Independent State of Papua New Guinea

FY2021 Ex-Post Evaluation Report of Japanese ODA Loan

"Port Moresby Sewerage System Upgrading Project" / "Technical Assistance Project related to ODA Loan "Port Moresby Wastewater Management Improvement Project[1]"

External Evaluator: Hirofumi Azeta, Japan Economic Research Institute Inc.

0. Summary

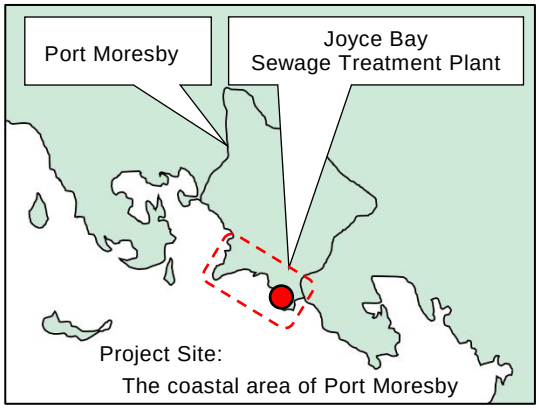
The Port Moresby Sewerage System Upgrading Project (hereinafter referred to as the ODA Loan Project) was implemented to provide sewerage services to the coastal area of Port Moresby and to prevent the discharge of contaminated water to the coastal waters by developing sewerage facilities in the area thereby contributing to the improvement in residents' living environment and industrial development through establishing a sanitary living environment and conserving the marine environment. The Port Moresby Sewerage Management Capacity Improvement Project (hereinafter referred to as the Technical Assistance Project) was also implemented in combination with the ODA Loan Project targeting on improving the management capacity of the National Capital District Water and Sewerage Limited (hereinafter referred to as 'Eda Ranu') that operated and managed sewerage facilities in Port Moresby.

Although both projects (hereinafter referred to as the projects') were not implemented in coordination with other projects of JICA or other organizations other than JICA, they were highly relevant to the development policies and development needs at the time of the appraisal and ex-post evaluation. Therefore, their relevance and coherence are high. The outputs of the ODA Loan Project were revised based on the minutes of discussion (hereinafter referred to as M/D) concluded in 2014 after the ODA Loan Project was launched. The efficiency of the projects is high because the actual project cost and project period exceeded the planned project cost, which were recalculated in accordance with the revised project outputs, and revised planned project period, only slightly. The qualitative effects of the projects, such as the establishment of a sanitary living environment and conservation of the marine environment, were identified, and impacts, such as improvement in residents' living environment and industrial development, were partly identified. However, because quantitative effects such as the volume of sewage treatment and the utilization rate of sewerage facilities were much lower than the targets, the effectiveness and impact of the projects are moderately low. Although there were some minor issues in the operation and maintenance of the projects in terms of policy and system, as well as institutional and organizational aspect, the sustainability of the projects is high because they were expected to be settled.

[1] "Port Moresby Wastewater Management Improvement Project" is an ODA loan project incidental to the "Port Moresby Sewerage System Upgrading Project" and is subject to an integrated evaluation. For details, please refer to "1.3 Evaluation Policy."

In light of the above, the projects are evaluated to be satisfactory.

1. Project Description



Project Location
(Source: Japan Economic Research Institute)

Joyce Bay Sewage Treatment Plant developed under the ODA Loan project
(Source: Japan Economic Research Institute)

1.1 Background

In Papua New Guinea, sewerage facilities were mainly developed in the capital city, Port Moresby, and local cities. Sewerage facilities were developed in the inland area of Port Moresby by Australia during the 1960s and the early 1970s before independence, while those in local cities such as Mount Hagen and Madang were developed with the loans from the Asian Development Bank (ADB) in 1999 and 2000.

