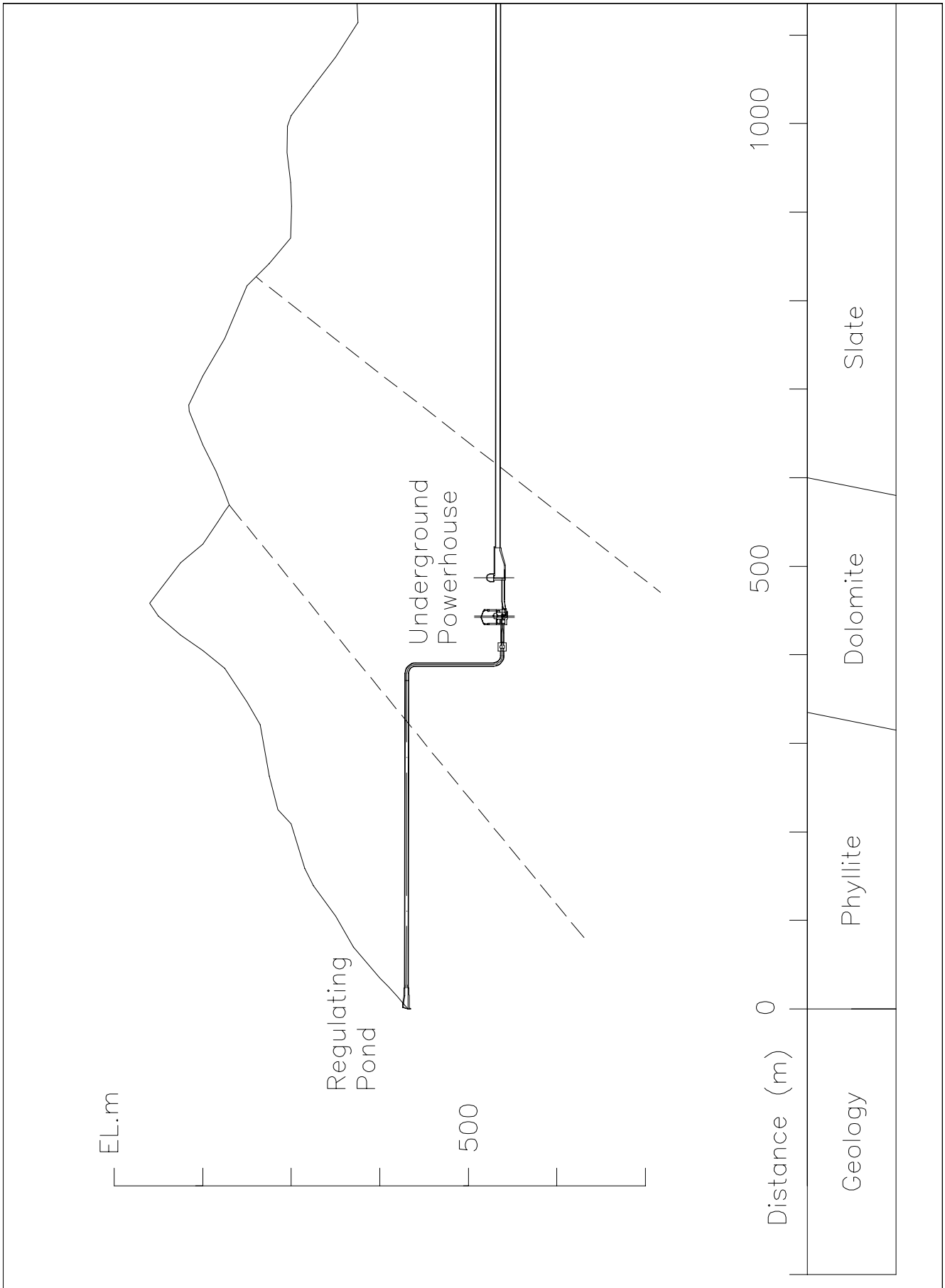
FIGURES

Chapter 8

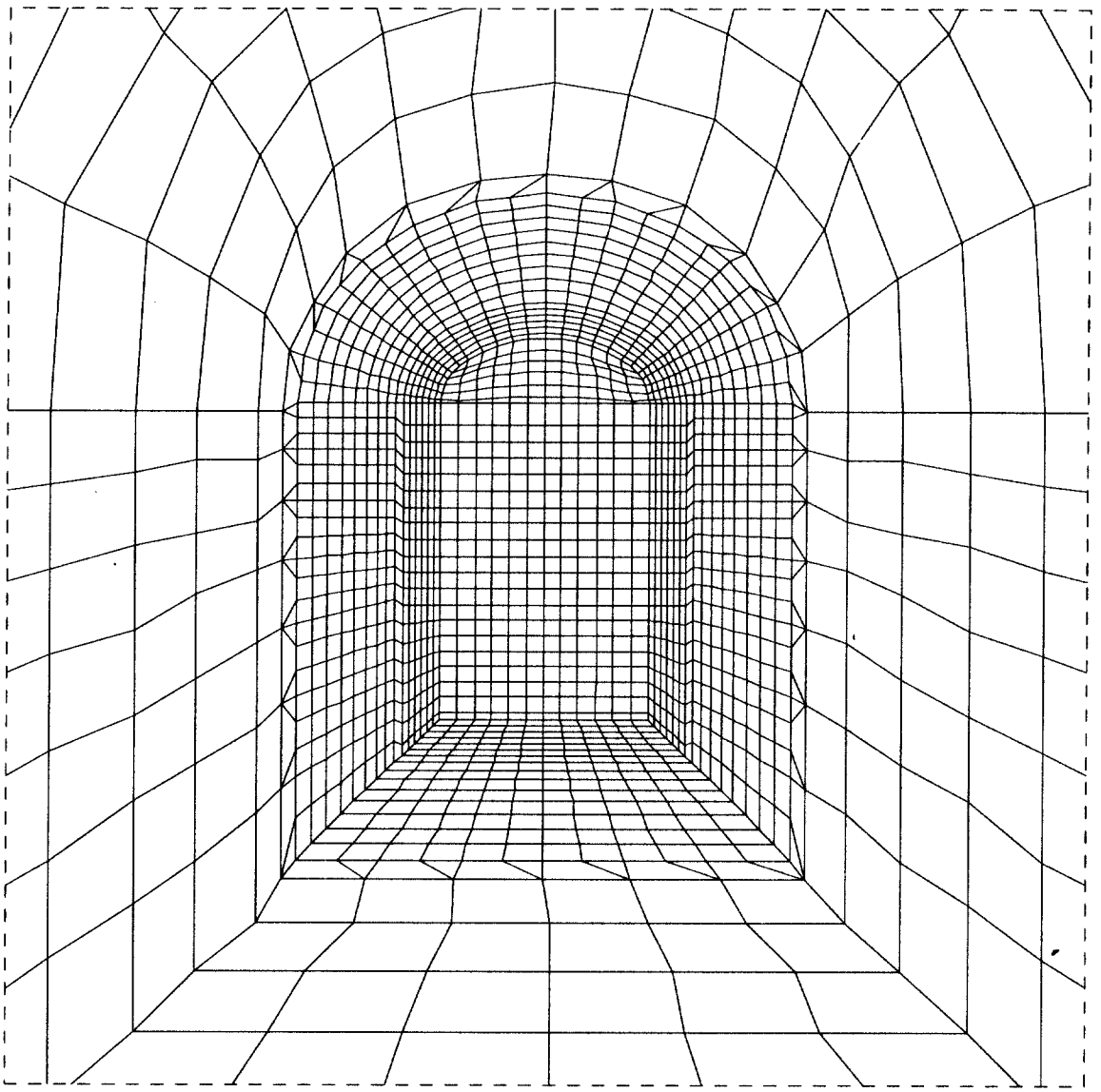


THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

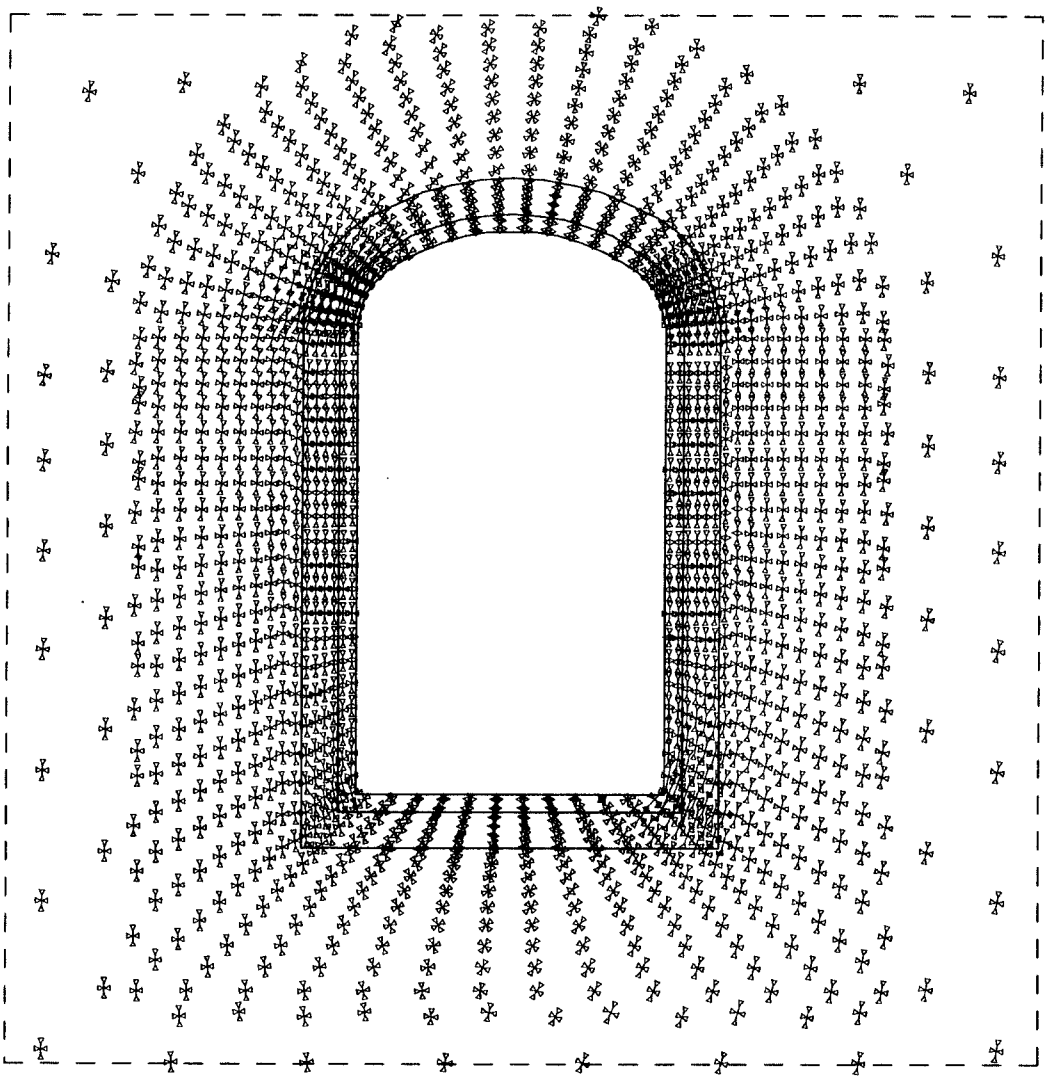
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 8.5.1

Geological Conditions



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.5.2 Analysis Meshes
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.5.3 Stress Distribution
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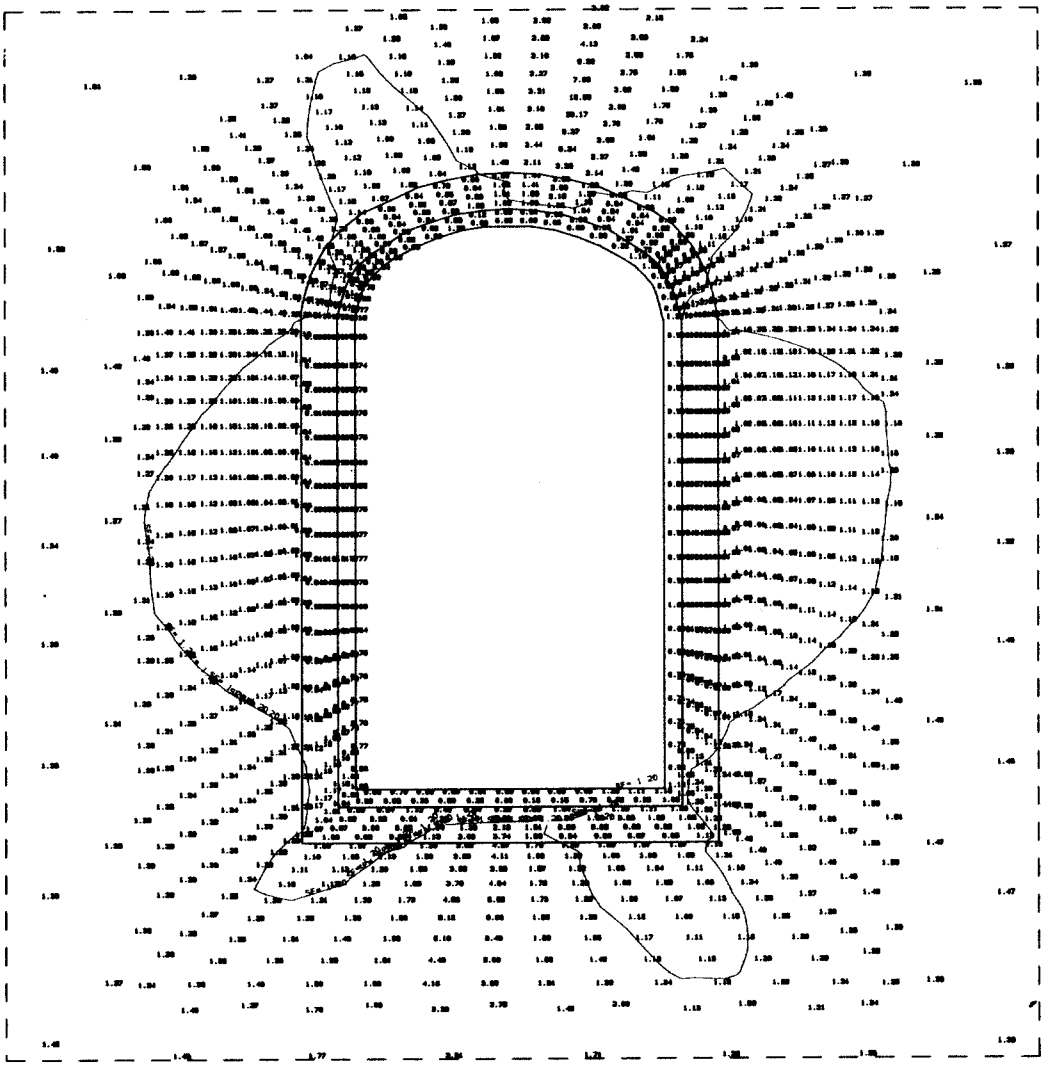
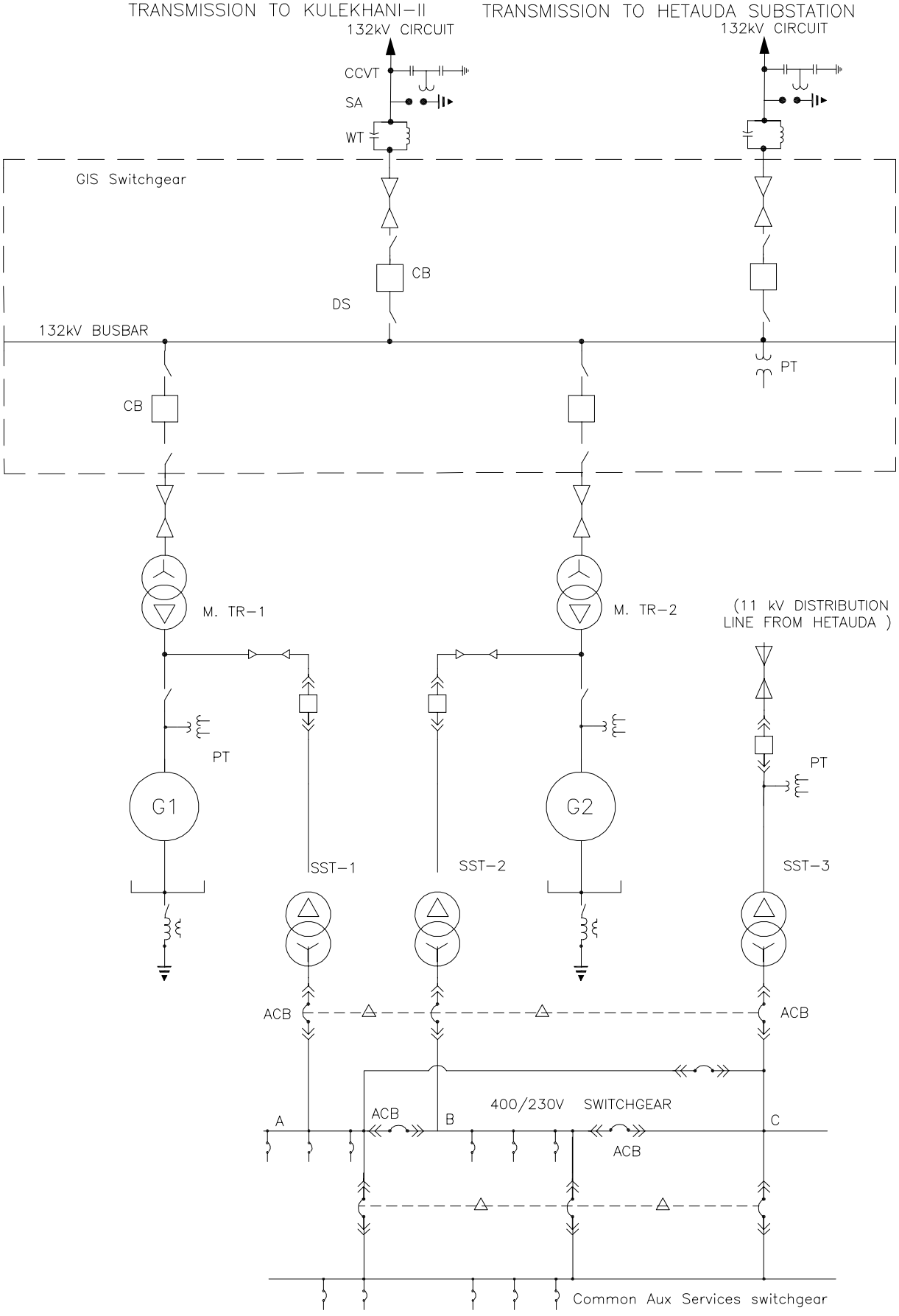
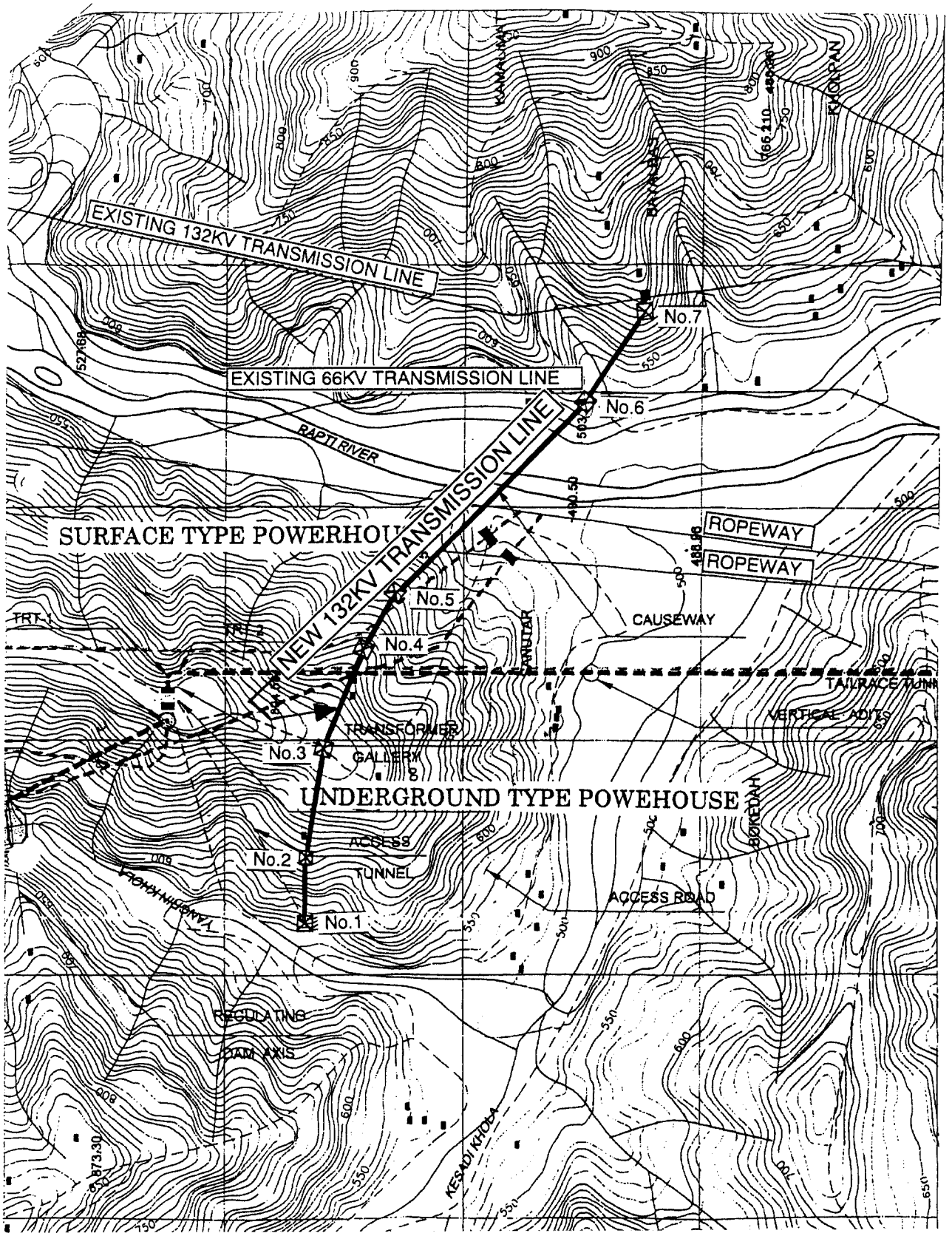


