China

Ex-Post Evaluation of Japanese ODA Loan

Suzhou Water Environmental Improvement Project

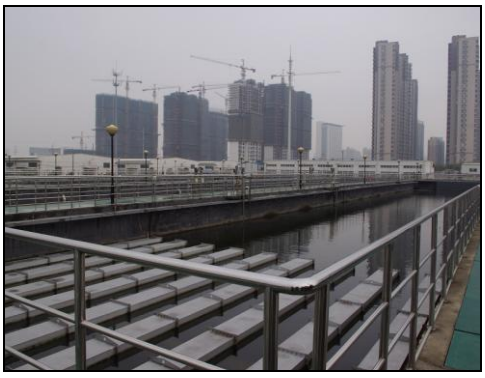
External Evaluator: Kenji Momota, IC Net Limited

0. Summary

The improvement of water quality for Suzhou City, with its extensive network of waterways, had been a major public environmental issue requiring prompt attention. Since the completion of the project, the sewage treatment plant has been operating smoothly, achieving remarkable outcomes including a more than 50% improvement in the quality of water in the city's waterways. The objective of the project can generally be described as having been achieved, as evidenced by the opinion of many city residents who acknowledged the improvement in water quality, as well as by the healthy growth of the city's tourism industry. The Suzhou City government places a high political priority on water resources; hence, no problems are anticipated in terms of the technical and financial sustainability of the project. In the future, it will be necessary to convert the sludge treatment method from that of the currently employed landfill method to one of incineration or other more advanced technologies. In the light of the above, this project can be evaluated as highly satisfactory.

1. Project Description

Project Location



Fuxin Treatment Plant

1.1 Background

The Province of Jiangsu in southern China comprises Shanghai and other large cities, and as of 1997 ranked second in economic size. The city of Suzhou, located in the south of the province, has the status of a major city; it is enjoying growth as a tourist destination with its many World Heritage sites in addition to its importance as an industrial city. Suzhou is also known for its abundant water resources: it is surrounded by numerous lakes, large and small, as well as by the Beijing-Hangzhou Grand Canal, and within the city there is an extensive network of waterways. As much as 43% of the city's surface area is water.

The rapid growth in Suzhou's economy and population since the 1980s increased the amount of sewage and industrial effluent. However, the treatment facilities were poor in both coverage and efficiency. A large portion of the wastewater was discharged to the city's waterways without proper treatment to meet the national quality standards, thus aggravating the problem of water pollution. Furthermore, the 1992 diversion work of the Beijing-Hangzhou Grand Canal and other measures reduced the volume of water flowing into the city waterways. Accordingly, the natural purification capacity decreased and water pollution became more serious. The quality of water in the city's waterways failed to meet even the Classs V water quality level, which is the lowest rank in China's national water quality standards.

Fig. 1 A Waterway Before the Project

Fig. 2 A Highly Eutrophic[1] Waterway

[1] Eutrophication refers to the phenomenon of lakes and other closed water areas receiving an inflow of nitrogenous compounds, phosphates and other nutritious salts from the basin over a long period of time and transforming into nutrient-rich lakes with high rates of biological production. In an eutrophic lake, toxic substances such as algae and the like proliferate; they consume much of the oxygen in the water, leaving the lake poor in oxygen and killing aquatic life. The water quality deteriorates, the clarity decreases, bad odors are released, and the color turns green, brown, or red brown.

1.2 Project Outline

The objective of this project is to improve the water quality of rivers in the city of Suzhou, Jiangsu Province, by constructing a sewage treatment plant and sewer systems to increase the sewage treatment capacity, and thereby contribute to an improved living environment for citizens.

Loan Approved Amount/ Disbursed Amount	6,261 million yen / 6,261 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2000 / March 2000
Terms and Conditions	Interest Rate: 0.75% Repayment Period: 40 years (Grace Period of 10 years) Conditions for Procurement: Bilateral; tied
Borrower / Executing Agencies	People's Republic of China/Suzhou People's Government, Suzhou Qingyuan Construction & Development Company
Final Disbursement Date	July 2007
Main Contractor	Sainty International Group Jiangsu Machinery I/E Corp Ltd. (People's Republic of China)
Main Consultant	
Feasibility Studies, etc.	"Feasibility Study on Water Environment Comprehensive Improvement Project in the Urban Area of Suzhou" (Suzhou CIECC Engineering Consulting Co., Ltd. / Suzhou Qingyuan Construction & Development Company, 1998)
Related Projects (if any)	"China–Tai Basin Urban Environment Project" (World Bank, 2004)

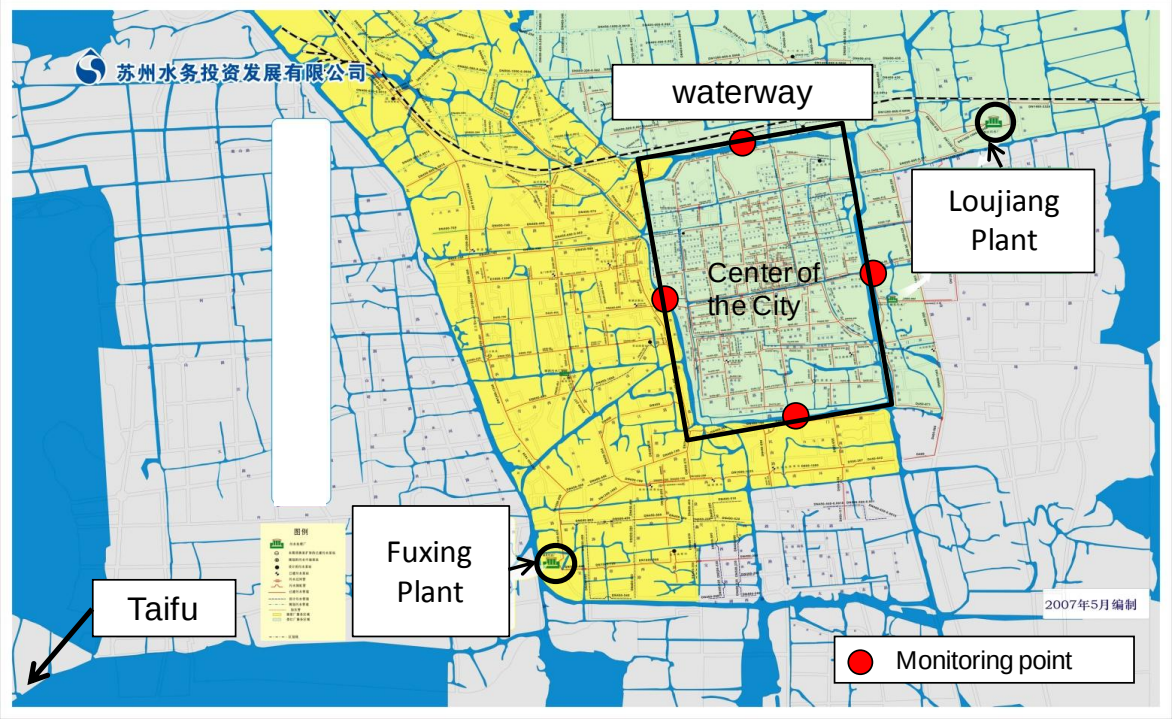


Figure 3 Suzhou City Zone and Project Sites

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenji Momota, IC Net Limited

2.2 Duration of the Evaluation Study

For the purpose of this ex-post evaluation, studies were made in the following periods:

