Ex-Post Project Evaluation 2018: Package III-2 (China, Kenya)

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People's Republic of China

FY2018 Ex-Post Evaluation of Japanese ODA Loan Project

"Guangxi Zhuang Autonomous Region Yulin City Water Environment Improvement Project"

External Evaluator: Kenji Momota, IC Net Limited

0. Summary

This project was conducted for the purpose of reducing water pollutant emissions and supplying water safely and stably to improve the living environment of the local residents by establishing clean water infrastructure and sewage treatment facilities in Yulin City, Guangxi Zhuang Autonomous Region. The relevance of this project is high because of its conformity with the Japanese government's policies and needs as well as Chinese policies and needs. While the scope of the project has been revised and the period has been extended, the infrastructure has been established mostly as planned, and thus the efficiency of this project can be evaluated as fair. Since the implementation of this project, the water supply and sewage infrastructure has been operating satisfactorily, with highly effective reduction of water pollutants through the construction and operation of sewage treatment facilities. The water supply system has also been operating steadily, responding to the increasing demand and providing a stable water supply to the local residents. The expansion and improvement of the water and sewage infrastructure are still ongoing. Additionally, the responsible organizations have been structured with stable foundations with regard to technology and finances, which indicate good sustainability. In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Nanliujiang River flowing through Yulin City

1.1 Background

While China has achieved rapid economic growth, the industrialization and population increase have been causing environmental pollution since the 1980s. The government of China has been working hard to protect the water environment, but the sewage treatment rate in urban

areas has been less than 50% while the household water usage has increased. With the increasing pollution of water resources caused by untreated sewage, it has become an imperative to treat household wastewater. Although the water supply coverage rate in China as of 2004 was 89%, the water resource amount per person was 2,040 m^3/person, which is only a quarter of the world average. Delay in water price reforms and water leakage due to aging infrastructure are some of the issues that surfaced. It was a great concern to develop new safe water sources, and improve the efficiency of water source usage, as well as to improve the existing water supply systems to promote the availability of water-saving techniques.

In Yulin City, Guangxi Zhuang Autonomous Region, located in the southwestern part of China, while the sewage discharge increased along with economic growth, the development of sewage treatment facilities had not caught up and a sewage plant for treating household wastewater had yet to be established. Untreated wastewater was directly discharged into the Nanliujiang River, Yulin City's main water source, and was causing pollution in the river. Excessive drawing of water from underground water sources and water contamination also occurred, making the development of stable and safe water sources in place of the Nanliujiang River and underground water an urgent matter.

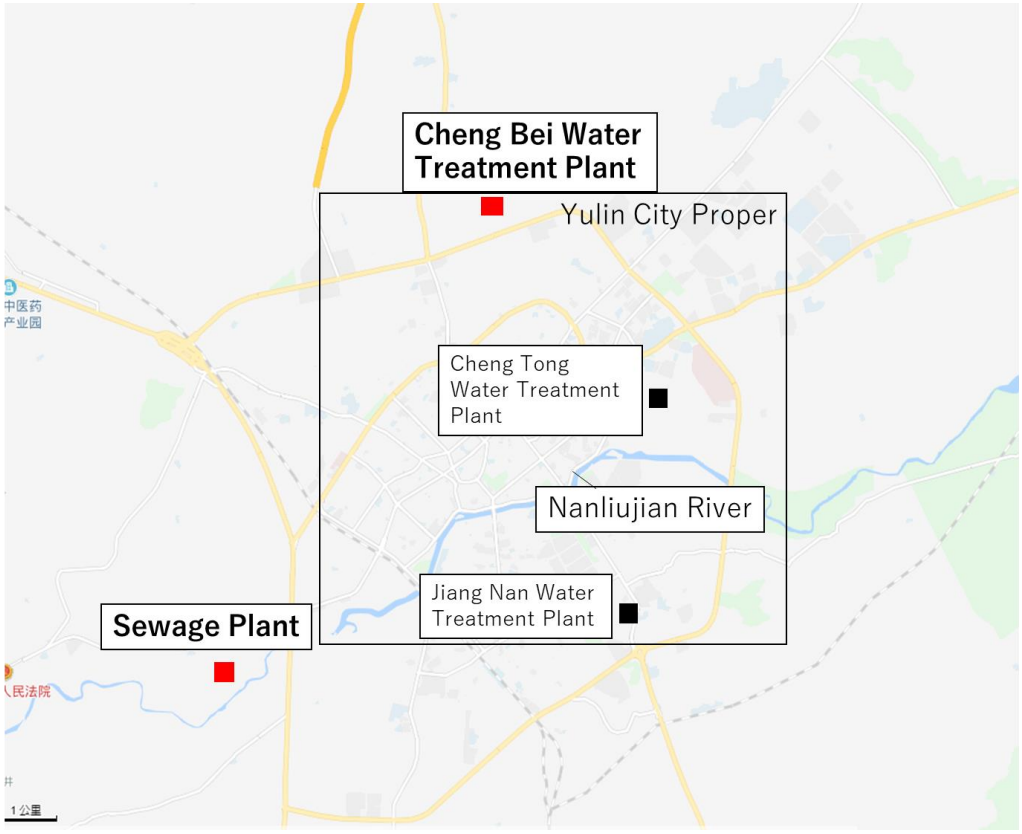
1.2 Project Outline

The objective of this project is to reduce the water pollutant emissions flowing into the Nanliujiang River, which is located in Yulin City, Guangxi Zhuang Autonomous Region, and suffering from significant water pollution, as well as to provide a stable and safe water supply for Yulin City by developing a water supply and sewage infrastructure in this area, thereby contributing to the improvement of the living environment of the Yulin City residents.

Loan Approved Amount/ Disbursed Amount	6,282 million yen / 5,736 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	June 2006 / June 2006
Terms and Conditions	[Sewage Treatment Project] General untied, 0.75% interest rate, 40-year repayment period, and 10-year grace period [Water Diversion Project] General untied, 1.5% interest rate, 30-year repayment period, and 10-year grace period [Training] General untied, 0.75% interest rate, 40-year repayment period, and 10-year grace period
Borrower /	The Government of the People's Republic of China /

Executing Agency	Yulin People's Government (YPG)
Final Disbursement	October 2015
Main Contractors (Over 1 billion yen)	1. Hubei Rich States Industry Investment Co., Ltd. (People's Republic of China) / China Ove Environmental Engineering Co., Ltd. (People's Republic of China): Provision of machinery and other supplies 2. China Ove Environmental Engineering Co., Ltd. (People's Republic of China): Provision of machinery and other supplies
Main Consultant	N/A
Related Studies (Feasibility Studies, etc.)	FS: Prepared by the Guangxi Environmental Protection Research Institute, October 2005
Related Projects	N/A

The map below shows the relationship among the central part of Yulin City, the project site, and the Nanliujiang River.



Source: Prepared by External Evaluator using Baidu Maps (URL: http://map.baidu.com/)

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: September 2018 – October 2019

Duration of the Field Study: January 18 – 30, 2019 and May 12 – 30, 2019

2.3 Constraints during the Evaluation Study

Of the evaluation items for efficiency, the project cost requires the calculation of the total project cost with the addition of the part borne by the partner government to the original Japanese ODA Loan part. However, in this study, as it was impossible to calculate the accurate amount of the part borne by the partner government, the project cost was evaluated only by a comparison using the Japanese ODA Loan parts.

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

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of China

(1) Development policy at the time of the appraisal

The government of China had a goal of reducing the total emission of major pollutants by 10% compared to that from 2000 and reaching a 45% sewage treatment rate in urban areas[3] in *the 10th Five-year Environmental Protection Plan (2000–2005)* (hereinafter "*10th Five-year Plan*"). In the subsequent *11th Five-year Environmental Protection Plan (2006–2010)* (hereinafter "*11th Five-year Plan*"), the government of China set water quality improvement goals for core target areas for environmental protection for the improvement of water environments. In addition, the government of China established a drinking water source protection zone, set the goal of a 70% urban sewage treatment rate by 2010, and stepped up the construction of urban sewage treatment facilities and the collection of sewage treatment fees in order to strengthen the regulation on pollutant emissions to major rivers, lakes, and reservoirs. On the other hand, the development of a water supply system focused on the establishment of urban water supply infrastructure and the procurement of water sources for water-short areas in *the 10th Five-year Plan* and *the 11th Five-year Plan*. In particular, the Plans aimed to conserve water sources by increasing water supply capacity, securing safe drinking water, and reducing

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

[2] ③: High, ②: Fair, ①: Low

[3] In cities with a population of more than 500,000 people had a goal of attaining a 60% urban sewage treatment rate.

water leakage rate through building new water facilities and upgrading aging facilities in the urban areas.

In response to this, the Yulin People's Government set up the Nanliujiang River as one of the core areas for environmental protection in *Yulin City's 10th Five-year Environmental Protection Plan (2001–2005)* and focused on solutions for environmental pollution and ecological destruction. The Yulin People's Government set forth in *the Yulin City General Urban Plan (2004–2020)* to construct a sewage plant with a processing capacity of 450,000 m^3 per day on the western side of the Yulin City Proper and set up a goal to solve the water source shortage problem by diverting water from the Yujiang River that runs through Guigang, a city adjacent to Yulin City.

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

1) National-level policy

There is no significant change in the development policy at the time of the ex-post evaluation. Regarding water pollution, the central government planned to reduce major water pollutants and conserve drinkable water sources by developing a separated sewerage network and constructing sewage treatment facilities as set forth in the *12th Five-year Environmental Protection Plan (2011–2015)* (hereinafter "*12th Five-year Plan*"). Specifically, the central government was aiming to develop basic sewage treatment capacity in all counties and major townships, and increase the load rate of sewage treatment facilities to 80% or higher and the urban sewage treatment rate to 85%. In the subsequent *13th Five-year Environment Protection Plan (2016–2020)* (hereinafter "*13th Five-year Plan*"), the central government set the goal of improving the rates of the National Surface Water Quality Standard Classes I through III[4] to 70% or higher. This Plan also sets the goals of establishing sewage collection and treatment capacities in all townships with county municipal governments and other core townships by 2020 and significantly raise the sewage treatment rate through constructing urban sewage plants and sewerage networks as well as promoting a separate treatment network for rainwater and wastewater and preferentially promoting the connection to wastewater networks for rural areas. Regarding the water supply policy, *the 12th Five-year Plan* set forth a goal for improving the quality of the water environment and listed stricter protection on drinkable water sources and regulations on pollutant discharge ports as specific efforts. In the subsequent *13th Five-year Plan*, the government set a goal to improve the quality rates (Classes I through III) of

[4] The water quality of rivers is classified into Classes I through V by the Surface Water Environment Mass Standard (GB3838-2002). Class I: Primarily water source water. National nature reserve, Class II: Primarily household drinking water. First-grade reserve, rare fish reserve, fish/shrimp spawning ground, Class III: Primarily household drinking water. Second-grade reserve, general fish reserve, swimming area, Class IV: Primarily general industrial water. General industrial water zone, entertainment water zone where water does not come into direct contact with human bodies, Class V: Primarily agricultural water. Agricultural water zone, applied to be secured for general landscape.

centralized drinking water sources at provincial- or prefectural-level cities to 93% or higher by 2020 through preferential protection of good water areas.

2) Municipal-level policy

In Yulin City's *13th Five-year Environmental Protection Plan (2016–2020)*, the municipal government set a goal to improve the rates of the National Surface Water Quality Standard Classes I through III to 96.2% or higher by 2020 through reducing the total amount of river inflow pollutants by strengthening the control of the river basin environment. Additionally, for the protection of drinkable water sources, the municipal government aims to introduce an environmental safety evaluation and establish a sustainable water source management mechanism. The government has also set a goal to reach a water quality standard attainment rate of 94.9% or higher for centralized drinking water sources for municipalities by 2020 through strengthened supervision of pollutant sources. This is also reflected in *the Yulin City General Urban Plan (2004–2020)*, which sets forth a goal of attaining a 85% sewage treatment rate, along with the development of sewage treatment facilities and the promotion of separating rainwater and wastewater sewerage in the city proper. The water supply policy specifies the Suyan Dam, Luotian Dam, and Yujiang River as the primary water sources to divert water from, and the Nanliujiang River and Qingwanjiang River as secondary water sources. It also mentions the development of the Chengbai Water Treatment Plant, Jiangnan Water Treatment Plant, and Chengtong Water Treatment Plant among the specific measures.

This project constructs a sewage treatment system in Yulin City to improve the water quality of the Nanliujiang River, where wastewater and processed water are currently discharged. The project also aims to stably supply safe water by diverting water after developing safe water sources and constructing a water supply system. Therefore, it is highly consistent with the development policy of the government of China, which endorses the reduction of pollutants and the improvement of water environments as core missions.

3.1.2 Consistency with the Development Needs of China

According to the documents at the time of the appraisal, a sewage treatment system for treating household wastewater had yet to be established in Yulin City, and the sewage treatment rate as of 2004 was approximately 11%. Consequently, 150,000 m^3 of household wastewater was discharged into the Nanliujiang River on a daily basis, causing the water quality of the river to deteriorate below Class V from severe water pollution. In addition, a rapid increase in the demand for clean water had led to an excessive drawing of underground water, which triggered ground subsidence and water contamination. Thus, the development of stable, safe water sources was urgently needed. While the daily maximum water supply from the Suyen Dam and other major water sources at the time was approximately 90,000 m^3 per day, the maximum

water usage in one day by the Yulin City Proper in 2003 was 192,300 m^3 per day, which is a demand more than double the supply. Furthermore, as it was forecast that the maximum water supply was to reach approximately 370,000 m^3 per day by 2015, which made the development of new water sources to replace the Nanliujiang River and underground water a pressing issue.

The needs remain mostly unchanged at the time of the ex-post evaluation. Yulin City has been undergoing economic growth since 2006, when the appraisal was conducted. As of 2018, the population has grown to approximately 5.81 million, with 740,000 people living in the city proper (increased by 4% and 6%, respectively, compared to the population in 2006). The sewage plant constructed in this project is still the only public sewage plant as of today. As of 2017, the household wastewater (12,000 m^3/day) from rural areas outside of the target area of this project[5] was discharged untreated into the Nanliujiang River. Improving the water quality of the Nanliujiang River is still a persisting issue, including the fact that the water quality of the river was observed to have deteriorated to Class V of the National Surface Water Quality Standard as of 2017. The water supply development also needs to take into account the significant increase in the regional population and the resulting expansion in the water supply target areas, alongside the general population increase and economic growth. The Yujiang river water source that has been developed by this project replaces the Nanliujiang River, whose water quality deteriorated. Therefore, the project is highly necessary to use the river for water supply to the city proper. Furthermore, along with the expansion of the city proper to the former townships and villages, the target area of this project was expanded to replace underground water with the surface water of the Yujiang River as water sources for the former townships and villages.

As described above, Yulin City continued and continues to grow economically after the appraisal. The need for water and sewerage infrastructure continues to intensify with the increasing population associated with urban development, and thus it remains highly consistent with this project.

3.1.3 Consistency with Japan's ODA Policy

In *the Medium-Term Strategy for Overseas Economic Cooperation Operations (2004 to the first half of 2007),* among the core areas including the aid for combating poverty, establishment of infrastructure for sustainable growth, and support for global issues and peacebuilding, the Japan International Cooperation Agency (hereinafter "JICA") focuses on rural development by establishing water and sewerage infrastructure in poverty-stricken areas, promotion of sustainable growth by establishing needed socioeconomic infrastructure such as water and sewerage systems and energy facilities, and prevention of water supply pollution, and hence aims for compatibility between development and environmental protection.

[5] At the time of the ex-post evaluation, they are included in the treatment target area of the Yulin City sewage plant.

Additionally, in its *Country Assistance Strategy*, JICA specifies environmental problems caused by rapid economic growth as issues and includes environmental conservation centering on inland areas as a core effort.

This project establishes the water and sewerage systems, which is the social infrastructure underlying the urban development and industrial progress in Yulin City, located inland, and aims to improve the water quality of rivers and the living environment of residents through such undertakings. Therefore, the project is highly consistent with Japan's ODA policy.

3.1.4 Appropriateness of the Project Plan and Approach

(1) Differences between the plan and achievements of the Yujiang Water Diversion Project

The water supply system development project in this project aimed to complement the existing water sources, which were insufficient to meet the demand at the time of the appraisal. The project planned to build a 75-km channel from Yulin City to the Yujiang River to supply 250,000 m^3 of water per day to an area including the region along the channel.

The actual amount of water drawn from the Yujiang River at the time of the ex-post evaluation (2019) was approximately 90,000 m^3 per day, which is slightly less than 40% of what was initially planned. There are two reasons for this difference: 1. the existing water sources are still used because of their lower cost compared to the cost of drawing water from the remote Yujiang River, the cost of which nearly doubled since the initial estimates; and 2. The amount of water available from the existing water sources has been greater than estimated, and has been able to support the current demand.[6] The current state of supply and the background are detailed below.

1) The water treatment plants in Shanxin Township and Dapingshan Township, both of which supply was planned for in this water diversion project, and the Chengtong Water Treatment Plant, whose water source is the Nanliujiang River, continue to draw water from dams that cost less to draw from.
2) The major factors behind the increase in the cost of diverting water from the Yujiang River include the increased maintenance costs (including personnel costs and electricity costs) from the delay in the completion of the project and the increase in the unit cost due to the sluggish growth of the water drawing amount. The estimation of the water diverting cost at the time of planning has some unclear factors regarding appropriateness, such as whether the depreciation of equipment investment was considered in the calculation.

[6] At the time of planning, the cost of diverting water from the Yujiang River was estimated to be an expenditure of an annual 42.57 million yuan when supplying water at 200,000 m^3 per day. The actual cost in 2017 was 82.6 million yuan, approximately double the planned expenditure, including personnel costs, increased interest rate, and depreciation. On the other hand, the cost of drawing water from the Suyen Dam in 2017 was an annual 41.73 million yuan including electricity costs, operation and maintenance costs, personnel costs, and interest rate, which is about half of the above.

3) Additionally, there is a possibility of an error in the estimation of the maximum limit of the amount of water that can be drawn from the Suyen Dam.[7] Moreover, given that a water source that was not being considered as a water source at the time of planning is currently being used, it is unclear how far the current state and the availability of the existing water sources were studied at the time of planning.

The demand for clean water is growing amid the continued development of Yulin City, and the reliance on existing water sources has already come to its limit. The amount of water to be diverted from the Yujiang River is expected to increase in the future. The cost of diverting water is also expected to decrease as the amount of water diverted increases, and therefore, the need for the water diversion project is high in a medium-to-long term perspective. Nevertheless, the operating status up to this date, since the completion of the project, significantly underruns the initial plan. This situation is considered to stem from insufficient review at the time of planning. With regard to appropriateness of the project plan, there is room for improvement, such as a more detailed review of alternative water sources.

From the above, while a few issues are found in the appropriateness of the project plan and approach, it is fair to say that, the project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The plan and actual performance of this project are as shown in the table below. The initially planned outputs were mostly developed as planned. However, because some of the facilities that were initially planned to be developed using the Japanese ODA Loan fund were actually implemented by an independent fund, the outputs as a Japanese ODA Loan project have been significantly altered.

[7] The actual amount of water drawn from the Suyen Dam for the Yulin City Proper with Chengbai Water Treatment Plant and Chengtong Water Treatment Plant combined is 146,300 m^3 per day in 2018, which surpasses the estimated maximum amount of water that can be drawn from the dam.

Table 1: List of Project Outputs

	Plan	Actual
Sewage treatment system	Sewerage network: 156 km	Development by Japanese ODA Loan is significantly reduced (23.76 km) 130 km was developed by a national road development project fund. The overall development is 153.76 km, mostly in line with the plan.
	Sewage pumping station (2 new establishments) Binjiang Road Pumping Station Nanmentang Embankment Pumping Station	Changed to 1 establishment (1 minus) Binjiang Road Pumping Station was constructed using national funds and thus was removed from the scope of the Japanese ODA Loan project.
	Sewage treatment plant (1 new establishment): Yulin City Sewage Plant 100,000 m^3/day	As planned
Water supply system	Water supply channel: 75 km	Mostly as planned (74.02 km)
	Water supply pumping stations: 4 Watang Pump Station 250,000 m^3/day Zhanjiang Pump Station 220,000 m^3/day Mingshui Pump Station 210,000 m^3/day Fumian Pump Station 30,000 m^3/day	3 establishments (1 minus) Fumian Pumping Station was constructed using national funds and thus was removed from the scope of the Japanese ODA Loan project.
	Water treatment plants (2 new establishments) Shanxin Water Treatment Plant 10,000 m^3/day Dapingshan Water Treatment Plant 10,000 m^3/day	Canceled Constructed using national funds and thus were removed from the scope of the Japanese ODA Loan project.
	Water treatment plant (1 expansion): Chengbai Water Treatment Plant Expanded from 100,000 m^3/day to 270,000 m^3/day	As planned
	Water distribution pipe network: 12 km	23.62 km (197% compared to plan)
Training	Training in Japan regarding water and sewage operations, targeting the personnel of the executing agency	Canceled Substitute training has been given domestically

Source: The plan data is based on documents provided by JICA while the actual performance data is based on responses given in a questionnaire issued to the project executing agency.

The major changes to the project outputs are described below.

(1) Sewage treatment facilities

A sewage pump station (Binjiang Road Pumping Station) was removed from the scope of the Japanese ODA Loan project and constructed using national funds in 2017. The negotiation with farmers who own the land planned for the construction of the Binjiang Road Pumping Station

did not go smoothly; thus, acquiring a different land for the construction was considered. This led to the review and revision of the basic design, which required time to obtain permission from the Land Management Section. To prevent this delay from causing the development of other relevant coordinating facilities of the Japanese ODA Loan project to stagnate, the development of the pumping station was removed from the scope of the Japanese ODA Loan project and was constructed using national funds.

Yulin City Sewage Plant (bioreactor)

Nanmentang Embankment Sewage Pump Station (coarse screen)

(2) Water supply facilities

1) As the Japanese ODA Loan project procedure was delayed for the two new water treatment plants (Shanxin Water Treatment Plant and Dapingshan Water Treatment Plant), they were constructed using national funds prior to the project. Because of the Yulin City Government's and provincial government's limited experience in aid projects, much time was spent on the approval process. As the urgency for water supply was increasing in the Shanxin and Dapingshan districts, they were to be constructed using national funds, which allows projects to be spun up more quickly. The plan was changed in March 2009 and the water treatment plants were removed from the scope of the Japanese ODA Loan project upon JICA's approval.
2) One water supply pumping station (Fumian Pump Station) was developed prior to the project in 2017 using national funds. The reason for this change is the same as 1) above, specifically to accelerate the response to the water demand. The plan was changed in March 2009, and it was removed from the scope of the Japanese ODA Loan project.
3) The water distribution pipe network was extended to 23.62 km from the planned 12 km. This is a 197% increase compared to the plan. The reason for this increase is the significant increase in the water supply area compared to the initial plan, which came with the development of the city proper. Along with the expansion of the city proper, part of the water supply target area covered by the Chengbai Water Treatment Plant, which was developed at the same time, was added to the scope of development.

Yujiang River, the water source

Chengbai Water Treatment Plant

(3) Training for the staff of the executing agency

As this project was the first construction and operation of sewage treatment facilities for Yulin City, training in Japan in cooperation with the local government of Japan was planned. However, after the commencement of this project, training in Japan was canceled because of the stricter control on overseas training in the Chinese government policy.

