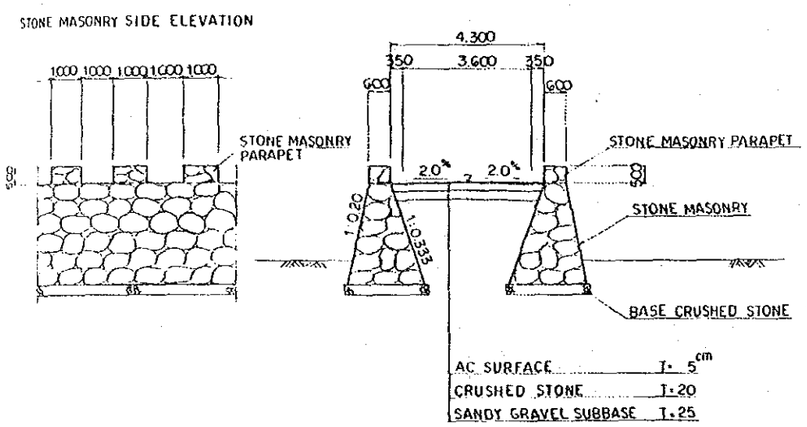
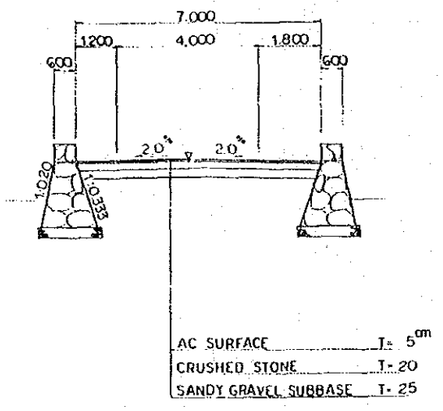
TYPICAL CROSS SECTION

S = 1:100

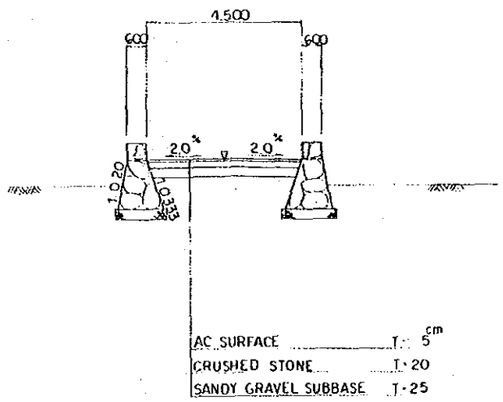
A-A SECTION



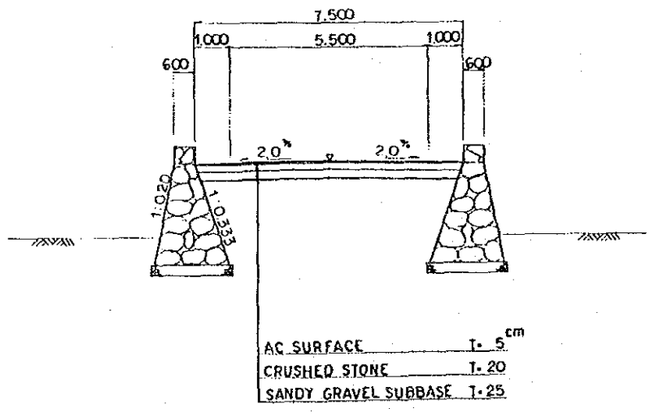
C-C SECTION



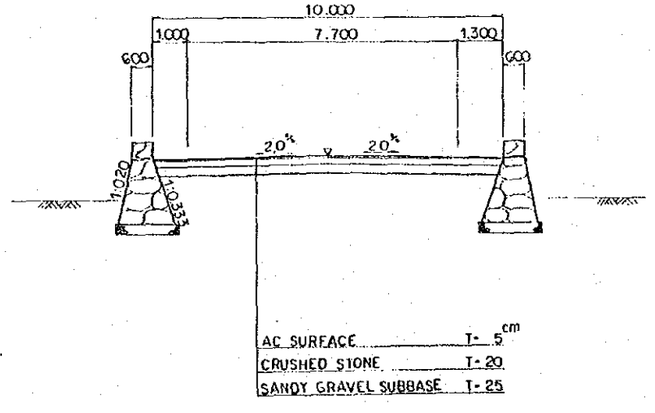
E-E SECTION



B-B SECTION



D-D SECTION



F-F SECTION

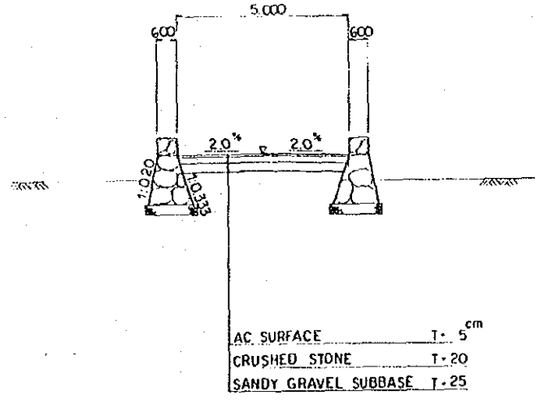


Fig. 5.16 New Jangsa Bridge — Access Road

5.3 Implementation Plan

5.3.1 Work Situation

(1) Work Circumstances

Basic considerations affecting the construction work are as below:

1) As manpower is insufficient, it is planned to use construction equipment as much as possible.

2) The equipment is proposed to be procured in Japan, since such equipment is not available in Bhutan and the equipment will contribute to other construction work after the project completion.

3) The amount of equipment owned by the Government of Bhutan is limited and it is relatively difficult to find equipment operators. The supply of operators is to be the responsibility of the Government of Bhutan.

4) Land acquisition, removal of obstacles to the work, supply of electricity and water, construction of access roads, land development, offer of borrow areas, tax exemption and customs procedures, equipment insurance, legal matters, and such are to be handled by the Government of Bhutan.

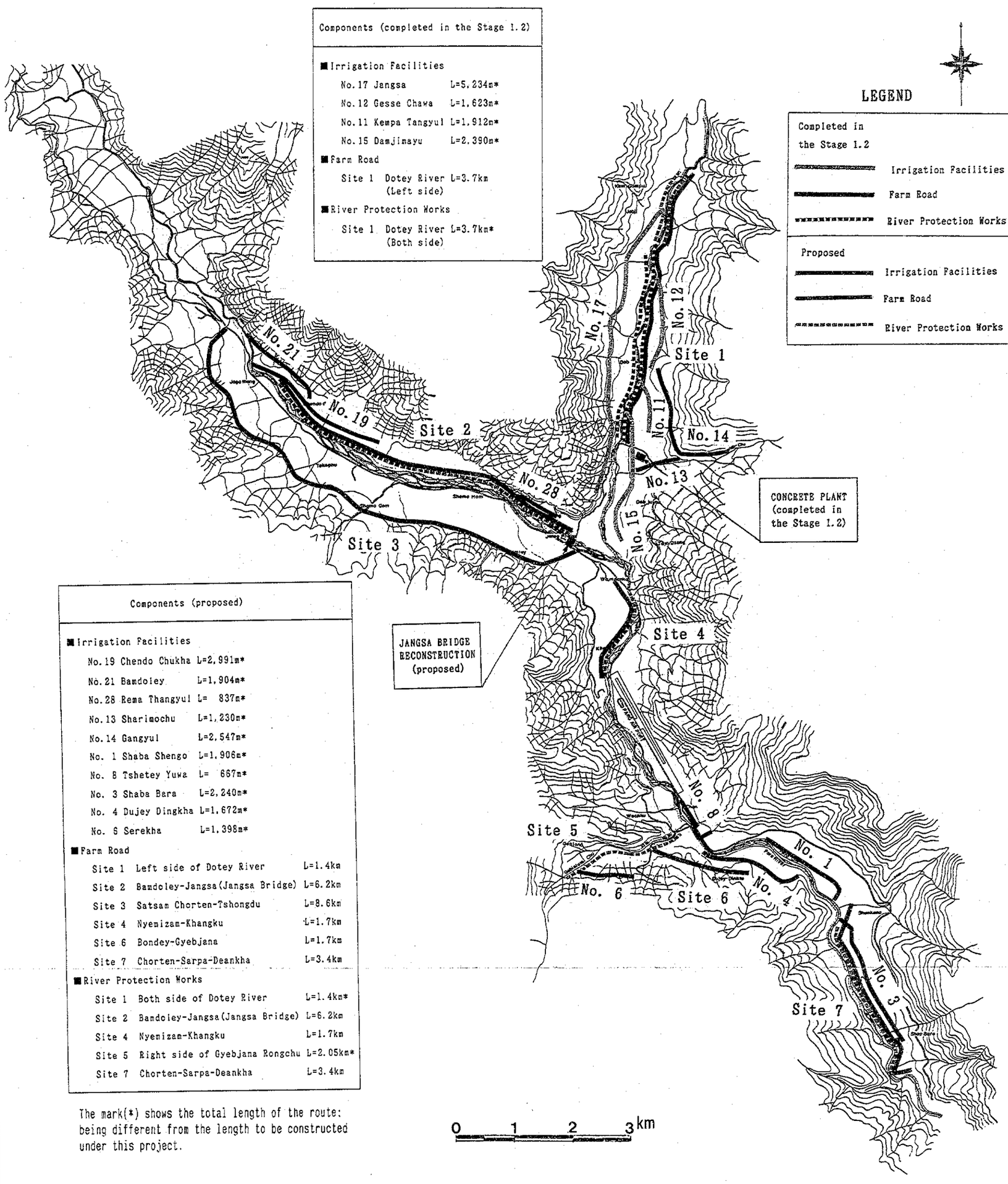
5) Japanese engineers, who will be specially dispatched, are a mechanical engineer to check and control the existing plants at the time they resume operation, and a bridge engineer for the construction of the bridge superstructure, which are both in Stage 1.3.

6) The executing agency of the Government of Bhutan is the Department of Agriculture, the Ministry of Agriculture, with the on-site agency being the Paro Valley Agricultural Development Project Office for the entire project. As for the bridge construction, the Department of Road staff is to work together the Project Office, giving technical assistance.

(2) Construction Time

The whole project is divided into 2 stages: Stage 1 involves sites upstream on the Paro and Dotey Rivers, and Stage 2 downstream sites. Stage 1 is further divided into 3 substages, and Stage 2 into 2 substages. As described in Chapter 2, Stages 1.1 and 1.2 have already been completed. The remaining work and recently requested additional work are scheduled to be implemented so that the annual disbursement for the project is almost uniform. The following points were considered:

PARO VALLEY AGRICULTURAL DEVELOPMENT PROJECT



Components (proposed)

■Irrigation Facilities

No.19	Chendo Chukha	L=2,991m*
No.21	Bamdoley	L=1,904m*
No.28	Rema Thangyul	L= 837m*
No.13	Sharimochu	L=1,230m*
No.14	Gangyul	L=2,547m*
No. 1	Shaba Shengo	L=1,906m*
No. 8	Tshetey Yuwa	L= 667m*
No. 3	Shaba Bara	L=2,240m*
No. 4	Dujey Dingkha	L=1,672m*
No. 6	Serekha	L=1,398m*

■Farm Road

Site 1	Left side of Dotey River	L=1.4km
Site 2	Bamdoley-Jangsa(Jangsa Bridge)	L=6.2km
Site 3	Satsam Chorten-Tshongdu	L=8.6km
Site 4	Nyemizam-Khangku	L=1.7km
Site 6	Bondey-Gyebjana	L=1.7km
Site 7	Chorten-Sarpa-Deankha	L=3.4km

■River Protection Works

Site 1	Both side of Dotey River	L=1.4km*
Site 2	Bamdoley-Jangsa(Jangsa Bridge)	L=6.2km
Site 4	Nyemizam-Khangku	L=1.7km
Site 5	Right side of Gyebjana Rongchu	L=2.05km*
Site 7	Chorten-Sarpa-Deankha	L=3.4km

The mark(*) shows the total length of the route: being different from the length to be constructed under this project.

Fig. 5.17 Work Schedule

1) Prior to the construction of the Bamdoley Channel and the Chendo-Chukha Channel, the Bamdoley-Jangsa Road will have to be built for the purpose of accessing the channels; and prior to the Shaba-Bara Channel work, the Chorten-Sarpa-Deankha Road will be constructed. Otherwise, the construction of the channels will be difficult.

2) In order to reduce construction costs, work safely, and decrease effects upon the public roads, works adjacent to each other are to be done during the same stage.

The work schedule, divided by stages, is shown in Fig. 5.17.

5.3.2 Further Work Considerations

(1) Work Concerns

The private contractor system has not yet developed to a large extent in Bhutan, and the amount of construction equipment owned by the few contractors is quite limited. Most of them have only concrete mixers and the like. The labor force is insufficient because the employment of foreigners is restricted by law. In particular, there is a lack of skilled technicians. Most of them work for AMC or other government organizations. Accordingly, some skilled technicians will be dispatched from Japan. The transportation of some construction materials, particularly, long materials (10 m at the maximum) and heavy ones (20 ton at the maximum), will be relatively difficult due to road conditions. In the rainy season, the conditions will be especially bad.

(2) Incidental Considerations

Other considerations to be taken are as follows:

- Conforming to conventional customs, stones taken from a river have to be used for work at that point in the river, in principle.
- It should be noted that when concrete work is done during the winter, temperature differs by area, even within Paro, by as much as 3 degrees centigrade.
- During the course of banking work, the most suitable density method should be used, because the banking materials will become too dry in the dry season, and too wet in the rainy season.
- As transportation conditions are inappropriate, materials, the quality of which is changeable, should be carefully stored.

- The excavation depth of the bridge pier work will be around 5 m. The soil is composed of loose boulders and sand. Therefore, care should be taken regarding collapse of the excavated slope.

5.3.3 Construction Supervision

The detail design will be commenced just after the conclusion of the Exchange of notes (E/N). A detailed topographical survey should be carried out for the detail design. Upon completion of the detail design, a tender for the construction work will be made. Considering that the Japanese fiscal year begins in April and the rainy season in Paro continues until September, only about 5 months will be available for the preparatory work, including the survey and the detail design. Therefore, the on-site staff should be increased in order to finish within this time frame. The construction supervision is scheduled as shown in Table 5.17.

Table 5.17 Construction Supervision Schedule

Stage	Work	Supervisor	Assignment Period
1.3	- Management	Project manager	(1+0.5) months
	- Bridge (Substructure)	Civil engineer	Full time
	- " (Superstructure)	Steel engineer	1 month
	- Farm roads	Road engineer	Full time
	- Equipment procurement (1)		
2.1	- Management	Project manager	(0.5+0.5) month
	- Irrigation facilities	Irrigation eng'r	Full time (during the dry season)
	- Farm roads and river protection	Civil engineer	Full time
	- Equipment procurement(2)	Equipment eng'r	1 month
2.2	- Management	Project manager	(0.5+0.5) month
	- Irrigation facilities	Irrigation eng'r	Full time (during the dry season)
	- Farm road and river protection	Civil engineer	Full time

5.3.4 Equipment Procurement Plan

(1) Construction Equipment

Construction equipment will be procured in Stages 1.3 and 2.1. The procurement will be done in Japan, as it is almost same as that done in Stage 1.1.

