

Republic of Paraguay

FY 2016 External Ex-Post Evaluation of Japanese Grant Aid Project

“The Project for the Improvement of Water Supply System in Concepcion and Pilar Cities”

External Evaluator: Hiromi Suzuki S., IC Net Limited

## **0 Summary**

The Project for the Improvement of Water Supply System in Concepcion and Pilar Cities (hereinafter referred to as “the Project”) was implemented for the purpose of improving the quality of waterworks, increasing the water supply volume and improving access to safe water for residents of the cities of Concepcion and Pilar in Paraguay by means of rehabilitating the water intake facilities and constructing water treatment plants in these two cities, thereby contributing to improvement of the living environment and reduction of the morbidity of water-borne diseases. The Project is highly consistent with Paraguay’s national development policies as well as Paraguay’s development needs and Japan’s ODA policies. Although the project period was within the planned period, the project cost exceeded the planned cost due to an increase of the Paraguay portion of the project cost. Therefore, the efficiency of the Project is fair. The construction of new intake and water treatment facilities in both cities led to an increased water production volume and water distribution volume, boosting the size of the population served by the water supply service together with an expanded service area of the Paraguay Sanitation Service Corporation (Empresa de Servicios Sanitarios del Paraguay S.A.: ESSAP) in both cities. In Pilar, however, the target water production volume could not be reached as water demand did not increase as expected. This was because some large consumers withdrew their investments, and new ones could not be attracted due to the delay in the urban development plan which existed already at the time of the Preparatory Study. Meanwhile, the water quality targets (turbidity and color) were achieved at both water treatment plants. In both cities, the immediate use of tap water for drinking became easier due to improvement of the water quality and establishment of a stable water supply without water cuts which has reduced the water-related cost, contributing to improvement of the living environment. Meanwhile, no significant change can be observed regarding the frequency of water-borne diseases because the project areas experienced only a relatively low morbidity of water-borne diseases to start with. The overall picture is that the Project did produce the planned effects and its effectiveness and impact are high. Regarding operation and maintenance, the decision-making process and authority are concentrated at the ESSAP Headquarters and the support system of the Headquarters to individual water treatment plants is not completely satisfactory. The facts that most of the people who received training under the technical assistance (hereinafter referred to as ‘soft component’) of this Project have now left ESSAP and that ESSAP does not have a firmly established human resources development program cause concern regarding the technical aspects of operation and maintenance. There are no issues regarding the

financial aspect of the operation and maintenance. Therefore, the sustainability of the effects that were brought about by the Project is fair.

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

## 1 Project Description



Project Locations



Concepcion Water Treatment Plant: Chemical Sedimentation Tank

### 1.1 Background<sup>1</sup>

The water supply coverage in Paraguay in 2007 was estimated to be 79.3% in urban areas and 38.2% in rural areas. Even though the situation had been gradually improving, the quality of the water supply service greatly differed from one city to another. In many cities, safe water for drinking was not supplied as less than 24% of the water supply utilities<sup>2</sup> were able to supply water which met the national water quality standards for drinking in Paraguay.

Of the two target cities of the Project, Concepcion, a central city of Concepcion Department, is located some 543 km north of Asunción, the capital, and has long developed as a strategic site for transport on the Paraguay River. Meanwhile, the city of Pilar is located some 385 km southwest of Asunción and is on the border with Argentina lying on the other side of the Paraguay River. It is an important site for logistics in southern Paraguay as it has a port capable of serving large ships. Although both cities played an important role as local cities along the Paraguay River, they suffered from the insufficient development of infrastructure, especially water supply and sewerage infrastructure. Both cities had a water treatment plant (hereinafter referred to as WTP) constructed in 1979. While these WTPs were still in operation at the time of the planning for the Project, the water treatment system in use was a simple system relying on direct filtration whereby the process of settling suspended solids in the water for removal was lacking. The existing system was incapable of adequately treating raw water from the Paraguay River which is characterized by a high level of turbidity and color. Moreover, the entire water supply facilities were highly deteriorated. With an increase of the water demand due to population growth, both WTPs had

<sup>1</sup> Based on the report for the Preparatory Study.

<sup>2</sup> With regard to water supply and sewerage services in Paraguay, the urban water supply service in cities with a population of 10,000 or more is under the jurisdiction of ESSAP.

been operating beyond their normal treatment capacity. As such, the water supply service in these cities was run at a risk in terms of stable supply as well as safety of the supplied water.

Under these circumstances, the Government of Paraguay made a request to the Government of Japan in 2007 for grant aid for the construction and rehabilitation of water treatment facilities and distribution pipelines in the cities of Concepcion and Pilar.

## 1.2 Project Outline

The purpose of the Project was to improve the quality of water, to increase the amount of water supply and to improve the access to safe water for residents of the cities of Concepcion and Pilar in Paraguay by means of rehabilitating the water intake facilities and constructing water treatment plants, thereby contributing to improvement of the living environment and reduction of the morbidity of water-borne diseases in these cities.



Concepcion Water Treatment Plant



Pilar Water Treatment Plant

E/N Grant Limit/Actual Grant Amount	1,489 million yen/1,489 million yen
Exchange of Notes Date/ Grant Agreement Date	August 2011/August 2011
Executing Agency	Ministry of Public Works and Communications (Ministerio de Obras Publicas y Comunicaciones: MOPC)
Project Completion	September 2013
Main Contractor	Hazama Ando Corporation
Main Consultant	Kyowa Engineering Consultants Co., Ltd.
Basic Design	February 2011-March 2012
Related Projects	[Technical Cooperation] The Project for Capacity Development of Distribution Network Management of ESSAP (March 2011-February 2014) [Grant Aid] The Project for Development of Groundwater for Drinking in Rural Areas (January 2009-February 2012); The Project for Improvement of the Drinking Water System for Coronel Oviedo City (September 2014-December 2018)

	[Other Projects] Strengthening the Management Technology of the Water Distribution Network (2010-2015); Water and Sanitation Sector Modernization Project (April 2009-September 2017)
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## 2 Outline of the Evaluation Study

### 2.1 External Evaluator

Hiromi Suzuki S. (IC Net Limited)

### 2.2 Duration of Evaluation Study

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

Duration of the Study: October 2016 to February 2018

Duration of the Field Survey: 2<sup>nd</sup> to 23<sup>rd</sup> March and 30<sup>th</sup> July to 4<sup>th</sup> August 2017

## 3 Results of Evaluation (Overall Rating: B<sup>3</sup>)

### 3.1 Relevance (Rating: ③<sup>4</sup>)

#### 3.1.1 Consistency with the Development Policies of Paraguay<sup>5</sup>

At the time of planning, *the Strategic Economic and Social Plan 2008-2013* which represented the national development policy of Paraguay at the time emphasized economic development and aimed at increasing competition with the participation of the civil society and private sector and at improving the living environment as well as the reducing poverty through the continuous creation of employment. *The Public Policy for Social Development: Paraguay for All the People 2010-2020* formulated to supplement the social aspect of the above Strategic Plan lists four goals to be achieved by 2020 and the Project was highly relevant to one of these goals, namely, “improvement of the quality of people’s lives”. Meanwhile, *the Poverty Gap Reduction Plan* (formulated by the Economic Planning Agency in 2004) adopted the target of increasing the water supply coverage from 60.8% in 2004 to 80.5% by 2015.

The national development policy of Paraguay at the time of ex-post evaluation is the *National Development Plan 2014-2030*. This Plan has three pillars. The first pillar which is “reduction of poverty and social development” includes the goal of increasing the water supply coverage of 64% and sewerage coverage of 11% in 2014 to 100% by 2030. As the improvement of infrastructure in the water supply and sanitation sector is a theme involving multiple ministries, there is no sectoral policy as was the case at the time of planning the Project and the relevant matters are included in the plans of the Ministry of Health and the Environment Agency. For example, the *National Poverty Reduction Program* formulated based on the national development

<sup>3</sup> A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

<sup>4</sup> ①: Low; ②: Fair; ③: High

<sup>5</sup> Sources: Ex-ante evaluation sheet for the Project, *Japan’s ODA Data for Paraguay 2010 and 2011*, Report on the Presidential Address in 2016 and Website for the National Poverty Reduction Program (NPRP).

policy includes the development of water supply as part of the improvement of the living and sanitation environments of the poor.<sup>6</sup>

Based on the above, the Project is highly consistent with the national development policies of Paraguay at the time of both planning and ex-post evaluation.

### 3.1.2 Consistency with the Development Needs of Paraguay<sup>7</sup>

At the time of planning, 23% of the people of Paraguay did not have access to safe water (2011). The water supply facilities in Concepcion and Pilar, the target cities of the Project, were constructed in 1979 and despite their advanced stage of deterioration, were operating above their nominal treatment capacity to meet an increasing water demand due to population growth. Based on the treatment capacity at the time, it was estimated that Concepcion and Pilar would face a water supply shortage of some 2,700 m<sup>3</sup>/day and 1,500 m<sup>3</sup>/day respectively by 2014. The water treatment facilities in other cities in Paraguay were using the rapid filtration system. Concepcion and Pilar were exceptions as they were using the upward and downward counter-flow filtration system<sup>8</sup> and this system was not fully capable of dealing with the high level of turbidity and color of the raw water from the Paraguay River. The daily average turbidity of the treated water in these two cities was 5.5 NTU<sup>9</sup> (maximum of 11.4 NTU) in Concepcion and 5.0 NTU (maximum of 10.0 NTU) in Pilar which was much higher than the quality standard for drinking water of a daily average value of 1.0 NTU in Paraguay. The color was also high at a maximum of 20, far exceeding the standard value of 5. Apart from a problem of the water supply volume, a problem of the water quality in these cities was highlighted by a number of people suffering from water-borne diseases. Moreover, the WTPs in both cities faced such technical problems as a lack of manuals for plant operation and failure to inject the correct amount of chemicals to match the fluctuations of the turbidity and color of the raw water.