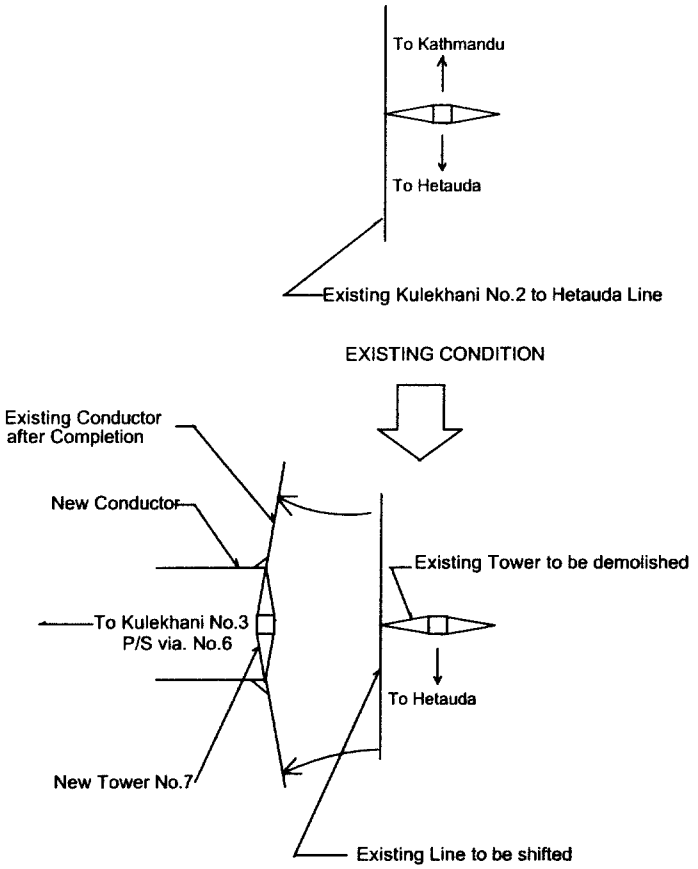
THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.5.4 Relaxed Zone
JAPAN INTERNATIONAL COOPERATION AGENCY	

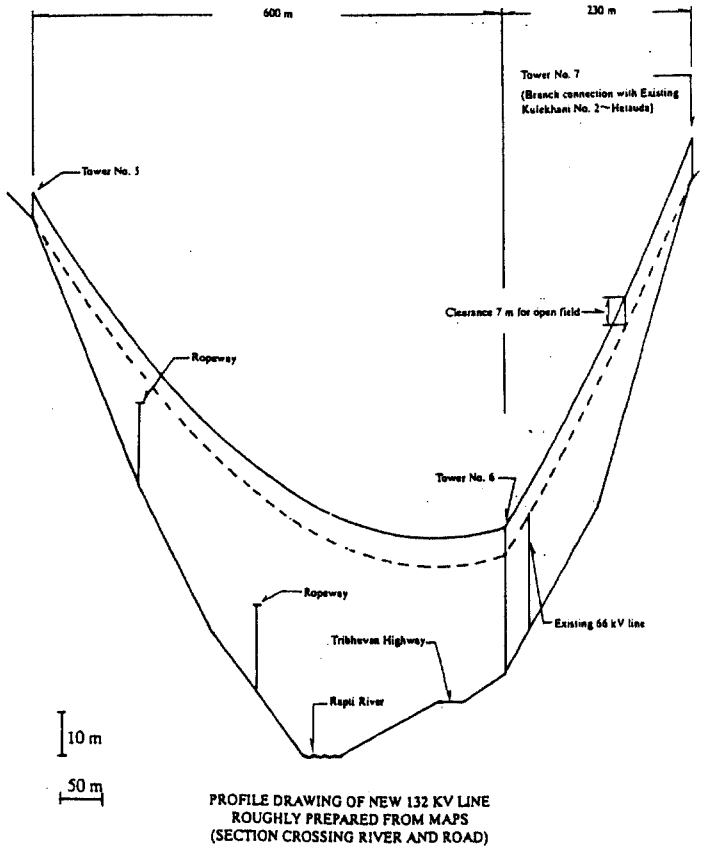


THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.9.1 Single Line Connection Diagram
JAPAN INTERNATIONAL COOPERATION AGENCY	



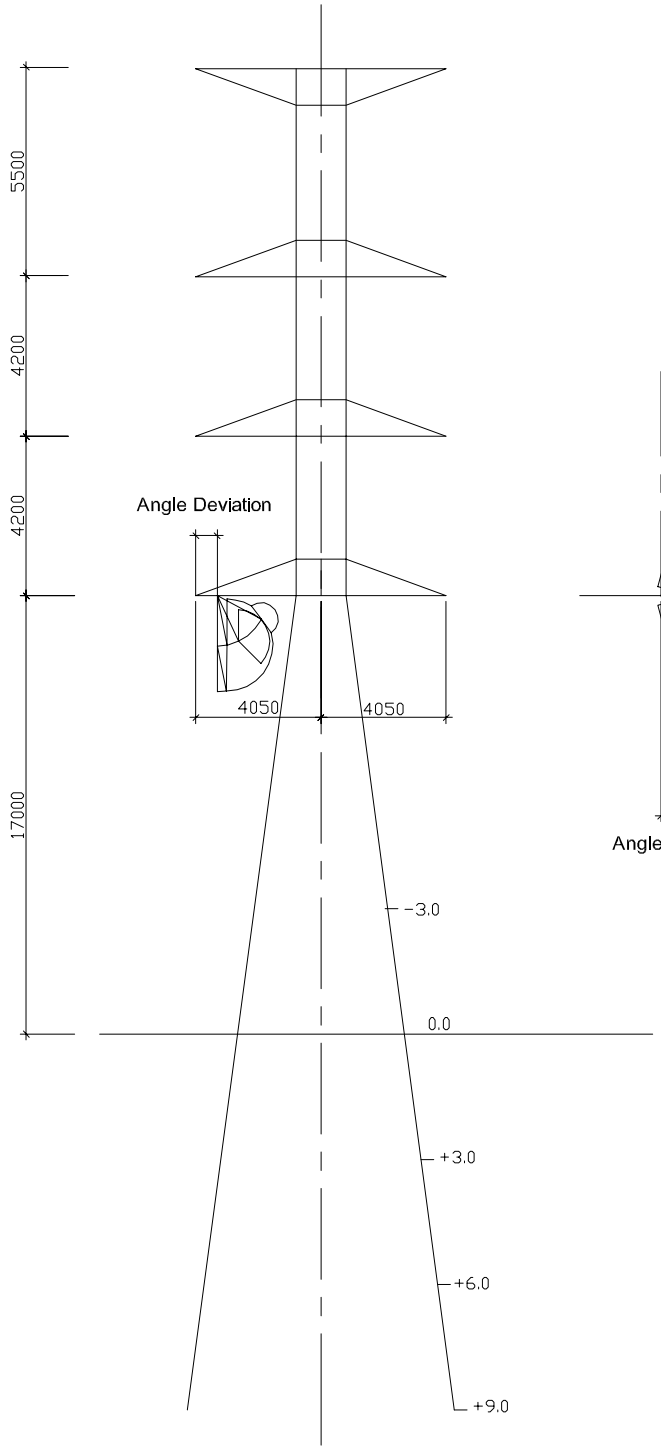
THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.10.1 132kV Transmission Line Route
JAPAN INTERNATIONAL COOPERATION AGENCY	

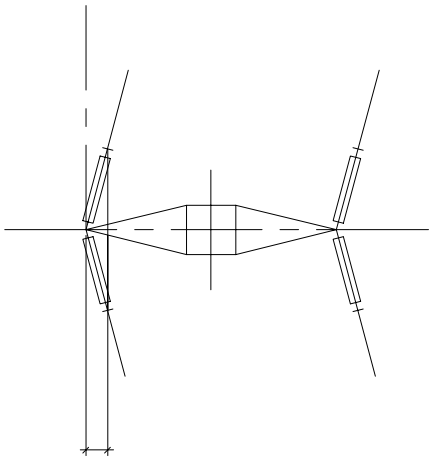


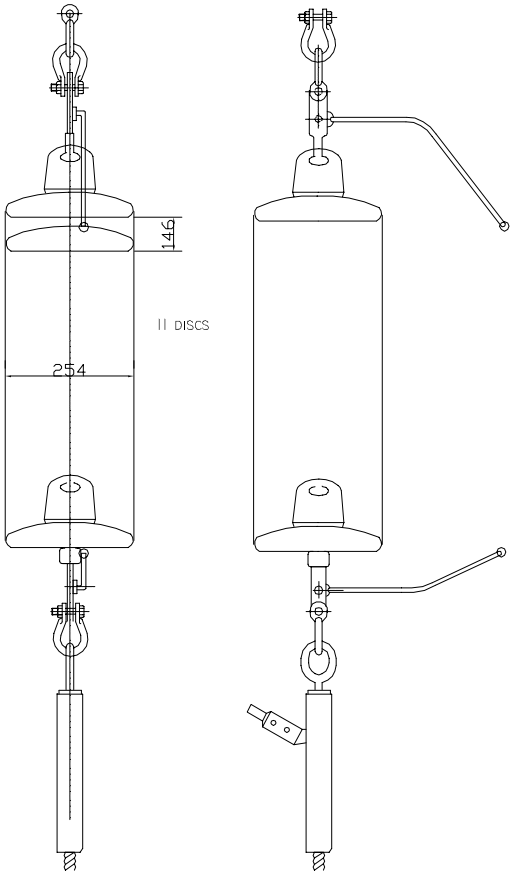


PROFILE DRAWING OF NEW 132 KV LINE
ROUGHLY PREPARED FROM MAPS
(SECTION CROSSING RIVER AND ROAD)

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 8.10.2 Connection of New Lines with Existing 132kV Conductors
JAPAN INTERNATIONAL COOPERATION AGENCY	







Single Tension Insulator Strings

Dimensions for body extensions are shown in m.
Other dimensions shown in the drawing are in mm and minimum requirement.

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 8.10.3
Transmission Lines
Typical Steel Tower (Angle up to 30 deg.) and Insulator Strings

Chapter 9

CHAPTER 9 CONSTRCUTION PLAN AND COST ESTIMATE

9.1 General

This chapter describes the construction plan and cost estimate, both of which are made based on the preliminary design and several site conditions.

The construction plan is to be utilized as a guide not only for the implementation of the construction works but also for the project cost estimate. Therefore, 1) outline of the practical construction method, 2) specification for the construction equipment required, and 3) detailed construction schedule are examined in the construction plan.

The project cost estimate is made with the unit price estimate method in principal. The project cost consists of 1) construction cost comprising civil works, metal works, generating equipment and transmission line, 2) environmental cost, 3) administration expenses, 4) engineering service cost and 5) contingency.

9.2 Construction Plan and Schedule

9.2.1 Basic Conditions

(1) Workable Days

The annual rainfall in the construction site area ranges from 1,700 mm to 3,300 mm (about 2,400 mm on average), according to daily rainfall data that has been recorded during the ten-year period from 1992 to 2001 at the Nibuwatar rainfall gauging station located near the construction site. The summary of the rainfall record is shown in Table 9.2.1. From this rainfall record, intensive rainfall is observed in the period between May and September with the total rainfall during this period accounting for about 90% of the annual rainfall.

Workable days for major construction work, comprising excavation work, embankment work, concrete work and grouting work are based on the above daily rainfall data. The monthly mean rainy day on each rainfall range has been computed as shown in Table 9.2.2.

The suspended days due to rainfall for major construction work are assumed as below:

Unit: day

Daily Rainfall Range (mm)	Excavation	Embankment	Concrete	Grouting
0<x<=5	0	0	0	0
5<x<=10	0	0	0	0
10<x<=20	0	0.5	0	0
20<x<=30	0	0.5	1.0	0
30<x<=40	1.0	1.0	1.0	1.0
40<	1.0	1.0	1.0	1.0

Based on the above data, the monthly workable days for major construction work have been estimated as shown in Table 9.2.3.

As a result, the annual total and monthly mean workable days for each work are summarized as below:

Unit: day

Work Items	Annual Total	Monthly Mean
Excavation	277	23
Embankment	261	22
Concrete	265	22
Grouting	277	23

For the underground works, 25 workable days per month can be applied through a year.

(2) Construction Materials

1) Aggregate materials

As a result of the construction material survey, the coarse and fine aggregates for concrete work can be obtained from the riverbed deposit of the Rapti river in the vicinity of the Kulekhani I Powerhouse, located about 15 km upstream from the construction site. To produce both aggregates, an aggregate crushing plant with a rod mill needs to be installed at the Project site.

2) Cement

The cement in Nepal is being produced and distributed mainly by Hetauda cement Industries Limited and Udayapur Cement Industries Limited. On the other hand, cement imported from India is also available in and around the Project Site. Although the domestic products are to be utilized as much as possible, the cost estimate is made based on the unit price of the cement imported from India, which has the advantage of a better market price compared to the domestic products.

3) Reinforcement bar

The reinforcement bar in Nepal is being produced and distributed by several factories, located between Hetauda and Birgunj. At present these are being utilized in the Sindhuli Road Construction Project, therefore, the reinforcement bar will be obtained from those domestic markets.

4) Explosive

Explosives and detonators required for the rock blasting work will be obtained from the domestic market.

5) Wood materials

Wood materials such as plywood and other timbers will be obtained from the domestic market.

(3) Temporary Facilities

The temporary facilities for the construction work consist mainly of temporary buildings (contractor's office, camp, etc.), workshop, concrete batching plant, aggregate crushing plant and spoil bank. These temporary facilities can be located around the Ghumaune village, located on the left bank of the Yangran River.

Four spoil banks can be located as shown in Drawing 1. The total volume is estimated at about 790,000 m^3.

9.2.2 Construction Method

(1) Khani Head Work

The common excavation will be carried out using a 21 ton bulldozer with ripper, 1.4 m^3 wheel loader, 0.6 m^3 backhoe and 10 ton dump truck. The rock excavation will be carried out by the low bench cut method, with a bench height of less than 3 m.

The open concrete work will be carried out using a 25 ton truck crane with bucket capacity of 1.0 m^3, 100 m^3/h concrete pump car and 4.5 m^3 agitator car. The pre-cast concrete Hume pipe will be placed by the 25 ton truck crane. The backfill work will be carried out using the same equipment fleet as the excavation work.

The excavation work will commence from October of the 1st year after the wet season, provided the order to commence is issued by June of the 1st year. The concrete work will commence from November of the 1st year. The construction period, except metal work, is estimated at about 5 months from October of the 1st year to February of the 2nd year.

(2) Siphon Structures

The excavation work will be carried out using the same equipment fleet as the head work construction. The siphon structural concrete will be placed by a 100 m^3/h concrete pump car. This construction works can be done in parallel with the head work construction.

(3) Connection Tunnel

The connection tunnel is a horseshoe type tunnel of about 3.5 km length and 3.25 m finished diameter. One work adit of about 500 m length is needed for the access to the connection tunnel.

The work adit will be driven by the full-face attacking method, using a 2-boom wheel jumbo, 2.1 m^3 side dump type muck loader and 10 ton dump truck. The temporary supporting work will be done with shotcrete, rock bolt, and steel support. As a result of the cycle time analysis, the monthly progress of the adit excavation is expected to be about 125 m/month.

The connection tunnel will be divided into two sections. The upper section will be driven from the downstream side through the work adit, applying the full-face attacking method. The lower section will be driven from the downstream side (outlet), applying the same method as the upper section. Due to the narrow tunnel heading, a railed muck hauling system will be applied to the whole section. As a result, a 2-boom rail jumbo, backhoe type loader, battery locomotive, 4.5 m^3 muck car, 1.4 m^3 wheel loader and 10 ton dump truck will be employed. As a result of the cycle time analysis, the monthly progress of tunnel excavation is expected to be about 135 m/month for each section.

After the tunnel excavation, the lining concrete for the arch section will be placed using a 12m-long circular traveling steel form, 100 m^3/h concrete pump car and 4.5 m^3 agitator car. The monthly progress of lining concrete is expected to be about 300 m/month as calculated below, using 2 sets of concrete form.

Span length	12m
Cycle time	2 days
Workable day per month	25 days/month
Nos. of form	2 sets
Monthly progress rate	300 m (= 12 x 25/2 x 2)

The construction progress of the invert concrete is expected to average about 1,200 m/month.

The seepage water into the tunnel during construction will be gathered into the ditch and drained out into the tunnel outlet.

The work adit construction will commence from October of the 1st year after the wet season. After completion of the work adit, the connection tunnel excavation will commence from February of the 2nd year. The construction period, including the work adit, is estimated at about 28 months from October of the 1st year to January of the 4th year.

(4) Regulating Dam

The dam is a RCC (Roller Compacted Concrete) type being 50 m in height and 105 m in crest length. The work quantities of major work items are as below:

Work Item	Quantity
Excavation, common	33,000 m^3
Excavation, rock	45,000 m^3
RCC	69,000 m^3
Structural concrete	7,000 m^3

The river diversion will be achieved by means of the open channel installed on the right bank of the Yangran River. After the river diversion, the excavation work on the both sides can be commenced. The common excavation will be carried out using a 32 ton bulldozer with ripper, 3.1 m^3 wheel loader and 10 ton dump truck. The rock excavation will be carried out by the low bench cut method with a bench height of less than 3 m.

After the excavation work, the placement work of the RCC and structural concrete will be carried out from the riverbed portion. The RCC will be directly hauled from the concrete batching plant to each concrete placing site by 10 ton dump truck. The spreading and compaction works will be carried out using a 16 ton low pressure bulldozer and a 10 ton vibrating roller in horizontal lifts of 30 cm respectively. The joints will be formed by the insertion of joint sheets into each layer, using vibrating cutting machine with a wedge shaped blade.

The placement of the structural concrete portion such as spillway, stilling basin, will be carried out using a 25 ton truck crane with bucket capacity of 1.0 m^3 and 100 m^3/h concrete pump car. The mixed concrete will be hauled by a 4.5 m^3 agitator truck.

