11.3.4 Stage Construction

Since the project scheme is relatively large, the possibility of stage construction is examined to maximize the economic benefit of the Project.

The possibility of stage construction might be considered in such categories as the pavement (black top).

The stage construction of pavement, however, is not advantageous because of the following reasons:

- The Project Road has been designated as trunk road and classified to Class I road in accordance with the Nepal Load Standards (2027) in which surface treatment on the road is specified.

- The Project Road is passing through hilly and mountainous terrain with steep gradient so that rainwater running on road surface would erode road surface and cause sometimes serious damage on road structure unless a bituminous surface seal be applied.

- The maintenance cost of gravel surface road would be remarkably increased especially in such a mountainous road.

The stage construction of pavement is therefore not recommended from the engineering point of view.

11.3.5 Construction Plan and Method

In view of the features set out in clause 11.3.1, construction plan and method for each construction section has been carefully studied paying attention not only to

the primary works of earthwork, bridge consstruction and slope protection work but also the proqurement method of principal construction materials and equipment by provision of pilot road.

The detailed construction plan and method for each section is described as shown below and the construction chart for each section is presented in Fig. 11.2.

(1) Section I (Bardibas - Sindhuli Bazar: 37 km)

The subject of the project in Section I is to improve the existing road between Bardibas and Sindhuli Bazar by constructing bridges and pavement with a minor improvement of alignment and width of the existing road, side drain, and slope protection.

The construction period of Section I is estimated to be 4 years. The existing road can be utilized as an access for the construction of the Section I work, however, it becomes not passable sometime in rainy season, since there are no temporary bridges at all on the existing road.

Bridge construction constitutes a critical path for the construction schedule of Section I. It will require 40 months for its construction assuming that the substructure work will be conducted only in dry seasons. Temporary bridges will be requuired to expedite the construction schedule.

Pavement work, consisting of subbase course, base course, surface course and shoulder course, is also main subject of the Project in Section I. The work requires prompt securement of stable production and supply of aggregate materials. Subbase work should be carried out immediately after finishing earthwork.

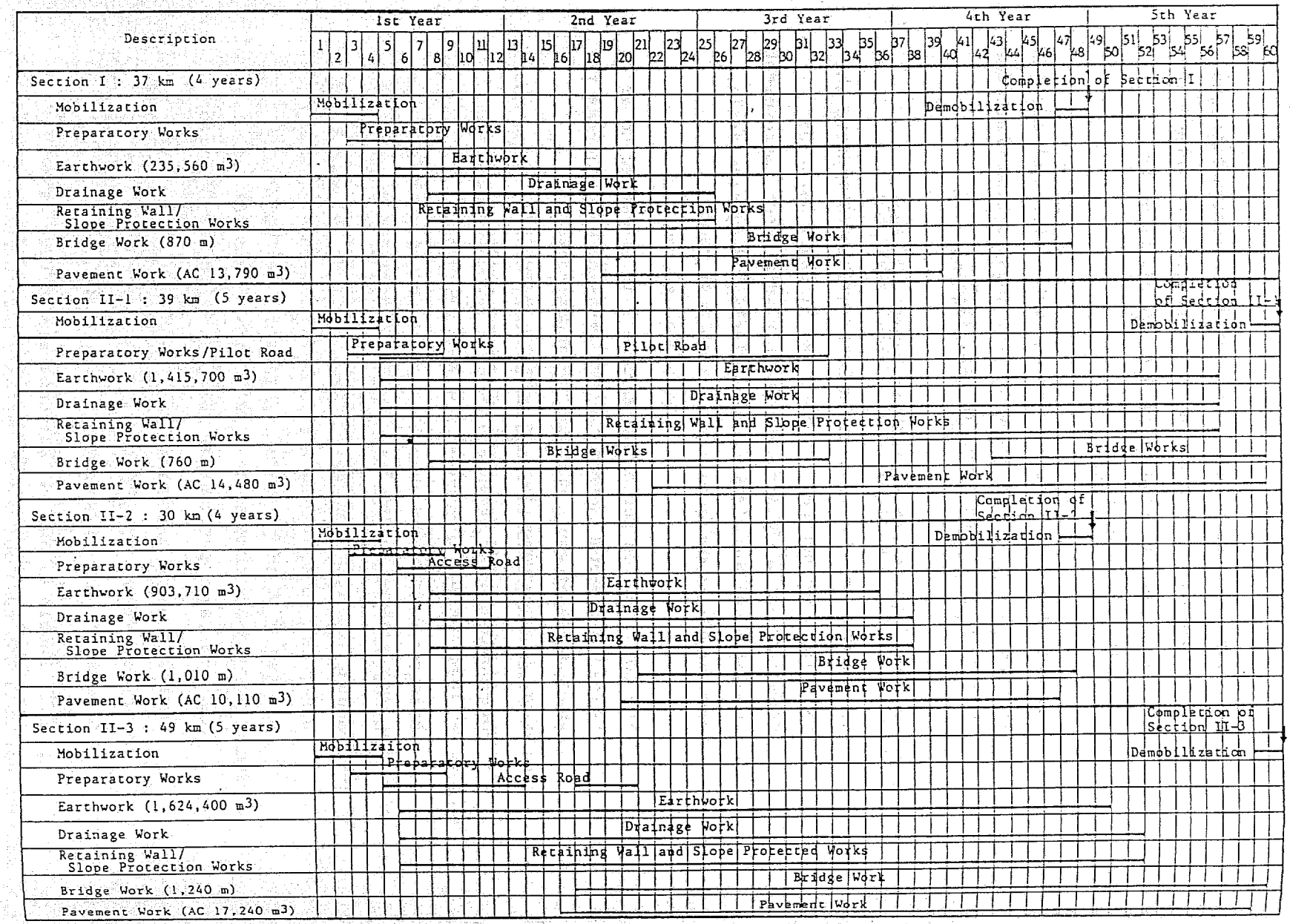


Fig.11.2 Construction Plan of the Project Road

Aggregate to be used for bridge construction, retaining structure, gravel and pavement work would be use of river gravel. Large quantities of good quality aggregate materials are found in the riverbeds of Ratu and Kamala rivers.

Other minor works, such as widening of roadway width, provision of side drainage, construction of slope protection, etc. are carried out simultaneously with bridge and pavement works.

(2) Section II-1 (Sindhuli Bazar - Khurkot: 39 km)

Section II-1 is the most difficult section in the Project since the road has to cross the Mahabharat Range of which topographical and geological conditions are extremely complicated and unstable.

As stated in clause 11.3.1, there are no existing mortable roads in Section II between Sindhuli Bazar and Dhulikhkel so that the subject of the Project in this section is to construct a new road.

The construction period of Section II-1 is estimated to be 5 years taking following factors into consideration:

- no access to the project site,
- poor and unstable geology,
- difficulty in earthwork due to steep topography and road alignment with haipin bends.

Earthwork constitutes a critical path for the construction of Section II-1 because of large amounts of earth to be moved due to steep topography. In order to accomplish the

work smoothly within the schedule, it is recommended that the pilot road be initially constructed.

The pilot road is to be constructed to enable subsequent construction of earthworks simultaneously at the various points along the project road. It will be used not only for transporting construction materials and equipment but also for providing working place of the retaining and drainage structures. It may be necessary for the pilot road to deviate temporarily from the final road alignment at some points where construction is extremely difficult due to steep unstable slope of topography.

The construction of pilot road is required to be completed during the 2 year so as to finish all the works within 5 years. For the final earthwork, it is necessary to employ 7 construction units after constructing the pilot road.

Procurement of aggregate materials would be either use of river gravel or production through crushing of rock materials obtained from road excavation. The route passes in the area of much rock availability, however, it might be difficult to obtain said rock in large quantities because of the steep terrain condition. It is, therefore, recommended that the major portion of aggregate materials shall be obtained from river gravel of Gadeuli and Gwang Kholas.

It is noted that the construction period has been estimated to be 5 years from the engineering point of view taking into consideration difficulty of the work due to extremely steep and unsable topographical condition of the Mahabharat Range. However, it might be possible to shorten its construction period from 5 years to 4 years by introduction of additional construction units as well as employing work system in two shifts, if necessary.

(3) Section II-2 (Khurkot - Nepalthok: 30 km)

The construction period of Section II-2 is estimated to be 4 years taking quantities of the works as well as site conditions into consideration.

As there is no access to the project site from outside, this section could be started after providing temporary road, either from Sindhuli Bazar or from Dhulikhel side.

The Project Road has to cross 8 nos. of major tributaries of Sun Kosi river in the section between Khurkot and Nepalthok. The construction of bridge, therefore, constitutes a critical path for the construction scheudle of this section. In order to expedite construction of the bridge work, it is recommended to construct pilot road on the riverbed of the Sun Kosi river with temporary bridges at river crossing points of tributaries. These temporary bridges are to be set at the riverbed level so that they will be submerged during the rainy season.

Three construction units might be required for road construction in order to complete the work within the planned schedule of 4 years.

Large quantities of good quality aggregate materials is found in the riverbeds of tributaries of the Sun Kosi river. The sand and gravel producing in the riverbed of the main Sun Kosi river, however, is not suited as aggregate materials because of its highly micaceous and fine grained.

(4) Sectiono II-3 (Nepalthok - Dhulikhel: 49 km)

This section is estimated to be 5 years construction period taking account of large scale of the work quantities and long distance of its project length.

There is no existing road to the project site with the exception of the first 10 km from Dhulikhel up to Buchakot. The existing road in the first 10 km is jeepable road with 4 to 5 m wide. It might be used an access to the project site during the construction with minor improvement of the road surface by introduciton of gravel, provision of temporary drainage and widening at sharp curve portions.

After Buchakot, it is necessary to construct the pilot road up to Nepalthok taking the project length as well as work quantities into consideration. The pilot road is recommended to construct at the initial stage in order to expedite the work in line with consstruction schedule.

This pilot road will enable not only subsequent simultaneous implementation of the construction of Section II-3 but also early implementation of Section II-2. In between Nepalthok and the confluence of the Dabcha Khola, the pilot road is to be constructed on the riverbed of the Rosi Khola with temporary bridges which might be submurged in the rainy season.

Rosi Khkola is one of the biggest tributaries of Kosi River and its runoff peak during the flood would be more than 3,000 cubic meter per second. The Project Road will cross this main river near the confluence of the Dabcha Khola by provision of steel truss bridge. In addtion to the main river of Rosi Khola, the Project Road has to cross sover 5 nos. of large tributaries in this section. The construction of bridges, therefore, is the critical works on the overall construction schedule of the Section II-3.

Geological conditions in the section between Nepalthok and Dabcha Khola are very poor and unstable because of the

large fault zone of the Main Boundary Thrust (MBT). The numerous large landslides have been developed on the hillslope of Rosi Khola through which the route has to passs. The slope protection works should be conducted promptly in the dry season in parallel with the earthwork. This work will also constitute the critical path for the construction schedule.

Although the quantities of earth moving work is large, earthwork will not constitute the critical work in Section II-3, since it will be able to cary out simultaneously at the various points along the route by the use of pilot road.

The river gravel suited for the aggregate materials are found sufficiently in the riverbeds of the main river of Rosi Khola, therefore, procurement of aggregate materials to be used for this section would be no problems.

It is, however, difficult for the Dhulikhel section to find material sources for aggregate materials along the route. Possible material sources for the Dhulikhel section will be either river deposits of Jikhu Khola, 6 km east from Dhulikhel on Kodari Road, or the river quarry at Panauti, 5 km south from Banepa.

There is the pedestrian suspension bridge across Rosi Khola at Nepalthok which will obstruct the construction of the Project Road. This existing bridge, therefore, has to be removed and replacee by new one at the same place under the Project. Temporary bridge will be necessary during the construction of the Project.

