Thailand

Fourth Bangkok Water Supply Improvement Project (II) and Fifth Project Networks System Improvement Project

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Field Survey: December 2004

1. Project Profile & Japan's ODA Loan

Bangkok Metropolis

Maha Sawat Water Treatment Plant

1.1 Background

In the early 1990s, the population of the Bangkok Metropolis was forecast to grow from 8,073,000 in 1991 to 9,353,000 in 1996, and this growth would lead to an increase in maximum water demand from 3,460,000 m^3/day in 1992 to 4,330,000 m^3/day in 1996. As the production capacity of water supply facilities at the Metropolitan Waterworks Authority (MWA) around that time was only 3,780,000 m^3, there would be a supply-demand gap of 550,000 m^3.[1] The gap would continue to grow at 200,000 m^3 annually to be as much as 1,090,000 m^3 in 1999. In particular, the west bank area of the Chao Praya River, where the population was growing rapidly, was predicted to suffer a serious shortage of water supply, resulting in a supply-demand gap of 350,000 m^3 in 1992 and 550,000 m^3 in 1999. Commercial and industrial development as well as improvement of living standards in the Metropolis would further accelerate this trend. Moreover, water transmission and distribution facilities were also decrepit and weak, causing a high proportion of non-revenue water (NRW). In addition, the Bangkok Metropolis had a serious land subsidence problem because of overuse of groundwater, and there was an

[1] The preceding ODA loan projects for MWA included the 1st, 2nd, 3rd, and 4th (I) Water Supply Improvement Projects. Major outputs of the 4th Project (I) (L/A: September 1991; disbursed amount: 5,849 million yen) were (i) siphons at the raw water canal, (ii) water treatment facilities at Bang Khen water treatment plant, (iii) pumping units at transmission pumping stations, and (iv) transmission and distribution pipelines.

urgent requirement for MWA to expand its coverage area to prevent further use of groundwater.

1.2 Objective

The objectives of the projects were to cope with increasing water demand and reduce water leakage as well as to improve water quality by constructing water treatment plants and improving distribution network systems in the Bangkok Metropolis, thereby contributing to improving public health, enhancing industrial and commercial activities, and reducing use of groundwater.

1.3 Borrower/Executing Agency

Metropolitan Waterworks Authority/Metropolitan Waterworks Authority

1.4 Outline of Loan Agreement

	Fourth Bangkok Water Supply Project (II) and Fifth Project	Networks System Improvement Project
Loan Amount Loan Disbursed Amount	16,969 million yen 11,675million yen	5,599 million yen 3,735million yen
Date of Exchange of Notes Date of Loan Agreement	December 1992 January 1993	September 1993 September 1993
Terms and Conditions Interest Rate Repayment Period (Grace Period) Procurement	 3.0% p.a. 25 years (7 years) General Untied	 3.0% p.a. 25 years (7 years) General Untied
Final Disbursement Date	November 2000	January 2001
Contractors	Summit Grand, ltd (Thai) Asano Corporation (Jpn.) Sino Thai (Thai) Other Firms	ABB Industry Limited (Thai.) Other Firms
Consultants	Nihon Suido Consultants (Jpn.) Sts Engineering (Thai) Safege Consulting (Fr.) Team Consulting Engi (Thai)	--
Project Planning (F/S)	M/P (MWA1990)	M/P (MWA1990)

2. Results & Evaluation

2.1 Relevance

2.1.1 Relevance at the time of appraisal

Thailand's 7th National Economic and Social Development Plan (NESDP) (1992-1996) emphasized the importance of expanding the city's water supply facilities and reducing

water leakage. Corresponding to a serious water shortage at that time, MWA proposed the expansion of water supply facilities in its master plan prepared in 1990.[2] Hence, the subject projects had a high priority, as these projects aimed at expanding water production and distribution facilities in the Metropolis to address these problems.

