b) Vertical alignment

In compliance with the geometric standard in Sri Lanka, the maximum vertical grade has been set at 4% for a design speed of 60km/h.

The topsoil is clayish but there exists a shallow distribution of hard rocks (partially outcropping). Hence, a plan has been worked out calling for a vertical alignment with a low banking that requires the least amount of rock excavation and makes it easy to accommodate present drainage facilities. The important points to consider for the vertical alignment are as follows:

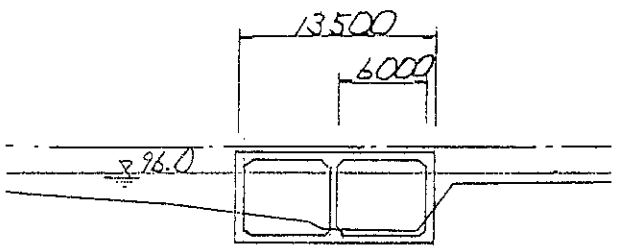
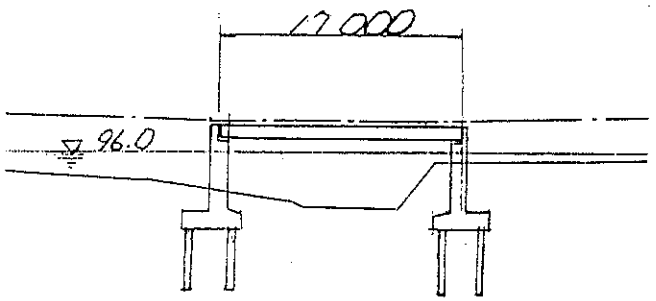
- Runoff point of existing roads at starting point (left bank)
- Runoff point of existing roads in the vicinity of kilopost no.2+00Km
- H.W.L. of the waterway near kilopost no.4+0.400Km
- H.W.L. of the Mahaweli River
- Runoff point at end point (on right bank)

Along the access roads there are some crossings, most of them for waterways, and the existing cross-sectional areas of these structures will be left intact when planning roads. The crossing with the largest cross-sectional area on the access roads is the waterway in the vicinity of kilopost no.4+0.400Km, for which there are two alternatives under consideration. One of them is a box culvert and the other a bridge as shown in Table-3.3.4. The box culvert has been chosen because of its smaller cross-sectional area and lower construction cost. For other intersected waterways, a small box or pipe culvert with a small cross section will be installed.

3.3.5 Basic Design Drawing

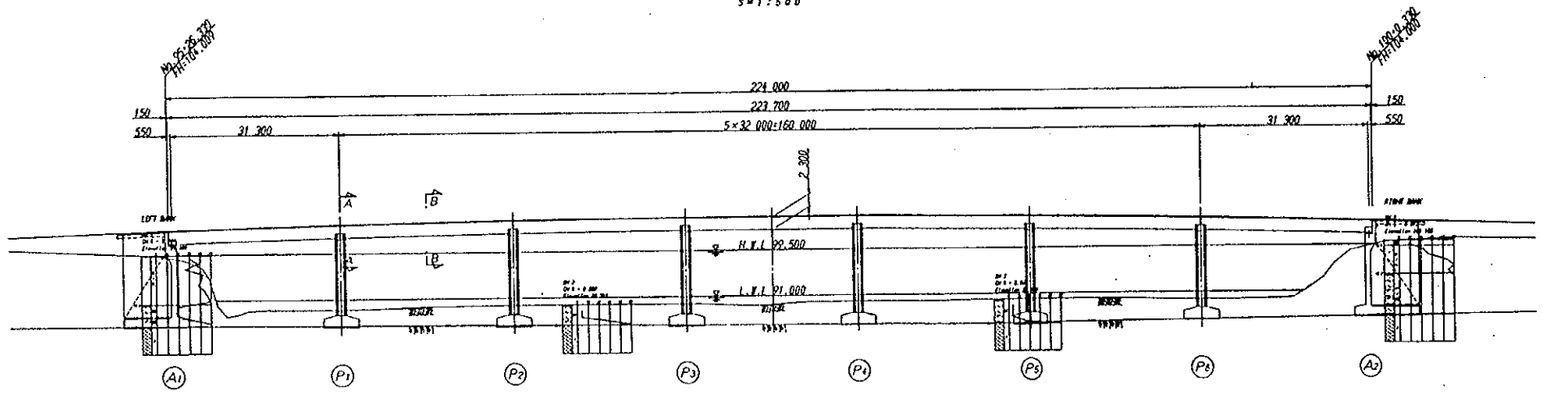
The basic design drawing has been completed for the bridge and the access roads in order to estimate the amount of construction needed, to prepare a construction plan, and to estimate the project's cost. The general drawings for the main bridge and superstructure are shown in Figures-3.3.1 through 3.3.3. Furthermore, the typical cross sections for the access roads, vertical alignment, horizontal alignment, and culverts drawings are as shown in Figures-3.3.4

Table-3.3.4 Comparisons of Structure in the Vicinity of No.4 + 0.400km

	Box Culvert	Bridge (RC hollow deck slab bridge)
Cross Section		
Approximate Quantity	Concrete V=360m^3 Reinforcing bar W=53t	Concrete Superstructure V1 = 110m^3 Substructure V2 = 370m^3 V = 480m3 Reinforcing bar W = 64t
Characteristics of Structure	- Excellent structural characteristics with smaller cross section than bridge alternative owing to rigid-frame structure. - No problem in general though deformation from surrounding ground.	- Simplest bridge structure. - Will not subside since piles penetrate to rock strata.
Construct ability	- No problem to construct in dry season because of no water. If built in the rainy season, it is necessary to cut a waterway. Advisable to construct in dry season.	- Necessary to use pile driving machine - Superstructure to be constructed with supports. - Construction during dry season.
Cost	Low (Index=100)	High (Index=100)

GENERAL VIEW (1)

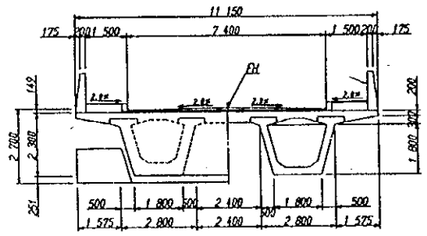
PROFILE
S=1:600



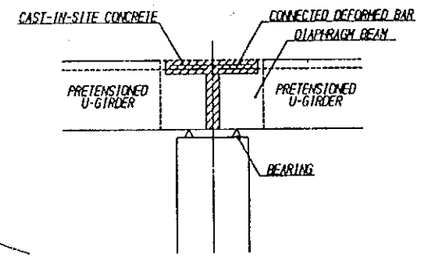
LONGITUDINAL GRADE	
PROPOSED HEIGHT	
GROUND HEIGHT	
ACCUMULATIVE DISTANCE	
DISTANCE	
STATION No.	
CURVATURE	
SUPER ELEVATION	

SECTION
S=1:100

A – A B – B



DETAIL OF CONNECTION
S=1:100



PLAN
S=1:500

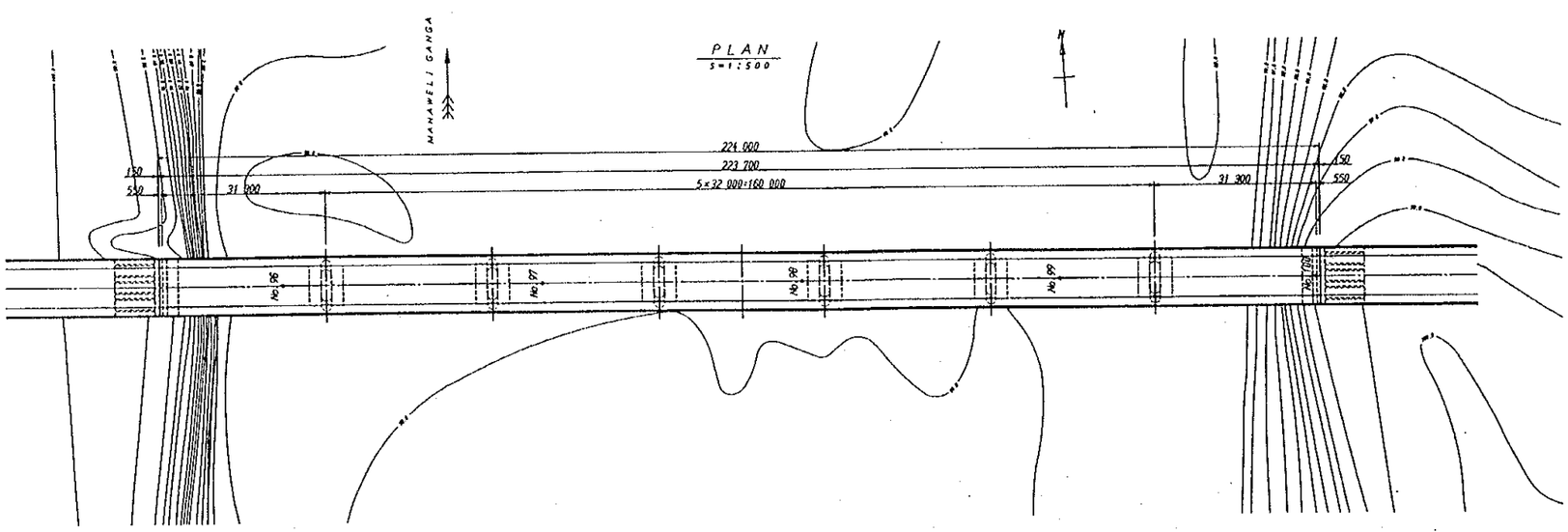


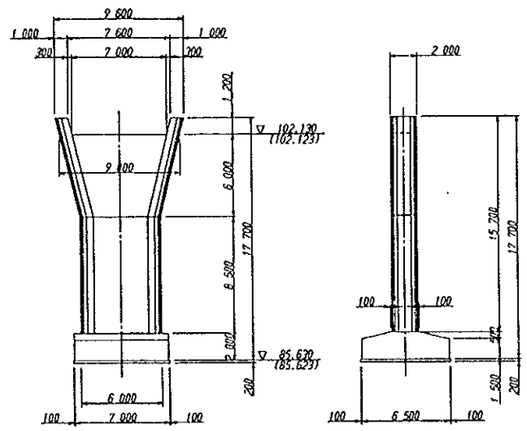
Figure-3.3.1

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: GENERAL VIEW OF BRIDGE (1)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 1	

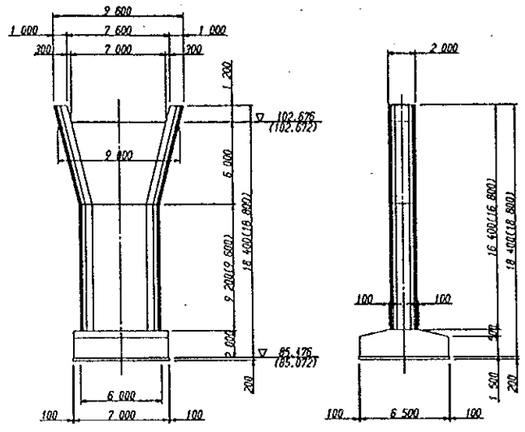
GENERAL VIEW (2)

PIERS
S=1:200

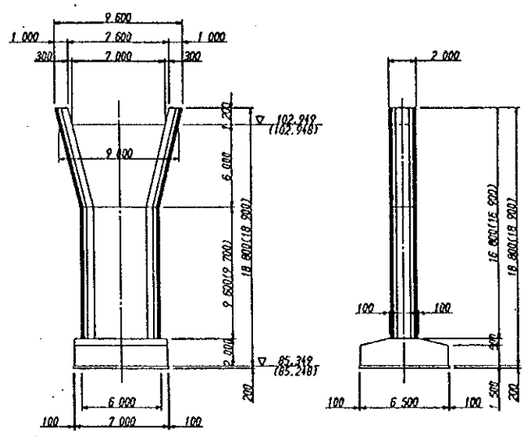
(P1) ((P6))



(P2) ((P5))

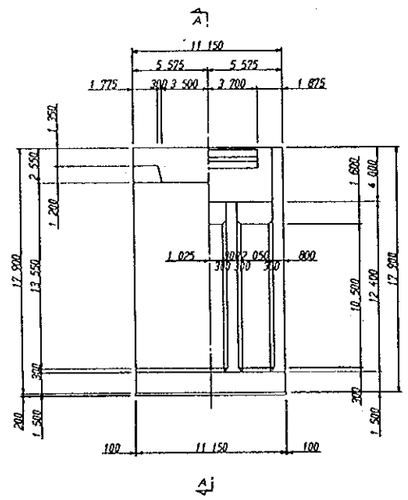


(P3) ((P4))



ABUTMENTS
S=1:200

(A1) ((A2))



A – A

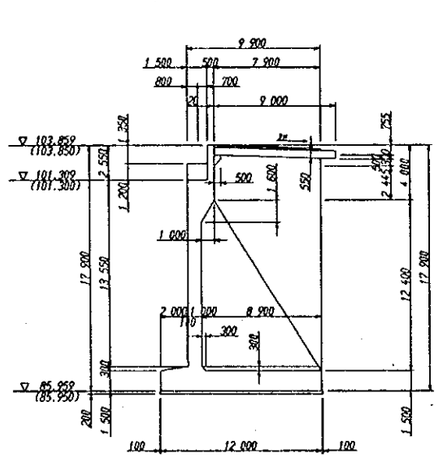
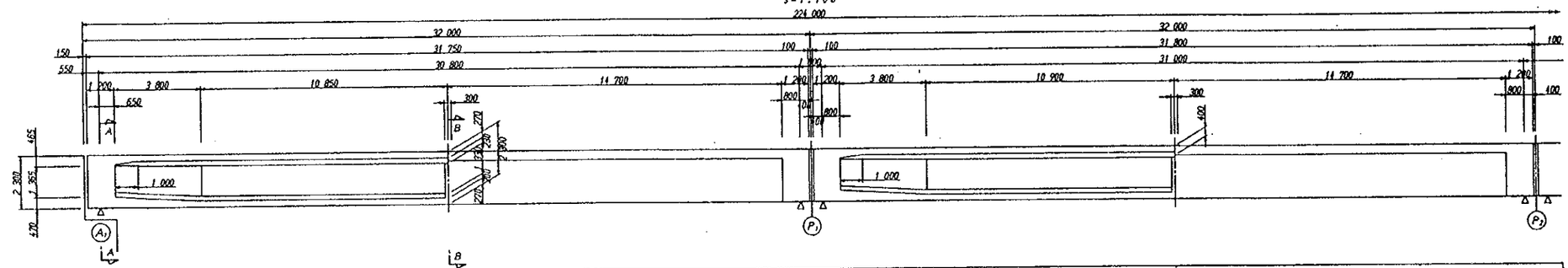


Figure-3.3.2

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: GENERAL VIEW OF BRIDGE (2)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 2	

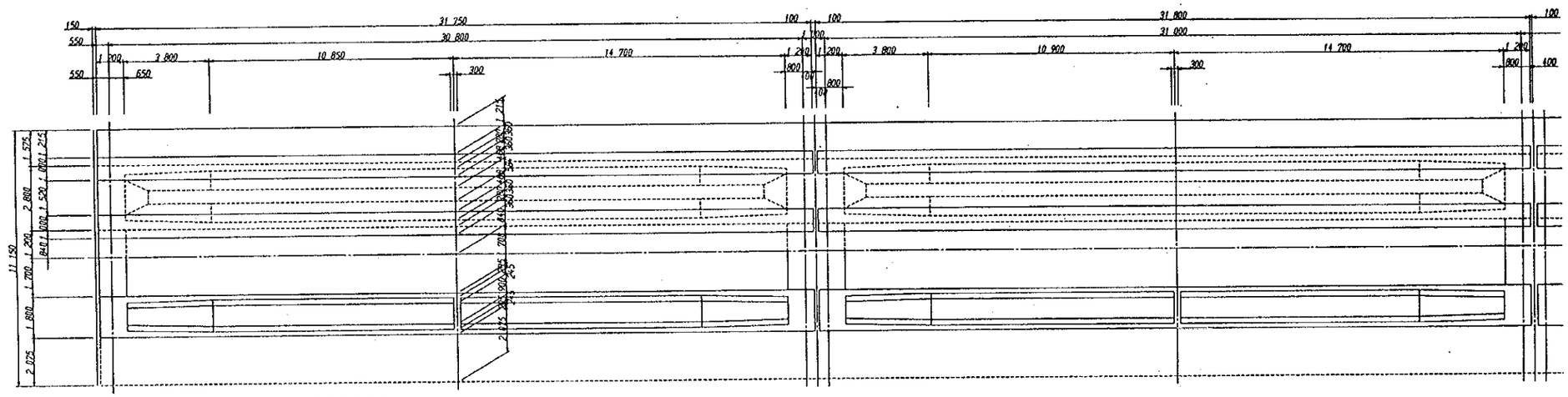
DETAILED DIMENSIONS OF STRUCTURE

ELEVATION
S=1:100



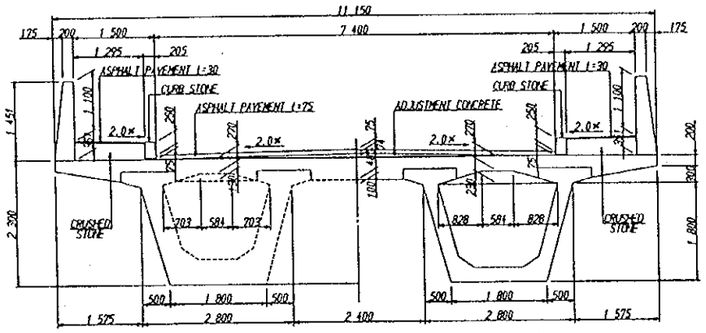
UPPER SLAB	
WEB	
BOTTOM SLAB	
DEPTH	

PLAN
S=1:100

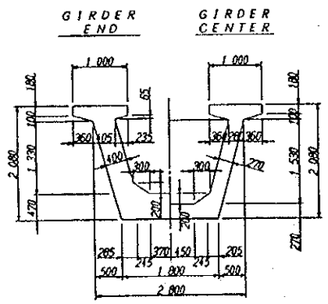


CROSS SECTION
S=1:50

A – A　　B – B



GIRDER END　　GIRDER CENTER



KEY PLAN

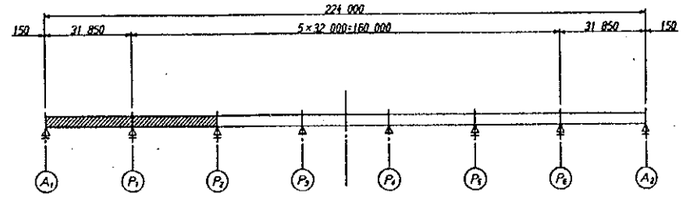
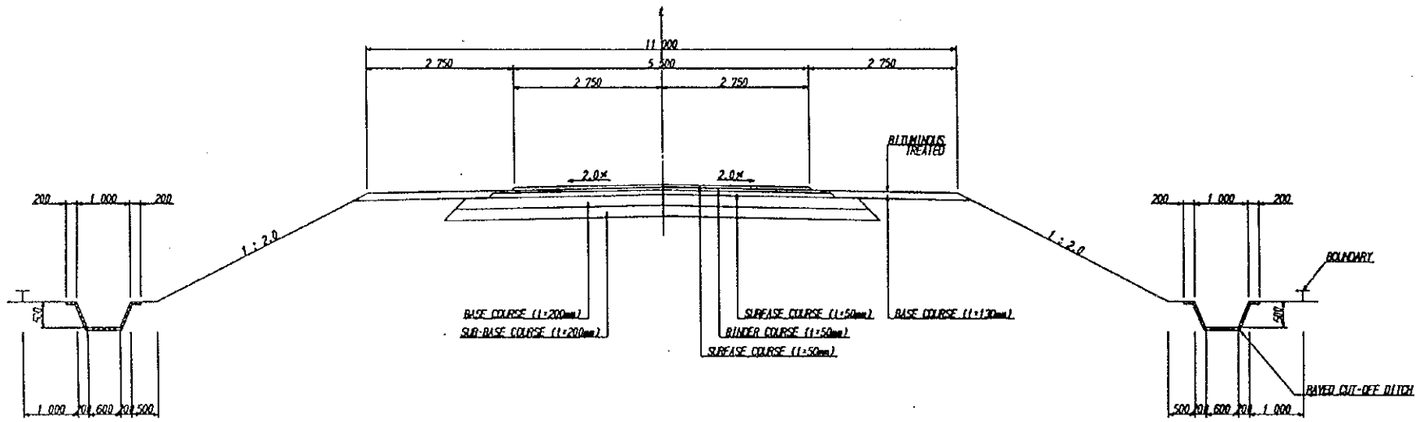


Figure-3.3.3

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: DETAILED DIMENSIONS OF STRUCTURE	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 3	

