o Construction Period

Construction period was first planned to span 1988 to 1995 (eight years), the Basic Design Study advises that the completion time be extended by the end of 1996.

o Project Cost

Project cost was first estimated at 5,664,314 Kip (US$8,091,878 equivalent, where 1US$ = 700 kip)

o Implementing Parties Concerned

- The Employer:
  MOPTC (current MCTPC)

- The Consultant:
  Initial designs was carried out by Vietnamese No.8 Unit. After withdrawal of the Unit from Laos in 1988, the Company and Lao Communications Institute took over the function.

- The Contractor:
  National Road No.8 Construction Company

b) Design Criteria

Typical cross section of the Project road currently proposed by the Company is shown in Fig. 4.2.1.2. However, the designs initially made by Vietnamese No.8 Unit comprized following criteria:

- Width of base course
  Base course width was to be 9.00 m, also 7.5 m and 8.0 m was applicable in narrower area.

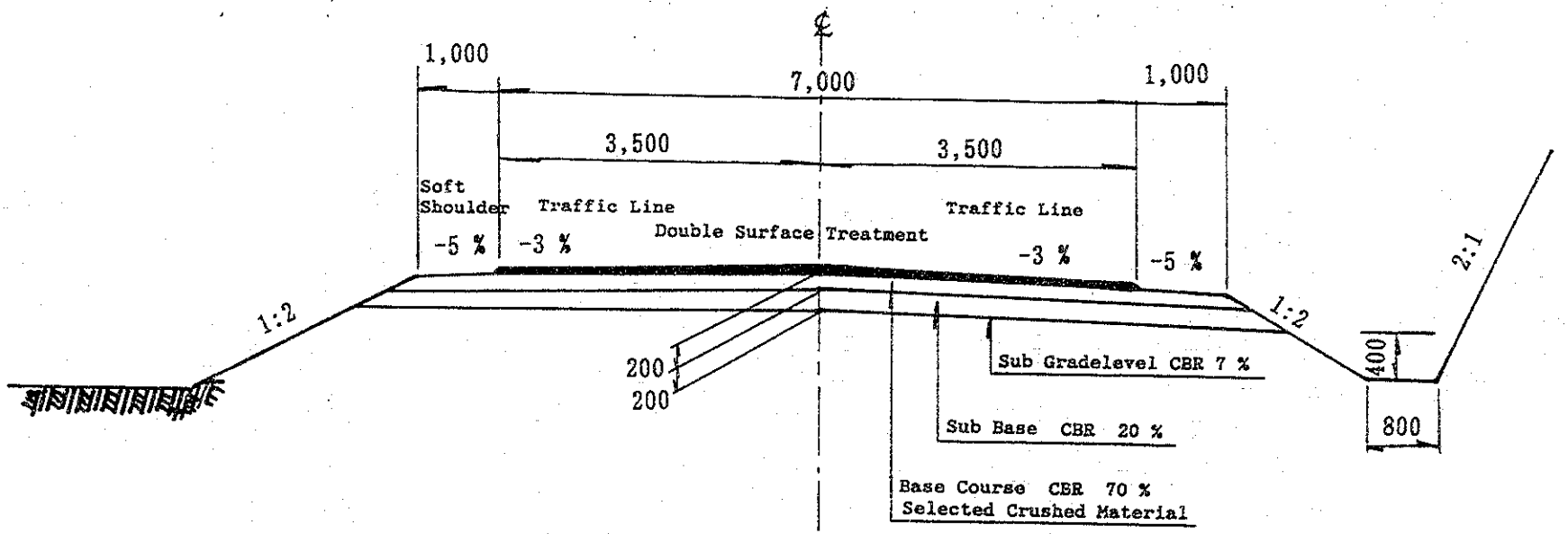


Fig. 4.2.1.2

CROSS-SECTION IN CUT AND ON FILL

S=1/75 (Unit : mm)

Sources:National Road No.8 Construction Company

- Minimum radius
  Minimum radius was to be 120 m, 40 m was to be applied in the critical portions. For most critical area such as steep mountainous section form Mt. Hai to Sanam Basin, 25 m width was to be accepted for practical reason.

- Maximum vertical gradient was to be 8%. 10% could be applicable in restricted area.

- Minimum sight distance
  Minimum sight distance was to be 70 m. 50 m was also applicable in the steep area.

- Pavement width
  pavement width was to be 7 m having 6 m of asphaltic surface course (2-lanes) and 0.5 m of a gravel shoulder on each side. Omitting the shoulder was to be accepted in narrower area.

- Design traffic
  Design traffic was assumed to be 300 - 1,000 vehicle per day.

- Bridge and culvert
  Bridge width was to be 7.0 m. Structure type was to be of bailey bridge (panel bridge).

2) Estimate of the Work Volume of Project Road

Table 4.2.1.2 shows the completed work volume of National Road No.8 for the period 1988-91 together with planned volume for the period 1992-95. Table 4.2.1.3 also gives the work volume completed for single year 1992.

Details of work volume for each item are shown in the following Tables:

Table 4.2.1.4	Quantity of Earthwork
Table 4.2.1.5	Quantity of Bridge
Table 4.2.1.6	Quantity of Pipe Culvert
Table 4.2.1.7	Quantity of Box Culvert

Those are reviewed and bill of quantity remained for the Project Section (L = 50.642 km) is newly clarified as shown in Table 4.2.1.8.

3) Construction Period

The Company primarily intended to complete the construction by the end of 1995. However, the Basic Design Team estimates that the completion shall be postponed until around October, 1996 based on the analysis of remaining works to be executed (Table 4.2.1.8) and the Company's existing fleet capacity. The analysis comprises the study of the essential equipment required for the project road and work capacity of the fleets to be reinforced and renewed taking into account the procurement schedule of the additional equipment. The construction period set out will be examined in relation to the type and number of equipment requested by the Government of Lao P.D.R. (Table 4.2.1.1)

Table 4.2.1.2 Achievement and Annual Planned Schedule of Construction of the National Road No.8 (as of February 1992)

Work Item		Unit	Quantity	Achieve-ment	Schedule			
					1992	1993	1994	1995
1	Clearing	ha	152	130	22			
2.	Cutting	m^3	2,164,320					
2.1	Rock	m^3	787,340	474,880	140,000	170,460	-	-
2.2	Soil	m3	1,376,980	692,306	307,000	385,306		
3.	Filling	m^3	496,067					
3.1	Hard rock	m^3	13,102	-	3,102	10,000	-	-
3.2	Soil	m^3	432,310	349,704	28,000	28,000	26,606	-
4.	Bridge	unit/length	10/278	8/174	2/104	-	-	-
5.	Box Culvert	unit/length	-	-	-	-	-	-
5.1	200 x 200	unit/length	1/11	-	1/11	-	-	-
5.2	400 x 400	unit/length	6/62	2/10	3/33	2/19	-	-
5.3	500 x 600	unit/length	6/66	1/11	3/33	2/22	-	-
5.4	600 x 600	unit/length	1/12	-	1/12	-	-	-
6.	Pipe Culvert	unit/length	197/4,210					
6.1	ø75	unit/length	91/1,993	66/1,436	13/294	12/263	-	-
6.2	2 ø75	unit/length	1/24	1/24	-	-	-	-
6.3	ø100	unit/length	74/1,576	57/1,025	18/350	9/201	-	-
6.4	2 ø100	unit/length	21/596	4/116	10/262	7/218	-	-
6.5	3 ø100	unit/length	1/24	-	1/24	-	-	-
7.	Sub-Base Course	m^3	35,445	-	-	11,815	11,815	11,815
8.	Base Course	m^3	53,190	-	-	17,730	17,730	17,730
9.	Bitumenous Surface Dressing (the first layer)							
9.1	Crushed Stone	m3	25,860	-	-	8,620	8,620	8,620
9.2	Binder	t	2,100	-	-	700	700	700
10.	Bitumenous Surface Dressing (the second layer)							
10.1	Crushed Stone 10-20mm	m^3	4,800	-	-	1,600	1,600	1,600
10.2	Asphalt Sealing	t	480	-	-	160	160	160
11.	Bitumenous Surface Dressing 5-10m	m^3	1,800	-	-	600	600	600
12.	Shoulder	m^3	22,800	-	-	7,600	7,600	7,600
13.	Slope Protection	m^2	2,040	-	-	680	680	680
14.	Side Ditch	m	28,500	-	-	9,500	9,500	9,500

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.3 Achievement of Construction of the National Road No.8 (Jan. 1992 - Dec. 1992)

Item	Unit	Quantity
1. Hard rock excavation	m^3	181,587
2. Soil excavation	m^3	268,867
3. Backfilling (soil)	m^3	31,446
4. Backfilling (hard rock)	m^3	2,498
5. Filling (soil)	m^3	4,400
6. Filling (hard rock)	m^3	8,144
7. Pipe culvert	m	61
8. Pipe culvert ø100	m	344
9. Pipe culvert 2 ø100	m	171
10. Box culvert 600x600	unit	1
11. Box culvert 400x400	unit	1
12. Bridge (sub structure)	unit	3
13. Bridge (super structure)	m	166

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.4 Quantity of Earthwork of the Project Section National Road No.8 (Sta. 0+000~50+642)

Distance (km)	Cutting		Filling		Memo
	Soil	Hard rock	Soil	Hard rock	
0	3,037	-	13,109	-	
1	7,616	-	5,194	-	
2	4,325	-	10,509	-	
3	6,327	-	9,573	-	
4	4,836	-	20,768	-	
5	8,840	-	4,294	-	
6	10,609	-	8,784	-	
7	16,314	-	4,495	-	
8	30,255	29,806	38,901	-	mountainous
9	84,968	54,713	4,961	-	mountainous
10	67,026	-	10,318	-	
11	50,733	-	8,988	-	
12	37,793	-	9,512	-	
13	21,791	-	4,610	-	
14	17,200	-	21,318	-	
15	1,332	-	11,961	-	
16	4,993	532	9,427	-	
17	24,346	15,079	880	22	mountainous
18	21,718	12,621	4,421	389	mountainous
19	42,832	-	2,642	641	
20	9,296	-	4,629	-	
21	7,052	-	23,496	-	
22	4,395	-	21,591	-	
23	6,211	-	22,032	-	
24	3,839	-	12,349	-	
25	3,670	-	22,994	-	
26					

(Continued)

Distance (km)	Cutting		Filling		Memo
	Soil	Hard rock	Soil	Hard rock	
27	3,894	-	9,327	-	
28	9,984	-	11,187	-	
29	1,978	-	11,613	-	
30	3,603	825	13,475	-	mountainous
31	10,182	9,230	4,429	1,396	mountainous
32	7,600	4,156	1,103	2,705	mountainous
33	39,788	38,246	5,491	577	mountainous
34	47,362	41,093	4,949	2,658	mountainous
35	34,512	32,034	5,744	1,869	mountainous
36	54,489	54,383	2,433	-	
37	54,200	48,881	3,887	1,103	mountainous
38	44,440	44,440	5,071	742	mountainous
39	55,271	49,599	4,971	227	mountainous
40	49,440	43,930	3,127	213	mountainous
41	22,718	13,223	6,589	-	mountainous
42	2,509	-	26,446	-	
43	2,266	-	12,091	-	
44	21,754	14,600	5,119	151	mountainous
45	66,729	4,858	2,401	303	mountainous
46	84,562	89,562	97	-	mountainous
47	37,678	23,518	8,656	80	mountainous
48	50,712	26,427	8,067	-	mountainous
49	36,138	17,858	9,355	-	
50	81,152	65,059	2,594	-	mountainous
51	52,670	52,670	2,987	26	
Sub-Total	1,376,980 m^3	787,340 m^3	482,965 m^3	13,102 m^3	
Total	2,164,320 m^3		496,067 m^3		

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.5 Quantity of Bridge of Project Section of National Road No.8 (as of November 1990)

Station (km)		Length (m)	Type
1.	4 + 553	21.336	Bailey Bridge (double panel, single layer)
2.	8 + 129	21.336	Bailey Bridge (double panel, single layer)
3.	12 + 520	82.296	Bailey Bridge (double panel, single layer)
4.	14 + 743	21.336	Bailey Bridge (double panel, single layer)
5.	21 + 840	21.336	Bailey Bridge (double panel, single layer)
6.	23 + 000	21.336	Bailey Bridge (double panel, single layer)
7.	25 + 208	21.336	Bailey Bridge (double panel, single layer)
8.	25 + 672	24.384	Bailey Bridge (double panel, single layer)
9.	27 + 773	21.336	Bailey Bridge (double panel, single layer)

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.6 Quantity of Pipe Culvert of Project Section of National Road No.8 (as of May, 1992)

Station (km)		Length (km)	Diameter (cm)	Already Finished	Not Yet	Remarks
1.	1 + 247.00	15.00	ø100	+		
2.	2 + 800.00	15.00	ø100	+		
3.	3 + 357.00	17.50	ø75	+		
4.	3 + 764.20	19.00	ø75	+		
5.	3 + 968.80	16.50	ø100	+		
6.	4 + 197.20	17.50	ø100	+		
7.	5 + 152.20	18.00	ø75	+		
8.	5 + 434.00	18.00	ø75	+		
9.	6 + 840.00	20.00	ø100	+		
10.	6 + 840.00	20.00	ø75	+		
11.	7 + 140.48	24.00	ø75	+		
12.	7 + 247.82	24.50	ø75	+		
13.	7 + 512.75	22.50	ø100	+		
14.	7 + 512.75	22.50	ø100	+		
15.	7 + 623.00	20.50	ø100	+		
16.	7 + 720.40	19.50	ø75	+		
17.	7 + 761.90	18.00	ø75	+		
18.	7 + 887.37	19.00	ø75	+		
19.	7 + 937.13	19.00	ø75	+		
20.	8 + 304.70	22.00	ø75	+		
21.	8 + 348.32	23.00	ø75	+		
22.	8 + 524.45	20.00	ø75	+		
23.	8 + 608.25	18.50	ø75	+		
24.	8 + 608.25	18.50	ø75	+		
25.	8 + 709.00	24.00	ø75	+		
26.	8 + 836.30	27.85	ø75	+		
27.	8 + 913.30	25.00	ø75	+		
28.	9 + 017.65	33.00	ø75	+		
29.	9 + 148.45	19.00	ø75	+		
30.	9 + 305.85	15.50	ø75	+		

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.7 Quantity of Box Culvert of Project Section on National Road No.8 (as of May, 1992)

Station (km)		Dimension (mm)	Length (m)	Already Finished	Not Yet
1.	1 + 306.00	600 x 500	11	+	
2.	2 + 300.00	600 x 500	11	+	
3.	3 + 158.00	600 x 500	11	+	
4.	6 + 060.23	600 x 500	11	+	
5.	11 + 468.50	400 x 400	11	+	
6.	22 + 833.50	600 x 500	11	+	
7.	26 + 859.10	600 x 500	11	+	
8.	27 + 856.10	400 x 400	12	+	
9.	38 + 977.22	400 x 400	12		-
10.	42 + 605.00	600 x 600	12		-
11.	45 + 619.16	400 x 400	16		-
12.	46 + 529.46	400 x 400	11		-
13.	46 + 973.93	200 x 200	11		-
Total			151	89	62

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

Table 4.2.1.8 Bill of Quantity of Project Road (as of February, 1993)

Work Item	Unit	Designed (1988)	Achievement (1988-92)	Balance	Ratio of Remaining work for the Design Volume (%)
1. Clearing	ha	152	137	15	9.9
2. Cutting	m^3	2,164,320	1,617,640	546,680	25.3
3. Filling	m^3	496,067	446,847	49,220	9.9
4. Bridge Work	m	278 units	198	80	28.8
5. Box Culvert	m	151	65	86	57.0
6. Pipe Culvert	m	4,210	2,535	1,675	39.8
7. Sub Base Course	m^3	103,310	0	103,310	100.0
8. Base Course	m^3	74,950	0	74,950	100.0
9. Surface Dressing	m^2	354,550	0	354,550	100.0
10. Shoulder	m^3	22,790	0	22,790	100.0
11. Slope Protection	m^2	2,040	346	1,694	83.0
12. Side Ditch	m	28,500	0	28,500	100.0

Source: MCTPC Interim Inspection Report on National Road No.8 Construction Project, 1992

