CHAPTER VI

IMPLEMENTATION PROCEDURE

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6.1 Implementation Procedure

Overall Procedure

The executing agency for implementation of the Project is expected to be the Ceylon Electric Board. The Executing Agency will form an implementation committee composed of members from responsible government agencies.

The implementation procedure can be roughly divided into : (1) preparation of a loan package, (2) detailed design, preparation of tender documents, and selection of construction contractors, and (3) construction work. As mentioned previously, the operation of the Project is scheduled to start in 1997. In order to fulfil this schedule it is necessary to complete all the construction and installation work by December 1996. The construction work is anticipated to require a minimum of 5.5 years. The implementation procedure is roughly planned as presented in the table hereunder.

Item	Period	Timing
(1) Internal Procedure and Approval	4-month	Sep. 1987 - Dec. 1988
(2) Loan Package Preparation	5-month	Jan. 1988 - May 1988
(3) Detailed Design, Tender Document Preparation, Tendering, etc.	3-year 3-month	June 1988 - May 1991
(4) Construction Work	5-year 6-month	June 1991 - Dec. 1996
Total	9-year 4-month	

Construction Schedule

Construction of the Talawakelle headrace tunnel is the critical pass for implementation of the Upper Kotmale Project. Work access tunnels are planned to limit the longest construction segment of the 13.4km tunnel to 7.4km.

The overall construction plan is formulated so that the completion of major work items coincides to the extent possible with the completion of the longest (7.4km) tunnel segment. However, works which must be completed prior to the start of other works will be scheduled accordingly. The overall construction schedule is presented in FIG.6.2-1.

Facility Procurement

Procurement is considered as follows on the basis of field survey and interviews conducted during the study.

1) Domestic procurement will be difficult in the case of almost all large equipment, facilities and construction machinery.

2) Amounts procurable domestically are likewise limited in the case of construction materials such as cement, steel, lumber, etc. In terms of quality, it is appropriate to use imported ones.

3) Aggregate is to be quarried from the right bank upstream of Caledonia dam.

4) Fuel and lubricants can be procured in Sri Lanka as the Ceylon Petroleum Corporation imports crude pretroleum and refines it locally. The nearest CPC sales point to the Project site is at Kotagala 15km from Talawakelle along highway A7.

6.2 Preparatory Works

A large nmber of preparatory works are necessary such as power facilities for construction, construction access road, site offices, staff housing, etc. Critical aspects of preparatory works will be commenced as required considering the overall progress of the works.

The most urgent component of preparatory works is the facilities required to commence construction of the above described 7.4km long headrace tunnel for Talawakelle power station.

6.2.1 Construction Camp

The base camp from which overall Project construction will be supervised and coordinated, is planned at level area on the right bank about 1.0km downstream of the Talawakelle dam site. As the Project area is large, forward camps will also be established at the Caledonia dam site and the Talawakelle power station site.

These camps will be utilized as operations facilities following start-up of the completed power stations. The camps offer a favorable residential environment as the commercial centers of Talawakelle and Lindula are located along the nearby national highway.

At the base camp at Talawakelle, a site office, guest house, social and medical care facilities, as well as the staff housing indicated below, will be constructed. Of these, 1 unit of 4-bed residence, 15 units of 3-bed residences, 20 units of 2-bed residences and 1 unit each of B and C class dormitories will be facilitated at the Talawakelle power station camp.

4 bed residence:	3 units
3 bed residence:	45 units
2 bed residence:	65 units
Dormitory for singles (A class):	3 buildings
Dormitory for singles (B class):	3 buildings
Dormitory for singles (C class):	2 buildings

6.2.2 Access Road

Status of air transport, harbors, roads and railroads is discussed in the APPENDIX-V. Existing roads will be utilized for both transport of equipment and material from Colombo to the Project sites during construction, as well as for operation and maintenance of dam and power station facilities upon Project completion.

As shown in FIG.3.1-1, there are two possible routes from Colombo to the Project area; one follows Route A_1 throught Kandy and then Route A_9 through Gampola to Talawakelle while the other follows Route A_7 to Talawakelle via Ginigathena and Hatton.

Access to the following 3 points from Colombo was studied with regards to Project construction:

Talawakelle Dam Site and Caledonia Power Station

Use of Route A_7 is considered most appropriate for access to this work site (See FIG.6.2-1). This route has already been used effectively for transport of construction materials to the Maskeliya Oya Project. Deterioration of the road surface however, is pronounced.

Between Hatton and Talawakelle intersection of this route with the railway line occurs in 3 places. At Rosita located 8.8km from Talawakelle, the road passes through a brick tunnel. The cross-section of this tunnel is anticipated to be too small for passage of cranes and other heavy equipment.

Due to the crowded traffic conditions near Talawakelle, safety precautions are required. Reconstruction of the bridge downstream from the Talawakelle railway bridge is necessary at the Talawakelle dam site. Route A_7 can be used directly to reach the Talawakelle power station. Use of the Colombo - Talawakelle railway is also possible for transportion of construction materials (cement, etc.).

The main city intervals, railroad crossings and narrow sections of road are shown below.

1) Colombo←58km→Arissawela←40km→Ginigathena←30km→

Hatton←10km→Talawakelle←6.8km→Nuwara Eliya

2) Railroad crossings: From Talawakelle: 2.4km, 11.0km, 16.7km points

3) Narrow sections: From Talawakelle 5.1km point (B=4.0m), 28.6km point (B=4.1m)

Caledonia Dam Site

Access to the Caledonia Dam site follows Route A7 via Talawakelle to Lindula and from there it follows the Lindula-Agra road (See FIG.6.2-1). Difficulties in transport in terms of road width and curvature are not envisioned. However, if aggregate and concrete plants are located on the right bank where quarry sites are situated, access to the right bank from the existing left bank road will be necessary. For this, the existing road and bridge will accordingly be rehabilitated. The distance from Talawakelle is as follows:

Talawakelle←4.2km→Lindula←2.6km→Tillicoultry

←4.5km→Caledonia dam site

Talawakelle Power Station

With construction of the Kotmale dam, access to the Kotmale dam via Kandy is facilitated. A connecting road from Kirindewela at the end of the reservoir on the reservoir's left bank is presently under construction and nearing completion (See FIG.6.2-1). The Talawakelle power station is planned downstream of Wavahena where the Kotmale Oya and the above road intersect, and good accessibility is envisioned for construction on the Project.

6.2.3 Power and Telecommunication Facilities

Power Facilities

Although some unilluminated areas are present, the vicinity of the Project area is generally well electrified. 33kV distribution line is in place. However, distribution line at present is utilized primarily for lighting and power at tea factories, and lacks sufficient capacity for construction purposes. For this reason, a new 33kV line is planned to supply power for Project construction. The line will be run from the Nuwara Eliya grid substation scheduled for construction in 1988-1990.

Although the new 33kV distribution line is intended firstly to supply power for Project construction, it will contribute after Project implementation to the general power supply of the area by augmenting insufficient capacity of the existing area grid and functioning in place of superannuated line. This will also be utilized for back-up power supply and dam facilities operation.

As shown in the Design Drawings, the new distribution line route will be 12km in length from Nuwara Eliya to the Caledonia power station site, and extend along the Nanu Oya. From the Caledonia power station site, two branch lines are to be constructed both roughly 5km in length and extending along the Kotmale Oya to the Caledonia dam and Talawakelle dam sites, respectively. A separate distribution line will be constructed from Nuwara Eliya to the Talawakelle power station site. Said line will be 19km in length and pass along national highway A5 (Kandy highway) and the Pundal Oya.

Principal reception points for power, and the areas to be supplied therefrom are shown below:

Principal Reception Point	Area Supplied
Caledonia Power Station Site	Caledonia power station, downstream portion of Caledonia waterway
Caledona Dam Site	Caledonia dam, upstream portion of Caledonia waterway
Talawakelle Dam Site	Talawakelle dam, upstream portion of Talawakelle waterway
Talawakelle Power Station Site	Talawakelle power station, downstream portion of Talawakelle waterway

Telecommunications Facilities

Standard telecommunications facilities exist in the Project area. These facilities will be expanded to secure adequate communications during construction and for operation and maintenance after Project completion, as well as to contribute to improvement of the overall communications network of the area.

Expansion of capacity will be primarily achieved by increasing the number of circuits of existing facilities. However, a certain portion of superannuated facilities will be replaced.

6.3 Dam Construction

6.3.1 Caledonia Dam

Principal construction works for Caledonia dam are as indicated below.

Temporary Diversion

The temporary diversion tunnel is a standard horseshoe type with inner diameter of 7.2m. Gradient is 1/30 and total length is 395m. The falls with 10m head located 70m downstream of the stilling basin will serve as the downstream cofferdam.

Tunnel construction will proceed from the downstream end. The 150m segment from the intake end and the 50m segment from the outlet end will be concrete lined to 70cm thickness. The remaining tunnel segment will be lined by rockbolt and shot-mortar. Average excavation speed is designed at 80m/month.

After completion of the temporary diversion tunnel, the upstream cofferdam will be constructed during the low discharge month of April. The coffer dam is to be a concrete dam with crest elevation of EL.1,311.0m. This crest elevation was planned on the basis of a diversion tunnel design discharge of 840m3/s.

Dam

Main dam construction quantities are as follows

Foundation excavation	102,000m3
Foundation grouting	15,500m
(consolidation and curtain grouting)	
Dam concrete	250,000m3

For dam foundation excavation, surface soil and weathered layer is to be removed by power shovel and bulldozer. Freshrock is to be excavated by blasting. Rough excavation is to be within 0.50-1.00m of design dimensions, with finishing performed by leg hammer or coalpick hammer.

Dam concrete is to be placed over a 20 month construction period concentrated during the dry season. 9-ton capacity cable crane with 3m3 bucket is to be used for placement.

Average monthly placement:	12,500m3
Maximum monthly placement:	21,000m3

Bucket capacity:	$3.0m^3$
Operating capacity:	$40m^3/h$
Batcher plant:	56 x 2 units
Concrete production capacity:	$60-72m^3/h$

A 35-ton truck crane with $1.5m^3$ bucket will be utilized for concrete placement beyond the range of the cable crane.

Consolidation grouting will be perfomed before concrete placement, beginning from the foundation excavation surface. Curtain grouting will be carried out from the upstream dam footing. Primary holes will be placed vertically on the upstream side and secondary holes vertically on the downstream side. Grouting will be carried out first for the curtain pilot, then the primary holes and finally the secondary holes.

The concrete wall on the right bank is to be 2m thick. Excavation and concrete placement for the wall will be performed after concrete for the main dam body has been placed upto the elevation of the bottom of the wall. Following completion of concrete placement for the dam body, low pressure grouting will be carried out from the downstream gallery.

Saddle Dam

The saddle dam is to be a rock fill dam. Principal work quantities are:

Foundation excavation:	$6,700m^3$
Diaphram wall:	$7,100m^2$
Core embankment:	$20,000m^3$
Rock material (including filter) embankment:	$60,000m^3$

Both the right and left banks are to be cut downward from the slope shoulder by backhoe shovel and excavated by bulldozer. Two months will be required for foundation excavation. After completion of foundation excavation, diaphram wall construction will commence along the dam axis.

Core material will be spread by scraper and tamped by tire-roller. Rock material will be thinly spread in accordance with grain size and zone of application. Filter and gravel materials are to be spread 30-50cm thick, and rock is spread 1-2m thick.

Filter and gravel materials will be tamped by tire roller. Rock material will be leveled by bulldozer. Water will be sprinkled on the layer surface for effective compaction.

6.3.2 Construction Schedule

Caledonia Dam

Construction works performed during each respective year are set out below.

(1) First Year (1993):

Construction of roads connecting the left and right banks of the dam site prior to the installation of the temporary facilities for dam construction.

Excavation of temporary drainage tunnel. This is to be performed as single front excavation commencing at the downstream outlet in consideration of possible flood outpour during excavation.

Start of foundation works for temporary construction facilities (mixers, conveyers, placing equipment).

