Federative Republic of Brazil

Ex-Post Evaluation of Japanese ODA Loan

Guanabara Bay Basin Sewerage System Construction Project

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

0. Summary

The Guanabara Bay Basin Sewerage System Construction Project (hereinafter referred to as "the Project") was implemented to improve the hygiene environment for residents and to reduce the inflow volume of pollutants to the said bay by means of constructing sewerage facilities in the western part of the Guanabara Bay Basin in the State of Rio de Janeiro. As the purpose of the Project was consistent with not only the development policies and needs of the aforementioned state but also with the ODA policy of Japan, the overall relevance of the Project is high. While highly efficient secondary treatment facilities were constructed, the actual sewage treatment volume remained as low as some 30% of the planned volume due to the incompletion of some of the planned sewage collection facilities. As a result, the pollutant reduction volume was some 70% of the planned level. Some areas where the sewerage system was completed have seen an improvement of the hygiene environment. Flow of pollutant to the Guanabara Bay has been reduced, while no significant improvement of the water quality has been observed in the bay. Given the limited impact, the effectiveness of the Project is judged to be fair. While the project cost remained within the planned budget, the project period substantially exceeded the planned period. Given the fact that not all of the sewage collection facilities had been completed at the time of the ex-post evaluation, the efficiency of the Project is evaluated to be low. Meanwhile, the insufficient budget for equipment maintenance at the wastewater treatment plants (WWTPs) and its delayed execution, the insufficient deployment of manpower coupled with the lack of a preventive maintenance system is responsible for the inadequate maintenance of some equipment. In Meriti which is included in the project area and where the municipal authority has taken the responsibility to operate and maintain the sewerage system, neither the organizational set-up nor the organizational capacity to properly execute the work has yet been firmly established. Accordingly, the sustainability of the Project is judged to be low.

Based on the above, this Project is evaluated to be unsatisfactory.

1. Project Description

Project Location

Alegria Waste Water Treatment Plant

1.1 Background

Guanabara Bay facing the city of Rio de Janeiro has gained much popularity as a symbol of Brazil due to its beautiful scenery, boosting the value of Rio de Janeiro as an international tourist city. In the early 1990's, however, the water quality of the bay seriously deteriorated due to the massive inflow of raw sewage and the illegal dumping of waste, adversely affecting local fisheries and tourism. As the city's population exceeded nine million with the absence of a properly constructed sewerage system, especially in low income areas, some 120 tons of raw sewage were discharged to the bay every day, constituting one factor for the deterioration of the water quality. This situation made the development of an extensive sewerage system in the Guanabara Bay Basin an urgent task.

To rectify the situation, the State Government of Rio de Janeiro prepared the Rio Environment Program and began to improve the environment of the Guanabara Bay Basin through the development of a sewerage system by *Companhia Estadual de Aguas e Esgotos do Rio de Janeiro* (Rio de Janeiro State Water and Sewerage Corporation, hereinafter referred to as "CEDAE"). Based on the latest census in 1991, the CEDAE reviewed the Water and Sewerage Master Plan and conducted a feasibility study for the project in the Phase 1. This project (Phase 1) was put into implementation in 1993 with a joint loan by the Inter-American Development Bank (hereinafter referred to as "IDB") and the Japan International Cooperation Agency (hereinafter referred to as "JICA" (the former Overseas Economic Cooperation Fund). The Guanabara Bay Basin Sewerage System Construction Project (the target project of the ex-post evaluation) was part of the project in the Phase 1.[1]

1.2 Project Outline

The objective of this Project is to improve living conditions for residents and also to reduce the volume of pollutant inflow to the bay by constructing sewerage facilities in the western part of Guanabara Bay Basin in the State of Rio de Janeiro, thereby contributing to an improvement of residents' life as well as conserving fishery and tourism resources at the Guanabara Bay.

Loan Approved Amount/ Disbursed Amount	31,475 million Yen / 31,467million Yen
Exchange of Notes Date / Loan Agreement Date	March, 1993 / March, 1994
Terms and Conditions	Interest Rate: 5.0% (Consulting Service: 3.25%) Repayment Period: 25 years (Grace Period: 7 years) Procurement type: General untied
Borrower/Executing Agency	Rio de Janeiro State / Rio de Janeiro State Water and Sewer Company (CEDAE: *Companhia Estadual de Águas e Esgoto*)
Final Disbursement Date	December, 2006
Main Contractors	・ Camargo Correa(Brazil)・Sergen(Brazil)・Engeform(Brazil)（JV） ・ Via Engenharia S.A.(Brazil)・Ecal – Engenheiros Construtores Associados(Brazil)・Hans Brochier Gmbh & Co.(Germany) ・ Construtora Queiroz Galvao S.A.(Brazil)・Etesco - Construcoes e Comercio Ltda.(Brazil)（JV） ・ Encalso Construcoes Ltda.(Brazil)・Stemag Engenharia e Construcoes Ltda.(Brazil)・Coneng Engenharia Ltda.(Brazil)

[1] In the State of Rio de Janeiro, this project in the Phase 1 was called the Guanabara Bay Depollution Program with three components featuring water supply, sewerage and solid-waste disposal. The Japanese ODA Loan project being evaluated here formed part of the sewerage component. The other parts were financed by the IDB. In 1994, JICA conducted the Study on Recuperation of the Guanabara Bay Ecosystem (a master plan study). This study took place after the commencement of the Project.

	（JV） ・ Construtora Passarelli S.A.(Brazil)・Construbase Engenharia Ltda.(Brazil)（JV）
Main Consultant	・ Iesa-Internacional de Engenharia S.A.(Brazil)/Logos Engenharia S/A(Brazil)・Pacific Consultants International (Japan)・Kaiser Engineers & Constructors, Inc.(USA)（JV） ・ Earth Tech Brasil Ltda.(Brazil) ・ Aquacon Consortium(Brazil) ・ Hidroservice Consortium (Brazil)
Feasibility Studies, etc.	- The Study on Recuperation of the Guanabara Bay Ecosystem (JICA, 1994） - The Study on Management and Improvement of the Environmental Conditions of Guanabara Bay in Rio de Janeiro (JICA, 2003）
Related Projects	Basic Sanitation Program for the Guanabara Bay Basin (Phase I) (IDB, BR-072、1993～）

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

2.2 Study Period

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

Study Period: September, 2012 - July, 2013
Field Survey : 18 November - 7 December, 2012
27 - 30 May, 2013

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to Development Plan of Brazil

In 1991, the State Government of Rio de Janeiro prepared the Rio Environment Program and the CEDAE implemented a water supply and sewerage facilities construction project to improve the environment of the Guanabara Bay Basin.

The State Government of Rio de Janeiro has been stepping up its efforts to improve the environment, including the expansion of the sewage collection and treatment facilities and the dredging and cleaning of lagoons, beaches, rivers and canals following the United Nations Conference on Sustainable Development (Rio +20) in 2012 and in anticipation of the World Cup in 2014 and the Olympics in 2016. The Pacto Pelo Saneamento (Pact for Sanitation) adopted by the State Government in April, 2011 aims at improving both collection and treatment rates to 80% by 2018.