(2) Construction Materials

Construction materials available in Bhutan are as follows:

1) Bhutanese-made Materials

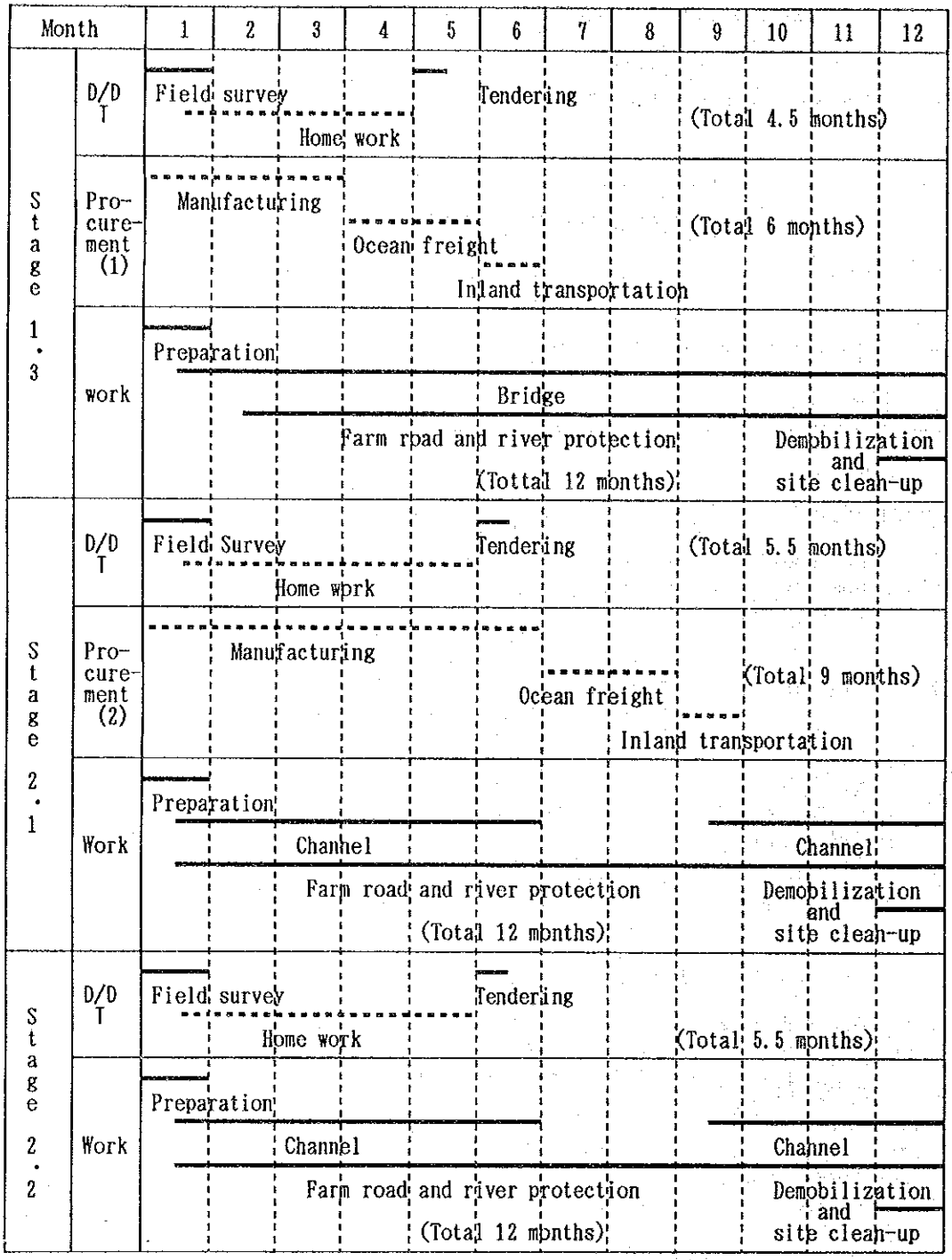
- Portland cement : 50 kg bag
- Aluminum cement : 50 kg bag
- Reinforced concrete pipe : Inner diameters of 225, 300, 450, 600, 750, 900, 1050, and 1200 mm
- Polyethylene pipe : Outer diameters of 20, 25, 32, 40, 50, 63, 75,90, 110, 140, 160, and 225 mm
- Timber
- Stone
- Wire for fences
- U-shaped concrete block (U-300 & U-500): Product of Stage 1.1 plants
- L-shaped concrete block (L-600x300) : "
- Ready-mixed concrete : "
- Crushed stone and sand : "

2) Indian-made Materials

- Wire for gabions : Diameters of 3.2 mm and 4.0 mm
- Deformed steel bar : Diameters of 8, 10, 12, 16, 20, 22, and 25 mm
- Steel plate, galvanized steel plate and galvanized wire
- Construction sheet
- Shuttering material
- Light oil, gasoline, light oil, engine oil and grease
- Electrical materials
- Tires, etc.

5.3.5 Implementation Schedule

The implementation schedule, after the signing of the consultant agreement, is given in Fig. 5.18.



D/D : Detailed Design T : Tendering

Fig. 5.18 Implementation Schedule

5.4 Equipment Plan

5.4.1 Planning Policy

(1) Construction Equipment

Some of the construction equipment to be procured in the coming stages is of the same type as that in Stage 1.1; the same manufacturers are recommended.

Equipment should be selected taking into account the remaining work volume and the life span of the equipment procured for the last stages. After completion of the project, the equipment should be able to be used effectively for agricultural development in Paro.

As described in the preceding section, the equipment change requested in the Phase III study will be considered. On the other hand, consideration should also be given regarding the exclusion of farmland consolidation work and the addition of bridge construction work.

(2) Plants

Judging by a plant's hours in operation, it is considered adequate to supply spare parts for those which have deteriorated.

When the work sites are far from the existing plants, transportation costs rise, since road construction requires a lot of crushed stones. The concrete volume used is less than that of crushed stones. As the existing crushing plant is somewhat movable, its movement to a site near the road construction work is one possibility. As a result of a comparative study, it was found that the construction cost of a new plant (7 million Yen) is cheaper than that of the movement of the existing plant (25 million Yen). This is due to the fact that there are no engineers qualified to do the movement work in Bhutan and they would have to come from Japan. Therefore, the construction of a new plant is proposed.

5.4.2 Factors for Consideration

(1) Construction Equipment

The Paro Valley Agricultural Development Project Office (PVAD) managed the construction equipment during the Stage 1.2 work. In addition, the equipment was rented to farmers for small-scale farm work and environmental improvement work, and to the Dzongkhag for road repair work. To determine the type and amount of equipment necessary, the above circumstances will be considered. Spare parts will be supplied in the coming stages. The rental cost should include costs for maintenance and repair in order to ensure that almost the same maintenance as that during Stage 1.2 can be expected. Furthermore, the actual operation hours recorded in Table 5.18 are also to be considered. Going by the rate of deterioration of the equipment used in Stage 1.2, the life span of the equipment will be about 70-80 % of that of equipment in Japan.

Table 5.18 Actual Operation Hours of Equipment

Equipment	Operation Hours (As of April 1992)
Major construction equipment	
- Bulldozer (21 ton)	1,100 hrs
- " (15 ton)	930-1,240 hrs
- Backhoe (0.6 m^3)	990-1,160 hrs
- " (0.2 m^3)	1,140 hrs
- Dozer shovel (3 ton)	1,150 hrs
Other construction equipment	
- Backhoe (0.25 m^3)	330-490 hrs
- Wheel loader (0.34 m^3)	770 hrs
- Vibration roller	600 hrs
Major transportation equipment	
- Dump truck (11 ton)	10,000-12,000 hrs
Other transportation equipment	
- Truck mixer (2.2 m^3)	5,000-6,000 hrs
- Self loader	"
- Truck with crane	"

(2) Plant

During the course of Stage 1.2, the plants were maintained by a Japanese contractor, since there was a lack of Bhutanese operators.

Although technology transfers will gradually make progress in the future, operating conditions like those in Stage 1.2 will continue until the end of the project. At the end of Stage 1.2, the total hours in operation of the plants were as below.

Crushing plant : 750 hrs
Bathching plant : 350 hrs
Concrete plant : 320 hrs

From the above, the crushing plant probably has deteriorated considerably, since local stones contain a large amount of mica, although its hours in operation were not as long as those of the construction equipment.

5.4.3 Basic Plan

(1) Construction Equipment

1) Items and Quantity

The types and quantities of the required construction equipment are described below.

Equipment	Number of Units	
	Supplied already	To be supplied
a) Bulldozer (21 ton)	1	1
b) Bulldozer (15 ton)	4	1
c) Motor grader	-	1
d) Backhoe (0.6 m^3)	3	2
e) Backhoe (0.2 m^3)	1	1
f) Dump truck (11 ton)	6	5
g) Mixer truck (2.2 m^3)	2	2
h) Vibrating roller	1	1
i) Wheel loader	1	1
j) Pick-up truck (4 WD)	2	1
k) High pressure washer	-	1
l) Crushing plant	1	1
m) Concrete test machine	-	1

2) Spare Parts

In general, when the operating hours of equipment reach a certain level, the number of problems rapidly increases, resulting in the need for overhaul work. The overhaul times for major pieces of equipment are projected in Table 5.16. As shown in the table, comparatively complicated parts which are expensive will reach the time of overhaul after 3-5 years of operation. The exchange of such parts requires much time. If they are exchanged in the form of an assembled unit, time can be saved. In order to extend the life spans of the equipment, supplied and to be supplied, the supply of assembled units, such as engines, transmissions, and steering and hydraulic systems, is proposed. Repair tools will also be supplied. In addition, it is proposed that the Government of Bhutan train technicians and prepare workshops.

3) Time of Procurement

The next stage is the construction of the Jangsa Bridge and the Bamdoley-Jangsa Farm Road (excluding the subsurface work). Mixer trucks (2.2 m^3) and a wheel loader (2.2 m^3) are necessary in addition to previously procured equipment. In order to make the annual disbursements of the project uniform, the above two items will be procured in Stage 1.3; and the remaining in Stage 2.1.

Table 5.19 Overhaul Time Period

Equipment	Time span for overhaul (Hours)	Time for overhaul (Approximate years in use)
Bulldozer		
- Engine	6,000 hours	5 years
- Transmission	6,000	5
- Steering	6,000	5
- Hydraulic system	6,000	5
- Truck frame	1,500	1.5
Backhoe (PC-200)		
- Engine	6,000	5
- Hydraulic system	6,000	5
- Bucket	1,500	1.5
- Truck frame	3,500	3
Backhoe (PC-60)		
- Engine	4,000	4
- Hydraulic system	4,000	4
- Bucket	1,500	1.5
- Truck frame	3,000	3
Backhoe (PC-05)		
- Engine	3,000	5
- Hydraulic system	4,000	5
- Bucket	1,500	2.5
- Truck frame	3,000	2.5
Dozer shovel (D-21S-6)		
- Engine	3,000	3
- Transmission	3,000	3
- Steering	3,000	3
- Hydraulic system	3,000	3
- Truck frame	1,500	1.5
Wheel loader (WA70-1)		
- Engine	3,000	3.5
- Transmission	3,000	3.5
- Final drive	3,000	3.5
- Hydraulic system	3,000	3.5
- Bucket	3,000	3.5
- Tire	3,000	3.5
Vibrating roller (JV-100WA)		
- Engine	5,000	5
- Transmission	3,000-5,000	3-5
- Truck frame	3,000-5,000	3-5

Chapter 6. EFFECTS OF THE PROJECT AND CONCLUSION

6.1 Effects of the Project

The effects that can be expected through the implementation of this project are directly increase of farmers' income because of increase of agricultural products, increase of self-sufficiency in food, improvement of local living environment, promotion of farmers' production activities; and indirectly promotion of socio-economic activities of the local people, as described below.

(1) Irrigation Facilities

Present Situation and Problems	Agricultural land area - Paddy field : 1,561 ha - Cultivated land : 1,790 ha - Horticultural land : 143 ha - Orchard : 360 ha For the above, only paddy fields are irrigated with river water through earth channels. However, their intake facilities are not secured and water transmission is not effective; resulting in low productivity of rice.
Countermeasure in the Project	14 irrigation channels, or 28.6 km in total length will be improved, including improvement of intake facilities. The command area is estimated at about 450 ha.
Effects of the Project	Productivity in paddy will increase to more than 5.0 ton/ha in the future from present productivity of 4.3 ton/ha. It will be 15 % increase in rice production: resulting in increase of 900 ton. Further, irrigation water will be able to be taken even in the dry season, and production increase of wheat and potatoes can be expected as the second crops. Its increase will be 2,800 ton in potatoes and cash crop.

(2) Farm Roads

Present Situation and Problems	There are 51 km of farm roads in Paro; however, motor roads are few in the farm roads. Therefore, transportation of agricultural materials and agricultural products is not easy and agricultural productivity remains low. Further, daily life of farmers is not convenient.

Countermeasure in the Project	6 farm roads, or 26.7 km in total distance, will be constructed. Beneficiaries will be 500 farm houses and farm land to be benefited will be 850 ha.
Effects of the Project	Increase in paddy production, above mentioned, is based on the construction of the farm roads by which agricultural materials such as fertilizer are transported. This means that farm roads contribute to the agricultural production increase. Following the construction of the farm roads, orchard is expected to be expanded by 140 ha, resulting in increase of 3,400 ton apples.

(3) River Protection

Present Situation and Problems	Most rivers in the project area have not been protected with river banks, except places of rivers located along the National Highway and along the Paro Airport; hence, farm lands located along rivers have been gradually eroded during the rainy seasons.
Countermeasure in the Project	5 sites of rivers, or 18.5 km in total distance will be protected with river protection work.
Effects on the Project	About 100 ha of farm lands will be protected from disaster.

(4) Reconstruction of the Jangsa Bridge

Present Situation and Problems	Due to flood occurred in 1991, 2 piers of the Jangsa Bridge were washed away, and a steel-truss girder was installed as the emergency countermeasure. This temporary bridge restricts heavy vehicles being more than 10 ton; that does not facilitate transportation of agricultural products. This bridge is the key infrastructure of transportation in the area, and passage by 20 ton vehicles is required from a viewpoint of the construction work involved in the project.
Countermeasure in the Project	Reconstruction of the Jangsa Bridge. - Length of the bridge :100.0 m - Number of spans : 5 spans - Superstructure :H-shaped steel girder - Width of the bridge : Carriageway 5.5 m and : walkway 1.0m x both sides

Effects of the Project	Socio-economic activities in the area will be recovered, since this bridge is the key facility of transportation in the area. Further, this bridge will facilitate safe and proper implementation of the project.

6.2 Conclusion

The Paro Valley is an advanced agricultural region in Bhutan. But it lags behind in infrastructure consolidation.

Irrigation channels proposed for repair in the project were planned in order to make proper water management possible, and an increase in land productivity is expected. Concrete and the U-shaped and L-shaped flumes to be used in the project are to be produced in the project area. Thus, it is hoped that the local farmers participate in the project, constructing irrigation facilities, and even after the project the Bhutanese will be able to implement the same kind of projects in other areas on their own.

As noted in the previous section, this project should result in an increase in paddy and cash crop production. The expected increases are as follows:

- Paddy : 900 ton
- Potatoes : 2,800 ton
- Apples : 3,400 ton

The increase in production of these three products combined is equivalent to about 260 million Yen considering into this year's farm gate prices, or 140,000 Yen per household. In proportion to the increase in farmers' income, agricultural mechanization will be promoted and agricultural productivity improved, as well as the improvement in farmers' living standards. Further, the project will greatly contribute to the progress of the National Development Plan, as a model of a self-sufficient area.

The reconstruction of the Jangsa Bridge shows that the construction work of the project can unquestionably be done. The bridge is a key part of the transportation infrastructure in the area and facilitating

the rapid shipment of agricultural products and the construction of new farm roads.

From the effects outlined above, it is deemed appropriate to implement this project utilizing Japanese grant aid.

Agricultural mechanization is believed to be promoted by construction of farm roads, but, the local residents still regard the use of livestock highly, the farmers in this area intend through future agricultural mechanization to maintain their present mixed system of agriculture and livestock raising without significantly reducing the number of animals.

APPENDICES

Appendix 1. Field Survey Team Member List

(1) Motonobu **NISHIMURA** ..... Team Leader,
Official, Grant Aid Division,
Economic Cooperation Bureau,
Ministry of Foreign Affairs

(2) Ken'ichi **SHISHIDO** ..... Project Coordinator,
Staff of First Basic Design Study Division,
Grant Aid Study & Design Department,
JICA

(3) Takao **YODA**..... Agricultural Infrastructure Designer,
Chief of Second Design Section,
Iiyama Construction Office,
Ministry of Agriculture, Forestries & Fisheries

(4) Kaoru **HOSHII** ..... Agricultural Development Planner,
Deputy General Manager,
Irrigation, Drainage and
Land Reclamation Department,
Hokkaido Engineering Consultants Co., Ltd.

(5) Fujiya **FUJII**..... Bridge Designer,
Chief Engineer of Bridge Department,
Hokkaido Engineering Consultants Co., Ltd.

(6) Hideki **YAMAZAKI** ..... Construction Planner,
Chief Engineer of Overseas Department,
Hokkaido Engineering Consultants Co., Ltd.

(7) Shogo **SHIBATA** ..... Surveyor,
Senior Engineer of Overseas Department,
Hokkaido Engineering Consultants Co., Ltd.

Appendix 2. Record of Field Survey Team's Activities

Date (1992)	Activities
7 Apr.(Tue) -	Leave Tokyo (Arrival at Delhi : Nishimura, Shishido, Yoda, and Hoshii)
	" (Arrival at Bangkok : Fujii, Yamazaki, and Shibata)
8 Apr.(Wed) -	Visit Embassy of Japan/Delhi and JICA India Office/Delhi (Nishimura, Shishido, Yoda and Hoshii)
-	Arrival at Paro (Fujii, Yamazaki and Shibata)
9 Apr.(Thr) -	Visit Paro Valley Project Office and site inspection (Fujii, Yamazaki and Shibata)
-	Arrival at Paro (Nishimura, Shishido, Yoda, and Hoshii)
10 Apr.(Fri) -	Trip from Paro to Thimphu by vehicle
-	Visit : Ministry of Agriculture Department of Agriculture Planning Commission Department of Road Ministry of Finance Ministry of Foreign Affairs
11 Apr.(Sat) -	Trip from Thimphu to Paro by vehicle
-	Site inspection survey (Existing facilities)
12 Apr.(Sun) -	Team's internal meeting Site inspection
13 Apr.(Mon) -	Trip from Paro to Thimphu (Nishimura, Shishido, Yoda, Hoshii, and Yamazaki)
-	Discussions with Ministry of Agriculture together withagencies concerned
-	Jangsa Bridge site survey (Fujii and Shibata)
14 Apr.(Tue) -	Discussions with Ministry of Agriculture
-	Drafting of Minutes of Discussions Test operation of bridge site testing equipment
15 Apr.(Wed) -	Signing of Minutes of Discussions
-	Trip from Thimphu to Paro
-	Test operation of loading test equipment
-	Traffic survey around Jangsa Bridge
16 Apr.(Thr) -	Trip from Paro to Delhi by air (Nishimura, Shishido, and Yoda : Visit Embassy of Japan/Delhi and JICA India Office/Delhi; Leaving for Japan)
(The following was carried out by the Consultants members)	
-	Meeting with Paro Valley Project Office
-	Confirmation of new Jangsa Bridge alignment and topographical survey on the alignment
17 Apr.(Fri) -	Topographical survey on Jangsa bridge and Paro River
-	Survey on operation record of construction machinery
18 Apr.(Sat) -	Traffic volume survey around Jangsa Bridge
-	Loading test for new Jangsa Bridge piers
-	Survey on operation record of concrete plant
19 Apr.(Sun) -	Traffic volume survey around Jangsa Bridge

..... Continued .....

