the site reconnaissance along the route, soil investigations at prospective tower locations are to be undertaken. Manual excavation, concrete mixing with portable mixer, backfilling with rammer or the like of it are to be used for civil works, while tower erection is to be carried out with pole type erector (gin pole) and line stringing with tension stringing method.

#### Construction Schedule 10.5

#### 10.5.1 First Stage Construction

The first stage construction is to construct the power station having the installed capacity of 201 MW (3 units, 67 MW each) to cope with the domestic power demand after the middle of 1990s. The scheduled commissioning time of each unit is as shown below.

> Unit No. 1 June 1994

Unit No. 2 September 1994

Unit No. 3 June 1999

[Commissioning time of unit 3 will change on September 1998 for the two stage development scheme.]

The construction schedule is drawn aiming at these commissioning dates on the basis of work plans described in 10.4 above. construction schedule for the first stage is shown in Fig. 10-6 which also indicates the times required for the detailed design, tendering, etc.

The schedule of commencement of the major works are as shown below.

November 1987 Access road Diversion tunnel November 1989 Dam & spillway November 1990 Headrace tunnel November 1989 Powerhouse (civil) June 1990 Generating equipment November 1992

Transmission &

substation facilities 1992 June

The critical path for execution of the first stage construction runs along access road and headrace tunnel as observed in Fig. 10-6. As to access road, it is planned to complete the first phase works which allow vehicle traffic to the dam site for transportation of construction materials and equipment by October 1989 in 24 months, and then to execute the finishing works as the second phase during the succeeding 24 months.

In order to start the road construction in November 1987, the utmost efforts of the related parties have to be exerted to shorten the necessary time for the detailed design, tendering, etc.

While, for shortening the construction period of headrace tunnel, it is planned to adopt tunnel boring machine (TBM) for driving the upstream tunnel section of 7.5 km long.

#### 10.5.2 Second Stage Construction

The second stage construction is the extension of the generating facilities of 201 MW (3 units, 67 MW each) for the purpose of mainly power export. It is scheduled to start the second stage construction in June 1994 which is set up in consideration of the time required for negotiation of power export with the importing country which will be entered at the time of commencement of the first stage construction in November 1989 and the time for the detailed design, fund arrangement, tendering, etc., as discussed with NEA.

The overall construction schedule including the first and second stages is shown in Fig. 10-7. As shown there, the major works included in the second stage are the construction of headrace No. 2 and installation of the additional turbines, generators, etc. The time necessary for construction of headrace tunnel No. 2 is considered to be same as that for headrace tunnel No. 1.

The total project with the installed capacity of 402 MW including the first and second stages is planned to be completed in June 1999.

Fig. 10-6 Construction Schedule of 1st Stage (Without Export)

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Feasibillty Study			<b>1</b>	inal Report										
Support Facilities			T/A							-1				
Access road	L = 115 Km		\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	T I ST		2 nd (Finishi	ng work)							
Preparatory works	L.S		1	D/D T/A	> <del> </del>   > <del> </del>	1-1-1-0	<del>┡</del> ╇╗╾	<del>┈</del> ┾╛╍╄╸ <del>╏═</del> ╿╼	<del>┞╸╵╍</del> ╸ <del>┞╸</del> ┆╾┿╺					
Water Storage Facilities		1 1		10/0	$\Phi$	Cras & Cras				Plug +				
Diversion tunnel	D= 7.0 m L= 354 m					Exca,8 Conc.		<del>├</del> <del></del>	╉┺┪╍╋╒╤╬╵ ╂┼┼╎┼┼	RT !				<del>                                     </del>
Coffer dam	L,S						<del>-0-1 + 0-</del>	ca.& Conc.	Conc	te				
Dam & Spillway	Exca. 108,300 m <sup>3</sup> Conc. 160,700 m <sup>3</sup>						<b>70 &gt;0</b>		Conc.		<del>                                     </del>			$\frac{1}{1}$
			┧╎╏╏┇┤ ┷┷╧╌╂ <del>╏</del> ╅╇═┺	10/0	T/A	+	(Gate)	┡═╣═╪╌╬═ ┡═┼╶╀═┼	<b>╆┡┩┿╅┩</b> ╆╫╫╫		<del>                                     </del>			
Waterway				•	>0			Exag & Copc	Conc.	Gata I	┨┞┆╏╏╷ <del>┨┩</del> ┸╂╫			
Intake& Desanding basin	Exca. 225,900 m <sup>3</sup> Conc. 42,700 m <sup>3</sup>					TBM Prep	No.1	Exca. & Conc.	<b>P</b>	Gate	1 1 1 1 1	+ + + + + + +		<del></del>
Headrace tunnel (U.S)	L= 7.5 Km(TBM)					Const.	9++1		oncrete lining	1 1   1   1   1   1   1   1   1				
·	L= 0.2 km(CBM)					adit	Shotcrete !	<del>                                     </del>	الكائسنشار بسنارا يهرب سه	<b>→</b>			1 1 1	
Headrace tunnel (D.S)	L= 3.7Km(CBM)					1 1 1		ca. 120 m/ M						
						Shoi	crete	Exca.	Lining 90 my	Y				
Surge tank	Exca. 38,300 m <sup>3</sup> Conc. 7,400 m <sup>3</sup>						I Adit !	Exca.	Pipe insta			1 1 1 1 1 1		
Penstock	Exca. 25,200 m <sup>3</sup> Conc. 7,400 m <sup>3</sup>						1/A	1 1 1	i i i					
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Powerhouse	Exca. 132,900 m <sup>3</sup> Conc. 36,900 m <sup>3</sup>					8 Cabi	Co	vern)	outlet Exca.8 Con					
Tailrace & Outlet	Exca. 39,300 m <sup>3</sup> Conc. 11,200 m <sup>3</sup>					l i tunn	el Tun	<del></del>	xca.8 iConc.	<b></b>	1 1 1 1	1111		+
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Turbine & Generator	L,S						<b>N-1-+ ++ -</b>	<b>†</b> ¬¬¬+ <b>&gt;0</b> ¬	Ins	X-X-	<del>                                     </del>			
Auxiliary equipment	L.S								Ins	X				
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Transmission line	L.S							<b>`</b> ⊤> <b>°</b> ⊤	Insta.					
Substation	L.S							<u> </u>						

Fig. 10-6 Construction Schedule of 1st Stage (Without Export)

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Fig. 10-7 Construction Schedule of 1st & 2nd Stages (With Export)

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Access road	L= 115 Km		<b></b>		<b></b>	214 (11131	<del>                                    </del>					<del>                                      </del>	<del></del>	
Preparatory works	L.S		>	<b>0</b>	>O->O->O-	<u> </u>	<b>├</b>	\	<del>┡</del> ╺╈╼╽╾┷╴╅ <del>╏╶</del> ┇╶╅╼╽╾┷╴╅					
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Diversion tunnel	D= 7.0 m L= 354 m					xco. 8. Conc.	+	<del> </del>	<del>╽╸┆┈╎╸</del> ┆╸┤	PI			<u> </u>	
Coffer dam	L.S						co & Conc	ca.B. Conc.	Cons					.
Dam & Spillway	Exca. 108,300 m <sup>3</sup> Conc. 160,700 m <sup>3</sup>				<u> </u>			<b>***</b>	onc.	<b>^</b> -1				
					7/0	<u> </u>	(Gate)	<del>╽╴┆╸┆╸┞╸┆╸┩</del> ╺	<u> </u>					
/aterway			<b> </b>	0/0	>0 1/A					Cata T				1 1
Intake&Desanding basin	Exca. 225,900 m <sup>3</sup> Conc. 42,700 m <sup>3</sup>						+->0	Exco.	<b>P</b> • • • • • • • • • • • • • • •	Gate, TBM_		Exca. 280 m/		
Headrace tunnel (U.S.)	L= 7.5Km(T8M)					onst.	No.l	Exco. 28	T +	Prepo		<del>                                     </del>		
	L= 0.2km(C BM)				i	add8	Shotcrete	<del>                                     </del>	ncrete lining 90 r	M.	Shotcrete		crete lining 90	M.V.
Headrace tunnel (D.S.)	L=3.7 Km(CBM)						No.I Ex	6a. 120 m/M	<b>&gt;</b> ○	>0	<u> </u>	xco. 120 m/M	<b>&gt;</b> 0+  -  -  -  -  -  -  -  -  -  -  -  -  -	
						Shoter	ete!   >	Concrete		M Sho	otcrete i	Ψ	lining 90 m	M
Surge tank	Exca. 71,800 m <sup>3</sup> Conc. 12,000 m <sup>3</sup>					<del>                                </del>	<b>→</b> → <b>→</b>	No.1	Conc.			No.2	Conc.	┝╌┼┼
Penstock	Exca. 37,400 m <sup>3</sup> Conc. 14,700 m <sup>3</sup>					1 1	->Q	Exca >	Pipe insta,	<b>→→→</b>		Exca.	Pipe I	nsta,
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Turbine & Generator	L.S	1 1 1		<del>                                      </del>			<b></b>		Insta		++++	<del> </del>	Ins	ta.'
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Fig. 10-7 Construction Schedule of 1st & 2nd Stages (With Export)

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# CHAPTER 11. COST ESTIMATE

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#### CHAPTER 11. COST ESTIMATE

#### 11.1 General Concept

Construction costs of the Arun 3 project are estimated based on the following concepts.

- (1) Project cost is divided into 7 categories; supporting facilities, civil works, hydraulic equipment, electromechanical equipment, transmission line and substation equipment, administration including engineering services and contingency.
- (2) The unit prices of the similar works in Nepal are referred for cost estimate, however, those applied to works in Japan and other countries are also referred.
- (3) The price level is on June 1, 1986 and the exchange rate of 21.35 Rupees per US\$ (by Nepal Rastra Bank) is adopted.
- (4) The administration including engineering services is calculated at 7.5% of the direct cost which is generally applied to the projects of similar scale.
- (5) The contingency is calculated at 15% of cost for the supporting facilities and civil works and 10% for the hydraulic equipment, electromechanical equipment and transmission line and substation equipment and administration including engineering services.
- (6) The interest during construction and price escalation are not included in the project cost.
- (7) The construction costs are divided into two portions, namely, the foreign currency portion pertaining to those for equipment and materials to be imported and the local currency portion for labour, materials and equipment available in Nepal, inland transportation, etc.
  - (8) Taxes and duties are excluded in the cost estimation.

#### 11.2 Component of Cost

#### (1) Supporting facilities

#### (i) Access road

The cost for access road includes the construction cost of new road from Dhankuta (Hile) to the dam site of about 115 km and also the cost for improvement of the existing road between Dharan and Dhankuta. The breakdown of the cost for the new road is shown in the separate Volume II.

#### (ii) Preparing works

The cost for preparation works includes those for camp facilities, telecommunication facilities and temporary diesel power plant.

The costs for camp facilities are for providing office buildings and living quarters to be used by NEA and the Engineer. The costs for telecommunication facilities are for providing wireless system between Kathmandu and the project site and also telephone system in the project area. The costs for temporary power plant are providing diesel engine generator being described in paragraph 10.3 and appurtenant facilities, fuel, and operation and maintenance of the plant.

The costs required for the above supporting facilities are calculated at respective lump sum prices. However, the costs for aggregate plant, concrete mixing and placing equipment, service roads in the project area, temporary bridges, water supply and drainage facilities, etc. which are directly required for execution of the works are to be included in the unit prices of civil works.

#### (2) Civil works

The costs for civil works are calculated on the basis of work quantities estimated based on design drawings described in Chapter 9 "Feasibility Design" multiplied by corresponding unit prices. The unit prices are figured taking into consideration labour wages in Nepal (Table 11-6), prices of materials (Table 11-7), unit prices of the works adopted at the similar projects, etc. which are mainly collected during the field investigations as well as local conditions particular to the Arun 3 project. Some of the unit prices for constructing headrace tunnel and powerhouse are estimated referring to those applied to the similar works in Japan with adjustment for local conditions in Nepal.