As such, improvement of the local sewerage system has been a priority issue since the time of the ex-ante to the ex-post evaluation.[4]

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③: High , ② Fair, ①: Low

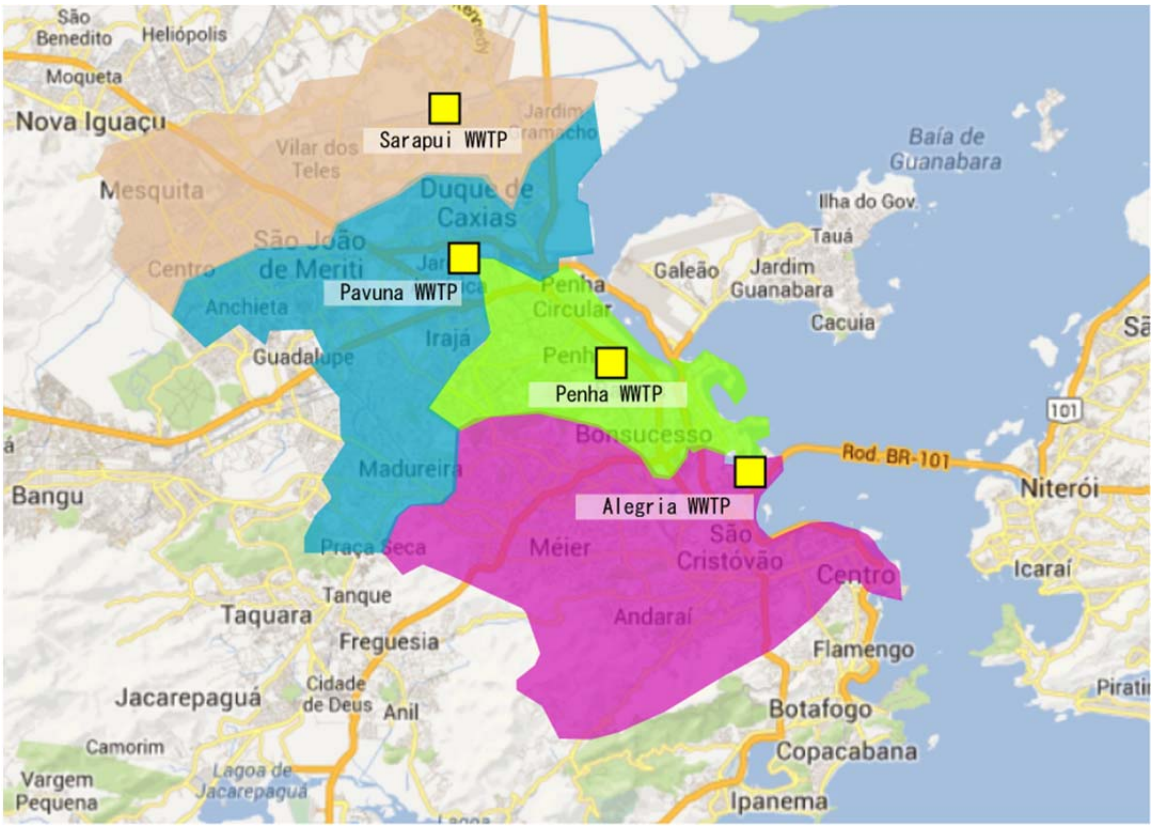

Figure 1. Waste Water Treatment Plants included in the Project and Their Serving Areas

3.1.2 Relevance to Development Needs of the State Rio de Janeiro

As described in 1.1 Background, improvement of the sewerage system in the Guanabara Bay Basin was an urgent priority at the time of appraisal.

The sewage collection rate and sewage treatment rate in the Guanabara Bay Basin were 40% and 44% respectively in 2006.[5] As of 2012, only 14% of the total Biochemical Oxygen Demand (BOD) load in the said basin is removed by sewage treatment plants.[6] According to the Department of Environment of the State Government of Rio de Janeiro, the water quality in Guanabara Bay has little improved in the last 10 years. Therefore, there is still a strong need for improvement of the sewerage facilities at the time of the ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policy

In 1992, Japan sent the Comprehensive Study Mission for Economic Cooperation to Brazil and agreed with the Brazilian side that the environment, industry and agriculture were three priority sectors for

[4] In 2007, the Federal Government of Brazil adopted the Basic Sanitation Act and the National Plan for Environmental Sanitation proposed in April, 2011 aimed at achieving an urban sewage collection rate of 91% and a sewage treatment rate of 88% by 2030.

[5] At the national level, only 47% of the total population of Brazil enjoy adequate sewage treatment as of 2008, leaving the remaining 53% in need of proper sanitation facilities. National Department of Environmental Sanitation data indicate a nationwide sewage collection rate and sewage treatment rate of 46% (54% for urban areas) and 40% respectively as of 2010.

[6] The BOD is the amount of dissolved oxygen to be consumed by aerobic biological organisms in a body of water to oxidise and breakdown organic materials present in the water. A higher BOD value indicates a higher level of water pollution. The BOD is used as a general indicator of water pollution.

Japan's ODA. In the environment sector, the main focus has been placed on the protection of the natural environment, including the preservation of tropical rain forests in the Amazon and the mitigation and prevention of urban as well as industrial pollution. The target project of the present evaluation is in the category of the environment sector.

Based on the above observation, the Project has been highly relevant with the development plan, development needs of the State of Rio de Janeiro as well as Japan's ODA policy, therefore its relevance is high.

3.2 Effectiveness[7] (Rating: ②)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

The primary objective of the Project was to reduce the pollutants such as BOD load discharged to Guanabara Bay in sewage from the Guanabara Bay Basin by means of constructing sewage collection and treatment facilities. At the time of appraisal, BOD concentration and Suspended Solids (SS) concentration of treated sewage were selected as indicators[8]. For the purpose of the present evaluation, considering the above objective of the Project, sewage treatment volume, utilization rate and treatment efficiency (rate of pollutant removal) at each WWTP are analysed with special emphasis on removal of the BOD load.

The installed treatment capacity, volume of treated sewage and utilization rate (volume of treated sewage divided by installed treatment capacity) are shown in Table 1 for three newly constructed WWTPs (Alegria, Pavuna and Sarapui WWTPs) and the Penha WWTP where a sludge centrifugal dewatering units were newly installed. Of the three new WWTPs, the Alegria WWTP receives a sewage volume of slightly more than 50% of the respective treatment capacity while the utilization rate of the other two WWTPs is very low. The main reason is that some parts of the sewage collection facilities are either incomplete or unconnected (refer to 3.4. Efficiency for further details) at these WWTPs. In the case of the Penha WWTP, while the new sludge centrifugal dewatering unit is the only one newly installed under the Project, the deterioration of other equipment necessitates restriction of the volume of sewage to be received in order to ensure appropriate treatment.

Table 1 Volume of Treated Sewage and Utilisation Rate of WWTPs
(January through October, 2012 average)

WWTP	Installed Treatment Capacity (litres/second)	Volume of Treated Sewage (litres/second)	Utilization Rate (%)
Alegria*	2,500	1,365	55%
Pavuna	1,500	127	8%
Sarapui	1,500	220	15%
Penha	1,600	600	38%
Total	7,100	2,312	33%

Source: Prepared by the external evaluator based on the relevant CEDAE data and findings of a series of interviews at WWTPs.

Note: Although the treatment capacity of the primary treatment at the Alegria WWTP is 5,000 litres/second, the treatment capacity of the secondary treatment is 2,500 litres/second, forcing the actual operation of the primary treatment to run at 2,500 litres/second.

The BOD and SS treatment efficiency (pollutant removal rate) at each WWTP is shown in Table 2. As secondary treatment by conventional activated sludge process is conducted at all of these WWTPs, the

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

[8] Suspended solids refers to small solid particles in suspension in water as colloids or because of the motion of water. SS is used as an indicator of the water quality.

overall treatment efficiency is sufficiently high.[9] At the time of appraisal, a post-secondary treatment concentration and pollutant removal rate of 20 mg/litre and 90% respectively were planned for both the BOD and SS.