2.1.2 Relevance at the time of ex-post evaluation

The present 9th NESDP (2002-2006) also points out a priority need for improving water supply facilities. Significant needs for stable water supply services still remain, particularly for improvements in volume, pressure, and quality. Thus, the projects continue to hold importance and relevance to address these issues.[3]

2.2 Efficiency

2.2.1 Outputs

A comparison between the planned outputs at appraisal and the actual outputs at ex-post evaluation shows that most of the major components were implemented as planned with only slight variations (see Table 1 and Figure 1).

In the 4th Water Supply Improvement Project (II) (4th Project (II)), the improvement of the existing canal was cancelled because the canal was later found to have sufficient conveying capacity if some sections of canal banks were raised. This bank raising was conducted through the maintenance activities of MWA. Moreover, in the Network Systems Improvement Project (Network Systems Project), five controlling systems at distribution pumping stations were additionally installed to enhance the operational efficiency of pumping units.

On the other hand, in all the three projects, the pipeline components, such as transmission conduits, trunk mains, and distribution pipelines were modified. The reasons for the modifications were (i) to cope with the increasing water demand in newly expanded service areas, (ii) to adjust to specific conditions of project sites, and (iii) to coordinate with other governmental agencies such as the Bangkok Metropolitan Administration (BMA) and the Department of Highways (DOH).

These modifications made in the course of implementation were reasonable and did not affect the overall efficiency of the project implementation.

[2] The master plan, "Master Plan for Water Supply and Distribution of Metropolitan Bangkok," was prepared by the Thai DCI in association with Southeast Asia Technology, the Team Consulting Engineers, and the Safege Consulting.

[3] The 7th Water Supply Improvement Project (1999-2006), partially financed by JBIC, is currently being implemented.

Table 1: Appraisal Plans & Actual Performance (Outputs)

Phase	Plan	Actual	Reason of modifications
4th Project (II)	(1) Improvement of the existing raw water canal from Sam Lae raw water PS to Bang Khen WTP: 17.8 km	(1) Cancelled	(1) The existing canal was later found to have sufficient conveying capacity for supplying raw water if the canal banks were raised in certain sections. MWA did this with its own resources.
	(2) Pumping unit at Bang Khen raw water PS: 348 m^3/m	(2) As planned	
	(3) Lad Krabang Distribution PS: 111 m^3/m; Power station: 7,500 KVA	(3) As planned	
	(4) Transmission conduits: 20.5 km	(4) As planned	
	(5) Trunk mains: 56.7 km	(5) 18.1 km	
	(6) Distribution pipelines: 600 km	(6) 819 km	
	(7) Rehabilitation of distribution pipelines: 163 km	(7) 310 km	
	(8) Consulting services: a) Review of tender documents, tender evaluation; b) Construction supervision (1,662 M/M)	(8) As planned	
5th Project	(1) Maha Sawat WTP: 400,000 m^3/d	(1) As planned	
	(2) Trunk mains: 109.5 km	(2) 219.5 km	
	(3) Distribution pipelines: 1,000 km	(3) 669.3 km	
	(4) Consulting services: a) D/D for water treatment plants, review of D/D for other components; b) Construction Supervision (1,720 M/M)	(4) As planned	
Network Systems Project	(1) Bang Khen WTP; Reservoir: 40,000 m^3; Power station: 7,500 KVA	(1) As planned	(2) Controlling systems at the 5 distributing PSs were additionally installed to increase the operational efficiency of pumping units.
	(2) Distribution pumping units: 7	(2) 5 controlling systems added	
	(3) Trunk mains: 130 km	(3) 216.4 km	
	(4) Distribution pipelines: 370 km	(4) 296 km	
	(5) Consulting services: a) D/D; b) Construction Supervision (329 M/M)	(5) As planned	