Duration of the Study: November 2010 – November 2011

Duration of the Field Study: February 26, 2011– March 9, 2011 and June 4, 2011–June 11, 2011

2.3 Constraints during the Evaluation Study

None of significance

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

3.1 Relevance (Rating: ③[3])

3.1.1 Relevance to the Development Policy of China

(1) Development policy at the time of project appraisal

Since the 1980s, China's rapid industrialization and urbanization have increased the urgent demand for potable and industrial water. This situation aggravated the problem of water quality deterioration. As a result, the Chinese government made the improvement of environmental water quality a high, long-term priority that became part of its basic policy. The national environmental standards, including those of water quality, have been tightened a number of times. With respect to lakes, in particular, the problem was serious in the Three Lakes (Lake Tai, Lake Chao, and Dian Chi). The most important policy item identified in the Ninth Five-Year Plan (1996–2000) was the improvements of urban sewer systems, along with the tightened control of industrial effluents, to control wastewater inflow into rivers and lakes in order to secure safe water sources.

Table 1 Water Quality Improvement Targets in Suzhou

Targets	By 2000	By 2010
Beijing-Hangzhou Grand Canal and waterways	Class IV - V	Class IV
Potable water source Class 1 protected zone	Class II	Class II
Lake Tai, Yangcheng Lake, other rivers and lakes	By district	n.a.

In pursuit of these targets, the Province of Jiangsu established the Jiangsu Province Lake Tai Water Pollution Control Ordinance in 1996, which provided for the formulation and implementation of a plan to improve sewer treatment facilities and for ordinances to protect waterways.

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

The Eleventh Five-Year Plan (2006–2010) set out a policy to strengthen environmental protection measures, calling for the implementation of ten major environmental protection projects. Of these, water quality improvements were given a high priority. Thus urban sewage treatment was considered crucial, hence, the specific target of treating 70% of sewers nationally.

The Suzhou Municipal City Government recognized that improvements to the water resource environment of the city were vitally important, because it is closely linked to the city's socioeconomic life. Accordingly, it promotes investment plans on a continual basis. The "City Total Development Plan (1996–2010)" of Suzhou City, which may be regarded as the city's urban planning master plan, cites improvements and conservation of the water environment as a major objective. Specific water resource environment improvement plans are implemented in accordance with the long-term plan, the "Suzhou Municipal City Urban Water Environment

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

[3] ③: High; ②: Fair; ①: Low

Improvement Plan (2007–2020).” Capital investment projects, for which the total cumulative expenditure will amount to 836 million Yuna (approximately 10.8 billion yen), are planned for the modernization of existing facilities, the extension of the sewer network, and the improvement of river channels. Options for fund raising have been explored, including the BOT scheme[4] and other private investments.

In line with the above policy, the Suzhou Qingyuan Construction & Development General Company, which is the executing agency of this project, will be involved in the extension and upgrading of the treatment plant (Phase II Project), and in river improvement and conduit projects on a continual basis, even after the completion of the project. By way of background, an interview with the president[5] of the executing agency confirmed that the project under evaluation was critical in encouraging and facilitating investment in these subsequent projects. The project under evaluation has triggered the need for this series of sewage treatment projects up to the present.[6]

3.1.2 Relevance to the Development Needs of China

Suzhou, while important as a major industrial city in Jiangsu Province, is famous also as a tourist destination[7] with a 2,500-year history. The rivers and canals that run through the city have themselves been an important element of this scenic beauty. At the time of planning the project, Suzhou had insufficient wastewater treatment capacity to cover the increasing discharge of household sewerage and industrial effluents caused by rapid economic growth and population increase. Pollutant removal measures were inefficient and even the treated water often did not meet its standards. In addition, the canal diversion work carried out during the 1990s roughly halved the flow rate of waterways in the city; in particular, the volume of Lake Tai water that was of relatively good quality decreased, thus exacerbating the problem of poor water quality. As a result, the quality of water in the city’s waterways failed to reach even the lowest national standard (Grade V), requiring urgent attention in terms of both improvements to the living environment and protection of the scenic beauty.

Subsequent to the implementation of the project under evaluation, Suzhou has continued its economic and urban growth and there is greater need than ever for sound sewage treatment. The need for water quality improvement in the project location remains critical.

[4] BOT (Build, Operate, Transfer) scheme: a scheme under which a private sector enterprise builds, operates, maintains, and manages, in most cases, a public facility with its own funds and transfers the ownership of the facility to the public sector at the end of the contracted period of operation.

[5] A position in a Chinese business enterprise, corresponding to the representative director in a Japanese business enterprise

[6] Projects that were implemented after the project under evaluation include (i) the Phase II expansion of the Loujiang and Fuxing Treatment Plants, (ii) upgrading of city center treatment plants, (iii) rainwater/sewerage separation and branch line/user connection, (iv) Xitang river channeling, (v) city center comprehensive river management, and (vi) city center flood control.

[7] Four gardens in the city were designated as World Heritage sites in 1997.

3.1.3 Relevance to Japan's ODA policy

The Country Assistance Program for China in effect at the time of this project appraisal cited environmental protection as one of its areas of focus, and laid out a policy of promoting assistance for sewage treatment and other water pollution control measures in line with the needs of China. Further, the Medium-Term Strategy for Overseas Economic Cooperation Operations then in effect for China[8] identified the environment, agriculture, and reduction of regional differences through inland development as three major areas of priority. This project under evaluation is an environmental protection project in the city of Suzhou where the water resource environment is very closely related to the living environment of residents. It was in line with the Country Assistance Program and the Medium-Term ODA Strategy for China, and it is adjudged to have played an important role in the development of the Program and Strategy.

As described above, this project has been highly relevant to the country's development plan and development needs, as well as to Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The table below summarizes the comparison between the planned and actual selected project output parameters. The project under evaluation was generally implemented as planned.

