Ex-Post Evaluation Report of Japanese ODA Loan Projects 2009 (China V)

October 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

Earth and Human Corporation

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 2007. 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.

October 2010
Atsuro KURODA
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.

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People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

Liuzhou Environmental Improvement Project

External Evaluator: Machi KANEKO, Earth and Human Corporation

1. Project Description

Project Location

Gas Supply Project

1.1 Background

Since its shift to a course of reform and liberalization in 1987, China has experienced steady economic growth to achieve remarkable economic development. However, its excessive dependence on coal in primary energy consumption, especially as fuel for power plants and as industrial materials, has caused serious air pollution. A number of damage caused by acid rain has been reported recently and environmental problems caused by industrialization are serious issues that require attention, while achieving a good balance with development.

Liuzhou that is the project site is an industrial city in Guangxi Zhuang Autonomous Region in southwest China. Air pollution, acid rain pollution in particular, caused by coal combustion has become a serious problem. In addition, the amount of garbage is increasing each year mainly due to the rapid economic development in recent years and the city also faces an urgent need to solve the waste disposal problem.

Against the backdrop, a decision was made to implement the project in order to promote a gas supply project, waste treatment plant construction, and environmental improvement at non-public plants, in Liuzhou City.

1.2 Project Outline

Increase in gas supply, construction of a waste disposal site and installation of exhaust treatment systems at plants in order to reduce air pollution and improve water quality as well as urban health will contribute to the betterment of living environment in Liuzhou City.

Approved Amount / Disbursed Amount	2,300 million yen／2,299 million yen
Exchange of Notes Date / Loan Agreement Signing Date	December, 1996 / December, 1996
Terms and Conditions	Interest Rate: 2.1%; Repayment Period: 30 years (Grace Period: 10 years); Conditions for Procurement: General Untied Loan
Borrower / Executing Agencies	Guarantor: Government of People's Republic of China / People's Government of Liuzhou Municipality
Final Disbursement Date	January, 2003
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	-
Feasibility Studies, etc.	F/S: JICA study for Liuzhou Environmental Improvement Project, December 1995 SAPROF: 1995 to 1996
Related Projects	JICA technical assistance: Environmental Program in Liuzhou (M/P production)

2. Outline of the Evaluation Study

2.1 External Evaluator

Machi KANEKO, Earth and Human Corporation

2.2 Duration of Evaluation Study

The ex-post evaluation was conducted in the following periods:

Duration of the Study: December 15, 2009 － October 29, 2010

Duration of the Field Study: February 28, 2010 － March 23, 2010

May 6, 2010 － May 29, 2010

2.3 Constraints During the Evaluation Study

Because the project consists of four subprojects, it was difficult to examine the effectiveness of the project in its entirety. Thus, the project was evaluated based on the examination of expected outputs and achievement level of operation and effect indicators of effectiveness of each subprojects as well as the overall project from a panoramic perspective. Although each evaluation item is described per subproject as much as possible, relevance, impact and sustainability are evaluated as a whole.

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

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of China

At the time of project appraisal, the Chinese government formulated 'The Ninth Five-Year

Plan for National Environmental Protection and Long-Term Targets for 2010' and announced the policy to include an environment plan in 'The National Five-Year Plan' (ninth five-year plan 1996 to 2000). The environment plan contains two strategic projects—the "Total Pollutant Discharge Control Policy" and "Trans-Century Green Project". The plan specified an increase in investment in environment, implementation of total pollutant discharge control, and priority in pollution to be placed on water and air pollution in order to implement the strategic projects.

At the time of ex-post evaluation, the Chinese government has expressed in the basic principle of 'The 11th Five-Year Plan 2006-2010' (hereinafter referred to as "11.5 plan") its shift of the focus on emphasis both on environmental protection and economic growth, based on the evaluation stating that many of environmental issues did not improve during the period of the previous policy, 'The 10th Five-Year National Environmental Protection Plan 2001-2005'. The 11.5 plan also specifies the numerical targets to reduce the sulfur dioxide emissions and chemical oxygen demand by 10 percent each by 2010, indicating that the prevention of the expansion of acid rain is also a priority issue. Liuzhou is designated as one of 113 key cities for environmental protection in the 11.5 plan and intends to make qualitative improvement of air conditions with the focus on comprehensive prevention and treatment of air pollution.

The municipal government also has stated that it will emphasize a good balance between industry and environmental protection in the course of economic development in its "Outline of 10.5 plan for people's economy and social development of Liuzhou" and "Outline of 10.5 plan for environmental protection of Liuzhou and the long-term targets for 2015". It has expressed its policy to work on the creation of energy-efficient society and enhancement of environmental protection and the need to realize development that allows harmony between humans and nature.

Therefore, the project has been highly relevance with the policy of the recipient country at the times of the project appraisal and ex-post evaluation, respectively.

3.1.2 Relevance with the Development Needs of China

(1) Development Needs at Project Appraisal

Liuzhou is an industrial city in Guangxi Zhuang Autonomous Region in southwest China and coal has been widely used for industrial and consumer use. Coal that had been used widely in the city was low-quality coal (3000 kcal/kg) with very high content of sulfur (4% to 7%) and ash (50%). This caused serious air pollution in the city to the level of annual average SO_2 concentration at 0.217 mg/Nm^3 in 1993, 3.6 times higher than the national environmental standards grade 2 (0.06 mg/Nm^3). Average pH of acid rain was 4.18 to 4.76[1] and the frequency was 86 percent to 98 percent, which shows that the city was one of Chinese cities

[1] The pH is around 5.6 because carbon dioxide in the air is in the rain even when it is not polluted. Thus, rain with the pH of 5.6 or below is considered acid rain.

with the most serious acid rain pollution.

The city also had a serious garbage increase problem in accordance with steady economic growth. The population of Liuzhou reached 800,000 by 1994, while there was only one small landfill. It was estimated to be filled in mid 1998. The city also had environmental and public health problems related to the garbage issue as conventional disposal facilities were not equipped with leachate treatment equipment and other facilities for public health maintenance.

(2) Development Needs at Ex-post Evaluation

Liuzhou has developed as the biggest industrial city in Guangxi Zhuang Autonomous Region.The gross industrial production of state-run enterprises and non-state-run enterprises with annual sales of five million yuan or more reached 55 billion yuan in 2007. On the other hand, the city has invested huge funds to strengthen corporate pollutant emissions control and worked hard on river wastewater treatment and solid waste treatment in the urban zone for the last several years in an attempt to solve the serious acid rain problem caused by air pollution and river pollution caused by industrial waste. As a result, air quality has significantly improved—the national air quality standards were achieved in 360 days in FY2008. The acid rain problem also improved—its frequency in 1995 was 84.6 percent (average pH=4.19) and it improved to 43.4 percent (average pH=5.07) in 2008.

As the gross industrial production is likely to continue to grow, further reduction of acid rain frequency by carrying out thorough air pollution countermeasures remains to be a major issue Liuzhou needs to tackle. Due to rapid urbanization and population increase, garbage generated by consumers is on the rise and thus waste treatment remains to be also a serious issue.

Therefore, achieving a good balance between environmental protection and economic growth remains to be a key development issue and development needs remain high, although the environment of the target city is improving.

3.1.3 Relevance with Japan's ODA Policy

The ODA Charter in 1992 stated that environmental protection was one of ODA fundamental principles and Japan expressed its intention to increase environmental ODA significantly in five years from 1992 to 1996 externally on such occasions as UN meetings.

Japan's assistance policy for China in those days also placed the following as a key issue: "to provide assistance that will contribute to economic infrastructure development mainly in the form of loan assistance and pay more attention to the assistance for inland regions where the space for development is relatively large". It also takes environment as one of focal areas and intends to make use of its experiences and technologies to assist improvement of energy efficiency, waste recycling, smoke treatment and flue-gas desulfurization for air pollution

prevention and measures to prevent water contamination such as sewerage development.

The project was implemented as one of environmental yen-loan projects for China that are the key of environmental cooperation for China that was launched in full scale in the late 1990s and thus it was consistent with Japan's aid policy at the time of appraisal.

3.1.4 Selection of Subprojects

The Liuzhou municipal government has committed itself to environmental issues. For example, it closed 10 small and medium-sized enterprises (including a spinning and dyeing factory) that were serious sources of pollution in 2007. It has also been working hard to develop model companies in order to encourage large companies that consume a big volume of energy to tackle environmental problems in an attempt to realize reduction of coal consumption and pollutant discharge more steadily. For example, Liuzhou Steel Plant Group Corporation that is one of the plants where a subproject was conducted began a full-scale investment in environmental issues in 2001 upon request from the Liuzhou municipal government and is considered as one of model companies.

Four subprojects were implemented in the project. Against the above backdrop, one pollutant treatment facility that was introduced in the project was renewed into a facility with higher treatment capacity as a result of the Liuzhou municipal government setting the target level of pollutant reduction for companies higher than the national standards. On the other hand, specifications of one of the introduced facilities did not satisfy the needs due to production increase and sharp rise in raw material prices and the facility was renewed or the plan was changed.

However, because such alteration were made in order to enhance environmental measures and respond to changes in market needs, the selection of subprojects itself was reasonable.

Considering the above, 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 Efficiency (Rating: b)

3.2.1 Project Outputs

Several conditions of the China side have changed significantly since the appraisal, which are described below in order to evaluate the outputs of the projects.

1) At the time of appraisal, two subprojects, "3) Liuzhou chemical fertilizer plant emissions treatment" and "4) Liuzhou Steel Plant coke combustion gas desulfurization" were expected to be implemented through the two-step loan procedure. However, the procedure was eventually cancelled in response to the following requests made by the China side:

- ＊ These two subprojects are regarded as non-public work, while any kinds of projects in China are generally supervised by the municipal government. Thus, the People's Government of Liuzhou Municipality shall be the executing agency of the two subprojects, in Lieu of the Export-Import Bank of China.
- ＊ The project should be implemented as a comprehensive environment improvement measure. However, if those "non-public" subprojects cannot benefit from the preference interest rate for special environmental projects that is applicable only to public work projects, they will face stiffer loan conditions and the project will lose its significance. Therefore, application of the two-step loan procedure shall be reconsidered.

2) There was a gap between the introduced facility and current needs in three of four subjects and the facility has been renewed in whole or in part funded by the executing bodies.

As shown in Table 1 below, all the four subprojects had some changes in specifications of facility and materials and equipment from the original plan. Particularly, 1) Gas supply project plan was changed significantly in response to sharp crude oil price rise and changes in market needs. It was reasonable to make the changes because best measures were examined and implemented as needed as the circumstances changed in order to implement a highly-public gas supply project. As for 2) Waste disposal site construction, it was also a measure to respond to construction standards changes by the government and thus it was force majeure for the project executor.

Table 1 Comparison between Original Plan and Actual Results

1) Gas supply project (executing body: Liuzhou Zhrongran City Gas Development Company)		
Original Plan	Actual Results	Note
① City gas supply grid: 110km ② 27 gas pressure regulation stations ③ For liquefied petroleum gas 4 storage tanks: 400 m^3 each Mixing equipment (mix liquefied gas with air) ④ For coke gas 2 storage tanks: 54,000 m^3 each	① City gas supply grid: 110 km ② 27 gas pressure regulation stations ③ For liquefied petroleum gas Panlongshan gas storage station 4 storage tanks: 100 m^3 each Mixing equipment (mix liquefied gas with air) Loading device Banliyuan gas storage station 2 storage tanks: 2000 m^3 each ④ For coke gas Liubei gas storage station 2 storage tanks: 50,000 m^3 each	Significant changes in specifications and installation locations; reasons and changes are described below. Original plan: Supply both liquefied petroleum gas (LPG) and coke gas (drawn from Liuzhou Steel) to residents in the city. Change 1: Although coke gas was originally planned to be drawn from Liuzhou Steel in accordance with JICA's intention, it was determined that it is difficult to secure a stable amount of gas and all facility plans were changed to be those for LPG and the construction began.

		Change 2: LPG price rise continued as a result of crude oil price hike and residents' demand dropped sharply. As a result, it was determined that continued injection in LPG would not be financially viable and later construction was suspended. Use of liquefied natural gas (LNG) that is cheaper than LPG was decided and facility was partially used while supply and sales for residents began. Change 3: Because stable supply of coke gas from Liuzhou Steel Plant became possible, the"Liubei coke gas storage station plan" was formulated, its construction officially began in May 2008 and it was completed and city gas supply for residents began in November 2009.

2) Waste disposal site construction (executing body: Bureau of City Appearance Environmental and Sanitation of Liuzhou Municipality)

Original Plan	Actual Results	Note
① Waste disposal site construction: rockfill dam embankment (Installation of drainage landfill dam and flood control wall) ② Construction of accessory facilities (leachate catchment, gas release treatment facility, etc.) ③ Management building construction: 800 m^2 ④ Installation of environmental monitoring facility ⑤ 10 garbage delivery vehicles Rear Loaded Compressed 7-8 t	① Waste disposal site construction: rockfill dam embankment (Installation of drainage landfill dam, flood control wall and sheet to prevent leachate) ② Construction of accessory facilities (leachate catchment, gas release treatment facility, etc.) ③ Management building construction: 800 m^2 ④ Installation of environmental monitoring facility ⑤ 10 garbage delivery vehicles Rear Loaded Compressed 7-8 t	Because of the introduction of new national standards for waste treatment facilities, redesign and acquisition of construction permit (installation of sheet to prevent leachate into soil, etc.) were needed. This prolonged the project term. The construction permit after the design change was obtained in January 2001.

3) Liuzhou Chemical fertilizer plant emissions treatment (executing body: Liuzhou Chemical Industry Group Corporation)

Original Plan	Actual Results	Note
Installation of facility to treat emissions from Liuzhou Chemical fertilizer plant (emissions denitration facility of NO.1 nitric acid production plant (18,000 Nm^3/h))	Installation of facility to treat emissions from Liuzhou Chemical fertilizer plant (emissions denitration facility of NO.1 nitric acid production plant (21,000 Nm^3/h))	It was discovered in the detailed design that the emissions denitration facility (18000 Nm^3/h) in the original plan would not be able to satisfy the future demand and the facility was changed to one with higher treatment capacity (21,000 Nm^3/h).

4) Liuzhou Steel Plant coke combustion gas desulfurization (executing body: Liuzhou Steel Plant Group Corporation)		
Original Plan	Actual Results	Note
Installation of coke combustion gas desulfurization facility at Liuzhou Steel Plant	Installation of desulfurization facility for coke combustion gas at Liuzhou Steel Plant [Specifications] 1. Desulfurization facility Capacity: 27,000 m^3/h 2. Surplus gas storage tank: 50,000 m^3 3. Wet naphthalene washing facility Capacity: 27,000 m^3/h (Diesel oil for naphthalene washing is collected and reused.)	It was discovered in the detailed design that the emissions desulfurization facility in the original plan would not be able to satisfy the future demand and the facility was changed to one with higher treatment capacity.

3.2.2 Project Input

3.2.2.1 Project Period

The project period was planned to be 63 months from October 1996 to December 2001. However, its completion delayed substantially—it took 158 months to complete it, beginning in October 1996 and ending in November 2009.

The project period per subproject is shown in Table 2 below. Although the completion of 1) Gas supply project and 2) Waste disposal site construction required much longer period than the plan, other two projects were completed before the end of scheduled project period.

Table 2 Original Plan and Actual Results of Each Subproject Period

Subproject Name	Original			Actual			Difference (Actual /Original)	Evaluation
	Launched	Completed	Period (month)	Launched	Completed	Period (month)		
1) Gas supply project	October 1996	January 2000	40 months	October 1996	November 2009	158	395%	c
2) Waste disposal site construction	October 1996	August 1998	23 months	October 1996	November 2004	98	426%	c --> a
3) Liuzhou Chemical fertilizer plant emissions treatment	October 1996	December 2001	63 months	October 1996	October 2000	49	78%	a
4) Liuzhou Steel Plant coke combustion gas desulfurization				October 1996	April 2000	43	68%	a

Based on above, the project period was evaluated first by subproject and then as a project in its entirety. It was evaluated as follows: 3-level evaluation based on the difference between the original plan and actual results (the actual period was a: not exceeding 100% of the plan, b: longer than 100% and not exceeding 150% of the plan, and c: longer than 150% of the plan),

addition of 2 points for a, 1 for b, and 0 for c, and overall rating of (a) when the total of the points is over 80 percent, (b) when it is more than 50 percent and under 80 percent, and (c) when it is 50 percent or less. The subproject 2) Waste disposal site construction delayed in order to respond to the new construction standards. Because it is considered as force majeure for the project executing body, it did not affect the evaluation negatively (c evaluation→a evaluation).

As a result, as shown in Table 2 above, the project period of two subprojects were below 100 percent and two other subprojects were more than 150 percent of the plan.

The overall evaluation result is (b) exceeding the plan as shown in Table 3 below.

Table 3 Evaluation of Project Period

	(a) Evaluation Shorter than planned [2 points]	(b) Evaluation Longer than planned [1 point]	(c) Evaluation Much longer than planned [0 point]	Total	Evaluation result
Subproject Quantity	3	0	1	4	
Point [maximum: 8]	6 points	0 point	0 point	6 points	75% = (b)

3.2.2.2 Project Cost

Although the total project cost was planned to be 4,168 million yen (2,300 million yen of which is yen loan), the actual cost was 11,762 million yen (2,300 million yen of which was yen loan).

The cost per subproject is shown in Table 4 below. As the table shows, all of them cost more than the original plan; 1) Gas supply project and 2) Waste disposal site construction cost 50 percent more than the original plan, 3) Liuzhou Chemical fertilizer plant emissions treatment and 4) Liuzhou Steel Plant coke combustion gas desulfurization cost between 0 percent and 50 percent more than the plan. It is mainly because of the following reasons and executing bodies took following action:

- 1) Gas supply project:

  The design was changed three times due to sharp price increase of raw materials and changes in market needs, which resulted in the increase in the project cost. The surplus was borne by the executing body.

- 2) Waste disposal site construction:

  Because of the introduction of new national standards for waste disposal sites, redesign and acquisition of construction permit (installation of sheet to prevent leachate into soil, etc.) were needed. Construction permit was obtained in January 2001 after design change, and funding from the Chinese side (Liuzhou municipal government fund and

central western loans) was increased before the construction began.

- 3) Liuzhou Chemical fertilizer plant emissions treatment and 4) Liuzhou Steel Plant Liuzhou Steel Plant coke combustion gas desulfurization:

  It was assessed in the detailed design that the emissions treatment facility in the original plan would not be able to satisfy the future demand and the facility was changed to one with higher treatment capacity. Although the change required additional cost, the surplus was borne by the executing body.

Table 4 Comparison of Original Plan and Actual Project Cost

(Unit: million yen)

Subproject Name	Plan		Actual		Difference (Actual/Original)	Evaluation
	Project Cost	Yen Loan in Project Cost	Project Cost	Yen Loan in Project Cost		
1) Gas supply project	2,416	1,116	4,033	1,350	167%	c
2) Waste disposal site construction	1,045	477	6,945	456	665%	c --> a
3) Liuzhou Chemical fertilizer plant emissions treatment	707	707	785 (214) (571)	494 (111) (383)	111%	b
4) Liuzhou Steel Plant coke combustion gas desulfurization						b
Total	4,168	2,300	11,762	2,300		

Based on above, the project cost was also evaluated first by subproject and them as a project in its entirety as it was in the case of project period. It was evaluated as follows: 3-level evaluation based on the difference between the plan and actual results (the actual result was a: not exceeding 100% of the plan, b: more than 100% and below 150% of the plan, and c: 150% or more of the plan), with addition of 2 points for a, 1 for b, and 0 for c, and overall rating of (a) when the total of the points is over 80 percent, (b) when it is more than 50 percent but under 80 percent, and (c) when it is 50 percent or less. As for the subproject 2) Waste disposal site construction, the reason for the cost increase is changes in government standards and it is considered as force majeure for the project executing body and thus it did not affect the evaluation negatively (c evaluation→a evaluation).

As a result, as shown in Table 4 above, the project cost of one subproject was equal to or less than 100 percent of the plan, two were between 100 percent and 150 percent, and the remaining one was over 150 percent of the plan.

The overall evaluation result is (b) exceeding the plan as shown in Table 5 below.

Table 5 Evaluation of Project Cost

	(a) Evaluation Lower than planned [2 points]	(b) Evaluation Higher than planned [1 point]	(c) Evaluation Much higher than planned [0 point]	Total	Evaluation result
Subproject Quantity	1	2	1	4	
Point [maximum: 8]	2 points	2 points	0 point	4 points	50% = (b)

As shown above, the project cost and period both exceeded the plan, therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: b)

3.3.1 Quantitative Effects

3.3.3.1 Results from Operation and Effect Indicators

Table 6 below shows the operation effect indicator of each subproject. The achievement level of operation and effect indicators of each subproject is as shown in the following table. The right-hand column of the table has “a” in case the achievement level is over 80%, “b” in case the achievement level is over 50% and under 80%, and “c” in case the achievement level is 50% or it cannot be observed because the facility is removed. Changes in the circumstances of each subproject are also described in the table.

Table 6 Targets and Actual Results of Operation Effect Indicators

Subproject	Target values (no target year)	Actual results (at ex-post evaluation)	Evaluation
1) Gas supply project	・Coke-oven supply volume at existing gas plant (Liuzhou Steel Plant) 156,000 m³/day gain ・Liquefied petroleum gas (LPG) supply volume: 7,000 m³/year gain (400 m³/day) ・Number of gas consuming household: 120,000 ・Reduction of pollutants: SO_2 6,220 t/year TSP 7,700 t/year	・Coke gas supply volume (Pipeline for coke gas installed from Liuzhou Steel Plant) 62,000 m³/day (daily maximum supply capacity: 100,000 m³) ・LPG supply volume: 38,000 m³/day ・Number of gas consuming household 100,000 Liquefied natural gas (56,000 households) Coke gas (44,000 households) ・Reduction of pollutants ・SO_2 7,680 t/year ・TSP 9,507 t/year	a
<<Changing circumstances around subproject>>	LPG gas supply for consumers was suspended due to a sharp increase of crude oil price. However, later LNG gas supply began instead. Because stable supply of coke gas from Liuzhou Steel became possible, the project plan was reexamined and funds of the corporation were injected in order to supply less expensive coke gas. The supply began in November 2009.		

Subproject	Target values (no target year)	Actual results (at ex-post evaluation)	Evaluation
2) Waste disposal site construction	・Remaining years of the disposal site: 36 years ・Landfill volume: 8 million m³ ・Leachate catchment: 600 m³/day ・ Maximum wastewater treatment capacity: 1,059 m³/day	・Remaining years of the disposal site: 17 years (use began in 2004) ・Landfill volume: 8 million m³ ・Leachate catchment: 600 m³/day ・Maximum wastewater treatment capacity: 1,059 m³/day ・Garbage generated by consumers in Liuzhou: 339,500 t/day ・Number of users: 1.0184 million (2008)	a
<<Changing circumstances around subproject>>	Although no original target figure was set up, design change due to introduction of new standards is likely to have enhanced soil pollution prevention effect. The increase rate of garbage generated by consumers exceeded the estimate due to urbanization and population increase and the remaining years decreased to 17 years from 36 years in the original plan. Liuzhou is now constructing a new disposal site in the upper area of the existing site as one of garbage handling efforts for the future.		
3) Liuzhou Chemical fertilizer plant emissions treatment	NOx emissions concentration: 905 mg/N m^3 NOx reduction volume: 181.2 t/year	In 2003 ・NOx emissions concentration: 360 mg/N m^3 ・NOx reduction volume: 47.6 t/year (Both emissions and reduction achieved the national standards grade 2 as of July 2002.) At ex-post evaluation No data available because facility was renewed.	c
<<Changing circumstances around subproject>>	With the leadership of the Liuzhou municipal government, the pollutant reduction volume for key pollution-causing companies was increased significantly. Although the exhaust NOx treatment unit introduced in the project satisfied the national emissions standards, operation of the facility was suspended in 2003, because tougher environmental measures were sought in response to the demand from the residents[2] , and installation of new facility was completed in 2005.		
4) Liuzhou Steel Plant coke combustion gas desulfurization	SO_2 emissions concentration: 60 mg/N m^3 SO_2 reduction: 1,849 t/year	2001 to 2005 ・SO_2 emissions concentration: 0.084 mg/m^3 (annual average concentration inside plant) ・SO_2 reduction volume: 1,817.8 tons (annual average) ・H2S (hydrogen sulfide) concentration: 11.53 mg/m^3 (annual average concentration and removal rate at the outlet of desulfurization unit: 99.74%) ・Total of coke gas supply volume: For industrial use: 1,312 million tons For household use: 108 million tons At ex-post evaluation ・Naphthalene washing volume: 280 tons (2009) ・Diesel oil collection and recycle volume: 301,435 L (2009)	c
<<Changing circumstances around subproject>>	Upon request from the Liuzhou municipal government, Liuzhou Steel Group Corporation began full-scale investment in environmental issues in 2001 and it now serves as a model company for creating recycling-oriented economy. On the other hand, coke gas production of the company increased significantly thanks to good business operation and the coke gas desulfurization system (capacity: 27,000 m^3/h) introduced in the project was no longer able to satisfy the demand. Thus, the system was partially removed (desulfurization unit) and a new coke gas desulfurization system (capacity: 100,000 m^3/h) was introduced in 2004. Of the desulfurization system introduced in the project, the gas tank to store surplus gas and wet naphthalene washing unit are still in operation.		

[2] Although the exhaust NOx treatment unit introduced in the project satisfied 200 ppm or less that is the national emissions standard, the exhausts are yellow and residents in the area called the smoke “yellow dragon”.

As shown in the table above, subprojects “1) Gas supply project” and “2) Waste disposal site construction” were evaluated as “a” because they achieved the target level. However, the remaining years of the “2) Waste disposal site” decreased significantly from 36 years to 17 years and such measures as charging garbage collection fees and environmental education need to be examined as efforts for reduce domestic garbage. As for subprojects “3) Liuzhou Chemical fertilizer plant emissions treatment” and “4) Liuzhou Steel Plant Liuzhou Steel Plant coke combustion gas desulfurization”, as described in the table, the facilities introduced in the project was removed and new facility was built with funds from the Chinese side in order to enhance environmental measures and cope with sharp demand increase. Thus, the equipment installed through the yen loan is not so much related to the indicator achievement levels; the effect is inevitably deemed low at present, and “c” is given as evaluation.

The effectiveness of the whole project were also evaluated based on the sum of the ratings of all subprojects. 2 points were given for the rating of “a”, 1 point for “b” and 0 point for “c”. Then a rating of (a) was given when the total score was over 80% , (b) when over 50% up to 80%, and (c) when under 50% or less. The evaluation result based on this rule is as shown in the following Table 7. The total score was 72% of the highest score. Therefore, the effectiveness of the whole project was (b).

