Plurinational State of Bolivia

Ex-Post Evaluation of Japanese Grant Aid Project

"Project for Improvement of Potable Water System in Southeast of the City of Cochabamba"

External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

The Project was implemented in the City of Cochabamba, Plurinational State of Bolivia (hereinafter simply referred to as "Bolivia") with the aim of continually supplying clean water in sufficient quantity for residents of the south-eastern zone of the city by means of expanding the existing water treatment plant and constructing new water transmission and distribution pipelines, thereby contributing to improvement of the sanitation and living environment of the project area. At the time of both the ex-ante evaluation and ex-post evaluation, the Project was found to be highly relevant to the development policies of Bolivia and compatible with the need for the development of the water supply system in Cochabamba City in general and the project area in particular. It was also in line with the Japan's aid policy at the time of ex-ante evaluation. However, due to the somewhat insufficient information gathering/examination and verification of very important preconditions prior to the commencement of the Project, the relevance of the Project is fair. The Project mostly achieved its planned outputs and the actual project cost was within the plan. Meanwhile, the actual project period exceeded the plan. As such, the efficiency of the Project is fair. As a result of project implementation, local residents have benefited from improved water pressure and quality, increased use of water, reduction of water use-related expenditure and improved sanitation. However, because of failure to materialise associated projects and time consuming construction of water distribution networks by the residents' organizations, the benefiting population was only half of the plan, the water supply volume was only 10% of the plan and the water supply hours were only 2.7 hours/week compared to the planned continual water supply for 24 hours/day. Because of these shortcomings, the effectiveness/impact of the Project are low. No major problems were observed with SEMAPA or residents' organizations relating to the institutional, technical and financial aspects of the operation and maintenance of the facilities which are functioning well, making the sustainability of the Project high. In light of the above, this project is evaluated to be unsatisfactory.

1. Project Description

Project Location

Aranjuez Water Treatment Plant

1.1 Background

In 2009, the Government of Bolivia had the National Basic Sanitation Plan (2000 - 2010) which focused on improvement of the water supply and sewerage facilities with the target of improving the national coverage of water supply to 90% by 2010.

The City of Cochabamba (with a population of approximately 600,000 in 2006) is the third largest city in Bolivia and is the capital of Cochabamba Department. At the time of the ex-ante evaluation in 2009, the water supply situation in the city was extremely tight. The municipal access rate to water supply was as low as 48% and the development of the water supply and sewerage facilities was urgently required in the light of an impending increase of the water demand. The development and operation of these facilities in the city was the responsibility of the Municipal Water and Sewerage Service in Cochabamba (hereinafter simply referred to as "SEMAPA") of which the business plan envisaged an increase of the water access rate among the citizens of the city to 83% in 2012 and 95% in 20027 As SEMAPA did not have a water supply network in the south-eastern zone of the city despite the rapid urbanization of this zone, local residents were forced to rely on piped water supply from wells or other sources run by residents' organizations or the purchase of water from water tank trucks operated by private vendors.[1] Water from these sources did not have a quality guarantee, the water supply volume was limited and the cost was much higher than the cost of water supplied by SEMAPA.

Under these circumstances, the Government of Bolivia made a request to the Government of Japan for the provision of grant aid for improvement of the water supply facilities in the south-eastern zone of Cochabamba City. In response, the Japan International Cooperation Agency (JICA) conducted

[1] The residents' organizations referred to in this report are locally called "basic territorial organizations", most of which have corporate status. While the organizational structure and financial sources widely differ from one organization to another, they are entitled to conduct wide-ranging public works, including water supply. They also participate in the planning and monitoring / evaluation of public works conducted by the municipal government so that the latter can implement public works which correspond to the needs of basic territorial organizations.

the Basic Design Study in 2007 and the Implementation Review Studies in 2008 and implemented the Project from 2009 to 2011.

1.2 Project Outline

The objective of the Project was to realize continual supply of clean water in sufficient quantity for residents of the south-eastern zone of Cochabamba City in Bolivia by means of expanding the existing WTP and constructing new water transmission and distribution pipelines, thereby contributing to improvement of the sanitation and living environment of the project area.

Grant Limit/Actual Grant Amount	1,215 million yen/1,092 million yen
Exchange of Notes Date/Grant Agreement Date	May, 2009/May, 2009
Implementing Agency	Municipal Water and Sewerage Service in Cochabamba (SEMAPA)
Project Completion Date	April, 2011
Main Contractor	Hazama Corporation
Main Consultant	Tokyo Engineering Consultants Co., Ltd.
Basic Design	August, 2007
Detailed Design	September, 2009
Related Projects	Andes Development Corporation (CAF), “Sinergia-Barrilete Project” (2004-2013); Misicuni Company, “Misicuni Multipurpose Project” (1998- in implementation)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan)

2.2 Duration of the Evaluation Study

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

Duration of the Study : September, 2014 to July, 2015
Duration of the Field Survey: November 11th to 26th, 2014, and
April 15th to 17th, 2015

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

3.1 Relevance (Rating: ②[3])

3.1.1 Relevance to Development Plan of Bolivia

As already mentioned in "1.1 Background", at the time of the ex-ante evaluation, the Government of Bolivia emphasised improvement of the water supply and sewerage services throughout the country. The National Basic Sanitation Plan (2011-2015) which is in force at the time of this ex-post evaluation upholds the notion that access to water supply and sanitation services is a basic human right. While stressing the role to be played by the public sector, this plan adopts a target access rate to water supply of 90% (95% in urban areas and 80% in rural areas) in 2015, focusing on the improvement of water supply and sewerage facilities. As such, the Project is highly relevant to the development policies of Bolivia at the time of both the ex-ante evaluation and ex-post evaluation.

3.1.2 Relevance to the Development Needs of Bolivia

As already mentioned in "1.1 Background", at the time of the ex-ante evaluation, there was an urgent need in Cochabamba City for improvement of the water supply in the south-eastern zone. As Cochabamba City has hardly any water sources within its municipal boundaries, it is forced to rely on water sources located in the areas of neighbouring municipalities. However, the SEMAPA's water production volume has not increased, partly because of the delay of Phase I of the Misicuni Project [4] which is expected to significantly improve the water supply situation in Cochabamba City and beyond and partly because of the unwillingness of neighbouring municipalities to allow their water sources to be used for water supply to Cochabamba City. The water supply situation in Cochabamba City has worsened by the time of the ex-post evaluation and water supply has not improved in the project area as described in more detail in 3.3 Effectiveness. In effect, there is still a strong need for the development of the water supply system in Cochabamba City at the time of the ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policies

This Project falls under "Water and Sanitation" in "Social Development" which is one of the priority sectors identified by Japan's Country Assistance Program for Bolivia (2007) and is, therefore, relevant to Japan's ODA policies.