While training on the water supply system, budget management, water supply metering control system, leak prevention, and automatic control with regard to water supply facilities was planned, this too was canceled.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The amount of national funds used for the sewerage system for this project could not be obtained,[8] which also prevented the calculation of the total project cost.[9] Therefore, the External Evaluator compared the plan and the actual performance amounts of the Japanese ODA Loan for evaluation. The amount of the Japanese ODA Loan was changed from the initially estimated 6,282 million yen to an estimated 6,144 million yen because of the change in the scope of the project. The actual amount was 5,736 million yen, which was lower than the planned amount at 93%. This reduction in the amount occurred as a result of the scope of the project being reduced for the cancellation of one sewage pumping station, part of the piping network development, establishment of two new water treatment plants, and establishment of a new water supply pumping station.

[8] According to the executing agency, in particular the development of the part of the piping network among the scope of the project was financed by national funds as part of the governmental road development project and covers an extensive area including the part included in the scope of the Japanese ODA Loan project, which makes it difficult to accurately calculate the amount borne by the Japanese ODA Loan.

[9] The total project cost is unknown because of the inability to calculate the total project cost of the development of sewage treatment facilities. However, the executing agency confirms that the part of the sewage treatment facilities covered internally has significantly increased along with the change in the scope and the delay in the project schedule. Considering this point, it is possible that the total project cost of the entire project may have exceeded the planned one.

3.2.2.2 Project Period

This project was initially planned to run from June 2006 (L/A signing) to December 2010 (54 months). However, it actually ran from June 2006 to June 2019 (157 months, 275% of planned duration), which was significantly longer than planned. The project period for each project scope is provided below, which particularly shows the impact of the delay in the water supply system project.

Table 2: Project Period

	Plan	Actual
Overall	June 2006 to December 2010 (54 months)	June 2006 to June 2019 (157 months) 290% of planned duration
Sewerage system project	June 2006 to December 2010 (54 months)	June 2006 to September 2012 (76 months) 146% of planned duration
Water supply system project	June 2006 to December 2010 (54 months)	June 2006 to June 2019 (157 months) 291% of planned duration

Source: The plan data is based on documents provided by JICA while the actual performance data is based on responses given in a questionnaire issued to the project executing agency.

The reasons for delay are provided below.

1) Sewerage system project

The construction of the sewage plants was completed in December 2008, and a trial operation started on the same month. In contrast, the development of the sewage pipes was completed in September 2012, delayed by 18 months compared to the plan. This is due to the time spent on the redesigning and the procedure for design change when the design of a part of the sewerage piping network was changed.

2) Water supply system project

The water supply facilities underwent delay in all processes, specifically in preparation and design, bidding and procurement, civil engineering, and trial operation. The details are as follows.

Factor	Details
Redoing of detailed design	Initially unknown information on the geological characteristics and soil was detected during the preparation and design phase of the construction to divert water from the Yujiang River, causing a need to redo the detailed design and conduct a geological study. As a result, the detailed design was completed in November 2013, approximately 3 years later (35 months) than planned.
Problem in the negotiation to acquire land	The procedure for land tenancy of the part of land in Guigang, a city adjacent to Yulin City, of the land planned for diverting water from the Yujiang River, took time, and 7 years (2008 to 2015) were required to complete the negotiations. In addition to the complexity of the procedure and practices for land tenancy, changing the land to be acquired and the negotiation of compensation amount took more time than planned, resulting in a significant delay in land acquisition. This delay in land acquisition also impacted the progress of the above-mentioned geological study and led to the delay in the completion of the design phase of the project.
Delay in the project appraisal procedure	The delay in the detailed design phase caused a delay of almost 4 years in starting the bidding and procurement. The rise in prices during this period further led to a reconsideration of the project cost in December 2008, and the financing and appraisal procedure for the reconsidered project cost also took time.
Delay in the construction schedule	Because of the prolonged period from the start to the completion of the construction (2008 to 2017), the negotiation for delivery of the facilities with the construction company, which demanded additional construction payment reflecting the increase in prices during this period, did not proceed smoothly, causing a delay in starting the trial operation, which was finally conducted in September 2017. This is a delay of nearly 7 years (81 months) compared to the initial plan.

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

The financial internal rate of return (FIRR) as of the appraisal was calculated based on a project life of 30 years, with benefit calculated as utility charge revenue and the expenses calculated as project cost, operating and management cost, and maintenance cost.[10]

As a result of re-calculating the FIRR for the water supply system, the 3.3% FIRR at the time of the appraisal turned to a negative. The possible reasons behind this include the shorter benefit period due to the delay in the completion of the construction of the facilities, the increase in income tax rate after the appraisal, and the significant currency exchange rate fluctuations during the period along with a general rise in the prices.

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

[10] While the FIRR for the sewage treatment system was 2.8% at the time of the appraisal, as mentioned previously, because of the inability to calculate the total amount of the overall project cost including the domestic part, it was not possible to calculate the internal rate of return.

3.3 Effectiveness and Impacts (rating: ③[11])

3.3.1 Efficetiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

In this section, the External Evaluator confirms the degree of achievement of the project purpose; namely, to what extent "Reduction of water pollutants flowing into the Nanliujiang River and stabilization of water supply in the City" was achieved at the time of the ex-post evaluation. Specifically, quantitative effects such as the amount of water supply and the amount of sewage treatment, as well as qualitative effects such as effects of water quality improvement are evaluated mainly in terms of the indicators set at the time of planning.

(1) Sewage treatment facilities

The operation status of the sewage treatment facilities developed in this project is as follows. In 2010, this sewage treatment plant was expanded in the second phase with domestic funds, and the current treatment capacity per day was expanded from 100,000 m^3 to 200,000 m^3. As a result, all of the following indicators are actual results of the entire treatment plant including the second phase of this project, and are not accurate quantitative comparisons with planned values.

Table 3: Operation status of the sewage treatment plant

Name of indicator	Baseline	Target	Actual			
	2005	2011[12]	2012	2013	2017	2018
		1 Year After Completion	Completion Year	1 Year After Completion	5 Years After Completion	6 Years After Completion
Population connected to sewage treatment facilities (ten thousand people)	0	35	60	60	70	75
Sewage treatment capacity (ten thousand m^3/day)	0	10	20	20	20	20
Sewage treatment volume (ten thousand m^3/day)	0	10	11.9	14.2	14.4	18.8
Treatment rate (%)	0	77	88.81	100	92.31	100
Generated sludge (tons)	0	–	10,604	7,300	16,694	18,407
Sludge treatment amount (%)	0	–	100	100	100	100

Source: Responses to the questionnaire to the executing agency

1) Actual performance one year after project completion (2013) exceeded the project's targets in all indicators, including population connected to sewage treatment facilities, sewage treatment

[11] Rating for Effectiveness is to be put with consideration of Impacts.

[12] At the time of planning, the targets were set for 2011, one year after the project was scheduled to be completed. As evaluation should be implemented under the optimum operating condition of the facilities, the targets were evaluated based on the 2013 results, one year after the actual project completion.

volume, and treatment rate, which shows that sewage treatment facilities are working as expected.

2) Population connected to sewage treatment facilities at the time of the ex-post evaluation (2018) reaches 750,000 people, which exceeded twice the initial target. Yulin City has been developing its sewer network, and neighboring rural areas are added to the treatment area, which leads to an increasing demand for it.
3) As a result, average sewage treatment volume per day has reached 188,000 m^3, which is almost the upper limit of treatment capacity. The City plans to expand its capacity by an additional 150,000 m^3/day and construct a new treatment plant for industrial wastewater in order to meet the increasing demand in the future.

Table 4 indicates the effects on reduction of water pollutants and degree of achievement of national criteria for water quality by this project.

Table 4: Effects of the sewage treatment plant on reduction of pollutants

Name of indicators	Base-line 2005	Target 2011 1 Year After Completion	Actual 2009 Completion Year	Actual 2010 1 Year After Completion	Actual 2018 1 Year After Completion of the 2nd Phase Construction	National criteria B of the first-class (former criteria at the time of planning)	National criteria A of the first-class (new criteria from 2017)
BOD (biochemical oxygen demand)							
Influent quality (mg/l)	–	–	82.01	46.66	46.33		
Effluent quality (mg/l)	–	20	**9.86**	**1.11**	**0.97**	<<20 mg/l	<<10 mg/l
Reduction rate (%)	–	–	88.0%	97.6%	97.9%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
SS (suspended solids)							
Influent quality (mg/l)	–	–	140.24	118.75	104.42		
Effluent quality (mg/l)	–	20	**15.91**	**15.95**	**7.92**	<<20 mg/l	<<10 mg/l
Reduction rate (%)	–	–	88.7%	86.6%	92.4%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
T-N (total nitrogen)							
Influent quality (mg/l)	–	–	22.58	20.76	17.34		
Effluent quality (mg/l)	–	20	**14.83**	**13.79**	**11.83**	<<20 mg/l	<<15 mg/l
Reduction rate (%)	–	–	34.3%	33.6%	31.8%		
Degree of achievement	–	–	**Achieved**	**Achieved**	**Achieved**		
T-P (total phosphorus)							
Influent quality (mg/l)	–	–	2.31	2.81	1.84		
Effluent quality (mg/l)	–	1.5	**1.29**	**1.57**	**0.45**	<<mg/l	<<0.5 mg/l
Reduction rate (%)	–	–	44.2%	44.1%	75.5%		
Degree of achievement	–	–	**Achieved**	**Not achieved**	**Achieved**		

Source: Responses to the questionnaire to the executing agency

1) Reduction of pollutants has achieved the targets in almost all indicators as well as the national criteria at the time of planning. Thus, it can be evaluated that expected effects have been achieved.
2) Subsequently, because water quality criteria for sewage treatment set by the national government have become stricter, construction for improving treatment process was also carried out at this treatment plant in 2017 in order to meet the new criteria. Currently, effects of treatment have fully achieved these new criteria, and the treatment maintains good effects.
3) The fact that the sewage treatment plant has enhanced the effects of reducing pollutants by its own efforts can be appreciated as well. Yulin City's sewerage system mainly adopts a combined sewer system. Therefore, when rainwater increases, organic matter is reduced, resulting in declined treatment efficiency. To solve this problem, waste liquids containing organic matter are received from a neighboring beer factory without any charge and are utilized to enhance the efficiency of advanced treatment.

(2) Water supply facilities

Because the Dapingshan Water Treatment Plant and the Shanxin Water Treatment Plant, which were originally to be built through a Japanese ODA Loan project, were excluded, this section will mainly evaluate water supply in Yulin City Proper, including water supply population and amount of water supply. In addition, considering the situation of using the water conveyance project from the Yujiang River, effects as a Japanese ODA Loan project will be evaluated comprehensively. In addition to the Chengbai Water Treatment Plant improved by the Japanese ODA Loan project, two water treatment plants[13] are currently operating in the Yulin City Proper. The following data indicate the total of these three water treatment plants, and a strict comparison to targets will not be carried out.

1) Situation of water supply to Yulin City Proper

The status of water supply to the entire Yulin City Proper and the areas covered by the facilities by the Japanese ODA Loan project (colored area) are as follows.

[13] The Jiangnan Water Treatment Plant and the Chengtong Water Treatment Plant, whose water source is the Nanliu River, were planned to be converted to a reserved water supply facility for the Chengbai Water Treatment Plant after the completion of this project. Modifying the initial plan, the water treatment plants changed their water source and continue to supply water to the urban area. The Jiangnan Water Treatment Plant is sourced from the Yujiang River developed by this project, and the Chengtong Water Treatment Plant is sourced from Suyan Dam.

Table 5: Water supply to the urban area of the City carried out by this project

Name of indicator	Baseline 2004	Target 2011	Actual 2017	Actual 2018
		1 Year After Completion	Completion Year	1 Year After Completion
Water supplied population (ten thousand people)	29	57	–	–
Water supplied population of the urban area of the City (ten thousand people)	29	56	71.2	75.63
Among the above, area covered by Chengbai Water Treatment Plant (ten thousand people)	29	56	36.67	40
Among the above, area covered by Jiangnan Water Treatment Plant (ten thousand people)	–	–	16.61	17.1
Among the above, area covered by Chengtong Water Treatment Plan (ten thousand people)	–	–	17.92	18.53
Water supply capacity per day (ten thousand m^3/day)	9.3	26	–	–
Water supply capacity per day to the urban area of the City (ten thousand m^3/day)	–	24	23.69	23.73
Among the above, Chengbai Water Treatment Plant (ten thousand m^3/day)	–	24	15.10	15.50
Among the above, Jiangnan Water Treatment Plant (ten thousand m^3/day)	–	–	3.69	3.95
Among the above, Chengtong Water Treatment Plant (ten thousand m^3/day)	–	–	4.90	4.28
Average daily quantity of water intake of Chengbai Water Treatment Plant (ten thousand m^3/day)	–	–	13.15	13.67
			3.15	3.67
Among the above, quantity of water intake from Yujiang River			10	10
Among the above, quantity of water intake from the existing water source (Suyan Dam)				
Average daily water supply (ten thousand m^3/day)	–	–	–	–
Average daily water supply to the urban area of the City (ten thousand m^3/day)	–	–	21.55	21.57
Among the above, Chengbai Water Treatment Plant (ten thousand m^3/day)	–	–	13.00	13.50
Among the above, Jiangnan Water Treatment Plant (ten thousand m^3/day)	–	–	3.65	3.8
Among the above, Chengtong Water Treatment Plant (ten thousand m^3/day)	–	–	4.90	4.27

Coverage of the water supply system (%)	59	91	–	–
Coverage of the water supply system in the urban area of the City (%)	72	100	100	100
Among the above, Chengbai Water Treatment Plant (%)	72	100	100	100
Among the above, Jiangnan Water Treatment Plant (%)	–	–	100	100
Among the above, Chengtong Water Treatment Plant (%)	–	–	100	100

Source: JICA technical appraisal report, responses of the questionnaire to the executing agency

1. In one year after project completion in 2018, coverage of the water supply system[14] in the Yulin City Proper reached 100% and water supplied population[15] in the City reached 756,300 people. Water supplied population, which is covered by the Chengbai Water Treatment Plant improved in this project as well as the Jiangnan Water Treatment Plant using the channels of the Yujiang River, totaled 571,000 people,[16] exceeding 560,000 people at the time of planning. This accounts for 75% of the water supplied population of the entire City.
2. Water supply capacity per day to the urban area of the City has almost reached the target, 240,000 m^3/day, and the target of water supply is almost achieved. Quality of supplied water also meets the national criteria and no major problems have been observed. However, in the Chengbai Water Treatment Plant, average daily water supply and water supply capacity per day are 56% and 68% of the planned capacity, respectively, and the water supplied population and water supply capacity of the water treatment plant itself have not achieved its initial plan.
3. Reason for this includes an optimized water supply system. The Jiangnan Water Treatment Plant and the Chengtong Water Treatment Plant, which were scheduled to be converted to reserved water supply facilities, are now fully operational along with the expansion of the city proper. As a result, it is considered that the assumed water supply area covered by the Chengbai Water Treatment Plant at the time of planning shrank, reducing the water supplied population to be covered.
4. The area where water is supplied by the Chengbai Water Treatment Plant is expected to expand further, because a part of Beiliu City adjacent to Yulin City will be merged into Yulin City.

[14] Coverage of the water supply system is defined as a proportion of water supplied population to population living in the water supplied area.
[15] Water supplied population is defined as a population that actually receives water supply by connecting water pipes.
[16] Because the Jiangnan Water Treatment Plant started water intake from the Yujiang River in 2018, values of 2018 and beyond are used as indicators.

Based on the above, at the time of the ex-post evaluation, the purpose of this project, developing a sewage treatment system in the urban area of the City has been mostly achieved, while the operational status of the Chengbai Water Treatment Plant built using a Japanese ODA Loan has not yet reached the plan. Water supply is likely to increase further in the future, but the overall effect of the water supply system project is evaluated as being fair.

2) Water conveyance project from Yujiang River

As mentioned in "3.1.4 Appropriateness of the Project Plan and Approach," water conveyance volume from the Yujiang River remains at only about 40% of the original plan as of 2018. The three water treatment plants supplying water to the city proper take in water from the existing Suyan Dam as the main water source, and the Chengbai Water Treatment Plant also takes in more than 70% of the whole water from the existing Suyan Dam.

1. Besides low cost of water intake, the main reason was that as full-scale operation of the water conveyance project delayed to the year 2017, it is still under adjustment period for operation. Currently, the water from the Yujiang River is conveyed to the Chengbai Water Treatment Plant and the existing Jiangnan Water Treatment Plant, from which water is supplied to the city proper. Current water supply to city proper is about 70,000 m^3, and is gradually increasing.
2. In the initial plan, it was planned to supply a part of 250,000 m^3/day of water conveyance volume from the Yujiang River to neighboring cities and rural areas. At the time of the ex-post evaluation, as shown in the table below, in addition to the initially planned Qiaoxu Township and Shinan Township of Guigang City, a plan is underway to sell raw water to four townships by 2020. Water supply to some areas has already started.

Table 8: Future prediction of water conveyance from Yujiang River to urban areas and other townships

Estimated average water supply volume per day	Period to start supplying	2019	2020	2021	2022	2023
Total (ten thousand m^3/day)		**6.79**	**11.16**	**13.70**	**16.30**	**19.90**
Urban area of the City	Has already started	4.00	5.00	6.50	8.80	12.00
Qiaoxu Township (Guigang City)	Has already started	1.00	1.97	2.50	2.70	3.00
Zhanjiang Township (Guigang City)	Has already started	0.29	0.60	0.70	0.80	0.90
Shinan Township (Yulin City)	Made a contract (Scheduled to start from July 2019)	1.50	3.00	3.00	3.00	3.00
Xingye County Industrial Park (Yulin City)	From June 2020	0.00	0.58	1.00	1.00	1.00

Source: Responses to the questionnaire to the executing agency

Over the next five years, total water supply is anticipated to increase to approximately 200,000 m^3, which amounts for about 80% of its water conveyance capacity of 250,000 m^3, and is expected to achieve a favorable utilization.

In summary, the sewerage system project has almost achieved its plan. On the other hand, although the water supply system project has almost achieved its objective of stabilizing water supply to the urban area of the City, the water conveyance project of the Yujiang River has just started partial utilization because of delays in development of facilities. Considering this point, effectiveness of the water supply improvement project including the water conveyance project at the time of the ex-post evaluation is evaluated to be still fair. However, as it has been confirmed that there is a high possibility of facilitating full-scale utilization in the next two to three years, the overall effectiveness of this project is evaluated to be high. It is desirable to monitor the future progress on a regular basis to confirm whether the operation status of the entire system including the water conveyance project advances as expected.

3.3.1.2 Qualitative Effects (Other Effects)

Refer to Section 3.3.2 “Impacts.”

3.3.2 Impacts

3.3.2.1 Intended Impacts

In this project, “improvement of living environment of residents of Yulin City” is regarded as an impact. Specifically, the External Evaluator analyzed “improvement of water environment” and “improvement of residents' convenience and satisfaction/improvement of living environment through improvement of water environment” by developing water supply and sewerage systems in this project as specific impacts.

(1) Improvement of water environment

1) Monitoring data at the observation points of the Nanliujiang River

The following data indicate the change of water quality at the observation points of the Nanliujiang River that discharges treated sewage and the Qingwanjiang River that flows into the Nanliujiang River. The lower point of Yulin City serves as the lower observation point of the Nanliujiang River that is closest to the sewage treatment plant. The river water quality is affected by the degree of pollution in the upper area of the river, and the amount of water treated by the sewage treatment plant is very small compared to the amount of river water of the Nanliujiang River Therefore, as it is difficult to clearly examine the relationship with this project, the External Evaluator analyzes the contribution of this project qualitatively.

Table 9: Water quality of Nanliujiang River

Observation section	Observation year	PH	SS (mg/m^3)	COD (mg/m^3)	BOD (mg/m^3)	T-P (mg/m^3)
In front of city where water flows into Nanliujiang River	2002	7.43	–	–	–	–
	2018	7.24	3.02	15.01	0.51	0.47
Upper point of Nanliujiang River	2002	7.66	–	–	–	–
	2018	7.52	3.82	18.8	0.82	0.34
Middle point of Yulin City (Nanliujiang River)	2004	7.42	29	51.33	17	0.021
	2018	7.36	4.01	30.65	1.38	0.65
Lower point of Yulin City (Nanliujiang River)	**2004**	**7.57**	**29**	**48.67**	**7**	**0.594**
	2018	**7.34**	**5.11**	**17.81**	**1.21**	**0.38**
	Compared to 2004	**-3%**	**-82%**	**-63%**	**-83%**	**-36%**
In front of city where water flows into (Qingwanjiang River)	2004	7.2	22.33	5.67	1.1	–
	2018	7.17	2.85	11.24	0.85	0.21
In the city (Qingwanjiang River)	2004	7.34	41.67	33.33	3.93	0.64
	2018	7.23	3.96	13.41	1.32	0.21

Source: data for 2002 and 2004 at the time of the appraisal were retrieved from the technical appraisal report, and observed data for 2018 were provided from the executing agency

1. At the observation section adjacent to the sewage treatment plant developed by this project, a decrease in concentration of major water pollutant of greater than 50% was confirmed. It shows that river water quality has an improving tendency in general.
2. By calculating total amount of reduced water pollutants by this project based on the annual treatment amount by the sewage treatment plant, a reduction effect of 311 kg in BOD and 2,020 kg in COD can be estimated according to the results of 2018. These reductions can be evaluated as contributing to some extent to improving river water quality and curbing its deterioration.

(2) Improvement of residents' convenience and satisfaction/improvement of living environment through improvement of water environment

1) Result of the interviews with beneficiaries

To grasp recognition and evaluation of beneficiaries about the "improvement of water environment," interviews[17] were conducted with residents of Yulin City and real estate companies in the City. Then, the following were examined: water environment, improvement in residents' convenience and their living environment, as well as changes in river environment before the project implementation (2006) and at the time of the ex-post evaluation (2018). Examples are summarized below.

[17] In the interviews, a group discussion was conducted with eight participants from a property management company, a water supply company, a real estate developer, and retired workers (seven men and one woman), to confirm changes in water environment and its effects on their lives. Interviewees were selected in the cooperation with the executing agency.

1. Improvement in residents' convenience and their living environment: Several comments were found that comfort with domestic water use such as the stabilization of water pressure by improvement of water supply has been increased. One respondent said, "Before development of this project, low water pressure hindered convenience of our living such as using showers only at night when the amount of water use got lowered, but now water pressure is stable and we can use water at any time." Another respondent (real estate agent) said, "Previously, low water pressure induced frequent suspension of water supply at the 3rd floor or above, limiting housing development to low-rise housing. However, development of water supply allowed building of high-rise houses." From the comment, it can be assumed that development of water infrastructure facilitated real estate development and urban development.

2. Changes in water environment/river environment: Some respondents recognized the effects of improvement of health and increased time for enjoying leisure at rivers by water quality improvement. According to a respondent, well water was used until around 2007, but very high ammonia nitrogen led to safety issues, and many people had suffered from diseases such as throat irritation and hepatitis. After development of this project, tap water quality has reached the level allowing use, which greatly improved these issues. One respondent is able to enjoy fishing because water quality of the river has improved, odor and turbidity have been reduced, and the riverbed has been improved.

The results of the interview above, in spite of a limited sample, show that many respondents stated that stabilization of water brought about effects such as improvement of housing conditions. Therefore, it can be inferred that overall satisfaction with current water supply environment has increased.

3.3.2.2 Other Positive and Negative Impacts

(1) Antipollution measures

At the time of planning, sludge discharged from the sewage treatment plant was to be disposed at the existing landfill site. Although the plan has not greatly changed for now, sludge is dehydrated and disposed at the existing landfill site, or it is sometimes transported to a fertilizer factory for reuse.[18] As mentioned in the section of Effectiveness, the generated sludge is 100% treated and there are few negative environmental impacts.