Output	Plan	Actual
1) Sewage treatment plants		
1. Loujiang Plant		As planned
Daily treatment volume	60,000 m^3/d	(expanded to 140,000 m^3/d by now)
2. Fuxing Plant		As planned
Daily treatment volume	80,000 m^3/d	(expanded to 180,000 m^3/d by now)
		*For both plants, deodorization units were procured in addition.
3. Sewer line		
Network improvement	Total 110 km	Total 108 km
Sewer system repair	19 connections	As planned
4. Pumping stations	20 locations	As planned
2) Waterway improvement and channeling		
1. Waterway improvement		
Dredging	65.3 km	As planned
Broadening	4.4 km	As planned
Bridge upgrading	21 locations	As planned
2. Channeling (Lake Tai)		
Intake volume	350,000 m^3/d	As planned
Conduits	29.1 km	As planned

[8] The Medium-Term Strategy for Overseas Economic Cooperation Operations was a document that was prepared by JICA every three years, on the basis of MFA's ODA Charter and the Medium-Term Policy on ODA.

Pumping station	1 location	As planned

Major changes from the original plan are as follows:

- The discharge outlet of the Loujiang Sewage Treatment Plant was originally designed to be situated upstream of Jinji Lake in the development zone. The outlet was installed downstream to avoid negative impact on water quality of Jinji Lake.
- Additional deodorization units were procured because increased housing development in the neighborhood of the construction sites meant the odor from the plants would become a potential problem[9].

To respond to the increased demand for sewage treatment after the completion of the project, a Phase II treatment capacity extension project was implemented with World Bank assistance. The current capacity is double that of the original (320,000 m^3/day). A Phase III project was then implemented in order to respond to the upgraded national standards for environmental and water quality[10]. The last project sought to raise the treatment capacity of pollutants that had not been included in the original design. It was completed at the end of 2010. In addition to the above-mentioned odor prevention measures, further deodorization/upgrading works are underway at the Fuxing Plant. Previously, the plant was located in a suburban area with few houses in the neighborhood and, therefore, no particular odor prevention measures were taken; however, subsequent economic growth stimulated housing development projects in the vicinity and deodorization became necessary to accommodate nearby residents.

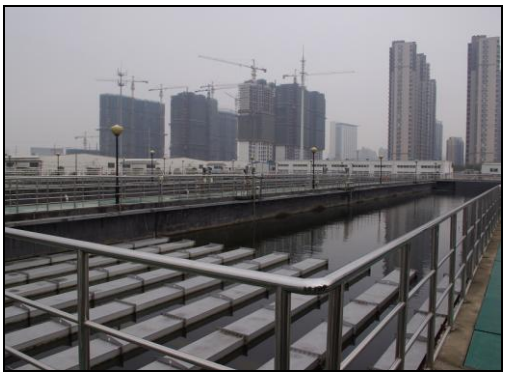


Fig. 4 Biological Reaction Pond, Fuxing Plant

Fig. 5 Waterway Alongside Houses

[9] The additional procurement amounted to approximately 500 million yen, which was financed by the ODA project loan. Efforts at odor prevention continue; at the time of ex-post evaluation, additional work in covering the reaction pond was underway.

[10] The equipment that was renovated or added included graded frames, an aeration sand settling tank, an improved alternating biological reaction vessel, and a blower room and power distribution room for the secondary reaction vessel; their main purpose was to achieve the national discharge standard of Class 1-A/1-B.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost amounted to 17,067 million yen (of which 6,261 million yen was ODA Loan), a slight increase over the planned cost of 16,578 million yen (of which 6,261 million yen was ODA Loan). The total cost includes approximately 510 million yen, accounting for the additional procurement of the deodorization unit. The actual cost of completing the original project was 16,558 million yen, which was lower than the planned cost (99.87%) due to exchange rate fluctuations and other factors, despite such factors as increases in land acquisition costs (approximately 275 million yen).

3.2.2.2 Project Period

The actual project period was 94 months from March 2000 through December 2007, as against the planned period of 46 months from March 2000 through December 2003. Therefore, the project ran significantly (204%) longer than planned. Major reasons included the following:

- Commencement and completion of the conduit installation work (about 1 km) had to be postponed until 2007 because of a government order to make it coincide with the renovation of the Suzhou railway station.
- Some of the conduit installation locations experienced heavy traffic and the permits from responsible authorities were not granted in a timely fashion.
- Land acquisition negotiations for the pumping stations took longer than anticipated at six locations, including the Baiyangwang and Qimen graded crossings, which led to a delay in starting work.

As described above, although the project cost was within the plan, the project period was exceeded, therefore the efficiency of the project is fair.

3.3 Effectiveness (Rating ③)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) Evaluation perspectives

The operation of the sewage treatment plants was evaluated mainly from the perspective of conformance (or non-conformance) with China's national environmental standards. Normally, evaluation criteria would be whether the performance of the treatment plant reaches the planned capacity and planned effects. However, China's wastewater discharge standards have become more stringent since the project was planned due to a national policy to tighten environmental standards. The sewage treatment plants under the present evaluation have implemented a series of plant extensions and upgrades to cope with the tightening of these standards. It is unrealistic

to measure the plants' performance against the plan because the treatment capacity has substantially exceeded that of the original plan. It is necessary to look at the overall effects of the project, including the measures subsequently added, if we are to make a true evaluation of the effectiveness of the project.

Table 2 National Standards for Treated Effluents

Indicator	When planned Class 1-B standard	Present Class 1-A standard
COD_{cr}[11]	60 mg/l max.	50mg/l max.
BOD_s[12]	20 mg/l max.	10 mg/l max.
SS[13]	20 mg/l max.	10 mg/l max.
NH_3-N[14]	8(15) mg/l max.	5 (8) mg/l max.
TP[15]	1 mg/l max.	0.5 mg/l max.

Source: Discharge standards for pollutants for municipal wastewater treatment plant (GB18918-2002)

(2) Operation of sewage treatment plants

1) Operation of Fuxing and Loujiang Treatment Plants

The two treatment plants can cover the treatment demand far beyond its original estimation, and operating at more than 100% of their rated capacity since they were commissioned. As was reviewed in Efficiency, both plants have been expanded to more than double their original capacities through the Phase II and Phase III projects. The city today has three plants including the Chengdong Treatment Plant that was already in service before the project. Their total treatment capacity has been increased to 320,000 tons/day, which is large enough for the time being to meet the treatment demands of the city.

[11] COD (Chemical Oxygen Demand) = the amount of oxygen consumed to oxidize organic compounds in water by means of an oxidizing agent; used like BOD to indicate the degree of water contamination

[12] BOD (Biochemical Oxygen Demand) = an indicator of water contamination; an especially important indicator for the control of industrial effluents. This is the amount of oxygen consumed by microorganisms to decompose organic compounds in water. The greater the BOD value, the dirtier the water.

[13] SS (suspended solid) = insoluble particle matter suspended in water. This includes minute particles derived from clay minerals, animal and plant plankton and their remnants, organic compounds and metal sediment derived from sewerage and industrial wastewater.