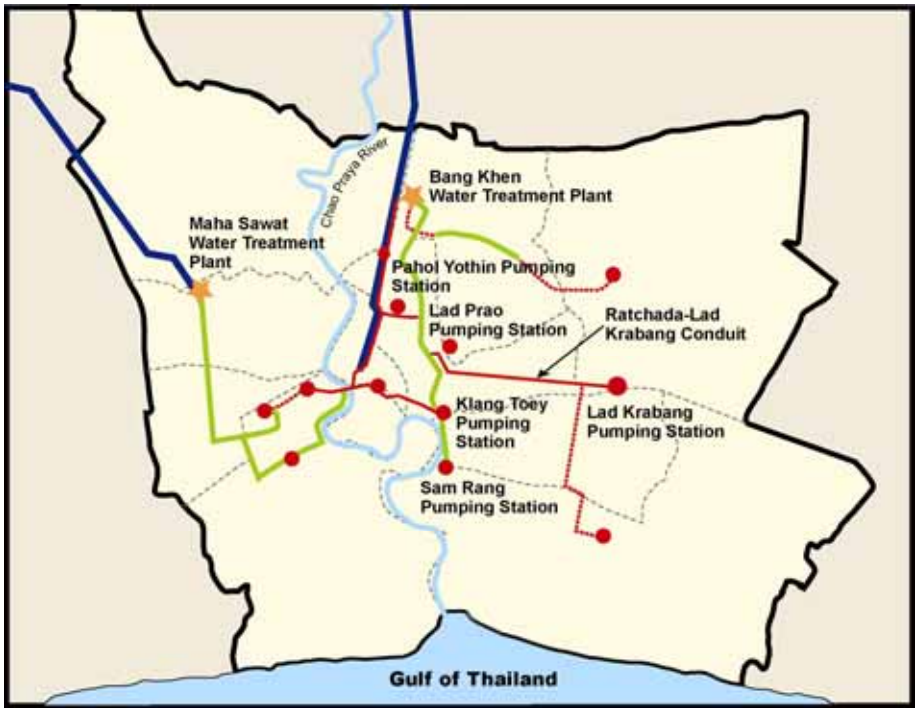

Fig. 1: Project Site Map (Actual)

2.2.2 Project Period

Table 2 presents a comparison between the planned project period at appraisal and the actual project period at ex-post evaluation. The pipeline components were greatly delayed, while the water production components were completed on time. The delays were primarily attributable to (i) delays in obtaining construction permissions from BMA, (ii) flooding in November 1995, and (iii) cash-flow problems of contractors due to the Asian economic crisis in 1997.

Table 2: Appraisal Plans & Actual Performance (Project Period)

Phase	Plan	Actual
4th Project (II)	January 1993 – June 1996 (42 months)	January 1993 – June 2000 (90 months)
5th Project	January 1993 – April 1996 (40 months)	January 1993 – January 2002 (109 months)
Network Systems Project	September 1993 – February 1998 (54 months)	September 1993 – September 2004 (133 months)

2.2.3 Project Cost

Table 3 shows a comparison between the planned project cost at appraisal and the actual project cost at ex-post evaluation. In all the three projects, the actual project costs were within the initial budgets. These cost under-runs were primarily a result of (i) intense competition among contractors during the tender and (ii) depreciation of local

currency.

Table 3: Appraisal Plans & Actual Performance (Project Cost) (¥ million)

Phase	Plan			Actual		
4th Project (II)	¥ 22,955	Foreign	¥ 8,066	¥ 13,388	Foreign	¥ 6,440
		Local	¥ 14,889		Local	¥ 6,948
5th Project	¥ 39,084	Foreign	¥ 16,017	¥ 20,335	Foreign	¥ 5,057
		Local	¥ 23,067		Local	¥ 15,278
Network Systems Improvement Project	¥ 20,522	Foreign	¥ 5,599	¥ 12,206	Foreign	¥ 3,319
		Local	¥ 14,923		Local	¥ 8,887

2.3 Effectiveness

2.3.1 Increase in Production Volume

As indicated in Figure 3, since its start in 1996, the Maha Sawat water treatment plant has operated effectively at an operation rate of more than 70% on average.[4] The water production volume in 2003 reached as much as 85.8% of the planned figure. In 2000, the subsequent 6th Water Supply Improvement Project further increased the production capacity by 400,000 m^3/day.