Table 7 Evaluation of Operation and Effect Indicators

	(a) Evaluation Indicator achievement level 80% or more	(b) Evaluation Indicator achievement level 50% to 80%	(c) Evaluation Indicator achievement level 50% or below, or data not available because the facility is not operating	Total
Subproject Quantity	2	0	2	4
Point [maximum: 8]	4 points	0 point	0 point	4 50%= (b)

Effectiveness of the project have the following characteristics: subprojects “1) Gas supply project” and “2) Waste disposal site construction” that are highly public showed high effectiveness, while it was impossible to confirm in the ex-post evaluation the effectiveness of “3) Liuzhou chemical fertilizer plant emissions treatment” and “4) Liuzhou Steel Plant coke combustion gas desulfurization”, which were implemented for private enterprises, as a result of their response to changes in the circumstances. However, because the effect of the project that had emerged in the beginning induced the enhancement of additional environmental measures, it is evaluated as an impact.

3.3.1.2 Results of Calculations of Rates of Return(IRR)

Among four subprojects, Financial Internal Rate of Return (FIRR) of subprojects “1) Gas supply project” and “2) Waste disposal site construction” had been obtained at the appraisal

time. However, because of three major changes in "1) Gas supply project" before the launch of the subproject, the basis for FIRR calculation changed completely.

As for "2) Waste disposal site construction", garbage treatment fees were originally posted as income in the FIRR calculation. However, it was discovered when we confirmed at the ex-post evaluation that no garbage treatment fee is collected and that all the cost for the facility is managed by the municipal government.

Thus, FIRR is not obtained in the evaluation.

Although Economic Internal Rate of Return (EIRR) can be estimated with the willingness to pay as the indicator as a result of health and public services improvement as a result of air pollution improvement as benefits. However, the benefit indicators cannot be used for comparison because no EIRR was obtained at the project appraisal. Because it is also impossible to obtain data at the appraisal, EIRR is not calculated in the evaluation.

3.3.2 Qualitative Effects

The primary qualitative effect of the project is residents' recognition of improvement of air quality and reduction of discarded waste as a result of the reduction of air pollutants and expansion of waste disposal site.

As shown in the table below, more than 90 percent of the respondents of beneficiary survey recognized the improvement of air quality in Liuzhou compared to 10 years ago. About 60 percent of respondents pointed out "reduction of flue gas concentration from plants by the advanced technologies" and "use of gas at home" as main causes of the improvement.

Table 8 Residents' Recognition of Air Quality Improvement (beneficiary survey result)

Changes in air quality in comparison with 10 years ago (number of days of acid rain and smog)	Total (%)
Improved very much	45
Rather improved	52
Not changed much	3
Rather deteriorated	0
Deteriorated very much	0
Don't know	0

(Of responses "Improved or rather improved") Main causes of improvement [multiple answers allowed]	Total (%)
Plants relocated to suburbs	73
Gas is used at home	60
Flue gas concentration from plants reduced by the advanced technologies	57
Government's environmental projects were promoted	43
Economic force of the city as a whole improved	34
Municipal government control was strengthened	18

Note: Beneficiary Survey Result in Ex-Post Evaluation (150 residents of the city were surveyed in May 2010.)

Eighty-eight percent of those surveyed said that discarded waste reduced compared to 10 years ago. About half of them said that it is mainly because of the "expansion of disposal site" and "number of garbage collection vehicles" related to the project (waste disposal site

construction), while only 30 percent said it is because of “increased awareness of garbage treatment among residents”. About 15 percent said it is because of “tightened control by the municipal government”. Thus, the environmental protection agency is expected to take such action as promotion of environmental education for the residents.

Table 9 Residents’ Recognition of Reduction of Discarded Waste

Change in discarded waste in comparison with 10 years ago	Total (%)
Improved very much	37
Rather improved	51
Not changed much	11
Rather deteriorated	0
Deteriorated very much	0
Don’t know	1

(Of responses “Improved or rather improved”) Main causes of improvement [multiple answers allowed]	Total (%)
Garbage collection vehicles increased	60
Government’s environmental improvement projects were promoted	49
Disposal site expanded	48
City's economic force improved	39
Awareness of garbage treatment among residents increased	32
Municipal government's control strengthened	15

Note: Beneficiary Survey Result in Ex-Post Evaluation (150 residents of the city were surveyed in May 2010.)

The effects emerged as a result of effective collaboration and complement with China’s its own efforts for environmental improvement. Therefore, they are not solely of the project itself, though its contribution is estimated to be large in general.

Therefore, this project has somewhat achieved its objectives, therefore its effectiveness is fair.

3.4 Impact

3.4.1 Intended Impacts

Because the Liuzhou municipal government tackled various environmental problems actively when the project was implemented, the impacts were not necessarily those of the project. However, it is estimated to have had significant impact on the improvement of people’s living environment and beautification of the city, based on the environmental indicators and beneficiary survey of the city. The project that includes environmental measures of Liuzhou Steel Plant Group Corporation and Liuzhou Chemical Industry Group Corporation that are major private companies in Liuzhou is considered to have helped deepen the recognition of the importance that major companies should take a leadership role in taking environmental measures in order to achieve the target level for environmental improvement set by the municipality and, as a result, concrete measures by the municipal government has been further

promoted.

(1) Air quality improvement in Liuzhou

Achievement level of air quality indicators of Liuzhou has improved since the beginning of the project as shown in Table 10. For example, the national air quality standards were achieved 360 days in 2008. According to the municipal environmental protection agency, environmental indicators in Table 10 cannot be compared simply with past data because of the improved accuracy of measuring devices and increase in the measurement points. According experts of the agency, conditions of air quality and acid rain in the city have improved significantly than those at the beginning of the project, although environmental measures need to be enhanced in order to achieve the environmental standards.

Table 10 Environmental Indicators of Liuzhou (annual average)

Indicator \ Year	1996	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of Days when National Air Quality Standards are Achieved Note 1)	-	-	-	-	-	289	339	313	351	360	-
TSP/PM_{10} Notes 2), 3)	0.190	0.207	0.194	0.158	0.206	0.101	0.064	0.055	0.040	0.037	0.054
SO_2 Concentration (mg/m^3) Note 4)	0.152	0.092	0.073	0.070	0.070	0.104	0.072	0.094	0.071	0.071	0.061
NO_2 Concentration (mg/m^3) Note 4)	0.036	0.038	0.030	0.028	0.030	0.036	0.033	0.038	0.030	0.031	-
COD (t/year) Note 5)	51,068	37,737	76,802	47,461	129,334	51,068	103,900	105,800	101,900	97,700	-

Note 1) China's national environmental air quality standards are categorized into three grades and grade 2 applies to residential area, mixed areas of commercial, transport and residential districts, cultural areas, general industrial areas and rural areas. The concentration limit to be counted as days of achievement of grade 2 is 0.15 mg/ m (daily average) for SO_2 and 0.15 mg/m^2 (daily average) for PM10.

Note 2) TSP stands for Total Suspended Particular, particulate matters suspended in the air with a diameter of 100 μm or less in atmospheric dynamics.

Note 3) PM10 stands for "Particular Matter less than 10 μm" suspended in the air with a diameter of 10 μm or less in atmospheric dynamics. In Liuzhou, PM10 has been used as the indicator instead of TPS since 2005.

Note 4) The concentration limits of the national air quality grade 2 are 0.06 mg/m^2 (annual average) for SO_2 and 0.054 mg/m^2 for PM10.

Note 5) Because a new COD observation method was introduced in 2005, comparison of COD values before and after 2005 is difficult.

* Source: Liuzhou official environment report

As shown in Table 11 below, the annual average frequency of acid rain has also improved significantly since the beginning of the project, from 84.6 percent (average pH=4.19) in 1995 to 43.4 percent (average pH=5.07) in 2008.

Table 11 Acid Rain Indicator in Liuzhou

Year / Indicator	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
pH Annual average	4.19	4.61	4.94	4.97	5.17	5.20	5.17	5.40	5.66	-	4.69	4.95	5.09	5.07
Frequency of acid rain (%)	84.6	54.4	65.1	44.4	31.0	30.0	27.2	19.4	15.0	47.6	57.1	52.4	42.8	43.4

Note) Rain of pH=5.6 or less is generally categorized as acid rain.
* Source: Liuzhou official environment report

(2) Improvement of citizens' living environment and livelihood

As shown in Table 12, more than 90 percent of respondents of the beneficiary survey recognized the improvement of air quality and reduction of acid rain in Liuzhou.

As shown in the table on the left side below, many residents pointed out the improvement of their daily living that includes the "reduction of contaminated clothing" as an effect of air quality improvement. As shown in the right-side table below, about 70 percents pointed out the "improvement of water quality of water source" as an effect of improvement of acid rain and more than 50 percent pointed out the reduction of "physical stimulation".

Ninety-five percent of respondents recognized the "improvement of efficiency of household duties" as a result of the city gas development, which shows the improvement of people's living environment and livelihood.

Table 12 Citizens' Recognition of Improvement of Living Environment

Effect of Air Quality Improvement [multiple answers allowed]	Total (%)
Reduction of clothing contamination by dust	63
Able to hang laundry outside	57
No need to use masks and sunglasses for dust protection any more	29
Health improvement	62
Others	0

Effect of Acid Rain Improvement [multiple answers allowed]	Total (%)
Water quality improvement of water source Liujiang River	67
Reduction of physical (eyes, skin, hair, etc.) stimulation in rain	53
Improvement of living environment of creatures in rivers and lakes	47
Slowing in deterioration of historical structures and buildings	36
Defoliation in forests reduced	28
Others	0

Note: Beneficiary Survey Result in Ex-Post Evaluation (150 residents of the city were surveyed in May 2010.)

(3) City beautification and improvement of public health

As shown in Table 13 below, more than 70 percent of those surveyed pointed out the "city beautification" and "reduction of foul odor" as effects of waste treatment improvement. Ninety-five percent of respondents recognized the improvement of garbage treatment service that includes increase in frequency of garbage collection. This shows that people recognize the improvement of public heath environment.

Table 13　Citizens' Recognition of Improvement of Waste Treatment

(beneficiary survey result)

Effect of Improvement of Waste Treatment [multiple answers allowed]	Total (%)
Progress of city beautification	79
Reduction of foul odor from discarded garbage	75
Reduction of illegal dumping in city and rivers	51
Water quality improvement of water source Liujiang River	43
Reduction of pest in city	24

Note: Beneficiary Survey Result in Ex-Post Evaluation (150 residents of the city were surveyed in May 2010.)

3.4.2　Other Impacts

1) Impacts on the Natural environment

The EIA was approved before the launch of the project and no special impact on natural environment is recognized according to an interview with the environmental protection agency.

2) Land Acquisition and Resettlement

The project did not involve any relocation of residents and the land of 64 hectares for the waste disposal site construction was acquired smoothly.　Foul odor and leachate that had been problems of the conventional waste disposal site were not recognized in the result of beneficiary survey.

3) Enhancement of environmental measures by Liuzhou municipal government

According to the interview with concerned Liuzhou municipal government agencies (finance agency, environmental protection agency and executing bodies), they often said that the implementation of the project before the city government took full-scale environmental measures had a significant meaning.　They consider that the project had positive impacts on the improvement of the municipal government's awareness of environmental issues.　In particular, although the facility introduced as part of "3) Liuzhou chemical fertilizer plant emissions treatment" and "4) Liuzhou Steel Plant coke combustion gas desulfurization" in the project was removed after several years of operation, it accelerated the environmental measures for companies as those for Liuzhou Steel Plant Group Corporation and Liuzhou Chemical Industry Group Corporation that represent the city were taken at an early stage.

4) Unintended Positive/Negative Impacts

No noise or vibration problem was expressed in the interview with the environmental protection agency or in the beneficiary survey.

Thus, the project significantly improved the environmental quality of Liuzhou and had significant positive impacts on daily living of local people.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

Subprojects “1) Gas supply project” and “2) Waste disposal site construction” are regarded as key projects for the creation of environmentally-friendly city in its “Outline of 10.5 plan for people’s economy and social development of Liuzhou” and “Outline of 10.5 plan for environmental protection of Liuzhou and the long-term targets for 2015” of the municipal government. The municipal government clearly expressed its intention to assist smooth operation of the projects. Thus, although, as for subproject “1) Gas supply service” that used to be provided by state-run enterprise was privatized, there is an established structure for proper operation, maintenance and management based on the municipal government policy so that the former state-run city gas company that is the only one of its kind in Liuzhou will be able to operate itself safely and supply gas in a stable manner. As for “2) Waste disposal site”, its operation, maintenance and management is conducted under the supervision of the municipal government and there is no organizational or human resources problem.

As for “3) Liuzhou chemical fertilizer plant emissions treatment”, although the business environment has changed greatly because of its privatization, its operation, maintenance and management system is enhanced more than expected as a result of the improvement of management efficiency (reduction of human resources in production and increase in engineers) as a result of privatization. As for “4) Liuzhou Steel Plant coke combustion gas desulfurization”, there is no problem in its operation, maintenance and management system as business operation of the Liuzhou Steel Plant Group Corporation has been going well.

3.5.2 Technical Aspects of Operation and Maintenance

As for equipment and machinery that were introduced in “1) Gas supply project” and “2) Waste disposal site construction”, there is no technical problem related to operation and maintenance of facilities and materials and equipment. As for “3) Liuzhou chemical fertilizer plant emissions treatment”, because the facility that was introduced in the project was removed, verification cannot be performed. As for “4) Liuzhou Steel Plant coke combustion gas desulfurization”, the equipment and machinery in operation is maintained properly and there is no technical problem.

Details are described below.

1) Gas supply project: They observe inspection standards stipulated in laws and are committed to safety measures so that they will be able to respond to occurrences of problems. Thus, safety management and technical training is provided regularly for its

employees, according to the survey.

2) Waste disposal site construction: According to employees who work at the waste disposal site, they pay full attention to operation of the wastewater treatment unit and conducts daily monitoring thoroughly in order to keep values under the standards stipulated in laws. In addition to the daily inspection, they also provide training for engineers regularly in order to develop human resources for maintenance.
3) Liuzhou chemical fertilizer plant emissions treatment: The facility installed in this subproject was removed; sustainability cannot be verified.
4) Liuzhou Steel Plant coke combustion gas desulfurization: Although desulfurization unit was removed, the naphthalene washing unit and diesel oil collection unit are maintained properly by engineers in charge, according to the survey.

3.5.3 Financial Aspects of Operation and Maintenance

As for "1) Gas supply project", according to the executing body, efforts for operation efficiency and profitability improvement has been enhanced rapidly, using other similar projects as reference, after the merger with a Hong Kong capital enterprise that operates city gas business in China. As for coke gas supply, it has concluded a gas supply contract with about 20,000 households. Upon the completion of pipe-work, it is planned to begin supply of gas. As a result of user increase, the growth of profit is also expected.

Although "2) Waste disposal site" provides waste treatment service as free public service, however according to the employees of the site, sufficient operation and maintenance fund is secured and replacement parts are provided properly due to the good financial condition of the municipal government.

Although the facility installed in "3) Liuzhou chemical fertilizer plant emissions treatment" was removed, Liuzhou Chemical Industry Group Corporation's business operation is going well and it has continued fund injection in environmental protection measures. As for "4) Liuzhou Steel Plant coke combustion gas desulfurization", Liuzhou Steel's business operation is also going well and there is no financial problem.

3.5.4 Current Status of Operation and Maintenance

According to the beneficiary survey results, majority of citizens are satisfied with the gas supply and waste treatment services, and thus it is fair to say that there is no problem in their operation.

1) Gas supply project: The date and time of inspections and the name of inspectors were clearly indicated at each facility when we visited the site and thus it is fair to conclude that regular inspections are carried out properly by maintenance personnel. According to the interview with the environmental protection agency, there has been no accident or problem

and the facility has been operated safely since the launch of gas supply service.

2) Waste disposal site construction: No foul odor or noise was observed in the neighborhood at the time of the field visit. Because a sufficient maintenance budget is secured, they have no difficulty in handling failures or purchasing wastewater treatment chemicals and spare parts, according to the interview.

3) Liuzhou chemical fertilizer plant emissions treatment: The facility introduced in this subproject was removed; however, no yellow smoke that had been the cause of complaints from residents in the neighborhood was observed at the time of the field visit, which shows that the environmental standards are achieved well.

4) Liuzhou Steel Plant coke combustion gas desulfurization: Although the desulfurization unit was removed when we visited the facility, its accessory equipment, the naphthalene cleaning unit and diesel oil collection unit, were in operation. In particular, they place importance on daily maintenance of the naphthalene washing unit, because the unit is essential for the operation of the renewed desulfurization system, according to the interview.

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

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Although the project is highly relevant, its effectiveness and efficiency are moderate because the pollutant treatment facilities introduced in the project were removed in whole or in part because of changes in circumstances of the subprojects. There is no notable problem in its sustainability. In light of the above, this project is evaluated to be satisfactory (B).

4.2 Recommendations

4.2.1 Recommendations for Executing Agencies

1) While plant regulations and waste treatment services are improved, environmental education for residents is not provided sufficiently. Because further urbanization and population increase are expected to continue in Liuzhou, the city needs to enhance its efforts to raise residents' awareness of environmental issues, especially of waste volume, through such measures as publicity and environmental education. It also needs to create a system to collect fees for waste treatment from residents in order to handle ever-increasing waste treatment work in future.

2) Liuzhou has taken measures to tackle pollutants problems that can be carried out easily,

which include the installation of the pollutant treatment unit in the end of production processes at plants, as part of environmental pollution countermeasures of the municipal government. For further reduction of pollutant emissions, more drastic measures need to be taken, including the relocation of pollution-causing companies to outside of the city and conversion of energy source of coal-dependent major companies into energy that imposes less environmental burden.

4.3 Lessons Learned

Although environmental issues need to be tackled by the region as a whole, the project focused on Liuzhou Steel Group Corporation and Liuzhou Chemical Industry Group Corporation, both major companies in Liuzhou, as leading companies that are committed to environmental issues, which promoted the efforts by the city as a whole to take environmental measures. Because both companies are designated as key environmentally-friendly companies in Liuzhou, the project progress was introduced in the official annual environment report issued by the environmental protection agency and the "10.5 plan for environmental protection of Liuzhou 2001-2005", which led concerned parties to learn about the outputs of the yen-loan project.

Areas where manufacturing companies and power plants concentrate tend to suffer serious environmental problems. It is important to prioritize business entities that will play a leadership role in tackling local environmental problems in selecting the target through discussions with the partner government. It is also important to promote the efforts of the business entities by regularly informing ministries, agencies and corporate personnel concerned, of the achievement status of environmental indicators of the whole area.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1.Project Outputs 1) Gas supply project	City gas supply grid: 110 km ・27 gas pressure regulation stations ・2 tanks (400 m^3 each) for liquefied petroleum gas ・3 tanks (54,000 m^3 each) for coke gas	・City gas supply grid: 110 km ・27 gas pressure regulation stations ・For liquefied petroleum gas 4 storage tanks (100 m^3 each) 2 storage tanks (2000 m^3 each) Mixing unit (mix liquefied gas and air) Loading device ・For coke gas 2 storage tanks (50,000 m^3 each)
2) Waste disposal site construction	・Waste disposal site construction: rockfill dam embankment (installation of drainage landfill dam and flood control wall) ・Construction of accessory equipment (leachate catchment, gas release treatment facility, etc.) ・Management building construction: 800 m^2 ・Installation of environmental monitoring facility ・10 garbage delivery vehicles Rear Loaded Compressed 7-8t	・Waste disposal site construction: rockfill dam embankment (installation of drainage landfill dam and flood control wall) ・Construction of accessory equipment (leachate catchment, gas release treatment facility, etc.) ・Management building construction: 800 m^2 ・Installation of environmental monitoring facility ・10 garbage delivery vehicles Rear Loaded Compressed 7-8t
3) Liuzhou Chemical fertilizer plant emissions treatment	Installation of facility to treat emissions from Liuzhou Chemical fertilizer plant (emissions denitration facility of NO.1 nitric acid production plant (18,000 Nm^3/h)	Installation of facility to treat emissions from Liuzhou Chemical fertilizer plant (emissions denitration facility of NO.1 nitric acid production plant (21,000 Nm^3/h))
4) Liuzhou Steel Plant coke combustion gas desulfurization	Installation of coke combustion gas desulfurization facility at Liuzhou Steel Plant	Installation of coke combustion gas desulfurization facility at Liuzhou Steel Plant
2.Project Period	October 1996 － December 2001 (63 months)	October 1996 － November 2009 (158 months)
3.Project Cost Amount Paid in Foreign currency Amount Paid in Local currency Total Japanese ODA loan portion Exchange rate	 2,300 million yen 1,868 million yen 4,168 million yen 2,300 million yen 1 yuan = 12 yen (As of January 1996)	 2,300 million yen 9,462 million yen 11,762 million yen 2,300 million yen 1) Gas supply business: 1 yuan = 14.27 yen (Average between 1996 and 2009) 2) Waste disposal site construction: 1 yuan = 14.24 yen (Average between 1997 and 2004) 3) Liuzhou Chemical fertilizer plant emissions treatment: 1 yuan = 13.36 yen (Average between 1999 and 2000) 4) Liuzhou Steel Plant coke combustion gas desulfurization: 1 yuan = 13.36 yen (Average between 1999 and 2000)

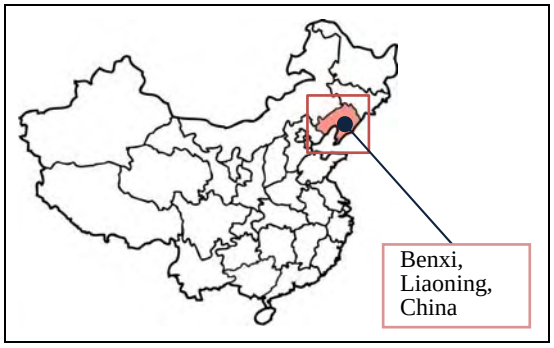
People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

Benxi Environmental Improvement Project Phase (1) (2) (3)

External Evaluator: Machi KANEKO, Earth and Human Corporation

1. Project Description



Project Location

Beitai Iron & Steel Group (Left: coke oven environmental pollution control facilities, right: facilities for utilization of emission gas)

1.1 Background

In China, while the national economy grew steadily, industrialization and population growth increased environmental pollution from the 1980s. As the country depended on coal for industrial materials and fuel for power generation and heating, air pollution with sulfur dioxide (SO_2) and Total Suspended Particles[1] (TSP) generated by coal combustion was especially serious. Moreover, although the demand of water for both domestic and industrial use was growing, the construction of wastewater treatment facilities was slow. Therefore, the river water quality also deteriorated.

The city of Benxi, where this project was carried out, is located in a mountainous area of southeast Liaoning Province and is one of the major heavy industry cities in China. In Benxi, basic material industry such as iron and cement manufacturing developed from the 1940s and the economy rapidly grew mainly in the iron manufacturing from 1980s. On the other hand, the air pollution in the city became so serious that the city was called "a city invisible from the satellite", partially because of the geographic condition that it is surrounded by mountains. Moreover, the Taizi River, a major river in Benxi that flows through the city for 27 km, was also seriously polluted as most of the city's domestic and industrial wastewater flew into it. The Taizi River was a drinking water source and the water safety was also a concern.

[1] Total Suspended Particles (TSP): Particulate matters suspended in the atmosphere that are equal to or smaller than 100 micrometers in diameter. The city of Benxi has been using "Inhalable particles (particulate matters smaller than 10 μm: PM10)" as a substitute index for TSP since 2005.

Under these circumstances, the city of Benxi established a long-term plan (till 2000) and started taking measures for environmental improvement. As part of such efforts, this project was carried out for comprehensive improvement of the environment.

1.2 Project Outline

To contribute to the environmental improvement of the city of Benxi, where water and air pollution caused by rapid economic growth became serious issues, by improving air and water quality through the following actions:

- Equipment renewal and installation of pollution control facilities at factories that discharge contaminants
- Construction of a water intake station
- Construction of an environmental observation center

Approved Amount / Disbursed Amount	Phase I: 4,110 million yen/4,076 million yen Phase II: 3,237 million yen/3,082 million yen Phase III: 1,160 million yen/1,159 million yen Total: 8,507 million yen/8,317 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	Phase I: September 1997/September 1997 Phase II: December 1998/December 1998 Phase III: March 2000/March 2000
Terms and Conditions	Phase I: Interest rate: 2.1% Repayment period: 30 years (Grace period: 10 years) General untied Phase II: Interest rate: 0.75% Repayment period: 40 years (Grace period: 10 years) Partially untied Phase III: Interest rate: 0.75% Repayment period: 40 years (Grace period: 10 years) Bilateral tied loan
Borrower / Executing Agencies	Government of People's Republic of China / People's Government of Benxi Municipality
Final Disbursement Date	Phase I: April 2003 Phase II: July 2004 Phase III: July 2005
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	-
Feasibility Studies, etc	F/S: Benxi Environmental Protection Center, etc. August 1989 – June 1996 SAPROF: JBIC 1995-1996
Related Projects	Grant aid: Sino-Japan Friendship Center for Environmental Protection

2. Outline of Evaluation Study

2.1 External Evaluator

Machi KANEKO, Earth and Human Corporation

2.2 Duration of Evaluation Study

The ex-post evaluation was conducted in the following periods:

Duration of the Study: December 15, 2009 – October 29, 2010

Duration of the Field Study: February 28, 2010 – March 23, 2010

May 6, 2010 – May 29,2010

2.3 Constraints during the Evaluation Study

It was difficult to check the effectiveness of the whole project as it consisted of 20 subprojects. Therefore, we checked these 20 subprojects in terms of achievement level of the outputs, operation and effect indicators for effectiveness, and also evaluated the whole program from a panoramic perspective. Although each evaluation item is described per subproject as much as possible, relevance, impact and sustainability are evaluated as a whole.

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

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of China

At the time of appraisal, the Chinese government established 'The Ninth Five-Year Plan for National Environmental Protection and Long-Term Targets for 2010,' placing priority on "water and air pollution source control" and "urban environment improvement". Regarding these two major tasks, the government also planned such concrete measures as full compliance with emission standards at the water and air pollution sources, closure or transformation of production process at small old-type plants, conversion to city gas and promotion of greening. In response to such policy of the central government, the city of Benxi also established 'The Seven-Year Plan for Environmental Improvement' and promoted environmental conservation projects.