In Port Moresby, three sewage treatment plants, located at Waigani, Morata, and Gerehu, were in operation and provided sewerage services to approximately 90,000 residents in the inland area out of a total population of approximately 290,000. However, there were no sewage treatment plants in the coastal area of Port Moresby, where 67,000 people lived, and sewage was either discharged into the sea through ocean outfalls or seeped underground after pretreatment in septic tanks.

Sewage discharged into the sea without sufficient treatment caused water pollution in the coastal area, which led to the deterioration of the sanitary environment for local residents and destruction of the marine environment, including coral reefs. Consequently, the waterborne disease rate was higher in coastal areas than in other areas. For example, the average diarrhea incidence rate was 31% in the coastal area and 5% in the city.

Therefore, improving the sanitary environment for local residents and the marine environment by constructing sewerage facilities in the coastal area of Port Moresby was necessary.

1.2 Project Outline

The objective of the projects was to provide sewerage services in the coastal area of Port Moresby and to prevent the discharge of sewage into the coastal waters by developing sewerage facilities in the area thereby contributing to the improvement in residents' living environment and industrial development through establishing a sanitary living environment and conserving the marine environment in the area.

<ODA Loan Project> "Port Moresby Sewerage System Upgrading Project"

Loan Approved Amount/ Disbursed Amount	8,261 million yen / 8,181 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	December 2009 / January 2010	
Terms and Conditions	Interest Rate	0.2%
	Repayment Period (Grace Period	40 years 10 years)
	Conditions for Procurement	Tied (Special Terms for Economic Partnership (STEP))
Borrower / Executing Agency	Independent Public Business Corporation (Renamed to Kumul Consolidated Holdings)	
Project Completion	January 2020	
Target Area	Coastal Area of Port Moresby	
Main Contractors	Hitachi, Ltd. / Dai Nippon Construction	
Main Consultant	NJS Consultants Co. Ltd.	
Related Studies (Feasibility Studies, etc.)	The Study on Sewerage System of Port Moresby (1998) JETRO, The feasibility study of sewerage system development of Port Moresby in Papua New Guinea (2003) Special Assistance for Project Formation for Port Moresby Sewerage System Upgrading Project (2005)	
Related Projects	[Asian Development Bank] The ADB Water Operators Partnership program (2013)	

<The Technical Assistance Project> "Port Moresby Wastewater Management Improvement Project"

Overall Goal		Efforts to improve the level of sanitation and the living environment and to preserve the ocean environment of coastal area of Port Moresby City are continuously implemented.
Project Purpose		Capacity of sewerage management system in Port Moresby City, run by National Capital District Water and Sewerage Ltd. (Eda Ranu), is enhanced.
Outputs	Output 1	Operation and management capacity for sewerage system is strengthened.
	Output 2	Financial planning capacity for sewerage system is strengthened.
	Output 3	Implementing capacity for awareness activities and environment education activities for consumers is strengthened.
Total cost (Japanese Side)		351 million yen
Period of Cooperation		April 2017 - April 2020
Implementing Agency		National Capital District Water and Sewerage Limited (merged with Water PNG in 2020)

1.3 Policy of the Evaluation

In the projects, the sewerage facilities were developed under the ODA Loan Project, and the management capacity of Eda Ranu, which operated and managed the sewerage facilities, was strengthened through the Technical Assistance Project. Therefore, the ODA Loan Project and the Technical Assistance Project were evaluated in an integrated manner.

While relevance and coherence were collectively evaluated for the ODA Loan Project and Technical Assistance Project, efficiency was separately evaluated. As for effectiveness, the contributions of the Technical Assistance Project to the effects of the projects, such as improvement in the percentage of the sewered population as a result of environmental education and awareness-raising activities, were considered in the evaluation. As for impact, additional impacts of the Technical Assistance Project on the improvement of the living environment of residents and industrial development were considered in the evaluation of the projects.

Sustainability was evaluated in an integrated manner by considering the contributions of the Technical Assistance Project, such as the preparation of operation and maintenance manuals for sewerage facilities, proposals on organizational structure, and proposals on policies and systems, in addition to the evaluation of the ODA Loan Project.