The unit prices include the costs for labour, equipment and materials, transportation, insurance premium, temporary facilities and other incidental works. The costs for the works other than the major items are brought up together and estimated at the lump sum prices as miscellaneous.

#### (3) Hydraulic equipment

The costs for closure gate at the diversion tunnel, spillway gates, intake gates and trashracks, gates and other facilities in the desanding basin, steel lining in headrace tunnels and surge tanks, penstock steel pipes and tailrace gates are included in this category. The cost for each equipment pertains to materials, fabrication, transportation, installation, insurance premium and all other incidental works.

#### (4) Electromechanical equipment

The cost for the electromechanical equipment pertains to materials, fabrication, transportation, installation, insurance premium and other incidental works of turbines, generators, main transformers, auxiliary powerhouse equipment, switchyard, etc. The cost for each work item is estimated at the lump sum price.

#### (5) Transmission line and substation

#### (i) For domestic power supply

Costs for the following transmission lines and substations are included in the project cost.

#### ° Transmission line

Transmission line connecting Arun 3 P/S - Dubi S/S - Dhalkebar S/Y - New Kathmandu S/S (220 kV, 2 cct), excepting those as follows:

New Kathmandu S/S - Balaju S/S (132 kV, 1 cct)

New Kathmandu S/S - Siuchatar S/S (132 kV, 1 cct)

Hetauda S/S - Dhalkebar S/S - Dubi S/S (132 kV, 1 cct)

#### ° Substation/Switchyard

Dubi S/S (220 kV and 132 kV equipment), Dhalkebar S/Y (220 kV equipment) and New Kathmandu S/S (220 kV and 132 kV equipment), excepting those as follows:

Expansion of 132 kV equipment at Hetauda S/S Static condenser and shunt reactor facilities at the existing power system near Kathmandu

#### (ii) For power export

In addition to the above facilities to be constructed in Nepal, the cost for the part inside Nepal only of 220 kV trnasmission lines (2 cct) and substation facilities at the Dubi S/S are included for power export.

#### (6) Compensation cost

The compensation cost includes those required for acquisition of lands to be occupied by dam and reservoir, surge tanks, facilities around powerhouse, access road, transmission line towers, substations, etc. and for removal of private houses and is esti-

mated at approximately US\$1.6 millions. The details of compensation are as described in Chapter 12. Since the compensation cost of the above amount is relatively small compared with the others, this cost is included in the contingency cost for the project.

#### (7) Allocation of foreign currency portion

Percentage of foreign currency portion in respective construction costs are estimated as shown below, referring to the latest values applied to the projects of similar nature in Nepal.

Access road	74.1%
Preparatory works	76.1%
Civil works	85.0%
Hydraulic equipment	90.0%
Electromechanical equipment	90.0%
Transmission line and substation	90.0%
Administration and engineering services	85.6%
Contingency	84.8%
Total	85.5%

#### 11.3 Construction Cost

#### 11.3.1 Construction Cost for First Stage

The total construction cost for the first stage (3 units, 67 MW each, 201 MW in total) which is planned to cope with the domestic power demand is as shown below and Table 11-1. The above cost also includes those for a part of the facilities for power export in the future such as intake, desanding basin, powerhouse (extension), tailrace, etc. which are necessarily constructed simultaneously.

# Summary of Construction Cost for 1st Stage (US\$)

Supporting facilities	48,700,000
Civil works	131,187,000
Hydraulic equipment	11,673,000
Electromechanical equipment	38,400,000
Transmission line and substation	87,500,000
Administration and engineering services	23,810,000
Contingency	43,121,000
Total	384,391,000

Table 11-1 Total Construction Cost (1st Stage)

		F/C portion (10 <sup>3</sup> US\$)	L/C portion (10 <sup>3</sup> US\$)	
(1)	Supporting facilities	36,280	12,420	48,700
	Access road  New Construction  Improvement of existing road	28,900 28,900 0	10,100 5,100 5,000	39,000 34,000 5,000
	Camp facilities	0	1,500	1,500
•	Telecommunication facilities	900	100	1,000
	Diesel engine generator	6,480	720	7,200
(2)	Civil works	111,509	19,678	131,187
	Diversion tunnel & cofferdam	5,797	1,023	6,820
	Dam & spillway	20,748	3,662	24,410
	Intake & desanding basin	18,114	3,197	21,311
	Headrace tunnel & surge tank	44,222	7,804	52,026
	Penstock	2,502	441	2,943
	Powerhouse & switchyard	15,938	2,812	18,750
	Tailrace tunnel & outlet	4,188	739	4,927
(3)	Hydraulic equipment (Gate, trashrack & penstock)	10,506	1,167	11,673
(4)	Electric equipment (Turbine, generator, transformer, auxiliary equipment & switchgear)	34,560	3,840	38,400
(5)	Transmission line & substation facilities	78,750	8,750	87,500
(6)	Administration & engineering services $\underline{1}/$	20,370	3,440	23,810
(7)	Contingency <u>2</u> /	36,586	6,535	43,121
	Grand Total	328,561	55,830	384,391

Note  $\frac{1}{2}$ : 7.5% of total cost for works from (1) to (5) above.  $\frac{2}{2}$ : 15% of total cost for works (1) and (2) plus 10% of (3) to (6) above.

The yearly disbursement and breakdown of the total construction cost for the first stage are as shown in Table 11-2 and Table 11-3.

Table 11-2 Disbursement Schedule (1st Stage)

Column   C		-	į									i	1	!	a	Unit: 1,000 US\$	0 08\$
F.C. 28,900 2,890 10,115 10,115 1,290 2,890 10,116 1,010 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1	Item		Total Cost	1 1987	2 1988	3 1989	1990	5 1991	6 1992	1993	8 1994	9 1995	10 1996	11 1997	12 1998	13 1999	14 2000
F.C. 111, 509	1. Access Road	F.C. L.C. Total	28,900 10,100 39,000	2,890 1,010 3,900	10,115 3,535 13,650	10,115 3,535 13,650	2,890 1,010 3,900	2,890 1,010 3,900	. 0	0	0	1, <b>0</b> ,	0	0	0	0	
Trotal 131,187	2. Preparatory Works	F.C. L.C. Totel	7,380 2,320 9,700	• • • • • • • • • • • • • • • • • • •	1,699 533 2,232	1,291 407 1,698	1,477 464 1,941	583 183 766	966 304 1,270	966 304 1,270	398 125 523			<b>o</b> *	0	O	
Hydraulic Equipment F.C. 10,506  Hydraulic Equipment F.C. 10,506  L.C. 1,167  Hydraulic Equipment F.C. 10,506  L.C. 1,167  L.C	3. Civil Works	F.C. Total	111,509		<b>O</b>	1,159 205 1,364	10,659 1,881 12,540	25,786 4,551 30,337	32,552 5,744 38,296	29,389 5,186 34,575	11,167 1,971 13,138	0	. 4	0	478 84 562	319 56 375	*
Electromechanical F.C. 34,560  Equipment L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 3,840  L.C. 20,370  L.C. 3,440  L.C. 3,440  L.C. 3,840	4. Hydraulic Equipment.		10,506	0			0	1,050	2,102 233 2,335	4,202 467 4,669	3,152 350 3,502	o .	0	O	Ö		
Transmission Line F.C., 78,750 6 Substation L.C. 8,750 6 Substation L.C. 8,750 7 Substation L.C. 8,750 7 Substation L.C. 8,750 7 Substation L.C. 8,750 7 Substation L.C. 8,750 7 Substation L.C. 1,019	5. Electromechanical Equipment	F.C. L.C. Total	34,560 3,840 38,400	0		• 0		2,626. 292 2,918	10,437 1,160 11,597	7,845 872 8,717	5,219 580 5,799	¢	0	4,217 468 4,685	3,387	829 92 921	
Administration 6 F.C. 20,370 251 1,019 1,072 1,180 2,508 3,938 6,196 2,995 506 506 51 1,019 1,019 1,072 1,180 2,508 1,046 506 506 1,046 506 506 1,046 506 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,046 506 1,048 506 1,048 500 1,048 5,051 1,048	6. Transmission Line & Substation	F.C. L.C. Total	78,750 8,750 87,500		0	0		0	7,087 788 7,875	42,604 4,734 47,338	21,342 2,371 23,713				4,646 516 5,162	3,071 341 3,412	•
F.C. 36,586 521 2,122 2,233 2,456 5,051 7,276 10,328 4,837 428 889 L.C. 6,535 93 379 439 439 11,300 1,845 864 Total 43,121 614 2,501 2,632 2,895 5,952 8,576 12,173 5,701 0 0 504 1,048 F.C. 328,561 4,109 16,731 17,605 19,365 41,005 63,724 99,138 47,761 698 2,843 2,992 3,292 6,967 10,828 16,846 8,116 805 1,634 1,634 1,647 19,574 20,597 22,655 47,772 74,552 115,984 55,877 0 0 5,540 11,247	7. Administration & Engineering Services	F.C. L.C. Total	20,370 3,440 23,810	251 42 293	1,019	1,072 181 1,253	1,180	2,508 424 2,932	3,938 665 4,603	6, 196 1,046 7,242	2,995 506 3,501	0	6	300 51 351	609 103 712	302 51 353	·
F.C. 328,561 4,109 16,731 17,605 19,365 41,005 63,724 99,138 47,761 4,761 4,735 9,613 1.C. 55,830 698 2,843 2,992 3,290 6,967 10,828 16,846 8,116 80.116 805 1,634 Total 384,391 4,807 19,574 20,597 22,655 47,972 74,552 115,984 55,877 0 0 5,540 11,247	8. Contingency	F.C. I.C. Total	36,586 6,535 43,121	521 93 614	2,122 379	2,233 399 2,632	2,456 439 2,895	5,051 901 5,952	7,276 1,300 8,576	10,328 1,845 12,173	4,837 864 5,701	0	0	428 76 504	889 159 1,048	445 80 525	
	Grand Total	F.C. Total	328,561 55,830 384,391	4,109 698 4,807	16, 731 2,843 19,574	17,605 2,992 20,597	19,365 3,290 22,655	41,005 6,967 47,972	63,724 10,828 74,552	99,138 16,846 115,984	47,761 8,116 55,877			4,735 805 5,540	9,613 1,634 11,247	4,775 811 5,586	

F.C. : Foreign currency portion L.C. : Local currency portion

Table 11-3 Breakdown of Construction Cost (1st Stage)

					(US\$)
Item	Unit	Unit Price	Q'ty	Cost	Note
(1) Supporting Facility					
Access Road					
New construction	LS		1	34,000,000	
Improvement	LS		1	5,000,000	
Sub-total				39,000,000	·.
Camp Facilities	LS		1	1,500,000	•
Telecommunications	LS		1	1,000,000	
Diesel engine generator	LS		1	7,200,000	
Sub-total			· .	9,700,000	
Total				48,700,000	
(2) Diversion Tunnel					
Common excavation	m <sup>3</sup>	5	530	2,650	
Rock excavation		12	2,120	25,440	
Tunnel excavation	11	48	19,000	912,000	
Structure concrete	19	170	810	137,700	: · · · · · ·
Lining concrete	u	150	4,500	675,000	
Tunnel form	m	310	355	110,050	
Plug concrete	$\epsilon_{\mathrm{m}}$	130	1,280	166,400	
Shotcrete	m <sup>2</sup>	40	1,400	56,000	
Wire mesh	m <sup>2</sup>	15	1,400	21,000	
Rock bolt (L=3m)	pcs	70	200	14,000	
Reinforcement	t	635	1,00	63,500	
Grouting	t	410	100	41,000	