[18] At present, investigation on hazardous substances such as heavy metals has not been carried out, but within the scope of confirmation during the field survey, no machinery, electrical, or electronics factories where heavy metals are used were founded in the covered area. It is therefore considered that there are no major concerns.

Sludge treatment

Truck for taking out sludge

(2) Impacts on the natural environment

At the time of appraisal, this project was classified as Category B of *the JBIC Guidelines for Confirmation of Environmental and Social Considerations* (April 2002) and was judged to have no undesirable and significant impact on the environment. The Yujiang River, the source of water intake, has abundant water. Therefore, any impacts on the natural environment/ecosystem due to water intake are unforeseen. Moreover, it is considered that advanced treatment in sewage treatment can minimize the environmental impacts on the river where treated water is discharged. No environmental protection areas exist in the area covered by this project and its neighboring area. In addition, no issues that had not been envisaged in the EIA report were found at the time of the ex-post evaluation.

(3) Impacts on the social environment

1) Resettlement and land acquisition: No resettlement caused by this project has been carried out. As for land acquisition, 13 ha was planned to be acquired in total for water supply and sewerage systems, and the area actually acquired was about 12.4 ha,[19] which was a slight decrease from the plan. This is because a part of the planned site for a sewage pumping station was designated as a relocation site of residents in development plan of the City, thereby shrinking the site for the pumping station. It took about seven years to reach an agreement on all land acquisitions, and nine years to complete payment. Because of the rise in land prices during this period, the acquisition cost amounted for about 50 million yuan (about 685 million yen), a 160% increase from the plan.
2) Difficulties in negotiations on land acquisition: It can be assumed that careful proceedings of the land acquisition process paradoxically required more time than expected. As stated in the section of efficiency, it was difficult to negotiate on compensation with farmers in the land acquisition of the water supply facilities. Although the compensation amount

[19] The breakdown is 7.23 ha acquired for sewage treatment facilities and 5.15 ha for water supply facilities.

initially presented to the target people was in accordance with the national criteria, the farmers did not agree with the amount and the negotiations were prolonged. Eventually, the negotiations reached an agreement that an infrastructure development project in the target area would be carried out in addition to the compensation. In addition, a part of the planned site for a channel is located in neighboring Guigang City, and the administrative organization of Guigang City was mainly in charge of negotiations on acquisition of the land in the City. As a result, it took time to coordinate between the two cities as well as to confirm the agreement.

As described above, this project has achieved expected outcome in general. However, due to the partial delay of construction work, outcome of the project is still in the process of emergence. Therefore, effectiveness and impacts at the time of the ex-post evaluation are fair, though it is expected to achieve high effectiveness in the near future.

3.4 Sustainability (Rating: ③)

3.4.1. Institutional / Organizational Aspect of Operation and Maintenance

At the time of the planning of this project, the Yulin People's Government was supposed to be in charge of the entire project. The Finance Bureau of the city government and the Environmental Protection Bureau were supposed to be in charge of monitoring the finances and environmental aspects, respectively. Currently, the operation and maintenance system has not been greatly changed. The operational management system in the water supply and sewerage system project is as follows.

(1) Sewage treatment facilities

In accordance with its plan, the operation and maintenance of sewage treatment facilities is carried out by "Yulin City Meirin Sewage Treatment Limited Liability Company" under the umbrella of state-owned company "Yulin City Urban Construction Investment Group Limited Company." The company consists of six sections, including the Facilities Maintenance Section, Production Management Section, and Pipeline Maintenance Section, with 59 employees. Among them, 51 employees are engineers, who are properly assigned. There is no problem of shortage in labor.

(2) Water supply facilities

In accordance with its plan, a state-owned company "Yulin Water Supply Company" is responsible for the operation and maintenance of the water supply improvement project. Yulin Water Supply Company consists of three water treatment plants, three pumping stations, and

fourteen sections, including the Pipeline Operation and Maintenance Office, the Water Supply Section, and the Manufacture Technology Management Section. The company has been granted patent management rights by the Yulin People's Government and has received an entrustment from the City to operate the services. Yulin Water Supply Company has a total of 400 employees, including 50 to 60 employees at the Chengbai Water Treatment Plant.

3.4.2 Technical Aspects of Operation and Maintenance

(1) In both water supply and sewerage systems, technologies and specifications of introduced facilities have already been established in China. The staff members in charge, who have national qualifications required for each process with practical experience, have been assigned. Therefore, no major concern on technical aspects of operation can be found.

(2) Experts in sewerage system projects participated in the field survey to interview staff members in charge. The staff members gave appropriate responses such as knowledge and experience of treatment technologies and how to handle problems that may occur. In addition, manuals for operation, maintenance, and inspection are prepared in both water supply and sewerage systems, so that people in charge at each facility can always confirm. The records of periodic inspections were reviewed as well; the records are found to be properly managed in all facilities and there are no problems with management capability.

(3) With regard to human resource development, training for employees has also been institutionalized. Because an environment has been prepared in which employees can take training courses in the autonomous region, it can be evaluated that there are no major technical problems.

3.4.3 Financial Aspect of Operation and Maintenance

(1) Sewage treatment facilities

"Yulin City Meirin Sewage Treatment Limited Liability Company," which operates sewage treatment facilities, does not collect sewerage charge directly; instead, the government provides the company a grant as annual revenue. Current revenue and expenditures are as follows.

Table 10: Financial status of sewage treatment plants

Item	2015	2016	2017
1. P/L indicators			
Revenue (Unit: Thousand Yuan)	17,335	17,681	18,366
Expenditure (Unit: Thousand Yuan)	17,379	17,678	18,085
Operating profits (Unit: Thousand Yuan)	**-44**	**3**	**281**
Operating profit margin (%)	-25.5%	0.016%	1.5%
2. B/S indicators			
Capital adequacy ratio (%)	21.99	19.16	21.05
Current ratio (%)	196.2	150.6	–

Source: Prepared based on responses to the questionnaire

Although the plants had run a slight deficit in 2015, it turned into a single-year surplus due to lowering administrative costs from 2016, and since then the plants have recorded profits. The sewerage charge at the time of the ex-post evaluation was set at 0.95–1.4 yuan/m^3, and has been raised from 0.82 yuan/m^3 at the time of the appraisal. The sewerage charge is controlled by the Price Bureau of the Autonomous Government, and the current price is set at a level that barely maintains the soundness of service operations. Despite its low profitability, the service operation is based on the government budget, and no major problems have occurred in financial management.

(2) Water supply facilities

1) Water supply services

According to the water company that operates the water supply facilities, the water supply services have introduced an independent profit system and no subsidy has been received from the government. The recent profit and loss statement is as follows.

Table 11: Financial status of the water supply facilities

Items	**2015**	**2016**	**2017**	**2018**
1. P/L indicators				
Operating revenue (Thousand Yuan)	115,271	118,733	124,086	148,761
Operating costs (Thousand Yuan)	89,401	84,681	101,208	145,370
Operating profits (Thousand Yuan)	30,716	34,357	23,183	3,684
Operating profit margin (%)	26.65%	28.94%	18.68%	2.48%
Net profit (Thousand Yuan)	27,024	30,163	20,142	4,197
2. B/S indicators				
Capital adequacy ratio (%)	30.34%	36.61%	38.18%	37.97%
Current ratio (%)	707%	761%	136%	129%

Source: Prepared by the External Evaluator based on data provided by the executing agency

1) From 2015 to 2017, very high operating profits were yielded at 20–30%. According to the executing agency, the results were brought by sales such as water pipe connection work and sales of installed devices, in addition to revenue from water charge. It can be estimated that 2018's operating profit margin of about 2.5% reflects usual profitability of water supply services. The capital adequacy ratio has also been kept at nearly 40%, and it can be said that a sound financial footing has been generally maintained.
2) Expansion of water supply area brought about steady growth of the revenue from water charge, and operating revenue in 2018 greatly increased by 14% year-on-year.
3) Water charge is set by the autonomous government in consideration of profitability. The water charge at the ex-post evaluation was raised from 1.55 yuan/m^3 at the time of the appraisal to 2.3–4.49 yuan/m^3. Currently, the standard rate for general households is 2.3 yuan/m^3, and the water supply cost per m^3 is about 1.8 yuan/m^3. Therefore it can be evaluated that profitability in service operation is secured.
4) As mentioned in the section of Effectiveness, the water company sells water from the Yujiang River to other townships and Guigang City, and the water conveyance volume is expected to grow significantly in the future. Revenues from these above are also expected to become a stable financial source for future operation and maintenance.

3.4.4 Status of Operation and Maintenance

(1) Sewerage system project

The operation and maintenance of sewage treatment facilities are generally carried out appropriately, and no serious problems have been confirmed. Annual maintenance cost is 2.07 million yuan (approximately 34.36 million yen), and repairs are carried out regularly. Japanese experts in sewerage system projects also participated in the tour of the facilities, and confirmed the following two points regarding the durability and operational issues of the facilities.

・ Damaged coarse screen: The coarse screen[20] prepared with the Japanese ODA Loan was damaged two years after installation and was replaced with other equipment. The experts in sewerage system projects who attended the field survey point out that the installed screen was inexpensive and may have had low durability, and that it was installed at a narrow and steep slope, resulting in the screen being subjected to overload more than expected. Equipment replacement is carried out quickly and no operational problem occurs, but periodic replacement may be necessary in the future.

・ Deterioration of outdoor facilities (aeration tank, settling tank): Deterioration of foundations (concrete structures) of outdoor facilities became noticeable. According to the opinion of the

[20] A device that removes large garbage items and floating matter flowing into a sewage treatment plant

attending experts, in addition to air pollution such as acid rain, there may be other factors such as issues on the quality of the material and insufficient frequency of coating[21] as well. According to the executing agency, regular painting work is planned. Therefore, if the work proceeds as planned, it can be considered that durability of the facilities will not be significantly affected. However, if the deteriorated part were abandoned, the durable life of the facilities might be shortened. Therefore, regular maintenance should be appropriately planned and carried out as planned.

Damaged coarse screen

Deteriorated part of concrete structures

(2) Water supply system project

Because the water supply facilities have been recently completed, the operation status and facilities are in good condition. Management is carried out in accordance with the safety management manual, and no problems are found. The water supply pumping station also has stable operation hours, and no major failure has occurred in the electrical facilities. A system of replacing parts as well as their suppliers in case of failure have been established. It is reported that water pipes and water distributing pipes are normal in all sections.

Both water supply and sewerage systems are already common infrastructures in China, and the system for maintaining this project and conducting the sewage treatment services has been prepared with regard to technology, finance, and current state. In terms of management of facilities, deterioration of the fundamental structures of sewage treatment facilities was observed, but there was no serious concern because a repair plan has been formulated at this time. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

This project was conducted for the purpose of reducing water pollutant emissions and supplying water safely and stably to improve the living environment of the local residents by establishing clean water infrastructure and sewage treatment facilities in Yulin City, Guangxi

[21] Lime is used for coating because of its inexpensiveness.

Zhuang Autonomous Region. The relevance of this project is high because of its conformity with the Japanese government's policies and needs as well as Chinese policies and needs. While the scope of the project has been revised and the period has been extended, the infrastructure has been established mostly as planned, and thus the efficiency of this project can be evaluated as fair. Since the implementation of this project, the water supply and sewage infrastructure has been operating satisfactorily, with highly effective reduction of water pollutants through the construction and operation of sewage treatment facilities. The water supply system has also been operating steadily, responding to the increasing demand and providing a stable water supply to the local residents. The expansion and improvement of the water and sewage infrastructure are still ongoing. Additionally, the responsible organizations have been structured with stable foundations with regard to technology and finances, which indicate good sustainability. In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Improvement of the maintenance plan for sewage treatment facilities

In sewage treatment facilities, external appearance of outdoor facilities was deteriorated and some equipment malfunctioned. The malfunctioned equipment is inexpensive but has a problem in terms of durability. It is necessary to continue regular maintenance and keep the frequency of repairment in the future. In addition, it can be assumed that major causes of deterioration of external appearance of outdoor facilities include painting with low-cost lime, air pollution, and acid rain. Thus, it is desirable to strengthen the maintenance and inspection system in order to keep the durable life of the facilities, such as using corrosion-resistant materials and improvement of maintenance frequency.

4.2.2 Recommendations to JICA

Nothing in particular.

4.3 Lessons Learned

Improvement of accuracy of the Project Plan and Approach

The operation rate of the water conveyance project developed by this project is only about 40% of the initial plan. This is due to factors such as the ability to secure a greater quantity of water intake of the existing water source than in the initial plan, as well as significantly increased water intake cost from the time of planning. This means that these possibilities might not have been fully examined at the project planning stage. In the future, in addition to the initially expected water supply for the city proper, needs for water supply to the area along the channel are expected. If accurate examination of needs and alternatives means had been

conducted throughout the project planning period, effects on the entire durable life of the facilities could have appeared much earlier, such as preferential supply to the area along the channel where water can be supplied at a lower cost.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs		
1) Sewer network improvement	156 km	Almost as planned (153.76 km)
2) Sewage pumping stations	Newly built 2 stations	Newly built 1 station
3) Sewage treatment plant	Newly built 1 plant 100,000 m^3/day	As planned
4) Water supply channel	75 km	Almost as planned (72.02 km)
5) Water supply pumping stations	Newly built 4 stations	Newly built 3 stations
6) Water treatment plant (newly built)	Newly built 2 plants	Canceled
7) Water treatment plant (extended)	Extended 1 plant 10,000 m^3/day → 27,000 m^3/day	As planned
8) Training	Training in Japan regarding water and sewage operations, targeting the staff of the executing agency	Canceled
2. Project Period	June 2006–December 2010 (54 months)	June 2006–June 2019 (157 months) 290% compared to the planned period
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	6,644 million yen 6,792 million yen 13,436 million yen 6,282 million yen 1 yuan = 13.7 yen (As of September 2005)	5,736 million yen Cannot be calculated[22] Cannot be calculated[23] 5,736 million yen 1 yuan = 15.13 yen (Average exchange rate from 2006 to 2017)
4. Final Disbursement	October 2015	

[22] According to the executing agency of development projects for sewage treatment facilities, the cost of the construction of the drainage pipe network among the project scope was spent as part of a road improvement project by the government. The section to be improved was more extensive, including the Japanese ODA Loan project. Thus, it could not be calculated because it was difficult to calculate the accurate amount allocated to the sewage treatment facilities maintenance project.

[23] For the reason mentioned above, the total cost of this project including water supply and sewerage systems could not be calculated.

People's Republic of China

FY2018 Ex-Post Evaluation of Japanese ODA Loan

Ningxia Hui Autonomous Region Urban Water Environment Improvement Project

External Evaluator: Kenji Momota, IC Net Limited

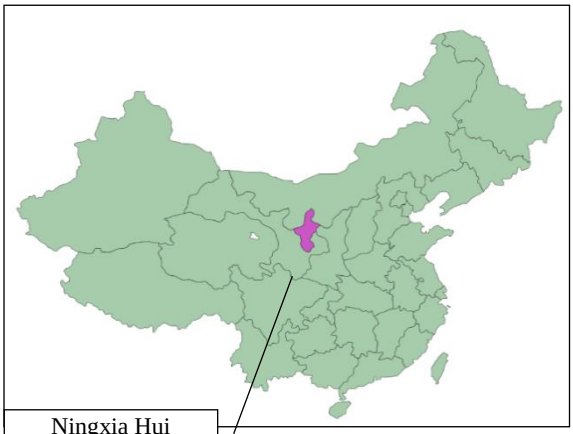
0. Summary

This project was implemented to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities (Reuse of treated sewerage water) in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby contributing to the improvement of the living environments for residents of in both cities.

This project is in line with the policies and needs of the Japanese and Chinese governments and is relevant in general. However, as for Shizuishan City, the project outputs and effects deviated from the project plan along with stagnation of urban development, and there was possibly a problem with the accuracy of the project plan at the time of the appraisal and project management. Regarding the project outputs, facilities were built as planned in general, although changes were made and the period extended because of substitute improvements based on domestic funds. The project cost was lower than planned but the project period was significantly longer than planned; thus, the efficiency of the project was fair.

Regarding the resulting effects of this project, there is a contrast between Yinchuan City and Shizuishan City. Satisfactory results were accomplished in Yinchuan City, whereas the results in Shizuishan City were less satisfactory because the water supply work was not accomplished as planned owing to population decrease in the targeted areas, and the sewerage facilities are barely in operation. Thus, the effectiveness of this project is evaluated as fair. Regarding the operation and maintenance, for both cities, there are no problems with the structure of the organization in charge and technical and financial aspects. However, in Shizuishan City, a situation with no chance of using the facilities, especially sewerage and reclamation facilities, has continued, and thus there seems to be some problems with sustainability. Based on the above, this project is evaluated as partially satisfactory.

1. Project Description



Project Location Map


Sewerage Treatment Plant Built under This Project (Yinchuan City)

1.1 Background

The Ningxia Hui Autonomous Region, which is located in the Ningxia plain in the upstream of the Yellow River in China, is in an arid zone and considered one of the regions facing the most severe water shortage. In its major cities, Yinchuan City and Shizuishan City, the water demand due to industrialization and urbanization increased and exceeded the existing supply capacity in 2007. Areas without water service were facing excessive pumping of groundwater due to the increased number of shallow wells built. In addition, the sewage drainage volume exceeded the city's treatment capacity, and wastewater from houses and plants flowed without treatment into rivers in the city and the underground, worsening water, soil, and groundwater pollution. Given this situation, the Chinese government tightened the control of water resources, such as strengthening of the regulations on private wells , developing new groundwater resources, and promoting of use of reclaimed water, in order to promote overall improvement of water environments through water pollution measures based on improvement of the wastewater treatment capacity.

1.2 Project Outline

The objective of this project is to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby contributing to the improvement of the living environments for residents of both cities.

Loan Approved Amount/ Disbursed Amount	8,432 million yen/8,368 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2007/March 2007

Terms and Conditions	Sewerage treatment facility: General untied loan, at 0.75% interest, redemption period of 40 years, deferment period of 10 years Water supply facility: General untied loan, at 1.5% interest, redemption period of 30 years, deferment period of 10 years Training: General untied loan, at 0.75% interest, redemption period of 40 years, deferment period of 10 years
Borrower / Executing Agency	People's Republic of China/Ningxia Hui Autonomous Region Administrative Agency
Project Completion	September 2015
Main Contractor (Over 1 billion yen)	NINGXIA COAL BASIC CONSTRUCTION CO., LTD (People's Republic of China)
Main Consultant (Over 100 million yen)	None
Related Studies (Feasibility Studies, etc.)	F/S: Created by the Academy of Architectural Design for Plans of Yinchuan City and Shizuishan City in China, on June 2005
Related Projects	None

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: September 2018 – March 2020

Duration of the Field Study: May 12–30, 2019; October 9–17, 2019

2.3 Constraints during the Evaluation Study

In this project, collection of data and information for some items was not sufficient, especially for relevance. Regarding Section 3.1.4 Appropriateness of the Project Plan and Approach, it was not possible to make contact with government officials concerned with Shizuishan City at the time of the appraisal and responsible people involved in the project plan owing to reasons such as retirement and staff turnover, and there were not enough opportunities for discussion, although arrangements were attempted. Much of the information concerning relevance was not recorded in documents, and there was no choice but to analyze the details at that time according to limited estimations. This difficulty is significant because it affects the entire evaluation; in fact, it affected not only the relevance but also the evaluation of effectiveness and sustainability.

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

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of China

(1) Development policy at the time of the appraisal

1) **National level** In the *11th Five-Year Plan (2006–2010)*, the Chinese government set goals of strengthening efforts to secure water resources for cities with a severe water shortage, improving the water supply capacity through extension and upgrading of water service facilities, securing safe drinking water, and saving water resources by reducing the rate of leakage. The *National 11th Five-Year Plan for Environmental Protection (2006–2010)* set a goal of improving the water quality of the Yellow River, designated as a high-priority protection basin, to the level of drinking water. In the *11th Five-Year Plan (2001–2005)*, the goals of the sewerage sector were to achieve a sewerage treatment rate of 70% in urban areas, improve the water quality of water resources through implementation of a comprehensive set of measures in the middle and upper basin of the Yellow River, and promote pollutant reduction measures such as introduction of a system to collect the cost for pollutant emissions.
2) **Provincial level** The government of the Ningxia Hui Autonomous Region formulated the *11th Five-Year Plan for Ecological Construction and Environmental Protection in Ningxia Hui Autonomous Region (2006–2010)*, the goals of which were to ensure that 100% of drinking water in urban areas meets the water quality standards and the sewerage treatment rate reaches 70% by the year 2010. The *Elements of Water Saving Society Construction Plan for Ningxia (2004–2020)* was designed, because of increasingly severe water shortages due to economic development and population increase along with industrialization and urbanization, to produce reclaimed water with the use of technology that reuses treated waste water and build a water-saving society that strives to reduce the amount of clean water usage.

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

1) **National level** The *13th Five-Year Plan for National Environmental Protection (2016–2020)* states that all water supply processes from water sources to faucets will be managed to improve the water quality of drinking water. This plan made it obligatory for local governments and water supply utilities to regularly inspect and evaluate the water quality of drinking water sources, treated water from water purification plants, and water for supply, and set a goal of ensuring that, for the concentrated drinking water sources in urban areas, the ratio of water quality Class I to III[3] exceeds 93% by the year 2020. The plan also states

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

[2] ③: High, ②: Fair, ①: Low

[3] River water qualities are classified into five classes (Class I to V) according to the Surface Water Environmental Quality Standards (GB3838-2002). Class I: Mainly water of water resources. National nature reserve; Class II: Mainly drinking water for household use. Class A reserve. Rare fish species reserve. Spawning grounds for fishes and

clearly that the government will build a water-saving society to protect the environment, with goals of developing counties and cities that serve as a resource recycling economy model, spreading new billing methods such as water billing based on smart metering, and strengthening the accountability for producers. The objective in the sewerage field is that for national surface waters, the ratio of water quality Class I to III will exceed 70%, and it was declared that by the year 2020, sewerage treatment facilities will be built for all of the towns in which a county government is located and the towns with high priority, with the target of achieving a sewerage treatment rate of around 95% and 85%, respectively.

2) **Provincial level** The *13th Five-Year Plan for Ningxia Hui Autonomous Region (2016–2020)* sets out a vision to promote water conservation and efficient water use management in order to resolve water resource constraints, a bottleneck for social and economic development. This plan states clearly that the government will build a water-saving society model through comprehensive use of water, including recycled water (reclaimed water). The government is working on consideration of an ordinance that makes it mandatory for some business operators to use reclaimed water and water-saving campaigns for residents. Yinchuan City and Shizuishan City prohibit excessive extraction of groundwater and are committed to working toward improving rivers through the promotion of sewerage systems.

3) **Municipal level** The *13th Five-Year Plan for Yinchuan City (2016–2020)* recognizes the achievement of the water quality standards for major rivers but still recommends living a daily life as a consumer who is environmentally conscious for sustainable development, and plans water resource development projects in addition to water resource uses such as the storage of rainwater, effective use of Yellow River water resources, protection of groundwater, and diversification of water. The *12th Five-Year Plan for Shizuishan City (2010–2015)* still gave priority to water resource management but set out a new policy to transform the urban development model into a more comprehensive one with emphasis on the replacement of coal with new energy. This policy caused coal business and other related businesses with large amounts of water usage to move to other provinces, drastically reducing the number of companies and people, which had a significant impact on the project scope and effects to be mentioned later. Subsequently, the *13th Five-Year Plan for Shizuishan City (2016–2020)* set a goal of ensuring that the rate of achieving the water quality standards for drinking water is 100%, the rate of achieving the water quality Class III for the basin of the Yellow River is 100%, and the sewerage treatment rate is 85%.

