EX-POST PROJECT EVALUATION 2011: PACKAGE I-1 (CHINA)

SEPTEMBER 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

SANSHU ENGINEERING CONSULTANT
GLOBAL LINK MANAGEMENT, INC.

EV
JR
12-10

Preface

Ex-post evaluation of ODA projects has been in place since 1975 and since then the coverage of evaluation has expanded. Japan's ODA charter revised in 2003 shows Japan's commitment to ODA evaluation, clearly stating under the section "Enhancement of Evaluation" that in order to measure, analyze and objectively evaluate the outcome of ODA, third-party evaluations conducted by experts will be enhanced.

This volume shows the results of the ex-post evaluation of ODA Loan projects that were mainly completed in fiscal year 2009, and Technical Cooperation projects and Grant Aid projects, most of which project cost exceeds 1 billion JPY, that were mainly completed in fiscal year 2008. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

The lessons and recommendations drawn from these evaluations will be shared with JICA's stakeholders in order to improve the quality of ODA projects.

Lastly, deep appreciation is given to those who have cooperated and supported the creation of this volume of evaluations.

September 2012
Masato Watanabe
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

This volume of evaluations, the English translation of the original Japanese version, shows the result of objective ex-post evaluations made by external evaluators. The views and recommendations herein do not necessarily reflect the official views and opinions of JICA. JICA is not responsible for the accuracy of English translation, and the Japanese version shall prevail in the event of any inconsistency with the English version.

Minor amendments may be made when the contents of this volume is posted on JICA's website.

JICA's comments may be added at the end of each report when the views held by the operations departments do not match those of the external evaluator.

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

Xi'an Environmental Improvement Project

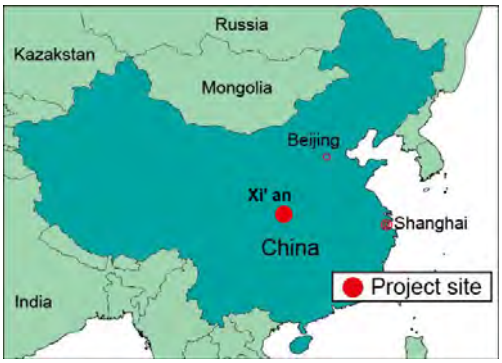
External Evaluator: Akemi Serizawa, Global Link Management, Inc.

0. Summary

The objective of this project was to contribute to the enhancement of wastewater treatment capacity in Xi'an by constructing No.3 and No.4 Wastewater Treatment Plants and developing drainage pipeline networks, and then to the water quality improvement of the rivers and better living conditions. This project was highly relevant with China's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. It has contributed to the enhancement of the wastewater treatment capacity in Xi'an as planned and also to the water quality improvement of the rivers to a certain extent; therefore its effectiveness and impact are high. The project cost was higher than planned and the project period was significantly longer than planned; therefore the efficiency is low. Sustainability of the project effect is high as no major problems have been observed in structural, technical and financial aspects of the operation and maintenance system.

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

1. Project Description



Project Location

Xi'an No.3 Wastewater Treatment Plant

1.1 Background

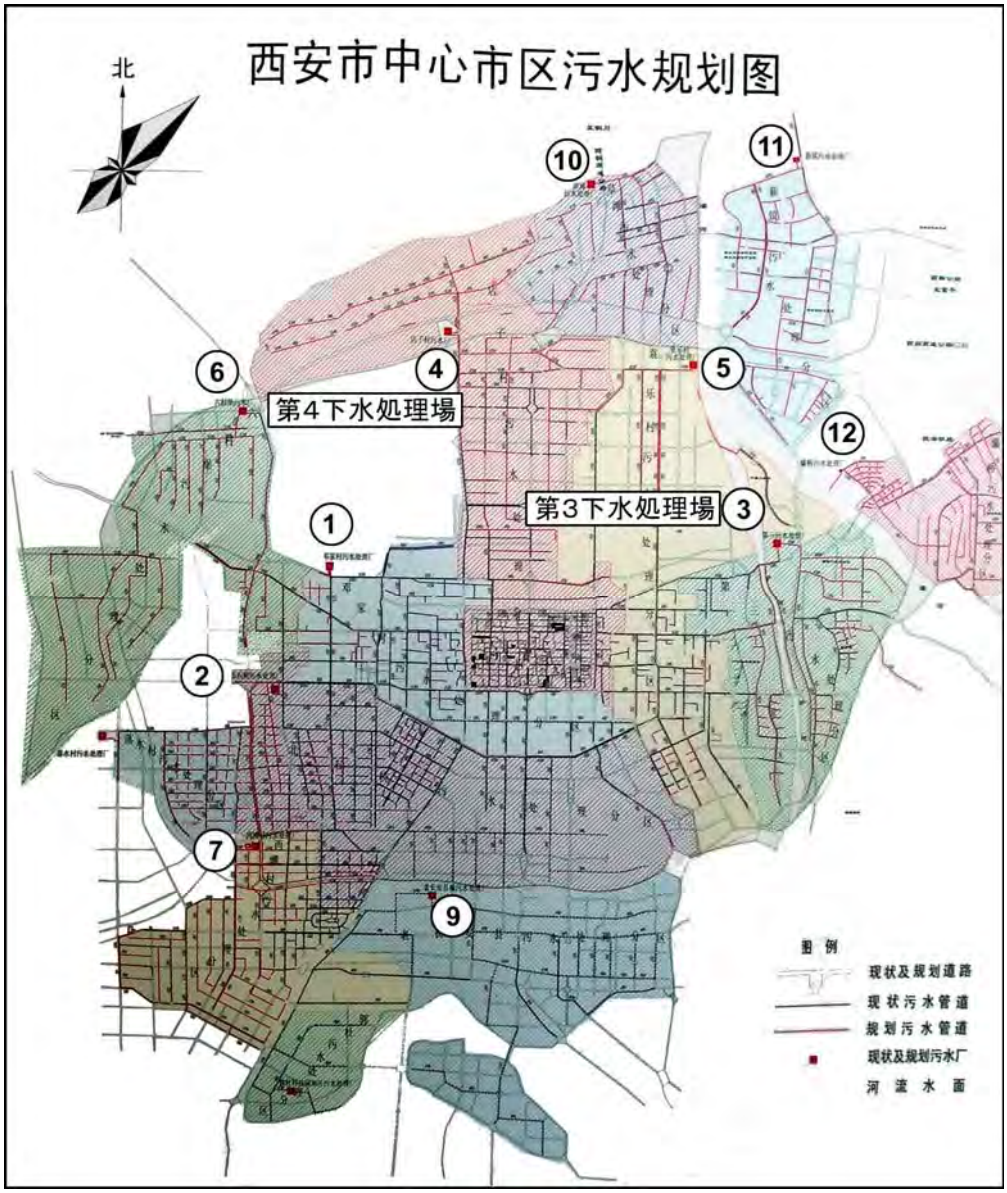
Environmental pollution in China was serious since the 1980s due to the rapid industrialization and increase of population as consequences of rapid economic growth. The Chinese government strengthened its environmental protection policy in the late 1990s, but it had limitations to solve the problem. The domestic sewage had increased by the urbanization and improved standard of living, and became more than the half of the total volume of sewage

in the country in 2000, while the industrial sewage, which had been the main source of water pollution before, had decreased by various efforts. In 2000, the percentage of wastewater treated in large cities in China was only 34%, and the rivers were heavily polluted. Also in Xi'an, the capital of Shaanxi Province and one of the oldest cities in China that attracts many tourists, anti-water pollution measures had not cached up the development of the city and the water pollution of the rivers was serious. The percentage of wastewater treated of Xi'an was only 23% in 2002. Xi'an was urged to enhance its wastewater treatment capacity.

1.2 Project Outline

The objective of the project was to enhance the wastewater treatment capacity in Xi'an by the construction of No.3 and No.4 Wastewater Treatment Plants and the development of drainage pipeline networks, thereby contributing to the water quality improvement of the rivers and to better living conditions in Xi'an.

Loan Approved Amount / Disbursed Amount	9,764 million yen / 8,917 million yen
Exchange of Notes Date / Loan Agreement Signing Date	March 2002 / March 2002
Terms and Conditions	Wastewater treatment plants Interest rate: 0.75%, Repayment Period: 40 years (Grace period: 10 years), Bilateral-tied Drainage pipelines Interest rate: 1.70%, Repayment Period: 30years (Grace period: 10 years), General untied
Borrower / Executing Agency	Government of the People's Republic of China / People's Government of Xi'an City
Final Disbursement Date	January 2010
Main Contractor (Over 1 billion yen)	China Xi'an International Economic Technical Trade Group (China) / China National Chemical Construction Corporation (China) / Beijing High Standard Environmental Equipment Co., Ltd. (China)
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	Feasibility Study by Xi'an Municipal Engineering Design and Research Institute, Co., Ltd. (August 2001)
Related Projects	JICA: Xi'an Water Supply Project I,II (1993,1995), Shaanxi Province Water Environmental Improvement Project (2005) Denmark: Xi'an No. 1 Wastewater Treatment Plant Nordic Development Fund: Xi'an No. 2 Wastewater Treatment Plant



Source: Xi'an Sewage Treatment Co., Ltd.
Note: Numbers in circles indicate the locations of the wastewater treatment plants (1st Wastewater Treatment Plant, etc.)

Figure 1. Project sites

2. Outline of the Evaluation Study

2.1 External Evaluator

Akemi Serizawa (Global Link Management, Inc.)

2.2 Duration of Evaluation Study

Duration of the Study: July 2011 - September 2012

Duration of the Field Study: 9 October - 22 October 2011, 21 February - 2 March 2012

2.3 Constraints during the Evaluation Study

The water quality improvement of the rivers was one of the intended impacts of the project. However, the contribution of the project did not clearly appear in the water quality data of the rivers because of the geographical conditions of the inspection points and the effects of polluted water from other sources that were not covered by the wastewater treatment plants constructed by this project. This limitation is commonly experienced in other wastewater treatment projects in large cities. The details are discussed in the section of Impact.

3. Results of the Evaluation (Overall Rating B[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

The 10th Five-Year Environmental Conservation Plan of China (2001-2005) aimed to reduce the total pollutant emissions by 10% from the year 2000, to increase the percentage of wastewater treated[3] to 45% in the urban areas and to improve the water quality of the large rivers. The 10th Five-Year Plan of Shaanxi Province aimed to establish more wastewater treatment plants in large cities including Xi'an and raise the percentage of wastewater treated in Xi'an to more than 50% by 2005.

The objectives of the 11th Five-Year Plan of China (2006-2010) included the prevention of water pollution and the improvement of percentage of wastewater treated in large cities to 70% by construction of wastewater treatment plants. The 11th Five-Year Plan of Shaanxi Province also intended to increase the percentage of wastewater treated in the province to 60% by construction of wastewater treatment plants. The 11th Five-Year Plan of Xi'an aimed to prevent water pollution, construct wastewater treatment plants including No.3 and No.4 plants by this project as well as raise the percentage of wastewater treated to 70%. It also planned to develop drainage pipeline networks and to increase the percentage of population served by sewage pipelines to 85% and that by rainwater pipelines to 70%.

The ongoing 12th Five-Year Plans at all levels retain the same direction. The national plan aims to increase the percentage of wastewater treated in the urban areas to 85%. The provincial plan of Shaanxi Province promotes water saving and recycling of water. The municipal plan of Xi'an aims to increase wastewater treatment plants. The Strategic General Plan of Xi'an Municipality (2004-2020) aims to increase the percentage of wastewater treated to 70% by 2010 and to 90% by 2020.

The project was in line with the development plans of the national, provincial, and municipal levels both at the appraisal and ex-post evaluation as the prevention of water

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[2] ③: High, ② Fair, ① Low
[3] Percentage of wastewater treated = Amount of wastewater treated / Amount of wastewater

pollution and construction of wastewater treatment plants were among the priorities.

3.1.2 Relevance with the Development Needs of China

At the time of the appraisal, the percentage of wastewater treated in Xi'an central districts was only 23%. The pollution of river water was serious because of the insufficient wastewater treatment capacity. In 2001, the water quality of Wei River, which runs from west to east through the northern part of the central districts, was worse than Class V (the worst category) of the national water quality standards. At that time, Xi'an central districts had only two wastewater treatment plants (No.1 and No.2) of 270,000 m^3/day capacity in total while other three plants were to be constructed. This project aimed to enhance the wastewater treatment capacity by construction of No. 3 and No.4 Wastewater Treatment Plants (100,000 m^3/day and 250,000 m^3/day capacity respectively) as well as to develop the drainage pipeline networks.

At the time of the ex-post evaluation, the percentage of wastewater treated in Xi'an central districts had increased to 86% by 2010 and the wastewater treatment capacity had reached to 1,180,000 m^3/day by 2011. The municipality plans to enhance its wastewater treatment capacity to 1,910,000 m^3/day by 2020 by construction of new plants. As discussed in the section of Impact later, the water quality in 2010 at the inspection points of downstream of No.3 and No.4 Wastewater Treatment Plants was still Class V (the worst category) of the national Environmental Quality Standards for Surface Water (GB3838-2002) or worse than that. The contribution of the project to the water quality improvement of the rivers did not clearly appear on the data because the effect of polluted water from other sources that were not covered by the wastewater treatment plants constructed by this project, while the citizens and the project executing agencies recognized the positive change in water quality. The municipality is intended to continue efforts for the water quality improvement of the rivers.

From the above, the needs to enhance the wastewater treatment capacity in Xi'an were high both at appraisal and ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

Japan's Economic Cooperation Program for China (October 2001), Overseas Economic Cooperation Implementation Policy of JICA (JBIC at that time) and JICA country program implementation policy 2001 all prioritized environmental conservation. The country program implementation policy gave priorities to water infrastructure projects such as construction of wastewater treatment plants and promotion of water saving and water recycling. This project was in line with the Japan's ODA policies as it aimed to enhance the wastewater treatment capacity of Xi'an.

The project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness[4] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) Enhancement of wastewater treatment capacity

Table 1 shows the change in the wastewater treatment capacity of Xi'an central districts. This project constructed No.3 and No.4 Wastewater Treatment Plants (100,000 and 250,000 m^3/day respectively), which have 30% of the total wastewater treatment capacity in Xi'an central districts (1,180,000 m^3/day) in 2011. The total extension of the drainage pipelines laid by the project was 117.6 km, which composed 10% of that in Xi'an central districts. The share of the project in the increase of the wastewater treatment capacity since 2001 (at appraisal) is 38% (350,000 m^3/day out of 910,000 m^3/day) and that in the total extension of the drainage pipelines is 16% (117.6 km out of 710 km). It shows that the project had contributed to the increase of capacity to a certain extent.

Table 1. Wastewater treatment capacity in Xi' an central districts

Year	2001	*(2006 Target)*	2006 Actual	2007 Actual	2008 Actual	2009 Actual	2010 Actual	2011 Actual
Percentage of wastewater treated	23%	*(65%)*	60%	62%	65%	81%	86%	No data
Wastewater treatment capacity (10,000 m^3/day)	27	*(62)*	37	37	62	62	87	118
Total extension of drainage pipelines (km)	484.12	*(No data)*	951	1,033	1,033	1,145	1,145	1,194
Output of this project			Drainage pipelines 117.6 km (Dec. 2005) No.3 Plant (100,000 m^3/day) (Dec. 2006)		No.4 Plant (250,000 m^3/day) (Oct. 2008)			

Source: Appraisal documents, Project Completion Report (PCR), Questionnaire responses

The wastewater treatment plants in Xi'an central districts are shown in Table 2 and Figure 1.

[4] Sub rating for Effectiveness is to be put with consideration of Impact.

Table 2. Wastewater treatment plants in Xi'an central districts

(Unit: 10,000 m^3/day)

Plant	Location	Operating company	2001	2006	2008	2010	2011	Expansion plan
No.1	Dengjia Village	Xi'an Venture Water Co., Ltd.	12	12	12	12	12	+6
No.2	Beishiqiao		15	15	15	15	15	+10
No.3	Textile City	Xi'an City Sewage Treatment Co., Ltd.	-	**10 (*1)**	10	15 (+5)	15	+12.5 To be completed in June 2012
No.4	Dianzi Village		-	-	**25 (*1)**	25	25	
No.5	Yuanle Village		-	-	-	**20 (*2)**	20	
No.6	Liucunbao							+10 To be completed in July 2012
No.7	Southwest suburb, High-Tech Zone	Xi'an High-Tech Zone Sewage Treatment Co., Ltd.					**8 (*2)**	
No.8	Cunhuang Town in Gaoling County	Xi'an Economic Development Zone Sewage Treatment Co., Ltd.					**10 (*2)**	
No.9	Chang'an District	Beijing Sound Group					5	
No.10	Caotan	Xi'an City Sewage Treatment Co., Ltd.						+4 Completed in Dec. 2011. Under test-run.
No.11	Xingzhu Street	Xi'an International Trade and Logistics Park Administrative Committee					5	
No.12	Ba Bridge	Chanba Ecological District Administrative Committee					2.5	
Total			27	37	62	87	117.5	(*3)

(Note) (*1) No.3 Plant (100,000 m^3/day) and No.4 Plant (250,000 m^3/day) were constructed by this project.
(*2) No.5 Plant (200,000 m^3/day), No.7 Plant (80,000 m^3/day) and No.8 Plant (100,000 m^3/day) were constructed by another JICA loan project.
(*3) Constructions of several other wastewater treatment plants are being planned.

Source: Executing agency

Table 3 shows the actual volume of treated wastewater of No.3 and No.4 Wastewater Treatment Plants. The rates of facility utilization were around 85% as of 2011.

Table 3. Actual volume of treated wastewater of No.3 and No.4 Plants

(Unit: 10,000 m^3/day)

Year	2007	2008	2009	2010	2011
No.3 Plant	6.83	8.52	8.59	8.86	12.53 (rate of facility utilization: 84%)
No.4 Plant	N/A	N/A	16.59	21.34	21.55 (rate of facility utilization: 86%)

Source: Questionnaire responses

Table 4 and Table 5 below show that in 2011 both plants achieved the targets of the annual emissions and those of the quality of treated water at the completion of construction (it was planned to be in 2006) which had been set up at appraisal. The actual wastewater treatment capacity, emissions of COD and other pollutants and quality of treated water indicate that the two plants have been functioning as expected in view of the quality and quantity. Although the water quality at the entrance of the wastewater treatment plants in 2011 (see data at the entrance in Table 5) was worse than that of 2001, the emissions (see Table 4) and the water quality (see Table 5) at the exit were much better than the targets. While data of annual emissions and quality of treated water at the construction completion of the plants (December 2006 for No.3 Plant and October 2008 for No.4 Plant) were not available, the water quality at the entrance at that time was likely to be better than that of present, and therefore the two plants were likely to have achieved the targets of emissions and quality of treated water when they started operation.

Table 4. Annual Emissions of No.3 and No.4 Wastewater Treatment Plants

(Unit: ton/year)

Year	2001 (baseline)	*2006 (target)*	2011 (actual)
No.3 Plant COD (*1)	14,235	*(2,190)*	1,638
No.3 Plant BOD (*2)	7,300	*(730)*	540
No.3 Plant SS (*3)	9,125	*(730)*	526
No.4 Plant COD	37,413	*(5,475)*	2,540
No.4 Plant BOD	20,988	*(1,825)*	560
No.4 Plant SS	22,813	*(1,825)*	827

(Note) (*1) COD (chemical oxygen demand)
(*2) BOD (biochemical oxygen demand)
(*3) SS (suspended solids)

Source: Appraisal documents, PCR, Questionnaire responses

Table 5. Water quality of treated wastewater

(Unit: mg/L. MPN/100mL for total coliform)

Year	2001 (baseline)		*2006 (target) (*5)*		2011 (actual)	
Plant	No.3	No.4	No.3	No.4	No.3	No.4
COD cr (*1) Entrance	390	410	*N/A*	*N/A*	666.67	615.92
COD cr Exit	N/A	N/A	*<60*	*<60*	38.07	33.22
BOD5 (*2) Entrance	200	230	*N/A*	*N/A*	240.67	346.11
Exit BOD5	N/A	N/A	*<20*	*<20*	12.56	7.33
SS Entrance	250	250	*N/A*	*N/A*	565.67	477.89
SS Exit	N/A	N/A	*<20*	*<20*	12.22	10.82
TP (*3) Entrance	4	5	*N/A*	*N/A*	7.37	4.37
TP Exit	N/A	N/A	*<0.5*	*<1.0*	0.37	0.72
NH_4^+-N (*4) Entrance	30	40	*N/A*	*N/A*	42.81	32.45
NH_4^+-N Exit	N/A	N/A	*<15*	*<15*	4.70	1.83
Total coliform Entrance			*<1000 thousand*	*<1000 thousand*	-	-
Total coliform Exit	N/A	N/A	*<300 thousand*	*<300 thousand*	*<10 thousand*	*<10 thousand*

(Note) (*1) COD cr: Chromium chemical oxygen demand

(*2) BOD5: Biochemical oxygen demand of wastewater during decomposition occurring over a 5-day period.

(*3) TP: Total phosphorus

(*4) NH_4+-N: Ammonia nitrogen

(*5) The targets of 2006 are the same as Class 1-B of the national Discharge standard of pollutants for municipal wastewater treatment plant (GB18918-2002).

No. 3 Wastewater Treatment Plant

No. 3 Wastewater Treatment Plant

3.2.2 Qualitative Effects

(1) Recycling

Recycling of treated water and sludge was expected in this project. No.3 Wastewater Treatment Plant has a water recycling capacity of 50,000 m^3/day as planned and the recycled water is used for cooling of industrial plants, street cleaning, utility water in construction sites, watering plants, car washing and toilets. The actual volume of recycled water in 2011 was 14,000 m^3/day. According to Xi'an City Sewage Treatment Co., Ltd. that

manages the plant, there has been no profit from recycling of treated water so far because the cost and sales price are same (1.25 yuan/ m^3), but the profit is expected in the near future as the cost of water recycling would be reduced after the upgrading of the plant from Class 1-B to 1-A of the "Discharge standard of pollutants for municipal wastewater treatment plant" (GB18918-2002) and the quality of treated water would be improved.

The original plan of the project was to dispose most of the sludge to a landfill and recycle some as fertilizer for urban greening if they meet the quality standard. Currently, all sludge is disposed to a landfill after biological treatment because the technology of drying sludge has not been fully developed and the recycling cost is high.

3.3 Impact

3.3.1 Intended Impacts

(1) Water quality improvement of the rivers

There are eight large rivers in Xi'an. Wei River is the largest and runs from west to east in the northern part of Xi'an central districts. Chan River runs from south to north in the eastern part of the central districts, and Ba River runs east of Chan River. No.3 Wastewater Treatment Plant is located in the eastern part of the central districts along Chan River at 4.9km upstream of the junction of Chan River and Ba River. No.4 Plant is located in the northern part of the central districts along Wei River at 6.8km upstream of the junction of Wei River and Zao River.

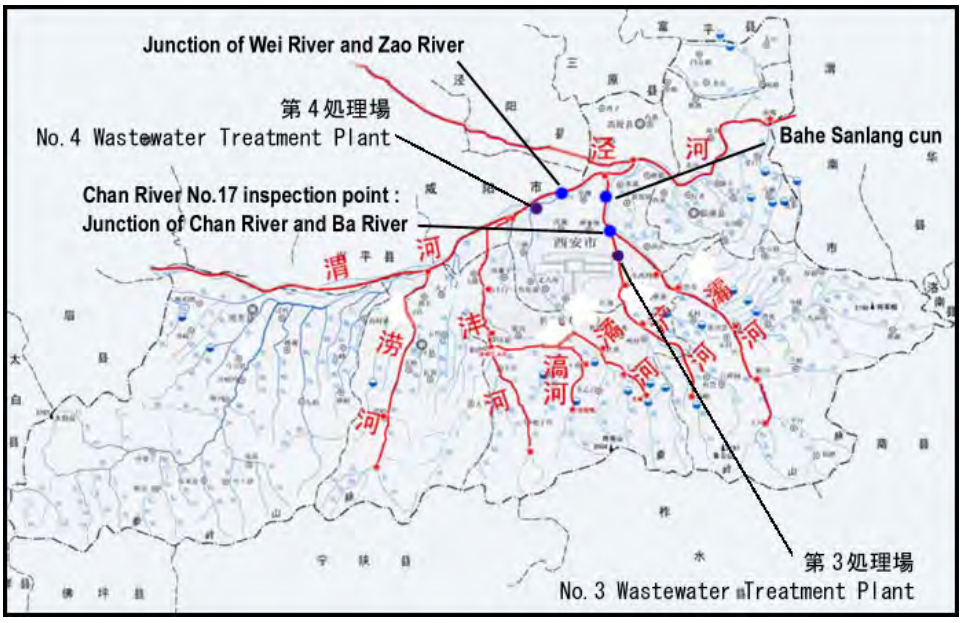


Figure 2. Rivers in Xi'an

At appraisal, JICA and the executing agencies agreed to measure COD, BOD5, SS, TP, and NH_4^+-N of Chan River, although they did not specify the inspection points, baseline or target. Regarding Wei River, they agreed on the baseline and target of the water quality as shown in Table 6 below, although the inspection points were not identified.

Table 6. Target of water quality of Wei River (at appraisal)

(Unit: mg/L)

Year	2001 (baseline)	2005 (target)	2010 (target)
COD	40	33	20
BOD5	12	10.1	4
NH_3^+-N (*1)	0.15	0.12	0.02

Note: (*1) NH_3^+-N: Ammonia nitrogen
Source: appraisal documents

Table 7 shows the national Environmental Quality Standards for Surface Water.

Table 7. Environmental Quality Standards for Surface Water, China (GB3838-2002)

(Unit: mg/L)

	Class I	Class II	Class III	Class IV	Class V
COD	15	15	20	30	40
BOD	3	3	4	6	10
NH_3^+-N	0.15	0.5	1.0	1.5	2.0

Water quality data from three inspection points were obtained from executing agencies as shown in Table 8, 9, 10 below.

Table 8. Chan River No.17 inspection point
(Junction of Chan River and Ba River:
4.9km downstream of No.3 Wastewater Treatment Plant)

(Unit: mg/L)

Year	2006	2007	2008	2009	2010
COD	77	50	62	103	56
BOD	20	9	19	31	13
NH_3^+-N	9.908	9.274	4.966	3.110	3.508

Note: No.3 Wastewater Treatment Plant was constructed in December 2006.
Source: Executing agencies

At this inspection point, the water quality data of 2007 and 2008 were better than those of 2006 before No.3 Plant was constructed. The water quality at this inspection point is affected more by Ba River, which is not covered by No.3 Plant, than Chan River, as the former has a flow of 552 million m^3/year and the latter has 132 million m^3/year. Therefore, the effect of No.3 Plant on this inspection point is limited. Because wastewater from the upstream of Ba River had increased due to the rapid development since 2008, the data did

not show a clear trend of improvement of water quality since then. The water quality of this inspection point in 2010 was worse than Class V (the worst category) of the national Environmental Quality Standards for Surface Water.

Table 9. Ba River Sanlang cun

(13.6km downstream of No.3 Plant. 8.7km downstream of No.17 inspection point)

(Unit: mg/L)

Year	2006	2007	2008	2009	2010
COD	45	44	14	49	38
BOD	8	7	4	13	9
NH_3^+-N	9.568	17.17	5.084	5.169	0.936

Note: No.3 Wastewater Treatment Plant was constructed in December 2006.
Source: Executing agencies

The water quality of Sanlang cun was better than that of No.17 inspection point despite the fact that the former is downstream of the latter. The reasons are that Chanba Ecological Zone is located between these two inspection points and Xi'an Municipal Government had made efforts for environmental conservation in this area, and that the pollution materials tend to sink to the bottom of the river due to the slow flow of water at this point. The water quality in 2010 was Class V of the national Environmental Quality Standards for Surface Water.

Table 10. Junction of Wei River and Zao River

(6.8km downstream of No.4 Plant)

(Unit: mg/L)

Year	2006	2007	2008	2009	2010
COD	685	512	274	161	127
BOD	220	198	84	49	41
NH_3^+-N	22.64	13.5	25.12	33.16	19.71

Note: No.4 Plant was constructed in October 2008.
Source: Executing agencies

At this inspection point, the water quality has improved since the construction of No.4 Plant. In 2010, however, it was still worse than Class V of the national Environmental Quality Standards for Surface Water.

The contribution of the project did not clearly appear in the above water quality data of the rivers because of the geographical conditions of the inspection points and of the polluted water from other sources that were not covered by the wastewater treatment plants constructed by this project.

Comparison between the baseline, the target and the actual figures was not possible because of the following reasons. At appraisal, the inspection points of Wei River were not specified while there were baseline data and target. Regarding Chan River, there were no

baseline or target, and inspection points were not specified.

Although the water quality data did not clearly show the improvement of the water quality at these inspection points, 97% of the respondents of the beneficiary survey (Table 11) felt that the water quality (turbidity and smell) had improved mostly between 2007 and 2009 after the construction of No.3 and No.4 Wastewater Treatment Plants. This project has contributed to the water quality improvement of rivers at least to a certain extent as most respondents thought that it happened after the construction of these plants.

(2) Improvement of living conditions in Xi'an

According to the beneficiary survey results, 76% of the respondents consider that the sanitary conditions at home have improved and 95% consider that that of Xi'an have improved thanks to the enhanced wastewater treatment capacity. They pointed out that there were fewer stenches of the rivers and that sewage water no longer overflew in heavy rain thanks to the drainage pipelines. They think that the living environment along the rivers has been improved as well as at home and in the community.

Table 11. Result of the beneficiary survey

(100 respondents living in the catchment areas either of No.3 or No.4 Plant. 53 men and 47 women)

Effects of No.3 and No.4 Wastewater Treatment Plants	Percentage of respondents who agree with the statement in the left column
Wastewater treatment capacity of Xi'an has been enhanced.	100%
Wastewater is managed appropriately	100%
Water quality of the rivers has been improved.	97% (Turbidity 97%, smell 95%) 84% think that it improved between 2007 and 2009.
Sanitary conditions at home have improved thanks to the enhanced wastewater treatment capacity.	76%
Sanitary conditions in Xi'an have improved thanks to the enhanced wastewater treatment capacity.	95%
Wastewater treatment fees are appropriate.	88%
There are no negative impacts.	97%

The respondents pointed out following impacts of this project.

- Birds have returned to the rivers.
- We can enjoy walking along the rivers and playing on the riverbanks as the stenches from the rivers reduced.
- We can see the water plants and stones in the bottom of the rivers through the clearer water.
- Water from Wei River is used for irrigation.
- The 3rd stage of the Formula 1 Powerboat Racing 2007 (held in Xi'an in October 2007) and the World Horticultural Expo 2011 (held in Chanba area from April to October 2011) were possible because the water quality of the rivers had been improved.

- Hanchen Lake (downstream of No.4 Plant) became a popular tourist destination thanks to the improved water quality and fewer stenches.
- Thanks to the improved drainage pipeline networks, there is no overflow of the sewage in heavy rain and the pipelines are no longer blocked. There are no more stenches in the community after heavy rains. There are fewer mosquitos.

3.3.2 Other impacts

(1) Impacts on the natural environment

Both No.3 and No.4 Wastewater Treatment Plants were designed to meet Class 1-B of the national "Discharge standard of pollutants for municipal wastewater treatment plant." They always operate automated measurement system of the quality of treated water at the exit regarding 12 items including COD, BOD5 and SS (please refer to Table 5 as well)[5] according to the standard, and they report the results monthly to the municipal Environmental Protection Bureau.

No negative impacts of this project have been observed on the natural environment because the wastewater treatment plants take measures to prevent environmental pollution. In order to prevent odors from the wastewater treatment plants, the related facilities are sealed and the green belts were built around the plants for insulation. The pomp stations have noise insulation systems. The reservoirs in the plants have large capacity to prevent the wastewater from overflowing into the rivers in case of emergency.

(2) Land Acquisition and Resettlement

Table 12. Land acquisition

Wastewater treatment plant	Land acquired	Cost of land acquisition	Resettlement	Compensation
No.3	22.52ha	46.08 million yuan	None	None
No.4	58.77ha	61.92 million yuan	None	None

Source: Questionnaire responses

Land acquisition process was carried out by the Bureau of Land and Resources of Xi'an. Its Baquao Branch and Weiyang Branch were responsible for No.3 and No.4 Wastewater Treatment Plants respectively. They observed the land acquisition plans and obtained the consent from the land owners. As explained in the section of Efficiency (project period), the decision of land acquisition for No.4 plant was delayed because of the lengthy discussions with the organizations around the project site. However, the executing agency explained that there were no problems in the negotiation process with the land owners. There was no resettlement.

[5] The twelve items are COD, BOD5, SS, oil extracted from animals and plants, petroleum, anionic surfactant, nitrogen, ammonia nitrogen, total phosphorus, color, pH, and total coliform.

(3) Unintended Positive/Negative Impacts

As reported in the beneficiary survey results, the improved water quality of the rivers made it possible to hold the 3rd stage of the Formula 1 Powerboat Racing 2007 (held in October 2007) and the World Horticultural Expo 2011 (held in Chanba District from April to October 2011) in Xi'an. In the expo site, good quality water was available in the ponds, streams and water facilities.

This project has largely achieved its objectives; therefore its effectiveness and impact are high.

3.4 Efficiency (Rating：①)

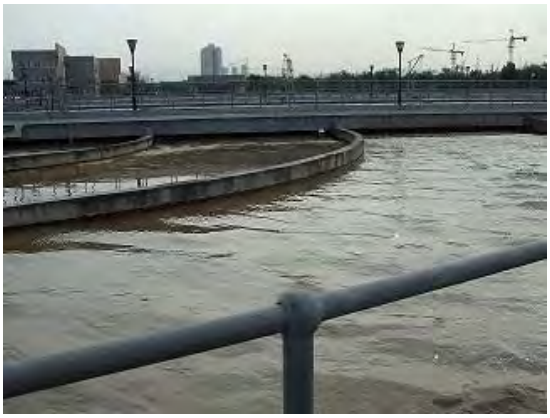
3.4.1 Project Outputs

The actual project outputs were as planned, as summarized in Table 13.

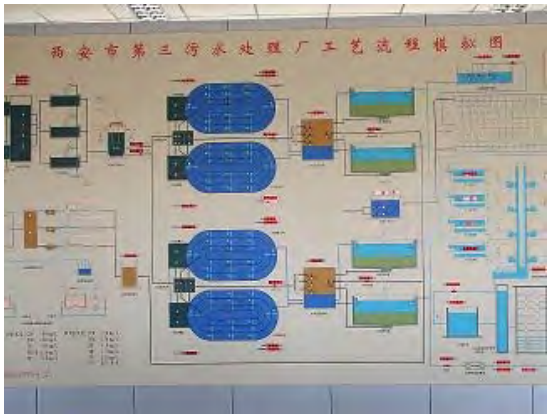
Table 13. Outputs

Item	Plan and actual
A. No.3 Wastewater Treatment Plant: 10,000 m^3/day Oxidation ditch system (Orbal system[6]) + Recycled water 50,000 m^3/day	Pomp rooms, first sedimentation tank, biological reaction tank, final sedimentation tank, filtering tank, sludge treatment plant, etc.
B. No.4 Wastewater Treatment Plant 250,000 m^3/day A2O system[7]	Pomp rooms, first sedimentation tank, aeration tank ,final sedimentation tank, etc.
C. Drainage pipeline networks	Total extension: 117.6km (17 sections)

Source: PCR



No.3 Wastewater Treatment Plant
(Orbal oxidation ditch)



No.3 Wastewater Treatment Plant
Monitoring room

[6] Orbal system is one of the oxidation ditch systems. The Orbal oxidation ditch has three concentric channels. The outer channel is an aerated anoxic reactor. The second channel is a mixer. The last channel removes remaining BOD and ammonia.

[7] A2O (Anaerobic-Anoxic-Oxic System): One of the cyclic activated sludge technologies.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The project cost was higher than planned. The estimated project cost at appraisal was 14,990 million yen, of which the Japanese loan was to be used only for the foreign currency portion amounting to 9,764 million yen and the rest was to be financed by the Xi'an Municipal Government and loan from China Development Bank. The actual project cost was 18,156 million yen, of which the Japanese loan covered the foreign currency portion in full amounting to 8,917 million yen and the rest was financed by the Xi'an Municipal Government and loan from China Development Bank. It was 121% of the estimated cost in Japanese yen and 136% of it in Chinese yuan. The increase in the project cost was due to the escalation of the price of raw materials during the extended project period, which is explained in the next section. The maximum average increase in price per year was 62% for steel and 19% for cement between 2006 and 2008. The increase in price of raw materials raised the cost of civil engineering work of No.3 and No.4 Wastewater Treatment Plants (completed in December 2006 and October 2008 respectively), which was financed by local currency.

Table 14. Project cost

	Plan					Actual				
	FC*	LC**		Total		FC	LC		Total	
	Mill. yen	Mill. yuan	Mill. yen	Mill. yuan	Mill. yen	Mill. yen	Mill. yuan	Mill. yen	Mill. yuan	Mill. yen
No.3 Plant	1,965	33	500	164	2,465	1,427	119	1,591	226	3,018
No.4 Plant	3,222	44	653	258	3,875	3,626	226	3,021	497	6,648
Drainage pipeline networks	3,775	252	3,775	503	7,550	3,864	346	4,626	635	8,490
Sub total	8,962	329	4,928	925	13,890	-	-	-	-	-
Price escalation	337	3	49	26	386	-	-	-	-	-
Contingency	465	17	249	48	714	-	-	-	-	-
Total	9,764	348	5,226	999	14,990	8,917	691	9,239	1,358	18,156

Source: Appraisal documents, PCR, questionnaire responses
Exchange rate: 1yuan=JPY15 at appraisal. 1yuan=JPY13.37at ex-post evaluation (average of during the loan period)
Note: FC*: Foreign currency, LC**: Local currency

No.4 Wastewater Treatment Plant

No.4 Wastewater Treatment Plant

3.4.2.2 Project Period

The actual project period was significantly longer than planned. The project period planned at appraisal was 50 months from March 2002 (signing of the Loan Agreement) to April 2006 (completion of inspection). The actual project period was from March 2002 (signing of Loan Agreement) to October 2008 (completion of inspection) with a total of 80 months, which is 160% of the plan.

The delay was due to the postponement of the construction commencement of both No.3 and No.4 wastewater treatment plants. The construction was to be commenced in June 2003, but it was postponed to 2004 due to the SARS pandemic in 2003. The construction of No.3 Plant started in October 2004 and completed in December 2006. The construction of No.4 Plant started in December 2006 and completed in October 2008. The reason for the substantial delay in construction commencement of No.4 Plant was that, after the request for the preliminary review of the land acquisition plan for No.4 Plant was submitted to the Ministry of Land and Resources in March 2004, the new urban master plan of Xi'an was launched, and educational institutions and economic development zones were constructed rapidly around the planned project site of No.4 Plant, and discussions took time to obtain the consent of these neighboring institutions on the construction of No.4 Plant as they had biased views on these plants. Xi'an Municipal Government and the Ministry of Land and Resources repeated discussions, and the land acquisition plan was finally approved in September 2005. They were prepared to find an alternate project site for No.4 Plant at the same time in case that the neighbors did not give consent. They finally agreed with the original project site, and the land acquisition process was complete in November 2006. The new urban master plan of Xi'an assumed co-existence of No.4 Plant and other new institutions surrounding it as the plan of No.4 Plant had existed earlier, and the Municipal Government did not seem to have anticipated the resistance of the neighbors. The rapid development around the planned project site and the resistance caused the delay of the construction of No.4 Plant, which was unexpected by the executing agencies, and they would not be able to avoid the delay. The prolonged discussions with the neighboring institutions to obtain their consent have contributed to, as a result, the smooth operation of the plant.

3.4.3 Results of Calculations of Internal Rates of Return

Financial Internal Rates of Return (FIRR) and Economic Internal Rates of Return (EIRR) at appraisal for each sub-component of this project are shown in Table 15. The Benefits included water charge revenue for the wastewater treatment plants and indirect profit for the calculation of EIRRs. The Costs included construction costs and operation and maintenance costs. The project life was assumed as 23 years for the wastewater treatment plants (which included three years for the construction) and 25 years for the

drainage pipeline networks (which included four years for the construction).

Table 15. Internal Rates of Return at Appraisal

	FIRR	EIRR
No.3 Plant	5.2%	16.12%
No.4 Plant	5.0%	17.17%
Drainage Pipeline Networks	Not calculated	15.67%

Source: Appraisal documents

It was not possible to re-calculate the FIRRs and EIRRs at ex-post evaluation, as the formula used at appraisal were not clear and it was not easy to substitute the values collected at ex-post evaluation in the formula.

The project cost was slightly exceeded the plan, while the project period was significantly exceeded the plan, therefore efficiency of the project is low.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance

The entities responsible for operation and maintenance of the infrastructures constructed by the project are same as planned. The wastewater treatment plants constructed by the project are operated by Xi'an City Sewage Treatment Co., Ltd., a state-owned company fully financed by Xi'an Municipal Government. The drainage pipeline networks are maintained by the Public Utility Bureau of Xi'an Municipal Government, which is responsible for operation and maintenance of all public infrastructures in Xi'an. In addition to No.3 and No.4 Wastewater Treatment Plants (150,000 m^3/day and 250,000 m^3/day respectively) that were constructed by this project, Xi'an City Sewage Treatment Co., Ltd. also manages No.5 Wastewater Treatment Plant (200,000 m^3/day). It will also operate No. 10 Plant (40,000 m^3/day) that were completed in 2011 and is now under test-run and No.6 Plant (100,000 m^3/day) that is to be completed in July 2012. The total capacity of the wastewater treatment plants managed by this company at present is 600,000 m^3/day, which is more than half of the wastewater treatment capacity of Xi'an central districts (1,180,000 $m^{3/}$day). As indicated in Table 2, there are twelve wastewater treatment plants in Xi'an central districts. All operating companies are state-owned, except for Beijing Sound Group that operates No.9 Plant.

3.5.2 Technical Aspects of Operation and Maintenance

Xi'an City Sewage Treatment Co., Ltd. has 35 senior engineers, 56 engineers and 237 skilled workers. The Public Utility Bureau of Xi'an Municipal Government has 150

engineers specialized in operation and maintenance of infrastructure. In view of good condition of the wastewater treatment plants and the drainage pipelines managed by them, the both units have sufficient number of engineers and technical capacity.

3.5.3 Finance Aspects of Operation and Maintenance

The source of income of the wastewater treatment companies in Xi'an including Xi'an City Sewage Treatment Co., Ltd. is wastewater treatment charges from Xi'an Municipal Government[8]. The user fees paid to the municipal government and the wastewater treatment charges paid from the government to the wastewater treatment companies are not directly related. The wastewater treatment companies in Xi'an do not have their own source of income, and totally depend on the wastewater treatment charges paid by the government. Table 16 shows the water and wastewater treatment rates in Xi'an.

Table 16. Water and wastewater treatment rates of Xi'an (revised in September 2008)

(Unit: yuan/ m^3)

	Water rates		Wastewater treatment rates	Whole price
	Basic water rates	Water resource rates		
Private house	1.95	0.30	0.65	2.90
Industrial	2.25	0.30	0.90	3.45
Administrative	2.65	0.30	0.90	3.85
Commercial	3.10	0.30	0.90	4.30
Special	15.80	0.30	0.90	17.00

Note: "Special" category includes car washing, hair dressing, baths and swimming pools.
Source: Questionnaire responses

As shown in Table 17, the equity ratio of Xi'an City Sewage Treatment Co., Ltd. was 58.2% in 2011 and has never been below 56%. The equity ratio of this level indicates the strong financial status of the company. At the same time, the company has experienced operational loss almost every year. According to them, all state-owned wastewater treatment companies in Xi'an have the same problem, as the wastewater treatment charges paid by the municipal government has been the same (0.8yuan/ m^3) in spite of the increased operational cost including labor cost. Also, the current liabilities accrued during the construction of wastewater treatment plants are recorded under the cost of sales account, which is a factor leading to the operational loss. Supposing that the company covered the operational loss since 2006 (52.5 million yuan in total) by borrowing, the debt to total

[8] The wastewater treatment charges are calculated from the actual amount of treated water (the unit price is 0.8yuan/ m^3), the data of which are automatically sent from the plants to the municipal government. The users pay water and wastewater treatment fees together to the municipal government, and the government pools the portion of the wastewater treatment fees in a specific account for wastewater treatment.

assets ratio[9] would be 47.2% and the equity ratio would be still high at 52.8%. Xi'an Municipal Government plans to raise the unit price of the wastewater treatment 2012[10], by which the company can expect improvement of its financial status from this year[11]. The company also expects the increase in income by the increase of the amount of wastewater treated by the enhanced treatment capacity, and also by the reduction of the cost of recycling water by upgrading of the wastewater treatment plants to Class 1-A of the national Discharge standard of pollutants for municipal wastewater treatment plant, which will lead to the improvement of the quality of treated water. From the above, there is no particular problem with the financial status of the company.

Table 17. Financial status of Xi'an City Sewage Treatment Co., Ltd.

(Unit: million yuan)

	2006	2007	2008	2009	2010	2011
Annual sales (gross revenue)	36.63	67.00	58.42	54.01	90.55	151.95
Costs of sales	5.18	5.46	5.56	7.57	9.63	10.35
Operation and maintenance cost	53.36	67.91	50.96	49.34	97.30	146.54
Operating profit/loss	-21.91	-6.37	1.90	-2.9	-16.38	-4.94
Total assets	545.74	596.35	387.36	843.45	882.51	1,428.03
Current assets	24.50	35.83	65.62	96.94	82.34	141.82
Non-current assets	521.24	560.52	321.74	746.51	800.17	1,286.20
Current liabilities	67.83	138.67	134.53	310.00	328.76	531.01
Shareholder's equity	436.01	431.12	218.74	497.21	513.16	831.72
Liabilities	109.73	165.23	168.62	346.24	369.35	596.30
Equity ratio *Debt to total assets ratio*	79.9% *(20.1%)*	72.3% *(27.7%)*	56.5% *(43.5%)*	58.9% *(41.1%)*	58.1% *(41.9%)*	58.2% *(41.8%)*

Source: Questionnaire responses

According to the Public Utility Bureau of Xi'an Municipal Government, the operation and maintenance cost of infrastructures was 470 million yuan in 2010 and 570 million yuan in 2011. They estimate that about 8% of it is for the drainage pipelines in Xi'an, which was 38 million yuan in 2010 and 46 million yuan in 2011. They consider that they keep sufficient fund for operation and maintenance of the drainage pipelines.

3.5.4 Current Status of Operation and Maintenance

The wastewater treatment plants have annual operation and maintenance plans and implement the work according to them. According to the observation during the site visits, the plants and equipment were in good condition and no particular problems were observed.

[9] The liabilities are 648.8 million yuan (596.3+52.5). The total assets are 1,375.53 million yuan (1,428.03-52.5).

[10] Xi'an Municipal Government plans to raise the unit price of the wastewater treatment to 1.0 yuan/ m^3.

[11] Trial calculation using the figures of 2011: amount of wastewater treated was 189.93 million m^3 (151.95 million yuan (gross revenue in 2011) divided by 0.8 yuan/ m^3). Increase of unit price by 0.2 yuan (189.93 million m^3 x 0.2 yuan/ m^3 = 37.99 million yuan) covers the operational loss of 2011 (-4.94 million yuan).

The drainage pipelines are maintained similarly: the Public Utility Bureau has annual operation and maintenance plans and implements the work according to them. Normal wear and tear of the pipelines are taken care of at appropriate intervals considering the years passed since they were laid. Unexpected damages caused by natural disasters or accidents are repaired on a case by case basis. Damages caused by the third parties are subject to the claims for compensation.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusions

The objective of this project was to contribute to the enhancement of wastewater treatment capacity in Xi'an by constructing No.3 and No.4 Wastewater Treatment Plants and developing drainage pipeline networks, and then to the water quality improvement of the rivers and better living conditions. This project was highly relevant with China's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. It has contributed to the enhancement of the wastewater treatment capacity in Xi'an as planned and also to the water quality improvement of the rivers to a certain extent; therefore its effectiveness and impact are high. The project cost was higher than planned and the project period was significantly longer than planned; therefore the efficiency is low. Sustainability of the project effect is high as no major problems have been observed in structural, technical and financial aspects of the operation and maintenance system.

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

4.2 Recommendations

4.2.1 Recommendations for the executing agencies

None.

4.2.2 Recommendations for JICA

None.

4.3 Lessons learned

The project aimed to contribute to the water quality improvement of the rivers and had set up baseline data and target at appraisal to measure the water quality of Wei River along which No.4 Wastewater Treatment Plant was located, while the water inspection points were not specified. Regarding Chan River along which No.3 Plant was located, no baseline data or target of the

water quality was specified. Therefore, it was not possible to compare the current data with the baseline and the target. At appraisal of loan projects to construct wastewater treatment plants, it is necessary to agree with the executing agency on the water inspection points to measure the water quality.

The water quality data of the rivers did not clearly indicate that the river water quality had been improved by the new wastewater treatment plants constructed by the project. Water quality data are affected more largely by the geographical conditions of the inspection points and by the inflow of the wastewater from other sources of pollution that are not covered by the wastewater treatment plants in question. Therefore, the contribution of the wastewater plants to the improvement of water quality of the rivers is limited, at least on the data. Other similar wastewater treatment projects have experienced the same. The indicators of the water quality, the inspection points and the targets should be agreed to the extent that the effects of the wastewater treatment plants are visible.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	No.3 Wastewater Treatment Plant: 100,000 m^3/day (Oxidation ditch method (Orbal method)) plus recycled water 50,000 m^3/day No.4 Wastewater Treatment Plant: 250,000 m^3/day (A2O method) Drainage pipelines: Total extension 117.6km (17 sections)	As planned. No.3 Wastewater Treatment Plant: 100,000 m^3/day (Oxidation ditch method (Orbal method)) plus recycled water 50,000 m^3/day No.4 Wastewater Treatment Plant: 250,000 m^3/day (A2O method) Drainage pipelines: Total extension 117.6km (17 sections)
2. Project period	March 2002 – April 2006 (50 months)	March 2002 – October 2008 (80 months)
3. Project cost Amount paid in Foreign currency Amount paid in Local currency Total Japanese ODA Loan portion Exchange rate	 9,764 million yen 5,226 million yen (348 million yuan) 14,990 million yen 9,764 million yen 1 yuan = 15 yen (As of September 2001)	 8,917 million yen 9,239million yen (691 million yuan) 18,156million yen 8,917million yen 1 yuan = 13.37 yen (Average between March 2002 and January 2010)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Taiyuan Environmental Improvement Project"

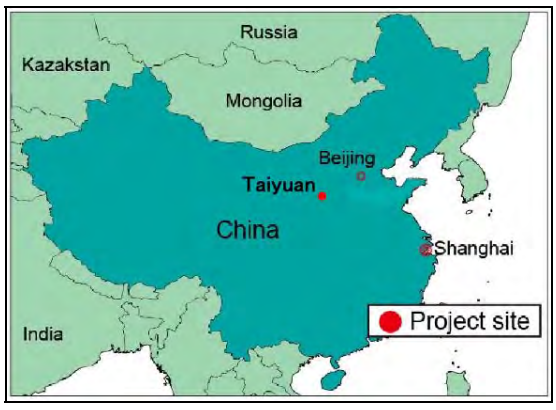
External Evaluator: Yasuhiro Kawabata, Sanshu Engineering Consultant

0. Summary

The objective of the project was to improve the environmental condition including air, water, and industrial solid waste pollution by introducing the cleaner production technology, installing emission treatment facilities and ensuring efficient use of waste energy at Taiyuan Iron and Steel Company (TISCO), thereby contributing to the improving the living environment of the people in Taiyuan. The project has been highly relevant to the development plans and needs of China and Shanxi Province, as well as Japan's ODA policies, and therefore its relevance is high. Regarding the improvement of environmental condition including air and water pollution, which is the project's objective, the project has largely achieved its objectives, therefore its effectiveness is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Since no major problems have been observed in the operation and maintenance system (organizational setup, technical capacity and financial status), sustainability of the project is considered high.

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

1. Project Description



Project Location

Blast Furnace Gas Combined Cycle Power Plant (Control Center)

1.1 Background

At the appraisal time (2001), the air pollution caused by SO_2, which evolved from coal burning (main energy resource), the total suspended particles (TSP), and NOx exhausted from motor vehicles was in the critical condition in China. The treated ratio of the sewage water in urban regions was low as 34.3% and the water pollution was also in the serious condition. In addition, as the economy had developed, the volume of industrial waste had been increasing, and thus occupation of huge land and adverse impacts to the river and ground water had been concerned issues.

Shanxi Province, where the project is located, is abundant with coal as it is called “Coal Province”, and it thrives with heavy industries using coal. Taiyuan, which is the capital city of Shanxi, has been developing as a heavy industry city. However, since renovation of facilities at each enterprise had been delayed, the air pollution level had been worsened. In 1998, Taiyuan was recognized as one of the worst 10 polluted cities in the world by World Health Organization (WHO). Moreover, even in China it was ranked as the worst among 91 cities in terms of the overall rating based on the national environmental standards in 1999, and the implementation of urgent countermeasures to improve air pollution had been anticipated. Regarding the water pollution, among 22 monitoring stations along Fen River, flowing through Taiyuan City, the water quality as a source for drinking water cleared the national standards only at one station. Thus, the domestic sewage issue was also needed to be urgently resolved.

The amount of industrial solid waste produced was huge, and the total amount produced in the province ranked in second in China in 2000. Most of solid waste have been buried or recycled. However, some of waste was illegally disposed without proper treatment, and environmental pollution has been concerned. At the appraisal time, the recycling ratio had been slightly decreasing, and thus, plans to properly treat the increasing industrial solid waste were anticipated.

1.2 Project Outline

The objective of the project isto improve the environmental condition including air, water, and industrial solid waste pollution by introducing the cleaner production technology, installing emission treatment facilities and ensuring efficient use of waste energy at Taiyuan Iron and Steel Company (TISCO), thereby contributing to the improving the living environment of the people in Taiyuan. The location of the project site is shown in Figure 1.

Figure 1 Location of Project Site

Loan Approved Amount/ Disbursed Amount	14,144 million yen / 13,995 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2002 / March 2002
Terms and Conditions	Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: General untied (Works) and Bilateral tied (Consultants)
Borrower / Executing Agency (ies)	Government of People's Republic of China/ Shanxi Provincial Government
Final Disbursement Date	October 2009
Main Contractor (Over 1 billion yen)	Sinosteel Equipment & Engineering Company (China) /Marubeni/Nippon Steel, Acre Coking & Refractory Engineering Consulting Corporation (China) /Steel Plantec /Shinko Corp., Hangzhou Steam Turbine Co., Ltd. (China) /Marubeni/Mitsubishi Heavy Industries, China CMIIC Engineering Corp.(China), China National Heavy Machinery Corp.(China)
Main Consultant (Over 100 million yen)	-
Feasibility Studies, etc.	F/S by Taiyuan Iron and Steel Company Design Institute (2001)
Related Projects (if any)	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasuhiro Kawabata, Sanshu Engineering Consultant

2.2 Duration of Evaluation Study

Duration of the Study: July 2011 – September 2012

Duration of the Field Study: October 9 - October 22, 2011 and February 14 - February 24, 2012

2.3 Constraints during the Evaluation Study (if any)

None

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

The 9th Five-Year Environmental Protection Plan (1996-2000) stated that China would make efforts to reduce the total emission amount of major pollutants such as SO_2, dust (soot and industrial dust), and COD up to the level in 1995 (23.7 million tons of SO_2, 17.44 million tons of dust and 22.33 million tons of COD) by 2000 and thus would develop the urban environmental fundamentals such as control of industrial pollution, sewage system and gas pipelines in the urban area. Under the 10th Five-Year Plan (2001-2005), China aimed to reduce the total emission amount of major pollutants by 10% against the amount in 2000 in order to further improve the environmental condition. In line with the central government plans, in the Metallurgic Industry 10th Five-Year Plan, the implementation of Cleaner Production (CP) at 14 model industries including TISCO was planned. In addition, under the Taiyuan 10th Five-Year Plan, the following programs for environmental improvement were planned: i) reduction of air pollution caused by coal burning; ii) enforcement of shutdown of sources for industrial pollution; iii) protection of sources for drinking water; iv) improvement of water quality of Fen River in Taiyuan; and v) enforcement of control of industrial waste pollution.

The main targets of the current China's 12th Five-Year Environmental Protection Plan (2011-2015) are to reduce the emitted amount of main pollutants, and thus to improve the environment to the level clearly visible. In order to achieve the target, China aimed to reduce the emitted amount of COD and SO_2 by 8% against the amount in 2010 respectively, and those of NH_3-N and NO_X by 10%, respectively. The following specific strategies to achieve the target have been established: i) the total emission amount shall be further reduced; ii) environmental protection measures are strengthened; iii) the environmental risk shall be lowered; and iv) the fundamental public service to address the environmental issues shall be improved. The Taiyuan's 11th Five-Year Plan (2006-2010) aims to transform the economic development policy and thus to construct the environmentally friendly urban city by protecting natural resources. In line with the city's plan, under the Taiyuan 11th Five-Year Environmental Protection Plan (2006-2010), the following targets are established: i) control of worsening of the environmental pollution; ii) promotion of effective use of resources; iii) reduction of the total emission amount of pollutants; and iv)

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ② Fair, ① Low

improvement of the ecological and environmental condition.

3.1.2 Relevance with the Development Needs of China

At the appraisal time, Shanxi Province was an important base for industries of energy, heavy metal and science/technology sectors in China and one of major cities for industries of coal mining, metallurgy, mechanical, chemistry, and electricity sectors. However, since aged facilities had been used in the factories, the environmental pollution was worsened in Shanxi Province. Particularly, the condition in Taiyuan, which is the capital of the province, was worst in the Province. If TISCO[3] which was the biggest pollution producer in Shanxi, should have continued increase of production of steel without any effective measures to reduce pollution, it was obvious that the environment in the province would have been further worsened. Thus, improvement of air quality, treatment of domestic waste water, and proper treatment of industrial waste materials were considered to be the issues to be urgently resolved.

Taiyuan's 11th Five-Year Plan (2006-2010) states that the "Blue Sky Action Plan" shall be implemented in order to improve the air pollution. It requires enterprises producing heavy pollution to move to other locations or stop their operation or improve their production facilities. The large enterprises, which cannot be easily relocated, would be requested to improve control of emission of pollutants. Regarding the water quality control, the following strategies were established: i) protection of sources for drinking water shall be tightened; ii) recycling rate of sewage water shall be increased; and iii) discharge of industrial and domestic waste water to rivers shall be prohibited. Moreover, the recycling rate of industrial solid waste shall be also increased and eventually the recycling rate needs to be upgraded to 95% by 2010.

3.1.3 Relevance with Japan's ODA Policy

Under the Economic Cooperation Plan for China (2001), which is equivalent to the Country Assistant Strategy, the following policy was established: Priority shall be given to the following theme or sector: conservation of the environment and ecology, where pollution and destruction are in the critical condition, poverty alleviation and social development in inland regions, human resource development, institutional reform, and technology transfer. Furthermore, the aid assistance to address the global issues such as environmental problems was classified as the top priority issue among the priority agenda.

Accordingly, the project has been highly relevant with the Chinese and Shanxi's

[3] TISCO is a large scale state-owned enterprise with 72,000 employees, and a largest stainless steel sheet and magnetic steel maker.

development plan and needs, as well as Japan's ODA policies, therefore its relevance is high.

3.2 Effectiveness[4] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) Amount of Pollutants emitted by Taiyuan Iron and Steel Company (TISCO)

The amount of pollutants emitted by TISCO after completion of the project is shown in Table 1.

Table 1 Amount of Pollutants emitted by TISCO

Indicators	unit	2000 Base year	2007	2008	2009	2010
SO_2 (sulphur dioxide)	ton/year	3,048	2,500 (250)	303	245	240
Dust	ton/year	1,124	650 (166)	161	160	156
H_2S (hydrogen sulphide)	ton/year	23.3	23.3 (0)	23.3	0	0
HCN (hydrocyanic acid gas)	ton/year	10.4	10.4 (0)	10.4	0	0
Reduction of use of coal	1,000 ton /year	-	- (239.6) [5]	60.8	193.9	279.8
COD (chemical oxygen demand)	ton/year	4,525	200 (110)	75	0	0
Oil	ton/year	70	2.8 (3.7)	1.2	0	0
SS (suspended solids)	ton/year	2,309	50 (36.5)	0	0	0
BOD (biochemical oxygen demand)	ton/year	1,118	- (36.5)	13	0	0
NH_3N (ammonium nitrogen)	ton/year	406	20 (9.1)	4	0	0
Recycled amount of slug	1,000 ton/year	-	- (500) [6]	1,450	1,515	1,550

Source: Responses to Questionnaire

Note 1: Numbers in ( ) are projected figures (targets) at the planning stage

The emitted amount of SO_2 was slightly reduced from 2000 (base year) to 2007, and was substantially reduced upon completion of the project (2008). The emitted amount in 2010 was 240 tons/year (about 8% of the 2000's actual), which is less than the projected amount

[4] Sub-rating for Effectiveness is to be put with consideration of Impact.