					(US\$)
<u>Item</u>	Unit	Unit <u>Price</u>	Q'ty	Cost	Note
Miscellaneous	LS		1	111,260	5%
Sub-total				2,336,000	
Closure gate	t	3,400	40	136,000	
Total				2,472,000	
(3) Khoktak Khola Diver	sion			+ - I	
Common excavation	m <sup>3</sup>	5	200	1,000	
Rock excavation	11	12	300	3,600	
Tunnel excavation	11	48	2,200	105,600	·
Dyke concrete	#1	125	500	62,500	
Structure concrete	\$1	170	100	17,000	1
Lining concrete	13 <b>H</b>	150	470	70,500	4
Tunnel form	: <b>m</b>	250	135	33,750	-
Shotcrete	m <sup>2</sup>	40	1,200	48,000	· 1. ·
Wire mesh	11	15	1,200	18,000	
Rock bolt (L=3m)	pcs	70	700	49,000	
Miscellaneous	LS		1	21,050	5%
Total			e e	430,000	
(4) <u>Cofferdam</u>			:	ta sa	
Upstream cofferdam		·	-	y. Vilo	
Impervious core	<sub>m</sub> 3	12	10,200	122,400	
Rockfill	11	12	68,600	823,200	
Slurry trench	11	450	570	256,500	
Dewatering	LS	re y	43 - 1 - 1	200,000	
Reconstruction	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		1	1,580,000	
Miscellaneous	LS			296,900	10%
Sub-total				3,279,000	
		11 – 11		en en groupe de la companya de la companya de la companya de la companya de la companya de la companya de la c La companya de la companya de la companya de la companya de la companya de la companya de la companya de la co	
					•

					(US\$)
Item	Unit	Unit Price	Q'ty	Cost	Note
Downstream cofferdam					, e tres
Impervious core	r <sub>m</sub> 3	12	2,500	30,000	
Rockfill	· ·	. 12	11,320	135,840	×
Slurry trench	**	450	460	207,000	
Re-construction	LS		1	332,000	
Miscellaneous	LS		1	70,160	10%
Sub-total				775,000	
Total				4,054,000	
(5) Dam and Spillway					
Reservoir cleaning	ha	1,000	75	75,000	* = 1
Common excavation	<sub>m</sub> 3	8	52,500	420,000	
Rock excavation		15	55,800	837,000	
Foundation clean up	<sub>m</sub> 2	13	8,800	114,400	
Mass concrete	<sub>m</sub> 3	115	150,900	17,353,500	-1
Structure concrete	. "	170	9,800	1,666,000	v., •,
Reinforcement	t	635	820	520,700	: <u>.</u>
Grouting	m	140	8,600	1,204,000	
Miscellaneous	LS		1	2,219,400	10%
Sub-total				24,410,000	
Spillway gate	t	5,000	600	3,000,000	
Total				27,410,000	
(6) Intake				gir jarih da	
Common excavation	<sub>m</sub> 3	8	9,740	77,920	eval. I.
Rock excavation	. <b>n</b>	15	39,000	585,000	
Tunnel excavation	**	48	26,000	1,248,000	:*

			•		(US\$)
<u> Item</u>	Unit	Unit Price	<u>Q'ty</u>	Cost	Note
Structure concrete	. m3	170	13,200	2,244,000	
Lining concrete		150	8,100	1,215,000	
Tunnel form	m	530	150	79,500	
Shotcrete	<sub>m</sub> 2	40	5,400	216,000	
Wire mesh	m <sup>2</sup>	15	5,400	81,000	
Rock bolt (L=3m)	pcs	70	440	30,800	
Reinforcement	t	635	680	431,800	
Grouting	t	410	90	36,900	
Miscellaneous	LS		1	312,080	5%
Sub-total				6,558,000	
Control gate	t	5,000	160	800,000	
Trashrack		3,000	70	210,000	
Sub-total	٠			1,010,000	et to
Total				7,568,000	
(7) Desanding Basin					
Underground excavation	. <u>m</u> 3	45	144,000	6,480,000	
Tunnel excavation	, , , <b>, ,</b> ,	48	7,400	355,200	
Side wall concrete	· · · · · ·	170	16,100	2,737,000	
Base concrete	***	155	11,000	1,705,000	
Lining concrete		150	2,700	405,000	e e e e e e e e e e e e e e e e e e e
Tunnel form	m	250	600	150,000	
Shotcrete	m <sup>2</sup>	1. fr. <b>40</b>	15,800	632,000	
Wire mesh	•	15	15,800	237,000	
Rock bolt	pcs	<b>7</b> 0	9,300	651,000	
The second secon			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		

Reinforcement

635

		Unit		(vs\$)
Item	Unit	Price	<u>Q'ty</u>	Cost Note
Miscellaneous	r2		1.	702,300 5%
Sub-total				14,753,000
Drainage gate	t	5,000	90	450,000
Steel pipe		3,200	100	320,000
Sub-total				770,000
Total			:	15,523,000
(8) Headrace Tunnel		,		18 12 13 14 15 14 15 14 15 15 15 15 15 15 15 15 15 15 15 15 15
Common excavation	<sub>m</sub> 3	5	3,000	15,000
Rock excavation	**	12	5,000	60,000
Tunnel excavation (TBM)	n	47	290,000	13,630,000 Upstream
" (CBM)	ч	48	156,000	part 7,488,000 Downstream
Adit tunnel excavation	<sub>m</sub> 3	48	41,000	part 1,968,000
Lining concrete	m <sup>3</sup>	150	55,500	8,325,000
Tunnel form	m .	310	4,600	1,426,000
Invert concrete	m <sup>3</sup>	150	2,000	300,000
Culvert concrete	**	170	7,550	1,283,500
Plug concrete	**	130	6,250	812,500
Shotcrete	m <sup>2</sup>	40	114,500	4,580,000
Wire mesh	. n .	15	114,500	1,717,500
Rock bolt (L=3m)	pcs	70	17,000	1,190,000
Reinforcement	t	635	1,950	1,238,250
Grouting	t	410	650	266,500
Rock trap	LS		1	1,200,000
Miscellaneous	LS	7	1	2,275,750 5%
Sub-total				47,776,000

<u> Item</u>	Unit	Unit Price	Q'ty	Cost	(US\$)
Steel pipe	. <b>t</b>	3,200	150	480,000	
Total		**		48,256,000	÷
(9) Surge Tank					
Common excavation	$\epsilon_{ m m}$	5	4,000	20,000	Section 1
Rock excavation	· . •	12	15,500	186,000	
Shaft excavation	18	70	15,550	1,088,500	
Adit tunnel excavation	n	61	9,150	558,150	
Lining concrete	19 ;	150	1,100	165,000	1.7
Prelining concrete	n	175	650	113,750	
Shaft concrete	It	210	3,650	766,500	
Bottom concrete	u	170	1,950	331,500	
Plug concrete		130	2,850	370,500	
Shotcrete	<sub>m</sub> 2	40	1,450	58,000	
Wire mesh	<b>"</b>	15	1,450	21,750	*
Slope protection	<sub>m</sub> 2	60	1,650	99,000	•
Reinforcement	t	635	295	187,325	÷
Grouting	**	410	200	82,000	
Miscellaneous	LS		1	202,025	5%
Sub-total			*	4,250,000	
Steel lining	t	3,200	205	656,000	
Total		3,200	203	4,906,000	
IOLAI				4,900,000	
(10) Penstock					
Common excavation	<sub>m</sub> 3	5	500	2,500	
Rock excavation	- 100 M	12	1,000	12,000	
Tunnel excavation	- A. R	61	2,900	176,900	F . 1
Shaft excavation		56	8,800	492,800	en North American Historian
		11 – 15			

				(US\$)
<u>Item</u>	Unit	Unit Price	Q'ty	Cost Note
dit tunnel excavation	<sub>m</sub> 3	48	13,000	624,000
tructure concrete	**	170	650	110,500
illing concrete	i»	130	6,300	819,000
lug concrete		130	1,400	182,000
hotcrete	<sub>m</sub> 2	40	5,800	232,000
ire mesh	at .	15	5,800	87,000
einforcement	t	635	100	63,500
iscellaneous	LS		1	140,800 5%
Sub-total				2,943,000
teel penstock	t	3,200	1,300	4,160,000
Total				7,103,000
ll) Powerhouse				
owerhouse				
Underground excavation	$\epsilon_{\rm m}$	45	82,000	3,690,000
Adit tunnel excavation		48	3,300	158,400
Arch concrete	rt.	190	4,600	874,000
Side wall concrete		170	11,000	1,870,000
Base concrete	ti .	155	7,300	1,131,500
Shotcrete	$m^2$	40	13,600	544,000
Wire mesh		15	13,600	204,000
Rock bolt (L=3m)	pcs	70	670	46,900
Rock bolt (L=5m)	4	120	450	54,000
Rock bolt (L=15m)	kE	1,000	450	450,000
Reinforcement	t	635	1,740	1,104,900
Mortar injection	<sub>m</sub> 3	250	300	75,000
Architectural finishing work	LS		1	1,260,000
• .		11 – 16		

					(US\$)
Item	Unit	Unit Price	<u>Q'ty</u>	Cost	Note
Miscellaneous	LS		1	573,300	5%
Sub-total				12,036,000	
Main Trans. Room					
Underground excavation	m <sup>3</sup>	45	17,300	778,500	
Arch concrete	u	190	1,800	342,000	
Side wall concrete	11	170	3,800	646,000	
Base concrete	<sub>m</sub> 3	155	300	46,500	
Shotcrete	<sub>m</sub> 2	40	6,400	256,000	V.
Wire mesh	i	. 15	6,400	96,000	
Rock bolt (L=3m)	pcs	70	320	22,400	
Rock bolt (L=5m)	pcs	120	300	36,000	
Rock bolt (L=15m)	pcs	1,000	150	150,000	
Reinforcement	t	635	400	254,000	
Miscellaneous	LS		1	131,600	5%
Sub-total				2,759,000	
Access Tunnel					
Common excavation	E <sub>m</sub>	5	1,400	7,000	**
Rock excavation	. 0	12	5,400	64,800	
Tunnel excavation	**	48	9,000	432,000	
Wall concrete	, <b>u</b> ,	170	200	34,000	
Lining concrete	44	150	3,000	450,000	
Tunnel form	m	310	330	102,300	
Reinforcement	t	635	160	101,600	
Miscellaneous	LS		1	59,300	5%
Sub-total			•	1,251,000	:

•				(U
Item	Unit	Unit Price	Q'ty	Cost No
Cable Tunnel				the area.
Common excavation	m <sup>3</sup>	5	11,000	55,000
Rock excavation		12	1,000	12,000
Banking	· •	4	7,000	28,000
Tunnel excavation	n ·	48	2,500	120,000
Culvert concrete	11	170	2,400	408,000
Lining concrete	11	150	900	135,000
Tunnel form	m	250	173	43,250
Reinforcement	t,	635	150	95,250
Miscellaneous	LS		1	44,500
Sub-total			1	941,000
Busbar Tunnel	e .			And Andrews
Tunnel excavation	$\epsilon_{m}$	48	1,700	81,600
Lining concrete	10	150	600	90,000
Tunnel form	m	250	190	47,500
Reinforcement	t	635	50	31,750
Miscellaneous	LS	635	1	12,150
Sub-total				263,000
Total				17,250,000
				en en en en en en en en en en en en en e
(12) Switchyard and		ling		erior e di Arabi e de la Constantina de la Constantina de la Constantina de la Constantina de la Constantina d La constantina de la Constantina de la Constantina de la Constantina de la Constantina de la Constantina de la
Switchyard	LS			500,000
Control building	LS			1,000,000
Total				1,500,000