Fig. 2: Filter at Maha Sawat Water Treatment Plant

In 2003, the Maha Sawat water treatment plant treated 14.5% of the total MWA water production. The establishment of the Maha Sawat water treatment plant has made an extremely important change to the entire MWA system, as it reduces the dependence on the Bang Khen water treatment plant and serves the western part of the Bangkok Metropolis.

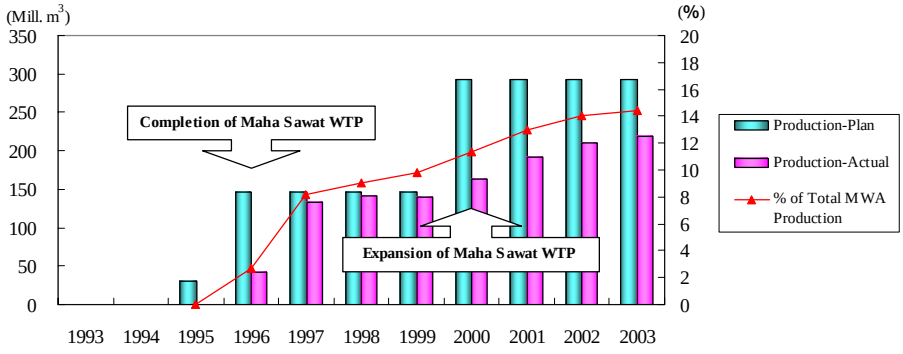

Fig. 3: Appraisal Plans & Actual Performance (Water Production Volume) (Source: MWA)

2.3.2 Improvement in Water Supply Services in Bangkok Metropolis

As Table 4 presents, MWA has improved its overall water supply services since the

[4] Operational rate = average daily production / facility capacity x 100

beginning of the projects in 1993. However, the actual figures of population served and total water sales have fallen below the original plan, largely because the Asian economic crisis negatively affected the population growth trend (2003: forecast 11.3 million; actual 7.8 million) as well as commercial and industrial activities in the Bangkok Metropolis. Meanwhile, the fact that the percentage of the population served and service area have exceeded the plan indicates that MWA has successfully expanded its service capacities even under unfavorable socioeconomic conditions.

Table 4: Appraisal Plans & Actual Performance (Water Supply Services)

FY	Project Implementation Period*			Population Served (000)		Percentage of Population Served (%)		Service Area (km^2)		Total Water Sales (mill. m^3)	
	4	5	NS	(Plan)	(Actual)	(Plan)	(Actual)	(Plan)	(Actual)	(Plan)	(Actual)
1993				6,559.0	5,583.0	76.4	77.7	780.0	784.4	965.8	836.1
1994				6,790.0	5,792.0	76.8	80.0	810.0	822.3	1,071.0	816.1
1995				7,023.0	5,959.0	77.2	82.2	850.0	892.9	1,178.5	870.3
1996				7,258.0	6,124.0	77.6	83.7	890.0	968.9	1,171.6	911.2
1997				7,495.0	6,307.0	78.0	85.7	940.0	1,096.4	1,193.1	944.7
1998				7,789.0	6,369.0	78.7	85.6	1,000.0	1,129.3	1,334.3	914.8
1999				8,088.0	6,232.0	79.4	85.3	1,030.0	1,148.4	1,352.3	856.6
2000				8,390.0	6,345.0	80.1	84.2	1,060.0	1,242.7	1,445.4	880.3
2001				8,697.0	6,500.0	80.8	85.3	1,090.0	1,279.5	1,445.4	929.5
2002				9,007.0	6,703.0	81.5	86.9	1,120.0	1,448.8	1,554.9	969.4
2003				9,322.0	6,931.0	82.2	87.5	1,150.0	1,515.1	1,554.9	1,013.9