According to data (for 2015) obtainable at the time of ex-post evaluation, the proportion of the population with no access to safe water was 15% which was an improvement from the time of planning. The ratio of population connected to the public water supply network increased from 64% to 73% as a result of progress of the development of water supply infrastructure in the period from 2014 to 2016.<sup>10</sup> The water supply coverage in Concepcion and Pilar, the target cities of the

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<sup>6</sup> The contents of both *the Public Policy for Social Development 2010-2020: Paraguay for All the People* and *Poverty Gap Reduction Plan* at the time of planning have been integrated and rearranged in the *National Development Plan 2014-2030*.

<sup>7</sup> The ex-ante evaluation sheet for the Project and *Japan's ODA Data for Paraguay 2010* are used to analyse this consistency related to the time of planning and the *National Development Policy* and materials provided by the MOPC are used to analyse this consistency related to the time of ex-post evaluation.

<sup>8</sup> The upward and downward counter-flow filtration system feeds raw water at the middle of the filtration layer to facilitate filtration in two filtration channels (upward and downward). (Source: Japan Water Works Association).

<sup>9</sup> NTU stands for Nephelometric Turbidity Unit which is used for the measurement of turbidity using the turbidity caused by formazin as the reference value. 1 NTU is defined as the turbidity caused by the dissolution of 1 mg of formazin in 1 litre of distilled water. (Source: Public Works Research Center).

<sup>10</sup> Regulatory Body for Sanitation Services (Ente Regulador de Servicios Sanitarios: ERSSAN).

Project, increased to 72% and 79% respectively as a result of the implementation of the Project and the daily average turbidity value also improved to 0.2 NTU and 0.1 NTU respectively. The color improved to 3 in both cities, clearing Paraguay's water quality standard for drinking water. The construction of WTPs under the Project has contributed to such improvement, illustrating the important role played by the Project even after its completion. There is still a need for the continuous development of the water supply and sewerage infrastructure in other cities and rural areas. There is also a need for the further improvement of infrastructure and technologies as the state of maintenance, water quality, service quality, etc. widely vary from one city to another even in those local cities where water supply and sewerage infrastructure is in place.

Based on the above, the Project is highly consistent with the development needs of Paraguay in general and those of Concepcion and Pilar in particular at the time of both planning and ex-post evaluation.

### 3.1.3 Consistency with Japan's ODA Policy<sup>11</sup>

In regard to the Japanese ODA policy for Paraguay, the Economic Cooperation Policy Consultation for Paraguay in FY 2010 was held in July 2010 by the Field ODA Task Force taking the *National Development Plan* and development themes into consideration and it was agreed through such consultation that Japan would provide cooperation for three priority areas: (1) measures to combat poverty (consolidation of social services and livelihood improvement for the poor), (2) sustainable economic development (promotion of industries, consolidation of economic and social infrastructure and introduction of environmental measures) and (3) strengthening of governance. The Project was considered to particularly contribute to "sustainable economic development". As such, the Project is highly consistent with Japan's ODA policies.

Based on the above, this Project is highly relevant to Paraguay's development plan as well as Paraguay's development needs and Japan's ODA policy. Therefore, its relevance is high.

## 3.2 Efficiency (Rating: ②)

### 3.2.1 Project Outputs

Under the Project, a new water treatment facility using the rapid sand filtration system was constructed on the premises of the existing WTP in addition to the construction/renewal of the intake facility in both cities at the expense of the Japanese side. Moreover, training on the operation and maintenance of WTPs was conducted as the soft component of the Project. Meanwhile, the Paraguay side paid for the auxiliary work for the two WTPs, construction of a distribution reservoir in Concepcion and renewal of the transmission pipeline in Pilar.

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<sup>11</sup> Based on the ex-ante evaluation sheet for the Project and *Japan's ODA Data for Paraguay 2010*.

The planned contents and actual results of the infrastructure development, including WTPs, and soft component of the Project for which the Japanese side was responsible are shown in Table 1 and Table 2.

(1) Infrastructure development: Although minor changes, including those of the structure, shape, etc., of some facilities and the location of the staircase, were made for both WTPs, there was no impact on the project cost or project period. The two principal changes are described below.

- At the Concepcion WTP, following confirmation that the site boundary could be changed, the locations of the distribution reservoir, rapid filtration tank and pump room were moved southward by approximately 6 m.
- Because of the delayed loading of the reinforcing bars dispatched from Japan to a smaller vessel in Argentina at the stage of the foundation works for the WTPs, some of the reinforcing bars for the main structural bodies of the WTPs (flocculator, sedimentation tank, rapid filtration tank, distribution reservoir and pump room) were replaced by those which could be locally procured. This meant the mixed use of reinforcing bars made in Japan and those locally procured with different diameters and it was necessary to change the bar arrangement (narrowing of the interval to secure the required quantity of reinforcing bars or alternate use of two different reinforcing bars).

(2) Soft component: Guidance on water treatment technologies was provided through lectures and practice, targeting the managers of local ESSAP branches, head of each WTP and operators of the WTPs (Table 2). The actual results were similar to those planned. Evaluation of the degree of achievement of the technical assistance concluded that the intended results were achieved almost as planned (see 3.5.2 Technical Aspects of Operation and Maintenance for further details).

Table 1 Japanese Outputs: Planned Facilities and Actual Results

Item	Original Plan		Actual
	Concepcion	Pilar	
<b>I. Intake Facilities</b>			
1. Design Water Intake Volume	10,760 m <sup>3</sup> /day (125L/sec.)	8,200 m <sup>3</sup> /day (95L/sec.)	As planned at both WTPs
2. Rehabilitation of the slab for the pump	Concrete base for pumps (existing water intake facilities will be used)		
3. Renovation of pump	3 vertical shaft type mixed flow pumps (one unit as a spare)		
	Q=3.70m <sup>3</sup> /min. H=16m	Q=2.85m <sup>3</sup> /min. H=16m	
4. Renovation of control and electrical panel	New (with interlock)		
5. Renovation of conduction pipes and internal pipes	Pipes around the pump (existing footbridges will be used)		
	Conduction pipe of Φ300, L=Approx. 150m	-	
<b>II. Water Treatment Facilities</b>			
1. Receiving well	Dwelling time 1.5 min.		As planned at both WTPs
2. Stirrer for rapid mixing of chemical products	Parshall Flume		
	Injection and hydraulic jump parts		
3. Flocculator	3 phases ,2 horizontal flow flocculation tanks		
4. Horizontal Flow Sedimentation tank	L38m×W6.7m×2 tanks	L34m×W6.0m×2 tanks	
	Installation of channel for overflow, effective depth of 4m		
5. Rapid filtration tank	L6.3m×W3.8m×4 tanks	L5.5m×W3.4m×4 tanks	
	Sand layer thickness 70cm		
6. Back wash pump	2 volute type mixed flow pumps (one unit as a spare)		
	Q=19.12m <sup>3</sup> /min. H=8m	Q=14.72m <sup>3</sup> /min. H=8m	
7. Surface wash pump	2 centrifugal pumps of horizontal axis single suction (one unit as a spare)		
	Q=4.07m <sup>3</sup> /min. H=15m	Q=2.76m <sup>3</sup> /min. H=15m	
8. Clean water management tank	L7.4m×W0.9m 1 tank Used also as dosage tank		
9. Reservoir	W5.0m×L27.8m×2 tanks	W9.0m×L20.0m×2 tanks	
	Used also for clean water cannel Effective depth 3.6m		
10. Conveying pump	3 centrifugal pumps with horizontal axis single suction (one as reserve)		
	Q=3.4m <sup>3</sup> /min. H=67m	Q=2.15m <sup>3</sup> /min. H=45m	
11. Pump for works inside the plant	Lifting pump of standard pressure with direct connection (independent alternative/automatic operation) Q=0.3m <sup>3</sup> /min. H=20m		
12. Aluminium sulphate injector	Control room, dosing pump equipment		
13. Coal injector	Control room, dosing pump equipment		
14. Chlorine injector	Control room, dosing pump equipment, alarm system for detection of chlorine gas		
15. Measuring equipment	Raw water volume meter Parshall Flume		
	Filtered water volume meter Channel with rectangular plate of total width dam		
	Dispatched water volume meter Electromagnetic flow meter		
	Back wash water volume meter Flow meter by pressure difference with orifice plate		
	Water level meter inside the tanks with pump interlock function. Installed in the reservoir		
16. Sewer pipes inside the plant	Φ700mm L=Approx.235m	Φ600mm L=Approx. 64m	
	Concrete sewer pipes		
			Only at Concepcion WTP, the reservoir was moved approx. 6 m to the south
			As planned at both WTPs

Source: Documents provided by JICA.



