India

Teesta Canal Hydroelectric Project (I)(II)

Report Date: July 2002
Field Survey: September 2001

1. Project Profile and Japan's ODA Loan

Location Map of the Project

Teesta Canal Hydroelectric Power Station No.3

1.1 Background

West Bengal State has the fourth largest population and the third largest gross state production in India, and has been recognized as the industrial center of Eastern India. However, the state was faced with low agricultural productivity resulting from underdeveloped irrigation facilities and infrastructure. Thus, the share of agricultural sector outlay in the state's development budget was 20.7% (FY 1985-1986).

In 1984, the state experienced a 331MW power supply shortage, which was especially problematic at peak times. The problems resulted from the low availability of generating facilities corresponding to peak hours, and from the low plant load factor[*1] of existing installations. This peak supply shortage compelled West Bengal State Electricity Board (WBSEB) to carry out load shedding[*2] at peak times. Without the expansion of hydraulic generation and the efficient operation of existing power stations, peak time supply shortages were expected to continue in the future.

1.2 Objective

To stabilize electricity supply and promote regional development in the Darjeeling and West Dinajpur Districts of West Bengal State through the construction of three hydroelectric power stations on the Mahananda Main Canal (MMC) of the Teesta Irrigation Project[*3].

1.3 Project Scope

1. Installation of nine generating units (Valve type water-wheel generator with capacity of 7.5 MW each)
2. Construction of three Power Station buildings (PS-1, PS-2, and PS-3)[*4]
3. Construction of switchyard

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[1] The ratio of the electrical energy produced by a generating unit for a year to the electrical energy that could have been produced at continuous full-power operation during that year.

[2] Removal of pre-selected equipment demand from a customer's electric system in the facility to maintain electric load below a certain level

[3] Teesta Irrigation Project has been developed by the Irrigation and Water Department of West Bengal State. The project comprises multiple interconnected barrages and corresponding main canals (including MMC) branching off them. The target area on completion of all the stages of the planned development will be a little more than 0.9 million ha, covering the entire northern part of the state of West Bengal.

[4] Each power station having three generating units (3 Power Stations x 3 Units x 7.5 MW= 67.5MW in total)

4. Construction of approach canal, by-pass canal, and tail race canal
5. Consulting services for design and construction supervision

Total estimated project cost was 17,762 million yen equivalent, of which 100 % of the foreign currency portion (8,025 million yen) and 59.5% of the local currency portion (5,155 million yen) were to be covered by Japanese ODA loan.

1.4 Borrower/ Executing Agency

The President of India /West Bengal State Electricity Board (WBSEB)

1.5 Outline of Loan Agreement

	1st Phase (ID-P40)	2nd Phase (ID-P72)
Loan Amount Loan Disbursed Amount	8,025 million yen 7,882 million yen	6,222 million yen 6,121 million yen
Exchange of Notes Loan Agreement	August 1986 December 1986	September 1990 January 1991
Terms and Conditions Interest Rate Repayment Period (Grace Period) Procurement	 3.25 % p.a. 30 years (10 years) Partially Untied	 2.50 % p.a. 30 years (10 years) Partially Untied
Final Disbursement Date	March 2000	March 2000

2. Results and Evaluation

2.1 Relevance

West Bengal State had a generating capacity of 2,394 MW in 1984, and peak demand reaching 1,270 MW. However, due to the low plant load factor (about 40%) of its thermal power plants and due to insufficient peaking facilities[*5], the state experienced 331 MW of peak shortage, and was compelled to execute load shedding during peak time. To cope with increasing demand, the West Bengal State Government planned to add 704.7 MW of generating capacity during the period covered by its 7th five-year plan (1985-1990) of the Government of India. Given the lack of peaking facilities within the state, the Central Electricity Authority placed great importance on the hydropower project and gave official approval for it in September 1985. Thus, the project was deemed consistent with development policy at that time.

At present, the state is still suffering peak shortages, and it was compelled to implement 67.8 GWh of load shedding during the 1999-00 period, owing to a peak shortage of 117 MW during that time. The energy supply conditions are rather severe in the northern part of the state, as a result of insufficient transmission and distribution facilities[*6] and the concentration of power stations in the southern part of the state. In addition, since thermal power stations are still predominant in the state, 5 hydro power stations[*7], totaling 1,060 MW, are being constructed in order to achieve the best mix of generation capacity. As the project facility is located in the northern part of the state and has the largest hydro power station in the state, the project has been and is expected to continue to play an important role as a peaking facility. Consequently, the project objective is still quite relevant to West Bengal State's power development plan.