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

[3] ③: High; ② Fair; ①: Low

[4] The Misicuni Project is, in fact, a multipurpose dam construction project undertaken by Misicuni Company which was established in 1987 based on a special law introduced by the Government. At the time of the ex-ante evaluation, the original plan was to complete the Phase I construction work by 2009. However, the actual construction work substantially fell behind schedule due to an increase of the project scale, default of the contractor and other reasons. At the time of the ex-post evaluation, the completion of Phase I is expected in February, 2016.

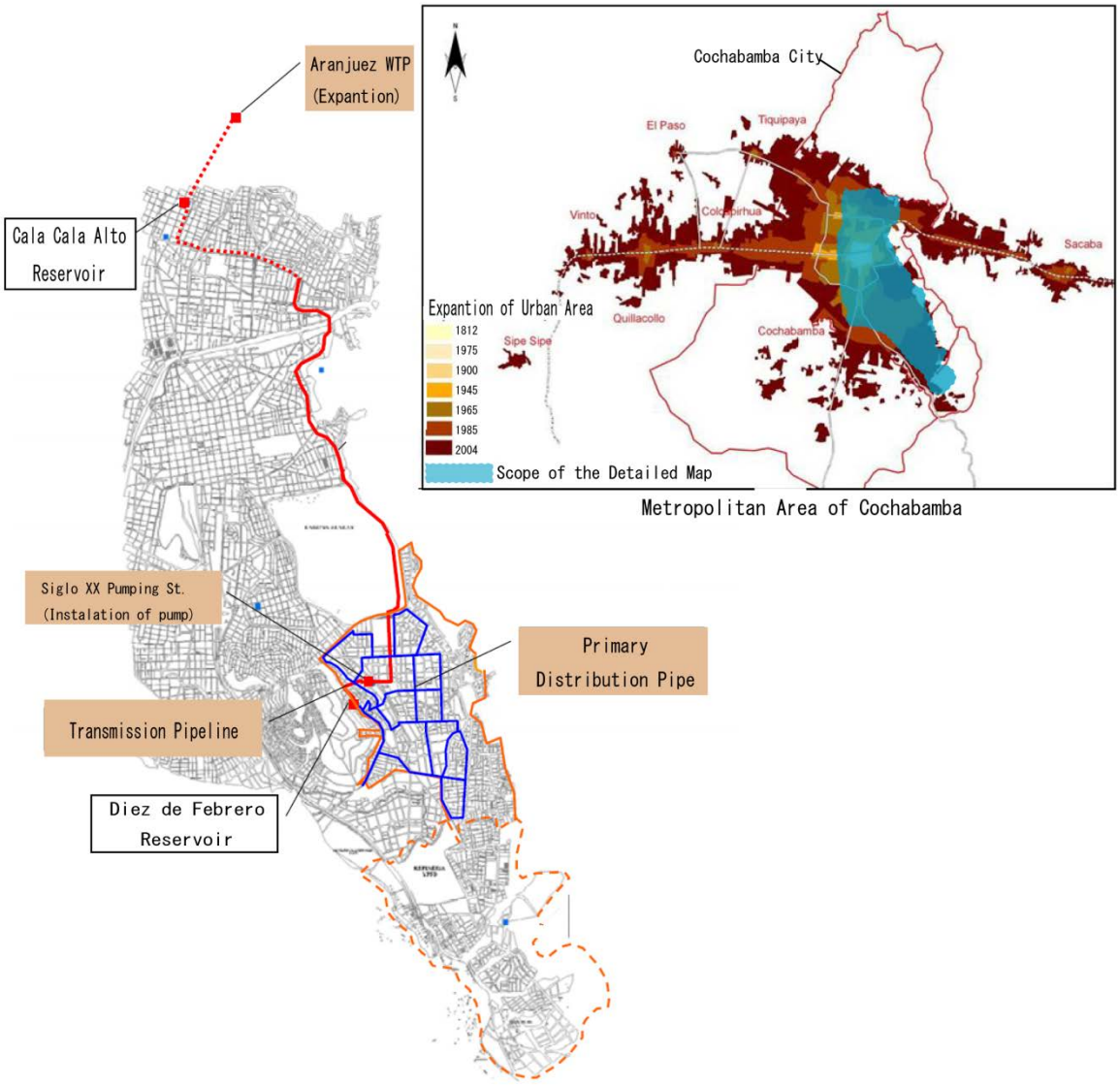


Fig. 1.Water Supply Facilities under the Project

3.1.4 Appropriateness of the Project Plan and Approach

As will be explained in "3.3 Effectiveness", the effectiveness of the Project was judged to be low. As the factors for this, there were following shortcomings in relation to information gathering/examination and the confirmation of very important preconditions at the planning stage prior to the commencement of the Project.

(1) The Project planned to utilise the water distribution networks owned by most of the 21 residents' organizations in the project area as they were, and to only construct a secondary distribution network for areas covered by two residents' organizations which did not have a water distribution network. However, it was found that these existing networks could not be used to distribute water supplied by SEMAPA because of their old age, absence of pipeline maps and/or prohibition of mixing water from existing water sources with water supplied by SEMAPA. These points were not recognised at the time of the ex-ante evaluation, and construction of new distribution network

was planned only for two residents' organizations. Because of this, it was necessary for 15 among the 19 remaining residents' organizations to construct a new network separately from the Project, and the prolonged time period for their construction constitutes one cause of the delayed manifestation of the project effects.[5] In addition, the fact that much information provided by the residents' organizations was not correct caused major delays in construction of the secondary distribution network under the Project.

(2) The Project entailed expanding Aranjuez Water Treatment Plant (WTP) and constructing new water transmission and distribution pipelines with the aim of supplying water for residents of the south-eastern zone of the city where the SEMAPA water supply network has not yet reached. However, in order for water supply to this district to be realized, it is necessary for the following two associated projects to be implemented by SEMAPA (expansion of Wara Wara water source, Sinergia-Barrilete Project; see Figures 1 and 2). The implementation of these related projects was considered to be a precondition for the commencement of the Project. The Japanese side implemented the Study for Implementation and signed the Exchange of Note to commence the Project based on its own judgement that the precondition would be met on the ground of the commencement of study for the project, the firm promise for its implementation, etc. However, the Project actually started without the said precondition being met due to the objections by local communities and related municipalities. In fact, these preconditions had still not been met at the time of the ex-post evaluation.