[5] After the commencement of the project, specifications of some facilities were revised (refer to 3.4.1 Outputs). Although the planned reduction amount of coal use was also revised, it is not clear how each facility affected the reduction amount. Thus, the reduction amount projected at appraisal is used as the planned amount.

[6] After the commencement of the project, the specifications of the plant were reviewed and the treatment capacity for slug recycling was tripled. Thus, it is assumed that the planned recycled amount would be also increased by three times of the originally planned amount (500,000 tons), that is, 1.5 million tons.

(250 tons/year) at the project completion. The emitted amount of dust was also substantially reduced. The emitted amount in 2010 was 156 tons/year (about 14% of the 2000's actual), which is less than the projected amount (166 tons/year) at the project completion. Other pollutants such as hydrogen sulphide, hydrocyanic acid gas, COD, Oil, suspended solids, BOD, and ammonium nitrogen have not been emitted upon completion of the project.

The reduced amount of coal used right after completion of the project (2009)[7] was 190,000 tons. However, it exceeded the planned reduced amount (240,000 tons/year) in 2010 and has reached up to about 280,000 tons.

Before the project, the slug, which is scrap after steel melting, was neither crushed nor treated, and abandoned. By introducing the treatment facilities under the project, it became possible to reuse the slug as a construction material. In 2008, after the slug treatment facility was completed in December 2007 and the reuse of slug became possible, 1.45 million tons of slug, which is about the planned amount was recycled as construction materials. The recycled amount of slug was 1.55 million tons in 2010.

(2) Monitoring Indicators on Environment in Taiyuan

Improvement of environmental conditions in Taiyiuan after the completion of the Project is shown in Table 2.

Table 2 Improvement of Environmental Conditions in Taiyuan

Indicators	unit	2000 Base Year	2007	2008	2009	2010
SO_2 (sulphur dioxide)	ton/year	198,226	106,650 (67,000)	100,089	90,487	94,233
	mg/N m^3	0.200	0.077 (0.06)	0.073	0.059	0.056
TSP/PM10 (particle matter)	mg/N m^3	0.401	0.124 (0.1)	0.094	0.091	0.089

Source: PCR , Responses to Questionnaire, Taiyuan Annual Statistics 2008-2011
Note 1: Numbers in ( ) are projected values at appraisal
Note 2: The monitoring indicator on air floating particle matter in Taiyuan was changed from TSP to PM10 since 2001
Note 3: The numbers show the total amount emitted in Taiyuan urban area.

Because of the additional efforts made to improve the environmental condition by major industries in Taiyuan, the SO_2 amount emitted in 2008 was reduced by 50% against the amount emitted before the project (2000) in ton unit, and by 63% in mg/Nm^3 unit. The emitted amount in 2010 was reduced by 52% (in ton unit) against the amount emitted in the base year. Even though the Taiyuan's GDP as of 2010 was increased by 17% against the

[7] The originally planned completion date at appraisal was December 2006. However, it was extended to December 2008. Details are discussed under 3.4.2.2 Project Period.

2008 GDP, and the amount of industrial products has increased, the amount of SO_2 emitted is constant. The SO_2 amount emitted by TISCO was about 1.54% of the amount emitted in Taiyuan in 2000 (base year). However, the share of TISCO was reduced as low as about 0.25% in 2010. Because of the efforts made by Taiyuan Municipal Office to reduce the air pollution, the level of TSP/PM10 (particle matter) in 2010 has been lowered to the 78% of that observed before the project (2000).

3.2.2 Qualitative Effects

(1) Environmental Improvement (Air and Water Pollution)

In this ex-post evaluation work, beneficiary surveys through interviews were conducted in the project affected area. The total number of respondents was 100. The classification of respondents by sex was 50% female and 50% male. Main results of the beneficiary surveys are as follows. Regarding the improvement of air quality, almost all the respondents admit that the air quality has been improved after the project (December 2008). With respect to the level of improvement, 44% of respondents cognize that it is substantial and 55% do that it is fairly. Regarding the water quality of Fen River, all the respondents admit that it was improved after the project. With respect to the level of improvement, 49% of respondents cognize that it is substantial and remaining 51% think that it is fair.

3.3 Impact

3.3.1 Intended Impacts

(1) Improvement of urban and living environment

As mentioned previously, TISCO was one of main sources generating air pollution in Taiyuan. Thus, it was expected that the implementation of the project with the objective to improve environmental condition of TISCO plants would greatly contribute to the improvement of environmental condition in Taiyuan. Changes of environmental condition made before and after the project in Taiyuan are shown in Table 3.

Table 3 Changes of Environment before and after the Project in Taiyuan

Indicator	2007	2008	2009	2010
Amount of Industrial Water discharged (million tons/ year)	31.04	26.25	24.83	25.57
Amount of Industrial Dust emitted (1,000 tons/year)	35.97	32.35	30.46	27.85
Amount of Industrial Solid Waste produced (million tons/ year)	26.39	25.32	24.10	25.54
Amount of Industrial Solid Waste disposed (million tons/ year)	0.45	0.19	0.09	0.08
GDP and Growth Rate of Taiyuan (100 million yuan)	1,291	1,526 (18.2%)	1,545 (1.2%)	1,778 (15.0%)

Source: Taiyuan Annual Statistics 2008-2011

GDP in 2009 was almost the same as the previous year due to the economic crisis after the Lehman Shock, and all other indicators were also slightly lowered. However, if values of indicators before the project (2007) are compared with those in 2010, values of each indicators were lowered (substantially lowered particularly with the amount of dust emitted) even though GDP was increase by 38%. It is clear that the efforts to improve the environmental condition by Taiyuan Municipal Office are successful.

The perception by citizens on improvement of living environment through the beneficiary surveys are shown in Table 4 and 5.

Table 4　Perception by Citizens on Improvement of Living Environment (Air)

Effects by improvement of Air (multiple choice)	%
Lowering of dirtiness of clothes by dust	91
Less coughing and eye's pain	91
Possible to dry clothes outside	98
No use of mask and sun glass to prevent dust	74

Table 5　Perception by Citizens on Improvement of Living Environment (Water)

Improvement of water quality (Fen River)（multiple choice）	%
Turbidity improved	100
Less smell than before	98
Fishing possible	98
Possible to use as irrigation water	97
Landscaping along the river improved	100

The improvement of living environment (air and water quality) in Taiyuan was not achieved only by this project. However, it was proven through the results of the beneficiary surveys that the improvement of environment of TISCO, which was the most polluted industry in Taiyuan, contributes to the improvement of living environment. To the question on the contribution of the project to improvement of environment, 36% of respondents cognize that the living environment (air and water quality) was substantially improved upon completion of the project and 64% cognize that it was fairly improved.

As an overall assessment to the project, 15% of respondents answer that they are totally satisfied and 85% answer that they are fairly satisfied. From these results, it was confirmed that citizens admit the contribution of the project to the improvement of urban/living environment.

3.3.2 Other Impacts

Impacts on the natural environment:

The construction waste materials disposed from the project were hauled to the special treatment depot in the TISCO's compound and treated properly. Currently, the environmental protection bureau (staffed with 50 employees) of TISCO (now Shanxi TISCO Stainless Steel Company) has been automatically monitoring the air quality at 87 ejecting points and water quality at 4 discharging points in the TISCO compound, and it is reported that the ejected air and discharge water meet the standards required for each item. The monitoring results are reported to the Environmental Protection Bureau of Taiyuan Municipal Office, and no particular problem has been identified.

Land Acquisition and Resettlement:

Since the project scope is improvement or reconstruction of the facilities and equipment within the existing TISCO compound, no additional land acquisition occurred. According to the executing agency, since two families of company employees lived in the area where the sewage plant was to be constructed, it took longer time to negotiate the compensation for relocation with the house owners. Construction commenced after the complete agreement had been made.

This project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The original and actual output of the project is shown in Table 6.

(1) Construction and Installation of Facilities to reduce Pollution at Taiyuan Iron and Steel Company

Table 6 Output (original and actual)

Item	Original	Actual
1. Coke Dry Quencher (CDQ) Plant	Installation of CDQ facilities (treatment capacity of 110 tons/hour) to No. 5 and 6 coke ovens	Installation of CDQ facility (treatment capacity of 150 tons/hour) to No. 7 coke oven
2. Desulphurization and HCN Removal Plant	Installation of desulphurization facility (treatment capacity of 63,000 m^3/hour) Vacuum Carbonate/Claus	Treatment capacity increased to 130,000 m^3/hour and treatment process was changed to MEA removal method
3. Blast Furnace Gas Combined Cycle Power Plant (CCPP)	Installation of Combined Cycle Power Plant (output power 81.4 MW)	Output power was lowered to 51.6 MW
4. Top Gas Recovery Turbine (TRT) Plant	Installation of a turbine plant to No.3 blast furnace (Output power 6 MW)	Output power was increased to 12 MW
5. Electric Arc Furnace (EAF)	Construction of Arc Furnace with dust collectors (capacity 90 tons) Disposal of 6 old small furnace	as planned
6. Steel Dregs Treatment Plant	Installation of steel dregs treatment plant, capacity: 380,000 tons/year for ordinary steel and 120,000 tons/year for stainless steel	Installation of steel dregs treatment plant, capacity:920,000 tons/year for ordinary steel and 760,000 tons/year for stainless steel
7. Sewage Treatment Plant	Construction of a sewage plant to be used for domestic water discharged from residential area (treatment capacity: 50,000 m^3/day)	as planned

Source: PCR, Response to Questionnaire
CDQ : Coke Dry Quenching

All the facilities to reduce pollution under the project were constructed and installed. However, changes of specifications were made on some facilities. Major changes of output are as follow:

1) Coke Dry Quencher (CDQ): Originally, CDQs were planned to be installed to No. 5 and 6 plants. However, since both plants were abandoned (decision made in September 2005), the CDQ was installed to newly constructed No.7 plant. The treatment capacity was increased from the original 110 tons/hour to 150 tons/hour. Another new No.8 plant was constructed with their own fund.
2) Since the originally planned treatment method was not appropriate to handle the treatment capacity of No. 7 and 8 plants, the desulphurization treatment capacity was increased to 130,000 m^3 /hour and the treatment process was changed as well.
3) The originally planned ready-made power plant with the output power of 81.4 MW was not available in the market, the output power was changed to 51.6MW.
4) Since the furnace capacity was increased from 1,200 m^3 to 1,800 m^3, the specification of the turbine plant was upgraded and the generating power was also increased to 12 MW.

5) Since the steel production amount was increased and thus the slug amount was also increased, increase of the slug treatment capacity was needed. The annual slug treatment capacity was increased to 920,000 tons for normal steel and 760,000 tons for stainless steel.

After the loan was signed in 2003, the need for increase of production capacity based on the future demand projection was reviewed. As a result, it was judged that the increase of production capacity was needed and design changes were partly made. Changes made are essential for an enterprise to promptly cope with the technical innovation, and they are considered appropriate.

(2) Consulting Services

The originally planned consulting services included the consulting assignment with a total input man/month of 30 M/M on the following facilities: Coke Dry Quencher (CDQ) Plant (5M/M), Desulphurization and HCN Removal Plant (6M/M), Top Gas Recovery Turbine (TRT) Plant (10M/M), and Electric Arc Furnace (EAF) (9M/M). The consulting services included assistance in bidding activities, review of detailed designs, construction supervision, and safeguards (review of impacts on environmental improvement). However, since no qualified consultant submitted an Expression of Interest to the assignment on Desulphurization and HCN Removal Plant (6M/M), this assignment was cancelled. The actual input by consultants was 24 M/M.

Electric Arc Furnace (EAF)

Desulphurization and HCN Removal Plant

3.4.2 Project Inputs

3.4.2.1 Project Cost

The estimated project cost at appraisal was 23.403 billion yen, of which the Japanese ODA loan with a total amount of 14.144 billion yen was to be used to only the foreign currency portion and the rest was to be funded by TISCO. Since the specifications of some

plans were revised during the project implementation, the planned project cost was revised to be 26.072 billion yen. The actual project cost was 25.734 billion yen, of which the Japanese ODA loan used was 13.995 billion yen and the rest was funded by TISCO. The actual cost is equivalent to 98.7% of the planned cost based on the revised specification, and thus it was lower than planned.

Table 7 Comparison of Project Cost (Planned and Actual)

Item	Planned					Actual				
	Foreign	Local		Total		Foreign	Local		Total	
	million yen	million yuan	million yen	million yuan	million yen	million yen	million yuan	million yen	million yuan	million yen
Coke Dry Quencher (CDQ) Plant	1,722	41	618	156 (373)	2,340 (5,140)	1,945	243.78	3,604	375.39	5,549
Desulphurization and HCN Removal Plant	495	46	696	79 (194)	1,191 (2,673)	1,749	47.5	702	165.81	2,451
Blast Furnace Gas Combined Cycle Power Plant (CCPP)	5,897	76	1,145	469	7,042	4,971	105.4	1,558	441.69	6,529
Top Gas Recovery Turbine (TRT) Plant	635	13	201	56	836	285	7.96	118	27.26	403
Electric Arc Furnace (EAF)	3,171	183	2,746	394	5,917	3,623	243	3,592	488.09	7,215
Steel dregs treatment plant	524	22	326	57	850	955	97.9	1,447	162.49	2,402
Sewage Treatment Plant	437	28	413	57	850	385	48.6	718	74.62	1,103
Taxes & Management	0	174	2,608	174	2,608	14	-	-	0.95	14
Consulting services	104	0	0	7	104	68	-	-	4.60	68
Price escalation	492	5	78	38	570	-	-	-	-	-
Contingency	667	29	428	73	1,095	-	-	-	-	-
Total	14,144	617	9,259	1,560 (1,892)	23,403 (26,072)	13,995	794.14	11,739	1740.90	25,734

Source: Appraisal documents, PCR, Responses to Questionnaire

Note 1: Exchange rate at appraisal: 1 yuan = 15 yen, Exchange rate at post evaluation 1 yuan = 14.782 yen (average during the period between July 2004 and March 2009)

Note 2: Taxes, management costs and contingencies spent are included in the cost of each component at post evaluation.

Note 3: Since changes of specifications on the Coke Dry Quencher Plant and Desulphurization and HCN Removal Plant were approved though the formal procedures, the revised planned costs were estimated as shown in parentheses. The exchange rate used at reestimation (September 2005) is 1 yuan = 13.78 yen.

Main reasons for the increased/lowered project cost against the original plan are as follows.

1) Since the treatment capacity of dry quencher plant of CDQ facility was increased from the original 110 tons/hour to 150 tons/hour, the specifications of heat boilers and generators were also upgraded, resulting in increase of construction cost. However, the actual cost spent was almost equivalent to the revised planned cost.
2) The desulphurization treatment capacity was increased to 130,000 m^3/hour and the treatment process was also changed. However, the actual cost spent was lower than the revised planned cost.
3) Since the Blast Furnace Gas Combined Cycle Power Plant (CCPP) was constructed with lower output power, construction cost was reduced.
4) When the cost estimation was made on the Top Gas Recovery Turbine (TRT) Plant at the planning stage, the equipment to be installed was assumed to be imported. However, since the awarded contractor actually installed the domestic product, the cost was reduced.
5) Regarding the Electric Arc Furnace (EAF), the latest model of imported equipment was procured and the furnace facility, which was originally covered by roof only, was included in the building resulting in cost increase.
6) With respect to the Steel Dregs Treatment Plant, the cost was increased because of delay of the implementation schedule and upgrading of the treatment capacity.
7) Regarding the sewage treatment plant, since the material costs including steel and cement was increased, the civil work and installation costs, which were locally funded, were increased.

3.4.2.2 Project Period

The project period was longer than planned. The project period planed at appraisal was from March 2002 (signing of the Loan Agreement) to December 2006 (completion of civil work) with a total period of 58 months. The actual project period was from March 2002 (signing of the Loan Agreement) to December 2008 (completion of civil work) with a total period of 82 months, equivalent to 141% of the planned period.

Main reasons for delay of the project period are as follows:

1) Since the person in charge of the execution agency was unfamiliar with the JICA's procurement procedure and process and it took longer time to secure the internal clearance, the implementation of some sub-projects was delayed by about 2 years against the original plan.

2) Regarding the Coke Dry Quencher (CDQ) Plant, the change of project scope, redesigns and revision of designs have occurred (destruction of No. 5 and 6 furnaces, and new construction of No.7 and 8 furnaces).
3) Although the Desulphurization and HCN Removal Plant was once bid through the International Competitive Bidding (ICB) procedure as one package, the bid was not realized. Consequently, this package was divided into three packages (2 direct contracts and one ICB contract), and the rebid took longer time resulting in delay of the construction period.
4) Regarding the Blast Furnace Gas Combined Cycle Power Plant (CCPP), it took longer time to review the technical specification to make balance between the amount of gas turbine and the capacity of a gas emission furnace.
5) Although the Steel Dregs treatment plant was once bid through the ICB procedure as three packages, the bid was not realized. Thus, two packages were rebid through the ICB procedure and one package was changed to the direct contract. The rebid took longer time resulting in delay of the construction period.
6) Regarding the Sewage Treatment Plant, since two families lived in the area where the plant was to be constructed, it took longer time to negotiate with the house owners. Construction commenced after the complete agreement had been made, resulting in delay of construction period.

Steel dregs treatment plant

Sewage Treatment Plant

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

Financial Internal Rate of Return

By using the same conditions and assumptions applied to calculate FIRRs at appraisal, the FIRRs at post evaluation was calculated by the executing agency as shown in Table 8. The construction cost of some sub-projects substantially increased because of upgrading of the specification, while the benefits also increased. Consequently, FIRRs of each sub-project were calculated to be slightly higher than those calculated at the planning stage.

Table 8 FIRR (at appraisal and at post evaluation)

Facility	Benefits	Cost	FIRR (%)	
			at appraisal	at post evaluation
Coke Dry Quencher Plant	Collected steam and others	Construction, and Operation/ Maintenance costs	8.0	8.1
Desulphurization and HCN Removal Plant	Coke gas	- do -	7.8	7.9
Blast Furnace Gas Combined Cycle Power Plant	Electricity	- do -	10.8	11.5
Top Gas Recovery Turbine Plant	Electricity	- do -	7.3	7.7
Electric Arc Furnace (EAF)	Reduction of production costs	- do -	8.3	9.6
Steel dregs treatment plant	Recycled slugs as construction materials	- do -	7.7	8.9
Sewage Treatment Plant	Reuse the recycled water	- do -	4.4	6.2

Note: Project life 20 years

Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance

Shanxi TISCO Stainless Steel Company (owned by TISCO by 64.24%), which is a subsidiary company of Taiyuan Iron and Steel Company (TISCO), is currently responsible for operation and maintenance of the facilities constructed under the project. Shanxi TISCO Stainless Steel Company was established in 1998 and listed in the Shenzhen Stock Market. In June 2006, it purchased the main assets (steel production division and related equipment/facilities) of the parent company and became the largest steel production company in China. The company has 21 divisions and offices under the management of President and General Manager with a total number of 21,000 employees. The number of staff in charge of operation and maintenance of each facility and plant is shown in Table 9. Sufficient number of staff is assigned to operation and maintenance work, and thus, no problem is observed in its institutional setup.

Table 9 Numbers of Staff in charge of Operation and Maintenance of Each Facility and Plant

unit: persons

Facility	Number of staff
Coke Dry Quencher Plant	33
Desulphurization and HCN Removal Plant	15
Blast Furnace Gas Combined Cycle Power Plant	22
Top Gas Recovery Turbine Plant	12
Electric Arc Furnace (Special Steel Plant)	52
Steel dregs treatment plant	20
Sewage Treatment Plant/Energy Source/ Power Plant deepening process	12
Total	166

Source: Response to Questionnaire

3.5.2 Technical Aspects of Operation and Maintenance

The technical level of staff, who are responsible for operation and maintenance of each facility and plant is shown in Table 10.

Table 10 Technical Level of Workers who are Responsible for Operation and Maintenance of each Facility and Plant

Facility	Technical level
Coke Dry Quencher Plant	Workers are graduated from college, junior college, high school and vocational school. Their technical level is junior engineer's level and they have more than three-year working experience in the equipment maintenance and repairs.
Desulphurization and HCN Removal Plant	Workers are graduated from high school and vocational school. Their technical level is engineer's level and they have more than ten-year working experience in the equipment maintenance and repairs.
Blast Furnace Gas Combined Cycle Power Plant	Among 22 workers, five are graduated from college and three from technical junior college. Their technical level is junior or middle engineer's level. A few workers have more than ten-year working experience in the fields of electric, gas, boiler and steam turbine, and the rest are fresh workers graduated from school.
Top Gas Recovery Turbine Plant	Among 12 workers, one is graduated from college and 8 from technical junior college. Their technical level is engineer's level. All have more than ten-year working experience in the operation of electric equipment.
Electric Arc Furnace	Among 52 workers, one is graduated from graduate school, 2 from college and the remaining 49 are from high school. Their technical level is junior or middle engineer's level. All have more than eight-year working experience in the operation of furnace.
Steel dregs treatment plant	Among 20 workers, one is graduated from college, one from technical junior college and the remaining 18 are from high school. Their technical level is junior or middle engineer's level.
Sewage Treatment Plant	Among 12 workers, two are graduated from college, 6 from technical junior college and the remaining 4 are from high school. All have been engaged in the sewage treatment work since joined the company.

Source: Response to Questionnaire

Employees have taken training modules (lasting for 2 days through 40 days) in each field offered by the TISCO Training Center and external institutes in 2010. The number of training modules offered was 16, and the number of trainees was between 1 and 22 depending on the subject.

From the interview with employees during the inspection of TISCO plants, it was confirmed that the technical level of employees are solid, and that the manuals and guidelines on each facility including the following are well prepared.

- TISCO CDQ Equipment Maintenance and Management Regulations (TISCO Coke Furnace, 2008)
- Desulphurization Treatment Manual, Acid Production Operating Manual
- Gas Turbine Operating Manual
- Gas and its Related Knowledge (TISCO Training Center)
- Electric Steel Production Process Manual (TISCO)
- Steel Slug Treatment Process and Operating Manual
- Local Sewage Treatment Equipment Maintenance and Management Regulations and Technical Operating Regulations (TISCO Water Supply Station, 2007)

3.5.3 Financial Aspects of Operation and Maintenance

The revenue and expenditure status of Shanxi TISCO Stainless Steel Company for the past three years is shown in Table 11.

Table 11 Revenue and Expenditure Status of Shanxi TISCO Stainless Steel Company for the past Three Years

unit: 000 yuan

Item	2008	2009	2010
Main business revenue	71,330,765	57,970,542	75,339,849
Operating costs	62,902,972	51,487,557	67,833,736
Taxes and miscellaneous expenses	262,251	77,921	75,165
Sales expenses	1,110,801	988,198	1,187,469
Management costs	2,382,757	2,618,062	2,861,214
Financing costs	1,732,634	960,622	1,129,194
Depreciation	1,138,248	598,935	825,938
Investment effectiveness ratio	-5,276	42,594	1,193,662
Operating profit	1,795,824	1,281,840	2,620,795
Non business revenue	94,969	88,159	44,556
Non business expenses	89,190	52,512	37,509
Profit before tax	1,801,604	1,317,487	2,627,842
Corporate taxes	-149,858	42,184	73,033
Net Profit	1,951,462	1,275,303	2,554,809

Source: Response to Questionnaire

In 2009, the sales revenue decreased due to the economic crisis after the Lehman Shock. However, in 2010, the revenue went up more than that in 2008 and the company has remained in surplus for the past three years.

The budgets allocated to operation and maintenance of each plant and expenditures actually spent are shown in Table 12.

Table 12 Budgets allocated to Operation and Maintenance of each Plant and Expenditures actually Spent

unit: million yuan

Facility	Budget (year)	Expenditure		
		2008	2009	2010
Coke Dry Quencher Plant	13	21	11.1	12
Desulphurization and HCN Removal Plant	3.5	0.8	1.2	3.35
Blast Furnace Gas Combined Cycle Power Plant	14	-	-	13.5
Top Gas Recovery Turbine Plant	7.5	7.1	7.45	7.51
Electric Arc Furnace	13.20	11.37	12	12.31
Steel dregs treatment plant	7.0	6.3	6.5	6.7
Sewage Treatment Plant	0.53	0.40	0.16	0.40

Note: Operation and maintenance costs for the equipment and facilities constructed and installed under the project.

Budgets for operation and maintenance have been allocated to each facility every year, and the required maintenance costs have spent depending on needs.

The company has remained in surplus for the past three years. The budget needed for operation and maintenance of the equipment and facilities procured under the project is secured, and thus, no major financial issue is observed.

3.5.4 Current Status of Operation and Maintenance

The current status of operation and maintenance of the facilities installed/constructed under the project is as follows:

Coke Dry Quencher Plant: The periodic maintenance of the plant has been undertaken every 1.5 – 2 months, and the major overhaul inspection every 1.5 years. The plant has been operating properly and the operational efficiency is high.

Desulphurization and HCN Removal Plant: The overhaul inspection has been implemented every year. The plant has been operating properly and the desulphurizing efficiency is high. All the required technical parameters meet the planned targets.

Blast Furnace Gas Combined Cycle Power Plant: The required overhaul has been

implemented every 12,000 operational hours or every 1.5 years. The plant has been operating as planned and the high quality material supply has been required.

Top Gas Recovery Turbine Plant: The overhaul has been undertaken every 2 years. The plant has been operating properly. Since there are some minor problems on scaling of blades, some chemical agent needs to be added depending on the gas condition.

Electric Arc Furnace: The regular inspection, which needs 6 - 8 hours, has been implemented three times a month. Moreover, the medium-level comprehensive inspection, which needs two days, has been implemented twice a year. The furnace with dust collectors has been operating properly.

Steel dregs treatment plant: The spot check has been implemented every two hours every day, and the specific professional spot check once a week. The plant has been operating properly.

Sewage Treatment Plant**:** The spot check has been implemented every two hours every day, and the specific professional spot check once a week. When any irregularities were found, repairs are made immediately. The plant has been operating properly. The quality of the treated water is satisfactory and recycled for reuse.

The operation and maintenance has been regularly implemented per management plans. No major issues on the quality and physical durability on the facility and equipment installed/constructed were found.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of the project was to improve the environmental condition including air, water, and industrial solid waste pollution by introducing the cleaner production technology, installing emission treatment facilities and ensuring efficient use of waste energy at Taiyuan Iron and Steel Company (TISCO), thereby contributing to the improving the living environment of the people in Taiyuan. The project has been highly relevant to the development plans and needs of China and Shanxi Province, as well as Japan's ODA policies, and therefore its relevance is high. Regarding the improvement of environmental condition including air and water pollution,

which is the project's objective, the project has largely achieved its objectives, therefore its effectiveness is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Moreover, since no major problems have been observed in the operation and maintenance system (organizational setup, technical capacity and financial status), sustainability of the project is considered 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

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Since the executing agency was unfamiliar with the clearance process among the domestic relevant agencies and the JICA's procurement process and procedures regarding the implementation of the Japanese ODA loan project, the implementation was delayed at the early stage of the project implementation. Thus, it is suggested that during discussions with the executing agency at appraisal, detailed review and discussions should be held on the implementation schedule and technical specifications of the equipment to be procured.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs		
Coke Dry Quencher (CDQ) Plant	Installation of CDQ facilities (treatment capacity of 110 tons/hour) to No. 5 and 6 coke ovens	Installation of CDQ facility (treatment capacity of 150 tons/hour) to No. 7 coke oven
Desulphurization/HCN Removal Plant	Installation of desulphurization facility (treatment capacity of 63,000 m^3/hour) Vacuum Carbonate/Claus	Treatment capacity increased to 130,000 m^3 /hour and treatment process was changed to MEA removal method
Blast Furnace Gas Combined Cycle Power Plant (CCPP)	Installation of Combined Cycle Power Plant (output power 81.4 MW)	Output power was lowered to 51.6 MW
Top Gas Recovery Turbine (TRT) Plant	Installation of a turbine plant to No.3 blast furnace (Output power 6 MW)	Output power was increased to 12 MW
Electric Arc Furnace (EAF)	Construction of Arc Furnace with dust collectors (capacity 90 tons) Disposal of 6 old small furnace	as planned
Steel dregs treatment plant	Installation of steel dregs treatment plant, capacity: 380,000 tons/year for ordinary steel and 120,000 tons/year for stainless steel	Installation of steel dregs treatment plant, capacity: 920,000 tons/year for ordinary steel and 760,000 tons/year for stainless steel
Sewage Treatment Plant	Construction of a sewage plant to be used for domestic water discharged from residential area (treatment capacity: 50,000 m^3/day)	as planned
2. Project Period	March 2002– December 2006 (58 months)	March 2002– December 2008 (82 months)
3. Project Cost		
Amount paid in Foreign currency	14,144 million yen	13,995 million yen
Amount paid in Local currency	9,259 million yen 617 million yuan	11,739 million yen 794.14 million yuan
Total	23,403 million yen	25,734 million yen
Revised project cost	26,072 million yen	-
Japanese ODA loan portion	14,144 million yen	11,739 million yen
Exchange rate	1 yuan = 15 yen (As of September 2001)	1 yuan = 14.782 yen (Average between July, 2004 and March, 2009)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Chongqing Environment Improvement Project"

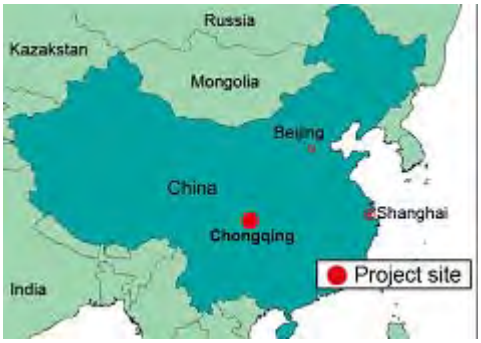
External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

The Government of China and the Chongqing Municipal People's Government (CMPG) gave priorities to water pollution control of Yangtze River and its tributary, Jialing River, and have undertaken various actions. This project was implemented as a part of such efforts. In Chongqing City, due to rapid urbanization and industrialization, domestic and industrial wastewater increased, thus water contamination was worsened. In addition, as the Three Gorges Reservoir is located in the downstream of Yangtze River, it was urgent and highly necessary to improve the water quality of the rivers by constructing wastewater treatment facilities. The following expected effects have been observed almost as planned: the increase of wastewater treatment capacity, reduction in pollutants emission, improvement of quality of treated water, improvement of water quality of the rivers in the city. These effects have been contributing to the enhancement of the living standards of the residents along the rivers. Therefore, the effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, 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

Jiguanshi Wastewater Treatment Plant
Digestion Tank

1.1 Background

In China, due to rapid urbanization and industrialization and the improvement of living standards since 1980's, domestic and industrial wastewater increased drastically. The wastewater treatment ratio in metropolitan cities in 2000 remained as low as at 34.3%. In addition, in the seven major river basins (Wai, Liao, Hai, Songhua, Huang, Zhu and Yangtze Rivers), the monitoring sections which did not reach Class III of the National Surface Water Quality Standards[1] (the level which can be used as source of water for drinking)[2] stood at 42.3% in 2000.

The City of Chongqing is the central city of economy, transportation and trade in the upper stream of Yangtze River. It became a government-ruled municipality[3] in 1997. Due to rapid expansion of the city central areas due to population growth and development of manufacturing industry, domestic and industrial wastewater increased. It reached 856,000 m^3/day in 2001. On the contrary, Tangjiaqiao wastewater treatment plant (WWTP) with a capacity of 48,000 m^3/day, was single WWTP in Chongqing City. The wastewater treatment ratio in the urban area of Chongqing City was extremely as low as 6%. As a result, untreated wastewater was directly flown into the rivers in the City, and the water quality of Jialing River was Class IV of the National Environmental Quality Standards for Surface Water. Under this circumstance, it was urgently needed to construct WWTPs in the City.

1.2 Project Outline

The objective of this project is to improve the water quality of rivers in the City of Chongqing by constructing WWTPs (secondary treatment facilities in Tangjiatuo and Jiguanshi), thereby contributing to the improvement of living environment of the City. The location of the project site is shown in Figure 1.

---

1 The National Environmental Quality Standards for Surface Water (GB3838-1988) categorized thirty water quality parameters from Class I to Class V. The standards were revised in 2002. The current standards (GB3838-2002) categorize twenty four parameters.

2 Similar to Japan, the water quality standards in China are regulated by the utilization purpose of the water area and by its protection purpose. Class I-III water is appropriate water for drinking. If the water quality does not meet Class V standards, it is called as "below Class V".

3 The central government administers these municipalities directly and these municipalities are the same administrative units as provinces. These include Beijing, Shanghai, Tianjin and Chongqing.

Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	9,017million yen / 9,017million yen
Exchange of Notes Date / Loan Agreement Signing Date	March, 2002 / March 2002
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Chongqing Municipal People's Government
Final Disbursement Date	July 2009
Main Contractor (Over 1 billion yen)	China Construction Seventh Engineering Bureau, Ebara Corporation (Japan), Chongqing Chuanyi Automation, Co., Ltd., Biwater Man Lee Limited., Tianjin Machinery & Electric Equipment Import and Export Co., Ltd.
Main Consultant (Over 100 million yen)	NJS Consultants (Japan)
Feasibility Studies, etc.	Tangjiatuo Wastewater Treatment Plant (WWTP): F/S by Central and Northern China Municipal Engineering Design and Research Institute, July 2001, Jiguanshi WWTP: F/S by Shanghai Municipal Engineering Design and Research Institute, July 2001.
Related Projects	In the late 1990's, the project preparation study including the revision of the wastewater master plan was conducted by using the grant aid by Japan, France, UK, Australia, Italy and Switzerland. The primary treatment facility and wastewater pipes of Tangjiatuo and Jiguanshi WWTPs were constructed as the first stage construction under the loan by the World Bank. The secondary treatment facility and the sludge treatment facility were constructed as the second stage construction under this project.

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August, 2011 to September, 2012

Duration of the Field Study: November 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

The primary treatment facility and wastewater pipes of Tangjiatuo and Jiguanshi WWTPs were constructed as the first stage under the loan from the World Bank, and the secondary treatment facility and the sludge treatment facility were constructed as the second stage under this project. It is considered that the above two projects and continuous efforts for improving water quality of rivers by the CMPG jointly resulted in the observed effects. Thus, it was difficult to strictly distinguish the effect by this project and the effect by other interventions.

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

3.1 Relevance (Rating: ③[5])

3.1.1 Relevance with the Development Policy of China

At the time of appraisal (2002), China's 10th Five-Year Environment Protection Plan (2001-2005) set the following specific objectives: decrease in the major pollutants emission by 10% compared against 2000; raise wastewater treatment ratio in urban areas to 45% (60% in the cities with a population of more than 500,000); and improve water quality in major rivers such as Yangtze, Huang and Songhua Rivers.

Chongqing's 10th Five-Year Environment Protection Plan (2001-2005) set a goal of achieving 60% of wastewater treatment ratio in the urban areas in the City and announced further promoting pollution control of wastewater. In addition, the wastewater master plan towards 2020, which was formulated in 2001, planned developing wastewater pipes and 11 WWTPs and gave a highest priority to this project among the WWTP construction projects. As shown in the table below, the facility capacity under this project occupied 84% of the overall plan towards 2010 and 62% of the overall plan towards 2020.

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[5] ③: High, ②: Fair, and ①:Low.

Table 1 Summary of Wastewater Treatment Master Plan

Unit: ten thousand m^3/day

Wastewater Treatment Plant	Until 2010		Until 2020	
	Capacity	Target Year	Capacity	Target Year
Tangjiatuo (This Project)	30	2005	10	2013
Jiguanshi (This Project)	60	2005	20	2013
Qiezixi	5	2007	3.1	2013
Lijiatuo	5	2007	4	2013
Zhongliangshan	5	2010	2	2013
Jinkou	2	2010	0	
Sub-total	107		39.1	
Total			146.1	

Source: JICA appraisal documents

The 11th Five-Year National Conservation Plan (2006-2010) targeted raising wastewater treatment ratio in urban areas to 70% and decreasing the emission of Chemical Oxygen Demand[6] (COD) by 10%. The current 12th National Conservation Plan (2011-2015) set the following objectives: raise wastewater treatment ratio in urban areas to 85%; decrease in the emission of COD by 8%; and decrease in the emission of ammonia nitrogen by 10%.

In the 11th Chongqing Conservation Five-Year Plan (2006-2010), priority was given to the treatment of wastewater and waste proposal. The objective of the plan was to construct 21 WWTPs in the Yangtze River Basin in order to improve the water quality of the Three Gorges Reservoir[7], which is located at the downstream of Chongqing City[8]. The current 12th Five-Year Plan (2011-2015) targeted achieving 95% of the wastewater treatment ratio in the urban areas and achieving 90% of the wastewater treatment ratio in the whole City of Chongqing. Furthermore, the plan is also to promote appropriate processing of sludge in order to achieve the goals of detoxifying and recycling the sludge which is emitted from WWTPs. The locations of Yangtze and Jialing Rivers and the Three Gorges Reservoir are shown in Figure 2.

[6] COD is the indicator which shows the degree of water contamination. It indicates the oxygen amount which is required when organic matters are treated with an oxidizing agent.

[7] The distance between the central area of the City of Chongqing and the Three Gorge Reservoir is approximately 680km.

[8] At the time of the implementation of the Three Gorge Project in 2003, it was anticipated that the self-cleansing capacity of the Three Gorge Reservoir would decrease and that the water quality of the Three Gorge Reservoir would decrease if wastewater is not treated properly in the upper stream. It was also urgently needed to improve water quality of Yangtze and Jialing Rivers in order to secure water sources for the residents around the Three Gorge Reservoir. Source: Project Completion Report (PCR).

Figure 2　Map of the Chongqing City and surrounding areas (Yangtze and Jialing River Basin)

3.1.2　Relevance with the Development Needs of China

At the time of appraisal, in the urban areas of Chongqing City (175km^2, population of 2,400,000), due to rapid urbanization, population growth and development of manufacturing industry, the domestic and industrial wastewater increased rapidly to the total of 856,000 ton/day in 2001. On the contrary, there was only one Tangjiaqiao WWTP with the treatment capacity of 48,000 ton/day. Waste water treatment ratio in the urban area was extremely as low as 6%. Because waste water was released into the rivers directly, the water quality of the Jialing River was Class IV according to the National Environmental Water Quality Standards for Surface Water, which means that the water did not meet the standards as water source for drinking.

At the time of ex-post evaluation, due to urbanization, population growth, industrialization and the development of sightseeing industry, the demand for wastewater treatment is increasing. Both WWTPs under this project are operating to those maximum capacities. Currently, based on the master plan for wastewater treatment, the third stage construction of the two WWTPs is being implemented; thus the daily treatment capacity of 100,000 tons for Tangjiatuo and that of 200,000 tons for Jiguanshi will be expanded.

Based on the facts that Yangtze and Jialing Rivers are single water sources and receiving points for treated wastewater, and that wastewater treatment in Chongqing City plays important roles in the protection of water environment of the Three Gorge Reservoir, environmental protection by wastewater treatment is continuously urgent issue.

3.1.3 Relevance with Japan's ODA Policy

The Economic Cooperation Plan towards China of the Government of Japan gave priorities to environment issues, poverty reduction and social development in inland areas, institutional formulation, and technical transfer. Among them, the cooperation for responding to global issues such as environmental issues was one of the top priorities. In addition, the Overseas Economic Cooperation Implementation Policy of Japan International Cooperation Agency (JICA, former JBIC) issued in 1999 identified environmental issues as one of the three top priorities for the loan projects for China. The country-wise Implementation Policy for China was also to consider the construction of wastewater treatment facilities and the public projects for water-saving and water resource recycling as priority issues.

In light of the above, this project has been highly relevant with the development plans of China and of CMPG, development needs, as well as Japan's ODA policies, therefore its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators

(1) Improvement of wastewater treatment capacity

The planned and actual wastewater treatment capacity of Tangjiatuo and Jiguanshi WWTPs is summarized in Table 2. Wastewater treatment capacity achieved 90,000 ton/day as planned.

Table 2 Wastewater treatment capacity (Plan/Actual)

Unit: ten thousand m^3/day

Indicators	Plan after the project completion (2005)	Actual after the project completion (2007)
Tangjiatuo WWTP	30	30
Jiguanshi WWTP	60	60
Total	90	90

Source: Planned figures from the appraisal documents. Actual figures from the questionnaire answer of Chongqing Drainage Company (CDC).

Table 3 summarized wastewater treatment amount[9] and facility operation ratio[10] as the indicators showing whether the wastewater treatment facilities are fully operating. Since the project completion in 2007, both wastewater treatment amount and facility operation

[9] The wastewater amount which WWTPs receive and process.
[10] Daily average treatment amount/ treatment capacity.

ratio are rising steadily and the facility operation ratio keeps more than 80% every year, thus it can be said that the facilities have been used effectively. As mentioned earlier, the third stage construction are undergoing at both WWTPs in response to the increasing wastewater amount in Chongqing City.

Table 3 Daily average wastewater treatment amount and facility operating ratio

Unit (excluding treatment ratio): ten thousand m^3/day

WWTPs	2007		2008		2009		2010		2011		Facility Capacity
	Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount	Ratio	
Tangjiatuo	23.1	77%	24.1	80%	23.3	78%	25.9	86%	26.5	88%	30
Jiguanshi	47.2	79%	57.3	96%	58.6	98%	61.5	103%	64.0	107%	60
Total	70.3		81.4		81.9		87.4		90.5		90

Source: Questionnaire Answer from CDC

(2) Wastewater treatment ratio in the urban areas in Chongqing City

Table 4 shows the baseline and planned figures of wastewater treatment in the urban areas in Chongqing City. According to the Chongqing Environment Protection Bureau (CEPB), actual data of treatment ratio of whole wastewater and industrial wastewater in the urban areas were not available; however, the domestic wastewater treatment ratio in the urban areas in 2011 was approximately 95%. Therefore, as far as domestic wastewater treatment ratio in the urban areas, it can be said to have achieved its target. Regarding the industrial wastewater, the CEPB explained that a number of factories discharge wastewater into the rivers after treating wastewater by their own facilities, and that the strict emission standards were established.

Table 4 Wastewater treatment ratio in the urban areas in Chongqing City

Unit: %

Indicator	Baseline (2001)	Plan (2005 and 2010)	Actual (2011)
Wastewater Treatment Ratio	6	95	Domestic wastewater: 95 Total and industrial wastewater: Unknown

Source: Baseline and planned figures from JICA appraisal documents. Actuals from the interview with the CEPB.
Note: Wastewater treatment ratio= wastewater treatment amount / total wastewater.

The target wastewater treatment ratio in the urban areas in Chongqing City has been achieved not only by this project; however, based on the fact that the treatment capacity of facilities under this project occupied 84% of the overall wastewater treatment plan towards 2010, it can be considered that this project has contributed to the improvement of wastewater treatment ratio in the urban areas in the City.

(3) Pollutants emission reduction amount

Table 5 shows the baseline and planned figures of emission of major water pollutants: COD, Biochemical Oxygen Demand[11] (BOD) and Suspended Solids[12] (SS) as well as the target reduced amount (target - baseline). Table 6 and Table 7 illustrate the actual emission amount of those pollutants of each WWTP. As those tables show, the targets of the above indicators were achieved at both WWTPs.

Table 5 Pollutant emission amount (baseline and plan) and target reduced amount of the two WWTPs

Unit: ton/year

WWTP	Baseline of emission amount (2001)			Planned emission Amount after proiject completion (2005)			Planned reduced amount		
	COD	BOD	SS	COD	BOD	SS	COD	BOD	SS
Tangjiatuo	30,478	15,374	21,353	5,125	1,708	1,708	25,623	13,666	19,644
Jiguanshi	65,700	32,850	45,625	10,950	3,650	3,650	54,750	29,200	41,975
Total	96,178	48,224	66,978	16,075	5,358	5,358	80,373	42,866	61,619

Source: Questionnaire answer from CDC

Table 6 Pollutant emission amount and reduced emission amount of Tangjiatuo WWTP (actual)

Unit: ton/year

Indicators	Emission amount				Reduced amount from baseline (2010)
	2007	2008	2009	2010	
COD	2,776	2,444	2,504	2,525	27,953
BOD	428	343	360	284	15,090
SS	1,019	1,306	1,271	891	20,462

Source: Questionnaire answer from CDC

Table 7 Pollutant emission amount and reduced emission amount of Jiguanshi WWTP (actual)

Unit: ton/year

Indicators	Emission amount				Reduced amount from baseline (2010)
	2007	2008	2009	2010	
COD	3,982	4,491	4,267	3,872	61,828
BOD	838	855	898	673	32,177
SS	1,467	1,497	1,797	1,420	44,205

Source: Questionnaire answer from CDC

[11] Similar to COD, BOD is also an indicator showing the degree of water contamination and is one of the regulatory parameters of industrial wastewater.

[12] SS are the solids which are suspended in water and cannot be melted.

(4) Improvement of quality of water treated at WWTPs

The density values of COD, BOD and SS after treatment specified in the Grade I-B of the Urban Wastewater Treatment Plant Emission Standards (GB18918-2002), which was revised in 2002, were adopted as the target values for this project. The density of all the parameters of COD, BOD and SS after treatment met the standards. Table 8 shows the baseline, planned and actual density of the three parameters.

Table 8 Density of major pollutants after treatment

Unit: mg/L

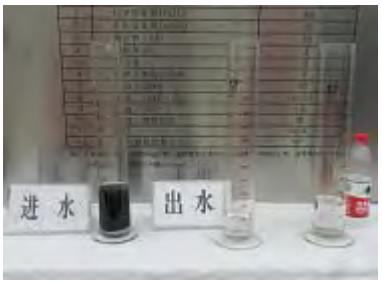
Indicators	2001 Baseline		Plan after Project Completion (Note)		2011 Actual	
	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi
Inlet COD	360	360	360	360	301	323
Outlet COD	360	360	60	60	32	20
Inlet BOD	180	180	180	180	181	152
Outlet BOD	180	180	20	20	4	4
Inlet SS	250	250	250	250	212	438
Outlet SS	250	250	20	20	11	7

Source: Appraisal documents, Questionnaire answer from CDC.
Note: Target values of the density of outlet COD, BOD and SS are in accordance with Grade I-B of GB18918-2002.

It was confirmed during the evaluator's field visit that the wastewater before treatment was black and the treated water was as transparent as mineral water on the contrary.

Overview of sedimentation pond and biological reaction pond

Wastewater Outlet of Juguanshi WWTP



Water before treatment (left), water after treatment (center), mineral water (right)

(5) Improvement of water quality of rivers in Chongqing City

It was confirmed from the interview with the CEPB that the water quality monitoring sections related to this project were Cuntan and Daxiguo sections, which are located between the starting points of wastewater pipes and the ends of the pipes/ the locations of the Tangjiatuo and Jiguanshi WWTPs. The implementation completion and results report of the first stage construction of the two WWTPs (by the loan from the World Bank) use the

data of Cuntan and Daxiguo sections[13] for its evaluation, too.

The time-series data regarding water quality category of Cuntan section of Yangtze River is shown in Table 9. While the water quality of Cuntan section was Class III in 2000, it has been Class II since 2006, thus it can be said that the water quality is on the improving trend.

Table 9 Water quality category at Cuntan section of Yangze River

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Category	III	NA	III	IV	II	III	III	III	II	II	II	II	II

Source: The data of 1998 is drawn from the implementation completion and results report of Chongqing Urban Environment Project (2010). The data after 2000 was provided by CEPB.

According to the above report, while the water quality of Daxiguo section of Jialingjiang River was Class IV in 1998, it was Class II in 2008. According to the Chongqing Municipality State of the Environment Reports, the water quality, not only of Daxiguo section, but also of all the sections under the supervision of the CEPB, has been Class II since 2006[14]. Therefore, it can be assumed that the water quality of Jialing River is also on the improving trend.

The above report indicated the monitoring results of Cuntan and Daxiguo sections between 1998 and 2008 regarding Permanganate Index[15] and BOD5[16], which are particularly important among the 24 parameters regulated by the current National Environmental Quality Standards for Surface Water (GB 3838-2002). The current standards are shown in Table 10. The annual average values of Cuntan and Daxiguo sections are shown in Table 11 and 12. The monitoring results show that the Permanganate Index was reduced by 11% (from 3.10mg/l to 2.77mg/l) and that BOD5 was reduced by 42% (from 1.93mg/l to 1.12mg/l) between 1998 and 2008 in Cuntan section. It also indicates that the Permanganate Index was reduced by 35% (from 4.34mg/l to 2.82mg/l) and that BOD5 was reduced by 49% (from 2.52mg/l to 1.29mg/l) between 1998 and 2008 in Daxiguo section. Comparing with the national standards, the average values of both sections in 2008 are within the limit of Class II.

[13] Source: Implementation completion and results report of Chongqing Urban Environment Project (2010). The original data was from CEPB.

[14] Source: Chongqing Municipality State of the Environment Report 2006, 2007, 2008, 2009 and 2010.

[15] Permanganate Index is same as the Chemical Oxygen Demand by manganese method (CODMn), which has been adopted in Japan. There are two methods for measuring COD: manganese method and chrome method (CODCr). The current national emission standards in China adopt CODCr. However, in 1998, the Chongqing Urban Environment Project set the permanganate index as one of the monitoring items. Thus, the report evaluated the project by using the same index.

[16] BOD5 is the oxygen demand amount when organic matters are cultivated for five days in the room of 20 degrees Celsius.

Table 10 National Environmental Quality Standards for Surface Water (Limit)

Unit: mg/L

Category / Standard Value / Item	Class I	Class II	Class III	Class IV	Class V
Permanganate Index	2	4	6	10	15
BOD5	3	3	4	6	10

Source: The data is drawn from the implementation completion and results report of Chongqing Urban Environment Project (2010). The original data was from the CEPB.

Table 11 Annual average values of Cuntan Section

(unit: mg/l)

Year	Permanganate Index	BOD5
1998	3.10	1.93
1999	2.48	1.32
2000	2.48	1.23
2001	1.91	1.79
2002	2.23	1.56
2003	2.77	1.77
2004	2.36	1.36
2005	2.72	1.29
2006	3.61	1.49
2007	2.57	1.10
2008	2.77	1.12

Table 12 Annual average values of Daxiguo Section

(unit: mg/l)

Year	Permanganate Index	BOD5
1998	4.34	2.52
1999	2.80	1.79
2000	2.46	2.01
2001	2.60	1.53
2002	2.58	1.83
2003	3.23	2.46
2004	2.68	1.49
2005	3.06	1.49
2006	2.70	1.60
2007	2.51	1.79
2008	2.82	1.29

Source: The implementation completion and results report of Chongqing Urban Environment Project (2010). Original data is drawn from the CEPB.

Meanwhile, Yangtze River is 6,300 km long (longest in China) and Jialing River is 1,119km, thus the water quality of those rivers is easily affected by several factors such as the pollution situations of those upstream. In the target area of this project, various actions for water quality improvement had been undertaken: the first stage construction, industrial pollution control, etc. Therefore, it is difficult to verify the relationship between the improving trend of the river water quality and this project. However, based on the facts that this project reduced pollutants emission more than planned and that the wastewater after treatment fulfills the national emission standards Grade I-B, it can be judged that this project had contributed to the improvement of river water quality to certain degree.

3.2.2 Qualitative Effects

3.2.2.1 Water quality improvement of the rivers (Yangtze and Jialing Rivers) in Chongqing City

Beneficiary surveys (100 samples: 65 male and 35 female) were conducted for the

residents along Yangtze and Jialing Rivers[17]. As a result, 80% respondents answered that the river water quality had improved very much, and 20% respondents answered that the quality had slightly improved. There was none who responded “no change” or “aggravated”. Regarding the timing of the water quality improvement, as Figure 3 illustrates, many respondents perceived that the water quality of the rivers had improved between 2006 and 2008. As the project was completed in July 2007, it is considered that not only this project but also the implementation of the first stage construction and the CMPG’s efforts for controlling industrial wastewater contributed to the improvement of river water quality in a synergistic manner.

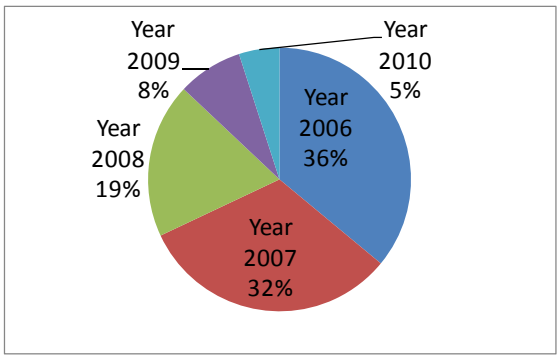


Figure3 Perception of the timing of water quality improvement observed in the beneficiary survey result (N=100)

3.2.2.2 Recycled Effect (Sludge recycling)

Table 13 shows the amount of treated sludge and reused sludge of the two WWTPs.

Table 13 Amount of treated sludge and amount of reused sludge

Unit: ton/day

Indicators	Target for 2010		Actual for 2010		Actual for 2011	
	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi	Tangjiatuo	Jiguanshi
Amount of treated sludge	48	105	85	269	92	267
Amount of reused sludge	0	0	59 (69%)	90 (33%)	73 (79%)	94 (35%)

Source: Questionnaire answer from CDC

Parts of sludge have been used mainly as cement materials and fertilizer. While the percentage of recycled sludge amount against the processed sludge amount at Jiguanshi WWTP was as low as about 30%, the percentage at Tangjiatuo WWTP is as high as

[17] Gailanxi (Jiangbei) 10 persons, Xiaojiahe (Jiangbei and Yuzhong) 10 persons, former Chang’ An Auto plant (Jiangbei) 10 persons, Hutouya (Shapingba) 10 persons, Heishizi(Jiangbei) 10 persons, fomer Tianyuan Chemical Industry Plant (Jiangbei) 10 persons, Daxiguo (Yuzhong) 10 persons, South Pingyabadong (Nan’ An) 10 persons, Gongyadong (Yuzhong) 10 persons, Jiguanshi 5 persons and Tangjiatuo 5 persons.

between 70 and 80%. According to CDC, this is because the company installed a sludge drying facility at Tangjiatuo WWTP by its own funds in 2009. Out of the total 270 tons/day of processed sludge, Jiguanshi WWTP transports approximately 90 tons/day to a cement factory and reclaims about 180 tons/day. However, as the newly introduced sludge drying facility at Tangjiatuo WWTP was found to be effective, CDC also decided installing the same facility at Jiguanshi WWTP. It is planned to be installed by the end of 2012. It is expected that the recycling ratio will be improved after 2013.

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of living environment

The planned and actual target areas and service population under this project are summarized in Table 14. While the target area increased than planned, the target population is same as the planned. The target districts increased from six to seven. The reason for this increase was that Liangjiang New District, a new administrative district, was added[18].

Table 14 Target area and service population (Plan and actual)

	Area (unit: km^2)			Target population (unit: ten thousand)			Target Districts
	Target for 2005	Target for 2010	Actual 2011	Target for 2005	Target for 2010	Actual 2011	
Tangjiatuo	46	68	100	80	88	82	Yubei, Liangjiang New, Jiangbei (Northern and eastern area of Chongqing City Proper)
Jiguanshi	98	108	315	130	154	144	Nan'an, Yuzhong, Jiulongpo, Shapingba (Southern area of Chongqing City Proper)
Total	144	176	415	210	242	226	

Source: Plan from JICA appraisal document. Actual from Questionnaire answer from CDC.

According to the beneficiary survey, 97% respondents answered that the domestic sanitary environment had improved by the installation of toilets and connection of wastewater pipes. 100% respondents answered the living environment in the city had improved. The installation of toilets and connection of wastewater pipes were not included in this project; however, without the wastewater treatment facility under this project, those

[18] Source: Questionnaire answer from CDC.

installations could not be carried out. Thus, the improvement of the domestic sanitary environment can be considered as indirect effect of this project.

The following points were raised by the respondents regarding the improvement of the river water quality.

- Water quality at Chaotianmen (cross-section between Yangtze and Jialing Rivers) has improved. Sanitary environment along Jiubin Road (along Yangtze River in Yuzhong District) has improved. In the past, flow of black liquid was observed in Yangtze River along Nanbin Road (Nan'an District), but such black water is no longer observed. The water in the Three Gorges Dam is cleaner than before.
- Odor from ditches disappeared. Odor along Beibing Road in Zhangbei District (along Jialing River) disappeared. No odor of rivers is sensed when taking ferries. (Because no odor is sensed,) people can open the windows of the room.
- The number of flies and mosquitoes has decreased.
- People can fish at Chaotianmen. The fish from the rivers can be eaten now.
- People can swim in the rivers now.
- The river water near Jiguanshi WWTP has become clean, and boat tours are available now.

It cannot generalize from the above beneficiary result due to the limited samples, but as shown above, it implies that the improvement of water quality of Yangtze and Jialing Rivers has been appreciated by the residents and that the recreation activities such as fishing, swimming and boat tours became available. It is considered that the CMPG's continuous efforts for improving river water quality including this project have contributed to the improvement of sanitary situations and the living environment.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

No particular negative impact on the natural environment has been observed from the data provided by CDC and the EPB, field observation, beneficiary survey, etc.

Regarding the environmental monitoring system, both WWTPs regularly conduct water quality inspection of inlet and outlet wastewater. While there are eight parameters (BOD, COD, TN, NH3-N, TP, pH, SS and coliform) for daily inspection, there are four parameters (oil extracted from animals and plants, petroleum oil, surface-active agent and

chromaticity) for monthly inspection[19]. Water quality after treatment fulfills the national emission standard Grade I-B. Both WWTPs are connected with the major pollutant source monitoring system established by the Environment Model City Project[20], thus major parameters are ready for confirmation at the monitoring center every hour.

[Sludge processing]

Heavy metal content test fulfills the national standards. Some parts of sludge have been re-used as cement materials and fertilizers, others have been filled at the final disposal site properly.

[Odor and noise]

Both WWTPs are located away from the residential areas. According to the beneficiary survey, no negative impact on odor and noise has been observed.

3.3.2.2 Land acquisition and Resettlement

According to the report[21] of the first stage construction by the loan from the World Bank, resettlement and land acquisition went smoothly during the first stage construction, and the compensation for the resettled residents was paid properly. During the second stage construction under this project, there was no resettlement and land acquisition.

3.3.2.3 Unintended Positive/Negative Impact

In Chongqing City, the view of Yangtze and Jialing Rivers itself is a sightseeing resource, thus it is assumed that the water quality improvement of those rivers has also brought economic effects. The CMPG constructed a few kilometers long walking trails and some parks along the rivers. It was also reported that number of boat restaurants and river-view restaurants and observation decks were increasing around the Central Peninsula, which is the intersection of Yangtze and Jialing Rivers, year by year [22]. Although it was not possible to obtain the data which illustrates the water quality improvement of the rivers and the development of sightseeing and food industry, CMPG's continuous efforts for improving water quality including this project and construction of walking trails are considered to

[19] Source: Questionnaire answer from CDC.

[20] The Environment Model City Projects were the loan projects from the Government of Japan as a part of the Environment Model City Framework. The projects were conducted in the cities of Chongqing, Dalian and Guiyang in order to improve environment by implementing air pollution control intensively and building environment monitoring system and then to replicate the successful cases in other cities in the end. In Chongqing, the following sub-projects were carried out between 2000 and 2009: the extension of natural gas supply system, establishment of the pollutants monitoring system and the installation of flue-gas desulfurization (FGD) equipment.

[21] Implementation Completion and Result Report of Chongqing Urban Environment Project (2010).

[22] Source: Interview with CDC.

have supported the development of sightseeing and food industry in Chongqing City.

This project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating:②)

3.4.1 Project Outputs

The scope of this project for the two plants is summarized in Table 15. Outputs were completed as planned, except the facility to accelerate the speed of sludge drying process.

Table 15 Output (Planned and actual)

Items	Plan	Actual
Tangjiatuo with the capacity of 300,000 m^3/day	1) Civil work, procurement of equipment Sludge treatment facility, primary sedimentation ponds, biological reaction ponds, secondary sedimentation ponds, etc. 2) Consulting services a) construction management b) Technical training for wastewater treatment i Transfer of sludge recycling technology ii Transfer of technology required for O&M including water monitoring	As planned
Jiguanshi with the capacity of 600,000 m^3/day	Same as above	Almost as planned except the addition of the facility to accelerate the speed of sludge drying process (Voltage stabilizer, boilers and antiseptic injection facility).

Source: JICA appraisal documents, Questionnaire answer from CDC.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The total project cost estimated at appraisal was 13,747 million yen (of which the Japanese ODA loan amount was 9,017 million yen and the rest was to be locally funded). The actual total project cost was 12,123 million yen (of which the Japanese ODA loan amount was 9,017 million yen and the rest was locally funded), which was 88% of the planned amount. The total cost decreased from the plan due to efficient order placement by competitive bidding.

3.4.2.2 Project Period

The project period exceeded the planned. The planned project period at appraisal was from March 2002 (Loan Agreement signing) to December 2005 (project completion), for a total of 45 months. The actual period was from March 2002 (Loan Agreement signing) to

July 2007 (project completion), for a total of 64 months (142% of the planned period). The reasons for the delay are described below[23]:

1) Delay of procurement procedures by six months due to the prevalence of Severe Acute Respiratory Syndrome (SARS);
2) Sharp rise in material price between 2002 and 2004 required deliberate consideration and counter-measures for design, preparation for bidding process and bidding evaluation, which took approximately one year;
3) During the project implementation period, it was claimed by the landfill plant, which receives sludge from Jiguanshi WWTP, that the WWTP needed to accelerate the speed of sludge drying process in order to prevent secondary contamination. Thus, it required changing the design of sludge processing system and changing the facilities;
4) Due to the special structure of egg-shaped sludge digestion tanks, there was a slight delay in design and civil work; and
5) During the project implementation period, geological conditions required the adjustment of working drawing and contents.