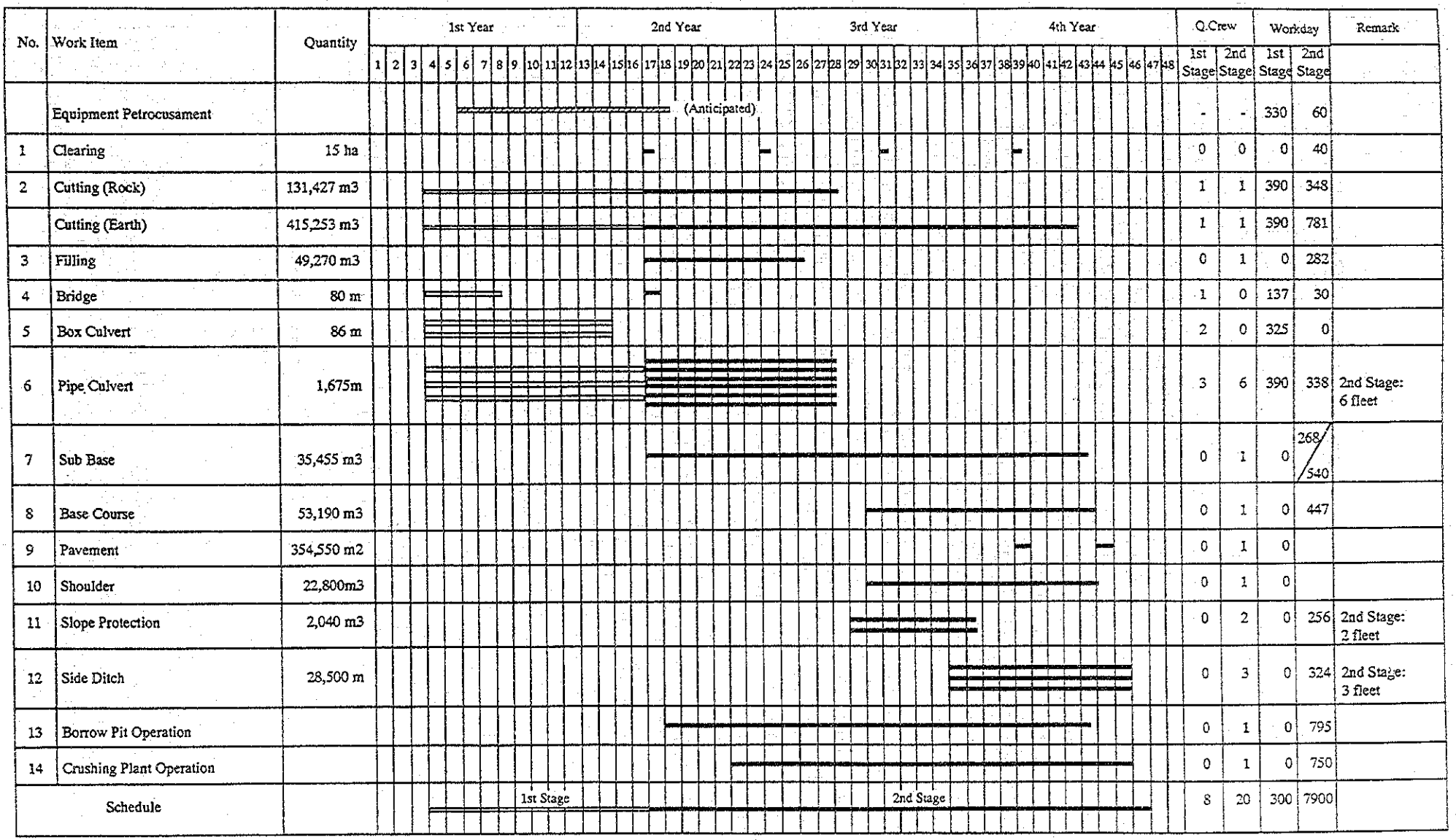
Note: Sub base course: Q = 10.2 m (average width) x 0.2 m (thickness) x 50,640 m (length) = 103,310 m^3

Base course: Q = 7.4 m (average width) x 0.2 m (thickness) x 50,640 m (length) = 74,950 m^3

Shoulder: Q = 2.0 m (both sides average width) x 0.23 m (thickness) x 50,642 m^3 (length) = 22,790 m^3

These quantity are calculated on the basis of proposed pavement design shown in Fig. 4.2.1.2.

Table 4.2.1.9 Analysis of Construction Schedule of National Road No.8 Construction Project



No.	Work Item	Quantity	Q.Crew 1st Stage	Q.Crew 2nd Stage	Workday 1st Stage	Workday 2nd Stage	Remark
	Equipment Petrocusament		-	-	330	60	
1	Clearing	15 ha	0	0	0	40	
2	Cutting (Rock)	131,427 m3	1	1	390	348	
	Cutting (Earth)	415,253 m3	1	1	390	781	
3	Filling	49,270 m3	0	1	0	282	
4	Bridge	80 m	1	0	137	30	
5	Box Culvert	86 m	2	0	325	0	
6	Pipe Culvert	1,675m	3	6	390	338	2nd Stage: 6 fleet
7	Sub Base	35,455 m3	0	1	0	268/540	
8	Base Course	53,190 m3	0	1	0	447	
9	Pavement	354,550 m2	0	1	0		
10	Shoulder	22,800m3	0	1	0		
11	Slope Protection	2,040 m3	0	2	0	256	2nd Stage: 2 fleet
12	Side Ditch	28,500 m	0	3	0	324	2nd Stage: 3 fleet
13	Borrow Pit Operation		0	1	0	795	
14	Crushing Plant Operation		0	1	0	750	
	Schedule		8	20	300	7900	

Note: (1) The 1st Year may correspond to the Calendar Year 1993.
(2) "1st Stage" = to be executed by the existing fleet
"2nd Stage" = to be executed by the renewed fleet

(3) Study on the Equipment required for the Project Road

1) Study on the Plan of Operation

To conclude the remaining work volume of the Project road, the work volume completed as of January 1991 and that of calculated from revised designs are reviewed in details. Then the most appropriate type, number and fleet composition are presumably proposed. Finally, work schedule analysis is conducted based on the required work duration of each work item.

2) Selection of Equipment Type

Based on the activities required for each work item of the remaining work and site condition, the most appropriate equipment type are selected. Also, ancillary equipment to be subsidiary to the main equipment for each work item will be selected taking into account the effectiveness as of a brigade. It is summarised as follows:

Equipment Type	Activities
Air Compressor	for blasting and quarry work
Asphalt Distributor	transport and spraying of asphaltic materials
Bulldozer	cutting and filling work
Concrete Mixer	concrete mixing
Drilling Machine	drilling of blasting hole
Dump Truck	transport of aggregates and excavated material
Flat Bed Truck	transport of construction materials
Fuel Tanker	transport of fuel
Generator	for crushing plant use
Hydraulic Excavator	excavation work
Pick Up	for supervision use
Mobile Workshop	maintenance and repairing of equipment
Motor Grader	for base course, sub-base, subgrade and side ditch works
Vibration Roller	for compaction of materials
Tyre Roller	for compaction of materials
Tractor/Trailer	transport of heavy equipment
Hydraulic Crane	for bridge super-structure, concrete pipe work, etc.
Water Tanker	watering for fill work, base course, sub-base and subgrade work
Wheel Loader	loading of excavated material on to the dump truck

3) Conditions for Determination of Equipment Number

Completion period is set forth at the end of October, 1996 as shown in Table 4.2.2.9. Conditions of work are assumed as follows:

A. Scheduling

Work duration of earth work item is estimated as: determination of an appropriate type and number of equipment for each work item, estimates of productivity by the equipment brigade, number of days required, then calendar days (duration) required.

B. Number of Work Days per Year

Work days per year is calculated as: calendar days per year 365 minus holiday, unworkable days due to rain and maintenance/repairing days for equipment. The details is as follows:

Ratio of Workday per Year (d):	calendar day per year	365
	holiday	109
	unworkable day due to rain	38
	days for maintenance/repairing of equipment	22

Accordingly, d = { 365 - (109+38+22) } / 365 = 0.526 ≒ 0.53

Table 4.2.1.10 Working Per Year

Calendar Day	1	2	3	4	5	6	7	8	9	10	11	12	Total
Number of Day	31	28	31	30	31	30	31	31	30	31	30	31	365
Saturday	5	4	4	4	5	4	5	4	4	5	4	4	52
Sunday	5	4	4	4	5	4	4	5	4	5	4	4	52
Holiday	2	0	0	1	1	0	0	0	0	0	0	1	5
Work day	19	20	23	21	20	22	22	22	22	21	22	22	256
Unworkable days due to rain	0	0	4	5	11	11	5	0	0	0	0	0	38
Routine Maintenance	1	1	1	1	1	1	1	1	1	1	1	1	12
Periodic Maintenance	0	0	1	0	0	1	0	0	1	0	0	1	4
Repair	0	0	0	0	0	3	0	0	0	0	0	3	6
Actual work day	18	19	17	15	8	0	16	21	20	20	21	17	192

Number of Rainy day is estimated from Signo Station Record (1989).

Table 4.2.1.11 Rainfall Record (Signo, 1989)

(unit: mm)

Day	1	2	3	4	5	6	7	8	9	10	11	12
1						0.5	1.5					
2					(43.0)	(8.0)	1.8					
3					(10.0)	(50.0)						
4												
5			(14.5)		(58.2)	1.0	(4.0)					
6							(3.5)					
7						(30.0)						
8												
9						(4.5)						
10							1.0					
11						(280.0)	0.9					
12						(15.5)	(17.5)					
13						(8.5)	(15.5)					
14						(16.0)	(4.5)					
15					(2.5)	(20.0)						
16						(28.0)						
17						(12.4)						
18				(4.0)								
19			(4.0)									
20			0.8									
21			(4.5)									
22												
23			(5.0)	2.3	(53.0)	(16.0)						
24				(2.4)		(3.5)						
25					(22.5)							
26				(16.0)	(48.0)	(13.5)						
27				(5.0)	(12.0)	(8.0)						
28					(5.0)	(16.0)						
29				(55.0)	(10.0)							
30						(4.5)						
31					(18.0)							
Total			28.8	84.7	282.5	535.9	50.2					

Note: The Day whose rainfall figure is shown by ( ) is regarded as unworkable.

Source: Lower Mekong Hydrologic Yearbook 1989

C. Actual Work Hour per Day

Actual work hours per day is calculated: nominal working hour of 8 hours minus resting hours necessary for mechanised work to be 4 hours.

Table 4.2.1.12 Work Hour per Day of Construction Equipment

Item		Hour
Nominal Work Hour		8.0
Checking, before, while and after work	0.33 x 3 h	1.0
Filling of Fuel and Lubricating		0.3
Greasing		0.5
Loss Time while Operation	0.125 x 8 h	1.0
Meeting, Transport, Waiting, Change of Site	0.15 x 8 h	1.2
Actual Work Hour		4.0

D. Mechanical Efficiency

Mechanical efficiency which results from power efficiency of the equipment and operator's skill is estimated as follows:

Mechanical efficiency of the existing equipment: E = 0.8
Mechanical efficiency of the new equipment: E = 0.9

Table 4.2.1.13 Equipment Factor and Work Efficiency

Item	Existing Equipment	Renewed Equipment
Remaining	0.8	1.0
Operator's Skill	0.0	2%
Initial Operation	0.0	5%
Work Efficiency	0.0	3%
Equipment Factor	E = 0.8	E = 0.9

E. Productivity of Main Equipment

Productivity of main equipment in each activity is calculated according to the type and specifications, then required work volume is divided by such productivity to get the required work days, and the work duration (Calendar days) is established.

Table 4.2.1.14 Factors determining the Work Schedule

Work Item	Main Equipment	Factors
1. Clearing	Bulldozer	Area to be cleared per hour.
2. Cutting	Bulldozer	Earth volume to be cut per hour.
3. Filling	Dump truck	Earth volume to be transported per hour per unit. Spreading and compaction work are not considered as determining work. Accordingly, productivity of motor grader, compaction roller, bulldozer, water tanker are not considered in work schedule.
4. Bridge	-	Curing period for concrete, accordingly productivity of mixing plant, crane, etc. are not considered in work schedule.
5. Box Culvert	-	Manual work, accordingly productivity of excavator for occasional hard rock excavation is not considered in work schedule.
6. Pipe Culvert	-	Manual work, accordingly productivity of excavator for occasional hard rock excavation is not considered for this work. Production of concrete pipe is determined by number of forms and curing period, accordingly productivity of mixing plant is not considered in work schedule.

(continued)

Work Item	Main Equipment	Factors
7. Sub-Base Course	Dump Truck	Material volume to be transported per hour per unit. Spreading and compaction work are not considered determining work. Accordingly, productivity of motor grader, compaction roller, bulldozer, water tanker are not considered in work schedule.
8. Base Course	Dump Truck	Material volume to be transported per hour per unit. Spreading and compaction work are not considered determining work. Accordingly, productivity of motor grader, finisher, compaction roller, bulldozer, water tanker are not considered in work schedule.
9. Surface Course	Chip Spreader	Productivity of chip spreading per hour. Material transport and chip production are not considered determining work. Accordingly, productivity of dump truck and crushing plant are not considered.
10. Shoulder	Dump Truck	Material volume to be transported per hour per unit. Spreading and compaction work are not considered determining work. Accordingly, productivity of motor grader, compaction roller, finisher, water tanker are not considered in work schedule. Same material with base course is used, accordingly, those two work to be done simultaneously.
11. Slope Protection	-	Manual work
12. Side Ditch	-	Manual work
13. Borrow Pit	Dump Truck	Volume of materials, laterite, sand, chip, to be transported per hour per unit.
14. Crushing Plant	Crushing Machine	Productivity of crushing plant per hour.

(a) Bulldozer (225 HP)

o Productivity per hour: $Q = 60 \times g \times F \times E/Cm$

Q	=	pushing volume per hour (m^3/h)
g	=	pushing volume per cycle (m^3)
F	=	operation factor
E	=	soil factor
Cm	=	cycle time (min)
Cm	=	L/V1 + L/V2 + Tg
L	=	pushing distance (m)
V1	=	forward speed (m/min)
V2	=	backward speed (m/min)
Tg	=	operation time (gear change, etc.)

o Site Condition

site condition is assumed as follows:

- site factor E: hard rock, boulder ---0.3
  soil mixed with boulder ---0.45
  normal soil ---0.50
- speed: V1 = forward = 3.8 (km/h) = 63.3 (m/min)
  V1 = backward = 4.9 (km/h) = 81.7 (m/min)
- operation factor: F = 0.9
- operation time (gear change, etc.): Tg = 0.3 (min)
- pushing volume per cycle: g = 3.42 (m^3)
- pushing distance: average L = 20 (m)

o Hard Rock:

Cm = 20/63.3 + 20/81.7 + 0.3 x 3 = 1.47 (min)

Q = 60 x 3.42 x 0.9 x 0.3 x 1/1.47 = 37.67 (m^3/h)

o Soil Mixed with Boulder:

Cm = 15/63.3 + 15/81.7 + 0.3 x 3 = 1.28 (min)

Q = 60 x 3.42 x 0.9 x 0.45 x 1/1.28 = 64.9 (m^3/h)

(b) Dump Truck for Fill- and Sub-base Works (8 Capacity)

- Productivity per hour: $Q = 60 \times c \times F \times E/Cm$

Q	=	transport volume per hour (m^3/h)
c	=	loading capacity (m^3/unit)
F	=	work efficiency
E	=	driving factor
Cm	=	cycle time (min)
Cm	=	Tt + (Cms x n/60 x Es)
Tt	=	T1 + T2
T1	=	average driving time = L/V
L	=	hauling distance (km)
T2	=	average loading time (min)
V	=	average speed (km/h)
Cms	=	loading time (min)
n	=	loading number on to one unit (time)
Es	=	loading factor

- Site Condition

c	=	5.26 (m^3)
F	=	0.9
n	=	c/3 (times)
Es	=	0.55

going speed (loaded) = 20 (km/h), returning speed (empty) = 30 (km/h), then, average speed = 25 (km/h)

Cms	=	0.60 (min)
E	=	0.9

loading: T2 = 3.0 (min) (embankment·subgrade)

hauling distance L = 5.0 km

- T1 = 10/25 = 0.4 (h) = 24 (min)
- Tt = 24 + 3.0 = 27 (min)
- Cm = 27 + (0.6 x 3) = 28.8 (min)
- Q = 8.9 (m^3/h)

o L = 2.0 km

T1 = 4/25 = 0.16 (h) = 9.6 (min)

Tt = 9.6 + 3.0 = 12.6 (min)

Cm = 12.6 + 1.8 = 14.4 (min)

Q = 17.7 (m^3/h)

(c) Dump Truck for Aggregate Transport (8t Capacity)

o Site Condition

c = 5.26 (m^3)

F = 0.9

n = 3 (times)

Es = 0.55

going speed (loaded) = 20 (km), returning speed (empty) = 30 (km/h), average speed = 25 (km/h)