11.4 Implementation Schedule

As stated in clause 11.2, the Project has been divided into four (4) construction sections as shown below:
(See Fig. 11.3)

Section I	Bardibas - Sindhuli Bazar	(37 km)
Section II-1	Sindhuli Bazar - Khurkot	(39 km)
Section II-2	Khurkot - Nepalthok	(30 km)
Section II-3	Nepalthok - Dhulikhel	(49 km)

Four (4) alternative implementation schedules have been considered as shown in Fig. 11.4, on the basis of above construction sections.

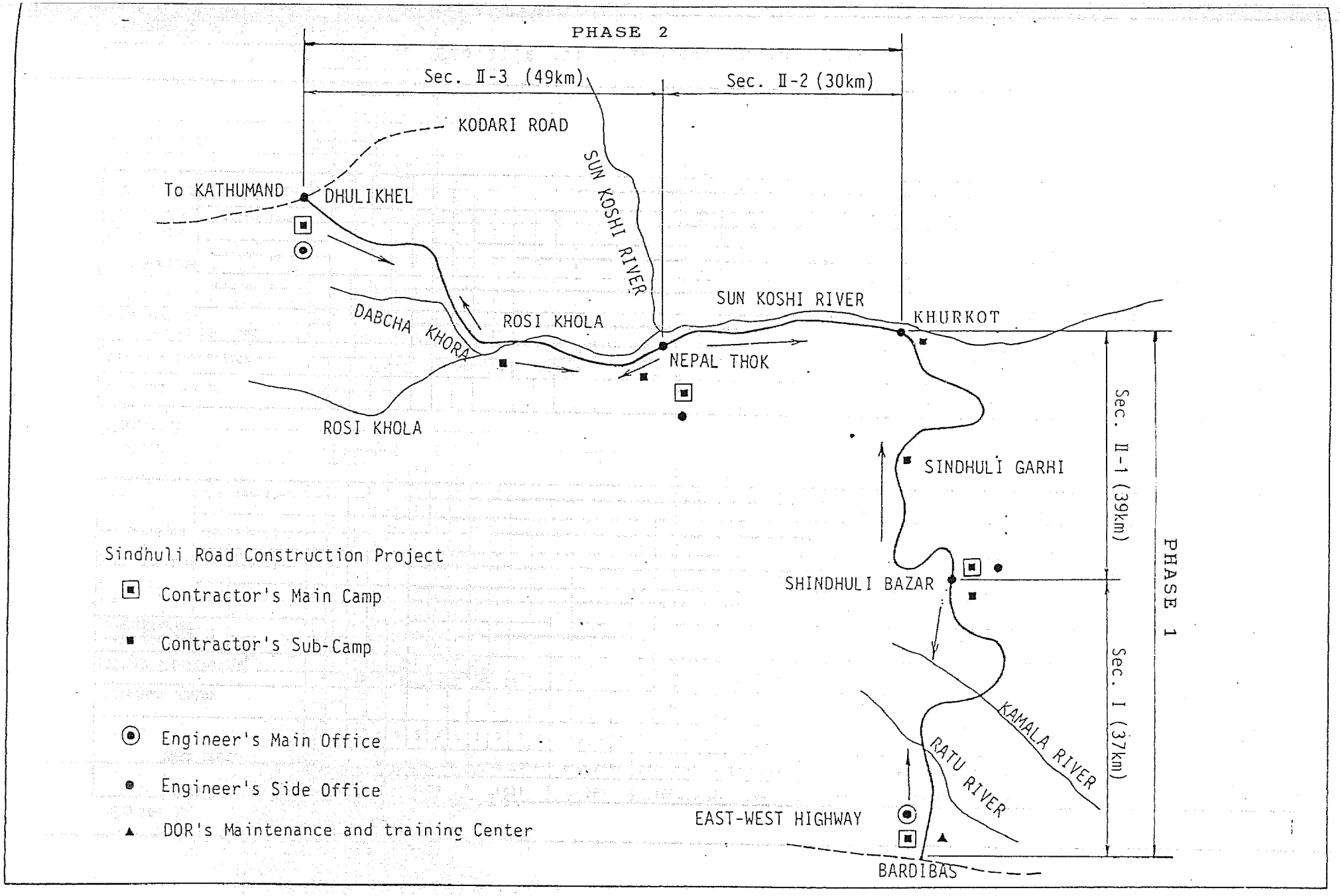
(1) Preparatory Work

Prior to the construction, it will be necessary to carry out such preparatory works as detailed design, financial arrangement, tender and contract award and land compensation and aquisition.

The minimum period required for such preparatory works excluding land compensation and aquisition is estimated to be one and half year.

It will take one year for the detailed design which consists of review of preliminary design conducted in the feasibility study, preparation of tender documents and prequalification of a contractor.

Financial arrangement should be made in parallel with the detailed design, on the basis of the cost estimate conducted in the feasibility study.


PHASE 2
Sec. II-3 (49km)
Sec. II-2 (30km)
KODARI ROAD
To KATHUMAND
DHULIKHEL
SUN KOSHI RIVER
SUN KOSHI RIVER
DABCHA KHORA
ROSI KHOLA
KHURKOT
NEPAL THOK
ROSI KHOLA
SINDHULI GARHI
Sec. II-1 (39km)
PHASE 1
SHINDHULI BAZAR
Sec. I (37km)
KAMALA RIVER
RATU RIVER
EAST-WEST HIGHWAY
BARDIBAS
Sindhuli Road Construction Project
Contractor's Main Camp
Contractor's Sub-Camp
Engineer's Main Office
Engineer's Side Office
DOR's Maintenance and training Center

Case 1

WORK ITEM		1989				1990				1991				1992				1993				1994				1995				1996				1997				1998				1999				2000			
		1st Year				2nd Year				3rd Year				4th Year				5th Year				6th Year				7th Year				8th Year				9th Year				10th Year				11th Year				12th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
DETAILED DESIGN																																																
TENDER & EVALUATION				Sec.I		II-1&II-3				Sec.II-2																																								
LAND ACQUISITION AND COMPENSATION																																																
CONSTRUCTION & SUPERVISION	Section I																																															
	Section II-1																																															
	Section II-2																																															
	Section II-3																																															

Case 2

DETAILED DESIGN																																																
TENDER & EVALUATION					Sec.I					Sec.II-1				Sec.II-3				Sec.II-2																																
LAND ACQUISITION AND COMPENSATION																																																
CONSTRUCTION & SUPERVISION	Section I																																															
	Section II-1																																															
	Section II-2																																															
	Section II-3																																															

Fig.11.4 (1) Implementation Schedule

Case 3

WORK ITEM		1989				1990				1991				1992				1993				1994				1995				1996				1997				1998				1999				2000			
		1st Year				2nd Year				3rd Year				4th Year				5th Year				6th Year				7th Year				8th Year				9th Year				10th Year				11th Year				12th Year			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
DETAILED DESIGN																																																
TENDER & EVALUATION				Sec.I & II-3																				Sec.II-1 & II-2																									
LAND ACQUISITION AND COMPENSATION																																																
CONSTRUCTION & SUPERVISION	Section I																																															
	Section II-1																																															
	Section II-2																																															
	Section II-3																																															

Case 4

			1989				1990				1991				1992				1993				1994				1995				1996				1997				1998				1999				2000			
DETAILED DESIGN																																																
TENDER & EVALUATION				Sec. I & II-2														Sec. II-2 & II-3																																	
LAND ACQUISITION AND COMPENSATION																																																
CON-STRUC-TION & & SUPER-VISION	PHASE 1	Sec. I																																														
		Sec. II-1																																															
	PHASE 2	Sec. II-2																																															
		Sec. II-3																																															

Fig.11.4 (2) Implementation Schedule

Tender and its evaluation will be conducted immediately after finishing the detailed design and the contract will be awarded upon approval of the government concerned.

(2) Construction Period

The construction period of each construction section has been determined from the engineering point of view as stated in the subclause 11.3.5 and summarized below:

Section I : 4 years
Section II-1: 5 years
Section II-2: 4 years
Section II-3: 5 years

(3) Alternative Implementation Schedules

Four (4) alternative implementation schedules have been considered as stated below. Required period for the detailed design, tender and construction period of each section are assumed to be same for each case, and the detailed design is to be started at the same time.

Case 1:

This alternative schedule is made aiming at the shortest implementation schedule of the Project. The outline of the schedule is as follows:

- The whole Project Road is scheduled to be completed within five (5) years,

- Construction of Sections I, II-1 and II-3 are scheduled to be start at same time, while Section II-2 starts one year later, and

- Large investment is required in the short term.

Case 2:

Case 2 is an alternative schedule characterized by the diversified investment as follows;

- The whole of the Projec is assumed to be completed within seven (7) years,

- Commencement of each construction section is staggered one year later, and

- Annual investment required is reduced comparing with Case 1.

Case 3:

This alternative is made aiming at the minimization of annual investment required for the project, thus the implementation period is the longest among four (4) alternatives.

- The implementation of the Project is scheduled to be 10 years,

- Sections I and II-3 is planned to be implemented in the first 5 years taking no access between Sindhuli Bazar and Dhulikhel into consideration. Sections II-1 and II-2 is scheduled to begin subsequently in the second 5 years, and

- Annual investment required for the project is the smallest among four alternatives.

Case 4:

Case 4 is an alternative schedule taking the implementation schedule of Jiri-Ramechap Road connecting Busti on Jiri road and Ramechap into consideration.

- The implementation of the Project is divided into 2 phases, namely Phase 1 and Phase 2 with each construction period of 5 yeras,

- Sections I and II-1 is planned to be implemented in the first phase (Phase 1), in order to maximize the project benefit by connection with the Jiri-Ramechap road.

- The implementation of the Project is scheduled to be 8 years, thus Phase 2 is conducted with overlapping Phase 1 by 2 years.

(4) Recommendation

Case 4 is recommended for the implementation of the Project as shown below, taking into consideration the implementation of Jiri-Ramechap road which is under construction by DOR and scheduled to be connected with the Project Road at Khurkot.

Case 4 (Construction Period: 8 years)

Phase	Section	Year	1	2	3	4	5	6	7	8
Phase 1	Section I	4								
	Section II-1	5								
Phase 2	Section II-2	4								
	Section II-3	5								

Since the construction cost of the Project is considerably large, if there exist any difficulty in financial arrangement, it is recommended that the Phase 1 between Bardibas and Khurkot be initially implemented because of the following reasons:

(i) In addition to the existing route of Prithivi Highway via Muglin, Kathmandu Valley will have the alternative route connecting Terai Plain via Jiri Road, by implementation of Phase 1 of the Project as well as Jiri-Ramechap Road, although Jiri-Ramechap section does not meet the requirement of the design standards of trunk road.

(ii) The Project Road will contribute greatly to the improvement of the basic human needs of the people living in romote hill areas by completion of north-south link in the Central Development Region.

(iii) The Project Road will form a part of Janakpur Highway connecting Jiri Road and East-West Highway in Terai. Road network in Central Development Region will be improved by completion of Phase 1 of the Project.

Phase 2 (Section II-2 & Section II-3) between Khurkot and Dhulikhel should be implemented later stage after arranging financial source.

11.5 Disbursement Schedule

Annual disbursement schedule is prepared for each alternative based on the implementation schedule shown in Fig. 11.4 (1) and Fig. 11.4 (2).

The cost for the price escalation of Case 1 is estimated at 5% of the sum of construction cost (contract cost), physical contingency, engineering services cost and land acquisition cost. As for Case 2, Case 3 and Case 4, the percentages are to be 8%, 12% and 9% respectively.

Summary of annual disbursement schedule are presented in Table 11.2 and detailes in Table 11.3 (1) through Table 11.3 (4) respectively.

Case 1

Case 1 reveals that majority of the project cost will be invested in the short term during the peirod from 2nd to 6th year. The amount of annual investment will exceed NRs. 800 x 10^6 for four (4) years.

