People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan

Shaanxi Water Environmental Improvement Project (Shaanxi Province)

External Evaluator: Noriyo Aoki, IC Net Limited

0. Summary

The objective of the project is to achieve a stable supply of safe water in 13 regional cities in Shaanxi Province by improving water supply facilities, thereby contributing to an improvement in living environment.

The project is consistent with priority areas in China's development policy and in Japan's ODA policy. Development needs are also high. Therefore, the relevance of the project is high. The main operation and effect indicators, such as population served by water supply, water supply coverage rate and water leakage rate, were achieved mostly as planned, and the beneficiary survey conducted as part of this evaluation study also confirmed a high degree of recognition for an improvement in water supply. Therefore, the effectiveness of the project is high. Although the project needed more time than planned, project costs were mostly as planned, therefore the efficiency of the project is fair. No major problems have been observed in sustaining the institutional and technical aspects of operation and maintenance, and the financial issues regarding some of the water purification plants are headed toward amelioration. Therefore, sustainability of the project effect is high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Filter ponds at the Tongchuan Water Purification Plant

1.1 Background

From 1990, China's population increased rapidly, and the country became urbanized and industrialized by leaps and bounds. The demand for water, such as domestic water and industrial water, also surged, exacerbating water shortages in many regional cities. As a result, not only did the

economy slow down, but some regions also suffered from serious damage, such as land subsidence caused by the excessive pumping up of groundwater. In other areas, water sources were polluted by effluent seeping into deteriorated pipe networks, and safe drinking water could not be secured. This resulted in the needs to renovate pipe networks and expand new water purification facilities.

Shaanxi Province, which is located in northwestern China, achieved rapid development along with the national government's Great Western Development Strategy[1] and urbanization policies. However, particularly in regional cities, an improvement of basic infrastructure had lagged behind and there were growing needs for supply of drinking water.

1.2 Project Outline

The objective of this project is to achieve a stable supply of safe water in 13 regional cities in Shaanxi Province by improving water supply facilities, thereby contributing to an improvement in living environment.

Loan Approved Amount/ Disbursed Amount	7,700 million yen / 7,699 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 29, 2005 / March 30, 2005
Terms and Conditions	• Interest rate: 1.5%, training only: 0.75% • Repayment period: 30 years (grace period: 10 years), Repayment period for training only: 40 years (grace period: 10 years) • Conditions: General untied
Borrower / Executing Agency	Government of the People's Republic of China / Shaanxi Provincial People's Government
Final Disbursement Date	July 26, 2010
Main Contractor (Over 1 billion yen)	China National Chemical Construction Corporation (China) / China Henan International Cooperation Group Co., Ltd.(China) / Sinohydro Engineering Bureau 15 Co., Ltd. (China)
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	F/S, Shaanxi Survey & Design Institute of Water Conservancy and Hydropower, June 2003
Related Projects	Shaanxi Water Environmental Improvement Project (Xi'an)

[1] This is a plan for developing the western inland region of China which had been left behind relative to the economic development of the eastern coastal region. Shaanxi Province was made the key pivotal province in the plan. The decision was made at the National People's Congress in March 2000.

The project is comprised of sub-projects conducted in 13 regional cities, and is described according to the abbreviated names of the sub-projects. The following lists the abbreviated name and description of each sub-project as stated in their respective reports.

Table 1: Description of Sub-Projects

	City	Abbreviated name of sub-project[2]	Project description			
			Water supply capacity at the time of planning (km^3/d)	Laying of conveyance pipes and distribution pipes	Water source	Construction of water purification plants and distribution stations[3]
1	Xianyang	Xianyang	345.0	Conveyance pipes	Surface water	Water purification plant× 1
2	Tongchuan	Tongchuan	40.0	Distribution pipes	Surface water	Water purification plant × 1
3	Yulin	Yulin	50.0	Conveyance pipes Distribution pipes	Surface water	Water purification plant × 1
4	Xi'an	Lantian County	20.0	Conveyance pipes Distribution pipes	Surface water	Water purification plant × 1
5	Baoji	Fengxiang County	15.0	Conveyance pipes Distribution pipes	Surface water	Water purification plant × 1
6	Baoji	Long County	10.0	Conveyance pipes Distribution pipes	Surface water	Water distribution station × 1
7	Baoji	Chencang District (Baoji County)	29.5	Conveyance pipes Distribution pipes	Groundwater	Water distribution station × 2
8	Baoji	Fufeng County	23.5	Conveyance pipes Distribution pipes	Groundwater	Water purification plant × 1 Water distribution station × 3
9	Baoji	Qianyang County	10.0	Conveyance pipes Distribution pipes	Groundwater	Water distribution station × 1
10	Weinan	Hua County	19.0	Conveyance pipes Distribution pipes	Groundwater	Water distribution station × 2
11	Weinan	Heyang County	20.0	Distribution pipes	Groundwater	Water distribution station × 1
12	Weinan	Fuping County	30.0	Distribution pipes	Groundwater	Water distribution station × 1
13	Weinan	Baishui County	13.0	Conveyance pipes Distribution pipes	Groundwater	Water distribution station × 2

[2] The Baoji County sub-project was renamed the Chencang District sub-project at the time of the ex-post evaluation.
[3] Water purification plants are facilities for purifying and sterilizing surface runoff such as from reservoirs and rivers and then directing this to the water supply. Here, the term "water distribution station" refers to a facility that pumps up groundwater directly and sterilizes it before providing it to the water supply.

Figure 1: Distribution Map of the 13 Regional Cities where Sub-Projects Are Located

2. Outline of the Evaluation Study

2.1 External Evaluator

Noriyo Aoki, IC Net Limited

2.2 Duration of Evaluation Study

The ex-post evaluation was conducted as follows:

Duration of the Study: August 2012 –January 2014

Duration of the Field Study: February 24 – April 4, 2013 and May 28 – June 8, 2013

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Relevance to the Development Plan of China

3.1.1.1 Development Policy at the Time of the Appraisal

1) 10th Five-Year Plan (2001–2005)

The Government of China has regarded improving the water supply infrastructure in regional cities as a priority issue since the 9th Five-Year Plan. In the 10th Five-Year Plan, the government again positioned improving the waterworks infrastructure in regional cities as a priority issue alongside securing water sources for medium- and large-scale cities where there are severe shortages of water. Specifically, in regional cities, the plan set out to strengthen water supply capacity, secure safe drinking water and economize on water resources by reducing water leakage rates, through the construction of new waterworks facilities and the renovation of facilities constructed between the 1950s and 1970s.

2) 10th Shaanxi Province Five-Year Plan (2001–2005)

The Shaanxi provincial government came out with the 10th Shaanxi Province Five-Year Plan and the 10th Shaanxi Province Five-Year Plan for Development and Utilization of Water Resources. The aim of these plans was to provide safe drinking water to some two million people in the province who were currently finding it hard to secure drinking water, by developing water resources capable of meeting the demand for water in 2010 and by improving water supply facilities.

3.1.1.2 Development Policy at the Time of the Ex-Post Evaluation

1) 12th Five-Year Plan (2011–2015)

The 12th Five-Year Plan seeks to increase the annual water supply capacity to 40 billion m^3 by proceeding to improve regional infrastructure and enhancing supply capacity, thereby achieving a supply of safe water. The aim of the plan is to decrease water leakage rates by upgrading deteriorated facilities and pipe networks, and to promote the effective utilization of water resources through the creation of a water-saving society[6].