The consolidation grout and curtain grout are scheduled to be done in parallel with the dam concrete placement. The boring work will be carried out using a 5.5 kW rotary boring machine, while the grouting work will be carried out using a 7.8 kW 37-100 l/min. grout pump. The cement grout will be mixed at the central plant equipped with 200 liter x 2 grout mixer.

The excavation work will commence from October of the 1st year after the wet season. The concrete works, including consolidation grouting, will commence

from April of the 2nd year. The construction period, except metal work, is estimated at about 14 months from October of the 1st year to November of the 2nd year.

(5) Check Dam

The common excavation will be carried out using a 15 ton bulldozer with ripper, 0.8 m^3 backhoe, and 10 ton dump truck. The rock excavation will be carried out by the low bench cut method with a bench height of less than 3 m.

The concrete placement will be carried out using a 25 ton wheel crane with bucket capacity of 1.0 m^3 and 4.5 m^3 agitator truck.

The excavation work will commence from October of the 2nd year after the wet season. The concrete work will commence from January of the 3rd year. The construction period is estimated at about 7 months from October of the 2nd year to April of the 3rd year.

(6) Headrace Tunnel

The headrace tunnel is a circular type tunnel of about 0.4 km length and 4.1 m finished diameter.

The tunnel will be driven by the full-face attacking method, using the same equipment fleet as the adit tunnel. The temporary supporting work will be done with shotcrete, rock bolt, and steel supports. As a result of the cycle time analysis, the monthly progress of the tunnel excavation is expected to be about 110 m/month.

The lining concrete will be placed with a 12m-long circular traveling steel form. The monthly progress of lining concrete is expected to be about 150 m/month, using 1 set of concrete form.

The tunnel excavation work will commence from February of the 2nd year after completion of the access road. The lining concrete work will commence from August of the 3rd year after installation of the penstock pipe, since the penstock pipe needs to be hauled through the headrace tunnel to the upper penstock tunnel. The construction period is estimated at about 4 months from February to May of the 2nd year for the tunnel excavation work, and about 3 months from August to October of the 3rd year for the lining concrete work.

(7) Penstock Tunnel

The penstock tunnel is a steel lined tunnel connecting to the powerhouse cavern. The tunnel consists of the following three parts:

Upper horizontal tunnel	18 m long, 4.1 m dia.
Shaft	108 m, 3.6 m dia.
Lower horizontal tunnel	55 m, 4.1 m dia.

The upper and lower horizontal tunnel will be driven by the same method as the headrace tunnel. Therefore, the monthly progress of the tunnel excavation is expected to be about 110 m/month.

The shaft will be excavated by the pilot hole and downward enlargement method. The pilot hole will be driven with a raise climber upward from the lower horizontal tunnel. The drilling work will be made by 2 sets of stopper drill and 2 m long guide-rail will be extended after every 2 rounds of blasting work. The average progress rate for the pilot hole excavation is expected to be about 70 m/month. After the pilot hole excavation, enlargement excavation will be carried out downward from the upper horizontal tunnel by the drill and blasting method. The excavated rock material will be dropped to the lower horizontal tunnel through the pilot hole and then hauled to the outside by dump truck through the access tunnel. The monthly progress of the enlargement excavation is expected to be about 65 m/month.

The concrete placement around the steel penstock pipe will be carried out in parallel with the installation work of the pipes, using a concrete bucket controlled by a winch. The concrete pouring will be made after jointing 4 pieces of 6 m long unit pipe.

The upper horizontal tunnel excavation will commence from June of the 2nd year, following the headrace tunnel excavation. On the other hand, the lower horizontal tunnel excavation will commence from July of the 2nd year after completion of the penstock adit excavation. Therefore, the shaft excavation will commence from August of the 2nd year after completion of the lower horizontal tunnel excavation. The installation of penstock pipe and backfill concrete work will commence from January of the 3rd year after the shaft excavation. The construction period is estimated at about 14 months from June of the 2nd year to July of the 3rd year.

(8) Access Tunnel and Work Adit Tunnel

The access tunnel is a road tunnel connecting to the operation floor of the underground house, about 800 m in total length and 5.6 m in diameter. Five work adit tunnels will be provided in order to connect the access tunnel with the powerhouse arch, powerhouse bottom, lower penstock horizontal tunnel, tailrace chamber, and tailrace tunnel respectively.

The access and work adit tunnels will be driven by the same method as the headrace tunnel. The invert concrete in the access tunnel will be placed after the

tunnel excavation. During this period, the excavation work for each work adit tunnel will need to be suspended.

The access tunnel excavation will commence from September of the 1st year after both mobilization and construction of a temporary access road to the access tunnel. The construction period for both the access tunnel and powerhouse top adit is estimated at about 8 months from September of the 1st year to April of the 2nd year.

(9) Powerhouse

The powerhouse is a bullet type having a dimension of 17 m wide, 31 m high, and 74 m long. The powerhouse consists of valve floor, turbine floor with cubicle room, generator floor with erection bay and transformer room, and air conditioning plant and machine room.

The cavern excavation work will be carried out in 2 steps: arch excavation and body excavation with pre-splitting blasting method.

The arch excavation will be carried out with a center drift heading and side enlargement method, approaching from the upper work tunnel branching off from the access tunnel and employing the same equipment fleet as the headrace tunnel. The setting of PS anchor and glory holes will be made in parallel with the excavation work. The construction period for arch excavation is estimated at about 3 months from May to July of the 2nd year after completion of the work adit tunnel to the powerhouse arch.

After the arch excavation, the powerhouse ground will be lowered to its bottom level by the bench cut method. The pre-splitting blasting method will be applied for the wall to minimize damage to the surrounding rock and to get a smooth wall surface. The muck will be loaded by 2.3 m^3 wheel loader into 10 ton dump truck, and hauled to the outside through each work adit tunnel and access tunnel. The seepage water during construction will be gathered into the ditch and drained to outside using a submersible pump. The construction period for body excavation is estimated at about 7 months from August of the 2nd year to February of the 3rd year.

The concrete work will be carried out, floor by floor, from the powerhouse bottom. The mixed concrete will be delivered to the cavern by 4.5 m^3 agitator truck and placed by 100 m^3/h concrete pump car. The required construction period for the concrete work is estimated at about 8 months from March to October of the 3rd year.

After the civil work, architectural and utility work including the electrical work will be carried out. These works will be completed within about 12 months.

(10) Tailrace Chamber and Draft Tunnels

The tailrace chamber is a cavern of 36.5 m long x 9.5 m wide and 14.5 m high, located about 43 m downstream from the powerhouse cavern. Above the chamber, a gate chamber will be constructed. The tailrace chamber is connected with the powerhouse by 2 lanes of draft tunnels.

The gate chamber will be driven with upper heading and bottom bench cut methods, approaching from the access tunnel. The gate chamber construction is required to precede the tailrace chamber construction.

The tailrace chamber will be excavated by the same method as the powerhouse. The concrete will be hauled by 4.5 m^3 agitator truck to the site through the access road and placed by a 100 m^3/h concrete pump car. The construction period for the gate chamber and tailrace chamber, except metal work, is estimated at about 7 months from August of the 2nd year to February of the 3rd year after completion of the work adit tunnel to the tailrace chamber.

The excavation work for 2 lanes of the draft tunnels with a finished bottom width of 4.4 m and length of 36 m will be driven by the full-face attacking method from the tailrace chamber toward the powerhouse, one by one. The monthly progress of the tunnel excavation is expected to be about 110 m/month. The construction period for the draft tunnels is estimated at 2 months from August to September of the 2nd year and will occur in parallel with the tailrace chamber construction.

(11) Tailrace Tunnel and Culvert

The tailrace consists of tunnel section, culvert section, and outlet section. The tailrace tunnel is a D-shape type free flow tunnel of 1,659 m length and 4.4 m finished diameter, which is divided into two sections: 1) the upper tunnel section of 814 m length and 2) the lower tunnel section of 845 m length. Meanwhile, the tailrace culvert is a box culvert type 350 m in length, crossing the Kesadi River between the above upper and lower tunnels.

The tunnel section will be driven by the same method as the headrace tunnel. The upper tunnel excavation will be carried out from its upstream end toward the outlet, approaching from the work adit tunnel through the access tunnel, while the lower tunnel excavation will be carried out from its outlet toward the upstream end. The monthly progress of the tailrace tunnel excavation is expected to be about 105 m/month. After the tunnel excavation, the lining concrete will be placed by the same method as the headrace tunnel. The monthly progress of lining concrete is expected to be about 150 m/month. The construction period for the upper tunnel section is estimated at 15 months from September of the 2nd year to

November of the 3rd year after completion of the work adit tunnel to the tailrace tunnel. The construction period for the lower section is estimated at 15 months from November of the 1st year to January of the 3rd year after completion of the tailrace outlet excavation.

The construction of the culvert section needs to be done taking into account 1) river diversion of the Kesadi River and 2) the water draining system during the construction. The river diversion will be achieved by means of an open diversion canal, excavated in the left bank terrace of the Kesadi River. After the river diversion, the construction of the culvert on the right bank section will be commenced. The water for both rainfall in and around the site, and seepage through the ground during construction, will be gathered into a ditch provided along the culvert and drained out into the tailrace outlet through the lower tailrace tunnel section. After completion of the culvert on the right bank section, the river flow will be transferred back to the original river flow, and then the construction of the culvert on the left bank section will be commenced. The water drain during construction will be also achieved by means of a ditch and will drain out into the tailrace outlet.

The common open excavation, will be carried out using a 21 ton bulldozer with ripper, 1.4 m^3 wheel loader, 0.6 m^3 backhoe, and 10 ton dump truck. The open rock excavation will be carried out by the low bench cut method with a bench height of less than 3 m. The open concrete work will be carried out using a 25 ton truck crane with bucket capacity of 1.0 m^3, 100 m^3/h concrete pump car, and 4.5 m^3 agitator car. The construction period for the culvert section is estimated at 12 months from February of the 3rd year to May of the 4th year after completion of the lower tailrace tunnel. The planned construction period allows for suspension of activity during the wet season.

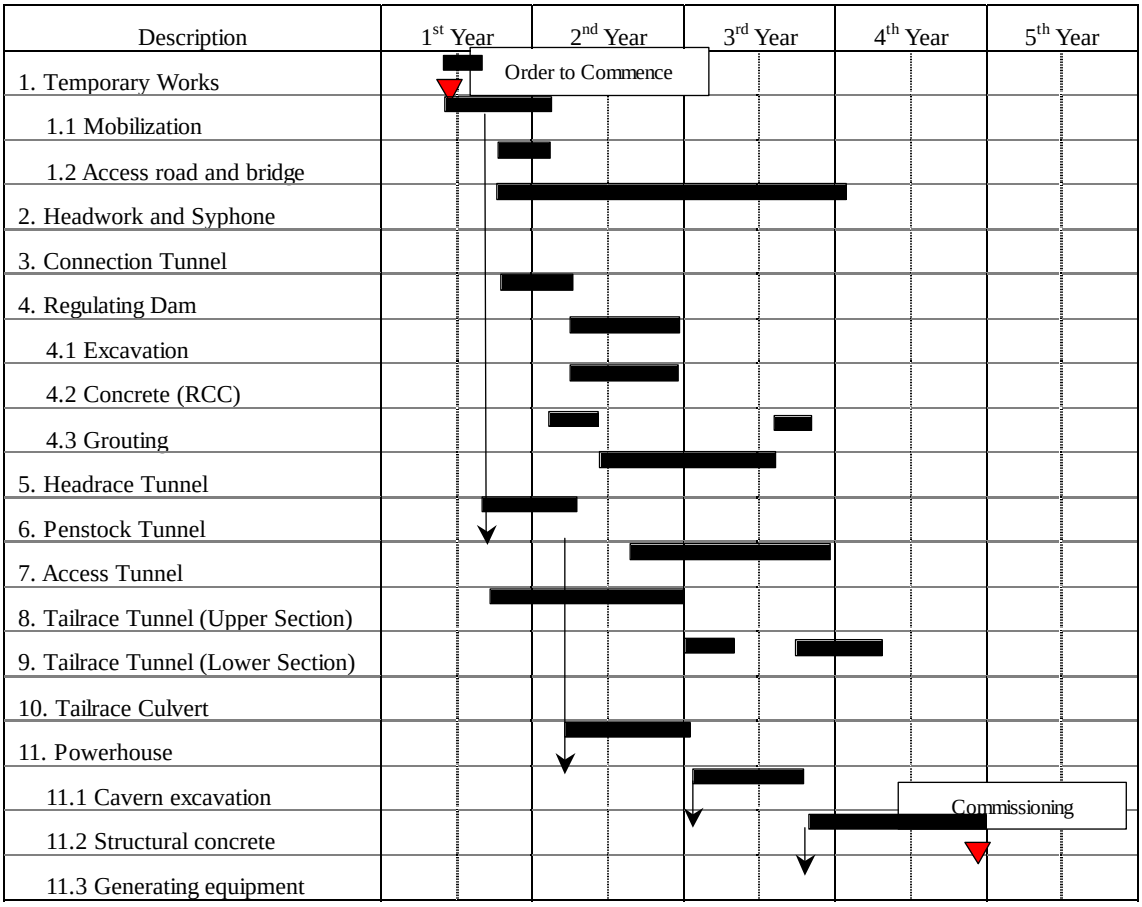
All the major construction equipment required for each work, mentioned above in this Section, is summarized in a matrix in Figure 9.2.1. The figure shows almost all the construction equipment required could be transferred for common use to similar works in the Project.

9.2.3 Construction Schedule

The construction schedule is prepared based on the assumption that the order to commence would be issued in June of the 1st year. The detailed construction schedule is shown in Figure 9.2.2. As shown in the figure, the critical path of the construction schedule after mobilization is placed on the construction of the access tunnel and underground powerhouse and installation of the generating equipment. Therefore, in order to keep the overall construction schedule, the

equipment. Therefore, in order to keep the overall construction schedule, the construction of a temporary access road to the access tunnel should be started just after the commencement of the main civil work contract, and completed by the end of August of the 1st year.

A brief outline of the schedule is summarized below:



The following works are on the critical path in the overall construction schedule.

Work	Period (month)
1) Mobilization for civil work	3.0
2) Excavation in access tunnel	6.0
3) Excavation in powerhouse top adit tunnel	2.0
4) Powerhouse cavern excavation	10.0
5) Powerhouse structural concrete work	8.0
6) Installation of overhead travelling crane	1.0
7) Installation of turbine generator	11.0
8) Wet test of Unit No.1	1.0
9) Wet test of Unit No.2	1.0
Total period	43.0

9.3 Cost Estimate

9.3.1 Basic Conditions and Assumptions

The project cost consists of; 1) Construction cost, 2) Environmental cost, 3) Administration cost, 4) Engineering service cost and 5) Contingency. The basic conditions and assumptions of the cost estimate are as follows:

(1) The cost estimate is made in US dollar (US$) for both foreign and local currency components.
(2) The local currency component covers cost of locally available materials including reinforcing bars, fuel, explosives, and local labor. The costs of imported materials, imported machineries for mechanical and electrical works and depreciation of construction equipment are allocated in the foreign currency component.
(3) The exchange rate used in the cost estimate is US$ 1.0 = Rs.78.30 which was fixed by Nepal Rastra Bank on July 16, 2002.
(4) It has been assumed that the construction work will to be undertaken by competent contractors selected through international competitive bidding (ICB).
(5) The construction cost is estimated with the unit price estimate method in principal.
(6) Each of the unit prices of major civil works is developed by a breakdown of unit price. The cost of metal works, generating equipment and transmission line are estimated from data obtained from manufacturers and from recent bidding unit prices of similar projects in Asian countries.
(7) No tax has been included in the cost estimate.

9.3.2 Preparatory Works

The preparatory works consist of the access roads, including a bridge of 150 m length and 7 m width, and the temporary facilities consisting of base camp, water supply system, electric power supply system and telecommunication system. The construction cost for the access road is estimated based on the detailed work quantities and unit prices. The construction cost for the bridge is estimated by a lump sum basis. The cost for the temporary facilities including base camp is assumed at 5% of the total cost of the civil works.

9.3.3 Civil Works

The construction cost for each civil work is estimated by multiplying work quantity and unit price in principal. The cost components of the breakdown of unit price comprise labor wage, material cost, equipment cost and contractor's indirect cost. Each cost component is explained as below.

(1) Labor Wage

Labor wage obtained from the government district office at Hetauda is based on the basic daily wages in 8-hour per shift for each kind of labor. Each labor wage is shown in Table 9.3.1.

(2) Material Cost

As described in the preceding Section 9.2 Construction Plan and Schedule, almost all the materials except cement will be obtained from the domestic market. The aggregate materials, including fine aggregate, will be produced by using the riverbed deposit materials at Rapti River. Both coarse aggregate and fine aggregate are therefore estimated based on the production cost at the aggregate crushing plant and hauling charge to the site. Each material cost is shown in Table 9.3.2.

(3) Equipment Cost

The equipment cost consists of depreciation cost, repair and maintenance cost and annual administration cost. The equipment cost on hourly or daily basis is estimated, referenced to authorized guidelines which are available in Japan to determine the life time, rate of repair, maintenance and administration expenses.

(4) Contractor's Indirect Cost

Overhead expenses and profits have been allocated to the unit rates of each work item. These expenses are estimated at 25% of the direct cost comprising labor wage, material cost and equipment cost.

(5) Unit Prices of Major Civil Works

The unit prices of major civil works are made using the above base costs and the production rates of equipment and labor, in consideration of the construction plan. Each unit price is shown below.

Unit Price :US$

Work Item	Unit	F/C portion	L/C portion
Open excavation, common /*	m^3	1.5	0.7
Open excavation, rock /*	m^3	6.8	2.9
Tunnel excavation, truck	m^3	32.3	14.7
Tunnel excavation, rail	m^3	36.0	16.3
Shaft tunnel excavation	m^3	49.4	14.0
Cavern excavation	m^3	17.7	8.7
Structural concrete	m^3	55.3	12.5
Lining concrete	m^3	54.2	12.1
Invert concrete	m^3	52.8	12.6
Backfill concrete /*	m^3	48.8	10.9
RCC	m^3	31.4	13.5
Formwork for structure /*	m^2	3.0	12.0
Formwork for tunnel lining /*	m^2	16.0	4.0
Reinforcement bar	ton	24.5	534.4
Steel support	ton	1,286.4	134.2
Rock bolt, D25	m	5.3	12.8
Shotcrete (5cm)	m^2	14.9	2.1
Shotcrete (10cm)	m^2	22.7	2.8
Shotcrete (15cm)	m^2	30.5	3.5
Shotcrete (16cm)	m^2	32.3	3.7
Shotcrete (24cm)	m^2	74.0	5.8
Shotcrete (32cm)	m^2	96.5	8.4
PS anchor (100ton, 15m)	m	111.2	3.1
PS anchor (60ton, 13m)	m	87.1	3.1

Note /*: These unit prices were determined by referring to the recent data on similar projects.

9.3.4 Metal Works

The cost for metal works consists of the CIF price at Calcutta in India, inland transportation charge, and installation cost. The unit price per weight of respective type of structure has been determined by reference to recent bidding data of similar works. The metal works have the following structural components:

- Intake gate and trashrack
- Sand flush gate
- Bottom outlet gate
- Steel conduit
- Diversion gate
- Penstock

- Tailrace gate with monorail hoist

9.3.5 Generating Equipment

The cost for generating equipment consists of the CIF price at Calcutta in India, inland transportation charge, and installation cost. The unit price of respective components of the generating equipment has been determined by reference to recent bidding data of similar works. The components of general equipment are as follows:

- Turbines & ancillary
- Generator & ancillary
- Main transformer
- OHT cranes
- 132 kV switchgear
- Indoor switchgear, 11 kV
- Supervisory control system
- Auxiliary equipment
- Miscellaneous

9.3.6 Transmission Line

The cost for tower materials and conductors consists of the CIF price at Calcutta in India, inland transportation charge, and installation cost. The civil works such as site clearance, earthwork, and foundation treatment are included in the transmission line cost. The unit price of respective components of the transmission line has been determined by reference to the recent bidding data of similar works.

9.3.7 Environmental Cost

The environmental cost consists of 1) Environmental management cost (Kulekhani Environmental and Social Management Unit), 2) Natural environmental mitigation and monitoring plan and 3) Social environmental mitigation and monitoring plan including land compensation. These costs are estimated by taking into account the results of the environmental impact study in this feasibility study. Each environmental cost is summarized in Table 9.3.3.