[14] NH_3-N=ammonic nitrogen. A substance generated by the decomposition of proteins, urea, uric acid, etc., and an indicator of nitric contamination. Together with phosphates, ammonic nitrogen accelerates eutrophication.

[15] TP = Total phosphor. The total amount of phosphates in water, expressed as a phosphor concentration. Phosphates are contained in urine, detergents, fertilizers, etc., and total phosphor is used as an indicator of eutrophication. In some closed water areas, it is regulated as a discharge standard.

Table 3 Operation of Fuxing Plant

	Indicator	Unit	Planned	2008	2009	2010	applicable national standard
1	Population coverage	ten thousand				25.4	
2	Treated water	(m^3/day)		79,500	113,000	125,200	
3	Rate of facility utilization	(%)		99.4%	62.8%	69.6%	
4	BOD density (mg/l)	in	180	145.1	139.8	117.4	
		out	30	7	5.1	2.81	Class A
		% of reduction	83.3%	95.2%	96.4%	97.6%	
		Quantity of reducition	4380	4007	5554	5237	
5	COD density(mg/l)	in	360	324.6	332	309	
		out	120	35.7	32	32	Class A
		% of reduction	66.7%	89%	90%	90%	
		Quantity of reducition	7008	8,383	12,374	12,658	
6	SS density(mg/l)	in	250	169	168	171	
		out	30	15	13	10	Class A
		% of reduction	88.0%	91.1%	92.3%	94.2%	
		Quantity of reducition	6,424	4,467	6,393	7,367	
7	NH3-N density(mg/l)	in	35	27.1	25.8	23.3	
		out	25	21	4.4	3.6	Class A
		% of reduction	28.6%	22.5%	82.9%	84.5%	
		Quantity of reducition	292	177	883	898	
8	TP density(mg/l)	in	4	3.7	4.19	3.72	
		out	1	1	0.95	0.51	Class B
		% of reduction	75.0%	73.0%	77.3%	86.3%	
		Quantity of reducition	88	78	134	147	
9	Quantity of treated sludge	t/year		23,599	28,684	44,032	
10	Rate of sludge recycle	(%)		100	100	100	

Source: Suzhou Qingyuan Construction & Development Company

The pollutant reduction rates at the plants had reached almost 90% by 2010 by most indicators. The design targets of post-treatment water quality and reduction rates have generally been met. The present level of treatment efficiency conforms to the original target for Class 1-B standards in all aspects. Conformance to the new target for Class 1-A standards is also considered fairly satisfactory, with all aspects being met with the exception of SS and TP.

Table 4 Operation of Loujiang Plant

	Indicator	Unit	Planned	2008	2009	2010	applicable national standard
1	Population coverage	ten thousand				20.2	
2	Treated water	(m^3/day)		61,200	124,000	123,900	
3	Rate of facility utilization	(%)		100%	89%	89%	
5	BOD density (mg/l)	in	180	95.3	102.7	111	
		out	20	6	4.01	2.99	Class A
		% of reduction	89%	94%	96%	97%	
		Quantity of reducition	3,504	1,995	4,467	4,885	
6	COD density(mg/l)	in	360	231.3	249	259	
		out	60	29.4	27.8	25.8	Class A
		% of reduction	83%	87%	89%	90%	
		Quantity of reducition	6,570	4,510	10,012	10,545	
7	SS density(mg/l)	in	250	119	124	124	
		out	20	13	12	11	Class B
		% of reduction	92%	89%	90%	91%	
		Quantity of reducition	5,037	2,368	5,069	5,110	
8	NH3-N density(mg/l)	in	35	24	23	23.3	
		out	15	4.6	2.52	3.64	Class A
		% of reduction	57%	81%	89%	84%	
		Quantity of reducition	438	433	927	889	
9	TP density(mg/l)	in	4	3.4	3.76	3.72	
		out	0.5	0.8	0.75	0.51	Class B
		% of reduction	88%	76%	80%	86%	
		Quantity of reducition	77	58	136	145	
10	Quantity of treated sludge	t/year		13,635	24,104	28,409	
11	Rate of sludge recycle	(%)		100%	100%	100%	

Source: Suzhou Qingyuan Construction & Development Company

(3) Channeling operation

The water intake operation from Lake Tai is operating as summarized below. Since the quality of the city's waterways has improved and integration with other water channeling operations has advanced, the emphasis of the project's channeling operation has shifted from stimulating water circulation so as to improve its quality to transmitting source water for the city's tap water system.

Table 5 Status of Channeling Operation

	Planned	2008	2009	2010
Intake (10,000 m^3/d)	35	31.9	23.8	18.8
Portion for tap water		9.9	9.8	9.8
Portion for circulation		22	14	9
Annual channeling days	300	365	365	365
Portion for tap water		365	365	365
Portion for circulation		22	16	10

Source: Suzhou Qingyuan Construction & Development Company

In 2010, channeling for waterway circulation purposes was performed during only ten days in the year, implicating that the water quality had improved significantly. The water transmission function operates throughout most of the year, proof that the ODA facilities are effectively utilized. In a parallel effort, Suzhou City implemented the Xitang River channeling project. This project is designed to introduce Yangtze River water into the city's waterways through the Xitang and Wangyu Rivers with a view to increasing the water volume and natural cleansing capacity of the river and water environment in the city. By now, its operation is coordinated with those of the Lake Tai channeling operations of the ODA project.

Fig.6 Water Intake at Lake Tai Shore

Fig.7 Intake Pumping Station

(4) Water quality improvement of city's waterways

The project was implemented to reduce the direct discharge of wastewater into the city's rivers and waterways by constructing and improving sewage treatment plants, sewer systems, and waterways; thereby contributing to improved water quality in the rivers and waterways. The table below summarizes the quality of water at key locations in the city's rivers and waterways (city center and inner moats). National standard IV, which represents the quality level required for scenic waters, is met at all locations.

As Table 6 shows, improvements of roughly 50% or more can be observed in terms of COD, BOD, and other indicators over pre-project levels. Remarkable improvements were seen in the quality of the waterways. A sampling survey that was carried out at five locations in the city

during the Field Evaluation Study confirmed sustained good water quality, with no apparent contamination or eutrophication. In addition, the effect of the sewage treatment project was confirmed through the positive responses (awareness of and appreciation for the improved water quality) of a number of respondents in the beneficiary survey, which will be detailed later in this report.