However, the delay during the construction is minimal. One of the reasons is that the Japanese consultant and the local management company conducted construction management properly. According to CDC, as a result of the appropriate construction management, this project resulted in winning the National Good Project Silver Prize in 2007 (Tangjiatuo) and in 2008 (Jiguanshi).

3.4.3 Results of Calculations of Internal Rate of Return (reference only)

Using the same assumptions at appraisal[24], the financial internal rate of return (FIRR) was recalculated as shown in the table below. The reason for the higher FIRR of Tangjiatuo WWTP at the ex-post evaluation than planned could be that the wastewater treatment charge was raised from 0.8 RMB/m^3 to 1.24 RMB/m^3. FIRR of Jiguanshi WWTP was not recalculated due to lack of some data. However, the FIRR of CDC is 10.14%, thus it can be said that there is no problem. The economic internal rate of return (EIRR) was not calculated at appraisal, therefore was not recalculated at the ex-post evaluation.

[23] Source: PCR, JICA documents, Questionnaire answer from CDC and interviews.
[24] The assumption used at the appraisal is that the total project cost and increased operation/maintenance costs during the operation stage, are “costs” and that the income from the wastewater treatment charges is “benefits”, Project life: 20 years.

Table 16 Financial internal rate of return (FIRR)

	At the time of Appraisal	At the time of ex-post evaluation
Tangjiatuo WWTP	8.2%	9.12%
Jiguanshi WWTP	5.5%	NA
Chongqing Drainage Company Overall	NA	10.14%

Source: JICA appraisal document and questionnaire answer from CDC

Although the project cost was within the plan, the project period was exceeded the plan, therefore efficiency of the project is fair.

Photo provided by CDC

Tangjiatuo WWTP (Left: Yangtze River, left egg-shaped facility: sludge digestion tank, right: sedimentation ponds and biological reaction ponds, etc)

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The executing agency was the CMPG, but the implementing agency was CDC, which is a national company established in 1999. In 2001, Chongqing Water Group Co., Ltd. (CWG) consisting of 22 subsidiary companies was established, and CDC became one of those subsidiaries. CWG is one of the eight biggest investment groups in Chongqing City with a market value of 33.5 billion RMB. CWG is responsible for protecting water environment of the middle and lower reaches of the Yangtze River and has been the biggest enterprise group in China that works on water protection of the reservoir of the Three Gorges. CWG operates plants with a daily water supply capacity of 2,030,000 m^3 and a daily wastewater treatment capacity of 2,080,000 m^3 as a group.

Operation and maintenance of Jiguanshi WWTP is managed by CDC. Meanwhile, CWG and Sino French Water Investment Company[25] established Chongqing Sino French Tangjiatuo Wastewater Treatment Co. Ltd. in 2007, and the company is responsible for

[25] Sino French Water Investment Company is a company which merged with French private company.

operation and maintenance of Tangjiatuo WWTP by obtaining management right from the CMPG. Number of staff of the two WWTPs is summarized in Table 17.

Table 17 Number of staff by position

Unit: persons

Position	Chongqing Drainage Company	Jiguanshi WWTP	Tangjiatuo WWTP
Manager	5	0	12
Senior Engineer	14	2	3
Engineer	27	4	6
Technical staff	50	4	30
Technician	5	2	3
Skilled worker	191	88	46
Total	292	100	95

Source: JICA appraisal document and responses to the questionnaire

Note 1: Because Tangjiatuo WWTP is managed by Chongqing Sino French Tangjiatuo Wastewater Treatment Co. Ltd., the managers are different from the managers of CDC. 3 senior engineers and 2 engineers also functions as managers.

Note 2: Tangjiatuo WWTP include foreign staff.

In light of the above, no major problem has been observed in the operation and maintenance system. It can also be said that the number of staff required for operation and maintenance has been ensured.

3.5.2 Technical Aspects of Operation and Maintenance

The number of operation and maintenance staff by position is shown above. It was confirmed through the interview with CDC that the contents of the training on wastewater treatment technology which was conducted under this project was appropriate and that operation and maintenance has been carried out without major problems since operation partly because of the training. The regular training by the implementing agencies includes safety production, quality control, wastewater treatment regulations, company management system and finance. Training is conducted not only at the WWTPs, but also at the training center of CWG and that of Chongqing Sino French Tangjiatuo Wastewater Treatment Company. CWG was awarded as one of the top ten companies at the national wastewater treatment operation inspection in 2008. Jiguanshi WWTP was also awarded as one of the national top ten wastewater treatment plants[26].

As mentioned above, training contents and training opportunities are sufficient; operation and maintenance has been managed without major problems since operation; CWG and Jiguanshi WWTP have received nation-wide high reputation for their performances; Tangjatuo WWTP has been making continuous efforts to improve

[26] Source: Introduction of Jiguanshi WWTP.

wastewater treatment technology by its cooperation with a French company, which invests in Sino French Water Investment Group. Thus, it can be said that both WWTPs have necessary technical capacities in operation and maintenance.

3.5.3 Financial Aspects of Operation and Maintenance

Both at the time of appraisal and at the ex-post evaluation, wastewater treatment charges have been collected together with the water charges by the CMPG. Wastewater treatment tariff in Chongqing City are shown in Table 18. Wastewater treatment tariff has been revised together with water tariff, and the range of its increase has been almost as planned. In addition, according to the beneficiary survey, 92% respondents answered that the tariff was reasonable. Thus, it can be said that the tariff is reasonable.

Table 18 Wastewater charges in Chongqing City

unit: yuan /m^3

Category	Plan for 2005 (Project Completion)	Plan for 2010	2006 Actual	2007-2009 Actual	2010- Up to present Actual
Household	0.8	1.5	0.6	0.7	1.0
Commerce			0.9	1.0	1.3
Industry			0.9	1.0	1.3

Data source: Questionnaire Answer from CDC.

At the time of appraisal, it was planned that the CMPG allocated necessary expenses for operation and maintenance to each WWTP and that the CMPG provided subsidies in case of lack of funding. After the project completion in 2007, it changed that charges were paid by unit in accordance with the amount of treated wastewater. Under the contract between the CMPG and CDC, the unit price for wastewater treatment is 3.25 yuan m^3/day. It made possible for CDC to allocate the revenue not only for operation and maintenance cost but also for future investment in facilities.

Table 19 shows the financial situation of CDC. After the project completion in 2007, gross revenue and profit increased due to the above reason and the increase of treatment amount.

In addition, taking the opportunity of the above change of pricing method, CDC has been making efforts for business improvement such as streamlining of operation work and cost cut, which resulted in an increase of profit. Thus, no major problem has been observed in terms of financial sustainability. Financial statement of Chongqing Sino French Tangjiatuo Wastewater Treatment Company could not be obtained.

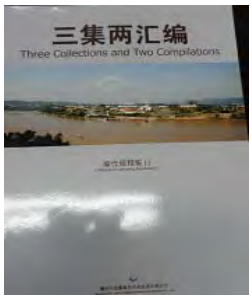
Table 19 Financial situation of Chongqing Drainage Company

Item	2006	2007	2008	2009	2010
Gross revenue	202.63	639.49	761.39	785.37	824.13
Selling, general and administrative expenses	202.31	261.63	406.59	314.21	405.99
(Operation and maintenane cost)	103.5	138.9	273.81	185.86	269.76
Operating profit	0.32	377.86	354.8	471.16	418.14
Total assets	3211.95	3394.84	3655.85	3600.47	3595.4
Current assets	338.11	875.05	1014.95	991.65	1069.27
Non-current assets	2873.84	2519.79	2640.9	2608.82	2526.13
Current liabilities	208.49	117.6	94.87	57.48	50.12
Shareholder's equity	1285.09	1268.63	1271.63	1271.63	1591.77
Liabilities	1926.86	2126.21	2384.22	2328.84	2003.63

Data source: Questionnaire Answer from CDC.

3.5.4 Current Status of Operation and Maintenance

According to the degree of difficulty in operation and maintenance, equipment is categorized into three types: important equipment, major equipment and general equipment. Operation and maintenance plans have been formulated respectively for each category. It was confirmed during the evaluator's field visit that the facilities of both WWTPs were organized and maintained well. Manuals have also been developed well. Major handbooks and manuals confirmed during the field visit are listed below.



Tangjiatuo WWTP operation manual

Jiguanshi WWTP operation regulation, handbooks, etc.

Tangjiatuo WWTP: regulations/system manual, operation manual, emergency response manual, operation flow chart and record formats.
Jiguanshi WWTP: Staff handbook, safety production handbook, facility safety operation regulations and operation safety regulations.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Government of China and the CMPG gave priorities to water pollution control of Yangtze River and its tributary, Jialing River, and have undertaken various actions. This project was implemented as a part of such efforts. In Chongqing City, due to rapid urbanization and industrialization, domestic and industrial wastewater increased, thus water contamination was worsened. In addition, as Three Gorges Reservoir is located in the downstream of Yangtze River, it was urgent and highly necessary to improve the water quality of the rivers by constructing wastewater treatment facilities. The following expected effects have been observed almost as planned: the increase of wastewater treatment capacity, reduction in pollutants emission, improvement of quality of treated water, improvement of water quality of the rivers in the city. These effects have been contributing to the enhancement of the living standards of the residents along the rivers. Therefore, the effectiveness and impact is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, 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 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

None.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Output 1) Civil work, procurement of equipment 2) Consulting services	Tangjiatuo with the capacity of 300,000 m^3/day and Jiguanshi with the capacity of 600,000 m^3/day Sludge treatment facility, primary sedimentation ponds, biological reaction ponds, secondary sedimentation ponds, etc. a) construction management b) Technical training for wastewater treatment i Transfer of sludge recycling technology ii Transfer of technology required for O&M including water monitoring	Tangjiatuo: As planned. Jiguanshi: Almost as planned except the addition of the facility to accelerate the speed of sludge drying process (Voltage stabilizer, boilers and antiseptic injection facility). As planned.
2. Project Period	March 2002-December 2005 (45 months)	March 2002-July 2007 (64 months)
3. Project Cost Foreign currency Local currency Total Japanese ODA loan Exchange rate	 9,017million yen 4,730million yen (315million yen) 13,747million yen 9,017million yen 1yuan=15Japanese Yen (As of September 2001)	 9,017 million yen 3,106million yen (218 million yen) 12,123 million yen 9,017 million yen 1yuan=14.28yen (Average between March 2002 and July 2009)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

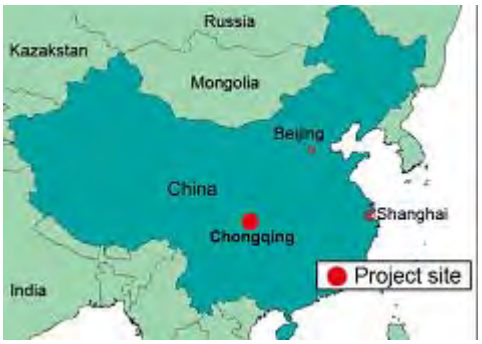
"Chongqing Environment Model City Project (1) (2)"

External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

Environment Model City Projects were implemented in Chongqing, Dalian and Guiyang in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework[1]", which was aiming to replicating the good practices of the projects in other cities in China. As Chongqing City's energy structure depends on coal, the City was facing serious air pollution along with recent rapid industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control and in building an environmental monitoring system. As a result of the implementation of this project, the following indicators have been achieved: reduction in air pollutants emission amount, desulfurization efficiency of Flue-Gas Desulfurization (FGD) and operating hours of the monitoring system, thus, it can be said that expected effects have been observed almost as planned. In addition, these effects have contributed to the improvement of the living environment by betterment of air quality and to the enhancement of the environmental management capacity. Therefore, effectiveness and impact of this project is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agencies of each sub-project. Financial situations are also stable. 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

Toutong Natural Gas Station

[1] The framework was proposed at the Japan-China Summit in 1997.

1.1 Background

In China, along with steady economic growth since 1980's, environmental pollution had been worsened due to industrialization and population growth. Particularly, emission of Sulfur Dioxide[2] (SO_2), Total Suspended Particular[3] (TSP) and Nitrogen Oxide[4] (NOx) was serious due to the burning of coals as industrial materials, power generation and heating materials. As a result, density of SO_2 and TSP of the major cities in China was too high to meet the national environment standards. The target area of this project, the urban areas in Chongqing City, also faced serious air pollution problems along with industrialization and the increase of the number of automobiles. Due to the energy structure, which depends on coals, and the industrial structure, which mainly consists of heavy chemical industry, air pollution was worsened by gas emission from coal burning. SO_2 density exceeded the National Environment Ambient Air Quality Standards Grade II[5] (hereinafter refers as the National Standards Grade II) considerably. Under this circumstance, Chongqing City was selected as one of the model cities of "Environment Model City Framework", then this project was implemented.

1.2 Project Outline

The objective of this project is to improve the air quality in Chongqing City[6], by following five sub-projects: 1) Chongqing Natural Gas Transmission and Distribution Extension Project (hereinafter refers as the natural gas supply sub-project); 2) Natural Gas Filling Stations Project; 3) Major Pollutant Sources Monitoring and Control Project (hereinafter refers as the major pollutant sources monitoring system sub-project)[7]; and 4) Chongqing Jiulong West Power Plant Desulfurization Project; thereby contributing to the improvement of the environment of Chongqing City. The location of the project site is shown in Figure 1[8].

---

[2] SO_2 is one of the major air pollutants. It is generated by burning the fuels including sulfur such as coal or oil. SO_2 is one of the causes of acid rain.

[3] TSP is particulate matter which is less than 100 micron in diameter. Smoke dust is one of the smokes. It is solid particulate matter such as soot and burned embers.

[4] Nitrogen Oxide is one of the pollutants which are generated by burning of coals or traveling of vehicles. It is one of the causes of photochemical smog.

[5] These current standards were raB3095-1996). The standards were divided into three grades and Grade I is the stricter standards. Grade I standards are applied for natural conservation area. Grade II standards are applied for commercial, residential and agricultural and general industrial areas. Grade III standards are applied for special industrial area.

[6] It was recorded that the central area in Chongqing City was the "model area" in the JICA appraisal documents. However, some parts of the major pollution sources monitoring and control project are located in the suburbs. Since the JICA appraisal documents and the Minutes of Discussion also set "Chongqing City" as the target area, this study also follows this definition.

[7] The monitoring sites include the main pollution sources such as chemical factory, power plants and wastewater treatment plants. The system consists of monitoring centers and monitoring facilities for waste air and waste water. For more details, see the section of "Efficiency".

[8] As the major pollution sources monitoring system sub-project covers the whole model area, its location are not shown in the map. The natural gas supply sub-project also covers the whole model area, but its gas storage

Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	(I) 4,412million yen / 4,257million yen (II) 3,289million yen / 876 million yen
Exchange of Notes Date / Loan Agreement Signing Date	(I) March 2000 / March 2000 (II) March 2001 / March 2001
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Chongqing Municipal People's Government
Final Disbursement Date	(I) December 2009, (II) April 2007
Main Contractor (Over 1 billion yen)	China National Precision Machinery Import and Export Corp.
Main Consultant (Over 100 million yen)	NA
Feasibility Studies, etc.	Feasibility Studies were conducted as follows. Natural Gas Filling Stations: Chongqing Steel Design Institute, April 2000. Chongqing Power Station FGD: West South Power Design Institute, November 1999. Monitoring System: Chongqing Architecture University Architecture Design Institute, August 1999 Natural Gas (Station): China Municipal Central North Design Research Institute, 2000-2001. Natural Gas (Pipes): Zhongxing Group, International Engineering Group and Chongqing Design Institute. Natural Gas (Automatic control): Chongqing Automatic Institute, 2000-2001. SAPROF was conducted for the monitoring system in March 2000.

stations only are shown in the map. As the natural gas filling stations sub-project was cancelled, its location is not shown in the map.

Related Projects	Osaka City has carried out technical cooperation regarding the high level of natural gas with Chongqing City, and this project was implemented based on the above cooperation. In addition, in responding to the needs of Chongqing City, Osaka City also conducted joint study on the gas supply technology such as automatic supply, industrial combustion technology such as boilers and detection technology for gas leakage.

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August, 2011 to September, 2012

Duration of the Field Study: November, 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

Among the sub-projects, the natural gas supply sub-project aimed at reducing air pollutants emission by promoting the project of converting small and medium-sized boilers in the urban areas to natural gas[9]. However, the conversion project was out of scope of this project, and it has passed long time since the completion of the conversion project. Thus, it was not possible to confirm by reports the actual figures of small and medium-sized boilers which had been converted, and the precise date of the project completion. Therefore, the sub-project was evaluated by confirming JICA internal documents and interviewing with the responsible person in Chongqing Environmental Protection Bureau (CEPB).

3. Results of the Evaluation (Overall Rating: A[10])

3.1 Relevance (Rating: ③[11])

3.1.1 Relevance with the Development Policy of China

3.1.1.1 Development Policy at the time of appraisal

At the time of appraisal (2000), China's 9th Five-Year Environmental Protection Plan (1996-2000) set the following specific objectives: decrease in the major pollutants emission to the level of 1995; and achieve the emission standards at industrial pollution sources. The Government of China introduced the concept of "SO_2 pollution control area" and "acid rain

[9] At the time of planning, it was also considered to include the conversion project into the scope of this project, but the conversion project was deleted from this project for the following reasons: as medium-small boilers are scattered in wide range, it takes long time; as the owners of medium-small boilers are small enterprises, the conversion project does not match with the loan project. Source: JICA appraisal documents.

[10] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[11] ③: High, ②: Fair, and ①:Low.

control area" [12] by the revision of air pollution control regulations in 1995[13], and took intensive actions by designating those areas in 1998. In order to take further actions for the improvement of environment, the current 10th Five-Year Environmental Protection Plan (2001-2005) targeted reducing the emission of major pollutants by 10% compared with the year of 2000; and decreasing the total SO_2 emission amount in the above two pollution control areas by 20% compared with the year of 2000.

The Chongqing's 9th Five-Year Environmental Protection Plan (1996-2000) and the Long-term Plan towards 2010 targeted the achievement of the National Standards Grade II by 2005 regarding the annual average air pollution density. The target values are as shown below.

Table 1 Target of annual average of air pollution density in Chongqing City

Unit: mg/m^3

Pollutants	National Standards II	Year 2000	Year 2005	Year 2010
SO_2	0.06	0.15	0.06	0.06
TSP	0.20	0.25	0.20	0.20
NOx	0.05	0.07	0.05	0.05

Source: JICA appraisal documents

In order to achieve the above targets, the following specific directions were announced: 1) enhancement of the clean combustion technology and combustion facilities; 2) promotion of natural gas usage as domestic fuel; and 3) promotion of the FGD projects.

3.1.1.2 Development Policy at the time of ex-post evaluation

The 11th Five-Year National Environmental Protection Plan (2006-2010) targeted reducing SO_2 emission by 10%. The current 12th[t] Five-Year National Environmental Protection Plan (2011-2015) set the goal of reducing SO_2 emission by 8% as a binding objective[14]. While the national target of reducing SO_2 emission by 10% in the 11th Five Year Plan was equivalent to 22.94 million tons, the national target of reducing SO_2 emission by 8% in the 12th Five Year Plan was equivalent to 20.86 million tons. For example, in order to achieve those targets,

[12] SO_2 pollution control area is the area of serious contamination of SO_2. Acid rain control area is the area where acid rain occurs or where there is a possibility that acid rain will occur in the future.

[13] The basic framework of air pollution control in China is regulated by Air Pollution Action Law. It was enacted in 1987, and it was revised in 1995 and 2000. The basic principle of controlling air pollutants emission is regulating the density of air pollutants at pollution sources. The State Council established the national environmental air quality standards and established national emission standards accordingly in order to achieve the air quality standards. The local government has a right to establish local standards for the parameters which the state government has not established and to establish local standards which are stricter than the state government.

[14] Binding objectives have legal effects unlike predictive objectives. The 11th Five Year Plan introduced the concept of biding objectives for the first time.

specific targets were set for each province. In Chongqing City, the following objectives were set: reducing from 837,000 to 737,000 (by 11.9%) in the former plan and reducing from 609,000 to 566,000 (by 7.1%) in the latter plan.

Chongqing's 11th Five-Year Environmental Protection Plan (2006-2010) set the following objectives: 290 days per year in achieving the National Standards Grade II; reducing the emission of SO_2, smoke and dust; and strengthening the control of gas emission from automobiles. With respect to natural gas supply, the following specific goals were set: increasing the annual usage from 3.6 billion m^3 in 2005 to 7.8 billion by 2010; and increasing the natural gas consumption ratio in all the energy consumption from 14.2% to 20%. The current Chongqing's 12th Environmental Protection Plan (2011-2015) further strengthened environmental policies and set the following targets: achieving the National Standards Grade II in terms of the annual average air pollution density of major pollutants; 311 days per year in achieving the National Standards Grade II; and keeping the acid rain frequency per year within 45%.

3.1.2 Relevance with the Development Needs of China

At the time of appraisal, the central areas in Chongqing City faced serious air pollution problems along with industrialization and the increase of the number of automobiles. Due to the heavy dependency on coals as energy sources and the industrial structure in which heavy chemical industry is dominant, air pollution by waste gas from coal burning became serious, thus SO_2 density exceeded the National Standards Grade II significantly. As the urban areas[15] and some counties of Chongqing City were designated as acid rain control areas in 1998, CPMG reinforced its pollution control actions. Prior to this, CMPG enacted the "law of SO_2 pollution control along with coal burning in Chongqing City" in 1997. By this law, it became compulsory for the power plant, which uses coals with more than one percent of sulfur, to reduce SO_2 by installing FGD facility or by other means. In particular, the Chongqing Jiulong Power West Plant under this project was next to the residential areas, thus it was desired to reduce SO_2 and TSP.

Meanwhile, Chongqing City is rich in natural gas resources. At the time of appraisal, the annual natural gas production amount by China National Petroleum Corporation was 3.654 billion m^3. Among them, a total of 2 billion m^3 (1.4 billion for industrial large consumer and 0.6 billion for the urban domestic gas) was supplied to Chongqing City, and a total of 1.654 billion m^3 was supplied to Sichuan and Yunnan Provinces. Although the 9th

[15] The districts such as Yuzhong, Zhanbei, Shapingba, Nan'an, Jiulongpo, Dadukou, and Yubei.

Chongqing Five Year Plan aimed promoting gas for domestic use, the gas supply capacity in the urban areas was merely 0.6 billion m^3 per year, thus it needed to expand its supply capacity. Moreover, CMPG enacted Clean Auto Action Article 13 of the Science Technology Commission, which made it compulsory for all the buses and taxies in the urban area of Chongqing City to be natural gas vehicles by the end of 2001. Therefore, it became an urgent issue to build efficient storage and supply system of natural gas.

At the same time with implementing air pollution control actions intensively, strengthening environmental management capacity was also urgently needed. In 2003, disposal fee collection, use and management ordinance (State Council Order 369) was introduced. In order to calculate the disposal fee properly and swiftly, it became more necessary to measure pollutant emission amount properly and rapidly by building major pollutant sources monitoring system and others.

Even after the appraisal, due to urbanization and economic development, the demands for air pollution control actions have been increased. Online monitoring systems, which were not obligatory at the time of appraisal, are obligatory in each province/city at present.

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, the Operational Policy for the Overseas Economic Cooperation of the Japan International Cooperation Agency (JICA, former JBIC) set environmental issues as one of the priority areas for loan projects for China. In addition, the Operational Policy of JBIC for China also regarded the environmental issues in China as global issues, thus announced its policy of focusing on lending support to China through air pollution control actions. The Economic Cooperation Policy of the Government of Japan towards China (2001) gave priorities to environment issues, poverty reduction and social development in inland areas, human resource development, legal system, and technical transfer. Among them, assistance cooperation for responding to global issues such as environmental issues was one of the top priorities.

Moreover, this project was implemented based on the "Environment Model City Framework" which was launched at the Japan-China Summit between then-Prime Minister Ryutaro Hashimoto and then-Prime Minister Li Peng in 1997. Thus, this project was highly consistent with the Japan's ODA policy. In the selection process of the model cities, serious air pollution situations (Chongqing City and Guiyang City) and past experiences of cooperation between Japan and China (Dalian City) were taken into account.

This project has been highly relevant with China's development plans, development needs, as well as Japan's ODA policies; therefore, its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators

(1) Air pollutants emission and reduction amount

[Chongqing Natural Gas Supply Project]

This natural gas supply sub-project aimed at reducing air pollutants emission by promoting the project of converting small and medium-sized boilers in the urban areas to natural gas (the latter is out of the scope of this project). Therefore, this study reviewed whether this project and the conversion project were carried out as planned. Table 2 shows the plan and actual of emission amount of air pollutants. Table 3 shows coal consumption amount by each energy source before and after the boiler conversion projects and the emission amount of SO_2, TSP and NOx, which are the breakdowns of Table 2.

Table 2 Emission amount of air pollutants from small-medium boilers in the urban areas in Chongqing City (Baseline/Plan/Actual)

Unit: ton/year

Indicators	Baseline	Plan after the project completion	Actual after the project completion
	Year 2000	Year 2003	Year 2001
SO_2	274,000	194,980 (-79,020)	194,980
TSP	43,000	29,830 (-13,170)	29,830
NOx	32,100	27,470 (-4,630)	27,470

Source: Baseline and plan are from JICA appraisal documents.Actuals are from interview with CEPB.
Note: The figures in ( ) shows the estimated reduction amount to be achieved through the small-medium boilers conversion project, which are promoted by this sub-project.

Table 3 Coal consumption amount by each energy source before and after the boiler conversion projects and the emission amount of SO_2, TSP and NOx in the urban areas in Chongqing City

Unit: ton/year (excluding the numbers of boilers)

Project		Large scale boiler conversion project	Small-medium boiler conversion project				
Item		>10t/h Boiler	Boiler with less than10t/h	Tea boilers	Cooking boilers	Households	Total
Numbers		30	1,153	1,500	18,500	180,000	
Coal consumption amount	Before Project	3,013,000	867,000	197,000	179,000	144,000	4,400,000
	After Project	0	0	0	0	36,900	36,900
	Reduced Amount	3,013,000	867,000	197,000	179,000	107,100	4,363,100
SO2	Before Project	191,000	49,000	13,100	11,600	9,300	274,000
	After Project	0	270	40	1,210	2,460	3,980
	Reduced Amount	191,000	48,730	13,060	10,390	6,840	270,020
TSP	Before Project	28,900	7,500	2,500	2,300	1,800	43,000
	After Project	0	120	20	260	530	930
	Reduced Amount	28,900	7,380	2,480	2,040	1,270	42,070
NOx	Before Project	25,700	5,300	600	260	240	32,100
	After Project	0	1,460	190	40	80	1,770
	Reduced Amount	25,700	3,840	410	220	160	30,330

Source: Compiled based on the JICA appraisal documents.

As this sub-project was completed as planned (see the outputs in the section of efficiency) and the small-medium boiler conversion project was completed in June 2001[16], it can be judged that the targets have been achieved. However, as noted in the section of "Constraints during the Evaluation Study", it was not possible to verify by reports the actual figures of small and medium-sized boilers which had been converted and the precise date of the project completion. Therefore, this sub-project was evaluated by reviewing JICA internal documents and by interviewing with the responsible person in CEPB. At the time of appraisal, this project incorporated the effects of the small-medium boilers (10t/h and less than 10t/h) conversion project only in its assumption. However, beyond the assumption, the large scale boilers (more than 10t/h) conversion project was also completed by 2006[17], and the number of natural gas served households increased from 560,000 to 2,600,000. This suggests that air pollutants have been reduced more than the original targets of this project.

[Chongqing Jiulong West Power Plant Desulfurization Project]

Baseline, plan and actual of the SO_2 emission amount are shown in Table 4. Power generation amount, which affects SO_2 emission amount, is also indicated in the same table for reference.

Table 4 Power generation amount and SO_2 emission amount (Baseline/Plan/Actual)

Unit : GWh for power generation amount and ton/year for SO_2

Indicators	Baseline (Note 1)	Plan after project completion (Note2)	Actual						
			2005	2006	2007	2008	2009	2010	2011
Power generation amount (Reference only)	1,163	1,000～1,200	1,152	1,224	1,049	814	975	1,060	1,203
SO2 emission amount	40,000	2,000(-38,000)	23,064	8,052	4,129	4,055	4,242	3,709	2,921

Source: Baseline and planned figures are from JICA appraisal documents. Actual figures are from the Questionnaire answer of Chongqing Jiulong Power Corporation.

Note 1: Annual power generation amount is the actual in 1997. SO_2 emission amount is the actual in 2000.

Note 2: Power generation amount is the demand forecast. The figures of SO_2 in ( ) shows the reduced amount, which was calculated based on the assumption that limestone-plaster FGD.

Power generation amount was almost as planned except that the demand was decreased in 2008 and 2009. The reason why the SO_2 emission amount was high in 2005 and 2006 was because the FGD facility was in a test operation and adjustment. The SO_2 emission amount remained at the level of approximately 4,000 tons/year between 2007 (two years after the project completion) and 2010. Although it did not reach the target of 2,000 tons/year, the reduction amount from the baseline was 36,000 tons/year, which

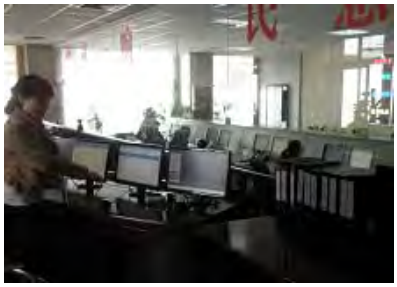
[16] Source: JICA internal documents.

[17] Source: interview with CEPB.

was equivalent to 95% of the plan (36,000 tons/year divided by 38,000 tons/year). Furthermore, the SO_2 emission at the time of ex-post evaluation in 2011 was 2,921 tons/year and its reduction amount from the baseline was 37,079 tons/year, which was equivalent to 97% of the plan (36,000 tons/year divided by 38,000 tons/year). In light of the above, the target has almost been achieved[18]. Meanwhile, compared with the time of appraisal, SO_2 emission standards became stricter. While the emission standards in 2001 were 8,250 tons/year, the standards in 2011 were 4,000 tons/year. The SO_2 emission amount in 2011 met the current standards, thus it can be said that there is no concern.

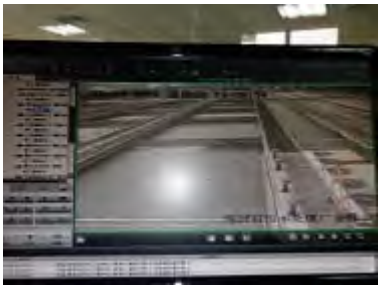
(2) Operating hours of the major pollutant sources monitoring system

The major pollutant sources monitoring system has been operating as planned for 24 hours throughout the year, in total of 8,760 hours/year, except the outage time due to maintenance[19]. The responsible agency of the system is CEPB. Operation and maintenance of the monitoring system (O&M of network and transmission facilities and data collection) has been managed by the Chongqing City Environmental Protection Intelligence Center (sub-ordinate of CEPB). Daily check, cleaning, calibration and repair of the monitoring equipment of each major pollutant source are outsourced to Chongqing Jiaxing Environmental Engineering Co. Ltd. (for details of the outputs, see the section of efficiency).



Central Monitoring Center

Major pollutant sources and monitoring items



Real-time picture of camera at Jiguanshi Wastewater Treatment Plant

[18] Initially, TSP emission reduction amount was also established as an effective indicator of this project. However, it was confirmed from the JICA appraisal documents and the interview with Jiulong Power Corporation that the dust removers, which are the pre-conditions for TSP reduction, were included neither in local portion nor in foreign portion of this project. Therefore, this study did not include the TSP emission reduction amount into the scope of evaluation.

[19] Source: Questionnaire answer from CEPB.

(3) Efficiency of FGD at the Chongqing Jiulong West Power Plant

Table 5 shows the baseline and planned figures of FGD efficiency at the Chongqing Jiulong West Power Plant. The FGD efficiency was between 89.5% and 94.5% between the project completion in 2005 and the ex-post evaluation in 2011. It was slightly below the target (95% or above). However, since 2005, the Plant has kept more than 90% of the target consecutively. The FGD efficiency in 2011 was also 96% (91.4% divided by 95%). Hence, it can be judged that the target has been almost achieved.

Table 5 FGD efficiency (Plan and Actual)

Unit: %

Indicator	Plan after project completion	Actual						
		2005	2006	2007	2008	2009	2010	2011
FGD efficiency	95.0% or above	94.5	91.9	91.4	92.0	89.5	91.3	91.4

Source: Questionnaire answer from Chongqing Jiulong Power Corporation.

Chongqing Jiulong Power Plant West Plant

FGD facility

Central control room

3.2.2 Qualitative effects

3.2.2.1 Increase of natural gas supply and number of service population

It was confirmed that the supply amount of natural gas and the number of households receiving natural gas from Chongqing Gas Group Co., Ltd. (former Chongqing Gas Co., Ltd.) were increased by this project and others, although these were not established as effective indicators of this project. The planned and actual supply amount and the number of service households are shown in Table 6 and 7. The supply amount was increased by 3.3 times between 2001 and 2010. The number of households receiving natural gas was increased by 4.9 times, and the number of public facilities and factories receiving natural gas was increased by 9.2 times in the same period.

Table 6 Natural gas supply amount (Baseline/Plan/Actual)

Unit: m^3 /year

	Baseline (2001)	Plan (Project Completion)	Actual (2010)
Supply amount	About 583 million	About 1,554 million	About 2 billion

Source: Baseline is from JICA appraisal documents. Actual is from the data provided by Chongqing Gas Group.

Table 7 Households/facilities which receive natural gas (Baseline/Actual)

Unit: number

	Households		Public facility, commercial facilities & factories	
	Baseline (2001)	Actual (2010)	Baseline (2001)	Actual (2010)
Number of households	About 530,000	About 2,600,000	6,505	About 60,000

Source: JICA appraisal documents for the plan. Data provided by Chongqing Gas Group for the actual.

In addition, Chongqing Gas Group has also provided some service stations with natural gas. At the time of appraisal, there were only nine service stations in Chongqing City. Since it became compulsory for taxis and buses to use natural gas in 2001, there are more than 70 gas service stations in Chongqing City at the time of ex-post evaluation[20].

Filtration machine at Toutong Gas Storage Station

Natural gas supply status shown in the Supervisory Control And Data Acquisition (SCADA) system[21] (supplied areas are shown in red)

Fixed route bus run by natural gas in Chongqing City (Out of the scope of this project)

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of air quality in Chongqing City

According to the National Standards Grade II which has been applied since 1996 to the present, the limit value of average density of pollutants such as SO_2, TSP and NOx, which were set as the effect indicators for this project at the time of appraisal, is regulated. Not only these parameters, but also the limit value of the average density of Particulate Matter less than 10 micron[22] (PM10) and Nitrogen Dioxide (NO_2) is also regulated by the National Standards Grade II. Similar to other cities in China, the CPMG monitors mainly PM10 and NO_2 instead of TSP and NOx. The data obtained during this study was that of SO_2, PM10 and NO_2. Table 8 illustrates the baseline, plan and actual of SO_2, TSP, PM10,

[20] Source: Interviews with Chongqing Gas Group. Gas service stations have been operated by a few companies such as China Petro, China Petro Chemicals and Chongqing Gas Group/ Chongqing City Public Transportation Group.

[21] A centralized monitoring and control system for geographically distributed systems such as natural gas pipeline system.

[22] PM10 is the particulate whose trapping efficiency becomes 50% in the ten micron of aerodynamic diameter. It is the definition is generally used worldwide.

NOx and NO_2.

As shown in Table 8, the annual average density of air pollution in 1999 was recorded as the baseline data in the JICA appraisal documents. However, it is unknown whether the baseline data was that of the whole Chongqing City or that of the urban areas of the City. At the time of ex-post evaluation, the data obtained from the CEPB is the annual average air pollution density of the urban areas of the City. Thus, it is not possible to compare simply. Considering these, this study compares the plan (National Standards Grade II) and the actual data of SO_2, PM10 and NO_2 in the urban areas of the City.

Table 8 Annual average density of air pollution in the urban areas of Chongqing City (Baseline/Plan/Actual)

Unit: mg/ m^3

Indicators	Chongqing City (Baseline)	Plan (National Standards Grade II)	Urban areas in Chongqing City (Actual)			
	1999	2005/2010	2005	2009	2010	2011
SO2	0.171	0.060	0.073	0.053	0.048	0.038
TSP	0.204	0.200	NA	NA	NA	NA
PM10	NA	0.100	0.120	0.105	0.102	0.093
NO_X	0.062	0.050	NA	NA	NA	NA
NO2	NA	0.040	0.048	0.037	0.039	0.032

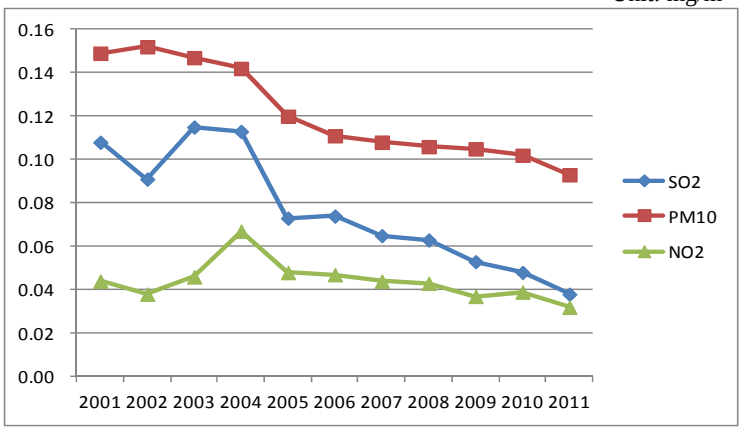
Source: Baseline and plan are from the JICA appraisal documents. Actuals are from Chongqing Municipality State of the Environment and the data provided by CEPB.

Note: The figures for the plan are those of the target in the 9th Five-Year Chongqing Environmental Conservation Plan (1996-2000) and the Long-term Plan for 2010.

The 9th Five-Year Chongqing Environmental Protection Plan (1996-2000) and the Long-term Plan for 2010 aimed at the achievement of the National Standards Grade II by 2005 through the environmental improvement actions including this project. As Table 8 shows, as of 2005, all the parameters of SO_2, PM10 and NO_2 did not achieve their targets. However, in 2009 when the project was completed, SO_2 and NO_2 reached their targets. In 2011, two years after the project was completed, PM 10 also reached its target.

Figure 2 shows the changes of annual average air pollution density between 2001 and 2011. As the Figure shows, the density of SO_2 and NO_2 was increasing between 2002 and 2004, but since 2005, it has been decreasing. The density of PM10 remained on the same level between 2001 and 2004, but it has been decreasing since 2005.

Unit: mg/m^3



Source: Chongqing Municipality State of the Environment and the data provided by CEPB.

Figure 2 Annul average density of air pollution in the urban areas of Chongqing City (Actual)

The number of days per year in which the National Standards Grade II was achieved is shown in the table below, although this was not established as an indicator for this project. The Chongqing's 11th Five Year Plan (2006-2010) set a goal of achieving 290 days per year, and it has been met every year since 2008. The target of the 12th Five Year Plan (2011-2015) was 311 days per year, and it was met in 2011.

Table 9 Number of days in which the National Standards Grade II were achieved

Unit: days

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of days	207	221	238	243	266	287	289	296	303	311	324

Source: Chongqing Municipality State of the Environment and the data provided by CEPB.

In light of the above, it can be judged that the air quality in the urban areas in Chongqing City has been improved. However, as this project includes only two sub-projects for reducing air pollutants in the urban areas, this project's direct quantitative contribution to the air quality improvement is considered to be limited. Regarding the degree of contribution of this project to the improvement of air quality, "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC), it was estimated that the reduction amount of SO_2 by this project (approximately 114,000 tons) accounted for 10.8 % of the total SO_2 emission amount (approximately 1,050,000 tons) in Chongqing City in 2003. However, each sub-project made an important role which cannot be measured quantitatively. Chongqing Jiulong Power West Plant is a small-scale plant, but in light of

the significance of air quality improvement in the urban area, FGD was installed at this plant for the first time except one among the 30 plants in Chongqing City, thereby contributing to the reduction of SO_2 particularly in the urban area. Similarly, it is assumed that the natural gas supply sub-project has contributed to reducing SO_2 and TSP not only through the medium-small boilers conversion project, but also through providing natural gas steadily for taxi and buses, which have been obliged to utilize natural gas since 2001.

3.3.1.2 Perception of air quality improvement by residents in Chongqing City

Beneficiary surveys were conducted for 100 people [23]: 50 residents in Huangjiaoping Area in Jiulongpo District near the Chongqing Jiulong Power Plant West Plant and 50 residents and taxi drivers in Shapingba District.

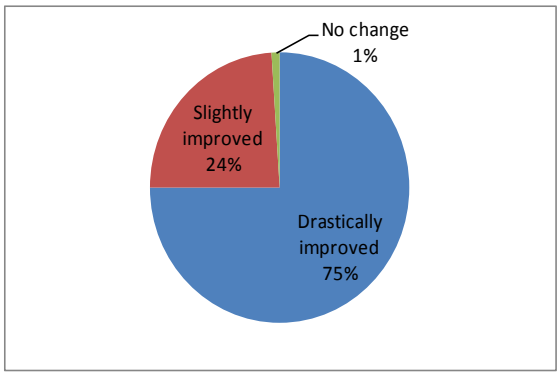


Figure 3 Perception of citizens about the improvement of air quality (N=100)

According to the survey, 75% of the respondents answered that the air quality has improved significantly; 24% answered that the quality improved slightly; and 1% answered there was no change. There was no respondent who answered "aggravated". Regarding the perception of the timing of improvement, 27% of the respondents answered that the air quality has started to improve in 2005; 51% in 2006 and 11% in 2007. To summarize, about 90% of the respondents answered that the air quality had started to improve between 2005 and 2007. This period coincides with the timing when the annual average air pollution density in Chongqing City fell down.

The following reasons for air quality improvement were identified by the beneficiary respondents (multiple answers allowed): decrease in the utilization of coals at households (63%), relocation of factories to the suburbs (60%); decrease in the utilization of coals at factories (42%); government's regulations on factories for pollutant emissions (35%); control of pollutant emissions by advanced technology (32%); control on the gas emission from automobiles (7%). The reason why 63% of the respondents identified the decrease in the utilization of coals at households as one of the reasons for air quality improvement is because natural gas has been widely used by now.

[23] 21 respondents own gasoline-vehicles, 14 respondents own natural-gas vehicles, 65 respondents do not own vehicles. There was nobody who owns hybrid vehicles. The natural-gas vehicles owners are drivers of taxis and buses.

3.3.1.3 Enhancement of the living environment by improving air quality

The followings were raised as effects of air quality improvement (multiple answers allowed): dirt on clothing by dust has decreased (61%); dry clothing outside became possible (45%); sore eyes and coughing has decreased (10%); and use masks and sunglasses for protecting from dust less than before (1%).

3.3.1.4 Enhancement of the environment management capacity of the administration

Based on the regulation for the disposal fee collection, usage and management in 2003, CMPG issued the Chongqing Environment Protection Regulation in 2007, which decided to impose penalties on a daily basis based on the monitoring data when enterprises discharge pollutants beyond the emission standards. This project has contributed to the advancement of the environmental monitoring capacity by building the automatic monitoring system of major pollutant sources. At the same time, it has also made possible to utilize the real-time objectively monitored data for collecting disposal fees and to utilize emission data for environment administration. Before introducing the above system, monitoring staff used to visit each major pollutant source regularly for collecting and recording the data by using simple equipment. As the previous system did not contain a function of transmitting data online to the monitoring center, there was no sufficient evidence to demonstrate the relationship between the pollutants emission data and the conduct of discharging. Thus, when imposing penalties on enterprises, some troubles used to occur. At present, the emission data has been widely utilized for issuing disposal permission, collection of disposal fees and penalties, allocation of subsidies, environmental administration such as total volume control and decision making. Upon the project completion, the platform of the monitoring system and the 30 major pollution sources developed under this project were connected by local funds with seven sub-monitoring centers and 400 pollution sources of 300 enterprises. It became a primary management tool for the environmental administration in Chongqing City.

Column

The role of the major pollution sources automatic monitoring system in implementing the disposal fee collection system

China's disposal fee collection system was regulated by the environmental law in 1979 using the German system as a model, and the current system was developed based on the disposal fee collection, usage and management regulation in 2003. In the system before 2003, discharge fees for wastewater, waste gas and solid waste were to be paid only for the exceeded portion from the standard emission amount. However, in the system after 2003, disposal fees are to be paid for the total emission amount. Furthermore, in the case of discharging beyond the standards, penalties are to be paid. The number of regulated pollutants was increased from one to three. Disposal fees are to be calculated after adding together the equivalent weights for each pollutant type. The intended uses of the disposal fees are the following four: 1) prevention and processing of major pollutant sources; 2) prevention and processing of regional pollution; 3) development of new technology for preventing and processing pollution, and dissemination and application of the technology; and 4) prevention and processing of pollution which the State Council decides.

In the current system, even if observing the standards, the payment amount for disposal fees increases in proportion to the increase of total emission amount. This put more burdens on enterprises than before. It is therefore more important to measure emission amounts objectively by the automatic monitoring system in order to obtain the support by enterprises. Regarding penalties, after the automatic monitoring system was introduced, it became possible for each enterprise to check its emission amount precisely and in real time, and to take counter-measures in advance. It was pointed out that the above situation has minimized penalties and brought economic benefits for enterprises. For example, the system of the monitoring center in Chongqing City can detect automatically when the emission amounts of some plants exceed its standards, and the center sends notices to the concerned plants immediately. The concerned plants have three hours to take counter-measures, and only when the situations are not rectified in three hours, penalties are imposed.

Emission data is an essential part of the disposal fee collection system. If the emission amount is not monitored properly and in real time, the disposal fee collection system is also difficult to function properly. In this sense, it can be said that this project has made certain contribution to the implementation of the disposal fee collection system, as this project assisted CMPG in building automatic monitoring system, particularly in its infrastructure.

Reference: "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC) and the questionnaire response from CEPB.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

Under the natural gas supply sub-project, sound-proof facility was installed during the construction in order to minimize the noise of compressors. In addition, dust, noise and soil drain by the construction were minimized through implementing the construction management control strictly[24]. Under the sub-project for the monitoring system of major pollutant sources, a large scale construction was not conducted, and no major problems have been pointed out. At the Chongqing Jiulong West Power Plant, automatic monitoring station for waste air was installed under the monitoring sub-project, thus environment monitoring has been conducted properly. According to the beneficiary survey, all the respondents in Jiulongpo District, where the West Power Plant is located, answered that no major problems have been observed regarding noise and vibration during the installation of the FGD facility. Processing of disposals from the FGD facility (plaster, wastewater, etc) has been entrusted to Chongqing Power Plant, and it has been processed properly. A total of approximately 130,000 ton of plaster has been discharged annually, and it has been reused as solidified material by Chongqing Jieyu Plaster Comprehensive Use Co. Ltd.[25].

No other negative impact on the natural environment has been observed as far as known from the questionnaire answers by the implementing agencies and beneficiary survey result.

3.3.2.2 Land acquisition and Resettlement

The planned and actual resettlement and land acquisition under the natural gas supply sub-project is shown in Table 10. Land acquisition was completed as planned. Regarding resettlement, while the planned number of relocation was 100 persons, the actual was 80 persons. The reasons why it decreased may be partly because Wutaishan Gas Storage, which was expected to be constructed at the time of appraisal, was canceled and partly because the site acquired for the Liudianzi Gas Storage was slightly different from the originally planned location, but details are unknown. According to the implementing agency, the procedure of resettlement was carried out by the Land Resource Bureau of CMPG, and its compensations were paid appropriately in accordance with the land law[26]. According to the beneficiary survey, no particular problem was pointed out. Under other sub-projects, there was no resettlement and land acquisition.

---

[24] Source: Questionnaire answer from Chongqing Gas Company.
[25] Source: Questionnaire answer from Chongqing Jiulong Power Plant.
[26] Source: Questionnaire answer and interview with Chongqing Gas Company

Table 10 Resettlement and land acquisition (Baseline and Actual)

Households		Public facility, commercial facilities, factories	
Baseline (2001)	Actual (2010)	Baseline (2001)	Actual (2010)
100 persons	80 persons	Approximately 6ha	6.03ha

Source: Plan from JICA appraisal documents. Actual from the questionnaire answer of Chongqing Gas Company.

3.3.2.3 Unintended Positive/Negative Impact

Through this project, CEPB introduced a major pollutant sources monitoring system, a new management tool, prior to other provinces and cities in China, and succeeded in making it compulsory to operate the system[27]. This made possible for CEPB to provide its knowledge and experiences regarding the management know-how of the system and the specification of the facilities, which CEPB has accumulated as a pioneer, for the State Environment Protection Agency. As a result, it has contributed to the wide use of the system throughout China. A number of the Environmental Protection Bureaus in other provinces such as Sichuan, Guangxi and Shanxi inspected the system of Chongqing City as a model in building their own systems.

According to CEPB, since the 24-hour automatic monitoring began, enterprises started to make efforts from their own initiatives in reducing their pollutants emission, thereby contributing to the betterment of air and water quality, and to the ecological conservation of the Three Gorge Reservoir. CEPB has also a view that the real-time monitoring brought not only economic effects for enterprises, but also economic and social effects by reducing the risks of environmental disasters such as the discharge of wastewater[28].

In the labor safety aspect, a positive impact by installing the automatic monitoring system was observed. Before the project completion, the staff needed to climb 200 meter or higher chimneys frequently in order to take samples of smoke from power plants for regular monitoring and inspection of equipment. Thus, the occurrence of accidents did not stop as the staff fell down from chimneys. After the automatic monitoring system was installed on the ground by this project, the number of accidents decreased partly because the staff's monitoring of emission amount at chimneys by hand became limited only for comparison tests every three months and partly because regular check of the equipment can be done on the ground. Moreover, it was also heard that the staff has less chances in touching wastewater and waste smoke directly, thereby contributing to the reduction in health hazards.

[27] CEPB has also operated an automatic monitoring system for general air quality parameters in five stations since 1994.

[28] Source: Questionnaire answer from CEPB.

In light of the above, this project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating:②)

3.4.1 Project Outputs

The planned and actual outputs and reasons of change are summarized in Table 11. Among the four sub-projects, there were changes in two sub-projects and one sub-project was cancelled. However, the change and addition of the natural gas system sub-project and the monitoring system sub-project is reasonable in terms of the project purposes. Regarding the natural gas service stations sub-project, the cancelation of the project is considered to be reasonable because the both Japanese and Chinese parties have undertaken possible measures accordingly under the changing environment of the project.

Table 11 Output (Plan and Actual)

Sub-projects	Plan	Actual
1) Chongqing Natural Gas Supply	Eight gas storage tanks (10,000 m^3 x 6 tanks, 5,000 m^3 x1 tank, 1,000 m^3 x1 tank, 66,000 m^3 in total). SCADA system. A total length of 262 km of pipelines. Technical guidance.	Gas storage tanks: As planned except one tank of 1,000 m^3. SCADA system: As planned. Pipes: Increased to approximately 371km. The reason for the increase was that the areas which need the installation of gas pipes were increased due to the adjustment of the city planning.
2) Natural Gas Filling Stations	30 gas service stations.	Cancelled as a sub-project. The reasons for the cancelation are the followings. Financial situations of the implementing agency were aggravated. Its parent company also decided to withdraw because it was difficult to acquire the land for a set of 30 gas stations at once and because there are only few available sites for construction. CMPG called for other candidates, but there was application only from private companies, not from national companies. Finally, the sub-project was cancelled due to the following reasons: it was difficult to go through procedures to change the implementing agency to a private company; and there was time constraint in terms of loan disbursement deadline.
3) Major Pollution Sources Monitoring System	1 central monitoring center, 1 sub-monitoring center, 18 waste air monitoring facilities and 18 wastewater monitoring facilities.	Central and sub-monitoring centers: As planned. Waste air monitoring facilities: 11. Wastewater monitoring facilities: 19. The reason for the changes is that it took two to three years from the appraisal to the implementation and that the target factories and the number of target sites were changed as the structural adjustment of chemical industry and power sector occurred and as the relocation of factories occurred. The followings were additional items and the reasons for the addition. 1) Video camera of 21 sites: For strengthening supervision capacity.

Sub-projects	Plan	Actual
		2) Online remote control system: At the time of appraisal, regulations and technical standards for environmental monitoring was not established. However, since the disposal fee collection, use and management regulations were enacted in July 2003, it was judged that remote control system is required for observing the emission standards strictly and for comprehensive environmental management. 3) Anti-thunder system: To prevent damage of the monitoring equipment by thunder.
4) Chongqing Jiulong West Power Plant Desulfurization	Installation of FGD at the existing power generation unit (200MW).	As planned.

Source: Plans are from JICA appraisal documents. Actuals are from PCR and questionnaire answers.

3.4.2 Project Inputs

3.4.2.1 Project Cost

While the total project cost estimated at appraisal was 18,971 million yen (of which the Japanese ODA loan amount was 7,701 million yen), the actual total project cost was 13,327 million yen (of which the Japanese ODA loan amount was 5,133 million yen), thus the actual was within the plan. The actual total cost was 82% of the planned amount excluding the portion of the cancelled sub-project, which was 16,316 million yen. The actual project cost of the natural gas supply sub-project was 78% of the plan; that of the monitoring system sub-project was 102% of the plan; and that of the power plant sub-project was 91% of the plan.

Regarding the natural gas supply sub-project, the actual cost was as low as 78% of the plan for the following reasons: 1) cancelation of a gas storage tank; 2) it became possible to purchase reasonable domestic gas storage tanks for the four tanks to be procured during the latter half of the implementation period; and 3) efficient placement of order by competitive bidding.

For the Chongqing Power West Plant sub-project, the actual cost remained at 91% of the plan because the project utilized foreign currency only for the consulting services related to the purchase and installation of FGD, which was imported from Japan, and utilized local currency for procuring other facility and equipment, following the CMPG's decision after the signing of the Loan Agreement.

As per the major pollutant sources monitoring system, foreign currency was increased for adding GPS equipment, but local currency was decreased due to the efficient placement of order by competitive bidding. Thus, the actual cost was 102% of the plan.

3.4.2.2 Project Period

Regarding the natural gas supply project, the project period was 169% of the plan. For the major pollution sources monitoring project, it was 167% of the plan. For the Chongqing Power West Plant, it was 98% of the plan. The reasons for the delay are as described below.

Table 12 Project Period (Plan and Actual)

Sub-project	Plan	Actual
Chongqing Natural Gas Supply	March 2000- December 2005 (70 months)	March 2000- December 2009 (118 months, 169% of the plan) The reasons for delay are the followings: 1) at the preparation stage, the location of the Liudianzi gas storage station was changed due to the fire-fighting safety, thus it was necessary to review overall design and procurement materials (15 month delay); 2) procurement procedures such as the preparation of bidding documents were delayed due to the prevalence of SARS (6 months delay); 3) as the surroundings of the Liudianzi Station was ameliorated, the original plan was revived. It took time for review and procedures (18 months delay); and 4) due to the adjustment of the city planning, the areas which need the installation of gas pipes were increased. As the installation work of pipes was done in line with the construction work of new roads, a delay was caused.
Major Pollution Sources Monitoring System	March 2001- March 2005 (49 months)	March 2001- December 2007 (82 months, 167% of the plan) The reason of the delay is due to the addition of the on-line monitoring control system and the anti-thunder system.
Chongqing Jiulong West Power Plant Desulfurization	March 2001- December 2004 (46 months)	March 2001- November 2004 (47 months, 98% of the plan)

Source: JICA appraisal documents for the plan. PCR, Questionnaire answer and JICA internal documents for the actual.

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

At the time of appraisal, neither Financial Internal Rate of Return (FIRR) nor Economic Internal Rate of Return (EIRR) was calculated. The assumptions such as expenses, benefits and projects life are also unknown. Therefore, those were not recalculated at the ex-post evaluation.

In light of the above, the project cost was within the plan, although the project period was within the plan in one sub-project, it significantly exceeded the plan in the two sub-projects, therefore efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The O&M system of the implementing agencies of the three sub-projects are stable. The O&M system of each organization is summarized in Table 13.

Table 13 O&M system

Sub-project	Implementing agency	O&M system
Chongqing Natural Gas Supply	Chongqing Gas Group	One of the five biggest companies in China for supplying natural gas in the urban areas. Chongqing Gas Group is responsible for O&M for natural gas storage tanks. A total of 65 staff works at Toutong and Liudianzi stations. Maintenance of pipelines is outsourced to Pipeline Maintenance Company (150 staff). Maintenance of automatic control system is outsourced to Information Center (70 staff). A chain of command for accidents is also very clear.
Major Pollution Sources Monitoring System	CEPB	The responsible agency of the system is CEPB. Operation and maintenance of the monitoring system (O&M of network and transmission facilities and data collection) is managed by Chongqing City Environmental Protection Intelligence Center (sub-ordinate of CEPB). Daily check, cleaning, calibration and repair of the monitoring equipment of each major pollutant source are outsourced to Chongqing Jiaxing Environmental Engineering Co. Ltd. Regarding the Information Center, one manager and two technicians have been involved in the O&M of this monitoring system. For Jiaxing Company, one manager and eight technicians have worked for O&M of the system. According to CEPB, the number of staff is sufficient.
Chongqing Jiulong West Power Plant Desulfurization	Chongqing Jiulong Electric Power Co. Ltd.	In 1994, it became independent from Chongqing Electric Power Co. Ltd. East Plant and the Third Plant are managed by Chongqing Electric Power Co. Ltd, and the West Plant is managed by Chongqing Jiulong Electric Power Co. Ltd. The number of O&M staff is 15. A group of three persons work in four shifts a day.

Source: JICA appraisal document, responses to the questionnaire and interviews.

3.5.2 Technical Aspects of Operation and Maintenance

Technical level and training system of the implementing agencies and the companies which are entrusted for operation and maintenance is summarized as below.

Table 14 O&M technical capacity

Sub-project	O&M technical capacity
Chongqing Natural Gas Supply	Among 65 staff of Tongtong and Liudianzi gas stations, 25 persons are university graduates, 40 persons are technical college graduates. Among 150 O&M staff for pipes, 50 persons are university graduates and 100 persons are technical college graduates. All the 70 O&M staff for automatic control system is university graduates. There are many staff who has been working more than three years. In addition to the training course for new staff, technical training has been carried out two to three times a year. As a part of this project, technical guidance was provided by experts from Tokyo and Osaka Gas Companies. In addition, a joint study on the gas supply technology and gas leak detection technology was conducted in cooperation with Osaka Municipal Government.

Sub-project	O&M technical capacity
	Toutong Gas Station holds fire-fighting training by using fire-distinguishers once a year. This station is the biggest gas storage stations in Western China and is one of the biggest stations in China. It is also designated as Chongqing City Gas Industry Practical Training Base as well as National Occupation Competency Evaluation Office. Various companies and agencies visit the station from all over the country.
Major Pollution Sources Monitoring System	For the staff in the central monitoring center, training is conducted by inviting trainers from the State Environmental Protection Agency four times a year. For the staff in the sub-monitoring centers, the staff of the central monitoring center conducts training twice a year. According to the CEPB, the skill level of the staff of the Environmental Protection Intelligence Center and Jiaxing Company is sufficient.
Chongqing Jiulong West Power Plant Desulfurization	No technical problem has been observed because the FGD of this project is the same specification as the FGD at the Chongqing Power Plant Third Plant by the loan from Germany. Many O&M staff is technical college graduates. It is obligatory for the staff to pass the exam in safe production and technology every year.

Source: JICA appraisal document and responses to the questionnaire

Required number of staff is allocated and technical guidance has been conducted properly at all the implementing agencies. In particular, regarding the major pollution source monitoring system, it can be said that technical sustainability is high given the fact that the system is connected with more than 400 monitoring points as of 2012, as mentioned in the section of “impact”. As there was no precedent for the major pollutant automatic monitoring system in China at the time of appraisal, CEPB has accumulated the knowledge and experiences regarding the design and specifications of the system, temperature control, etc. by trial and error. Although it took longer than planned, it is worth to mention that CEPB has continuously developed the system by itself after the project completion and that it became possible for CEPB to share the know-how with other cities.

3.5.3 Financial Aspects of Operation and Maintenance

[Chongqing Gas Group Co., Ltd.] (Former Chongqing Gas Co., Ltd.)

Although financial statement was not obtained, it can be assumed that the financial foundation of Chongqing Gas Group is stable as the Group will list its stocks in 2012. According to the Group, listing of its stocks will not affect its credits and debts. The Group has not experienced deficit in the past, and its maintenance cost has been secured every year[29]. Maintenance and repair cost was two million RMB in 2009[30]. The gas tariff is as shown below.

[29] Source: Questionnaire answer from Chongqing Gas Group.

