

therefore causes the occurrence of many pot-holes on the stretch. To facilitate smooth transport, advanced maintenance care shall be required.

Farm road from route 10 near ferry on Ban Hai side going up to the north-east direction will also be able to use as a haul road of small equipment. This road is of about 5 meters wide with lateritic pavement. This road has been used as an access road to Route 10 for inhabitants of Ban Hai area.

#### 9.4 Construction Materials and Equipment

Principal construction materials and equipment which may be available in Lao PDR are as follows:

##### 1) Materials

Sand and gravel for concrete and surfacing, Timber, Fuel, and Bitumen

##### 2) Equipment

Limited number of the Bulldozer, Motor-grader, Tired roller, Macadam roller, and Dump truck may be hired out from the local contractors.

Other required materials and equipment shall be brought into Lao PDR from abroad.

## 9.5 Implementation Schedule

### Design and Tendering

The duration required for the designs and tender and contracting process will be about 12 months. The preliminary designs undertaken in this feasibility study will satisfy the level of engineering required as for the basic design.

### Construction

The critical component of the construction schedule will be the in-situ concrete piles work for the bridge substructures and pre-load or surcharge operation for the fill work on the very soft foundation of the left bank.

Preparatory work for erection of temporary buildings, approach to the bridge site, and temporary bridge facility may be finished before such a peak flow as may occur in August.

Planned schedule is shown in attached Figure.

## 9.6 Estimation of Project Cost

### Basic Conditions

#### Base date of estimation

The project cost is estimated at the price level of August, 1990 and expressed in two components; Japanese Yen for foreign currency and US\$ for local currency.

### Structure of cost items

As there have not been established prevailing system or structure for the formulating of construction cost estimated for the engineering works in Lao PDR, the method authorized in Japan such as unit price analysis method was applied.

### Currencies and conversion rate

The currency for the estimation for the local labour, materials, equipment and any other management related costs is expressed in US dollar, while that for the foreign tradable or imported cost elements are shown in Japanese Yen. The conversion rates of US dollars for Japanese Yen and Lao Kip, shall apply as follows: 1US\$ = 153 Yen = 715 Kip

### Contractors

Taking into the high construction expertise of the bridge required and the magnitude of the project cost, the contractors of the project shall be selected by international competitive tenders.

### Construction Cost

Construction costs expressed in US\$ are summarized as follows. They are estimated on condition that the construction period be 36 months as seen in attached Table.

Description	Financial cost (100 US\$)
Bridge	43,952
Approach road	13,337
Temporary bridge	8,260
Rivetment work	4,636
<b>Total Direct construction cost</b>	<b>70,184</b>
Preliminaries and general items	11,938
Packing and transport	14,771
Dispatch of expatriate technician	12,503
Site on cost	12,093
Overhead	8,269
<b>Total of Indirect construction cost</b>	<b>59,574</b>
<b>Total of Construction Cost</b>	<b>129,758</b>

## 9.7 Maintenance Programme

### Maintenance Capability of Lao PDR/DCTC

#### Road

In practice, maintenance works have been limited to small scale ones such as asphaltic repainting on road surface, repair of potholes, and grass cutting. Maintenance gangs of the municipality, therefore can do in routine with skills maintenance works on double or single bituminous treated surfaces. Actual maintenance work for road has been undertaken about 30 to 40 Km per annum on the paved roads. The Project for which pavement is planned with DBST will, therefore, be well maintained. has been undertaken maintenance works on double

#### Bridge

Pre-stressed concrete bridge shall in principle require the least maintenances among various types of bridges. The following are,

however, will be essential for safety of traffic.

- a) Remove dirt and debris from drainage pipe and drain pits.
- b) Remove accumulated dirt and debris of the deck surface.
- c) Remove dirt and debris of the bridge seats and bearing.

#### Maintenance Cost

##### Road

Most of Road maintenance cost for the project road will be consumed mainly for surface course such as resealing, pot-hole maintenance and repaving through out the project life time. While, minor amount of the maintenance cost will be used for grass cutting, side ditch, shoulder, road marking, traffic sign and other relatively small items.

Based upon the maintenance requirement, estimated an annual and periodic maintenance costs are as follows.

Type of Maintenance Work	Cost
Routine maintenance cost, annually	4,400 US\$
Periodic maintenance cost, every 7 years	73,500 US\$

## 10. Economic Evaluation

### 10.1 Economic Evaluation

The economic benefits can be classified into 1) saving of economic costs without the Project and 2) economic benefits derived from the Project.

Economic costs without the Project are;

- 1) Time cost of passengers crossing Nam Ngum River at Tha Ngon
- 2) Economic loss due to no ferry operation
- 3) Extra vehicle operation cost(VOC) and time costs due to diversion from Route 10 to Route 13
- 4) Extra VOC and time cost of diverted traffic from Route 13 to Route 10
- 5) Ferry operation and maintenance costs
- 6) Replacement of ferry boat

Economic benefit with the Project are;

- 1) VOC saving of generated and developed traffic
- 2) Salvage value of the ferry boat
- 3) Residual value of the proposed bridge and approach roads

Financial project costs are converted into economic costs according to the following assumptions:

- 1) Direct transfer payments such as taxes and subsidies are deleted.
- 2) 5% of the foreign portion costs are considered as import taxes and thus excluded.
- 3) The standard conversion factor is 0.9.
- 4) A shadow wage rate for construction labour is 0.4.

With an assumption that the Project initiates in 1992 and the proposed bridge opens at the beginning of 1996, the economic internal rate of return(EIRR) is calculated at 11.90% for 20 year project life. Net present value of the Project is about US\$ 8.3 million with discount rate of 8%. The B/C ratio is 1.62. The Project is relatively sensitive to future traffic volume.

The results of sensitivity analysis are as follows.

Case	EIRR (%)	NPV(US\$1,000)
Base case	11.90	8,345
Construction cost 10% up	11.17	7,164
Construction cost 25% up	10.22	5,392
Traffic growth rate 10% down	9.35	2,494
2 years rapid construction	11.25	6,602

## 10.2 Non-quantification Benefits

The Project is expected to yield also the following non-quantifiable benefits in the influence area:

- 1) Increase in agricultural production
- 2) Improvement of tourism
- 3) Promotion of regional development
- 4) Dispersion of market economy

### 10.3 Social Impacts

In addition to economic impacts, the Project will bring the following social impacts to the influence area and surrounding area of the proposed bridge:

- 1) Reduction of psychological distance between the influence area and Vientiane.
- 2) Assurance of emergency traffic
- 3) Relocation of shops along the landing slope to the edges of the proposed bridge
- 4) Exclusion of the through traffic from the center of Ban Tha Ngon
- 5) Improvement of living conditions in the left side of Nam Ngum River



## 11. Conclusion and Recommendation

### 11.1 Conclusion

#### Gross Domestic Product

Lao economy grew at a relatively high pace between 1982 and 1986. In 1987, the severe drought hampered Lao economy. The economy, however, significantly recovered from the down. The average annual growth rate during the period of 1982-89 is 4.9% which is excess of population growth rate.

Year	1982	1983	1984	1985	1986	1987	1988	1989
GDP(bil.kip)*	190	196	205	221	244	223	228	265
Growth rate(%)		3.0	4.5	7.7	10.4	-8.2	0.1	16.0

Note : \* means GDP in 1988 constant prices

#### Preliminary Design

Under these economic growth, however, present manner to cross the Nam Ngum River is only the way by means of ferry boat having capacity of 45 tons. This is the bottle neck for traffic on Route 10.

Construction site of the proposed bridge is on the alternative route No.4. Bridge length is planned 230m with 5 spans. Substructure is consisting of Reverse Circulation method concrete pile with pier and superstructure shall be the PC concrete beams. The bridge has 2 lanes and one carriageway is 3.0 meters width. 2.5 meters side walk and balcony on the upper stream side are prepared with lighting facility.

On the other hand, approach road is having 3,350 meters in total. The carriage width is 3.0 meters and surface course is designed Double Bituminous Surface Treatment(DBST).