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shrimps; Class III: Mainly drinking water for household use. Class B reserve. General fish species reserve. Swimming area; Class IV: Mainly water for industrial use. General industrial water area. Area of recreational water with no direct contact with a human body; Class V: Mainly water for agricultural use. Agricultural water area. Applied to general landscape conservation.

As seen above, from the time of the appraisal to ex-post evaluation, the policies in the water supply and sewerage sector put emphasis on securing safe drinking water and saving water resources; no significant change is seen in those policies. This project is meant to construct new treatment facilities for water supply, reclaimed water, and sewage in Yinchuan City and Shizuishan City, where there are restrictions on the use of surface water and groundwater, thereby expanding the overall treatment capacity of the cities. The project is highly consistent with the Chinese government's development policies, where the priority areas include reduction of pollutants and improvement of water environments.

3.1.2 Consistency with the Development Needs of China

(1) Situation at the time of the appraisal

The Ningxia Hui Autonomous Region has an annual precipitation of 200 mm, which is less than the national average of 585 mm. In addition, the amount of domestic water use per person per day is 110 L, which means that water use is limited to half the national average, with severe water shortages. At the time of the appraisal, the water supply-demand balance of Yinchuan City and Shizuishan City was such that the demand was two to three times the supply capacity and the shortage was dependent on development of a private well. The water demand increased further owing to rapid social and economic growth at that time, and it was feared that the groundwater sources would be depleted if things continued as they were. Under this environment, both cities were working mainly on improvement of the existing water supply facilities and spread of water-saving technologies for efficient use of water resources. For the Ningxia Hui Autonomous Region with scarce water resources, the necessity of replacing clean water demanded by plants and other facilities with reclaimed water was high, and at the time of the appraisal, reclaimed water was used for greening, plant use, and other purposes. In the case of Yinchuan City, the forecast of demand for reclaimed water in 2010 was 150,000 m^3/day, including the prospect of using the thermal power station under construction, whereas Shizuishan City predicted that the demand would grow to 138,000 m^3/day, in expectation of demand for use in thermal power stations, cement factories, chemical plants, etc.[4]

The amount of domestic wastewater also increased with increasing water demand. In 2005, the amount of wastewater in Yinchuan City and Shizuishan City was 288,000 m^3/day and 185,000 m^3/day, respectively, both of which greatly exceeded the treatment capacity. The untreated water was discharged directly into the Yellow River, and water pollution was becoming more serious; for example, a red tide occurred 82 times in 2005.

[4] Source: Provided by the executing agency, Yinchuan City Architectural Design and Planning Co., Ltd. (2005).

(2) Situation at the time of the ex-post evaluation

Currently, the needs of securing safe water and preparing sewerage systems are still the same. The total population of Yinchuan City in 2018 was 2.25 million, up about 40 percent compared with 2007 (1.617 million people); the demand for clean water was 900,000 m^3/day, 1.5 times higher than the supply capacity (600,000 m^3/day), and the demand for sewerage systems was 600,000 m^3/day, which also exceeded the treatment capacity of 500,000 m^3/day.

At the time of the appraisal, regarding the total population of Shizuishan City, the population in the water supply project areas was predicted to grow by 7% per year because of the expansion of on-site jobs by new energy industries, the domestic automobile industry, and the coal industry. However, unlike the prediction, the population started declining from 2010 owing to reasons such as the withdrawal of local big companies and the relocation of residents, and remained on almost the same level, 730,000 people, with sluggish demand for water; the water demand is 400,000 m^3/day for the supply capacity of 370,000 m^3/day, and the supply and demand are roughly in balance. The demand for sewerage systems is 163,000 m^3/day for the treatment capacity of 80,000 m^3/day, which still needs to be strengthened.

As described above, urban development has continued in Yinchuan City, and the associated demand for infrastructure of water and sewerage is still high. For Shizuishan City, water and sewerage facilities are needed as a whole, but the urban development is stagnant, and the demand has not increased to the extent expected at the time of the appraisal.

3.1.3 Consistency with the Japan's ODA Policy

The *Medium-Term Strategy for Overseas Economic Cooperation Operations (2004–first half of 2007)* by the Japan International Cooperation Agency (hereinafter referred to as JICA), among its priority areas such as support for poverty reduction, infrastructure development toward sustainable growth, and support for global problem solution and peace building, focuses on rural development through improvement of water supply and sewerage systems in poor regions, promotion of sustainable growth through the development of highly needed economic and social infrastructure such as water, sewerage and energy facilities, and the implementation of measures against the pollution of supply water while ensuring that development is compatible with environmental protection.

In addition, the *Country Assistance Strategy* by JICA recognizes environmental problems due to rapid economic growth as a challenge and selected environmental conservation primarily in inland areas as a priority area.

This project is highly consistent with Japan's ODA policy because it is meant to develop water supply and sewerage systems, which make up the environmental infrastructure that is required along with the urban and industrial development of Yinchuan City and Shizuishan City in the

Ningxia Hui Autonomous Region located in an inland area, and thereby to improve the water quality of rivers and the living environment of residents.

3.1.4 Appropriateness of the Project Plan and Approach

(1) Changes in the project scope and working situation in Shizuishan City

Regarding the sewerage project for Shizuishan City, the scale of the operation was reduced by half[5] from the original plan, and the developed sewerage plant was not put into full operation and continued to be suspended until the time of the ex-post evaluation (2019). This is because the situation of the city changed greatly from the time of the appraisal, and the demand itself decreased significantly. More specifically, the coal industry, which was the key industry of the city, went into a sharp decline under the national policies, and coal-related companies, which had been high-volume consumers, withdrew from the city, resulting in a population decline. Since then and up to the present, no alternative industry has developed. For this present situation, whether there were problems with the planning at the time of the appraisal is examined next mainly from two perspectives: 1) the predictability of urban development plans, and 2) the demand review process in the detailed design phase.

1) Predictability of urban development plan of Shizuishan City's population.

At the time of the appraisal, the population of the water supply project areas in urban areas in Shizuishan City was predicted to increase from 280,000 in 2005 to 380,000 in 2010, assuming a growth rate of 7% per year according to the *11th Five-Year Plan for Shizuishan City*. However, the predicted growth was not actually seen, and the population of the water supply project areas in 2010 remained at 330,000. The growth rate of 7% is higher compared to the population growth rate (2.7%: average of 2006 to 2010)[6] of the urban areas in Ningxia Hui Autonomous Region, indicating that the prediction may have been too high.

The biggest factor contributing to the stagnant population growth is the withdrawal of coal-related companies, the signs of which appeared in about 2008; then, the situation worsened further with the world financial crisis in 2009. After 2015, the production adjustment in the coal industry and related processing industries led to further decreases in production output, by which, combined with environmental protection regulations and development of eco-friendly fuels, many local companies were forced to close down. By 2016, 100,000 employees and their family members of Shenhua Ningxia Coal Group Co., Ltd., which was one of the biggest local companies, moved to areas outside the Ningxia Autonomous Region, resulting in a large decrease in population. According to the executing agency, the decrease in population of the city due to the

[5] At the time of the appraisal, the new construction of a sewerage plant with a treatment capacity of 40,000 m^3/day was planned, but in the detailed design stage in 2010, the demand forecast was revised downward, and the treatment capacity was changed to 20,000 m^3/day, half the originally planned capacity.

[6] China Statistics Yearbook 2015

decline of the coal industry amounts to 200,000, including the relocation of other coal-related industries.[7]

2) Appropriateness of demand review in the detailed design phase

In response to the environmental changes mentioned above, in 2010, the executing agency scaled down the project scope. As a result, the plan for construction of the 3rd Sewerage Plant was changed so that the construction would be implemented in two periods by halving the initially planned capacity of 40,000 m^3/day. By the ODA loan project, ancillary facilities were constructed on the same scale as planned initially, and a treatment facility for one period with a capacity of 20,000 m^3/day was constructed.

In the consultation at the time of the ex-post evaluation with the Municipal Development and Reform Commission and the executing agency, they were not able to predict the severe population decrease as mentioned above even at this stage, and responded that they assumed the possibility that there was a certain level of demand. The city government has also worked on the adjustment of industrial structure, attraction of enterprises, preferential agricultural land policies, and plans for immigration from other provinces in order to address the decline of the key industry; however, as yet, there has been no significant change in the population and situation of the city.[8]

Regarding these changes, the evaluator checked with those who[9] involved how at the time of the appraisal,the city government was able to ascertain the trends in the policies of the central government and the structural adjustment for the coal industry and whether there was any defect in that process. Here is an overview:

1. Amid a boom of economic development at the time, there were optimistic predictions on the economic growth of the city, the awareness of environmental regulations was still low, and there was the "economy-first" sentiment. This situation was reflected in the predictions on attraction of enterprises to the industrial development zone and how many of them would move in; this then may have led to too high a prediction.
2. For the water demand, there were guideline values specified by the central government. These values were adopted without taking into account the actual needs.
3. Regarding the withdrawal of coal-related industries, which is the biggest factor contributing to the population decline, there was then already a trend to strengthen environmental

[7] This relocation plan was incorporated into the *12th Five-Year Plan for Shizuishan City (2010–2015)*, and the details were not determined at the time of the appraisal.

[8] At the time of appraisal, about 200 companies were located in the corresponding industrial development zone, but there are currently 170 companies, many of which are said to be small and medium-sized companies. Only less than two-thirds of the available sites in the development zone were occupied, and plants not in operation were often left as they were.

[9] The evaluator interviewed city government officials who participated in the preliminary survey at the time for this project. They were then in charge of collection of data related to the urban development plan and coordination with the design sector.

regulations, but it was not predicted that the regulations would be strengthened this radically and rapidly. To the best of their memory, rumors about company relocation began to be heard from around 2011.

4. Regarding changes in the project scope, a consultation was conducted with JICA after determination of the directions for changes. As for the process that led to the determination, they do not remember having consulted with JICA.

It was about 10 years ago, so it is not certain how accurate their memories are; but there is a high possibility that the predictions on the development of the industrial development zone and the demand for water were not verified strictly. The trends and other changes in the coal industry due to the shift in energy policies were recognized on a medium- to long-term perspective, but for the rapid strengthening of regulations, it cannot be said that there was a predictability at the time of appraisal. To summarize, failure to predict the stagnation of the urban development of Shizuishan City was unavoidable, whereas with regard to project management, the process of review and consensus building on the project plan along with environmental changes had problems with understanding the situation in a timely manner, consultation and coordination with JICA, the accuracy of design, etc.

(2) Appropriateness of feasibility evaluation of reclaimed water supply

Regarding the reclamation facilities implemented in this project, the usage in both cities was far less than the plan (to be detailed in Section 3.3 Effectiveness). With the sluggish growth of demand for clean water, under the circumstance that the lack of water resources had not yet been actualized, the additional investment that user have to bear for the installation of reclamation facilities seems to be a factor that prevented the widespread use of reclaimed water. It is not clear how this factor was evaluated at the time of the appraisal.

Consultation with the agency that conducted a field study revealed that the prevailing view was that the large initial investment for branch sewers, water supply systems, and other equipment required for introduction of reclamation facilities and the high cost to be borne by users prevented the widespread use of reclaimed water. It is acknowledged that, in each treatment plant, negotiations with users are still making slow progress.

The use of reclaimed water is limited to such purposes as water sprinkling and cooling water for plants. Thus, the demand is likely to vary depending on the economic situation. Especially in Shizuishan City, the coal industry, which had been a key industry thus far, moved outside the city; then, industries with a small amount of water usage were invited, and the reclaimed water demand itself decreased significantly. As was described above, these rapid changes took place after the start of the project, therefore it was difficult to predict at planning stage. As a consequence of this, the verification of the feasibility of reclamation facilities might have been left inadequate.

The government still maintains its policy of promoting the use of reclaimed water from the perspective of efficient use of water resources. As a policy measure for that purpose, the government has adopted the *Reclaimed Water Pipe Network Construction and Ordinances for 2016 to 2030*, by which it is mandatory to install reclaimed water pipes in the case of construction of an office building and a housing complex with more than a certain size building area. Through the implementation of these measures, the demand is expected to increase to a certain degree.

Judging from the above, the implementation of this project has problems with the appropriateness of the project planning and approaches, but as a whole, it has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The plans and actual results of the outputs of this project are as shown in Table 1. In Yinchuan City, one water purification plant and one sewerage plant were excluded from the scope of the ODA loan project, while in Shizuishan City, the construction of a water intake facility was cancelled, and the scale of reclamation and sewerage facilities was reduced; in both cities, the construction was scaled down from the plan at the time of the appraisal. In the case of Yinchuan City, many of the facilities that had been initially planned to be constructed by ODA loan project were constructed by domestic funds, and the outputs required to achieve the purpose of this project were actually provided.

Table 1　Plans and Actual Results of the Outputs of This Project

(1) Yinchuan City

	Plans	Actual results
Development of water supply facilities	Water purification plants: Extension of 5th Purification Plant (40,000 m^3/day) New construction of 7th Purification Plant (50,000 m^3/day) New construction of 8th Purification Plant (50,000 m^3/day)	**Some changes made** **As planned** **Cancelled** **As planned**
	Preparation of raw water transmission lines: 121 km	**As planned**
	Construction of wells in 72 places in total 5th Purification Plant: 20 places in total (7,300,000 m^3/year) 7th Purification Plant: 28 places in total (9,130,000 m^3/year) 8th Purification Plant: 24 places in total (9,130,000 m^3/year)	**Changes made** 42 places in total (30 places fewer) **18 places in total (2 places fewer)** **Cancelled** **As planned (24 places)**
Development of sewerage facilities	Sewerage treatment plants New construction of 5th Sewerage Plant (50,000 m^3/day) New construction of 6th Sewerage Plant (50,000 m^3/day) Preparation of distribution pipes Combined sewer system: 147 km Pumping station renovation (1 place)	**Changes made (cancelled partially)** **As planned** **Cancelled** **Changes made** **Preparation of distribution pipes 10 km** **As planned**
Development of reclamation facilities	New construction of a reclamation facility for 3rd Sewerage Plant (30,000 m^3/day) Preparation of reclaimed water pipes: 15 km	**As planned** **Almost as planned 14.8km**

(2) Shizuishan City

	Plans	Actual results
Development of water supply facilities	Water purification plants: Extension of Huinong Purification Plant (80,000 m^3/day) New construction of water intake station in Huinong (180,000 m^3/day) Preparation of raw water transmission lines (53 km)	**As planned** **Cancelled** **Some changes (scale down) 18.2 km (-34.8 km)**
Development of sewerage facilities	New construction of 3rd Sewerage Plant (40,000 m^3/day) Preparation of distribution pipes: Separate sewer system (76 km)	**Some changes (scale down)** Scaled down to 20,000 m^3/day. **Some changes (scale down)** 31.4 km (-45.6 km)
Development of reclamation facilities	New construction of a reclamation facility for 2nd Sewerage Plant (30,000 m^3/day) New construction of a reclamation facility for 3rd Sewerage Plant (20,000 m^3/day) Preparation of reclaimed water pipes (38 km)	**As planned** **Some changes (scale down)** **Altered to 10,000 m^3/day.** **Some changes (scale down) 10.4 km (-27.6 km)**
Training	Manager training and training regarding water reclamation technology in Japan, intended for staff members of executing agency.	**Almost as planned** With seven participants, manager training and training regarding water-saving technology were conducted in Japan in 2008.

Source: The plans are based on materials provided by JICA; the actual results are based on answers to questionnaires by the executing agency.

The details and reasons of changes are as follows:

(1) Water supply facilities in Yinchuan City

1) Construction of the 7th Purification Plant that had been planned to be built by ODA loan project was cancelled. This was because a water purification plant was built earlier in the neighborhood by domestic funds. In 2012, the Helanshan Purification Plant that uses water from Yellow Riverwas built by domestic funds near the planned construction site for the 7th Purification Plant. Yinchuan City had used groundwater as an intake source, but to prevent depletion of groundwater sources and subsidence of land, a water supply facility that employs surface water was determined to be constructed for groundwater conservation in the city planning of Yinchuan City in 2010. It was then decided that this water supply facility would supply water to the planned water service area of the 7th Purification Plant, the construction of which was then cancelled. This also reduced the scope of the construction of wells, and the construction of 28 sites that had been planned to be developed in connection with the 7th Purification Plant was cancelled.

5th Purification Plant (Pumping Station)

5th Purification Plant (Control Room)

(2) Sewerage facilities in Yinchuan City

The 6th Sewerage Plant that had been planned to be constructed in this project was built by domestic funds. The reason for this change was the urgency of construction. Amid the growing demand for sewerage systems, it took much time to go through each approval process for an ODA loan project. Because of this, the plan was changed in March 2009 to use domestic funds that allow construction work to start in a short period of time. In addition, the total length of water pipes was greatly reduced from the planned 147 km to 10 km. This was also due to the shift to domestic fund-based construction because of the urgency of construction.

(3) Water supply facilities in Shizuishan City

The construction of Huinong District Water Intake Station was cancelled; instead, an intake pump station was built in the center of the Yellow River by domestic funds. The Huinong District Water Intake Station was originally planned to be constructed as an ancillary facility to the Huinong District Purification Plant, but the main consumer was a nearby thermal power station. Because the Yellow River Central Intake Pump Station was constructed for this power station, it was determined that it became possible to satisfy the demand in Huinong District with the existing water intake facilities. The total length of raw water transmission lines was also reduced greatly because some of the pipes were built earlier by domestic funds, in addition to the cancellation of the construction of a water intake station.

Huinong Purification Plant Prepared built under This Project

Water Pump System Prepared built under This Project

(4) Sewerage facilities in Shizuishan City

1) In the high-technology district in which economic development with coal had been expected at the detailed design stage, the demand was revised downward owing to population decline, and then the treatment capacity was changed to 20,000 m^3/day, half the originally planned capacity. In addition, the constructed treatment plant has been virtually non-operational since its completion.

2) Regarding distribution pipes, the construction by this project accounted for only 40% of the originally planned work because of prior construction by domestic funds and cancellation of some sections due to decrease in demand. More specifically, 12 km of about 27.2-km sections to be built for the 3rd Sewerage Plant was developed domestically. In addition, the length of distribution pipes of the 2nd Sewerage Plant was greatly reduced to 15.4 km. This was because the coal plants of Ningxia Coal Group moved outside the province and was followed by relocation of residents living in housing complexes, as described above.

3rd Sewerage Plant Not in Operation

Plant Left Unattended in an Industrial Development District (Shizuishan City)

(5) Reclamation facilities in Shizuishan City

The construction of reclaimed water pipes was scaled down from the planned 38 km to 10.4 km because, in planned sites, no tenants had been expected to be present.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost of this project in the planning stage was 18.247 billion yen, of which 8.432 billion yen was to be covered by ODA loan. Of the project outputs, large facilities such as part of a sewerage plant and pipes were constructed by domestic funds, as described above. It was not possible to ascertain how those changes affected the project cost, especially how much in the cost China actually bore. For this reason, here the plan and actual result of the amount of ODA loan project to execute are compared and evaluated. The amount of expenses to be covered by ODA loan project was initially expected to reach 8.432 billion yen, whereas the actual result was 8.368 billion yen, the ratio of which to the plan was 99%, which was lower than planned. However, considering that the total length of pipes of water supply and sewerage systems was shortened and that the construction of wastewater treatment plants was partially covered by domestic funds, it is highly likely that the actual project cost exceeded the planned cost.

3.2.2.2 Project Period

The implementation period of this project was planned to be from June 2007 to July 2012 (62 months), but actually it was extended from June 2007 to October 2018 (136 months), which was significantly longer than planned (220% compared to the plan). The implementation period of each facility is as shown below. The delay in the construction of water supply and sewerage systems in Shizuishan City is especially remarkable. The primary reason was that it took time to make adjustments in the planning stage such as basic design and land expropriation.

Table 2 Implementation Period per Scope

	Target (month)		Actual (Month)		Gap
Yinchuan City Water Supply	2007.6-2012.7	60	2007.6-2014.9	88	147%
	5th Water supply	60	2007.6-2010.1	28	47%
	8thS Water Supply	60	2007.6-2014.5	84	140%
Sewerage	2007.6-2012.7	60	2007.6-2014.9	87	145%
Sewerage & Water Reclamation	2007.6-2012.7	60	2007.6-2009.11	29	48%
Shizuishan City Water Supply	2007.6-2012.7	60	2007.6-2018.10.	136	227%
	2007.6-2012.7	60	2007.6-2018.6	132	220%
Sewerage	2007.6-2012.7	60	2007.6-2018.10	136	227%
Sewerage & Water Reclamation	2th Sewerage & Water Reclamation	60	2007.6-2016.6	107	178%
	3rd Sewerage & Water Reclamation		2007.6-2016.6	71	118%

Note: The month and year of completion of the acceptance inspection, which means the completion of the project, was unknown. Thus, the time of completion was set to the year 2015 so as to suit the Minutes of Discussions (2007).

Table 3 Causes of Delay

Project	Causes of Delay
Yinchuan City Water Supply	It took time to complete the procedure for expropriation of land near residential districts because the study to verify the impact on water resources by the excavation work took longer than planned, and the start of construction was delayed.
Yinchuan City Sewerage	The construction costs per procurement package increased owing to exchange rate variation at the time of acceptance of bid. Because of adjustment of the budget, the design details needed to be revised multiple times, and the start of construction was delayed.
Shizuishan City Water Supply	The restrictions on the intake of water from the Yellow River became more stringent because of water resource management, and it took time to receive permission from the irrigation committee to draw water.
Shizuishan City Sewerage & Water Reclamation	Because the population that requires sewerage treatment was predicted to decrease owing to the downsizing of the coal business mentioned above, a need arose to revalidate the project plan, and it took time to revise and redesign it.

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

At the time of appraisal, FIRR were calculated under the following assumptions, such as 30 years of project life, revenue fee as benefit, capital cost, operation and maintenance cost as cost. The results are as follows.

	Appraisal	Ex-post evaluation
Yinchuan City		
Water supply	14.7%	7.13%
Sewage	5.8%	3.38%
Reclamation	12.8%	Negative

FIRR of the project of Yunchun City, both water supply and sewage, declined from that at the time of appraisal. FIRR of water supply declined to 7.13%, as it was calculated based on the net revenue of treatment facilities. However, the actual financial is presumably stable since the executing agency has made TOT-based contract with the city government. FIRR of sewage project was 3.38%, declined from that in the appraisal as well. It was presumably caused by the decline of unite rate of sewage fee from the expected rate. However, it is fair to conclude that the project reaches the certain financial soundness as public-utility industry.

As for Shizuishan City, the evaluator was not able to conduct recalculation due to the lack of adequate data. However, as to be mentioned in 3.3 Effectiveness below, FIRR are highly likely to turn negative on all segment by the factor such as the suspension of sewage facility, decline of water supply and reclamation below the half of planned quantity.

Judging from the above, although the project cost corresponding to the ODA loan project was within the plan, the project period significantly exceeded the plan. Therefore, the efficiency of the project is fair.

3.3 Effectiveness (Rating: ②[10])

3.3.1 Quantitative Effects (Operation and Effect Indicators)

This section is to check the achievements of the target of this project, or achievements of "safe and stable water supply and reduction of water pollutant discharge" in Yinchuan City and Shizuishan City at the time of the ex-post evaluation.[11] Specifically, the indicators set in the planning stage were used to evaluate quantitative effects such as the amounts of water supply,

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

[11] The target values and actual values of two years after project completion are compared. For Yinchuan City, data of the water supply and sewerage treatment projects were taken in 2016, two years after 2014, when the project was completed. Data for the reclamation project were taken in 2011, two years after 2009, when the project was completed. In Shizuishan City, since the project was completed in 2018, the same year as that of this evaluation survey, data of the year of project completion were used.

treated sewage, and reclaimed water use in Yinchuan City and Shizuishan City, and qualitative aspects such as the effect of water quality improvement.

