

Peru

Lima-Callao Water Supply and Sewerage Systems Development Project

External Evaluator: Hajime Sonoda
(Global Group 21 Japan)
Field Survey: March 2009

1. Project Profile and Japan's ODA Loan



Map of the Project Area



Water distribution pump
(Rimac District, Lima)

1.1 Background

The water supply and sewerage services in most parts of the Lima-Callao Metropolitan Area (population of some seven million in 1995) are provided by *Servicio de Agua Potable y Alcantarillado de Lima* (Lima Water and Sewerage Service Company, SEDAPAL). As of 1996, the coverage ratio of 74% for the water supply service and 72% for the sewerage service was relatively high. In regard to the water supply service, however, the unaccounted-for water ratio was as high as 47% because of leakage due to the aging of the facilities and virtual absence of water charge collection based on meter readings, resulting in a serious water shortage particularly in the emerging districts where the population was rapidly growing. In case of the sewerage service, the aging facilities, contamination of drinking water and groundwater as well as overflow of sewage onto the streets worsened the sanitation conditions while untreated sewage was discharged to rivers and the sea, causing serious pollution to the water systems. As in the case of the water supply service, the emerging districts lacked sufficient sewerage facilities.

To solve these problems, the Lima-Callao Water Supply and Sewerage Systems Development Project was implemented in the period from 1996 to 2004 as a co-financing project with the World Bank for such purposes as the efficient utilisation of limited water resources, reduction of the pollution caused by sewage and expansion of the service area in emerging districts.

1.2 Objective

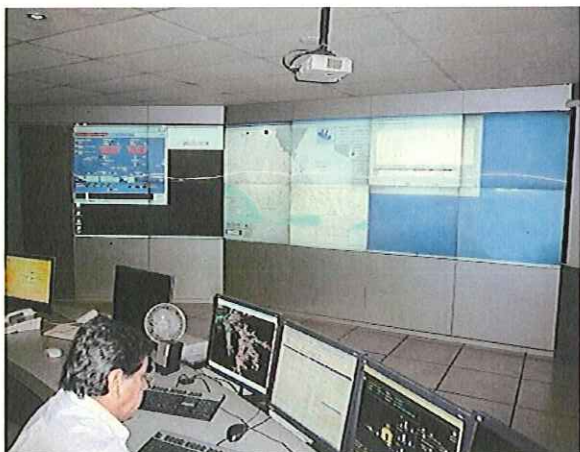
To improve the water supply and sewerage services of Lima-Callao Metropolitan Area by (i) (in regards to the water supply system) realizing the efficient use of water resources through the rehabilitation of deteriorated primary and secondary networks, installing water meters, and reinforcement and installation of water mains, (ii) (in regards to the sewerage system) rehabilitating the deteriorated sewerage network, and (iii) expanding the water supply and sewerage services to emerging districts, thereby contributing to improvement of the sanitation conditions.

According to the findings of the customer survey conducted annually by SEDAPAL to 3,000 households in the Metropolitan Area, the ratio of customers who are satisfied with the water supply service increased from 30% in 1998 to 62% in 2007, clearly indicating improvement of the service.

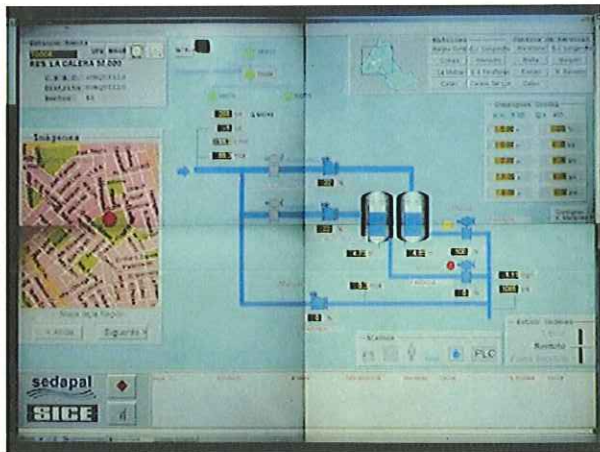
According to a water users survey conducted to 120 households targeted under the JICA Loan, half of these households are aware of improvement in terms of the supply hours, water pressure and water quality compared to 10 years ago and more than 90% are satisfied with the current supply hours, water pressure, water quality and water supply service in general. Almost all of the households replied that they conserve water use compared to 10 years ago and the main reason for this for some 25% of these households was to keep their water bill low. Approximately 20% of households replied that the current level of the water charge is too high⁴.

(4) Service Expansion in Emerging Districts

Under the Project, the water supply service was expanded in emerging districts and 200,000 mostly low income households were newly connected to the water supply service. While this work was conducted under the World Bank portion, the leakage reduction and optimization of the water distribution under the JICA Loan portion indirectly contributed to the service expansion through an increase of the available water volume.