(2) Second Year (1994):

Continuation of foundation works for temporary facilities and excavation/lining of the temporary diversing tunnel. After completion, flow of the Kotmale Oya is shifted by coffer dam construction prior to commencement of the rainy season.

Excavation of dam foundation is begun and at the same time temporary facilities for dam construction are erected.

20 months will be required for concrete-placing.

(3) Third Year (1995):

Continuation of concrete-placing. Installation of release pipe, foundation treatment from the gallery, and installation of gauging equipment.

(4) Fourth Year (1996):

Continuation of concrete-placing for main dam. Closing of temporary diversion tunnel and shift to passage of river discharge through bypass in dam body three months prior to completion of concrete placement.

Following completion of foundation excavation and treatment including seepage prevention works, saddle dam embankment construction is carried out. After completion of seepage prevention works at the saddle dam, diaphram wall is constructed from the upstream side to the downstream side.

Subsequent to completion of saddle dam construction and grouting, bypass is closed and test ponding begins from the end of September.

Test ponding at end of July. Operations test from November to December. In November-December turbine test is performed.

Talawkelle Dam

Talawakelle dam is designed at 20m high and with crest length of 102m. The dam is to be equipped with three roller gates (each gate: 8m [H] x 12m [B]). Construction period is to be three years. Work items for each respective year are set out below.

(1) First Year (1994):

Completion of construction of road on the right bank of the dam site before the dry season. Closure of right bank during dry season and performance of foundation excavation. Installation of concrete placing facilities.

(2) Second Year (1995):

Placement of concrete for apron, pier and revetment after completion of foundation treatment. Utililzation of 35-ton track crane for concrete placement. Installation of regulating gates. Closure of the left bank during the dry season and lifting of gate at the right bank to divert discharge. Conduct foundation excavation and treatment for the left bank .

(3) Third Year (1996):

After finishing foundation excavation and treatment, completion of concrete placement for revetment, apron and pier construction. Installation of regulating gate. Completion of pond slope protection works. Operations test after completion of appurtenent power station facilities.

6.4 Tunnels, Headraces and Power Stations

6.4.1 General

Power station related civil works, from intake through to tailrace outlet consist of mainly underground structures. As much of the construction for these various structures is inter-related, it is necessary to pay particular attention to cost-effectiveness in formulating a construction plan.

Major equipment required are tunnel excavating equipment such as boring machines, explosives, and conveyers. Supplementary equipment for ventilation, air supply, and drainage are also necessary. Equipment required for tunnel lining are concrete conveyer cars, shotcrete equipment, boring machines, etc.

Equipment required for work outside tunnels are earth-moving equipment, aggregate plant, concrete plant, and transport vehicles. Heavy transport equipment, cranes, pipe benders, and welding machines are required for the installation of generator and transformer facilities, penstock , and gates. Particularly with regards to penstock which will be transported to site as sheet steel, bending, welding, etc are to be performed at site.

Main access tunnel to the power stations will be utilized not only for transport of materials and equipment to the power station and removal of excavated debris from the power station cavern, but also for removing excavated debris from the penstock route and bringing in equipment and materials for the lower portion of the penstock route.

In addition to this main access tunnel, two additional tunnels at key levels at each power station will be constructed to serve as operation corridors following completion of construction.

The installation of major generating equipment is to be done with the help of ceiling cranes. The installation of draft pipes is to be carried out in conjunction with a portion of civil works utilizing separately installed carrier and crane, etc.

It is estimated that the total construction time required from the starting of the excavation to completing of the installation of the equipment and facilities at the Caledonia and Talawakelle power stations will be approximately 3 years and 3 years 4 months, respectively.

In perfoming headrace construction, access tunnels will be constructed at key locations along the route for removal of excavated debris and bringing in of equipment and materials. The Talawakelle headrace tunnel from the Talawakelle pond to the Pundal oya, which is a critical pass in the overall Project construction schedule, passes through rugged terrain making placement of access tunnels extremely difficult. The Talawakelle headrace tunnel segment is the longest of the Project at 7,400m. Access tunnels will be placed at both ends of the segment.

Tunnel excavation is planned at this stage to be by conventional methods. However, it is recommended that detailed geologic survey be carried out over the entire tunnel route, and the possible merits in terms of construction period and cost-effectiveness of tunneling by the TBM (Tunnel Boring Machine) method be examined during the detailed design stage. Construction period by conventional methods is estimated at 5.5 years. A rough schedule is presented below:

Preparation:	6-month
Temporary facilities and access tunnel excavation:	3-month
Excavation: 7,400m / 2 sectors (5m/day×22 days / month)	34-month
Concrete Lining: 7,400m / 2 sectors (10m/day×22 days / month)	17-month
Invert Concrete: performed simultaneous to concrete lining	3-month
Grouting: performed simultaneous to concrete lining	3-month
Total	66-month (5.5 year)

Construction method and year-wise construction works for the Caledonia and Talawakelle power stations are as presented below

6.4.2 Caledonia Power Station

Construction Method

(1) General:

Of the Caledonia power station civil works, the power station structure requires the longest construction period. Construction of the power station structure will accordingly be given priority.

(2) Intake:

Open excavation for the intake structure will be scheduled last as the quarry site is planned immediately above the site. Principal works are 10,000m3 of rock excavation and concrete works.

(3) Headrace Tunnel:

The headrace tunnel is of circular cross-section with diameter of 3.9m. Length is 2,980m. Excavation will be performed simultaneausly from the upstream side access tunnel (L=200m) and the downstream access tunnel below the surge shaft (L=180m). Full face excavation utilizing 3 boom hydraulic jumbo and 1.6m3 capacity hydraulic loador will permit average daily progress of 5.0m, and an overall excavation period of 13-month. Lining will be carried out parallel to excavation. Progress rate for lining is 10m average per day for total lining period of 7-month.

(4) Surge Shaft:

Soil and soft rock at the top of the surge shaft will be excavated and hard rock removed after drilling a pilot shaft. Excavated debris will be removed from the access tunnel also serving for penstock construction. Excavation and concrete works quantities are 10,000m3 and 3,400m3, respectively. Construction is to be carried out simultaneous to tunnel construction and to be completed prior to penstock construction.

(5) Penstock:

The penstock route (L=227m) will be excavated starting from the lowest access tunnel to the power station cavern by first drilling a pilot shaft.

(6) Penstock Pipe:

Penstock sections will be prepared at the surface in 6-9m circular sections, transported to the power station cavern by access shaft and welded together section by section from the power station side, and concrete placed.

(7) Powerhouse:

Prior to construction of the main power station structure, a main access tunnel (L=600m) and two branch tunnels, one (L=150m) to the upper portion of the power station cavern and the other (L=160m) to the lower portion, are to be constructed. These access tunnels are to be excavated by conventional full-face tunneling requiring 9 months. Excavation for the main power station structure is to performed for the arch portion from the upper access tunnel, for the middle portion from the main access tunnel and for the lower portion from the lower access tunnel.

After completing 2,500m3 of excavation and 1,100m3 of concrete works for the arch portion, excavation for the main part of the cavern will be by the bench cut method. The cable shaft will be excavated downwards after first drilling a pilot shaft. A period of 28 months will be necessary for completion of the 20,500m3 of excavation and 7,500m3 of concrete works for the power station. Time required for installation of turbines and generating equipment, including operation testing, is 12 months.

(8) Tailrace Tunnel:

The upper and lower access tunnels are to be utilized for construction of the tailrace gate chamber and tailrace surge chamber at the upstream portion of the tailrace (L=2,170m). Required construction period for the tailrace is 24 months.

(9) Tributaries Intake:

Intake facilities for the Nanu oya can be implemented independently of other construction works. For this reason, intake dam and other facilities directly on the river are to be constructed during the dry season. A coffer dam will be erected for intake dam construction.

Intake tunnel is to consist of two small cross-section segments, 1,650m and 2,480m in length respectively. Tunnel segments are to be excavated from both ends, utilizing small-scale loaders and rail carts for debris removal.

Year-wise Construction Schedule

(1) First Year (1993):

Construction of main access tunnel (L=600m) to power station cavity, and branch shafts (150m and 160m, respectively) to upstream and downstream of the power station cavity. Excavation for power station structure and upper arch, and concrete lining.

(2) Second Year (1994)

Commencement of excavation of access tunnels (at the 200m point from intake and at the surge shaft site), penstock route and surge shaft. Excavation of power station cavern, and tailrace route.

(3) Third Year (1995):

Concrete lining of headrace following completion of excavation. Construction of intake tunnel section. Placement of 1/2 of total penstock following conmpletion of penstock route excavation.

(4) Fourth Year (1996):

Completion of open excavation, concrete placement and gate and screen installation for intake structure. Concrete lining and high pressure grouting of headrace tunnel. Completion of remaining 1/2 of penstock. Concrete lining of surge shaft. Installation of turbine and generating equipment at power station. Switchyard and tailrace outlet construction.

6.4.3 Talawakelle Power Station

Construction Method

(1) Intake:

Intake structure is the overflow shaft type. Following completion of open excavation and tunnel excavation, tunnel concrete lining is carried out followed by open concrete works.

(2) Headrace:

The headrace tunnel is 13.1km in total length and requires the longest construction period of all the Project works. Tunnel construction is to be performed from three access tunnels, i.e.

upstream tunnel (L=400m), Pundal Oya tunnel (L=450m) and downstream tunnel (L=250m). Headrace tunnel length breakdown is as follows:

Intake-upstream access tunnel: 1,202m

Upstream access tunnel-Pundal Oya access tunnel: 7,400m (60-month)

Pundal Oya access tunnel-downstream access tunnel: 4,000m (35-month)

Downstream access tunnel-surge shaft: 650m

Construction method is the same as for the headrace tunnel in the Caledonia scheme.

(3) An access tunnel (L=360m) is to be constructed at the lower portion of the surge shaft for removal of excavated debris. Pilot shaft is drilled first, and actual excavation will be carried out from the top downwards using the pilot shaft to throw off excavated debris. Conventional excavation methods are to be adopted. Major works are 20,300m ^{3} of excavation and 5,900m ^{3} of concrete placement.

(4) Penstock:

An access tunnel (L=150m) will be constructed at the level portion of the penstock route, and the penstock tunnel is divided into two segments for construction. For the upper segment the access tunnel will be utilized for removal of excavated debris, and pipe and cement are to be brought in from the surge shaft. For the lower portion of the route, carry out of excavated debris is to be from the power station lower tunnel, and pipe and cement are to brought in by the access tunnel (with the exception of the portion of penstock route closest to the power station). Excavation period is to consist of 7 months for inclined pilot shaft and 5 months for widening. Each of the two segments of penstock route will be installed starting from the lowermost end of the segment.

A 1.5m/day progress rate for installation of penstock is possible for a total of 12 months for penstock installation alone. However, as temporary works in the tunnel and concrete placement around pipe are also necessary, total installation period is 22 months.

(5) Powerhouse:

In prepation for power station construction, a main tunnel (L=730m), an upper tunnel (L=160m), and a lower tunnel (L=220m) will be excavated. The effective use of these three tunnels is necessary as the power station is a large scale underground structure requiring excavation height of 40m, 46,000m3 of excavation and 15,500m3 of concrete placement.

Access/Debris Removal	Major Sector	Excavation Quantity
Upper Tunnel	Arch portion	5,600m3
Main Tunnel	Assembly room floor and above	38,400m3
Lower Tunnel	Assembly room floor and below	2,200m3

Following excavation and concrete lining of the arch from the upper tunnel, excavation is perfomed from top down by the benchcut method.

Excavated debris will be thrown from the excavated surface by glory hole to the access tunnel for removal. PC anchors will be placed as excavation proceeds to prevent loosening of the excavated wall surface. Civil works will require 30 months and equipment installation including operations test will require 12 months.

(6) Tailrace:

The tailrace (L=410m) and tailrace gate chamber are constructed principally from the power station lower tunnel and the tailrace outlet. Gate chamber is to be constructed using power station upper tunnel.