Case 2

Case 2 shows that annual amount of investment can be reduced comparing Case 1, however, it requires still high annual investment amounting NRs. 600 x 10^6 to NRs. 800 x 10^6 for five (5) years.

Case 3

Case 3 is an alternative assuming that the whole of the Project Road will be constructed for ten (10) years, therefore, annual required investment will be the smallest among three alternatives. The annual investment required will be NRs. 300 x 10^6 to NRs. 500 x 10^6 in average.

Case 4

Case 4 is the implementation schedule recommended for the Project implementation. The annual investment required will range from NRs.300 x 10^6 to 700 x 10^6. In case that only Phase 1 be implemented due to the financial difficulty, the annual amount of investment will become small ranging from NRs.200 x 10^6 to 400 x 10^6 (Y1,600 million to Y2,400 million), as shown in Table 11.2, and Table 11.3(5).

Table 11.2 Summary of Annual Disbursement Schedule

Unit: 10^6 NRs.

Year	CASE 1			CASE 2			CASE 3			CASE 4			CASE 4 (Phase 1 Only)		
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
1st Year	65	1	66	67	1	68	69	1	70	34	1	35	26	1	27
2nd Year	453	87	540	67	12	79	323	57	380	225	43	268	225	43	268
3rd Year	684	123	807	307	56	363	417	71	488	333	61	394	333	61	394
4th Year	747	127	874	549	97	646	487	74	561	314	47	361	281	47	328
5th Year	709	121	830	642	109	751	417	66	483	478	87	565	232	43	275
6th Year	725	101	826	629	115	744	227	38	265	625	105	730	248	41	289
7th Year	123	12	135	719	121	840	321	57	378	559	93	652	65	7	72
8th Year				562	71	633	334	69	403	504	85	589			
9th Year				64	6	70	377	68	445	503	66	569			
10th Year							436	62	498	64	6	70			
11th Year							264	44	305						
12th Year							68	6	74						
Total	3,506	572	4,078	3,606	588	4,194	3,740	610	4,350	3,639	594	4,233	1,410	243	1,653

Table 11.3 (1) Disbursement Schedule (Case 1)

Unit: NRs. 1,000

	Total			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost																	
Section I	355,076	50,955	406,031	-	-	49,455	7,565	111,299	18,421	91,956	12,060	84,527	11,191	17,839	1,718	-	-
Section II-1	655,075	132,631	797,706	-	-	116,400	24,794	133,848	28,584	115,370	23,303	86,280	21,455	164,771	29,602	48,406	4,893
Section II-2	605,465	99,321	704,786	-	-	-	-	91,862	16,005	105,824	25,124	156,066	29,591	226,535	26,260	25,178	2,341
Section II-3	1,008,672	180,225	1,188,897	-	-	181,445	34,910	186,398	34,864	258,303	43,511	215,127	38,079	145,564	26,114	21,835	2,747
Sub-total (1)	2,634,288	463,132	3,097,420	-	-	347,300	67,269	523,407	97,874	571,453	103,998	542,000	100,316	554,709	83,694	95,419	9,981
2.Physical Contingency	395,143	69,470	464,613	-	-	52,095	10,090	78,511	14,681	85,718	15,600	81,300	15,047	83,206	12,555	14,313	1,497
3.Engineering Services	(309,742)	(-)	(309,742)														
Design	61,948	-	61,948	61,948	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervision	247,794	-	247,794	-	-	32,213	-	49,559	-	54,515	-	52,036	-	52,035	-	7,434	-
4.Land Acquisition	-	12,000	12,000	-	1,200	-	4,800	-	4,800	-	1,200	-	-	-	-	-	-
Total (1 - 4)	3,339,173	544,602	3,883,775	61,948	1,200	431,608	82,159	651,477	117,355	711,686	120,798	675,337	115,363	689,951	96,249	117,166	11,478
5.Escalation	166,959	27,230	194,189	3,098	60	21,580	4,108	32,574	5,868	35,584	6,040	33,767	5,768	34,498	4,812	5,858	574
Grand Total	3,506,132	571,832	4,077,964	65,046	1,260	453,188	86,267	684,051	123,223	747,270	126,838	709,104	121,131	724,449	101,061	123,024	12,052

	Total			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost																	
Section I	355,076	50,955	406,031	-	-	49,455	7,565	111,299	18,421	91,956	12,060	84,527	11,191	17,839	1,718	-	-
Section II-1	665,075	132,631	797,706	-	-	-	-	116,400	24,794	133,848	28,584	115,370	23,303	86,280	21,455	164,771	29,602
Section II-2	605,465	99,321	704,786	-	-	-	-	-	-	-	-	91,862	16,005	105,824	25,124	156,066	29,591
Section II-3	1,008,672	180,225	1,188,897	-	-	-	-	-	-	181,445	34,910	186,398	34,864	258,303	43,511	215,127	38,079
Sub-total (1)	2,634,288	463,132	3,097,420	-	-	49,455	7,565	227,699	43,215	407,249	75,554	478,157	85,363	468,246	91,808	535,964	97,272
2.Physical Contingency	395,143	69,470	464,613	-	-	7,418	1,135	34,155	6,482	61,088	11,333	71,723	12,805	70,237	13,771	80,394	14,591
3.Engineering Services	(309,742)	(-)	(309,742)														
Design	61,948	-	61,948	61,948	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervision	247,794	-	247,794	-	-	4,956	-	22,301	-	39,647	-	44,603	-	44,603	-	49,559	-
4.Land Acquisition	-	12,000	12,000	-	480	-	2,640	-	2,640	-	2,640	-	2,640	-	960	-	-
Total (1 - 4)	3,339,173	544,602	3,883,775	61,948	480	61,829	11,340	284,155	52,337	507,984	89,527	594,483	100,808	583,086	106,539	665,917	111,863
5.Escalation	267,134	43,568	310,702	4,956	38	4,946	907	22,732	4,187	40,639	7,162	47,559	8,065	46,647	8,523	53,273	8,949
Grand Total	3,606,307	588,170	4,194,477	66,904	518	66,775	12,247	306,887	56,623	548,623	96,689	642,042	108,873	629,733	115,062	719,190	120,812

Unit: NRs. 1,000

	8 Year		9 Year	
	F.C.	L.C.	F.C.	L.C.
1.Construction Cost				
Section I	-	-	-	-
Section II-1	48,406	4,893	-	-
Section II-2	226,535	26,260	25,178	2,341
Section II-3	145,564	26,114	21,835	2,747
Sub-total (1)	420,505	57,267	47,013	5,088
2.Physical Contingency	63,076	8,590	7,052	763
3.Engineering Services				
Design	-	-	-	-
Supervision	37,169	-	4,956	-
4.Land Acquisition				
Total (1 - 4)	520,750	65,857	59,021	5,851
5.Escalation	41,660	5,269	4,722	468

Table 11.3 (3) Disbursement Schedule (Case 3)

	Total			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost																	
Section I	355,076	50,955	406,031	-	-	49,455	7,565	111,299	18,421	91,956	12,060	84,527	11,191	17,839	1,718	-	-
Section II-1	665,075	132,631	797,706	-	-	-	-	-	-	-	-	-	-	-	-	116,400	24,794
Section II-2	605,465	99,321	704,786	-	-	-	-	-	-	-	-	-	-	-	-	91,862	16,005
Section II-3	1,008,672	180,225	1,188,897	-	-	181,445	34,910	186,398	34,864	258,303	43,511	215,127	38,079	145,564	26,114	21,835	2,747
Sub-total (1)	2,634,288	463,132	3,097,420	-	-	230,900	42,475	297,697	53,285	350,259	55,571	299,654	49,270	163,403	27,832	230,097	43,546
2.Physical Contingency	395,143	69,470	464,613	-	-	34,635	6,371	44,654	7,993	52,539	8,336	44,948	7,391	24,510	4,175	34,515	6,531
3.Engineering Services	(309,742)	(-)	(309,742)														
Design	61,948	-	61,948	61,948	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervision	247,794	-	247,794	-	-	22,301	-	29,735	-	32,213	-	27,257	-	14,868	-	22,302	-
4.Land Acquisition	-	12,000	12,000	-	360	-	2,280	-	2,160	-	2,160	-	2,160	-	2,160	-	720
Total (1 - 4)	3,339,173	544,602	3,883,775	61,948	360	287,836	51,126	372,086	63,438	435,011	66,067	371,859	58,821	202,748	34,167	286,914	50,797
5.Escalation	400,701	65,352	466,053	7,434	43	34,540	6,135	44,650	7,613	52,201	7,928	44,623	7,059	23,334	4,100	34,430	6,096
Grand Total	3,739,874	609,954	4,349,828	69,382	403	322,376	57,261	416,736	71,051	487,212	73,995	416,482	65,880	227,115	38,267	321,344	56,893

Unit: NRs. 1,000

	8 Year		9th Year		10th Year		11th Year		12th Year	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost										
Section I	-	-	-	-	-	-	-	-	-	-
Section II-1	133,848	28,584	115,370	23,303	86,280	21,455	164,771	29,602	48,406	4,893
Section II-2	105,824	25,124	156,066	29,591	226,535	26,260	15,178	2,341	-	-
Section II-3	-	-	-	-	-	-	-	-	-	-
Sub-total (1)	239,672	53,708	271,436	52,894	312,815	47,715	189,949	31,943	48,406	4,893
2.Physical Contingency	35,951	8,056	40,716	7,934	46,922	7,157	28,492	4,792	7,261	734
3.Engineering Services										
Design	-	-	-	-	-	-	-	-	-	-
Supervision	22,301	-	24,780	-	29,735	-	17,346	-	4,956	-
4.Land Acquisition	-	-	-	-	-	-	-	-	-	-
Total (1 - 4)	297,924	61,764	336,932	60,828	389,472	54,872	235,787	36,735	60,623	5,627
5.Escalation	35,751	7,412	40,432	7,299	46,737	6,584	28,294	4,408	7,275	675

Table 11.3 (4) Disbursement Schedule (Case 4)

Unit: NRs. 1,000

	Total			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost																	
Section I	355,076	50,955	406,031	-	-	49,455	7,565	111,299	18,421	91,956	12,060	84,527	11,191	17,839	1,718	-	-
Section II-1	665,075	132,631	797,706	-	-	116,400	24,794	133,848	28,584	115,370	23,303	86,280	21,455	164,771	29,602	48,406	4,893
Section II-2	605,465	99,321	704,786	-	-	-	-	-	-	-	-	-	-	91,862	16,005	105,824	25,124
Section II-3	1,008,672	180,225	1,188,897	-	-	-	-	-	-	-	-	181,445	34,910	186,398	34,864	258,303	43,511
Sub-total (1)	2,634,288	463,132	3,097,420	-	-	165,855	32,359	245,147	47,005	207,326	35,363	352,252	67,556	460,870	82,189	412,533	73,528
2.Physical Contingency	395,143	69,470	464,613	-	-	24,878	4,854	36,772	7,051	31,099	5,304	52,838	10,133	69,131	12,328	61,880	11,029
3.Engineering Services	(309,742)	(-)	(309,742)														
Design	61,948	-	61,948	30,974	-	-	-	-	-	30,974	-	-	-	-	-	-	-
Supervision	247,794	-	247,794	-	-	15,857	-	23,372	-	19,415	-	33,585	-	43,445	-	38,885	-
4.Land Acquisition	-	12,000	12,000	-	360	-	2,280	-	2,160	-	2,160	-	2,160	-	2,160	-	720
Total (1 - 4)	3,339,173	544,602	3,883,775	30,974	360	206,590	39,493	305,291	56,216	288,814	42,827	438,675	79,849	573,446	96,677	513,298	85,277
5.Escalation	300,526	49,014	349,540	2,788	32	18,593	3,553	27,476	5,059	25,993	3,854	39,481	7,186	51,610	8,701	46,197	7,675
Grand Total	3,639,699	593,616	4,233,315	33,762	392	225,183	43,046	332,767	61,275	314,807	46,681	478,156	87,035	625,056	105,378	559,495	92,952