Remote control room at SEDAPAL's main office



Example of panel display for SCADA



Emerging District (Villa El Salvador)



City center (San Isidro)

⁴ According to the survey it is estimated that the average expense for water is some 4 % of household income.

The water users survey conducted to some 40 households in emerging districts where the residents mostly belong to the low income group found that 80% of local residents recognize that the water supply hours, water pressure and water quality have improved compared to 10 years ago and nearly 90% are satisfied with the general water supply service. However, because of the high elevation of some of these areas, the proportion of households receiving water supply for 24 hours a day during the drought season is still low at some 60%. 30% of the households replied that they can only receive water supply for up to 12 hours a day during the drought season. More than half of the households expressed their dissatisfaction with the frequent water supply cuts without advance notice.

2.3.2 Sewerage

According to the data between 2002 and 2007 from 2 districts covered in the JICA loan portion, positive effects were seen such as a reduction of the number of complaints regarding bad odour and sewerage blockage, and a reduction of the number of sewer repair works. The rise in sewerage service coverage rate by 15% between 1995 and 2008 is assumed to be a result of this project.

The water users survey found that half of the households in the 7 target districts of the JICA loan portion believe that contamination and bad odour from sewerage has decreased. 75% replied that sewage blockage has decreased in the last 10 years and 62% replied that the sewerage service has improved in the same period. 73% replied that they have not found any special problem with the current sewerage service, and 79% expressed their satisfaction with the service.

In areas where the sewerage network was rehabilitated under the Project, the sewerage service has improved. From the above analysis, it can be judged that the project objective for the sewerage service was mostly achieved. Meanwhile, while the sewerage service coverage rate in the Lima-Callao Metropolitan Area exceeded 90% in 2008, the sewage treatment rate of some 15% remains low.⁵

Table 4 Indicators for the Sewerage Sector

	Before the Project	After the Project
Number of Complaints (2 Districts under the JICA Loan Portion)	1,174 (2002)	821 (2007)
Number of Sewer Repairs (2 Districts under the JICA Loan Portion)	128 (2002)	55 (2007)
Sewerage Service Coverage Rate	75% (1995)	90.4% (2008)
Sewage Treatment Rate	1.3% *(1996)	14.6% (2008)

Source: SEDAPAL

*An estimated value from amount of water production and amount of sewage treatment

2.3.3 Financial Analysis

At the time of appraisal, financial analysis was conducted for the water supply part of the Project and the financial internal rate of return (FIRR) was estimated to be 11.6%. Recalculation using the same technique indicates a FIRR of 19.5% at the time of ex-post evaluation. The main reason for this increase in the FIRR is assumed to be the increase in the water charge.⁶ The preconditions for the financial analysis are listed below. Economic internal rate of return (EIRR) was not calculated at

⁵ SEDAPAL has completed the construction of the San Bartolo Waste Water Treatment Plan (treatment capacity: 0.8 m³/sec) under the Lima South Sewerage Development Project, a JICA loan project. It plans to commence the work to construct a new waste water treatment plant (treatment capacity: 14 m³/sec) in 2009 using private funding

⁶ The average water charge was US\$ 0.31/m³ at the time of appraisal and was assumed to increase in stages to US\$ 0.37/m³ by 1997. However, the reality is that the water charge in 2007 stood at US\$ 0.60/m³.

appraisal. Recalculation at ex-post evaluation was not done as the data could not be fully obtained within the scope of the ex-post evaluation study.

- Cost : Investment and cost for consulting service by the Project
Increase of the operation and maintenance expenses
- Benefit : Increased revenue from the water charge
Decrease of the operation and maintenance expenses
- Project life : 30 years

2.4 Impacts

2.4.1 Improvement of Sanitary Conditions

According to the water users survey, 58% of households in the seven target districts replied that the state of sanitation at home has improved compared to 10 years ago, primarily because of the improved access to water. Water quality monitoring conducted by SEDAPAL found that almost all samples taken from the water distribution pipes in the 7 districts under the JICA loan met the water standards, confirming the adequacy of the quality of the water supplied. Moreover, the level of bad odour and cases of sewer blockage decreased in the 7 target districts as mentioned earlier, suggesting a real improvement of the environmental sanitation in urban areas.

According to the data provided by the Ministry of Health shown in Table 5, there has been a decline in the number of incidents of diarrhoea and dysentery in the 7 target districts. As the incidence rate of diarrhoea and dysentery generally fluctuates according to the accessibility to clean water and such hygiene customs as washing hands before meals, it may well be the case that the positive effect of the Project in this regard is being reinforced by the influence of these other factors. The Ministry of Health has been implementing a nationwide campaign to encourage frequent hand washing to prevent diarrhoea. There has not been an outbreak of cholera in Peru since the late 1990's.