2) 12th Shaanxi Province Five-Year Plan (2011–2015)

Under the 12th Shaanxi Province Five-Year Plan and the 12th Shaanxi Province Five-Year Plan for Development and Utilization of Water Resources, in addition to effectively improving water supply capacity through projects for the repair and extension of water supply facilities in

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③: High, ②: Fair, ①: Low
[6] The term "water-saving society" refers to a society that economizes on water resources as much as possible, such as by raising awareness for saving water, popularizing water-efficient household goods, promoting measures to combat leaks in the water supply and improving the percentage of industrial water recovered.

urban areas, the Shaanxi provincial government seeks to enhance water supply programs in medium and large-scale cities and in the newly constructed development zones, and to comprehensively promote water conservation and the recovery of resources from waste water in industries that consume a massive quantity of water. Specifically, in an attempt to create a water-saving society, which was reinforced in the 11th Shaanxi Province Five-Year Plan (2006–2010), the plans continued to promote water conservation, raising the idea of introducing a water rates system tailored to the water supply conditions of each region as well as the idea of discriminatory pricing dependent on the region and industry. Furthermore, under the 12th Shaanxi Province Five-Year Plan for Environmental Preservation and Industrial Development, targets have been set to reduce the volume of industrial water to less than 80% of 2011 levels and to increase the rate of recycled industrial water to more than 70% by 2015. According to the 12th Shaanxi Province Five-Year Plan for Development and Utilization of Water Resources, with an objective of developing water supply infrastructure, plans have been made to develop new water sources (primarily dams) and to promote the reuse of water by developing sewerage systems.

From the above, it can be seen that the project is highly consistent with development policies both at the time of the appraisal and at the time of the ex-post evaluation as the objective of the project is to improve water supply, which is regarded as a priority area in development plans at the state and Shaanxi Province level.

3.1.2 Relevance to the Development Needs of China

The Great Western Development Strategy and urbanization policies led to the rapid development of regional cities in Shaanxi Province. However, supply was lower than demand, and water shortages were conspicuous during the dry season. Water shortages in regional cities were particularly severe in the dry season, and in cases where water was sourced from shallow groundwater, the quality of drinking water was poor.

Most existing water supply facilities were constructed in the 1970s. Consequently, reduced water quality and leaks[7] due to deteriorated facilities were apparent, and these issues had to be urgently dealt with.

Even at the time of the ex-post evaluation, in order to develop Shaanxi Province's regional cities as bases of the Great Western Development Strategy, the government has been promoting an enhanced stable water supply in terms of both quality and quantity throughout the year. The Shaanxi provincial government, meanwhile, has been developing water supply infrastructure and promoting water conservation policies to secure a stable water supply in Shaanxi Province despite limited water resources. As a result of various water conservation policies, a progress has been made in economizing on industrial water and domestic water,[8] and growth in the demand for water

[7] "Water leakage rate" is defined as the percentage of water that leaks from the pipe network, that is, the physical leakage rate.

[8] Based on the Shaanxi Provincial Ordinance on Water Resources Management, the capacity of water use by industry in Shaanxi Province has been determined in detail in the "April 2004 Shaanxi Province Notification on Fixed Amount of

has also been lower than at the planning stage of the project. Table 1 shows changes in water demand and a comparison of actual water supply in Shaanxi Province.

Table 2: Water Demand & Supply and Changes of Water Supply Coverage Rate in Shaanxi Province

	2005 Forecast demand	2005 Actual supply	2010 Forecast demand	2010 Actual supply
Forecast water demand and actual water supply (billion m^3/year)	8.74	7.87	14.44	8.33
Agricultural water [9]	6.06	5.38	8.67	5.74
Industrial water	1.45	1.38	3.87	1.17
Domestic water	1.23	1.11	1.90	1.42
Water supply coverage rate: (%)				
Urban	85	90	95	92
Rural	60	45	75	65

Source: Quote from materials at the time of the appraisal by JICA and from public announcement by Shaanxi Province on water resources

Note: Forecast demand, which was obtained from questionnaire responses at the time of the ex-post evaluation, was 10.035 billion m^3/year in 2015 and 11.398 billion m^3/year in 2020.

Although the overall trend for water demand has changed since the planning stage of this project, demand still exceeds supply capacity, and the need for improving water supply infrastructure remains largely unchanged.

The plan for the project was to meet this demand, and the need for implementing this project was confirmed from both supply and demand perspectives.

3.1.3 Relevance to Japan's ODA Policy

Japan's Economic Cooperation Plan for China and JICA's (former JBIC's) Medium-Term Strategy for Overseas Economic Cooperation Operations and Country Assistance Strategy for China in 2004 placed emphasis on "environmental protection."

In a situation where water shortages had become more critical as a consequence of water quality worsening and facilities deteriorating, the purpose of the Country Assistance Strategy for China was to facilitate water supply projects that also assist in measures to prevent infectious diseases from the perspective of public health by ensuring safe drinking water, and to provide assistance such as for human resources development for such projects.

In light of the above, this project has been highly relevant to China's development policy and development needs, as well as to Japan's ODA policy. Therefore, its relevance is high.

Industrial Water" and the "September 2003 Shaanxi Province Water Conservation Methods."

[9] This water supply project covers industrial water and domestic water.

3.2 Effectiveness[10] (Rating: ③)

The objective of the project was to achieve a stable supply of safe water by improving water supply facilities, and in terms of the main indicators for measuring the degree of achievement, operation and effect indicators were set as shown in Table 2.

3.2.1 Quantitative Effects (Operation and Effect Indicators)

3.2.1.1 Operation and Effect Indicators

Table 2 shows the main operation and effect indicators for the water supply facilities improved through the project. For more detailed results of operation and effect indicators for each water purification plant and distribution station, see Appendix 1.

At the time of the ex-post evaluation, the population served by water supply in targeted areas of the project that actually received water supply was 84.3% against the plan. As mentioned below, improvements had been made to water quality, and a 24-hour water supply had been realized. As for other indicators, the water supply coverage rate reached 98.9%, the water leakage rate was 91.9%, and unaccounted-for water rate achieved 94.8% against the plan. Hence, it can be regarded that a stable supply has been achieved. In terms of the amount of water supply, there was a change in the demand for water in Shaanxi Province compared to at the planning stage of the project. In particular, growth of the population served by the water supply become sluggish, and water-saving measures for both domestic water and industrial water has been promoted. Thus, growth in the actual demand for water was lower than initially projected. However, based on the situation described above, it can be judged that a "stable supply of water" has been achieved for the demand. Therefore, it can be evaluated that the effectiveness of this project is high. Usually in the evaluation of water supply projects, growth in the amount of water supply is regarded as a key indicator, but in Shaanxi Province where there are limited water resources, as a result of reducing water consumption and implementing other measures, the demand for water has remained low. In fact, this is preferable thing from a perspective of the sustainability of future resources, and it also fits with the Shaanxi Province's environmental protection policies promoting cleaner production[11] and ecological protection.

[10] The rating has been assessed by taking impact into account when determining the effectiveness.
[11] Cleaner production aims to create a production system with low environmental load. The government of China enforced Cleaner Production Promotion Law in January 2003.

Table 3: Operation and Effect Indicators

Indicator		Standard value 2003	Target value 2012[12]	Actual value 2012	Ratio to planned target
Supply capacity of facilities (1,000 m^3/day)		Unknown	625.0	625.0	100%
Population served by water supply (person)		805,727	1,727,122	1,455,580	84.3%
Amount of water supply (m^3/day)	(i) Daily maximum	208,600	830,400	372,697	44.9%
	(ii) Daily average	161,100	684,540	305,010	44.6%
Facility utilization rate (%/day)[13]	(i) Daily maximum	100	100	64.3	64.3%
	(ii) Daily average	77	82	52.6	64.1%
Water supply coverage rate (%)		44	92	91	98.9%
Water supply per capita[14] (m^3/day)	(i) Daily maximum	0.259	0.481	0.256	53.2%
	(ii) Daily average	0.200	0.395	0.210	53.2%
Water leakage rate (%)[15]		15	8	8.7	91.9%
Unaccounted-for water rate (%)[16]		19	11	11.6	94.8%

Source: Questionnaire responses from the Shaanxi Provincial Department of Water Resources.

The following describes the sub-project trends for each indicator.

1) Population served by water supply

The population served by water supply reached 84.5% of the target value. Differences can be seen in the extent to which planned targets were achieved in each urban area. An achievement was favorable in Fengxiang County, Long County, Fufeng County, Qianyang County, Fuping County, Heyang County and Baishui County. The achievement rate for population served by water supply was low in Xianyang, Tongchuan, Yulin, Chencang District and Hua County. The reasons are as follows.