At the time of the ex-post evaluation, environmental protection was still an important policy and 'The 11th Five-Year Plan (2006-2010)' (hereinafter the "11.5 plan"), which defined the national policy for environmental protection, presented the basic principle of shifting its focus to environmental protection and economic growth. The 11.5 plan also set a numeric goal to reduce sulphur dioxide emission and chemical oxygen demand by 10% each by 2010. Moreover, 'The 11th Five-Year Plan 2006-2010' of the city of Benxi also stated treatment of air pollution, water pollution and sold waste as major ongoing challenges.

In light of the above, it is deemed that the relevance of this project with government policies was high both at the time of appraisal and the time of ex-post evaluation.

3.1.2 Relevance with the Development Needs of China

(1) Development Needs at the Time of Appraisal

In 1995 the annual average SO_2 concentration was 0.15 mg/Nm^3 and the annual average TSP concentration was 0.41 mg/Nm^3 in Benxi. These numbers exceeded the national ambient air quality standard grade 3[2] (annual average SO_2 concentration: 0.10 mg/Nm^3, TSP concentration: 0.30 mg/Nm^3), a standard applied only to industrial areas, and there was a concern about the public health effects of air pollution. To respond to this situation, the city of Benxi, designated as "sulfur dioxide pollution control area[3]" by the State Council in February 1998, planned to enhance measures for pollution control.

(2) Development Needs at the Time of Ex-post Evaluation

Benxi is located in Liaoning Province, the largest economy among the three northeast provinces[4], and the GDP of the city reached 68 billion yuan in 2009 (15.81 billion yuan in 2000). Moreover, belonging to the "Central Liaoning City Cluster[5]", the province's new regional development strategy, the city has been growing with a large steel complex and other various manufacturing industries including as metallurgy, machinery, building material, pharmaceutical, chemical and spinning.

The city has also been actively tackling environmental issues, and the water quality of the Taizi River, a water source for Benxi, has achieved the national surface water quality standard grade 2 in 2008. As for the air quality, the SO_2 level achieved the national ambient air quality standard grade 2 (annual average) in 2005 and the level of inhalable particulate matters (PM10[6]) has achieved grade 2 (annual average) in 2008. Both air and water quality has significantly improved.

As the total industrial production is expected to continue to grow in the future, ensuring a balance between environmental protection and economic growth is still a major development challenge for the city.

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[2] National ambient air quality grade 3 is applied to industrial areas. The threshold for effects on health of long-term residents is grade 2.

[3] Cities with a high level of SO_2 emission where the annual average of SO2 concentration exceeds the national ambient air quality standard grade 2 and the daily average exceeds grade 3

[4] Three northeast provinces: three provinces in northeast China (Liaoning, Jilin and Heilongjiang)

[5] Central Liaoning City Cluster: seven cities of Shenyang, Anshan, Fushun, Benxi, Yingkou, Liaoyang and Tieling, one of the areas where the economy is most remarkably growing in the northeastern China

[6] Inhalable particulate matters (particulate matters smaller than 10 μm, PM10): Atmospheric particulate matters suspended in the atmosphere that are smaller than 100 micrometers in diameter. The city of Benxi has been using PM10 as a substitute index for TSP since 2005.

In light of the above, the development needs in Benxi are high.

3.1.3 Relevance with Japan's ODA Policy

The ODA Charter in 1992 stated that environmental protection was one of ODA fundamental principles and Japan expressed its intention to increase environmental ODA significantly in five years from 1992 to 1996 externally on such occasions as UN meetings.

Japan's assistance policy for China in those days also placed the following as a key issue: "to provide assistance that will contribute to economic infrastructure development mainly in the form of loan assistance and pay more attention to the assistance for inland regions where the space for development is relatively large". It also takes environment as one of focal areas and intends to make use of its experiences and technologies to assist improvement of energy efficiency, waste recycling, smoke treatment and flue-gas desulfurization for air pollution prevention and measures to prevent water contamination such as sewerage development. Moreover, the "Japan China Environmental Cooperation toward the 21st Century" was agreed on at a Japan-China summit meeting in September 1997.

The project was implemented as one of environmental yen-loan projects for China that are the key of environmental cooperation for China that was launched in full scale in the late 1990s and thus it was consistent with Japan's aid policy at the time of appraisal.

3.1.4 Selection of Subprojects

Affected by the reform of state-owned enterprises in China that started in 1998, the management environment of the executing agencies has significantly changed since the time of appraisal; e.g., over 70% of the executing agencies have been privatized. Moreover, as the economic liberalization required privatized companies to improve technical capabilities, market competitiveness and profitability, some companies have ended up with production stoppage, bankrupt or downsizing. In addition, as part of the efforts to enhance its environmental policy, the government tends to further tighten regulations on environmentally harmful companies.

In the situation described above, although the project planned to carry out 20 subprojects, some of them were not able to cope with such environmental changes and production was stopped. However, it is deemed that there was no problem in the selection of each project because the enhancement of environmental measures and privatization of enterprises were carried out to remedy environmental issues and management issues of state-owned enterprises.

Considering the above, 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 Efficiency (Rating: b)

3.2.1 Project Outputs

Before evaluating the outputs of this project, we would like to mention the following two major changes from the original plan.

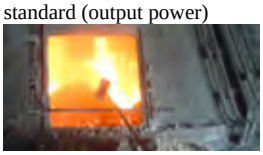
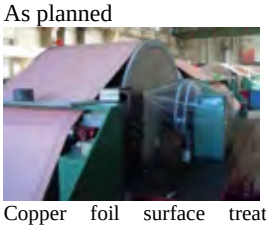
1) Two of the 20 subprojects were cancelled because of the “closedown due to land readjustment” and “the Chinese government’s policy change and decision not to guarantee repayment after privatization”. These cancellations were deemed unavoidable and approved through consultation via L/A alteration decision request on December 3, 1999. Therefore, the two subprojects should be excluded from the efficiency, effectiveness and sustainability evaluation.
2) In three of the 18 subprojects that have acquired a loan, the production has been stopped (virtually bankrupt).

We have individually checked the outputs of each subproject and confirmed that the inputs were provided as planned in 14 subprojects out of the total 18. As for the remaining four subprojects, changes were made after the time of the appraisal but these changes were made to deal with changes in the market needs or the government’s design criteria. Therefore such changes are deemed to be a kind of force majeure events for the business units; inputs to these four subprojects were also appropriate.

Table 1 Comparison between Original Plan and Actual Outputs

Phase I

Original Plan	Actual Outputs	Notes
1) Emission Gas and Wastewater Treatment at Benxi Electrical Equipment Plant (executing body: Benxi Electrical Equipment Plant)		
① Introduction of electrostatic spraying equipment ② Introduction of wastewater treatment equipment ③ Introduction of desulfurizing and dust collection equipment to 2 boilers	Cancelled	Excluded from evaluation
2) Converter Emission Gas Control at Second Plant of Benxi Iron & Steel (executing body: Benxi Iron & Steel Group Co., Ltd.)		
① Enclosure of a converter ② Introduction of equipment to treat emission gas when the converter opens and closes ③ Converter gas control ④ Improvement of a primary dust collection system: Annual processing capacity 240 mil. m^3 Fan room 12 m x 72 m, 2-story, building area 1,910 m^2 ⑤ New construction of a secondary dust collection system: Fan room 15 m x 42 m, single-story, building area 932 m^2	① Enclosure of a converter ② Introduction of equipment to treat emission gas when the converter opens and closes ③ Converter gas control ④ Improvement of a primary dust collection system: Annual processing capacity 240 mil. m^3 Fan room 12 m x 72 m, 2-story, building area 1,910 m^2 ⑤ New construction of a secondary dust collection system: Fan room 15 m x 42 m, single-story, building area 932 m^2	As planned  Converter dust collection system
3) Relocation and Improvement of DMSO Plant of Benxi Rubber Chemical (executing body: Benxi Fine Chemical Co., Ltd.)		
① Relocation of a rubber chemical plant of Benxi (plot area 22,000 m^2, building area 3,791.4 m^2) ② Construction of a DMSO plant with new emission and wastewater treatment equipment	① Relocation of a rubber chemical plant of Benxi (plot area 22,000 m^2, building area 3,791.4 m^2) ② Construction of a DMSO plant with new emission and wastewater treatment equipment	As planned  Emission and wastewater treatment equipment
4) Dust Proofing at Benxi Cement Factory (executing body: Benxi Cement Factory)		
① Construction of coal silos with dust removal equipment (diameter 15 m x height 30 m, 3 silos)	Cancelled	Excluded from evaluation
5) Emission Gas and Wastewater Treatment of W & Mo Production Process at Alloy Plant in Benxi (executing body: Benxi Abundance Tungsten & Molybdenum Co., Ltd.)		
① Introduction of SO_2, HCI, NH_2 and dust treatment equipment ② Introduction of acid and alkaline discharge treatment equipment ③ Conversion of the existing technology for molybdenum refinement	① Introduction of SO_2, HCI, NH_2 and dust treatment equipment Equipment: Purification towers Scale/specs: 7 units, BF-10 ② Introduction of acid and alkaline discharge treatment equipment Equipment: Neutralizing ponds Scale/specs: 2 ponds, 2 m x 10 m	[Plan changed] Reasons: - The budget was run over due to rising yen and equipment could no be procured as planned. - Equipment was not procured as planned due to the molybdenum market contraction. - Neutralization ponds were downsized due to lack of space in the plant.

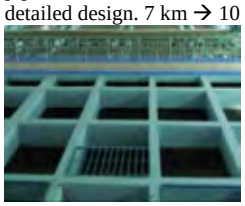
6) Emission Control of Carbide Production Process at Mineral Chemistry Plant in Benxi (executing body: Carbide Plant of Benxi Fubisheng Calcium Carbide Co., Ltd.)		
① Semi-enclosure of a carbide furnace ② Introduction of a dust collector Equipment: Pulse-jet dust collector, PPC-96-8 ③ Construction of a 10,000 kVA closed carbide furnace	① Semi-enclosure of a carbide furnace ② Introduction of a dust collector Equipment: Pulse-jet dust collector, PPC-96-8 ③ Construction of a 12,500 kVA closed carbide furnace	[Plan changed] Reason: Change of government standard (output power)  Closed carbide furnace
7) Expansion of Environment Observation Center (executing body: Benxi Environment Observation Center)		
① Automatic air monitoring system ② Mobile air and water quality monitoring system ③ Automatic monitoring system (video-surveillance of environmentally sensitive areas) ④ Regular monitoring system ⑤ Renovation and expansion of the office/auxiliary building of the center	① Automatic air monitoring system ② Mobile air and water quality monitoring system ③ Automatic monitoring system (video-surveillance of environmentally sensitive areas) ④ Regular monitoring system ⑤ Renovation and expansion of the office/auxiliary building of the center	As planned  Atomic analysis equipment: Measures heavy metals in the air
8) Utilization of Blast Furnace Gas at Steel Plant of Beitai Iron & Steel (executing body: Beitai Iron & Steel Group Co., Ltd. in Benxi)		
① A 75 t/h gas boiler ② A 12 MW single bleeder turbine power generation unit ③ Installation of other related facilities	① A 75 t/h gas boiler ② A 12 MW single bleeder turbine power generation unit ③ Installation of other related facilities	As planned  Emission gas utilization equipment
9) Construction of Water Intake Station (executing body: Benxi Waterworks Department)		
① Construction of a water intake station with an intake capacity of 350,000 m^3/day ② Installation of conductive tubes (double tubes) - 13.5 km, DN1400 (1,400 mm in diameter)	① Construction of a water intake station with an intake capacity of 350,000 m^3/day ② Installation of conductive tubes (double tubes) - 13.5 km, DN1400 (1,400 mm in diameter)	As planned  Inside of the water intake station (intake pumps)
10) Comprehensive Utilization of Coal Ash (executing body: Material Plant of Benxi Water Supplies Department)		
① Introduction of sprinklers ② New construction of a building material plant - Produces 50,000 m^3/year of ALC blocks with a high fly-ash content	① Introduction of sprinklers ② New construction of a building material plant - Produces 50,000 m^3/year of ALC blocks with a high fly-ash content	Production shutdown → Equipment provided as planned
11) Emission Gas and Wastewater Treatment at Copper Processing Plant in Benxi (executing body: Benxi Jinyuan Copper Foil Co., Ltd.)		
① Introduction of emission gas treatment equipment Equipment: Acidic mist purifier, combustion enhancement equipment Scale/specs: ≥ 95-98%, 5,000 m^3/h ② Improvement of water purification technologies Improvement: Integration of water treatment systems ③ Integration of a heat exchanging system	① Introduction of emission gas treatment equipment Equipment: Acidic mist purifier, combustion enhancement equipment Scale/specs: ≥ 95-98%, 5,000 m^3/h ② Improvement of water purification technologies Improvement: Integration of water treatment systems ③ Integration of a heat exchanging	As planned  Copper foil surface treatment equipment

and a filter system (wastewater treatment systems to neutralize or detoxify SO_3 mist, sulfuric acid, hydrochloric acid, copper and chromium generated in the electrolytic copper foil production process) ④ Improvement of copper foil surface treatment technologies Improvement: Adoption of automatic micro-control	system and a filter system (wastewater treatment system to neutralize or detoxify SO_3 mist, sulfuric acid, hydrochloric acid, copper and chromium generated in the electrolytic copper foil production process) ④ Improvement of copper foil surface treatment technologies Improvement: Adoption of automatic micro-control	
12) Wastewater Treatment at Pharmaceutical Plant in Benxi (executing body: Benxi Haida Pharmaceutical Co., Ltd.)		
① Introduction of an automatic process control system ② Introduction of wastewater treatment equipment Equipment: Air compressor, plate frame filter press Scale/specs: 450 t/day ③ Installation of a temperature regulator and a biological treatment facility to reduce COD and BOD generated in wastewater at the yeast production process ④ Introduction of deep well aeration - fluid bed type, activated sludge process, secondary treatment technologies ⑤ Construction of a receiving basin, a distributing basin, a deep well facility, a biological fluid bed	① Introduction of an automatic process control system ② Introduction of wastewater treatment equipment Equipment: Air compressor, plate frame filter press Scale/specs: 450 t/day ③ Installation of a temperature regulator and a biological treatment facility to reduce COD and BOD generated in wastewater at the yeast production process ④ Introduction of deep well aeration - fluid bed type, activated sludge process, secondary treatment technologies ⑤ Construction of a receiving basin, a distributing basin, a deep well facility, a biological fluid bed	As planned  Wastewater treatment facility
13) Renovation of Caustic Soda Production Process at Plastic Chemical Plant in Benxi (executing body: Benxi Dongfang Chlor-Alkali Co., Ltd.)		
① Construction of production equipment with an annual capacity of 20,000 tons ② Updating of a production process Before After Fusion method → Ion diaphragm method ③ Introduction of emission gas and wastewater treatment equipment ④ (New construction of a secondary salt water purifying system, a pure and salt water chlorine removal system, a water purifying system and a pure acid production system)	① Construction of production equipment with an annual capacity of 20,000 tons ② Updating of a production process Before After Fusion method → Ion diaphragm method ③ Introduction of emission gas and wastewater treatment equipment ④ (New construction of a secondary salt water purifying system, a pure and salt water chlorine removal system, a water purifying system and a pure acid production system)	As planned  Caustic soda production system with ion diaphragm

Phase II

Original Plan	Actual Outputs	Notes
1) City Gas Supply Phase 5 (executing body: Benxi Wanhua Gas Co., Ltd.)		
① Construction of a coke-oven gas supply station (for storage and distribution of LPG) (Gaotaizi gas liquefaction process) ② Construction of 2 LPG supply stations (for gas mixing) (Caitun/Dayu gas mixing processes) ③ Gas piping (Zhuanshan gas system) ④ Construction of an LP gas cylinder supply station (for storage and distribution of gas) (Zhuanshan gas system)	① Construction of a coke-oven gas supply station (for storage and distribution of LPG) (Gaotaizi gas liquefaction process) ② Construction of 2 LPG supply stations (for gas mixing) (Caitun/Dayu gas mixing processes) ③ Gas piping (Zhuanshan gas system) ④ Construction of an LP gas cylinder supply station (for storage and distribution of gas) (Zhuanshan gas system)	As planned  Coke oven gas supply station

2) Converter Emission Gas Control at Beitai Iron & Steel (executing body: Beitai Iron & Steel Group Co., Ltd.)		
① A 50,000 m^3 rubber-sealed dry type gas tank 2 electrostatic converter gas dust collectors ② Construction of an electrostatic dust collection system ③ Construction of a coal gas pressurising station (2 units of gas pressurising equipment) ④ Construction of automatic control gauges (2 sets each for combustion equipment, heat conduction equipment, gas bleeding dust collecting equipment, blower, control system and material supply equipment) ⑤ Construction of compressed slag ball production equipment with a capacity of 20,000 t/year	① A 50,000 m^3 rubber-sealed dry type gas tank 2 electrostatic converter gas dust collectors ② Construction of an electrostatic dust collection system ③ Construction of a coal gas pressurising station (2 units of gas pressurising equipment) ④ Construction of automatic control gauges (2 sets each for combustion equipment, heat conduction equipment, gas bleeding dust collecting equipment, blower, control system and material supply equipment) ⑤ Construction of compressed slag ball production equipment with a capacity of 20,000 t/year	As planned  Equipment related to emission gas utilization
3) Pollution Control at Chemical Plant (executing body: Benxi Fine Chemical Co., Ltd.)		
① Installation of desulfurization equipment at DMDS plant ② Relocation to a block of chemical engineering area (25,000 m^3) within an existing chemical engineering site ③ Construction of a plant of a new process with wastewater treatment and other environmental protection facilities that produces 1,000 tons of dimethyldisulphide per year	① Installation of desulfurization equipment at DMDS plant ② Relocation to a block of chemical engineering area (25,000 m^3) within an existing chemical engineering site ③ Construction of a plant of a new process with wastewater treatment and other environmental protection facilities that produces 1,000 tons of dimethyldisulphide per year	Production shutdown → Equipment installed as planned
4) Pollution Control at Solvent Plant (executing body: Auxiliaries Plant in Benxi)		
① Establishment of a soft calcium carbonate plant ② Production process improvement and installation of desulfurization equipment at an anti oxidant plant - To reduce 20 tons of ammonia nitrogen per year - To reduce 0.14 tons of asphalt per year - To reduce 42.4 tons of SS per year ③ Installation of a dust collector ④ Installation of a settling basin and other environmental control equipment	① Establishment of a soft calcium carbonate plant ② Production process improvement and installation of desulfurization equipment at an anti oxidant plant - To reduce 20 tons of ammonia nitrogen per year - To reduce 0.14 tons of asphalt per year - To reduce 42.4 tons of SS per year ③ Installation of a dust collector ④ Installation of a settling basin and other environmental control equipment	Production shutdown → Equipment installed as planned
5) Pollution Control at Lubricant Plant (executing body: Benxi Huante Petrochemical Co., Ltd.)		
① Improvement of production processes at a molybdenum sulfide plant, a lube oil plant and a grease plant ② Construction of production and auxiliary facilities for molybdenum disulfide powder (300 tons/year), molybdenum disulfide based oil products (5,000 tons/year) and molybdenum disulfide lube oil (5,000 tons/year) ③ Construction of environmental protection facilities with Public Construction Commission ④ Installation of environmental control equipment such as SO_2 collecting unit, oil recovery unit and wastewater treatment unit	① Improvement of production processes at a molybdenum sulfide plant, a lube oil plant and a grease plant (Renewal of roasting furnaces: 2 closed rotary kilns and 2 pyrolysis kilns) ② Construction of production and auxiliary facilities for molybdenum disulfide powder (300 tons/year), molybdenum disulfide based oil products (5,000 tons/year) and molybdenum disulfide lube oil (5,000 tons/year) ③ Construction of environmental protection facilities with Public Construction Commission ④ Installation of environmental control equipment such as SO_2 collecting unit, oil recovery unit and wastewater treatment unit	As planned  Grease production equipment

6) Taizi River Drinking Water Pollution Control (executing body: Benxi Waterworks Department)		
① Purified water supply equipment: 80,000 m^3/day ② Distribution pipe network: 7 km	① Expansion of a water purifying plant Processing ability: 80,000 m^3/day ② Improvement of distribution pipes Length: 10 km	Plan changed] Reason: The length of the drain pipe was extended as a result of detailed design. 7 km → 10 km  Settling basin

Phase III

Original Plan	Actual Outputs	Notes
1) Beitai Iron & Steel Coke Oven Pollution Control (executing body: Beitai Iron & Steel Group Co., Ltd.)		
① Construction of two sets of 38-hole stamp charging coke production facilities (JNO38-2; coal preparation, coke production, gas collection and purification system and wastewater treatment) with a production capacity of approx. 560,000 tons/year ② Construction of ancillary facilities including a substation and other facilities for production aid, management and environmental improvement (total lot area 261, 000 m^3)	① Construction of a 65-hole JN43-804 coke oven and coke production facilities with a production capacity of approx. 450,000 tons/year (Coal preparation, coke production, gas collection and purification system and wastewater treatment) ② Construction of ancillary facilities including a substation and other facilities for production aid, management and environmental improvement	[Plan changed] Reason: As a result of detailed calculation of required production capacity, specs of the coke oven were changed.  Coke oven

3.2.2 Project Inputs

3.2.2.1 Project Period

The planned and actual project periods are as follows. There is a delay in general.

Phase I	Planned period:	October 1997 – December 2001 (51 months)
	Actual period:	October 1997 – December 2002 (63 months)
Phase II	Planned period:	December 1998 – March 2002 (40 months)
	Actual period:	December 1998 – July 2004 (68 months)
Phase III	Planned period:	July 2000 – March 2002 (21 months)
	Actual period:	July 2000 – June 2002 (24 months)

The period of each subproject is as shown in Table 2 below. In Phase I, the actual period of five subprojects out of 11 were longer than planned because there were so many subprojects and the city government and executing agencies were not accustomed to the procedures and project management. In Phase II, two subprojects out of the total 6 were much longer (150%-) than planned due to the slow process of privatization and delay of funding in the executing agencies. (The executing agencies of these two subprojects are practically bankrupt now.) Two other projects were slightly longer than planned (100%-) due to the delay of equipment procurement. In Phase III, there was only one subproject, which was delayed for three months due to the delay of equipment procurement.

We first evaluated each subproject and then the whole project. It was evaluated as follows:

3-level evaluation based on the difference between the original plan and actual results (the actual period was a: not exceeding 100% of the plan, b: longer than 100% and not exceeding 150% of the plan, and c: longer than 150% of the plan), addition of 2 points for a, 1 for b, and 0 for c, and overall rating of (a) when the total of the points is over 80 percent, (b) when it is more than 50 percent and under 80 percent, and (c) when it is 50 percent or less. (See the right-hand column of Table 2.)

As a result, as shown in Table 3, the actual period was shorter than planned or mostly as planned (not exceeding 100%) in eight subprojects, longer than planned (100%-150% of the plan) in eight subprojects and much longer (150%-) in two subprojects. As a result of the calculation described above, the project period is rated as (b) “longer than planned”.

Table 2 Original Plan and Actual Results of Each Subproject Period

Subproject Name	Original (at appraisal)			Actual (at ex-post evaluation)			Difference (%)(Actual / Original)	Evaluation
	Launched	Completed	Period (month)	Launched	Completed	Period (month)		
Phase I								
1)Emission gas and wastewater treatment at Benxi electrical equipment plant	October 1997	December 2001	51	-	-	-	-	Cancelled
2)Converter emission gas control at second plant of Benxi Iron & Steel	October 1997	December 2001	51	October 1997	December 2002	63	124	b
3)Relocation and improvement of DMSO plant of Benxi rubber chemical plant	October 1997	December 2001	51	October 1997	September 2002	60	118	b
4)Dust proofing at Benxi cement factory	October 1997	December 2001	51	-	-	-	-	Cancelled
5)Emission gas and wastewater treatment of W & Mo production process at alloy plant in Benxi	October 1997	December 2001	51	October 1997	July 2002	58	114	b
6)Emission control of carbide production process at mineral chemistry plant in Benxi	October 1997	December 2001	51	October 1997	December 2001	51	100	a
7)Expansion of Environment Observation Center	January 1998	December 2001	48	January 1998	November 2000	35	73	a
8)Utilization of blast furnace gas at steel plant of Beitai Iron & Steel	October 1997	December 2001	51	October 1997	November 2000	38	75	a
9)Construction of water intake station	October 1997	December 2001	51	October 1997	October 2002	61	120	b
10)Comprehensive utilization of coal ash	October 1997	December 2001	51	October 1997	December 2000	39	76	a
11)Emission gas and wastewater treatment at copper processing plant in Benxi	October 1997	December 2001	51	October 1997	June 2002	57	112	b
12)Wastewater treatment at pharmaceutical plant in Benxi	October 1997	December 2001	51	October 1997	December 2000	39	76	a

Subproject Name	Original (at appraisal)			Actual (at ex-post evaluation)			Difference (%)(Actual / Original)	Evaluation
	Launched	Completed	Period (month)	Launched	Completed	Period (month)		
13)Renovation of caustic soda production process at plastic chemical plant in Benxi	October 1997	December 2001	51	October 1997	September 2001	48	94	a
Phase II								
1)City gas supply Phase 5	December 1998	March 2002	40	December 1998	December 2002	49	123	b
2)Converter emission gas control at Beitai Iron & Steel	April 1999	March 2002	36	April 1999	December 2001	33	92	a
3)Pollution control at chemical plant	January 1999	March 2002	39	January 1999	July 2004	67	172	c
4)Pollution control at solvent plant	January 1999	March 2002	39	January 1999	November 2003	59	151	c
5)Pollution control at lubricant plant	January 1999	March 2002	39	January 1999	November 2001	35	90	a
6)Taizi River drinking water pollution control	December 1998	March 2002	40	December 1998	October 2002	47	118	b
Phase III								
1)Beitai Iron & Steel coke oven pollution control	July 2000	March 2002	21	July 2000	June 2002	24	114	b

Table 3 Evaluation of Project Period

	(a) Evaluation Shorter than planned [2 points]	(b) Evaluation Longer than planned [1 point]	(c) Evaluation Much longer than planned [0 point]	Total	Evaluation result
Subproject Quantity	8	8	2	18	
Point [maximum: 36]	16 points	8 points	0 point	24 points	67% = (b)

3.2.2.2 Project Cost

The planned and actual project costs are as shown below. The total project costs of all phases were lower than planned.

Phase I Plan: Total 9,918 million yen (Japanese ODA loan portion 4,110 million yen)
Actual: Total 9,652 million yen (Japanese ODA loan portion 4,076 million yen)

Phase II Plan: Total 6,564 million yen (Japanese ODA loan portion 3,237 million yen)
Actual: Total 5,916 million yen (Japanese ODA loan portion 3,082 million yen)

Phase III Plan: Total 5,362 million yen (Japanese ODA loan portion 1,160 million yen)
Actual: Total 1,980 million yen (Japanese ODA loan portion 1,159 million yen)

As for the cost of each subproject, the actual cost was higher than planned in 10

subprojects out of the total 18, as shown in the following Table 4. It was mainly because the sum of all prices slightly exceeded the estimated cost as a result of competitive bidding.