Item  Tailrace Tunnel  nel excavation (A)  nel excavation (B)  t tunnel excavation  g concrete  ing concrete  nel form (A)  nel form (B)  tcrete  e mesh  k bolt (L=3m)  nforcement	Unit m3 " " m " m2 " pcs	Unit Price  48  61  48  130  150  310  250  40  15  70	7,700 8,300 1,500 1,500 5,300 180 340 1,500	Cost  369,600 506,300 72,000 195,000 795,000 55,800 85,000 60,000 22,500	Note  Branch tunnel  Branch tunnel
nel excavation (A) nel excavation (B) t tunnel excavation g concrete ing concrete nel form (A) nel form (B) tcrete e mesh k bolt (L=3m)	" " " " " " 2 " pcs	61 48 130 150 310 250 40	8,300 1,500 1,500 5,300 180 340 1,500	506,300 72,000 195,000 795,000 55,800 85,000 60,000	tunnel Branch
nel excavation (B)  t tunnel excavation  g concrete  ing concrete  nel form (A)  nel form (B)  tcrete  e mesh  k bolt (L=3m)	" " " " " " 2 " pcs	61 48 130 150 310 250 40	8,300 1,500 1,500 5,300 180 340 1,500	506,300 72,000 195,000 795,000 55,800 85,000 60,000	tunnel Branch
t tunnel excavation g concrete ing concrete nel form (A) nel form (B) tcrete e mesh k bolt (L=3m)	" " m " m <sup>2</sup> " pcs	48 130 150 310 250 40	1,500 1,500 5,300 180 340 1,500	72,000 195,000 795,000 55,800 85,000 60,000	tunnel Branch
g concrete ing concrete nel form (A) nel form (B) tcrete e mesh k bolt (L=3m)	m m m <sup>2</sup> "	130 150 310 250 40	1,500 5,300 180 340 1,500	195,000 795,000 55,800 85,000 60,000	Branch
ing concrete nel form (A) nel form (B) tcrete e mesh k bolt (L=3m)	m m 2 m2	150 310 250 40 15	5,300 180 340 1,500	795,000 55,800 85,000 60,000	
nel form (A) nel form (B) tcrete e mesh k bolt (L=3m)	m " m <sup>2</sup> " pcs	310 250 40 15	180 340 1,500	55,800 85,000 60,000	
nel form (B) tcrete e mesh k bolt (L=3m)	m <sup>2</sup> " pes	250 40 15	340 1,500	85,000 60,000	
tcrete e mesh k bolt (L=3m)	m <sup>2</sup> " pcs	40	1,500	60,000	
e mesh k bolt (L=3m)	pes	15		- ·	tunnel
k bolt (L=3m)	pcs		1,500	22.500	
		70			
nforcement			200	14,000	
	t	635	200	127,000	
cellaneous	LS	·	1	115,800	5%
Sub-total		2		2,418,000	
ft gate	t	5,000	120	600,000	
Total		÷		3,018,000	
) Tailrace Outlet					
mon excavation	8 m	. 5	7,000	35,000	
k excavation	H	12	16,000	192,000	
l concrete		170	2,000	340,000	
ucture concrete	11 11	170	2,500	425,000	
tcrete	<sub>m</sub> 2	40	2,700	108,000	
e mesh		15	2,700	40,500	
nforcement	t	635	220	139,700	
e of river	LS	10	1	1,000,000	eregi Storica Storica Storica Storica Storica
	non excavation  c excavation  L concrete  cture concrete  crete  e mesh	mon excavation m <sup>3</sup> c excavation "  L concrete "  cture concrete "  crete m <sup>2</sup> e mesh "  nforcement t	mon excavation m <sup>3</sup> 5  x excavation " 12  L concrete " 170  acture concrete " 170  corete m <sup>2</sup> 40  e mesh " 15  aforcement t 635	mon excavation m <sup>3</sup> 5 7,000 x excavation " 12 16,000 L concrete " 170 2,000 L concrete " 170 2,500 L corete m <sup>2</sup> 40 2,700 L corete mesh " 15 2,700 L corement t 635 220 L cof river LS 1	mon excavation m <sup>3</sup> 5 7,000 35,000 c excavation " 12 16,000 192,000 L concrete " 170 2,000 340,000 c except m <sup>2</sup> 40 2,700 108,000 c mesh " 15 2,700 40,500 mforcement t 635 220 139,700 c of river LS 1 1,000,000

					(US\$)					
Item	Unit	Unit Price	<u>Q'ty</u>	Cost	Note					
Miscellaneous	LS		1	228,800	10%					
Sub-total			•	2,509,000						
Tailrace gate	t	5,000	210	1,050,000						
Total				3,559,000						
(15) Electromechanical E	quipmer	1 <b>t</b>			, e · · ·					
Turbine	LS	-	1	10,080,000						
Generator	11		1	8,520,000						
Main transformer	41		1	1,660,000	e de dise					
Others	17		1	9,940,000						
Sub-total				30,200,000						
Arun 3 switchyard	LS		1	8,200,000	. 5					
Total				38,400,000	y Maria dia ya Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria Maria  (16) Transmission Line a	nd Subs	tation			
Transmission Line										
Arun 3 S/Y - Dubi S/S	LS		1	23,200,000						
Dubi S/S - Dhalkebar S/Y	28		1	14,800,000						
Dhalkebar S/Y - New Kathmandu S/S	17		1	12,100,000						
Sub-total	· ·			50,100,000	*					
Substation and Switchyard			-							
Dubi S/S	LS	. '	1	11,900,000						
Dhalkebar S/Y	to .		1	7,500,000						
New Kathmandu S/S			1	12,500,000	na di Salaharan Salaharan Salaharan Salaharan Salaharan Salaharan Salaharan Salaharan Salaharan Salaharan Salah Salaharan Salaharan					
Sub-total				31,900,000						
Telecommunication	LS		1	5,500,000	n ib krátk					
Total				87,500,000						

#### 11.3.2 Total Construction Cost for First and Second Stages

The total construction cost for the whole project (6 units, 67 MW each, 402 MW in total) which includes both the first stage for domestic power demand and the second stage for power export is shown below and Table 11-4. In connection with the transmission line and substation facilities required for power export, only the costs for those to be constructed in Nepal are included in the above total cost.

# Summary of Construction Cost for 1st and 2nd Stages (US\$)

Supporting facilities	48,700,000	
Civil works	185,872,000	
Hydraulic equipment	17,569,000	
Electromechanical equipment	69,400,000	
Transmission line and substation	107,000,000	
Administration and engineering services	32,141,000	
Contingency	57,797,000	
Grand Total	518,479,000	

Table 11-4 Total Construction Cost (1st & 2nd Stages)

		F/C portion (10 <sup>3</sup> US\$)	L/C portion (10 <sup>3</sup> US\$)	
(1)	Supporting facilities	36,280	12,420	48,700
	Access road Construction Improvement of existing road	28,900 28,900 0	10,100 5,100 5,000	39,000 34,000 5,000
	Camp facilities	. 0	1,500	1,500
	Telecommunication facilities	900	100	1,000
	Diesel engine generator	6,480	720	7,200
(2)	Civil works	157,991	27,881	185,872
	Diversion tunnel & cofferdam	5,797	1,023	6,820
	Dam & spillway	20,748	3,662	24,410
	Intake & desanding basin	18,114	3,197	21,311
	Headrace tunnel & surge tank	86,686	15,298	101,984
	Penstock	4,161	734	4,895
	Powerhouse & switchyard	17,101	3,018	20,119
	Tailrace tunnel & outlet	5,383	950	6,333
(3)	Hydraulic equipment (Gate, trashrack & penstock)	15,812	1,757	17,569
(4)	Electro-mechanical equipment (Turbine, generator, transformer, auxiliary equipment & switchgear)	62,460	6,940	69,400
(5)	Transmission line & substation facilities	96,300	10,700	107,000
(6)	Administration & engineering services 1/	27,664	4,477	32,141
(7.)	Contingency 2/	49,365	8,432	57,797
	Grand Total	445,872	72,607	518,479

Note  $\frac{1}{2}$ : 7.5% of total cost for works from (1) to (5) above,  $\frac{2}{2}$ : 15% of total cost for works (1) and (2) plus 10% of (3) to (6) above.

The yearly disbursement for the first stage and second stages are as shown in Table 11-3.

Table 11-5 Disbursement Schedule (1st and 2nd Stages)

<ol> <li>Access Road</li> <li>Preparatory Works</li> <li>Civil Works</li> </ol>	ប់ប៉ ម៉ូត់	rost.	1987	1988	1989	1990	1991	1992	1993	1994	9 1995	10	11 1997	12 1998	13 1999	2000
. Preparatory Works	Total	28,900 10,100 39,000	2,890 1,010 3,900	10, 115 3, 535 13, 650	10, 115 3, 535 13, 650	2,890 1,010 3,900	2,890 1,010 3,900	0	0	0	0	O	0	0	0	
. Civil Works	Total	7,380 2,320 9,700	0	1,699 533 2,232	1,291 407	1,477 464 1,941	583 183 766	966 304 1,270	966 304 1,270	398 125 523	O	. 0	0	٥	0	
	F.C. L.C.	157,991 27,881 185,872	. 0	• `	1,159	10,659 1,881 12,540	25,786 4,551 30,337	32,552 5,744 38,296	29,389 5,186 34,575	15,583 2,750 18,333	. 8,330 1,470 9,800	13,764 2,429 16,193	15,350 2,709 18,059	5,100 900 6,000	319 56 375	
4. Hydraulic Equipment	int F.C. L.C. Total	15,812 1,757 17,569	0	0	0	0	1,050	2,102 233 2,335	4,202 467 4,669	3,152 350 3,502	O	0	2,893 321 3,214	2,416 268 2,684	0	ż
5. Electromechanical Equipment	F.C. L.C. Total	62,460 6,940 69,400	•	<b>o</b> .	0	0	2,626 292 2,918	10,437 1,160 11,597	7,845 872 8,717	5,219 5,799	0	0	18, 169 2, 019 20, 188	14,547 1,616 16,163	3,619 402 4,021	17
6. Transmission Line 6. Substation	T.C. Total	96,300 10,700 107,000	٥	٥	0	0		7,087 788 7,875	42,604 4,734 47,338	21,342 2,371 23,713		0	15,188 1,688 16,874	10,080 1,120 11,200	. 0	
7. Administration & Bogineering Services	F.C. L.C. Total	27,497 4,644 32,141	251 42 293	1,019 172 1,191	1,072	1,180 199 1,379	2,508 424 2,932	3,938 665 4,603	6,196 1,046 7,242	3,328 562 3,890	628 107 735	1,039	3,743 632 4,375	2,312 391 2,703	283 47 330	e de la companya de l
8. Contingency	F.C. L.C. Total	49,034 8,763 57,797	521 93 614	2,122 379 2,501	2, 233 399 2, 632	2,456 439 2,895	5,051 901 5,952	7,276 1,300 8,576	10,328 1,845 12,173	5,530 988 6,518	1,310 234 1,544	2,164 387 2,551	6,086 1,088 7,174	3,542 633 4,175	417 75 75 492	
Grand Total	T.C. Total	445,374 73,105 518,479	4,109 698 4,807	16,731 2,843 19,574	17,605 2,992 20,597	19,365 3,290 22,655	41,005 6,967 47,972	63,724 10,828 74,552	99,138 16,846 115,984	54,552 7,724 62,276	10,268 1,811 12,079	16,965 2,992 19,957	61,427 8,457 69,884	37,997 4,928 42,925	4,637 580 5,217	

F.C. : Foreign currency portion L.C. : Local currency portion

Table 11-6 Labour Wage

	Rate per	day
Labour Type	1/ Rs	US\$ 2/
Head labour	50	2.34
Labour	40	1.87
Porter	60	2.81
Head mason	80	3.74
Mason	70	3.28
Carpenter	70	3.28
Painter	80	3.74
Plumber	100	4.68
Electrician	100	4.68
Auto Mechanics	100	4.68
Auto Electrician	120	5.62
		]

<sup>1/</sup> Wage at 1986 price level

<sup>2/</sup> Exchange rate 1US\$ = Rs21.35

Table 11-7 Price of Construction Materials

Material	Unit	Price (US\$)	Remarks
Cement	t	150	CIF plus inland transportation
Reinforcement bar	t	- 380	H .
Formed steel	t	490	n
Petroleum	k1	520	Mark San
Light oil	k1	360	<b>11</b>
Explosive	kg	5.2	H
Detonator	pcs	1.0	u y y y y
Rock bolt (L=3m)	pcs	27	<b>u</b>
Rock bolt (L=5m)	pcs	43	u
P.C. bar (L=15m)	pcs	160	a

# CHAPTER 12. ENVIRONMENTAL IMPACT

# CHAPTER 12. ENVIRONMENTAL IMPACT

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# CHAPTER 12. ENVIRONMENTAL IMPACT

### 12.1 General

The project area is presently only accessible by footpaths or trails. By implementation of the Arun 3 project and its long access road environmental changes of different magnitude may occur in the villages as well as to the natural ecosystem.