- The expansion of the Wara Wara water source in the neighbouring city of Sacaba from which raw water was supplied to the Aranjuez WTP was a precondition for the expansion of this WTP. The Japanese side judged that this precondition would be met on the grounds that SEMAPA had begun a study on the proposed expansion of the Wara Wara water source with a firm promise of subsequently implementing the necessary work and that the then Ministry of Water had promised to support the smooth implementation of this expansion project. However, after commencement of the study by SEMAPA, the local community of this water source area and the Sacaba municipal authority opposed the proposed water source development which would only benefit another city, forcing SEMAPA to suspend the study.[6] Unfortunately, this fact was not relayed to the Japanese side and the Exchange of Note was signed to commence the Project. With the mediation of the Ministry of Water, SEMAPA subsequently tried to

[5] A new water distribution network was constructed for areas served by 20 of the 21 residents' organizations in the project area, including the 2 residents' organizations for which construction of distribution network was originally planned. However, some facilities were still undergoing construction and were not yet complete in some residents' organizations at the time of the ex-post evaluation. The funding sources for this work were the Project (with Japan providing pipes and other materials and the Bolivian side conducting the pipe laying work), the Cochabamba Municipal Authority and NGOs.

[6] JICA conducted the Implementation Review Study twice in 2008 (the work was limited in Japan). Meanwhile, after the commencement of the SEMAPA's study, the Sacaba municipal authority and affected local community expressed their opposition to the water source development which would only benefit another city (May, 2008) and submitted a letter rejecting the extension project to SEMAPA in February, 2009.

obtain the necessary consent of the Sacaba municipal authority and local community concerned but negotiations were unsuccessful. SEMAPA eventually terminated the study and the proposed expansion work did not take place.

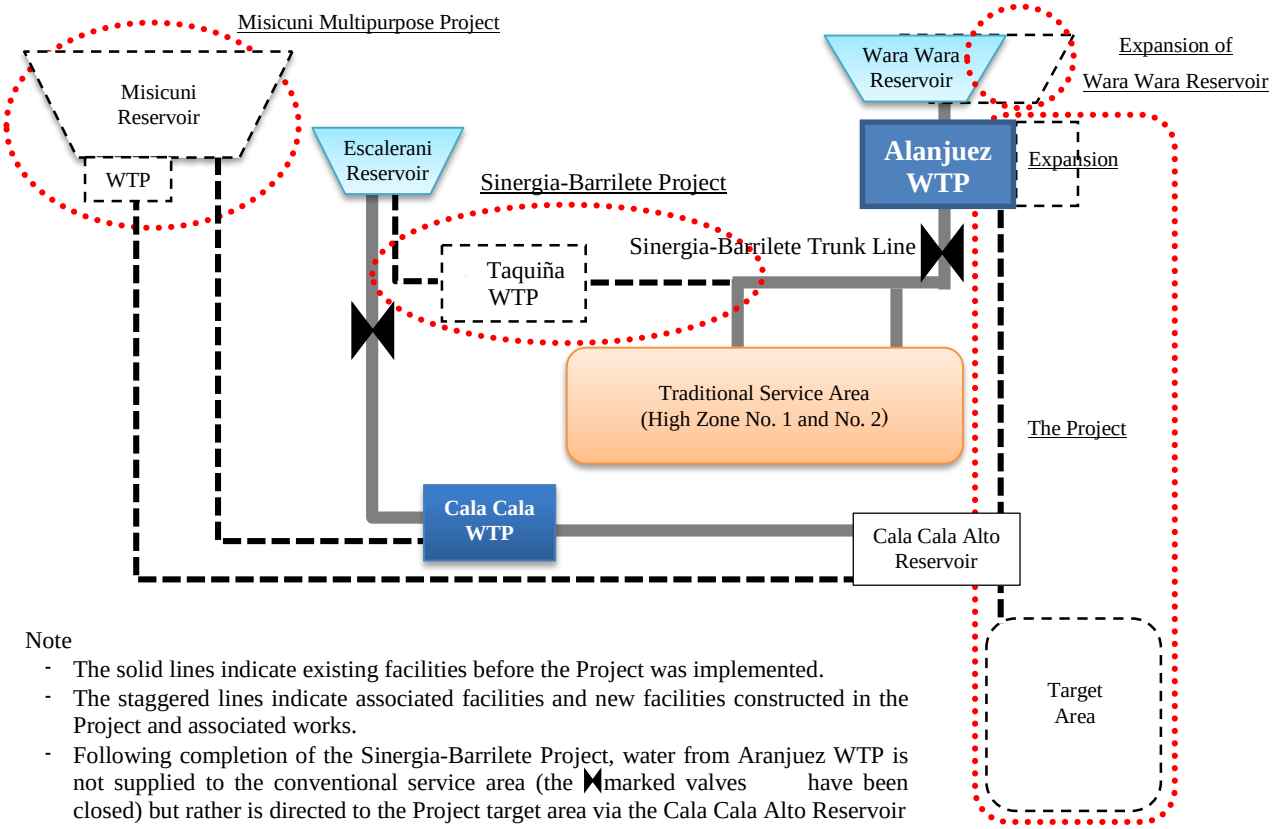
- The implementation of the Sinergia-Barrilete Project was a precondition for the reliable conveyance of water from the Aranjuez WTP to the project area (refer Figure 2). In other words, in order to convey water from Aranjuez WTP to the Project target area, it was necessary for Taquiña WTP, which was to be constructed in the Sinergia-Barrilete Project, to supply water to the conventional service area (High Zone No. 1 and High Zone No. 2) of Aranjuez WTP. As the municipal authority of Tiquipaya (a neighbouring municipality of Cochabamba) which is located in the subject area of this Sinergia-Barrilete Project and SEMAPA had agreed on the implementation of the project in question, JICA judged that this precondition was met and commenced the Study for Implementation of the Project. However, the actual construction work was much delayed because the residents in areas of Tiquipaya and Cochabamba opposed to the Project on the grounds that the work to lay the conduction pipeline through the areas was of no advantage to them. In the end, the pipeline was finally completed in 2013. Moreover, the conveyance of water using the new pipeline has been delayed because of a shortage of raw water at the Taquiña WTP which is assigned to produce the necessary treated water and is now expected to commence in February, 2016 or later when a sufficient water source is made available under the Misicuni Multipurpose Project.

The direct cause for the non-fulfilment of the required precondition has been opposition by other municipalities and their citizens. The New Constitution introduced in Bolivia in January, 2009 has increased the scope of local autonomy, leading to a nationwide movement to oppose various national projects by local municipalities and their citizens. It is, however, difficult to retrospectively assess the degree of predictability of such opposition (risk to the Project) during the preparatory planning period of the Project from 2006 to 2008.

It should be noted that no socio-political risks associated with the two projects considered as preconditions were mentioned in the preparatory studies for the Project, meaning that such risks would have not been investigated in these studies. As for the expansion of Wara Wara water source, there might have been some measures to further confirm its implementation, for example, requesting SEMAPA periodical report on the progress of the study, collecting information on site as a part of the implementation review studies, etc. As well, it should have been recognized that the Misicuni Multipurpose Project, which had been in reality one of the preconditions for the Sinergia-Barrilete Project, was also one of the preconditions for the Project.