Table 5 Historical Changes of the Incidence Rate of Diarrhoea (in the seven districts)

	2005	2006	2007	2008
Diarrhoea	41,499	43,449	38,639	31,892
Dysentery	2,346	1,603	1,269	836

Source : Ministry of Health

2.4.2 Improvement of the Living Environment of the Low-income Population

In the emerging districts covered under the World Bank portion, the water supply and sewerage services have improved in the following manner compared to 10 years ago, resulting in improvement of the living environment of the low-income population.

- 80% of residents replied that the water supply hours, water pressure and water quality have improved. In the past, 20% of residents required 1 - 2 hours a day to fetch water but hardly anyone is required to do so today. During the dry season, however, water supply is only available for 12 hours a day for 30% of the households in these towns. 60% of residents express their dissatisfaction with the sudden cuts in water supply that occur without prior notice. For this reason, two-thirds of households store water at home.
- 90% of residents replied that the state of sanitation at home has improved, primarily because of the improved access to water. 70% of residents also replied that improvement of the sewerage system has improved the level of sanitation in the neighbourhood.

2.4.3 Other Impacts on the Environment

As anticipated at the time of appraisal, the installation of new water mains has led to less pumping of groundwater in some areas, resulting in the recovery of the groundwater level at some pumping wells (see 2.3.1-(2) Improvement of the Distribution Efficiency).

The rehabilitation of the sewerage system was expected to reduce the contamination of groundwater by sewage. Even though the groundwater at most of the pumping wells now meets the water quality standards, the existence of pumping wells where the groundwater fails to meet the water quality standard for nitrate nitrogen or nitrous nitrogen, suggests possible contamination of groundwater by sewage. As mentioned in 2.3.2 Sewerage, the sewerage treatment rate remains low at 14.6%, which is an issue to be tackled. Because of limited data, a comparison cannot be made between the level of contamination prior to and after the project.

The increased water consumption as a result of the Project has led to an increased discharge of sewage. It is inferred that the volume of sewage has increased by 1.4 m³/sec compared to the 1995 level. At the same time though, the increase of the sewage treatment capacity during the same period is larger, therefore the overall discharge volume of untreated sewage has been reduced. The construction of the new Daboada sewage treatment plant with a capacity of 14 m³/sec is due to commence in 2009. When this plant is completed, the sewage treatment ratio will improve to more than 80%, substantially reducing the negative effects to the environment.

2.5 Sustainability (Rating: a)

No major problem has been observed in the capacity of the executing agency nor its operation and maintenance system, therefore sustainability of the project is high.

(1) Institutional Aspects

At the time of appraisal, it was planned to transfer the operation department of SEDAPAL to a private company. However, this plan was cancelled by the new administration after 1995. Instead, SEDAPAL has been implementing a series of reforms, including improvement of the human resource policies⁷, introduction of an operation and financial management system, formulation of a short-term plan and long-term strategy and concession of some of the maintenance work and meter reading work. Furthermore, SEDAPAL has an annual management agreement with the Ministry of Housing, Construction and Sanitation with a view to achieving the agreed annual performance targets regarding quality, operation and finance.⁸ The positive effects of these efforts include the improved service mentioned earlier as well as improved labour productivity⁹ and an improved financial performance.

SEDAPAL assesses the performance level of its external contractors in the range of fair to excellent. From its experience over the years, it is judged that SEDAPAL is capable of selecting external contractors with adequate ability.

⁷ Simplification and levelling of the pyramidal organizational structure, introduction of the principle of competition to the salary system and strengthening of the training system for better quality of service and productivity.

⁸ The actual performance is evaluated every year and the bonuses for staff members partly reflect the evaluation results. In 2008, for example, most of the targets were achieved.

⁹ As a result of conscious efforts to suppress an increase of the staff compared to the increase of the number of customers (connections), the number of permanent employees per 1,000 connections decreased from 2.49 in 1994 to 1.77 in 2008.

Based on the above analysis, it is judged that SEDAPAL has a well-established organizational structure and sufficient capacity to sustain the effects of the project.

(2) Technical Aspects

SEDAPAL employs some 2,200 people, almost all of which undergo training every year. The average annual training hours per person are 32 hours or as many as 66 hours for those in managerial positions.

SEDAPAL acquired ISO-certified status regarding quality management and environmental management in 2002 and 2003 respectively. It has also received a number of awards, including Peruvian Company of the Year 1999 and Best Water and Sewerage Management 1998.

In view of the well-established training system, ISO-certified status, series of awards and good operation records, SEDAPAL is believed to have sufficient technical capacity.