Table 2 Japanese Side Outputs:  
Planned and Actual Outputs of Technical Guidance as Soft Component

Item	Planned	Actual
Target Persons	Managers of local ESSAP branches; heads of WTPs; WTP operators	<ul style="list-style-type: none"> <li>• Concepcion WTP: 30 (including 3 from the MOPC)</li> <li>• Pilar WTP: 28 (including 2 from the MOPC)</li> <li>• Total: 58</li> </ul>
Lecture Contents	<ul style="list-style-type: none"> <li>• Theories: Characteristics of the quality of water from the Paraguay River; simplified hydrology at a WTP; theory of coagulation and flocculation and the jar test; mastering of proper knowledge concerning water treatment processes (sedimentation and filtration) and operation of a WTP (efficiency); understanding of an operation and maintenance manual; safety management (especially handling of chlorine gas and electrical equipment); method to adjust the quality of treated water; reduction of the operating cost and maintenance cost; understanding of a manual for routine maintenance.</li> <li>• Field activities: Accidents and safety at a WTP; operation and maintenance of a WTP</li> </ul>	As planned
Results	WTP operation and maintenance manual; lecture and practice materials; completion report	As planned

Source: JICA for the planned contents. The actual number of participants is based on the attendance records kept by the MOPC.

The planned outputs for which the Paraguay side was responsible involved seven types of work, i.e. (1) WTP ground levelling, (2) construction of an access road at the Pilar WTP site, (3) power supply extension work to the WTP site, (4) fencing and other exterior work, (5) construction of a distribution reservoir in Concepcion, (6) renewal of the transmission pipeline in Pilar and (7) other (opening of a bank account and payment of the administrative cost, taxes and customs and import duties on equipment and materials and commissions). These outputs were achieved as planned.

In addition, ESSAP conducted the following work at its own expense after the completion of the Project to secure the stable operation of the two WTPs.

- Construction of a revetment on both sides of the intake tower in Pilar: Work to protect the river banks using gabions was conducted to ensure the safety of the conduction pipes from the intake tower to maintain stable water intake operation in the face of more than anticipated bank erosion.
- Installation of a private power generator at each WTP: A private power generator was installed at each WTP (300 KVA at the Concepcion WTP and 200 KVA at the Pilar



Private power generator at  
Pilar Water Treatment Plant

WTP) in 2015 as the unstable power supply in Paraguay meant a series of power cuts which caused cutting off of the water supply in the early days of the operation of the new WTPs.

As described above, the planned outputs of both countries were generally achieved without any major changes.

### 3.2.2 Project Inputs

#### 3.2.2.1 Project Cost

The planned total project cost at the time of planning was 1,546 million yen (Japanese portion of 1,489 million yen and Paraguay portion of 57 million yen). The actual total project cost was 1,571 million yen (Japanese portion of 1,487 million yen and Paraguay portion of 83 million yen), exceeding the planned total project cost by 2%.

Table 3 Planned and Actual Project Cost\*

(Unit: thousand yen)

Item	Planned (Ex-Ante Evaluation)	Actual
<b>【Japanese Portion】</b>		
<b>I. Construction Cost</b>	<b>1,353,600</b>	<b>1,350,000</b>
1. Direct cost	-	935,800
2. Costs of common temporal facilities, supervision, general and administration	-	414,200
<b>II. Design and Supervision Cost</b>	<b>136,000</b>	<b>137,612</b>
1. Detailed design and work supervision cost	130,000	130,860
2. Soft component	6,000	6,752
<b>Sub-total</b>	<b>1,489,000**</b>	<b>1,487,612</b>
<b>【Paraguay Portion】</b>		
1. WTP ground levelling	1,123	485
2. Construction of an access road at Pilar WTP site	2,724	8,671
3. Power supply extension work to the WTP site	470	330
4. Fencing and other exterior work	800	5,003
5. Construction of a distribution reservoir in Concepcion	20,429	38,310
6. Renewal of the transmission pipeline in Pilar	30,000	29,079
7. Other (Commissions, etc.)	1,520	1,532
<b>Sub-total</b>	<b>57,066</b>	<b>83,410</b>
<b>Total</b>	<b>1,546,066</b>	<b>1,571,002</b>

Source: JICA for the Japanese portion. JICA for the planned Paraguay portion and the MOPC and ESSAP for the actual results for the Paraguay portion.

\*Estimating conditions at the time of planning (November 2011): Exchange rates: US\$1=79.04 yen, Gs1=0.02 yen, at the time of ex-post evaluation: The average rate from 2011 to 2013 (Exchange rate of OANDA is used due to the absence of the IMF data) Gs1=0.019391 yen

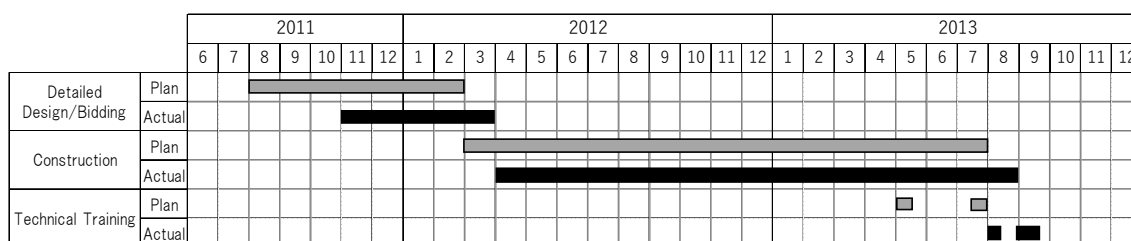
\*\*The figures are based on JICA documents, but the figure for Sub-total is rounded up and does not coincide with the total of the above breakdown figures.

Although the Japanese portion of the project cost was within the planned cost, the Paraguay portion of the project cost ended at 146% of the planned cost. According to ESSAP, the reason for this cost over-run may have been under-estimation of the cost at the time of planning because

cost estimation at the time was not based on a detailed study.<sup>12</sup>

### 3.2.2.2 Project Period

The planned project period was from August 2011 to July 2013 (24 months). The actual project period was from November 2011 to September 2013 (23 months) which was 96% of the planned period.<sup>13</sup>



Source: JICA for the planned period; JICA and the MOPC for the actual period.

Fig. 1 Planned and Actual Project Periods

Because the detailed design and commencement of the tender were delayed by three months, project completion was delayed by two months. However, the actual project period was within the planned project period.

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

### 3.3 Effectiveness<sup>14</sup> (Rating: ③)

#### 3.3.1 Quantitative Effects (Operation and Effect Indicators)

The Project aimed at “supplying safe water in Concepcion and Pilar”. At the time of planning, four main indicators for the operation and effects were set: (1) population served, (2) production

<sup>12</sup> With respect to Paraguay’s portion at the time of planning, a detailed analysis such as whether there was an underestimation or not, was not possible, as ESSAP has not kept the information on the quantities and unit costs of the items.

<sup>13</sup> On the ex-ante evaluation sheet, the project period was set at 24 months. Checking of the work schedule in the report for the Preparatory Study found that the above period did not include the time from the G/A to D/D. Because according to the “Evaluation Reference” it is necessary to compare the planned period to the actual period based on the same conditions, the planned project period here was from August 2011 when the detailed design commenced instead of the date of signing of the G/A to the completion of the Project. The completion of the Project is defined as the commissioning of the planned WTPs or completion of the soft component. Of the seven outputs to be achieved by the Paraguay side, the construction of a distribution reservoir in Concepcion was completed in December 2014 while the other outputs were completed by November 2014. Because this construction of a distribution reservoir was an extension to an existing facility, the delay did not hinder the opening of the WTP. Accordingly, the delay of the Paraguay outputs is not taken into consideration by this ex-post evaluation as far as the project period is concerned.

<sup>14</sup> The effectiveness is rated in consideration of not only the effects but also the impacts.

volume of the WTP, (3) average distribution volume and (4) quality of the treated water (color and turbidity) (Table 4). In this ex-post evaluation, four auxiliary indicators are added: (5) quality of the treated water (key items other than color and turbidity), (6) water supply time, (7) plant operation rate (production volume ÷ production capacity) and (8) unaccounted for water (Table 5).

#### (1) Main Operation/Effect Indicators

The target for (1) population served was achieved in both cities as the service area of ESSAP was expanded. Although expansion of the service area was the result of another project implemented by ESSAP, it is safe to say that the increased treatment capacity (supply capacity) as a result of the Project made such expansion possible. Both (2) production volume of the WTP and (3) average distribution volume increased in both cities. While both targets were achieved in Concepcion, the target achievement rate in Pilar was 79% for (2) production volume of the WTP and 84% for (3) average distribution volume. In order to find the reasons for the targets in Pilar not achieving 100%, the contents of the Preparatory Study were analysed in detail in collaboration with ESSAP and it was found that the urban development plan which was used in order to estimate the water demand, consisted of a plan to expand the residential area, and a plan to attract new large consumers. The former proceeded more or less as planned, thus the target of the population served could be achieved. However, the latter did not proceed as planned, and in addition to that, some large consumers withdrew their investment seeing that the urban development plan was experiencing a substantial delay in its implementation. The fact that the number of large consumers, whose water demand per consumer is big, and accounted for a considerable part of the water demand estimation did not grow, resulted in the overall amount of water demand not achieving the levels of that were originally estimated, which in turn led to the failure to achieve the target for the (2) production volume of the WTP. However, at the time of ex-post evaluation, the implementation of this urban development plan by the Pilar municipal government is making progress to the point that further growth in number of customers, an increase of the water production volume and increase of the water distribution volume can be expected to take place in 2018 and thereafter.<sup>15</sup>

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<sup>15</sup> At the time of ex-post evaluation, Phase I (2015-2025) of the Pilar Municipal Water Supply System Master Plan which is part of an urban development plan formulated by the Pilar municipal government is in progress. According to this Master Plan, the infrastructure development for water supply in Pilar will increase the average daily water demand to 13,337 m<sup>3</sup> by 2025. One immediate outcome of the Master Plan will be the construction of a new distribution network to enable water supply to some 600 households in the San Jose, San Vicente and San Juan Pablo Districts in Pilar by the end of FY 2017. These new connections will increase not only the water demand but also the water production and distribution volumes to enable achievement of the water production and distribution targets of the Project.

