Ex-Post Project Evaluation 2017:

Package I-1 (China, Pakistan)

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People's Republic of China

FY2017 Ex-post Evaluation of Japanese ODA Loan

"Sichuan Water Environmental Improvement Project"

External Evaluator: Kenji Momota, IC Net Limited

0. Summary

This project was implemented in five cities in the upper river basin of the Chang Jiang River in Sichuan Province to reduce the discharge of water pollutants into the rivers in each city and facilitate stable and safe supply of water through the construction of sewage and water supply facilities, thereby contributing to improvement of the living environment for the residents in the area.

The project is consistent with China's development policy and needs at the national and municipal levels between the time of the appraisal and the time of the ex-post evaluation; therefore, the project as a whole is highly relevant. Although the outputs were significantly modified from the time of project planning, as this was a flexible response to the urban planning of each city, it is fair to say that these changes were appropriate in achieving the purpose of the project. The efficiency is fair because the project period took much longer than planned despite the project cost was a little lower than planned. The constructed water supply/sewage facilities are operating smoothly and, except for some cities where urban development was delayed, the volume of treated sewage, coverage, and the reduction of the water pollutants have all achieved their targets as planned. By the improvement of sewage treatment rate, the volume of polluted water discharged into the river has been reduced, contributing to the improvement in water quality of major rivers in each city; therefore, the effectiveness and the impact of this project is high. With regard to the sustainability of this project, institutional capacity and technical aspects developed without any problem; however, financial information of some cities has not been confirmed, therefore its financial sustainability is fair. Main facilities are in good condition and overall sustainability is high. In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project location

Sewage treatment plant in Panzhihua city

1.1 Background

Although China has achieved rapid economic growth, environmental pollution has become more serious since the 1980s because of industrialization and population growth, and the pollution level of the river was significantly worse than the national standard. During *China's 10th Five-Year Plan (2001–2005)*, the Chinese government concentrated its efforts on water environment protection through measures like designation of major protection areas and setup of quantitative target on the reduction of water pollutants. However, with the constant economic growth, they failed to achieve the targeted reduction of the water pollutants as they were not able to control the growing discharge of domestic and industrial sewage. In urban area of Sichuan Province, the amount of sewage increased because of economic development while the construction of sewage facilities lagged behind. For that reason, untreated domestic and industrial sewage was discharged directly into the upper river basin of Chang Jiang River, which is also important as a source of drinking water. There are water systems whose quality index reaches below Class V[1] during the drought season, which indicates severe water pollution, and it is essential to improve the water environment without delay. In addition, contamination of sources of drinking water has made it difficult for some cities to use existing water sources. It is therefore necessary to develop new water sources.

1.2 Project Outline

The objective of this project is to reduce the amount of polluted water discharged into the river in five cities (Yibin city, Suining city, Mianyang city, Panzhihua city and Ziyang city) located in the upper river basin of Chang Jiang River in Sichuan Province and realize a stable supply of safe water by improving sewage facilities and water supply/sewage facilities in each city, thereby contributing to improvement of the living environment of residents in this area.

Loan Approved Amount/ Distributed Amount	6,300 million yen/6,065 million yen
Exchange of Notes Date / Loan Agreement Signing Date	March 2007/March 2007
Terms and Conditions	Interest rate 0.75%/1.75%, Repayment 30/40 years (Grace period: 10 years) General Untied
Borrower/Executing Agency	Government of the People's Republic of

[1] River water quality in China is classified into Classes I to V according to the Environmental Quality Standards for Surface Water (GB3838-2002). Class-I water is mainly water at the source of a river in a national natural protection area. Class-II water is used mainly for drinking and exists in a first-class protection area, an area for rare kinds of fish, or a place for fish or shrimp spawning. Class-III water is used mainly for drinking and exists in a second-class protection area, an area for protection of general fish, or a swimming area. Class-IV water is used mainly as general industrial water and exists in a general industrial water area or a water area for entertainment where people cannot directly touch the water. Class-V water is mainly used for agriculture and exists in an agricultural water area. It is also used for securing the general landscape.

	China/Sichuan Provincial People's Government
Project Completion	April 2017
Main Contractor (Over 1 billion yen)	None
Main Consultant (Over 100 million yen)	None
Related Studies (Feasibility Study, etc.)	Prepared by the Southwestern China Municipal Engineering Design & Research Institute in December 2006
Related Projects	1. World Bank: Sichuan Urban Environment Project (1999) 2. World Bank: Sichuan Urban Environment Project (2006)

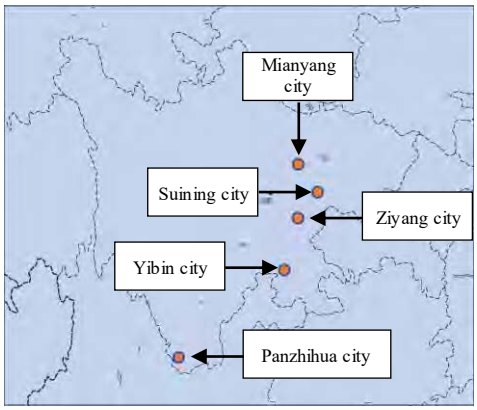

Figure 1: Five cities subject to this project

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenji Momota, IC Net Limited

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: July 2017–March 2019

Duration of the Field Study: November 2–20, 2017, March 29 – April 5, 2018

2.3 Constraints during the Evaluation Study

In this project, the project scope was partially changed because of the Sichuan Earthquake. With regard to changes in project expenses and scope due to these changes, details of changed plans, etc., were not confirmed sufficiently at the site, and the evaluation of efficiency was constrained in part. In addition, with regard to sustainability, financial statements of implementing organizations in each city contained much non-disclosure information. It was therefore difficult to analyze financial sustainability on the basis of detailed financial information.

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

3.1 Relevance (Rating: (3)[3])

3.1.1 Consistency with the Development Plan

(1) Consistency with the development plan at the time of the appraisal

During China's *10th Five-Year Plan (2001–2005)*, the Chinese Government started working on the improvement of urban environments, such as improvement of sewage system and industrial pollution. In the subsequent *11th Five-Year Plan (2006–2010)* and *Notice on Distribution of the Comprehensive Work Plan for Energy Saving and Emissions Reduction by the State Council (June 2007)*, the government reinforced efforts to improve the environment and set a goal to reduce the total amount of discharge of major pollutants by 10% compared with 2005. With regard to sewage system, a goal was set to achieve a sewage treatment rate of 70% in urban areas (80% in major provincial cities) and Class II level of water quality through environmental improvement measures in the upper river basin of Chang Jiang River. River basins relevant to major protection were specified in *China's 11th Five-Year Plan for Environmental Protection (2006–2010)* for the improvement of river water quality, and a goal was set to achieve a certain standard of water quality through the prevention of water pollution in river basins that are important as sources of drinking water as well as measures like conversion of water sources.

In response to these plans, Sichuan Province defined environmental pollution and ecological destruction in the upper river basin of Chang Jiang River through construction of sewage treatment plants and conversion of water sources as major issues in *Sichuan's 11th Five-Year Plan for Economic and Social Development (2006–2010)*.

Improvement of urban water supply infrastructure was identified as an important issue in regard to water supply after China's *9th Five-Year Plan (1996–2000)*. The securing of water sources in urban cities with severe water shortages was also specified as an important issue in China's *11th Five-Year Plan (2006–2010)*. This included reinforcement of water supply capacity by newly establishing and updating waterworks, securing safe drinking water and saving water sources by reducing leakage rates, etc. In order to resolve the shortage of funds, it also addressed reforming the water supply cost structure (introduction of a gradual increase system, combination of flat rate and commodity charge, etc.), securing of facility investment by reinforcement of water charge collection, promotion of water conservation and reinforcement of pollution countermeasures.

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

[3] (3) High, (2) Fair, (1) Low

(2) Development plan at the time of the ex-post evaluation

China's *12th Five-Year Plan (2011–2015)* established by the central government set a concrete goal to achieve an 85% sewage treatment rate in urban areas by promoting measures for water pollution in important river basins, protecting the river environment and reinforcing ecological management as important tasks. The *13th Five-Year Plan (2016–2020)* has set a goal to achieve a 95% sewage treatment rate in urban areas, along with the promotion of sewage treatment facilities and drainage construction in urban areas, which have made numerical goals stricter.

Both the 12th and 13th five-year plans consistently consider measures to prevent water quality pollution to be important. After the *11th Five-Year Plan*, the sewage treatment rate was specified as a national goal and has been raised gradually. The provincial level of the development plan continuously defined water supply/sewage sector as an important basic infrastructure; in particular, the sewage project has been defined as important from the perspective of reinforcing measures for the environment.

In *Sichuan's 13th Five-Year Plan for Economic and Social Development (2016–2020)*, measures for water pollution have been announced continuously as a part of environment conservation measures, and an action plan has been submitted to improve sewage treatment facilities and the piping network and tighten regulations on large-scale sources of pollution such as industrial estates. In particular, there have been calls to tighten the management of industrial estates and papermaking and the chemical industry, which includes rivers designated as important river basins in neighboring cities subject to this project, such as the Min Jiang and Tuo Jiang Rivers.

In light of the above, improvement of water quality and air pollutants have been defined as priority items in each development measure at the national and Sichuan Province level. Consistency with this project is high, which is implemented for the purpose of improving the river environment by improving sewage facilities. This position has been the same from the time of the appraisal to the time of the ex-post evaluation, and the national development plan promotes tightening of regulations to reduce the amount of water pollutants discharged. In Sichuan Province, five cities subject to this project has maintained the same position since the time of the appraisal, and this project has been highly relevant to the country's development policy. Therefore, its relevance is high.

3.1.2 Consistency with Development Needs

(1) Situation of each city from the time of project planning to the time of the ex-post evaluation

The amount of sewage has been increasing in each city of Sichuan Province because of economic growth; at the same time, there are delays in the construction of sewage treatment

facilities. Therefore, untreated domestic sewage and industrial sewage are discharged directly into the upper river basin of Chang Jiang River, which is a source of drinking water. There are water systems whose water quality index reaches below Class V during the drought season, which indicates severe water pollution, and it is essential to improve the water environment without delay.

In Sichuan Province at that time, water pollution due to delays in the construction of sewage treatment facilities had an influence on the water supply situation, and existing water sources could not be used in some cities. For that reason, it was necessary to improve the water supply infrastructure by development of new water sources.

With this background, five cities located in the river basin of Chang Jiang River were selected in this project. The specific selection process and project plan were promoted based on the *Water Pollution Prevention Plan for Sanxia Dam and its Upstream Area* issued in 2001. At that time, a national development project of Sanxia Dam was in progress. Measures to prevent pollution from occurring in water sources were a major issue, and major cities located in the river basin of Chang Jiang River in Sichuan Province were also greatly affected by water quality. Therefore, nearly 40 cities were selected and improvement of stable water supply capacity, sewage treatment facilities and measures for regulations, etc. of severely polluting industries, etc. were implemented. Five cities subject to this project were included in these cities and a Japanese ODA Loan project was implemented as part of these measures.

Still, improvement of water quality has been important in the five cities subject to this project. Economic development such as population increase and industrial estates, which can be a factor of pollution, has progressed in each city, and the quality of the river water in the province has deteriorated. For that reason, continuous implementation of measures for water quality pollution is sought, and the sewage project, a core infrastructure, continues to take higher priority.

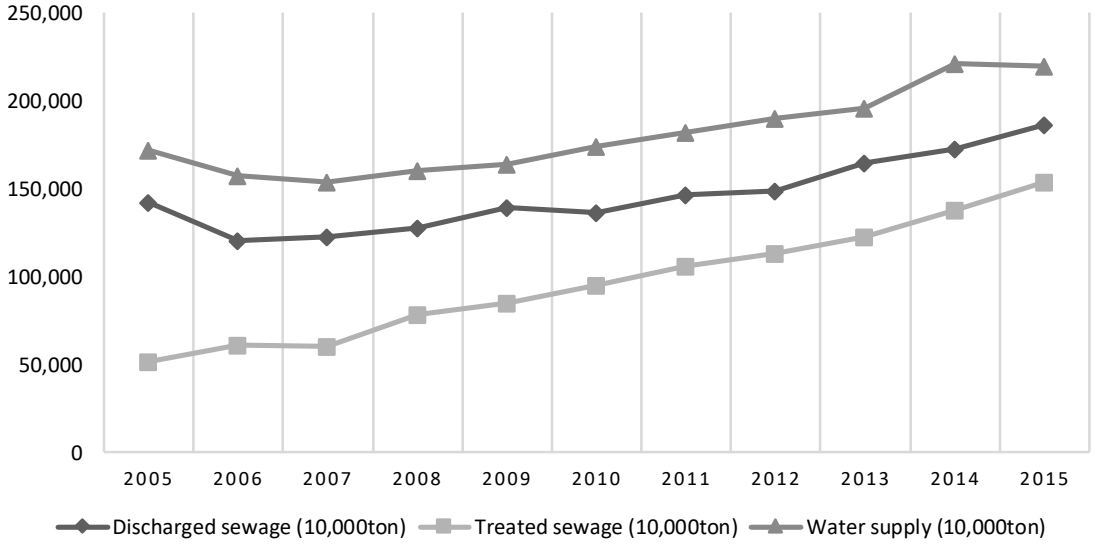


Figure 2: Aging data related to water supply/sewage systems in urban areas of Sichuan Province
Source: China Environment Statistics Yearbook, Sichuan Statistic Yearbook, and China Urban Construction Statistics Yearbook

(2) Appropriateness of the project plan and approach, etc.

The output of this project was planned and implemented to support and construct water supply/sewage systems in five cities subject to the project. The output of the Japanese ODA loan occupies a part of the entire water and sewage system in each city, but a main sewage line and a unique or main sewage treatment plant were implemented in each city, and these play an important role in the functioning of the water and sewage system of the entire city. Thus, it can be evaluated that its position was planned appropriately.

3.1.3 Consistency with Japan's ODA Policy

In the *Medium-Term Strategy for Overseas Economic Cooperation Operation* (2005 to the first half of 2008) of the Japan International Cooperation Agency (JICA), of all the priority sectors, such as support for poverty reduction, development of infrastructures for sustainable development, and support for measures to cope with global problems and peacebuilding, JICA clarified the importance of developing farming villages through the construction of sewage systems in poverty areas, the promotion of sustainable growth through the development of much-needed economic and social infrastructures, such as waterworks, sewage systems, and energy facilities, and measures against air and water pollution for the purpose of making the development compatible with the environment.

Moreover, in the *Country Assistance Strategy*, JICA has identified environmental problems resulting from rapid economic growth, and places importance on environmental conservation mainly in inland areas.

While economic development has progressed in each city since implementation of the project, comprehensive measures for water quality pollution are carried out to control water quality pollution, and improvement and diffusion of sewage treatment plants and tightening of regulations on pollutants continue to be carried out. In light of the above, this project has been highly relevant to the development policy and development needs of the Chinese Government, Sichuan Provincial government and municipal governments of five cities subject to this project, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: (2))

3.2.1 Project Outputs

The following table shows the planned and actual outputs in this project, indicating that there is no change in the structure of main facilities, but there are major changes in the amount and scale.

Table 1: List of outputs

	Plan	Actual
Sewage system	Length of sewage pipe Total 297 km Yibin city 62 km Suining city 27 km Mianyang city 140 km Panzhihua city 21 km Ziyang city 47 km	Length of sewage pipe Total 192.03km (65%) Yibin city 33.3 km (54%) Suining city 18.5 km (69%) Mianyang city 94.75 km (68%) Panzhihua city 7.4 km (35%) Ziyang city 39.41 km (83%)
	Pump station 20 locations Mianyang city 14 locations Yibin city 6 locations	Pump station 8 locations (-12 locations) Mianyang city 2 locations (-12 location) Yibin city As planned (6 locations)
	Sewage treatment plant 4 locations Capacity 99,000 m³/day Suining city 1 location 60,000 m³/day (Expanded) Panzhihua city 3 locations 39,000 m³/day (Newly established)	Treatment plant 6 locations (+2 locations) 112,000 m³/day (113%) Suining city 1 location 60,000 m³/day (Newly established) Panzhihua city 2 locations (-1 location) 39,000 m³/day (Newly established) Mianyang city 3 locations (+3 locations) 13,000 m³/day (Newly established)
Water supply system	Length of water supply pipe Panzhihua city 9 km	Length of water supply pipe Panzhihua city 10.8 km (120%)
Training	Training on management staffs, training on sewage treatment technology	Cancelled

Source: The planned outputs are based on materials provided by JICA, while the actual outputs are based on the implementing organizations' responses to questionnaires.

(1) Main changes in outputs

Background to main changes in the outputs are as follows:

1) Changes in the entire plan due to detailed design: Detailed site investigations were conducted at the stage of detailed design and the plan was reviewed after confirming the

existing sewage pipe and the necessity of pump stations, etc. The total length of sewage pipe was therefore reduced in all five cities.

2) Efficiency of laying plan: With regard to sewage pipe, the diameter of the pipe to be laid was changed to a larger diameter in the detailed design. Pipe was planned to be laid running parallel to both sides of the road, but was laid on one side of the road only and the total length was shortened. There are other cases where sewage pipe was found to be already laid when the road was constructed in site investigations.
3) Review because of earthquake disaster: In Mianyang city, the plan was revised again due to the Sichuan Earthquake in 2008. At that time, a document issued by the Sichuan Provincial People's Government Development Reform Committee (dated December 10, 2008) mentioned that there were plans to construct new sewage treatment plants at three locations and pump stations at three locations. Later, a site investigation was conducted for the first time at the final design, and the number of pump stations was changed from three to two because it was confirmed in the site investigation that there was an existing pump station and a new pump station did not need to be constructed.

Pump station in Yibin city

Songya Treatment Plant in Mianyang city

In light of the above, the output was changed in a major way. From the discussion with each city, although there were changes on the project components of the Japanese ODA loan project, the entire development of water supply and sewage treatment system progressed as planned. And the current operational status of system, which will be described in 3.3 Effectiveness, implies that function and capacity were generally developed as planned. The outputs of Japanese ODA were organized and changed to meet the entire development plan of each city. In light of the above, it was observed as appropriate changes in line with the entire plan of system.

(2) Training program

Because of the great earthquake in Sichuan Province and further tightening of the overseas training system in China, the training program was not implemented. When it was confirmed whether the training program instead of visiting Japan for training was implemented in each city, it was not implemented as a part of this project, but company or organizations responsible for operation of respective facilities conducted regular human resource development program such as sending their personnel in training and visit to other sewage treatment facilities. Sewage treatment technique was already established in China and it was evaluated that cancellation of the training program did not have a major influence on achieving the project goal.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Although the total project cost was initially estimated to be 10,709 million yen (including a Japanese ODA loan of 6,300 million yen), in reality it was 9,460 million yen (including a Japanese ODA loan of 6,065 million yen), 88% of the estimate. The total project cost was within the plan, but the actual project cost is different according to each city. The total project cost was as planned mainly because sewage pipe was effectively laid in the detailed design. However, the project scope was changed many times since it was planned. With regard to the implementation status of the project cost compared with the changed scope, it was not possible to examine the details of output structure of the revised scope. Therefore, it is difficult to analyze suitability of project cost expenditure because of change in scope.[4]

3.2.2.2 Project Period

Although the initially planned period was between March 2007 and December 2012 (70 months), the actual period was considerably prolonged, between March 2007 and April 2017 (122 months, 174% of the initial plan.) The main reasons for the difference between the actual period and planned period according to each city are as follows.

[4] There are several documents containing a variety of information concerning the output in Mianyang city and it is difficult to verify the matter exactly by comparing to the plan. Therefore, it is also difficult to verify the validity of project cost associated with the change in project scope. However, a survey conducted at the project implementation organization in each city showed that the project cost exceeded the planned cost in Mianyang city only, and that the cost increased mostly because of the increase in amount in local currency. It seems that there will be no influence on the rating itself.

Table 2: Reasons for the difference between the actual period and planned period in each city

City name	Actual ( ) compared to planned	Reason
Yibin city	Oct. 2008 to Dec. 2012 51 months (75%)	A sewage treatment plant was not included in the output. In addition, when the sewage pipe was developed, the city reduced the time for internal coordination by making frequent communication and coordination with government organizations, and created an environment to execute the project as planned.
Suining city	Jul. 2009 to Dec. 2014 66 months (97%)	There was a delay in the improvement of the sewage piping network due to the revision of the development of industrial estate which had been developed together. However, the entire period was almost as planned.
Mianyang city	Jan. 2010 to Apr. 2017 45 months (125%)	The plan was changed several times in and after 2008 because of the Sichuan Earthquake, and it took time to approve the details of applications every time.
Panzhihua city	May 2008 to Jul. 2011 39 months (57%)	The entire city regarded the sewage project as high priority. In addition, the quality of the detailed design was advanced and construction management was thoroughly conducted.
Ziyang city	Jul. 2008 to May 2015 83 months (118%)	The sewage piping network was changed in one section because of changes in urban planning. Moreover, roads and railroads had already started to be constructed in some sections, which required changes in the method of laying the pipe.

Reference: The plans are based on materials provided by JICA and the implementing organizations' responses to questionnaires.

Note: Among packages implemented in each city, the actual period of the relevant city started when the project first entered into the process and ended at the end time when the package that was completed ultimately ended.

Here are the reasons why the period was different especially from the plan in each city.

1) The project period was shortened in Yibin city and Panzhihua city. In addition to the changes on the project scope such as reduction of total length of the pipeline, this was largely because of smooth progress of internal coordination and approval process of the government such as procurement contract due to the smooth coordination with the people's government and executing agencies. In Panzhihua city in particular, the people's government understood this project well, which made the project work smoothly.
2) There were long delays in the project compared to the plan in Ziyang city because areas where sewage pipe was planned to be laid crossed the jurisdiction of railway department. In this case, the Railroad Service did not regard this project as important, which resulted in significant delays.

3) In Mianyang city, the commencement of the project delayed due to the review of the plan by the consultation with the concerned organizations upon the happening of the Sichuan Earthquake. In addition, there was a further delay of the project due to the delay in the procurement.

In consultation with the provincial government, procurement methods, construction and implementation management were put in the hands of each city, and project executing agencies and a framework and functions related to united construction management were not introduced. For that reason, understanding and response to this project vary according to the people's government of each city, which may affect the efficiency of implementation in each city.

3.2.3 Results of Calculations for Internal Rate of Return (Reference only)

(1) Financial Internal Rate of Return (FIRR)

At the time of the appraisal, the financial internal rate of return (FIRR) of the sewage project was 4.1%, which was calculated under the following conditions: project life should be 30 years; the benefit should be the revenue from the sewage rate charge; and the cost should be the project cost, operation and maintenance cost. Generally, it was calculated again at the time of the ex-post evaluation in the same way, and the following results were confirmed. Net budget as the project showed a loss in many facilities.[5]

Table 3: Recalculated result of Financial Internal Rate of Return (FIRR)

Project	Financial Internal Rate of Return (FIRR)	
Panzhihua city 1. Panzhihua city (Large) Sewage treatment plant 2. Panzhihua city (Small) Sewage treatment plant	At the time of the appraisal (entire city) 4.88%	Actual (entire city) Minus 1. 0.72% 2. Minus
3. Yibin city Pump station	At the time of the appraisal 5.11%	Actual 10.30%
4. Suining city Sewage treatment plant	At the time of the appraisal 4.04%	Actual Minus
Mianyang city 5. Mianyang city (Luxi-Huayuan) Sewage treatment plant 6. Mianyang city (Chenkang) Sewage treatment plant	At the time of the appraisal (entire city) 3.21%	Actual (Entire city) 10.74% 5. 14.45% 6. Minus 7. Minus

[5] Prerequisite is generally the same as the one at the time of the appraisal. The benefit should be the sewage treatment rate; the cost should be initial construction investment and maintenance cost. However, the output of Ziyang city, which was not relevant to recalculate, is excluded because it is sewage piping network only and difficult to extract the laying location of this project only and calculate the cost. In addition, regarding Yibin city, data related to the pump station management are acquired, so FIRR related to the cost of the pump station was recalculated. IRR for water supply was not calculated.

7. Mianyang city (Songya) Sewage treatment plant		

Source: Implementing organizations' responses to questionnaires and survey at local site
Note: Recalculation of entire city was calculated by adding expenses of each sewage treatment plant.

With regard to the recalculated results in each city, the main reasons why the result was different from the one at the appraisal are as follows.

1) Method of calculating sewage rate charge revenue: Likewise, at the time of the appraisal, the sewage rate charge revenue was set as the benefit. However, the flow of actual revenue from many treatment facilities adopts a system to receive an amount that adds a slight profit to the sewage treatment cost from the municipal government. [6]These revenues are set on the basis of maintaining soundness with single year management of this project, and the internal rate of return including initial investment showed as negative.
2) Two treatment plants in Mianyang city and Xiaoshaba sewage treatment plant in Panzhihua city remain a 30 to 60% sewage treatment amount and as a result, it is estimated that the internal rate of return is low. On the other hand, management of Luxi-Huayuan sewage treatment plant was commissioned to private company by the form of PPP contract for 30 years since 2015. It is assumed that higher FIRR was calculated since the city government has been paying higher treatment charge to the plant based on this contract.
3) Still, when revenue shows a loss, it adopts a system whereby the municipal government supplements the loss. It is therefore not so worrying that there is a severe restriction on project management finance. (detailed description in 3.4.3 in "Sustainability") Upon recalculation, financial statements are not submitted, so the amount by which the loss is supplemented is not confirmed.

In summarizing the evaluation of overall efficiency, the structure of the output changes in a major way from the time of the appraisal. However, this is because this project was placed in the entire development plan of each city at that time. It was inevitable that the details of the project changed because of the progress of the plan. Details of the changes are mostly appropriate from the perspective of achieving the project goal.

[6] As the method of calculation at the time of the appraisal did not clarify the details of revenue setting and structure of financial supplementation, it was difficult to have an exact comparison. However, with the consultation at the local site and confirmation of the materials, there is high possibility that IRR calculates the actual revenue of the project estimating financial supplementation, which assumed that recalculation of the net budget base was low. Two sewage treatment plants in Suining city and Panzhihua city, whose sewage treatment amount reaches 90% of treatment capacity, are greatly influenced by the factor described above. In the case of recalculation including financial supplementation amount, IRR is considered to be higher.

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

3.3 Effectiveness and Impact (Rating: (3)[7])

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and effect indicators)

As this project was implemented to bear a part of the development plan in each city, structure varies according to the needs and situation of each city, such as comprehensive improvement from sewage treatment plant to sewage pipes, and partial improvement of sewage pipes. To consider the evaluation of effect from the viewpoint of the nature of this project, attention was paid to the development situation of the entire water supply and sewage system of each city, especially, to what extent the basic capacity of sewage treatment was improved. The following is a specific analysis of operation and effect indicators in each city.

(1) Sewage facilities

1) Operation status of sewage treatment system

Table 4: Operation and effect indicator in each city

		Population treated (10,000 people)	Treatment amount (10,000 m^3/day)	Treatment rate (%)
Total of five cities[8]	Plan	**131.36**	**29.41**	**80%**
	Actual	**100.26**	**24.47**	**88%**
	Compared with the plan	**76%**	**83%**	**110%**
Yibin city	Plan	45.27	7.49	64%
	Actual	-	5	75%
	Compared with the plan	-	67%	**117%**
Suining city	Plan	36.3	10	53%
	Actual	46.6	12	85%
	Compared with the plan	128%	120%	**160%**
Mianyang city	Plan	7.21	1.56	100%
	Actual	3.55	0.45	100%
	Compared with the plan	49%	29%	**100%**
Panzhihua city	Plan	14.58	3.41	100%
	Actual	14.11	2.54	-
	Compared with the plan	97%	74%	-
Ziyang city	Plan	28	6.95	81%
	Actual	36	4.48	90%
	Compared with the plan	129%	64%	**111%**

Source: Materials provided by JICA and the implementing organizations' responses to questionnaires

[7] Sub-rating for Effectiveness is to be put with consideration of Impacts.

[8] Total number was calculated and evaluated by the data of 4 cities except Yibin City, since the respective data was not obtained from the executing agency.

With regard to the sewage project, which is the main part of this project, the result varies according to each city but overall, the population treated and treatment amount reach nearly 80% of the plan, which can be evaluated as satisfactory in general. The result was significantly lower than planned in Mianyang city and the background is as follows.

In Mianyang city, because of the Sichuan Earthquake in 2008, factories were not moved to scheduled economic development areas as main users and residents evacuated from some target area owing to the earthquake, which meant that the actual treatment amount dropped to approximately 53 to 70% of treatment capacity. According to local government personnel concerned, it is expected that the number of factories to be moved to the target area is secured, and it is planned to construct a new residential estate and to extend sewage pipe in the future. However, a specific plan was not confirmed at the time of the ex-post evaluation and the realization of the effect at the time of the ex-post evaluation is fair.

2) Effects in reducing pollutants in water

The following table compares water quality when main pollutants flow in and water quality when pollutants are treated in each city.

Table 5: Treatment effect of pollutants in water in the sewage treatment plant in each city subject to this project

	BOD (mg/L)			COD (mg/L)			SS (mg/L)		
	Input	Output	Reduction rate	Input	Output	Reduction rate	Input	Output	Reduction rate
Planned value		<10-20						n/a	
National standard		10			10			50	
Yibin city	123.3	15.2	88%		45.5		171.2	17.5	90%
Suining city	68.9	6.2	91%		24.9		75	6	92%
Mianyang city	70.4	8.7	88%	208.5	27.8	87%	100	9	91%
Panzhihua city	96.5	5.8	94%		15.1		180.3	5.5	97%
Ziyang city	132.92	13.2	90%	188.55	15.0	92%	132.9	13.2	90%

Source: Materials provided by JICA and the implementing organizations' responses to questionnaires

It is confirmed that discharged water from the sewage treatment plant which was constructed as an output of this project almost satisfied major pollutants such as BOD and COD among the National Class I Standard A, which is the strictest standard, and achieves the planned level of reduction. With regard to the reduction capacity of pollutants in the sewage treatment system in each city, it maintains the level as planned. With the future increase in demand, a higher effect will be expected.

Facilities improved through this project constitute the main part of a sewage system such as a main treatment plant and main line in the sewage system in each city, and considered to be the foundation of each city's own project lasting up the present. In that sense, it can be

evaluated that the facilities make an important contribution to the development of sewage infrastructure in each city. The following table summarizes details of the output contribution in each city.

Table 6: Position and contribution of this project in each city

City name	Position and contribution of this project
Yibin city	• Improvement of sewage pipes: Sewage pipe is laid to connect and carry waste to the existing sewage treatment plant, and a pump station was established, which helps to carry sewage in some urban areas to the sewage treatment plant located downstream. In addition, the improvement of sewage pipe in this project promoted conversion from a combined system to a separated system that is effective in increasing the treatment rate.
Suining city	• Sewage treatment plant: The sewage treatment plant of this project was constructed as a new sewage treatment plant that responds to the increased amount of sewage because it was impossible to expand the existing treatment plant, which was in a saturation state at that time. • Improvement of sewage pipe: The main pipe network was laid to carry sewage from industrial estates to the sewage treatment plant, which forms part of a sewage treatment system capable of treating an increasing amount of sewage discharge.
Mianyang city	• Sewage treatment plant: Contributed to improve the quality of the river and living environment in three town-level areas in the city where sewage treatment plants, which help to attract industrial estates and sewage treatment facilities, were established in areas where sewage was discharged directly into the river.
Panzhihua city	• Sewage treatment plant: Contributed to improve the river and living environment by establishing a sewage treatment plant in the area where sewage was discharged directly into the river.
Ziyang city	• Improvement of sewage pipe: Contributed to make the existing sewage pipe network complete as a cyclic structure in the urban area. Moreover, the sewage pipe network laid by this project made possible the conversion from a combined system to a separated system; at the same time, parks were maintained along the river in surrounding areas where pipe was laid, which helped to improve the living environment of residents.

Source: Implementing organizations' responses to questionnaires

(2) Water supply facilities

Panzhihua city is the only city where water supply is included in this project. Penetration of water supply at the time of ex-post evaluation is as follows.

Table 7: Coverage of water supply in Panzhihua city

	Standard	Plan	Actual	Compared to the plan
Diffusion of water supply (%)	95%	98%	n/a	n/a
Water supply population (10,000 people)	56	59	68.5	116%
Amount of water supply (10,000 m^3/day)	14	15	17.1	114%

Source: Implementing organizations' responses to questionnaires

It was unable to confirm an accurate diffusion rate but the water supply population and amount of water supply were significantly higher than planned, which proved that the expected effect is realized. This project is a limited output concerning the improvement of approximately 11 km of water supply pipe and system of the entire city. However, this section covers from the reservoir to filtration plant, which is an extremely important section

on water supply functionality. The contribution of this project to the entire functionality of the municipal water supply system is evaluated to be great.

In summary, the water supply project already achieves the goal and overall effect of the sewage project that is the main project of this project, reaching nearly 80%. It is therefore evaluated that the level of achievement of the entire effect is high.

3.3.2 Impacts

3.3.2.1 Intended Impacts

In this project, "Improvement of river water quality," and "Improvement of living environment of the residents in the target area" are positioned as impacts.

(1) Improvement of river water quality

1) Monitoring data of observation points

The following table compares the most recent water quality monitoring data of the major river systems at the time of the ex-post evaluation with data at the time of project planning.

Table 8: Water quality data at the downstream observation points of the relevant sewage treatment plants in each city involved in this project

City	Cross-section name	Test item	2007	2016
Yibin city[9]	Nanguan town	Water quality grade	—	III
		BOD (mg/L)	—	—
		COD	—	—
Suining city	Duiying river outlet	Water quality grade	III	III
		BOD (mg/L)	2.1	1.4
		COD	4.1	3.2
Mianyang city[10]	No data	Water quality grade		
		BOD (mg/L)		
		COD		
Panzhihua city	Jinsha Jiang river/ Jin Jiang cross-section	Water quality grade	I	II
		BOD (mg/L)	2.4	1.8
		COD	n/a	6
Ziyang city	Xingfu village	Water quality grade	III	IV
		BOD (mg/L)	2.2	2.8
		COD	16	16

Source: Materials provided by JICA and the implementing organizations' responses to questionnaires

[9] With regard to Yibin city, the external evaluator was unable to obtain satisfactory data from the Environmental Protection Bureau of Yibing Municipal Government.

[10] With regard to Mianyang city, the external evaluator was unable to obtain data to measure the impact of this project because no monitoring equipment for observation has been installed by the Environmental Protection Bureau at the tributary into which the sewage treatment plant discharges the sewage because the size of the river is too small.

The overall trend is that, although some indicators worsened, both the volume of pollutant loads and the river water quality (grade) are not showing much change. The Environmental Protection Bureaus of each city mentioned that the main reasons for this are (1) the fact that factors adversely impacting on water quality have been increasing with the progress of urbanization and industrialization by the economic development and (2) deterioration due to the industrial sewage from Chengdu (the capital of the province) in the upper river basin.

Recently, the Environmental Protection Bureaus have also been intensifying their restrictions on sources of pollution and taking such actions as improved monitoring systems and providing guidance by way of on-site inspections, so it seems that more pollutant reduction measures have progressively been installed.

Although the external evaluator was able to confirm that measures including this project have been effective in controlling contamination of the water to a certain degree in "Effectiveness," it seems that, regarding long-term improvement of river water quality, continuous regulatory and control measures as well as monitoring are essential.

2) Improvement of living environment of the residents

In this project, it was expected that improvement of the living environment would be achieved by improving the sewage system. During the field survey period, the external evaluator conducted interviews with local residents and other stakeholders in each city and confirmed the following opinions:

- Mianyang city (local resident): Before the improvement of the sewage pipeline, sewage was flowing without any treatment, so there were many flies and mosquitoes, and parasitic worms as well. In addition, as untreated household sewage including cooking oil and detergent was discharged directly into the river, it was impossible to use the river water for agriculture. At that time, septic tanks were installed in each household, but as methane gas was generated from the wastewater stored in the septic tank, people's health was at risk. In particular, the odor coming from the septic tank was strong in summer. As these problems were all eliminated by improvement of the sewage system, everyday life became a lot more comfortable.
- Mianyang city (proprietor of a restaurant): Previously, the business of those stores that were located alongside the river was adversely affected by mosquitoes and flies, odor, etc. However, such problems have been eliminated now; the environment has improved and customers are coming back. In addition, response to hygiene issues has been improved because of stricter government control; for example, nowadays they are using waste disposal companies to dispose of their oil and food scraps.

- Panzhihua city (local resident / a resident who lives opposite the sewage treatment plant alongside the river): Before the improvement of the sewage treatment plant and sewage pipeline, untreated rainwater and sewage was discharged directly into the river during heavy rain, so the color of the river was exactly the same as the sewage. However, now the color of the river has changed to a "pure" color and the odor has gone as well. The water quality has been improved so much that we can use the river water for bonsai plants and house cleaning.

The Jinsha Jiang river, located in the upper river basin of the Chang Jiang River, into which sewage is discharged from Panzhihua city sewage treatment plants

A riverside park in Ziyang city

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

At the time of project planning, the impacts on the natural environment by this project were assessed as follows and the following mitigation measures were to be implemented:

1) The target areas of the project do not fall under the category of a susceptible area such as a national park or its vicinity; therefore, undesirable impact on natural environment should be minimal.
2) As the drainage from sewage treatment plants will be discharged into the river after it is treated so as to satisfy domestic sewage standards in China, no specific impact is anticipated in relation to the discharge of treated water.
3) The sludge generated at the sewage treatment plants should be properly disposed of at existing landfill disposal sites.

When the external evaluator checked the implementation status on the site, no serious problems that could not have been anticipated at the beginning in any cities was observed; therefore, it is fair to evaluate that, in general, appropriate measures have been taken.

With regard to treatment of sludge, all sewage treatment plants are treating their sludge by drying it in the plant to lower the moisture content to a certain level; then, they give it to those companies that make fertilizer from sludge, concrete companies, and other sludge

disposal companies. Regarding form of contract, some sewage treatment plants pay fees to dispose their sludge, while others sell their sludge. The following table shows environment-related measures at the time of construction and monitoring systems in five cities subject to this project.

Table 9: Measures and monitoring system to mitigate the environment impact on surrounding areas during construction in each city

City	Mitigation measures on environment impact	Monitoring system
Yibin city	Waste disposal: Building material waste was transported to designated disposal/repository sites. Dust: Sprinkling with water was implemented. Noise: Installation of noise insulation and absorption device.	—
Suining city	Waste disposal: Building material waste and gravel waste was transported to Chuangxin Industrial Park and disposed as banking material. Dust: Sprinkling with water was implemented. Noise: Elaborating construction plan and installation of noise insulation device.	At the time of construction, Environmental Protection Bureau of the Sichuan Provincial Government carried out an inspection and assessment. In January 2015, as a result of a post-construction environmental assessment meeting, this project received a Notification of Acceptance from the Environmental Protection Bureau of the Sichuan Provincial Government.
Mianyang city	Waste disposal: Intensive collection and transportation was carried out. Dust: Sprinkling with water was implemented. Noise: Installation of noise insulation and absorption device. Sewage: Sedimentation in a sedimentation pond was carried out.	Under the guidance of the Urban Construction Environmental Protection Bureau, the sub-contractor company carried out an on-site inspection once a month to check the status of dust and noise-related measures.
Panzhihua city	Waste disposal: Building material waste was transported to designated disposal sites. Dust: Sprinkling with water was implemented. Noise: Construction was carried out in compliance with specific national standards[11]. When some work is required at night in relation to concrete depositing, application was made to obtain night work permission.	It was implemented by respective implementing organizations under the guidance of the Environmental Protection Bureau of Panzhihua municipal government.
Ziyang city	Dust: Sprinkling with water was implemented Noise: Construction work was not carried out at night; and an insulation device was installed at the construction site.	The Environmental Protection Bureau of Ziyang municipal government, once a month, carried out inspection of water quality, soil, noise, vibration, and dust.

Source: Implementing organizations' responses to questionnaires

(2) Impacts on the social environment

At the time of planning, it was scheduled to obtain 13 ha of land. However, actually in almost all the cities, the government had already acquired the sites in advance. Therefore, most outputs were constructed on state-owned land. The only exception was the case in Panzhihua city where six small factories were relocated for the construction of Xiaoshaba sewage treatment plant. It was due to the unforeseen changes of the site during detailed design stage, and the compensation was paid to acquire a plot of 3.32 ha in accordance

[11] Regulatory standard: To be complied with GB3096-93, GB12348-90

with relevant legislation[12]. In addition, in case of Dadukou sewage treatment plant in Panzhihua city, as they cut down the trees on the site at the time of construction of the sewage treatment plant, they paid the cost of planting the same number of trees they had cut down to the town-level government.

As stated above, this project has largely achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: (3))

3.4.1 Institutional Aspect of Operation and Maintenance

According to the plan, in this project, the Sichuan Provincial People's Government is the overall project implementing body to oversee each municipal government, and relevant implementing organizations in each city (relevant state-owned enterprises) are in charge of everything from construction to management. Such an implementing and managing framework has been implemented almost according to the plan, and the project was implemented with the Sichuan Provincial People's Government sitting on top of everything. Project offices were established inside each municipal government and actual implementation was carried out by investment companies and sewage treatment business operators in each city.

With regard to operation and maintenance, there has been no major change either and the business operators in each city are in charge of them. All of them are business corporations that manage all aspects of water and sewage operation in each city; therefore, responsibilities and the chain of command concerning the operation and maintenance of water supply and sewage system have all been clearly articulated.

The outline of each city including organizational framework and the number of staff are shown as follows:

Table 10: Operational Framework for Water supply/sewage System in Each City

City	Outline and analysis of name of organization, scale, and framework
Yibin city	1. Changes from the plan: **Yes (change of name)** 2. Detail: Yibin Qingyuan Water Affairs Limited Company (state-owned enterprise) is in charge of construction of the pumping station and sewage pipeline and maintenance and management of the pumping station after that. The management division of the pumping station consists of approximately 36 staff members. The sewage pipeline is under the jurisdiction of Bureau of Water Affairs.
Suining city	1. Changes from the plan: **Yes (elimination and consolidation of organization)** 2. Detail: Suining Water Affairs and Investment Limited Company (state-owned enterprise) is in charge of construction of a sewage treatment plant & sewage pipeline and management of the sewage treatment plant after that. The maintenance and management of the sewage pipeline is carried out by the Housing Construction Committee. In addition, the Suining Water Affairs and

[12] The following legislation was applied: *Panzhihua city urban housing control bylaw* and *People's Republic of China Land Act*

	Investment Limited Company is also checking the manholes at regular intervals. Approximately 24 staff members are in charge of operation including administrative staff.
Mianyang city	1. Changes from the plan: **Yes (change of management company)** 2. Detail: The companies which constructed respective outputs and the companies that operate respective sewage treatment plants and pumping stations are different. Summary of operating companies are as follows. • Luxi-Huayuan Sewage treatment plant: Mianyang Kaitian Environmental Protection Company (a PPP-style private limited company); This sewage treatment plant is operated by 14 staff members including management and administrative staff. • Songya Sewage treatment plant: Mianyang Jingkai Water Affairs Limited (state-owned enterprise); This sewage treatment plant is operated by around 10 staff including operations management and other technical staff. • Chenkang Sewage treatment plant: Mianyang Xiantong Environmental Protection Science & Technology Limited Company (state-owned enterprise); Operated by around 18 staff members including administrative staff.
Panzhihua city	1. Changes from the plan: **Yes (change of management company)** 2. Detail: All outputs have been transferred from those companies that were in charge of construction to those that are in charge of operation and maintenance of the water supply/sewage system. The Panzhihua Water Affairs (Group) Limited (state-owned enterprise) is in charge of water supply/sewage operation and no major organizational change is scheduled for the future. Operated by around 30 staff members including administrative staff.
Ziyang city	1. Changes from the plan: **Yes (change of management company)** 2. Detail: Currently, sewage pipelines are under jurisdiction of the Ziyang city Municipal Administration Bureau[13].

Source: Implementing organizations' responses to questionnaires

On the basis of interviews in these cities, it has been confirmed that, in regard to arrangement of the staff and operational framework, an appropriate number of staff members are allocated in proportion to the size of the respective sewage treatment plants and treatment system. Therefore, the operational framework of each city at the time of the ex-post evaluation does not have any problem for the purpose of operation and maintenance.

3.4.2 Technical Aspects of Operation and Maintenance

Compared with the time of the appraisal, operational technologies concerning sewage treatment have been well established in China as well, and project implementing organizations of each city has also accumulated sufficient experience. As they provide training to many employees every year concerning professional knowledge and technical knowhow, systems to maintain engineering skills have been generally established. In addition, with regard to the collaboration between these cities and mutual exchange, there has been almost no history of that as they are operating independently.

The following table shows an outline of each city's skill level and training system for skill development.

[13] At the time of the first field survey, the external evaluator confirmed that, because of administrative reform, jurisdiction would be transferred from Ziyang city Water Affairs Bureau, which has been in charge of maintenance and management of sewage pipelines, to Municipal Administration Bureau, a separate organization. However, as the Municipal Administration Bureau was still in the transition period, the external evaluator confirmed the framework of the Water Affairs Bureau which was directly responsible for management. In addition, the external evaluator obtained an answer from the staff of the Water Affairs Bureau that the current framework in the Water Affairs Bureau would be maintained as it is.

Table 11: Skill level and training system for skill development in each city

City	Technical evaluation items and their overall condition
Yibin city	1) **Skill level:** A dedicated department has been established to manage the pumping station and engineers are posted exclusively for the pumping station. In addition, at the site, they post "Organize" and "Tidy up," a part of 5S, as their code of conduct. The staff on duty was able to tell me the details of inspection and response at the time of emergency. In addition, with regard to the record of routine inspection, the inspection record book of the applicable date was confirmed. 2) **Training system:** They implement training sessions 38 times a year, and they are keen to let their engineers participate in government-sponsored training and vocational school courses in addition to in-house training.
Suining city	1) **Skill level:** As they are also in charge of operation of No. 1 Sewage Plant, they exchange their engineers regularly so that engineers can share the experience at both sewage plants. Engineers, including the director of the plant and engineers for water quality inspection, were able to give a briefing concerning the details of inspection, response at the time of trouble, and so on without a problem. 2) **Training system:** In addition to sending their staff to different sewage plants in other cities for inspection as well as opportunity for studying, they implement training sessions three to four times a year including training on operation and management.
Mianyang city	1) **Skill level:** When the external evaluator checked, the details of verbal inspection and responses at the time of emergency with those engineers who were carrying out routine inspections at each sewage treatment plant at the time of the field survey, it was found that they were able to give explanations about the respective procedures without a problem. 2) **Training system:** At the respective sewage treatment plants, they conduct training sessions at least three times a year and up to nine times a year. Regarding the contents, they range from operation and management to safety measures and sewage plant technologies.
Panzhihua city	1) **Skill level:** Periodic exchange of engineers has been implemented among four sewage treatment plants operated by the managing company and lessons and knowhow are also shared. Engineers, including the director of the plant and engineers for water quality inspection, were able to give a briefing about the details of inspection, how to obtain parts at the time of breakdown, and response at the time of emergency in a positive manner. 2) **Training system:** They provide training on sewage treatment plants once or twice a year.
Ziyang city	1) **Skill level:** Because, at the time of the field survey, the external evaluator was only able to interview an engineer who could only open/close a manhole, the evaluator has not been able to confirm the procedures, etc. related to inspection of a manhole. According to the response to the questionnaire, they conduct inspection on sewage pipeline four times per month. 2) **Training system:** The Ziyang city Water Affairs Bureau,[14] which is responsible for the operation and maintenance of sewage pipeline, conducts a staff training session three to four times a year.

Source: Implementing organizations' responses to questionnaires

In evaluating the engineering skills of each city, the external evaluator prepared a checklist in cooperation with an expert on sewage system and had a session with local stakeholders along the lines of these listed items. As a result, it has been confirmed that, at each sewage treatment plant, the answers of engineers who carry out on-site inspections are appropriate and they have established a good system regarding things to do in inspection and response at the time of emergency. In addition, the external evaluator saw that all sewage treatment plants of the five cities which gave answers to the evaluator's questionnaire have appropriate management procedures and abilities to implement them; for example, they have a handling manual for emergency situations.

On the basis of the above, it is confirmed that there is no major problem in regard to technical aspects of operation and maintenance.

[14] As mentioned in the previous footnote, as the bureau in charge of operation and maintenance of sewage pipeline was in a transition period at the time of survey, the external evaluator confirmed this with the Bureau of Water Affairs which is the previous organization before the transition.

3.4.3 Financial Aspect of Operation and Maintenance

(1) Plan at the time of the appraisal and outlook for financial soundness

As it was planned that the cost of operation and maintenance should be covered by the water and sewage rate income, it was planned that the water affairs company consigned by the respective municipal government would collect sewage rates together with water service rates. As the level of sewage rates (0.1–0.35 yuan/m^3) was too low to cover the cost of operation and maintenance, it was considered that they should be increased gradually from 2006 to a level (0.8 yuan/m^3)[15] that was high enough to cover the cost of operation and maintenance by 2010.

(2) Actual financial management situation

As financial statements of each city were not allowed to be disclosed, the external evaluator was unable to analyze the financial situation in detail on the basis of financial statements. In the table below, the external evaluator carried out an overall analysis mainly on the basis of two standpoints, the total structure of the operation as public utility services (expenditure of subsidies, etc.) and the direct income and expenditure structure of the operation.

Table 12: Financial situation at each city

City	Profitability
Yibin city	Rate income: None Profitability of the service in itself: △ The government provides funding for the operation and maintenance in relation to the operation of pumping stations.
Suining city	Rate income: None Profitability of the service in itself: △ The government allocates some funding in proportion to the volume of sewage they treated at a unit price which is set in consideration of a certain level of profit. If the operation resulted in deficit, the deficit is compensated by the government.
Mianyang city	Rate income: None Profitability of the service in itself: △ The government allocates some funding in proportion to the volume of sewage they treated at a unit price which is set in consideration of a certain level of profit. If the operation resulted in deficit, the deficit is compensated by the government. In addition, with regard to PPP style, payment is made at a unit price which is approximately four times as much as the actual volume of sewage treated. However, it should be noted that, as the volume of sewage any of the sewage treatment plants is treating is up to 70% or so of the capacity at the moment, the unit cost per treatment volume becomes higher than the one for the sewage treatment plant that is operating at its maximum capacity.
Panzhihua city	Rate income: None Profitability of the service in itself: △

[15] The water supply/sewage service rate planned for 2010 was approximately 4.9% for Panzhihua city, where the average income rate per household was the highest, and the rate was considered within an affordable range for the users. As of July 2017, as the water supply/sewage service rate per household in Panzhihua city is 2.7 yuan/m^3, the current average income rate is approximately 5% which is almost unchanged compared with the time of planning. Although service rates in themselves have increased along with economic development and Consumer Price Index (CPI) increase, they are staying in an affordable range for the users.

	The government allocates some funding in proportion to the volume of sewage they treated at a unit price which is set in consideration of a certain level of profit. If the operation resulted in deficit, the deficit is compensated by the government.
Ziyang city	Details were not identified

Source: Implementing organizations' responses to questionnaires

In each city, the financial management of the treatment system is not self-sustained structure by the revenue of water charge, but it takes the form of the budget allocation by the municipal government, which covers the necessary cost for service operation. To work out such input, also applicable to the PPP-style company, a unit price consisting of sewage treatment cost by the government plus a certain margin of profit has been established, and if the operation ended up in deficit, the deficit is compensated by the municipal government. Therefore, it is a structure where the actual soundness of financial management depends on the financial situation of the respective government.

In addition, as the management and operation of sewage services are almost separate in each city except for a part of Mianyang city (Water Affairs Bureau, Finance Bureau, or a commissioned company are in charge of rates collection), the departments/organizations in charge of the sewage system in each city could not obtain all the details/data concerning actual rate income and collection status.

Although there is no major concern regarding financial matters and the service is being operated without a problem at this point of time, as the external evaluator has not been able to obtain detailed information concerning the financial status of each city, the project's financial sustainability is fair.

3.4.4 Status of Operation and Maintenance

With regard to the status of facilities management in each city, the external evaluator checked such matters as the actual condition of facilities, how spare parts are prepared, and how maintenance is being carried out by on-site inspections to see the actual facilities, interviews with relevant local agencies, and checking the inspection records, etc. The following table shows the summarized status in each city.

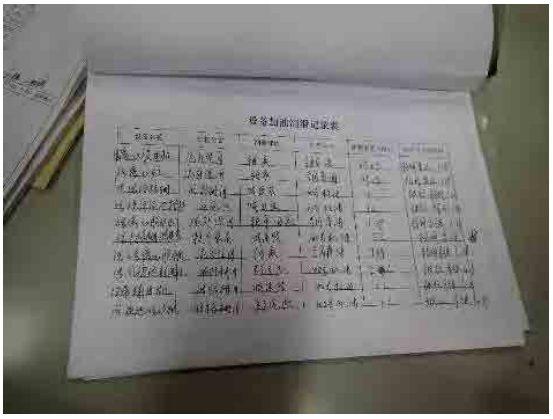
Table 13: Facilities maintenance and management status in each city

City	Condition of the facilities/Maintenance status
Yibin city	1. Facilities: Good 2. Maintenance status: The details and frequency of routine inspections have been established for sewage pipeline and pumping stations, and inspection records are kept in accordance with established procedures. In addition, they have engineers who have repairing skills. With regard to spare parts, they do not have any problem either as all spare parts are ones that can be procured domestically.
Suining city	1. Facilities: Good 2. Maintenance status: The details and frequency of routine inspections have been established for sewage pipeline and pumping stations, and inspection records are kept in accordance with established procedures. In addition, they have engineers who have repairing skills. With regard to spare parts, they do not have any problem either as all spare parts, although they are the parts

	of an overseas manufacturer, are ones which can be procured domestically.
Mianyang city	(Summary of 3 locations) 1. Facilities: Good 2. Maintenance status: The details and frequency of routine inspections have been established for sewage pipeline and pumping stations, and inspection records are kept in accordance with established procedures. In addition, they have engineers who have repairing skills. With regard to spare parts, they do not have any problem either as all spare parts, although they are the parts of an overseas manufacturer, are ones which can be procured domestically.
Panzhihua city	1. Facilities: The conditions of both sewage treatment plants and pipeline network (water supply/sewage) are good. 2. Maintenance status: Monthly inspection items and frequency have been established for all facilities and inspection is carried out by a team of two to five members. Manuals are issued for routine inspection and training; and, inspection records are kept. For example, the water service pipeline is set to be inspected for damages, etc. four to eight times a month.
Ziyang city	1. Facilities: Good (manholes in the city) 2. Maintenance status: The Water Affairs Bureau, by way of a team of two to four people, conducts routine inspections four times a month

Source: Implementing organizations' responses to questionnaires

Mianyang city
FY2017 safety check work plan table for the Songya Sewage treatment plant



Suining city
Record of sewage treatment plant maintenance

Main facilities have been maintained in good condition, partially because it has not been too long since completion, and there is no major concern at this time. Maintenance plans and access to after-sales services by the manufacturers are confirmed as adequate to maintain the condition. Spare parts, etc. are also in stock. It is fair to evaluate that they generally keep stable management.