Cms = 0.60 (min)

E = 0.9

unloading: T2 = 1.5 (min)

o Km 5 Borrow Pit

T1 = 10/25 = 0.4 (h) = 24 (min)

Tt = 24 + 1.5 = 25.5 (min)

Cm = 25.5 + (0.6 x 3) = 27.3 (min)

Q = 60 x 5.26 x 0.9 x 0.9/27.3 = 9.4 (m^3/h)

o Km 10 Borrow Pit

T1 = 20/25 = 0.8 (h) = 48 (min)

Tt = 48 + 1.5 = 49.5 (min)

Cm = 49.5 + (0.6 x 3) = 51.3 (min)

Q = 60 x 5.26 x 0.9 x 0.9/51.3 = 4.98 (m^3/h)

o Km 20 Borrow Pit

T1 = 40/25 = 1.6 (h) = 96 (min)

Tt = 96 + 1.5 = 97.5 (min)

Cm = 97.5 + (0.6 x 3) = 99.3 (min)

Q = 60 x 5.26 x 0.9 x 0.9/99.3 = 2.57 (m^3/h)

(d) Dump Truck for Base Course (8t Capacity)

o Site Condition

c = 5.26 (m^3)

F = 0.9

n = 3 (time)

going speed = 20 (km/h), returning speed = 30 (km/h), then average speed = 25 (km/h)

Cms = 0.60 (min)

Cmx = mixing time of base course materials = 3.0 (min)

E = 0.9

T2 = 5.0 (min) for feeding to finisher

hauling distance L = 5.0 (km), assumed

T = 10/25 = 0.4 (h) = 24 (min),

Tt = 24 + 3.0 + 5.0 = 32 (min)

Cm = 32 + (0.6 x 3) = 33.8 (min)

Q = 60 x 5.26 x 0.9 x 0.9/33.8 = 7.6 (m^3/h)

F. Work Day Estimates for Work Item

(a) Clearing

Remaining work volume for clearing is estimated at 15 Ha. In addition to mechanised work, assumed 20% of manual work be required, that is:

mechanical work:	15 Ha	(100%)
manual work:	3 Ha	(20%)

o Composition of Equipment of a Standard Brigade (per day)

Equipment	Unit
Bulldozer	1
Wheel Loader	1
Hydraulic Excavator	1
Dump Truck	1
Chain Saw (with engine)	2
Hydraulic Crane	1

o Composition of Staff and Labour

Staff and labour	Person
Engineer	0.2
Foreman	1.0
Operator	3.0
Driver	2.0
Labour	4.0

o Productivity
Area: 15 Ha
Work volume: 150,000 m^2 x 0.05 m (clearing thickness) = 7,500 m^3

o Working days required for Bulldozer:
7,500 m^3 (38 m^3/h x 4 h x 0.8) = 61 days

o Actual Working day required (Calendar day) converted
61/0.53 (working factor) = 115 days

Thus, the clearing work will be assigned for one month for every year for the 4 years period (115 days/4 years = 29 days ≒ 1 month). Mechanical working unit of cutting work shall be diverted to this clearing work where necessary.

(b) Cutting

Remaining work volume for cutting is estimated at 546,680 m^3 being composed of hard rock excavation which needs blasting of 131,427 m^3 and normal excavation for soil with boulder of 415,253 m^3.

Scheduling of work shall accord with the method set out in Table 4.2.1.9, i.e. the estimates is to be done in 2 steps corresponding to the difference of fleet capacity. The first stage corresponds to the period before introduction of additional equipment be made (1st Stage), where the works shall be executed using only the existing equipment, and the second stage corresponds to the period after additional equipment (2nd Stage) be introduced, where the work shall be executed using both the existing and newly procured equipment.

o 1st Stage

As indicated in Table 4.2.1.9, the total calendar day available by using the existing equipment only is estimated at 390.

o Composition of Existing Brigade (2-working brigade, per day)

Equipment	Unit
Crawler Drill	1
Jack Hammer	2
Air Compressor	2
Blasting Machine	1
Bulldozer	3
Hydraulic Excavator	1

Staff and labour	Person
Engineer	2.0
Blasting Technician	2.0
Foreman	4.0
Skilled Labourer (Blasting)	6.0
Operator	7.0
Common Labourer	5.0

o Work Capacity of Existing Fleet
Two-Bulldozers (225 Hp) which were introduced in 1991 and 1992 respectively are available.

o Work Capacity of the Bulldozer under the Conditions established for Site

- work efficiency: E = 0.8
- work factor: d = 0.53
- productivity for hard rock excavation (standard): 38 (m^3/h)
- excavation volume of hard rock: 38 x 0.8 x { 4 (h/day) x 390 (day) x 0.53 } x 1.5 (nos. in average) = 37,700 (m^3)
- productivity of excavation for soil with boulder (standard): 64 (m^3/h)
- excavation volume of soil with boulder: 64 (m^3/h) x 0.8 x {4 (h/day) x 390 (day) x 0.53} x 1.5 (nos. in average) = 63,500 (m^3), thus,

o Cutting volume to be required in the 2nd Stage:
Hard rock excavation: 131,400 - 37,700 = 93,700 (m^3)
Soil with boulder: 415,300 - 63,500 = 351,800 (m^3)

o Scheduling of the construction shall be made on the basis of the 2nd Stage volume.

o Composition of Fleet (2-working brigades, per day)

Equipment		Unit
Crawler Drill	1 x 2	2
Jack Hammer	4 x 2	6
Air Compressor	2 x 2	4
Blasting Machine	1 x 2	2
Bulldozer	3 x 2	6
Hydraulic Excavator	1 x 2	2

o Composition of Staff and Labour (2-working brigades, per day)

Staff and labour	Person
Engineer	2.0
Blasting Technician	1.0
Foreman	4.0
Skilled Labourer (Blasting)	5.0
Operator	14.0
Common Labourer	6.0

o Productivity

Productivity of the working brigade composed of the existing and additional equipment to be procured is estimated as follows:

- Productivity of combined fleet

i) productivity of existing fleet:
hard rock -- 38 x 0.8 = 31 (m^3/h)
soil with boulder -- 64 x 0.8 = 51 (m^3/h)

ii) work efficiency: En = 0.7

iii) productivity of additional equipment to be procured:
hard rock -- 38 x 0.9 = 34 (m^3/h)
soil with boulder -- 64 x 0.9 =58 (m^3/h)

iv) combined productivity:
hard rock -- (31 + 34) x 1/2 = 33 (m^3/h)
soil with boulder -- (51 + 58) x 1/2 = 55 (m^3/h)

v) combined productivity:
hard rock -- 33 (m^3/h) x 5.2 (h) = 172 (m^3/day)
soil with boulder -- 55 (m^3/h) x 5.2 (h) = 286 (m^3/day)

vi) work day required for bulldozer:
hard rock -- 93,700 (m^3)/(172 m^3/day x 3) = 182 days
soil with boulder -- 351,800 (m^3)/(286 m^3/day x 3) = 410 days

o Actual Workday Required (calendar day) for bulldozer:
hard rock -- 183/0.53 = 345 days
soil with boulder -- 411/0.53 = 775 days

(c) Filling

Work schedule depends only on hauling capacity of dump truck. The capacity is determined by the number of dump trucks to be used, and hauling distance which varies according to the work site of filling. Work day required of dump truck shall be determined as follows:

o Composition of Fleet (1-working brigade, per day)

	Equipment	Unit
Transport	Dump Truck	4
	Bulldozer	1
	Motor Grader	1
Compaction	Vibration Roller Patfoot	1
	Vibration Roller Smooth	1
	Vibration Roller Hand guideed	1
	Water Tanker (Bowser)	1

o Staff and Labour (1-working unit, per day)

Staff and labour	Person
Engineer	1.0
Foreman	1.0
Operator	5.0
Driver	4.0
Common Labourer	5.0

o Productivity

Handling capacity is the determining factor for work schedule. Work day required of dump truck shall be calculated as follows:

- loading capacity of dump trucks: 8 t (5.26 m^3)
- hauling capacity per hour (hauling distance 2 km): 17.7 m^3/h/day unit
- transport volume per day:
  (17.7 m^3/h x 5.5 h/day x 0.9) x 4 unit = 350 m^3/day
- workday required of dump truck:
  {49,220 m^3 x 1.05 (compaction factor) } / 350 m^3/day = 148 days

o Actual Workday Required (calendar day)

148 days/0.53 = 280 days

Spreading and compaction work are not determining work of work schedule.

(d) Bridges

Bridge work is divided into two work items, i.e. sub structure and super structure. Construction of four Bailey bridges (Panel bridge) of the length of 20 m (eight abutment) is remained.

Equipment		Unit
Sub structure	Concrete Mixer	1
	Hydraulic Crane	1
	Concrete Mixing Truck	1
	Hydraulic Excavator	1
	Bulldozer	0.5
	Dump Truck	1
	Air Compressor	1
Upper structure	Hydraulic Crane	1

o Staff and Labour (1-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Operator	4.0
Driver	2.0
Carpenter	6.0
Form Worker	8.0
Common Labourer	15.0

o Productivity

• concrete volume of a abutment: 45.3 m^3

Work Item			Quantity	Work day
Footing	:	1 m^3/form	5.4 m^2	5 days
Wall	:	36 m^3/form	52 m^2	20 days
Parapet	:	8.3 m^3/form	8.5 m^2	10 days
Total				35 days

- 2 abutments for a bridge: 2 x 35 = 70 days,
  installation of super structure, 2 days, total 72 days
- construction of super structure takes 20 days.
- Actual workday required (calendar day):
  72 days/0.53 = 136 days

(e) Concrete Box Culvert

The remaining length of box culvert is 86 m (7 places of average length of 12 m).

o Composition of Fleet (2-working brigades, per day)

Equipment	Unit
Hydraulic Excavator	1
Concrete Plant	1
Air Compressor	1
Concrete Mixing Truck	1
Concrete Mixer	1
Flat Bed Truck	1
Hydraulic Crane	1

o Staff and Labour (2-working brigades, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Operator	2.0
Driver	3.0
Carpenter	6.0
Common Labourer	18.0

o Productivity

Workday required is calculated as follows:

• Lower Slab	Excavation----------	3
	Reinforcement----------	7
	Form work ----------	2
	Concreting----------	2
• Wall	Reinforcement----------	7
	Form work ----------	10
	Concreting----------	2
• Upper Slab	Reinforcement----------	3
	Form work ----------	10
	Concreting----------	2
Total		49 days/place

o Workdays Required

- Actual workdays required per place
  49 days / 0.53 = 93 days
- For 7 places: 93 days x 7 = 651 days
- Workdays required per working brigade: 651 x 1/2 = 325 days (2-working brigades)

(f) Pipe Culvert (Installation of Concrete Pipe)

The remaining length of pipe culvert is 1,675 m (140 places of average length of 12 m).

Additional equipment to be procured (concrete mixer, truck, etc.) may be delivered by May 1994, accordingly for the period from January 1993 to April 1994 (390 days), the work shall be executed using only the existing fleet. After then the fleet combined with the existing and additional equipment shall execute the work.

o 1st Stage

The work shall be executed in 390 calendar days by the following work unit:

- Composition of Fleet (3-working brigades, per day)

Equipment	Unit
Hydraulic Excavator	1
Concrete Plant	1
Flat Bed Truck	0
Concrete Mixer	0
Hydraulic Crane	1
Dump Truck	1

- Staff and Labour (3-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Driver	2.0
Operator	1.0
Carpenter	6.0
Common Labourer	18.0

o Productivity and Workday Required

Productivity of installation varies according to pipe diameter. A case of diameter ø750 mm is adopted for the estimates of workday required of the installation in per one place.

• Foundation	Excavation ----------	1
	Compaction (manual)--------	1
• Installation	Installation of pipe ----------	2
	Joint Mortar----------	3
	Backfill and compaction-----	4
• Inlet/Outlet Ditches	Form work----------	3
	Concreting ----------	2
Total		12 days/place

o Workday Required

- Actual workday required per place: 12 days/0.5 = 23 days
- Number of places: (390 days/23 days) x 3 = 51 places

o 2nd Stage

Of a total of 140 places, 51 places shall be completed in the 1st Stage, and ;89 places shall be executed using the equipment to be procured together with 6 work brigades.

o Composition of Fleet (6-working brigades, per day)

Equipment	Unit
Hydraulic Excavator	1
Concrete Mixer	6
Flat Bed Truck	2
Truck Crane	1

o Composition of Staff and Labour

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Driver	3.0
Operator	1.0
Carpenter	12.0
Common Labourer	30.0

o Productivity and Workday Required

A case of diameter ø750 mm is adopted for the estimates.

• Foundation	Excavation ----------	1
	Compaction (manual)--------	1
• Installation	Installation of pipe ----------	2
	Joint Mortar----------	3
	Backfill and compaction-----	4
• Inlet/Outlet Ditches	Form work----------	3
	Concreting ----------	2
Total		12 days/place

o Workday Required

- Workday required per place: per work unit (12 days/0.53) x 89 places = 2,015 days
- Workday required per 6 work unit: 2,015/6 = 335 days

(g) Sub-base Course

Sub-base course work comprises borrow excavation, mixing, transport, spreading and compact spreading and compaction.

o Composition of Fleet (1-working brigade, per day)

Equipment		Unit
Borrow and mixing		sum
Transport of material	Dump Truck	8
Spreading and compaction	Vibration Roller, Pat Foot	1
	Vibration Roller	1
	Smooth Tyre Roller	1
	Water Tanker (Bowser)	1
	Motor Grader	2

o Composition of Staff and Labour(1-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Operator	6.0
Driver	9.0
Skilled Labourer (for equipment)	5.0
Common Labourer	5.0

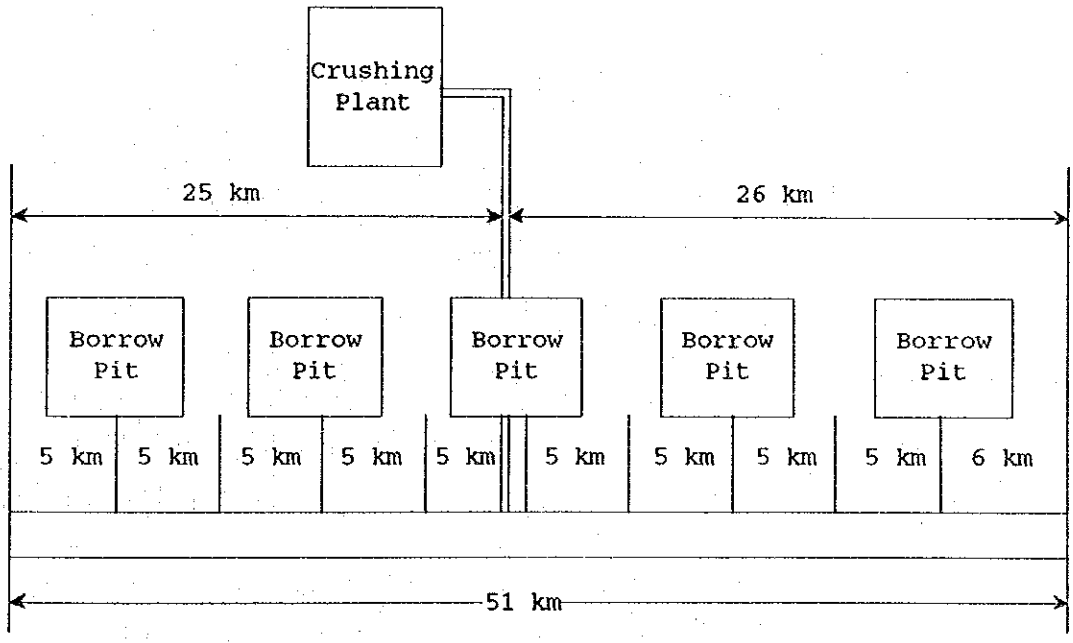
o Productivity and Workday Required

- Work volume of sub-base course is estimated as 103,310 m^3 (road length 50,642 m), the work comprises material production (borrow and mixing), transport, spreading and compaction.
- Mixing ratio shall be:
  lateritic soil + sand: 40%
  crushed rock (0 - 40 mm): 60%
  CBR > 20%
- Transport distance is assumed to be 5 km
- Volume transported per day: { 8.9 (m^3/h) x 5.5 (h/day) x 0.9 } 8 units = 352 m^3/day
- Workday required for dump truck: { 103,310 (m^3) x 1.05 (compaction factor) }/352 (m^3/day) = 308 days

o Actual Work Day Required (calendar day)
308 days/0.53 = 581 days

(h) Base Course

Schedule of base course work shall be determined by the distance between crushing plant and working site. The distance is assumed to be as follows: Crushing plant shall be set up at Km 25, the middle point of the entire section. The aggregates (0-40 mm) produced at the crushing plant shall be transported to the borrow pits which be set up at every 10 km of interval along the road to be constructed. The aggregates shall be mixed with sand, lateritic soil (solid sandy soil with gravel) excavated at the borrow pits, then the mixture is used for base course material.



