China

Xi'an Water Supply Project (1)(2) External Evaluator: Mitsue Mishima (OPMAC) Filed Survey: September 2004

1. Project Profile and Japan's ODA Loan



Project site location map (Xi'an, Shaanxi Province)

Nanxiao Water Treatment Plant and Heihe Dam

1.1 Background

Xi'an, one of the largest city in Northwestern China, has been playing an important role in the industries and culture of China since ancient times. Particularly at the time of the appraisal of this project (1993), industrial development was rapidly progressing as various measures were planned or implemented for the development of new technology and the electronics industry under the Xi'an Comprehensive Development Plan. Also, this ancient city formerly called Changan is a famous tourist town with rich cultural heritages visited by many tourists every year.

However, domestic and industrial water was in shorter supply than other major cities in China, and over-pumping of groundwater accelerated land subsidence and formation of cracks on the land surface. Therefore, the problems of water shortage and land subsidence were expected to worsen with population growth and economic development.

1.2 Objectives

The project's objective was to cope with the tight water demand and control over-pumping of groundwater by improving the water supply system and constructing a multi-purpose dam in Xi'an, and thereby contribute to the improvement of sanitary conditions of residents and economic development of the region.

1.3 Borrower / Executing Agency

Government of the People's Republic of China / Ministry of Construction

Project	Xi'an Water Supply Project (1) Xi'an Water Supply Project				
Loan Amount /	4,587 million yen /	2,552 million yen /			
Disbursed Amount	4,587 million yen	2,551 million yen			
Exchange of Notes/	August 1993 /	October 1995 /			
Loan Agreement	August 1993	November 1995			
Terms and Conditions					
- Interest Rate	2.6%	2.1%			
- Repayment Period	30 years	30 years			
(Grace Period)	(10 years)	(10 years)			
- Procurement	General untied	General untied			
Final Disbursement	Contourbox 1000	December 2002			
Date	September 1998				
Contractors					
(Civil Works and	-				
Equipment)					
Consultants	-				
	Chinese Government (1984)				
Feasibility Study (F/S),	Preliminary Study by Japan Bank for International Cooperation				
etc.	(JBIC) (1992)				

1.4 Outline of Loan Agreement

2. Results and Evaluation

2.1 Relevance

In the Eighth National 5-Year Plan of China (1991-1995), improvement of water supply facilities was listed among priority items, and improvement of the water supply system was planned at approximately 450 locations throughout the nation including Xi'an. Also, the Heihe Water Diversion Project (this project) was identified as a priority project in the Eighth and Ninth 5-Year Plans of Shaanxi Province. This project involving the improvement of the water supply system and construction of a multi-purpose dam in Xi'an was of high priority and urgency in implementing the above-mentioned plan.

The Tenth National 5-Year Plan (2001-2005) mentions expanding the urban water supply capacity as well as increasing amount supplied and improving water quality through the improvement of decrepit water supply facilities as the tasks to be tackled. China Western Development Plan also sets a target of promoting water resource development. The Tenth 5-Year Plan of Shaanxi Province calls for a further increase in the use of surface water through the use of the Heihe Dam with a goal of increasing the amount supplied and securing safe water. These policies are relevant to the objective of the project.

2.2 Efficiency

2.2.1 Output

Both the water supply portion (water intake, treatment, and supply/distribution facilities) and the Heihe Dam portion achieved most of the planned output (Table 1). Although the expansion of Qujiangchi Water Treatment Plant was cancelled because it was found to be unsuitable for expansion work due to cracks on the land surface, the cancelled portion of the treatment volume (200,000m³/day) was covered by increasing the installed capacity of the new water treatment plant (300,000 500,000m³/day), and there was no change in the total treatment capacity of the plants. The maximum output of the power generation plant was changed from 15MW to 20MW in order to maximize the power generation efficiency taking into consideration the water volume of the dam. As for the consulting service, supervision of dam construction was conducted with the counterpart funds, and overseas training of the executing agency's employees was not implemented as a result of the review of necessity.