Date (1992)	Activities
20 Apr.(Mon)	- Technical meeting on new Jangsa Bridge
	- Preparation of soil test pit
	- Site survey on irrigation channels
21 Apr.(Tue)	- Test pit survey for new Jangsa Bridge
	- Site survey on irrigation channels
22 Apr.(Wed)	- Test pit survey for Shari River intake
	- Site survey on irrigation channels
23 Apr.(Thr)	- Quarry site / borrow area survey
	- Site survey for river protection work
24 Apr.(Fri)	- Team's internal meeting
	- Site survey for river protection work
25 Apr.(Sat)	- Site survey on the extension of Dotey farm road
	- Site survey on farm roads
26 Apr.(Sun)	- Topographical survey on the extension of Dotey farm road
27 Apr.(Mon)	- Foreign aid projects survey
	- Data collection
	- Survey on bridges/road in Paro
28 Apr.(Tue)	- Borrow area sites survey
	- Site survey on farm roads
29 Apr.(Wed)	- Quarry site survey
	- Data collection
30 Apr.(Thr)	- Trip from Paro to Thimphu
	- Visit and presentation of Field Report to Ministry of Agriculture, Department of Road and agencies concerned
	- Data collection
1 May (Fri)	- Trip from Thimphu to Paro
	- Supplementary data collection
2 May (Sat)	(Bhutanese National Holiday)
3 May (Sun)	- Preparation for departure
4 May (Mon)	- Trip from Paro to Delhi by air
5 May (Tue)	- Cement material survey
	- Leaving Delhi for Japan (Fujii and Shibata)
6 May (Wed)	- Visit Embassy of Japan/Delhi and JICA India Office/Delhi (Hoshii and Yamazaki); thereafter departure for Japan
7 May (Thr)	- Arrival at Tokyo

Appendix 3. List of Participants

Ministry of Agriculture
- Dasho Leki Dorji (Deputy Minister)
- Mr. Kinley Dorji (Deputy Secretary, PPD)

Ministry of Finance
- Dasho Yeshey Zimba (Joint Secretary)

Ministry of Foreign Affairs
- Mr. D.K. Chettri (Joint Secretary, BMD)

Department of Works and Housing
- Mr. Lhendup Dorji (Director)

Department of Agriculture
- Mr. D.S. Rai (Officiating Director)
- Mr. Kelzang Tshering (Officiating Superintending Engineer, I)

Department of Road
- Mr. Rinchen Dorji (Officiating Secretary)
- Mr. Phuntsho Wangdi (Superintending Engineer, MTC)
- Mr. R.W. Hole (United Nations' Volunteer)
- Mr. R.G. Krishnan (United Nations' Volunteer)
- Mr. P.K. Sharma (Assistant Engineer)

Planning Commission
- Dasho Pema Wangdi (Director)
- Mr. Kunzang Norbu (Programme Officer)

Paro Valley Agricultural Development Project
- Mr. Kunzang Namgyal (Project Manager)
- Mr. Mani Kumar Chettri (Irrigation Engineer, Deputy Project Manager)
- Mr. Jigme Rinchen (Equipment Engineer)

Paro Dzongkhag
- Dasho Jigme Tshultim (Governor)

Japan Overseas Cooperation Volunteers (JOCV/JICA) Office in Bhutan
- Mr. Tomoaki Tsugawa (Coordinator)

Embassy of Japan (in Delhi)
- Mr. Hajime Matsuo (First Secretary)

JICA India Office (in Delhi)
- Mr. Toshio Hida (Resident Representative)

Appendix 4. Minutes of Discussion

MINUTES OF DISCUSSION
ON THE BASIC DESIGN STUDY (PHASE III)
ON THE PARO VALLEY AGRICULTURAL DEVELOPMENT PROJECT
IN THE KINGDOM OF BHUTAN

In response to the request of the Royal Government of Bhutan, the Government of Japan decided to conduct a Basic Design Study on the Paro Valley Agricultural Development Project in the Kingdom of Bhutan (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bhutan a study team, headed by Mr. Motonobu Nishimura, official, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs from April 9 to May 4, 1992.

The team held discussions with the officials concerned of the Royal Government of Bhutan and conducted a field survey in the Project area.

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

Thimphu, April 15, 1992

Mr. Motonobu Nishimura
Team Leader,
Basic Design Study Team
JICA

Dasho Leki Dorji
Deputy Minister,
Ministry of Agriculture,
The Royal Government of Bhutan

Witness :

Mr. D.K. Chettri
Joint Secretary (BMD),
Ministry of
Foreign Affairs,
The Royal Government
of Bhutan

Dasho Pema Wangdi
Director,
Planning Commission,
The Royal Government
of Bhutan

Mr. Rinchen Dorji
Officiating Secretary(DOR),
Ministry of Communications,
The Royal Government
of Bhutan

ATTACHMENT

1. The Objective of the Project

The objective of the Project is to contribute to increasing farmers' income and to upgrading living standard of farmers in the Project area through improvement of agricultural and social infrastructures such as roads, bridge, irrigation channels and river banks.

2. The Project Area

The project area is located in Paro Valley.

3. Implementing Organization

1) The Department of Agriculture (DOA), Ministry of Agriculture is to be the executing agency of the Project.
2) On behalf of the executing agency, the Department of Road (DOR), Ministry of Communications is responsible for all technical matters relating to the bridge construction.

4. Components of the Project

1) The components of the request made by the Royal Government of Bhutan are listed in ANNEX I.
2) Procurement plan of construction equipment will be made in accordance with the operation and maintenance plan and the future agricultural development plan.
3) The components of the basic design will be finalized based on further studies.

5. Operation and Maintenance Plan

The Royal Government of Bhutan has explained the operation and maintenance plan after completion of the Project as described in ANNEX II.

6. Utilization of Construction Equipment

1) The construction equipment purchased under the Japan's Grant Aid must be kept in the Project area and well maintained until the completion of the Project.
2) The Royal Government of Bhutan has explained the future agricultural development projects to the team and promised to submit

the concrete scheme to the Team by the end of April 1992. The Team has stressed that above-mentioned equipment should be utilized exclusively for those projects.

7. Grant Aid Program Explained by the Team

1) The Royal Government of Bhutan has understood the system of Japanese Grant Aid Program explained by the Team.
2) The Royal Government of Bhutan will take the 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.

8. Schedule of the Study

1) The Consultants will proceed to further studies in Bhutan until May 4, 1992.
2) JICA will prepare the draft report on the Project in English and dispatch a mission to Bhutan in order to explain the contents of the report in/ around August, 1992.
3) In the case that the contents of the report accepted in principal by the Royal Government of Bhutan, JICA will compile the final report on the Project and send it to the Royal Government of Bhutan in/ around October, 1992.

9. Technical Cooperation

The Royal Government of Bhutan has requested technical cooperation related to the Project in the field of maintenance of construction equipment and concrete plant procured. The Team has understood the necessity generally and explained that an official request should be made.

10. List of Attendance

Attendances are listed in ANNEX IV.

ANNEX I. Components Requested by the Royal Government of Bhutan

(1) Agricultural Facilities

a. Irrigation Channels
- Channel No.21 (Bamdoley)
- " No.19 (Chendo Chukha)
- " No.28 (Rema Thangyul)
- " No.13 (Sharimochu)
- " No.14 (Gangyul)
- " No. 1 (Shaba Shengo)
- " No. 8 (Tshetey)
- " No. 3 (Shaba Bara)
- " No. 5 (Dujey Dingkha)
- " No. 6 (Serekha)

b. Farm Roads
- Site 2 (Bamdoley-Jangsa, Left side of Paro River)
- " 3 (Satsam Chorten-Tshongdu)
- " 4 (Nyemizam-Khangku)
- " 6 (Bondey-Gyebjana)
- " 7 (Chorten-Sarpa-Deankha)
- " 1 (Dotey farm road extension to upstream around 1.4 km)(*)

c. River Protection Work
- Site 2 (Bamdoley-Jangsa, Left side of Paro River)
- " 4 (Nyemizam-Khangku)
- " 5 (Right side of Gyebjana Rongchu)
- " 7 (Chorten-Sarpa-Deankha)

d. Procurement of Construction Equipment
- Bulldozer
- Backhoe
- Dumptruck
- Vibro-roller
- Motor grader (*)
- Mixer truck (*)
- Wheel loader (*)
- Pick-up (*)
- High pressure washer (*)

(Note 1): The component of "Farmland consolidation" was excluded from the Project, as a result of the discussion.

(Note 2): Items with the mark of (*) are newly requested by the Royal Government of Bhutan.

(2) Bridge (Reconstruction of the Jangsa Bridge)

a. Reconstruction work composed of substructure (abutments and piers) and superstructure (beams and slabs).
b. Accessory Works
- Protection work of bank for abutments and piers
- Realignment of irrigation channel

(Note): Location of the bridge is around 15 m upstream of the existing Jangsa Bridge.

ANNEX II. Operation and Maintenance Plan

Component	Operation	Maintenance	Responsible Organization	Supervising Organization
1) Irrigation channels	Farmers' Organization / WUA	Farmers' Organization for ordinary maintenance, and Dzongkhag Administration for major repair work	Dzongkhag Administration	DOA/ MOA
2) Farm roads	Dzongkhag	Dzongkhag	Dzongkhag Administration	Dzongkhag
3) River banks	-	Dzongkhag	Dzongkhag Administration	DWH/ MSS
4) Bridge	Dzongkhag	Dzongkhag	Dzongkhag Administration	DOR/ MOC

(Note)
WUA : Water Users Association
DOA : Department of Agriculture
MOA : Ministry of Agriculture
DWH : Department of Works and Housing
MSS : Ministry of Social Services
DOR : Department of Road
MOC : Ministry of Communications

ANNEX III : Necessary Measures to be Taken
by the Royal Government of Bhutan

1. To provide data and information necessary for implementation of the Project.

2. To secure the land for the Project and to clear the site as needed before commencement of construction, including demolition and resettlement of house/s located at the bridge renewal site.

3. To ensure prompt unloading, tax exemption, customs clearance of the goods for the Project at the port of disembarkation in Bhutan and prompt internal transportation therein of the products purchased under the Grant Aid.

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

5. To accord Japanese nationals whose services may be required in connection with the Project under the verified contracts such facilities as may be necessary for their entry into Bhutan and stay therein for the duration of their work period.

6. To provide necessary permissions, licenses and other authorization for carrying out the Project.

7. To bear two kinds of commissions to the Japanese foreign exchange bank for the banking services based on the Banking Arrangement as follows:
   (1) Advising commission to the Authorization to Pay
   (2) Payment commission

8. To bear all the expenses, other than those to be borne by the Grant Aid.

9. To ensure the necessary budget and personnel for the proper and effective implementation of the Project, including operation and maintenance of the equipment procured under the Grant Aid.

ANNEX IV

LIST OF ATTENDANCE

ROYAL GOVERNMENT OF BHUTAN

1. Dasho Leki Dorji, Dy. Minister, Ministry of Agriculture
2. Dasho Yeshey Zimba, Joint Secretary, Ministry of Finance
3. Dasho Pema Wangdi, Director, Planning Commission
4. Mr. D. K. Chhetri, Joint Secretary, BMD, Ministry of Foreign Affairs,
5. Mr. Lhendup Dorji, Director, Department of Works and Housing
6. Mr. Kinley Dorji, Dy. Secretary (PPD), Ministry of Agriculture
7. Mr. Kinzang Namgyel, Project Manager, Paro Valley Dev. Project
8. Mr. Rinchen Dorjee, Oftg. Secretary, Dept. of Roads
9. Mr. D. B. Rai, Oftg. Director General, Department of Agriculture
10. Mr. Kelzang Tshering, Oftg. Superintending Engineer (I), Department of Agriculture

GOVERNMENT OF JAPAN

1. Motonobu NISHIMURA, Team Leader, Official, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs
2. Ken'ichi SHISHIDO, Project Coordinator, Staff of First Basic Design Study Division, Grant Aid Study and Design Department, JICA
3. Takao HOSHII, Agricultural Infrastructure Designer, Chief of Second Design Section, Ilyama Construction Office, Ministry of Agriculture, Forestries and Fisheries
4. Kaoro HOSHII, Agricultural Development Planner, Deputy General Manager, Irrigation, Drainage and Land Reclamation Department, Hokkaido Engineering Consultants Co. Ltd.
5. Hideki YAMAZAKI, Construction Planner, Chief Engineer of Overseas Department, Hokkaido Engineering Consultants Co. Ltd.

Appendix 5. Present Land Circumstances in the Upstream Region of the Dotey River

(1)

No.	Farmer's Name	Wet Land Area (Acres)	Wet Land Area (ha)	Dry Land Area (Acres)	Dry Land Area (ha)	Apple Trees (Nos.)
1	Kuandu	4.00	1.62	4.00	1.62	50
2	Serab Dorji	10.00	4.05	1.00	0.40	74
3	Deki Salma	-	-	-	-	20
4	Jamo	1.00	0.40	1.00	0.40	-
5	Rinzin Daimo	-	-	2.00	0.81	140
6	Pemo	-	-	-	-	-
7	Wangjee	1.00	0.40	-	-	130
8	Laymo	9.00	3.64	8.00	3.24	20
9	Tenzin	2.00	0.81	9.00	3.64	-
10	Phub Dorji	4.00	1.62	3.00	1.21	197
11	Thiuley Zangmo	5.00	2.02	7.00	2.83	50
12	Gumbu	-	-	1.00	0.40	10
13	Gumbu	3.00	1.21	2.00	0.81	80
14	Chimi Wangmo	3.00	1.21	3.00	1.21	13
15	Rinzin Wangmo	3.00	1.21	1.00	0.40	30
16	Tshring Penjor	6.00	2.43	3.00	1.21	150
17	Chencho	3.00	1.21	2.00	0.81	40
18	Kinley Tenzin	-	-	3.00	1.21	20
19	Thujie Wangmo	-	-	5.00	2.02	80
20	Chireho Wangmo	-	-	3.00	1.21	40
21	Nichip Wangmo	-	-	2.00	0.81	-
22	Dorji Gyehrsun	-	-	-	-	30
23	Wangmo	-	-	1.00	0.40	-
24	Gambu Tswring	3.00	1.21	1.00	0.40	23
25	Namgaymo	-	-	5.00	2.02	-
26	Gambu Dorji	-	-	2.00	0.81	60
27	Lam Rinzin	6.00	2.43	8.00	3.24	20
28	Ugyen Dalmo	5.00	2.02	4.00	1.62	80
29	Shepdo	2.00	0.81	2.00	0.81	10
30	Pemo Wangmo	2.00	0.81	4.00	1.62	150
31	Jeemo	2.00	0.81	22.00	8.90	35
32	Tandin Budir	4.00	1.62	2.00	0.81	70
33	Karma Dorji	7.00	2.83	9.00	3.64	90
34	Gom Chem	4.00	1.62	3.00	1.21	10
35	AD Dorji	6.00	2.43	7.00	2.83	90
36	Zomba	1.00	0.40	2.00	0.81	5
37	Wangdi	5.00	2.02	5.00	2.02	60
38	Loy lang	-	-	5.00	2.02	53
39	Sangay Penjir	4.00	1.62	3.00	1.21	90
40	Chencho Dorji	9.00	3.64	7.00	2.83	140