	8 Year		9th Year		10th Year	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost						
Section I	-	-	-	-	-	-
Section II-1	-	-	-	-	-	-
Section II-2	156,066	29,591	226,535	26,260	25,178	2,341
Section II-3	215,127	38,079	145,564	26,114	21,035	2,747
Sub-total (1)	371,193	67,670	372,099	52,374	47,013	5,088
2.Physical Contingency	55,679	10,151	55,815	7,856	7,052	763
3.Engineering Services						
Design	-	-	-	-	-	-
Supervision	35,109	-	33,958	-	4,168	-
4.Land Acquisition	-	-	-	-	-	-
Total (1 - 4)	461,981	77,821	461,872	60,230	58,233	5,851
5.Escalation	41,578	7,004	41,568	5,422	5,247	528
Grand Total	503,559	84,825	503,440	65,652	63,475	6,379

Table 11.3 (5) Disbursement Schedule (Case 4)
(Phase 1 Only)

Unit: NRs.1,000

	Total			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1.Construction Cost																	
Section I	355,076	50,955	406,031	-	-	49,455	7,565	111,299	18,421	91,956	12,060	84,527	11,191	17,839	1,718	-	-
Section II-1	665,075	132,631	797,706	-	-	116,400	24,794	133,848	28,584	115,370	23,303	86,280	21,455	164,771	29,602	48,406	4,893
Section II-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Section II-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total (1)	1,020,151	183,586	1,203,737	-	-	165,855	32,359	245,147	47,005	207,326	35,363	170,807	32,646	182,610	31,320	48,406	4,893
2.Physical Contingency	153,023	27,538	180,561	-	-	24,878	4,854	36,772	7,051	31,099	5,304	25,621	4,897	27,392	4,698	7,261	734
3.Engineering Services	(120,374)	(-)	(120,374)														
Design	24,075	-	24,075	24,075	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervision	96,299	-	96,299	-	-	15,857	-	23,372	-	19,415	-	16,277	-	17,114	-	4,264	-
4.Land Acquisition	-	12,000	12,000	-	360	-	2,280	-	2,160	-	2,160	-	2,160	-	2,160	-	720
Total (1 - 4)	1,293,548	223,124	1,516,672	24,075	360	206,590	39,493	305,291	56,216	257,840	42,827	212,705	39,703	227,116	38,178	59,931	6,347
5.Escalation	116,419	20,081	136,500	2,167	33	18,593	3,554	27,476	5,059	23,205	3,855	19,143	3,573	20,440	3,436	5,394	571
Grand Total	1,409,967	243,205	1,653,172	26,242	393	225,183	43,047	332,767	61,275	281,045	46,682	231,848	43,276	247,556	41,614	65,325	6,918

11.6 Road Maintenance

11.6.1 Maintenance Work

Maintenance has been defined as "the preserving and keeping any highway structure and its ancillary features and facilities, in such as state as to ensure the continuous and safe passage of traffic and to safeguard the high capital investment made initially when the road is constructed or improved.

The road maintenance is divided into the following two categories:

(1) Cleaning work including cleaning the road surface, drainage facilities, guard rail, grass cutting, regulatory signs and other services.

(2) Repairing work including road surface repair, overlay, cut & fill slope repairs, painting of bridges and guard rails, inspection and repair of traffic control facilities, etc.

11.6.2 Establishment of Maintenance and Training Center

Since the Project Road passes through extremely difficult terrain of the Mahabhrat Range, proper and timely maintenance work is indispensable for keeping not only highway structure itself but also the public traffic in safety.

Historically, Nepal has carried out road maintenance based on labvour intensive techniques, however, it is not been worked out effectively due to shortage of skilled labour and seasonal fluctuation on availabilityi of labour. Moreover, DOR is decentralizing its maintennace operations

and is deploying most of its organization to the regional offices, resulting in critical shortage of equipment and manpower.

With the growth of the DOR's activities, a need has arisen for reinforcing number of qualified professional staff to plan, program and manage road development project, and also trained personnel at the techniciaan level such as supervisors, equipment operators and mechanics to ensure that the expanding road network is soley maintained.

Recognizing an importance of maintenance work for such a mountainous road as Sindhuli Road as well as the necessity for strengthening the capability of DOR's maintennace operation, it is recommended to establish the "Maintenance and Training Center" in the vicinity of the Project Road at Bardibas. Organization and layout of Maintenance and Training Center are as shown in Figs. 11.5 and 11.6 respectively and the major component of the Training Center are listed in Appendix 11.5.1.

The objectives of the "Madintenance and Training Center" are;

(1) to build-up an efficient maintenance system to secure the construction investment and conduct proper maintenance for the Project Road;

(2) to provide trained personnel who covers not only the engineers level but also the technicians level such as supervisors, operators and mechanics to cope with the expanding need for road maintenance; and

(3) to conduct not oly the maintenance work for the Project Road but also the construction of feeder roads in its adjoining areas to stimulate and promote development in

remote area along the road, especially the hill area of Ramechap District.

11.6.3 Implementation Schedule of Maintenance & Training Centre

During the construction of the Project Road, the contractor will have responsibility for their maintennace including the improved section of existing roads whilst they are in his possession. The contractor will also be responsible for rectifying any defects for a period of 12 months from completion of the particular section, as in usual in international construction contracts on the basis of FIDIC.

However, as soon as construction of the various sections of road is completed, the maintenance responsibility for other than rectifying defects will fall upon the DOR. It is therefore recommended that the Maintenance and Training Centger should be in operation by the time that the construction of the roads is completed.

Based on the above understanding, the implementation schedule for the Center is tentatively made as shown in Fig. 11.7.

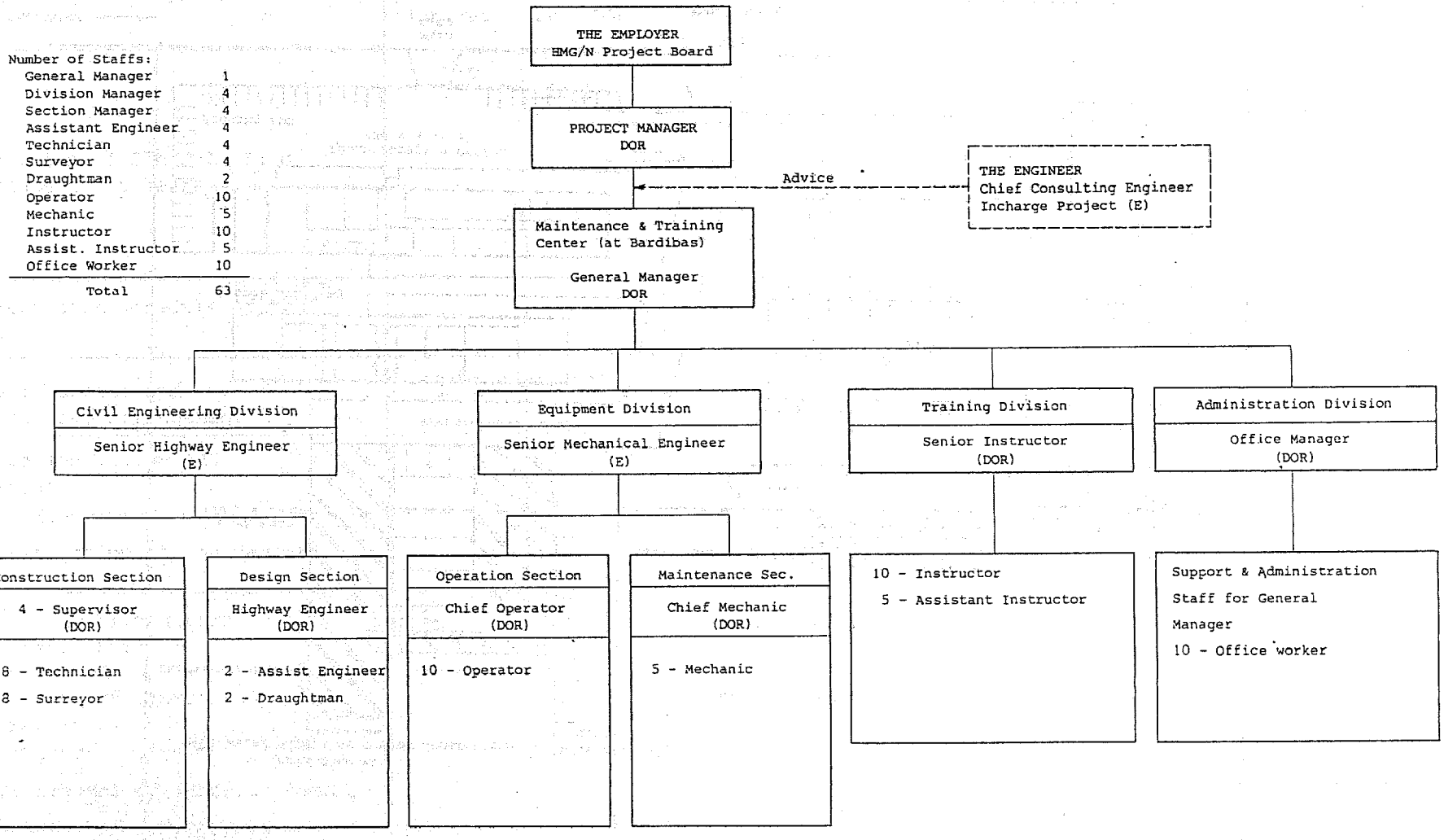
Estimated cost required for establishing the Center is shown in Table 11.4.

It is noted that the cost required for the Center is estimated separately from the construction cost of Sindhuli Road Project shown in Chapter 10 because the maintenance work defined in this Project is only the maintenance consisting of cleaning work and repairing work which has to be carried out at regular intervals of a year.

Table 11.4 Approximate Estimated Cost for Maintenance & Training Center

Item	Unit	Amount (10^3 NRs.)
1. Construction cost of offices, workshop, laboratory, stockyard etc.	Sum	80,000
2. Equipment and tools for workshop, laboratory, training room etc.	Sum	35,000
3. Construction machineries	Sum	65,000
4. Construction cost of houses	Sum	20,000
5. Other miscellaneous cost (20%)	Sum	40,000
Total		NRs. 240,000 x 10^3

Appendix 11.4.1 shows the detailed plan on maintenance and training center proposed by the Study Team.



Note : "E" indicates post to be filled by Expatriate, who will be assigned in the initial stage of training course.