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	Plan		Actual
1.	Water intake facilities: approx. 156km	1.	As planned
2.	Water treatment facilities:	2.	Expansion of Qujiangchi Water Treatment
	Expansion of Qujiangchi Water Treatment		Plant was cancelled and the planned
	Plant (600,000 800,000 m ³ /day)		expansion portion of 200,000m3/day was
	Construction of a new water treatment plant		covered by changing the treatment capacity
	(300,000m ³ /day)		of the new water treatment plant (300,000
3.	Water supply/distribution facilities: total		500,000m ³ /day)
	length 105,070m	3.	As planned
4.	Heihe Dam: total water storage capacity	4.	As planned
	204.21 million tons	5.	Maximum output: 20MW
5.	Power generation equipment: maximum	6.	Cancelled
	output 15MW		
6.	Consulting service (supervision of dam		
	construction and overseas training for		
	employees of the executing agency): 12M/M		

Table 1. Comparison of Output (Plan/Actual)





2.2.2 Project Period

The implementation period of the water supply portion was 101 months from August 1993 to December 2001, 53% longer than 66 months from August 1993 to January 1999 planned at the time of appraisal. The Heihe Dam portion also took much longer than the planned 63 months from November 1995 to January 2001; it took 103 months from November 1995 to May 2004, 63% longer than planned.

This is because the soil of dam site was more clayey than expected, and soil replacement was necessary. As a result, the dam construction work was delayed and consequently it led to the delay in the construction of the water treatment plant and the power plant, which was scheduled to start and progress according to the progress of the dam construction. Moreover, regarding the power plant, it took time to negotiate with the electric power company that was to purchase electricity over the price and other conditions, and the actual operation started in May 2004. The operation of the dam had already started in December 2002.

2.2.3 Project Cost

The total project cost was estimated to be 21,612 million yen at the time of appraisal, whereas the actual cost was 33,337 million yen, up about 53%. This is because the actual prices were much higher than those used as the basis for estimating the project cost at appraisal time reflecting the price increase as a result of the policy of the central government (the shift from controlled prices to market prices).

2.3 Effectiveness

2.3.1 Response to the Water Demand

(1) Population served

The population served in the area covered by the project (6 districts in the urban area of Xi'an City) has increased by 40% from 1.79 million at the time of appraisal (1992) to nearly 2.5 million (2003), exceeding the planned 2.2 million.

(2) Amount of water supply

According to Table 2, the daily average and maximum amount of water supply in the whole service area have changed little since 1995 and have been below the level expected to be achieved after the completion of the project at the time of appraisal (average: 1.43 million m^3/day ; maximum: 1.72 million m^3/day). This is because the conventional use of groundwater has been stopped (since 2001, water has been supplied only from the water treatment plants covered by this project)¹ and water consuming industries such as the cotton spinning industry reduced production due to the change in the national policy adopted during the implementation of this project, and therefore the volume of water used for industrial purposes has decreased by more than predicted (according to Xi'an Water Supply General Company, the share of industrial water among water sold has declined significantly from 33.1% in 1995 to 19.9% in 2003). However, considering that the water supply from the Heihe water intake system is expected to grow as mentioned later (see (4)), amount of water supply in Xi'an is also expected to increase for the future.

The share of domestic water has increased significantly taking over the share of industrial water, from 32% in 1995 to 41% in 2003. This fact shows that the project managed to cope with the increase in the demand for domestic water. The results of the beneficiary survey² indicate that a majority of the households that had been receiving water from Xi'an Water Supply General Company since before the start of the project use

¹ The average amount of water supply 0.8 million m^3/day in 2004 is near to 0.916 million m^3/day , the planned amount of surface water supply at the time of appraisal.

 $^{^2}$ An interview survey on the effects and impact of this project was conducted from September to October 2004 to the sample water users from general households in 6 districts covered by the project - 25 persons from each district selected randomly on an equal basis. In addition, 10 randomly selected organizations (school, hospital, company, etc) were interviewed.

more water since the project was implemented. Before the completion of the project, restrictions on water supply were imposed. In the summer of 1995, water supply was suspended for 7 days owing to water shortage affecting about 70,000 citizens of Xi'an. Since the completion of the project, no restriction has been imposed on water supply.