Although it is difficult to make a precise evaluation on financial sustainability as detailed information was not confirmed, it is fair to say that the sustainability of this project, except for some cities, is high supported by fiscal funds from each municipal government[16]. On the basis of the above, no major problems have been observed in institutional, technical and financial

[16] According to the responses from the implementing organizations, collection rates for water supply/sewage system services of 2017 in each city are as follows: 100% in Yibin city, Suining city, and Panzhihua city; 90% in Ziyang city, and "no answer" for Mianyang city. These results cannot be used to directly evaluate what respective cities' financial conditions are, but they can be used as an index to ensure sustainability.

aspects, or the current status of the operation and maintenance system. Therefore, sustainability of the project effects is high.

4 Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented in five cities in the upper river basin of the Chang Jiang River in Sichuan Province to reduce the discharge of water pollutants into the rivers in each city and facilitate stable and safe supply of water through the construction of sewage facilities and water supply facilities, thereby contributing to improvement of the living environment for the residents in the said area.

The project is consistent with China's development policy and requirements at the national and municipal levels between the time of the appraisal and the time of the ex-post evaluation; therefore, the project as a whole is highly relevant. Although the outputs were significantly modified from the time of planning, as this was a flexible response to the urban planning of each city, it is fair to say that these changes were appropriate in achieving the purpose of the project. The efficiency is fair because although the project cost is a little lower than planned, the project period is far longer than planned. The constructed water supply/sewage facilities are operating smoothly and, except for some cities where urban development was delayed, the volume of sewage treated, coverage, and the effect of reducing the discharge of pollutants have all achieved their goals as planned. Thanks to the improvement of sewage treatment rate, the volume of polluted water discharged into the river has been reduced, contributing to the improvement in water quality of major rivers in each city; therefore, the level of achievement regarding effectiveness and impact of this project is high. With regard to the sustainability of this project, no significant problem is found in the institutional and technical aspects. The fiscal management of some cities are stable at this stage, since detailed financial information of some cities were not obtained, financial sustainability of the project is evaluated to be fair. Main facilities are in good condition and total sustainability is high. In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Improvement of effectiveness and efficiency by reinforcing coordination with the city development plan:

In this project, the implementation period deviated greatly from city to city resulting in extreme differences in the construction period, with the fastest construction period being within 60% of the plan and the slowest period more than double it. In successful cities like Panzhihua city, the importance of the project was clearly identified from the planning stage, municipal government took the initiative of prompt procurement and contract process, coordination with concerned sections. This promoted sectional coordination and smooth coordination with development projects implemented in parallel. When the project is significantly linked to the overall infrastructure development of the city and flexible modification or adjustment is required in relation to the overall plan, it would be effective to integrate the project into the development plan from the planning stage through the execution of the project, and authorize the executing agency to skip certain procedures required for design or scope change, or incorporate the framework similar to program loan by defining the assistance for the entire urban development plan. In addition, it would enhance the efficiency of implementation if each city shares their knowledge and experience through the monitoring of the provincial government.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1.Project Outputs		
1) Sewage pipeline	Sewage pipeline In total: 297 km Yibin city 62 km Suining city 27 km Mianyang city 140 km Panzhihua city 21 km Ziyang city 47 km	Sewage pipeline In total: 192 km Yibin city 33.3 km Suining city 18.5 km Mianyang city 93.4 km Panzhihua city 7.4 km Ziyang city 39.4 km
2) Pumping station	Total: 20 locations Mianyang city: 14 locations Yibin city: 6 locations	Total: 8 locations Mianyang city: 2 locations Yibin city: 6 locations
3) Sewage treatment plant (New construction: one location)	Total: 4 locations Treatment capacity: 99,000 m^3/day Suining city: 1 place; 60,000 m^3/day Panzhihua city: 3 locations; 39,000 m^3/day	Total: 6 locations Treatment capacity: 112,000 m^3/day Suining city: As planned Panzhihua city: 2 locations; 39,000 m^3/day Mianyang city: 3 locations; 13,000 m^3/day
4) Water supply	Water supply pipeline Panzhihua city 9 km	Water supply pipeline Panzhihua city 10.8 km
5) Training	Training on management staffs, training on sewage treatment technology	Cancelled
2 Project period	March 2007–December 2012 (70 months)	March 2007–June 2017 (124 months)
3 Project cost Amount Paid in Foreign Currency	6,815 million yen	6,116 million yen
Amount Paid in Local Currency	3,894 million yen (263.1 million yuan)	3,344 million yen (225.94 million yuan)
Total	10,709 million yen	9,460 million yen
ODA Loan Portion	6,300 million yen	6,065 million yen
Exchange rate	1 yuan = 14.8 yen (As of December 2006)	1 yuan = 15.08 yen (average exchange rate between 2007 and 2016)
4 Final Disbursement	September 2015	

People's Republic of China

FY2017 Ex-post Evaluation of Japanese ODA Loan Project

"Henan Province Nanyang City Comprehensive Environment Improvement Project"

External Evaluator: Kenji Momota, IC Net Limited

0. Summary

This project was implemented to reduce the discharge of water pollutants into the rivers in Nanyang City, Henan Province, and ease the air pollution burden, through the construction of wastewater treatment facilities and gas supply facilities that impose low environmental burdens, thereby contributing to the improvement of the living environment in the city.

The project is consistent with China's development policy and needs at the national and municipal levels from the appraisal to the present time. Although there have been changes in the operation of bio-gas production facilities as a result of an increase in natural gas supply under the national policy, the project as a whole is highly relevant. The efficiency is low because the project cost is a little higher than planned and the project period is far longer than planned. The constructed wastewater treatment facilities are operating smoothly and the effect of reducing the discharge of pollutants has manifested itself as expected. Although there is some concern that the bio-gas production facilities may have problems, gas has been supplied to Nanyang City almost as planned and the purpose of popularizing cleaner energy than coal has almost been achieved. Because the wastewater treatment ratio increased and the amount of wastewater discharged into the rivers decreased, the water quality of the main river, the White River (Baihe River), in the city is on improving trend. In addition, along with increase in the gas supply resulted in decrease in the consumption of coal and any other type of energy that imposes a high environmental burden, air pollution has been prevented from worsening. For these reasons, the effectiveness and impact of the project are high. With regard to the sustainability of this project, no significant problem is seen in the organizational and technical aspects. Although there is a slight concern over the financial condition of the gas production facilities, the gas supply is expected to increase in the future and it is likely that the financial condition will improve from both the mid- and long-term perspectives, and thus the influence seems limited. In light of the above, this project is evaluated to be satisfactory.

1. Project Description

Project location

Gas station in Nanyang City

1.1 Background

In China, while rapid economic growth was achieved, environmental pollution was accelerated from the 1980s because of its industrialization and increasing population. As a result, both the water and air environments continued to be far worse than the national standards. During the term of *the 10th Five-Year Plan (2001–2005)*, the Chinese government strived to protect the water environment through such measures as designating important protection areas and setting numerical reduction targets for the amounts of water pollutants. However, the government could not cope with the increasing discharge of industrial and domestic wastewater as a result of the rapid economic growth, and failed to reach the targets. On the other hand, air pollution became serious because of the substances produced through the burning of coal, the main primary energy source, such as sulfur oxides (SOx), total suspended particles (TSP), and nitrogen oxides (NOx) contained in automobile exhaust gases and dust. In addition, it was necessary to immediately restrain the emission of carbon dioxide (CO_2), etc., which causes global warming. To cope with this situation, China established *the 9th and the 10th Five-Year Plans (1996–2000 and 2001–2005 respectively)* to carry out measures against industrial pollution and develop urban infrastructures, such as city gas. However, China failed to fulfill the objective of reducing the emissions of main pollutants by 10% compared with 2000.

Nanyang City in Henan Province is located along the middle basin of the Yangzi, one of the seven major rivers in China. In the city, while the amount of wastewater increased as a result of the economic growth, the construction of wastewater treatment facilities was delayed. Without being treated, domestic and industrial wastewater was directly discharged into the middle basin of the Yangzi, which is important as a source of drinking water. As a result, the water quality[1]

[1] River water quality is classified into Grades I to V according to the Environmental Quality Standards for Surface Water (GB3838-2002). Grade-I water is mainly water at the source of a river in a national natural protection area. Grade-II water is used mainly for drinking and exists in a first-grade protection area, an area for rare kinds of fish,

of the Baihe River, which runs through the center of the city, sometimes reaches Grade below V, indicating a serious state of water pollution. In addition, energy demand was satisfied mainly by energy produced from coal, which has become the main source of air pollution. Therefore, improving the air environment was a urgent task.

1.2 Project Outline

The project aims to reduce the discharge of water pollutants into the rivers in the city and ease the air pollution burden, through the construction of wastewater treatment facilities and gas supply facilities which impose low environmental burdens, thereby contributing to the improvement of the living environment in Nanyang City, Henan Province.

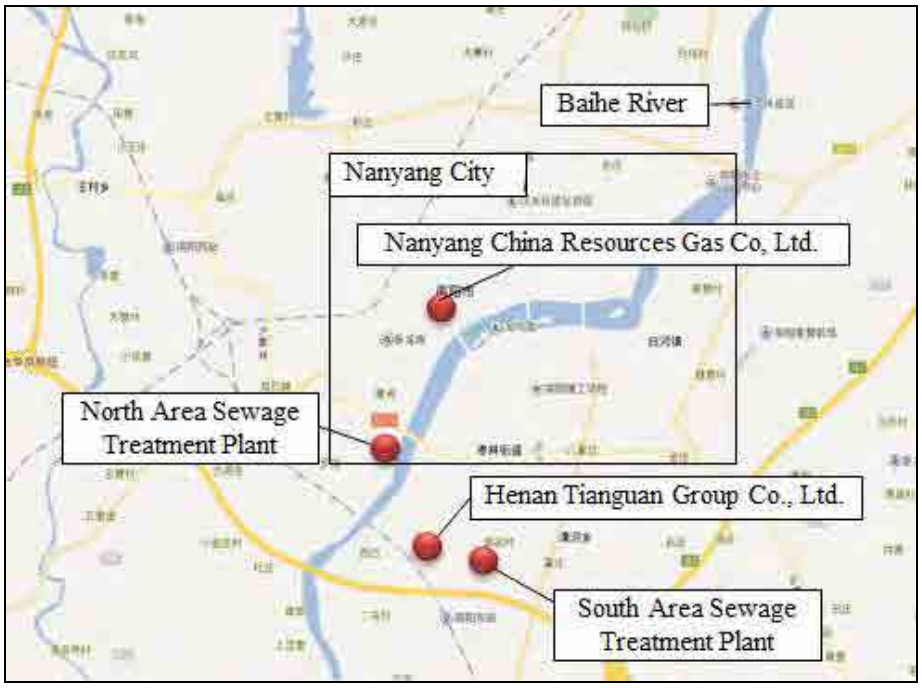
<ODA Loan Project>

Loan Approved Amount / Disbursed Amount	11,500 million yen / 10,114 million yen
Exchange of Notes Date / Loan Agreement Signing Date	December 2007 / December 2007
Terms and Conditions	Interest rate: 0.65% Repayment Period: 40 years (Grace period: 10 years) General Untied
Borrower / Executing Agency	Government of the People's Republic of China / Henan Provincial People's Government
Project Completion	April 2015
Main Contractors (Over 1 billion yen)	1. Beijing Zhonghui United Environmental Engineering Co., Ltd. (People's Republic of China): supply of materials and equipment 2. Henan Haorui General Engineering Co., Ltd. (People's Republic of China): supply and installation of plant equipment
Main Consultant (Over 100 million yen)	None
Related Studies (Feasibility Studies, etc.)	F/S (prepared by the Central and Southern China Municipal Engineering Design & Research Institute in May 2007)

or a place for fish or shrimp spawning. Grade-III water is used mainly for drinking and exists in a second-grade protection area, an area for protection of general fish, or a swimming area. Grade-IV water is used mainly as general industrial water and exists in a general industrial water area or a water area for entertainment where people cannot directly touch the water. Grade-V water is mainly used for agriculture and exists in an agricultural water area. It is also used for securing the general landscape.

Related Projects	[Japanese ODA loan] Henan Environmental Improvement Project (2002) [Asian Development Bank] Henan Wastewater Management and Water Supply Sector Project (2005)

The following map shows the central area of Nanyang City, the project site, and the Baihe River, which runs through the city.



Source: Prepared by the author based on Baidu Maps (URL: http://map.baidu.com/ (Accessed 4 June 2018))

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenji Momota, IC Net Limited

2.2 Duration of the Evaluation Study

This ex-post evaluation study was conducted according to the following schedule.

Duration of the Study: August 2017–March 2019

Duration of the Field Survey: October 23–November 1, 2017; March 25–30, 2018

2.3 Constraints during the Evaluation Study

None in particular.

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

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of China

(1) Consistency with the Development Plan at the Time of the Appraisal

Although the Chinese government began to carry out measures for improving the urban environment, such as the development of sewerage systems, measures against industrial pollution, and the establishment of urban gas systems according to *the 10th Five-Year Plan*, the objective was not attained. Thus, in *the 11th Five-Year Plan (2006–2010)* and in *the Notice on Printing of the Comprehensive Work Plan for Energy Saving and Emissions Reduction by the State Council (June 2007)*, the government included the objective of strengthening environmental improvement measures and reducing the total emissions of main pollutants by 10% compared with 2005. Moreover, the government restricted the construction of coal thermal power plants in urban areas and promoted the construction of thermal sources with lower air pollution burdens, such as centralized heat supply facilities and gas supply facilities.

In *the 11th Five-Year Plan for Economic and Social Development of Henan Province*, Henan Provincial People's Government expressed the objective of reducing the amount of main water pollutants and air pollutants by 10% by 2010 through promoting the construction of wastewater treatment facilities and promoting the use of alternative renewable energy sources in the existing energy systems. Responding to this, Nanyang Municipal People's Government established *the 11th Five-Year Plan for Economic and Social Development of Nanyang City* and *the 11th Five-Year Plan for Environmental Protection of Nanyang City*. These plans promoted improvement of the water and air environments through such measures as developing wastewater treatment facilities connected to the Baihe River, which was the most heavily polluted of all the rivers running through the city, substituting any coal-using facilities in the city with gas supply facilities, and strengthening environmental monitoring.

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

Regarding measures against water pollution, in *the 12th Five-Year Plan (2011–2015)*, the central government placed importance on the promotion of measures to prevent water pollution in important basins, the protection of river environments, and the strengthening of ecological control, aiming to reach the target of 85% for the wastewater treatment ratio in urban areas. In *the 13th Five Year Plan (2016–2020)*, this target was raised to 95% to make the numeric target stricter. *The 12th and 13th Five-Year Plan for Economic and Social Development of Henan Province*, the corresponding plans at the provincial/municipal level, aim to promote the construction of urban sewerage networks and construct wastewater treatment facilities in new

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

[3] ③: High, ②: Fair, ①: Low

urban areas, intensive industrial zones, and population settlements for the efficiency of the treatment system. In addition, they encouraged those companies discharging polluted water and intensive industrial zones to strengthen their control of the total emissions of pollutants in a strict fashion and promoted the concentrated treatment of wastewater, urging the seriously polluting companies to construct facilities for the prior treatment of wastewater. Following these main plans of Henan Province, Nanyang City plans to construct wastewater treatment facilities in the central area and the prefecture-class administrative wards, make sludge from the wastewater treatment facilities harmless, remodel and expand its urban network of sewage pipes, and construct a network of pipes for dividing rainwater and wastewater.

In the atmosphere sector, the central government's *12th Five-Year Plan* expresses the objective of making the air quality level[4] Grade II or better in 80% in the urban areas of prefectural- or higher-level administrative areas. In addition, it is stated that the government encourages the diversification of clean energy, including biomass energy, as a measure for reducing air pollutants. *The 13th Five-Year Plan* also places importance on the reduction of air pollutants and sets forth the objective of increasing the city gas ratio with the objective of a 25% reduction in the number of days of heavy pollution in the urban areas of prefectural- or higher-level administrative areas. In addition, at the provincial/municipal level, the plan sets forth the objective of improving urban air pollution comprehensively and keeping the air quality level in province-class cities at Grade II or better for 292 or more days. Nanyang City's plan designates the Tianguan group, the agency who is implementing this project, as the core firm for promoting biomass energy and large-scale industrial bio-gas,[5] and promotes remodeling and expansion of gas pipes in the central urban area of Nanyang City.

As described above, priority is given to the improvement of water and air pollutants at the level of each development plan of Nanyang City and Henan Province as well as the national level, and thus highly consistent with this project, which aims to improve the river and atmospheric environments through the construction of both wastewater treatment facilities and gas supply facilities with low environmental burdens. The improvement of water and air pollutants continued to be given priority in the period between the appraisal and the ex-post evaluation. The central government has encouraged companies to keep their target volume of emissions reduction in a stricter fashion than before in the national development plan. Both Nanyang City and Henan Province have also maintained the attitude of placing importance on improvement since the appraisal. Therefore, the project is highly relevant to the development plan.

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[4] Air quality is divided into three grades according to *the Ambient Air Quality Standards (GB3095-2002)* (new standards came into force in 2016 and the number of grades was reduced to two). Grade I: nature protection areas, etc.; Grade II: residential areas, general industrial areas, farming areas and other areas designated under the urban plan; Grade III: specified industrial areas (integrated into Grade II in 2016)

[5] Main projects include the Tianguan group's production of 300,000 tons of ethanol a year, production of 240 million m^3 of bio-gas, and biomass electric generation of 1.01 billion kwh.

3.1.2 Consistency with the Development Needs of China

At the time of the appraisal, the population of Nanyang City was about 800,000. With the development of the economy, the volume of domestic and industrial wastewater was increasing, while the wastewater treatment ratio in the urban district was 52.2% because of a delay in the construction of wastewater treatment facilities. Unprocessed sewage flowed out into the rivers in the city, worsening the water quality of the Baihe River, the city's main river, down to Grade below V. In addition, although 86% of the demand for energy in the city was fulfilled by energy produced from coal, the facilities that were using coal had low energy efficiency and lacked adequate dust catching and desulfurizing systems. While these were the main causes of air pollution, the supply rate of gas, one of the alternative energies, was only 11.4%.

In the period between the appraisal and the ex-post evaluation, the population further increased by more than 70%, from about 800,000 at the time of the appraisal (in 2007) to about 1.4 million in 2015. Consequently, in Nanyang City, the number of cars, which cause air pollution increased and became tenfold the one at the time of the appraisal (from 212,000 in 2008 to 2,267,000 in 2015).[6] Allowing for further increases in population in the future, the development needs for wastewater treatment and gas supply remain high even at the time of the ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

In *the Medium-Term Strategy for Overseas Economic Cooperation Operation* (2005 to the first half of 2008) of the Japan International Cooperation Agency (JICA), of all the priority sectors, such as support for poverty reduction, development of infrastructures for sustainable development, and support for measures to cope with global problems and peacebuilding, JICA clarified importance on the development of farming villages through the construction of sewerage systems in poverty areas, the promotion of sustainable growth through the development of highly needed economic and social infrastructures, such as waterworks, sewerage systems, and energy facilities, and measures against air and water pollution for the purpose of making the development compatible with the environment.

Moreover, in *the Country Assistance Strategy for China*, JICA has identified environmental problems resulting from rapid economic growth and places importance on environmental conservation mainly in inland areas.

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[6] Source: Statistical Report on the Economic and Social Development in Nanyang City

3.1.4 Appropriateness of the Project Plan and Approach

(1) Changes in the Use of Bio-gas Production Facilities

The bio-gas business established under the project mainly consists of gas production facilities and gas supply facilities through pipelines. Although the produced bio-gas was planned to be used as the main source of supply of gas sent to the city through pipelines, it is now regarded as a supplementary source of supply of gas to the city and the amount of supply is only about 10% of the initially planned amount. This is due to the influence of changes in the national policy. The facts and backgrounds can be described specifically as follows:

1) Nanyang City requested the central government to supply natural gas under the West-East Gas Pipelines Project (WEPP), a China's national project.[7] When the project was planned initially, natural gas was planned to be supplied by using the WEPP. However, because Nanyang City was not able to obtain the supply of gas in the first term of the WEPP, which began in 2004, the project was planned by incorporating gas production facilities.
2) Although most of the produced gas was supplied to the city from the beginning of the project until 2012, it was decided in 2012 that Nanyang City could obtain a supply of natural gas in the second term of the WEPP. As a result, the main gas to be supplied was changed to natural gas. Bio-gas was changed to a supplementary energy source to natural gas. Because of this change, facilities for purifying gas were constructed for gas production, and bio-gas has continued to be supplied together with natural gas.
3) The amount of bio-gas sent through pipelines after purification accounts for only about 10% of the total amount of supplied gas. Types of produced gas have been diversified, including those used for other purposes.

Because of the background described above, the purpose of use of the produced bio-gas changed and the ratio of the amount of produced bio-gas to the total amount of supplied gas decreased. This change was inevitable because it was influenced by the low foreseeability of the national policy at that time. When the project was planned, while demand for gas was high, Nanyang City was not able to obtain the supply of gas in the first term of the WEPP. Because Nanyang City, a local city, could not predict when it could obtain the supply of natural gas, it seems appropriate that the city secured its own source for supplying gas under the project. In addition, the pipelines used for gas supply were designed so that they could be used for both bio-gas and natural gas, and from the outset measures were enacted on the assumption that bio-gas would be used together with natural gas. Therefore, the impact of changes in the policy was minimized. Moreover, because Nanyang City continues to expect an increase in gas supply

[7] Under the WEPP, natural gas is collected from the Tarim oil field in the Shinjang Uyghur Autonomous Region and is transported to major cities in the eastern coastal area through pipelines with a total length of about 4,000 km. In the first term, the whole section was completed in 2004.

and because the supply of only natural gas will make it difficult to secure the stable supply of gas, demand for bio-gas produced under the project is expected to increase in the future.

Therefore, the implementation of the project is highly relevant to the development plan and development needs of the Chinese People's Government, the Henan Provincial People's Government, and the Nanyang Municipal People's Government as well as Japan's ODA policy. In addition, although there has been a change in the project plan concerning the purpose of use of the produced bio-gas, it can be evaluated that the project as a whole, including this change, is highly relevant if consideration is given to the response to the high needs for gas supply at the time of the appraisal, the preliminary response to the prediction of conversion in the future, and the stable supply of gas through the diversification of supply sources.

3.2 Efficiency (Rating: ①)

3.2.1 Project Outputs

The following table shows the planned and actual outputs in this project, indicating that this project was carried out almost as planned:

Table 1: List of Outputs

	Plan	Actual
Wastewater treatment facilities	Total length of drain pipes: 224 km	Almost as planned[8]
	Wastewater treatment plants (expansion of 1 plant): 100,000 m^3/day (water recycling facilities: 30,000 m^3/day	Almost as planned The treatment method was changed.
	Wastewater treatment plants (construction of 1 plant): 100,000 m^3/day	As planned The treatment method was changed.
Gas supply facilities	Gas production facilities: bio-gas, 395,000 m^3/day	Almost as planned 4 IC reactors were changed to 10 UASB reactors.
	Gas pipe network: 250 km	As planned
	Gas vaporization facilities, gas pressure governor facilities	As planned

[8] Regarding the extent of treatment at the North-area Wastewater Treatment Plant, it was confirmed that the sewage pipe networks initially planned to be constructed were covered. Regarding the extent of treatment at the South-area Wastewater Treatment Plant, the local development plan was partially changed and the plan for sewage pipe networks also was changed. Sewage pipe networks have been established in the already developed areas. Because it was difficult to acquire statistical information about sewage pipe networks, it was difficult to measure the total length of the networks constructed by Japanese ODA loans accurately. However, based on consultations with local related agencies, it was judged that the initially planned networks were constructed almost as planned.

Training	Training program in Japan for the implementing agency's staff concerning sewerage service and gas supply service	Training in sewerage service was changed to training in China. Two staff members participated in gas supply service training program in Japan.

Source: The planned outputs are based on materials provided by JICA, while the actual outputs are based on the implementing agency's responses to questionnaires.

The background to main changes in the outputs is as follows:

(1) Wastewater treatment facilities

Although there was no change in the outputs concerning drain pipes, all the portions planned to be constructed using Japanese ODA loans were constructed using domestic funds, because the Nanyang City government planned to construct new roads in the initially planned sites and, at the same time, install drain pipes next to the roads.

As the process for treating sewage, the improved A_2O process has been adopted by both the North- and South-area Wastewater Treatment Plants. When the feasibility study was carried out for this project, the AO process was selected to fulfill the second-class standards among the national drainage standards,[9] but the Environmental Protection Bureau of Nanyang Municipal People's Government requested in November 2007 that this project should improve the drainage level to first-grade A. Thus, with the appraisal approval of the Provincial Development Reform Committee, the wastewater treatment process was changed to the improved A_2O activated sludge process, which is highly effective for removing nitrogen and phosphorus.

Although training could not be held in Japan because of stricter domestic procedures under cost-saving ordinance (December 2012), domestic technical training was held for the staff of the wastewater treatment center three times as a substitute.

[9] Regarding China's standards for drainage from wastewater treatment plants, *the Standards for Irrigation Water Quality (GB18918-2002)*, which were enacted by the State Environmental Protection Administration and the General Administration of Quality Supervision, Inspection and Quarantine, classifies drainage levels into first-grade A, first-grade B, second grade, and third grade in light of the condition, purpose of use, and other aspects of the area to which the sewage is discharged.

Aeration tank at the North-area Wastewater Treatment Plant
(The improved A_2O process was adopted)

Aeration tank at the South-area Wastewater Treatment Plant
(The improved A_2O process was adopted)

(2) Gas supply facilities

Regarding gas production, although it was initially planned that four IC reactors would be procured, in reality ten UASB reactors were procured. Because UASB reactors are more popular than IC reactors in China and can lower the cost, it was possible to increase the number of reactors.

Regarding the training program in Japan, one gas production staff member and one Japanese ODA loan office staff member participated in a 20-day training program in Japan concerning "Technologies for plant wastewater treatment and recycled water use" in October 2012.

Gas production facilities

Gas supply regulator station

3.2.2 Project Inputs

3.2.2.1 Project Cost

Although the total project cost was initially estimated to be 27,388 million yen (including a Japanese ODA loan of 11,500 million yen), in reality it was 29,701 million yen (including a Japanese ODA loan of 10,114 million yen), 108% of the estimate. The cost increased mainly

because of increases in the raw material cost and the personnel cost during the project period. In addition, the following points need special mention concerning the project cost:

- The wastewater treatment process was changed from the AO process to the A_2O process, which is more precise. Accordingly, the procured equipment and the suppliers were changed. As a result, the planned cost increased.
- Because of changes in the urban plan of Nanyang City, the installation of drain pipes, including the improvement of drainage canals and rivers, was carried out using domestic funds before the Japanese ODA loans were issued.
- Because the training program in Japan was substituted with domestic training, the cost decreased.

3.2.2.2 Project Period

Although the initially planned period was between December 2007 and January 2013 (61 months), the actual period was prolonged much longer, between December 2007 and May 2016 (101 months, 66% longer than planned). The period of each subproject was as follows:

Subproject	Plan (at the time of L/A signing) (2007)	Actual[10]	Compared with plan
1) Wastewater treatment facilities	Dec. 2007 to Jan. 2013 (61 months)	Dec. 2007 to May 2016 (101 months)	166%
2) Gas supply facilities (Gas production)	Dec. 2007 to Nov. 2011 (47 months)	Dec. 2007 to Apr. 2012 (52 months)	111%
2) Gas supply facilities (Gas supply)	Dec. 2007 to Dec. 2011 (48 months)	Dec. 2007 to Apr. 2016 (100 months)	208%

Sources: The plan dates are based on materials provided by JICA; the actual results are based on the project-implementing agency's responses to questionnaires.

Reasons for the delay in subprojects are as follows:

1) Wastewater treatment facilities

Regarding the wastewater treatment facilities, the design and the issuance of approval were delayed at the preparation stage, which influenced the processes thereafter. As a result, the trial run of the North-area Wastewater Treatment Plant began in September 2012. Moreover, construction of the network of main drainage pipes connected to the South-area Wastewater Treatment Plant was delayed because of a delay in the development of the entire area, which was a new industrial area, covered by the treatment. Because the treatment plant could not be operated until the network of drainage pipes had been completed, the start of construction of the

[10] At the time of planning, the time of completion was defined as the time of completion of the Henan Provincial People's Government's project inspection, which was planned to be carried out one year after the beginning of trial run. However, the actual inspection was greatly delayed because some subprojects were inspected, including equipment installed using domestic funds. Therefore, at the time of the evaluation, the time of completion was defined as the initially planned time of inspection – that is, one year after the beginning of trial run.

plant was delayed because of the delay in the construction of the network. Although there were no problems that might have caused a delay during the construction process, the duration of the subproject became 66% longer than initially planned mainly because of the reasons above.

2) Gas supply facilities

The establishment of gas production facilities smoothly progressed from the design stage to construction and was not delayed greatly.

The establishment of gas supply facilities was greatly delayed and took twice as much time as planned. This was because construction of part of the gas pipeline network was delayed for about two years. The gas supply itself already began in December 2012, when about 70% of the whole network had been completed. The establishment of the pipeline network was delayed mainly because approval for construction to begin could not be gained owing to the priority given to the construction of fields for the national athletic meet for farmers held in Nanyang City in 2012. In addition, in line with this project, part of the supply pipeline network was installed using the government funds. Within the framework of the whole plan, including the part installed using the funds, the part of the pipeline network covered by this project was completed in April 2015.[11]

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

(1) Financial Internal Rate of Return

At the time of the appraisal, the financial internal rate of return (FIRR) was calculated under the following conditions: the project life should be 30 years; the benefit should be the revenue from charges; and the cost should be the construction and maintenance costs. When FIRR was recalculated in the same way at the time of the ex-post evaluation[12], FIRR for the wastewater treatment facilities increased to 4.83% from 3.8% at the time of the appraisal. FIRRs for gas production and supply are 6.31%[13] and 6.24% respectively, slightly decreasing from 8.1% at the time of the appraisal. Regarding the factors for improvement of the wastewater treatment facilities, although a simple comparison is difficult because the calculation method is different

[11] The point in time when all planned values were achieved was regarded as being the time the trial run began, and the time of completion was estimated to be one year after (April 2016).

[12] When FIRR was recalculated, the revenue from charges as main benefit was multiplied by income unit price of each facility (e.g., income per m^3) and the actual amount (e.g., the amount of wastewater treatment, gas production and gas supply). In the cost, the construction cost was allocated by payment year as initial investment, and the maintenance cost was multiplied by the actual expenditure unit price and the actual amount. For example, the actual amount of treated wastewater was multiplied by the cost and revenue per m^3. Because the sewerage plants do not directly collect charges from the beneficiaries, it was assumed that the revenue and cost of treatment per unit was the total revenue and operational expenditure in the financial statements, divided by the annual amount of treatment.

[13] As a result of changes in the project scope, there are various operations, including not only those related to bio-gas but also purified bio-gas production and electricity generation added by domestic funds. When this was calculated, consideration was also given to the operation costs, production costs, and revenues of the bio-gas purification facilities and the electricity generation facilities.

from that at the time of the approval, as described below in the "Effectiveness and Impacts" section, it is fair to say that improvements in the quality of the wastewater flowing into the treatment plants resulted in a reduction in the treatment cost per unit and an improvement in the rate of return. The reasons for the declining rate of return at gas supply facilities seem to be complex ones such as a change in the structure of the production side and the supply side due to the change in the project scope, a decrease in the production amount of bio-gas described later, a slight decrease in the supply unit price according to the government policy. However, because both operations have achieved a certain rate of return, some financial stability has been secured for the management of operations. The Economic Internal Rate of Return (EIRR) was not calculated, because it was not long after the completion of this project and it was difficult to collect data on the beneficiary areas.

Based on what was described above, the project cost slightly exceeded and the project period significantly exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness and Impacts (Rating: ③[14])

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The following is a specific analysis of the operation and effect indicators of each subproject.

(1) Wastewater Treatment Facilities

Name of indicator	Standard 2005	Target 2013	Actual performance 2015 Year of beginning	Actual performance 2016 Year of completion	Ratio to target Actual performance / target value
North-area Wastewater Treatment Plant Population of treatment (10,000 people)	52.2	55	100	-	182% (Year of beginning ratio)
North-area Wastewater Treatment Plant Wastewater treatment capacity (10,000 m^3/day)	10	20	18.9	18.9	95% (Year of completion ratio)
North-area Wastewater Treatment Plant Wastewater treatment volume (10,000 m^3/day)	10	20	20	20	100% (Year of completion ratio)
South-area Wastewater Treatment Plant Population of treatment (10,000 people)	0	24	28	30	125% (Year of completion ratio)

[14] Sub-rating for Effectiveness is to be put with considerations of Impacts.

South-area Wastewater Treatment Plant Wastewater treatment capacity (10,000 m^3/day)	0	10	10	10	100% (Year of completion ratio)
South-area Wastewater Treatment Plant Wastewater treatment volume (10,000 m^3/day)	0	10	4.65	7.07	71% (Year of completion ratio)
Wastewater treatment ratio (%)	34	67	-	-	

Sources: Materials provided by JICA, the project-implementing agency's responses to questionnaires

The total capacity of both treatment plants is 300,000 m^3/day. In 2016, the capacity reached 259,700 m^3/day of sewage, 87% of the designed treatment capacity. It is fair to say that this state of operation is satisfactory. On the other hand, because there is no extra room in the treatment capacity, polluted water was deposited in the sewage pipes, and the plants have been running at a high water level.[15] Although there is no serious effect at present, if this state continues, the generation of hydrogen sulfide or stinking gas may result in the corrosion of equipment, and the shortage of organic substances may result in the worsening quality of the treated water. Therefore, it may be necessary to take measures to maintain the stability of the wastewater treatment systems for extended periods of time. The population of treatment reached 162% of the target in 2015,[16] with both the treatment amount and the population of treatment almost achieving their targets. Because demand is estimated to increase further, the North-area Plant plans to expand its capacity by 100,000 m^3/day, using domestic funds.

The following table compares water quality at the time of the main pollutants' inflow and after treatment at each treatment plant.

[15] In Japan, a wastewater treatment plant is designed with an ample capacity calculated based on the maximum annual amount of sewerage. However, both plants were designed based on the daily average amount of inflow according to the ordinary design method in China. Because the treatment capacity is not large enough, pipe storage and high-water level operations, in which the plants usually store sewage in pipes and uniformly pump it up for 24 hours a day, have been continuously performed by storing sewage in the sewer. (for details, see the separate detailed analysis paper).

[16] The degree of achievement for the population of treatment is higher than the degree of achievement for the amount of treatment because the standards for wastewater discharge from plants have been applied more strictly than at the time of planning and local people's awareness of water conservation has increased, resulting in a considerable improvement in the quality of the water flowing into the treatment plants.

Name of indicator	Standard 2005	Target 2013	Actual performance 2015 Year of beginning	Actual performance 2016 Year of completion	1st-class level A
BOD concentration at North-area Wastewater Treatment Plant					
Entrance	280	-	125.3	93.1	-
(mg/L) Exit	-	30	5.3	5.3	10
COD concentration at North-area Wastewater Treatment Plant					
Entrance	500	-	218.9	172.4	-
(mg/L) Exit	-	100	27	26.6	50
SS concentration at North-area Wastewater Treatment Plant					
Entrance	280	-	19.86	21.94	-
(mg/L) Exit	-	30	0.93	0.87	10
BOD concentration at South-area Wastewater Treatment Plant					
Entrance	280	-	74	80	-
(mg/L) Exit	-	30	5.6	5.2	10
COD concentration at South-area Wastewater Treatment Plant					
Entrance	500	-	328.36	267.07	-
(mg/L) Exit	-	100	22.82	11.58	50
SS concentration at South-area Wastewater Treatment Plant					
Entrance	280	-	125	115	-
(mg/L) Exit	-	30	6	5	10
Removal COD (tons/year)	-	27,000	18,425	16,655	-
Removal BOD (tons/year)	-	-	9,439	7,988	-

Sources: Materials provided by JICA, the project-implementing agency's responses to questionnaires

Both wastewater treatment plants' average rate of reduction of the amount of pollutants has reached 93%. Since both plants began operating, they have achieved first-grade level A, the regulation level for treated water. Because the standards for wastewater discharge from factories are applied more strictly than at the time of the appraisal, the quality of sewage flowing into the treatment plants has improved and the quality of the treated water has greatly improved since the time of the planning. The treatment plants are monitoring data in real time, including the chemical oxygen demand (COD), and the suspended solids (SS) at the entrance and exits. Data are also sent to the Environmental Protection Bureau of Nanyang Municipal People's Government. Because strict measurement and control systems have been adopted, the reliability of the data is high.

The target rate of removal COD by this subproject was 68% in the beginning year. As described above, however, the concentration at the entrance has become much lower than the standard level. Accordingly, the amount of COD reduced by the treatment plants has decreased.

(2) Gas Supply Facilities

The gas supply facilities are evaluated in terms of the status of bio-gas production and the diffusion of gas supply to Nanyang City. The following are the main indicators:

Name of indicator	2005	2013	2014	2015	2016	Target
Gas supply						
Population of supply (10,000 people)	52.2	49.2	63.9	69.3	84.2	79
Amount of supply (10,000 m^3/day)	2.9	14.1	17.7	19.8	24.1	-
(Converted into bio-gas)*	-	28.1	35.4	39.6	48.1	42
Gas pipelines	-	12.7	9.4	17.2	21.2	-
(Converted into bio-gas)	-	25.4	18.9	34.4	42.3	-
Bio-gas equipment	-	1.4	8.3	2.6	2.9	-
(Converted into bio-gas)	-	2.7	16.6	5.3	5.8	42
Supply rate in whole city (%)	11.4	-	-	-	-	37.7
(Supply rate in urban area)**	16	41	45	46	52	33.5
Gas production						
Production capacity (10,000 m^3/day)	10	49.5	49.5	49.5	49.5	49.5
Amount of production (10,000 m^3/day)	-	33.6	39.8	38.7	16.9	49.5
Production of bio-gas	-	30.3	19.7	32.3	9.8	49.5
Conversion to purified bio-gas (Amount of terminal supply) ***	-	1.4	8.3	2.6	2.9	-
Amount of TSP reduction (tons/year)	-	7,800	-	-	-	
Amount of SO^2 reduction (tons/year)	-	25,200	-	-	-	

* Purified process (purified bio-gas) is necessary for supplying bio-gas as natural gas. Usually, the amount of unit production of finally produced purified bio-gas is equivalent to half of that of bio-gas.

** Because it was difficult to acquire information on population, the supply rate in the whole target area, the effectiveness indicator at the time of the appraisal, was replaced with the supply rate in the urban area.

*** Converted into purified bio-gas

At present, the population of gas supply in Nanyang City is about 840,000 and the amount of gas supply in the city is about 240,000 m^3 (480,000 m^3 if converted into bio-gas). The supply rate has reached 52%. These indicators are higher than initially planned. On the other hand, although the plants have kept their bio-gas production capacity at 495,000 m^3/day as planned, the actual production has remained at only around 34% of the initially planned production. This is mainly for the following two reasons:

- As described in "3.1.4 Appropriateness," because it was decided that natural gas would be introduced to Nanyang City through the national gas pipeline network, the main source for the gas supply is natural gas at present and bio-gas is used as a supplementary gas source.

- Since 2016, production has been adjusted, because international oil price fluctuations resulted in a decrease in the supply amount of raw materials for bio-gas (liquid waste discharged from factories).

Meanwhile, regarding the future status of utilization, the gas supply facilities is expected to be used more, because of the implementing agency following measures and changes in the business environment. To use the surplus production capacity effectively, the implementing agency used domestic funds to construct facilities for generating electricity using bio-gas in the gas supply facilities and began to operate them in May 2013. In 2017, the implementing agency began to sell electricity for the national power networks. In the future, in addition to using it as a supplementary supply source, the agency will attempt to use it effectively through these supply services.

In addition, the central government's priority measures for bio-fuels are expected to improve the business environment. In 2017, 15 government offices, including the National Development and Reform Commission, announced the plan to use bio-fuels for ethanol gasoline and expand the production of it, declaring the objective of entirely popularizing ethanol gasoline for automobiles by 2020. It is difficult for gas producers to secure a sufficient amount of factory-discharged liquid waste as a raw material for gas production because this depends on the volume of production by ethanol factories as suppliers. However, with the increase in demand for ethanol fuels owing to national policy, ethanol factories, the raw material suppliers, are expected to increase production.

Based on what was described above, the effectiveness of the whole project will be discussed. Regarding the wastewater treatment facilities, because almost all the indicators, such as population of treatment, the amount of treatment, and improvement of the quality of the discharged water, have been fulfilled, it is fair to say that this project has produced effects. Regarding the gas supply facilities, improvement in the gas supply within the city and an increase in the diffusion rate have almost been achieved. Given the increase in the population of supply also, it can be evaluated that the purpose of popularizing clean gas as a substitute for coal has almost been achieved. In addition, because the impacts described below demonstrate the tendency to improve air quality in Nanyang City, it can be evaluated that the purpose of this project has been favorably achieved. However, the gas production facilities constructed under this project have not produced even half of the initially planned amount of gas. Although the bio-gas production equipment has performed its function as a supplementary source in case of a shortage of natural gas as a supplementary energy source and has played an important role in establishing the system for a stable gas supply, issues remain concerning use of the outputs, which account for about 20% of the total project cost. However, the effectiveness of this project

can be expected to increase from both mid- and long-term perspectives because of the following: demand for ethanol fuels is likely to increase due to the national policy; demand for bio-gas can be expected to increase; and measures have been taken to diversify the purpose of use through development of the power generation business using gas.

In light of the above, the whole gas supply project is evaluated to have achieved the initial purpose.

3.3.2 Impacts

3.3.2.1 Intended Impacts

In the project, "Improvement of river water quality," "Improvement of air environment," and "Improvement of gas supply" are positioned as impacts.

(1) Improvement of River Water Quality

1) Monitoring data of observation points

The following data show changes in the water quality at major observation points on the Baihe River where treated sewage is discharged.

Name of indicator	2007	Target value	2013	2014	2015	2016
Water quality at the discharge destination (grade)	Below V	IV	V	IV	IV	IV
Water quality at the discharge destination (BOD: mg/L)	36.6–38.4	6	5.66	5.64	5.19	5.28
Water quality at the discharge destination (COD: mg/L)	139–146	30	25.2	26.6	22.9	24.7
Water quality at the discharge destination (NH_3-N: mg/L)	4.25–4.41	1.5	1.71	0.841	0.897	0.839

Source: Materials provided by the implementing agency
The water quality at the discharge destination is the water quality of the observation cross-section (Wa Dian) which is the same as that during the FS conducted in 2007.

Values of the water quality at the discharge destination have been declining across all indicators (water quality grade, the biochemical oxygen demand (BOD), COD, and ammonia nitrogen (NH_3-N)), compared with those at the time of the project planning (2007). This resulted in a significant improvement in the national standard water quality grade from category Below V to category IV. All sewage generated in the urban areas of Nanyang City is treated in the north plant and the south plant which were improved in this project. Improvements in the sewage treatment systems significantly improved the water pollution in the Baihe River. As for improvement of water quality at the discharge, it is necessary to consider the influence of stricter pollution control of factory wastewater since the revision of the Environment Protection Law in 2015. However, in 2014, all target values had already been achieved, and the impact of water quality improvement by the project is still considered to be high.

2) Results of interviews with beneficiaries

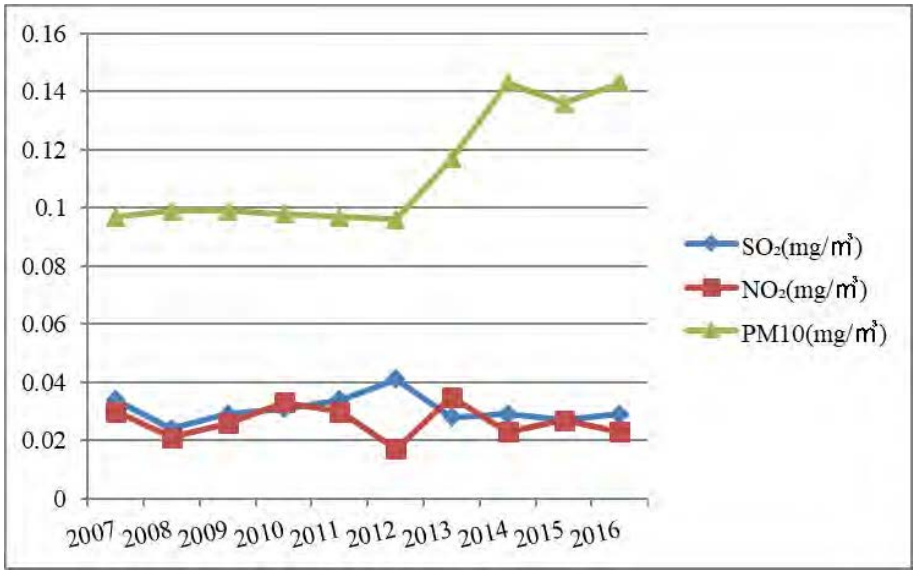
To understand what the beneficiaries think about "improvement of the river water quality," interviews were conducted with related enterprises and organizations to investigate changes in both the corporate activity environment and the river environment before the project implementation (2007), and at the time of the ex-post evaluation (2018). The results of these interviews are summarized below.

- Effects of benefits on businesses: According to a man who runs a transportation company which collects gravel from the bottoms of rivers and sells it as building material, the gravel collected from the bottom of the Baihe River could not be sold as a product when he established the company in 2006 as its color was black and its quality was poor. Therefore, he went outside the city to collect gravel. Because of the high costs needed for long-distance transportation, the company's profitability declined. However, since around 2012, the color of the gravel in the Baihe River has improved. By digging deep and collecting gravel that had a low impact from the sludge, he could meet the quality standards requested by his customers and collect gravel effectively. This improved the company's earnings.
- Effects of benefits on residents: According to a man who enjoys fishing and swimming in the river on a daily basis, he was accustomed to swimming only in the upper river basin because of the poor water quality, but now he can swim in the lower river basin as well. In addition, fish caught around the lower river basin had a muddy smell when cooked, but those caught recently do not have a muddy smell and are tasty. He realized the water quality has improved.

Although these results are based on interviews with a limited number of beneficiaries, what they realized indicates the improvement of the river water quality described above. It is fair to say that these results demonstrate the recent improvement in river water quality.

(2) Improvement of Air Environment

The table below shows changes in the annual average values of the contamination of air pollutants in Nanyang City.



With the progress of urban development, PM10[17] has been increasing. On the other hand, sulfur dioxide (SO_2) and nitrogen dioxide (NO_2), which are generated mainly owing to the combustion of fossil fuels, have been slightly declining. It seems that a decline in the use of coal-derived fuels is the main cause for this. As mentioned in "Relevance," Nanyang City's GDP and population have been continuously increasing, and the number of private vehicles has been dramatically increasing. However, SO_2 and NO_2, which increase in proportion to such increases, have been slightly declining. It is supposed that, of the city's entire energy consumption, fossil fuels have been consumed less or environmental measures have been taken to energy consumed.

The gas supply ratio in urban areas of Nanyang City increased from 16% before the appraisal to over 50% at the time of the project completion. Accordingly, it is fair to say that the spread of the gas supply has made a certain contribution to improving the air environment, with the decline in the consumption of coal and other inefficient energy sources.

(3) Improvement of Gas Supply

During the field survey, interviews were conducted with beneficiaries who were receiving the gas supply, such as crude processing-related enterprises and regional residents. The opinions from the enterprises include the following: "The introduction of natural gas has enabled us to achieve the national standard value of air pollutant emissions (imposed on each enterprise), which has been tightened in recent years, and contributed to our stable operation," and "The introduction of natural gas has increased the efficiency of our heating furnace." Among the opinions from the residents are "The change from propane gas to natural gas has improved the heating efficiency of our cooking utensils and the uniformity of the heating power," and "The change has reduced the cooking time."

[17] Of particulate matter floating in the air, matter with a particle diameter of 10 μm (0.01 mm) or less

Based on the opinions above, the results of the interviews show that the gas supply project has made a certain contribution to improving corporate activities and the living environment.

3.3.2.2 Other Positive and Negative Impacts

(1) Pollution Control Measures

In the project construction phase, the following measures were taken upon requests from the Environmental Protection Bureau and the Construction Administration Management Bureau of Nanyang Municipal People's Government:

- Dust control measures: Motor sprinklers were used to prevent soil dust.
- Noise control measures: Noise-reduction devices were used during the construction period. At sites where it was necessary to carry out construction work at night, noise-reduction measures were taken for the construction devices, and sound insulating walls were placed around the site. Night-time work was prohibited.
- Sewage pollution control measures: Discharged water generated during the construction period was collected in the sewage collection pond and delivered to the existing intake pump through the sewage pipe.

As a result of these measures, it was confirmed that the contamination in the surrounding environment was minimized and no delay or accident was caused by such contamination.

Concerning discharged water and sludge generated in the project implementation phase, the following measures have been taken:

1) Sewer plants

Until June 2017, all sludge generated had been reclaimed at waste treatment plants. After the sludge treatment center, developed by Nanyang City using its own funds, started operations in July 2017, all sludge generated at the sewage treatment plants has been treated with compost at the sludge treatment center after performing the dewatering process to reduces the moisture content to 80% or less.

2) Gas supply plants

Concerning discharged water generated during the production process of bio-gas, A_2O treatment, OD treatment, and final sedimentation are processed. The value of the treated water has been decreased to the regulatory value for discharged water or below, as specified by the Environmental Protection Bureau of Nanyang Municipal People's Government. The water is directly discharged into the Baihe River while part of the water is recycled as regenerated water.

Sludge dewatering process at the North-area Wastewater Treatment Plant

Drainage treatment in the gas production project

(2) Impacts on the Natural Environment

Problems not intended in the EIA report have not occurred, and as described above, since adequate contamination measures are taken at the time of the project construction and implementation, particular negative impacts on the natural environment have not been observed.

(3) Impacts on the Social Environment

An acquisition of 22 ha of land was planned at the time of the project planning, but a total of approximately 40 ha of land was actually acquired. The land acquired includes an area of land acquired for the next construction of a sewage treatment plant (land for purposes other than the project)[18]. As had been planned, there has been no resettlement. The land acquisition and compensation were made in accordance with land-related laws such as the "People's Republic of China Land Act," the "Implementation Regulations of the People's Republic of China Land Management Act," and the "Henan Province 'Land Management Act' Implementing Act," with specific compensation standards for each area.

In addition, complaints from residents have not occurred due to the implementation of the project.

(4) Others

With the Clean Development Mechanism (CDM) application in November 2011, the Certified Emission Reductions (CERs) transfer, of up to 5.95 million tons of CO_2, from the gas production project to a British enterprise (Allied Energy Capital UK Limited) was approved, and the project was identified as a clean energy project. It can be said that CO_2 reduction effect of the project was internationally recognized.

[18] The project site is adjacent to the planned site for the construction in the subsequent term in the same premises, and it is difficult to calculate the area of the project site precisely. However, the impact on the social environment is considered low because it was confirmed that the acquired land is an abandon area without residents.

As stated above, the project has almost achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspects of Operation and Maintenance

(1) Sewer Plants

As had been planned, the sewer plants have been managed by "Nanyang Sewage Purification Center," a state-owned enterprise. The center is an organization that focuses on treatment plants and sewage treatment, and does not collect sewage rates. Currently, the total number of its employees is 233 (including 22 administrative managers, 159 technical personnel, and 52 clerks). The percentage of technical personnel is around 68% of the total employees.

(2) Gas Supply Plants (Production/Supply)

The gas production project has been operated by a methane gas production company established as a subsidiary of "Henan Tianguan Enterprise Group Co., Ltd.," a state-owned enterprise. Currently, the total number of employees for the production project is 131 (including 106 production personnel and 25 non-production personnel). An alcohol plant which provides liquid waste, a raw material for bio-gas production, to the production project is also a subsidiary of Tianguan Enterprise Group. The plant has applied a system to supply all generated liquid waste.

The gas supply project had been operated by "Nanyang ZhengRan Fuel Gas Co., Ltd.", which had been a state-owned enterprise. Then in 2009, the company became a subsidiary of the China Resources Group[19] and was renamed as "Nanyang China Resources Gas Co, Ltd". The total number of its employees is 750 (Technical personnel: 35%). With improvements to operational efficiency, such as the use of unattended stations, the number of employees has been declining.

Concerning the method of collaboration between the production section and the supply section, they determine the supplied amount and the quality of bio-gas based on a contract, and through the procurement operation system, their procurement centers promptly communicate with each other by telephone.

3.4.2 Technical Aspects of Operation and Maintenance

As the operational technology for sewage treatment and gas supply had been established in China at the time of the appraisal, no major problems have been observed. An expert in the sewer service joined the field survey and evaluated both the capacity and the operating system from a technical perspective. This evaluation confirmed that the operation sections of all the

[19] A listed enterprise in Hong Kong in which state-owned funds account for over half of its issued shares

treatment plants had sufficient experience and skills, and had the appropriate technical capacity for project operation. In addition, each implementing agency has prepared manuals concerning operation and maintenance as well as inspection, and provides training on specialized and technical knowledge each year, intended for many employees. It is fair to say that there is no major problem with maintaining the technical level.

(1) Sewer Plants

- Technical personnel are mainly recruited from those people living in the region and those who graduated from a university in the region. The number of employees who leave their jobs is only around one or two a year mainly because of retirement. The retention rate is high.
- In a certain month every year, training on maintenance, facilities, and theory has been continuously provided intended for selected personnel according to their job type.
- As for matters related to electricity and facilities, technical examinations for electrical technicians, crane technicians, pressure vessel technicians, and machinists are held.
- According to the expert in sewer operations who joined the field survey, the levels of understanding of treatment flow, application of adopted technology, and response to trouble and problems were high. It was confirmed that their technical capacity for efficient operations was sufficient.

(2) Gas Supply Plants

- In the gas production project, technical training on sewage treatment, and gas production and purification was conducted 100 times in 2016. The project has introduced the position qualification system to have employees acquire a qualification during training after employment and be at their posts.
- In the gas supply project, technical, safety and operation management training on gas operation was conducted both internally and externally. In 2017, technical and safety training, such as training on the handling of hazardous materials and firefighting, was conducted approx. 30 times intended for selected personnel according to job type.
- According to the expert above who joined the field survey on the production and supply sections, the levels of understanding of treatment flow, and the handling and operation of facilities were carried out properly. It was confirmed that their technical capacity regarding effluent treatment in the gas production process was sufficient.

3.4.3 Financial Aspects of Operation and Maintenance

(1) Sewer Plants

Costs for the operation, maintenance, and management of sewage treatment plants are paid by the Financial Bureau of the city to the sewage treatment plants as sewage treatment costs. Each sewage treatment plant submits an invoice to the Financial Bureau each month based on the amount and the quality of water treated, and the Financial Bureau examines the invoice and reimburses the actual costs. The operation, maintenance, and management costs paid by the Financial Bureau are covered by the water and sewer rate income collected altogether by the water service company. The financial management is secured by municipal government finances. It is stipulated by law to cover any financial deficit of the plans.[20]

The sewer rates (income) collected by the water service company are 0.8 yuan/m^3 on average, which has not changed since the appraisal, and the current sewage treatment costs (expenditure) are 0.4-0.5 yuan/m^3. Thus, the profitability of the plants is secured.[21] As the government will not need to bear the financial burden for the time being, financial stability is also secured.

(2) Gas Supply Plants

1) Gas production project

Recent financial data for the gas production company are provided below. Major income sources of the project are gas selling rate, power generation-related rate,[22] and liquid waste rate. Gas selling rates are paid by the gas supply project and Tianguan Enterprise Group companies, power generation-related rates are paid by the State Grid Corporation of China,[23] steam selling rates are paid by Tianguan Enterprise Group companies, and liquid waste treatment rates are paid by the ethanol plant, which is a supply source of raw materials (industrial waste).