o Composition of Fleet (1-working brigade, per day)

Equipment		Unit
Transport of material	Dump Truck	9
Spreading and compaction	Vibration Roller, Smooth	2
	Tyre Roller	1
	Finisher (Base Course Material)	1
	Water Tanker (Bowser)	1
	Motor Grader	2
	Vibration Roller, Hand Guided	2

o Composition of Staff and Labour (1-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Operator	8.0
Driver	14.0
Skilled Labourer (for equipment)	9.0
Common Labourer	8.0

o Productivity and Workday Required

- Work volume of base course and shoulder are estimated as 74,950 m^3 + 22,790 m^3 = 97,740 m^3 (42.2 km)
  The work comprises material production, transport, spreading and compaction
- Actual volume of material to be transported: 97,740 (m^3) x 1.05 (compaction factor) = 102,627 (m^3)
- Mixing ratio shall be:
  lateritic soil + sand: 10%, 10,263 (m^3)
  sandy soil: 10%, 10,263 (m^3)
  crushed rock (0-40 mm): 80%, 82,102 (m^3)
- Transport distance is assumed to be 5 km
- Volume transported per day:
  { 7.6 (m^3/h) x 5.5 (h/day) x 0.9 } x 9 units = 339 (m^3/day)

- Workday required for dump truck:
  { 102,627 (m^3)/339 (m^3) } = 303 days

o Actual Work Day Required (calendar day)
  303 days/0.53 = 572 days

(i) Surface Course (Double Surface Treatment)

Surface course work comprises, asphaltic emulsion spray by distributor, spreading of aggregates by chip spreader, and compaction. Two times of surface treatment be repeated get to the thickness required (thickness: 30-50 mm).

o Work volume: 354,550 m^2 (road length 50,642 m)

o Composition of Fleet (1-work brigade, per day)

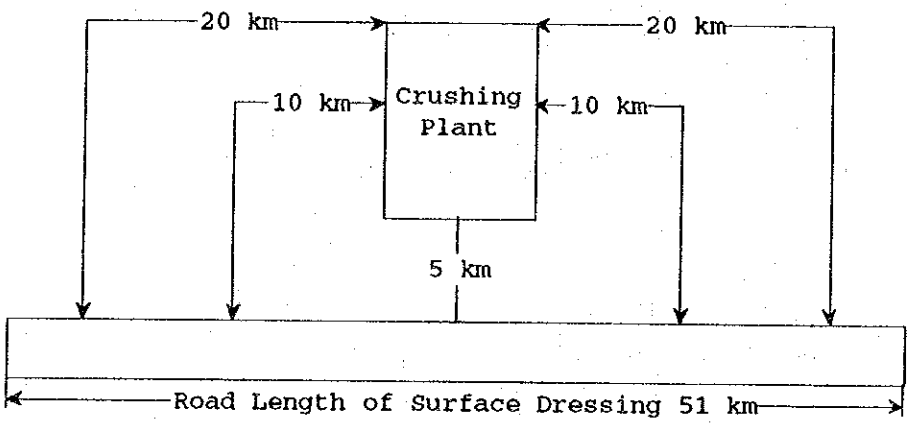
Equipment	Unit
Chip Spreader	1
Vibration Roller	1
Vibration Roller, hand Guided	1
Tyre Roller	1
Asphalt Distributor	1
Dump Truck	5
Road Sweeper	1

o Composition of Staff and Labour

Staff and labour	Person
Engineer	2.0
Surveyor	6.0
Foreman	2.0
Operator	5.0
Driver	9.0
Common Labourer	10.0

o Productivity and Workday Required

- Work productivity is determined by the capacities of spreading and transport of dump truck for aggregates.
- Surface course shall be two layer (thickness to be 40 mm in average).
- Spreading speed shall be 10 m/min with width of 3.5 m.
- Work length per day: 60 (min/h) x 10 (m/min) x 6.5 (h/day) = 3,900 (m/day)
- Road length to be executed per day: 3,900/4 (2-layers, 2-lanes) = 975 (m)
- Actual road length to be executed per day: Say, 975/4.0 = 250 (m)
- Material volume required per day: 250 (m) x 7.0 (m) x 0.04 (m) = 72.0 (m^3)
- Transport distances assumed to be as shown under:



o Productivity of chip spreading per day to be 149 m^3/day, thus number of dump truck required for the transport of chips from crushing plant to site is as follows:

- In case of distance to be 20 km:
  72 (m^3/day)/17 (m^3/day.unit) x 1.2 = 5 units
- In case of distance to be 10 km:
  72 (m^3/day)/33 (m^3/day.unit) x 1.2 = 4 units
- In case of distance to be 5 km:
  72 (m^3/day)/61 (m^3/day.unit) x 1.2 = 2 units

o Work volume required (surface dressing): 354,550 m^2

- Productivity per day:
  250 (m/day) x 7.0 (m, width) = 1,750 (m^2/day)

o Workday required:
  354,550 (m^2)/1,750 (m^2/day) = 203 days

- Actual workday required (calendar day):
  203 days/0.53 = 383 days

(j) Slope Protection

Cobble stone wall shall be used for slope protection. The remaining work volume is estimated to be 1,694 m^3.

o Composition of Fleet (1-working brigade, per day)

Equipment		Unit
Extraction of Stone	Dump Truck	2
Loading	Wheel Loader	1
Concrete-in-fill	concrete Mixer	2
	Flat Bed Truck	1

o Composition of Staff and Labour (2-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	1.0
Operator	1.0
Driver	2.0
Mason	4.0
Common Labourer	15.0

o Productivity and Workday Required

Cobble stone shall be extracted manually and loaded on dump truck by wheel loader.

- Productivity per day:
  4.5 (m^3, wall surface 15 m^2 equiv.)/work unit x 2 units = 9 (m^3)
- Workday required: 1,694 (m^3)/9 (m^3/day) = 188 (days)
- Actual workday required (calendar day):
  188 (day)/0.53 = 355 (days)

(k) Side Ditch

o Side ditch shall be graded by motor grader. Ditch slope shall be protected by gobble stone pitching. Maximum diameter of the stone not exceed 20 cm. Surface of pitching per meter is to be 1.5 m^2 from standard road cross section.

- Stone volume required: 0.2 m x 1.5 m2 = 0.3 m^3
- Grouting mortar required: 0.3 m^3 x 20% = 0.06 m^3

o Composition of Fleet (3-working brigades, per day)

Equipment	Unit
Dump Truck	2
Wheel Loader	1
Jack Hammer	1
Concrete Mixer	3
Motor Grader	1
Flat Bed Truck	1

o Composition of Staff and Labour (3-working brigades, per day)

Staff and labour	Person
Engineer	1.0
Foreman	6.0
Operator	1.0
Driver	5.0
Mason	12.0
Common Labourer	36.0

o Productivity and Workday Required

- Productivity per day:
  40 (m/working unit) x 3 (unit) = 120 (m/day)
- Workday required:
  28,500 (m)/120 (m/day) = 238 (days)
- Actual workday required (calendar day):
  238 day/0.53 = 449 days

(l) Borrow Pit

The work comprises excavation of borrow material, stock piling of crushed stones from crushing plant, mixing of aggregates for base, sub-base, and transport of the mixed materials to work site.

As the distance between borrow pit and work site determines the work schedule, the location shall be selected properly. Lateritic soil and sandy soil to be mixed up ar generally found along the route, thus setting borrow pits in every 10 km interval is possible. Five borrow pits shall be set up along the route. mix ratio is as follows:

o Sub-base course material:
  laterite + sand : 40%, 41,324 m^3
  crushed rock (0-40 mm) : 60%, 61,986 m^3

o Base course material:

laterite	: 10%,	10,263 m^3
sand	: 10%,	10,263 m^3
crushed rock (0-40 mm)	: 80%,	82,101 m^3

o Composition of the equipment to be deployed at a borrow pit is as follows:

o Composition of Fleet (1-working brigade, per day)

Equipment	Unit
Bulldozer	1
Wheel Loader	1
Dump Truck	3
Generator	1
Water Tanker	1

o Composition of Staff and Labour (1-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	1.0
Operator	2.0
Driver	4.0
Common Labourer	5.0

o Productivity and workday required for production of mixed material for Sub-base Course

- 8 nos. of dump trucks to be deployed for transport of crushed rock (0-40 mm) from crushing plant to borrow pit. Volume to be transported is 61,986 m^3.

o Distance 20 km (2-places)

- Capacity of transport per day:
  { 2.6 (m^3/h) x 6.5 (h) x 0.9 } x 8 (unit) = 123 (m^3/day)
- Workday required:
  61,986 (m^3) x 1.05 x 2/5 /123 (m^3/day) = 211 (days)
- Actual workday required (calendar day):
  211 days/0.53 = 398 days

o Distance 10 km (2-places)

- Capacity of transport per day:
  { 5.0 (m^3/h) x 6.5 (h) x 0.9 } x 6 (unit) = 176 (m^3/day)
- Workday required:
  61,986 (m^3) x 1.05 x 2/5 /176 (m^3/day) = 148 (days)
- Actual workday required (calendar day):
  148 days/0.53 = 279 days

o Distance 5 km (1-place)

- Capacity of transport per day:
  { 9.4 (m^3/h) x 6.5 (h) x 0.9 } x 6 (unit) = 330 (m^3/day)
- Workday required:
  61,986 (m^3) x 1.05 x 2/5 /330 (m^3/day) = 39 (days)
- Actual workday required (calendar day):
  39 days/0.53 = 74 days

o Actual workday required in case of dis. = 20 km	398 days
o Actual workday required in case of dis. = 10 km	279 days
o Actual workday required in case of dis. = 5 km	74 days
Total	751 days

Results of the above analysis is summarised in Table 4.2.1.9.

- Location of the crushing plant determines not only the above mentioned mixing schedule of sub-base material but also base course material, and surface course. Thus it shall be established at the middle point of site, Km 25. (where site office has been set up)
- Productivity and workday required for production of mixed material for Base Course and Shoulder
- 8-10 nos. of dump trucks to be deployed for transport of crushed rock (0-40 mm) from crushing plant to borrow pit. volume to be transported is 82,101 m^3.

- Distance 20 km (2-places)
  - Capacity of transport per day:
    { 2.6 (m^3/h) x 6.5 (h) x 0.9 } x 10 (unit) = 153 (m^3/day)
  - Work required:
    82,101 (m^3) x 1.05 x 2/5 /153 (m^3/day) = 225 (days)
  - Actual workday required (calendar day):
    225 days/0.53 = 424 days

- Distance 10 km (2-places)
  - Capacity of transport per day:
    { 5.0 (m^3/h) x 6.5 (h) x 0.9 } x 8 (unit) = 235 (m^3/day)
  - Work required:
    82,101 (m^3) x 1.05 x 2/5 /176 (m^3/day) = 195 (days)
  - Actual workday required (calendar day):
    195 days/0.53 = 276 days

- Distance 5 km (1-place)
  - Capacity of transport per day:
    { 9.4 (m^3/h) x 6.5 (h) x 0.9 } x 8 (unit) = 440 (m^3/day)
  - Work required:
    82,101 (m^3) x 1.05 x 2/5 /440 (m^3/day) = 40 (days)
  - Actual workday required (calendar day): 40 days/0.53 = 75 days

o Actual workday required in case of dis. = 20 km	424 days
o Actual workday required in case of dis. = 10 km	276 days
o Actual workday required in case of dis. = 5 km	75 days
Total	775 days

(m) Crushing Plant

Aggregates for concrete, sub-base course, base course and surface course shall be produced at the crushing plant. Volume required is as follows:

Concrete for structures:	350 m^3
Sub-base course:	61,986 m^3
Surface course: 354,550 m^2 x 0.04 x 1.2 =	17,000 m^3
Base and shoulder:	82,100 m^3
Total	161,486 m^3

Two crushing plant shall be established.

o Composition of Fleet (2-working brigades, per day)

Equipment	Unit
Bulldozer	1
Wheel Loader	2
Dump Truck	5
Small Air Compressor (for Blasting Drill)	2
Medium Air Compressor	1
Drilling Machine	2
Jack Hammer	5
Vibrating Screen	2
Crushing Plant	2
Generator	2
Blasting Machine	2

o Composition of Staff and Labour (2-working brigades, per day)

Staff and labour	Person
Engineer	2.0
Foreman	4.0
Operator	10.0
Driver	5.0
Mechanics	3.0
Mechanics Support	2.0
Skilled Labourer (Blasting)	7.0
Common Labourer	4.0

o Productivity and workday required for production of crushed rock

- Production per hour of crushing plant (then USSR made PS25) is 30 t (19 m^3/h).
- Production per unit per day:
  19.0 (m^3/h) x 8 (h) x 0.9 = 137 (m^3/day)
- Production by two plant per day:
  137 (m^3/h) x 2 (unit) = 274 (m^3/day)
- Workday required:
  161,486 (m^3)/274 (m^3/day) = 589 (days)
- Actual workday required (calendar day):
  589 days/0.7 = 841 days

(n) Concrete Plant

Concrete for bridge abutment, box culvert and pipe culvert shall be produced at the mixing plant.

o Composition of Fleet (1-working brigade, per day)

Equipment	Unit
Wheel Loader	1
Dump Truck	1
Flat Bed Truck	1
Concrete Mixer, 0.3 - 0 m^3	2
Generator	2
Hydraulic Crane	1

o Composition of Staff and Labour (1-working unit, per day)

Staff and labour	Person
Engineer	2.0
Foreman	2.0
Operator	3.0
Driver	2.0
Common Labourer	8.0
Carpenter	3.0
Plaster	5.0

(o) Supporting Work

The following fleet shall support the work:

o Composition of Fleet (1-working brigade, per day)

Equipment	Unit
Flat Bed Truck	1
Pick Up	2
Fuel Tanker	3
Tractor/Trailer	2
Asphalt Distributor	1
Mobile Workshop	2
Mobile Maintenance Vehicle	4
Generator	4
Welder	3
Micro Bus	1

o Composition of Staff and Labour (1-working brigade, per day)

Staff and labour	Person
Engineer	1.0
Foreman	2.0
Operator	2.0
Driver	12.0
Mechanic	8.0
Welder	2.0
Electrician	2.0
Skilled Labourer (logistics)	4.0
Skilled Labourer (Support)	6.0
Common Labourer	4.0

(p) Supervision

The following brigade shall supervise the work:

o Composition of Fleet (1-working brigade, per day)

Equipment	Unit
Pick Up	4
Generator	1
Survey Equipment	3
Concrete, Soil Testing Equipment	2

o Composition of Staff and Labour (1-working brigade, per day)

Staff and labour	Person
Engineer	4.0
Surveyor	4.0
Social and Materials Specialist	3.0
Survey Support	6.0
Material Test Support	2.0
Common Labourer	6.0

(4) Existing Condition of the Equipment possessed by the Company

1) Logistics and Service Condition of the Equipment

The Company has partially succeeded 70 nos. of the equipment from the National Road No. 9 Construction Company when the Company became independent in 1988 to start the construction of National Road No. 8. Since then 44 nos. have been newly added. The total fleet is composed of 114 equipment. Of which, 23nos. (22.2%) are serviceable. 28nos (24.6%) require light repair, 42nos. (36.8%) that of heavy repair like overhaul, and remaining 21 nos. (18.4%) are scrap.

Table 4.2.1.15 Existing Condition of the Equipment possessed by the Company

Existing Condition	Nos.	Ratio (%)
Serviceable	23	20.2
Light Repair	28	24.6
Heavy Repair	42	36.8
Scrap	21	18.4
Total	114	100

Note: Serviceable : Normal operation
Need Light Repair: Usable if replaced with spare parts
Need Heavy Repair: Usable if heavy repair like overhaul be made
Scrap : Not usable

Source: National Road No.8 Construction Company

As shown in Table 4.2.1.15 the serviceability (ratio of serviceable equipment to the total = 20.2%) is significantly low. Of the serviceable equipment, 7 nos. are deployed to Ban Lao Quarry, where aggregates for concrete are produced. (used for construction of National Road No. 8 and No. 13). Details are shown in Table 4.2.1.16.

Table 4.2.1.16 Equipment Deployment of the Company to the Ban Lao Quarry

Equipment	Nos.
Crushing Plant	1
Wheel Loader	1
Dump Truck	2
Generator	1
Hydraulic Excavator (scrap)	(1)
Drilling Machine	1
Air Compressor	1
Total	7

Source: National Road No.8 Construction Company

2) Details of Existing Condition of the Equipment

Details of existing condition of the equipment possessed by the Company are shown in Table 4.2.1.17.