No.	Farmer's Name	Wet Land Area (Acres)	(ha)	Dry Land Area (Acres)	(ha)	Apple Trees (Nos.)
41	Tandin Dorji	-	-	2.00	0.81	60
42	Bay bay	6.00	2.43	7.00	2.83	80
43	Chencho Wangmo	3.00	1.21	4.00	1.62	90
44	Rinzin Wangmo	4.00	1.62	3.00	1.21	10
45	Dorji	-	-	2.00	0.81	90
46	Chencho Dorji	5.00	2.02	3.00	1.21	200
47	Pema Gyeltshen	2.00	0.81	1.00	0.40	60
48	Dorji	-	-	1.00	0.40	60
49	Chencho Pem	1.00	0.40	1.00	0.40	40
50	Tandin Dorji	1.00	0.40	1.00	0.40	30
51	Bey bey	6.00	2.43	9.00	3.64	100
52	Rinchen Zam	1.00	0.40	1.00	0.40	2
53	Gyalzim	2.00	0.81	1.00	0.40	-
54	Shera Dorji	1.00	0.40	-	-	-
55	Sangay Denjor	2.00	0.81	5.00	2.02	150
56	Dezang	1.00	0.40	5.00	2.02	500
57	Wangoli	2.00	0.81	1.00	0.40	50
58	Clgen Dem	2.00	0.81	-	-	-
59	Dorji	1.00	0.40	5.00	2.02	-
60	Wangyel	-	-	5.00	2.02	500
61	Kaka	-	-	2.00	0.81	100
62	Karma Dorji	1.00	0.40	2.00	0.81	100
63	Sangay Dorji	8.00	3.24	6.00	2.43	30
64	Gempo Lham	2.00	0.81	3.00	1.21	-
65	Dukda	3.00	1.21	8.00	3.24	150
66	Lam Rinzin	2.00	0.81	1.00	0.40	100
67	Phup Dorji	-	-	3.00	1.21	100
68	Sangay Wangmo	-	-	6.00	2.43	-
69	Pascung	1.00	0.40	5.00	2.02	-
70	Thinley Zangmo	1.00	0.40	3.00	1.21	-
71	Tashi Dorji	-	-	3.00	1.21	-
72	Khandu	-	-	3.00	1.21	-
	T O T A L	172.00	69.61	254.00	102.79	4,762

Appendix 6. Irrigation Water Requirements

Paddy is the main crop in the project area. The amount of water for irrigation will be calculated in terms of the amount of water used in growing paddy. This is because paddy is grown in nearly all areas of the Paro Valley with irrigation facilities, and also because more water is needed to grow paddy than to grow other crops. The water requirements are evaluated below:

$$GWR = ETc + PL + Ps$$
$$NWR = (GWR - RE)/IE$$

wherein,
- GWR : Gross water requirement
- ETc : Evapotranspiration of crop ; ETc = Kc x ETc
- PL : Seepage loss ; for small scale irrigation 3 mm/day
- Ps : Amount of puddling water
- NWR : Net water requirement
- IE : Irrigation efficiency
- Kc : Crop efficient
- ETo : Evapotranspiration estimated by Blaney-Criddle method

The average length of daylight time by latitude, the average sunshine hours, estimated evapotranspiration, crop coefficient, and effective precipitation are calculated based on the FAO IRRIGATION AND DRAINAGE PAPER NO.24.

(1) Estimated Evapotranspiration (ETo)

The estimated evapotranspiration is calculated under the following conditions and according to the Blaney Criddle method:

- Latitude of Paro Dzongkhags : North 27°30'
- Average temperature : Taking past records of rainfall into consideration

The results are shown on the next page.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
T mean(C)	7.0	8.0	10.3	13.4	15.8	20.0	20.6	20.6	18.8	13.3	11.4	6.7
p (**1)	0.24	0.26	0.27	0.29	0.30	0.31	0.31	0.29	0.28	0.26	0.25	0.24
p(0.46T+8)	2.7	3.0	3.4	4.1	4.6	5.3	5.4	5.1	4.7	3.7	3.3	2.7
RH (min)	med	med	med	high	high	high	high	high	high	high	high	med
	43.5	40.0	43.5	50.5	52.5	64.0	70.0	74.5	72.5	65.5	58.5	43.0
n/N (**2)	med	low	low	low	low	low	low	low	low	low	med	low
	0.61	0.52	0.50	0.38	0.39	0.30	0.20	0.29	0.34	0.51	0.60	0.50
U daytime	"	U daytime" is assumed approximately 3.5 m/sec.										
ET0	2.0	2.0	2.5	2.3	2.8	3.5	3.6	3.2	2.9	1.8	2.0	1.5

(**1) : Mean daily percentage(p) of annual daytime hours
(**2) : n ; Sunshine hours per day ; Bhutan average
N ; Mean daily duration of maximum possible sunshine hours for different month and latitude

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
n	6.5	5.8	6.0	4.9	5.3	4.2	2.7	3.8	4.2	5.9	6.5
N	10.6	11.2	12.0	12.8	13.5	13.9	13.7	13.1	12.4	11.6	10.8
n/N	0.61	0.52	0.50	0.38	0.39	0.30	0.20	0.29	0.34	0.51	0.60

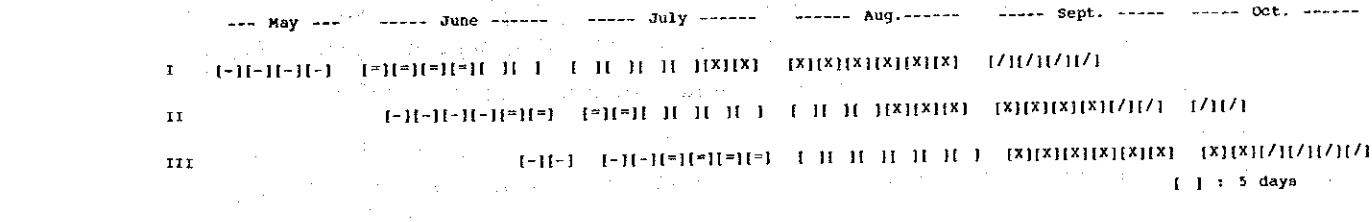
(2) Crop Coefficient

Crop Coefficient is determined for growth stages as follows:

Growth Stage	Term(days)	Kc	Mark
(Nursery)	40		
(Presaturation)	20		[-]
Initial	20	1.1	[=]
Crop development	30	1.1	[ ]
Mid-season	40	1.05	[X]
Late-season	20	0.95	[/]

(3) Cropping Pattern

Paddy cropping is assumed that cultivation activities would shift from upstream to downstream in 3 stages.



(4) Amount of Puddling Water

The amount of puddling water is determined as a function of the void ratio in topsoil.

Soil type	Sand	Sandy loam	Loam	Clay loam	Clay	Peat
Void ratio in %	40	45	50	55	60	65

$$Ps = (t \times p \times 0.8 + df)/d$$

where, Ps : Amount of puddling water

t : Thickness of cultivated soil ; average 25 cm

P : void ratio ; Sandy loam 45%

df : Ponding depth

D : Term for puddling ; 20 days

$$Ps = (0.25 \times 0.45 \times 0.8 + 0.06)/20 = 0.0075 m/day = 7.5 mm/day$$

5) Water Requirement during Puddling Period

Daily water requirement during puddling period is estimated as follows:

$$GWRn = (n/20) \times I + Ps$$

where, n : number of elapsed days

i : Water required to keep ponding depth ; ETo + PL

6) Normal Water Rainfall (RE)

Normal water requirement is estimated as follows:

$$GWRn = Kc \times ETo + PL$$

7) Effective Rainfall (RE)

Effective rainfall is estimated taking past records of rainfall into consideration.

8) Total Irrigation Efficiency (IE)

The total irrigation efficiency is approximately 60%, considering apply efficiency, facility efficiency, and conducting efficiency.

The water requirements estimated according the above conditions are shown on the next page.

Low Land Paddy

Month	Day	ETO mm/day	Step-1 kc-1	Step-1 ETcrop mm/day	Step-1 Presat. mm/day	Step-2 kc-2	Step-2 ETcrop mm/day	Step-2 Presat. mm/day	Step-3 kc-3	Step-3 ETcrop mm/day	Step-3 Presat. mm/day	Effective Rainfall mm/day		Total ton/day	GWR lit./sec	NWR lit./sec
May																
	1	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	2	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	3	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	4	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	5	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	6	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	7	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	8	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	9	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	10	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	11	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	12	2.8		1.16	7.50		0.00			0.00		1.35	7.31	73.10	0.85	1.41
	13	2.8		1.45	7.50		0.00			0.00		1.35	7.60	76.00	0.88	1.47
	14	2.8		1.74	7.50		0.00			0.00		1.35	7.89	78.90	0.91	1.52
	15	2.8		1.16	7.50		0.00			0.00		1.35	7.31	73.10	0.85	1.41
	16	2.8		1.45	7.50		0.00			0.00		1.35	7.60	76.00	0.88	1.47
	17	2.8		1.74	7.50		0.00			0.00		1.35	7.89	78.90	0.91	1.52
	18	2.8		2.03	7.50		0.00			0.00		1.35	8.18	81.80	0.95	1.58
	19	2.8		2.32	7.50		0.00			0.00		1.35	8.47	84.70	0.98	1.63
	20	2.8		2.61	7.50		0.00			0.00		1.35	8.76	87.60	1.01	1.69
	21	2.8		2.90	7.50		0.00			0.00		1.35	9.05	90.50	1.05	1.75
	22	2.8		3.19	7.50		0.00			0.00		1.35	9.34	93.40	1.08	1.80
	23	2.8		3.48	7.50		0.00			0.00		1.35	9.63	96.30	1.11	1.86
	24	2.8		3.77	7.50		0.00			0.00		1.35	9.92	99.20	1.15	1.91
	25	2.8		4.06	7.50		0.00			0.00		1.35	10.21	102.10	1.18	1.97
	26	2.8		4.35	7.50		0.00			0.00		1.35	10.50	105.00	1.22	2.03
	27	2.8		4.64	7.50		0.00			0.00		1.35	10.79	107.90	1.25	2.08
	28	2.8		4.93	7.50		0.00			0.00		1.35	11.08	110.80	1.28	2.14
	29	2.8		5.22	7.50		0.00			0.00		1.35	11.37	113.70	1.32	2.19
	30	2.8		5.51	7.50		0.00			0.00		1.35	11.66	116.60	1.35	2.25
	31	2.8		5.80	7.50		0.00			0.00		1.35	11.95	119.50	1.38	2.31

Low Land Paddy

Month	Day	ETO mm/day	Step-1 kc-1	Step-1 ETcrop mm/day	Step-1 Presat. mm/day	Step-2 kc-2	Step-2 ETcrop mm/day	Step-2 Presat. mm/day	Step-3 kc-3	Step-3 ETcrop mm/day	Step-3 Presat. mm/day	Effective Rainfall mm/day		Total ton/day	GWR lit./sec	NWR lit./sec
June																
	1	3.5	1.10	6.85			0.33	7.50		0.00		2.70	11.98	119.75	1.39	2.31
	2	3.5	1.10	6.85			0.65	7.50		0.00		2.70	12.30	123.00	1.42	2.37
	3	3.5	1.10	6.85			0.98	7.50		0.00		2.70	12.63	126.25	1.46	2.44
	4	3.5	1.10	6.85			1.30	7.50		0.00		2.70	12.95	129.50	1.50	2.50
	5	3.5	1.10	6.85			1.63	7.50		0.00		2.70	13.28	132.75	1.54	2.56
	6	3.5	1.10	6.85			1.95	7.50		0.00		2.70	13.60	136.00	1.57	2.62
	7	3.5	1.10	6.85			2.28	7.50		0.00		2.70	13.93	139.25	1.61	2.69
	8	3.5	1.10	6.85			2.60	7.50		0.00		2.70	14.25	142.50	1.65	2.75
	9	3.5	1.10	6.85			2.93	7.50		0.00		2.70	14.58	145.75	1.69	2.81
	10	3.5	1.10	6.85			3.25	7.50		0.00		2.70	14.90	149.00	1.72	2.87
	11	3.5	1.10	6.85			3.58	7.50		0.00		2.70	15.23	152.25	1.76	2.94
	12	3.5	1.10	6.85			3.90	7.50		0.00		2.70	15.55	155.50	1.80	3.00
	13	3.5	1.10	6.85			4.23	7.50		0.00		2.70	15.88	158.75	1.84	3.06
	14	3.5	1.10	6.85			4.55	7.50		0.00		2.70	16.20	162.00	1.88	3.13
	15	3.5	1.10	6.85			4.88	7.50		0.00		2.70	16.53	165.25	1.91	3.19
	16	3.5	1.10	6.85			5.20	7.50		0.00		2.70	16.85	168.50	1.95	3.25
	17	3.5	1.10	6.85			5.53	7.50		0.00		2.70	17.18	171.75	1.99	3.31
	18	3.5	1.10	6.85			5.85	7.50		0.00		2.70	17.50	175.00	2.03	3.38
	19	3.5	1.10	6.85			6.18	7.50		0.00		2.70	17.83	178.25	2.06	3.44
	20	3.5	1.10	6.85			6.50	7.50		0.00		2.70	18.15	181.50	2.10	3.50
	21	3.5	1.10	6.85		1.10	6.85			0.33	7.50	2.70	18.83	188.25	2.18	3.63
	22	3.5	1.10	6.85		1.10	6.85			0.65	7.50	2.70	19.15	191.50	2.22	3.69
	23	3.5	1.10	6.85		1.10	6.85			0.98	7.50	2.70	19.48	194.75	2.25	3.76
	24	3.5	1.10	6.85		1.10	6.85			1.30	7.50	2.70	19.80	198.00	2.29	3.82
	25	3.5	1.10	6.85		1.10	6.85			1.63	7.50	2.70	20.13	201.25	2.33	3.88
	26	3.5	1.10	6.85		1.10	6.85			1.95	7.50	2.70	20.45	204.50	2.37	3.94
	27	3.5	1.10	6.85		1.10	6.85			2.28	7.50	2.70	20.78	207.75	2.40	4.01
	28	3.5	1.10	6.85		1.10	6.85			2.60	7.50	2.70	21.10	211.00	2.44	4.07
	29	3.5	1.10	6.85		1.10	6.85			2.93	7.50	2.70	21.43	214.25	2.48	4.13
	30	3.5	1.10	6.85		1.10	6.85			3.25	7.50	2.70	21.75	217.50	2.52	4.20

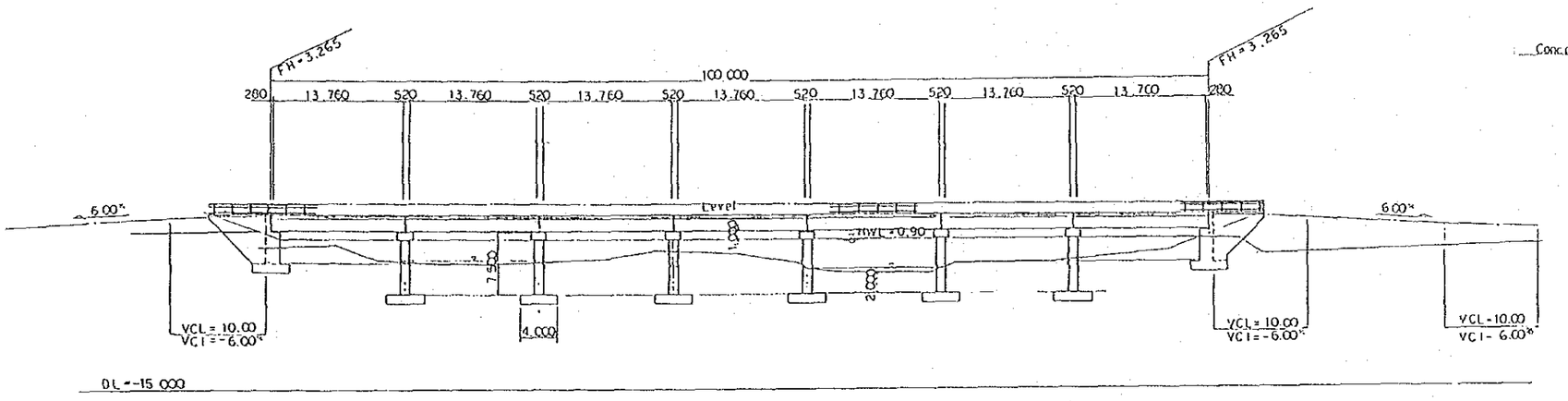
Low Land Paddy

Month	Day	ETO mm/day	Step-1 kc-1	Step-1 ETcrop mm/day	Step-1 Presat. mm/day	Step-2 kc-2	Step-2 ETcrop mm/day	Step-2 Presat. mm/day	Step-3 kc-3	Step-3 ETcrop mm/day	Step-3 Presat. mm/day	Effective Rainfall mm/day		Total ton/day	GWR lit./sec	NWR lit./sec
July																
	1	3.6	1.10	6.96		1.10	6.96			3.63	7.50	3.45	21.60	216.00	2.50	4.17
	2	3.6	1.10	6.96		1.10	6.96			3.96	7.50	3.45	21.93	219.30	2.54	4.23
	3	3.6	1.10	6.96		1.10	6.96			4.29	7.50	3.45	22.26	222.60	2.58	4.29
	4	3.6	1.10	6.96		1.10	6.96			4.62	7.50	3.45	22.59	225.90	2.61	4.36
	5	3.6	1.10	6.96		1.10	6.96			4.95	7.50	3.45	22.92	229.20	2.65	4.42
	6	3.6	1.10	6.96		1.10	6.96			5.28	7.50	3.45	23.25	232.50	2.69	4.48
	7	3.6	1.10	6.96		1.10	6.96			5.61	7.50	3.45	23.58	235.80	2.73	4.55
	8	3.6	1.10	6.96		1.10	6.96			5.94	7.50	3.45	23.91	239.10	2.77	4.61
	9	3.6	1.10	6.96		1.10	6.96			6.27	7.50	3.45	24.24	242.40	2.81	4.68
	10	3.6	1.10	6.96		1.10	6.96			6.60	7.50	3.45	24.57	245.70	2.84	4.73
	11	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	12	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	13	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	14	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	15	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	16	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	17	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	18	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	19	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	20	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	21	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	22	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	23	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	24	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	25	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	26	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	27	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	28	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	29	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	30	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	31	3.6	1.15	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33

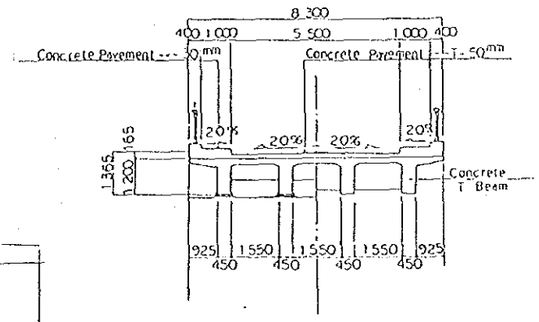
Appendix 7. Bridge Design Alternatives

The four bridge design alternatives are shown in the following drawings.