[30] Source: PCR.

Table 15 Tariff of Gas

unit: yuan /m^3

Category	At the time of appraisal	At the time of ex-post evaluation
Households	1.06	1.72
Public facilities	1.70	2.29(Note)
Commerce	2.00	2.24
Industry	0.753	2.29

Data source: JICA appraisal documents for the figure of appraisal. Questionnaire Answer from Chongqing Gas Group for the figure of ex-post evaluation.

Note: Gas tariff of school kitchens is same as that of households.

In the case of natural gas, material costs are relatively low and the heat supply amount by unit is large, thus operation costs are relatively low. As shown in Table 16, based on the costing in 2005, the tariff of Chongqing Gas Group for domestic use was 1.1 RMB/m^3 while the O&M cost was 1.06 RMB/m^3. This shows that the company could recover the O&M costs even the gas tariff is below the gas charge of other cities.

Table 16 O&M cost of gas supply and tariff of gas for households in 2005

unit: yuan /m^3

Gas companies	O&M cost	Gas tariff for households
Baotou Coal Gas	0.65	0.8
Hohhot Coal Gas	1.24	0.8-1.4
Liujiu LPG Gas	9.00	4.0
Changsha LPG Gas	4.90	3.8
Chongqing Natural Gas	1.06	1.1

Data source: JICA Study, 2005

[Chongqing Environmental Protection Bureau]

Required budget for operating and maintaining the monitoring system (management fee, personnel, patrolling vehicles, etc) is allocated by the CMPG every year. The actual O&M cost between 2006 and 2008 is shown in the table below. The actual amount was between 94% and 104% of the budget. Since the project completion in December 2007, the number of monitoring points of the major pollutant sources was significantly increased by using local funds. Thus, after 2008, the O&M cost increased accordingly. The annual O&M cost after 2009 is eight million RMB[31]. As described earlier, some portions of disposal fee, which have been collected, are funding sources for processing major pollutant sources.

Table 17 O&M cost of the major pollutant sources monitoring system (actual)

unit: 00,000 RMB

Year	system management	O&M of monitoring points	Total
2006	37	15	52
2007	45	23	68
2008	51	191	242

Data source: PCR.

[31] Source: Interview with the CEPB.

[Chongqing Jiulong Power Corporation]

As planned at the time of appraisal, Chongqing Jiulong Power Corporation listed its stocks on the Shanghai Stock Exchange in 2000. As the government still holds 67% of the stocks even after the listing, the financial situation of the company is stable[32]. Since the project completion in 2006, approximately 40 million RMB has been secured for operation and maintenance cost of the output of this project[33].

3.5.4 Current Status of Operation and Maintenance

As far as known from the O&M status of each facility and equipment, O&M plan, operation record, procurement and replacement status of spare-parts, which were confirmed during field inspection, no major problem has been observed.

Operation manual
Toutong Natural Gas Station

Natural gas supply flowchart
at Toutong Station

Staff inspecting the equipment
at Toutong Station

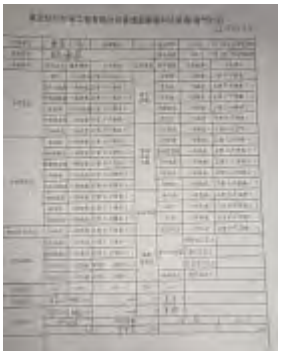
It was confirmed that the environment monitoring system was operating properly, although it cannot be generalized from the inspection of the following three facilities: the central monitoring center, the waste air monitoring facility at the Chongqing Power Plant and the wastewater monitoring equipment at the Second Plant of Xinan (West South) Synthetic Pharmaceutical Company. The frequency of the inspection, washing and replacement of the monitoring equipment (weekly, monthly, annually, etc) is fixed depending on the type of equipment. Based on the plan, inspection, washing and replacement have been conducted accordingly[34]. This was also verified by the regular check sheet. As the lifetime of some equipment such as chemical analyzers is seven to eight years, it has been replaced as needed. Some monitoring equipment made by a different manufacturer from the original manufacturer has been installed, but no major trouble has occurred so far. According to the CEPB, spare-parts can be purchased easily as there are the agents for the manufacturers in Chongqing City.

---

32 Source: Interview with Chongqing Jiulong Power Corporation.
33 Source: PCR and questionnaire answer from Chongqing Jiulong Power Corporation.
34 Source: PCR and questionnaire answer from CEPB.

Wastewater monitoring equipment in Xinan Synthetic Pharmaceutical Factory

Waste air monitoring equipment at Chongqing Power Plant



O&M record of the equipment as shown left

In light of the above, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Environment Model City Projects were implemented in Chongqing, Dalian and Guiyang in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the “Environment Model City Framework”, which was aiming to replicating the good practices of the projects in other cities in China. As Chongqing City’s energy structure depends on coal, it was facing serious air pollution along with recent rapid industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control and in building an environmental monitoring system. As a result of the implementation of this project, the following indicators have been achieved: reduction in air pollutants emission, desulfurization efficiency of Flue-Gas Desulfurization (FGD) and operating hours of the monitoring system. Thus, it can be said that expected effects have been observed almost as planned. In addition, these effects have contributed to the improvement of the living environment by betterment of air pollution and to the enhancement of the environmental management capacity. Therefore, effectiveness and impact of this project is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agencies of each sub-project. Financial situations are also stable. 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 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

4.3.1 Lessons learned for collection of data required for evaluation

This project established the reduction amount of pollutants emission by relevant project as effective indicators. Although the progress of the relevant project was verified in this study, it was difficult to collect the actual data as it has passed for ten years since its completion. In case of setting an indicator to be achieved jointly by the target project and relevant project as effective indicator, it is recommended for concerned departments to collect the actual data of a relevant project in advance.

4.3.2 Combination of approaches (good practice)

While installing FGD facilities for reducing air pollutants from major pollution sources partially, this project took an approach of establishing a major pollution sources online monitoring system as a core component of the project as early as in 2000, which is thought to have brought bigger effects than expected. As mentioned in the sections of impact and column, the above system has continuously developed since the project completion and is an indispensable management tool for the environmental administration in Chongqing City now. The real-time and objective data obtained by the system has been widely used not only for collecting disposal fees but also for environmental administration such as total volume control.

Therefore, in the case of a project which implements environmental protection measures comprehensively, it is recommended to consider incorporating some components for strengthening environmental management capacities such as the establishment of online monitoring system together with air and water pollution control components.

In addition, dealing flexibly with the ever-changing situations and needs such as the enactment of environmental ordinances and making the use of online system mandatory, for example by adding outputs, may bring broader effects.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Output		
1) Chongqing Natural Gas Transmission and Distribution Extension Project	8 gas storage tanks. SCADA system. A total length of 262 km of pipelines. Technical guidance, etc.	Gas storage tanks: As planned except the cancellation of one tank of 1,000 m^3. SCADA system: As planned. Pipes: Increased to approximately 371km.
2) Natural Gas Filling Stations Project	30 gas service stations.	Cancelled.
3) Main pollution sources monitoring and control Project	1 central monitoring center, 1 sub-monitoring center, 18 waste air monitoring facilities and 18 wastewater monitoring facilities.	Central monitoring center and sub-monitoring center: As planned. Waste air monitoring facilities:11. Wastewater monitoring facilities:19. Video camera of 21 sites, online remote control system and anti-thunder system were added.
4) Chongqing Jiulong West Power Plant Desulfurization Project	Installation of FGD at the existing power generation unit (200MW).	As planned.
2. Project Period	(I) March 2000~December 2005 (70 months) (II) March 2001~March 2005 (49 months)	(I) March 2000~December 2009 (118 months) (II) March 2001~December 2007 (82 months)
3. Project Cost Foreign currency Local currency Total Japanese ODA loan Exchange rate	(I) 4,412 million yen 8,265.75 million yen (551.05 million RMB) 12,678million yen 4,412million yen 1yuan=15 Japanese Yen (As of November 1999)	(I) 4,257million yen 5,694.91million yen (401.05million RMB) 9,952million yen 4,257million yen 1yuan=14.2yen (Average between March 2000 and December 2009)
 Foreign currency Local currency Total Japanese ODA loan Exchange rate	(II) 3,289 million yen 3,003.78 million yen (231.06 million RMB) 6,293 million yen 3,289 million yen 1yuan=13 Japanese Yen (the time of exchange: unknown)	(II) 876million yen 2.499.63million yen (176.03million RMB) 3,375million yen 876 million yen 1yuan=14.2yen (Average between March 2001 and April 2007)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Dalian Environment Model City Project (1) (2)"

External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

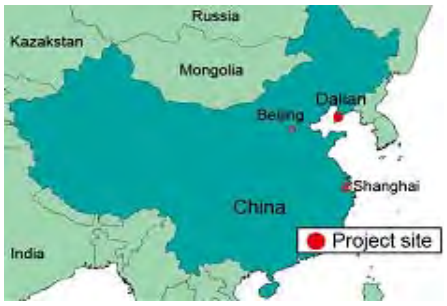
Environment Model City Projects were implemented in Dalian, Chongqing and Guiyang Cities in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework[1]", which was aiming to replicating the good practices of the projects in other cities in China. As Dalian City's energy structure depends on coal, Dalian City was facing serious air pollution along with recent industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control. Regarding the reduction in the emission of air pollutants such as Sulfur Dioxide[2] (SO_2) and Total Suspended Particular[3] (TSP), expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. Regarding the one sub-project in which actual data could not be confirmed directly with the implementation agency, as far as known from the available information, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high. Regarding efficiency of this project, the project cost exceeded the plan, and the project period also significantly exceeded the plan, therefore efficiency of the project is low. Meanwhile, no major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agency of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be satisfactory.

1 The framework was proposed at the Japan-China Summit in 1997.

2 SO_2 is one of the major air pollutants. It is generated by burning the fuels including sulfur such as coal or oil. SO_2 is one of the causes of acid rain.

3 TSP is particulate matter which is less than 100 micron in diameter. Smoke dust is one of the smokes. It is solid particulate matter such as soot and burned embers.

1. Project Description



Project Location

Dust remover installed at the tail of kiln

1.1 Background

In China, along with steady economic growth since 1980's, environmental pollution had been worsened due to industrialization and population growth. Particularly, emission of SO_2, TSP and Nitrogen Oxide[4] (NOx) was serious due to the combustion of coals as industrial materials, power generation and heating materials. As a result, density of SO_2 and TSP of the major cities in China was too high to meet the National Environment Ambient Air Quality Standards Grade II[5] (hereinafter refers as the National Standards Grade II).

The target area of this project, the urban areas in Dalian City, also faced serious air pollution problems along with rapid industrialization and the increase of the number of automobiles. Although air pollution in Dalian City was not serious as much as in Guiyang and Chongqing, the dependency rate on coals as energy sources was as high as 69%. SO_2 density in winter exceeded the National Standards Grade II. Under this circumstance, Dalian City was selected as one of the model cities of the "Environment Model City Framework", then this project was implemented.

1.2 Project Outline

The objective of this project is to improve the air quality in Dalian City, by following sub-projects: 1) (then) Dalian Pharmaceutical Factory[6] Environmental Protection Project; 2) Thermal Power Station Project in Yandao Chemical Area; 3) Chunhai Thermal Power Station Extension Project; 4); Dalian Cement Plant Dust Pollution Treatment Project; and 5) (then)

---

[4] Nitrogen Oxide is one of the pollutants which are generated by burning of coals or traveling of vehicles. It is one of the causes of photochemical smog.

[5] These national standards were established for the density of air pollutants such as SO_2, TSP and NO_2. The standards were divided into three grades and Grade I is the most strict standards. Grade I standards are applied for natural conservation area. Grade II standards are applied for commercial, residential and agricultural and general industrial areas. Grade III standards are applied for special industrial area.

[6] Dalian Medicine Group Dalian Pharmaceutical Factory has changed to Dalian Merro Pharmaceutical Company in 2000.

Dalian Steel[7] Plant Air Pollution Treatment Project; thereby contributing to the improvement of the environment of Dalian City. The location of the project site is shown in Figure 1.

Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	(I) 5,315million yen/ 2,273million yen (II) 3,202million yen/ 3,116 million yen
Exchange of Notes Date / Loan Agreement Signing Date	(I) March, 2000/March 2000 (II) March, 2001/March 2001
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Dalian Municipal People's Government (DMPG)
Final Disbursement Date	(I) May 2006, (II) July 2010
Main Contractor (Over 1 billion yen)	Dalian International Company (China), Marubeni (Japan).
Main Consultant (Over 100 million yen)	NA
Feasibility Studies, etc.	Feasibility Studies were conducted as follows. 1) Dalian Pharmaceutical Factory Environmental Protection Project: Shanghai Pharmaceutical Design Institute (June 1996) 2) Thermal Power Station Project in Yandao Chemical Area: Shengyang Color Metallurgy Design Institute (May 1998)

[7] Dalian Iron and Steel Group Co. Ltd. was changed to Dongbei Special Steel Company in 2004.

	3) Chunhai Thermal Power Station Extension Project: Heilongjiang Power Design Institute (January 1998) 4) Dalian Cement Plant Dust Pollution Treatment Project: Tianjin Cement Industrial Design Institute (December 1999). For the relocation: Nanjing Cement Design Institute (February 2005). 5) Dalian Steel Plant Air Pollution Treatment Project: Beijing Steel Design Institute (March 2000).
Related Projects	◆ Environmental cooperation with Kita-kyushu Municipal Government (1992-1995). ◆ Development Study "Dalian City Environmental Model Area Development Plan" (1996-2000).

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August 2011 to September 2012

Duration of the Field Study: November 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

The following two points were identified as the constraints in terms of effectiveness.

Chuhai Thermal Power Station aimed at reducing air pollutant emission amount by replacing large scale boilers with medium-small scale boilers; however, it was not possible to verify the operating situations of the installed facilities and actual data of the reduced amount of air pollutant emission due to the following reasons: this project was implemented completely by local funds; its implementing agency's management has changed; and the location of the station was also relocated. Consequently, evaluation of this sub-project was done using supplemental information by the Dalian Environment Protection Bureau (hereinafter refers as the DEPB).

Regarding the Dalian Steel Plant Air Pollution Treatment Project, independent SO_2 emission data of the facility covered under this project was not available. Thus, regarding the reduced amount of SO_2 emission by introducing the project facilities, this study compared the target, which was set at the time of the appraisal, with the estimate, which was obtained at the time of the ex-post evaluation.

Based on the above evaluation constraints, judgment of effectiveness was done.

3. Results of the Evaluation (Overall Rating: B[8])

3.1 Relevance (Rating: ③[9])

3.1.1 Relevance with the Development Policy of China

3.1.1.1 Development Policy at the time of appraisal

At the time of appraisal (2000), China's 9th Five-Year Environmental Protection Plan (1996-2000) set the following specific objectives: decrease in the major pollutants emission to the level of 1995; and achieve the emission standards at industrial pollution sources. The Government of China introduced the concept of "SO_2 pollution control area" and "acid rain control area" [10] by the revision of air pollution control regulations in 1995[11], and took intensive actions by designating those areas in 1998. In order to take further actions for improving the environment, the 10th Five-Year Environmental National Protection Plan (2001-2005) targeted reducing the emission of major pollutants by 10% compared with the year of 2000; and decreasing the total SO_2 emission amount in the above two pollution control areas by 20% compared with the year of 2000.

The Dalian's 9th Five-Year Environmental Protection Plan (1996-2000) and the Long-term Plan towards 2010 targeted the achievement of the National Standards Grade II by 2005 regarding the annual average air pollution density. The target values are shown as below.

Table 1 Target annual average of air pollution density in Dalian City

Unit: mg/ m^3

Pollutants	National Standards II	Year 2000	Year 2005	Year 2010
SO_2	0.06	0.05	0.04	0.014
TSP	0.20	0.18	0.15	0.034
NOx	0.05	0.06	0.05	0.07

Source: JICA appraisal documents

In order to achieve the above targets, the following directions were announced: 1) reallocation of industries and restructuring of industry by city planning such as the relocation/reconstruction of primary pollutant sources; 2) strengthening the prevention of

[8] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[9] ③: High, ②: Fair, and ①:Low.

[10] SO_2 pollution control area is the area of serious contamination of SO_2. Acid rain control area is the area where acid rain occurs or where there is a possibility that acid rain will occur in the future. Dalian urban areas are designated as SO_2 pollution control area.

[11] The basic framework of air pollution control in China is regulated by Air Pollution Action Law. It was enacted in 1987, and it was revised in 1995 and 2000. The basic principle of controlling air pollutants emission is regulating the density of air pollutants at pollution sources. The State Council established the national environmental air quality standards and established national emission standards accordingly in order to achieve the air quality standards. The local government has a right to establish local standards for the parameters which the state government has not established and to establish local standards which are more strict than the state government.

industrial pollution and exclusion of negative impacts on air quality by the total volume control of pollutant emissions; and 3) strengthening the construction of the metropolitan environmental facilities comprehensively and building metropolitan functions by the expansion of the intensive heat supply system.

3.1.1.2 Development Policy at the time of ex-post evaluation

The 11th Five-Year National Environmental Protection Plan (2006-2010) targeted reducing SO_2 emission by 10%. The current 12th Five-Year National Environment Protection Plan (2011-2015) set the goal of reducing SO_2 emission by 8% as a binding objective[12]. While the national target of reducing SO_2 emission by 10% in the 11th Five-Year Plan was equivalent to 22.94 million tons, the national target of reducing SO_2 emission by 8% in the 12th Five-Year Plan was equivalent to 20.86 million tons. For example, in order to achieve those targets, specific targets were set for each province. In Liaoning Province, the following objectives were set: reducing from 1,200,000 to 1,050,000 (reduction rate by 12%) in the former plan and reducing from 1,170,000 to 1,050,000 (reduction rate by 11%) in the latter plan.

Dalian's 11th Environmental Protection Plan (2006-2010) aimed at the following targets for the total emissions: less than 100,000 tons for SO_2; less than 50,000 tons for Chemical Oxygen Demand[13] (COD); and less than 70,000 tons for TSP. Major specific actions to be taken were raised as follows: 1) strengthening management in priority geographical areas; 2) building an energy-saving society towards the promotion of the development of recycling economy; 3) adjusting energy structure for solving air pollution issues; 4) constructing wastewater treatment plants and improvement of marine environment; 5) strengthening the waste management system; 6) pollution control; 7) strengthening rural and ecological environmental protection; and 8) enhancing the environmental management capacities by improving the environmental monitoring system. Regarding the first one, it was pointed out that the five companies in Gangjingzi District, where air pollution is serious, were to be relocated and that pollution control was to be strengthened. More specifically, it included the relocation of former Dalian Steel and Dalian Cement companies, the introduction of advanced technologies, disposing small scale furnaces, which were not environmentally-friendly, and introducing energy-efficient furnaces, which leads to the solution of smokes.

[12] Binding objectives have legal effects unlike predictive objectives. The 11th Five-Year Plan introduced the concept of biding objectives for the first time.

[13] COD is an indicator which shows the degree of contamination of river water.

3.1.2 Relevance with the Development Needs of China

At the time of appraisal, the central areas in Dalian City faced serious air pollution problems along with rapid industrialization and the increase of the number of automobiles. Although air pollution in Dalian City was not serious as much as in Guiyang and Chongqing, the dependency rate on coals as energy sources was as high as 69%. SO_2 density in winter exceeded the National Standards Grade II. Since Dalian City was designated as SO_2 pollution control areas in 1998, it has been reinforcing its pollution actions until the time of the ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, the Implementation Policy for the Overseas Economic Cooperation of the Japan International Cooperation Agency (JICA, then-JBIC) set environmental issues as one of the priority areas for loan projects for China. In addition, the Implementation Policy for China also regarded the environmental issues in China as global issues, thus announced its policy of focusing on lending support to China through air pollution control actions. The Economic Cooperation Policy of the Government of Japan towards China (2001) gave priorities on environment issues, poverty reduction and social development in inland areas, human resource development, legal system, and technical transfer. Among them, assistance cooperation for responding to global issues such as environmental issues was one of the top priorities.

Moreover, this project was implemented based on the "Environmental Model City Framework" which was launched at the China-Japan Summit between then Prime Minister Hashimoto and then Prime Minister Li Peng in 1997. Thus, this project was highly consistent with the Japan's ODA policy. In the selection process of the model cities, serious air pollution situations (Chongqing City and Guiyang City) and the past experiences of cooperation between Japan and China (Dalian City) were taken into account.

This project has been highly relevant with the development plans of China, development needs, as well as Japan's ODA policies, therefore its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators (pollutants emission and reduction amount)

(1) Dalian Pharmaceutical Factory Environmental Protection Project (Phase I)

Table 2 shows the plan and actual of emission amount of pollutants and its reduction rate[14].

[14] Reduction amount/baseline emission amount.

Table 2 Emission amount of pollutants and reduction rate (Plan and actual)

Indicators	Base-line	Plan	Actual					
	2000	2003 (after project completion)	2004 (after project completion)	2005	2006	2007	2008	2011
SO_2 emission amount (ton/year)	170	0 (-170)	0	0	0	0	0	115 (-55)
TSP emission amount (ton/year)	364	0 (-364)	0	0	0	0	0	0
COD emission amount (ton/year)	10,074	25 (-10,049)	31.8 (-10,042)	31.8 (-10,042)	31.8 (-10,042)	31.8 (-10,042)	13.8 (-10,060)	30 (-10,044)
COD reduction rate (%)	-	99.8	99.7	99.7	99.7	99.7	99.9	99.7

Source: Baseline and Planned figures are from JICA appraisal documents. Actual figures are from the questionnaire answer of Dalian Merro Pharmaceutical Company.

Note 1: Figures in ( ) shows the reduced amount.

Note 2: The planned reduced amount of SO_2 and TSP was calculated based on the assumption that the existing boilers were to be replaced by the central heat supply system from Gaoxinyuan District. The planned COD reduced amount was calculated based on the assumption that waste water treatment facility was to be constructed.

Note 3: Data for 2009 and 2010 was not available because the plants were not operated in 2009 and 2010 due to the relocation of the plant.

[SO_2 and TSP]

In October 2003, the factory was relocated from Shahekou District to Gaoxinyuan District as planned, and its self heat supply system was converted to the central heat supply system of Gaoxinyuan District as planned. By this conversion, the SO_2 and TSP emission amount by coal and heavy oil conbustion was zero between 2004 and 2008. The reduction ratio was 100%. Meanwhile, the SO_2 emission amount in 2011 was 115 tons/year (reduction ratio was 32.4%) because the factory had to use its own heat supply system, not the central heat supply system, due to its re-relocation to Yingchengzi area in Gangjingzi District, which was not expected at the time of appraisal.

[COD]

The wastewater treatment facility was completed as planned. As shown in Table 2, COD reduction ratio between 2004 and 2007, and 2011 was 99.7%, the ratio in 2008 was 99.9%.

New Plant
International Production Department

Blister packing machine

Packing Machine

(2) Thermal Power Station Project in Yandao Chemical Area (Phase I)

Table 3 shows the planned and actual emission amount of air pollutants and their reduction rate.

Table 3 Emission amount of pollutants and reduction rate (Plan and actual)

Indicators	Base-line	Plan	Actual				
	2000	2003 (after project completion)	2005 (after project completion)	2006	2007	2008	2009
SO_2 emission amount (ton/year)	4,515	1,081 (-3,434)	1,078 (-3,437)	1,092 (-3,423)	1,089 (-3,426)	1,091 (-3,424)	1,080 (-3,435)
SO_2 reduction rate(%)	-	76.0	76.1	75.8	75.9	75.8	76.1
TSP emission amount (ton/year)	411.	154 (-257)	149 (-262)	151 (-260)	153 (-258)	155 (-256)	152 (-259)
TSP reduction rate (%)	-	62.5	63.7	63.3	62.8	62.3	63.0
NOx emission amount (ton/year)	1,419	928 (-491)	925 (-494)	934 (-485)	927 (-492)	925 (-494)	926 (-493)
NOx reduction rate (%)	-	34.6	34.8	34.2	34.7	34.8	34.7

Source: Baseline and planned figures are from JICA appraisal documents. Actual figures are from the questionnaire answer of Dalian Dye & Chemical Co. Ltd..

Note: Figures in ( ) shows the reduced amount. This reduced amount was calculated based on the assumption that the existing 14 medium and small scale boilers were to be abolished.

As the pre-conditions for the reduction of the emission amount of SO_2, TSP and NOx, the existing fourteen medium and small boilers were disposed of, and the large scale boilers and generation units were installed as planned (for details, see the section of efficiency). The facilities were operated as planned. As Table 3 shows, the reduction rate of SO_2, TSP and NOx were almost as planned.

Meanwhile, in order to reduce air pollutants, during the 11th National Five-Year Plan period (2006-2010), the government adopted a policy called “Shangda yaxiao”, which is a policy promoting closing small scale thermal power stations and integrating them into large and medium scale thermal power stations[15]. For the plan to close small-scale power stations in the total of 50 million kW for the country as a whole, those with 60.06 million kW were closed by 2009[16]. This thermal power plant ceased its heat supply service in 2009 as a part of the policy. Although it is not an effect by this project, closing of small-scale thermal power stations have been contributing to the betterment of air pollution, thus it cannot be

[15] Source: Interview with the Dalian Dye and Chemical Company.

[16] Source: Current status and trend of the green development in China’s 12th Five-Year Plan, China Research Center of the Japan Science and Technology Agency, 2011.

evaluated negatively in terms of effectiveness.

Full view of Yendao Thermal Power Station

Generator

Exterior view of generation facility

(3) Chunhai Thermal Power Station Extension Project (Phase I)

Table 4 shows the baseline and plan of emission amount of air pollutants.

Table 4 Emission amount of air pollutants (Baseline and plan)

Unit: ton/year

Indicators	Baseline	Plan
	2000	2003 (After project completion)
SO_2	5,277	1,141(-4,136)
TSP	1,147	743(-404)
NOx	2,584	1,813(-771)

Source: JICA appraisal documents.

Note: The planned figures in ( ) shows the reduced amount. The reduced amount was calculated based on the assumption that the existing twenty four medium-small scale boilers are disposed of.

According to the interview with the Bureau of Finance of the DMPG, the following facts were found: the implementation agency of this sub-project was merged by other company; the Chunhai Thermal Power Station ceased its operation; and the power station was relocated from Dalian Port to Dayao Bay. In addition, the bureau mentioned that the output of this sub-project was cancelled due to the relocation after the loan agreement was signed. On the other hand, according to the JICA internal document in 2002, it was reported by the DMPG that all the outputs were completed by using local funds by the end of 2002. In any case, the following data was not available: whether large scale boilers installed by this project was re-installed at the relocated place or not; operational status if the large scale boilers were re-installed; and emission amount of air pollutants. Thus, it was not possible to evaluate; however, according to the interview with the DEPB, it was said that almost all the medium and small scale boilers were replaced by large scale boilers and that there are no thermal power stations which emit pollutants beyond the environmental standards.

(4) Dalian Cement Plant Dust Pollution Treatment Project (Phase II)

Table 5 shows the plan and actual of emission amount of air pollutants and its reduction rate.

Table 5 Emission amount and reduction rate of air pollutants (Plan and actual)

Indicators	Base-line	Plan	Plan after revision	Actual			
	2000	2003	2008 (After project completion)	2008 (Note2)	2009 (after project completion)	2010	2011
Cement production amount (0,000 ton/year) (reference only)	55	73	182	77.4	162.0	212.1	181.1
SO_2 emission amount (ton/year) Note1	2,070	1,638 (-432)	269 (-1,801)	89.0 (-1,981)	109.1 (-1,961)	123.0 (-1,947)	127.3 (-1,943)
SO_2 reduction rate (%)	-	20.1	87	95.7	94.7	94.1	93.9
TSP emission amount (ton/year) Note1	8,370	700 (-7,670)	466 (-7,904)	160.6 (-8,209)	259.4 (-8,111)	291.3 (-8,079)	283.5 (-8,086)
TSP reduction rate (%)	-	91.6	94.4	98.1	96.9	96.5	96.6

Source: Baseline and planned figures are from JICA appraisal documents. The plan after revision in 2008 was the one established in 2006. Actual figures are from the questionnaire answer from Dalian Cement Group Company.

Note1: The planned figures in ( ) shows the reduced amount.

Note 2: The new factory started its operation in July 2008, thus the cement production amount and SO_2 and TSP emission amount in 2008 are of the five months (August-December).

As explained later in the section of efficiency, as a part of the environmental policies by the DMPG, the cement plant was relocated from Gangjingzi District in the urban areas of Dalian City to its suburb, Jinzhou New District during the implementation stage. Along with the relocation plan, it was agreed by both Chinese and Japanese parties that the contents of the outputs and the targets for the emission amount of SO_2 and TSP were changed. Based on the revised plan, the outputs were completed almost as planned (For details, see the section of efficiency). As shown in Table 5, the actual reduction rate of both SO_2 and TSP exceeded the revised targets.

Bag Filter

Turbine of the remaining heat supply system

Conveyor for limestone

(5) Dalian Steel Plant Air Pollution Treatment Project (Phase II)

Table 6 shows the planned and actual emission amount of air pollutants. As mentioned in the section of evaluation limitation, the scope of this project included only a part of the plant facilities. Because TSP and SO_2 emission data limited to the facility covered under this project was not available, emission amount for the factory as a whole (ten production lines in total) are shown as below. Steel production amount is also indicated in Table 6 for easy reference. Furthermore, the completion time of the outputs differs, and some outputs were installed at the old plant while others were installed at the new plant. Therefore, the completion time of the outputs linked with its relationship with the emission amount are also indicated in Table 6.

As explained later in the section of efficiency, as the DMPG made a decision to relocate the factory to the suburb in 2005, the old factory was closed in August 2011, then all the functions were transferred to the new factory. The new plant has started to be fully operational since 2011.

Table 6 Emission amount and reduction rate of air pollutants (Plan and actual) and its relation with the outputs

Item		Baseline (2000)	Plan upon the project completion	Actual of old plant								Actual of new plant	
				2003	2004	2005	2006	2007	2008	2009	2010	2010	2011
Steel production amount (0,000 ton/year) (reference only)		35.0	43.0	45.8	53.5	51.3	45.0	50.0	41.0	42.0	42.0	12.4	46.3
Coal consumption amount (0,000 ton/year) (reference only)		12.1	NA	18.4	23.6	28.2	NA	NA	NA	NA	NA	NA	NA
SO2	Discharge amount (ton/year)	160.0	78.0	259.0	306.7	398.9	396.0	275.5	309.0	309.0	309.0	90.0	185.0
	Reduction amount (ton/year)	-	82.0	-99.0	-146.7	-238.9	-236.0	-115.5	-149.0	-149.0	-149.0	70.0	-25.0
	Reduction rate (%)	-	51.3	-61.9	-91.7	-149.3	-147.5	-72.2	-93.1	-93.1	-93.1	43.8	-15.6
TSP	Discharge amount (ton/year)	3,613	243.0	572.7	318.3	306.4	306.4	308.6	378.0	378.0	378.0	80.0	169.0
	Reduction amount (ton/year)	-	3370.0	3,040	3,295	3,307	3,307	3,304	3,235	3,235	3,235	3,533	3,444
	Reduction rate (%)	-	93.3	84.1	91.2	91.5	91.5	91.5	89.5	89.5	89.5	97.8	95.3

(Old Second Plant) Completed installing 1 set of dust remover for 40 ton furnace in 2003. Completed installing 1 set in 2004. Both dust removers had opereted until 2011. Contributed to the reduction of TSP.

(New Plant) Installed Continuous Contricaster in 2009 and operating now. Contributed to the reduction of SO2.

(Old Second Plant) Disposed of three 20 ton furnance in 2004 (Installation of dust removers were cancelled because the furnances were disposed of. Contributed to the reduction of TSP.

(New Plant) Installed one set of 40 ton AOD and dust remover and operating now. Contributed to the reduction of TSP.

(Old First Plant) Three 10 ton furnance + three 15 ton furnance were disposed of as planned (by local funds) .Contributed to the reduction of TSP.

Source: Baseline and planed figures are from JICA appraisal documents. Actual data is from Questionnaire answer from Dongbei Special Steel Company. The SO_2 and TSP emission data are originally from the monitoring report by the DEPB.

Note: The planned reduced amount of SO_2 was calculated based on the assumption that continuous conticaster is installed. TSP planned reduced amount was calculated based on the assumption that the existing furnaces are disposed of and dust removers are installed.

[TSP] Disposing obsolete furnaces and installing dust removers, which were indispensable requirements for reducing TSP emission, were completed as planned by 2004 (For more details, see the section of efficiency). Since the project completion in 2003, TSP reduction rate has been between 80% and 90% of the plan, slightly less than the target value of 93.3%.

One set of 40 ton Argon-Oxygen Decarburization[17] (AOD) furnace with the annual production capacity of 100,000 tons and dust remover was installed at the new plant in 2009[18]. In 2011, when the new plant was fully functional, TSP reduction rate was 95.3%, while the target was 93.3%. As the set of AOD furnace and dust remover installed at the new plant is the only one set in the plant[19], it is possible to say that the implementation of this project has brought the achievement of the above indicator.

[SO_2] One set of continuous conticaster[20] (hereinafter refers as CC), which was the indispensable requirement for reducing SO_2 emission was installed at the new factory at the end of 2009[21]. Figure 2 shows the image of CC.

Independent SO_2 emission data of the facility covered under this project in 2011, when the new factory became fully functional, was not available. Thus, this study compares the target reduction amount of SO_2 emission by introducing the project facilities, which was set at the time of the appraisal, with the estimate, which was obtained at the time of the ex-post evaluation. According to the estimate by Dongbei Special Steel Company, SO_2 emission amount was reduced by 82.5 tons/year by introducing one set of the CC procured under this project. The calculation method of the estimate is as follows: The CC produces a total of 312,500 tons billets/year. Coal gas consumption is 1,000 m^3 per one ton of billet production by the blooming method (see footnote 20). Therefore, it can be considered that a total of 312,500,000 m^3 coal gas consumption was saved by introducing the CC. SO_2 emission amount per one million m^3 of coal gas consumption is 264 kg. Therefore, it is estimated that a total of 82.5

17 AOD is the process of accelerating decarburization reaction by blowing oxygen which is diluted by argon.
18 Source: Interview with Dongbei Special Steel Company.
19 Source: Same as above.
20 CC is the facility to produce certain shape of billets, which are the half-finished products, in the process that melted iron becomes solid. In Japan, until 1960's, steel factories used to pour melted irons into molds, to wait until the irons cool down, to heat the irons again, and to spread the irons by blooming pressing machines in order to produce billets. However, this blooming method was not good in terms of energy-efficiency because it needed to heat the cooled irons repeatedly. Since CC was invented in 1970's, the blooming process was omitted, then it became possible to produce billets from liquid steel directly. As a result, the enhancement of production and saving energy was achieved. Source: Nippon Steel Corporation, "Book about Iron and Steel", 2004.
21 Source: Interview with Dongbei Special Steel Company.

tons/year SO_2 emission amount was saved (312.5 m^3 x 264kg=82,500kg)[22]. Because JICA appraisal documents do not indicate the estimation method of the target SO_2 reduction amount of 82 tons/year, simple comparison cannot be allowed, but, it can be said that the target reduction amount was achieved by introducing the project facility.

At the new factory, there are three more sets of CC which have the same production capacity as the one procured by this project or more, the total production capacity is equivalent to approximately 1,530,000 tons/year. If calculating simply, a total of 404 tons/year SO_2 emission amount (1,530,000 tons/312,500 tons x 82.5 tons) was saved for the factory as a whole by introducing four sets of CC.

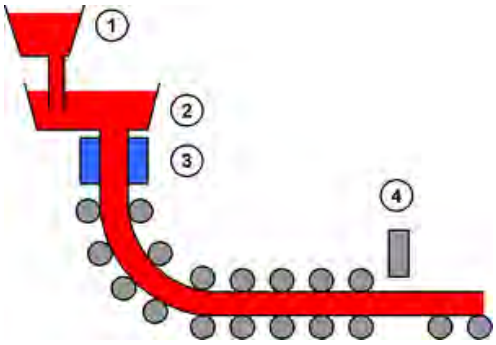


Figure 2 Outline drawing of Continuous Conticaster

1. Ladle: Pour liquid steel into the ladle in the upper part. Remove inclusion contained in liquid steel.
2. Tundish nozzle: Remove inclusion.
3. Molds: Molds are cooled down by water. Liquid steel starts to be solid.
4. Gas cutting machine: Solid steel is cut by gas cutting machine into certain length.

Source: Nippon Steel Corporation, "Tetsu to Tekkou ga wakaru hon" (Book about Iron and Steel), 2004.

Overview of Dongbei Special Steel Plant

AOD furnace and dust remover

Continuous Conticaster

[22] Source: Questionnaire answer from Dongbei Special Steel Company.

3.2.2 Qualitative effects

Apart from the indicators, it was confirmed that the consumption amount of coals, petrol and power was reduced by implementing this project. For example, at the pharmaceutical plant, energy consumption amount for each energy source was as follows in 1997: 2,509 tons/year of coals; 60 million kWh of power; about 15,000 tons/year of heavy oil; 115 tons/year of gasoline; 171 tons/ year of diesel; 30,811 tons in total by Standard Coal Equivalent (SCE). The energy consumption after the project completion was approximately 5,200 tons by SCE in 2005, which means it was reduced to 17% of the energy consumption in 1997[23].

At the cement factory, this project installed generator (7,500KW), and the factory has been generating 50,400,000kWh/year by using the remaining heat of the kiln inlet and outlet. This made it possible that a total of 20,000-30,000 coals are saved annually and that a total of 50,000 CO_2 emission amount is reduced annually[24]. Furthermore, by replacing the facilities along with the relocation of the plant, the required coal consumption for producing one ton of cement was reduced from 240kg to 110kg. Power consumption required for producing one ton of cement was also reduced from 125kWh to 98kWh.

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of air quality in Dalian City

According to the National Standards Grade II which has been applied since 1996 to the present, the limit value of average density of pollutants such as SO_2, TSP and NOx, which were set as the effect indicators for this project at the time of appraisal, is regulated. Not only these parameters, but also the limit value of the average density of Particulate Matter less than 10 micron[25] (PM10) and Nitrogen Dioxide (NO_2) is also regulated by the National Standards Grade II. Similar to other cities in China, the DPMG monitors PM10 and NO_2 instead of TSP and NOx. The data obtained during this study was that of SO_2, PM10 and NO_2. Because it was not possible to compare the plan and actual data regarding PM10 and NO_2, this study compares the limit value of the average density regulated by the National Standards Grade II with the actual average density. Table 7 illustrates the baseline, plan, actual and the limit value regulated by the National Standards Grade II regarding SO_2, TSP, PM10, NOx and NO_2.

[23] Source: Loan Situations Report of Dalian Merro Pharmaceutical Company.
[24] Source: Questionnaire answer from Dalian Cement Company.
[25] PM10 is the particulate whose trapping efficiency becomes 50% in the ten micron of aerodynamic diameter. It is the definition is generally used worldwide.

Table 7 Annual average density of air pollution in the central areas of Dalian City (Baseline/Plan)

Unit: mg/ m^3

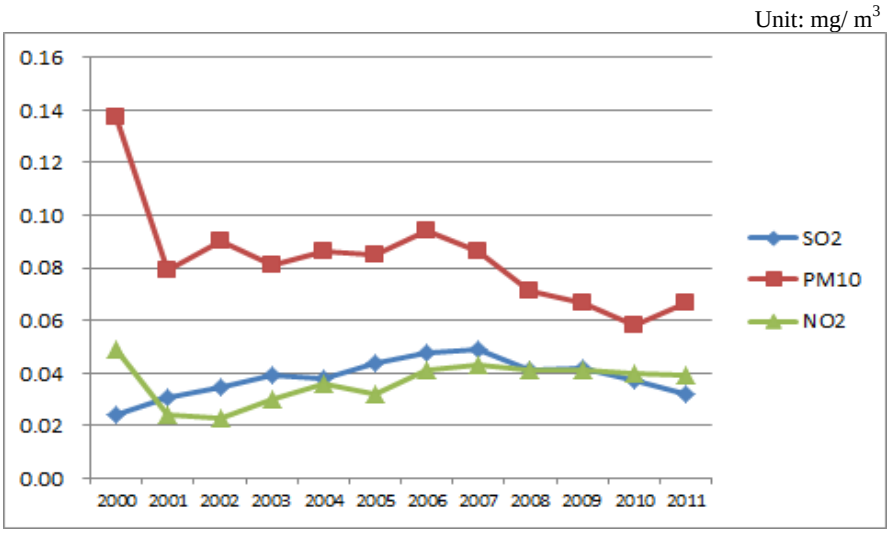
Indicators	Standards Grade II	Central area in Dalian City (Baseline)	Dalian City (Plan)			Dalian City (Actual)	
		1999	2000	2005	2010	2005	2010
SO2	0.060	0.038	0.050	0.040	0.014	0.044	0.037
TSP	0.200	0.146	0.180	0.150	0.034	NA	NA
PM10	0.100	NA	NA	NA	NA	0.085	0.058
NO_X	0.050	0.046	0.060	0.050	0.070	NA	NA
NO2	0.040	NA	NA	NA	NA	0.032	0.040

Source: The baseline and planned figures are from JICA appraisal documents. The actual data is from the data provided by the DEPB (original data: Dalian Municipality State of the Environment).

Note: The planned figures were the one established in the Ninth Dalian Environmental Conservation Five Year Plan (1996-2000) and the long-term plan for 2010.

As shown in Table 7, the targets for 2000 adopted in the Ninth Dalian Environmental Protection Five Year Plan (1996-2000) were achieved in 1999. Regarding the targets for 2005 and 2010, the plan aimed at maintaining the 1999 levels of air pollution density by taking environmental actions including this project, considering that it was expected that air pollution would be worsened along with industrialization. The target of SO_2 was not achieved in 2005 and 2010. The possible reason is that air pollution became more serious than expected due to industrialization and the increase of the number of automobiles in spite of the environmental actions. On the contrary, comparing the actual data of SO_2 with the limit value of the National Standards Grade II, it fulfilled the standards both in 2005 and 2010. The actual data of PM10 and NO_2 fulfills the standards in 2005 and 2010.

Figure 3 illustrates the trend of annual average density of air pollution in Dalian City between 2001 and 2011. In spite of rapid industrialization, no sudden aggravation was found for any parameter. The possible reasons why the density has been kept at the previous level include the followings: environmental cooperation project in cooperation with Kita-kyushu City and the Development Study “Dalian City Environmental Model Area Construction Plan” (see the “Related Projects”) were implemented in 1990’s; even after 2000, various environmental counter-measures such as this project and private sector’s investment in cleaner production technology were implemented.



Source: Dalian Municipality State of the Environment and the original data provided by Dalian Environmental Protection Bureau

Figure 3 Annul average density of air pollution in Dalian City (actual)

Regarding the degree of contribution of this project to the improvement of air quality, "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC), was estimated that the the reduction amount by this project (approximately 4,100 tons) accounted for 1.5% of the total SO_2 emission amount (approximately 271,000 tons) in Dalian City in 2003. This study analyzed that the degree of contribution was limited because SO_2 emission amount had been drastically reduced by other interventions prior to the implementation of this project.

3.3.1.2 Perception of air quality improvement by the residents in Dalian City

A beneficiary survey was conducted for 30 persons in Shahekou District and 70 people in Ganjingzi District (100 samples: 73 male samples and 27 female samples). According to this survey, 73% respondents answered that the air quality was improved significantly; 22% answered "improved slightly"; 2% answered "no change"; 2% answered "aggravated"; and 1% answered "don't know"(See Figure 4). Geographically speaking, among 30 residents who live near

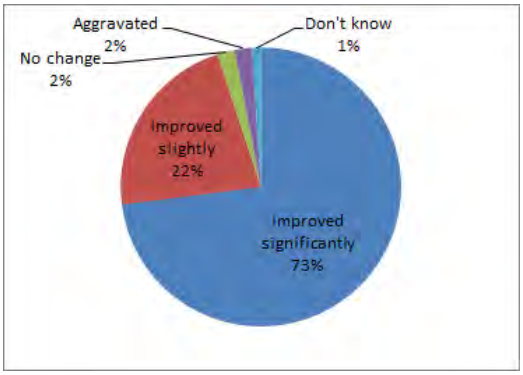


Figure 4: Perception of citizens about the improvement of air quality (N=100)

the old plant of former Dalian Pharmaceutical Company in Shahekou District, 19 respondents (consisting 63% of 30 residents) answered that the air quality was improved around 2000 when the old plant was relocated. Among 40 residents who live near the old plant of former Dalian Steel Company in Gangjingzi District, 38 respondents (consisting 95%) answered that the air quality was improved between 2003 and 2004, and that it made possible for the people to open windows and to dry clothing outside. As explained in the section of effectiveness, the possible reason for this change includes the followings: two sets of dust removers were installed at the old plant between 2003 and 2004; and consequently TSP was reduced from about 3,600 tons/year in 2000 to about 572 tons/year in 2003, then to about 318 tons/year in 2004.

The following reasons for air quality improvement were identified by the beneficiary respondents (multiple answers allowed): relocation of factories to the suburbs (100%); government's regulations on factories for pollutant emissions (97%); control of pollutant emissions by advanced technology (95%); control on the gas emission from automobiles (85%); decrease in the utilization of coals at factories (74%); and decrease in the utilization of coals at households (51%). The above result shows that the citizens understand the environmental policy of Dalian City such as the relocation of factories, the pollutant emission control by regulations or advanced technology.

3.3.1.3 Enhancement of the living environment by improving air quality

The followings were raised as the effects of air quality improvement (multiple answers allowed): dirt on clothing by dust has decreased (93%); it became possible to dry clothing outside (93%); sore eyes and coughing has decreased (93%); and use masks and sunglasses for protecting from dust less than before (91%). Apart from this choice selection, the survey requested the respondents to answer freely. They pointed out the following effects: black smoke from chimneys was decreased; dust on the office desks was reduced; dust on the automobiles was reduced; dust on the clothing dried outside was reduced; and blue sky can be seen than before.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

As far as known from the acceptance and observation report by the State Environmental Observation Center, monitoring reports by Dalian Environmental Observation Center, questionnaire answers from the implementing agencies and the evaluator's field visit, no particular negative impact on the natural environment has been observed. The implementation status and results regarding the environmental counter-measures during the

construction period and the environmental monitoring were described as below.

Then-Dalian Pharmaceutical Factory Environmental Protection Project:

As the counter-measures for noise during the construction period, the following actions were undertaken: the prohibition of construction during night time; the use of anti-noise construction machines; reinforcement of supervision; and regular inspection[26]. Upon the project completion in 2003, the company received the acceptance permission for the project. It was certified as one of the "Environmental Protection Advanced Company" in Dalian City in 2004[27]. DEPB monitors the quality of wastewater and gas emission every year, and the plant also regularly monitors them by itself. The wastewater has been processed in the plant compound, thereby meeting the Grade I of the Liaoning Province Coastal Areas Wastewater Direct Discharge Maritime Standards (DB21-59-89)[28].

The current COD's emission standards are more strict than the standards at the time of appraisal. While the emission standards at the time of appraisal were less than 100mg/l, it is 50mg/l at the time of ex-post evaluation[29]. According to the monitoring report by Dalian Environmental Observation Center, the COD emission density was 31.8mg/l in 2007, 13.8mg/l in 2008, and 30mg/l in 2011, thus it can be said that there is no problem.

Thermal Power Station Project in Yandao Chemical Area:

According to the implementing agency, the environmental monitoring result shows that the emission meets the standards[30].

Dalian Cement Plant Dust Pollution Treatment Project:

During the construction period, the following environmental counter-measures were undertaken: placement of environmental protection management staff; anti-noise actions; the prohibition of construction at night; and watering for preventing sand scattering[31]. No particular problem was pointed out in the acceptance/monitoring report by the State Environmental Observation Center in 2009. Upon the project completion, environmental monitoring has been carried out regularly, but the data could not be obtained.

Then-Dalian Steel Plant Air Pollution Treatment Project:

---

26 Source: Questionnaire answer from Dalian Merro Pharmaceutical Company.
27 Source: Loan Situations Report of Dalian Merro Pharmaceutical Company.
28 Source: Project Completion Report (PCR), Loan Situations Report of Dalian Merro Pharmaceutical Company.
29 Source: JICA appraisal document, Questionnaire answer from Dalian Merro Pharmaceutical Company.
30 Source: Questionnaire answer from Dalian Dye & Chemical Co. Ltd..
31 Source: Questionnaire answer from Dalian Cement Group Company.

According to the monitoring report by the Dalian Environmental Observation Center in 2005, regarding the project facilities under this project, the TSP emission density of No. 10 dust remover in the old plant was 10.0mg/ m^3 (98.5% of treatment efficiency) and that of No. 11 dust remover in the old plant was 13.5mg/ m^3 (98.2% of treatment efficiency). According to the Grade II of the previous industrial furnace and kiln air pollution emission standards (GB9078-1996), the TSP emission density was to be less than 150mg/ m^3 (less than 100mg/ m^3 in the current standards). The TSP emission density of No.4 dust remover in the new plant (former No.11 dust remover at the old plant) was 11.1 mg/ m^3 [32]. In the above respective cases, the actual data was far below the national standards, thus no problem was found.

Regarding Chunhai Thermal Power Station, data related to the counter-measures during the construction and the environmental monitoring could not be obtained.

3.3.2.2 Land acquisition and Resettlement

The planned and actual data regarding resettlement and land acquisition for each sub-project is shown in Table 8. According to the questionnaire and interview with each implementing agency, land acquisition was conducted smoothly. Resettlement did not occur in the three sub-projects out of five sub-projects. Regarding Yandao Thermal Power Station, according to the implementing agency, there was no problem with the contents of compensation for resettlement. However, it was not possible to directly confirm with the employees who had lived in the staff dormitory and had received compensations. For the Chunhai Thermal Power Station Project, direct verification with the resettled households was not possible, either.

Table 8 Resettlement and land acquisition (plan and actual)

Sub-project	Land acquisition		Resettlement	
	Plan	Actual	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	Had already obtained about 7.6 ha for resettlement site.	As planned for the old plant in Qixianling. Obtained 15.5ha for the new factory in Yingchengzi.	None.	None for both old and new plants.
Thermal Power Station Project in Yandao Chemical Area	Had already obtained about 2.7ha for Construction site.	As planned.	None.	65 persons. Paid compensations to the employees who had lived in the dormitory because the dormitory was demolished.

[32] Source: Questionnaire answer from Dongbei Special Steel Company.

Sub-project	Land acquisition		Resettlement	
	Plan	Actual	Plan	Actual
Chunhai Thermal Power Station Extension Project	Had already obtained about 3.2 ha for construction site.	As planned.	243 households (by September 1999) and two factories (by December 1999).	Same as left.
Dalian Cement Plant Dust Pollution Treatment Project	None.	Acquired 37.2 ha for the new factory.	None.	None. Landfill of the sea.
Then-Dalian Steel Plant Air Pollution Treatment Project	None	Acquired 300 ha for the new factory.	None.	None. Landfill of the sea.

Source: Questionnaire answer from each implementing agency

In light of the above, regarding the reduction in air pollutants emission amount, expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. As the central government announced a new environmental policy, the thermal power station in Yandao ceased its operation. But, closing the small-scale thermal power station has been contributing to the alleviation of air pollution in the end, thus it cannot be evaluated negatively in terms of effectiveness. Regarding the one sub-project in which actual data could not be confirmed directly with the implementing agency, as far as known from the available information from the DEPB, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high.

3.4 Efficiency (Rating:①)

3.4.1 Project Outputs

The planned and actual outputs and reasons of change are summarized in Table 9. Among the five sub-projects, the outputs were almost as planned in the four sub-project, although there were some changes in one sub-project (Dalian Cement Plant Dust Pollution Treatment Project). In this sub-project, the change and addition of the outputs occurred due to the relocation of the factory, which was not expected at the time of appraisal. However, as the relocation of the plant was a part of the DMPG's environmental protection policy and as the addition and change of the outputs was consistent with the project purpose, it can be judged that the change was reasonable. After the revision of the plan, the outputs were carried out as revised.

Table 9 Output (Plan and Actual)

Sub-projects	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	Installation of the production line along with the relocation (liquid filling and sealing machine, capsule filling machine, blister packaging machine, pharmaceutical facility, air pressure and cooling facility, etc. and the construction of wastewater treatment facility (580 tons/day).	As planned. The wastewater treatment facility was constructed by the local fund. Almost all the equipment was re-installed at the plant in Yingchengzi area. A wastewater treatment was also newly constructed there.
Thermal Power Station Project in Yandao Chemical Area	Construction of the boilers (75 tons/h x 3), generation units (12,000kw x 2), coal delivery system, electrical system and thermal control system.	As planned except that the performance of the generation units was changed to 15,000kw.
Chunhai Thermal Power Station Project	Construction of the boilers (130 tons/h x 2) and generation units (25,000kw x 1).	As planned, but all the outputs were completed by the local fund. In order to accelerate the completion time, the DMPG made a decision to carry it out including the loan portion by its local fund.
Dalian Cement Plant Dust Pollution Treatment Project	Bag filter, dust collector for kiln, remaining heat generating system (generator and boiler), coal mill, cement mill, air compressor, central control system, etc.	As planned except the addition of the limestone conveyor system (3.75km) and the change from the air compressor to induced fun. Cement mill, coal mill and central control system were carried out by the local fund (as revised in 2006).
Then- Dalian Steel Plant Air Pollution Treatment Project	Dust removers for one set of 40 ton Electric Furnace (EAF) and one set of 40 ton Ladle Furnace (LF), 40 ton AOD furnace (with the production capacity of 100,000 tons) and the dust removal, Continuous Conticaster (with the total production capacity of 300,000 tons). The above items were to be covered by the loan. Installation of dust removers for three sets of 20 ton furnace. Abolishment of three sets of 20 ton furnace and three sets of 15 ton furnace. The above items were to be covered by the local fund.	As planned. At the time of relocation, dust removers for 40 ton EAF/LF were demolished. AOD furnace and dust remover and CC were installed at the new plant. As the three sets of 20 ton furnace had limited capacities and were inefficient in energy, those were demolished, thus the dust removers for these furnaces (by the local fund) were cancelled. In order to supplement this loss, one set of 25 ton AOD, one set of 40 ton furnace and dust removers were installed at the new plant.

Source: Plans are from JICA appraisal documents and revised plant. Actuals are from PCR and questionnaire answers.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The total project cost estimated at appraisal was 14,684 million yen (of which the Japanese ODA loan amount was 8,517 million yen and the rest was to be locally funded).

The actual total project cost was 21,623 million yen (of which the Japanese ODA loan amount was 5,389 million yen and the rest was locally funded), which was 147% of the planned amount. In the case that the Chunhai sub-project, which foreign currency was zero and the amount of the local fund is unknown, is excluded from the total planned cost, the total project cost was 232% of a total of 9,310 million yen. The actual project costs of the

pharmaceutical sub-project and the thermal power plant sub-project in Yandao were 124% and 121% of the plan respectively. That of the cement sub-project was 658% of the original plan and 140% of the revised plan. That of the steel sub-project was 109% of the plan.

For the pharmaceutical project, the reason for the increase was that there was a rise in prices between the time of estimate, which was calculated at the Feasibility Study (F/S) in 1996, and the time of the project implementation in 2003.

For the thermal power plant project in Yandao, the increase was caused for the following reasons: geographical conditions were found to be more complex during the outline design; it required digging the building's base deeper than estimated at the time of the F/S; and then the civil work cost was increased.

For the cement plant project, the reasons for the increase include the followings, which were caused by the unexpected relocation of the factory: ground leveling and constructing the new plant; purchasing the mining rights of the limestone mountain; constructing a limestone warehouse; adding bag filters; and installing solar energy facilities.

For the steel plant project, the cost was increased as follows: some procedures were required due to the restructuring in January 2003 and the change of regulating authority in September 2004; the procurement procedure for the facilities covered by the yen loan was suspended for about two years; there was a sharp price rise during the intermittence.

Meanwhile, as the thermal power plant project in Yandao ceased its operation, the facility covered under this project is not operating, either. Comparing with the project cost of a total 3,741 million yen, the facility had operated only for five years, thus it is difficult to say that the funds were effectively utilized. At present, the implementing agency and the DMPG have consultations on how to use the existing facilities.

3.4.2.2 Project Period

The actual project period of the pharmaceutical sub-project, the thermal power plant sub-project in Yandao, Chunhai sub-project, the cement sub-project and the steel sub-project was 488%, 233%, 63%, 390% (105% of the revised plan) and 424% of the plan respectively. The planned and actual project period and the reasons for delay are described in Table 10.

Table 10 Project Period (Plan and Actual)

Sub-project	Plan	Actual
Then-Dalian Pharmaceutical Factory Environmental Protection Project	March 2000- November 2000 (9 months)	March 2000- October 2003 (44 months, 488% of the plan) The reasons for delay are the following four: 1) it took longer than planned until the loan agreement became effective (for four months after the Loan Agreement (L/A signing); 2) it took longer than planned until China Export-Import Bank and the Finance Bureau of the DMPG signed the loan sublease agreement and until the Finance Bureau and Dalian Pharmaceutical Group signed the sublease agreement (it took 12 months after the L/A effectiveness); 3) it took longer than planned for selecting a bidding company for the procurement of equipment by the loan portion, for bidding procedures and for contract agreement (it took 12 months after the signing of the sublease agreements); 4) the construction was suspended for six months due to the prevalence of SARS in 2003. The construction of the plant and the installation of the equipment covered by the local fund were completed without delay.
Thermal Power Station Project in Yandao Chemical Area	March 2000- February 2002 (24 months)	March 2000- October 2004 (56 months, 233% of the plan) Same as above, it took longer for L/A effectiveness and the signing of the sublease agreement (about 16 months), and the construction was suspended for six months due to SARS in 2003.
Chunhai Thermal Power Station Project	March 2000- June 2001 (16 months)	March 2000- December 2000 (10 months, 63% of the plan) As the DMPG made a decision to carry out the project by its local fund only, the project completion was earlier than planned.
Dalian Cement Plant Dust Pollution Treatment Project	March 2001- December 2002 (22 months)	March 2001- April 2008 (86 months, 390% of the plan, 105% of the revised plan) It was delayed because it took longer for the procedures, civil work and the change of the plan related to the plant's relocation to Jinzhou New District (at 46 km away from the central city). The reasons for relocations are as follows: 1) the population around the old factory in Gangjingzi District was increased than the estimate at the time of appraisal; 2) the Dalian Airport, next to the old plant, was expanded; 3) as mentioned in the section of relevance, the DMPG made a decision to relocate the plant to the suburb as a part of environmental protection policy in consistent with the Dalian 11th Environmental Protection Five Year Plan.
Then-Dalian Steel Plant Air Pollution Treatment Project	March 2001- March 2003 (25 months)	March 2001- December 2009 (106 months, 424% of the plan) The reasons of delay includes the followings: 1) the procurement procedures were delayed due to the restructuring of the implementing agency and the change of regulating authority[33] (33 months); 2) similar to the cement factory, it took time for the relocation procedures and relocation civil work of the factory to the suburb (24 months) and for re-installation civil work (12 months) along with the DMPG's decision.

Source: JICA appraisal documents for the plan. PCR, questionnaire answer from each implementing agency and JICA internal documents for the actual.

[33] Restructuring from Dalian Iron & Steel Group Co. Ltd to Dongbei Special Steel Group required procedures for asset transfer from the DPMG to Liaoning Provincial Government. It also became necessary to review the sublease agreement of this project. In January 2005, the procurement procedures resumed again. However, due to the rise in prices during the suspension period, contract procedures were difficult in some contract packages. The signing of the contract was extended to September 2005, thus the project was suspended for 33 months.

As Table 10 shows, the common reasons of delay for the Phase I projects included the followings: it took longer than expected until the loan agreement became effective and the relevant parties signed the loan sublease agreement; and the construction was suspended due to the prevalence of SARS. The common reasons of delay for the Phase II project included the followings: the DPMG made a decision to relocate the factories to the suburb as a part of the actions for air pollution alleviation; consequently it required time for the plants to arrange relocations, to relocate, to change some outputs and to re-install some facilities, which were installed at the old plant, at the new plant.

3.4.3 Results of Calculations of Internal Rate of Return (reference only)

At the time of appraisal, neither Financial Internal Rate of Return (FIRR) nor Economic Internal Rate of Return (EIRR) was calculated. The assumptions such as expenses, benefits and projects life are also unknown. Therefore, those were not recalculated at the ex-post evaluation.

In light of the above, the project cost exceeded the plan, and the project period significantly exceeded the plan; therefore efficiency of the project is fair. However, the reason of delay in the project period included the followings: delay in the signing of the loan sublease agreement; intermittence of the construction due to the prohibition of civil work labors' movement along with the prevalence of SARS; and the relocation of the factories during the implementation period in accordance with the government's decision. It can be pointed out that these were beyond the control by the implementing agencies of each sub-project.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The O&M system of the implementing agencies of the three sub-projects in operation are stable. The O&M system of each organization is summarized in Table 11.