9.3.8 Administration Expenses

Administration expense of the Project owner (NEA) is estimated at 2.5% of the total construction cost.

9.3.9 Engineering Services

The cost for engineering service for supervision is estimated at 7.5% of the direct

construction cost.

9.3.10 Contingency

The contingency required for the project budgeting consists of; 1) Physical contingency to cover unforeseen changes of physical conditions and 2) Price contingency to compensate for future price escalation.

The rates of physical contingency is estimated at 10% of the total cost for civil works, environmental cost, administration expenses, and engineering services, and 5% of the total cost for metal works, generating equipment and transmission.

The price escalation for foreign currency portion is assumed to be 0% per annum, which is predicted based on the G-5 MUV (Manufacturing Unit Value) Index published by the World Bank. The MUV index series show the current deflation trend for prices for manufacturing exported by the G-5 countries (France, Germany, Japan, United Kingdom and the United States) to the developing countries.

The local currency portion is estimated in terms of the US Dollar. Therefore the inflation rate for the Nepal Rupee has been deflated by the same level as the devaluation of foreign exchange rate. On the other hand, the inflation rate for the US Dollar is to be applied to the local currency portion. In the cost estimate, the price escalation for the local currency portion is assumed to be 2.3% per annum, which is the escalation rate applied to the feasibility study on similar projects in Nepal. This price escalation rate is also produced as an average escalation rate from the recent USA CPI (Consumer Price Index).

9.3.11 Total Project Cost

Total project cost is estimated at US$ 77.7 million comprising foreign currency portion of US$ 55.8 million and local currency portion of US$ 21.9 million and is summarized below and detailed in Table 9.3.4.

Unit : Thousand US$

Description	F.C.	L.C.	Total
1. Civil Works	29,844	12,522	42,366
2. Metal Works	4,500	500	5,000
3. Generating Equipment	13,228	1,113	14,341
4. Transmission Line	343	86	429
Total Construction Cost (1 to 4)	**47,915**	**14,221**	**62,136**
5. Administration Expenses	0	1,553	1,553
6. Engineering Services	3,594	1,067	4,661
7. Environmental Cost	0	1,835	1,835
Base Cost (1 to 7)	**51,509**	**18,676**	**70,185**
8. Physical Contingency	4,247	1,783	6,030
Total (1 to 8)	**55,756**	**20,459**	**76,215**
9. Price Contingency	0	1,474	1,474
Total Project Cost	**55,756**	**21,933**	**77,689**

9.3.12 Annual Disbursement Schedule

The annual disbursement schedule is made in accordance with the project cost and construction schedule and is summarized below and detailed in Table 9.3.5.

Unit : Thousand US$

Year	F.C.	L.C.	Total
2004	7,058	4,434	11,492
2005	19,660	7,868	27,528
2006	23,699	7,224	30,923
2007	5,338	2,407	7,745

TABLES

Chapter 9

Table 9.2.1 Summary of Rainfall Record at Nibuwater Rainfall Gauging Station

Unit: mm

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1992	2	13	0	11	180	333	503	371	146	73	10	22	1,664
1993	12	7	49	159	169	375	1,181	642	253	13	0	0	2,859
1994	51	23	52	43	149	464	312	386	392	0	2	0	1,872
1995	12	27	26	8	245	413	562	706	314	4	93	9	2,417
1996	52	34	4	3	129	378	547	533	332	85	0	0	2,096
1997	13	7	11	170	145	330	476	461	99	66	3	154	1,933
1998	4	16	97	33	123	352	1,085	713	137	47	6	0	2,612
1999	10	0	0	9	350	754	931	720	273	275	0	3	3,325
2000	1	8	21	96	372	509	693	899	306	1	0	2	2,908
2001	5	17	4	61	349	348	469	717	371	97	0	0	2,437
Mean	16	15	26	59	221	426	676	615	262	66	11	19	2,412

Table 9.2.2 Monthly Mean Rainy Day

Unit: day

Daily Rainfall Range (mm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
=0	28.6	25.0	27.8	22.9	14.5	8.2	2.4	2.2	9.6	24.7	28.2	29.8	223.9
0<x<=5	1.6	1.8	2.1	4.2	6.8	7.8	8.8	10.6	9.0	3.3	1.4	0.5	57.9
5<x<=10	0.5	0.8	0.3	1.3	2.9	3.0	4.5	4.1	3.3	1.3	0.2	0.2	22.4
10<x<=20	0.1	0.4	0.3	0.7	3.3	3.8	5.9	4.9	3.5	0.6	0.0	0.2	23.7
20<x<=30	0.0	0.0	0.4	0.4	1.2	2.4	2.9	2.8	2.1	0.6	0.1	0.1	13.0
30<x<=40	0.1	0.0	0.0	0.3	0.9	1.6	1.9	1.6	1.1	0.3	0.0	0.1	7.9
40<	0.1	0.0	0.1	0.2	1.4	3.2	4.6	4.8	1.4	0.2	0.1	0.1	16.2
Total	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0

Table 9.2.3 Monthly Workable Days

Unit: day

Excavation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Holiday	2.0	3.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0	7.0	3.0	0.0	19.0
Sunday	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	51.6
Rain	0.2	0.0	0.1	0.5	2.3	4.8	6.5	6.4	2.5	0.5	0.1	0.2	24.1
Overrap	0.3	0.4	0.3	0.2	0.5	0.7	0.9	0.9	0.4	1.1	0.4	0.0	6.2
Total of Suspended Day	6.2	6.9	6.1	5.6	7.1	8.4	9.9	9.8	6.4	10.7	7.0	4.5	88.5
Workable	24.8	21.1	24.9	24.4	23.9	21.6	21.1	21.2	23.6	20.3	23.0	26.5	276.5

Embankment	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Holiday	2.0	3.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0	7.0	3.0	0.0	19.0
Sunday	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	51.6
Rain	0.3	0.2	0.5	1.1	4.6	7.9	10.9	10.3	5.3	1.1	0.2	0.4	42.5
Overrap	0.3	0.5	0.4	0.3	0.8	1.1	1.6	1.5	0.8	1.2	0.5	0.1	8.8
Total of Suspended Day	6.2	7.0	6.4	6.1	9.1	11.1	13.6	13.1	8.8	11.2	7.0	4.6	104.3
Workable	24.8	21.0	24.6	23.9	21.9	18.9	17.4	17.9	21.2	19.8	23.0	26.4	260.7

Concrete	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Holiday	2.0	3.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0	7.0	3.0	0.0	19.0
Sunday	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	51.6
Rain	0.2	0.0	0.5	0.9	3.5	7.2	9.4	9.2	4.6	1.1	0.2	0.3	37.1
Overrap	0.3	0.4	0.4	0.3	0.6	1.0	1.3	1.3	0.7	1.2	0.5	0.0	8.0
Total of Suspended Day	6.2	6.9	6.4	5.9	8.2	10.5	12.4	12.2	8.2	11.2	7.0	4.6	99.7
Workable	24.8	21.1	24.6	24.1	22.8	19.5	18.6	18.8	21.8	19.8	23.0	26.4	265.3

Grouting	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Holiday	2.0	3.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0	7.0	3.0	0.0	19.0
Sunday	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	51.6
Rain	0.2	0.0	0.1	0.5	2.3	4.8	6.5	6.4	2.5	0.5	0.1	0.2	24.1
Overrap	0.3	0.4	0.3	0.2	0.5	0.7	0.9	0.9	0.4	1.1	0.4	0.0	6.2
Total of Suspended Day	6.2	6.9	6.1	5.6	7.1	8.4	9.9	9.8	6.4	10.7	7.0	4.5	88.5
Workable	24.8	21.1	24.9	24.4	23.9	21.6	21.1	21.2	23.6	20.3	23.0	26.5	276.5

Table 9.3.1 Labor Wage

Unit: US$

Labor	Unit	Wage
Foreman	day	2.92
Operator	day	2.34
Driver for heavy truck	day	2.34
Driver for light vehicle	day	1.95
Concrete worker	day	1.30
Carpenter	day	2.34
Plumber	day	2.34
Mechanic	day	2.34
Electrician	day	1.95
Welder	day	1.95
Skilled labor	day	2.34
Unskilled labor	day	1.69
Common labor	day	1.30

Remarks: Labor cost is based on the basic daily wages in 8-hour per shift.

Table 9.3.2 Material Cost

Unit: US$

Material	Unit	Unit Price
Diesel	liter	0.38
Gasoline	liter	0.60
Portland cement	ton	71.38
Deformed bar 8mm dia	ton	329.66
Deformed bar 12-25mm dia.	ton	302.40
Deformed bar 28-32mm dia.	ton	320.57
Binding wire	ton	452.95
Timber for Formwork	m^3	363.40
Plywood for Formwork 10mm	m^2	3.12
Plywood for Formwork 19mm	m^2	4.15
Explosives	kg	1.95
Electric detonator	No.	0.03
Coarse aggregate /*	ton	4.41
Fine aggregate /*	ton	8.31
Electric power	kWh	0.09

Remarks: /* The cost is estimated based on the products through the crushing plant.

Table 9.3.3 Environmental Cost

Unit: US$

Description	Total Cost
1. Environmental Management Cost (KESMU /*)	
1.1 NEA Staff and Consultants	252,886
1.2 Facilities	232,184
Total (1)	**485,070**
2. Natural Environmental Mitigation and Monitoring Cost	
2.1 Mitigation Measures during Pre-Construction Phase	32,822
2.2 Monitoring Measures during Pre-Construction Phase	7,548
2.3 Mitigation Measures during Construction Phase	112,644
2.4 Monitoring Measures during Construction Phase	59,055
Total (2)	**212,069**
3. Social Environmental Mitigation and Monitoring Cost	
3.1 Resettlement Plan during Pre-Construction Phase	7,024
3.2 Social Action Plan during Pre-Construction Phase	22,031
3.3 Public Consultation during Pre-Construction Phase	14,045
3.4 Resettlement Plan during Construction Phase	
3.4.1 Compensation for Private Land (15 ha)	325,670
3.4.2 Compensation for Privately Owned Trees (3,255 trees)	70,128
3.4.3 Compensation for Houses (26 houses)	75,360
3.4.4 Miscellaneous	61,881
Sub-total (3.4)	533,039
3.5 Social Action Plan during Construction Phase	
3.5.1 Improvement of Intakes for 5 water mill canals	1,596
3.5.2 Design & Construction 3 Irrigation Canals	76,628
3.5.3 Improvement Intakes for 3 Irrigation Canals Downstream Tailrace	1,277
3.5.4 Construction of 1 Suspension Bridges	191,571
3.5.5 Awareness Progam	36,718
3.5.6 Agricultural Development	63,857
3.5.7 Community/ Public Health & Education Enhancement	25,543
3.5.8 Skill Enhancement	15,964
3.5.9 Rural Electrification	63,857
3.5.10 Neighborhood Support	47,893
3.5.11 Women's Development	20,434
Sub-total (3.5)	545,338
3.6 Public Consultation during Construction Phase	16,424
Total (3)	**1,137,902**
Grand Total	**1,835,041**

Remarks: /* Kulekhani Environmental and Social Management Unit

Table 9.3.4 Breakdown of Construction Cost of Civil Works (1/4)

Unit: US$

Work Item	Unit	Unit Price (F/C)	Unit Price (L/C)	Quantity	Cost (F/C)	Cost (L/C)	Total
1. Khani Headwork							
1.1 Excavation							
(1) Common	m^3	1.5	0.7	5,491	8,000	3,600	11,600
(2) Rock	m^3	6.8	2.9	0	0	0	0
1.2 Backfill	m^3	1.5	0.7	2,994	5,000	2,000	7,000
1.3 Structural Concrete	m^3	55.3	12.5	2,641	146,000	33,000	179,000
1.4 Formwork	m^2	3.0	12.0	2,641	8,000	32,000	40,000
1.5 Reinforcement bars	ton	24.5	534.4	132	3,200	71,000	74,200
1.6 Precast 1m concrete hume pipe	m	11.1	25.9	307	3,400	8,000	11,400
1.7 Others (7% of 1.1 to1.6)					12,000	10,000	22,000
Sub Total					**185,600**	**159,600**	**345,200**
2. Syphone Structure							
2.1 Excavation							
(1) Common	m^3	1.5	0.7	41,453	64,000	27,400	91,400
(2) Rock	m^3	6.8	2.9	2,971	20,000	9,000	29,000
2.2 Backfill	m^3	1.5	0.7	29,812	46,000	20,000	66,000
2.3 Masonry	m^3	1.0	4.0	1,102	1,100	4,400	5,500
2.4 Backfill concrete	m^3	33.0	33.0	949	31,300	31,300	62,600
2.5 Structural Concrete	m^3	55.3	12.5	4,920	272,000	61,000	333,000
2.6 Formwork	m^2	3.0	12.0	4,920	14,800	59,000	73,800
2.7 Reinforcement bars	ton	24.5	534.4	490	12,000	261,900	273,900
2.8 Others (7% of 2.1 to 2.7)					32,000	33,000	65,000
Sub-Total					**493,200**	**507,000**	**1,000,200**
3. Connection Tunnel							
3.1 Excavation in Tunnel	m^3	36.0	16.3	45,400	1,634,000	740,000	2,374,000
3.2 Concrete (Arch)	m^3	54.2	12.1	10,200	553,000	123,000	676,000
3.3 Concrete (Invert)	m^3	52.8	12.6	2,400	127,000	30,000	157,000
3.4 Formwork	m^2	16.0	4.0	37,000	592,000	148,000	740,000
3.5 Shotcrete (5 cm)	m^2	14.9	2.1	15,800	235,000	33,000	268,000
3.6 Shotcrete (10 cm)	m^2	22.7	2.8	16,000	363,000	45,000	408,000
3.7 Shotcrete (15 cm)	m^2	30.5	3.5	1,000	31,000	3,500	34,500
3.8 Rock Bolt	m	5.3	12.8	26,600	141,000	340,000	481,000
3.9 Steel Support (H-100)	ton	1286.4	134.2	49	63,000	6,500	69,500
3.10 Reinforcement Bar	ton	24.5	534.4	17	400	9,100	9,500
3.11 Others (7% of 3.1 to 3.10)					262,000	103,000	365,000
Sub-Total					**4,001,400**	**1,581,100**	**5,582,500**
4. Work Adit							
4.1 Excavation in Tunnel	m^3	32.3	14.7	8,000	258,000	118,000	376,000
4.2 Shotcrete t=100mm	m^2	22.7	2.8	120	2,700	300	3,000
4.3 Concrete in portal	m^3	54.2	12.1	120	6,500	1,500	8,000
4.4 Formwork	m^2	9.0	6.0	180	1,600	1,100	2,700
4.5 Rock bolt 25 mm, 2m length	m	5.3	12.8	1,100	5,800	14,000	19,800
4.6 Reinforcement Bars	ton	24.5	534.4	6	100	3,200	3,300
4.7 Others (7% of 4.1 to 4.6)					19,000	10,000	41,000
Sub-Total					**293,700**	**148,100**	**441,800**
5. Regulating Dam							
5.1 Excavation							
(1) Common	m^3	1.5	0.7	33,000	51,000	22,000	73,000
(2) Rock	m^3	6.8	2.9	45,000	306,000	131,000	437,000
5.2 Structural Concrete	m^3	55.3	12.5	7,000	387,000	88,000	475,000
5.3 Roller Compacted Concrete	m^3	31.4	13.5	69,000	2,169,000	929,000	3,098,000
5.4 Formwork	m^2	3.0	12.0	1,700	5,100	20,400	25,500

Table 9.3.4 Breakdown of Construction Cost of Civil Works (2/4)

Unit: US$

Work Item	Unit	Unit Price (F/C)	Unit Price (L/C)	Quantity	Cost (F/C)	Cost (L/C)	Total
5.5 Reinforcement Bars	ton	24.5	534.4	400	10,000	214,000	224,000
5.6 Others (15% of 5.1 to 5.5)					439,000	211,000	650,000
Sub-Total					**3,367,100**	**1,615,400**	**4,982,500**
6. Diversion Work							
6.1 Excavation, Rock	m^3	6.8	2.9	2,500	17,000	7,000	24,000
6.2 Embankment for Coffer Dam	m^3	1.5	0.7	6,000	9,200	4,000	13,200
6.3 Removal of Coffer Dam	m^3	1.5	0.7	6,000	9,200	4,000	13,200
6.4 Corgate Pipe	m	171.0	19.0	240	41,000	5,000	46,000
6.5 U type Corgate Frume	m	162.0	18.0	150	24,000	3,000	27,000
6.6 Others (7% of 6.1 to 6.5)					7,000	2,000	9,000
Sub-Total					**107,400**	**25,000**	**132,400**
7. Check Dam							
7.1 Excavation							
(1) Common	m^3	1.5	0.7	17,800	27,000	11,700	38,700
(2) Rock	m^3	6.8	2.9	15,800	107,000	46,000	153,000
7.2 Random Backfill	m^3	1.5	0.7	5,000	7,700	3,300	11,000
7.3 Structural Concrete	m^3	55.3	12.5	16,200	896,000	203,000	1,099,000
7.4 Formwork	m^2	3.0	12.0	16,200	49,000	194,000	243,000
7.5 Reinforcement Bars	ton	24.5	534.4	160	3,900	85,500	89,400
7.6 Others (7% of 7.1 to 7.5)					76,000	38,000	114,000
Sub-Total					**1,166,600**	**581,500**	**1,748,100**
8. Headrace Tunnel							
8.1 Excavation	m^3	32.3	14.7	7,990	258,000	117,000	375,000
8.2 Concrete	m^3	54.2	12.1	2,840	154,000	34,000	188,000
8.3 Formwork	m^2	16.0	4.0	4,500	72,000	18,000	90,000
8.4 Shotcrete (5cm)	m^2	14.9	2.1	0	0	0	0
8.5 Shotcrete (10cm)	m^2	22.7	2.8	5,910	134,000	17,000	151,000
8.6 Rockbolt	m	5.3	12.8	5,740	30,000	73,000	103,000
8.7 Steel Support	ton	1,286.4	134.2	7	9,000	900	9,900
8.8 Reinforcement Bars	ton	24.5	534.4	53	1,300	28,000	29,300
8.9 Others (7% of 8.1 to 8.8)					46,000	20,000	66,000
Sub-Total					**704,300**	**307,900**	**1,012,200**
9. Penstock Tunnel							
9.1 Shaft Tunnel Excavation	m^3	49.4	14.0	2,600	128,000	36,000	164,000
9.2 Tunnel Excavation	m^3	31.9	13.6	800	26,000	11,000	37,000
9.3 Backfill Concrete	m^3	48.8	10.9	2,100	102,000	23,000	125,000
9.4 Shotcrete t=50mm	m^2	14.9	2.1	37,000	551,000	78,000	629,000
9.5 Rock bolt 25 mm dia, 2m length	m	5.3	12.8	25,900	137,000	332,000	469,000
9.6 Others (7% of 9.1 to 9.5)					66,000	34,000	100,000
Sub-Total					**1,010,000**	**514,000**	**1,524,000**
10. Access Tunnel							
10.1 Excavation	m^3	32.3	14.7	35,100	1,134,000	516,000	1,650,000
10.2 Concrete (Arch)	m^3	54.2	12.1	600	33,000	7,300	40,300
10.3 Concrete (Invert)	m^3	52.8	12.6	1,300	69,000	16,000	85,000
10.4 Formwork	m^2	16.0	4.0	1,400	22,000	6,000	28,000
10.5 Shotcrete (10cm)	m^2	22.7	2.8	20,500	465,000	57,000	522,000
10.6 Rockbolt	m	5.3	12.8	38,000	201,000	486,000	687,000
10.7 Steel Support	ton	1,286.4	134.2	185	239,000	25,000	264,000
10.8 Reinforcement Bars	ton	24.5	534.4	5	100	2,700	2,800
10.9 Others (7 % of 10.1 to 10.8)					151,000	78,000	229,000
Sub-Total					**2,314,100**	**1,194,000**	**3,508,100**
11. Powerhouse							

Table 9.3.4 Breakdown of Construction Cost of Civil Works (3/4)