GENERAL ELEVATION S = 1:300
TYPE-A

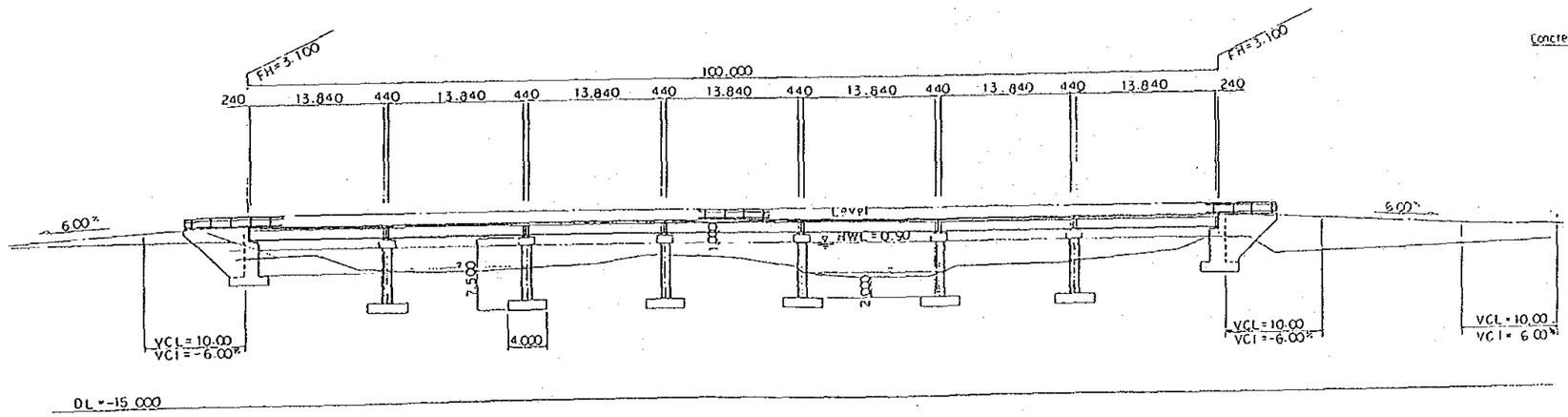


CROSS SECTION S=1:100

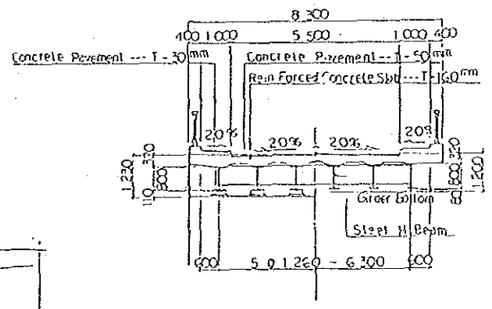


Alternative Type-A
New Jangsa Bridge

GENERAL ELEVATION S = 1:300
TYPE-B

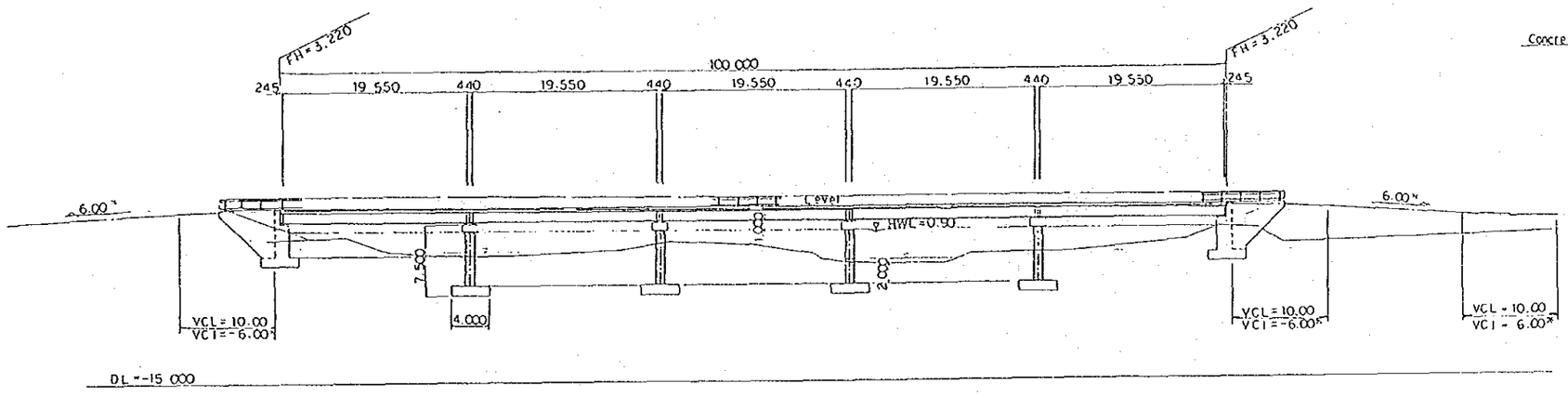


CROSS SECTION S=1:100

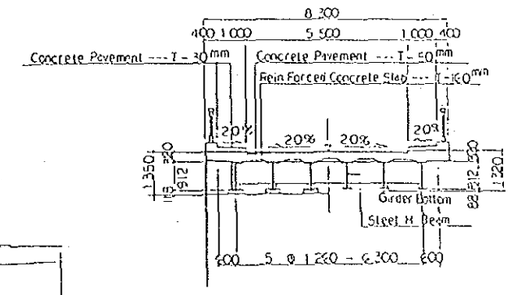


Alternative Type-B
New Jangsa Bridge

GENERAL ELEVATION S = 1:300
TYPE-C

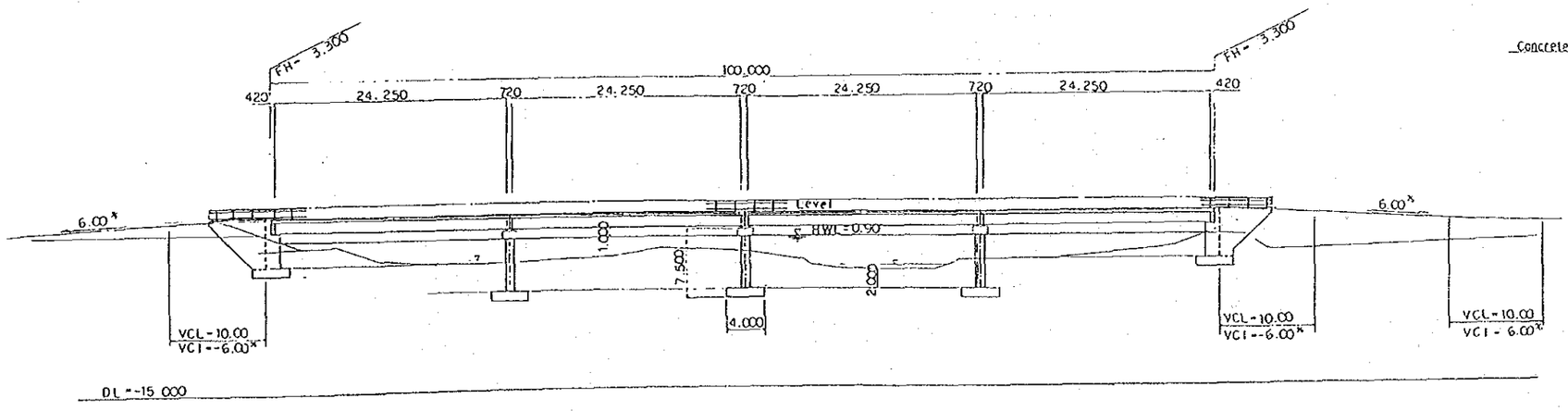


CROSS SECTION S=1:100

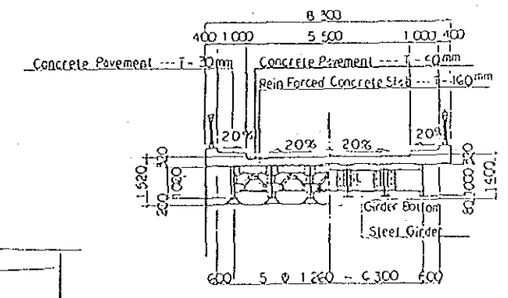


Alternative Type-C
New Jangsa Bridge

GENERAL ELEVATION S = 1:300
TYPE-D



CROSS SECTION S=1:100



Alternative Type-D
New Jangsa Bridge

Appendix 8. The Hours in Operation of Selected Equipment

Equipment	-- Equipment -- Model No	Serial No.	---- Engine ---- Model No.	Serial No.	Hours in Operation as of March 1992
Bulldozer	D83E-1	1109	S6D125-2	45322	1105 hrs
"	D63E-1	1335	6D125-1	45710	928 hrs
"	"	1336	"	44281	1237 hrs
"	"	1337	"		1080 hrs
"	"	1338	"	45711	1146 hrs
Excavator	PC200-5	58223	S6D95L-1	86189	989 hrs
"	"	58224	"	86190	1061 hrs
"	"	58225	"	86191	1046 hrs
"	"	58226	"	86192	1152 hrs
"	PC60-6	34720	4D95L-1	104211	1144 hrs
"	PC05-1	7542	3D72-2B	09264	332 hrs
"	"	7545	"	09178	492 hrs
Tractor shovel	D21S-6	60503	4D95S-W	102819	1154 hrs
Wheel loader	WA70-1	13599	4D95L-W	106795	774 hrs
Vibration roller	JV100WA-1	20190	S6D105-1	110155	599 hrs

Appendix 9. Traffic Volume Survey

(1) Traffic Types

The traffic types surveyed ware passengers cars, buses, trucks, power tillers and tractors, motor cycles and scooters, bicycles, and pedestrians: 7 traffic types.

(2) Survey Time

The survey was carried out over 24 hours on each of 3 days: 15 April (Wed) 1992, 18 April (Sat) and 19 April (Sun), from 05:00 to 05:00 of the following day.

(3) Survey Point

The traffic volume was surveyed at two points: on the right bank of the Paro River and in front of a gasoline station on National Highway No.1.

(4) Survey Result

The survey results are summarized below and the details are given on the
following pages.

Summary of traffic volume (1) (in front of gas station) Unit:Number

April 1992	Cars (a)	Buses (b)	Trucks (c)	Sub Total (a+b+c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
15(Wed.)	719	33	264	1,016	42	394	98	1,720
18(Sat.)	900	50	283	1,233	51	626	76	1,639
19(Sun.)	1,151	61	599	1,811	95	937	207	2,315

Summary of traffic volume (2) (on the Jangsa Bridge) Unit:Number

April 1992	Cars (a)	Buses (b)	Trucks (c)	Sub Total (a+b+c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
15(Wed.)	268	12	66	346	124	117	28	911
18(Sat.)	335	4	111	450	54	242	39	1,080
19(Sun.)	369	6	86	461	90	281	63	1,526

Traffic Volume Record (1-1) (in front of gas station) (15 April 1992)(Wed.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	11	1	7	2	2		72
7:00							
	111	4	42	6	47	15	271
9:00							
	185	10	60	6	115	20	410
11:00							
	107	2	31	11	60	17	190
13:00							
	105	2	63	7	35	16	180
15:00							
	65	3	30	1	45	10	335
17:00							
	100	9	21	7	60	16	160
19:00							
	24	2	7	2	24	4	56
21:00							
	8		2		4		32
23:00							
	3		1		2		14
1:00							
3:00							
5:00							
Total	719	33	264	42	394	98	1,720

Traffic Volume Record (1-2) (in front of gas station) (18 April 1992)(Sat.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	20	4	11	4	5	5	60
7:00							
	60	5	30	1	50	7	175
9:00							
	85	1	20	3	30	5	150
11:00							
	155	6	65		88	17	270
13:00							
	185	2	45		115	17	200
15:00							
	185	11	65	30	190	2	335
17:00							
	155	20	27	11	118	15	310
19:00							
	52	1	18	2	28	8	115
21:00							
	3		2		2		15
23:00							
							4
1:00							
3:00							
							5
5:00							
Total	900	50	283	51	626	76	1,639

Traffic Volume Record (1-3) (in front of gas station) (19 April 1992)(Sun.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	17	14	17	1	6	3	85
7:00							
	245	20	135	25	200	70	700
9:00							
	240		105	3	225	30	340
11:00							
	230	2	142	40	163	12	450
13:00							
	225	3	12	13	210	51	300
15:00							
	47	12	22		44	4	128
17:00							
	103	10	42	10	63	32	178
19:00							
	36		7	3	16	5	85
21:00							
	6		2		8		45
23:00							
1:00							
3:00							
	2		2		2		4
5:00							
Total	1,151	61	599	95	937	207	2,315

Traffic Volume Record (2-1) (on the Jangsa Bridge) (15 April 1992)(Wed.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	6		1	7	2		40
7:00							
	23	1	10	6	9	5	106
9:00							
	36	5	17	16	30	5	135
11:00							
	68	3	10	6	15	9	154
13:00							
	33		6	6	12		80
15:00							
	43	1	3	65	16	1	192
17:00							
	44		14	4	15	8	154
19:00							
	11		4	8	10		30
21:00							
	3	2		4	5		15
23:00							
	1		1	2	3		5
1:00							
3:00							
5:00							
Total	268	12	66	124	117	28	911

Traffic Volume Record (2-2) (on the Jangsa Bridge) (18 April 1992)(Sat.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	7			3	1	2	40
7:00							
	17		8	6	11	2	105
9:00							
	20		3	1	6		115
11:00							
	7		4		3		90
13:00							
	80		35	3	45	10	175
15:00							
	120		30	30	108	10	265
17:00							
	55	4	15	5	45	13	183
19:00							
	22		12	3	14	2	88
21:00							
	6		3	2	9		13
23:00							
	1		1	2	3		5
1:00							
3:00							
	1		1	1			6
5:00							
Total	335	4	111	54	242	39	1,080

Traffic Volume Record (2-3) (on the Jangsa Bridge) (19 April 1992)(Sun.)

Hours	Cars (a)	Buses (b)	Trucks (c)	Power Tillers and Tractors	Motor Cycles and Scooters	Bicycles	Pedestrians
5:00							
	4			1	2	1	40
7:00							
	33		13	14	53	7	380
9:00							
	85		10	37	83	23	400
11:00							
	115	1	32	15	80	10	276
13:00							
	48	5	6	8	21	9	209
15:00							
17:00							
	46		16	10	22	9	137
19:00							
	30		6	4	13	3	54
21:00							
	4		2	1	6	1	21
23:00							
	2		1		1		7
1:00							
3:00							
	2						2
5:00							
Total	369	6	86	90	281	63	1,526

Appendix 10. Plate Loading Test and Test Pitting

(1) Plate Loading Test

i) Selection of Testing Method

A bridge plays an important role in a road system. The ground under the foundation supports the superstructure and substructure, and should insure stability in regard to bearing capacity, settlement, sliding and overturning. It is general practice for a boring survey to be carried out as part of a geological survey. Due to the technical skill necessary and the condition of equipment in Bhutan, a boring survey seemed problematic. Instead of a boring survey, a plate loading test and test pitting were performed in-situ. Bearing capacity and settlement are derived from the soil data from the plate loading test and the foundation type and depth are determined from the results of test pitting.