(3) Financial Aspects

Since 2004, SEDAPAL has been able to steadily increase its annual turnover and operating profit based on the increase of the water charge, reduction of the unaccounted-for water supply and improvement of the operational efficiency. With the approval of the regulatory body (SUNASS), a system is in place to raise the water charge in accordance with SEDAPAL's water production cost and financial performance. SEDAPAL's operational efficiency as reflected in its working ratio (annual cost/annual turnover) shows a trend of annual improvement, and such indicators as the Current Ratio (current assets/current liabilities) and the Debt Ratio (liabilities/capital) are within an acceptable range. Expenses for facility maintenance and repair have increased in line with the annual turnover, indicating adequate funding practices. Based on these analysis results, it is judged that there are no special problems regarding the financial sustainability of SEDAPAL.

Table 6 Financial Performance of SEDAPAL

(Unit: million sol)

	2004	2005	2006	2007	2008
Turnover	624.0	660.8	748.1	827.4	959.1
Operating Profit	53.7	56.0	110.0	177.7	204.5
Net Profit	96.9	9.0	93.2	125.8	4.1
Maintenance & Repair Expenses		52.6	54.0	66.5	82.0

Source : SEDAPAL

Table 7 Financial Performance Indicators for SEDAPAL

	2004	2005	2006	2007	2008
Working Ratio	62%	61%	55%	52%	44%
Current Ratio	64%	46%	91%	87%	98%
Debt Ratio	51%	50%	45%	46%	50%

Source : SEDAPAL

(4) Current Status of Operation and Maintenance

The head office of SEDAPAL is responsible for the operation and maintenance of the water mains and distribution pipes (up to the entry point of each section) while some repair work is entrusted to external contractors. Cleaning and repair of primary sewers is conducted by external contractors while the terminal distribution pipes and sewers are operated and maintained by the maintenance department of each of the seven service centers. Connection to new users and pipeline

maintenance and repair work are entrusted to external contractors. The control room at the head office remotely controls water production, transmission and distribution through the SCADA system. This system almost entirely covers the project area while in those areas which are not covered by the SCADA system, operators are deployed in each area to manually operate the pumps and valves.

The field survey findings and a report of SEDAPAL indicate that all of the new facilities constructed/installed under the Project, including those under the JICA loan portion, are working favourably and no major maintenance problems have been encountered.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

Although the implementation of the Project was delayed by approximately two years, the Project has resulted in a substantial improvement of the water supply service in the Lima-Callao Metropolitan Area due to the reduction of leakage through the rehabilitation of the water supply network, suppression of water consumption through the installation of water meters, efficient use of water through sectorization and other measures. Meanwhile, the rehabilitation of the sewerage network is believed to have contributed to the improvement of environmental sanitation. In the emerging districts, expansion of the sewerage system has contributed to improving the living environment of the low income population. SEDAPAL has the capacity to operate and maintain the Project in an appropriate manner and financial sustainability is feasible with the setting of an adequate water charge.

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

3.2 Lessons Learned

When a more effective approach to maximize a project's effectiveness is found, it should be well examined and incorporated into the project design even after the commencement of the project.

In the Lima-Callao Water Supply and Sewerage Systems Development Project, rehabilitation of the water supply and sewerage systems was planned without sectorization, and the sectorization and SCADA system was implemented after project commencement. Despite the fact that the number of connections in the metropolitan area increasing by 50%, the average water supply hours increased to 21.5 hours a day and better satisfaction of water users was achieved even though the total length of the rehabilitated pipelines nor the reduced amount of leakage achieved the original targets, and the volume of water production did not increase (due to a delay in construction of water plants that was out of the Project's scope). These achievements can be attributed to the implementation of the approach that was introduced after the commencement of the Project, the sectorization and SCADA.

3.3 Recommendations

- Although the unaccounted-for water ratio of SEDAPAL has improved, it is still high at 37%. A further reduction of this rate is urgently required in view of the future increase of the water demand, scarcity of water sources of Lima-Callao Metropolitan Area, as well as further improvement of financial performance of SEDAPAL. While leakage was reduced in 12 districts under the Project, there are still areas with a high water leakage rate in the Lima-Callao Metropolitan Area. SEDAPAL's continuation of rehabilitation work similar to that employed under the Project, putting priority in those areas with a high water leakage rate, is essential.
- SEDAPAL should complete the planned construction work for the Taboada waste water treatment plant as soon as possible in order to reduce environmental pollution to the surrounding water system.