Environmental impact studies in connection with a large development project have a short history in Nepal. Therefore, available data are scarce and systematic analysis of data and evaluation is a very difficult task. The present study attempts to quantify the possible magnitude of compensation and to qualitatively identify the probable areas of environmental impact, including both ecological and socioeconomic impacts to be induced by the project. Limited field survey on land-use in the vicinity of the project areas was conducted and the existing land utilization maps (1/50,000 scale) were extensively used for the study.

# 12.2 Methodology

An environmental impact assessment (EIA) is defined by Munn as being actively designed to identify and predict the impact on man's health and well-being and on environmental conditions, of legislative proposals, policies, programs, projects, and operational procedures, and to interpret and communicate information about them.

The present study will attempt to identify the environmental impact by the following two approaches:

### (1) Estimation of Compensation

The amount of compensation was estimated in connection with land acquisition and resettlement involving houses, cultivated &

Munn, R.E., 1975: Environmental Impact Assessment - Principles and Procedures. SCOPE Report 5. Toronto, Canada

non-cultivated land, forests, etc. to be affected by the Arun 3 project including the access road, the transmission line, and substations. The existing land utilization maps (1/50,000 scale) were used to obtain land-use data on the entire geometrical location to be affected by the project. Distribution of houses is based on field inspection and newly developed 1/10,000 scale maps which cover an area of about 180 km<sup>2</sup> containing two alternative access road routes.

# (2) Qualitative Identification of Impact Areas

Impact areas were identified by a systematic approach developed by Aegerter and Messerli for a formal EIA to identify significant impact areas and probable effects. Elaborate mathematical treatment has been omitted due to the lack of substantive data.

The following terminology is defined to clarify the approach:

- (1) actions: man's activities in connection with a project
- (2) effects: change of environmental conditions due to a project
- (3) impacts: change of environmental quality and of human well-being

The study will identify activities and impact area of effects, followed by prediction and estimation of the extent of environmental impact on the qualitative basis.

Project work is classified into three categories:

# (1) Preparation Phase:

This includes engineering studies, land acquisition and compensation.

<sup>1/</sup> Aegerter, S., and Messerli, P., 1985: The Impact of Hydroelectric Power Plants on a Mountain Environment. Chapter 4 of Integrated Mountain Development. Himalayan Books, New Delhi, India

### (2) Construction Phase:

This involves all construction activities, both permanent and temporary. Also included are actions related to socio-cultural-economic area such as creation of jobs, migration of workers and exposure of the local people to foreign workers.

# (3) Operation Phase:

This covers a variety of action components such as operation of existing installations (pondage, roads, buildings, etc.), creation of permanent jobs, generation of energy and development of fish culture in the pondage.

Detailed action components are listed in Table 12-1.

Impact areas consist of a spectrum of possible areas to be affected or influenced directly or indirectly by the specified actions. Major components are (1) Non-Biotic Area, (2) Biotic Area, (3) Social Area, (4) Cultural Area, (5) Economic Area, and (6) Political Area. A detailed breakdown of each area mentioned above is shown in Table 12-2.

The relationship between the actions and the impact areas for a particular project can be conveniently expressed by the Relevance Matrix a sample of which is shown below.

Actions

O O O

Impact
Areas

O O O

: certain effect is expected

O: effect is possible

Fig. 12-1 Relevance Matrix

The matrix only shows the result of systematic entry of certain and possible effects on the impact areas corresponding to each action. The matrix does not show whether the effect attached to the impact area identified is significant enough for predicting impacts. Such effects will be disclosed through an iteration process generally using subjective judgment because quantitative measuring of most effects except for limited cases such as the number of houses to be inundated is not practical in this study due to the difficulty in collecting relevant data or the time factor involved.

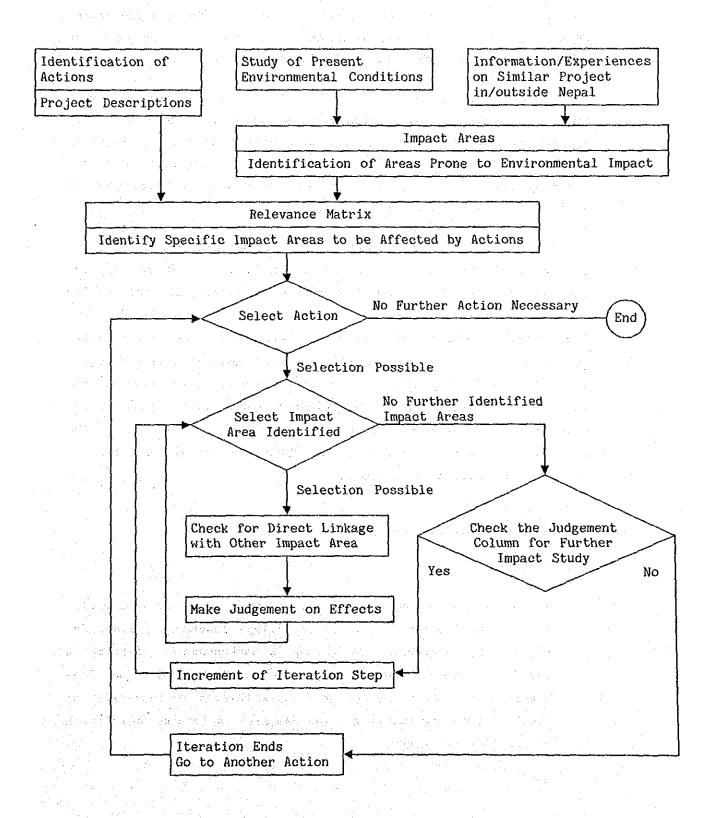
For each action an iterative consideration is made for further scrutiny of the entire impact area identified as effective by the matrix. During an iteration each sub-impact area prone to a certain effect is examined for its direct linkage to the overall impact area. Through the iteration process the effects in the impact areas become clearer and enhanced, and the process is terminated when there is no additional impact to be considered. Fig. 12-2 shows a flow chart of the process.

# 12.3 The Project

The project is composed of the power generating facilities (civil & electro-mechanical works) and the access road. The former consist of major components such as a pondage, an underground desanding basin, a power tunnel, a surge tank and penstock, and an underground power-Since the project is a typical run-of-river type utilizing high quality flow of the Arun river the project is essentially simple The pondage creates despite its large power generating capacity. only 4 km of backwater with a maximum water level rise of 50 m which will minimize the possibility of inundation of forest and cultivated Local villagers generally live on the high elevation terrace Houses, therefore, will not be affected. Major civil works are of the underground type like the desanding basin, the power tunnel, and the underground type powerhouse. These facilities will be invisible from the surface or very low-key in appearance, with minimal disturbance of the natural landscape.

The main flow of the Arun river is partially diverted throughout the year to the desanding basin, and then flows into the power tunnel

Fig. 12-2 Flow Chart for Environmental Impact Study



reaching the surge tank. Water drops through the penstock to the powerhouse and eventually returns to the Arun river. Even during the dry season the minimum flow of 10 m<sup>3</sup>/sec will be available eliminating drying-up of the river section between the dam and the powerhouse. This planning consideration is particularly important for maintaining the aquatic environment in the said section.

The project requires a long access road because the only motorable road terminates near Hile-Basantapur in the Dhankuta District about 100 km south of the project site. The proposed alignment of the road is the river-side route. Consequently the alignment near the riverbed is generally at a lower elevation than the terraced or cultivated field typical on the hills.

The transmission line is divided into three sectors; namely, (a) the powerhouse - Dubi substation sector which is about 120 km long, (b) the 146 km long Dubi - Dhalkebar substation sector, and (c) the 120 km long Dhalkebar - Kathmandu substation sector. The first sector (a) generally follows the access road but there will be more short cuts and straight sections through hill areas eventually reducing the total distance. The sector (b) is located in the Terai running from east to west. The sector (c) is oriented in the north west direction passing Sindhuli and the Swalik range to the Kathmandu valley. The details are shown in Chapter 9. The land space requirement for the transmission tower is very small.

# 12.4 Present Environmental Conditions

### (1) Location

The project area covering the dam and the powerhouse (550 m elevation) is located in the three village panchayats, i.e., Num (1,200 m), Pathibhara and Diding in Sankhuwasabha District in the Kosi Zone of the Eastern Development Region. The long access road runs along the Arun river through the districts of Sankhuwasabha and Dhankuta. The dam site is located 40 km south of the Chinese border.

### (2) Natural Environment

The majority of local people are engaged in farming using the terrace fields on the hills. There are no irrigation facilities and natural environment is tranquil without any sizable industrial activities. Air pollution is non-existent. The Arun river has a low fluctuation of annual discharge with steep gradients and high sediment loads of both suspended and bed-loads. The climate is subtropical with a moderate temperature fluctuation between 7°C and 20°C on the average. District-wise average annual rainfall is 1,950 mm.

The topography shows a typical Midland landscape of rolling terrain with gentle slopes along the Arun river surrounded by steep ridges. Most of the slopes are composed of terraced slopes and barren hillsides. This area is geologically called the Tumlingtar Window and is rectangular in shape, 20 km wide and extending 50 km (direct distance) with its southern boundary near Pakharibas sitting atop of the ridge in northwest Hile. The northern boundary lies near Diding where the powerhouse is located. The sector between the powerhouse and the dam shows steep topography.

# (3) Biotic Environment

The total forest area is about 160,000 ha which is approximately 45% of the total district area. The area under cultivation is 9,000 ha. There are many grassy slopes and no rare species of flora and fauna are found in the project area or in the area along the access road. Among the protected wildlife species, the tiger is reported to be found in the project area. There is no protected species of aquatic vegetation in the Arun river and its tributaries close to the project areas. Only limited information is available on fish distribution and habitat and there appears to be no fish migration.

### (4) Social Environment

The total area of the district is 3,480 km<sup>2</sup> with a population density of 37.2/km<sup>2</sup> (1981). This sparsely populated condition is partially due to migration of the villagers to the Terai Plain where there are better living conditions. Average family size per household is 5 persons with a declining trend due to the fragmentation of households and other reasons. Population composition for the three groups of (1) under 14 years, (2) between 15 and 49, and (3) over 49, is 39%, 48% and 13%, respectively. Communication with other parts of the nation is possible through postal services and private porters who carry messages to the postal facilities. Telecommunication services are available between Khandbari, the district headquarters, and Kathmandu.

### (5) Cultural Environment

Availability of hospital beds is about 4 persons per bed. There is one health center in Chainpur and 8 health posts. Schools in the district include 131 primary, 51 lower secondary and 5 secondary schools.

Traditional land use includes cultivation, buildings for both people and cattle, forest for fuelwood and grazing, and paths and trails. Ethnic composition shows a leading majority of Rai (36%) followed by Chetri (18%) and Magar (18%). The rest are Damai, Kami, Newar, Tamang and Gurung in order of population size. There are no outstanding archeological or cultural sites in the area.