- Tongchuan, Yulin and Hua County are geared toward new development zones, but the populations of the development zones have not grown as projected at the time of planning. Nevertheless, according to interviews with water purification plants and distribution stations, the population served by water supply is increasing year by year, and population growth in development zones and

[12] Three years after completion of the project.
[13] Total amount of water supply ÷ Total capacity × 100.
[14] Water supply per capita includes the amount of domestic water and the amount of industrial water.
[15] Amount of physical leakage ÷ Total amount of water supply × 100.
[16] Amount of unaccounted-for water rate ÷ Total amount of water supply × 100.

urban areas is progressing.

- In the case of Chencang District, there had been plans to construct an automobile plant and a housing complex for factory workers, but these were built in another province.[17]
- As for Xianyang, there were delays in development of the distribution pipeline network, which was out of scope of the project.

2) Amount of water supply and facility utilization rate

The supply capacity of the water supply facilities in each urban area has been maintained mostly as planned, but the actual amount of water supply has only risen to about 50% of the planned target. Two possible major factors as to why the amount of water supply is less than planned are promotion of the abovementioned water conservation policies and the low growth in demand due to a decrease in the population supplied with water.

Each of the urban areas targeted in the project has been designated as a model city for water-saving society. Water conservation is being promoted at the community level, school level and industry level. Even at the household level, water saving devices and low-flush toilets are being used, and families are conscientiously conserving water when bathing and reusing water. As a result of these efforts, progress has been made in curbing the use of domestic water through changes in lifestyle.

Comparing the 2012 target value and actual value for the amount of water supply per capita, the average daily amount of water supply calculated at the planning stage of the project was 0.395 m^3, whereas in fact it is only 0.21 m^3. This is also confirmed by the beneficiary survey conducted as part of the ex-post evaluation. As for the question of water conservation behavior, it is recognized that close to 80% of respondents are actively conscious of saving water.

Efforts have also been advanced for the conservation of industrial water. In accordance with the information from related personnel of Shaanxi Provincial Department of Water Resources, it was confirmed locally that water demand for industrial activity has been kept under control as a result of rigorously applying the highly restrictive water-saving standards set by the Shaanxi provincial government and continuing to sift out technologies and equipment that do not conform to those standards. Although no detailed data was obtained on the amount of reduced water consumption in each sector, according to the Shaanxi provincial government's Office for the Promotion of Water Efficiency, in the industry sector, the amount of water used per 10,000 yuan of industrial added value had been reduced to 52 m^3 in 2009, which was less than one-third of the national standard of 163 m^3.

3) Water leakage rate and unaccounted-for water rate

One of the reasons for improvements in water leakage rate and unaccounted-for water rate is the improvement of pipe networks. In addition to the project, other projects for developing the networks of distribution pipes have also been conducted concurrently, financed by the province, cities and

[17] Questionnaire responses from the Shaanxi Provincial Department of Water Resources, and results of interviews with water purification plants and distribution stations.

counties. Therefore, although not necessarily as a consequence of just this project, it can be regarded that the project did achieve a certain effect.

3.2.1.2 Quality of Supplied Water

The situation of water quality inspections undertaken at each water purification plant was checked at the time of the field study. It verified that treated water at the 13 plants cleared the national health standard for drinking water, which was implemented in July 2007, and thus there are no major problems in terms of water quality. According to interviews with the operation and maintenance agencies, in some urban areas, such as Qianyang County and Xianyang, there had been problems with water quality because they used to use private wells (shallow wells), but since starting to supply piped water, quality had improved considerably. In addition it was reported that, prior to the project, drinking water used to be sourced from agricultural water in Lantian County, but by switching the water source to the Qinling Mountain Range, water quality had been improved remarkably.

From the perspective of enhancing water quality control, the project led to establishment of water quality laboratories at each water purification plant and distribution station, capable of measuring 21 items. Thus, the frequency and checked items of water quality inspections were increased, and the system for monitoring water quality was strengthened. In addition to individual water purification plants and distribution stations, municipal health departments also monitor water quality and conduct periodic inspections. Each water purification plant and distribution station inspects measurable water quality items before and after treatment, and reports these quarterly to the city and county governments. Municipal health departments carry out spot checks at arbitrary sites in the respective water supply areas.

A sample of results from a water quality inspection carried out at the Fengxiang County water purification plant is listed in the Table 3 for reference.

Table 4: Water Quality Standards and Actual Quality of Treated Water[18]of the Fengxiang County Water Purification Plant

Typical items	National standard	Quality of treated water
pH value	6.5-8.5	8.14
Turbidity (NTU)	≤1	0.88
Chromaticity (degrees)	≤15	2
Objects visible to the naked eye	None	None
Total hardness (mg/l)	≤450	232.4
Iron (mg/l)	≤0.3	<0.05
Copper (mg/l)	≤1.0	<0.02
Zinc (mg/l)	≤1.0	<0.02
Manganese (mg/l)	≤0.1	<0.02
Chlorides (mg/l)	≤250	12.45
Lead (mg/l)	≤0.01	<0.0005
Nitrates (mg/l)	≤20	0.48
Chemical oxygen consumption (mg/l)	≤3	1.62

Note) Treated water collected on December 12, 2012, representative items only

Source: Inspection results from the Shaanxi Province Urban Water Quality Monitoring Board's Baoji Monitoring Station; obtained from the Shaanxi Provincial Department of Water Resources.

3.2.1.3 Stable Water Supply

According to results of interviews with personnel from water purification plants and distribution stations and the results of the beneficiary survey, the development of pipe networks, and the construction of water purification plants and distribution stations, has led to a secure water supply that is stable in terms of water pressure and water volume. Insufficient water pressure and water cutoffs during peak periods were improved, securing a 24-hour water supply.

3.2.2 Qualitative Effects

In the project, there were also expectations that improving the water supply infrastructure would prove effectual in achieving a stable supply of water. A questionnaire survey of residents was conducted in order to verify these effects, and their responses are summarized below.

3.2.2.1 Improvements in Water Pressure, Water Volume and Water Quality

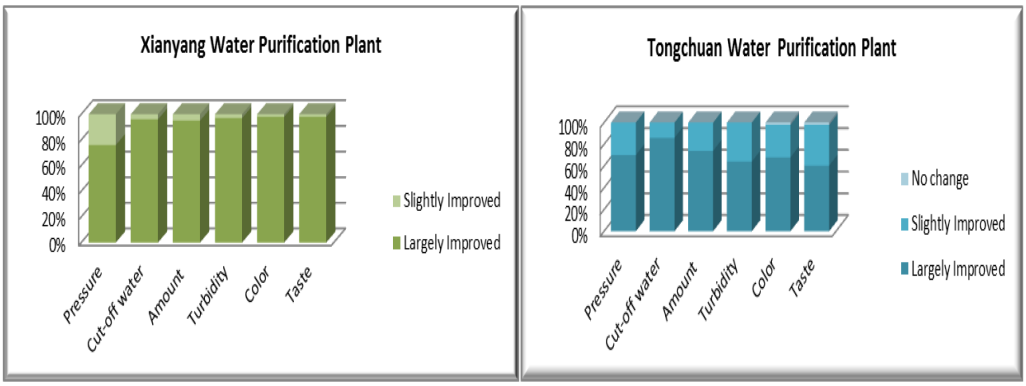
In conducting the beneficiary survey,[19] Xianyang and Tongchuan were selected from among the target urban areas, and a sample of 100 residents from Xianyang, ten business establishments from Xianyang and 50 residents from Tongchuan were surveyed.

Improvements in water pressure, water volume and water quality, compared to prior to the

[18] Although data on treated water prior to the project could not be obtained from the Fengxiang County Water Purification Plant, because the water was also sourced from groundwater after the project, in this case, personnel from the Fengxiang County Water Purification Plant responded that, although fundamentally there had been no major changes to water quality, the water quality inspections had been strengthened.