Comparison Between the Original Plan and Actual Results

Item	Original	Actual
1. Outputs	<p>< Rehabilitation of Water Supply System ></p> <ul style="list-style-type: none"> • JICA Loan Portion (7 Districts) <ul style="list-style-type: none"> - Rehabilitation of water distribution mains ... 392 km - Replacement of gate vales ... 652 - Installation of fire hydrants ... 791 - Replacement house connections ... 72,276 • World Bank Portion (5 Districts) <ul style="list-style-type: none"> - Rehabilitation of water transmission lines and reservoirs; procurement of maintenance equipment <p>< Rehabilitation of Sewerage System ></p> <ul style="list-style-type: none"> • JICA Loan Portion (7 Districts) <ul style="list-style-type: none"> - Replacement of concrete sewers ... 417 km - Replacement of house connections ... 83,291 - Replacement of manholes ... 8,331 • World Bank Portion (5 Districts) <ul style="list-style-type: none"> - Rehabilitation of primary sewers, secondary sewers and household service pipes; procurement of maintenance equipment <p>< Rehabilitation of Pumping Wells ></p> <ul style="list-style-type: none"> • World Bank ... 85 <p>< Installation of Water Meters ></p> <ul style="list-style-type: none"> • World Bank ... 406,000 <p>< Extension of Water Transmission Lines ></p> <ul style="list-style-type: none"> • JICA and World Bank ... 73 km <p>< System Expansion in Emerging Districts > World Bank</p> <ul style="list-style-type: none"> - Laying of new water transmission lines and water mains ... 89 km - Laying of new sewers ... 33 km - New connections ... 302,000 households <p>< Consulting Service (JICA; World Bank) ></p> <ul style="list-style-type: none"> - Detailed design; work supervision; management service; related surveys 	<p>< Rehabilitation of Water Supply System ></p> <ul style="list-style-type: none"> • JICA Loan Portion (7 Districts) <ul style="list-style-type: none"> - Rehabilitation of water distribution mains ... 270 km - Replacement of gate vales ... 814 - Installation of fire hydrants ... 791 - Replacement of house connections ... 12,974 • World Bank Portion (5 Districts) <ul style="list-style-type: none"> - Rehabilitation of water transmission lines and reservoirs; procurement of maintenance equipment <p>< Rehabilitation of Sewerage System ></p> <ul style="list-style-type: none"> • JICA Loan Portion (7 Districts) <ul style="list-style-type: none"> - Replacement of concrete sewers ... 165 km - Replacement of house connections ... 9,890 - Replacement of manholes ... 3,105 • World Bank Portion (5 Districts) <ul style="list-style-type: none"> - Rehabilitation of primary sewers, secondary sewers and household service pipes; procurement of maintenance equipment <p>< Rehabilitation of Pumping Wells ></p> <ul style="list-style-type: none"> • World Bank ... 89 <p>< Installation of Water Meters ></p> <ul style="list-style-type: none"> • World Bank ... 427,000 <p>< Extension of Water Transmission Lines ></p> <ul style="list-style-type: none"> • JICA and World Bank ... 61 km <p>< System Expansion in Emerging Districts > World Bank</p> <ul style="list-style-type: none"> - Laying of new water transmission lines and water mains ... 64 km - Laying of new sewers ... 37 km - New connections ... 200,000 households <p>< Consulting Service (JICA; World Bank) ></p> <ul style="list-style-type: none"> - Detailed design; work supervision; management service; related surveys
2. Project Period	February, 1995 to November, 2001 (82 months)	March, 1996 to September, 2004 (103 months)
3. Project Cost JICA loan Portion World Bank Portion Total of which JICA Loan Exchange Rate	<p>¥11,236 million ¥21,087 million ¥32,323 million ¥8,427 million US\$ 1 = ¥103 (as of 1994)</p>	<p>¥11,321 million ¥22,254 million ¥33,575 million ¥8,415 million US\$ 1 = ¥121 (Based on the actual exchange rate at the time of each payment)</p>

1.3 Borrower/Executing Agency

Borrower: Government of the Republic of Peru

Executing Agency: *Servicio de Agua Potable y Alcantarillado de Lima* (Lima Water and Sewerage Service Company, SEDAPAL)

1.4 Outline of Loan Agreement

Approved Amount/Disbursed Amount	¥8,427 million/¥8,420 million
Exchange of Notes/Loan Agreement	July 1995/March 1996
Terms and Conditions	Interest Rate: 3.0% Repayment Period (Grace Period): 30 years (10 years) Procurement: General untied
Final Disbursement	August 2006
Main Contractors (contract amount of ¥1 billion or more)	10 companies, including Corefic and GYM S.A.)
Main Consultant (contract amount of ¥100 million or more)	Montgomery Watson; PYV; Safege Consulting
Feasibility Study (F/S)	1994

2. Evaluation Results (Rating: A)

2.1 Relevance (Rating: a)

This project has been highly relevant with the country's national policies and development needs at the times of both appraisal and ex-post evaluation, therefore its relevance is high.