TYPICAL CROSS SECTION S = 1 : 50

EMBANKMENT



CUTTING

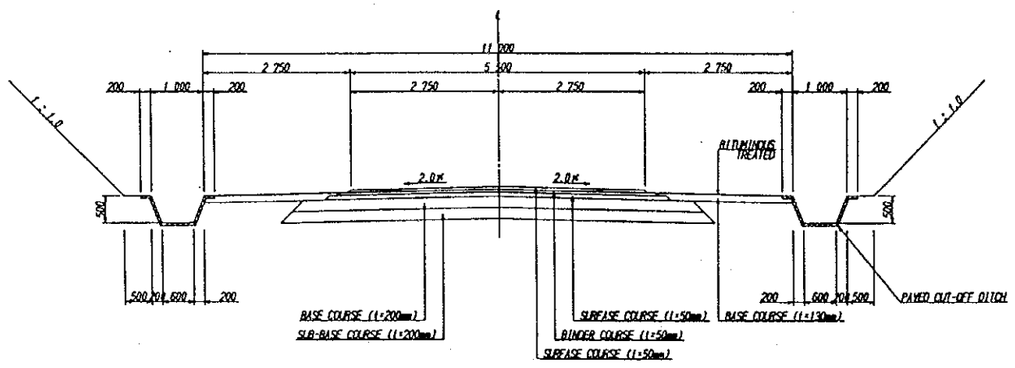


Figure-3.3.4

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: TYPICAL CROSS SECTION		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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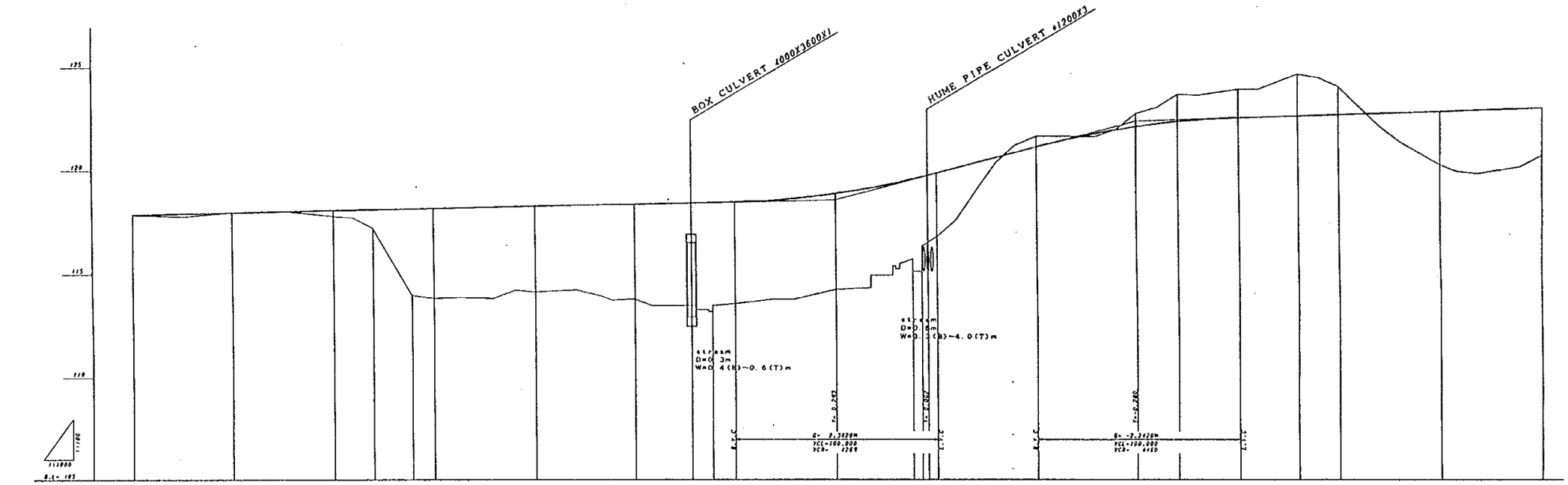

Figure-3.3.5

NO.-2 ~ NO.12

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (1)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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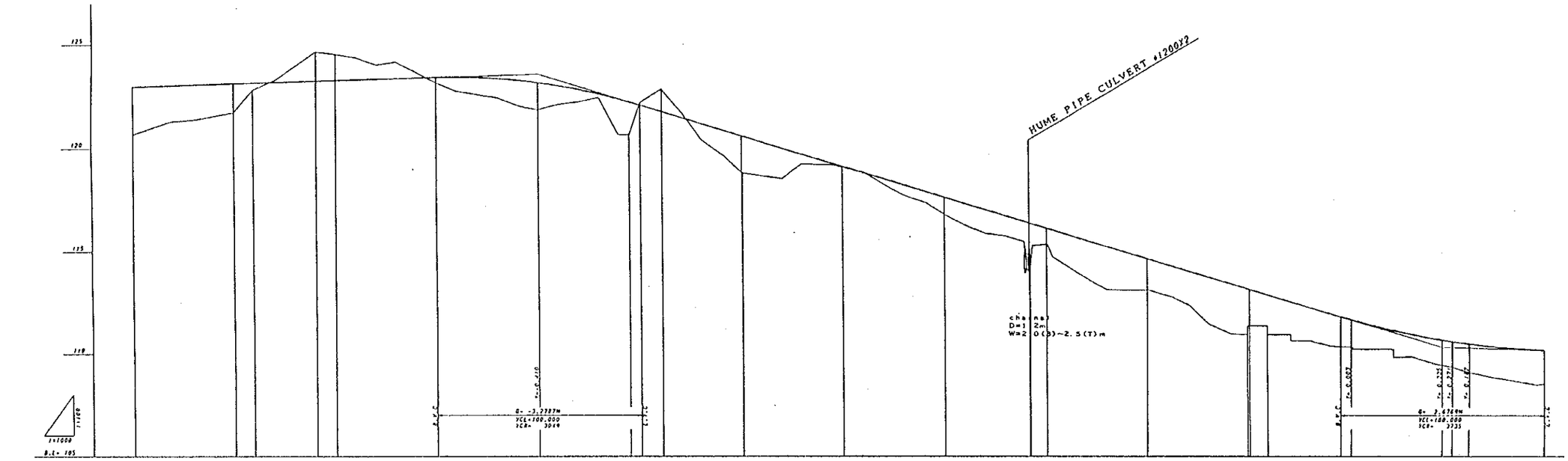

Figure-3.3.6

NO.12 ~ NO.25+45.000

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (2)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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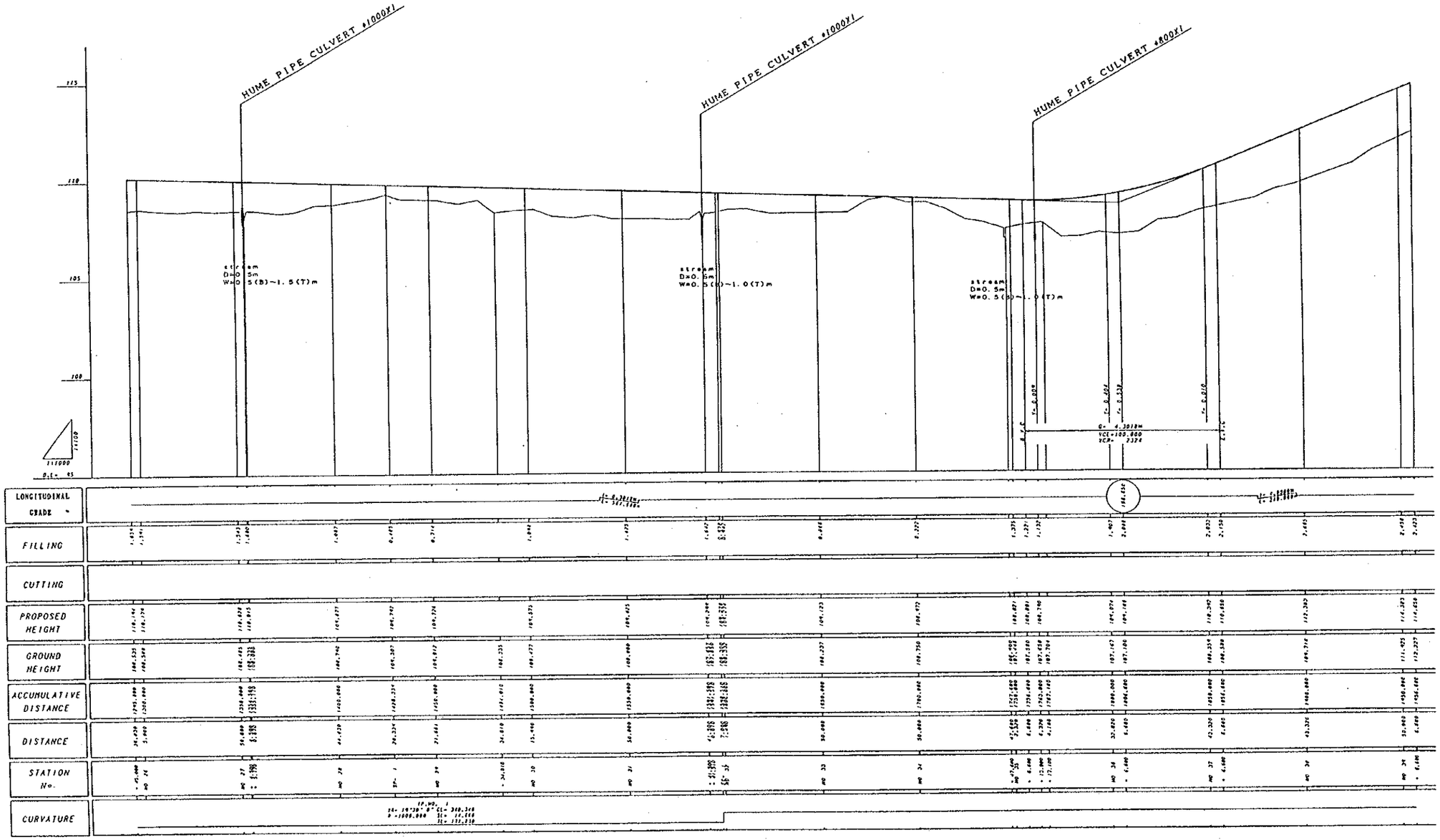

Figure-3.3.7

NO.25+45.000~NO.39+6.680

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (3)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 7	

Figure-3.3.8

NO.39+6.680~NO.51+26.730

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (4)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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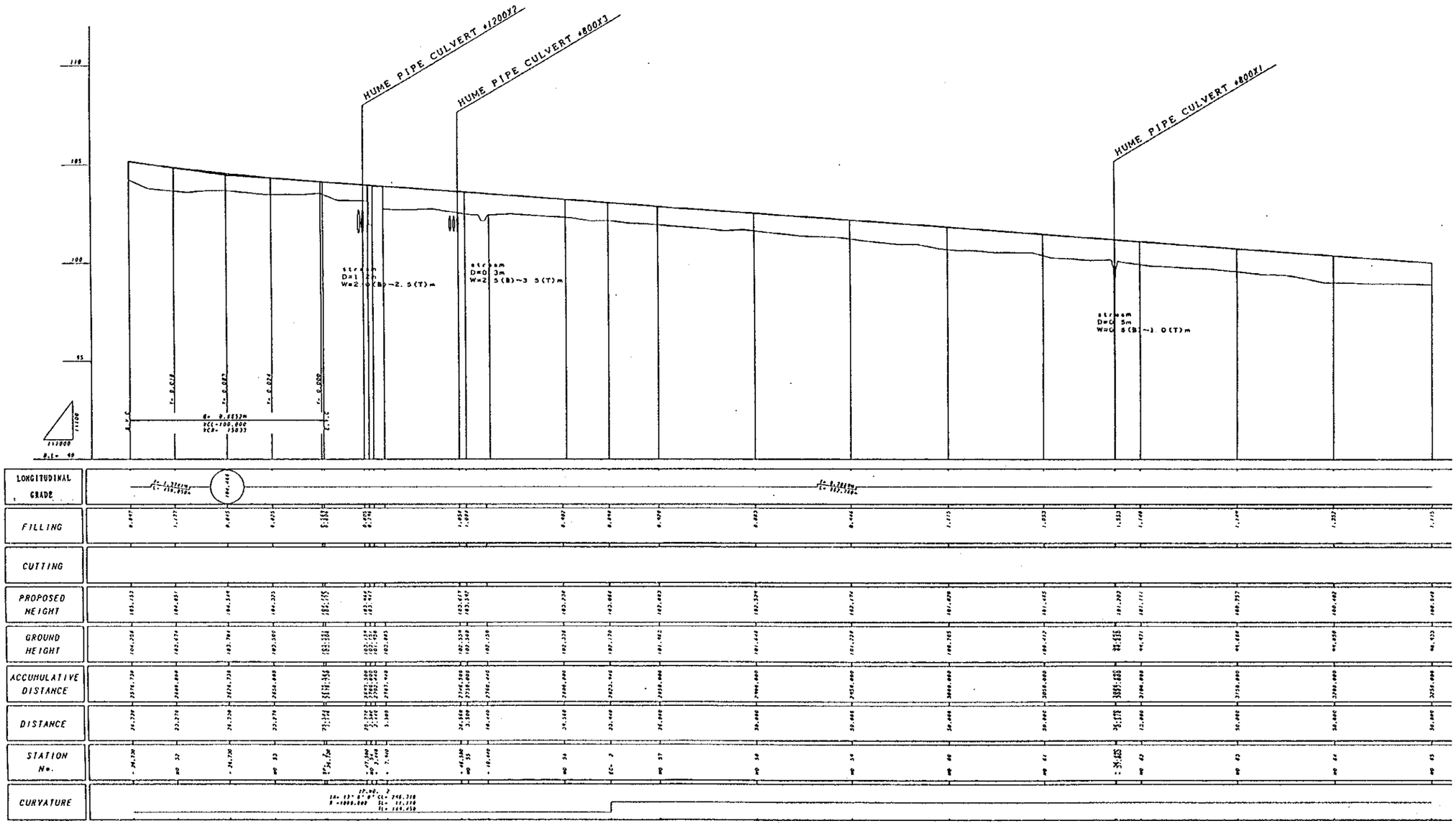

Figure-3.3.9

NO.51+26.730~NO.65

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (5)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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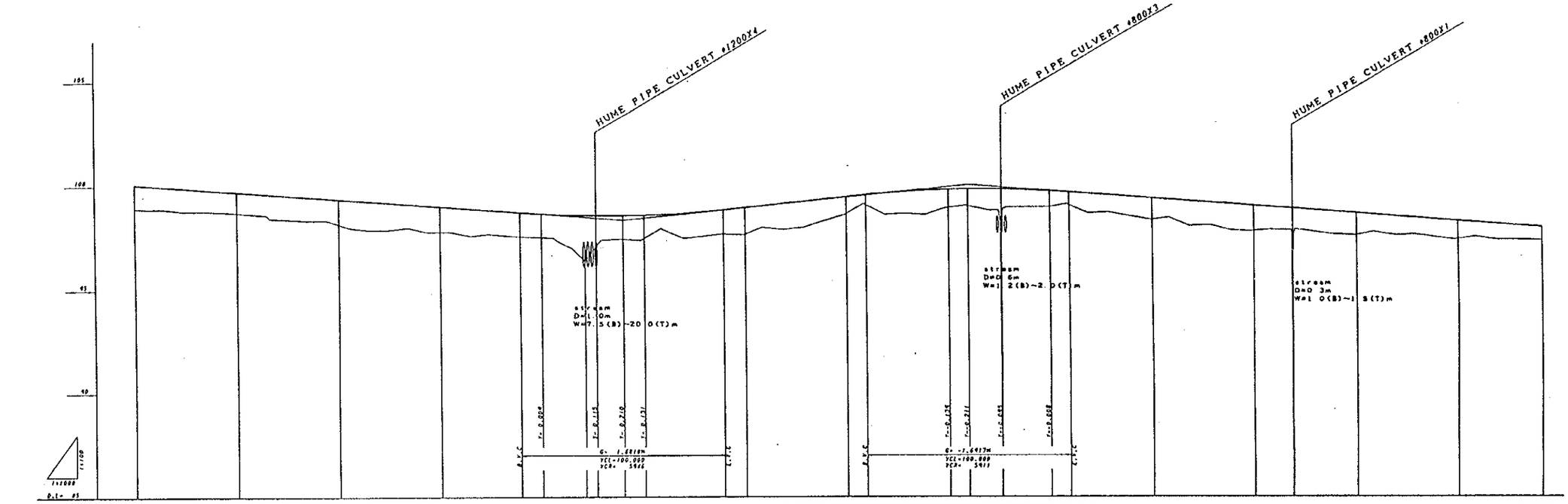

Figure-3.3.10

NO.65~NO.78+40.650

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (6) DATE: February 1995 / DRAWING NO: 10	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.

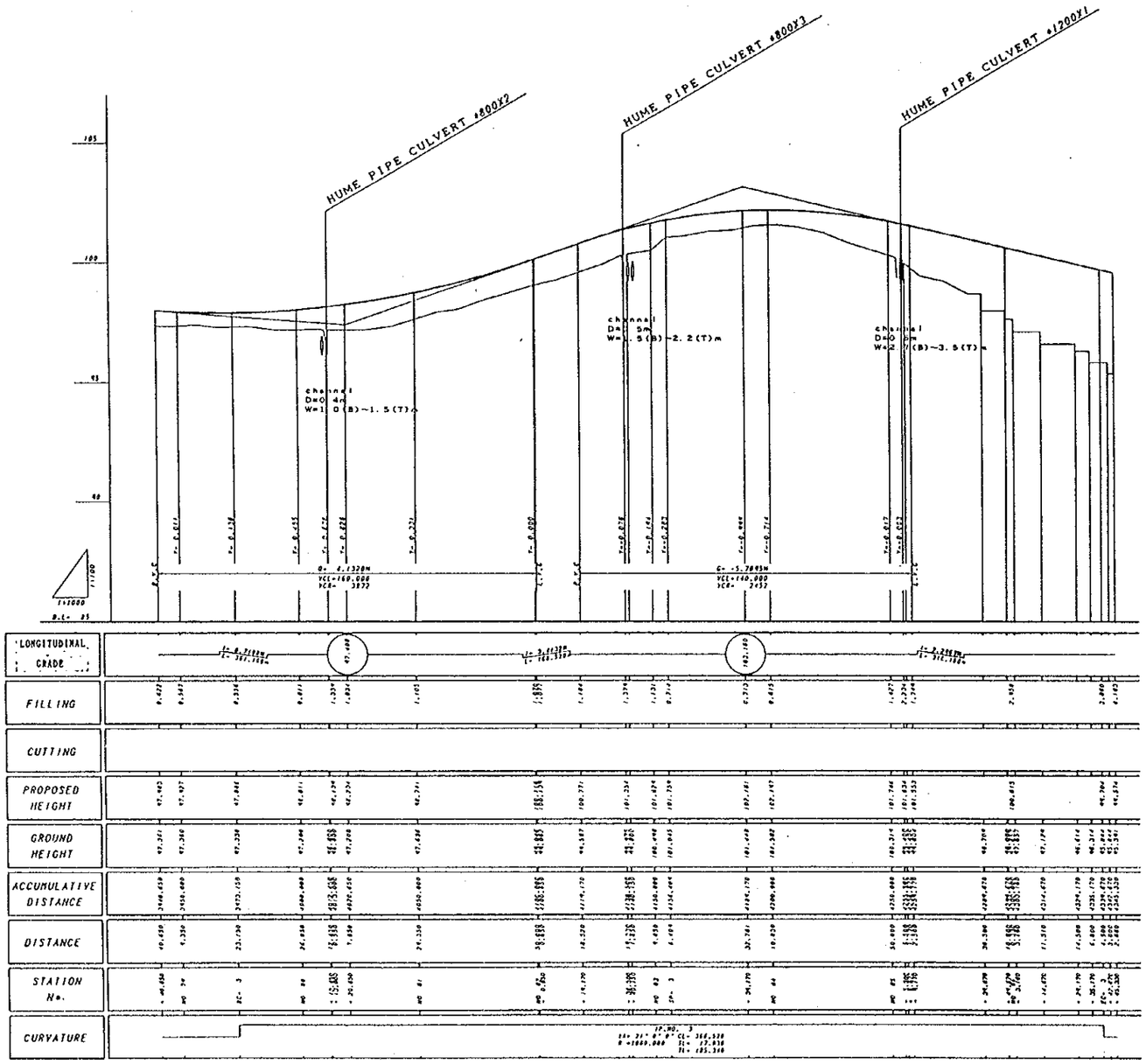

Figure-3.3.11

NO.78+40.650~NO.86+45.330

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (7)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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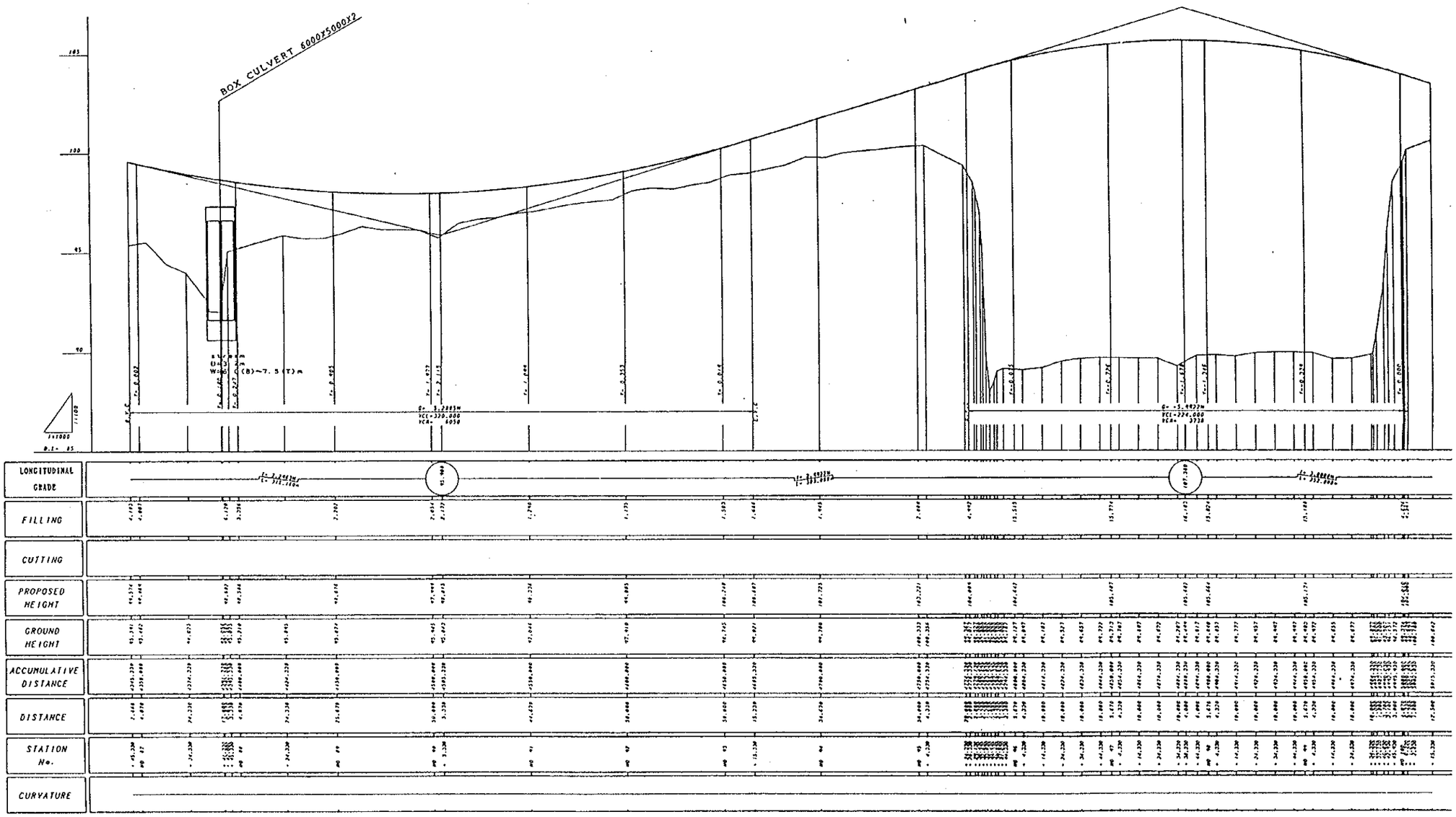