Future Traffic Volume

Estimated future traffic by year on the planned new route is ;

<u>Year</u>	<u>M/C</u>	<u>P/C</u>	<u>P/U</u>	<u>M/T</u>	<u>H/T</u>	<u>L/B</u>	<u>H/B</u>	<u>Sum</u>	<u>PCU</u>
1990*	228	61	58	23	79	14	16	479	575
1996	647	156	143	71	224	26	33	652	1,548
2000	1,054	229	212	110	348	39	50	2,042	2,414
2005	1,755	346	322	179	564	61	77	3,304	3,883
2010	2,923	523	486	289	909	195	121	5,345	6,238
2015	4,006	699	650	396	1,246	130	165	7,292	8,507

Note : \* shows present traffic volume

PCU means passenger car equivalent unit

Costs

Estimated construction costs for the Project are ;

Description	Financial cost (100 US\$)
Bridge	43,952
Approach road	13,337
Temporary bridge	8,260
Rivement work	4,636
<hr/>	
Total Direct construction cost	70,184
Preliminaries and general items	11,938
Packing and transport	14,771
Dispatch of expatriate technician	12,503
Site on cost	12,093
Overhead	8,269
<hr/>	
Total of Indirect construction cost	59,574
<hr/>	
Total of Construction Cost	129,758
<hr/>	
Land Acquisition Cost	952
Engineering Service Cost	16,338
Contingency	6,479
<hr/>	
Total Project Cost	153,527

### Benefits

Economic costs without the Project are;

- 1) Time cost of passengers crossing Nam Ngum River at Tha Ngon
- 2) Economic loss due to no ferry operation
- 3) Extra vehicle operation cost(VOC) and time costs due to diversion from Route 10 to Route 13
- 4) Extra VOC and time cost of diverted traffic from Route 13 to Route 10
- 5) Ferry operation and maintenance costs
- 6) Replacement of ferry boat

Economic benefit with the Project are;

- 1) VOC saving of generated and developed traffic
- 2) Salvage value of the ferry boat
- 3) Residual value of the proposed bridge and approach roads

The economic internal rate of return(EIRR) is calculated at 11.90% for 20 year project life with an assumption that the Project initiates in 1992 and the proposed bridge opens at the beginning of 1996. Net present value of the Project is about US\$ 8.34 million with discount rate of 8%. The Project is relatively sensitive to future traffic volume.

The results of sensitivity analysis are as follows.

Case	EIRR (%)	NPV(US\$1,000)
Base case	11.90	8,345
Construction cost 10% up	11.17	7,164
Construction cost 25% up	10.22	5,392
Traffic growth rate 10% down	9.35	2,494
<hr/>		
2 years rapid construction	11.25	6,602

## 11.2 Recommendation

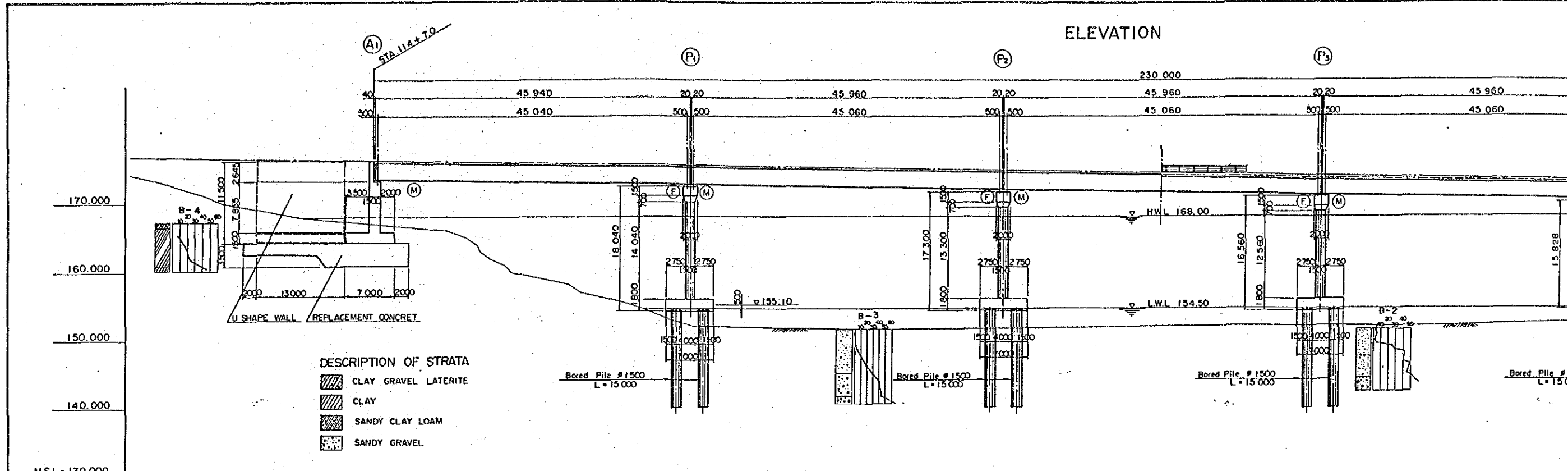
As the results of this Feasibility Study, it is found that the Project is feasible with EIRR of 11.90%(base case). It is clearly understood that the Project will rush the national socio economic development scheme and also give great assistance to the public activities.

The Project needs only US\$ 15 million consisting of US\$ 7 million direct construction costs, 6 million of indirect costs and others. Besides total benefits is counting about US\$ 80 million.

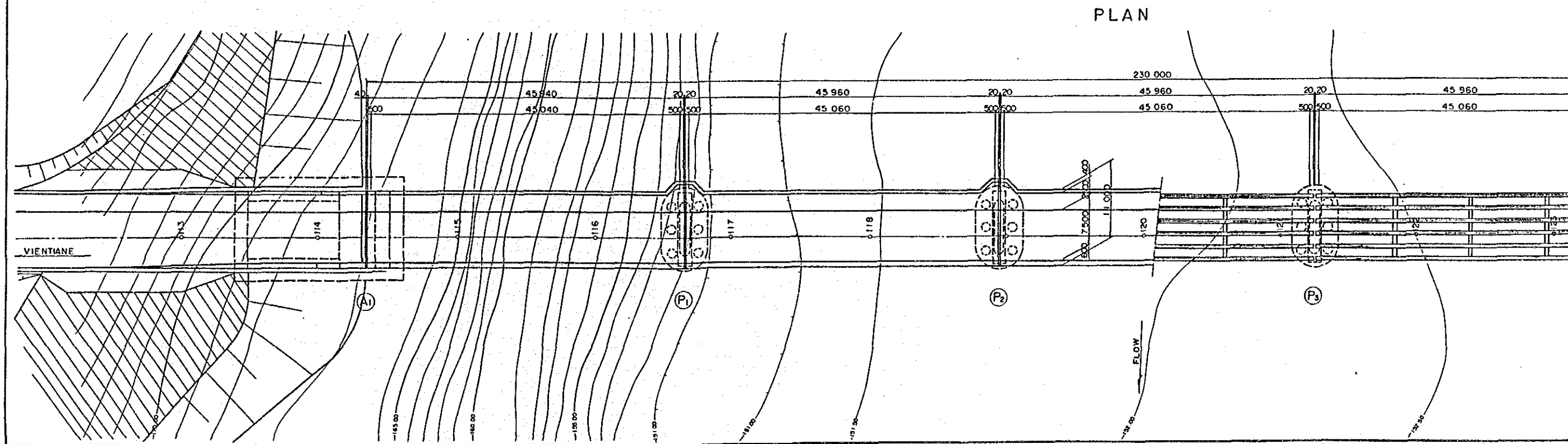
Other than above, uncountable national economic losses are born from ferry troubles. Thus it is strongly recommended that the Project shall be started as soon as possible.