In short, while the Project was compatible with the development needs of Bolivia due to its high level of relevance of the country's development policy at the time of both the ex-ante evaluation and ex-post evaluation, there were some shortcomings in relation to information

gathering/examination and confirmation of the important preconditions prior to the commencement of the Project. Accordingly, the overall relevance of the Project is fair.



Note
- The solid lines indicate existing facilities before the Project was implemented.
- The staggered lines indicate associated facilities and new facilities constructed in the Project and associated works.
- Following completion of the Sinergia-Barrilete Project, water from Aranjuez WTP is not supplied to the conventional service area (the ⋈marked valves have been closed) but rather is directed to the Project target area via the Cala Cala Alto Reservoir
- Following the completion of the Misicuni Multipurpose Project, Cala Cala WTP obtains raw water from Misicuni reservoir, while Taquiña WTP obtains raw water from Escalerani Reservoir. The completion of Misicuni Multipurpose Project is also a condition for Taquiña WTP to obtain ample raw water.

Fig. 2. Relationship between the Project and the Other Related Projects

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The planned and actual outputs of the Project are shown in Table 1. As far as secondary distribution pipelines are concerned, the need to lay such pipelines in areas not included in the original plan at the time of ex-ante evaluation was verified and SEMAPA procured and laid additional pipelines with a total length of 1,595m and total length reached to some 120% of the original plan. Other than this, other outputs were produced generally as planned. The work to be conducted by the Bolivian side (provision of temporary yards and work to install secondary pipelines and water supply equipment) was completed as planned. According to SEMAPA, the quality level of the project design and construction work was very high.

Table 1 Planned and Actual Project Outputs

	Planned	Actual
Expansion of the Aranjuez WTP	120 litres/sec	As planned
Rehabilitation of transmission (conveyance) pipelines • Cala Cala Reservoir to Siglo XX Pumping Station • Siglo XX Pumping Station to Diez de Febrero Reservoir	 8,156 m 667 m	 8,111 m As planned
Installation of conveying pump (at Siglo XX Pumping Station)	Two units	As planned
Laying of primary distribution pipelines	18,852 m	As planned
Procurement of materials, etc. • Secondary distribution pipes • Water supply equipment (500 units of snap taps and meters, etc.; to be installed by SEMAPA) • Water quality measuring instruments (pH meters; conductance meters; turbidity meters)	 7,943 m	 9,538 m As planned As planned

Sources: documents provided by JICA; SEMAPA

Siglo XX Pumping Station

Diez de Febrero Reservoir

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned and actual project costs are shown in Table 2. The project cost was lower than planned as the actual cost was 95% of the planned cost. The actual cost of laying the secondary distribution network (including the additional length) by the Bolivian side was much lower than the original plan because of competition[7].

Table 2 Planned and Actual Project Costs

	Planned	Actual
Japanese portion	1,159 million yen	1,092 million yen
Bolivian portion	65 million yen	12 million yen

[7] In the Project study, the cost of installing secondary distribution pipes was estimated as 4,180,000 BOB (526 BOB per meter), however, in reality it came to 1,052,000 BOB (134 BOB per meter). Since the cost is around 100 BOB per meter in similar projects implemented by SEMAPA in 2015 and it is not known why the unit cost estimate for the Project was so large, there is a good likelihood that the cost was overestimated in the study.

Total	1,224 million yen	1,104 million yen

Sources: documents provided by JICA, SEMAPA

3.2.2.2 Project Period

The planned project period was one year and 10 months (22 months) from the date of the signing of the Exchange of Note. The actual project period was two years and four months (28 months) from the signing of the Exchange of Note in May, 2009 to completion in August, 2011. The actual project period was, therefore, 127% of the planned project period. The principal reason for the delayed completion of the Project was that the work of the Bolivian side to lay the secondary water distribution lines took eight months (double the planned period of four months).[8] According to the responsible staff member in SEMAPA, much of the information provided by the residents' organizations was found to be inaccurate; for example, when digging up roads for laying the planned 7,943 meters of secondary distribution pipes, distribution pipes were discovered in places where they were not supposed to exist. Accordingly, the plans were reviewed upon asking the residents' organizations to once more provide information; and as a result the length of distribution pipes was increased to 9,538 meters before restarting the works. The actual implementation of the works itself didn't experience major problems.

Even if the increase of the work period due to the increase of the total length of secondary pipelines (a 20% increase compared to the original plan) is taken into consideration, the project period is longer than planned.

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

3.3 Effectiveness[9] (Rating: ①)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

The Project was implemented with the aim of continually supplying clean water in sufficient quantity to some 50,000 residents in the project area in the south-eastern zone of Cochabamba City. For the purpose of evaluating the effectiveness of the Project, the evaluator evaluated the water production volume at the Aranjuez WTP, water distribution volume to the project area, benefited population in the project area, water supply hours and water supply pressure. (Refer Table 3. for planned and actual figures of operation and effect indicators)

Table 3 Planned and Actual Performance of Operation and Effect Indicators

	Baseline	Target	Actual
	2006	2011	2011～2014

[8] The work by the Japanese side was completed in 22 months in April, 2011 as planned (28th May, 2009 to 8th April, 2011).

[9] The effectiveness is rated in consideration of not only the effects but also the impacts.

	Year of Ex-Ante Evaluation	Year of Project Completion	0-3 Years after Project Completion
Operation Indicators			
Water Production at the Aranjuez WTP	50 - 70 *l*/sec	120 *l*/sec	74.7 *l*/sec (average during July, 2011 - June, 2014)
Water quality at the Aranjuez WTP	Unknown	●Turbidity ≤ 5NTU ●No detection of colon bacilli ●Residual chlorine: 0.2-0.5mg/l	All targets were achieved after the completion of the Project.
Clean Water Supply in the Project Ares	0 *l*/sec	81 *l*/sec	9 *l*/sec(November, 2014)
Effect Indicators			
Size of Benefiting Population in the Project Area	0	Approx. 50,000	Approx. 24,000 (November, 2014)
Water Supply Hours in the Project Area	Irregular for a few hours	24 hours a day	Weekly 1 – 2 times for 2.7 hours (2014)
Water Supply Pressure in the Project Area	Sometimes insufficient to supply water to even the ground floor	Water supply on the first floor through a tap	5% of users are dissatisfied with the water pressure (2014)

Sources: documents provided by JICA; SEMAPA, the beneficiary survey
Note: To determine the actual water pressure level, the beneficiary survey examined the degree of satisfaction on the part of residents with the water pressure in view of the fact that not all houses in the project area have 2 stories.