Figure-3.3.12

NO.86+45.330~NO.100+15.330

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (8)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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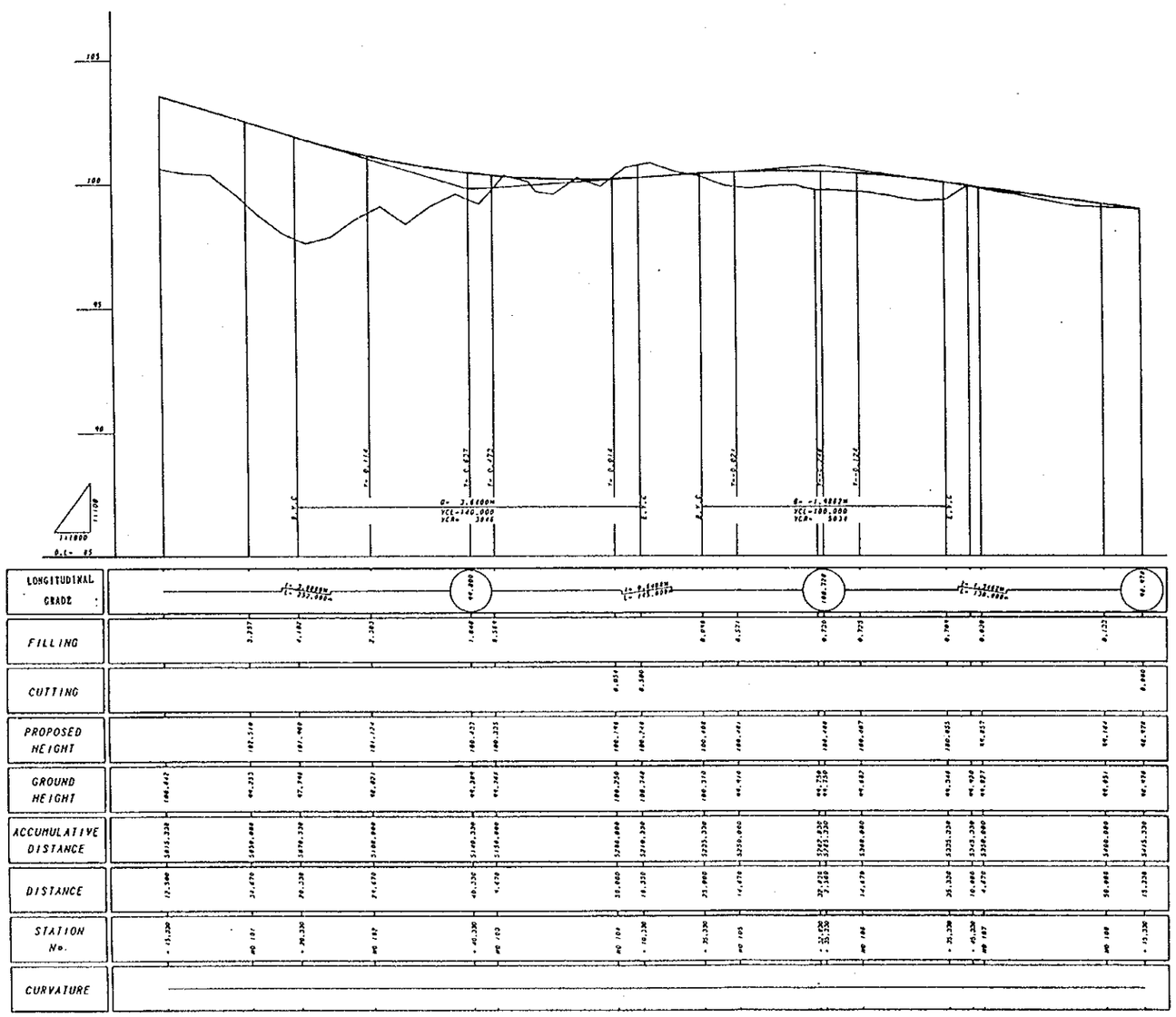

Figure-3.3.13

NO.100+15.330~NO.108+15.330

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PROFILE (9)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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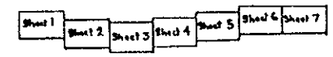
SHEET No 1 OF
7 SHEETS



Key diagram of Sheets

DEAD MEASURMENT FOR STARTING POINT

DEAD MEASURMENT FOR B.M.02

ROAD CENTER LINE

SCALE 1:1,000

CONTOUR INTERVAL 0·5 m

Figure-3.3.14

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (1)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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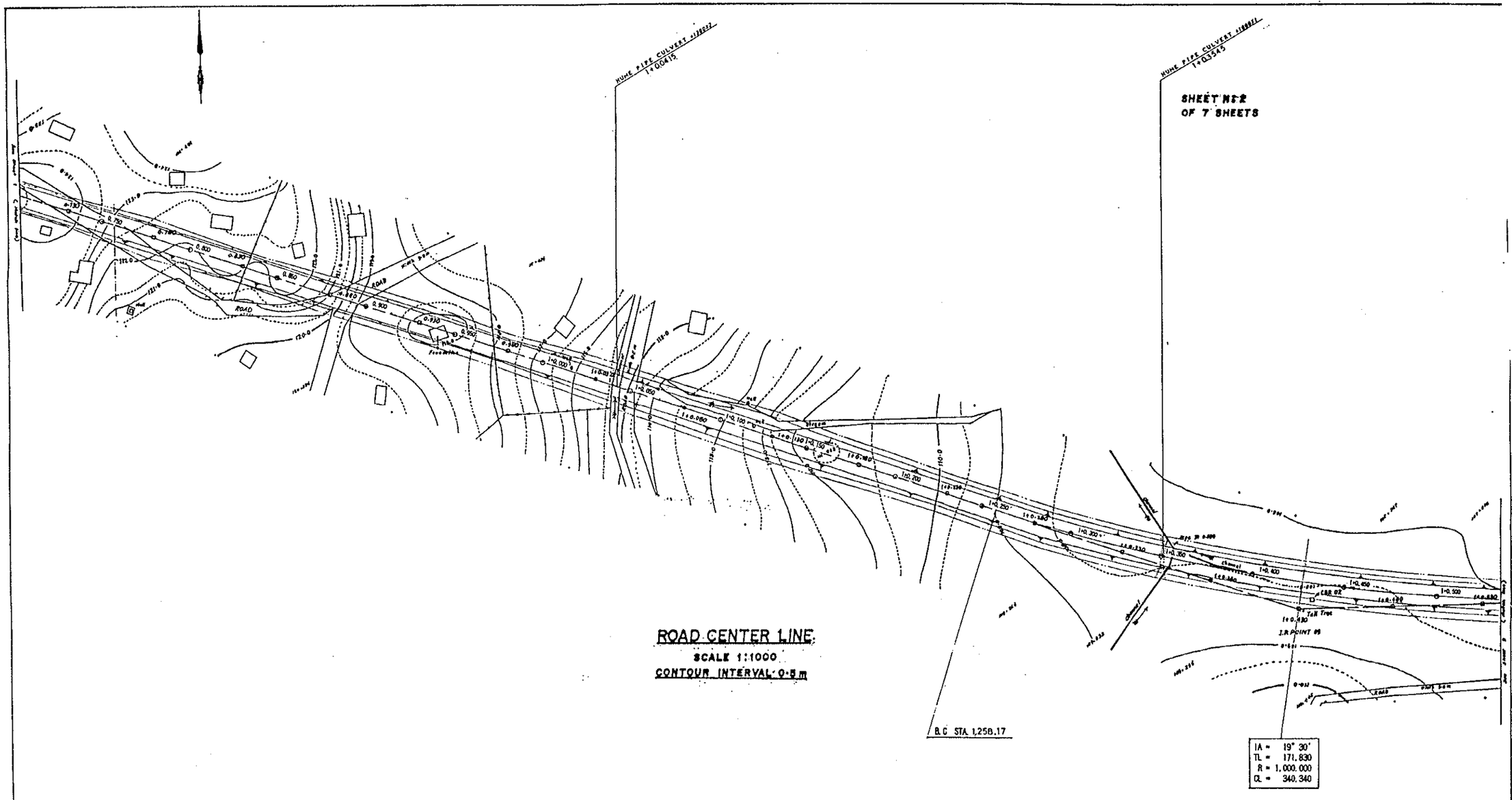

Figure-3.3.15

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (2)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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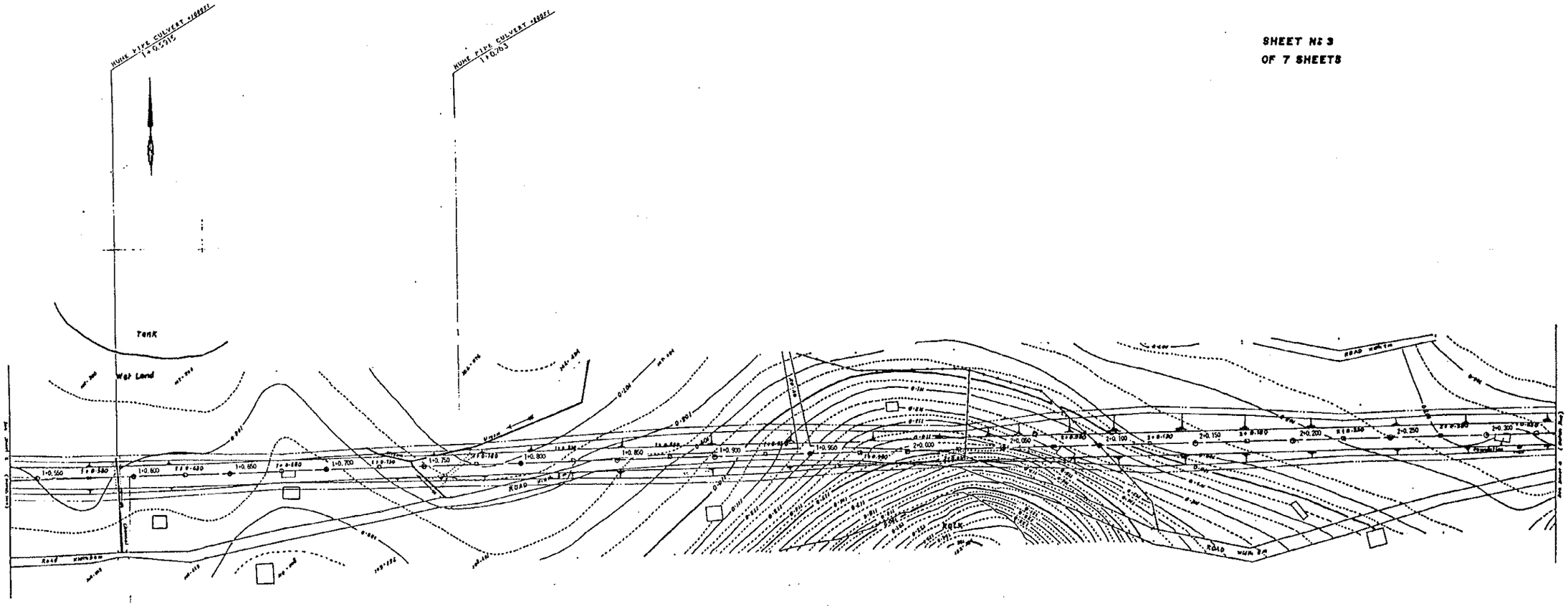
OF 7 SHEETS



ROAD CENTER LINE
SCALE 1:1000
CONTOUR INTERVAL 0.5m

Figure-3.3.16

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (3)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995	DRAWING NO: 16	

SHEET Nr 4
OF 7 SHEETS

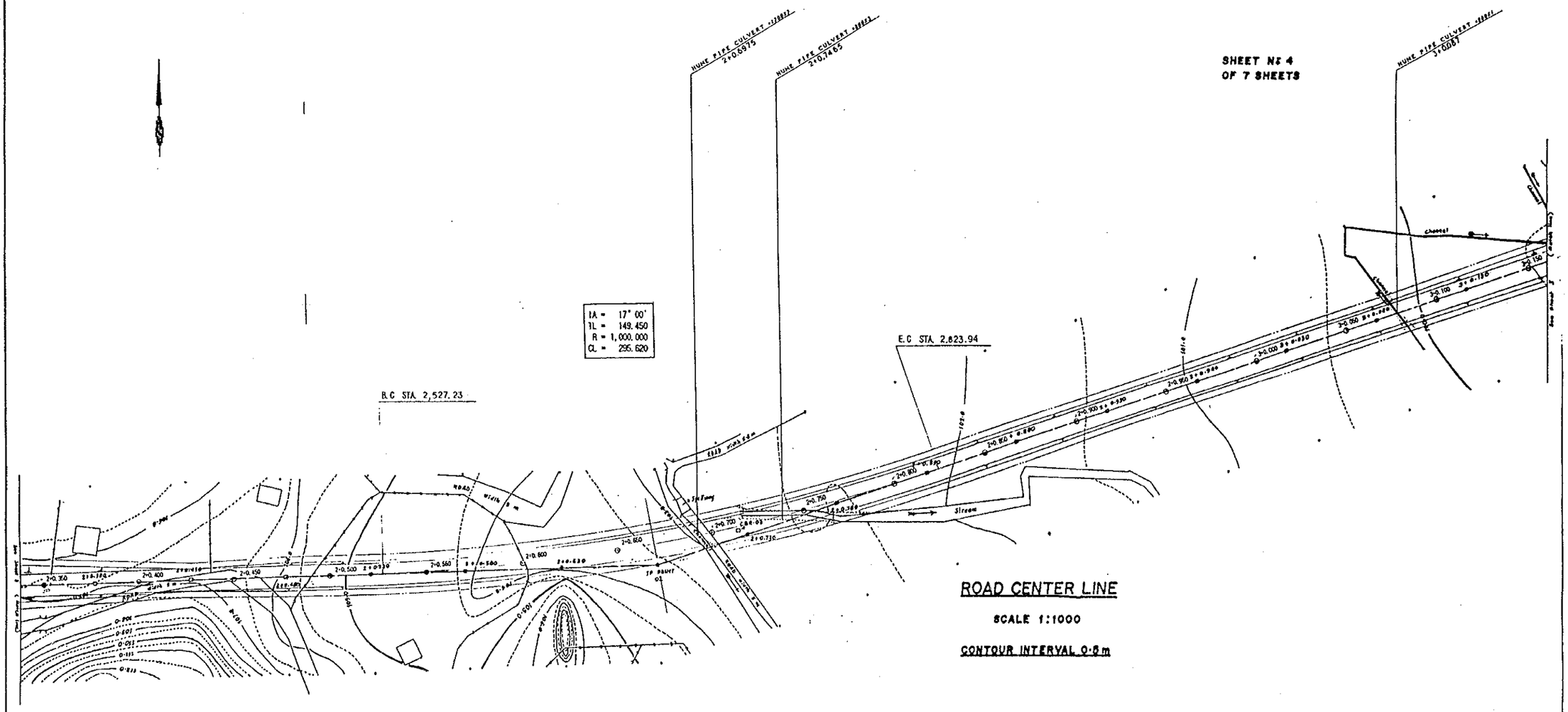


Figure-3.3.17

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (4)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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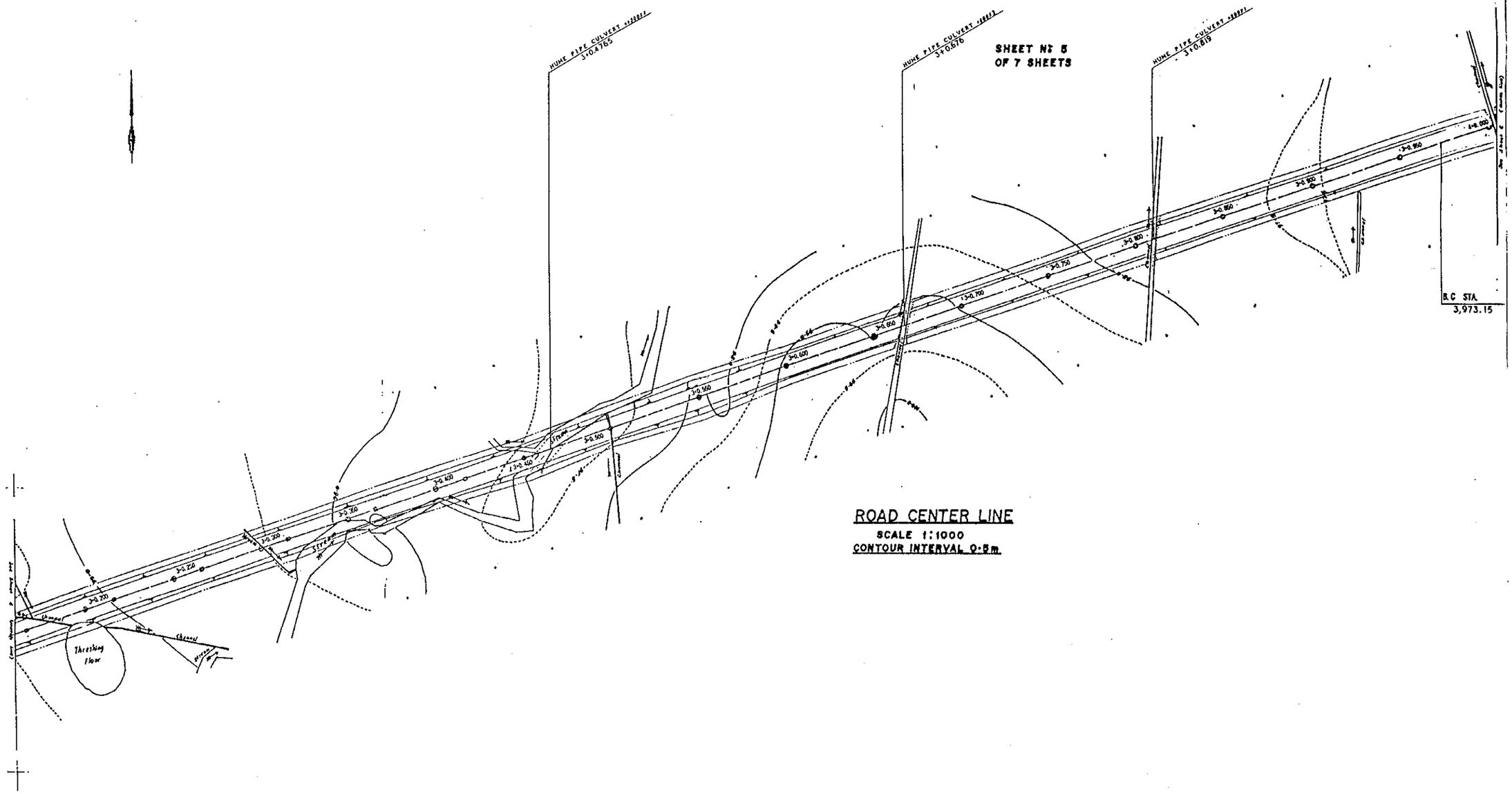