The project cost was also evaluated first by subproject and them as a project in its entirety as it was in the case of project period. It was evaluated as follows: 3-level evaluation based on the difference between the plan and actual results (the actual result was a: not exceeding 100% of the plan, b: more than 100% and below 150% of the plan, and c: 150% or more of the plan), with addition of 2 points for a, 1 for b, and 0 for c, and overall rating of (a) when the total of the points is over 80 percent, (b) when it is more than 50 percent but under 80 percent, and (c) when it is 50 percent or less. (See the right-hand column of Table 4.)

As a result, as shown in Table 5, the actual cost was lower than planned or mostly as planned (not exceeding 100%) in eight subprojects, and higher than planned (100%-150% of the plan) in 10 subprojects. Based on the calculation described above, the sub-rating of the project cost is (b) “higher than planned”.

Table 4 Comparison of Original Plan and Actual Project Cost

(Unit: million yen)

Subproject Name	Plan		Actual		Difference (Actual / Original)	Evaluation
	Project Cost	Yen Loan in Project Cost	Project Cost	Yen Loan in Project Cost		
Phase I						
1)Emission gas and wastewater treatment at Benxi electrical equipment plant	188	61	-	-	-	Excluded
2)Converter emission gas control at second plant of Benxi Iron & Steel	1,345	499	1,376	475.2	102%	b
3)Relocation and improvement of DMSO plant of Benxi rubber chemical works	985	502	998	558.1	101%	b
4)Dust proofing at Benxi cement factory	231	114	-	-	-	Excluded
5)Emission gas and wastewater treatment of W & Mo production process at alloy plant in Benxi	486	200	497	200	102%	b
6)Emission control of carbide production process at mineral chemistry plant in Benxi	658	298	663	295.9	101%	b
7)Expansion of Environment Observation Center	292	151	297	151.3	102%	b
8)Utilization of blast furnace gas at steel plant of Beitai Iron & Steel	2,019	819	1,903	806.3	94%	a
9)Construction of water intake station	1,578	503	1,609	494.6	102%	b
10)Comprehensive utilization of coal ash	186	101	189	101.3	101%	b

Subproject Name	Plan		Actual		Difference (Actual / Original)	Evaluation
	Project Cost	Yen Loan in Project Cost	Project Cost	Yen Loan in Project Cost		
11)Emission gas and wastewater treatment at copper processing plant in Benxi	618	228	631	221.6	102%	b
12)Wastewater treatment at pharmaceutical plant in Benxi	231	140	240	140.3	104%	b
13)Renovation of caustic soda production process at plastic chemical plant in Benxi	1,101	494	1,249	613.6	114%	b
Phase I Total	9,918	4,110	9,652	4,058		
Phase II						
1)City gas supply Phase 5	1,725	573	1,523	466.4	88%	a
2)Converter emission gas control at Beitai Iron & Steel	890	442	832	442.4	94%	a
3)Pollution control at chemical plant	992	640	883	640.5	89%	a
4)Pollution control at solvent plant	526	382	447	382.5	85%	a
5)Pollution control at lubricant plant	1,191	551	1,025	558	86%	a
6)Taizi River drinking water pollution control	1,241	649	1,205	597.3	97%	a
Phase II Total	6,565	3,237	5,916	3,087		
Phase III						
1)Beitai Iron & Steel coke oven pollution control	5,362	1,160	1,980	1,159.4	37%	a
Phase III Total	5,362	1,160	1,980	1,159		
Project Total	21,845	8,507	17,547	8,305		

Table 5 Evaluation of Project Cost

	(a) Evaluation Lower than planned [2 points]	(b) Evaluation Higher than planned [1 point]	(c) Evaluation Much higher than planned [0 point]	Total	Evaluation result
Subproject Quantity	8	10	0	18	
Point [maximum: 8]	16 points	10 points	0 point	26 points	72% = (b)

As shown above, both project period and project cost exceeded the plan; therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: b)

3.3.1 Quantitative Effects

3.3.3.1 Results from Operation and Effect Indicators

The achievement level of operation and effect indicators of each subproject is as shown in the following table. The right-hand column of the table has “a” in case the achievement level is

over 80%, “b” in case the achievement level is over 50% and under 80%, and “c” in case the achievement level is 50% or below or the production is shut down.

Table 6 Targets and Actual Results of Operation and Effect Indicators

Phase I

Subproject	Target values (2000)	Actual results (2009)	Evaluation
1) Emission gas and wastewater treatment at Benxi electrical equipment plant	Cancelled	-	Excluded
2) Converter emission gas control at second plant of Benxi Iron & Steel	Flue dust concentration: 120 g/m^3→ 0.1 g/m^3 (99.92% reduced)	Flue dust concentration: 0.035 g/m^3 (99.97% reduced compared to 1996)	a
3) Relocation and improvement of DMSO plant of Benxi rubber chemical works	DMSO production scale: 2,000 t/year Annual reduction of SO_2 emission: 43.9 t (reduction rate 50.8%) CDO concentration in wastewater: to be reduced to 15.58 mg/L COD reduction rate: 87.5% Reduction of solid waste: 17.84 t/year DMSO collection rate: 60% → 90%	DMSO production scale: 3,339 t/year (Target in 2009: 4,000 tons) Annual reduction of SO_2 emission: 45 tons CDO concentration in wastewater: reduced to 15.6 mg/L COD reduction rate: 88% Reduction of solid waste: 18.1 t/year DMSO collection rate: 91%	a
4) Dust proofing at Benxi cement factory	Cancelled	—	Excluded
5) Emission gas and wastewater treatment of W & Mo production process at alloy plant in Benxi	- Annual reduction of SO_2: 223.1 tons (Reduction rate 100%) - Reduction of solid waste: 24.9 tons (Reduction rate 100%) - Standards for discharged SO_2, hydrochloric acid mist, ammonia gas and waste liquid: Discharged waste liquid (alkaline) PH>9 → PH=7 (improved amount 420 t/year) Discharged waste liquid (acidic) PH2-2.5 → PH=7 (improved amount 3,840 t/year) - Annual production of ammonium molybdate: 400 tons - Increased production of hot rolled steel plates and cold rolled steel plates: to be increased by 45t /year	- Annual reduction of SO_2: 0 ton - Reduction of solid waste: 0 ton - Standards for discharged SO_2, hydrochloric acid mist, ammonia gas and waste liquid: Discharged waste liquid (alkaline) PH>9 → PH=7 (improved amount 700 t/year) Discharged waste liquid (acidic) PH2-2.5 → PH=7 (improved amount 8,000 t/year) - Annual production of ammonium molybdate: 1,544 t/year - Annual production of molybdenum: 34 t/year - Increased production of hot rolled steel plates and cold rolled steel plates: 0 ton (because equipment was not procured as planned) Note: Reduction of SO_2 and solid waste was not the effect of equipment installation but of the production process change (outsourcing of molybdenum oxide production).	b
6) Emission control of carbide production process at mineral chemistry plant in Benxi	- Dust emission: 100 mg/m^3 or below - Utilization of recycled water: Recycled water to be used for all production processes - Production of formic acid with use of CO generated as by-product of a carbide furnace	Dust emission: 80 mg/m^3 - Utilization of recycled water: Recycled water to be used for all production processes - Production of cement with use of by-product of a carbide furnace (Cement materials produced instead of formic acid according to the needs of the market) : 10,406 t/year - Dust collection: 1,460 t/year - Real output of carbide: 22,076 t/year	a
7) Expansion of Environment Observation Center	- Environmental monitoring ability: achievement of national ambient air quality standard grade 3 - Full-scale automatic air monitoring, regular monitoring of all water systems and major dams in the city,	- Environmental monitoring ability: Achieved national ambient air quality standard grade 3 and passed the laboratory-level examination conducted by the parent department.	a

Subproject	Target values (2000)	Actual results (2009)	Evaluation
	and full-scale control of major water sources in the city		
8) Utilization of blast furnace gas at steel plant of Beitai Iron & Steel	- Standard quantity of alternative to coal: 3.99 t/year - Annual SO_2 emission reduction: 1,640-1,760 tons - Flue dust reduction: 1,340 tons - Annual power feed: 144.4 million kWh	- Standard quantity of alternative to coal: 148,800 t/year - Annual SO_2 emission reduction: 1,840 t/year - Flue dust reduction: 1,240 t/year - Annual power feed: 147.6 million kWh (up 89% from 2002)	a
9) Construction of water intake station	Environmental effect: To supply daily life water to 400,000-500,000 people living in the central part of the city; to improve the water supply coverage for 800,000 people to more than 99%; to improve the quality of tap water to meet the standard	- Real number of beneficiaries: 830,000 - Water quality: achieved grade 2 standard	a
10) Comprehensive utilization of coal ash	Environmental effects To control fly ash pollution at a Bengang plant and generate positive economic and social effects Production: 50,000 m^3/year of ALC blocks with a high fly-ash content	Production shutdown	c
11) Emission gas and wastewater treatment at copper processing plant in Benxi	Copper concentration: 0.5 mg/L Copper emission: 0.27 t/year Chrome concentration: 0.05 t/year Chrome discharge: 0.03 t/year Reduction of wastewater: 320,000 t/year *To collect 13 tons of copper per year Acid mist concentration in working area: 200 mg/m^3 or below	Copper concentration: 0.45 mg/L Copper emission: 0.26 t/year Chrome concentration: 0.049 mg/L Chrome discharge: 0.03 t/year Reduction of wastewater: 330,000 t/year Acid fog concentration in working area: 150 mg/m^3 or below Real output of electrolytic copper foils: 1,333 tons (up 22% from 2000)	a
12) Wastewater treatment at pharmaceutical plant in Benxi	COD concentration (mg/L): 10,000 → 50 (99%) COD discharge (t/year): 1,280 → 8 BOD concentration (mg/L): 4,500 → 30 (99%) BOD discharge (t/year): 575 → 4.8 SS reduction rate: 97.5% Wastewater treatment: 450-500 t/day	COD concentration (mg/L): 80-90 COD discharge (t/year): 4 BOD concentration (mg/L): 32 BOD discharge (t/year): 3 (down 23% from 1977) SS reduction rate: 97% Wastewater treatment: 100 t/day Note: Although the target values of COD and BOD concentration have not been achieved, all the other indicators have been mostly achieved. However, it is not the effect of the provided equipment but mainly because of the downsizing of production. (Drug materials and drugs cannot be produced in the same plant due to the tightened government regulations on pharmaceutical companies.)	b
13) Renovation of caustic soda production process at plastic chemical plant in Benxi	Annual COD reduction: 337.6 tons Annual BOD5 reduction: 47.1 tons Annual SS reduction: 350.6 tons Annual SO^2 reduction: 114 tons Annual TSP reduction: 16.3 tons	Annual COD reduction: 827 tons (2007) Annual BOD5 reduction: 416 tons (2007) Annual SS reduction: 2,072 tons (2007) Annual SO^2 reduction: 254.2 tons (2007) Annual TSP reduction: 25 tons (2007) Caustic soda production: 50,000 tons (2007) Note: Although the target values were achieved in 2007, the production scale was downsized in 2008 and was stopped in 2009 due to decreased market needs.	b

Phase II

Subproject	Target values (2000)	Actual results (2009)	Evaluation
1) City gas supply Phase 5	Coal consumption reduction: 126,000 t/year SO_2 emission reduction: 3,600 t/year TSP discharge reduction: 9,900 t/year	Coal consumption reduction: 130,000 t/year SO_2 emission reduction: 3,550 t/year TSP discharge reduction: 10,000 t/year Coke gas supply: 100,000 m^3/day Liquefied petroleum gas supply: 6,000 t/year Gas users: 54,000 households Users of liquefied petroleum gas cylinders: 6,000 households Users of liquefied petroleum gas pipeline: 14,000 households	a
2) Converter emission gas control at Beitai Iron & Steel	SO_2 emission reduction: 160 t/year CO gas emission reduction: 32,369 t/year Flue dust reduction: 90 t/year --> 122 t/year Solid waste reduction: 5,690 t/year --> 7,587 t/year Dust reduction: 966 t/year Steel converter slag reduction: 200,000 t/year Reduction of dust collector sludge: 20,000 t/year	SO_2 emission reduction: 165 t/year CO gas emission reduction: 30,520 t/year Flue dust reduction: 114 t/year Solid waste reduction: 6,586 t/year Dust reduction: 1,013.33 t/year Steel converter slag reduction: 200,000 t/year Reduction of dust collector sludge: 18,000 t/year Iron products output: 2,471,316 tons (up 25% from 2002)	a
3) Pollution control at chemical plant	SO_2 emission reduction: 154 t/year → 38 t/year SO_2 concentration: 15.9 mg/m^3 → 10.5 mg/m^3 COD discharge: 3.3 t/year COD concentration: 1,000 mg/L → 97mg/L Other: To eliminate almost all environmental impact of methanethiol, sulfur ether and other malodorous substances	Production shutdown (The company went bankrupt.)	c
4) Pollution control at solvent plant	SO_2 reduction: 148 t/year TSP reduction: 90 t/year Environmental effect: To improve low-level production technologies; to reduce pollution; to achieve emission standards	Production shutdown (The company went bankrupt.)	c
5) Pollution control at lubricant plant	SO_2 reduction: 373 t/year BOD reduction: 2.8 t/year Sulfurated hydrogen reduction: 65 t/year SS reduction: 24 t /year Ammonia nitrogen reduction: 1.7 t/year Oil reduction: 10.5 t/year	SO_2 discharge: 0 t/year BOD discharge: 0 t/year Sulfurated hydrogen discharge: 0 t/year SS discharge: 0 t/year Ammonia nitrogen discharge: 0 t/year Oil discharge: 0.5 t/year Note: Although the target values have been achieved, it was not the effect of the provided equipments but mostly because of significant downsizing of production compared with the original plan.	b
6) Taizi River drinking water pollution control	Drinking water quality standard: Class II achieved Maximum water supply capacity: daily processing capacity 80,000 m^3 → 160,000 m^3	Served population for water supply: 830,000 (up 17% from 1997) Water supply: 140,000 m^3/day (up 100% from 1997) Facility utilization rate Leakage rate: 25% (down 10 points from 1997) Water intake: 330,000 m^3/day (up 38% from 1997) Water quality standard: Class II achieved Water supply coverage rate: 100% (up 10 points from 1997) Maximum daily processing capacity: 160,000 m^3 (up 100% from 1997)	a

Phase III

Subproject	Target values (2000)	Actual results (2009)	Evaluation
1) Beitai Iron & Steel coke oven pollution control	SO_2 emission reduction: 334 t/year TSP emission reduction: 1,052 t/year COD discharge reduction: 19 t/year Petroleum oil discharge reduction: 3 t/year	SO_2 emission reduction: 770 t/year TSP emission reduction: 2,420 t/year COD discharge reduction: 136 t/year Petroleum oil discharge reduction: 13.11 t/year	a

As shown in the table above, out of the total 18 subprojects, it was given a rating of "a" to 11 subprojects that achieved the target values. A rating of (b) was given to Phase I: "5) Emission gas and wastewater treatment of W & Mo production process at alloy plant in Benxi", "12) Wastewater treatment at pharmaceutical plant in Benxi", "13) Renovation of caustic soda production process at plastic chemical plant in Benxi" and Phase II: "5) Pollution control at lubricant plant", because their target achievement was not made by the introduction of equipment but mainly by production cut or change of production processes. Moreover, Phase I: "10) Comprehensive utilization of coal ash", Phase II: "3) Pollution control at chemical plant" and "4) Pollution control at solvent plant" received a rating of "c", because production was shut down in those projects and the actual results could not be checked. The major reasons for production shutdown were updating of a production process or a slow process of privatization.

The effectiveness of the whole project was also evaluated based on the sum of the ratings of all subprojects. 2 points were given for the rating of "a", 1 point for "b" and 0 point for "c". Then a rating of (a) was given when the total score was over 80% , (b) when over 50% up to 80%, and (c) when under 50% or less. The evaluation result based on this rule is as shown in the following Table 7. The total score was 72% of the highest score. Therefore, the effectiveness of the whole project was (b).

Table 7 Evaluation of Operation and Effect Indicators

	(a) Evaluation Indicator achievement level 80% or more	(b) Evaluation Indicator achievement level 50% to 79%	Rating (c) Indicator achieved less than 49% or no operation	Cancellation (Excluded from evaluation)	Total
Subproject Quantity	11	4	3	2	20
Point [maximum: 36]	22 points	4 points	0 point	-	26 points 72%= (b)

3.3.1.2 Results of Calculations of the Internal Rate of Return

Financial Internal Rate of Return (FIRR) values of Phase I and Phase II were not calculated at the time of appraisal and will not be calculated because it was difficult to obtain necessary information from the Chinese side. FIRR of the "Beitai Iron & Steel Coke Oven Pollution Control" of Phase III was calculated with coke sale revenue. However, at the time of ex-post

evaluation, it was found out that coke was not sold but was consumed in the course of steel production. Moreover, it was pointed out that the facilities used for subproject evaluation were only part of the coke production facilities and that it was difficult to calculate the maintenance and operation cost and other expenses only for this portion. Therefore, FIRR will not be calculated for Phase III, either.

Economic Internal Rate of Return (EIRR) benefit indicators could be health improvement made by air quality improvement and amount of money people would like to pay for improved public service. However, comparison with similar benefit indicators cannot be conducted because EIRR was not calculated at the time of appraisal, and no other similar benefit indicators is not available for evaluation. It is also difficult to obtain data of the time. Therefore, EIRR is not calculated in this evaluation.

3.3.2 Qualitative Effects

The primary qualitative effect of this project is that "with reduction of air and water contaminants and supply of safe drinking water, local people become aware of improvements of air and water quality".

As shown in the following table, over 90% of the respondents of the beneficiary survey are aware that the air quality in Benxi has improved compared with 10 years ago. Many respondents pointed out "plant relocation", "reduction of plant smoke concentration with the use of advanced technologies", "tightened control" and "increase of households supplied with gas" as major improvement factors.

Table 8 Residents' Recognition of Air Quality Improvement

Changes in air quality in comparison with 10 years ago	Total (%)
Improved very much	90.8
Rather improved	8.3
Not changed much	0.8
Rather deteriorated	0
Deteriorated very much	0
Don't know	0

(Of responses "Improved or rather improved") Main causes of improvement [multiple answers allowed]	Total (%)
Plants relocated to suburbs	81.7
Flue gas concentration from plants reduced by the advanced technologies	74.2
Municipal government control was strengthened	73.3
Gas is used at home	68.3
Improved financial strength of the city	55.0
Promotion of public works in local cities	25.0

Note: Result of a beneficiary survey conducted during the ex-post evaluation (survey of 120 residents of the city in May 2010)

As for the water quality of the Taizi River, the water source of Benxi, over 90% people responded that it has improved compared with 10 years ago, and many of them pointed out

"relocation of intake sources to the upstream", "tightened control" and "plant relocation", all conducted in this project, as major improvement factors.

Table 9 Residents' Awareness about Water Quality of the Taizi River

(Result of Beneficiary Survey)

Water quality of the Taizi River compared with 10 years ago	Total (%)
Improved very much	76.7
Rather improved	20.0
Not changed much	1.7
Rather deteriorated	0
Deteriorated very much	0
Don't know	1.7

Major factors that improved water quality (Multiple answers of respondents who marked "Improved" or "Generally improved")	Total (%)
Relocation of intake sources to the upstream	86.7
Municipal government control was strengthened	57.5
Promotion of public works in local cities	46.7
Improved financial strength of the city	43.3
Relocation of plants to suburbs	40.0
Flue gas concentration from plants reduced by the advanced technologies	30.8

Note: Result of a beneficiary survey conducted during the ex-post evaluation (survey of 120 residents of the city in May 2010)

These effects were developed through the effective cooperation with and supplement to the environmental improvement activities that the Chinese parties had been carrying out on their own. Therefore, the project was not the only contributor to these effects, but its overall contribution seems significant.

As described above, the achievement level of the operation and effect indicators and qualitative effects of the whole project show that this project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

Although the environmental improvement of the whole city of Benxi is largely attributed to the efforts outside this project, such as long-term environmental measures and advances in contaminant processing technologies, the environmental indicators of the whole city and the result of the beneficiary survey indicate that the project has a major impact on the improvement of the local people's living environment.

Benxi had such serious environmental issues that it was called "a city invisible from the satellite" at the time of appraisal. Therefore, implementation of various environmental measures in this project, including measures for companies that had a negative impact on the environment (Beitai Iron & Steel Group and Benxi Iron & Steel Group) and measures to improve drinking water and city gas supply that have a significant impact on the public life, is deemed to have

made no small contribution to the environmental improvement of the whole city.

(1) Improvement of Air and Water Quality in Benxi

As shown in Table 10, the air quality index of the city of Benxi dramatically improved from 2001 to 2005. In 2005 the average SO_2 concentration achieved the national ambient air quality grade 2 (0.06 mg/ m^2) for the first time, and in 2008 the level of PM10 also achieved grade 2 (0.054 mg/m^2). Moreover, after the relocation of the Dayu water source from an urban district to 13.5 km upstream in Phase I "9) Construction of Water Intake Station", the water quality of the water source has achieved the water quality standard grade 2 and the downstream water quality has also been improving.

Table 10 Indicators of Air Quality in Benxi (annual average)

(mg/m^3)

Index	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TSP/ PM10	0.47	0.41	0.41	0.39	0.346	0.288	0.282	0.280	0.119	0.110	0.108	0.092	0.090
SO_2 concentration	0.15	0.11	0.09	0.09	0.071	0.068	0.060	0.060	0.059	0.044	0.047	0.046	0.050
NO_x concentration	0.03	0.05	0.05	0.05	0.033	0.036	0.039	0.032	0.036	0.028	0.031	0.034	0.032
Total particle emissions (t)	39.6	38.4	36.9	35.7	28.5	27.3	26.0	25.0	22.9	22.0	21.4	21.1	20.3

Note 1: PM10 replaced TSP in 2005.
Note 2: The SO_2 and TSP values from 2006 to 2009 include pollutants from area-wide observation and cannot be simply compared with the values before 2006, which were obtained only through fixed-point observation.
*Reference: Benxi Environment Year Book

Table 11 Indicators of Water Quality in the Downstream of the Taizi River in Benxi (annual average)

(mg/L)

Index	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BOD	4.06	4.34	5.42	5.12	3.52	4.35	4.86	4.75	4.63	4.75	4.05	3.52	4.62
COD	42.9	30.0	37.8	29.6	20.5	23.0	21.7	32.7	27.3	22.3	20.8	16.9	17.8

Note : The BOD and COD values from 2006 to 2009 include pollutants from area-wide observation and cannot be simply compared with the values before 2006, which were obtained only through fixed-point observation.
*Reference: Benxi Environment Year Book

(2) Improvement of the Local People's Living Environment

According to the result of the beneficiary survey described in the following table, many citizens are aware that their living environment and the level of their life have been improved

thanks to the enhanced air and water quality in Benxi.

Many respondents especially pointed out “reduction of dirt on clothes” and “reduction of cough and soreness in the eyes” as beneficial effects of the air quality improvement.

Table 12 Public Awareness about Living Environment Improvement

Beneficial effects of air quality improvement [multiple answers]	Total (%)
Reduction of clothing contamination by dust	89.2
Reduction of cough and soreness in the eyes	81.7
Able to hang laundry outside	60.0
No need to use masks and sunglasses for dust protection any more	24.2
Others	0.8

Note: Result of a beneficiary survey conducted during the ex-post evaluation (survey of 120 residents of the city in May 2010)

(3) Improvement of the Level of Life with the Development of Urban Infrastructures

As shown in the following table, over 90% of the citizens are aware of the “qualitative improvement of the life” with the development of city gas and water infrastructures. Especially regarding the water project, the level of satisfaction is high in terms of water supply quantity, water pressure and water quality. Therefore, it is assessed that the level of the public life has improved.

Table 13 Public Awareness about Improvement of Life

(Result of Beneficiary Survey)

Beneficial effects of city gas supply [multiple answers]	Total (%)
Much contributed to the qualitative improvement of life	63.3
Contributed to the qualitative improvement of life	31.7
Did not contribute to the qualitative improvement of life	4.2
Not sure	0.8

Effect of water source relocation and water supply [multiple answers]	Total (%)
Much contributed to the qualitative improvement of life	85.8
Contributed to the qualitative improvement of life	11.7
Did not contribute to the qualitative improvement of life	0.8
Not sure	1.7

Note: Result of a beneficiary survey conducted during the ex-post evaluation (survey of 120 residents of the city in May 2010)

(4) Strengthened Environmental Measures of the City of Benxi

Improvement of equipments in the environment observation center was conducted as one of the subprojects. Therefore, the monitoring ability of the city of Benxi has been enhanced and the municipal government is encouraged to take environmental measures more actively.

Moreover, according to the result of a hearing with the environmental protection agency,

although, right after this project was started, their environmental preservation program[7] was not making much progress due to fund shortage and the air pollution issues were still considered as major issues, 20 projects selected by the agency were later implemented as subprojects of this project. The agency understands that, as a result, these subprojects had good effects and promoted understanding of investment and loan in the environmental field, and therefore helped the subsequent structural enhancement.

3.4.2 Other Impacts

1) Impacts on the Natural Environment

The EIA was ratified before the start of this project, and no negative impact on the natural environment was found, according to the hearing with the environmental protection agency.

2) Land Acquisition and Resettlement

There has been no relocation of residents as planned during the appraisal. On the other hand, 22,000 m^2 of land has been acquired for the Phase I subproject "3) Relocation and Improvement of Benxi Rubber Chemical DMSO Plant" in an industrial area far from residential areas with no problem. Although it was heard that local residents made many complaints about emission gas and wastewater from the plant before the relocation, no such issues were identified in the beneficiary survey conducted after the relocation.

3) Unintended Positive/Negative Impacts

The results of the hearing with the environmental protection agency and the beneficiary survey do not show any issues of noise and vibration.

In light of the above, it is concluded that this project significantly improved the quality of the environment in Benxi and has a positive impact on the daily life of the local residents. Therefore the impact of the project is large.