3.3.1.1 Water Production at the Aranjuez WTP and Quality of Water Produced

Although the design maximum production capacity of the Aranjuez WTP prior to the Project was 100 litres/sec, the actual production was 60 – 70 litres/sec because of technical issues relating to the structure of this WTP. The average production for the period from 1994 to 2010 before the completion of the Project was 55.7 litres/sec. After the completion of the Project, the Aranjuez WTP has been operating without any stoppages and the average production for the 36 month period from July, 2011 to June, 2014 was 74.7 litres/sec or 134% of the pre-project level. In 20 of these 36 months, the monthly average production exceeded the pre-project monthly average maximum production of 70 litres/sec and the monthly average maximum production was 97 litres/sec.

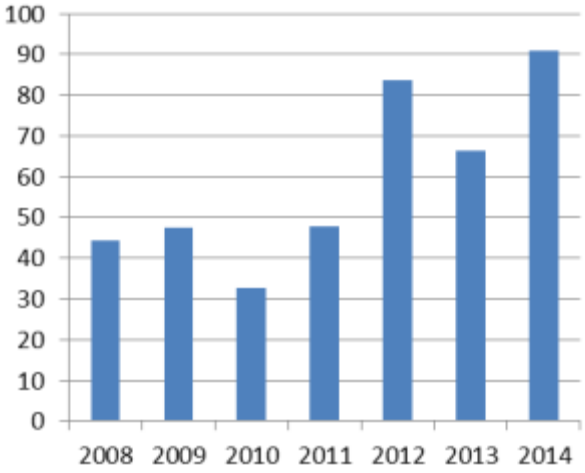


Fig. 3 Annual Average Production at the Aranjuez WTP (litres/sec)

In this way, while effects of the expansion of the Aranjuez WTP can be recognized, the water production at the Aranjuez WTP is restricted by the available raw water supply capacity and is primarily dependent on the level of rainfall in the water source area and water level at the Wara Wara Reservoir. In 2013 for example, the production was kept low by the low water level of the said reservoir, in turn caused by the low rainfall level. If the planned increase of the raw water supply of 30 litres/sec which is a precondition for expansion of the WTP had been met, the actual production would have been greater. It must be noted, however, that the level of contribution of the Aranjuez WTP to Cochabamba City is not particularly large as its water production volume accounts for only 7% of the total water production volume of SEMAPA.

The quality of the water supplied by the Aranjuez WTP meets the entire water quality standards. The issue of chromaticity which was considered to pose a problem at the time of the ex-ante evaluation has improved to meet the relevant standard.[10] At the time of the ex-ante evaluation, since the pH of raw water was below the standard level during the rainy season, a pH regulator injection pump was installed at the WTP. However, no adjustment has been required since the completion of the Project as the raw water quality meets the relevant standard.

3.3.1.2 Water Distribution Volume of the Project Area

Originally it was planned for water to be supplied to the target area via Cala Cala Alto Reservoir following completion of the Project. The water produced at the Aranjuez WTP is mostly conveyed to the Sinergia – Barrilete Trunk Line as previously was the case for its distribution to High Zone No. 1 and No. 2.[11] This is because of the non-operational status of the Taquiña WTP from which water was going to be distributed to these zones through the said trunk line due to the raw water shortage caused by non-completion of Misicuni Multipurpose Project as explained in 3.1 Relevance.

[10] At the Aranjuez WTP, the residual chlorine is measured twice daily while the sampling and inspection of the water quality at the headquarters' laboratory are conducted daily.

[11] No accurate data on the water distribution volume to the Barrilete Trunk Line was obtained.

The remaining water of the Aranjuez WTP is conveyed to the Cala Cala Alto Reservoir. This reservoir receives water also from other water sources (groundwater and the Cala Cala WTP) and distributes water to many areas, including the project area.

According to operation records at the Siglo XX Pump Station, water distribution from the Cala Cala Alto Reservoir to the project area began in January, 2012 at an average flow of 3.9 litres/sec for a 35 month period up to November, 2014. This was only 5% of the planned flow (81 litres/sec.) As shown in Figure 4, the water distribution, in fact, showed a gradually increasing trend reflecting the increased number of users in the project area to 7.5 litres/sec in November, 2014 or 9% of the planned level[12].

Fig. 4 Monthly Average Water Distribution to the Project Area (litres/sec)

3.3.1.3 Benefiting Population in the Project Area

There is a total of 21 residents' organizations in the project area, each of which was traditionally engaged in its own water supply service using groundwater or other water sources. The Project intended the replacement of the entire water supply by these residents' organizations with water produced at the SEMAPA's Aranjuez WTP. At the end of November, 2014, 11 residents' organizations had completed a water supply agreement with SEMAPA, of which 10 were receiving actual water supply through the connected water distribution pipeline. At that point, the total number of connected users was approximately 24,000 of some 3,900 households, i.e. 49% of the planned figure or 43% of the local population. Among the remaining 10 residents' organizations, 7 have reached agreements with SEMAPA as of March 2015, and the benefiting population it expected to increase in future.

The main reasons for the slow progress of the commencement of water supply to residents' organizations due to the absence of agreement with SEMAPA were ① time-consuming work to

[12] However, until the Misicuni Multipurpose Project is finished and SEMAPA obtains sufficient raw water, it will not be able to greatly increase water supply even if the number of users increases.

construct a secondary distribution network independently by each BTO (several years are required to complete the work with the budget size annually allocated by the municipal authority), ② slow process for a BTO to prepare the necessary documentation and ③ time-consuming procedure to eliminate potential overlapping between the permit for water supply service to be issued to some residents' organizations and similar permit to be issued to SEMAPA which was discovered in 2011. In cases where water supply cannot be started even though agreement has been reached with SEMAPA, this is because the secondary water distribution testing has not been completed.

3.3.1.4 Water Supply Hours and Water Pressure in the Project Area

Even though the original plan was to supply water for 24 hours a day to the project area, according to the beneficiary survey,[13] those residents receiving water from SEMAPA (hereinafter referred to as "beneficiaries") actually receive water only twice a week (the first 2 residents' organizations that got agreement with SEMAPA) or once a week (other residents' organizations), and the beneficiaries receive water supply once a week for an average of 2.7 hours which is far below the planned service level. This very short water supply duration reflects the severe water shortage faced by SEMAPA.[14] Some 60% of beneficiary residents own water tanks so that they can store the SEMAPA water for later use, however, they still do not have enough. Therefore, the beneficiaries supplement their water need with the supply of well water by existing residents' organizations or by the direct purchase of well water from water tank trucks operated by private vendors.

The evaluator assessed the degree of satisfaction with the water pressure on the part of those residents using water supplied by SEMAPA. Only 5% of those surveyed expressed dissatisfaction with the water pressure, suggesting a reasonably high water pressure in the project area.