Table 4 Main Indicators for Project Effects: Degree of Target Achievement

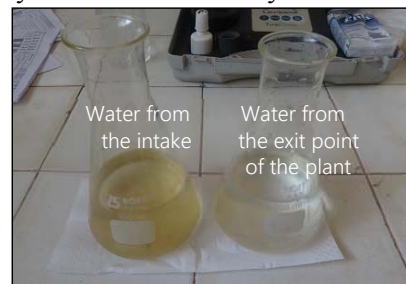
Indicator	Reference Value Year of Project Planning 2010)	Target to be achieved three years after Project completion (2016)	Actual		
			Three years after Project completion (2016)	Degree of target achievement	
(1) Population served (persons)*					
Concepcion	26,565	29,685	34,150	115%	
Pilar	22,492	25,672	33,840	132%	
(2) Production volume of the WTP**(m <sup>3</sup> /day)					
Concepcion	6,346	8,906	9,080	102%	
Pilar	4,404	6,434	5,067	79%	
(3) Average volume distributed to ESSAP service area**(m <sup>3</sup> /day)					
Concepcion	5,897	8,096	8,835	109%	
Pilar	3,652	5,849	4,889	84%	
(4) Quality of treated water (Recommended standard water quality in Paraguay)					
Concepcion	Color (grade)	35 (Maximum)	≤ 5 (constant)	3 (constant)	100%
	Turbidity (NTU)	11.3 (Maximum)	≤ 1 (constant)	0.1-0.4	100%
Pilar	Color (grade)	20 (Maximum)	≤ 5 (constant)	3 (constant)	100%
	Turbidity (NTU)	24(Maximum)	≤ 1 (constant)	0.1-0.4	100%

Source: JICA for the reference values and target values. ESSAP for the actual values.

\* Coverage (population served ÷ population targeted) is 60% for Concepcion and 71% in Pilar in 2016.

\*\* As the detailed check of the planned values in the ex-ante comparison table discovered that the values used were those for 2019 in the report for the Preparatory Study, they were corrected for 2016 values. The water production volume at a WTP is not the same as the water supply volume as 10% of the produced water is assumed to be used for the WTP operation, including the washing of the filtration tank.

The target for (4) quality of the treated water (color and turbidity) was achieved at both WTPs where the recommended standard water quality in Paraguay has been constantly met. Water quality data for the Paraguay River (source of raw water) for 2016 shows a maximum color value of 100 to 120 in the dry season (April to November) and 120 to 140 in the wet season (December to March) but the color of the treated water is constantly 3. Similarly, the turbidity of the raw water widely fluctuates between 9.6 NTU and 75 NTU irrespective of season while the turbidity of the treated water by the WTP is stable at 0.1 to 0.4 NTU.



Concepcion Water Treatment Plant: Water from the intake and the exit point of the plant

## (2) Auxiliary Operation/Effect Indicators

At both WTPs, (5) quality of the treated water (total coliform count, residual chlorine<sup>16</sup>,

<sup>16</sup> The concentration of residual chloride is checked every hour at the WTP while others are checked, tested and recorded once every two weeks using samples collected by the Quality Control Section of ESSAP Asunción Metropolitan Area Branch. Although inspection of the total coliform count, manganese and total iron does not follow the recommended frequency (once a day) of the quality standards for drinking water in Paraguay, the

manganese and total iron) meets the relevant national standard. The water quality standard for the concentration of residual chloride is that of the distribution network. In Pilar, water quality data from six monitoring points for the distribution network shows a concentration range of between 1.0 mg/L and 1.8 mg/L which meets the relevant standard. The concentration value of 2.5-2.7 mg/L at the outlet of the WTP is acceptable.

Table 5 Auxiliary Indicators for Project Effects: Degree of Target Achievement

Indicator	Reference Value (2010)	Target to be achieved three years after Project completion (2016)	Actual		
			Three years after Project completion (2016)	Degree of target achievement	
(5) Quality of treated water (Recommended standard water quality in Paraguay) *					
Concepcion	Total coliform count (MPN)	0	0 (constant)	0 (constant)	100%
	Concentration of residual chloride (mg/L)	2.4	0.2-2.0 (constant within the distribution network)	1.0-1.5	100%
	Manganese (mg/L)	<0.05	≤30 (constant)	Not detected	100%
	Total iron (mg/L)	0.2	0.3 (constant)	0.075 (average)	100%
Pilar	Total coliform count (MPN)	0	0 (constant)	0 (constant)	100%
	Concentration of residual chloride (mg/L)	2.1	0.2-2.0 (constant within the distribution network)	2.5-2.7	100%
	Manganese (mg/L)	<0.05	≤30 (constant)	0 (constant)	100%
	Total iron (mg/L)	0.2	0.3 (constant)	0.092 (average)	100%
(6) Water supply time (hours/day) *					
Concepcion	About 24 hours	24 hours	Approx. 24 hours	Almost achieved	
Pilar	About 24 hours	24 hours	Approx. 24 hours	Almost achieved	
(7) Plant operation rate (%) (production volume ÷ production capacity) *					
Concepcion	NA	—	84%	—	
Pilar	NA	—	62%	—	
(8) Unaccounted-for water (%)					
Concepcion	40%	—	39%		
Pilar	21%	—	21%		

Source: JICA for the reference values and target values. ESSAP for the actual values.

\*: Because of the lack of accurate data to use as the reference values, findings of the social conditions survey conducted as part of the Preparatory Study were used. According to this study, 24 hour water supply operation was basically in place and there was no planned supply cut in either the rainy season or the dry season in principle. Irregular supply cut due to power cut, etc. did occur 2 to 4 times a month in both cities.

MPN: the most probable number in 100 ml of sampled water.

In the case of (6) water supply time, even though some water supply cut-off incidents occurred after the commissioning of the WTPs due to a power cut, 24-hour water supply has been maintained since 2015 when ESSAP installed a power generator for emergency use at both WTPs.<sup>17</sup> The plant operation rate is determined by the ratio of the production volume to the

ERSSAN which is the regulatory body for water supply and sewerage services in Paraguay and which supervises the water quality control and other operations of water supply service providers approves the present inspection regime.

<sup>17</sup> Efforts were made to obtain data to determine the plant utilization rate (annual operating hours ÷ 8,760 hours x

production capacity of the WTP and ESSAP considers a ratio of 80% or higher to be adequate. The actual figure for the Concepcion WTP is 84% but that for the Pilar WTP is as low as 62%. The reason for this is as described earlier. Due to the substantial delay of the implementation of the urban development plan of the Pilar municipal government, the water demand growth by large consumers could not be expected, resulting in the sluggish performance of the water production volume. In the case of (8) unaccounted for water, the figure for Concepcion slightly improved from the reference value of 40% to 39%. In Pilar, both the reference value in 2010 and the actual figure in 2016 were 21%, showing no specific change. It must be noted that this indicator is used for reference as the Project was not designed to improve unaccounted for water.

### **3.3.2 Qualitative Effects (Other Effects)**

The qualitative effects of the Project assumed at the time of planning were (1) reduction of the morbidity of water-borne diseases, including diarrhoea, due to improvement of the water quality and (2) accumulation of accurate knowledge of the treated water and improved WTP operation and maintenance skills through technical guidance on WTP operation and maintenance technologies under the soft component of the Project. The actual performance regarding (1) is analysed in 3.4.1 Intended Impacts while that regarding (2) is analysed in 3.5.2 Technical Aspects of Operation and Maintenance.

In summary, the Project led to the increased production of safe water in both cities while increasing the population served, distribution volume and water supply time. In Concepcion, all the indicators achieved their respective targets. In Pilar, the water production volume and water distribution volume achieved some 80% of their respective targets and this achievement rate is expected to increase in the near future. All the other indicators achieved their respective targets. Therefore, the effectiveness of the Project is judged to be high.