As far as this project is concerned, the total treatment capacity of the newly constructed water treatment plant and the existing Qujiangchi Purification Plant is 1.1 million m³/day and the maximum water supply in 2004 was 1.02 million m³/day, representing a maximum facility utilization ratio of as high as approximately 92%.

		1995	1998	1999	2000	2001	2002	2003	2004
			(completion	(completion		(completion	(completion		
			of conduits)	of water		of water	of dam)		
Year				supply/		treatment			
				distribution		plant)			
				pipe					
		_		nstallation)		_			
Population served ¹⁾		205.6	210.1	213.5	227.7	235.1	245.9	249.7	n.a.
Water supply coverage ¹⁾ (%)	82.0	86.0	84.0	85.0	84.0	86.0	85.0	n.a.
A vorage water $\operatorname{supply}^{2)}$	Total	74.0	83.7	81.2	78.4	77.1	77.8	78.8	80.0
(ten thousand m ³ /day)	This Project	49.8	52.8	52.8	52.8	77.1	77.8	78.8	80.0
Maximum water $\operatorname{supp}(x^{2})$	Total	91.6	94.4	94.4	96.5	95.4	94.8	104.3	102.0
(ten thousand m ³ /day)	This Project	55.8	57.0	58.2	58.2	95.4	94.8	104.3	102.0
Facility utilization ratio ²⁾ (average,%)	Total	71.2	80.5	78.1	75.4	74.1	50.5	51.2	51.9
	This Project	83.0	88.0	88.0	88.0	70.1	70.7	71.6	72.7
Facility utilization ratio ²⁾ (maximum,%)	Total	88.1	90.8	90.8	92.8	91.8	61.6	67.7	66.2
	This Project	93.0	95.0	97.0	97.0	86.8	86.2	94.8	92.7

Table 2. Operational and Effectiveness Indicators of Xi'an Water Supply General Company

Source: Xi'an Water Supply General Company

Note 1): Population served and the water supply coverage in 6 Urban Districts of Xi'an City (excluding rural areas included in 3 districts) served by Xi'an Water Supply General Company. Xi'an Water Supply General Company is the only company which supplied water to these 6 districts.

Note 2): The "Total" figures are the indicators for all water treatment plants (8 including 2 covered by this project and 6 others) owned by Xi'an Water Supply General Company. Figures for "This Project" are total indicators for the newly constructed Nanxiao Water Treatment Plant and the existing Qujiangchi Water Treatment Plant (since the conduit to Qujiangchi Water Treatment Plant is included in the project).

(3) Leakage rate

The leakage rate was expected to be 7.9% at the time of appraisal, whereas it has been around 13% in recent years. This is mainly attributable to decrepit water distribution pipes not covered by the project (the "Shaanxi Water Environmental Improvement Project", which was approved in FY 2004, includes improvement of the water supply system in Xi'an, and therefore the figure is expected to improve).

(4) Amouont of water supplied from Heihe water intake system³

The water filling process of the dam proceeded as planned and the dam was almost filled up to its capacity in September 2004 when the field survey was conducted. The water supply capacity of the Heihe water intake system is 305 million m³/year, while the actual in 2004 was 207 million m³/year due to a greater than expected decrease in the use of industrial water mentioned above. The supply of irrigation water in 2003 was 2,412m³/year against the irrigation water supply capacity of 12,300m³/year. The reason for small supply volume is that the planned new irrigation facilities have not been constructed.

Thus, facilities are not used to their full capacity at present. According to the City of Xi'an, however, considering that the Changan District Water Treatment Plant (50,000 m^3/day) and the Huxian Water Treatment Plant (25,000 m^3/day) in the city are operated through the Heihe water intake system and that the water supply/distribution pipes extension project is now being implemented, further increase in water use is expected in the near future.

The Xi'an City's Master Plan (1995-2010) approved by the State Council of China includes a target to close domestic wells in all districts in Xi'an by 2010 and a prediction that urban water use will increase as the development of suburban districts is promoted. Some of these elements are to be integrated into the water supply system of Xi'an Water Supply General Company.