Figure-3.3.18

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (5)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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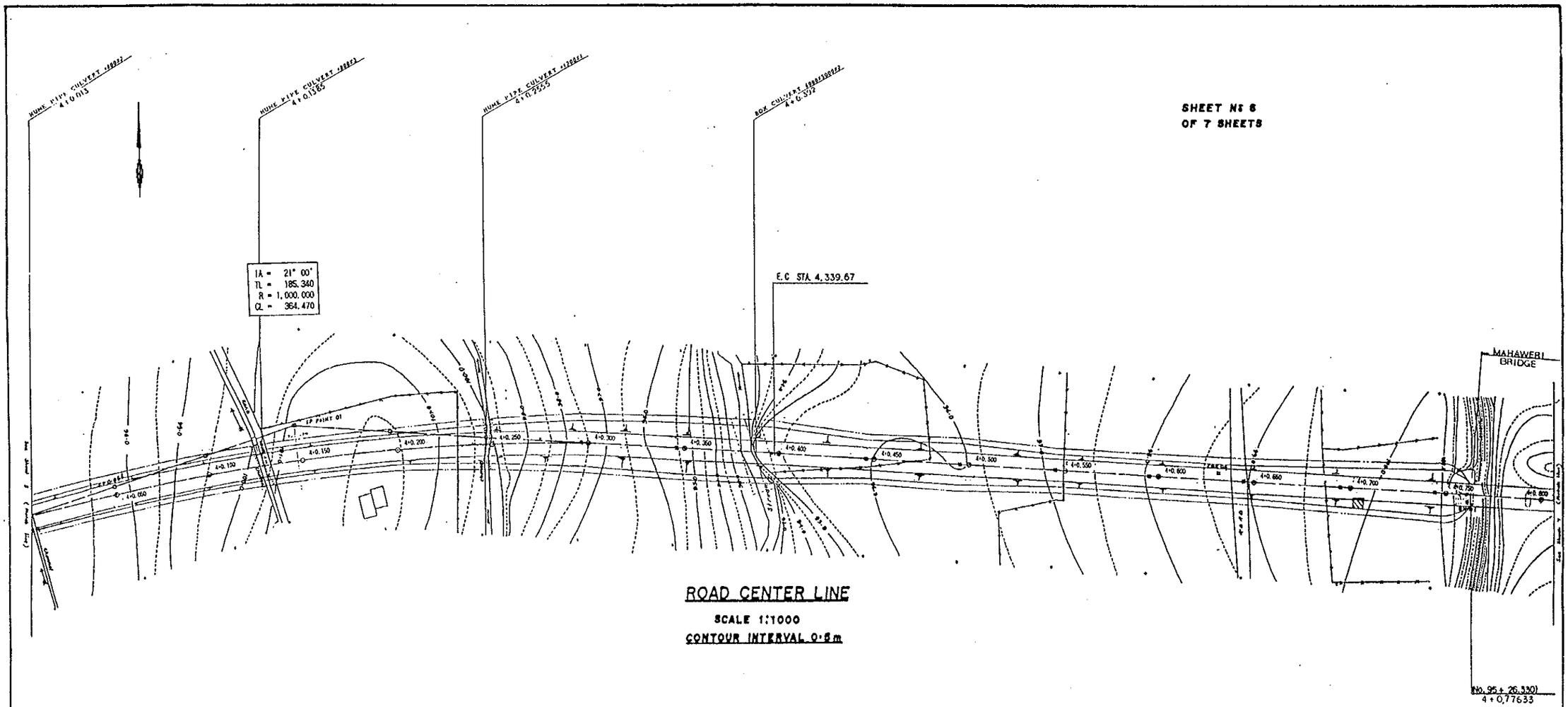

ROAD CENTER LINE

SCALE 1:1000

CONTOUR INTERVAL 0.5m

Figure-3.3.19

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (6)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
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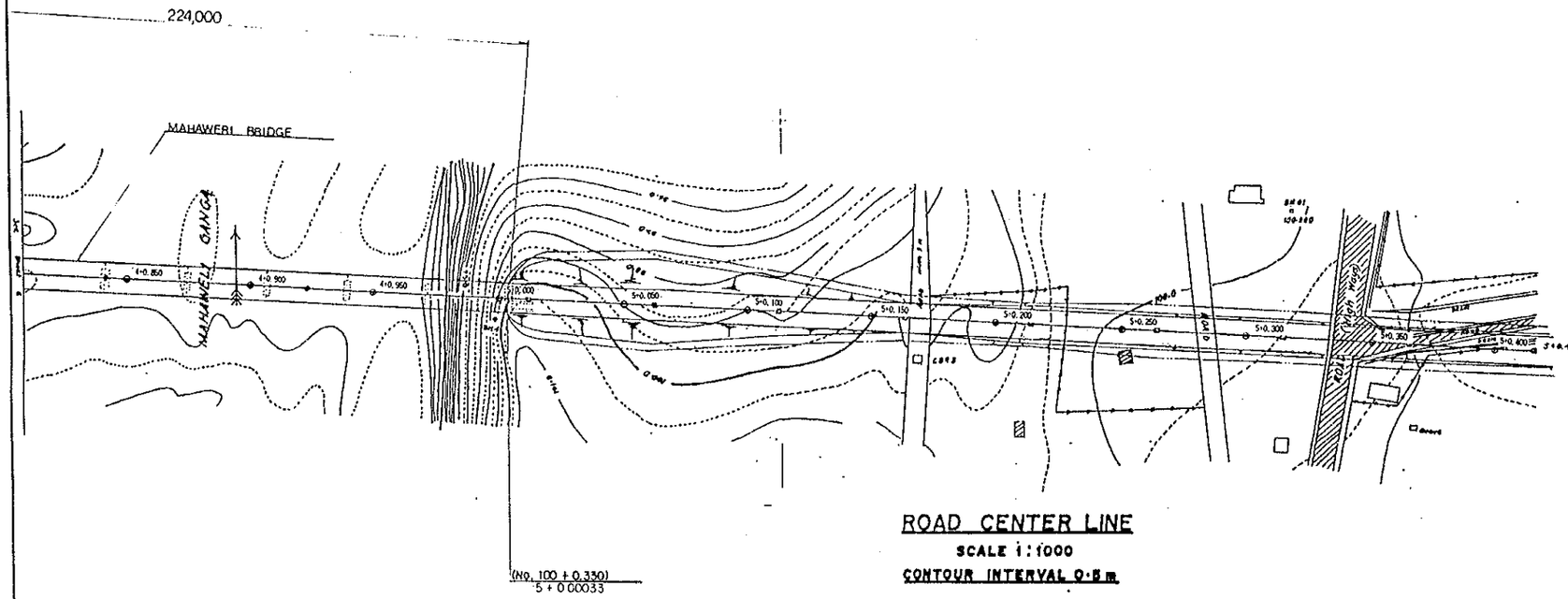
OF 7 SHEETS



ROAD CENTER LINE
SCALE 1:1000
CONTOUR INTERVAL 0·5 m

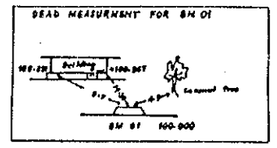
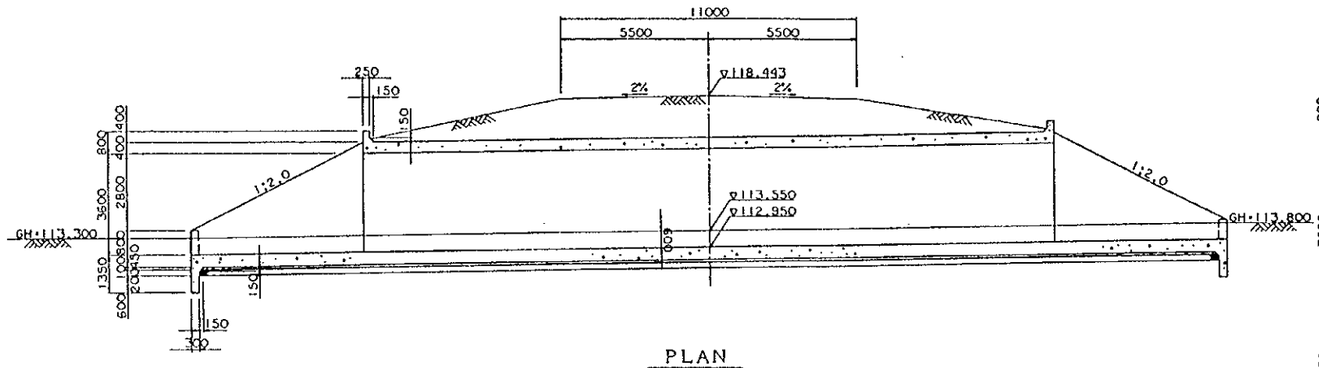


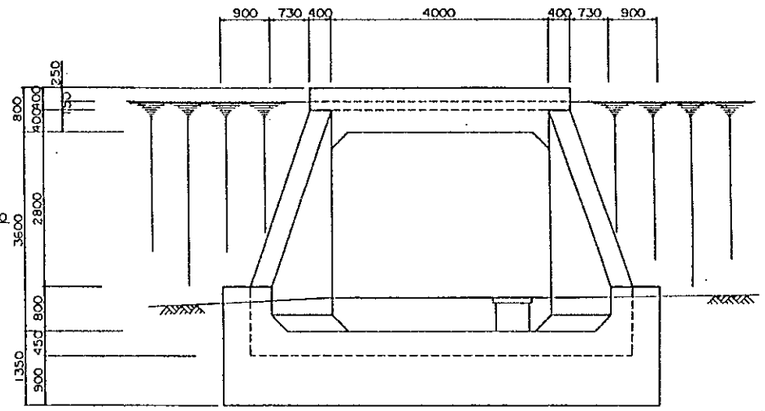
Figure-3.3.20

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: PLAN (7)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995	DRAWING NO: 20	

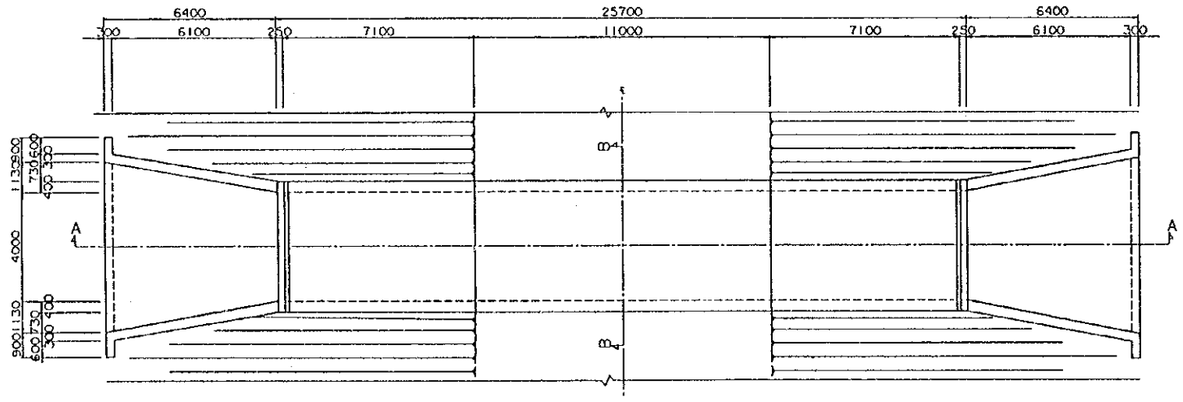
SECTIONAL ELEVATION A-A
S=1/100



SIDE ELEVATION
S=1/50



PLAN
S=1/100



SECTION B-B
S=1/50

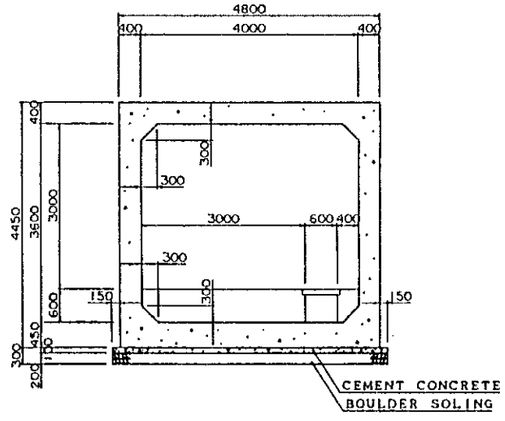
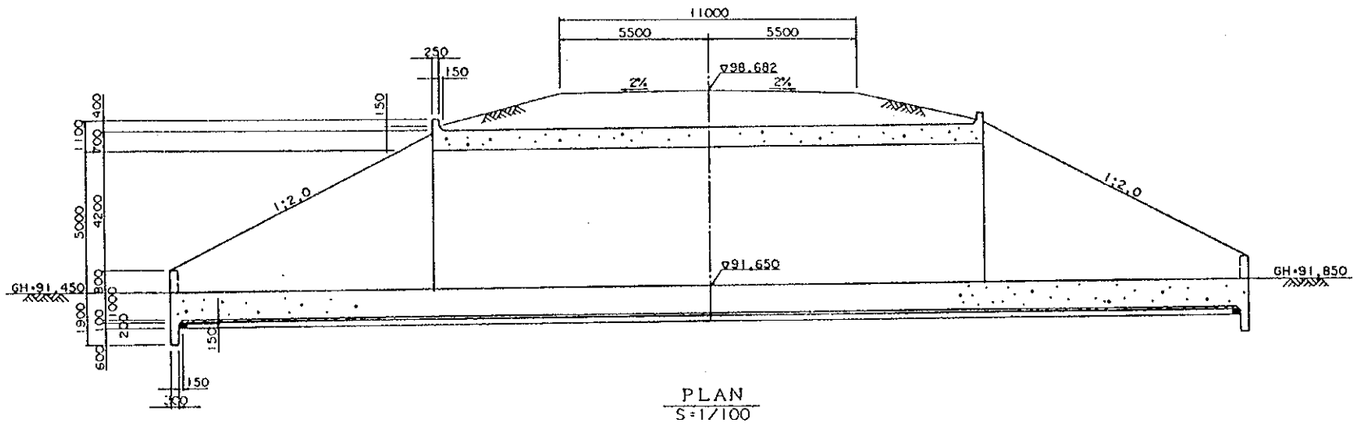


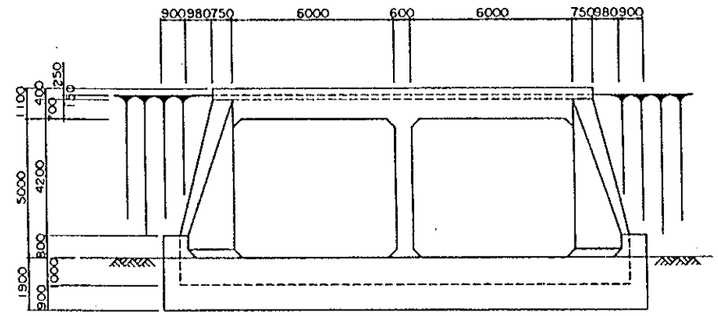
Figure-3.3.21

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: GENERAL VIEW OF BOX CULVERT (1)	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 21	

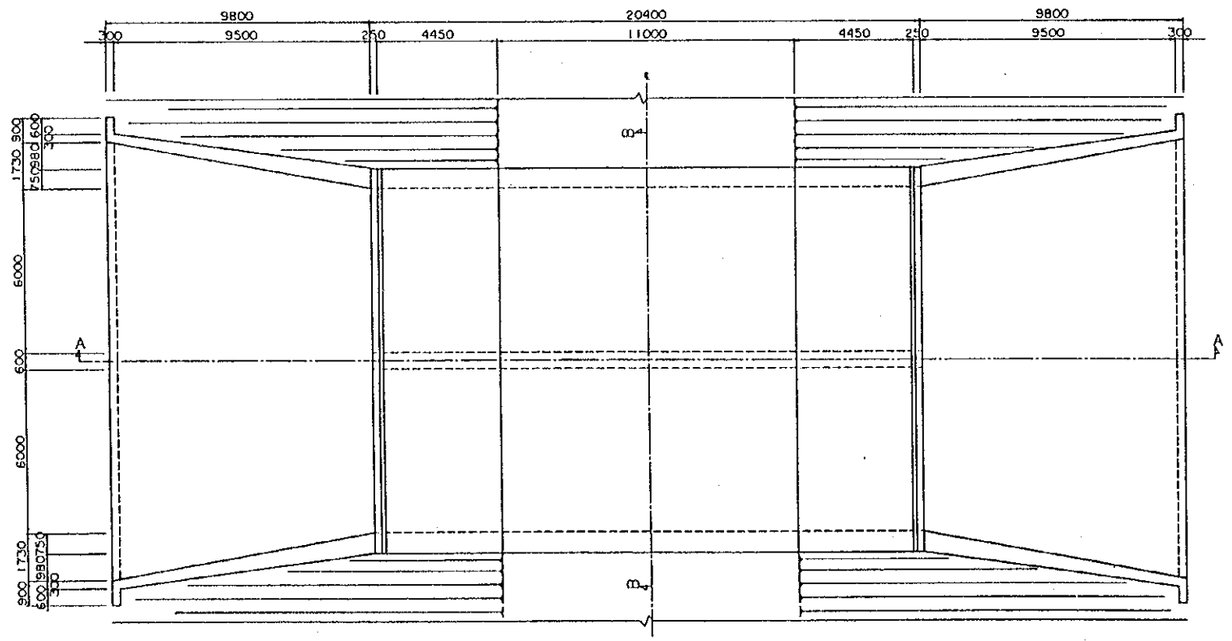
SECTIONAL ELEVATION A-A
S=1/100



SIDE ELEVATION
S=1/100



PLAN
S=1/100



SECTION B-B
S=1/50

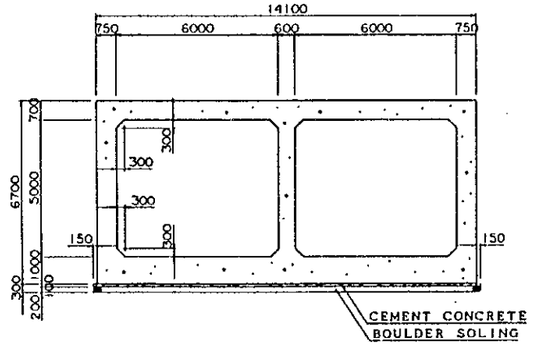
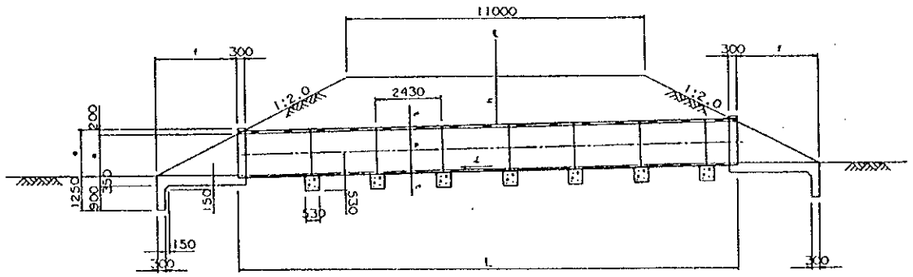


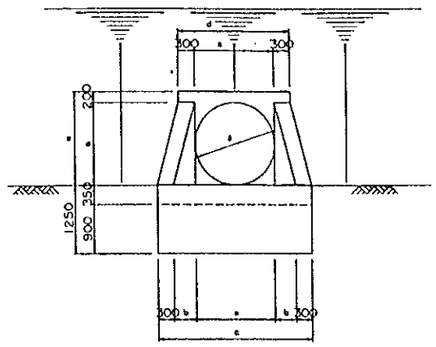
Figure-3.3.22

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: GENERAL VIEW OF BOX CULVERT (2)		JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995	DRAWING NO: 22	

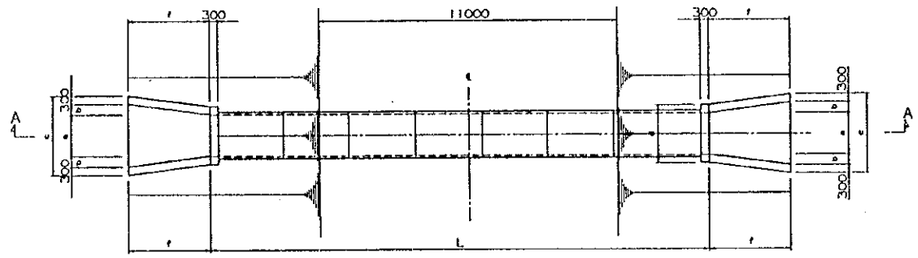
SECTIONAL ELEVATION A-A
S=1/100



SIDE ELEVATION
S=1/50



PLAN
S=1/100



HUME PIPE CULVERT

station No	GROUND HEIGHT	PROPOSED HEIGHT	TYPE	EARTH COVERING	NUMBER OF HUME PIPES	LENGTH	NUMBER OF COLLARS AND SUPPORTS	LONGITUDINAL GRADE. (%)
1 No 3145.50	116,533	119,746	1200	3323	3	24200	9	1,38
2 No 20141.50	114,100	116,407	1200	1142	2	12200	5	0,59
3 No 271 4.50	108,335	110,015	1000	1158	1	13000	5	0,88
4 No 31441.50	107,657	109,299	1000	1220	1	11000	4	2,00
5 No 35113.00	107,658	108,790	800	1271	1	25800	10	2,93
6 No 53147.50	103,159	103,964	1200	1142	2	12200	5	0,59
7 No 54146.50	102,559	103,617	800	1136	3	48800	20	0,48
8 No 61437.00	99,650	101,203	800	1142	1	13800	5	0,59
9 No 63126.50	97,089	98,557	1200	1128	4	25200	10	0,33
10 No 72926.00	98,200	99,790	800	1186	3	14800	6	1,39
11 No 76119.00	97,550	98,857	800	1138	1	16800	6	0,50
12 No 80113.00	96,800	98,139	800	1128	2	11800	4	0,33
13 No 82138.50	99,975	101,354	800	1238	3	11800	4	2,33
14 No 851 5.50	99,400	101,634	1200	1191	1	12200	5	1,47

TYPE	a	b	c	d	e	f	t		
800	800	210	1820	1400	1000	1600	66		
1000	1000	260	2120	1600	1200	2000	82		
1200	1200	320	2440	1800	1400	2400	95		

Figure-3.3.23

THE GOVERNMENT OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA	BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF THE MAHAWELI ROAD BRIDGE	TITLE: GENERAL VIEW OF PIPE CULVERT	JAPAN INTERNATIONAL COOPERATION AGENCY ORIENTAL CONSULTANTS CO., LTD. in association with CHIYODA ENGINEERING CONSULTANTS CO., LTD.
		DATE: February 1995 / DRAWING NO: 23	

through 3.3.23.