3.5 Sustainability (Rating: b)

3.5.1 Structural Aspect of Operation and Maintenance

There are a total of 12 executing bodies involved in currently ongoing subprojects and eight of them were privatized during or after construction in connection with the reform of state enterprises. All these privatized companies except the city gas supply company (merged with a Hong Kong capital company), seven companies out of eight, were small-to-midsize material

[7] This municipal program started in the latter half of the ninth five-year plan and the seven-year environmental development plan of the municipal government. The environment protection agency planned as much as 50 environmental development plans but faced severe financial problems. Against the backdrop, the fund pumped into this project at project Phase I accounted for about 40% of total environmental investment in the city.

manufacturers. As a result of efforts for business efficiency improvement (personnel reduction in production departments and increase of professional engineers) to cope with increased competition in domestic and international markets, they have a stronger operation and management structure than assumed. However, some small and medium-sized companies cut back production after the financial crisis in 2008, and the result of the hearing with the officials of the environmental protection agency implies that this trend will continue. Moreover, as for the small and medium-sized companies that are environmentally harmful, the possibility that such companies will be eliminated by political selection is also pointed out.

On the other hand, the two companies that still keep the form of state enterprise are Benxi Iron & Steel Group Co., Ltd. and Beitai Iron & Steel Group Co., Ltd. These companies are major leading companies in the iron manufacturing industry, which support the steady economic growth of Benxi, and do not seem to have any problems as they have taken sufficient measures for operation and management in aspects of organization and human resources. As for the iron manufacturing, as the central government has declared its policy to promote corporate consolidation on a national basis, there may be changed in the management form in the future. However, it is believed that the operation and management structure will not be affected.

In addition, no problem has been observed in the two organizations that belong to the municipal government, the Environment Observation Center and the Benxi Waterworks Department, with a proper operation and management structure constructed under the control of the municipal government. Also in the city gas supply company, a proper operation and management structure has been established under the control the municipal government, so that city gas is supplied in a safe and stable manner.

In light of the above, it is deemed that, although currently there is no problem observed with the operation and management structure, some subproject executing agencies have unstable factors for the future.

3.5.2 Technical Aspects of Operation and Maintenance

As for the subprojects where equipment has been introduced and are in operation, there is no technical problem in particular with the operation and maintenance of such installed facilities and materials. Safety control and staff training about technical matters are given priority especially in gas and water projects, as such projects are highly public and beneficial to a large number of people and therefore safe operation is required.

It is said that small and medium-sized manufacturers pay close attention to daily checks of equipment and actions after checks as the achievement of the target production volume affects business management. Moreover, some companies also actively try to support young engineers, providing technical training on their own.

In light of the above, no problem has been observed in technical aspects.

3.5.3 Financial Aspects of Operation and Maintenance

According to the explanation of the executing agencies, public utility corporations (city gas and water service) and large state-owned corporations do not seem to have any financial problems as they are well managed and have enough funds for operation and management. Small and medium-sized companies that are continuously run in a stable manner are seeking to enhance profit-earning capacity through privatization and loans are properly repaid. However, in response to the tightened environmental standards, some small and medium-sized companies have been already showing a trend toward production reduction, which is an unstable factor about the future company management.

3.5.4 Current Status of Operation and Maintenance

As for the facilities, equipment and materials, there is no problem related to daily operation, maintenance, and actions against failure, trouble and repair. The result of the inspection of each subproject shows that the operation and maintenance of facilities and equipments introduced are generally conducted in a proper manner. In the companies that had malodor or noise issues at the beginning, the conditions have been improved with plant relocation, introduction of enclosed facilities and other measures.

To a question about supply of city gas and water asked as part of the beneficiary survey, the majority of the respondents answered that they are satisfied with the current status and there is no problem with the operation. According to the environmental protection agency, the air quality improvement in Benxi is largely attributed to the introduction of emission gas treatment systems to plants of Benxi Iron & Steel Group and Beitai Iron & Steel Group. It is considered that the proper operation and maintenance of the facilities and equipment introduced through this project contribute to the air quality improvement.

In light of the above, it seems that currently there is no problem with the maintenance of this project in terms of organization, technology and financial status. Though some problems have been observed in terms of future organizational and financial conditions in several subprojects, sustainability of this project is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Although the relevance and effectiveness of this project are high, the project management is difficult with as many as 18 subprojects. Therefore, the efficiency is moderate. As for the sustainability, some subprojects show unstable factors related to the future company management.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agencies

Executing agencies of some subprojects emit pollutants that are very harmful to the environment. Therefore, the environmental protection agency should strengthen monitoring while sharing information with the financial agency so that pollutants can be properly treated in case the business environment should suddenly deteriorate. Moreover, the executing agencies should collect proper information and perform monitoring, because they are required to provide information to JICA based on the viewpoint of General Terms and Conditions Article 6.01 (b), if a target enterprise becomes bankrupt.

4.3 Lessons Learned

In the beginning of this project, it was very difficult to conduct activities in the field of environmental protection sector due to the lack of understanding of the Chinese side about financial input into the environmental sector and enhancement of environmental measures. In this situation, the implementation of this project did not only resolve fund shortage, but promoted understanding about investment and loan in the environmental field and contributed to the enhancement of the implementation system. Promotion of understanding about environmental measures among municipal government officials and company personnel especially accelerated the improvement of environmental measures of the city of Benxi.

Although the environmental measures of the Chinese side did not show much progress, as a result of giving support to the implementation of high-priority subprojects selected by the environment protection agency, the sense of responsibility was increased in the agency and many subprojects have been continued until now despite rapidly changing economic circumstances and environmental policies. Therefore, selecting high-priority subprojects in cooperation with the government of the recipient country (executing agencies) with full understanding of the current status and issues in the target areas and sectors improves the sense of ownership of the recipient country, which then contributes to the improvement of the sustainability of the whole project.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs Phase I 1) Emission gas and wastewater treatment at Benxi electrical equipment plant	① Introduction of electrostatic spraying equipment ② Introduction of wastewater treatment equipment ③ Introduction of desulfurizing and dust collection equipment	Subproject cancelled
2) Converter emission gas control at second plant of Benxi Iron & Steel	① Enclosure of a converter ② Introduction of equipment to treat emission gas when opening and closing ③ Converter gas control ④ Improvement of a primary dust collection system ⑤ New construction of a secondary dust collection system	① Enclosure of a converter ② Introduction of equipment to treat emission gas when opening and closing ③ Converter gas control ④ Improvement of a primary dust collection system ⑤ New construction of a secondary dust collection system
3) Relocation and improvement of DMSO plant of Benxi rubber chemical works	① Relocation of a rubber chemical plant of Benxi (plot area 22,000 m^2, building area 3,791.4 m^2) ② Construction of a DMSO plant with new exhaust and wastewater treatment equipment	① Relocation of a rubber chemical plant of Benxi (plot area 22,000 m^2, building area 3,791.4 m^2) ② Construction of a DMSO plant with new exhaust and wastewater treatment equipment
4) Dust proofing at Benxi cement factory	① Construction of coal silos with dust removal equipment (diameter 15 m x height 30 m, 3 silos)	Subproject cancelled
5) Emission gas and wastewater treatment of W & Mo production process at alloy plant in Benxi	① Introduction of SO_2, HCI, NH_3 and dust treatment equipment ② Introduction of acid and alkaline discharge treatment equipment ③ Conversion of the existing technology for molybdenum refinement	① Introduction of SO_2, HCI, NH_3 and dust treatment equipment ② Introduction of acid and alkaline discharge treatment equipment
6) Emission control of carbide production process at mineral chemistry plant in Benxi	① Semi-enclosure of a carbide furnace ② Introduction of a dust collector ③ Construction of a 10,000 kVA closed carbide furnace	① Semi-enclosure of a carbide furnace ② Introduction of a dust collector ③ Construction of a 12,500 kVA closed carbide furnace
7) Expansion of Environment Observation Center	① Automatic air monitoring system ② Mobile air and water quality monitoring system ③ Automatic monitoring system ④ Regular monitoring system ⑤ Renovation and expansion of the office/auxiliary building	① Automatic air monitoring system ② Mobile air and water quality monitoring system ③ Automatic monitoring system ④ Regular monitoring system ⑤ Renovation and expansion of the office/auxiliary building
8) Utilization of blast furnace gas at steel plant of Beitai Iron & Steel	① Gas boiler ② Single bleeder turbine power generation unit ③ Installation of other related facilities	① Gas boiler ② Single bleeder turbine power generation unit ③ Installation of other related facilities
9) Construction of water intake station	① Construction of a water intake station ② Installation of conductive tubes (double tubes)	① Construction of a water intake station ② Installation of conductive tubes (double tubes)
10) Comprehensive utilization of coal ash	① Introduction of sprinklers ② New construction of a building	① Introduction of sprinklers ② New construction of a building material

	material plant	plant
11) Emission gas and wastewater treatment at copper processing plant in Benxi	① Introduction of emission gas treatment equipment ② Improvement of water purification technologies ③ Introduction of a heat exchanging system and a filter system ④ Improvement of copper foil surface treatment technologies	① Introduction of emission gas treatment equipment ② Improvement of water purification technologies ③ Introduction of a heat exchanging system and a filter system ④ Improvement of copper foil surface treatment technologies
12) Wastewater treatment at pharmaceutical plant in Benxi	① Introduction of an automatic process control system ② Introduction of wastewater treatment facilities ③ Installation of a temperature regulator and a biological treatment facility for yeast production process ④ Deep well aeration ⑤ Construction of a receiving basin, deep well equipment, a biological fluid bed	① Introduction of an automatic process control system ② Introduction of wastewater treatment facilities ③ Installation of a temperature regulator and a biological treatment facility for yeast production process ④ Deep well aeration ⑤ Construction of a receiving basin, deep well equipment, a biological fluid bed
13) Renovation of caustic soda production process at plastic chemical plant in Benxi	① Construction of production equipments with an annual capacity of 20,000 tons ② Updating of a production process (Ion diaphragm method) ③ Introduction of emission gas and wastewater treatment facilities ④ New construction of a secondary salt water purifying facility, pure and salt water chlorine removal system, a water purifying system etc.	① Construction of production equipment with an annual capacity of 20,000 tons ② Updating of a production process (Ion diaphragm method) ③ Introduction of emission gas and wastewater treatment facilities ④ New construction of a secondary salt water purifying facility, pure and salt water chlorine removal system, a water purifying system etc.
Phase II 1) City gas supply Phase 5	① Construction of a coke-oven gas supply station ② Construction of 2 LPG supply stations ③ Gas piping ④ Construction of an LP gas cylinder supply station	① Construction of a coke-oven gas supply station (Gaotaizi liquefied gas process) ② Construction of 2 LPG supply stations ③ Gas piping ④ Construction of an LP gas cylinder supply station
2) Converter emission gas control at Beitai Iron & Steel	① A 50,000 m^3 rubber-sealed dry type gas tank 2 electrostatic converter gas dust collectors ② Construction of an electrostatic dust collection system ③ Construction of a coal gas pressurising station (2 units of gas pressurising equipment) ④ Construction of automatic control gauges ⑤ Construction of compressed slag ball production equipment with a capacity of 20,000 t/year ⑥ Establishment of drum type equipment to steam converter steel slag	① A 50,000 m^3 rubber-sealed dry type gas tank 2 electrostatic converter gas dust collectors ② Construction of an electrostatic dust collection system ③ Construction of a coal gas pressurising station (2 units of gas pressurising equipment) ④ Construction of automatic control gauges ⑤ Construction of compressed slag ball production equipment with a capacity of 20,000 t/year ⑥ Establishment of drum type equipment to steam converter steel slag
3) Pollution control at chemical plant	① Installation of desulfurization equipment at DMDS plant ② Relocation of existing chemical engineering plants to allotted blocks within chemical engineering area (25,000 m^3) ③ Construction of a plant with a new	① Installation of desulfurization equipment at DMDS plant ② Relocation of existing chemical engineering plants to allotted blocks within chemical engineering area (25,000 m^3) ③ Construction of a plant with a new

	production process with wastewater treatment and other environmental protection facilities	production process with wastewater treatment and other environmental protection facilities
4) Pollution control at solvent plant	① Establishment of a soft calcium carbonate plant ② Production process improvement and installation of desulfurization equipment at an anti oxidant plant ③ Installation of a dust collector ④ Installation of a settling basin and other environmental control facilities	① Establishment of a soft calcium carbonate plant ② Production process improvement and installation of desulfurization equipment at an anti oxidant plant ③ Installation of a dust collector ④ Installation of a settling basin and other environmental control facilities
5) Pollution control at lubricant plant	① Improvement of production processes at a molybdenum sulphide plant, a lube oil plant and a grease plant ② Construction of production and auxiliary facilities ③ Construction of environmental protection facilities with Public Construction Commission ④ Installation of environmental control equipment such as SO_2 collecting unit, oil recovery unit and wastewater treatment unit	① Improvement of production processes at a molybdenum sulphide plant, a lube oil plant and a grease plant ② Construction of production and auxiliary facilities ③ Construction of environmental protection facilities with Public Construction Commission ④ Installation of environmental control equipment such as SO_2 collecting unit, oil recovery unit and wastewater treatment unit
6) Taizi River drinking water pollution control	① Purified water supply equipment 80,000 m^3/day ② Distribution pipe network 7 km	① Expansion of a water purifying plant Processing ability: 80,000 m^3/day ② Improvement of distribution pipes Extension length: 10 km
Phase III 1) Beitai Iron & Steel coke oven pollution control	① Construction of coke production facilities (coal preparation, coke production, gas collection and purification system, and wastewater treatment) ② Construction of ancillary facilities including a substation and other production aid facilities and management and environmental improvement facilities (total lot area 261,000 m^3)	① Construction of a coke oven and coke production facilities (coal preparation, coke production, gas collection and purification system, and wastewater treatment) ② Construction of ancillary facilities including a substation and other production aid facilities and management and environmental improvement facilities
2. Project Period	Phase I: Oct 1997 – Dec 2001 (51 months) Phase II: Dec 1998 – Mar 2002 (40 months) Phase III: July 2000 – Mar 2002 (21 months)	Phase I: Oct 1997 – Dec 2002 (63 months) Phase II: Dec 1998 – July 2004 (68 months) Phase III: July 2000 – June 2002 (24 months)
3. Project Cost Amount paid in Foreign Currency Amount paid in Local Currency Total Japanese ODA Loan Portion Exchange Rate	Phase I Foreign Currency: 4,110 million yen Local Currency: 5,808 million yen Total: 9,918 million yen Japanese ODA Loan Portion: 4,110 million yen Exchange Rate: 1 yuan = 12 yen Publication Phase II	Phase I Foreign Currency: 4,058 million yen Local Currency: 5,594 million yen Total: 9,652 million yen Japanese ODA Loan Portion: 4,076 million yen Exchange Rate: 1 yuan = 14.13 yen (Average between 1997 and 2002)

	Foreign Currency: 3,237 million yen Local Currency: 3,327 million yen Total: 6,564 million yen Japanese ODA Loan Portion: 3,237 million yen Exchange Rate: 1 yuan = 12 yen (January 1996) Phase III Foreign Currency: 1,160 million yen Local Currency: 4,202 million yen Total: 5,362 million yen Japanese ODA Loan Portion: 1,160 million yen Exchange Rate: 1 yuan = 12 yen (January 1996)	Phase II Foreign Currency: 3,082 million yen Local Currency: 2,829 million yen Total: 5,916 million yen Japanese ODA Loan Portion: 3,237 million yen Exchange Rate: 1 yuan = 13.93 yen (Average between 1998 and 2004) Phase III Foreign Currency: 1,160 million yen Local Currency: 820 million yen Total: 1,980 million yen Japanese ODA Loan Portion: 1,159 million yen Exchange Rate: 1 yuan = 13.85 yen (Average between 2000 and 2002)

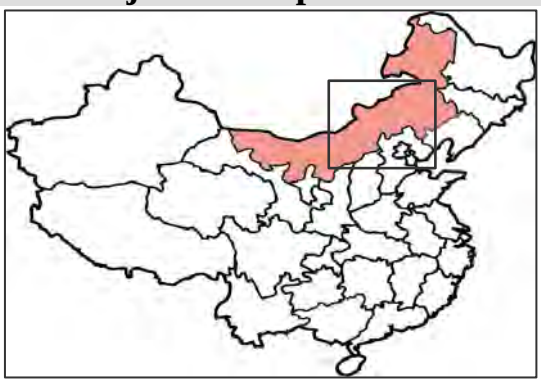
People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

Hohhot and Baotou Environmental Improvement Project (1) (2)

External Evaluator: Jun TOTSUKAWA, Sano Planning Co., Ltd.

1. Project Description



Project Location

Baotou Heat Supply Co.

1.1 Background

In China, while the economy has been rapidly growing since 1980s, air quality in urban areas has been steadily deteriorating due to overdependence on coal for primary energy consumption. Especially with many cases of acid rain damage reported since 1990s, having an equal emphasis on environment and development has become one of the most important tasks for the country.

The cities of Hohhot and Baotou of the Inner Mongolia Autonomous Region, the target areas of this project, are the capital and the biggest industrial city, respectively, of the region. In these cities air pollution has become so serious due to the increasing urban population and industrial development that in early 1990s the dust level (TSP) was 2-4 times higher than the national standard.

As the population and economy of these cities were expected to keep growing, there was a high probability that air pollution would be even more serious with growing demand for coal. Taking effective environmental measures against industrial and domestic emissions was an urgent task.

1.2 Project Outline

To improve air and water quality in the cities of Hohhot and Baotou of the Inner Mongolia Autonomous Region by introducing gas and heating supply facilities with lower environmental impact and contaminant treatment facilities, and therefore to contribute to the improvement of living conditions in these cities.

Approved Amount / Disbursed Amount	10,000 million yen (1), 5,629 million yen (2) / 9,917 million yen (1), 4,987 million yen (2)
Exchange of Notes Date/ Loan Agreement Signing Date	December 1996 (1), September 1997 (2) / December 1996 (1), September 1997 (2)
Terms and Conditions	Interest Rate: 2.1%; Repayment Period: 30 years (Grace Period: 10 years); Conditions for Procurement: General Untied Loan
Borrower/Executing Agencies	The Ministry of Foreign Trade and Economic Cooperation of the People's Republic of China (1) (2) / (1) National Environmental Protection Agency (2) People's Government of Inner Mongolia Autonomous Region
Final Disbursement Date	January 2003 (1), April 2003 (2)
Main Contractor (Over 1 billion yen)	None
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	Conducted SAPROF: Feasibility study was conducted as environmental SAPROF from August 1995 to March 1996.
Related Projects	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Jun TOTSUKAWA, Sano Planning Co., Ltd.

2.2 Duration of Evaluation Study

The ex-post evaluation was conducted in the following periods:

Duration of the Study : December 15, 2009 – October 29, 2010

Duration of the Field study : February 28, 2010 – March 23, 2010

May 6, 2010 – May 29, 2010

2.3 Constraints during the Evaluation Study

Out of the 22 entities that carried out the subprojects of this project, 11 had gone bankrupt or closed up operation by the time of ex-post evaluation. We were not able to collect information about these 11 entities as they had already been reorganized or dissolved. Therefore, for the evaluation of the subprojects these deceased companies were involved in, we used information from former officials of the yen loan office and existing documents.

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

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of China

(1) Policies at the Time of Appraisal

As air pollution caused by coal combustion became very serious, the government of the

city of Hohhot established the “Blue Sky and Green Land Plan” in 1993, with an emphasis on efforts to improve air quality. For comprehensive activities to improve environmental quality, the “Hohhot Comprehensive Urban Environmental Program” was established in 1995 and was considered as an essential part of the city’s policies at the time of appraisal and the start of this project.

Similarly, the city of Baotou, an industrial city, established “Blue Sky, Clean Water and Green Land Plan” for the improvement of environmental quality in its 9th five-year plan (1996-2000), announcing that the city would strengthen efforts for air and water quality improvement, urban greening, and forest and environmental conservation.

As stated above, in mid-1990s these cities presented policies to strengthen efforts for environmental improvement and such activities were considered as part of their important policies. Especially, many of the subprojects composing this project were included as priority projects defined in the environmental protection programs of the cities, which shows that this project was one of the important aspects of the environmental policies of the cities.

(2) Policies at the Time of Ex-Post Evaluation

Compared with the time of appraisal, the environmental quality in Hohhot and Baotou significantly improved at the time of ex-post evaluation. However, environmental improvement is still emphasized as one of the important policy concerns of the municipal governments and the government of the autonomous region.

Currently aiming to be certified as “National Model City for Environmental Protection”, the city of Hohhot mentions “promotion of installation of desulfurization equipment at power plants and such other facilities, control of pollution caused by coal combustion in winter, and improvement of dust control” as special remarks for air pollution measures in its 11th five-year plan for environmental protection (2006-2010). The city of Baotou, also aiming at the same certification of model city for environmental protection, has been tackling concrete goals according to the action plan for contaminant reduction announced in its 11th five-year plan for environmental protection.

As described above, the improvement of environmental quality is still an important task for these cities and the direction of environmental improvement this project aimed at is still highly consistent with the policies of these cities.

3.1.2 Relevance with the Development Needs of China

(1) Development Needs at Project Appraisal

In mid-1990s, air pollution, especially pollution with dust caused by coal combustion, was extremely serious in Hohhot and Baotou and the pollution level was 4.7 times and 2.1 times,

respectively, higher than the Grade 2 standard[1] (daily average TSP value). As further economic growth and urbanization was expected in these cities, the largest economies in Inner Mongolia, air pollution control was an urgent task. Therefore, it is deemed that the aim and details of this project were consistent with the development needs of these cities.

Table 1 Environmental Quality in Hohhot and Baotou (1993)

	Number of days when national ambient air quality Grade 2 standard was achieved (per year)	Average SO_2 concentration on the ground	Average TSP concentration on the ground
Hohhot	Approx. 100 days	0.329 mg/m^3 (1.3 times higher than the national standard)	1.418 mg/m^3 (4.7 times higher than the national standard)
Baotou	Less than 50 days	0.258 mg/m^3 (1.0 time of the national standard)	0.630 mg/m^3 (2.1 times higher than the national standard)

Source: Hearing with Municipal Environmental Protection Agencies of Hohhot and Baotou and data used for JICA appraisal

(2) Development Needs at the Time of Ex-Post Evaluation

Air pollution in these cities has been significantly improved at the time of ex-post evaluation. Considering the fact that in 2009 the air quality in Hohhot and Baotou met the national ambient air quality Grade 2 on 342 days and 309 days (about 100 days and a little less than 50 days in 1993), respectively, the air quality has obviously improved. However, although these cities have achieved the standard, comprehensive air pollution control is still considered as an important task as they barely meet the grade 2 standard on many days and new types of air pollutants that were not considered important, such as NOx contained in automobile exhaust, have been rapidly increasing.

3.1.3 Relevance with Japan's ODA Policy

In 1992 environmental conservation was presented as one of the basic ODA principles in the ODA Charter of the time, and the Japanese government announced that it would significantly expand environmental ODA in the five years from 1992 to 1996.

Moreover, the policy for aid to China of the time included "further consideration of providing aids to inland China" and "provision of aids for air pollution control such as smoke and soot removal and for water pollution control with the use of Japan's experience and technologies in the field of environment".

[1] National standard Grade 1 is for nature preserves, Grade 2 for residential, commercial and general industrial areas, and Grade 3 for specific industrial areas such as heavy industry areas. Therefore, Grade 2 is usually used for evaluation of air quality in urban areas. (From the ambient air quality standard GB3095-1996 of the People's Republic of China)

In light of the above, this environmental improvement development project is deemed to have been consistent with the Japanese aid policy in terms of its contents and areas.

3.1.4 Relevance of the Selection of Subprojects

It is believed that it was foreseeable at the time of appraisal that one of the business entities involved in subprojects (related to Hohhot Wrought Iron Plant) would be eliminated in the near future according to a national policy. This fell in the category of entities of the business scale and contents that were likely to be eliminated in the long to medium terms, and the business actually went bankrupt in the late 2000s[2]. Considering the above, it is "highly probable" that the selection of entities for subprojects was partially inappropriate.

However, the basis of this argument is an evaluation survey conducted in 2009 (by the Sino-Japan Friendship Centre for Environmental Protection) and the exact name of the policy of the time that specified the targets for business closure could not be identified during the ex-post evaluation. Therefore, such inappropriateness of the selection was described as "highly probable". In addition, considering that there was only one business unit that fell into the category of inappropriate selection, we would only like to point out this matter as above and do not consider it as a negative factor to give minus point for the evaluation of relevance.

Considering the above, 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 Efficiency (Rating: a)

3.2.1 Project Outputs

Before evaluating the outputs of this project, we would like to mention the following three major changes from the original plan.

- Project implementation by two-step loans that was originally planned for part of the project has been cancelled. The portion was implemented as subprojects by yen loans. (Phase I subprojects no. 6 to 13 in the following table)
- The subproject for refining of oven gas at the Baotou Iron and Steel Co. was cancelled[3] and the excess funds went to new subprojects. Therefore, additional five subprojects were created in Baotou (Phase II subprojects no. 9 to 13).
- Many companies went bankrupt or stopped operation. (11 entities of the total 22)

[2] There was a government policy to close blast furnaces smaller than 400 m^3, and the size of the furnace at the Hohhot Wrought Iron Plant was about 170 m^3. (Data from the Sino-Japan Friendship Centre for Environmental Protection)

[3] Construction of new coke ovens (No. 6 and 7) planned at the time of appraisal was cancelled due to the government notice to decrease iron production. Therefore, there was no need for the installation of treatment facilities and the implementation of this subproject was cancelled.

The table below shows comparison between planned outputs and actual results of the subprojects and includes costs and periods as well. It also shows ratings of inputs. If change in government policies or other event of force majeure had a negative effect on outputs, such case was not considered as a negative factor for evaluation. Moreover, as there was not enough information about deceased businesses, we only evaluated the subprojects where the target businesses are still operating.

Rating "a" was given if the project cost/period was smaller/shorter than planned (100% or below), "b" if higher/longer than planned (above 100% and below 150% of the plan), and "c" if much higher/longer than planned (above 150% of the plan). (Please see the section of "Input" for the approach to comprehensive evaluation based on these ratings.)