The water used to generate electricity in this project is supplied through MMC, which was built and is managed by the Irrigation & Waterways Department[8] (I & W Department) as part of the Teesta Irrigation

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[5] Insufficient Peaking Facility: A hydro power station is generally suitable for peaking facility by making use of its load follow-ability. On the other hand, a thermal power station is basically used as a base load facility. As of 1984, 97% of generating capacity was attributable to thermal power stations.

[6] At present, the JBIC is financing to the WBSEB for "West Bengal Transmission System Project", in order to improve the demand-supply situation in the state. The scope of the project consists of i) construction and improvement of transmission lines (total length: 708km), and ii) construction and expansion of related substations (31 sites).

[7] Among the 5 power stations under construction, the Purulia pumped storage project (4x225 MW) is the project being financed by the JBIC.

[8] Irrigation & Waterways Department: A Department of the Government of the West Bengal, which responsible for construction, operation, maintenance, and management of irrigation canal within the West Bengal State.

Project. As a result, the effectiveness and sustainability of the project is entirely dependent on the I&W Department. By its very design, this project had already taken on a significant risk that the I&W Department may not properly maintain MMC.

2.2 Efficiency

2.2.1 Project Scope

The original scope envisaged at appraisal was actualized without any major deviation. Also, in addition to the original scope, i) a diesel power generator and ii) an escape canal and remote control radial fall gate system were installed/constructed to ensure the project outcome. The detailed reasons are as follows:

a) Diesel Power Generator

At the time of the operational start, the power station required some electricity from the grid in order to operate its starter; in other words, this station cannot start operation if a grid failure occurs. Thus, a diesel power generator was installed to supply energy to the power station's starter. At present, by making use of its quick-start ability and its diesel generator, the power station supplies the northern region's power stations with the energy needed to restart operation after blackouts.

b) Escape Canal and Remote Control Radial Fall Gate System

In the case of sudden tripping/closure of the power station, water flow is dammed up in front of the intake gate, bringing about a sudden surge in water levels. In order to avoid such complications, an escape canal was constructed at PS-1 and PS-3[*9]. In addition, a remote control-type radial fall gate was constructed on the MMC to avoid the type of flooding that might occur when water levels surge.

2.2.2 Implementation Schedule

The project was completed in March 2000, seven years after the scheduled completion date of March 1993. According to the executing agency, it is considered that the delay was brought on by the following factors:

a) Technical Factors

- An unexpectedly high water table resulted in a large quantity of groundwater gushing during the excavation work, inundating the excavation sites. Considerable time was required for the following measures: installation of a drain pump and drain pipe and construction of a drainage canal.
- Mismatched components and defects in procured components forced changes in design and replacement/mending.
- Poor schedule control by the contractors resulted in substantial delays in civil works.

b) Non-Technical Factors

- Substantial time was required for design, contract finalization, bidding and construction/installation of the additional scope.
- Acute constraints on local fund, which should have been disbursed by the Government of West Bengal, forced the suspension of civil work at PS-2 and PS-3 for a period of 3 years.
- There was a two-year delay arising from a legal dispute over the acquisition of land along the tailrace canal of PS-2. (See details in section 2.4.2)

All of these factors were unforeseeable at the time of appraisal. However, most appeared to have been caused by insufficient management capability on the part of the executing agency and by inappropriate geological surveys and initial design. Due to the cost overrun experienced during Phase I of this project – the result of land acquisition, delays in construction and procurement of generating equipment – JBIC disbursed Phase II funding. Even so, Phase II implementation was delayed for a total of seven years.

2.2.3 Project Cost

At appraisal of the 2nd phase loan, the estimated project cost consisted of 9,092 million yen in foreign

[9] Escape canal at PS-2 was kept out of project scope, because the Irrigation and Waterways Department agreed to construct it under their budget. However, it was not yet actualized due to budget constraint.

currency and 1,008 million rupees in local currency. The actual project cost consisted of 6,229 million yen in foreign currency and 3,521 million rupees in local currency. The substantial cost overrun in the local portion, 349% of the appraisal estimate, was caused by additional civil work and by price escalation resulting from completion delays. However, there was no cost overran in total (the sum of foreign and local currency disbursed in the 1st and 2nd phase loans).

2.3 Effectiveness

2.3.1 Performance of the Project Facility

The Teesta canal fall hydro project consists of three power stations (PS-1, 2 and 3), each having three 7.5 MW generating units. These power stations, with a total capacity of 67.5 MW, were commissioned consecutively from October 1997 to August 1999, and began commercial operation on 1st April 2000. Three power stations are located on the MMC, which takes in water from the Teesta River through the Mahananda barrage and the Teesta-Mahananda Link Canal. As the project was designed, the power station utilized the existing falls on MMC of the Teesta Barrage Project, so its energy production is completely dependent on the available discharge in the canal.