(7) Outlet:

As the tailrace outlet is to be constructed at a location lower than the present riverbed, a coffer dam will be constructed and excavation of riverbed is to be carried out during the dry season.

(8) Tributary Diversion:

Construction for tributary diversion will be performed during the dry season for those structures directly on the river. Coffer dams will be constructed in order to implement intake dam works.

The longest tunnel segment for diversion from the Devon, Puna and Pundal rivers is the 3,280m segment from Puna intake No. 2 to the Pundal Oya. Construction will be performed from both tunnel ends, and required period is 24 months. In excavating the Pundal oya intake shaft, a pilot shaft will be drilled and then widened from the top down. Debris removal will be by the Pundal oya access shaft. The intake shaft will be constructed simultaneously to the headrace tunnel.

(9) Transmission:

The transmission line route (220kV, 2 circuit, L=18.5km) is designed to pass along the mountain terrain on the left bank of the existing Kotmale reservoir. Number of steel towers would be in excess of 50. Access road will be constructed for erection of towers at sites well distanced from existing road. Construction period is 2 years.

Year-wise Construction Schedule

(1) First Year (1991):

Road construction. Base camp erection. Construction of power facilities.

(2) Second Year (1992):

Construction of upstream and Pundal Oya access tunnels. Start of excavation of upstream 7.4km segment of headrace tunnel utilizing the two tunnels.

(3) Third Year (1993):

Continuation of excavation of upstream tunnel segment. Construction of downstream access tunnel. Start of excavation of downstream portion (4km) of headrace tunnel. Construction of conveyance and upper and lower access shafts for power station. Completion of excavation of upper power station cavern and arch.

(4) Fourth Year (1994):

Open construction of surge shaft and completion of access tunnel to the lower portion of the surge shaft. Completion of 1/2 of penstock route excavation. Completion of one portion of concrete works for power station. Cable shaft excavation and construction of tailrace and tailrace gate chamber.

(5) <u>Fifth Year (1995):</u>

Open construction for intake structure. Completion of headrace tunnel excavation and start of concrete lining. Concrete lining of surge shaft. Completion of excavation for penstock route. Installation of penstock pipe and placement of concrete. Completion of concrete works for power station structure. Installation of draft tube. Completion of construction of cable shaft and tailrace canal. Erection of steel towers for transmission line. Land preparation and foundation works for outdoor switchyard. Completion of 1/2 of construction works for tributary diversion.

(6) <u>Sixth Year (1995):</u>

Completion of tunnel portion of intake works. Grouting and concrete lining of headrace tunnel. Completion of remainder of penstock construction. Installation of generating equipment. Construction of transmission line and switchyard facilities. Test operation.

CHAPTER VII

PROJECT COST

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PROJECT COST

7.1 Basic Criteria

The following basic prerequisites were considered in estimation of Project cost:

(1) Costs are estimated at price levels as of the end of 1986.

(2) Exchange rates adopted are: US$1=Rs.28.5, US$1=¥161.6, Rs.1=¥5.67.

(3) All works will be performed by contractors. Contractors will provide all necessary construction equipment and facilities. The cost for these will be included in the contract price.

(4) The executing agency for the Project is expected to be the Ceylon Electricity Board. As a result, in contrast to the Mahaweli development projects being implemented by the Mahaweli Authority, various duties and taxes on imported equipment and materials must be paid by the contractor. These taxes and duties will be reimbursed by the implementing agency.

(5) Construction unit costs are determined on the basis of market survey, Project construction procedure and work quantities, as well as study of unit costs adopted for other similar projects in Sri Lanka.

(6) Engineering and administrative cost is calculated at 10% the total cost for preparatory works, civil works, electro-mechanical works, and land aquisition and compensation.

(7) Physical contingency is calculated at 10% the total cost for preparatory works, civil works, electro-mechanical works, land aquisition and compensation, and engineering and administration cost.

(8) Interest during the construction period is not included in the Project cost.

(9) Project life is determined at 59 years, consisting of 9 years for design, construction, etc. and 50 years for civil structure life.

Project cost estimated on the basis of the above criteria is considered as the financial cost for the Project, Economic and financial analysis in Chapter 8 is based on this financial cost (considering conversion factor in the case of economic analysis).

This financial cost, however, will not be the same as the cost to be borne by CEB for actual Project implementation in the future. This is because the estimated financial cost may rise as a result of price escalation, and also, interest during construction will have to be paid by CEB. These additional costs are not included in the economic and financial analysis based on the principle of project evaluation. Cost including contingency for price escalation and interest during construction is estimated , however, for reference.

Assumptions for calculation of price escalation contingency and interest during construction are presented below:

(1) Price Escalation Rate

Price escalation rate is assumed at 2.5% per annum for foreign currency portion and 4.0% for domestic portion. In determining these rates, consideration was given i) in the case of foreign currency portion, to the simple average (2.85%) for the wholesale price index of the G-5 countries (U.S., Japan, West Germany, France and Great Britain) over the past 5 years, and ii) in the case of domestic portion, to the average price escalation (7.03%) for the same period in Sri Lanka. Values were subsequently adjusted to reflect world price escalation forecast (1.12%) by the World Bank for 1986-1995.

(2) Interest During Construction

Interest during construction is estimated assuming the following interest rate.

	Source	Portion	Interest rate
Foreign Portion	Bilateral assistance or International agency	100% of foreign currency portion, 30% of domestic currency portion	3%
Domestic Portion	CEB internal reserves and Domestic lending institution	70% of domestic currency portion	7% (average)

7.2 Construction Unit Costs

On-site prices were calculated as exfactory prices as of the end of 1986, or in the case of imported equipment and material, CIF price Colombo, plus the relevant duties and taxes as well as transport cost to site. Site costs were subsequently calculated as on-site prices plus various overhead and loss. Computed unit costs are presented below. Details are set out in APPENDIX-V.

Wages

With the exception of highly skilled labor (including foremen) and security personnel, local labor is to be procured through labor suppliers. Standard number of working days per year is assumed at 270. Wages for skilled labor from off-shore (form carpenters, welders, etc.) are assumed at US$2,000/month (Rs.1,900/day).

DAILY WAGES

Unit: Rs.

Forman	Heavy Machinery Operator	Driver	Form Carpenter	Concrete Mechanic	Worker
283	283	212	167	147	102

Port charges

Port charges consist of off-loading charges and customs commmissions. The former include wharf charges, crane fees, etc. and run US$3.65 per m^3 or ton (whichever is larger). The latter is US$2.42 per m^3

or ton. Both are consequently calculated at US$6.07 per m^3 or ton (whichever is larger).

Transport Cost to Site

Where cement is transported to site by hauling companies in 50kg bags, transport cost is US$11.95/t (Rs.340/t); bulk haulage for the same is US$17.95/t (Rs.512/t). Transport cost for other materials and equipment (reinforcing bar, penstock pipe, heavy equipment, etc.) is US$19.08/t (Rs.544/t).

Construction Machinery

In principal, contractors are to pay duties and taxes on construction machinery brought in from off-shore, and these expenditures are to be included in the contract price. Said expenditures are estimated on the basis of the following criteria.

i) Customs duties: 10% CIF

ii) BTT: 10% (CIF + customs duties)

iii) Port charges: 2% CIF

iv) Transport costs: Transport cost is ignored as it is assumed that contractors will haul machinery themselves.

v) Administrative and overhead costs: 12% CIF

On the basis of the above, site cost for construction machinery is computed as: CIF (100%) + customs duties (10%) + BTT (11%) + port charge (2%) + administrative/overhead cost (12%) = 135% CIF.

Fuel Cost

Fuel for Project implementation consists almost entirely of diesel for construction machinery and power generation, and some lubricants. Fuel will be obtained from the Ceylon Petroleum Corporatin and has a site cost of Rs.10/ℓ.

Cement

At present both domestically produced and imported cement (from Indonesia, Kenya, Soviet Union, etc.) is used in Sri Lanka. Use of cement from off-shore is envisaged for the Project in view of the shortages of locally available cement. Site cost is Rs.3,160/t.

Steel

Steel consists primarily of reinforcing bar. Although re-bar is produced locally by the Ceylon Steel Corporation, the practice in the past on large-scale national projects has been to utilize imported steel from the standpoint of quality and quantities procurable in Sri Lanka. Off-shore steel will be used for the subject Project as well. Site cost is Rs.15,200/t.

Electro-mechanical Equipment, Transmission Line, Penstock, etc.

Turbines, generators, electrical facilities, penstock pipe, transmission line, etc. are to be procured by the CEB. It will be necessary for CEB to pay customs of 5%, BTT of 10%, port charges (estimated at 2% CIF), and transport costs to site (Rs.544/t; assumed for estimation purposes to be 2.5% CIF). Upto-site cost is accordingly calculated at 120% CIF.

Others

This cost item consists of power utility costs, concession rights fees for aggregate production, miscellaneous expenditures, etc. These items are estimated on the basis of costs on site.

Compensation Costs

Refer to the following section.

Construction Unit Costs

On the basis of the above criteria, unit costs for each construction work item are presented in TABLE 7.2-1. Input-wise composition ratio and input-wise foreign currency portions are indicated in the said table.

TABLE 7.2-1 UNIT COST PER CONSTRUCTION ITEM AND INPUT-WISE COMPOSITION

Construction Item	Specification	Unit Cost	a.Labor Cost			b.Machinery cost	c.Fuel cost	d.Materials Cost		e.Facilities	f.Others
			Unskilled Labor	Skilled Labor (L)	Skilled Labor (F)			Cement	Steel		
			(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Dam											
Excavation	Soil	100/m3	2	2	1	68	24	-	-	-	3
"	Rock	300/m3	3	4	1	42	18	-	-	-	32
"	Tunnel	1,800/m3	6	5	3	58	11	-	5	-	12
"	Finishing	740/m3	40	14	1	40	4	-	-	-	1
Concrete	Open	2,700/m3	5	6	2	29	15	25	-	-	18
"	Tunnel	5,000/m3	2	2	1	15	10	46	-	-	24
"	Plug	4,500/m3	1	1	1	16	10	50	-	-	21
Shotcrete		10,000/m3	1	1	9	11	6	60	-	-	12
Concrete Form	Dam	850/m2	16	26	8	5	1	-	44	-	-
Re-bar		25,000/t	4	24	4	5	2	-	61	-	-
Boring		2,000/m	12	10	13	44	8	-	-	-	13
Grout	Curtain	12,000/t	3	2	1	28	27	34	-	-	5
Mortar	Low Pressure Grouting	6,000/t	1	1	9	8	4	54	-	-	23
Foundation Cleaning		800/m3	50	16	1	25	8	-	-	-	-
Concrete Diaphragm		7,000/m3	6	2	2	40	18	15	11	-	6
Sheet Pile		24,000/t	1	1	1	42	5	-	50	-	-
Riprap		300/m3	2	2	-	44	28	-	-	-	24
Concrete Block		1,400/m2	10	2	-	10	3	60	5	-	10
Concrete Slab		3,500/m3	10	5	1	31	15	38	-	-	-
Road Paving	Asphalt	1,800/m2	5	6	3	33	18	-	-	-	35
Gates		186,000/t	1	2	7	2	1	-	3	84	-
Bottom Outlet	Valve	8,000,000	2	10	14	2	1	-	2	69	-
Headrace/Power Sation											
Excavation	Open, Rock	300/m3	3	4	1	42	18	-	-	-	32
"	Tunnel	1,800/m3	6	5	3	58	11	-	5	-	12
Concrete	Open	3,000/m3	5	6	2	29	15	35	-	-	8
"	Tunnel	5,000/m3	2	2	1	15	10	46	-	-	24
"	Plug	4,500/m3	1	1	1	16	10	50	-	-	21
Shotcrete		10,000/m3	1	1	9	11	6	60	-	-	12
Concrete Form	Tunnel	500/m2	14	24	6	5	1	-	50	-	-
Re-bar		31,000/t	2	4	2	-	-	-	92	-	-
Mortar	Low Pressure Grouting	5,000/Tm	1	1	9	8	4	54	-	-	23
Grout	High Pressure	10,000/Tm	7	6	7	18	36	17	-	-	9
P/S Structure	Talawakelle	67,000,000	5	10	15	13	7	15	10	-	25
	Caledonia	40,000,000	5	10	15	13	7	15	10	-	25
Rock Bolt	Tunnel	250/m	2	4	2	18	4	-	70	-	-
P/C Anchor	Power Station	25,000/no.	2	10	31	16	8	2	26	-	5
Gates		200,000/t	1	2	7	2	1	-	3	84	-
Screen		80,000/t	20	20	3	4	1	-	-	52	-
Penstock	Penstock	88,000/t	2	5	30	5	3	2	-	53	-
F.C.Portion (%)			0	0	100	74	40	59	71	83	20

7.3 Land Acquisition and Compensation

Land aquisition area and quantities of dwellings and facilities requiring compensation are as indicated in section 5.8. Costs are estimated as set out below.