Table 6 Improvement of Water Quality in the City's Waterways

(Unit: mg/l)

		Pre-project		Present		
		1998	1999	2008	2009	Change from 1998
Xiangmen Bridge	COD[16]	38.9	39.1	22.23	20.21	-48%
	BOD	8.1	8.2	4.6	3.7	-54%
	NH_3-N	1.89	1.91	1.53	1.04	-45%
	TP	1.58	1.59	0.75	0.52	-67%
Pingmen Bridge	COD	39.3	39.2	23.4	21.32	-46%
	BOD	7.9	8.0	4.7	3.6	-54%
	NH_3-N	1.88	1.92	1.49	1.09	-42%
	TP	1.63	1.63	0.72	0.49	-70%
Guxu Bridge	COD	39.6	39.5	22.14	20.18	-49%
	BOD	8.3	8.1	4.9	3.8	-54%
	NH_3-N	1.91	1.9	1.44	1.16	-39%
	TP	1.59	1.63	0.67	0.46	-71%
Renmin Bridge	COD	39	39.3	21.98	20.01	-49%
	BOD	8.2	8.3	4.5	3.3	-60%
	NH_3-N	1.9	1.93	1.5	1.13	-41%
	TP	1.59	1.6	0.65	0.53	-67%

Source: Suzhou Environmental Protection Bureau

Fig. 8 A section of the City's Waterways

Fig. 9 Grand Canal in a City Suburb

[16] The documents for project appraisal used CODmr as the COD value. Since the value currently in use is CODcr, a comparison between the project appraisal and ex-post evaluation was made by collecting new corresponding data. There are two measurement methods for COD: the CODMn method that expresses oxygen consumption in potassium permanganate-based oxidation is widely used in Japan, while the CODcr method that employs the oxidation reaction by potassium dichromate is prevalent in China. Potassium permanganate is less potent as an oxidant. If an identical sample is analyzed by the two methods, CODMn gives a lower value (about one-third of the CODcr value).

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

The financial internal rate of return (FIRR) for the project was recalculated on the basis of the assumptions made at the time of project planning, incorporating the actual data. The recalculated FIRR is 1.86% against the original 6.2%. Major reasons for this deterioration include the increased cost of sewage treatment and the lower-than-anticipated sewage treatment fee. The sewage treatment cost (expenses) was estimated to be 0.6 Yuan/m^3 in the project plan, but the actual cost has risen to 0.65 Yuan/m^3. Moreover, the sewage treatment fee (benefit) was to start at 0.6 Yuan/m^3 and be raised every year to ultimately be 1.4 Yuan/m^3. In reality, the fee started at the level of 0.4–0.55 Yuan/m^3 and is now set at 1.15 Yuan/m^3. This narrower margin than that in the original plan has apparently resulted in the low FIRR. In an interview with the executing agency, it was explained that sewage treatment is by nature a public work and the current fee level is not intended to stress profitability but rather to recover the costs directly required for the sewage treatment operation.

Assumptions	Plan	Ex-post Evaluation (in 2011)
1.Expenses: initial capital investment, operating and maintenance costs 2. Benefit: sewage treatment fee income	**FIRR 6.2%**	**FIRR 1.86%**

3.3.2 Qualitative Effects

The project has brought about qualitative effects including better city scenery due to improved water quality and a better living environment. These will be discussed in detail in the Impact section.

As described above, this project has largely achieved its objectives, and therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

The project had the objective of contributing to the improved water quality of the city's rivers and waterways and the improved living environment of residents through improvements to sewage treatment facilities. In this section, we analyze the results of a survey that was conducted to assess the impact of the treated effluents on the quality of water in the rivers and waterways as well as to ascertain any changes in Suzhou citizens' awareness regarding their water environment.

3.4.1.1 Water quality of rivers and other water sources in the vicinity of the sewage treatment plants

As Table 7 shows, the quality of river water near the effluent discharge points[17] of the Loujiang and Fuxing treatment plants has been continually improving. At most of the monitoring points, the national standard for surface water Class IV has been met. The quality of river water is affected by the degree of contamination of water upstream and other factors, and it is not possible to clearly link water quality improvements with the project. However, the quality of effluents discharged into rivers from the project plants conforms to national standard Classes 1-A or 1-B, meaning that the quality has been improved to levels that do not leave an adverse impact on river quality. The discontinuation of discharges of untreated sewerage likely contributed to these improvements.

Table 7 River Water Quality near Loujiang and Fuxing Plant Discharge Points

1) Near discharge point of Loujiang Plant					
Monitoring point	Indicator	2003	2008	2009	National standard
Zhujiacun	COD_{mn} (mg/l)	6.2	5.0	4.7	50
	BOD (mg/l)	3.7	2.8	2.4	10
2) Near discharge point of Fuxing Plant					
Monitoring point	Indicator	2003	2008	2009	National standard
1.Qinghua warehouse	COD (mg/l)	35.8	25.8	20.2	50
	BOD (mg/l)	5	4.4	4.2	10
2.Changqiao	COD (mg/l)	30.7	20.4	20.2	50
	BOD (mg/l)	4.9	4.1	4.0	10

Source: Suzhou Environmental Protection Bureau

3.4.1.2 Overall water quality improvements in Suzhou

As discussed earlier, the quality of waterways in Suzhou has improved significantly, satisfying the water quality standard Class IV required for scenic waters. The overall sewage treatment coverage ratio is above the target, evidencing that this project and other initiatives of

[17] The two treatment plants discharge effluents to the Loujiang River (Loujiang Plant) and Beijing-Hangzhou Grand Canal (Fuxing Plant), respectively.

the city in support of water quality improvements have been effective. The president of the Suzhou Qingyuan Construction & Development Company stated in an interview during our field survey that the implementation of the project as planned and the smooth operation of the sewage treatment plants proved the high project implementation capacity of the executing agency and the effectiveness of sewage treatment in improving water quality, which in turn facilitated fund raising from donor organizations and accelerated the implementation of the Phase II Project and other water quality improvement initiatives. It can thus be said that the project played an important pump-priming role for a number of similar efforts that have ensued.

Table 8 Water Source Environment in Post-Project Suzhou

Indicator	2000	Plan	Actual
Water quality			
City waterways	Class V	Class V	Class IV
Drinking water sources	Class III	Class II	Class II
Sewage treatment			
Treatment ratio	50%	75%	Household 95% Industrial 100%
Sewer system coverage	85%	90%	n.a.

Source: Appraisal document

Note: No official data on sewer system coverage was available from the City Government. However, the executing agency stated that the coverage in the city area (urban area) was over 90%.

3.4.1.3 Improvement to the living environment of residents

One of the objectives of this project was to improve the living environment of residents through the improvement of the quality of the city's waterways. As part of the present ex-post evaluation study, a beneficiary survey was conducted with a view to understand the relationship between water quality improvement and the living environment. A questionnaire was distributed to a total of 100 individuals living or working near a waterway in Suzhou (Qili Shantang Scenic Area and Canglantin) and 98 valid responses were collected. The major results are described below.