Fig. 11.5 Organization of Maintenance & Training Center of Sindhuli Road Construction Project

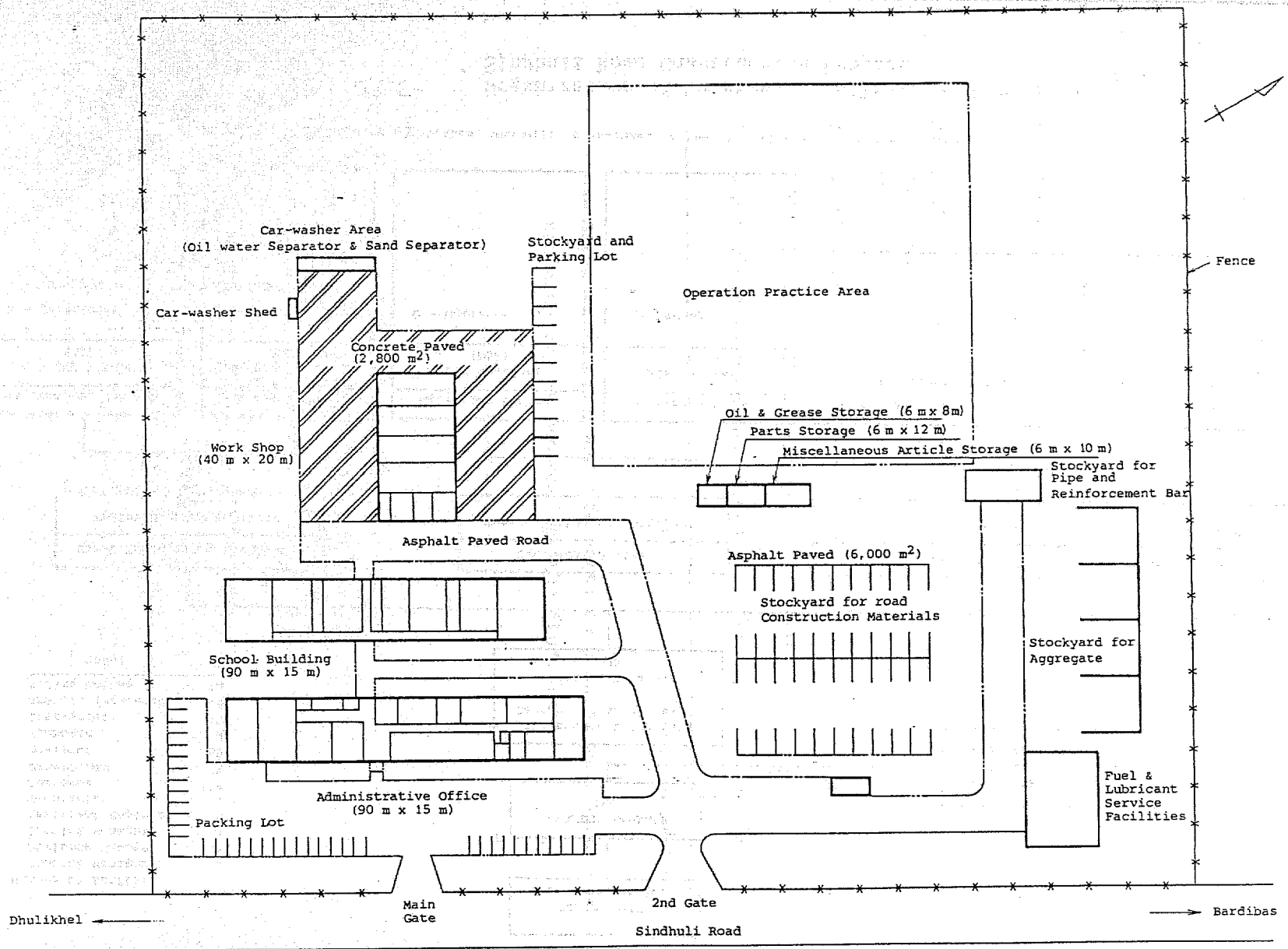


Fig. 11.6 Layout of Proposed Maintenance & Training Center

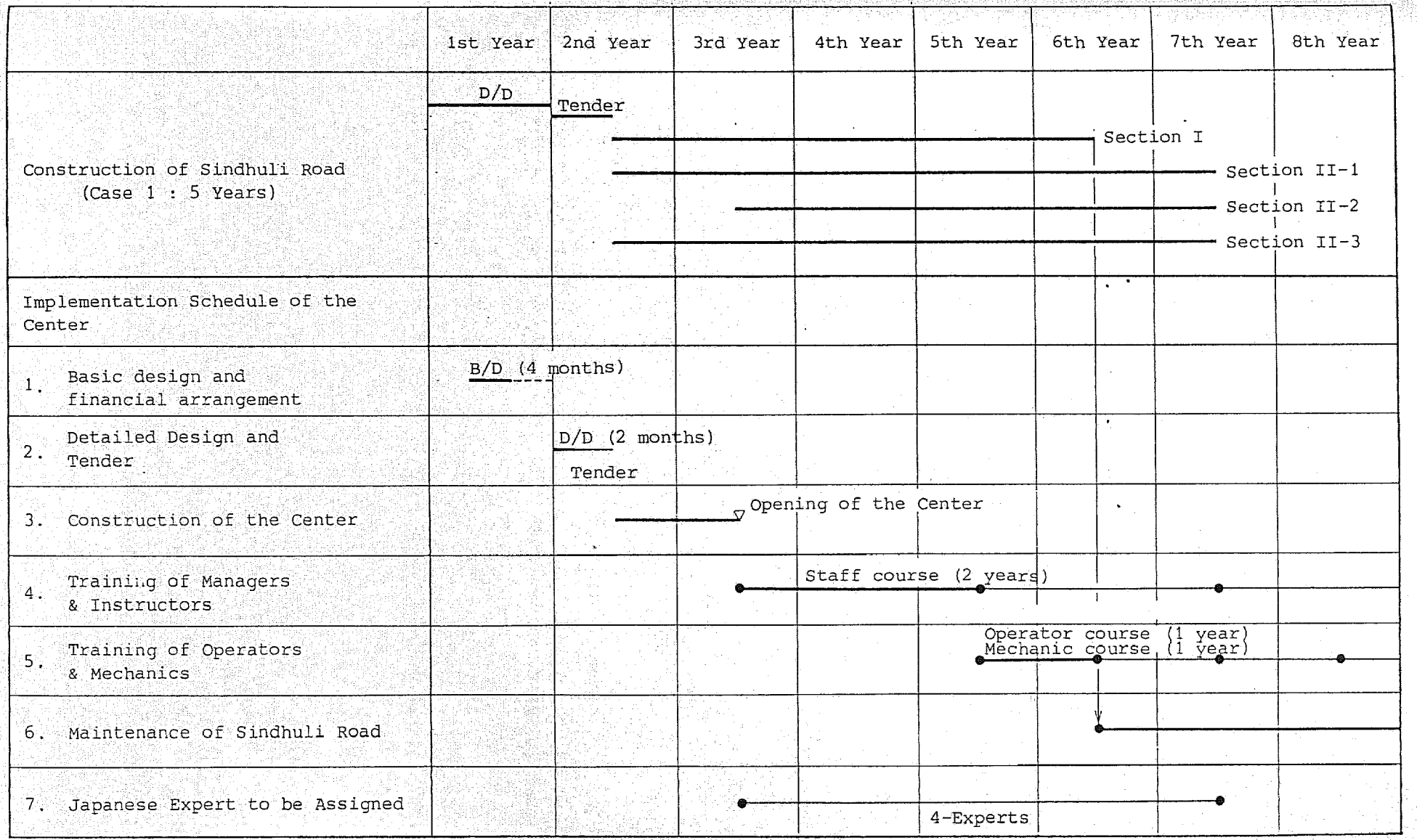


Fig. 11.7 Implementation Schedule of Maintenance & Training Center

CHAPTER 12 ECONOMIC EVALUATION

12.1 Basic Concept

12.1.1 Introduction

In this chapter, the cost of the Project Road, expressed in terms of economic cost, is evaluated by the benefit accrues from the Project, which is also expressed in economic cost. Cost of the Project Road, here is obtained through some modification of cost estimated in the previous chapter. On the other hand, benefit from the Project Road is estimated as the sum of the savings in vehicle operating cost and travel time cost. In this respect, the evaluation of benefit is strongly related with the procedure of traffic assignment. The work flow of the economic evaluation is illustrated in Fig. 12.1.

12.1.2 Indicators for Economic Evaluation

In general, three types of indicators are used for the evaluation of road construction project as explained below:

(1) Internal Rate of Return (I.R.R.)

I.R.R. is calculated through the solution of the following equation:

$$B(R) - C(R) = 0$$

$$B(R) = \sum_{t=1}^{n} \frac{Bt}{(1+R)^t}$$

$$C(R) = \sum_{t=1}^{n-1} \frac{Ct}{(1+R)^t}$$

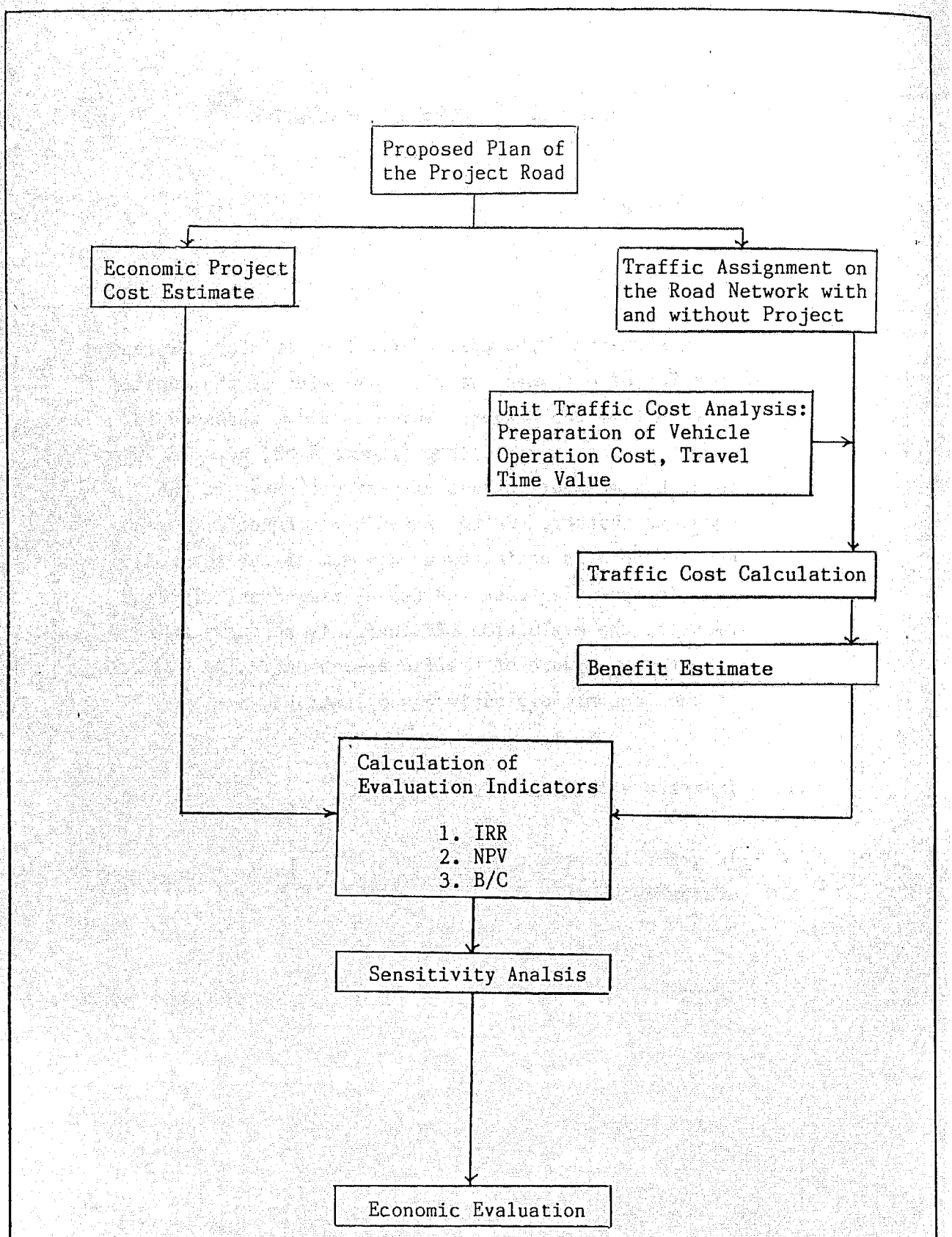


Fig. 12.1 Work Flow of Economic Evaluation

where,

R : Internal Rate of Return
Bt: Benefit in the year (t)
Ct: Cost in the year (t)
n : Project life in years

This indicator comes up with the discount rate which gives the break even point between the present value of benefit and that of cost in the stream of these values during the period of project life of the Road.