* 4 = 4th Project; 5 = 5th Project; NS = Network Systems Project

(Source: MWA)

On the other hand, the planned targets for non-revenue water (NRW) ratio have not been achieved (Figure 4). The NRW ratio increased dramatically from 31.9% in 1993 to 43.1% in 1997 because water production volume had increased and consequently raised water pressure in the pipelines. From the peak level in 1997, however, MWA has managed to decrease NRW through a number of measures, including the pipeline components of the projects as well as the recent Water Loss Improvement Project (2002-2005).[5]

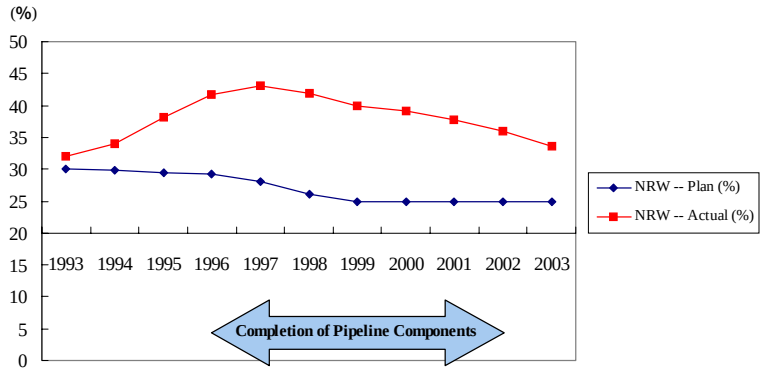

Fig. 4: Appraisal Plans & Actual Performance (Non-revenue Water Ratio) (Source: MWA)

[5] The project aims at reducing NRW ratio to less than 30% by 2006. Specific measures include improvement of distribution facilities and introduction of automatic control system with IT enhancement.

The results of the beneficiary survey show that the beneficiaries of the projects are generally satisfied with the changes that the projects have brought about (see Figure 5).[6] The proportion of interviewees who answered “largely improved” or “improved” was 86.5% when referring to water availability and 85.5% when referring to water stability.

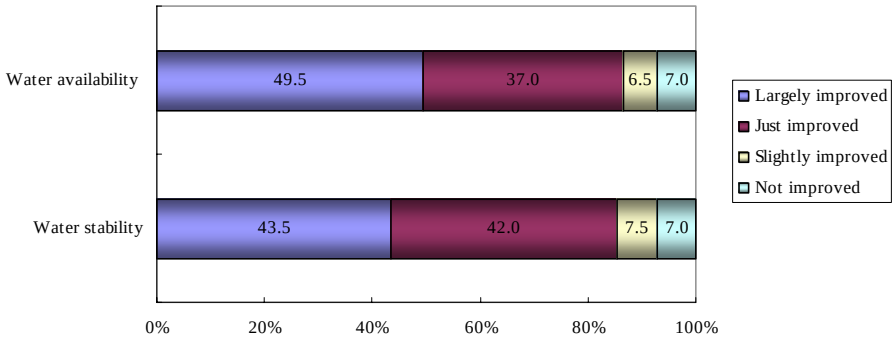

Fig. 5: Beneficiary Interview Survey (Improvement of Water Supply Services) (N=200)

It should be noted that these improvements have become possible with the implementation of other water supply sector projects such as the West Bank Raw Water Canal Project (1993-2002), the Pipe Networks System Improvement Project (1994-2003), the 6th Water Supply Improvement Project (1995-2006) and the 7th Project (1999-2006).

2.3.3 Improvement in Water Quality

The subject projects have also contributed to improving the water quality of MWA. The water quality currently satisfies set standards, which are based on the 1993 WHO recommendations on international drinking water standards (see Table 5).

Table 5: Water Quality Standards of MWA

Item	MWA
Escherichia coli	None
Color	15
Turbidity	5
Arsenic	0.01mg/l

(Source: MWA)

This is also evidenced by the fact that 91.0% of the interviewees in the beneficiary interview surveys evaluated water quality as “largely improved” or “improved”.