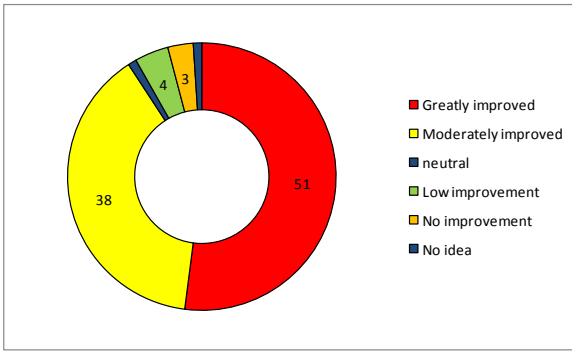


Fig. 10 Appreciation for Water Improvements

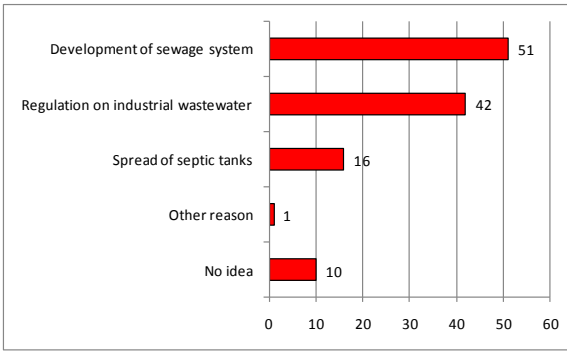


Fig.11 Causes of Water Improvements

Approximately 90% of respondents affirmed the quality improvements of the city's waterways in comparing these before and after the project, evidencing that the improving trend of water quality that we discussed in Section 2.3 was also recognized at the resident level.

Further, approximately half of the respondents cited the installation of the sewage treatment facilities as the cause of the improvement, showing that the project was well known by residents. The reasons for such a high awareness of the sewage treatment facilities are believed to include the presence of treatment plants not far from residential districts, and an environmental education campaign and other initiatives taken by the treatment plants.[18]

With respect to the link between water quality improvements and living environment improvements, approximately 85% of respondents gave positive answers. Specifically, they mentioned the reduction of strange or obnoxious odors from the waterway in front, the reduction of flies and other harmful insects, and better scenery through improved coloring of the water surface. In addition, the waterway improvements have led to wider leisure options in residents' daily lifestyle, such as strolling by the waterway. In this respect, too, the project can be said to have had some impact.

Meanwhile, there were complaints that some residents continues to discharge their household wastewater directly into the waterway. The executing agency has not taken any direct action to address this problem, because it does not have the authority. Continued environmental education is required to alter such behavior, in cooperation with the Environmental Protection Bureau and other organizations.

3.4.1.4 Improvement of scenery and growth of tourism industry in Suzhou

As many as approximately 85% of respondents to the beneficiary survey were aware that their living environment including scenic beauty had improved after the implementation of the project. A clear improvement trend was confirmed. Encouraged by such water quality improvement, the Suzhou City Government has taken a number of initiatives to promote river tourism including the Shantang–Shangtanghe circuit cruise and the Pingjiang Cultural Water Corridor. These and other efforts have resulted in steady growth in the number of tourists visiting Suzhou since the 2000s (See Fig.12).

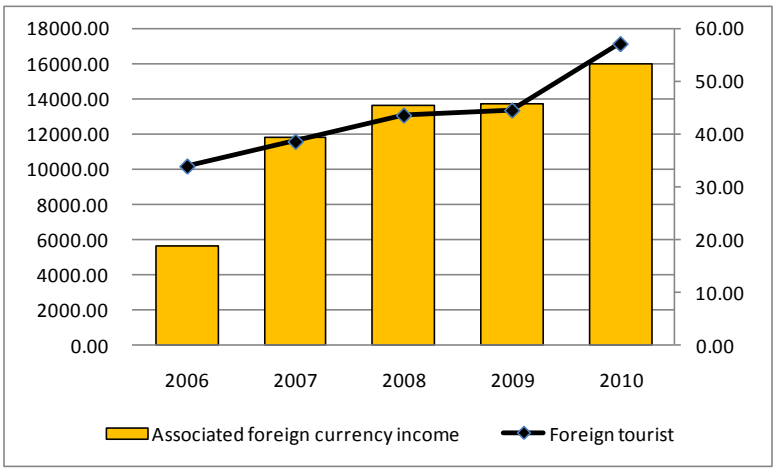


Figure 12 Number of Non-Chinese Tourists and Associated Foreign Currency Income to Suzhou

[18] The executing agency makes public outreach and environmental education efforts by hosting, for example, plant tours for nearby residents several times a year.

Source: Suzhou Tourism Bureau

An interview with the deputy director general of the Tourism Bureau of Suzhou City revealed the following:

- In the last ten years, the number of tourists has increased steadily, at an annual average rate of 14–17 %. It has more than quadrupled from its 2006 level. In terms of income from tourism, the foreign currency income is three times the 2006 level and the total income more than five times.
- The opinions of tourists as expressed in Tourist Bureau questionnaires include much fewer complaints about bad odors from the water compared to before. A visitor satisfaction survey of major tourist cities in China ranked Suzhou in sixth place.
- For Suzhou, which is known as the "Water Castle of the Orient," the sceneries of waterways and water resources are tourism assets. The recent improvements in water quality have had a very positive impact. The 2010 China National Tourism Administration survey on customer satisfaction with regard to tourist cities shows that Suzhou's ranking has moved from 11th to 7th to 3rd in the previous three years, which suggests the increasing attractiveness of Suzhou as a tourist destination.

While it is very difficult to measure quantitatively the contribution of the water quality improvement project to the growth of the tourism industry, the interviews described earlier in this report reaffirmed that waterways and water resources play a very important role in making Suzhou an attractive tourist destination. From this perspective, too, it can be concluded that the project under evaluation and other continued efforts to improve water quality have been contributing positively to the healthy development of the city's tourism industry up to this time.

3.4.2 Other impacts

(1) Sludge disposal: present situation and future challenges

The sludge generated in the process of sewerage treatment is disposed of under a contract with a private sector firm (engaged in farm technology and fertilizer production) located in Changshu in the north of Suzhou. There the sludge is mixed with organic waste to make compost. The firm treats 200 tons of sludge per day. However, a large portion of the compost thus produced is simply stored as stock, because there are not enough outlets for the product. While necessary storage space is said to be secured for the foreseeable future, the development of new sales channels is a challenge for the sustainable circulation of treated materials.[19] The firm making the compost argues that sludge-based compost is little known in the market and, hence, government assistance and other measures are needed to establish the healthy recycling process of sludge treatment–composting–and market distribution on a medium- to long-term

[19] Of the compost produced, 20% is purchased by the government, another 20% is sold through independent channels, and about 60% is kept as inventory.

basis. It is worth mentioning that, as the table below shows, a sampling test reportedly has shown that the quality of well water in the neighborhood of the sludge disposal site (four locations) met the national standards, posing no problems at this point in time.