Table 2 BOD and SS Treatment Efficiency (January through October, 2012 average)

BOD Treatment Efficiency	Pre-Treatment BOD Concentration (mg/litre)	Post-Treatment BOD Concentration (mg/litre)	BOD Removal Rate (%)
Alegria	240	4.7	98%
Pavuna	140	6.1	96%
Sarapui	120	17.0	86%
Penha	240	24.0	90%
SS Treatment Efficiency	**Pre-Treatment SS Concentration (mg/litre)**	**Post-Treatment SS Concentration (mg/litre)**	**SS Removal Rate (%)**
Alegria	240	4.7	98%
Pavuna	120	7.8	96%
Sarapui	120	35.0	86%

Source: Prepared by the external evaluator based on the relevant CEDAE data and findings of a series of interviews at WTPs.
Note: No SS data was obtained for the Penha WWTP.

Primary Treatment Facility (Sarapui WWTP)

Secondary Treatment Facility (Alegria WWTP)

Treated Water Before Discharge (Alegria WWTP)

Sludge Centrifugal Dewatering Units (Penha WWTP)

[9] Although the treatment efficiency at the Sarapui WWTP is less than 90%, the low BOD concentration of the incoming sewage remains the post-treatment BOD sufficiently low.

Based on the above data, the removed BOD load at each WWTP was estimated. The estimated values are compared to the planned values in Table 3. At the Penha WWTP, sludge produced by the sewage treatment process used to be discharged to a river without any further processing. Due to the abolition of sludge discharge after the installation of a sludge centrifugal dewatering units under the Project, the BOD load removed at this WWTP is considered as an effect of the Project.

Table 3 Comparison of Planned and Actual BOD Load Removal
(January through October, 2012)

WWTP	Planned BOD Load Removal (tons/day)	Actual BOD Load Removal (tons/day)	Achievement Rate Actual/Planned (%)
Alegria	20.7	27.7	130%
Pavuna	5.2	1.4	27%
Sarapui	5.2	2.1	40%
Penha	29.9	11.2	37%
Total	61.0	42.5	70%

Source: Prepared by the present evaluator based on the relevant CEDAE data and findings of a series of interviews at WTPs.

Note: BOD removal volume = volume of treated sewage x pre-treatment BOD concentration x BOD removal rate.
As the planned values were set at the time of appraisal (1994), they did not reflect subsequent changes, including the addition of secondary facilities.

The total BOD load removal is estimated to be 42.5 tons/day. This is equivalent to 70% of the planned value and more than a half has been achieved by the Alegria WWTP. It must be noted that the planned value used for comparison were set at the time of appraisal and, therefore, did not include subsequent planning changes, such as expansion of the treatment capacity at the Pavuna and Sarapui WWTPs and the additional installation of a secondary treatment facility at the three new WWTPs (refer to 3.4 for details of the planning changes). After these changes, the target BOD load removal was 145.5 tons/day and the actual achievement rate compared to this is as low as 29%. The better performance of the Alegria WWTP than the planned performance is due to the higher BOD removal rate with the addition of a secondary treatment facility. The operating status of each WWTP is outlined below.

Alegria WWTP

98% of the BOD load is removed by secondary treatment. However, only half of the trunk lines connecting the existing sewer network to the WWTP have been completed, resulting in an actual sewage treatment volume of 1.3 m^3/sec compared to the planned 2.5 m^3/sec. The BOD load removal is approximately 28 tons/day.

Pavuna WWTP

Although the BOD load removal rate by secondary treatment is as high as 96%, the partially incomplete as well as unconnected sewer network means a low sewage treatment volume of 0.13 m^3/sec compared to the planned 1.5 m^3/sec. The low BOD concentration of the incoming sewage can likely be attributed to the intrusion of river water. The BOD load removal is approximately 1.4 tons/day.

Sarapui WWTP

The BOD removal rate by secondary treatment of 86% is slightly below the planned rate. The partially incomplete as well as unconnected sewer network is responsible for the low sewage treatment volume of 0.22 m^3/sec compared to the planned 1.5 m^3/sec. The low BOD concentration of the incoming sewage can likely be attributed to the intrusion of river water. The BOD load removal is approximately 2.0 tons/day.

Penha WWTP

The complete removal of sludge which was formerly discharged with hardly any treatment (some 30 tons/day in terms of the BOD load) through a dewatering process was planned. As the sewage treatment volume has fallen to the some 40% level of the volume at the time of planning due to the general deterioration of the WWTP, the current BOD load removal is approximately 11 tons/day (At this WWTP, only the sludge centrifugal dewatering units were installed with Japanese ODA Loan).

In short, the actual BOD load removal is estimated to be approximately 43 tons/day (for January through October, 2012 average) compared to the planned 61 tons/day at the time of appraisal (achievement rate of 70%). The reason for the achievement of 70% of the planned BOD load removal despite the substantially lower sewage treatment volume than planned is the addition of secondary treatment facilities (refer to 3.4 for further details). Because of the delayed completion of the WWTPs, however, the realization of the positive effects of the Project was also delayed by 3–5 years compared to the original plan. During this period, untreated sewage continued to be discharged to Guanabara Bay.

The low BOD load removal can be directly attributed to the partially incomplete as well as unconnected sewer networks for sewer collection at the three new WWTPs and the restriction on the volume of incoming sewage at the Penha WWTP due to the deterioration of the plant. Because of this, the target BOD load removal has not been achieved despite a higher BOD removal rate due to the addition of a secondary treatment. If the sewage collection facilities had been completed as planned, the actual BOD load removal would be three times higher than the current volume.

3.2.2 Qualitative Effects

The qualitative effects assumed at the time of appraisal included improved public hygiene, improved river water and bay water quality, recovery of fisheries in the bay and conservation of tourism resources in the Guanabara Bay Basin. These issues are analyzed in the next section as impacts (3.3 Impacts).

3.3 Impact

3.3.1 Intended Impacts

(1) Impact on Improvement of Public Hygiene

Some parts of the service areas of the Pavuna and Sarapui WWTPs were newly connected to the sewerage system as a result of the Project. According to the CEDAE, some 26,000 households had been newly connected to the sewerage system by May, 2013. This figure represents some 70% of the planned 35,000 households (refer to 3.4 Efficiency for further details).

As part of the ex-post evaluation, a questionnaire survey was conducted featuring 105 households newly connected to the sewerage system in 2000 onwards[10]. 41% of these households are found to be satisfied with the service while the remaining households point out such problems as the leakage and odour of sewage. 46% of the newly connected households believe that the hygiene environment of their homes and in the neighbouring area has improved. Meanwhile, 15% of the respondents said that water-borne infectious diseases are still occurring after connection to the sewerage system.[11]

[10] The questionnaire survey was carried out at those areas where sewer was constructed after 2000. Totally 105 households (53 for Pavuna WWTP and 52 for Penha WWTP) were interviewed. 64% of the interviewee were female, 70% were over 46 years old, and 55% have received secondary education or higher.

[11] No data on water-borne infectious diseases was obtained to make it possible to compare the pre-project and post-project status of such diseases.

In short, the Project had a positive impact on the improvement of public hygiene for some 26,000 households by May, 2013. The sewage collection rate and sewage treatment rate in the Guanabara Bay Basin in the State of Rio de Janeiro have improved to 40% and 44% respectively from the 25% and 15% respectively at the time of appraisal. The main contributory factor has been the Guanabara Bay Depollution Program which includes the Project.