2. Outline of the Evaluation Study

2.1 External Evaluator

Hirofumi Azeta (Japan Economic Research Institute Inc.)

2.2 Duration of Evaluation Study

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

Duration of the Study: November 1, 2021 – January 31, 2023

Duration of the Field Study: April 11 - May 1, 2022 and September 4 - September 11, 2022

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

3.1 Relevance / Coherence (Rating: ③[3])

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Papua New Guinea

Before the start of the projects, the government of Papua New Guinea gave expenditure priority to health care services in the *Medium-Term Development Strategy* (2005-2010), with particular emphasis on the improvement of primary healthcare services, including public health in urban areas. Protection of the natural environment, including coral reefs, was also one of the expenditure priorities.

At the time of the ex-post evaluation, the government of Papua New Guinea regarded infrastructure development, including water supply and sanitation, as one of the core strategic development areas in *Vision 2050* (2011). In the *Development Strategic Plan* (2010–2030), the government has set the target that 70% of the population will have access to improved sanitation, including flushing toilets, by 2030. The *Medium-Term Development Plan* (2018–2022), which regarded sustainable use of water as one of the goals, also aimed at improving access to safe drinking water and affordable sanitation, while the strategies of the *National Water, Sanitation and Hygiene Policy* (2015–2030) targeted "increased water, sanitation and hygiene sector funding," "appropriate technology promotion," and "increased sector capacity building and training."

In light of the above, it can be concluded that the development policies emphasized improvement in public health and identified the need for investment in water and sanitation, both at the time of the appraisal and ex-post evaluation. Therefore, the projects were confirmed to be consistent with the development plans at the national level, both at the time of the appraisal and ex-post evaluation.

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

[3] ④: Very High, ③: High, ②: Moderately Low, ①: Low

3.1.1.2 Consistency with the Development Needs of Papua New Guinea

Before the start of the projects, there were no sewage treatment plants in the coastal area of Port Moresby, and sewage was either discharged into the sea through ocean outfalls or seeped underground after pre-treatment in septic tanks. Sewage discharged into the sea without sufficient treatment causes water pollution in the coastal area, which has a considerable impact on the health of residents, such as the high incidence of waterborne diseases. For example, the diarrhea incidence rate of residents in the coastal area (31%) was higher than the city average of 5%.

At the time of the ex-post evaluation, most of the sewage from the coastal area of Port Moresby flowed into the Joyce Bay Sewage Treatment Plant, which was constructed under the ODA Loan Project. The sewage was treated in the plant and then discharged into the sea; thus, the water quality of the coastal waters considerably improved. However, because sewage is still discharged into the sea or rivers without sufficient treatment outside the project area, the water pollution problems remain unsolved in Port Moresby. In the interview survey conducted as part of this ex-post evaluation, many interviewees reported that they had diarrhea in the last year, suggesting that there were still issues in sanitary living conditions.

For the above reasons, improvement in the water quality of the coastal waters and sanitary living environment of the local residents was essential at the time of the appraisal and ex-post evaluation. Therefore, the projects were highly consistent with the development needs at the time of both appraisal and ex-post evaluation.

3.1.2 Coherence (Rating: ②)

3.1.2.1 Consistency with Japan's ODA Policy

In the Fifth Pacific Islands Leaders Meeting held in May 2009, Japan regarded the environment and climate change as one of the main areas of support for Pacific island countries. In contrast, one of the priority areas for assistance to Papua New Guinea by JICA was infrastructure development in response to the country's rapid socioeconomic development. As the projects aimed to contribute to the improvement in residents' living environment and industrial development by developing sewerage facilities in the coastal area of Port Moresby, it can be said that the projects were consistent with Japan's ODA policy.

3.1.2.2 Internal Coherence

There were no JICA projects that were linked, complemented, harmonized, or coordinated with the projects, both at the time of the appraisal and ex-post evaluation.