Description	1st Year												2nd Year												3rd Year												4th Year												5th Year												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1. Design and Tendering																																																													
Contract of Consultant																																																													
Detailed Design																																																													
Preparation of Tender Documents																																																													
Advertising																																																													
Prequalification																																																													
Approval of Prequalification																																																													
Distribution of Tender Documents																																																													
Tendering																																																													
Evaluation																																																													
Negotiation																																																													
2. Construction																																																													
Preparatory Work & Mobilization																																																													
Temporary Bridge																																																													
Temporary Landing Pier																																																													
Platform																																																													
A1 Abutment																																																													
P1 Pier																																																													
P2 Pier																																																													
P3 Pier																																																													
P4 Pier																																																													
A2 Abutment																																																													
Fabrication of Girder																																																													
Erection of Girder																																																													
Deck slab																																																													
Reinment Work (Right)																																																													
Reinment Work (Left)																																																													
Roadway Work (Right)																																																													
Roadway Work (Left)																																																													
Demobilization																																																													

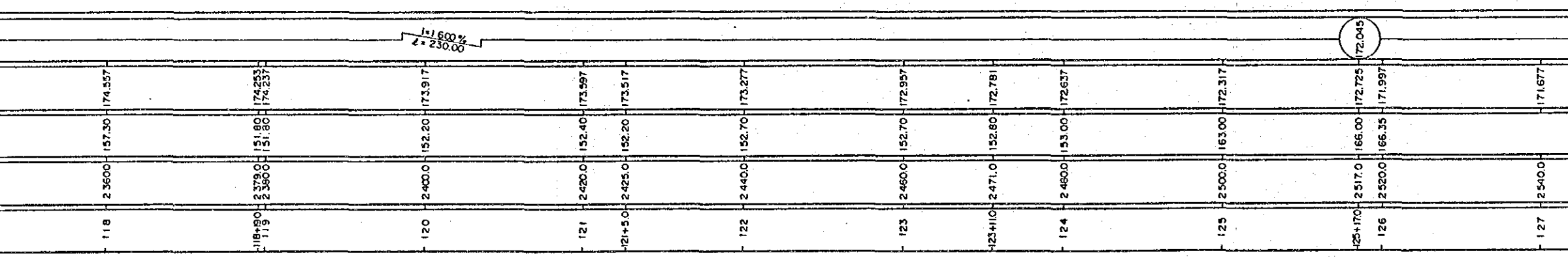
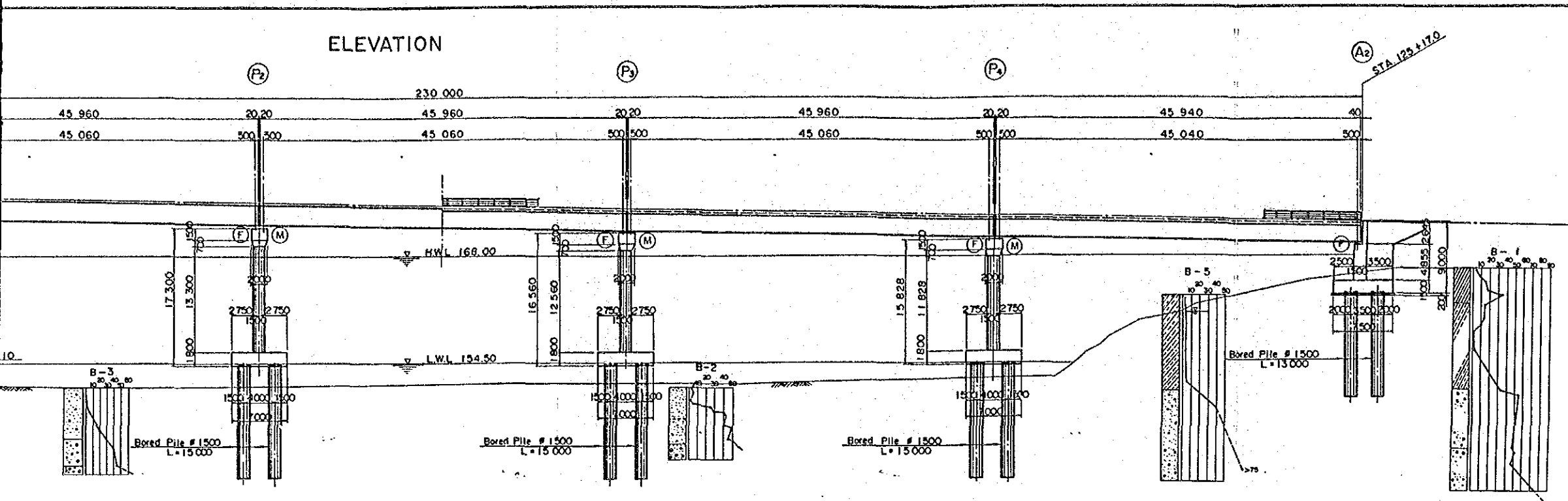
FIG Implementing Time Schedule for THA NGON Bridge



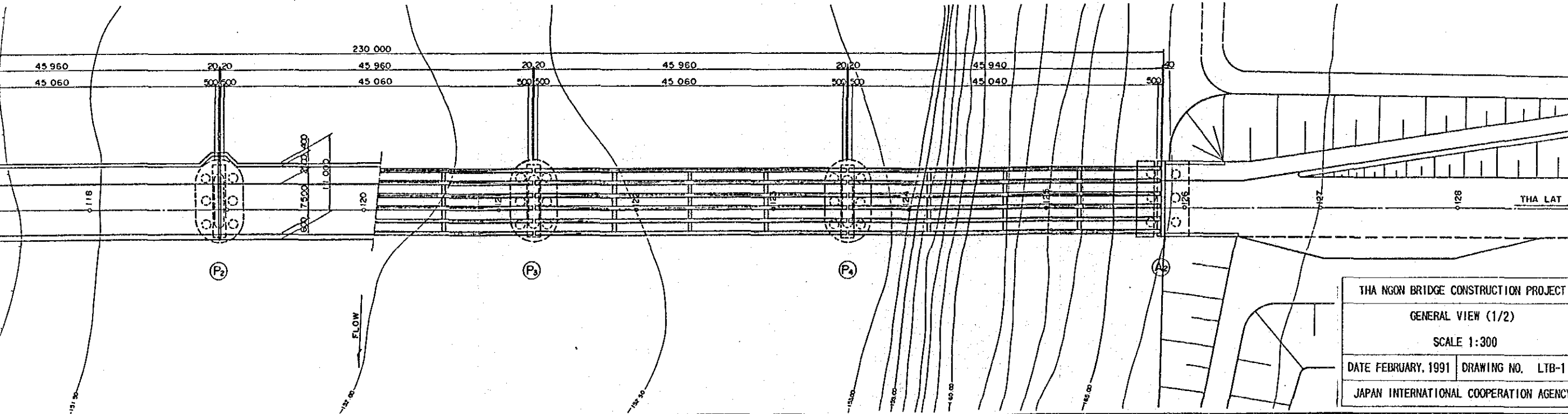
STATION	CUMULATIVE DISTANCE	GROUND LEVEL	ROAD LEVEL	GRADIENT
113	22600	171.92	176.157	
114	22800	167.77	175.837	
114+70	22870	167.00	175.725	1:1.600 L=230.00
115	23000	165.20	175.517	
116	23200	157.30	175.197	
116+30	23330	152.30	174.989	
117	23400	151.40	174.877	
118	23600	157.30	174.557	
118+90	23790	151.80	174.253	
119	23850	151.80	174.237	
120	24000	152.20	173.917	
121	24200	152.40	173.997	
121+50	24250	152.20	173.517	
122	24400	152.70	173.277	
123	24600	152.70	172.957	