Table 11 O&M system

Sub-project	Implementing agency	O&M system
Then-Dalian Pharmaceutical Factory Environmental Protection Project	(Then) Dalian Medicine Group Dalian Pharmaceutical Factory (Current) Dalian Merro Pharmaceutical Factory	In January 2000, Dalian Medicine Group Dalian Pharmaceutical Factory became Dalian Merro Pharmaceutical Factory. The number of staff is as follows: 48 managers, 88 technicians, 365 operators, 142 assistants and other staff, 643 persons in total. In 2005, this company received the certificate from Therapeutic Goods Administration (TGA) of the Government of Australia. In March 2010, a new plant was completed in Yingchengzi Industrial Park. In May in the same year, it received an authentication of Good Manufacturing Practice (GMP) by the National Food and Drugs Supervision and Management Department for the first time in China, then started its operation (Source: PCR, the report from Dalian Merro Pharmaceutical Company).
Dalian Cement Plant Dust Pollution Treatment Project	Dalian Cement Group Company	Since 1970's, various actions for environmental protections has been undertaken. Among 410 employees, there are 72 O&M staff. (Source: interview with Dalian Cement Factory).
Then-Dalian Steel Plant Air Pollution Treatment Project	(Then) Dalian Iron and Steel Group Company (Current) Dongbei Special Steel Company	In January 2003, as a result of merger between Dalian Iron and Steel Group Co. Ltd. and Wushun Special Steel Co.Ltd., Liaoning Special Steel Group was established. After merging with Beiman Special Steel Group in September 2004, Dongbei Special Steel Company was established. As a result, the company became the national special steel manufacturer which is the biggest in China and the fifth biggest in the world. The number of staff is about 21,000 persons. As O&M is implemented totally by the company, there is no out-sourcing (Source: JICA internal documents and interview with Dongbei Special Steel).

3.5.2 Technical Aspects of Operation and Maintenance

In each implementing agency, required number of staff with sufficient technical capacities has been allocated. Technical training has been conducted properly. Necessary manuals are also ready for use. Details are described as below.

Table 12 O&M technical capacity

Sub-project	O&M technical capacity
Dalian Pharmaceutical Factory Environmental Protection Project	As the equipment purchased by international competitive bidding were the imported materials with advanced level, the operational capacity of the staff was not sufficient. Therefore, in-country training was conducted seven times (a total of 27 persons) and overseas training was conducted three times (a total of 10 persons). In addition, in order to carry out regular training comprehensively and systematically, the company prepares an annual training plan for each department and for the factory every year. Functional training, quality control training, management training have been carried out and exams are also taken place strictly. At the factory as a whole, training is conducted 40 times a year and a total of 2,000 employees participates the training. The company is keen to hire the technicians with under-graduate diplomas. Among 643 employees, 169 have under-graduate diplomas, four have master degree and two have doctor degree. Along with mechanization, manuals for facility operation and O&M were developed. These counter-measures solved the technical issues which the company faced at the time of project completion. (Source: PCR)
Dalian Cement Plant Dust Pollution Treatment Project	Five staff of the safety and environmental protection section is responsible for the environmental protection. One staff is the graduate from the Environmental Protection Study in Shandong University. Some staff received O&M guidance at the time of hand-over of equipment such as dust remover. Technicians receive a guidance regarding safety and environmental protection at the in-house training every year. (Source: interview with Dalian Cement Factory)
Dalian Steel Plant Air Pollution Treatment Project	Training is conducted regarding operation by position, facility management and regulations. O&M manuals have been utilized not only for regular operation and troubles, but also utilized for training (Source: Interview with Dongbei Special Steel Company).

3.5.3 Financial Aspects of Operation and Maintenance

According to the financial statements and interviews with the implementing agencies, no major problem was observed for their financial situations respectively. Details for each implementing agency are described as below.

[(Then) Dalian Pharmaceutical Factory Environmental Protection Project (Current Dalian Merro Pharmaceutical Factory)]

As shown below, the company has kept surplus for three consecutive years. The stock price was about 6.8 RMB as of march 2012[34]. Before the project completion, there was deficit since the costs for coals and heavy oil boosted production costs[35]. Meanwhile, as mentioned in the section of effectiveness, the energy consumption was reduced to approximately 17% of the 1997 level in the SCE upon the project completion. As the production costs were reduced, it created surplus.

Since the factory did not operate in 2009 and 2010 due to the relocation of the plant, gross revenue was decreased tentatively; however, as the new plant has been operational since 2011, the gross revenue is expected to increase.

[34] Source: Interview with the Dalian Merro Pharmaceutical Company.
[35] Source: Loan situations report of the Dalian Merro Pharmaceutical Company.

Table 13 Financial status of Dalian Merro Pharmaceutical Factory

Unit: million RMB

Item	2008	2009	2010
Gross revenue	123.36	108.69	70.56
Costs of sales	67.52	53.49	19.9
Selling, general and administrative expenses	26.88	32.12	31.22
Operating profit/loss	29.39	18.27	2.51
Total asset	415.56	396.93	648.16
Current asset	97.5	89.36	79.51
Non-current asset	325.08	67.31	281.92
Current liabilities	414.06	395.73	643.89
Liabilities	415.56	396.93	648.16

Source: Questionnaire answer from Dalian Merro Pharmaceutical Company.

[Dalian Cement Plant Dust Pollution Treatment Project]

The shareholding company of the Dalian Cement Group Company was changed to China Great-wall Asset Management Company, but the company has been operating continuously as a state-owned company[36]. Since the plant could not operate in the first six months in 2008 due to its relocation, the cement production amount remained as low as at 42% of the plan in the same year, and operating profit also dropped as shown in the table below. However, as the plant has fully operated since 2009, both gross revenue and operating profit were increased, which created surplus.

Table 14 Financial status of Dalian Cement Group Company

Unit: million RMB

Item	2008	2009	2010
Gross revenue	364	551	653
Costs of sales	292	457	582
Selling, general and administrative expenses	52	74	92
Operating profit/loss	1	15	16
Total asset	1,250	1,404	1,572
Current asset	548	278	324
Non-current asset	679	1,106	948
Current liabilities	828	710	744
Shareholder's equity	401	448	477
Liabilities	849	955	1,094

Source: Questionnaire answer from Dalian Cement Group Company.

[36] Source: JICA internal documents.

[(Then) Dalian Steel Plant Air Pollution Treatment Project (Dongbei Special Steel Company)]

As Dalian Iron and Steel Group Co. Ltd. was merged with Dongbei Special Steel Company, it became the national special steel manufacturer which is the biggest in China and the fifth biggest in the world. As a result, its management foundation was reinforced. The capital of Dongbei Special Steel Company is approximately 3,644.17 million RMB (47,300 million JPY)[37]. Regarding the proportion to the capital, Dalian Iron and Steel Group Co. Ltd. has 36%; Liaoning Provincial Government has 28%; Wushun Special Steel has 22%; and Heilongjiang Provincial Government has 14%[38]. As shown below, the financial status had been stable in the past three years.

Table 15 Financial status of Dongbei Special Steel Company

Unit: million RMB

Item	2008	2009	2010
Gross revenue	13,307.20	10,553.50	12,496.22
Costs of sales	11,923.50	9,717.80	10,986.60
Selling, general and administrative expenses	675.6	679.6	727.1
Operating profit/loss	126.73	317.8	124.59
Total asset	22,533.27	25,880.60	35,909.67
Current asset	8,527.24	8,429.30	12,743.95
Non-current asset	10,717.56	13,921.40	19,861.35
Current liabilities	11,238.67	13,042.20	20,976.91
Shareholder's equity	6,371.33	5,634.80	4,543.32
Liabilities	16,161.94	20,245.80	31,366.35

Source: Questionnaire answer from Dongbei Special Steel Company.

3.5.4 Current Status of Operation and Maintenance

As far as known from the O&M status of each facility and equipment, O&M plan, and operation records, no problem was observed. It was confirmed that the equipment, which were re-installed at the new plants of the steel company and of the pharmaceutical company, has operated without problems. According to the interview with each implementing agency, it was ensured that the spare-parts, which were imported from Germany, USA and Japan, were also easily available.

In light of the above, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

[37] Source: Interview with the Dongbei Special Steel Company.
[38] Source: same as above.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Environment Model City Projects were implemented in Dalian, Chongqing and Guiyang Cities in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework", which was aiming to replicating the good practices of the projects in other cities in China. As Dalian City's energy structure depends on coal, it was facing serious air pollution along with recent industrialization and increase of vehicles. Thus, Dalian City was urgently needed to take actions in air pollution control. Regarding the reduction in the emission of air pollutants such as SO_2 and TSP, expected effects have been observed almost as planned in the four sub-projects, in which actual data were confirmed. Regarding the one sub-project in which actual data could not be confirmed directly with the implementation agency, as far as known from the available information, there was no such evidence that the plants emit pollutants beyond the environmental standards. In addition, effects other than indicators and positive impacts were also observed. Therefore, effectiveness and impact of this project is high. Regarding efficiency of this project, the project cost exceeded the plan, and the project period also significantly exceeded the plan, therefore efficiency of the project is low. Meanwhile, no major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agency of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

In this project, one of the sub-projects was completed only by the local fund, and more than ten years has already passed since the completion of the sub-project. Thus, as it was not possible to verify the operating situations of the installed facilities and actual data of the reduced amount of air pollutant emission, the effectiveness of the sub-project could not be evaluated. In the similar project consisting of more than one sub-projects, the actual data of each sub-project is important in evaluating the project overall appropriately. Therefore, it is recommended for the concerned parties to collect actual data even for the portion, which was implemented completely by the local fund, upon the agreement with the executing agencies.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Output 1) Dalian Pharmaceutical Factory Environmental Protection Project	Installation of the production line along with the relocation and the construction of wastewater treatment facility.	As planned.
2) Thermal Power Station Project in Yandao Chemical Area	Construction of the boilers, generation units, coal delivery system, electrical system and thermal control system.	As planned except that the performance of the generation's unit was changed to 15,000kw.
3) Chunhai Thermal Power Station Project	Construction of the boilers and generation units.	As planned.
4) Dalian Cement Plant Dust Pollution Treatment Project	Bag filter, dust collector for kiln, remaining heat generating system, coal mill, cement mill, air compressor, central control system, etc.	As planned except the addition of the limestone conveyor system (3.75km) and the change from the air compressor to induced fun.
5) Dalian Steel Plant Air Pollution Treatment Project	Dust removal for one set of 40 ton Electric Furnace (EAF) and one set of 40 ton Ladle Furnace (LF), 40 ton AOD furnace and the dust removal, and Continuous Conticaster. The above items were to be covered by the loan. Installation of dust removers for three set of 20 ton EAF. Abolishment of three sets of 20 ton furnace and three sets of 15 ton furnace. The above items were to be covered by the local fund.	As planned.
2. Project Period	(I) March 2000~February 2002 (24 months) (II) March 2001~March 2003 (25 months)	(I) March 2000~October 2004 (56 months) (II) March 2001~December 2009 (106 months)
3. Project Cost Foreign currency Local currency Total Japanese ODA loan Exchange rate	(I) 5,315million yen 4,860million yen (324.02 million RMB) 10,175million yen 5,315million yen 1yuan = 15Japanese Yen (As of October 1999)	(I) 2,273 million yen 3,584million yen (257.15million RMB) 5,857million yen 2,273 million yen 1yuan = 13.94yen (Average between March 2000 and May 2006)
Foreign currency Local currency Total Japanese ODA loan Exchange rate	(II) 3,202million yen 1,307million yen (100.53million RMB) 4,509million yen 3,202million yen 1yuan = 13Japanese Yen (the time of exchange: unknown)	(II) 3,116 million yen 12,652million yen (887.88million RMB) 15,766 million yen 3,116 million yen 1yuan = 14.25yen (Average between March 2001 and July 2010)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Xinjiang Water-saving Irrigation Project"

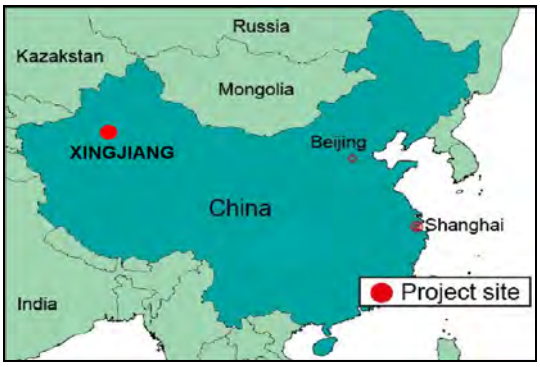
External Evaluator: Makiko Soma, Global Link Management, Inc.

0. Summary

China is one of the world's thirteen countries of the scarcest water endowment where the volume of its total water resources is less than a quarter of the world average. In Xinjiang Uygur Autonomous Region, hereinafter referred to as Xinjiang, annual precipitation is around 150 mm and it embraces a large rural population. For both China and Xinjiang, stable supply of water, improvement in water management ability, and improvement in agricultural productivity are important issues. Thus, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high. This project has largely achieved its objectives in terms of volume and ratio of water saved. It also contributed to increase in the crop yield and farmers' income to some extent. Therefore, its effectiveness and impact are both high. Although the project cost was lower than planned, the project period was longer than planned; therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

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

1. Project Description



Location of the Project Site

Main Canal (Turpan)

1.1 Background

China is a water poor nation specified by the United Nations, usage of water resources per capita is about one-fourth of the global average. As of 2000, irrigation water accounted for 70% of water supply for agricultural purposes. Xinjiang was faced with many challenges such as

slow development in irrigation facilities, obsolete water facilities not replaced with new ones, inefficient use of agricultural water, unreasonably low water fees not being able to cover the cost of maintenance expenses.

Xinjiang Uygur Autonomous Region is located in the westernmost part of China. Its area covers 1,650,000 square kilometers of land, or about one-sixth of China, which is equivalent to 4.5 times the size of Japan's land, and is the largest among the provinces and autonomous regions of China. About a quarter of Xinjiang was desert as of 2001, accounting for about two-thirds of the total land area of the desert all over China, in which farming was not possible without irrigation. There are great needs for saving water in such an arid area; however, the amount of water loss was extremely high because the irrigation facilities were mostly earth canal. Xinjiang's total population was about 19 million as of 2001, the two thirds was non-Han ethnic minorities. The region suffers from a serious inland poverty and there was a large income disparity between the inland and the coastal area. Maximizing the limited water resources was an important issue for the region to improve agricultural productivity and profitability, hence, to improve living standards of the local residents.

1.2 Project Outline

The Project aims to increase agricultural production while reducing water intake from the riverine system through establishment of canal lining, construction of water-saving irrigation facilities and construction and rehabilitation of wells, thereby contributing to the mitigation of desertification and increased incomes of farmers within the 9 areas of Xinjiang Uygur Autonomous Region.

Loan Approved Amount/ Disbursed Amount	14,400 Million Yen/ 13,347 Million Yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 30, 2001/ March 30, 2001
Terms and Conditions	Interest Rate: 1.3 % p.a. Repayment Period: 30 years (Grace Period 10 years) General untied
Borrower/ Executing Agency	People's Republic of China/ Water Resources Bureau (WRB), Xinjiang Uygur Autonomous Region
Final Disbursement Date	March 8, 2010
Main Contractor	Xinjiang North Construction Co., Ltd. (China)・Xinjiang Sutong Engineering Construction Co., Ltd. (China) (JV)
Main Consultant	NA
Feasibility Studies etc.	F/S conducted by Xinjiang Survey and Design Institute of Water Resources and Hydropower (May, 2000)
Related Projects	JICA: "Model Planning Project for Water-Saving Measures on Large-Scale Irrigation Scheme (2001-2006)," World Bank (IDA) Tarim Basin I (1992-1997): Water resources management, agriculture and livestock etc. World Bank (IDA & IBRD) Tarim Basin II (1998-2003): Water resource management, farmland reclamation, environmental monitoring etc.

Source: WRB

Figure 1 Map of the Project area (Project Areas are specified in squares)

2. Outline of the Evaluation Study

2.1 External Evaluator

Makiko SOMA, Global Link Management Inc.

2.2 Duration of Evaluation Study

This evaluation study was conducted in the following schedule.

Duration of the Study: July, 2011 – September, 2012

Duration of the Field Study: October 9, 2011 – October 22, 2011 and
February 21, 2012 – March 2, 2012

2.3 Constraints during the Evaluation Study

In consultation with the Xinjiang Uygur Autonomous Region, three cities/counties were selected for the beneficiary survey and site visits among the eight[1] target cities/counties considering the time constraints and accessibility. The three cities/counties are namely, Turpan, Tacheng, and Changji. Therefore, the results of the field study might not represent the situation of all target areas.

[1] The plan of the target area was scheduled for 9 districts at the time of the appraisal. However, it became 8 districts since Urumqi was canceled. The reasons of the cancelation are detailed in 3.4.1.

3. Results of the Evaluation (Overall Rating: A[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance with the Development Plan of China

In the Ninth Five-Year Plan (1996-2000), China aimed at prevention of desertification and comprehensive water resources management. To achieve the aim, Chinese government set out three national plans and goals; designation of 300 water-saving irrigation production model prefectures, achievement of 18,670,000 ha water-saving irrigation area in total at the end of 2000, and saving of 6 billion cubic meters of agricultural water every year.

In the Tenth Five-Year Plan (2001-2005), to combat the further aggravated desertification during the Ninth Five-Year Plan, the government put further emphasis on the maintenance of vegetation cover in arid lands that had been prone to desertification. In addition, there had been a growing emphasis on the production yield increase in order to meet the growing demand for food along with the population growth. The reclamation of the land had been strictly restricted after the Yangtze River Flood in 1998; thus the production volume had to increase solely by the yield improvement without expanding the cultivation area. Introduction of highly efficient water-saving irrigation had been, in this regard, counted as important measures to ultimately maintain the vegetation cover, to ensure food security, and to address to poverty.

In the Eleventh Five-Year Plan (2006-2010), water-saving technology was promoted in order to accelerate the dissemination of water-saving agricultural technology, to shift to higher-yield cultivation, to expand water saving agricultural area. In addition, continuous emphasis was put on the prevention of desertification through afforestation in the three north (Northeast, Northwest, and North), establishment of a protection forest, and conversion of degraded farmland into forest/grass.

The Twelfth Five-year plan (2011-2015) as well, put emphasis on the prevention of desertification, pursuit of water-saving agriculture and sustainable use of resources, enhancement of agricultural productivity through improved efficiency.

As for the anti-poverty measures, the development policy is currently being implemented to put on track the economic growth in the western district of inland by stages for a period of 50 years from 2001 through the China Western Development as the policy of correcting the disparities that were resulted from the priority development of eastern coastal district.

In the 11th Five-Year Plan (2006-2010), the Government of Xinjiang was placing importance on the water saving by recovering vegetation cover, preventing desertification, and by diffusing both the water-saving agriculture and the irrigation technology. Pursuant

[2] A: Highly Satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[3] ③: High, ②: Fair, ①: Low

to the “National Construction Plan of Ecological Environment” (January, 1999), they laid out the goals to increase water-saving irrigation area, to raise irrigation water use coefficient, and to enhance water-saving awareness while aiming to realize the water-saving society by 2010.

In Xinjiang’s 12th five-year plan (2011-2015), the emphasis was also placed on preventing desertification of the Tarim Basin and the Dzungaria Basin. It laid out the goals to almost double the highly-efficient water-saving irrigation area by 2015, to further increase the irrigation water use coefficient, to increase the number of paved canal, and to reduce the total quantity of water demanded for irrigation.

3.1.2 Relevance with the Development Needs of China

In China, use of irrigation water remained inefficient and its improvement was desired. For example, in 2000, in Israel where irrigation technique was highly advanced, productivity of grain was 2.32 kg per cubic meter of water, while it was only 1 kg per cubic meter of water in China. Adaptation of water-saving irrigation technique was even slower in inland China. In Xinjiang, located in a deprived area of inland China, enhancement of productivity by introducing water-saving irrigation was expected to contribute to income increase of the poor rural households and to redressing the disparity between the inland and coastal areas.

In JICA’s technical cooperation project, “Model Planning Project for Water-Saving Measures on Large-Scale Irrigation Scheme (2001-2006),” priority model irrigation schemes established in three provinces were disseminated to twenty irrigation sites. Among these twenty sites, Manas County, one of the target areas of this Project, was included. This inclusion of Manas in JICA technical cooperation project implies the high needs of this Project in the target areas.

In addition to scarce precipitation and severe natural environment, Xinjiang embraced a large rural population. It was 12.09 million, accounting for 64.4% of the total population in 2001; and it increased to 12.41 million in 2009, accounting for 56.9% of the total population.

In Xinjiang, annual flow rates of the rivers were unstable, thus supply of stable irrigation water was a crucial bottleneck in the region’s agricultural development. Upgrading of irrigation facilities still had a room for improvement at ex-post evaluation. In Xinjiang, with severe natural environment and large rural population, there still were great needs for upgrading the irrigation facilities for the purpose of supplying stable irrigation water, improvement in water management ability, and improvement in agricultural productivity.

3.1.3 Relevance with Japan's ODA Policy

JICA's Strategy for Overseas Economic Cooperation Operations (December 1999 to March 2002) set out three prioritized areas, namely, "environment," "Food/Poverty," and "prioritization of inland for redressing the regional disparity." Japanese government, in its Economic Cooperation Program for China, publicized that they would emphasize controlling desertification, environmentally sustainable agriculture, rural development and poverty alleviation through improvement in agricultural productivity, water projects for efficient water use.

This project has been highly relevant with the development plan and development needs of China and of Xinjiang, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness[4] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) The water-saving ratio

One of the objectives of this project is the reduction of water intake from a river-system, and the main indicator to measure the project effect is the water-saving ratio[5] of the targeted area of the project. As shown in Table 1, the volume of irrigation water demand decreased from 18,040 million m^3 to 17,180 million m^3, indicating the water-saving ratio of 4.8% which almost achieved the targeted ratio of 4.9%[6]. The water use efficiency[7] of all of the irrigation method introduced, namely, canal, sprinkler, drip, and pipe, also exceeded the target.

Table 1 Irrigation water demand and amount of water-saving

(Unit: 100 million m^3)

Indicators	Before the project	After the project	Amount of water-saving	
Irrigation water demand	180.4	171.8	8.6 (Water saving rate 4.8%)	
			Breakdown of water-saving	
			Canal lining	4.3
			Sprinkler	1.5
			Drip	2.3
			Pipe	0.5

Source: Appraisal document, WRB

4 Sub-rating for Effectiveness is to be put with consideration of Impact

5 Water-saving ratio is obtained as the volume of water saved divided by the total water irrigation water demand before the Project.

6 Agricultural production volume of the Project sites increased from 2,017,220 tons in 2000 to 2,205,262 tons in 2010. Cultivated land area increased from 1.27 million ha in 2000 to 1.29 million ha in 2010. Thus, the saving of water is not a result of decrease in agricultural production.

7 The water use efficiency, in this report, is obtained as the water reached to the crop root zone divided by the total volume of water got into the farm.

Table 2 Water-use efficiency

	Target	Achievement (2009)
Canals	57%	93%
Sprinkler	81%	97%
Drip	85%	100%
Pipe	84%	97%

Source: Appraisal document, WRB

Pumping machine and fertilizer mixing machine (Tacheng)

Cotton field with drip irrigation (Changji)

(2) Farm products unit yield

The unit yields of the major crops in the Project targeted areas increased as shown in Table 3. At the time of the ex-post evaluation, the unit yield increased by 176% from the original value for wheat, 139% for corn, 140% for cotton, and 143% for fruit. Owing to upgrading and improvements of irrigation facilities as well as various technical trainings on water management, the stability and timeliness of water supply have improved. These facility improvements and trainings on water management greatly contributed to increase the yields. As another contributing factor, the guidance provided by Xinjiang agricultural bureau and by the local governments' agricultural offices on the technical matters such as effective use of fertilizers, pesticides and mulching[8] seem to have been effective. The drip irrigation facilities, for example, can improve water-saving efficiency when combined with farming technologies such as mulching that has moisture retention and the thermal effects. This kind of combination can further improve farm productivity. In this project, there seems to have been no particular cooperation between the Xinjiang WRB and the agricultural bureau for conducts of the trainings. There might have been a possibility of overlaps in the contents of the training and the training schedules may not have been the most efficient. If both agencies had cooperated in planning and in implementation of the

[8] Mulching is to place plastic or paper over the soil surface to maintain soil moisture, to gain thermal effect, to prevent runoff of fertilizers and pesticides and overgrowth of weeds etc.

training, the overlaps of the training contents would have been avoided and the contents might have been enriched further.

Table 3 Unit yield by major crops

(Unit: kg/ha)

	Before the project (2000)	After the project (2011)	Rate of increase
Wheat	4,978	8,774	176%
Corn	7,781	10,828	139%
Cotton	3,403	4,751	140%
Fruits	39,625	56,643	143%

Source: WRB

3.2.2 Qualitative Effects

In this ex-post evaluation, the questionnaire survey has been carried out for 25 people in four areas (100 people in total), namely, Changji, Shā-wān, Turpan and Xinhe, of the project sites. According to the survey, 100% of the respondents answered positively to the question, “Water-saving has become more effective owing to the irrigation facilities introduced by this project compared to the time before the Project.” From this, it is clear that the farmers recognize that this project has contributed to water-saving. In addition, 96% replied positively to the question, “the productivity of the farm had improved.” The farmers also recognized the yield increase in their farm products.

3.3 Impact

3.3.1 Intended Impacts

(1) Prevention of desertification through the vegetation coverage

The Xinjiang government does not have the data such as the secular changes of the desert area in the autonomous region, but the forest coverage of the targeted areas increased from 2.22% to 4.52% and the vegetation coverage from 12.8% to 26.4%, as shown in Table 4; thus, exacerbation of desertification has been restrained to a certain degree. The direct cause of the increase in the vegetation coverage should be ascribed to the result of the tree planting project of the Chinese government, thus it is difficult to clarify the direct causality of this project and vegetation increase. However, effective water resources management through the facilities maintenance of this project should have contributed to prevention of desertification, as one of the important and appropriate, though not a direct, countermeasures. In the beneficiary survey, it was revealed that the local inhabitants recognized the following effects and changes.

・ Desertification has been alleviated 96%

・ Dust storms have been reduced 97%

・ Wind erosion has been reduced 95%

Table 4 Vegetation coverage increase

(Unit: Million ha)

	Baseline (2000)	Target (2006)	Achievement (2009)	At ex-post evaluation (2011)
Forest area	1.86 (2.22%)	2.06 (2.45%)	2.94 (3.5%)	4.02 (4.52%)
Vegetation coverage area	10.75 (12.8%)	12.0 (14.27%)	14.95 (17.78%)	23.5 (26.4%)

Source: WRB

(3) The livelihood improvement of the farmers

Unit revenue of major crops in the Project sites has increased except for cotton, as shown in Table 5[9]. Unit yield increase, as mentioned earlier and the rise in trading prices of major crops except for cotton have contributed to the income increase. This is confirmed by the result of the beneficiary survey, in which 98% of respondents replied that their "Agricultural income had increased."

Table 5 Revenue per unit of major crops

(Unit: RMB/Mu[10])

	Before the project (2000)	After the project (2011)	Rate of change (%)
Winter wheat	365.2	1228.5	336%
Corn	467.1	1225.7	262%
Cotton	2837.5	2528.0	89%
Fruits	2907.3	8684.8	299%

Source: WRB

Table 6 compares the before- and after-change in the annual agricultural incomes of the farmers in the Project sites according to the irrigation methods. Income increase among the farmers is apparent.

[9] Unit price of major crops other than cotton has increased when comparing the data before the project (2000) and ex-post evaluation (2011) (1.9 times increase for winter wheat and corn, 2.1 times for fruits). The unit price of cotton has been reduced to about two-thirds.

[10] Mu is a unit that represents the land area in China. 1 mu = 0.0667ha.

Table 6 Agricultural income per year (per person) by irrigation types

(Unit: RMB)

	Before the project (2000)	At project completion (2009)	At ex-post evaluation (2011)	Increase in the rate between 2000 and 2011 (%)
Canal Irrigation	2,520	4,634	5,902	234%
Sprinkler Irrigation	2,095	4,644	6,236	298%
Drip Irrigation	2,808	6,352	7,588	270%
Pipe Irrigation	2,755	4,235	5,410	196%

Source: WRB

The result of the beneficiary survey is shown in Table 7. Since the improvement of the living standard among the respondents should be, at least partially, ascribed to the general economic growth of China, it cannot be simply concluded that it is the direct effect of this project. In the beneficiary survey, however, following effects were reported; decrease in the total consumption of water with the introduction of water-saving irrigation technology, reduced workload by automation of the watering, reduction in the amount of fertilizer application by sending the pesticides or chemical fertilizers to the root zones directly with drip pipes. These savings in irrigation water and amount of applied fertilizer must have decreased the production cost. Thus, through the effective and stable irrigation water supply, remarkable income improvement, and the savings in production cost for water and fertilizers as well as workload, the Project's contribution to improvement in standard of living among beneficiary farmers should be granted to a certain extent

Table 7 Beneficiary survey results

Effect on the improvement of livelihood	Respondents with positive answers.
Labor has been reduced	90%
Personal property has increased	99%
Savings has increased	98%
Children's educational level has improved	93%
The health of the family members has improved	99%
Livestock population has increased	93%
Spending on furnishings has increased	98%
Housing environment has improved	97%

Source: Beneficiary survey results

3.3.2 Other Impacts

Impacts on the natural and social environment

At the time of the appraisal, salinization, increase in the pumping groundwater, influence of construction activities on vegetation had been of major concerns. In actual conduct of the Project, no major problems have been reported at the time of ex-post evaluation. Part of the canal lining site was canceled because it was designated as afforestation site by the Chinese government, which should have actually contributed to the improvement of

vegetation recovery. Pumping groundwater has been strictly regulated by the government, thus overuse of groundwater has not been a problem. Land acquisition and resettlement did not take place in the Project.

This project has largely achieved its objectives; therefore its effectiveness is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

In the eight Project sites of Xinjiang, except Urumqi which was excluded from the Project in 2005, the followings were carried out: earth canal pavements, improvement of water-saving irrigation facilities (sprinkler, drip, and pipe), and establishment and rehabilitation of the pumping wells. In the original plan, nine sites had been targeted but later became eight sites because of cancelation of Urumqi. The reasons for cancellation were as follows. Between the time of a feasibility study (1998) and the start of the actual construction (2003), many farmers had begun to adopt a relatively high irrigation technology, because of which the Urumqi city government changed their plan and wanted to invest in private corporations instead of farmers. Xinjiang government, however, did not approve this new idea of Urumqi since their intension and one of the main purposes of this Project was poverty alleviation among poor farmers. Therefore, in 2005, the WRB decided to distribute the project budget that had originally been allocated for Urumqi to the other counties (Changji, Shā-wān, Turpan, and Hami) where there were greater needs for the Project among the farmers.

There were changes in the target figures of the outputs as shown in Table 8. The changes were made after the visit of mid-term supervisory team by JICA in September, 2002. The reasons for changes in output targets are as follows.

- As a result of detailed survey conducted for each county and city in 2002, the detailed figures for the entire scopes including all types of irrigation facilities that had not been finalized at the appraisal were finalized.
- Since a part of the scheduled sites for the branch canal construction was designated as a forest plantation site in 2002, the scale for branch canal construction was reduced.
- The sprinkler irrigation was reduced largely from the scientific standpoint that it should be avoided as much as possible because of the high water evaporation rate and strong wind in the Project sites.
- The drip irrigation facilities were increased to replace the sprinklers and for the purpose of fruit cultivation.
- Since the overuse of groundwater was raised as an issue to be avoided, the new well development was canceled, and changed to renovation and the improvements only.

・ In Southern Xinjiang (the southern part of Xinjiang), the “Tarim river conservation plan” was to be carried out in 2001 by the Chinese national grant investment of 10,700 million RMB in total. Thus the WRB excluded the overlapped portion in Aksu and Bazhou from the scope of this Project.

The Table 8 shows the changes made for the output. Actual achievements of the “(6) Rehabilitation of the pumping well” was substantially modified because, in the construction package of the well, all the bidders outbidded the price and they were not accepted. This unsuccessful bidding portion was changed to drip irrigation construction that had great needs.

Table 8 Outputs

	Target (Target year 2006)	Target after 2002 amendments (Target year 2006)	Achievement (2011)	Differences (Compared to the 2002 plan)
(1) Laying concrete lining on main canals	1,256 km	1,265 km	1,692 km	+427 km
(2) Improvement of irrigation facilities on branch canals	2,401 ha	1,333 ha	1,333 ha	0
(3) Improvement of sprinkler	68,550 ha	25,392 ha	23,628 ha	-1,764 ha
(4) Improvement of drip irrigation facilities	24,767 ha	43,135 ha	50,154 ha	+7,019 ha
(5) Pipe irrigation facilities	6,797 ha	6,535 ha	6,647 ha	+112 ha
(6) Rehabilitation of pumping wells	2,401	1,745	1,033	-712

Source: WRB

As noted above, there had been changes in the Project outputs and in the target sites. These changes were made after thorough reviews of the local needs during the Project implementation, and the responses are considered appropriate to evade negative influences and to achieve the purpose of the Project.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The project cost was within the planned budget (79% of the original plan on a yen basis, 74% on a local currency basis). This is because the outputs of the project decreased as a whole along with the changes in the target figures, and the cost for the project was reduced accordingly as shown in table 9. The total project cost estimated at the time of the appraisal was 25,678 million yen (with 14,400 million yen that was to be loaned by yen, and the remainder was going to be covered by the budget of the local governments). The actual

cost was 20,221.02 million yen (with 13,346.54 million yen loaned by yen, and the remainder was defrayed by the Xinjiang government for the amount of 129.7 million RMB, 59.8 million RMB by the district government, and 309.2 million RMB by the city and the prefectural governments).

Table 9 Actual project cost

(Unit: million yen)

Items	Local Currency (million RMB)		Total (million yen)	
	Entire	Loan	Entire	Loan
Canal lining	739.7	488.2	10,194.58	6,728.40
Sprinkler irrigation facilities	145.9	96.3	2,010.80	1,327.21
Drip irrigation facilities	426.3	281.4	5,875.29	3,878.27
Pipe irrigation facilities	32.4	21.4	446.54	294.94
Rehabilitation of pumping wells	122.9	81.1	1,693.81	1,117.72
Total	1,467.20	968.4	20,221.02	13,346.54

Source: Appraisal document, WRB

Exchange rate:1RMB = 13.78205yen (Average throughout the project period)

In this project, “participation in the form of labor,” in which farmers voluntarily offer their labor without compensation, was not applied.

The Table 10 shows the planned cost, amended project cost at the time of the mid-term supervisory mission in 2002, and unit price comparison for every component. Changes in the project cost were mostly accompanied with changes in the figures of the outputs, thus the changes are considered appropriate. When the planned budget and the actual expenditures are compared, the unit cost of the component decreases or they remain about the same level except for the “(1) Laying concrete lining on main canals”. The unit cost rose for this item because part of the costs of “(2) Installation of branch canal irrigation facilities”, “(3) Installation of sprinkler,” “(4) Installation of drip irrigation facilities”, and “(5) Installation of pipe irrigation” are included here for accounting reasons. Other reasons include the rise in the material cost and additional expenditure incurred for the treatment applied to canal lining to prevent water leakage.

Table 10 Changes in project cost unit price of each component

	Plan(Target year 2006)			Amended plan(2002)			Attained Results(2009)			
	Quantity	Cost (million yen)	Unit price (million yen)	Quantity	Cost (million yen)	Unit price (million yen)	Quantity	Cost (million yen)	Unit price (million yen)	Unit price compared to plan (%) [11]
(1) Laying concrete lining on main canals	1,256 Km	5,805	4.622	1,265 km	8,472	6.7	1,692 km	10,194.58	6.025	130%
(2) Improvement of irrigation facilities on branch canals	2,401 ha	52	0.022	1,333 ha	45.5	0.03	1,333 ha	Included in ①	--	--
(3) Improvement of sprinkler	68,550 ha	5722	0.083	25,392 ha	2,159	0.09	23,628 ha	2,010.80	0.085	102%
(4) Improvement of drip irrigation facilities	24,767 ha	3316	0.134	43,135 ha	5,835	0.14	50,154 ha	5,875.29	0.117	90%
(5) Pipe irrigation facilities	6,797 ha	611	0.090	6,535 ha	570	0.09	6,647 ha	446.54	0.067	74%
(6) Rehabilitation of pumping wells	2,401	4,033	1.680	1,745	2,592	1.49	1,033	1,693.81	1.640	98%

Source: Appraisal document, WRB

3.4.2.2 Project Period

The project period was longer than planned. The actual period was 105 months from March, 2001 (L/A) to November, 2009 (commissioning of all the facilities to the county/city), which was 150% of the planned period at appraisal. The planned period was 70 months from March, 2001 (L/A) to December, 2006.

The reasons that the project period exceeded the plan are as follows.

- Extreme weather with very cold winter and hot summer shortened the construction period, thus some construction work was prolonged to the following years.
- It took time to change and make adjustments in the scope of the Project because the targeted farms were scattered over a large area and because it was the first yen loan project for Xinjiang government who were unfamiliar with the procedures.
- The competitive bidding in 2003 was delayed due to the influence of SARS.
- As previously mentioned, it took time to solve the trouble in the process of the competitive tender bid of the construction package of the wells.

Although the overall project period was extended, the period for each construction item was not extended or even shortened from the original plan except for the concrete lining. The delay was largely due to external factors, such as SARS or the weather conditions,

[11] Comparison with the plan at the time of the appraisal.

which are considered unavoidable.

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

The Economic internal rate of return (EIRR) of this project is calculated with the project life of 50 years, and with the benefits of increased incomes from the farm products produced in the Project such as wheat, vegetables and fruits. The value of the EIRR was 15.0% at the time of the appraisal, and it was recalculated to be 15.27% at the time of ex-post evaluation by the same calculating method.

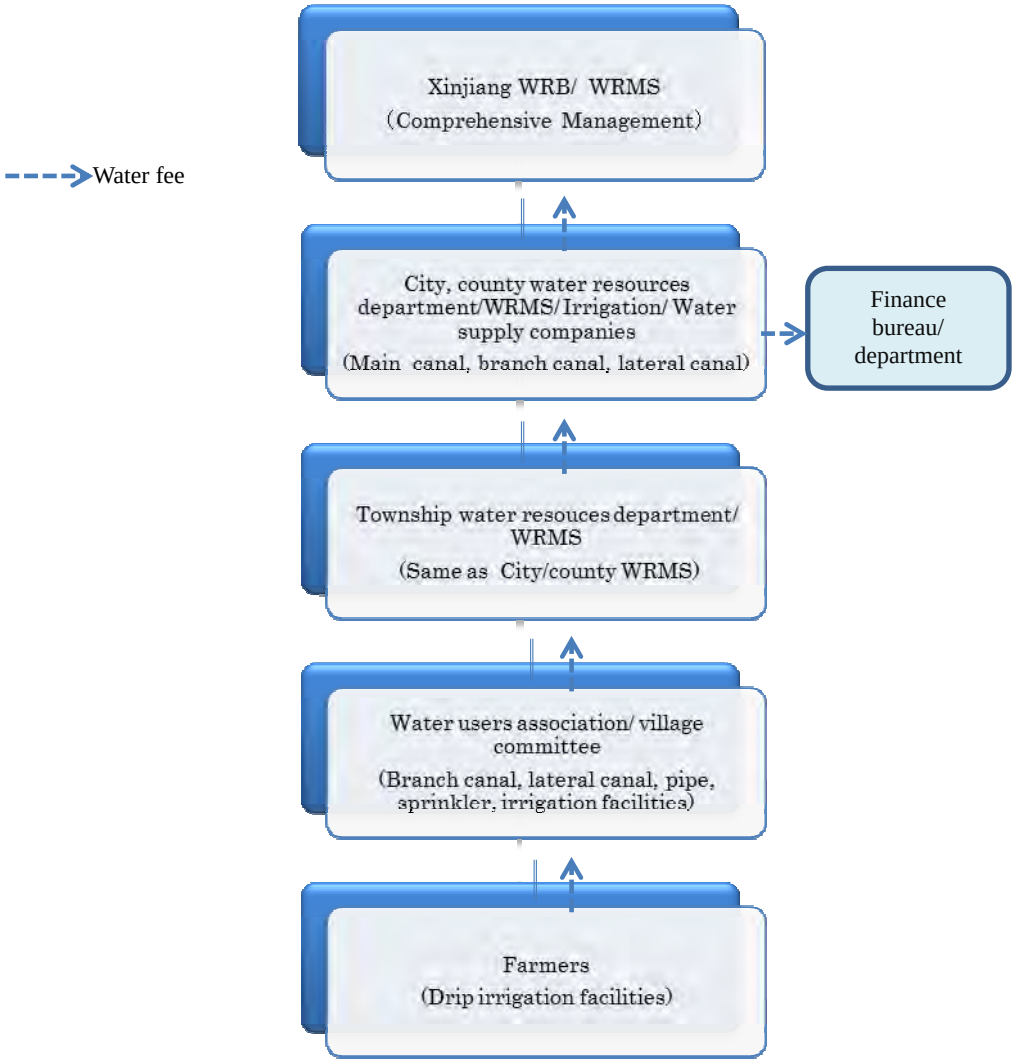
Although the project cost was within the plan, the project period was exceeded, therefore efficiency is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspect of Operation and Maintenance

As for the operation and maintenance structure of facilities, there were no major changes from the original plan. The operation and maintenance of the main canals are carried out by the Water Resources Management Stations, WRMS hereafter, under county/city's Water Resources Bureaus (or Water Supply Companies in some places). The operation and maintenance of branch canals, lateral canals, drain ditches, water-saving irrigation facilities including the pipes or the sprinklers are carried out by the Water Users' Associations[12], WMA hereafter, and the village committees. As for the drip irrigation facilities in the farms, they are managed by individual farmers. According to the beneficiary survey, 89% of farmers maintain irrigation facilities every six months or more frequently, and 22% maintain them once a month or more.

[12] Water Users' Association is in charge of maintenance of irrigation facilities and collection of water fee, etc.



Source: WRB

Figure 2 Management Structure

Branch canal (Turpan)

Grapes grown by drip irrigation (Turpan)

3.5.2 Technical Aspects of Operation and Maintenance

Technical aspect of the maintenance of main canals should not entail a problem since sufficient numbers of engineers are placed in each of the counties/cities as shown in Table 11, and the manuals are available and well-utilized. During and after the project implementation, being led by the WRM and the local government, a lot of trainings were carried out on the construction, management technology of the canals and irrigation facilities for WMAs, village committees, and the WRMS of the local governments. At every WRMS, the technical levels of the staff are classified as junior technician, intermediate technician, and advanced technician; and evaluations are conducted to maintain the technical levels of the staff. For the farmers, to get them acquainted with the use of the facilities that require high technique such as the drip or the sprinkler irrigation facilities, the technical staffs selected from the WRMS visited the villages and instructed the farmers directly about the use and management of the water-saving irrigations. Particularly, the trainings carried out in winter time (agricultural off-season) were called "The winter for science and technology," and the technical training for the WMA and village committees were carried out intensively. At the beginning of the Project, many farmers had hesitated to participate in this project because of the high level of techniques required to operate the irrigation facilities. But when the Project effects gradually became visible among some of the farmers, the neighbor-farmers who witnessed the success were inspired and became willing to learn the technique. WMA played a central role in improving the water-saving consciousness of the farmers as well as in improving the technical capability of pipe installing technology, and operation and maintenance capability of the drip and the sprinkler irrigations. In addition, WRM and the city/county governments monitored river flow and groundwater levels to control the volume of diverted water.

Table 11 Operation and maintenance work, the number of workers and technicians

	Number of groups or people	Contents of operation and maintenance work	Number of staff	Number of technicians (%)
City/county water resource management station	35 groups	Reservoir, Main canal, Branch canal	1,298	763 (59%)
Water Supply Companies (10 cities/counties)	80 groups	Branch canal	1,313	742 (57%)
Village committee	853groups	Branch & lateral canal	1,209	265 (22%)
Water Users' Association	898 groups	Water-saving irrigation facilities	1,875	686 (37%)
Farmers using drip irrigation	228,529 people	Management of drip irrigation	--	--

Source: Appraisal document, WRB

3.5.3 Financial Aspects of Operation and Maintenance

Rates of water fees vary in different cities/counties, but in general, the water fee paid by farmers ranges around 0.1 to 0.18 RMB/m^3, of which about 0.02 to 0.03 RMB/m^3 are saved for maintenance of the branch canals at WUA, and the remaining 0.07 to 0.16 RMB/m^3 is used for the maintenance of the main canals at WRMS. The average collection rate of water fees in the target sites is very high around 99%; however, the total collected amount is still insufficient to cover the maintenance cost. The local governments and the Xinjiang government subsidize the operation and maintenance costs to make up for the expenses for the shortage. Since there are financial resources such as the “basic construction budget for the water supply in small agricultural farms” in Xinjiang government, maintenance and administration of the facilities do not encounter a serious problem. As for the management of the sprinkler and pipe irrigation facilities and the branch canals, WUAs can cover the maintenance and administration expenses with the water fees collected. The facilities of the drip irrigations installed inside the farms, individual farmers bear all the maintenance and administrative expenses.

According to the beneficiary survey, 91% of the farmers replied that the collected amount of the water supply costs was adequate, and 97% replied that they paid the water fees without deficiency or delay.

At the time of the appraisal, there had been a concern that collecting water fees from the poor farmers would be difficult in two counties in south of Xinjiang, namely Kashgar and Aksu. But it has turned out that the water fee collection rates in both counties are close to 100% at the time of ex-post evaluation. The wary of difficulty in collection did not become a problem because the farmers were able to save expenditure for water fees compared with before. They reduced total consumption of the irrigation water with the introduction of water-saving irrigation facilities. Before this Project was introduced, a large quantity of irrigation water had been used for inefficient surface irrigation, which kept the water consumption and associated water fees very high. By switching to water-saving irrigation, it became possible for them to control and lessen the expenditure for water fees.

3.5.4 Current Status of Operation and Maintenance

The main canals, branch canals, pumping facilities, pipes for the drip irrigation, low-pressure pipes etc. in Turpan City, Changji City, and Shā-wān County observed during the site visit were maintained in good condition. In beneficiary survey, 98% of farmers replied that the facilities introduced by this project are operating in good condition.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion (same as "0. Summary")

China is one of the world's thirteen countries of the scarcest water endowment where the volume of its total water resources is less than a quarter of the world average. In Xinjiang Uygur Autonomous Region, hereinafter referred to as Xinjiang, annual precipitation is around 150 mm and it embraces a large rural population. For both China and Xinjiang, stable supply of water, improvement in water management ability, and improvement in agricultural productivity are important issues. Thus, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high. This project has largely achieved its objectives in terms of volume and ratio of water saved. It also contributed to increase in the crop yield and farmers' income to some extent. Therefore, its effectiveness and impact are both high. Although the project cost was lower than planned, the project period was longer than planned; therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, 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

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Since the facilities adopted in this project, such as the drip or the sprinkler irrigation, require a high level of technique for operation and maintenance, WRB and WRMS at local governments made significant efforts in the trainings and awareness raising activities for the farmers. According to WRB, it was difficult to get the understanding of the farmers for the first couple of years because the farmers thought the required techniques were too difficult for them. But after continuation of on-site technical guidance and the awareness raising activities with effective involvement of WUAs, the effects of the Project gradually became visible among some farmers. The successful cases of such farmers caught attention of neighbor-farmers. This way, the willingness had spilled over to other farmers and ended up in the active participation of many farmers in the Project. In this kind of Project where the beneficiaries are required to acquire relatively high technology or technique, awareness building is obviously important. Moreover, the presence of the farmers acting as "role models" is very important and effective to stimulate others to be their followers, as observed in this project. For a Project such as this one where

beneficiaries' ownership is crucial for technology dissemination, selecting well-motivated farmers at the initial stage to intensively strengthen their capacity to create good models would be an effective strategy.

Another lesson learned is about the cooperation of different agencies. To disseminate and to promote water-saving irrigation technology, it is considered that, by cooperating not only with the water resources sectors, but with the agricultural sectors, a higher synergy effect would be achieved. In this project, the expected effects such as the yield increase in the major crops were achieved; thus, absence of cooperation of the WRB and Agricultural Bureau was not particularly brought into question. But to avoid overlap in training menus and to make its contents even more meaningful, it would be desirable for both agencies to cooperate in planning and carrying out the trainings.

Comparison of the plan and actual of the project[13]

Items	Plan	Actual
① Outputs	① Laying concrete lining on main canals:1,256 km ② Improvement of irrigation facilities on branch canals:2,401 ha ③ Improvement of sprinkler:68,550 ha ④ Improvement of drip irrigation facilities:24,767 ha ⑤ Pipe irrigation facilities:6,797 ha ⑥ New establishment and rehabilitation of pumping wells:2,401	① Laying concrete lining on main canals:1,692 km ② Improvement of irrigation facilities on branch canals: 1,333 ha ③ Improvement of sprinkler:23,628 ha ④ Improvement of drip irrigation facilities:50,154 ha ⑤ Pipe irrigation facilities:6,647 ha ⑥ Rehabilitation of pumping wells:1,033
② Project Period	March, 2001 - December, 2006 (70 months)	March, 2001 – November, 2009 (105 months)
③ Project cost Amount paid in Foreign currency Amount paid in Local Currency Total Japanese Yen loan portion Exchange rate	 0 million yen 25,671 million yen (1,975 million RMB) 25,671 million yen 14,400 million yen 1RMB=13yen (as of March 2001)	 0 million yen 20,221.02 million yen (1,467.20 million RMB) 20,221.02 million yen 13,346.54 million yen 1RMB = 13.78205yen (Average throughout the project period)

[13] Comparison with the plan at the time of the appraisal

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Ningxia Afforestation and Vegetation Cover Project"

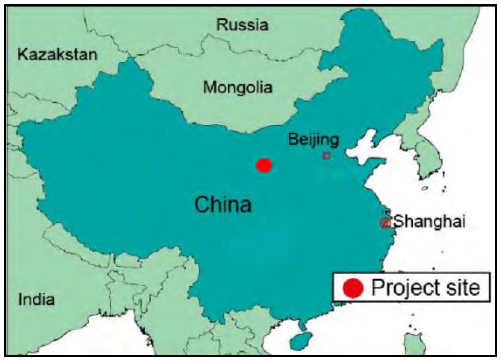
External Evaluator: Makiko Soma, Global Link Management Inc.

0. Summary

Situated in the Yellow River basin of Northwestern China, Ningxia Hui Autonomous Region, hereinafter referred to as Ningxia, is one of the areas with the severest precipitation scarcity throughout China. Controlling desertification by increasing forest and vegetation cover had been an urgent task for environmental protection of Ningxia. Poverty ratio in Ningxia had been higher than in the entire China, thus, there was a substantial need for assistance in poverty alleviation through plantation activities by the local farmers. This project was highly consistent with China's national development programs, local development needs as well as Japanese ODA policy; therefore relevancy of this project is high. The project has largely achieved its objective of increasing forest cover ratio and fenced grasslands' vegetation cover ratio; therefore its effectiveness is high. The planted economic forests and medicinal herbs have contributed to increase the income of the farmers; therefore its impact is high. Both project cost and project period were mostly as planned; therefore efficiency of the project is high.

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

1. Project Description



Location of the Project Site

Protective Sand Fixation Forest, Zhongwei

1.1 Background

Northern part of Ningxia is one of the least precipitated regions throughout China. Forest cover ratio in 2001 was 8%, roughly half of the national average, and the vegetation had been severely degraded. Under such harsh environment, uncontrolled logging, grazing and land exploitation had further accelerated desertification and threatened the people's livelihood.

According to the statistical survey in 2000, annual per capita income in the rural area of Ningxia was 1,724 RMB, about three-fourth of the national average. Poverty ratio of the Project sites had reached 10%, while it had been 3 % for all over China. The poor tended to overexploit natural resources for livelihood, which led to a vicious cycle of poverty and environmental degradation. Desertification had been one of the serious factors that had restrained the sustainable development of social-economy in Ningxia, thus its control by afforestation is an important and urgent task in environmental protection in the region.

1.2 Project Outline

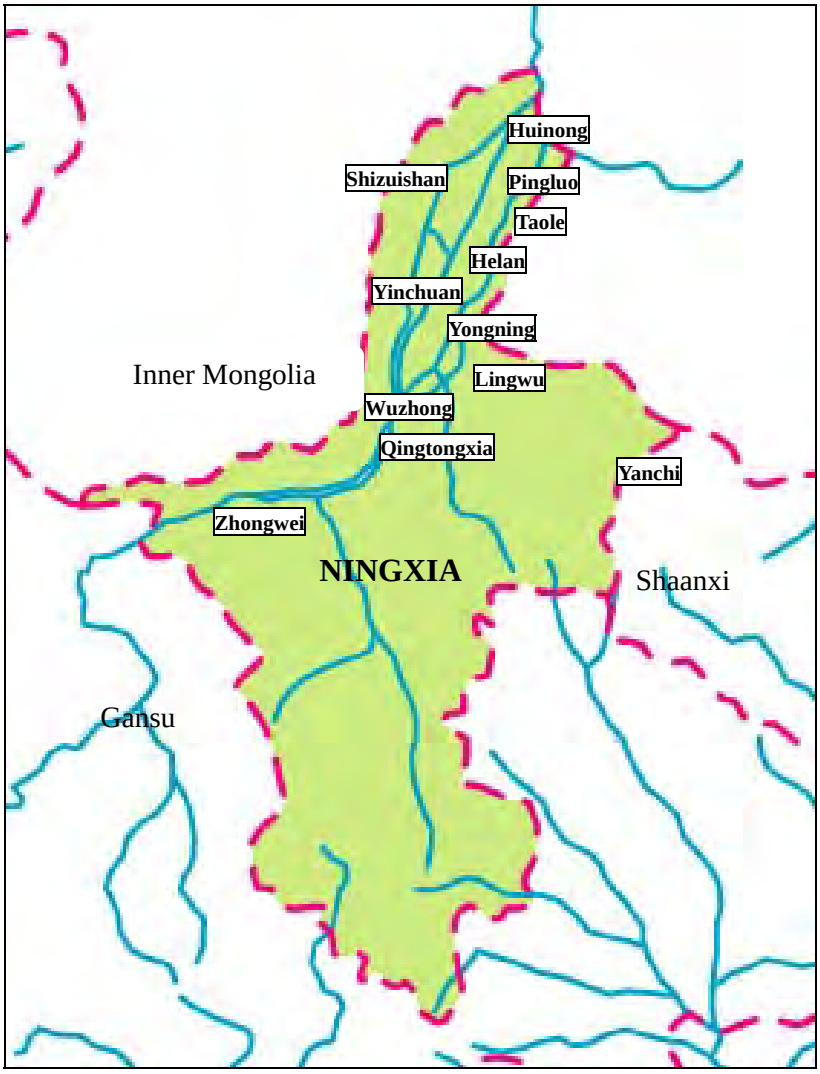


Figure 1 Map of project area (Project Areas are specified in squares)

Loan Approved Amount/ Disbursed Amount	7,977 million yen / 7,977 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 29, 2002 / March 29, 2002
Terms and Conditions	Interest Rate: 0.75 % p.a. Repayment Period: 40 years (Grace Period 10 years) Bilateral-tied
Borrower/ Executing Agency	People's Republic of China / Ningxia Hui Autonomous Region Government
Final Disbursement Date	July27, 2009
Main Contractor	None
Main Consultant	None
Feasibility Studies etc.	Feasibility Study conducted by Ningxia Academy of Forestry Planning and Design (2001)
Related Projects	JICA: Forest Protection Research Project in Ningxia-Hui Autonomous Region (1994 – 2001) JICA: The Project for Afforestation for Conservation of Middle Stream of Huang He (2000 – 2003)

The objective of this project is to increase forest cover and vegetation cover of the project sites by planting trees, shrubs and medicinal herbs; thereby controlling desertification in and around the project sites and contributing to poverty alleviation through the local people's participation in the plantation activities within 12 counties/cities in the northern part of Ningxia Hui Autonomous Region.

2. Outline of the Evaluation Study

2.1 External Evaluator

Makiko SOMA, Global Link Management Inc.

2.2 Duration of Evaluation Study

This evaluation study was conducted in the following schedule.

Duration of the Study: July, 2011 – September, 2012

Duration of the Field Study:

October 9, 2011 – October 22, 2011

February 21, 2012 – March 2, 2012

2.3 Constraints during the Evaluation Study

In consultation with the Ningxia Hui Autonomous Region, five cities/counties were selected for the beneficiary survey and site visits among the 12 target cities/counties. The five cities/counties are namely, Lingwu, Zhongwei, Wuzhong, Yinchuan, and Helan. Therefore, the results of the field study might not represent the situation of all target areas.

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevancy (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

In 1998, China State Council approved the "National Ecological Environment Construction Plan" to set the national framework of environmental conservation in the sectors of forestry, water utilization, agriculture and natural environment. The plan is divided into a short-term plan until 2010, mid-term plan until 2030, and long term-plan until 2050 to mitigate soil erosion, to conserve desertified land, and to increase forest cover etc. The short-term plan specifies the "lower and middle Yellow River basin," "upper and middle Yangtze River basin," "desertified area" and "steppes" as four priority areas. Ningxia belongs to the above "desertified area," on which this project took measures of plantation of protective sand fixation forest, economic forest, grassland formation and fencing closure.

Chinese government had continued to promote "National Ecological Environment Construction Plan" in its Eleventh National Five Years Plan (2006-2010) and prioritized environmental protection activities such as conversion of degraded farm land into forest/grass**.**

China's Twelfth National Five Years Plan (2011-2015) sets out the realization of environmentally conscious society. It aims at natural forest protection, conversion of degraded farm land into forest/grass, prevention of desertification, conservation of soil and water, protection of wetland, sand fixation, and conservation of biodiversity to prevent and mitigate natural disasters.

To address poverty, Chinese government has been carrying out "China Western Development," a fifty-year policy to redress the disparity between the eastern waterfront district and inland, since 2001.

In Ningxia, sustainable development with harmonization of economy, society and environment had been stipulated in its Eleventh Five Years Plan (2006-2010). Along with the plan, the government carried out programs and projects on natural forest protection, conversion of degraded farm land into forest/grass**,** protective forest plantation, wetland conservation, designation of natural reserves, as well as soil and water conservation.

In Ningxia's Twelfth Five Year Plan (2011-2015), afforestation, grassland protection and prevention of desertification have again been placed emphasis. Under the plan, aesthetic forests and protective forests have been established in the "Green Great Wall" project. Wetland rehabilitation, designation of comprehensive desertification prevention areas, and

[1] A: Highly Satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ②: Fair, ①: Low

grassland protection projects have also been carried out pursuant to the plan.

As stated above, at the times of both appraisal and ex-post evaluation, the objectives of the Project were in line with these national and regional policies of China and Ningxia that aimed at increasing forest and vegetation cover as well as improving the livelihood of the local populace.

3.1.2 Relevance with the Development Needs of China

Northern Ningxia is one of the areas with the severest precipitation scarcity throughout China. In 2001, forest cover was only 8% of the total land area and the land had been severely degraded due to uncontrolled logging, grazing and land exploitation. In addition to such harsh environment, the region embraced large number of rural population, thus, various projects had been carried out for livelihood improvement, securing of drinking water, and assistance for farm production.

At the time of ex-post evaluation, Ningxia Government was executing “Ningxia Central Dry Zone Development Project (2007~2011)” to cover the 67,367 ha of arable land with vegetation and to increase the forest cover ratio of Yanghua Irrigation district up to 15-20%. In Ningxia, the population under poverty line had decreased significantly from 959,000 in 2001 to 168,000 in 2009; while rural population, on the other hand, did not see a drastic decrease. In 2001, the rural population was 4.12 million and accounted for 73% of the total population; and in 2009, it was 3.88 million and still accounted for 63% of the total population in Ningxia.

At the times of both appraisal and ex-post evaluation, the objectives and approach of the Project to cover arable land with vegetation to prevent desertification as well as to improve the livelihood of the local people were in line with the development needs of the region.

3.1.3 Relevance with Japan’s ODA Policy

In “Economic Cooperation Program for China” and the “Strategy for Overseas Economic Cooperation Operations,” both laid out by Japanese government, environmental protection, poverty alleviation, and livelihood improvement of the inland were emphasized as priority issues. Therefore, this Project is consistent with aforementioned Japanese policies.

This project has been highly relevant with the country’s development plan, development needs, as well as Japan’s ODA policy; therefore its relevance is high.

3.2 Effectiveness (Ratings: ③[3])

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) Forest cover ratio / Vegetation cover ratio

The land area of the project sites in 12 counties/cities is 818,978 ha. Before the launch of the project in 2001, forest cover ratio of the area was 6.9% (56,401 ha) and fenced grasslands' vegetation cover ratio was 30%. As shown in Table 1, forest cover ratio at the time of ex-post evaluation in 2011 was 12.4% (101,533 ha) and vegetation cover ratio was 70%; both figures achieved the targets. Of the 12.4% of forest cover ratio, 1.4% was accomplished by Chinese national tree planting project.

Table 1 Forest cover ratio / Vegetation cover ratio

Indicators	Baseline (2001)	Target (2009)	Baseline (2009)	Target (2011)
Forest cover ratio in the project sites	6.9%	10%	11.4%	12.4%
Vegetation cover ratio in the fenced grasslands	30%	70%	70%	70%

Source: Appraisal document, Ningxia Agricultural Comprehensive Development Office (ACD)

(2) Other Indicators

As shown in Table 2, survival rates of both protective sand fixation forest and economic forest have achieved the targets. These target figures of survival rates are defined in "Checking regulation in project for conversion of cropland to forest."