[19] A survey method of visiting subjects to conduct the survey was adopted for both residents and businesses. The gender breakdown of resident respondents was as follows: 58% male and 42% female. Their age distribution was as follows: 10.7% aged 20-29, 22.0% aged 30-39, 29.4% aged 40-49, 22.6% aged 50-59, and 15.3% aged 60 or older. The surveyed residents had been living in the local area for an average of 6.4 years. The survey of business establishments in Xianyang covered those establishments with between 300 and 1,500 employees. Ten businesses were surveyed, including a spinning machine plant, the Xianyang No. 1 People's Hospital and the Blue Horse Brewery Co., Ltd.

project, were acknowledged by the majority of respondents. Particularly in Xianyang, where the water supply had been primarily sourced from groundwater, there were dramatic improvements in terms of turbidity, color and taste. Some of the residents of Tongchuan responded that water pressure, water volume and water quality have improved compared to the old part of town[20] where they used to live.



Source: Results of the beneficiary survey.

Figure 2: Improvements in Water Pressure, Water Volume and Water Quality

[20] The water supply to the old part of town was sourced from the surface runoff from the reservoir. This is different to the water source for the water purification plant in this project.

Table 5: Outline of Results of Interview on Water Supply at Water Purification Plants and Distribution Stations[21]

	Water source	Construction of water purification plants and distribution stations	Summary of interview results
Xianyang	Surface water	Water purification plant × 1	Water was frequently being cut off because of insufficient water volume due to the use of groundwater and delays in developing the distribution pipe network. The situation has improved.
Tongchuan	Surface water	Water purification plant × 1	Water volume and water pressure were improved.
Yulin	Surface water	Water purification plant × 1	Water pressure, insufficient water volume, and water cutoffs were improved.
Lantian County	Surface water	Water purification plant × 1	Water quality was poor because of water being sourced from down flows of agricultural water. Water was being cut off during peak time in the afternoons of summer. At the time of the ex-post evaluation, around-the-clock water supply has become possible, and both water quality and water pressure had improved.
Fengxiang County	Surface water	Water purification plant × 1	Water quality improved and water volume increased.
Long County	Surface water	Water distribution station × 1	There had been problems of water pressure and water being cut off at night, but these were improved.
Chencang District	Groundwater	Water distribution station × 2	The insufficient water volume during peak periods was improved.
Fufeng County	Groundwater	Water purification plant × 1 Water distribution station × 3	Water pressure and water volume were improved. The deteriorated network of distribution pipes was improved, making a stable supply possible.
Qianyang County	Groundwater	Water distribution station × 1	At the time of planning, there were water cutoffs and planned water consumption. Previously, the water supply coverage rate was 60%, and many households used private wells. At the time of the ex-post evaluation, water supply coverage rate has reached 98%, and both water volume and water quality were improved.
Hua County	Groundwater	Water distribution station × 2	At the time of planning, the water supply was suspended at night. Now, a 24-hour water supply is possible.
Heyang County	Groundwater	Water distribution station × 1	Both water volume and water quality were improved.
Fuping County	Groundwater	Water distribution station × 1	Considerable improvements were made in shortages of water amount.
Baishui County	Groundwater	Water distribution station × 2	At the time of planning, water would be cut off because of insufficient water pressure and water volume, and the old pipes would often rupture. This situation was improved.

Source: Results of interviews with personnel of water purification plants and distribution stations.

[21] Results of interviews with each water purification plant and distribution station at the time of the field study.

3.2.2.2 Promotion of Efficiency

At the water purification plants in Xianyang, Lantian County, Fengxiang County, Tongchuan and Yulin, automated systems and information management systems were developed, making for more efficient management of water purification, and leading to lower costs by a reduction in labor costs.[22]

3.2.2.3 Effects of Training in Japan

As part of the project, in collaboration with local government (Kyoto Prefecture), JICA Training Course in Japan was conducted for the purpose of building the capacity of personnel from each of the executing agencies and from water purification plants and distribution stations. Interviews conducted in the field have confirmed that participants utilized the outcomes of their training, and this has led to specific initiatives such as those described in the table 5. Staff involved in decision making at the Shaanxi Provincial Department of Water Resources, staff from the Water Resources Bureau at the county/city level and operation and maintenance managers and technicians at water purification plants and distribution stations participated in the training together, and immediately put into practice what they learned. The training participants have come to have a sense of sharing issues and challenges, and this was consequently put into practice immediately right after their return to China.

Table 6: Initiative Learnt at Training and its Application and Effect

Type of Action Undertaken	Specific description	Specific effect
Water quality control	• Use of activated charcoal and anthracite (Tongchuan, Yulin) • Rigorous water quality inspections (Heyang County, Yulin, Chencang District)	• Improved water quality (removal of taste and odor) • Strengthening training, appointment for personnel involved in water quality inspections
Scheme operations	• Automation of systems at water purification plant (Lantian County) • Installation of water usage meters outside homes (Fufeng County)	• Reduction in personnel • Improved tariff collection rate, more efficient tariff collection
Water resources management	• Installation of roof over water source (Heyang County) • Development of emergency reservoir (Tongchuan)	• Protected water source • Secured water source for emergencies
Measures for pipeline	• Measures to combat leaks in pipe networks (Fuping County, Heyang County) • Acquisition of method for installing circular cast-iron pipes (Fufeng County)	• Lowered water leakage rate • Shortened construction period
Operation and maintenance	• Installation of building for treatment facility at water purification plant (Tongchuan, Yulin)	• Power-saving effect, reduction in failure of automated equipment, reduction in personnel costs such as for cleaning yellow sand

[22] Results of interviews with water purification plants and distribution stations.

The JICA Training Course in Japan also highlighted some of the future issues that will have to be improved. The interviews with staff, who participated in training, drew attention to such future issues as downsizing through automation of water treatment technology, enhancing efficiency in tariff collection systems, and quality improvement of materials of pipes.

The project led to expansion of the population served by water supply, improvements in water volume and water quality, and the possibility of a stable 24-hour water supply. The development of pipe networks led to an improvement in water leakage rate and unaccounted-for water rate, which in turn resulted in an improved overall water supply service. Taking a comprehensive assessment of the above, the effectiveness of the project can be evaluated as high.

3.3 Impact

3.3.1 Intended Impacts

3.3.1.1 Improvement of Livelihood Environment

As shown in Table 6 and Table 7, in Xianyang and Tongchuan, hygiene conditions inside households were improved, with washing and cleaning being conducted more frequently. In Tongchuan, 74% of respondents said that they no longer had to draw water and store it. No changes in water-borne diseases were confirmed and it remains the same level as before in either the Xianyang or Tongchuan urban areas.

Table 7: Changes Brought by Improvements in the Water Supply in Xianyang

	(Multiple answers allowed)
Washing is done more often.	83%
Hygiene conditions of household improved.	45%

Source: Results of the beneficiary survey.

Table 8: Changes Brought by Improvements in the Water Supply in Tongchuan

	(Multiple answers allowed)
No longer have to draw water for storage.	74%
Time spent on drawing water has decreased.	56%
Washing is done more often.	62%
Cleaning is done more often.	64%
Hygiene conditions of household improved.	50%

Source: Results of the beneficiary survey.

Tongchuan residents were asked, “Since less time is spent on drawing water, what kinds of activities do you spend that time on now?” (multiple answers allowed). Their answers were: I do more work (41%), I take breaks (62%), I take care of my family (41%), I do other housework (51%).

3.3.1.2 Contributions to Production Activity and Improvement of Investment Climate

The survey of business establishments in Xianyang revealed that better water supply

conditions have produced effects as shown in Table 8. In the case of Xianyang, a cut-off of time is long, and even in manufacturing sectors that do not use a massive quantity of water, the better conditions have had an effect on production.

Table 9: Changes Brought by Better Water Supply Conditions
(response of business establishments)

	(Multiple answers allowed)
Amount of production increased.	100%
Hours of operation increased.	80%
Earnings increased.	20%
Stable production activity became possible.	20%
Investment in the same area increased.	10%

Source: Results of the beneficiary survey.