2.1.1 Relevance at Appraisal

As described earlier, the water supply and sewerage facilities of SEDAPAL were severely deteriorated as of 1996 and the unaccounted-for water ratio was as high as 47%. This caused serious water shortage, worsening sanitation conditions and growing severity of water pollution in some urban areas. Improvement of these services was urgently required in the Lima-Callao Metropolitan Area which was experiencing rapid and continuous increase in population. Therefore, the Project was highly relevant at appraisal.

2.1.2 Relevance at the Time of Ex-Post Evaluation

Although the coverage ratio of the water supply and sewerage services in the urban areas of Peru grew during the period from 1994 to 2005, the overall levels are still relatively low compared to those of neighbouring countries. The current Garcia Administration has adopted a policy of "Agua para Todos" (Water for Everyone) which aims at providing access to safe water for all Peruvians by 2011 when its current term of office comes to an end, designating the water supply and sewerage sectors as one of the priority sectors for Peru's development.¹

In the Lima-Callao Metropolitan Area, while the coverage rates of the water supply and sewerage services exceed 90% with average daily water supply hours of 21.5 hours as of 2008, the unaccounted-for water ratio of 37% is still very high. Meanwhile, the water demand in 2015 is expected to exceed the present water supply level of 21.0m³/sec by some 30%, making it an urgent issue to secure new water sources and to reduce the unaccounted-for water supply ratio. The sewage treatment ratio of 14.6% (2008) is still low, falling far short of the national target of 100% by 2015. In short, as the water supply and sewerage services in the Metropolitan Area must tackle such important issues as the securing of new water sources, reduction of the unaccounted-for water and improvement of the

¹ The National Environmental Sanitation Plan 2006 - 2015 aims at improving the coverage rates of the water supply service and sewerage service in urban areas to 89% and 84% respectively by 2015.

sewage treatment ratio, it is judged that the Project is highly relevant for the situation in the project area at present.



Manhole for the underground water distribution valve chamber at a public park



Remotely controlled water distribution valve

2.2 Efficiency (Rating: b)

Although the project cost was mostly as planned, the project duration exceeded the original plan, therefore the efficiency of this project is fair.

2.2.1 Outputs

The JICA loan portion of the project covered rehabilitation of existing water supply and sewerage networks and extension of the existing water mains in seven districts of the Lima-Callao Metropolitan Area (Jesus Maria, Lince, La Victoria, San Isidro, Miraflores, Rimac and Callao). The World Bank portion covered the rehabilitation of existing water supply and sewerage networks in an additional five districts, rehabilitation of water mains, distribution reservoirs, wells, extension of the water mains a metering program in all districts and improvement of the water supply and sewerage networks in emerging districts. All of the 12 districts in which rehabilitation of the existing water supply and sewerage networks was conducted are central districts with medium or high income. Priority was given to these districts on the grounds that reduction of unaccounted-for water by means of rehabilitation will lead to improved profitability for SEDAPAL compared to similar work in other districts.

The detailed outputs of the Project are shown in Table 1. While the target districts and types of output were as originally planned, the quantity of actual achievement varied considerably. It appears that these discrepancies can be attributed to the following circumstances in addition to the fact that the outputs set at the time of appraisal were rough estimates.

<Rehabilitation of the Water Supply Network>

- After the conclusion of the loan agreement, the Sectorization Program was implemented based on the findings of a study assisted by the World Bank, and the rehabilitation of large diameter distribution pipes (not included in the original plan) was conducted.² Many of the relatively large

² The main purposes of the sectorization are, leveling of the distribution pressure, advancement of water distribution management and localisation of repair work or accident damage. The distribution sectors can basically be classified into three levels: large, medium and small. A large sector means a trunk system of which the main purpose is water conveyance. A medium sector means a mid-level water distribution network of which the main purpose is the control of water distribution. A small sector is set up to allow the

diameter water pipes required rehabilitation, pushing up the average unit cost of the rehabilitation work. Because of the limited budget size, the total length of the rehabilitated distribution pipes was shortened compared to the original plan. For the same reason, the number of replacements for gate valves increased compared to the original plan.

- Part of the work to replace household connection was conducted under the metering program by the World Bank portion, and as a result the number of household connections covered under the JICA loan decreased compared to the original plan.