[6] The beneficiary interview survey was undertaken as a part of this evaluation to measure the contribution of the subject projects to improving the MWA water supply services and subsequently the environment in the Bangkok Metropolis. In each of four selected areas, 50 interviewees were randomly chosen. The interview locations included Bangkok Outer Ring Road and Lad Krabang from the 4th and 5th projects as well as Phahol Yothin and Srinakarindra from the network systems project. These locations were chosen in thorough consultation with MWA.

2.3.4 Financial Reevaluation

The recalculated financial internal rates of return (FIRRs) of the 4th Project, 5th Project, and the Networks System Project are 12.8%, 5.0%, and 10.7%, respectively (Table 6).[7] These figures surpass the expected FIRRs at appraisal, primarily because of (i) the decrease in project costs and (ii) decrease in operation and maintenance (O&M) costs due to the enhancement of operational efficiency by reducing personnel (i.e. increase in the customer to employee ratio) and introducing IT.

Table 6: Appraisal Plans & Actual Performance (FIRRs)

Phase	Plan	Actual
4th Project	5.4%	12.8%
5th Project	4.7%	5.0%
Networks System Project	4.5%	10.7%

2.4 Impacts

2.4.1 Improvement in Sanitation

The Bangkok Metropolis had long suffered from poor sanitation and, consequently, a high incidence of waterborne disease. Even though the results of the beneficiary survey do not clearly indicate that the beneficiaries are aware of the projects' contribution, the cases of acute diarrhea per 100,000 people decreased from a peak level of 877.58 in 1998 to 676.98 in 2002.[8]

The beginning of this trend coincides with the implementation of trunk main and distribution pipeline improvement, and it is therefore suggested that the projects have assisted in improving sanitary conditions in the Bangkok Metropolis.

2.4.2 Enhancement of Commercial and Industrial Activities

The subject projects also appear to have enhanced commercial and industrial activity in the Bangkok Metropolis. In particular, positive impacts on economic and commercial activities have been evident in the areas where the Lad Krabang distribution pumping station was constructed under the 4th Project. The average annual GRDP growth rate from 2000 to 2002 in this area was 7.48%, more than double the national average of 3.17%.

Fig. 6: Lad Krabang Pumping Stations

[7] The FIRR calculations performed at appraisal took costs to be construction costs and O&M costs (for all the projects), and benefits to be the incremental increase in revenue from water sales (for all the projects) and reduction in water loss (4th Project and Network Systems Project only) as well as savings in energy consumption (for Network Systems Project only). The recalculations of this evaluation use the same terms. It should be noted that these evaluations of the 4th Project cover both the phase I and the phase II.

[8] 18.5% of the interviewees answered "Yes" to the question asking if the Projects have decreased waterborne disease in neighborhood, while 4.5% said "No" and 77.0% "Don't know."

2.4.3 Reduction of Groundwater Use

As shown in Table 7, the use of groundwater has decreased since the mid-1990s from 238,400 m^3/day to none in 2004. This is primarily because (i) several MWA projects, especially the networks system project, have expanded the area served by the central system, and (ii) the government amended the Groundwater Act in 2003 to tighten the enforcement of rules on groundwater use. The areas with land subsidence of more than 3 cm/year have significantly reduced.

Table 7: Groundwater Use in Bangkok Metropolis (1000 m^3/day)

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
120.3	191.8	238.4	251.8	214.3	109.3	21.0	24.0	12.0	11.4	7.1	0.0

(Source: MWA)

2.5 Sustainability

2.5.1 Executing Agency

2.5.1.1 Technical Capacity

The technical capacity of MWA is strong enough to ensure the sustainability of the project effectiveness. In order to further enhance the technical capabilities of each employee, MWA provides a range of training programs at the National Waterworks Technology Training Institute (NWTTI) and external institutions.[9] Moreover, MWA seeks to improve its managerial capacity by obtaining ISO 9001 certification and other measures.