2.3.2 Alleviation of Land Subsidence

According to the City of Xi'an, the maximum land subsidence recorded during the 1984-1995 period was 80-100mm/year, whereas that in 2003 was 28.33mm/year, indicating that land subsidence has been alleviated substantially. Water supply under this project seems to have contributed to the improvement by helping reduce the use of groundwater from wells (422 wells were closed after 1999 to the time of the field survey). The well water use restriction policy enforced by Shaanxi Provincial Government in 2000 (prohibiting pumping up of groundwater from wells in the regions where new water distribution pipes are installed) also contributed to the improvement. With the alleviation of land subsidence, cracks have decreased, too. The largest size of cracks has been reduced from 55mm/year before 1995 to 20mm/year after 1995.

³ Since most surface water along the Heihe River including water from the Shitouhe Dam (see Fig. 1) is used via water intake facilities covered by this project, amount of water supplied from the whole Heihe water intake system is analyzed.

2.3.3 Power Generation

Since the completion in May 2004, the power plant has been operating smoothly. Power generation from June 2004 to May 2005 was 65,600Mwh, almost achieving the planned annual power generation of 65,930Mwh.

2.3.4 Recalculation of Internal Rate of Return

At the time of appraisal, Financial Internal Rate of Return (FIRR) was calculated to be 10.8%. The recalculation as of the time of this evaluation resulted in 9.6% by taking into consideration the predicted increase in water use for the future.

(Assumptions for the calculation of FIRR)

Project life: 30 years from the start of investment

Benefits: income from water and electricity charges generated by the project

Benefits: cost of investment in the project + cost of investment in related projects (cost of rehabilitation of existing dams + construction of existing water treatment plants) + operation and maintenance cost

2.4 Impact

2.4.1 Improvement of Sanitation Conditions/Living Standards

The quality of water treated at the new plant satisfies the standards set by the State Environmental Protection Administration of China. According to the beneficiary survey, increase in water pressure and improvement of water quality (taste, smell, and color) are perceived by over 60% of all respondents. This may be attributable to the decreased use of groundwater and increased supply of good quality surface water (however, no one mentioned a specific case that evidences improvement of the situation of water-borne infectious diseases, etc.).

According to the results of the beneficiary survey, a majority of household users (62 out of 106 respondents) indicated a positive impact of the project. About 80% of them pointed out "improvement of sanitation condition" and "saving of time to obtain water", and 70% pointed out "reduction of labor to obtain water" as impacts (see Fig.2). Some respondents said, "Stable water supply stabilized our lives and made us feel more relaxed than before". Also in the beneficiary survey for organizations (company, school, hospital, etc.), "improvement of sanitation conditions" (9 out of 10 respondents) and "reduction in time to obtain water" (6 out of 10 respondents) were pointed out as positive impacts.







2.4.2 Contribution to Economic Development of the Region

In the beneficiary survey for organizations (company, hospital, school, etc.), 6 out of 10 respondents indicated the project contributed to their business activities. Xi'an Municipal Development Reform Commission said that this project led to stabilization of business activities in tourism, commerce, and manufacturing industries as well as the expansion of investment from foreign funds, and therefore had an impact on industrial development. Before project completion, the water supply restriction period was specified, during which many companies in manufacturing and tourist service industries had to suspend production (operation) either totally or partially. After the completion of the project, such problems were eliminated.

China's average annual GDP growth rate for the 1995-2003 period was 8.4%, and the average annual GRDP growth rate of Xi'an was about 13.5%, marking a higher growth rate than all of China. The amount of direct investment in Xi'an also increased steadily from US\$188.53 million in 1995 to US\$255.57 million in 2003.

Judging from the above, it can be said that this project contributed to the vitalization of business activities and the economic development of the region consequently.

2.4.3 Resettlement and Environmental Impact

For the construction of the dam, 1,318 residents were scheduled to be resettled and 1,537 residents were actually resettled. The resettlement process was carried out as planned with the consent of the resettled residents, who moved to new residences of better conditions than before. No problem was found as far as we know from the interviews with several residents at three relocation destination sites we visited for inspection.⁴

The environmental impact of the dam construction has been examined and certified by

⁴ The relocation destination sites are sufficiently equipped with infrastructures such as electricity and water supply. In the interview, some respondents said that their income increased with the increase in agricultural production and that transportation is more convenient and schools are closer.

the State Environmental Protection Administration. Since afforestation and other measures were taken to prevent adverse impacts that dam construction generally may have on the environment, no serious problem was found.