[20] In case of a deficit due to a shortage in sewage treatment costs, the deficit is ensured to be covered by Nanyang City under the policy of Article 33 of the State Council Order No. 641 "If sewage treatment costs collected for a special reason are insufficient to pay the costs of normally operating sewage treatment plants in the city, the local people's government will cover these costs."

[21] To enhance the sewer network and expand the treatment plants, a survey on increasing the sewer rates was conducted by the municipal government in August 2017. Sewer rates are scheduled to be increased in the near future.

[22] Power selling income and income by selling steam generated during power generation

[23] A state-owned enterprise that transmits electricity throughout the country

Unit: Thousand yuan	2012	2013	2014	2015	2016
Total Sales	116,154	136,295	179,502	194,386	80,925
Year on year rate		117.3%	131.7%	108.3%	41.6%
Operating income	28,237	50,904	49,656	25,463	-64,353
Operating income margin	24.3%	37.3%	27.7%	13.1%	-79.5%
Net income	23,232	43,415	46,102	24,618	-62,052
Capital adequacy ratio	19.3%	37.1%	38.2%	36.1%	31.0%
Flow ratio	18.6%	619.0%	193.7%	225.6%	191.3%

Source: Created by the evaluator based on materials provided by the implementing agency

Although sales of the company had been stable over the past several years, it did post a deficit in 2016. The cause of this deficit was a production adjustment due to a material shortage. The ethanol plant, which is also in the Tianguan Enterprise Group[24] and a supply source of raw materials, adjusted production in the wake of the international fluctuations in oil prices.

The gas production and supply sections have a year-round contract to adjust the amount of daily supply according to seasonal demands. It was confirmed during the field survey that discussions had been held towards increasing the supply amount of the bio-gas production section in the future, based on a shortage in natural gas supply and the future increase in gas demand through expansion of the supply network.

As for electric power selling, a long-term contract (three to five years) has been concluded based on the selling price determined by the National Development and Reform Commission. As there is no limitation on the purchase amount, all electricity produced has been purchased.

Regarding the shortage in raw materials, which is the main factor for the current deficit, the production of raw materials is expected be increased in the medium- to long-term, with the implementation of the national plan to promote the use of ethanol fuels as described in "Effectiveness." However, currently, no specific plan on such increase has been confirmed.

As stated above, the financial situation may improve in the future, in the medium- to long-term, as an increase in the production of raw materials is expected and the sales destinations of these raw materials after elimination of this shortage has been clarified. However, judging from the current financial situation, the financial sustainability of this subproject is fair.

2) Gas supply project

Recent financial data for the gas supply company are provided below.

[24] A plant designated by the government as one of the five fuel ethanol production plants nationwide

Unit: Thousand yuan	2013	2014	2015	2016
Total Sales	167,783	244,502	294,858	314,117
Year on year rate		145.7%	120.6%	106.5%
Operating income	12,765	25,293	34,494	38,391
Operating income margin	7.6%	10.3%	11.7%	12.2%
Net income	16,720	22,558	29,008	29,380
Capital adequacy ratio	28.3%	29.5%	27.3%	29.6%
Flow ratio	57.5%	77.8%	83.2%	97.8%

Source: Created by the evaluator based on materials provided by the implementing agency

Costs for the operation, maintenance, and management are covered by gas rate income. Currently, the company has been operating in the black. Standards for the gas rate collection are set by the national government at 1.8254 yuan/m^3 for residents and 2.72 yuan/m^3 for non-residents as of October 2017. Although these unit rates as a whole have been slightly declining under the national policy to promote natural gas supply, the amount of decline has been minimal,[25] and a significant revision of the rates has not been planned. As for the supply system, the supply network has been further expanded in line with the increase in future demand. It is expected that an increase in the supply amount caused by the network expansion will promote the efficiency of the system, and the supply cost per unit will decline in the future. Based on what is described above, no major concerns have been observed with regard to both income and expenditure, and the financial stability is relatively high.

3.4.4 Status of Operation and Maintenance

(1) Sewer Plants

The management status of the plants is good, and no failure has currently been observed. The operation status of the plants is monitored in the central control room around the clock. If an abnormal value is detected in the real-time online system, a three-level alarm is activated, and responsible personnel and technical personnel check the site and take actions according to the level and situation.

For the maintenance and management, regular inspections are conducted once a month for all equipment. Results of these inspections are saved in electronic or printed form.

Most of the main equipment used, such as pumps, blowers, and centrifugal dehydrators, is imported, but spare parts can be procured without any difficulty as there are many distributors in

[25] The rates as of October 2017 declined by approx. 0.4 yuan/m^3 from 2012 when the gas supply started.

China. Even in case of a major equipment upgrade, operations will not be affected as the upgrade is ensured by the manufacturer by making an appointment in advance.

Both treatment plants have introduced a monitoring system to measure data[26] on COD, NH_3-N and flow rate at the entrance/exit. The data measured are distributed online to the Environmental Protection Bureau of Nanyang Municipal People's Government in real time every two hours. The measurement equipment is strictly managed through monitoring by a third party delegated by the government.

Daily water quality results are displayed on the board at the entrance to the North-area Wastewater Treatment Plant.

Imported blower at the South-area Wastewater Treatment Plant

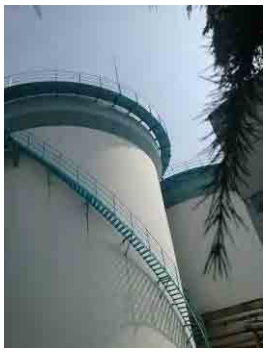
(2) Gas Supply Plants

1) Gas production project

The plants have been maintained according to the maintenance and management plan, and no failure has currently been observed. During the first field survey, many parts with severe corrosion were found in the metal part of the gas tank external stairs. However, anticorrosion work was carried out by a professional in the winter of 2017, and it was confirmed during the second field survey that these parts had been restored to a good condition. Although a delay in the regular anticorrosion work was undesirable, the corrosion of the auxiliary equipment does not greatly affect the operation of the plants and does not cause any major concern. The treated water discharge destination of the production facilities has an online monitoring system installed by the Environmental Protection Bureau of Nanyang Municipal People's Government to constantly monitor the quality of the discharged water. As most of the equipment used, including the main equipment, is sourced domestically, there is no major problem with procurement of spare parts and repair of the equipment.

[26] COD and NH_3-N are measured using wavelength of ultraviolet rays

Fermentation tank of the gas production project section at the time of the first survey (October 2017)



Fermentation tank of the gas production project section at the time of the second survey (March 2018)

2) Gas supply project

The overall status of the operation, management, and supply is managed in the central control room. With respect to operation and management, a government-affiliated management bureau provides instructions and carries out investigations on a regular basis. In particular, it conducts inspections and provides instructions on sewage discharge indicators, safe production of hazardous chemical industrial products, quality monitoring and measurement of high-pressure hermetic containers, and checking pressure gauges intended for enterprises on a regular basis.

Inspections and parts exchange are also conducted on a regular basis according to the manual. For example, the gas gate station has a major inspection once a year or once every two years in addition to a daily inspection. Inspection items vary in accordance with the manual. In the daily inspection, corrosion and the sanitary condition of equipment, as well as values for gas leakage, pressure, temperature, and flow volume are checked and patrolled once an hour, and this inspection data is recorded once every two hours.

On the basis of the above, no major problems have been observed in the institutional and technical aspects of the project operation and maintenance system. Although the gas production project is currently in the red and there are still concerns over the stable securing of materials, it is fair to say that the impacts of these concerns are limited when considering the overall gas production project because the production project is just an auxiliary gas source in consideration of the overall subproject. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to reduce the discharge of water pollutants into the rivers in Nanyang City, Henan Province, and ease the air pollution burden, through the construction of wastewater treatment facilities and gas supply facilities that impose low environmental burdens, thereby contributing to the improvement of the living environment in the city.

The project is consistent with China's development policy and needs at the national and municipal levels between the time of the appraisal and the present time. Although there have been changes in the operation of bio-gas production facilities as a result of an increase in natural gas supply under the national policy, the project as a whole is highly relevant. The efficiency is low because the project cost is a little higher than planned and the project period is far longer than planned. The constructed wastewater treatment facilities are operating smoothly and the effect of reducing the discharge of pollutants has manifested itself as expected. Although there is some concern that the bio-gas production facilities may have problems, gas has been supplied to Nanyang City almost as planned and the purpose of popularizing cleaner energy than coal has almost been achieved. Because the wastewater treatment ratio increased and the amount of wastewater discharged into the rivers decreased, the water quality of the main river, the Baihe River, in the city is on an improving trend. In addition, along with an increase in the gas supply resulted in a decrease in the consumption of coal and any other type of energy that imposes a high environmental burden, air pollution has been prevented from worsening. For these reasons, the effectiveness and impact of this project are high. With regard to the sustainability of this project, no significant problem is seen in the organizational and technical aspects. Although there is a slight concern over the financial condition of the gas production businesses, the gas supply is expected to increase in the future and it is highly likely that the financial condition will improve from both the mid- and long-term perspectives, and thus the influence seems limited. In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Measures against Future Issues of Pipe Storage and High-Water Level Operations

Because of the insufficient treatment capacity of the sewage treatment plants improved in this subproject, pipe storage and high-water level operations have been continuously performed by storing sewage in the sewer. As this operation method may lead to deterioration of the plant equipment and the quality of treated water in the future, a combination of short- and long-term measures is necessary. Drug infusion is a possible urgent short-term measure. From a long-term perspective, improvements in operational technology need to be considered, such as introducing low-water level operations once a day to pump a fixed quantity of sewage so that it reaches the lower limit water level during hours when the influent quantity is relatively low. (For more details, refer to the detailed analysis paper separately created.)

(2) Measures to Improve the Durability of Auxiliary Equipment

During the first survey of the plant equipment in Nanyang City, peeling paint and rust were found in the inspection corridors and frames of the equipment at all plants. These were

addressed by the anticorrosion work carried out before the second survey, but the quality of used steel, the coating method, the processing method, or environmental factors are considered as the cause of the corrosion. To improve the durability of the plants in the future, it seems important to clarify the cause of this corrosion and prevent the deterioration of materials by taking appropriate measures according to the conditions. For example, carefully removing rust in the metal welded parts, antirust coating, anticorrosion coating, and light resistant coating are all worth considering.

4.2.2 Recommendations to JICA

The pipe storage and the corrosion of auxiliary equipment described above may be solved by examining the design specifications or the equipment selection method used at the time of procurement. To further improve the durability of the sewage treatment plants, it is desirable to consider the overall life-cycle costs during the planning and design phases. Specifically, it is recommended to standardize the "criteria and methods for selecting the methods at the time of planning," then use these criteria and methods for planning and designing a sewage pump station and sewage treatment plant, and continuously support the establishment of planning and design methods according to the actual situation in developing countries.

4.3 Lessons Learned

Reduction in project risks through flexible project design in consideration of the impacts of national policies and development plans

It was initially expected that the bio-gas produced in this project would function as a supply source of main gas for Nanyang City. However, as the current main gas source has been changed to the natural gas supplied in many areas in China, this project has been used as a supplemental supply source. Such a drastic change in the project environment may greatly affect the effective use of project outputs. This project designed the gas pipe network, which was concurrently improved, so that it enables transportation of a combination of bio-gas and natural gas, and took measures under the assumption that the project was implemented with the natural gas project since the beginning. Thus, impacts by the policy change could be minimized. As energy policy is greatly affected particularly by national policy or the market environment, it is desirable to develop a project plan that has flexibility in the design of project scope and change in the specifications, in consideration of mid- and long-term policy trends and market uncertainty.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
(1) Project Outputs		
1) Sewage pipe	224 km	Almost as planned
2) Sewage treatment plant (Expansion of 1 plant)	100,000 m^3/day (Recycled water plant: 30,000 m^3/day)	Almost as planned Changed the treatment method
3) Sewage treatment plant (Construction of 1 plant)	100,000 m^3/day	Almost as planned Changed the treatment method
4) Gas production facilities	Bio-gas: 395,000 m^3/day	Almost as planned Changed from four IC reactors to ten UASB reactors
5) Gas pipe network	250 km	As planned
6) Gas vaporization facilities and gas pressure adjustment facilities	Newly established	As planned
7) Training program	Training program in Japan on sewer and gas supply projects intended for employees of the implementing agency	Training program in Japan for sewer plants Two people from gas supply plants participated in the training program in Japan.
(2) Project Period	December 2007 to January 2013 (61 months)	December 2007 to May 2016 (101 months)
(3) Project cost		
Amount Paid in Foreign Currency	12,248 million yen	10,114 million yen
Amount Paid in Local Currency	15,140 million yen (970 million yuan)	19,587 million yen (1,299 million yuan)
Total	27,388 million yen	29,701 million yen
ODA Loan Portion	11,500 million yen	10,114 million yen
Exchange rate	1 yuan = 15.6 yen (as of June 2007)	1 yuan = 15.08 yen (average exchange rate between 2007 and 2016)
(4) Final Disbursement	April 2015	

People's Republic of China

FY 2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Hunan Municipal Solid Waste Treatment Project"

External Evaluators: Toshihiro Nishino and Miho Sakuma, International Development Center of Japan Inc.

0. Summary

The objective of the project is to facilitate the appropriate treatment of waste generated in local cities (16 cities and counties) in Hunan Province by developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental consideration in these areas. The Project is highly relevant to the development needs of the Government of China and Government of Hunan Province such as improvement of the living and sanitation conditions and environmental conservation in the province. It is also relevant to Japan's ODA policy. Therefore, its relevance is high. In relation to efficiency, while the project cost was within the planned cost, the project period was significantly longer than the planned period (2.64 times longer than planned). Therefore, the efficiency of the Project is only fair. As a result of the successful introduction of facilities to treat urban household waste under the Project, the target values for the operation indicators (treatment volume at sanitary landfill facilities, BOD and COD [1]concentration, volume of suspended solids, waste collection rate, etc.) set during the project appraisal have been generally achieved. Meanwhile, the service population which is an effect indicator far exceeds the target value. Moreover, positive confirmation has been made for such qualitative indicators as "improvement of the living conditions and townscape", "improvement of the water quality of water sources as well as river water" and "fostering of related industries". Significant improvement has been specially observed in the case of "living conditions and townscape". Therefore, the effectiveness and impacts of the Project are high. In regard to the "waste sorting facility" constructed under the Project (in Changsha), there is a structural problem in that the sorting of solid waste as a precondition for the efficient operation of this facility has not been achieved. The facility also faces the difficulty for the outsourced private enterprise to secure the profitability of operation due to the lack of any subsidy. Meanwhile, the sustainability of treatment facilities in the other 15 cities and counties is judged to be high in terms of the institutional, technical and financial aspects and the current status of operation and maintenance. Therefore, the sustainability of the positive effects of the Project as a whole is high.

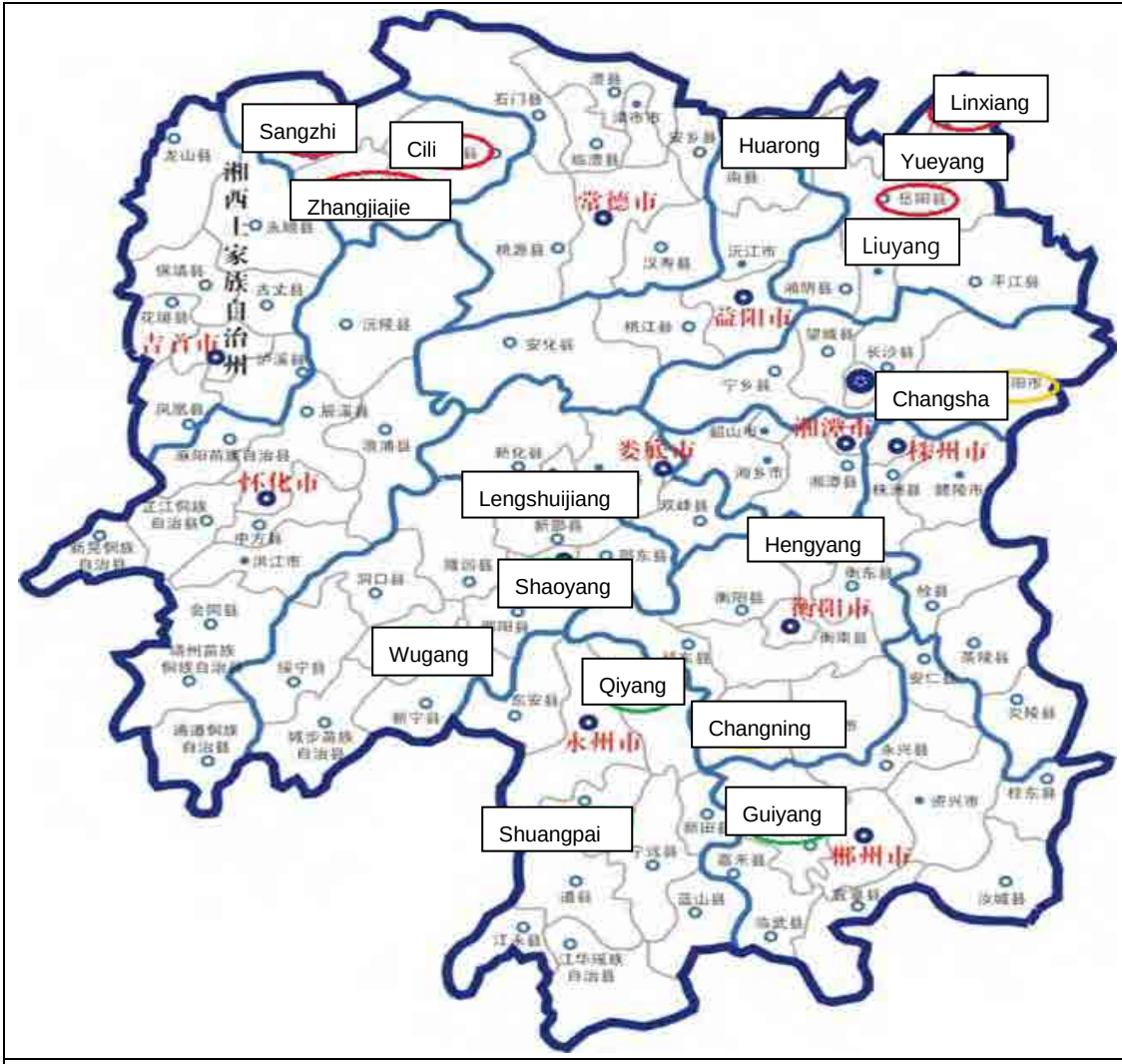
Based on the above, the Project is evaluated as highly satisfactory.

[1] COD means chemical oxygen demand, and BOD means biological oxygen demand.

1．Project Description

Landfill facility constructed under the Project (Huarong)

A large container procured under the Project (Hengyang)



Project Location

１．１ Background

In its *10th Five Year National Plan for Environmental Protection (2001 – 2005)*, the Government of the People's Republic of China (hereinafter simply referred to as "China") prioritized the establishment of an efficient waste treatment system (sorted collection, storage/transportation and treatment) and the volume reduction as well as recycling of solid waste while promoting the detoxification[2] of urban household waste and the centralized safe treatment of hazardous waste. The reality of urban household waste in China, however, was that the treatment capacity could not catch up with the ever increasing volume of such waste. Even though the number of detoxification facilities, such as sanitary landfill facilities and incineration plants, and their overall treatment capacity increased to 471 sites and 256,300 tons/day (annual detoxification treatment volume of 80.51 million tons) respectively, the collection/transportation volume was as much as 156 million tons in 2005, reducing the detoxification rate in 2005 to 51.7% from the previous year. Under these circumstances, the Outline of the 11th Five Year National Plan for Economic and Social Development emphasized the construction of urban household waste treatment facilities as part of enhanced environmental protection and set up the target detoxification rate of exceeding 60% by 2010.

In Hunan Province, the development of waste treatment infrastructure had been considerably slow, partly because of the relatively late start of conscious waste treatment efforts. The volume of generated urban household waste in 2005 was 8.82 million tons while the detoxification rate in the urban areas of counties remained as low as 1.3%. The common practices in most areas of the province were treatment at simple landfill facilities which did not meet the national standards, open-air dumping and open-air burning among others, causing serious detrimental impacts on the soil, rivers, groundwater, air, etc. There was, therefore, an urgent need to secure new sanitary landfill sites with a view to improving the sanitation as well as living conditions in local cities of the province.

１．２ Project Outline

The purpose of the Project was to facilitate the appropriate treatment of waste (household waste) generated in local cities (16 cities and counties) in Hunan Province by means of developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental conservation in these areas.

[2] Detoxification treatment in China is conducted in accordance with the relevant national standards and means sanitary landfill, composting or incineration.

Loan Approved Amount / Disbursed Amount	10,500 million yen / 10,483 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	December, 2007/ December, 2007
Terms and Conditions	Interest Rate 0.65% Repayment period 40 years (Grace Period: 10 years) Conditions for Procurement General untied
Borrower / Executing Agencies	Government of the People's Republic of China/ Hunan Provincial People's Government
Project Completion	October, 2015
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	-
Related Study	Feasibility Study by the Hunan Province International Engineering Consulting Co., Ltd.
Related Project	-

2. Outline of the Evaluation Study

2.1 External Evaluator

Toshihiro Nishino and Miho Sakuma, (International Development Center of Japan Inc.)

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: July, 2017 – March, 2019

Duration of the Field Survey: November 12 – 25, 2017 and January 26 – February 8, 2018

2.3 Constraints during the Evaluation Study

It was originally planned to adopt the random sampling method using the resident register to select the subject persons for an interview survey featuring beneficiaries and resettled inhabitants due to the construction of a sanitary landfill facility in order to ensure the objectivity of the survey. However, it was found that no government-affiliated research institutions in China used this sampling method to obtain public opinion and that the implementing enterprise in each city or country had no previous experience of using the said method. It was decided, therefore, to designate areas of residence, gender, age group and other matters (ordinary citizens not related to the administration, etc.) of the subject people for interview while leaving the actual selection to the implementing enterprises. This means that the interview results may not necessarily represent the overall opinions of the beneficiaries, etc.

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

３．１　Relevance (Rating: ③[4])

３．１．１　Consistency with the Development Plan of China

The development policy of China at the time of the appraisal of the Project emphasized environmental issues, including the treatment of waste, as priority policy issues as indicated in *the 10th Five Year National Plan for Environmental Protection (2001 – 2005)* and *Outline of the 11th Five Year National Plan for Economic and Social Development (2006 – 2010)*. In view of the fact that there was a shortage of the absolute number of facilities to treat urban household waste, particular emphasis was placed on the construction of such facilities to establish an efficient treatment system comprising sorted collection, storage/transportation and treatment, thereby improving the detoxification treatment rate of urban household waste. Subsequent five year plans have consistently emphasized the establishment of an efficient treatment system and improvement of the detoxification rate of urban household waste. Following some concrete progress of the construction of urban household waste treatment facilities, *the 13th Five Year National Plan for Economic and Social Development (2016 – 2020)* and other plans and policies at the time of this ex-post evaluation call for the strengthening of efforts to promote urban household waste treatment of a higher standard, including "further improvement of the detoxification rate (95% or higher)", "technological development and enhancement of facilities relating to incineration, biological treatment, waste-to-energy, waste sorting, etc.", "realization of the volume reduction and recycling of waste at a higher level" and "promotion of the disclosure of information on waste treatment".

In response to these policies of the central government, the government of Hunan Province has been intensifying its efforts to deal with urban household waste. *The 13th Five Year Plan of Hunan Province (2016 – 2020)* envisages the stable operation of urban household waste treatment facilities in the province with a view to achieving a 100% urban household waste detoxification rate at the county level. Meanwhile, Changsha City has been designated a city for the enhanced sorted collection of waste by the central government. Trial sorted collection was implemented in parts of the city in 2016 and it is currently planned to promote the city-wide sorting and volume reduction of household waste based on *the Changsha Municipal Plan to Implement a Sorted Waste Collection System*.[5]

Accordingly, the Project is relevant to the household waste treatment policy of China at the time of both its appraisal and ex-post evaluation because "it seeks to improve the living and sanitation conditions of local inhabitants and to facilitate environmental conservation through the establishment of an efficient urban household waste treatment system".

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[3] A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

[4] ③: High, ②: Fair, ①: Low

[5] Based on the reply to the questionnaire by the implementing enterprise and the Changsha Municipal Plan to Implement a Sorted Waste Collection System (December 22, 2017).

Table 1 Principal Targets of Development Plans Related to the Project

Category	At the Time of Appraisal	At the Time of Ex-Post Evaluation
Waste Treatment Policy/National Development Plan	*10th Five Year National Plan for Environmental Protection (2001 – 2005)* • Establishment of an efficient waste treatment system (sorted collection, storage/transportation and treatment) to prioritize the volume reduction and recycling of solid waste while promoting the detoxification of urban household waste and centralized safe treatment of hazardous waste *11th Five Year National Plan for Economic and Social Development (2006 – 2010)* • Emphasis on the construction of urban household waste treatment facilities as part of the policy to strengthen environmental protection, strengthening of the collection of the urban household waste treatment charge and improvement of the detoxification rate to 60% or higher by 2010.	*13th Five Year National Plan for Environmental Protection (2016 – 2020)* • Improved volume reduction, recycling and detoxification of urban household waste to achieve a nationwide detoxification rate of urban household waste of 95% or higher • Full development of a waste collection, storage and transportation system to facilitate the enclosed collection and transportation of waste throughout the system in urban areas • Strengthening of treatment of exuded water from waste, treatment of incineration ash, utilization of methane generated at landfill sites and treatment of foul odor while facilitating the public disclosure of the state of pollutant discharge from waste treatment facilities. *13th Five Year National Plan for Economic and Social Development (2016 – 2020)* • Urgent construction of urban household waste treatment facilities along with the full development of the collection and transportation system, improvement of the waste incineration rate and full installation of an exuded water treatment system; full installation of waste treatment facilities and achievement of the targets specified by the relevant standards.
Ministry of Construction Policy/Related Laws	*Ministry of Construction :"Act for Management of Urban Household Waste" (2007)* • Stipulation of fines when generators of urban household waste fail to pay the obligatory treatment charge. • Clarification of stricter requirements for the qualifications to be met by a supervisory body (Department of Environmental Health) as well as private enterprises involved in urban household waste treatment.	*Proposal by the Ministry of Construction, etc. Regarding Strengthening of the Urban Household Waste Incineration Business (2016)* • Strengthening of the establishment of a support system for the collection, transportation, recycling and terminal treatment of household waste. Construction Bureau of Hunan Province: *"On the Plan to Accelerate the Construction of Urban Household Waste Detoxification Facilities in Hunan Province" and "Opinion of the People's Government of Hunan Province on the Promotion of the Recycling of Urban Household Waste" (2014)* • Acceleration of the construction of urban household waste detoxification facilities • Promotion of the recycling of urban household waste.
Hunan Province Development Plan	*11th Five Year Plan for Environmental Protection of Hunan Province (2006 – 2010)* • Reduction of the total pollutant emission volume by 10% and	*13th Five Year Plan for Environmental Protection of Hunan Province (2016 – 2020)* • Enhancement of the quality of the environment as a central tenet with emphasis placed on the solving of

	improvement of the urban household waste detoxification rate to 60% or higher in prefectural-level cities (relatively large urban area) and to 20% or higher in urban areas of counties by 2010.	prominent problems in terms of ecology to strengthen ecological conservation. • Pursuit of the realization of the total treatment of urban waste, stable operation of treatment facilities and achievement of various indicators. • Achievement of a 100% urban household waste detoxification rate at the county level.

Source: Materials provided by JICA and various plan documents

３．１．２ Consistency with o the Development Needs of China

Because of the relatively slow start of conscious waste treatment efforts, the development of waste treatment infrastructure in Hunan Province significantly lagged behind that of other provinces at the time of project appraisal. The annual volume of urban household waste discharged in 2005 was 8.82 million tons (4.88 million tons from relatively large cities and 3.94 million tons from urban areas of counties). The detoxification rate was 39.7% in large cities and a meagre 1.3% in urban areas of counties. The common practices in most areas of the province were treatment at simple landfill facilities which did not meet the national standards, open-air dumping and open-air burning among others, with serious detrimental impacts on the soil, rivers, groundwater, the air, etc. There was an urgent need to secure new sanitary landfill sites with a view to improving the sanitation as well as living conditions in local cities of the province. At the time of appraisal, four detoxification facilities were under construction in Human Province in addition to eight such facilities already in operation. The construction of 15 new sanitary landfill facilities under the Project was expected to contribute to the partial achievement of the target value for the detoxification rate in 2010. To be more precise, the Project was expected to account for 36% of the target rate of 60% or more in relatively large cities and 52.1% of the target rate of 20% in urban areas of counties.[6]

Interviews conducted as part of this ex-post evaluation with those in charge at the implementing enterprises found that the detoxification rate in urban areas of Hunan Province exceeded 95% while the volume of generated urban household waste had significantly increased from the time of appraisal due to an increase of the urban population as well as an increase of the per capita urban household waste generated. Because of the additional need to deal with solid waste discharged in rural areas, the volume of household waste requiring treatment is increasing, making the continual strengthening of the waste treatment facilities in both urban and rural areas essential. Moreover, the progress of the construction of new urban household waste treatment facilities has upgraded the level of required urban household waste treatment. To be more precise, the need for “recycling” and “volume reduction” has increased in addition to “detoxification” from the viewpoint of the effective use of treatment facilities and waste. Food waste treatment and incineration which are the principal means of achieving “recycling” and “volume reduction” are progressing with the introduction of private capital. One

[6] Materials provided by JICA.

crucial factor for the efficient incineration of waste to achieve a certain level of profitability is the removal of water by means of compression, etc. (to secure a suitable incineration temperature). The construction of a basic urban household waste treatment system has important implications as the foundation for the development of the next level of waste treatment.

Consequently, the Project is relevant to the development needs of both China and Hunan Province at the time of both appraisal and ex-post evaluation.

３．１．３ Consistency with Japan's ODA Policy

Japan's ODA Charter (2003) at the time of appraisal emphasized efforts to tackle global issues (environmental issues) while t*he Medium-Term Policy on ODA (2005)* emphasized the protection of individuals from the "fear" of environmental destruction, etc. from the viewpoint of "human security" and the establishment of such "environmental pollution control measures" as waste treatment as a priority field. All of *the Economic Cooperation Program for China (2001, Ministry of Foreign Affairs)*, *Medium-Term Strategy for Overseas Economic Cooperation Operations (2002, JICA)* and *Country Assistance Strategy for China (2002, JICA)* emphasized environmental conservation, indicating the relevance of the Project to Japan's ODA policies.

３．１．４ Appropriateness of the Project Plan and Approach

In Changsha, Hengyang, Yueyang and other places where a sanitary landfill facility already existed at the time of appraisal, a system was functioning whereby road sweeping workers and dedicated refuse collectors transported urban household waste to a transfer station using a hand cart or a small vehicle, followed by the use of a dedicated garbage truck to transport waste from such transfer station to a major transfer base from which the transferred waste is finally transported to a sanitary landfill facility by a large truck (some of the waste was used for gas power generation). In many other urban areas, once solid waste transferred to a local station filled the storage capacity of the station, it was simply transported to a simple landfill facility in a suburb. As the collection and transportation capacity in these areas was limited, the waste collection service did not reach the stage of detoxification (introduction of sanitary landfill facility).[7] In the face of such reality, the Project aimed at developing a collection and transportation system following the examples of such large cities as Changsha, etc. in Hunan Province by means of constructing sanitary landfill facilities, transfer stations, etc. in the targeted 15 cities and counties other than Changsha of Hunan Province and also at achieving the "detoxification" and "volume reduction" of solid waste through strengthening of the technical capability by training in Japan.

These sub-projects for 15 cities and counties other than Changsha accounted for most of the project inputs. As the inputs in these target areas have produced outputs leading to the achievement of the project purpose and emergence of positive development effects, it is safe to judge that the declared

[7] Materials provided by JICA.

purpose of the Project and selected approach to support the Project were appropriate.

Meanwhile, a sub-project to construct a sorting facility was planned for Changsha with a view to advancing to a higher stage of "volume reduction" and "recycling" as the city was the most urbanized area in Hunan Province and had achieved a certain degree of detoxification treatment at the time of appraisal. At that time, five or six such facilities were in operation in Shanghai and the plan for Changsha was based on the operating performance of these sorting facilities in Shanghai. However, no sufficient examination was conducted from the viewpoint of determining whether or not the system in Shanghai was applicable to Changsha. It also appears that examination of the medium to long-term operation cost and profitability of the envisaged system in Changsha was inadequate partly because the implementing enterprise was a state enterprise at the time.[8]The introduction of a sorting facility was the first such attempt in Hunan Province and the actual inputs to this sub-project were the construction of a facility and training in Japan as in the case of other 15 cities and counties. While this component of constructing a sorting facility in Changsha accounted for a minor proportion of the total project input, more careful examination of the necessary support for this component is believed to be necessary because of the more advanced objective of this sub-project compared to other sub-projects.

Based on the above, the Project was relevant to China's development policies as well as development needs and Japan's ODA policies at the time of appraisal. The Project is still highly relevant today as the basic direction of the development policies and needs of the Government of China have been maintained. In the case of the sub-project to construct a sorting facility in Changsha, however, given the much higher purpose associated with this sub-project within the Project compared to sub-projects in other 15 cities and counties, more detailed examination of inputs (including the necessity for a technical support component other than the construction of a facility) should have been conducted to produce outputs leading to the achievement of the project purpose and emergence of positive development effects even though this sub-project accounted for only a very small proportion of the Project.

３．２ Efficiency (Rating: ②)

３．２．１ Project Outputs

The planned outputs of the Project at the time of appraisal are shown in Table 2 along with the actual outputs. The outputs by target city/county are given in a separate appendix. The principal outputs of the Project are ① sanitary landfill facility and exuded water treatment equipment at 15 sites (total capacity of sanitary landfill facilities: 65.69 million m^3), ② collection and transportation facilities (136 new transfer stations, improvement of 57 transfer stations, etc.), ③ sorting facility for recycling (one in Changsha and ④ training in Japan. The feasibility study for the Project was conducted in 2007. The detailed design of the project contents after signing of the loan agreement (L/A) adjusted the scales of sanitary landfill facilities, exuded water regulating basin and exuded water treatment equipment,

[8] No relevant information was found in the reference materials used at the time of appraisal.

number of new transfer stations and other components of the Project. As a result, the planned outputs were subsequently changed slightly even though these changes were not large enough to affect the achievement of the purpose of the Project. As shown in Table 2 below, the actual outputs show slight decreases of the total capacities of the sanitary landfill facilities and exuded water treatment equipment.

Table 2 Planned and Actual Outputs

Item	Planned (at the Time of Appraisal)	Actual
Sanitary Landfill Facility	15 sites Capacity: total of 68.28 million m^3 Treatment method: Improved anaerobic method (semi-aerobic method for the Guiyang site only) Capacity: Exuded water regulating basins: total of 309,100 m^3	15 sites Capacity: 65.69 m^3 (96% of planned) Treatment method: Improved anaerobic method (semi-aerobic method for the Guiyang site only) Capacity: Exuded water regulating basins: total of 223,200 m^3 (72% of planned)
Exuded Water Treatment Equipment	15 sites Total capacity: 4,940 m^3/day	15 sites Total capacity: 2,950 m^3/day (60% of planned) (The equipment introduced offers a higher treatment level compared to the originally planned at the time of appraisal.)
Collection and Transportation Facility	New transfer station: 132 sites Improved transfer stations: 34 sites Waste collection and transportation vehicles: 193	New transfer stations: 136 sites (104% of planned) Improved transfer stations: 57 sites (168% of planned) Waste collection and transportation vehicles: 224 (116% of planned)
Sorting Facility for Recycling (Changsha)	Sorting facility for recycling: 1,000 tons/day Other facilities: water treatment facilities; warehouse and administration buildings On-site equipment, etc.: bulldozers, loaders and trucks	Sorting facility for recycling: 1,000 tons/day Other facilities: water treatment facilities; warehouse and administration buildings On-site equipment, etc.: bulldozers, loaders and trucks
Training	Training in Japan: 45 persons Training in China: 270 persons	Training in Japan: 92 persons (204% of planned) Training in China: 8 persons (3% of planned)

Sources: Materials provided by JICA and replies to the questionnaire survey with implementing enterprises.

Note: The figures for the capacity of sanitary landfill facilities, capacity of exuded water regulating basins and capacity of exuded water treatment equipment and new transfer stations were adjusted figures by the detailed design.

With some exuded water treatment equipment, the treatment method (level-up, including the addition of a reverse osmosis[9] device) was changed due to the introduction in 2008 of stricter national standards for the discharge of exuded water after landfill treatment. The adoption of separate treatment for rainwater and foul water meant a decrease of the treatment volume, thereby reducing the scales of the exuded water regulating basin and exuded water treatment equipment in some cities and counties. In Yueyang, the scale of the sanitary landfill facility was reduced partly because of the change of the

[9] Reverse osmosis treatment relies on a technology which uses a semipermeable membrane which allow only water molecules to pass through to separate and remove dissolved organic matters, salt, etc. in water, making the quality of treated water extremely high.

construction side, in turn necessitated by the designation of the originally planned site as a provincial forest park, and partly because of the construction of an incineration plant. In the case of other related equipment, while the nature of the equipment actually introduced was as planned, the quantity was partially modified due to ① adjustment made by the detailed design, ② additional procurement using the remains of the ODA loan and ③ change of needs. As far as training is concerned, the training sessions in Japan were increased by one to four sessions because of the excellent training effects in Japan where there are many examples of the advanced treatment of solid waste as well as exuded water. As these changes were made to reflect a change of policy and/or actual demands, they are judged to be appropriate.

Treatment of waste at a transfer station (Linxiang)

On-line monitoring system for exuded water quality (Sangzhi)

３．２．２ Project Inputs

３．２．２．１ Project Cost

The actual project cost was 19,152 million yen (86% of planned) as shown in Table 3 and was within the planned cost of 22,169 million yen. The principal factors for this were ① the improvement of some related equipment and transfer stations was conducted with the own funds of the city or county, reducing the cost for the Project, ② the advancement of the separate treatment of rainwater and foul water in some cities and counties had the effect of reducing the capacity of the exuded water regulating basin and exuded water treatment equipment and ③ the capacity of the sanitary landfill facility in some cities and counties was reduced. Considering the fact that higher grade exuded water treatment equipment was installed to match the revised national standards as mentioned earlier, this reduction of the project cost reflected a reduction of the outputs, indicating efforts to contain the Project cost in an adequate manner.

Table 3　Planned and Actual Project Costs

Unit: million yen

	Planned (at the Time of Appraisal)			Actual		
	Foreign Currency Portion	Domestic Currency Portion	Total	Foreign Currency Portion	Domestic Currency Portion	Total
Procurement of Equipment and Materials	9,999	0	9,999	10,141	302	10,443
Civil Engineering Work	0	6,403	6,403	0	4,742	4,742
Training	48	0	48	47	1	48
Inflation	424	0	424	266	73	339
Reserve Fund	510	318	829	14	19	33
Interest during Construction	179	629	807	179	77	256
Commitment Charge	15	0	15	15	66	81
Land Acquisition Cost	0	3,398	3,398	0	2,043	2,043
Management Fees, etc.	0	246	246	0	1,167	1,167
Total	11,175	10,994	22,169	10,662	8,490	19,152

Source: Materials provided by JICA and replies to the questionnaire survey with the implementing enterprises.
Notes
1) Foreign exchange rate: planned rate at the time of appraisal: 1 CNY = 15.6 JPY (June, 2007); actual rate: 1 CNY = 14.9 JPY (mean exchange rate for 2007 through 2015)
2) Of the planned foreign currency portion, the amount other than the ODA loan was 675 million yen (179 million yen for interest during construction and 496 million yen for the reserve fund)
3) Of the actual foreign currency portion, the amount other than the ODA loan was 179 million yen for the interest during construction.

３.２.２.２ Project Period

The actual project period extended to 95 months (December, 2007 to October, 2015), far exceeding the planned period of 36 months (January, 2008 to December, 2010) (exceeded by 59 months or 264% of the planned period). The causes for this excessive extension were ① the time-consuming work to examine the detailed design which was conducted after the signing of the L/A, ② additional work to design a new version of exuded water treatment equipment and to obtain a permit for such equipment as a result of upgrading of the national standards, ③ time-consuming (i) change of the planned sanitary landfill site and (ii) resettlement of inhabitants from the planned construction site for a sanitary landfill facility in some cities/countries and ④ addition to the scope of the construction work to use the remains of the ODA loan.

Table 4　Planned and Actual Project Periods

	Planned (at the Time of Appraisal)	Actual
Signing of the Loan Agreement	December, 2007	December, 2007
Entire Project	January, 2008 - December, 2010 (Project period: 36 months)	December, 2007 - October, 2015 (Project period: 95 months)
Sanitary Landfill Facilities	April, 2008 - December, 2010	September, 2009 - October, 2015
Transfer Stations	August, 2008 - June, 2010	January, 2010 - February, 2015
Sorting Facility	May, 2008 - September, 2009	2009 -～ October, 2010
Land Acquisition	January, 2008 - December, 2008	December, 2007 - January, 2014
Training	June and October, 2008 and June, 2009	November, 2010 and November, 2013

Source: Materials provided by JICA and replies to the questionnaire survey with the implementing enterprises.

３.２.３ Results of Calculations for Internal Rates of Return (Reference Only)

As neither the economic internal rate of return (EIRR) nor the financial internal rate of return (FIRR) were calculated at the time of project appraisal, it was impossible at the time of ex-post evaluation to compare the performance before and after the Project. Therefore, no analysis of the internal rate of return was conducted.

Based on the above, the project cost was within the planned cost while the project period significantly exceeded the planned period. Therefore, the efficiency of the Project is fair.

３.３ Effectiveness [10] (Rating: ③)

３.３.１ Quantitative Effects (Operational and Effect Indicators)

The situation of various operation and effect indicators set at the time of appraisal or ex-post evaluation to indicate the quantitative effects of the Project are shown in Table 5 below. The situation of these indicators by individual target cities/counties is given in a separate appendix.

[10] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 5　Changes of Operation and Effect Indicators

Indicator	Planned Value (two years after project completion)	Actual Value (two years after project completion: 2017)
【Operation Indicators】		
Treatment Volume at Sanitary Landfill Facilities	1,765,465 tons/year	1,377,578 tons/year
BOD Concentration of Exuded Water after Landfill Treatment	30 - 600 mg/l	3.4 - 82.7 mg/l (simple average:15.7 mg/l)
COD Concentration of Exuded Water after Landfill Treatment	100 - 1,000 mg/l	3.0 - 378.0 mg/l (simple average: 59.0mg/l)
Ammoniac Nitrogen after Treatment	-	0.1 - 34.0 mg/l (simple average: 8.3mg/l)
Suspended Solids	200.0 mg/l	5. 0 -101.0 mg/l (simple average: 18.3mg/l)
Treated Volume of Exuded Water	-	599,003 ㎥/year (14 cities/counties)
Detoxification Rate of Urban Household Waste	-	95 - 100% (simple average: 99%)
Collection Volume of Urban Household Waste	-	3,765,962 tons/year 14 cities/counties)
Collection Rate of Urban household waste	-	100% (simple average: 100%)
Treatment Volume of Urban Household Waste at Transfer Stations	-	977,011 tons/year 7 cities/counties)
Waste Reduction Volume[11] by Sorting Facility (㎥/year)	469,755	0
【Effect Indicators】	-	
Service Population	6.1 million	9.71 million
Of which the population served by sanitary landfill facilities	-	9.71 million
Of which the population served by transfer stations	-	5.69 million
Of which the population served by waste collection and transportation vehicles	-	6.41 million
Number of Illegal Dumping Sites	-	None

Sources: Materials used for the appraisal, replies to the questionnaire survey and results of the field interviews.
Notes
1) The target treatment volume at sanitary landfill facilities is the value adjusted by the detailed design.
2) The actual values for BOD, COD, ammoniac nitrogen, collection rate of urban household waste, detoxification rate of urban household waste and number of illegal dumping sites show a range between the largest value and the smallest value among the target cities/counties (those in the brackets are simple averages among the target cities/counties). The values for BOD, COD and ammoniac nitrogen indicate the levels achieved after treatment.
3) The planned service population consists of 1.96 million for Changsha and 4.14 million for 15 cities and counties other than Changsha. The actual value is only for 15 cities and counties other than Changsha.

The actual performance of the operation indicators in 2017, i.e. two years after project completion, showed that operation indicators for BOD as well as COD concentration and volume of suspended

[11] This means a reduction of the cubic volume of waste. Volume reduction leads to not only reduction of the landfill volume but also improvement of the physical as well as chemical stability of waste. Apart from sorting, incineration, compaction, etc. can achieve volume reduction.

solids in exuded water after landfill treatment achieved the respective targets. Meanwhile, the target achievement rate for the treatment volume at sanitary landfill facilities of 78% was low. One reason for the lower treatment volume at sanitary landfill facilities than the planned was the increasing volume of waste incineration as newly constructed household waste incineration plants in Hengyang, Qiyang and Yueyang incinerated 419,750 tons, 33,639 tons and 73,000 tons of such waste respectively, totaling 526,389 tons, in 2017. (The total treatment volume by landfilling plus incineration in these three cities/county was 1,903,967 tons/year which exceeded the target.)

Following the construction of sanitary landfill facilities in Hunan Province by the Project, final waste disposal at a sanitary landfill facility has become the norm and the detoxification rate of urban household waste in the target cities and counties has reached almost 100%. This achievement has been considerably helped by the realization of a solid waste collection and transportation system whereby household waste generated in urban areas is collected at a rate of almost 100%. The volume of solid waste handled by transfer stations which play a vital role in the collection and transportation of household waste was nearly one million tons/year for seven cities/counties for which relevant data is available, showing that various facilities constructed by the Project have greatly contributed to improvement of the detoxification rate.

In regard to the post-treatment leachate BOD and COD concentration (and ammoniac nitrogen), the relevant national standards were strengthened in 2008 as mentioned earlier. Accordingly, the actual facilities, etc. introduced under the Project were of a higher standard than the originally planned, resulting in a higher level of treatment. All of the relevant targets have been achieved in all of those cities and counties where the targets have been set.[12] The treatment volume of exuded water reached 599,003 m^3/year in 14 target cities and counties. Some indicators, such as COD, are constantly monitored at all sanitary landfill facilities using an on-line link with the environmental bureau of a city or county, suggesting that exuded water after landfill treatment is sufficiently managed.

Meanwhile, the sorting facility for recycling (Changsha) was constructed as planned. However, although this facility operated for some time, it is no longer in operation. At the time of appraisal, this facility was expected to deal with commercial waste containing relatively high proportions of valuables and plastics discharged from relatively scattered hotels and commercial premises.[13] After the commissioning of this sorting facility in 2011, it was discovered that the proportion of valuables in the collected commercial waste was lower than assumed. Coupled with another problem of a low ratio of

[12] Of the target cities and counties, the actual values in Linxiang were higher than others even though they were below the target values. According to the implementing enterprise in this city, the exuded water treatment system is based on 1996 national standards (only pretreatment without the use of a membrane) and the absence of a membrane results in a higher reading of the COD concentration. The city employs an indirect drainage system whereby pre-treated exuded water from the sanitary landfill facility is sent to the Linxiang Municipal Sewage Treatment Plant located 2 km away via an underground drain for further treatment along with urban sewage before final discharge. The reasons why the city has opted for this indirect drainage system are ① the landfill facility is geographically near the sewage plant, ② the sewage plant had surplus capacity to treat the exuded water from the landfill facility and ③ there was a need for highly activated microrganisms pretreated by exuded water treatment equipment for the efficient treatment of urban sewage, establishing efficient coordinated operation between exuded water treatment equipment and the sewage plant.

[13] Materials provided by JICA.

more valuable metals, PET bottles and aluminum cans due to their collection by specialist companies, the facility only operated for one year in 2011 and its operation has been suspended since 2012 as sufficient operation profitability could not be secured under these conditions,.[14] The implementing enterprise in Changsha was a public body at the time of appraisal but was privatized around 2012, stressing business profitability more than before. According to this implementing enterprise, factors leading to the suspension of the poorly profitable operation were ① low proportion of valuables with a small amount of highly valuable items in the commercial waste to be sorted, ② decline of the prices of valuables to be sorted out from the collected commercial waste, ③ high operation cost, including the electricity charge, ④ frequent breakdowns of the equipment to sort out the commercial waste and ⑤ lack of government subsidy. In view of the fact that the sorted collection of household waste will start in 2018 throughout Changsha, the implementing enterprise intends to work on the municipal government to restart operation of the sorting facility.

Only the service population among the effect indicators was given a target value at the time of appraisal. In Changsha, the target service population has become zero because of the suspended operation of the sorting facility as described above. The actual figure for the service population of 9.71 million (235% of the planned target value) for 15 cities and counties (excluding Changsha) where sanitary landfill facilities have been constructed under the Project far exceeds the target value (4.14 million, which excludes the population of Changsha from the overall population of 6.1 million). (The service population of each sanitary landfill facility in the target cities and counties is given in a separate appendix.) This much higher level of actual service population than the target is due to ① the more than expected increase of the urban population and ② the significant widening of the service area of each sanitary landfill facility and also of the areas served by the collection and transportation vehicles and other vehicles procured under the Project to rural areas as active efforts have been made to promote the treatment of household waste in rural areas. All of the target cities and counties emphasize strengthening of the treatment of household waste in rural areas and plan to actively use the facilities, such as sanitary landfill facilities, and equipment provided under the Project. There is, therefore, a prospect of a steady increase of the service population in the future. In the case of illegal dumping sites, no target value was set and the actual situation prior to the commencement of the Project is unknown, making it difficult to use this data as an indicator to evaluate the Project. There was no illegal dumping site in any of the target cities or counties. As the level of illegal dumping tends to increase when the solid waste treatment system is not smoothly functioning, the number of illegal dumping sites is often used as a quantitative indicator for the situation of solid waste treatment. The fact that no illegal dumping sites have been recorded may well be used as proof that adequate solid waste treatment operation is in place. The ratio of household waste treatment facilities constructed under the Project to the total number of such facilities owned by the target cities and counties at the time of ex-post evaluation (2017) is shown in Table 6. The Project accounts for 100% of the sanitary landfill facilities

[14] The sources are replies by implementing enterprises to the questionnaire and results of a series of field interviews.

(in the case where Phase II sanitary landfill facilities are in operation, only such facilities are considered) and 97% of the exuded water treatment equipment, indicating the massive contribution of the Project to the establishment of household waste treatment facilities in the target cities and counties. Meanwhile, the Project accounts for a more modest 44% of transfer station as it played only a supplementary role in the construction of transfer stations by the Chinese side.

Table 6 Contribution of the Project to Household waste Treatment Facilities in the Target Cities and Counties

Facility	Number of Target Cities and Counties	Household waste Treatment Facilities	Facilities Constructed Under the Project	Contribution Ratio of the Project
1.Sanitary Landfill Facility	15	Total Capacity: 65.69 million ㎥	Total Capacity: 65.69 million ㎥	100%
2.Exuded Water Treatment Equipment	15	Treatment Volume: 3,050 ㎥/day	Treatment Volume: 2,950 ㎥/day	97%
3.Transfer Station	14	377 sites	165 sites	44%

Source: Replies by the implementing enterprises to the questionnaire.

3.3.2 Qualitative Effects

At the time of appraisal, facilitation of the appropriate treatment of solid waste generated in the target area was assumed to have certain qualitative effects which are schematized in Fig. 1 based on the strategic targets for development established by JICA's theme-specific guidelines for "waste management".

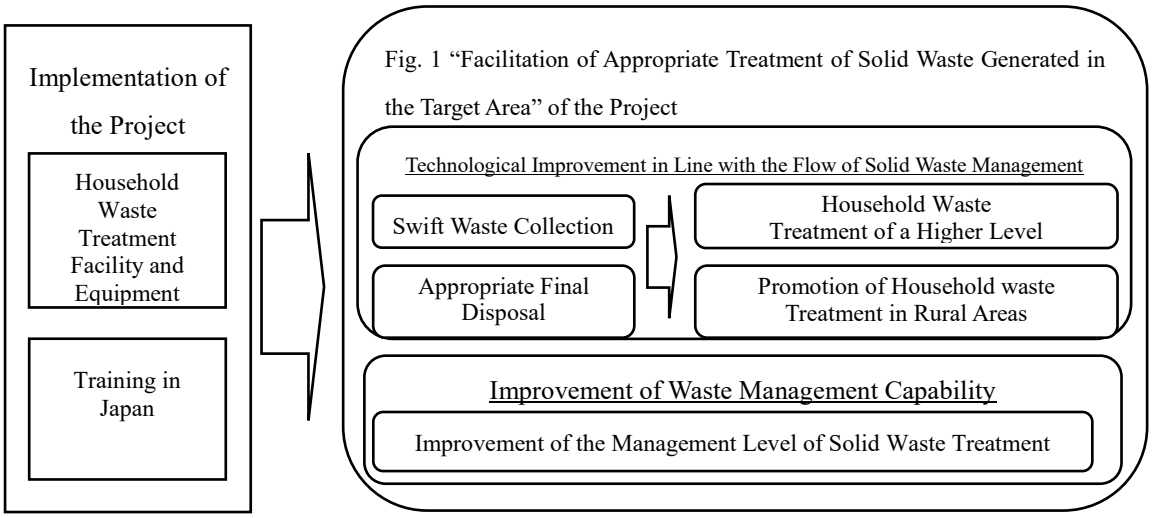


Fig. 1 "Facilitation of Appropriate Treatment of Solid Waste Generated in the Target Area" of the Project

An interview survey was conducted with the environmental bureaus and implementing enterprises of the 15 target cities and counties where a sanitary landfill facility and transfer stations were constructed under the Project to determine whether or not the Project produced any qualitative effects

and the following points have been confirmed.

As mentioned earlier, open dumping (open-air dumping and illegal dumping) and landfill without proper pollution control measures were the common final waste disposal methods in many of the target cities and counties prior to the implementation of the Project. The development of suitable processes (collection, transportation, sanitary landfill, etc.) to treat urban household waste under the Project has realized ① swift waste collection and ② appropriate final disposal (without producing an environmental burden), thereby achieving the originally expected "technological improvement in line with the flow of solid waste management". Moreover, the smooth progress of the construction of basic household waste treatment facilities and services under the Project as originally planned produced such effects as ① realization of household waste treatment of a higher level (advanced treatment in the form of "volume reduction", "recycling", etc.) and ② facilitation of household waste treatment in rural areas. The establishment of a solid waste treatment system of a certain level under the Project has been taking urban household waste treatment in the target cities and counties to the next level characterized by "volume reduction", "recycling", etc. To be more precise, the construction of incineration plants[15] by means of public-private partnerships (PPP)[16] and the introduction of sorted collection (trial) are in progress partly because of the policy of the Government of China.