(1) Yinchuan City

The operating conditions of the water supply facilities, sewerage treatment facilities and reclamation facilities constructed in this project are described below. As the population of the City is growing, demand on these facilities is increasing. Except for the reclamation facilities, the target for water supply and sewerage treatment has almost been achieved as planned.

1) Water supply project

Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Water-Supply Pervasion (%)	90.6	91.1	96	96	96
Water-Supplied Population (ten thousand)	71.6	101.2	140	143	145
Average Water Supply per Day (ten thousand m^3/day)	20	34	31.36	34.88	38.98
Added by This Project		9	7.88	8.05	8.33
Maximum Water Supply per Day		(Designed	45.57	47.15	47.13
Added by This Project		Value)	12.87	12.78	12.46
Water Quality Criteria					
PH		6-9			7.53
Chlorine Compounds		≤250			5
Copper		≤1.0			<0.01
Zinc		≤1.0			<0.05

Source: The plans are based on materials provided by JICA; the actual results are based on answers to questionnaires by the executing agency.
Note: Water-Supply Pervasion = Water-supplied population/Population in the water-supplied area

The water-supplied population of Yinchuan City in 2018 was 1,450,000, showing a significant increase from 720,000 at the time of the appraisal. The target value for two years after completion was 1,010,000, whereas the actual value for the same year was 1,400,000 (139% compared to the plan). The target value for average water supply per day was 340,000 m^3/day, whereas the actual value was 313,600 m^3/day (92% compared to the plan). These data show that the targets have been almost achieved.

As for two water purification plants developed under this project, the average water supply from the 5th Purification Plant (design capacity: 50,000 m^3/day[12]) was 480,000 m^3/day, and that from the 8th Purification Plant (design capacity: 50,000 m^3/day) was 30,800 in 2014, the facility operation rates being 96% and 62%, respectively. The target value for the overall water supply pervasion in the City was 91.1%, whereas the actual value was 96% (105% compared to the plan).

[12] The capacity of the existing facilities (10,000 m^3/day) and that of the newly built facilities (40,000 m^3/day) were added to have this design capacity.

Because the water quality criteria are satisfied, it is fair to say that safe water is supplied in a stable manner.

2) Sewerage treatment project

Name of Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Population Accessible to Sewerage Treatment Facilities (ten thousand)	57.7	93.1	125.1	126.6	141.3
Volume of Treated Sewage (ten thousand m^3/day)	13.2	32.1	41.7	42.2	47.1
Added by This Project		5 (Designed Value)	4.46	4.37	8.32*
Sewerage System Coverage (%)	56[Note]	87	95.2	95.3	95.5
Pollutants					
BOD Concentration					
Quality of Influent (mg/l)			154	140	119
Quality of Discharged Water (mg/l)	180~200	30	13.3	9.3	3.7
Reduction Rate (%)			91.4%	93.4%	96.9%
COD Concentration					
Quality of Influent (mg/l)	350	100	688	862	665
Quality of Discharged Water (mg/l)			41	30	22
Reduction Rate (mg/l)			94%	97%	97%
SS Concentration					
Quality of Influent (mg/l)	10		40.48	40.23	36.06
Quality of Discharged Water (mg/l)			3.41	2.23	0.31
Reduction Rate (%)			92%	94%	99%

Note: Although technical examinations showed that it was 0, it was corrected to be 56 in MD. This was verified by the executing agency.
Sewerage System Coverage = Sewerage Treatment Capacity/Volume of Sewage

The population accessible to sewerage treatment facilities in the whole of Yinchuan City was 577,000 at the time of the appraisal and significantly increased to 1,251,000 (135% compared to the plan) two years after completion, and further increased to 1,410,000 by 2018. The volume of treated sewage was 132,000 m^3/day at the time of the appraisal and increased to 417,000 m^3/day. It was much larger than the target value of 321,000 m^3/day (130% compared to the plan). The average volume of treated sewage per day of the 5th Sewerage Plant (design capacity: 50,000 m^3/day), which was constructed in this project, was 44,600 m^3/day. The facility operation rate was as high as 90%, showing that it was operating in good conditions. The sewerage system coverage was 95.2%, which was higher than the target value of 87% (109% compared to the plan).

The volumes of pollutants reduced also proved that the effect of treatment was quite high. The reduction rates were higher than 90% both for the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD). To cope with severer environmental policies and discharge criteria determined later, additional improvement work was carried out in 2015. The water quality had been significantly improved by 2018 and reached 1st Class A, the highest quality level specified by the country.

5th Sewerage Plant Constructed under This Project

Comparison of the Water Quality Levels before and after Treatment

1. Reclamation project

Name of Indicator	Baseline	Target	Actual		
	2005	2014	2016	2017	2018
	Year of Planning	2 Years after Completion	2 Years after Completion		
Volume of Reclaimed Water Supply (ten thousand m^3/day)	0.2	5.2	2.726	3.3149	7.2149
Added by This Project		3 (Designed Value)	1.05	1.07	1.3
Proportion in Relation to the Volume of Treated Water (%)	1.4	16.2	6.22	7.48	14.63

Note: Proportion in relation to the volume of water treated in the reclamation facilities = consumption of reclaimed water/volume of treated sewage
The baseline values include those for the existing facilities in Yinchuan City (six water supply facilities, three sewerage treatment facilities and one reclamation facility)

Although the need of plants and public facilities for reclaimed water in 2020 was estimated to be 240,000 m^3/day at the time of the appraisal, the water supply to businesses (main users) is not increasing as expected. This is because many users do not want to share the cost of installing reclaimed water pipes and because awareness on reclaimed water has not been sufficiently raised among businesses. Although the supply of reclaimed water increased by 2018 from 2,000 m^3/day at the time of the appraisal to 72,000 m^3/day in 2018 at the time of the ex-post evaluation, it remained low when compared with the value of demand expected at the time of appraisal.[13] Although the design capacity of the reclamation facility in the 3rd Sewerage Plant constructed in this project was 30,000 m^3/day, the actual volume of supply was 13,000 m^3/day as of 2018, and the facility operation rate had been lower than half the design capacity since the time of the start

[13] Many of the present sewerage treatment plants have upgraded their treatment processes to cope with restrictions that are getting severer, and the water quality after treatment is high enough to be used as reclaimed water. They say that the existing sewerage treatment plants have enough capacity to supply reclaimed water sufficiently if the demand would increase and the pipe network was fully developed.

of operation. Main users of reclaimed water were limited to thermal power plants and tree-planting businesses in economic development areas.

The executing agency says that ordinance were introduced to facilitate water saving, in which it is required to install reclaimed water pipes whenever a plant or housing complex with a certain area size is constructed. Therefore, the network of reclaimed water pipes may be developed, and the demand for reclaimed water may increase to a certain extent. At present, however, it is not possible to have a clear view of future increases in demand, because demand for plant construction is not growing and because the effectiveness of the regulations has not been fully proven.

To facilitate the use of reclaimed water, additional investment is needed for developing the network of reclaimed water pipes. At present, use of reclaimed water is limited, and it would be difficult to expand the demand for such water. In the discussion with the experts who accompanied the evaluator, it was pointed out that the demand for reclaimed water would not significantly expand for the time being, and that reclaimed water could possibly be supplied to water supply systems if measures are taken such as additional installation of desalination apparatus.[14]

(3) Shizuishan City

The operating condition of the water supply facilities, sewerage treatment facilities and reclamation facilities developed by this project are described below. Unlike the situation of Yinchuan City, the population of Shizuishan City has not significantly increased, and the amounts treated both in the water supply facilities and sewerage treatment facilities were much less than those expected at the time of appraisal.

[14] To improve the quality of reclaimed water so that it can be used as clean water, desalination apparatus should be installed to remove soluble salt that remains in reclaimed water. Such apparatus can separate soluble salt from water. In treating reclaimed water whose salt concentration is quite low, the apparatus is expected to use significantly less energy than in treating other types of water. Therefore, use of reclaimed water in the water supply system could be feasible if the construction cost of the apparatus is kept low.

1) Water supply project

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Completion
Water-Supply Pervasion (%)	45.0	83.0	94	94
Water-Supplied Population (ten thousand)	12.5	34.4	41	41
Average Water Supply per Day (ten thousand m^3/day)	9	17.6	13.86	13.67
Added by This Project (ten thousand m^3/day)		8 (Designed Value)	3.39	3.35

As of 2018, there were four water purification plants in Shizuishan City, the total supply capacity being 190,000 m^3/day. The water supply capacity of Huinong Purification Plant, which had been developed in this project, was the maximum at 120,000 m^3/day (40,000 m^3/day by existing facilities and 80,000 m^3/day by newly added facilities). Although the total amount of water supply for the City was 90,000 m^3/day at the time of the appraisal, it had increased to 136,700 m^3/day by 2018 (78% compared to the plan). The water-supplied population had also increased from 125,000 to 410,000 in the same period (120% compared to the plan). The amount of water supply from Huinong Purification Plant, which had been developed in this project, was almost unchanged (fluctuating in the range of 32,000 to 48,000 m^3/day) over the past ten years. In the year of project completion, it was 33,500 m^3/day. The facility operation rate had been in the range of 30 to 40%. The major reason for the stagnant operation rate is that, as mentioned in the section of Relevance, the total population in Shizuishan City had been almost unchanged. Huinong, which used to receive many businesses at one time, has seen its population decrease, and demand for service water has not increased much. Although the Government of Shizuishan City is trying to invite businesses from various industries to promote urban development, it has not succeeded to attract big enterprises, which could play a central role in establishing a basic industrial sector in the City. As there is no evidence that the situation will improve in a short period of time, it should be expected that the operation rate of water supply facilities will stay low. The quality of treated water is high enough to meet the national standards.

2) Sewerage treatment project

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Project Completion
Population Accessible to Sewerage Treatment Facilities (ten thousand)	12.5	34.4	41	41
Volume of Treated Sewage (ten thousand m^3/day)	2.7	17.1	7.21	7.51
Added by This Project		2 (Designed Value)*	Operation Stopped	Operation Stopped
Sewerage System Coverage (%)	62	38	96%	94%
Quality of Discharged Water (BOD Concentration) (mg/l)	200	30	N/A	N/A
Quality of Discharged Water (COD Concentration) (mg/l)	400	100	N/A	N/A

As of 2018, Shizuishan City had four sewerage treatment plants, the total treatment capacity being 127,600 m^3/day. The total volume of treated sewage in the City increased from 27,000 m^3/day at the time of the appraisal to 75,100 m^3/day in 2018 (44% compared to the plan). The population accessible to sewerage treatment facilities increased from 125,000 to 410,000 (120 % compared to the plan). The sewerage system coverage was also improved from 62% to 94% (247% compared to the plan). The 3rd Sewerage Plant (20,000 m^3/day) was newly built in this project, and it was completed in October 2012. Since the completion of construction, however, the plant has been hardly operated.[15] The reason for this is the same as that described for the water supply project. The population of the targeted area decreased significantly because a coal producer, which had been assumed to be a large-scale demander, moved out of the City and the employees of the company also moved out. The demand for sewage had not increased as predicted due to the decline of local industry which consume huge amount of water. The Government of the City says that it plans to have new economic development areas to attract businesses, and this sewerage treatment plant could be effectively used to treat sewage produced in these areas.[16] At present, however, it is not clear if they will succeed in this effort. Even if medium-term development of the City is taken into consideration, it is fair to say that the impact of the sewerage treatment project was proved to be low.

3) Reclamation project

Reclamation facilities are installed in the 1st to 3rd Sewerage Plants, and the total production capacity for these Sewerage Plants is 82,600 m^3/day. The total production capacity in the City is

[15] A test operation of the plant was conducted in June 2013. It operated for four months in 2014 and only produced a small amount of reclaimed water.

[16] It is also planned to construct industrial wastewater treatment facilities in sewerage treatment plants to treat sewage produced in the economic development areas. According to the schedule, construction will start in December 2019. However, the amount of sewage treated by these facilities is estimated to be only in the order of several thousand m^3.

80,000 m^3/day, against the planned of 90,000m^3/day (89% compared to the plan) and the total production water in 2018 was 75,100 m^3/day in 2018. However, the supplied reclaimed water was only 9,500 m^3/day, which just accounts for 12.6% of the actual consumption to the production. Although the reclaimed water supply capacity is maintained, the efficiency of the reclamation facilities is considered low from the perspective that reclaimed water is intended to be used in place of clean water.

As of 2018, although the amount of reclaimed water supply from the 2nd Reclamation Facility constructed in the 2nd Sewerage Plant in this project was 32,600 m^3/day, the actual consumption of reclaimed water was only 4,000 m^3/day.[17] The reclaimed water was supplied to a power station nearby to be used as cooling water. Reclaimed water consumption remained at a low level partly because there were not enough demanders in the City. Similar to the case of Yinchuan City, it was also because users were not willing to share the cost of installing reclaimed water pipes. In this project, the 3rd Reclamation Facility was also constructed in the 3rd Sewerage Plant. Because the plant is not operating, the reclamation facility has no record of operation.

Use status of the Reclamation Facility installed in the 2nd Sewerage Plant

Indicator	Baseline	Target	Actual	
	2005	2014	2017	2018
	Year of Planning	2 Years after Completion		Year of Project Completion
Amount of Reclaimed Water Supply (ten thousand m^3/day)	0.2	9.0		3.26
Actual Consumption				0.4
Proportion in Relation to the Volume of Treated Water (%)	6.3	16.2	4	5

As explained above, the benefit of the reclamation project will not grow for the time being. In future, however, demand for reclaimed water may increase. A project for developing a reclaimed water pipe network, which was jointly founded by the government and the executing agency, was approved, and the construction work started in the summer of 2019. When this project is completed, the pipe network will be significantly improved, and reclaimed water will be supplied to about 50 companies. It is planned that reclaimed water may be supplied at the rate of about 30,000 m^3/day in five years, and at the rate of about 60,000 m^3/day in 20 years.

4) Operating conditions throughout the two cities: The table below shows the operating conditions of main facilities in the two cities and comparison between the total target values and actual total values. When comparing the total volumes of water supply for the two cities

[17] Since completion of the sewerage treatment plant in 2012, the actual consumption of reclaimed water has been at a low level, and 11,300 m^3/day was the highest record.

with that of the target values, the average target achievement rates of water supply facilities and sewerage treatment facilities were found to be 60 to 70%, which is a medium level.

	Target			Actual(2018)			Target Achievement Rate
	Total	Yinchuan	Shizuishan	Total	Yinchuan	Shizuishan	
Amount of Clean Water Supply	51.6	34	17.6	13.67	N/A	13.67	N/A
Added by This Project (Design Value)	**17**	**9**	**8**	**11.68**	**8.33**	**3.35**	**69%**
Amount of Treated Water	49.2	32.1	17.1	49.21	41.7	7.51	100%
Added by This Project (Design Value)	**7**	**5**	**2**	**4.32**	**4.32**	**0**	**62%**
Amount of Reclaimed Water Supply	14.2	5.2	9	10.47	7.21	3.26	74%
Added by This Project (Design Value)	**6**	**3**	**3**	**1.7**	**1.3**	**0.4**	**28%**

*Because complete data of the two cities were not available, comparisons between designed capacity and actual operational conditions were made mainly for the facilities that were developed in the project financed by ODA loan project.

Based on data shown above, the effects of this project are evaluated as follows.

1) As the operation level of the facilities in Yinchuan City is much higher than the planned level, effectiveness of the facilities is evaluated as highly satisfactory. Although the achievement level of the reclamation facilities is low, the negative effectiveness is considered small in view of the objective of this project, "safe and stable water supply and reduction of water pollutant discharge." In consideration of the small amount of investment, the overall effects of the facilities in Yinchuan City are evaluated as high.
2) The operational conditions of clean water supply facilities, reclamation facilities and sewerage treatment facilities in Shizuishan City are all at a low level. Because the population is not growing, demand increase cannot be expected, and this situation will probably not change drastically in a short period of time. Consumption of reclaimed water may increase in the future because ordinance on the promotion of reclaimed water use have been established. At present, however, it is not possible to have a clear view regarding the effectiveness of regulations, and progress of the situation must be watched. Consequently, the effectiveness of the facilities in Shizuishan City is evaluated as low at this moment.
3) When compared with Shizuishan City, the benefit of and the amount of water supply for Yinchuan City is larger. If the values of the two cities are combianed, the target achievement rate of water supply facilities and sewerage treatment facilities is found to be 60 to 70%. In consideration of the fact that effectiveness is low in Shizuishan City and high in Yinchuan City, the overall effect could be evaluated as fair.

Consequently, the effectiveness of the project is evaluated as fair.

3.4 Impacts

3.4.1 Intended Impacts

In this project, the impacts are related to the "improvement of living environment for people of Yinchuan City and Shizuishan City." To be precise, the effects of constructing sewerage treatment facilities and water supply facilities were verified in view of 1) water environment improvement, and 2) betterment of residents' convenience and satisfaction, and dwelling environment improvement. Because the quality of river water may be affected not only by development of sewerage treatment facilities but also by many other factors, it is difficult to determine to what extent this project contributed to the improvement of extensive river water quality. As for interview results, as the number of people interviewed is limited, they should be only used as qualitative supplemental data for understanding the results confirmed for effectiveness of the project.

(1) Water environment improvement

1) Data obtained from monitoring at a Yellow River observation spot

The water quality of the Yellow River in Yinchuan City has changed as shown in the table below. The water quality in Yinchuan City has improved from Class III at the time of the appraisal (2005) to Class II, and this means that it can be suitably used as a drinking water source. During this period, the sewerage treatment rate in Yinchuan City improved from 56% to 95%, and the amount of untreated sewage flowing into the Yellow River decreased substantially. Although it is difficult to show a direct causal relationship, it can be assumed that the installation of sewerage treatment facilities had a positive impact of improving the river water quality to a certain degree.

	2004	2005	2016	2017	2018
Classification of River Water Quality	Class IV	Class III	Class II	Class II	Class II
COD (mg/m^3)	17.2	11.7	9.0	9.0	7.8
BOD (mg/m^3)	3.2	3.4	2.0	1.5	0.8
Sewerage Treatment Rate (%)	N/A	56%	95.2%	95.3%	95.5%

Source: Data for 2004 and 2005 are from documents provided by JICA.
Data for 2017 and 2018 are taken from questionnaire responses of Government of Ningxia Hui Autonomous Region
*The observation spot was Ye Sheng Yellow River Bridge in Yinchuan City

As mentioned above, because the sewerage treatment plants in Shizuishan City are not in operation, it is judged that there is no apparent positive impact on water quality.

(2) Betterment of residents' convenience and satisfaction, and dwelling environment improvement as a result of water environment improvement

1) Beneficiary interview results

An interview with residents of Yinchuan City[18] was conducted to ascertain the level of awareness and evaluation of beneficiaries regarding "water environment improvement," and to study the betterment of residents' convenience and satisfaction and dwelling environment improvement by comparison of the situation before the project start (2005) with that at the time of the ex-post evaluation (2019). Some of the interview results obtained are shown below.

1. Improvement of residents' convenience and dwelling environment

There were several comments that, because of the construction of distribution pipes and the sewerage system, a nasty smell in houses and the environment was removed and the living comfort of residents was improved. An interviewee said, "Before the start of this project, as sewage pipes were thin, sewage pools were formed on the ground. Windows of rooms could not be opened in summer or after rainfall because of the nasty smell. Now the rooms are brighter as we can open windows without worrying about it." Another interviewee answered, "Formerly, distribution pipes were thin, and clogging was caused often. We took a shower only once a week to reduce the production of wastewater. Now we can take a shower whenever we like." Many people said that hygiene in the environment had improved with the installation of drain ditches.

A couple who run a beauty salon in a housing complex said, "Life satisfaction increased because infrastructure such as water supply and sewerage systems had been improved. Although we used to suffer the inconvenience of frequent water supply suspension, we have not experienced any water supply suspension since we moved here."

2. Changes in water environment and river environment

They commented that their health condition had improved and they can enjoy leisure time in the river area. An interviewee said, "As the quality of river water was improved, the nasty smell and muddiness was reduced. The riverbed environment is maintained, and we now enjoy fishing there."

Irrigation Channel near a Sewerage Treatment

Residents Interviewed (Yinchuan City)

[18] A group interview was held in the form of a discussion to hear comments on changes in the water environment and its impacts on the life of residents. Eight interviewees (seven men and one woman) were selected with the cooperation of the executing agency.

Facility Constructed in This Project
(Yinchuan City)

Although the number of the interviewees was limited, several people commented that their dwelling conditions had improved owing to the stable water supply. Therefore, it seems that people's total satisfaction regarding the water supply has increased.

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

In the environmental impact assessment (hereinafter referred to as EIA) conducted at the time of the appraisal, it was concluded that negative impacts on the natural environment were at the lowest level because this project was carried on in regions far from natural parks or other vulnerable areas.[19] Although ground water is being used as a source of water supply in Yinchuan city, it was concluded that significant effects from construction of well were not expected when the location of aquifers and the amount of target water were taken into consideration. It was confirmed in the project plan that the sludge produced in the sewerage treatment facilities could be adequately disposed of at existing landfills. It was planned that environmental effect mitigation measures would be taken to prevent ground pollution and the production of noise and vibration. Therefore, it was considered that significant concerns were not generated by this project. Because field study proved that unpredicted problems were not caused in actual construction work or during the stage of plant operation, it was concluded that no specific problems had arisen.

(2) Impacts on the Social Environment

At the time of the appraisal, it was informed that they had already obtained the right to use planned construction sites, and there was no need for land acquisition nor resettlement of residents. When the executing agency was interviewed for the ex-post evaluation, they said that it was devastated land and legally acquired without causing any problems, and that resettlement of residents was not needed.

Based on the considerations described above, the effectiveness and impacts of the project are fair. As mentioned in the section for Effectiveness, it was confirmed that water supply facilities and sewerage systems in Yinchuan City were generally operating in good condition, the water quality of the Yellow River in the City indicated an improving trend, and the satisfaction of residents was quite high. In Shizuishan City, however, the operation rates of water supply facilities and sewerage systems are much lower than the target values because the key industry of the City moved out, and urban development and population growth are at a lower level than

[19] According to the *Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations (April 2002)*, it was classified as Category B.

expected in the initial plan. Taking these factors into consideration, the overall project effect in the two cities is evaluated as fair.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional/Organizational Aspect of Operation and Maintenance

The construction was carried out by Yinchuan City Urban Construction Co., Ltd. and Shizuishan Xinghan Municipal Industry Group Co., Ltd., which take charge of public works related to the water environment improvement in the Ningxia Hui Autonomous Region. At the time of the appraisal, it was said that a state-owned company would be responsible for the operation and maintenance of this project on consignment from the City Government. At the time of the ex-post evaluation, however, it was found that the institutional/organizational system of operation and maintenance was changed in Yinchuan City. Sewerage treatment plants are operated and maintained by a joint corporation with a foreign company using the TOT method.[20] The institutional/organizational systems of operation and maintenance in the two cities are described below.

(1) Yinchuan City

1) Water supply project

At the time of the appraisal, it was planned that the water supply project would be operated and maintained by a state-owned company, Yinchuan Water Supply Company. At the time of the ex-post evaluation, however, it was actually managed by Yinchuan Railway Waterworks Group Co., Ltd., which was established in 2011. It is a state-owned self-supporting company, for which the State-owned Assets Supervision and Administration Commission takes a 51% stake, and Railway Corporation takes a 49% stake. The number of employees is 1,000, and 300 of these employees are qualified engineers.