3.1.2.3 External Coherence

As the projects were to reduce the discharge of sewage into the sea and improve the residents' sanitary environment in the coastal area of Port Moresby, it can be said that the projects were consistent with the SDG targets "3. Good health and well-being" and "14. Life below water."

Although there is no unified international standard for treated sewage quality, treated sewage discharged from the Joyce Bay Sewage Treatment Plant, developed under the Projects, met the Japanese standard on the number of coli bacteria, biochemical oxygen demand (BOD) concentration and hydrogen ion concentration.

There was no specific coordination with other Japanese projects, other donors, or international frameworks at the time of the appraisal and ex-post evaluation.

The projects were consistent with the development plans of Papua New Guinea both at the time of the appraisal and ex-post evaluation, and development needs such as the need for improvement in the water quality of coastal waters prevalent at the time of the ex-post evaluation. The outputs of the ODA Loan Project were revised by the M/D in 2014, and the treatment capacity of the sewage treatment plant was expanded. This change in outputs seems reasonable, as the necessity for the gradual expansion of the treatment capacity was recognized even at the time of planning, as explained in Section 3.2.1. Despite this change in the outputs, the project logic leading from the inputs to outcomes and impacts that the projects were to provide sewerage services and to prevent the discharge of sewage into the coastal waters by developing sewerage facilities, thereby contributing to the improvement in residents' living environment and industrial development, remained unchanged, and there was no inconsistency in this logic either.

The projects were consistent with Japan's ODA Policy, but there were no specific linkages with other projects or assistance from JICA or with other organizations and international frameworks, both at the time of the appraisal and ex-post evaluation.

Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

The planned and actual outputs of the ODA Loan Project were as listed in Table 1. The outputs of the ODA Loan Project were revised based on the M/D concluded between JICA and Papua New Guinea in May 2014. In the M/D, the treatment capacity of the sewage treatment plant was increased from the original plan, while the length of the sewer pipes was

shortened, and the number of pumping stations was reduced owing to the reduction in the project area.

Through the implementation of the ODA Loan Project, most of the project outputs, which were revised based on the M/D in May 2014, were achieved as planned.

Table 1 Planned and actual project outputs

Planned	Actual
(1) Sewerage facilities a) Construction of sewage treatment plant, access road, and ocean outfall - Sewage treatment plant (13,800 m^3/day, oxidation ditch process) - Access road (1.73 km) - Ocean outfall (1.4 km) This component was revised based on the M/D concluded in May 2014 as follows: - Sewage treatment plant (18,400 m^3/day, oxidation ditch process) - Access road (1.5 km) - Ocean outfall (1.6 km)	(1) Sewerage facilities a) Construction of sewage treatment plant, access road, and ocean outfall - Sewage treatment plant (18,400 m^3/day, oxidation ditch process) - Access road (1.25 km) - Ocean outfall (1.6 km)
b) Sewer pipe installation - Trunk sewer (17.2 km) - Branch sewer (17.7 km) This component was revised based on the M/D concluded in May 2014 as follows: - Trunk sewer (13.6 km) - Branch sewer (15.6 km)	b) Sewer pipe installation - Trunk sewer (12.4 km) - Branch sewer (13.2 km)
c) Construction and rehabilitation of pumping stations - Construction: 8 pumping stations - Rehabilitation: 9 pumping stations This component was revised based on the M/D concluded in May 2014 as follows: - Construction: 4 pumping stations - Rehabilitation: 9 pumping stations	c) Construction and rehabilitation of pumping stations - Construction: 4 pumping stations - Rehabilitation: 9 pumping stations
d) Construction of sludge drying beds at the Morata Sewage Treatment Plant This component was excluded from the project outputs because it was agreed that the sludge generated from the sewage treatment plant was to be dried by a more advanced process than the natural process of drying them on sludge drying beds, based on the M/D concluded in May 2014.	
(2) Consulting Services - Review of tender documents, tender assistance, and supervision of construction work - Training for Eda Ranu staff members on the operation and maintenance of sewerage facilities - Implementation of environmental	(2) Consulting Services - Review of tender documents, tender assistance, and supervision of construction work - Training for Eda Ranu (currently Water PNG) staff members on the operation and maintenance of sewerage facilities - Implementation of environmental

