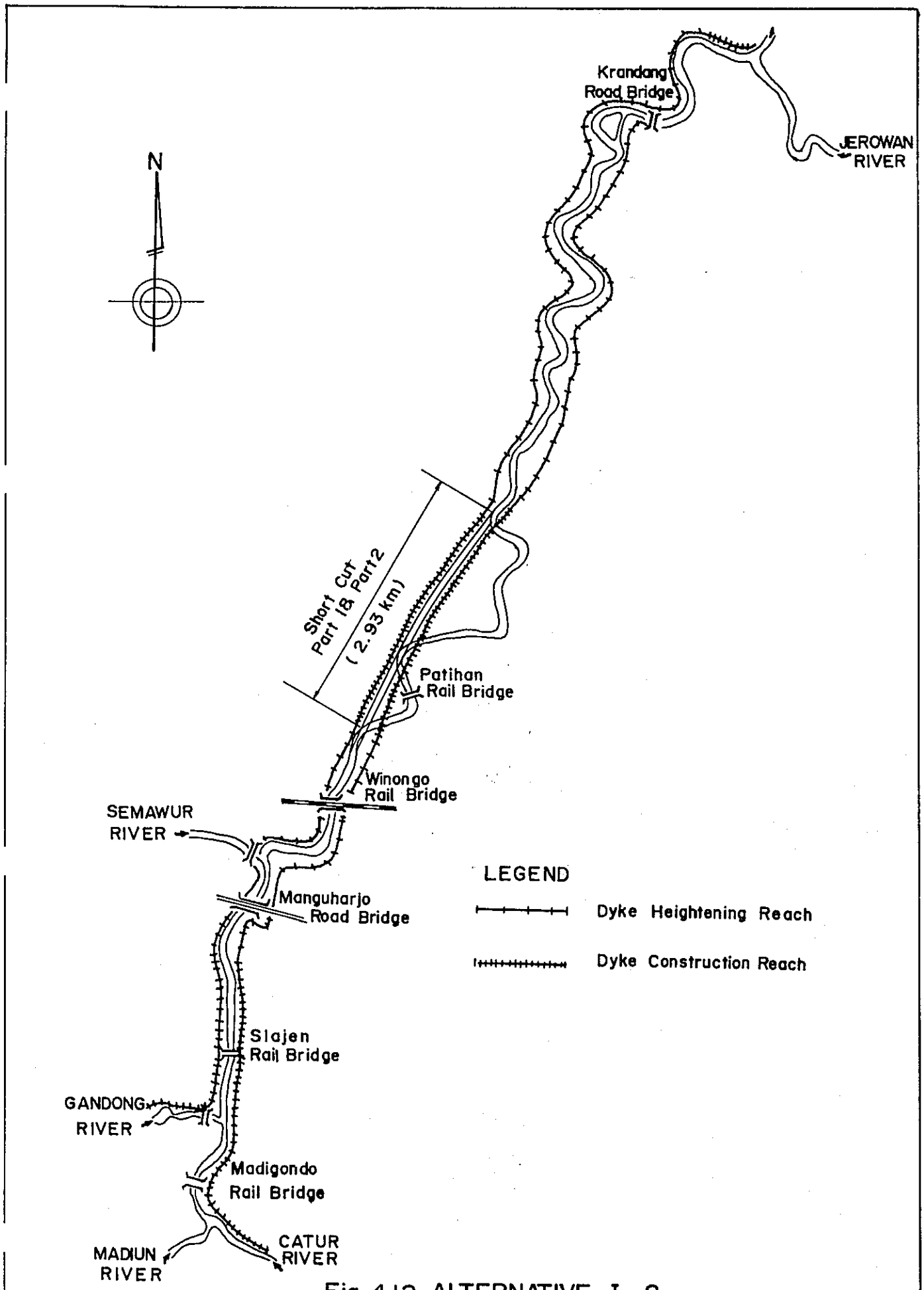


Fig .4.12 ALTERNATIVE I-2.

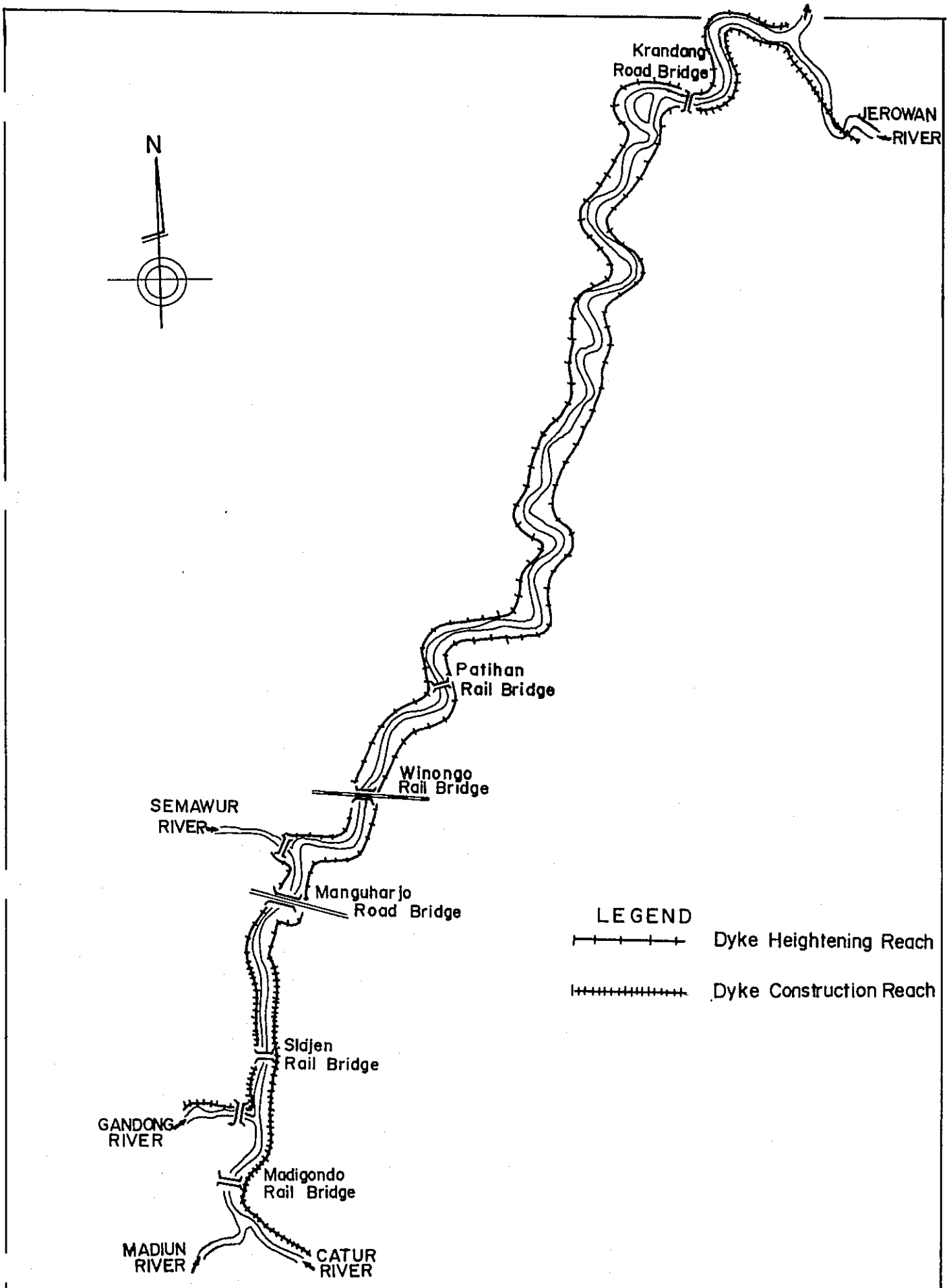


Fig 4.1.3 ALTERNATIVE II-1

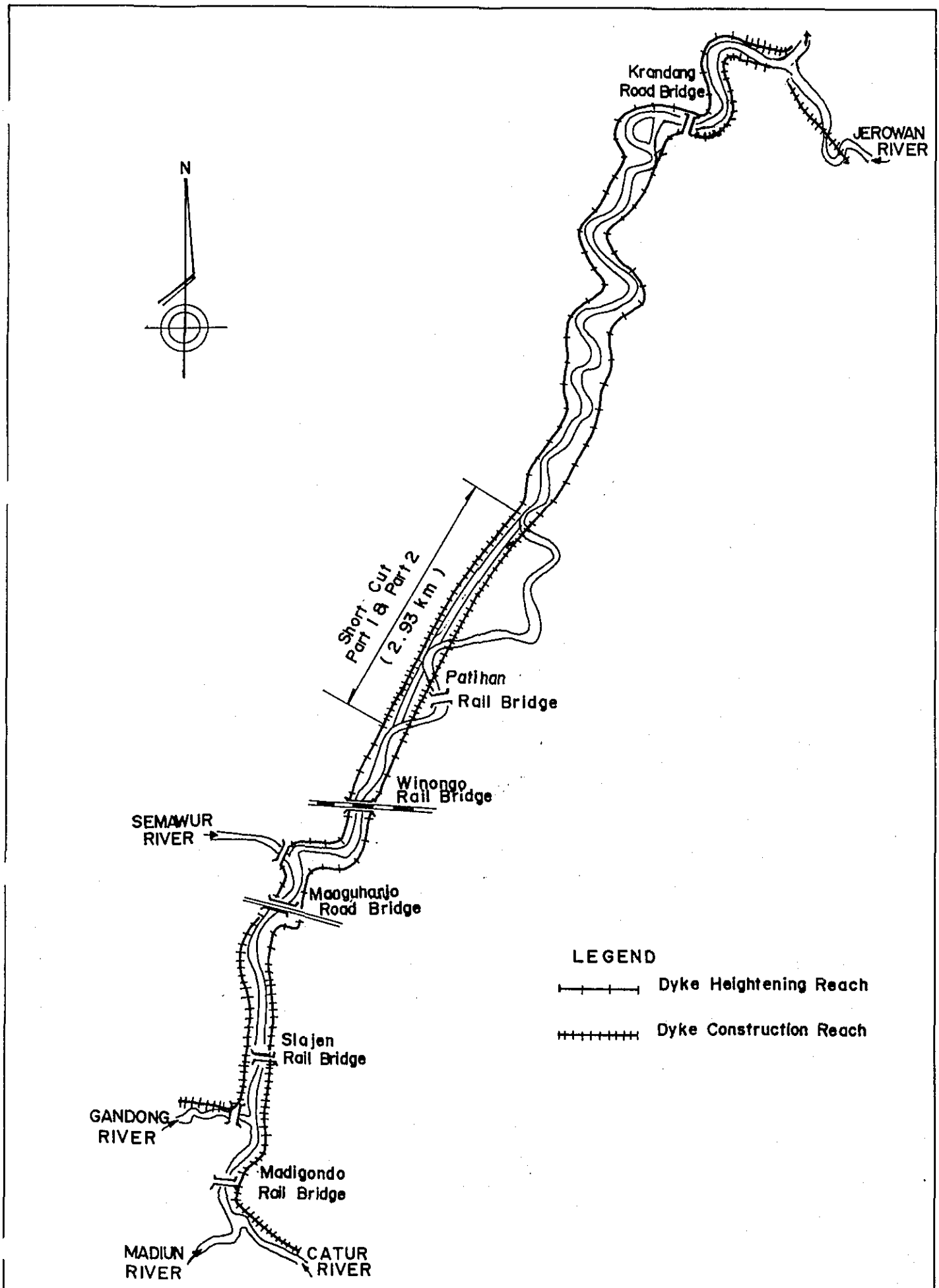


Fig.4.1.4 ALTERNATIVE II-2

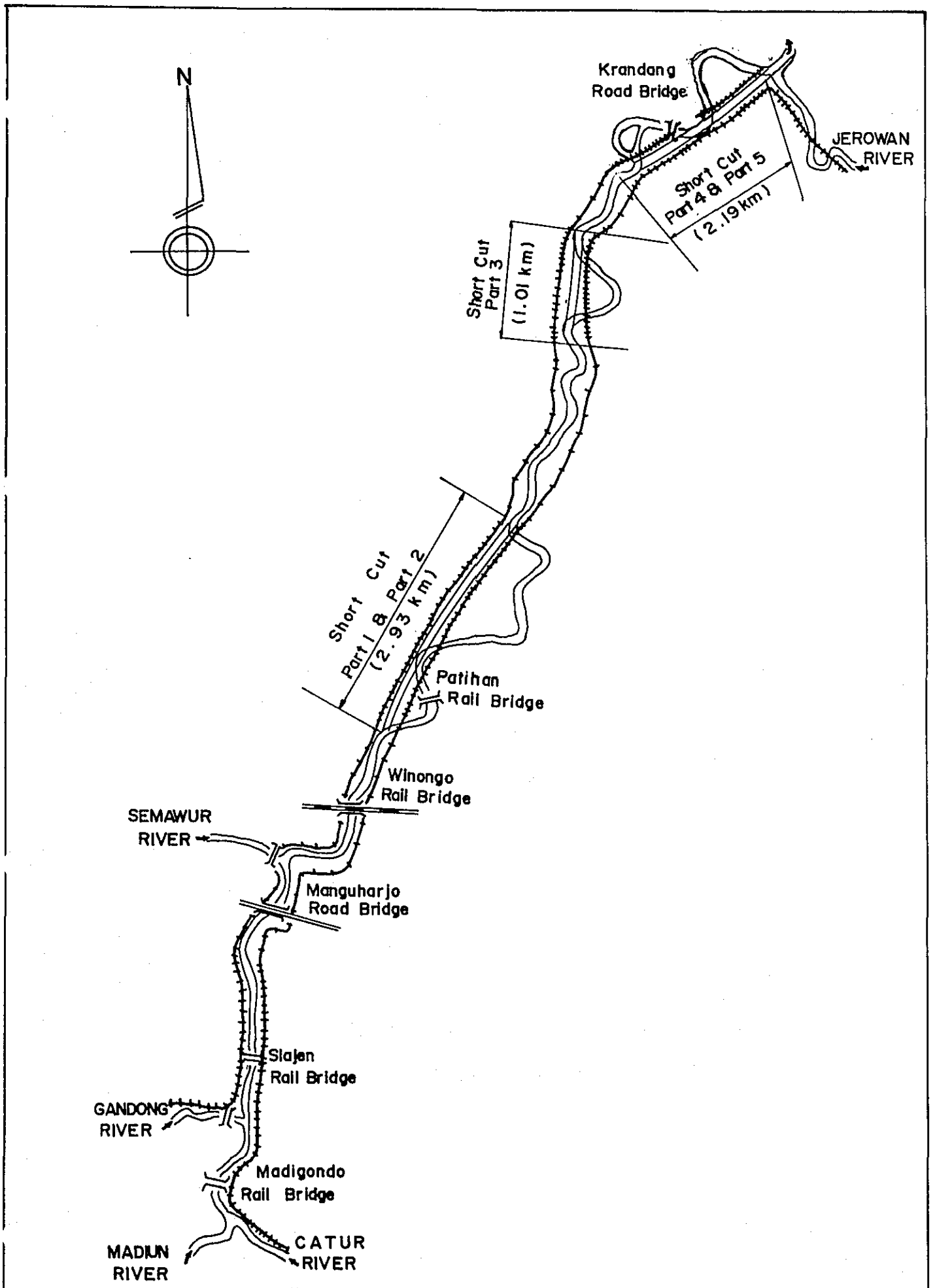


Fig.4.1.5 ALTERNATIVE II-3

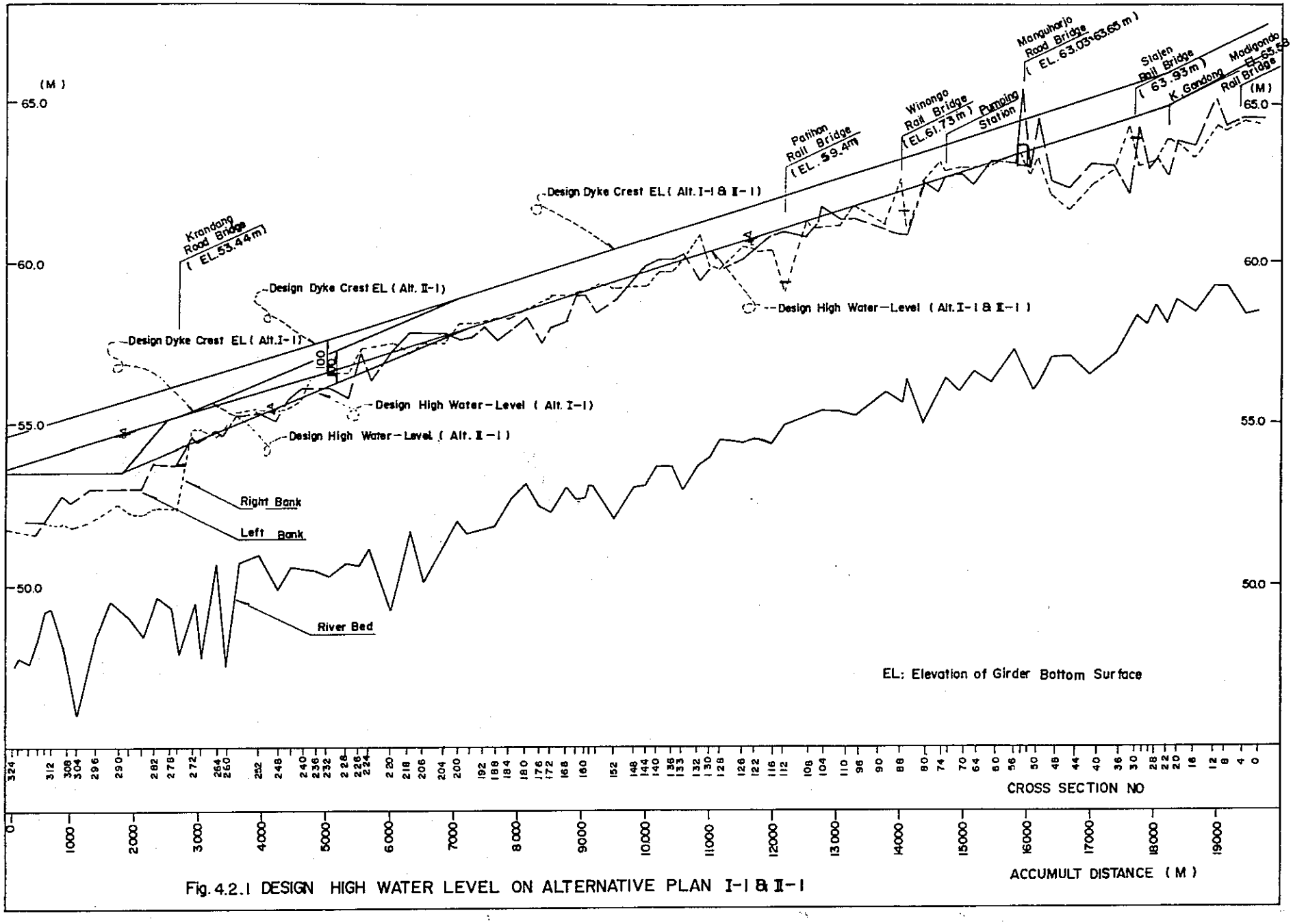


Fig. 4.2.1 DESIGN HIGH WATER LEVEL ON ALTERNATIVE PLAN I-1 & II-1

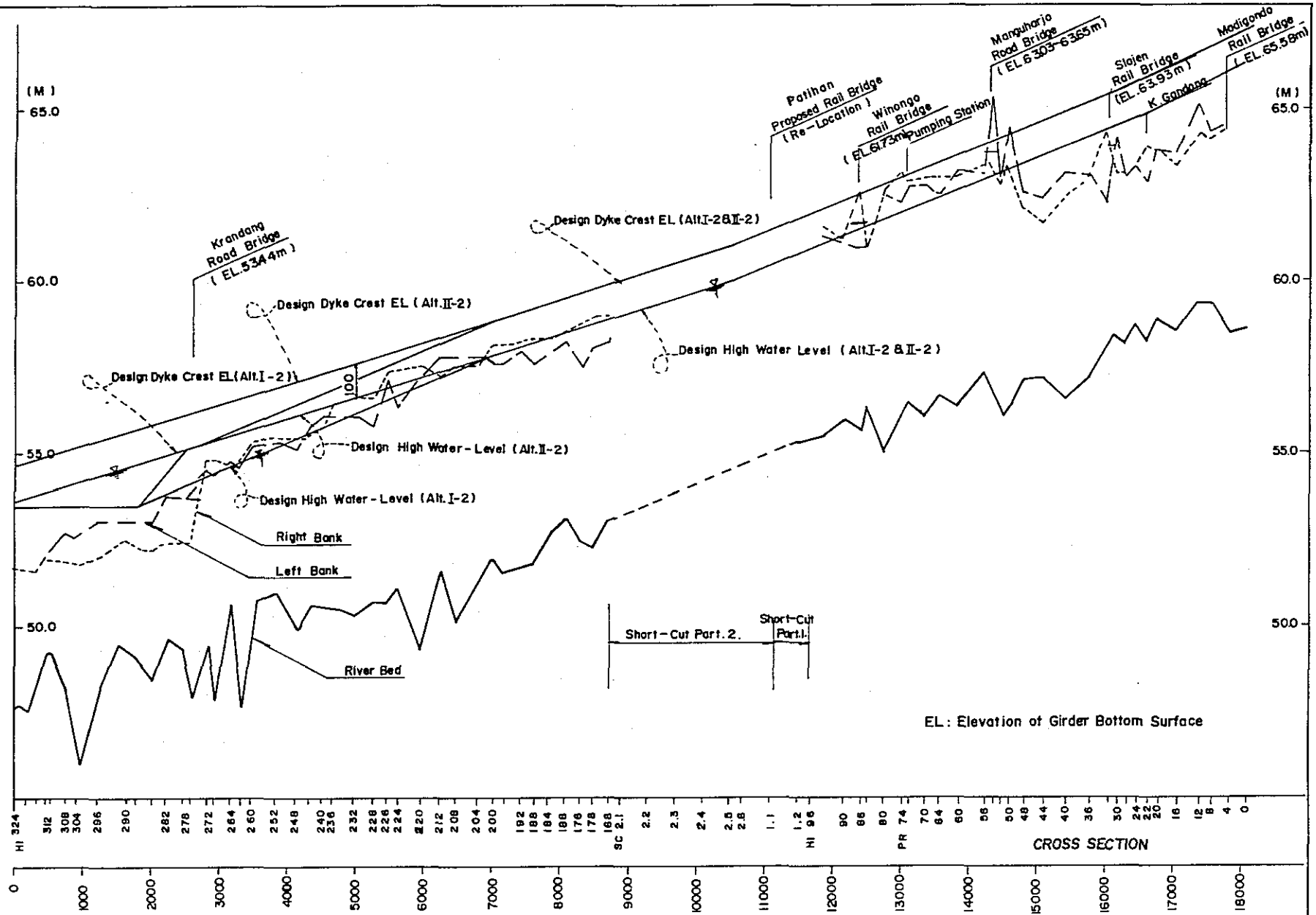


Fig.4.2.2 DESIGN HIGH WATER-LEVEL ON ALTERNATIVE PLAN I-2 & II-2
(INCLUDING SHORT-CUT 1 & 2)

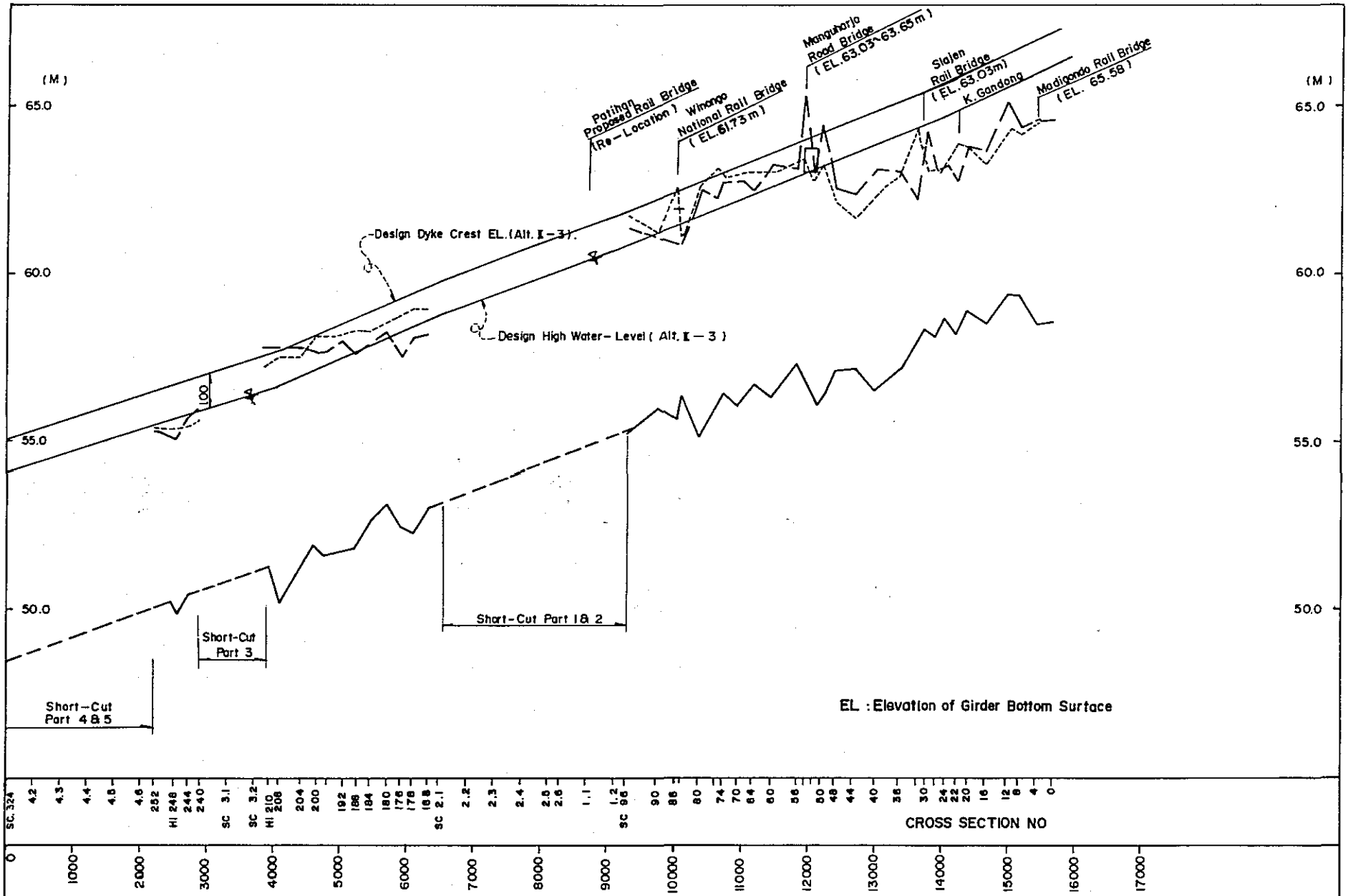
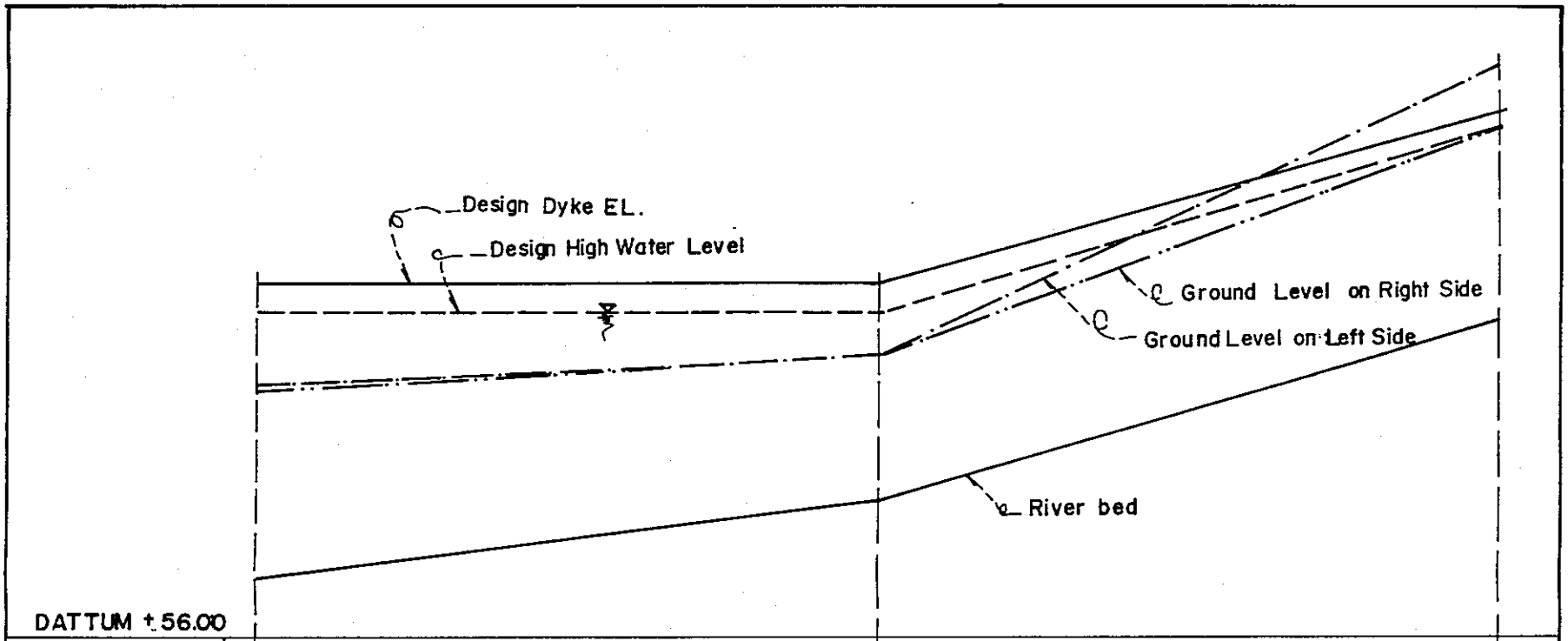
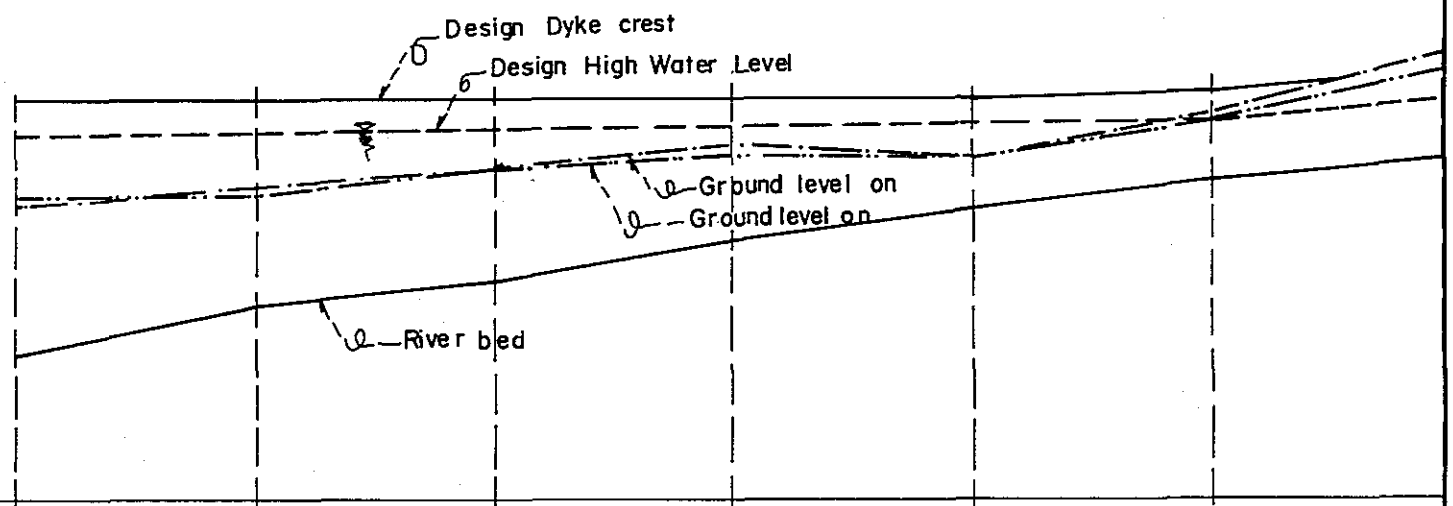