In regard to incineration plants, electricity generation is combined with incineration in many cases from the viewpoint of ensuring the financial viability of PPP. Transfer stations equipped with a compressing function and garbage-compacting trucks, both of which were introduced under the Project, have contributed to a reduction of the water content of solid waste so that the essential burning temperature for efficient power generation can be maintained. Furthermore, the introduction of a solid waste treatment system is in progress in rural areas, capitalizing on the experience of establishing such a system in urban areas of the target cities and counties. There are many cases where a sanitary landfill facility constructed under the Project is the destination for solid waste generated in rural areas, illustrating the direct contribution of the Project to the facilitation of solid waste treatment in rural areas. In the case of Cili County for example, four staff members of the implementing enterprise who participated in the training in Japan under the Project have actively implemented solid waste control measures in rural areas, having learned the Japanese practice of not distinguishing rural areas from urban areas for solid waste management. Their achievements so far include the formulation of a treatment plan for all 25 towns in the county, development of an administrative system (establishment of an environment and sanitation section with the allocation of some 10 staff members) and construction of related facilities. Solid waste treatment in rural areas is currently an important issue in China and Cili County is praised as a pioneer in this field.

"Improvement of the waste management capability" has been promoted from the viewpoint of "improvement of the management level of solid waste treatment". As a result of the establishment of

[15] In many cases, supplementary payment is made in correspondence with the treatment volume.
[16] General term for the joint provision of a public service by the public and private sectors utilizing the funds and management skills of the private sector.

basic solid waste treatment facilities under the Project, each of the target cities and counties has introduced transfer station management rules and records of the treated volume of solid waste, improving the management level of solid waste treatment.

The training in Japan has certainly had a positive contribution to achieving such qualitative effects as ① technological improvement in line with the flow of solid waste management and ② improvement of the waste management capability. Interviews[17] with the training participants in Japan found some concrete examples of their application of what they had learned in Japan. These include ① the implementation of solid waste control measures in parallel with the Project, taking the situation in Japan which does not have a separate system for solid waste treatment in urban and rural areas into consideration (example of Cili County described above), ② early implementation of technological improvement efforts, including the examination of an incineration plant from the long-term perspective as is the case in Japan, ③ adopting of a blowing system to deal with fallen leaves as witnessed in Japan and ④ planned introduction of Japanese-style sorted collection based on a proper understanding of the importance of thoroughly sorted collection. There have been observed cases of such concepts learned in Japan as "spirit or philosophy", "business development" and "application to the actual work" being widely implemented. For example, the implementing enterprise in Hengyang has established a space to educate on the solid waste treatment process at its incineration plant for study visits by primary and secondary school pupils and to provide practical training for students studying environmental engineering at one of the city's two universities. The promotion of sorted collection has become an important issue for each city or county from the viewpoint of reducing the volume of waste. Various measures have been tried without much success in these cities and counties. The common practice at present is to sort "valuables from non-valuables" or to dump "the entire solid waste unsorted". As the active participation of local residents in sorting is not expected, the training in Japan apparently made many of the participants aware of the importance of raising the environmental awareness of the public. The Fukuoka-style "semi-aerobic method"[18] adopted for the sanitary landfill facility in Guiyang is praised by the stakeholders in Guiyang County as an effective method to achieve ① volume reduction of solid waste to prolong the life expectancy of the facility, ② reduction of the exuded water treatment cost due to few impurities in such water and ③ realization of environmental conservation in the surrounding area as this method encourages the decomposition of solid waste by micro-organisms. In 2015, this method was explained to those responsible for waste treatment in cities and counties in Hunan Province at various meetings, etc. as the model for solid waste treatment in Hunan Province.

[17] These interviews took place in Hengyang, Liuyang, Guiyang, Qiyang and Cili with a total of nine of the participants of the training in Japan.

[18] The semi-aerobic landfill structure was researched and developed by Fukuoka University in Japan and was made a practical technology through collaboration between Fukuoka University and Fukuoka Municipal Government. This structure was adopted as Japan's standard structure in the Guidelines for Sanitary Landfill Facilities introduced by Japan's former Ministry of Health (currently the Ministry of the Environment) in 1979. It was also certified in 2011 as a method applicable to the Clean Development Mechanism (system to reduce greenhouse gas emissions) stipulated by the United Nations Framework Convention on Climate Change. The characteristics of this structure are ① prevention of the infiltration of exuded water into the foundation ground of a landfill site and ② facilitation of the aerobic decomposition of solid waste so that exuded water is purified as much as possible at the stage of collecting the said water.

However, each city or county has the authority to decide its own treatment method and the Guiyang model has not been adopted in other areas of the province as of the present time.

3．4 Impacts

3．4．1 Intended Impacts

(1) Reduction of Annual CO_2 Emission Volume

At the time of appraisal, "reduction of the annual CO_2 emission volume" was assumed to be a quantitative impact of the Project. 920,000 tons/year[19] established as the target figure is the assumed "annual CO_2 emission volume" in the case where a sanitary landfill facility is constructed in all of the 15 target cities and counties. Although the target figure for the annual CO_2 reduction volume by city/county (including the calculation method[20]) is not available at the time of ex-post evaluation, historical data on the actual annual CO_2 reduction volume is obtained for five cities/counties as shown in Table 7. The total reduction volume for these five cities/counties accounts for more than 50% of the overall target figure 920,000 tons/year (approximately 50% and 70% in 2014 and 2016 respectively) but the overall situation of target achievement is unclear because of the lack of actual data for the other 10 cities/counties.

Table 7 Annual CO_2 Emission Reduction Volume

(tons/year)

	2014	2015	2016
Guiyang	128,800	156,900	184,000
Qiyang	-	12,000	26,000
Changning	120,000	153,000	198,000
Linxiang	184,200	192,100	201,800
Lengshuijiang	23,000	21,000	25,000
Total	456,000	535,000	634,800

Source: Replies by the implementing enterprises to the questionnaire.

(2) Improvement of the Living and Sanitation Conditions for Residents of the Target Areas

At the time of appraisal, "improvement of the living and sanitation conditions for residents of the target areas" was assumed to be a qualitative impact. An interview survey was conducted with the environment bureaus of the target cities and counties where a sanitary landfill facility and transfer stations were constructed and also with the beneficiaries[21] on the existence of any qualitative impact

[19] According to materials provided by JICA, the landfill gas emission volume (greenhouse gas reduction volume) changes with the years passed since the original landfill. Here, the annual reduction volume is conveniently calculated as a simple annual average figure by dividing the presumed total emission volume of some 27.6 million tons from the sanitary landfill facilities in question by the assumed number of years of emission (30 years).

[20] The Ministry of the Environment of Japan stipulates that the reduction volume of greenhouse gases originating from the landfill of solid waste is calculated by multiplying the volume of solid waste landfilled at a landfill site by the emission volume of the unit solid waste volume (for each type of solid waste) and also specifies the emission volume (emission coefficient) per unit solid waste volume (https://ghg-santeikohyo.env.go.jp/calc). It is guessed that a similar calculation method is used in China.

[21] The beneficiaries survey was conducted with 36 residents (29 males and 7 females) living near a sanitary landfill facility or

of the Project. This survey confirmed ① improvement of the living conditions and townscape and ② improvement of the water quality of water sources as well as river water as "improvement of the living and sanitation conditions for residents of the target areas" due to the implementation of the Project.

Street cleaning by a cleaning crew.
(Shuangpai)

A clean footpath after rubbish collection.
(Qiyang)

In regard to "improving of the living conditions and townscape", the results of interviews with officials of environment bureaus and beneficiaries in the target cities/counties found that, prior to the implementation of the Project, it was very common for rubbish to scatter from waste collection sites, mainly set up in town centres, due to the lack of regular collection in addition to untidy streets which seemed to aggravate littering. In suburban and rural areas, the scarcity of waste collection due to the absence of waste collection sites eant that rubbish was simply piled up at empty lands, resulting in severely adverse conditions of bad odor, foul water and the propagation of flies and mosquitoes. Since the implementation of the Project, household waste is collected several times a day in urban areas and street cleaning and rubbish collection are regularly conducted by cleaning crews. Streets littered with rubbish have become scenes of the past and the drastic improvement of street sanitation has eliminated bad odor and foul water. The introduction of dedicated containers for household waste as well as closed type waste collection vehicles has prevented the scattering of rubbish in the streets, contributing to improvement of the living conditions and townscape. Due to the fact that the situation prior to the implementation of the Project was extremely bad, the effect of the Project on improvement of the living conditions and townscape is very substantial. According to the results of interviews with residents living near a sanitary landfill facility in the target cities and counties, improvement of the living conditions and townscape has been particularly great in suburban areas due to the lack of measures in the past and these residents are extremely happy with the visible, significant improvement. Many of the interview respondents state that the clean and tidy streets appear to have changed the environmental awareness and behavior of the public in that the level of littering has declined and people pick up litter in the street and put it in the newly installed litter bins.

transfer station in seven cities/counties (Qiyang, Changning, Yueyang, Shaoyang, Wugang, Zhangjiajie and Shuangpai).

The next issue is “improvement of the water quality of water sources and river water”. Interviews with officials of the environment bureaus and beneficiaries in the target cities and counties found that prior to the implementation of the Project, there were many cases where litter dumped in rivers was just left to float. The quality of rivers was also worsened by foul water flowing from dumped litter on river banks. The implementation of the Project has greatly reduced instances of scattered litter and the occurrence and seepage of foul water from dumped litter, thereby much improving the quality of river water. Many beneficiaries expressed their actual feeling that the situation and water quality of small rivers running near their homes have much improved.

(3) Fostering of Industries Related to Urban household waste Treatment

Following the policy of the Government of China to actively use the private sector for the front-line work for various public services while making government organizations concentrate on administrative work, the number of outsourcings of solid waste treatment to the private sector has been increasing. In fact, the private sector is the principal provider of the solid waste treatment service necessitated by the implementation of the Project. As a result, conscious efforts have been made to foster industries related to solid waste treatment. The number of cases of a private enterprise being responsible for the operation of a sanitary landfill facility or transfer station and accompanying cleaning and waste collection and transportation has been increasing even though it was originally assumed that these operations would be conducted by a local administration or state enterprise at the time of appraisal. Especially, the operation of the exuded water treatment equipment installed under the Project is now entirely conducted by the private sector. As explained in the section on Effectiveness, the development of infrastructure for solid waste treatment under the Project has made it possible to raise household waste treatment to a higher level, ranging from incineration and power generation using methane gas to the treatment of food waste (production of animal feed and composting). Most such new businesses are based on PPP and their markets are expanding, making a tangible contribution to the fostering of related industries. In the case of Zhangjiajie City which is a world-famous sightseeing location with a World Heritage site, the state of scattered rubbish before the implementation of the Project caused many tourist complaints. The significant improvement of the townscape since the implementation of the Project is said to have certainly contributed to the promotion of the local tourism industry.

(4) Expansion of Employment Opportunities Related to the Urban Household waste Treatment Business

Following the implementation of the Project, the public service related to household waste treatment has been enhanced. There has been a particularly strong need for the business of collecting household waste from litter bins introduced to homes and streets and the scale of employment for this business has expanded. According to the results of interviews with the implementing enterprises,

employment related to solid waste management has changed between the pre-project time and ex-post evaluation time as shown in Table 8. The scale of related employment has increased in most of the target cities and counties. The total number of employed persons in the 15 target cities and counties has increased by some 2.7 times from 4,755 persons to 12,665 persons. As the work involved is mainly simple, solid waste treatment provides valuable employment opportunities, especially for non-skilled older people in their 50's or older.

Table 8 Change of Employment Related to Solid Waste Treatment

Unit: persons

	Hengyang	Liuyang	Guiyang	Qiyang	Changning	Yueyang	Linxiang	Huarong
Pre-Project	620	265	200	345	400	0	261	400
At the Time of Ex-Post Evaluation	3,293	730	500	893	700	120	443	800
	Shaoyang	Wugang	Lengshuijiang	Cili	Zhangjiajie	Sangzhi	Shuangpai	Total
Pre-Project	1,000	200	304	300	300	60	100	4,755
At the Time of Ex-Post Evaluation	2,000	450	606	670	1,000	260	200	12,665

Sources: Replies by the implementing enterprises to the questionnaire and results of interviews with the implementing enterprises in each city or county.

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

Interviews with members of the implementing enterprises and environment protection bureaus found that monitoring of air, noise, water quality, dust, etc. was conducted during the construction period of sanitary landfill facilities in particular, which are a type of facility causing concern in regard to an undesirable load on the natural environment, by the municipal or county environment bureaus in accordance with national laws and regulations. This monitoring did not find any serious issues in any of the target cities and counties. A minor issue of dust or noise was addressed through consultations with the constructor. After the construction of a sanitary landfill facility, monitoring of the impacts on the natural environment continues in accordance with national laws and regulations. In almost all of the monitoring reports obtained from the implementing enterprises in the target cities and counties, the observed values for the quality of air, exuded water, groundwater, etc. are below the relevant standard values, confirming that no problematic issues have occurred. In regard to exuded water treatment, a matter of special importance, some data (on COD, ammoniac nitrogen, etc.) is transmitted on-line to the environmental bureau while regular monitoring is conducted in connection with other important indicators (BOD, suspended solids, etc.), suggesting adequate management of these indicators. As far as impacts on the natural environment other than exuded water are concerned, each municipal or county environment bureau conducts regular monitoring as well as snap inspection of the water quality at sanitary landfill facilities. The air quality around a sanitary landfill facility is also monitored using an ordinary monitoring system. The sanitary landfill facility in Changning experienced groundwater contamination in the surrounding area in 2013, resulting in the temporary suspension of its operation. However, investigation later found that the culprit was a large-scale pig farm nearby.

The water discharged from a transfer station is fed to a general sewage pipeline in each city or county and the quality of this mixed sewage is then monitored.

Because of the measures described above, no negative impacts on the natural environment are observed at the time of ex-post evaluation and, therefore, no negative impacts on the natural environment by the Project are identified.

(2) Resettlement and Land Acquisition

The situation of resettlement and land acquisition in connection with the implementation of the Project is shown in Table 9. The total area of land acquired slightly increased from the planned 299 ha to 321 ha.

Table 9 Situation of Resettlement and Land Acquisition

(Resettlement)

City/County	Numbers	Time of Resettlement	Form of Resettlement	Compensation Situation
Hengyang	12 households involving 50 persons	2007	Resettlement site is secured for those resettled	Funding for new farmland and house is provided in accordance with the national standards. Social infrastructure, such as electricity and water supply, nursery, etc., is provided.
Liuyang	20 households involving 60 persons	2008 - 2010	House and rsettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Wugang	15 households involving 50 persons	2008 - 2010	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Cili	6 households involving 21 persons	2008 - 2009	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant. No farmland is provided.
Zhangjiajie	35 households involving 100 persons	2011 - 2014	House and resettlement site is secured in the same village area	New houses and housing plots are provided in accordance with the national standards. No farmland is provided.
Sangzhi	6 households involving 20 persons	2008 - 2010	House and resettlement site is secured in the same village area	New houses and housing plots are provided in accordance with the national standards. No farmland is provided.
Shuangpai	41 households involving 144 persons	2008	House and resettlement site is secured in the same village area	New houses are provided in accordance with the national standards along with a grant.
Total	135 households involving 445persons			

Sources: Materials provided by JICA, replies by the implementing enterprises to the questionnaire and results of interviews with implementing enterprises in each city or county.

At the time of appraisal, the non-occurrence of resettlement was confirmed. However, since 2008 the strict application of the “technical standards for the treatment of household waste at a landfill

facility" of the Ministry of Construction which stipulates that "residents living within a distance of 500 m of a sanitary landfill facility must be resettled" necessitated the resettlement of 445 people of 135 households living within a distance of 500 m of a sanitary landfill facility in seven cities and counties because of the implementation of the Project. It has not been established why "a resettlement plan", which should be prepared whenever resettlement becomes necessary, was not prepared. However, even though the actual form of resettlement slightly varied from one city/county to another, a new house or the money to construct a new house was provided in accordance with the national standards as shown in Table 9. Most of the resettled people were farmers (many were elderly) and compensation was paid for farmland in accordance with the national standards. In addition, infrastructure (water supply, roads, nursery, etc.) for daily life was arranged. The relevant implementing enterprise monitored the progress of resettlement in accordance with the national rules. On the Japanese side, those responsible for the Project visited the planned resettlement sites to check the progress of resettlement. As such, no problems were found regarding resettlement. The interviews[22] with those resettled and visits to the resettlement sites found that all resettlement took place within the same village area. Because of the development of infrastructure, the standard of living has actually improved (in some cases, the income level was unchanged) and all of the resettled people have expressed their contentment.

As no negative impacts of resettlement and land acquisition are observed at the time of ex-post evaluation, it is judged that no negative impacts have been caused by resettlement and land acquisition under the Project.

In the targeted 15 cities and counties other than Changsha, the implementation of the Project has achieved technological improvement in line with the flow of solid waste management and has contributed to the (i) detoxification treatment of urban household waste in Hunan Province and (ii) volume reduction of such waste through removal of the water content with the introduction of transfer stations equipped with the compression function and garbage-compacting trucks. Moreover, positive effects have emerged regarding "improvement of the living and sanitation conditions for residents", "improvement of the water quality situation at water sources and rivers" and "fostering of related industries". Therefore, the effectiveness and impacts of the Project are high.

However, in the face of a rapidly increasing volume of solid waste beyond the forecast made at the time of appraisal, many transfer stations have been constructed by the Chinese side with its own budget in the target areas of the Project. Moreover, an incineration plant has been constructed in Hengyang and Qiyang after the start of the Project. Such work by the Chinese side using its own funds is believed to have also contributed to achievement of the project purpose. As such, the high evaluation of the effectiveness and impacts is judged to be the combined result of the Project and own efforts of the Chinese side. Efforts to achieve sorted collection have just begun in Changsha in 2018 after a trial period. According to members of the implementing enterprise and local government officials, it will

[22] The target persons for this interview were selected by the village authorities to ensure a good balance in terms of age, gender, etc. as requested by the evaluators. During the on-site visits, unplanned visits were made to a number of households for interview purposes.

take some time for positive effects in terms of “volume reduction” and “recycling” to emerge through the strict implementation of sorted collection.

３．５ Sustainability (Rating: ③)

３．５．１ Institutional Aspect of Operation and Maintenance

The treatment of urban household waste in China is under the jurisdiction of the Ministry of Construction. This work in the target cities and counties of the Project is managed by the urban authority (the name varies from one city/county to another). In regard to the maintenance and operation of sanitary landfill facilities, exuded water treatment equipment and solid waste collection and transportation facilities (transfer stations, garbage trucks, etc.), exuded water treatment equipment is maintained and operated by a specialist company in many of the target cities and counties. In the case of sanitary landfill facilities and solid waste collection and transportation facilities, these are either directly operated and maintained by the administration (environment bureau of the urban authority or state enterprise) or an outsourced private enterprise. The operating bodies by city/county are shown in Table 10. When the work is outsourced to the private sector, an enterprise with sufficient experience is selected periodically by means of tender and is supervised by the urban authority of each city or county. There are cases where both the sanitary landfill facility and exuded water treatment equipment are operated by a single enterprise. As both the central government and provincial governments have a policy of promoting the outsourcing of front-line solid waste treatment work to the private sector, the number of outsourcings is expected to increase in the coming years. The number of staff members for a sanitary landfill facility or exuded water treatment equipment is small at around 10 or less per site but the operation and management work at such facilities is smoothly conducted. In contrast, several hundred people, including those engaged in solid waste collection work, are employed by the administration or outsourced enterprise to operate and manage solid waste collection and transportation facilities/vehicles although the actual number varies from one city/county to another depending on the scale of the work involved.

Table 10 Operating Bodies of Household waste Treatment Business in the Target Cities and Counties of the Project

City/County	Sanitary Landfill Facility	Exuded Water Treatment	Transfer Station Operation	Solid Waste Collection and Transportation
Hengyang	Administration	Administration	Administration	Administration
Liuyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Guiyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Qiyang	Administration	Administration	Administration	Administration
Changning	Administration	Outsourced to the Private Sector	Administration	Administration
Yueyang	Administration	Administration	Administration	Administration
Linxiang	Administration	Administration	Administration	Administration
Huarong	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Outsourced to the Private Sector
Shaoyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector・Administration	Outsourced to the Private Sector
Wugang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector
Lengshuijiang	Administration	Administration	Administration	Administration
Cili	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration
Zhangjiajie	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Sangzhi	Administration	Administration	Administration	Administration
Shuangpai	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector

Source: Replies by the implementing enterprises to the questionnaire.

At the time of appraisal, it was assumed that the operation of sanitary landfill facilities was conducted by the municipal/county administration or state enterprises. However, because of the policy and preference of the Government of China, etc., the number of outsourcings is currently increasing for the operation of sanitary landfill facilities. As this is a general trend for solid waste treatment throughout China, no problems have emerged due to a change of policy. The interview survey with officials of the target cities and counties found that there were no problems regarding the current staff strength, causing no structural problems although further strengthening of the institutional arrangements to expand household waste treatment in rural areas is necessary.

In the case of a waste sorting facility in Changsha, the business is conducted by an outsourced private enterprise to which the necessary equipment, etc. have been leased by the municipal government. While the original plan envisaged the treatment of recyclable waste after the sorting of valuables, this precondition was not met, forcing the facility to deal with a massive volume of solid waste containing much valueless items. As sufficient operation profitability could not be secured under these conditions, actual sorting has been suspended.

３．５．２ Technical Aspect of Operation and Maintenance

In regard to “sanitary landfill” and “exuded water treatment”, both of which require technical operation and maintenance capability, they are conducted in accordance with the relevant domestic standards in China. Meanwhile, training for workers involved in such operation is conducted several times a year by the administration (the provincial housing construction agency), industrial association, etc. to improve their technical skill level. The “improved anaerobic landfill method” which is employed at all sanitary landfill facilities constructed under the Project except that in Guiyang is commonly used in China, posing no technical problems. In regard to the semi-aerobic landfill method employed in Guiyang, conscious efforts have been made to master the necessary skills through training sessions held at sanitary landfill facilities in Qingdao and other Chinese cities where this method is used. Any decision on outsourcing to a private enterprise is taken based on the premise that the enterprise in question is permitted to operate such facilities in China and has sufficient technical capability based on its past performance of similar work and its possession of the necessary manuals. All outsourced enterprises have operation and maintenance experience of multiple similar facilities to the facilities, etc. constructed under the Project and of the technologies involved. Consequently, both the administration and outsourced enterprises have the necessary technical operation and maintenance capability. Regular maintenance and response to any problems have been properly implemented, producing no special problems after the commissioning of the various facilities. In regard to collection and transportation, efforts have been made to improve the service management since the introduction of the facilities, including the formulation of management rules and the introduction of automatic disinfection and deodorizing equipment, etc. .

As there have been many cases of more than 10 enterprises applying for a tender for outsourcing, it is possible to select an enterprise capable of providing a high quality service based on its past performance. Outsourcing to the private sector has achieved such positive results as ① improved management of transfer work due to the installation of cameras at transfer stations and ② more efficient collection due to the introduction of small garbage trucks. Based on the above, there are no problems regarding the technical aspects of operation and maintenance.

In the case of the solid waste sorting facility in Changsha, the technical standards regarding the operation, etc. of the facility cannot be assessed properly because of ① suspension of operation and ② the fact that the outsourced enterprise does not necessarily have rich experience of the operation of a sorting facility although it does of rich experience of treating food waste.

３．５．３ Financial Aspect of Operation and Maintenance

At the time of appraisal, it was assumed that a waste treatment charge of 4 – 6 CNY/month per household would be collected to secure the necessary funding for solid waste treatment. However, only seven cities/counties of the 15 target cities/counties where a sanitary landfill facility and transfer stations were newly constructed under the Project currently collect such charge (3 – 5 CNY/month per

household).[23]

Some cities and counties are unable to collect the waste treatment charge as they have been unable to achieve a sufficient understanding of its necessity on the part of citizens. The actual charge per household varies from 1 CNY/month to 8 CNY/month, indicating the slow progress of efforts to secure a steady income which is essential for the stable progress of urban household waste treatment. Data on the amount of fiscal expenditure for urban household waste treatment is only available for some cities and counties and the figure varies from some 4 million CNY to 20 million CNY depending on the size of the city or county. Even in those cities and counties where the waste treatment charge is collected, the overall income is less than half of the relevant expenditure. In some cities and counties, the income accounts for only some 10% of the expenditure, making it necessary to supplement the shortfall from the general account.

Although exact fiscal information was not obtained, interviews with the implementing enterprises found that there is no mechanism for the central government or provincial government to subsidize the cost of urban household waste treatment. However, the expenditure amount for the treatment of household waste has shown a tendency to increase in each of the target cities and counties, reflecting the trend of an expanding service area of household waste treatment to rural areas and other developments, in turn originating from the ① growing emphasis in recent years on environmental issues, including living conditions, and ② achievement of visible great effects of moves to facilitate the treatment of urban household waste. Local financial authorities well understand the need to secure the fund for such treatment and have provided the necessary budget for operation and maintenance. In some cities and counties for which the relevant fiscal data is available, the annual growth rate of the solid waste treatment budget has exceeded 10% which is above the growth rate of the overall fiscal expenditure. Accordingly, no problems regarding the financial aspects of operation and maintenance are found at the time of ex-post evaluation. The results of interviews with the implementing enterprises target prefectural city or county officials indicate the prospect of continued availability of the necessary budget as "stagnation of the treatment of urban household waste would directly affect the lives of citizens". This prospect is supported by the favourable steady growth of the fiscal revenue of the target cities and counties. There is concern, however, regarding an increase of the fiscal burden in the long term to provide large funding for the continued improvement of treatment facilities if the volume of solid waste requiring treatment continues to increase, including the treatment of household waste generated in rural areas, as described earlier. Such a prospect necessitates ① volume reduction through the wider implementation of the 3R[24], including sorted collection currently in progress, and ② introduction of an adequate waste collection charge and its collection without fail.

When the work to treat urban household waste is outsourced to a private enterprise, payment is

[23] The level of the waste treatment charge is not a burden for ordinary citizens. As this charge is collected on top of the water charge, the collection rate for ordinary citizens is high. In Zhangjiajie, Linxiang, etc., the waste treatment charge is separately collected from business operators. The collected charges are accounted as revenue by the municipal/county government (Finance Agency).

[24] 3R stands for Reduce, Reuse and Recycle, indicating the important approaches to environmental consideration.

made based on the treatment volume of ordinary solid waste and exuded water (standard price per unit treatment volume x volume of treatment) as in the case of other similar work, ensuring a certain level of profitability for the outsourced enterprise.

There are currently no major problems regarding the financial aspects of operation and maintenance because of the facts that ① the necessary fiscal expenditure is secured even though the collection of the waste treatment charge is insufficient in some cities and counties and ② there is an adequate response to long-term issues.

３.５.４ Status of Operation and Maintenance

Monitoring, maintenance and regular inspection of the various facilities introduced under the Project are appropriately conducted by the urban management bureaus of individual cities and counties and outsourced enterprises in accordance with the national standards and management rules of China. Especially regarding exuded water treatment equipment, a system is in operation to automatically detect any problems. Some outsourced enterprises monitor entrusted facilities from their head offices as part of a system to provide an immediate response to emerging problems. The maintenance and inspection of facilities are properly conducted in accordance with China's national standards (and the standards of those enterprises which are stricter than the national standards). No major problems have occurred at any of the facilities, etc. since the start of their operation to the time of ex-post evaluation. No problems have occurred with the procurement of spare parts. The field reconnaissance conducted as part of the ex-post evaluation has confirmed that ① each facility is generally maintained in a tidy, clean and orderly manner, ② active efforts are made regarding guidance and awareness raising for all stakeholders by means of the introduction of various notice boards, etc. to ensure smooth operation and maintenance and ③ transportation records of urban household waste are properly kept at many transfer stations. According to officials involved in facility operation, any breakdown or abnormality of equipment is smoothly dealt with through collaboration with the outsourced enterprise. As a result, the conditions of the main facilities and equipment are generally good. However, the field reconnaissance discovered cases where household waste brought for landfill is not properly weighed at some public sector-run sanitary landfill facilities, making the steady improvement of the management level essential.

The operating rate of the facilities is generally high due to urbanization and the promotion of household waste treatment in rural areas as described earlier.

In the case of the waste sorting facility in Changsha of which the operation is currently suspended, an officer of the enterprise in charge of this facility points out that the facility is in working order as maintenance work has been done regularly. The warehouse and office space of this facility are used as a food waste treatment plant and office respectively at the time of ex-post evaluation.

No major problems are observed with the institutional, technical and financial aspects and current status of the operation and maintenance system. Therefore, the sustainability of the project effects is

high.

4. Conclusions, Recommendations and Lessons Learned

4.1 Conclusion

The objective of the project is to facilitate the appropriate treatment of waste generated in local cities (16 cities and counties) in Hunan Province by developing a suitable waste treatment system, thereby contributing to improvement of the living as well as sanitation conditions for inhabitants and environmental consideration in these areas. The Project is highly relevant to the development needs of the Government of China and Government of Hunan Province such as improvement of the living and sanitation conditions and environmental conservation in the province. It is also relevant to Japan's ODA policy. Therefore, its relevance is high. In relation to efficiency, while the project cost was within the planned cost, the project period was significantly longer than the planned period (2.64 times longer than planned). Therefore, the efficiency of the Project is only fair. As a result of the successful introduction of facilities to treat urban household waste under the Project, the target values for the operation indicators (treatment volume at sanitary landfill facilities, BOD and COD concentration, volume of suspended solids, waste collection rate, etc.) set during the project appraisal have been generally achieved. Meanwhile, the service population which is an effect indicator far exceeds the target value. Moreover, positive confirmation has been made for such qualitative indicators as "improvement of the living conditions and townscape", "improvement of the water quality of water sources as well as river water" and "fostering of related industries". Significant improvement has been specially observed in the case of "living conditions and townscape". Therefore, the effectiveness and impacts of the Project are high. In regard to the "waste sorting facility" constructed under the Project (in Changsha), there is a structural problem in that the sorting of solid waste as a precondition for the efficient operation of this facility has not been achieved. The facility also faces the difficulty for the outsourced private enterprise to secure the profitability of operation due to the lack of any subsidy. Meanwhile, the sustainability of "sanitary landfill facilities, exuded water treatment equipment and collection and transportation facilities" in the other 15 cities and counties is judged to be high in terms of the institutional, technical and financial aspects and the current status of operation and maintenance. Therefore, the sustainability of the positive effects of the Project as a whole is high.

Based on the above, the Project is evaluated as highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agencies

Implementation of Efforts to Utilize the Sorting Facility in Changsha

As described earlier, the waste sorting facility in Changsha is not currently used because of failure to meet its precondition (collection of commercial waste containing a large volume of recyclable items)

even though it did operate for a short period of time after its completion. In view of the current situation in China where efforts to sort solid waste have been actively made in recent years, the relevant agencies and organizations in Hunan Province and Changsha are required to examine the situation in a concrete manner with a view to the utilization of this facility.

４．２．２ Recommendations to JICA

None

４．３ Lessons Learned

Importance of Selecting and Developing Suitable Facilities Based on the Current State of Solid Waste Management

The waste sorting facility in Changsha began operation after its completion but is no longer used because of failure to meet its precondition (collection of solid waste containing a large volume of valuables). The original plan intended the sorting of valuables from partially sorted solid waste delivered to the facility. In reality, however, advance partial sorting was not conducted and the resulting treatment of the non-sorted solid waste led to equipment breakdowns, etc., resulting in non-profitable operation. This suggests the extreme importance of introducing a facility only after any precondition(s) (in connection with the current situation of waste collection and treatment) for the smooth operation of the facility in question has been carefully identified and is fully understood. In the case of a facility such as a waste sorting facility for efficient waste treatment and achievement of the 3R, which requires the participation or involvement of ordinary members of the public to meet its preconditions, it is essential for JICA to conduct an in-depth examination of the relevance of the facility at its planning stage. When the construction of a sorting facility is a sub-project of a project to construct multiple different facilities as in the case of the present Project, special care is required because there is a chance that in-depth examination will not be conducted when it is considered as the minor status of the sub-project in the overall project.

Formulation of a Project Taking Verification of the Project Effects into Consideration

The Project originally planned examination of the feasibility of applying the clean development mechanism (CDM)[25] as the establishment of sanitary landfill facilities could reduce the emission of greenhouse gases (CO_2, etc.) through the recovery and effective use of landfill gas which had been simply released to the atmosphere.

The waste treatment method employed for the newly constructed sanitary landfill facilities under the Project was the improved anaerobic method (the most common method in China) at 14 out of 15

[25] CDM is a mechanism whereby advanced countries provide technical and financial assistance for developing countries to implement projects designed to reduce the emission or absorption of greenhouse gases so that a certain proportion of the reduced emission can be considered a greenhouse gas emission reduction applicable to the assisting countries.

sites and the semi-aerobic method (the most common method in Japan) which is certified as a CDM method at one site. However, the indicators and calculation method to verify the greenhouse gas reduction effects were not specified in an appropriate manner at the time of appraisal. Moreover, neither indicators to compare the effects of the anaerobic method and the semi-aerobic method nor a system to monitor the operation of these facilities were not properly established. Because of these deficiencies, it was impossible to thoroughly collect greenhouse gas reduction data which is essential for CDM application. Proper comparison of the effects of the two difference treatment methods was not possible. In the case of a project which intends CDM application and/or the comparison of different treatment methods, it is important to specify the indicators and indicator calculation method(s) at the time of appraisal while including the arrangement of the development of a monitoring system and other necessary measures in a component designed to assist smooth project implementation.

Importance of Establishing Appropriate Targets for Indicators Necessary for Detailed Evaluation

The service population in the case of the Project was the only effect indicator for which a target value was set to verify the effectiveness of the Project. For the ex-post evaluation, the number of illegal dumping sites was introduced as an additional effect indicator as this indicator is often used to check the effectiveness of a solid waste treatment project more precisely. However, evaluation of the Project from this viewpoint is unsatisfactory because of the poor awareness of illegal dumping in China and the absence of a target value at the start of the Project meant that there was no real data on illegal dumping at the time in question. Consequently, sufficient evaluation has not been possible with this indicator.

The absence of a target value in the Project for the number of illegal dumping sites is likely a reflection of the state of urban household waste treatment in China at the start of the Project. When the number of indicators for which target values are set is limited, there is concern regarding the difficulty of conducting a detailed evaluation. It is, therefore, necessary to properly consult with the executing agency of the recipient country at the start of the Project to set appropriate target values for indicators which are essential for detailed evaluation. A solid waste treatment project in a developing country requires much attention and the careful examination of indicators and their target values because such a project is often a pioneering project for the recipient country.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Sanitary landfill facility: 15 sites - Total capacity: 68.28 million m^3 - Exuded water regulating basin: 309,100 m^3 2) Exuded water treatment equipment: 15 sites - Total capacity: 49.4 million m^3 3) Collection and transportation facility: - New transfer station: 131 sites - Improved transfer station: 34 sites - Collection vehicles: 193 vehicles 4) Sorting facility for recycling (Changsha): 1,000 tons/day - Other facilities: water treatment facilities; warehouse and office buildings - On-site equipment: bulldozers; loaders; trucks 5) Training - Training in Japan: 45 persons - Training in China: 270 persons	1) Sanitary landfill facility: as planned - Total capacity: 65.69 million m^3 - Exuded water regulating basin: 223,200 m^3 2) Exuded water treatment equipment: as planned - Total capacity: 29.5 million m^3 3) Collection and transportation facility - New transfer station: 136 sites - Improved transfer station: 57 sites - Collection vehicles: 216 vehicles 4) Sorting facility for recycling (Changsha): as planned - Other facilities: as planned - On-site equipment: as planned 5) Training - Training in Japan: 92 persons - Training in China: 8 persons
2. Project Period	January, 2008 – December, 2010 (36 months)	December, 2007 – October, 2015 (95 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 11,175 million yen 10,994 million yen 22,169 million yen 10,500 million yen 1 CNY = 15.6 JPY (as of June, 2007)	 10,482 million yen 8,490 million yen 18,972 million yen 10,482 million yen 1 CNY = 14.9 JPY (mean for 2007 through 2015)
4) Final Disbursement	October, 2015	

【Appendix】

Appendix Table1　Main Project Outputs by Target Prefectural City/County

	Planned (at the time of appraisal)	Actual		Planned (at the time of appraisal)	Actual
1. Sanitary landfill facility					
1-1 Processing volume					
Hengyang	13,200,000 ㎥	13,200,000 ㎥	Shaoyang	5,430,000 ㎥	8,600,000 ㎥
Liuyang	5,200,000 ㎥	4,500,000 ㎥	Wugang	3,440,000 ㎥	3,440,000 ㎥
Guiyang	3,200,000 ㎥	3,000,000 ㎥	Lengshuijiang	5,060,000 ㎥	4,980,000 ㎥ (147)
Qiyang	5,170,000 ㎥	3,130,000 ㎥	Cili	4,350,000 ㎥	4,350,000 ㎥
Changning	5,070,000 ㎥	5,070,000 ㎥	Zhangjiajie	4,120,000 ㎥	3,950,000 ㎥
Yueyang	2,140,000 ㎥	2,000,000 ㎥	Sangzhi	1,650,000 ㎥	1,740,000 ㎥ (51)
Linxiang	5,250,000 ㎥	3,850,000 ㎥	Shuangpai	2,050,000 ㎥	1,100,000 ㎥
Huarong	2,950,000 ㎥	2,780,000 ㎥ (50)			
1-2 Leachate pondage volume					
Hengyang	21,000 ㎥	20,000 ㎥	Shaoyang	40,000 ㎥	42,000 ㎥
Liuyang	15,000 ㎥	7,600 ㎥	Wugang	18,000 ㎥	12,000 ㎥
Guiyang	12,600 ㎥	7,000 ㎥	Lengshuijiang	16,000 ㎥	20,000 ㎥
Qiyang	20,000 ㎥	10,000 ㎥	Cili	18,000 ㎥	5,600 ㎥
Changning	28,000 ㎥	28,000 ㎥	Zhangjiajie	18,000 ㎥	10,000 ㎥
Yueyang	19,000 ㎥	19,000 ㎥	Sangzhi	20,000 ㎥	12,000 ㎥
Linxiang	30,000 ㎥	15,000 ㎥	Shuangpai	12,500 ㎥	5,000 ㎥
Huarong	21,000 ㎥	10,000 ㎥			
2. Leachate treatment equipment					
2-1 Volume					
Hengyang	550 ㎥/day	400 ㎥/ day	Shaoyang	300 ㎥/ day	400 ㎥/ day
Liuyang	480 ㎥/ day	400 ㎥/ day	Wugang	270 ㎥/ day	150 ㎥/ day
Guiyang	300 ㎥/ day	160 ㎥/ day	Lengshuijiang	240 ㎥/ day	100 ㎥/ day
Qiyang	300 ㎥/ day	220 ㎥/ day	Cili	280 ㎥/ day	100 ㎥/ day
Changning	530 ㎥/ day	200 ㎥/ day	Zhangjiajie	350 ㎥/ day	200 ㎥/ day
Yueyang	200 ㎥/ day	10 ㎥/ day	Sangzhi	300 ㎥/ day	50 ㎥/ day
Linxiang	300 ㎥/ day	300 ㎥/ day	Shuangpai	240 ㎥/ day	160 ㎥/ day
Huarong	300 ㎥/ day	100 ㎥/ day			
3. Collection and transportation facilities					
3-1 Construction of new transfer station					
Hengyang	1	1	Shaoyang	18	18
Liuyang	20	4	Wugang	16	12
Guiyang	15	12	Lengshuijiang	15	3
Qiyang	5	20	Cili	0	4
Changning	3	3	Zhangjiajie	6	26
Yueyang	6	3	Sangzhi	3	6
Linxiang	15	15	Shuangpai	0	0
Huarong	8	9			
3-2 Modification of transfer station					

Hengyang	0	0	Shaoyang	0	18
Liuyang	0	0	Wugang	18	5
Guiyang	5	5	Lengshuijiang	0	12
Qiyang	0	0	Cili	0	0
Changning	3	3	Zhangjiajie	0	0
Yueyang	0	0	Sangzhi	6	12
Linxiang	2	2	Shuangpai	0	0
Huarong	0	0			
3-3 Solid waste collection vehicles					
Hengyang	24	0	Shaoyang	46	34
Liuyang	12	26	Wugang	8	7
Guiyang	10	17	Lengshuijiang	10	10
Qiyang	18	65	Cili	4	0
Changning	6	19	Zhangjiajie	18	0
Yueyang	5	0	Sangzhi	3	9
Linxiang	15	22	Shuangpai	3	0
Huarong	11	15			

	Planned (at the time of appraisal)	Actual
4. The sorting facility for recycling (Changsha)		
・Sorting facility for recycling	1,000 tons/day	As planned
・Other facilities	Water treatment equipment, warehouse and office buildings	As planned
・On-site equipment	Bulldozers, loaders, trucks	As planned
5. The equipment related to waste treatment		
・The equipment of facilities（15 cities/counties excluding Changsha）	・On-site equipment（Bulldozers, loaders, Other facilities, loading、Excavator, Spray cars etc.） ・Other facilities and equipment（Weighing equipment, Car wash facilities, Telecommunication equipment etc.）	As planned
・Collection equipment（15 cities/counties excluding Changsha）	・The equipment of collection, transport and cleaning（Waste transport trucks, Waste compression and collection vehicles）, A sweeping and watering car ・Waste collecting box（0.2-4 ㎥ class）	As planned
6. Training（Province and entire cities/counties）		
・Training in Japan	45 persons	92 persons
・Training in China	270 persons	8 persons

Source: Documents provided by JICA, replies by executing companies to the questionnaire.

Note: Sanitary landfill facility volume includes 7,020,000 ㎥（Huarong 2,280,000 ㎥、Lengshuijiang 3,510,000 ㎥、Sangzhi 1,230,000 ㎥）, which has already finished basic construction and plan to construct facilities such as sheet etc..

Appendix Table 2　Operation and Effect Indicators by Target Prefectural City/County

Prefectural city/county	Hengyang		Liuyang		Guiyang		Qiyang	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	387,000	18,250 (incineration 419,750) (458,102 in 2015)	118,625	222,930	66,800	102,200	149,400	53,643 (incineration 33,639) (89,282 in 2014)
Post-treatment leachate BOD concentration (mg/l)		4.5	30	3.4		14.0		14.7
Post-treatment leachate COD concentration (mg/l)		40.0	100	13.5		36.0		14.7
suspended substance and suspended solids (mg/l)	200	24.0	200	21.0		13.0		-
Post-treatment ammoniacal nitrogen (mg/l)		15.7		0.1		6.7		8.3
Treated leachate volume (m^3/year)		36,500		115,000		25,000		32,945
Harmless treatment rate of municipal solid waste (%)		100		100		100		100
Collection volume of municipal solid waste (tonnes/year)		2,409,000		222,930		102,200		89,643
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		320,000		200,000		89,936		-
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	102	300	20	90	18	33	31	30
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		300 (Entire city)		90 (Urban area + some rural areas)		33 (Urban area + some rural areas)		30 (Urban area + some rural areas)
(out of which) beneficiaries of transfer station (in units of 10,000 people)		200 (Urban area)		30 (Urban area)		33 (Urban area + some rural		28 (Urban area)

						areas)		
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		200 (Urban area)		90 (Urban area + some rural areas)		33 (Urban area + some rural areas)		30 (Urban area + some rural areas)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Changning		Yueyang		Linxiang		Huarong	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	84,000	116,750	71,000	15,000 (incineration 73,000) (25,000 in 2015)	107,000	49,823	94,900	50,277
Post-treatment leachate BOD concentration (mg/l)		10.0		3.9		82.7		9.9
Post-treatment leachate COD concentration (mg/l)		60.0		20.7		378.0		99.0
suspended substance and suspended solids (mg/l)		5.0		6.0		101.0		9.9
Post-treatment ammoniacal nitrogen (mg/l)		-		1.0		34.0		-
Treated leachate volume (m^3/year)		84,900		6,300		24,300		13,235
Harmless treatment rate of municipal solid waste (%)		100		100		95		100
Collection volume of municipal solid waste (tonnes/year)		88,000		-		52,132		69,300
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		-		-		39,238		50,277
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	17	82	15	24	21	20	25	71
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		82 (Urban area + some rural		24 (Entire zone)		20 (Urban area + some		71 (Entire county)

		areas)				rural areas)		
(out of which) beneficiaries of transfer station (in units of 10,000 people)		28 (Urban area)		24 (Entire zone)		14 (Urban area)		25 (Urban area + some rural areas)
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		28 (Urban area)		24 (Entire zone)		14 (Urban area)		35 (Urban area + some rural areas)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Shaoyang		Wugang		Lengshuijiang		Cili	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	262,800	264,978	95,000	87,400	95,000	82,752	98,000	114,975
Post-treatment leachate BOD concentration (mg/l)		3.0		14.0	30	7.0		13.0
Post-treatment leachate COD concentration (mg/l)		15.0		34.0	100	16.0		27.0
suspended substance and suspended solids (mg/l)		12.0		6.0	30	6.0		4.0
Post-treatment ammoniacal nitrogen (mg/l)		0.1		6.0		1.2		-
Treated leachate volume (m^3/year)		110,751		35,000		42,772		-
Harmless treatment rate of municipal solid waste (%)		100		100		97		100
Collection volume of municipal solid waste (tonnes/year)		239,837		87,400		93,588		113,400
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		239,837		-		37,723		-
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	52	95	17	60	19	38	20	71
(out of which) beneficiaries of		95		60		38		71

sanitary landfill (in units of 10,000 people)		（Urban area + some rural areas）		（Urban area + some rural areas）		（Urban area + some rural areas）		（Entire county）
(out of which) beneficiaries of transfer station (in units of 10,000 people)		70（Urban area）		30（Urban area）		15（Urban area）		15（Urban area）
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		70（Urban area）		30（Urban area）		15（Urban area）		15（Urban area）
Illegal dumping sites		0		0		0		0
Prefectural city/county	Zhangjiajie		Sangzhi		Shuangpai		Total	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	73,000	113,500	31,000	48,600	31,940	36,500	1,765,465	1,377,578
Post-treatment leachate BOD concentration (mg/l)		20.0		20.0		-	30-600	3.4-82.7
Post-treatment leachate COD concentration (mg/l)		60.0		60.0		11.7	100-1,000	3.0-378.0
suspended substance and suspended solids (mg/l)		30.0		-		0.0	200	5.0-101.0
Post-treatment ammoniacal nitrogen (mg/l)		10.0		-		-		0.1-34.0
Treated leachate volume (m^3/year)		24,000		11,800		36,500		599,003 (14 cities/counties)
Harmless treatment rate of municipal solid waste (%)		100		100		100		95-100 (average 99%)
Collection volume of municipal solid waste (tonnes/year)		113,500		48,532		36,500		3,765,962 (14 cities/counties)
Collection rate of municipal solid waste (%)		100		100		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)		-		-		-		977,011 (7 cities/coun

								ties)
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	21	30	7	18	6	9	390	971
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		9 (Urban area + some rural areas)		971
(out of which) beneficiaries of transfer station (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		-		569
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		30 (Urban area)		18 (Urban area + some rural areas)		-		641
Illegal dumping sites		0		0		0		0

Source: Replies by executing companies to the questionnaire.
Note: The target and actual values reflect 2 years after project completion (actual values are from 2017). Collection rate of municipal solid waste = collected MSW volume / generated MSW volume. The shaded boxes reflect indicators that are outside the scope of this evaluation.

Appendix3 The Number of Beneficiaries of Project Facilities by Target Prefectural City/County

	Region	Beneficiaries	Region	Beneficiaries	Region	Beneficiaries	
Hengyang	Entire city	3,000,000	Urban area	2,000,000	Urban area	2,000,000	3,000,000
Liuyang	Urban area + some rural areas	900,000	Urban area	300,000	Urban area + some rural areas	900,000	900,000
Guiyang	Urban area + some rural areas	330,000	Urban area + some rural areas	330,000	Urban area + some rural areas	330,000	330,000
Qiyang	Urban area + some rural areas	300,000	Urban area	280,000	Urban area + some rural areas	300,000	300,000
Changning	Urban area + some	820,000	Urban area	280,000	Urban area	280,000	820,000

	rural areas						
Yueyang	Entire zone	240,000	Entire zone	240,000	Entire zone	240,000	240,000
Linxiang	Urban area + some rural areas	200,000	Urban area	140,000	Urban area	140,000	200,000
Huarong	Entire county	710,000	Urban area + some rural areas	250,000	Urban area + some rural areas	350,000	710,000
Shaoyang	Urban area + some rural areas	950,000	Urban area	700,000	Urban area	700,000	950,000
Wugang	Urban area + some rural areas	600,000	Urban area	300,000	Urban area	300,000	600,000
Lengshuijiang	Urban area + some rural areas	380,000	Urban area	150,000	Urban area	150,000	380,000
Cili	Entire county	710,000	Urban area	150,000	Urban area	150,000	710,000
Zhangjiajie	Urban area	300,000	Urban area	300,000	Urban area	300,000	300,000
Sangzhi	Urban area + some rural areas	180,000	Urban area + some rural areas	180,000	Urban area + some rural areas	180,000	180,000
Shuangpai	Urban area + some rural areas	90,000	-	-	-	-	90,000

Source: Replies by executing companies to the questionnaire.
Note: Total figure excludes duplicates.

Appendix Table4 Operating Bodies of Household Waste Treatment Business in the Target Cities and Counties of the Project

City/County	Sanitary Landfill Facility	Exuded Water Treatment	Transfer Station Operation	Solid Waste Collection and Transportation
Hengyang	Administration	Administration	Administration	Administration
Liuyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Guiyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration

Qiyang	Administration	Administration	Administration	Administration
Changning	Administration	Outsourced to the Private Sector	Administration	Administration
Yueyang	Administration	Administration	Administration	Administration
Linxiang	Administration	Administration	Administration	Administration
Huarong	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Outsourced to the Private Sector
Shaoyang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector・Administration	Outsourced to the Private Sector
Wugang	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector
Lengshuijiang	Administration	Administration	Administration	Administration
Cili	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration
Zhangjiajie	Outsourced to the Private Sector	Outsourced to the Private Sector	Administration	Administration
Sangzhi	Administration	Administration	Administration	Administration
Shuangpai	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector	Outsourced to the Private Sector

Source: Replies by the implementing agencies to the questionnaire.

People's Republic of China

FY 2017 Ex-Post Evaluation of Japanese ODA Loan

"Anhui Municipal Solid Waste Treatment Project"

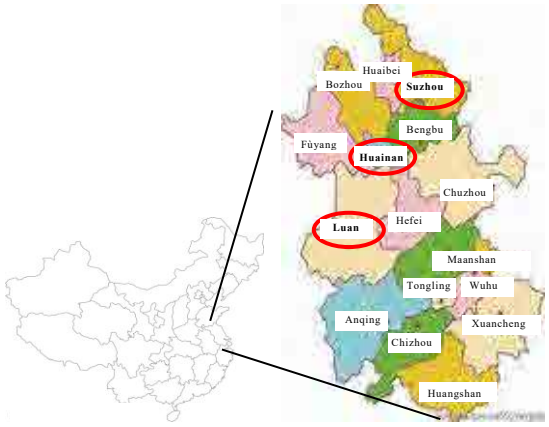
External Evaluators: Toshihiro Nishino, Miho Sakuma, International Development Center of Japan Inc.

1. Summary

The objective of this project is to promote the proper handling of the household solid waste generated in the regional cities of Anhui Province (7 prefectural cities and counties) by the construction of a solid waste treatment system, thereby contributing to environmental conservation and improvements in the living environments and sanitary conditions of local residents. The project conforms to the policies for household solid waste management of the Chinese Central Government and the Anhui Provincial Government. It is in line with China's developmental needs, such as the construction of an efficient solid waste treatment system and improvements in the sanitary conditions and living environments of regional cities in the province. It has been also relevant to Japan's ODA policy. Therefore, its relevance is high. Evaluation team assess the efficiency of the project as a whole to be fair, since the project cost was reduced commensurate to changes in project outputs, but the project period exceeded the planned duration due to newly required permits resulting from changed national standards for leachate treatment equipment. Additionally, as a result of setting up the basic facilities and equipment needed for municipal solid waste management, the operation and effect indicators (volume of sanitary landfill processed, post-treatment leachate BOD/COD concentration, harmless treatment rate of household solid waste, number of beneficiaries, etc.) at ex-post evaluation all achieved the target values set during the project appraisal. In addition, evaluation team verified a wide range of qualitative effects with respect to "promoting proper handling of the solid waste generated in target areas," such as (1) swift collection of household solid waste, (2) proper final disposal, (3) promoting higher-level treatment of household solid waste, (4) encouraging the management of household solid waste in rural areas, and (5) elevated solid waste management standards. There was also a remarkable impact with regard to "improvements in the living environments and sanitary conditions of residents in the target areas", consisting of (1) improvements in the residential environment and landscape, and (2) improvements in the water quality of rivers and water sources. Evaluation team also observed contributions by this project to the cultivation of industries related to municipal solid waste management, and increased employment opportunities in jobs related to municipal solid waste management. Therefore, Evaluation team believe the project has a high level of effectiveness and impact. Evaluation team also believe it to have high sustainability, given the excellent operation and maintenance of the equipment and

facilities, and the absence of problems from institutional, technical or financial aspects. In light of the above, this project is evaluated to be highly satisfactory.

2. Project Description



Project Locations

Transfer station set up for the current project (Yè jí)

2.1 Background

In *the Tenth National Five-Year Plan for Environmental Protection (2001-2005)*, the Chinese government constructed an efficient waste management system (separated collection, storage/transportation, and treatment), prioritized the reduction and reuse/recycling of solid waste, and promoted the harmless treatment[1] of municipal solid waste (MSW) and centralized safe management of hazardous waste. However, the state of China's municipal solid waste was such that the treatment capacity could not keep up with the rate of waste generation. Although there has been growth in harmless treatment facilities such as sanitary landfills and incineration plants, with the number of locations increasing to 471 nationwide and the processing capacity to 256,300 tonnes/day (annual volume of harmless treatment at 80.51 million tonnes), the volume of collected and transported waste reached 156 million tonnes/year in 2005, while the harmless treatment rate for 2005 decreased from the previous year to 51.7%. Given these circumstances, The Outline of *the Eleventh National Five-Year Plan for Economic & Social Development* aimed to increase the construction of MSW treatment facilities as part of its environmental conservation efforts, and set targets to raise the harmless treatment rate above 60% by 2010.

Infrastructural development related to solid waste management in Anhui Province was delayed significantly, as initiatives for solid waste management started relatively late. The municipal solid waste generated in 2005 was 5.02 million tonnes annually. Even in urban

[1] Harmless treatment in China refers to the following 3 processes: sanitary landfill, composting, and incineration.

areas the harmless treatment rate stagnated at 17.6%, making it the third worst province after Shanxi and Gansu. The common practices in most areas of the province were treatment at simple landfill facilities which did not meet the national standards, open-air dumping and open-air burning among others, causing serious detrimental impacts on the soil, rivers, groundwater, air, etc. Therefore, there was great urgency to the construction of new sanitary landfill facilities and the improvement of sanitary conditions and living environments in the regional provincial cities.

2.2 Project Outline

The objective of this project is to promote the proper handling of the household solid waste generated in the regional cities of Anhui Province (7 prefectural cities and counties[2]) by constructing a solid waste treatment system, thereby contributing to environmental conservation and improvements in the living environments and sanitary conditions of local residents

Loan Approved Amount/Disbursed Amount	6.8 billion yen / 5.188 billion yen	
Exchange of Notes Date/ Loan Agreement Signind Date	December 2007 / December 2007	
Terms and Conditions	Interest rate Repayment period (Grace period Conditions for procurement	0.65% 40 years 10 years) General Untied
Borrower/ Executing Agency	The Government of People's Republic of China / The People's Government of Anhui Province	
Project Completion	August 2015	
Main Contractor	-	
Main Consultant	-	
Related Studies (Feasibility Studies, etc.)	F/S conducted by Shanghai Municipal Engineering Design General Institute (March 2007)	
Related Projects	-	

[2] Lu'an City, Huoshan County, Huo Qiu County, Yè jí Zone (Huoshan County, Huo Qiu County, and Yè jí Zone are administrative districts of the city of Lu'an), Huainan City, Suzhou City, and Tongling City.