With regard to the impact of better water supply conditions on the investment climate, no quantitatively supported data has been obtained on the number of investments and the total amount of investment. During the implementation period, water-saving standards in each sector were made stricter, and despite it becoming impossible to invest in production sectors that use a massive quantity of water, according to the *Shaanxi Statistical Yearbook* and *Industrial Development in Shaanxi Province*, the around-the-clock water supply has become a factor in facilitating investment in those manufacturing sectors that do not use much water, such as metalworking, machine tools, automotive assembly and crude oil processing. In particular, according to the interview with the government manager of water resources, in Tongchuan and Yulin, which have natural gas, oil and other resources, development of the urban water supply for development zones has been one of the chief causes facilitating corporate investment.

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

A requirement of the Environmental Impact Assessment Report[23] was that, once it had gone through a control process, any noise from water purification plants and distribution stations shall conform to the national standard. At the time of planning, facilities had been designed to meet the standard on noise control, and even at the time of the ex-post evaluation, the noise emitted from water purification plants and distribution stations conformed to the national standard.[24]

There was a requirement for environmental monitoring to be carried out during construction. Monitoring was conducted at the specified locations, frequency by using the specified methods, for water contamination at construction sites and near water intakes, dust generated from construction, air pollution caused by the combustion of fuel by construction vehicles, and noise related to the construction. Necessary steps were taken if problems arose.[25] By way of example

[23] Materials at the time of the appraisal.
[24] According to interviews with personnel from water purification plants and distribution stations.
[25] Interviews with officials from the Shaanxi Provincial Department of Water Resources.

as one of the measures undertaken, the sheet piles were used to make a temporary closure and water was changed out as part of intake facility construction, and as a result, preventing contamination of water quality. [26]

As for environmental monitoring of water purification plants and distribution stations in service, divisions in charge of environmental protection determine personnel of observation, points of observation, items of observation, and their frequency. Monitoring of groundwater levels is conducted by the Water Resources Bureau and the water company in each county, and the results are reported annually by the Water Resources Bureau to the Shaanxi Provincial Department of Water Resources. According to environmental monitoring reports thus far, there has been no land subsidence or other negative impacts caused by the project. There have been no reports at this stage about any pumping-related impacts at water distribution stations that use groundwater, because the water table of each station is deep: 850m (Fuping County and Heyang County), 355 m (Hua County) and 200 m (Fufeng County). In terms of positive impacts, fissures of the ground have been eased at some water purification plants by switching the source of water from groundwater to surface water (Xianyang).[27]

There are two methods used for processing sludge that is discharged from water purification plants. Some water purification plants dry the sludge in the sun and then transport this to refuse dumps or landfill sites (Lantian County and Xianyang), and others get it processed at sewage treatment plants via sewer pipes (Yulin and Tongchuan). Measures are taken to minimize the burden on the environment.

3.3.2.2 Land Acquisition and Resettlement

The National Land and Resources Bureau[28] of each regional government acquired land for these sub-projects in accordance with the State Council's "Regulation on Land Acquisition Compensation and Resettlement of Migrants for Large and Medium Water Conservation and Power Construction Projects". There were not any particular problems or disputes. One hundred and ninety six hectares of land was acquired for an acquisition price of 27.24 million yuan.[29] No residents needed to be resettled. Although approximately 35 ha had been required at the time of planning, in fact, more land has been acquired than planned.[30] In the case of the Xianyang water purification plant, the plan was for 10.8 ha, but land of 92.264 ha has been acquired.

3.3.2.3 Impact of Construction on Nearby Residents

Although the project was intended for the supply of water in urban areas, the facilities of water purification plants and distribution stations are located in rural areas. The surrounding lands are used for general farming, and no residents live in the vicinity. Therefore, there was no

[26] According to interviews with personnel from water purification plants and distribution stations.
[27] Information provided by officials from the Shaanxi Provincial Department of Water Resources.
[28] Bureau name changed to the Land and Resources Bureau at the time of the ex-post evaluation.
[29] Calculated based on information provided by each water purification plant and distribution station.
[30] Land has been acquired assuming that it will be needed for the future expansion of water supply facilities. Separate information was not available on the size of land needed for this project and the size of land needed for future use.

impact on nearby residents. During construction, monitoring was performed by personnel from water purification plants and distribution stations. There was no impact on the surrounding area particularly during construction.[31]

In light of the above, water supply conditions have improved. The project fulfills such indicators as population served by water supply, water supply coverage rate and water leakage rate. Favorable results of the JICA Training Course in Japan were also confirmed. Given that positive impacts on improved living environment and corporate production activity are acknowledged by the findings of the beneficiary survey, this project has achieved its effects as planned. Therefore, its effectiveness and impact is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The project provided facilities and equipment as planned. The JICA Training Course in Japan was conducted with three more courses than planned. Since there was a need for human resources development in regional cities, and the budget is available for implementing additional training courses, they were able to be conducted.

1) Facilities and equipment

Table 9 shows the outputs developed and provided by the project (planned and actual). Facilities were developed and provided as planned.

[31] Information provided by personnel from water purification plants.

Table 10: Outputs (Planned and Actual)

Location	Water supply capacity (km^3/d)	Water source	Laying of conveyance pipes and distribution pipes	Construction of water purification plants and distribution stations	Actual[32]
Xianyang	345.0	Surface water	Conveyance pipes: 73 km	Water purification plant × 1	As planned
Tongchuan	40.0	Surface water	Distribution pipes: 228 km	Water purification plant × 1	As planned
Yulin	50.0	Surface water	Conveyance pipes: 3 km Distribution pipes: 25 km	Water purification plant × 1	As planned
Lantian County	20.0	Surface water	Conveyance pipes: 1 km Distribution pipes: 17 km	Water purification plant × 1	As planned
Fengxiang County	15.0	Surface water	Conveyance pipes: 24 km Distribution pipes: 31 km	Water purification plant × 1	As planned
Long County	10.0	Surface water	Conveyance pipes: 19 km Distribution pipes: 7 km	Water distribution station × 1	As planned
Baoji County	25.0	Groundwater	Conveyance pipes: 16 km Distribution pipes: 7 km	Water distribution station × 2	As planned
Fufeng County	23.5	Groundwater	Conveyance pipes: 18 km Distribution pipes: 43 km	Water purification plant × 1 Water distribution station × 3	As planned
Qianyang County	10.0	Groundwater	Conveyance pipes: 5 km Distribution pipes: 30 km	Water distribution station × 1	As planned
Hua County	19.0	Groundwater	Conveyance pipes: 13 km Distribution pipes: 24 km	Water distribution station × 2	As planned
Heyang County	20.0	Groundwater	Distribution pipes: 22 km	Water distribution station × 1	As planned
Fuping County	30.0	Groundwater	Distribution pipes: 24 km	Water distribution station × 1	As planned
Baishui County	13.0	Groundwater	Conveyance pipes: 6 km Distribution pipes: 33 km	Water distribution station × 2	As planned
Total	625.0	-	-	-	

Source: Data from the Shaanxi Provincial Department of Water Resources.

2) JICA Training Course in Japan

In cooperation with local government (Kyoto Prefecture), 11 training courses were conducted in Japan, with participation by a total of 142 staff members from the Shaanxi Provincial Department of Water Resources, staff from water purification plants and distribution stations, and persons in charge of water resources at each county and city. Although at the time of planning eight courses were set to be run, three more courses were added because there was some remaining budget which came from the budget of the facilities and equipment and the contingency of the project, and there was a need for training to strengthen the human resources in regional cities in particular. The training group was separated into the Project Management Course and the Technical Course. The training was conducted over a period of about 14 days. Even at present, the staff members who participated in the training are employed in positions related to water resources at each water purification plant and distribution station.[33]

[32] There were slight changes in the lengths of conveyance pipes and distribution pipes.
[33] Among the staff who were from water purification plants and distribution stations, a few have transferred to

Table 11: Training Results

Description of training	Number of training courses	Number of training participants
Project Management Course	4	43
Technical Course	7	99
Total	11	142

Source: Data from the Shaanxi Provincial Department of Water Resources.