Unit: US$

Work Item	Unit	Unit Price (F/C)	Unit Price (L/C)	Quantity	Cost (F/C)	Cost (L/C)	Total
11.1 Underground Cavern Excavation	m^3	17.7	8.7	37,000	655,000	322,000	977,000
11.2 Shotcrete							
(1) 320 mm	m^2	96.5	8.4	1,900	183,000	16,000	199,000
(2) 240 mm	m^2	74.0	5.8	2,400	178,000	14,000	192,000
(3) 160 mm	m^2	32.3	3.7	1,400	45,000	5,000	50,000
11.3 PS Anchor							
(1) 100t (15 m)	m	111.2	3.1	26,000	2,891,000	81,000	2,972,000
(2) 60t (13 m)	m	87.1	3.1	9,500	827,000	29,000	856,000
11.4 Rock Bolt	m	5.3	12.8	11,000	58,000	141,000	199,000
11.5 Structural Concrete	m^3	55.3	12.5	9,000	498,000	113,000	611,000
11.6 Formwork	m^2	3.0	12.0	9,000	27,000	108,000	135,000
11.7 Reinforcement Bars	ton	24.5	534.4	450	11,000	240,000	251,000
11.8 Others (7 % of 11.1 to 11.7)					376,000	75,000	451,000
Sub-Total					**5,749,000**	**1,144,000**	**6,893,000**
12. Draft Tunnel							
12.1 Excavation	m^3	32.3	14.7	700	23,000	10,000	33,000
12.2 Concrete (Arch)	m^3	54.2	12.1	300	16,000	3,600	19,600
12.3 Concrete (Invert)	m^3	52.8	12.6	100	5,300	1,300	6,600
12.4 Formwork	m^2	16.0	4.0	600	9,600	2,400	12,000
12.5 Shotcrete (10cm)	m^2	22.7	2.8	400	9,100	1,100	10,200
12.6 Rockbolt	m	5.3	12.8	800	4,200	10,200	14,400
12.7 Steel Support	ton	1,286.4	134.2	5	6,400	700	7,100
12.8 Reinforcement Bars	ton	24.5	534.4	5	100	2,700	2,800
12.9 Others (7% of 12.1 to 12.8)					5,200	2,200	7,400
Sub-Total					**78,900**	**34,200**	**113,100**
13. Tailrace Chamber							
13.1 Cavern Excavation	m^3	17.7	8.7	4,500	80,000	39,000	119,000
13.2 Shotocrete (15 cm)	m^2	30.5	3.5	1,300	40,000	4,600	44,600
13.3 Structural Concrete	m^3	55.3	12.5	1,700	94,000	21,000	115,000
13.4 Formwork	m^2	16.0	4.0	1,700	27,000	7,000	34,000
13.5 Reinforcement Bars	ton	24.5	534.4	85	2,100	45,400	47,500
13.6 Rock Bolts	m	5.3	12.8	4,500	24,000	58,000	82,000
13.7 Others (7% of 13.1 to 13.6)					19,000	12,000	31,000
Sub-Total					**286,100**	**187,000**	**473,100**
14. Tailrace Tunnel							
14.1 Excavation in Tunnel	m^3	32.3	14.7	39,100	1,263,000	575,000	1,838,000
14.2 Concrete (Arch)	m^3	54.2	12.1	6,690	363,000	81,000	444,000
14.3 Concrete (Invert)	m^3	52.8	12.6	2,270	120,000	29,000	149,000
14.4 Formwork	m^2	18.0	2.0	17,870	322,000	36,000	358,000
14.5 Shotcrete (5 cm)	m^2	14.9	2.1	700	10,000	1,000	11,000
14.6 Shotcrete (10 cm)	m^2	22.7	2.8	20,400	463,000	57,000	520,000
14.7 Rock Bolt	m	5.3	12.8	26,000	138,000	333,000	471,000
14.8 Steel Support (H-100)	ton	1,286.4	134.2	92	118,000	12,000	130,000
14.9 Reinforcement Bar	ton	24.5	534.4	24	600	12,800	13,400
14.10 Others (7% of 14.1 to 14.9)					196,000	80,000	276,000
Sub-Total					**2,993,600**	**1,216,800**	**4,210,400**
15. Tailrace Culvert							
15.1 Excavation							
(1) Common	m^3	1.5	0.7	490,000	755,000	323,000	1,078,000
(2) Rock	m^3	6.8	2.9	55,000	373,000	160,000	533,000
15.2 Backfill	m^3	1.5	0.7	490,000	755,000	323,000	1,078,000
15.3 Structural Concrete	m^3	55.3	12.5	6,700	371,000	84,000	455,000
15.4 Formwork	m^2	3.0	12.0	9,000	27,000	108,000	135,000

Table 9.3.4 Breakdown of Construction Cost of Civil Works (4/4)

Unit: US$

Work Item	Unit	Unit Price (F/C)	Unit Price (L/C)	Quantity	Cost (F/C)	Cost (L/C)	Total
15.5 Reinforcement Bars	ton	24.5	534.4	405	10,000	216,000	226,000
15.6 Others (10% of 15.1 to 15.5)					229,000	121,000	350,000
Sub-Total					**2,520,000**	**1,335,000**	**3,855,000**
16. Tailrace Outlet							
16.1 Excavation, Common	m3	1.5	0.7	7,700	12,000	5,100	17,100
16.2 Structural Concrete	m3	55.3	12.5	900	50,000	11,000	61,000
16.3 Formwork	m2	3.0	12.0	900	2,700	10,800	13,500
16.4 Reinforcement Bars	ton	24.5	534.4	45	1,100	24,000	25,100
16.5 Others (7 % of 16.1 to 16.4)	m3				5,000	4,000	9,000
Sub-Total					**70,800**	**54,900**	**125,700**
17. Access Road							
17.1 Excavation, Common	m3	1.5	0.7	166,000	256,000	110,000	366,000
17.2 Excavation Rock	m3	6.8	2.9	280,000	1,901,000	815,000	2,716,000
17.3 Embankment	m3	1.5	0.7	14,000	22,000	9,000	31,000
17.4 Bridge	L.S.				700,000	300,000	1,000,000
17.5 Others (7% of 17.1 to 17.4)					202,000	86,000	288,000
Sub-Total					**3,081,000**	**1,320,000**	**4,401,000**
Total (1 to 17)					**28,422,800**	**11,925,500**	**40,348,300**
18. Temporary Facility (5 % of Total)					**1,421,000**	**596,000**	**2,017,000**
Grand Total of Civil Works					**29,843,800**	**12,521,500**	**42,365,300**

Table 9.3.5 Disbursement Schedule

Description	F.C. (Thousand US $)					L.C. (Thousand US $)				
	2,004	2,005	2,006	2,007	Total	2,004	2,005	2,006	2,007	Total
1. Civil Work	5,969	11,938	8,953	2,984	29,844	2,504	5,009	3,757	1,252	12,522
2. Metal Work		2,250	2,250	0	4,500		250	250	0	500
3. Electro-Mechanical Work		2,646	9,260	1,323	13,228		223	779	111	1,113
4. T/L			69	274	343			17	69	86
Total Construction Cost	5,969	16,833	20,531	4,582	47,915	2,504	5,481	4,803	1,432	14,221
Administration (2.5%)						212	558	633	150	1,553
Engineering Service (7.5%)	448	1,262	1,540	344	3,594	188	411	360	107	1,067
Environmental Cost					0	963	291	291	290	1,835
Base Cost	6,416	18,096	22,071	4,925	51,509	3,867	6,741	6,087	1,980	18,676
Price Contingency					0	180	476	580	238	1,474
Physical Contingency	642	1,565	1,628	413	4,247	387	651	556	189	1,783
Total	7,058	19,660	23,699	5,338	55,756	4,434	7,868	7,224	2,407	21,933

FIGURES

Chapter 9

Equipment	Headwork / Syphone		Connection tunnel		Regulating dam			Headrace tunnel		Penstock tunnel		Powerhouse		Tailrace tunnel		Tailrace culvert	
	Excavation	Concrete	Excavation	Lining	Excavation	Concrete (RCC)	Grouting	Excavation	Lining	Excavation	Lining	Excavation	Concrete	Excavation	Lining	Excavation	Concrete
Wheel jumbo, 2 boom drill								X		X		X		X			
Rail jumbo, 2 boom drill			X														
Raise climber (stopper drill & guide-rail)										X							
Muck loader, side dump type, 2.1 m^3								X		X		X		X			
Backhoe type loader			X														
Dump truck, 10 ton	X				X	X		X		X		X		X		X	
Battery locomotive & Muck car, 4.5 m^3			X														
Concrete pump car, 100 m^3/h		X		X					X		X		X		X		X
Circular travelling form, 12 m long				X					X		X				X		
Agitator truck, 4.5 m^3		X		X					X		X		X		X		X
Bulldozer with ripper, 32 ton					X												
Bulldozer with ripper, 21 ton	X															X	
Bulldozer, low pressure type, 16 ton						X											
Wheel loader, 3.1 m^3					X												
Wheel loader, 1.4 m^3	X															X	
Backhoe, 0.6 m^3	X															X	
Vibrating roller, 10 ton						X											
Truck crane with 1.0 m^3 bucket, 25 ton		X															X
Boring machine, rotary, 5.5 kW							X										
Grout pump, 7.8 kW							X										
Grout mixer, 200 lit x 2							X										

Figure 9.2.1 Major Construction Equipment for Each Work Item

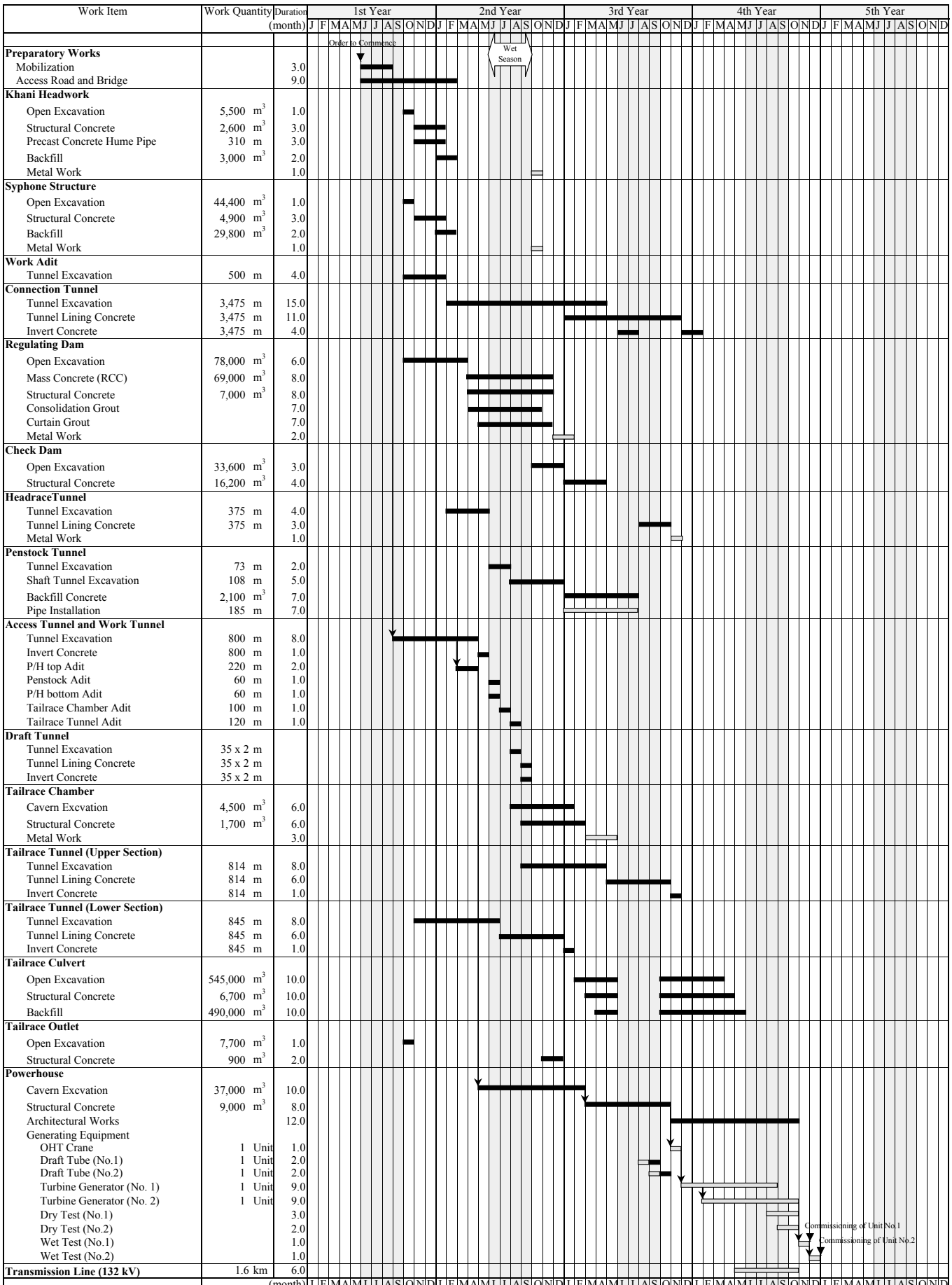


Figure 9.2.2 Construction Schedule of Kulekhani III Hydropower Project

Chapter 10

CHAPTER 10 PROJECT EVALUATION

10.1 Introduction

The economic and financial viability of the Kulekhani III Hydropower Project is evaluated in this chapter. This viability is measured by an Economic Internal Rate of Return (EIRR) for the economic viability and a Financial Internal Rate of Return (FIRR) for the financial viability, together with an analysis of loan repayability in the Project.

The economic evaluation aims at clarifying the degree of the Project benefit in terms of the national society, while the financial analysis ascertains the financial viability of the Project for the executing agency, in association with the analysis of loan repayability

In the economic evaluation, the financial costs of the Project are converted to economic costs. The economic costs reflect the real cost of the Project to the entire national society through elimination of transfer payment and shadow pricing. In the financial analysis, the Project cost estimated on the market price is compared with the actual revenue to be accrued from the sale of electricity generated by the Project. The repayability of loans is analyzed by assuming various financing conditions for the Project's investment cost.

10.2 Economic Evaluation

10.2.1 Conditions of Economic Evaluation

The following conditions and assumptions are adopted in the economic evaluation of this Study:

a) The cost is estimated based on the market price in the middle of 2002.

b) The monetary value is stated in US dollars in principle. The exchange rate of 78.3 Nepalese rupees per US dollar as of July 16, 2002 is applied.

c) Standard Conversion Factor (SCF) of 0.9 is applied for shadow pricing to the local currency portion of the Project cost to derive the economic cost.

d) The operation and maintenance costs of the Project are estimated at 0.5% of the construction cost for civil works and 2.0% for the metal works.

e) The economic life is assumed to be 50 years for civil works and 30 years for mechanical and electric works. The replacement of metal works is considered every 30 years.

f) An evaluation period of 50 years starting from the commissioning is adopted for both economic and financial evaluations. In examining the repayability of loans, repayment is considered to be assured through 30 years of the repayment period.

g) The opportunity cost of capital is assumed at 10%, following recent practice of similar studies in Nepal.

10.2.2 Economic Benefit and Cost

(1) Economic Cost

The estimated capital cost of the Project, based on the market price, and annual disbursement schedule is summarized in Table 10.2.1. The total capital cost of constant price in 2002 is estimated at US$74.300 million with the breakdown of foreign currency portion of US$55.756 million and local currency portion of US$18.545 million.

This financial cost is adjusted to economic cost based on the conditions and assumptions stated in the preceding Subsection 10.2.1. The conversion of financial cost to economic cost is summarized in Table 10.2.1. In deriving economic cost, the standard conversion factor (SCF) of 0.9 is applied to the local currency portion. The annual disbursement schedule is shown in Table 10.2.1.

(2) Economic Benefit

The economic benefit is estimated by the conversion of the alternative thermal for the firm peak energy and for the capacity. The secondary energy is estimated by the peak energy cost of the rainy season from the Long Run Marginal Cost (LRMC) of US$0.015/kWh, which was estimated by the ADB study in 1998. Considering the characteristics of power generation in the Project, one of the gas turbine thermal power plant candidates listed in the current feasibility study in Nepal is selected as the alternative to the Project. The items and their values applied for the calculation of alternative thermal cost are shown in Table 10.2.2.

The power generation pattern of the Project is particularly for peak time operation and the generated power is reliable with the advantage of the location being near to the national energy consumption center of the Kathmandu valley, where the nation's capital and national economic center is located. The hydropower project with these characteristics could be substituted by the limited type of power plant such as the above mentioned one. Therefore the cost of the alternative thermal is considered as an appropriate way to measure the Project benefit for the firm peak energy and the capacity. The secondary energy is valued by commonly used LRMC value for the rainy season's peak energy.

It must be true that the cost value of the alternative power plant is much higher than the economic value of the energy based on the willingness to pay. At the same time there is no proper alternative to a hydropower station, other than the thermal plant option, that would enable NEA to avoid load shedding during the peak time at the Project's scheduled commissioning. As already mentioned above, the advantage of the Kulekhani III Project's location (close to Kathmandu valley) allows the Project's generated peak energy to be consumed by the area and avoid the necessity to load shed. This characteristic of the Project makes measurement of economic benefit by an alternative a sensible way of evaluation.

The cost data of the alternative is derived from a similar feasibility study. The data is based on the 1998 price level in US dollars. The MUV index used for the price adjustment indicates deflation from 1998 to the date as explained in Section 9, while the local currency portion, which occupies a small percentage of the total cost, is in slight inflation. Considering these trends, it is conservative not to apply the price adjustment for the Study. The fuel cost used is NRs. 23.4/l, the same as for estimating the cost of the Project. The computed value of the cost per kW and the cost per kWh are adjusted by coefficients to equalize the different conditions for losses between hydropower and thermal power plants.

The total cost of the alternative is computed based on the per kW cost and the kWh cost by multiplying the installed capacity and energy output of the Project. (refer to Table 10.2.2)

10.2.3 Economic Evaluation

The economic viability of the Project is summarized below and the economic cash flow is shown in Table 10.2.3.

Item	Unit	Index
Economic Internal Rate of Return (EIRR)		15.3%
B/C		1.34
Net Present Value	US$1,000	23,797
Net Present Benefit	US$1,000	94,240
Net Present Cost	US$1,000	70,443
Discount Rate		10.0%

The EIRR value of 15.3% well surpasses the opportunity cost of capital of 10% as adopted in Nepal. This indicates that the Project is economically viable to the national society. The net present value and net Benefit/Cost (B/C) ratio are US$23.797 million and 1.34 respectively.

In addition to the benefit stated in Sub-section 10.2.1, the emission benefit is applicable to the Project. The value of US$ 20 per ton is adopted as the emission

penalty of CO_2, recommended by the World Bank. The result of the case with the CO_2 emission is shown as the following table.

Item	Unit	Index
Economic Internal Rate of Return (EIRR)		16.0%
B/C		1.39
Net Present Value	US$1,000	27,304
Discount Rate		10.0%

In the case that avoiding load shedding during peak time is imperative for the NEA, the application of the alternative thermal would be justified in the circumstance of not having any other appropriate alternative. Taking into account that the Government of Nepal places priority on a reliable and high quality electricity supply as a base for national economic development, avoiding load shedding in the national economic center during peaks is regarded as imperative.

10.2.4 Sensitivity Analysis

The sensitivity analysis is carried out for the case without emission benefit. The change of EIRR value is examined by varying the determinants of benefit and cost of the Project in two ways. The determinant for the benefit is represented by the fuel cost of alternative thermal which fluctuates significantly under the international market conditions. The Project cost is represented by the Project's construction cost.

	Fuel Cost +10%	Base	Fuel Cost -10%
Construction Cost -10%	18.5%	17.8%	17.2%
Base	15.9%	15.3%	14.7%
Construction Cost +10%	13.9%	13.4%	12.9%

As shown in the above table, the change of fuel cost affects EIRR value less than the change of construction cost. The EIRR reduces if the construction cost increases and if the fuel cost decreases. But even in the worst case, of the construction cost being 10% higher and the fuel cost 10% lower, the EIRR exceeds the 10% value of the opportunity cost of capital.

In addition to the above, a case with a construction delay for one year by extending the construction period is examined. The resulted EIRR is 14.0% which is close to the value of the case with the construction cost 10% higher or the fuel cost 10% lower.