### (6) Economic Environment

More than 97% of the labor force is engaged in agriculture, forestry and fishing. Other sectors, including public services, manufacturing and commerce, occupy at most 3% of the labor force.

Principal cereals are paddy, maize, millet, wheat and barley. Cash crops are oilseeds, potato and sugarcane. The majority of

cultivated land is allocated for paddy and maize. Per hectare production is low and the trend shows a declining production rate. Forests are mainly used for firewood, construction materials and grazing. The average farmer's agricultural production meets only his own subsistence needs and only surplus is given for trading. Due to the low production rate, the average farmer purchases foods to make up the supply deficit. Livestock production also contributes to cash income. Low-income villagers are generally engaged as porters on a regular basis. Wages are subject to seasonal fluctuation varying between 20 and 40 Rupees/day.

Tourist attraction centers are Chainpur for the main trade center, Khandbari for the district headquarters, Tumlingtar for the airfield and pottery industries, and Chyankerti Bhanjyang for viewing the Himalayan Peaks. There are no roads except footpaths and trails. Hile or Tumlingtar is the starting point for trekking to the base-camp of Mount Makalu. Hile-Piluwa-Tumlingtar-Khandbari is the only main trail for the passage of porters. There are no hotels for travelers and trekkers beyond Khandbari.

# (7) Political Environment

Sankhuwasabha District is included in the Kosi Zone of the Eastern Development Region. The district is sparsely populated. The area is 3,480 km<sup>2</sup> and administratively divided into 36 village panchayats. Development plans for hydropower generation and construction of motorable roads are well received among the villagers as a means for betterment of the living standard. National level interest in development in the district is focussed on inter alia, rural electrification, advancement of agricultural production, cottage industries, water supply, and forest conservation.

### 12.5 Impact Assessment

This section describes the results of (1) estimation of compensation and (2) qualitative impact identification study. Table 12-3 summarizes the estimated compensation. Table 12-4 through 12-20 show the results of impact identification. Identified impacts are described in the following subsections according to the major subjects relevant to the impact assessment.

# (1) Negligible Compensation Requirement

Inundation of forest and cultivated areas by the small pondage to be created is minimal and the access road will require minimum acquisition of residential and cultivated lands. The road alignment along the riverbed can make such route selection possible.

As shown in Table 12-3, the estimated total compensation cost in connection with the major civil works and the access road is US\$0.312 million. This cost, as it is relatively small, is included in the project contingency cost. Similarly the estimated compensation cost for the transmission line and substations, is only US\$1.627 million and is included within the contingency cost for this work component.

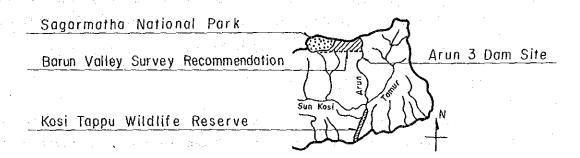
### (2) Negligible Impact on the Ecology

Encroachment on flora and fauna will be negligible due to the fact that the project is a typical run-of-river type and the access road will mostly follow the route near the riverbed of the Arun river where the geology is stable and houses and farmland are scarce. There is no ecologically sensitive area nor endangered species in the project areas.

The Sagarmatha National Park is located 80 km northwest of the dam site. The present boundary of the park does not reach the Arun river. The project area including 4 km backwater of the pondage is far to the east of the park boundary. Although the Barun Valley Survey recommends expansion of the Sagarmatha National Park such that the present park boundary will be

extended directly eastward to the Arun river, the expected new boundary still be outside the Arun 3 project area. Fig. 12-3 shows approximate boundaries of the park and the dam site.

Fig. 12-3 Location of the Sagarmatha National Park



# (3) Climatic Change & Pondage

Local climatic change by the development of a small pondage is not expected. The estimated surface area of the pondage is about 50 hectares and thus evaporation from such a small surface will not alter climate in the pondage vicinity.

The pondage will attract birds migratory. This type effect was already demonstrated by the Kosi Barrage which created a large swamp area now designated as Kosi Tappu Wildlife Reserve gazetted in July 1976.

Possible adverse effects would be as follows:

- silting in the pondage
- scouring or lowering of the riverbed downstream of the dam
- possible breeding of mosquitos (although seasonal water fluctuation and rapid movement of the surface water layer may preyent such breeding)
- the creation of the pondage may effect the slope stability of the weak zone in the area, and thus adequate precautionary measures may be required.

### (4) Air Pollution

Air pollution by internal combustion engines operated during the construction period is temporary and if it occurs at all, will occur only in very limited locations. Therefore, no environmental problem is envisioned. Possible air pollution by traffic along the access road will not be an immediate environmental issue but some plan for monitoring the degree of pollution may be necessary for an extended period.

# (5) Fishery

A fish ladder facility is not considered because there is no reported fish migration activities in the Arun river near the project site. Reported fish production rate in Nepal varies from 6 kg/ha/year to 39 kg/ha/year. An expected water surface of 50 ha may not significantly contribute to fish production.

### (6) Forest Conservation

Rapid reduction in forest resources in the Himalaya range is posing serious problems for Nepal. People in Nepal heavily relies on wood for their daily supply of energy. Wood accounts for almost 87% of total energy. This heavy reliance on wood is the major reason for the disappearance of forest.

Deforestation will eventually be stabilized by the following factors:

- Demand reduction for new farmland due to the increase of agricultural production and availability of cheap surplus foods obtainable by the improved transportation system.
- Availability of alternative sources of energy for fuelwood such as kerosene and electricity. As shown in the following table, fuelwood is the source for 95% of domestic energy consumption while electricity accounts for only 2%. It is envisaged that transition from fuelwood to other alternative sources of energy may take some time.

Table 12–22 Sectoral Distribution of Total Energy Consumption by Major Sources of Energy in Nepal

Year 1978-79 in Toe (Tons of equivalent)

c		Fired w	ood	Veget Was		Anta Dun	g	Co	and kes	Petro	leum	Electi	icity	All ene	rgies
	ector	Toe	X	Toe	*	Toe	z	Toe	X	Toe	X	Toe	ž	Toe	- 3
1. т	ransportation							3000	5.0	56775	94.7	153	0.3	59928	100
2. D	onestic .	2516700	95	52000	2.0	20000	0.8			28685	1.1	6559	0.2	2623944	100
3. A	griculture									4403	86.5	688	13.5	5091	100
	commercial & ndustrial	20300	28.9					33078	47.0	10956	15.6	6013	8.5	70347	100
	treet ightning				٠							175	100	. 175	100
6. 0	ther uses											5000	100	5000	100
Ā	il Uses	253700	91.8	52000	1.9	20000	0.7	36078	1.3	100819	3.6	18588	0.7	2764485	100

Ref.: C. K. Sharea, Water and Energy Resources of the Himalayan Block

- Since approximately one million cubic meters of waste soil and rock debris will be produced during the construction of the access road, this waste could be utilized to develop new useful land for various purposes including reforestation.

# (7) Rural Electrification and Telecommunication

Besides the national level benefit in energy supply, people near the project area and also the entire district will eventually benefit from the supply of electricity. Water supply and irrigation will be potential projects. Local people will benefit from the telecommunication facility (Power Line Carrier System) of the Arun 3 Project.

### (8) Employment Opportunity

The construction period is about six years including the main facilities and the access road. But power generation capacity will be developed in stages up to the maximum capacity. This will require additional years of upgrading and maintenance works. The construction works will require the operation of various heavy construction equipment and considerable manpower thus creating many short-term and long-term employment opportunities to the local villagers and people farther away from the project areas.

The access road will eventually become a trunk road for transportation in the district, and generated electricity will be provided to the local people. Moreover the project will require a certain number of people for operation and maintenance of the facilities. The project site will also become a new tourist attraction and various development activities will be planned and implemented. Creation of project related employment is envisaged.

# (9) Multiple Impacts of the Access Road

Interconnection of people on the hills and the Terai Plain will create complex influences on the total socio-economical area of the hill people. The following are major items to be considered:

- Increase in migration of people
- Stimulation to new industries

With the supply of cheap electricity and availability of good access, certain mineral resources may commercially be developed at the following sites:

- a. limestone at Mamling and Nigale near Dhankuta
- b. semiprecious minerals, e.g., pegmatite, at Hykule and Phakuwa
- c. lead and zinc at Hykule and Phakuwa
- d. copper in the area between Khandbari and Phakuwa
- e. garnet 10 km east of Khandbari

Fig. 12-4 shows the above mentioned locations.

- Development of tourism and associated new jobs
- Better communications
- Requirements for public services and facilities in the fields of health, education, administration, and vocational training

Special attention should be given to coping with infections diseases related with labourer inflow and traffic increase. Some examples are as follows:

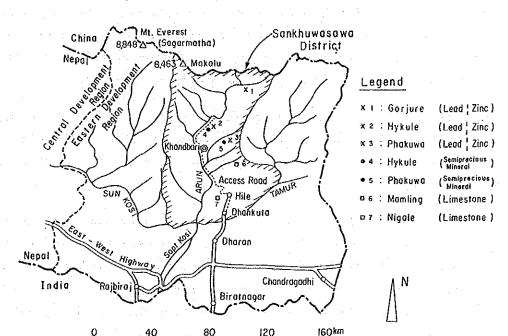


Fig. 12-4 Locations of Mineral Deposits

- a. gastro-intestinal parasitic infections
- b. tuberculosis
- c. dysentery
- d. malaria

Adequate health and sanitation facilities should be prepared and health check of labourers should be carried out.

# (10) Improved Living Standard and Social Reform

Income increase, agricultural modernization, and exposure of the local people to various outside technical and socio-cultural influences will force the local community to change in a number of ways in different degrees, which will likely contribute to the betterment of the quality of their lifestyle and well-being.

### 12.6 Conclusion and Recommendations

This study was qualitatively conducted based on the limited field survey and document research. It is obvious that a large project like the Arun 3 Hydropower Project and its long access road will inevitably have a profound influence on the health and well-being of the local villagers living close to the project and to certain people

throughout the district. From the study it may be concluded that there will be no detrimental or harmful effects to local people or the ecosystem except for very limited compensation or resettlement of people. A total compensation cost is estimated at about two million U.S. dollars. The magnitude of compensation is very small.

The following recommendations are made towards the successful implementation of the project to eliminate unnecessary and unintended environmental effects and to avoid jeopardizing the fundamental well-being of people:

- (1) Although compensation or resettlement will create no problem due to the small magnitude, there will be a need for careful implementation to ensure appropriate timing of disbursement and care of the villagers who will be compensated or removed. Their experiences will be totally new to them thus requiring relevant advice and guidance from the concerned authority.
- (2) Disturbance during the construction period to the natural ecosystem should be minimized, and construction planning should be critically reviewed from this standpoint. Adequate health and sanitation facilities should be provided at the construction camps and health check of labourers should be carried out.
- (3) Design and construction of the access road should be carefully conducted to minimize landslide and soil erosion along the route. Sufficient funds for maintenance should be allocated.
- (4) A relevant monitoring program should be launched for long term observations in the areas of environmental impacts which require long term data collection and subsequent analyses. Such areas may include air pollution, deforestation, population movement and other socio-economical studies. These will provide important informaton for future large scale development projects.
- (5) Education of villagers should be considered as one of the prime means towards better management of their potential in adjusting to the new environment to be created by the project. The new environment will include new job opportunities and associated income increase, access road for efficient transportation and better communications.

(6) Impact studies of the access road require a continuous and elaborate scope of works. Linking the mountain communities and those in the plain by the access road will produce valuable data on environmental impact assessment for a future large scale development project. Implementation of a relevant EIA project in connection with the Arun 3 project is recommended.