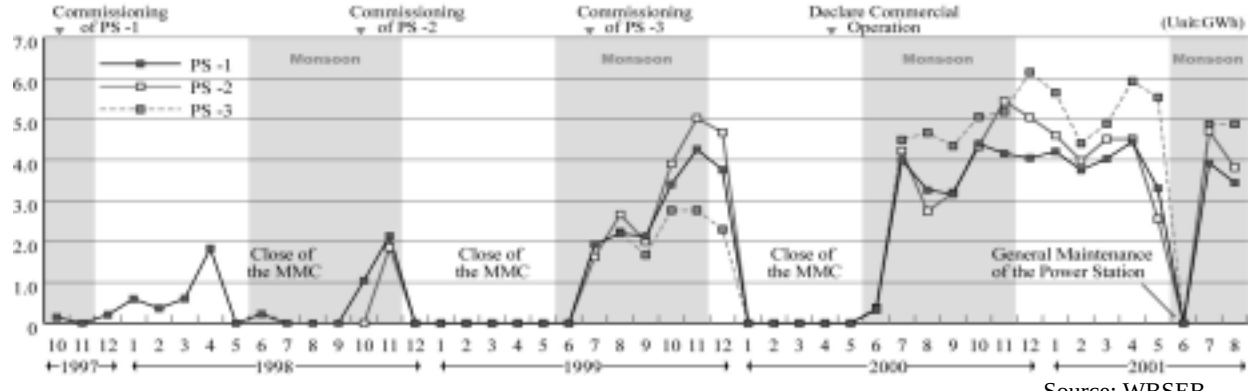
The three power stations require 330 m^3/sec-310 m^3/sec of water flow for full operation. However, water flow in MMC has been well below that level because of: i) deterioration of MMC, ii) lack of discharge capacity at lower reaches of MMC, iii) deposition of large amounts of silt on the canal bed and intake of power stations, and iv) floating deposits at the intake gate of the power station. To make matters worse, MMC had to shut down frequently for maintenance and when the system collapses. The specific reasons for low water availability and ameliorative measures will be mentioned in section 2.5.3 of this report.

As a result of temporary repairs MMC and negotiation with the Irrigation and Waterways (I&W) Department, water availability at the MMC has improved. Also, along with improved water availability, the performance of the power stations has gradually improved, though it is still far below original target levels.

Table-1: Performance Indicators of the Project Facilities by Fiscal Year

		Original Target Level**	1997-98	1998-99	1999-00	2000-01	2001-02***
Gross Energy Production (GWh)	PS-1	109.9	1.17	5.03	17.34	34.85	11.47
	PS-2	107.3	-	1.86	19.78	37.93	11.60
	PS-3	102.7	-	-	11.58	44.85	16.33
	Total	319.9	1.17	6.89	48.71	117.64	39.40
Peak Load (MW)	PS-1	22.5	7.7	11.0	13.2	13.4	13.0
	PS-2	22.5	-	7.5	7.6	10.8	11.6
	PS-3	22.5	-	-	11.8	13.6	12.0
Plant Load Factor (%)	PS-1	55.8	1.74	4.76	16.08	32.16	-
	PS-2	54.4	-	1.74	18.58	35.89	-
	PS-3	52.1	-	-	11.38	45.19	-
Water Flow in the MMC at PS-1 (m^3/sec)	Average*	194.3	45	85	95	110	130
	Max.	332.0	50	110	120	145	175
	Min.*	56.6	40	60	70	80	85

Note): *: Excluding the period of close of the MMC **: Original target level was quoted from JBIC appraisal report.
***: Up to 1st July 2001 Source: WBSEB



Source: WBSEB

Figure-1: Power Station-wise Monthly Energy Production

At appraisal, it was expected that each power plant would generate 102.7-109.9 GWh of electricity annually, equivalent to 52-56% of plant load factor. Especially during the monsoon season (from June to November), the plants were expected to fully utilize the plentiful supply of water.

In order to achieve the target levels, each power station has to generate 8.6-9.2 GWh/month of electricity on average. However, in actuality, even in the monsoon season, that target has yet to be reached (See Figure-1).