10.3 Financial Evaluation

10.3.1 Financial Cost and Benefit

The cost and benefit adopted in the financial analysis are the cost and benefit to be accrued to the executing agency of the Project i.e. NEA. The total capital cost is US$77.689 million with the breakdown of US$55.756 million of foreign currency portion and US$21.933 million of the local currency portion in current price as shown in Table 10.2.1.

As stated in Chapter 9, the price escalation in financial analysis is incorporated in this Study. The inflation rate is set at 2.3% per annum for both foreign and local currency portions, presuming that the local portion of inflation is traded off by the currency exchange devaluation of Nepal Rupees against the US dollar. The inflation ratio adopted by current studies for similar projects is accepted by this Study with due consideration to current trends in U.S. inflation. The foreign currency portion of the Project capital cost, however, has inflation applied, taking into account the current trend of MUV indicators. To avoid the influence on the future fluctuation of exchange rate for the Nepal Rupee against the US dollar and the inflation ratio for the local currency portion, all the monetary values are expressed in terms of US dollar except in some of the loan repayability analyses.

Gate price for the Project's electricity amounting to US$0.0711 per kWh is estimated based on the NEA's average tariff in FY2002 as detailed in Table 10.3.1. Station service ratio of 0.5% is applied to calculate the disposable energy volume.

10.3.2 Financial Evaluation

There are three kinds of FIRR that vary with the approach taken in the financial analysis:

a) Financial rate of return to all resources engaged: calculated from the incremental net benefit before financing for the enterprise.

b) Financial rate of return to equity before income tax: calculated from the incremental net benefit after financing for the private investors.

c) Financial rate of return to equity after taxes: calculated from the incremental net benefit after financing and taxes for the equity owners.

Since the NEA belongs to enterprise criteria in nature, the a) type of FIRR is adopted in this Study. Corporate tax has not been included in the costs since it is paid from net income when the enterprise earns it, and therefore is considered as a part of the net income. This method of FIRR computation follows the usual practice of the World Bank.

The FIRR of 5.0% calculated as shown in Table 10.3.2 is with the assumption that the construction commencement and the generation commission will be June 2004 and November 2007 respectively.

The figure is lower than the cost of the capital 10% applied in Nepal. This means that even though the Project benefit is worth more to the national society when compared to the Project cost, the implementation of the Project is burdensome for the NEA in terms of finance. The on lent interest from the Government to the NEA is 10.25% at present. The Project's earning capability against the capital investment indicated by a FIRR of 5.0% is lower than the said interest rate of 10.25%.

Therefore, the application of the subsidiary support for the Project from the Government is proposed in order to relax the burdensome led by the Project.

There ought to be several ways for the Government to support NEA including provision of a subsidized loan. Utilizing a soft loan from a donor country for the subsidized Project financing would be one option for the Government to realize financing with marginal burden.

To summarize:

a) As a result of the economic evaluation indicator, the Project is valuable for the nation, while the financial burden for the Project implementation is large for NEA.

b) For the materialization of the Project, Government support, especially for the financial subsidy such as provision of an on-lent loan with generous conditions would be required.

c) For practicing such subsidiary measures, the utilization of a soft loan from a donor country is recommended.

10.3.3 Sensitivity Analysis

The sensitivity analysis of FIRR is carried out through examining the change of FIRR value through varying the revenue and cost of the Project in a method similar to the one taken in Sub-Section 10.2.4. The revenue and cost are assumed to change by 10% respectively and the resulted FIRR change is as shown below.

	Revenue +10%	Base	Revenue -10%
Project Cost -10%	6.2%	5.5%	4.8%
Base	5.6%	5.0%	4.3%
Project Cost +10%	5.1%	4.5%	3.8%

As shown in the above table, the lowest FIRR value is 3.8% with a 10% increase in cost and a 10% decrease in revenue.

As with the sensitivity analysis in the economic analysis, the case with a construction delay of one year by extending construction period is examined. The resulting FIRR of 5.0%, however, is the same as for the base case. Therefore, the influence of construction time extension is not significant to the FIRR calculation.

The case without price escalation in and after FY 2008 is examined as a reference. In this case, FIRR lowers to 2.5 %.

10.3.4 Loan Repayability

The analysis of loan repayability is conducted to articulate its basic financial viability with a soft loan from a donor country and an appropriate domestic loan interest rate for the implementation of the Project.

Eight cases are taken for the above purpose as follows:

a) The interest rate of 1% per annum and the loan duration of 30 years with a grace period of 10 years and the repayment period of 20 years is applied for the entire capital investment cost including interest during construction (IDC) in US dollars (Table 10.3.3),

b) An identical loan condition is applied to case a) for the foreign portion of the capital investment cost and a 4.6 % per annum interest rate with the same condition except the interest rate for the local portion and all IDC in US dollars (Table 10.3.4),

c) A loan with a 7.8 % per annum interest rate and 24 years loan duration starting from the construction with a 4 year grace period and 20 year repayment period for the foreign currency portion of the capital investment cost including IDC and equity investment for the local portion in Nepalese rupees (Table 10.3.5),

d) A loan with a 5.0% per annum interest rate with identical loan condition to case c) except the interest rate for the foreign portion of the capital investment cost including IDC of which principal repayments are to be converted to equity investment and equity investment for the local portion in Nepalese rupees (Table 10.3.6),

e) A loan with a 1.8% per annum interest rate with identical loan condition to case c) except the interest rate for the entire capital investment cost including IDC in Nepalese rupees (Table 10.7),

f) A loan with a 7.5% per annum interest rate and 30 years loan duration

starting from the construction with a 10 year grace period and 20 years repayment period for the foreign currency portion of the capital investment cost including IDC and equity investment for the local portion in Nepalese rupees (Table 10.3.8) ,

g) A loan with a 7.6% per annum interest rate with identical loan condition to case f) except the interest rate for the foreign portion of the capital investment cost including IDC of which principal repayments are to be converted to equity investment and equity investment for the local portion in Nepalese rupees (Table 10.3.9) ,

h) A loan with a 5.0% per annum interest rate with identical loan condition to case f) except the interest rate for the entire capital investment cost including IDC in Nepalese rupees (Table 10.3.10),

The financial viability of the Project with a foreign soft loan is confirmed for case a) and b) with the calculation results shown in Table 10.3.3 and 10.3.4 respectively. No liquidity problem is shown in these cases.

Cases c) to h) analyze the viability of on-lending from the Government to NEA. In these cases, the values are converted from US dollars to Nepalese rupees applying an exchange rate of NRs 78.30 per US$1.00 and a 6% price escalation. The cases and their corresponding interest rates and brief loan condition are summarized below.

Case	Interest Rate	Brief Conditions
c)	5.0% p.a.	Local Currency Portion is Equity Investment
d)	7.8% p.a.	L. C. Portion is E. Inv with Principal Conversion to E.
e)	1.8% p.a.	Totally Loan Financed
f)	7.5% p.a.	Case c) with 10 Year grace Period
g)	7.6% p.a.	Case d) with 10 Year grace Period
h)	5.0% p.a.	Case e) with 10 Year grace Period

These cases indicate the ceiling interest rates without liquidity problem in basic for the Project financing, since an approximate ceiling rate is applied in each case as shown in Table 10.3.5 - 10.3.10. Case d) admits the highest interest rate of 7.8% p.a., while case e) shows the lowest admissible interest rate. The results show a larger influence of equity investment share to the Project financing. It is also observed that the higher the loan share, the effects of any grace period extension is greater.

From the results of the above study, case f), which is the loan with a 7.5% per annum interest rate and 30 years loan duration starting from the construction with a 10 year grace period and 20 years repayment period, is most feasible on-lent

condition from Nepal government. It does not impose any burden on the financial condition of NEA.

This project is expected to apply the Yen loan. Taking account of the application of the Yen loan, the repayability is examined on condition that 85% of the total project cost is covered by the foreign loan. Other loan conditions is same with case f) except the annual interest rate of the foreign loan portion. In this case, a loan with 6.3 % per annum interest rate is applicable as shown in Table 10.3.11.

As a reference, a current case with on-lending based on a recent similar feasibility study is shown in Table 10.3.12. In this case, the most cumulative financial burden estimated for NEA is NRs. 2,208 million in the 16th year from the construction commencement. The maximum annual negative financial impact is NRs. 329 million and negative net cash flow endures for 12 years. In the 25th year from the construction commencement, the cumulative cash flow amount becomes positive which means that the cost recovery, including the financing cost, is completed in that year.

In accordance with the advice from the World Bank and Asian Development Bank, NEA has increased power tariff rates for his efficient management. The average power tariff rate from FY1991 to FY 2001, which is calculated from dividing total revenue by total sold energy, is shown in below table.

The average power tariff is increased from 1.40 NRs./kWh to 6.23 NRs./kWh (4.5 times) by the escalation rate of 16 %/year, equivalent to 3.28 US ¢ /kWh to 8.35 US ¢ /kWh (2.5 times) by the escalation rate of 9.6 %.

FY	91	92	93	94	95	96	97	98	99	00	01
NRs./ kWh	1.40	1.98	2.59	3.38	4.10	4.15	4.96	5.05	5.01	5.70	6.23
NRs./ US$	42.70	42.60	49.00	49.11	50.45	56.25	56.75	67.60	68.15	70.40	74.65
US ¢ / kWh	3.28	4.65	5.10	6.88	8.13	7.38	8.74	7.47	7.35	8.10	8.35

The escalation rate of 6 % is applied for this study with reference to the variation of GDP deflator and the increment of the power tariff for 10 years mentioned above. However, according to "Corporate Development Plan of FY 2001/02" prepared by NEA, ETFC (Electricity Tariff Fixation Commission) rules, which has been amended by HMG, describes that semiautomatic tariff adjustment once in a year not exceeding 5 % is possible. Therefore, the case of the price escalation rate of 5 % is examined with the loan condition of case f). In this case, the loan with annual interest rate of 6.7 % is applicable for the Project. In addition, the case without the price escalation in and after FY 2008 is examined as the most severe condition. In this case, the repayable annual interest rate becomes 2.7 %.

10.4 The Results of the Economic and Financial Analysis and Recommendation

The results of the study on the economic and financial evaluation are summarized below:

- The economic evaluation indicates that the Project is valuable for the nation, while the financial burden for the implementation of the Project is large to NEA.
- The utilization of a soft loan from a donor country is recommended, since the Project can supply reliable peak power to the demand center of Kathmandu, and the economic benefit of the Project to the national society is reasonably high.
- To materialize the Project, the support of the Government is needed for the financial subsidy such as a provision of on-lent loan with generous condition.

TABLES

Chapter 10

Table 10.2.1 Project Costs and Disbursement Schedule

(Unit: US$1,000)

Description	Economic Cost			Financial Cost		
	Foreign Portion	Local Potion	Total	Foreign Portion	Local Potion	Total
1. Civil Work	29,844	11,270	41,114	29,844	12,522	42,366
2. Metal Work	4,500	450	4,950	4,500	500	5,000
3. Electro-Mechanical Work	13,228	1,002	14,230	13,228	1,113	14,341
4. T/L	343	77	420	343	86	429
Total Construction Cost	47,915	12,799	60,714	47,915	14,221	62,136
Administration (2.5%)	0	1,518	1,518	0	1,553	1,553
Engineering Service (7.5%)	3,594	960	4,554	3,594	1,067	4,660
Environmental Cost	0	1,652	1,652	0	1,835	1,835
Base Cost	51,509	16,928	68,437	51,509	18,676	70,185
Price Contingency	0	0	0	0	1,474	1,474
Physical Contingency	4,247	1,616	5,864	4,247	1,783	6,030
Total	55,756	18,545	74,300	55,756	21,933	77,689
Disbursement Schedule	Foreign	Local	Total	Foreign	Local	Total
1st Year	7,058	3,845	10,903	7,058	4,434	11,492
2nd Year	19,660	6,699	26,359	19,660	7,868	27,528
3rd Year	23,699	6,036	29,735	23,699	7,224	30,923
4th Year	5,338	1,965	7,303	5,338	2,407	7,745
Total	55,756	18,545	74,300	55,756	21,933	77,689

Table 10.2.2 Capacity Value and Energy Value of the Alternative Gas Turbine Power

Item	Value	Item	Value
Installed Capacity	25 MW	Variable O&M Cost	0.0026 US$/kWh
Fuel Type	HSD	Fuel Cost (Updated)	0.1173 US$/kWh
Unit Construction Cost	660 US$/kW		
Fixed O&M cost	34 US$/kW	Former Fuel Cost	
Station Service	1.5%	Fuel Cost	0.094 US$/kWh
Outage Maintenace Day	55 day	Fuel Cost	30 $/Mkcal
Outage Forced	20%	Average Heat Rate	3,120 kcal/kWh
Total Outage	35.07%		
		Current Fuel Data (HS)	
kW-adjustment factor	1.520	FuelCost	23.46 NRs/Lt
kWh-adjustment factor	1.012	Exchange rate US$1=	78.30 NRs
		Fuel Consumption	0.2996 US$/Lt
Hydro Power		Fuel Cost in Rs	0.3950 Lt/kWh
Forced Outage	0.5%	Fuel Cost in US$	0.1183 US$/kWh
Station Serv.	0.3%	Local Ratio	10% 0
Overhaul	2.0%	SCF	0.9 0
		Economic Price	0.1173 US$/kWh
		Emission Rate	750 g /kWh

Table 10.2.3 Economic Analysis Calculation on Kulekhani III Hydropower Project

B/C	1.338
IRR	15.3%
Capacity Cost (US$/kW)	1,660
Energy Cost (US$/kWh)	0.200
Net Present Value ($1,000)	23,797
Net Present Benefit ($1,000	94,240
Net Present Cost ($1,000)	70,443
Discount Rate	10%

Inst. Capac.		44.8 MW
Annl Gener.		47.29 GWh
Firm P Ener.		29.54 GWh/yr
Other P En.		17.75 GWh/yr

Alternative Thermal		Other Peak Benefit	
Unit Construction Cost	660 US$/kW	Summer Peak LRMC	0.015 US$/kWh
Fixed O&M cost	33.6 US$/kW		
Variable O&M Cost	0.0026 US$/kWh		
Fuel Cost	0.1173 US$/kWh		
kW-adjustment factor	1.520		
kWh-adjustment factor	1.012		

(Unit: US$1,000 in basic)

Year	Frm Comm	Cap. Cost	O&M Cost	Total Cost	Firm Peak Energy GWH/Yr	Other Peak Energy GWH/Yr	Cap. MW	Firm Peak Energy Benefit	Other Peak Energy Benefit	Cap. Benefit	Total Benefit	Net Benefit
1		10,903		10,903							0	-10,903
2		26,359		26,359							0	-26,359
3		29,735		29,735						22,451	22,451	-7,285
4		7,303	299	7,601	14.77	8.88	22.4	2,935	133	22,451	25,519	17,918
5	1		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
6	2		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
7	3		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
8	4		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
9	5		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
10	6		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
11	7		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
12	8		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
13	9		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
14	10		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
15	11		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
16	12		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
17	13		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
18	14		598	598	29.54	17.75	44.8	5,870	266	22,451	28,587	27,990
19	15		598	598	29.54	17.75	44.8	5,870	266	22,451	28,587	27,990
20	16		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
21	17		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
22	18		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
23	19		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
24	20		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
25	21		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
26	22		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
27	23		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
28	24		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
29	25		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
30	26		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
31	27		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
32	28		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
33	29		598	598	29.54	17.75	44.8	5,870	266	22,451	28,587	27,990
34	30	19,558	598	20,156	29.54	17.75	44.8	5,870	266	22,451	28,587	8,432
35	31		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
36	32		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
37	33		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
38	34		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
39	35		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
40	36		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
41	37		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
42	38		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
43	39		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
44	40		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
45	41		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
46	42		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
47	43		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
48	44		598	598	29.54	17.75	44.8	5,870	266	22,451	28,587	27,990
49	45		598	598	29.54	17.75	44.8	5,870	266	22,451	28,587	27,990
50	46		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
51	47		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
52	48		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
53	49		598	598	29.54	17.75	44.8	5,870	266		6,136	5,539
54	50		299	299	14.77	8.88	44.8	4,078	133	-28,438	-24,226	-24,525
Total		93,859	29,879	123,737	1477.00	887.50		291,720	13,313	151,168	459,136	335,399

Table 10.3.1 Estimation of Gate Price

Average Tariff in FY 2002	6.81	Rs/kWh
Average Exchange Rate in FY2002	76.48	Rs per US$1
AvPrice$	0.0890	US$/kWh
Real Increase Ratio for FY2003*	4.5%	
Further Adjustment Required	0.5%	
Estimated Average Tariff in FY 2003	0.0935	US$/kWh
Peak Tariff Incrimental Ratio	15%	
Estimated Peak Tariff in FY 2003	0.1075	US$/kWh
Gate Price Factor	66.10%	
Estimated Gate Price in FY 2002 Price	0.0711	US$/kWh

*: 4.5% per annum increase in real price is recommended by ADB

Tariff Adjustment

Average Price in 2001	6.23	Rs/kWh
Average Price in 2002	6.81	Rs/kWh
Average Exchange Rate in 2001	73.70	Rs per US$1
Average Exchange Rate in 2002	76.48	Rs per US$1
Average Price in 2001	0.0845	US$/kWh
Average Price in 2002	0.0890	US$/kWh
Incremental Ratio 2001-02	5.3%	
Adjusted by US Inflation	4.0%	
US Inflation	1.3%	

Gate Price Factor Estimation

Cost Structure of NEA		
	1999	2001
Energy Cost	2.33	2.92
Energy Cost Ratio/Total Cost	47.17%	51.32%
Transm. Cost	0.34	0.37
Distri. Cost	1.14	1.17
Loss	0.84	0.95
Direct Cost	4.65	5.41
Overhead	0.29	0.28
Total	4.94	5.69
Average Incre. Ratio for Energy Cost		4.31%
Energy Cost Ratio in Commision Year		66.10%

Source: JBIC SAPS Study in 2002

Peak Tariff Factor Estimate

	Peak Tariff	Normal	Incr. Ratio
Industrial	6.55	5.75	13.91%
Commercial	8.5	7.35	15.65%
Non-Commercial	8.85	7.7	14.94%
Average for above 3 categories			14.83%
Irrigattion	3.85	3.4	13.24%
Water Supply	4.55	3.95	15.19%
Transport	4.7	4.15	13.25%
Street Light	5.7	2.85	100.00%

Table 10.3.2 Financial Analysis Calculation on Kulekhani III Hydropower Project

FIRR	5.0%

Annual Generation	47.29	GWh
Assumed Real Tariff in 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff in 2002 Price*	0.1075	$/kWh
Assumed Gate Price in 2002 Price*	0.0711	$/kWh
Generation Station Ratio	66.10%	
Station Service	0.50%	
PriceEscal	2.3%	