Land

The Project site and its vicinity are a reknown tea producing area, and the location of numerous tea estates. These are national tea estates, falling under the jurisdiction of either the State Plantation Corporation (SP) or the Janatha Estate Development Board (JEDB). Each plantation cultivates both the high yielding VPT (vegetatively propagated tea) and the traditional variety seedling tea in ratios varying from estate to estate. According to the Evaluation Department, SP and JEDB, the acquisition cost or assessed value at the feasibility study stage for area cultivated with tea averages Rs.40,000/acre, or Rs.98,880/ha, regardless of whether the type of tea crop is VPT or seedling tea. The total compensation required for tea estate land is accordingly : Rs.98,850/ha x 870ha = Rs.86,000,000.

Households not employed on tea estates are engaged primarily in cultivation of vegetables and grain crops other than rice, or are engaged in commerce. According to the Evaluation Department, fertile land is cultivated, and the value thereof is assessed at Rs.60,000/ac. As farmland is limited to the periphery of residence occupied area in the case of this Project, both are assessed under the Project at the same value. Thus compensation for this residence and farmland area is Rs.148,300/ha. Compensation total is Rs.148,300/ha x 85ha = Rs.12,600,000.

River, wasteland, and road area is excluded from compensation consideration.

Dwellings, Public Facilities

Residences, commercial establishments and public facilities within the Project area requiring compensation are preliminarily estimated at approximately 1,000. At the feasibility study stage, the value for an average dwelling or facility was assessed by the Evaluation Department at Rs.150/ft^2. On the basis of this and data on compensation and construction costs for tea estate facilities obtained from SP and JEDB, unit cost for dwellings and facilities was estimated (see TABLE 7.3-1).

Total compensation cost for all relevant dwellings and facilities was estimated at Rs.210,000,000.

Resettlement Cost

The population of the area for which compensation will be necessary consists primarily of tea estate workers, farmers and persons engaged in commerce, and their respective families. In addition to compensation, cost for resettlement of this population will be also borne by the Project.

The majority of tea estate workers, (roughly 1,900 households) would be relocated to other tea estates where labor is lacking. The Project executing agency, CEB, would be required to allocate Rs.12,500 moving fee per family. In addition, it would be necessary to construct twin cottages at the tea estates to which households have been resettled. Construction of twin cottages has been the recent policy of SP and JEDB, and construction cost per single cottage is Rs.100,000. Consequently, cost for resettlement would be :

(Rs.12,500/family x 1,900 families) + (Rs.100,000/cottage x 950 cottages) = Rs.119,000,000

For farmer households and population engaged in commerce, it would be necessary to allocate an average Rs.10,000 moving fee and provide a land alotment of 2 acres per family. Acccording to concerned Government officials, residents of the Project area are not receptive to relocation to lowland due to the climate change, and it would most likely be necessary to resettle them on land inside tea estates.

Dwellings and facilities of households engaged in agriculture or commerce and requiring compensation under the Project total 400. As commmunal living is common, actual number of individual families is about twice this figure. In the case of other similar projects, roughly half the households (particularly those engaged in commercial activities) tended to remain in the project area vicinity.

TABLE 7.3-1 COMPENSATION FOR DWELLINGS AND FACILITIES

No.	Facilities	Total Numbers	Average Floor Area (ft^2)	Average Unit Cost ($Rs./ft^2$)	Total Costs (Rs.'000)
1	Factories	8	-	3 million/ factory	24,000
2	Estate Offices	7	-	500,000/office	3,500
3	Bungalows	16	-	600,000/bungs	9,600
4	Quarters	150	-	400,000/qua.	60,000
5	Twin Cottages 1/	(114)	-	(100,000/t.c.)	(11,400)
6	Lines 2/	(206)	-	(300,000/line)	(61,800)
7	Workshops/Stores/Sheds /Garages	60	1,000	190	11,400
8	Schools	9	1,200	190	2,100
9	Dispensaries/Maternity Ward/ Nursery Schools/Baby Rooms	15	-	200,000/nit	3,000
10	Hindu Temples/Buddhist Temples/Churches/Mosqu es	26	600	250	3,900
11	Residences/Shops 1) Big Scale	31	1,200	250	9,300
	2) Medium Scale	169	600	200	20,300
	3) Small Scale	186	200	150	5,600
12	Other Important Facilities (Bank, Gov. Offices, Sports Club, etc.)	14	-	4 million/ facility	56,000
	Total	1,011			208,700

Note: Compensation costs for 1/ and 2/ are counted in resettlement cost

Under the subject Project, actual families to be resettled is estimated at 400, requiring alotment of 800ac or 324ha (see TABLE 5.8-1). Total moving fee is estimated at: Rs.10,000/family x 800 families = Rs.8,000,000. In addition, it is necessary to construct required infrastructure (power distribution, water service facilities, etc.) and public welfare facilities (community centers, dispenseries, primary schools, etc.) at the resettlement destination. Such costs approximate Rs.24,000,000.

Compensation Related Costs

On the basis of the above calculation, total compensation related costs are calculated as follows:

(1) Land aquisition and compensation — Rs.99,000,000

Tea field: @Rs.99,000/ha × 870ha = 86,000,000

Vegetable field: @Rs.148,300/ha × 85ha = 13,000,000

(2) Dwellings, public facilities — Rs.210,000,000

(3) Relocation and development of relocation destination: — Rs.151,000,000

- Moving fee (tea estate workers)

@Rs.12,500/family × 1,900 families = Rs.24,000,000

- Moving fee (agricultural and commercial population)

@Rs.10,000/family × 800 families = Rs.8,000,000

- Twin cottage construction cost (tea estate worker families)

@Rs.100,000/cottage × 950 cottages = Rs.95,000,000

(4) Infrastructure development: — Rs.24,000,000

TOTAL: — Rs.460,000,000

7.4 Overall Project Cost and Annual Disbursement

7.4.1 Overall Project Cost

The overall Project cost is estimated as follows:

TABLE 7.4-1 PROJECT COST

Unit: Rs. million

Cost Item	Caled.	Talaw.	Total	FC	LC
1. Preparatory Works	154	365	519	263	256
2. Civil Works	2,350	2,714	5,064	2,569	2,495
Dam	1,215	114	1,329		
Canal and Power Station	1,135	2,600	3,735		
3. Electro-mechanical Facilities	478	1,358	1,836	1,520	316
Gates, Penstock, etc.	89	278	367		
Turbines, Generators, Transformers, etc.	389	1,080	1,469		
4. Transmission Facilities and Works	6	95	101	83	18
5. Land Aquisition and Compensation	450	130	580	62	518
(subtotal for above)	(3,438)	(4,662)	(8,100)	(4,497)	(3,603)
6. Engineering and Admi. Cost 1/	344	466	810	469	341
(sub-total for above)	(3,782)	(5,128)	(8,910)	(4,966)	(3,944)
7. Physical Contingency 2/	378	512	890	496	394
Total	4,160	5,640	9,800	5,462	4,338

1/ Engineering and administrative cost is assumed at 10% of items 1.to 5.

2/ Physical Contingency is assumed at 10% of items 1.to 6.

TABLE 7.4-2 presents a detailed breakdown of cost for individual construction work items. Based on foreign and local currency portions as set out in TABLE 7.4-5, and considering price escalation as discussed in section 7.1, price escalation contingency during the construction period is estimated at Rs.2,626.6 million (see Table 7.4-4).

Further taking into account interest during construction as presented in section 7.1, said interest for Project cost is Rs.687.5 million for the foreign loan portion, and Rs.851.9 for the domestic loan portion to yield a total of Rs.1,539.4 million. Project cost including price contingency and interest during construction is thus estimated at Rs.13,966.0 million.

7.4.2 Annual Disbursement

On the basis of the above overall Project cost and construction schedule as indicated in FIG.6.1-1, annual disbursement of Project implementation cost is presented in TABLE 7.4-3. TABLE 7.4-4 shows annual price escalation and interest during construction.

7.4.3 Input-wise Annual Disbursement

Input-wise annual disbursement is presented in TABLE 7.4-5. These values are utilized in calcualtion of foreign and local currency portions and economic prices.

TABLE 7.4-2 BREAKDOWN OF PROJECT COST

Unit : Rs.million

Work Item	Caledonia	Talawakelle	Total
1. Preparatory Works	154.0	365.0	519.0
Roads	52.0	226.0	278.0
Electricity during Construction	17.0	24.0	41.0
Project Camp	85.0	115.0	200.0
2. Civil Works			
2.1 Dam Works	1,215.0	114.0	1,329.0
Temporary Diversion	100.0	19.0	
Main Dam	84.0	75.0	
Foundation Treatment	107.0	3.0	
Saddle Dam	100.0		
Miscellaneous	68.0	17.0	
2.2 Water Way and Power Station Works	1,135.0	2,600.0	3,735.0
Tributary Diversion	135.6	266.3	
Intake	26.7	47.2	
Diversion Tunnel	268.4	1,341.3	
Surge Tank	37.4	102.8	
Penstock	28.2	101.5	
Powerhouse	304.8	426.4	
Tailrace Tunnel	188.7	67.2	
Outlet	9.3	20.5	
Switchyard	21.9	35.6	
Powerhouse Interior Structure	40.0	67.0	
Miscellaneous	54.0	124.2	
3. Electro-mechanical Facilities and Works	478.0	1,358.0	1,836.0
Gates and Penstocks, etc.	89.0	278.0	367.0
Turbines, Generators, Transformers, etc.	389.0	1,080.0	1,469.0
4. Transmision Facilities and Works	6.0	95.0	101.0
5. Land Acquisition and Compensation	450.0	130.0	580.0
(Subtotal for Above)			(8,100.0)
6. Engineering and Administration			810.0
(Subtotal for above)			(8,910.0)
7. Physical Contingency			890.0
Total			9,800.0

TABLE 7.4-3 ANNUAL DISBURSEMENT OF CONSTRUCTION COST (FINANCIAL COSTS)

Unit: Rs. million

	Total	1988	1989	1990	1991	1992	1993	1994	1995	1996
Preparatory Works	519				367.8	151.2				
Civil Work	5,064					152.0	583.5	1,047.2	1,898.1	1,383.2
Caledonia Dam	1,215					-	51.3	198.0	584.9	380.8
Caledonia Power Station	1,135					-	157.1	257.2	442.2	278.5
Talawakelle Dam	114					-	-	13.2	46.2	54.6
Talawakelle Power Station	2,600					152.0	375.1	578.8	824.8	669.3
Electrical & Mechanical Facilities	1,836						367.3		1,008.5	460.2
Gates & Penstock, etc.										
Caledonia	89						-		30	58.3
Talawakelle	278						-		96.4	181.6
Turbine & Generator										
Caledonia	389						97.3		233.4	58.3
Talawakelle	1,080						270.0		648.0	162.0
Power Transmission Facilities	101								55.6	45.4
Caledonia	6								3.3	2.7
Talawakelle	95								52.3	42.7
Land Aquisition & Compensation	580				490.0	30.0	18.0	18.0	12.0	12.0
Caledonia	450				382.5	22.5	13.5	13.5	9.0	9.0
Talawakelle	130				107.5	7.5	4.5	4.5	3.0	3.0
Engineering and Administrative Cost	810	160.0	160.0	20.0	64.4	49.5	67.5	70.2	124.4	94.0
Physical Contingency	890	16.0	16.0	2.0	92.2	38.3	103.5	113.5	309.2	199.3
Total	9,800	176.0	176.0	22.0	1,014.4	421.0	1,139.8	1,248.9	3,407.8	2,194.1