Fig 4.23 DESIGN HIGH WATER-LEVEL ON ALTERNATIVE PLAN II-3



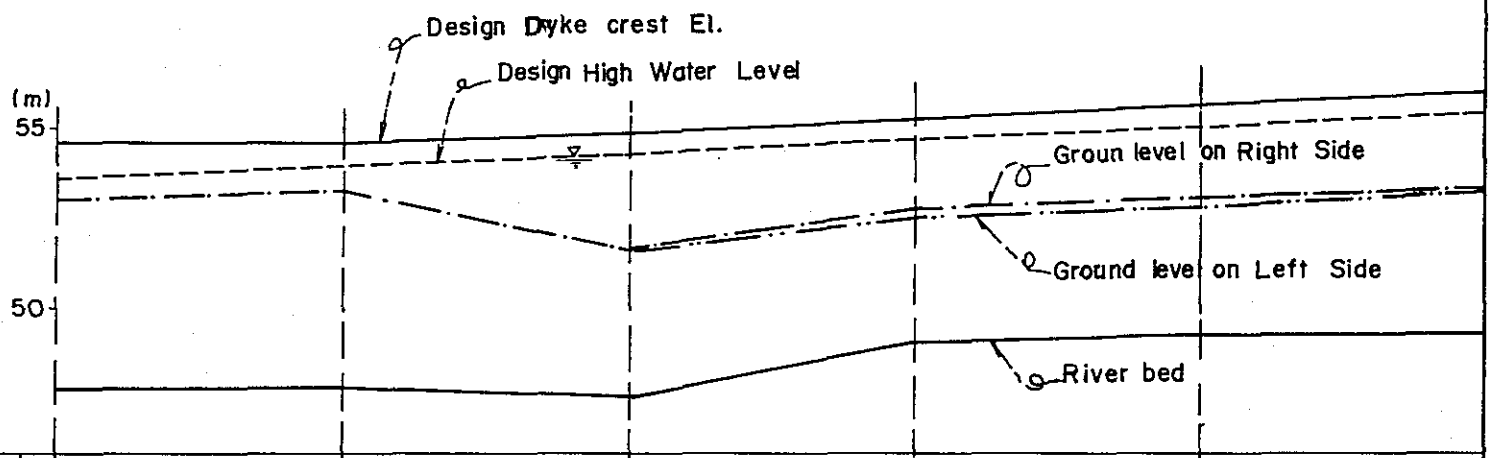
NUMBER OF C.S	0		2
DISTANCE	1.000	1.000	
WATER ELEVATION	66.31	66.33	
RIVER BED	57.73	60.25	66.14
LEFT GROUND ELEVATION	64.00	64.96	74.16
RIGHT GROUND ELEVATION	63.78	65.13	72.16

Fig.4.3.1 DESIGN HIGH WATER LEVEL OF CATUR RIVER



NUMBER OF C.S	0	1	2	3	4	5
DISTANCE	5.00	5.00	5.00	5.00	5.00	5.00
WATER ELEVATION		65.04	65.08	65.12	65.34	65.34
RIVER BED	58.88	60.27	61.01	62.04	62.96	63.83	64.32
GROUND LEFT ELEVATION	63.15	63.61	64.09	64.77	64.40	65.64	67.30
GROUND RIGH ELEVATION	63.27	63.46	64.07	64.52	64.72	65.51	66.79

Fig.4.3.2 DESIGN HIGH WATER LEVEL OF GANDONG RIVER



NUMBER OF C.S	0		1		2		3		4		5
DISTANCE		1.000		1.000		1.000		1.000		1.000	
WATER ELEVATION	53.60		53.94		54.28		54.62		54.96		55.29
RIVER BED	47.68		47.72		47.56		49.03		49.16		49.21
LEFT GROUND ELEVATION	53.00		53.18		51.67		52.69		52.97		53.34
RIGHT GROUND ELEVATION	53.08		53.17		51.52		52.51		52.77		53.17

Fig.4.3.3 DESIGN HIGH WATER LEVEL OF JEROWAN RIVER

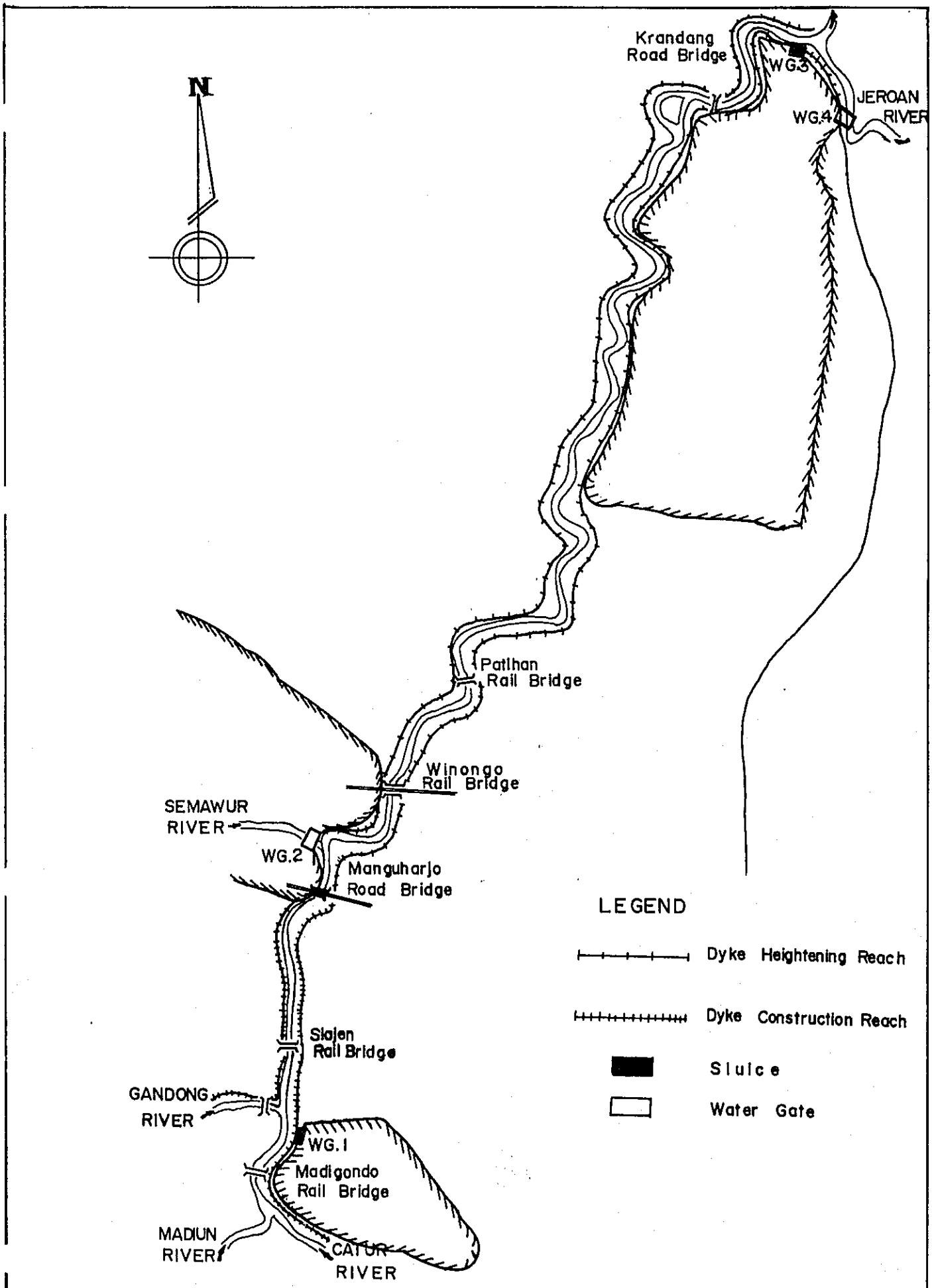


Fig.4.4 THE PROPOSED LOCATION OF SLUICE AND WATER GATE

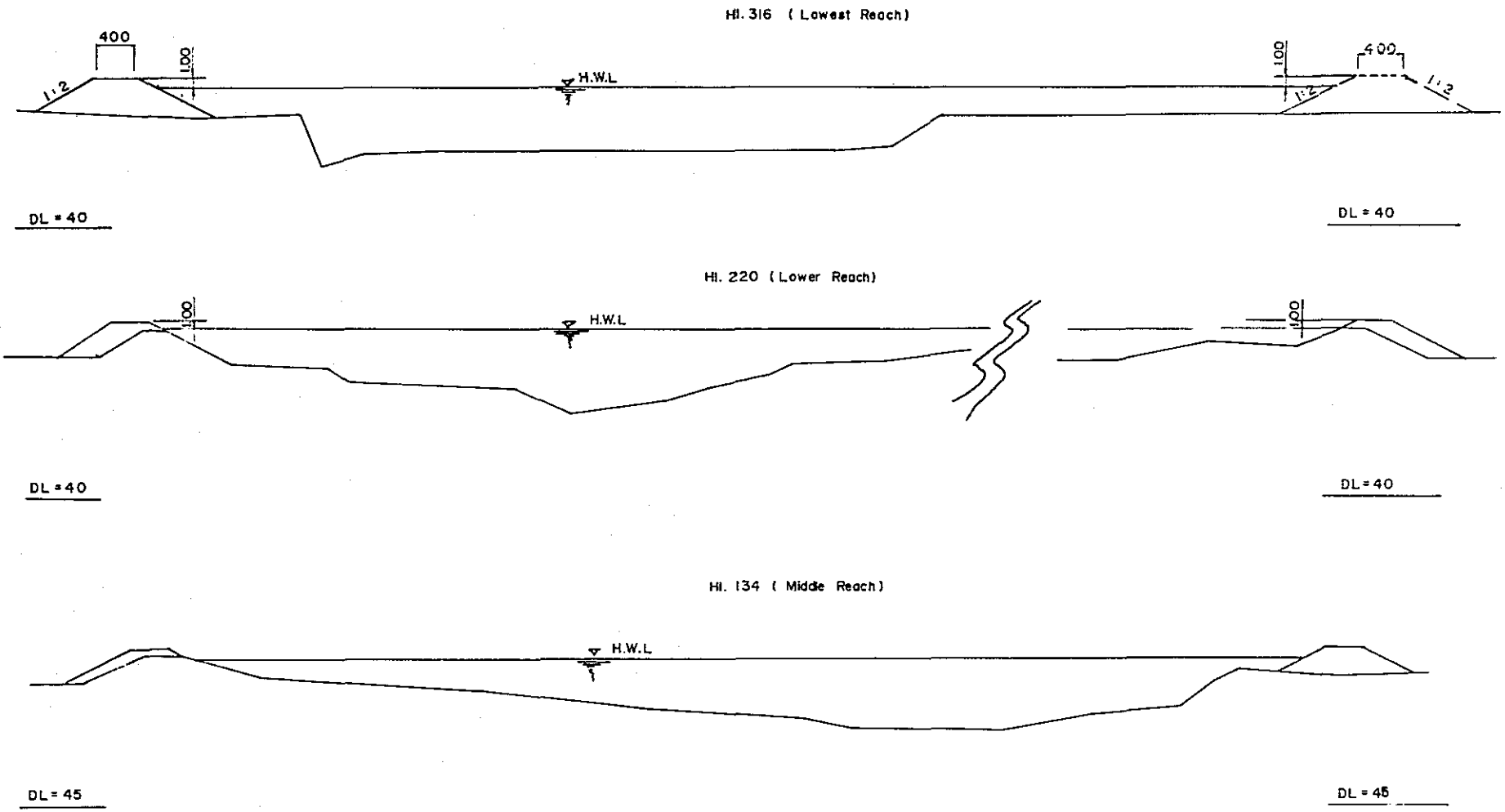


Fig .4.5.1 CROSS SECTION OF MADIUN RIVER (I)

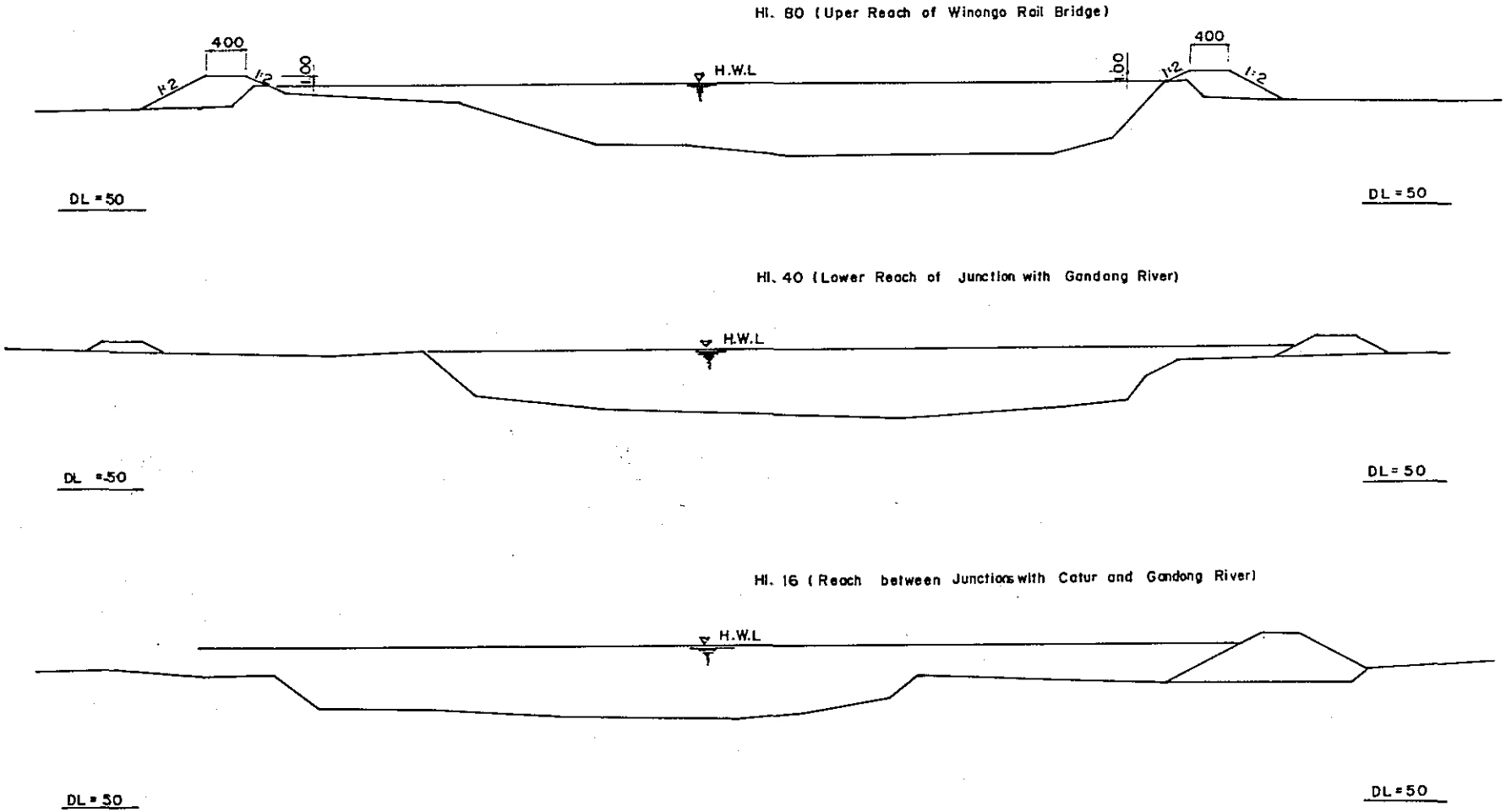


Fig. 4.5.2 CROSS SECTION OF MADIUN RIVER (2)

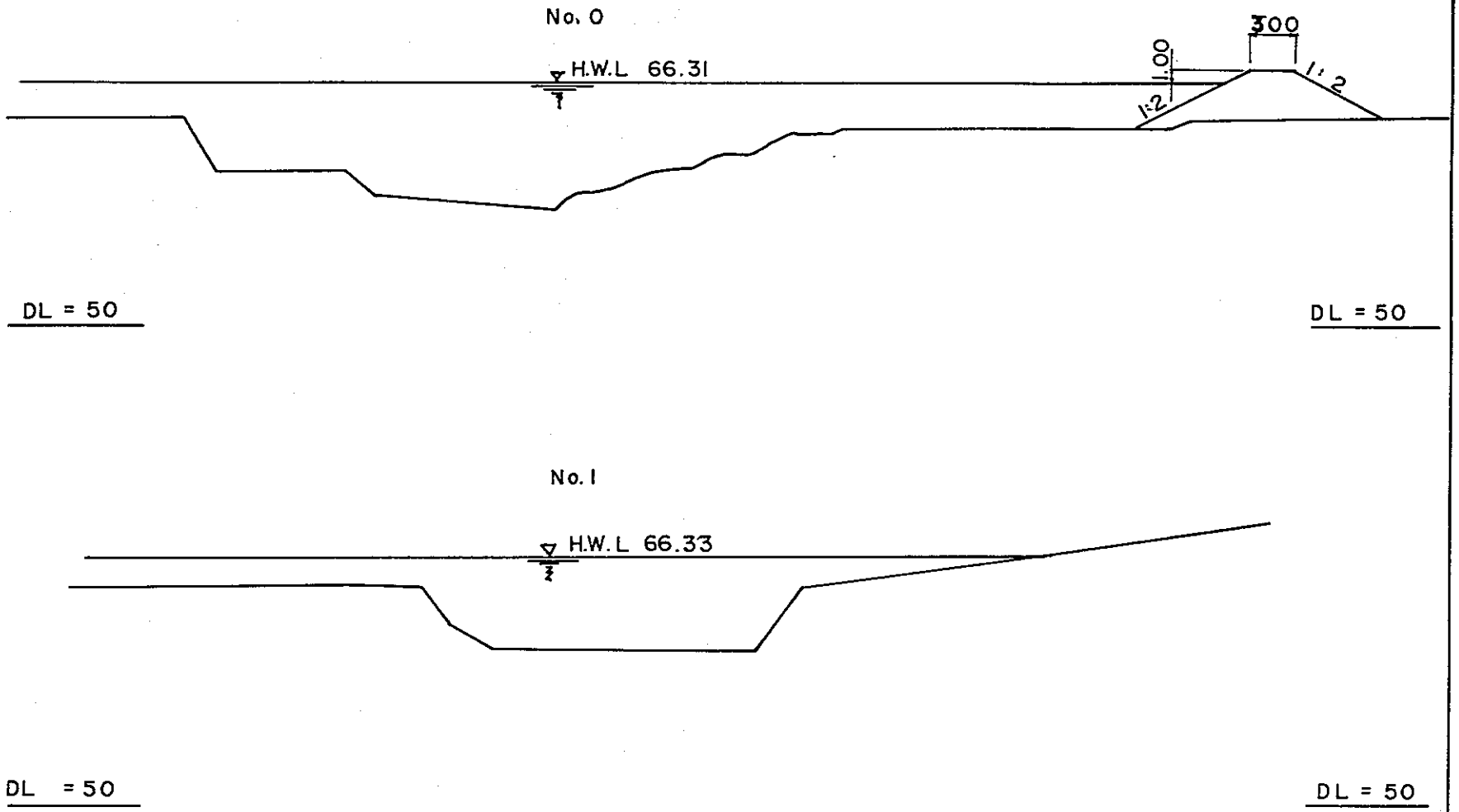


Fig. 4.6.1 CROSS SECTION OF CATUR RIVER

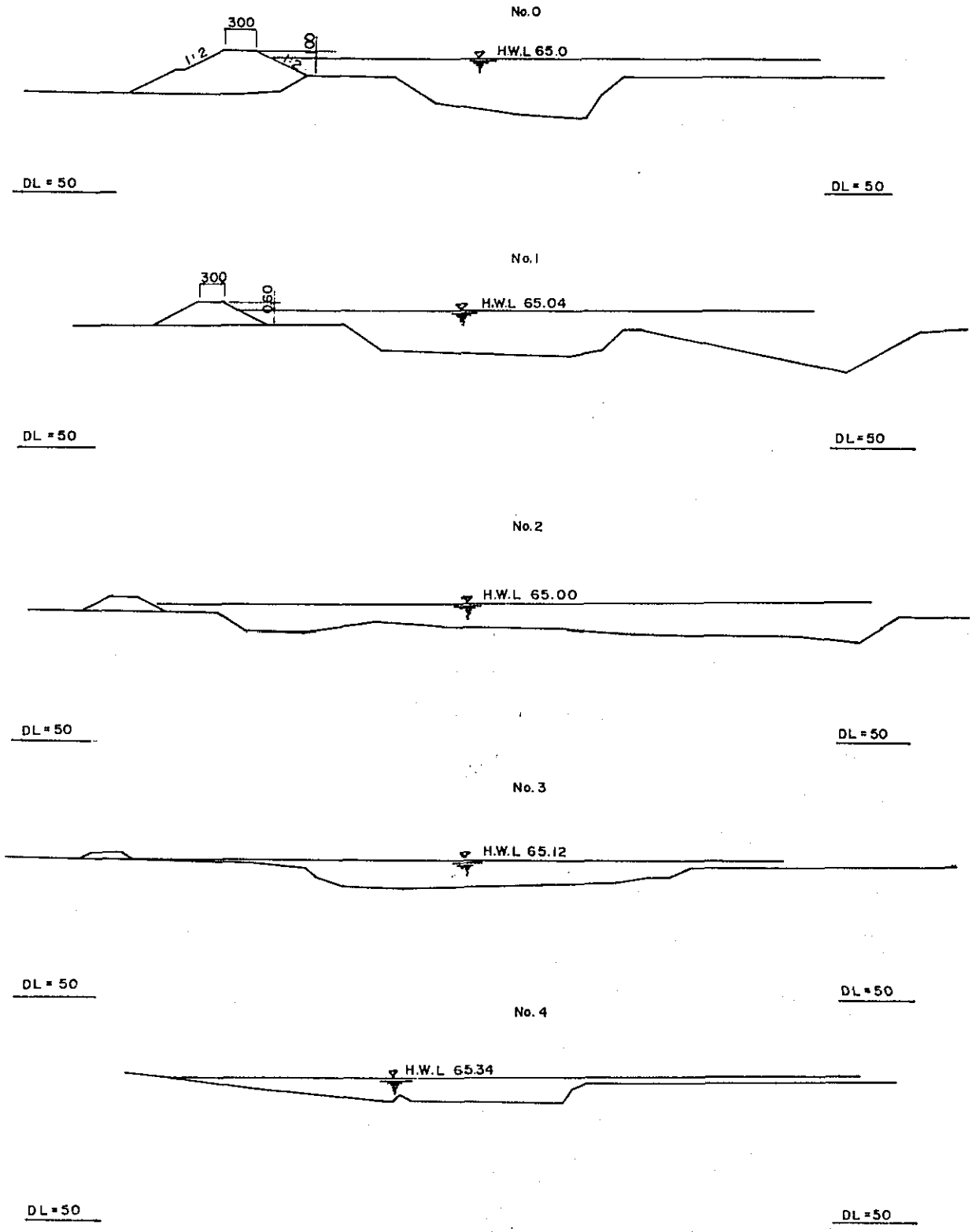


Fig.4.6.2 CROSS SECTION OF GANDONG RIVER

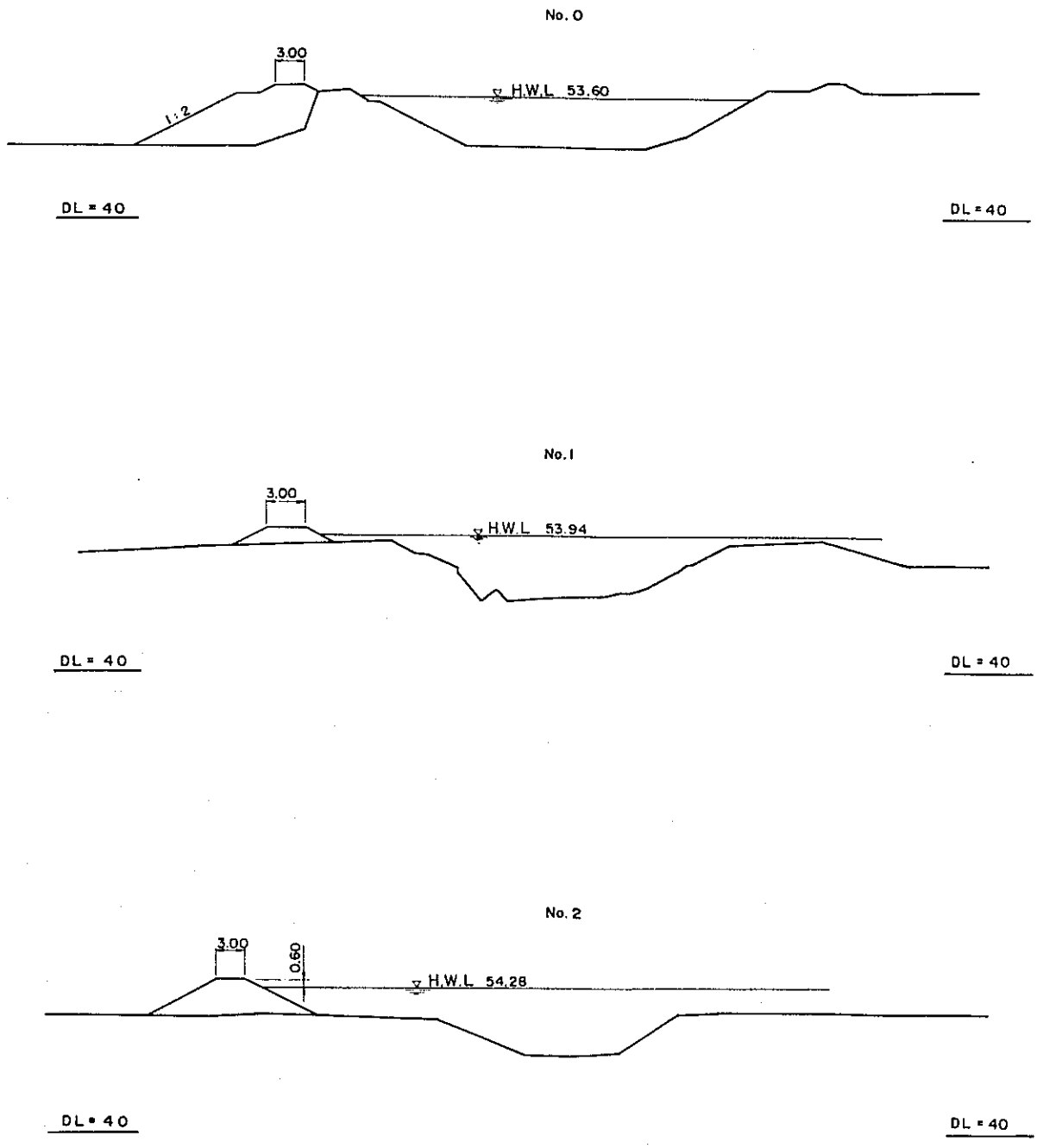


Fig.4.63 CROSS SECTION OF JEROWAN RIVER (1)