3.3.6 Summary of Bill of Quantity

Based on the basic design, the major construction is as follows:

Bridge scale	:	224m X 10.4m (effective width)
Number of bridge abutments	:	2 (RC buttress)
Number of bridge piers	:	6 (Reverse RC T-type)
Access roads	:	West bank (Hettipola) 4.8km
		East bank (Hembarawa) 0.35km

Major Materials

Material	Concrete (m^3)		Reinforcement (t)		PC Steel (t)	Earthworks (m^3)	
	Superstructure	Substructure	Superstructure	Substructure		Embankment	Cut
Quantity	2,013	3,145	346	209	44	155,865	9,217

3.4 IMPLEMENTATION PLAN

3.4.1 Construction Condition

Based on the above analysis, the following can be stated:

1) Construction period

Construction will be divided into the following stages: mobilization, preparation work, substructure, superstructure, access road, general work, and removal work. Completion of construction will require approximately 32 months. The 4 months from November to February is the rainy season, and there will be no river construction or road drainage work during this time.

2) Local Consultants

Consultants in Sri Lanka will assist in some aspects of the construction management.

3) Local contractors

Local contractors will be utilized as much as possible as sub-contractors.

4) Japanese engineers

Areas of construction that Sri Lanka has little experience in will be carried out by Japanese engineers. This will consist of

will be carried out by Japanese engineers. This will consist of temporary passage construction, cofferdam work and excavation, PC girder work, girder erection, bridge deck work, work on appurtenant facilities, blasting, culvert work, and pavement work.

5) Operational structure of Sri Lanka

The Irrigation Department (Ministry of Irrigation, Power and Energy) will be the project's counterpart during construction. After completion, the bridge's management and maintenance will be transferred to the Road Development Authority.

3.4.2 Implementation Method

A temporary road is constructed across the river along the bridge. A deck is built of covering plate and is supported by girders and H-type steel piles erected with a vibrohammer.

Cofferdams are then constructed with steel sheet piles for substructure work and open excavation with strutting continues until rock is reached. Then the substructure is constructed.

Each girder for the superstructure's span is then manufactured on site and erected with an erection girder starting from the right bank. When the girders are in place, the deck's slab concrete is cast.

After clearing the site, access road drainage facilities are built during the first dry season, with embankment work carried out in the second dry season and work on pavement and appurtenant facilities done in the third dry season.

During construction, the following items are the matters that require attention. It is also necessary to take into consideration climatic conditions and the procurement of machinery and materials.

1) Intensive work during the dry season

Since carrying out work during the wet season (November to February) is dangerous, it is recommended that construction work be executed during the dry season. Consequently, it is necessary to draw up a machinery and material plan suitable for intensive work

during the dry season.

A desirable time to start the main part of the construction work is in March, with mobilization, preparatory work, and the transport of machinery and materials beginning about four months before that.

2) Land acquisition and leasing

Land acquisition for access roads and securing the necessary leases for working space, the girder manufacturing yard, and the construction office site are the responsibilities of the Sri Lankan side. All of the above-mentioned should be completed before the start of construction.

The working space and other yards, which are to be established on the east bank, are not under the jurisdiction of the Irrigation Department, so making arrangements with the relevant organizations will be necessary.

3) Customs procedure

Machinery and materials procured in Japan will be unloaded at the Port of Colombo. It is necessary for the Sri Lankan side to ensure that they are processed by Customs smoothly.

4) Safety measures

Safety measures during construction should be taken, especially concerning work at high places on the bridge. Traffic safety measures are also necessary because there will be many vehicles at the construction site.

3.4.3 Construction Supervisory Plan

After contracting consultants for such stages as detailed design, tender document preparation and the tender itself, Japanese staff will be in charge of the following work: project management, substructure design, superstructure design, road design, tender documentation, construction planning/cost estimation, etc. Japanese engineers will be dispatched and stay on site to supervise and provide the necessary guidance for major work during the period of

construction.

3.4.4 Procurement Plan

1) Labor force

Most of the bridges recently built in Sri Lanka are made of concrete for reasons of economy and maintenance. Many of them also have prestressed concrete girders with short spans (the length is less than 18m for transportation reasons). There are manufacturing plants also.

There are a few examples of post-tensioned concrete bridges like the one in this project. Thus, some local construction firms can undertake related general construction work.

At the actual stage of construction when a Japanese contractor employs skilled workers, it is advisable that it hire local subcontractors itself, since skilled labor is usually hired by the Japanese contractors themselves.

2) Supply of machinery and materials for construction

The difficulty in procuring for construction the necessary quality machinery and materials was investigated, with the intention of utilizing as much as possible in this project Sri Lankan products. Since domestic supply was found to be insufficient during the investigation (August 1994), it is important to decide what machinery and materials should be imported. The following are the results of the investigation about the procurement of major machinery and materials:

(1) Construction materials

(a) Cement

In Sri Lanka, according to 1992 data, cement is produced by Puttalam Company and Galle Company at a relatively low annual output of 476,000 tons and 220,000 tons, respectively. This supply is insufficient to meet home demand and cement is constantly imported.

(b) Concrete

There is no concrete plant around the project site. Judging from the scale of the project, as well as the quality demanded for the project, it is necessary to establish a concrete plant at the site.

(c) Reinforcing bar

Ceylon Steel Company produces 50,000 tons of reinforcing bars a year, most of which are 5.5mm and 6.0mm in diameter. The firm does not manufacture reinforcing bars used in engineering work. In addition, it is unable to satisfy domestic demand and supplies from other countries are being considered. It is advisable that the bars be obtained from Japan, taking into consideration stable supply, quality and price fluctuations.

(d) Crushed stone and sand

The approval of both RDA and RC&DC (Road Construction and Development Company) have been obtained regarding the supply of crushed stone and sand from a crushing plant that is owned by RC&DC 5km east of Mahiyangana (or 30km from the bridge site).

As for quality, there is no problem using the above as concrete aggregate.

Sand can be obtained from the Mahaweli River during the dry season.

(e) Filling and subgrade materials

Mountains near the access road are mostly rock and it is difficult to obtain filling material from there. It is necessary to obtain and/or purchase this from private land owners.

(f) Asphalt

It is possible to obtain asphalt within the country.

Hot mixed asphalt can be purchased at an asphalt plant

owned by RC&DC that is located at Ganewalpota approx. 120km away (travel time is approx. four hours).

(g) Steel

Steel H-beams and sheet piles are to be imported because they are not manufactured domestically.

(h) Other construction materials

The plan for procuring other construction materials, including those mentioned above, are as follows:

Table-3.4.1 Construction Material Procurement Plan

	In Sri Lanka	In Japan	Other Country	Reason
Cement	○			Obtainable on site
Reinforcing bar		○		Stable supply and price
Crushed stone / sand	○			Domestically obtainable
Asphalt emulsion	○			Domestically obtainable
Steel (section steel / steel sheet pile)		○		Domestically unobtainable
Prestressed steel wire		○		Domestically unobtainable
Prestressed steel bar		○		Domestically unobtainable
Prestressed anchor		○		Domestically unobtainable
Asphalt concrete	○			Domestically obtainable
Concrete additive		○		Domestically unobtainable
Expansion joint (steel made, rubber system)		○		Domestically unobtainable
Brick	○			Domestically obtainable
Form (steel)		○		Stable supply
Timber		○		Stable supply
Frame support work / scaffolding		○		Domestically unobtainable

(2) Construction machinery

In Sri Lanka, it is possible to lease construction machinery, although the type and number of machinery is limited. In order to complete construction of the bridge and access roads within a short time (in order to avoid the wet season), some of the machinery should be supplied from Japan. Consequently, the following should be considered when leasing machines within the country or when transporting them from overseas:

(a) A machine should be obtained from Japan when there is a short supply of that machine in Sri Lanka.

(b) A machine should be obtained from Japan when such a machine will affect the construction schedule.

Considering the above-mentioned conditions, the major construction machinery and its supplier for the project is as shown in the Table-3.4.2.

Table-3.4.2 Construction Machinery Supply Plan

	Capacity	Sri Lanka	Japan
Dump Truck	11tons	○	
Cargo Truck	4tons	○	
Back-Hoe	0.6m^3	○	
Truck Crane	60tons		○
Truck Crane	20tons	○	
Crawler Crane	50tons	○	
Vibration Hammer	90kw		○
Waterjet			○
Portable Concrete Mixer	0.5m^3	○	
Asphalt Sprayer	200lit.	○	
Vibration Roller	1000kg		○
Welding Plant	300A	○	
Winch	2tons	○	
Bulldozer	15tons	○	
Bulldozer	21tons	○	
Wheel Loader	1.8m^3	○	
Macadam Roller	10-20tons	○	
Tire Roller	8-20tons	○	
Rammer	60kg	○	
Concrete Bucket	0.6m^3	○	
Soil Compactor	600-800kg		○
Compressor	7m^3/min	○	
Generator	100KVA		○
Generator	50KVA		○
Water Pump	150mm		○
Concrete Vibrator		○	
Grout Pump	37-100lit.		○
Grout Mixer	2.2kw		○
Clamshell	0.6m^3	○	
Trailer	40tons	○	
All Casing Excavation	1,500mm		○
Concrete Plant	25-30m^3/h	○	
Asphalt Plant		○	
Motor Grader	3.1m	○	
Motor Sprinkler	5,500-6,500l	○	
Asphalt Finisher	Automatic/Flora type 2.4m-5m	○	
Crawler Drill			○
Rock Drill			○
Crushing Plant			○

3.4.5 Implementation Schedule

After the Exchange of Notes, this project will be executed according to the procedures below.

1) Commissioning of consultants for detailed design

After commissioning consultants, detailed design is carried out, followed by the preparation of drawings, specifications, and bid documents.

2) Construction Bidding and Contract

The system for concluding construction contracts is such that contracts shall be concluded between the Sri Lankan Government and Japanese contractors. In other words, a public competitive bid system restricted to Japanese construction firms is adopted.

In advance of the tender, the Sri Lankan side will consult with JICA about the criteria for examining the qualifications of contractors, in order to screen applicants and give official approval to those that pass the ability to submit bids. The examination is carried out by the consultant as a proxy for the execution agency of the Sri Lankan Government.

Government officials of Sri Lanka, the consultants, and tender participants need to examine tenders and determine a successful bidder in the presence of JICA officials. After approval by the Japanese Government, the contract for construction follows.

With the contract's conclusion, the Sri Lankan Government will make arrangements with a licensed foreign exchange bank in Japan as soon as possible, for the purpose of opening and using a special account that will permit the Sri Lankan Government to receive the necessary funds from Japan for paying Japanese contractors.

The bank arrangement is necessary for the Sri Lankan Government in order to issue an Authorization to Pay (A/P). The A/P is necessary for applications to be submitted by Japanese contractors to the Ministry of International Trade and Industry of Japan to obtain approvals for exports, as well as for receiving advanced

payments as stated in the contract for payments to Japanese contractors. In other words, this arrangement is a requirement for the immediate execution of the construction after concluding the contract.

Next comes contract certification, a requisite for issuing the contract. Here, the Japanese Government confirms the contract and its appropriateness as a subject for assistance (grant aid).

The Japanese Ministry of Foreign Affair then receives a written contract from the government of the recipient country, usually through the Japanese embassy of the recipient nation, and decides on the merit of the certification. The contractor on the Japanese side then fulfills the contract after receiving the certified written contract and Authorization to Pay (A/P).

3) Construction work

The construction starts with preparatory work, foundation work, substructure work, superstructure work (girder, bridge deck), and other related construction work that includes access roads. Then, after such related work as revetment, construction machinery and materials are removed. As the rainy season is from November through February, construction work on the river will be restricted during this period.

The construction schedule is shown in Table-3.4.3. The execution of the project requires approximately 32 months.

3.4.6 Scope of Works

The works to be executed by the Japanese side and the Sri Lankan side are summarized below, together with the required undertakings by GOS.

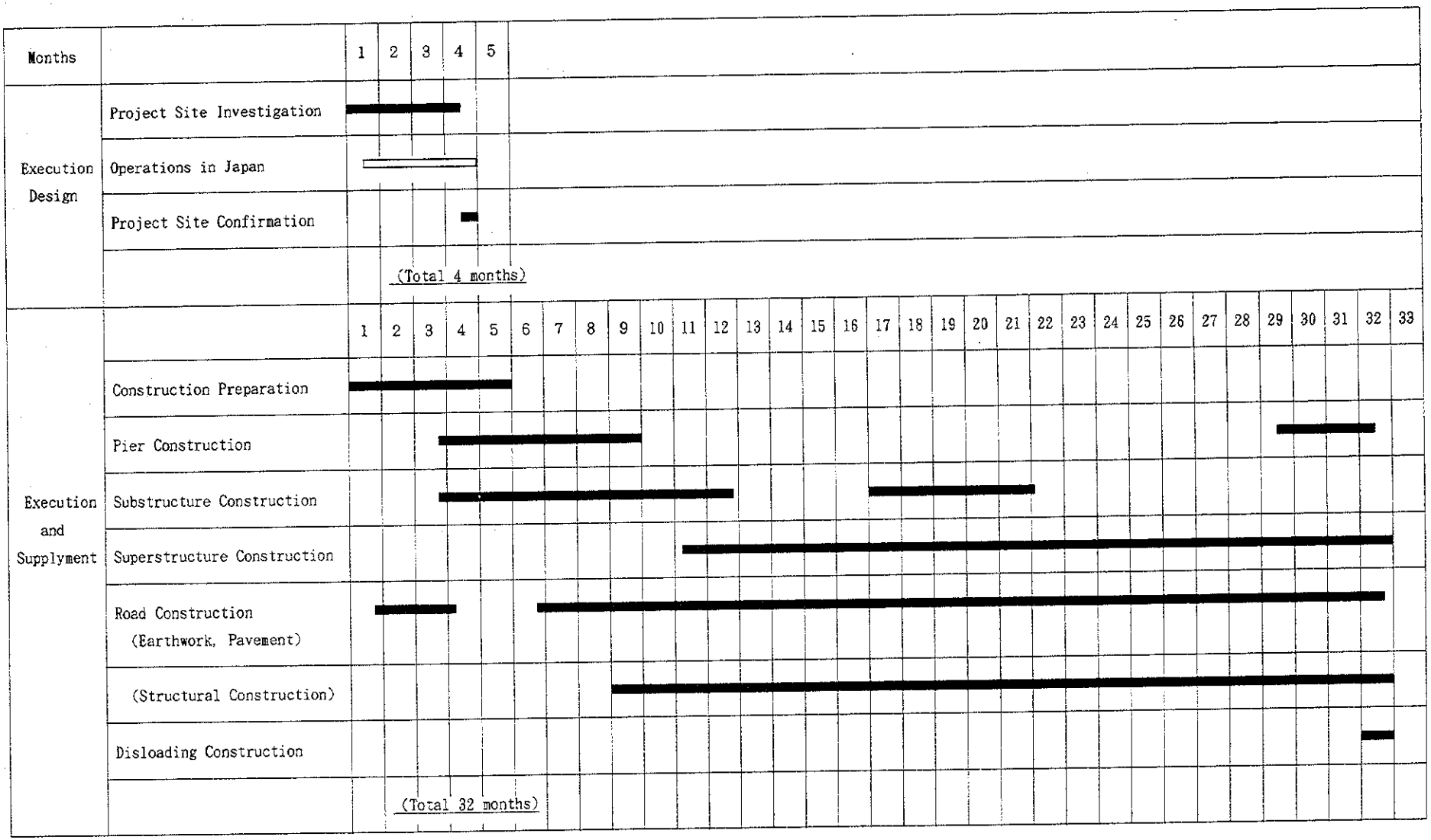
1) Scope of Works to be executed by the Japanese Side

(a) Construction of Mahaweli Bridge.

(b) Construction of the approach roads for the above bridge.

2) Undertakings by GOS

Table-3.4.3 Construction Schedule



(a) Provision of necessary land for construction of bridge and approach roads to be implemented by GOJ.
(b) Demolition of impediments within the above mentioned land.
(c) Tax exemption on the construction equipment and materials imported for the project.

The expenditure to be borne by GOS in connection with the implementation of the Project is estimated as shown below:

(1) Land Acquisition	6.86 million Rupees
(2) Yard Leasing	0.02 million Rupees
(3) ID Administration	2.40 million Rupees
(4) RDA Annual Maintenance	1.25 million Rupees

CHAPTER 4

CHAPTER 4 PROJECT EVALUATION AND CONCLUSION

The feasibility of this project under the conditions of the Grant Aid System of the Japanese Government was confirmed by the Preliminary Study Team dispatched by JICA in the spring of 1994.

4.1 BENEFICIAL EFFECT

The objective of this project is, by constructing a bridge across the Mahaweli River, to improve the living conditions of residents on both sides of the river and to stimulate the economy of the whole area by improving the transportation network.

Existing problems	Measures Proposed by Project	Effects of Project
1. Agricultural and social infrastructure development is insufficient resulting to Economy stagnation and standard of living and income level of local people relatively low compared to otherareas in the country. 2. Area accessibility is poor due to insufficient road network development. 3. Lack of access between Minipe and System resalting to poor Cooperation.	1. Construction of bridge on Mahaweli River	1. Access to Minipe area improved, resulting in the standard of living of the project area being raised 2. Possible to directly transport products of the project area to consumers in such western cities such as Matale and Dambulla 3. To develop both the project area and Minipe area through interaction by establishing direct connection between them

4.2 PROPRIETY AS A GRANT AID PROJECT

The Study Team recognizes that this project is appropriate as a grant aid project for the following reasons: ① estimated traffic volume is considerable; ② the new bridge will improve access for the residents to go to hospitals, agricultural warehouses, markets, etc., and produce substantial social and economic benefits; ③ it will strengthen the road network, since as many as 300,000 residents are forced to make a detour of about 80km without the bridge; and ④ the project is specified in the National Investment Plan and a

budget and the organizations to be in charge have already been designated.

4.3 CONCLUSION

This project is confirmed to be feasible using Japanese grant aid, because it is expected to produce the many benefits mentioned above, which will greatly contribute towards meeting the basic human needs of the local people. Regarding the management and administration of the project, there will be no problem since the Sri Lankan side has enough personnel and funds to carry it out.

APPENDIX

Appendix 1. Member List of the Survey Team

a. For the Study

HOSHINA Hideaki	Leader/Regional Development Development Specialist, JICA
NANJO Atsushi	Technical Advisor/Roads and Bridges Subchief, Research Division, Second Kobe Construction Department, Hanshin Expressway Public Corporation
OHARA Manabu	Project Coordinator First Project Management Division, Grant Aid Project Management Department, JICA
YANAGIDA Kazuro	Chief Consultant/Bridge Planner Oriental Consultants Co., Ltd.
HIROTANI Akihiko	Road and Bridge Designer Oriental Consultants Co., Ltd.
KUBOYA Nobuhiro	Construction Planner/Cost Estimator Oriental Consultants Co., Ltd.
FURUKAWA Yasuo	Natural Conditions Surveyor Chiyoda Engineering Consultants Co., Ltd.
MATSUBARA Atsushi	Traffic Planner Oriental Consultants Co., Ltd.

b. For Explanation Draft Final Report

KIYOMIZU Kenji	Leader Development Specialist, JICA
YANAGIDA Kazuro	Chief Consultant/Bridge Planner Oriental Consultants Co., Ltd.
HIROTANI Akihiko	Road and Bridge Designer Oriental Consultants Co., Ltd.