Table 9 Quality of Well Water in Xuxingcun, Yuexizhen

(Unit: mg/l)

Indicator	Measurement	Standard
COD_{mn}	4.8	n.a.
NH_3-N	0.37	25.0
PH	7.4	6.0 - 9.0

Source: Suzhou Qingyuan Construction & Development Company

Fig. 13 Sludge Treatment in Changshu

Fig. 14 Product Compost

In a discussion with representatives of the executing agency's parent company (Water Affairs Investment Co., Ltd.), it was mentioned that upgrading the sludge treatment through the introduction of recycling, reuse, or other advanced technologies was under consideration but costs and other challenges would have to be properly addressed. The parent company intends to consider this course of action in its future long-term planning. In this discussion, interest was shown in possible technical studies or overseas cooperation regarding economical and efficient options for introducing new technology.

(Reference information) Sludge Treatment in China: Present Situation and Challenges

(1) Present situation of sludge treatment

The demand for sewerage treatment is increasing rapidly in step with nationwide economic growth and urbanization. Since the 1990s, the Chinese Government has focused on the construction and modernization of sewage plants using Japanese ODA and other means. While the infrastructure for sound sewerage treatment has been upgraded to a large extent, the disposal of the sludge that is generated in the process remains a big challenge. The national plan currently in force (the Twelfth Five-Year Plan) estimates 35–60 million tons of sludge is generated annually in the country, indicating an impending issue. Currently, sludge is disposed of mostly by landfill or simple piling. Secondary pollution from organics and heavy metals contained in the sludge poses a genuine risk. The introduction of advanced technologies such as sludge incineration and recycling is considered necessary, especially in coastal areas where landfill sites are increasingly difficult to secure.

(2) Efforts of the Chinese Government

The Chinese Government has put in place a variety of policies and regulations on sludge treatment/disposal; these include "Guidelines on Treatment/Disposal Technologies for Sludge from City Sewage Treatment Plants (2011)" and other measures that set out criteria for the selection of sludge treatment technologies and processes to promote sound management. In recent years, there have been strong initiatives to utilize private sector funds for the construction of sludge treatment plants through BOT and other schemes. Still, challenges remain with respect to such advanced technologies in terms of financing, treatment cost reduction, and the choice of optimum technologies and treatment methods suited to individual local conditions.

Selected list of leading or pilot projects for sludge treatment

Province	Project name	Treatment method and others
Dalian	Dialingdongtaixiajiahe Sludge Treatment Plant	Anaerobic digestion; BOT scheme; model project with German technology
Qingdao	Qingdaomaidao Sewerage Treatment Plant	Anaerobic digestion; generated methane gas used for power generation
Qinhuangdao	Qinhuangdaoivgang Sludge Treatment Plant	Automatically controlled biological composting
Xiamen	Advanced dehydration treatment, recycling disposal and utilization of Xiamen city sludge	Advance dehydration; recycling of dehydrated cake, etc.
Zhejiang	Zhejiang xiaoshan Sludge Drying and Incineration Project	Drying and incineration; incineration slag is used as a cement raw material, etc.

(3) Cooperation by Japan

The Japanese Government has extended indirect cooperation through, for example, seminars organized by JICA to present the sludge treatment technologies of Japanese companies. In addition to the continuation of such seminars, there is a need for support in the form of project feasibility studies at various locations in China, because sludge treatment technologies must be optimized to suit the stage of local development and other local peculiarities.

(2) Resettlement and Land Acquisition

Resettlement had been partly completed when the project was being planned. A representative of the executing agency responded that resettlement was carried out as planned, even though there was a delay due to prolonged negotiations about compensation. Qingyuan Company agreed to increase the compensation in an effort to avoid forcible expropriation and similar actions; it seems to have taken a rather long time before a final agreement was reached. The reason for the prolonged negotiation was that the national standard for the computation of compensation fees had been determined in 1996 and did not reflect any subsequent increases in the cost of living and land. People who were asked to resettle demanded a compensation fee above the official standard.

Table 10 Resettlements Made for the Project

	Planned (families)	Actual
Loujiang Treatment Plant	80	As planned
Fuxing Treatment Plant	None	None
Waterway improvement	600	As planned
Conduit installation	20	As planned

Source: Suzhou Qingyuan Construction & Development Company

As mentioned in the section on Efficiency, the prolonged negotiation resulted in a longer-than-planned duration for the project. However, this is deemed to have been a necessary and appropriate step to implement resettlement in an amicable manner.

As described above, this project's impact on the improvement of the living environment and the development of the tourism industry in Suzhou was confirmed to be real. It is a fair evaluation that the implemented project contributed to improving and upgrading the overall environment of the City of Suzhou. Future efforts to address the question of more sophisticated sludge treatment will be necessary as well as to tackle other medium- to long-term challenges.

3.5 Sustainability (Rating ③)

3.5.1 Structural Aspects of Operation and Maintenance

The facilities of this project are operated and maintained by the organizations listed in the table below. In the original project plan, Suzhou Qingyuan Construction & Development Company (a state company wholly owned by the Suzhou People's Government) was to act as the executing agency and would continue being responsible for operation and maintenance. At present, there have been some changes to the organizations and names responsible for operation and maintenance, even though there have been no substantive changes.

Table 11 List of Executing Agencies and Alterations

	Planned	Current
1.Sewage Treatment Plants	Suzhou Qingyuan Construction & Development Company	Suzhou Drainage Co., Ltd (newly created)
2. Sewer network	Public Service Bureau, Suzhou City	
3.Waterways		River Management Department, Water Management and Service Bureau, Suzhou City
4.Channeling facilities	Suzhou Qingyuan Construction & Development Company	Suzhou Waterworks Company

At the end of 2008, the city agencies for wastewater management in Suzhou were reorganized by separating the operating bodies from the policy agencies. The Suzhou Qingyuan Construction & Development Company, which was the executing agency at the time of project planning, was made into a company that specialized in the infrastructure development of the waterworks and sewer systems. On the other hand, the operation of the sewerage treatment plants became the responsibility of a newly created company, Suzhou Wastewater Company, Ltd. As an overarching body, the Suzhou Water Service Investment and Development Co., Ltd. supervises these companies and heads a group of companies involved in water resource management in Suzhou. All of these entities are state companies under the same umbrella and there seem to be no problems in their equity or cooperative relations.

3.5.2 Technical Aspects of Operation and Maintenance

Observations made during the Field Survey with respect to facility operation and staff work suggest that there is a good degree of expertise in terms of routine operation and maintenance and no problems seem to exist. Employees responsible for the operation carry “Special Work Operator Certificates” that are subject to periodic reexamination and retraining. Employee training and education programs are thus in place.