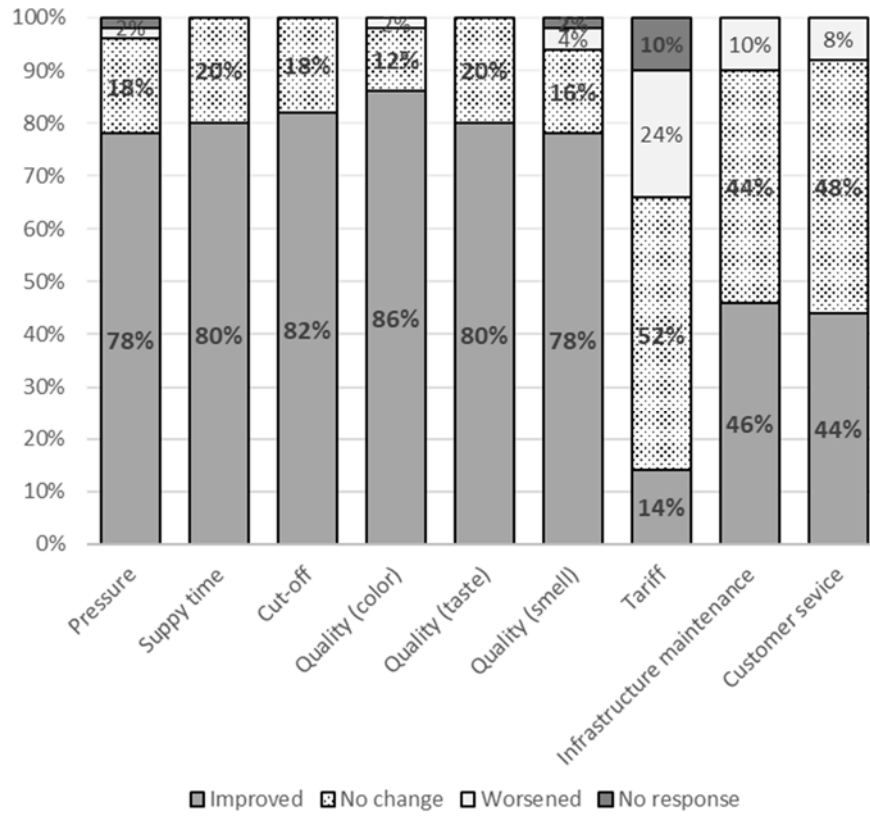
## **3.4 Impacts**

### **3.4.1 Intended Impacts**

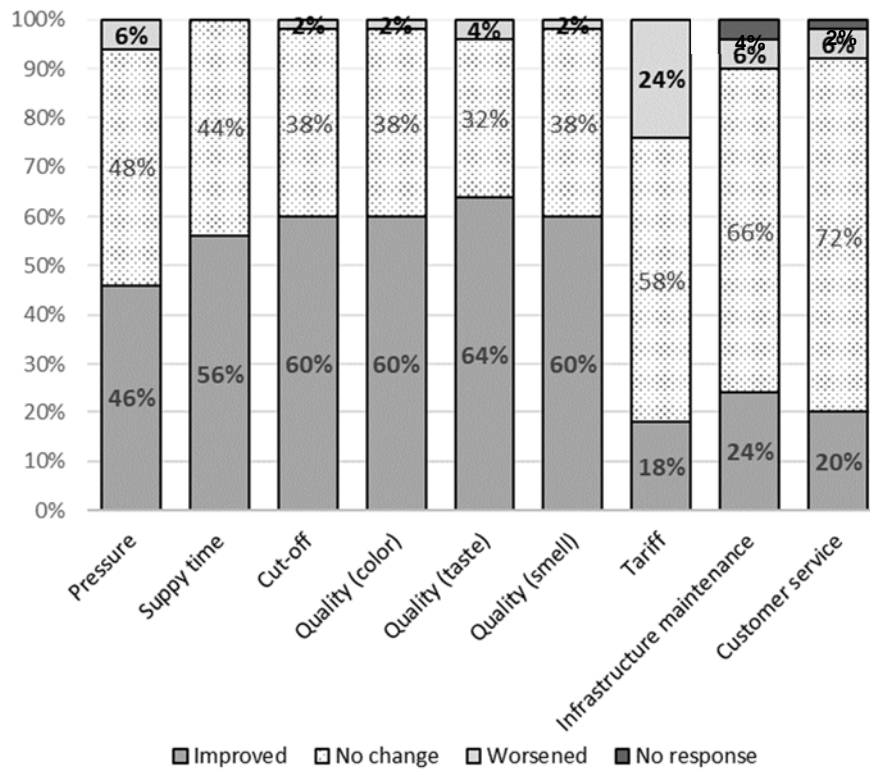
The expected impacts of the Project were “improvement of the living environment of residents in Concepcion and Pilar” and “reduction of the morbidity associated with diarrhoea and other water-borne diseases due to improvement of the water quality”.

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100). However, it was impossible to obtain accurate data as much of ESSAP’s data is not digitalized and the added figures in the paper records are often inaccurate.



Concepcion



Pilar

Source: Beneficiary Survey

Fig. 2 Changes of Tap Water Before and After the Project



(1) Improvement of the living environment of residents in Concepcion and Pilar:

To ascertain improvement of the living environment, a beneficiary survey<sup>18</sup> was conducted to check any improvement (in terms of colour, taste and odour) of tap water felt by customers when using or consuming water, reduction of the frequency of water cuts, any change of water usage and reduction of the water cost. As shown in Fig. 2, most respondents to this survey selected the answer “improved” in both cities regarding the water supply time, frequency of water cuts and quality of tap water. The actual ratio of positive replies was higher in Concepcion than Pilar, indicating a difference in the perception between the water users in these cities. A conceivable reason for this difference is the different awareness of the operation of a new WTP since 2013 by the residents of these cities (80% of the respondents in Concepcion were aware of a new WTP in the city compared to 56% in Pilar).<sup>19</sup> It is inferred that such biased awareness led to a difference in the perception of any changes of tap water due to the Project among the residents of the two cities. The water treated by the new WTP constructed under the Project meets the quality standards for drinking water as evidenced by the actual performance of the various indicators listed in Table 4 and Table 5 and by the water quality inspection results of ESSAP for tap water in the two cities. It is, therefore, safe to judge that the Project has contributed to improvement of the living environment in both Concepcion and Pilar.

Meanwhile, the overall level of satisfaction with the Project was high at 92% in Concepcion and 90% in Pilar as shown in Fig. 3. The biggest reason cited for satisfaction is that “the water quality has improved”. Even before the Project, tap water was the main drinking water for residents but there was now a change of how to treat potable water for drinking after the Project. Before the Project, the proportion of people “drinking potable water without any treatment” was 36% in Concepcion and 64% in Pilar. After the Project, this figure increased to 94% and 84% in the respective cities.<sup>20</sup> The second reason cited is “the substantial reduction of the frequency of water cuts”. Before the Project, water cuts frequently occurred in the morning and during the dry season. Currently, there are virtually no water supply fluctuations in terms of the supply hours or season and water supply is basically provided 24 hours a day. Before the Project, it was not unusual for residents to use well water of questionable quality or to purchase water from a supplier other than ESSAP with an average monthly payment of Gs 10,000-50,000. Because there are

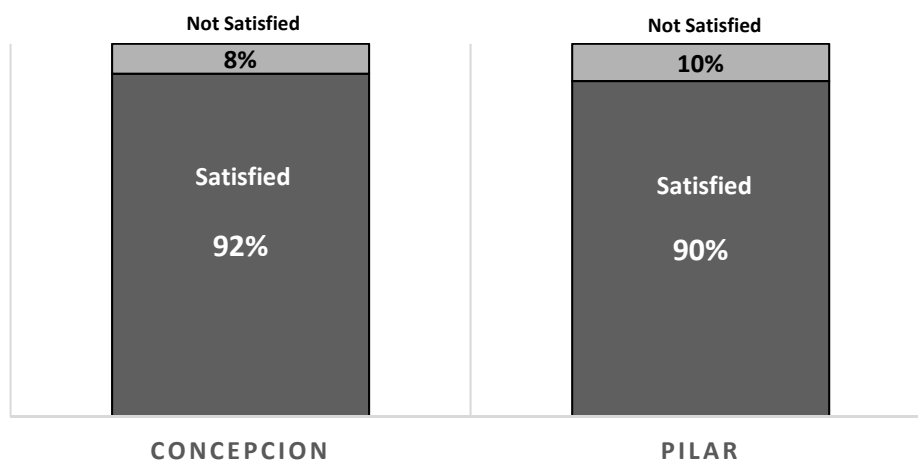
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<sup>18</sup> The beneficiary survey was conducted on 18<sup>th</sup> and 19<sup>th</sup> March 2017 in Concepcion and 21<sup>st</sup> and 22<sup>nd</sup> March 2017 in Pilar. It featured any changes before and after the Project and one condition for the respondents was that each respondent had been a customer of ESSAP before and after the Project. The sample size was 50 households in each city, totalling 100 households. For the purpose of sampling, five blocks in Concepcion and nine blocks in Pilar were selected. The sampling rules were the random selection of the survey starting point on the map, followed by an actual visit to one out of every two randomly selected households. The gender ratio was 50% male and 50% female in Concepcion and 44% male and 56% female in Pilar.

<sup>19</sup> As the Concepcion WTP is located inside the city, the Project was part of the daily life of the local residents throughout its planning, construction and operation stages. In contrast, the Pilar WTP was constructed at a military site located with some distance from the urban area and it is possible that the level of its recognisability among the local residents could have been low from its construction stage.

<sup>20</sup> The treatment of potable water before the Project included the use of filters, bottling, settling or injection of chlorine.

currently no water cuts, people no longer worry about how to obtain water at the time of a water cut or how to pay the cost.