(2) Impact on Qualitative Improvement of River Water and Bay Water

Table 4 compares the BOD load generated by sewage in the Guanabara Bay Basin with the BOD load removal at the four WWTPs included in the Project. In 2010, the BOD load removal by the four WWTPs was 10.5% of the total BOD load generated, quadrupling the volume before the Project in 2000. Based on CEDAE data, it is estimated that some 29 tons of BOD load are removed daily by other WWTPs in the basin (2012). The total BOD load removal in the basin is, therefore, some 72 tons/day or approximately 15% of the total BOD load generated. The decline of the BOD load removal between 2010 and 2012 was caused by the decline of the sewage treatment volume at the Penha WWTP because of the deterioration of the plant.

Table 4 Comparison of BOD Load and Removal Volume by the Project in the Guanabara Bay Basin

	BOD Load Generation in Guanabara Bay Basin (tons/day)	BOD Load Removal by the Project (tons/day)	Removal Rate (%)
2000	448.2	11.3	2.5%
2005	469.8	12.8	2.7%
2010	486.0	50.8	10.5%
2012	494.6	42.5	8.6%

Source: Prepared by the external evaluator based on the relevant CEDAE data and findings of a series of interviews at WTPs.

Note: The BOD load is based on the estimated load in "The Study on Management and Improvement of the Environmental Conditions of Guanabara Bay in Rio de Janeiro, the Federative Republic of Brazil" (2004) by JICA with adjustment made to take the actual population increase into consideration. For 2012, the figure is an estimate based on the actual performance from January through October.

According to the Department of Environment of the State Government of Rio de Janeiro, the water quality is worse in the western part of Guanabara Bay because of a concentration of pollution sources there. While the area benefiting from the Project is this very western part, improvement in terms of the BOD concentration in the period from 2000 to 2010 to the level of two-thirds that recorded in the pre-project period is not far from satisfactory.[12] No tangible improvement of the water quality has been observed at Sarapui River to which treated sewage is discharged by the Pavuna and Sarapui WWTPs.

Table 5 Transitions of BOD Concentration in Sarapui River and Western Part of Guanabara Bay

(Unit: mg/litre)

	1990	2000	2010
Sarapui River	33.6	27.0	36.4
Guanabara Bay ①	14.6	15.2	10.7
Guanabara Bay ②	na	18.2	11.7

Source: Department of Environment, State Government of Rio de Janeiro

Note: Refer Figure 3. For the locations of Guanabara Bay ① and ②

[12] Cunha Canal in the eastern part of the bay where accumulated sludge hampered water circulation underwent dredging in 2009. This may have been a contributory factor for the improved water quality at the sampling points. The JICA's Study on Recuperation of the Guanabara Bay Ecosystem in 1994 set the target BOD concentration in 2004 at 10 mg/litre.

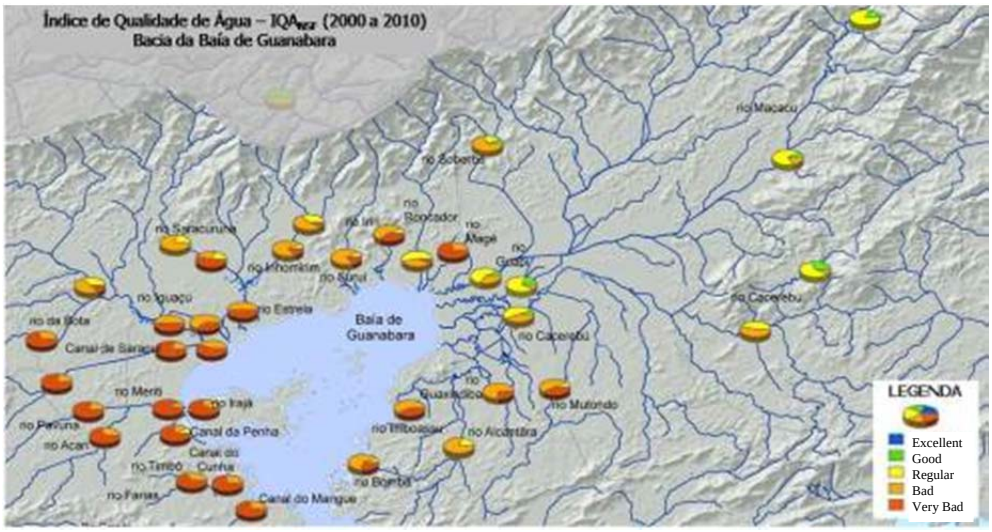

Figure 2. Water Quality of the Rivers in Guanabara Bay Basin
(Distribution of the measured values during 2000 – 2010)
Source: Department of Environment, State Government of Rio de Janeiro

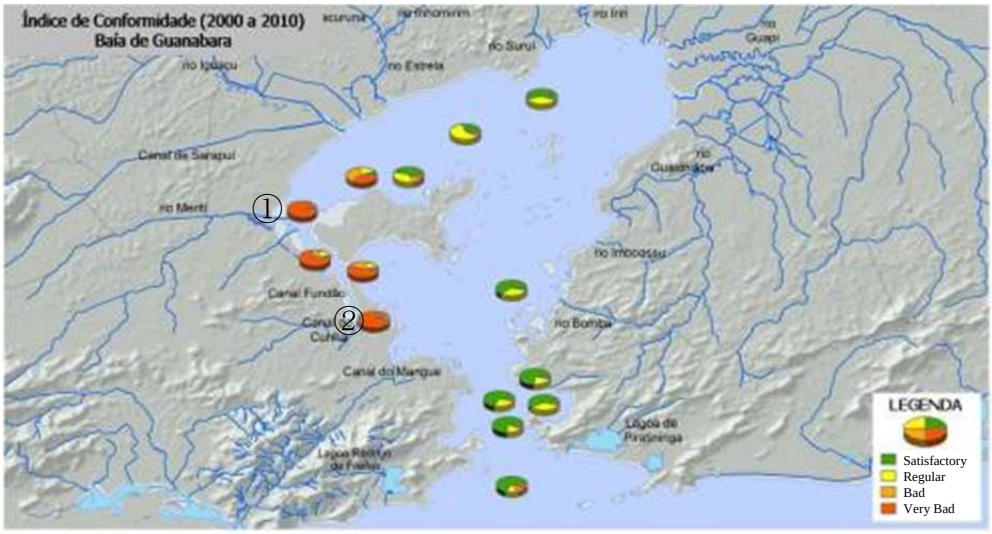

Figure 3. Water Quality of the Guanabara Bay
(Distribution of the measured values during 2000 – 2010)
Source: Department of Environment, State Government of Rio de Janeiro

Beach at the Guanabara Bay (Right: Western Part, Left: Eastern Part)

Fisherman in the Bay (Western Part)

View of Guanabara Bay from a Pleasure Boat

A series of interviews with various stakeholders in the water quality of Guanabara Bay has discovered the following facts.[13]

- The pollution in the bay is caused by not only discharged raw sewage but also by a massive inflow of rubbish from rivers after rain. A large-scale oil spill in 2000 appears to have affected the opinion of pollution on the part of fishermen and visitors to the beach. [14]

- In 2001, some 10,000 local fishermen were engaged in artisanal fisheries in the bay, most of whom pointed out a decline of the fish varieties and the catch due to the pollution of the bay by sediment sludge and rubbish. These same fishermen believe that the situation of water pollution in the bay has worsened in the last 10 years. Prawn fishing which used to record a catch of some 200 to 300 tons a year in the 1980's is no longer practiced in the bay.