(2) Net Present Value (N.P.V.)

N.P.V. indicates the balance between the discounted benefit and cost under the assumed discount rate, e.g. opportunity cost of capital. Consequently, a positive value of this indicator means the project is economically feasible.

$$N.P.V. = B(r) - C(r)$$

$$= \sum_{t=1}^{n} \frac{Bt}{(1+r)^t} - \sum_{t=0}^{n-1} \frac{Ct}{(1+r)^t}$$

where,

Bt: Benefit in the year (t)
Ct: Cost in the year (t)
r : Discount rate
n : Project life in years

(3) Benefit Cost Ratio (B/C Ratio)

B/C ratio is an indicator obtained by dividing the present value of benefit by that of cost:

$$\text{B/C Ratio} = \frac{B}{C}$$

$$B = \sum_{t=1}^{n} \frac{Bt}{(1+r)^t}$$

$$C = \sum_{t=0}^{n-1} \frac{Ct}{(1+r)^t}$$

where,

Bt: Benefit in the year (t)
Ct: Cost in the year (t)
r : Discount Rate
n : Project life in years

12.2 Estimation of Economic Project Cost

12.2.1 Cost Disbursement Schedule

Cost Disbursement Schedule is one of the greatest factors which affect the result of economic evaluation. Although the detailed implementation schedule will be established at the detailed study of the construction program, preliminary cost disbursement schedule is assumed as shown in Fig. 11.2. in which four alternatives of implementation are being proposed.

12.2.2 Estimation of Economic Project Cost

The project cost estimated in Chapter 10 was converted into economic cost through the following procedure:

- Deduction of Tax and Duty
  Transfer factor included in the project cost, such as taxes and duties, were deducted.

- Exemption of Price Escalation
  The portion of price escalation included in the project cost was deleted.

- Deduction of Land Acquisition Cost
  The land acquisition cost was deducted from the project cost*.

The stream of economic costs obtained through the above adjustment are listed in Table 12.1 by alternative of implementation schedules.

The construction period and the opening year of the all sections of the Project to the public in each cases are as follows.

Case 1	Construction period	7 years
	Opening year	1995
Case 2	Construction period	9 years
	Opening year	1997
Case 3	Construction period	12 years
	Opening year	2000
Case 4	Construction period	10 years
	Opening year	1998

12.2.3 Maintenance Cost

Annual maintenance cost after the opening of the Project Road was estimated at NRs. 7 million. Cost for full scale overlay, which will be conducted for every 15 years, was estiamted at NRs. 55 million in terms of economic cost.

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* It is generally accepted that the amount of land acquisition cost is not included in economic cost from the following reason; Utility of the land, due to the construction of road will rise with the project and at least the same amount of opportunity benefit of the land will be realized going aside the project road.

Table 12.1 (1) Economic Cost Stream* (Case 1)

(Unit: 1000 NRs. in 1987 Price)

Year	Foreign Portion	Local Portion	Total
1989	61,948	-	61,948
1990	431,608	66,064	497,672
1991	651,477	96,256	747,733
1992	711,686	102,382	814,068
1993	675,337	98,786	774,123
1994	689,951	82,274	772,225
1995	117,166	9,795	126,961
Total	3,339,173	455,557	3,794,730

(2) Economic Cost Stream (Case 2)

(Unit: 1000 NRs. in 1987 Price)

Year	Foreign Portion	Local Portion	Total
1989	61,948	-	61,948
1990	61,829	7,467	69,296
1991	284,155	42,338	326,493
1992	507,984	74,192	582,176
1993	594,484	83,975	678,459
1994	583,086	90,375	673,461
1995	665,916	95,679	761,595
1996	520,750	56,504	577,254
1997	59,021	5,027	64,048
Total	3,339,173	455,557	3,794,730

(3) Economic Cost Stream (Case 3)

(Unit: 1000 NRs. in 1987 Price)

Year	Foreign Portion	Local Portion	Total
1989	61,948	-	61,948
1990	287,836	41,907	329,743
1991	372,086	52,576	424,662
1992	435,011	54,827	489,838
1993	371,859	48,613	420,472
1994	202,781	27,459	230,240
1995	286,914	42,698	329,612
1996	297,924	52,700	350,624
1997	336,932	51,974	388,906
1998	389,472	46,878	436,350
1999	235,787	31,157	266,944
2000	60,623	4,768	65,391
Total	3,339,173	455,557	3,794,730

(4) Economic Cost Stream (Case 4)

(Unit: 1000 NRs. in 1987 Price)

Year	Foreign Portion	Local Portion	Total
1989	30,974	-	30,974
1990	206,590	31,624	238,214
1991	305,291	46,031	351,322
1992	288,814	34,607	323,421
1993	438,675	66,390	505,065
1994	573,446	80,762	654,208
1995	513,298	72,543	585,841
1996	461,981	66,837	528,818
1997	461,872	51,736	513,608
1998	58,232	5,027	63,259
Total	3,339,173	455,557	3,794,730

* Total amount of construction cost, physical contingency and engineering service.

12.3 Estimation of Traffic Cost

In order to estimate benefit accrues from the Project Road, traffic cost on the road network was estimated. The traffic cost on the road network is composed of two components: Vehicle operating cost and travel time cost. The first step for the estimation of traffic cost is to determine the unit vehicle operation cost, e.g. NRs./km and NRs./minute. In the second step, these unit costs are applied to the result of traffic assignment. Therefore, the traffic cost estimate is closely linked with the process of traffic assignment.

12.3.1 Vehicle Operating Cost

(1) Characteristics of Vehicle Operating Cost

Vehicle operating costs are composed of fuel consumption, lubricating oil consumption, tire and tube consumption, depreciation and capital cost, repair and maintenance cost (parts and labour), crew cost, and overhead. The level of vehicle operating cost tends to differ by vehicle type, model of vehicle, driving speed and many other factors relative to driving condition.

(2) Representative Vehicle

Representative vehicles for each vehicles type were determined as shown in Table 12.2 on the basis of market share in recent Nepal.

Vehicle operating costs for each vehicle type were estimated for each of the representative vehicles assumed here.

Table 12.2 Representative Vehicle

Vehicle Type	Representative Vehicle	Market Share
Passenger Car	Toyota (Delux) Corrola	65%
Bus	63 Seater Long Chasis TATA	70%
Truck	7-8 ton TATA	70%
Motor Cycle	Hero Honda	50%

Source: The Study Team

(3) Unit Vehicle Operating Cost

Unit vehicle operating costs in terms of economic cost were estimated by vehicle type on the information gathered by the Study Team for each item of cost which composes the whole of the vehicle operating cost. Unit vehicle operating costs, at the ideal driving condition, were estimated as shown in Table 12.3 based on the information listed in Appendix 12.3.1.

(4) Unit Vehicle Operating Cost by Level of Speed

Each component of vehicle operating cost was categorized into two types of cost according to their nature, e.g. time-related cost and distance-related cost.

- Time-related vehicle operating cost

  Such costs as fuel cost, oil cost, capital cost and crew cost are included in this category of cost, which are generally strongly related with the level of vehicle speed.

- Distance-related vehicle operating cost

  Such costs as tire cost, depreciation, maintenance cost are included in this group, which are generally independent from the level of vehicle speed.

  As for the time-related vehicle operating costs, unit costs were estimated by speed level based upon existing information about the relation between the level of unit cost and speed level (Refer to Appendix 12.3.1). Unit vehicle operating costs at an ideal driving condition and those at different levels of driving speed are listed in Table 12.3 and 12.4 (1), (2), (3), (4).

Table 12.3 Unit Vehicle Operating Cost (Economic Cost)*

(Unit: NRs./1000 km)

Items	Vehicle Type			
	Passenger Car	Bus	Truck	Motorcycle
Fuel	742.0	1,656.0	1,251.0	222.4
Oil	53.6	131.0	100.4	15.6
Type and Tube	44.4	432.0	432.0	33.3
Depreciation & Interest	472.0	1,101.9	1,546.1	271.7
Maintenance (Parts)	44.9	114.0	104.7	21.8
Maintenance (Labour)	72.0	24.0	42.0	48.0
Crew Cost	66.7	200.0	200.0	-
Overhead	149.6	914.7	919.1	61.3
Total	1,645.2	4,573.6	4,595.3	674.1

* On level and paved roads, running speed is around 50 km/h, considering Nepal's road condition.

Table 12.4 (1) Unit Vehicle Operating Cost by Speed Level (Passenger Car)

(Unit: NRs/1,000 km)

Speed (km/h)	Fuel	Oil	Tire	Depreciation	Maintenance		Capital Cost	Crew Cost	Subs-total	Overhead	Total
					Parts	Labour					
5	1,962.6	228.3	44.4	239.4	273.6	49.3	1032.8	833.4	4,663.8	699.6	5,363.4
10	1,566.3	182.3	44.4	239.4	273.6	49.3	516.4	416.7	3,288.4	493.3	3,781.7
15	1,310.4	152.3	44.4	239.4	273.6	49.3	344.3	277.8	2,691.5	403.7	3,095.2
20	1,122.3	130.4	44.4	239.4	273.6	49.3	258.2	208.4	2,326.0	348.9	2,674.9
25	1,001.3	116.6	44.4	239.4	273.6	49.3	206.6	166.7	2,097.9	314.7	2,412.6
30	907.5	105.4	44.4	239.4	273.6	49.3	172.1	138.9	1,930.6	289.6	2,220.2
35	833.7	96.9	44.4	239.4	273.6	49.3	147.5	119.1	1,803.9	270.6	2,074.5
40	786.5	91.6	44.4	239.4	273.6	49.3	129.1	104.2	1,718.1	257.7	1,975.8
45	739.3	86.2	44.4	239.4	273.6	49.3	114.8	92.6	1,639.6	245.9	1,885.5
50	712.7	83.1	44.4	239.4	273.6	49.3	103.3	83.3	1,589.1	238.4	1,827.5
55	692.1	80.4	44.4	239.4	273.6	49.3	93.9	75.8	1,548.9	232.3	1,781.2
60	678.8	79.1	44.4	239.4	273.6	49.3	86.1	69.5	1,520.2	228.0	1,748.2
65	672.2	78.2	44.4	239.4	273.6	49.3	79.4	64.1	1,500.6	225.1	1,725.7
70	678.8	79.1	44.4	239.4	273.6	49.3	73.8	59.5	1,497.9	224.7	1,722.6
75	685.5	80.0	44.4	239.4	273.6	49.3	68.9	55.6	1,496.7	224.5	1,721.9
80	698.8	81.3	44.4	239.4	273.6	49.3	64.5	52.1	1,503.4	225.5	1,728.9
85	712.7	83.1	44.4	239.4	273.6	49.3	60.7	49.0	1,512.2	226.8	1,739.0

Table 12.4 (2) Unit Vehicle Operating Cost by Speed Level (Bus)

(Unit: NRs/1,000 km)