Table 12: Details of JICA Training Course in Japan

	Results
Training location	Training conducted in Japan in cooperation with local government (Kyoto Prefecture)
Description of training	Project Management Course: project management, procurement management, financial management, operation and maintenance management, monitoring and assessment Technical Course: Advanced management of water supply systems, GIS for piping networks, maintenance of facilities and equipment

Source: Data from the Shaanxi Provincial Department of Water Resources.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned total project cost for the project was 12,630 million yen, whereas the actual cost was 12,647 million yen. The ratio of actual to planned cost is 100.13%. The increase of 17 million yen was due to the local currency portion of costs being projected at 4,930 million yen, but actually coming in at 4,947 million yen. Although increases in the total local currency amount were kept in check by fluctuations in the exchange rate, a rise in commodity prices ultimately led to an overall increase.

3.4.2.2 Project Period

The project period for the project was supposed to be from March 2005 to December 2007 (34 months),[34] but actually lasted from March 2005 to June 2010 (63 months). Although there was no change in outputs, owing to the 29-month extension, the ratio of actual to planned cost is 185%. Generally, procuring equipment and materials took time, and in Fuping County and Hua County in particular, the project lasted 63 months. On the other hand, operations commenced relatively early at water purification plants and distribution stations in Yulin (46 months), Qianyang County (45 months) and Heyang County (46 months).

departments/bureaus related to water resources at the province, cities and counties, and a few have retired.

[34] Completion is defined as the point at which operations officially commence at all sub-projects.

3.4.3 Results of Calculations of Internal Rates of Return (IRR)

With regard to the financial internal rate of return (FIRR), in accordance with appraisal documents, the mean value of FIRRs at each water purification plant and distribution station was described. The detailed information of the calculation and the calculation results of each water purification plant and distribution station were not able to be confirmed.

For reference, an attempt was made to recalculate the FIRR value based on the conditions below. Two samples from a water purification plant and a water distribution station which are able to obtain data required for FIRR calculation are selected. Although the results of the calculation cannot simply compare with the average value at the time of appraisal, it was considered that it could utilize as reference to confirm in what ways the financial situation of water purification plant and water distribution station has been changed. Based on the pre-conditions, the results are shown below.

Table 13: FIRR and its Calculation Results

Pre-conditions	Planned (2004)	Actual (2012)
Project life: 30 years Costs:[35] Construction costs, operation and maintenance costs Benefits: Revenue from water tariffs	FIRR: 6.01%	Tongchuan Water Purification Plant FIRR: 3.15% Fuping County Water Distribution Station FIRR: negative

Sources: Appraisal documents provided by JICA, and materials at the time of the ex-post evaluation.

In light of the above, although the project cost was within the plan, the project period significantly exceeded the plan. Therefore, efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

3.5.1.1 Implementing Agency

There were no organization changes from the time of planning for the project. The implementing and supervisory agency is the Shaanxi Provincial Department of Water Resources.

3.5.1.2 Operation and Maintenance Agencies

Basically, there have been no changes to the operation and maintenance agencies for the 13 water purification plants from the time of planning. Two of the operation agencies, however,

[35] Taxes, land acquisition expenses and interest during construction during construction are not included in the cost items. Operation and maintenance costs include personnel expenses.

changed their organization names.[36] Each of the operation and maintenance agencies are either a state-owned enterprise or a state holding company funded and managed by the regional government. There are no plans to privatize these in the future. Each of the 13 operation and maintenance agencies has adopted a self-supporting accounting system. There are two types of operation and maintenance companies: water companies and water supply companies (or water purification companies). Water companies are able to provide other paid services to compensate for any businesses running deficits, such as by selling water in addition to supplying water. Water supply companies like the Xianyang Water Purification Plant, however, are only responsible for purifying water. They are unable to perform paid services like water companies, and their ability to make up for operating deficits is limited. Basically, each company is charged with operation and maintenance. Each company is audited by the Water Resources Bureau of the competent county or city.

[36] In the case of the Baoji County Water Company, the name of the administration changed from Baoji County to Chencang District, and so the name of the water company was also changed. In the case of the Yulin High-Tech Zone Water Supply and Sewage Limited Liability Company, when the company became a limited company, its name was changed from the Yulin Xisha District Water Supply and Distribution Company Limited to its current name.

Table 14: Operation and Maintenance Agencies at the Time of the Ex-Post Evaluation, and Organizational Form

	Operation and maintenance agency	Organizational form	Operational form
Xianyang	Xianyang City Shitou River Water Supply Company	State-owned enterprise	Water purification company
Tongchuan	Shaanxi Tongchuan Water Supply Company Limited[37]	State holding company	Water purification company
Yulin	Yulin High-Tech Zone Water Supply and Sewage Limited Liability Company★	State holding company	Water company
Lantian County	Lantian County Water Company	State-owned enterprise	Water company
Fengxiang County	Fengxiang County Water Company	State-owned enterprise	Water company
Long County	Long County Water Company	State-owned enterprise	Water company
Baoji County	Chencang District Water Company★	State-owned enterprise	Water company
Fufeng County	Fufeng County Water Company	State-owned enterprise	Water company
Qianyang County	Qianyang County Water Company	State-owned enterprise	Water company
Hua County	Hua County Water Company	State-owned enterprise	Water company
Heyang County	Heyang County City Water Supply Limited Liability Company	State holding company	Water purification company
Fuping County	Fuping County Urban Water Supply Company	State-owned enterprise	Water purification company
Baishui County	Baishui County Water Company	State-owned enterprise	Water company

Source: Data from the Shaanxi Provincial Department of Water Resources.
Note: The ★ symbol indicates that the operation and maintenance agency changed its name.

3.5.2 Technical Aspects of Operation and Maintenance

3.5.2.1 Technical Level of Human Resources at Water purification plants and Distribution Stations

According to questionnaire responses and the results of interviews at the time of the field visit, the technical level of each water purification plant and distribution station is well-matched to the operation and maintenance of the equipment and facilities. Given the details of interviews with on-site engineers and the training initiatives described in the next section, it is fair to say that efforts have been made to improve the technical level.

Internal training at each water purification plant and distribution station includes training for new employees, position-specific training and seminars with experienced engineers. Training sessions on water treatment and measurement techniques have also been held, with instruction given by external experts and manufacturers. Qualified personnel with high levels of technical expertise at the time of appointment are employed to engage in water quality test at each water purification plant and distribution station. At some water purification plants, technicians visit a

[37] With limited companies and limited liability companies, each shareholder has limited responsibility to the company depending on their equity investment, and the company is responsible for repaying debt using its total assets.

number of other plants to learn about plant maintenance (Tongchuan and Yulin). As for improving the capability of water quality tests, efforts are made to improve techniques in cooperation with the Center for the Measurement of Water Quality (Tongchuan, Fufeng County, Long County, Fengxiang County and Qianyang County).

At the provincial level, the Shaanxi Water Resource Association conducts training once a year, with participation by people involved in maintaining water supply in Shaanxi Province. At this training, participants share their experiences in water purification, water quality control and maintenance.

Figure 3: Turbidity record at the Automatic Control Room (Tongchuan)

Figure 4: Chlorine Dioxide[38] Generation Facility (Fuping County)

Figure 5: Water Quality Test Laboratory (Long County)

3.5.3 Financial Aspects of Operation and Maintenance

3.5.3.1 Revenue and Expenditure at Each Water Purification Plant and Distribution Station

In relation to financial aspects, in principle, each operation and maintenance company funds its operating expenses on their own. In accordance with interviews to personnel in charge of each operation and maintenance company, when a balance of revenue and expenditure become worsening, such company receives subsidies from the province and city governments. It can be judged that the companies in charge are financially stable. In fact, Xianyang purification plant run by subsidies from province and city.