47.5757576

(Unit: US$1,000 in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Disposable Energy GWH/Yr	Energy Sales Revenue	Net Revenue	Cumulative Cash Flow
1	2004	11,492		11,492			-11,492	-11,492
2	2005	27,528		27,528			-27,528	-39,020
3	2006	30,923		30,923			-30,923	-69,943
4	2007	7,745	340	8,086	23.53	1,917	-6,168	-76,111
5	2008		696	696	47.05	3,923	3,227	-72,885
6	2009		712	712	47.05	4,013	3,301	-69,584
7	2010		728	728	47.05	4,105	3,377	-66,207
8	2011		745	745	47.05	4,200	3,455	-62,752
9	2012		762	762	47.05	4,296	3,534	-59,218
10	2013		780	780	47.05	4,395	3,615	-55,603
11	2014		798	798	47.05	4,496	3,698	-51,904
12	2015		816	816	47.05	4,600	3,784	-48,121
13	2016		835	835	47.05	4,705	3,871	-44,250
14	2017		854	854	47.05	4,814	3,960	-40,291
15	2018		874	874	47.05	4,924	4,051	-36,240
16	2019		894	894	47.05	5,038	4,144	-32,096
17	2020		914	914	47.05	5,153	4,239	-27,857
18	2021		935	935	47.05	5,272	4,337	-23,521
19	2022		957	957	47.05	5,393	4,436	-19,084
20	2023		979	979	47.05	5,517	4,538	-14,546
21	2024		1,001	1,001	47.05	5,644	4,643	-9,903
22	2025		1,024	1,024	47.05	5,774	4,750	-5,154
23	2026		1,048	1,048	47.05	5,907	4,859	-295
24	2027		1,072	1,072	47.05	6,043	4,971	4,676
25	2028		1,097	1,097	47.05	6,182	5,085	9,761
26	2029		1,122	1,122	47.05	6,324	5,202	14,962
27	2030		1,148	1,148	47.05	6,469	5,321	20,284
28	2031		1,174	1,174	47.05	6,618	5,444	25,728
29	2032		1,201	1,201	47.05	6,770	5,569	31,297
30	2033		1,229	1,229	47.05	6,926	5,697	36,994
31	2034		1,257	1,257	47.05	7,085	5,828	42,822
32	2035		1,286	1,286	47.05	7,248	5,962	48,784
33	2036		1,316	1,316	47.05	7,415	6,099	54,884
34	2037	21,783	1,346	23,129	47.05	7,586	-15,544	39,340
35	2038		1,377	1,377	47.05	7,760	6,383	45,723
36	2039		1,408	1,408	47.05	7,938	6,530	52,253
37	2040		1,441	1,441	47.05	8,121	6,680	58,933
38	2041		1,474	1,474	47.05	8,308	6,834	65,767
39	2042		1,508	1,508	47.05	8,499	6,991	72,758
40	2043		1,543	1,543	47.05	8,694	7,152	79,910
41	2044		1,578	1,578	47.05	8,894	7,316	87,226
42	2045		1,614	1,614	47.05	9,099	7,485	94,711
43	2046		1,652	1,652	47.05	9,308	7,657	102,367
44	2047		1,689	1,689	47.05	9,522	7,833	110,200
45	2048		1,728	1,728	47.05	9,741	8,013	118,213
46	2049		1,768	1,768	47.05	9,965	8,197	126,410
47	2050		1,809	1,809	47.05	10,195	8,386	134,796
48	2051		1,850	1,850	47.05	10,429	8,579	143,375
49	2052		1,893	1,893	47.05	10,669	8,776	152,151
50	2053		1,936	1,936	47.05	10,914	8,978	161,129
51	2054		1,981	1,981	47.05	11,165	9,184	170,313
52	2055		2,027	2,027	47.05	11,422	9,396	179,708
53	2056		2,073	2,073	47.05	11,685	9,612	189,320
54	2057		1,060	1,060	23.53	5,977	4,916	194,236
Total		99,472	63,351	162,823	2352.68	355,142	194,236	

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.3 Loan Repayment Analysis: Case a) Foreign Soft Loan Case

Annual Generation	47.29 GWh
Assumed Real Tariff 2002 Price*	0.0935 $/kWh
Assumed Peak Tariff 2002 Price*	0.1075 $/kWh
Assumed Gate Price 2002 Price*	0.0711 $/kWh
PriceEscal	2.3%

Loan Condition	
Interest Rate per Year	1.0%
Duration (Year)	30
Grace Period	10
Principal Rep	20

(Unit: US$1,000 in basic)

Year	FY Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Loan Inflow 77,689	IDC 1,981	Debt Service	Principal 79,670	Interest	Net Cash Flow	Cumulative Cash Flow
1	2004	11,492		11,492		-11,492	11,492	115	0	0	0	0	0
2	2005	27,528		27,528		-27,528	27,528	390	0	0	0	0	0
3	2006	30,923		30,923		-30,923	30,923	699	0	0	0	0	0
4	2007	7,745	340	8,086	1,917	-6,168	7,745	777	0	0	0	1,577	1,577
5	2008		696	696	3,923	3,227			797	0	797	2,430	4,007
6	2009		712	712	4,013	3,301			797	0	797	2,504	6,511
7	2010		728	728	4,105	3,377			797	0	797	2,580	9,092
8	2011		745	745	4,200	3,455			797	0	797	2,658	11,750
9	2012		762	762	4,296	3,534			797	0	797	2,737	14,487
10	2013		780	780	4,395	3,615			797	0	797	2,819	17,305
11	2014		798	798	4,496	3,698			4,415	3,618	797	-716	16,589
12	2015		816	816	4,600	3,784			4,415	3,654	761	-631	15,958
13	2016		835	835	4,705	3,871			4,415	3,691	724	-544	15,413
14	2017		854	854	4,814	3,960			4,415	3,728	687	-455	14,958
15	2018		874	874	4,924	4,051			4,415	3,765	650	-364	14,593
16	2019		894	894	5,038	4,144			4,415	3,803	612	-271	14,322
17	2020		914	914	5,153	4,239			4,415	3,841	574	-176	14,147
18	2021		935	935	5,272	4,337			4,415	3,879	536	-78	14,068
19	2022		957	957	5,393	4,436			4,415	3,918	497	21	14,090
20	2023		979	979	5,517	4,538			4,415	3,957	458	123	14,213
21	2024		1,001	1,001	5,644	4,643			4,415	3,997	418	228	14,441
22	2025		1,024	1,024	5,774	4,750			4,415	4,037	378	335	14,775
23	2026		1,048	1,048	5,907	4,859			4,415	4,077	338	444	15,219
24	2027		1,072	1,072	6,043	4,971			4,415	4,118	297	556	15,775
25	2028		1,097	1,097	6,182	5,085			4,415	4,159	256	670	16,445
26	2029		1,122	1,122	6,324	5,202			4,415	4,201	214	787	17,232
27	2030		1,148	1,148	6,469	5,321			4,415	4,243	172	907	18,138
28	2031		1,174	1,174	6,618	5,444			4,415	4,285	130	1,029	19,167
29	2032		1,201	1,201	6,770	5,569			4,415	4,328	87	1,154	20,321
30	2033		1,229	1,229	6,926	5,697			4,415	4,371	44	1,282	21,604

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.4 Loan Repayment Analysis: Case b) Foreign Soft Loan with Local Finance

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	2.3%	

Loan Condition	Foreign	Local
Interest Rate per Year	1.0%	4.6%
Duration (Year)	30	30
Grace Period	10	10
Principal Rep	20	20

(Unit: US$1,000 in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Loan Inflow	Loan Inflow F	Loan Inflow L	Ttl IDC	IDC Foreign	IDC Local	Debt Service	Foreign Principal	Foreign Interest	Local Principal	Local Interest	Net Cash Flow	Cumulative Cash Flow
	0						77,689	55,756	21,933	4,076	1,400	2,677		55,756		26,009			
1	2004	11,492		11,492		-11,492	11,492	7,058	4,434	275	71	204	0	0	0	0	0	0	0
2	2005	27,528		27,528		-27,528	27,528	19,660	7,868	833	267	566	0	0	0	0	0	0	0
3	2006	30,923		30,923		-30,923	30,923	23,699	7,224	1,402	504	898	0	0	0	0	0	0	0
4	2007	7,745	340	8,086	1,917	-6,168	7,745	5,338	2,407	1,566	558	1,009	0	0	0	0	0	1,577	1,577
5	2008		696	696	3,923	3,227							1,754	0	558	0	1,196	1,473	3,050
6	2009		712	712	4,013	3,301							1,754	0	558	0	1,196	1,547	4,597
7	2010		728	728	4,105	3,377							1,754	0	558	0	1,196	1,623	6,220
8	2011		745	745	4,200	3,455							1,754	0	558	0	1,196	1,701	7,920
9	2012		762	762	4,296	3,534							1,754	0	558	0	1,196	1,780	9,700
10	2013		780	780	4,395	3,615							1,754	0	558	0	1,196	1,861	11,562
11	2014		798	798	4,496	3,698							5,107	2,532	558	820	1,196	-1,408	10,154
12	2015		816	816	4,600	3,784							5,107	2,557	532	858	1,159	-1,323	8,831
13	2016		835	835	4,705	3,871							5,107	2,583	507	898	1,119	-1,236	7,595
14	2017		854	854	4,814	3,960							5,107	2,609	481	939	1,078	-1,147	6,448
15	2018		874	874	4,924	4,051							5,107	2,635	455	982	1,035	-1,056	5,392
16	2019		894	894	5,038	4,144							5,107	2,661	428	1,027	990	-963	4,429
17	2020		914	914	5,153	4,239							5,107	2,688	402	1,075	942	-867	3,561
18	2021		935	935	5,272	4,337							5,107	2,715	375	1,124	893	-770	2,792
19	2022		957	957	5,393	4,436							5,107	2,742	348	1,176	841	-670	2,121
20	2023		979	979	5,517	4,538							5,107	2,769	320	1,230	787	-568	1,553
21	2024		1,001	1,001	5,644	4,643							5,107	2,797	293	1,286	731	-464	1,089
22	2025		1,024	1,024	5,774	4,750							5,107	2,825	265	1,346	671	-357	732
23	2026		1,048	1,048	5,907	4,859							5,107	2,853	236	1,407	609	-248	485
24	2027		1,072	1,072	6,043	4,971							5,107	2,882	208	1,472	545	-136	349
25	2028		1,097	1,097	6,182	5,085							5,107	2,911	179	1,540	477	-22	327
26	2029		1,122	1,122	6,324	5,202							5,107	2,940	150	1,611	406	95	422
27	2030		1,148	1,148	6,469	5,321							5,107	2,969	121	1,685	332	215	637
28	2031		1,174	1,174	6,618	5,444							5,107	2,999	91	1,762	255	337	974
29	2032		1,201	1,201	6,770	5,569							5,107	3,029	61	1,843	173	462	1,437
30	2033		1,229	1,229	6,926	5,697							5,107	3,059	31	1,928	89	591	2,027

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.5 Loan Repayment Analysis: Case c) Local Loan with Equity Investment

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	5.0%
Duration (Year)	24
Grace Period	4
Principal Rep	20

Equity		
Total	1,935	mill. Rs.
NEA	1,451	75%
Governm.	484	25%

(Unit: mill. Rs in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow	Loan Inflow F	Equity Inflow	Ttl IDC	IDC	Debt Service	Loan Principal	Loan Interest	Net Cash Flow	Cumulative Cash Flow
	0						6,301	4,366	1,935	548	548		4,914			
1	2004	925		925		-925	925	553	373	28	28	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	105	105	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	197	197	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	218	218	0	0	0	154	154
5	2008		67	67	394	326						394	149	246	-68	86
6	2009		71	71	418	346						394	156	238	-48	38
7	2010		76	76	443	367						394	164	230	-27	10
8	2011		80	80	469	389						394	172	222	-5	5
9	2012		85	85	497	412						394	181	214	18	23
10	2013		90	90	527	437						394	190	205	43	65
11	2014		96	96	559	463						394	199	195	69	134
12	2015		101	101	592	491						394	209	185	97	231
13	2016		107	107	628	520						394	220	175	126	357
14	2017		114	114	665	552						394	231	164	157	514
15	2018		121	121	705	585						394	242	152	190	704
16	2019		128	128	748	620						394	254	140	225	930
17	2020		136	136	793	657						394	267	127	263	1,192
18	2021		144	144	840	696						394	280	114	302	1,494
19	2022		152	152	891	738						394	294	100	344	1,838
20	2023		162	162	944	782						394	309	85	388	2,226
21	2024		171	171	1,001	829						394	324	70	435	2,661
22	2025		182	182	1,061	879						394	341	54	485	3,146
23	2026		193	193	1,124	932						394	358	37	537	3,683
24	2027		204	204	1,192	988						394	376	19	593	4,277
25	2028		216	216	1,263	1,047						0	0	0	1,047	5,323
26	2029		229	229	1,339	1,110						0	0	0	1,110	6,433
27	2030		243	243	1,419	1,176						0	0	0	1,176	7,610
28	2031		258	258	1,505	1,247						0	0	0	1,247	8,856
29	2032		273	273	1,595	1,322						0	0	0	1,322	10,178
30	2033		289	289	1,690	1,401						0	0	0	1,401	11,579

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.6 Loan Repayment Analysis: Case d) Local Loan with Equity Investment and Principal Conversion to Equity

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	7.8%
Duration (Year)	24
Grace Period	4
Principal Rep	20

Equity		
Total	1,935	mill. Rs.
NEA	1,451	75%
Governm.	484	25%

(Unit: mill. Rs in basic)

Year	FY Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow 6,301	Loan Inflow F 4,366	Equity Inflow 1,935	Ttl IDC 855	IDC 855	Debt Service	Loan Principal 5,220	Loan Interest	Net Cash Flow	Cumulative Cash Flow
1	2004	925		925		-925	925	553	373	43	43	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	163	163	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	308	308	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	341	341	0	0	0	154	154
5	2008		67	67	394	326	117		117			524	117	407	-81	73
6	2009		71	71	418	346	126		126			524	126	398	-52	21
7	2010		76	76	443	367	136		136			524	136	388	-22	0
8	2011		80	80	469	389	146		146			524	146	378	11	11
9	2012		85	85	497	412	158		158			524	158	366	46	57
10	2013		90	90	527	437	170		170			524	170	354	83	139
11	2014		96	96	559	463	183		183			524	183	341	122	262
12	2015		101	101	592	491	197		197			524	197	327	164	426
13	2016		107	107	628	520	213		213			524	213	311	209	635
14	2017		114	114	665	552	229		229			524	229	295	257	892
15	2018		121	121	705	585	247		247			524	247	277	308	1,200
16	2019		128	128	748	620	266		266			524	266	257	362	1,562
17	2020		136	136	793	657	287		287			524	287	237	420	1,983
18	2021		144	144	840	696	310		310			524	310	214	482	2,465
19	2022		152	152	891	738	334		334			524	334	190	548	3,013
20	2023		162	162	944	782	360		360			524	360	164	618	3,631
21	2024		171	171	1,001	829	388		388			524	388	136	693	4,324
22	2025		182	182	1,061	879	418		418			524	418	106	773	5,098
23	2026		193	193	1,124	932	451		451			524	451	73	859	5,956
24	2027		204	204	1,192	988	486		486			524	486	38	950	6,906
25	2028		216	216	1,263	1,047	0		0			0	0	0	1,047	7,953
26	2029		229	229	1,339	1,110	0		0			0	0	0	1,110	9,063
27	2030		243	243	1,419	1,176	0		0			0	0	0	1,176	10,239
28	2031		258	258	1,505	1,247	0		0			0	0	0	1,247	11,486
29	2032		273	273	1,595	1,322	0		0			0	0	0	1,322	12,808
30	2033		289	289	1,690	1,401	0		0			0	0	0	1,401	14,209

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.7 Loan Repayment Analysis: Case e) Local Loan

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	F Portion	L Portion
Interest Rate per Year	1.8%	1.8%
Duration (Year)	24	24
Grace Period	4	4
Principal Rep	20	20

(Unit: mill. Rs in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow	Loan Inflow F	Loan Inflow L	Ttl IDC	IDC Foreign	IDC Local	Debt Service	Foreign Portion Principal	Foreign Portion Interest	Local Portion Principal	Local Portion Interest	Net Cash Flow	Cumulative Cash Flow
	0						6,301	4,366	1,935	289	197	91		4,563		2,027			
1	2004	925		925		-925	925	553	373	17	10	7	0	0	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	57	38	19	0	0	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	102	71	31	0	0	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	113	79	35	0	0	0	0	0	154	154
5	2008		67	67	394	326							395	192	82	85	36	-69	85
6	2009		71	71	418	346							395	195	79	87	35	-49	36
7	2010		76	76	443	367							395	199	75	88	33	-28	7
8	2011		80	80	469	389							395	202	72	90	32	-6	1
9	2012		85	85	497	412							395	206	68	91	30	17	18
10	2013		90	90	527	437							395	209	64	93	29	42	59
11	2014		96	96	559	463							395	213	60	95	27	68	127
12	2015		101	101	592	491							395	217	57	96	25	96	223
13	2016		107	107	628	520							395	221	53	98	23	125	348
14	2017		114	114	665	552							395	225	49	100	22	156	504
15	2018		121	121	705	585							395	229	45	102	20	189	693
16	2019		128	128	748	620							395	233	41	104	18	224	918
17	2020		136	136	793	657							395	237	36	105	16	262	1,179
18	2021		144	144	840	696							395	242	32	107	14	301	1,480
19	2022		152	152	891	738							395	246	28	109	12	343	1,823
20	2023		162	162	944	782							395	250	23	111	10	387	2,210
21	2024		171	171	1,001	829							395	255	19	113	8	434	2,644
22	2025		182	182	1,061	879							395	259	14	115	6	484	3,128
23	2026		193	193	1,124	932							395	264	10	117	4	537	3,665
24	2027		204	204	1,192	988							395	269	5	119	2	592	4,257
25	2028		216	216	1,263	1,047							0	0	0	0	0	1,047	5,304
26	2029		229	229	1,339	1,110							0	0	0	0	0	1,110	6,414
27	2030		243	243	1,419	1,176							0	0	0	0	0	1,176	7,590
28	2031		258	258	1,505	1,247							0	0	0	0	0	1,247	8,837
29	2032	0	273	273	1,595	1,322							0	0	0	0	0	1,322	10,159
30	2033		289	289	1,690	1,401							0	0	0	0	0	1,401	11,560

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.8 Loan Repayment Analysis: Case f) Local Loan with Equity Investment and 10 Year Grace Period

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	7.5%
Duration (Year)	30
Grace Period	10
Principal Rep	20

Equity		
Total	1,935	mill. Rs.
NEA	1,451	75%
Governm.	484	25%

(Unit: mill. Rs in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow	Loan Inflow F	Equity Inflow	Ttl IDC	IDC	Debt Service	Loan Principal	Loan Interest	Net Cash Flow	Cumulative Cash Flow
	0						6,301	4,366	1,935	822	822		5,188			
1	2004	925		925		-925	925	553	373	41	41	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	157	157	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	296	296	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	327	327	0	0	0	154	154
5	2008		67	67	394	326						389	0	389	-63	91
6	2009		71	71	418	346						389	0	389	-43	48
7	2010		76	76	443	367						389	0	389	-22	26
8	2011		80	80	469	389						389	0	389	0	26
9	2012		85	85	497	412						389	0	389	23	49
10	2013		90	90	527	437						389	0	389	48	97
11	2014		96	96	559	463						509	120	389	-46	51
12	2015		101	101	592	491						509	129	380	-18	33
13	2016		107	107	628	520						509	138	370	11	44
14	2017		114	114	665	552						509	149	360	43	87
15	2018		121	121	705	585						509	160	349	76	163
16	2019		128	128	748	620						509	172	337	111	273
17	2020		136	136	793	657						509	185	324	148	421
18	2021		144	144	840	696						509	199	310	187	609
19	2022		152	152	891	738						509	214	295	229	838
20	2023		162	162	944	782						509	230	279	273	1,111
21	2024		171	171	1,001	829						509	247	262	320	1,432
22	2025		182	182	1,061	879						509	265	243	370	1,802
23	2026		193	193	1,124	932						509	285	224	423	2,225
24	2027		204	204	1,192	988						509	307	202	479	2,704
25	2028		216	216	1,263	1,047						509	330	179	538	3,242
26	2029		229	229	1,339	1,110						509	354	154	601	3,843
27	2030		243	243	1,419	1,176						509	381	128	667	4,510
28	2031		258	258	1,505	1,247						509	410	99	738	5,248
29	2032		273	273	1,595	1,322						509	440	69	813	6,061
30	2033		289	289	1,690	1,401						509	473	36	892	6,953

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.9 Loan Repayment Analysis: Case g) Local Loan with Equity Investment and Principal Conversion with 10 Year Grace Period

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	7.6%
Duration (Year)	24
Grace Period	4
Principal Rep	20

Equity		
Total	1,935	mill. Rs.
NEA	1,451	75%
Governm.	484	25%

(Unit: mill. Rs in basic)