3.3.2 Qualitative Effects (Other Effects)

According to the findings of the beneficiary survey, the degree of satisfaction with the water quality and water pressure is high among users but is modest in regard to the water supply hours, water charge and maintenance of the distribution network (Fig.5). Most of the beneficiaries would like to see an increase of the water supply frequency and duration. Meanwhile, most of non-beneficiaries (those local residents of the project area who do not yet receive water supply by SEMAPA) would like to see the start of water supply by SEMAPA.

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[13] As part of this ex-post evaluation, a beneficiary survey using a questionnaire was conducted. 100 households of five residents' organizations receiving water from SEMAPA and 50 households of three residents' organizations not receiving water from SEMAPA in the project area were interviewed. In addition, a representative of each of the 21 residents' organizations in the project area was interviewed.

[14] As SEMAPA cannot secure a sufficient quantity of water, it does not provide a 24 hour/day water supply service to any part of Cochabamba City. The actual frequency of water supply is once or twice a week for only several hours each time.

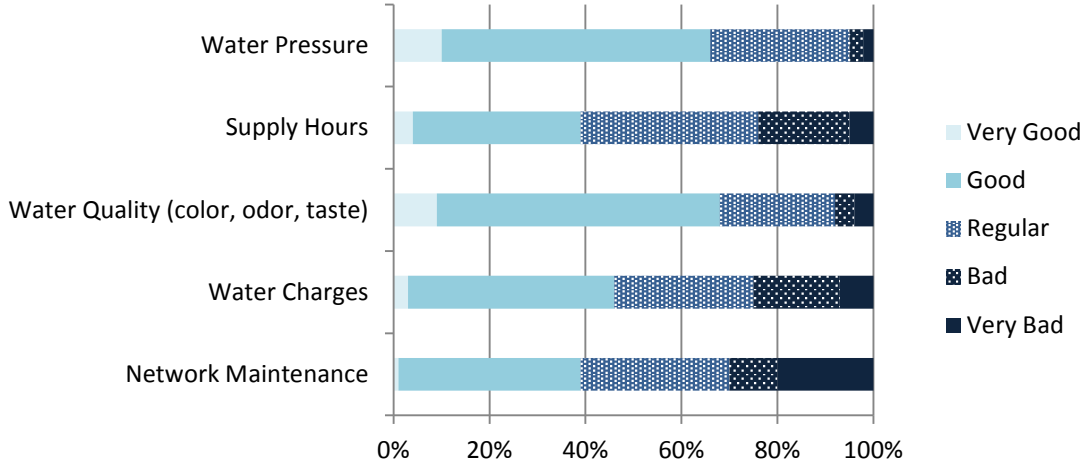

Fig. 5 Degree of Satisfaction with Water Supply Service of SEMAPA

3.4 Impacts

3.4.1 Intended Impacts

At the time of the ex-ante evaluation, the Project identified the overall goal of improving the living environment for residents of the project area and such indirect effects as improved convenience of water use, lower financial burden associated with water use and lower risk of contracting water-borne diseases. According to the findings of the beneficiary survey, the beneficiaries of SEMAPA's water supply enjoy a higher level of improvement in terms of the quantity of water use, convenience of water use, cost of water use and sanitation compared to non-beneficiaries as described in more detail below.

(1) Increased Use of Water

The volume of water use by beneficiaries is 12% higher than that by non-beneficiaries and has increased by approximately 2.5 times compared to five years ago. During the same period, the volume of water use by non-beneficiaries has increased by 1.7 times. Thus, the level of increase among beneficiaries over the same period was higher. Upon asking such households why their water use increased, 66% pointed to higher needs and 27% said that it was because water had become more readily available. Therefore, improvement in the convenience of water use has been more conspicuous among beneficiaries rather than non-beneficiaries.

Water supplied by SEMAPA accounts for some 80% of the total volume of water use by beneficiaries. The remaining 20% consists of well water purchased from water tank trucks operated by private vendors and/or water (well water) supplied by residents' organizations. Water supplied by SEMAPA is used for multiple purposes, including drinking, cooking, cleaning, washing and toilet flushing. While water purchased from private vendors is also used for multiple purposes, water supplied by residents' organizations is used for purposes other than drinking or cooking because of its low quality. On the other hand, non-beneficiaries rely 70% of their water consumption on the water supplied by residents' organization (underground water) and 30% on the water purchased from private

vendors. Water from the both sources is used for multi-purposes, while more water of private vendor are used for drinking and cooking purposes.

(2) Improved Convenience of Water Use

75% of beneficiaries replied to the questionnaire that the situation relating to the convenience of water use has "slightly improved" in the past five years. Only 7% replied that the situation has "greatly improved", presumably because of the fact that the increase of the water supply volume and water supply hours as a result of the Project is modest. Among non-beneficiaries, 34% replied that the situation has either "slightly improved" or "greatly improved". Their proportion is less than half of that among beneficiaries. Thus, improved convenience of water use is observed more for the beneficiaries than the non-beneficiaries.

(3) Reduced Cost of Water Use

According to the beneficiary survey, SEMAPA charges an average of 4.4 Bs per cubic meter of water supply. Although this is only slightly higher than the cost of water supplied by the Residents' organizations (3.1 Bs), it is one-fifth of the cost of water purchased from water tank trucks operated by private vendors (22.8 Bs). The monthly average expenditure of beneficiaries for water is some 82 Bs which is more or less the same as it was before the Project (2009), however, since the quantity of water use has increased by 2.5 times, the average unit rate of water is 40% of what it was before the Project. Beneficiaries use 12% more water than non-beneficiaries, however, their expenditure on water is only 76% that of non-beneficiaries.

(4) Improved Sanitation

As shown in Table 4, a higher proportion of beneficiaries replied that both personal / household hygiene practices (hand-washing, bathing, washing, cleaning and toilet flushing) and household sanitation have improved compared to non-beneficiaries. According to SEMAPA, when starting water distribution to the residents' organizations, explanations on water conservation methods, the importance of sanitary management, methods of conducting effective sanitary management with little water and so on are given in residents' assemblies. It is surmised that the effects of such education efforts have manifested in line with the improvement of water supply services.

In the period from 2010 to 2014, the frequency of the occurrence of water-borne diseases, including diarrhoea, tends to be lower among beneficiaries compared to non-beneficiaries.[15] However, the earliest start of water supply by SEMAPA to the project area in 2011 means that such a difference cannot be immediately described as a beneficial impact of the Project.

[15] 10% of beneficiaries and 20% of non-beneficiaries replied that one or more family members had experienced diarrhoea in the past five years.