TABLE 7.4-4 ANNUAL PRICE ESCALATION CONTINGENCY AND INTEREST DURING CONSTRUCTION

Unit: Rs.million

Item	Total	1988	1989	1990	1991	1992	1993	1994	1995	1996
Project Cost	9,800.0	176.0	176.0	22.0	1,014.4	421.0	1,139.8	1,248.9	3,047.8	2,194.1
Foregin Currency Portion	5,461.8	123.2	123.2	11.0	247.1	217.1	728.7	659.7	2,057.0	1,294.8
Local Currency Portion	4,338.2	52.8	52.8	11.0	767.3	203.9	411.1	589.2	1,350.8	899.3
Price Escalation Contingency (foreign currency portion 2.5%/year)	1,157.8	4.6	7.8	1.0	29.0	31.6	126.9	134.2	480.4	342.3
Price Escalation Contingency (local currency portion 4%/year)	1,468.8	3.2	5.4	1.6	148.1	49.1	119.4	201.5	534.5	406.0
Price Escalation Contingency Total	2,626.6	7.8	13.2	2.6	177.1	80.7	246.3	335.7	1,014.9	748.3
Total	12,426.6	183.8	189.2	24.6	1,191.5	501.7	1,386.1	1,584.6	4,422.7	2,942.4
Interest During Construction (foreign loan portion 3%/year)	687.5	4.3	8.8	9.3	25.8	35.5	66.0	96.9	190.0	250.9
Interest During Construction (locally procured portion 7%/year)	851.9	2.7	5.6	6.2	51.1	63.5	89.5	128.2	220.6	284.5
Total Interest During Construction	1,539.4	7.0	14.4	15.5	76.9	99.0	155.5	225.1	410.6	535.4
Grand Total	13,966.0	190.8	203.6	40.1	1,268.4	600.7	1,541.6	1,809.7	4,833.3	3,477.8

Note: Foreign and local currency portions are values calculated in tables 7.4-5.

TABLE 7.4-5 INPUT-WISE ANNUAL DISBURSEMENT (FINANCIAL COSTS)

Unit : Rs. million

	Foreign Currency Ratio	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total	Foreign Currenc Portion	Domestic Currency Portion
a.Labor													
Unskilled	0	-	-	-	19.9	18.0	34.5	56.3	110.6	76.7	316.0	-	316.0
Skilled (Local)	0	-	-	-	39.8	25.6	40.3	62.1	139.8	93.9	401.5	-	401.5
Skilled (foreign)	100	-	-	-	59.7	31.6	60.2	47.6	159.7	128.0	486.8	486.8	-
b.Construction Machinery	74	-	-	-	51.7	109.4	264.3	378.8	512.7	329.9	1,646.8	1,218.7	428.1
c.Fuel	40	-	-	-	27.8	29.4	65.5	111.7	260.0	183.5	677.9	271.2	406.7
d.Construction Materials													
Cement	59	-	-	-	59.7	29.7	57.8	150.1	449.9	320.0	1,067.2	629.6	437.6
Steel	71	-	-	-	39.8	25.4	56.8	100.5	187.1	123.3	532.9	378.4	154.5
e.Facilities	83	-	-	-	-	-	308.5	0.7	850.6	443.2	1,603.0	1,330.5	272.5
f.Others	20	-	-	-	99.5	64.2	80.9	157.5	303.5	202.3	907.9	181.6	726.3
g.Compensation	0	-	-	-	460.0	-	-	-	-	-	460.0	-	460.0
(Sub Total)					(857.9)	(333.3)	(968.8)	(1,065.3)	(2,973.9)	(1,900.8)	(8,100.0)	(4,496.7)	(3,603.3)
h.Engineering & Admi. Cost	70 (~'90) 50 ('91~)	160.0	160.0		64.4	49.5	67.5	70.2	124.4	94.0	810.0	469.0	341.0
(Sub Total)		(160.0)	(160.0)	(20.0)	(922.3)	(382.8)	(1,136.3)	(1,135.5)	(3,098.3)	(1,994.8)	(8,910.0)	(4,965.7)	(3,944.3)
i.Physical Contingency		16.0	16.0	2.0	92.1	38.2	103.5	113.4	309.5	199.3	890.0	496.0	394.0
Total		176.0	176.0	22.0	1,014.4	421.0	1,139.8	1,248.9	3,407.8	2,194.1	9,800.0	5,461.8	4,338.2
Foreign Currency Portion		123.2	123.2	11.0	247.1	217.1	728.7	659.7	2,057.0	1,294.8	5,461.8		
Domestic Currency Portion		52.8	52.8	11.0	767.3	203.9	411.1	589.2	1,350.8	899.3	4,338.2		

CHAPTER VIII

PROJECT EVALUATION

CHAPTER VIII

PROJECT EVALUATION

8.1 Economic Evaluation

8.1.1 General

The objective of economic analysis is to provide the concerned decision makers with sufficient criteria to determine whether a particular project warrants implementation from the standpoint of the national economy. In other words, whether the project should be implemented or not is evaluated considering the degree to which the project contributes to the optimum allocation of scarce resources.

According to the proposition of economic theory, the optimum allocation of resources is realized by equilibrium prices in a completely competitive market. Consequently, in economic theory, equilibrium prices under total competition, rather than prevailing market prices, are applied to project inputs and outputs. However, with the exception of very few cases, completely competitive markets do not in reality exist, and as a consequence, real equilibrium prices do not exist either.

Thus, as a result, equilibrium price proxies are employed. In the case of traded items, international prices (CIF price in the case of imported items and FOB price in the case of exported items) are adopted, and for non-traded items, i.e., services, land, etc., opportunity costs expressed in border prices are applied.

Opportunity costs expressed in border prices are defined as opportunity costs firstly expressed in local currency (hereinafter referred to as economic prices) and then converted to international prices (hereinafter referred to as accounting prices) through application of a Standard Conversion Factor (hereinafter referred to as SCF). The conversion is premised on the fact that the exchange rate of the subject country is distorted by the existence of tariffs, export duties, subsidies, etc. On the basis of the above described proxy prices, project cost and benefit are compared.

Economic evaluation of power projects is essentially carried out in line with the above described approach. Nevertheless, there is a certain methodology applied specifically to power projects regarding quantification of benefits. In several aspects, power projects differ from production projects of such goods as agricultural and industrial products.

First, in particular, generated power has no value in and of itself. It only bears benefit when generated power is input into production activities as in the manufacturing industry, or when the generated power is converted to lighting, appliance operation, etc. in home use.

Second, power is a unique product in that it is not subject to the competitive market as it is generally supplied by public entities at controlled prices, based on government policies and with few exceptions (Nepal ~ India, Uganda ~ Kenya, etc.) is not sold across borders.

As a result, international prices for energy do not exist. It is therefore extremely difficult to quantify the benefits of power. Even if quantification were possible, expression in equilibrium prices or opportunity costs expressed by an international standard would be virtually impossible.

In this connection, specifically with regards to hydropower projects, the conventional approach to economic analysis has been the so called "alternative facility method" whereby benefit is evaluated in terms of savings in initial investment costs, and operating and maintenance costs for alternative facilities of equivalent power generating capacity which must be implemented for secure supply if the said hydropower project is not realized.

The internal rate of return obtained through the above approach is then a discount rate which equates the economic costs for the hydropower project in question with economic costs for alternative energy sources or facilities. This simply means that provided the calculated internal rate of return shows higher percentages than that of the opportunity cost of capital, the said project is more economical (in that it costs less) than implementation of alternative power facilities.

Accordingly, this indicator does not represent an IRR calculated on the basis of the real value of power itself, it is only a cost comparison with possible alternative facilities for producing the same energy. It is thus different in nature from the IRR obtained in agricultural and industrial production projects whereby said IRR indicates economic (but not financial) viability of the project itself. For the purposes of this report, although IRR will be calculated in the above discussed conventional manner for hydropower projects, it will be referred to as the economic internal rate of return based upon alternatives (or hereinafter "alternative EIRR").

In recent years, the World Bank and other international institutions have developed an analytical approach whereby tariffs are established on the basis of long-run marginal costs (hereinafter referred to as LRMC) and multiplied to power output to determine the inherent benefit of power production. This approach derives from economic theory which advocates that under a completely competitive market, long-run marginal costs maximize economic efficiency and optimize allocation of scarce resources.

Over the past few years, the CEB has also conducted research on the LRMC method, and is calculating annual LRMC on a trial basis. The latest LRMC study draft, which has just been prepared in March 1987, contains some theoretical problems as well as problems of data application. In addition to that, both internationally and within Sri Lanka, the alternative facility method is still the mainstream in economic analysis for power projects. Thus in this report, economic internal rate of return will not be obtained basing on energy costs and capacity costs derived from trial LRMC calculations of CEB.

8.1.2 Conversion Factor

Standard Conversion Factor (SCF)

All financial costs for the subject Project have been estimated in terms of fixed domestic prices in Sri Lanka as of December 1986. It is subsequently necessary to convert these financial costs into economic costs computed by accounting prices. The preliminary step for this is to derive the Standard Conversion Factor (SCF).

By definition, SCF is obtained from the following equation;

$$SCF = \frac{M + X}{M(1 + t) + X(1 + s - tx)}$$

where

M: Total values of major imported goods (CIF prices)

X: Total values of major exported goods (FOB prices)

t: Weighted average of import duties on major imported goods (%)

s: Weighted average of export subsidies on major exported goods (%)

t_x: Weighted average of export duties on major exported goods

In developing the above equation, all statistics regarding trades, government revenues and expenditures for the period of past few years including the year of the project's evaluation must be collected. However, as only statistics for 1985 could be obtained during the previous field survey, it was impossible to derive the SCF for 1986.

On the other hand, the Department of National Planning in the Treasury, which appraises national development projects, applies a SCF value of 0.90 in project evaluation, and this same value was accordingly adopted for the purposes of this Report. (The Department of National Planning is also calculating individual conversion factors of major production factors.)

Other Conversion Factors (CF)

As for major items of expenditures which constitute project (financial) costs, individual conversion factors (hereinafter refered to as CF) are to be obtained. CF is defined as "accounting prices divided by market prices" of goods and services. Financial costs are estimated according to market prices which the implementing agency is really paying. Therefore, if the individual CF of major inputs (as well as outputs) have been obtained in advance, economic costs based on accounting prices can also be obtained by multiplying each CF by items of expenditures in financial costs. According to the guidelines of such international organizations as the World Bank, it is recommended to obtain individual CF provided the portion of a certain item of expenditure exceeds ten (10) percent of total project costs. When a certain cost item is less than ten percent of total costs, economic viability will not be so affected even if financial costs are not converted into economic costs applying CF.

Procedures to Derive Conversion Factors

Each conversion factor for major goods and services input into the Project is obtained through following procedures.

(1) Each item of expenditures is divided into components of traded goods and non-traded goods including services

(2) For traded goods, such transfer payments as import duties and Business Turnover Taxes (BTT) are subtracted from prices.

(3) For non-traded goods and services, factors which constitute prices are broken down into traded goods and other production factors such as land, unskilled labours, etc.

(4) For other production factors (e.g. land and unskilled labours) excluding traded goods, opportunity costs or economic prices are calculated.

(5) Opportunity costs are multiplied by SCF in order to rectify the distortion of foreign exchange rate, as these costs are expressed in terms of domestic currency level. The costs multiplied by SCF are accounting prices by definition.