ELEVATION



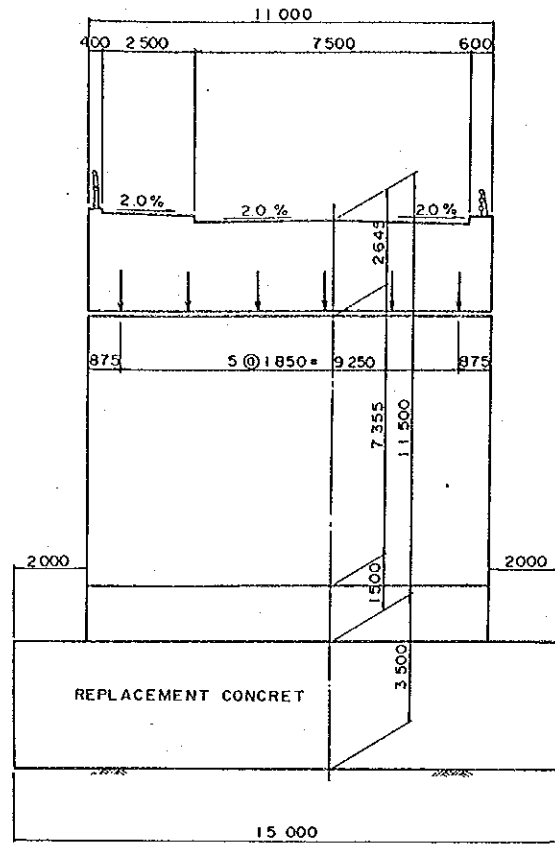
PLAN



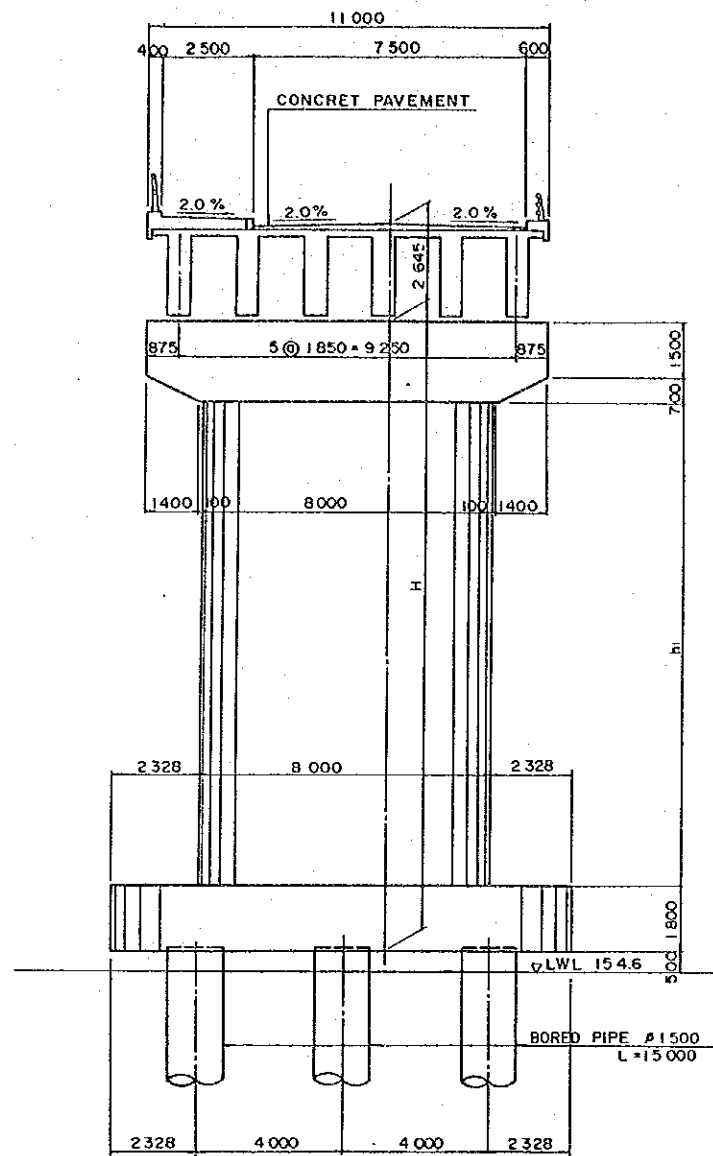
THA NGON BRIDGE CONSTRUCTION PROJECT	
GENERAL VIEW (1/2)	
SCALE 1:300	
DATE FEBRUARY, 1991	DRAWING NO. LTB-1
JAPAN INTERNATIONAL COOPERATION AGENCY	



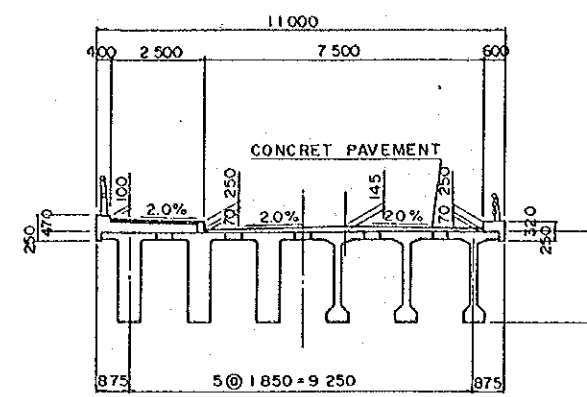
A1 ABUTMENT SCALE 1:100



PIERS SCALE 1:100



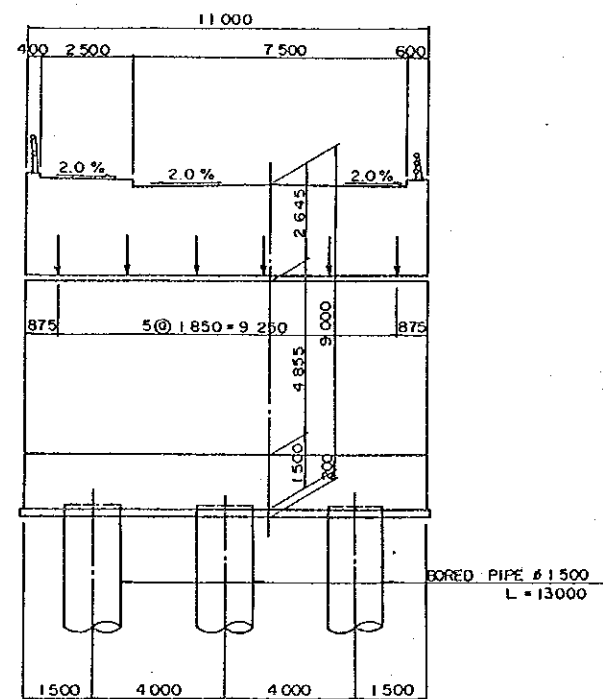
SECTION SCALE 1:100



DIMENSION OF PIERS

	H	h <sub>i</sub>
P 1	18 040	14 040
P 2	17 300	13 300
P 3	16 560	12 560
P 4	15 828	11 828

A2 ABUTMENT SCALE 1:100



DESIGN STANDARD AND CRITERIA

DIMENSIONS	TYPE	5-SPAN PRESTRESSED CONCRETE T-GIRDER BRIDGE
LENGTH		230 M
SPAN		45 060 M
WIDTH		OVERALL WIDTH: 11.0 M
		CARRIAGEWAY: 7.5 M
		SIDEWALK: 2.5 M
DESIGN ROAD	LIVE LOAD	DECKS: T-20(JAPANESE STANDARD) GIRDER: L-20( )
	SEISMIC ROAD	0.05 G
MAIN GIRDER	CONSTRUCTION	GIRDER ERECTION METHOD
	CONCRETE	$\sigma_{ck} = 350 \text{ kg/cm}^2$
	PRESTRESSING STEEL REINFORCING BAR	SWPR 7A; SWPR 19 SD 30 (JIS G 3112)
SUBSTRUCTURE	CONCRETE	$\sigma_{ck} = 240 \text{ kg/cm}^2$
	REINFORCING BAR	SD 30 (JIS G 3112)
FOUNDATION	BORED PILE	$P_0 = 354 \text{ T/PILE}$
	SPREAD FOUNDATION	$Q_0 = 40 \text{ T/M}^2$