3. Outline of the Evaluation Study

3.1 External Evaluators

Toshihiro Nishino and Miho Sakuma (International Development Center of Japan Inc.)

3.2 Duration of Evaluation Study

The ex-post evaluation study was conducted with the following schedule.

Duraion of the Study: July, 2017 – March, 2019

Duraion of the Field: October 29, 2017 – November 11, 2017; January 21-25, 2018

3.3 Constraints during the Evaluatiom Study

Evaluation team had planned to conduct interviews with beneficiaries of the project as well as residents who had been resettled due to the construction of the sanitary landfills, arbitrarily selecting residents from the directory to ensure objectivity. However, in China even government research institutes have not been able to use this sampling method to solicit opinions from ordinary citizens; neither did the executing agencies in the prefectural cities/counties have any experience implementing this method. Therefore, evaluation team designated place of residence, gender, age, and other requests (for example, ordinary citizens with no governmental affiliation), and allowed the executing agencies in each prefectural city/county to select the subjects.[3] Therefore, the interview survey results may not entirely represent the opinions of all beneficiaries.

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

4.1 Relevance (Rating: ③ [5])

4.1.1 Consistency with the Development Plan of People's Republic of China

As evidenced by *the Tenth National Five-Year Plan for Environmental Protection (2001–2005)* and the Outline of *the Eleventh National Five-Year Plan for Economic & Social Development (2006–2010)*, the Chinese Government's developmental plans have emphasized environmental issues (including waste management) as a priority policy while this project was at the time of appraisal. Given the shortage in the absolute number of municipal solid waste (MSW) treatment facilities, the plans stressed the increased construction of facilities and the efficient waste management system building (comprised of separated collection, and storage/transportation), and improvements in the harmless treatment rate of municipal solid wast as a result of the efficient waste management system. The subsequent National Five-Year Plans have also consistently

[3] Interviews were conducted with about 10 resettled residents (roughly 40% women) in Lu'an City, Huoshan County, and Yè jí Zone.

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

[5] ③: High, ②:Fair, ①: Low

focused on the construction of an efficient waste management system and improvements in the harmless treatment rate of municipal solid waste. However, given some progress in the construction of MSW treatment plants, the plans and policies during the ex-post evaluation period (such as *the Thirteenth National Five-Year Plan for Economic & Social Development (2016-2020)*) reveal stronger initiatives for a higher standard of MSW treatment, including further improvements in the harmless treatment rate (over 95%); technological development and facility improvements pertaining to incineration, biological treatment processing, waste-to-energy, and waste separation; achieving a high level of reduction, reuse, and recycling of resources; and disclosure of information pertaining to solid waste management.

Taking a cue from the central government's policies, Anhui Province also stepped up its response to MSW treatment. *Anhui Province's Thirteenth National Five-Year Plan (2016-2020) for Environmental Protection* outlines a plan to optimize the construction of MSW treatment facilities, strengthen their operation and management, and further improve harmless treatment rates.

Therefore, during both at the time of appraisal and ex-post evaluation periods, the objectives and details of this project aligned with China's policies on household solid waste management, in that it aims for "environmental conservation and improvements in the living and sanitary conditions of local residents through the construction of an efficient MSW treatment system."

Table 1　Primary Objectives of the Development Plans Related to This Project

Type	During Project Examination	During Ex-Post Evaluation
Solid waste management policy / National development plan	Tenth National Five-Year Plan for Environmental Protection (2001 – 2005): ・Construct an efficient waste management system (separated collection, storage/transportation, and treatment); prioritize the reduction and reuse/recycling of solid waste; and promote the harmless treatment of municipal solid waste and focused centralized safe management of hazardous waste. Outline of the Eleventh National Five-Year Plan for Economic & Social Development (2006 – 2010): ・As part of environmental protection efforts, ramp up the construction of MSW treatment facilities, and collection of fees for MSW treatment, and aim for a harmless treatment rate of 60% or more by 2010.	Thirteenth National Five-Year Plan for Environmental Protection (2016 – 2020): ・Reduce the amount of MSW processed, and increase the reuse/recycling of resources; raise the standard of harmless treatment; and raise the national rate for the harmless treatment of MSW to 95% or more. ・Build a collection, storage, and transportation system; promote full-scale, sealed waste collection and transportation in the municipality. ・Increase the management of waste leachate and ash emitted during incineration; increase methane use and odor management at landfills; and promote the social disclosure of pollutant emissions from waste processing plants. Thirteenth National Five-Year Plan for Economic & Social Development (2016 – 2020): ・Immediately start the construction of urban solid waste processing plants; build a collection and transportation system; improve the waste incineration rate; and complete a leachate treatment plants. Build waste management facilities and achieve standard targets.

Department of Residential Construction policies / related ordinances	Dept. of Construction: MSW management methods (2007): ・Clearly indicate what fines will be imposed to those who generate municipal solid waste and fail to pay the waste management fees. ・Clarification and tightening of the licenses and requirements expected of the supervisory body (Department of Environmental Health) and private enterprises in relation to municipal solid waste management.	Proposal by departments such as Dept. of Residential/Urban Construction to boost the MSW incineration project (2016): ・Strengthen the support system for collection, transportation, resource utilization, and end processing related to the separation of household trash. Notice by the Office of the Secretary of the People's Government of Anhui Province on the enforcement of the household solid waste separation project (2017): ・Strengthen on-site management of incineration facilities. ・Construction of a high-standard, waste-to-energy ("clean") incineration project. ・Improvement of facility operations by boosting regulations.
Anhui Province development plan	Anhui Province's Eleventh Five-Year Plan for Environmental Protection (2006 – 2010): ・By 2010, Achieve a harmless treatment rate in the municipality (chéngzhèn :cities and towns) of 40% or more and a harmless treatment rate of 60% or more in prefectural-level cities ・As a main project, plan the development of solid waste management plants in 31 cities including the urban areas of counties (county central towns).	Anhui Province's Thirteenth Five-Year Plan for Environmental Protection (2016 – 2020): ・Promote separated collection and sealed transportation of household solid waste. Complete a centralized waste management system. Scientifically and rationally select sites and further optimize the construction of municipal waste management facilities. Boost facility operation and management. ・In 2020, achieve implementation of harmless treatment of household solid waste across the entire province basically, achieve over 90% harmless treatment rate for household solid waste in the county, and achieve 95% waste management in Jiànzhì zhèn (towns, rural regions where commercial industry is developed to a certain extent and with a comparatively large concentration of non-agricultural population).

Source: Documents provided by JICA, plan documents.

4.1.2 Consistency with the Developmental Needs of People's Republic of China

As mentioned above, at the project proposal (examination) there were significant delays in the infrastructural development for solid waste management in Anhui Province. Even in urban areas the harmless treatment rate stagnated at 17.6%, which is low even for Chinese domestic figures. In much of the province, citizens carried out waste management that did not meet national standards, such as the use of simple landfills, dumping, and burning of trash, seriously affecting the quality of soils, rivers, groundwater, and the atmosphere. Therefore, there was great urgency in building an efficient solid waste treatment system, through the construction of new sanitary landfill facilities, and improving the sanitary conditions and living environments of the local provincial cities. The project is therefore highly pertinent.

According to an interview with a representative of the executing agencies the harmless treatment rate in urban area of Anhui Province at the time of ex-post

evaluation had reached over 90%. On the other hand, the increases in urban population and municipal solid waste (MSW) per capita have also led to a significant increase in the volume of municipal solid waste generated, compared to levels during the project examination. In addition, because of the additional need to deal with solid waste discharged in rural areas, continuous enhancements are needed for solid waste management facilities in both urban and rural areas. The demand for MSW treatment has become more sophisticated given the certain progress in the construction of MSW treatment facilities. Demand for reuse/recycling and reduction has also increased, in addition to harmless treatment, from the viewpoint of the increased demand for effective utilization of treatment facilities and waste. The primary methods for reuse/recycling and reduction, incineration and food waste recycling, have advanced through the input of private capital. One important factor for the efficient incineration of solid waste to achieve a certain level of profitability is the removal of moisture through methods such as waste compaction, which results in a guaranteed incineration temperature. The transfer stations and the compressed container method (used by transport vehicles) developed with this project have contributed greatly to the elimination of moisture. These help to bring MSW treatment to the next level, in the target prefectural cities/counties, such as the construction of incineration plants and the (trial) introduction of separated solid waste collection. The construction of a basic MSW treatment system is also significant as a foundation to move to the next level of solid waste management.

Therefore, our opinion is that this project is in line with the developmental needs of Anhui Province, China, both during the project examination and ex-post evaluation.

4.1.3 Consistency with Japan's ODA Policy

During the examination of this project, Japan's *ODA Charter (2003)* emphasized initiatives to address global environmental problems, and *the Medium-Term Policy on ODA (2005)* focused on protecting individuals from the "fear" such as environmental destruction, from the angle of guaranteeing safety for humans. Countermeasures to environmental pollution (such as solid waste management) have been established as an area of focus. In addition, *the Economic Cooperation Program for China (2001, Ministry of Foreign Affairs), the Medium Term Strategy for Overseas Economic Cooperation Operations (2002, JICA),* and the *Country Assistance Strategy (2002, JICA)* all place an emphasis on environmental conservation. This project is therefore consistent with Japan's ODA policy.

From the aforementioned points, evaluation team can see that the implementation of

this project was fully compatible with China's developmental plans and developmental needs, both during project examination and ex-post evaluation, as well as with Japan's ODA policy during project examination. Therefore its relevance is high.

4.2 Efficiency (Rating: ②)

4.2.1 Project Outputs

From the initial project plan submitted for examination, the following initiatives have been canceled and rendered outside the scope of the current project: all projects in two city/county (Fēng tái County and the prefecture-level city of Huaibei); and projects related to the Tongling cement plant. Table 2 lists the reasons why these initiatives were regarded to be outside of the project's scope.

Table 2 Reasons for Revisions to the Project Plan

Projects rendered out of scope	Reason
All projects in Fēng tái County / Huaibei City	It became necessary to make further adjustments, along with affiliated organizations and stakeholders, with respect to the selection of the project implementation site. There was also a change in policy to urge the executing agencies and prefectural city governments to self-finance the construction.
Projects related to the incineration of household solid waste at the Tongling cement plant	After the start of the project, the executing agencies and city government adopted a policy of carrying out the projects sooner using their own funds, using a new building technology developed by the cement factory.

Source: Documents provided by JICA, and questionnaire responses by the executing agencies

Although circumstances in each region (described above) caused the exclusion of these initiatives from the current project, they had no impact on the achievement of the project objectives as the developmental needs remained the same.

The table below shows the project outputs at the following stages: (1) original plans at project examination, (2) post-revision plans, and (3) actual values. The table in the Appendix shows the project outputs broken down by the prefectural cities/counties targeted in this project.

The main outputs of this project include the following: 1) 5 locations of sanitary landfills and leachate treatment plants (volume of sanitary landfill: 43.1 thousand m^3); 2) collection and transportation facilities (new transfer stations[6] at 61 locations, and

[6] In China, it is common for the following two methods to be used simultaneously: one where the transportation vehicles collect and directly transport household solid waste to the sanitary landfill facility or incineration plant, and the other where the household solid waste is first transported to an in-town transfer station, then usually brought to the sanitary landfill facility or incineration plant following a waste compaction process. The transfer station plays an important role in the efficient collection and transportation of household solid waste.

modified transfer stations at 62 locations); 3) access roads to the sanitary landfill facilities (8,276 m); 4) equipment related to solid waste management; 5) managed area building structures and parking for waste transportation vehicles; and 6) training sessions in Japan. There were no major changes to the project outputs other than the canceled initiatives described above. A portion of the surplus funds from the cancelled Tongling cement factory project was diverted into the development of collection and transport facilities and the construction of parking for waste transport vehicles. Similarly, the funds that were freed up by the cancellation of these initiatives have been used to set up some of the facilities and equipment originally planned to be financed from domestic funds in the project proposal. As Table 3 shows, when comparing the revised plans and the actual outputs[7], evaluation team observe increases in some of the project outputs ('managed area building structures' and 'access roads to the sanitary landfill'), while others decrease to a certain degree ('sanitary landfill volume', 'collection and transport facilities', and 'parking for waste transport vehicles'). The sanitary landfill volume shrank due to decreased demand for landfills in Lu'an City, resulting from the construction of incineration plants for household solid waste. In addition, the project deployed higher quality equipment for leachate treatment, due to the increased national standards for post-treatment leachate. According to interviews with the executing agencies and other related documents, the changes to project outputs other than sanitary landfill volumes and leachate treatment equipment correspond to changes in demand within the scope of the current project, and thus pose no problems. These include (1) a portion of the equipment requiring urgent deployment, and therefore being self-funded; and (2) some of the equipment and tools planned either being changed to other equipment/tools or reduced in output during the project implementation.

[7] Due to the circumstantial changes surrounding the project, and the formulation of a revised plan mutually agreed upon by Japan and China, the comparative analysis conducted during the ex-post evaluation to the comparison of actual results with the planned outcomes outlined in the revised plans.

Table 3 Planned and Actual Project Outputs

Details	Planned (as originally submitted for examination)	Planned (post-revision[8])	Actual
Sanitary landfill facility	7 locations Volume: Total 14.23 million m³ (Fēng tái and Huaibei 675) Design: Improved anaerobic method Leachate pondage: Total 68,600 m³ (Fēng tái and Huaibei 2.94)	5 locations Volume: 7.48 million m³ Design: Improved anaerobic method Leachate pondage: Total 39,200 m³	5 locations Volume: 6.967 million m³ (93% of planned volume) Design: Improved anaerobic method Leachate pondage: Total 43,100 m³ (110% of planned volume)
Leachate treatment equipment	7 locations Volume: Total 880 m³/day (Total of 5 prefectural cities/counties, as the planned volumes of Fēng tái and Huaibei are unknown)	5 locations Volume: Total 880 m³/day (Plans revised to deploy equipment with higher treatment capabilities than originally planned)	5 locations Volume: Total 880 m³/day (100% of planned volume) (Deployed equipment with higher treatment capabilities than originally planned)
Collection and transportation facility	New transfer stations: 87 locations Modified transfer stations: 74 locations Waste collection vehicles: 140	New transfer stations: 71 locations Modified transfer stations: 74 locations Waste collection vehicles: 189	New transfer stations: 61 locations (86% of number planned) Modified transfer stations: 62 locations (84% of number planned) Waste collection vehicles: 82 (43% of number planned)
Access roads to the sanitary landfill facility	7 locations 8,076 m (Total of 5 prefectural cities/counties, as the planned volumes of Fēng tái and Huaibei are unknown)	5 locations 8,076 m	5 locations 8,276 m (102% of length planned)
Equipment related to solid waste management	Treatment plant equipment: 59 Related vehicles: 47 Others: 9	Treatment plant equipment: 42 Related vehicles: 45 Others: 1	Treatment plant equipment: 31 (74% of number planned) Related vehicles: 48 (107% of number planned) Others: 1 (100% of number planned)
Cement plant facilities related to the	300 tonnes/day × 2 lines	None (outside of project scope)	None (outside of project scope)

[8] JICA approved the adjustments to the implementation plan, based on the application submitted by the executing agencies, as follows: in September 2008, the sanitary landfill facility, leachate treatment equipment, access road to the sanitary landfill, building structures on the managed area, and parking for waste transportation vehicles; in September 2014, the collection and transportation equipment, and cement factory facilities related to the incineration of household solid waste. (Source: JICA internal document)

incineration of household solid waste			
Managed area building structures and parking for waste transportation vehicles	Managed area building structures: 11,991 m², 8 locations Parking for waste transportation vehicles: 2,360 m², 4 locations	Managed area building structures: 6,110 m², 6 locations Parking for waste transportation vehicles: 29,900 m², 3 locations	Managed area building structures: 6,483 m² (106% of area planned), 5 locations Parking for waste transportation vehicles: 13,546 m² (45% of area planned), 5 locations
Training in Japan	Management training: 30 persons (15 persons × 2 sessions) Technical training: 30 persons (15 persons × 2 sessions)	Management training: 30 persons (15 persons × 2 sessions) Technical training: 30 persons (15 persons × 2 sessions)	Management skill training: 43 persons (Total 3 sessions of 14 persons, 12 persons, and 17 persons) (72% of number planned)

Source: Documents provided by JICA, and questionnaire responses by executing agencies

Waste processing at the transfer station (Tongling)

Landfill constructed for the current project (Huoshan)

Table 4 shows the ratio of the facilities established by this project to all household solid waste management facilities owned by the target prefectural cities/counties involved in this project, at the time of ex-post evaluation (2017). This project has established one hundred percent of the sanitary landfill facilities (considering only phase 2 of the sanitary landfill facility where that is the only phase in operation), and the majority of leachate treatment equipment and transfer stations, and thus has made an extremely large contribution to the establishment of household solid waste management facilities in its target prefectural cities and counties.

If problems emerged the target prefectural cities/counties during the implementation of the project, JICA personnel visited the location to consult and take steps toward resolution, along with the representatives of the target prefectural cities/counties. The parties involved in the provincial executing agencies have rated this highly.

Table 4 Contribution of This Project toOverall Household Solid Waste Management Facilities in the Target Prefectural Cities/Counties

Facility	No. of prefectural cities/counties targeted by the current project	All household solid waste management facilities	Facilities equipped by the current project	Proportion equipped by the current project
1. Sanitary landfill facilities	5	Volume: 6,967,000 m³	Volume: 6,967,000 m³	100%
2. Leachate treatment equipment	5	Volume treated: 1,030 m³/day	Volume treated: 880 m³/day	85%
3. Transfer stations	7	197 locations	123 locations	62%
4. Collection vehicles for household solid waste	6	455 vehicles	82 vehicles	18%

Source: Questionnaire responses by executing agencies

4.2.2 Project Inputs

4.2.2.1 Project Cost

As Table 5 shows, the actual costs associated with this project, 8.103 billion yen, stayed within the planned (post-revision) budget of 11.333 billion yen (71% of the planned cost)[9]. Factors that caused the actual costs to dip below the planned costs were as follows: (1) changes in demand caused the project outputs for collection and transport facilities and parking for waste transportation vehicles to decline by a set amount; (2) reduction of land acquisition costs and administrative costs[10] due to the availability of state-owned land for use in some prefectural cities/counties, and the budgeting of a higher amount during the feasibility study (FS) than what was generally incurred in practice; (3) tenders suppressing the cost of domestic public works, and (4) appreciation of the yen over the project period. If evaluation team consider the deployment of high-grade equipment for leachate treatment, due to changes in national standards[11], evaluation team regard the project costs to have been properly reduced as they have been conducted in line with the reduction in project output.

[9] As mentioned above, the project cost (local currency) of the post-revision plan is significantly less than the original plan submitted for review, as revisions to the plan were primarily made to divert the Japanese ODA funding from the cancelled initiatives to cover a portion of the facilities/equipment originally planned with domestic funding.

[10] Another reason for the low administrative expenses was the presence of some cases where it was difficult to calculate the administrative expenses separately; thus a portion of these expenses was lumped in with the costs for materials procurement / public works.

[11] The actual cost of setting up the leachate treatment equipment to meet the new benchmark was ov er roughly 1.54 times the planned amount.

Table 5 Planned vs Actual Project Costs

Units: in million yen

	Planned (as originally submitted for examination)			Planned (post-revision)			Actual		
	foreign currency portion	local currency portion	Total	foreign currency portion	local currency portion	Total	foreign currency portion	local currency portion	Total
Materials procurement /public works	6,335	5,365	11,700	6,343	2,669	9,012	5,150	2,331	7,481
Training	35	0	35	27	0	27	20	-	20
Inflation	396	0	396	396	0	396	-	-	-
Contingencies	338	268	606	17	0	17	-	-	-
Interest rate during construction	178	0	178	0	0	0	-	78	78
Commitment charge	0	0	0	17	0	17	17	35	52
Land acquisition costs	0	1,549	1,549	0	814	814	-	288	288
Administrative expenses, etc.	0	1,433	1,433	0	1,050	1,050	-	183	183
Total	7,282	8,615	15,897	6,800	4,533	11,333	5,188	2,915	8,103

Source: Documents provided by JICA, and questionnaire responses by executing agencies

Note: 1) The exchange rates are as follows: planned value (at project examination/revision), 1 yuan = 15.6 yen (June 2007); actual value, 1 yuan = 14.9 yen (average exchange rate for the period 2007-2015). 2) The exchange rate remained unchanged during the revision of the project plans (project cost). 3) The Japanese ODA loan covered 6.8 billion yen of the foreign currency portion in the original project plan submitted for examination; the Japanese ODA loan covered the entire foreign currency portion in the post-revision plan and actual execution of the project.

4.2.2.2 Project Period

The actual duration of the project was 93 months (December 2007 – August 2015), which was longer than the planned duration (post-revision) of 67 months (December 2007 – June 2013)[12], by 26 months (139% of the planned duration). Compared to the original plan submitted for examination (57 months), the actual duration went over by 36 months (163% of the planned duration at the time of appraisal). The fact that the project period was longer than expected is attributable to the following causes: (1) new designs and permits became necessary due to tightened national standards for leachate treatment equipment; (2) the time newly required for land acquisition and resettlement of the residents who lived within 500 m of the sanitary landfill (see 3.4.2 (2) below for details); (3) , and adjustments to the use of the Japanese ODA loan funds (including adjustments between prefectural cities and counties) became necessary as the result of changes in needs and construction of facilities by

[12] The revised project plan does not specify the duration for each project individually.

self-funding outside the current project; and (4) new designs and permits became necessary due to required route changes in a part of the road.

Table 6 Planned vs. Actual Project Period

	Planned (at project examination)	Planned (post-revision)	Actual
Date of Loan Agreement	December 2007	December 2007	December 2007
Entire project	January 2008 – September 2012 (Project period: 57 months)	December 2007 – June 2013 (Project period: 67 months)	December 2007 – August 2015 (Project period: 93 months)
Access roads	January 2008 – November 2010		January 2008 – March 2013
Transfer stations	January 2008 – March 2012		June 2008 – August 2015
Sanitary landfills	January 2008 – December 2008		March 2008 – August 2014
Land acquisition	January 2008 – December 2008		December 2007 – December 2009
Training	June, August 2008; May 2009		July 2009, September 2010, December 2011

Source: Documents provided by JICA, and questionnaire responses by executing agencies

4.2.3 Results of Calculations for Internal Rates of Return (Reference only)

Evaluation team did not calculate an Internal Rate of Return, since Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR) were not calculated at the project examination, and comparisons cannot be made at ex-post evaluation.

The project cost fell within the planned budget, but the project period exceeded the plan. Therefore, efficiency of the project is moderate

4.3 Effectiveness[13] (Rating: ③)

4.3.1 Quantitative Effects (Operation and Effect Indicators)

Table 7 shows the operation and effect indicators, which had been set at the project examination and ex-post evaluation to show the quantitative impacts of this project.[14] The Appendix shows the operation and effect indicators broken down by target prefectural city/county.

[13] Sub-rating for Effectiveness is to be put with consideration of Impacts.
[14] During revisions to the original plan, no changes were made to the operation and effect indicators that show quantitative impact.

Table 7　Changes in the Operation and Effect Indicators

Indicators	Target Value (2 years after completion of project)	Actual Value (2 years after completion of project: 2017)
【Operation indicator】		
Disposal volume of sanitary landfill	495,574 tonnes/year	514,772 tonnes/year
Post-treatment leachate BOD concentration	30-600 mg/l (simple average 396 mg/l)	2-30 mg/l (simple average 14 mg/l)
Post-treatment leachate COD concentration	100-1,000 mg/l (simple average 680 mg/l)	7-100 mg/l (simple average 49 mg/l)
Post-treatment ammoniacal nitrogen	-	0.5-20.0 mg/l (simple average 8.2 mg/l)
Treated leachate volume	-	705,425 m³/year
Municipal solid waste harmless treatment rate	50-100% (simple average 93%)	98-100% (simple average 100%)
Volume of collected municipal solid waste		885,225 tonnes/year
Proportion of collected municipal solid waste	-	96-100% (simple average 100%)
Volume of household solid waste disposed via transfer stations	-	1,011,895 tonnes/year
【Effect Indicator】	-	
Number of beneficiaries / target population for services	2.208 million people	5.31 million people
(out of which) beneficiaries of sanitary landfill	-	2.24 million people
(out of which) beneficiaries of transfer stations	-	4.57 million people
(out of which) beneficiaries of waste collection & transport vehicles	-	4.81 million people
Illegal dumping sites	-	0-9 locations (simple average: 1.3 locations)

Source: Questionnaire responses and field survey interviews
Note: The figures for BOD, COD, ammoniacal nitrogen, MSW collection rate, municipal solid waste harmless treatment rate, and illegal dumping sites represent the maximum and minimum figures in the target counties (the figures in parentheses represent the simple averages of the prefectural city/county values). In addition, the figures for BOD, COD, and ammoniacal nitrogen represent always achieved level following treatment.

(1) Status of operation indicators

The actual values taken 2 years after project completion (2017) for the following operation indicators (set during project examination), all achieved their targets: (1) disposal volume of sanitary landfill, (2) harmless treatment rate for municipal solid waste, and (3) BOD/COD concentration of post-treatment leachate. The disposal volume of sanitary landfill represents the actual values of the four target prefectural cities/counties excluding Yè jí. This is because Jinzhai County, Yè jí's neighbor to the south, constructed a household solid waste incineration facility with a capacity of 300 tonnes/day in 2013. Because this incineration facility could not meet full capacity using

only Jinzhai County's municipal waste, it provisionally started incinerating Yè jí's household solid waste and processing the post-incineration waste in the county's sanitary landfill. Jinzhai County is outside the project scope, but is an administrative district falling under the jurisdiction of Lu'an City, similar to Yè jí Zone, Huoshan County, and Huo Qiu County, which are targets of this project. Yè jí's sanitary landfill facility was not being used at the time of ex-post evaluation, but according to interviews with the Lu'an executing agency, processing is expected to be resumed in 2018 following adjustments within Lu'an City. Apart from the sanitary landfill, the transfer stations and transport vehicles constructed and provided by this project continue to be used. Jinzhai County plans to collect and incinerate household solid waste not only from urban areas but also from rural areas; if this plan is implemented, the incineration plant will be at full operation using only the waste from Jinzhai County. In such a case, Yè jí will use the sanitary landfill facility constructed by the current project, since the county's household solid waste is collected and disposed of in Yè jí. Therefore, although Yè jí's sanitary landfill facility is not currently used, evaluation team judge that the actual processing volume exceeds the target. For the four target prefectural cities/counties excluding Yè jí, the actual value (514,772 tonnes/year) is 113% of the target value (453,753 tonnes/year). The deployment of incineration plants has progressed even in the four target prefectural cities/counties excluding Yè jí, in order to extend the longevity of the sanitary landfill. On the other hand, the volume of household solid waste requiring disposal via sanitary landfill has continually increased, due to increased household solid waste management in rural areas, higher-than-expected increases in the urban population, and increases in per-capita household solid waste due to improvements in living standards. The disposal volume of waste has therefore increased at a higher pace than planned.

Through the construction of sanitary landfills by this project, final waste disposal at a sanitary landfill facility has become the norm and the MSW harmless treatment rate has reached nearly 100% in the prefectural cities/counties targeted by this project, as mentioned above. In addition, the structure for municipal solid waste collection (made up of the equipment and systems for waste collection and transportation) has made a substantial contribution to achieving a 100% harmless treatment rate. The municipal solid waste collection rate has also reached nearly 100%. At transfer stations, which fill an important role in the collection and transportation of household solid waste, the volume of disposed household solid waste exceeds 1 million tonnes/year. These facts indicate the significant contributions made by the various facilities supplied by the project to improving the harmless treatment rate.

As mentioned above, the national standards for BOD/COD and ammoniacal nitrogen

concentrations in post-treatment leachate were further tightened in 2008, forcing the deployment of higher quality equipment than initially planned. As a result, the necessary treatments are executed at high standards, and all counties without exception have achieved targets in the indicators where target values had been set. The volume of treated leachate in the five target prefectural cities/counties have also reached 705,425 m³/year. Some indicators, such as COD levels, are constantly monitored at all sanitary landfill facilities using an on-line link with the environmental agency. The other indicators are also monitored regularly, and thus evaluation team consider that post-treatment leachate is sufficiently managed.

(2) Status of the Effect Indicators

"Number of beneficiaries/target population for services" is the only effect indicator that has a target value at the time of appraisal; the actual value of this indicator (5.31 million people) greatly exceeded the target, achieving 240% of target figures (2.208 million people). The reason for this is, as mentioned above, the unexpected increase in the urban population (the urban population of the seven target prefectural cities/counties is roughly 2.98 million people, which itself exceeds the target), in addition to the promotion of household solid waste management in rural areas. As a result, the target area for the sanitary landfill and the area of activity for the collection and transportation facilities and vehicles supplied by this project, largely shifted into rural areas. The number of beneficiaries and the target population for services are expected to increase in the future, as the target prefectural cities and counties will continue to emphasize household solid waste management in rural areas and plan to utilize the facilities and equipment supplied by this project, such as the sanitary landfill. Additionally, a target number had not been set for illegal dumping sites, nor was the actual figure known prior to the start of the project. However, this number came out close to zero when evaluation team excluded Yè jí.

4.3.2 Qualitative Effects

The qualitative effect assumed during the project proposal (examination) is the “promotion of the proper handling of waste generated in target areas." Evaluation team recognize the qualitative effects as shown in the figure below, classified according to the developmental strategy goals outlined in the “Solid Waste Management” section of JICA’s issue-specific guidelines.

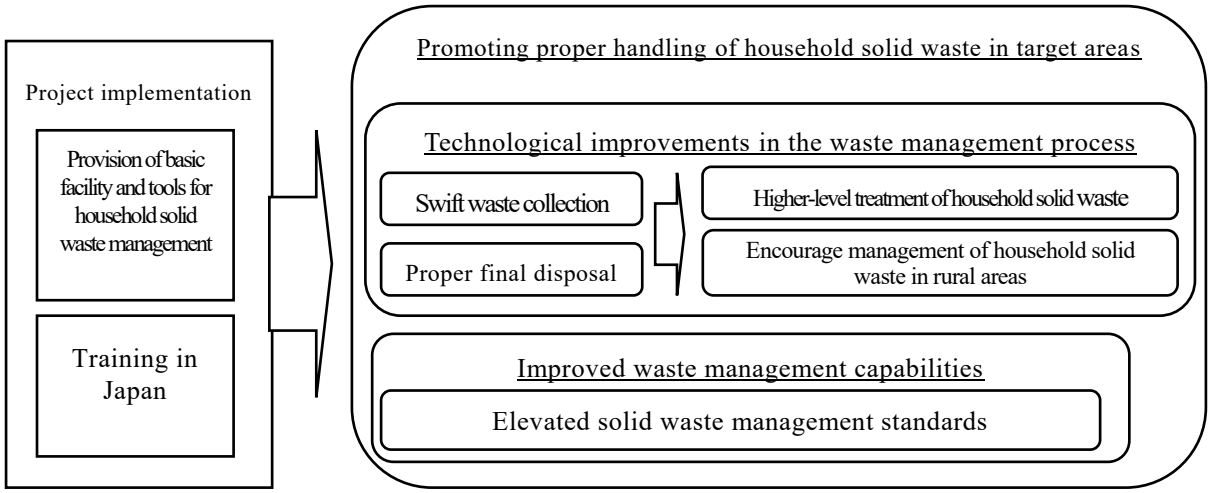


Figure 1 "Facilitation of Appropriate Treatment of Solid Waste Generated in the Target Area" of this Project

The qualitative outcome of this project, the "promotion of proper handling of household solid waste in target areas," can be classified as follows:

First, this project provided the related facilities and tools required by each process of municipal solid waste management (collection/transportation, final disposal). This paved the way for technological improvements in the waste management process (as originally anticipated) through the realization of the following 2 points: (1) swift waste collection and (2) proper final disposal (with no burden to the environment). Evaluation team can say that this project streamlined the flow of solid waste management through to final disposal, and thus built a foundation for MSW treatment. As mentioned above, open dumping and untreated landfills were commonly regarded as the final disposal method for waste in many prefectural cities and counties prior to the implementation of this project. However, the project was able to realize the harmless treatment of municipal solid waste using sanitary landfills. Swift MSW collection has been made possible through the establishment of a proper method for the final disposal of MSW, which is the nucleus of solid waste management, and the provision of collection and transport facilities/equipment to yield quantitative and qualitative outputs (that is, the efficient transportation of waste made possible through the enhanced functionality of waste compaction in transfer stations and collection/transportation vehicles). As a result, dramatic improvements can be observed in waste collection services; in the urban areas of the target prefectural cities/counties, garbage collection is conducted several times a day.

In addition, the provision by this project of basic MSW facilities and services has

yielded 2 effects: (1) achieving a higher standard of household solid waste management (due to the sophistication of treatments such as reduction, reuse/recycling, etc.), and (2) promoting household solid waste management in rural areas (through the expansion of the target areas). Through this project, the construction of a waste management system of a given standard encourages each prefectural city/county to step up to the next level of MSW treatment, such as reduction and reuse/recycling. Specifically, owing partly to the policy of the Chinese government, PPP (public-private partnership) projects have been carrying out the construction of incineration plants[15] and the trial introduction of solid waste separation. Many incineration plants also generate power to guarantee profitability for the PPP. The transfer stations and collection/transportation vehicles supplied by this project which possess a waste compaction function have contributed to the removal of moisture from waste, a step necessary to ensure the incineration temperatures required for efficient power generation. In addition, each prefectural city/county has been utilizing their experiences of constructing solid waste treatment systems in urban areas to build similar systems in rural areas. In many cases the sanitary landfills constructed by this project also receive waste from rural areas. Evaluation team therefore observe direct contributions by this project to the promotion of solid waste management in rural areas. The project's large impact on household solid waste management has also promoted governmental understanding with respect to environmental actions, initiatives for solid waste management, and budget expenditures. Evaluation team also noted the effect the project had on facilitating the procurement of the necessary budgets for new developments.[16]

Next, this project elevated solid waste management standards and promoted improvements to waste management capabilities. The establishment of basic solid waste management facilities by this project led to the formulation of transfer stations management rules, and the collection and maintenance of waste disposal volume records in each prefectural city/county. Evaluation team observed improvements in solid waste management standards.

In addition, evaluation team observed the impact of the training in Japan, expressed in two qualitative effects: (1) technological improvements in line with waste management flow, and (2) improvements in waste management capacity. An interview with training participants revealed a wide range of ideas, such as "spirit/philosophy," "business development," and "individual applications" as embodied by the following example statements:

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[15] In many cases, supplementary payments are made according to treatment volume.

[16] Evaluation team only obtained data from 4 cities with respect to government expenditures on environmental protection. However, each city's expenditure on environmental protection had more than doubled between 2011 and 2016, indicating rapid growth as compared to general government expenditures.

1. “I was inspired by a lecturer who stated, ‘Japan neglected the environment and paid a large price as a result. China needs to learn from Japan.’ These words helped me re-acknowledge the importance of solid waste management and simultaneously carry out conscious operational modifications and capacity enhancements so that the initiative is considerate of the environment.”
2. “Understanding the present situation of Japan helped me gain a long-term perspective and push for technological improvements from an early stage, such as the consideration of incineration plants.”
3. “I was able to recognize the importance of environmental consciousness among citizens, and so I promoted environmental education at schools while simultaneously employing examples from Japan to prepare posters for waste separation.”

4.4 Impact

4.4.1 Intended Impacts

(1) Reduction of Annual CO_2 Emissions

At the project examination, a reduction in annual CO_2 emissions was assumed to be a quantitative measure of impact. The annual target of 530,000 tonnes/year represents the reduction in annual CO_2 emissions originally assumed possible with the development of sanitary landfills in the seven target prefectural cities/counties in the sanitary landfill construction project. However, at ex-post evaluation, evaluation team have not been able to obtain target values (including calculation method) for each prefectural city/county’s reduction in annual CO_2 emissions, nor their actual values. However, evaluation team consider that reductions in annual CO_2 emissions have been achieved as planned, even though the specific amount of reduction for each prefectural city/county is unknown. Evaluation team believe this to be true because, as stated above, the sanitary landfill facilities were completed as planned in all five prefectural cities/counties targeted by this project. In addition, according to interviews with the executing agencies, even Fēng tái County and Huaibei City (which had originally been included in the project but were eventually deemed to be outside its scope) have self-funded the development of sanitary landfills. If evaluation team include these facilities, evaluation team believe that the actual value clears the annual target of 530,000 tonnes/year reduction in CO_2 emissions.

(2) Promotion of Municipal Solid Waste Management in Anhui Province

In Anhui Province, as mentioned above, municipal solid waste management was at

low levels prior to this project. This project provided basic infrastructure and tools related to municipal solid waste management in multiple prefectural cities/counties (7 located in Anhui Province). Since then, MSW treatment has also been promoted in locations outside the target prefectural cities/counties in parallel with this project. Table 8 displays the current state of MSW treatment in the whole of Anhui Province, and the contributions by this project (2016).

Table 8 Current State of MSW Treatment in All of Anhui Province and the Contributions by this Project (2016)

	Volume of household solid waste disposed of in sanitary landfills	Volume of municipal solid waste collected	Number of municipal transfer stations
Entire province	4.6 million tonnes	8.61 million tonnes	687 locations
This project	510,000 tonnes	890,000 tonnes	123 locations
Percentage contribution of this project	11%	10%	18%

Source: Questionnaire responses

Evaluation team observe that this project has equipped or processed 10-odd % of the following in all of Anhui Province: volume of sanitary landfill processed, volume of municipal solid waste collected, and number of municipal transfer stations. In particular, less than 20% of the municipal transfer stations in the province were newly constructed or modified by this project. Therefore, evaluation team consider that this project has made a certaion level of contribution to household solid waste management and the development of facilities in all of Anhui Province.

(3) Improvements in Residents' Living Environments and Sanitary Conditions in the Target Areas

A qualitative impact assumed at the project examination was an improvement in the living environments and sanitary conditions of the target areas. Evaluation team observed two aspects of this impact: (1) improvements in the residential environment and landscape, and (2) improvements in the water quality of rivers and water sources.

First, evaluation team will discuss the improvements in the residential environment and landscape. Waste collection sites existed in the urban areas of the target prefectural cities/counties prior to the implementation of this project, but collection was insufficient and it was common for these dumpsters to overflow with household solid waste for several days. Many people discarded their waste in city centres, and it was normal for garbage to be strewn all over the city. In the suburbs and rural areas, there were many areas where waste collection sites existed but were rarely emptied, or where residents burned or buried their accumulated trash due to their absence. In such areas, abandoned

garbage piled up in vacant lots, generating noxious odors and effluent, and attracting flies and mosquitoes severely. As a result, household solid waste had had deleterious effects on residential environments and landscapes in urban, suburban and rural areas.

As mentioned above, this project established the collection of household solid waste multiple times daily in urban areas, and set up cleaning crews to clean the city and pick up litter. As a result, the cities resolved their litter problem; the cities were beautified dramatically and relieved of foul odors and effluents. Sealed trash bins and waste collection/transport vehicles have also contributed to the improvements in residential environment and landscape, as the lids prevent the scattering of waste in city centres. There has been an extremely large impact with respect to improvements in the residential environment and landscape; the size of the impact is partly due to the poor condition of the residential environment prior to project implementation. In particular, there has been a remarkable effect on suburbs where no measures had been taken previously. Citizens have expressed a high level of satisfaction regarding the conspicuous improvements. Many citizens also say that the beautification of the city has made an impact on their environmental awareness and behavior, such as reduced littering, and disposing of waste found in the city into the installed trash cans.

Next, evaluation team discuss improvements in the water quality of rivers and water sources. Prior to this project, waste was often disposed in rivers; evaluation team observed negative impacts on river water quality where accumulated trash would remain floating in the river or emit effluent into the river. The implementation of this project improved the water quality in the rivers due to large reductions in the scattering of waste and subsequent emission/outflow of wastewater. Many residents are experiencing improvements in the condition and water quality of creeks near residential areas, and evaluation team also observed large rivers with improved water quality after project implementation. In particular, Pihe River, the main river in the Lu'an City region which provides water to big cities in Anhui Province, such as Hefei, and where the project constructed four sanitary landfill facilities, saw an improvement in water quality from Class IV (mainly general industrial use) to Class III (mainly daily use and drinking water) in the national environmental standard[17].

(4) Cultivation of Industries Related to Municipal Solid Waste (MSW) Treatment

Use of private contractors has increased in tasks related to solid waste management,

[17] In 1988, the State Environmental Protection Administration of China put into effect the "Environmental Quality Standard for Surface Water (GB 3838-1988)" to categorize the 30 indicators related to water quality, such as chemical oxygen demand (COD), into 5 grades (I, II, III, IV, V). Water quality decreases from Class I to Class V. The COD values of the 2002 revised standard, "GBIII 838-2002," are set as follows: Class I and II, 15 mg/l or less; Class III, 20 mg/l or less; Class IV, 30 mg/l or less; and Class V, 40 mg / l or less.

given the Chinese government's policy to actively promote the utilization of the private sector to operate the front-line work for public services so that government agencies can focus on administration. A private company even plays the key role in the solid waste management services required following project implementation; as a result, industries related to solid waste management have developed. Private companies have also increasingly taken over the operation of sanitary landfills and transfer stations, as well as accompanying businesses such as sanitation and garbage collection and transportation, which had been assumed at the project appraisal to be operated by the government or state-owned enterprises. In particular, the operation of all leachate treatment equipment for this project has been entrusted to private contractors. As mentioned in the section on Effectiveness, the project's development of a foundation for solid waste management has allowed advancements in higher-standard household solid waste management, such as incineration, power generation using methane gas, and food waste recycling (feed and fertilizer), and their market size has grown. However, a majority of these were developed through PPP projects, contributing greatly to the development of related industries,

(5) Expansion of Employment Opportunities in Jobs Related to MSW Treatment

The implementation of this project has enhanced the public services related to household solid waste management. In particular, the growing demand for the collection of household solid waste from garbage bins set up in homes and across the city has increased employment in related jobs. Table 9 shows the changes in employment for jobs related to household solid waste management between the pre-project time and ex-post evaluation time based on interviews with the executing agencies of each prefectural city/county. In most prefectural cities/counties, there was increased employment in jobs related to household solid waste management, and the employment figure in all seven of them increased roughly 1.5 times, from 6,286 to 9,622.[18] It is notable that since many of these jobs are simple, they are a valuable source of employment particularly for unskilled seniors over the age of 50. Prior to the implementation of this project, waste pickers existed in small numbers in some waste disposal/dumping sites (mainly farmers living near the sites during their off-season), but evaluation team did not observe any waste pickers during the ex-post evaluation for the following reasons: (1) declining profitability due to increased income level and a slump in the price of valuables in recent years, and (2) employment in jobs related to solid waste management.

[18] Even though there are no gender-specific data, women make up a certain ratio according to the executing agencies of each county.

Table 9　Changes in Employment Related to Solid Waste Management

Units: persons

	Lu'an	Huoshan	Huo Qiu	Yè jí	Huainan	Suzhou	Tongling	Total
Before project implementation	1,200	210	330	119	1,851	280	2,296	6,286
During ex-post evaluation	2,010	254	590	257	1,791	1,316	3,404	9,622

Source: Questionnaire responses by executing agencies, and interviews with the executing agencies in each prefectural city/county

4.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

Among the projects, there are concerns in particular about the burden that sanitary landfills have on the natural environment. Therefore, the environmental agencies of the prefectural cities/counties have carried out monitoring of factors such as air quality, noise, water quality, and dust during the construction period, according to national laws and regulations. As a result, no major problem has been reported in any prefectural city or county. There were cases where minor problems occurred in relation to dust and noise, but the situation was improved through discussions with project personnel.

There has been continued monitoring of the impacts on the natural environment even after the completion of the construction of the sanitary landfills, and based on national laws and regulations. Exuded water treatment, which is particularly important, is precisely managed by sending a portion of the data (COD, nitrogen/ammonia, etc.) wirelessly to the environmental agency for monitoring (as described above), and regularly monitoring other important indicators (BOD, suspended substance and suspended solids, etc.). Post-treatment leachate is often used as irrigation water. Monitoring has been carried out of impacts on the natural environment other than leachate; in addition to the periodic monitoring of the water quality of surrounding rivers and the atmosphere of surrounding areas, the environmental agencies of the prefectural cities/counties have carried out surprise inspections and guidance with respect to environmental considerations and the emission of odors. Leachate emitted from waste transfer stations is generally discharged as sewage; it is commonly monitored and treated with the rest of the sewage. However, some prefectural cities/counties collect transfer station leachate into a tank to treat with leachate treatment equipment.

As a result of these measures, no negative impact to the natural environment was observed at the time of ex-post evaluation; thus evaluation team determine the project to have no negative impact to the natural environment.

(2) Resettlement and Land Acquisition

Table 10 summarizes the resettlements and land acquisitions implemented during this project.

Table 10 Implementation of Resettlement and Land Acquisition

(Resettlement)

Prefectural city/County	Number of resettled individuals	Resettlement date	Resettlement format	Compensation status
Lu'an	119 households, 350 persons	Unknown	Procured residential community for resettled residents	Provision of farmland and funds for housing construction based on national standards. Construction of social infrastructure such as electricity, water, kindergartens.
Huoshan	32 households, 93 persons	2009	Procured residential community for resettled residents	Provision of funds for housing construction. Provision of financial compensation for farmland but not actual farmland.
Huo Qiu	None	-	-	-
Yè jí	43 households, 160 persons	2009, 2014	Resettlement in multiple community blocks	Provision of 45 m² housing per person, compensation for farmland but not actual farmland. Provision of financial compensation based on building conditions.
Huainan	None	-	-	-
Suzhou	None	-	-	-
Tongling	None	-	-	-
Total	194 households, 603 persons			

(Land Acquisition)

Planned	Actual
73 ha	68 ha

Source: Documents provided by JICA, questionnaire responses by executing agencies and interviews with executing agencies in each prefectural city/county

Documents submitted during project examination stated that resettlement would not occur, but in actuality 603 persons from 194 households were relocated in 3 prefectural cities/counties. A majority of the resettlements were a result of the stricter enforcement after 2008 of the housing and construction agency's standards for sanitary landfill technology for household solid waste, which stipulated that residents living within 500 meters of the sanitary landfill facility must be relocated. During the resettlement process, executing agencies properly assisted with the necessary paperwork, compensation, and living assistance at the new relocation site, as outlined by JICA guidelines and the provincial laws of Anhui Province, China. Despite differences in format in each prefectural city/county, the resettled residents were provided with new Residential area

and housing or funds for residential construction (including land price) as shown in the table above. For farmlands and other lands, the resettlement provided substituted land or compensation funds in accordance with national standards. Evaluation team also observed some prefectural cities/counties that set up living infrastructure (water supply, roads, construction of a kindergarten, etc.) in the new residential community, or provided preferential job placement in treatment plants for resettled residents. Evaluation team have gathered from interviews with relocated residents and visits to resettlement sites that most of the resettled residents were relocated closer to urban areas and to areas where living infrastructure was supplied. Thus for most, the standard of living improved (income level either increased or remained the same), and all interviewed residents were satisfied. These resettlements were due to revised sanitary landfill volumes, following topographical examination during the stages of detailed design and construction.

At ex-post evaluation, evaluation team did not observe any negative impact from resettlement and land acquisition, and thus evaluation team determine that there is no negative impact related to resettlement and land acquisition caused by this project.

Housing for displaced residents (Lu'an)

Development of apartment buildings along the road constructed for this project (Lu'an)

(3) Regional Social Development Near the Road Developed by this Project

Japanese ODA loan funds financed the construction of a 4.5 km road leading to the sanitary landfill in Lu'an City. But because the newly constructed road makes up not only the access road to the sanitary landfill but also a part of the route leading to other regions, it is used all day long by many general vehicles and not only waste collection and transportation vehicles. Although the exact vehicular traffic is unknown, there is high usage. Also, the construction of the road has advanced the development of apartment buildings and housing developments in neighboring areas; numbers of

residents have also increased. Therefore, evaluation team determine that the construction of the road contributed to the regional social development to a certain degree.

(4) Promotion of Household Solid Waste Management Modeled after Japan

Through the implementation of this project and training in Japan, key personnel in Anhui Province have been able to learn the philosophy, approach, technique, and methodology of household solid waste management in Japan, and were able to introduce these concepts within Anhui Province. The province rated the training opportunity and content highly, and has modeled its household solid waste management projects and their administration after Japan. This is a notable impact of this project. Specifically, Anhui Province continues to regularly send provincial staff to training sessions in Japan using its own funds and routes even after the completion of this project. The training participants are expected to learn about the Japanese philosophy/approach pertaining to household solid waste management, as well as initiatives to address the challenges Anhui Province will face in the future, such as waste separation, and to facilitate the Japanese model of household solid waste management taking root in the province.

From the aforementioned points, evaluation team determine effectiveness to be high, as all quantitative indicators are at levels that achieve their target values, and evaluation team observe qualitative effects such as improvements in technology/service and waste management capacity. As far as the impacts of this project are concerned, positive impacts have emerged, including the promotion of household waste treatment using a Japanese method as the model for Anhui Province in addition to those presumed quantitative and qualitative impacts of this project. Therefore, evaluation team evaluates this project has a high level of effectiveness and impact.

BOX: Improvements in the Solid Waste Management Project based on Knowledge Gained from the Training in Japan

This project conducted 3 training sessions in Japan, which combined lectures at Hokkaido University on solid waste management policies and technologies, and visits to solid waste management facilities. A total of 42 people attended including managers and engineers of waste management facilities from the target regions.

Training participants from Lu'an City mentioned that understanding the current state of Japanese household solid waste management, clearing up the long-term vision for solid waste management and administration, as well as what issues need to be addressed going forward to achieve this vision, have made it possible to develop business with

confidence and with the future in mind. As a specific example, securing land to construct sanitary landfills for household solid waste had not always been recognized as a big problem in China. However, upon hearing that “urbanization will make it difficult to secure the land needed to construct sanitary landfills," the participants returned and promoted the incineration of household solid waste ahead of Chinese policies. As a result, a waste-to-energy plant was completed in 2013 as a BOT project, the earliest endeavor among medium-sized cities in Anhui Province. A project is planned in the future to tackle the conversion of food waste into fertilizer/feed.

Collection of household solid waste by waste collection and transport vehicle (garbage truck)

The newly-built household solid waste incineration plant

In addition, many participants in the training in Japan said that they learned a lot from viewing the current state of waste sorting at home and environmental education at school. Training participants from Huoshan County stated, "Based on what we learned in the Japan training, we started an environmental education initiative here for elementary school students, once a month at the solid waste management facility, and have taken on initiatives to improve waste management, such as signs that admonish littering or illustrated displays for trash receptacles in the city. We also introduced trials to separate garbage, but so far it has not succeeded." On the other hand, Tongling City was designated as a model city for waste sorting in 2015, and launched trials to separate waste in ordinary households (30 target communities, approximately 20,000 people) and government agencies. Training participants from Tongling City witnessed the current state of waste sorting in Japan and realized the important role that municipalities play. Therefore, Tongling City involves housing management companies and committees in addition to solid waste management and recycling companies in order to promote waste sorting. In addition, utilizing the knowledge gained from the Japan training, the training participants put efforts into educational activities for residents, such as starting to invite elementary schools to create environmental posters, and incorporating environmental

education for students and teachers at a pilot junior high school. The separation of waste is slowly becoming accepted by the community, but raising the awareness of the residents remains a task for the future. They state that in order to promote waste sorting, they need to consider action such as warning or announcing the names of communities or agencies that do not comply with guidelines, or other compulsory measures.

4.5 Sustainability (Rating: ③)

4.5.1 Institutional / Organizational Aspect of Operation and Maintenance

In China, municipal solid waste (household solid waste) treatment falls under the jurisdiction of the housing and construction agency, and is managed in the target prefectural cities/counties of this project by urban management agencies (the names of which may vary slightly depending on prefectural city/county). Among sanitary landfills, leachate treatment equipment, and waste collection and transportation facilities (waste transfer stations, waste transport vehicles, etc.), only the maintenance and operation of leachate treatment equipment is contracted to business specialists in all prefectural cities/counties. The operation and maintenance of sanitary landfill facilities and collection and transport facilities vary by prefectural city/county; some are directly operated and managed by government (the sanitation office of the urban management agency, or a state-owned enterprise), while others are outsourced to private companies. The table below shows the administrating entity by prefectural city/county. In the case of private contractors, companies with sufficient experience are selected periodically through a bidding process, and the urban management agency of each prefectural city/county provides management guidance to the contracted company. The number of private contractors is expected to rise in the future as policies exist on a national/provincial level promoting the outsourcing of solid waste management operations to private enterprises. The staff sizes of sanitary landfills and leachate treatment facilities are small, with about 10 persons or less in each, but both are operated smoothly. For waste collection and transport facilities, the size of the staff involved in maintenance, and operations varies according to the size of the prefectural city/county, but several hundred staff (including waste collection operatives) are currently employed and work either for the government or contractors.

At the time of the project examination, the operation of sanitary landfills was assumed to be carried out by governmental organizations or state-owned enterprises. Despite some changes from the original plan, such as the increased roles of private contractors in the operation of the sanitary landfill facilities, due to China's policies, evaluation team see no problem as this is a structure consistent for solid waste management throughout China. In addition, according to interviews with stakeholders in

each target prefectural city/county, the future expansion of household solid waste management into rural areas will require further growth of the organizational system. But presently there is no shortage of staff, and so there have not been any institutional problems.

Table 11 OperatingEntities of the Household Solid Waste Management Businesses in the Prefectural Cities/Counties Targeted by the Current Project

Prefectural city/county	Sanitary landfill	Leachate treatment	Transfer station operation	Collection/ transport of waste
Lu'an	government	private contractor	government	government
Huoshan	government	private contractor	private contractor	private contractor
Huo Qiu	government	private contractor	private contractor	private contractor
Yè jí	government	private contractor	government	government
Huainan	private contractor	private contractor	government	government
Suzhou	government	private contractor	government	government
Tongling	private contractor	private contractor	government	government

Source: Questionnaire responses by executing agencies

4.5.2 Technical Aspect of Operation and Maintenance

The table below summarizes the technologies related to operation and maintenance, broken down by facility/operation.

Table 12 Technologies Related to Operation and Maintenance, by Facility/Operation

Facility/ Operation	Current state of technology
Sanitary landfill facility and leachate treatment	・The operation of the facilities conforms to Chinese domestic standards and manuals, regardless of whether the administrating entity is governmental or private. Periodic training is carried out several times a year by the provincial housing and construction agencies / business groups. ・The private contractors entrusted with operating the sanitary landfill and leachate treatment have received authorization to operate domestic facilities related to household solid waste management in China, and possess experience in operating and maintaining numerous facilities of a similar nature in addition to those set up by this project. In addition, the companies periodically conduct technical training internally. Prior experience and areas of technical expertise are taken fully into consideration during the selection of contractors. ・Even for sanitary landfills operated by the government, technical training is conducted for the acquisition of skills related to household solid waste management.
Collection and transport	・Collection and transport may not be thought to require particularly advanced technology, but the public offering of private contracts often attracts bids from more than 10 companies. The contractors are chosen based on past achievements and quality of service. Private contractors have improved service levels, with methods such as the installation of cameras in waste transfer stations, or the introduction of new compact vehicles. ・Even in cases where the government runs operations, service improvements have been made, such as the creation of new management regulations for waste transfer stations, or bulletins showing hours of operation.