Table 2 Survival Rates of Planted Protective Sand Fixation Forest and Economic Forest (Average of 12 Counties/ Cities)

	Target (2001)		Achievement (2004-2010)	
	1st Year	3rd Year	1st Year	3rd Year
Survival rate of protective sand fixation forest	More than 70%	65%	85%	70%
Survival rate of economic forest	More than 85%	85%	85%	85%

Source: Appraisal document, ACD

The vegetation cover ratios of grassland and medicinal-herb gardens have both achieved the target figure of 90% after 3 years of plantation. Although some planted seedlings had withered to death in several target districts due to extremely cold weather in 2004, supplemental planting was carried out to compensate for 100% of the dead seedlings in protective sand fixation forest. With respect to the expenditure for supplemental planting, local governments paid for the seedlings planted in public places while farmers paid for those planted around their farmland.

[3] Sub-rating for Effectiveness is to be put with consideration of Impacts

Protective sand fixation forest (Zhongwei)

Protective sand fixation forest around farms and lateral canal (Lingwu)

3.2.2 Qualitative Effects

In this project, beneficiary survey was conducted for a total of 100 residents in 4 target districts, namely, Yinchuan, Wuzhong, Zhongwei, and Lingwu. In the survey result, 94% of the farmers replied that "vegetation cover and forests in the region have increased." This confirms that increase in the rate of forest and vegetation cover has been recognized by the residents. In the project, planting activities were carried out in degraded lands, where there had originally been no vegetation, by developing irrigation facilities and farm roads. Construction of such infrastructure facilities enhanced efficiency in plantation and cultivation activities and in shipments of the produce from economic forest and medicinal herb gardens.

3.3 Impact

3.3.1 Intended Impacts

(1) Prevention of desertification by increased vegetation cover

This project has afforested the land area of 58,385 ha, which has contributed to the prevention of desertification exacerbation and yellow dust damages in the target areas. Vegetation cover has been increased in wastelands and bare grounds and active sand dunes have been fixed by the protective sand fixation forests. In the beneficiary survey result, 97% of the respondents replied positively to the question, "Desertification has been alleviated / greatly alleviated." Reduction of dust storm and floating dust has also been reported as follows. The contributing effects of this project on preventing desertification are recognized by residents.

- Desertification has been alleviated / greatly alleviated: 97%
- Dust storm has been reduced / greatly reduced: 96%
- Floating dust has been reduced / greatly reduced: 96%

(2) Improved standard of living of the poor in remote areas

Population living in poverty in Ningxia was 904,500 in 2001 (16.11% of the total population) and 168,000 in 2009 (2.72% of the total population). Chinese government revised the definition of poverty at the end of 2008 from annual per capita income of 1,067 RMB to 1,196 RMB.

In this project, irrigation facilities and farm roads were developed in the degraded lands where there had originally been no vegetation. In these areas, farmers planted cash crops such as wolfberry, alfalfa, licorice, jujube, and fruits by expanding farmland, which brought farmers additional sources of income. In carrying out the planting activities, large-scale farmers and grazers employed workers, and this created employment opportunities in the region. Both unit yield and unit production value of the above mentioned cash crops, with the influence of commodity price increase, have increased in 12 counties/cities as shown in Table 3.

Table 3 Unit Yield and Income Increase of Major Crops in 12 Counties/ Cities

	Before the project (2001)			After the project (2011)			Increment (%)
	Yield (tons/ha)	Unit price (RMB)	Income per 1ha (RMB)	Yield (tons/ha)	Unit price (RMB)	Income per 1ha (RMB)	
Wolfberry	2.4	16,000	38,400	2.8	28,000	78,400	204%
Alfalfa	18.6	1,100	20,460	19.5	1,500	29,250	143%
Licorice	15.4	28,000	431,200	15.7	35,000	549,500	127%
Jujube	9.5	8,600	81,700	15	12,000	180,000	220%
Fruits	8.4	2,400	20,160	10.8	3,600	38,880	193%

Source: ACD, Interview

Farmers to ship the red jujube (Yinchuan)

Licorice that is harvested in the medicinal herb garden (Lingwu)

In the result of the beneficiary survey, 73% of the respondents replied that their cash income has increased by the additional revenue from their economic forest and medicinal plants. The rest of the respondents mentioned that their crops have not yet generated income because some varieties take a long time until harvest. Plantation of economic

forests was completed in 2007, and some of the planted fruit trees require a minimum of three to five years to fruition such as apples and almonds. About the productivity of farmland, 86% of the respondents answered that it has improved, and 96% replied that the economy of the region has been activated by this project. This project has contributed to improve the livelihood of the local farmers to a certain extent.

3.3.2 Other Positive/Negative Impacts

(1) Cooperation with a local government in Japan

Ningxia has been promoting formal and informal exchanges with Shimane Prefecture since 1993. On July 30, 1997, Ningxia and Shimane signed a friendship agreement on forest reclamation and they carried out planting of 15ha in Lingwu between 1998 and 2001. Tree-planting activities have been continuously funded by both Ningxia and Shimane since then, and 400 thousand trees have been planted in the 50 ha of land to date.

(2) Participation and burdens of farmers

The number of beneficiaries of this project has reached to 63,120 households for the target of 59,372 households. The number of farmers mobilized for providing labor went up to 49,640 people for the target of 35,800 people. Both figures well exceeded the targets. According to the beneficiary survey, 76% of the residents who contributed their labor to the activities such as plantation of protective sand fixation forests or construction of main canals answered that the workload was heavy (heavy 36%, very heavy 40%). However, their actual engagement with such activities was equal or less than 4 man-days per Mu[4], which was sufficiently below the national regulations of 10 man-days per Mu in 2008. In addition, to avoid overburdening the farmers with labor contribution in protective sand fixation forest plantation activities, recommended ratios of the planting items were specified as follows: “protective sand fixation forest should be around 1.7 mu (14%), red jujube should be around 2.5 mu (21%), wolfberry should be around 5.0 mu (42%), and grassland should be around 2.8 mu (23%).” The participated farmers were monitored not to deviate greatly from these ratios and labor contribution was maintained well within the recommended ratio in actual implementation.

In this project, the local governments had made advance payments for seedlings and materials for participated farmers and asked them for repayment once they start to generate revenues from the fruit trees and medicinal plants. Loans were made available only to the farmers who had ability to repay. In some cases, large-scale farmers or village committee chiefs became borrowers on behalf of small-scale farmers. Although repayment terms are

[4] Mu is an area unit and 1 Mu = 0.067 ha.

in accordance with the conditions of ODA loans, arrangements and scheduling are made flexible (0.75% to 0.9% interest rate, repayment period of 15 years to 40 years). According to ACD, there have been no interest payments arrears. In the beneficiary survey, 80% of the residents have responded that the burden of repayment has not been excessive. In Yinchuan and part of Wuzhong, local governments paid subsidies or seedling costs to encourage farmers to switch from wheat and cotton production to economic forest, in accordance with the policy for conversion of degraded farm land into forest.

(3) Impacts on the natural and social environment

At the time of appraisal, there were concerned environmental impacts as follows: possible negative environmental impacts from the use of pesticides and insecticides, soil salinization from over-extraction of groundwater, possible negative impacts from construction activities and from the changes in land use. However, no major problem has been observed as the government strictly controlled these issues by prohibiting the use of chlorine-based pesticides or by imposing permits for groundwater pumping. Construction impacts on the environment were also strictly monitored. As for the land use change, increase in vegetation cover on the degraded land should actually be considered as positive impacts on the local environment. In the beneficiary survey, 90% of respondents answered that wind erosion and soil erosion have been reduced.

(4) Other Impacts

This project was reported in China's national newspaper such as “People’s Daily” and local newspapers in Ningxia, and in other media as a sandstorm prevention project. It was also published in 23 scientific journals. The success of the project was highly acclaimed by the Chinese government. ACD held a nationwide meeting in Ningxia in 2006 to exchange experiences about desertification prevention. Ningxia is increasing awareness as a model area for desertification prevention.

During this project, technology that had been transferred in the “Ningxia Forest Protection Research Program (April, 1994 –March, 2001),” such as controlling long-horned beetles, was widely used.

From the above, this project has largely achieved its objectives; therefore its effectiveness is high.

3.4 Efficiency (Rating: ③)

3.4.1 Project Outputs

Within the 12 counties/cities in the northern part of Ningxia Hui Autonomous Region, trees, shrubs and medicinal plants were planted and related facilities were established. The

outputs of this project were carried out mostly as planned as follows.

Table 4 List of outputs

	Target at the time of appraisal (2009 as Target Year)	Actual outputs at project completion (2009)
Afforestation and vegetation cover	57,600 ha	58,385 ha[5]
Fencing closure	26,090ha	26,090 ha
Protective sand fixation forest	12,550ha	13,200 ha
Economic forest	10,050ha	10,088 ha
Grassland formation	7,690ha	7,787 ha
Medicinal plant cultivation	1,220ha	1,220 ha
Seedling Center	1,100ha Production Capacity Arbor trees: 70 million seedlings Shrubs: 10-12 million seedlings Seeds: 16,500kg	1,122 ha Production Capacity Arbor trees: 76.5 million seedlings Shrubs: 10.98 million seedlings Seeds: 16,680 kg
Model Area Construction	1,100ha (Note)	1,064 ha
Road Construction	Main Roads (40km), Branch Roads (80km), Farm Roads (200km)	320 km
Livestock Stable Construction	100,000 m^2	103,080 m^2
Irrigation Facilities	Branch Canal (120km), Lateral Canal (294km), Farm Canal (1,350km), Sprinklers (667ha) , Drip Irrigation Facilities (667ha)	Canal (1852 km), Sprinklers (903 ha), Drip Irrigation Facilities(880 ha)
Environmental Monitoring	Procurement of monitoring equipment	30 sets
Vehicles etc.	Procurement of Vehicles, Computers, and Office Construction etc.	40 Vehicles. Office Construction
Technical Extension and Trainings	Training on plantation of trees and shrubs for participating farmers and County forestry bureau's staff. Training centers: 1 center for technicians in Yinchuan and another center for farmers in Pingluo	2850 farmers have participated in the training.

Source: Appraisal document, ACD

(Note) Although the target figure of the district model had been stated as 1100 ha in the appraisal document, ACD had recorded and recognized it as 1064 ha, which ended up in this gap of 36 ha.

The protective sand fixation forest reached 13,200 ha and exceeded the original target by 650 ha because the farmers expanded the forest voluntarily around their farms for the

[5] As reference information, examples of forest planting interval are as follows: Locust to be used for forest protection 2mx3m, fruit trees 2mx4m, *Caragana Microphylla* 2mx8m, Medlar 1mx3m, alfalfa 10cmx35cm, herbs such as licorice 10cmx25cm, and the like.

purpose of sand and wind prevention. While city and county governments absorbed the expenses for plantation in public places, the plantations made around the farms for the purpose of wind/ sand breaks were born by the farmers. Sprinkler and drip irrigation area has been increased from the original plan since more facilities were identified necessary during the implementation of the project.

Grassland (Yinchuan)

Irrigation canal (Wuzhong)

3.4.2 Project Inputs

(1) Project Cost

The actual project cost was mostly as planned (99.8% of the plan). In Japanese yen, the total project cost was budgeted as 10,683 million yen at the time of appraisal, of which the finance portion of yen loan was 7,977 million yen, consisting of 159 million yen in foreign currency and 7,818 million yen in the local currency. The rest was to be covered by the Ningxia and local governments' budget and provision of labor by farmers. The total actual project cost was 10,665 million yen, of which yen loan was 7,977 million yen, consisting of 171 million yen in foreign currency and 7,806 million yen in the local currency. The rest was covered by the Ningxia government (1,143 million yen), city and county governments (900 million yen), and provision of labor by farmers which accounted for 645 million yen.

Table 5 Actual project cost

(Unit: Million Yen)

Items	Foreign currency		Local currency		Total	
	Total	JICA funded	Total	Total	JICA funded	Total
Afforestation and vegetation cover	0	0	5,949	5,295	5,949	5,295
Auxiliary Facilities Construction and Equipment	171	171	2,910	2,511	3,081	2,682
Administration, taxes, and Interest during Construction	0	0	1,635	0	1,635	0
Total	171	171	10,494	7,806	10,665	7,977

Source: Appraisal document, ACD

Exchange rate at the time of ex-post evaluation：1 RMB = 14.3 Yen

(2) Project Period

Project period was mostly as planned. It was completed in 94 months from March 2002 (signed L/A) to December 2009 as planned. The definition of project completion is as follows.

- Afforestation and Vegetation Cover: In accordance with "Checking regulation in project for conversion of cropland to forest", to pass the inspection within 3 years after planting
- Fencing closure: In accordance with "Checking regulation in project for conversion of cropland to forest", to pass the inspection after 3 years of completion
- Infrastructure facilities and vehicles, etc.: Commissioning to the local agencies and governments

Details of the actual project period are shown in Table 6.

Table 6 Actual project period

	Project Period	
	Plantation Period	Inspection Approval (Definition of Approval)
Fencing Closure	March 2003 to December 2005	June, 2009 (At least 50% vegetation cover with more than 20% of shrubs 3 years after plantation)
Sand Fixation Forest	March 2003 to December 2007	June, 2009 (At least 70% survival 1 year after plantation. Those who did not pass the inspection after 1 year should conduct replantation to reach 70% within 3 years)
Economic Forest	March 2003 to December 2007	June, 2009 (At least 85% survival after 1 year. Those who did not pass the inspection after 1 year should conduct replantation to reach 85% within 3 years)
Grassland Formation	March 2003 to December 2006	December, 2009 (At least 80% grass cover after 3 years)
Medicinal Plants	March 2003 to December 2006	December, 2009 (At least 80% coverage after 3 years)
Road Construction	March 2003 to December 2006	
Irrigation Facility Construction	March 2003 to September 2008	
Contract with farmers	June 2003 to December 2007	
Procurement of materials	May 2003 to December 2007	
Technical training on plantation	March 2003 to June 2009	

Source: Appraisal document, ACD

The project started in March 2003, approximately one year later than planned. The postponement was due to delay in signing of L/A and entering into E/N, which was carried out at the end of March 2002 and missed the planting season in the same year. There was also a delay in planting activities of the protective forest and economic forest that had been

scheduled to be completed by the end of 2006. The delay was due to severe droughts and frosts which damaged young seedlings for which re-planting was made. Despite these delays, the plantations successfully passed the inspection within the planned period in accordance with the “Checking regulation in project for conversion of cropland to forest.”

3.4.3 Internal Rates of Return (IRR)

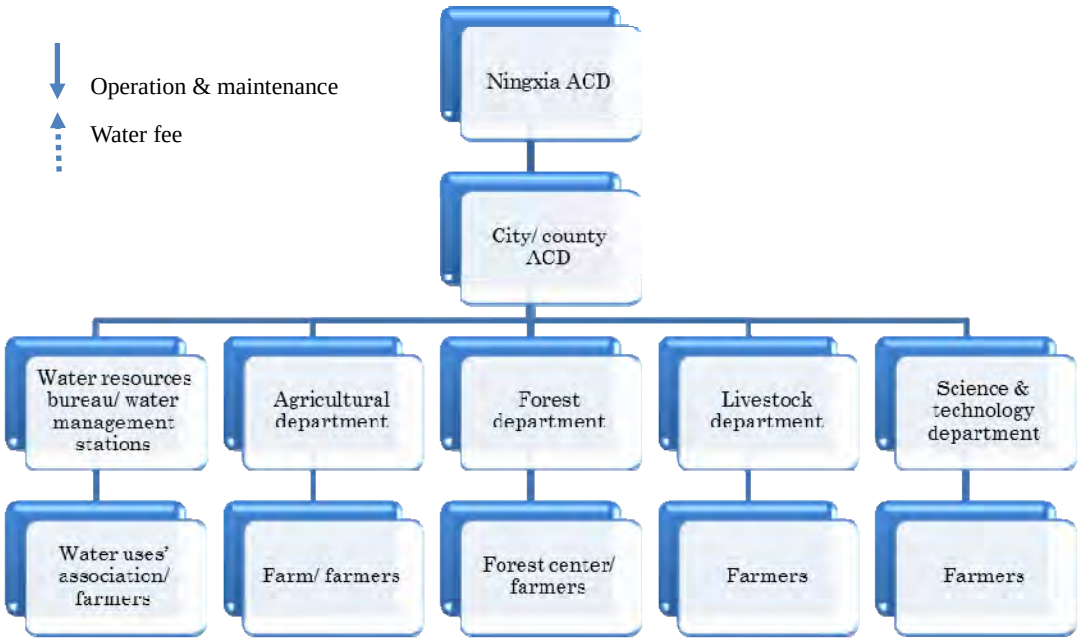
In this Project, only economic forests and medicinal plants can be monetized to see the direct effect on the income. Other components require long time for the effects to be seen. Thus, a quantitative analysis of the internal rate of return was not conducted.

Both project cost and project period were mostly as planned, therefore efficiency of the project is high.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspect of Operation and Maintenance

There is no change in the structure of operation and maintenance of the plantations and facilities constructed during the project from the original plan. The city and county governments implement the operation and maintenance of the roads, fencing closures, and protective sand fixation forests. Each farmer manages economic forests, grassland, herb gardens and the protective sand fixation forests around their farms. The model forests are managed with the cooperation of farmers and forestry bureau, while irrigation facilities are managed with the cooperation of water resources bureaus and water management associations. There are no particular problems arisen in the target areas since ACD offices have experienced similar projects in the past and have accumulated technical knowledge and know-how in the project management. Cultivation by each farmer has been actively carried out especially for economic forests, medicinal plants, and pasture, since cash income can be generated from these produce, which serves as an incentive.



Source: ACD

Figure 2 Management Structure

In this project, it was necessary to involve many actors such as the farmers and various offices of each of the 12 county/city governments (Forestry Bureaus, Agricultural Bureaus, Pastoral Bureaus, Water Management Bureaus, Science and Technology Bureaus) from the project implementation phase to maintenance, as shown in Figure 2. The reason for successful conduct of maintenance activities involving the various government agencies would be attributed to the ACD's high management capacity to oversee these institutions both at autonomous region government and local government levels.

According to the beneficiary survey results, 77% of the residents carry out daily maintenance of the trees, shrubs, herbs, grass, etc. planted in the project; while 85% do the maintenance at least once a week. Maintenance of irrigation facilities has been conducted on a regular basis in March and October every year.

Possible reasons for high ownership of the farmers would be because they had been involved in the project from the beginning and designing stage of the project and because the farmers had paid (or loaned) for their own seedlings. In part of Wuzhong and Yinchuan, although the governments had borne the cost of seedlings pursuant to the government policy of conversion of degraded farm land into forest/grass, the farmers seem to have had enough motivation to take care of the plants because the economic forests became their means to earn living after the conversion.

3.5.2 Technical Aspects of Operation and Maintenance

In this Project, afforestation technology as well as nursing and management of seedlings follow the provisions such as "provision of afforestation technology," a national standard, and "Ningxia technical provision of afforestation and sand treatment", and "Ningxia grassland management ordinance." As shown in Table 7, the number of staff and their technical level are adequate. Manuals for operation and maintenance have also been developed. As indicated in Table 8, various trainings were carried out during the implementation of the project. Even after the completion of the project, various trainings on planting, nursery, and management, etc. have been carried out by ACDs and local governments.

Table 7 Operation and administrative work, the number of workers and technicians

	Office/ entity/ individual in charge of O&M	Description of O&M work	Approx. number of O&M staff allocated
Afforestation and Vegetation Cover			
Fencing Closure	County Animal Husbandry Bureau	Fence repair, fair prevention, pest and disease control	260 (120)
Protective Sand Fixation Cover	County Forestry Bureau or Forestry Centre	Irrigation, fertilization, fire prevention, pest and disease control, pruning	860 (360)
Ecological Economic Forests	Project implementation farmers	Irrigation, fertilization, fire prevention, pest and disease control, pruning	2250 (426) (Note)
Grassland	Project implementation farmers	Irrigation, fertilization, fire prevention, pest and disease control, pruning	2010 (810) (Note)
Medicinal Herb Cultivation	Project implementation farmers	Irrigation, fertilization, fire prevention, pest and disease control	320 (196) (Note)
Seedlings & Seed Nurseries	Farm factory	Irrigation, fertilization, fire prevention, pest and disease control	128 (56) (Note)
Model Area Construction	Farm factory& Forestry Bureau	Irrigation, fertilization, fire prevention, pest and disease control, pruning	260 (145) (Note)
Road Construction	County Government	Revamping, flattening	240 (12)
Livestock Stable Construction	Farmers	Revamping	48 (6) (Note)
Irrigation Facilities Construction	Water Conservancy Bureau or	Revamping	360 (148)
Environmental Monitoring	Environmental Monitor Station	Maintenance of the facilities	18 (6)
Procured Vehicles, Computers, and Constructed Office	District and Country Project Office	Maintenance of the facilities	16 (16)

Source: ACD

(Note): Number of technicians in () refers to dedicated technicians in case of a farm; and extension workers of local government's forestry office.

Manuals have been formulated by Ningxia Forestry Bureau, local governments and in forestry centers as follows.

- Forestry Project Management Approach, 2002, Lvfeng Forestry Farm in Zhongwei City
- Water Supply and Electricity Management System, 2002, Lufeng Forestry Farm in Zhongwei City
- Lufeng Forestry Farm Safety Management System, 2002, Lufeng Forestry Farm in Zhongwei City
- Forest Production Management System, 2002, Qingtongxia Forestry Bureau
- Wells Operation and Management Approach, 2002, Shizuishan Ecological Forestry Farm
- West Mountain Shelter Forest Management Approach, 2002, Shizuishan Bureau of Parks and Woods
- Yinchuan City Western Shelter Forest Management Approach, 2003, Yinchuan Western Shelter Forest Management Office
- Returning Farmland to Forest and Grassland Management Approach, 2002, Ningxia Forestry Department

Table 8 List of trainings conducted during project implementation

Organization of trainees	Name of training provider	Training subject	Year/ Hours	Total No. of trainees
Autonomous Region Project Office	Ningxia University, Ningxia Academy of Agriculture, Beijing Chinese Medicine University, Nanjing Forestry University	Project management	2002/24	36
		Financial Management	2002/16	18
		Planting techniques of medicinal herbs	2003/12	45
		Comprehensive ecological control techniques	2005/16	34
Cities and counties Project Management Office	Ningxia University, County Agricultural Technology Promotion Center, County Agriculture Bureau, County Conservancy Bureau	Demonstration of sand treatment technology	2003/16	126
		Construction of hydraulic engineering	2003/8	108
		Seeding breeding technology	2003/16	56
		Water-saving irrigation techniques	2004/8	146
		Planting and land preparation techniques	2004/16	246
		Medicinal herb planting techniques Jujube planting techniques	2004/12	128
		Grape planting techniques	2004/6	320
		Cultivation technology of red jujube	2004/6	360
		Cultivation technology of wolfberry	2004/8	128
		Pest control techniques	2005/8	246

Source: ACD

3.5.3 Financial Aspects of Operation and Maintenance

Each county/city government bears the management cost of the protective sand fixation forests, roads, and main canals, which were established in public places. Individual farmers pay for the maintenance and management cost of economic forests, medicinal plants, and peripheral irrigation facilities. Budget of the forestry sector, operating and administrative expenses, and water fee collection revenue of 12 counties/cities in total are shown in Table 9 and 10. Both the sector budget and operating/administrative expenses have been increasing over the past five years.

Table 9 Budget of the forestry sector, operating/administrative expenses, and irrigation fee revenue of 12 counties/cities in total

(unit: million RMB)

	2007	2008	2009	2010	2011
Forestry sector budget	27,600	32,010	35,220	40,850	44,120
Allocation for Operation and Maintenance total	11,040	12,804	13,380	15,520	15,440
Revenue from water collection fees	6,950	6,490	6,980	7,100	6,990

Source: ACD

Table 10 Irrigation fee

(Unit: RMB/m^3)

	2006	2007	2008	2009	2010
Water fees	0.0195	0.0195	0.0195	0.0195	0.0195
Collection rates	98%	99%	98%	97%	98%

Source: Questionnaire responses

Note: No data available in 2011

Each county/city government spends the cost of operation and maintenance for irrigation facilities that are not covered by irrigation fee. Management of peripheral irrigation facilities can be sufficiently covered by irrigation fees. Main canal operation or large scale repair projects, on the other hand, need to be compensated and are fulfilled by the budgets of Ningxia government such as “small field irrigation basic construction expenditure” or by the budget of local governments. According to the beneficiary survey results, 96% of the residents answer that irrigation fee is reasonable.

In Zhongwei, Meili Papermaking CO. Ltd, a semi state-owned paper company, purchases the thinned trees from Lufeng Forestry Center (6,670ha), one of the project sites and provides financial resources of maintenance and management of the forest in the center.

3.5.4 Current Status of Operation and Maintenance

Operational status of established facilities is generally good. During the site visits, forests, irrigation facilities, model areas, fencing closures, and protective sand fixation

forests were managed and maintained properly.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Situated in the Yellow River basin of Northwestern China, Ningxia Hui Autonomous Region, hereinafter referred to as Ningxia, is one of the areas with the severest precipitation scarcity throughout China. Controlling desertification by increasing forest and vegetation cover had been an urgent task for environmental protection of Ningxia. Poverty ratio in Ningxia had been higher than in the entire China, thus, there was a substantial need for assistance in poverty alleviation through plantation activities by the local farmers. This project was highly consistent with China's national development programs, local development needs as well as Japanese ODA policy; therefore relevancy of this project is high. The project has largely achieved its objective of increasing forest cover ratio and fenced grasslands' vegetation cover ratio; therefore its effectiveness is high. The planted economic forests and medicinal herbs have contributed to increase the income of the farmers; therefore its impact is high. Both project cost and project period were mostly as planned, therefore efficiency of the project 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

There is no recommendation to the Executing Agency.

4.2.2 Recommendations to JICA

There is no recommendation to JICA.

4.3 Lessons Learned

There are several reasons for the success of this large-scale afforestation project in the region with such scarce precipitation. First of all, the project not only involved plantation of forests and grass, but also integrated infrastructures such as roads and irrigation facilities to augment the efficiency of the plantation and nursing activities. Secondly, high coordination and management capability of the ACD enabled the local government offices in 12 counties/ cities and farmers to collaborate efficiently. Thirdly, in technical aspect, the project was able to utilize advanced technology obtained during the preceding technical cooperation project "Ningxia Forest Protection Research Plan (April, 1994 – March, 2001)". Fourthly, farmers' involvement from

the early stages of the project enhanced their participation; and the project design that encouraged the farmers to pay (loan) for their own seedlings gave them the incentive to take care of the plants. Economic forests, medicinal plants, and pasture grass gave them increased opportunities of income generation. And this serves as the incentive for the farmers to contribute their labor in planting and maintaining the protective sand fixation forests established around their farms in order to protect their plants. For the activities that are more of a public nature such as plantation of protective sand fixation forests in public places and water canal construction, farmers were compensated with allowance, which also provided economic incentives for poor farmers to participate in the Project.

Comparison of the original and actual scope of the Project

Items	Original	Actual
1. Project Outputs	<Afforestation and vegetation cover Total> 57,600 ha Fencing closure: 26,090ha Protective sand fixation forest: 12,550ha Economic forest: 10,050ha Grassland: 7,690ha Medicinal plants: 1,220ha <Seedling center> 1,100ha <Model Area> 1,100ha <Road construction> Main road (40km), Branch roads (80km), Farm roads (200km) <Livestock stable> 100,000 m^2 <Irrigation Facilities > Branch Canal (120km), Lateral Canal (294km), Farm Canal (1,350km), Sprinklers (667ha), Drip Irrigation Facilities (667ha) <Environmental Monitoring > Procurement of monitoring equipment <Vehicles etc.> Procurement of Vehicles, Computers, and Office Construction etc. <Technical Extension and Trainings> Training on plantation of trees and shrubs for participating farmers and County forestry bureau's staff. Training centers.	Mostly as planned. <Afforestation and vegetation cover Total> 58,385 ha Fencing closure: 26,090 ha Protective sand fixation forest: 13,200 ha Economic forest: 10,088 ha Grassland: 7,787 ha Medicinal plants: 1,220 ha <Seedling center> 1,122 ha <Model Area> 1,064 ha <Road construction> 320 km <Livestock stable> 103,080 m^2 <Irrigation Facilities > Canal (1852 km), Sprinklers (903 ha), Drip Irrigation Facilities (880 ha) <Environmental Monitoring > 30 sets of monitoring equipment <Vehicles etc.> Vehicles 40. Office Construction <Technical Extension and Trainings> 2850 farmers have participated in the training.
2. Project Period	March, 2002 –December, 2009 (94 Months)	March, 2002 –December, 2009 (94 Months)
3. Project cost Amount paid in Foreign currency Amount paid in Local Currency Total Japanese Yen loan portion Exchange rate	 159 Million Yen 10,524 Million Yen (701.6 Million RMB) 10,683 Million Yen 7,977 Million Yen 1RMB=15Yen (as of September 2001)	 171 Million Yen 10,494 Million Yen (733.8 Million RMB) 10,665 Million Yen 7,977 Million Yen 1RMB=14.3Yen (average between March 2002 and July 2007)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Shanxi Wangqu Thermal Power Plant Construction Project (1) (2)"

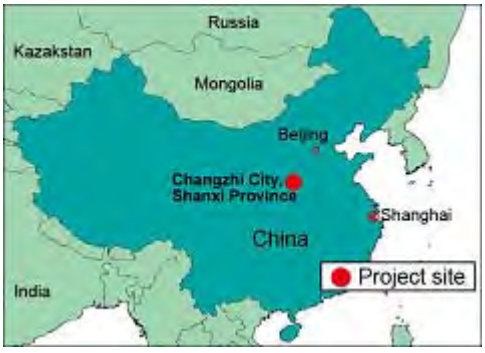
External Evaluator: Yasunori Nakamura, Global Link Management Inc.

0. Summary

The objective of this project is to contribute to accelerating the economic development in both Shandong and Shanxi provinces through meeting the increasing electricity demand in Shandong province and strengthening coal industries and power industries in Shanxi province by constructing total 1,200 coal-fired thermal power plants (600MW x 2 units) in Changzhi city, Shanxi province and transmitting the generated electricity to Shandong province. The project has been highly relevant with the country's as well as Shanxi and Shandong provinces' development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The project has largely achieved its objectives of meeting the increasing electricity demand in Shandong province, strengthening coal and electricity industries in Shanxi province and thereby fostering economic development of two provinces, therefore its effectiveness is high. Although the project cost was within the plan, the project period was exceeded on a large scale; therefore efficiency of the project is fair. Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be (B) satisfactory.

1. Project Description



Project Site

Wangqu Thermal Power Plant

1.1 Background

Between the mid-1980's and the mid-1990's, China recorded an average annual GDP growth rate of slightly less than 10 %. It recorded higher GDP growth rate of slightly less than 12 % in 1990's. As a driving force to sustain such high GDP growth, China developed more than 100,000 MW of the installed power generation capacity between 1985 and 1994. By the end of

1994, the total installed power generation capacity in China reached 197,000 MW. In the same period, the electricity supply in China increased by 2.3 times and reached 928.1 billion kWh in 1994. However, for the past 30 years, the electricity supply had never reached the electricity demand. There still existed more than 20 % of supply-demand gap in 1994. It was expected that the annual growth rate of the electricity demand would be 8% from 1995 to 2000. Accordingly, Chinese Government planned to increase the installed power generation capacity to 300,000 MW by 2000. The investment for the development of the installed power generation capacity was therefore required from China as well as from abroad.

Shanxi province, which had the largest coal reserves in China, fulfilled its electricity demand. It also transmitted its generated electricity to Beijing and Tianjin as mine mouth power producing area. Shanxi province gave high priority to construction of the power plant which transmits its generated electricity to other provinces in order to make electricity exports one of main industries of the province alongside coal exports. Meanwhile, the installed capacity of Shandong province was not able to provide enough electricity to fulfil its increasing electricity demand. It, therefore, required electricity import from mine mouth power plants.

1.2 Project Outline

The objective of this project is to meet the growing electricity demand in Shandong province and strengthen coal industries and power industries in Shanxi province by constructing total 1,200 MW coal-fired thermal power plants (600MW x 2 units) in Changzhi City, Shanxi province and transmitting the generated electricity to Shandong province, thereby contributing to the economic development in both Shandong and Shanxi provinces.

	(1) CXIX-P96	(2) CXX-P96
Loan Approved Amount/ Disbursed Amount	30,000 million yen / 26,512 million yen	27,000 million yen / 13,833 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	September, 1997 / September, 1997	December, 1998 / December, 1998
Terms and Conditions	Interest Rate: 2.3 % Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: Untied	Interest Rate: 1.8 % Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: Untied
Borrower / Executing Agency(ies)	Government of People's Republic of China/ Shanxi Lujin Wangqu Power Generation Co. Ltd.	
Final Disbursement Date	July, 2009	March, 2010
Main Contractor (Over 1 billion yen)	Doosan Babcock Energy Limited (UK), Hitachi / Itochu / Dongfang Electric Corporation of China (China), Honeywell International Inc. (US)	
Main Consultant (Over 100 million yen)	Tokyo Electric Power Services Co., Ltd.	
Feasibility Studies, etc.	"Feasibility Study for Shanxi Wangqu Power Plant Phase I" Shanxi Province Electric Power Survey and Design Institute, July, 1996	
Related Projects (if any)		

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasunori Nakamura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: July, 2011 – September, 2012

Duration of the Field Study: October 16, 2011 – October 29, 2011, February 25, 2012 – March 6, 2012

3. Results of the Evaluation (Overall Rating: B[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

The 9th Five-Year Plan (1996-2000) prioritized the development of electricity sector because the electricity demand was expected to increase. The construction of high efficiency large scale thermal power plants was set out at the centre of its development. In its 9th Five-Year Plan, the Ministry of Electric Power set forth the following policies as priorities; i) Construction of mine mouth power plants in North and Central China, which are coal producing areas, and construction of large scale transmission line to transmit the generated electricity at mine mouth power plants to East and South China, which are large electricity consuming areas, ii) Moderate development of coal-fired power plants in power generation, and iii) Acceleration of high efficiency power plants with the installed power generation capacity of more than 300 MW in order for an increase of power generation efficiency. Meanwhile, in its 9th Five-Year Plan, Shanxi province set forth a shift in its energy development policy, i.e. from 'Coal Transport by Train' to 'Electricity Transport to coastal area in East China'.

The 12th Five-Year Plan (2011-2012) sets forth the development of diversified and clean energy sources, which includes the development of clean and efficient large scale power plants. It also sets forth the acceleration of building power grid system including west-to-east power transmission (Transmitting the electricity generated at inland area of North and Central China which are rich in natural resources to coastal area in South-West China which consume large electricity). Shanxi province, in its 11th Five-Year Plan (2006-2010), plans to continue the development of coal-based electricity-centred energy industries, which fulfil the electricity demand in the province and expand the electricity supply to other provinces. Meanwhile, Shandong province, in its 12th Five-Year Plan

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ①: High, ② Fair, ③ Low

(2011-2015), plans to accelerate the electricity import from other provinces.

This project is therefore in consistent with national development plan, provincial development plans at the time of appraisal as well as at the time of the ex-post evaluation. However, in the last 2 years of the 9th Five-Year Plan, the State Development Planning Commission announced the policy to stop the approval to start the construction of new thermal power plants for 3 years from January, 1999. In this period, the electricity was oversupplied due to the structural reform in Chinese industrial sector starting in the late period of the 8th Five-Year Plan (1991-1995), Asian Currency Crisis starting in 1997 and the flood of Yangtze River in 1998. Therefore, in this certain period of the project period, this project was not consistent with a national development policy of China. However, three-year-suspension of construction of the new power plants caused the electricity supply shortage after 2002.

3.1.2 Relevance with the Development Needs of China

The electricity demand in Shandong province was 79.7 billion kWh (1996) at the time of appraisal. It was expected to increase approximately by 9.2 % per year between 1996 and 2000 and approximately by 7.2 % per year between 2001 and 2010. The required installed power generation capacity was expected to be approximately 21,630 MW in 2000 and approximately 45,090 MW in 2010. Whereas, the electricity development plan of Shandong province set out 20,930 MW in 2000 and 43,520 MW in 2010 as target installed power generation capacity. It is, therefore, expected that the electricity supply shortage would still exist in the future. Meanwhile, at the time of appraisal, out of the installed power generation capacity of 9,560 MW (1996) of Shanxi province, 1,760 MW was the electricity exported to other provinces. It planned to increase the installed power generation capacity for the electricity export to other provinces to 11,000 MW by 2010. Shanxi province had a limited coal transporting capacity. That is, in 1995, it transported 210 million tons of coal while the total transporting capacity of train in the province was 260 million tons. The demand for coal exports was expected to be 300 million tons in 2000. Therefore, it was required to export coal through electricity generation alongside increasing a transporting capacity of train.

The electricity demand in Shandong province grew approximately by 11.5 % per year between 2005 and 2010. Whereas, the electricity supply increased approximately by 8.7 % per year. Therefore, although from 2005 to 2007, the electricity supply was slightly higher than the electricity demand, the electricity supply has not met the electricity demand since 2008. Especially during the peak demand period in summer and winter, the electricity is required to be imported from the other provinces. Shanxi province, meanwhile, exports approximately 30 % of the generated electricity to other provinces between 2005 and 2009

in accordance with the provincial 11th Five-Year Plan. In addition, there is still a problem in the coal transporting capacity in Shanxi province. In 2010, 340 million tons of coal were transported while 610 million tons of coal were produced.

Table 1 Electricity Supply and Demand in Shandong Province (2005-2010)

Unit: 100,000,000kWh

Year	2005	2006	2007	2008	2009	2010
Electricity Supply	2,002	2,314	2,691	2,697	2,871	3,043
Electricity Demand	1,912	2,272	2,596	2,727	2,941	3,298

Source: Executing Agency's Reply to Questionnaire

Table 2 Electricity Supply in Shanxi Province and Electricity Supply to Other Provinces (2005-2010)

Unit: 100,000,000kWh

Year	2005	2006	2007	2008	2009	2010
Electricity Supply	1,312	1526	1,761	1,786	1,873	2,121
Electricity Supply to Other Provinces	369	432	463	486	641	-

Source: Executing Agency's Reply to Questionnaire

Note1: It was impossible to obtain the data for electricity supply to other provinces in 2010

This project is therefore in consistent with the development needs of Shandong and Shanxi provinces at the time of appraisal and at the time of the ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

Country Assistance Policy to China in Japan's ODA Annual Report (1997) indicated that 'Japan is providing assistance, primarily through ODA loans, to support improvement of economic infrastructure. In addition, in order to promote balanced development, Japan devotes more effort to China's inland regions, which have a relatively large potential for development, and provides assistance for agriculture and development of rural areas, as well as assistance to develop China's plentiful natural resources.' Meanwhile, in its 4th Yen Loan to China, which was disbursed between 1996 and 2000, Overseas Economic Cooperation Fund (OECF) emphasized the projects related to the development of the inland regions in addition to the economic infrastructure. This project, which was to contribute the improvement of economic infrastructure by using rich coal resources in China's inland regions, was in consistent with Japanese ODA policy at the time of appraisal.

This project has been highly relevant with the country's as well as provinces' development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness[3] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Operation and Effect Indicators from the project completion in 2006 to 2010 are shown below.

Table 3 Operation and Effect Indicators

			2006	2007	2008	2009	2010
Maximum Output	MW	Plan	1,200	1,200	1,200	1,200	1,200
	MW	Actual	1,200	1,200	1,200	1,200	1,200
Net Electricity Energy Production	1,000,000,000 kWh	Plan	18.9	66.3	66.3	66.3	66.3
	1,000,000,000 kWh	Actual	24.8	70.1	63.1	62.6	66.5
Plant Load Factor	%	Plan	63.26	63.26	63.26	63.26	63.26
	%	Actual	71.64	66.36	66.38	66.33	66.43
Availability Factor	%	Plan	68.49	68.49	68.49	68.49	68.49
	%	Actual	91.96	92.48	91.24	88.5	92.81
Auxiliary Power Ratio	%	Plan	4.8	4.8	4.8	4.8	4.8
	%	Actual	5.03	4.95	4.98	4.91	5.06
Gross Thermal Efficiency	%	Plan	32	32	32	32	32
	%	Actual	41.9	41.97	41.48	41.32	41.5
Outage Hours for Every Cause (Hours/Year)	Human Error		0	0	0	0	0
	Machine Trouble		65	46	13	0	0
	Planning Outage		456	1727	1526	2014	1259
Outage Hours for Every Cause (Times/Year)	Human Error		0	0	0	0	0
	Machine Trouble		8	5	4	0	0
	Planning Outage		2	2	4	4	4

Source: JICA Appraisal Documents, Executing Agency's Reply to Questionnaire

Note: Each Operation and Effect Indicator is calculated by using the following formula:

Net Electricity Energy Production	=	annual electricity production – annual electricity consumption within a plant
Plant Load Factor	=	annual electricity production/(rated output x number of hours a year) x 100
Availability Factor	=	(hours of operation a year/ number of hours a year) x100
Auxiliary Power Ration	=	(annual electricity consumption within a plat/annual electricity production) x 100
Gross Thermal Efficiency	=	(annual electricity production x 860) / (annual fuel consumption volume x fuel calorific value) x 100

At the time of appraisal, operation and effect indicators were not planned. Therefore, at the time of the ex-post evaluation, planned operation and effect indicators for reference were calculated by referring the data applied in Financial Internal Rate of Return (FIRR)

[3] Sub-rating for Effectiveness is to be put with consideration of Impact

calculation at the time of appraisal, and then compared with the actual data. As a result of such comparison, all indicators mostly met the planned indicators for reference. There were outage hours caused by machine troubles in 2006, 2007 and 2008. The reasons for the machine troubles were as follows; steam leaked out of a boiler during commissioning, bottom ash[4] turned into a solid mass at bottom of a boiler due to a change of coal and an unstable ignition in a boiler made protection system activated. These machine troubles were properly repaired. At the time of the ex-post evaluation, the power plant was operated without machine troubles.

The electricity generated at the power plant is transmitted to the power grid in Shandong province through Lucheng Switching Station, Handan East Xin'an Substation in Hebei province with 500 kV double-circuit line. At the time of appraisal, the transmission lines between Wangqu Power Plant and Laiyang Substation in Shandong province were planned to be constructed with Yen loan project and Chinese local currency. However, Yen loan was cancelled due to Chinese Government's request and the procurement for transmission lines from Wangqu Power Plant to Shandong province was done only with Chinese local currency.

Transmission line from Wangue Power Plant to Shandong Province

3.2.2 Qualitative Effects

(1) Efficient use of coal resources

Wangqu Power Plant contributes to efficient use of coal resources of Shanxi province, which has a limited coal transportation capacity, by consuming approximately 2.5 million tons of coal per year at the power plant which transmits its generated electricity to other provinces. The interview with a coal company in Shanxi province also reveals that Wangqu Power Plant contributes to an increase of coal production in Shanxi province by consuming coal (Refer to Box 1).

(2) Improvement of living standards by stable electricity supply

Wangqu Power Plant has transmitted stable electricity of over 6 billion kWh, which is equivalent to approximately 2-3 % of the electricity demand in Shandong province, to Shandong province since 2007. Growth Domestic Production (GDP) per capita in

[4] Coal ash dropped on the bottom of a boiler after coal combustion.

Shandong province increased annually by 15% on average from 2006, when Wangqu Power Plant was constructed, to 2010. In contrast, Consumer Price Index (CPI) increased annually by 3.6% in the same period, therefore it can be said that living standards in Shandong province improved from economic view point. However, Wangqu Power Plant supplies only approximately 2-3% of the electricity demand in Shandong province. In addition, the electricity supply in Shandong province increased approximately by 35 billion kWh per year between 2005 and 2007. Therefore it is difficult to identify direct impact of this project on growth of GDP per capita in Shandong province. Whereas, the interview with a company in Shandong province reveals that (although it is difficult to identify the direct impact of this project) since 2007 there have been the decrease in frequency of electricity restrictions and the improvement in electricity stability, which enabled full operation of its factory and increased its producing capacity . Considering such fact, it can be considered that Wangqu Power Plant, which has transmitted the stable electricity to Shandong province since 2007, has contributed to revitalization of economic activities in Shandong province through playing a part in stabilization of the electricity in Shandong province.

Box 1 Notes: Interview with Electricity bulk users

CET Shandong Power Equipment Co. Ltd. (Jinan, Shandong province)

Transformers manufacturing company established in 1958 and having 1,300 employees. 'Since 2007, both the electricity supply and electricity stability have been improved. Business profit was increased by 22 times between 2006 and 2009. An increase in the demand of transformers is the biggest factor for such increase. However an increase of producing capacity is also an important factor. That is, since 2007, there have been less electricity restrictions, and it has got possible to run the factory at full capacity and a producing capacity has been also increased. Whereas, it is impossible to see a direct impact of Wangqu Power Plant in it because the electricity is procured from power grid of Shandong province.'

Luan Mining Group (Changzhi, Shanxi province)

3rd largest mining company in Changzhi established in 1987 and having 980 employees. 'Since 2005, coal production has been increased by 10 million tons annually. 0.6 to 0.7 million tons of coal are yearly supplied to Wangqu Power Plant. Business profit has increased by 5 times between 2005 and 2010. In addition to an increase in coal production, an increase in coal price has contributed to an increase in business profit. In Shanxi province, which has limited coal transportation capacity, it is beneficial for coal industries that power plants like Wangqu consumes coal in the province and exports the electricity to other provinces.'

Shanxi Coal Transportation and Sales Group Co. Ltd. (Changzhi, Shanxi province)

Coal trading company in Changzhi established in 2006 and having 60 employees. 'Coal provided to Wangqu Power Plant by trucks are supplied by our company. Coal is procured from regional small coal mining companies in Changzhi. One third of coal treated by our company, which amounts to approximately 1.6-1.8 million tons per year, is sold to Wangqu Power Plant.'

3.3 Impact

3.3.1 Intended Impacts

(1) Economic development in Shandong province by meeting the electricity demand

The below table shows GDP and industrial sector[5]'s share in GDP of Shandong province in the last 5 years.

Table 4 GDP and Industrial Sector's share in GDP of Shandong Province (2006-2010)

Unit: million yuan

Year	2006	2007	2008	2009	2010
GDP (Actual)	2,430,501	2,775,632	3,108,708	3,487,970	3,916,992
Industrial Sector's Share	52.8%	52.0%	52.1%	49.8%	47.9%

Source: National Bureau of Statistics of China

Table 5 Industrial sector's share in electricity consumption in Shaanxi Province (2006-2010)

Year	2006	2007	2008	2009	2010
Industrial Sector's Share	79.9%	79.9%	78.9%	78.3%	77.5%

Source: National Bureau of Statistics of China

Average annual GDP growth rate from 2006 to 2010 was 12.7%. However, with regard to a contribution of this project to such GDP growth, it is difficult to identify how much Wangqu Power Plant has directly contributed to economic development of Shandong province. For, as mentioned in 3.2.2, the electricity supply in Shandong province increased approximately 31.2 billion kWh between 2005 and 2006 while it has also increased annually by 8.73 % on average between 2006 and 2010. Whereas, the industrial sector had approximately 50% share in GDP of Shandong province between 2006 and 2010 and was the biggest component of GDP in Shandong province while as shown in Table 5, the industrial sector had approximately 80% share in the electricity consumption of Shandong province. Considering these facts, it can be considered that this project has partly contributed to the economic development of Shandong province through the stable electricity supply[6].

(2) Economic Development of Shanxi province through the development of coal industries and power industries

The below table shows nominal GDP and energy sector's GDP of Changzhi city, prefecture-level city of Shanxi province, and Lucheng city, country-level city of Changzhi city, where Wangqu Power Plant is located[7].

---

[5] Industrial sector includes mining, manufacturing, electric/gas/water industries.

[6] This evaluation presupposes that the electricity supplied to the power grid of Shandong province is distributed equally to each sector.

[7] Nominal GDP was used for Changzhi and Lucheng city because actual GDP data were not able to be obtained. .

Table 6 Nominal GDP and Energy Sector's GDP of Changzhi City and Lucheng City (2005-2010)

Unit: million yuan

	2006	2007	2008	2009	2010
Changzhi City's GDP (Energy Sector)	46,040 (24,520)	55,060 (30,270)	68,210 (40,140)	77,530 (45,280)	92,020 (57,290)
Lucheng City's GDP (Energy Sector)	4,810 (3,030)	5,650 (4,420)	6,210 (4,860)	6,750 (5,100)	7,210 (5,370)

Source: Lucheng City Economic and Information Technology Commission

Annual GDP growth rate in Changzhi city from 2006 to 2010 is 18.9% on average while annual GDP growth of energy sector is 23.6% on average during the same period. Meanwhile, annual GDP growth rate in Luchange city is 10.65 % on average while annual GDP growth rate of industrial sector is 15.38 % on average during the same period. It is, therefore, able to see that energy sector is a driving force for GPD growth in both cities. With regard to the contribution of this project, according to Lucheng city, Wangqu Power Plant consisted of 10-20 % of its tax revenue in the same period. This shows that Wangqu Power Plant has large economic impact in Lucheng city. Therefore, it can be said that Wangqu Powe Plant's contribution to the development of electricity industries and economic development in Lucheng city is large. Meanwhile, Wangqu Power Plant purchased approximately 2.5 million tons of coal, which is equivalent to approximately 2.5% of coal production in Changzhi city in 2011[8], from mining companies and coal trading companies in Changzhi city. Therefore, it can be considered that the Power Plant plays a role in the development of coal industries in Changzhi city.

3.3.2 Other Impacts

(1) Impacts on the natural environment

① Fuel Gas

Following measures against fuel gas emission were taken as planned at the time of appraisal; i) low-sulfer coal of 0.35 % sulphur was used for a measure against Sulfer Oxides (SOx), ii) low-Nox burners and two stage combustion were installed for a measure against Nitrogen Oxides (Nox), and iii) high-performance electrostatic precipitators with more than 99 % dust collection for measure against dust emission. In addition, in accordance with the revision of Emission Standard for Air Pollutants for Thermal Power Plants of China (hereafter referred to as 'Emission Standard') in 2003, which requested to be followed by 2004, the project procured 2 units of fuel gas desulfurization (FGD) at its own cost in 2005 and 2006[9]. As a result, all actual fuel gas

[8] Source: Popular Government of Changzhi City

[9] At the time of appraisal, planned SOx concentration was 590.5mg/Nm3. Whereas, SOx concentration set forth in

emission met Emission Standard. Meanwhile, the power plant installed an online monitoring system in 2009. Shanxi province environmental protection agency monitors all fuel gas emission from Wangqu Power Plant through this monitoring system. Emission Standard was also revised in 2012 and existing power plants are requested to take necessary countermeasures to meet new standards by 2014. Because Wangqu Power Plant does not meet the new standard for NOx, it is required to take necessary countermeasure to meet the new standard. With regard to new Emission Standard, mercury emission standard of 0.03 mg/Nm^3 is added and is requested to be met by 2015. However, detailed information on mercury concentration standard has not yet come from the provincial environmental protection agency.

Fuel Gas Monitoring System

Network Equipment for Online monitoring system

Table 7 Emission Standard for Air Pollutants for Thermal Power Plants

Standard / Item	-	New Standard (2012) (GB13223-2011)	At completion of the project (GB13223-2003)	At the time of appraisal (GB13223-91)
	Actual (2011)	Standard	Standard	Standard
SOx	104.74mg/Nm^3	200mg/Nm^3	400mg/Nm^3	-[10]
NOx	254.21mg/Nm^3	100mg/Nm^3	650mg/Nm^3	-
Dust	25mg/Nm^3	30mg/Nm^3	50mg/Nm^3	469mg/Nm^3

Source: Executing Agency's Reply to Questionnaire
Note: New Standard (GB13223-2011) will be applied from 2014 for existing power plants

② Noise

As a measure against noise, sound wall was installed. As a result, actual noise meets the standard.

---

the Emission Standard was 400mg/Nm^3.

[10] While SOx concentration was not set forth, the amount of SOx emission was set forth as 20,440 kg/h (without FGD).

Table 8 Emission Standard for noise

Standard / Item	-	Latest (GB12384-2008)	At the time of appraisal/ At the project completion (GB12384-90)
	Actual	Standard	Standard
Noise level	45.9-49.1dB (Night) / 47.9-52dB (Day)	50dB (Night) 60dB (Day)	50dB (Night) /60dB (Day)

Source: Executing Agency's Reply to Questionnaire

③ Others (Effluent, Ash Treatment, Coal Yard[11])

With regard to effluent, it was planned to discharge the wastewater into the river after water treatment within the standard. However, according to the executing agency, the wastewater are treated with wastewater treatment system and fully recycled in the power plant. Site inspection during the ex-post evaluation found that fly ash is disposed in a landfill at the disposal site located about 2 Km north-west of the power plant as planned at the time of appraisal. As a measure against powder dust from fly ash, followings measures were planned and actually implemented; fly ash is transported with trucks with water spray system and belt conveyer with dust cover, fly ash is consolidated periodically with water spray, and trees and grass are planted around the disposal site. Meanwhile, yellow soil lining[12] is also used in order to avoid polluting groundwater. A measure against powder dust at coal yard is also taken as planned at the time of appraisal. That is, sprinkler and fence are installed, trees are planted and special road for the trucks transporting coal is prepared.

(2) Land Acquisition and Resettlement

A discussion on land acquisition was completed at the time of appraisal while there was not resettlement required. The acquired land was approximately 1.59 km^2[13].

(3) Other positive/negative impact

With regard to other positive impact, there is an employment creation at local area. Among major staffs at Wangqu Power Plant, 40 % were hired at local area while 270 staffs are employed for cargo carriers, cleaners and guards.

This project has largely achieved its objectives, therefore its effectiveness is high.

---

11 There are no standards for ash treatment and coal yard. The site inspection at the time of the ex-post evaluation found that there was no powder dust from the ash disposal site and coal yard

12 To cover yellow soil, which has high water holding capacity, in order to avoid water from seeping into the underground.

13 The land is for phase I which was financed by this project and for phase II which is now under preparation.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The below table shows the output (plan/actual) of this project.

Table 9 Output (Plan/Actual)

	Numbers, Specification	
	Plan	Actual
Boiler	2 units, Supercritical pressure coal fired	Same as planned
Turbine Generator	2 unites, Output 600MW,Reheat condensing tandem compound, 50Hz, 3,000pm, Water-Hydrogen Cooling System	Same as planned
Main Transformer	2 x 3 x 240 MVA + 1 x 240 MVA	Same as planned
Instruments & Control	Dispersed Control System (DCS)	Same as planned
Coal Pulverizer	High level of pulverization, Middle Speed	Same as planned
Combustion System	-	Same as planned
Water Treatment System	400m^3/h	Same as planned
Electrostatic Precipitator	2 units, dust collection efficiency more than 99 %	Same as planned
Stack	Double-shaft 220m x 1 units	Same as planned
Coal Handling System	Truck-hopper 2 units, Bottom-hopper, Coal Storage 200,000 tons, Coal Bin 6 units, Unloader 700,000 tons/year	Same as planned
Ash Handling System	Dry type	Same as planned
Cooling Tower	Natural Draft 2 units, Spray area 7,500 m^2, Height 135 m	Same as planned
Switch Yard	500kV and 220kV	Same as planned
Hydrogen producing device	-	Same as planned
Consulting Services	Total107M/M Project Manager 23M/M, Mechanical Engineer (2) 28M/M, Electrical Engineer (2) 28M/M, I&C Engineer (2) 28M/M provide following services; ① Assistance in finalizing bidding documents ② Assistance in bid evaluation ③ Assistance in technical contract negotiation ④ Assistance in designs ⑤ Supervision for progress of project ⑥ Assistance in commissioning	Total121M/M Preparation for Bidding documents for Boiler and Turbine Generator (27.9M/M) Preparation/Contract Conclusion for Transformer, Combustion system (15.1M/M) Management for designs (61M/M) Commissioning (10M/M) Performance test (7.0M/M)
FGD	-	Added. 2 units, SOx removal efficiency of more than 97 %

Source: JICA appraisal documents, Executing Agency's Reply to Questionnaire

Project outputs were mostly realized as planned at the time of appraisal. However, additional 14 M/M were used for consulting services due to the late in the bidding process affected by the late in the construction approval in China. Meanwhile, the project procured 2 units of FGD in order to meet the standard for SOx, whose emission concentration standard was additionally set out when Emission Standard was revised.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned project cost was 138,492 million yen (Foreign currency 57,082 million yen/Local currency 81,410 million yen) while the actual project cost was 69,960 million yen (Foreign currency 40,345 yen/Local currency 29,615 yen). The actual project cost was 51% of the planned project cost and lower than planned. The cost for consulting services, for which more M/M was used, was also under the planned cost.

Table 10 Project Cost (Plan/Actual)

	Plan					Actual			
	FC		LC	TOTAL		FC	LC	TOTAL	
	million yen	Loan in 1997	million yuan	million yuan	million yen	million yen	million yuan	million yuan	million yen
Boiler	21,391	13,440	554	2,127	28,925	18,946	-	1,324	18,946
Turbine	24,886	11,577	469	2,299	31,264	19,761	-	1,381	19,761
I&C	2,512	855	110	295	4,008	1,086	-	75	1,086
Sub-station (Swithgear)	1,651	674	263	384	5,228	-	218	218	3,117
Construction Machinery	329	329	-	24	329	-	83	83	1,187
Laboratory Equipment	249	249	45	63	86	-	10	10	143
Transportation Equipment	-	-	74	74	1,006	-	10	10	143
Auxiliary Equipment	-	-	189	189	2,570	-	1	1	14
Welfare Equipment	-	-	44	44	598	-	1	1	14
Railroad outside the plant	-	-	165	165	2,244	-	104	104	1,487
Microwave Equipment	-	-	5	5	68	-	-	-	-
Custom and import tax	-	-	1,216	1,216	16,538	-	0	0.0	5
Others	-	-	703	703	9,561	192	-	14	192
FGD	-	-	-	-	-	-	117	117	1,673
Construction Engineering	-	-	-	-	-	-	1,037	1,037	14,829

	Plan					Actual			
	FC		LC	TOTAL		FC	LC	TOTAL	
	million yen	Loan in 1997	million yuan	million yuan	million yen	million yen	million yuan	million yuan	million yen
Installation Engineering	-	-	-	-	-	-	489	489	6,993
SUB-TOTAL	51,018	27,124	3,837	7,588	103,201	39,985	2,071	4,894	69,600
Consultant	379	379	-	28	379	359	-	25	359
Price Escalation	2,985	1,087	1,864	2,083	28,335	-	-	-	-
Physical Contingency	2,700	1,410	285	484	6,576	-	-	-	-
TOTAL	57,082	30,000	5,986	10,183	138,492	40,345	2,071	4,920	69,960

Source: JICA Appraisal Documents, Executing Agency's Reply to Questionnaire

Note: Exchange rate at the time of appraisal 1 yuan = 13.6 yen, Exchange rate at the time of the ex-post evaluation 1 yuan = 14.3 yen (Average during loan period)

The followings are the main reasons for reduction of the project cost.

① Foreign procurement spent less cost as a result of international competitive bidding which was affected by huge decrease in material prices such as steal price

② The decrease of material prices in China

③ Customs and import tax were not applied because National Development and Reform Commission approved to apply tax exemption for equipment import for this project in 2004.

There was a restriction in the evaluation of the cost efficiency. That is, because the executing agency used cost items which were different from those at the time of appraisal, it was difficult to compare the project cost for each item. According to the executing agency, such difference was caused by change of the executing agencies during the project implementation period.

3.4.2.2 Project Period

The project period was significantly longer than planned. At the time of appraisal, the project period was planned to be 72 months from January, 1997 (Starting month of reviewing conceptual design) to December, 2002 (Commissioning of Unit 2). However, the actual project period was 116 months from January, 1997 to August, 2006, which are 161% of the planned project period.

The followings are the main reasons for such excess.

① As described in the relevance clause, the electricity reform by State Development Planning Commission restricted its approval to start construction of the new power

plant for 3 years from 1999. An approval of construction for this project was also postponed for 53 months from December, 1997 to April, 2002.

② An approval of the feasibility study by the State Council was delayed for 15 months from June, 1997 to August, 1998 due to a delay in the project procedure in China.

Meanwhile, with regard to the period from the approval of construction to commissioning of unit 2, it was planned to be 61 months from December, 1997 to December 2002. However, it was actually 52 months from April, 2002 to August, 2006, which are 85 % of the planned period.

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

At the time of the ex-post evaluation, FIRR was recalculated to 6.06%, which is lower than the planned FIRR of 15.63%. Main reasons for such reduction are as follows; the coal price was much higher than planned, the electricity selling price was lower than planned and the local tax rate was higher than planned. However, according to the executing agency, because it is difficult to estimate the coal price and the electricity selling price in the future, the actual contract price in 2012 is applied for the coal price in the future while the electricity selling price after 2012 is calculated by using the increase rate of the electricity selling price between 2010 and 2011. Therefore, recalculated FIRR are not calculated based on the accurate estimation. Economic Internal Rate of Return (EIRR) was not calculated at the time of appraisal.