2.5.1.2 Operation and Maintenance System

The responsibility for O&M of the facilities and equipment under the subject projects lies with several departments under the Deputy Governor of Production and Transmission, which include the Office of Bang Khen Water Treatment Plant, Maha Sawat and Thon Buri Water Treatment Plant Department, and the Office of Water Treatment and Distribution Systems (see Figure 7).

The Board of Directors makes important decisions, such as on changes to water prices, in consultation with the Ministry of Interior.[10]

[9] NWTTI was established through the receipt of grand aid from the Japanese government in 1988.

[10] The tariff structure of MWA is different between domestic and business/governments users. Both types have proportional tariff classifications according to consumption amount with the minimum rate of 8.50 Baht/m^3 (23.3 Yen) for domestic users and 9.50 Baht (26.0 Yen) for business/government users. Minimum tariffs for domestic users are 0.75 Ringgit (20.0 Yen) for domestic users and 1.80 Ringgit (51.4 Yen) for industrial and commercial users in Kuala Lumpur, and 1,335 Rupee (15.2 Yen) for domestic users and 5,200 Rupee (59.4 Yen) for commercial and industrial users in Jakarta.

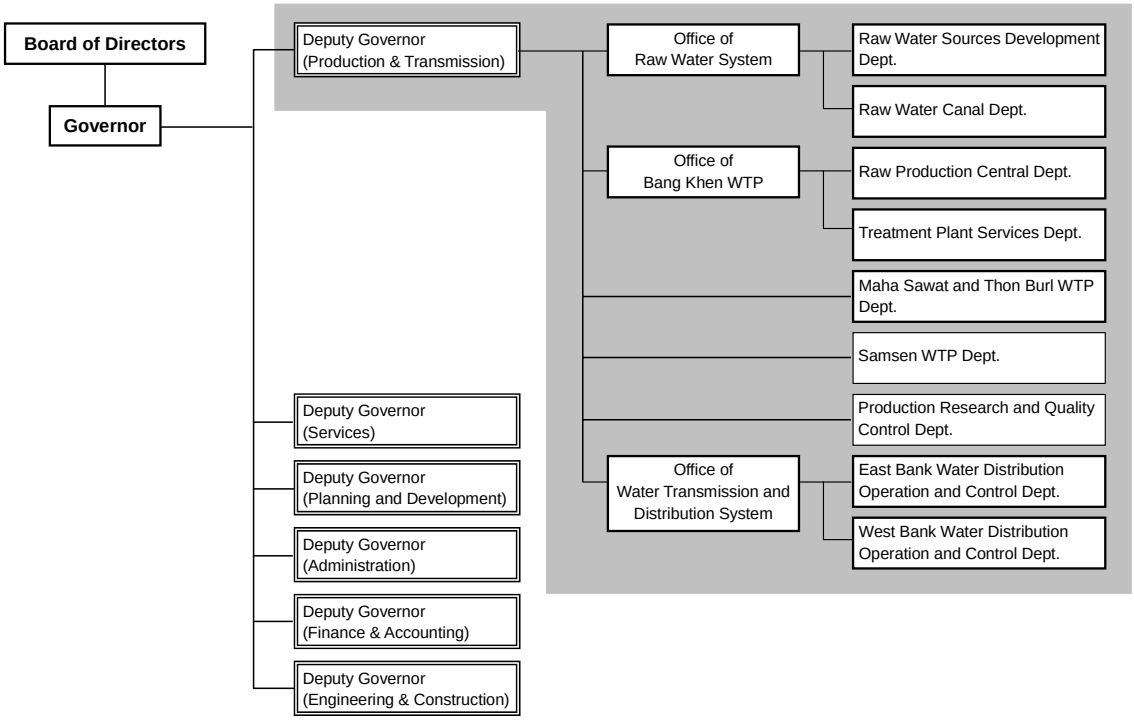

Fig.7: O&M Organizational Chart

2.5.1.3 Financial Status

Table 8 indicates the key financial indicators of MWA for the past three years. Overall, the financial status has been stable with a net income ratio of over 20% and an equity to capital ratio of over 40%, levels that should ensure the sustainability of the project facilities. Price increases in 1997, 1998, and 1999 raised the MWA's effective rate from 7.14 Baht/m^3 in 1994 to 11.88 Baht/m^3, and this has contributed to the financial performance.