(6) For traded goods, accounting prices for such costs originating within Sri Lanka such as transportation cost, which have been obtained through the above procedures (3) ~ (5), are added to CIF Colombo prices. Thenafter, the resultant sum is divided by domestic price to obtain CF.

(7) For non-traded goods and services, each accounting price comprising a cost constituent factor is calculated and the accounting price weighted average is divided by the domestic price to obtain CF.

Thus, each CF for major inputs into the Project has been obtained as follows. Details of calculation are presented in APPENDIX-IV.

TABLE 8.1-1 CONVERSION FACTORS FOR MAJOR INPUTS

Input	Conversion Factor
Port Charges	0.90
Transportation Costs	0.82
Wages: Unskilled	0.60
Skilled (Local)	0.90
Skilled (Foreign)	1.00
Construction Machinery	0.83
Fuel	0.77
Cement	0.75
Steel	0.74
Facilities and Equipment	0.87
Others	0.90
Administrative Costs	0.97/0.95

With regard to compensation related cost, economic cost was calculated based on analysis as discussed in detail in APPENDIX VI.

8.1.3 Economic Cost

Based on the above conversion factors and Input wise Annual Financial Costs Disbursement as tabulated in TABLE 7.3-4, input wise annual economic costs were obtained as presented in TABLE 8.1-2. Economic cost for the Project is calculated at Rs.8,463.5 million.

TABLE 8.1-2 INPUT-WISE ANNUAL DISBURSEMENT (ECONOMIC COSTS)

Unit: Rs. million

	Conversion Factor	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
a. Labor											
-Unskilled	0.60				11.9	10.8	20.7	33.8	66.4	46.0	189.6
-Skilled (local)	0.90				35.8	23.1	36.3	55.9	125.8	84.5	361.4
-Skilled (foreign)	1.00				59.7	31.6	60.2	47.6	159.7	128.0	486.8
b. Construction Machinery	0.83				42.9	90.8	219.4	314.4	425.5	273.8	1,366.8
c. Fuel	0.77				21.4	22.7	50.4	86.0	200.2	141.3	522.0
d. Construction Materials											
-Cement	0.75				44.8	22.3	43.3	112.6	337.4	240.0	800.4
-Steel	0.74				29.4	18.8	42.0	74.4	138.5	91.2	394.3
e. Facilities	0.87						268.4	0.6	740.0	385.6	1,394.6
f. Others	0.90				89.6	57.8	72.8	141.8	273.1	182.1	817.1
g. Compensation					585.2						585.2
(Subtotal)					(920.6)	(277.9)	(813.5)	(867.1)	(2,466.6)	(1,572.5)	(6,918.2)
h. Engineering & Admi. Cost	0.97 (~'90) 0.95 ('91~)	155.2	155.2	19.0	61.2	47.0	64.1	66.7	118.2	89.3	775.9
(Subtotal)		(155.2)	(155.2)	(19.0)	(981.8)	(324.9)	(877.6)	(933.8)	(2,584.8)	(1,661.8)	(7,694.1)
i. Physical Contingency		15.5	15.5	1.9	98.2	32.5	87.8	93.4	258.4	166.2	769.4
Total		170.7	170.7	20.9	1,080.0	357.4	965.4	1,027.2	2,843.2	1,828.0	8,463.5

8.1.4 Economic Benefit

Alternative Facility Benefit

As discussed in the previous section 8.1.1, the conventional approach to economic analysis of a hydropower project is to define its benefit as the cost saved in construction and operation (fuel cost) of the cheapest alternative facility that could provide power supply of equivalent quality and quantity to the intended beneficiaries. For this report, diesel generation, likewise considered as the most viable alternative to hydropower by the CEB, was selected as the cheapest alternative energy source, and the necessary construction and operation costs for such facilities required to replace the Project are adopted as the Project benefit. However, in cases where international funding and bilateral assistance institutions appraise big scale hydropower (usually defined as over 50,000kw), generally coal-fired or oil-fired facilities are considered as the alternative energy source. Accordingly, for the purposes of the subject report, oil-fired and coal-fired facilities as well as diesel facilities were studied in determining Project benefit in consideration of future request to development assistance institutions for implementation funding.

Although it is felt that there is some room for reassesssment1/ of the standard unit costs applied by CEB in evaluation of its projects, these costs were adopted by the Team as well under the Study for the sake of uniformity of evaluation criteria with those used in regards to the other CEB power projects.

(1) Initial Construction Cost

(a) Diesel Generation

Applying a kW adjustment coefficient of 1.2424, diesel facilities with a total capacity of 308MW are considered necessary as an alternative to the total capacity of 248MW for the Upper

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1/ For example, CEB adopts the FOB price at producer countries as the border price for various fuels. This price does not, therefore, include insurance, freight, port charges, and CPC overhead. As these services costs must be paid and differ from transfer payment, they should be added to the FOB price in order to obtain an accurate border price.

Kotmale hydropower stations. The construction costs for such diesel facilities are estimated at Rs.4,201 million (see evaluation criteria in section 4.3). These costs represent economic costs calculated as border prices, or in other words accounting prices. Consequently, they can be used in calculation of economic internal rate of return.

It is assumed that it will take three years for construction of the diesel plant including design stage, and disbursement of funds is assumed at 30% of the total in the initial year, 40% in the second year and 30% in the third year.

(b) Oil-fired Generation

The total capacity for alternative oil-fired facilities is calculated at 318MW, applying a kW adjustment coefficient of 1.2812. The economic cost for such facilities is calculated as Rs.8,877 million (see evaluation criteria set out in section 4.4).

On the basis of past projects, construction period is assumed at 4 years, with disbursement of funding broken down into 20% the first year, 20% the second year, 40% the third year and 20% the final year.

(c) Coal-fired Generation

Applying a kW adjustment coefficient of 1.3623, alternative coal fired facilities would require a total capacity of 338MW. Economic cost for the said facilities would be Rs.11,209 million.

On the basis of past projects, construction period is assumed at 4 years, with disbursement of funding broken down into 20% the first year, 30% the second year, 40% the third year and 10% the final year.

(2) Fuel Cost

(a) Diesel Generation

According to the "Long Range Generation and Transmission Plan", diesel generators under study utilize residual oil instead of diesel (roughly equivalent to bunker-C grade heavy oil used in Japan). Fuel cost is calculated at Rs.0.834/kWh. Domestically refined supply of residual oil in Sri Lanka exceeds demand, and a certain portion is exported. However, if diesel generation is realized, supply of residual oil would not meet the required amount by the plants, and it would be necessary for Sri Lanka to import from the foreign market.

Thus, CEB's unit cost based on Singapore FOB can be applied in computing economic cost.

(b) Oil-fired Generation

As with diesel generation, CEB envisages use of residual oil for oil-fired generation of power. Economic cost computed by accounting price is also Rs.0.821/kWh.

(c) Coal-fired Generation

Australian coal is to be used for coal-fired power generation for the calculation of unit cost (future import from South Africa, China, etc. is also given consideration). Fuel cost is estimated at Rs.486/kWh. This estimate is derived from Australian FOB and does not include import duties, etc. As a result, this cost is assumed as calculated as economic cost.

(3) Operation and Maintenance Cost

In the "Long Range Generation and Transmission Plan", monthly operation and maintenance costs for diesel, coil-fired and oil-fired generation are estimated at Rs.10.0/kW, Rs.12.0/kW and Rs.7.0/kW, respectively (the same for hydropower is assumed at Rs.4.0/kW). These O/M costs are assumed as economic costs.

(4) Replacement Cost

If generating equipment is properly maintained and operated, its life is assumed at 20 years in the case of diesel, and 25 years in the case of coal-fired and oil-fired, respectively. The scrap value for such consumed equipment, as well as residual value for overall facilities in the final year of the project life are negligible, and accordingly assumed at zero.

Based on previous projects undertaken in other countries, the cost for facility replacement is estimated at 90% the initial construction cost (economic cost).

8.1.5 Evaluation

NPV and EIRR

Above, benefit has been quantified based on the conventional "alternative facility method". Below, the net present value NPV and "alternative EIRR" are sought. NPV at the discount rate of 10% as an evaluation standard by the Government of Sri Lanka for public investment projects is Rs.3,408.3 million, and alternative EIRR is 11.90% (see APPENDIX-IV)

Sensitivity analysis

Sensitivity analysis was conducted for the cases set out below, based on mainly negative changes of parameters or factors perceived as having a direct effect on the economic feasibility of the Project. (However, sensitivity analysis is restricted to the base case.)

i) One year delay of realization of project benefits due to construction delays (however, costs are as for the base case): alternative EIRR of 10.59%

ii) Two year delay of realization of project benefits for the same reason as i) above : alternative EIRR of 9.62%

iii) 10% cost over-run for initial construction cost: alternative EIRR of 10.61%

iv) 20% cost over-run for initial construction cost: alternative EIRR of 9.55%

v) A relative 10% rise in fuel costs (price of residual oil) in comparison with other general costs (10% price contingency): alternative EIRR of 12.62%

vi) 20% relative rise in fuel costs under the same conditions as v) above: alternative EIRR of 13.32%

vii) Raising of Kotmale dam 10 years after operation commencement of this Project: alternative EIRR of 11.76%

viii) Raising of Kotmale dam 15 years after operation commencement of this Project: alternative EIRR of 11.81%

ix) i), iii) and v) above occur together: alternative EIRR of 11.87%

x) ii), iv) and vi) above occur together: alternative EIRR of 8.23%

xi) In addition to x) above, 30% rise in economic fuel costs by taking into consideration accounting prices of services involved in import of fuel: alternative EIRR of 9.22%.

<u>Economic analysis conclusions</u>

As computed above, EIRR of the Project based upon the alternative facility ("alternative EIRR") for the base case is 11.90%, while alternative EIRRs by oil and coal are 27.44% and 37.41%, respectively.. All these figures are higher than the 10% discount rate set by the Government of Sri Lanka for the evaluation of public investment projects (or the opportunity cost of capital). The high alternative EIRR indicates that implementation of the envisioned hydropower scheme is clearly more effective allocation of resources than implementation of alternative generations from a standpoint of the national economy given the premise that construction of generating facilities with firm capacity of 248MW and energy supply of 728.1GWh (809GWh; system loss rate of 10%) is a prerequisite. The total net present value (NVP) at a discount rate of 10%, in other words the economic savings obtained through hydropower over the most economic alternative energy generation, i.e. diesel generation reaches Rs.759.8 million.

These figures are derived from unit costs which were calculated in "Long Rang Generation and Transmission Plan (1986)" by CEB. As mentioned previously (footnote in 8.1.4), these unit costs for economic costs for alternative benefit do not include sevice costs involved in import of fuel. On the other hand, in economic cost estimates of this Project, accounting prices of all service costs are added to FOB price of fuel. This fact means that economic costs for the alternative facility, i.e. economic benefit for this Project, are estimated lower than actual economic costs. Thus, provided that cost and benefit are analized by the same standard, the values of alternative EIRR and NPV are very likely to rise (as described in footnote in 8.1.4, economic cost of fuel, for instance, will rise by 30% if all accounting prices are added to imported materials and equipment,).

The results of Sensitivity Analysis show that among all parameter changes assumed, the delay of construction and cost over-run have the worst effect on economic viability. For instance, if construction is delayed two years, EIRR drops to 9.62%, and to 9.55% with 20% cost over-run. If these situations arise or are expected to arise, and as long as CEB's data are applied, implementation of alternative diesel generation would appear to be more beneficial from the viewpoint of the national economy. However, in actuality, these negative aspects would be off-set by more probable and positive changes as explained later.