Source: Questionnaire responses by executing agencies, and interviews with concerned parties in the target prefectural cities/counties and private contracting companies

Operations were carried out in line with Chinese domestic standards for sanitary landfill facilities and leachate treatment, for which the operation and maintenance require technical skill. The government (provincial housing and construction agency) and business groups conducted training for workers several times a year to improve technical capabilities. The improved anaerobic method adopted in the project's sanitary landfills is a common technique used in China, and no technical problems have occurred. With regards to outsourcing to private enterprises, the prefectural city/county selects the contractor on the premise that they possess sufficient technical expertise, based on achievements in similar past projects and the creation of manuals; they are selected from companies authorized to operate household solid waste management-related facilities in China. Companies taking on contract work have experience operating and maintaining numerous similar facilities and technologies outside of the facilities set up by this project. As a result, both government and contractor firms possess the technology necessary for operation and maintenance. Equipment maintenance and issue management are properly carried out, and no problems have occurred since the start of operation. Collection and transport may not be thought to require advanced technology,

but operators have improved the level of management and service following the development of facilities, through the creation of management regulations and the installation of automatic disinfectant/deodorizing equipment. There are many cases where bids are received from more than 10 companies during the selection of a private contractor, in which case the contracting firm is selected based on past achievements and quality of service. Evaluation team even observed cases where the private contracting firm improved operations and management through the installation of cameras in the waste transfer stations, and improved the efficiency of collection work through the introduction of compact collection vehicles. From the aforementioned points, evaluation team determine there are no problems with the technical aspects of operation and maintenance.

4.5.3 Financial Aspect of Operation and Maintenance

At the project examination, the proposal assumed a monthly waste management fee of 4-6 yuan per household in order to secure a budget for solid waste management. However, only 5 of the 7 target prefectural cities/counties collect waste management fees from ordinary citizens (3-5 yuan/month per household).[19] Evaluation team observed the presence of prefectural cities/counties (Huo Qiu, Yè jí), which were unable to collect waste management fees due to a lack of understanding by the public, signifying that securing of revenue necessary to stably advance municipal solid waste management is not necessarily underway. Information could be obtained only from 4 prefectural cities/counties (Huoshan, Yè jí, Huainan, Suzhou) regarding fiscal expenditures on municipal solid waste management, but the expenditures vary according to the size of each area (roughly 10-80 million yuan). Even the prefectural cities/counties that receive income from waste management fees receive less than half the value of the expenditure related to MSW treatment; some prefectural cities/counties receive about 10% of the expenditure. The shortage is expended and compensated from the general budget.

In interviews with the executing agencies, there is no system to provide special financial assistance from the national/provincial government to subsidize the cost of urban household waste treatment. However, fiscal authorities have a deep understanding of the need to budget household solid waste management, for the following reasons: (1) environmental issues, including living environments, have been emphasized in recent years, and (2) municipal solid waste management has yielded large, visible results. Thus,

[19] The garbage disposal fee does not present a heavy burden for the general public. There is a high collection rate for the waste treatment fee from the general public, as it is added to the water bill. Also, Huainan City separately collects a waste treatment fee from enterprises. The proceeds are accounted for as revenues of the prefectural city/county government (Finance Agency).

even while expenditures are on the rise with household solid waste management expanding into rural areas, the budget necessary for the operation and maintenance has been secured. In prefectural cities/counties where data was available (Yè jí, Huainan), about 1-2% of fiscal expenditure was allocated to the budget for solid waste management. As the solid waste management-related budget has grown over 10% annually in one prefectural city/county (Lu'an), the annual growth rate of the solid waste management budget has exceeded the growth rate of the overall fiscal expenditure. Therefore, at ex-post evaluation, finances had not caused problems with operation and maintenance. Even from interviews with executing agencies and stakeholders in target prefectural cities/counties, MSW treatment is expected to continue securing the necessary budgets in the future, as fiscal revenues in each target prefectural city/county steadily rise, and since the "stagnation of MSW treatment will directly affect citizens' lives." However, there is concern that the financial burden will increase long-term, as considerable investment capital will be needed to continue building waste management facilities, if the volume of household solid waste requiring treatment continues to increase in the future; for example due to the increased management of household solid waste in rural areas, as mentioned previously. Therefore, from the viewpoint of financial sustainability, it is important to minimize reduce volume of waste by ingraining the 'Three Rs' (reduce, reuse, recycle) – including the current endeavor of waste sorting – and to optimize waste management fees for reliable collection.

When outsourcing municipal solid waste management to a private firm, payment is made taking into consideration the firm's experience with other similar work and corresponding to the amount of ordinary solid waste and leachate water processed (base amount per unit treated × volume treated); thus a certain level of profit is guaranteed.

From the above, evaluation team observe that (1) despite the presence of prefectural cities/counties with insufficient collection of waste management fees, fiscal expenditures are supported without problems, and (2) measures are being taken to counteract long-term issues. Thus evaluation team do not note any problems with the financial aspects of operation and maintenance.

4.5.4 Status of Operation and Maintenance

The equipment supplied by this project is properly monitored, maintained, and periodically inspected by the urban management agency of each prefectural city/county and contracting firms, in line with Chinese standards and management regulations. The leachate treatment equipment in particular is managed by a system that automatically detects issues. Some contracting firms also possess systems through which they can monitor the operational status of the facilities from their headquarters and respond

immediately when problems arise. Maintenance and inspection are also conducted regularly, conforming to domestic standards (and the more stringent standards of each company). No major problems have occurred for any facility, from the start of operations through to ex-post evaluation. Evaluation team also have not observed any problems obtaining spare parts. Even during ex-post evaluation, evaluation team confirmed the following during the field survey: (1) the equipment is generally well organized and maintained in a sanitary condition, (2) various bulletins are displayed for smooth operation and maintenance, proactively providing guidance and raising awareness among stakeholders, and (3) proper record-keeping practices exist at many transfer stations regarding MSW transportation. According to a person involved in facility operations, malfunctions and damage to equipment are also handled smoothly in cooperation with the contracting firm. The condition of the main facilities and equipment are generally very good. Additionally, as described above, the operating rate of the facility has increased with urbanization and the promotion of household solid waste management in rural areas.

As mentioned in Section 3.3.1 (1), the solid waste management facility in Yè jí is expected to restart in 2018, and is properly maintained to return to use at any time; waste transfer stations and transport vehicles continue to be used, and no problems have emerged. The incineration plant in Lu'an City is currently in full operation, and its sanitary landfill facility has no extra capacity. The zone bordering Yè jí to the east may start using Yè jí's solid waste management facility in the future, as they lack their own. Lu'an City plans to expand the collection and treatment of household solid waste to rural areas given the situation in the city; as the plan progresses, the operating rate of Yè jí's solid waste management facility is also expected to rise.

No major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore sustainability of the project effects is high.

5. Conclusion, Lessons Learned and Recommendations

5.1 Conclusion

The objective of this project is to promote the proper handling of the household solid waste generated in the regional cities of Anhui Province (7 prefectural cities and counties) by the construction of a solid waste treatment system, thereby contributing to environmental conservation and improvements in the living environments and sanitary conditions of local residents. The project conforms to the policies for household solid waste management of the Chinese Central Government and the Anhui Provincial

Government. It is in line with China's developmental needs, such as the construction of an efficient solid waste treatment system and improvements in the sanitary conditions and living environments of regional cities in the province. It has been also relevant to Japan's ODA policy. Therefore, its relevance is high. Evaluation team assess the efficiency of the project as a whole to be fair, since the project cost was reduced commensurate to changes in project outputs, but the project period exceeded the planned duration due to newly required permits resulting from changed national standards for leachate treatment equipment. Additionally, as a result of setting up the basic facilities and equipment needed for municipal solid waste management, the operation and effect indicators (volume of sanitary landfill processed, post-treatment leachate BOD/COD concentration, harmless treatment rate of household solid waste, number of beneficiaries, etc.) at ex-post evaluation all achieved the target values set during the project appraisal. In addition, evaluation team verified a wide range of qualitative effects with respect to "promoting proper handling of the solid waste generated in target areas," such as (1) swift collection of household solid waste, (2) proper final disposal, (3) promoting higher-level treatment of household solid waste, (4) encouraging the management of household solid waste in rural areas, and (5) elevated solid waste management standards. There was also a remarkable impact with regard to "improvements in the living environments and sanitary conditions of residents in the target areas", consisting of (1) improvements in the residential environment and landscape, and (2) improvements in the water quality of rivers and water sources. Evaluation team also observed contributions by this project to the cultivation of industries related to municipal solid waste management, and increased employment opportunities in jobs related to municipal solid waste management. Therefore, Evaluation team believe the project has a high level of effectiveness and impact. Evaluation team also believe it to have high sustainability, given the excellent operation and maintenance of the equipment and facilities, and the absence of problems from insttitutional, technical or financial aspects. In light of the above, this project is evaluated to be highly satisfactory.

5.2 Recommendations

5.2.1 Recommendations to the Executing Agency

None.

5.2.2 Recommendations to JICA

None.

5.3 Lessons Learned

Training Sessions in Japan as a Guideline of Problem Solving Tailored to Regional Characteristics and Needs

Participants in the training sessions in Japan use the skills and knowledge gained from the training as a model and apply them to each region according to its characteristics and needs. Thus the training plays a large role in improving solid waste management in the target regions of this project. A factor in this success is that the project implementation period coincided with the transition period for waste management. Due to the sharp increase in MSW volume in Anhui Province, the method of disposal shifted from a landfill-centric one to the deployment of incineration plants; waste sorting had been introduced and was becoming full-scale. The training participants themselves were facing various challenges and questions about the technologies and operation management structures for solid waste management. In such a situation, the experiences gained in the training program, learning about Japanese policies and techniques in solid waste management and observing current programs of environmental education and garbage separation, became a large asset to the returning trainees to use while tackling the challenges of solid waste management in each target area. However, there are regional differences, even within the same province, with respect to population, solid waste volume, and residents' willingness to sort their waste. Therefore, when implementing future training sessions in Japan, it will be necessary to incorporate content such as case studies that show how different Japanese local governments arrived at different responses to the same issues (e.g. methods of waste disposal, methods of waste sorting), or reasons why a certain measure was effective. In this way, the content will aid the trainees in considering the measures suited to their own municipality from among multiple options upon their return.

Comparison of the Original and Actual Scope of the Project

Item	Plan (post-revision)	Actual
1. Project Outputs	1) Sanitary landfill facility: 7.48 million ㎥ 2) Leachate treatment equipment: 880 ㎥/day 3) Collection and transport facilities: ・new transfer stations: 68 +3 ・modified transfer stations : 69 +5 ・Waste collection vehicles: 115+74 4) Access road to sanitary landfill facility: 8,076 m 5) Equipment related to solid waste management ・Equipment for treatment: 42 ・Related vehicles: 45 ・Others: 1 6) Managed area building structures and parking for waste transportation vehicles: ・Managed area building structures: 6,110 ㎡ ・Parking for waste transportation vehicles: 29,900 ㎡ 7) Training in Japan ・Management training: 30 persons (15 persons × 2 sessions) ・Technical training: 30 persons (15 persons × 2 sessions)	1) Sanitary landfill facility: 6.97 million ㎥ 2) As planned 3) Collection and transport facilities: ・New transfer stations: 61 ・Modified transfer stations: 62 ・Waste collection vehicles: 82 4) Access road to sanitary landfill facility: 8,276 m 5) Equipment related to solid waste management ・Equipment for treatment: 31 ・Related vehicles: 48 ・Others: 1 6) Managed area building structures and parking for waste transportation vehicles: ・Managed area building structures: 6,483㎡ ・Parking for waste transportation vehicles: 13,546㎡ 7) Training in Japan ・Management skill training: 43 persons
2. Project Period	January 2008 – September 2012 (57 months)	December 2007 – August 2015 (93 months)
3. Project Cost Amount Paid in	6.8 billion yen	5.188 billion yen

Foreign Currency Amount Paid in Local Currency Total ODA Loan (Yen Loan) Portion Exchange Rate	4.598 billion yen (295 million yuan) 11.398 billion yen 6.8 billion yen 1 yuan ＝ 15.6 yen (as of June 2007)	2.915 billion yen (196 million yuan) 8.103 billion yen 5.188 billion yen 1 yuan＝ 14.9 yen (average 2007-2015)
4. Final Disbursement	September 2015	

【Appendix】

Table　Main Project Outputs by Target Prefectural City/County

			Planned (at project examination)	Planned (post-revision)	Actual
1. Sanitary landfill facility	1-1 Processing volume	Lu'an	1,200,000 ㎥	1,200,000 ㎥	600,000 ㎥
		Huoshan	1,400,000 ㎥	1,400,000 ㎥	1,400,000 ㎥
		Huo Qiu	2,030,000 ㎥	2,030,000 ㎥	2,030,000 ㎥
		Yè jí	1,050,000 ㎥	1,050,000 ㎥	1,137,000 ㎥
		Huainan	None	None	None
		Suzhou	1,800,000 ㎥	1,800,000 ㎥	1,800,000 ㎥
		Tongling	None	None	None
	1-2 Leachate pondage volume	Lu'an	None	None	None
		Huoshan	5,800 ㎥	5,800 ㎥	9,700 ㎥
		Huo Qiu	10,400 ㎥	10,400 ㎥	10,400 ㎥
		Yè jí	3,000 ㎥	3,000 ㎥	3,000 ㎥
		Huainan	None	None	None
		Suzhou	20,000 ㎥	20,000 ㎥	20,000 ㎥
		Tongling	None	None	None
2. Leachate treatment equipment	2-1 Volume	Lu'an	300 ㎥/day	300 ㎥/day	300 ㎥/day
		Huoshan	100 ㎥/day	100 ㎥/day	100 ㎥/day
		Huo Qiu	100 ㎥/day	100 ㎥/day	100 ㎥/day
		Yè jí	80 ㎥/day	80 ㎥/day	80 ㎥/day
		Huainan	None	None	None
		Suzhou	300 ㎥/day	300 ㎥/day	300 ㎥/day
		Tongling	None	None	None
3. Collection and transportation facilities	3-1 Construction of new transfer station	Lu'an	16	16	16
		Huoshan	8	8	11
		Huo Qiu	8	8	6
		Yè jí	6	6	6
		Huainan	10	10	10
		Suzhou	8	8	3
		Tongling	12	3	3
	3-2 Modification of transfer station	Lu'an	8	8	8
		Huoshan	8	8	0
		Huo Qiu	0	0	0
		Yè jí	0	0	0
		Huainan	30	30	23
		Suzhou	3	8	8
		Tongling	20	6	6
	3-3 Solid waste collection vehicles	Lu'an	30	30	18
		Huoshan	0	0	0
		Huo Qiu	4	4	6
		Yè jí	7	7	9
		Huainan	22	22	43
		Suzhou	12	12	6
		Tongling	40	74	74
4. Access road to sanitary landfill facility		Lu'an	4,300 m	4,300 m	4,500 m
		Huoshan	340 m	340 m	340 m
		Huo Qiu	1,286 m	1,286 m	1,286 m
		Yè jí	950 m	950 m	950 m
		Huainan	None	None	None

		Suzhou	1,200 m	1,200 m	1,200 m
		Tongling	None	None	None
5. Equipment related to solid waste management	Treatment equipment	All prefectural cities/counties	4 Refuse compactors 9 Excavators 15 Bulldozers 9 Loaders 2 Light buses 6 Cars for project management 4 Dump trucks 4 Spraying vehicles 4 Small maintenance vehicles 2 Cargo buses	2 Refuse compactors 6 Excavators 11 Bulldozers 7 Loaders 1 Light bus 6 Cars for project management 2 Dump trucks 2 Spraying vehicles 4 Little tool vehicles 1 Cargo bus	0 Refuse compactors 5 Excavators 6 Bulldozers 5 Loaders 1 Light bus 7 Cars for project management 0 Dump trucks 2 Spraying vehicles 5 Little tool vehicles
	Collection vehicles	All prefectural cities/counties	2 Cargo trucks 16 Road sweepers 15 Garbage-compacting trucks 5 Road sweepers 5 Road washing machines 2 Large water trucks 2 Hydraulic turbines	0 Cargo trucks 16 Road sweepers 15 Garbage-compacting trucks 5 Road sweepers 5 Road washing machines 2 Large water trucks 2 Hydraulic turbines	2 Cargo trucks 19 Road sweepers 15 Garbage-compacting trucks 5 Large water trucks 7 Street sweepers
	Others	All prefectural cities/counties	2 lightweight bridges 1 car wash equipment 1 maintenance equipment 1 fuel supply equipment 1 electrical equipment 1 communication equipment 1 control device 1 set of furniture equipment	1 set of furniture equipment	1 set of furniture equipment
6. Managed area building structures and parking for waste transportation vehicles:	6-1 Managed area building structures	Lu'an	1,550 ㎡	1,550 ㎡	1,600 ㎡
		Huoshan	1,250 ㎡	1,250 ㎡	1,751 ㎡
		Huo Qiu	300 ㎡	300 ㎡	None
		Yè jí	650 ㎡	650 ㎡	800 ㎡
		Huainan	None	None	None
		Suzhou	1,400 ㎡	1,400 ㎡	1,019 ㎡
		Tongling	960 ㎡	960 ㎡	1,313 ㎡
	6-2 Parking for waste transportation	Lu'an	None	None	3,600 ㎡
		Huoshan	150 ㎡	150 ㎡	1,080 ㎡
		Huo Qiu	None	None	None

	vehicles:	Yè jí	None	None	200 ㎡
		Huainan	None	None	None
		Suzhou	450 ㎡	450 ㎡	441 ㎡
		Tongling	None	29,300 ㎡	8,225 ㎡
7.Training in Japan		All counties	60 persons	60 persons	43 persons

Source: Questionnaire responses by Eexecuting companies
Note: "Planned (at project examination)" excludes all projects in Fēng tái and Huaibei, as well as the incineration facilities related to household solid waste at the Tongling cement plant.

Table Operation and Effect Indicators by Target Prefectural City/County

Prefectural city/county	Lu'an		Huoshan		Huo Qiu		Yè jí	
Indicator	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value	Target Value	Actual Value
(Operation indicator)								
Processed volume of sanitary landfill (tonnes/year)	153,335	195,625	57,753	57,600	66,430	66,430	41,821	0
Post-treatment leachate BOD concentration (mg/l)	600	4	30	2	600	30	150	2
Post-treatment leachate COD concentration (mg/l)	1,000	30	100	7	1,000	100	300	10
Post-treatment ammoniacal nitrogen (mg/l)	-	0.5	-	2.0	-	8.5	-	10.1
Treated leachate volume (m^3/year)	-	60,825	-	36,000	-	525,600	-	18,000
Harmless treatment rate of municipal solid waste (%)	100	98	100	100	100	100	100	100
Collection rate of municipal solid waste (tonnes/year)	-	195,625	-	57,600	-	73,811	-	41,040
Collection rate of municipal solid waste (%)	-	100		96		100		100
Volume of household solid waste disposed of via transfer stations (tonnes/year)	-	176,550	-	57,600	-	82,125	-	10,900
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	46.8	70.0	17.6	36.0	20.3	50.0	12.8	27.8
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)		70.0 (Entire city)		24.0 (Urban areas + some rural areas)		50.0 (Urban areas + town center)		12.0
(out of which) beneficiaries of transfer station (in		70.0 (Entire		12.0 (Urban		20.0 (Urban		8.0 (Urban

units of 10,000 people)		city)		areas)		areas)		areas)
(out of which) beneficiaries of waste collection & transport vehicle (in units of 10,000 people)		70.0 (Entire city)		36.0 (Entire county)		20.0 (Urban areas)		8.0 (Urban areas)
Illegal dumping sites		0		0		0		0
Prefectural city/county	Huainan		Suzhou		Tongling		Total	
(Operation indicator)								
Volume processed at sanitary landfill facility (tonnes/year)	-	-	176,235	195,117	-	-	495,574	514,772
Post-treatment leachate BOD concentration (mg/l)	-	-	600	30	-	-	30-600	2-30
Post-treatment leachate COD concentration (mg/l)	-	-	1000	100	-	-	100-1,000	7-100
Post-treatment ammoniacal nitrogen (mg/l)			-	20.0			-	0.5-20.0
Treated leachate volume (m^3/year)				65,000			-	705,425
Municipal solid waste harmless treatment rate (%)	50	100	-	100	100	100	93	100
Volume of collected municipal solid waste (tonnes/year)				244,800				885,225
Collection rate of municipal solid waste (%)	-	100		100				100
Volume of household solid waste disposed of via transfer stations (tonnes/year)	-	365,800	-	195,117	-	131,303	-	1,011,895
(Effect Indicator)								
Number of beneficiaries / target population for services (in units of 10,000 people)	14.3	115.0	53.8	80.0	55.2	172.0	220.8	531.0
(out of which) beneficiaries of sanitary landfill (in units of 10,000 people)				80.0 (Urban areas + some rural areas)				224.0
(out of which) beneficiaries of transfer station (in units of 10,000 people)		115.0 (Urban areas)		60.0 (Urban areas)		172.0 (Entire city)		457.0
(out of which) beneficiaries of waste collection &		115.0 (Urban		60.0 (Urban		172.0 (Entire		481.0

transport vehicle (in units of 10,000 people)		areas)		areas)		city)		
Illegal dumping sites		9		0		0		1.3

Source: Questionnaire responses by executing companies

Note: The target and actual values reflect 2 years after project completion (actual values are from 2017). Collection rate of municipal solid waste = collected MSW volume / generated MSW volume. The shaded boxes reflect indicators that are outside the scope of this evaluation.

Table The Number of Beneficiaries of Project Facilities in Target Prefectural CityCounty

	Sanitary landfill/leachate treatment		Transfer stations		Collection and transport		Total
	Region	Beneficiaries	Region	Beneficiaries	Region	Beneficiaries	
Lu'an	Entire city	700,000	Entire city	700,000	Entire city	700,000	700,000
Huoshan	Urban area + some rural areas	240,000	Urban areas	120,000	Entire county	360,000	360,000
Huo Qiu	Urban area + some rural areas	500,000	Urban areas	200,000	Entire county	200,000	500,000
Yè jí	-	-	Urban areas	80,000	Entire county	80,000	80,000
Huainan	-	-	Urban areas	1,150,000	Entire county	1,150,000	1,150,000
Suzhou	Urban area + some rural areas	800,000	Urban areas	600,000	Entire county	600,000	800,000
Tongling	-	-	Entire city	1,720,000	Entire city	1,720,000	1,720,000
Total	-	2,240,000	-	4,570,000	-	4,810,000	5,310,000

Source: Questionnaire responses by executing companies

Note: Total figure excludes duplicates.

Table Operating Entities of the Household Solid Waste Management Businesses in the Prefectural Cities/Counties Targeted by the Current Project

Prefectural city/county	Sanitary landfill	Leachate treatment	Transfer station operation	Collection/ transport of waste
Lu'an	government	private contractor	government	government
Huoshan	government	private contractor	private contractor	private contractor
Huo Qiu	government	private contractor	private contractor	private contractor
Yè jí	government	private contractor	government	government
Huainan	private contractor	private contractor	government	government
Suzhou	government	private contractor	government	government
Tongling	private contractor	private contractor	government	government

Source: Questionnaire responses by executing agencies

Islamic Republic of Pakistan

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project
"Dadu-Khuzdar Transmission System Project"

External Evaluator: Hiroaki NAGAYAMA[1], IC Net Limited

0. Summary

This project aims to respond to the growing electricity demand in Balochistan Province by conducting a new construction of a 220 kV transmission line (total length of about 300 km) from Dadu, Sindh Province to Khuzdar, Balochistan Province and 220/132 kV substation, thereby contributing to the revitalization of the regional economy of the province and improvement of the livelihood. The purpose of the project is consistent with Pakistan's development policy and development needs at the time of appraisal and ex-post evaluation, as well as Japan's aid policy at the time of appraisal, and its relevance is therefore high. The project period was significantly longer than planned due to a number of reasons such as the impact of sanctions against Iran (suspension of Iran-related transactions by banks), delay in opening letters of credit, delay in transportation of materials and equipment. Due to these delays, the project cost was significantly higher and, consequently, efficiency of the project is low. Since the operational status of the facilities provided by the project is steady, operation and effect indicators such as reduction of load shedding risk and improvements of voltage drop rate at the demand point are largely achieved, the effectiveness is high. It is estimated that this project has a high impact in contributing directly and indirectly to the industrial revitalization of Balochistan province, expansion of employment, and improvement of the livelihood of the local residents. Operation and maintenance status and technical aspects of the current facility equipment are generally good. However, due to security problems[2], there are some difficulties in mobilizing the staff for the maintenance of transmission lines and the substation located in Khuzdar, causing some issues on the feasibility of the inspection. The sustainability of the project effect is therefore rated as fair.

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

[1] Support to IC Net Limited. The actual affiliation of the evaluator is to the Kyoto University (Professor).

[2] According to the executing agency, the security situation has now improved a lot and mobilization of staff for maintenance of transmission lines and substation, which was then difficult is now possible with requisite coordination with concerned authorities of the area. On the other hand, since the evaluation analysis is based on the data attained during the field study and the evaluator could not obtain enough evidence to confirm the comments, the contents of main report are maintained.

1. Project Description

Project location

New facility at Khuzdar substation : 220kV powered circuit[3]

1.1 Background

Electricity demand in the Balochistan Province located in the southwestern part of Pakistan was 6% of the total demand in 2005. The electrification rate was also the lowest at 26% against the national average of 72% as of the end of 2005, and the demand growth rate during 2000 to 2005 was the largest at 94% (average around 14% a year) compared to the national average of 35%. In Balochistan Province, the electricity consumption in the agricultural sector is large, mainly being utilized as a power source for pumping up groundwater, and the consumption per customer is about 4.6 times the national average. In addition to cold storage facilities of crops and cotton industry and mineral industry etc., their electricity demand has been increasing[4].

At the time of this project appraisal, the main electricity supply to the Balochistan Province was a transmission line extending from neighboring Guddu in Punjab Province to the northern part of Balochistan Province. This transmission line was partially constructed with the ODA Loan approved in 1989 "Second 220kV Guddu-Sibbi-Quetta Transmission Project ".

In the terminal distribution network in the central region of Balochistan, where load shedding was carried out for 8 hours a day, factors such as the shortage of transmission infrastructure hindered the development of the agriculture sector in the central region of Balochistan and the restoration of other industries.

1.2 Project Outline

This project aimed to cope with the demand of electricity in Balochistan Province by establishing a new 220kV transmission line from Dadu of Sindh province to Khuzdar in

[3] Receiving power from Dadu.
[4] Source: Materials provided by JICA

Balochistan province, newly establishing a substation in Khuzdar and adding new facility to the existing substation equipment in Dadu. This will contribute to revitalizing the regional economy and improving the livelihood of the state.

Loan Approved Amount/ Disbursed Amount	3,702 million yen / 3,147 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	December 2006 / December 2006	
Terms and Conditions	Interest rate Repayment period （Grace period） Conditions for procurement	1.3％ 30 years 10 years） General untied
Borrower / Executing Agencies	THE PRESIDENT OF THE ISLAMIC REPUBLIC OF PAKISTAN/ National Transmission and Dispatch Company Limited :NTDC	
Project Completion	April 2016	
Main Contractors	・ ICC(Pvt.) Limited (Pakistan) ・ Iran Power & Water Equipment & Services Export Co. (Sunir)(Iran)/UCC(Pakistan) ・ Iran Power & Water Equipment & Services Export Co. (Sunir)(Iran)/MECONS(Pakistan)	
Main Consultants	-	
Related Studies (Feasibility Studies, etc.)	F/S（April 2004）	
Related Projects	【Yen loan】 ・National Transmission Lines and Grid Stations Strengthening Project （March 2010） 【Other international organizations, aid agencies, etc.】 ＜World Bank＞ ・Electricity Distribution and Transmission Improvement Project（June 2008） ＜ADB＞ ・Power Distribution Enhancement Investment Program-Tranche 2（December 2010）	

2. Outline of the Evaluation Study

2.1 External Evaluator

Hiroaki NAGAYAMA[5]（IC Net Limited）

2.2 Duration of Evaluation Study

This ex-post evaluation was conducted with the following schedule.

Duration of the Study：July 2017-March 2019

Duration of the Field Study：November 15-30, 2017 and April 25-July 3, 2018（Field survey by local surveyors）

2.3 Constraints during the Evaluation Study

(1) For security reasons in Pakistan, field surveys including business sites were conducted by field survey assistants under the supervision of external evaluators who carried out desk evaluations. For this reason, a missing part is recognized in obtaining detailed data.

(2) The security situation in the target area was extremely bad, and an on-site survey by the field investigation assistant placed safety management as a top priority. In particular, tribal conflicts between Larkana and Khuzdar occurred frequently, which is regarded as extremely dangerous, and on-site investigation was avoided in this area. The qualitative survey chose a region[6] with representative characteristics similar to Balochistan as much as possible, but the results from qualitative surveys have the possibility of being slightly biased because the tribe, culture and customs of the Balochistan province are greatly different depending on the region.

3. Results of the Evaluation (Overall Rating:C[7])

3.1 Relevance（Rating：③[8]）

3.1.1 Consistency with the Development Plan of Pakistan

At the time of appraisal, the Government of Pakistan stated in the *10 Year Development Plan* (FY 2001 - FY 2010) the development and enhancement of transmission and distribution networks, promotion of rural electrification, reduction of transmission and distribution loss, etc.[9]. Specifically, in a new capital investment plan in the power sector, it was decided to continually develop transmission and distribution facilities in order to cope with the increasing demand for electricity. According to *Poverty Reduction Strategy Paper* (2003) and the Medium Term

[5] Participate for reinforcement

[6] Regional representation means the area that can be inferred that the data obtained in that area captures the characteristics of the entire Balochistan state.

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

[8] ③："High", ②：" Fair ", ①："Low"

[9] Materials provided by JICA

Development Framework (MTDF) (2005-2010), the supply of electricity was recognized as a catalyst to generate economic activity, employment and growth.

The Pakistan Ministry of Water and Power (MOWP) announced the *National Electricity Policy 2013* in July 2013, stating that "Pakistan responds to the needs of the people in a sustainable and inexpensive way and develops the most efficient and consumer-oriented generation, transmission and distribution system necessary for economic development". Among them, the following are listed as the 2017 target, and emphasis is placed on eliminating the gap of the supply-demand balance in particular.

1) Improvement of supply-demand balance gap: To reduce the power shortage of 4,000 to 5,000 MW to 0 by 2017.
2) Reduction of power generation unit price: 12 US cents / kWh to 10 US cents/ kWh by 2017.
3) Reduction of transmission/distribution loss rate: 23 - 25% to 16% or less by 2017.

Even in the latest power sector plan after MTDF[10](Annual Plan 2018 - 2019) (April 2018), emphasis is placed on reinforcement of transmission and distribution networks and loss reduction.

From the above, the implementation of this project is relevant to Pakistan's national development plan and power sector development plan at the time of appraisal and ex-post evaluation.

3.1.2 Consistency with the Development Needs of Pakistan

Within the terminal distribution network in the central Balochistan province, load shedding was sometimes implemented for 8 hours a day. Therefore, it was highly necessary to supply electric power sufficiently and stably to the central region of Balochistan province through the establishment of this transmission line.

At the time of appraisal, many of the thermal power generation was located in central and southern Pakistan, and most of the hydroelectric power was located in the northern part. Because they were away from the center of electricity demand, the Pakistan government needed to implement efficient and stable operations of 500 kV and 220 kV of super high voltage transmission lines.

It is expected that the population will grow significantly within the Quetta Electric Supply Company (QESCO[11]) jurisdiction including Khuzdar, which is projected to increase to around 2 times, from 6.7 million (2005) to 11.9 million (2040)[12]. According to *Pakistan 2025*, published

[10] It is updated every year after MTDF.
[11] There are ten power distribution companies in Pakistan, and the power distribution company supplies power from the 132 kV power reception to the customer. QESCO is in charge of the Balochistan Province except the Lasbela area.
[12] National Institute of Population Studies

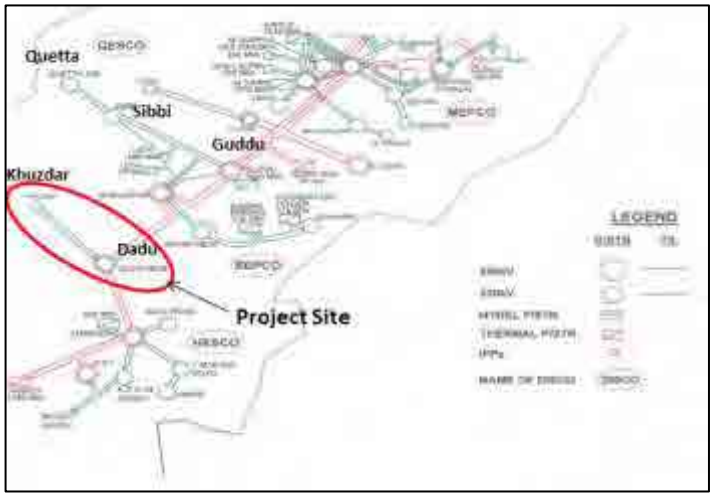
by the Ministry of Planning and Development Reform in 2014, it is expected that GDP will grow by nearly 8%. According to the *White paper 2017-2018*: Finance Department of Balochistan, the real GDP growth rate for FY 2007 - FY 2015 is 3.03%, slightly lower than the national average of 3.26% (World Development Indicator). However, the maximum demand growth in the QESCO department from 2006 to 2015 is higher than the national average (PEPCO[13]). (Table 1)

Table 1 Maximum (peak) demand in QESCO and PEPCO

(MW)

	QESCO	Growth	PEPCO	Growth
2006-2007	951	100	14,604	100
2007-2008	1,180	124	17,084	117
2008-2009	1,157	122	18,881	129
2009-2010	1,316	138	19,288	132
2010-2011	1,430	150	20,559	141
2011-2012	1,480	156	21,997	151
2012-2013	1,530	161	22,883	157
2013-2014	1,650	174	23,425	160
2014-2015	1,762	185	23,419	160
2015-2016	1,765	186	23,267	159
2016-2017	1,770	186	24,290	166

Source：NEPRA State of Industry report 2011,2012,2017
Note 1: Growth is an index with setting 2006-2007 as 100.
Note 2: KESC that supplies electricity to Karachi is not included in PEPCO.



Source: The evaluator added to what was received from the NTDC Planning Bureau on April 25, 2018 (Data is January 15, 2018)

Figure 1: Location of this project in the NTDC transmission network (220 kV, 500 kV)

[13] In October 2007, the Water and Power Development Authority (WAPDA) was divided into two companies: WAPDA and Pakistan Electric Power Company (PEPCO). WAPDA is in charge of hydraulic development, while PEPCO is in charge of construction, operations, maintenance and charging of thermal power generation, transmission and distribution facilities. PEPCO has jurisdiction over Pakistan excluding the Karachi district (controlled by Karachi Electric Supply Company n (KESC)).

Since the load factor of transmission and transformation equipment is high at this time, development needs continue to be high even at the time of ex-post evaluation. This project also meets the demand in the Balochistan province and is the only transmission line constructed to supply electricity to the Balochistan province instead of the Guddu - Sibbi - Quetta transmission line.

From the above information, the necessity of this project is recognized at the time of appraisal and ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

In Japan, the *Country Assistance Program for Pakistan* (February 2005) aimed for the "development of a healthy market economy", which has been shown as one of the priority areas. "The importance of the expansion and improvement of economic infrastructure supporting for "Activate market economy and poverty reduction" was demonstrated. In JICA's *Medium-Term Strategy for Overseas Economic Cooperation Operations* (April 2005), development of infrastructure for sustainable development was a priority area for supporting Pakistan. JICA's Country Assistance Strategy for Pakistan (March 2006) proactively supported the idea that securing a highly reliable electricity supply system in terms of both quantity and quality will contribute to economic development.

From the above, this project aims to construct power transmission facilities to meet the demand of electricity in Balochistan Province, and was relevant to Japan's ODA policy.

3.1.4 Appropriateness of the Project Plan and Approach

This project is planned by taking into account lessons from other projects in order to improve the efficiency of the project. In the "Second 220kV Guddu-Sibbi-Quetta Transmission Project", additional costs and a delay in the construction schedule occurred because some construction materials and equipment were stolen during the construction stage. This unstable security was mainly due to NTDC prioritizing the reduction of the project cost, and some of the transmission line routes being far from the main road, making regular repair work and patrol activities difficult. In this project, based on such a precedent, measures were taken to prevent the above problems by setting most of the power transmission route along the main road.

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

3.2 Efficiency（Rating：①）

3.2.1 Project Outputs

The plan and actual output of this project are as shown in Table 2.

Table 2 Comparison of the Planned and Actual Outputs

	Plan	Actual
1. 220 kV Dadu-Khuzdar Transmission Line	Extension of high voltage 220 kV double circuit single conductor transmission lines from Dadu to Khuzdar with a total length of 300 km, , 833 Steel Towers (Double circuit), Conductors (Rail,1800 km), OPGW 300 km.	220 kV double circuit Transmission Lines with a length of 275 km. Steel Towers 761, Conductor 1650 km and OPGW 275 km.
2. Grid Station at Khuzdar	2 Auto Transformers (160 MVA, 220kV), Bus Isolators (14 sets for 220 kV and 6 sets for 132 kV), Line Isolators (2 sets for 220kV), Circuit Breakers (6 sets for 220 kV and 3 sets for 132 kV) and 2 Shunt Reactors (18 MVAR, 220kV).	2 Auto Transformers (160 MVA, 220kV), Bus Isolators (16 sets for 220 kV and 9 sets for 132 kV), Line Isolators (2 sets for 220kV), Circuit Breakers (8 sets for 220 kV and 3 sets for 132 kV) and 2 Shunt Reactors (18 MVAR.220kV)
3. Grid Station at Dadu	Expansion of 220kV Grid station at Dadu. Bus Isolators（6 sets）, Line Isolators（2 sets）, Circuit Breakers（3 sets）	220kV Switch yard 500/220/132kV extension Dadu GS（2 Bays）
4. Consulting Services	To assist NTDC in Engineering Services and detailed Project design, preparation of Tender Documents, Evaluation of Tenders, Award of Contract, Supervision of Construction Work, verification of Bills of Quantities and Contractor's Bills, and Testing and Commissioning of the Project.	Detailed Project design, preparation or Tender Documents, Evaluation of Tenders, Award of Contract, Supervision of Construction Work. Verification of Bills of Quantities and Contractor's Bills, and Testing and Commissioning of the Project.

Source: Created based on the materials provided by JICA

Note 1: In order to shield the electric wire from the lightning, the OPGW(Optical ground wire) uses wiring at the top of the tower. OPGW is applied to the full length of the power transmission line and has the role of transferring data of the control system.

Note 2: Changes related to the Khuzdar substation: Two pairs of 220 kV circuit breakers and two pairs of 220 kV disconnectors (insulation devices) were installed for 220 kV shunt reactors (to accommodate system voltage rise). Also, the 132 kV isolators were installed for the 132 kV bus coupler, the device used to connect one bus to another without interrupting power supply and without generating a dangerous arc, and the 132 kV instrument transformer (to measure high voltage by lowering 132 kV to 110 V).

After the appraisal, the optimum route was selected and the Dadu-Khuzdar transmission line was shortened by 25 km from the planned time. Additionally, the number of steel towers and the length of conductors also decreased. Transmission lines are constructed along the main road, but

geographical constraints and route adjustments occurred. Several iron towers in Balochistan province were located off the main road. As confirmed by NTDC, in Sindh province, the transmission line from Dadu to Mehar is along the main road, but some points are separated from the main road from Méhar to Shahdadkot. In mountainous areas where there are few suitable places to build steel towers, they are built at intervals of 500 to 600 meters. According to the interview with the NTDC, these changes could be made at no additional cost by the discretion of the construction site (team/managers,etc.).

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost at the time of appraisal was 6,280 million yen (including foreign currency of 3,702 million yen, and internal currency of 2,578 million yen). The yen loan covered was 3,702 million yen for the foreign currency portion. At the time of the ex-post evaluation, we were unable to confirm the actual amount of self-funds (general administrative expenses, land compensation, royalties, interest during construction, etc.) of the Pakistan side. Therefore, the planned project cost excluding these cost (5,852 million yen) is compared with actual cost. The actual amount was 8,159 million yen, which was higher than planned (139% of the planned amount). Costs increased due to rising steel prices[14] and fluctuations in exchange rates during the project period[15].

3.2.2.2 Project Period

The project period planned at the time of appraisal was November 2006 - March 2011 (53 months). At the time of appraisal, completion of the project was set for March 2011 when the one year period of the warranty expired, after completion of equipment and materials provision and installation (March 2010); actual results are from November 2006 to December 2015[16]. It took 110 months, significantly longer than planned (208% of the planned time).

In addition to procedural delays such as delays in construction work and related procedures, the project led to a delay due to multiple factors including sanctions against Iran (suspension of Iran-related transactions by banks), flood disasters and public security. Main reasons for this project's delay are as follows.

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[14] In the World Bank Commodity Price Data, the spot price of iron ore ($ / dmtu) rose from 69.33 ($ / dmtu) in 2006 at the start of the project to 145.86 ($ / dmtu) in 2010 when it was planned for installation. DMTU is an abbreviation of Dry Metric Ton Unit, a unit of display of iron ore price per 1% iron content.

[15] Price preliminary expenses reflecting price increases are recorded in the contracts of each package, and expenses have increased in response to price increases of cement, petroleum and wages.

[16] Warranty period is stated in the construction contract of this project that it is 18 months from the completion date of the facility, or 12 months from the facility operation start date. This project is divided into Package 1 (220 kV Dadu-Khuzdar transmission line), 2 (Khuzdar substation station), and 3 (Dadu substation station). In the ex-post evaluation, we considered the day when all packages were completed (the end date of the collateral period of package 3) as the completion date of this project.

【Construction work / related procedures】

· Delayed opening of letters of credit (all packages)

· Delay in delivery of alkyd galvanized metal towers (transmission line package)

· Inspection of OPGW before loading and delay in customs clearance (transmission line package)

· Delay due to change of foundation (transmission line package)

· Delay in installing steel towers due to ROW (Right Of Way)[17] correspondence, delay in OPGW laying work (transmission line package)

· Delay in approval of shutdown (transmission line package)

Since the 220 kV transmission line of this project crosses both lines of the 500 kV transmission line, that is, "Dadu-Guddu" and "Guddu-Dadu", shutting down both lines becomes necessary; because "the north and south of the National Grid System" were to be temporarily divided, delayed approval of shutdown occurred.

· Delay of issuance of NOC (No Objection Certificate) of the Ministry of Defense because the transmission line passes through the military premises (transmission line package)

· Delay in arrival of drawings, etc. (transmission line package)

【Problems concerning sanction against Iran】

· Sanctions against Iran have made it difficult to transfer funds for construction projects to Iranian banks and Iranian builders (Sunir). Sunir could not receive payment until at least April 2013. Therefore, project progress was delayed as Sunir responded by reducing the number of workers according to its cash flow and equipment procurement.

【Public security】

·Balochistan Province has been in an unstable security situation from issues such as terrorism and the abduction of foreigners since around 2007. In August 2010, the Pakistan Ministry of Foreign Affairs stated that foreigners should refrain from visiting Balochistan as much as possible. As a result, the persons concerned (NTDC, consultants, construction companies) with the project were restricted from accessing the site of transmission lines and substations. The work was therefore restricted and there was a delay in project progress (Effective period from August 2010 to the completion of the project).

【Flood in 2010, flooding of construction site due to heavy rain in 2011】

· Floods caused by heavy rain occurred in early August 2010, and access to the transmission line and Khuzdar substation was restricted. The project was thereby suspended for approximately six months until the water was drained. Similarly, in early August 2011, heavy

[17] This is not a resettlement, but a matter of compensation for agricultural harvests.

rain caused about 6 months of business disruption. When combined with 2010, the project was suspended for about 12 months, which led to project delay.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

Since the economic internal rate of return (EIRR) was not calculated at appraisal, recalculation has not been carried out. Financial Internal Rate of Return (FIRR) at the time of appraisal was calculated to be 8.29% with construction and maintenance expenses, benefits as a unit of system charge, and a project life of 29 years after the start of service. In the recalculation at the time of ex-post evaluation, the same conditions as at the time of appraisal were used. However, for benefits, electricity sale income (wheeling charge) was estimated from the actual electricity supply amount of the substation[18]. Regarding expenses, we cannot confirm the amount of investment for each year, so we allocated the actual amount of the project cost by using the expenditure ratio of the yen loan disbursement amount each year. The recalculated FIRR was negative[19] due to increase in costs, such as rising steel prices during the project period and fluctuations in the exchange rate.

The project cost exceeded the plan and project period significantly exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness and Impacts[20] （Rating：③）

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Hereafter, the degree of realization of "Responding to Electricity Demand in the Balochistan province ", which is the outcome of this project (direct effect), is verified by three indicators as " Capacity operation rate (%)", "load shedding risk reduction (MW)" and "the voltage drop rate at the demand point (%)". (Table 3)

[18] Calculation of fee income of the substation is based on MVA and MDI (Maximum Demand Indicator), and MDI used by NTDC was utilized. Specifically, the MDI of the substation is multiplied by the electricity usage fee unit price of the substation (136 Pakistan Rupee (PKR) / kW / month).

[19] FIRR at the time of appraisal is 7.8%, and FIRR at recalculation is negative when the date of the loan agreement (L/A) signing date is taken as the starting point of project life.

[20] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 3 Operation / Effect Indicator

	Baseline	Target	Actual
	(Yr2005)	(Yr2013)	(Yr2017)
		2 years after completion	3 years after completion
Capacity Operation Rate of Transmission Lines（%）	--	63%	85%
Load Shedding（MW）	7(MW)	0MW	0MW
Voltage Drop at End User（%）	24%	0%	10%

Source: Data provided by JICA, materials provided by executing agencies
Note 1: Operating rate of the facility means the percentage of the maximum electric power (MW) to be energized relative to the capacity of the facility, and the reserve capacity as to whether there is a need to construct a new facility.
Note 2: The load shedding is the maximum value of the load shedding of the Khuzdar substation.
Note 3: Voltage drop is the maximum voltage drop rate with respect to the reference voltage of the 132 kV bus at Khuzdar substation. That is, (reference voltage-maximum voltage drop) / (reference voltage).

(1) Capacity operation rate

The MDI of the two transformers at Khuzdar substation from June 2014 to June 2018 is shown in Figure 2. The capacity operation rate has remained at 85% or more, exceeding the target value at the time of appraisal of 63%. At the time of appraisal, the target value was set to 63% for the sake of convenience. However, since it should be seen that the aim was not to cause an overload of substation equipment, in addition to the fact that the capacity operation rate is 100% or less, it is considered that the facilities are being used moderately at a level exceeding the target value of 63%. Therefore, it was judged that it is appropriate to consider that this indicator has achieved the target.

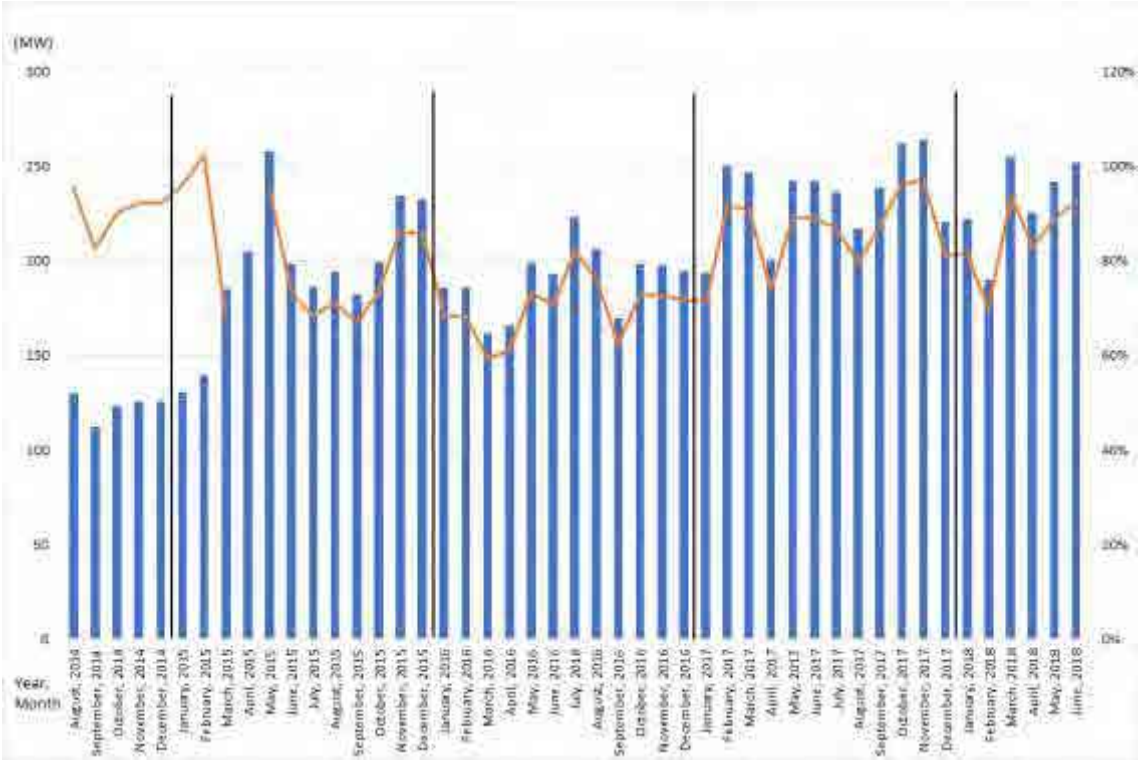

Figure 2 Numerical values of MDI at Khuzdar substation

Source: Data provided by NTDC Lahore

Note: Since the transformer (T-2) was energized since March 2015, Maximum Demand Indicator (MDI), which is the Demand Factor, is calculated based on maximum 160 MVA until February 2015.

(2) Load shedding

The implementation of this project reduced the risk of the load shedding. The load shedding did not occur and it achieved the target value.

(3) Voltage drop at demand point（%）

Voltage drop did not reach 0% of the target value, but it decreased from 24% of the baseline value (2005) to the actual value of 10% (2017). This is because it became possible to avoid extending the line from a long distance because a substation was established near the demand site. In NTDC's grid code, acceptable range of voltage fluctuation is + 8% to -5% in the normal state, but in an N-1 emergency, that is, in a situation where one out of two lines line is blocked, fluctuation of ± 10% is acceptable. Therefore the actual value of 10% in 2017 is within the allowable range of the grid code. The reason for this descent is due to the equipment of the local public distribution company QESCO rather than this project[21].

[21]According to the local interview, it is as follows: 1) While the distance of the distribution line is usually 11 - 15 km, this project has reached 70 km (it seems to be a common phenomenon in the sparsely populated area of Balochistan), 2) the quality of the lead of QESCO is bad and maintenance is not enough. The resistance value increases because of impurities in the aluminum wire used for conductors and the joints. 3) The load of agricultural well pumps and fan motors is large and the power factor is low.

（reference）Increase in sales volume at QESCO

As QESCO's power sales volume is increasing, it can be said that the demand for electricity across Balochistan is increasing substantially. Thanks to this project, the transmission and substation transformers are being developed and operating since 2015, so we can see that QESCO are increasing supply in response to Balochistan's electricity demand (Table 4).

Table 4 Power supply and transmission / distribution loss in the QESCO region

		30-6-2015		30-6-2016	
Average Monthly Demand Index (MDI)	[MW]	935		1,166	
Units Purchased (A)	[GWh]	5,186		5,547	
Transmission Losses (132kV) (B)	[GWh]	311	(6.0%) Transmission Losses = (B)÷(A)	305	(5.5%)
Distribution Losses (C)	[GWh]	882	(17.0%) Distribution Losses = (C)÷(A)	1,022	(18.5%)
Units Sold to Customers	[GWh]	3,993		4,220	

Source: QESCO materials provided

3.3.2 Impacts

3.3.2.1 Intended Impacts

At the time of appraisal, it was assumed that the stability of the power system and the revitalization of the regional economy in Balochistan province were the impacts of this project.

（1） Stabilization of the power distribution system by new expansion of transmission and substations

Electricity was supplied to the Balochistan province by only the Guddu - Sibbi - Quetta transmission line, but due to the secured alternative route by this project, reliability of power supply of the entire QESCO jurisdiction, including the Khuzdar and NTDC system network, increased. Load shedding become avoidable.

The number of System Average Interruption Frequency Index (SAIFI)[22] and System Average Interruption Duration Index (SAIDI)[23] in the QESCO jurisdiction decreased significantly in 2015 and 2016, indicating that the reliability of the power distribution system also improved. (Table 5)

[22] System average interruption frequency index (SAIFI) is the number of power outages per customer (number of times per year).

[23] System average interruption duration index (SAIDI) is the power outage time per customer (minutes / year).

Table 5 System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI) in the QESCO jurisdiction

	2012	2013	2014	2015	2016
System Average Interruption Frequency Index (SAIFI) (No/year)	156.08	153.80	144.95	112.58	107.00
System Average Interruption Duration Index (SAIDI)(Minutes/year)	12,810.70	12,635.00	11,868.10	7,506.81	7,290.00

Source：State of Industry report 2016, NEPRA

The number of voltage changes[24] in Khuzdar greatly declined since the substation maintenance. (Table 6)

Table 6 Number of voltage changes

The number of changes in voltage fluctuation	GS	2014-15	2015-16
220 kV	Khuzdar	1,140	796

Source：NEPRA-State of Industry Report 2016

（2） Development of industry, revitalization of the regional economy and improvement of living infrastructure

We interviewed customers during this ex-post evaluation period[25]. The following is the result of the local beneficiary interview.

Overall, this project reduced the local power outages (planned power transmission stop to avoid power failure). This lengthened the nighttime opening hours by having lighting, and economic activity became active (local residents near Khuzdar). Land owners began to invest in local business, regional purchasing power improved and economic activity became active. Also, the number of wells pumped up by electric tubes increased, and agricultural activities became active. As a result, demand for fertilizer has also increased (farmer). Small-scale businesses also became able to receive revenue more than before as demand for consumer products, especially agricultural fertilizer, has increased (seedling production and sales company). In particular, Balochistan is a

[24] The number of voltage changes exceeds the allowable variation range. It is not preferable as it increases.

[25] An on-site research assistant interviewed local residents in the Khuzdar region of the Balochistan province. The local coordinator selected subjects from each occupation while receiving assistance from stakeholders in the target area and interviewed people who got consent among the subjects. The breakdown consists of one student, eight owners of stores, one mayor, one executive director, three farmers(including a day-hired farmer), two land owners, two seedling production and sales company employees, one electrician and one businessman. Because of religious and cultural background, women were not included in this interview. Students at the engineering technology university were interviewed at the dormitory, but because there was only a male dormitory at the university, female student interviewees could not be obtained.

poor state and the development of value-added industries was a challenge. Therefore, the development of industries with high added value as seen in the increase in marble factories is a big positive impact (common answers from several people).

On the other hand, no negative impact was mentioned.

From Table 7, it can be said that the per capita GDP of the Balochistan province is increasing after the start of this project.