The Jangsa Bridge had some piers damaged by flood in 1990, then two piers were washed away and another inclined by flood in 1991. By visual observation of the existing bridge, it was concluded that the main causes were piers with a short penetration depth, an insufficient bearing capacity, and an increase in settlement which was caused by the ground washing away under the footing by river bed scouring. The investigation was carried out considering the above-mentioned problems.

ii) Testing Position

The plate loading test was carried out 14m upstream from the upstream side of the existing Jangsa Bridge and 24m into the river from the right side abutment. It is almost where the new bridge will be constructed. The test pitting was carried out 20m upstream from the plate loading test. The elevation of the plate loading test was +2,266.54m and that of the test pitting was +2,266.26m.

.PA

iii) Plate Loading Test

1) Testing Method

The test adopted a single-cycle loading method with a planned loading of 8 stages, making load changes in 1.25 ton increments, and a maximum planned load of 10 tons (141.5 ton/m^2). The table of loading stages is shown below.

Loading Stages

(unit:ton)

Preliminary loading	0 -> 1.00 -> 0 -> 1.00 -> 0 -> 1.00 -> 0
Main loading	0 -> 1.25 -> 2.50 -> 3.75 -> 5.00 -> 6.25 -> 7.50 -> 8.75 -> 10.0 -> 8.75 -> 7.50 -> 6.25 -> 5.00 -> 3.75 -> 2.50 -> 1.25 -> 0

ii) Test Equipment

The test equipment consisted of loading equipment and measuring apparatuses. Loading equipment was separated into a loading system and a reaction system; the measuring apparatuses were separated into a load measuring device and a deflection device.

The reaction system used a hydraulic backhoe with a capacity of 0.6m^3 (weight: 18ton); the loading system a hydraulic jack (capacity: 50ton). The load measuring devices used a load cell (capacity: 50ton) and digital indicator, and the deflection measuring device used four dial gauges (precision: 0.01mm). Each system and each device was leveled as it was set up, the small gap which occurred on final setting was adjusted by a ball and socket joint.

As the test surface was gravel stratum, when the loading plate was set up, to get rid of surface irregularities the surface was covered with a small amount of sand (fine and coarse sand).

Preliminary loading and unloading were carried out three times. At this time, the loading weight was 1 ton which was 80% of the first stage load (1.25 ton).

iii) Test Results

The final maximum load strength should be 123.8 ton/m^2, which was exactly the maximum planned load in the test, because settlement was over 10% of the diameter (30mm) of the loading plate.

This test did not find an ultimate load. The relationship between load and settlement is shown in the load-settlement curve on the next page. From this figure the rate of settlement increase is large at a 53.1 ton/m^2 load strength. As the ground had many voids (there was not much sand and/or fine-grained soil), the settlement became large. It could be concluded that there was not much settlement from 17.7 ton/m^2 load strength to 53.1 ton/m^2 load strength due to the placed sand. The load which spring on the surface is changeable spread depth, so that a light load could spread only to a part of surface, but a heavy load could spread further to deeper point.

It did not find an ultimate load, but it is assumed that the final maximum load should be the ultimate load. Consequently, in this respect, the allowable bearing capacity (Pa_1) was 41 ton/m^2.

In terms of the allowable settlement, which was 15mm, the allowable bearing capacity(Pa_2) was 27 ton/m^2.

Being cautious and choosing the lower of the two, the allowable bearing capacity was set at 27ton/m^2.

A module of the subgrade reaction which follows from the test is below.

$$Kv = \Delta P / \Delta S \ (kg/cm^3)$$

P=3.75 ton ; S=4.25 mm
P=6.25 ton ; S=17.67 mm

$$Kv = (6.25-3.75)/(17.67-4.25)\ (ton/mm^3)$$
$$= 1863\ (kg/cm^3)$$

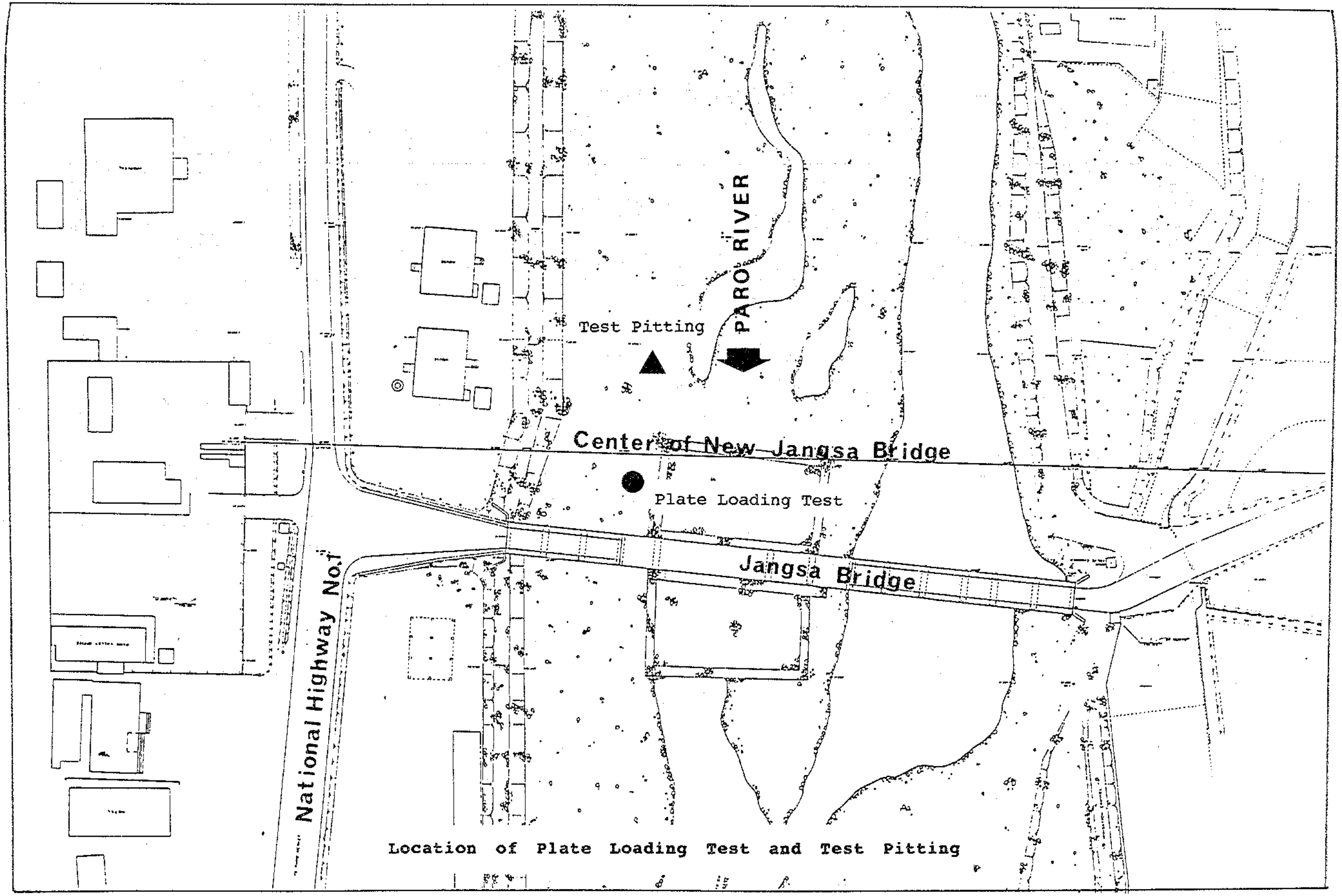
A model module of deformation is as follows.

$$Es = Ip * B * (1-v^2) * \Delta P / \Delta S$$

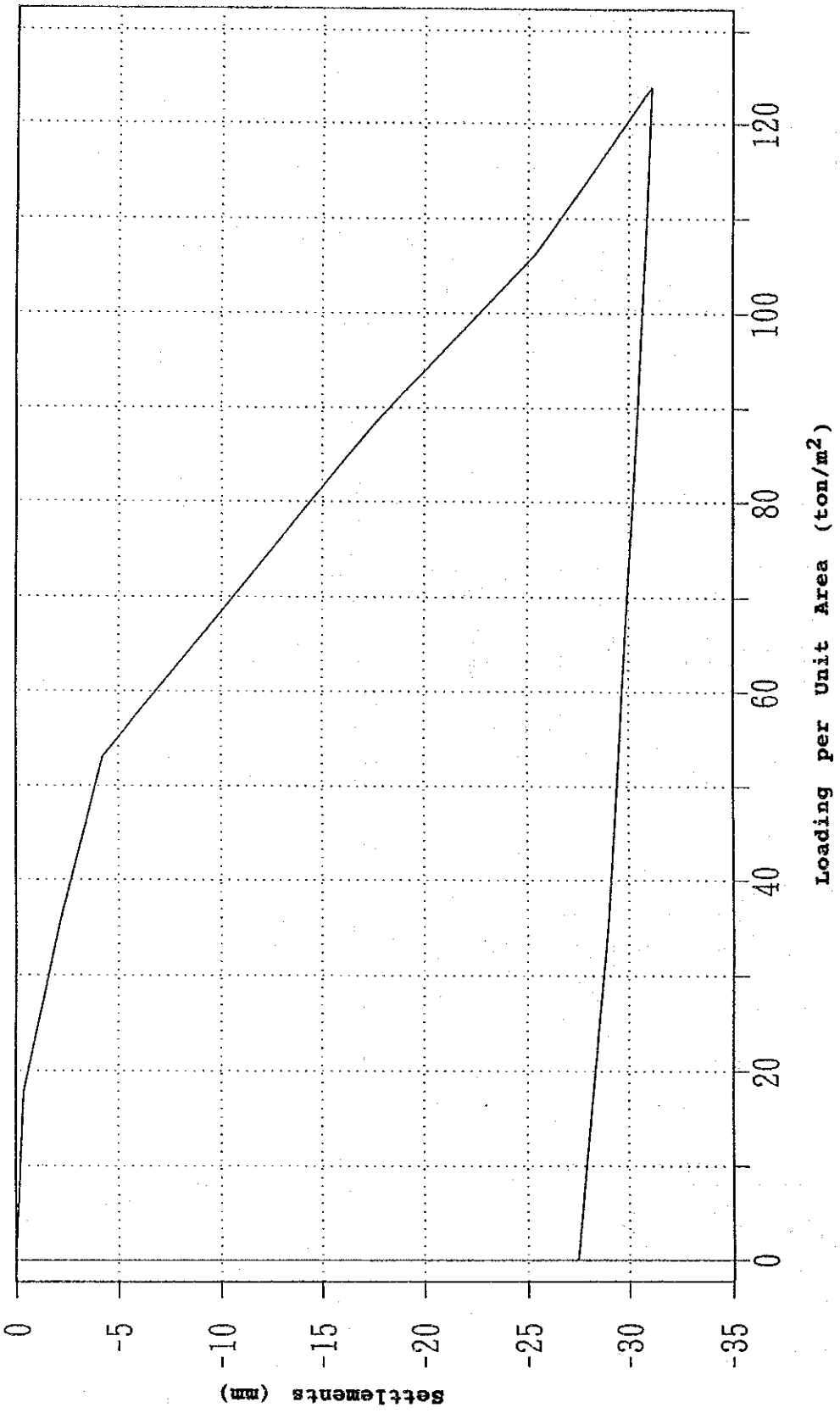
Ip : influence value (steel circle plate:0.79)
B : diameter of the loading plate (30cm)
v : Poison's ratio (sandy soil:0.3, cohesion soil:0.5)

$$Es = 0.79 * 30 * (1-0.3^2) * 1863$$
$$= 40179\ (kg/cm^2)$$

The results of test pitting show: the gravel stratum continues downward; there are no soft strata midway; and the soil stratum density increases with depth. It is reasonable safe to conclude that the allowable bearing capacity found in this test can be adopted as the allowable bearing capacity for the bridge foundation.



Location of Plate Loading Test and Test Pitting



Loading per Unit Area - Settlements Curve

Data sheet No.1

Load (ton)	Passing Time (min)	Displacement Gauges No.1 (1/100mm)	No.2 (1/100mm)	No.3 (1/100mm)	No.4 (1/100mm)	Average (mm)	Settlements (mm)
0	0	2500	2500	2500	2500	25.00	0
1.25	0	2465	2446	2475	2481	24.67	-0.33
	1	2465	2446	2475	2481	24.67	-0.33
	2	2464	2445	2472	2480	24.65	-0.35
	5	2464	2446	2473	2480	24.66	-0.34
	10	2462	2444	2471	2480	24.64	-0.36
	15	2462	2445	2472	2480	24.65	-0.35
	20	2462	2445	2472	2480	24.65	-0.35
	25	2462	2446	2471	2479	24.65	-0.35
	30	2462	2446	2471	2479	24.65	-0.35
2.50	0	2324	2321	2352	2343	23.35	-1.65
	1	2332	2318	2349	2339	23.35	-1.65
	2	2331	2306	2342	2329	23.27	-1.73
	5	2303	2288	2330	2312	23.08	-1.92
	10	2298	2283	2321	2304	23.02	-1.98
	15	2292	2280	2308	2291	22.93	-2.07
	20	2291	2278	2307	2290	22.92	-2.08
	25	2289	2275	2307	2289	22.90	-2.10
	30	2287	2274	2306	2288	22.89	-2.11
3.75	0	2141	2154	2170	2150	21.54	-3.46
	1	2137	2131	2168	2148	21.46	-3.54
	2	2122	2112	2152	2123	21.27	-3.73
	5	2103	2096	2135	2111	21.11	-3.89
	10	2086	2080	2121	2095	20.96	-4.04
	15	2072	2075	2108	2082	20.84	-4.16
	20	2069	2065	2104	2081	20.80	-4.20
	25	2067	2063	2103	2079	20.78	-4.22
	30	2064	2061	2099	2076	20.75	-4.25

Data sheet No.2

Load (ton)	Passing Time (min)	Displacement Gauges No.1 (1/100mm)	No.2 (1/100mm)	No.3 (1/100mm)	No.4 (1/100mm)	Average (mm)	Settlements (mm)
5.00	0	1815	1815	1853	1818	18.25	-6.75
	1	1772	1771	1809	1780	17.83	-7.17
	2	1755	1756	1790	1768	17.67	-7.33
	5	1692	1695	1721	1702	17.03	-7.97
	10	1599	1595	1620	1588	16.01	-8.99
	15	1545	1518	1562	1551	15.44	-9.56
	20	1511	1508	1535	1522	15.19	-9.81
	25	1454	1451	1474	1465	14.61	-10.39
	30	1407	1403	1430	1419	14.15	-10.85
6.25	0	922	895	942	925	9.21	-15.79
	1	903	879	920	905	9.02	-15.98
	2	855	830	870	865	8.55	-16.45
	5	822	796	845	839	8.26	-16.74
	10	789	761	812	805	7.92	-17.08
	15	768	742	785	776	7.68	-17.32
	20	760	735	778	770	7.61	-17.39
	25	745	715	760	753	7.43	-17.57
	30	734	702	752	742	7.33	-17.67
Reset Gauges		2484	2471	2581	2507	25.11	
7.50	0	1857	1868	2045	2345	20.29	-22.49
	1	1838	1831	2013	2331	20.03	-22.75
	2	1803	1806	1992	2219	19.55	-23.23
	5	1694	1709	1891	2192	18.72	-24.06
	10	1655	1666	1855	2056	18.08	-24.70
	15	1629	1641	1828	2025	17.81	-24.97
	20	1612	1625	1820	2011	17.67	-25.11
	25	1599	1612	1802	2001	17.54	-25.24
	30	1589	1603	1794	1991	17.44	-25.34

Data sheet No.3

Load (ton)	Passing Time (min)	Displacement Gauges No.1 (1/100mm)	No.2 (1/100mm)	No.3 (1/100mm)	No.4 (1/100mm)	Average (mm)	Settlements (mm)
8.75	0	1325	1341	1620	1705	14.98	-27.80
	1	1311	1332	1605	1694	14.86	-27.92
	2	1286	1310	1580	1668	14.61	-28.17
	5	1225	1245	1512	1597	13.95	-28.83
	10	1131	1144	1410	1490	12.94	-29.84
	15	1051	1070	1339	1420	12.20	-30.58
	20	1023	1043	1312	1419	11.99	-30.79
	25	1008	1030	1297	1375	11.78	-31.00
	30	998	1020	1285	1364	11.67	-31.11
7.50	0	1021	1044	1322	1404	11.98	-30.80
	1	1020	1042	1323	1405	11.98	-30.80
	2	1020	1043	1323	1406	11.98	-30.80
6.25	0	1067	1087	1342	1449	12.36	-30.42
	1	1068	1087	1341	1450	12.37	-30.41
	2	1070	1089	1340	1450	12.37	-30.41
5.00	0	1118	1132	1387	1491	12.82	-29.96
	1	1119	1133	1389	1493	12.84	-29.94
	2	1119	1133	1389	1494	12.84	-29.94
3.75	0	1153	1178	1437	1536	13.26	-29.52
	1	1155	1180	1439	1538	13.28	-29.50
	2	1156	1181	1439	1540	13.29	-29.49
2.50	0	1204	1233	1489	1589	13.79	-28.99
	1	1205	1235	1491	1591	13.81	-28.97
	2	1207	1236	1491	1592	13.82	-28.96
1.25	0	1268	1305	1568	1666	14.52	-28.26
	1	1271	1308	1570	1668	14.54	-28.24
	2	1273	1310	1572	1669	14.56	-28.22
0	0	1312	1391	1661	1751	15.29	-27.49
	1	1315	1393	1662	1753	15.31	-27.47
	2	1318	1397	1664	1755	15.34	-27.44

2. Test pitting

The test pitting was carried out with a hydraulic backhoe with a capacity of $0.6m^3$. The location of the test pitting was 34m upstream from the upstream side of the existing Jangsa Bridge and 24m into the river from the right side abutment of the existing Jangsa Bridge. The pit was excavated to a depth of 4m from the surface. The ground characteristics are gravel and sand-gravel beds with a maximum bolder size of 600mm. The elevation at the top surface of the pit was +2266.26m. The results are shown below.