THA NGON BRIDGE CONSTRUCTION PROJECT

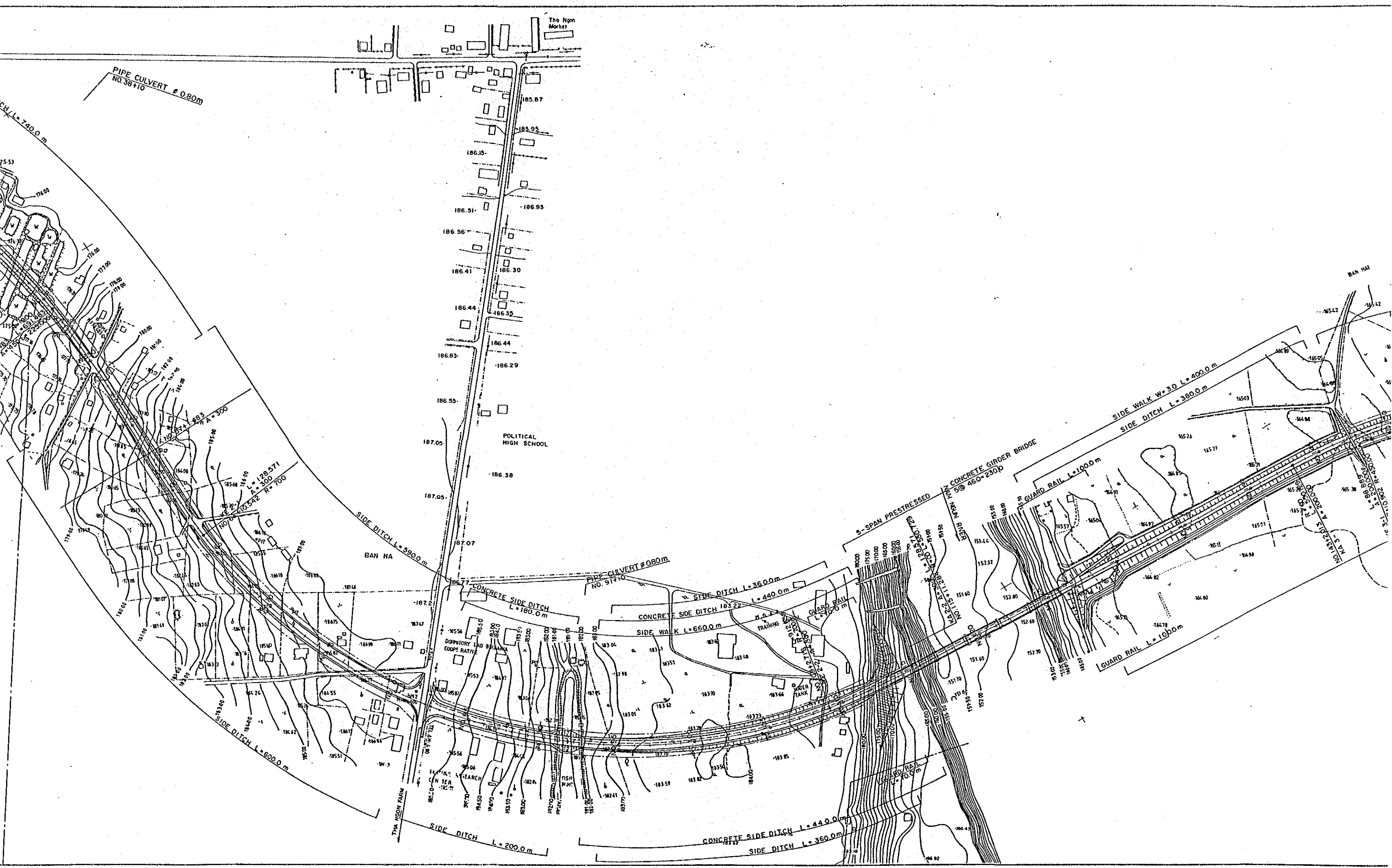
GENERAL VIEW (2/2)

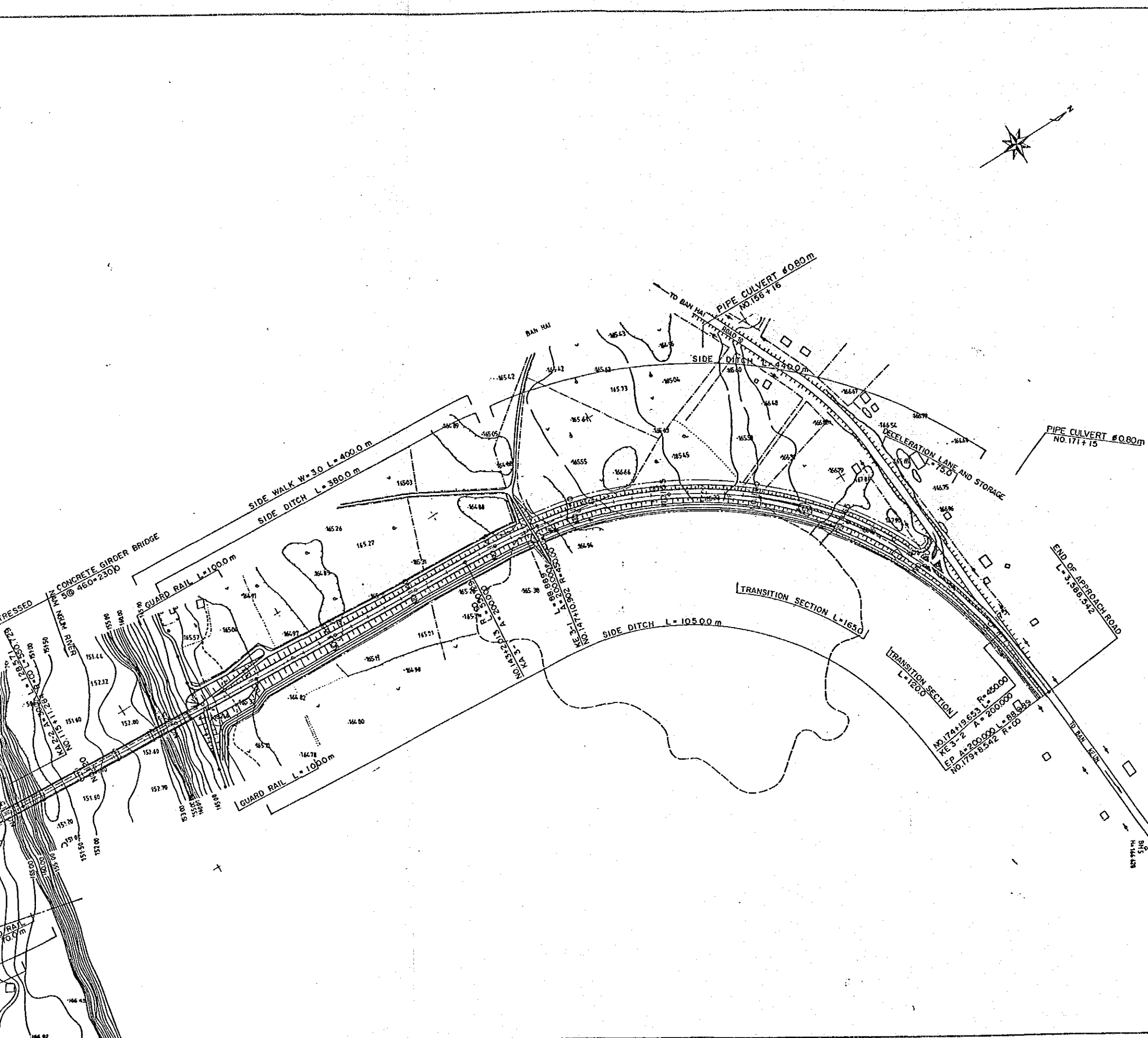
SCALE 1:100

DATE FEBRUARY, 1991 DRAWING NO. LTB-2

JAPAN INTERNATIONAL COOPERATION AGENCY







Note:

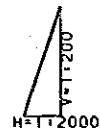
— shows the limit of right of way

LEGEND

- CEMETARY
- TRVERSE POINT
- BENCH MARK
- SPOT LEVEL
- INTERSECTION POINT
- CENTER PEG
  
- HOUSE
- SHED
- ROAD
- FOOT PATH
- FENCE
- CENTER LINE
- 5m
- 1m
- 0.5m
- CONTOUR LINE
- VEGETATION AREA
- TRUCK FARM
- ORCHARD
- GRASS LAND
- FOREST
- CLUMBLING EARTH CLIFE
- DEPRESSION
- ELECTRIC POLE

SCALE 1:2000

THA NGAN BRIDGE CONSTRUCTION PROJECT	
PLAN	
SCALE 1:2,000	
DATE FEBRUARY, 1991	DRAWING NO. LTR-1
JAPAN INTERNATIONAL COOPERATION AGENCY	



DI = 140.00

STATION	HORIZONTAL ALIGNMENT	SUPER ELEVATION	DISTANCE	CUMULATIVE DISTANCE	GROUND LEVEL	ROAD LEVEL	HEIGHT OF CUT	HEIGHT OF FILL	GRADIENT
NO. 0	10.0+0.00		0.00	0.00	170.5	170.5	0.00	0.00	
NO. 1			20.00	20.00	170.4	170.5	0.00	0.00	
NO. 2			20.00	40.00	170.4	170.5	0.00	0.00	
NO. 3			20.00	60.00	170.4	170.5	0.00	0.00	
NO. 4			20.00	80.00	170.4	170.5	0.00	0.00	
NO. 5			20.00	100.00	170.3	170.5	0.00	0.00	
NO. 6			20.00	120.00	170.2	170.5	0.00	0.00	
NO. 7			20.00	140.00	170.2	170.5	0.00	0.00	
NO. 8			20.00	160.00	170.1	170.5	0.00	0.00	
NO. 9			20.00	180.00	169.9	170.5	0.00	0.00	
NO. 10			20.00	200.00	169.9	170.5	0.00	0.00	
NO. 11			20.00	220.00	169.1	170.5	0.00	0.00	
NO. 12			15.00	235.00	169.1	170.5	0.00	0.00	
NO. 13			20.00	255.00	169.0	170.5	0.00	0.00	
NO. 14			20.00	275.00	168.8	170.5	0.00	0.00	
NO. 15			20.00	295.00	169.1	170.5	0.00	0.00	
NO. 16			20.00	315.00	169.0	170.5	0.00	0.00	
NO. 17			20.00	335.00	169.2	170.5	0.00	0.00	
NO. 18			20.00	355.00	169.3	170.5	0.00	0.00	
NO. 19			20.00	375.00	169.1	170.5	0.00	0.00	
NO. 20			20.00	395.00	169.9	170.6	0.00	0.00	
NO. 21			20.00	415.00	170.0	170.6	0.00	0.00	
NO. 22			20.00	435.00	170.0	170.8	0.00	0.00	
NO. 23			10.00	445.00	170.1	170.8	0.00	0.00	
NO. 24			20.00	465.00	170.2	170.9	0.00	0.00	
NO. 25			20.00	485.00	170.5	171.1	0.00	0.00	
NO. 26			20.00	505.00	170.7	171.3	0.00	0.00	
NO. 27			20.00	525.00	171.0	171.6	0.00	0.00	
NO. 28			20.00	545.00	171.2	171.9	0.00	0.00	
NO. 29			20.00	565.00	171.6	172.2	0.00	0.00	
NO. 30			20.00	585.00	171.7	172.5	0.00	0.00	
NO. 31			20.00	605.00	171.2	172.8	0.00	0.00	
NO. 32			20.00	625.00	172.2	173.1	0.00	0.00	
NO. 33			20.00	645.00	172.5	173.4	0.00	0.00	
NO. 34			20.00	665.00	172.7	173.8	0.00	0.00	
NO. 35			20.00	685.00	172.6	174.1	0.00	0.00	
NO. 36			20.00	705.00	172.8	174.4	0.00	0.00	
NO. 37			20.00	725.00	172.5	174.7	0.00	0.00	
NO. 38			20.00	745.00	172.7	175.0	0.00	0.00	
NO. 39			20.00	765.00	173.6	175.3	0.00	0.00	
NO. 40			20.00	785.00	173.6	175.7	0.00	0.00	
NO. 41			20.00	805.00	173.5	176.0	0.00	0.00	
NO. 42			20.00	825.00	173.7	176.3	0.00	0.00	
NO. 43			20.00	845.00	174.1	176.6	0.00	0.00	
NO. 44			20.00	865.00	174.2	176.9	0.00	0.00	
NO. 45			20.00	885.00	174.2	177.2	0.00	0.00	
NO. 46			16.48	901.48	175.7	177.5	0.00	0.00	
NO. 47			3.52	905.00	176.0	177.8	0.00	0.00	
NO. 48			20.00	925.00	176.0	177.9	0.00	0.00	
NO. 49			20.00	945.00	176.6	178.2	0.00	0.00	
NO. 50			20.00	965.00	177.5	178.5	0.00	0.00	
NO. 51			20.00	985.00	178.6	178.8	0.00	0.00	
NO. 52			20.00	1005.00	178.5	179.1	0.00	0.00	
NO. 53			20.00	1025.00	179.5	179.4	0.00	0.00	
NO. 54			20.00	1045.00	180.0	179.8	0.00	0.00	
NO. 55			20.00	1065.00	180.5	180.1	0.00	0.00	
NO. 56			20.00	1085.00	181.2	180.4	0.00	0.00	
NO. 57			20.00	1105.00	181.7	180.7	0.00	0.00	
NO. 58			20.00	1125.00	182.0	181.0	0.00	0.00	
NO. 59			20.00	1145.00	183.0	181.3	0.00	0.00	
NO. 60			18.52	1163.52	183.0	181.4	0.00	0.00	
NO. 61			1.48	1165.00	183.2	181.6	0.00	0.00	
NO. 62			20.00	1185.00	183.6	182.0	0.00	0.00	
NO. 63			20.00	1205.00	183.6	182.3	0.00	0.00	
NO. 64			20.00	1225.00	183.7	182.6	0.00	0.00	
NO. 65			20.00	1245.00	183.6	182.9	0.00	0.00	