In the initial plan, water purification plants covered by this project were assumed to be operated and maintained by 23 staff members. As work efficiency has increased by appropriately distributing experienced members and introducing an unmanned central control room, the 5th Purification Plant is now operated by 13 staff members, and the 8th Purification Plant by 15 staff members. This means that efficient operation has been realized with the staff size being cut nearly by half. The Government of the Ningxia Hui Autonomous Region and the City Government implement periodic supervision and instruction of the plants. It was proved that the institutional/organizational system of operation and maintenance had no problems.

2) Sewerage Treatment Project

[20] TOT is an abbreviation for Transfer Operation Transfer. It means a patent management right with which plants are constructed in a project financed by ODA loan project, managed (operated and maintained) by a private company and returned to the state of China at the end of a certain contact period. The period for this project is 30 years.

At the time of the appraisal, it was planned that the sewerage treatment project would be operated and maintained by Yinchuan Sewerage Treatment Co., Ltd. It is now managed by Shangye Environmental Co., Ltd. because Yinchuan Sewerage Treatment Co., Ltd. was purchased by this enterprise. Since 2015, this project has been managed adopting a 30-year TOT (Transfer Operation Transfer) method. As shown in the table below, sewerage treatment plants are managed by joint corporations under the supervision of Shangye Environmental Co., Ltd.

Plant Covered by This Project	Name of Managing Company	Outline
3rd Sewerage Plant	Duli Sewerage Treatment Co., Ltd. (joint corporation with Malaysia)	30 staff members of which6 engineers, 1 with professional qualification
5th Sewerage Plant	Shangmi Environment (Yinchuan) Sewerage Treatment Co. (joint corporation with Singapore)	26 staff members of which 1 with professional qualification)
6th Sewerage Plant	Yinchuan Xing Environmental Development Co., Ltd. (state-owned company)	30 staff members of which 1 with professional qualification)

(3) Shizuishan City

The system described in the plan has not been changed, and Shizuishan Xingji Group Sufficient Water Supply-Discharge Co., Ltd., a subsidiary company of Shizuishan Xinghan Municipal Industry Group Co., Ltd. takes charge of operation and maintenance of the water supply plants and sewerage treatment plants. The company has 455 employees (including 273 engineers). The water supply plants and sewerage treatment plants are mainly administered by the company's Administration Department, Finance Department, Safety Control Department and Technical Development Department. Huinong Branch Company (number of employees: 187), a subsidiary company, operates and maintains Yellow River Purification Plant (40 engineers) and the 2nd Sewerage Plant (five engineers). Although Dawu Branch Company, another subsidiary company, was expected to operate and maintain the 3rd Sewerage Plant, it was not operated at the time of the ex-post evaluation, and four staff members were posted there for inspection. As each organization has sufficient experience in the management of water supply and sewerage treatment facilities, no special problems are found concerning the system scale of these organizations.

3.5.2 Technical Aspect of Operation and Maintenance

(1) Yinchuan City

As for water supply and sewerage plants in Yinchuan City, all the managers of the 5th and the 8th Purification Plants are engineers. Although a periodic inspection manual is not provided, no technical problems are seen because they have a satisfactory size of staff that can cover processes related to the design and construction of water supply systems, water supply and distribution, information control, legal work, electrical work, etc. Training courses are provided for staff

members to improve their technical skills. They may be sent to the Chinese Water Supply Association for training or may participate in periodic training offered by the company.

(2) Shizuishan City

As for water supply and sewerage plants in Shizuishan City, Yellow River Purification Plant has 40 engineers, and they receive training 12 times a year to keep and improve their technical skills in operation and maintenance. Regular and periodic inspections are performed appropriately by an associated company. Maintenance and inspection manuals are provided only for reclamation facilities. During the period of field study, facility maintenance logs, inspection records, etc. were used to interview the staff. Because all the staff members answered the questions properly concerning the workflow and responses in the process of which they were in charge, it was confirmed that the skills and knowledge required for operation were maintained and management was performed systematically. In reclamation facilities, cross-checking is also done by asking an external institution to assess water quality and noise quarterly. Water safety is also evaluated by an external third-party organization, and it was accredited to meet safety criteria for 3C.

Based on the considerations described above, it is concluded that both the water supply system and the sewerage treatment system are infrastructure already established in China. Therefore, their technical skills required for operation are evaluated as satisfactory. Each organization allocates specialists to the facilities. Periodic training courses are given to provide expertise and technical knowhow. These efforts show that the technical level of operation and maintenance is satisfactory without causing any particular problems. In 2003, as a first attempt in China, Yinchuan City provided a smart water meter for each family. As the City is located in a dry region, this active attempt is expected to solve the water-shortage problem. Furthermore, it may improve residents' convenience in paying for water charges and improve non-revenue water control.

Central Control Room of the Executing Agency (Shizuishan City)

Central Control Room of the Executing Agency (Shizuishan City)

3.5.3 Financial Aspect of Operation and Maintenance

Pieces of key information such as the financial conditions of the executing agency, particularly profit and loss statement and balance sheet, were not disclosed because they were deemed confidential. Therefore, soundness of the financial conditions had to be analyzed using interview results obtained on site. Because detailed analysis based on financial statements was not performed, the analyses below do not reflect the actual financial conditions in a satisfactory manner.

(1) Yinchuan City

In Yinchuan City, the water supply project has been operated in the form of a public benefit service by a state-owned company without experiencing any significant changes since the time of the appraisal. As for the sewerage treatment plants, each plant is operated on a self-supporting basis by introducing TOT with a private company. A rough estimation on the financial conditions of each organization is shown below.

1) Water supply project

Yinchuan Railway Waterworks Group Co., Ltd. maintains surplus management and has no profitability problems. The water supply project has been operated in the form of a public benefit service by a state-owned company, and water charges are officially fixed. As a public benefit service company, its performance evaluation is stable at a top-class level. As smart water meters and electric payment have been introduced to pay for water charges, the degree of collection rate has increased. Because introduction of such payment systems is supported financially by the State Government, the company may be able to increase capital investment.

2) Sewerage treatment project

According to the policy of the Yinchuan City Government, each of the eight sewerage treatment plants in the City entrusts its operation to a private company based on TOT. For example, the 3rd Sewerage Plant, construction of which was financed by an ODA loan, entrusted its operation to Duli Sewerage Treatment Co., Ltd., a joint corporation with Malaysia, under the contract that an administrative cost of 810 million yuan (about 14 billion yen) can be received for 30 years. It was also determined under the contract that an earning rate of 7% is ensured. As an additional contract of 1.2 billion yuan was concluded later, there should not be any significant problems caused in terms of revenue.

(2) Shizuishan City

Shizuishan Xinghan Municipal Industry Group Co., Ltd., the parent company of the executing agency, is a state-owned company established in 2004. Its total capital is 3.8 billion yuan (about 64.6 billion yen), and annual income is 1 to 1.2 billion yuan (about 17 to 20.4 billion yen.) As mentioned above, additional investment in sewerage treatment plants, whose operation is

suspended, is being considered, and it was assumed that its financial soundness has been maintained. Because the water supply project and the sewerage treatment project are both operated in the form of a public benefit service, the business investment relies on government expenditure. Therefore, it is assumed that the financial soundness required to maintain operation will be ensured for the time being, even if the operation rates of water supply and the sewerage treatment facilities are lower than the target values.

State-owned companies are supported by capital investment from the State Government, and the foundation for profits for private companies participating in the project based on TOT is ensured by the contract. Although detailed information is limited, it is assumed that there are no significant problems with regard to the financial conditions of the projects.

3.5.4 Status of Operation and Maintenance

The facilities constructed in the two cities in this project are maintained and inspected periodically, and fundamental soundness has been maintained so far. In Yinchuan City, a 24-hour online control system was introduced, and a stable management system has been established. In Shizuishan City, however, operation of the 3rd Sewerage Plant and the 3rd Reclamation Facility has been suspended since a certain point of time in 2004. Although periodic inspections are being performed, there is a concern that some machines may have deteriorated in the medium and long period of time owing to passage of water through them. There is a great concern that early operation restart of these plants cannot be expected when the lifetime of the facilities is being shortened.

As mentioned above, there is no significant problem in this project concerning the institutional /organizational and technical aspects of operation and maintenance. Although the financial aspects could not be fully verified, both the state-owned companies and the private companies are financially sound owing to the support from one of the City Governments. The current status of the facilities in Yinchuan City is satisfactory and has not caused any problems.

On the other hand, the sewerage treatment facilities and reclamation facilities in Shizuishan City have been mostly unoperated since the time of their construction completion, and it is not expected that this situation will improve in the short term. As the facilities will deteriorate in the medium and long term, and the life expectancy of the facilities left are being shortened, there is a concern in view of the effective sustainability of these facilities.

It is concluded that some minor problems have been observed with regard to the current status. Therefore, the sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to secure a stable and safe water supply and to reduce the discharge of water pollutants by building water supply and sewerage facilities and reclamation facilities in Yinchuan City and Shizuishan City in the Ningxia Hui Autonomous Region, thereby improving the living environments for residents in both cities.

This project is in line with the policies and needs of the Japanese and Chinese governments and is relevant in general. However, as for Shizuishan City, the project outputs and effects deviated from the project plan along with stagnation of urban development, and there was possibly a problem with the accuracy of the project plan at the time of the appraisal. Regarding the project outputs, facilities were built as planned in general, although changes were made and the period extended because of substitute improvements based on domestic funds. The project cost was lower than planned but the project period was significantly longer than planned; thus, the efficiency of the project was fair.

Regarding the resulting effects of this project, there is a contrast between Yinchuan City and Shizuishan City. Satisfactory results were accomplished in Yinchuan City, whereas the results in Shizuishan City were less satisfactory because the water supply work was not accomplished as planned owing to population decrease in the relevant areas, and the sewerage facilities are barely in operation. Thus, the effectiveness of this project is evaluated as fair. For both cities, there are no problems with the structure of the organization in charge and technical and financial aspects. However, in Shizuishan City, a situation with no chance of using the facilities, especially sewerage and reclamation facilities, has continued, and thus there seems to be some problems with sustainability. Based on the above, this project is evaluated as partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

1) **Need for maintaining reclamation facilities and sewerage treatment facilities in Shizuishan City**

Operation of reclamation and sewerage treatment facilities in Shizuishan City has been suspended owing to a reduction in needs caused by the population decrease. At present, water is partially passed, and periodic inspections are conducted by the executing agency. As a rapid increase in needs cannot be expected, it is desirable to reexamine how to maintain the facilities. For example, machinery could be uninstalled and stored separately to prevent deterioration in anticipation of operation restart.

2) **Further use of reclamation facilities**

Reclamation facilities are also not fully used in Yinchuan City. This is because the use of reclaimed water is limited owing to its quality and because capital investment is needed to develop a network of reclaimed water pipes. Use of reclaimed water may be facilitated by improving reclaimed water quality. For example, reclaimed water could possibly be supplied to water supply systems if a desalination apparatus is installed to remove salt.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Timely scope change and response required by significant change of external environment

Although population growth is essential to increase the needs for supply water and sewerage treatment, it was depressed in Shizuishan City, leading to low effectiveness of the project. The main reason for this is change in the industrial structure, which was uncontrollable as it was caused by the country's policy. It may have been possible to reduce the impacts, however, if the trend had been well examined and discussions had been held with those concerned at an early stage to reduce risks. In this project, communication with JICA concerning a review of the project plan was not taken in a timely manner. It is desirable to establish a risk management system in which risk factors interfering with achievement of the project's goal are pointed out, and information sharing and cooperation with those concerned is facilitated on important occasions such as at the time of appraisal and detailed designing.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs 1) Yinchuan City a. Water supply project Water purification plants Water supply pipe Construction of wells b. Sewerage treatment project Sewerage treatment plants Sewerage water pipe Reclamation facility 2) Shizuishan City a. Water supply project b. Sewerage treatment project Sewerage treatment plant Reclamation facility 3) Training	 Two newly built plants, one plant as an extension 121 km 72 in total Two newly built plants 147 km One newly built reclamation facility, pipe length 15 km Water purification plant (extension), water intake station (newly built), pipe development (53km) One newly built sewerage treatment plant, pipe length 76 km Two newly built reclamation facilities, pipe length 38 km Training in Japan on water supply and sewerage treatment projects	 One newly built plant, one plant as an extension As planned 42 in total One newly built plant 10 km As planned Water intake station cancelled, reduction of the total pipe length Reduction in size, total pipe length 31.4 km Size reduction of one facility, total pipe length 10.4 km Almost as planned
2. Project Period	June 2007 – July 2012 (62 months)	June 2007 – October 2018 (136 months) target achievement rate: 220%
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange rate	 9,758 million yen 8,489 million yen 18,247 million yen 8,432 million yen 1 yuan = 14.8 yen (As of December 2006)	 Cannot be calculated Cannot be calculated Cannot be calculated[21] 8,368 million yen 1 yuan = 15.13 yen (Average from 2006 to 2017)
4. Final Disbursement	September 2015	

[21] The total cost of the project outputs could not be calculated because it was difficult to determine how much of a domestic fund was invested in cancelled or scaled-down output, and to what extent it was supported by an ODA loan. Therefore, the project cost of the whole output of this project could not be calculated.

Republic of Kenya

FY2018 Ex-Post Evaluation of Japanese ODA Loan Project
"Sondu-Miriu Hydropower Project Sang'oro Power Plant"

External Evaluator: Ryuji Kasahara, IC Net Limited

0. Summary

This project was carried out for the purpose of expanding power supply by constructing a hydropower station with an installed capacity of 21.2 MW in the Kisumu District of Nyanza Province in Western Kenya, thereby contributing to the improvement of the living standards of Kenyans and the sustainable economic growth of the country.

As this project was in accord with Kenya's power development policy and development needs at the time of the appraisal and the ex-post evaluation and Japan's ODA policy at the time of the appraisal, the relevance of this project is high. As there was no change in the general outputs and the project costs and duration were within the plan, the efficiency of this project is high. The target values set as indicators of effectiveness were largely achieved. Additionally, as impacts from this project, this project has contributed to the alleviation of the tight power supply and demand as well as stable power supply. At the time of project implementation and the ex-post evaluation, while some issues were detected concerning the impacts on the natural environment, resettlement, land acquisition, employment, and work environment, no serious negative impact was observed. Therefore, effectiveness and impacts of this project are high. The sustainability of effects generated by this project has no major problem overall despite a room for improvement with respect to finances. Therefore, 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 Map

Sang'oro Power Station

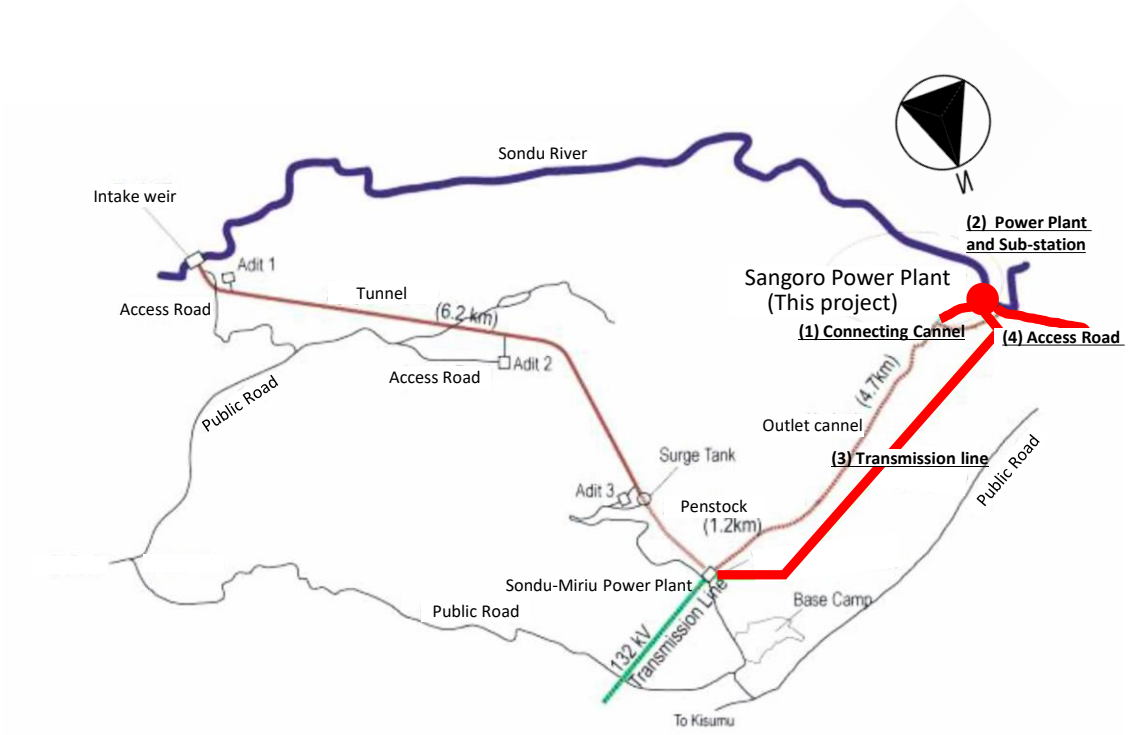
1.1 Background

Around 2005, at the time of this project's appraisal, Kenya was aiming for economic development and poverty reduction through infrastructure development. In those days, there was a tight power supply and demand in Kenya as the power supply could not keep up with the growing power demand because of such reasons as the deterioration of equipment. Thus, the development of electrical power was an urgent issue that the country needed to address, and the Kenyan government was considering measures to tackle the issue immediately. The government

worked out a medium-term power plant construction plan, but the projects implemented concretely as part of this plan were only the Olkaria Geothermal Power Station and the Sondu Miriu Power Station.[1]

Under these circumstances, the Kenyan government requested that a loan be granted for this project, which aimed to develop electrical power using the unused height difference downstream of the outlet channel of the Sondu Miriu Power Station, and JICA appraised the project. Completion of the Sondu Miriu Power Station was scheduled for 2007 and the development project was expected to be carried out in a short period of time if such a loan was granted. In addition, it was assumed that the construction cost of the project would be reduced because it could fully use the existing facilities.

Figure 1 and Figure 2 show a map of how the Sondu Miriu Power Station is related to this project, and photographs of the major components of the project, respectively.



Source: This figure has been created using materials provided by JICA.

Note: The red line on the map indicates the portion of the system that was covered by this project. The project consists mainly of (1) the connecting channels, head tank, and penstock, (2) the power station, generator, and substation, (3) power transmission lines, and (4) the access road.

Figure 1: Summary Map of the Project

[1] The Sondu/Miriu Hydropower Project (E/S) (LA was signed in October 1989), Sondu/Miriu Hydropower Project (LA was signed in March 1997), and Sondu/Miriu Hydropower Project (II) (LA was signed in February 2004)

(1) Connecting channel

(1) Penstock pipe and
(2) the power station

(2) Generator

(2) Substation

(3) Power transmission lines

(4) Access road

Source: Photographs were taken by the external evaluator.
Note: The numbers in the titles of the photographs correspond with those in the Figure 1 map.

Figure 2: Photographs Related to the Project

1.2 Project Outline

The objective of this project is to expand the power supply by constructing a hydropower station with an installed capacity of 21.2 MW in the Kisumu District of Nyanza Province in the western part of the Republic of Kenya, thereby contributing to the improvement of the living standards of Kenyans and the sustained growth of the Kenyan economy.

Loan Approved Amount/ Disbursed Amount	5,620 million yen / 4,318 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	January 10, 2007 / January 23, 2007	
Terms and Conditions	Interest Rate Repayment Period (Grace Period Conditions for Procurement	0.75% 40 years 10 years) General untied
Borrower / Executing Agency	Kenya Electricity Generating Company (KenGen) / Kenya Electricity Generating Company (KenGen)	
Project Completion	July 2013	
Target Area	Kisumu District of Nyanza Province in western Kenya	
Main Contractor	Sinohydro Corporation (China)	
Main Consultant(s)	Nippon Koei Co., Ltd. (Japan)	
Related Surveys (Feasibility Studies, etc.)	<JICA> Preliminary studies for the Sondu River multipurpose development project (1982), preparatory studies for the Sondu River multipurpose development project (1983), and feasibility studies for the Sondu River hydropower development plan (1985) <KenGen> Detailed design of an additional power station for the Sondu-Miriu/Sang'oro hydropower plant construction project (2000) and the implementation program for the	

	Sondu-Miriu/Sang'oro hydropower plant construction project (2005)
Related Projects	Electric power rehabilitation project (World Bank, European Investment Bank, Agence Française de Développement, and Nordic Development Fund, 2003–2014), Kenyan Electricity Modernization Project (World Bank, 2015–2020), and KenGen guarantee project (World Bank, 2018–2021)

2. Outline of the Evaluation Study

2.1 External Evaluator

Ryuji Kasahara (IC Net Limited)

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.
Duration of the Study: December 2018–February 2020
Duration of the Field Study: January 26–February 9, 2019; and May 11–17, 2019

2.3 Constraints during the Evaluation Study

(1) Because the evaluator could not obtain the project progress report and the completion report, both of which were compiled by consultants, it should be noted that the information obtained during the implementation period is overly dependent on interviews with the executing agency and with representatives of the residents.
(2) Kenya Electricity Transmission Company (KETRACO) is supposed to undertake the maintenance of the power transmission lines built under this project. However, in practice, Kenya Power and Lightning Company Limited (KPLC) was in charge from after completion of construction to the time of the ex-post evaluation. The lines were handed over to KETRACO but are being maintained by KPLC under a service level agreement between KETRACO and KPLC. KETRACO will undertake the maintenance in the future, but at the time of the ex-post evaluation, the evaluator could not pinpoint an exact date when the maintenance will be transferred. Therefore, the sustainability of the project was assessed based on KPLC's operation and maintenance system, technology and finances.

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

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of Kenya

At the time of the appraisal and the ex-post evaluation, the Kenyan government's national development policy documents and electric power sector development plan (*Least Cost Power Development Plan: LCPDP*)[4] highlighted the development of power sources as one of the government's development priorities, and this project was highly consistent with the government's policy. At the time of the appraisal, the Kenyan government viewed the importance of developing power sources as a way to "develop the economic infrastructure to ensure stable economic growth, and as a way to respond to the tight power supply and demand." At the time of the ex-post evaluation, the Kenyan government positioned it as "a means of laying the foundation for National Transformation and providing electricity at an affordable

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③: High, ②: Fair, ①: Low
[4] This consists of the Kenyan government's medium-term plan, *Investment Program for the Economic Recovery Strategy for Wealth and Employment Creation (IP-ERS)*, and *LCPDP 2006–2026* at the time of the appraisal, its *Third Medium Term Plan 2018–2020*, *Kenya Vision 2030*, and *LCPDP 2007–2037* at the time of the ex-post evaluation.

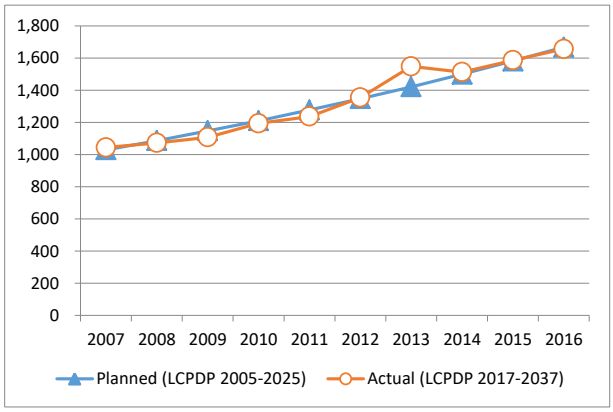
price, in an appropriate and stable manner to support industrial development." This project was listed in the *LCPDP* at the time of appraisal.

This project, which involved building a power station, was in accordance with the government's policy to promote the development of power sources.