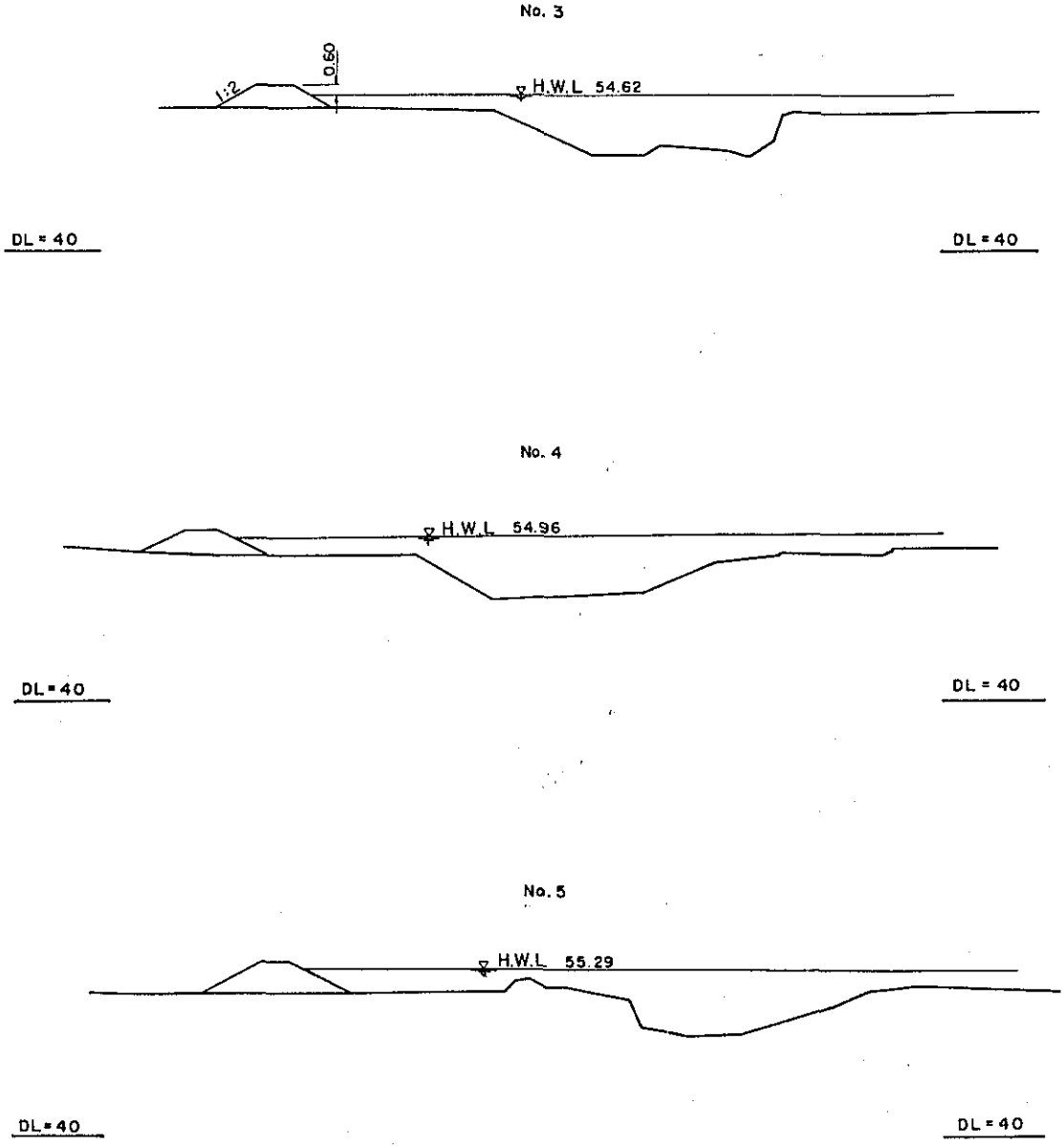


Fig.4.6.4 CROSS SECTION OF JEROWAN RIVER (2)

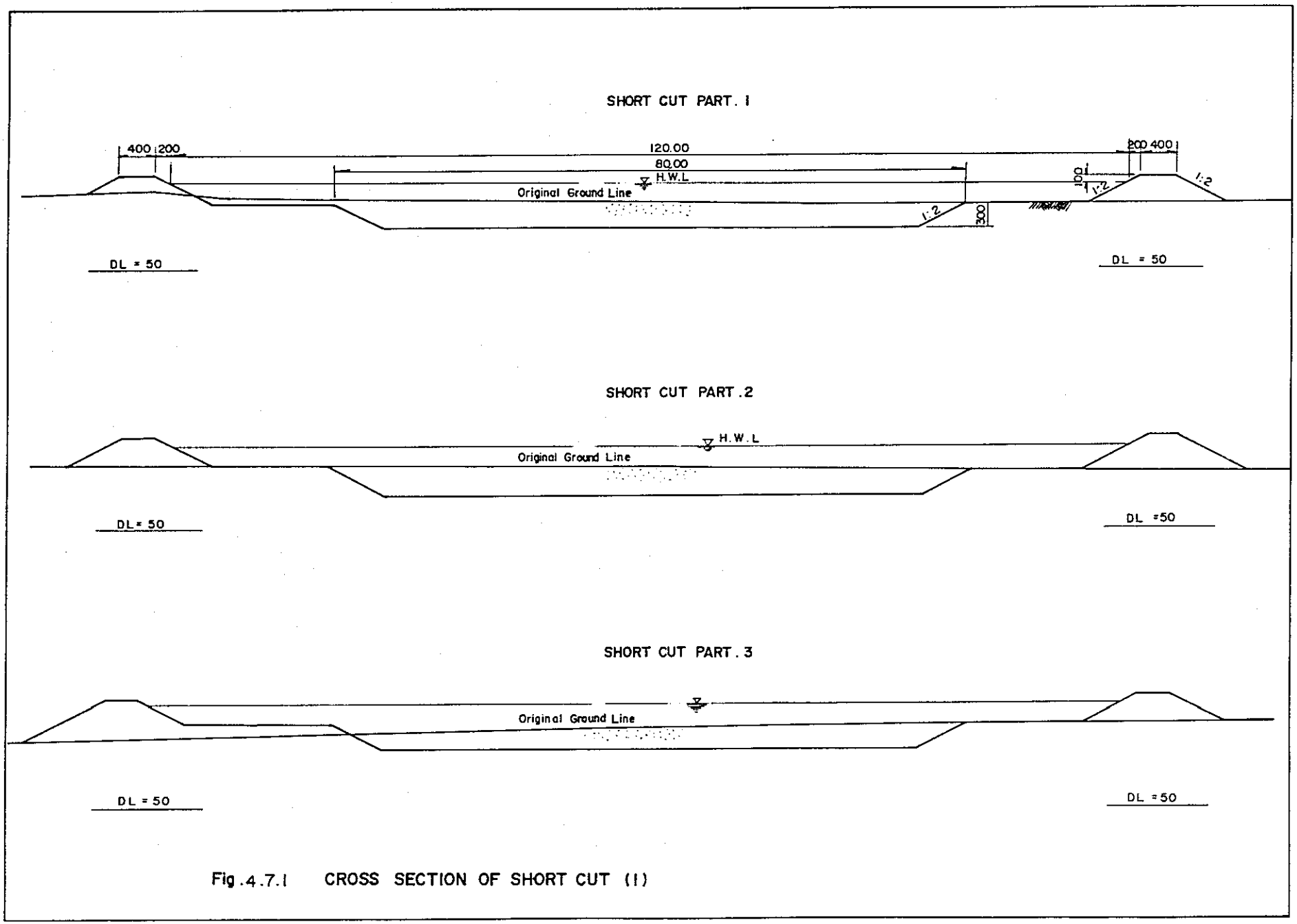


Fig. 4.7.1 CROSS SECTION OF SHORT CUT (1)

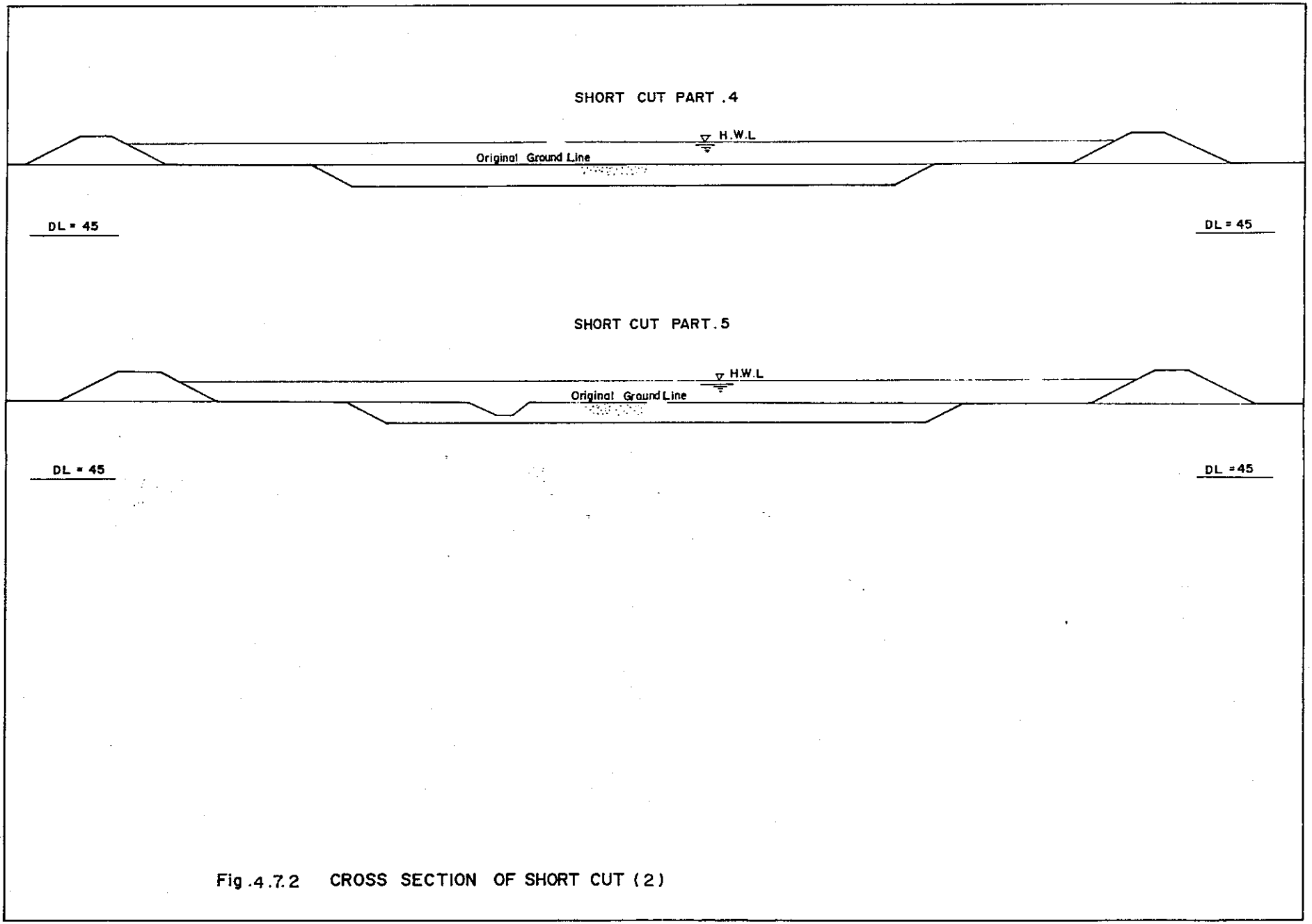


Fig .4.7.2 CROSS SECTION OF SHORT CUT (2)

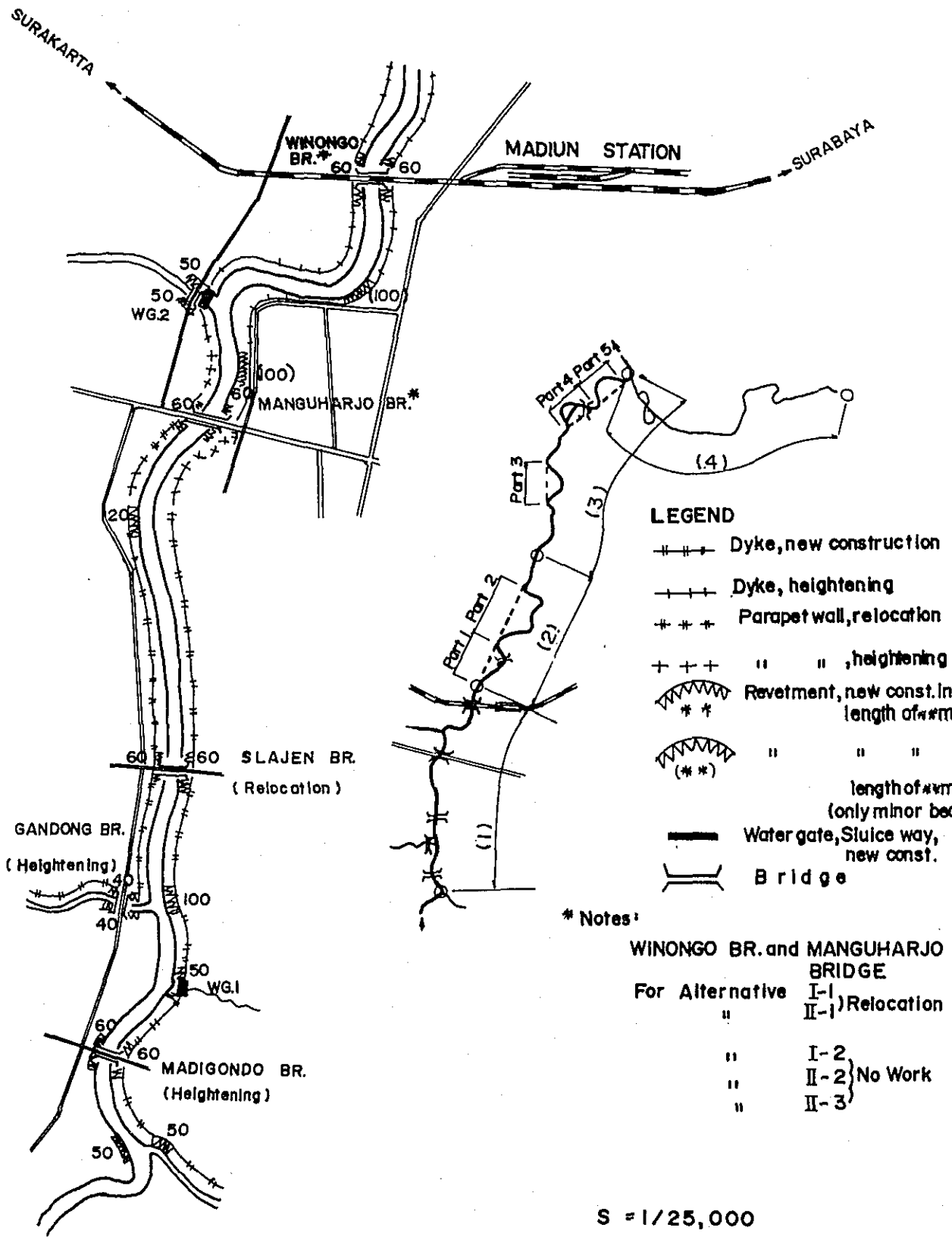


Fig. 4 . 8 LOCATIONS OF NEWLY PROPOSED STRUCTURES (1)

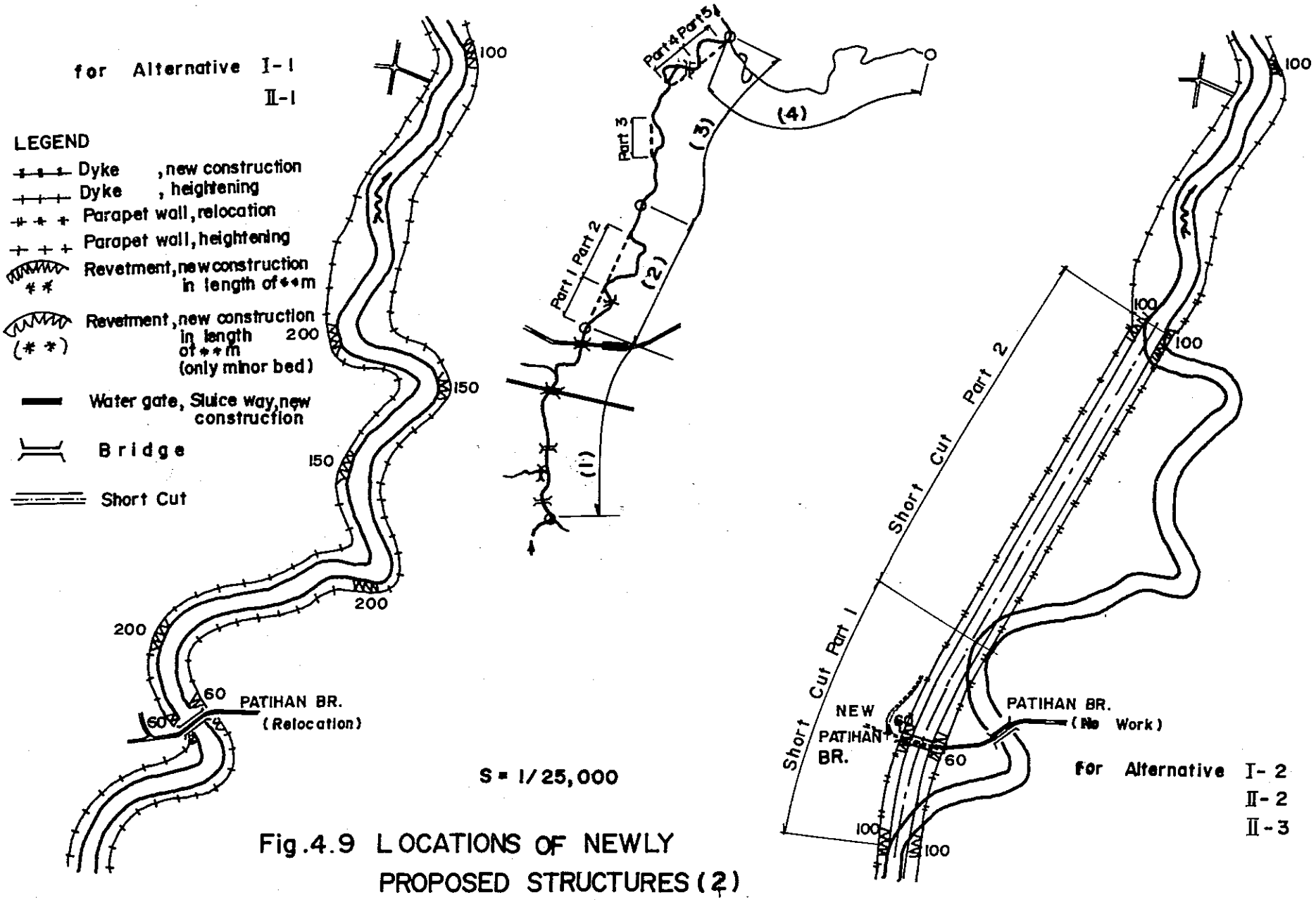


Fig.4.9 LOCATIONS OF NEWLY PROPOSED STRUCTURES (2)

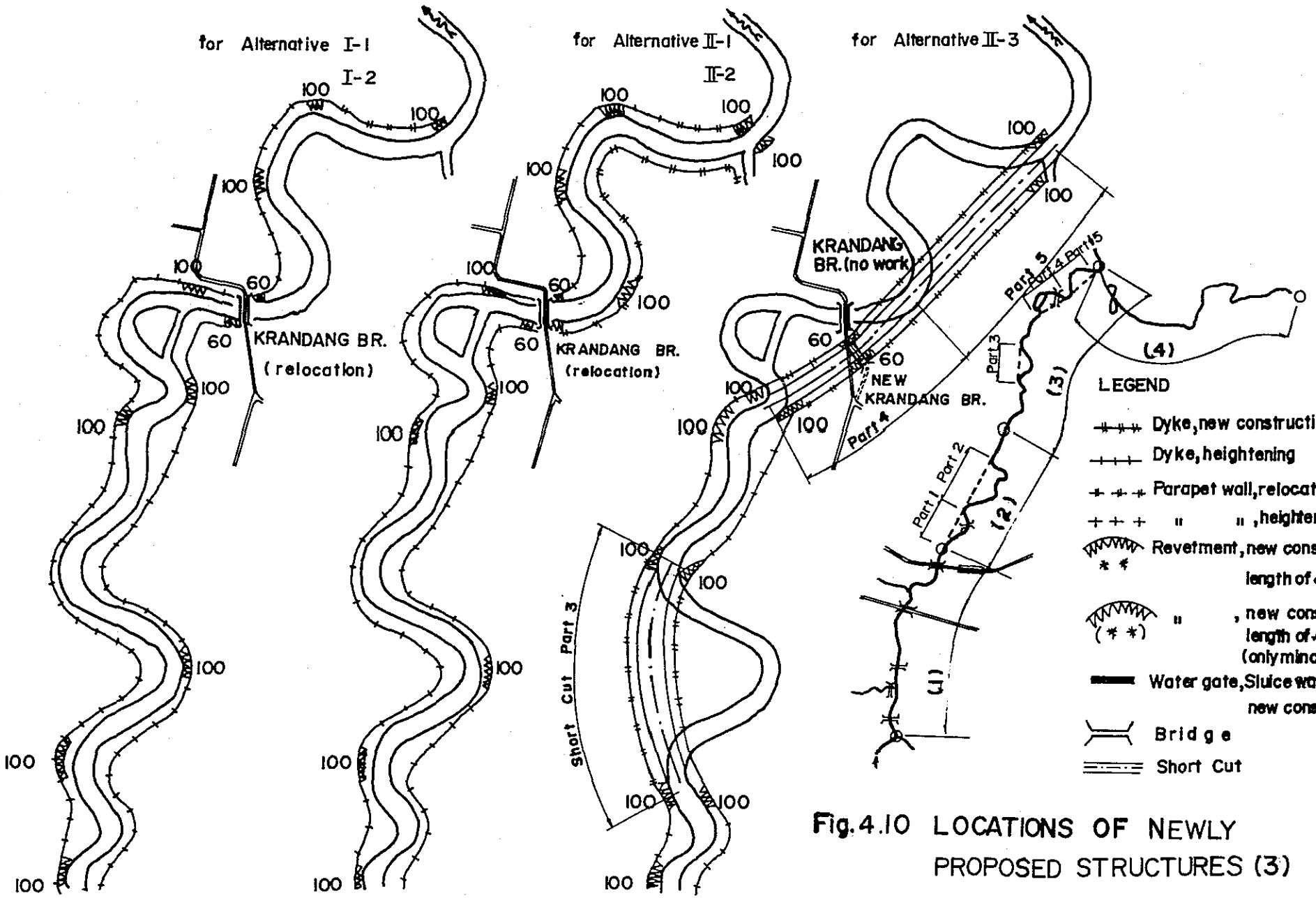


Fig. 4.10 LOCATIONS OF NEWLY PROPOSED STRUCTURES (3)

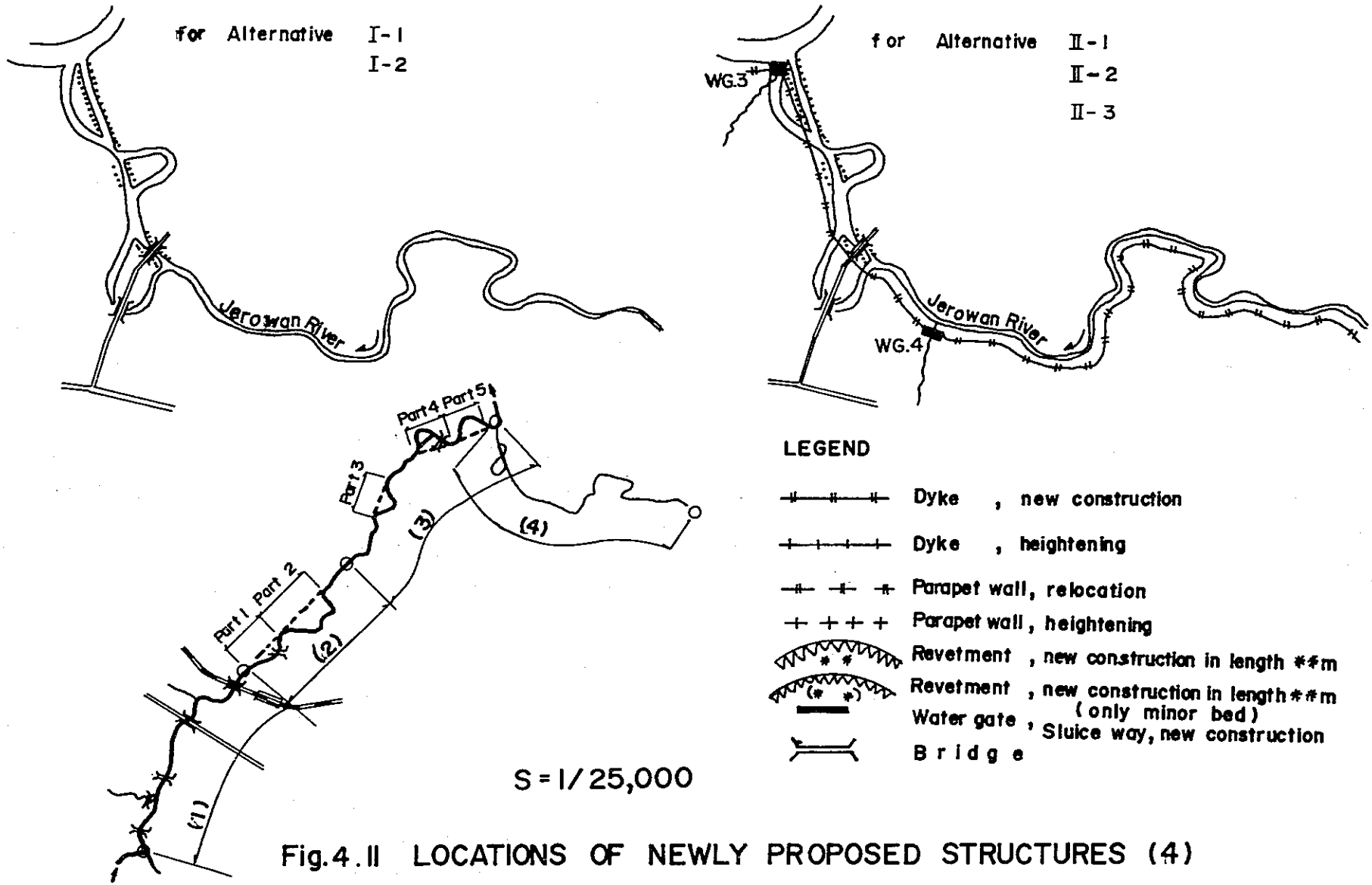


Fig.4.11 LOCATIONS OF NEWLY PROPOSED STRUCTURES (4)

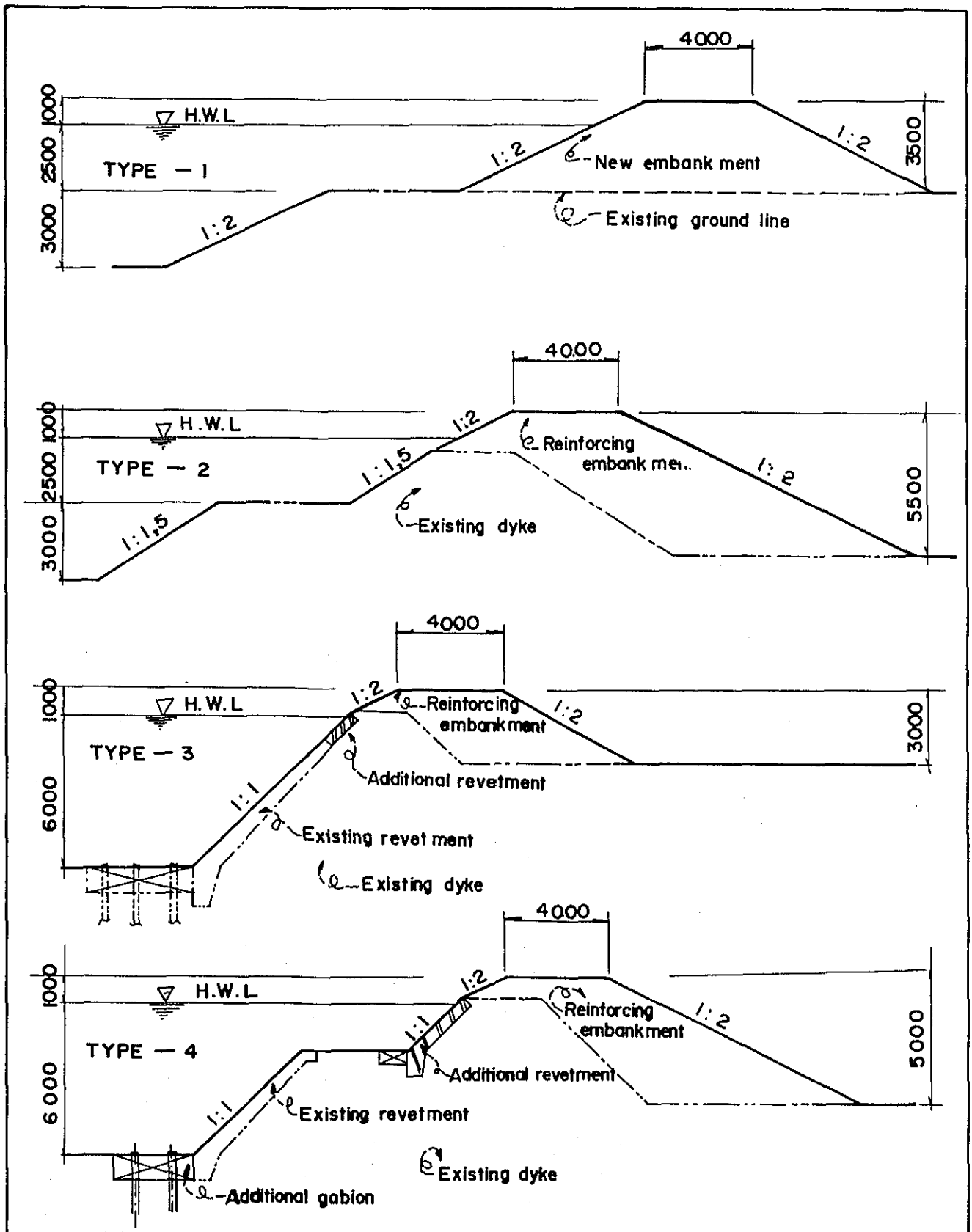


Fig. 4 12 TYPICAL SECTION OF DYKE

S = 1/200

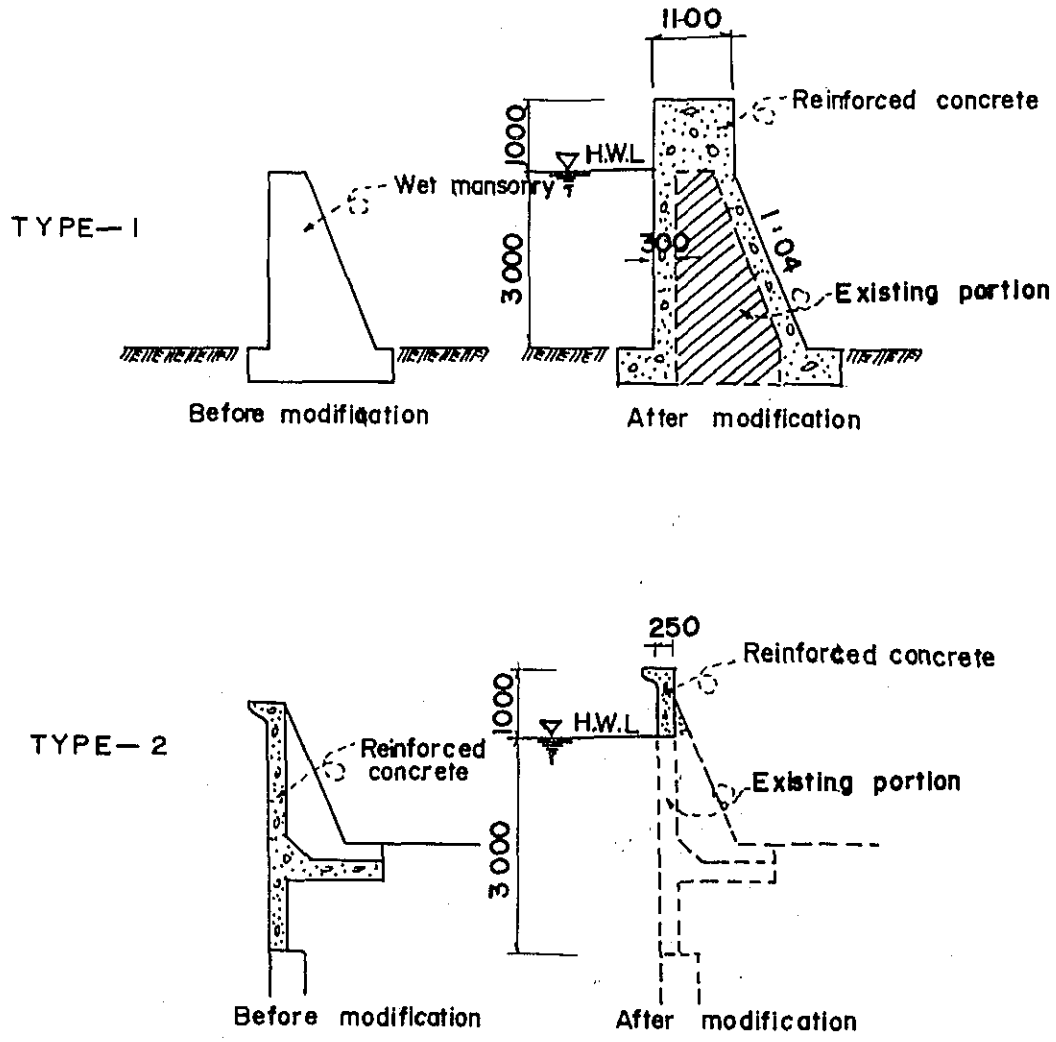


Fig.4.13 MODIFICATION OF PARAPET WALL S=1/100
(TYPICAL SECTION)