As discussed in Section 3.1 “Relevance,” Suzhou places a high priority on the improvement of water quality and is aggressively pursuing capital investment and technology introduction for new projects. It is believed that such initiatives have contributed to raising and maintaining high technical levels. The table below is a summary of the evolution of the number of employees engaged in operation and maintenance. Increased efficiency in the treatment process and the automation of certain equipment has made it possible to reduce the number of employees to about half of that originally planned. Responses of on-site technical staff members during our plant tour were accurate and to the point, suggesting that the technology has been successfully transferred to the shop floor level of the host country.

Table 11 Number of Employees at Major Facilities

Site	Plan	Actual
Loujiang Treatment Plant	50 (80*)	45
Fuxing Treatment Plant	70 (110*)	50
Sewer network	16	16

Source: Suzhou Qingyuan Construction & Development Company

* Numbers in parenthesis show manpower planned for post-Phase II Expansion

3.5.3 Financial Aspects of Operation and Maintenance

Suzhou Drainage Co., Ltd., which is responsible for the operation of the sewage treatment plants, is financed from the city government coffers into which all of the sewage treatment fees flow. Any shortfalls are made up for by the city government. The parent company, Suzhou Water Service Investment and Development Co., Ltd., invests constantly in water and is believed to have the necessary, stable budget allocated, given the importance of water quality in the city's waterways in terms of both its impact on citizens' lives and its value to tourism. Given the above, it is fair to say that the financial risk of the executing bodies involved in the project is low.

The sewage treatment fee was 0.55 Yuan/m^3 at the time of planning and was raised to 1.15 Yuan/m^3 in June 2002 and then to 1.33 Yuan/m^3 in April 2010. The current fee is set at a level just sufficient to cover the direct cost of sewage treatment (0.65 Yuan/m^3). The operating income is currently almost break-even.

Table 12 P/L Statement (Suzhou Drainage Co., Ltd 2010)

(Unit: RMB)

Item	Year 2010
Operating revenue	65,410,930
Operating cost	65,988,414
Operating income	-577,484
Non-operating income[20]	606,441
Income from ordinary operations	28,957
Net income	21,718

Source: Suzhou Drainage Co., Ltd

The current sewage treatment fee is set at a level that maintains a balance between the public service nature of the enterprise and the need for it to be a going concern. While no huge profit is expected, no real financial risks are anticipated.

[20] According to the executing agency, non-operating income accrues mostly when an operating income deficit is made up for by government expenditure.

3.5.4 Current Status of Operation and Maintenance

The operational data of major equipment is good and our observations during the plant tour uncovered no significant defects or deficiencies. The equipment is subject to periodic patrols and sample checks by the Construction Agency of the Provincial Government. A representative of the sewage treatment plants noted that equipment corrosion by acidic gases generated in the treatment process is a problem and corrosion prevention measures are taken on a periodic basis.

As described above, no major problems have been observed in the operation and maintenance system. Thus the sustainability of the project effect is high.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

Water quality improvement was a major potential issue for the living environment of citizens in the City of Suzhou. Since the completion of the project, the sewage treatment plants have been operating smoothly and have produced remarkable outputs including a more than 50% improvement in the quality of water in the city's waterways. Many residents have openly acknowledged the improved water quality, and the city's tourism industry has achieved steady growth. The objectives of the project can be said to have been accomplished for the most part. The Suzhou City Government continues to place a high priority on water resources and no problems are foreseen with respect to the technical and financial sustainability of the project. One challenge for the future is the needed shift from the present landfill disposal of sludge to incineration and other technologically advanced disposal methods.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) The currently employed sludge disposal method is problematic because the sales outlet of recycled compost is underdeveloped and the future prospects of stockyard availability are somewhat uncertain. To construct a more sustainable disposal process, the introduction of an advanced technology should be considered as a future course of action. From a medium- to long-term perspective, studies should be made to identify the disposal process that is most efficient and suited to the local conditions of Suzhou.

(2) While the infrastructure for the treatment of household sewage is evaluated to have been well developed, there appears to be room for improvement in the awareness and behavior of residents, as indicated by the continued direct discharge of sewage into the waterways. Environmental education and similar efforts should be promoted, not by the water service

agencies alone, but in cooperation with the Environmental Protection Bureau and other agencies.

4.2.2 Recommendation to JICA

While this project has produced an excellent outcome, the present sludge disposal process will eventually have to be replaced by a drying/incineration or other more advanced process. The executing agency has expressed its need for continued cooperation. Effective results can be expected if JICA considers continuing the currently offered technical exchange seminars and extending technical assistance in the form of optimum disposal technology selection and project feasibility study.

4.3 Lessons Learned

This project significantly improved the quality of the waterways in Suzhou City and had a strong socioeconomic impact in terms of an improved living environment and the promotion of the tourism industry. It is worth noting that the project was highly visible to residents of Suzhou because their homes are located close to the city's waterways and rivers and they easily recognized the changes brought about by the project. Further, the waterways and scenery by themselves constitute an asset to the city's tourism industry and the latter's improvement and prosperity was clearly understood. Such a high degree of understanding and acknowledgement of the development project creates a virtuous cycle leading to continual improvement of the climate for further development. Thus, the pioneer project and its objective and effects are rendered more sustainable. It is believed that public outreach activities by the executing agency have played a role in the creation of this virtuous cycle. Public relations activities should not simply be regarded as publicity but rather as an effective tool to sustain and reinforce the objectives and impacts of the project.

End

Comparison of Original State and Actual Scope of the Project

Item	Original	Actual
1. Project Output		
(1) Sewage treatment plants		
1) Loujiang Treatment Plant		
Daily treatment volume	60,000 m^3/d	As planned
2) Fuxing Treatment Plant		
Daily treatment volume	80,000 m^3/d	As planned
3) Sewer line		
Network improvement	Total 110 km	Total 108 km
Sewer system repair	19 connections	As planned
4) Pumping stations	20 locations	As planned
2. Waterway improvement & channeling		
(1) Waterway improvement		
Dredging	65.3 km	As planned
River broadening	4.4 km	As planned
Bridge upgrading	21 locations	As planned
(2) Channeling (Lake Tai)		
Intake volume	350,000 m^3/d	As planned
Conduit	29.1 km	As planned
Pumping station	1 location	As planned
2. Project Period	March 2000–December 2003 (46 months)	March 2000–December 2007 (94 months)
3. Project Cost		
Amount paid in Foreign currency	6,261 million yen	6,261 million yen
Amount paid in Local currency	10,317 million yen (688 million Yuna)	10,806 million yen (860 million Yuna)
Total	16,578 million yen	17,067 million yen
Japanese ODA loan portion	6,261 million yen	6,261 million yen
Exchange rate	1 Yuan = 15 yen (As of March 2000)	1 Yuan = 14 yen (Average between January 1996 –December 2010)