3.1.2 Consistency with the Development Needs of Kenya

The peak electricity demand, which stood at 908 MW in 2005 at the time of the appraisal, was expected to grow at an annual rate of about 5% over the following decade. The actual peak electricity demand confirmed at the time of the ex-post evaluation almost corresponded with this prediction, indicating that an enough power capacity to meet the peak electricity demand nationwide had been maintained. In addition, the construction of a power station with an installed capacity of 21.2 MW under the project was in agreement with the government's need to meet the growth in peak electricity demand. In Figure 3, the blue line shows changes in peak electricity demand as estimated at the time of the appraisal with the red line indicating the actual changes confirmed at the time of the ex-post evaluation.

Meanwhile, at the time of the appraisal, there was an urgent need to stabilize the regional power supply by implementing the project in the Western region, particularly West Kenya,[5] where there were only a few power stations. In the same region, the biofuel power station in Mumias (21.5 MW) and the gas-fired power station in Muhoroni (30 MW)[6] were the only power stations newly built during the period from the time of the appraisal to the time of the ex-post evaluation, and even at the time of the ex-post evaluation, the number of power stations in the Western region was small. This project is considered consistent with the need to stabilize the regional power supply by building a power station in the region.



Source: LCPDP2005 and LCPDP 2017

Figure 3: Planned and Actual Peak Electricity Demand

3.1.3 Consistency with Japan's ODA Policy

At the time of the appraisal, the *Country Assistance Program* (2000) stated that the Japanese government would strive to develop economic infrastructure, including energy support development. The *Implementation Policy for Overseas Economic Cooperation Operations* (April 2005 to March 2008) at the time of the appraisal emphasized that the development of

[5] Power stations are controlled by dividing the country into four regions (The parentheses indicate sub-districts): Coast, Nairobi (Nairobi South, Nairobi North, and Nairobi West), Mt. Kenya (Mt. Kenya, North, and North Eastern) , and Western (North Rift, Central Rift, West Kenya, and South Nyanza). Because there have been slight changes to the division of the country since fiscal 2014, attention needs to be paid when analyzing the data by region. For reference, the region was formerly divided into Coast, Nairobi (Nairobi South, Nairobi North, and Nairobi West) , Mt. Kenya (Mt. Kenya North and Mt. Kenya South) , and Western (North Rift, Central Rift, and West Kenya) .

[6] This gas-fired power station was relocated from Embakasi (Nairobi).

electric power was important to bring and expand development effects, that in view of such importance, the Japanese government intended to grant an ODA loans, and that it should keep regional development in mind when granting ODA Loans. Therefore, the project (power generation project) , which kept the need to relieve the tight power supply and demand, and the need to stabilize regional power supply in mind, was consistent with Japan's aid policy at the time of the appraisal.

3.1.4 Appropriateness of the Project Plan and Approach

According to the executing agency's strategy document[7] at the time of the appraisal, considering the planning and construction period up to completion, the construction of a thermal power station was chosen as a measure to cope with the tight power supply and demand.[8]

At the time of the ex-post evaluation, the *Power Generation and Transmission Master Plan* (2015-2035) and the *Climate Change Adaptation Plan* (2015-2030), both formulated in 2015, highlighted the policy of reducing dependency on hydroelectric power generation, which is affected by rainfall, and developing electric power through geothermal power generation as a way to reduce such dependency. In other words, at the time of the appraisal, thermal power generation was considered as a principal means of developing electric power, and at the time of the ex-post evaluation, geothermal power generation was considered as such, indicating that at both points in time, hydroelectric power generation was not regarded as a principal means of developing electric power, although the need of hydroelectric power generation was recognized for a flexible capacity to the power system.

According to the planning department of the executing agency, by the time of the appraisal, the project planning and land acquisition required for the construction of a power station had been completed through the development of the Sondu Miriu Power Station; therefore, it was assumed that it was possible to complete the project early, and the project was added to the list of measures to cope with the tight power supply and demand.

Both at the time of the appraisal and at the time of the ex-post evaluation, there were only a small number of candidates for power stations using renewable energy efficiently that could be built in western Kenya. One of such few candidates was the current project whose approach was to make the most of the water flowing out of the Sondu Miriu Power Station to build an additional hydroelectric power station. In fact, as shown by the implementation of the Olkaria-Lessos-Kisumu Transmission Lines Construction Project (whose L/A was signed in December 2010), electricity needs to be transmitted to western Kenya from outside as the demand for power there grows.

Therefore, the project plan and approach were appropriate as a way to alleviate the tight power supply and demand and to stabilize the regional power supply.

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

3.2 Efficiency (Rating: ③)

3.3 Effectiveness and Impacts[16] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The effectiveness of the project was evaluated based on operation and effect indicators, which were included in the ex-ante evaluation paper at the time of the appraisal. The five indicators

[7] *KenGen 2007 Transformation Strategy*

[8] No large (medium-sized) hydroelectric power station was built after this project. It was assumed that the construction of a thermal power station was not a long-term solution because thermal power generation is costlier than other types of power generation (hydroelectric and geothermal) in terms of fuel expenses.

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

used were: (1) Unplanned outage (days/year), (2) Capacity factor (%), (3) Planned outage (days/year), (4) Maximum output (MW), and (5) Amount of electricity at the transmission end (GWh/year). At the time of the appraisal, targets were set for two years after project completion. Based on the materials collected at the time of the ex-post evaluation, the effectiveness of the project was evaluated by considering the 2015 results as those for two years after project completion. Table 5 lists the targets, actual results, and the degree of achievement for the abovementioned five indicators.

Table 5: Targets and Actual Results for Operation and Effect Indicators

		Targets (Note 1)	Actual Results (Note 1)						
	Indicators	2015 2 years after project completion	2012* Completion of construction	2013 Project completion	2014 1 year after project completion	2015 2 years after project completion	Degree of achievement (Result/ target)	2016	2017
(1)	Unplanned outage (days/year) (Note 2)	2	31.3	9.7	7.8	2.0	100%	86.6	13.0
(2)	Capacity factor (%) (Note 2)	57.2	75.0	59.0	67.3	75.7	132%	48.4	69.6
(3)	Planned outage (days/year) (Note 3)	14	0.4	31.7	25.7	16.9	82%	12.5	11.9
(4)	Maximum output (MW)	21.2	21.2	21.2	21.2	21.2	100%	21.2	21.2
(5)	Amount of electricity at the transmission end (GWh/year) (Note 4)	106.2	117.3	109.3	124.6	140.3	132%	89.7	128.9

Source: Materials provided by JICA, the executing agency, etc.

*Data for (1) to (3) in July and August 2012 are missing.

Note 1: Because a new power station was being built, the base value for each indicator was zero, and its listing was omitted. Targets were set referring to the materials provided by JICA. Indicators were evaluated for one year; the fiscal year from July to June of the following year. Construction was completed in July 2012, but because it was assumed that the project was completed in July of fiscal 2013, fiscal 2015 was set as two years after project completion.

Note 2: At the time of the appraisal, the equipment use rate (%) was calculated using the following formula: (Amount of electricity at the transmission end (GWh/year) × 1,000) ÷ (Maximum output (MW) × 24 hours × 365 days). The same formula was also applied for this evaluation.

Note 3: The degree of achievement was calculated using the following formula: (Result/365 days) ÷ (Target/365 days).

Note 4: The amounts were calculated using the amount of electricity generated (kWhrs), which was provided by the executing agency, and in-facility power consumption.

Apart from Indicator (3) Planned outage (days/year), all indicators achieved their targets. However, the degree of achievement for Indicator (3) exceeded 80%, indicating that overall, the project largely achieved its targets. The following section explains more about each indicator.

Indicator (1) Unplanned outage (days/year) achieved the target. The target was two days/year, and the result was two days/year, making the degree of achievement 100%. However, the results in fiscal 2016 and 2017 dropped below the target. According to the executing agency, the reasons that the result fell far below the target were droughts for both years and particularly in fiscal 2016 the sudden functional failure of the generators' oil cooler. The countermeasure after the breakdown was explained in the section "3.4.4 Status of Operation and Maintenance."

The target and result for Indicator (2) Capacity factor (%) were 57.2% and 75.7%, respectively, with a degree of achievement of 132%. This indicator attained the target. In fiscal 2016, the target was not reached because there was a substantial number of unplanned power failures, but in 2017, the power supply recovered so as to exceed the target.

With its target and result at 14 days/year and 16.9 days/year, respectively, Indicator (3) Planned outage (days/year) had a degree of achievement of 82%. In fiscal 2015, the indicator went below the target, but in fiscal 2016 and 2017, it exceeded the target. Interviews with the

executing agency indicated that the reason the indicator fell below the target was the blackouts planned by KPLC, which was responsible for electricity distribution.

The target for Indicator (4) Maximum output (MW) was 21.2 MW, and the result was 21.2 MW, meaning that the target was achieved. The project aimed to achieve an output of 21.2 MW by operating the two generators it procured, and the result indicated that both generators were in operation at all times.

Indicator (5) Amount of electricity at the transmission end (GWh/year) achieved the target with a degree of achievement of 132%. The target was 106.2 GWh/year, and the result was 140.6 GWh/year. In fiscal 2016, the result was 89.9 GWh/year, falling below the target, because generator failures and droughts occurred simultaneously. However, in fiscal 2017, the result was 129.3 GWh/year, exceeding the target. According to the executing agency, the reason the result exceeded the target was that at the time of the appraisal, targets were set on the assumption that some of the water discharged from the Sondu Miriu Power Station would be used for the Kano Plain Irrigation Project, but then in 2015, that the irrigation project was not developed, the water expected for irrigation now being used for power generation.

Therefore, the efficiency of the project was high because the results generally exceeded the targets set for the hydroelectric power station constructed under the project.

3.3.1.2 Qualitative Effects (Other Effects)

Refer to Section 3.3.2 “Impacts.”

3.3.2 Impacts

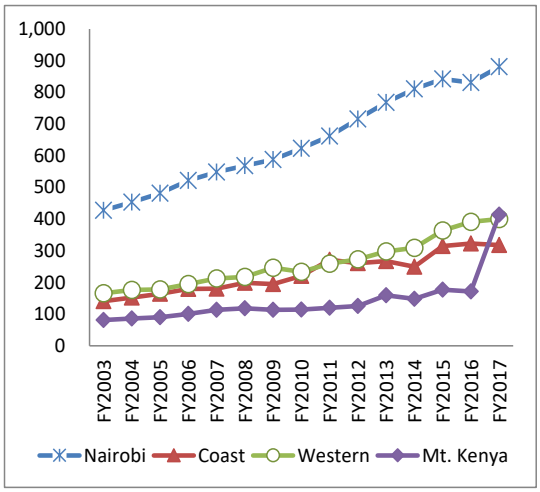
3.3.2.1 Intended Impacts

According to the documentation provided by JICA, the following three impacts of this Sang’oro Power Station development project were expected: ① to contribute to the improvement of citizens’ living standards and sustainable economic growth, ② to promote regional electrification through increasing power supply, and ③ to alleviate the tight power supply and demand, and to improve the stability of the power supply. Because various factors are intricately involved with the attainment of ① and ②, it is difficult to analyze in isolation any direct causal connection to this project. Therefore, ① and ② are treated as reference information for evaluation while ③ will be the main subject of evaluation. As shown below, the information on (1) power supply and demand, (2) electrification rate, (3) economic growth, and (4) the planned targets and actual achievements of power plant development is organized by region.[17]

(1) Power supply and demand

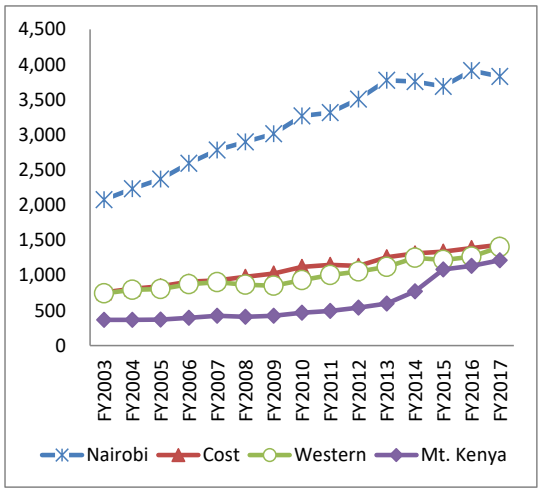
Figure 4 and Figure 5 show the trends of peak-time power demand (MW) and annual power supply (GWh/yr) by region. These also present an increasing trend in power demand and power supply in the western region, where power development has progressed through this project.

[17] The four KPLC divisions used in power management (Nairobi, Coast, Western, and Mt. Kenya) are used.



Source: KPLC Annual Report

Figure 4: Peak-time Power Demand by Region (MW)



Source: KPLC Annual Report

Figure 5: Power Supply and Consumption by Region (GWh/yr)

(2) Electrification

Table 6 shows the changes in the electrification rate in the entire country, urban areas, and rural areas. As a whole, electrification is progressing in rural areas. Increases in the electrification rate should also note factors aside from new power source development, such as improvements in access to existing power grids.[18]

Table 6: Electrification Rate (%)

	2003 (1)	2009 (2)	2014 (1)	2018 (3)
Urban areas	50.2	50.40	68.40	No data
Rural areas	4.6	5.10	12.60	No data
Entire country l	16.0	No data	36.00	75.00

Source: (1) Demographic and Health Survey, (2) Population Census, (3) National Electrification Plan 2018

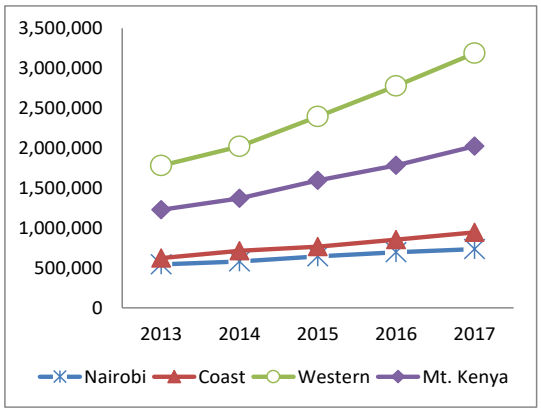
Note: Because the sources of information vary, it should be noted that definitions, such as urban-rural distinction, and the way information was collected are not consistent.

(3) Economic growth

Figure 6 and Figure 7 show the proportion of nominal regional GDP values and regional GDPs in the total GDP of Kenya.[19] The western region, where power development has progressed through this project, is showing an increasing trend in normal GDP value and proportion, which can be understood as enjoying positive economic growth.

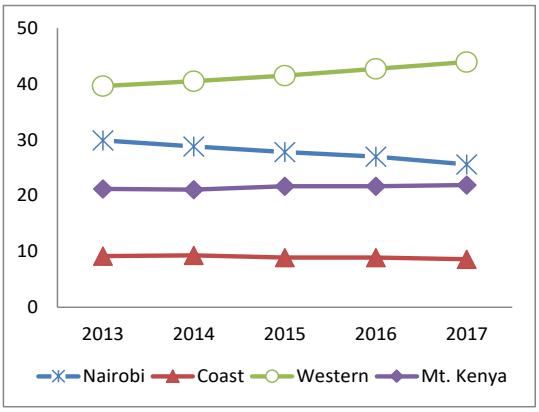
[18] According to KPLC's 2017 annual report, the Last Mile Connectivity Project ongoing from 2015 has been contributing to electrification.

[19] GDP by county, issued by the Kenya National Bureau of Statistics, is summarized into the four KPLC-based management regions. County means the local municipality in Kenya.



Source: Kenya National Bureau of Statistics 2019

Figure 6: Regional GDP per Capita (In nominal value, Unit: million Kenyan shillings)

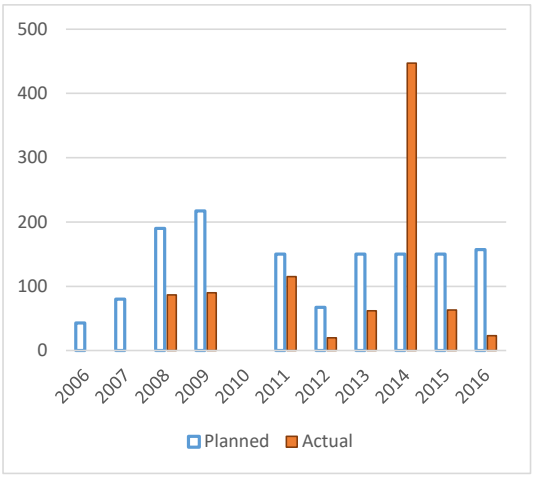


Source: Kenya National Bureau of Statistics 2019

Figure 7: Regional GDP per Capita (%)

(4) Planned targets and actual achievements of the power generation development

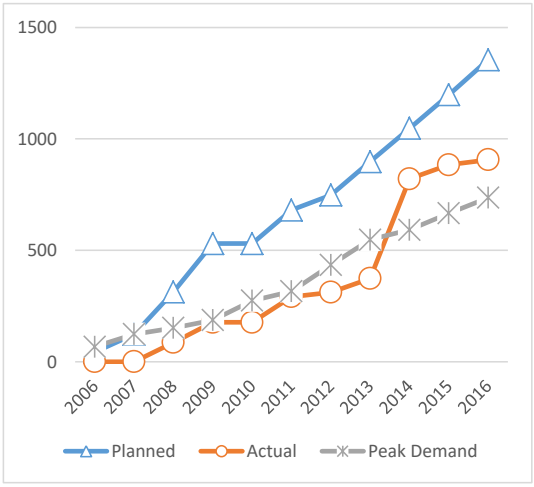
Figure 8 and Figure 9 compare the power capacity (MW) in the new construction plan for the power plant mentioned in the 2006 power development plan (*LCPDP*) and that of the actual achievements of the new power plant as provided by the 2016 power master plans.[20] The planned values and actual performance values diverge, which indicates that the new power plant construction was not progressing as planned and that the power development had not caught up with the increase in peak-time power demand.[21] It was in the midst of such a tight situation that the Sang'oro Power Station was constructed in 2012.



Source: LCPDP 2006, Power Master Plan 2016

Note: The planned target and achievement values are both zero for 2010.

Figure 8: Planned Targets and Achievements of Power Generation Development (MW)



Source: LCPDP 2006, Power Master Plan 2016

Figure 9: Planned Targets and Achievements of Power Generation Development (MW/Cumulative)

[20] *Least Cost Power Development Plan 2006–2026* and *Development of a Power Generation and Transmission Master Plan, 2015–2035*.

[21] Figure 8 does not indicate that the peak-time power demand (MW) exceeds the total installed capacity (MW). The total installed capacity as of 2006 was 1,197 MW, and the peak-time power demand was 987 MW, which means that there was a generation reserve margin of 210 MW. Figure 8 suggests that the generation reserve margin will be low at times with only the new power plant construction because the increase in new power plant construction has not fully caught up with the increase in peak-time power demand. This divergence is partially closed by the emergency Aggreko Power Station (120 MW), which commenced operations in 2008.

Based on the information described in (1), (2), and (3) above, it is difficult to adequately measure the contribution rate of this project alone on the impacts ① and ②. Nevertheless, a general positive relationship is observed between power supply and demand, as well as between electrification rate and economic growth. From the information in (4) above, the Sang'oro Power Station, which was constructed as a part of this project and started power generation in 2012, is deemed to have contributed to impact ③, namely the alleviation of the tight power supply and demand as well as stable power supply.

3.3.2.2 Other Positive and Negative Impacts

This section details other positive and negative impacts of this project with regard to (1) natural environment, (2) resettlement and land acquisition, and (3) others, including a) employment, b) workers' health and safety, c) relationship with other development projects, and d) the application of Clean Development Mechanism (CDM). A committee is established to facilitate the execution of this project by the stakeholders, including beneficiaries, sharing and understanding the issues of environmental and social considerations associated with the project and reviewing, discussing, and proposing measurements. The efforts of this committee, called the Technical Committee, are summarized under item (4).

In relation to the impact items, the evaluator conducted interviews with the members of the Technical Committee as well as the members of the Stakeholders' Coordination Committee[22] about the situation during and after the execution of this project.[23]

(1) Natural environment

The *Environment Impact Assessment Report* of this project is accepted by the National Environment Management Authority (NEMA) in September 2004.[24] The project had obtained permission for developing a power plant inside the Koguta Forest Reserve.

The submission of an annual environmental monitoring report was mandated by the NEMA during the execution of the project. According to the executing agency, it submitted quarterly environmental monitoring reports to NEMA. From the reports, the evaluator observed, it was confirmed that the executing agency was periodically monitoring air pollution, noise, and impact on the ecosystem during the execution of the project. No serious environmental destruction has been reported during on-site interviews.[25]

The recovery of the Koguta Forest Reserve is conducted by means of the executing agency providing saplings to the residents. No issues were reported regarding the rehabilitation of the Koguta Forest Reserve during interviews with the executing agency.

Additionally, after the completion of the project, KenGen, which is responsible for the maintenance of the Sang'oro Power Station, undertakes an annual internal environmental audit for the Sang'oro Power Station and submits the report thereof to NEMA.[26]

(2) Resettlement and land acquisition

At the time of the appraisal, compensation was planned for the acquisition of land for the

[22] From the Technical Committee's successful experience of being a vehicle for dialogue with the residents, the executing agency recently organized the Stakeholders' Coordination Committee, which has similar functions as the former. (Source: KenGen Weekly - The Official Weekly e-Newsletter: Vol.9 Issue 13 Friday, April 12, 2019.)

[23] The evaluator interviewed four members of the Technical Committee and four members of the Stakeholders' Coordination Committee.

[24] This project is a part of the Sondu/Miriu Hydropower Project, whose developmental construction started before the Kenyan environmental review system was established; therefore, at the time of the appraisal, it was determined unnecessary to acquire environmental compliance certification for this project alone. The environmental review system was established in Kenya based on the 1999 Environmental Management and Co-ordination Act. The NEMA was founded in 2002 to supervise the environmental review.

[25] The above monitoring report reported on inappropriate water quality, noise, and disposal.

[26] It is mandated to examine any impact on the Koguta Forest Reserve by means of site reconnaissance by the supervisory agency (Kenya Forest Service and NEMA) and the County Environmental Committee in the municipality after the completion of the project. As of the ex-post evaluation, this has not been conducted yet.

construction of transmission towers for power transmission lines for this project as well as for the way leave for power transmission lines. This compensation was paid based on the laws of Kenya. For the acquisition of land, a fixed amount of compensation is paid per land necessary for the construction of a transmission tower. For the way leave, the amount of compensation is decided in negotiation between the land owner and the executing agency. In addition to land, the structure constructed on the land for which compensation is paid, the constraint of livelihood, and inconvenience are considered and added to the total compensation amount. No gross negligence has been reported regarding the compensation for the relocation of buildings, etc.[27]

(3) Others

(a) Employment

The employment of local workers has been promoted through efforts such as the construction business operator establishing Recruitment Officers for the employment of local workers and the screening of applicants and referral of successful candidates to the construction business operator by a sub-committee (employment and economic opportunities) of the Technical Committee.

(b) Health and safety

At the time of the appraisal, the executing agency is required to ensure the workplace health and safety of civil engineering workers as well as take measures against adverse effects in society such as the spread of HIV/AIDS. In fact, the executing agency has been providing facilities to the Voluntary Counseling and Testing Center, which it is established under the Sondu-Miriu Hydropower Project. The environmental monitoring report, which the evaluator reviewed, reported that the distribution of safety gear to civil engineering workers had been insufficient, but fortunately, it did not lead to gross negligence as a result.

(c) Relationship with other development projects

The amount of water that can be used for power generation at the Sang'oro Power Station depends on whether the development of Kano Plains Irrigation, which uses the Sondu River, takes place. From the interviews with the National Irrigation Board, it was confirmed that Kano Plains Irrigation had not been developed yet at the time of the ex-post evaluation. However, the evaluator has also received information that the National Irrigation Board has conducted a survey on the Kano Plains Irrigation Project and that future development can be expected depending on the allocation of Kisumu County's project budget. The future direction of this process should be closely observed.