Source: Beneficiary Survey N = 100 (50/city)

Fig. 3 Overall Degree of Satisfaction with the Project

In summary, although there are some differences between the two cities, positive impacts of the Project on improvement of the living environment can be observed, including improvement of the quality of tap water, stable water supply without water cuts and elimination of the opportunity cost of obtaining water.

(2) Reduction of the morbidity associated with diarrhoea and other water-borne diseases due to improved water quality:

For this ex-post evaluation, efforts were made to obtain statistics on the morbidity associated with water-borne diseases from the Ministry of Health and local hospitals in each city following similar efforts at the time of planning. However, as local hospital covers not only residents of urban areas where ESSAP supplies water but also people in rural areas where suppliers other than ESSAP supply water and areas where people rely on well water because water supply infrastructure is not in place, neither the Ministry of Health nor local hospitals have detailed information on such water supply situation. Accordingly, it is difficult to quantify the “reduction of the morbidity associated with diarrhoea and other water-borne diseases due to improvement of the water quality by the Project” based on available statistics.<sup>21</sup>

In interviews with an epidemiologist at a local hospital in Concepcion and the head of a local

<sup>21</sup> According to statistics obtained for Pilar, the proportion of people suffering from mild diarrhoea among the total number of patients fell from 8% in 2008 and 2009 to 1% in 2016. At the same time, the proportion of patients suffering from diarrhoea and dehydration fell from 1% in 2008 and 2009 to much less than 1% at 0.05%-0.1% in 2014-2016. However, the proportion of ESSAP customers among patients is unknown.

hospital in Pilar, the substantial improvement of the quality of tap water in both cities after the implementation of the Project is highly appraised. However, one problem pointed out is the level of awareness of the importance of sanitation management on the part of residents as illustrated by inadequate hygiene control when cooking (lack of washing of raw material, thorough heating, etc.) and lack of routine hand-washing after visiting the toilet. According to the beneficiary survey, the proportion of residents replying that “the number of people suffering from water-borne diseases was not high to start with even before the Project and no specific change has taken place since the Project” is high at 86% in Concepcion and 92% in Pilar. No actual decrease of the morbidity associated with water-borne diseases is evident as an impact of the Project.

From the above, this indicator was considered only to a limited extent, because a clear causal relationship between the Project and the number of persons that contracted water-borne diseases could not be verified.

### 3.4.2 Other Positive and Negative Impacts

#### (1) Impacts on the natural environment:

An environmental management plan (EMA) was formulated based on the findings of the environmental impact assessment (EIA) and the Concepcion WTP and Pilar WTP were issued an environmental licence by the Environment Agency in September 2012 and 2013 respectively. In the Preparatory Study, the Project was determined to have “a minimum or hardly any impact” on 18 of the 23 check items suggested by the JICA Guidelines for Environmental and Social Considerations and “a positive impact” on the remaining five items in Concepcion. Similarly, it was considered that the Project would have “a minimum or hardly any impact” on 20 items while three items would experience “a positive impact” in Pilar. In short, it was believed that the Project would have very little negative impact on the environment in both cities. Several measures were adopted during the construction period to minimize any negative impact caused by noise or vibration, etc. on the social and natural environments. These included the transportation of construction waste and sludge to the municipal waste collection yard using dedicated vehicles and the spraying of water at the construction sites to suppress dust. As far as noise is concerned, the construction hours avoided the early morning and night-time. A vibration suppression method was employed to control vibration.<sup>22</sup> As for the environmental monitoring after the starting of WTP operations, both ESSAP and ERSSAN are monitoring the water quality and these satisfy the water quality standards of Paraguay. The Report on the Implementation Status of the EIA

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<sup>22</sup> The beneficiary survey also investigated the possible impacts of the Project on the environment and the proportion of respondents who said that “there was no impact” was 88% in Concepcion and 100% in Pilar. The Pilar WTP site is located on a military site which is far away from any urban area. Therefore, such impacts as waste water, rubbish and vibration that might appear during the construction period were not felt by the residents in Pilar. Meanwhile, in the case of Concepcion, 12% of the respondents answered to have felt these impacts. In Concepcion where the WTP is located in an urban area, ESSAP held advance meetings to explain the Project to nearby residents, and since ESSAP had already gained their understanding, the actual construction work proceeded without any problems.

submitted by ESSAP to the Environment Agency was approved in 2015, confirming that the impacts of the Project on the natural environment have been kept to a minimum.

(2) Resettlement and land acquisition:

As the Project was intended to renew existing facilities and equipment, no resettlement or acquisition of new land was necessary.

(3) Other impacts:

In addition to the expected impacts described so far, it was anticipated that the Project would have positive impacts regarding (i) the facilitation of poverty reduction, (ii) gender consideration and (iii) cooperation with other schemes of other donors. Regarding (i), as ESSAP service areas are not the dwelling areas of poor people to start with, the proportion of ESSAP users among residents was high even before the Project. This impact cannot be achieved unless the water supply service is extended to reach the dwelling areas of poor people. In regard to (ii), while it was planned to balance the gender proportion of the possible participants of the explanatory meeting held prior to the commencement of the construction work, the majority of the participants of this meeting and other events tended to be male due to the cultural background. Nevertheless, no negative impact of this unbalanced gender presence was confirmed. Regarding (iii), there was an expectation of cooperation with the Project for Capacity Development of Distribution Network Management of ESSAP (2011-2014), a technical cooperation project of JICA. As this project includes the Concepcion and Pilar branch offices of ESSAP in its scope of cooperation, it was hoped that the infrastructure development under the Project would effectively drive the cooperation between the two projects (two schemes) forward. However, the change of the government in 2014 triggered a change of staff at these branches and neither the MOPC nor ESSAP has detailed information to corroborate this impact.

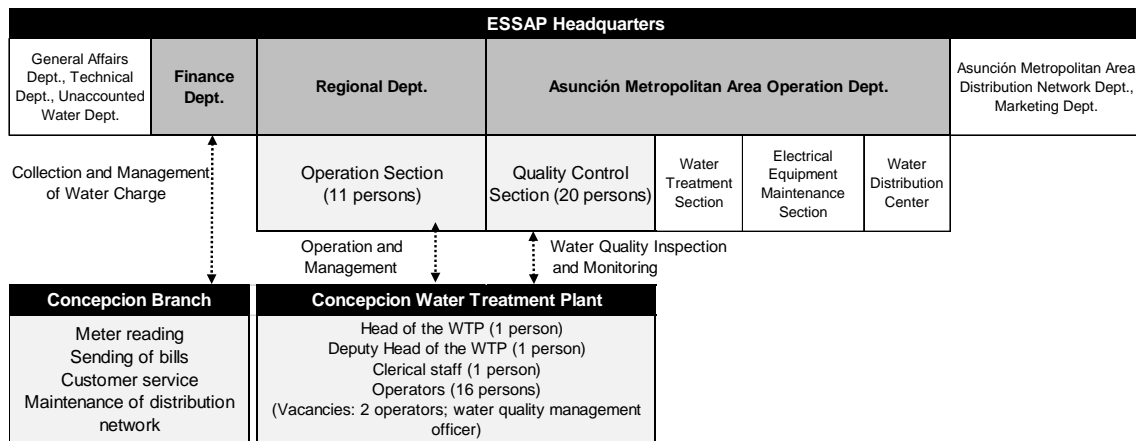
Based on the above, positive impacts are confirmed regarding “improvement of the living environment of the citizens of Concepcion and Pilar” among the envisaged impacts. These impacts include improvement of the tap water quality and a stable water supply without water cuts. In contrast, no clear difference is observed before and after the Project regarding a reduction of the morbidity of diarrhoea and other water-borne diseases due to improved water quality. Meanwhile, the impacts on the natural environment have been kept to a minimum and no land acquisition or resettlement has been necessary.

The Project has largely achieved its objectives and, therefore, its effectiveness and impact are high.

### 3.5 Sustainability (Rating: ②)

#### 3.5.1 Institutional Aspects of Operation and Maintenance

The competent body responsible for supervision of the Project is the MOPC which is the executing agency of the Project and the actual operation and maintenance work is delegated to ESSAP. The authority for the operation and maintenance of water supply and sewerage services is almost entirely concentrated at the ESSAP Headquarters. Fig. 4 shows the operation and maintenance system for water supply service taking Concepcion as an example, but the system is the same in Pilar.



Source: ESSAP.

Fig. 4 Operation and Maintenance System: Example of the Concepcion WTP

As shown in Fig. 4, the section responsible for the operation and maintenance of the WTPs constructed under the Project is the Operation Section of the Regional Department of the ESSAP Headquarters. While routine operation and maintenance is conducted by each WTP, emergency maintenance and maintenance requiring a high level of professional skill are conducted by each WTP in cooperation with the Operation Section of the Regional Department. In the case of water quality inspection, eight items, including turbidity, color and pH, are checked by an operator at each WTP on a daily basis but more detailed checking is conducted by the Asunción Metropolitan Area Quality Control Section.<sup>23</sup> This section has 20 chemical engineers and is well equipped. These 20 engineers oversee water quality management for “Asunción Metropolitan Area” and “other areas” on a rotation basis. The WTPs constructed under the Project receive visits for sampling once every two weeks. After the water quality analysis of the sampled water, the section reports the analysis results and provides guidance on necessary measures to be implemented to each WTP. The Asunción Metropolitan Area Quality Control Section also conducts the water

<sup>23</sup> The Asunción Metropolitan Area consists of Asunción (the capital) and 12 neighbouring cities.

quality analysis of river water from the Paraguay River, which is the source of the raw water for the two WTPs, and shares the information with the two WTPs. Similarly, information on the eight water quality check items for each WTP is sent every day by next early morning to the Quality Control Section. Each city has a branch of ESSAP and these branches constantly share information with the relevant WTPs. Each branch acts as an independent body and is responsible for meter reading, sending of bills, customer service and maintenance of the distribution network. In short, the organizational structure and command chain are clearly defined at the headquarters, branches and WTPs.