monitoring - Support on the implementation of a pilot project on the introduction of flush toilets for inhabitants in water-houses and on the implementation of hygiene and environmental education programs - Support on the implementation of HIV/AIDS prevention programs for workers employed for the ODA Loan project and the surrounding residents	monitoring - Support on the implementation of HIV/AIDS prevention programs for workers employed for the ODA Loan project and the surrounding residents

(1) Sewerage facilities

a) Construction of sewage treatment plant, access road, and ocean outfall

At the time of the appraisal, the treatment capacity of the sewage treatment plant under the ODA Loan Project was determined to be 75% (13,800 m^3/day) of the projected sewage volume of 18,400 m^3/day in 2020. The expansion of the treatment capacity to the remaining 25% was to be considered after the commencement of the operation of the sewage treatment plant. However, when the environmental permit issued by the Department of Environment and Conservation in 2007 expired in 2013, the Department indicated that the capacity of the sewage treatment plant had to be set based on the sewage volume in 2042, 25 years after the completion of the project, in order to renew the permit. Consequently, the government of Papua New Guinea and JICA agreed to revise the treatment capacity to be 18,400 m^3/day in 2014.

It was not clear why the Department of Environment and Conservation changed the target year for setting the capacity of the sewage treatment plant from 2020 to 2042. However, both the original assumption, on which the treatment capacity was to be expanded gradually, and the revised assumption, on which the treatment capacity was to meet the sewage volume for at least 25 years after completion, were reasonable because both assumptions targeted the provision of sewerage services in the coastal area of Port Moresby over the long term.

The length of the access road was determined to be 1.5 km in the M/D concluded in 2014; however, it was changed to be 1.24 km prior to the tender construction. This change seems to be mainly owing to the location of existing dwellings.

b) Sewer pipe installation

The project area of the ODA Loan Project was reduced to the area south of Konedobu, called “POMSSUP South,” in the coastal area of Port Moresby, based on the M/D concluded in 2014, because the project cost was expected to increase because the treatment capacity of the sewage treatment plant expanded from 13,800 m^3/day to 18,400 m^3/day, as mentioned above. Hence, the lengths of the trunk sewer and branch sewer were reduced from 17.2 km to 13.6 km and from 17.7 km to 15.6 km, respectively.

Even during construction, the length of the trunk sewer was revised from 13.6 km to 12.4 km due to route changes caused by road construction. In addition, the length of the branch sewer was further shortened to 13.2 km because residential land development did not take place as planned and the branch sewer to be connected to the residential land became unnecessary.

c) Construction and rehabilitation of pumping stations

Four out of eight newly constructed pumping stations were not included in the POMSSUP South area mentioned above. Therefore, they were excluded from the project scope based on the M/D in 2014. The other 13 pumping stations were developed as planned (4 newly constructed pumping stations and 9 rehabilitated pumping stations).

d) Sludge drying beds at the Morata Sewage Treatment Plant

In the original plan, sludge drying beds, by which sludge was to be dried in the sun, were planned to be constructed on land next to the Morata sewage treatment plant. The transfer of sludge from the Joyce Bay Sewage Treatment Plan to the sludge drying beds was planned. However, the construction of the sludge drying beds was excluded from the project scope because it was agreed in the M/D concluded in 2014 that a more advanced sludge treatment process would be adopted.

The sludge drying beds were subsequently replaced with a centrifuge dewatering system installed at the Joyce Bay Sewage Treatment Plant.