- Nearly half of those representing commercial facilities and yacht clubs in the bay believe that the water quality has somewhat improved in recent years. However, they also say that the pollution of the bay continues to adversely affect their businesses, pointing out a decline of tourists, decrease of marine leisure activities and damage to ships by rubbish.

- More than half of local residents visiting the beach in the bay believe that the water quality has worsened in the last 10 years. Almost no local residents dare to swim in the bay.

To summarise, the impact of the Project on water quality improvement is judged to be limited as the BOD load removal by the Project is as low as some 10% of the total BOD load discharged to the bay in sewage. The water quality in the western part where pollution sources are concentrated is still poor and pollution by rubbish is also serious in this part. Water pollution in the bay is still badly affecting local fisheries and the operation of commercial and recreational facilities along the coast. In short, no visible positive impacts have been produced by the Project in relation to the conservation of fishing as well as tourism resources.

[13] As part of the ex-post evaluation, a series of interviews was conducted with 56 persons representing fishermen's cooperatives, restaurants, NGOs and tourist facilities as well as researchers and visitors to the beach.

[14] An oil spill involving some 13 billion litres of petroleum oil occurred in the Duque de Caxias refinery area in January, 2000.

3.3.2 Other Impacts

The sludge produced at the WWTPs amounts approximately 13 ton / m^3 in 2011 and is currently transported by truck to the Gerinchino landfill site located some 30 – 40 km from the WWTPs for sanitary landfill. The field observation confirmed that the sludge treatment at this site is appropriate as suitable soil cover and planting are practiced.

The Project did not involve the resettlement of residents or encountered any major problems in terms of land acquisition. One exception is the lengthy negotiations with a municipality to obtain consent for the shaving of a cliff located next to the site for the secondary treatment facility at the Alegria WWTP.

No other special positive or negative impacts of the Project are observed.

In summary, the Project achieved around 70% of BOD load removal targeted at the time of appraisal[15], and improved public hygiene of some 26 thousand households by May 2013. Inflow of BOD load to the Guanabara Bay was reduced by 10% and no visible impact has been realized in the western part of the Bay. Therefore, this Project has somewhat achieved its objectives, and its effectiveness is fair.

3.4 Efficiency (Rating: ①)

3.4.1 Project Outputs

The construction of three new WWPTs began in 1997.[16] In 2001 when the construction of the primary treatment facilities was almost completed, the original plan was revised to expand the capacity of each primary facility and to add secondary treatment facilities. These changes were approved by JICA as a means of further enhancing the outcomes of the Project in view of the facts that the required funding for these changes could be secure within the original loan limit and that the land required to accommodate the additional facilities had been already prepared.
In December, 2006 when the extended expiry date for loan disbursement arrived, the construction of the sewage collection facilities had still not been completed. Because of this, the subsequent construction work continued thereafter with funding by the Federal Government of Brazil and the State Government of Rio de Janeiro. Table 6 shows the planned project outputs at the time of appraisal, actual outputs up to 2006 and subsequent works completed between 2007 and May, 2013.

The planned sewage collection facilities (trunk lines and sewer networks) are incomplete and their construction work is still in progress (refer to 3.4.2.2 Project Period for the reasons of delay). The facilities completed by the expiry date for loan disbursement in December, 2006 included 42.7 km of trunk lines (59% of the planned total) and 240.9 km of sewer networks (36% of the planned total). Through the contracts made under the Project, 77% (55.4km) of trunk lines and 51% (334.2km) of sewer networks were constructed by October, 2013. Under new contracts, the CEDAE has been continuing the remaining works. A total of 70% of the trunk lines in the Alegria WWTP service area, 82% of the trunk lines and 90% of the sewer network in the Pavuna WWTP service area and 95% of the trunk lines and 93% of the sewer network in the Sarapui WWTP service area were completed by March, 2013.[17]

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[15] In judging the level of effectiveness / impact of the Project, the plans and targets set at the time of appraisal, not the plans and targets modified in 2001 to expand primary treatment capacity and add secondary treatment, were considered as "the original plan" for comparison, as they were the basis for an international agreement through the Exchange of Notes.

[16] At the three new WWTPs, the construction of only primary treatment facilities had begun as planned at the time of appraisal. At the Alegria WWTP, the construction of an additional primary treatment facility with a capacity of 1,000 litres/sec to be funded by the State Government of Rio de Janeiro was suspended because of funding difficulties. As a result, the original plan was scaled up to include the construction of a primary treatment facility with a capacity of 5,000 litres/sec under the Project instead of 4,000 litres/sec.

[17] The CEDAE's plan as of March, 2013 consists of the following components.

Table 6 Planned and Actual Project Outputs

WWTP	Planned (1994)	Actual		
		1994 to 2006	2007 to May, 2013	Total to Oct, 2013
Alegria WWTP*				
Primary Treatment	4000 (l/s)	5,000 (l/s)		5,000 (l/s)
Secondary Treatment	None	2,500 (l/s)		2,500 (l/s)
Trunk Lines	23.1km	14.0 km	2.9 km	16.9 km
Pavuna WWTP				
Primary Treatment	1,000 (l/s)	1,500 (l/s)		1,500 (l/s)
Secondary Treatment	None	1,500 (l/s)		1,500 (l/s)
Trunk Lines	30.7 km	11.7 km	3.7 km	16.1 km
Sewer Network	373.8 km	90.1 km	62.0 km	153.0 km
Pumping Station	9 locations	0 locations		0 locations
New Connections	26,500	811	8,894	9,705
Sarapui WWTP				
Primary Treatment	1,000 (l/s)	1,500 (l/s)		1,500 (l/s)
Secondary Treatment	None	1,500 (l/s)		1,500 (l/s)
Trunk Lines	18.2 km	17.0 km	4.4 km	22.4 km
Sewer Network	284 km	150.8 km	25.8 km	181.2 km
Pumping Station	8	0		0
New Connections	8,500	2,122	13,708	15,830
Penha WWTP				
Sludge Centrifugal Dewatering Units	4 units	4 units	4 units	4 units

Source: The planned values are based on material compiled at the time of appraisal. The actual values are based on CEDAE data.

Note: The work for the secondary treatment facility at the Alegria WPT included civil engineering work to allow treatment at a rate of 5,000 litres/sec and the construction of a secondary treatment facility with suitable equipment for treatment at a rate of 2,500 litres/sec. The actual performance since 2007 is the performance under the construction agreement concluded for the Project.