Test Pit Result

Depth	Soil	Description
0m		
	Gravel	The stratum had very little sand and very little fine soil, but many boulders with sizes from 400mm to 600mm. This stratum was very permeable, and it was obvious that river water flowed at depths from 0.8m to 1.0m under the surface.
1.5m		
	Sand and Gravel	The amount of sand with grain sizes from 0.74mm to 2mm surpassed the amount of gravel with sizes from 200mm to 400mm. This is a more compact stratum than the upper stratum, well grained and dense. There was no inflow of river water and it was not very permeable. Even though the stratum filled up a void as moderate fine grained soil.
2.5m		
	Sand and Gravel	The amount of sand, with grain sizes from 0.74mm to 2mm, surpassed the amount of gravel, with sizes from 50mm to 250mm. This was a more compact stratum, well grained and denser. There was no inflow of river water and it was not permeable. It was concluded that this stratum had the characteristics required for a bridge foundation.
4.0m		

The ground around the bridge reconstruction is river bed deposit, and the gravel stratum continues downward. It was found that there were no poor strata midway from the surface. As the depth increased, so did the amount of sand and the density.

Assuming a open bridge foundation, the test pitting results show that the contact ground under a footing should be more than 2.5m deep.

However, the plate loading test, which resulted in an allowable bearing capacity of 27ton/m^2, was done at a depth of 0.5m. It is reasonably safe to assume from the soil characteristics around the reconstruction point that this allowable bearing capacity of 27ton/m^2 may be adopted as the allowable bearing capacity of the bridge foundation.

Appendix 11. Estimate of the Maximum Flood Discharge and the Design High Water Level

(1) Estimate of the Maximum Flood Discharge

The maximum flood discharge at the existing bridge site occurred in 1968, and the highest water level reached was 0.5 m below the girders of the existing bridge.

The river cross-section surveyed in April 1992 and the discharge rating curve are shown on the following page. The curve is based on the uniform flow calculation method. The conditions applied are as follows.

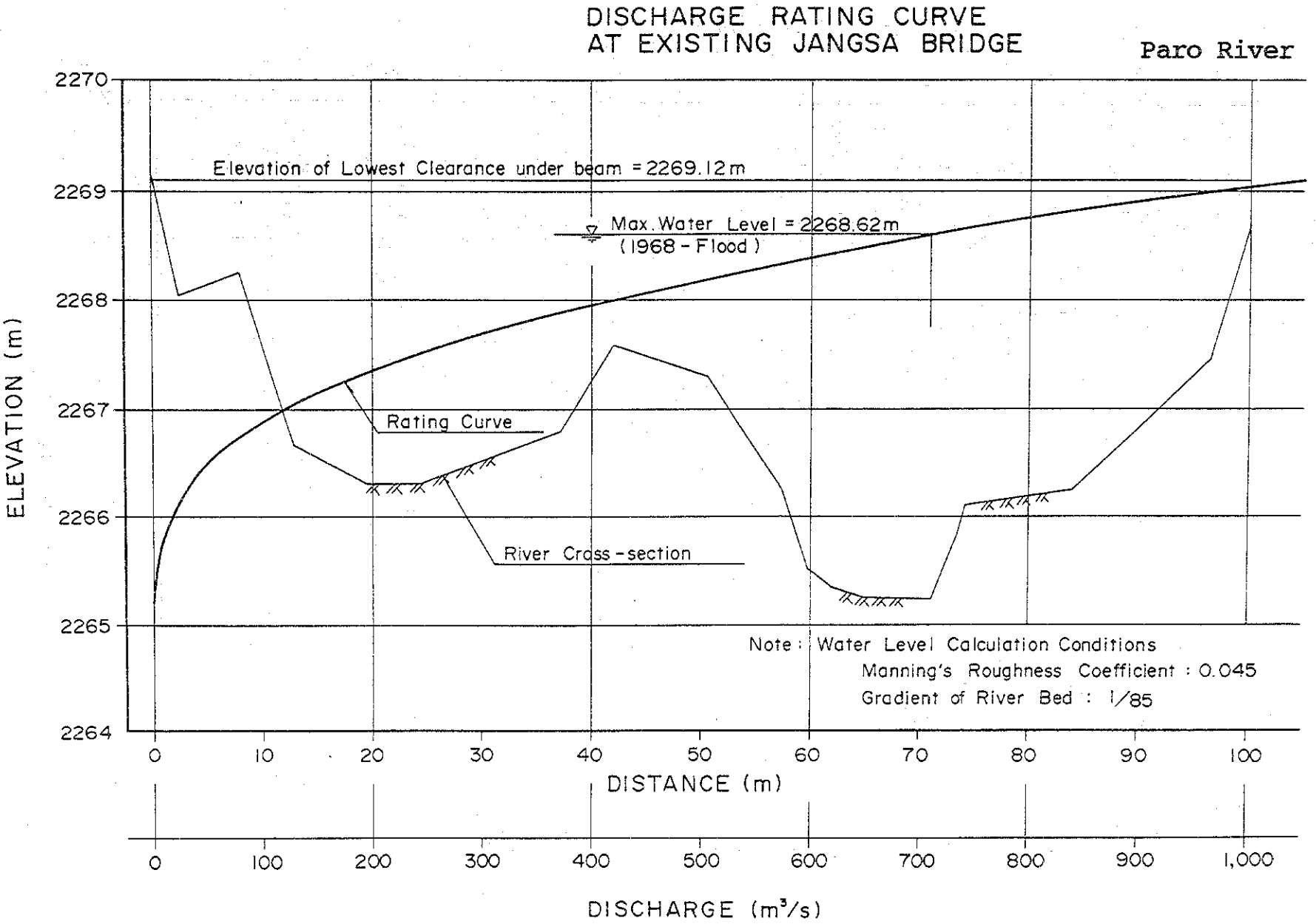
- Coefficient of Manning's Formula : 0.045
- The riverbed longitudinal gradient : 1/85
- The river cross-section : Surveyed in April 1992

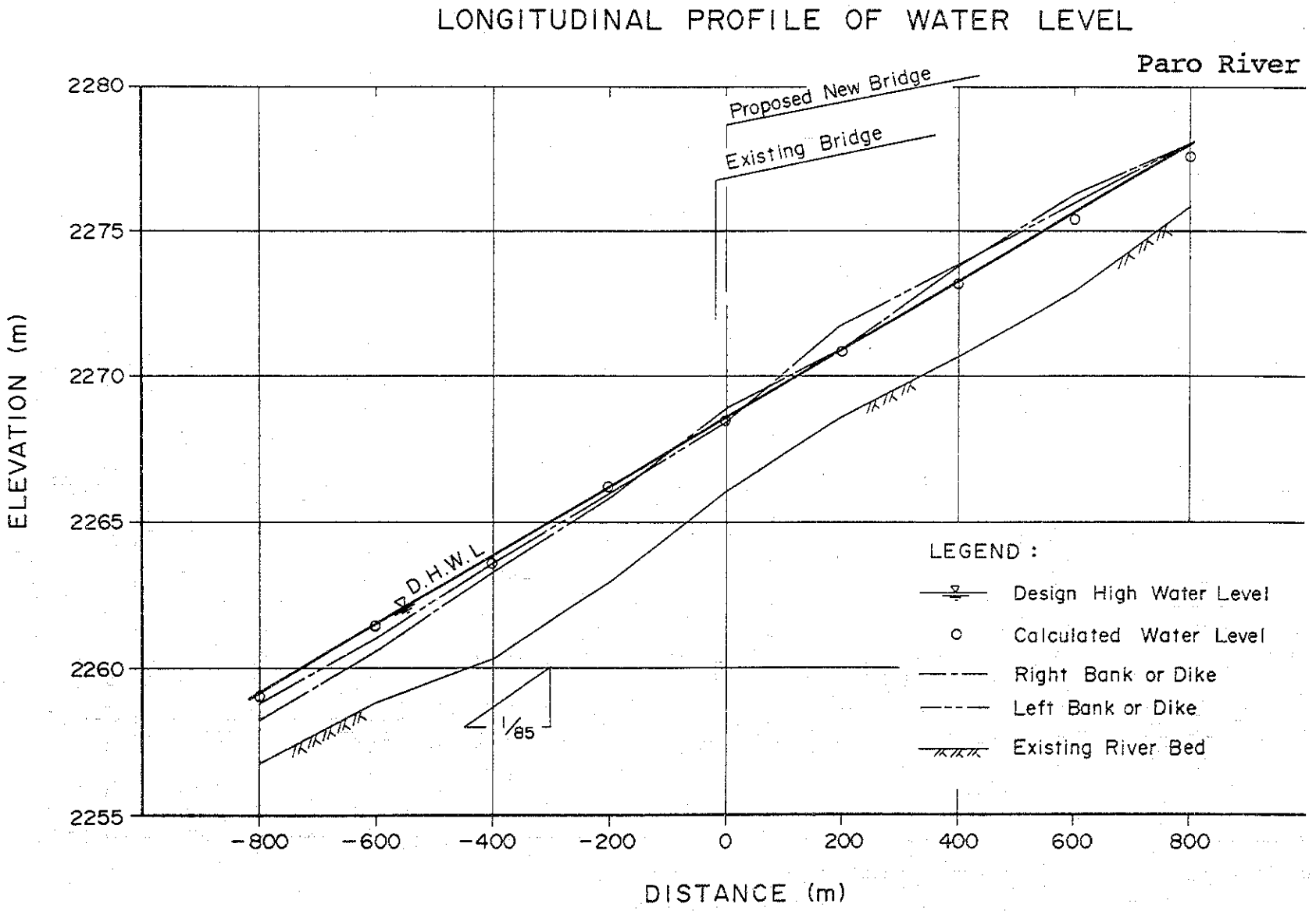
From the discharge rating curve, the discharge at maximum high water in the 1968 flood has been calculated at 710 m^3/sec.

(2) Design High Water Level

The design high water level at the bridge was determined based on the uniform flow formula for a design discharge of 710 m^3/sec. The river cross-section was assumed to be same as it was in April 1992. The design high water level was defined as the calculated water level which made an envelope-curve, in an area from 1.5 km upstream to 1.5 km downstream of the bridge. The river cross section at the location of the new bridge was used for the water level calculation for the riverbed protection work.

Presently, riverbed protection work is underway for the pier foundations 40 m upstream. This is cofferdam work and the installation of gabions 1.5 m in height. Due to this work, the river cross section at the new bridge location has decreased and the riverflow capacity has decreased greatly. Therefore, preparatory work to maintain the previous cross-sectional area and to protect the pier foundations will be necessary prior to the construction of the new bridge.


DISCHARGE RATING CURVE
AT EXISTING JANGSA BRIDGE
Paro River
Elevation of Lowest Clearance under beam = 2269.12 m
Max. Water Level = 2268.62 m
(1968 - Flood)
Rating Curve
River Cross-section
Note : Water Level Calculation Conditions
Manning's Roughness Coefficient : 0.045
Gradient of River Bed : 1/85
ELEVATION (m)
2270
2269
2268
2267
2266
2265
2264
0
10
20
30
40
50
60
70
80
90
100
DISTANCE (m)
0
100
200
300
400
500
600
700
800
900
1,000
DISCHARGE (m³/s)


LONGITUDINAL PROFILE OF WATER LEVEL
Paro River
Proposed New Bridge
Existing Bridge
D.H.W.L
1/85
ELEVATION (m)
2280
2275
2270
2265
2260
2255
-800
-600
-400
-200
0
200
400
600
800
DISTANCE (m)
LEGEND :
Design High Water Level
Calculated Water Level
Right Bank or Dike
Left Bank or Dike
Existing River Bed

Appendix 12. Cement Analysis

Generally, the strength per unit area which is needed in bridge construction is from 200kg/cm^2 to 400kg/cm^2. In stage 1.2, the Bhutanese cement strength was insufficient. Accordingly, 2 types of Bhutanese cements and 3 types of Indian cements were brought to Japan for analysis.

The items of the analysis were separated into physical properties and chemical properties. The items are shown below.

The Indian cement were tested regarding its physical properties only.

The reference results of the cement analysis tests done in Bhutan are shown on another page.

Cement Analysis Items

Physical properties	Chemical properties
Specific gravity	Ignition loss
Fineness	SiO_2
Setting time	Al_2O_3
Soundness	Fe_2O_3
Flow test	CaO
Compressive strength	MgO
	SO_3

The strength of Bhutanese cement was felt to be lacking by the powers that be in Bhutan and production regulations were passed.

The first sample of Bhutanese cement was produced before the production regulations took effect. Accordingly, another sample was brought back to Japan for analysis.

Results of Ordinary Portland Cement Analysis No.1

Results of Test in Japan

Producing country	--- Bhutan ---		-------- I n d i a --------		
Brand	PENDEN (*1)	PENDEN (*2)	LARSEN TOUBRO	SHIRIRAM	LAKHERI
Particulars					
Specific gravity	3.12	3.07	3.17	3.14	3.16
Fineness (cm^2/g)	3,190	3,220	2,900	3,210	2,590
Setting time (hours:minutes)					
(initial)	2:43	2:54	3:46	3:31	4:43
(final)	3:40	3:45	4:55	4:45	6:02
Soundness	bad	bad	good	good	good
Compressive strength (kg/cm^2)					
(3 days)	69	54	101	143	71
(7 days)	104	82	160	238	107
(28 days)	183	132	282	379	173

(*1):before production regulations were announced.
(*2):after production regulations were announced.

Results of Ordinary Cement Analysis No.2

Results of Test Certificate from Factory

Producing country	--- Bhutan ---		-------- I n d i a --------		
Brand	PENDEN (**1)	PENDEN (**2)	LARSEN TOUBRO	SHIRIRAM	LAKHERI
Particulars					
Specific gravity	-	-	-	-	-
Fineness (cm^2/g)	3,930	3,610	2,952	2,973	3,290
Setting time (hours:minutes)					
(initial)	2:40	2:55	2:40	1:56	2:20
(final)	3:20	3:45	3:20	2:43	3:15
Soundness	-	-	-	-	-
Compressive strength (kg/cm^2)					
(3 days)	204	230	365	400	180
(7 days)	270	280	485	440	268
(28 days)	387	370	-	-	-
Date of Dispach	Mar. 1992	Mar. 1990	21 Mar. 1992	7 Jan. 1992	25 Nov. 1991

(**1):Al_2O_3
(**2):R_2O_3-Fe_2O_3

Appendix 13. Meteorological Data

Meteorological Data in Bondey Farm (1985 - 1988)

	Year:1985				Year:1986			
	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm
Jan.	-3.6	13.3	4.9	-	-2.7	16.6	7.0	-
Feb.	2.1	13.6	7.9	-	-1.3	17.2	8.0	1.2
Mar.	7.6	21.4	14.5	11.2	1.7	18.9	10.3	6.8
Apr.	8.8	22.6	15.7	26.0	6.7	20.1	13.4	36.4
May	10.4	22.5	16.5	35.5	9.5	22.1	15.8	23.1
June	13.2	25.3	19.3	62.3	15.1	24.9	20.0	94.0
July	17.4	23.0	20.2	253.7	16.5	24.8	20.7	163.2
Aug.	16.7	24.8	20.8	204.3	15.4	25.9	20.7	58.1
Sept.	15.0	22.7	18.9	92.4	14.0	23.6	18.8	107.5
Oct.	10.5	21.2	15.9	102.8	6.7	19.9	13.3	56.8
Nov.	2.7	18.1	10.4	1.0	3.3	19.4	11.4	-
Dec.	-0.5	18.7	9.1	6.9	-2.3	15.6	6.7	18.0
(Total)				(796.1)				(565.1)