It is notified that remarkable number of Bulldozer, Dump Truck, Hydraulic Excavator, Motor Grader, Water Truck is fallen into the condition of "Need Heavy Repair" and "Scrap".

Table 4.2.1.17 Details of Existing Condition of the Equipment

Equipment	Serviceable	Need Light Repair	Need Heavy Repair	Scrap	Total
Air Compressor	0	3			3
Asphalt Distributor	1	1			2
Bar Bender	2		1		3
Bulldozer	3	2	3	10	18
Concrete Mixer	1				1
Drilling Machine		2	2	1	5
Dump Truck		4	17	3	24
Flat Bed Truck		2	2	1	5
Fuel Tanker		3	3	1	7
Generator	4	5	1	1	11
Hydraulic Excavator		1	2	3	6
Jeep	2				2
Mobile Workshop	1				1
Microbus		1	1		2
Motor Grader			2		2
Pickup	2				2
Crushing Plant	1				1
Vibration Roller, smooth	2				2
Tyre Roller		1	1		2
Tractor/Trailer			1		1
Transformer for Welder			1		1
Hydraulic Crane	1		2		3
Water Tanker		1	3	1	5
Welder	1	1			2
Wheel Roller	2	1			3
Total	23	28	42	21	114
Ratio	20.2%	24.6%	36.8%	18.4%	100%

3) Country of Origin of the Equipment

Country of origin of the equipment possessed by the Company is as shown follows.

The equipment of USSR origin account 101 nos. (88.6%) all of which are fallen into the conditions of "Need Light Repair", "Heavy Repair" and "Scrap", that is, they are not serviceable now. It is due to the serious difficulty to procure spare parts of these equipment. Thus, some of them needs canivarising the parts of other equipment, the equipment in "Scrap" condition increases. As for the equipment of Japanese origin, two bulldozers (1991, 1992), one vibration roller (1991) and two pickups, (1991) were procured, which spare parts supply does not meet any problems so far.

Table 4.2.1.18 Country of Origin of the Equipment

Equipment	USSR	Japan	FRG	Sweden	China	Total
Air Compressor	3					3
Asphalt Distributor	2					2
Bar Bender	3					3
Bulldozer	16	2				18
Concrete Mixer	1					1
Drilling Machine	5					5
Dump Truck	25					25
Flat Bed Truck	5					5
Fuel Tanker	7					7
Generator	7	3	1			11
Hydraulic Excavator	6	1				6
Jeep	1				1	2
Mobile Workshop	1					1
Microbus	2					2
Motor Grader	2					2
Pickup		2				2
Crushing Plant	1					1
Vibration Roller, smooth	1	1				2
Tyre Roller	2					2
Tractor/Trailer	1			1		1
Transformer for Welder	1					1
Hydraulic Crane	3					3
Water Tanker	5					5
Welder	2					2
Wheel Roller	1			2		3
Total	101	8	1	2	2	114

4) Age of the Equipment

All of the equipment were procured from 1978 through 1992. Details are shown in Table 4.2.1.19.

Table 4.2.1.19 Age of the Equipment

Year of Start of Service	Total	Serviceable	Need Light Repair	Need Heavy Repair	Scrap
1978	2	3	0	0	0
1981	4	1	0	3	0
1982	4	0	1	2	1
1983	3	0	0	3	0
1984	11	0	1	4	6
1985	8	0	2	1	5
1986	10	1	1	3	5
1987	27	0	5	21	1
1988	23	4	11	5	3
1989	8	1	7	0	0
1990	4	4	0	0	0
1991	7	7	0	0	0
1992	2	2	0	0	0
Total	114	23	28	42	21
Ratio	100%	20.2%	24.6%	36.8%	18.4%

In relation to the progress of the work, several equipment were additionally procured, particularly in 1987 and 1988. Also, number of the equipment in "Need Light Repair" and "Need Heavy Repair" increased in same 1987 and 1988.

5) Cause of Breakdown

Major causes of breakdown are: wear and tear of under-carriage for almost all equipment due to heavy duty in rocky terrain, choke of filter or radiator due to dust of the silty soils in dry season, of which the latter is partly due to improper maintenance.

Table 4.2.1.20 Cause of Breakdown

Equipment	Place of Breakdown	Causes	Countermeasure
1. Construction Equipment	Crawer (under-carriage)	Rocky terrain	Supply of parts
	Carriage system	Improper operation	Preventive maint.
	Blade, Cutting Edge	Rock excavation	Supply of parts
	Hydraulic system	Dust, Inadequate maint.	Proper maint.
	Engine	Dust, Inadequate maint.	Periodic maint.
2. Vehicle	Tyre	Rocky terrain	Supply of tyre
	Shock absorber	Improper driving	Proper loading
	Blake system	Dust. Inadequate maint.	Preventive maint.
	Engine		Periodic maint.

Most of the breakdown are attributed to improper maintenance, thus initial training for operators and mechanics shall be necessary in case new equipment be procured.

6) Budget for Equipment Maintenance

The budget allocated to the equipment maintenance of the National Road No.8 construction project for the period of 1988-1992 is shown in Table 4.2.1.21.

Kip 37,500,000 (equiv. US$54,000) were allocated in 1992. The amount has been increased in the past five years by 2-4% annum. But significant budget increase shall be required in proportion to the aged equipment increase, or major number of the existing equipment shall be replaced.

Table 4.2.1.21 Budget for Equipment Maintenance

(1,000 Kip)

Item	1988	1989	1990	1991	1992
Budget amount	30,037	10,788	31,915	33,041	37,547
Site Workshop	NA	NA	NA	NA	9,540
Contract Repair	NA	NA	NA	NA	21,006
Expenditure	NA	NA	NA	NA	30,546

Source: National Road No.8 Construction Company

7) Budget for fuel and lubricants

Kip 213,000,000 (US$304,000) are allocated in 1993 which is equivalent of 852,000 ltr. of fuel (diesel oil price Kip 250/ltr.), or, consumption for 25,800 hours operation by bulldozer (25t class, consumption per hour assumed to be 331 ltr.) Since average operating hours per year bulldozer.to be 2,000 hours, it is equivalent of fuel operation by 13 nos. of bulldozers.

It can be concluded that all the serviceable equipment have been used effectively in the period 1989-1992.

Table 4.2.1.22 Budget for Fuel and Lubricants

Year	Budget	Bulldozer (25t class equiv)	
		Equiv. Workhour	Nos. Equiv.
1989	17,897	21,600	11
1990	189,786	23,000	12
1991	198,318	24,000	12
1992	185,698	22,500	12
1993	(213,000)	(25,800)	(13)

Source: National Road No.8 Construction Company

8) Depreciation of the Equipment

Method of depreciation adopted by the Company is: depreciation period set out to be 10 years (for all equipment) by constant rate of depreciation. In case of an equipment of US$100,000 of procurement price, the depreciation is to be US$10,000 annum for entire 10 years period. Unit rate of operation (hire rate) is to be calculated based on the residual value.

Repairing and maintenance cost is set out of 50% of annual depreciation. But it results in unreasonably low maintenance cost when constant rate is applied, in spite of the fact that the cost will increase in inverse proportional to residual value. It is strongly recommended that the repairing and maintenance cost be increased reasonably.

(5) Physical Residual Lives of the Equipment

Estimate of serviceability of the existing equipment for the period 1994-1996 (Project Period) is expressed by "residual ratio" as shown in Table 4.2.1.23, which is derived from cumulated workhours of each equipment and spare parts ratio consumed for repair and maintenance for the period for past several years (1987-1993).
Annex 6.2 of this report indicates the spare parts ratio of equipment (ratio of spare parts consumed to the procurement price) in relation to cumulated workhours. (Table C-1 to Table C-17).

Estimate of residual life by "residual ratio" adopted in this analysis is considered reasonable. For example, residual ratio of bulldozer (250HP, 25t class) of 3 years old is calculated as follows:

Cumulated workhours = 365 x (1 - 0.526) x 5h/day) x 3 years = 2,595 h.

A spare parts ratio corresponding to 2,595 hours use is indicated in Annex 6-2, which is equal to be 0.10. This ratio is considered as "depreciation ratio" of the bulldozer. Then, "residual ratio" is derived as 1 - 0.1 = 0.9, and then this value shall mean the probability of the availability of the equipment for the project road construction period. Where "residual ratio" of new equipment equal to be 1.

Table 4.2.1.23 Residual Lives of the Equipment

No.		Cumulative Work hour (hr)							Depre-ciation Ratio	Resi-dual Ratio	
		1987	1988	1989	1990	1991	1992	1993			
	Group I										
1.	Bulldozer		865	1730	2595	3460	4325	5190	0.25	0.75	C-1
2.	Hydraulic Excavator		865	1730	2595	3460	4325	5190	0.19	0.81	C-2
3.	Vibration Roller, Pat foot					865	1730	2595	0.12	0.88	C-12
4.	Vibration Roller, Smooth				865	1730	2595	3460	0.18	0.82	C-12
5.	Tyre Roller	865	1730	2595	3460	4325	5190	6055	0.22	0.78	C-11
6.	Motor Grader		865	1730	2595	3460	4325		–	–	C-5
7.	Wheel Loader		865	1730	2595	3460	4325	5190	0.28	0.72	C-3
	Group II										
1.	Dump Truck	865	1730	2595	3460	4325	5190	6055	0.47	0.53	C-7
2.	Flat bed Truck			865	1730	2595	3460	4325	0.25	0.75	C-14
3.	Pickup	865	1730	2595	3460	4325	5190	6055	0.41	0.59	C-14
4.	Water Tanker Truck		865	1730	2595	3460	4325	5190	0.32	0.68	C-14
5.	Fuel Tanker Truck			865	1730	2595	3460	4325	0.25	0.75	C-14
6.	Trailer	1730	2595	3460	4325	5190		–	–	–	
	Group III										
1.	Air Compressor $7m^3/m$		865	1730	2595	3460	4325	5190	0.47	0.53	C-9
2.	Air Compressor $17m^3/m$								–	–	
3.	Pedestrian Roller								–	–	
4.	Drilling Machine	3460	4325	5190	6055	6920	7785	8650	0.7	0.3	
5.	Jack Hammer								–	–	
6.	Concrete Mixer $0.3m^3$								–	–	
7.	Concrete Mixer $0.5m^3$								–	–	
8.	Asphalt Distributor		865	1730	2595	3460	(865)	1730	0.8	0.92	
9.	Mobile Workshop								–	–	
10.	Mobile Service Truck		865	1730	2595	3460	4325	5190	0.32	0.68	C-14
11.	Vibration Screen								–	–	
12.	Crushing Plant								–	–	
13.	Generator		865	1730	2595	3460	4325	5190	0.11	0.89	C-10
14.	Truck with Crane			865	1730	2595	3460	4325	0.09	0.91	C-17
15.	Survey Equipment								–	–	
16.	Testing Equipment								–	–	
17.	Finisher								–	–	
18.	Chip Spreader								–	–	
19.	Chain Sew								–	–	
20.	Blasting Equipment								–	–	
21.	Concrete Mixer	1730	2595	3460	4325	5190	6055	6920	0.42	0.58	C-8
22.	Rod Sweeper								–	–	
23.	Bar straighterBender								–	–	
24.	Bar Bender								–	–	
25.	Micro Bus								–	–	
26.	Welder		865	1730	2595	3460	4325	5190	0.26	0.74	C-15

Table 4.2.1.24 Analysis Quantification of the Equipment to be Strengthened for the Implementation of the National Road No.8

No.	Equipment	Clearing	Cutting	Filling	Bridge	Box culvert	Pipe culvert	Sub base	Base course	Surface treatment	Shoulder	Slope protection	Side ditch	Borrow pit	Crushing plant		Concrete plant	Assisting work	For supplier	Standard requirement	Unit possed by the Company				Ser dur
																					Currently Serviceable	Repairable	Sub total	Availability	
Group I (Earth works)																									
1)	Bulldozer	1	2	1	(1)	(1)	(1)							1		1				7.5	3	2	5	0.75	
2)	Hyd. Excavator	(1)		1	(1)	(1)	(1)						1							4	0	1	1	0.81	
3)	Vibration Roller			(1)				1												1.5	1	0	1	0.88	
4)	Vibration Roller							(2)	2	(3)	-									4.5	1	0	1	0.82	
5)	Tire Roller							1	1	(1)	-									2.5	0	1	1	0.78	
6)	Motor Grader			1				2					(1)	1						3.5	0	0	0	-	
7)	Wheel Loader	(1)		1								(1)	(1)	1	1	1	1			6	2	1	3	0.72	
Group II (Transportation works)																									
1)	Dump Truck	(1)		4	(1)		(1)	(8)	(9)	(5)	-	(2)	(2)	(3)	(2)	(3)	(1)			21	0	4	4	0.53	
2)	Flat Bed Truck					(1)	(1)					(1)	(1)				(1)	(1)		3	0	2	2	0.75	
3)	Pick-Up																	2		5	4	0	4	0.59	
4)	Water Tank Truck			1				(1)	(1)		-			1						3	0	1	1	0.68	
5)	Fuel Tank Truck																	3		3	0	3	3	0.75	
6)	Trailer & Tractor																	2		2	0	0	0	-	
Group III (Ancillary works)																									
1)	Air Compressor 7 m^3/min		2		(1)	(1)									1	1				5	0	3	3	0.75	
2)	Air Compressor 17 m^3/min		2												1	1				4	2	0	2	0.75	
3)	Vibration Roller			(1)						(1)	(2)									2	0	0	0	-	
4)	Drilling Machine		2												1	1				4	0	2	2	0.3	
5)	Jack Hammer		6										1		2	3				13	6	0	6	1.00	
6)	Concrete Mixer					1	(6)					(2)	(3)							6.5	0	0	0	-	
7)	Concrete Mixer				(1)	(1)											2			3	0	0	0	-	
8)	Asphalt Distributor									1								1		2	1	0	1	0.92	
9)	Mobile Workshop									1								2		2	0	0	0	-	
10)	Maintenance Car																	4		4	1	3	4	0.68	
11)	Crushing Plant														1	1				2	1	1	2	1.00	
12)	Screen for Aggregate														1	1				2	1	0	1	1.00	
13)	Generator													1	1	1	2	4	1	10	4	5	9	0.89	
14)	Mobile Hyd. Crane				(1)	(1)	(1)													2	1	0	1	0.91	
15)	Survey Instrument																		3	3	2	0	2	1.00	
16)	Soil & Conc. Test																		2	2	1	0	1	1.00	
17)	Finisher								1		-									1	1	0	1	1.00	
18)	Chip Spreader									1										1	1	0	1	1.00	
19)	Saw Machine	2																		2	2	0	2	1.00	
20)	Blasting Machine		2												1	1				2	2	0	2	1.00	
21)	Concrete Mixer Truck				(1)	(1)											1			2	1	0	1	1.00	
22)	Brushing Car									1										1	1	0	1	0.58	
23)	Bar Bend Machine					1														1	1	0	1	1.00	
24)	Straighten Bar Machine					1														1	1	0	1	1.00	
25)	Microbus																	1		1	0	1	1	1.00	
26)	Welding Machine (in Mobile Workshop)																	3		3	1	1	2	0.74	
27)	Tool Set, Heavy Duty																	1		1	1	0	0	-	
	Construction Duration	115	735* 1,165**	280	543	325	725	581	572	383	572	355	449	775	841		730	1,290	1,290	149	43	31	73		

Note: Unit Nos. show in ( ) means number of equipment under a specified job which be convertible to other jobs in the same operation day. (multiply 0.5 and half the number be expressed as "Standard requirement")