(d) Application of the Clean Development Mechanism (CDM)

The feasibility of the CDM application to this project was to be discussed during the appraisal. Prior to applying for review of the CDM application for this project, the CDM application for the Sondu-Miriu Hydropower Project had been reviewed, where it was concluded that the Sondu-Miriu Hydropower Project was not eligible for CDM application as it developed before the establishment of CDM. Because it was deemed that the same conclusion would apply to this project, which started as a part of the development of the Sondu-Miriu Hydropower Project, applying for review of the CDM application did not take place.

(4) Dialogue with residents

For this project, taking after the experience from the Sondu-Miriu Hydropower Projects (I) and (II), a Technical Committee was established as a vehicle for problem solving and dialogue between the executing agency and residents. The Technical Committee consists of representatives of local residents, NGOs, academics, specialists, politicians, regional administrative officials, the executing agency, etc. JICA also participated in regular meetings. Four sub-committees were established under the Technical Committee: land acquisition and compensation, health safety and security, environment, and employment and economic

[27] The easement acquired by the executing agency for the project was transferred to KETRACO, responsible for the management of power transmission lines, from the executing agency in 2015.

opportunities. The quarterly environmental monitoring report includes a record of the activities of each sub-committee, reporting their recognition of the status of issues and action proposals. The Technical Committee was active from December 2008, which is after the construction of Sang'oro Power Station started, to July 2012, when this power plant construction was completed. According to members of the Technical Committee, no activity took place after the completion of the power plant construction, and the Technical Committee was dissolved upon the establishment of the Stakeholders' Coordination Committee, as explained below.

Based on the experiences from Sondu-Miriu Hydropower Projects (I) and (II) and this project, the executing agency KenGen established the Stakeholders' Coordination Committee in each regional office in order to facilitate dialogue between the executing agency and the residents. According to interviews with the executing agency, it has organized two committees, one for the construction phase of the power plant and the other for the operation and maintenance of the power plant after the completion of the construction. At the Western Region Office, which has jurisdiction over the Sang'oro Power Station, the Stakeholders' Coordination Committee was organized upon selecting members by means of election by residents around November 2018.[28] The Stakeholders' Coordination Committee is expected to solve complaints that were heard during on-site interviews through dialogues: for example, a problem in the access road between the Sang'oro Power Station and the main road is causing flooding in the school building of an elementary school adjacent to the access road during the rainy season.

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

3.4 Sustainability (Rating: ②)

Table 7 and Figure 10 show key organizations involved with the electricity sector as of the ex-post evaluation, along with their roles and relationships. The maintenance of the power plant and power transmission lines constructed in this project are undertaken respectively by KenGen, the executing agency for this project, and KPLC. The maintenance of the power transmission lines was originally a role to be undertaken by KETRACO,[29] organized in 2008 after the appraisal of this project. From on-site interviews, it was found that KPLC was actually undertaking maintenance on behalf of KETRACO at the time of the ex-post evaluation. For this reason, the maintenance system, capability, and finance of both KenGen and KPLC were evaluated. Information on KETRACO's maintenance is limited to partial summarization.

Table 7: Key Organizations Related to the Electricity Sector

Organization (Note 1)	Major function
Ministry of Energy	Policymaking for the electricity sector
Energy and Petroleum Regulatory Authority (EPRA)	Electricity-related regulations (Note 2)
Kenya Generation Company (KenGen)	Electricity development (Power generation)
Geothermal Development Company (GDC)	Geothermal power generation development
Kenya Transmission Company (KETRACO)	Power transmission (established in 2008)
Kenya Light and Power Company (KPLC)	Power distribution and transmission
Rural Electrification Authority (REA)	Rural electrification

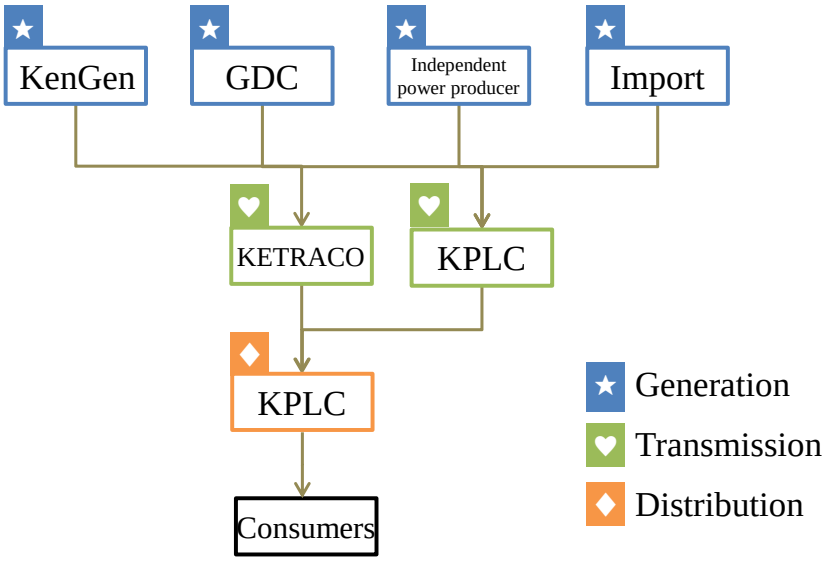
Source: Created based on https://www.ketraco.co.ke/learn/electricity-sub-sector.html (June 24, 2019)

Note 1: The government owns 70% of KenGen's shares, 100% of GDC's shares, approximately 50% of KPLC's shares, and 100% of KETRACO's shares.

Note 2: Organization changed from the Energy Regulatory Commission to EPRA based on the Energy Act 2019.

[28] Information on the members of the Stakeholders' Coordination Committee was not obtained. The number or frequency of meetings held, scope of roles and duties, whether or not there were sub-committees, and other information were undefined as of the time of the ex-post evaluation.

[29] https://www.africa-energy.com/article/ketraco-takes-over-independent-system-operator-kenya (June 9, 2019)



Source: Created based on https://www.ketraco.co.ke/learn/electricity-sub-sector.html (June 24, 2019)

Figure 10: Key Organizations in the Electricity Sector

3.4.1 Institutional / Organizational Aspects of Operation and Maintenance

KenGen undertakes maintenance of power plants and manages power plants by region. The Western Region Office, responsible for the operation and maintenance of the Sang'oro Power Station, was assumed to be in charge of only the Sondu Miriu Power Station and Sang'oro Power Station, but at the time of the ex-post evaluation, it was undertaking operation and maintenance of other nearby power plants[30] in addition to the Sondu Miriu Power Station. The number of staff members for the operation and maintenance of the Sondu Miriu Power Station and Sang'oro Power Station was assumed to be 26 at the time of the appraisal, but 23 staff members were actually assigned as of the ex-post evaluation, which is almost as planned. Figure 11 shows the organizational structure of KenGen as it relates to the Sang'oro Power Station.

KPLC undertakes the maintenance of power plants and manages them by dividing the country into 10 sub-districts/regions.[31] The power transmission lines constructed in this project were assumed to be under the jurisdiction of a sub-region of the Western Region during the appraisal, but as of the ex-post evaluation, they were operated and maintained by the Western Kenya Office. While the number of staff members for the operation and maintenance of the power transmission lines was assumed to be six at the time of the appraisal, 10 staff members were actually assigned as of the ex-post evaluation, which is almost as planned. Figure 12 shows the organizational structure of KPLC as it relates to the Sang'oro Power Station (power transmission lines).

The organizational structure of KETRACO, which will be responsible for the maintenance of power transmission lines of this project in the future, was uncertain while the interviews as of the ex-post evaluation suggested progress in developing a maintenance structure by converting the existing structure for another power transmission line development project.

Although the future structure at KETRACO needs attention, it is deemed that the maintenance structure for the power plants and power transmission lines are established as of the ex-post evaluation.

[30] Hydropower plants GoGo and Sosiani, and gas thermal power plant Muhuorni.
[31] Managed in four districts. The parentheses indicate sub-districts. See footnote 5 for details.

KenGen

Operations Division	➔ **Within Operations Division**		➔ **Within Western Region Department**
Company Secretary & Legal Affairs Division	Western Region Department		Regional Manager
Human Resource & Administration Division	Upper Tana Department		Ass. Operations Manager
Finance & ICT Division	Eastern Region Department		**-Station in-charge Sondu/ Sangoro / Sosiani**
Corporate & Regulatory Services Division	Technical Services Department		**- Shift supt. Sondu/ Sangoro**
Business Development Division	Thermal Department		- Station in-charge Gogo
Geothermal Development Division	Operations Dispatch Department		- Station in-charge Muhoroni Gas Turbine
Strategy & Innovation Division			AG. Chief Engineer
Supply Chain Division			

Source: Created from information in the annual report of the executing agency
Note: The part colored by gray is the offices in charge of operation and maintenance.

Figure 11: KenGen's Organizational Structure for Sang'oro Power Station

KPLC

Business Strategy	**Administrative Regions**	➔ **West Region Office**
Infrastructure Development	Nairobi North	Regional Manager
Network Management	Nairobi South	Chief Engineer／Technical Services Engineer
Street Lighting	Nairobi West	**Transmission Engineer**
Customer Service	Coast	Protection Engineer
Regional Coordination	Central Rift	Electrical Plant Engineer
Company Secretary	West	
Supply Chain	North Rift	
Internal Audit	South Nyanza	
Human Resource and Administration	Mount Kenya	
Finance	North Eastern	
Information and Communication Technology (ICT)		

Source: KPLC Company Profile (2017)
Note: The part colored by gray is the offices in charge of operation and maintenance.

Figure 12: KPLC's Organizational Structure for Sang'oro Power Station (Transmission Lines)

3.4.2 Technical Aspects of Operation and Maintenance

KenGen undertakes maintenance of power plants and clearly defines the competence standards for each position. For example, managerial positions in organizations that undertake operation and maintenance are required to have a bachelor's degree in mechanical engineering and several years of on-site work experience. KenGen conducts personnel evaluations twice a year for each worker and provides training opportunities according to the evaluation result. KenGen develops training programs every year and offers training opportunities to its workers. KenGen has developed and uses a manual for hydropower generation in general and a manual specifically for the operation and maintenance of the Sang'oro Power Station and prepares periodic maintenance reports. As described in "3.4.4 Status of Operation and Maintenance," KenGen swiftly responded to the breakdown of the oil cooler for the power generator that occurred in 2017. Thus, it seems fair to say that KenGen has sufficient technical capacity.

KPLC undertakes the maintenance of power transmission lines and clearly defines the role division and required functions, work experience, and academic background for each office organization. For example, a transmission engineer, which is a managerial position in an organization responsible for the operation and maintenance of power transmission lines, is required to have a bachelor's degree in electrical engineering and five years of work experience. KPLC offers periodic competence training every year and has developed a manual for the operation and maintenance of power transmission lines to manage the technical standards.

According to interviews with the JICA country office, the technical competence of KETRACO, which is to take on the maintenance of power transmission lines of this project in the future, would be sufficient to not cause a serious problem in the maintenance of the five-kilometers of power transmission lines constructed in this project. This can be inferred from its handling of the Olkaria-Lessos-Kisumu Transmission Lines Project, a Japanese ODA Loan Project for which KETRACO is the executing agency. Thus, it seems fair to say that KETRAO has technical capacity to manage the said transmission lines at the time of ex-post evaluation.

Therefore, it seems that KETRACO has the technical capacity for the operation and maintenance of power plants and power transmission lines.

3.4.3 Financial Aspects of Operation and Maintenance

The financial status of KenGen, which maintains the power plants, is shown below. Table 8 shows KenGen's financial statements and financial indicators, KenGen's overall sales, expenditures, and maintenance cost, as well as KenGen's sales, maintenance cost budget and actual cost related to KenGen Sang'oro Power Station. The income from the Sang'oro Power Station is enough to cover the necessary expenses for maintenance. Cost distribution is such that the actual cost exceeds the budget. According to interviews with KenGen, the company prioritizes the allocation of budget to maintenance cost as a general management policy of KenGen. Looking at KenGen overall, a certain level of expenditures is maintained for maintenance cost. KenGen's financial status based on past financial statements is sustained at a sound level in terms of equity ratio, debt ratio, and current ratio. KenGen used a debt equity swap in fiscal 2015, and KenGen guarantee project that started in 2018 with the support of the World Bank is predicted to undergo difficulty in paying short-term debts after fiscal 2018 because of the accumulated previous borrowings; therefore it must be noted that the KenGen guarantee project has refinanced existing debt to improve KenGen's financial soundness.

Table 8: KenGen's Financial Statements and Balance

(Unit: million Shs, financial indicators present actual figures)

	2014	2015	2016	2017
Total assets	342,520	366,738	376,730	379,353
Fixed assets	321,151	344,822	347,090	347,941
Current assets	21,369	21,916	29,639	31,412
Combined total of liabilities and net assets	342,520	366,738	376,730	379,353
Net assets (Capital and reserves)	141,594	172,385	182,836	190,104
Fixed liabilities	178,446	176,163	173,800	168,370
Current liabilities	22,480	18,190	20,093	20,879
(1) Financial indicator: Equity ratio	0.41	0.47	0.49	0.50
(1) Financial indicator: Debt ratio	0.47	0.43	0.42	0.52
(1) Financial indicator: Current ratio	0.95	1.20	1.48	1.50
(2) Income	36,611	39,301	43,432	45,290
(2) Pre-tax profit	8,690	11,171	11,461	11,745
(2) Expenditure (Operating expenses)	4,285	4,559	4,778	-*
(2) Expenditure (Maintenance cost)	1,386	1,624	1,554	1,669
(3) Income (Sales)	818	924	597	856
(3) Expenditure (Maintenance cost/budget)	24	28	30	27

	2014	2015	2016	2017
(3) Expenditure (Maintenance cost/actual)	31	37	39	44

Source: Financial statements and (1) KenGen's annual report (basically the financial statements from fiscal 2017), (2) Documents provided by KenGen and KenGen's annual report, and (3) KenGen's offerings (received data from 2014)
* Expense account has been changed.
(1) Financial indicators: The figures of financial indicators are the results of the following calculations: Equity ratio = Equity / Total assets, Debt ratio = Debt / Equity (Net assets), Current ratio = Current assets / Current liabilities, (2) KenGen's overall income, expenditures, and maintenance cost. (3) Income and maintenance cost of the Sang'oro Power Station.

The financial status of KPLC, which maintains the power transmission lines of this project, is shown below. Table 9 shows KPLC's financial statements and financial indicators, as well as KPLC's overall sales, expenditures, and maintenance cost. KPLC underwent higher depreciation and lower profit in 2017 compared to other years. The maintenance cost also went down. The debt ratio has stayed high for the last few years. The current ratio is dropping, increasing the risk of short-term fund shortage. As of the ex-post evaluation, KPLC is preparing to refinance short-term debts with long-term debts.[32]

Table 9: KPLC's Financial Statements and Balance

(Unit: million Shs, financial indicators present actual figures)

	2014	2015	2016	2017
Total assets	272,286	289,583	331,236	336,655
Fixed assets	206,224	242,265	269,943	282,035
Current assets	66,062	47,318	61,293	54,620
Combined total of liabilities and net assets	272,286	289,583	331,236	336,655
Net assets (Capital and reserves)	57,970	59,379	63,334	64,207
Fixed liabilities	168,717	180,091	189,074	166,190
Current liabilities	45,599	50,112	78,829	106,258
Financial indicator: Equity ratio	0.21	0.21	0.19	0.19
Financial indicator: Debt ratio	1.40	1.69	1.94	1.88
Financial indicator: Current ratio	1.45	0.94	0.78	0.51
Income	106,764	108,375	120,742	125,854
Pre-tax profit	12,254	12,082	7,657	3,089
Net income	7,432	7,197	5,280	1,918
Expenditure (Administration)	11,851	14,830	18,679	15,910
Expenditure (Maintenance cost)	1,114	1,040	1,287	854

Source: KPLC annual report (financial statements from fiscal 2017, fiscal 2016, and fiscal 2015)
Note: The figures of financial indicators are the results of the following calculations: Equity ratio = Equity / Total assets, Debt ratio = Debt / Equity (Net assets), Current ratio = Current assets / Current liabilities

The financial status of KETRACO, which originally had the responsibility of maintaining the power transmission lines of this project, is shown below. Table 10 shows KETRACO's financial statements and financial indicators, as well as KETRACO's overall sales, expenditures, and maintenance cost. KETRACO is a relatively new organization, founded in 2008, and receives and operates wheeling charge from KPLC, which sells electricity. This wheeling charge is determined by government policy and includes maintenance cost. KETRACO's equity ratio and current ratio are both low while its debt ratio is high. Attention must be given to KETRACO's short and medium-to-long term fund management capacity.

[32] https://www.businessdailyafrica.com/news/Short-term-Sh16bn-debt-takes-toll-on-Kenya-Power/539546-4868866-idjjfz/index.html (June 9, 2019)

Table 10: KETRACO's Financial Statements

(Unit: million Shs, financial indicators present actual figures)

	2013 (Note 1)	2014	2015	2016
Total assets	50,128	71,344	109,421	134,860
Fixed assets	45,592	68,685	103,342	126,020
Current assets	4,536	2,659	6,079	8,840
Combined total of liabilities and net assets	50,128	71,344	109,421	134,860
Net assets (Capital and reserves)	1,184	1,002	1,661	2,091
Fixed liabilities	43,250	61,739	97,962	117,985
Current liabilities	5,694	8,603	9,798	14,785
Financial indicator: Equity ratio (Note 2)	0.02	0.01	0.02	0.02
Financial indicator: Debt ratio (Note 2, Note 3)	-	2.98	1.87	1.34
Financial indicator: Current ratio (Note 2)	0.80	0.31	0.62	0.60
Income from wheeling charge	50	735	2,011	2,011
Pre-tax profit	64	371	654	566
Expenditure (Maintenance cost)	No data	239	659	430

Source: KETRACO annual report (basically financial statements from fiscal 2016)

Note 1: Financial statements from fiscal 2014 and fiscal 2015 have been corrected in the financial report for fiscal 2016.

Note 2: The figures of financial indicators are the results of the following calculations: Equity ratio = Equity / Total assets, Debt ratio = Debt / Equity (Net assets), Current ratio = Current assets / Current liabilities

Note 3: Debt ratio was not published in the annual report. The result of the calculation by the evaluator was used.

Therefore, the finances for the operation and maintenance of power plants and power transmission lines have a room for improvement. It is necessary to keep paying attention to fund operation by KenGen, KPLC, and KETRACO.

3.4.4 Status of Operation and Maintenance

KenGen, which maintains the power plants, has been conducting half-term and annual inspections on the Sang'oro Power Station. During the appraisal, it was assumed that KenGen would conduct quarterly and annual inspections, as well as a full inspection every six years. According to interview, full inspection is no longer planned, by reason of a change in KenGen's maintenance policy to use a combination of time-based maintenance, where maintenance is conducted at fixed intervals, and condition-based maintenance, where maintenance is only conducted when deem necessary, and there is an alarm or malfunction.

As of the ex-post evaluation, the following issues and KenGen's responses have been observed: (1) A problem in the main inlet valve has caused a failure to completely stop the water flowing into the power generator's turbine. Water leakage has been resolved by replacement of the valve seal with one from the valve manufacture which was determined not to be robust for the operating conditions hence premature failures. KenGen is planning to redesign and replace with a more suitable seal material. (2) Peeling off of power plant wall tiles and cracks in walls inside the power plant were found, but it has been confirmed that they do not reduce the efficiency or effectiveness of power generation. (3) A problem was found in the IT system designed to enable operation and management of the Sang'oro Power Station from the control room of Sondu Miriu Power Station, which prevented sufficient remote control and management. KenGen plans to replace this IT system by 2020. (4) The oil cooler of the power generator broke down in January 2017. Because importing it from the supplier in China would be costly and time-consuming due to export and customs procedures, KenGen used redesigning techniques to manufacture and procure parts from the domestic market and repaired it in short time to make it in time for the annual inspection.

KPLC, responsible for the maintenance of power transmission lines, has been inspecting the power transmission lines between Sang'oro and Sondu every three to four months. No major problem was found in the power transmission lines or transmission towers during the site visit.

Therefore, it is fair to say that the operation and maintenance of power plants and power transmission lines are in an appropriate state.

In light of the above, a room of improvement has been observed in terms of the financial aspect. Therefore sustainability of the project effects is fair. The power transmission lines, for which the maintenance responsibility is to be transferred from KPLC to KETRACO, need attention in terms of future change in maintenance structure.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was carried sout for the purpose of expanding power supply by constructing a hydropower station with an installed capacity of 21.2 MW in the Kisumu District of Nyanza Province in Western Kenya, thereby contributing to the improvement of the living standards of Kenyans and the sustainable economic growth of the country.

As this project was in accord with Kenya's power development policy and development needs at the time of the appraisal and the ex-post evaluation and Japan's ODA policy at the time of the appraisal, the relevance of this project is high. As there was no change in the general outputs and the project costs and duration were within the plan, the efficiency of this project is high. The target values set as indicators of effectiveness were largely achieved. Additionally, as impacts from this project, this project has contributed to the alleviation of the tight power supply and demand as well as stable power supply. At the time of project implementation and the ex-post evaluation, while some issues were detected concerning the impacts on the natural environment, resettlement, land acquisition, employment, and work environment, no serious negative impact was observed. Therefore, effectiveness and impacts of this project are high. The sustainability of effects generated by this project has no major problem overall despite a room for improvement with respect to finances. Therefore, the sustainability of this project is fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

As a vehicle for dialogue with residents, the Stakeholders' Coordination Committee was organized in place of the Technical Committee. As the basis of bilateral communication, when defining the scope of works of the Stakeholders' Coordination Committee in the future, it is important to clarify the commitments between KenGen and the residents, such as those concerning the term of members and frequency of meetings, and to mutually abide by these commitments.

4.2.2 Recommendations to JICA

The maintenance of the power transmission lines and transmission towers constructed in this project will be substantively undertaken by KETRACO in the near future. Compared to KPLC, which is currently undertaking maintenance, KETRACO is a young organization and may experience issues with respect to the maintenance structure or technical aspects. Information should be collected as necessary, and assistance should be considered as needed.

4.3 Lessons Learned

<u>Ensuring means for dialogue with residents for large-scale projects and the maintenance thereof</u>

In this project and its predecessor, the Sondu-Miriu Hydropower Project, a committee was organized as a system for consultation and solving issues related to the execution of the project

through periodic dialogues with residents. This system was adopted by the executing agency, and a rule was established in the organization to set up a similar committee in the execution phase of other projects and in the maintenance phase of constructed facilities. For development projects, especially projects that involve land acquisition and compensation, health and safety, natural environment, and employment, it is desirable that the executing agency ensures a means of dialogue with residents, such as the above committee, and alleviate any major negative impacts on the residents through dialogue throughout the entire project management cycle, including project planning, execution, and maintenance.

END of Document

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1. Construction of connecting channels, a head tank, and a penstock 2. Construction of power plant 3. Installation of power generators (10.6 MW x 2 units) and transformers 4. Installation of power transmission lines	As planned
2. Project Period	January 2007 to December 2013 (84 months)	January 2007 to July 2013 (79 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 4,575 million yen 2,037 million yen (1,397 million Kenyan shillings) 6,612 million yen 5,620 million yen (1 Kenyan shilling = 1.46 yen) (As of September 2005)	 3,769 million yen 1,691 million yen (Unknown) 5,499 million yen 4,318 million yen (1 Kenyan shilling = 1.20 yen) (Average between 2007 and 2016)
4. Final Disbursement	August 2016	