Table 7 Real GDP Per Capita Per province (1999-2000 to 2014-2015)

(Fixed value based on 1999-2000)

	1999-2000	2007-08	2012-13	2014-15
Balochistan				
Provincial GDP (billion Rs)	214.5	272.6	297.0	313.7
Population (million)	6.9	8.4	9.8	10.0
Per Capita GDP (1,000 Rs)	**31.086**	**32.452**	**30.306**	**31.370**
Deviation from National Average (%)	**-26.2**	**-38.6**	**-44.0**	**-44.9**
Annual Growth Rate (%)		**0.53**	**-1.36**	**1.74**
Pakistan				
GDP (billion Rs)	5,693.1	8,549.5	9,816.3	1,0644.1
Population (million)	135.13	161.841	181.255	187.033
Per Capita GDP (1,000 Rs)	**42.130**	**52.826**	**54.157**	**56.910**
Annual Growth Rate (%)		**2.86**	**0.50**	**2.51**

Source：Dr. Hafiz A. Pasha (December 2015) "Institute For Policy Reforms, IPR Brief, Growth Of The Provincial Economies"

From the above, it is unknown how much this project contributed to the Balochistan Province per capita GDP as the start of service of this project is 2014. Nevertheless, based on the results of the qualitative survey, contribution to the revitalization of the regional economy is presumed.

3.3.2.2 Other Positive and Negative impacts

（1） Impacts on the Natural Environment

This project falls under category B on the "JBIC Guidelines for Confirmation of Environmental and Social Considerations (April 2002)". The Environmental Impact Assessment (EIA) report of this project was not obligated to be prepared under the domestic legal system of Pakistan. At the time of appraisal, air pollution accompanying construction, noise, etc. were considered not to have a particularly negative effect due to factors such as proper use of construction machinery. When we confirmed with NTDC at the time of ex-post evaluation, it was confirmed that environmental

monitoring was implemented, appropriately dealt with in accordance with NTDC policy, and no negative impact on the natural environment occurred.

（2）Resettlement and Land Acquisition

At the time of appraisal, it was necessary to acquire land for construction of the tower of the transmission line. However, the land was already acquired, and resettlement of residents was assumed not to occur[26]. According to NTDC, resettlement of residents was not undergone; only payment was made for residents whose harvests were damaged. Regarding compensation, there is a provision of Right of Entry (a real estate recovery and land restoration right) in Article 14 (2) of the Manual of WAPDA Laws (Revised Edition) that was effective in 1958. This provision ensured compensation for damages incurred. In the transmission line construction contract of this project, a total of 35 million Pakistan Rupees was accounted for due to the repair of agricultural products, trees and homes that were unavoidably damaged.

This project has achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability（Rating：②）

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

Construction of the transmission line is the responsibility of the power transmission network construction department (Project Delivery / GSC) [27] of NTDC's Ultra High Voltage Division (EHV). The responsibility for operation and maintenance (O&M) of the transmission and substation after completion of construction is transferred to the Asset Management Operations Department (GSO / AM). GSO / AM South is based in Hyderabad and is responsible for O&M of the transmission of 220 kV and 500 kV in southern Pakistan. Fig. 3 is an organization chart relating to O&M of NTDC. The Khuzdar office of NTDC is in charge of daily inspection and maintenance work for the Khuzdar substation and transmission line. The Dadu office is involved in daily inspection and maintenance work for the Dadu substation and transmission line.

[26] Materials provided by JICA

[27] EHV has a first and second division. EHV - I controls the northern part of Pakistan and is based in Lahore. EHV - II manages the southern part of Pakistan and is based in Hyderabad. EHV-I / Project Delivery North is responsible for the construction of existing facilities and transmission facilities in the Islamabad and Lahore areas. EHV-II / Project Delivery South is responsible for the construction of existing facilities and new facilities in the Multan, Hyderabad and Quetta areas.

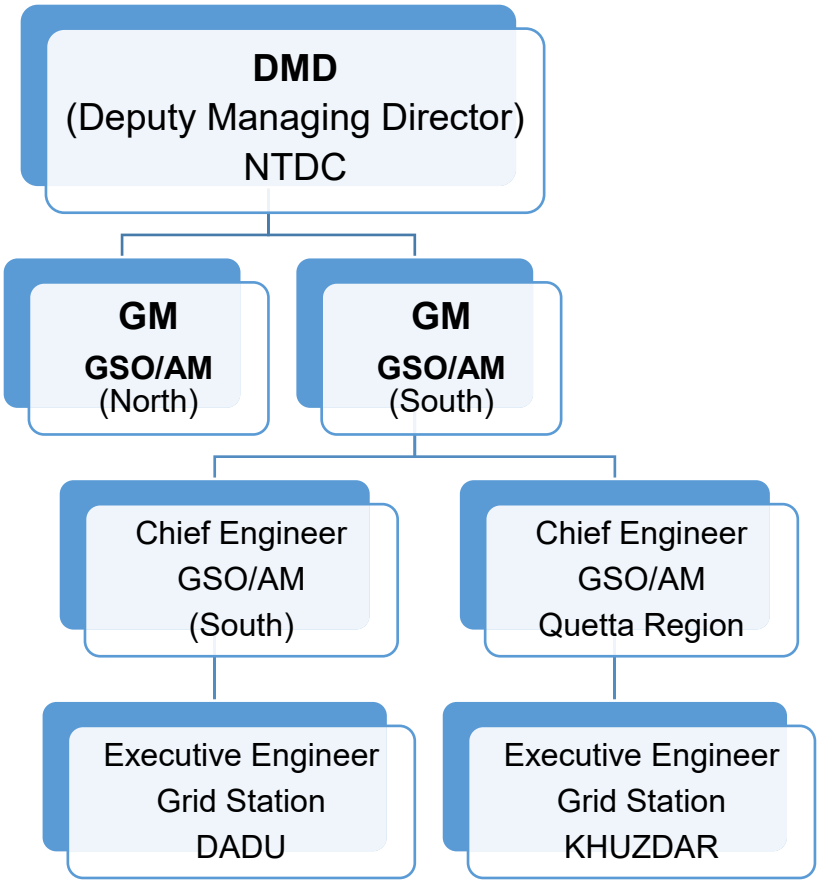

Figure 3 NTDC maintenance system

Source: obtained from NTDC

Note: GSO / AM: Grid Station Operations & Asset Management

Regarding the Khuzdar substation, 152 staff positions are available including the executive engineer related to the 220 kV system, and 64 positions are occupied and there are 88 vacancies. The maintenance staff in charge of maintenance and management of this project has an availability of 15 people, of which 6 people are working and 9 positions are available. Of the 42 possible staff positions in charge of transmission lines, there are 11 people working. The security staff position has 31 people working out of an available 33 positions. Other staff positions in charge of administration include 4 people working out of 25 total available positions.

In an interview with the Khuzdar substation and the Dadu substation, we received a response stating that the lack of staff in the area has an impact on O & M performance. The post that was approved at the Khuzdar substation remains vacant for the following reasons. In Pakistan, legislation stipulates that federal government-controlled organizations (NTDC, NEPRA, WAPDA, etc.) hire employees from all areas according to fixed constants defined by the government in the approved post. In addition to the fact that there are not many human resources in the Balochistan Province, people are reluctant to work in the Balochistan and Sindh outback due to security

concerns and long travel distances. The shortage of the staff here is dealt with not by new recruitment, but by transferring NTDC's other facility staff to the Khuzdar and Dadu substation. In the event of an emergency, NTDC 's Khuzdar and Dadu substation may ask for support from Quetta branch. In this way, securing human resources locally and from other areas is not easy, and the chronic shortage of maintenance personnel is a challenge in the operation and maintenance system.

3.4.2 Technical Aspect of Operation and Maintenance

NTDC's Technical Services Group (TSG[28]) will train NTDC staff[29] in charge of O & M in this project at three training centers (Faisalabad[30], Lahore[31], Tarbella[32]). Training manuals are in place here. According to the interview with the NTDC Hyderabad office, there is no training at the substation or regional office level, and there is no training manual.

The staff who actually do O & M have a bachelor's degree in engineering and a qualification as an associate engineer. Employees respond to everyday imperfections[33] and TSG provides support when serious flaws[34] occur.

3.4.3 Financial Aspect of Operation and Maintenance

3.4.3.1 Procedure for executing budget for operation and maintenance

The budget related to O & M is allocated by GSO to each substation. Resident engineers[35] at substations send budget proposals to GSO chief engineers, where the budget plan for that year is prepared. Subsequently, the GSO of each region presents a budget proposal to the finance department (asset management department) of the NTDC head office. Following the approval of the Board of Directors, a budget proposal is presented in accordance with the SOP (Standard Operating Procedure). The Head of Finance at NTDC Headquarters distributes the budget after getting confirmation of the relevant GSO chief.

3.4.3.2 Financial health of NTDC

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[28] TSG is a part of NTDC established in 1985 by Canada's Canadian International Development Agency (CIDA) that provides technical and financial support.

[29] The person to be trained is recommended by GSO (department in charge of O & M of NTDC).

[30] Faisalabad's training center conducts training on the maintenance and operation of the electricity grid.

[31] After the theoretical training at Tarbella, Lahore's training center conducts maintenance and maintenance management training of the transmission grid. (Source: CHIEF ENGINEER TSG NTDCL LAHORE, JUNE 2013, TSG-BRCH-001 / R0, http://www.ntdc.com.pk/publications.php)

[32] Tarbella's training center conducts theoretical training necessary for the maintenance of the power transmission system and practical training of exercise forms. (Source: CHIEF ENGINEER TSG NTDCL LAHORE, JUNE 2013, TSG-BRCH-001 / R0, http://www.ntdc.com.pk/publications.php)

[33] Tripping caused by overvoltage, failure of control relay, including breaker replacement. (Source: Executive Engineer Khuzdar)

[34] Shunt reactors, including transformer maintenance and testing. (Source: Executive Engineer Khuzdar)

[35] The resident engineer is under the control of a chief engineer. Resident engineers are responsible for O & M only for the distribution system of substations in their area. The chief engineer is responsible for all the transmission and distribution systems in the area to which it belongs.

NTDC[36] is a state-owned enterprise. Income from the operation of the transmission network is wheeling charge, which is imposed on fixed costs and variable costs.

Upon appraisal, the delinquency in payment of the distribution company (DISCO) affected the low level of the NTDC's sales and operating profits. According to the policy of the government, NTDC should be on the safe side financially, and the wheeling charge are set higher than the revenue standard that the distribution company can obtain so that NTDC can reliably supply electricity to DISCO. Therefore, it is considered that the non-payment issue at DISCO will limitedly affect NTDC's financial situation.

Due to the separation of CPPA[37] from NTDC in 2015, current assets were separated from NTDC. The net profit margin after tax is extremely high at around 30% (Table 8). This ratio is high for a power transmission project and can be said to be stable in terms of management[38]. Regarding financial sustainability, the capital adequacy ratio increased from 12% to 34% in 2014-2016, and the current ratio also increased from 100% to 161%.

Table 8 NTDC Financial Analysis

(Million Rupees)	Use of System wheeling charges	Profit before tax for the year	Profit for the year from continuing operation(Ater Tax)	Total Assets	Total equity	ROA(%)	ROE(%)	Net income to sales ratio(%)	Capital-to-asset ratio	Curent Ratio
2014	19,836	7,068	7,011	684,665	83,568	1%	8%	35%	12%	100%
2015	22,235	10,213	10,072	290,275	94,511	4%	11%	45%	33%	137%
2016	27,545	13,574	9,227	281,138	96,628	5%	10%	33%	34%	161%

Source：NTDC Financial Statement

3.4.3.3 NTDC income from the wheeling charge and operation and maintenance expenses

CPPA collects electricity charges from large customers and DISCO and pays electric power producers. After CPPA separated from NTDC in 2015, NTDC's income is revenue from wheeling charges under the electricity delivery contract with WAPDA (hydropower), IPP and KESC (Karachi electricity supply company).

NTDC must conduct transmission and distribution under the regulation[39] of transmission and distribution business under the approval of NEPRA[40]. It also includes restrictions on the wheeling

[36] NTDC was incorporated in November 1998 and started providing power in Pakistan on December 24, 1998. To allow NTDC to engage in the power transmission business exclusively for 30 years, according to Section 17 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997, Transmission License No. TL 01/2002 was approved by the Electricity Regulatory Authority (NEPRA) on 31 December 2002. According to "Market Operator (Climb Record, Standards and Procedures) Rule 2015" NTDC functions as a system operator. (Source: Provided by JICA)

[37] The Central Power Purchasing Agency (CPPA), established in 1984 under the Corporate Law, is a company fully owned by the Pakistan government and has taken over the business of NTDC in June 2015. CPPA procures electricity from GENCO (thermal power generation company), WAPDA (hydroelectric power generation) and IPP (independent power generation company) on behalf of DISCO.

[38] For reference, the UK national grid has a post-tax profit margin of 10% to 30% in 2007 to 2010, and a Netherlands Tennet has margin of 6% to 14% at the same time.

[39] Source：Annual Report 2011-2012

[40] NEPRA (Electricity Business Regulatory Authority) approves electricity price regulation and investment plan and was established to introduce transparent and wise economic regulations based on sound commercial principles in the power sector of Pakistan. The Pakistan government announced the enactment of the Regulation Act on Generation,

charge. Pakistan's wheeling charges is determined by NEPRAas a fixed cost (Rs / kW per month). After that, NTDC is notified after being submitted to the government.

O & M expenses/revenue income of 2016 (July 2015 - June 2016) occupies only 0.03% of revenue from the wheeling charge (11 million rupees ÷ 27, 545 million rupees). There should be no major problem in securing O & M resources. (Tables 9 and 10).

Table 9 NTDC Overall Operation and Maintenance Expenses

(Unit: Pakistan Rupee)

Sr#	Description	Amount in Rs.
FOR FINANCIAL YEAR 2014-15		
1	Pay & Allowances.	2,836,260
2	Honoraria	71,460
3	Overtime Claim	152,280
4	R&M of Grid Station & T/Line	25,000
5	TA／DA	263,978
		3,348,978
FOR FINANCIAL YEAR 2015-16		
1	Pay & Allowances.	9,709,118
2	Honoraria	1,007,680
3	Overtime Claim	215,163
4	R&M of Grid Station & T/Line	55,500
5	TA／DA	318,970
		11,306,431
FOR FINANCIAL YEAR 2016-17		
1	Pay & Allowances.	17,766,450
2	Honoraria	1,517,150
3	Overtime Claim	433,132
4	R&M of Grid Station & T/Line	193,776
5	TA／DA	571,280
		20,481,788

Source: NTDC

Note 1: The fiscal year of the Government of Pakistan starts on July 1 and ends on June 30 of the following year. 2016 (July 2015 - June 2016), 2015 (July 2014 - June 2015), 2014 (July 2013 - June 2014)

Note 2: TA / DA is TA = Traveling Allowance, DA = Daily Allowance

Transmission and Distribution (1997) which was enforced on December 13, 1997 in the Official Gazette of 16th December 1997. The responsibilities of NEPRA are as follows: 1. Approve power generation, transmission and distribution, 2) Establish criteria for ensuring high quality operations and safety, conduct implementation, 3) Approve power utility investment plan for utility companies, 4) Set fees for power generation, power transmission and distribution. (Source: http://www.nepra.org.pk/nepra.htm (September 16, 2013))

Table 10 Trends in NTDC's wheeling charge income

(Unit: Million Pakistan Rupees)

	Wheeling Charge	Profits from Continuing Operation
2014	19,836	7,011
2015	22,236	10,073
2016	27,545	9,226

Source: NTDC Financial Statement 2014, 2015, 2016

*NTDC handed over the market operation business to the newly established CPPA through a company split. NTDC is continuing the construction and management of traditional transmission lines.

3.4.4 Status of Operation and Maintenance

Inspection of the transmission lines are conducted every five to six months by the supervisor of the transmission line of the second department of the ultra-high voltage division (EHV-Ⅱ). Additionally, inspection through surveillance system, monitoring through visual inspection and patrol by walking is carried out. GSO / AM is conducting O & M of the power transmission system. Large-scale maintenance of the transmission line is sometimes carried out by the second department ultra-high voltage. The maintenance is done as a way to prevent any damage, such as defects, in the system or to prevent damage caused by large natural disasters such as storms in advance.

In the region, the area is wide and the population density is sparse, so security problems may be considered. However, monitoring of such places is handled without problems.

Spare parts of transmission lines are kept in Swan, Karachi and Hyderabad storage areas under the management of EHV-Ⅱ. At Khuzdar and Dadu substations, NTDC stores spare parts concerning 220 kV substation equipment.

Maintenance store of Khuzdar substation (Provided by NTDC)

Dadu substation on site 198kV surge arrester(Provided by NTDC)

At the time of ex-post evaluation, there was no breakdown of the transmission line, and large-scale repair was not conducted. Regarding the confirmation of equipment status, both the transmission line and the substation have problems in terms of feasibility because there are security and geographical problems in the Khuzdar substation and around the Khuzdar substation. There is support from TSG, which is the internal technology group of NTDC, and there is no problem with the technical level at the present time. As O & M costs are appropriately allocated, there is no particular problem in regular inspections, management of spare parts, etc. in the future. However, due to lack of staff and security concerns, there is concern about the future of O & M and the feasibility of inspection.

From the above, some minor problems have been observed in terms of the institutional aspect. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aims to respond to the growing electricity demand in Balochistan Province by conducting a new construction of a 220 kV transmission line (total length of about 300 km) from Dadu, Sindh Province to Khuzdar, Balochistan Province and 220/132 kV substation, thereby contributing to the revitalization of the regional economy of the province and improvement of the livelihood. The purpose of the project is consistent with Pakistan's development policy and development needs at the time of appraisal and ex-post evaluation, as well as Japan's aid policy at the time of appraisal, and its relevance is therefore high. The project period was significantly longer than planned due to a number of reasons such as the impact of sanctions against Iran (suspension of Iran-related transactions by banks), delay in opening letters of credit, delay in transportation of materials and equipment. Due to these delays, the project cost was significantly higher and, consequently, efficiency of the project is low. Since the operational status of the facilities provided by the project is steady, operation and effect indicators such as reduction of load shedding risk and improvements of voltage drop rate at the demand point are largely achieved, the effectiveness is high. It is estimated that this project has a high impact in contributing directly and indirectly to the industrial revitalization of Balochistan province, expansion of employment, and improvement of the livelihood of the local residents. Operation and maintenance status and technical aspects of the current facility equipment are generally good. However, due to security problems, there are some difficulties in mobilizing the staff for the maintenance of transmission lines and the substation located in Khuzdar, causing some issues on the feasibility of the inspection. The sustainability of the project effect is therefore rated as fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executiong Agency

Due to the security situation in Balochistan, there is concern that talented people are difficult to gather in remote areas such as Khuzdar and in areas with poor security. NTDC needs to focus on such areas in terms of sustainability in the future. For example, when arranging staff in the same area, measures such as further consideration of salaries are required. Profits are secured with regard to financial aspects, and training is also being conducted, so NTDC seems to have sufficient ability to take measures.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

<u>It is necessary to prepare enough for foreseeable delay risks.</u>

This project was delayed drastically, and as a result, the cost also increased from the original plan. The political issues such as sanctions against Iran and the flood condition are pointed out. Besides this, there are delays in opening letters of credit, approval of drawings, transportation of materials and equipment, and the payment procedure and problems of right of way in the construction area, which could be avoided by the efforts of the implementing organization. Prior to the project, JICA and implementing agencies should consider risk of delays and their countermeasures carefully so as to avoid such situations. It will also be necessary to prepare a projectplan that anticipates a preliminary period. Furthermore, it is desirable for the executing agency to summarize details of delay factors in progress reports and the like.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1.Project Outputs		
1)220 kV Dadu - Khuzdar transmission line	Extension of high voltage 220 kV double circuit single conductor transmission lines from Dadu to Khuzdar with a total length of 300 km. 833 Steel Towers (Double circuit), Conductors (Rail,1800 km, and OPGW 300 km.	220 kV Double Circuit Transmission Lines with a length of 275 km. Steel Towers 761, Conductor 1650 km and OPGW 275 km.
2)Khuzdar substation	2 Auto Transformers (160 MVA, 220kV), Bus Isolators (14 sets for 220 kV and 6 sets for 132 kV), Line Isolators (2 sets for 220kV), Circuit Breakers (6 sets for 220 kV and 3 sets for 132 kV) and 2 Shunt Reactors (18 Mvar, 220kV).	2 Auto Transformers (160 MVA, 220kV), Bus Isolators (16 sets for 220 kV and 9 sets for 132 kV), Line Isolators (2 sets for 220kV), Circuit Breakers (8 sets for 220 kV and 3 sets for 132 kV) and 2 Shunt Reactors (18 Mvar, 220kV)
3)Dadu substation	Expansion of 220kV Grid station at Dadu. Bus Isolators（6 sets）, Line Isolators（2 sets）, Circuit Breakers（3 sets）	220kV Switch yard 500/220/132kV extension Dadu GS（2 Bays）
4)Consulting Services	To assist NTDC in engineering services and detailed project design, preparation of tender documents, valuation of tenders, award of contract, supervision of construction work, verification of Bills of Quantities and/Contractor's Bills, and Testing and Commissioning of the Project.	Detailed project design, preparation of tender documents, evaluation of tenders, Award of contract, supervision of construction work, verification of Bills of Quantities and Contractor's Bills, and Testing and Commissioning of the Project.
2.Project Period	November 2006 - March 2011 (53 months)	November 2006 - December 2015 (110 months)
3. Project Cost Amount paid in foreign currency Amount paid in local currency Total ODA loan portion Exchange rate	 3,702 million yen 2,578 million yen 6,280 million yen 3,702 million yen 1 dollar = 112 yen = 60 Pakistan Rupees 1 Pakistan Rupee 1.87 yen (as of May 2006)	 4,583 million yen 3,576 million yen 8,159 million yen 3,147 million yen 1 dollar = 86.2 Pakistan Rupees 1 yen = 0.874 Pakistan Rupees 1 euro = 111.56 Pakistan rupees (Average between 2006 and 2016)
4.Final Disbursement	June 2015	

Islamic Republic of Pakistan

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Rural Roads Construction Project (II) (Sindh)"

External Evaluator: Hiroaki Nagayama, IC Net Limited

0. Summary

This project aims to improve traffic conditions in rural areas by improving pavement roads in remote locations of Sindh, thereby contributing to poverty alleviation and regional disparity correction through the improvement of access to neighboring urban regions and enhancement of rural living standards. From the time of appraisal to now, this project has been consistent with the development policy of Pakistan and the development needs of the target area. In order to cope with the flood damage that occurred during the project implementation period, the section to be paved was changed dramatically. However, this is an appropriate change in accordance with the needs, and its relevance is high. Efficiency is moderate, as the project cost fell short of the plan while the expected project period was exceeded. Traffic volume on rural roads paved by the project roughly increased from before the project, almost reaching the target in about half of the sections. However, strict verification was not possible due to differences in the method of measuring the target value. As a result of road improvement, access to various public facilities and hospitals improved, and certain economic effects such as increased shipment quantities of agricultural products were observed. From the above information, the effectiveness/impact is moderate. Regarding sustainability, maintenance and management systems and technical aspects are not problematic, but uncertainty arises whether or not it is possible to secure a stable maintenance budget. Additionally, some road conditions are deteriorating. Therefore, the sustainability is moderate.

In considering the above observations, the evaluation of this project is assessed as having some problems.

1. Project Description

Project location

A paved road (Dadu District 2018)

1.1 Background

The total extension of the road network in Pakistan was about 260,000 km in 2006 and the road paving rate was about 60% throughout the country. These roads account for approximately 89% of passengers and 96% of cargo in land transportation, and road transport occupied an important position as a major means of transportation. The number of registered automobiles has also increased at an annual average of 4.3%, and the importance of road transport is expected to increase further in the future.

Meanwhile, about 40% of the national highways at the time were in bad condition due to damage from such things as overloading trucks, and there was a shortage of maintenance and management fund. In response to this situation, the Medium Term Development Framework (2005-2010) (hereinafter referred to as "MTDF (2005-2010) ")[1] strengthened the transportation capacity of existing road networks through rehabilitation, etc. rural development of new economically feasible roads including rural roads, improvement of road maintenance management.. Development of state and local roads among road networks is positioned among the rural development programs of each provincial government. The Sindh Province is located in the southeastern part of Pakistan. In their provincial development plan (Sindh vision 2015), shortening times for the transportation of agricultural products and raising incomes of farmers are listed as priorities, and rural road improvement is necessitated.

In 1993, the Japanese Government implemented an ODA loan called the "Rural Roads Construction Project" that covered all four provinces of Pakistan (a total extension of 936 km and a completion of 941 km) to contribute towards road improvement. This project has been effective and the need for ongoing support projects has increased.

1.2 Project Outline

The objective of this project is to increase traffic volume and to shorten traffic time in rural areas by improving pavement roads in rural area of Sindh Province, thereby contributing to improvement of living standards of rural area and the improvement of access to neighboring urban regions and activation of rural economies.

Loan Approved Amount/ Disbursed Amount	9,126 million yen / 7,752 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	May 2008 / May 2008
Terms and Conditions	Interest Rate: 1.2% (the consultant portion is 0.01%), Repayment: 30 years (Grace period 10 years),

[1] This is featured in the National Development Plan called the Mid-Term Development Framework (MTDF) from 2005 to 2010.

	Conditions for Procurement: General untied
Borrower / Executing Agencies	The President of the Islamic Republic of Pakistan / Sindh Province Public Works and Services Department
Project Completion	October 2015
Main Contractors (Over 1 billion yen)	none
Main Consultants (Over 100 million yen)	Katahira Engineers International Co., Ltd. (Japan)
Related Studies (Feasibility Studies, etc.)	none
Related Projects	【ODA loan】 Pakistan Rural Road Construction Project (1993) East-West Road Improvement Project (National Route 70) (I) (2008) 【Grant Aid】 National Route 25 (Calaro-Wad) Renovation plan (2006) 【Technical cooperation】 The Project for the Enhancement of Training Capabilities of Construction Machinery Training Institute (2006)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hiroaki Nagayama [2] IC Net Limited,

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of Study: September 2017-March 2019

Duration of the Field survey: October 21, 2017 - February 22, 2018, April 27, 2018 - June 4, 2018

2.3 Constraints during the Evaluation Study

For security reasons in Pakistan, field surveys including project sites visits were conducted by field survey assistants under the supervision of external evaluator, and external evaluator carried

[2] Support to IC Net Limited, Professor of Kyoto University

out desk evaluations. Moreover, the project covers large rural areas with 500km length of roads in Sind province. Due to the security situation, measuring the effects of all sections through this survey and conducting the survey with statistically representative characteristics was not possible. An evaluation was carried out based on the results of the sample survey in some sections pertaining to the measurement of effects such as section traffic volume.

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

3.1 Relevance (Rating:③[4])

3.1.1 Consistency with the Development Plan of Pakistan

At the time of appraisal (2008), rural development through the national level long-term plan's "Vision 2030" (2005-2030) was regarded as an important matter, and infrastructure development including rural roads was one of the countermeasures. MTDF (2005- 2010) mentioned a road sector development strategy in 1.1 for 1.Strengthening transportation capacity of existing road networks centered on rehabilitation and widening, 2 Selection for economically feasible new road construction including rural roads 3.Improvement of the road network to promote trade with Afghanistan, central Asia and India, 4. Promotion of private entry into the road sector, 5.Improvement of road maintenance and promotion of traffic safety measures, 6. Strengthening police control over overloading, and 7. Improvement of implementation for the capacity of the road sector executing agency.

Under this circumstance, Sindh Province, the target area of this project, stated in its provincial development plan that it would "reduce the transportation time of agricultural products to the market, thereby increasing farmers' income" under Provincial Development Planning (Sindh vision 2015). Through this, rural areas of Sindh Province and cities are also intended to strengthen the connection with each other.

The national development plan "Vision 2025[5]" (formulated in 2014) at the time of the ex-post evaluation is aiming at establishing an efficient and integrated transportation system promoting competitive economic development and improving regional connectivity. The main objectives are: to reduce transportation costs and increase mobility safety; ensure efficient connectivity between rural and market/urban centers, interstate high speed connections and the integrated road/rail network between economic bases (airports, ports and dry ports); and to establish a high-performance transportation road connecting major trading partners. Within the plan, the

[3] A：Highly satisfactory, B：Satisfactory, C：Partially satisfactory, D：Unsatisfactory
[4] ③: High, ②: Fair, ①: Low
[5] This was prepared by the Planning Commission Ministry of Planning, Development & Reform and approved by the National Economic Council in 2014.

transport sector will occupy 10% of GDP and 6% of employment, and the road density is targeted at 64 km/100 sq. km^2, doubling that of the previous 32 km/100 sq. km^2.

The Works and Services Department's (hereinafter referred to as the "WSD") "WSD Vision 2025" of the Sindh Province Public Works Bureau set up countermeasures against damage and deterioration to infrastructure caused by heavy rainfall and flooding, listing them as a new development subject. The countermeasures were prepared for the roads damaged by the flood that occurred in 2010. The countermeasures have had an influence on the selection of the paved roads as will be described later. Based on the above, it is highly consistent with the development policy of the country.

3.1.2 Consistency with the Development Needs of Pakistan

In the above-mentioned MTDF (2005-2010), we acknowledge that the current status of rural roads and the importance of maintenance are causing the poor quality of roads, congestion and economic loss due to undeveloped roads. It was positioned as a high-demand area along with the improvement of the living environment (food security, health sanitation, educational environment, etc.). According to a survey conducted by WSD which is the counterpart agency, it was pointed out that more than half of the existing roads in Sindh Province required improvement[6].

In addition to contributing to economic growth and poverty reduction in rural areas, rural road development makes it possible to efficiently transport agricultural products, and convenient access to social facilities such as schools and medical institutions is also improved.

Efficient transportation of agricultural products and improvement in access to social infrastructure facilities has contributed to the alleviation of the regional disparity by providing better living conditions of rural villages. Since the project has also contributed to the improvement of economic and social indicators, the project is highly recognized as an important project.

As described above, the improvement of rural roads is important from the viewpoint of economic and social development both during the appraisal and ex-post evaluation, consistency with the needs of the country is high, and the necessity of this project is recognized.

3.1.3 Consistency with Japan's ODA Policy

Pakistan's Country Assistance Policy by the Japanese Government in 2012 had three priority areas with a major goal of building a stable and sustainable society through economic growth. One of them, "Improvement of the economic base", will support assistance for productivity

[6] In the International Roughness Index (IRI) that quantitatively evaluates road conditions, many roads were regarded as bad.

improvement and poverty reduction in the agricultural sector, which accounts for a large proportion of the workforce. The relevance of this project will therefore be recognized.

The 'Overseas Economic Cooperation Operation Implementation Policy' (April 2005) by JICA sets the foundation for sustainable growth as one of its priority areas. As a country-specific policy for Pakistan, Japanese government focuses on areas that contribute towards a balanced regional society and economic development. In addition, it is necessary for strengthening the road sector, which is responsible for nearly 90% of domestic transport to support private-led economic development that is also in the "Country-specific business implementation policy" (February 2007). Regarding rural roads, importance is also placed from the viewpoints of, among other things, poverty reduction, securing access to markets, assisting in earthquake reconstruction and rectifying disparities. Based on the above, it is highly consistent with Japan's aid policy.

3.1.4 Appropriateness of the Project Plan and Approach

In this project, the total length and the target section were greatly changed due to several reasons after the start of the project. Below is a history of the time series.

1) Extension of the total length of the Road (2008): At the start of the project, a total extension of approximately 450 km was approved, and the subject road was selected by the Works and Services Department, based on selection criteria of the country after signing the ODA loan agreement. Then, the total extension was changed to 500 km in 2008. This is because it was assumed that the unit cost can be lowered by lengthening the road to be maintained. Construction started in 2010 in the initial section selected above, and 232 km out of 500 km has been developed as the "Selection Section" as of October 2012.
2) The plan changes due to flooding (2012): Recordable heavy rains occurred in various parts of Pakistan from the end of July 2010, and flooding caused severe damage to rural roads in Sindh Province. In September 2010, both the Japanese and Pakistan governments began considering prioritizing roads in flood-damaged areas. In December 2012, 268 km of not constructed road (out of the initial plan of 500 km) was selected as an "alternative section" to adopt criteria for flood damage countermeasures.
3) Extension of the total length of the road (Second extension, January 2014): Since the project cost of the civil engineering work in the above alternative section fell within the plan and surplus funds are made, further maintenance of "the additional 28.5 km section" was decided. As a result, the maintenance section general extension by this project increased from the initial plan of 450 km to 528.5 km.

Regarding the above circumstances, it can be said that it was an appropriate change that resulted

in an increase in output, as the total extension of the road increased by the planned ratio due to the efficiency of the project cost, etc. The flood damage that occurred during the implementation period was enormous, and the priority for restoration was significantly high. For this reason, it can be said that the drastic change of the alternative section from the initial maintenance section was appropriate in accordance with the project purpose.

However, about 160 km out of 232 km of the selected road was also damaged by the flood after selection. The surrounding environment of the road is largely changed from the time when the planned value used for the effectiveness of this evaluation was set at 2010 when the economic and social survey was conducted. Therefore, it may be difficult to achieve the level of effect expected by this survey. The effect of this project, which will be described later, will be analyzed taking this point into consideration.

This project has been highly relevant to the country's development plan and needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating:②)

3.2.1 Project Outputs

The output of this project is as follows. For the planned 452 km, the actual result was maintained at 528.2 km. The initial selected section was 226 km, the alternative section was 274 km and the additional section was 28.5 km.

Table 1 List of Outputs

Item	Plan	Actual in parentheses, ratio to the planning value
(1) Civil engineering work	56 sections Total Length 452km	73 sections Total Length 528.2km (117%)
1)Dadu	5 sections 31.4km	6 section 41.70km(133%)
2)Hyderabad	4 sections 22.8km	2 sections 16.42km(72%)
3)Thatta	5 sections 30.6km	4 sections 27.589km(90%)
4)Khairpur	16 sections 157.8km	25 sections 183.9km(117%)
5)Sukkur	2 sections 10km	2 sections 10.57km(106%)
6)Jacobabad	12 sections 89km	14 sections 103.155km(116%)
7)Shikarpur	9 sections 79.9km	10 sections 71.636km(90%)
8)Larkana	3 sections 30.6km	10 sections 73.21km(239%)
Road specification	Pavement width 3.7m Shoulder width 2m	As planned

(2) Consulting Services	Detailed design, bidding assistance, construction management work, capacity building of executing agencies, etc.	There is no change in work content. As a result of the civil engineering change mentioned above, the business volume increased by 20%.

Source： PCR Oct 2015, P5

As mentioned in 3.1.4, approximately half of the roads were changed from the maintenance target section at the time of the plan due to flood occurrences in this project. Allowing only one interpretation for the purpose of road maintenance also differs between the road selected as originally planned and the road sections developed as a restoration project from countermeasures against floods, both of which were selected based on an appropriate review process. Therefore, it can be evaluated that appropriate sections and distances have been established according to the project purpose. There are no major changes in other basic road specifications.

3.2.2 Project Input

3.2.2.1 Project Cost

The actual project cost was 8.384 billion yen (of which the yen loan portion was 7.752 billion yen) against the initial plan of 9.869 billion yen (with a yen loan portion of 9.126 billion yen), amounting to 85% of what was planned. Due to the depreciation of the rupees[7] mainly during the period, yen-denominated project costs were drastically reduced. As mentioned above, more than half of the maintenance sections were selected from the alternative roads sections, and due to the nature of restoration from flood damage, the maintenance cost was higher than usual. However, the construction method leading to the bidding effect and cost reduction (Triple Surface Treatment) was introduced, and the project cost was lower than planned and implemented without exceeding the planned project costs.

3.2.2.2 Project Period

The project length actually exceeded the plan of running from May 2008 to June 2013 (62 months), but in reality from May 2008 to June 2015 (85 months / 137% of the plan). The main reason for the postponement was because the project plan needed to be drastically reviewed due to the 2010 abovementioned flooding. This required approximately one and a half years for the selection, planning and approval of the alternative 268 km section. About project period, we could not conduct evaluation in detail due to following reasons; 1) Lack of information on project design and details, which was extended due to response to the flooding, 2)The possibility that increase in the total length of the road as main output by around 17% from the plan may have influenced

[7] The assumed exchange rate at the time of planning was 1.93 yen per rupee, and the average rate during the project implementation period (2008 - 2015) was 1.08 yen, which remained significantly strong.

the extended days of the road construction.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

(1) Financial Internal Rate of Return

Due to the fact that this project pertains to a rural road, it is difficult to directly measure its benefits as a concrete amount, and FIRR calculation was therefore not implemented from the beginning.

(2) Economic Internal Rate of Return

In the original plan, IRR was supposed to be calculated again in the socio-economic survey carried out by the consultant after the start of the project[8]. The economic internal rate of return (EIRR) in this survey was calculated as project and maintenance costs within the project lifespan of 20 years with the benefits being the reduction of travel expenses.

In this ex-post evaluation, we attempted the same calculations and comparative analysis as the results of the socio-economic survey that were adopted as the planned value. These results were based on the actual measurement data of a traffic survey in 14 sample sections selected by the method described in the clause of effectiveness. The following is the calculation result, but this comparison is also not described as a comparison under the same conditions strictly due to constraints[9] of the investigation plan, etc. It is thus used as a reference.

Table 2 Economic Internal Rate of Return (EIRR)

Province	Section	Preliminary Survey	Recalculation	Ratio to plan	Comparison with social discount rate (12%) [10]
Dadu	D-2	41.0%	19.0%	low	high
	DA-3	30.0%	37.0%	high	high
Larkana	LA-8	13.0%	21.0%	high	high
	LA-4 & LA-7	31.0%	11.0%	low	low
Shikarpur	SH-52	50.0%	35.0%	low	high

[8] In the initial plan, meeting the EIRR 12% or more is regarded as the criterion for section selection, and the predicted value of 13.9% was set as a whole. However, with regard to this calculation, details of the basis and calculation method cannot be confirmed at the screening mission conducted at the time of planning, and eventually it was decided to reset the planned value based on the calculation result after the start of the project.

[9] As we could not confirm the presupposition of the original plan, the traffic volume survey in the economic and social survey was measured for 12 hours from 6 o'clock a.m. to 6 o'clock p.m., and for 12 hours during the nighttime. The annual average daily traffic volume was calculated by multiplying the measured data by the coefficient of 0.24. The survey time and the survey spot of each section are unknown. In this ex-post evaluation, we measured for 6 to 9 hours in different time zones for each section due to security problems, etc., and regarded this as daytime traffic volume. As described above, there are differences in several points such as implementation time, measurement time and place, prediction coefficient of traffic demand, etc. in the economic and social survey and this ex-post evaluation study. In general, the calculation was carried out based on a more conservative estimate in the calculation of this ex-post evaluation. Therefore, the internal rate of return may be lower than the planned value.

[10] As the EIRR's plan comparison is significantly difficult, we also added a comparison based on the social discount rate of Pakistan as a criterion. Here, we adopted 12% used by the Asian Development Bank, etc. as a standard.

	SHA-2	24.0%	19.0%	low	high
Hyderabad	HA-1	16.0%	10.0%	low	low
	H-5	37.0%	50.0%	high	high
Sukkur	SK-4	29.0%	1.0%	low	low
	SK-5	28.0%	3.0%	low	low
Thatta	TA-2	15.0%	2.0%	low	low
	TT-2	20.0%	3.0%	low	low
Khaipur	KA1-1 & KA1-2	42.0%	22.0%	low	high
	K-31	31.0%	3.0%	low	low
	Average	29.1%	16.9%	low	high

From the above assessment, we could confirm the following.

1) Section 11 had a low internal rate of return from the plan and Section 3 had a high internal rate.
2) In the initial plan, the internal rate of return of 12% was adopted as the selection criteria. Since this number was adopted as the selection criteria in other international organizations as well, we tried to compare the result this time with this standard, the section exceeding 12% is half of seven sections, the average of the whole is also 12% exceeded. Although it is not an exact comparison under the same condition, it can be inferred that a section with a certain validity is selected based on the result of the internal rate of return for the selected road.
3) On the other hand, the internal rate of return of cities such as Sukkur, Tatta, etc. are particularly low. The traffic volume in these sections is sluggish (20~60%) to be described in the clause of effectiveness, may have influenced on lower EIRR figures.

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

3.3 Effectiveness and Impacts[11] （Rating:②）

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects

At the time of this project plan, there is supposed to be an apparent degree of achievement regarding "whether the volume of traffic in the project target area has increased" or "the required time has shortened" as the main effect indicator, and the increase in traffic volume based on this project's estimated values were calculated[12]. However, this evaluation was affected by the external

[11] Sub-rating for Effectiveness is to put with consideration of Impacts.

[12] The indicators set at the time of appraisal are "annual average daily traffic volume" and "required time" in 56 business sections. The "annual average daily traffic volume" was set as the reference value of 516 to 3,468 (machines / day) in 2003 and the target value of 927 to 6,282 (machines / day) two years after completion of the project. However, because the data for each section was not set to this reference, it was impossible to evaluate by comparison between the plan and actual result.

factors such as flood during the project implementation period. Therefore, in this ex-post evaluation, the analysis was made based not by comparison with the plan at the time of appraisal, but on the resetting the following planned value;

(1) Resetting the target value of the effectiveness index

As stated in efficiency, the flood that occurred in July of 2010 under this project also caused major damage to Sindh Province. As a result, the planned value of the project effect, especially pertaining to the annual average daily traffic volume of each road, the following needs were identified to be revised from the time of appraisal;

1) As mentioned in the efficiency section, JICA was considering measures at that time to support flood- damaged areas in September 2010. Given that part of this project was changed among the unselected section (about 265 km) of this project, about 60% of 165 km was selected as a measure to support areas with significant flood damage. As a result, the sections where the target and the planned value were not set increased greatly at the time of appraisal.
2) In February 2011 and October 2013, an economic and social survey was carried out as a consulting service for this project[13] that include the measurement of the road traffic volume of the target sections. The former was a process determined at the time of planning, and the planned value of this project was to be decided by the results of this investigation in the preliminary evaluation table. Furthermore, in October 2013, an additional socioeconomic survey was carried out on the newly-affected flood areas in response to the change in the project plan of 2) above.
3) Traffic volume measured by both surveys can be thought of as the most correctly-reflected and recent data of each road situation. Therefore, in this evaluation: 1. the data of the survey conducted in 2010 is used as the reference value for roads selected before the flood occurrence, and 2. the actual traffic volume in 2013 is adopted as a reference value for the roads selected after the flood occurrence. Based on the same way of thinking, we adopted the increase prediction of the traffic volume established in every survey for each planned value after the maintenance of this project.

In order to adjust the resetting the target value of the effectiveness index of this project, we will analyze the target achievement level for the traffic volume increase of each road and make a judgment after comprehensively taking the development of other effects into consideration. For the traffic volume data, the analysis is based on a limited sample survey, and these data therefore

[13] This survey was conducted in the consulting and service contract, which is in charge of construction management of this project, and was confirmed from JICA's record at the time that it was used as a criterion for judging roads, etc. in flood-damaged areas. From this, it can be said that it is reasonable to adopt it as a formal planned value.

do not represent the entire project effect.

(2) Traffic volume at the time of ex-post evaluation (October 2017)

Since we did not measure accurate traffic volume on a daily basis for this project road in order to grasp the current traffic volume, traffic volume survey was conducted by this method in the following way.

1) The total number of roads on which actual measurements were taken was 14 sections[14], of which 7 sections were already selected before the flood occurred, and 7 sections were additionally added after the flood occurred, more than 20% of the whole 65 sections. Although it is not a sample with strict representation due to restrictions such as safety and access to the survey site, we have selected certain sections from the target 6 districts without exception after consideration.
2) Traffic survey conducted in this ex-post evaluation took the form of a fixed-point observation by the researcher's team that conducted surveys for 6 to 8 hours during the daytime at multiple points on the target road. As stated above, this survey does not make rigorous comparison because there are differences between the socioeconomic survey such as with measurement points, time and the method of calculating actual measurement values.

Based on the above observation, the plan and actual results of the annual average daily traffic volume[15] for the 14 sections' surveyed target areas are as follows.

Table 3 The plan and actual results of the annual average daily traffic volume for the 14 sections' surveyed

(Unit: number / day)

	District	Section	Reference value	Planned value	Actual (2017)	Ratio to plan	Achievement
Initial Section	Dadu	D-2	136	391	583	149%	high
		DA-3	304	651	1,005	154%	high
	Larkana	LA-8	39	90	967	1074%	high
		LA-4 /7	227	431	191	44%	low
	Shikarpur	SH-52	976	2,542	1,018	40%	low
		SHA-2	315	796	474	60%	moderate
	Hyderabad	HA-1	130	286	255	89%	high

[14] Selection of the section to be investigated was decided in consultation with the Works and Services Department, JICA Pakistan Office and a consultant company in charge of construction management of this project. There are differences between roads regarding the time when we conducted the measurement. This was because we needed to avoid early morning or after sunset in road sections which have safety problems during those hours.

[15] Totalization was carried out by vehicle type such as rikisyas, trucks and vehicles in totalizing traffic volume. However, since there are some differences between the vehicle type of the reference value and the planned value and the vehicle type at the actual aggregation, it is difficult to strictly compare the planned results for the total traffic volume in sections by type.

		H-5	138	405	1,422	351%	high
Alternative Section	Sukkur	SK-4	115	310	93	30%	low
		SK-5	116	348	104	30%	low
	Thatta	TA-2	100	218	128	59%	moderate
		TT-2	138	369	87	24%	low
	Khaipur	KA1-1/1-2	1,176	1,812	388	21%	low
		K-31	150	392	90	23%	low
		Average	4,060	9,041	6,804	75%	moderate

Note 1: For the reference value, the year of confirmed data of traffic volume are different between the roads where selection and construction was advanced before the flood occurred and the roads selected after the flood. Therefore, we adopted the figures for 2010 and 2013, respectively.

Note 2: Planned value, which was compared against actual, was set as the forecasted data for target per section considering the change of traffic volume year by year after constructing roads. Because the measured traffic volume data is for 2017, traffic volume forecast data predicted by the elapsed years up until 2017 after completion of each road was adopted.

Note 3: The degree of accomplishment has been arranged in three stages: over 80% of the plan is considered high, over 50% to less than 80% is medium and less than 50% is low.

Survey of traffic volume (January 2018)

Survey of traffic volume (January 2018)

As a whole, the project has reached 75% of the planned value, and 5 sections' traffic volume has reached 80% of the planned value. The medium degree of achievement is 2 sections, and the section with the low achievement degree is 7 sections. The majority is lower than the plan, especially in the alternative sections selected after the flood occurrence. Below we analyze the degree of accomplishment and its factors. For detailed traffic by the type of vehicles, please refer to reference 1.

1) High achievement sections (5 out of 14 sections)

1. In Dadu (D - 2, DA - 3), motorcycles in particular increased significantly and boosted the total value. D - 2 is a road connected to the major city, Jochi, where schools and hospitals are located, and it is thought that this kind of traffic volume increased due to improved access.

According to interviews with local residents, DA - 3 is a road leading to a temple considered as a sanctuary, and many people started to use the road because access became easier.

2. In Lalcana (LA - 8), there has been a drastic increase despite the security problems. It is a road connecting the city Hailepur and Mohenjoda and it has become possible to move to Mohenjohdaro in a short time with road the improvement.
3. Hyderabad (H-5) has had a large increase in motorcycles. It is apparent from the interview survey of local residents that the movement to the city of Hyderabad with the hospital has become easy.

2) Sections with low degree of accomplishment (7 out of 14 sections)

According to an interview with local resident of Thatta (TT - 2, TA - 2), Khaipur (KA 1 - 1 & KA 1 - 2), Shikapur (SH - 52, SHA - 2) Larcana'LA-4/L-7),and Sukkar (LA-4 / L-7), in particular, inhabitants tend to refrain from going out from night to dawn since public safety has deteriorated, such as the occurrence of bicycle-theft As a result, the traffic volume has declined also declining considerably.

3) Other changes by vehicle type

In assessing by type of vehicle, the increase in motorcycles is conspicuous, whereas industrial vehicles such as trucks are decreasing. Regular vehicles such as compact cars, pickups and wagons are on the rise due to improvement of roads, but there are few large vehicles such as four or five-wheeled trucks. This is thought to be due to the fact that there are increased opportunities for individual households to buy motorcycles for commuting to work rather than traveling by large vehicles. The purpose of this project is to improve pavement of rural roads, and it is thought that access to neighboring urban areas was improved and contributed to an increase in the traffic volume of motorcycles and rikisyas that are farmers' means of transportation. It is presumed that the maintenance section of each road is as short as 5 to 11 kilometers and is not connected to the main road, so it contributed to intra-regional traffic. The fact that security problems have not been solved affects the insufficient increase in traffic volume.

(3) Time required change

In this evaluation survey, the assessment was conducted by investigators every 14 sections. As a result, except for two sections, the time reduction effect was confirmed and the required time was shortened to 40% or less in 11 sections. As a whole, the expected effect is occurring and it can be said that the time reduction effect by road improvement is high.

Table 4 Duration of traffic time by the roads

District	Section	Before Maintenance (min)	Now (2017)	Shortening effect (min)	Time required ratio
Dadu	D-2	15	5	10	33%
	DA-3	15	10	5	67%
Larkana	LA-8	17	20	-3	118%
	LA-4 & LA-7	15	15	0	100%
Shikarpur	SH-52	20	7	13	35%
	SHA-2	11	4	7	36%
Hyderabad	HA-1	13	4	9	31%
	H-5	24	8	16	33%
Sukkur	SK-4	12	4	8	33%
	SK-5	11	4	7	36%
Thatta	TA-2	10	3	7	30%
	TT-2	22	7	15	32%
Khaipur	KA1-1 & KA1-2	15	5	10	33%
	K-31	16	5	11	31%
	Average	15.4	7.2	8.2	47%

As mentioned above, the average annual daily traffic volume has reached a moderate level or more in the target ratio, and the time required for section travel has been improved within almost all of the sample sections, and its constant improvement effect was seen in the target area. On the other hand, it is difficult to accurately compare the target value at the time of appraisal with the actual result, and this data cannot say the effectiveness of this project is high or low.[16]

3.3.2 Impacts

3.3.2.1 Intended Impacts

The impact expected from this project was the "improvement of living standard of rural areas", "improvement of access with neighboring urban areas" and "revitalization of regional economy". A qualitative survey was conducted with the aim of confirming the occurrence situation of these impacts. The main survey items were examined to gauge: whether mobility improved through project implementation such as convenience and comfort of buses, whether access to social services such as schools and hospitals improved (improvement of living standards in rural areas), if the time to reach to the city has shortened (improvement of access to neighboring urban areas), whether the distribution increased and contributed to the revitalization of the regional economy

[16] According to the JICA 'External Ex-post Evaluation Reference', in cases where it is impossible to compare the planned value with the actual value of the operation effect indicator, or when it is impossible to objectively judge because data/information cannot be obtained, the rating is not ③ or ①, but ② .

(regional economy revitalization). We interviewed local residents, chambers of commerce and business owners in a group interview format[17].

In Dadu (D - 2, DA - 3), where bicycles and motorbikes have increased significantly, local residents mentioned the improved access such as " I have access to other areas and hospitals easier" " make it easier for milk drums to transport to the city", "I got more chance to local assembly" and "I got to be able to go to the temple." On the other hand, there were opinions that it did not lead to regional development such as "there are no entertainment facilities after the road is formed" and "there is not an increase in local employment opportunities".

Dadu District (D2) Karam Village
Interview with residents

Dadu District (Da - 3) Saeed Mad Village
Interview with self-employed residents

In Lalkana (LA - 8), the road connecting the city Heilpur and Mohenjoda was renovated, and the distance between Hypur and Gos Prani Good was shortened by 20 kilometers. Since agriculture is the main source of income for many residents, there is an opinion that agricultural chemical companies in other areas can easily access villages to sell their products, and the convenience for residents has also increased. In Hyderabad (H - 5), there were many people who owned motorcycles and say that the time to travel to school in the center of Hyderabad was shortened. It is said that access to schools and hospitals in Rahimabad City has become easier with Shikarpur (SH - 52).

[17] A traffic volume survey of 127 people were surveyed in total in the 14 residential areas, including 40 farmers, 30 self-employed persons and 57 with other occupations. Between January 2nd and 11th of 2018, we set up residences and shops near the roadside roads and extracted samples that agree with the purpose and contents of the survey. Considering local cultures and customs, we conducted interviews only to men in this evaluation. Therefore, it was difficult to get female opinions.

Shell Khanjatai Village in Larkana District
Interview with residents

Baulam Village Shilarpur District
Interview with self-employed residents

Even in the districts where no significant increase in traffic volume was observed, the residents mentioned the contribution to regional development saying such things as "dairy farming and sericulture was activated " and " the number of rice flour mills and ice factories increased", and people commented on how access was improved by the road by saying things such as "it became possible to go to sell fish caught nearby ", "it became easy to go to hospital and school" and "time required for city was shortened".

Although we could not examine a clear relationship with how much this project has contributed to activation of the regional economy, it can be estimated that this project has made certain contributions due to the many cases in which improvement of distribution resulting from the enhancement of roads are more significant in areas with less improved roads, especially in rural areas. Furthermore, the actual responses of those who have benefited support this claim.

On the other hand, issues that are constraining regional development and traffic volume increase were also revealed with people stating "there are safety concerns especially at night and early morning time", "there is no entertainment facility" and "road maintenance is bad".

From these facts, it can be said that the implementation of this project improved access to neighboring urban areas and had a certain impact on rural life improvement and activation of regional economy.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

In 2010, JICA and the WSD were supposed to carry out environmental surveys based on the checklist and make public announcements. When there was a change in the environmental consideration matter, they agreed to revise them in a timely manner. However, I could not confirm the record in these ex-post evaluation studies. In April 2011 after the flood, an environmental impact assessment report on alternative roads was prepared by WSD. Here, it is assumed that the project target area does not fall near or within sensitive areas such as national parks, and

undesirable effects on the natural environment are minimal. Since it was not possible to obtain an environmental impact assessment report at the time of the ex-post evaluation, the impact on the natural environment was difficult to be evaluated.

(2) Resettlement and Land Acquisition

This project's purpose was to expand and improve existing roads, excluding some sections, and was to be built on unpaved roads and walking roads that do not affect existing houses, farmlands and property. At the time of appraisal, although it was necessary to acquire land, landowners were supposed to offer their land to the public utilities department free of charge[18]. In addition, if it is necessary to acquire additional land after the detailed design, it is said that the WSD and the owner will consult and, if necessary, proceed according to domestic procedures in the country. In addition, WSD submitted a transfer report to JICA in 2010 when land acquisition and relocation became necessary. WSD decided to carry out smoothly and appropriately in accordance with the Land Acquisition Act of 1894 under the assistance of related agencies such as local governments.

According to the executing agency, there are some landowners that are incentivized to offer the land free for expecting the land price increase in the area, the better distribution road of agricultural products, better access to schools and hospitals. Therefore they voluntarily transferred the land. Although such cases of voluntary transfers are seen, it was not possible to confirm whether such a consensus was made in the entire land acquisition, or whether an involuntary relocation of residents occurred, as we could not get opportunities of interviews to operational institutions and owners[19].

From the above, this project has achieved its objectives to some extent. Therefore, effectiveness and impacts of the project are fair.