Appendix 2. Survey Schedule

a. Itinerary of the Study (July 23, 1994 - September 1, 1994)

No.	Date	Day	Hoshina	Nanjo	Ohara	Yanagida	Hirotani	Kuboya	Furukawa	Matsubara
1	7/23	Sat	Tokyo-Bangkok TG641(11:00-15:30) <Bangkok>			Accompanied by Hoshina			Accompanied by Hoshina	Entered Sri Lanka on 7/19 for preparatory activities
2	7/24	Sun	Bangkok-Colombo TG307(10:40-12:25) <Colombo>			Accompanied by Hoshina			Accompanied by Hoshina	Joined study team
3	7/25	Mon	Courtesy call and meeting at Japan Embassy. Courtesy call ERD, NPD ID. <Colombo>		Tokyo-Colombo <Colombo>	Accompanied by Hoshina			Accompanied by Hoshina	
4	7/26	Tue	Meeting at JICA Office Meeting at ID, Courtesy call at RDA Colombo-Hasalaka <Hasalaka>						Accompanied by Hoshina	
5	7/27	Wed	Cnstruction site survey (Hasaraka-Hettipora-Mahiyangana-Hembarawa, etc.) <Hasaraka>						Accompanied by Hoshina	
6	7/28	Thu	Confirmation of construction site location, Courtesy call and meeting at Mahaweli Development Authority <Hasalaka>				Confirmation of construction site location, Instructions to local contractors <Hasalaka>	Tokyo-Bangkok TG641 <Bangkok>	Accompanied by Hirotani	
7	7/29	Fri	Survey of road conditions around construction site Hasalaka-Candy <Candy>					Bangkok-Colombo TG307 <Colombo>	Survey of natural conditions (Management of local contractors) <Mahiyangana>	Hasalaka-Colombo <Colombo>
8	7/30	Sat	Survey of conditions around construction site Candy-Colombo <Colombo>					Colombo-Hasalaka <Hasalaka>	ditto	Data collection <Colombo>
9	7/31	Sun	Data analysis Preparation of Minutes of Discussion <Colombo>					Hasalaka-Colombo <Colombo>	ditto	Accompanied by Hoshina
10	8/1	Mon	Delibration of Minutes of Discussion at ID, Courtesy call at Mahaweli Development Authority <Colombo>						ditto	Accompanied by Hoshina
11	8/2	Tue	Data collection and analysis <Colombo>						ditto	Accompanied by Hoshina
12	8/3	Wed	Signing of Minutes of Discussion. Reported to Japan Embassy and JICA Office Colombo-Tokyo			Signing of Minutes of Disucussion. Reported to Japan Embassy and JICA Office Site Survey <Colombo>			ditto	Colombo-Tokyo
13	8/4	Thu				Site Survey <Colombo>			ditto	
14	8/5	Fri				Colombo Hasalaka <Hasalaka>			ditto	
15	8/6	Sat				Site Survey <Halasaka>			ditto	
16	8/7	Sun				Hasalaka-Colombo <Colombo>			ditto	
17	8/8	Mon				Site Survey <Colombo>			ditto	
18	8/9	Tue				Site Survey <Colombo>			ditto	
19	8/10	Wed				Reported to Japan Embassy and JICA Office Colombo-Bangkok <Bangkok>	Site Survey <Colombo>		ditto	

No.	Date	Day	Hoshina	Nanso	Ohara	Yanagida	Hirotani	Kuboya	Furukawa	Matsubara
20	8/11	Thu				Bangkok-Tokyo	Site Survey <Colombo>		ditto	
21	8/12	Fri					Colombo-Tokyo	Site Survey <Colombo>	ditto	
22	8/13	Sat						Site Survey <Colombo>	ditto	
23	8/14	Sun						Site Survey <Colombo>	ditto	
24	8/15	Mon						Site Survey <Colombo>	Hasalaka-Colombo <Colombo>	
25	8/16	Tue						Site Survey <Colombo>	Data analysis in Colombo <Colombo>	
26	8/17	Wed					Tokyo-Colombo <Colombo>	Data analysis in Colombo <Colombo>	Data analysis in Colombo <Colombo>	
27	8/18	Thu					Data analysis in Colombo <Colombo>			
28	8/19	Fri					Data analysis in Colombo <Colombo>			
29	8/20	Sat					Data analysis in Colombo <Colombo>			
30	8/21	Sun					Data analysis in Colombo <Colombo>			
31	8/22	Mon					Site Survey <Colombo>		Colombo-Hasalaka <Hasalaka>	
32	8/23	Tue					Site Survey <Colombo>		Construction site management <Hasalaka>	
33	8/24	Wed					Site Survey Colombo		ditto	
34	8/25	Thu					Site Survey <Colombo>	Colombo-Bangkok <Bangkok>	ditto	
35	8/26	Fri					Colombo-Hasalaka <Hasalaka>	Bangkok-Tokyo	ditto	
36	8/27	Sat					Confirmation of conditions of construction site <Hasalaka>		ditto	
37	8/28	Sun					Hasalaka-Colombo <Colombo>		Accompanied by Hirotani	
38	8/29	Mon					Data analysis <Colombo>		Accompanied by Hirotani	
39	8/30	Tue					Data analysis <Colombo>		Accompanied by Hirotani	
40	8/31	Wed					Colombo-Bangkok <Bangkok>		Accompanied by Hirotani	
41	9/1	Thu					Bangkok-Tokyo		Accompanied by Hirotani	

b. Explanation of DF/R

No.	Date	Day	KIYOMIZU	YANAGIDA	HIROTANI
1	11/21	Mon	Tokyo-Colombo UL455(12:45-19:15) <Colombo>		
2	11/22	Tue	Meeting at JICA Office, Courtesy call at Japan Embassy Courtesy call to authorities concerned (External Resources Dept., National Planning Dept., Irrigation Dept.) Delibrations at Irrigation Dept. <Colombo>		
3	11/23	Wed	Delibration with authorities concerned <Colombo>		
4	11/24	Thu	Meeting at Irrigation Dept., Hasalaka Office <Hasalaka>		
5	11/25	Fri	Site Survey <Hasalaka>		
6	11/26	Sat	Hasalaka-Colombo <Colombo>		
7	11/27	Sun	Prepararation of Minutes of Discussion <Colombo>		
8	11/28	Mon	Reported to Japan Embassy and JICA Office <Colombo>		
9	11/29	Tue	EK076 (10:10-16:25) <Singapore>		
10	11/30	Wed	Singapore-Tokyo JL712 (8:20-15:40)		

Appendix 3. Member List of Party Concerned

SRI LANKAN SIDE

Irrigation Department, Ministry of Irrigation, Power and Energy

MR. K. YOGANATHAN	Director
MR. W. N. M. BOTEJU	Additional Director
MR. K. THURAIRAJARETNAM	Senior Deputy Director
MR. S. SENTHINATHAN	Deputy Director
MR. S. SELVARAJAH	Deputy Director (Disign)
MR. D. M. ABAYARATNE	Chief Resident Engineer, Minipe and Nagadeepa Irrigation Rehabilitation Project
MR. J. W. M. R. T. SEIMON	Chief Irrigation Engineer
MR. B. SIVAPALAN	Irrigation Engineer

External Resources Department, Ministry of Finance

MS. D. D. J. KUDALIGAMA	Director
MR. A. M. P. K. ATTANAYAKA	Additional Director
MS. D. SENANANAYAKE	Assistant Director

National Planning Department, General Treasury Colombo

MR. FAIZ MOHIDEEN	Additional Director General

Road Development Authority, Ministry of Transport, Highways, Environment and Women's Affairs

MR. K. S. C. de FONSEKA	Chairman
MR. Denzil D. SENANAYAKE	General Manager
MR. Takeo KAI	JICA Expert, Advisor to RDA
DR. C. L. A. J. DE. SILVA	Director, Engineering Services
MR. R. G. RAJAPAKSE	Deputy Director (Traffic & Planning)

Mahaweli Authority of Sri Lanka, Ministry of Irrigation, Power and Energy

MR. S. W. K. J. SAMARANAYAKE	Director General
MR. P. T. SENARATHE	Secretary General

JAPANESE SIDE

Embassy of Japan in Sri Lanka

MR. Kunihiro DOI	First Secretary

Japan International Cooperation Agency, Sri Lanka Office

MR. Jiro IIDA	Assistant Reader Representation

Appendix 4. Minutes of Discussions

Appendix 4a. Study Mission

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY
on
THE MAHAWELI BRIDGE CONSTRUCTION PROJECT
in
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a Basic Design Study on the Mahaweli Bridge Construction Project in the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team headed by Mr.Hideaki HOSHINA, Development Specialist of JICA from July 24 to August 25, 1994.

The team held discussions with the officials concerned of the Government of Sri Lanka and conducted field surveys in the study area.

In the course of the discussions and field surveys, both parties have confirmed the main items described on the attached sheet. The team will proceed to further works and prepare the Basic Design Study Report.

Colombo, September 28 , 1994

Mr.Hideaki Hoshina
Leader
Basic Design Study Team
JICA

Mr.K.Yoganathan
Director
Irrigation Department
Ministry of Forestry and Irrigation

Mrs.D.D.J.Kudaligama
Director
Department of External Resources
Ministry of Finance

ATTACHMENT

1. Objectives of the Project

The objectives of the Project are to stimulate the economics, social and cultural activities in the Project Area (Minipe and Mahaweli Development System C areas) and to improve the road network through the construction of the bridge across the Mahaweli river.

2. Project Site

The Project site is in between Hettipola and Hembarawa. (See Annex-I.)

3. Executing Agency of the Government of Sri Lanka

The Irrigation Department of Ministry of Forestry and Irrigation (hereinafter referred to as "ID") is the government agency responsible for the implementation of the Project. (See Annex-II.)

4. Contents of Request from the Government of Sri Lanka

After discussions with the Basic Design Study Team, the request for the Project by the Government of Sri Lanka was confirmed as follows;

1) Construction of Bridge

Bridge Name	Route	Area	Length(m)
Mahaweli Bridge	Between Hettipola and Hembarawa	Minipe and Mahaweli Development System C	Approx. 260m

2) Construction and Improvement of Access Roads

3) Number of Lanes : 2 lanes (one lane in each direction)

4) Carriageway Width : 7.4 m (2 x 3.7m) (with footpaths)

5) Structural Types of Bridge
- Superstructure : Pre-stressed Concrete
- Substructure : Reinforced Concrete
- Foundation : To be determined based on the results of geotechnical investigation

However, the final components of the Project will be decided after further studies.

5. Japan's Grant Aid System

1) The Government of Sri Lanka has concurred with the system of Japan's Grant Aid explained by the Team.

2) The Government of Sri Lanka will take necessary measures, described in Annex-III, for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

3) ID has agreed to secure the budget for fulfilling the undertakings to be covered by the Government of Sri Lanka prior to the commencement of the Project.

6. Schedule of the Study

1) The Study Team will proceed to further studies in Sri Lanka until August 25, 1994.

2) JICA will prepare the draft report of the Basic Design Study in English and dispatch a mission in order to discuss its contents in and around November 1994.

3) In case that the contents of the draft report are accepted in principle by Sri Lankan side, JICA will complete the final report and send it to the Government of Sri Lanka at the beginning of February, 1995.

7. Summary of Discussions

1) The location of the site of the bridge is agreed as requested in between Hettipola and Hembarawa.

2) External Resources Department of Ministry of Finance and ID shall be responsible for coordinating related government agencies such as Road Development Authority of Ministry of Transport and Highways (hereinafter referred to as "RDA") and Mahaweli Authority of Sri Lanka of Ministry of Mahaweli Development (hereinafter referred to as "MASL") and others in order to secure the smooth implementation of the Project.

3) ID shall acquire sites for the bridge construction and its access roads and clear the sites prior to the commencement of the construction in the Western side of the river.

4) MASL shall be responsible for acquiring and clearing the sites for the access road to the bridge in the Eastern side of the river.

5) RDA shall be responsible for the maintenance and operation of the bridge and access roads after the completion of the Project.

6) Design Standard for the Project

(1) Design Standard	:	Design Specifications for Highway Bridges in Japan
(2) Live Load	:	Live Load Type A of the said Specification.

ANNEX-III NECESSARY MEASURES TO BE TAKEN BY THE GOVERNMENT OF SRI LANKA IN CASE JAPAN'S GRANT AID IS EXTENDED

1. To secure and clear the sites necessary for construction of the Project facilities prior to the commencement of the Project.

2. To provide the land for a temporary site office, warehouse and stock yards during the implementation of the Project.

3. To provide facilities for the Project such as a distribution of electricity, water supply and other incidental facilities and allocation for wireless radio.

4. To bear the commissions to the Japanese foreign exchange bank for the exchange services based upon the Banking Arrangement.

5. To exempt Japanese nationals involved in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Sri Lanka with respect to the supply of the products and services under the verified contracts.

6. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contracts such facilities as may be necessary for their entry into Sri Lanka and stay therein for the performance of their works.

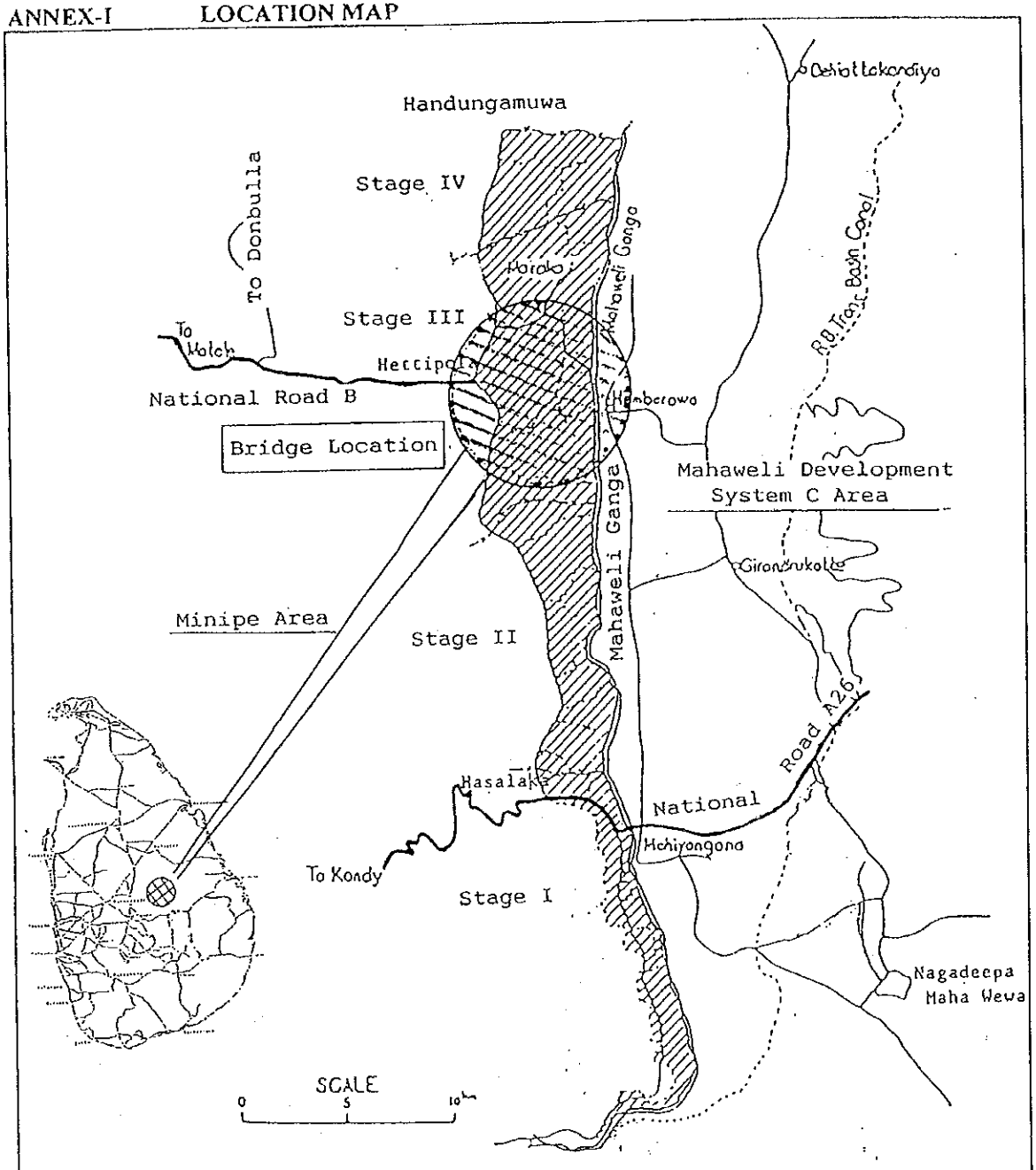
7. To secure the safety of Japanese nationals involved in the Project during the Project period.

8. To bear all expenses, other than those to be borne by the Grant Aid necessary for the execution of the Project.

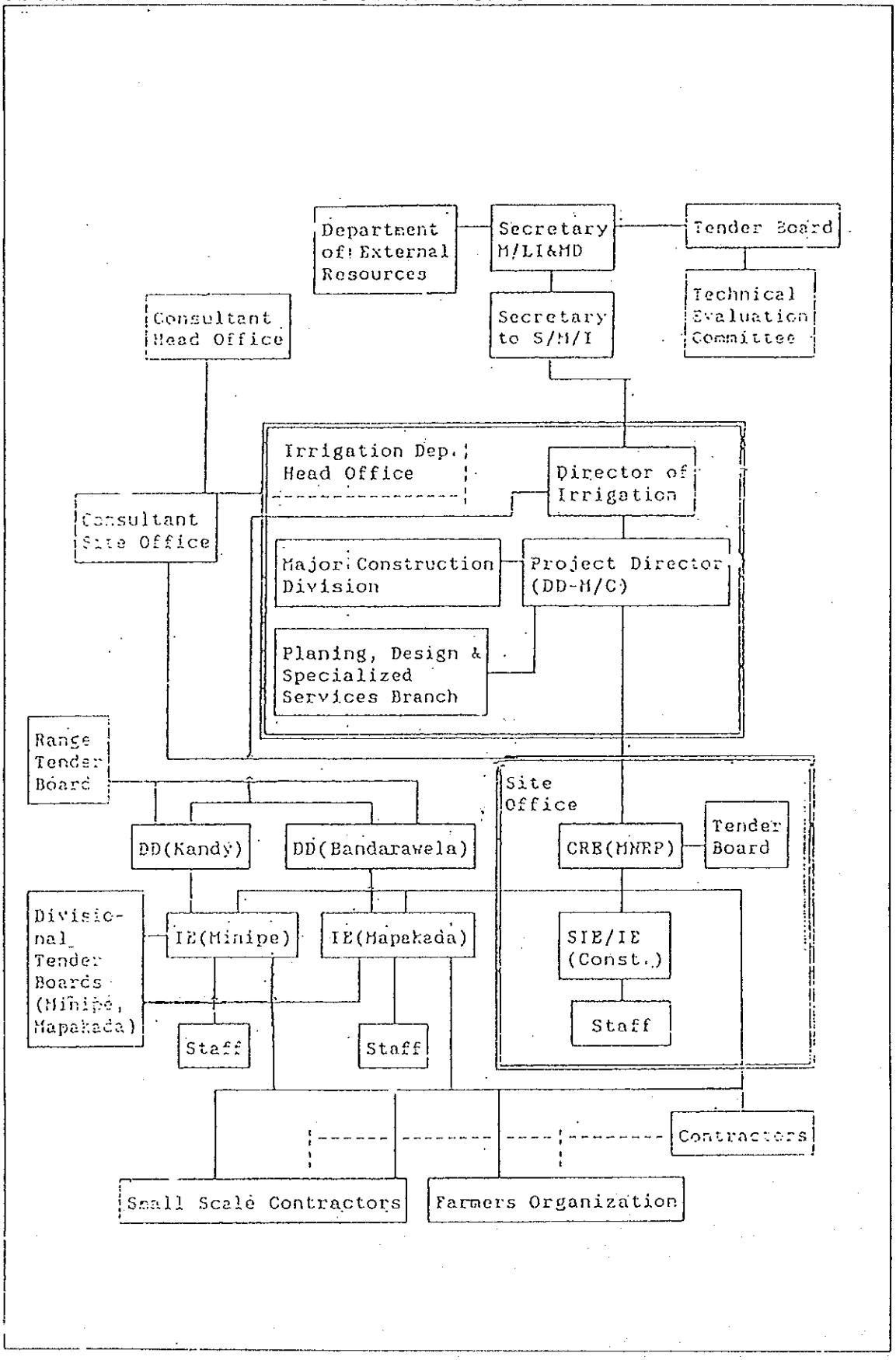
9. To assign exclusive counterpart engineers/technicians, for the Project.

10. To use and maintain properly and effectively the facilities constructed under the Grant Aid.

ANNEX-I LOCATION MAP



ANNEX-II ORGANIZATION OF THE PROJECT



ANNEX-IV PARTICIPANTS LIST

SRI LANKAN SIDE

Irrigation Department, Ministry of Forestry and Irrigation

Mr.K.YOGANATHAN	Director
Mr.W.N.M.BOTEJU	Additional Director
Mr.S.SENTHINATHAN	Deputy Director
Mr.K.THURAIRAJARETNAM	Senior Deputy Director
Mr.D.M.ABAYARATNE	Chief Resident Engineer, Minipe and Nagadeepa Irrigation Rehabilitation Project

External Resources Department, Ministry of Finance

Mrs.D.D.J.KUDALIGAMA	Director
Mr.A.M.P.K.ATTANAYAKA	Additional Director

National Planning Department, General Treasury Colombo

Mr.H.BANDURATNE	Deputy Director

Road Development Authority, Ministry of Transport and Highways

Mr.M.B.S.FERNANDO	Chairman
Mr.Denzil D.SENANAYAKA	General Manager
Mr.Takeo KAI	JICA Expert, Advisor to RDA
Dr.C.L.A.J.DE SILVA	Director, Engineering Services

Mahaweli Authority of Sri Lanka, Ministry of Mahaweli Development

Mr.Palitha PALPOLA	Director General
Mr.P.T.SENARETUS	Secretary General

JAPANESE SIDE

Basic Design Study Team

Mr.Hideaki HOSHINA	Leader/Regional Development (Development Specialist, JICA)
Mr.Atsushi NANJO	Technical Advisor/Road and Bridge (Subchief, Research Division Second Kobe Construction Department Hanshin Expressway Public Corporation)
Mr.Manabu OHARA	Project Coordinator (First Project Management Division Grant Aid Project Management Department, JICA)
Mr.Kazuro YANAGIDA	Chief Consultant/Bridge Planner (Oriental Consultants Co.,Ltd.)
Mr.Akihiko HIROTANI	Road and Bridge Designer (Oriental Consultants Co.,Ltd.)
Mr.Nobuhiro KUBOYA	Construction Planner/Cost Estimator (Oriental Consultants Co.,Ltd.)
Mr.Yasuo FURUKAWA	Natural Conditions Surveyor (Chiyoda Engineering Consultants Co.,Ltd.)
Mr.Atsushi MATSUBARA	Traffic Planner (Oriental Consultants Co.,Ltd.)

Embassy of Japan in Sri Lanka

Mr.Kunihiro DOI	First Secretary

Japan International Cooperation Agency, Sri Lanka Office

Mr.Jiro IIDA	Assistant Resident Representative

Appendix 4b. DF/R Mission

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY
ON
THE MAHAWELI BRIDGE CONSTRUCTION PROJECT
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

(CONSULTATION OF DRAFT REPORT)

In July 1994, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team on the Mahaweli Bridge Construction Project (hereinafter referred to as "the Project") in the Democratic Socialist Republic of Sri Lanka, and through discussion, field survey, and technical examination of the results in Japan, has prepared a Draft Report of the Study.

In order to explain and to consult the Sri Lankan side on the components of the Draft Report, JICA sent to Sri Lanka a Draft Report Explanation Team, headed by Mr. Kenji KIYOMIZU, Development Specialist, JICA, from November 21 to November 29, 1994.