Table 2　Comparison between Original Plan and Actual Outputs and Inputs

Phase I		
1) City Gas Supply in Hohhot (executing body: China City Gas Development Company – former Hohhot Gas Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Construction of gas purification equipment (1 dry desulfurization unit and 1 dehumidifier) ② Laying of distribution pipes in the city 59.6 km ③ Construction of a gas tank (1 tank – 50,000 m^3) ④ Construction of gas pressure regulation stations (4 locations) ⑤ Introduction of an operation management system (SCADA)	Some outputs have changed. (Changes are underlined.) ① Construction of gas purification equipment (1 dry desulfurization unit only. A dehumidifier has not been installed.) *Switched to natural gas in Sep. 2008 ② Laying of distribution pipes in the city 59.6 km ③ Construction of a gas tank (1 tank – 50,000 m^3) ④ Construction of gas pressure regulation stations (4 locations) ⑤ Introduction of an operation management system (SCADA)	*A dehumidifier has not been installed. As the result of detailed study showed the water content in gas was lower than originally expected, it was decided that the introduction of a dehumidifier was not necessary. * Switched to natural gas in Sep. 08 * The project period was extended mainly for design work to respond to changes of dehumidifier installation condition. However, as it was an appropriate and necessary action, it is not considered as a negative factor for the evaluation of the project period. (Thus the evaluation result is described as b→a below. Hereinafter the same.)
Project cost: 54.57 million yuan	Project cost: 40.33 million yuan	(Project cost)　a
Project period: Jan. 1998 – Mar. 2000 (27 months)	Project period: Jan. 1998 – Jul. 2000 (31 months)	(Project period) b→a
2) Heat Supply in Hohhot (executing body: Hohhot Urban Development Investment Management Co., Ltd. – former Hohhot Heat Supply Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Construction of water heating plants (29 MW x 4 units in Northeast Plant and 58 MW x 5 units in Southeast Plant,	Some outputs have changed. (Changes are underlined.) ① Construction of water heating plants (29 MW x 4 units in	* Laying of heat distribution pipes 45 km * Heat exchange stations in 55 locations

total 406 MW) ② Laying of heat distribution pipes 39 km ③ Heat exchange stations in 60 locations ④ Introduction of an operation management system (SCADA)	Northeast Plant and 58 MW x 5 units in Southeast Plant, total 406 MW) ② Laying of heat distribution pipes 45 km ③ Heat exchange stations in 55 locations ④ Introduction of an operation management system (SCADA)	- With changes of urban planning, routes of distribution pipes and locations of stations were changed. * The project period was extended for procurement processes, e.g. many rebidding processes.
Project cost: 610 million yuan	Project cost: 606 million yuan	(Project cost) a
Project period: Jan. 1998 – Mar. 2000 (27 months)	Project period: Apr. 2001 – Dec. 2003 (33 months)	(Project period) b

3) City Gas Supply in Baotou (executing body: Baotou City Gas Co.)

Original Plan	Actual Outputs	Difference and Input Evaluation
① Construction of a gas plant ② Laying of distribution pipes in the city 167 km ③ Construction of gas tanks (100,000 m^3 x 1 unit and 500,000 m^3 x 1 unit) ④ Gas pressure regulation stations 15 units ⑤ Introduction of an operation management system (SCADA)	Some outputs have changed. (Changes are underlined.) ① Construction of a gas plant ② Laying of distribution pipes in the city 133 km ③ Construction of a gas tank (500,000 m^3 x 1 unit only. Another unit – 100,000 m^3 – was not constructed.) ④ Gas pressure regulation stations 15 units ⑤ Introduction of an operation management system (SCADA) ⑥ Construction of heating stations	* Laying of distribution pipes in the city 133 km - With changes of the urban planning, routes of distribution pipes were changed. * Construction of gas tanks (One of the two tanks, a 100,000 m^3 tank, was not constructed.) - Gradual transition to natural gas was decided. * Construction of heating stations
Project cost: 398 million yuan	Project cost: 338 million yuan	(Project cost) a
Project period: Dec. 1997 – Dec. 2001 (49 months)	Project period: Apr. 1999 – Dec. 2002 (45 months)	(Project period) a

4) Heat Supply in Baotou (executing body: Baotou Heat Supply Co.)

Original Plan	Actual Outputs	Difference and Input Evaluation
① Addition of boilers (29 MW x 2 units, and 58 MW x 4 units at Southeast Plant, total 290 MW) ② Laying of heat distribution pipes, primary supply pipes (6 km) and secondary supply pipes ③ Heat exchange stations in 30 locations ④ Introduction of an operation management system (SCADA)	No change in outputs: ① Addition of boilers (29 MW x 2 units, and 58 MW x 4 units at Southeast Plant, total 290 MW) ② Laying of heat distribution pipes, primary supply pipes (6 km) and secondary supply pipes ③ Heat exchange stations in 30 locations ④ Introduction of an operation management system (SCADA)	No change in outputs * As the procurement cost for heat distribution pipes etc. increased, the total project cost became higher than planned.
Project cost: 375.4 million yuan	Project cost: 425.4 million yuan	(Project cost) b

Project period: Sep. 1998 – Dec. 2002 (52 months)	Project period: Jul. 1998 – Oct. 2002 (52 months)	(Project period) a
5) Purchase of Monitoring Equipment in Baotou (executing body: Baotou Municipal Environmental Protection Agency)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Purchase of monitoring equipment	No change in outputs: Monitoring equipment	No change in outputs:
Project cost: 13.4 million yuan	Project cost: 12.49 million yuan	(Project cost) a
Project period: Apr. 1999 – Jul. 2000 (16 months)	Project period: Apr. 1999 – Jun. 2000 (15 months)	(Project period) a
6) Wastewater Treatment at Calcium Carbonate Plant in Hohhot (executing body: Inner Mongolia Sanlian Chemical Industry Co., Ltd. – former Hohhot Chemical Industry)		
Original Plan	Actual Outputs	Difference and Input Evaluation
New construction of a closed furnace	No change in outputs: New construction of a closed carbide furnace	No change in outputs: * Due to the delay of appraisal, the total project period became longer. * As the project period was extended, the procurement cost slightly increased.
Project cost: 58.19 million yuan	Project cost: 61.85 million yuan	(Project cost) b
Project period: Jan. 1999 – Feb. 2002 (38 months)	Project period: May 2000 – Dec. 2003 (44 months)	(Project period) b
7) Wastewater Treatment at Chemical Fiber Plant in Hohhot (executing body: Inner Mongolia Chemical Fiber Plant)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of wastewater treatment equipment	No change in outputs: Installation of wastewater treatment equipment (capacity 4,500 m^3/day)	No change in outputs: Company in bankruptcy
Project cost: 17 million yuan	Project cost: Unknown	
Project period: May 2000 – Jul 2004 (51 months)	Project period: Unknown	
8) Replacement of Boilers at Rubber Chemical Plant in Hohhot (executing body: Hohhot Rubber Plant)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Installation of 3 circulating fluidized bed boilers (20 t/h x 1 boiler and 10 t/h x 2 boilers) ② Generator (1.5 MW turbine generator x 1 unit)	No change in outputs: ① Installation of 3 circulating fluidized bed boilers (20 t/h x 1 boiler and 10 t/h x 2 boilers) ② Generator (1.5 MW turbine generator x 1 unit)	No change in outputs: Company in bankruptcy
Project cost: 15 million yuan	Project cost: Unknown	
Project period: Jan. 1999 – Dec. 2001 (36 months)	Project period: Unknown	

9) Wastewater Treatment at Sugar Factory in Hohhot (executing body: Hohhot Sugar Factory)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of water film dust removers etc. (change of coal combustion method)	Cancelled	Cancelled
Project cost: Unknown		
Project period: Unknown		
10) Treatment of Emission Gas Containing Fluorine from Aluminum Plant in Baotou (executing body: Baotou Aluminum Co., Ltd. – former state-owned Baotou Aluminum Refinery)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Improvement and extension of existing electrolytic cells ② Measures against smoke and dust including installation of bag filters	Some outputs have changed. (Changes are underlined.) ① <u>New</u> installation of electrolytic cells ② Measures against smoke and dust including installation of bag filters	* <u>New</u> installation of electrolytic cells As originally planned extension of existing electrolytic cells was not approved based on a new environmental control standard, new equipment was installed. Since this change was made according to a new environment policy, this extension of project period is not considered as a negative factor.
Project cost: 494.3 million yuan (Budget after redesign)	Project cost: 490 million yuan	(Project cost) a
Project period: Dec. 1999 – Dec. 2000 (13 months)	Project period: May 2001 – Aug. 2002 (16 months)	(Project period) b→a
11) Relocation of Rare Earth Metal Plant in Baotou (executing body: Baotou Rare Earth Metal Plant)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Construction of a new plant with new technologies in the suburbs	Changes in outputs unknown (Company in bankruptcy)	Unknown (bankrupt)
Project cost: Unknown		
Project period: Unknown		
12) Utilization of Coal Ash at First Thermal Power Plant in Baotou (executing body: Baotou First Thermal Power Co., Ltd.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Construction of a brick factory with the use of coal ash	No change in outputs: Construction of a brick factory with the use of coal ash	No change in outputs: * The actual project cost was higher than planned because the procurement cost was estimated low at the time of feasibility study and design. * The project period was extended due to delay of procurement procedures etc.
Project cost: 21.5 million yuan	Project cost: 30 million yuan	(Project cost) b
Project period: May 1999 – Jun. 2001 (26 months)	Project period: Aug. 1999 – Dec. 2002 (41 months)	(Project period) c

13) CO Gas Collection at Ironworks in Baotou (executing body: Baotou Iron and Steel Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of converter emission gas treatment equipment	No change in outputs: Installation of converter emission gas treatment equipment (gas blower pressure regulation system, gas tanks and electric dust collectors)	No change in outputs:
Project cost: 98.92 million yuan	Project cost: 98.92 million yuan	(Project cost) a
Project period: Oct. 1999 – May 2001 (20 months)	Project period: Apr. 1999 – Sep. 2000 (18 months)	(Project period) a
Phase II		
1) Construction of Sewerage Treatment Plant in Baotou (executing body: Baotou Wastewater Industry Co., Ltd. – former Baotou Municipal Engineering Administration Department)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Expansion of a sewerage treatment plant (Sewerage treatment plant in the northern suburbs) 15,000 m^3/day → 70,000 m^3/day ② New construction of sewerage treatment plants (Donghe west sewerage treatment plant) 30,000 m^3/day (Donghe east sewerage treatment plant) 20,000 m^3/day	No change in outputs: ① Expansion of a sewerage treatment plant (Sewerage treatment plant in the northern suburbs) 15,000 m^3/day → 70,000 m^3/day New construction of sewerage treatment plants (Donghe west sewerage treatment plant) 30,000 m^3/day (Donghe east sewerage treatment plant) 20,000 m^3/day	No change in outputs:
Project cost: 268 million yuan	Project cost: 266 million yuan	(Project cost) a
Project period: Nov. 1998 – Sep. 2003 (59 months)	Project period: Nov. 1998 – Jul. 2003 (57 months)	(Project period) a
2) Purification of Coke Oven Gas from Ironworks in Baotou (executing body: Baotou Iron and Steel Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of coke gas purification equipment Purification capacity: 50,000 m^3/hour	Cancelled	Cancelled
Project cost: 408 million yuan		
Project period: Cancellation decided before detailed design		
3) Comprehensive Wastewater Treatment at Ironworks in Baotou (executing body: Baotou Iron & Steel Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Construction of a comprehensive wastewater treatment plant Capacity → 80,000 m^3/hour	Some outputs have changed. (Changes are underlined.) Construction of a comprehensive wastewater treatment plant Capacity → 60,000 m^3/hour	* Construction of a comprehensive wastewater treatment plant Capacity →<u>60,000 m^3/hour</u> - With advances in technology, the quantity of wastewater decreased and the planned capacity was not required any more.

Project cost: 235.92 million yuan	Project cost: 166.6 million yuan	(Project cost) a
Project period: Sep. 2001 – Jun. 2003 (22 months)	Project period: Jul. 2002 – Jun. 2003 (12 months)	(Project period) a
4) Blast Furnace Gas Power Generation at Ironworks in Hohhot (executing body: Wrought Iron Factory in Hohhot)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Installation of gas boilers (10 t/hour x 2 units) ② Installation of turbine generators (1.5 MW x 2 units)	No change in outputs: ① Installation of gas boilers (10 t/hour x 2 units) ② Installation of turbine generators (1.5 MW x 2 units)	No change in outputs: Company in bankruptcy
Project cost: 18.1 million yuan	Project cost: Unknown	
Project period: Oct. 1999 – Nov. 2001 (26 months)	Project period: Unknown	
5) Caustic Soda Production Process Improvement at Chemical Plant in Hohhot (executing body: Inner Mongolia Sanlian Chemical Industry Co., Ltd. – former Hohhot Chemical Industry)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Emission gas and wastewater treatment equipment (From fusion method to ion diaphragm method) ② Installation of cyclone dust collectors and bag filters	No change in outputs: ① Emission gas and wastewater treatment equipment (From fusion method to ion diaphragm method) ② Installation of cyclone dust collectors and bag filters and chlorine leak absorption towers	No change in outputs: * The project cost exceeded the plan due to the increase of procurement cost.
Project cost: 46.24 million yuan	Project cost: 49.87 million yuan	(Project cost) b
Project period: Oct. 1998 – May 2000 (20 months)	Project period: Oct. 1998 – Jan. 2000 (16 months)	(Project period) a
6) Expansion of City Gas Supply in Hohhot (executing body: City Gas Development Co., Ltd. – former Hohhot Gas Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of 7 gas generators (2 for backup) Gas generation capacity 516,000 m^3/day	Cancelled	Cancelled
Project cost: 41.5 million yuan		
Project period: Cancellation decided before detailed design		
7) Comprehensive Utilization of Coal Ash in Hohhot (executing body: Hohhot Purple Sand Pottery Resource Development Co.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Construction of a building material production plant Quantity of wastes (coal ash) used → 12,000 t/year	Changes of outputs unknown (bankrupt)	Unknown (bankrupt)
Project cost: 38.4 million yuan		
Project period: May 1995 – 2002 (month unknown)		

8) Dust Control at Cement Factory in Qingshuihe County, Hohhot (executing body: Cement factory in Qingshuihe County, Hohhot)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of electric dust collectors and bag filters	No change in outputs: Installation of electric dust collectors and bag filters	No change in outputs: Company in bankruptcy
Project cost: 7 million yuan	Project cost: Unknown	
Project period: Mar. 1998 – 2004 (month unknown)	Project period: Unknown	
9) Comprehensive Measures for Heat and Electricity Environment at Baotou Jiujiu Group (executing body: Baotou Jiujiu Group)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of boilers (modification of 3 boilers and new installation of 1 boiler)	Changes of outputs unknown (bankrupt)	Unknown (bankrupt)
Project cost: 44.8 million yuan		
Project period: Nov. 1999 – Dec. 2001 (26 months)		
10) Wastewater Control at Baotou Hefa Rare Earth Refinement Plant in Baotou (Implemented at: Hefa Rare Earth Co., Ltd. – former Baotou Hefa Rare Earth Co., Ltd.)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of ammonium chloride wastewater treatment equipment	No change in outputs: Installation of ammonium chloride wastewater treatment equipment	No change in outputs: * Bidding and other procurement procedures required some time.
Project cost: 29.7 million yuan	Project cost: 28.07 million yuan	(Project cost) a
Project period: Jan. 1999 – Dec. 2001 (36 months)	Project period: Aug. 1999 – Dec. 2002 (41 months)	(Project period) b
11) Comprehensive Environmental Measures at Baotou Yellow River Chemical Industry (executing body: Tomorrow Technology Co., Ltd. – former Yellow River Chemical Industry)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of equipment to treat wastewater containing phenol and acid wastewater	No change in outputs: Installation of equipment to treat wastewater containing phenol and acid wastewater	No change in outputs: Company in bankruptcy (in process)
Project cost: 81.7 million yuan	Project cost: 81.7 million yuan	
Project period: Jul. 1998 - (months unknown)	Project period: Jan. 2003 – Jan. 2005 (25 months)	
12) Emission Gas, Smoke and Wastewater Treatment at Insulation Material Factory in Baotou (executing body: Insulation material factory in Baotou)		
Original Plan	Actual Outputs	Difference and Input Evaluation
Installation of equipment to treat wastewater containing phenol and organic gas	Changes of outputs unknown (bankrupt)	Unknown (bankrupt)
Project cost: 33.2 million yuan		
Project period: Feb. 1999 – May 2001 (28 months)		

13) Comprehensive Environmental Measures at Enamel Plant in Baotou (executing body: Enamel plant in Baotou)		
Original Plan	Actual Outputs	Difference and Input Evaluation
① Installation of a boiler SO_2 control system ② Installation of dust and noise control systems	No change in outputs: ① Installation of a boiler SO_2 control system ② Installation of dust and noise control systems	No change in outputs: Company in bankruptcy
Project cost: 30.5 million yuan	Project cost: Unknown	
Project period: Dec. 2001 – Dec. 2003 (25 months)	Project period: Unknown	

Note: Information in the table (plan, actual results, project cost and project period) is taken from the replies to the questionnaire sent by the ex-post evaluation team and documents of Sino-Japan Friendship Centre for Environmental Protection.

The following factors caused above-described differences between the original plan and the actual result.

- Project details were changed to meet governmental policy changes. (E.g., city gas supply in Hohhot and Baotou – switch from coke gas to natural gas was encouraged.)
- The government introduced new environmental standards. (E.g., treatment of emission gas containing fluorine from an aluminum plant – new facilities were introduced as the originally planned specifications did not meet tightened environmental standards.)
- Layout and scale of necessary facilities were changed to meet changes in urban planning. (E.g., heat supply in Hohhot – changes including re-routing of distribution pipes.)
- Requirements about scale and details of facilities were changed according to the result of detailed study through basic design survey (B/D) and detail design (D/D). (E.g., city gas supply in Hohhot – it was decided dehumidifiers would not be necessary because the water content in gas found out to be lower than expected.)

3.2.2 3.2.2 Project Inputs

3.2.2.1 Project Period

At the time of appraisal, Phase I period was planned to be December 1996 to December 2001 (61 months) and Phase II to be July 1997 to December 2001 (54 months). However, we evaluated the project period only with the ongoing subprojects, as we did for the project cost, as there is not enough information about deceased businesses. 2 points was given to subprojects with rating “a”, 1 point to rating “b” and 0 point to rating “c”. The subprojects whose total score exceeded 80% of the highest score were evaluated as (a), from 50% to 80% as (b), and less than 50% as (c). As a result of calculation based on this, the project period is deemed to be mostly as planned.

Table 3　Evaluation of Project Period

	(a) Same as or shorter than planned [up to 100%]	(b) Longer than planned [above 100% and below 150%]	(c) Much longer than planned [150% or more]	Total	Evaluation
Subproject Quantity	9	3	1	13	
Point	18	3	0	21	81%　= (a)

As for the project period, some subprojects were delayed. In addition to governmental approval processes and procurement, redesign and reinvestigation to respond to new environmental standards introduced by the government and review of urban planning also had influence.

3.2.2.2 Project Cost

The planned and actual costs of this project are as shown in the following table.

Table 4　Comparison of Planned and Actual Project Costs (Unit: million yen)

	Planned Cost		Actual Cost	
	Phase I	Phase II	Phase I	Phase II
Foreign currency (yen loan)	10,000	5,629	9,917	4,987
Domestic currency	7,680	8,761	Unknown	Unknown
Total	17,680	14,390	Unknown	Unknown

Many of the companies involved in this project are now in bankruptcy and the actual cost in the local currency portion is unknown. Therefore, we also evaluated the project cost only with 13 ongoing subprojects. The rating method is the same as the one for project period evaluation described above, and scores were given according to the ratings of subproject cost. (2 points for “a”, 1 point for “b” and 0 point for “c”. The sub-project cost is rated as (a) if the total score exceeds 80% of the highest score, (b) if it is from 50% up to 80%, and (c) if it is less than 50%.) As a result of this calculation, the project cost is deemed to be mostly as planned. The following table shows the rating calculation of sub-projects.

Table 5 Evaluation of Project Cost

	(a) Same as or smaller than planned [up to 100%]	(b) Larger than planned [above 100% and below 150%]	(c) Much larger than planned [150% or more]	Total	Evaluation
Subproject Quantity	9	4	0	13	
Point	18	4	0	22	85% = (a)

For the reasons stated above, both project cost and period are mostly as planned if the scope is limited to the businesses that are still operating; therefore the efficiency of this project is high.

3.3 Effectiveness (Rating: b)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

The achievement level of operation and effect indicators of each project is as shown in the following table.

All the entities that are still operating have achieved the original goals as the facilities and equipment constructed by this project have been effectively utilized. As for the deceased businesses, analysis of the causes will be described later.

The table shows ratings (a, b and c, in the order of highest to lowest) in the right column. Subprojects whose achievement level is 80% or more receive rating “a”, from 50% to 80% “b”, and if the achievement level is less than 50% or the entity is in bankruptcy, the subproject received rating “c”. The ratings are based on the achievement level as of 2009.

Table 6 Targets and Actual Results of Operation and Effect Indicators

Phase I			
Subproject	**Target values (2000)***	**Actual results (2009)**	**Achievement level**
1) City gas supply in Hohhot	Reduction of coal consumption: 59,897 t/year Reduction of SO_2 emission: 2,000 t/year Reduction of TSP emission: 3,007 t/year Gas supply → Supply of 164,000 m^3/day newly created	Reduction of coal consumption: 838,214 t/year Reduction of SO_2 emission: 27,989 t/year Reduction of TSP emission: 42,081 t/year Gas supply: 60,000 m^3/day → 1,156,000 m^3/day	a
2) Heat supply in Hohhot	Reduction of coal consumption: 167,940 t/year Reduction of SO_2 emission: 5,896 t/year Reduction of TSP emission: 9,812 t/year	Reduction of coal consumption: 167,980 t/year Reduction of SO_2 emission: 5,964 t/year Reduction of TSP emission: 9,862 t/year	a

3) City gas supply in Baotou	Reduction of coal consumption: 99,000 t/year Reduction of SO_2 emission: 1,584 t/year Reduction of TSP emission: 3,713 t/year Gas supply → Supply of 146,400 m^3/day newly created	Reduction of coal consumption: 424,914 t/year Reduction of SO_2 emission: 14,061 t/year Reduction of TSP emission: 150,141 t/year Gas supply → Supply of 547,900 m^3/day newly created	a
4) Heat supply in Baotou	Reduction of coal consumption: 56,042 t/year Reduction of SO_2 emission: 1,062 t/year Reduction of TSP emission: 4,206 t/year	Reduction of coal consumption: 67,795 t/year Reduction of SO_2 emission: 1,285 t/year Reduction of TSP emission: 5,088 t/year	a
5) Purchase of monitoring equipment in Baotou	More than 150 items can be monitored.	More than 200 items can be monitored.	a
6) Wastewater treatment at calcium carbonate plant in Hohhot	TSP: 1,805 t/year → 435 t/year CO: 9,460 t/year → 0 t/year	TSP: 31 t/year CO: 0 t/year	a
7) Wastewater treatment at chemical fiber plant in Hohhot	COD: 235 → 120 mg/L S2-: 2.4 → 1 mg/L Zn2＋: 27 → 3.2 mg/L	Bankrupt	c
8) Replacement of boilers at rubber chemical plant in Hohhot	SO_2: 1,031 → 237 mg/Nm^3 TSP: 5,835 → 225 mg/Nm^3	Bankrupt	c
9) Wastewater treatment at sugar factory in Hohhot	TSP: 879 → 250 mg/Nm^3 COD: 6,837 → 6,000 mg/L BOD: 3,026 → 3,000 mg/L SS: 2,815 → 312 mg/L	Cancelled	-
10) Treatment of emission gas containing fluorine from aluminum plant in Baotou	TSP: 3,303 → 494 kg/year Fluorinated compounds: 480 → 85 t/year	TSP: 145 kg/year Fluorinated compounds: 48 t/year	a
11) Relocation of rare earth metal plant in Baotou	SO3: 13,000 → 0 mg/Nm^3 Chlorine: 2,420 → 480 mg/Nm^3 Hydrogen fluoride: 520 → 10mg/L	Bankrupt	c
12) Utilization of coal ash at First Thermal Power Plant in Baotou	Utilization of wastes (coal ash): 50,000 t/year	Utilization of wastes (coal ash): 55,000 t/year	a
13) CO gas collection at ironworks in Baotou	TSP: 100 →10 mg/Nm^3 CO: 160,000 t/year → 0 t/year	TSP: 10 mg/Nm^3 or lower CO: 0 t/year	a

Note: The year for the base data described in the columns for targets (to the left of the arrow) in the columns of targets is unknown. (This table contains data from 1996 summary of appraisal items, but the summary does not specify the years.)

Phase II			
Subproject	**Target values (2000)***	**Actual results (2009)**	**Achievement level**
1) Construction of sewerage treatment plant in Baotou	① Expansion of a sewerage plant (Sewerage plant in the northern suburbs) 15,000 m^3/day → 70,000 m^3/day ② New construction of sewerage plants (Donghe west sewerage treatment plant) 30,000 m^3/day (Donghe east sewerage treatment plant) 20,000 m^3/day	① Expansion of a sewerage plant (Sewerage plant in the northern suburbs) 15,000 m^3/day → 70,000 m^3/day ② New construction of sewerage plants (Donghe west sewerage treatment plant) 30,000 m^3/day (Donghe east sewerage treatment plant) 20,000 m^3/day ③ COD: 200 mg/L → 50 mg/L (National standard Grade 2 achieved)	a
2) Purification of coke oven gas from ironworks in Baotou	Installation of coke oven gas purification equipment Purification capacity: 50,000 m^3/hour	Cancelled	-
3) Comprehensive wastewater treatment at ironworks in Baotou	Construction of a comprehensive wastewater treatment plant Treatment capacity: 80,000 m^3/hour	Construction of a comprehensive wastewater treatment plant Treatment capacity: <u>60,000 m^3/hour</u> - As the scale of the wastewater treatment plant was reduced according to the needs, the planned capacity was modified at the time of basic design. The plant was constructed according to the modified plan; therefore this is not considered as a negative factor for achievement evaluation.	b → a
4) Blast furnace gas power generation at ironworks in Hohhot	No concrete target specified	Bankrupt	c
5) Caustic soda production process improvement at chemical plant in Hohhot	Reduction of coal consumption: 10,000 t/year	Reduction of coal consumption: 10,000 t/year - Coal consumption reduced to 1/5	a
6) Expansion of city gas supply in Hohhot	Installation of 7 gas generators (2 for backup) Gas generation capacity: 516,000 m^3/day	Cancelled	-
7) Comprehensive utilization of coal ash in Hohhot	Construction of a building material plant Quantity of wastes (coal ash) used: 12,000 t/year	Bankrupt	c
8) Dust control at cement factory in Qingshuihe County, Hohhot	No concrete target specified	Bankrupt	c

9) Comprehensive measures for heat and electricity environment at Baotou Jiujiu Group	No concrete target specified	Bankrupt	c
10) Wastewater control at Baotou Hefa Rare Earth Refinement Plant in Baotou	No concrete target specified	NH3-N: 25mg/L National industrial wastewater standard achieved - The standard was not met before the implementation of this project, but it has been achieved now. Therefore the achievement level is evaluated as “a”.	a
11) Comprehensive environmental measures at Baotou Yellow River Chemical Industry	No concrete target specified	Bankrupt (in process)	c
12) Emission gas, smoke and wastewater treatment at insulation material factory in Baotou	No concrete target specified	Bankrupt	c
13) Comprehensive environmental measures at enamel plant in Baotou	No concrete target specified	Bankrupt	c

For evaluation of effectiveness, total rating is given based on the total scores of subprojects. 2 points is given for “a”, 1 point for “b” and 0 point for “c”. Then the project is evaluated as (a) if the total score exceeds 80% of the highest score, (b) if it is between 50% and 80%, and (c) if it is less than 50%. The evaluation result based on this method is as seen in the following table. As the total score is 56% of the highest score, the effectiveness of this project is evaluated as (b).