Table 1 Project Outputs (Original and Actual)

	Original	Actual
< Rehabilitation of Water Supply System (System Rehabilitation) >		
• JICA Loan Portion		
- Rehabilitation of water distribution pipes: diameter of up to 10"	394 km	256 km
12 - 28"	0 km	14 km
- Replacement of gate valves	652	814
- Installation of fire hydrants	791	719
- Replacement of household connections	72,276	12,974
• World Bank Portion		
- Rehabilitation of water distribution pipes	226 km	191 km
- Rehabilitation of pumping wells	85	89
< Rehabilitation of Sewerage System (System Rehabilitation) >		
• JICA Loan Portion		
- Rehabilitation of sewage pipes Ø up to 12"	417 km	154 km
Ø 14 - 28"	0 km	11 km
- Replacement of household connections	83,291	9,890
- Replacement of manholes	8,331	3,105
• World Bank Portion		
- Rehabilitation of sewers	200 km	82 km
< Improvement of Efficiency of Water Resources Utilization (Water Conservation) >		
• Installation of water meters (World Bank Portion)	406,000	427,000
• Extension of water transmission pipes (JICA Loan Portion and World Bank Portion)	73 km	61 km
< System Expansion in Emerging Districts (World Bank Portion) >		
• Installation of new water supply pipes and water distribution pipes	89 km	64 km
• Installation of sewage pipes	33 km	37 km
• New house connections	300,000	200,000
< Consulting Services >		
• JICA Loan Portion: supervision of the work under the JICA loan portion		
• World Bank Portion: detailed design, supervision of the work under the World Bank Portion and related survey		

Source: SEDAPAL's response to external evaluator's questionnaire

localised stoppage of water supply or repair work. With the introduction of a SCADA (supervisory control and data acquisition) system which consists of many water sectors where water movement is controlled using valves and meters, it is possible to establish facilities and a management style which is capable of performing a water distribution operation function (water pressure adjustment) and management function (data acquisition, data processing and facility operation). It is planned that the water supply system in the Lima-Callao Metropolitan Area will ultimately consist of some 450 small sectors. As of January, 2009, 176 sectors have been constructed and the SCADA system is in operation for 101 sectors.

<Rehabilitation of Sewerage Network>

- The conditions of large diameter sewage pipes were much worse than expected. The subsequent decision to prioritize the rehabilitation of these large diameter sewage pipes under a limited budget led to a rise in the average unit cost of the rehabilitation work, thus reducing the overall length of the rehabilitated sewage pipes. As the rehabilitation of sewage pipes was given priority for the allocation of the limited budget, the number of replacements for household connection pipes was far fewer than planned.

<Service Expansion to Emerging Districts>

- In emerging districts, the actual number of households newly connected to the water supply system did not reach the plan because the National Housing Fund (FONAVI), which was planning to install secondary distribution pipes, was abolished and could not complete the necessary work.³

2.2.2 Project Cost

The total project cost combining the JICA loan portion and the World Bank portion was ¥33.58 billion which was equivalent to 104% of the estimated project cost at the time of appraisal (89% on a US dollar basis). In terms of the JICA loan portion, the project cost of ¥11.32 billion and loan amount of ¥8.42 billion were almost as planned. The project cost for improving efficiency in water resource utilization increased from the planned figure because of the introduction of the SCADA system. The consulting service cost also increased because of the additional cost of modifying the design as necessitated by new findings after the commencement of the work and also because of the cost of an additional survey for the sectorization program.

Table 2 Project Cost (Original and Actual)

Item	(Unit: ¥ million)	
	Original	Actual
Total Project Cost	32,323 (US\$ 306 million)	33,575 (US\$ 273 million)
Cost Breakdown by Component		
• System rehabilitation	15,898	16,682
• Water conservation	5,490	8,917
• Network expansion	4,011	3,052
• Consulting service	2,282	4,924
• Contingency for price escalation	4,643	-
Cost Breakdown by Portions		
• JICA Loan Portion	11,236	11,321
• World Bank Portion	21,087	22,254
Breakdown of Funding by Source		
• JICA Loan	8,427	8,415
• World Bank Loan	15,450	18,148
• Government of Peru	8,466	7,012

Source: Project Completion Report (SEDAPAL)

Foreign Exchange Rate: US\$ 1 = ¥103 (planned); US\$1 = ¥121 (actual)

³ The World Bank provided an additional loan which was not part of the Project to implement the planned laying of the secondary distribution pipes.

2.2.3 Project Period

The project was planned to start from February 1995 and end in November 2001 with a duration of 82 months, but in reality the project was started in March 1996 and ended in September 2004 with a duration of 103 months or 126% of the original plan.

At the time of appraisal, it was planned that the work under the JICA loan portion would commence in the middle of 1997, however the work only commenced in September 1999, more than two years later than planned. Reasons are that procurement procedure took longer than expected and the restrictions imposed by the Peruvian government on the amount of ODA and counterpart funds to be used in view of Peru's tight fiscal situation. In subsequent years, the process of obtaining permits, etc. from local authorities and complicated work involving the excavation of existing streets led to further delay. As a result, the Project was finally completed in September 2004, nearly three years later than the originally planned completion date.