With regard to fluctuations in prices of fuel, only relative price increase with respect to other general prices was considered. This is because all international organizations or institutions which forecast world-wide demand and supply of energy predict relative oil price rises. According to "Price Prospects for Major Primary Commodities (October 1986)" prepared by the World Bank, prices of oil are predicted to rise by 83.7% during 1986 and 1995, while other general prices (for 33 items) rise by 37.0% during the same period. In other words, the rise of oil price relative to other items is forecast to be 3.9% per annum. If this price contingency is considered, the price of oil would rise by 50% in 1996 when the Project is scheduled to commence operation, even assuming that other prices remain stable. In Sensitivity Analysis, modest contingencies of 10% and 20% are applied to allow a safety margin, and 0.72% and 1.42% rises in EIRR against the base case are obtained.

As for the raising of existing Kotmale dam, changes in EIRR are found marginal and it is recognized that the raising does not have much effect on economic viability of the Project.

Finally, in the case that all negative changes occur simultaneously (case x), EIRR drops to 7.86%, which is lower than the discount rate for evaluation and indicates non-economic viabililty of the Project as compared to alternative diesel generation. However, this figure is derived taking into account only negtative changes and does not include the most probable change, in other words, fuel price escalation. In addition, the economic cost of the alternative facility is estimated lower than actual cost. If the increase in economic cost by adding sevice accounting prices is assumed to be 30%, EIRR rises to 9.22%. Furthermore, in the case that price contingency for oil price is also considered together with the increase in economic cost, EIRR is expected to rise to around 10%.

On the basis of the above discussion, should negative fluctuations occur, the economic viability would not be deteriorated as more probable positive fluctuations would off-set negative ones.

TABLE 8.1-3 CASHFLOW FOR EIRR CALCULATION

ECONOMIC INTERNAL RATE OF RETURN BASED UPON ALTERNATIVE FACILITY

CASE - 100

MILLION RS

		COSTS			ALTERNATIVE BENEFITS								
NO.	YEAR	INVESTMENT AND REPLACEMENT	OPERATION AND MAINTENANCE	TOTAL COSTS	INVESTMENT AND REPLACEMENT	FUEL COST	OPERATION AND MAINTENANCE	TOTAL BENEFITS	BENEFITS - COSTS	DISCOUNT FACTOR (10.00%)	NET PRESENT VALUE	DISCOUNT FACTOR (11.90%)	NET PRESENT VALUE
1	1988	170.70	0.00	170.70	0.00	0.00	0.00	0.00	-170.70	1.000	-170.70	1.000	-170.70
2	1989	170.70	0.00	170.70	0.00	0.00	0.00	0.00	-170.70	0.909	-155.18	0.894	-152.55
3	1990	20.90	0.00	20.90	0.00	0.00	0.00	0.00	-20.90	0.826	-17.27	0.799	-16.69
4	1991	1080.00	0.00	1080.00	0.00	0.00	0.00	0.00	-1080.00	0.751	-811.42	0.714	-770.79
5	1992	357.40	0.00	357.40	0.00	0.00	0.00	0.00	-357.40	0.683	-244.11	0.638	-227.95
6	1993	965.40	0.00	965.40	0.00	0.00	0.00	0.00	-965.40	0.621	-599.44	0.570	-550.25
7	1994	1027.20	0.00	1027.20	1260.00	0.00	0.00	1260.00	232.80	0.564	131.41	0.509	118.58
8	1995	2843.20	0.00	2843.20	1681.00	0.00	0.00	1681.00	-1162.20	0.513	-596.39	0.455	-529.02
9	1996	1828.00	0.00	1828.00	1260.00	0.00	0.00	1260.00	-568.00	0.467	-264.98	0.407	-231.05
10	1997	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.424	294.03	0.364	252.03
11	1998	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.386	267.30	0.325	225.23
12	1999	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.350	243.00	0.290	201.28
13	2000	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.319	220.91	0.259	179.87
14	2001	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.290	200.82	0.232	160.74
15	2002	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.263	182.57	0.207	143.65
16	2003	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.239	165.97	0.185	128.37
17	2004	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.218	150.88	0.165	114.72
18	2005	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.198	137.17	0.148	102.52
19	2006	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.180	124.70	0.132	91.62
20	2007	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.164	113.36	0.118	81.87
21	2008	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.149	103.06	0.106	73.17
22	2009	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.135	93.69	0.094	65.39
23	2010	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.123	85.17	0.084	58.43
24	2011	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.112	77.43	0.075	52.22
25	2012	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.102	70.39	0.067	46.67
26	2013	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.092	63.99	0.060	41.70
27	2014	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.084	58.17	0.054	37.27
28	2015	0.00	11.50	11.50	1681.00	667.80	37.00	2385.80	2374.30	0.076	181.11	0.048	114.06
29	2016	0.00	11.50	11.50	1681.00	667.80	37.00	2385.80	2374.30	0.069	164.64	0.043	101.93
30	2017	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.063	43.71	0.038	26.60
31	2018	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.057	39.73	0.034	23.77
32	2019	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.052	36.12	0.031	21.24
33	2020	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.047	32.84	0.027	18.98
34	2021	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.043	29.85	0.024	16.96
35	2022	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.039	27.14	0.022	15.16
36	2023	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.035	24.67	0.020	13.55
37	2024	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.032	22.43	0.017	12.11
38	2025	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.029	20.39	0.016	10.82
39	2026	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.027	18.54	0.014	9.67
40	2027	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.024	16.85	0.012	8.64
41	2028	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.022	15.32	0.011	7.72
42	2029	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.020	13.93	0.010	6.90
43	2030	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.018	12.66	0.009	6.17
44	2031	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.017	11.51	0.008	5.51
45	2032	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.015	10.46	0.007	4.92
46	2033	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.014	9.51	0.006	4.40
47	2034	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.012	8.65	0.006	3.93
48	2035	0.00	11.50	11.50	1681.00	667.80	37.00	2385.80	2374.30	0.011	26.92	0.005	12.04
49	2036	0.00	11.50	11.50	1681.00	667.80	37.00	2385.80	2374.30	0.010	24.47	0.005	10.76
50	2037	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.009	6.50	0.004	2.81
51	2038	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.009	5.91	0.004	2.51
52	2039	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.008	5.37	0.003	2.24
53	2040	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.007	4.88	0.003	2.00
54	2041	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.006	4.44	0.003	1.79
55	2042	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.006	4.03	0.002	1.60
56	2043	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.005	3.67	0.002	1.43
57	2044	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.005	3.33	0.002	1.28
58	2045	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.004	3.03	0.002	1.14
59	2046	0.00	11.50	11.50	0.00	667.80	37.00	704.80	693.30	0.004	2.76	0.001	1.02
TOTAL		8463.50	575.00	9038.50	10925.00	33390.00	1850.00	46165.00	37126.50		759.84		-0.00

8.2 Financial Evaluation

The financial analysis of a feasibility study for public investment projects evaluates a given project in terms of its future income earning capability, in other words the internal rate of return on the invested capital of the project itself. Thus, in contrast to financial analysis in business accounting, interest regardless of its form is ignored, and in principal, direct taxes levied on the implementing agency are likewise disregarded. Also, as price escalation affects costs as well as benefits, the affect of such escalation is considered as canceling itself out. Market prices at the time of project cost estimation are applied as fixed prices. In this light, it must be noted that financial costs estimated at the feasibility stage will be different than actual costs required in the future for project construction and operation. As discussed before, although price escalation is not generally considered, allowance is made in terms of price contingency for relative price fluctuation where such fluctuation (up or down) can be forecasted with a high degree of reliability.

8.2.1 Financial Cost

As presented in Chapter 7, costs for the subject Project, ie. initial construction cost for all power generation facilities as well as annual operating costs following start-up have been computed in terms of fixed prices as of the end of 1986. In line with the discussion in preceding section 7.2, this financial cost excludes interest and price escalation.

8.2.2 Financial Benefit

In terms of financial analysis, Project benefit is defined as revenue from power sale. This is equivalent to the multiplied product of unit power rates and total power sales. As of the end of 1986, the tariff system of CEB comprised various rates depending on type of consumption (general household, religious or charitable establishment, street lighting, industrial enterprise, general purpose [stores, offices, public facilities, etc.]) and category of rate (fixed charge, unit charge, maximum demand charge, etc.). However, the overall average rate in 1986 for all types of consumer and all categories of rate was Rs.1.50/kWh (revenues from power sales: Rs.3.347 million / total power sales: 2,232GWh).

The above tariff system is determined by conventional investment recovery method, and is revised every 2~3 years. (The most recent revision was in March 1985, and the last revision before that was in June 1982). Specifically, the said system was established in view of CEB's overall power supply system and in line with the following consideration : i) recovery of all operating and maintenance costs, ii) payment of interest and principal on borrowing, iii) provision for internal cash generation for funding at least 30% of future projects, iv) 8% profit against the total book value of all assets in operation, v) payment of taxes (discussed below). In addition to the above tariff system, application of rates on the basis of LRMC is currently under study.

The Government of Sri Lanka provides no financial assistance to the CEB in the form of subsidies (in contrast to other developing countries where the government subsidizes public power entities). In fact, the CEB is levied both a business turnover tax (3% of total sales) and an income tax (50% of profits) by the Government.

In this report, project benefit from a financial analysis standpoint is computed as the product (before taxes) of the above described average unit rate and total amount of power sold. In view of the fact that Sri Lanka is promoting industrialization, it is anticipated that the ratio of industrial use for which power rates are set at a relatively high level will increase, resulting in parallel rise in the average unit rate per kWh. In other words, calculation of benefit by the current average unit rate per kWh will be somewhat low and on the safe-side compared with what might actually be expected in the future with Project implementation.

According to CEB data, transmission, substation and distribution system loss is currently at 17%. CEB has formulated a plan to reduce this to 10% by the early 1990's. In this report, loss is assumed at 10% or in other words the amount of power sold, or effective power production, is 90%. As a result, revenues from power sales after completion of the Project would be: $(809 \text{ GWh} \times 0.90)\ 10^{6} \times \text{Rs.}1.50/\text{kWh} \times 10^{-6} \doteq \text{Rs.}1{,}092.2$ million.

8.2.3 Evaluation

(1) FIRR

FIRR for the base case is 9.06%.

(2) Sensitivity Analysis

Sensitivity analyses are undertaken assuming the following fluctuations.

i) Realization of Project benefits is delayed one year due to construction delays (however, the disbursement schedule is the same as for base case): FIRR of 8.41%

ii) Realization of Project benefits is delayed two years due to construction delays (however, disbursement is the same as for base case): FIRR of 7.86%

iii) 10% cost over-run for initial construction cost: FIRR of 8.32%

iv) 20% cost over-run for initial construction cost: FIRR of 7.68%

v) Reduction of system loss is not 10%, but 15%: FIRR of 8.61%

vi) Kotmale dam is raised after 10 years of operation of the Project: FIRR of 8.96%

vii) Kotmale dam is raised after 15 years of operation of the Project: FIRR of 9.00%

viii) i) and iii) occur together: FIRR of 7.75%

ix) ii) and iv) occur together: FIRR of 6.48%

x) 3% deduction of Business Turnover Tax from revenues: FIRR of 8.82%

(3) Financial Analysis Conclusions

The financial internal rate of return (FIRR) based upon present tariffs revised in March 1985 is 9.09% for the base case and is a relatively lower value than EIRR. However, power tariffs were not established specifically for the subject Project, but rather had been determined on the basis of the overall CEB system which consists of highly economical facilities. The financial feasibility of the subject Project will be assessed on the basis of whether or not investments on the project generate income for CEB in excess of the said additional investment amount in the future.

As discussed above, CEB is supposed to pay both sales tax and income tax on revenue from power sales. The latter is levied on profits, while the former should be paid automatically in correspondence to amount of power sold. In other words, sales tax can be considered as a consumer tax added into the power tariff.

At the very minimum, CEB is at least obligated to pay from incremental revenues the above described sales tax and interest on borrowings. Case sensitivity analysis above, which is undertaken using after sales tax value, yields an FIRR value of 8.82%. This, in other words, represents approximately the Project capability to bear loan interest. Accordingly, in order to increase surplus to be retained by CEB as a result of Project implementation, it is desirable that interest on borrowed funds be minimized to the extent possible (another factor at play here, however, is the ratio of equity to borrowings).