	Year:1987				Year:1988			
	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm
Jan.	-3.3	15.7	6.2	4.1	-2.0	16.6	7.3	-
Feb.	-0.4	16.6	8.1	17.8	-0.4	17.6	8.6	13.6
Mar.	4.2	17.2	10.7	28.0	4.1	17.5	10.8	30.0
Apr.	5.6	20.7	13.2	37.8	7.7	21.4	14.6	24.7
May	8.5	22.2	15.4	18.9	11.1	24.0	17.6	36.4
June	15.0	24.3	19.7	90.5	13.8	26.4	20.1	137.8
July	16.1	24.2	20.2	145.0	16.6	24.7	20.7	117.4
Aug.	15.2	22.9	19.1	123.6	16.6	24.7	20.7	181.6
Sept.	15.0	23.4	19.2	107.4	14.3	24.9	19.6	128.2
Oct.	7.9	20.9	14.4	63.3	5.7	24.7	15.2	8.6
Nov.	1.3	20.6	11.0	1.8	1.3	19.4	10.4	11.5
Dec.	-1.7	18.7	8.5	1.2	-0.2	16.9	8.4	16.2
(Total)				(639.4)				(706.0)

Meteorological Data in Bondey Farm (1989 -1991)

	Year:1989				Year:1990			
	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm
Jan.	-0.7	13.3	6.3	25.0	0.4	16.3	8.4	0.0
Feb.	-0.4	14.5	7.1	110.0	0.2	15.4	7.8	15.2
Mar.	3.4	18.5	11.0	62.0	0.8	17.5	9.2	27.0
Apr.	5.8	20.9	13.4	50.2	4.9	20.6	12.8	63.6
May	11.4	23.5	17.5	175.2	10.9	23.1	17.0	49.2
June	14.3	23.5	18.9	190.6	15.1	25.7	20.4	55.2
July	16.2	24.0	20.1	168.0	15.9	24.4	20.2	78.6
Aug.	15.2	23.7	19.5	98.2	13.9	24.6	19.3	136.4
Sept.	15.4	24.0	19.7	95.4	13.6	21.5	17.6	67.0
Oct.	8.2	22.4	15.3	10.4	7.4	21.0	14.2	46.8
Nov.	3.0	17.8	10.4	0.0	0.2	20.3	10.3	0.0
Dec.	-2.9	15.7	6.4	2.0	0.3	16.4	8.4	0.0
(Total)				(987.0)				(539.0)

	Year:1991			
	Average Minimum Temp.(C)	Average Maximum Temp.(C)	Average Temp.(C)	Rain Fall mm
Jan.	-2.6	10.0	3.7	70.5
Feb.	1.5	3.4	2.4	-
Mar.	0.9	16.8	8.9	37.0
Apr.	4.5	21.3	12.9	20.0
May	8.8	23.9	16.3	33.4
June	12.7	21.8	17.2	188.2
July	14.2	26.3	20.3	84.7
Aug.	14.4	26.1	20.2	261.0
Sept.	11.8	24.9	18.4	151.9
Oct.	6.1	23.7	14.9	-
Nov.	0.7	18.8	9.7	20.0
Dec.	-4.9	20.0	7.5	7.4
(Total)				(874.1)

Appendix 14. Test Pitting at the Intake Site of Sharimouchu Channel

Test Pit Results

Depth	Soil	Description
0m		
	Sand	This stratum was a sand-gravel mixture which was light brown in color. This was a flood plain deposit which included grass, roots, and gravel mixed with volcanic ash. The stratum had a small number of 600mm boulders and a large amount of sand.
0.8m		
	Sand, gravel mixture	This stratum was a sand-gravel mixture which was light brown in color. It had more gravel, and few 800mm size boulders, and many stones with gravel sizes with from 100mm to 400mm. The sand was mixed with a small amount of volcanic ash. The stratum included comparatively comparatively little fine-grained soil .
2.0m		
	Sand and Gravel	This stratum had dense sand and gravel and was yellow brown in color. It had a few large boulders which were over 1m in size, and had and many stones which were from 100mm to 300mm in size. The sand had no volcanic ash. This stratum had little fine-grained soil and was comparatively dense. Ground water was found to flow into the pit from this stratum.
3.0m		
	Sand and gravel	This stratum was composed of sand and gravel which was yellow brown in color. The stratum had a large amount of small and angular gravel from 50mm to 200mm in size. This was an impermeable and stratum because the fine-grained soil included silt. Ground water flowed into the pit from the upper stratum and then the tone of color changed to yellow brown. Consequently, it was concludedthat the foundation of intake weir should set on this stratum.
5.0m		

Appendix 15. Necessary Measures to be Taken by the Royal Government of Bhutan

Item	Unit	Quantity
Stage 1.3		
- Preparation of storage yard and land development 30 m x 50 m x 2 sites	m^2	3,000
Crushed stone foundation 1,500 m x 0.2 m x 2 sites	m^3	600
Fencing 160 m x 1 sites	m	160
Lighting	set	1
- Land aquisition	L.S.	1
- Arrangement of borrow area	L.S.	1
- Arrangement of spoil area for demolished concrete structures	L.S.	1
Stage 2.1		
- Preparation of storage yard and land development 30 m x 30 m x 1 sites	m^2	1,500
Crushed stone foundation 1,500 m^2 x 0.2 m 1 sites	m^3	300
- Land development for a crushing plant		
Land development 30 m x 30 m	m^2	900
Load surplus soil 900 m^2 x 0.2 m	m^3	180
Removal of surplus soil	m^3	180
Banking t=50cm	m^3	450
Crushed stone t=10cm	m^3	90
Electric cables	set	1
- Land aquisition	L.S.	1
- Arrangement of borrow area	L.S.	1
Stage 2.2		
- Preparation of storage yard and land development 30 m x 50 m x 1 site	m^3	1,500
Crushed stone foundation 1,500 m^2 x 0.2 m x 1 site	m^3	300
- Repair of roads' surface		
Asphalt pavement	m^2	3,000
- Removement(Shifting) crusher plant		
Land development 30 m x 30 m	m^2	900
- Land aquisition	L.S.	1
- Arrangement of borrow area	L.S.	1

Appendix 16. Equipment Utilization Program by the Government of Bhutan

UTILIZATION OF CONSTRUCTION EQUIPMENT (Break Period)

During the break period (i.e April 1992 to March 1993) the construction equipments procured under the Japan's Grant Aid will be utilised for the NASEPP slope protection works.

The plants will be operated periodically to maintain them in working condition. Few items like "U"& "L" channel sections will be manufactured for the maintenance of Irrigation channels which have been constructed during stage 1.2. The mass production of above items can also be done for future stages of Projects. However, the consultants are expected to advise on this matter.

UTILIZATION OF PLANTS AND EQUIPMENTS PROCURED AND TO BE PROCURED UNDER JAPAN'S GRANT AID.

With the completion of Paro Valley Agricultural Development Project, many areas in Paro Valley will be benefitted. Farm productivity is expected to increase through assured irrigation and other infrastructures developed under this project.

The purpose of the project is to encourage the Bhutanese to construct similar infrastructure and to present a model of work for the new areas which needs to be expanded and created within Paro Valley for the areas which have not been covered in the current project implementation. It is expected that with the experience and technical knowhow gained through implementation of current project, it will enable the local engineers to plan and carry out the operation and maintenance works of the implemented project on a regular basis.

The construction equipments and plants procured through this project will be utilised after the completion of the project to :-

- develop infrastructure in the areas not covered under this project in the Paro Valley for agriculture development.
- expand into new areas to promote agriculture developoment.
- maintain on a regular basis the facilities constructed under the project and subsequent constructions of irrigation channels, farm roads and river bank protection works etc.

Appendix 17. Field Survey Team Member List
(Draft Report Explanation Team)

(1) Kanji KITAZAWA ..... Team Leader,
Deputy Director, Grand Aid Division,
Economic Cooperation Bureau,
Ministry of Foreign Affairs

(2) Kaoru HOSHII ..... Agricultural Development Planner,
Deputy General Manager,
Irrigation, Drainage and
Land Reclamation Department,
Hokkaido Engineering Consultants Co., Ltd.

(3) Hideki YAMAZAKI ..... Construction Planner,
Chief Engineer of Overseas Department,
Hokkaido Engineering Consultants Co., Ltd.

Appendix 18. Record of the Field Survey Team's Activities
(Draft Report Explanation Team)

Date (1992)	Activities
August	
26 (Wed)	- Leave Tokyo and arrival at Delhi
27 (Thr)	- Visit : - Embassy of Japan / Delhi - JICA India Office / Delhi
28 (Fri)	- Leave Delhi and arrival at Paro Airport - Trip from Paro to Thimphu - Visit : - Department of Agriculture - Ministry of Agriculture - Planning Commission - Ministry of Finance - Department of Road
29 (Sat)	- Trip from Thimphu to Paro - Visit the Project Office, Paro - Site survey
30 (Sun)	- Site survey - Trip from Paro to Thimphu
31 (Mon)	- Explanation of the Draft Report and Discussion
September	
1 (Tue)	- Discussion on the the Draft Report - Preparation of the Minutes of Discussion
2 (Wed)	- Signing of "Minutes of Discussion" - Trip from Thimphu to Paro
3 (Thr)	- Leave Paro Airport and arrival at Delhi - Visit : - Embassy of Japan/Delhi - JICA Office/Delhi
4 (Fri)	- Leaving for Tokyo
5 (Sat)	- Arrival at Tokyo

Appendix 19. List of Participants
(At the time of the Draft Report Explanation)

Ministry of Agriculture
- Dasho Leki Dorji (Deputy Minister)

Department of Agriculture
- Dasho (Dr.) Kinzang Dorji (Director General)
- Mr. Wangdi Gyaltshen (Officiating Superintending Engineer, Irrigation Division)

Planning Commission
- Lyonpo C. Dorji (Minister)
- Mr. Namgay Wangchuk (Planning Officer)

Ministry of Finance
- Mr. Wangdi Norbu (Director, National Budget and Accounts)
- Mr. Sonam (Assistant Finance Officer, External Resources Division, National Budget and Accounts)

Department of Road, Ministry of Communications
- Mr. Rinchen Dorji (Superintending Engineer)

Paro Valley Agricultural Development Project Office
- Mr. Sherub Gyaltshen (Project Manger)
- Mr. Mani Kumar Chettri (Irrigation Engineer, Deputy Project Manager)

Japan Overseas Cooperation Volunteers (JOCV/JICA) Office In bhutan
- Mr. Tomoaki Tsugawa (Coordinator)

Embassy of Japan (in Delhi)
- Mr. Hajime Matsuo (first Secretary)

JICA India Office (in Delhi)
- Mr. Toshio Hida (Resident Representative)

Appendix 20. Minutes of Discussion
(At the time of the Draft Report Explanation)

MINUTES OF DISCUSSION
ON THE BASIC DESIGN STUDY (PHASE III)
ON THE PARO VALLEY AGRICULTURAL DEVELOPMENT PROJECT
IN THE KINGDOM OF BHUTAN
(CONSULTATION ON DRAFT REPORT)

In April and May 1992, the Japan International Cooperation Agency (JICA) despatched a Basic Design Study team on the Project for the Paro Valley Agricultural Development Project (hereinafter referred to as "the project") to the kingdom of Bhutan, and through discussions, field survey, and technical examination of the results in Japan, has prepared the draft report of the study.

In order to explain and to consult with the Bhutanese side on the components of the draft report, JICA sent to Bhutan a study team headed by Mr. Kanji Kitazawa, Deputy Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs from 27th August to 3rd September, 1992.

As a result of discussion, both parties confirmed the main items described on the attached sheets.

Thimphu, 2nd September, 1992

Mr. Kanji Kitazawa
Leader,
Basic Design Study Team,
JICA

Dasho Kinzang Dorji
Director General,
Ministry of Agriculture
The Royal Government of
Bhutan

Mr. Wangdi Norbu
Director,
Ministry of Finance
Royal Government of
Bhutan

Mr. Namgay Wangchuk
Planning Officer,
Planning Commission
The Royal Government
of Bhutan

Mr. Rinchen Dorji
Supdt. Engineer(DWHR),
Ministry of
Communications
Royal Government of
Bhutan

I **Components of Draft Report**

The Royal Government of Bhutan has agreed and accepted in principle the components of the Draft Report proposed by the team. However, the following comments have been made by the Bhutanese side:

i) The construction equipment viz. motor grader - 1 unit (for levelling work) and high pressure washer - 1 unit (for equipment washing) be procured in Stage 1.3 instead of as proposed in Stage 2.1 in the Draft Report considering the urgent requirement of these machines.

ii) The Royal Government of Bhutan requested for the modification of the farm road Site 3 from Satsham Chorten to Taju instead of Satsham Chorten to Tshongdu, in view of high cost and complication that would involve with the acquisition of land passing through prime paddy fields and township.

iii) The Royal Government of Bhutan requested for the change in the intake structures in Stage 2.2 for irrigation facilities for Nos. 1,3 & 4 into concrete or masonry weir intake instead of wooden mattress intake proposed in the Draft Report. The Royal Government of Bhutan was concerned that the maintenance cost would be high with wooden mattress intake. However,the team informed the Bhutanese side that it would be difficult for the Japanese side to accept this request mainly due to financial consideration.

iv) The Royal Government of Bhutan enquired regarding the possibility of improvement in the design of farm road and/or method of construction after observing the road constructed under Stage 1.2, Site 1. The Royal Government of Bhutan also offered the use of laboratory available with Department of Works, Housing and Roads for the tests of road construction materials. The team agreed to look into it. However, the team advised that the farm roads should be maintained on a regular basis.

v) The Royal Government of Bhutan informed that a private stone crushing plant would be set up in Shaba area and that the project could consider purchase of crushed stones from the crushing plant. The team assured that they would study the comparative benefits from that plant.

vi) On Appendix 15 of the Draft Report, regarding the necessary measures to be taken by the Royal Government of Bhutan, it was agreed that all the conditions would be met before the implementation of construction work.

vii) The team informed that the demolition of the house near the bridge construction site which was earlier required was no longer technically necessary.

II. Japan's Grant Aid System

i) The Royal Government of Bhutan has understood the system of Japanese Grant Aid Programme explained by the Team.

ii) The Royal Government of Bhutan will take the necessary measures described in the Annex attached here to for smooth implementation of the Project on the condition that Grant Aid by the Government of Japan is extended to the Project.

III. Other Important Issues Related to the Project

i) Both sides reconfirmed all the items appearing in the Minutes of Discussions signed on 15 April, 1992, a copy of which was reproduced in the Draft Report.

ii) Particular emphasis was renewed on the items 5 and 6 in the Minutes and with respect to the item 9, it was confirmed that the field of bridge engineering would be added as technical cooperation for the Project.

iii) The construction machinery supplied and concrete plants constructed under the Japanese Grant Aid should be properly maintained so as to be workable in the coming stages of the project.

iv) The plant and equipment supplied and to be supplied under the Japanese Grant Aid will be exclusively used for agriculture development projects of Paro Valley after the completion of the Project.

IV. Further Schedule

i) If the Royal Government of Bhutan has any further comment it will communicate to the Japanese side through diplomatic channels by 20th September 1992.

ii) The team will make final report in accordance with confirmed items, and send it to the Royal Government of Bhutan by the end of November, 1992.

Annex: Necessary measures to be taken by the Royal Government of Bhutan in case Japan's Grant Aid is extended.

1. To secure the site for the Project.

2. To clear, level and reclaim the site prior to commencement of the construction.

3. To undertake incidental outdoor works such as fencing, gates and exterior lighting in and around the site.

4. To construct the access road to the site prior to commencement of the construction.

5. To provide necessary facilities for the Project such as electricity, water supply, drainage, and other incidental facilities.

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

7. To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the project at the port of disembarkation.

8. To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Bhutan and stay therein for the performance of their work.

9. To maintain and use properly and effectively the facilities constructed and equipment purchased under the Grant.

10. To bear all the expenses other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and the installation of the equipment.

LIST OF ATTENDANCE

GOVERNMENT OF JAPAN :

1.	Mr.Kanji Kitazawa	Team Leader, Deputy Director, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs.
2.	Mr.Kaoru Hoshii	Agriculture Development Planner, Deputy General Manager, Irrigation, Drainage and Land Reclamation Department, Hokkaido Engineering Consultants Co., Ltd.
3.	Mr.Hideki Yamazaki	Construction Planner, Chief Engineer of Overseas Department, Hokkaido Engineering Consultants Co. Ltd.

ROYAL GOVERNMENT OF BHUTAN :

1.	Dasho (Dr.)Kinzang Dorji	Director General, Ministry of Agriculture Thimphu.
2.	Mr. Wangdi Norbu	Director (NBA) Ministry of Finance, Thimphu.
3.	Mr. Rinchen Dorji	Superintending Engineer (DWHR) Ministry of Communications, Thimphu.
4.	Mr. Namgay Wangchuk	Planning Officer, Planning Commission, Thimphu.
5.	Mr. Sherub Gyaltshen	Project Manager, Paro Valley Agricultural Development Project, Paro.
6.	Mr. Sonam	Assistant Finance Officer, External Resources Division, National Budget and Accounts, Thimphu.
7.	Mr. Wangdi Gyeltshen	Offtg. Superintending Engineer, Department of Agriculture, Thimphu.
8.	Mr. M.K. Chhetri	Project Engineer, Paro Valley Agricultural Development Project, Paro.