As a result of discussions, both parties confirmed the main items described on the attached sheet.

Colombo, November 28, 1994

Kenji Kiyomizu.

Mr. Kenji Kiyomizu
Leader
Draft Report Explanation Team
JICA

Mr. W.N.M. Boteju
Additional Director
Irrigation Department
Ministry of Irrigation, Power and Energy

Mrs. D.D.J. Kudaligama
Director
Department of External Resources
Ministry of Finance

1. Components of Draft Report

The Government of Sri Lanka has agreed and accepted in principle the components of the Draft Report explained by the Team.

2. Japan's Grant Aid system

(1) The Government of Sri Lanka has understood the system of Japanese Grant Aid explained by the Team.

(2) The Government of Sri Lanka will take necessary measures, described in Annex-I, for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

3. Further Schedule

The Team will make the Final Report in accordance with the confirmed items, and send it to the Government of Sri Lanka in and around March 1995.

4. Summary of Discussions

(1) External Resources Department of Ministry of Finance and Irrigation Department of Ministry of Irrigation, Power and Energy (hereinafter referred to as "ID"), shall be responsible for coordinating related government agencies such as Road Development Authority of Ministry of Transport, Highway, Environment and Women's Affairs (hereinafter referred to as " RDA"), Mahaweli Authority of Sri Lanka of Ministry of Irrigation, Power and Energy (hereinafter referred to as "MASL"), and others in order to secure the smooth implementation of the Project.

(2) ID shall acquire sites for the bridge and access roads construction and clear the site prior to the commencement of the construction in the West side of the river.

(3) ID shall prepare budget to reimburse, if necessary, the internal taxes paid by the Japanese companies/personnel, related to the Project.

(4) MASL shall be responsible for acquiring and clearing the site for the access road to the bridge in the East side of the Project, prior to the commencement of the construction.

(5) RDA shall be responsible for the maintenance and operation of the bridge and access roads after the completion of the Project.

ANNEX-I NECESSARY MEASURES TO BE TAKEN BY THE GOVERNMENT OF SRI LANKA IN CASE JAPAN'S GRANT AID IS EXTENDED

1. To secure and clear the sites necessary for construction of the Project facilities prior to the commencement of the Project.

2. To provide the land for temporary site offices, warehouses and stock yards during the implementation of the Project.

3. To provide facilities for the Project such as a distribution of electricity, water supply and other incidental facilities and allocation for wireless radio.

4. To bear the commissions to the Japanese foreign exchange bank for the exchange services based upon the Banking Arrangement.

5. To exempt Japanese nationals involved in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Sri Lanka with respect to the supply of the products and services under the verified contracts.

6. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contracts such facilities as may be necessary for their entry into Sri Lanka and stay therein for the performance of their works.

7. To secure the safety of Japanese nationals involved in the Project during the Project period.

8. To bear all expenses, other than those to be borne by the Grant Aid necessary for the execution of the Project.

9. To assign exclusive counterpart engineers/technicians, for the Project.

10. To use and maintain properly and effectively the facilities constructed under the Grant Aid.

ANNEX-II PARTICIPANTS LIST

SRI LANKAN SIDE

Irrigation Department, Ministry of Irrigation, Power and Energy

Mr.K.YOGANATHAN	Director
Mr.W.N.M.BOTEJU	Additional Director
Mr.K.THURAIRAJARETNAM	Senior Deputy Director
Mr.S.SENTHINATHAN	Deputy Director
Mr.S.SELVARAJAH	Deputy Director (Design)
Mr.D.M.ABAYARATNE	Chief Resident Engineer, Minipe and Nagadeepa Irrigation Rehabilitation Project
Mr.J.W.M.R.T.SEIMON	Chief Irrigation Engineer
Mr.B.SIVAPALAN	Irrigation Engineer

External Resources Department, Ministry of Finance

Ms.D.D.J.KUDALIGAMA	Director
Mr.A.M.P.K.ATTANAYAKA	Additional Director
Ms.D.SENANANAYAKE	Assistant Director

National Planning Department, General Treasury Colombo

Mr.FAIZ MOHIDEEN	Additional Director General

Road Development Authority, Ministry of Transport, Highways, Environment and Women's Affairs

Mr.K.S.C.de FONSEKA	Chairman
Mr.Denzil D.SENANAYAKE	General Manager
Mr.Takeo KAI	JICA Expert, Advisor to RDA
Dr.C.L.A.J.DE SILVA	Director, Engineering Services
Mr.R.G.RAJAPAKSE	Deputy Director (Traffic & Planning)

Mahaweli Authority of Sri Lanka, Ministry of Irrigation, Power and Energy

Mr.S.W.K.J.SAMARANAYAKE	Director General
Mr.P.T.SENARATHE	Secretary General

JAPANESE SIDE

Draft Report Explanation Team

Mr.Kenji KIYOMIZU	Leader (Development Specialist, JICA)
Mr.Kazuro YANAGIDA	Chief Consultant/Bridge Planner (Oriental Consultants Co.,Ltd.)
Mr.Akihiko HIROTANI	Road and Bridge Designer (Oriental Consultants Co.,Ltd.)

Embassy of Japan in Sri Lanka

Mr.Kunihiro DOI	First Secretary

Japan International Cooperation Agency, Sri Lanka Office

Mr.Jiro IIDA	Assistant Resident Representative

Appendix 5. Country Data

1994.7.

1. General Index		
Country Name	Democratic Socialist Republic of SRI LANKA	
Political System	Republic	
Head of State	President Dingiri WIJETUNGA	
Independence Day	04 February, 1948	
Racial Composition	Sinhalese 74%, Tamil 18%	
Language	Sinhalese, Tamil, English	
Religion	Buddist 69%, Hindu 15%	
Entry to United Nation	December, 1955	
Entry to World Bank/IMF	August, 1950	
Land	65,000 Square km	
Population	17,838,000	(1993)
Capital City	Srijayewardenepurakotte	
Other Major Cities	Galle, Jafuna, Matale	
Labor Population	6,600,000	(1985)
Compulsory Education Years	7 years	(1992)
Attendance Rate to Primary Education	—%	(0000)
Literacy Rate	88.0%	(1990)
Population Density	268.0/km^2	(1992)
Population Growth Rate	1.11%	(1993)
Life Expectancy	Average 71, Male 68.9, Female 74.2	
Decease Rate of 5 years and yonger	22.8/1000	(1993)
Calorie Assimilation	2,250.0 Cal/day/Cap.	(1990)

2. Economic Index		
Currency	Sri Lanka Rupee	
Currency Exchange Rate	1US$ = Rp. 49.04	
Fiscal Year	January to December	
National Budget	US$	(1992)
Annual Income	US$ 1,939.4 mil.	
Annual Expenditure	US$ 2,710.6 mil.	
Balance of International Payment	US$ 223.9 mil.	(1992)
Income from ODA	US$ 658.00	(1992)
Gross Domestic Product (GDP)	US$ 9,623.00	(1992)

GDP per Capita	US$ 500.0	(1991)
GDP Composition by Industry	Agriculture	27.0%
	Manufacture and Mining	25.0%
	Service Industry	48.0%
Employment by Industry	Agriculture	49.0%
	Manufacture and Mining	21.0%
	Service Industry	30.0%
Economic Growth Rate	4.1%	(1992)
International Trade		(1993)
Export	US$ 2,859.0 mil.	
Import	US$ 3,974.0 mil.	
Rate of Import Cover	2.8%	(1992)
Main Export Product	Textile, Tea, Rubber	
Main Import Product	Food, Drink, Textile, Oil	
Export to Japan	US$ 151.0 mil.	(1992)
Import from Japan	US$ 359.0 mill.	(1992)
Foreign Currency Holding	US$ 1,977.0 mil.	(1994)
Foreign Currency Debt	US$ 6,401.0 mil.	(1992)
Debt Return Ratio	15.5%	(1992)
Inflation Ratio	10.1%	(1992)
National Planning	Fourteenth Public Investment Plan (1992)	

3. Meteorological Data (1954~1979, Colombo, Altitude 7m)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Maximum Temperature	30.0	31.0	31.0	31.0	31.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.7℃
Minimum Temperature	22.0	22.0	23.0	24.0	26.0	25.0	25.0	25.0	25.0	24.0	23.0	22.0	23.8℃
Mean Temperature	26.0	26.5	27.0	27.5	28.5	27.0	27.0	27.0	27.0	26.5	26.0	25.5	26.7℃
Precipitation	89.0	69.0	147.0	231.0	371.0	224.0	135.0	109.0	160.0	348.0	315.0	147.0	2345.0mm
Season				R	R	R				R	R		

(R: Rain Season)

4. ODA Performance from Japan

(Disbursement Unit: Million US$)

Year / Description	1989	1990	1991	1992
Grant Aid	17.79	16.58	19.23	20.97
Technical Cooperation	75.84	74.39	48.05	43.78
Loan Assistance	91.57	85.10	188.86	31.31
Total	185.20	176.07	256.14	96.06

DAC Countries Economic Assistance Reference
The World Factbook (C.I.A)
Human Development Report (UNDP)
International Financial Statistics (IMF)
World Debt Tables (WORLD)
New World Handbook (Tokyo Publication)
Japan's Offical Development Assistance (Ministry of Foreign Affairs)
Oversees Economic Assistance Fact book (Oversees Economic Cooperation Fund)
Cooperation Information by Countries (JICA)

Appendix 6. Cost Estimation Borne By The Recipient Country

The costs to be borne by the Sri Lankan side is as follows:

(1) Construction site acquisition cost: 1866 million rupees (3861 million yen)

(2) Yard site rental: 2 million rupees (5 million yen)

(3) Administrative costs of Irrigation Department: 240 million rupees (497 million yen)

(1) Construction site acquisition cost

a) Site acquisition cost

Land acquisition cost (Irrigation Dept. info.):5,000 rupees/ha

Area: 5,150m X average width of 30m = 154,500m^2 = 15.45ha

Site acquisition cost:15.45ha X 75,000 = 1,158,750 rupees

= approx. 116 million rupees

= 240 million yen

b) Cost of compensation for relocation

Cost of compensation for farmhouses, etc. (Irrigation Dept. info.): 50,000 rupees/house

Number of houses receiving compensation: approx. 35 houses

Cost of compensation for relocation: 35 houses X 50,000 = 17.5 million rupees

= 3621 million yen

c) Subtotal of construction site acquisition cost

Site acquisition cost + cost of compensation for relocation

= 1,866 million rupees

= 3,861 million yen

(2) Rental cost on yard site

Yard site rental (Irrigation Dept. info.): 7,500 rupees/ha/year

Area of yard site: 200m X 150m = 30,000m^2 = 3ha

Total yard site rental: 3 years X 7,500 = 22,500 rupees

= 2 million rupees

= 5 million yen

(3) Administrative costs of Irrigation Department

Senior engineers are stationed on site in order to transfer technology and act as liaisons for smooth communication with local parties concerned.

Unit cost of engineer (including on-the-spot cost)

25,000 rupees/man · month

Number of engineers: 3 engineers for 32 months = 96 man · months

Administration cost: 25,000 X 96 = 2,400,000 rupees

= 240 million rupees

= 497 million yen

(4) Maintenance and administration costs

a) Routine cleaning cost

Weeding, cleaning of side drains, small-scale repairs and personnel expenses for administration (Irrigation Dept. info.)

: 500,000 rupees/year

b) Pavement replacement cost

Replacement of pavement (only asphalt and concrete part) once every 25 years (includes this year)

Replacement cost: Rs. 18,670,000/25 years

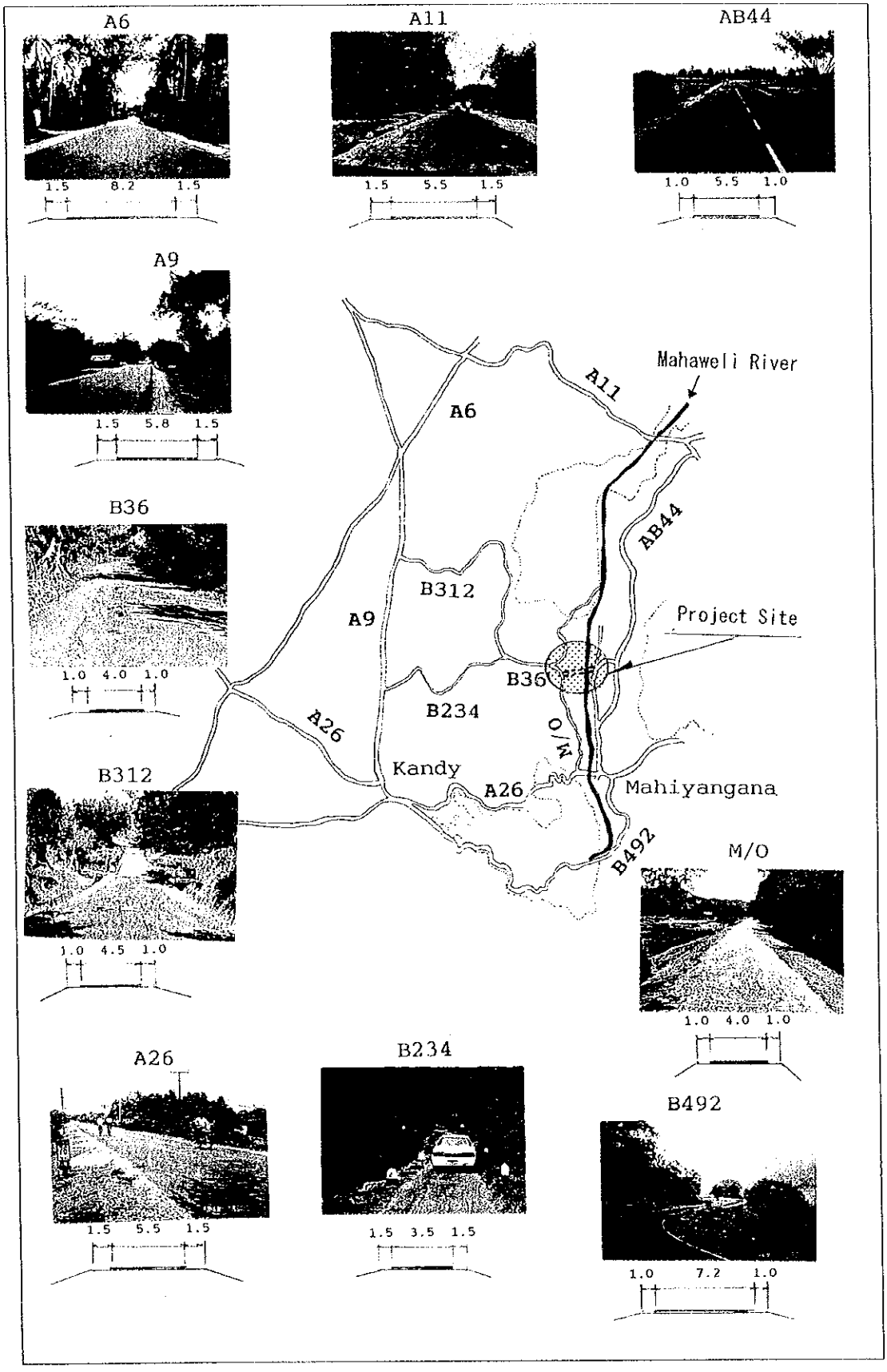
= Rs. 750,000/year

c) Annual total maintenance cost: Rs. 1,250,000/year

(approximately 2,600,000 yen/year)

Appendix 7. Study Data

Appendix 7a. Roads in Vicinity



Appendix 7b. Traffic Volume Survey

(1) Traffic Volume Survey (Hasalaka→Mahiyangana)

Time	Motorcycle	Automobile	Bus	Truck		Total
				2 axles	More than 2 axles	
5:00 ~ 5:30	0	0	2	2	0	4
5:30 ~ 6:00	4	2	4	10	0	20
6:00 ~ 6:30	5	3	4	8	1	21
6:30 ~ 7:00	5	6	8	9	2	30
7:00 ~ 7:30	6	5	8	17	5	41
7:30 ~ 8:00	11	11	14	12	2	50
8:00 ~ 8:30	25	12	15	14	2	68
8:30 ~ 9:00	15	18	15	15	2	65
9:00 ~ 9:30	14	17	13	16	3	63
9:30 ~ 10:00	17	17	16	18	2	70
10:00 ~ 10:30	19	13	11	9	1	53
10:30 ~ 11:00	7	12	11	9	1	40
11:00 ~ 11:30	17	10	11	8	1	47
11:30 ~ 12:00	11	17	18	14	6	66
12:00 ~ 12:30	10	8	17	14	1	50
12:30 ~ 13:00	5	9	10	15	1	40
13:00 ~ 13:30	10	4	13	10	2	39
13:30 ~ 14:00	8	9	9	13	1	40
14:00 ~ 14:30	8	17	10	9	1	45
14;30 ~ 15:00	7	10	14	8	2	41
15:00 ~ 15:30	7	10	11	9	0	37
15:30 ~ 16:00	9	10	12	11	1	43
16:00 ~ 16:30	5	16	10	12	0	43
16:30 ~ 17:00	3	8	7	12	0	30
17:00 ~ 17:30	13	7	9	11	1	41
17:30 ~ 18:00	12	10	3	15	1	41
18:00 ~ 18:30	6	6	7	10	0	29
18:30 ~ 19:00	12	13	11	15	0	51
Total	271	280	293	325	39	1208

Source : This Study (July 28, 1994)

(2) Traffic Volume Survey (Mahiyangana→Hasalaka)

Time	Motorcycle	Automobile	Bus	Truck		Total
				2 axles	More than 2 axles	
5:00 ~ 5:30	0	0	0	7	0	7
5:30 ~ 6:00	1	2	2	4	0	9
6:00 ~ 6:30	2	1	5	5	0	13
6:30 ~ 7:00	5	4	9	9	1	28
7:00 ~ 7:30	6	7	11	5	2	31
7:30 ~ 8:00	12	1	18	10	0	41
8:00 ~ 8:30	16	9	17	14	0	56
8:30 ~ 9:00	18	7	23	7	4	59
9:00 ~ 9:30	18	15	22	15	1	71
9:30 ~ 10:00	15	12	13	8	0	48
10:00 ~ 10:30	13	8	14	12	2	49
10:30 ~ 11:00	11	4	16	9	0	40
11:00 ~ 11:30	18	6	18	9	0	51
11:30 ~ 12:00	11	11	20	9	1	52
12:00 ~ 12:30	8	9	13	10	3	43

12:30 ~ 13:00	8	10	5	14	2	39
13:00 ~ 13:30	8	9	11	10	0	38
13:30 ~ 14:00	9	14	6	9	0	38
14:00 ~ 14:30	11	7	9	13	1	41
14;30 ~ 15:00	4	10	13	9	0	36
15:00 ~ 15:30	16	9	5	11	1	42
15:30 ~ 16:00	7	11	12	19	0	49
16:00 ~ 16:30	7	11	7	10	1	36
16:30 ~ 17:00	11	18	4	8	0	41
17:00 ~ 17:30	14	32	10	20	0	76
17:30 ~ 18:00	13	16	6	12	0	47
18:00 ~ 18:30	16	13	7	13	0	49
18:30 ~ 19:00	6	9	4	15	0	34
Total	284	265	300	296	19	1164

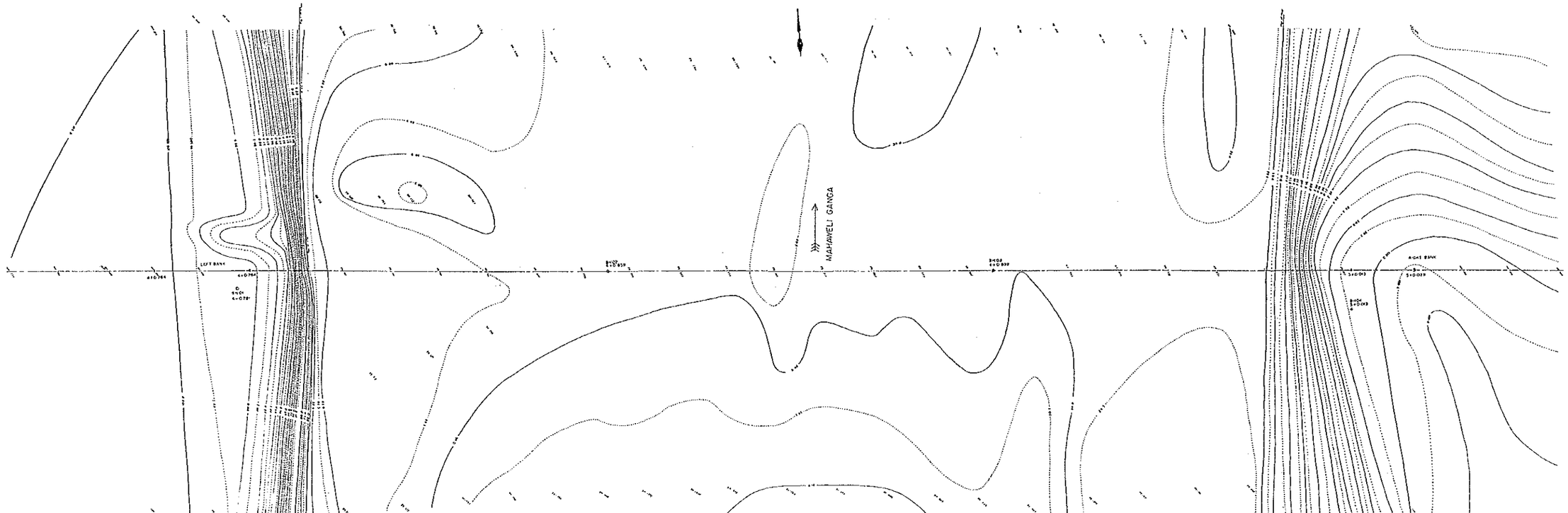
Source : This Study (July 28, 1994)