Table 8: Key Financial Indicators

FY	Total Revenues (Mill. Baht)	Operating Income (Mill. Baht)	Net Income (Mill. Baht)	Equity to Capital Ratio (%)
1992	5,653	1,542	1,670	44.3
2001	12,083	3,142	2,660	37.7
2002	12,766	3,613	3,669	43.0
2003	13,992	4,200	3,536	45.7

(Source: MWA)

2.5.2 Operation and Maintenance Status

The O&M status of the project facilities constructed through the projects is generally favorable.

3. Feedback

3.1 Lessons Learned

None.

3.2 Recommendations

None.

Comparison of Original & Actual Scope

Items	Planned	Actual
(1) Outputs		
- 4th Bangkok Water Supply Improvement Project (II)	・ Improvement of the existing raw water canal from Sam Lae raw water PS to Bang Khen WTP: 17.8 km	・ Cancelled
	・ Pumping unit at Bang Khen raw water PS: 348 m^3/m	・ As planned
	・ Lad Krabang Distribution PS: 111 m^3/m; Power station: 7,500 KVA	・ As planned
	・ Transmission conduits: 20.5 km	・ As planned
	・ Trunk mains: 56.7 km	・ 18.1 km
	・ Distribution pipelines: 600 km	・ 819 km
	・ Rehabilitation of distribution pipelines: 163 km	・ 310 km
	・ Consulting services: 1,662 M/M	・ As planned
- 5th Bangkok Water Supply Improvement Project	・ Maha Sawat WTP: 400,000 m^3/d	・ As planned
	・ Trunk mains: 109.5 km	・ 219.5 km
	・ Distribution pipelines: 1,000 km	・ 669.3 km
	・ Consulting services: 1,720 M/M	・ As planned
- Networks System Improvement Project	・ Pumping building; Reservoir: 40,000 m3; Power station: 7,500 KVA	・ As planned
	・ Distribution pumping units: 7	・ 5 controlling systems added
	・ Trunk mains: 130 km	・ 216.4 km
	・ Distribution pipelines: 370 km	・ 296 km
	・ Consulting services: 329 M/M	・ As planned
(2) Project period		
- 4th Project (II)	Jan. 1993 – Jun. 1996	Jan. 1993 – Jun. 2000
- 5th Project	Jan. 1993 – Apr. 1996	Jan. 1993 – Jan. 2002
- Networks System Improvement Project	Sept. 1993 – Feb. 1998	Sept. 1993 – Sept. 2004
(3) Project cost		
- 4th Project (II)		
Foreign currency	8,066 million yen	6,440 million yen
Local currency	14,889 million yen	6,948 million yen
Total	22,955 million yen	13,388 million yen
Japan's ODA loan	8,836 million yen	6,541 million yen
Exchange rate	(¥1 = B 0.196)	(¥1 = B 0.399)
- 5th Project		
Foreign currency	16,017 million yen	5,057 million yen
Local currency	23,067 million yen	15,278 million yen
Total	39,084 million yen	20,335 million yen
Japan's ODA loan	8,133 million yen	5,122 million yen
Exchange rate	(¥1 = B 0.196)	(¥1 = B 0.370)
- Networks System Improvement Project		
Foreign currency	5,599 million yen	3,319 million yen
Local currency	14,923 million yen	8,887 million yen
Total	20,522 million yen	12,206 million yen
Japan's ODA loan	5,599 million yen	3,730 million yen
Exchange rate	(¥1 = B 0.226)	(¥1 = B 0.379)