Table 7　Evaluation of Operation and Effect Indicators

	Rating (a) Achievement level over 80%	Rating (b) Achievement level 50% to 80%	Rating (c) Achievement level less than 50% or the company is in bankruptcy	Cancelled (-)	Total
Subproject Quantity	13	0	10	3	23
Point	26	0	0	—	26 (56% of the highest score 46 points)

Note: The three cancelled subprojects are not included in the total evaluation.

One of the characteristics of the effectiveness of this project is that many of the companies involved have gone bankrupt. Therefore, the total effectiveness is evaluated to be moderate although all the companies that are still operating have produced results exceeding targets.

[Deceased companies]

The background factors behind these bankruptcies were two major policies of the Chinese government, "reform of state enterprises" and "promotion of shakeout of companies with high environmental load (low productivity)".

The first policy, "reform of state enterprises", was quickly spread across the country with backing from the "Report on Ownership Reform of State-Owned Enterprises"[4] etc. It also happened in the Inner Mongolia. According to the "Progress Report on Restructuring the Economic System in the Autonomous Region" by the Economic Development Committee of the Inner Mongolia Autonomous Region, "ownership reform of enterprises owned by the autonomous region or the state have been progressing smoothly since the start in 2003, (snip) pending issues regarding 10 enterprises are expected to be solved by the end of the year". Although it is unknown how many state-owned enterprises in Inner Mongolia that were reorganized in the 4-5 years of the time, the report shows that the reform of state enterprises had been rapidly carried out during those 4-5 years.

Moreover, for the "promotion of shakeout of companies with high environmental load", the "Implementation Plan for the Shakeout of Companies with High Environmental Load in Inner Mongolia" was also established according to the 11th five-year plan, presenting the plan to "eliminate companies with a low production capacity and high environmental load" in 10 industries including cement, cokes, iron alloy and carbide industries in the autonomous region". As a result, many businesses have been eliminated as shown in the following table.

Table 8　Number of Companies Eliminated in Inner Mongolia according to the Company Shakeout Plan (2003-2007)

Industry	Iron and steel	Carbide	Cement	Coke refinement
Number of companies eliminated	57	5	17	75

Source: Inner Mongolia Development and Reform Commission and International Coal Network

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

Financial Internal Rate of Return (FIRR) was calculated for Hohhot and Baotou city gas supply subprojects and Hohhot and Baotou heat supply subprojects at the time of appraisal. However, we cannot calculate FIRR for the gas supply subprojects at the time of this ex-post

[4] Report by the State-owned Assets Supervision and Administration Commission of the State Council (November 2003)

evaluation, because, unlike the original plan, natural gas is now fully used instead of coke gas, and the basis for the calculation is totally different.

Moreover, the benefits of the heat supply subprojects cannot be identified, either, because the boilers installed through this project are now used with other boilers with higher heat efficiency that have been installed separately from this project in response to recent jumps in electricity and other material prices. Therefore, FIRR is not calculated in this evaluation.

Economic Internal Rate of Return (EIRR) was not calculated at the time of project appraisal and therefore the comparison of similar benefit indicators is not possible. Although we tried to use the data of reduction of patients with bronchial diseases, as an indicator to show the benefit of air quality improvement, EIRR calculation is difficult as data of the time cannot be obtained. Therefore, EIRR is not calculated in this evaluation.

3.3.2 Qualitative Effects

The primary qualitative effect of this project is that "the local people has become aware of the improvement of environmental quality and are now able to have comfortable daily lives". The result of the beneficiary survey (Hohhot) also shows that 75% of the residents were aware of the improvement of environmental quality and many said that they "do not use antidust masks in everyday life as often as before". This can be seen not only in the beneficiary survey result but in the "Survey of Satisfaction of Residents with Environment", conducted by the Chinese government on its own.

Such benefits have been produced through effective cooperation and complementary relationship between this project and the efforts for environmental improvement that the Chinese government has been making on its own. Therefore, these effects were not brought about by this project alone, but we would like to add that the general contribution of this project is deemed to be significant.

Table 9 Residents' Recognition of Air Quality Improvement

(Beneficiary survey result)

Change in air quality (in comparison with 10 years ago)	Total (%)
Improved very much	36
Rather improved	39
Not changed much	7
Rather deteriorated	13
Deteriorated very much	5

Beneficial effects pointed out by the respondents who selected "improved" or "generally improved" [multiple answers allowed]	Total (%)
Reduction of clothing contamination by dust	55
Able to hang laundry outside	56
No need to use masks and sunglasses for dust protection any more	60
Reduction of cough and soreness in the eyes	47
Other	5

Note: Result of a beneficiary survey conducted during the ex-post evaluation (survey of 100 residents of the city in April 2010)

Table 10 Result of Survey on Residents' Satisfaction with Environment
(Rate of respondents who answered "satisfied": %)
(Conducted by the Chinese government)

		2006	2007	2008
Hohhot	Air quality	79.4	70.4	86.5
	Water quality	80.9	73.1	87.9
Baotou	Air quality	72.0	79.4	81.2
	Water quality	71.3	80.8	81.5

Source: Survey on Residents' Satisfaction with Environment[5], conducted by the Chinese government

In light of the above, this project has somewhat achieved its objectives, therefore its effectiveness is fair..

3.4 Impact

3.4.1 Intended Impacts

The implementation of this project has the following impacts.

(1) Improvement of Air Quality in Both Cities

As seen in the table below, the air quality in Hohhot and Baotou has significantly improved since the implementation of this project. This is a synergetic effect of the implementation of this project and various other environmental projects and regulations that the Chinese government has been enforcing and promoting[6].

The ratio of investment amounts is one of the factors that imply the significance of the role of this project. For example, the investment amount for the subprojects of this project accounts for about 28% of the total investment amount for major projects for "urban environmental infrastructures and pollution source control" defined in the Hohhot 10th five-year plan (2000-2005).[7] Although the investment amount is not directly linked with environmental effect, the significance of the role/influence of this project is inferable.

[5] Survey on the residents' awareness conducted in selected major cities. Hohhot and Baotou have been covered since 2006. However, the number of samples is unknown.
[6] Neither of the cities received aids in the environmental field from other donors during the period of this project.
[7] The predicted SO_2 reduction caused by the subprojects of this project accounts for about 16% of the total amount of SO_2 reduction predicted. Electric power plants emit a particularly large amount of SO_2. Therefore, this project, which does not have subproject directly involved with electric power plants, has a slightly smaller impact on the reduction of SO_2 emission.

Table 11　Indicators of Air Quality in Hohhot

Indicator (unit)	Base value at the time of appraisal (1993)	Original target (2000 target)	Actual result (2008)
・ Total SO_2 emission (t) ・ Average SO_2 concentration on the ground (mg/Nm^3) ・ Total TSP emission (t) ・ Average TSP concentration on the ground (mg/Nm^3)	52,500 0.110 72,240 0.421	56,872 0.128 81,661 0.444	94,800 0.049 21,976 0.364 (2006)
・ Number of days national air quality standard Grade 2 was achieved (per year)	Approx. 100	-	342 (2009)

Source: Hohhot Municipal Environmental Protection Agency
Note: SO_2 emission has largely increased due to the construction of a power plant in the suburbs of Hohhot. However, as it is in the suburbs, the SO_2 concentrate measured at monitoring points in the city is not affected so much.

Table 12　Air Quality Indicators in Baotou

Indicator (unit)	Base value (1993)	Predicted value (2000)	Actual value (2008)
・ Average SO_2 concentration on the ground (mg/Nm^3) ・ Average TSP concentration on the ground (mg/Nm^3)	0.110 0.421	0.128 0.444	- -
・ Number of days national air quality standard Grade 2 was achieved (per year)	Less than 50		309 (2009)

Source: Website of China Information Statistics and Baotou Municipal Environmental Protection Agency
Note: We were not able to obtain data of environmental indicators (SO_2 and TSP) of Baotou because Baotou Environmental Protection Agency did not disclose the information.

(2)　Improvement of Infrastructures

The gas and heat supplied population is significantly larger than originally planned and it contributes the improvement of the local people's lives. Moreover, it is said that the infrastructures for stable supply of gas and heat have increased the values in the real estate market, especially in the new urban development districts[8].

Table 13　Changes in the Number of Households Supplied with Gas through Hohhot and Baotou Gas Supply Subprojects

	1998	2009
Hohhot gas supply subproject	70,000	313,000
Baotou gas supply subproject	57,000	140,000

Source: Responses to questionnaire

[8] From the responds to the questionnaire of Hohhot Heat Supply Co. and Baotou Gas Co.

(3) Decrease of Respiratory Diseases

Although it was expected at the time of project appraisal that this project would contribute to the decrease of respiratory diseases, it is difficult to determine the causal link with this project. However, 1/3 of the respondents to the beneficiary survey said respiratory diseases “have decreased”. Therefore, the local people are aware that this project has a positive impact.

3.4.2 Other Impacts

There has been no relocation of residents for the implementation of this project. As for the land acquisition, land for heat exchange stations (55 locations in Hohhot and 30 locations in Baotou) for heat supply subprojects and land for a new sewerage treatment plant for the subproject for the construction of a sewerage treatment plant in Baotou have been acquired. However, there has been no particular problem with such land acquisition and there is no negative impact.

In light of the above, this project has significantly improved the environmental quality of the cities of Hohhot and Baotou and has a positive impact on the daily life and infrastructures of the local residents. Therefore the impact of this project is large.

3.5 Sustainability (Rating: b)

3.5.1 Structural Aspects of Operation and Maintenance

It is deemed that the business units that are currently operating have certain sustainability in terms of the operation and maintenance system. Many businesses including state enterprises have enhanced the operation system in the last 10 years in the 2000s. This is as a result of the improvement of the organizational structure that has been achieved through 1) downsizing related to the reform of state enterprises (e.g., reduction of the employees of Baotou Iron and Steel to 2/3), 2) consolidation with a Hong Kong company (e.g., Hohhot gas co. – strengthening of the management structure), 3) merger and acquisition by major companies (e.g. Hohhot Chemical Industry and Hefa Rare Earth – instruction and supervision on the management structure by the parent companies) etc.

Moreover, along with changes in the structure, many businesses have also established a comprehensive structure for efficient operation and maintenance covering matters that have not been emphasized before, e.g., a customer service system and a system of security for accountability to outside parties.

3.5.2 Technical Aspects of Operation and Maintenance

For the implementation of this project, all companies provided special technical training to ensure appropriate operation of the new facilities and equipment. After the start of operation,

opportunities like technical training in each company and technology exchange meetings held by the national society of engineers and such other organizations have been positively utilized; therefore, technological sustainability is deemed to be almost assured.

For example, in the case of the Baotou sewerage treatment subproject, some engineers were sent to a wastewater technology school in Baotou for two years and the operation started mainly by the engineers who had completed the course. After that, training is provided to about 40 engineers every year in major cities in the country (such as Shanghai, Tianjin and Suzhou) and the central government has accredited the organization with "Urban Wastewater Control Certificate Class A". (Only a small number of organizations in the country have Class A certification.)

3.5.3 Financial Aspects of Operation and Maintenance

Before discussing the financial sustainability of this project, we will analyze the going business entities in the following categories.

Table 14 Categories of Going Business Entities

Category of businesses		Name
Highly public enterprises		Heat supply companies, gas companies
Commercial enterprises	Medium-scale	Inner Mongolia Sanlian Chemical Industry, Baotou Hefa Rare Earth
	Large-scale	Baotou Iron and Steel, Baotou Aluminum Co., Ltd, First Thermal Power Co., Ltd.

The highly public enterprises are actually under severe financial condition by their lower profitable business-model on their primary business field, especially heat supply companies. Revenue from heat supply cannot cover the surging material costs and such companies are actually run with financial support from the municipal government. However, the sustainability of these enterprises can be regarded to be high to some extent because such financial support from the municipal government is almost ensured. By contrast, gas companies have been financially healthy in gradual manner with the backing of policies such as the recent decision on mandate use of natural gas for public transportation.

On the other hand, large-scale commercial enterprises have already conducted streamlining of the organization and the financial conditions relating to operation and maintenance have been stable. It is difficult to determine the medium- to long-term stability of medium-scale commercial enterprises because of tough competition of products, carbides and caustic soda as well as large market price movements.

3.5.4 Current Status of Operation and Maintenance

Each company has conducted operation and maintenance of facilities and equipment by appointed engineers according to an annual maintenance plan with almost no problem.

On the other hand, some of the facilities and equipment that have been installed through this project are not in use or not likely to be used in the future, due to recent changes in environmental policies and standards. (Hohhot Gas Co.: there is no need to use the dry desulfurization unit because of the switch to natural gas, Baotou Heat Supply Co.: boilers may not be used in the future because the switch to cogeneration is now considered.)

However, except the above-mentioned facilities, most of the facilities will be continuously utilized and necessary maintenance including replacement of parts of facilities and equipment are likely to be conducted. For example, as a result of the field survey of the ex-post evaluation, it was confirmed that parts for an electrolytic cell (approx. 6 million yen) had been replaced according to the regulation in a manual.

As stated above, high sustainability can be seen in terms of organization, technology and finance of the going businesses. However, there are a total of 11 deceased entities; therefore such deceased companies are considered as a negative factor for the overall evaluation of sustainability.

Therefore, though some problems have been observed in terms of maintenance, sustainability of this project is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

With a major purpose of improving air and water quality in the cities of Hohhot and Baotou, Inner Mongolia, this project meets the needs of these cities and has been producing significant environmental effects through complementary relationship with various efforts of the Chinese government. As a result, the environmental quality in these cities has significantly improved. However, there have been some cases where expected effects did not last long, e.g., 11 business units out of 22 that conducted subproject of this project have gone bankrupt, mainly due to reformation of state-owned enterprises that was promoted in parallel with the country's rapid economic growth.

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

4.2 Recommendations

4.2.1 Recommendations for Executing Agencies

The Chinese government has indicated its intention to continue to reorganize or eliminate companies with high environmental load according to the company scale and other criteria. As

this policy might affect some of the companies involved in subprojects, the financial departments of the cities have to constantly monitor such movements. Moreover, executing agencies need to collect appropriate information and conduct monitoring as they need to provide information to JICA as stipulated under the article 6.01 (d) of the General Terms and Conditions in case the business goes bankrupt and sells facilities and equipment installed through this project.

4.2.2 Recommendations to JICA

In order to ensure compliance with the above-mentioned Article 6.01 of the GTC, JICA should keep communication at periodic intervals with the current contacts of the cities, the financial departments.

4.3 Lessons Learned

(1) In case of provision of support for environmental pollution control, the project sustainability will become higher if support is provided to the sectors related to highly sustainable public infrastructures. It is highly possible that, for financial reasons, commercial enterprises with environmental load cannot respond to slight changes in the national environmental policy and such companies are quite likely to be forcibly eliminated under the political system of China.

(2) As the offices that had been promoting project implementation (such as the yen loan office) was closed after the project completion, communication between JICA and executing agencies has become generally more difficult than during the project period. There is rather a high possibility that the structure and status of implementing business units will change in a project like this one, which is in the middle of dramatic changes in environmental policies. Therefore, it is important to maintain the same system and frequency of communication between two parties for a certain period after project completion so that the both parties will collect information and properly deal with it.

(3) When evaluating this project, which consisted of multiple subprojects, we found out that effect/operation indicators for the overall evaluation had not been set properly. Thus we evaluated the whole project with the sum of the scores of individual subprojects, but this method might be easily affected by the score scales. Although there should be some room left for slight changes to meet characteristics of individual projects, it is important to establish a uniform evaluation method.

Comparison of the Original and Actual Scope

Item	Original	Actual
1.Project Outputs	See Table 2 above	See Table 2 above
2.Project Period	Phase I Dec. 1996 – Dec. 2001 (61 months) Phase II Jul. 1997 – Dec. 2001 (54 months)	Jan. 1998 – Dec. 2003 (excluding subprojects for deceased businesses) Oct. 1998 – Jul. 2003 (excluding subprojects for deceased businesses)
3.Project Cost Amount paid in Foreign currency	Phase I 10,000 million yen Phase II 5,629 million yen	Phase I 9,917 million yen Phase II 4,987 million yen
Amount paid in Local currency	Phase I 7,680 million yen (Note 1) Phase II 8,761 million yen (Note 2) (Local currency) Phase I 640 million yuan Phase II 645 million yuan	Phase I 20,324 million yen (Note 3) Phase II 2,354 million yen (Local currency) Phase I 1,412 million yuan Phase II 163 million yuan
Total	Phase I 17,680 million yen Phase II 14,390 million yen	Phase I 30,241 million yen (Note 4) Phase II 7,339 million yen (excluding cost in subprojects for deceased businesses, for figures other than foreign currency)
Japanese ODA loan portion	Phase I 10,000 million yen Phase II 5,629 million yen	Phase I 9,917 million yen Phase II 4,987 million yen
Exchange rate	1 yuan = 12.00 yen (1996) 1 yuan = 13.60 yen (1997)	1 yuan = 14.38 yen (1998-2003 average)

Notes 1 and 2: Amount excluding project cost in local currency for two-step loans

Note 3: Amount including project cost in local currency for two-step loans. Two-step loans were planned for more than half of the subprojects, 8 subprojects out of 13. The total cost for Phase I shown in this table is larger than the plan because one of the Phase II subprojects (purification of coke oven gas from ironworks in Baotou – budget 5,948 million yen) was cancelled after the project appraisal and the budget was switched to a Phase I project (treatment of emission gas containing fluorine from an aluminum plant in Baotou) and for other reasons.

Note 4: The cost in local currency increased as described in Note 3; therefore the total amount also increased.

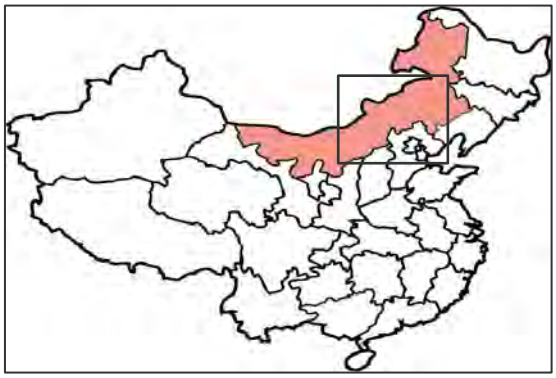
People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

Hohhot Water Supply Project

External Evaluator: Jun TOTSUKAWA, Sano Planning Co., Ltd.

1. Project Description



Project Location

Jinhe Water Purifying Plant

1.1 Background

With accelerated urbanization in China that started in 1990s, the rate of urban population in the city of Hohhot, the capital of the Inner Mongolian Autonomous Region, grew from approx. 35% in the late 1980s to 42% (810,000 people) in 1995.

At that time it was expected that, with such population growth in urban areas, the living standards of local individuals would improve and industrial areas would expand, and therefore the water demand in the city would increase. However, groundwater was the only source for water supply in the city and it would be difficult to meet such increasing water demand only with groundwater. Thus there was a concern that there would be severe water shortage in the long- and medium-term unless the city considered the use of other water sources.

In this situation, the city of Hohhot decided to carry out this project to increase the water supply capacity to meet the water demand through the construction of facilities to convey water from the Huang He River, which was approx. 80 km away from the city center, and also to promote long-term and stable use of groundwater sources.

1.2 Project Outline

In the city of Hohhot, Inner Mongolia, to ease the threatening water demand through the construction of water supply facilities that would use water from the Huang He River, and thus cope with the future increase of water demand and prevent groundwater level recession.

Approved Amount / Disbursed Amount	5,446 million yen / 5,426 million yen
Exchange of Notes Date / Loan Agreement Signing Date	December, 1996 / December, 1996
Terms and Conditions	Interest Rate: 2.1%; Repayment Period: 30 years (Grace Period: 10 years); Conditions for Procurement: General Untied Loan
Borrower / Executing Agencies	The Ministry of Foreign Trade and Economic Cooperation of the People's Republic of China (1) (2) / Ministry of Construction
Final Disbursement Date	September, 2002
Main Contractor (Over 1 billion yen)	TIANJIN MACHINERY IMPORT & EXPORT CORPORATION (China)
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	Inner Mongolian Water Resources and Hydropower Survey and Design Institute, North China Municipal Engineering Design & Research Institute, Hohhot Municipal Engineering Design Institute (1993)
Related Projects	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Jun TOTSUKAWA, Sano Planning Co., Ltd.

2.2 Duration of Evaluation Study

The ex-post evaluation was conducted in the following periods:

Duration of the Study: December 15, 2009－October 29, 2010

Duration of the Field Study: February 28, 2010－March 23, 2010

May 6, 2010－May 29, 2010

2.3 Constraints during the Evaluation Study

None

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

3.1 Relevance (Rating: a)

3.1.1 Relevance with Development Plan of Country People's Republic of China

Around the time of the start of this project, the Chinese government declared in its 9th five-year plan (1996-2000) a policy of strong promotion of water source development and water conservation activities to meet the rapidly increasing water demand in the country. The Inner Mongolia government also announced in its 9th five-year plan and the Inner Mongolia 15-year plan (1996-2010) an important policy objective of water conveyance from the Huang He River to secure long-term stable water supply in Hohhot.

When the ex-post evaluation is conducted in 2010, the above-mentioned Inner Mongolia 15-year plan is in the final phase. Stable water supply measures based on a long-term standpoint is still considered as an important policy objective of Hohhot and will remain in the next 15-year plan. This project is also described in the economic and social development master plan (1996-2010), which is the basis of the development planning of the city, as one of the most important projects to realize the city's policy in the water sector, "conservation of water resources, control of groundwater withdrawal, and appropriate use of water from the Huang He River".

In light of the above, the relevance of this project with government policies is deemed high both at appraisal and ex-post evaluation.

3.1.2 Relevance with Development Needs of Country People's Republic of China

(1) Development Needs at Project Appraisal

Needs related to Water Demand

When the appraisal of this project was conducted in the middle of 1990s, Hohhot was one of the 122 cities of high urgency out of 260 cities in China that were experiencing water supply shortage. The forecast of water demand in Hohhot at that time pointed out that the city would face a serious water supply shortage, as much as 600,000 m^3 a day, unless some measures were taken. Thus this water supply project with the use of water from the Huang He River met the city's urgent development needs of the time.

Needs related to Control of Excessive Pumping and Prevention of Groundwater Level Recession

At that time the city of Hohhot depended on groundwater for all the water supply in the city and excessive pumping caused ground water level recession. The ground water level lowered an accumulated total of 56 m from 1976 to 1999, and it was an urgent task to properly control the volume of groundwater withdrawal and secure alternative water sources. Moreover, ground subsidence in some areas was already reported. Thus, this project to use surface water was expected to bring about a significant effect to prevent groundwater level recession and therefore is deemed to have met the needs of the city.

(2) Development Needs at Ex-post Evaluation

On the other hand, looking at the needs from the launch of this project to the ex-post evaluation period, it does not seem for this project to have meet the "needs of water demand" as much as originally expected. This is confirmed by the fact that the actual water demand did not grow as much as forecasted at appraisal and the water demand in the city is basically met in 2010 although the quantity of water intake has reached only half of the quantity originally

planned. (See the section of effectiveness.) In other words, although there were certainly needs to fill the gap of water demand at the time of appraisal, the project did not directly give effects on reduction of the water demand's gap.

However, we would rather stress that this project has largely contributed to stabilizing water supply in Hohhot from a long-term viewpoint, that is, to preventing excess water pumping and establishing a more sustainable system to supply groundwater together with surface water. (This is where apparent success has been achieved. Please see the section of effectiveness again.) It is true that the city of Hohhot has been overly dependent on groundwater for many years, and, from this viewpoint, this project is still addressing the needs to "control excess pumping". Therefore we can say that this project has been responding to the development needs of the city.

3.1.3 Relevance with Japan's ODA Policy

In the ODA Charter of 1992, environmental conservation including water supply projects was presented as one of the fundamental ODA principles. The Japanese government also externally announced in the United Nation and on such other occasions that the country would substantially expand environmental ODA in the 5 years from 1992 to 1996.

Japan's assistance policy for China in those days also placed the following as key issues: "to provide assistance that will contribute to economic infrastructure development mainly in the form of loan assistance" and "to pay more attention to the assistance for inland regions where the development needs is relatively large".

In light of the above, this waterworks development project is deemed to have been relevance with the Japanese aid policy in terms of its contents and areas.

For the reasons stated above, 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 Efficiency (Rating: b)

3.2.1 Project Outputs

This project is to develop water supply facilities including water intake and conveyance facilities on the bank of the Huang He River, approx. 80km away from the center of Hohhot, a water purifying plant, and networks of intake pipes and aqueducts pipes for water supply.

When verifying the outputs of this project, it is particularly worth noting that the construction of this project was conducted in two separate periods, Phase I and Phase II. As shown in the section of "Project Period" below, although Phase I construction progressed as planned, Phase II construction has been progressing very slowly and some facilities had not

been completed yet at the time of the ex-post evaluation.

[Comparison of Plan and Actual Result]

The table below shows the comparison of the contents planned at the time of appraisal and the actual results that have been produced so far.

Although the progress has been slow, there has been no change or reduction/scaling-down of the planned contents except the 5th item in the following table, consulting service. The plan of the consulting service was changed after the appraisal according to the decision of Chinese and Japanese parties that a Chinese consulting firm with an established reputation, "Lanzhou China Municipal Engineering Institute", could handle technical matters. (The consulting firm provided consulting service for the selection of equipment to be procured.)