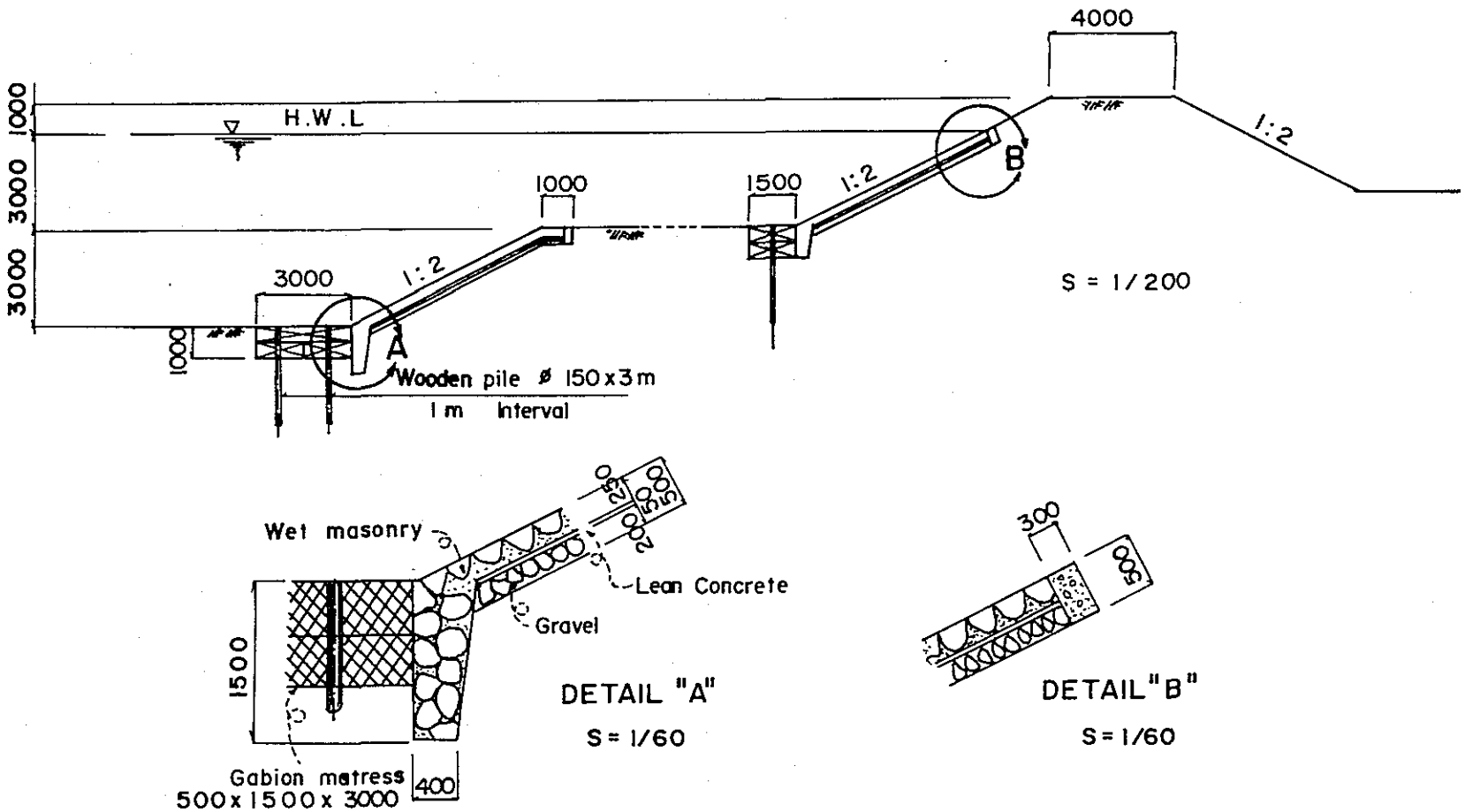


Fig. 4 .14 TYPICAL SECTION OF REVETMENT (NEW CONSTRUCTION)

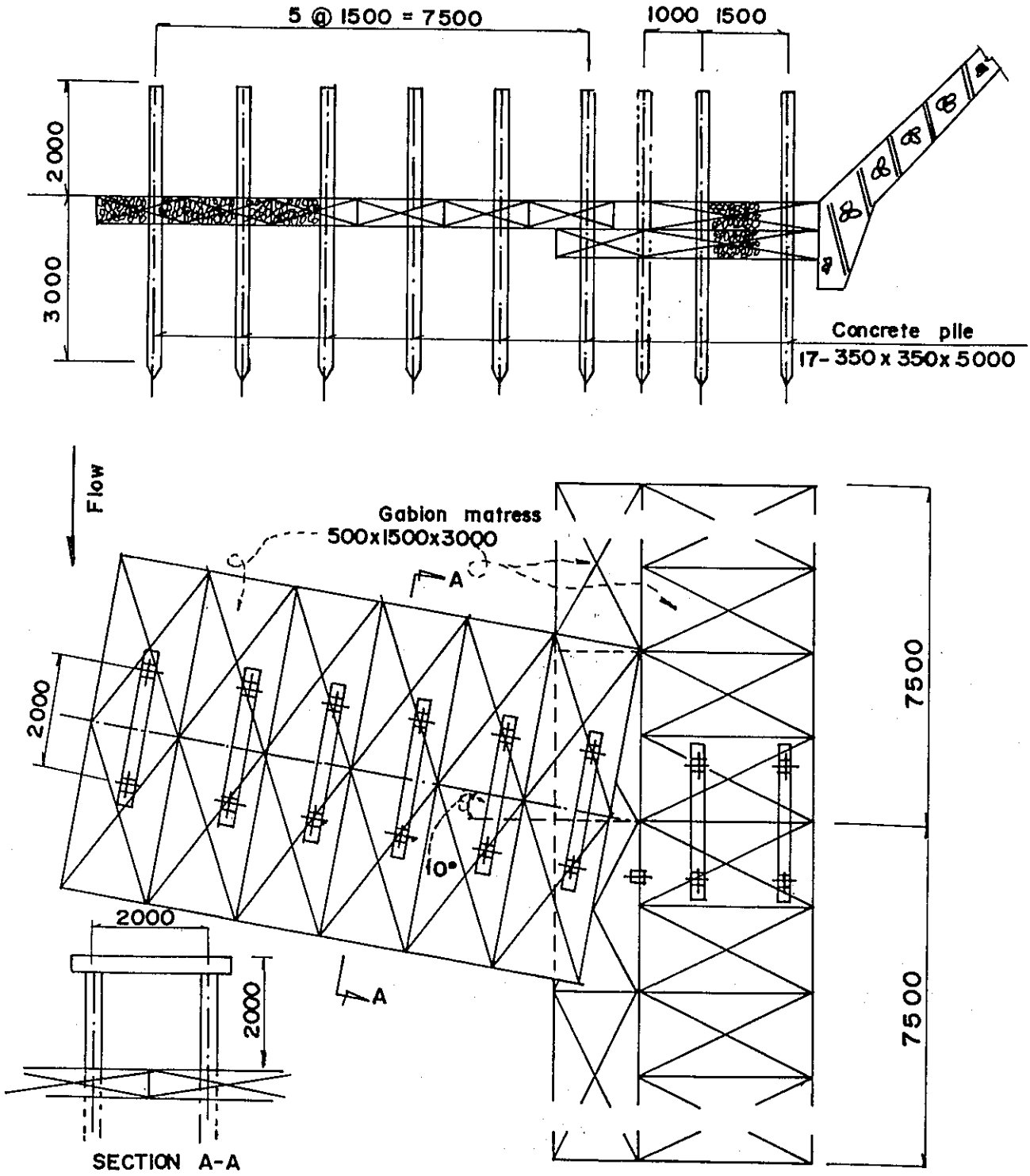


Fig. 4.15 TYPICAL ARRANGEMENT OF GROYNE

S=1/100

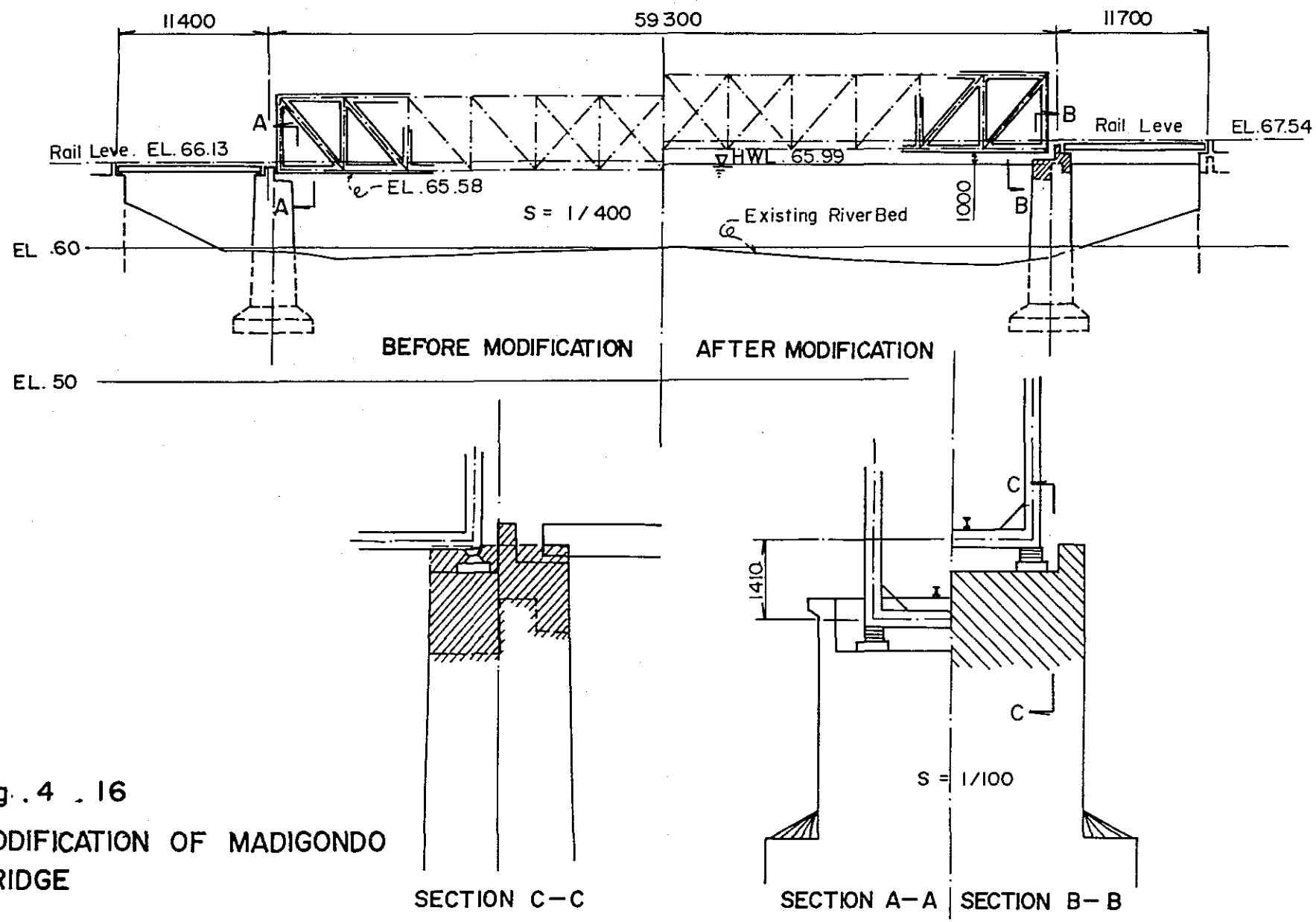


Fig. 4 . 16

MODIFICATION OF MADIGONDO BRIDGE

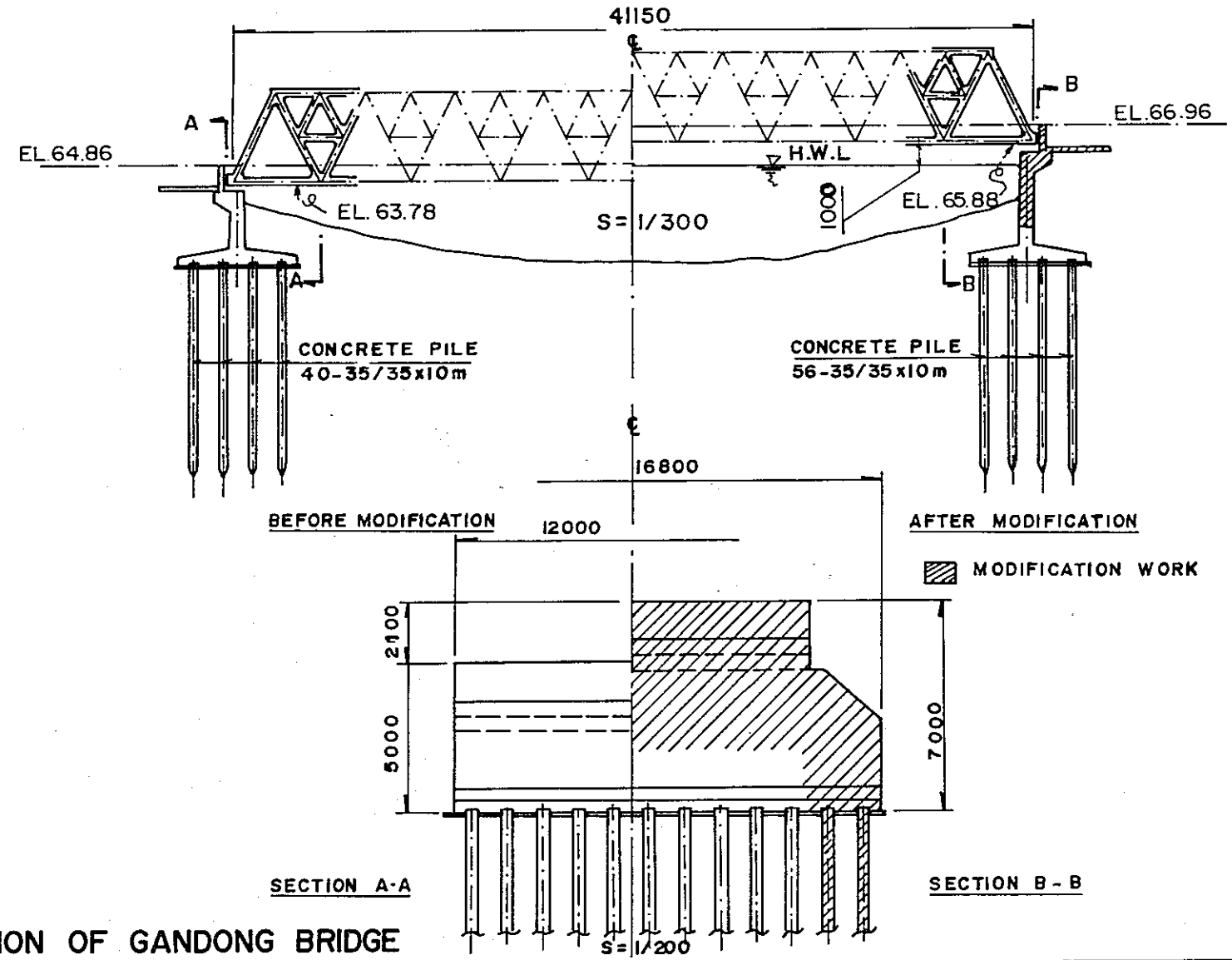
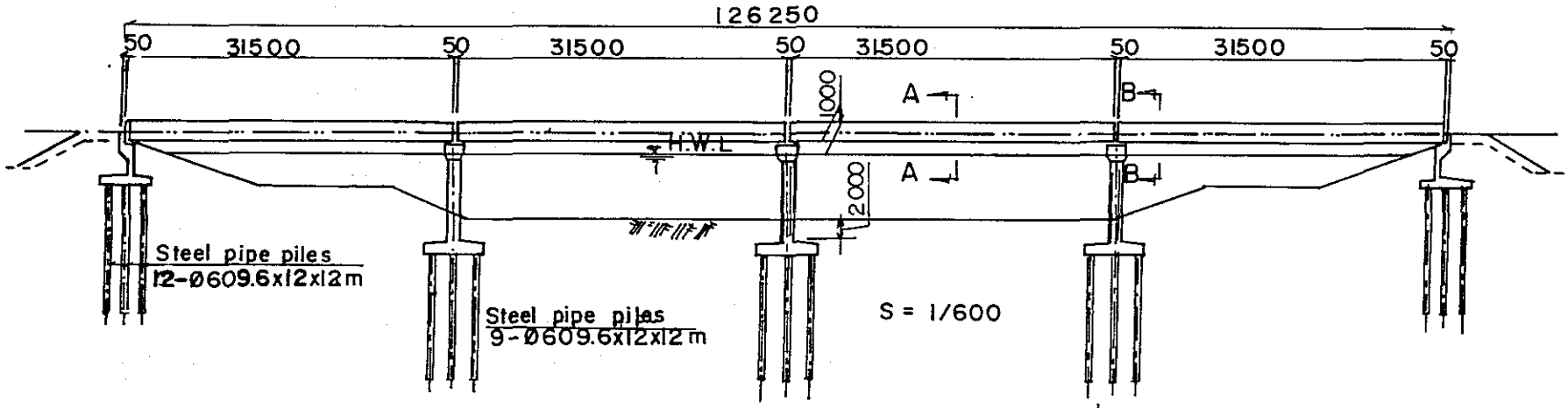


Fig. 4 . 17
MODIFICATION OF GANDONG BRIDGE



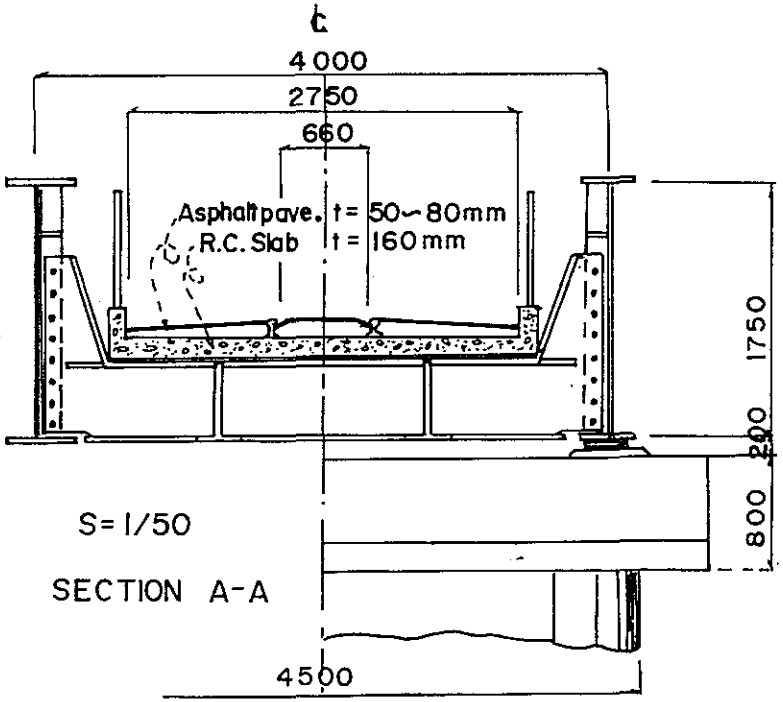


Fig. 4 .18 NEW PATIHAN BRIDGE

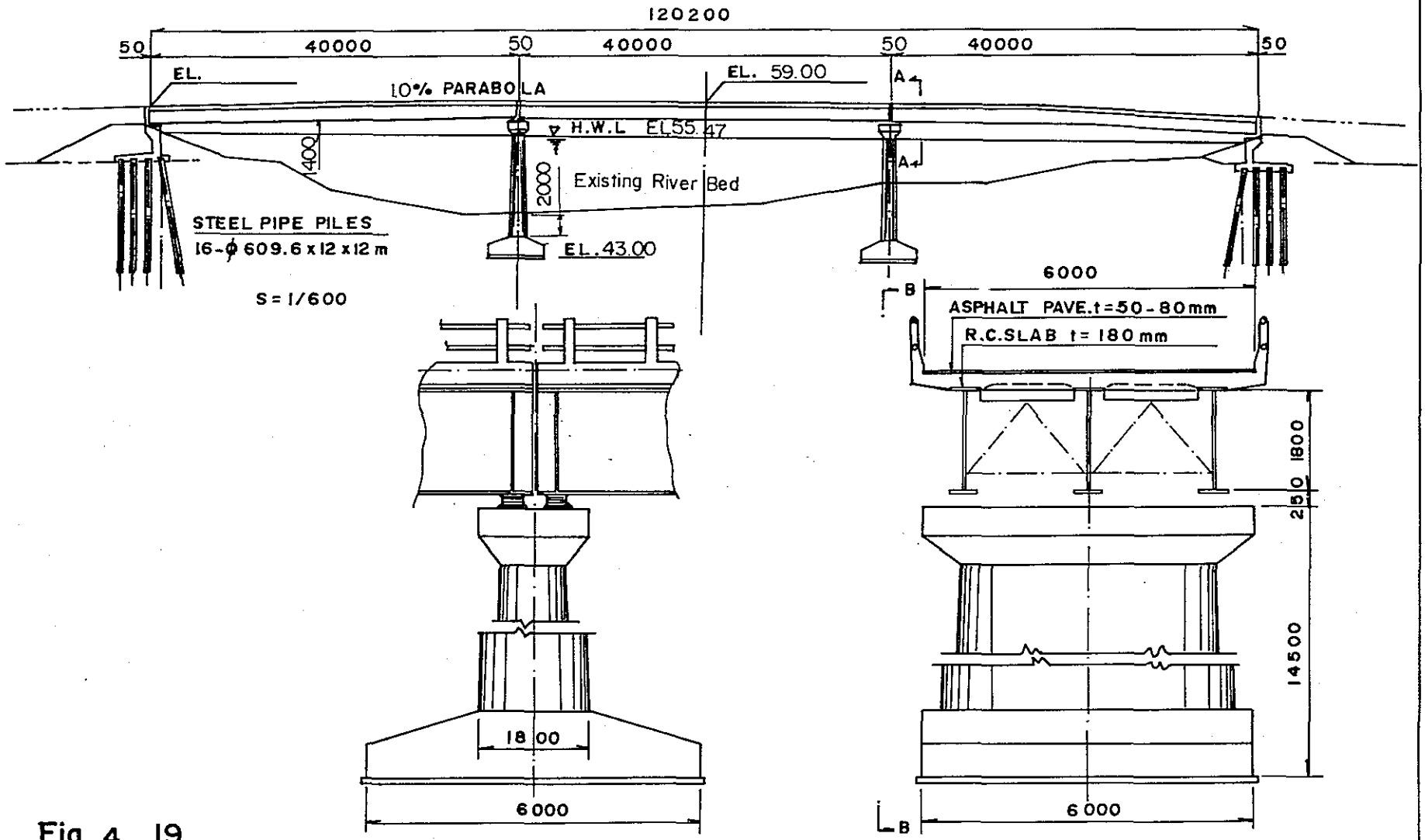


Fig. 4 . 19

NEW KRANDANG BRIDGE SECTION B-B S = 1/100

SECTION A-A S = 1/100

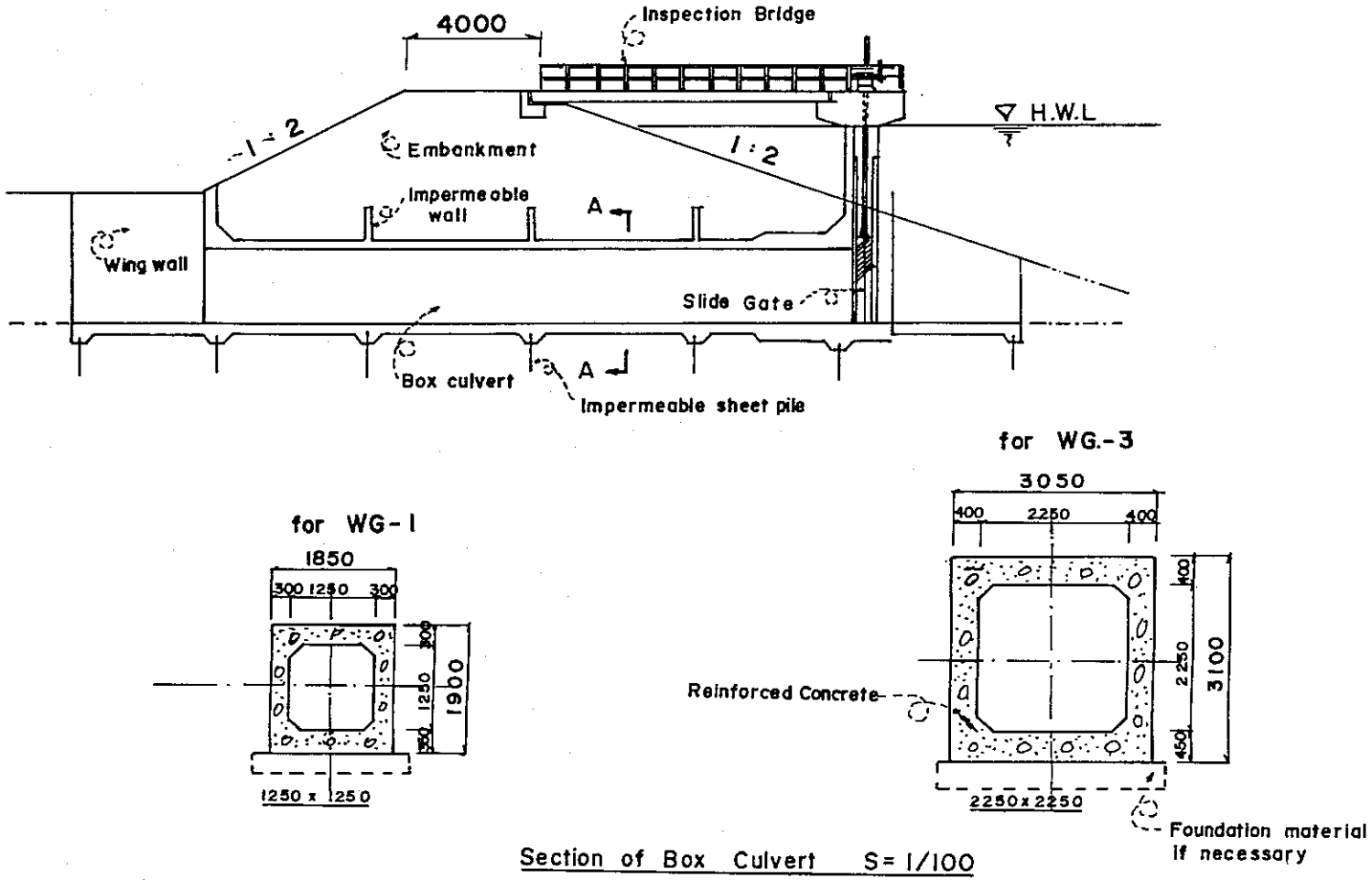


Fig.4.20. TYPICAL ARRANGEMENT & SECTION OF SLUICEWAY

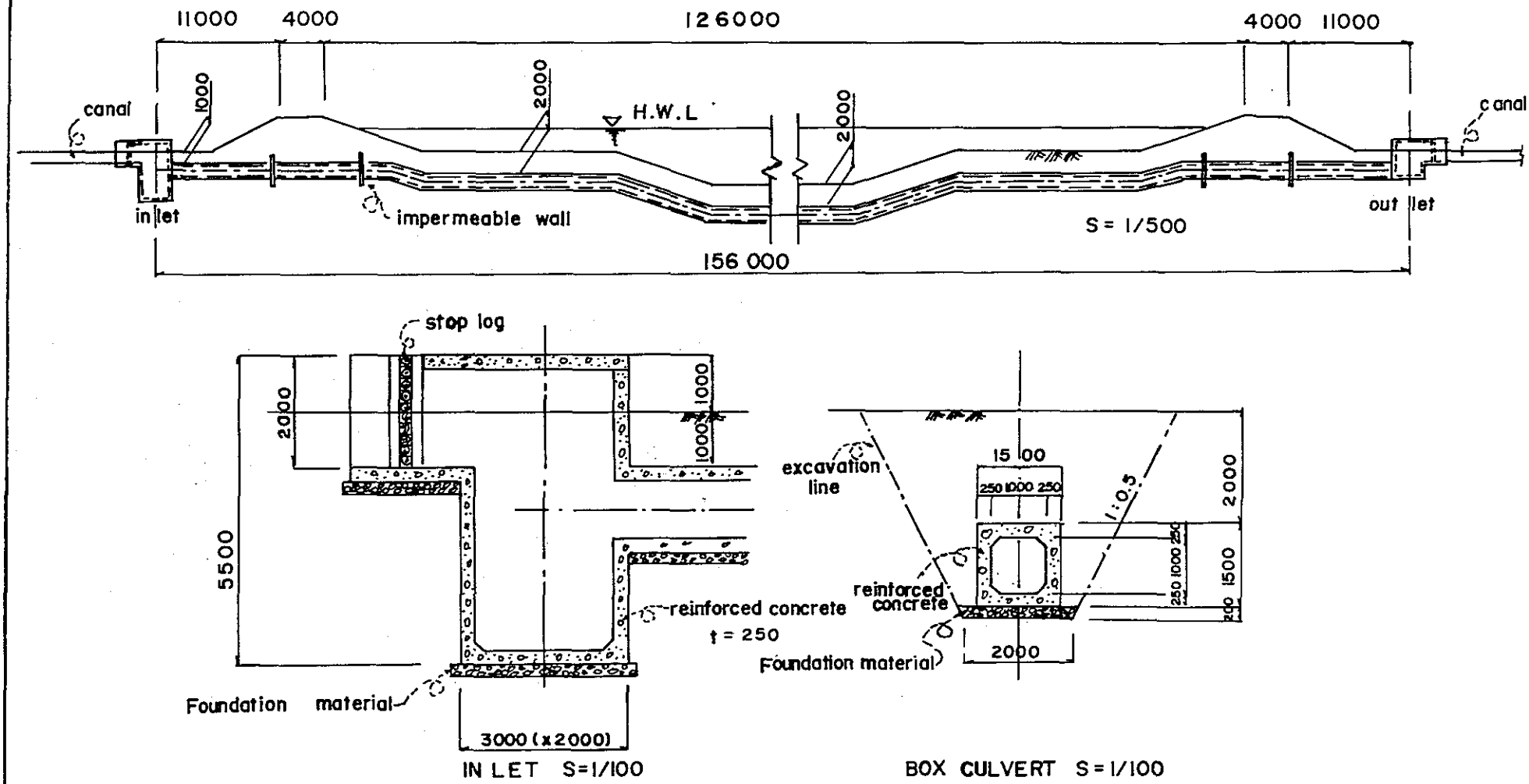


Fig. 4.21 TYPICAL SECTION OF SIPHON FOR IRRIGATION CANAL(SHORT CUT PORTION)