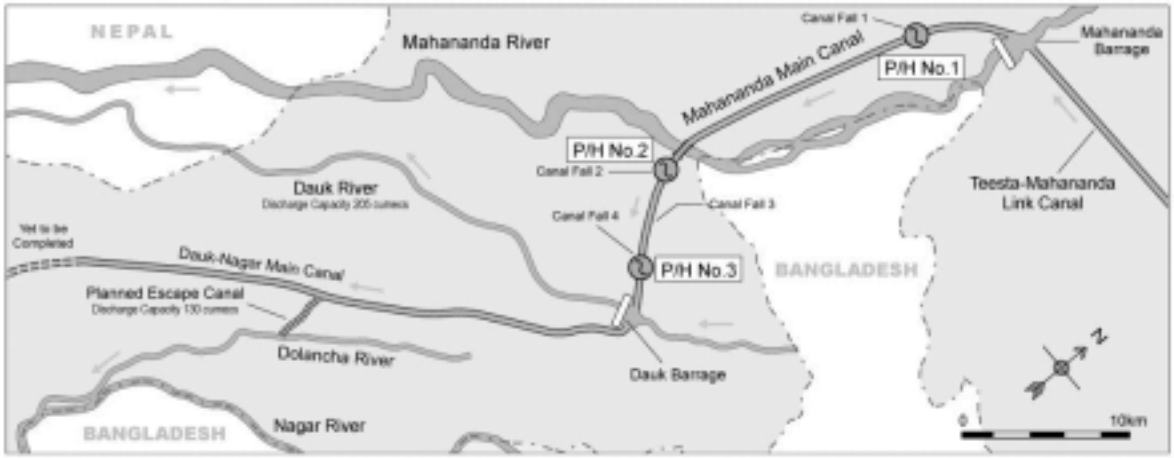


Figure-2: Schematic Map of the Project Site

2.3.2 Re-evaluation of Financial Internal Rate of Return

The financial re-evaluation of the project was undertaken following a methodology similar to that adopted at appraisal, taking into account the change in project cost, actual energy production, actual electricity tariffs, actual operation and maintenance cost, and other related variables. All cost and benefit streams used in the re-evaluation were expressed in 2000 local currency prices.

To date, the project facilities have performed below expected levels. In addition, there are many constraints that have not been solved, such as: i) deterioration of MMC, ii) insufficient discharge capacity in the lower tiers, iii) silt on MMC, and iv) floating/submerged trash at the intake gate (details will be discussed in 2.5.3). Hence, the project's future benefits are not clear at present. Even if these problems are solved by 2004-05 and the project generates benefits expected at appraisal, the re-evaluated FIRR will be 4.15%, while the FIRR estimated at the time of appraisal was 11.3%. (In this case, the sharp deterioration of financial viability was brought about largely by the cost overrun and completion delays.)

However, the prospects for settlement are gloomy (see 2.5.3). If appropriate remedial actions are not taken immediately, the net present value of the project will turn negative, and FIRR calculation will be impossible.

2.4 Impact

2.4.1 Positive Impacts on the Population in the Northern Part of the State

a) Contribution to promoting rural electrification

The average rural electrification ratio[*10] in West Bengal State was 77.33% as of 31st March 2000, lower than the national average of 86.3% on the same day. With a view to promoting rural electrification within the state, the West Bengal Rural Energy Development Corporation Limited (WBREDC) was set up in November 1999 as part of the power sector's restructuring efforts in the state. Thereafter, the transmission and distribution system in rural area was transferred from WBSEB, DPL[*11], and other agencies, to WBREDC. The company is planning to transfer and divest the part of ownership of its property in favor of any public or local institution. In addition, the company creates subsidiary companies at the district or sub-districts level for the program of rural energy development. Through various activities, WBREDC stimulates the participation of the local public/private institutions in an effort to reduce heavy financial

[10] Rural Electrification Ratio: number of electrified village / number of village

[11] The Durgapur Projects Limited (DPL) is a government company incorporated on 6th September 1961. It started business after acquiring the undertaking of the Durgapur Projects of the Government of West Bengal, consisting of Coke Oven Batteries, Bye-products Plant, Gas Grid Project, Thermal Power Plant and Water Works.

burdens on the state government. By the end of the central government's 9th five-year plan (31st March 2002), the company aims to achieve an 85% rural electrification ratio.

Since the project facilities began commercial operation on 1st April 2000, it is not yet possible to estimate the project's quantitative contribution toward rural electrification. However, taking into consideration the location*[12] and generating capacity of the project facilities, the project is expected to contribute overall to rural electrification in the northern part of the state.

b) Contribution to Improving the Demand-Supply Balance

Energy shortages during the evening peak times are particularly serious in the northern part of the state because of the concentration of power stations in the south and the lack of adequate transmission and distribution system capacity. Hence, household consumers, as well as energy-dependent industrial consumers, have been suffering from load shedding and frequent tripping. Thus, the project is expected to improve the demand-supply balance by making use of its flexible load follow-ability.