Although the project cost was within the plan, the project period was exceeded, therefore efficiency of the project is fair.

3.5 Sustainability (Rating: ②)

3.5.1 Structural Aspects of Operation and Maintenance

The power plant is owned by Shanxi Lujing Wangqu Power Generation Co., Ltd., a company invested by Shandong Luneng Group[14] (75%), Shandong International Trust Company Limited (20%), Emerging Energy Industry Group Ltd., Shanxi (5%) while it outsources operation and maintenance of the power plant to CPI North China Power Investment Power Engineering Co., Ltd(hereafter referred to as 'CPI') , a company invested by China Power Investment Corporation (51%) and Shanxi Zhangze Electric Power Co. Ltd. (49%). CPI allocates 132 staffs for integrated management, machine maintenance, electric maintenance, ash maintenance, fuel maintenance of Wangqu Power Plant.

[14] Shandong Luneng Group is owned by State Grid Corporation of China.

3.5.2 Technical Aspects of Operation and Maintenance

Among CPI staffs deployed for operation and maintenance of the power plant, 50 % are graduates from higher education. Over 65% has the working experience in power plants for more than 20 years.

With regard to the training courses for operation and maintenance, there are training courses for annual check and dehydration warehouse[15] renovation. As of today, 26 staffs and 42 staffs have taken the courses respectively. As the manuals for operation and maintenance, manuals are prepared for production supervision and management, safety rules, equipment maintenance and equipment management.

3.5.3 Financial Aspects of Operation and Maintenance

Business profit has been negative since 2008. Main reasons for such loss are the increase of main business cost due to the increase in coal price and the slow increase of main business income due to the control of the electricity selling price by the Government. Main business cost has increased by 30% since 2008 onward compared with 2007 due to the increase in the coal price. Whereas, main business income has increased by less than 10% during the same period because the electricity selling price has been controlled to stay low by the Chinese government. However, according to the executing agency, a discussion with the National Development and Reform Committee and the State Grid Corporation by Shandong Luneng Group, which is a top share holder of the company, has resulted in the increase of the electricity selling price by 19.8% since April, 2011. The executing agency forecast that the business profit in 2011 will be surplus. The financial sustainability in the future would not have a problem considering that the Chinese Government works on the stabilization of the coal price which causes the increase of the main business cost of the power plants. For example, the National Development Reform Commission notified the request to keep the coal price at the level of the previous year in April, 2011. Meanwhile, because the Power Plant has to take necessary measure in accordance with the new Emission Standard, the modification costs of the facilities will be required. According to the executing agency, such cost is included in its financial plan.

[15] Device to dehydrate bottom ash.

Table 11 Financial Status (2007-2010)

Unit: 1000 yuan

	2007	2008	2009	2010
Main Business Income	1,836,431	1,737,538	1,856,771	1,989,409
Main Operation cost	1,349,430	1,726,832	1,708,570	1,800,194
Business tax & VAT	24,212	15,847	12,186	13,198
Profit from main business	462,789	-5,141	136,015	176,017
Income from other business	0	209	371	2,981
Cost from other business	0	18	588	528
Financing costs	161,560	212,086	146,514	411,774
Business profit	301,229	-217,036	-10,716	-233,304

Source: Profit and Loss Statement

3.5.4 Current Status of Operation and Maintenance

In addition to a daily check, the power plant has 5-year cycle annual check which consists of 4 times of C-check (25 days) and one A-check (60 days). Since the start of the operation, the power plant has conducted annual check as planned and realized stable electricity supply.

Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project is to meet the growing electricity demand in Shandong province and strengthen coal industries and power industries in Shanxi province by constructing total 1,200 MW (600MW x 2) coal-fired thermal power plant in Changzhi City, Shanxi province and transmitting the generated electricity to Shandong province, thereby contributing to the economic development in both Shandong and Shanxi provinces. The project has been highly relevant with the country's as well as Shanxi and Shandong provinces' development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The project has largely achieved its objectives of meeting the increasing electricity demand in Shandong province, strengthening coal and electricity industries in Shanxi province and thereby fostering economic development of two provinces, therefore its effectiveness is high. Although the project cost was within the plan, the project period was exceeded on a large scale; therefore efficiency of the project is fair. Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be (B) satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Countermeasure to reduce NOx concentration should be taken by 2014 to meet the new Emission Standard. With regard to mercury concentration standard, the sensor to measure mercury concentration should be installed and, if required, necessary measure to meet the standard should be taken by 2015.

(2) The executing agency should take measure to secure financial sustainability of the power plant, for example continuing the discussion with the National Development and Reform Commission, Shandong provincial government and State Grid Corporation together with Shandong Lunang Group in order to increase the electricity selling price or obtain the subsidies for power plant operation.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

None.

End

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs		
Boiler	2 units, Supercritical pressure coal fired	Same as planned
Turbine Generator	2 unites, Output 600MW, Reheat condensing tandem compound, 50Hz, 3,000pm, Water-Hydrogen Cooling System	Same as planned
Main Transformer	2 x 3 x 240 MVA + 1 x 240 MVA	Same as planned
Instruments & Control	Dispersed Control System (DCS)	Same as planned
Coal Pulverizer	High level of pulverization, Middle Speed	Same as planned
Combustion System	-	Same as planned
Water Treatment System	400m^3/h	Same as planned
Electrostatic Precipitator	2 units, dust collection efficiency more than 99 %	Same as planned
Stack	Double-shaft 220m x 1 units	Same as planned
Coal Handling System	Truck-hopper 2 units, Bottom-hopper, Coal Storage 200,000 tons, Coal Bin 6 units, Unloader 700,000 tons/year	Same as planned
Ash Handling System	Dry type	Same as planned
Cooling Tower	Natural Draft 2 units, Spray area 7,500 m^2, Height 135 m	Same as planned
Switch Yard	500kV and 220kV	Same as planned
Hydrogen producing device	-	Same as planned
Consulting Services	Total107M/M Project Manager 23M/M, Mechanical Engineer (2) 28M/M, Electrical Engineer (2) 28M/M, I&C Engineer (2) 28M/M provide following services; ① Assistance in finalizing bidding documents ② Assistance in bid evaluation ③ Assistance in technical contract negotiation ④ Assistance in designs ⑤ Supervision for progress of project ⑥ Assistance in commissioning	Total121M/M Preparation for Bidding documents for Boiler and Turbine Generator (27.9M/M) Preparation/Contract Conclusion for Transformer, Combustion system (15.1M/M) Management for designs (61M/M) Commissioning (10M/M) Performance test (7.0M/M)
FGD	-	Added. 2 units, SOx removal efficiency of more than 97 %
2. Project Period	January, 1997 – December, 2002 (72 months)	January, 1997 – August, 2006 (116 months)
3. Project Cost		
Amount paid in Foreign currency	57,082million yen	40,345million yen
Amount paid in Local currency	81,410million yen (5,986 million yuan)	29,325million yen (2,071 million yuan)
Total	138,492million yen	69,960million yen
Japanese ODA loan portion	57,082million yen	40,345million yen
Exchange rate	1 yuan = 14.6 yen (As of February, 1997)	1 yuan = 14.36 yen (Average between September 1997 and March, 2010)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Shaanxi Hancheng NO.2 Thermal Power Plant Construction Project (1) (2)"

External Evaluator: Yasunori Nakamura, Global Link Management Inc.

0. Summary

The objective of this project is to meet the growing electricity demand in Shaanxi province by constructing total 1,200MW coal-fired thermal power plants (600MW x 2 units), thereby contributing to the regional economic development. The project has been highly relevant with the country's as well as Shaanxi province's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The project has largely achieved its objectives of meeting the increasing electricity demand in Shaanxi province and thereby fostering economic development of the province, therefore its effectiveness is high. Although the project cost was within the plan, the project period was exceeded on a large scale; therefore efficiency of the project is fair. Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be (B) satisfactory.

1. Project Description

Project Location

Hancheng No.2 Thermal Power Plant

1.1 Background

Between the mid-1980's and the mid-1990's, China recorded an average annual GDP growth rate of slightly less than 10 %. It recorded higher GDP growth rate of slightly less than 12 % in 1990's. As a driving force to sustain such high GDP growth, China developed more than 100,000MW of the installed power generation capacity between 1985 and 1994. By the end of 1994, the total installed power generation capacity in China reached 197,000MW. In the same period, the electricity supply in China increased by 2.3 times and reached 928.1 billion kWh in

1994. However, for the past 30 years, the electricity supply had never reached the electricity demand. There still existed more than 20 % of supply-demand gap in 1994. It was expected that the annual growth rate of the electricity demand would be 8% from 1995 to 2000. Accordingly, the Chinese Government planned to increase the installed power generation capacity to 300,000MW by 2000. The investment for the development of the installed power generation capacity was therefore required from China as well as from abroad.

Shaanxi province had rich coal resources. Especially, Hancheng city area, which was the project location of this project, was called "Black Belt" and was one of main coal producing areas in the province. However, despite of such rich natural energy resources, Shaanxi province had not developed an adequate installed power generation capacity. It did not meet even the electricity demand in the province.

1.2 Project Outline

The objective of this project is to meet the growing electricity demand in Shaanxi province by constructing total 1,200MW coal-fired thermal power plants (600MW x 2 units), thereby contributing to the regional economic development.

	(1) CXIX-P95	(2) CXX-P95
Loan Approved Amount/ Disbursed Amount	35,000 million yen / 28,464 million yen	22,970 million yen/ 5,702 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	September, 1997 / September, 1997	December, 1998 / December, 1998
Terms and Conditions	Interest Rate: 2.3 % Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: Untied	Interest Rate: 1.8 % Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: Untied (For FGD) Interest Rate: 075 % Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: Untied
Borrower / Executing Agency	Government of People's Republic of China/ Datang Hancheng No.2 Power Generation Co. Ltd.	
Final Disbursement Date	April, 2006	June, 2009
Main Contractor (Over 1 billion yen)	Toshiba/Harbin Power Engineering (China)/Mitsui Co., Ltd., Harbin Boiler Co., Ltd./Harbin Power Engineering (China), Mitsubishi Heavy Industries, Ltd./Mitsubishi Corporation, Emerson Process Management Asia Pacific Private Limited (Singapore)	
Main Consultant (Over 100 million yen)	Tokyo Electric Power Services Co., Ltd.	
Feasibility Studies, etc.	"Feasibility Study for Shaaxi Hancheng No.2 Power Plant " Northwest Electric Power Design Institute of the Ministry of Electric Power , 1996	
Related Projects (if any)		

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasunori Nakamura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: July, 2011 – September, 2012

Duration of the Field Study: October 16, 2011 – October 29, 2011,
February 25, 2012 – March 6, 2012

2.3 Constraints during the Evaluation Study (if any)

None.

3. Results of the Evaluation (Overall Rating: B[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

The 9th Five-Year Plan (1996-2000) prioritized the development of electricity sector because the electricity demand was expected to increase. The construction of high efficiency large scale thermal power plants was set out at the centre of its development. In its 9th Five-Year Plan, the Ministry of Electric Power set forth the following policies as priorities; i) Construction of mine mouth power plants in North and Central China, which are coal producing areas, and construction of large scale transmission line to transmit the generated electricity at mine mouth power plants to East and South China, which are large electricity consuming areas, ii) Moderate development of coal-fired power plants in power generation, and iii) Acceleration of high efficiency power plants with the installed power generation capacity of more than 300 MW in order for an increase of power generation efficiency. Meanwhile, the medium-term plan of electricity sector of Shaanxi province emphasized that the province would meet its electricity demand by 2001 and would export the electricity to other province as mine mouth power producing area during the 10th Five-Year Plan (2001-2005).

The 12th Five-Year Plan (2011-2015) sets forth the development of diversified and clean energy sources, which includes the development of clean and efficient large scale power plants. Meanwhile, in its 12th Five-Year Plan (2011-2015), Shaanxi province set out to develop 35,000MW of the installed power generation capacity by 2015 to make the total installed power generation capacity in the province 60,000MW.

---

1 A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

2 ③: High, ② Fair, ① Low

This project is therefore in consistent with the national development plan, the provincial development plan at the time of appraisal as well as at the time of the ex-post evaluation. However, in the last 2 years of the 9th Five-Year Plan, the State Development Planning Commission announced the policy to stop the approval to start the construction of new thermal power plants for 3 years from January, 1999. For, in this period, the electricity was oversupplied due to the structural reform in Chinese industrial sector starting in the late period of the 8th Five-Year Plan (1991-1995), Asian Currency Crisis starting in 1997 and the flood of Yangtze River in 1998. Therefore, in this certain period of the project period, this project was not consistent with a national development policy of China. However, three-year-suspension of construction of the new power plants caused the electricity supply shortage after 2002.

3.1.2 Relevance with the Development Needs of China

Average annual GDP growth in Shaanxi province between 1990 and 1995 was 9.4%. However, its installed power generation capacity has not been developed enough to meet the electricity demand. The electricity supply of Shaanxi province in 1995, which was 23.5 billion kWh, did not satisfy its electricity demand of 23.7 billion kWh.

The electricity demand in Shaanxi province increased annually by 14.5% on average between 2005 and 2010, while the installed power generation capacity of the province increased annually by 15.3% on average in the same period. The electricity supply and demand gap has narrowed little by little since 2007. However there is still the electricity supply and demand gap. Especially in the peak demand period, some areas in the province experience the electricity shortage.

Table 1 Electricity Supply and Demand in Shaanxi Province (2005-2010)

Unit:100,000,000kWh

Year	2005	2006	2007	2008	2009	2010
Electricity Supply	443.4	491.6	546.8	609.5	641.9	775.1
Electricity Demand	436.7	574.0	660.0	705.0	733.7	859.2

Source: Executing Agency's Reply to Questionnaire

This project is therefore in consistent with the development needs of Shaanxi Provinces at the time of appraisal and at the time of the ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

Country Assistance Policy to China in Japan's ODA Annual Report (1997) indicated that 'Japan is providing assistance, primarily through ODA loans, to support improvement of economic infrastructure. In addition, in order to promote balanced development, Japan

devotes more effort to China's inland regions, which have a relatively large potential for development, and provides assistance for agriculture and development of rural areas, as well as assistance to develop China's plentiful natural resources.' Meanwhile, in its 4th Yen Loan to China, which was disbursed between 1996 and 2000, Overseas Economic Cooperation Fund (OECF) emphasized the projects related to the development of the inland regions and the project related to environment in addition to the economic infrastructure. This project, which was to contribute to the improvement of economic infrastructure by using rich coal resources in China's inland regions and which was the first Yen Loan project providing fuel gas desulfurization (FGD) to Chinese thermal power plant, was in consistent with Japanese ODA policy at the time of appraisal.

This project has been highly relevant with the country's as well as province's development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness[3] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Operation and Effect Indicators from the project completion in 2006 to 2010 are shown below.

Table 2 Operation and Effect Indicators

Indicator	Unit	Plan/ Actual	2006	2007	2008	2009	2010
Maximum Output	MW	Plan	1,200	1,200	1,200	1,200	1,200
	MW	Actual	1,200	1,200	1,200	1,200	1,200
Net Electricity Energy Production	100,000,000kWh	Plan	61..0	61.0	61.0	61.0	61.0
	100,000,000kWh	Actual	49.7	66.6	59.1	57.0	56.4
Plant Load Factor	%	Plan	62.79	62.79	62.79	62.79	62.79
	%	Actual	50.26	66.91	59.78	57.69	57.32
Availability Factor	%	Plan	68.49	68.49	68.49	68.49	68.49
	%	Actual	84.22	93.03	88.63	89.56	90.82
Auxiliary Power Ratio	%	Plan	7.5	7.5	7.5	7.5	7.5
	%	Actual	5.97	5.37	5.92	6.06	6.31
Gross Thermal Efficiency	%	Plan	60	60	60	60	60
	%	Actual	39.18	39.73	40.52	40.85	40.94
Outage Hours for Every Cause (Hours/Year)	Human Error		0	0	0	0	0
	Machine Trouble		39	1	91	0	0
	Planning Outage		1343	610	905	914	803

[3] Sub-rating for Effectiveness is to be put with consideration of Impact

Indicator	Unit	Plan/ Actual	2006	2007	2008	2009	2010
Outage Hours for Every Cause (Times/Year)	Human Error		0	0	0	0	0
	Machine Trouble		3	1	2	0	0
	Planning Outage		9	4	7	5	4

Source: JICA Appraisal Documents, Execution Agency's Reply to Questionnaire

Note: Each Operation and Effect Indicator is calculated by using the following formula:

Net Electricity Energy Production	=	annual electricity production – annual electricity consumption within a plant
Plant Load Factor	=	annual electricity production/(rated output x number of hours a year) x 100
Availability Factor	=	(hours of operation a year/ number of hours a year) x100
Auxiliary Power Ration	=	(annual electricity consumption within a plat/annual electricity production) x 100
Gross Thermal Efficiency	=	(annual electricity production x 860)/(annual fuel consumption volume x fuel calorific value) x 100

At the time of appraisal, operation and effect indicators were not planned. Therefore, at the time of the ex-post evaluation, planned operation and effect indicators for reference were calculated by referring the data applied in Financial Internal Rate of Return (FIRR) calculation at the time of appraisal, and then compared with the actual data. In comparison with the planned indicators for reference, all indicators except gross thermal efficiency mostly met the target[4]. With regard to gross thermal efficiency, although the actual value of 41% is lower than the planned indicator for reference, it is similar to those of the developed countries[5]. Therefore, it can be said that this project has produced certain effect in gross thermal efficiency. There were outage hours caused by machine troubles in 2006, 2007 and 2008. The reasons for the machine troubles were detected to be transformer trips[6] and flashover[7] of contaminated lightning arrestor. These machine troubles were properly repaired. At the time of the ex-post evaluation, the power plant was operated without machine troubles.

Meanwhile, the electricity generated at the power plant is transmitted to power grid in Shaanxi province through Xizhuang substation, Gaoming substation and Xinyi substation.

[4] It assumes that among the data applied in FIRR calculation, the cost of coal was calculated by using the coal consumption of 1.96 million tons rather than 3.5 million tons which were planned by the power plant. As a result, the planned gross thermal efficiency has come to have an unrealistic figure.

[5] According Tokyo Electrici Power Company's document, examples of gross thermal efficiency of developed countries are as follows; USA 38.8%, Germany 39.5%, France 41.6%, Nordic 41.8%, Japan 43.2%, UK/Ireland 44.0% (Actual in 2007).

[6] To cut off the current in the case of over current

[7] To discharge electricity after not being able to keep insulation due to the dust adhering to the insulation.

3.2.2 Qualitative Effects

(1) Improvement of living standards by stable electricity supply

Hancheng No.2 Power Plant has transmitted stable electricity of 5.6 to 6.6 billion kWh, which is equivalent to 6 to 10% of the electricity demand in Shaanxi province, to Shaanxi province since 2007. Gross Domestic Product (GDP) per capita in Hancheng city, where the power plant is located, increased annually by 18.9 % on average from 2006, when Hancheng No.2 Power Plant was constructed, to 2010. In contrast, Consumer Price Index (CPI) increased annually by 4.4 % on average in the same period, therefore it would be able to say that living standards in Shandong province improved from economic viewpoint. The interview with Weinan Hancheng Electricity Supply Bureau, where Hancheng No.2 Power Plant is located, reveals that before the construction of Hancheng No.2 power plant, the electricity restriction was imposed during the outage of Hancheng power plant which was constructed in 1970, while the interview with a bulk electricity user reveals that because the electricity restriction has not been imposed after the construction of Hancheng No.2 Power Plant, it has become easier to plan the company's investment and given positive impact on the management of the company. Considering such fact, it can be said that this project has contributed to revitalization of economic activities in Hancheng city through the stable electricity supply and the improvement of the management of the company in Hancheng city.

Box 1. Notes: Interview with Electricity bulk users

Shaanxi Shaan-Han Co. Ltd. (A company under Hancheng Coal Bureau, Shaanxi province)

Mining company established in 1998 and having 15,000 employees. 'In the 1990s, due to the electricity supply and demand gap, even in mining sector which could preferentially secure the electricity by the Government policy, there was still electricity outage except for main machines. However, since 2000, the company has not experienced electricity outage. Therefore, a direct impact of the construction of Hancheng No.2 Power Plant is not seen. Whereas, there are the positive impact of the contribution to the regional economy through the stable electricity supply and the negative impact of the increase of traffic.

Shaanxi Longmen Iron and Steel Co., Ltd. (Hancheng, Shaanxi Province)

Steel company established in 1995 and having 1,280 employees. Its annual sales in 2009 were 16.4 billion yuan. It accounts for 1/3 of electricity consumption in Weinan city. 'Before the construction of Hancheng No.2 Power Plant, the company consumed approximately 1.3 billion kWh while after the construction, it consumes approximately 1.7 billion kWh. There were 1-2 electricity outages per month before the construction, however there have been no electricity outage after the construction. Thanks to this, it has become easier to plan the company's investment, which contributes to the increase in the business profit. Therefore, the construction of Hancheng No.2 power plant is highly satisfactory.'

3.3 Impact

3.3.1 Intended Impacts

(1) Economic development in Shaanxi province by meeting the electricity demand

The below table shows GDP and the industrial sector[8]'s share in GDP of Shaanxi province in the last 5 years.

Table 3 GDP and Industrial sector's share in GDP of Shaanxi Province (2006-2010)

Unit: million yuan

Year	2006	2007	2008	2009	2010
GDP(Actual)	576,910	668,061	777,623	883,380	1,012,348
Industrial Sector's Share	46.3%	46.6%	48.0%	42.9%	45.0%

Source: National Bureau of Statistics of China

Table 4 Industrial sector's share in electricity consumption in Shaanxi Province (2006-2010)

Year	2006	2007	2008	2009	2010
Industrial Sector's Share	65.6%	66.8%	66.1%	63.2%	64.2%

Source: National Bureau of Statistics of China

Average annual GDP growth rate between 2006 and 2010 in Shaanxi province is 15.1 %. However, it is difficult to identify how much Hancheng No.2 Power Plant contributes to economic development of Shaanxi province. For, the electricity supply in Shaanxi province increased annually by 11.82 % on average between 2006 and 2010. However, the industrial sector continuously had approximately 45% share in GDP of Shaanxi province between 2006 and 2010 and was a driving force behind GDP growth while as shown in Table 4, the industrial sector has approximately 65% share in the electricity consumption of Shaanxi province. Considering these facts, it can be considered that this project partly contributes to the economic development of Shaanxi province through the stable electricity supply.[9]

[8] Industrial sector includes mining, manufacturing, electric/gas/water industries.

[9] This evaluation presupposes that the electricity supplied to the power grid of Shaanxi province is distributed equally to each sector.

3.3.2 Other Impacts

(1) Impacts on the natural environment

① Fuel Gas

Fuel Gas Monitoring System

With regard to the measure against Sulfer Oxides (SOx), the power plant installed 2 units of FGD with SOx removal efficiency of 93%. At the time of appraisal, 1 unit of FGD with SOx removal efficiency of 65% (30% for the power plant) was planned to be installed. However, in accordance with the reinforcement of Emission Standard for Air Pollutants for Thermal Power Plants in China (hereafter 'Emission Standard'), the SOx removal efficiency was changed to 93% and the power plant also procured 1 more unit of FGD at its own cost after the completion of the project.[10]

Meanwhile, low NOx burners and two-stage combustion were installed for the measure against Nitrogen Oxides (NOx) while high-performance electrostatic precipitators with more than 99.5% of dust collection were installed for the measure against dust emission. As a result, all actual fuel gas emission met Emission Standard. Meanwhile, the power plant installed online monitoring system in 2009. Shaanxi Province Environmental Protection Agency monitors all fuel gas emission from Hancheng No.2 Power Plant through this monitoring system. Emission Standard was also revised in 2012 and existing power plants are requested to take necessary countermeasures to meet new standards by 2014. Because Hancheng No.2 Power Plant does not meet the new standards for SOx, NOx and Dust, it is required to take necessary countermeasures to meet the new standards. With regard to new Emission Standard, mercury emission standard of 0.03 mg/Nm^3 is also added and is requested to be met by 2015. However, detailed information on mercury concentration standard has not yet come from the provincial environmental protection agency.

[10] Emission Standard for Air Pollutants for Thermal Power Plants (GB13223-1996/Applied from 1997) set forth SOx concentration of 1,200mg/Nm^3. Using the FGD with the SOx removal efficiency of 65% as planned at the time of appraisal, SOx concentration was to be 1,500mg/Nm^3. Therefore, higher SOx removal efficiency was applied.

Table 5 Emission Standard for Air Pollutants for Thermal Power Plants

Standard / Item	-	New Standard (2012) (GB13223-2011)	At completion of the project (GB13223-2003)	At the time of appraisal (GB13223-91)
	Actual (January-September,2011)	Standard	Standard	Standard
SOx	300-400mg/Nm^3	200mg/Nm^3	400mg/Nm^3	-[11]
NOx	500-600mg/Nm^3	100mg/Nm^3	650mg/Nm^3	-
Dust	40-50mg/Nm^3	30mg/Nm^3	50mg/Nm^3	469mg/Nm^3

Source: Executing Agency's Reply to Questionnaire
Note: New Standard (GB13223-2011) will be applied from 2014 for existing power plants

② Effluent

The wastewater is discharged into the river after wastewater treatment within Class III of Integrated Wastewater Discharge Standard as planned at the time of appraisal. As a result, all actual figures which ought to be reported to Shaanxi Province Environmental Protection Agency, namely Power of Hydrogen (PH), Chemical Oxygen Demand (COD) and Suspended Solid (SS) .

Table 6 Integrated Wastewater Discharge Standard

Standard / Item	-	Latest/ At the project completion (GB8978-1996)	At the time of appraisal (GB8978-88)
	Actual (January-September, 2011)	Standard	Standard
PH	7-8	6-9	6-9
COD	20-40	150	500
SS	30-50	150	400

Source: JICA Appraisal Documents, Executing Agency's Reply to Questionnaire

③ Noise

As the measure against noise, 20-meter sound wall was installed. As a result, actual noise meets the standard.

Table 7 Emission Standard for industrial enterprises noise at boundary

Standard / Item	-	Latest (GB12384-2008)	At the time of appraisal/ At the project completion (GB12384-90)
	Actual	Standard	Standard
Noise level	45dB (Night) /55dB (Day)	50dB (Night) 60dB (Day)	50dB (Night) /60dB (Day)

Source: Executing Agency's Reply to Questionnaire

[11] While SOx concentration was not set forth, the amount of SOx emission was set forth as 20,941kg/h (with FGD with SOx removal efficiency of 30%).

④ Others (Ash Treatment)

With regard to ash treatment, site inspection at the time of the ex-post evaluation found that fly ash is disposed in a landfill at the disposal site located at the old river bed of Yellow River, which is about 1.5 km east of the power plant, as planned at the time of appraisal[12]. With regard to a measure against powder dust from fly ash, compressed air transfer pipeline is installed while yellow soil lining[13] is used for a measure against groundwater pollution as planned at the time of appraisal.

(2) Land Acquisition and Resettlement

Land acquisition of 135 hectors and resettlement of 83 households/435 people have been done as planned at the time of appraisal. Meanwhile, compensation of 17.86 billion yuan per household was paid while 200 ㎡ of land as well as brick and concrete structured house were allocated for each household at the resettlement site. Site inspection at the time of the ex-post evaluation found that the resettlement site is located approximately 5 minutes drive from Hancheng No.2 Power Plant and that it has become a village called Da Qian Xin Cun with village hall and gymnasium after the resettlement.

Resettlement site

This project has largely achieved its objectives; therefore its effectiveness is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The below table shows the output (plan/actual) of this project.

[12] There are no standards for ash treatment. The site inspection at the time of the ex-post evaluation found that there was no powder dust from the ash disposal site.

[13] To cover yellow soil, which has high water holding capacity, in order to avoid water from seeping into the underground.

Table 8 Output (Plan/Actual)

	Numbers, Specification	
	Plan	Actual
Boiler	2 units, Natural circulation or Forced circulation (Sub-critical pressure coal fired), Reheating type	Same as planned (Forced circulation was applied)
Turbine Generator	2 unites, Output 600MW, 50Hz, 3,000pm, Water-Hydrogen Cooling System	Same as planned
Main Transformer	3 x 240 MVA	Same as planned
Instruments & Control	Dispersed Control System (DCS)	Same as planned
FGD	1 unit, Limestone-gypsum process, SOx removal efficiency of 60% (30% for the power plant)	1 unit, SOx removal efficiency of 93%. One unit was added after the project completion. SOx removal efficiency of 93% for the power plant
Water Treatment System	2 x 50t/h	Change in the volume of water to be treated 2x 60t/h
Electrostatic Precipitator	4 units, dust collection efficiency more than 99.5 %	Same as planned (dust collection efficiency more than 99.79%)
Stack	240m x 1 unit, Diameter 10M	240m x 2 unit, Diameter 6.9M
Coal Handling System	Coal Yard: 53,000m^2, 250,000 ton	Same as planned
Coal Pulverizer	High level of pulverization, Middle Speed	Same as planned
Ash Handling System	Dry type, Pneumatic ash conveying system	Same as planned
Cooling Tower	Natural Draft	Same as planned
Consulting Services	Total 145M/M Project Manager 23M/M, Mechanical Engineer (2) 28M/M, Electrical Engineer (2) 28M/M, I&C Engineer (2) 28M/M, Desulfurlization Engineer 19M/M, Environment Engineer 19 M/M provide following services; ① Assistance in finalizing bidding documents ② Assistance in bid evaluation ③ Assistance in technical contract negotiation ④ Assistance in designs ⑤ Supervision for progress of project ⑥ Assistance in commissioning	Total 84.6M/M Bidding Process (62.3M/M) Designs (7.8M/M) Construction/Commissioning (14.5M/M)

Source: JICA appraisal documents, Executing Agency's Reply to Questionnaire

Project outputs were mostly realized as planned at the time of appraisal except changes in the specifications. Such changes are as follows; SOx removal efficiency has become higher in accordance with the reinforcement of Emission Standard in China, which set forth SOx concentration, the capacity of water treatment has become bigger in accordance with the actual volume of effluent, and the specification of stacks has been changed as a result of domestic bidding, by which the stacks with different specification, but lower cost and the same performance were applied. Meanwhile, although the consulting services spent 84.6 M/M, which is 58 % of the planned, the service contents were the same as planned. According to the executing agency, the reason for such difference could be that the plan was overestimated, however, the detailed reasons could not be found from the executing agency.

Turbine Generator

FGD

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned project cost was 131,315 million yen (Foreign currency 57,970 million yen/Local currency 73,345 million yen) while the actual project cost was 74,060 million yen (Foreign currency 34,167 yen/Local currency 39,893 yen). The actual project cost was 56% of the planned project cost and lower than planned. However, due to the changes in the specifications in the outputs, the cost for FGD and water treatment system exceeded the planned cost. Meanwhile, as a result of international competitive bidding, the cost for construction machinery exceeded the planned cost.

Table 9 Project Cost (Plan/Actual)

	Plan					Actual			
	FC		LC	TOTAL		FC	LC	TOTAL	
	Million Yen	Loan in 1997	Million Yuan	Million Yuan	Million Yen	Million Yen	Million Yuan	Million Yuan	Million Yen
Boiler	18,873	11,265	732	2,120	28,828	11,506	307	1,108	15,911
Turbine	22,008	13,019	824	2,442	33,214	13,906	330	1,299	18,641
I&C	2,914	2,046	202	416	5,661	1,200	110	193	2,778
FGD	3,370	1,987	99	347	4,716	3,803	68	333	4,778
Ash Handling System	980	726	189	261	3,550	711	60	109	1,572
Coal Handling System	2,157	1,298	193	352	4,782	984	141	209	3,007
Water Treatment Equipment	104	104	89	97	1,314	457	94	125	1,805
Sub-station Switchgear	1,105	825	584	665	9,047	627	194	237	3,410
Construction Machinery	228	228	11	28	378	618	-	43	618
Others	-	-	460	460	6,256	34	1,476	1,478	21,214
Consulting services	465	465		34	465	321	-	22	321
Price Escalation	3,027	1,392	1,752	1,975	26,849	-	-	-	-
Physical Contingency	2,739	1,645	258	459	6,248	-	-	-	-
TOTAL	57,970	35,000	5,393	9,656	131,315	34,167	2,780	5,161	74,060

Source: JICA Appraisal Documents, Executing Agency's Reply to Questionnaire

Note: Exchange rate at the time of appraisal 1 yuan = 13.6 yen, Exchange rate at the time of the ex-post evaluation 1 yuan = 14.35 yen (Average during loan period)

The followings are the main reasons for reduction of the project cost.

① Foreign procurement spent less cost as a result of international competitive bidding which was affected by huge decrease in material prices such as steal price

② The decrease of material prices in China

There was a restriction in the evaluation of the cost efficiency. That is, because the executing agency used cost items which were different from those at the time of appraisal, it was difficult to compare the project cost for each item. According to the executing agency, such difference was caused by the change of the executing agencies during the project implementation period.

3.4.2.2 Project Period

The project period was significantly longer than planned. At the time of appraisal, the

project period was planned to be 72 months from January, 1997 (Starting month of reviewing conceptual design) to December, 2002 (Commissioning of Unit 2). However, the actual project period was 111 months from January, 1997 to March, 2006[14], which are 154% of the planned project period.

The followings are the main reasons for such excess.

① As described in the relevance clause, the electricity reform by the State Development Planning Commission restricted its approval to start construction of the new power plant for 3 years from 1999. An approval of construction for this project was also postponed for 56 months from December, 1997 to July, 2002.

② An approval of the feasibility study by State Council was delayed for 10 months from June, 1997 to March, 1998 due to a delay in the project procedure in China.

Meanwhile, with regard to the period from the approval of construction or the first contract conclusion[15] to the project completion, it was planned to be 61 months from December, 1997 to December 2002. However, it was actually 58 months from June, 2001 to March, 2006, which are 95 % of the planned period.

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

At the time of the ex-post evaluation, FIRR was recalculated to 6.52%, which is lower than the planned FIRR of 12.01%. Main reasons for such reduction are as follows; the coal price was much higher than planned, the electricity selling price was lower than planned and the local tax rate was higher than planned. With regard to the coal price in the future, approximately 4% annual increase is estimated with reference to the Chinese Government policy of controlling the increase of the coal price. With regard to the electricity selling price in the future, the average annual increase rate between 2006 and 2011, which is 5%, is used for the calculation. Economic Internal Rate of Return (EIRR) was not calculated at the time of appraisal.

Although the project cost was within the plan, the project period was exceeded, therefore efficiency of the project is fair.

---

[14] Although commercial operation of the power plant started in August, 2005, it was March, 2006 when the FGD, which is one of the project outputs, commissioned. Therefore, March, 2006 is defined as the month of the project completion.

[15] In this project, the contracts for turbine generator and boiler were concluded in June, 2001 and August, 2001 respectively , which were before the approval of construction.

3.5 Sustainability (Rating: ②)

3.5.1 Structural Aspects of Operation and Maintenance[16]

Datang Hancheng No.2 Power Generation Co., Ltd., a company invested by Datang Shaanxi Power Generation Co., Ltd (60% share)[17] and Shaanxi Investment Group Company (40% share), is responsible for operation and maintenance of Hancheng No.2 Power Plant. 342 employees work in the following departments; human resource, finance, political work, planning, audit, supervision and production safety, fuel, power generation, electricity supply, environment protection. With regard to equipment check, Datang Hancheng No.2 Power Generation Co., Ltd. outsources to Hancheng Power Maintenance Carrier, which allocate 798 people for the power plant.

3.5.2 Technical Aspects of Operation and Maintenance

Among the employees of Datang Hancheng No.2 Power Generation Co., Ltd., 5 employees have master's degree or above, 186 have bachelor degree, 126 have degree from technical college. That is, over 90% of the employees are college graduates or above. In addition, among 191 staffs in power generation related departments, 1 has senior technician certificate, 7 have technician certificate, 75 have senior engineer certificate, 60 have intermediate engineer certificate.

With regard to the trainings for operation and maintenance, there were the trainings about I&C before the commissioning of the power plant. More than 150 employees participated in such trainings while those who participated in the trainings offer the trainings to other employees today. There are many manuals for operation and maintenance. For example, 16 manuals for check and management and 16 manuals for equipment management are prepared.

3.5.3 Financial Aspects of Operation and Maintenance

Business profit has been negative since 2008. Main reasons for such loss are the increase of main business cost due to the increase in coal price and the slow increase of main business income due to the control of the electricity selling price by the Government. Main business cost has increased by 50-100 % since 2008 onward compared with 2007 due to the increase in coal price[18]. Whereas, main business income has increased by less than

---

[16] Hancheng No.2 is responsible for operation and maintenance for 4 units of power plants, i.e. 2 units of Phase-1 which was constructed by this project and 2 units of Phase-2 which was constructed at its own cost. All information about Datang Hancheng No.2. in this report is for both Phases.

[17] A company fully owned by China Datang Corporation.

[18] With regard to the rate of increase of the main business income and the main business cost, it was impossible to see the rate only for Phase-1 because Phase-2 started its operation in 2008. Although the rate of increase changed significantly between 2007 and 2008 due to the start of Phase-2 operation, it is obvious that the main business

10-70 % during the same period because the electricity selling price has been controlled to stay low by the Chinese government. However, according to the executing agency, a discussion with the National Development and Reform Committee and State Grid Corporation by five Power Generation Groups[19] including China Datang Corporation, which is a parent company of Datang Hancheng No.2 Power Generation Co., Ltd have resulted in the increase of the electricity selling price by 16% since April, 2011. The executing agency forecasts that the financial status in 2011 will be improved and business profit will not be deficit in 2012. Such forecast by the executing agency seems relevant considering that the Chinese Government works on the stabilization of the coal price which causes the increase of the main business cost of the power plants. For example, the National Development Reform Commission notified the request to keep the coal price at the level of the previous year in April, 2011. Meanwhile, because the Power Plant has to take necessary measure in accordance with the new Emission Standard, the modification costs of the facilities will be required. According to the executing agency, such cost is included in its financial plan.

Table 10 Financial Status (2007-2010)

Unit: 1000 yuan

	2007	2008	2009	2010
Main Business Income	1,590,678	1,718,160	2,580,849	2,729,869
Main Operation cost	1,255,043	2,061,454	2,651,278	2,941,601
Business tax & VAT	19,299	9,626	20,811	1,532
Profit from main business	316,336	-352,920	-91,240	-213,264
Income from other business	6,929	7,336	4,249	4,819
Cost from other business	2,993	2,967	3,289	3,326
Financing costs	-60,003	53,807	284,040	248,846
Business profit	380,275	-402,358	-374,330	-460,617

Source: Loss and Profit Statement

3.5.4 Current Status of Operation and Maintenance

In addition to a daily check, the power plant has 6-year cycle annual check which consists of 5 times of C-check (25 days) and one A-check (65 days). Since the start of the operation, the power plant has conducted annual check as planned and realized stable electricity supply.

Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

---

cost increased more than the main business income.

[19] China Huaneng Group, China Datang Corporation, China Huadian Corporation, China Guodian Corporation, China Power Investment Corporation

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project is to meet the growing electricity demand in Shaanxi province by constructing total 1,200MW (600MW x 2) coal-fired thermal power plant, thereby contributing to the regional economic development. The project has been highly relevant with the country's as well as Shaanxi province's development plans, development needs, as well as Japan's ODA policy; therefore its relevance is high. The project has largely achieved its objectives of meeting the increasing electricity demand in Shaanxi province and thereby fostering economic development of the province, therefore its effectiveness is high. Although the project cost was within the plan, the project period was exceeded on a large scale; therefore efficiency of the project is fair. Some problems have been observed in terms of financial aspects of operation and maintenance, therefore sustainability of the project effect is fair.

In light of the above, this project is evaluated to be (B) satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Countermeasure to reduce SOx and NOx concentration as well as Dust emission should be taken by 2014 to meet the new Emission Standard. With regard to mercury concentration standard, the sensor to measure mercury concentration should be installed and, if required, necessary measure would be taken to meet the standard by 2015.

(2) The executing agency should take measure to secure financial stability of the power plant, for example continuing the discussion with the National Development and Reform Commission, Shaanxi provincial government and State Grid Corporation through China Datang Group in order to increase the electricity selling price or obtain the subsidies for power plant operation.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

None.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs		
Boiler	2 units, Natural circulation or Forced circulation (Sub-critical pressure coal fired), Reheating type	Same as planned (Forced circulation was applied)
Turbine Generator	2 unites, Output 600MW, 50Hz, 3,000pm, Water-Hydrogen Cooling System	Same as planned
Main Transformer	3 x 240 MVA	Same as planned
Instruments & Control	Dispersed Control System (DCS)	Same as planned
FGD	1 unit, Limestone-gypsum process, SOx removal efficiency of 65% (30% for the power plant)	1 unit, SOx removal efficiency of 93 %. One unit was added after the project completion. (SOx removal efficiency of 93.2% for the power plant)
Water Treatment System	2 x 50t/h	2x 60t/h
Electrostatic Precipitator	4 units, dust collection efficiency more than 99.5 %	Same as planned (dust collection efficiency more than 99.79%)
Stack	240m x 1 unit, Diameter 10M	240m x 2 unit, Diameter 6.9M
Coal Handling System	Coal Yard: 53,000m^2, 250,000 ton	Same as planned
Coal Pulverizer	High level of pulverization, Middle Speed	Same as planned
Ash Handling System	Dry type, Pneumatic ash conveying system	Same as planned
Cooling Tower	Natural Draft	Same as planned
Consulting Services	Total 145M/M Project Manager 23M/M, Mechanical Engineer (2) 28M/M, Electrical Engineer (2) 28M/M, I&C Engineer (2) 28M/M, Desulfurlization Enginner 19M/M, Environment Engineer 19 M/M provide following services; ① Assistance in finalizing bidding documents ② Assistance in bid evaluation ③ Assistance in technical contract negotiation ④ Assistance in designs ⑤ Supervision for progress of project ⑥ Assistance in commissioning	Total 84.6M/M Bidding Process (62.3M/M) Designs (7.8M/M) Construction/Commissioning (14.5M/M)
2. Project Period	January,1997 – December,2002 (72 months)	January, 1997 – March, 2006 (111 months)
3. Project Cost		
Amount paid in Foreign currency	37,970million yen	34,167million yen
Amount paid in Local currency	73,345million yen (5,393 million yuan)	39,893million yen (2,780 million yuan)
Total	131,315million yen	74.060million yen
Japanese ODA loan portion	57,970million yen	34,167million yen
Exchange rate	1 yuan = 13.6 yen (As of February, 1997)	1 yuan = 14.35 yen (Average between September, 1997 and June,2009)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Wuhan Urban Railway Construction Project"

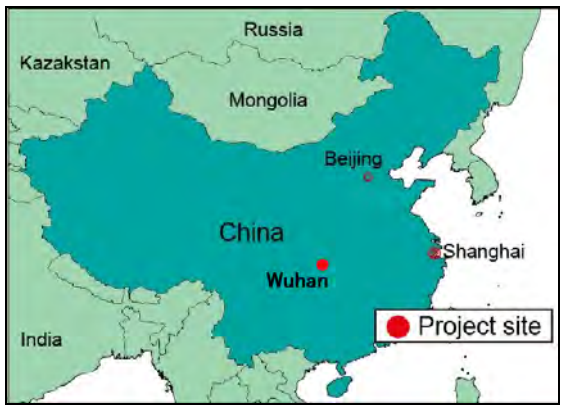
External Evaluator: Yasuhiro Kawabata, Sanshu Engineering Consultant

0. Summary

The objective of the project was to alleviate traffic congestion in the city center by constructing an urban railway with a total length of 10 km between Zongguan – Huangpulu in Wuhan, and thereby contribute to the improvement of air quality and promote social and economic development in Wuhan. The project has been highly relevant to the development plans and needs of China and Wuhan, as well as Japan's ODA policies, and therefore its relevance is high. Regarding the alleviation of traffic congestion, contributing to improvement of air quality and promotion of social and economic development, which is the project's objective, the project has somewhat achieved its objectives, and therefore its effectiveness is fair. Although the project cost was within the plan, the project period exceeded the plan slightly. Therefore, efficiency of the project is fair. No major problems have been observed in the operation and maintenance system (organizational setup, technical capacity and financial status), therefore the project's sustainability is considered high.

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

1. Project Description



Project Location

Train (4 cars)

1.1 Background

Because of the economic development and enhancement of the living standards after the reform and the start of open door policies in 1978, the urban transport problems, including

traffic congestion due to increase in vehicles and underdeveloped urban infrastructure, were the main issues in major cities at appraisal stage. Cognizant of these issues, the Chinese government decided to introduce the mass transit system, including subways in cities which have more than one million urban population and more than 50 billion yuan of GDP, in order to alleviate traffic congestion, promote economic development and improve the urban environment. A strategic plan was developed to introduce the mass transit system in 15 cities, including Beijing, Shanghai, Ganzhou, Dalian, Chongqing and Wuhan among 35 cities.

The constant growth in traffic congestion in Wuhan caused by: 1) increase in passenger cars due to lack of urban mass transit system, and 2) concentration of vehicles to specific arterial roads (such as Jiefang Avenue along the project corridor) due to undeveloped road network. In accordance with the central government policies, the Wuhan Municipal Government established in 1998 the Urban Transport Development Strategic Targets to resolve the traffic problems in the city centre districts, and to make the mass public transport system, focusing on urban railways, as the basic mode of city transport, which can partly contribute to construction of modern urban city.

1.2 Project Outline

The objective of the project was to alleviate traffic congestion in the city center by constructing an urban railway with a total length of 10 km between Zongguan – Huangpulu (phase 1 section) in Wuhan, among the 27 km section between Gutianyilu and Fujiapo in Wuhan, and thereby contribute to the improvement of air quality and promote social and economic development in Wuhan. The location of the project site is shown in Figure 1.

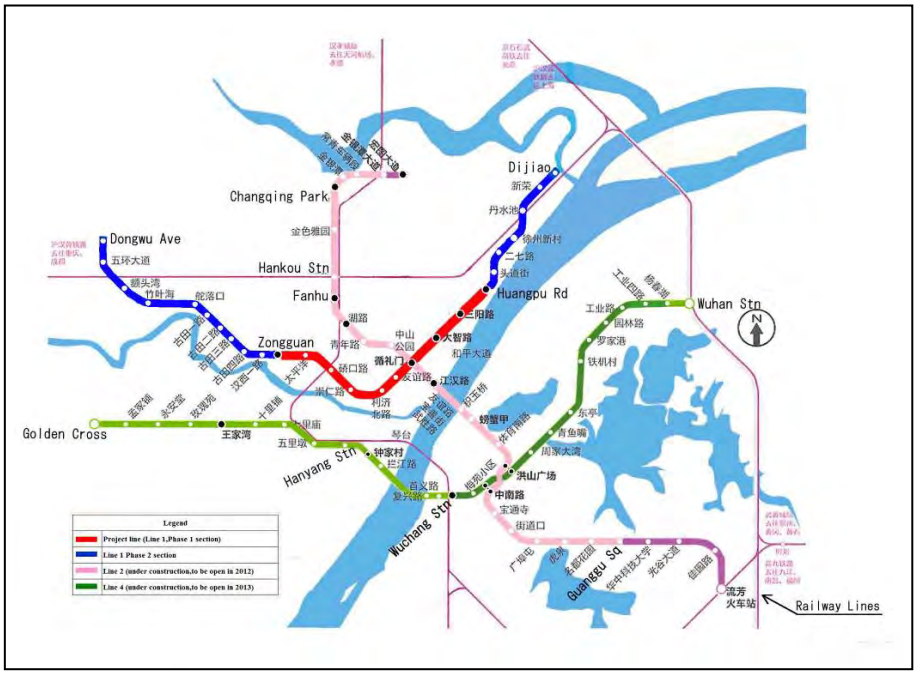


Figure 1 Location of Project Site

Loan Approved Amount/ Disbursed Amount	2,894 million yen / 2,340 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2001 / March 2001
Terms and Conditions	Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10years) Conditions for Procurement: Bilateral tied
Borrower / Executing Agency(ies)	Government of People's Republic of China/Wuhan Municipal Government
Final Disbursement Date	July 2006
Main Contractor (Over 1 billion yen)	Nissho-Iwai
Main Consultant (Over 100 million yen)	-
Feasibility Studies, etc.	F/S by Beijing City Planning and Design Research Institute (1999)
Related Projects (if any)	Project Identification/Promotion Study by Ministry of Transport (1994)

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasuhiro Kawabata, Sanshu Engineering

2.2 Duration of Evaluation Study

Duration of the Study: July 2011 –September 2012

Duration of the Field Study: October 9 - October 22, 2011 and February 14 - February 24, 2012

2.3 Constraints during the Evaluation Study (if any)

Since the alignment of phase 2 section was largely changed after the commencement of the project, it became difficult to compare the actual number of passengers per day and number of peak hour passengers with the numbers projected at appraisal, which are the basis for evaluation of project effectiveness.

3. Results of the Evaluation (Overall Rating: B[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of China

The China's 10th Five-Year Plan (2001 – 2005) states that the government would develop a comprehensive transport infrastructure. The Wuhan's Urban General Plan (developed in 1998) indicated the development targets for the urban development in each region, by dividing Wuhan city into three regions. The Wuhan Municipal Government developed the

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ② Fair, ① Low

Urban Transport Development Strategic Targets aimed at having a complete urban development and urban functions. Hence, the following objectives have been established for the transport sector: 1) improve the functions of each transport mode, including railways, waterways, roads and aviation, and enhance the synergistic effect among modes in order to develop a safe, comfortable, economical and convenient comprehensive transport system; and 2) give priority to the development of urban railway transport, mainly consisting of surface and public transport among the transport modes in the city area, in order to resolve the traffic problems in the city's central district. The urban railway transport network plan in Wuhan involved 6 lines with a total length of 142 km, including Line 1 under the project.

The China's 11th Five-Year Plan (2006-2010) states that priority shall be given to the development of public transport infrastructure, particularly the development of the urban railway in major cities and in urban areas. Moreover, it states that the development plans shall be developed as soon as possible and projects shall be implemented per the implementation schedule. The 12th Five-Year Plan (2011- 2015) states that the previous Five-Year Plan shall be sustained and that development of urban railways (subway, light rail and urban railway) shall be promoted.

The development of the urban railway is a priority agenda in the national and municipal development plans during appraisal and post evaluation of the project, thus making it consistent with both development plans.

3.1.2 Relevance with the Development Needs of China

The state of transport sector in Wuhan at appraisal was as follows:

- the operating speed of public transport has been decreasing year after year because the road/highway network in the city center was underdeveloped and traffic was concentrated into some arterial roads;
- traffic congestion in the city was a serious concern because of heavy traffic volume during the morning and afternoon peak hours;
- traffic congestion has been continually growing because of the combination of cars, bicycles and pedestrians. Thus, it was difficult to cope with the increasing traffic volume only with improvement and construction of roads and bridges; and
- the city environment has deteriorated because of traffic noise and exhaust gas.

Based on the above, development of public surface transport system focusing on railway transport was needed.

Under the Wuhan Urban General Plan (2010 - 2020), Wuhan is classified as a core city

in central China and an important industrial base. Wuhan's traffic congestion identified at appraisal has been improving. However, as the economy improved, the number of registered vehicles, including passenger cars, has also been increasing. Consequently, further development of public transport infrastructure is needed. For that reason, Wuhan city is constructing Lines 2-4 (to be completed by 2012, 2014 and 2013, respectively) under the Metro Network Development Plan, in which 12 lines with a total length of about 230 km are to be completed by 2020.

The urban environment has been deteriorating as well due to traffic noise and air pollution caused by traffic congestion. Thus, the need for the development of railway network targeting alleviation of traffic congestion in the project affected area was high during appraisal and post evaluation.

3.1.3 Relevance with Japan's ODA Policy

In the Annual Report on the Implementation of Japan's ODA (1999), the aid policy towards China was to resolve the lagging infrastructure development, including transport, communications and power sectors. This was an obstacle in China's economic development, thus making transport as one of the priority sectors. It was proposed to provide aid to projects that would increase transporting capacity by constructing transportation facilities and enhancing the maintenance and management technology that would raise transportation efficiency.

According to the former JBIC's Overseas Economic Cooperation Implementation Policy, the railway sector in China was a priority sector in the Japanese aid policy for alleviation of economic disparity between coastal and inland regions. At appraisal stage, it was determined that the subject project was in accordance with the Japanese aid policies.

Accordingly, the project has been highly relevant with the Chinese and Wuhan's development plan and needs, as well as Japan's ODA policies. Its relevance is therefore considered high.

3.2 Effectiveness[3] (Rating: ②)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) Passenger transport

1) Average number of passengers per day

Actual numbers of passengers during the period from the opening of phase 1 in July 2004 to last year are shown in Table 1.

[3] Sub-rating for Effectiveness is to be put with consideration of Impact

Table 1 Number of Passengers

Unit: Whole line average: 0,000/day, peak hour: 0,000/hour

	2004 1st year	2005	2006	2007	2008 5th year	2009	2010 Before completion of phase 2	2010 After completion of phase 2	2011
Whole line average	0.77	1.19	2.05	2.53	3.04	3.6	4.1	15.64	20.77
	(22.1)	(25.4)	(29.2)	(30.4)	(61.6)	(63.5)	(65.6)	(65.6)	(67.7)
Peak hour	0.13	0.21	0.34	0.27	0.27	1.31	-	1.45	2.07
	(0.8)	(0.9)	(1.1)	(1.2)	(1.4)	(1)	(1.6)	(1.6)	(1.8)

Source: Appraisal documents, Responses to Questionnarire

Note1: Completion of phase 2 of Line 1 was scheduled for 2007 at the appraisal stage. However, it was actually opened to the public on July 28, 2010.

Note 2: Numbers in ( ) are project numbers at the planning stage.

Note 3: The feasibility study report for the current Line 1 route was prepared in November 2005, in which the average number of whole line passengers was estimated at about 450,000 passengers per day. However, the estimate was made assuming that phase 2 would be completed by end 2012.

As shown in Table 1, the average number of passengers per day is much lower than planned at appraisal. The reasons are: i) route change[4] of phase 2 section of Line 1, ii) impacts to number of passengers due to delay in the completion of phase 2 section (delayed from 2007 to July 2010), and iii) over estimation of the projected number of passengers.

i) The alignment of the completed phase 1 section (Zongguan - Huangpulu) is exactly the same as proposed in the feasibility study. However, the actual alignment of phase 2 section is completely different from the originally proposed. As shown in Figure 2, in the original plan, phase 2 section was a key arterial route connecting between Hankou District, where the Wuhan Municipal Government is located with Fujiapo (currently Zhongnan) in Wuchang District, which is a political and cultural center of Wuhan, crossing the Changjiang river. Many public agencies and educational institutes are located in Wuchang District, including the Provincial Committee of the Communist Party, Hubei Provincial Government, Provincial People's Congress, Wuhan University, and Wuhan University of Technology. Thus, more metro users (passengers) than those on the current route (Line 1) were anticipated. The completed phase 2 section is extended to the north along the Changjiang river from Huangpulu and does not function as an arterial route crossing the river.

[4] In 2003, the new Metro Network Development Plan in Wuhan was established, and routes including sections in the subject project (phase 2 section) were also changed.

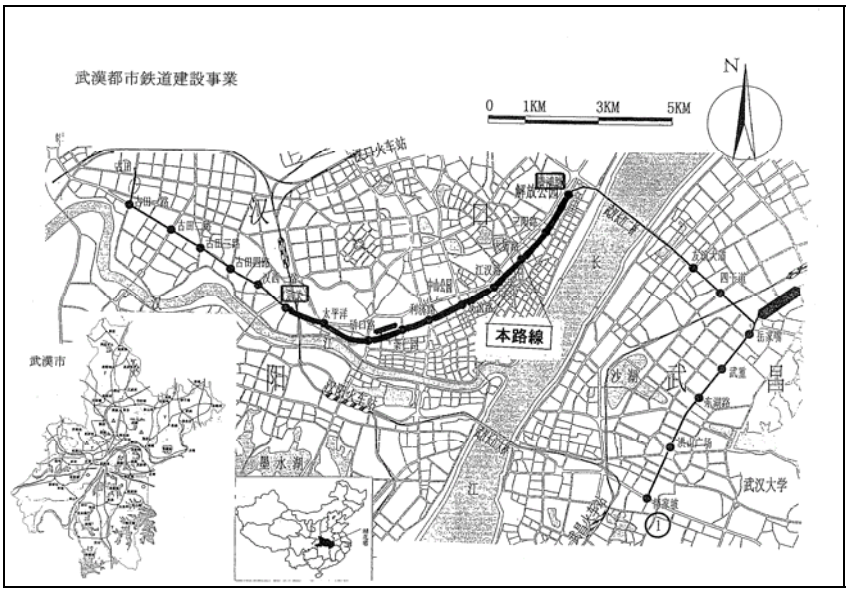


Figure 2 Route Alignment at the Planning Stage

ii) In the original feasibility study, the passenger projection was made assuming that the Zongguan - Huangpulu section would be completed by 2006, and phase 2 section (the extended section up to Fujiapo) by 2008. However, the realigned phase 2 section of Line 1 (Dongwudadao - Zongguan, and Huangpulu - Dijia) was completed on July 28, 2010. Consequently, realization of increase of passengers was delayed.

iii) On the basis of the projected number of passengers made at appraisal, the peak hour factor of passengers (number of passengers during the peak hour/average number of passengers per day for the whole route) was calculated. The average peak hour factor was 3.0%, ranging between 3.6% (2004) and 2.7% (2011). For reference, the peak hour factor of Line 13 of Beijing Metro at the planning stage was 7.25%, ranging between 7.4% (2006) and 7.1% (2010). Thus, the peak hour factor assumed for the Wuhan Urban Railway was less than half of that assumed for Beijing Metro. Since about 20,000 passengers during the peak hour was considered reasonable taking into account the capacity when 12 trains with four cars in each train were operated during peak hour, the planned average number of passengers per day, which was more than 30 times of the peak hour passengers was likely over estimated.

2) Number of passengers during peak hour

The fundamental operational effectiveness indicator for the railway projects was the number of passengers transported. The project's objective was to alleviate traffic congestion in the city central area. The actual number of passengers during peak hours

was reviewed as follows. The number of passengers during the peak hour at the first operational year 2004 was 1,300/hour, 16% of the planned. By 2008, the number increased to 2,700/hour, 19% of the planned. Since four high schools and a few shopping malls were completed along the project corridor by 2009, the number of passengers during the peak hour increased to 13,000/hour in 2009, 87% of the planned. Furthermore, in 2010 phase 2 section was completed, and the number of passengers increased to 20,700, 115% of the planned. The reason is likely that people acknowledge superiority of the urban railway, which can secure punctuality, and avoiding traffic jam.

3) Number of train operations

The actual number of train operations during the period from the opening of phase 1 in July 2004 to last year is shown in Table 2.

Table 2 Number of Train Operations

Unit: trains/hour

	Planned after completion	2004-2009	2010 Before completion of phase 2	2010 After completion of phase 2	2011
Peak hour	12	7	7	10	12
Off-peak hour	6 - 10	7	7	9	11

Source: Responses to Questionnaire

The planned number of train operations (a train consisting of 4 cars) was 6 to 10 trains during regular hours, and 12 trains during peak hours. The actual number of train operations in 2011 was more than planned during regular hours and as planned during peak hours.

4) Travel time required for the section completed (reduction of travel time)

The current travel time required for the section between Zongguan and Huangpulu by each mode is shown in Table 3.

Table 3 Current Travel Time required

Unit: minutes

Period	Mode	Planned	Actual
Peak hour	Bus	45	45
	Taxi	-	40
	Urban railway	17	17
Off-peak hour	Bus	45	35
	Taxi	-	20
	Urban railway	17	17

Source: Responses to Questionnaire

Note: Travel time by bus is the average time travelling 10 km section including boarding and alighting time.

The travel time by urban railway during off-peak hours is about half of that by bus, and slightly less than that by taxi. The travel time during the most congested peak hours is about 1/3 of that by bus and less than half of that by taxi. It was confirmed that the urban railway has more advantage than other existing public transport modes during both peak and off-peak hours.

5) Number of registered vehicles (Wuhan City)

The number of registered vehicles and growth rates for the past seven years in Wuhan city are shown in Table 4.

Table 4 Number of Registered Vehicles and its Growth Rates in Wuhan city

Unit: 000 vehicles

	2003	2004	2005	2006	2007	2008	2009	2010
Number of registered vehicles	271	334	370	418	484	556	669	808
Growth rates (%)	-	23.2	10.8	13.0	15.8	14.9	20.3	20.8

Source: Wuhan Annual Statistics 2004-2011

Note: Vehicles include only passenger cars, buses and trucks.

The traffic volume in Wuhan has been increasing because the number of registered vehicles is also increasing due to economic development with a growth rate of 17% per annum for the past five years. Although the number of urban railway passengers has been increasing as well, it is difficult to verify quantitatively how much the project has contributed to reduction of traffic volume (impact to the alleviation of traffic congestion).

However, it is possible to estimate how much more the traffic volume would have increased if the project has not been implemented. The transporting capacity of a train is about 1,000 passengers. If all the passengers used cars (assuming the average occupancy is 2.5 passengers per car), the number of cars would have been 8,280 (20,700 passengers/2.5 passengers). It is likely that the traffic volume would be reduced at most by 8,300 vehicles per hour during peak hours.