BEGINNING OF APPROACH ROAD

ROAD NO 10  
NO. 0+0.00

CONCRETE PIPE # 0.80m  
NO. 16+00

PIPE CULVERT # 0.80m  
NO. 22+18

PIPE CULVERT # 0.80m  
NO. 38+10

Y=0.000  
Y=0.004  
Y=0.10  
Y=0.19  
Y=0.32  
Y=0.39  
Y=0.32  
Y=0.19  
Y=0.10  
Y=0.04  
Y=0.00  
Y=0.000

CI=200  
CR=13000

I=0.00%  
L=0.000

I=70.50%  
L=0.000

I=1.58%  
L=1090.000

L=691.483  
R=900

L=225.000  
R=463

L=300  
R=129.059

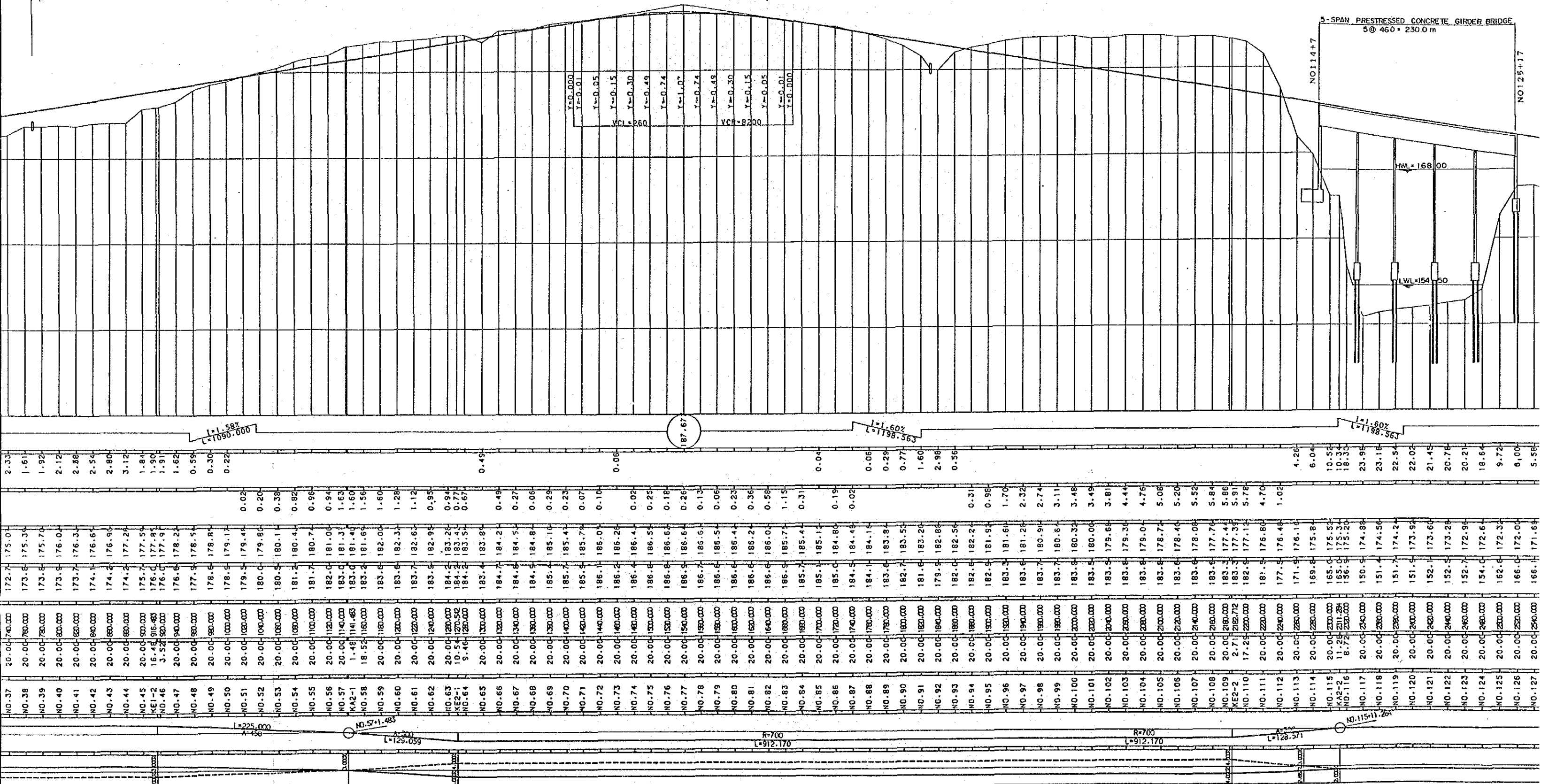
PIPE CULVERT  $\phi$  0.80 m  
NO. 38+10

EXISTING ROAD TO THA NGUY FARM  
NO. 82+00

PIPE CULVERT  $\phi$  0.80 m  
NO. 91+10

NAM NGUM RIVER

5-SPAN PRESTRESSED CONCRETE GIRDER BRIDGE  
5 @ 46.0 = 230.0 m



$i=1.58\%$   
 $L=1090.000$

187.67

$i=1.60\%$   
 $L=1198.563$

$i=1.60\%$   
 $L=1198.563$

$L=225.000$   
 $R=450$

NO. 57+1.483  
 $L=128.059$

$R=700$   
 $L=912.170$

$R=700$   
 $L=912.170$

NO. 115+11.284  
 $L=128.571$

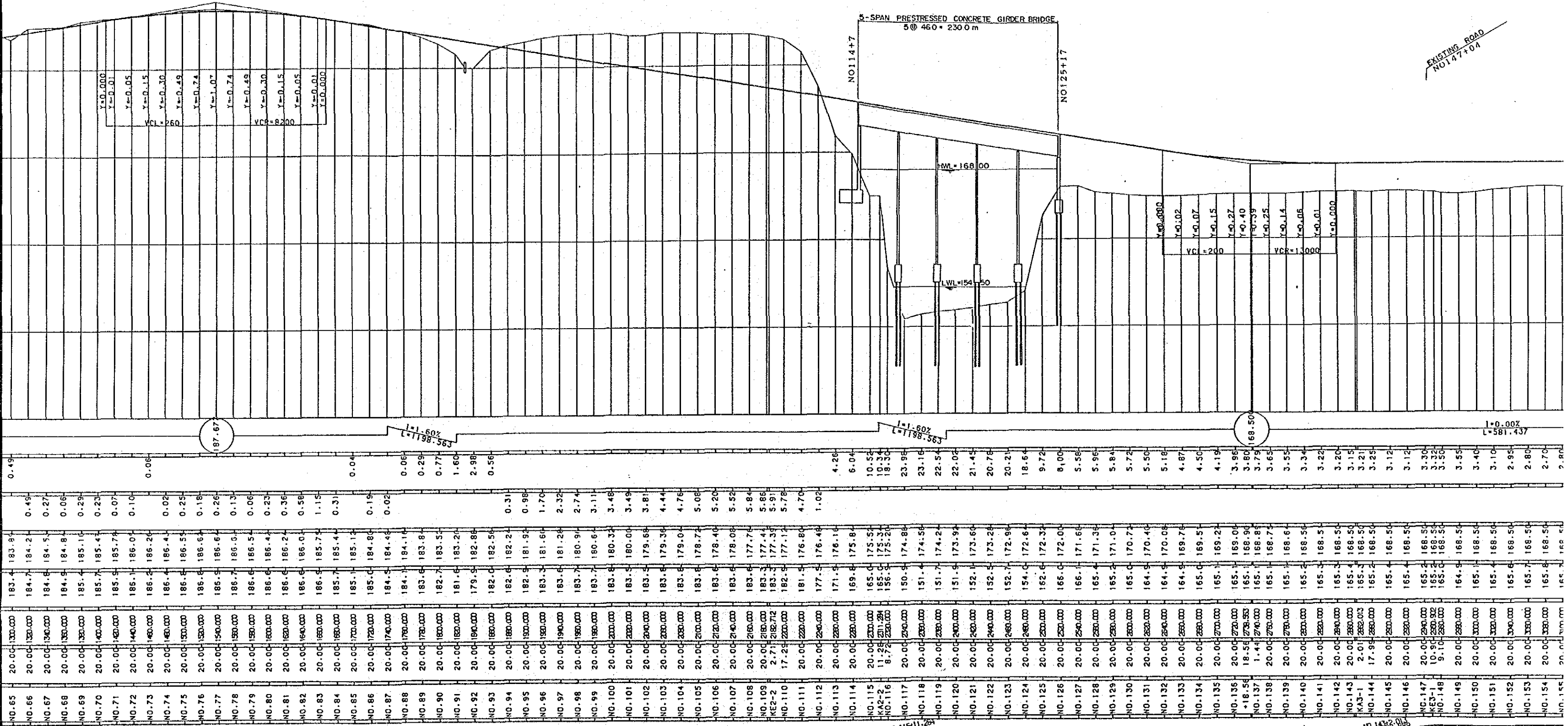
EXISTING ROAD TO THA MOU FARM  
NO. 82 + 00

PIPE CULVERT  $\phi$  0.80 m  
NO. 91 + 10

NAM NGUM RIVER

EXISTING ROAD  
NO. 147 + 04

5-SPAN PRESTRESSED CONCRETE GIRDER BRIDGE  
5 @ 46.0 = 230.0 m



$y = 0.000$
$y = -0.01$
$y = -0.05$
$y = -0.15$
$y = -0.30$
$y = -0.49$
$y = -0.74$
$y = -1.07$
$y = -0.74$
$y = -0.49$
$y = -0.30$
$y = -0.15$
$y = -0.05$
$y = -0.01$
$y = 0.000$