*: Hard
**: Common

tification of the Equipment to be Strengthened for the Implementation of the National Road No.8

g	Cutting	Filling	Bridge	Box culvert	Pipe culvert	Sub base	Base course	Surface treatment	Shoulder	Slope protection	Side ditch	Borrow pit	Crushing plant	Concrete plant	Assisting work	For supplier	Standard requirement	Unit possed by the Company: Currently Serviceable	Repairable	Sub total	Availability	Serviceable during Project	Required unit for Project	Strengthened Unit
	2	1	(1)	(1)	(1)							1	1				7.5	3	2	5	0.75	3.7	3.8	3
		1	(1)	(1)	(1)						1						4	0	1	1	0.81	0.8	3.2	3
		(1)				1											1.5	1	0	1	0.88	0.9	0.6	1
						(2)	2	(3)	-								4.5	1	0	1	0.82	0.8	3.7	2
						1	1	(1)	-								2.5	0	1	1	0.78	0.8	1.7	2
		1				2					(1)	1					3.5	0	0	0	-	0	3.5	4
		1								(1)	(1)	1	1	1			6	2	1	3	0.72	2.1	3.9	4
		4	(1)		(1)	(8)	(9)	(5)	-	(2)	(2)	(3)	(2)	(3)	(1)		21	0	4	4	0.53	2.1	18.9	17
				(1)	(1)					(1)	(1)				(1)	2	3	0	2	2	0.75	1.5	1.5	1
															2		5	4	0	4	0.59	2.3	2.7	2
		1				(1)	(1)		-			1					3	0	1	1	0.68	0.7	2.3	2
															3		3	0	3	3	0.75	2.2	0.8	1
															2		2	0	0	0	-	0	2	1
	2		(1)	(1)									1	1			5	0	3	3	0.75	2.2	2.8	2
	2												1	1			4	2	0	2	0.75	1.5	2.5	1
		(1)						(1)	(2)								2	0	0	0	-	0	2	2
	2												1	1			4	0	2	2	0.3	0.6	3.4	1
	6										1		2	3			13	6	0	6	1.00	60	7	5
				1	(6)					(2)	(3)						6.5	0	0	0	-	0	6.5	
			(1)	(1)										2			3	0	0	0	-	0	3	2
								1							1		2	1	0	1	0.92	0.9	1.1	1
								1							2		2	0	0	0	-	0	2	1
															4		4	1	3	4	0.68	2.7	1.3	1
													1	1			2	1	1	2	1.00	2.0	0	0
													1	1			2	1	0	1	1.00	1.0	1	1
												1	1	1	2	4	10	4	5	9	0.89	8.0	2.0	1
			(1)	(1)	(1)												2	1	0	1	0.91	0.9	1.1	1
																3	3	2	0	2	1.00	2.0	1	1
																2	2	1	0	1	1.00	1.0	1	1
							1		-								1	1	0	1	1.00	1.0	0	0
								1									1	1	0	1	1.00	1.0	0	0
																	2	2	0	2	1.00	2.0	0	0
	2												1	1			2	2	0	2	1.00	2.0	0	0
			(1)	(1)										1			2	1	0	1	1.00	1.0	0	0
								1									1	1	0	1	0.58	0.6	1.4	0
				1													1	1	0	1	1.00	1.0	0	0
				1													1	1	0	1	1.00	1.0	0	0
															1		1	0	1	1	1.00	1.0	0	0
															3		3	1	1	2	0.74	1.5	1.5	(1)
															1		1	1	0	0	-	0	1	1
	735* 1,165**	280	543	325	725	581	572	383	572	355	449	775	841		730	1,290	1,290	149	43	31	73		58.8	90.2	(1) 69

er of equipment under a specified job which be convertible to other jobs in the same operation day. (multiply 0.5 and half the number be expressed as "Standard requirement")

(6) The Equipment to be required

Work schedule for every work item is indicated in Table 4.2.19. Construction period is divided into two stages corresponding to the difference of fleet capacity. The first stage corresponds to the period before the time of introduction of additional equipment, when the work shall be executed using only the existing fleet, and the second stage conform to the period after their introduction, in which the work be executed using both the existing and newly procured equipment.
Work schedule in the first stage is indicated by white line and that of the second stage by black line as shown in Table 4.2.1.1.

Duration of the first stage is assumed to be 13 months (equal to 390 calendar days). Productivity of the existing fleet is regarded as constant through the period. As for the second stage, equipment type and number required for completion of each work item is set out in advance, thus scheduling is made based on the work productivity by the new fleet.

Actual duration required (calendar day) is calculated as demonstrated in above sub-clause (3). In conclusion, an assumption of the completion date of the Project road set forth, in advance, as of October 1996 is proved quite reasonable.

The equipment type and number required for each work item is indicated as "standard requirement" in Table 4.2.1.24. Figure in parentheses indicates the number of specified equipment to be possible to used for the two alternative work items within the one work day. Thus, the figure in ( ) will be reduced to the half value.

The existing equipment are assumed to be continuously available in the second stage, which include the serviceable equipment and to-be-serviceable equipment of the existing fleet of the Company. They are designated as "Serviceable during Project". The "Required unit for Project" is derived from "Standard requirement" minus "Required unit for Project".

The equipment to be requested under the Project is designated as "strengthened unit", which is concluded on the basis of "Required unit for Project", taking into consideration of the factors such as possibility of

equipment transfer or borrow from the other Road Construction Companies.

Comparison between this result and content of the request (Table 4.2.1.1) indicates immediately that the request be quite appropriate and necessary for the construction of Project road.

4.2.2 Study on the Implementation

(1) Organization

The executing agency of the Project is MCTPC. The equipment to be procured under the Project will be transferred to the National Road No.8 Company. Management of the equipment to be procured such as operation and maintenance will be conducted by the Company's well organised system. After completion of the Project road, National Road No.8, the equipment will be diverted for the construction of National Road No.1.

The company under the immediate control of MCTPC, within which the managerial order flows on the stream of the Minister-Vice Minister-Director of Communication-the Chief Director of the Company-Superintendent of Construction. Organization under the Superintendent includes General construction Manager, under whom Chief of Accountant, Equipment Maintenance Chief, Personnel Section Chief, Engineers for Earthwork, Structure, Concrete Mixing Plant, Transport, and Stone Crushing Plant.

The Company assigns 42 administrative and technical staff, 113 permanent workers and 100 temporary workers to the implementation of the Project Road. Of which, the Road and Bridge section comprises: 14 road and bridge engineers, 1 electric engineer, 19 assistant engineers, 18 mechanics, 72 technician, operators and drivers, and 131 workers. The Company will be required to reinforce those organizational strength up to some 485 personnel in case of the Project is implemented in terms of introduction of Japanese Grant Aid.

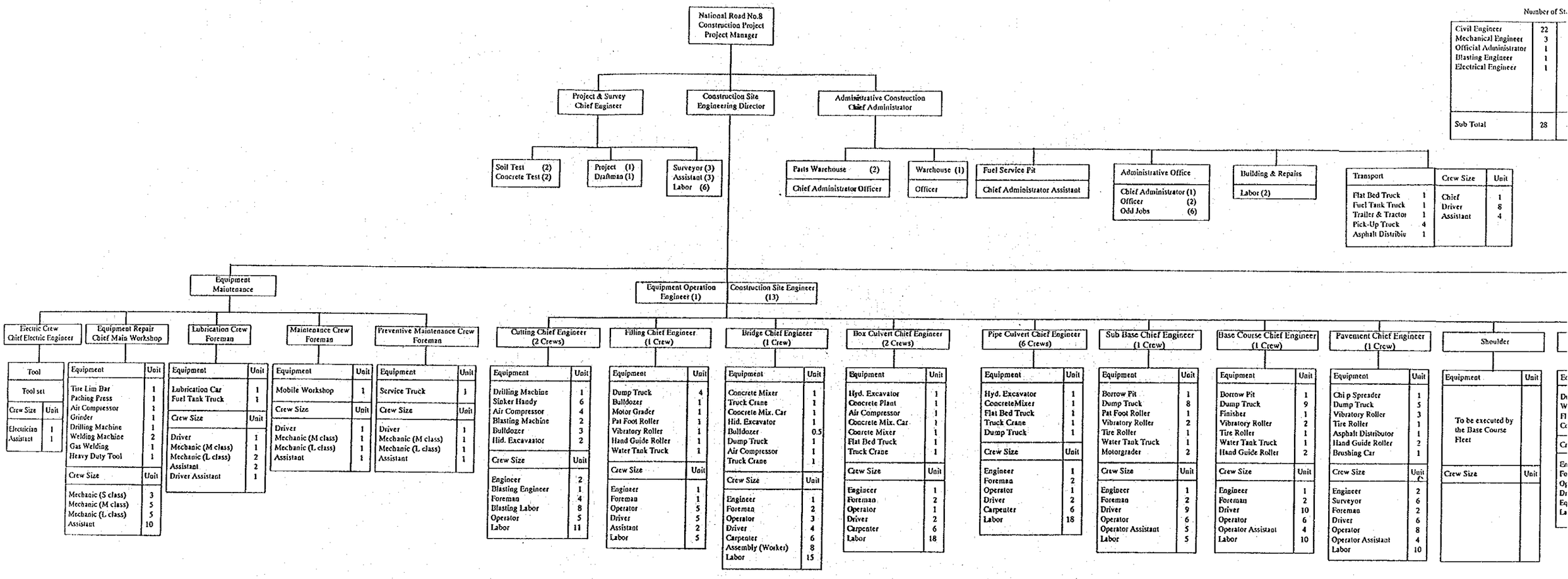


Fig.4.2.2.1

ORGANIZATION CHART OF THE NATIONAL ROAD NO.8 CONSTRUCTION PROJECT

Number of Staff and Workers for National Road No.5 Construction Project

Civil Engineer	22	Foreman	27	Officer	8	
Mechanical Engineer	3	Mechanical Foreman	5	Assistant Engineer	9	
Official Administrator	1	Operator	48	Odd Jobs	8	
Blasting Engineer	1	Driver	72	Mechanic (S class)	3	
Electrical Engineer	1	Assistant Operator	21	Mechanic (M class)	8	
		Assembly Worker	8	Mechanic (L class)	15	
		Blasting Labor	8	Mechanical Assistant	17	
		Carpenter	22	Electrician	1	
		Labor	177			
Sub Total	28	Sub Total	388	Sub Total	69	Total 485

1)

Fuel Service Pit

Chief Administrator Assistant

Administrative Office

Chief Administrator	(1)
Officer	(2)
Odd Jobs	(6)

Building & Repairs

Labor (2)

Transport		Crew Size	Unit
Flat Bed Truck	1	Chief	1
Fuel Tank Truck	1	Driver	8
Trailer & Tractor	1	Assistant	4
Pick-Up Truck	4		
Asphalt Distribu	1		

Pipe Culvert Chief Engineer (6 Crews)

Equipment	Unit
Hyd. Excavator	1
ConcreteMixer	1
Flat Bed Truck	1
Truck Crane	1
Dump Truck	1

Crew Size	Unit
Engineer	1
Foreman	2
Operator	1
Driver	2
Carpenter	6
Labor	18

Sub Base Chief Engineer (1 Crew)

Equipment	Unit
Borrow Pit	1
Dump Truck	8
Pat Foot Roller	1
Vibratory Roller	2
Tire Roller	1
Water Tank Truck	1
Motorgrader	2

Crew Size	Unit
Engineer	1
Foreman	2
Driver	9
Operator	6
Operator Assistant	5
Labor	5

Base Course Chief Engineer (1 Crew)

Equipment	Unit
Borrow Pit	1
Dump Truck	9
Finisher	1
Vibratory Roller	2
Tire Roller	1
Water Tank Truck	1
Hand Guide Roller	2

Crew Size	Unit
Engineer	1
Foreman	2
Driver	10
Operator	6
Operator Assistant	4
Labor	10

Pavement Chief Engineer (1 Crew)

Equipment	Unit
Chi p Spreader	1
Dump Truck	5
Vibratory Roller	3
Tire Roller	1
Asphalt Distributor	1
Hand Guide Roller	2
Brushing Car	1

Crew Size	Unit
Engineer	2
Surveyor	6
Foreman	2
Driver	6
Operator	8
Operator Assistant	4
Labor	10

Shoulder

Equipment	Unit
To be executed by the Base Course Fleet	

Crew Size	Unit

Slope Protection Chief Engineer (2 Crews)

Equipment	Unit
Dump Truck	2
Wheel Loader	1
Flat Bed Truck	1
Concrete Mixer	2

Crew Size	Unit
Engineer	1
Foreman	2
Operator	1
Driver	3
Equip. Assistant	1
Labor	15

Side Ditch Chief Engineer (3 Crews)

Equipment	Unit
Dump Truck	1
Wheel Loader	1
Flat Bed Truck	1
Concrete Mixer	3
Motor Grader	1

Crew Size	Unit
Engineer	1
Foreman	3
Operator	2
Driver	2
Equip. Assistant	1
Labor	30

Borrow Pit Chief Engineer (1 Crew)

Equipment	Unit
Bulldozer	1
Wheel Loader	1
Dump Truck	4
Water Tank Truck	1

Crew Size	Unit
Engineer	1
Foreman	1
Operator	2
Driver	5
Equip. Assistant	2
Labor	5

Quarry Site Chief Engineer (1 Crew)

Equipment	Unit
Wheel Loader	1
Drillin Machine	1
Air Compressor	4
Sinker Handy	2
dump Truck	3
Blasting Machine	1

Crew Size	Unit
Engineer	1
Foreman	1
Operator	2
Driver	5
Mechanical Assistant	2
Labor	5

Crushing Plant Chief Engineer

Operation Mechanical Engineer (1 Crew)

Equipment	Unit
Crushing Plant	1
Wheel Loader	1
Dump Truck	4

Crew Size	Unit
Engineer	2
Foreman	1
Operator	3
Mechanical Assistant	2
Labor	4
Driver	6

Concrete Plant Chief Engineer

Concrete Pipe Production Foreman

Equipment	Unit
Concrete Mixer	1
Metal Form	10
Flat Bed Truck	1

Crew Size	Unit
Engineer	1
Foreman	1
Carpenter	4
Labor	10

Operation Mechanical Engineer

Equipment	Unit
Concrete Plant	1
Flat Bed Truck	1
Pick-Up	1

Crew Size	Unit
Engineer	1
Foreman	1
Operator	2
Labor	8
Driver	2

RT OF
CONSTRUCTION

(2) Finance

Construction cost estimates was made by the Company and submitted to MCTPC for its approval and budget allocation.

Initial budget approved at the start of work in 1988 was Kip 5,664.31 million (US$8.09 million equivalent, then the cost per Km was Yen 19.04 million/Km, where US$1.00 = Kip 700 = Yen 120), and Kip 214,247 million (US$3.06 million equivalent) was expended. (as of May 1992) Accordingly available fund for the remaining work will be US$5.03 million. However, managerial analysis made by the study team indicates that the initially approved fund of US$5.03 million does not necessarily satisfy the actual expenditure which will be required for into the remaining work. The major reasons of the cost increase are as follows:

- extension of construction period by one year
- costs for reinforcement of the institutional strength
- costs for operation and maintenance of the additional equipment to be procured under the Project
- costs due from the design improvement of Sub-base, Base course and Double Surface Treatment
- inflation

Further endeavor by the Government for securing the budget for the construction of Project road is strongly expected.

Table 4.2.2.1 Past Achievement and Proposed Budget Allocation for the Project Road

(unit : Kip million)

Construction	1988	1989	1990	1991	1992	1993	1994	1995	1996
Road	136	248	448	538	242	424	891	931	508
Bridge	0	0	0	188	28	100	52	0	0
Box Culvert	32	58	56	60	9	100	200	46	0
Administration	28	4	1	41	33	80	90	80	20
Total Achievement	186	310	505	826	312	704	(1,233)	(1,057)	(528)
US$ equiv.	266	443	722	1.182	445	1.000	(1.760)	(1.510)	(760)
Proposed Budget	-	-	-	-	-	-	1,665	1,427	713
US$ equv.	-	-	-	-	-	-	2.379	2.039	1.019

Note: (1) Figures in 1994 through 1996 are expected budget amount.
(2) It is recommended that figures in 1994 through 1996 be increased by 35% respectively.

4.2.3 Projects Assisted by the Foreign Donor Agencies

There are no other projects assisted by other foreign donor agencies which this very Project may overlap or interfere or affect physically.

4.2.4 Outline of the Use of Equipment

Specified purposes of use of equipment introduced under the Project are outlined respectively as below.