2.4.2 Negative Socioeconomic Impacts

At the project's pre-construction period, a part of Madanbhita village was sinking because of the alignment of the tailrace canal of PS-2, and 25 families required relocation. The evaluation and negotiation of compensation was carried out with the direct intervention of the State Administration. These families received financial compensation, worked out according to state regulation, for the relocation. Nevertheless, some of the families did not move from their residences even after giving consent and receiving compensation, remaining on the premises for about 2 years. The legal process unfolded fairly normally, ending with the February 1994 eviction of the families. No subsequent legal dispute has been reported.

2.4.3 Environmental Impacts

Since the power station has not established an environmental monitoring system, there is no way to estimate the environmental impact in quantitative terms. In general, a hydro power station does not emit contaminants, and there have been no reports of negative environmental impacts so far.

2.5 Sustainability

2.5.1 Performance and Financial Status of the O&M Agency

a) General Features and Restructuring of WBSEB

The operation and maintenance of the project facilities are carried out by West Bengal State Electricity Board (WBSEB). WBSEB was established on 1st May 1955 under the Electricity (Supply) Act of 1948. The main duty of WBSEB is the promotion of coordinated development of generation, transmission and distribution of electricity within the state. It has a workforce of 37,431, serves 3.26 million consumers, and had 1246.51 MW of generating capacity, as of 31st March 2000.

Like most other states in the country, West Bengal is executing a power sector restructuring policy. Under this policy, all thermal power plants of WBSEB were transferred to the West Bengal Power Development Corporation Ltd. on 1st July 2001. In addition, the existing distribution zones are scheduled for conversion to Distribution Profit Centers (DPCs), and each center shall prepare its own commercial accounts/shadow profit & loss account by 31st March 2002. After that, the DPCs are supposed to pursue a self-supporting accounting system.

b) Financial Viability of WBSEB

According to the Electricity Supply Act of 1948, the SEBs are required to earn a minimum rate of return (ROR) of 3% on their net fixed assests in service, after providing for depreciation and interest charges. The State Governments could prescribe a higher return if necessary. However, most of the SEBs have yet to comply with this statutory stipulation. During the 1997-98 period, the average ROR with subsidy of the SEBs was -11.8%.

WBSEB maintained a 3% ROR until 1997-98 with the help of a waiver of interest liability and subsidies from the state government. However, since net income after tax had sharply deteriorated, its ROR with subsidy during the 1998-99 period reached –102%. This outcome resulted from the acceptance of a large

[12] The project facilities are located in the northern part of the state. Energy generated by the project facilities is mainly transmitted to the Darjeeling, Jalpaiguri, and Dinajpur districts through the 132 kV transmission line.

amount of disputed penal interest claims and power purchase claims of the CPSUs[*13].

In order to recover financial viability, an electricity tariff was amended in January 1999 with the help of the West Bengal Electricity Regulatory Commission*[14]. However, incremental revenue, coupled with increased subsidies, were not enough to offset the additional payment to the CPSUs. As a result, the ROR in 1999-99 was still negative at –80%.

Table-2: Five Years Summary of WBSEB's Profit & Loss Statement (Unit: million rupees)

	1995-96	1996-96	1997-98	1998-99	1999-00
A. Revenue	13,737.40	14,829.30	18,851.30	18,925.00	23,380.80
Revenue from Sales of Power	13,579.20	14,552.30	18,415.60	18,625.20	21,333.90
Other Revenue	158.2	277	435.7	299.8	2,046.90
B. Expenditure	14,382.3	17,102.0	20,493.1	27,966.5	33,669.0
Purchase of Power	9,021.70	10,334.80	13,991.00	17,164.40	17,474.30
Cost of Sales	4,737.70	6,162.20	6,934.90	8,046.80	9,032.90
Net Prior Periods Credit	-1,483.10	-1,537.60	-3,072.90	-212.3	3,971.40
Depreciation & Interest	2,009.90	3,623.70	4,202.40	5,253.10	5,930.70
Less: Expense Capitalized	0	1,506.80	1,640.20	2,350.10	2,835.30
Others	96.1	25.7	77.9	64.6	95
Net Income After Tax	-644.90	-2,272.70	-1,641.80	-9,041.50	-10,288.20
Subsidy & Grants	817.1	2,455.20	1,842.90	1,863.60	4,440.00
Surplus/(Deficit)	172.2	182.5	201.1	-7,177.9	-5,848.2

Source: WBSEB

In order to improve the financial condition of WBSEB, various measures, including restructuring of the energy sector, are being implemented. Reform measures include: i) an Energy Audit on receivables, which is being undertaken to identify and reduce T&D loss in order to attain a level of 20% for the year 2004-05, ii) restructuring of the distribution activity of WBSEB for conversion into a Profit Center, and iii) the boosting of Revenue Collection management to reduce receivables outstanding.