- Secondary treatment facility (2,500 litres/sec) at the Alegria WWTP: preparations in progress by the IDB to conduct the work in a succeeding project
- Manguinhos e Caleria de Cintura da Maré trunk line and Faria Timbó trunk line in the Alegria WWPT service area: preparations in progress by the IDB to conduct the work in a succeeding project
- Trunk lines and sewer network in the Sarapui WWTP service area (scheduled for completion in March, 2014):
  - Construction of the remaining works included in the Project: in progress with funding by the State Government
  - Expansion of the sewer network to connect 6,000 households: agreement concluded to fund the work by the State Government
  - Expansion of the sewer network to connect 4,130 households: agreement concluded to fund the work by the State Government
  - Expansion of the sewer network to connect 10,000 households and cleaning of the existing secondary sewer lines
- Trunk lines and sewer network in the Pavuna WWTP service area (scheduled for completion in March, 2014):
  - Construction of the remaining lines agreed under the Project: in progress with funding by the State Government
  - Expansion of the sewer network to connect 1,500 households: agreement concluded to fund the work by the State Government
  - Expansion of the sewer network to connect 38,000 households: preparations in progress by the IDB to conduct the work in a succeeding project
  - Cleaning of the sewer network constructed under the Project: examination in progress of the possible implementation of the work in the IDB's succeeding project

The original plan included new connection to the sewer network of 35,000 households in the Sarapui and Pavuna WWTP service areas. By 2006, only 2,933 households (8% of the planned target) were connected. This figure had improved to 25,535 households (73%) by October, 2013. Some of the sewer lines planned under the Project have been buried underground in the Sarapui and Pavuna WWTP service areas but not all of these lines have been connected to the WWTP or targeted households.[18] This is because of the piece-meal construction work. This is a factor for the low sewage treatment volume despite the overall progress of the construction work. No new connections have been made in the Alegria and Penha WWTP service areas because sewer networks had existed.

Several pumping stations were originally planned along the trunk lines but these have not been constructed because of the perceived difficulty of their maintenance. Instead, all of the lines now rely on gravity to carry sewage to WWTPs.

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned and actual project costs are shown in Table 9. Although the trunk line and sewer network construction work is still in progress, the project cost of the work implemented by the expiry date for loan disbursement (December, 2006) is analyzed here.

The construction cost of the primary treatment facilities specified in the project scope at the time of appraisal drastically dropped to some 40% (approximately ¥6,100 million) of the original level because of the huge depreciation of the local currency against the yen during the construction period from 1998 to 2001. With the addition of the secondary treatment facilities, however, the total construction cost of the WWTPs (primary and secondary treatment facilities) ended up at 138% of the planned cost. In the case of the sewer construction cost, the final cost was 54% of the planned cost due to the low completion rate of 59% for the trunk lines and 36% for the sewer network. The substantial extension of the project implementation period pushed up the consultant cost.

Because of the reasons described above, the total project cost (excluding the land acquisition cost) was ¥49,650 million, 83% of the planned project cost of ¥60,121 million. Meanwhile, the amount of loan disbursement was almost 100% of the planned amount. The project cost is, therefore, judged to be within the planned cost even when the increases and decreases of some of the outputs are taken into consideration. If it is assumed that all of the planned sewer lines were constructed as planned, the total cost of sewer construction would have been approximately double the actual cost. Meanwhile, based on the assumption that no additional work was conducted, the construction cost of the WWTPs would have been approximately ¥6,100 million. Based on these assumptions, the total project cost would have been some ¥50,000 million which is within the originally planned project cost.

The efficiency of the project cost cannot, however, be said to be high because of the low quality of the overall outputs as a sewage system, in turn caused by (i) the need for the cleaning of the new sewers which were constructed in a piece-meal manner and which were simply left buried underground without connection and (ii) the lengthy period of the low utilization rate of the new WWTPs after their completion.

[18] According to the CEDAE, there has been an increase of the inoperable secondary sewer lines due to their blockage by muddy rainwater while laying unused underground or by sewage discharged via drainage pipes illegally connected to them by owners of nearby houses. It is currently planned to clean and properly connect them in a succeeding project using an IDB loan.

Table 7 Planned and Actual Project Costs

(unit: ¥ million)

	Planned			Actual (December, 2006)		
	JBIC	RdJ* State	Total	JBIC	RdJ State	Total
WWTP	15,653	0	15,653	21,662	0	21,662
Sewer Lines / Network	10,324	19,172	29,496	4,036	12,008	16,044
Consulting Service	3,104	0	3,104	5,739	0	5,739
Taxes	0	7,355	7,355	0	6,205	6,205
Land Acquisition	0	1,253	1,253	Unknown	Unknown	Unknown
Physical Contingencies	2,396	2,117	4,513	-	-	-
Total	31,475	29,899	61,374	31,436	18,213	49,650

Source: The planned figures are based on materials compiled at the time of appraisal. The actual figures are prepared by the evaluator using the relevant data provided by JICA and CEDAE.

Note: RdJ State…Rio de Janeiro State

Exchange rates: At the planning stage: US$1 = Cr$2,395 = ¥133

Actual: R$1 = ¥46.25 (average for the project implementation period)

3.4.2.2 Project Period

It was originally planned that the Project would be implemented in a 60 month period (five years) from 1994 to 1998. In reality, even though it took 17 years and 9 months (213 months: 355% of the planned duration) to reach the expiry date for loan disbursement in December, 2006 from the time of the loan agreement which was signed in March, 1994, some of the planned sewage collection facilities (trunk and secondary) are not completed, and construction works are still in progress by the time of ex-post evaluation.

The consulting services and main construction work were originally scheduled to start in 1995 and 1996 respectively. Because of the delay of procurement preparations and actual procurement, however, the consulting services (four contracts in total) and the main construction work (four contracts in total) only started during 1996 to 1997 and 1997 to 2001 respectively. In the case of the sewage collection facilities in the Pavuna and Sarapui WWTP service areas where the construction work delay was the longest, the initial delay of consultant selection led to delayed procurement preparation work, including the detailed design. Together with the change of the procurement method, partly because of a change of the government, it took more than two years from public announcement to signing of the contract which finally took place in March, 2001.

In June, 2001 changes were made to the original contracts as the increased capacity of the primary treatment facilities and installation of secondary treatment facilities were added. At this time, the additional work was expected to be completed by the original expiry date for loan disbursement in July, 2003.[19]

Subsequently, the expiry date for loan disbursement was extended to December, 2006 for the following reasons.

- As the ground at the Alegria WWTP was much softer than anticipated, it was necessary to change the materials and construction method, delaying the actual construction work for more than a year.

- The state governor changed four times after signing of the loan agreement. Each time a new governor took office, many staff members of the CEDAE were replaced, causing confusion in the

[19] At this time, the construction of the primary treatment facilities was almost completed. In the Pavuna and Sarapui WWTP service areas, the construction contracts for the sewage collection facilities had just been concluded and any delays of the work execution were unforeseen.

project implementation. The audit conducted by the new governor regarding the administrative affairs of the previous governor resulted in an additional delay of procedural matters.

- In May, 2000, the Brazilian Fiscal Responsibility Law was promulgated for the purpose of ensuring fiscal discipline in the public sector, establishing legal restrictions designed to achieve balanced finance at the state level. Because of this, payment by the project implementing body to the contractors for the trunk line and sewer network construction work for which the funding by the State Government of Rio de Janeiro was fairly large was delayed. Because of this, the construction work itself was delayed.[20]

When the disbursement of Japanese ODA Loan ended in December, 2006 as the extended expiry date expired, some parts of the planned work had not been completed. This work then continued with funding by the State and Federal Governments.

Although the planned time of completion for the three new WWTPs was sometime in the first half of 1998, their primary treatment facilities were only completed in 2000 and 2001. The completion of the secondary treatment facilities had to wait until 2005 through 2009. At the Alegria WWTP site, the construction work of the secondary treatment facility was considerably delayed due to (i) changes of the construction materials and method to take the soft ground into consideration and (ii) delay of the rock excavation work caused by the delayed acquisition of the neighbouring land. As a result, this facility was not completed by the expiry date for loan disbursement. In the case of the Pavuna WWPT, only the work of installing a sludge centrifugal dewatering unit was completed by August, 2001.