# Table 12-1 List of Actions

# Preparation Phase

- 1. Engineering Studies (Field Activities: Seismic Prospecting, Boring, Survvey)
- 2. Payment of Compensation
- 3. Real Compensation
- 4. Resettling
- 5. Land Reform and Reform of Land Use
- 6. Development of Agricultural land & Forest
- 7. Improvement and Construction of Public Buildings & Installation

# Construction Phase

- 8. Land Use of the Entire Plant
- 9. Quarries (Stone and Gravel)
- 10. Timber Cutting
- 11. Storage and Deposit of Construction Material
- 12. Improvement or Modification of Existing Road
- 13. Road-Bed
- 14. Bridge
- 15. Protective Measures
- 16. Parking
- 17. Transportation by Road, Airplane, Heli
- 18. Diversion Tunnel
- 19. Coffer Dam
- 20. Dam & Spillway
- 21. Intake & Desilting Basin
- 22. Power Tunnel
- 23. Surge Tank
- 24. Penstock
- 25. Powerhouse
- 26. Tailrace
- 27. Switchyard
- 28. Erection of Towers and Installation of H/V Line
- 29. Blasting & Cleaning of Loose Rock
- 30. Erection of Protective Construction against Rock Falling
- 31. Protective Wroks for Land Slide
- 32. Reforestation
- 33. Landscaping
- 34. Temporary Accommodation
- 35. Storage of Construction Materials
- 36. Supply and Refuse Logistics
- 37. Construction Workers and Auxiliary Personnel
- 38. Technician
- 39. Professional Personnel
- 40: Service and Administrative Personnel
- 41. Contact with foreign Workers
- 42. Contact with Stranger
- 43. Contact with Science and Technology

# Operation Phase

- 44. Pondage
- 45. Buildings and Constructions
- 46. Transmission Line
- 47. Road
- 48. Energy Production
- 49. Permanent Jobs
- 50. Contract for Maintenance & Repair
- 51. Taxes (Revenue)
- 52. New Supply of Services & Consumer Goods
- 53. Outdoor Activities & Sport
- 54. Fishing
- 55. Hiking & Camping
- 56. Latent Risk
- 57. Connecting across the Valley
- 58. Seasonal Variation of Water Level
- 59. Emergency Drainage
- 60. Retention of Gravel & Slit
- 61. Dredging of Pondage
- 62. Production of Fish
- 63. Change of Erosion Process
- 64. Loss of Water
- 65. Transport of Gravel and Silt
- 66. Maintenance of Breaks (Pressure Ducts and Power Line)
- 67. Transport of Goods and Persons
- 68. Protective Construction

### Table 12-2 List of Impact Areas

### Non-Biotic Area

- 1. Air (1.1 Polution, 1.2 Noise Intensity)
- 2. Water (2.1 Surface Water, 2.2 Underground Water)
- 3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock)
- 4. Underground
- 5. Surface (Landscape)
- 6. Climate (6.1 Sunshine, 6.2 Micro-climate)

### **Biotic Area**

- 7. Flora and Fauna of the Soil
- 8. Surface Fauna Terrestrial Ecosystem
- 9. Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Glassland)
- 10. Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)

# Social Area

- 11. Population Structure (11.1 Age, 11.2 Profession)
- 12. Population Movement
- 13. Health (13.1 Physical Health, 13.2 Psychical Health)
- 14. Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security)
- 15. Aesthetic
- 16. Freedom of Choice and Decision
- 17. Communication

### Cultural Area

- 18. Institutions (18.1 School, 18.2 Cultural Sites)
- 19. Scales of Values
- 20. Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft)
- 21. Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected)

### Economic Area

- 22. Professional Structure
- 23. Agriculture and Forestry
- 24. Trade
- 25. Industry
- 26. Tourism
- 27. Public Service
- 28. Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply Service)
- 29. Management of Public Finances

### Political Area

- 30. Interest of Indigenous Population (30.1 Development, 30.2 Administration)
- 31. External (31.1 Economic, 31.2 Other Public, 31.3 Private)

Table 12-3 Estimation of Compensation

# 1. Dam and Powerhouse Areas

Facility	Effected Area (ha)	Land Use	Unit Rate (Rs/ha)	Compensation (Rs)
Pondage	23.0 17.00 35.00	B H G	5,000 25,000 25,000	115,000 425,000 875,000
Dam	0.48 1.32	B H	5,000 25,000	2,400 33,000
Intake	1.00	Н	25,000	25,000
Surge Tank	0.90	Н	25,000	22,500
Powerhouse & Switchyard	2.60	Н	25,000	65,000
Total				Rs1,630,400 (\$77,640)
				Rs1,562,900 (\$74,420)

Notes: B=Sand/Gravel/Boulder G=Grazing Land H=Forest

- 22 houses @ Rs50,000

### 2. Access Road

# a. House

(\$52,380)

b. Land

- Level Terrace (T) 24.612ha @ Rs50,000 = Rs1,230,600

- Sloping Terrace (C) 10.976ha @ Rs50,000 = Rs548,800

- Valley Floors including Tars, Foot Slopes, etc (V)

1.260ha @ Rs40,000 = Rs50,400

- Tars, Alluvial Fans, etc. (F)

10.794ha @ Rs50,000 = Rs539,700

- Grazing Land (G) 6.580ha @ Rs25,000 = Rs164,500

= Rs1, 100,000

	38.668ha @ Rs5,000	= Rs193,340
	- Forest (H) 90.384 @ Rs25,000	= Rs2,259,600
	Subtotal	Rs4,986,940
		(\$237,500)
3.	Substation & Transmission Line	
	a. Substation (Land Acquisition)	
	- Kathmandu	
	20,000m <sup>2</sup> @ Rs900	= Rs18,000,000
	- Dhalkiewar	
	10,000m <sup>2</sup> @ Rs520	= Rs5,200,000
	- Duhubi	
	20,000m2 @ Rs520	= Rs10,400,000
	Subtotal	Rs33,600,000
		(\$1,600,000)
	b. Transmission Tower (Land Acquisition)	
	- Arun 3 Powerhouse Substation (S.S Line Length)	.) to Duhubi S.S. (120km
	Land (B): 0.68ha @ Rs5,000	= Rs340
	Land (H): 6.345ha @ Rs25,000	= Rs158,625
	Land (V): 0.338ha @ Rs50,000	= Rs16,900
	- Duhubi S.S. to Dhalkiewar S.S. (146	km)
	Land (B): 0.383ha @ Rs5,000	= Rs1,915
	Land (H): 7.448ha @ Rs25,000	= Rs186,200
	Land (V): 0.383ha @ Rs50,000	= Rs19,150

- Sand/Gravel/Boulder (B)

Notes: B = Sand/Gravel/.Boulder

H = Forest

V = Cultivated Land

- Dhalkiewar S.S. to Kathmandu S.S. (120km)

Land (B): 0.068ha @ Rs5,000 = Rs340

Land (H): 6.345ha @ Rs25,000 = Rs158,625

Land (V): 0.338ha @ Rs50,000 = Rs16,900

Subtotal Rs558,995

(\$26,600)

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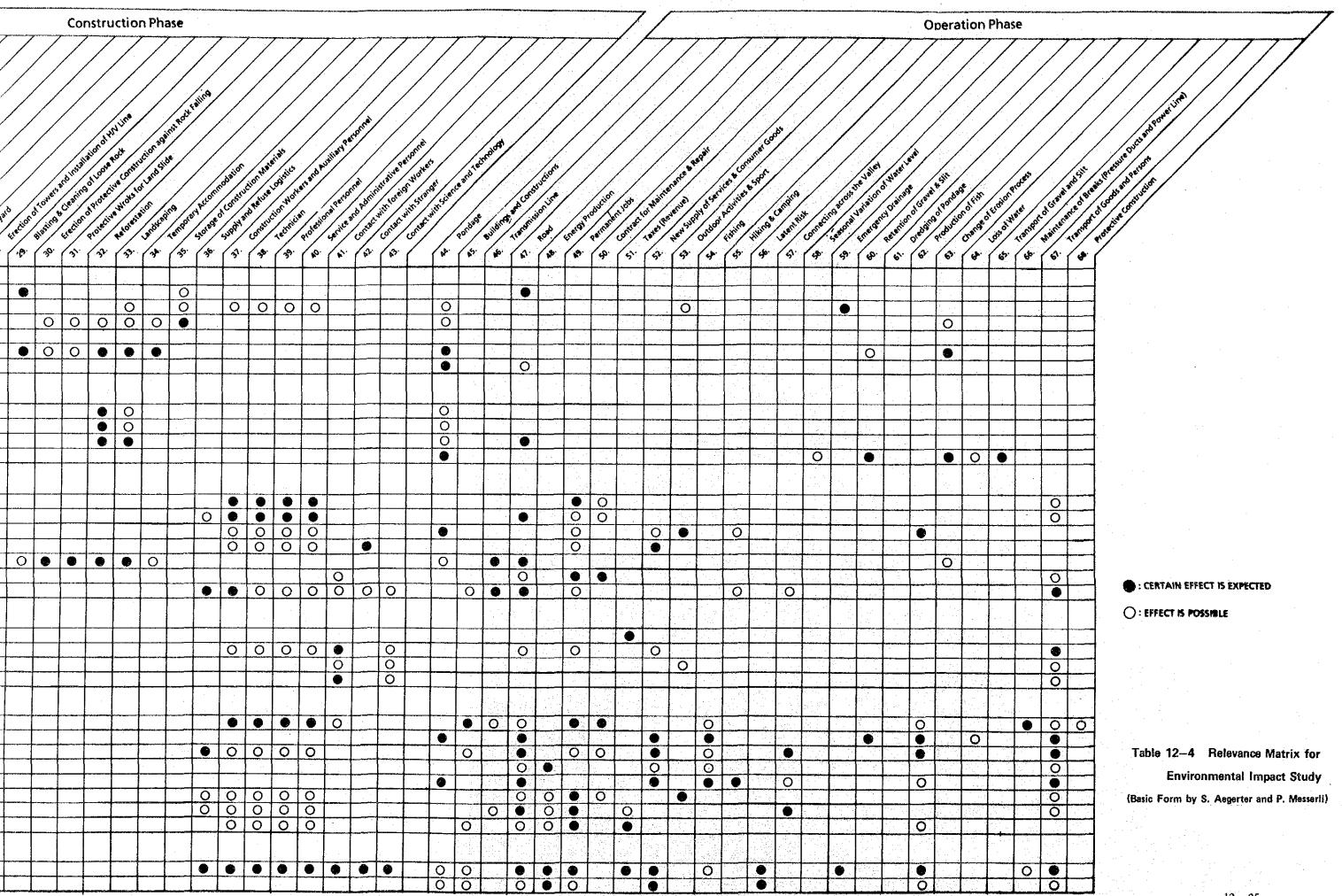


Table 12-5 Environmental Impact Study (1 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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Table 12-6 Environmental Impact Study (2 of 17)

(Basic Form by S. Aegerter and P. Messerli)

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Table 12-7 Environmental Impact Study (3 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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Table 12-8 Environmental Impact Study (4 of 17)

(Basic Form by S. Aegerter and P. Messerli)

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Table 12-9 Environmental Impact Study (5 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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Table 12-10 Environmental Impact Study (6 of 17)
(Basic Form by S. Aegerter and P. Messerli)