VCI = 260

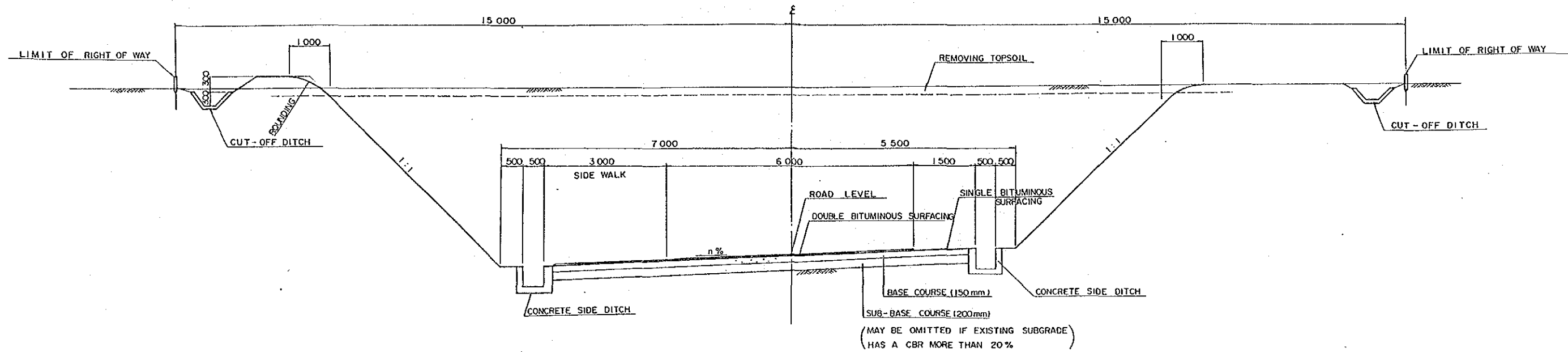
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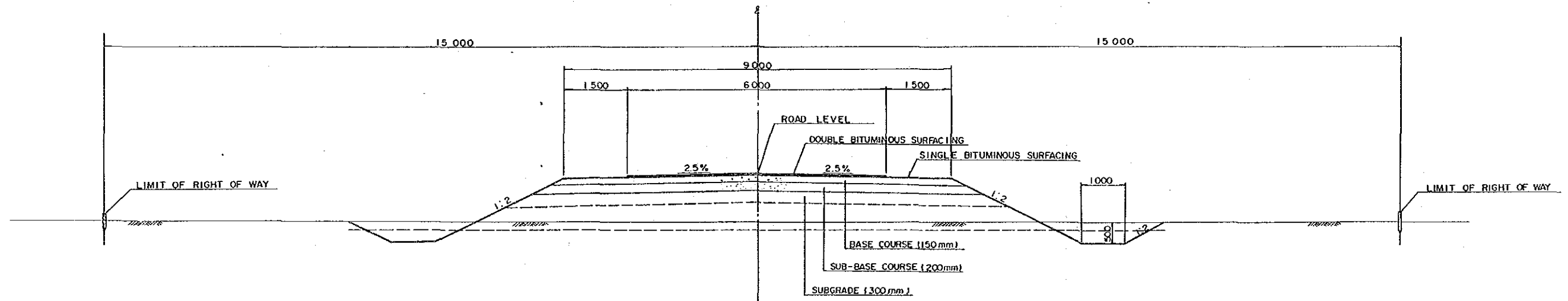




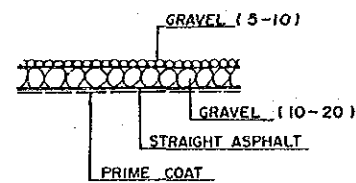
SECTION 93+00-112+00



SECTION 0+00-80+00

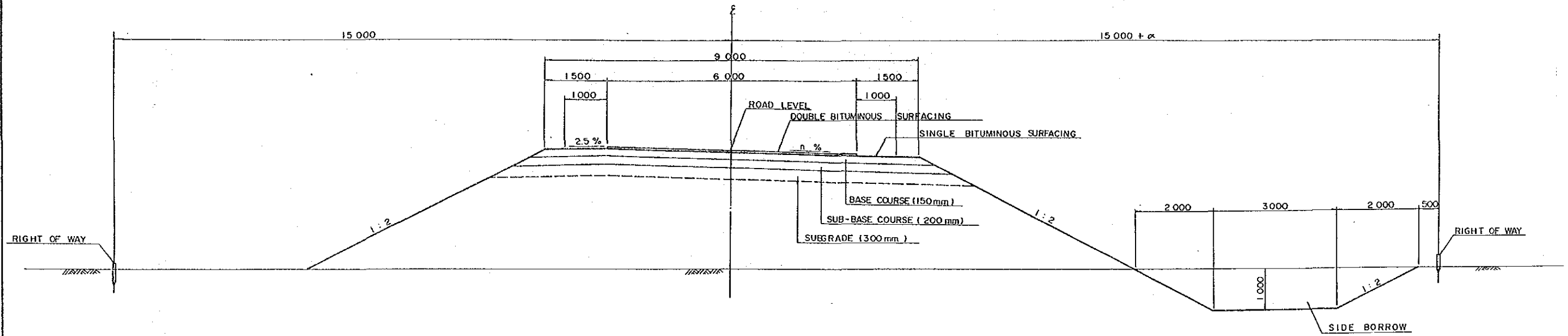


DOUBLE BITUMINOUS SURFACING

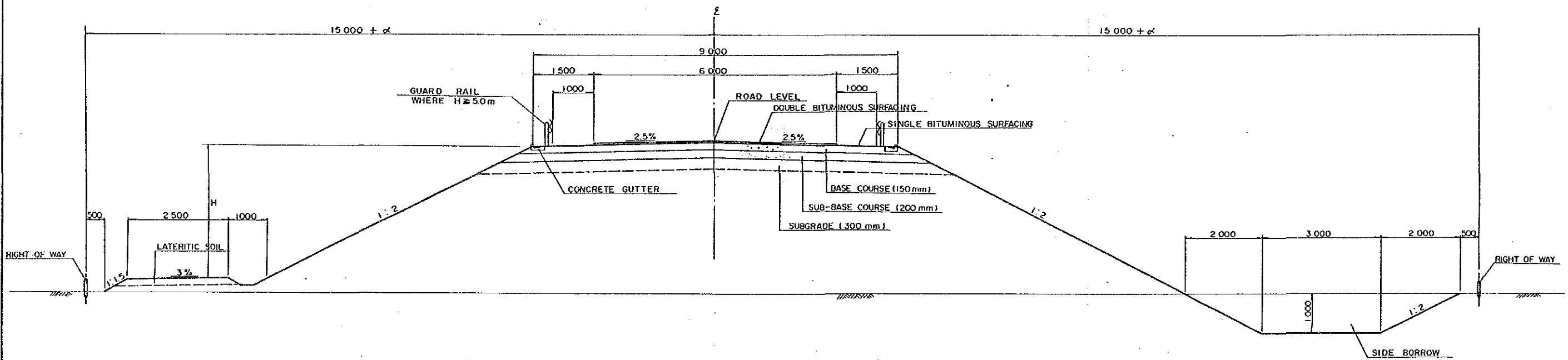


THA NGON BRIDGE CONSTRUCTION PROJECT	
TYPICAL CROSS SECTION (1/2)	
SCALE 1:50	
DATE FEBRUARY, 1991	DRAWING NO. LTR-3
JAPAN INTERNATIONAL COOPERATION AGENCY	

SECTION 148+00-169+00



SECTION 127+00-146+00



THA NGON BRIDGE CONSTRUCTION PROJECT	
TYPICAL CROSS SECTION (2/2)	
SCALE 1:50	
DATE FEBRUARY, 1991	DRAWING NO. LTR-4
JAPAN INTERNATIONAL COOPERATION AGENCY	



JICA