The construction of sewage collection facilities in the post-project years has been slow due to insufficient funding by the State Government of Rio de Janeiro. The work is not completed as of March, 2013 as described in 3.4.1 Project Outputs.

3.4.3 Results of Calculations of Internal Rates of Return (IRR)

At the time of appraisal, the Financial Internal Rate of Return (FIRR) was estimated to be 1.1% to 9.0% based on various combinations of preconditions. In the present ex-post evaluation, recalculation of the FIRR is not conducted because of (i) the slow progress of connection to the sewer network and (ii) lack of sufficient CEDAE data on the WWTP operation and maintenance cost.

In regard to the Economic Internal Rate of Return (EIRR), the estimate of the IDB was referred to at the time of appraisal, but recalculation to produce an estimate directly comparable to the earlier the estimation by the IDB has not been conducted.[21]

Based on the above, efficiency of the project cost was not high, while the project period was significantly exceeded the plan, therefore efficiency of the Project is low.

3.5 Sustainability (Rating:①)

3.5.1 Institutional Aspects of Operation and Maintenance

The Office of Production and Large Operation of the CEDAE is responsible for the operation and maintenance of WWTPs. In the case of the Pavuna and Sarapui WWTPs, a joint maintenance section is located at the Pavuna WWTP. The staff strength at the time of ex-post evaluation is shown in Table

[20] The loan accounted for 100% of the funding for the WWTPs while only accounting for 35% of the funding for the trunk and secondary sewer lines.

[21] The IDB estimate makes it possible to compare only trunk lines in the Alegria WWTP service area. At the time of appraisal, the EIRR for these trunk lines was estimated to be 32.5% and the post-project recalculation puts it at 19%.

8. The staffing level is less than half of the assumed level at the time of appraisal. Even though the WWTPs are not fully operating because of an insufficient incoming sewage volume, the CEDAE admits that there is a shortage of staff.

Table 7 Staff Deployment at WWTP

(Unit: persons)

WWTP	Alegria	Pavuna	Sarapui
Operation			
Engineer/Operator	26	15	15
Office Servant	5	4	5
Other	5	2	2
Maintenance			
Engineer	2	2	
Mechanic	3	5	
Electrical Engineer	4	4	
Other	3	1	
Total	48	27	28

Source: CEDAE

Note: Totals for Pavuna and Sarapui were given considering half of the persons who work both for Pavuna and Sarapui WWTPs.

Each WWTP has its own workshop and conducts equipment repair as well as the processing of simple parts. A maintenance contract with an external company covers the repair of some special pumps and sludge centrifugal dewatering units in the case of the breakdown of such equipment.

The Office of Major Repair of the CEDAE is responsible for the operation and maintenance of the trunk lines (pipe diameter of 500 mm or more). Sewer networks other than those in Meriti are operated and maintained by local offices of the CEDAE. Several sewer line teams in possession of appropriate equipment and tools are deployed at each local office. According to these local offices, while the number of teams is insufficient, their response is adequate except during the rainy season when many sewer lines are flooded by rain.

The municipality of Meriti located in the Pavuna and Sarapui WWTP service areas has decided to proceed with its own sewerage service by not renewing the sewerage concession with the CEDAE in view of the slow progress of the sewerage system development by the CEDAE. The city administration has been examining the feasibility of outsourcing the maintenance work but no concrete plan or organizational arrangements for such outsourcing have been decided as of December, 2012.

3.5.2 Technical Aspects of Operation and Maintenance

Field visits to and interviews at WWTPs found that the CEDAE has the technical capability to conduct the simple repair of pumps, etc. and to process certain parts in-house. Manuals for electromechanical equipment and systems are stored at each WWTP and are regularly referred to. Each WWPT has its own laboratory to conduct water quality inspection and microbiological testing. The high level of treatment efficiency indicates an in-house capacity to adequately manage secondary treatment using microbes. In 2009, the CEDAE introduced an in-house university system with which training are provided in an organized manner for the capacity building of its staff members.

The results of interviews with those working at the CEDAE and observation of the maintenance conditions of various facilities, however, suggest that the CEDAE is less capable of adequately planning and managing maintenance work at sewage treatment facilities. No plans are prepared to regularly appraise the need for the maintenance, inspection and repair of equipment and the management of such works. There is no maintenance plan for individual equipment and operation records for individual equipment are not prepared except in the case of some equipment subject to a maintenance contract.

In short, although the CEDAE possesses the skill to conduct the basic operation of electromechanical equipment and simple repair, it lacks the know-how and system to implement preventive maintenance. In regard to preventive maintenance at WWPTs, JICA is planning to implement a technical cooperation "The Project of Training in Operation and Maintenance of Sewerage System".

3.5.3 Financial Aspects of Operation and Maintenance

The water and sewerage charge is the main source of income for the CEDAE. As shown in Table 9, both the operating income and EBITDA margin increased between 2010 and 2011, improving the overall profitability. As the net D/E ratio (debt ratio) is less than 1, financial stability of the CEDAE is strong.

Table 9 Financial Status of the CEDAE

(Unit: R$ million)

	2010	2011
Gross Operating Income	3,231	3,516
Net Operating Income	2,884	3,167
EBITDA	880	842
EBITDA Margin	30.5%	31.3%
Net D/E Ratio	0.40	0.49

Source: Annual Report of the CEDAE

Note: EBITDA = Earnings Before Interest, Taxes, Depreciation and Amortization

According to the CEDAE, there are sufficient financial resources to operate the WWPTs and no operational problems have so far arisen. However, the same cannot be said in regard to maintenance given the fact that many equipment and systems are awaiting repair. The results of interviews with front-line workers also support this view. The procurement of materials and services is a lengthy process as the arrangement of a tender by the Department of Engineering, Construction and Project is required for any procurement needs which exceed R$ 16,000 (approximately ¥800,000). Along with the lack of any preventive maintenance, this lengthy process is believed to be one of the principal factors for the present inoperable state of some equipment at the WWPTs due to the lack of swift repair.

Table 10 shows the expenditure for the operation and maintenance of the WWPTs from 2009 to 2011 (excluding the personnel cost, electricity cost, chemical cost and expenditure for maintenance which is procured through a tender).

Table 10 Operation and Maintenance Expenditures of WWTPs

(Unit:R$ thousand)

	Alegria WWTP	Pavuna and Sarapui WWTPs
2009	167	126
2010	273	198
2011	257	195

Source: CEDAE


Primary treatment facility not available for operation (Alegria WWTP)

Sludge Centrifugal Dewatering Units waiting for repair (Alegria WWTP)

Secondary treatment facility not available for operation (Pavuna WWTP)

Workshop (Pavuna WWTP)

Maintenance works of sewer

3.5.4 Current Status of Operation and Maintenance

(1) WWTPs

All of the WWTPs have so far been in continual operation without any lengthy stoppage. Although there is subsidence at the Alegria WWPT due to it being located on reclaimed land, the civil engineering facilities supported by piles have been adequately functioning. The civil engineering facilities at the other WWTPs have not posed any maintenance problems.

There is no preventive maintenance regime for electromechanical equipment and the necessary parts must be procured for equipment repair whenever equipment breakdown occurs. Operation and maintenance records are not kept for individual equipment except for some pumps and sludge centrifugal dewatering units for which a maintenance contract has been concluded. Simple equipment can be repaired at the in-house workshop at each WWPT. Because of a lack of funds, general parts may be procured for processing in-house instead of the procurement of genuine parts.