Table 1 Comparison of Original Plan and Actual Outputs

Original Plan	Actual Outputs		Portion of Completed/Uncompleted (As of May 2010)
	Phase I	Phase II	
(1) Construction of Water Conveyance Facilities (water intake capacity 550,000 m^3/day)			
① 8 intake pumps and 8 feed pumps	4 intake pumps and 4 feed pumps	-	Uncompleted: 4 intake pumps and 4 feed pumps
② Huang He – Water Purifying Plant: Extension of aqueducts > Huang He – Sedimentation Plant: Aqueducts 2.731 km x 2	> Huang He – Sedimentation Plant: Aqueduct 2.731 km x 1	> Huang He – Sedimentation Plant: Aqueduct 2.3 km x 1	Uncompleted: About 400 m of one of the two aqueducts has not been completed.
> Sedimentation Plant – Reservoir: Aqueduct 63.2 km x 1	> Sedimentation Plant – Reservoir: Aqueduct 63.2 km x 1	Completed	Completed
> Reservoir – Purifying Plant: Aqueduct 16.22 km x 2	> Reservoir – Purifying Plant: Aqueduct 16.22 km x 1 Aqueduct 13.22 km x 1	> Reservoir – Purifying Plant: Aqueduct 3 km x 1	Completed
(2) Construction of Water Purifying Plant			
Construction of Jinhe Drinking Water Purifying Plant (Treatment capacity 400,000 m^3) (Rapid filtration method)	Construction of Jinhe Water Purifying Plant (Treatment capacity 200,000 m^3) (Rapid filtration method)	-	Uncompleted: The current treatment capacity of Jinhe Plant is half of the plan. (The plant was constructed with a rapid filtration system as planned.)
(3) Construction of Water Distribution Facilities			
> Extension of distribution pipes: 11.951 km x 2	> Extension of distribution pipes: 11.951 km x 1 and 7.2 km x 1	-	Uncompleted: About 4.75 km of one of the two distribution pipes has not been completed.
(4) Improvement of Distribution Pipe Network in the City			
> Extension of distribution pipe network in the city: 56.9 km extension	> Extension of distribution pipe network: 56.9 km extension	Completed	Completed

(5) Consulting Service			
Service to be implemented (Consulting service for equipment procurement)	Lanzhou China Municipal Engineering Institute (A local consulting firm was used. Services related to the selection of equipment were provided as planned.)	-	Completed

3.2.2 Project Inputs

Because Phase II construction has not been completed and the total outputs and inputs cannot be compared fairly, we will evaluate the efficiency of this project with the completed portion of Phase I. (For an informational purpose, we will also describe data of Phase II construction and the whole project.)

3.2.2.1 Project Period

At the time of appraisal, the construction period of this project was planned to be about 37 months (December 1996 – December 1999). However, as a result of the proposal to divide the construction period into two stages at the time of basic design study, the project was going to be implemented in Phase I (48 months from January 1998 to December 2001) and Phase II (24 months from January 2002 to December 2003).

The main reasons to divide the construction into two periods were the financial status of the city government at that time and propriety on securing the water supply (200,000 m^3/day) that needed to be met in the immediate future.

However, the actual construction periods of this project were quite different from the above-described planned periods. Phase I construction took a total of 56 months from April 1998 to November 2002 and Phase II construction has been carried out from December 2002 to May 2010 (still ongoing). Phase I was slightly longer than planned (and Phase II is already much longer than planned). There are various reasons for such delay, but the major causes are as follows.

Table 2 Planned and Actual Project Periods

Phase	Planned Period	Actual Period
Phase I	January 1998 – December 2001 (48 months)	April 1998 – November 2002 (56 months) (116% of the planned period)
Phase II	January 2002 – December 2003 (24 months)	December 2002 – ongoing (May 2010) (90 months --) (Exceeding 375% of the plan)
Total project period	January 1998 – December 2003 (72 months)	April 1998 – ongoing (May 2010) (Not completed; 146 months --) (Exceeding 203% of the plan)

[Difference between Planned Periods and Actual Periods]

(Delay in Design Stage)

There was a delay in the detailed design study due to the readjustment of the routes of aqueducts to keep consistency with the urban planning that was being reviewed at that time.

(Delay in Construction of Facilities)

Out of the planned constructions, the constructions of water conveyance facilities and distribution facilities have been making little progress since the start of Phase II due to fund shortage. Although the water corporation raised additional funds (140 million yuan) with a guarantee from the water authority, which supervises the corporation, the funds went to more urgent areas such as a distribution pipe network in a new economic development zone instead of being directly used for this project.

In addition to fund shortage, another cause of the delay was design changes made as a result of changes in an urban plan. Especially the laying of distribution pipes to link the water purifying plant to the urban district of the city had to be consistent with other urban development projects in the city and therefore had to wait for design change and clearance of a residential area, which delayed the construction.

3.2.2.2 Project Cost

The planned and actual expenditures for this project are as shown in the following table. The total cost (for Phase I construction) is slightly higher than planned.

Table 3 Planned and Actual Project Costs

	Planned Cost	Actual Cost
Phase I	16,968 million yen (Japanese ODA loan portion: 5,446 million yen)	19,817 million yen (117% of the plan) (Japanese ODA portion: 5,426 million yen)
Phase II	4,365 million yen (Japanese ODA loan portion: none)	2,896 million yen (Cost spent up to May 2010. Japanese ODA loan portion was none.)
Total cost	21,324 million yen (Japanese ODA loan portion: 5,446 million yen)	22,714 million yen (Cost spent up to May 2010) *It is currently estimated that another 5,700 million yen will be required for the construction of the uncompleted portion. Therefore, the total cost will be 28,421 million yen (or more) (133% of the plan).

Note 1: Calculated with the average exchange rate from 1998 to 2009 (14.34 yen)

Note 2: The planned amounts shown in the table are estimation made after the appraisal document was created and the decision was made to divide the project into two phases.

[Difference between Planned Costs and Actual Costs]

There was a time lag between the timing to estimate the project cost (in 1993) and the

actual start of the project. The actual cost became higher than planned mainly because of the cost increase for commodity procurement, labor etc. during that time.

The estimated construction cost for a reservoir and a water purifying plant was slightly different from the actual cost as the estimation was made based on the prices set in 1987 by the Inner Mongolian Water Resources and Hydropower Survey and Design Institute[1]. Moreover, another factor that had an impact on the increase of the expenditure was that the procurement costs for cement, steel products and pipes and rental cost for heavy machinery sharply increased during the Phase I construction period.

As stated above, the project cost was slightly higher and the period was also slightly longer than planned. Therefore, the efficiency of this project is moderate.

3.3 Effectiveness (Rating: b)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

The actual results related to operation indicators are as shown in the following table.

Table 4 Target Values and Achieved Values of Operation Indicators

Indicator	Target value (2000)	Actual value (2009 data)
a. Water supplied population	(No target)	860,000 people
b. Water supply quantity	400,000 m^3/day	200,000 m^3/day (Maximum water supply capacity)
c. Facility utilization rate (Jinhe Water Purifying Plant)	100%	75% (Max, per 200,000 m^3) 50% (Average, per 200,000 m^3)
d. Leakage rate	5%	30%
e. Water intake quantity	550,000 m^3/day	275,000 m^3/day (Maximum intake capacity)
f. Water quality	(No target was set in terms of sanitation standards or number of items to be achieved.)	Achieved 105 items of national standards for daily life and drinking water
g. Coverage of water supply	(No target value)	Approx. 80% (estimate) Area of water supply: 110,000 m^2
h. Quantity of daily life water per person	(No target value)	240 liter/person/day

Because the phase II construction has not been completed, achieved values of some operation indicators including water supply quantity and intake quantity are only half of the plan. On the other hand, as seen in Table 5, the water supplied population has grown from approx. 560,000 to 860,000 since the time of appraisal (mid-90s), showing great effect on the

[1] At that time there was a rule to use the basic prices for different types of structures and constructions that were set by the agency that had control over the project. For all civil engineering works except the construction of a reservoir and a purifying plant, 1993 prices described in the comprehensive fixed price regulation by the Inner Mongolian government were used.

increase of users and coverage of water service.

Table 5 Changes of Water Supplied Population and Area

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Water supplied population (10,000)	55.9	56.1	56.3	62.9	71.6	74.1	77.4	78.9	80.1	80.6	81.4	83.5	84.2	86.4
Water supplied area (1,000 m^3)	70	70	70	70	70	70	70	70	80	80	110	110	110	110

Source: Hohhot Water Corporation

The usage rate of the Jinhe Water Purifying Plant, constructed in Phase I, is 5% (150,000 m^3/day) at the maximum and 50% (100,000 m^3/day) on average. Considering that the average usage rates of similar facilities in Tokyo and Osaka Prefectures in 2008[2] are 63.2% and 51.1% respectively, the usage rate of the Jinhe Plant is at a sufficient level to cope with the peak demand.

As for the leakage rate, although the network of distribution pipes have been improved and updated one by one, there is great demand for water pipe networks in new development areas and it has been difficult to meet all the needs for improvement and update in the whole coverage city area. Therefore the leakage rate has not reached the expected value[3].

Table 6 Changes of Leakage Rate

(%)

Year	1996	2005	2006	2007	2008	2009
Leakage rate	10.3	22.0	26.5	25.6	26.5	30.0

Source: Hohhot Water Corporation

The followings have been observed regarding the indicators of “water demand and supply” and “groundwater withdrawal”.

(Water Demand and Supply)

Water supply quantity has not changed much since 2005, when the water supply was started through this project. As is obvious from the data of water supply quantity in Table 7, it is because the additional water supply created by this project has been replacing pumped groundwater that had been a major water source[4]. That is, now that surface water can be used

[2] Reference: Bureau of Waterworks, Tokyo Metropolitan Government

[3] Leakage rates in major domestic and overseas locations (2008) are 16% in Beijing, 26% in Hong Kong, 26% in London, 35% in Mexico City, 10% in Moscow and 3.6% in Tokyo.

[4] Here is additional explanation. The quantity of water supply in 2005, when the surface water supply started, was almost the same as in the previous year (219,000 m^3 in 2004, 213,000 m^3 in 2005). The same amount of water was supplied in both years although the surface water supply started in 2005. That means water from other sources than

for water service, the quantity of consumed groundwater is smaller by that amount.

Another factor that created gaps is that the water demand shown in the following table is estimation based on the result of feasibility study conducted in 1995 and does not properly reflect the current situation. The Hohhot Water Corporation indicates its intention to recalculate water demand before the full-scale implementation of Phase II construction.

It is believed that the gap between water demand and supply shown in the following table seems to have been filled because 1) there are private water sources in some places that the Hohhot Water Corporation does not have control over, 2) switch from collective water meters to individual meters for individual households raised local people's awareness about water saving and therefore the growth of water demand per household has become slower, and 3) water recycling has increased in large-scale plants that consume a large quantity of water and therefore the total water demand from plants has decreased.

Table 7 Changes of Water Demand

(10,000 m^3/day)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Demand (Forecast)	43.5	52.1	56.2	60.7	62.8	65.6	69.7	73.8	75.6	78.4	80.3	82.2	84.5	86.9	88.1
Supply (Actual)	23.0	22.8	23.6	22.8	21.8	22.1	22.4	22.0	21.6	21.9	21.3	21.1	23.7	25.5	37.9
Shortage	20.5	19.3	22.6	37.9	41.0	43.5	47.3	51.8	54.0	46.5	49.0	61.1	60.0	61.4	50.2

Source: Hohhot Water Corporation

Note: The area covered by the table is the city of Hohhot.

The other effect indicator, groundwater withdrawal, has been showing clear improvement in recent years and excessive withdrawal finally became negative in 2008. The implementation of this project and closure of wells promoted by the city of Hohhot seem to be large contributors to such improvement. Especially in 2009, when approx. 100 wells were closed, the groundwater withdrawal in the city significantly decreased, and, as a result, the surface water supply sharply increased.

Table 8 Changes of Groundwater Withdrawal

(10,000 m^3/day)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Groundwater withdrawal	37.1	37.4	36.6	37.1	35.0	37.6	41.9	38.0	36.1	33.2	30.0	28.2	25.3	23.0
Excessive withdrawal	11.4	11.7	10.9	11.4	9.3	11.9	16.2	12.3	10.4	7.5	4.3	2.5	-0.4	-2.7

Source: Hohhot Water Corporation

Note: The values in the table are the total quantity of water withdrawn by the water corporation and water from sources that are not controlled by the corporation. Therefore, the data of water supply by the corporation (Table 7) and the data of groundwater withdrawal in this table are not consistent.

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surface water, i.e. groundwater, was decreased.

3.3.1.2 Results of Calculation of Internal Rates of Return(IRR)

As a result of recalculation with the portion of construction that has been completed so far, the financial internal revenue rate (FIRR) was 2.51%. This is lower than the rate calculated at the time of appraisal, 6.92%, because the Phase II construction has not been completed and therefore expected water service revenue has not been generated. Moreover, from a cost viewpoint, civil engineering that was necessary regardless of the quantity of water intake, such as creation of a reservoir and laying of aqueducts, required more than half of the total project cost. Therefore, the FIRR has become lower than the estimation at the time of appraisal.

3.3.2 Qualitative Effects

In this ex-post evaluation, the items defined as qualitative effects at the time of appraisal, “improvement of infrastructures”, “contribution to economic growth such as increase of industrial production” and “prevention of groundwater level recession”, will be evaluated in next section “Impact” as they are rather impacts than outcomes.

For the reasons stated above, this project has somewhat achieved its objectives, therefore its effectiveness is fair.

3.4 Impact

3.4.1 Intended Impacts

The implementation of this project has produced the following impacts.

(1) Prevention of Groundwater Level Recession

As seen in the following table, the level of groundwater kept lowering at a constant rate, but rose in a couple of recently years (2006 and 2008). The recession of groundwater level has stopped mainly because the water supply through this project that started in 2005 has decreased the groundwater pumping.

Table 9 Groundwater Level Recession

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Recession (m/year)	1.3	1.2	2.0	1.4	1.4	1.5	2.2	1.7	1.6	1.7	1.6	2.2 up	2.3	3.9 up

Source: Hohhot Water Corporation
Note: Values are comparison with the level of previous year.

(2) Contribution to Economic Growth such as Increase of Industrial Production

This project has made an important contribution to the industrial development of Hohhot from the aspect of the improvement of water supply infrastructures. Especially in the petrochemical complex zone (economic development zone with a petroleum refinery, Jinqiao

power generation plant and a chemical fertilizer plant), this project has contributed to infrastructure improvement in neighboring residential areas as well as the industrial zone. This zone keeps growing as one of the largest economic development zones in the city that can provide residence and work places at a short distance.

There is a plan that this project will supply water to a new economic development zone (Tagtoh Qingshuihe Development Zone) that will soon be completed, in addition to the four existing economic development zones in the city. The project is expected to continue contributing to the increase of industrial production in the city from the viewpoint of the improvement of economic infrastructure.

(3) Awareness of Improvement of Infrastructures and Quality of Life with Stable Water Supply

The result of the beneficiary survey shows that the water supply condition in the households of the project area has generally improved, e.g., water supply is not cut off as often as before and the water pressure has become more stable. 49% of the respondents said "Water supply is not cut off as often as before" [5] and 31% said "Water pressure has become stable" [6]. Moreover, approx. 60% of the respondents said "The quality of life has improved" and "The efficiency of housework is enhanced" with the improvement of the water supply condition. The survey result confirms that this project has a positive impact on the improvement of the local people's life.

Table 10 Awareness of Effect of This Water Supply Project
(Result of Beneficiary Survey)

	Strongly agree	Generally agree	Disagree	Strongly disagree
Quality of (basic) life has improved	13%	46%	21%	20%
Efficiency of housework has enhanced	23%	37%	25%	15%

Source: Result of a beneficiary survey conducted in the ex-post evaluation (of 100 residents in the city in April 2010)

(4) Decrease of Waterborne Diseases

Although it is difficult to confirm a causal relationship between the decrease of waterborne diseases and the effect of this project, waterborne diseases have been decreasing in the city. At the time of appraisal, fluorosis and arsenic poisoning were considered to require caution, but there has been no case of these diseases in recent years[7].

[5] 29% said "Water supply is cut off as often as before".
[6] 30% said "There have never been problems about water pressure".
[7] There was only one case of arsenic poisoning reported in the Zhijiliang Village, located in the suburbs of Hohhot, in 1990. There has been no case of arsenic poisoning since then.

3.4.2 Other Impacts

(1) Impacts on the environment

Water filtered in the purifying plant is properly treated in the sedimentation basin. Sludge is discharged into the Xiaohei River but there has been no negative impact on the environment[8]. The plan to recycle sludge into bricks has been given up because of the high cost.

(2) Resident relocation and land acquisition

The local farmers once agreed on the sale of land (approx. 300 ha) for a sludge disposal site, but took it back later when the land price rose. Therefore, not all the land for a sludge disposal site has been acquired and part of it is still leased from farmers. As the area of land currently leased will not be enough in the long term, agreement has to be made on the land acquisition at some point in the future[9].

There has been no relocation of residents for the implementation of this project.

(3) Other

The taste of tap water that is mainly taken from surface water is not popular among all the residents in Hohhot, who have been enjoying groundwater for a long time. In the beneficiary survey, about half of the respondents (46%) said “The water is not tasty or has become less tasty”. In 2009 representatives of some citizens even submitted a written request to improve water quality (taste) to the Inner Mongolian government. The Hohhot Water Corporation is well aware of this problem and expressed its intention that they will try to use as much groundwater as possible for domestic use and surface water for industrial use while considering the balance of groundwater and surface water.

In light of the above, this project has a positive effect on the daily life of the local people and the economic growth of Hohhot. Therefore its impact is diverse and large.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

Operation and management of this project has been conducted by the Hohhot Water Corporation, which was established in 1966. The Water Corporation has recently reviewed its organizational structure and strengthened the overall system for water supply projects, e.g.

[8] Discharged sludge is properly treated in a wastewater treatment plant, located about 10 km downstream of the discharge location.

[9] The Hohhot Water Corporation is conducting negotiation about the land acquisition for the sludge disposal site as a responsible organization, trying to achieve resolution in the near future. However, the concrete schedule has not been set yet. The area of land currently leased is less than 10ha. Because the candidate site for the sludge disposal site is idle land and the area for lease is negotiated on an as-needed basis, there is no concrete boundary-line drawn. The sludge disposal site has enough area (capacity) to treat sludge for 50 years at full capacity of the intake facilities (according to the hearing with the Hohhot Water Corporation).

spinning off a corporation for water supply (300 employees) and setting up a corporation for distribution pipe network maintenance (680 employees). The Corporation has also enhanced its comprehensive organizational strength by increasing its employees from about 1,600 in 2003 to about 2,600 by now and improving customer services that was poor before. Moreover, the corporation expresses its intention to strengthen the capacities of individual employees and at the same time downsize the organization. Therefore, the sustainability of the organization is deemed high.

3.5.2 Technical Aspects of Operation and Maintenance

Since this water supply project with the use of surface water was the first practical operation for the Water Corporation, elaborate training was provided to engineers before the start of operation. Technical training was provided not only in the corporation but at the Shijiazhuang Water Supply Company and the Beijing Waterworks Group, to a total of 350 people. Moreover, after the operation started, the corporation examines the result of training and evaluates technical capabilities of the engineers as well as providing training as needed according to the annual training plan for engineers. Therefore, it is deemed that the system to maintain and enhance technical capabilities has been well established. Considering that there has been no serious trouble in operation, it is evaluated that the corporation has enough sustainability in terms of technical capabilities for operation and maintenance.

3.5.3 Financial Aspects of Operation and Maintenance

The financial condition of the Hohhot Water Corporation deteriorated especially in 2007 and 2008 due to the surge in fuel and other material prices, but has been improving since 2009.

The liquidity ratio, which clearly shows financial stability, was 137% in 2009, showing a certain degree of security. The capital adequacy ratio is still 36% although it has been decreasing since 2007. Considering these factors and the fact that the corporation is a public enterprise for public service infrastructures, it is deemed that the financial security is not at high level but there is no concern about its sustainability.

Since the corporation cannot raise water rates based on its own business decision, various cost reduction efforts are required to improve profitability. However, because the rates are set by fully distributed cost pricing[10] (where pricing is conducted to secure profitability), the financial sustainability is almost assured.

[10] Fully distributed cost pricing is usually used for pricing of water supply projects, which are free from market competition and are monopolistic in the region. This method is to sum up necessary costs and business payments and set the rates at the level that generates enough income to cover the total costs. (Source: *Management Efficiency Indicators for Fair Comparative Evaluation of Water Supply Projects*, Japan Water Works Association)

Table 11 Financial Status of Hohhot Water Corporation

	2004	2005	2006	2007	2008	2009
Sales amount (Yuan)	136,816,343	121,606,970	158,345,605	183,911,765	188,346,488	269,342,117
Ordinary profit (Yuan)	248,085	295,456	522,879	-49,641,136	8,494,857	32,003,417
Ordinary profit to sales (%)	0.18	0.20	0.33	-26.99	4.51	11.88
Profit to sales (%)	26.61	30.15	23.53	-1.22	27.64	14.99
Sales growth (%)	28.13	-11.12	30.21	-16.15	2.41	43.00
Cost to sales (%)	73.39	69.85	76.47	-101.22	72.36	85.01
Profit ratio of total capital (%)	0.02	0.02	0.03	-2.30	0.37	1.34
Turnover of total capital (%)	0.11	0.08	0.10	0.09	0.08	0.11
Capital adequacy ratio (%)	63.02	51.58	51.99	38.48	36.67	36.60
Liquidity ratio (%)	264.41	293.40	278.06	143.23	129.49	137.51
Fixed asset ratio (%)	119	125	112	132	131	127

Source: Hohhot Water Corporation

Table 12 Changes of Water Rates

(Yuan/m^3)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Daily life water	0.57	0.63	0.69	0.86	0.9	1.22	1.33	1.93	2.15	2.07	2.68	2.65	2.55	2.51
Industrial water	1	1.12	1.22	1	1.28	1.39	1.34	1.65	1.82	2	2.99	2.94	2.85	2.44
Others	0.11	0.27	0.4	0.6	0.6	0.77	0.8	1.12	2.18	1.25	0.78	0.87	0.82	1.59

Source: Hohhot Water Corporation

3.5.4 Current Status of Operation and Maintenance

As for maintenance, engineers in charge of equipment maintenance are placed in all major facilities such as purifying plants and pumping stations. There is also a cross-sectional maintenance center for the maintenance of all facilities, established in 2005, with 5 staff members supporting maintenance of all facilities as needed. Moreover, a budget plan and a maintenance manual have already been prepared. The maintenance system and actual activities are in good condition. Necessary updates of equipment and facilities have been gradually conducted based on the maintenance plan, and update of an automatic control system is planned in 2010. Considering the above, the condition of operation and management is deemed good.

When visual check was conducted during the field survey (May 2010), one of the intake pumps seemed to be in bad condition, but a new pump has already been procured and will be installed in July.

Moreover, the system for beneficiary service also seems to have improved with the establishment of a new customer center (22 staff members) and an office to address water

supply requests (7 staff members) and the introduction of prepaid cards for water bill payment.

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

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

In the city of Hohhot, which depended solely on groundwater for its water supply, this water supply project with the use of surface water from the Huang He River was to provide stable water supply in the long term and its effects have been steadily produced in such forms of decrease of groundwater withdrawal and increase of population/area served by piped water. Although there is an issue that some of the facilities constructed in Phase I have been left unused because Phase II construction has not been completed yet, the project is expected to produce larger effect when Phase II is completed. Moreover, there is no particular problem in the organizational structure or technical capabilities of the Hohhot Water Corporation regarding the maintenance in the future.

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

4.2 Recommendations

4.2.1 Recommendations for Executing Agencies

Considering the accelerated urbanization and economic growth of the city of Hohhot of recent years, there is a need to recalculate mid- and long-term water demand, and, based on this data as a major premise, Phase II construction needs to be completed soon so that long-term stable water supply will be achieved. The completion of Phase II construction also needs to be assured in the 12^{th} five-year plan, which is now being created. (The city of Hohhot plans to continue filling wells in the city and therefore there is little possibility of reversing the necessity of Phase II construction. In this section we do not recommend cancellation of Phase II.)

4.2.2 Recommendations for JICA

For the completion of Phase II construction, the progress needs to be monitored. At this point there is no particular work operation that needs technical assistant. However, when assistance is sought in the course of communication, provision of appropriate advice and such other actions will be required.

4.3 Lessons Learned

In the evaluation of efficiency and effectiveness of this project, it turned out that the root

cause that produced negative factors was the water demand forecast based on the feasibility study result. Obviously such forecast is difficult under rapidly changing social and economic conditions, but, even so, the forecasted water demand for this project was too far from the reality. Although it is also difficult to determine the cause of this gap, there was a high possibility that the outputs and inputs of this project would have been modified if the feasibility study result had been further examined (by a third party). In such case, it is believed that the efficiency and effectiveness of the project would have been higher. In this respect, further emphasis on the necessity of examination of feasibility study result (especially when the partner country conducts the study) can be a lesson from the ex-post evaluation of this project.

Comparison of the Original and Actual Scope

Item	Original	Actual
1.Project Outputs 1) Construction of Water Conveyance Facilities	(1) 8 intake pumps and 8 conveyance pumps (2) Huang He – Reservoir: extension of aqueducts (2-1) Huang He – Sedimentation basin: aqueducts 2.731 km x 2 (2-2) Sedimentation plant – Reservoir: aqueduct 63.2 km x 1 (2-3) Sedimentation plant – Reservoir: aqueducts 16.22 km x 2	Uncompleted: 4 intake pumps and 4 conveyance pumps have not been installed. Uncompleted: About 400 m of one of the two aqueducts has not been completed. Completed as planned Completed as planned
2) Construction of Water Purifying Plant	(1) Construction of Jinhe Purifying Plant (capacity 400,000 m^3)	Uncompleted: Facilities with processing capacity of 200,000 m^3 have been constructed and are in operation.
3) Construction of Water Distribution Facilities	(1) Extension of distribution pipes: 11.951 km x 2	Uncompleted: 4.7 km of one of the two distribution pipes has not been completed.
4) Improvement of Distribution Pipe Network in the City	(1) Extension of distribution pipes in the city: extension of 56.9 km	Completed as planned
5) Consulting Service	(1) To be introduced (consulting service for the selection of equipment to be procured)	Introduced (as planned)
2.Project Period	Phase I January 1998 – December 2001 (48 months) Phase II January 2002 – December 2003 (24 months) Total January 1998 – December 2003 (72 months)	April 1998 – November 2002 (56 months) December 2002 – ongoing (88 months –) April 1998 – ongoing (Uncompleted, 114 months –)
3.Project Cost Amount paid in Foreign currency	Phase I 5,446 million yen Phase II None	Phase I 5,426 million yen Phase II None
Amount paid in Local currency	Phase I 11,522 million yen Phase II 4,365 million yen (In local currency) Phase I 1,414 million yuan Phase II 363 million yuan	Phase I 14,391 million yen Phase II 2,896 million yen (uncompleted) (In local currency) Phase I 1,382 million yuan Phase II 202 million yuan
Total	Phase I 16,968 million yen Phase II 4,365 million yen	Phase I 19,817 million yen Phase II 2,896 million yen (uncompleted)
Japanese ODA loan portion	Total 21,324 million yen	Total 22,714 million yen (uncompleted)
Exchange rate	5,446 million yen 1 yuan = 12.00 yen (As of 1996)	5,426 million yen 1 yuan = 14.34 yen (Average between 1998 and 2009)