Table 4 Findings on Improved Sanitation

Compared to Five Years Ago	Beneficiaries	Non-Beneficiaries
• Washing hands and bathing more often	56%	44%
• Washing (clothes, etc.) more often	57%	38%
• Cleaning more often using water	49%	34%
• Flushing the toilet more often	53%	36%
• Improvement of household sanitation	68%	46%

Source: Beneficiary survey

3.4.2 Other Impacts

The Project was certified as a project with minor environmental impact (classified in the second least environmental impact category out of four categories) and it was judged that an EIA would not be required[16]. An environmental permit for the Project was obtained in October, 2007 and trees were planted in a former yard introduced in the western part of the Aranjuez WTP premises as part of environmental management. In this ex-post evaluation, no notable negative impacts on the natural environment were found.

SEMAPA acquired the right to use the land required for expansion of the Aranjuez WTP through negotiations with the landowner. Although some time was required to acquire this right, there were no special problems. The Project did not involve any resettlement of residents.

In implementing the construction work, SEMAPA and consultant jointly coordinated with the road cooperation as well as electricity, telephone and gas service providers while publicly disclosing information on the work progress through periodic newsletters to local residents and the SEMAPA's website. Some residents in areas where the conducting pipeline passed through were opposed to the work which would be of no benefit to them but the quick completion of the work meant that their opposition did not develop into a social problem. According to SEMAPA, such experience under the Project has been very helpful for the implementation of similar projects thereafter.

In summary, the Project resulted in such benefits as improved water quality and water pressure, increased water use, reduced cost of water use and improved sanitation for the beneficiaries. However, as the preconditions of implementing the related projects were not met and construction of water distribution networks by the residents' organizations is taking time, the actual benefiting population was only half of that planned, the water supply volume was only 10% of the planned volume and the water supply hours were only 2.7 hours average per week compared to the planned 24 hours a day. While the Project achieved its objectives at a limited level, the effectiveness and impact of the Project are low.

When the first phase of Misicuni Multipurpose Project is completed in February 2016, since raw water will be secured for Taquiña WTP, it will become possible for Aranjuez WTP to supply water to the Project target area as originally planned. In order to realize the early effect of the Project,

[16] The environmental category is established according to the size of environmental impact of public projects in Bolivia. In categories 1 and 2, which have a large environmental impact, it is necessary to implement an environmental impact survey either in general or for specific fields.

SEMAPA plans to construct a conducting pipeline from Misicuni Multipurpose Project to Cala Cala WTP, implement expansion of the said WTP, and construct a new water transmission pipe to the Project target area[17].

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

3.5.1.1 Operation and Maintenance System of SEMAPA

SEMAPA has 357 permanent and 8 to 10 contract employees. The operation and maintenance of the facilities constructed or improved under the Project are handled by the Operations Department, Treatment Department and Water Supply Maintenance Department of the Operations Bureau. Organizations for operation and maintenance of the facilities constructed by the Project are as follows. The operation and maintenance system of SEMAPA is adequate with the deployment of the necessary personnel.

The Aranjuez WTP has six operators and one shift with three operators work for 24 hours. This WTP is located at some 15 minute drive from SEMAPA's headquarters and staff members of the Treatment Department can quickly reach the WTP to assist operation in the case of an emergency.

The Siglo XX Pumping Station is run by two operators with each operator working a 24 hour shift. The Diez de Febrero Reservoir is run by two operators with each operator also working a 24 hour shift. One vehicle is deployed at this reservoir.

The transmission pipelines and distribution network directly managed by SEMAPA are maintained by the Distribution Network Management Section of the Water Supply Maintenance Department. There are two teams to maintain the trunk lines and five teams to maintain the secondary water distribution networks. Each team is composed of four personnel including a driver, an engineer, two technicians and owns a vehicle and equipment. These teams mainly go into action in response to reports by residents and the necessary repairs are basically completed in 48 hours. Along with repair work, the Distribution Network Management Section has been replacing old distribution pipelines. As a result, there has been a declining trend of the number of leakage repairs.

3.5.1.2 Operation and Maintenance System in the Project Area

As of the end of November, 2014, SEMAPA directly manages the distribution network in the areas of six residents' organizations out of 11 residents' organizations receiving water supply using facilities constructed under the Project. In these areas, SEMAPA exchanges a contract with each user, collects the water charge based on meter reading and maintains the local distribution network. In the remaining five areas, SEMAPA supplies water based on a large user contract with each residents'

[17] Cala Cala WTP is the main WTP in Cochabamba. When this plant becomes able to obtain raw water from the Misicuni Multipurpose Project, it is planned for the water of Escalerani Reservoir that was conventionally conveyed to Cala Cala WTP to be used as the raw water for Taquiña WTP. Moreover, because it has become difficult to control water flow due to installation of a branch on the section where Cala Cala Alto Reservoir is linked by the water transmission pipe newly constructed in the Project, construction of a new dedicated water transmission pipe (1,200m) that doesn't pass through Cala Cala Alto Reservoir is being advanced.

organization which exchanges a contract with each user, collects the water charge based on meter reading and maintains the local distribution network. In some cases, the existing residents' organization directly operates the water supply system. In other cases, a water committee is specifically established. In either cases, several officers and staff members are appointed to ensure a reliable operation and maintenance.

SEMAPA advises residents' organizations in the project area on distribution network construction in relation to the managerial and technical aspects. The Customer Service Department of the Customer Service Bureau of SEMAPA is responsible for negotiations and contracting issues with residents' organizations. Various departments of SEMAPA also provide advice on distribution network development by a residents' organization and the transfer of the water supply service to SEMAPA. The operators of the reservoir in the project area also provide a consultation service for residents' organizations.

3.5.2 Technical Aspects of Operation and Maintenance

3.5.2.1 SEMAPA

SEMAPA has been operating several WTPs in the city without any problems. At the Aranjuez WTP, the operation procedure has been firmly established, including backwashing of the filtration basin and the injection of chemicals.[18] The Treatment Department evaluates the operation and maintenance work every three months in relation to the injection of chemicals, cleaning and inspection at each WTP. Consequently, the operation and maintenance of the Aranjuez WTP is found to be adequate. So is the operation of the pumping stations. In the light of the above, SEMAPA is judged to possess the necessary technical competence.

3.5.2.2 Residents' organizations

Those residents' organizations which distribute water based on a large user contract with SEMAPA are responsible for the repair of the secondary distribution networks in their respective areas. According to the results of interviews with residents' organizations, they have built up experience and possess some repair equipment of their own. As such, residents' organizations appear to have a certain level of technical competence. As no technical problems are found with those residents' organizations with a large user contract, it is reasonable to conclude that they have the necessary skills to conduct the operation and maintenance of the secondary distribution networks.

3.5.3 Financial Aspects of Operation and Maintenance

3.5.3.1 SEMAPA

Interviews with staff members of SEMAPA found that SEMAPA has sufficient budget to maintain manpower to operate and maintain the WTPs and purchase chemicals and other consumables as well as equipment.