2.5 Sustainability

2.5.1 Executing Agency

2.5.1.1 Technical Capacity

As for the water treatment plant, the personnel have long experience in operating and maintaining plants of similar types as those covered by the project, and no problem has been found in their technical level. As for the dam, special skills tests and employees' performance evaluations are conducted in an effort to maintain the high quality of operation and maintenance activities. As part of training, employees are sent to schools on a regular basis and external instructors are invited to give on-site lectures to employees. Based on the above, it can be said employees have acquired operation and maintenance techniques.

2.5.1.2 Operation and Maintenance System

As of 2004, Xi'an Water Supply General Company is the only company that supplies water in Xi'an. It is a financially self-sustaining company owned by the national government and belongs to Xi'an Municipal Administration Commission. It is the largest water supply company in Shaanxi Province with about 2,700 employees. The organization chart is shown as Fig.3. As of 2004, 246 employees are working for the existing Qujiangchi Water Treatment Plant and 87 employees are working at the newly constructed Nanxiao Water Treatment Plant (19 managerial employees, 12 technical employees, and 56 employees in charge of water treatment). This gap in the number of employees is due to the difference in the degree of automation of equipment⁵ and does not cause any problem in maintaining the facilities.

Operation and maintenance of the dam, power plant, and conduit portions are carried out by Xi'an Heihe Water Supply Co. Ltd. (formerly Xi'an Heihe Water Supply Management Bureau). Fig.4 is the organization chart of the company. As with the case of the water treatment plant, a relatively a small number of employees are allocated. However, the scale is considered appropriate now that the technical level (degree of automation) and the management level have been improved as with the case of the water treatment plant.

⁵ According to the "Construction Standards for Water Supply Projects by Ministry of Construction, the People's Republic of China" (September 1994), the standard number of staff allocated to a surface water treatment plant with a capacity of 300,000-50,000 m³/day is 150-180. However, taking into consideration that the new Nanxiao Water Treamtnet Plant is highly automated while Qujiangchi Water Treatment Plant constructed in 1990 is not so highly automated, those would not be necessary to meet the above-mentioned standards.



2.5.1.3 Financial Status

According to Table 3 and Table 4, which show the financial status of Xi'an Water Supply General Company, the net profit turned from negative to positive after the completion of the project since 2002 with an increase in water sales income. Although the net income to sales ratio for 2003 declined a little from 2002 because the company started paying corporate taxes, a little increase in the total assets turnover shows that the company is making a profit as more equipment is put to use. As the new water distribution system is now being constructed, a further increase in income is expected with the increase in customers (see Fig. 5). Judging from the fact that the company maintained the equity ratio at over 50% from 2002 to 2003, it has no problem with its financial security.

Table 3. Main Business Income and Expenditure of Xi'an Water Supply General Company

		(unit: ten thousand yuan)			
Item	2001	2002	2003	2004	
Water Sales Income	21,758	30,597	36,421	41,146	
Water Selling Expenses	19,916	24,994	29,998	33,024	
Other Business Income	98	244	706	1,369	
Administrative and Financial Expenses	2,650	4,800	5,719	7,459	
Operating Income	-710	1,059	1,191	1,162	
Profit / Loss before Taxes	-668	1,046	1,139	1,324	

Source: Xi'an Water Supply General Company

Table 4. Major Financial Performance and Indicators of Xi'an Water Supply General Company

Item	2001	2002	2003	2004	
Financial Performance					
Total Capital	110,057	136,617	148,164	153,093	
Current Assets	19,711	22,794	23,459	28,099	
Current Liabilities	16,753	19,917	21,797	20,966	
Equity Capital	53,554	75,037	77,228	80,113	
Sales	21,857	30,823	36,827	42,739	
Net Income	-668	1,046	360	870	
Financial Indicator					
Profit Ratio of Total Capital(%) /	-0.6%	0.8%	0.2%	0.6%	
Total Asset Turnover /	0.20	0.23	0.25	0.28	
Net Income to Sales Ratio(%) /	-3.1%	3.4%	1.0%	2.0%	
Current Ratio(%) /	117.7%	114.4%	107.6%	134.0%	
Equity Ratio(%) /	48.7%	54.9%	52.1%	52.3%	