Water quality exam at the Asunción Metropolitan Area Quality Control Section

At the time of ex-post evaluation, the most important issue was the manpower shortage of each organization. According to the Operation Section of the Regional Department of the ESSAP Headquarters, maintenance support for WTPs in 22 cities nationwide is provided by 11 engineers/technicians. This means that breakdown maintenance is all they can cope with even though they would like to implement a plan and monitoring with more emphasis on preventive maintenance. The reality is that they are too busy with corrective maintenance; thus, the maintenance priority is given to those WTPs with more urgent problems. The support system of the ESSAP Headquarters for WTPs in local cities is not totally satisfactory as only two vehicles are assigned to this support in addition to a shortage of manpower. The planned minimum manpower strength for the operation and maintenance of each WTP under the Project was 21, consisting of the plant head (1), deputy plant head (1), 18 operators (two shifts per day with 12 hours/shift; 6 teams with 3 operators each) and one for the water quality management office. At the time of ex-post evaluation, the Concepcion WTP has three vacancies (two operators and one for the water quality management office) while the Pilar WTP has four vacancies (three operators and one for the water quality management office). Because of the absence of an intra-net covering the entire ESSAP, communication between the Headquarters and branches basically relies on personal mobile phones or the internal delivery service for paper documents, etc.

### 3.5.2 Technical Aspects of Operation and Maintenance

At the time of ex-post evaluation, high school is the highest educational background for most workers at the Concepcion WTP (there is one operator who is a qualified electrician and one clerk who is a university graduate). Similarly, at the Pilar WTP, there is one university graduate which is the plant manager, one qualified electrician, one qualified electromechanical worker and one qualified electronics worker. While the ESSAP Headquarters has many engineers and technicians with much front line experience at various WTPs, their knowledge and know-how are not fully

utilized to serve the entire ESSAP operation. ESSAP lacks an established human resources development system and that OJT is the only practical means of training.<sup>24</sup> The insufficient professional knowledge and know-how of the younger generation of employees and lack of a human resources development system are cited as matters of the strongest concern on the part of the ESSAP Headquarters and WTP management alike.

As the soft component of the Project, training was provided for 58 operators and other staff members of ESSAP. However, the change of the government in 2014 led to a major replacement of personnel throughout ESSAP for political reasons and a total of 38 staff members were forced to leave their jobs. As most of the remaining staff members are due to retire in two to three years' time, it is clear that the experience and know-how accumulated up to the present is likely to be lost in the near future. Those people who received training under the Project and who are still working at a WTP (present heads and team leaders at WTPs) are making a conscious effort to train young staff members by means of OJT. Many of these former trainees have expressed the common opinion that "we learned through the training of the importance of conducting operation and maintenance work based on a scientific understanding of the water treatment process and, therefore, we can teach the operation and maintenance procedure through OJT. However, our lack of professional knowledge to teach fundamental theories (for example, why it is necessary to adjust the quantity of chemicals to be injected) means a need for continuous training by an expert." In the case of the WTPs constructed under the Project, in addition to the fact that it is only a few



Pilar Water Treatment Plant:  
Inspecting the water intake  
pump

years since they started operations, the head of the Concepcion WTP and deputy head of the Pilar WTP are former trainees of the Project and have been supervising WTP operation and maintenance based on a manual which clearly explains the necessary operation and maintenance procedure for very easy understanding. Nevertheless, it cannot be said that "adequate operation and maintenance work is conducted in response to changes of the quality of raw water and quantity of intake based on a full understanding of the water treatment theory", causing

concern in regard to the sustainability of the technical aspects of operation and maintenance.

In regard to the issue of water quality management, the position of water quality manager is currently vacant at both WTPs. However, the technical expertise of the Asunción Metropolitan Area Quality Control Section of ESSAP is sufficient and its staff members conduct equipment inspection and calibration and OJT for operators when they visit a WTP. It is said that the stock

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<sup>24</sup> At the time of ex-post evaluation, a training session featuring "safety control: fire extinguishers", "safety control: urgent measures to be taken by staff at the time of an accident, etc." and "planning" is organized every two years and targets those working at the Headquarters and WTPs.

level of chemicals, equipment, etc. at this section is sufficient to conduct nationwide water quality management, including the WTPs in Concepcion and Pilar.

In summary, while the technical aspects concerning water quality management are satisfactory, improvement of some aspects of the operation and maintenance of the WTPs constructed under the Project is necessary because of (i) the departure of most of the operators trained under the soft component and (ii) lack of a comprehensive human resources development program for operation and maintenance on the part of ESSAP.

### **3.5.3 Financial Aspects of Operation and Maintenance**

As was the case at the time of planning, the entire operation and maintenance cost is controlled by ESSAP Headquarters. Neither a local branch nor a WTP has its own budget implementation plan and is only given a small amount of cash. As such, these bodies conduct routine maintenance work using their budget, materials, etc. allocated each year. The Headquarters has total budgetary authority for the expansion or improvement of facilities. A local branch only conducts meter readings and checking of the reading records and the collection and management of the water charge are conducted by the Finance Department of the Headquarters. Accordingly, the financial situation of operation and maintenance in the two target cities of the Project relies on the financial situation of ESSAP as a whole. Since 2009,<sup>25</sup> ESSAP has maintained a relatively healthy financial situation. The profit and loss statements up to 2015 which were obtained by the evaluator show that the profit of the term after income tax deduction (Gs 1,587,632,950) for 2015 is Gs 55,835,491,170, illustrating stable business which is in the black.

The assumed maintenance cost (for 2019) at the time of planning was Gs 1,069 million/year for the Concepcion WTP and Gs 713 million/year for the Pilar WTP. While it was difficult to obtain data on the actual maintenance cost, the interview survey with the heads and operators of the WTPs found that there has been no shortage of the necessary oil, lime and liquid chemicals, etc. for routine maintenance because of advanced application for their supply. The revenue from the water supply service in both cities showed an increasing trend from 2013 to 2015. Even though the expenditure also increased, the overall balance was in the black.

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<sup>25</sup> The responsibility for the improvement and operation of water supply facilities in Paraguay was transferred from the former Sanitation Enterprise Corporation (CORPOSANA) to ESSAP in 2003. ESSAP pays most of the revenue (some 80% in 2008) to the government as facility usage fees and its account has been in the red since the beginning. In 2008, the Ministry of Finance decided to waive these fees to reduce the financial burden on ESSAP. Following this decision, the business operation which had been in the red went into the black in 2009. The commissioning of the large-scale Asunción No. 3 WTP in 2012 quickly increased the water production volume, number of users and revenue from the water supply service, widening the account surplus. (Source: Preparatory Study for the Project for Improvement of the Water Supply System in Coronel Oviedo, 2014).



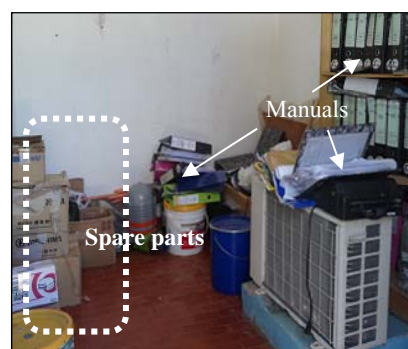
Table 6 Profit and Loss Statement of ESSAP (2013-2015)

(Unit: million Gs)

	2013	2014	2015
<b>Revenue</b>			
Water supply service	226,197	243,312	254,657
Sewerage service	49,527	53,876	56,058
Sub-total	275,724	297,188	310,715
<b>Expenditure</b>			
Administration cost	84,508	76,193	89,069
Water supply network maintenance	32,574	25,683	31,670
Operating cost	12,123	19,109	24,191
Water supply service	34,812	63,869	57,339
Sewerage service	42,550	46,246	51,023
Sub-total	206,567	231,100	253,292
<b>Profit/loss before income tax</b>	<b>69,160</b>	<b>65,087</b>	<b>57,423</b>

Source: ESSAP Annual Report (2015)

In summary, the ESSAP Headquarters has maintained its business in the black and no major problems can be foreseen regarding the financial aspects of operation and maintenance. Although the budget allocated to each WTP has been the minimum amount necessary, the budget allocation for a stable operation and maintenance has been sufficient, indicating no problems in the financial aspect in general.



Pilar Water Treatment Plant:

### 3.5.4 Current Status of Operation and Maintenance

The status of operation and maintenance and usage of the facilities at the time of ex-post evaluation are generally good as described in Table 7.