With regard to the situation of revenue and expenditure of each water purification plant and distribution stations, in accordance with data collected at the time of field survey[39], highly automated water purification plants, like those in Fengxiang County, Tongchuan and Yulin, had achieved surpluses[40]. The water purification plants and distribution stations which have financial deficits in revenue and expenditure, try to get surpluses for improvement of their financial balance by means of revenue from contract work related to water supply. They have made efforts to promote personnel downsizing and enhance efficiency of works. In addition, water purification plant and distribution station that have deficits in financial balance, use preferential

[38] Chlorine dioxide was used for sterilization and pasteurization at 11 water purification plants and distribution stations.
[39] The Statistics of Expenditure and Revenue on ODA Loan Water Supply Project in Shaanxi Province.
[40] Balance sheets including a depreciation of each purification plant and distribution plant and so forth, were not able to be obtained. It was judged by financial information on a cash-flow basis.

tax system[41]. The Xianyang Water Purification Plant which receives financial support from local government has promoted personnel downsizing and so forth for improving revenue of the plant. In addition to setting lower unit supply price at which water is sold to water companies (1.04 yuan /m^3) than production cost (1.27 yuan /m^3), it does not have other sources of revenue except revenue from water supply. Therefore, it has faced with difficulties in improving financial viability on its own account. Xianyang reduced personnel, disposed of assets, and consolidated the several existing water companies and the operation and maintenance agency into the Xianyang Waterworks Group Co., Ltd. The company has been granted special management rights. At present, it is authorized to order the closure of groundwater sources currently in use, and it is now able to determine and petition the composition of water tariffs by adding a tax to the costs and revenue of the water supply business.[42] At this stage, these moves for unification are expected to be complete in 2014. It is expected that these institutional reforms contribute to a certain level of improvement in terms of profitability.

3.5.3.2 Setting and Revision of Water Tariffs

In relation to the water tariff, the pricing divisions of each province and city determine water tariffs, based on the revenue of each water purification plant and distribution station, price escalation, other standard of utility prices and so forth. Having confirmed with each water purification plant and distribution station, it was found that the water tariffs of municipalities and counties are revised about once every three years.

As an example, Table 13 shows expenses of waterworks business in Hua County. Hua County government has submitted an application to Price Bureau of Weinan City for an increase in water tariffs because the cost of supplying per cubic meter of water exceeds the price charged.

[41] Lantian County, Chencang District, Fufeng County, Hua County, Heyang County, Fuping County, and Baishui County.
[42] "Notification of Special Management Rights for the Supply of Water by the Xianyang Municipal People's Government on Xianyang Co., Ltd (December 2012)"

Table 15: Analysis for Cost of Supplying Water and Price of Supply in Hua County

(Unit: yuan)

Item	Amount
Production costs (Breakdown)	1,842,350.23
Electricity	1,221,380.52
Depreciation	124,224.10
Water pump inspection	85,196.00
Tax	296,549.61
Structures, land	100,000.00
Sterilization through chlorination	15,000.00
Cost of producing 1 m^3 of water (A)	1.07
Selling costs (Breakdown)	3,081,779.69
Personnel expenses	1,676,898.00
Welfare costs	318,715.91
Financial expenses	24,323.71
Public service costs	102,199.30
Travel costs (flights, cars)	167,910.40
Other administrative costs	602,738.91
Loan repayment	90,000.00
Cost of selling 1m^3 of water (B)	1.80
Cost of supplying 1m^3 of water (A + B = C)	2.87
Price for supplying 1m^3 of water (D)	2.33
Profit per 1m^3 (D – C)	-0.54

Notes: The tariff collection rate in Hua County is 95%. Water is sourced from groundwater used by water distribution stations. The annual volume of water supplied is 1,711,200 m^3.
Source: Data from the Hua County Water Company.

An interview with the Xianyang Water Commission confirmed plans to submit an application to raise water tariffs to a fair price. The results of the beneficiary survey[43] also confirmed that there is scope to raise tariffs, with 80% of respondents thinking that current water tariffs are appropriate and 20% thinking they are low. If an increase in costs due to a rise in commodity prices leads to sustained deficits, or if the increase in water tariffs cannot be enforced, the municipal government will compensate the Xianyang Waterworks Group by way of subsidies.[44]

[43] Xianyang residents (n=100) and business operators (n=10).

[44] "Notification of Special Management Rights for the Supply of Water by the Xianyang Municipal People's Government on Xianyang Co., Ltd (December 2012)." Up until the time of the ex-post evaluation, subsidies were generally disbursed once a

3.5.3.3 Water Tariff Collection Rate

The average collection rate for water tariffs at the 13 water purification plants and distribution stations is 93.4%. Although the collection rate is high, many water purification plants have usage meters installed inside the users' houses, and this requires many collectors to check the usage. In order to increase the collection rate, Fufeng County installed usage meters outside the houses, and this resulted in achieving a collection rate of 100%.

With regard to the financial situation on operation and maintenance of the project, based on the information mentioned above, it was judged as described below.

1) Automated water purification plants which have not been influenced by an increase of population are expected to sustain financially on a stand-alone basis.

2) Water purification plants and water distribution stations of which expenditure exceed revenue are able to balance revenue and expenditure to some extent by other water related works. These companies enjoy preferential taxation measures. Therefore there is no problem in operation. Since water purification plants and water distribution stations have carried out downsizing and promoted efficiency of operations, a certain level of earnings recovery will be expected.

3) Water tariff is expected to increase, which brings profits of water supply to balance deficits to some degree.

4) In case these measures do not achieve a sufficient effect, local governments are subject to financially support their operations.

Judging from these comprehensively, financial sustainability is high because improvement is expected through independent efforts at each water purification plant and water distribution station, financial recovery is possible by raising water tariff, and at worst local governments would guarantee financial support by subsidies. In this regard, however, continuous financial monitoring is still preferred hereafter.

3.5.4 Current Status of Operation and Maintenance

Field studies confirmed that the operation and maintenance of equipment and facilities is favorable, with each water purification plant and distribution station having a maintenance plan, and conducting inspections and maintenance based on that plan. As for routine inspections and maintenance, daily, monthly and yearly records are kept.

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year.

Figure 6. A building housing a water purification plant (Tongchuan)

Figure 7. A water distribution station (Baishui County)

Figure 8. Conservation of water source for emergency use (Tongchuan)

Records of replaced parts are basically kept on either a regular or irregular basis. At some water purification plants, however, organized records were not being kept for managing the replacement of pump gland, and corrosion prevention was not being properly practiced, such as painting iron materials that are easily oxidized. This point was raised at the time of the first field study. By the time of the second field study, it had already been improved. The current on-site inspections and monitoring reports on water purification plants and distribution stations, which are conducted by officers of Water Resources Bureau of the municipal or county, will need to be continuously and thoroughly maintained.

Manuals are available which detail the frequency and methods of regular inspections and necessary spare parts are kept on hand. By way of example, an excellent initiative in maintenance is housing of water purification plants in buildings in Tongchuan and Yulin. There are great benefits from installing a water purification plant inside a building. As well as enabling countermeasures against clouds of dust and sand, including yellow sand, the setup also has a thermal insulation effect. In addition to saving electricity, settling basins and tanks do not have to be stirred up to prevent them from freezing in winter. The arrangement also protects the accuracy of precision machinery in automated water purification plants, and can prevent malfunctions. Automated water purification plants not housed in buildings are located in Lantian County, Xianyang and Fufeng County. At present, construction of the outer building is basically funded by the county or municipality which has authority over the water purification plant.

Eleven of the water purification plants and distribution stations used chlorination by chlorine dioxide, and two of the water purification plants fed chlorine into the water using chlorine gas tanks (Fengxiang County and Xianyang). In the case of facilities where chlorine was injected from chlorine gas tanks, training on the handling of chlorine and training for emergency responses were conducted.

With regard to the six water purification plants that source water from dams, measures have been taken to ensure water sources in the event of an emergency, such as drought or if effluent accidentally gets into the reservoir or into the rivers leading into the reservoirs. The five water

purification plants in Xianyang, Yulin, Lantian, Fengxiang and Fufeng use the groundwater wells that they used to use as an emergency source of water. The Tongchuan Water Purification Plant has installed a reservoir within its grounds, thereby securing enough water storage capacity[45] to supply water in an emergency for about three days.

In light of the above, with regard to the operation and maintenance of this project, no major problems have been observed in sustaining the institutional and technical aspects of operation and maintenance, and there is not any issue of concern about financial aspects. Therefore, sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of the project is to achieve a stable supply of safe water in 13 regional cities in Shaanxi Province by improving water supply facilities, thereby contributing to an improvement in living environment.