According to information provided by the CEDAE, some 30% of the electromechanical equipment at the Alegria, Pavuna and Sarapui WWPTs require repair as of December, 2012 and are currently not functional. Some equipment, including those of the primary treatment facility at the Alegria WWPT, require renewal as they are beyond repair. The equipment and system maintenance conditions are generally poor. Much rust is visible and hardly any repainting has been conducted. Because the incoming sewage volume is substantially below the treatment capacity, treatment has continued with little disruption by means of mobilising reserve equipment in place of the broken-down equipment. The situation where it is not urgently necessary to repair broken-down equipment has actually worsened the overall operational status of the WWPTs. At the Penha WWPT, deteriorated equipment is simply left unused instead of being renewed, and as a result, it has been necessary to restrict the volume of sewage accepted by the WWPT.

(2) Trunk Lines and Sewer Network

Trunk lines are cleaned before a carnival and other major events and when a decline of the flow rate is reported by a WWPT provided that any blockage or hampered flow can be visually confirmed through manholes. No repair has so far been necessary for the trunk lines constructed under the Project. In the case of the sewer networks, these are cleaned by the local CEDAE office in response to a notification by residents.

In the Pavuna and Sarapui WWPT service areas, there has been an increase of the number of areas where underground sewer pipes unused for a long time have become blocked by muddy rainwater or sewage discharged via drain pipes illegally connected to them by owners of nearby houses.[22]

As described above, the operation and maintenance system of the CEDAE is generally adequate as far as the sewage collection facilities are concerned. However, some of the equipment and systems at the WWTPs do not operate properly, partly because of the manpower shortage and partly because of the lack of proper funding for equipment maintenance. The lack of any preventive maintenance has exacerbated this inadequate maintenance situation. In Meriti where the municipal authority has opted for an independent sewerage maintenance system, the system has not yet been fully established. Based on the above observations, the sustainability of the Project is judged to be low.

4. Conclusion, Recommendations and Lessons Learned

4.1 Conclusion

The Project was implemented to improve the hygiene environment for residents and to reduce the inflow volume of pollutants to the said bay by means of constructing sewerage facilities in the western part of the Guanabara Bay Basin in the State of Rio de Janeiro. As the purpose of the Project was consistent with not only the development policies and needs of the aforementioned state but also with the ODA policy of Japan, the overall relevance of the Project is high. While highly efficient secondary treatment facilities were constructed, the actual sewage treatment volume remained as low as some 30% of the planned volume due to the incompletion of some of the planned sewage collection facilities. As a result, the pollutant reduction volume was approximately 70% of the planned level.

[22] Refer to footnote 17 for the relevant projects funded by IDB loan.

Some areas where the sewerage system was completed have seen an improvement of the hygiene environment. Flow of pollutant to the Guanabara Bay has been reduced, while no significant improvement of the water quality has been observed in the bay. Given the limited impact, the effectiveness of the Project is judged to be fair. While the project cost remained within the planned budget, the project period substantially exceeded the planned period. Given the fact that not all of the sewage collection facilities had been completed at the time of the ex-post evaluation, the efficiency of the Project is evaluated to be low. Meanwhile, the insufficient budget for equipment maintenance at the wastewater treatment plants (WWTPs) and its delayed execution, the insufficient deployment of manpower coupled with the lack of a preventive maintenance system is responsible for the inadequate maintenance of some equipment. In Meriti which is included in the project area and where the municipal authority has taken the responsibility to operate and maintain the sewerage system, neither the organizational set-up nor the organizational capacity to properly execute the work has yet been firmly established. Accordingly, the sustainability of the Project is judged to be low.

4.2 Recommendations

4.2.1 Recommendations to the CEDAE and Meriti Municipality

- The CEDAE should urgently complete the construction of the trunk lines and sewer network so that the treatment capacity of the three new WWPTs constructed under the Project is fully utilized. In addition, the construction of an additional secondary treatment facility at the Alegria WWTP should be urgently realised. At the Penha WWTP, given the ongoing process of deterioration, investment in new equipment should be realised to restore the plant's treatment capacity.

- Using the technical cooperation schedule of JICA, the CEDAE should proceed with technical analysis and system development to achieve an appropriate operation and maintenance system, including preventive maintenance, at all of the WWTPs. For this purpose, the CEDAE should prepare a facility rehabilitation plan as well as an operation and maintenance plan for each WWTP and should make the appropriate budgetary arrangements.

- The Municipality of Meriti should urgently establish the sewerage operation and maintenance system. The CEDAE should coordinate with the Municipality of Meriti fully and provide necessary information to the municipality.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

- In the case of a sewerage project which includes the construction of a WWTP(s), it is essential to construct appropriate sewage collection facilities at the same time. In the present Project, significant delays in construction of sewage collection facilities compared to the early completion of the WWTPs hampered realization of project benefit. In this regard, the following issues must be carefully considered in planning and implementation of such projects.

    - Even when the project implementing body has expressed its commitment to funding, the feasibility of such funding should be carefully analysed without prejudice. In order to minimize risks associated with funding limitations, planning should take into consideration such measures as appropriate share of funding by the implementing body, phased implementation, etc. If a change of government is foreseen during the implementation period, more cautious preparation is required.

    - If the implementing body is judged to have sufficient financial capacity compared to the size of the contract, it is desirable to include a part or the entire sewage collection facility in the same

package with the WWTP(s). By including sewage collection and treatment facilities together in one package would increase the probability of realization of project benefit.

- When the contract for the sewer collection facility is independent from the contract for the WWTP(s), it should be divided into lots of a suitable size to match the feasible funding. In deciding the way of division and the order of implementation of collection facilities, dates of completion and commissioning of the WWTP(s) should be well considered, so that the probability of realization of project benefit could be maximized by synchronizing the completion of WWTP(s) and the completion of collection facilities close to the WWTP(s).
- The construction plan for the sewage collection facility must ensure that sewers closer to the WWTP(s) are completed earlier so that the risk of unconnected and buried sewer due to unforeseen suspension of construction works can be minimized.

Comparison Between the Original Plan and the Actual Results

Item	Original Plan	Actual Results (As of December, 2006)
Outputs	1) Alegria WWTP Primary treatment: 4m^3/s Trunk lines: 23.1km 2) Penha Sludge centrifugal dewatering units: 4 units 3) Sarapui WWTP Primary treatment: 1m^3/s Trunk lines: 18.2km Sewer network: 289.4km Pumping stations: 7 locations 4) Pabuna WWTP Primary treatment: 1m^3/s Trunk lines: 30.7km Sewer network: 373.8km Pumping stations: 10 locations 5) Consulting Services	1) Alegria WWTP Primary treatment: 5m^3/s Secondary treatment: 2.5m^3/s Trunk lines: 14.0km 2) Penha Sludge centrifugal dewatering units: 4 units 3) Sarapui WWTP Primary treatment: 1.5m^3/s Secondary treatment: 1.5m^3/s Trunk lines: 17.0km Sewer network: 150.8km Pumping stations: 0 locations 4) Pabuna WWTP Primary treatment: 1.5m^3/s Secondary treatment: 1.5m^3/s Trunk lines: 9.3km Sewer network: 83.8km Pumping stations: 0 locations 5) Consulting Services
Project Period	January,1994 to December, 1998 (60 months)	March, 1994 to December, 2006 (213 months)
Project Cost - Japanese ODA Loan Portion - Executing Agency - Total - Exchange Rate	 ¥31,475 million ¥29,899 million ¥61,374 million US$ 1= ¥133	 ¥31,436 million ¥18,213 million ¥49,650 million 1Real= ¥46.25 (Average: 1994 – 2006)