5. CONSTRUCTION PLAN

5.1 General

The construction works for the Madiun River Urgent Improvement Project comprise preparatory works, survey and investigations, compensation, construction of levee, short cut, revetment, new bridges and gates, modification works of existing bridges and treatment of spoil bank.

All of the works are scheduled to be completed during four years including 2.0 years of detailed design and preparation of tender documents.

The implementation of the construction works for the Project is to be undertaken by the Bengawan Solo Project office of the Directorate of Rivers of Directorate General of Water Resources Development (DGWRD).

The construction works will be executed mechanically using mainly the construction equipment to be procured by the Government.

Preparatory works will be executed in 1982/1983 fiscal year under a separate local contract basis.

Main civil works, construction and modification works of new bridges and gates and treatment of spoil bank will be executed from 1983/1984 to 1984/1985 fiscal year under a local contract basis. The contractors will be selected through the local selective competative bidding.

The contractors will be furnished with the construction equipment, spare parts and steel materials for metal works by the Government. The project operation is assisted by selected consultant and minimum guidance personnel specialized in engineering and technical field operation.

5.2 Construction Work Quantity

The pincipal work quantities estimated based on the results of investigation and design are summarized as follows;

Work Items		Alternative				
		I-1	I-2	II-1	II-2	II-3
Embankment of dyke	(m^3)	971,000	894,000	1,385,000	1,308,000	1,308,000
Excavation of short cut	(m^3)	0	525,000	0	525,000	837,000
Wet masonry	(m^2)	41,500	40,960	44,300	44,000	51,200
Construction of bridge	(sets)	5	3	5	3	3
Modification of bridge	(sets)	2	2	2	2	2
Construction of gate Structure	(sets)	2	2	4	4	4
Treatment of spoil bank	(m^3)	70,000	210,000	70,000	210,000	525,000
Land to be purchased	(ha)	47	72	64	88	109
Land to be hired	(ha)	108	41	151	93	54
House to be removed	(pcs)	357	454	357	454	482

In addition to the works described above following preparatory works and survey works are necessary;

(i) Preparatory works

(a)	Access road	:	20 km
(b)	Site office	:	400 m^2
(c)	Repair shot and motor pool	:	1,800 m^2
(d)	Store house	:	400 m^2
(e)	Temporary store house	:	2,000 m^2

(ii) Survey and investigations

(a)	Topo and land survey	:	L.S.
(b)	River survey	:	L.S.
(c)	Route survey	:	L.S.
(d)	Soil test	:	L.S.
(e)	Concrete test	:	L.S.

5.3 Construction Time Schedule

The construction time schedule of the Madiun River Urgent Improvement Project is shown in Fig. 5.1.

The construction of all works are scheduled to be completed during four years including about 2.0 years of detailed design and preparation of tender documents.

The compensation and preparation works will be made during 1982/1983 fiscal year.

The works comprising the construction of levee, short cut, wet masonry, parapet wall, groyne, new bridges and gates, modification of the existing bridges and treatment of spoil bank will be constructed in two years from 1983/1984 to 1984/1985 fiscal year.

5.4 Spoil bank for excavated material

The spoil bank yard is difficult to obtain in the Project area since riparian areas along the stretch of the Madiun River are densely populated zone. Thus the spoil bank yard is selected in the meandering portion of the river where is scheduled to construct the short cut. The spoil materials to be transported to the spoil bank will be commenced after the river diversion work is finished.

5.5 Borrow pit

For the alternative II-2 the embankment material of 1,308,000 m^3 are required for the dyke construction. The material are to be borrowed by the excavation from short cut portion and the excavation from farm land located within one kilometer from the embankment site.

The volume supplied by the excavation of short cut is estimated at 525,000 cubic meters and remaining volume of 783,000 m^3 is scheduled to be supplied from excavation of farm land. The acreage of the farm land to be required is about 783,000 m^2 with an average depth of one meter.

5.6 Aggregate site

For the execution of the works such as pavement, revetment, concrete and etc, the following aggregate sites are selected after the site investigation.

	River Name		Quantity (m^3)
1.	K. Catur	more than	100,000
2.	K. Gandong	more than	80,000
3.	K. Jerowan	more than	50,000

Aggregate materials are classified into boulder, gravel and sand at the river side, and are transported to the respective work site.

5.7 Construction Method

5.7.1 Preparatory works

The access roads are to be used for transportation of soil material for levee embankment. The access roads are scheduled to be provided by enlarging the existing road or constructing newly on the farm land.

One site office having floor area of about 400 m^2 is scheduled to be constructed at the job site.

One repair shop having floor area of about 1,800 m^2 comprising facilities for repairing, washing place, saw mill, inspection pit, store house of spare parts and motor pool is scheduled to be provided at the job site.

One store house having floor area of about 400 m^2 for the storage of cement, reinforcement bar, etc is scheduled to be provided at the job site.

One temporary store house having floor area of about 20 m^2 to store small tools and miscellaneous materials is to be constructed at the riverine sites in interval of about 200 m. After the work is finished, they will be transferred to other sites to use their materials twice.

5.7.2 Survey and investigation

The survey and investigation comprising the works for topographic surveys and laboratory test are scheduled to be carried out every construction year as routine works.

5.7.3 Compensation

The works for compensation comprise borrowing of the land to be used for stock pile and borrow pit along river stretch and purchasing of the land to be used for short cut and levee embankment as well as the compensation of house located in the proposed short cut and embankment areas.

It is scheduled that these compensation works are carried out during 1982/1983 fiscal year before the commencement of physical works.

5.7.4 Embankment of levee

The embankment of levee comprise the embankment to reinforce the existing levee and embankment to provide new levee.

The embankment works will be executed from 1983/1984 to 1984/1985 fiscal year.

Earth material for levee embankment will be executed from the proposed borrow pits.

Excavation of earth material for levee embankment will be made by a combination of 1.2 m^3 class dozer shovel, 21 ton class bulldozer with ripper and six ton class dump truck.

Surface soil of foundation on which new levee is embanked will be stripped by 11 ton class bulldozer.

The embankment material transported from the borrow pit by six ton class dump truck will be directly spread to the area to be embanked.

The spread earth material will be compacted horizontally using 2.5 ton class vibrating roller.

The side slope of levee will be protected by revetment and sod facing.

5.7.5 Short cut

The short cut to be constructed in the left side comprises Part No.1 and Part No.2. These short cut will be carried out from 1983/1984 to 1984/1985 fiscal year.

Earth materials to be excavated in the short cut will be transported to the respective levee embankment site.

Excavation of earth materials will be made by a combination of 1.2 m^3 class dozer shovel, 21 ton class bulldozer with ripper and six ton class dump truck.

5.7.6 Revetment

The revetment works comprise the works for the wet masonry, parapet wall and groyne. The revetment works will be executed from 1983/1984 to 1984/1985 fiscal year.

The construction of wet masonry will be executed in order of coffering and unwatering, foot protection and stone masonry including backfilling.

The existing parapet wall comprises gravity type wall, pile type wall and buttress type wall. These existing parapet wall are reinforced by the reinforced concrete.

The concrete piles of the groyne will be arranged along the cross section. Prior to the pile driving, empty frame of the gabion mattress will be set along the existing river bed.

Empty frame of the gahion mattress will be packed by the boulder.

5.7.7 New bridges and gates

The works of new bridges and gates will be executed from 1983/1984 to 1984/1985 fiscal year.

The type of the bridge to be newly constructed is the metal girder bridge. The locations of the bridge installed are Slajen, Patihan and Krandang.

The type of the gate to be newly constructed is the sluice gate. The locations of the sluice gate installed are shown in Fig. 4.8 to 4.11.

5.7.8 Modification works

The modification works comprise the bridges, irrigation canal and public road. The works of modification will be executed from 1983/1984 to 1984/1985 fiscal year.

The existing irrigation canal located in the short cut portion will be removed to the appropriate place along the short cut. The works of modification comprise the irrigation canal and siphon.

The existing public road located in the short cut portion will be relocated to the appropriate place along the short cut, and also the access to the new bridges or the bridges to be modified will be contemplated.

5.8 Treatment of Spoil Bank

After finishing of all works, the spoil bank will be backfilled by the spoil materials piled in the stock pile and removing the existing levee material.

5.9 Possibility of Transferable Construction Equipment

In order to estimate the construction equipment transferable from the on-going project, the relation between the construction period of other project and construction time schedule of the Madiun River Urgent Improvement Project was checked.

The on-going project to be contemplated for checking of possibility of transferable equipment is Wonogiri Dam Project.

The major works of the Wonogiri Dam Project is being implemented and will be completed by 1980. All of construction equipment employed in this project are newly procured by OECF's loan. However, it is scheduled that majority of these equipment are transfered to Wonogiri Irrigation Project.

The Wonogiri Irrigation Project will be implemented from 1980 to 1983.

Thus, to transfer the construction equipment from other project is considered to be impracticable.

5.10 Availability of Contractor

In consideration of the work items, work volume and construction period of the Madiun River Urgent Improvement Project, the contractor will be required to have sufficient technical experience and financial capacity.

According to the results of prequalification and tendering for Wonogiri Irrigation Project and Way Rarem Irrigation Project, it is supposed that some of contractor have sufficient experience, personnel, equipment and financial capacity to be able to carry out the works of the Project.

5.11 Equipment Requirement

The kind of the construction equipment and their numbers to be required for the implementation of construction works were estimated based on the construction method mentioned in Paragraph 5.7.

The results of the estimation of construction equipment and their numbers for the alternative II-2 are shown in Table 5.1.

Table 5.1 Number of Equipment to be Required (1/2)

No.	Name of Equipment	Capacity	Q'ty	Remarks
1	Bulldozer w/Ripper	21 t	9	
2	Bulldozer	11 t	14	
3	Swamp Bulldozer	13 t	2	
4	Back Hoe	0.6 m^3	1	
5	Back Hoe	0.35 m^3	1	
6	Wheel Loader	2 m^3	1	
7	Dozer Shonel	1.2 m^3	14	
8	Dump Truck, 4 x 4	6 t	79	
9	Truck w/Crane	6 t	4	
10	Water Tanker	5 m^3	6	
11	Fuel Tanker	5 m^3	4	
12	Grease Car	6 t	2	
13	Maintenance Car	6 t	1	
14	Service Car	2 t	2	
15	Hydraulic Crane	30 t	2	
16	Hydraulic Crane	20 t	2	
17	Motor Grader	11 t	2	
18	Vibrating Roller	2.5 t	17	
19	Vibrating Roller	0.5 t	12	
20	Road Roller	8/10 t	2	
21	Tamper	80 kg	5	
22	Soil Compactor	90 kg	11	
23	Port Belt Conveyor	7 m	30	
24	Port Concrete Mixer	0.5 m^3	3	
25	Port Concrete Mixer	0.2 m^3	5	
26	Concrete Vibrator	45 mm	20	
27	Port Air Compressor	6 m^3	8	
28	Pick Hammer	1 m^3/min	9	
29	Engine Driven Winch	3 ps	2	
30	Submergible Pump	6 inch	4	

(To be continued)

Table 5.1 Number of Equipment to be Required (2/2)

(Continuation)

No.	Name of Equipment	Capacity	Q'ty	Remarks
31	Submergible Pump	4 inch	10	
32	Submergible Pump	3 inch	10	
33	Engine Driven Welder	200 A	4	
34	Trailer	30 t	1	
35	Generator	175 KVA	2	
36	Generator	60 KVA	3	
37	Generator	15 KVA	2	
38	Diesel Pile Hammer	2.5 t	1	
39	Inspection Car	6 persons	10	
40	Ambulance Car	1 Bed	1	
41	Repair Shop Tool & Crane		L.S	

Nº	DESCRIPTION	Q'ty
1	Detail Design & Preparation of Tender Documents	L. S.
2	Preparatory Works	
	2.1 Access road	20 km
	2.2 Site office	400 m^2
	2.3 Repair shop & motor pool	1.800 m^2
	2.4 Store house	400 m^2
	2.5 Temporary Store house	2.000 m^2
3	Survey & Investigations	L. S.
4	Compensation	
	4.1 Land to be purcahased	89 ha
	4.2 Land to be hired	100 ha
	4.3 Houses	454 p.c
5	Main Works	
	5.1 Embankment of levee	1.308.000 m^3
	5.2 Short cut	525.000 m^3
	5.3 Revetment	
	5.3.1 Wet masonry	41.000 m^2
	5.3.2 Parapet wall	4.200 m^3
	5.3.3 Groyne	240 m
6	New Bridges & Gates	
	6.1 Bridges	3 sets
	6.2 Gates	4 sets
7	Modification Works	
	7.1 Bridges	2 sets
	7.2 Irrigation canal	L.S
	7.3 Public road	L.S
8	Treatment of Spoil Bank	210.000 m^3

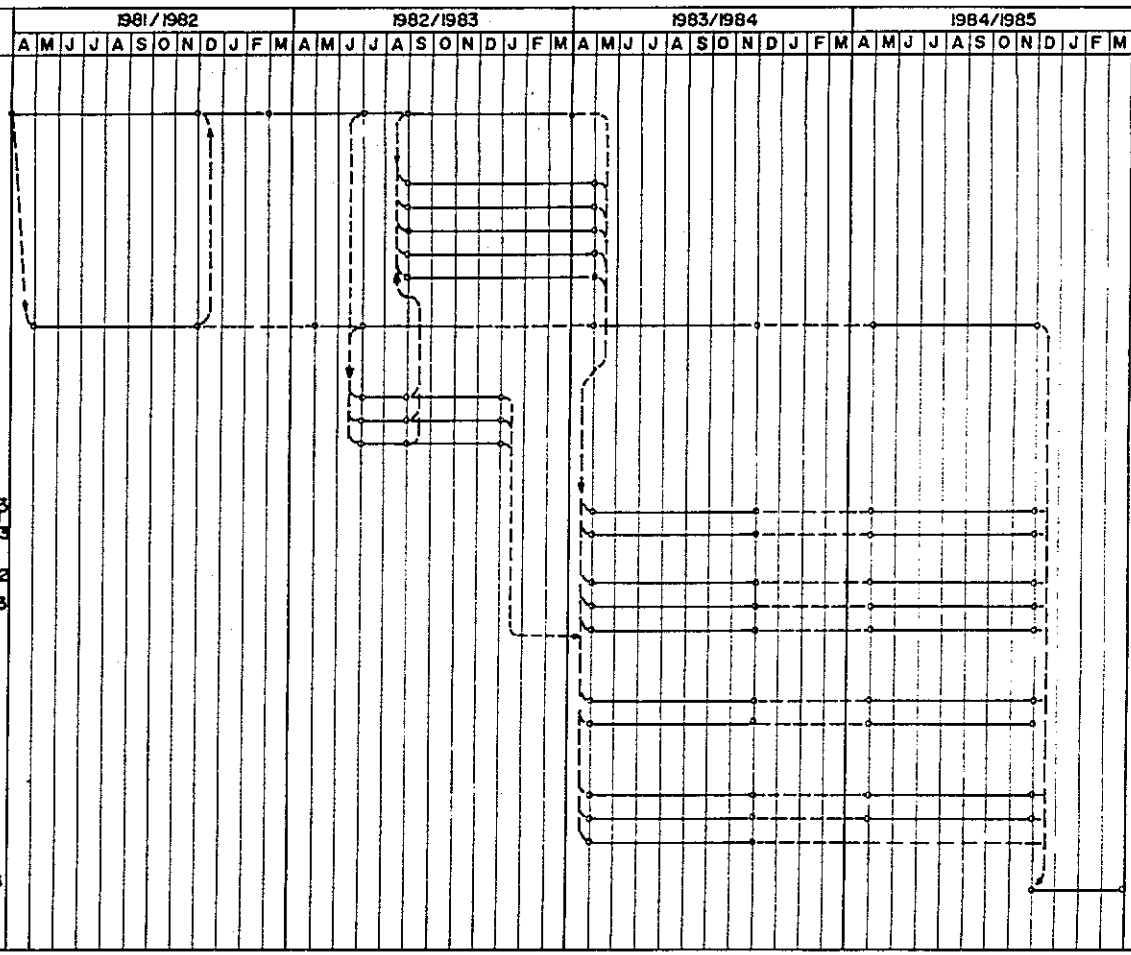


Fig. 5.1 CONSTRUCTION TIME SCHEDULE
(Alternative II — 2)

6. COST ESTIMATE

6.1 General

The implementation method and construction time schedule of the Madiun River Urgent Improvement Project were mentioned already in the fifth chapter.

The cost estimate is made at the price level of as of May 1980. The current material prices and the labour wages were summarized in Table 6.1. And the unit price schedule were developed and listed in Table 6.2.

The annual rate of the escalation of construction cost is assumed at 7% per annum for foreign currency portion and 10% per annum for domestic currency portion. The escalation of engineering service cost is taken at 6% per annum for foreign currency portion.

The physical contingency is estimated to be 10% of the estimated direct cost in foreign currency portion and 15% in domestic currency portion.

The conversion rate is based at U.S.$1.0 = Rp. 625,- = ¥240 throughout this estimate.

6.2 Construction Cost

6.2.1 Financial cost

The funds to be required for implementation of the Project were estimated based on the conditions mentioned above. The foreign currency portion was estimated in the terms of Japanese Yen and the domestic currency portion was estimated in terms of the Indonesian Rupiah. The financial costs were summarized as follows;

Currency	Alternative				
	I-1	I-2	II-1	II-2	II-3
F.C (Million Yen)	3,063	2,580	3,689	3,200	3,200
D.C (Million Rp)	9,486	8,895	10,951	10,347	11,560
Total (1,000$)	27,942	24,904	32,891	29,890	31,831

The foreign currency portion of 3,200,474 thousand Yen shall be disbursed for procuring the construction equipment, spareparts, steel materials of metal works and engineering services. The break down of the financial cost is presented in Table 6.3 for the case of the alternative II-2.

6.2.2 Economic cost

The economic cost of the Project was estimated on the same conditions as stated before as follows;

Currency	Alternative				
	I-1	I-2	II-1	II-2	II-3
F.C (Million Yen)	1,954	1,531	2,136	1,711	1,747
D.C (Million Rp)	7,427	7,072	8,593	8,230	9,195
Total (1,000$)	20,023	17,694	22,649	20,298	21,994

The estimated economic cost for the case of the alternative II-2 amounts to US $ 20.298 million equivalent comprising US $ 7.13 million equivalent for the foreign currency portion and US $ 13.168 million equivalent for the domestic currency portion as summarized in Table 6.4.

6.2.3 Annual disbursement schedule of construction fund

The annual disbursement of the required fund for construction of the Project in the case of the alternative II-2 is set out as shown in Table 6.5 on the basis of the construction time schedule.

6.3 OMR Cost

The annual operation, maintenance and repair cost of the Project is estimated at 0.5% of the construction fund.

Table 6.1 Material Price and Labour Wage

(Rp)

Material Price			Labour Wage	
Item	Unit	Unit Cost	Item	1 shift
Cement	kg	60	Operator	1,880
Reinforcement bar	kg	350	Assistant Operator	1,000
Wire for binding	kg	750	Driver	1,500
Wire BWQ - 8	kg	230	Foreman	1,540
Nail	kg	600	Coordinator	1,000
Square timber	m^3	100,000	Common labour	1,000
Board	m^3	110,000	Chief masonry	2,050
Log Q 15-5 m	PC	6,130	Masonry	1,380
Log Q 15-3 m	PC	3,680	Chief Carpenter	1,480
Log Q 10-5 m	PC	3,500	Carpenter	1,250
Log Q 10-3 m	PC	2,100	Chief bar bender	1,690
Bamboo, 5 m	PC	600	Bar bender	1,390
Bamboo net	m^2	530	Chief mechanic	1,950
Boulder 20/30	m^3	2,500	Mechanic	1,490
Gravel	m^3	4,000	Chief welder	2,020
Sand	m^3	2,000	Welder	1,510
Galvanized Corrugated iron sheet	Sheet	2,500	Laboratory staff	1,500
				2,010
Ijuk	kg	250		1,570
Light oil	〃	55		
Gasoline	〃	150		

Note: (1) Material prices and labour wages in May, 1980 are adopted.

(2) Material prices include transportation fee to the job site.

Table 6.2 UNIT PRICE SCHEDULE (1/3)

No.	Description	Unit	F.C (¥)	D.C (Rp)	Remarks
1.	Site office	m2		64,050	
2.	Repair shop	m2		42,000	
3.	Temporary store house	m2		13,310	
4.	Topo and land survey	ha		17,850	
5.	River survey	km		245,700	
6.	Route survey	"		66,150	
7.	Soil test	day		23,000	
8.	Concrete test	day		17,000	
9.	Compensation				
	Land to be purchased	m2		2,500	
	Land to be hired	m2		325	
	House	P.C		2,000,000	
10.	Hiring of 6t truck	day		30,000	
11.	Concrete 240 kg/cm2	m3	733	39,150	
12.	Concrete 180 kg/cm2	m3	373	34,429	
13.	Mortar	m3		48,906	
14.	Wooden form	m2		6,063	
15.	Bending & setting of reinforcement bar	t		503,716	
16.	Setting of water stop	m		6,876	
17.	Land levelling	m3	109	278	11t Bull., 11t Grader & 10t Roller

(to be continued)

Table 6.2 UNIT PRICE SCHEDULE (2/3)

No.	Description	Unit	F.C (¥)	D.C (Rp)	Remarks
18.	Excavation (Manpower dry)	m3		1,155	
19.	Excavation (Manpower wet)	m3		1,699	
20.	Excavation	m3	104	245	21t Bull. & 1.2m3 D.shovel
21.	Excavation	m3	118	269	11t Bull. & 1.2m3 D.shovel
22.	Excavation	m3	49	150	0.6 m3 Back hoe
23.	Excavation	m3	122	278	0.6 m3 Back hoe & 11t Bull.
24.	Excavation	m3	143	308	0.35m3 Back hoe & 11t Bull.
25.	Excavation	m3	58	164	21t Bull.
26.	Excavation	m3	72	188	11t Bull.
27.	Transportation L = 0.3 km	m3	55	144	6 t D. Truck
28.	Transportation L = 0.6 km	m3	72	188	6 t D. Truck
29.	Transportation L = 2.0 km	m3	150	390	6 t D. Truck
30.	Transportation L = 3.3 km	m3	219	572	6 t D. Truck
31.	Transportation L = 3.6 km	m3	235	613	6 t D. Truck
32.	Transportation L = 7.4 km	m3	437	1,140	6 t D. Truck
33.	Transportation L = 7.7 km	m3	453	1,181	6 t D. Truck
34.	Spreading	m3	33	120	21t Bull.
35.	Spreading	m3	34	120	11t Bull.
36.	Compaction	m3	37	150	11t Grader, 10t Roller
37.	Compaction	m3	29	118	2.5t V. Roller
38.	Compaction	m3	20	147	0.5t V. Roller & 90 kg S. compactor

(to be continued)

Table 6.2 UNIT PRICE SCHEDULE (3/3)

No.	Description	Unit	F.C (¥)	D.C (Rp)	Remarks
39.	Compaction	m3	26	125	2.5 V.Roller, 0.5t V.Roller & 90 kg S.Compactor
40.	Compaction	m3	10	154	80 kg Tamper
41.	Water sprinkling	m3	8	29	5 m3 W. Tanker
42.	Backfilling	m3	83	288	11t Bull. & 80kg Tamper
43.	Backfilling (Manpower)	m3		731	
44.	Sodding	m2		484	
45.	Asphalt Macadam	m2	6	3,520	11t Grader & 10t Roller
46.	Boulder filling	m3	20	4,749	80 kg Tamper
47.	Coffering & unwatering 2m x 2m	m	1,983	15,474	Submergible pump & Generator
48.	Steel pipe pile 600mmx12mmx10m	P.C	8,556	713,442	Diesel Pile Hammer 2.5t
49.	Concrete pile 350mmx350mmx5m	P.C	10,544	116,237	Diesel Pile Hammer 2.5t
50.	Breaking of Concrete	m3	70	7,344	Pick Hammer
51.	Installing & removal of rail	m		22,395	
52.	Foot protection	m	162	48,919	
53.	Wet masonry	m2		13,786	
54.	Groyne (Concrete)	m	467	296,702	
55.	Wooden gate	m3		159,017	

(Alternative II - 2)

Table 6.3 Construction Cost (Financial Cost) (1/2)

(Unit: 10^3¥, 10^3Rp)

No.	Item	Total Cost			1981/1982			1982/1983			1983/1984			1984/1985		
		Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)
1.	Preparatory Works															
	1.1 Access road	20 km		44,923				20 km		44,923						
	1.2 Site office	400 m^2		25,620				400 m^2		25,620						
	1.3 Repair shop & motor pool	1,800 m^2		75,600				1,800 m^2		75,600						
	1.4 Store house	400 m^2		16,800				400 m^2		16,800						
	1.5 Temporary store house	2,000 m^2		26,620				2,000 m^2		26,620						
2.	Survey & Investigation															
	2.1 Survey	L.S		9,610	L.S		2,403	L.S		2,403	L.S		2,402	L.S		2,402
	2.2 Investigation	L.S		29,200							L.S		14,600	L.S		14,600
3.	Compensation															
	3.1 Land to be purchased	88 ha		2,195,000				88 ha		2,195,000						
	3.2 Land to be hired	93 ha		302,250				93 ha		302,250						
	3.3 House	454 pcs.		908,000				454 pcs.		908,000						
4.	Main Works															
	4.1 Embankment of levee	1,308,000 m^3		1,011,633							654,000 m^3		505,817	654,000 m^3		505,816
	4.2 Short cut	525,000 m^3		408,201							262,500 m^3		204,101	262,500 m^3		204,100
	4.3 Revetment															
	4.3.1 Wet masonry	44,000 m^2		778,230							22,000 m^2		389,115	22,000 m^2		389,115
	4.3.2 Parapet wall	4,200 m^3		339,432							2,100 m^3		169,716	2,100 m^3		169,716
	4.3.3 Groyne	240 m		106,911							120 m		53,456	120 m		53,455
5.	New Bridges & Gates															
	5.1 Bridges	3 sets		379,842							1.5 sets		189,921	1.5 sets		189,921
	5.2 Gates	4 sets		73,891							2 sets		36,946	2 sets		36,945
6.	Modification Works															
	6.1 Bridges	2 sets		86,466							1 set		43,233	1 set		43,233
	6.2 Irrigation canal	L.S		63,553							L.S		31,777	L.S		31,776
	6.3 Public road	L.S		74,504							L.S		74,504			