(unit: ten thousand yuan)

Source: Xi'an Water Supply General Company

Fig. 5 Prospect of the Net Profit of Xi'an Water Supply General Company



(unit: ten thousand yuan)

Xi'an Heihe Water Supply Co. Ltd. was in the red as of 2003 because, as already mentioned, the water from the dam had yet to be fully utilized. However, as the company made a profit in 2004 and the water supply from the Heihe water intake system is expected to increase as mentioned above, a further income increase is expected in the future (see Table 5 and Fig. 6).

	(un	n. ton mou
Item	2003	2004
Main Business Income	10,463	11,153
Main Business Expenditure	5,575	5,065
Adiministrative and Finaincial Expense	8,351	5,924
Operating Income	-3,464	164
Profit / Loss before Taxes	-3,464	164

Table 5. Main Business Income and Expenditure of Xi'an Heihe Water Supply Co. Ltd.

(unit: ten thousand yuan)

Source: Xi'an Heihe Water Supply Co. Ltd.



Fig. 6 Prospect of the Profit / Loss before Taxes

(unit: ten thousand yuan)

2.5.2 Operation and Maintenance Status

Facilities are working normally with no breakdown requiring repair having been reported, and are considered to be properly operated and maintained.

3. Feedback

3.1 Lessons Learned

None

3.2 Recommendations None

Item	Plan	Actual		
Output	 Water intake facilities: total length approx. 156km Water treatment facilities: expansion of Qujiangchi purification Plant (existing) (600,000 800,000m³/day); construction of a new water treatment plant (300,000m³/day) Water supply/distribution facilities: total length 105,070m Heihe Dam: total water storage capacity 204.21 million tons Power generation equipment: maximum output 15MW Consulting service (supervision of dam construction and overseas training for employees of the executing agency): 12M/M 	 As planned Expansion of (existing) Qujiangchi Water Treatment Plant was cancelled and the planned expansion portion of 200,000m³/day was covered by changing the treatment capacity of the new water treatment plant (300,000 500,000m³/day) As planned As planned Maximum output: 20MW Cancelled 		
 Project Period 1. Land acquisition/ compensation for resettlement 2. Heihe Dam (1) Detailed design (2) Dam construction (3) Power plant construction (4) Consulting service 3. Construction of water intake facilities 4. Expansion of water treatment plant 5. Construction of a new water treatment plant 6. Installation of water supply/distribution pipes Project Completion 	Apr. 1987 – Sep. 1997 Oct. 1992 - Mar. 1994 Oct. 1994 - Dec. 2000 Jul. 1996 - Dec. 2000 Apr. 1996 - Sep. 1999 Jun. 1987 - Dec. 1998 Jul. 1993 - Dec. 1998 Apr. 1996 - Dec. 1998 Nov. 1989 - Dec. 1998 (1) Water supply facilities: Jan. 1999 (2) Haiba Dam: Jan. 2001	Apr. 1990 - Apr. 2000 Oct. 1992 - Dec. 1997 Jan. 1996 - Dec. 2002 Jan. 1999 - May 2004 Cancelled Jun. 1987 - Dec. 1998 Cancelled Jun. 1999 - Dec. 2001 Nov. 1989 - Dec. 1999 (1) Water supply facilities: Dec. 2001 (2) Haiba Dam: May 2004		
Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	 (2) Hethe Dam: Jan. 2001 7,139 million yen 14,473 million yen (1,237 million yuan) 21,612 million yen 7,139 million yen 1yuan = 11.7yen (as of Oct.1995) 	(2) Hethe Dam: May 2004 7,138 million yen 26,199 million yen (2,008 million yuan) 33,337 million yen 7,138 million yen 1yuan = 13.05yen (1994-1999 average)		

Comparison of Original and Actual