Speed (km/h)	Fuel	Oil	Tire	Depreci-ation	Maintenance		Capital Cost	Crew Cost	Subtotal	Overhead	Total
					Parts	Labour					
5	5,235.8	538.8	432.0	625.5	1,083.0	46.0	3,521.1	2,000.0	13,482.2	3,370.6	16,852.8
10	4,073.9	419.2	432.0	625.5	1,083.0	46.0	1,760.1	1,000.0	9,439.7	2,359.9	11,799.6
15	3,325.8	342.3	432.0	625.5	1,083.0	46.0	1,173.7	666.7	7,695.0	1,923.8	9,618.8
20	2,816.7	289.9	432.0	625.5	1,083.0	46.0	880.3	500.0	6.673.4	1,668.4	8,341.8
25	2,434.6	250.6	432.0	625.5	1,083.0	46.0	704.2	400.0	5,975.9	1,494.0	7,469.9
30	2,148.3	221.1	432.0	625.5	1,083.0	46.0	586.8	333.3	5,476.0	1,369.0	6,845.0
35	1,973.5	203.1	432.0	625.5	1,083.0	46.0	503.0	285.7	5,151.8	1,288.0	6,439.8
40	1,830.3	188.3	432.0	625.5	1,083.0	46.0	440.1	250.0	4,895.2	1,233.8	6,119.0
45	1,750.7	180.1	432.0	625.5	1,083.0	46.0	391.2	222.2	4,730.7	1,182.7	5,913.4
50	1,671.0	172.0	432.0	625.5	1,083.0	46.0	352.1	200.0	4,581.6	1,145.4	5,727.0
55	1,623.1	167.0	432.0	625.5	1,083.0	46.0	320.1	181.8	4,478.5	1,119.6	5,598.1
60	1,591.3	163.8	432.0	625.5	1,083.0	46.0	293.4	166.7	4,401.7	1100.4	5,502.1
65	1,623.1	167.0	432.0	625.5	1,083.0	46.0	270.9	153.9	4,401.4	1,110.4	5,501.8
70	1,702.7	175.2	432.0	625.5	1,083.0	46.0	251.5	142.9	4,458.8	1,114.7	5,573.5
75	1,782.4	183.4	432.0	625.5	1,083.0	46.0	234.7	133.3	4,520.3	1,130.1	5,560.4
80	1,925.5	198.2	432.0	625.5	1,083.0	46.0	220.1	125.0	4,544.3	1,163.8	5,819.1
85	2,084.9	214.6	432.0	625.5	1,083.0	46.0	207.1	117.6	4,810.7	1,202.7	6,013.4

Table 12.4 (3) Unit Vehicle Operating Cost by Speed Level (Truck)

(Unit: NRs/1,000 km)

Speed (km/h)	Fuel	Oil	Tire	Depreciation	Maintenance		Capital Cost	Crew Cost	Subtotal	Overhead	Total
					Parts	Labour					
5	4,096.7	505.9	432.0	495.4	874.9	46.0	2,788.8	2,000.0	11,239.7	2,809.9	14,049.6
10	3,131.5	386.7	432.0	495.4	874.9	46.0	1,394.4	1,000.0	7,760.9	1,940.2	9,701.1
15	2,537.1	313.3	432.0	495.4	874.9	46.0	929.6	666.7	6,295.0	1,573.8	7,868.8
20	2,128.9	262.9	432.0	495.4	874.9	46.0	697.2	500.0	5,437.3	1,359.3	6,796.6
25	1,832.0	226.2	432.0	495.4	874.9	46.0	557.8	400.0	4,864.3	1,216.1	6,080.4
30	1,658.2	204.8	432.0	495.4	874.9	46.0	464.8	333.3	4,509.4	1,127.4	5,636.8
35	1,472.7	181.9	432.0	495.4	874.9	46.0	398.4	285.7	4,187.0	1,046.8	5,233.8
40	1,398.6	172.7	432.0	495.4	874.9	46.0	348.6	250.0	4,018.2	1,004.6	5,022.8
45	1,299.5	160.5	432.0	495.4	874.9	46.0	309.9	222.2	3,840.4	960.1	4,800.5
50	1,262.2	155.9	432.0	495.4	874.9	46.0	278.9	200.0	3,745.3	936.3	4,681.6
55	1,237.7	152.8	432.0	495.4	874.9	46.0	253.5	181.8	3,674.1	918.5	4,592.6
60	1,250.0	154.5	432.0	495.4	874.9	46.0	232.4	166.7	3,651.9	913.0	4,564.9
65	1,262.2	155.9	432.0	495.4	874.9	46.0	214.5	153.9	3,634.8	908.7	4,543.5
70	1,299.5	160.5	432.0	495.4	874.9	46.0	199.2	142.9	3,650.4	912.6	4,563.0
75	1,361.3	168.1	432.0	495.4	874.9	46.0	185.9	133.3	3,696.9	924.2	4,621.1
80	1,472.7	181.9	432.0	495.4	874.9	46.0	174.3	125.0	3,802.2	950.6	4,752.8
85	1,596.4	197.2	432.0	495.4	874.9	46.0	164.0	117.6	3,923.5	980.9	4,904.4

Table 12.4 (4) Unit Vehicle Operating Cost by Speed Level (Motorcycle)

(Unit: NRs/1,000 km)

Speed (km/h)	Fuel	Oil	Tire	Depreciation	Maintenance		Capital Cost	Crew Cost	Subtotal	Overhead	Total
					Parts	Labour					
5	588.1	260.9	33.3	30.3	21.2	16.4	127.2	-	1,077.4	161.6	1,239.0
10	469.5	208.2	33.3	30.3	21.2	16.4	63.6	-	842.5	126.4	968.9
15	392.6	174.2	33.3	30.3	21.2	16.4	42.4	-	710.4	106.6	817.0
20	336.4	149.2	33.3	30.3	21.2	16.4	31.8	-	618.6	92.8	711.4
25	300.1	133.1	33.3	30.3	21.2	16.4	25.4	-	559.8	84.0	643.8
30	272.3	120.6	33.3	30.3	21.2	16.4	21.2	-	515.3	77.3	592.6
35	249.9	110.8	33.3	30.3	21.2	16.4	18.2	-	480.1	72.0	552.1
40	236.0	104.5	33.3	30.3	21.2	16.4	15.9	-	457.6	68.6	526.2
45	221.4	98.3	33.3	30.3	21.2	16.4	14.1	-	435.0	65.3	500.3
50	213.6	94.8	33.3	30.3	21.2	16.4	12.7	-	422.2	63.3	485.5
55	207.5	92.0	33.3	30.3	21.2	16.4	11.6	-	412.3	61.8	474.1
60	203.3	92.0	33.3	30.3	21.2	16.4	10.6	-	407.1	61.1	468.2
65	201.5	89.3	33.3	30.3	21.2	16.4	9.8	-	401.8	60.3	462.1
70	203.3	90.2	33.3	30.3	21.2	16.4	9.1	-	403.8	60.6	464.4
75	205.7	91.1	33.3	30.3	21.2	16.4	8.5	-	406.5	61.0	467.5
80	209.3	92.9	33.3	30.3	21.2	16.4	8.0	-	411.4	61.7	473.1
85	213.6	94.7	33.3	30.3	21.2	16.4	7.5	-	417.0	62.6	479.6

12.3.2 Time Cost

(1) General

Time cost is another factor which composes traffic cost. Savings of time cost is one of the major component of benefit from the Project Road. Although there exist many methods for measuring the time cost, the study here is based upon a methodology what is called "income approach", as the time value is strongly associated with income level of road users.

(2) Estimation of Time Value by Vehicle-user

1) Per Capita Income in the study area*

Population, number of economically active, income and per capita income for economically active in the study area are listed in Table 12.5 and 12.6. Per capita incomes in study area are estimated to be about NRs. 6,830, NRs. 8,700 and NRs. 9,650 for the years of 1985, 1995 and 2000 respectively.

2) Estimation of Hourly Income

Assuming the total number of workable day in Nepal as 290 days and one day's working hour 6 hours, the total working hours in a year are about 1,740 hours, as shown below:

6 hours/day x 290 days = 1,740 hours/year

From this, average per capita income of economically active for one hour is estimated as shown in Table 12.7.

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* In terms of GRP/number of economically active

Table 12.5 Population and Number of Economically Actives in the Study Area*

Region	Population (In thousand)			Number of Economically Actives (In thousand)		
	1985	1995	2000	1985	1995	2000
C.D.R.	5,433	6,879	7,631	2,363	2,992	3,319
E.D.R.	4,211	5,699	6,549	1,874	2,536	2,914
Study Area	9,644	12,578	14,180	4,237	5,528	6,233

* Refer to Table 6.1, shares of economically active are assumed 43.4% for C.D.R. and 44.5% for E.D.R. based on the information of 1985.

Table 12.6 GRP and Per Capita GRP in the Study Area*

Region	GRP (Mill. NRs.)			GRP/Number of Economically Actives (In NRs.)		
	1985	1995	2000	1985	1995	2000
C.D.R.	17,878	29,013	35,777	7,566	9,697	10,779
E.D.R.	11,068	19,083	24,391	5,906	7,525	8,370
Study Area	28,946	48,096	60,168	6,832	8,700	9,653

* Impact type economic frame

Table 12.7 Annual and Hourly Per-capita Income of Economically Actives in the Study Area

Per-Capita Income of Economically Actives (In NRs.)	1985	1995	2000
Annual	6,832	8,700	9,653
Hourly	3.9	5.0	5.5

3) Estimation of Time Value for Type of Vehicle

Time values for each vehicle type were estimated as shown in Table 12.8, applying average number of passengers*1) and share of economically active among them*2) to the hourly per-capita incomes listed in Table 12.7.

*1) Result of traffic survey conducted by the Study Team and information by DOR were used for the determination.

*2) The shares of economically active among passengers were estimated from the composition of trip-purposes, studied in traffic survey (Ref. Table 5.3).

4) Estimation of Unit Time Cost

Travel time saved by the Project Road is not always used for "productive purposes". This fact seems to come from following reasons:

- The purposes of trip are not related to income-yielding activities, e.g. in such trip-purposes as "shopping" "leisure" and "to school", no time value is reckoned.

- Even in case of "business" purpose and related ones, time saved is not always used for income-yielding activity. Sometimes it will be used for leisure, rest and idlely used.

From the above, unit time costs for each type of vehicle were modified into time costs applying the share of business trip and probability for selecting the productive activities. Unit time costs estimated by the above procedure are listed in Table 12.9.

Table 12.8 Unit Time Value (Gross)

Vehicle Type	Year	Hourly Per-capita Income (NRs) (1)	Average Number of Passenger (person) (2)	Share of Economic-Active among Passenger (3)	Time Value by Vehicle Type (NRs./h) (4)=(1)x(2)x(3)
Passenger Car	1985	3.9	3.44	0.626	8.4
	1995	5.0	3.44	0.626	10.8
	2000	5.5	3.44	0.626	11.8
Bus	1985	3.9	36.2	0.643	90.8
	1995	5.0	36.2	0.643	116.4
	2000	5.5	36.2	0.643	128.0
Truck	1985	3.9	2.0	0.643	5.0
	1995	5.0	2.0	0.643	6.4
	2000	5.5	2.0	0.643	7.0
Motorcycle	1985	3.9	1.76*	0.733	5.0
	1995	5.0	1.76	0.733	6.5
	2000	5.5	1.76	0.733	7.1

* Including drivers

Table 12.9 Unit Time Cost

Vehicle Type	Year	Gross Time Value (NRs/h) (Table 12.8) (1)	Share of Business Trip*1) (2)	Probability of selecting the Productive Activities*2) (3)	Unit Time Cost (NRs/h) (4)=(1)x(2)x(3)
Passenger Car	1985	8.4	0.568	0.5	2.4
	1995	10.8	0.568	0.5	3.1
	2000	11.8	0.568	0.5	3.4
Bus	1985	90.8	0.612	0.5	27.8
	1995	116.4	0.612	0.5	35.6
	2000	128.0	0.612	0.5	39.2
Truck	1985	5.0	0.612*3)	0.5	1.5
	1995	6.4	0.612	0.5	2.0
	2000	7.0	0.612	0.5	2.1
Motorcycle	1985	5.0	0.682	0.5	1.7
	1995	6.5	0.682	0.5	2.2
	2000	7.1	0.682	0.5	2.4

*1): Result of traffic survey conducted by the study team

*2): One half of opportunity for selecting productive activity was assumed.

*3): Same as bus

12.4 Benefit Estimates

12.4.1 Benefit Account

Theoretically, a variety of benefit will be brought about by the construction of new roads. But most of them are too abstract to be grasped quantitatively because of uncertainty in the processes in which these benefit are produced and lack of data to trace them. In general, among the total benefit brought about by new road, vehicle operating cost saving and travel time cost saving are two of the major benefits which constitute the total.