(Alternative II - 2)

Table 6.3 Construction Cost (Financial Cost) (2/2)

(Unit: 10^3¥, 10^3Rp)

No.	Item	Total Cost			1981/1982			1982/1983			1983/1984			1984/1985		
		Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)
7.	Treatment of Spoil Bank	210,000 m^3		59,640										210,000 m^3		59,640
8.	Inland Transportation of Equipment & Metal Works Material	L.S		21,023				L.S		21,023						
9.	Equipment & Spare Parts	L.S	1,619,417					L.S	1,619,417							
10.	Metal Work Materials	L.S	329,940					L.S	329,940							
	Total:		1,949,357	7,036,949			2,403		1,949,357	3,618,239			1,715,588			1,700,719
11.	Contingency															
	Price Escalation (F.C 7%, D.C 10%)		282,657	2,117,064			240		282,657	759,830			567,860			789,134
	Physical Contingency (F.C 10%, D.C 15%)		194,936	1,055,542			360		194,936	542,736			257,338			255,108
12.	Engineering Services for Detail Design & Tender Preparation Works.	L.S	360,000	63,084	L.S	217,906	30,698	L.S	142,094	32,386						
13.	Supervision & Technical Guidance Services	L.S	413,524	74,362							L.S	208,087	35,583	L.S	205,437	38,779
	Grand Total:		3,200,474	10,347,001		217,906	33,701		2,569,044	4,953,191		208,087	2,576,369		205,437	2,783,740
	US$ Equipment ($10^3$$):		13,335	16,555		908	54		10,704	7,925		867	4,122		856	4,454
	(1 US$ = ¥240 = Rp 625)			29,890												

(Alternative II - 2)

Table 6.4 Construction Cost (Economic Cost) (1/2)

(Unit: 10^3¥, 10^3Rp)

No.	Item	Total Cost			1981/1982			1982/1983			1983/1984			1984/1985		
		Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	(D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)
1.	Preparatory Works															
	1.1 Access road	20 km	16,425	44,923				20 km	16,425	44,923						
	1.2 Site office	400 m^2		25,620				400 m^2		25,620						
	1.3 Repair shop & motor pool	1,800 m^2		75,600				1,800 m^2		75,600						
	1.4 Store house	400 m^2		16,800				400 m^2		16,800						
	1.5 Temporary store house	2,000 m^2		26,620				2,000 m^2		26,620						
2.	Survey & Investigation															
	2.1 Survey	L.S		9,610	L.S		2,403	L.S		2,403	L.S		2,402	L.S		2,402
	2.2 Investigation	L.S		29,200							L.S		14,600	L.S		14,600
3.	Compensation															
	3.1 Land to be purchased	88 ha		2,195,000				88 ha		2,195,000						
	3.2 Land to be hired	93 ha		302,250				93 ha		302,250						
	3.3 House	454 pcs.		908,000				454 pcs.		908,000						
4.	Main Works															
	4.1 Embankment of levee	1,308,000 m^3	302,582	1,011,633							654,000 m^3	151,291	505,817	654,000 m^3	151,291	505,816
	4.2 Short cut	525,000 m^3	155,376	408,201							262,500 m^3	77,688	204,101	262,500 m^3	77,688	204,100
	4.3 Revetment															
	4.3.1 Wet masonry	44,000 m^2	6,106	778,230							22,000 m^2	3,053	389,115	22,000 m^2	3,053	389,115
	4.3.2 Parapet wall	4,200 m^3	1,543	339,432							2,100 m^3	772	169,716	2,100 m^3	771	169,716
	4.3.3 Groyne	240 m	202	106,911							120 m	101	53,456	120 m	101	53,455
5.	New Bridges & Gates															
	5.1 Bridges	3 sets	284,920	379,842							1.5 sets	142,460	189,921	1.5 sets	142,460	189,921
	5.2 Gates	4 sets	61,568	73,891							2 sets	30,784	36,946	2 sets	30,784	36,945
6.	Modification Works															
	6.1 Bridges	2 sets	1,529	86,466							1 set	765	43,233	1 set	764	43,233
	6.2 Irrigation canal	L.S	2,861	63,553							L.S	1,431	31,777	L.S	1,430	31,776
	6.3 Public road	L.S	355	74,504							L.S	355	74,504	L.S		

(Alternative II - 2)

Table 6.4 Construction Cost (Economic Cost) (2/2)

(Unit: 10^3¥, 10^3Rp)

No.	Item	Total Cost			1981/1982			1982/1983			1983/1984			1984/1985		
		Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)	Q'ty	F.C (¥)	D.C(Rp)
7.	Treatment of Spoil Bank	210,000 m^3	19,110	59,640										210,000 m^3	19,110	59,640
8.	Inland Transportation of Equipment & Metal Works Material	L.S		21,023				L.S		21,023						
	Total:		852,577	7,036,949			2,403		16,425	3,618,239		408,700	1,715,588		427,452	1,700,719
9.	Contingency Physical Contingency (F.C 10%, D.C 15%)		85,258	1,055,542			360		1,643	542,736		40,870	257,338		42,745	255,108
10.	Engineering Services for Detail Design & Tender Preparation Works	L.S	360,000	63,084	L.S	217,906	30,698	L.S	142,094	32,386						
11.	Supernision & Technical Guidance Services	L.S	413,524	74,362							L.S	208,087	35,583	L.S	205,437	38,779
	Grand Total:		1,711,359	8,229,937		217,906	33,461		160,162	4,193,361		657,657	2,008,509		675,634	1,994,606
	US$ Equivalent ($10^3$$): (1US$ = ¥240 = RP 625)		7,130	13,168		908	54		667	6,709		2,740	3,214		2,215	3,191
			20,298													

(Alternative II - 2)

Table 6.5 Annual Disbursement Schedule of Construction Cost

(Unit: 10^3¥, 10^3Rp)

No.	Item	Total Cost		1981/1982		1982/1983		1983/1984		1984/1985	
		F.C (¥)	D.C (Rp)	F.C (¥)	D.C (Rp)	F.C (¥)	D.C (Rp)	F.C (¥)	D.C (Rp)	F.C (¥)	D.C (Rp)
1.	Preparatory Works		189,563				189,563				
2.	Survey & Investigation		38,810		2,403		2,403		17,002		17,002
3.	Compensation		3,405,250				3,405,250				
4.	Main Works		2,644,407						1,322,205		1,322,202
5.	New Bridges & Gates		453,733						226,867		226,866
6.	Modification Works		224,523						149,514		75,009
7.	Treatment of Spoil Bank		59,640								59,640
8.	Inland Transportation		21,023				21,023				
9.	Equipment & Spare Parts	1,619,417				1,619,417					
10.	Metal Work Materials	329,940				329,940					
11.	Contingency										
	Price Escalation (F.C 7%, D.C 10%)	282,657	2,117,064		240	282,657	759,830		567,860		789,134
	Physical Contingency (F.C 10%, D.C 15%)	194,936	1,055,542		360	194,936	542,736		257,338		255,108
12.	Engineering Services	360,000	63,084	217,906	30,698	142,094	32,386				
13.	Supervision & Guidance Services	413,524	74,362					208,087	35,583	205,437	38,779
	Grand Total:	3,200,474	10,347,001	217,906	33,701	2,569,044	4,953,191	208,087	2,576,369	205,437	2,783,740
	US$ Equivalent (10^3 $):	13,335	16,555	908	54	10,704	7,925	867	4,122	856	4,454
	(1 US$ = ¥240 = Rp 625)	29,890									

7. FLOOD DAMAGE

7.1 Social and Economic Situation

Land use of the Rural area: Subdistrict (Kecamatan) Takiran, Geger, Jiwan, Nglame, Balerejo and Kwadungan area are included in the project area. And adding them, one urban area, Municipality (Kotamadya) Madiun exists in the area as shown in Fig. 7.1. The said Kecamatans except two Kecamatans, Takiran and Kwadungan, belong to Regency, Kabupaten, Madiun.

There are significant socio - economic differences between Kecamatans and Kotamadya. The status of population and land use in Kecamatans are shown in Table 7.1.

Population of Kecamatans are varied from 36 thousands up to 74 thousands and population densities per hectar are varied from 3.26 in Geger upto 12.07 in Takiran. Cencus in 1971 was resulted 5.39 person per hectar as population density in East Java Province (Propinsi Jawa Timur). Average population density in the related area, excluding Kotamadya of 6.19 shows high figure to some extent.

The land use in the project area is characterized by the sugar cane cultivation. Total cultivated acreage of sugar cane in the area is amount to 6,613 ha and occupies around 17% of sugar cane field in East Java Province, 38,429 ha in May 1978.

As summarized in Table 7.1, total paddy field is 30,156 ha. Among the paddy field, 26,983 ha have been irrigated. That is; almost 90% of the paddy field have been enjoying the favour of the irrigation. The main upland crops are maize and cassava but share of their field is estimated relatively small.

<u>Houses and Buildings in the Rural Area</u>: The residences in a village are classified into three classes as described in the monthly report prepared by the village (Desa) office. The classification are defined in accordance with the purchase price of the residence.

Population in the objective area is 360,504 and number of houses 70,198, which means average living in a house is 5.14 person per houses. This figure is almost same with the average living in a house of the whole country.

Number of the houses and buildings in the project area are shown in Table 7.2.

Activities of Madiun city: Population of Madiun city was 140,441 in 1979 and 137,052 in 1971. It means rate of increase of population is only 0.3% per annum during the period, which is very low comparing with population growth rate of whole Indonesia, more than 2% per annum. Comparative low population growth implys the low economic activities and the city might have been not attractive to habitants to continue to stay there.

Houses and yards are the main land use but irrigated paddy field is still remained from place to place. The residential and the irrigated paddy field areas are 981 ha and 930 ha.

Numbers of houses are 23,527 and average number of household is 6 person per house. The Madiun city acts as the center of the region, and hold the various numbers of offices, schools, hospitals, factories and shops.

In numbers, almost half of shops are restaurants (166). Gold trade (26) and construction material shops (24) follow the restaurants.

Drag (19), textiles (18), bag (16), shoes (14) and book stores (14) are the third group.

These figures are given in detail in Table 7.1 and 7.2.

7.2 Recorded Flood Damage

7.2.1 General

A few kind of reports on flood have been prepared by the various offices concerned.

Report on flood have beeb submitted from Kecamatan to Kabupaten and Routine Flood Report from head of Desa to Kecamatan. All the avilable ones were collected and studied.

The recorded flood damages were summarized in Table 7.3 quoting from the reports. Though the records seems to be incomplete the obtained information are still useful.

Even after the existing dyke was constructed, many flood damage has been reported (cases of small damage were eliminated from Table 7.3 for simplification). But most of those damages were caused not only by the flood from the Madiun river but were caused by local heavy rain.

On the other hand, discharge of more than 900 cubicmeters per second at the A. Yani gaging station have given severe damages to the basin.

According to the flood report the Kecamatan Balerejo have been frequently inundated. The correlated results of the damage and the discharge at the A. Yani station, it is presummed that the damage was caused not only by flood of the Madiun river also caused by the flood of the Jerowan river.

It is considered that to protect the Kecamatan Balerejo from the flood by the Jerowan river is quite necessary.

7.2.2 Recorded damage in 1978

The damage record of the flood occured on 30th June 78 is described in "Prefeasibility Study Floodway Kali Madiun, Buku III, Final Report, Proyek Bengawan Solo". The summary of the damages are quoted in Table 7.4.

The figures in Table 7.4 indicate the existence of a few problems concerned; The damage in the Madiun city was still large although some river improvements had been done; one third of houses were damaged by the floods in the Madiun city. The second problem is damage to Kecamatan Balerejo. Also one third of houses were damaged due to the flood and two fifth of cropping field damage were counted in the Kecamatan.

Sugar refinery is an important industry in the project area and one of the factories, PT. PG Rejoagung, is located near the riverside and has been suffered by several floods of the Madiun river.

Estimated damage of PT. PG Rejoagung in the case of 30th June 1978 flood is summarized as follows.

Contents	Amount in Rp.
Loss of sugar juice	Rp. 8,000,000.-
Damage to fence (around 175 m)	Rp. 750,000.-
Damage to Instruments stored in war house	Rp. 100,000.-
Damage to sugar cane stocked for processing	Rp. 12,330,000.-
Damage to sugar cane field owned by the company	Rp. 8,500,000.-
Others	Rp. 320,000.-
Total	Rp. 30,000,000.-

Source: hearing from PT. PG Rejoagung.

7.3 Concept for Damage Estimation

7.3.1 Possible inundation

The present channel capacity of the Madiun river was identified to be 700 cubic meters per second in the project area as discussed in the former chapter. In other words, a flood with the magnitude of more than 700 m^3/sec at the A. Yani gaging station has possibility to cause a inundation in the Madiun city and it's surroundings.

The inundation may occur at the upmost reach among the crest elevation of dyke less one meter, freeboard, thereof is lower than the relevant flood water level.

Actually the flood, the magnitude thereof are more than 700 m^3/sec, have been experienced several times in these years. And the inundation have not occurred for most of the cases. Even in these cases, however, the flood water levels reached almost the crest of the dykes. Consequently the dykes might have been breached and the inundation had been possible to take place in the Madiun city.

After the urgent river improvement project is realized, the flood of less than 1,200 m^3/sec in magnitude can be discharged safety in the Madiun city.

But ones of more than 1,200 m^3/sec may bring inundation in the Madiun city even after the project is implemented. And it is supposed that there is no difference in the inundation conditions in the cases of with and without project.

The each proposed alternative is expected to have the different inundation condition due to the different contribution to mitigate the possible inundation.

The possible inundation to be occurred were studied and assumed through the flood water level estimated by the non-uniform flow calculation method. The study were made for the cases with and without project and for the probable floods with the magnitudes of up to the design flood, 1,200 cubic meters per second.

The estimated inundation area were confirmed their possibilities comparing with the inundation map prepared by the PBS. The PBS developed the said map by the actual survey in the experienced inundation area from the confluence with the Catur river to the Ngawi.

There were no significant difference in area and location between the estimated and the surveyed. The estimated possible inundation area is 7,000 hectars in the project area in case without project and the surveyed inundation area is 6,800 hectars for the flood magnitude of 1,200 cubic meters per second. Whereas the estimated and the surveyed are 4,500 hectars and 4,600 hectars respectively in the downstream area from the confluence with the Jerowan river.

The assumed inundation were illustrated and the inundation maps were developed for floods with different occurrence probabilities.

The developed maps are presented in Fig. 7.2, 7.3 and 7.4.

7.3.2 Damage estimation

Benefits brought by the mitigation of flood damage accompanying river improvement projects can be divided into direct and indirect benefits. The direct benefits are the value of production and services gained directly from the project. These include a reduction in property damage, the prevention of declines in production, changes in land usage and stabilization of the people's livelihood. The indirect benefits are such that occur in addition to the direct benefits as a result of activities incidental to the project. These include such benefits as the stimulation of agricultural production, development of the social and economic activities of the inhabitants, as well as increased profit for business resulting from the purchase of products from, or the supply of commodities to, people benefiting directly from the project.

In this study, the discussion is confined to the direct and tangible benefits, such as reductions in property damage and the prevention of declines in production:

The costs of damage by a flood consist of the cost of properties washed away by the flood-waters and reductions in the value of assets. The possible damages were estimated in accordance with the probable floods with return periods of 2, 5, 10 and 17 years.

Damage to the assets consist of losses of property swept away by floodwaters and reductions in the value of property damaged by inundation. No damage are expected to occur by flood of up to 17 years return period after the project is realized.

The cost of flood damage was estimated for each Desa by the total amount of the damages to building, household effect and agricultural crop. The damage to a building was estimated as the product of the rate of damage and the value of the building. The same was applied to estimate the damage to the household effect.

The level of flood damage to a crop was assumed. And the unit price and the unit production of a crop was also assumed. The damage to a crop was estimated by the product of these items and the planted area.

7.3.3 Rates and values for damage estimation

The rates of damage were assusmed reflecting the result of the analysis on the collected data.

<u>Rate of damage of buildings</u>:

a) First storied buildings;

Structure of 1st storied buildings in Indonesia is mostly consisted with paved floor, brick wall and ceiling. Damage to these components are assumed as follows:

floor : independent from inundation depth and its weight to total house cost is 0.05.

wall : linearly dependent to inundation depth and whole wall cost weights 0.45 of total house cost.

ceiling : destroyed or flown away by over 3 m submergence and cost weight is 0.5.

According to the recorded damage the rate of damage were 15 percent of the drenched value on an average if the inundation depth is less than 3 m. But the damage rate becomes around 100 percent if the inundation depth is more than 3 meters.

b) Low class residence:

The wall of this type of house is made of bamboo. The material have larger possibilities of destruction and damage.

The rate of damage was assumed as follows basing on the average recorded damage;

Depth of Submergence	Rate of Damage
0.5 - 1 m	0.038
1 - 2 m	0.075
more than 2 m	1.0

Rate of damage of household effects/goods:

a) Residence:

Households effects in residence are usually placed from 0.3 m until 2 m above the floor. The households effects were assumed to be distributed evenly in this space. According to the damage records the rate of damage caused by drench was 15 percent on an average.

In this respect, the rate of decrease of value was estimated for each represented inundation depth as follows;

Depth of Inun. Water	Rate of decrease
0	0
0.3	0
0.5	0.018
0.75	0.039
1.0	0.062
1.5	0.107
2.0	0.15
3.0	0.15

b) Office, School, Hospital and Factory:

The similar consideration were applied to office, school, hospital and factory. However, the clerance was assumed to be 0.5 meters instead of 0.3 meters.

The estimated rates of decrease of value were given as follows:

Depth of Inun. Water	Rate of decrease
0	0
0.5	0
0.75	0.026
1.0	0.050
1.5	0.101
2.0	0.150
3.0	0.150

c) Shop:

The abovementioned idea is also applied except that the clearance height is assumed 0.1 m. Similar equation is introduced for the calculation of damage of goods in shop. The obtained rate of decrease of values were as follows;

Depth of Inun. Water	Rate of decrease
0	0
0.5	0.32
0.75	0.51
1.0	0.071
1.5	0.111
2.0	0.15
3.0	0.15

Value of buildings: The values of sampled buildings are examined by cooperation of each Kecamatan office under the guidance of Kabupaten office. The examined results are arranged in Table 7.5. The values varies Kecamatan by Kecamatan.

Value of buildings shown in the Table are considered to include the value of land, and 65% of these value are assumed as the building value incidently 35% as the land value except the building value of shops in Madiun city. With regard to the results of investigation, the building value of shops in Madiun city are considered as 30% due to the high land price in commercial center.

Value of fixtures related to value of Buildings:

Relationships between value of buildings and value of fixtures/equipment were studied for residence, office, school, hospital and factory. To estimate the fixture value, following assumptions were employed.

a) The value of the household effects are to be estimated by a linear function to the value of the building.

b) The obtained values of buildings for hospital and for factories were considered already include main equipment values.

Coefficients for the linear function were assumed as shown in Table 7.6 based on the investigations.

On the other hand, relationship between value of shops (building) and value of goods in shops were surveyed by each Kecamatan office for the sake of this study, and the results are shown in Table 7.7. Considerable differences are inherent to the values between the different Kecamatan. And a ratio was applied specifically to a Kecamatan.

Paddy field damage: The rate of damage to paddy due to submergence is related with depth of space submergence, its duration and growing stage of paddy.

Inundation area of more than 0.5 meters deep were counted in this damage estimation. The duration is assumed to be three days from the inundation records. And the rate of decrease in yield of paddy due to submergence is obtained as follows:

Tillering Stage 0-70th day	Booling Stage 71-87th day	Heading Stage 88-100th day	Ripening Stage 100-130th day
0.2	0.8	0.8	0.2

Source: *Prefeasibility Report of Aceh River Urgent Improvement Project, 1979.*

Monthly harvesting acreages reported to Kecamatan office from each Desa are obtainagle. Under the assumption of no damage from planting until harvesting and of four months for growing period, the harvested acreage of Nth month is considered to be same with the planted acreage of the N-4th month.

In this manner the planted acreage of the related Kecamatan in Kabupaten Madiun were estimated as given in Table 7.8.

The table presented above indicate the rate of damage to the paddy is 0.8 if the submergence occurred in the third month after seeding. The rates are 0.2, 0.2 and 0.2 for the first, second and fourth month as well.

The average monthly rate of decrease in yield in a certain paddy land is obtained as the cumulative products of the rate of damage for a growing stage and the rate of the planted area for the respective stage to the total paddy area in the month.

As an example the average monthly rate of decrease in yield in the Kecamatan in Kabupaten Madiun for the month of February is discussed below;

In February the paddy seeded before the last October have been harvested and no damage is brought by the flood in this month. The paddy seeded in the last November are in the fourth month, ripening stage. Accordingly the yield may decrease by 20 percent if a flood occurred in this month. In the same way the paddy seeded in December, January and February may decrease the yield by 80, 20 and 20 percent respectively.

On the other hand the respective seeded area in November, December, Janyary and February are 3,242, 5,143, 28 and 65 hectare. The total paddy area is 8,474 and the rates of the planted area for the respective stage to the total paddy area in February are 0.38, 0.61, 0.003 and 0.008.

The average monthly rate of decrease in yield for the month of February was resulted 0.57 by the cumulative products.

Same were carried out for the remaining months.

According to the hydrologic records, most of the flood occurred in February, March and April. The mean of the average monthly rates of decrease in yields for the months are approximated 0.35.

Average yields in Kabupaten Madiun in the period during January and April in 1978 are 4.133 tons per hectar for wet land paddy and 1.702 tons per hectar for upland paddy.

Ceiling price of dried unhulled rice is 105 Rp/Kg as of 1980 therefore through damage mean 433,965 Rp per hectar for wet land paddy, and 178,710 Rp per hectar for upland paddy.

Applying the average rate of decrease in yield of 0.35 to the estimated through damage, the damage of paddy field was estimated 152,000 Rp per hectar for wet land paddy and 62,500 Rp per hectar for upland paddy.

Sugar cane field damage: Sugar cane is seeded during May and October, and takes one year for growing. After one year of growing period, sugar cane is harvested (first harvest) but if the stub is remained in the field it starts regrowing and one more year after it reaches to the appropriate stage to be harvested (second harvest).

Due to variation of seeding period, growing stage of each sugar cane field is naturally variated, so the month of flooding does not become dominant factor to the damage.

The flood damage to sugar cane is considered to be the loss of the benefit, that is the opportunity cost. The opportunity cost is calculated as follows.

Assumed average sugar contents:	10% (quoted from the record of PG. Rejo Agung Baru)
Share of farmers to amount of sales:	0.61 (in the case of 10% contents)
Factory sugar price in 1979:	278.58 Rp/kg (306.44 Rp/Kg in 1980 with assumption of 10% inflation per annum)
Average yield in sugar cane:	100 ton/ha (10 ton/ha in sugar)
Rate of damage to death:	0.44
Expected loss of maturing period:	six months
Loss of opportunity cost to inundated field:	$306.44 \times 10^3 \times 10 \times 0.61 \times 0.44 \times 6/12 = 411,242.48$ Rp/ha.

<u>Upland crops damage</u>: Planted acreage of upland crops in Kabupaten Madiun are Maixe: 8,971 hectar, Cassava: 12,332 hectar, Sweet potatoes: 129 hectar, Peanuts: 429 hectar and Soy beans: 534 hectar.

The recorded monthly damaged area for maize and cassave in East Java Province indicate that the damage to cassave field is relatively small.

Consequently, only maize is descussed as main upland crops for flood damage calculation.

Average yield of maize in 1980 in the related five Kecamatan is 2.074 tons per hectar and harvested area is 821 hectar. Because no result of survey for inundated damage of maize in field was available the figure 0.5 is arbitranily assumed as rate of decrease to yield of maize by submergence. Farm gate price of maize in Kecamatan Jiwan on February 1980 was 150,000 Rp per ton.

Thus the amount of damage of maize by flood in unit of Rp is estimated 155,550 Rp per hectar.

7.4 Probable Flood Damage

7.4.1 Assumptions for the damage estimation

Main assumptions used for the damage estimation are summarized as follows:

a) The flood damage in downstream area from the confluence with the Jerowan river were considered to be independent from the river improvement in the upstream because no significant effect of the project to the downstream area was foreseen by the flood routing study.

b) The damage caused by the flood of more than 17 years return period were considered to be the same in cases with and without the project.

c) The planned river improvement protects the project area completely from the flood of less than 17 years return period.

The benefits of the project are to be obtained from the mitigated amount flood damage by the river improvement.

7.4.2 Possible inundation area and estimation of damage

Fig. 7.2, 7.3 and 7.4 in section 7.3.1 illustrate possible inundation area in the case of floods of 2, 5, 10 and 17 years return period. All of Desas located in these area counted for the population and land use subject to the inundation as shown in Table 7.9 as well as the number of buildings as shown in Table 7.10.

Madiun city included in probable flood area is a trading center of agricultural products and, therefore, the details of trading activities were examined and are arranged for the convenience of the damage calculation as Table 7.11. Number of desa inundated may be counted incidently as 43 in these Tables.

The area of inundated water depth in three classes, 0.5 m to 1 m, 1 m to 2 m and over 2 m, were measured on the flooding map in a scale of 1 to 10,000 by each desa.

To evaluate the effect of the dykes along the Madiun and Jerowan rivers, possible flood area was calculated.

Using these rates of inundated area and the rates of damage discussed in section 7.3, the possible damages were calculated and are shown in Table 7.12 in the case of without project.

The damages to be mitigated with Jerowan dyke are obtained by same manner and shown in Table 7.13.

Thus the benefits of the project were estimated and summarized in Table 7.14.

Table 7.1 Population and Land Use in the Related Area

Name of Kecamatan	Population				Area (ha)			
	Total	Density	Total	Residential	Irrigated Paddy	Upland Paddy	Upland Crops	Sugar Cane
Balerejo	39,716	5.41	7,339 1)	1,197	4,601	512	868	594
Geger	60,971	3.26	15,649	1,235	2,304	277	nr	82
Jiwan	74,032	6.60	11,222 1)	2,804	8,250	842	-	1,504
Kebonsari	50,111	6.86	7,310 1)	672	3,077	963	1,588	1,284
Kec. Madiun	36,212	10.20	4,019	842	2,161	nr	nr	159
Takiran	50,131	12.47	4,153	1,521	2,330	nr	nr	139
Kwadungan	49,331	8.30	8,597	1,027	4,260	579	1,597	656
Madiun city	140,441	51.75	2,714	981	930	62	61	249

Note 1) : Sum of each area is larger than total due to double account of residential area and upland crops, because farmers traditionary cultivate upland crops at the front yard of their house (Karang Kitri)

Source : Monthly report (May 1979) submitted from Desa office for Kecamatan office.

Table 7.2 Nos. of Houses in the Related Area

Name of Kecamatan	Residence 1)			Office	School	Hospital	Factory		Shop 2)
	Low class	Middle class	High class				Small	Middle & Large	
Balerejo	9,293	311	1,103	2	28	2	15	1	84
Geger	57	105	9,252	33	64	1	0	2	112
Jiwan	4,572	715	8,145	94	100	nr	11	18	93
Kebonsari	151	41	10,071	20	27	4	nr	nr	85
Kec. Madiun	721	177	6,500	22	27	3	12	23	13
Takiran	265	167	9,068	27	41	2	30	32	30
Kwadungan	7,543	789	1,152	26	74	1	2	19	279
Madiun city	5,348	1,703	16,476	125	193	13	88	60	356

Note: 1) Definition of Classification is not fixed but given as procurement cost in each Kecamatan.

2) No. of shops excluding small shop in village (warung)

Source: Monthly Report (May 1979) submitted from Desa office for Kecamatan office.

Table 7.3 Recent Flood Damage Record

Date	Damage in Kecamatan / Kotamadya						Discharge Volume at A. Yani Station(m^3/sec)
	Kota Madiun	Kec. Madiun	Jiwan	Geger	Kebonsari	Balerejo	
75. 10. 6						2491[1],954[2]	32
76. 2. 29						1870 ,615	-
76. 3. 9						2946 ,1273	708
78. 6. 30	3,017,101	1,137,739	2,457,499	2,290	3,652	3175 ,1068	1,200
78. 12. 20					14,337		585
79. 4. 16	6,463					1741 ,530	568
79. 5. 5	202,416		1,893,444			4306 ,1163	1,010
79. 5. 26		113					12
80. 1. 22		238				1170 ,440	568
80. 4. 15	9,127						347

Note : 1) number of house.
2) acreage of cropping fields (ha).

Source: Damage Report submitted from Desa to Kecamatan / Kotamadya.