The project is consistent with priority areas in China's development policy and in Japan's ODA policy. Development needs are also high. Therefore, the relevance of the project is high. The main operation and effect indicators, such as population served by water supply, water supply coverage rate and water leakage rate, were achieved mostly as planned, and the beneficiary survey conducted as part of this evaluation study also confirmed a high degree of recognition for an improvement in water supply. Therefore, the effectiveness of the project is high. Although the project needed more time than planned, project costs were mostly as planned, therefore the efficiency of the project is fair. No major problems have been observed in sustaining the institutional and technical aspects of operation and maintenance, and the financial issues regarding some of the water purification plants are headed toward amelioration. Therefore, sustainability of the project effect is high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

- Although reforms have been advanced to integrate the waterworks business and the water supply business in Xianyang, guidance should be given to ensure efficient operations by further streamlining the water supply system, with a particular focus on reducing personnel.
- The current on-site inspections and monitoring reports on water purification plants and distribution stations, which are conducted by officers from the relevant Water Resources Bureau of municipal or county, should continue to be strengthened.
- In relation to the financial situation of each water purification plant and water distribution station, in more than half of them, expenditures exceed revenues. However, it financially has no

[45] The water storage capacity is 80,000 m^3.

problems from the financial aspects because financial recovery is possible by raising water tariff, and local governments guarantee financial support by subsidies. However, continuous periodical financial monitoring is required hereafter.

4.2.2 Recommendations to the Operation and Maintenance Agencies

- The dust count for yellow sand is high in Shaanxi Province. Not only does it accumulate inside water purification plants and cause precision equipment to malfunction, but it also has an adverse effect on water quality. Some water purification plants have constructed buildings to house their plants in an attempt to maintain the internal water purification process in good order. Countermeasures against yellow sand need to be implemented for automated water purification plants in particular. From the perspective of ongoing maintenance, buildings to house water purification plants should be constructed where fiscally feasible to assist in plant management.

4.2.3 Recommendations to JICA

None in particular

4.3 Lessons Learned

During the JICA Training Course in Japan, staff working in the water supply sector in Shaanxi Province acquired knowledge on the operation and maintenance of waterworks from a local government in Japan which has friendly ties with Shaanxi Province. They gained a clear understanding of the issues and areas for improvement in water supply programs in China, and they made use of this knowledge for maintaining their respective water purification plants and distribution stations. More precisely, they used the knowledge acquired through the JICA Training Course in Japan and translated it into practice by conducting rigorous water quality inspections at their respective water purification plants and distribution stations, making improvements to their tariff collection systems, undertaking measures to combat leaks in their pipe networks, and improving their water resources management. Incorporating the JICA Training Course in Japan into the ODA loan project had a striking effect on the attitude of staff toward improving the operation and maintenance of water supply. In particular, the training participants—namely, staff involved in decision making at the Shaanxi Provincial Department of Water Resources, staff from the Water Resources Bureau at the county/city level, and operation and maintenance managers and technicians at water purification plants and distribution stations—were divided into the Management Course and the Technical Course, and developing a sense of sharing issues and challenges helped the training participants a great deal in putting what they learned into practice immediately after their return to China. Local governments in Japan have a wealth of accumulated experiences in relation to water supply operation and management. Inviting staff involved in making decisions in the water supply project and others responsible for water supply operation and maintenance, and then conducting two separate management and technical training courses has proven to be effective in improving operation and maintenance.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1) Project Outputs	(a) Xianyang 1 water purification plant: 345.0 km^3/d, conveyance pipes: 73 km (b) Tongchuan 1 water purification plant: 40.0 km^3/d, distribution pipes: 228 km (c) Yulin 1 water purification plant: 50.0 km^3/d, conveyance pipes: 3km, distribution pipes: 25 km (d) Lantian County 1 water purification plant: 20.0 km^3/d, conveyance pipes: 1 km, distribution pipes: 17 km (e) Fengxiang County 1 water purification plant: 15.0 km^3/d, conveyance pipes: 24 km, distribution pipes: 31 m (f) Long County 1 water distribution station: 10.0 km^3/d, conveyance pipes: 19 km, distribution pipes: 7 km (g) Baoji County 2 water distribution stations: 25.0 km^3/d, conveyance pipes: 16 km, distribution pipes: 7 km (h) Fufeng County 1 water purification plant: 3 water distribution stations, conveyance pipes: 18 km, distribution pipes: 43 km (I) Qianyang County 1 water distribution station: 10.0 km^3/d, conveyance pipes: 5 km, distribution pipes: 30 km (j) Hua County 2 water distribution stations: 19.0 km^3/d, conveyance pipes: 13 km, distribution pipes: 24 km (k) Heyang County 1 water distribution station: 20.0 km^3/d, distribution pipes: 22 km (l) Fuping County 1 water distribution station: 30.0 km^3/d, distribution pipes: 24 km (m) Baishui County 2 water distribution stations: 13.0 km^3/d, conveyance pipes: 6 km, distribution pipes: 33 m	As planned
2) Project Period	March 2005 – December 2007 (34 months)	March 2005 – June 2010 (63 months)
3) Project Cost Amount paid in foreign currency Amount paid in local currency	 7,700 million yen 4,930 million yen (3.70 million yuan)	 7,699 million yen 4,947 million yen (3.43 million yuan)

Total	12,630 million yen	12,647 million yen
Japanese ODA loan portion	7,700 million yen	7,699 million yen
Exchange rate	13.3 yen = 1 yuan (September 2004, base period for estimating costs)	14.4 yen = 1 yuan (average rate March 2005 – June 2010)

Appendix 1: Actual Operation and Effect Indicators (2012)

Actual Operation and Effect Indicators (2012)

	Target population served by water supply (people)	Actual population served by water supply (people)	Degree of achievement to population served by water supply **	Amount of daily water intake (m3/d)		Amount of daily water supply (m3/d)		Amount of daily water supply per capita (m3/d)		Water leakage rate	Water supply coverage rate	Water tariff collection rate	Unaccounted-for water rate
				Maximum	Average	Maximum	Average	Maximum	Average				
Total	1,726,000*	1,455,580	△	383,613	312,748	372,697	305,010	0.256	0.210	8.7%	91%	97%	11.6%
Xianyang	757,000	600,000	△	141,000	123,163	136,200	121,136	0.227	0.202	9%	89%	99%	9.9%
Tongchuan	175,000	138,000	△	52,000	44,000	49,200	41,000	0.357	0.297	8%	89%	95%	12.6%
Yulin	81,000	40,000	△	42,500	23,700	41,000	23,000	1.025	0.575	6%	100%	90%	15.4%
Lantian County	80,000	83,000	○	12,000	11,000	11,000	9,800	0.133	0.118	10.8%	98%	98%	12.6%
Fengxiang County	66,000	68,000	○	8,066	5,038	8,050	5,027	0.118	0.074	10.5%	92%	98%	12.3%
Long County	51,000	51,277	○	10,078	8,755	10,078	8,755	0.197	0.171	8%	98%	98%	9.8%
Chencang District	121,000	85,000	△	18,000	14,000	18,000	14,000	0.212	0.165	8%	70%	97.5%	10.3%
Fufeng County	61,000	65,000	○	29,000	24,400	28,200	23,600	0.434	0.363	10%	96%	100%	10.0%
Qianyang County	32,000	32,003	○	11,469	8,192	11,469	8,192	0.358	0.256	9.3%	98%	98%	11.1%
Hua County	66,000	56,000	△	7,500	7,000	7,500	7,000	0.134	0.125	7%	96%	95%	11.7%
Heyang County	84,000	85,000	○	15,000	14,000	15,000	14,000	0.176	0.165	10%	92%	98%	11.8%
Fuping County	91,000	91,300	○	20,000	18,000	20,000	18,000	0.219	0.197	8%	95%	98%	9.8%
Baishui County	61,000	61,000	○	17,000	11,500	17,000	11,500	0.279	0.189	9.3%	97%	96.5%	12.5%

* The target figures for each water purification plant and distribution station are stated in units of 1,000 people.

** Degree of achievement: ○ indicates planned target achieved, △ indicates planned target not achieved. Reasons for non-achievement have already been explained in main text.