Table 4.2.4.1 Purposes of Use of the Equipment

Group No./ Equipment	Purpose	Model
Group I (for Earthwork)		
1) Bulldozer	cutting, filling	225HP
2) Hydraulic Excavator	side ditch excavation, slope trimming	19 t, 0.7m^3
3) Vibration Roller	compaction for materials, sub-base, base, backfilling for structure	11t.
4) Vibration Roller	- do -	9.5t
5) Tyre Roller	compaction for surface course	9t
6) Motor Grader	garding for base, side ditch	155H, 3.7m
7) Wheel Loader	excavation and loading of material	110HP, 1.5m^3
8) Spare parts of the above		for two years use
Group II (for Transport)		
1) Dump Truck	transport for material	8t, 4x2
2) Flatbed Truck	transport for light equipment	2-3t
3) Pickup	supervision	double cabin
4) Water Tanker	watering	6000 lts
5) Fuel Tanker	fuel supply on site	4000 lts
6) Tractor/Trailer	transport for heavy equipment	30t, 280HP
7) Spare parts of the above		for two years use
Group III (Miscellaneous)		
1) Air Compressor	for drilling blasting holes	7.5m^3/min
2) Air Compressor	- do -	17.0m^3/min
3) Vibration Roller	light compaction	hand-guided
4) Drilling Machine	drilling blasting holes	crawler type. 7.0m^3
5) Jack Hammer	- do -	sinker, handy, 10kg
6) Concrete Mixer	concrete mixing	0.3m^3
7) Concrete Mixer	concrete mixing	0.5m^3
8) Asphalt distributor	spraying asphaltic materials	8000 lts
9) Mobile Workshop	for equipment maintenance and repair on Site	with welding machine
10) Mobile Maintenance Truck	for equipment maintenance and lubrication on Site	5t, flatbed truck
11) Vibrating Screen for Crushing Plant	screening of aggregates	25-35t/h, with belt conveyor
12) Generator	for crushing plant	1000kva, 220v
13) Hydraulic Crane	for bridge or heavy works purpose	15t - 20t
14) Survey Equipment	for survey	theodolitex2, level standard type c
15) Soil&Concrete Equipment	for testing materials	standard type c
16) Tool Set	to be attached to the equipment	heavy duty
17) Spare parts of the above		for two years use

4.2.5 Necessity of the Technical Assistance

As the equipment maintenance staff or mechanics of the Company have not been familiar with the equipment of Japanese origin, the initial stage of training by the suppliers shall be provided for operation, preventive maintenance, and even routine maintenance of the some specific equipment. However consecutive training at Site after the initial one by expatriates seems unnecessary, because the equipment management level of the Company has reached to cope with by itself the requirement.

As the equipment owned by the national construction companies may increase, the mechanised road construction will be extended across the country, and it will become necessary to establish the equipment management system and standardize the road maintenance services.

4.2.6 Basic Policy on Cooperation

Considering that the positive impact of the Project and the competent implementing capacity of the recipient country have been fully assured, and that the effect of the Project conforms to the institution of the general grant aid, it is regarded as appropriate to implement the Project with the General Grant Aid of the Japanese Government. Therefore, the outline of project will be summarized, and the basic design will be made on the premise that the Grant Aid of the Japanese Government be extended. However, the content of request of the Government of Laos should be partly revised as reviewed and described in the foregoing section.

4.3 Outline of the Project

4.3.1 Structure of the Construction Brigade

Based on the analysis made hereto the following will be essential for the formulation of the equipment fleet.

(1) to appoint a competent civil or mechanical foreman to every work brigade
(2) to assign reasonable numbers of equipment and workers to every work brigade
(3) to establish efficient management and supervisory unit

4.3.2 Construction Term and Work Volume of Main Item

Completion period of the Project road will be October, 1996. Work volume of main item for which the Project equipment be applied is set out as shown in Table 4.3.2.1.

Table 4.3.2.1 Estimated Work Volume of Main Item of Project Road

Work Item	Quantity	Remarks
1. Clearing	15 ha	-
2. Cutting	546,680 m^3	Include blasting of hard rock
3. Filling	49,220 m^3	-
4. Bridge	80 m	Bailey Bridge
5. Box Culvert	86 m	-
6. Pipe Culvert	1,675 m	-
7. Sub-base Course	103,310 m^3	Excavation, transport and placing of selected material
8. Base Course	74,950 ^{3}	Production materials by crushing plant, transport and placing materials
9. Surface Course	354,550 m^2	Double surface treatment
10. Shoulder	22,790 m^3	-
11. Slope Protection	1,694 m^2	-
12. Side Ditch	28,500 m	-
13. Operation of Borrow Pit	sum	Borrow excavation, mixing and transport of base course material
14. Operation of Crushing Plant	sum	Production of aggregates

(continued)

Work Item	Quantity	Remarks
15. Operation of Concrete Plant	sum	Production of concrete mix
16. Repair and Maintenance of Equipment	sum	-
17. Transport of Materials	sum	-
18. Survey	sum	-
19. Quality Control	sum	-
20. Supervision	sum	-

4.3.3 Location and Site Office

The Project road is located as shown in Fig. 4.2.2.1. The equipment to be procured under the Project shall be delivered to and handed-over to the MCTPC at the Company's camp located at some 28 km from the starting point (Ban Lao) on the Project road.

4.3.4 Outline of the Equipment

Following are outlines of the recommended equipment in case the Project be implemented through the extension of the Japanese Aid.

Recommended Equipment		Recommended Specification	Nos.
Group I (for Earthwork)			
The equipment in this group comprises equipment for road earthwork including cutting, filling, borrow excavation, for loading materials, for compacting materials and for pavement works, etc.			
1)	Bulldozer	225 HP	3
2)	Hydraulic Excavator	19 t, 0.7 m^3	3
3)	Vibration Roller	11 t, Pat-foot	1
4)	Vibration Roller	9.5 t, smooth drum	2
5)	Tyre Roller	9 t	2
6)	Motor Grader	155 HP, 3.7 m	4
7)	Wheel Loader	110 HP, 1.5 m^3	4
8)	Spare parts of the above	for two years use	sum

(continued)

	Recommended Equipment	Recommended Specification	Nos.
Group II (for Transport of Materials)			
This group comprises vehicles for material transport such as aggregates, lateritic soil or sand, for equipment transport, and for supporting work such as water and fuel transport, etc.			
1)	Dump Truck	8 t, 4 x 2	17
2)	Flat Bed Truck	2 - 3 t	1
3)	Pick up	double cabin	2
4)	Water Tanker	6,000 ltr.	2
5)	Fuel Tanker	4,000 ltr.	1
6)	Tractor/Trailer	30 t, 280 HP	1
7)	Spare Parts of the above	for two years use	sum
Group III (for Ancillary and Miscellaneous Work)			
The equipment in this group comprises equipment: for quarry works, crushing plant operation, pavement work, and supervision service, etc.			
1)	Air Compressor	7.5 m^3/min.	2
2)	Air Compressor	17.0 m^3/min.	1
3)	Vibration Roller	hand guided, 600 kg	2
4)	Drilling Machine	crawler type, 7.0 m^3/min.	1
5)	Jack Hammer	sinker type, handy, 10 kg	5
6)	Concrete Mixer	0.3 m^3	4
7)	Concrete Mixer	0.5 m^3	2
8)	Asphalt Distributor	8,000 litr.	1
9)	Mobile Workshop	with welding machine	1
10)	Mobile Service Truck	5 t, flat bed truck	1
11)	Vibrating Screen for Crushing Plant	25 - 35 t/h, with belt conveyor	1
12)	Generator	100 KVA, 220 V	1
13)	Hydraulic Crane	15 t - 20 t	1
14)	Survey Equipment	2-theodolite, 2-level, etc.	1
15)	Soil and Concrete Testing Equipment	standard set	1
16)	Tool Set	heavy duty	1
17)	Spare parts of the above	for two years use	sum

4.3.5 Structure for Maintenance of Equipment introduced under the Project

(1) Operational Structure

Maintenance of the equipment to be procured under the project shall be executed in five stages (1-5). The Company's site workshop will cover the 1-3 stages, while the (4-5) stages which include major repair services like engine overhaul will be made on the contract repair basis outside the Site.

The stages (1-2) include routine maintenance, periodic maintenance, lubricating, grease up, cleaning or minor repair, parts change, idling, etc. The services of the stages (1-2) will be covered by mobile workshop and mobile service truck to be procured under the Project., which thus realise preventive maintenance of the equipment. The stage (3) deals with major parts change, which is also covered by the Company's site workshop. The Company's workshop has already established the capacity to cope with above mentioned staged maintenance system.

Current checking system of equipment of the Company was introduced by US makers since around 1990. The items for the checking comprize work hour, fuel, parts change, maintenance hour, maintenance cost, etc. to effect the scheduling of maintenance of the equipment. The operational structure of the equipment maintenance of the Company is recommended as shown in Fig. 4.3.5.1.

The services of the stage (4-5) will be executed at the under private or public workshops in Vientiane. The equipment to be procured under the Project also shall be provided the services from those workshops. The heavy duty workshops in Vientiane are listed in Table 4.3.5.1.

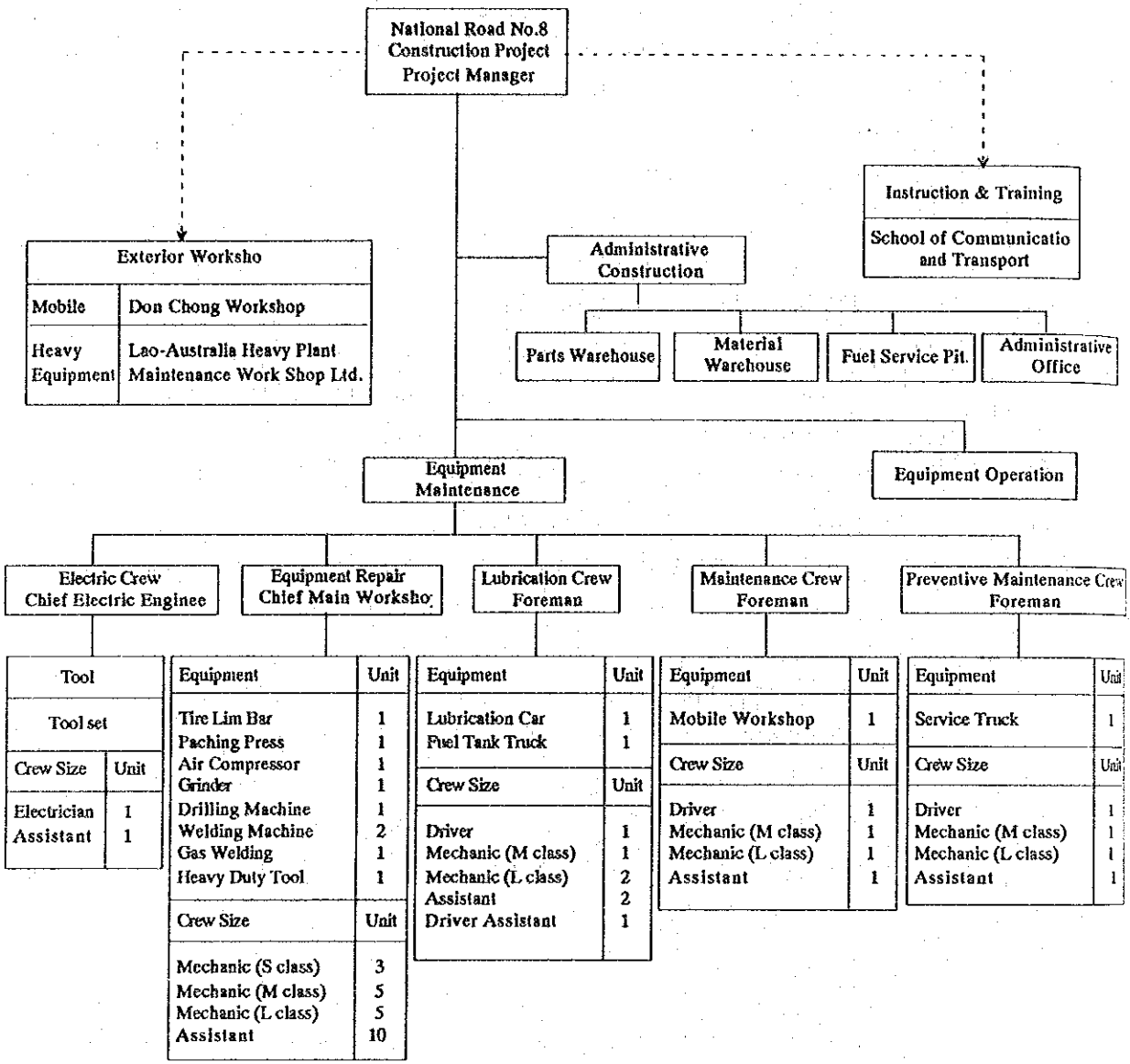


Fig. 4.3.5.1 Structure of the Equipment Maintenance

Table 4.3.5.1 Heavy Duty Workshop in Vientiane

Company	Maint. Level	Building	Tools	Mechanics	Organisation	Parts
Lao-Soviet	1-5	good	good	good	good	fair
Lao-Swedish	1-5	good	good	good	good	good
Lao-Australian (Private)	1-5	good	good	good	good	good
Thongpong	1-3	good	good	fair	-	-
Gen. Engine	1-3	fair	fair	fair	-	-
Project workshops:						
Road 13S	1-3	good	good	fair	good	good

Source: MCTPC National Transport Study, 1991

In particular, Lao-Australian Heavy Duty Workshop and Lao-Soviet Heavy Duty Garage out of the list can supply services for the heavy equipment and vehicles which will be procured under the Project.

(2) Budget and Staff for Maintenance of Equipment

The maintenance budget allocated to The Company in 1992 is as follows:

	(unit: Kip 1,000)
Equipment Maintenance Budget	37,547
The Company's Site Workshop	9,540
Private or Others	21,006
Total of Actual Expenditure	30,546

Spare parts for around two years use of the equipment will be prepared under the Project. Also the maintenance services in the first two years operation seem to be limited to the light maintenance services included in stages (1-3). Thus routine maintenance costs of the equipment during the Project period (1994-1996) will be confirmed to the cost increased operators and mechanics, additional fuel and lubricants, or other relevant costs due from the introduction of new equipment under the Project.

However, the frequency of breakdown of the equipment shall duly increase before the end of 1996, which may need heavy duty repairs categorized in stages (4-5). Hence, maintenance cost of the equipment to be procured under the Project together with existing equipment shall be properly estimated for securing a required budget.

As for the brigade for maintenance, it is appreciated that increasing the number of technician and upgrading the technical skills have been realised through various educational or training programmes either at Site or institutions.

CHAPTER 5 BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5.1 Design Policy

The Project comprises procurement of road construction equipment such as bulldozer, hydraulic excavator, dump truck, etc. for the construction of National Road No.8 through Japanese Grant Aid. As for determining the type and number of the equipment, following conditions have been considered:

5.1.1 Natural Condition

The equipment shall be specified to meet the following requirements:

- canopy cabin roof to protect from heavy tropical rainfall in rainy reasons or to keep safety from stone falling caused by the deep excavation work in mountainous and rocky terrains.
- protection of engine from aspirating of the silty dusts in dry seasons
- heavy wear and tear of the part of undercarriage caused in the works in rocky terrains

5.1.2 Capacity of the Executing Agency for Operation and Maintenance of the Equipment

As MCTPC and the Company have been fully experienced in road construction project and have established staff training system for equipment maintenance, thus, the capacity of the executing agency for operation and maintenance of the equipment which will be procured under the Project is considered substantially high.

5.1.3 Equipment Model to be Procured

As about 90% of the equipment possessed by the Company' fleet is of then USSR origin, those equipment have met problems in continuing maintenance and repair services due to their age and difficulty in supply of spare parts thereof.

Considering these conditions, the equipment introduced under the Project shall be of standard make, for which maintenance and repair services are commonly available.