Year	FY Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow 6,301	Loan Inflow F 4,366	Equity Inflow 1,935	Ttl IDC 833	IDC 833	Debt Service	Loan Principal 5,199	Loan Interest	Net Cash Flow	Cumulative Cash Flow
1	2004	925		925		-925	925	553	373	42	42	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	159	159	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	300	300	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	332	332	0	0	0	154	154
5	2008		67	67	394	326	0		0			395	0	395	-69	85
6	2009		71	71	418	346	0		0			395	0	395	-49	36
7	2010		76	76	443	367	0		0			395	0	395	-28	8
8	2011		80	80	469	389	0		0			395	0	395	-6	2
9	2012		85	85	497	412	0		0			395	0	395	17	19
10	2013		90	90	527	437	0		0			395	0	395	42	60
11	2014		96	96	559	463	119		119			514	119	395	68	128
12	2015		101	101	592	491	128		128			514	128	386	105	233
13	2016		107	107	628	520	137		137			514	137	376	144	377
14	2017		114	114	665	552	148		148			514	148	366	186	563
15	2018		121	121	705	585	159		159			514	159	355	230	793
16	2019		128	128	748	620	171		171			514	171	343	277	1,070
17	2020		136	136	793	657	184		184			514	184	330	327	1,397
18	2021		144	144	840	696	198		198			514	198	316	381	1,778
19	2022		152	152	891	738	213		213			514	213	300	438	2,215
20	2023		162	162	944	782	230		230			514	230	284	498	2,713
21	2024		171	171	1,001	829	247		247			514	247	267	562	3,276
22	2025		182	182	1,061	879	266		266			514	266	248	631	3,907
23	2026		193	193	1,124	932	286		286			514	286	228	704	4,611
24	2027		204	204	1,192	988	308		308			514	308	206	782	5,392
25	2028		216	216	1,263	1,047	331		331			514	331	183	864	6,256
26	2029		229	229	1,339	1,110	356		356			514	356	158	952	7,209
27	2030		243	243	1,419	1,176	383		383			514	383	130	1,046	8,254
28	2031		258	258	1,505	1,247	412		412			514	412	101	1,146	9,400
29	2032		273	273	1,595	1,322	444		443.7969			514	444	70	1,252	10,652
30	2033		289	289	1,690	1,401	478		477.5255			514	478	36	1,365	12,016

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.10 Loan Repayment Analysis: Case h) Local Loan with 10 Year Grace Period

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	F Portion	L Portion
Interest Rate per Year	5.0%	5.0%
Duration (Year)	30	30
Grace Period	10	10
Principal Rep	20	20

(Unit: mill. Rs in basic)

Year	FY Starting	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow	Loan Inflow F	Loan Inflow L	Ttl IDC	IDC Foreign	IDC Local	Debt Service	Foreign Portion Principal	Foreign Portion Interest	Local Portion Principal	Local Portion Interest	Net Cash Flow	Cumulative Cash Flow
	0						6,301	4,366	1,935	802	548	254		4,914		2,189			
1	2004	925		925		-925	925	553	373	46	28	19	0	0	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	158	105	53	0	0	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	283	197	86	0	0	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	315	218	97	0	0	0	0	0	154	154
5	2008		67	67	394	326							355	0	246	0	109	-29	125
6	2009		71	71	418	346							355	0	246	0	109	-9	116
7	2010		76	76	443	367							355	0	246	0	109	12	128
8	2011		80	80	469	389							355	0	246	0	109	34	161
9	2012		85	85	497	412							355	0	246	0	109	57	218
10	2013		90	90	527	437							355	0	246	0	109	82	300
11	2014		96	96	559	463							570	149	246	66	109	-107	193
12	2015		101	101	592	491							570	156	238	70	106	-79	114
13	2016		107	107	628	520							570	164	230	73	103	-50	65
14	2017		114	114	665	552							570	172	222	77	99	-18	46
15	2018		121	121	705	585							570	181	214	80	95	15	61
16	2019		128	128	748	620							570	190	205	84	91	50	111
17	2020		136	136	793	657							570	199	195	89	87	87	197
18	2021		144	144	840	696							570	209	185	93	82	126	324
19	2022		152	152	891	738							570	220	175	98	78	168	492
20	2023		162	162	944	782							570	231	164	103	73	212	704
21	2024		171	171	1,001	829							570	242	152	108	68	259	964
22	2025		182	182	1,061	879							570	254	140	113	62	309	1,273
23	2026		193	193	1,124	932							570	267	127	119	57	362	1,635
24	2027		204	204	1,192	988							570	280	114	125	51	418	2,052
25	2028		216	216	1,263	1,047							570	294	100	131	45	477	2,529
26	2029		229	229	1,339	1,110							570	309	85	138	38	540	3,069
27	2030		243	243	1,419	1,176							570	324	70	145	31	606	3,675
28	2031		258	258	1,505	1,247							570	341	54	152	24	677	4,352
29	2032	0	273	273	1,595	1,322							570	358	37	159	16	752	5,104
30	2033		289	289	1,690	1,401							570	376	19	167	8	831	5,935

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Table 10.3.11 Loan Repayment Analysis: 85% of Foreign Loan and 15 % of Local Loan with Equity Investment and 10 Year Grace Period

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	6.3%
Duration (Year)	30
Grace Period	10
Principal Rep	20

Equity		
Total	1,032	mill. Rs.
NEA	774	75%
Governm.	258	25%

(Unit: mill. Rs in basic)

Year	FY Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow 6,202	Loan Inflow F 5,171	Equity Inflow 1,032	Ttl IDC 831	IDC 831	Debt Service	Loan Principal 6,001	Loan Interest	Net Cash Flow	Cumulative Cash Flow
1	2004	910		910		-910	910	765	145	48	48	0	0	0	0	0
2	2005	2,192		2,192		-2,192	2,192	1,832	360	164	164	0	0	0	0	0
3	2006	2,477		2,477		-2,477	2,477	2,058	419	293	293	0	0	0	0	0
4	2007	624	32	656	186	-470	624	515	109	326	326	0	0	0	154	154
5	2008		67	67	394	326						378	0	378	-52	102
6	2009		71	71	418	346						378	0	378	-32	70
7	2010		76	76	443	367						378	0	378	-11	59
8	2011		80	80	469	389						378	0	378	11	70
9	2012		85	85	497	412						378	0	378	34	104
10	2013		90	90	527	437						378	0	378	59	162
11	2014		96	96	559	463						536	158	378	-73	89
12	2015		101	101	592	491						536	168	368	-45	44
13	2016		107	107	628	520						536	178	358	-16	29
14	2017		114	114	665	552						536	190	346	15	44
15	2018		121	121	705	585						536	202	334	49	93
16	2019		128	128	748	620						536	214	322	84	176
17	2020		136	136	793	657						536	228	308	121	297
18	2021		144	144	840	696						536	242	294	160	457
19	2022		152	152	891	738						536	258	279	202	659
20	2023		162	162	944	782						536	274	262	246	905
21	2024		171	171	1,001	829						536	291	245	293	1,199
22	2025		182	182	1,061	879						536	309	227	343	1,542
23	2026		193	193	1,124	932						536	329	207	396	1,937
24	2027		204	204	1,192	988						536	350	187	452	2,389
25	2028		216	216	1,263	1,047						536	372	165	511	2,900
26	2029		229	229	1,339	1,110						536	395	141	574	3,474
27	2030		243	243	1,419	1,176						536	420	116	640	4,114
28	2031		258	258	1,505	1,247						536	446	90	711	4,825
29	2032		273	273	1,595	1,322						536	474	62	786	5,610
30	2033		289	289	1,690	1,401						536	504	32	865	6,475

Table 10.3.12 Loan Repayment Analysis: Reference Case(Local Loan with Equity Investment as Current Practice)

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	10.25%
Duration (Year)	24
Grace Period	4
Principal Rep	20

Equity		
Total	1,935	mil. Rs
NEA	1,451	75%
Govern.	484	25%

(Unit: mill. Rs in basic)

Year	FY	Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Reve.	Net Reve.	Ttl Capital Inflow 6,301	Loan Inflow 4,366	Equity Inflow 1,935	Total IDC 1,123	IDC 1,123	Debt Service	Loan Princip. 5,489	Loan Inter.	Net Cash Flow	Cumul. Cash Flow
1	2004		925		925		-925	925	553	373	57	57	0	0	0	0	0
2	2005		2,225		2,225		-2,225	2,225	1,539	685	214	214	0	0	0	0	0
3	2006		2,508		2,508		-2,508	2,508	1,856	652	405	405	0	0	0	0	0
4	2007		643	32	675	186	-489	643	418	225	447	447	0	0	0	154	154
5	2008			67	67	394	326						656	93	563	-329	-175
6	2009			71	71	418	346						656	103	553	-310	-485
7	2010			76	76	443	367						656	113	543	-289	-774
8	2011			80	80	469	389						656	125	531	-267	-1,041
9	2012			85	85	497	412						656	138	518	-244	-1,285
10	2013			90	90	527	437						656	152	504	-219	-1,504
11	2014			96	96	559	463						656	167	488	-193	-1,696
12	2015			101	101	592	491						656	184	471	-165	-1,861
13	2016			107	107	628	520						656	203	452	-135	-1,997
14	2017			114	114	665	552						656	224	432	-104	-2,101
15	2018			121	121	705	585						656	247	409	-71	-2,172
16	2019			128	128	748	620						656	272	383	-36	-2,208
17	2020			136	136	793	657						656	300	355	1	-2,207
18	2021			144	144	840	696						656	331	325	41	-2,167
19	2022			152	152	891	738						656	365	291	82	-2,084
20	2023			162	162	944	782						656	403	253	127	-1,958
21	2024			171	171	1,001	829						656	444	212	174	-1,784
22	2025			182	182	1,061	879						656	489	166	223	-1,561
23	2026			193	193	1,124	932						656	539	116	276	-1,285
24	2027			204	204	1,192	988						656	595	61	332	-953
25	2028			216	216	1,263	1,047						0	0	0	1,047	94
26	2029			229	229	1,339	1,110						0	0	0	1,110	1,204
27	2030			243	243	1,419	1,176						0	0	0	1,176	2,380
28	2031			258	258	1,505	1,247						0	0	0	1,247	3,627
29	2032			273	273	1,595	1,322						0	0	0	1,322	4,949
30	2033			289	289	1,690	1,401						0	0	0	1,401	6,350
31	2034			307	307	1,792	1,485						0	0	0	1,485	7,835
32	2035			325	325	1,899	1,574						0	0	0	1,574	9,409
33	2036			345	345	2,013	1,669						0	0	0	1,669	11,077
34	2037		2,430	365	2,795	2,134	-661						0	0	0	-661	10,417
35	2038			387	387	2,262	1,875						0	0	0	1,875	12,291
36	2039			411	411	2,398	1,987						0	0	0	1,987	14,279
37	2040			435	435	2,542	2,107						0	0	0	2,107	16,385
38	2041			461	461	2,694	2,233						0	0	0	2,233	18,618
39	2042			489	489	2,856	2,367						0	0	0	2,367	20,985
40	2043			518	518	3,027	2,509						0	0	0	2,509	23,494
41	2044			549	549	3,209	2,660						0	0	0	2,660	26,154
42	2045			582	582	3,402	2,819						0	0	0	2,819	28,973
43	2046			617	617	3,606	2,988						0	0	0	2,988	31,961
44	2047			654	654	3,822	3,168						0	0	0	3,168	35,129
45	2048			694	694	4,051	3,358						0	0	0	3,358	38,487
46	2049			735	735	4,294	3,559						0	0	0	3,559	42,046
47	2050			779	779	4,552	3,773						0	0	0	3,773	45,818
48	2051			826	826	4,825	3,999						0	0	0	3,999	49,817
49	2052			876	876	5,115	4,239						0	0	0	4,239	54,056
50	2053			928	928	5,422	4,493						0	0	0	4,493	58,550
51	2054			984	984	5,747	4,763						0	0	0	4,763	63,312
52	2055			1,043	1,043	6,092	5,049						0	0	0	5,049	68,361
53	2056			1,106	1,106	6,457	5,352						0	0	0	5,352	73,713
54	2057			586	586	3,422	2,836						0	0	0	2,836	76,549

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

Chapter 11

CHAPTER 11 TRANSFER TECHNOLOGY

11.1 On-the-job Training

The counterparts of NEA assigned to the Upgrading Feasibility Study have been educated and trained well in the respective fields from the first to the forth field investigation. NEA's counterparts both on long-term and short-term basis are a Project Manager, a Hydropower Planner, three Civil Engineers, a Geologist, two Environmental Experts, a Electrical Engineer, a Construction Plan/Cost Estimator and a Electrical Engineer. The Study Team members have tried to introduce the latest knowledge relevant to executing the study in the respective field and expand their experiences. In addition to usual works carrying out with the respective counterparts, various discussions on technical matters have been functional as the effective means to do the transfer of the technology.

11.2 Presentation

The Study Team has made the presentations focused on the outcome of the Inception, the Progress, the Interim and the Draft Final Report. They were carried out for NEA counterparts at the end of the each field investigation.

In these presentations, the technologies adopted in and related to the Feasibility Study were explained, especially focusing on optimization of hydropower project including reservoir operation study, procedure of environmental survey and assessment, geological investigation, hydrological investigation, design, construction planning, cost estimate and economic and financial evaluation.

11.3 Counterpart Training in Japan

Under the program of technical cooperation by the government of Japan, one counterpart personnel of NEA have visited Japan for one month from November 24, 2002 and received a series of training in accordance with the training program. Through this program, he visited the existing and constructing project similar to the Kulekhani III hydropower project. This program included the lecture related to his specialty, especially hydropower planning and sedimentation control.

In addition to the above training, he reviewed the draft final report and discussed the geology, the hydrology, the optimum development plan, the technology, the environment, economic and finance and feasibility of the Project with the Study Team.

Chapter 12

CHAPTER 12 IMPLEMENTATION PROGRAM

12.1 Implementation Program

The Upgrading Feasibility Study of the Kulekhani III Hydropower Project clarified the viability of the implementation from technical, environmental and economic/financial viewpoints. Therefore, it is recommend proceeding to the detailed design of the Project as earlier as possible.

In order to implement the Project, it is necessary to smoothly carry out the arrangement of loan from donors, the detailed design for 10 months, pre-qualification, tendering, selection of contractors for civil works, hydro-mechanical works, generating equipment and transmission line and the main construction works for 3.5 years.

As explained in Section 5.2, the Corporate Development Plan of NEA in August 2002 recommends that the Project be input into the integrated system in 2007. The results of the study on the optimum installation timing of the Project and the construction plan and schedule also reveal that the Kulekhani III project is needed to commence its power generation in 2007 as described in Sections 6.4 and 9.2. Accordingly, it is recommended to smoothly carry out the arrangement of financial assistance to construction through tendering without delay for the implementation of the Project as follows:

Activity	0 Year (2003)	1st Year (2004)	2nd Year (2005)	3rd Year (2006)	4 th Year (2007)
1. Completion of F/S	▼ Feb.				
2. Financial Arrangement	▼				
3. Detailed Design		10months			
4. Tender Documents					
5. Pre-qualification	5 months				Power
6. Tendering	6 months			3.5years	Commission
7. Construction	Start of construction				
(1) Access road					
(2) Regulating dam					
(3) Waterway					
(4) Underground Powerhouse					
(5) Generating equipment					
(6) Transmission line					

12.2 Project Risk

Main risks associated with the implementation of the Project are categorized into: 1) risk before construction, 2) risk during construction, 3) risk during operation, 4) market risk, 5) financial risk, 6) environmental risk, 7) security risk and 8) political risk as shown in Table 12.2.1. These risks are taken by Parties

concerned risks such as international donor country, the Government of Nepal (GoN), NEA, the Engineer, the Contractors, Electricity power purchaser, insurance company, and Project affected families (PAFs).

In order to commence the power generation of the Kulekhani III project in 2007 without any delay caused by risks, the project organization should monitor the status of risks listed in Table 12.2.1 before/during construction and operation stages. This activity ensures to supply the reliable peak power without any shortage of peak power in the dry season. As a result, the Project does not produce the financial overburden of NEA caused by shortage of power supply.

Risks before and during construction are taken by main 4 concerned parities of GoN, NEA, the Engineer, and the Contractors. Risks before construction are conceived as delay of tendering and delay of construction. Risks during construction are adverse hydrology, adverse geology, design defects, cost overrun, time extension, in-completion of construction, and damage to third party. Monitoring and mitigation measures against these risks can lead to the viable implementation of the Project from technical and economical viewpoints. Therefore, it is recommended to establish a Risk Management Unit during construction for periodical monitoring of potential risks. The Risk Management Unit will analyze risk and propose countermeasures against risks when risks are realized. In addition, it is essential to invite Panel of Experts (PoE) for having high technological review and advice on risks.

Risks during operation (poor operation and maintenance, decline of power output by drought, and transmission line fault) are taken by main 3 concerned parities of GoN, NEA and power purchaser. NEA could supply the reliable peak power in the dry season by monitoring risks of poor operation and maintenance and transmission line fault, and preparing mitigation measures. NEA could become the sound organization from financial aspects by supplying the secure and reliable peak power. This reliable peak power supply of NEA could introduce the stable growth of development on industry sector and the stable economy in Nepal.

Environmental risk is taken by main 5 concerned parities of the Project such as NEA, the Engineer, and the Contractors, PAFs and NGO. Issues related to resettlement and land acquisition, vibration, dust, wastewater, and domestic water would occur before and during construction as environmental risk. As proposed in Section 4.5, the Kulekhani Environmental and Social Management Unit (KESMU) is needed to be organized in the Project, consisting of NEA, the Engineer, the Contractor, PAFs, and NGO. The KESUM should monitor the

impacts on natural and social environment, and solve environmental issues by preparing countermeasures in details. As a result, NEA could implement the Project from sound environmental aspects. As explained in Section 4.5, the natural environmental impacts (water quality, air pollution, dust, vibration, fauna and flora, aquatic life and spring water) should be also minimized by monitoring environmental risks before and during construction, and preparing mitigation measures. The public consultations before/during construction, and during operation are essential to promote mutual understanding of all concerned parties in long term.

Financial Risk is the delay of loan assistance before construction. The loan arrangement should be taken action before construction without any delay. As recommended in Section 10.2, the relaxation of on-lent condition form GoN to NEA is also needed. In the case of application of the on-lent interest of 10.25% from GoN to the Project, NEA will increase his own debt. Therefore, the GoN needs to relax the on-lent condition by applying interest less than 10.25% and longer grace period in order to proceed the Project in terms of social and economic development policy. Mitigation measures of on-lent condition could ensure NEA's financial condition.

12.3 Further Investigation of Detailed Design

The current design of this Study has been prepared as a feasibility-grade design. Therefore, further elaboration to grade up it to a level of the detailed design will be required to implement the Project before staring construction. For further elaboration in the detailed design, the additional engineering works will be required as follows:

1) Aerial photo mapping in the project area, detailed topographic survey in the main structures, and additional geological investigation of core drillings and rock tests at the underground powerhouse, the waterway and landslides R-1 and R2 including measurement of initial rock stress, uni-axial compressive strength test and pumping test,

2) Detailed sediment study on the Yangran River consisting of field investigations and numerical simulations,

3) Hydraulic model test of regulating dam including spillway and sand flushing facility, and

4) Continuation of supplemental environmental impact assessment survey including spring water survey.

TABLES

Chapter 12

Table 12.2.1 Project Risk and Parties Concerned Risk

	Risk Items	Parties Concerned Risk							
Risk Category	Cause of Risk and/or Consequence of Risk Occurrence	Donors	GoN	NEA	Engineer	Contractor	Power purchases	Insurance Co.	PAFs
Risk before Construction	Delay of tendering		X	O	O				
	Delay of construction		X	O	O	O			
Risk during Construction	Adverse hydrology		X	O	O	O			
	Adverse geology		X	O	O	O			
	Design defects			X	O	X		X	
	Cost overrun			O	O	O			
	Time extension	X	X	O	O	O	X		
	In-completion	X	X	O	O	O	X		
	Damage to third-party			X	X	O		O	
Risk during Operation	Poor operation and maintenance			O			O		
	Decline of power output by drought		X	O			O		
	Transmission line fault		X	O			O		
Environmental Risk	Land not acquired		O	O	X	X			O
	Opposition of Project Affected family (PAFs)		O	O	O	O			O
	Dust and vibration during construction			O	O	O			O
	Decrease of spring water			O	O	O			O
	Impact on natural environment			O	O	O			
Financial Risk	Delay of financial assistance	O	O	O					
	Increase of on-lent interest		O	O					
	Devaluation of exchange rate	O	O	O					
Market Risk	Non-payment of power purchaser		X	O			O		
	Decline of power output by low demand		X	O			O		
	Change of power tariff		X	O			O		
Force Majeure	Natural disaster and calamities			O	O	O		X	
Security Risk	Terro		O	O	O	O			
Political Risk	Expropriation, non-repatriation/remittance		O	O	O	O			

Note: "O" means main stakeholder, and "X" means stakeholder.