The above-mentioned measures have been undertaken with the objective of reaching a break-even point by March 2003 and getting positive returns thereafter. In addition, Power Finance Corporation Ltd, wholly owned by the Government of India, finances WBSEB's efforts to renovate and modernize of the hydro power plant, transmission and distribution system. The given measures are expected to result in the sustainable development of the power sector in the state.

2.5.2 Organization for Operation and Maintenance of the project facilities

Each power station has 4 operation groups consisting of one assistant engineer, 2 operators, and 2 assistants, that work in three shifts. Routine maintenance is carried out by 9-10 employees of the contractual companies, under the direction of one maintenance engineer in each power station. Overhauling is carried out with the help of a local supplier. As of now, the maintenance activity of each power station is executed, more or less, on schedule. Operation and maintenance activities are carried out systematically, as per the manuals supplied by the contractor. In addition, the supply of spare parts is adequate.

At the time of the site survey, Unit 5 in the PS-2 had some mechanical problems, and operations were suspended for two months. Similar problems also occurred at Unit 6 in the PS-2 at the time of its commissioning test. Since the machines of PS-1 and PS-3 have had no such problems so far, and since PS-2 adopted a different mechanical structure from PS-1 and PS-3, a turbine design flaw is suspected to be the root cause of PS-2's problems. The WBSEB requested a local supplier for restoration and inspection of damaged machines. The cause of the accidents and appropriate counter measures should be identified.

[13] Central Power Supply Utilities (CPSUs): The CPSUs consist of 9-generation companies, and were constituted under the 100% central governments equity for supporting the SEBs power development.

[14] West Bengal Electricity Regulatory Commission was established in 1998, under the Electricity Regulatory Commission Act, to determine a reasonable tariff. This tariff may include a Fuel Surcharge Cost of Electricity, a measure that will be determined after listening to the opinions of the Power Utilities, Consumers and other vested parties.

2.5.3 Current Constraints on achieving Project's Outcome and method of its settlement

As previously mentioned, the project facilities have not yet fulfilled the expectations outlined at appraisal. In order to achieve the expected outcome and to secure the project's sustainability, WBSEB is already planning countermeasures as described below. In view of project sustainability, these countermeasures should be put into practice.

a) Deterioration of MMC

MMC was built in 1988 by the I&W Department as a part of the Teesta Irrigation Project. After commissioning, there were frequent collapses of the concrete embankments. The I&W Department made temporary repairs to the damaged sections each time. From May-September 1998 and from December-June 1999, MMC was drained and repaired by the department, using fund from their own budget. However, the collapse of the embankment occurred frequently. A 600 m stretch of the left side of the embankment was completely breached on 29th December 1999. Since the canal bed of the breached section was above the ground level, no water could flow to MMC. The breached section was restored by the I&W Department, completed on 27th June 2000.

Taking this deterioration into account, the I&W Department has limited water release to MMC, thereby preventing further collapses. As a result, actual water release to MMC has been considerably less than estimated in the appraisal. The amount of water released was gradually increased in line with WBSEB's requirement, reaching maximum water flow of 175m^3/sec during the 2000-01 period from 50m^3/sec in 1997-98. Even so, this is far below the target level of 310-330 m^3/sec required for full operation.

According to the site survey, which was executed by WBSEB and the National Hydro Power Corporation[*15] (NHPC), 21 km of of MMC's total 38 km need rehabilitation and alignment modification. Since responsibility for the canal's maintenance lies with the I&W Department, WBSEB is not in a position to execute rehabilitation. Accordingly, the WBSEB has requested the I&W Department conduct rehabilitation of MMC.

Figure-3: Collapsed Embankment of MMC

b) Insufficient Discharged Capacity in the lower reaches of MMC.