For the purpose of reference, if 70% of total Project costs is financed by foreign lending institutions with an interest rate of 3%, and the remaining 30% is funded by CEB's internal cash generation and domestic borrowings at 12% interest rate, and further, if the ratio of internal cash generation and domestic borrowings is 4:6, the overall interest rate among foreign financing, internal cash generation and domestic borrowings will become 4.24%. FIRR of this Project exceeds this overall interest rate, which means the subject Project is able to produce surplus after paying interests assumed.

FIRR value naturally drops in response to various negative fluctuations (see section 7.2.4 above). In the worst case conceivable (2 years delay in realization of benefits from the Project, 20% cost over-run, 15% system loss and raising of Kotmale dam) FIRR before sales tax is only 5.44%. FIRR for this worst case still exceeds interests bases on assumed conditions; however, the value of FIRR is not enough to accumulate an acceptable level of internal cash generation or to meet taxes.

In consideration of the above parameter fluctuations, it is concluded that a low interest loan is strongly required for successful financial return from Project implementation.

TABLE 8.2-1 CASHFLOW FOR FIRR CALCULATION

FINANCIAL EVALUATION

CASE - 500

(UNIT - MILLION RS

NO.	YEAR	COSTS INVESTMENT AND REPLACEMENT	OPERATION AND MAINTENANCE	TOTAL COSTS	BENEFITS	BENEFITS -COSTS	DISCOUNT FACTOR (10.00%)	NET PRESENT VALUE	DISCOUNT FACTOR (9.06%)	NET PRESENT VALUE
1	1988	176.00	0.00	176.00	0.00	-176.00	1.000	-176.00	1.000	-176.00
2	1989	176.00	0.00	176.00	0.00	-176.00	0.909	-160.00	0.917	-161.38
3	1990	22.00	0.00	22.00	0.00	-22.00	0.826	-18.18	0.841	-18.50
4	1991	1014.40	0.00	1014.40	0.00	-1014.40	0.751	-762.13	0.771	-781.95
5	1992	421.00	0.00	421.00	0.00	-421.00	0.683	-287.55	0.707	-297.56
6	1993	1139.80	0.00	1139.80	0.00	-1139.80	0.621	-707.73	0.648	-738.66
7	1994	1248.90	0.00	1248.90	0.00	-1248.90	0.564	-704.97	0.594	-742.11
8	1995	3407.80	0.00	3407.80	0.00	-3407.80	0.513	-1748.74	0.545	-1856.69
9	1996	2194.10	0.00	2194.10	0.00	-2194.10	0.467	-1023.56	0.500	-1096.09
10	1997	0.00	13.40	13.40	1092.20	1078.80	0.424	457.52	0.458	494.15
11	1998	0.00	13.40	13.40	1092.20	1078.80	0.386	415.92	0.420	453.08
12	1999	0.00	13.40	13.40	1092.20	1078.80	0.350	378.11	0.385	415.43
13	2000	0.00	13.40	13.40	1092.20	1078.80	0.319	343.74	0.353	380.91
14	2001	0.00	13.40	13.40	1092.20	1078.80	0.290	312.49	0.324	349.26
15	2002	0.00	13.40	13.40	1092.20	1078.80	0.263	284.08	0.297	320.24
16	2003	0.00	13.40	13.40	1092.20	1078.80	0.239	258.26	0.272	293.63
17	2004	0.00	13.40	13.40	1092.20	1078.80	0.218	234.78	0.250	269.23
18	2005	0.00	13.40	13.40	1092.20	1078.80	0.198	213.44	0.229	246.86
19	2006	0.00	13.40	13.40	1092.20	1078.80	0.180	194.03	0.210	226.34
20	2007	0.00	13.40	13.40	1092.20	1078.80	0.164	176.39	0.192	207.54
21	2008	0.00	13.40	13.40	1092.20	1078.80	0.149	160.36	0.176	190.29
22	2009	0.00	13.40	13.40	1092.20	1078.80	0.135	145.78	0.162	174.48
23	2010	0.00	13.40	13.40	1092.20	1078.80	0.123	132.53	0.148	159.98
24	2011	0.00	13.40	13.40	1092.20	1078.80	0.112	120.48	0.136	146.69
25	2012	0.00	13.40	13.40	1092.20	1078.80	0.102	109.53	0.125	134.50
26	2013	0.00	13.40	13.40	1092.20	1078.80	0.092	99.57	0.114	123.32
27	2014	0.00	13.40	13.40	1092.20	1078.80	0.084	90.52	0.105	113.07
28	2015	0.00	13.40	13.40	1092.20	1078.80	0.076	82.29	0.096	103.68
29	2016	0.00	13.40	13.40	1092.20	1078.80	0.069	74.81	0.088	95.06
30	2017	0.00	13.40	13.40	1092.20	1078.80	0.063	68.01	0.081	87.16
31	2018	0.00	13.40	13.40	1092.20	1078.80	0.057	61.82	0.074	79.92
32	2019	0.00	13.40	13.40	1092.20	1078.80	0.052	56.20	0.068	73.28
33	2020	0.00	13.40	13.40	1092.20	1078.80	0.047	51.09	0.062	67.19
34	2021	0.00	13.40	13.40	1092.20	1078.80	0.043	46.45	0.057	61.61
35	2022	0.00	13.40	13.40	1092.20	1078.80	0.039	42.23	0.052	56.49
36	2023	0.00	13.40	13.40	1092.20	1078.80	0.036	38.39	0.048	51.79
37	2024	0.00	13.40	13.40	1092.20	1078.80	0.032	34.90	0.044	47.49
38	2025	0.00	13.40	13.40	1092.20	1078.80	0.029	31.73	0.040	43.54
39	2026	0.00	13.40	13.40	1092.20	1078.80	0.027	28.84	0.037	39.92
40	2027	0.00	13.40	13.40	1092.20	1078.80	0.024	26.22	0.034	36.61
41	2028	0.00	13.40	13.40	1092.20	1078.80	0.022	23.84	0.031	33.57
42	2029	0.00	13.40	13.40	1092.20	1078.80	0.020	21.67	0.029	30.78
43	2030	0.00	13.40	13.40	1092.20	1078.80	0.018	19.70	0.026	28.22
44	2031	0.00	13.40	13.40	1092.20	1078.80	0.017	17.91	0.024	25.87
45	2032	0.00	13.40	13.40	1092.20	1078.80	0.015	16.28	0.022	23.72
46	2033	0.00	13.40	13.40	1092.20	1078.80	0.014	14.80	0.020	21.75
47	2034	0.00	13.40	13.40	1092.20	1078.80	0.012	13.45	0.018	19.94
48	2035	0.00	13.40	13.40	1092.20	1078.80	0.011	12.23	0.017	18.29
49	2036	0.00	13.40	13.40	1092.20	1078.80	0.010	11.12	0.016	16.77
50	2037	0.00	13.40	13.40	1092.20	1078.80	0.009	10.11	0.014	15.37
51	2038	0.00	13.40	13.40	1092.20	1078.80	0.009	9.19	0.013	14.10
52	2039	0.00	13.40	13.40	1092.20	1078.80	0.008	8.35	0.012	12.93
53	2040	0.00	13.40	13.40	1092.20	1078.80	0.007	7.59	0.011	11.85
54	2041	0.00	13.40	13.40	1092.20	1078.80	0.006	6.90	0.010	10.87
55	2042	0.00	13.40	13.40	1092.20	1078.80	0.006	6.28	0.009	9.96
56	2043	0.00	13.40	13.40	1092.20	1078.80	0.005	5.71	0.008	9.14
57	2044	0.00	13.40	13.40	1092.20	1078.80	0.005	5.19	0.008	8.38
58	2045	0.00	13.40	13.40	1092.20	1078.80	0.004	4.72	0.007	7.68
59	2046	0.00	13.40	13.40	1092.20	1078.80	0.004	4.29	0.007	7.04
TOTAL		9800.00	670.00	10470.00	54610.00	44140.00		-599.06		-0.01

8.3 Intangible Benefit

Effect on Employment Opportunity Creation and Promotion of Linkage Industries

The overall cost required for implementation of the present Project is estimated at Rs.9,800 million. Of this, local currency portion which is to be spent in Sri Lanka amounts to Rs.4,338.2 million consisting of labour cost for construction works and material processing of Rs.717.5 million, import tax, transportation, storage, etc. cost for imported material and facilities of Rs.1,699.4 million, cost for locally procured facilities and materials of Rs.726.3 million, compensation and land acquisition cost of Rs.460.0 million, engineering and administrative service cost of Rs.341.0 million, and contingency for local currency portion of Rs.394.0 million.

Number of unskilled and skilled local labourers to be employed for construction works will average 2,100/day and 1,300/day, respectively. In addition to this, effect on employment opportunity creation through procurement, transportation, storage, etc. of materials brought to the site is also large. Procurement, transportation, storage etc. of materials will not only create employment opportunities but also will promote development of linkage industries in these fields.

Development of Social Infrastructures

Through the implementation of the present project, the road network in the area will be developed by rehabilitation (20km) of existing road and construction of new access road (10km). Power distribution lines will also be developed by construction of distribution lines (33kv, 40km) for construction works and telecommunication lines (30km).

Social facilities, e.g. schools, dispensaries, community centers and recreation centers will also be constructed at construction camps and relocation areas. These facilities will be available to rural residents after Project works completion.

Promotion of New Industries

National road Route A7 passes from Hatton to Nuwara Eliya at the upper reaches of the Project area. The upstream area is at high elevation of 1,200m to 1,400m, climate is good, and the area provides scenic beauty created by the magnificent topography and will developed tea fields.

Creation of tourism industries can be considered by developing tourism facilities such as recreation facilities and accommodations in addition to the other social infrastructures previously discussed.

Development of inland fisheries utilizing the proposed Caledonia reservoir also can be considered through analysis and study on introduction of fishes appropriate for a reservoir at a high altitude of EL. 1,360m and with relatively low water temperature.

8.4 Social and Environmental Impact

The size of the reservoir and regulating pond envisaged for the Project are relatively small. The Caledonia reservoir has a compensation area of 3.35km2, and that for the Talawakelle regulating pond is 0.34km2.

Area inundated by the Caledonia reservoir is comprised of 61% tea estates, 19% river and road, and 20% farmland and houselots. The same ratios for Talawakelle pond are 9%, 76%, and 15%, respectively. Although compensation and resettlement will be required in the case of the affected population as discussed in section 5.8, no negative impact on the environment, such as ecological repurcussions, is foreseen. Care must be taken, however, during the construction period to avoid water and other environmental pollution.

A problem often caused by the creation of a reservoir is inducement of landslide. However, it is concluded that no landslide threat of a scale posing danger to the area or its residents will result from ponding at the dams.

Another aspect of environmental impact under the Project is a decrease in tourism value of certain falls in the area. St. Clair, Devon, Ramboda and Puna falls are located at points where river discharge will be reduced as a result of the Project. Study was made on power development that would allow for preservation of all falls in the area; however, findings showed that this would not be possible in the case of the most desirable development plan. As a result of consultations with CEB, it was decided to allow under the Project for one third of river average annual flow regulated as required at Devon Falls. No such maintenace flow is considered for St. Clair and other falls.

There is an existing power station (336kW, commenced operation in 1930) at Yoxford, 7km downstream from Talawakelle dam. Facilites are small scale and it is concluded that they can operate effectively off of discharge from the residual catchment.

There are some minor intakes for irrigation and domestic use on the Kotmale and its tributaries; however, no intake or water use facilities will be adversely affected by the Project. Commercial base fisheries are not found in the area, and no adverse impact in this regard will thus occur under the Project. Residents bathe and do washing along the river, however, and the need for water supply facililties to meet this demand has to be studied at the detailed design stage.

Although no negative impact from the Project itself is foreseen on the environment, care must be taken during the construction period to avoid water and other environmental pollution.