Table 7.4 Recorded Damage Caused by 30th June 1978

Kecamatan/ Kotamadya	Desa	House	Wet field	Upland field	Note
Kota Madiun	Patihan	900	30		
	Madiun Lor	49	-		
	Winongo	400	26		
	Pangongan	250	-		
	Mangunharjo	600	36		
	Nambangan Lor	721	-		
	Nambangan Kidul	155	2	6.5	
	Kartoharjo	112			
	Kejuarn	30	7		
	Sub Total	3,017	101	6.5	
Keco. Madiun	Bagi	162	40	11	
	Nglames	270	54	20	
	Tawangrejo	370	95	40	
	Sumberrejo	60	66	22	
	Banjarsari	125	100	60	
	Sendangrejo	23	15	5	
	Gunung sari	-	15	5	
	Tiron	97	73	49	
	Tanjungrejo	30	78	5	
	Kelun	-	20	5	
	Sub Total	1,137	592	217	
Kec. Balcrejo	Balerejo	300	50	30	
	Garon	510	196	62	
	Glonggong	325	40	95	

(to be continued)

(Continuation)

Kecamatan/ Kotamadya	Desa	House	Wet field	Upland field	Note
	Sogo	340	50	75	
	Banaran	275	20	40	
	Pacinan	175	20	25	
	Kd. Jati	180	25	35	
	Jeruk Gulung	195	30	40	
	Warurejo	165	20	30	
	Babadan	185	15	50	
	Bulakrejo	145	10	20	
	Sb. bening	140	10	15	
	Gading	90	15	20	
	Sub Total	3,175	506	562	
Kec. Geger	Sambirejo	6	35	-	
	Putat	12	30	-	
	Kranggan	4	25	-	
	Sub Total	22	90	-	
Kec. Kebonsari	Pucang anom		11	-	
	Balerejo		-	-	
	Rejosari		1	-	
	Kedondang		40	-	
	Sub Total		52	-	
Kec. Jiwan	Bukur	223	11	14	
	Sambirejo	310	15.5	18	
	Ngregong	124	-	-	
	Sogatan	75	8	20	

(to be continued)

(Continuation)

Kecamatan/ Kotamadya	Desa	House	Wet field	Upland field	Note
	Sidomulyo	253	21	50	
	Pucangrejo	273	14	26	
	Rejosari	62	16	15	
	Krokeh	47	95	22	
	Lebakayu	92	18	38	
	Jiwan	47	11	15	
	Klangen serut	8	18	-	
	Wayut	20	-	-	
	Caboan	67	19	8	
	Sawahan	369	6	-	
	Kajang	147	-	2	
	Klumpit	340	-	14	
	Pule	-	-	4	
	Sub Total	2,457	252.7	246	
	Grand Total	9,844	1,593.3	1,031.5	

Source: Prefeasibility Study Floodway Kali Madiun Buku III, Final Report.

Table 7.5 Value of Buildings

Type of Building		Kecamatan/Kotamadya (in 103 Rp)			
		Kota Madiun	Kec Madiun	Balerejo	Jiwan
Residence	(lower)	550	500	750	500
	(middle)	2,500	2,000	3,500	2,500
	(higher)	5,600	5,500	5,500	5,500
Office		27,000	7,500	12,000	12,000
School		16,000	6,800	14,000	14,000
Hospital		100,000	6,000	10,000	ne
Factory	(small)	350	2,000	2,000	300
	(medium)	10,000	4,500	50,000	1,500
	(large)	200,000	14,000	ne	150,000
Shop	(furniture)	ne	ne	25,000	15,000
	(agr prodct)	ne	ne	1,500	1,500
	(gold)	50,000	ne	ne	ne
	(testile)	60,000	3,700	ne	ne
	(restorant)	28,000	ne	ne	17,000
	(food)	1,000	ne	150	1,100
	(cont mtrls)	20,000	5,000	ne	18,000
	(elect goods)	12,000	4,000	ne	ne
	(book)	20,000	3,500	ne	ne
	(watch)	25,000	ne	ne	ne
	(paint)	30,000	ne	ne	ne
	(bicycle)	50,000	ne	ne	ne
	(auto mobil)	100,000	ne	ne	ne
	(bag)	30,000	ne	ne	ne
	(shoes)	48,000	ne	ne	2,000
	(photo studio)	29,000	ne	ne	ne
	(machinery)	22,000	ne	ne	ne
	(drag store)	45,000	ne	ne	ne

Note: ne: non existing.

Table 7.6 Assumed Coefficients

Type of Building	Coefficient to Building
Residence (lower class)	0.2
Residence (middle class)	0.2
Residence (higher class)	0.2
Office	0.3
School	0.2
Hospital	0.2
Factory (small)	0.2
Factory (medium)	0.2
Factory (large)	0.2

Table 7.7 Value of Shops and Value of Stored Goods

Kecamatan/ Type of Shop	No. of Shop	Value (106 Rp) Shop	Value (106 Rp) Goods	Ratio (Good/House)
Kota Madiun				
Gold	26	50	50	1.00
Textile	18	60	45	0.75
Restaurant	12	28	0.5	0.02
Food	166	1	0.125	0.13
Const. Mtrls	24	30	100	3.33
Elect. goods	12	19	8	0.42
Book	14	20	19	0.95
Watch	2	25	5	0.20
Paint	9	30	100	3.33
Bicycle	10	50	53	1.06
Auto mobil	2	100	350	3.50
Bag	16	30	6	0.20
Shoes	14	48	2	0.04
Photo Studio	11	29	6	0.21
Machinery	1	22	250	11.36
Drag Store	19	45	25	0.56
Kec. Madiun				
Textile	3	3.7	2.5	0.68
Const. mtrls	3	5	.5	3.00
Book	7	3.5	1.5	0.43
Kec. Balerejo				
Furniture	2	25	50	2.00
Agr. Product	79	1.5	1	0.67
Food	3	0.15	1	0.67

(to be continued)

(Continuation)

Kecamatan/ Type of Shop	No. of Shop	Value (106 Rp) Shop	Value (106 Rp) Goods	Ratio (Good/House)
Kec. Jiwan				
Furniture	6	15	5	0.33
Agr. Product	9	1.5	0.8	0.53
Restaurant	9	17	0.5	0.03
Food	1	1.1	0.15	0.14
Const. mtrls	4	18	20	1.11
Shoes	2	2	1.25	0.63
Drag Store	2	5	3	0.60

Source: Special Survey done by each Kecamatan.

Table 7.8 Estimates of Planted Acreage of the Related Kecamatan in Kabupaten Madiun (Paddy Field)

Kecamatan	Month											
	10	11	12	1	2	3	4	5	6	7	8	9
Balerejo	60	1,190	1,145	66	-	420	538	141	81	-	-	-
Geger	-	158	1,659	30	-	295	380	-	-	15	-	54
Jiwan	50	1,285	437	-	60	1,012	200	-	-	5	-	-
Kebonsari	4	25	1,500	192	5	55	155	80	11	-	-	-
Nglames	30	584	402	-	-	548	459	67	10	54	10	-
Total	144	3,242	5,143	288	65	2,330	1,732	288	102	74	10	54

Source: Monthly Report from Desa to Kecamatan (1979).

Table 7.9 Population and Land Use in the Inundated Area

Desa	Population		Area (ha)					
	Total	Density (per ha)	Total	Residential	Irrigated Paddy	Upland Paddy	Upland Crops	Sugar Cane
Kota Madiun								
1. Madiun Lor	8,002	125	64	35	-	-	4	-
2. Pangongan	5,730	94	61	21	16	-	-	4
3. Krtoharjo	9,185	121	76	59	-	-	-	-
4. Oro-Oro Ombo	8,326	124	67[1)]	60	20	-	-	-
5. Sukasari	2,883	19	148	21	20	54	-	-
6. Patihan	4,358	28	155	33	33	-	-	-
7. Klegen	6,520	62	106	83	19	-	-	-
8. Rejomulyo	5,688	25	224	64	118	-	-	15
9. Mojorejo	9,355	77	122	76	25	-	-	8
10. Winongo	7,177	26	273	48	129	-	-	86
11. Nambangan Lor	13,852	161	86	32	29	-	5	-
12. Nambangan Kidul	8,334	119	70	42	2	8	-	-
13. Pandean	8,174	47	175	21	72	-	-	20
14. Kejuron	12,857	62	206	48	78	-	28	24
15. Josenan	3,783	19	195	43	91	-	12	42
16. Mangunharjo	6,006	33	184	44	84	-	-	49

(to be continued)

Table 7.9 (continuation)

Desa	Population		Area (ha)					
	Total	Density (per ha)	Total	Residential	Irrigated Paddy	Upland Paddy	Upland Crops	Sugar Cane
Kec. Madiun								
17. Nglames	3,691	29	152	73	53	-	-	6
18. Gunung sari	1,437	9	173	62	95	-	-	26
19. Bagi	3,946	9	450[1)]	102	325	-	-	54
20. Kelun	1,271	15	86[1)]	17	69	-	-	6
21. Sumberrejo	2,188	8	293	62	220	-	-	-
22. Tanjungrejo	1,818	7	319	26	232	-	-	-
23. Tiron	3,883	12	327	41	229	-	-	29
Kec. Balerejo								
24. Balerejo	3,300	4	753	125	427	125	29	30
25. Garon	2,984	7	406[1)]	136	390	85	22	35
26. Babadan lor	2,236	6	362[1)]	59	189	-	118	45
27. Jeruk gunung	2,066	6	353	70	152	45	35	44
28. Sumber bening	2,324	7	356	79	163	-	55	42
29. Gading	2,367	7	337	57	225	-	43	-

(to be continued)

Table 7.9 (continuation)

Desa	Population		Area (ha)					
	Total	Density (per ha)	Total	Residential	Irrigated Paddy	Upland Paddy	Upland Crops	Sugar Cane
Kec. Jiwan								
30. Bakur	2,351	10	229[1)]	53	170	-	-	30
31. Grobogan	3,197	14	228[1)]	66	156	-	-	33
32. Kajang	1,334	10	129[1)]	26	100	-	-	25
33. Golan	1,744	11	155[1)]	38	108	-	-	18
34. Krokeh	1,042	13	83[1)]	18	54	9	-	21
35. Lebakayu	2,012	11	178[1)]	45	119	14	-	19
36. Ngegong	1,998	15	136[1)]	36	85	-	-	24
37. Pucangrejo	2,298	12	194[1)]	29	151	8	-	28
38. Sawahan	1,731	9	190[1)]	20	135	23	-	57
39. Sogetan	2,033	18	113[1)]	52	53	-	-	12
40. Wayut	4,598	13	350[1)]	95	243	-	-	41
41. Sidomulyo	2,401	12	208[1)]	24	115	54	-	43
42. Cabean	2,102	8	253	63	188	-	-	47
43. Rejosari	2,534	11	231	52	154	-	-	30

Note: 1) Total is smaller than summation of acreage of specified land use.

Source: Monthly Report to Camat, ibid.

Table 7.10 Number of House in the Inundated Area

Desa	Residence			Office	School	Hospital	Factory		Shop
	Low	Middle	High				Small	Mid. and Large	
Kota Madiun									
1. Madiun Lor	322	120	899	17	32	1	1	2	44
2. Pangongan	213	-	654	20	14	-	-	-	41
3. Kartoharjo	285	104	743	24	15	2	-	5	27
4. Oro-Oro Ombo	161	101	1,023	3	12	1	-	1	11
5. Sukasari	164	75	234	1	3	10	2	-	-
6. Patihan	250	-	454	3	10	2	-	1	-
7. Klegen	327	157	946	3	12	1	-	-	3
8. Rejomulyo	64	12	1,156	1	8	1	35	2	-
9. Mojorejo	21	91	1,379	8	19	-	4	1	2
10. Winongo	120	10	1,006	1	5	1	1	-	-
11. Nambangan Lor	1,041	85	1,375	1	11	1	-	1	40
12. Nambangan Kidul	627	-	912	8	7	1	-	1	13
13. Pandean	320	275	1,041	2	9	-	18	33	59
14. Kejuron	334	275	1,841	3	8	1	-	2	91
15. Josenan	64	-	628	1	6	-	9	-	21
16. Mangunharjo	367	145	458	1	7	1	19	1	15

Table 7.11 Commercial Activities in Madiun City

Desa	Shop								
	Gold	Textile	Restaurant	Food, Drug Store	Construction Materials	Electric Goods	Book, Photo	Watch, Bag Shoes	Part of Auto
Kota Madiun									
Madiun Lor	-	-	-	37	6	1	1	5	-
Pangongan	2	4	2	11	4	4	4	4	2
Kartoharjo	-	-	2	7	1	1	3	4	3
Oro-oro Ombo	-	-	-	9	-	-	1	-	-
Sukosari	-	-	-	-	-	-	-	-	-
Patihan	-	-	-	-	-	-	-	-	-
Klegen	-	-	-	-	-	-	2	1	-
Rejomulyo	-	-	-	-	-	-	-	-	-
Mojorejo	-	-	-	1	-	-	1	-	-
Winongo	-	-	-	-	-	-	-	-	-
Nambangan Lor	2	1	6	15	14	1	3	3	2
Nambangan Kidul	-	-	-	10	2	-	1	-	-
Pandean	22	6	-	12	7	3	3	-	3
Kejuron	-	6	-	53	6	2	5	15	1
Josenan	-	-	-	20	1	-	-	-	-
Mangunharjo	-	1	2	9	1	-	1	-	-

Source : Monthly Report to Camat, ibid.

Table 7.12 Estimates of Damage (Madiun River)

in 10^3 Rp

	Return Period (years)			
	17	10	5	2
irrig. paddy	641,576	592,632	499,760	432,700
upland paddy	26,237	26,237	21,950	18,668
upland crop	35,041	29,019	17,178	13,952
sugar cane	341,830	327,191	282,371	223,404
residence (low)	827,607	491,647	420,540	345,317
residence (middle)	169,135	104,198	87,759	42,242
residence (high)	3,577,981	2,503,988	2,054,046	1,202,896
office	180,837	102,391	107,813	97,177
school	128,930	74,142	53,536	42,705
hospital	60,544	23,283	26,905	21,493
factory (small)	1,526	1,350	980	729
factory (medium)	21,402	12,837	3,074	2,296
factory (large)	94,740	62,240	44,964	34,361
shop	239,374	518,026	503,133	419,925
Total[1)]	6,736,767	4,869,188	4,124,014	2,888,876

Note: 1) Total is not concident due to rounding

Table 7.13 Estimates of Damage (Jerowan River)

in 10^3 Rp

	Return Period (years)			
	17	10	5	2
irrg. paddy	131,297	70,923	58,261	3,541
upland paddy	3,968	1,062	1,062	0
upland crop	21,721	19,045	17,209	9,180
sugar cane	62,502	42,559	39,598	9,827
residence (low)	302,144	34,481	28,094	7,536
residence (middle)	13,154	7,524	5,859	0
residence (high)	273,501	22,398	21,863	0
office	2,012	634	509	0
school	2,803	1,129	92	0
hospital	0	0	0	0
factory (small)	756	74	0	0
factory (medium)	327	61	61	0
factory (large)	750	0	0	0
shop	1,473	534	417	141
Total[1)]	816,686	200,968	173,029	30,228

Note: 1) Total is not coincident due to rounding

Table 7.14 Estimated Benefit of Project

in 10^3 Rp

	With Jerowan dyke Alternative II group	Without Jerowan dyke Alternative I group
17 yrs r/p	6,736,767	5,920,081
10 yrs r/p	4,869,188	4,668,220
5 yrs r/p	4,124,014	3,950,985
2 yrs r/p	2,888,876	2,858,648
Annual Average	1,740,539	1,670,401

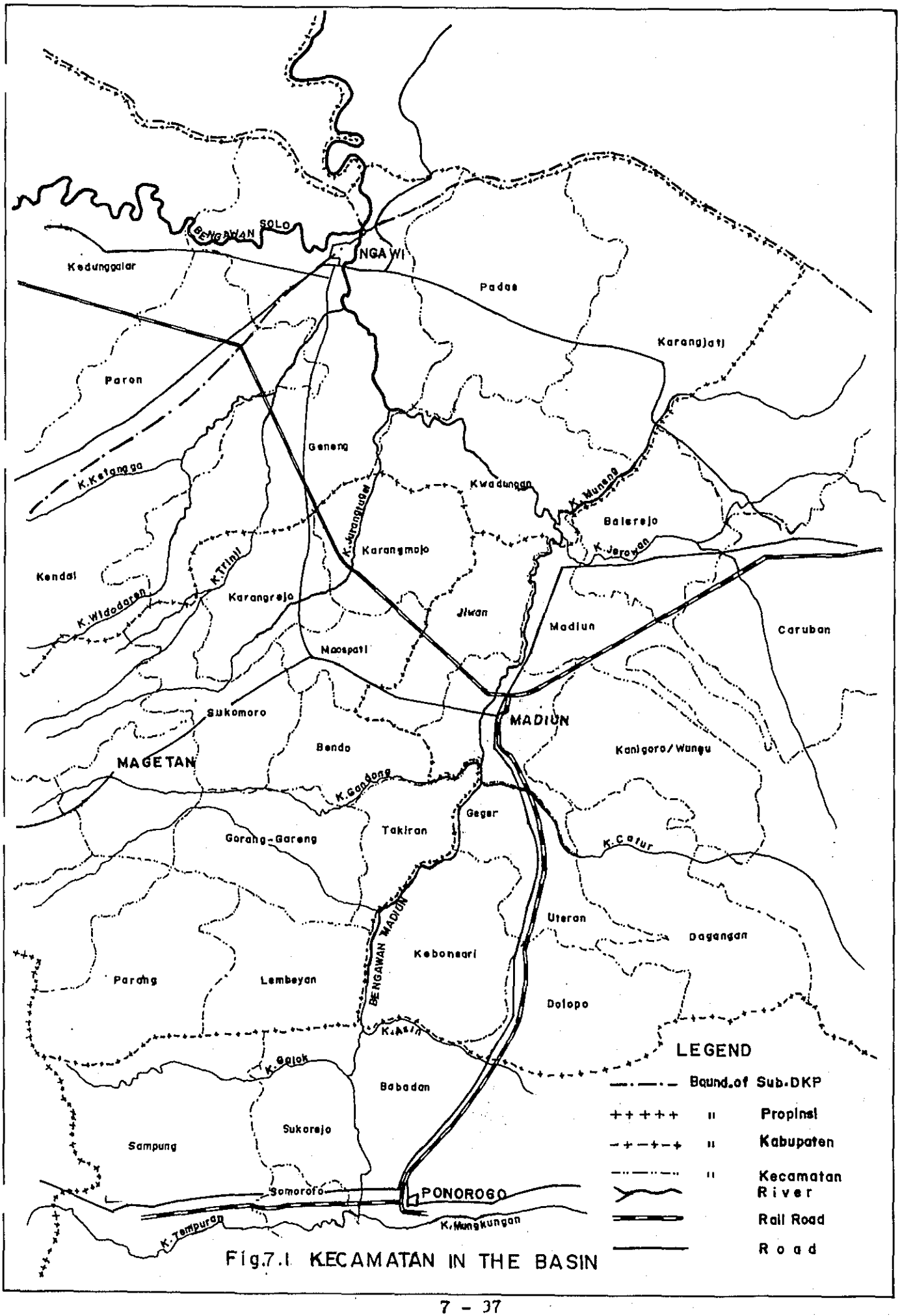


Fig.7.1 KECAMATAN IN THE BASIN

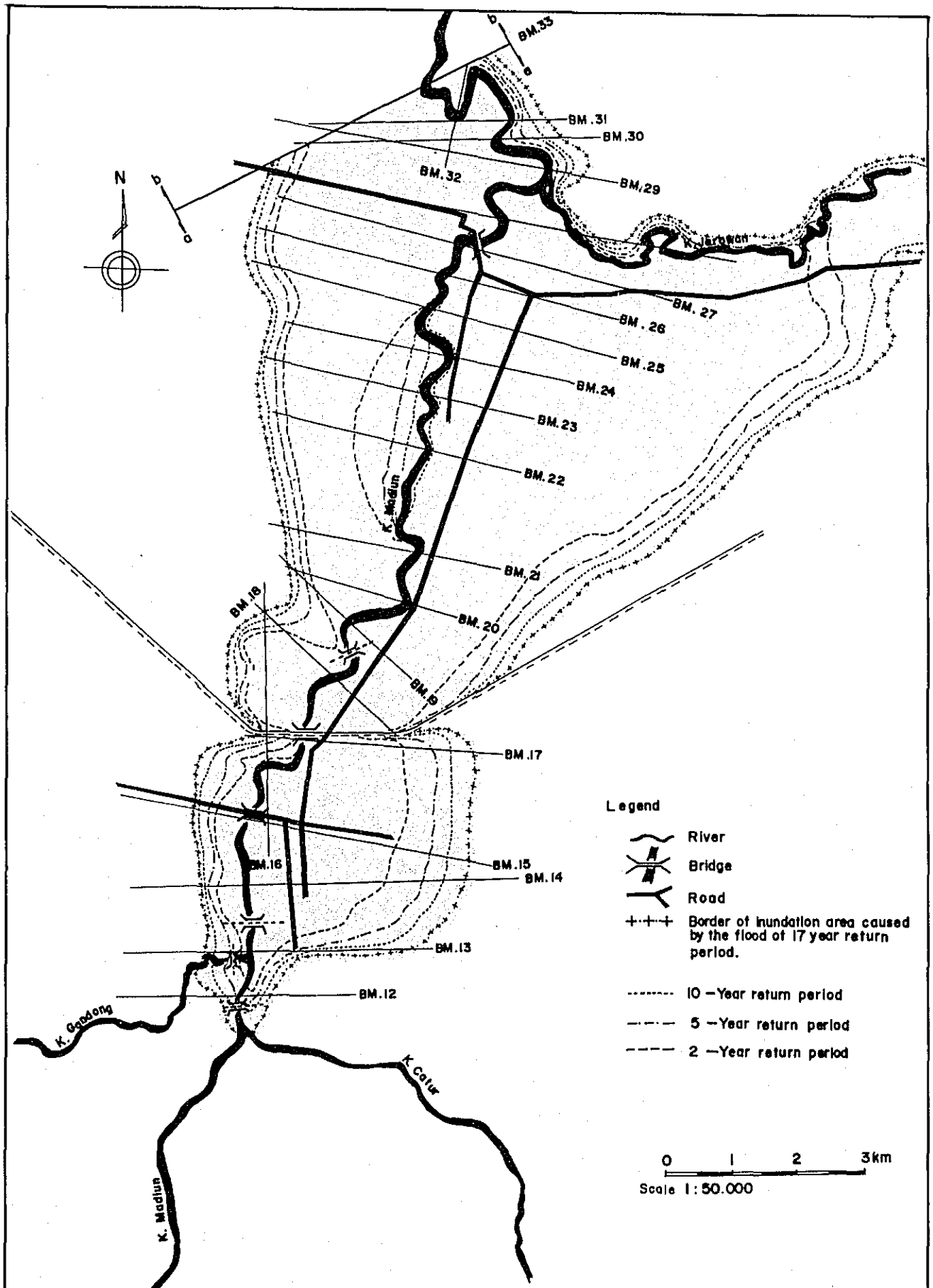


Fig. 7.2a POSSIBLE INUNDATION (Without Project)

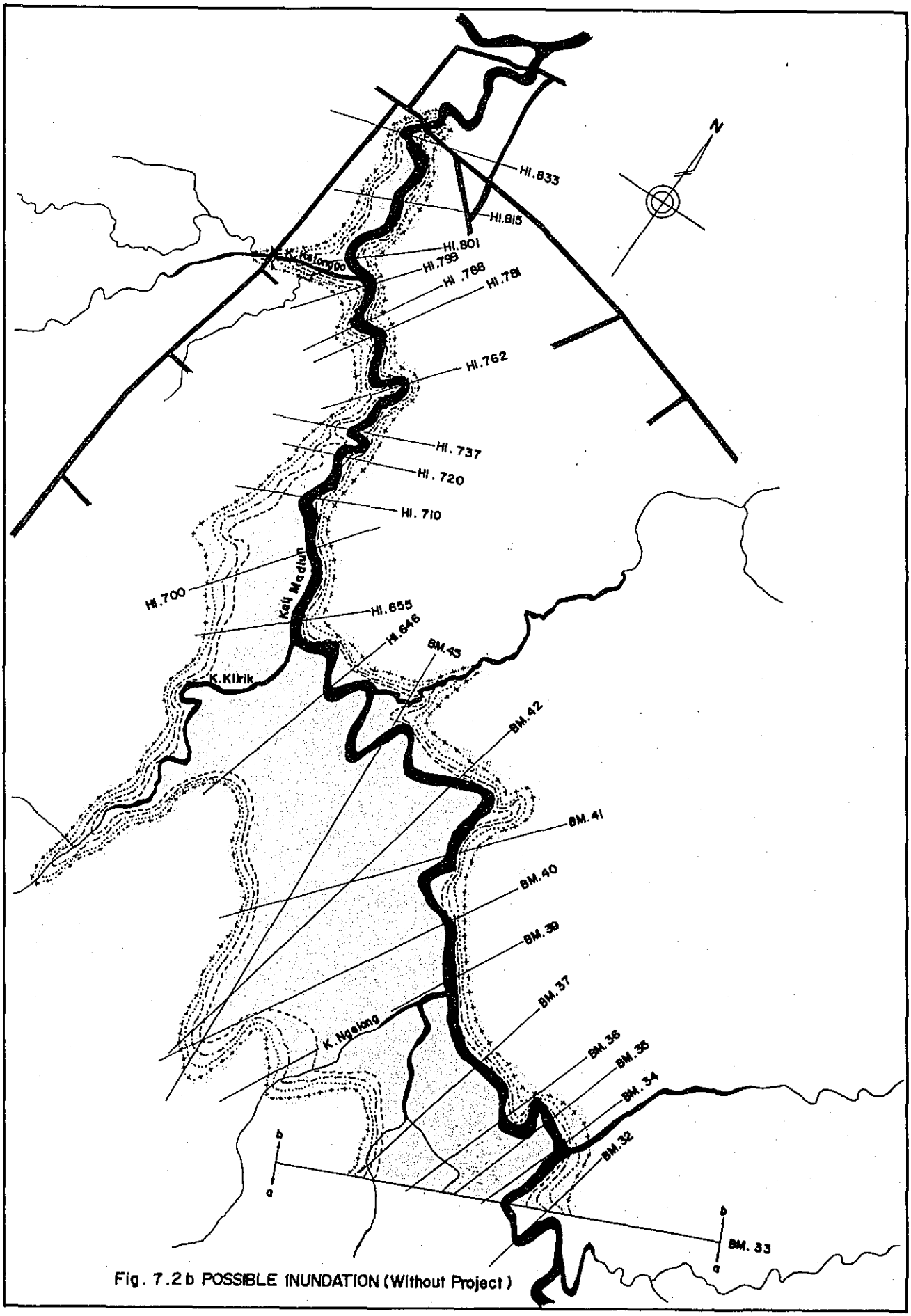


Fig. 7.2 b POSSIBLE INUNDATION (Without Project)

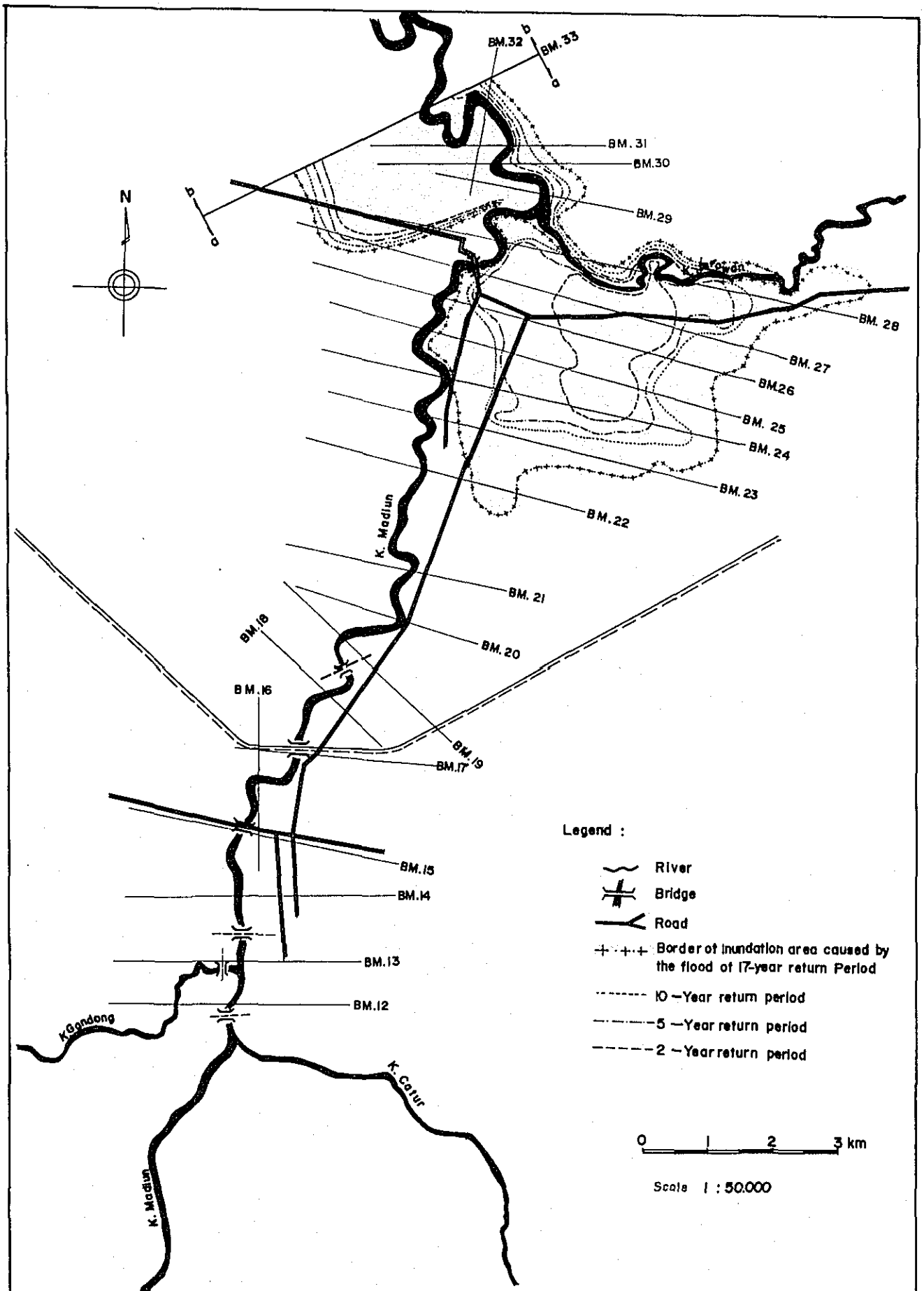


Fig. 7.3a. POSSIBLE INUNDATION (Alternative I-1 & 2).