Benefit from the Project Road was estimated as the balance of two traffic costs, or traffic cost under the road network "without" the Project Road and that of under the road network "with" the Project Road* as shown in Fig. 12.2.

12.4.2 Benefit Calculation Method

As explained in the beginning of this chapter, benefit estimates are closely related with the process of traffic assignment. Accordingly, benefit calculation formula described below were applied to the process of traffic assignment:

(Benefit Calculation Formula)

$$TB = TB_N + \frac{1}{2} TB_D$$

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* With and Without Comparison.

where,

$$TB_N = TC_N^O - TC_N^W$$
$$TB_D = TC_D^O - TC_D^W$$
$$TC_N^O = \sum_j \alpha_j \sum_i d_i \cdot V_{ij}^O + \sum_j \beta_j \sum_i t_{ij}^O \cdot V_{ij}^O$$
$$TC_N^W = \sum_j \alpha_j \sum_i d_i \cdot V_{ij}^W + \sum_j \beta_j \sum_i t_{ij}^W \cdot V_{ij}^W$$
$$TC_D^O = \sum_j \alpha_j \sum_i d_i \cdot U_{ij}^O + \sum_j \beta_j \sum_i t_{ij}^O \cdot U_{ij}^O$$
$$TC_D^W = \sum_j \alpha_j \sum_i d_i \cdot U_{ij}^W + \sum_j \beta_j \sum_i t_{ij}^W \cdot U_{ij}^W$$

In which,

TB : Total benefit

TB_N : Total benefit for normal traffic

TB_D : Total benefit for developed & induced traffic

TC_N^O : Total traffic cost for normal traffic in the case of "without" the Project Road

TC_N^W : Total traffic cost for normal traffic in the case of "with" the Project Road

TC_D^O : Total traffic cost for developed & induced traffic in the case of "without" the Project Road

TC_D^W : Total traffic cost for developed & induced traffic in the case of "with" the Project Road

V_{ij}^O : Assigned traffic volume of normal traffic on link (i) for vehicle with type (j), under the road netwaork "without" the Project Road

V_{ij}^W : Assigned traffic volume of normal traffic on link (i) for vehicle with type (j), under road network "with" the Project Road

U_{ij}^O : Assigned traffic volume of induced traffic on link (i) for vehicle with type (j), under road network "without" the Project Road

U_{ij}^{w} : Assigned traffic volume of developed & induced traffic on link (i) for vehicle with type (j), under road network "with" the Project Road

α_j : Unit vehicle operating cost (NRs/km) for vehicle type (j)

β_j : Unit time cost (NRs/h) for vehicle with type (j)

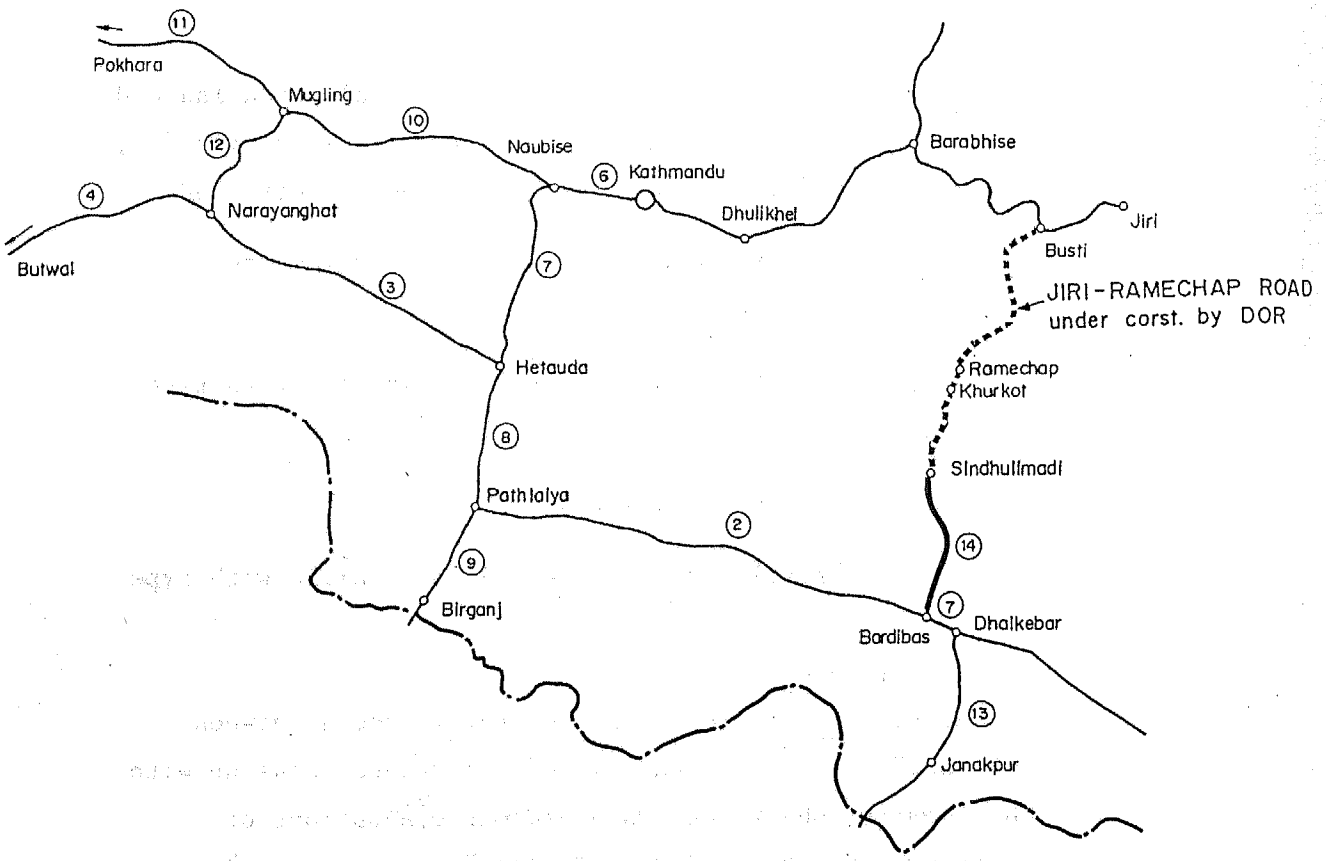
d_i : Length of link (i)

t_{ij} : Travel Time on link (i) for vehicle with type (j)

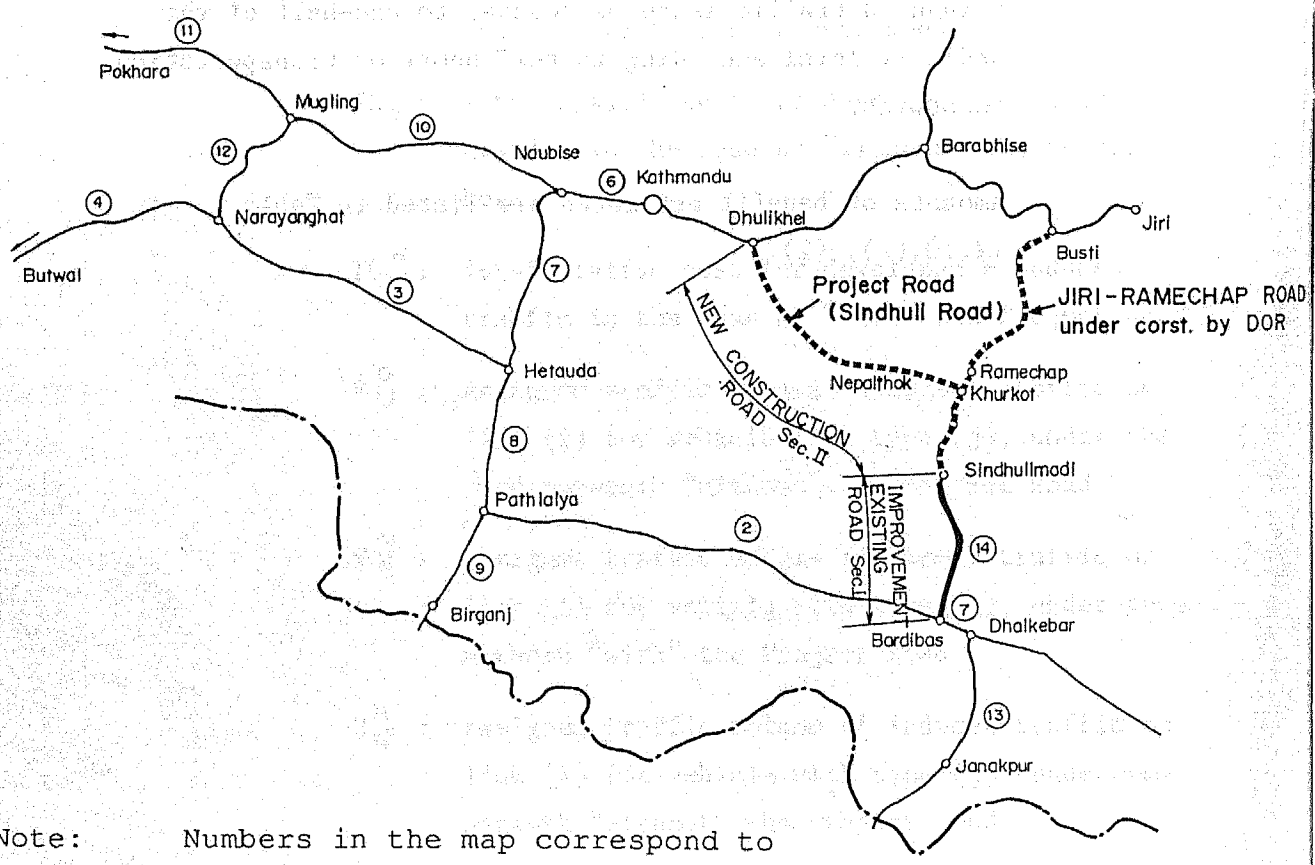
In short, the difference of two traffic costs between "without" the Project and "with" the Project ends up with the benefit, under the two different evaluations of benefit by two type of traffic, or "normal traffic" and "developed & induced traffic". The benefit from developed & induced traffic is to be reduced to one-half of the ordinary level according to the theory of transportation economics.

Amounts of benefit estimated are listed in Table 12.10.(1), (2).

Without the Project Road



With the Project Road



Note: Numbers in the map correspond to the road numbers shown in Table 5.9

Fig. 12.2 Road Network "without" and "with" the Project

Table 12.10.(1) Amounts of Annual Benefit

(In the case of all the sections of the Project Road are completed)

(Unit: Million NRs. in 1987 price)

Year	1995 Traffic Type			2000 Traffic Type		
Composition of Benefit	Normal	Developed & Induced	Total	Normal	Developed & Induced	Total
Vehicle Operating Cost Saving (1)	136.7	50.5	187.2	199.6	80.9	280.5
Time Cost Saving (2)	10.3	4.4	14.7	16.7	8.7	25.4
Benefit Total ((3)=(1)+(2)) (3)	147.0	54.9	201.9	216.3	89.6	305.9

Table 12.10.(2) Amounts of Annual Benefit

(In the case of only section I and Section II-1 of the Project Road are completed)

(Unit: Million NRs. in 1987 price)

Year	1995 Traffic Type			2000 Traffic Type		
Composition of Benefit	Normal	Developed & Induced	Total	Normal	Developed & Induced	Total
Vehicle Operating Cost Saving (1)	39.3	10.2	49.5	57.0	14.4	71.4
Time Cost Saving (2)	3.2	1.1	4.3	4.6	1.6	6.2
Benefit Total ((3)=(1)+(2)) (3)	42.5	11.3	53.8	61.6	16.0	77.6