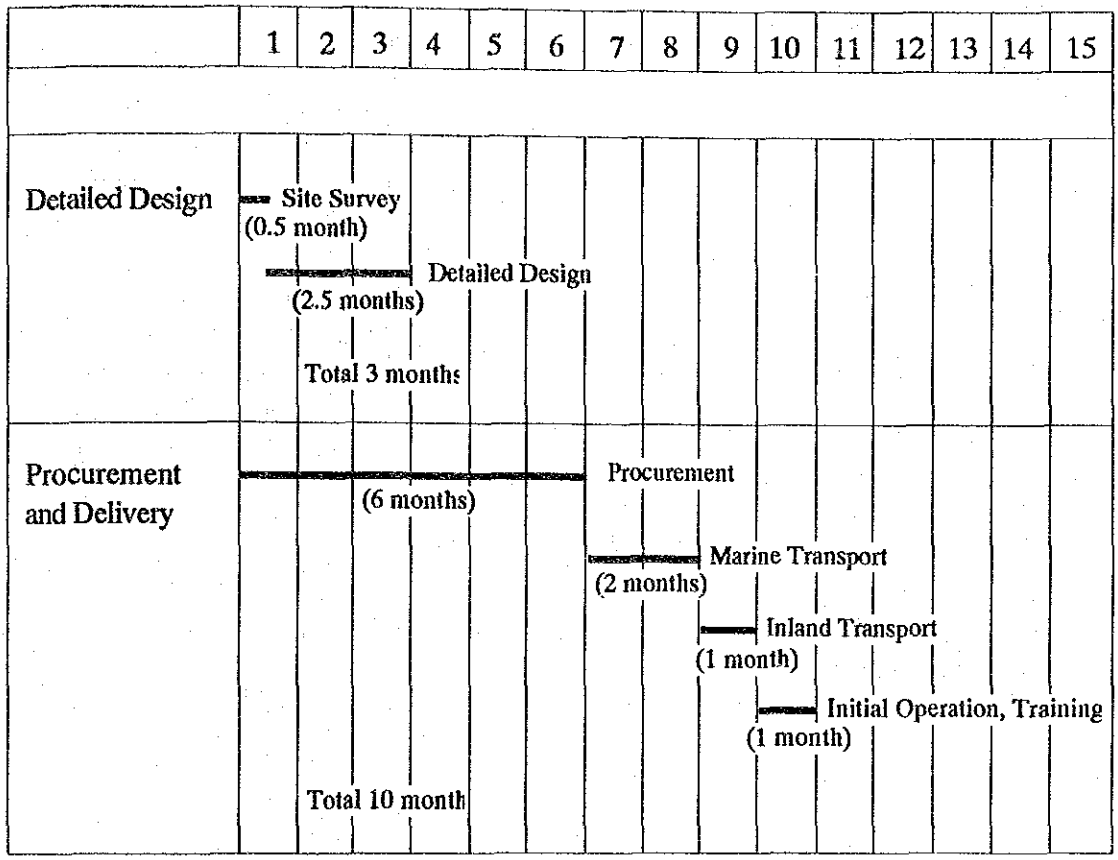
5.1.4 Procurement of Equipment from the Third Countries

As all items of the equipment under the Project are produced in Japan, and there are no special merits in procuring them from the third countries other than Japan in terms of the conformity with the required specification, market price, suppliable period, and availability of spare parts supply, all items of equipment are to be procured in Japan.

5.1.5 Procurement Period

It will require 3 months for detailed design, and 10 months from procurement of the equipment to initial operation and training of the equipment as shown in Table 5.1.5.1. Inland transport will be carried out preferably in dry season (November - March) in order to avoid difficulty in road transport.

Table 5.1.5.1 Implementation schedule



CHAPTER 6 IMPACT OF THE PROJECT AND CONCLUSION

CHAPTER 6 IMPACT OF THE PROJECT AND CONCLUSION

The Project road, National Road No.8 is the most important domestic east-west road spanned from Ban Lao on National Road No.13 to Vietnam frontier via Lak Sao which is the most urbanized area in the east region. It is also the shortest route which connects Vientiane Municipality and Cua Lo wharf at Vinh Port Complex in Vietnam and services as an international access toward China Sea, while National Road No.13 approaches to Thailand Bay.

National Road No.8 Company (The Company) involved in the construction of the Project road so far has owned a fleet consisting of 114 units of equipment, of which 85% of the equipment are already unserviceable, and remaining 15% are also continuing to be deteriorated mainly due to difficulty of provision of spare parts. Under the circumstances, it seems very difficult to proceed the construction of the Project road.

By providing the essential equipment under the Project, the capacity of the existing fleet the Company will be strengthened significantly, thus it leading to expediting the construction of work.

The following positive impacts are expected to accrue from the implementation of the Project:

1) Connection of Vientiane to Vinh port with the shortest route and access to the coastal area of China Sea via well established National Road No.8 will reduce commodity transport costs significantly compared to the route via National Road No.9. (_____ Km shortened)

2) Facilitate the development of the rural roads embraced by Bolikhamxay Provincial Government.

3) Improvement of living standards of rural population and promotion of development projects in relatively backward Bolikhamxay Province by means of improved access to the central area of Laos.

4) Promotion of the installation and/or renovation of pipelines from Vinh of Vietnam to Vientiane for petroleum gas transport.

Table 6.1.1.1 Effects of the Project

Present situation and Problems	Measures to be taken by the Project	Expected Effects and Their Extent of the Project
1. Because of aged and poor condition of the equipment possessed by the Company, the work in mountainous terrain meets serious difficulties. Thus progress of the National Road No.8 is decelerated.	To strengthen equipment and increase the capacity of the existing fleet owned by the Company to complete the work in time.	To accelerate the work progress and complete the Project in time.
2. As the distance of National Road No.9 or other roads serving as access to the China Sea from Vientiane for commodity transport are much longer than that of National Road No.8, it requires fairly higher transport cost.	To strengthen equipment, increase the capacity of the existing fleet of the Company to complete the work in time.	To realise the shortest route from Vientiane to Cua Lo wharf which is under study for construction within at Vinh Port Complex in Vietnam, by accelerating the work.
3. Rural roads development in Bolikhamxay Province is decelerated due to delay of the completion of the Project road.	To strengthen equipment, increase the capacity of the existing fleet of the Company to complete the work in time.	To facilitate development of the rural roads planned by Bolikhamxay Provincial Government, which shall link to the Project road.
4. Socio-economic development in Bolikhamxay Province is, in general, decelerated due to delay of the completion of the Project road.	To strengthen equipment, increase the capacity of the existing fleet of the Company to complete the work in time.	To improve living standard of rural population and promote development of agriculture, forest and mining industry in Bolikhamxay Province by providing an assured access from/to the central part of Laos.
5. Installation and/or renovation of the pipeline from Vietnam to Vientiane for petroleum is decelerated due to delay of the completion of the construction project.	The work progress is accelerated by strengthening the equipment to complete the work in time.	Promote the installation and/or renovation of pipelines from Vietnam to Vientiane for petroleum.

(continued)

Present situation and Problems	Measures to be taken by the Project	Expected Effects and Their Extent of the Project
6. International trade between Laos, Vietnam and Thailand is decelerated due to delay of the completion of the Project road.	The work progress is accelerated by strengthening the equipment of the Company to complete the work in time.	To increase international trade and accelerate the development of the national economy.

As the Project road will contribute not only to development of the economy, but also to improvement of the living standards of population in the project road influence areas, it is very reasonable to implement the Project to procure the construction equipment through Japanese Grant Aid.

It is also recognized that the Government of Lao P.D.R. has well organized authority in order to implement the Project road by utilizing the equipment fleet which will be procured under the Project.

APPENDIX

APPENDIX 1 List of Members of Survey Team

Members of the Basic Design Study Team
(23rd January 1993 ~ 10th February 1993)

Mr. Tadashi YOSHIDA	Leader, Deputy Director Construction Equipment Division Economic Affair Bureau Ministry of Construction
Mr. Yuji NAGAO	Road Planner, Deputy Director Engineering Works Section Second Construction Department The Japan Highway Corporation
Mr. Shuji ONO	Project Coordinator, Second Basic Design Department Grant Aid Study & Design Department Japan International Cooperation Agency
Mr. Yoichi HIGAKI	Road Development Planner, Construction Project Consultant, Inc.
Mr. Takashi ISAKARI	Construction Equipment Planner, Construction Project Consultant, Inc.
Mr. Shozo TAKEISHI	Construction Equipment Operation and Maintenance Planner, Construction Project Consultant, Inc.

APPENDIX 2 Survey Schedule

Date	Movement	Activities	Attendance
23rd Jan. (Sat)	Road Development Planner, Construction Equipment Planner and Construction Equipment and Maintenance Planner departed Japan. (Consultant Member of the Basic Design Study Team)		
24th Jan. (Sun)	Road Development Planner, Construction Equipment Planner and Construction Equipment Operation and Maintenance Planner arrived in Vientiane		
25th Jan. (Mon)			
Morning	Embassy of Japan in Lao P.D.R.	Courtesy call, explained of survey schedule, and summary of activities of the Study	Ambassador of Embassy of Japan, Mr. Shigeru ANDO
	MCTPC	Courtesy call, explained of survey schedule, explained of Inception Report	Vice-Minister of MCTPC, Mr. Noy INDAVONG Director of Dept. of Communication, Mr. Boualay SOUK ALOUN
Afternoon	MCTPC	Explained of Inception Report, submitted the Questionaire	

Date	Movement	Activities	Attendance
26th Jan. (Tue)			
Morning	MCTPC	Hearing on MCTPC's organization and operation. Hearing on National Road No.8 Construction Company present situation, Confirmation and examination of the items included in the Questionaire submitted.	General Manager of National Road No.8 Construction Company, Mr. Sommad PHOSEUA Project Manager of Road No.8 Construction & Bridge Nam Theune, Mr. Xayarath BAPHAUITH
Afternoon		Site survey on National Road No.13 Construction Company Survey the Motor Pool	
27th Jan. (Wed)			
Morning	Dept. Vientiane	Moved to National Road No.8	
Afternoon	Arvd. Ban Lao	Survey on the quarry plant operated by National Road No.8 Construction Company	
	Km 28 Camp	Group (1): arriving to Site Camp	
	Dept. Ban Lao Arvd. Thakehk	Group (2): heading to Thakehk, survey the route to carry the heavy equipment across Mekong River	

Date	Movement	Activities	Attendance
28th Jan. (Thu)			
Morning	The Construction Site of National Road No.8	Group (1): Survey the site under construction (51 km).	
Afternoon		Survey on heavy equipment for the Construction use.	
Morning	Thakehk	Group (2): Survey on ferry facilities between Thai and Laos (Thakehk) to carry the heavy equipment across Mekong River.	
	Thakehk Custom	Group (2): Hearing the matters regarding heavy equipments carriage delivery	
Afternoon	National Road No.8 Construction Site	Group (2): Survey on vehicles work shop, material and parts storage	
29th Jan. (Fri)			
Morning	Dept. National Road No.8 Construction Site	Survey the Site	
Afternoon	Arvd. Lak Sao		

Date	Movement	Activities	Attendance
30th Jan. (Sat)			
Morning	Lak Sao	Survey the route between the point of 110 km on National Road No.8 and border of Vietnam	
Afternoon		Survey on Nam Theune Bridge under construction on National Road No.8	
		Survey on operating equipment on Construction Site	
	Dept. 28 km Camp	Survey National Road No.13	
	Arvd. Vientiane		
31st Jan. (Sun)	Team Leader, Road Planner and Project Coordinator of the B/D Study Team arrived in Vientiane		

Date	Movement	Activities	Attendance
1st Feb. (Mon)			
Morning	Embassy of Japan in Lao P.D.R.	Courtesy Call, explained of full scale survey schedule	Ambassador of Embassy of Japan, Mr. Shigeru Ando
	MCTPC	Courtesy call, discussion of full scale survey schedule	Vice Minister of MCTPC, Mr. Noy INDAVONG Director of Dept. of Communication, Mr. Boualay SOUK ALOUN
	School of Communication and Transport (SCT) of MCTPC	Survey on training of road construction and maintenance techniques	Vice Director of SCT, Mr. Keo OUDOM Workshop Manager of SCT, Mr. Harry DICKINSON Director, Mr. SOMXAI
Afternoon	Lao-Australian Heavy Work Shop	Survey on existing capacity to repair and maintenance of the heavy equipment	
	Don Chong Work Shop	Survey on capacity to repair and maintain the vehicles	

Date	Movement	Activities	Attendance
2nd Feb. (Tue)			
Morning, Afternoon	MCTPC	Discussion on the required equipment for the implementation of Project Road	Director of Dept. of Communication, Mr. Boualay SOUK ALOUN Dept. Director Dept. of International Relation, Mr. Khanugeun KHAMVOUGSA

G(1): Detailed Survey on construction situation of National Road No.8 (Project Road)

G(2): Detailed Survey on management of construction and Equipment Maintenance (28 km Camp of the Company)

G(3): Detailed Survey on equipments maintenance shops managed by MCTPC and training elements of the School of Communication and Transport (in Vientiane)

Date	Movement	Activities	Attendance
3rd Feb. (Wed)	(G(1), G(2)		
Morning	Dept. Vientiane	Move to Construction Site of National Road No.8	
Afternoon	Arvd. Banlao	The Company's Quarry Plant Survey	
	Arvd. Construction Site Camp (28 km Camp)		
	G(3)		
Morning, Afternoon	Vientiane	Detailed Survey on repair capacity of Lao-Australian Heavy Workshop	

Date	Movement	Activities	Attendance
4th Feb. (Thu)	G(1)		
Morning	Construction Site of National Road No.8	Detailed Survey on construction situation of the Project Road	
	Project site and Nam Theun Bridge Construction Site	Detailed Survey on construction situation of Project Road and Nam Theun Bridge Construction	
Afternoon	Lak Sao	Survey on pavement situation existing road on National Road No.8,	
	Arvd. 28 km Camp		
Morning,	G(2)		
Afternoon	28 km Camp	Confirmation of the collected informations	
Morning,	G(3)		
Afternoon	Don Chong Workshop	Detailed Survey on repair capacity of the Workshop	Director of D.C. Workshop Mr. Som XAI

Date	Movement	Activities	Attendance
5th Feb. (Fri)	G(1), G(2)		
Morning	Dept. Construction Site of Road No.8	Survey on the existing situation of National Road No.8 and No.13	
Afternoon	Arvd. Vientiane		
Morning	G(3) S.C.T.	Detailed Survey on training elements of S.C.T.	Vice Director of SCT, Mr. Neo OUDOM R.T.C. English Unit, Mr. Vixay CHANG SAVANG
6th Feb. (Sat)			
Morning	MCTPC	Consultation and confirmation on the content of requested equipment for the implementation of the National Road No.8	Director of Dept. of Communication, Mr. Boualay SOUK ALOUN
Afternoon			

Date	Movement	Activities	Attendance
8th Feb. (Mon) Morning	MCTPC	Confirmation on the content of Minutes of Discussions	
	Japan Embassy	Reporting to the Japan Embassy on the result of the survey	
	MCTPC	Confirmation of the collected materials Signing of the Minutes of Discussions	Director of Dept. of Communication, Mr. Boualay SOUK ALOUN Vice Director of Dept. of International Relation MCTPC, Mr. Khanugenu KHEUN VOUGIA
9th Feb. (Tue)	Basic Design Study Team departed Vientiane.		
10th Feb. (Wed)	Basic Design Study Team arrived in Japan.		

APPENDIX 3 List of the Relevant Officials

Organization	Position
• Japan Embassy in Lao P.D.R.	
Shigemi ANDO	Ambassador
Toshikatsu AOYAMA	Counselor
Saburo SATDO	First Secretary
• JOVC in Lao P.D.R.	
Mitsuo INAGAKI	Head
• Ministry of Communication, Transport, Post and Construction (MCTPC)	
Noy INDAVONG	Vice-Minister
Boualay SOUK ALOUN	Director Department of Communication, MCTPC
Khanngeun KHAMVONGSA	Deputy Director of Dept. of International Relations, MCTPC
Chansy NOUAN MALY	Administrative Officer of Dept. of International Relations, MCTPC
Dapkeo DOUANGPRA CHANH	Officer of Dept. of Communication, Transportation and Construction, MCTPC
• National Road No.8 Construction Company	
Sommad PHOLSENA	General Manager of National oad No.8 Construction Company

• Organization	Position
Kayarath BAPHANITH	Project Manager of National Road No.8 Construction and Bridge Nam Theune
• National Road No.8 Construction Company, Quarry Plant	
Thongtheng SIDLAKONE	Supervisor of Quarry Plant
Inpaeng BOUDSANA	Supervisor of Quarry Plant
• National Road No.8 Construction Company, Thakhek Branch	
Ipong KHAINHAVONG	Director of Department of Communication of Kammoun Provincial Government
• School of communication and Transport (SCT), MCTPC	
Lattanamany KHOUNNYUONG	Director
Keo OUDOM	Vice Director
• Lao-Australian Heavy Plant Workshop, Ltd.	
Harrn DICKINSON	Director
• Don Chong Workshop	
Som XAI	Director
• National Road No.13 Construction Company	
Khammani SONG	Workshop Manager

APPENDIX 4

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY ON THE PROJECT

PROVIDING EQUIPMENT OF ROAD CONSTRUCTION

AND MAINTENANCE ON ROUTE 8 IN

LAO PDR

In response to the request from the Government of Lao PDR ,the Government of Japan decided to conduct a Basic Design Study on the project for Providing Equipment of Road Construction and Maintenance on Route 8 in Lao PDR (hereinafter referred to as the " Project ") , and entrusted the study to the Japan International Cooperation Agency (JICA) .

JICA sent to Lao PDR a study team, which is headed by Mr. Tadashi Yoshida , Deputy Director, Construction Equipment Division , Economic Affairs Bureau , Ministry of Construction , and is scheduled to stay in the country from January 24 to February 9 , 1993 .

The team held discussions with the officials concerned of the Government of Lao PDR and conducted a field survey at the study area.

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

Vientiane , February 8 ,1993

吉田正

Mr. Tadashi Yoshida
Leader
Basic Design Study Team
JICA

Mr. Boualay Souk Aloun
Director
Department of Communication
MCTPC