2.3 Effectiveness (Rating: a)

This project has largely achieved its objectives, therefore its effectiveness is high.

2.3.1 Water Supply

Based on the findings described below, the purpose of the Project in the water supply sector, i.e. realization of the effective utilization of water resources (water conservation) to improve the water supply service, was fully achieved.

(1) Increase in the Availability and Production of Water

Under the Project, the availability and production of water were increased by the following measures.

i) Reduction of Leakage

As a result of the rehabilitation of deteriorated water supply facilities in the 12 target districts, the leakage rate was reduced. At the time of appraisal, the planned leakage reduction was 1.30 m³/sec but the actual result according to a SEDAPAL estimate was 1.19 m³/sec.

ii) Conservation of Water

The wide dissemination of water meters and the collection of water charge based on the consumption volume led to an incentive for water users to conserve water. According to a SEDAPAL estimate, the average water consumption per capita per day dropped from 236 litres in 1994 to 176 litres in 2001. With the installation of a water meter at approximately 410,000 households under the Project, the combined water saving effect is estimated to be some 2.15 m³/sec. The fact that the water charge almost doubled in 10 years has presumably contributed to the water conserving behaviour of users.



Water meter of SEDAPAL

iii) Increasing of Production Capacity

As a result of the rehabilitation of wells under the Project, the production capacity of underground water increased. It is inferred that the production capacity increased by 1.42 m³/sec.

The combined effect of the implementation of the Project was an increase of water available for distribution by approximately 4.8 m³/sec, which is equivalent to 23% of the total water production

in Lima-Callao Metropolitan Area (approximately 21 m³/sec). It is, therefore, reasonable to assume that a serious water supply shortage would have occurred in the Metropolitan Area without the implementation of the Project.

(2) Improvement of the Distribution Efficiency

The Metropolitan Area is divided into two areas based on the main source of water supply, i.e. either surface water or groundwater. Prior to the Project, continual pumping of groundwater caused the level of groundwater to fall. Under the Project, new transmission pipes were laid in three districts that relied primarily on groundwater, and as a result achieved the complementary use of surface water to prevent continuous groundwater intake and to alleviate the water shortage. With the implementation of the Project, the water distribution volume to these three districts is estimated to have increased by 1.36 m³/sec (planned increase: 1.42 m³/sec). As a result of less groundwater intake, (other than in the dry season), the groundwater level at the pumping wells in these districts rose by 10 - 15 m.

(3) Improvement of the Water Supply Service in General

As shown in Table 3, the water service coverage in the Lima-Callao Metropolitan Area has increased to as high as 91% in the last 10 years during which the number of households receiving water supply has increased by approximately 50%. During this period, even though the water production did not increase, the average water supply hours greatly improved. It is inferred that such efficient use of water resources was made possible because of (i) reduction of leakage due to the rehabilitation of the water supply network, (ii) water saving due to the installation of water meters and raised water charge and (iii) optimization of the water distribution due to extension of the water mains, sectorization of the distribution network and introduction of the SCADA system.

Table 3 Main Indicators for Water Supply Service in the Lima-Callao Metropolitan Area

	Before the Project	After the Project	Planned Value (For Reference)
Water Service Coverage	75% (1995)	91.1% (2008)	88%
Number of Connections	839,000 (1997)	1,231,000 (2008)	1,020,000
Water Production	642 million m ³ (1997) 20.4 m ³ /sec (1997)	659 million m ³ (2008) 20.9 m ³ /sec (2008)	890 million m ³ 28.1 m ³ /sec
Average Water Supply Hours	11.5 hours/day (1995)	21.5 hours/day (2008)	No planned value
Physical Losses (Leakage)	31% (1994)	25% (2007)	29%
Unaccounted-for Water Ratio	45.0% (1994)	37.0% (2008)	41%
Water Meter Installation Ratio	3.4% (1994)	70.3% (2008)	46%

Sources: The actual values (after the Project) are provided by SEDAPAL while the planned values are the target values set at the time of appraisal by the World Bank (1995).

In the seven target districts in the JICA loan portion, some one million people (some 12% of the total population of 8.6 million in the Metropolitan Area) were using the water supply service in 2007. Although the number of households using this service increased by 10% in 10 years, the unaccounted-for water ratio dropped by 21%, reflecting the water conservation effect of the Project. The average water supply hours in these seven districts increased from some 16 hours a day in 1999 to 21.4 hours a day in 2008, almost reaching a 24 hours-a-day water supply except in the Callao District (19.5 hours a day) and Rimac District (20.2 hours a day). The number of repair works of the water supply system conducted by the Surquillo Service Center which is responsible for three of the seven districts fell from 802 in 2000 to 352 in 2008, showing the positive effects of the system rehabilitation.