3.4 Sustainability (Rating :②)

3.4.1 Institutional / Organizational Aspects of Operations and Maintenance

The executing agency of this project, the WSD, has not changed since its appraisal. The WSD is engaged in designing, constructing and maintaining Sind State provincial roads and local roads. At the time of appraisal, the total number of staffs was 5,294, of which 634 were engineers, and the operation, maintenance and management of this project was supposed to be carried out by the road department with 181 engineers. The organization chart of the station at the time of the ex-post evaluation is shown in Figure 1. The road department is in charge of the operations and maintenance of the local roads but adopts the form which the private contractors assume the actual maintenance and management. A group of qualified civil engineering experts work in a

[18] The policy of the Sindh Government decided that the authority to compensate local governments would not be given.
[19] JICA follows the Safeguard Policy of "Involuntary Resettlement" in the World Bank's Operation Manual 4.12. In the safeguard policy, the definition of "non-voluntary" is taken as "measures that can be done without consent or transfer of residents after providing the information".

system to select a target section over 5 years after construction and is responsible for its maintenance. Although detailed information could not be obtained, WSD realized that additional maintenance is not needed for the new roads until five years after construction. Therefore, even if repairs are ever required on the road, O&M will not be implemented for at least 5 years, as roads are not become scope of repairs till 5 years pass after construction. Although it is presumed that there is no major institutional problem in the structure of the whole organization, judging from the state of the road described later, the system where maintenance will not be carried out for the initial five years after construction is thought to have problems.

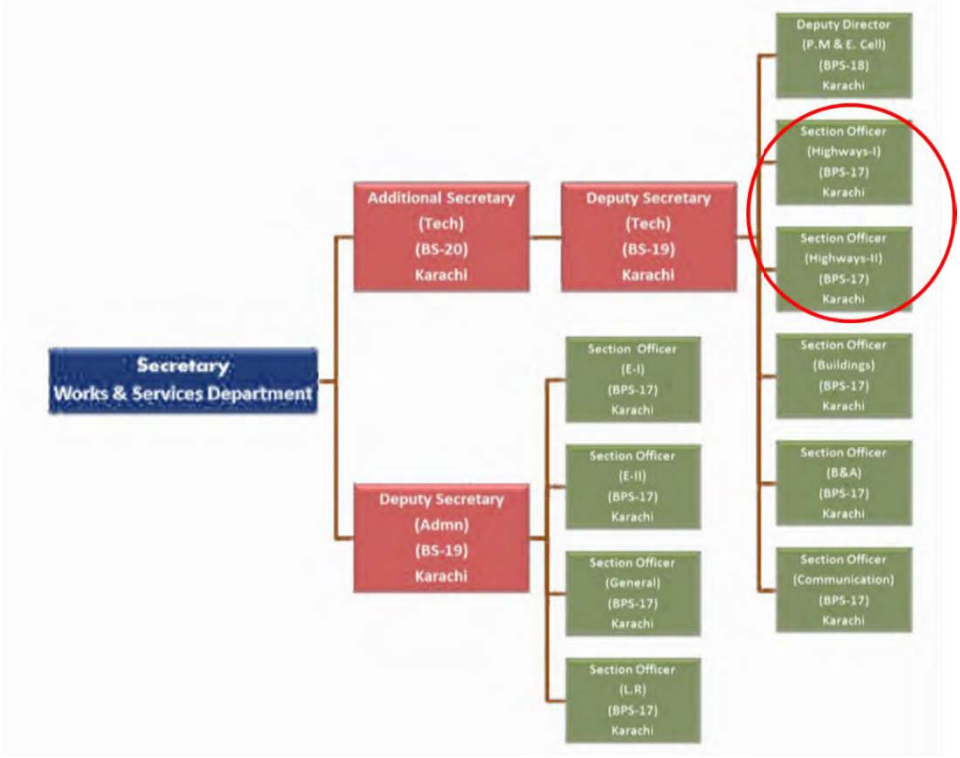

Figure 1 Organization chart of the WSD

Note 1: BS: Basic Scale and BPS: Basic Pay Scale of government employees represents salary level.
Note 2: The Co-Chief is responsible only for business related to technology.
Source: http: // wsdsindh.com/index.php/organogram/ (Access：December 10, 2018)

3.4.2 Technical Aspects of Operation and Maintenance

At the time of appraisal, the WSD had experience in handling the construction of the Sind province under the ODA loan project, "Rural Promotion Road Construction Project" conducted by the Federal Government Local Autonomous Development Department for all four Pakistan provinces. They also had the experience of financing projects for the Asian Development Bank. Therefore, it was judged that there are no particular concerns about the technical implementation capacity. At the time of ex-post evaluation, we could not obtain information on the technical level related to the operation and maintenance of the road section and the civil engineering expert group mentioned above. The WSD plans to allocate qualified engineers to the staff in charge of

operations and maintenance as shown in Table 5.

Also, no new technology has been adopted for roads subject to this project. The ordinary water tightening macadam method[20] and granular roadbed method[21] are currently being used, and triple surface treatment is commonly used as the final process of road construction in rural streets of Sindh province. We presume that there is no problem with the technology related to the basic operations and maintenance of this project.

Table 5 Position and required degree of maintenance and administration department

Staff position/title*	Expected academic degree
Chief Engineer	Bachelor of Engineering (Civil)
Superintending Engineer	Bachelor of Engineering (Civil)
Executive Engineer	Bachelor of Engineering (Civil)
Assistant Engineer	Bachelor of Engineering (Civil)
Sub-Engineer	Diploma of Associate Engineer (Civil)

Source: WSD

3.4.3 Financial Aspects of Operations and Maintenance

The WSD relies on the budget allocation from the Sindh Provincial Government for the majority of revenues, and there is other income from state jurisdiction toll roads. At the time of appraisal, there was no particular financial concern thus far since a sufficient budget was allocated without major problems of budgetary measures. According to the materials provided by the WSD at the time of the ex-post evaluation, there is a Maintenance & Repair Fund in the fund that the Road Department can use. As shown in Table 6, the funds tripled from the previous year in 2014/2015, and increased by 28% compared with the previous year in 2016/2017. In FY 2017/2018 as well, the fund secured approximately 4.8 billion rupees. On the other hand, expenditures have always exceeded the funds, and it is apparent that the budget for maintenance and repairs is not sufficient. An interview with the budget inspector of the WSD revealed that funds for maintaining and repairing all roads under WSD management were not sufficient.

Table 6 Maintenance and repair funds in the road section (Unit: million rupees)

Year	Allocated Budget	Actual disbursed
2012-13	776	678
2013-14	776	738

[20] One of the road construction methods which constructs by meshing the aggregate called macadam, a grainy roadbed. It is used for paving roads with little traffic.

[21] A method of spreading, leveling and granulating granular materials such as sand and gravel on the lower roadbed.

2014-15	2,395	1,513
2015-16	3,740	4,522
2016-17	4,804	5,827
2017-18	4,867	5,732

Source: WSD

The fund will not be allocated for five years after the construction of the road, and the project will be assessed for maintenance and repair expenses for the first time after five years; the budget will be based on the result. At the time of the ex-post evaluation, it has not yet reached five years after completion, and it is unclear how much repairs and maintenance expenses of this project will be, nor whether budgetary measures will only be taken to cover the cost. However, as described above, the maintenance and management expenses of the WSD continue to exceed the budget every year, and it is not expected that a stable maintenance and management budget can be secured in the future. Therefore, financial sustainability is evaluated as moderate.

3.4.4 Status of Operation and Maintenance

On the ex-post evaluation, we conducted a field survey of 16 roads and visually checked the road conditions. As a result, there were places where conditions were bad such as unevenness of the road surface in 13 sections, and as far as we visually checked, some repairs may be necessary. Therefore, we think it is necessary to conduct further investigation in more details. The deterioration of the roads is thought to have been influenced by weather conditions such as drying, geography[22] and the number of overloaded trucks. For example, in Tata and Hyderabad where the air is dry, the road conditions are relatively good. However, in Khaipur where there is significant rainfall, there is a road where irregularities are occurring even though the evaluation of the contractor is high. Also, as with Shikapur, there is heavy rainfall and high temperatures, and there are roads in bad condition where they are frequently used for closely located with the house. This is especially so in places like Dadu where traffic is high, and urgent repairs are necessary on roads where flooding easily occurs.

[22] Larkana and Dadu were influenced by flash floods several times a year from the neighboring Balochistan Province and the road flooded. Also, there are creeks in Sindh province that have drawn agricultural water from the Indus River. In cases where creeks are adjacent to the road, flood damage caused by rainfall frequently increased the amount of water.

Good condition road
Cicar Poole (SH-52)

Bad condition road
Dadu (DA - 3)

From the above observation, the operations/maintenance of this project has no problem pertaining to the system/technology. However, some minor problems have been observed in terms of the financial situation, repairs and maintenance situation. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aims to better traffic conditions in rural areas by improving pavement roads in remote locations of Sindh, thereby contributing to poverty alleviation and regional disparity correction through the improvement of access to neighboring urban regions and enhancement of rural living standards.

From the time of appraisal to now, this project is consistent with the development policy of Pakistan and the development needs of the target area. In order to cope with the flood damage that occurred during the project implementation period, the targeted section to be paved was changed dramatically. However, this was an appropriate change in accordance with the needs and its relevance is high. Efficiency is moderate, as the project cost was less than the planned amount, while the project period was exceeded. Traffic volume on rural roads paved by the project roughly increased compared to before the project, almost reaching the target in about half of the sections. However, due to differences in the method of measuring the target value, comprehensive verification was not possible. As a result of road improvement, access to various public facilities and hospitals improved, and certain economic effects such as increased shipment quantities of agricultural products were observed.

From the above considerations, the effectiveness/impact is moderate. Regarding sustainability, maintenance and management systems and technical aspects are not problematic. Nonetheless, there is uncertainty whether it is possible to secure a stable maintenance budget or not, and some

roads we inspected conditions are deteriorating in this evaluation. Thus, the sustainability is moderate.

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

4.2 Recommendations

4.2.1 Recommendation to the Executing Agency

The state of some of the roads has already deteriorated, and it is becoming a condition that requires repairs. However, the WSD is not able to grasp the details of the state of the road section. It was also confirmed that the budget for operations and maintenance was not started until 5 years after completion. It is thought that an efficient maintenance plan can be established to conduct repair work while road condition deterioration is minimal, and maintain regular upkeep of the maintenance plan according to regular inspection of road conditions and the state of deterioration. Thus, it is necessary to “reassess the entire management plan.

4.2.2 Recommendations to JICA

In this ex-post evaluation, since necessary preparation to receive external evaluator has not been made by the WSD, access to the information was limited, making proper data collection and interviewing was difficult. Also, some of the figures which are the basis of the planned value of effectiveness cannot confirm the basis of the figures, which restricted the appropriate evaluation. These data are also important from the viewpoint of business supervision in the future, and it is necessary to encourage executing agencies to manage information appropriately at each stage of the project planning and implementation.

4.3 Lessons Learned

A large flood occurred in 2010 during this project, and so the target section to be paved was changed significantly. Such changes may affect the project purpose. However, in this project, the target value was not formally modified and the unmodified value was left in official written document between the two countries based on this influence. It would be desirable to establish a system that enables the project monitoring and monitoring results to be quickly reflected in the project plan, such as reviewing and redefining the project purpose, installing appropriate indicators and baseline data etc., as soon as the environment surrounding the project has changed.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1.Project Output	**56 sections**	**73 sections**
(1) Civil engineering work	**Total Length 452km**	**528.2km(117%)**
1)Dadu	5 sections 31.4km	6sections 41.70km(133%)
2)Hyderabad	4 sections 22.8km	2sections 16.42km(72%)
3)Thatta	5 sections 30.6km	4sections 27.589km(90%)
4)Khairpur	16 sections 157.8km	25sections 183.9km(117%)
5)Sukkur	2 sections 10km	2sections 10.57km(106%)
6)Jacobabad	12 sections 89km	14sections 103.155km (116%)
7)Shikarpur	9 sections 79.9km	10sections 71.636km(90%)
8)Larkana	3 sections 30.6km	10sections 73.21km(239%)
9)Road specification	Pavement width 3.7m、Shoulder width 2m	As planned
(2) Consulting Services	Detailed design, bidding assistance, construction management work, capacity building of executing agencies etc.	There is no change in work content. As a result of the civil engineering change mentioned above, the business volume increased by 20%.
2.Project Period	May 2008 - June 2013 (62 months)	May 2008－June 2015 (85 months)
3.Project Cost		
Amount paid in foreign currency	522 million yen	470 million yen
Amount paid in local currency	9,347 million yen (4,868 million rupees)	7,914 million yen (7,354 million rupees)
Total	9,869 million yen	8,384 million yen
ODA loan portion	9,126 million yen	7,752 million yen
exchange rate	1 rupee=1.92 yen (June 2007)	1 rupee=1.08 yen (2000-2015)
4.Final Disbursement	May 2015	

(Reference 1) The plan and actual results of the annual average daily traffic volume for the 14 sections' surveyed by types of vehicles

	Province	Sections' name	Cars･Jeeps･Pickups			Minibuses･Wagons			Buses			Two-wheeled trucks			Three-wheeled trucks			Motorcycles		
			Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual
Selected Sections (sections selected before the flood)	Dadu	D-2	22	53	10	4	9	3	4	9	0	15	35	3	8	19	0	67	215	533
		DA-3	61	121	42	46	90	7	30	58	0	17	33	0	0	0	0	82	191	720
	Larkana	LA-8	3	6	132	0	0	21	0	0	0	0	0	18	0	0	6	27	63	655
		LA-4 & LA-7	30	56	17	7	13	5	6	11	0	15	27	0	10	18	0	152	291	129
	Shikarpur	SH-52	128	289	148	39	88	14	23	50	0	110	243	6	109	241	11	389	1116	668
		SHA-2	17	36	40	3	6	2	0	0	0	10	17	0	0	0	0	265	685	330
	Hyderabad	HA-1	23	46	27	0	0	0	0	0	1	24	47	2	0	0	70	70	163	132
		H-5	17	41	370	5	11	22	2	5	38	14	33	38	8	19	5	75	241	820
Alternate sections (sections selected after the flood)	Sukkur	SK-4	12	27	17	3	7	0	2	4	0	9	20	13	5	11	0	73	209	63
		SK-5	13	31	20	2	5	0	2	5	0	9	21	14	5	12	0	73	235	62
	Thatta	TA-2	18	36	66	0	0	0	0	0	0	24	47	0	0	0	0	54	126	55
		TT-2	12	27	30	5	11	0	2	4	0	15	33	0	8	18	0	78	224	42
	Khaipur	KA1-1/1-2	418	883	43	18	37	2	0	0	0	50	101	7	0	0	0	652	1583	287
		K-31	23	52	29	5	11	0	0	0	0	26	57	16	5	11	0	88	252	43
	Province	Sections' name	Rikisyas			Animalcarts			Bycicles			Tractor-trolleys			Four-wheeled trucks			Five-wheeled trucks		
			Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual	Original traffic volume	Planned	Actual
Selected Sections (sections selected before the flood)	Dadu	D-2	16	51	24	0	0	32	0	0	65	0	0	9	0	0	0	0	0	0
		DA-3	68	158	135	0	0	148	0	0	125	0	0	100	0	0	0	0	0	0
	Larkana	LA-8	9	21	89	0	0	115	0	0	10	0	0	43	0	0	2	0	0	0
		LA-4 & LA-7	37	71	32	0	0	32	0	0	15	0	0	8	0	0	0	0	0	0
	Shikarpur	SH-52	178	511	123	0	1	60	0	1	50	0	1	39	0	1	7	0	1	1
		SHA-2	20	52	95	0	0	39	0	0	23	0	0	6	0	0	0	0	0	0
	Hyderabad	HA-1	13	30	20	0	0	4	0	0	0	0	0	2	0	0	0	0	0	0
		H-5	17	55	128	0	0	45	0	0	19	0	0	0	0	0	0	0	0	0
Alternate sections (sections selected after the flood)	Sukkur	SK-4	11	32	0	0	0	12	0	0	9	0	0	0	0	0	0	0	0	0
		SK-5	12	39	8	0	0	19	0	0	9	0	0	0	0	0	0	0	0	0
	Thatta	TA-2	4	9	6	0	0	14	0	0	4	0	0	0	0	0	0	0	0	0
		TT-2	18	52	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Khaipur	KA1-1/1-2	38	91	19	0	0	25	0	0	22	0	0	29	0	0	0	0	0	0
		K-31	3	9	2	0	0	16	0	0	12	0	0	0	0	0	0	0	0	0

Note In the table above, sample data of the plan and actual results of the annual average daily traffic volume for the 14 sections' surveyed by types of vehicles are compared

Islamic Republic of Pakistan

FY2017 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Rehabilitation of Medium Wave Radio Broadcasting Network in the Islamic Republic of Pakistan"

External Evaluator: Yuko Kishino, IC Net Limited

0. Summary

This project was implemented to enable the expansion of radio broadcasting service to the Khyber-Pakhtunkhwa Province (hereinafter "KP") and the Federally Administered Tribal Areas (hereinafter "FATA") in the Afghan border regions by rehabilitating a deteriorated medium wave radio transmitter and equipment at a studio and master control room, thereby contributing to stabilization of the border regions.

The project was relevant to Pakistan's development plans and needs, both at the time of planning as well as at the time of the ex-post evaluation, and Japan's ODA policy at the time of planning; therefore, its relevance is high. There were no major changes in the project outputs, and the project cost was lower than planned. During the implementation of the project, Japanese engineers were forced to evacuate the project site because anti-government demonstrations occurred. The project period exceeded the planned timeframe by one month because construction was interrupted for three months along with the evacuation. The efficiency of the project is judged to be high, considering that the contract's force majeure clause was applied. After the completion of the project, the target value for the number of listeners in the coverage area was achieved through the expansion of the listening range of radio broadcasts (coverage area of the radio broadcasting services) to throughout KP and FATA, except Chitral District, a mountainous area. Daily broadcasting time exceeds the goal of 14 hours. This enables a variety of broadcast programs to be provided, including programs on social problems, government policies, terrorism issues, safety measures, and regional information. Therefore, this project has high effectiveness and a high level of impact. Because operation and maintenance has been implemented properly, there are no problems in the organizational or technical aspects. In contrast, no budget is secured for hiring new staff or replacing equipment. Therefore, there are some problems with the financial aspect, and the sustainability of this project is fair.

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

1. Project Description

Project Location

Faqirabad Transmitting Station

1.1 Background

The border issues with Afghanistan are extremely serious for Pakistan. Since the terrorist attacks in the United States on September 11, 2001, the stabilization of the border has been increasingly important as a matter of influence on the development of Pakistan.

However, in KP around the border and FATA on the border, as a consequence of the fight against terrorism by the Pakistani military and natural disasters, a socially and economically unstable situation continues, and the domestic displacement of people has occurred. A few areas in FATA are also reportedly activity bases for the armed groups. Socio-economic indicators have underperformed against the national average. In addition, poverty, distrust of the government, and access to biased information, from sources such as anti-government organizations, are allegedly foundations for the infiltration of the armed groups.

In the *Post Crisis Needs Assessmen*t, jointly announced by the Government of Pakistan, the World Bank, the Asian Development Bank, and the United Nations (UN) in October 2010, the improvement of information access through the radio was indicated as one of the development strategies for KP and FATA. According to UN statistics (2007), the source of information that people use the most in KP and FATA is the radio. Thus, radio broadcasting has been playing an important role as information media, which provides information related to humanitarian assistance to domestically displaced people and refugees from Afghanistan, as well as information for day-to-day living such as education, health care, weather reports and disaster prevention, security, and so forth.

At the time of planning, Pakistan's radio network was regarded to have the capacity to provide services to 98% of the population and 78% of national land areas through medium wave transmitting stations at the Pakistan Broadcasting Corporation (hereinafter "PBC"). However, the

coverage area had been decreasing every year because of the aging of transmitters.

Under such circumstances, the Government of Pakistan requested grant aid from the Government of Japan with regard to renewing equipment at the Faqirabad transmitting station, which covers the entire areas of KP and FATA, and equipment at PBC Headquarters in Islamabad.

1.2 Project Outline

The objective of this project is to improve access to radio broadcasting service in KP and FATA by providing and replacing the radio broadcasting equipment in Islamabad and Faqirabad in Punjab Province, thereby contributing to the stabilization of the Afghan border regions.[1]

Grant Limit / Actual Grant Amount	1,385 million yen / 1,351 million yen
Exchange of Notes Date /Grant Agreement Date	December 2012/ December 2012
Executing Agency	Pakistan Broadcasting Corporation
Project Completion Date	December 2014
Main Contractors	Mitsubishi Corporation/NEC Corporation (manufacturing and installation of a transmitter)
Main Consultant	Yachiyo Engineering Co., Ltd.
Preparatory Survey	October 2011 to May 2012
Related Projects	<USAID> - Digitization of audio archives of PBC (2012–2015) - Replacement of a 10-KW medium-wave transmitter in D. I. Khan with a 100-KW medium-wave transmitter and relocation of the broadcasting house to a new site (2010–2013) - Replacement of a 100-KW medium-wave transmitter in Peshawar with a 400-KW medium-wave transmitter (2010–2013)

2. Outline of the Evaluation Study

2.1 External Evaluator

Yuko Kishino, IC Net Limited

2.2 Duration of Evaluation Study

This ex-post evaluation study is a desk evaluation and was conducted with the following schedule. The field study was conducted by local field research assistants.

Duration of the Study: August 2017–March 2019

Duration of the Field Study: November 2017–March 2018

[1] The stabilization of the border area depends on many factors and it is difficult to assess the impact of this project. Consequently, the external evaluator defined the impact of the project as “being able to provide a variety of nationwide broadcast programs” in this evaluation. Refer to the section on “Impact.”

2.3 Constraints during the Evaluation Study

For security reasons in Pakistan, the field study, including site survey, was conducted by local field research assistants under the supervision of IC Net Limited and an external evaluator. FATA, a beneficiary area of the project, is a hazardous area where Pakistani people, except locals, do not intrude. Consequently, FATA was excluded from the survey area.

In the evaluation survey, the local field research assistants collected information based on a questionnaire created by the external evaluator and conducted project site surveys. Furthermore, IC Net Limited interviewed a person in charge of the project from the executing agency by inviting the person to a third country. Because this evaluation is a desk evaluation based on information obtained under such constraints, it is not necessarily able to reflect all the detailed information.

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

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of Pakistan

At the time of planning, the Government of Pakistan cited in *Vision 2030* (2005–2030), a long-term national development plan, that the role of public broadcasting was to broadcast widely on the topics of education, information, awareness activities, and culture, and to connect them to the good of the people of Pakistan. In the *10-year Long-term Development Plan* (2001–2011), the government set a target of radio coverage for 100% of the population. A draft of the *Broadcast Sector Development Plan* (2011–2017) stated that the role of the PBC was to provide information needed for people's lives, inform the people of government policy, help maintain and improve people's lives, and provide entertainment to enrich daily life and ethnic cultures.

At the time of ex-post evaluation, *Vision 2025* (2014–2025) replaced *Vision 2030* as the guideline for the Government of Pakistan. It puts emphasis on seven fields such as socio-economic development, sustainable comprehensive growth, infrastructure development, and so forth. Especially, to promote economic development and stabilization in developing regions in the country is emphasized. The *Broadcast Sector Development Plan* (2011–2017) cites that the core contents of broadcast should be education, health care, agriculture, women's empowerment, child labor, and others, all of which promote the safety and stability of the people. It also states that the PBC will rehabilitate medium wave services in Hyderabad, Multan, and elsewhere to increase the number of radio listeners, especially in developing regions in the country.

Thus, from the time of planning to the time of ex-post evaluation, Pakistan's long-term development plan regards the stabilization of developing border areas as indispensable for economic development. The broadcasting development plan clearly mentions the rehabilitation of

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

[3] ③High; ②Fair; ①Low

medium wave services in developing regions. As this project aims to improve access to radio broadcasting services in KP and FATA, both of which are developing regions on the Afghan border, this project is highly consistent with the national development policy.

3.1.2 Consistency with the Development Needs of Pakistan

At the time of planning, KP and FATA had higher poverty rates than urban areas, and were behind in the prevalence of medical care and education. Therefore, in order to assist administrative services and contribute to the achievement of the national development plan, it was necessary to improve access to information through radio broadcasting services. Although the Faqirabad transmitting station was an important one for covering the entire area of both KP and FATA, its medium wave transmitter degraded over a period of time, and the broadcasting coverage rate in 2010 was less than 50% of the intended coverage. The PBC shortened its daily broadcasting time from the original 22 hours to five hours in order to prevent equipment malfunction. According to the project consultant, daily broadcasting time was one or two hours at the time of planning because broadcasting through the vacuum tube type transmitter stopped when the vacuum tube overheated. Once it broke down, the broadcasting service had stopped for two or three days. Broadcast equipment at the PBC headquarters in Islamabad, which was a center for producing programs for national broadcasting, was also outdated, and production of major spare parts was discontinued. Thus, it has become difficult to acquire replacement parts for maintenance work. Under these conditions, there was a high need for updating equipment.

According to the PBC, the number of radio listeners at the time of ex-post evaluation reached 18.7 million[4] and there is a consistently high need for radio broadcasting services. A Pakistan economic survey shows that the literacy rates in KP and FATA are 53% and 33% respectively, which are lower than that of the national level of 58%.[5] Thus, the radio remains an important source of information. In addition to the Faqirabad transmitting station, it is necessary to rehabilitate the medium wave transmitters in Balochistan, Punjab, and Gilgit-Baltistan, all of which are decrepit.

From the above, it is fair to say that there is a high need for improvement of access to information through radio broadcasting service, and that this project is highly consistent with development needs, both at the time of planning and at the time of ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

Japan's *Country Assistance Policy for Pakistan* in 2012 put emphasis on three fields, aiming to build a stable and sustainable society through economic development. In the field of "stable and balanced development in border areas," it states that Japan will implement assistance contributing to anti-terrorism and stabilization of the Afghan border regions in order to improve security. Under the policy, the *Rolling Plan for Pakistan* stated that it was necessary to stabilize society through

[4] As of 2017
[5] As of 2017

life improvement assistance in KP and FATA from a long-term perspective. This project was implemented to provide information needed for daily life and on government policies through radio broadcasting to KP and FATA around the Afghan border. Therefore, it is fair to say that this project was highly consistent with Japan's aid policy at the time of planning.

As described above, this project has been highly relevant to Pakistan's development plan and needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

This project consists of updating a medium wave transmitter at the Faqirabad transmitting station and procuring studio equipment for producing programs at the PBC headquarters in Islamabad. The medium wave transmitting system is a system that consists of several pieces of equipment with functions to send an audio signal from a studio to existing antennas after signal processing and amplification. There was no change in the outputs by the Japanese side, and there was no problem in procurement, delivery, or installation (see Table 1). The outputs by the Pakistani side were removing unnecessary equipment, replacing the power supply equipment, and repairing the building. Aside from a few minor changes, they were implemented almost exactly as planned. One of the changes is as follows. The Integrated Services Digital Network (hereinafter "ISDN"), which transmits an audio signal from the National Broadcasting House in Islamabad to the Faqirabad transmitting station, was replaced with the satellite connection of the executing agency. At the time of planning, a fiber-optic network already existed, but the ISDN was selected because it was considered more reliable as a system and more competitively priced.[6] However, it turned out at the installation stage that the ISDN was not compatible with a terminal box for the telephone line. It was an appropriate selection for grant aid in terms of reliability and low price; however, the problem could have been avoided if compatibility had been clarified at the time of planning. This change did not affect the effect of this project.

[6] It was alternated with the satellite up-linking system that the PBC possessed. At the time of the ex-post evaluation, the ISDN is used for Internet connection.

Table 1: Planned and Actual Project Outputs by the Japanese Side

	Plan （2011）			Actual （2015）
1	Faqirabad Transmitting Station		1 set	as planned
	1－1	500kW Medium wave transmitter (250kW+250kW)	1 pair	
	1－2	500kW dummy load	1 set	
	1－3	Program inputting equipment rack (PIE)	1 set	
	1－4	Control console	1 set	
	1－5	11kV/400V reciving transformer	2 sets	
	1－6	Insulating transformer （400V/400V）	2 sets	
	1－7	Automatic voltage adjuster and distribution panel	2 sets	
	1－8	Air conditioner (for control room)	2 sets	
	1－9	Forced cooling system	1 set	
	1－10	Program transmitting system （ISDN codec）	1 set	
2	PBC Islamabad studio equipment		1 set	as planned
	2－1	On air studio systems	2 pairs	
	2－2	Production studio system	2 sets	
	2－3	Editing studio system	1 set	
	2－4	Master control room system	1 set	
	2－5	Existing studio equipment	15 sets	
	2－6	Clock unit	1 set	
3	Measuring devices and maintenance tools		1 set	as planned
	3－1	Measuring devices	1 set	
	3－2	Tool kit	1 set	
4		Replacement parts	1 set	as planned

Source: Preparatory survey report, and materials provided by the Japan International Cooperation Agency (JICA)

500 kW medium wave transmitter
at Faqirabad transmitting station

Master control room at the headquarters, Islamabad

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total actual cost of the project amounted to 1,407 million yen (JPY) (1,351 million yen on

the Japanese side and 56 million yen[7] on the Pakistani side), 96% of the planned budget of 1,459 million yen (1,378 million yen and 74 million yen,[8] respectively) at the time of planning and it remained within the plan. Although there was an additional cost of 7.27 million yen associated with restarting after the interruption due to anti-government demonstrations, it was covered with the remaining budget. The reason for the actual project cost borne by the Pakistani side being less than the planned one was that the banking arrangement fee indicated by the Government of Pakistan at the time of planning was higher than it should have been.[9]

3.2.2.2 Project Period

The actual period of the project was 22 months, which was 105% of the planned period of 21 months. The reason for the actual project period being longer than the planned one was that anti-government demonstrations occurred in August 2014 and the project had to be suspended. After the occurrence of demonstrations, the Government of Pakistan instructed Japanese engineers to leave the project site, and construction was interrupted for 14 days. Because the situation was unlikely to improve, the Japanese engineers returned home with the PBC's approval. Afterwards, they restarted installing studio equipment and providing technical assistance in November 2014, and completed project work in December 2014. In this evaluation, as shown in Table 2, three months, which the force majeure clause had been applied to,[10] were deducted from the planned 22 months. Therefore, the actual period of the project was considered to be 19 months, 90% of the planned period.

Table 2: Project Period

Project Period (including design/procurement and installation/bidding, which included both the first days of the initial month and the last days of the final month of the period)	Planned (month)	Actual (month)	% against the planned period
March 2013– (Contract date)[11]	21	22	105%
Project Period excluding the period of the force majeure clause		19	90%

In light of the above, both the project cost and the project period were within the plan. Therefore, the efficiency of the project is high.

[7] Exchange rate of the actual value: US $1.00 = JPY 97.6, Pakistan Rupee (PKR) 1.00 = JPY 0.960 (annual average value in 2013), US $1.00 = JPY 105.94, PKR 1.00 = JPY 1.048 (annual average value in 2014) [Source: International Financial Statistics (IMF)]

[8] Exchange rate of the planned value: US $1.00 = JPY 79.67, PKR 1.00 = JPY 0.909 (average value from May to October 2011).

[9] The background was not identified in the survey.

[10] From August 12 to November 22, when construction was not possible.

[11] Because the starting points of the project period presented in the ex-ante evaluation table were unclear, the process table in the Preparatory Survey Report was adopted. In the latter table, the dates of exchange of notes and grant agreement were not included, and the starting points of the project were the detailed design (the contract date of the consultant). Therefore, in this ex-post evaluation, the starting points of the detailed design are regarded as both the planned and actual ones of the project period.

3.3 Effectiveness and Impacts[12] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects

This project was implemented to improve access to radio broadcasting services in KP and FATA by replacing the medium wave transmitter. For the evaluation of effectiveness, i.e., whether access to radio broadcasting services improved, the extent to which the following three indicators presented in the ex-ante evaluation table (2012) had been achieved was measured: (1) population of coverage areas in the country as a whole, (2) size of the coverage areas, and (3) radio broadcasting hours.

Table 3: Operation and Effective Indicators

Indicators	Unit	Baseline	Target	Actual			Achievement
		2011	2017	2015	2016	2017	
			3 Years After Completion	1 Year After Completion	2 Years After Completion	3 Years After Completion	
National coverage population (the number of listeners)	10 thousand	3,600	6,300	6,400	6,410	6,420	102%
Coverage area in KP and FATA	%	50	100	85	85	85	85%
Radio broadcasting hours	hours/day	5	14	14	14	16	114%

Source: Reference value/target value provided by the ex-ante evaluation table. Actual value provided by the PBC.
Remark: Indicators are all from the Faqirabad transmitting station.

At the time of ex-post evaluation, there was no problem with operations for the project, including management of the power supply and voltage environment as well as air conditioning. The number of listeners increased from 36 million people at the time of planning to 64.2 million people and exceeded the target value of 63 million people (102% of the planned number). The coverage area of the 500 kW transmitting power is within a radius of 300 km from the Faqirabad transmitting station. It includes the entire area of both KP and FATA, where people had difficulty listening to the medium wave services at the time of planning. During the ex-post evaluation survey, with the PBC's cooperation, the status of transmission frequency 585 kHz radio wave was surveyed using equipment for measuring field strength at 24 points in KP in total, that is, seven points at Manshera, nine points at Swat, and eight points at Malakand. As a result, the survey revealed that it indicated more than 60 dBμ (V/m)[13] in all points, which is defined as an articulate sound level without any noise. Meanwhile, it was confirmed that the medium wave signal had not reached Chitral District, a 3,000 meter-class mountainous and canyon-filled area in KP. Thus, the achievement level of the target coverage remains at 85%.

[12]Sub-rating for Effectiveness is to be put with consideration of Impact.
[13] dBμ (d/B/micro) is a unit of power voltage. V/m (volt per meter) is used as a means of specifying the intensity of the one volt per meter electromagnetic field. Both are rounded off to the closest whole number.

Survey of wave reception signal

Equipment for measuring field strength

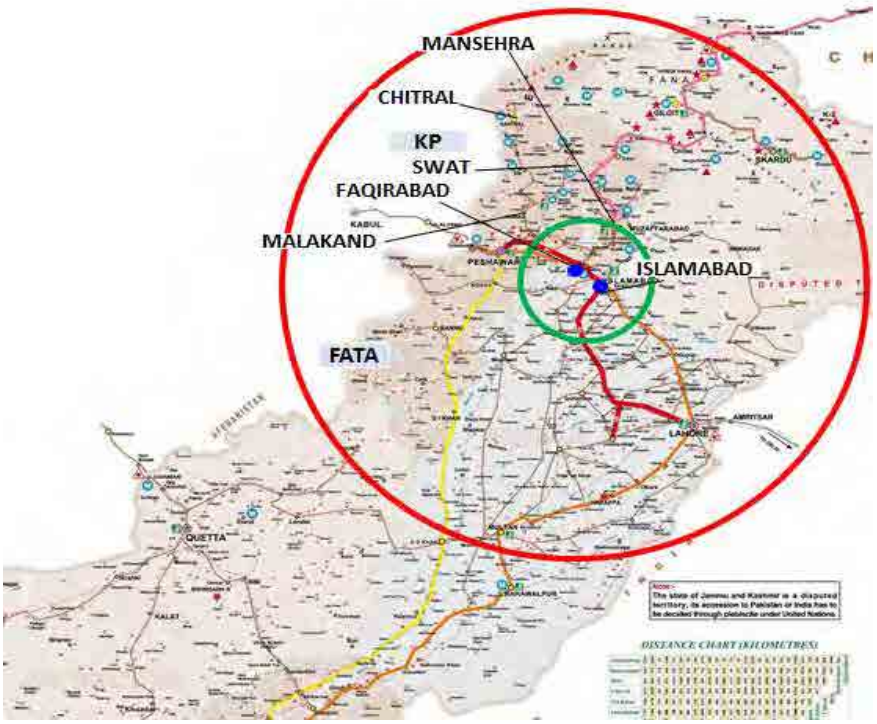

Figure 1: Map of the Coverage by the Project

Source: Information provided by the PBC (Map modified by the evaluation team)

As mentioned above, radio broadcasting hours had been reduced to five hours per day at the time of planning in order to prevent equipment failure. After the replacement of the transmitter in 2015, the target of 14 hours was achieved. In 2017, it was extended to 16 hours, responding listeners' requests. According to the PBC, the transition from analog to digital studio equipment and program production equipment in the master control room in the Islamabad headquarters has enabled program production time to be shortened by recording and editing digital signals using a non-linear editing system.[14] In addition, it has made the sound better without noise or strain and improved the

[14] To edit sound in a randomly accessible environment by recording it through digitization onto a hard disc. It is possible to reduce the working time in editing. URL address https://www.weblio.jp/content/%E3%83%8E%E3%83%B3%E3%83%AA%E3%83%8B%E3%82%A2%E7%B7%A8%E9%9B%86 (Accessed on May 30, 2018)

quality of broadcasting and programming drastically, making it possible to deliver a comfortable broadcasting services to radio listeners.

In light of the above, this project has expanded the coverage area, and not only enhanced the quality of sound, but also the program production time has also been shortened. Thus, it is fair to say that the effectiveness of the project is high.

3.3.2 Impacts

3.3.2.1 Intended Impacts

The impact of the project described in the ex-ante evaluation table is "to contribute to the stabilization of the Afghan border regions." However, stabilization of the border area depends on not only this project but also many other factors; therefore, it is difficult to assess the impact of this project through this evaluation study. Consequently, "to be able to provide a variety of nationwide broadcast programs." was assessed as an impact of the project in this evaluation based on the purpose of PBC radio broadcasting[15] and materials at the time of planning provided by JICA.

(1) Providing a variety of nationwide broadcast programs

Pakistan is a multiethnic country where four dominant ethnic groups and many ethnic minorities live. It has five dominant languages[16] in addition to Urdu, a national language, and English, the official language, as well as ethnic languages. Under these circumstances, radio broadcasting in multiple languages is an important means of disseminating information. After the renewal of the Faqirabad transmitting station, PBC was planning to provide radio programs in multiple languages on topics such as education, regional information, music and entertainment, culture, and health from 07:00 to 22:00 with a one-hour interruption for maintenance during broadcasting. In fact, expected radio broadcasting has been almost realized as planned from 05:45 to 24:00, in a schedule with an approximately two-hour interruption for maintenance. Table 4 shows the planned and actual broadcasting hours by program type.

[15] "The PBC broadcasts programs for the purposes of providing information necessary for daily life and information on government policies, contributing to maintaining and improving daily life, and offering entertainment and culture to enrich daily life." Source: Preparatory survey report (2012)[16] Pashto, Hindko, Punjabi/Phothwari, Shina, and Balti

[16] Pashto, Hindko, Punjabi/Phothwari, Shina, and Balti

Table 4: Broadcasting Hours at the Faqirabad Transmitting Station

Contents	Broadcasting hours	
	Plan	Actual
	2011	2017
Educational broadcasts	6	5
Special news	1	0
News	2	3
Traditional music and entertainment	3	3
Religion	1	2
Regional information*	1	3
Total	14	16

Source: PBC

Remark: *Programs for regional information in FATA

Table 5 shows the program at the Faqirabad transmitting station in 2017–2018. Regional programs are set daily between 18:10 and 19:00 in the five dominant languages other than the official national language. A program unique to the border region is also broadcast. The content of the program is considered so that it can lead to regional safety. In addition to regional traditional culture, program topics include maternal and child health, women's empowerment, terrorism issues and safety measures, and activities to improve the welfare of the border community residents. From the above, the target of "to be able to provide a variety of nationwide broadcast programs" is judged to have been achieved.

Table 5: Broadcasting Programs at the Faqirabad Transmitting Station

Time	Program	Outline	Language
05:45-07:00	Hayya Alfalalah	Religious programme	Arabic/Urdu
07:10-08:00	Subh-e- Pakistan	Radio reports on special days, cultural reports from different radio stations Pakistani music	Urdu
08:10-09:00	Hum Pakistan	Youth programme	Urdu
09:05-10:00	Zero Point	City service programme (to address the civic issues like health, sanitation, education, transportation)	Urdu
10:05-11:00	Rabta	Discussion / interviews of renowned experts belonging to different fields (related to health, education, sanitation, fundamental rights etc.) Live calls from listeners, and experts' replies to the listeners' queries	Urdu
11:05-12:00	Sukhi Ghar	Discussion on issues related to woman rights, education and health.	Urdu
12:10-14:00	Break (for maintenance of transmitter)		
14:05-15:00	Zarkhaiz Pakistan	Agriculture programme Discussion by agriculture experts and their live answers to listeners' questions Agriculture news and documentaries. Latest farming techniques and new technology.	Urdu
15:10-15:30	Back to back music	Entertainment programme	Urdu
15:30-16:00	Ao Bacho/Housaly Buland Apnay/ Mahol Zindagi Hay/Assas /Afkar/Yeah Hath Salamat Hain Jabtak	Special programme depending on the day of the week: children's programme; programme with special guests; programme on environmental issues; literary programme; programmes for workers	Urdu
16:05-16:30	Selected songs	Entertainment programme	Urdu
16:30-17:00	Hum Najwan	Youth programme: discussions and interviews on youth-related issues	Urdu
17:05-18:00	Rang-e-Marfat	Religious Program	Urdu
18:10-19.00	RASGHA BALTISTAN/RANGUNA/PALWASHY/HAZARA RANG/GALA BATTA/	Programmes in local languages depending on the day of the week covering topics including the following: waste management; women's empowerment; health facilities; educational facilities; culture; women in business; women in sports; Pashto music industry; military operation against terrorists; safety measures, hygiene and health of children; refugees; weather reports; and traffic reports	Pashto/Hindko/Punjabi/ Phothhoari/Shina/Balti
19:05-20:00	Jaiza	Current affairs programme Important national and international issues (interviews with prominent defense experts, former diplomats and journalists)	Urdu
20:00-21:00	Khabarnama	Special news bulletin (national and international news)	Urdu
21:10-22:00	Sports Plus	Sports programme Sports news, interviews of sportsmen/sports women and other people belonging to sports industry	Urdu
22:10-23:00	Aap ki Farmaaish	Entertainment programme	Urdu
23:05-24:00	Jaagta Pakistan	Program for Armed Forced	Urdu
24:00	END OF TRANSMISSION		

Source: PBC
Remarks: Breaking news every hour

(2) Feedback from radio listeners

In cooperation with the PBC, interviews were conducted with a total of 11 male residents in Manshera, Swat, and Malakand districts in KP regarding frequency of listening to the radio, a frequently-listened program, quality of sound, and variety of programming before and after the project. The listeners stated that the voices of the broadcasters became clear without noise and

distortion, and the program types increased. There were also opinions on the content: requests were made for an increase in programs on education and medical issues, discussions with experts, and programs for youth. A sizable number of the interviewees used the radio programs to gather information on the border region.

The impacts of radio broadcasting vary depending on programs and individuals. Many listeners attested that radio broadcasting made a positive impact on their life as follows. Those who listen to the religious program have tried to improve their conduct and feel compelled to fulfill their moral and social obligations in a better way. Another segment of listeners feel their lives have been invigorated by listening to the sports program. Those who listen to light music have felt more relaxed. The cultural program has educated listeners about their centuries-old culture and imbued in them a spirit to preserve it. Those who listen to the current affairs program feel more informed and enlightened on the latest national and international issues.


Interview survey scenes

In light of the above, this project has achieved its effects as planned, and it is fair to say that the effectiveness and impact of the project are high.

3.4 Sustainability (Rating: ②)

3.4.1 Institutional/Organizational Aspects of Operation and Maintenance

The PBC is a state-run company affiliated with the Ministry of Information and Broadcasting. The propose of the PBC is to provide reliable broadcasting at home and abroad as a governmental media organization in accordance with the Pakistan broadcasting law (1973, revised in 2002). For domestic broadcasting, the PBC provides services in 19 languages from 32 broadcasting stations, including the National Broadcasting House in Islamabad and 31 regional stations, 23 AM stations, 57 FM stations, and one short-wave station. The PBC also offers international broadcasting under the name “Radio Pakistan” in 10 languages.

As shown in Figure 2, the PBC is an organization with a total of 2,717 personnel, consisting of

the News, Program, Engineering, Finance, and Administration departments at the time of ex-post evaluation (2017). Operation and maintenance of the project is conducted by 59 engineers at the National Broadcasting House and 20 engineers at the Faqirabad transmitting station under the Engineering Department. According to the PBC, although the actual number of engineers at the Faqirabad transmitting station is below the planned number of 33, it is possible to manage and operate the station smoothly with this number by making two shifts in the morning/afternoon and night. However, the number of personnel for emergency measures has not been secured. This is because the number of employees who leave the PBC at the mandatory retirement age has increased recently and the PBC is not able to hire new engineers. Over the next three years, three more engineers will retire. After their retirement, the PBC plans to deploy engineers from other transmitting stations. In the light of this, although the PBC has a few minor problems with the number of personnel, there was no major problem with regard to the institutional aspects of operation and maintenance.

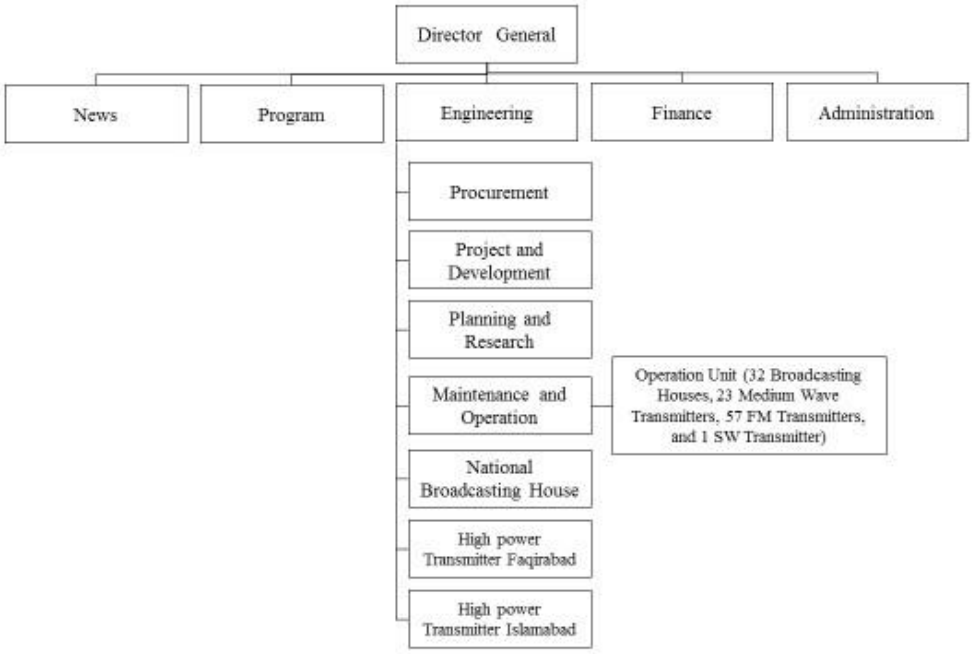

Figure 2: Organization Chart of PBC

Source: PBC

3.4.2 Technical Aspects of Operation and Maintenance

At the time of planning, it was assumed that there would be no problem with the technical aspects because the PBC personnel had already acquired operation and maintenance skills for analog broadcasting equipment. However, because they were not accustomed to operating and maintaining the latest equipment, it was observed that on-the-job training (hereinafter "OJT") was needed on basic knowledge, operation of the measuring instrument for fault finding, quality control, and replacement of repair parts. This was almost done as planned by the Japanese engineers at the time

of the installation of the equipment.[17] Fifteen personnel, mainly from the Faqirabad transmitting station, attended OJT on the transmitting system, and sixteen personnel, mainly from the National Broadcasting House, attended OJT on the studio equipment. Although not all the personnel remain at the time of ex-post evaluation, daily and periodical maintenance has been implemented reliably based on manuals.

According to the PBC, there is no technical problem with normal maintenance and management. However, there is a shortage of the techniques needed for repair and identification of sudden failure of facilities and equipment. While a special technique is required especially for troubleshooting the transmitter, only a one-day OJT session was done. Therefore, their technique is not yet up to a level that facilitates repair by themselves. The PBC needs training on troubleshooting skills by the manufacturer for engineers at the Faqirabad transmitting station and the National Broadcasting House in order to respond early in the event of a failure.

The equipment in the master control room is basically maintenance-free, and an accidental malfunction was to be addressed through replacement of parts. Accordingly, minimum spare parts necessary for a period of spare part procurement were procured in the project, and the after-sales service system was arranged. However, according to the PBC, not all critical spare parts for troubleshooting have been provided. In addition, it is impossible to procure them in Pakistan. Moreover, Pakistan has no engineers who can address these issues, and the PBC has no choice but to import spare parts from Japan. It is necessary to improve this situation so that the PBC can receive after-sales service promptly. Currently, it takes a long time to obtain spare parts after an application because import settlement procedures are time-consuming.

Based on the above, it is fair to say that a technical problem remains in troubleshooting, although there is no problem in normal maintenance and management.

3.4.3 Financial Aspect of Operation and Maintenance

Table 6 shows the PBC's financial status for the last five years. The PBC's main revenue is a subsidy from the government, and other revenues are advertisement income and operating revenue. The revenue in FY 2015/2016 was 3.95 billion Pakistan Rupees (hereinafter "PKR"), which is 1.5 times the revenue in FY 2011/2012. This was mainly because the subsidy increased in FY 2012/2013 by 42%, and because advertisement income had increased in FY 2013/2014 by 72%, both in comparison to the previous fiscal year. Meanwhile, expenditures also increased to about PKR 4.5 billion in FY 2015/2016, which was 1.5 times those in FY 2011/2012. The reasons for the increase in expenditures are that security guard measurement charges were imposed by the government on all broadcasting stations and retirement pay and pension increased from 2014/2015.

[17] The OJT period related to the transmitter system was 23 days and the one related to studio equipment was 17 days.

Table 6: PBC's Revenue and Expenditure

(Unit: Pakistan Rupee)

		2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
Revenues	Advertisment incomes	196,064,615	192,613,180	332,028,521	325,560,239	315,059,890
	Operating revenenue	35,157,489	11,507,003	33,622,693	14,837,479	33,834,909
	Subsidy	2,401,000,000	3,401,350,000	3,493,877,000	3,343,877,000	3,597,640,000
	Sub-total	2,632,222,104	3,605,470,183	3,859,528,214	3,684,274,718	3,946,534,799
Expenditures	Salaries, wages and benefits	1,505,307,816	1,777,115,870	1,838,062,034	1,989,697,939	2,104,306,463
	Pension and gratuity	835,559,997	1,204,842,875	963,254,873	7,056,715,149	1,268,416,684
	Power and fuel charges	171,874,192	171,239,530	185,935,353	221,102,827	219,677,315
	Programmes' expenses	104,917,251	124,292,964	127,597,107	181,350,474	252,321,056
	Repairs and maintenance	15,139,413	20,818,034	25,578,434	35,875,462	35,682,587
	Security guards charges	0	133,369,886	141,367,474	156,933,852	186,306,673
	Others	369,668,711	253,860,562	263,284,305	428,214,023	438,049,954
	Sub-total	3,002,467,380	3,685,539,721	3,545,079,580	10,069,889,726	4,504,760,732
Balance		-370,245,276	-80,069,538	314,448,634	-6,385,615,008	-558,225,933

Source: PBC

While the expenditure outweighs the revenue, the PBC can neither recruit personnel nor secure reserve funds for equipment updates in the long run. In 2018, the PBC received a government-financed bailout in the amount of PKR 500 million and is requesting a continued bailout in FY 2018/2019 as well. The subsidy has increased to about PKR 3.8 billion in FY 2017/2018 and is expected to increase more in FY 2018/2019. In addition, as the PBC has been trying to increase operating revenues and reduce expenditures through a variety of measures, its financial health is likely to improve.

The actual operation and maintenance costs of the project were PKR 35.68 million in FY 2015/2016 and PKR 23.5 million in FY 2016/2017, respectively, which are less than the projection at the time of planning. Under severe financial conditions, the PBC has been working to curtail electricity and fuel fees and suspend contract renewals of temporary personnel, and has tried to secure the budget for the minimum required operation and maintenance by diverting the budget from other items in case of equipment failure.

From the above, there are some problems with the financial aspect of operation and maintenance at the time of ex-post evaluation; however, it is judged that it would not have a considerable effect on the sustainability of the project.

3.4.4 Status of Operation and Maintenance

With the exception of a few, most facilities and equipment are operated and managed without a problem. A non-linear editing system in the master control room is not used. At the time of planning, the system was expected to share audio data files by establishing a network within the broadcasting station, connecting with a device called a digital audio archive, which records and saves data files in a large-capacity storage memory. However, it is not possible to share data files in the network at the time of ex-post evaluation because compatibility of software between the archive device and the

editing system has not been confirmed. The PBC has no technical capacity to address the issue above; therefore, an Indian engineer has been requested for support, but this has not been realized because he cannot enter the country owing to Pakistan's security problems.

In light of the above, some problems have been observed in the financial aspect. Therefore, the sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to enable the expansion of radio broadcasting service to KP and FATA in the Afghan border regions by rehabilitating a deteriorated medium wave radio transmitter and equipment at studios and a master control room, thereby contributing to the stabilization of the border regions.

The project was relevant to Pakistan's development plans and needs, both at the time of planning as well as at the time of the ex-post evaluation, and Japan's ODA policy at the time of planning; therefore, its relevance is high. There were no major changes in the project output, and the project cost was lower planned. During the implementation of the project, Japanese engineers were forced to evacuate the project site because anti-government demonstrations occurred. The project period exceeded the planned timeframe by one month because construction was interrupted for three months along with the evacuation. The efficiency of the project is judged to be high, considering that the contract's force majeure clause was applied.

After completion of the project, the target value for the number of listeners in the coverage area was achieved through the expansion of the listening range of radio broadcasts (coverage area of the radio broadcasting services) to throughout KP and FATA, except Chitral District, a mountainous area. Daily broadcasting time exceeds the goal of 14 hours. This enables a variety of broadcast programs to be provided, including programs on social problems, government policies, terrorism issues, safety measures, and regional information. Therefore, this project has high effectiveness and a high level of impact.

Because operation and maintenance has been implemented properly, there are no problems in the organizational and technical aspects. In contrast, no budget is secured for hiring new staff or replacing equipment. Therefore, there are some problems in the financial aspect, and the sustainability of this project is fair.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Daily maintenance and exchange of consumable parts, which are used constantly, are conducted properly. An overall renewal of the medium wave transmitter body is recommended 10 years after commencement of the operation, considering the depreciation period and technical innovation.

Under the severe financial condition at the time of the ex-post evaluation, the level of subsidy for FY 2017/2018 is increased and it is expected to stay at least at that level, along with the continuation of management efforts to increase operating revenues and cut costs. In parallel with this, from now until the time of updating equipment seven years later, it is necessary to make long-term maintenance and management plans, as well as to reserve funds for renewing overall equipment.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Effective use of a capacity building program (soft component) scheme in procurement of equipment that needs special techniques

By providing a system assembled with equipment items by one Japanese manufacturer, this project has aimed to secure the reliability of public broadcasting through guaranteed performance of the system as a whole. The project needed to provide technical training on operation and maintenance because the system and other equipment are not manufactured in Pakistan and the method of medium wave transmitting is different from the one used previously. The technical training on operation and maintenance by Japanese engineers dispatched at the time of installation, testing, and adjustment was conducted as planned. However, the period of the technical training was too short for engineers at the executing agency to attain a technical level to repair the system by themselves. As just described, when high-level maintenance techniques are required and no adequate engineers exist in the recipient country, it is desirable to use a soft component scheme with grant aid and assist executing agencies until their engineers attain such techniques and become able to perform proper maintenance by themselves.