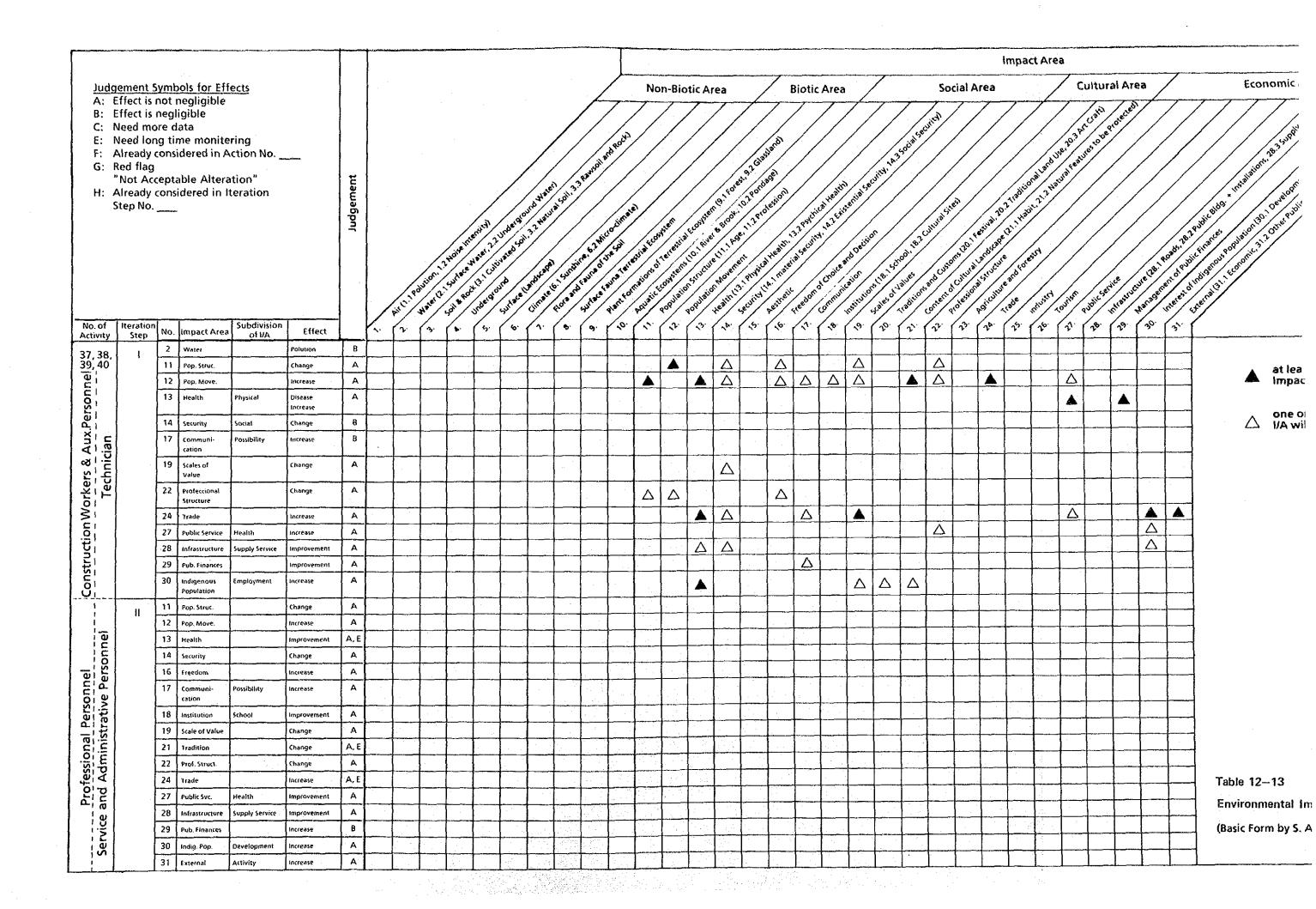
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Table 12-11 Environmental Impact Study (7 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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## Table 12-12 Environmental Impact Study (8 of 17) (Basic Form by S. Aegerter and P. Messerli)

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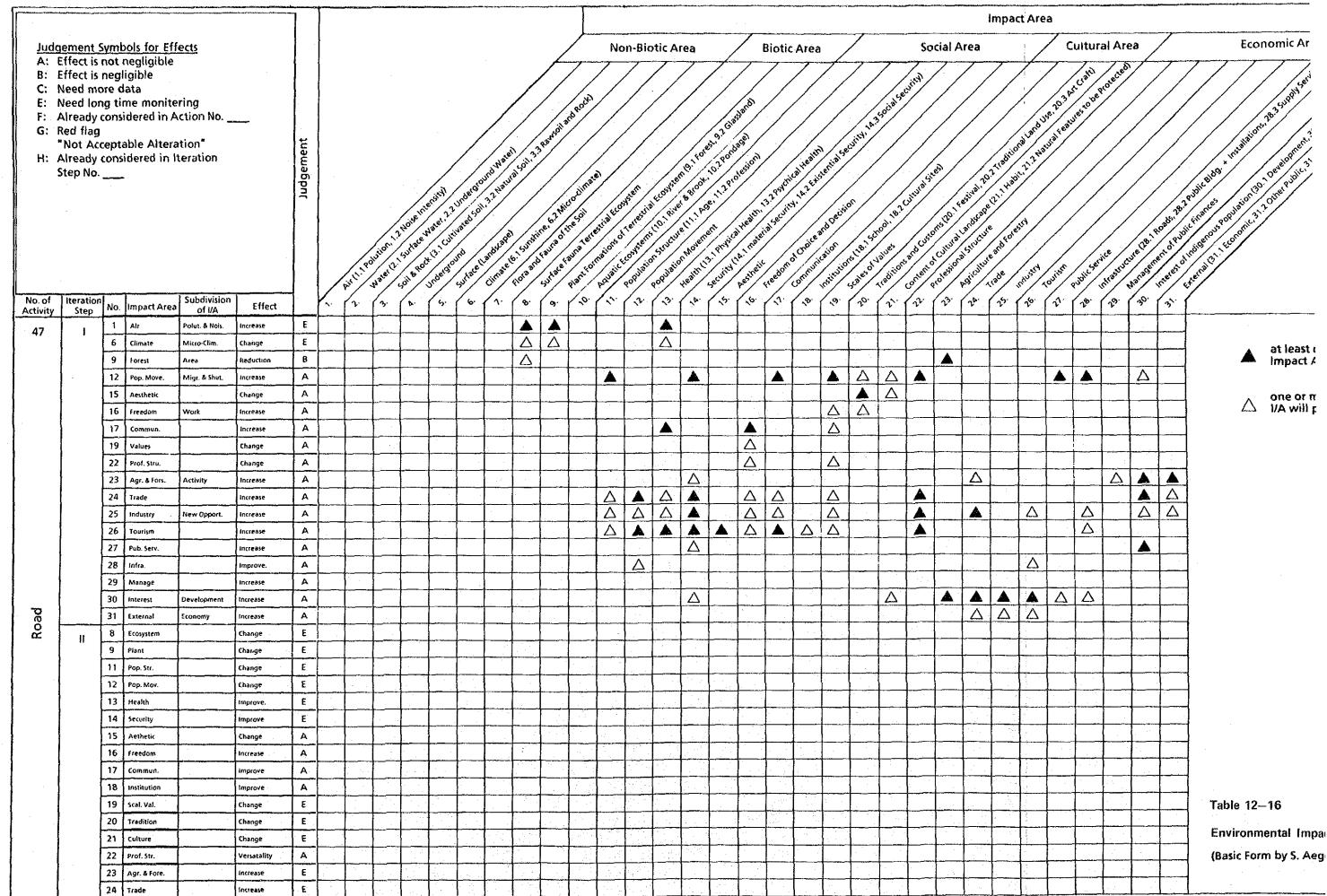
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Table 12-14 Environmental Impact Study (10 of 17)
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Table 12-15 Environmental Impact Study (11 of 17)
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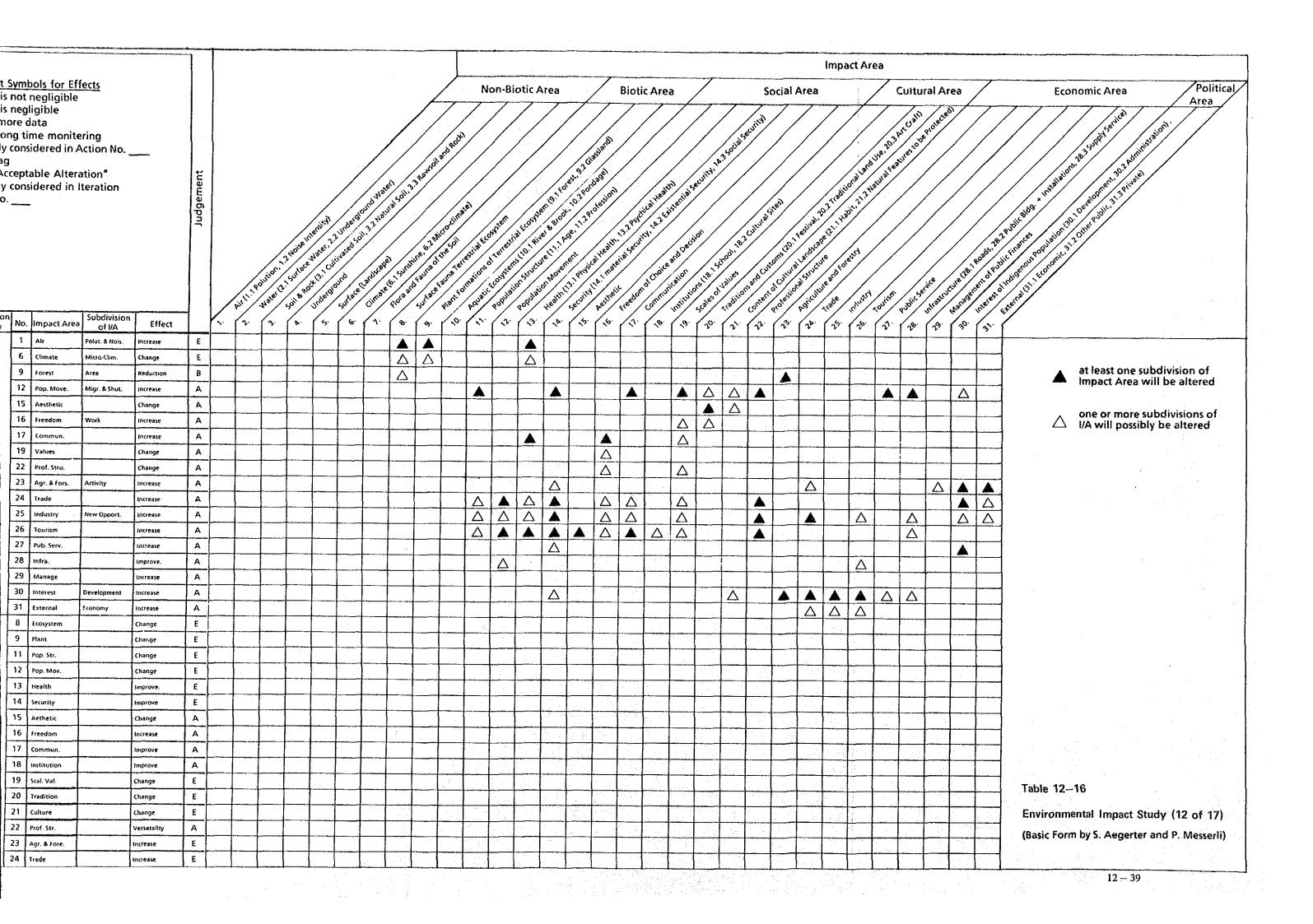


Table 12-17 Environmental Impact Study (13 of 17)

(Basic Form by S. Aegerter and P. Messerli)

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Table 12-18 Environmental Impact Study (14 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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Table 12-19 Environmental Impact Study (15 of 17)
(Basic Form by S. Aegerter and P. Messerli)

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## Table 12-20 Environmental Impact Study (16 of 17)

(Basic Form by S. Aegerter and P. Messerli)

	Juggement Symbols for Effects  A: Effect is not negligible  B: Effect is negligible  C: Need more data  E: Need long time monitering  F: Already considered in Action No  G: Red flag  "Not Acceptable Alteration"  H: Already considered in Iteration  Step No								in the state of th	Justin 12	San Band	india de la companya	grand state of the	A the desired the second secon	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
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Table 12-21 Environmental Impact Study (17 of 17) (Basic Form by S. Aegerter and P. Messerli)

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