(3) Traffic Volume Survey (both directions)

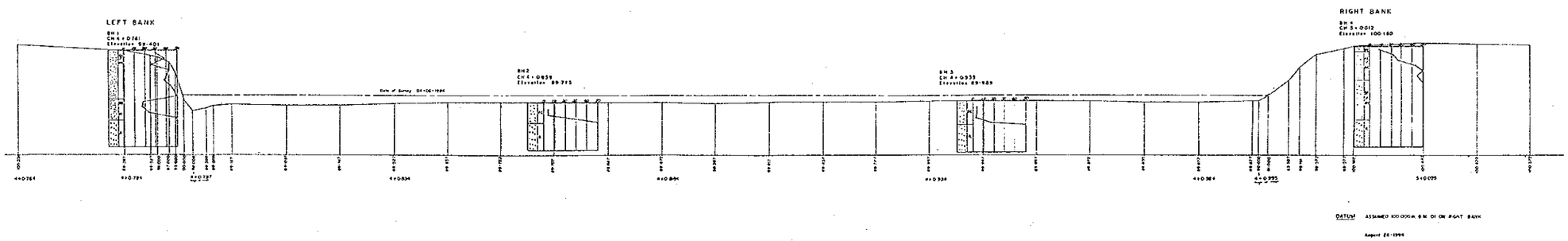
Time	Motorcycle	Automobile	Bus	Truck		Total
				2 axles	More than 2 axles	
5:00 ~ 5:30	0	0	2	9	0	11
5:30 ~ 6:00	5	4	6	14	0	29
6:00 ~ 6:30	7	4	9	13	1	34
6:30 ~ 7:00	10	10	17	18	3	58
7:00 ~ 7:30	12	12	19	22	7	72
7:30 ~ 8:00	23	12	32	22	2	91
8:00 ~ 8:30	41	21	32	28	2	124
8:30 ~ 9:00	33	25	38	22	6	124
9:00 ~ 9:30	32	32	35	31	4	134
9:30 ~ 10:00	32	29	29	26	2	118
10:00 ~ 10:30	32	21	25	21	3	102
10:30 ~ 11:00	18	16	27	18	1	80
11:00 ~ 11:30	35	16	29	17	1	98
11:30 ~ 12:00	22	28	38	23	7	118
12:00 ~ 12:30	18	17	30	24	4	93
12:30 ~ 13:00	13	19	15	29	3	79
13:00 ~ 13:30	18	13	24	20	2	77
13:30 ~ 14:00	17	23	15	22	1	78
14:00 ~ 14:30	19	24	19	22	2	86
14;30 ~ 15:00	11	20	27	17	2	77
15:00 ~ 15:30	23	19	16	20	1	79
15:30 ~ 16:00	16	21	24	30	1	92
16:00 ~ 16:30	12	27	17	22	1	79
16:30 ~ 17:00	14	26	11	20	0	71
17:00 ~ 17:30	27	39	19	31	1	117
17:30 ~ 18:00	25	26	9	27	1	88
18:00 ~ 18:30	22	19	14	23	0	78
18:30 ~ 19:00	18	22	15	30	0	85
Total	555	545	593	621	58	2372

Source : This Study (July 28, 1994)

Appendix 7c. Result of Geological and Topographic Surveys



TOPOGRAPHIC MAP AT BRIDGE LOCATION



RIVER CROSS SECTION AT BRIDGE LOCATION

Appendix 7d. Hydrological Analysis

1. General condition of river and basin at the project site

The Mahaweli River, the longest in the country, originates in a mountainous region in the mid-south and runs northward passing through four dams and then flows into Koddiyar Bay at Trincomalee on the east coast of Sri Lanka. The project site is located at the middle reaches of the river, where its width is approximately 200m. The discharge basin of the river is 10,327km^2 with a discharge of 11,016 x 10^6 m^3 , which corresponds to 44 percent of the total rainfall. An outline of the four dams on the river is as follows:

Table-7.d.1 Dams on the Mahaweli River

	Name and type of Dam			
	Kotmale	Victoria	Randenigala	Rantambe
	Rock-fill	Concrete arch	Rock-fill	Concrete
Full Supply Level above MSL	703m	438m	232m	152m
Crest Elevation	706.5m	443m	238m	155m
Gross Storage at FSL (Million m3)	174	730	860	21
Year Completed	1985	1986	1986	1989

The Mahaweli River is almost in its original natural state, except for some man-made structures such as dams and bridges.

The riverbed slope at the project site is very small (more or less level), meaning that the velocity of the current is slow. Therefore, it will not be necessary to take into account changes in the river's course or natural revetments. This area receives most of its rain from November to February, while in the dry season the water level falls so low that the riverbed can be seen. Average monthly water height and discharge are given below in Figure-7.d.1. This figure shows there is a clear relationship between water height and discharge, proving the reliability of the data.

Average annual discharge is given in Figure-7.d.2., which clearly indicates a decline over the years. As rainfall has not changed much over this time, it is assured that the dams and irrigation development have caused the decline in the river's discharge.

Height-Discharge
Mahiyangana (1989～1993)

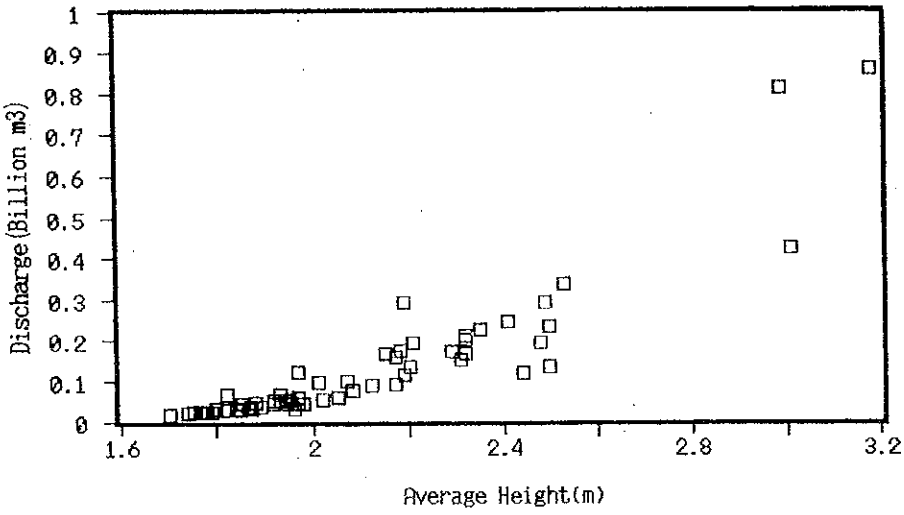


Figure-7.d.1

Average Annual Discharge

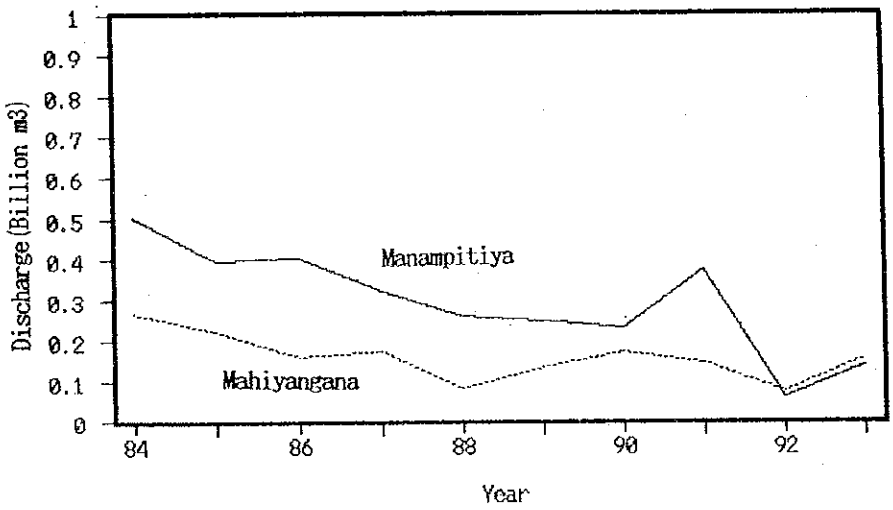


Figure-7.d.2

The water height at Mahiyangana is given in figures-7.d.3. and 7.d.4, representing monthly maximum height and average monthly height, respectively. The largest monthly maximum heights are from November to February, with December and January having the largest heights of more than 7m. In the other months, there is little fluctuation and the water height remains around 3~4 meters.

Monthly Maximum Height (m)
Mahiyangana (1989～1993)

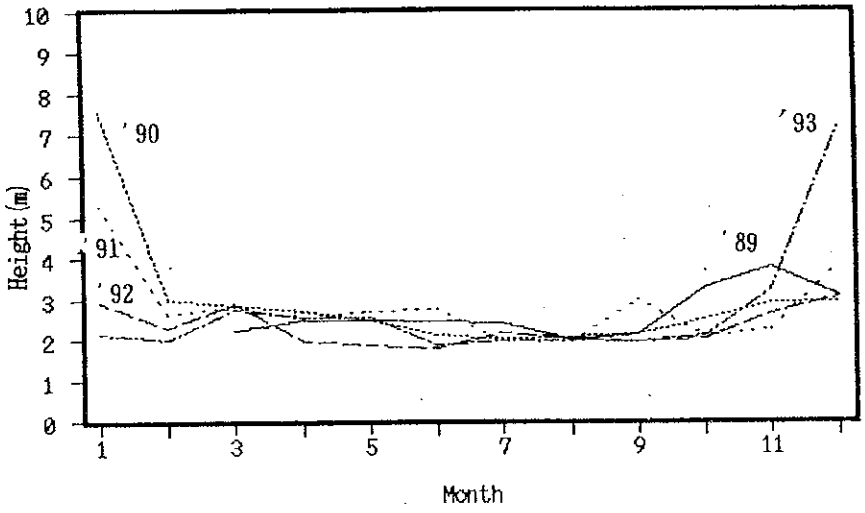


Figure-7.d.3

Average Monthly Height (m)
Mahiyangana (1989～1993)

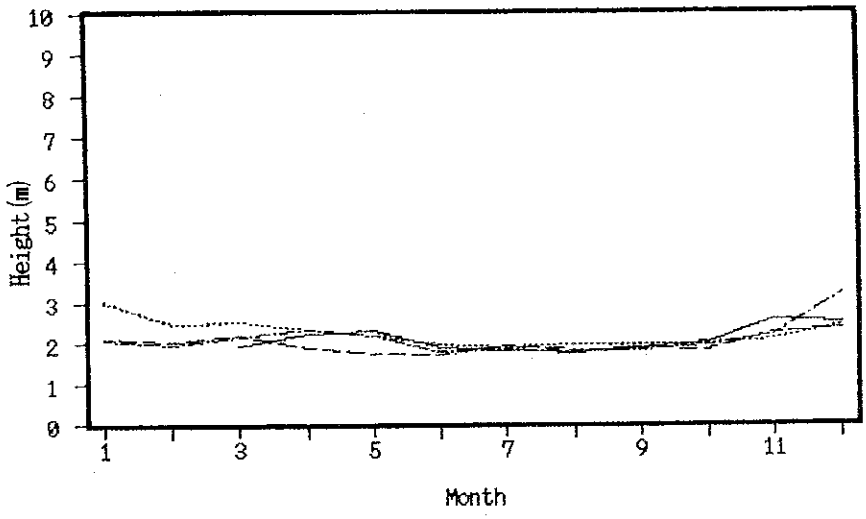


Figure-7.d.4

Average monthly discharge is shown in figures-7.d.5 to 7.d.8. The four dams on the Mahaweli River were completed in 1989. The average monthly discharge has been mostly stable since then, with high flow rates from November to February and the utilization of the dams basically remaining the same.

Average Monthly Discharge

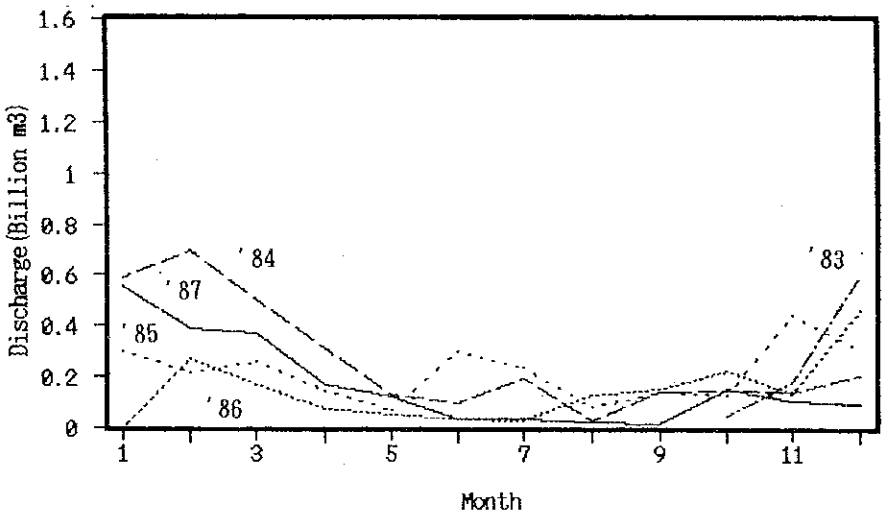


Figure-7.d.5

Average Monthly Discharge
Mahiyangana (1988～1993)

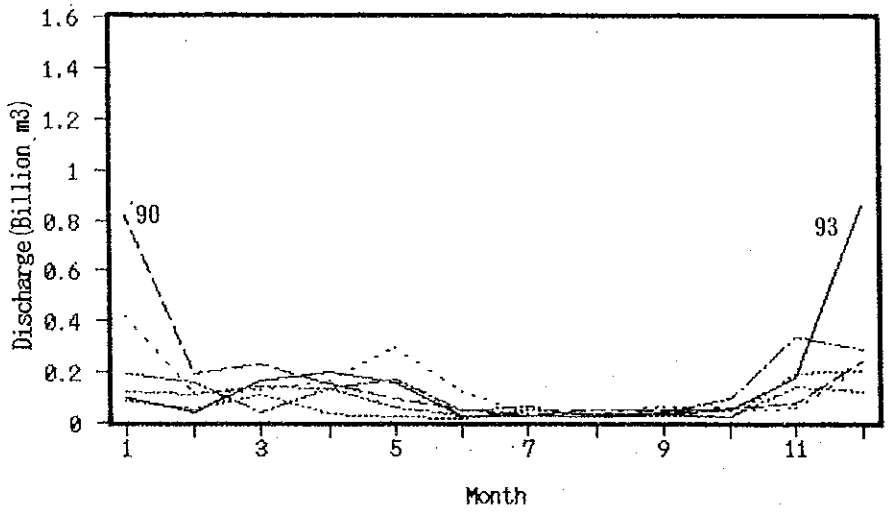


Figure-7.d.6

Average Monthly Discharge
Manampitiya (1982～1987)

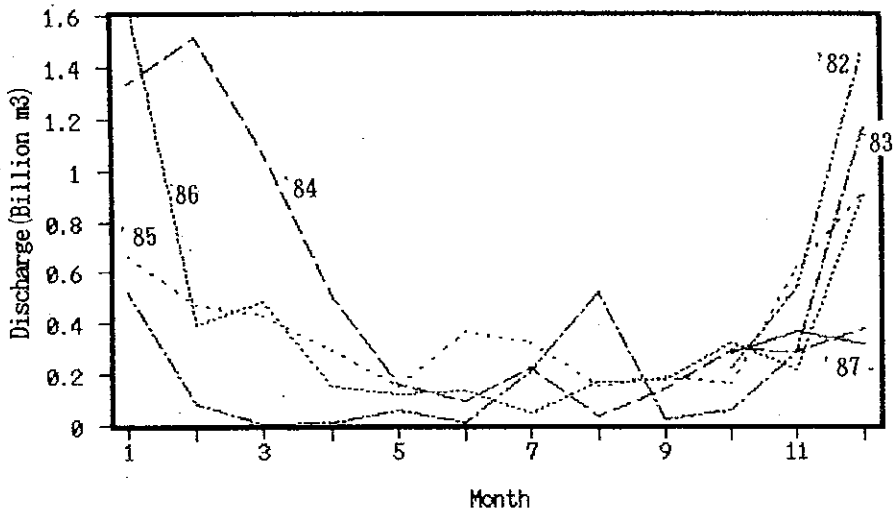


Figure-7.d.7

Average Monthly Discharge
Manampitiya (1988～1993)

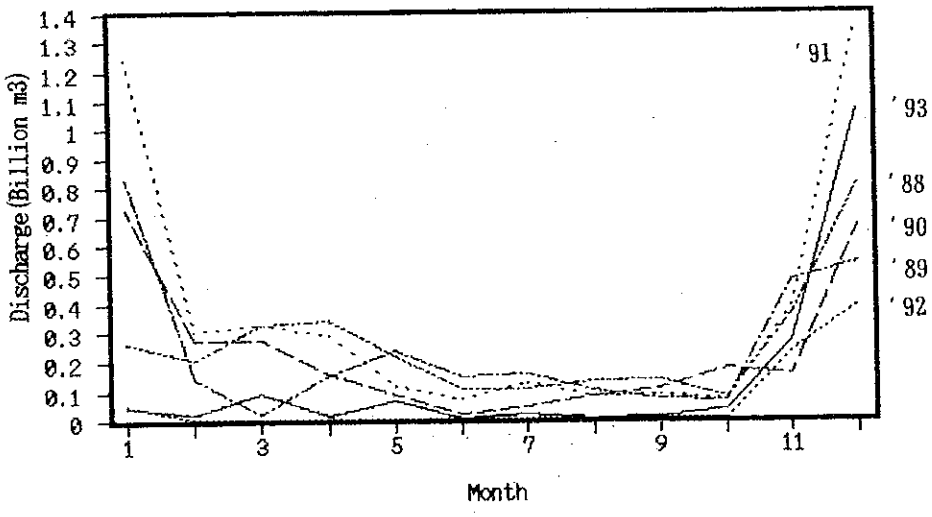


Figure-7.d.8

Since 1989 when the four dams (at the upstream of the project site)were completed, the highest water level at Mahiyangana (approx. 25km upstream from the project site) has been 7.6m. To securing clearance for the superstructure, however, this height may not be enough. That is, the highest water level recorded is 9m. This height (9m) seems more appropriate since it almost coincides with the height of the river bank. Clearance between the girders and the water's surface at the maximum water level should be 2m, since big trees may be washed away into the river during large discharges. It is advisable to secure this clearance so such outflows do not hit and damage the girders.

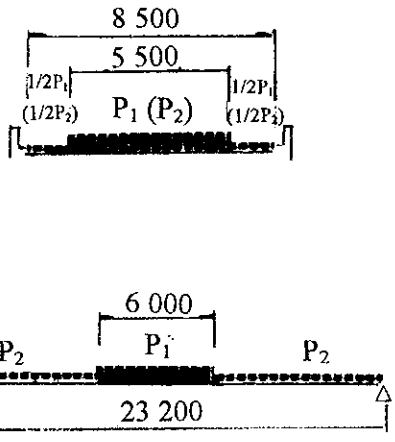
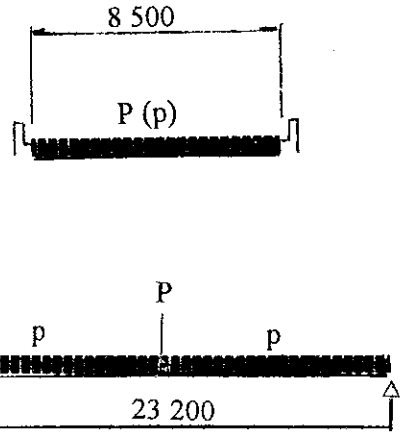
As for the method of ascertaining the design value of the maximum water level mark, it is impossible since the discharge of the Mahaweli River is controlled by four dams. Consequently, this value is determined via statistical processing, taking into considering previous data and the surrounding topography of the project site.

Appendix 7e. Design Standard For Bridge

To decide on the design standard for the bridge superstructure, a comparison of the Japanese standard (Specifications for Highway Bridges) and British standard (BS5400) for a simple 23.2m span example was carried out.

(1) Live load

The live loads of both standards are very comparable.

	Japanese (Live Load Type A)	British standard (BS5400-HA)
Live Load (Unit:t&m)		
	p_1=1.0tf/m^{2}X5.5m+1/2X1.0tf/m^2+3.0m=7tf/m p_2=0.35tf/m^{2}X5.5m+1/2X0.35tf/m^{2}X3.0m =2.45tf/m M_C=455.0tf·m	p =120KNX2/9.8=24.49tf p =30KN/mX2/9.8=6.12tf/m M_C=553.9tf·m

(2) Structural analysis

The methods adopted by the two standards are very different and can not be compared without trial analysis.

Japanese standard : Allowable stress method

British standard : Limited-state design method

(3) Trial analysis of T-girder bridge

In order to clarify the differences between the two design standards, a trial analysis on a T-girder pre-stressed concrete bridge was conducted, resulting in the figures shown in the table below.

The safety factor of both standards were almost the same, but a little higher for the Japanese Standard.

		Japanese Standard	British Standard (BS5400-HA)
Trial Analysis	Ultimate limited state for cross section failure	Dead Load 233tf·m Live Load 114tf·m M =1.7X(233+114)=590tf·m M_u=666.2tf·m	Dead Load 233tf·m Live Load 138tf·m M=1.1X(1.15X233+1.5X138) =522tf·m M_u=722tf·m
	Safety Factor	666.2/590=1.13	722/522=1.38(1.02)

Note; ( ): in case of (HA+HB) Load

(4) Conclusion

The Japanese design standard was shown to be very adequate for use in Sri Lanka.

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