The Dauk-Nagar Main Canal (DNMC) is situated at the lower extension of MMC and originally was supposed to serve as an irrigation canal as well as a discharge canal, guiding surplus water flows from MMC. DNMC was planned for completion before the commissioning of the hydroelectric power stations, and was the responsibility of the I&W Department. In reality, it has not yet been completed[*16] due to the critical problem of land acquisition[*17] and the I&W Department's lack of funds. Accordingly, surplus water from MMC was discharged only through the Dauk River.

The maximum discharge capacity of the Dauk River, however, is 205 m^3/sec, as against the 330-310 m^3/sec required for full-scale operation of the power stations. When taking into account the river's normal flow of 35 m^3/sec, the water discharge from MMC at the Dauk Barrage is naturally restricted to less than 180 m^3/sec.

c) Deposition of Silt at the Bed of MMC

The water that flows through MMC, which originates in the Teesta River, contains huge amounts of silt, especially during the monsoon period. Silt that had accumulated on the canal bed was 1.0-1.5 m thick, causing a reduction in canal discharge capacity. In addition, since silt also accumulated in front of the power station's intakes, water flowing into the power station was also reduced. At appraisal, it was assumed that silt would be flushed downstream gate operation on days of heavy rain. In reality, silt has not been flushed away because of the weak current.

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[15] National Hydro Power Corporation Ltd.: A Govt. of India Enterprise was set up in 1975 with the objective of harnessing the vast untapped hydropower potential in the country.

[16] Out of 80km of proposed length, only 45 km had completed as of October 2001.

[17] The land acquisition problem had settled in June 2001, after the over 20 years conflict.

d) Stack of Floating/Submerged Trash at the Intake Gates

The inflow of large amounts of floating/submerged trash, mainly plants, clogged the intake trash racks, resulting in the deposition of silt and further restricting the inflow of water. This trash was removed by laborers. This is hard work, especially in winter, as the laborers become soaked in water, and is executed every day between 06:00 and 22:00 in two shifts. WBSEB is planning to install an automatic trash-removing trash rack either at the intake gate of MMC or at the intake gate of each power station.

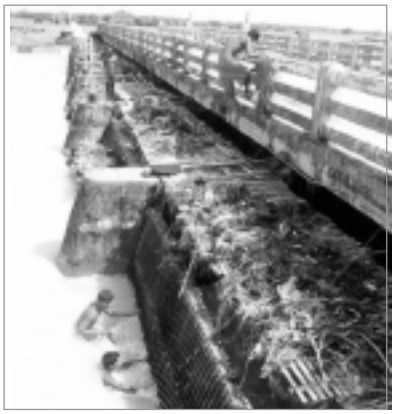

Figure-4: Removal of Floating Trash

3. Lessons Learned

3.1 Compatibility with Irrigation Projects

When an organization other than the executing agency performs O&M on canals supplying water for canal-supplied hydroelectricity generation projects, the activities of that organization can significantly influence the effectiveness and sustainability of the project. Therefore, a framework for setting up an appropriate O&M system should be established in a timely manner.

4. Recommendations

4.1 Necessity of Immediate Implementation of Countermeasures

For various reasons the project facilities have not yet achieved their expected outcome. Rudimentary analysis of these constraints has already been done by WBSEB with the help of NHPC. Although the proposal of countermeasures was prepared at the time of the post-evaluation mission's site survey, approval for taking these countermeasures has not yet been obtained. In view of the project sustainability, these countermeasures should be put into practice immediately and appropriately.

With the exception of the MMC rehabilitation project, all other countermeasures will be financed and executed by the WBSEB. MMC rehabilitation should be carried out under the responsibility of the I&W Department. However, taking into account the I&W Department's project priority and budget constraints, there seems little hope that the department will execute the work.

Accordingly, if it is financially feasible, WBSEB should finance part of the project cost and execute the rehabilitation project with the consent of the I&W Department. Otherwise, WBSEB should take countermeasures to ensure the MMC rehabilitation project.