Table 7 Status of Operation and Maintenance at Each WTP

[Concepcion WTP]	
<p>Rapid Filtration Tank</p>	<ul style="list-style-type: none"> <li>• Status of operation and maintenance: Generally good</li> <li>• Reinforcement of the control bridge of the intake facilities: The handrails and stage planks of the control bridge are not reinforced. An urgent response is required in view of an accident where an operator slipped on the bridge and broke a bone.</li> <li>• Lack of safety control: The WTP can be freely accessed by anyone as no guards are posted at the entrance.</li> </ul>

[Pilar WTP]



- Status of operation and maintenance: Generally good
- Problem with the intake: Because the gate at the intake<sup>26</sup> has worn out and it is not fulfilling its role anymore, small fish and sand are sucked into the intake pump. Despite the standard service life of 12-15 years with proper maintenance, the bearings have required replacement three times in four years, causing a much high maintenance work volume compared to that originally required.

- Repair of the flow meter at the rapid filtration tank: The flow meter of the rapid filtration tank is out of order due to a lightning strike and the coordination of its repair with the ESSAP Headquarters is necessary.
- Repair of access road to the WTP: Part of the road from the site entrance to the WTP property has been damaged by flooding of the river and has not been repaired, making it difficult to access the WTP in the rainy season.

The field survey at the WTPs found the following two minor issues requiring improvement.

- (1) The spare parts provided under the Project are randomly stacked in the warehouse and inventory control is inaccurate. The lack of a proper warehouse management system results in inefficiency, including the loss of a key to the warehouse when required and time-consuming search for required parts. This situation requires improvement by proper sorting and setting in order along with digitalization of the inventory and data management. Safety precautions (use of helmets, etc.) are not properly implemented.
- (2) One part (diaphragm) of the adjusting valve of the lime injection system is extremely worn. As a similar part which can be procured in the domestic market is of low quality, its quick procurement by either contacting the supplier or the consultant which supervised the work or considering the upgrading of the maintenance work, including the frequency of maintenance, is necessary. Lime produced in Paraguay is hard and frequently clogs the injection pipe, making it necessary to consider and implement pipe cleaning work more frequently than recommended in the manual. Because of the possibility that the current lime injection volume is more than necessary, consultation with the Quality Control Section may well be required.

At the time of defect inspection, two recommendations were made to the two WTPs: (1) staff members of both WTPs should exchange opinions and renew the maintenance manual in order to continue the good operation and maintenance situation and (2) each ESSAP branch should establish a stable operation system which does not rely on the Headquarters for the continual

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<sup>26</sup> According to interviews to the consultant and ESSAP, regarding Pilar WTP's water intake gate, the problem had already been pointed out at the moment of the Preparatory Study. However, because it would surpass the budget, it was not included in the Project, and ESSAP would fix the problem separately when the budget could be secured.

adequate operation and maintenance of the WTP facilities. More detailed recommendations for the Concepcion WTP include an increase of the manpower, storage and control of spare parts at the WTP, control of the cleaning frequency of the flocculator and sedimentation tank, etc. on the authority of the head of the WTP rather than the ESSAP Headquarters and the appointment of a person responsible for quality control at the WTP. While those recommendations relating to infrastructure have been implemented, the positions of some operators and quality control officer are still vacant. No fundamental reforms, including the exchange of opinions between the personnel of the WTPs and improvement of the dependency of ESSAP branches and WTPs on the Headquarters, have been implemented by the time of the ex-post evaluation.

From the above, some minor problems are observed in terms of the institutional and technical aspects and, therefore, the sustainability of the project effects is fair.

## **4 Conclusion, Recommendations and Lessons Learned**

### **4.1 Conclusion**

The Project was implemented for the purpose of improving the quality of waterworks, increasing the water supply volume and improving access to safe water for residents of the cities of Concepcion and Pilar in Paraguay by means of rehabilitating the water intake facilities and constructing water treatment plants in these two cities, thereby contributing to improvement of the living environment and reduction of the morbidity of water-borne diseases. The Project is highly consistent with Paraguay's national development policies as well as Paraguay's development needs and Japan's ODA policies. Although the project period was within the planned period, the project cost exceeded the planned cost due to an increase of the Paraguay portion of the project cost. Therefore, the efficiency of the Project is fair. The construction of new intake and water treatment facilities in both cities led to an increased water production volume and water distribution volume, boosting the size of the population served by the water supply service together with an expanded service area of the ESSAP in both cities. In Pilar, however, the target water production volume could not be reached as water demand did not increase as expected. This was because some large consumers withdrew their investments, and new ones could not be attracted due to the delay in the urban development plan which existed already at the time of the Preparatory Study. Meanwhile, the water quality targets (turbidity and color) were achieved at both water treatment plants. In both cities, the immediate use of tap water for drinking became easier due to improvement of the water quality and establishment of a stable water supply without water cuts which has reduced the water-related cost, contributing to improvement of the living environment. Meanwhile, no significant change can be observed regarding the frequency of water-borne diseases because the project areas experienced only a relatively low morbidity of

water-borne diseases to start with. The overall picture is that the Project did produce the planned effects and its effectiveness and impact are high. Regarding operation and maintenance, the decision-making process and authority are concentrated at the ESSAP Headquarters and the support system of the Headquarters to individual water treatment plants is not completely satisfactory. The facts that most of the people who received training under the technical assistance (hereinafter referred to as ‘soft component’) of this Project have now left ESSAP and that ESSAP does not have a firmly established human resources development program cause concern regarding the technical aspects of operation and maintenance. There are no issues regarding the financial aspect of the operation and maintenance. Therefore, the sustainability of the effects that were brought about by the Project is fair.

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

## **4.2 Recommendations**

### **4.2.1 Recommendations for the Executing Agency (MOPC)**

- While the contents (theory and practice) of the training organized as the soft component of the Project were highly appraised, the number of staff members who participated in this training and who still work for ESSAP at the time of ex-post evaluation is quite limited. Although these staff members lead the OJT for newly recruited young employees, many of them are due to retire in two or three years’ time, making the proper inheritance of their skills and know-how within ESSAP an urgent matter. Because ESSAP does not have an established human resources development program, it is essential for ESSAP to assess the training requirements, and to introduce a training program which targets WTP operators in local cities throughout Paraguay taking as a reference the contents of the training conducted under the soft component, while seeking external assistance. The training of in-house trainers is also necessary with a view to ensuring the sustainability of the new human resources development program.
- Even though the situation slightly differs from one WTP to another, the management of documents, reference materials and spare parts at WTPs are generally insufficient, meaning that it is difficult to quickly find what is required when it is required. Both the Concepcion and Pilar WTPs must establish the custom of cleaning and sorting out. The Concepcion WTP is making gradual progress in this regard by employing a clerk. It is essential that this work continue while thoroughly enforcing the custom of cleaning and sorting out in the routine work of all staff members. At the Pilar WTP, only the head of the WTP is in possession of a warehouse key and this practice is very inefficient. The warehouse even stores documents describing the maintenance schedule, composition of operation and maintenance teams, work schedule and responsible work of each staff member, all of which are required for daily work.

These documents which should be routinely consulted must be moved to the control room in which the operators work to ensure their proper use.

- At the Concepcion WTP, no guards are posted at the entrance of the WTP premises, allowing anyone free access to the WTP. The establishment of a controlled WTP access system is desirable to guarantee the proper operation of the WTP and supply of safe water for residents. In the case of the Pilar WTP, part of the access road from the entrance to the WTP proper becomes difficult to use, especially during the rainy season, as described in Table 7. The urgent repair of this section is desirable from the viewpoint of managing labour safety.
- Regarding the water intake gate for the Pilar WTP, as it is described in Table 7, it has worn out and it is not fulfilling its role anymore. This has resulted in heavy abrasion of the intake pump bearings, necessitating the replacement of the bearings more frequently than assumed. The urgent construction of this gate is desirable.
- Because the ex-post evaluation was conducted only a short time after the opening of the subject WTPs, both WTPs have not experienced any serious operation or maintenance issue. However, the concentration of the decision-making authority for many minor issues at the ESSAP Headquarters suggests a rather inefficient system in general. In the medium to long-term, the authority to determine the replacement frequency of spare parts, to procure spare parts, chemicals, etc. for water quality inspection and to arrange one's own budget should be given to the WTPs as a step towards more efficient operation and maintenance. At the same time, enhancement of the technical competence of the staff members of the WTPs and strengthening of the operation and maintenance system at the municipal level are desirable to secure the sustainability of the Project.

#### **4.2.2 Recommendations to JICA**

- It is hoped that JICA will examine the feasibility of introducing the dispatch of experts, third country training and other schemes so that ESSAP can establish and implement its own human resources development program.

#### **4.3 Lessons Learned**

Examination of a technology transfer method when the substantial replacement of personnel can be expected to take place at the time of a government change

A change of the government took place immediately after the completion of the Project, resulting in a sweeping change of the personnel of both the MOPC which is the executing agency for the Project and ESSAP which is responsible for the operation and maintenance of the project-related facilities. This meant that many of the people who underwent training to master essential

skills and know-how under the soft component of the Project were forced to leave their positions. The resulting lack of the inheritance of skills and know-how may well damage the sustainability of the Project in the medium to long-term. When a similar project is to be implemented in a country where a similar situation is likely to occur, it is desirable to consider the implementation of a separate training project targeting not only the staff members of the project-related WTP but also those of other WTPs as well as staff members of the sections in the headquarters who manage and provide technical assistance to WTPs nationwide, so that technical skills are accumulated as institutional capacity in the entity even if a major change of the personnel occurs.

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