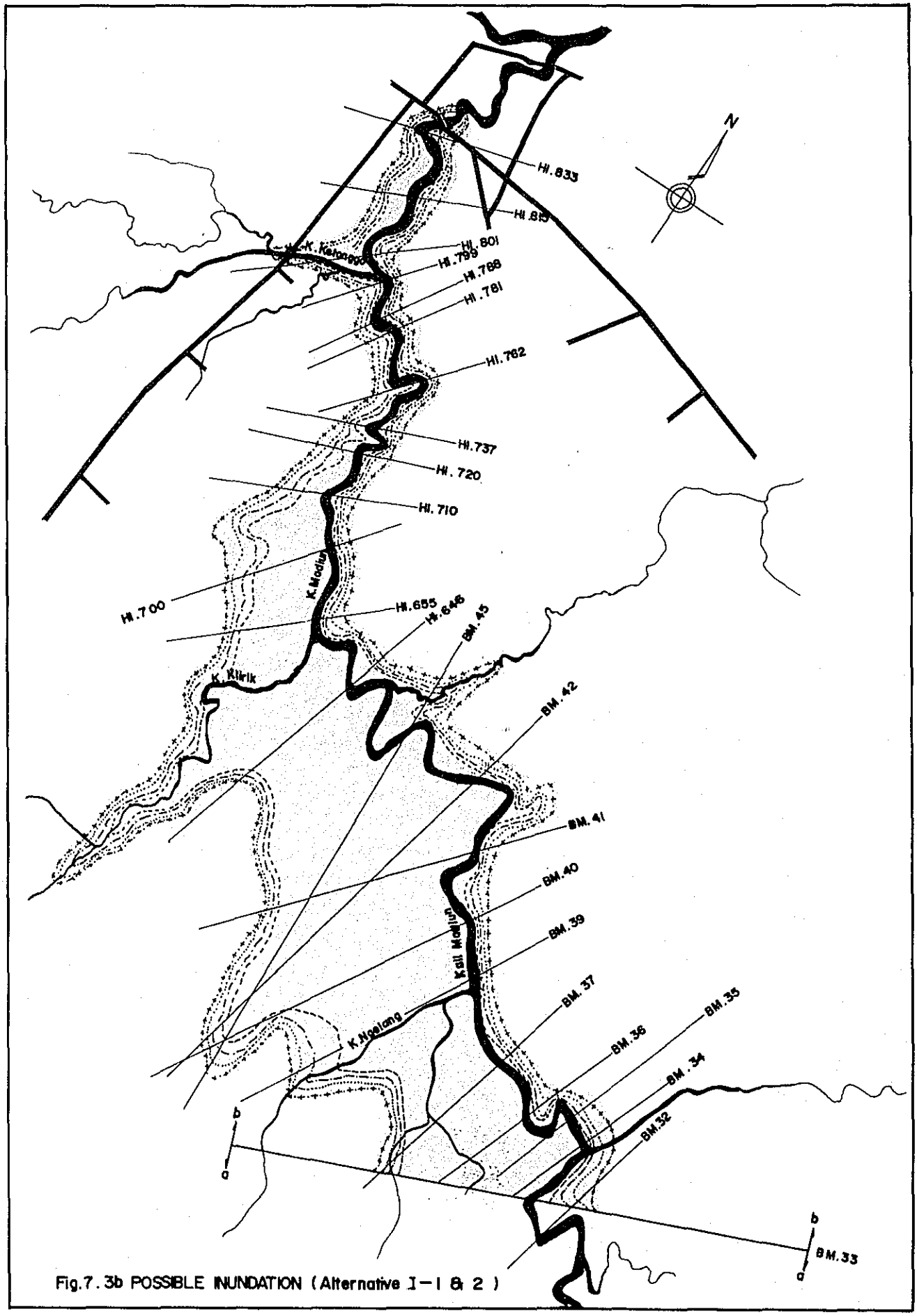


Fig.7.3b POSSIBLE INUNDATION (Alternative I-1 & 2)

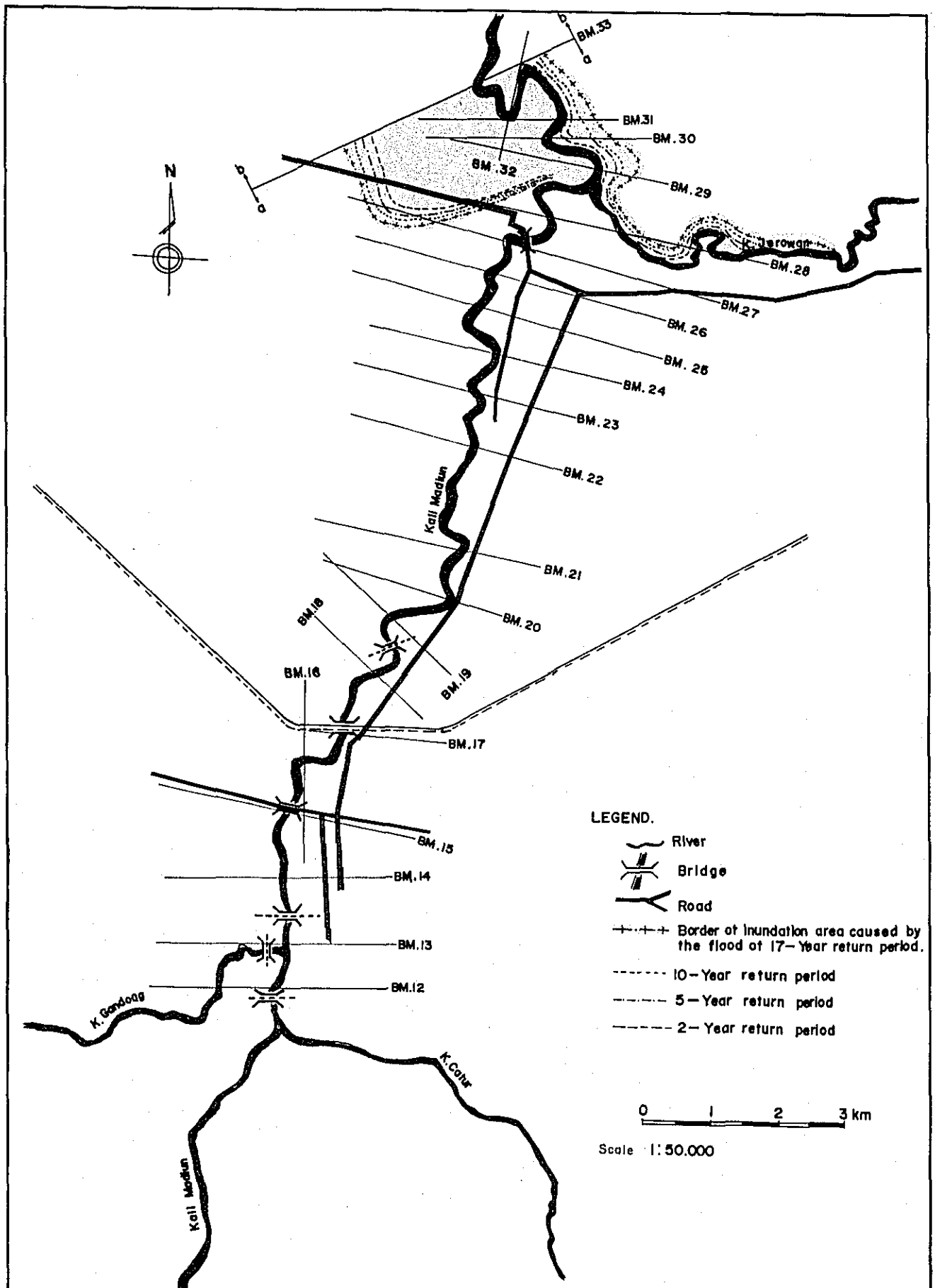


Fig. 7.4a POSSIBLE INUNDATION (Alternative I-1,2 & 3)

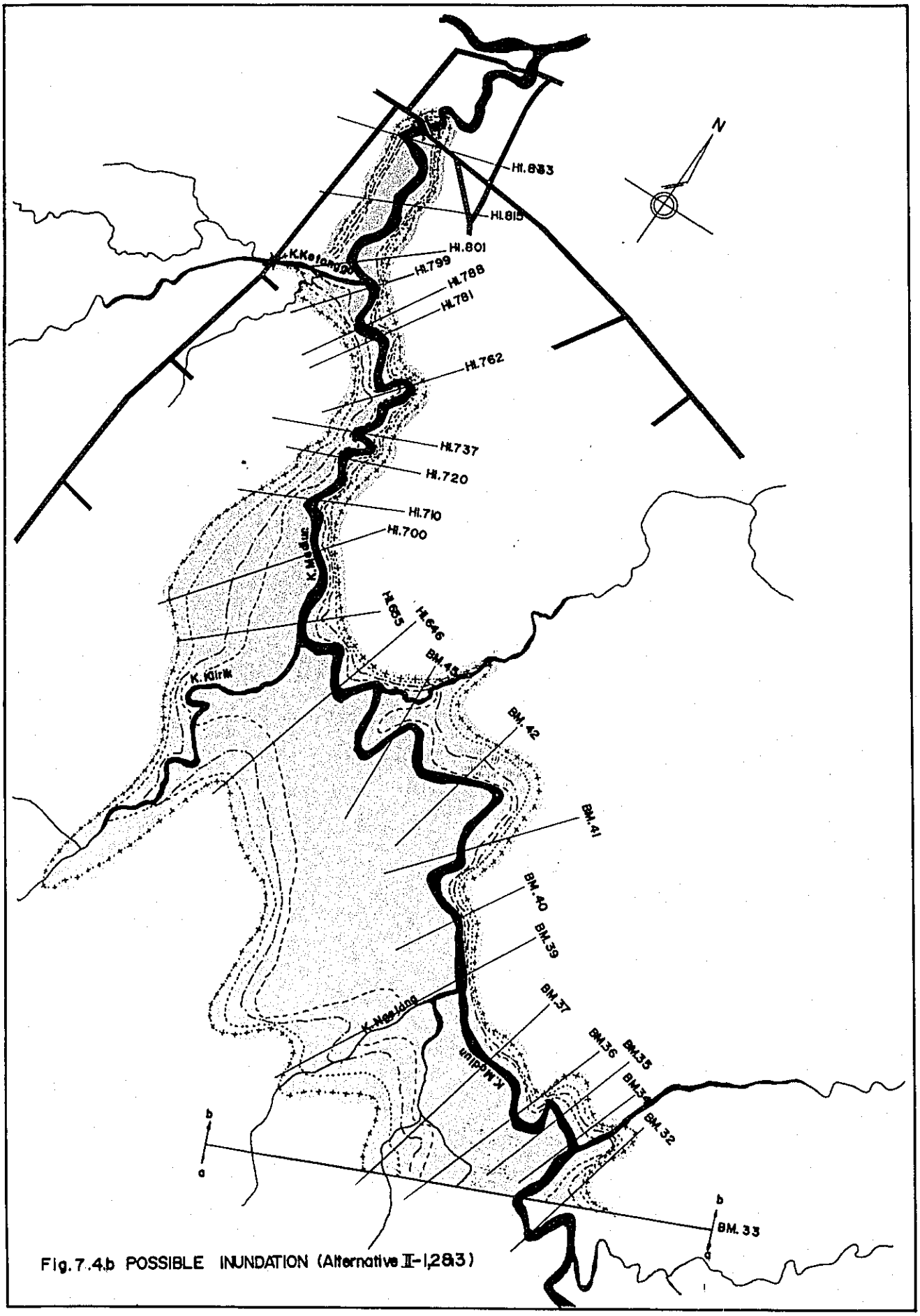


Fig. 7.4.b POSSIBLE INUNDATION (Alternative II-1,2&3)

8. ECONOMIC ANALYSIS OF THE PROJECT

Benefits: The average annual benefits which were derived from the work described in previous sections are set out in Table 8.1 The annual benefits was regarded to be obtained from the year after the completion of the construction.

Costs: Annual construction costs in Indonesian Rupiah during the construction period including equipment, materials, engineering service and other discussed in Chapter 6, are set out in Table 8.2.

Outlay for the operation and maintenance of the new facilities was counted for the years following the completion of the construction, in the same way as the average annual benefits. Conversely, the cost of operating and maintaining the old facilities was eliminated for the years following the completion of the construction and this amount was subtracted from average annual outlay for operation and maintenance for the years. The increase in the annual O.M. costs was accounted as the economic cost and summarized in Table 8.3.

The estimated benefits and costs are summarized in Table 8.4 for the period of the project life of 50 years and for each alternative.

The obtained benefits and costs were discounted by the rates of 2.5, 10.0 and 12.0 percent and the respective present worth benefits and costs were derived for each alternative, as presented in Table 8.5.

Through the figures in Table 8.5, economic feasibility of the project were assessed in the basis of the current values of benefits and the costs. The analysis was carried out in terms of: Net Present Value (NPV), Benefit Cost Ratio (BCR) and the Internal Rate of Return (IRR). The results were presented as follows;

Alterna-	NPV in 10^6 Rp			BCR			IRR
tives	2.5%	10%	12%	2.5%	10%	12%	(%)
I - 1	29,664	1,434	- 484	3.24	1.15	0.95	11.3
I - 2	31,181	2,459	454	3.66	1.28	1.05	12.6
II - 1	29,729	608	-1,341	2.98	1.05	0.87	10.5
II - 2	31,262	1,643	- 392	3.33	1.16	0.96	11.5
II - 3	30,114	783	-1,204	3.06	1.07	0.88	10.6

The NPV of 2,459 and 1,643 million rupiah were estimated to be secured by the alternative I-2 and II-2 respectively with the discount rate of 10 percent.

The obtained economic IRR proved the economic feasibility of the project since the estimated economic IRR thereof were as high as more than ten percent. The highest IRR of 12.6 percent was estimated for the alternative I-2.

Furthermore only the direct benefits which can be expressed in monetary terms were considered in this analysis as defined in Chapter 7. If the indirect benefits other than those mentioned above, which cannot be expressed monetary terms are taken into account, the economic feasibility of this project becomes even clearer.

Table 8.1 Average Annual Benefits

(Unit: Rp 10^6)

Alternative	Average Annual Benefits
Group I	1,670
Group II	1,740

Table 8.2 Annual Construction Costs

(Unit: 10^6 Rp)

Alternatives	Year				Total
	1st	2nd	3rd	4th	
I - 1	601	3,278	4,299	4,337	12,515
I - 2	601	3,956	3,234	3,268	11,059
II - 1	601	3,917	4,800	4,838	14,156
II - 2	601	4,610	3,721	3,754	12,686
II - 3	601	5,133	3,963	4,050	13,747

Table 8.3 Increase of Average Annual Operation and Maintenance Costs after Improvements

(Unit: 10^6 Rp.)

Alternatives	Increase of Annual Cost.
I - 1	62.6
I - 2	55.3
II - 1	70.8
II - 2	63.4
II - 3	68.7

Table 8.4 Costs and Benefits during the Life of the Project by Alternative

(Time Basis; 1980)

(Unit: 10^6 Rp.)

Year	Construction Costs 1)					Benefits	
	Alt. I-1	I-2	II-1	II-2	II-3	I	II
1	601	601	601	601	601	0	0
2	3,278	3,956	3,917	4,610	5,133	0	0
3	4,299	3,234	4,800	3,721	3,963	0	0
4	4,337	3,268	4,838	3,754	4,050	0	0
5	63	55	71	63	69	1,670	1,740
6	63	55	71	63	69	1,670	1,740
7	63	55	71	63	69	1,670	1,740
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
50	63	55	71	63	69	1,670	1,740

Note: 1) including operating and maintenance cost

Table 8.5 Discounted Benefit and Cost

(As of 1980)

Alternative	Discount Rate (percent)	Benefit $(10^6$ in Rupiah)	Cost $(10^6$ in Rupiah)
Alternative I - 1	2.5	42,910	13,246
	7.0	17,582	10,906
	10.0	11,309	9,874
	12.0	8,813	9,298
Alternative I - 2	2.5	42,910	11,728
	7.0	17,582	9,729
	10.0	11,309	8,850
	12.0	8,813	8,359
Alternative II - 1	2.5	44,709	14,979
	7.0	18,319	12,339
	10.0	11,783	11,175
	12.0	9,183	10,525
Alternative II - 2	2.5	44,709	13,446
	7.0	18,319	11,150
	10.0	11,783	10,139
	12.0	9,183	9,575
Alternative II - 3	2.5	44,709	14,594
	7.0	18,319	12,096
	10.0	11,783	10,999
	12.0	9,183	10,387

9. CONCLUSIONS AND RECOMMENDATIONS

The results of economic evaluation imply that the economic feasibility of the alternative group I is higher than that of the alternative group II. However the difference was deemed to be insignificant. Especially the economic IRRs of the alternative I-2 and II-2 were regarded similar considering the accuracy of the estimated construction costs and the benefits. In this evaluation the benefit to be brought by the protection of the Jerowan area were estimated based on the present land use and productivity records. However certain land development works are under way in this area. And a considerable increase in the benefit was expected as the consequence of the protective works for the area.

In this respect, it was concluded that the recomendable plan should be selected among the alternative group II. And, in the final, the alternative II-2 was selected as the most appropriate plan since the obtained IRR for the alternative is the maximum among ones for the group II.

Sensitivity of costs and/or benefits to IRR was examined in the case of alternative II-2 and the results are shown below;

Benefits	Cost			(c) - (a)
	10% up (a)	no change (b)	10% down (c)	
(1) 10% up	11.5	12.5	13.9	2.4
(2) no change	10.6	11.5	12.6	2.0
(3) 10% down	9.6	10.5	11.5	1.9
(1) - (3)	1.9	2.0	2.4	

Results of sensitivity analysis shows that change of 20 percent of costs or benefits yields difference of around 2 percent in the IRR. In the worst case, the cost increase by 10 percent and benefit decrease by 10 percent, the IRR of the project still maintain high rate of 9.6 percent.

The maximum possible riverbed degradation in the Madiun river was estimated at 1.2 meters as an effect of proposed shortcut works. However the degradation is confined within the immediate upstream of the Part 1 shortcut channel.

The estimated possible increase in the inundation depth was approximately twenty centimeters with respect to the design dischange in the downstream area from the confluence with the Jerowan river. An increase of a few percent in inundation area was measured in the existing map as an effect of the said depth increasure.

The inflow into the Solo river consequent to the occurance of the design flood at A. Yani under the present condition was estimated at nine hundreds cubic meters per second. The increment of 75 cubic meters per second was estimated to the above inflow as the effect of the improvement works by the alternative II-2. This increasure correspond to a few percent of the discharge in the Lower Solo river. And it was considered that the effect of the improvement works to the downstream reach would be insignificant.

It is recommendable to undertake the detailed design works and the subsequent implementation of the urgent improvement in accordance with the plan of the alternative II-2.

Various design criteria were applied to the feasibility design for the works and structures for the project. However, it will be necessary to provide more elaborate design criteria with careful examination of the construction sites in the detailed design.

Possible increment of the flood peak discharge in the downstream reach from the project area and the consequent inflow to the Lower Solo river should be studied more in detail by using more accurate topographic map and other data relevant to the problem. It will be of practical necessity to assess the compound effect of all the river works likely to be implemented in the reaches in the Upper Solo river

basin including the Madiun river. And practical measure to minimize the possible rise of the flood level in the downstream area should be studied in the detailed design for the convenience of the priority scheme to be implemented immediately after the urgent project.

Certain riverbed evolution may be brought as an effect of shortcut works of the project. The system design of the riverbed monitoring should be involved in the detailed design for the project.

The scope of the project was confined to the urgent project level with regard to the design conditions and the covering area to be protected. It is recommendable to grade up the improvement plan and to enlarge the area to be protected to more extensive one in the subsequent stage of improvement. In this future stage, following measures should be studied;

a) Construction of Badegan dam and/or Bendo dam.

b) More extensive shortcut works in the lower reaches of the Madiun river.

c) Construction of the floodway with an adequate capacity.

d) Diversion of the Gandong river to reduce the peak discharge of the flood run off passing the urban area of Madiun city.

e) Erosion control works in some tributary basins as necessary.

f) Establishment of a flood forecasting and warning system.

ANNEX

ANNEX-1

(RE-TYPED COPY)

MINUTES OF MEETING

ON

SCOPE OF WORK FOR THE FEASIBILITY STUDY

OF

THE MADIUN RIVER URGENT IMPROVEMENT PROJECT

The J.I.C.A. Preliminary Survey Team for the Madiun River Urgent Improvement Project and the Directorate of Rivers of the Directorate General of Water Resources Development, Ministry of Public Works, the Government of Republic of Indonesia exchanged their views concerning the scope of work for the feasibility study of the Madiun River Urgent Improvement Project.
Both sides agreed on the scope of work as attached hereto with the following understandings.

1) The scope of the feasibility study will focus on formulation of an optimum project plan for the urgent flood control of the Madiun River and its surrounding area upon conceptional review for overall flood control scheme of the entire Solo river system and identify the effects of the improvement to the downstream areas.

2) Japanese Survey Team will be dispatched by the end of March,1980 and during the period of its field survey, interim report will be provided and submitted to the Government of Indonesia.

3) To secure the smooth execution of the study, the Government of Indonesia shall prepare the necessary fundamental materials as soon as possible. Especially, the cross-section of the river course

between Ngawi and Madiun city together with transverse leveling of the inundation area should be completed by the middle of April, 1980.

4) Both sides will make the best effort to provide necessary materials for the earliest implementation of the Project.

Jakarta, February 16, 1980

Kanenobu Hagiwara
Leader of J.I.C.A.
Preliminary Survey
Team.

Ir. Putra Duwarsa
Director of Rivers,
Directorate General of Water
Resources Development,
Ministry of Public Works.

SCOPE OF WORK
FOR
THE FEASIBILITY STUDY
OF
THE MADIUN RIVER URGENT IMPROVEMENT PROJECT

1. INTRODUCTION

In response to the request of the Government of Indonesia, the Government of Japan has decided to conduct a feasibility study for the Madiun River Urgent Improvement Project in accordance with laws and regulations in force in Japan, and the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation program of the Government of Japan, will carry out the study in close cooperation with the authorities concerned of the Government of Indonesia.

2. OUTLINE OF THE STUDY

2.1 Objective of the Study

The objective of the study is to formulate an optimum project plan for urgent measures to mitigate the flood damage in Madiun city and its surroundings caused by the Madiun River and to assess its technical and economic feasibilities.

2.2 The area

The area covered by the study includes the whole basin of the Madiun River, in which the length of the main stream is nearly 100 km and the catchment area is about 3,800 km2.

The objective area of the urgent flood mitigation will cover mainly Madiun city and its surroundings.

2.3 Scope of Work

The scope of work to be carried out will include the following items :

1) Collection, review and analysis of available data, preceding studies and other information related to the Project.

2) Guidance and supervision of the additional survey of the following items if necessary to be carried out by the Indonesian Government.

   i) Topographic survey
   ii) Test boring
   iii) Sampling and test of soil materials
   iv) Sediment load

3) Hydrologic analysis.

4) Investigation of the damages caused by the floods.

5) Formulation of alternative plans for urgent flood control.

6) Estimation of the effect of improvement by the alternative plans.

7) Preliminary design and cost estimation of the alternative plans.

8) Study on the appropriate construction method and programme.

9) Selection and formulation of an optimum project plan, based on the comparative evaluation of the alternatives.

10) Recommendation for the implementation of the Project.

3. REPORTING

The JICA will prepare and submit the following reports to the Government of Indonesia :

Inception Report	(20 copies)	: At the beginning of the field survey
Interim Report	(20 copies)	: Within 4 months after commencement
Draft Final Report	(20 copies)	: Within 7 months after commencement
Final Report	(50 copies)	: Within 1.5 months after receipt of comments from the Indonesian Government on the Draft Final Report

4. UNDERTAKINGS OF THE GOVERNMENT OF INDONESIA

The Government of Indonesia will provide the following for the execution of the study :

1) All available data, reports, maps, aerial photographs, and any other information relevant to the Project ;

2) Approvals, permits and authorizations by the

Government of Indonesia necessary for the execution of the Study ;

3) Topographic surveys, geological investigations, sampling and tests of soil materials ;

4) Counterpart personnel required for the survey ;

5) Suitable office space necessary for the study ;

6) Exemption from taxes and duties for personnel and goods from and to Japan for the execution of the study in accordance with the Indonesian regulations.
Besides, the Indonesian Government will arrange vehicles with drivers.

5. UNDERTAKINGS OF THE GOVERNMENT OF JAPAN

The Government of Japan will contribute the following for the execution of the study :

1) To provide a Japanese expert team ;

2) To prepare necessary materials and equipment ;

3) Transferring the knowledge to the Indonesian counterparts during the period of the study in Indonesia and Japan.

6. STUDY SCHEDULE

A schedule of the study will be tentatively as follows :

Item	1980										1981			
	3	4	5	6	7	8	9	10	11	12	1	2	3	4
Field Survey														
Planning and Design														
Draft Final Report														
Final Report														

ANNEX - 2

Office, data and information were provided thereby.

Direktorat Jenderal Air, PDW

Direktorat Sungai, PWD

PBS, Pusat Surakarta

PBS, Wonogiri Dam Sub Proyek

PBS, Madiun Sub Proyek

PROSIDA, Madiun

Kantor Irigasi, Madiun

National Rail Way: Kantor Stasiun Madiun
Kantor Stasiun Solo

BINAMARGA: Madiun office
Surabaya office

Kantor Sensus D.I. Yogyakarta

Kantor Kabupaten Madiun

Kantor Kabupaten Ngawi

Kantor Kabupaten Magetan

Kantor Kecamatan Balurejo

Kantor Kecamatan Geger

Kantor Kecamatan Jiwan

Kantor Kecamatan Kebonsari

Kantor Kecamatan Kwadungan

Kantor Kecamatan Madiun

Kantor Kecamatan Nglames

Kantor Kecamatan Takiran

Kantor Kotamadya Madiun

Kantor A. Yani gaging station

Kantor Dam Jati gaging station

Universitas Gadjah Mada

PT. PG Rejo Agung

PT. PG Rejo Sari

PT. PG Kanigoro

Attendants of the Meetings

March 24th, 1980	in Surakarta PBS Office
PBS	Mr. Trie Mulat Sunaryo
	Mr. Sutanto M.
	Mr. Imam Hidayat
	Mr. Suprapto
	Mr. Graito Sutadi
	Mr. Masrul Kosam
	Mr. Suradji
	Mr. Ismoyo
	Mr. Supeno
Colombo Plan	Mr. Seki
Nippon Koei	Mr. Sawaya
J.I.C.A.	Mr. Nishikawa
	Mr. Takayanagi
	Mr. Kawahara
March 26th, 1980	in Madiun Sub Project PBS Office
PBS	Mr. Imam Hidayat
	Mr. Masrul Kosam
	Mr. Ismoyo
Madiun Office	Mr. Muryono
	Mrs. Nunik Tadani Retnoningrum
	Mr. Setiarjo
J.I.C.A. (Study Team)	Mr. Nishikawa
	Mr. Takayanagi
	Mr. Kawahara

April 4th, 1980	in Jakarta Directorate of River
Directorate of River (Jakarta)	Mr. Mardjono
	Mr. Putra Duarsa
	Mr. Amir Mnryadi
	Mr. Soekrisno Rammelan
	Mr. Imam Anshari
	Mr. Supriyana
	Miss Muryati
(PBS)	Mr. Imam Hidayat
	Mr. Suprapto
Colombo Plan	Mr. Hamamori
	Mr. Kuranobu
Embassy of Japan	Mr. Yamazaki
J.I.C.A. (Jakarta)	Mr. Shinoura
Advisory Committee	Mr. Nakao
	Mr. Murata
J.I.C.A. (Study Team)	Mr. Nishikawa
	Mr. Takayanagi
	Mr. Suganuma
May 20th, 1980	in Surakarta PBS Office
Directorate of River (Jakarta)	Mr. Putra Duarsa
	Mr. Djoko Sasongko
	Mr. M. Sidharto

(PBS)	Mrs. Diah Isnadi
	Mr. Imam Hidayat
	Mr. Suprapto
	Mr. Subyanto
	Mr. Bambang Hardiyatno
	Mr. Wismal Hari Ismoyo
	Mr. Abdul Muin Smt
	Mr. Sriarih
	Mr. Masrul Kosam
	Mr. Hari Buditiarso
	Mr. Sudiro
	Mr. Graito Sutadi
	Mr. Adisuryo
	Miss Aisya
Colombo Plan	Mr. A. Hamamori
	Mr. Takano
	Mr. Seki
J.I.C.A.	Mr. Takayanagi
(Study Team)	Mr. Suganuma
	Mr. Tanaka
	Mr. Tateishi
July 9th, 1980	in Jakarta Directorate of River
Directorate of River	Mr. Putra Duarsa
(Jakarta)	Mr. Amir Muryadi
	Mr. H. Pramudo
	Mr. T. M. Sunaryo
	Mr. Sidharta
	Mr. Satryo Untung
	Ms. Muryati

(PBS)	Mr. Trie Mulat
	Mr. Imam Hidayat
	Mr. Suprapto
	Mr. Masrul Kosum
Colombo Plan	Mr. Hamamori
	Mr. Takano
Embassy of Japan (Jakarta)	Mr. Yamazaki
J.I.C.A. (Jakarta)	Mr. Goto
Advisory Committee	Mr. Nakao
	Mr. Ono
J.I.C.A. (Study Team)	Mr. Nishikawa
	Mr. Takayanagi
	Mr. Takato
	Mr. Tanaka

November 24 and 25, 1980 in Jakarta Directorate of River

Directorate of River (Jakarta)	Mr. Putra Duarsa
	Mr. Mardjono N.
	Mr. Amir Muryadi
	Mr. H. Pramudo
	Mr. Suwarso
	Mr. Djoko Sasongko
	Mr. M. Sidharta
	Mr. Siswoko
	Mr. Satrio Untung
	Mr. Soemarno
	Mr. Sudarminto
	Mr. Edi Wahab
	Mr. W. Sabarno

(PBS)	Mr. Soelamto
Colombo Plan	Mr. Hamamori
	Mr. Takano
Advisory Committee	Mr. Tokuhiro
	Mr. Nakao
J.I.C.A.	Mr. Nishikawa
(Study Team)	Mr. Takayanagi