[18] However, the operation and maintenance plan is not documented. While there are operation records for facilities and equipment, there are no complete records of maintenance or repair work carried out.

SEMAPA's income from the water charge increased by 13% in the three year period from 2010 to 2013.[19] (Table 5) In recent years, many meter readers who were the main reason for an increasing personnel cost were made redundant and their jobs were replaced by outsourcing. Other management efforts to slim down the costs included the purchase of heavy machinery and vehicles instead of leasing them. As a result, the business income and expenditure of SEMAPA has been in the black since 2010.[20] The operating profit margin has been around 60% for the last three years, maintaining a high level of profitability. The current ratio in the last three years exceeds 500% and the capital-to-asset ratio of 85% or more is sufficiently high, indicating the generally healthy finance of SEMAPA.

Table 5 Business Income and Expenditure of SEMAPA

(Unit: '000 Bs)

	2010	2011	2012	2013
Total Income	112,276	108,907	125,889	127,426
Water Charge	106,490	103,190	118,967	120,356
Other Income	5,786	5,717	6,922	7,070
Total Expenditure	44,265	43,171	48,955	56,245
Personnel Cost	20,236	18,895	23,263	26,657
Other Costs	24,029	24,276	25,692	29,588
Balance	68,011	65,736	76,934	71,181

Source: SEMAPA

3.5.3.2 Residents' Organizations

A residents' organization which distributes water based on a large user contract collects the water charge set by itself to cover the cost of the raw water supplied by SEMAPA and the cost of operating and maintaining its own secondary distribution network. No residents' organization has so far experienced any difficulty in terms of operation and maintenance due to financial problems. However, some residents' organizations are in the midst of the process of cancelling their large user contracts in the hope of shifting to direct water supply by SEMAPA because of financial worry caused by insufficient water charge collection and difficulty of increasing the water charge.

3.5.4 Current Status of Operation and Maintenance

Defect inspection confirmed that the operating status of the facilities is very good and that facility inspection and cleaning, including the work to remove algae, are conducted on a daily basis. The field survey conducted as part of this ex-post evaluation also confirmed that both the WTP and distribution facilities are adequately maintained to perform their functions in full.

[19] SEMAPA reviews the level of its water charge in consideration of inflation. The water meter installation rate improved from 81.2% in 2005 to 86.7% in 2013. The water charge collection rate exceeds 90%.

[20] The depreciation amount in individual years does not reflect the actual income and expenditure because it is adjusted based on managerial judgement. It is not, therefore, considered in this report.

Since the completion of its expansion work, the Aranjuez WTP has been operating without interruption. However, a leakage incident occurred in April, 2014 involving a pipe connection section with the filtration basin, presumably because of sudden valve operation. Urgent repair work was conducted with the cooperation of staff members of SEMAPA's headquarters and pipe function was restored 18 hours later with little adverse impact on water production operation.

The pipe repaired at the Aranjuez WTP

The transmission pipeline from the WTP to the pumping station suffered dislocated pipes at the end of 2013 due to subsidence caused by an unknown reason. In regard to the secondary distribution networks, several incidents of damage by a contractor engaged in sewerage pipe laying work occurred in 2014. In each case, the damage was quickly repaired by staff members of the Distribution Network Management Section of SEMAPA.

There was also an incident of water leakage from the distribution network laid by a residents' organization due to gas work but the damage was promptly repaired.

Thus, it is deemed that the project facilities receive appropriate operation and maintenance.

Based on the above, no major problems have been observed in regard to the institutional, technical and financial aspects of the operation and maintenance system of SEMAPA or residents' organizations. Therefore, the sustainability of the project effects is high.

4 Conclusions, Lessons Learned and Recommendations

4.1 Conclusions

Te Project was implemented in the City of Cochabamba with the aim of continually supplying clean water in sufficient quantity for residents of the south-eastern zone of the city by means of expanding the existing water treatment plant and constructing new water transmission and distribution pipelines, thereby contributing to improvement of the sanitation and living environment of the project area. At the time of both the ex-ante evaluation and ex-post evaluation, the Project was found to be highly relevant to the development policies of Bolivia and compatible with the need for the development of the water supply system in Cochabamba City in general and the project area in particular. It was also in line with the Japan's aid policy at the time of ex-ante evaluation. However, due to the somewhat insufficient information gathering/examination and verification of very important preconditions prior to the commencement of the Project, the relevance of the Project is fair. The Project mostly achieved its planned outputs and the actual project cost was within the plan. Meanwhile, the actual project period exceeded the plan. As such, the efficiency of the Project is fair. As a result of project implementation, local residents have benefited from improved water pressure and quality,

increased use of water, reduction of water use-related expenditure and improved sanitation. However, because of failure to materialise associated projects and time consuming construction of water distribution networks by the residents' organizations, the benefiting population was only half of the plan, the water supply volume was only 10% of the plan and the water supply hours were only 2.7 hours/week compared to the planned continual water supply for 24 hours/day. Because of these shortcomings, the effectiveness/impact of the Project are low. No major problems were observed with SEMAPA or residents' organizations relating to the institutional, technical and financial aspects of the operation and maintenance of the facilities which are functioning well, making the sustainability of the Project high. In light of the above, this project is evaluated to be unsatisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

- SEMAPA should continually provide technical assistance for some residents' organizations with a view to assisting their efforts to complete the construction of secondary distribution networks and to concluding large user contracts so that these residents' organizations can commence the distribution of water produced by SEMAPA as soon as possible.
- It is essential for SEMAPA to construct water transmission and distribution facilities, including the conducting pipeline from the Misicuni Project to Cochabamba City so that a sufficient volume of water can be supplied to the project area in line with scheduled completion of the Misicuni Multipurpose Project Phase I in 2016.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Appropriate analysis and confirmation of preconditions for Project commencement:

Since commencement of the Project was conditional on the definite implementation of two associated projects (expansion of the Wara Wara water source and the Sinergia-Barrilete Project), the Project was started after confirming implementation of these. However, because one of these projects was cancelled and start of the other was greatly delayed due to the opposition of residents and impacted public authorities which could have not been predicted and delays in another major undertaking (the Misicuni Multipurpose Project) that could have not been clearly recognized as a precondition, manifestation of the Project effects was greatly impeded.

Therefore, in cases where project commencement is conditional on associated projects, it is necessary to conduct wide-ranging analysis of the technical, financial, social and political risks and so on that affect the implementation of such projects. In social aspect, it is important to fully grasp potential stakeholders including local residents and public authorities, and to specifically and continuously monitor the views of each party, trust relations with the project implementer,

progress in negotiations and so on. Also, it is necessary to analyse not only projects that are directly related but also projects that can indirectly have a major impact. Concerning the specific milestone events that determine the start of the project, it is necessary to set contents (associated projects) that have a high likelihood of being implemented without delay.