Comparison of Original and Actual Scope

Items/Activities	Original Schedule	Actual
(1) Project Scope		
1. Water Intake & Canal		
- Total Length of approach Canal	705 m	670 m
- Total Length of tail race Cannel	5,040 m	5,348 m
- Escape Canal	-	98 m (Newly Included)
2. Turbine		
- Maximum Generation	7.5MW	7.5MW
- Peak Discharge	332m^3/s	331.5 m^3/s
- Number of Units	3 Units	3 Units
3. Generator		
- Type	3 phase Synchronous	As Planned
- Number of Units	9	As Planned
4. Main Transformer		
- Voltage for Transformer	132/ 6.6	132/ 6.6
- Capacity	27.0 MVA per Unit, Total: 81 MVA	16.0 MVA per Unit, Total: 96.0 MVA
- Unit	3	6
5. Switch Yard Equipment	1 set	As planned
6. Diesel Generator	-	1 set (Newly Included)
7. Consulting Service		
- Detail Design	8.0 M/M*	N.A
- Supervision of Construction	7.0 M/M*	N.A
(2) Implementation Period		
1. Power Station 1		
- Power House	1989 – 1992	1991 – 1998
- Water Channel	1989 – 1992	1991 – 1997
- Electromechanical Equipment	Jan. 1989 – Aug. 1992	Dec. 1996 – Mar. 2000
2. Power Station 2		
- Power House	1989 – 1992	1991 – 1998
- Water Channel	1989 – 1992	1991 – 1998
- Electromechanical Equipment	Jan. 1989 – Sep. 1992	Dec. 1996 – Mar. 2000
3. Power Station 3		
- Power House	1989 – 1992	1991 – 2000
- Water Channel	1989 – 1992	1991 – 1999
- Electromechanical Equipment	Jan. 1989 – Mar. 1993	Dec. 1996 – Mar. 2000
4. Consultant	Jul. 1986 – Jun. 1991*	Jan. 1987 – Nov. 1999
(3) Project Cost		
Foreign currency	9,092 mil yen	6,229 mil yen
Local currency	1,008 mil rupees	3,521 mil rupees
Total	17,762 mil yen	17,261 mil yen
ODA Loan Portion	14,247 mil yen	14,003 mil yen
Exchange Rate	1 rupee = 8.6 yen (As of April 1990)	1 rupee = 3.13 yen (Weighted Average)

* Original scope of consulting service is at the time of appraisal of 1st phase.

Independent Evaluator's Opinion on Teesta Canal Hydroelectric Project(I) (II)

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The project had an obvious relevance when it was conceived and commissioned for the following reasons:

1. Need to realize untapped hydroelectric potential in India and West Bengal;
2. Availability of water channel to tap the potential; and
3. Need of the state of West Bengal for more power

West Bengal has an impressive installed capacity as indicated below:

i)	State's own generating capacity	4,834 MW	(as on 31.3.2001)
ii)	Share in central sector power plants	803 MW	(as on 31.3.2001)
iii)	Share from Damodar Valley Corporation	263 MW	(as on 31.3.1999)
	Total	5,900 MW	

The aggregate plant load factor of state owned generating units has been low: hence the continued relevance of the Project, particularly in the context of state's commitment of 100% rural electrification of March 2007 as against 77% rural electrification as on 31st March 2000 and the expected 85% of a total of 38,024 mauzas (villages) up to March 2002. Energization of a large number of irrigation pump sets is another objective which can be supported by such a project up to March 2001 only about 17% of the total pump-sets (drawing water mechanically from tube-wells) had been energized implying that high-cost diesel was being burnt in running the rest of 0.5 million plus tube-wells.

The project has had a good impact though not a full impact. 4 units (30 MW) had been commissioned in 1997-98, 2 units (15 MW) in 1998-99 and the remaining 3 units (22.5 MW) in 1999-2000. The delay was of 7 years, naturally pushing up project costs and per unit cost of generation. Generation level has been significantly lower than targeted: As against the aggregate average PLF of the 3 stations of 54.1%, even in the first full year after the commissioning of the 3rd station, i.e. in 2000- 2001 the average plant load factor was only 37.75%.

The project is certainly sustainable given the needs of the state, availability offeed stock (water) and clean environment friendly generation. However every effort should be made to generate power as per the target if not better. It is understood that Renovation & Modernization program has been prepared with the following components:

i) Cooling water system in 3 Power Stations
ii) Implementation of SCADA operation both for local and remote for PS- 2 and PS- 3
iii) Automatic trash cleaning machine at Head Race Canal trash racks in each of the Power Station

The expected cost of these 3 devices will be 56 million rupees. This would need to be provided. Ultimate sustainability of the Project would depend on more efficient operations and a more rational tariff

policy of the State Government/ WBSEB. In the current year (2002-03) the average tariff is projected at 2.96 rupee per unit as against the average cost of supply of 4.18 rupee per unit. This implies a short recovery of 1.22 rupees per unit, which is putting a heavy strain on WESEB, other utilities and the State Government. However, healthy development is the sharp reduction in negative contribution from 5,334 million rupees (-) last year to 640 million rupees (-) in 2002-03. Also that while there was a peak deficit of 200 MW (5.5%) in 2001-02 there was an overall energy surplus of 95 GWh (0.5%) during the year. This augurs well for the state and for the Project.