3.2.2 Qualitative Effects

(1) Alleviation of traffic congestion by shift of automobile users to the urban railway

According to the PR officer of Wuhan Metro, the completion of urban railway has raised people's awareness of urban environment, reduced the use of private cars, and instead promoted the use of public transport modes (urban railway and buses). Ultimately, they have been trying to achieve the low carbon economy by alleviating traffic congestion. Upon completion of the phase 2 section, the bus terminals in the downtown were relocated to both ends of the Line 1, and entering of large buses to downtown was prohibited.

Consequently, automobile passengers were guided to the urban railway, which have contributed to the reduction of traffic passing through downtown.

In the post evaluation work, beneficiary surveys through interviews with users were conducted in the project affected area (at 10 stations completed). The total number of respondents (railway users) was 100. The classification of respondents by sex was 31% female and 69% male. The main results of the beneficiary surveys are as follows. About 70% of respondents answered that they could shorten the travel time by using Line 1 and that they were satisfied with the achievement of the project. Thus, it is likely that the project has contributed to enhancing the convenience for the people who live along the project corridor. Although it is difficult to resolve the traffic congestion by the accomplishment of this project alone, 70% of respondents recognize that the level of traffic congestion has improved. It was also confirmed that people who used to take taxis or private cars before opening of Line 1 (about 10% of respondents) have shifted to the urban railway. If the project has not been implemented, the traffic congestion would have been worst. Thus, it seems that the project has contributed to alleviation of traffic congestion to some extent. On the other hand, only one third of respondents are currently satisfied with the bus service connection. Therefore, further improvement is needed.

3.3 Impact

3.3.1 Intended Impacts

(1) Promotion of economic development along the project corridor

The growth rates of the Gross Domestic Product (GDP) of the project area are shown in Table 5.

Table 5 GDP of the Project Area

Unit: million yuan

District	2003	2004	2005	2006	2007	2008	2009	2010
Jiangan	8,562	9,909 (15.7)	14,020 (41.5)	16,297 (16.2)	19,116 (17.3)	23,897 (25.0)	36,362 (52.2)	43,335 (19.2)
Jianghan	8,824	10,144 (15.0)	18,046 (77.9)	21,641 (19.9)	25,263 (16.7)	31,001 (22.7)	43,008 (38.7)	48,001 (11.6)
Qiaokou	6,956	8,007 (15.1)	15,011 (87.5)	17,295 (15.2)	19,768 (14.3)	24,557 (24.2)	27,893 (13.6)	30,772 (10.3)
National average (%)	10.0	10.1	10.4	11.1	11.4	9.6	9.1	10.3

Source: Wuhan Annual Statistics, China National Statistic Bureau

Not: Numbers in ( ) are the growth rates against the previous year (%)

Since phase 1 section (the project) was completed in 2004 and phase 2 section in 2010, the project corridor along the line has become popular because of their proximity between the working place and residence. The high-rise apartments, as well as schools, hospitals,

and shopping centres have been constructed, and as a result the commercial and economic activities along the corridor have been stimulated. As the population along the corridor has grown and the bus service connecting to the metro stations has commenced, the number of passengers using the urban railway has rapidly increased, particularly upon completion of the phase 2 section. The growth rate of GDP of the project affected area is much higher than the Chinese national average.

Changes of the land price in the project area are shown in Table 6.

Table 6 Changes of the Land Price

Unit: yuan/m^2

	2004	2005	2006	2007	2008	2009	2010
Qiaokou District	903	1,115	920	1,895	1,659	4,220	2,654

Source: Responses to Questionnaire

Although the real estate value has been affected by the change of policies of the Chinese Government, the current land value in the Qiaokou District has risen to about three times of that when the project (phase 1) was completed in 2004. The average inflation rate of commodities during the same period was 2.8%.

(2) Improvement of Environment (improvement of air pollution)

Changes of air pollution during the period from the opening of phase 1 in July 2004 to last year are shown in Table 7.

Table 7 Change of Air Pollution in Wuhan (monthly average)

	2005 March	2006 February	2007 June	2008 October	2009 September	2010 September	2011 September
SO_2 (mg/m^3)	0.058	0.049	0.035	0.033	0.037	0.034	0.031
NO_2 (mg/m^3)	0.058	0.040	0.035	0.055	0.049	0.039	0.049
PM10 (mg/m^3)	0.120	0.083	0.089	0.102	0.088	0.064	0.077

Source: Website of Environmental Protection Bureau of Wuhan City (www.whepd.gov.cn)
Note 1: PM10 (Particulate Matter less than 10 micron)
Note 2: Numbers are concentration in the air.

The emission amount of air pollutants specific to the project affected area was not available. The Environmental Protection Bureau of Wuhan City publishes partly the data on emission amount for the entire city. Since the environmental improvement countermeasures and efforts by Wuhan City are dominant, it is not clear how much the project has directly contributed to reduction of air pollutants. Since the opening of phase 1 section to the public in 2004, SO_2 has been declining and the SO_2 amount has been reduced by about half right after the opening. Regarding the NO_2, there is variability by year, and no substantial

improvement was observed. Improvement was observed in terms of PM10. Generally speaking, the air pollution level in Wuhan has been improving.

The result of the beneficiary surveys confirms that only 30% of respondents admit the impact by the project with respect to improvement of air pollution along the corridor, since the traffic volume has been increasing due to increase in number registered vehicles.

3.3.2 Other Impacts

(1) Impacts on the natural environment

During implementation, a folded noise barrier was installed along the route as a noise protection measure. For sites and sections needing special treatment, including Wuhan Second High School and Jinghan Garden, the higher noise barriers were installed. Furthermore, sections (close to schools, hospitals, and public buildings with about 1.6km both sides), which need special consideration for noise protection, elastic short sleepers and shock absorption ballast bed were adopted in order to reduce noise. During the operation stage, monitoring has been made according to the Environmental Impact Assessment (EIA). Based on the results of the monitoring report, in 2006 the noise protection work was undertaken at three locations where the noise level exceeded the standard. Upon completion of the work, the noise level was reduced by 2.0 - 7.6 dB(A), and the noise level became lower than the standard.

The business and domestic sewage discharged from stations is treated in the anaerobic tank within the station area and then discharged to the public sewage network. The industrial sewage, including oil-stained waste water and waste water from car wash in the depot, is treated in the special treatment plant located in the depot. The treated water is checked if the water meets the national standard for the treated water, and discharged to the public sewage network. However, part of the treated water is reused for cleaning cars.

(2) Land Acquisition and Resettlement

The acquired land area was about 3 ha and the number of households resettled was 623 with a total number of 1,980 people. The total amount of compensation paid was 197 million yuan. Since all the resettled people requested the compensation in cash, it was paid in cash. Even though it took longer time than expected to negotiate the compensation amount, there was no major issue in the resettlement.

As discussed above, although the average number of passengers per day is lower than the planned, the current number of passengers during peak hours, which is more relevant to traffic congestion, is higher than the planned. If the project has not been implemented, and

train riders used automobiles, it is estimated that the traffic volume would have increased by 8,300 vehicles per hour during a peak hour. Thus, it is considered that the project has contributed to the alleviation of traffic congestion. The results of beneficiary surveys confirm that seventy percent of respondents acknowledge the project's contribution to alleviation of traffic congestion upon completion of the project. Regarding the improvement of air pollution, although it is difficult to measure the direct impact of the project, the level of air pollution in Wuhan has been generally improving.

Based on the above, the project has somewhat achieved its objectives, and therefore its effectiveness is fair.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The original and actual output of the project is shown in Table 8.

Table 8 Output (original and actual)

Item	Original	Actual
Civil work/tracks	Zongguan - Huangpulu with a total length of 10 km (viaduct) 10 stations (viaduct)	as planned
Signals/telecommunication facilities	ATC and ATO by signals in cars Telecommunication between stations: optical cable, Between cars: wireless communication, communication with ground maintenance staff: wireless communication	as planned
Power supply/disaster prevention facilities	Substation: 13 locations	as planned
Management facilities	Control center, toll collection system	as planned
Trains	12 trains (48 cars)	as planned
Environmental protection	Sewage/drain water treatment, Noise protection wall	as planned
Depot/Yard	One Unit (Qiaokoulu - Lijibeilu with a total area of about 26,000 m^2)	32,700 m^2, about 25% increase

Source: Appraisal documents, Responses to Questionnaire

There were no major changes in the scope of works. Civil works and procurement of equipment have been implemented as planned. However, the precise location of the depot is between Qiaokoulu and Chongrenlu, and the area was increased to 32,700 m^2. The reason for the increase is that the area estimated at appraisal was based on the concept plan in the feasibility study, while the actual area is based on the detailed designs. Stores and shops were built under the depot, and the space has been leased/sublet to a private entity.

Train Operation Control Center

Tracks on viaduct section
(Jinghan Avenue)

3.4.2 Project Inputs

3.4.2.1 Project Cost

The estimated project cost at appraisal was 26.981 billion yen, of which the Japanese ODA loan with a total amount of 2.894 billion yen for the foreign currency portion alone and the rest to be funded by the Wuhan Municipality. The actual project cost was 24.388 billion yen, of which the Japanese ODA loan used was 2.34 billion yen and the rest was funded by the Municipality. The actual cost is equivalent to 91% of the planned cost. In Chinese yuan currency, the actual project cost was equivalent to 83% of the planned cost.

Table 9 Comparison of Project Cost (Planned and Actual)

Item	Planned					Actual				
	Foreign	Local		Total		Foreign	Local		Total	
	million yen	million yuan	million yen	million yuan	million yen	million yen	million yuan	million yen	million yuan	million yen
Civil work/tracks	0	454	5,902	454	5,902	0	412	5,760	412	5,760
Signal/Telecom.	674	167	2,171	219	2,845	598	128	1,790	170	2,388
Power supply/disaster prevention	254	231	3,003	250	3,257	442	189	2,642	221	3,084
Management	0	7	91	7	91	0	7	98	7	98
Trains	1,550	254	3,302	373	4,852	1,330	238	3,328	331	4,658
Environmental protections	0	42	546	42	546	0	45	629	45	629
Depot/yard	243	121	1,573	140	1,816	0	137	1,915	137	1,915
Others	0	446	5,798	446	5,798	0	421	5,886	421	5,886
Price escalation	35	48	624	51	659	-	-	-	-	-
Contingency	138	79	1,027	90	1,165	-	-	-	-	-
Total	2,894	1,849	24,037	2,072	26,931	2,340	1,577	22,048	1,744	24,388

Source: Appraisal documents, Responses to Questionnaire

Note: Exchange rate at appraisal : 1 yuan = 13 yen, Exchange rate at post evaluation: 1 yuan = 13.981 yen (average rate during the period of January 2000 - December 2004)

Main reasons for the lowered project cost are as follows.

1) During the implementation stage, designs were reviewed in detail, and construction methodologies, which led to elimination of ineffectual items and reduction of costs, were adapted.
2) Since the procurement of equipment (signals and telecommunication system, power supply and disaster prevention, and trains) was made through international competitive bidding (ICB) procedures, the competition produced lower bid prices resulting in the lower contract prices than the estimated costs.

3.4.2.2 Project Period

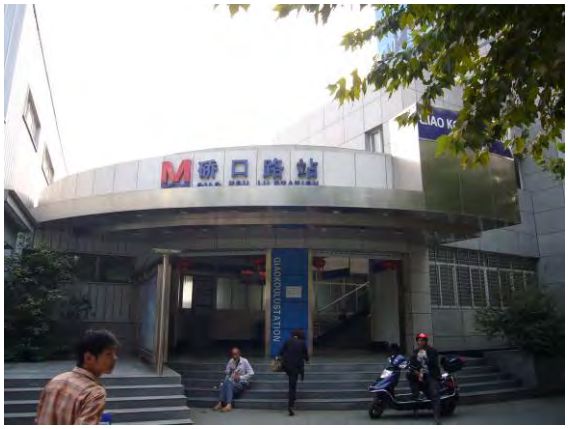
The project period was slightly longer than planned. The project period planned at appraisal was from March 2001 (signing of the Loan Agreement) to March 2003 (open to public) with a total period of 34 months. The actual project period was from March 2001 (signing of the Loan Agreement) to July 2004 (open to public) with a total period of 41 months, or equivalent to 121% of the planned period. The whole line with a total length of 29 km including the phase 1 section was open to public on July 28, 2010.

The main reasons for extension of the project period were: i) completion of civil works were delayed by a few months; but ii) with regards to the supply and installation of equipment, the ICB procedures process took longer than planned hence delaying the construction period. It was further delayed because of the final inspection and the test run lasted for a few months after the completion of all the project components. Eventually, the project period was delayed by 7 months, which was slightly longer than planned.

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

The Financial Internal Rate of Return (FIRR) calculated at appraisal was 4.9% and the Economic Internal Rate of Return (EIRR) at appraisal was 14.9%. It is difficult to calculate the FIRR and EIRR at the post evaluation stage because of the following reasons: i) the construction cost of phase 2 and the operation and maintenance cost by phase are not available; and ii) the assumptions made for calculation (including change of the route, the total plan of metro network and the implementation schedule) have completely changed.

Depot



Qiaokoulu Station

Although the project cost was within the plan, the project period slightly exceeded the plan. Therefore, efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance

Upon completion of the project, Wuhan Metro Operation Company (100% owned by Wuhan Metro Group), which is the subsidiary of Wuhan Metro Group (formerly called Wuhan Light Rail Transport Company) is undertaking operation and maintenance. The company has 12 divisions and offices with a total number of 1,600 employees at present (as of November 2010). Among 1,600 employees, about 500 staff are under the Maintenance and Management Division. The number of staff responsible for operations is about 50 for the Supervision and Dispatching Center, about 500 for Trains Division and about 500 for Passenger Transport Division.

3.5.2 Technical Aspects of Operation and Maintenance

Among the total 1,600 employees, 301 staff are college graduates and 1,262 staff graduated from vocational schools. Among the technical staff, four are senior engineers, 25 are engineers, and 37 are assistant engineers. The number of training modules implemented in 2011 is 14, including those on operating manuals, safety control, and countermeasures at emergency when the signals are not functioning. These training were undertaken internally and at the companies' supplied equipments. The training of each module lasted between 3 and 10 hours and the number of training recipients for each module was between 35 and 195. The training on safety and service enhancement was offered to all the employees once a year. Manuals prepared by the company include Management, Control and Procedures for Passenger Transport Service, Management, Control and Procedures for Operations and Safety Enforcement, Regulations for Train Dispatching Management, and Regulations for

Train Inspection and Repair Management. These manuals were developed for each job assignment.

3.5.3 Financial Aspects of Operation and Maintenance

At the planning stage, the flat fare (2 yuan/passenger during 2004-2012) was originally proposed for phase 1 section between Zongguan - Huangpulu section with a total length of about 10 km.

However, since the number of passengers was lower than expected upon commencement of operation, the charges were set low. Since then, fares have been raised and the current rate is 1.5 yuan for the first 6-station section and increased by 0.5 yuan for each of the following 3-station section. The revenue and expenditure status for the past four years is shown in Table 10.

Table 10 Revenue and Expenditure Status for the past Four Years

Unit: 000 yuan

Year	2008	2009	2010	2011
Fare revenue	16,513	19,515	56,546	95,980
Advertisement revenue	2,667	4,956	18,171	19,110
Revenue from lease of fixed assets	14,420	15,779	19,393	19,610
Subsidy from city government	18,000	18,000	18,000	18,000
Revenue total	51,600	58,250	112,110	152,700
Operation and maintenance costs	50,760	57,380	99,060	122,550
Balance	840	870	13,050	30,150

Source: Response to Questionnaire

Note: The revenue from lease of fixed assets includes revenues by leasing the space under the depot to the commercial entities.

Since the number of passengers was lower than expected, and the fare was set low, the fare revenue was not sufficient to the operation and maintenance costs. For the past 4 years, the Wuhan Municipal Government has provided subsidies amounting 18 million yuan every year. After opening the phase 1 section to the public in July 2004, the number of passengers was low and the business revenue was also quite low. However, on July 28, 2010 the whole alignment was opened to the public and the fare revenue has increased resulting in substantial surplus both in 2010 and 2011[5]. The parent company, Wuhan Metro Group is a state-owned company (100% owned by Wuhan Municipal Government), and it is also likely that the Municipal Government would continuously provide financial assistance. The budget needed for operation and maintenance of the equipment and facilities procured under the project is secure, and thus, no major financial issue is observed.

[5] The balance in 2011 ended in the black even excluding subsidies from the municipal government.

3.5.4 Current Status of Operation and Maintenance

Cleaning the inside cars and washing the train is regularly implemented. Train exteriors are inspected every 20,000 km of operation, and overhaul (dismantling bodies, detailed inspection and changes of worn out parts are implemented.) is implemented every 400,000-600,000 km. In addition, the tracks and power transmission lines are inspected every day. From the ocular inspection when riding the train, it was confirmed that trains and stations/platform have been cleanly maintained. Particularly, no difference was observed to the appearance between the trains procured under the project in 2004 and those procured under the phase 2 in 2010. This proves that the maintenance quality is high. The customer service of station staff is satisfactory and all the guide signs in the stations are quite visible.

No major problems have been observed in the operation and maintenance system, and therefore sustainability of the project effectiveness is rated high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of the project was to alleviate traffic congestion in the city center by constructing an urban railway with a total length of 10 km between Zongguan – Huangpulu in Wuhan, and thereby contribute to the improvement of air quality and promote social and economic development in Wuhan. The project has been highly relevant to the development plans and needs of China and Wuhan, as well as Japan’s ODA policies, and therefore its relevance is high. Regarding the alleviation of traffic congestion, contributing to improvement of air quality and promotion of social and economic development, which is the project's objective, the project has somewhat achieved its objectives, and therefore its effectiveness is fair. Although the project cost was within the plan, the project period exceeded the plan slightly. Therefore, efficiency of the project is fair. No major problems have been observed in the operation and maintenance system(organizational setup, technical capacity and financial status), therefore the project's sustainability is considered high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

At present, the number of passengers during peak hours has reached the planned. However, since the passengers during the off-peak hours are less than expected, the average number of passengers per day is quite low. In order to alleviate the congestion in

train cars during peak hours and traffic congestion in the city's road network during the day, it is suggested to implement the policy of limiting the use of private cars during the day, as implemented in Beijing.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) The project completion date (opening Line 1 to public) was July 2004, and the loan closing date was July 2006. The reason why the ex-post evaluation of the project is only undertaken now is because the completion of the whole project components, including phase 2 section, which was funded by own resources, not by the ODA loans, was July 2010, when the phase 2 section was officially open to traffic. When preparing ex-post evaluation seven years after the project was completed, it is difficult to collect the relevant data and information and meet the officials who were involved in the project. Thus, it might affect the accuracy and preciseness in the assessment and evaluation process. In order to make an accurate ex-post evaluation, it is essential to keep all the records and data properly.

(2) From around 2003 after the project commenced, there was a change in alignment of the project route (phase 2 section), and the metro network development plan in Wuhan was formulated. Thus, it required a review of the demand forecast (number of passengers) analyzed in the feasibility study. Since the targets have not been established after the substantial change in alignment, it is difficult to properly assess the effectiveness of the project. Since the change in the project scope greatly affects the project's objective and effectiveness, a detailed review and assessment of scope of work should have been made to the level required at appraisal. The review and assessment work including reconfirmation of the scope of work, review of revised implementation schedule, analysis of its impacts due to revisions, establishment of new targets of operational monitoring indicators, and economic/financial analysis should be made[6], when the change in the project scope, which would greatly affect the project's objectives and effectiveness was made.

[6] Since 2004, the mid-term review system has been introduced for the Japanese ODA loan projects on a trial basis. Regarding the project, which needs the confirmation at the mid-term stage because of some factors affecting the achievement of project effectiveness, its originally identified relevance and planned effectiveness are reassessed so that planning of the project, including reestablishment of monitoring indicators are made as needed.

(3) Due to delay in completion of phase 2 section (from the planned 2007 to July 2010), the expected impact/effectiveness to be achieved through phase 1 section of the project, particularly the average number of passengers per day, have not appeared. The timely completion of the phase 2 section, which was not funded by JICA, was essential in achieving the expected impact/effectiveness under phase 1 section. Thus, the progress of the project, which is not funded by JICA, but would affect the achievement of the JICA-funded portion, should be monitored by JICA as well, even after the loan was closed so that it is possible to assess the influence to the impact/effectiveness of the JICA-funded portion.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs		
Civil work/tracks	Zongguan - Huangpulu with a total length of 10 km (viaduct) 10 stations (viaduct)	as planned as planned
Signals/telecommunication facilities	ATC and ATO by signals in cars Telecommunication between stations: optical cable, Between cars: wireless communication, communication with ground maintenance staff: wireless communication	
Power supply/disaster prevention facilities	Substation: 13 locations	as planned
Management facilities	Control center, toll collection system	as planned
Trains	12 trains (48 cars)	as planned
Environmental protection	Sewage/drain water treatment, Noise protection wall	as planned
Depot/yard	One Unit (Qiaokoulu - Lijibeilu with a total area of about 26,000 m^2)	32,700 m^2, about 25% increase
2. Project Period	March 2001 – December 2003 (34 months)	March 2001 – July 2004 (41 months)
3. Project Cost		
Amount paid in Foreign currency	2,894 million yen	2,340 million yen
Amount paid in Local currency	24,037 million yen (1,849 million yuan)	22,048 million yen (1,577 million yuan)
Total	26,981 million yen	24,388 million yen
Japanese ODA loan portion	2,894 million yen	2,340 million yen
Exchange rate	1 yuan = 13 yen (As of March 2001)	1 yuan = 13.981 yen (Average between January, 2000 and December, 2004)

People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

"Broadcasting Infrastructure Improvement Project"

(Jinan City, Shandong Province)

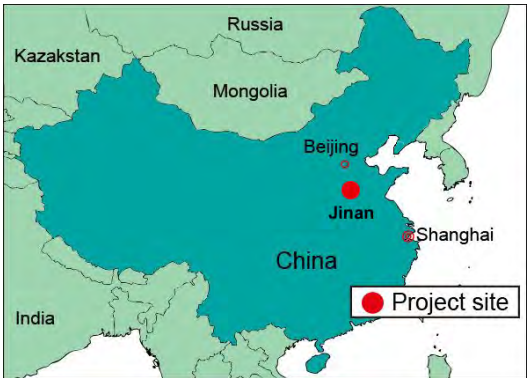
External Evaluator: Akemi Serizawa, Global Link Management, Inc.

0. Summary

The objective of this project was to contribute to the improvement of the broadcasting programs of Jinan both in quantity and quality by the innovation of equipment of the broadcasting stations as well as by training, and then to the knowledge enhancement and cultural enrichment of the citizens of Jinan and also to the promotion of their understanding about Japan. This project was highly relevant with China's development plans, development needs and Japan's ODA policy; therefore its relevance is high. While its effect on the promotion of the citizens' understanding about Japan was limited, it has contributed to the improvement of the broadcasting programs in Jinan both in quantity and quality, and also to the knowledge enhancement and cultural enrichment of the citizens to a certain extent; therefore the effectiveness and impact are high. The project period was within the plan and the project cost exceeded the plan, therefore its efficiency is fair. No major problems have been observed in the operation and maintenance system, therefore its sustainability is high.

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

1. Project Description



Project Location

High definition broadcasting van

1.1 Background

The broadcasting stations in China exist at the central, provincial, prefectural and county levels and are supervised by the corresponding governments. In 2001, the national percentage of population covered was 94% for the television and 93% for the radio, and broadcasting was

already fully integrated into the everyday life of the Chinese citizens. As broadcasting was vital for the information delivery to the citizens and the cultural enrichment, the Government of China had been working on the improvement of access to broadcasting in the remote areas.

This project aimed to improve broadcasting programs in Jinan both in quantity and quality in order to improve access of the citizens to the broadcasting programs, and then to contribute to the knowledge enhancement and cultural enrichment. The project was also expected to promote their understanding about Japan through the broadcasting programs. Also, the project planned to introduce Japanese broadcasting technology and equipment to China through the Special Terms for Economic Partnership (STEP) [1].

1.2 Project Outline

The objective of this project was to improve the quantity and quality of the TV and radio programs in Jinan by the innovation of the broadcasting equipment and provision of training to the staff of the broadcasting stations, thereby contributing to the knowledge enhancement and cultural enrichment of the citizens in Jinan and also to the promotion of their understanding about Japan.

Approved Amount / Disbursed Amount	2,914 million yen / 2,913 million yen
Exchange of Notes Date / Loan Agreement Exchange Date	March 2004 / March 2004
Terms and conditions	Interest rate : 0.75% p.a Repayment period (Grace Period): 40 years (12 years) Bilateral-tied
Borrower / Executing Agency	Government of the People's Republic of China / People's Government of Jinan City
Final Disbursement Date	January 2010
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	-
Feasibility Studies, etc.	F/S by Shandong Province Development Planning Commission Consulting Company (June 2003)
Related Projects（if any)	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Akemi Serizawa (Global Link Management, Inc.)

[1] JICA approved other five broadcasting projects in China at the same time with the Jinan project. The target areas of these five projects were Qiunhai Province, Yunnan Province, Anhui Province, Jilin Province and Ningxia Hui Autonomous Region.

2.2 Duration of the Evaluation Study

Duration of the Study: July 2011 – September 2012

Duration of the Field Study: 9 October – 22 October 2011, 21 February – 2 March 2012

2.3 Constraints during the Evaluation Study

None.

3. Results of the Evaluation (Overall Rating: A[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance with the Development Plan of China

The priority areas of the broadcasting sector in the Tenth Five-year Plan of China (2001-2005) included promotion of informatization, improvement of quality of cultural living, environmental conservation, protection of the ecosystems, improvement of education, consolidation of the legal systems, development of the system for the market-oriented economy, and improvement of the health and sanitation. The Tenth Five-year Plan of Radio, Film and Television and Science and Technology for the same period and the long-term plan 2010 of the State Administration of Radio, Film and Television of China aimed to improve the percentage of population covered of the television from 91% in 2000 to more than 97% and that of the radio from 92% in 2000 to more than 98% in the administrative villages. Jinan's Tenth Development Plan aimed to promote digitalization of broadcasting equipment and improve the quantity and quality of broadcasting programs.

The 11th national Five-year Plan (2006-2010) aimed to improve the news programs, broadcasting technologies and infrastructure. The current national 12th Five-year Plan (2011-2016) promotes informatization thorough the improvement of the broadcasting infrastructure and cultural enrichment through broadcasting. Jinan's 11th Five-year Plan emphasized cultural development and aimed to strengthen the impacts of radio and television. Its current 12th Plan prioritizes digitalization of the broadcasting equipment and aims to strengthen creativity of the programs for cultural enrichment.

This project was in line with these policies as it aimed to improve the broadcasting programs both in quantity and quality and to contribute to the knowledge enhancement and cultural enrichment of the citizens, both at appraisal and ex-post evaluation.

3.1.2 Relevance with the Development Needs of China

Jinan is the capital of Shandong Province and an economic center in the region with machinery, automobile, electric and chemical industries. Jinan needed to upgrade its

[2] Overall rating: A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[3] Rating: ③: "high", ②: "fair", ①: "low"

broadcasting programs in order to strengthen information delivery to the citizens and then to promote regional economy, to which this project was expected to contribute through the innovation of broadcasting equipment. At the time of appraisal, Jinan TV Station and Jinan Radio Station had not been able to upgrade the equipment due to insufficient budget despite Jinan's 8th Five-year Plan (1991-1995). They were not able to upgrade the technology and infrastructure, which hindered production of quality broadcasting programs.

At ex-post evaluation, the broadcasting stations felt the needs of continuous innovation of broadcasting equipment and improvement of technology in all aspects including production, editing and broadcasting. In particular, high definition technology is in demand. Broadcasting plays an important role to deliver useful information to the citizens such as knowledge about economy, culture and information on the everyday life. Broadcasting is essential for the development of the city and the knowledge enhancement and cultural enrichment of Jinan citizens.

From the above, the needs of innovation of broadcasting equipment and the improvement of technology in Jinan were high both at appraisal and ex-post evaluation.

3.1.3 Relevance with Japan's ODA policy

Japan's Economic Cooperation Program for China (October 2001) aimed to develop the environment to promote the market economy, to improve the livelihood to promote social development in the inland areas and to enhance economic activities in the private sector. The Overseas Economic Cooperation Implementation Policy (April 2002 – March 2005) of JICA (JBIC at that time) emphasized human resource development and considered the reduction of information gap in the developing countries was important for the reduction of the income disparities. Broadcasting delivers information to the people of different backgrounds, and it can contribute to the human resource development, promotion of economic and cultural activities and regional revitalization. Therefore, this project to upgrade broadcasting equipment and improve technology was in line with the Japan's ODA policies. At the same time, this project was expected to contribute to the promotion of understanding of Chinese citizens about Japan through the Japanese broadcasting programs. It was in line with Japan's Economic Cooperation Program for China, in which promotion of mutual understanding between the Chinese and Japanese was highlighted.

From the above, the improvement of broadcasting in quantity and quality as well as the knowledge enhancement and cultural enrichment of Jinan citizens accord with the development plans and needs of China and Japan's assistance policy. The promotion of citizens' understanding about Japan was in line with Japan's policy.

The project has been highly relevant with the country's development plan, development

needs, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness (Rating:③)

The effectiveness of this project was examined from the quantitative and qualitative viewpoints. Quantitative effects were measured by the operation and effect indicators such as number of viewers and listeners, percentage of population covered, number of programs and broadcasting hours. Qualitative effects such as the improvement of the programs were grasped from the opinions of the executing agencies and beneficiaries. The details are described below.

3.2.1 Quantitative Effects (Operation and Effect Indicators)

(1) Quantitative improvement of TV and radio programs

The five indicators in Table 1 were agreed with the executing agencies to measure the improvement of the broadcasting programs (number of viewers and listeners, percentage of population covered, share of independently produced programs, number of programs related to education, broadcasting hours per day of programs related to education). Data for the original target year (2008) were not available because the project was complete in December 2008. Instead, the actual figures of 2011 were compared with the targets as the target year was supposed to be two years after the completion of the project. The targets were achieved by 2011.

Table 1. Quantitative and qualitative improvement of TV and radio programs (Indicators agreed between the two countries)

Indicators	TV/ Radio	2003 actual (baseline)	2008 target (2 years after the project completion)(*)	2011 actual
Number of viewers/listeners (The population of Jinan was 6.81 million in 2011.)	T	884,000 households	900,000 household (TV and radio were not distinguished)	980,000 households (5.8million people)
	R	6 million people		8 million (including surrounding areas)
Percentage of population covered		T+R 98.3%	T+R 99.0%	T 100% (98.3% if calculated based on the number of people)
				R 100%
Share of independently produced programs	T	23.6%	35.0%	45%
	R	77.8%	85.0%	90%
Number of programs related to education	T	3/week	5/week	12/week
	R	6/week	9/week	15/week
Broadcasting hours per day of programs related to education	T	2hours/day	5 hours/day	10hours/day
	R	3 hours/day	7hours/day	14hours/day

T=Jinan TV Station. R=Jinan Radio Station

Note (*): According to the appraisal documents, the target year was 2008 (two years after the completion of the project). However, it was not consistent with the original plan to finish the project by December 2009.

Source: appraisal documents, questionnaire responses, interviews with the executing agencies

Table 2 shows other indicators which were selected by the Japanese side as supplementary indicators. Most of them have achieved the targets except for the number of programs produced in other countries (including Japan) that were broadcasted by Jinan TV Station. They did not broadcast any foreign programs as the purchase and broadcasting of foreign programs were restricted by the central government.

Table 2. Quantitative and qualitative improvement of TV and radio programs (other indicators)

Indicators	TV/ Radio	2003 actual (baseline)	2011 target (JICA appraisal documents)	2011 actual
Number of independently produced programs	T	43/week	60/week	65/week
	R	93/week	110/week	600/week
Number of channels (note)	T	Jinan TV: 6 (+ of other TV stations: 43)	8	Jinan TV: 8 (+ of other TV stations: 90)
	R	4	1	6
Broadcasting hours	T	44,100 min/week	58,380 min/week	58,880 min/week
	R	18hours/day	20 hours/day	24hours/day
Number of programs related to disaster management	T	2/week	3/week	8/week
	R	1/week	5/week	5/week
Number of programs related to environmental conservation	T	2/year	3/year	52/year
	R	2/year	4/year	6/year
Number of programs related to public health	T	2/year	5/year	360/year
	R	2/week	8/week	8/week
Number of programs related to the development of market economy	T	3/week	4/week	21/week
	R	3/week	6/week	6/week
Number of programs produced in other countries	T	12/year	17/year	0
	R	0/year	6/year	8/year
Number of programs produced in Japan	T	6/year	15/year	0
	R	0/year	4/year	4/year
Number of programs targeting minority ethnic groups	T	5/year	8/year	10/year
	R	3/month	5/month	5/month
Number of programs targeting women	T	5/week	8/week	21/week
	R	7/month	10/month	30/month
Number of programs targeting children	T	7/week	15/week	43/week
	R	5/week	10/week	10/week

T=Jinan TV Station. R=Jinan Radio Station

Note: Jinan TV Station has eight channels: news, urban life, films, variety, life, business, children and mobile. They are going to add high definition channel soon.

Source: Appraisal documents, questionnaire responses

Table 1 and Table 2 above show the quantitative improvement of broadcasting programs, such as the increase in numbers of viewers and listeners, increase in population covered, and increase in numbers of broadcasting programs.

3.2.2 Qualitative Effects

The quality of TV and radio programs has been improved: program production and editing technology has been upgraded and diversified; sound and screen images have been

improved; program contents became diversified and richer; and the viewers and listeners have been satisfied with the programs. The details are explained below.

(1) "Hard" aspects

By the innovation of the infrastructure and equipment, the broadcasting stations were able to promote digitalization and networking, upgrade and diversify the program production and editing technology, and improve the efficiency of the work. For example, it became possible to combine recorded materials with live programs, which has diversified the structures of the programs.

Jinan TV Station was awarded "1st prize of scientific technology innovation" from the State Administration of Radio, Film and Television of China for its integrated production-broadcasting network. It also won 3rd prize for its broadcasting general control system and the high definition broadcasting van.

(2) "Soft" aspects

Training has contributed to the capacity development of the staff of Jinan TV Station in operation of equipment and in program editing. They now use more diversified technology for program production. The increase in numbers and share of independently produced programs also indicates their improved capacity. They became more creative as shown in their own programs featuring Jinan and the regional culture, as listed below:

- Documentaries about regional culture: The World of Spring City[4]; Wonderful Jinan; etc.
- Wonderful Folk Culture of China (2007): It featured folk culture artists. The program became very popular and attracted attention from other broadcasting stations in China including CCTV (China Central Television).
- Heroes of Shandong Clapper Ballads (2008): Shandong clapper ballad is a folk art of story-telling. More than 50 performers competed in the elimination tournaments held in five big cities in China including Jinan and Beijing. The participants became popular and Shandong clapper ballad became widely known.
- Dance in Tokyo (2007): It is a documentary featuring Zhong Xue, a dancer from Shandong Province and had lived in Japan for 20 years. She has contributed to the promotion of mutual understanding between Chinese and Japanese as a creator and performer as well as an instructor of Chinese dance. The program was broadcasted in Jinan and in Japan.

According to Jinan TV Station, these programs featuring regional culture were well accepted by the viewers and other broadcasting stations, and the themes and performers

[4] Jinan is also known as Spring City. It has many springs.

appeared in the programs became widely recognized. These programs have raised interest of the public in the folk arts and in Jinan and Shandong Province. Some of these programs were broadcasted in Hong Kong and Taiwan in order to project a good image of Jinan for its promotion as a tourist destination.

According to the beneficiary survey in which 100 people in Jinan participated[5], 92% of the respondents said that the programs of Jinan TV had improved since 2008, and 83% reported the same about Jinan Radio. They pointed out following improvements:

TV

- Programs became more diversified.
- More programs respond to the needs of the viewers. Programs became closer to the viewers and their everyday life.
- The quality of the screen images and the sound has been improved.
- Broadcast reception became more stable.

Radio

- The radio station has many programs targeting different types of listeners.
- More programs respond to the needs of the listeners. The programs became closer to the listeners and their everyday life. The listeners have more opportunities to participate in radio programs.
- People have access to useful information for the everyday life through radio programs, such as transport information and weather forecast.

From the above, it can be concluded that the quality of the TV and radio programs have been improved as planned.

Inside of the broadcasting van

Inside of the broadcasting van

[5] Sixty-three men and 37 women participated. The age is from teenagers to 60s. They include employees, business owners, government staff, etc.

3.3 Impact

3.3.1 Intended Impacts

(1) Knowledge enhancement and cultural enrichment of Jinan citizens

According to the beneficiary survey results, the TV and radio programs are deeply integrated in the life of Jinan citizens, and they use information from the broadcasting programs in their everyday life.

Table 3. Beneficiary survey results Impacts from the broadcasting programs

I use information from TV programs in the everyday life.	77%
I use information from radio programs in the everyday life.	71%
TV and radio programs give positive impacts on myself, my family and the community.	69%
There are no negative impacts from TV or radio programs.	82%

The respondents explained what kind of information from the TV and radio they used in their everyday life. The responses included weather forecast, transport information, market information, legal information about business, domestic matters and real estates, crime-prevention measures, food safety, health information, and government information, among others. They also mentioned about positive impacts from TV and radio programs, such as a successful conflict solution in the family or community using information they obtained from broadcasting programs. No specific examples of negative impacts from TV or radio were available from the survey.

(2) Promotion of Jinan citizens' understanding on Japan

As explained in the section of Efficiency below, the soft components for the promotion of Jinan citizens' understanding on Japan were "collaboration with Jinan's friendship cities in Japan (Yamaguchi and Wakayama)", "purchase of Japanese broadcasting programs", and "co-production of programs with Japanese broadcasting stations." The documentary program "Dance in Tokyo" was co-produced between Jinan TV Station and a Japanese TV program production company whose representative is a Chinese, and was broadcasted in both countries. The viewers of this program were likely to have deeper understanding of the other country. Since it was the only co-produced program in this project, however, its impact on the promotion of citizens' understanding on Japan was limited. "Collaboration with the friendship cities" and "purchase of Japanese programs" were not implemented because of the reasons explained in the section of Efficiency.

At the same time, 40% of the beneficiary survey participants said that their impression about Japan had changed by TV or radio programs. They are interested in various things related to Japan, such as cartoon films, advanced technologies, politics, the big earthquake and the nuclear plant crisis in March 2011, culture (literature, music, fashion and beauty) and tourism,

which shows that they are well informed of Japan. It is likely that they obtain information about Japan from regular TV or radio programs such as news shows, rather than from particular programs featuring Japan. They were also able to list up their favorite Japanese programs including well-known cartoon films and variety shows. However, these programs were old ones that had been broadcasted well before this project started. Therefore, Jinan citizens' high level of interest in Japan and Japanese culture is not likely to be directly related to this project.

As explained above, the realized soft components were only training and a co-produced program. Therefore, this project has had limited impact on the promotion of Jinan citizens' understanding on Japan. Since the project has greatly contributed to the improvement of TV and radio programs in quantity and quality and to the knowledge enhancement and cultural enrichment of the citizens, however, the effectiveness and impact of this project are considered high.

3.3.2 Other Impacts

(1) Impacts on the natural environment

The project was implemented in the sites of Jinan TV Station and Jinan Radio Station, and the provided broadcasting equipment did not have functions to give negative impacts on the natural environment. Jinan Municipal Environmental Protection Bureau also confirmed that there were no negative impacts on the natural environment by this project such as air pollution, noise and airwaves.

(2) Land Acquisition and Resettlement

There was no land acquisition or resettlement by this project.

(3) Other impacts

The Jinan project was complete first among the six similar JICA STEP broadcasting projects in China. The Ministry of Finance of China and JICA jointly organized a meeting in June 2006 to share the experiences from the Jinan project with other five projects. The Jinan project shared the key factors for successful project implementation such as "scientific management and efficient implementation of the project", "selection and procurement of appropriate equipment matching to the identified needs", "regular monitoring of the progress of the project by the government leaders", and "promotion of mutual understanding between the Chinese project team and JICA through frequent meetings." According to the executing agencies, Jinan's experiences in the international competitive bidding process and preparation of bidding documents, and those in delivery inspection of the equipment were particularly useful for other five projects.

No particular negative impacts were observed.

From the above, this project has largely achieved its objectives, therefore its effectiveness and impacts are high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The planned and actual project outputs are compared in Table 4. Main points are as follows:

(1) "Hard" components

- At the planning stage, 12 packages were to be procured by the JICA fund, of which ten were for the TV Station, one was for the Radio Station, and another was for the Network Center. Five of these packages, four of which were for the TV Station and one was for the Network Center, were procured by the Chinese fund before the start of procurement by the JICA fund, and another package for the TV station (high definition equipment) was added to be procured by the JICA fund. Therefore, eight packages were actually procured by the JICA fund, seven of which were for the TV Station and one was for the Radio Station. The procured equipment on the whole was same as the plan in terms of the purposes and functions.
- The spec and the price of each of the procured equipment were different from the plan because of the advancement of the technology and change of the prices during the two years between the project planning and procurement. On the whole, the purchased equipment was more advanced and more expensive than the plan (please refer to Table 5 as well). The equipment purchased by the JICA fund was selected according to the spec and price so that the total price would not exceed the approved amount of JICA loan.
- The spec and the price of each of the procured equipment by the Chinese fund were also different from the plan because of the same reasons. It was not possible to compare the planned packages and the actually-procured packages because the packages were largely reshuffled and the executing agencies were not able to identify each of the purchased equipment with the original packages.

(2) "Soft" components

- The original plan was to train eight people from the three broadcasting stations, six of which were from the TV Station, one was from the Radio Station and another was from the Network Center, and each training course was supposed to last one month. The training was conducted for 20 people only from the TV Station for 12 days (the total person-days are 240 and same as the plan). As the most of the procured equipment was for the TV station, the training focused on the operation and maintenance of such equipment.

・ Other soft components were “purchase of broadcasting rights of Japanese programs”, “collaboration with Jinan’s friendship cities in Japan (Yamaguchi and Wakayama)”, and “co-production of programs with Japanese broadcasting stations.” Among these components, only one documentary titled “Dance in Tokyo” was co-produced by Jinan TV Station and a Japanese broadcasting program production company, as explained above. Other components were not implemented because of the restrictions by the Chinese broadcasting policy.

➢ “Purchase of broadcasting rights of Japanese programs”: it was not implemented because it was difficult for broadcasting stations at the municipality level to purchase and broadcast foreign programs. The central government restricts foreign programs for the purpose of protection of Chinese culture and the broadcasting industry.

➢ “Collaboration with the friendship cities”: In the plan, the broadcasting stations in Yamaguchi and Wakayama were among the candidate venues for the training for the staff of Jinan broadcasting stations. NHK Science and Technology Research Laboratories in Tokyo, not broadcasting stations in Yamaguchi or Okayama, was appointed as the training venue for its capacity to respond to the training needs of Jinan TV Station. The exchange of programs was also difficult because of the restrictions of foreign programs.

Table 4. Project Outputs (procured/implemented by the JICA fund)

		Plan	Actual
“Hard” components	Jinan TV Station	(10 packages) ・ Renovation of studio ・ Equipment (digital cameras, recorders, editors, monitors, etc.) ・ Broadcasting van	(7 packages) (*) ・ Renovation of studio ・ Equipment (digital cameras, recorders, editors, monitors, etc.) ・ Broadcasting van
	Jinan Radio Station	(1 package) Equipment (digital cameras, editors, work stations, mixers, etc.)	(1 package) Equipment (digital cameras, editors, work stations, mixers, etc.)
	Jinan Broadcast and TV Information Network Center	(1 package) Cable TV equipment (cable modem systems, receptor stations, servers, etc.)	None (*)
“Soft” components	Jinan TV Station	・ Training (program production, editing, operation and maintenance: 2 staff each x 1 month = 6 staff) ・ Collaboration with the friendship cities of Jinan (Yamaguchi and Wakayama) ・ Purchase of broadcasting rights of programs produced in Japan	・ Training (program production, editing, operation and maintenance: 20 staff x 12 days). Conducted in NHK Science and Technology Research Laboratories in 2007devided in two batches. ・ Collaboration with the friendship cities was not implemented.

		Plan	Actual
		・ Co-production of programs with Japanese broadcasting stations	・ Broadcasting rights of Japanese programs were not purchased. ・ A documentary titled “Dance in Tokyo” was co-produced by Jinan TV and a Japanese program production company.
	Jinan Radio Station	Training (radio technology): 1 staff x 1 month	None
	Jinan Broadcast and TV Information Network Center	Training (network technology): 1 staff x 1 month	None
Consulting services	Technical assistance in procurement	1) Preparation of detailed design (D/D) and pre-qualification (P/Q) documents 2) Evaluation of P/Q results 3) Preparation of tender documents 4) Evaluation of tender results	1) Preparation of detailed design (D/D) documents 3) Preparation of tender documents 4) Evaluation of tender results P/Q was not conducted.
	Technical assistance in training	1) Training in Japan 2) Co-production of programs with Japanese broadcasting stations 3) Purchase of Japanese programs and broadcasting rights	1) Training in Japan

Source: Appraisal documents, PCR, questionnaire responses

Note (*): Equipment not procured by JICA fund was procured by the Chinese fund. The equipment was procured as planned on the whole using both sources of funding.

Jinan TV Station: Studio 1

Jinan Radio Station: Recording a program

3.4.2 Project Inputs

3.4.2.1 Project cost

The estimated project cost at appraisal was 4,176 million yen, of which the Japanese loan was to be used only for the foreign currency portion amounting to 2,914 million yen and the rest was to be funded by the broadcasting stations. The actual project cost for "(part a) the eight packages of the equipment procured by the JICA fund, training and consulting services" was 4,185 million yen, of which JICA fund covered the foreign currency portion in full amounting to 2,913 million yen and the rest was financed by the broadcasting stations. The actual cost of "part a" was 100% of the estimated cost for the whole project in Japanese yen, and 99% of that in Chinese yuan. As stated in the previous section, the spec and the price of the procured equipment were higher than the plan because of the advancement of the technology and change of the prices during the two years between the project planning and actual procurement. Regarding "(part b) the equipment procured by the Chinese fund and excluded from the JICA fund", the executing agencies were not able to calculate the actual amount as the procurement packages had been reshuffled.

As shown in Table 6, the actual total amount of "part a" (the equipment procured by the JICA fund) exceeded the total planned cost of the corresponding packages. It is reasonable as the spec and price of the procured equipment were higher than the plan in general and a new package (No.13: high definition equipment) was added. Regarding the equipment procured by the Chinese fund (part b), it was not possible to decide whether the actual cost was appropriate compared to the procured equipment, and it was also difficult to compare the planned and the actual costs as the details of the actual spec and price were not identified. Therefore, the total actual cost of the whole project ("part a" plus "part b") was not known, and there was not sufficient information to show that the total actual project cost was reasonable compared to the procured equipment. It is clear at least that the total actual cost for the whole project exceeded the planned cost as the cost of "part a" was almost the same as the total estimated cost for the whole project. The project cost is rated "moderate" (sub rating ②) as there is no sufficient information to show that the higher project cost than the plan was reasonable for the modified outputs.

Table 5. Project cost

	Plan					Actual				
	FC*	LC**		Total		FC	LC		Total	
	Mill. yen	Mill. yuan	Mill. yen	Mill. yuan	Mill. yen	Mill. yen	Mill. yuan	Mill. yen	Mill. yuan	Mill. yen
Broadcasting Equipment	2,579	84	1,201	264	3,780	2,855	88	1,272	285	4,127
Training, etc.	55	0	0	4	55	16	0	0	1	16
Consulting services	62	0	0	4	62	39	0	0	3	39
Price escalation	83	0.1	1	6	84	-	-	-	-	-
Contingency	135	4	60	14	195	-	-	-	-	-
Loan administration	-	-	-	-	-	3	0	0	0.2	3
Total	2,914	88	1,262	292	4,176	2,913	88	1,272	289	4,185

Source: Appraisal documents, PCR, questionnaire responses

Note: FC*: Foreign currency, LC**: Local currency

Exchange rate: 1 yuan=14.3 yen at appraisal. 1 yuan = 14.46 yen at ex post evaluation (average during the loan period)

According to the record of JICA, the disbursement has not finished yet. The last disbursement was made on 4 April 2009, with the balance of 1 million yen between the accumulated total of disbursed amount and the approved loan amount. The executing agencies do not have an intention to use the remaining 1 million yen, therefore the disbursement is practically complete. Exchange rate at ex-post evaluation was calculated based on the assumption that the disbursement finished in April 2009.

The condition of STEP (Special Terms for Economic Partnership) was applied to this project. Main procurement contracts were bilateral-tied and the share of the equipment and materials of Japanese origin was required to be 30% or more of the total contract amount. The STEP condition was duly observed in this project, and the share of the equipment and materials of Japanese origin was 32.19% of the total contract amount, while it was lower than the original plan (63.20%). The executing agencies felt that STEP condition limited choices of contractors and reduced price competition as the number of the tender participants was less than that in similar tenders in China. The executing agencies managed to select the best contractors in terms of price and quality from as many candidates as possible even though the tender participants were limited. This is likely to have led to the lower share of the materials and equipment of Japanese origin at 32.19%, which still satisfied STEP condition (30%).

Table 6. Procurement packages: comparison between the plan and actual

	Plan			Actual		
Package	Total amount (mill. Yen)	Products of Japanese origin (mill. Yen)	Share of products of Japanese origin (%)	Total amount (mill. Yen)	Products of Japanese origin (mill. Yen)	Share of products of Japanese origin (%)
1. Radio station recording equipment (*1)	111.68	56.02	50.16	257	91	35.46
2. Network equipment (*2)	189.56	82.93	43.75	Self-financed. The actual amount is not identified as the procurement packages were reshuffled.		
3. Mobile TV vehicle	351.51	297.08	84.52	350	184	52.70
4. Elevator, etc.	348.57	170.32	48.86	161	0	0
5. Stationwide assets administration system	92.24	92.24	100.00	Self-financed. The actual amount is not identified as the procurement packages were reshuffled.		
6. Satellite vehicle, video equipment, etc.	148.99	73.97	49.65	596	72	12.21
7. Broadcast and transmission equipment	217.83	85.19	39.11	273	82	30.27
8. News center video/audio equipment	105.05	72.22	68.75	Self-financed. The actual amount is not identified as the procurement packages were reshuffled.		
9. High resolution production equipment	124.62	114.62	91.98	Self-financed. The actual amount is not identified as the procurement packages were reshuffled.		
10. Studio audio production system	153.28	112.73	73.55	237	30	13.08
11. Earlier stage and late stage production equipment	516.08	416.98	80.80	Self-financed. The actual amount is not identified as the procurement packages were reshuffled.		
12. General art and visual studio video equip, .etc.	219.22	71.35	32.55	486	49	10.27
13. High resolution production equipment	In the original plan, it was not included in the equipment to be procured by the JICA fund.			491	406	82.79
Total	2,578.63	1,645.65	63.82	2,851	918	32.19

Note: (*1) is for the radio station. (*2) is for the network center. The rest is for the TV station.

Source: Appraisal documents, PCR, questionnaire responses

Jinan TV Station: monitoring room

Jinan TV Station: monitoring room

3.4.2.2 Project period

The project period was shorter than planned. The project period planned at appraisal was 70 months from March 2004 (signing of the Loan Agreement) to December 2009 (completion of all project components[6]). The actual project period was 58 months from March 2004 (signing of the Loan Agreement) to December 2008 (completion of all project components), which was 83% of the plan.

Procurement of the equipment was to start in October 2004 and to finish in June 2008. Its actual commencement was in December 2005 and finish was in December 2008. During the period between the signing of Loan Agreement and the start of procurement, the Chinese and Japanese parties held discussions to review the equipment to be procured and make necessary adjustment. As explained above, some of the equipment that was originally to be funded by JICA was purchased by the Chinese fund during this period. The procurement by the JICA fund proceeded more quickly than the plan because Jinan Municipal Government closely monitored the progress and the executing agencies had frequent discussions with JICA China Office to promote mutual understanding. Training in Japan was held in 2007, and the consulting services were provided at the same time as the procurement of equipment.

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

It was not possible to calculate Internal Rates of Return at appraisal and also at ex-post evaluation because the effects of this project cannot be grasped quantitatively.

Although the project period is within the plan, the project cost exceeded the plan, therefore the efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance

As planned, Jinan TV Station and Jinan Radio Station are responsible for operation and maintenance of the respective equipment procured by this project.

Jinan TV Station has 331 staff members. Production Department, Rebroadcast Department and Broadcast Department are responsible for operation and maintenance of the equipment procured by this project and these three departments have 84 staff members in total. Jinan Radio Station has 137 staff members. Production and Broadcast Department and Transmission Department are responsible for operation and maintenance of the equipment procured by this project and they have 40 staff members in total. Both broadcasting stations

[6] The completion of the procurement of equipment was defined as the completion of delivery by the contractors. The completion of training was defined as the day on which the Chinese training participants returned from Japan to China (appraisal documents).

have sufficient number of staff for operation and maintenance in view of the good condition of the equipment. These departments implement regular checkups and repair either weekly, monthly, semi-annually or annually according to the needs of each machine, the frequency of which varies. If the broadcasting stations are not able to repair damages themselves, they contact the manufacturers' agents based in China for necessary actions.

It was not possible to obtain information about the current operation and maintenance structure of Jinan Broadcast and TV Information Network Center because it was transferred from Jinan Municipal Government to Shandong Provincial Government in June 2011 and it was not involved in the JICA-funded portion of this project.

3.5.2 Technical Aspects of Operation and Maintenance

The number of engineers responsible for operation and maintenance of the TV and radio stations is shown in Table 7. They were trained by the manufactures on operation and maintenance of the procured equipment at delivery. Also, twenty engineers from the TV station participated in the training in Japan (one of the "soft" components) on operation and maintenance of the equipment provided by this project. Both broadcasting stations have regular training sessions about operation and maintenance of equipment including the high definition broadcasting van and digital broadcasting equipment. Both stations have sufficient number of engineers who are capable of operation and maintenance.

Table 7. Number of engineers responsible for operation and maintenance (Jinan TV Station and Jinan Radio Station)

(Unit: person)

	Department	Senior engineers	Middle-level engineers	Total
Jinan TV	Rebroadcast	4	10	14
	Broadcast	2	10	12
	Production	3	8	11
Jinan Radio	Production and broadcast	8	12	20
	Radio transmission	6	10	16

Source: Questionnaire responses

In March 2012, eight engineers from Jinan TV Station, together with their counterparts from Liaoning Province, participated in JICA training in Japan on high definition and 3D technologies at Japanese broadcasting equipment manufacturers. Jinan TV Station feels that this training was useful to strengthen program production skills for high definition televisions as they are becoming more and more popular in China.

3.5.3 Financial Aspects of Operation and Maintenance

The financial status of Jinan TV Station and Jinan Radio Station is shown in Table 8 and Table 9 respectively. Their source of income is only advertisement, and they do not receive

subscription fees from viewers or listeners or any subsidies from Jinan Municipal Government. Both have operational profit and have been able to secure sufficient fund for operation and maintenance.

Table 8. Financial Status of Jinan TV Station

(Unit: million yuan)

Year	2006	2007	2008	2009	2010
Annual sales (gross revenue) (only from advertisement)	132	137	129	167	157
Selling, general and administrative expenses	127	124	120	132	143
Of which, cost for operation and maintenance	*20*	*25*	*22*	*29*	*30*
Operational profit	5	13	9	35	14

Source: Questionnaire responses

Table 9. Financial Status of Jinan Radio Station

(Unit: million yuan)

Year	2006	2007	2008	2009	2010
Annual sales (gross revenue) (only from advertisement)	44	50	59	62	84
Selling, general and administrative expenses	37	42	45	52	68
Of which, cost for operation and maintenance	*21*	*16*	*33*	*18*	*19*
Operational profit	7	8	14	10	16

Source: Questionnaire responses

3.5.4 Current status of operation and maintenance

The equipment procured by this project functions well and no particular problems were observed. The equipment is expected to operate in good condition for several years until replacement, the earliest of which is planned in 2016 by the broadcasting stations.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project was to contribute to the improvement of the broadcasting programs of Jinan both in quantity and quality by the innovation of equipment of the broadcasting stations as well as by training, and then to the knowledge enhancement and cultural enrichment of the citizens of Jinan and also to the promotion of their understanding about Japan. This project was highly relevant with China's development plans, development needs and Japan's ODA policy; therefore its relevance is high. While its effect on the promotion

of the citizens' understanding about Japan was limited, it has contributed to the improvement of the broadcasting programs in Jinan both in quantity and quality, and also to the knowledge enhancement and cultural enrichment of the citizens to a certain extent; therefore the effectiveness and impact are high. The project period was within the plan and the project cost exceeded the plan, therefore its efficiency is fair. No major problems have been observed in the operation and maintenance system, therefore its sustainability is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None.

4.2.2 Recommendations to JICA

JICA held a training session mainly on high definition technology for the engineers of Jinan TV Station in March 2012 as a response to their needs to strengthen their capacity in this technology. JICA might want to consider continue such training courses for other broadcasting stations in China because they are also likely to have same needs. As Japan has a comparative advantage in high definition technology, such training courses could also lead to business opportunities of Japanese manufacturers.

4.3 Lessons learned

- This project was expected to contribute to the promotion of Jinan citizens' understanding about Japan through broadcasting programs. Although some components related to this objective were implemented in this project, however, their contribution was limited because the effect of individual projects on such purpose is generally small. If a JICA loan project wishes to benefit Japan as well, project components for this purpose should also be relevant to the policy and needs of the recipient country. Technical areas in which Japan has an advantage would be attractive to both sides because the recipient country might have needs of such technology and Japanese relevant institutions can also be involved. For example, high definition technology can be beneficial for both sides when it is included broadcasting projects in China.

- Some of the "soft" components of this project were not implemented due to the restrictions by the Chinese broadcasting policy and system. If the project includes soft components that might be affected by the policies and systems of the recipient countries, the policies and systems should be fully examined at the planning stage in order to make sure that the soft components are feasible.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	a. Hard components <u>Jinan TV Station</u> (10 packages) ・Renovation of studio ・Equipment (digital cameras, recorders, editors, monitors, etc.) ・Broadcasting van <u>Jinan Radio Station</u> (1 package) Equipment (digital cameras, editors, work stations, mixers, etc.) <u>Jinan Broadcast and TV Information Network Center</u> (1 package) Cable TV equipment (cable modem systems, receptor stations, servers, etc.)	a. Hard components Equipment that was not procured by JICA fund was purchased by Chinese fund. Therefore, equipment was procured as planned on the whole. <u>Jinan TV Station</u> (7 packages) ・Renovation of studio ・Equipment (digital cameras, recorders, editors, monitors, etc.) ・Broadcasting van <u>Jinan Radio Station</u> (1 package) Equipment (digital cameras, editors, work stations, mixers, etc.) <u>Jinan Broadcast and TV Information Network Center</u> None
	b. Soft components <u>Jinan TV Station</u> ・Training (program production, editing, operation and maintenance: 2 staff each x 1 month = 6 staff) ・Collaboration with the friendship cities of Jinan (Yamaguchi and Wakayama) ・Purchase of broadcasting rights of programs produced in Japan ・Co-production of programs with Japanese broadcasting stations <u>Jinan Radio Station</u> Training (radio technology): 1 staff x 1 month <u>Jinan Broadcast and TV Information Network Center</u> Training (network technology): 1 staff x 1 month	b. Soft components Training for the TV Station and co-production of a program were implemented. <u>Jinan TV Station</u> ・Training (program production, editing, operation and maintenance: 20 staff x 12 days). Conducted in NHK Science and Technology Research Laboratories in 2007, divided into two batches. ・Collaboration with the friendship cities was not implemented. ・Broadcasting rights of Japanese programs were not purchased. ・A documentary titled “Dance in Tokyo” was co-produced by Jinan TV and a Japanese program production company. <u>Jinan Radio Station</u> None <u>Jinan Broadcast and TV Information Network Center</u> None

	c. Consulting services Technical assistance in procurement 1) Preparation of detailed design (D/D) and pre-qualification (P/Q) documents 2) Evaluation of P/Q results 3) Preparation of tender documents 4) Evaluation of tender results Technical assistance in training 1) Training in Japan 2) Co-production of programs with Japanese broadcasting stations 3) Purchase of Japanese programs and broadcasting rights	c. Consulting services Technical assistance in procurement 1) Preparation of detailed design (D/D) documents 3) Preparation of tender documents 4) Evaluation of tender results P/Q was not conducted. Technical assistance in training 1) Training in Japan
2. Project Period	March 2004 – December 2009 (70 months)	March 2004 – December 2008 (58 months)
3. Project Cost Amount paid in Foreign Currency Amount paid in Local Currency Total Japanese ODA Loan portion Exchange rate	 2,914 million yen 1,262 million yen (88 million yuan) 4,176 million yen 2,914 million yen 1 yuan = 14.3 yen (As of September 2001)	 2,913 million yen 1,272 million yen (88 million yuan) 4,185 million yen 2,913 million yen 1 yuan = 14.46 yen (Average between March 2004 and April 2009)