(2) Consulting services

During the implementation of the ODA Loan Project, most of the consulting service activities such as tender assistance, supervision of construction work, training, and environment monitoring were carried out as planned, although the pilot project on the introduction of flush toilets for inhabitants in waterhouses was not implemented. This was because the village where the pilot project was to be implemented was excluded from the project area owing to the reduction in the project area described in (1)b.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The cost of the ODA Loan Project was 10,802 million yen (of which the ODA loan amount was 8,261 million yen) in the original plan at the time of the appraisal. The project cost at the time of the appraisal was estimated to be 12,260 million yen, which was 1,458 million yen more than the original project cost, if the project cost was recalculated considering the changes in the project outputs and the unimplemented pilot project for

inhabitants in waterhouses, as described in Table 2.

Table 2 Recalculation of planned project costs

	Project cost at the time of appraisal	Increase/decrease in project outputs	Recalculated project cost at the time of appraisal
Sewage treatment plant	4,690 million yen	33% increase : Treatment capacity increased from 13,800 m^3/day to 18,400 m^3/day.	+1,563 million yen
pumping stations	368 million yen	87% increase : Total pump capacity increased from 114 m^3/min to 213 m^3/min.	+319 million yen
Sewer pipe (trunk sewer)	1,128 million yen	28% decrease : Length of trunk sewer decreased from 17.2 km to 13.6 km.	-315 million yen
Sewer pipe (branch sewer)	362 million yen	25% decrease : Length of branch sewer decreased from 17.7 km to 15.6 km.	-92 million yen
Pilot project	16 million yen	Not implemented.	-16 million yen
Change in total project cost			+1,458 million yen

Note: Individual project costs and total values do not necessarily match owing to rounding.

The planned project cost at the time of the appraisal, recalculated project cost, and actual project cost are listed in Table 3. The actual project cost, which was 14,647 million yen (of which the ODA loan amount was 8,181 million yen), was 19% higher than the planned project cost after adjustment, slightly exceeding the planned cost.

As the project scope was not revised after the M/D was concluded in 2014, the actual project cost exceeded the recalculated planned project cost mainly owing to the price hikes resulting from the delayed start of the project. This is also because of the increase in the cost of consulting services due to the expansion of project outputs.

Table 3 Planned and actual project cost

(Unit: million JPY)

	Plan			Recul-culated	Actual		
Item	Foreign Currencies	Local Currencies	Total	Total	Foreign Currencies	Local Currencies	Total
(1) Construction	2,541	4,024	6,565	8,023	3,723	9,375	13,098
(2) Consulting Services	384	393	777	777	966	216	1,182
(3) Price escalation	401	768	1,169	1,169	0	0	0
(4) Physical contingency	372	325	697	697	0	0	0
(5) Interest during construction	40	0	40	40	35	0	36
(6) Commitment charge	49	0	49	49	49	0	49
(7) Land acquisition	0	465	465	465	0	281	281
(8) Administrative cost	0	240	240	240	0	0	0
(9) Tax	0	800	800	800	0	0	0
Total	3,787	7,015	10,802	12,260	4,774	9,872	14,647

Source: Materials provided by JICA and Kumul Consolidated Holdings
Note: There are discrepancies in the totals due to rounding.

The actual project cost of the Technical Assistance Project was 351 million yen, which slightly exceeded the planned project cost of 320 million yen (110% of the plan) because the contract price determined through tender exceeded this.

3.2.2.2 Project Period

The project period at the time of the appraisal was 69 months, from January 2010 to September 2015, and was revised to 103 months until July 2018, when the project outputs were revised in 2014, as shown in Table 4.

When the project outputs were revised, Papua New Guinea proposed changing the treatment process of the sewage treatment plant from the oxidation ditch process to the sequencing batch reactor activated sludge process, and the discussion on the treatment process took considerable time. This caused a delay in tenders and contracts, as well as the commencement of construction. After the discussions, the Papua New Guinea and JICA sides agreed to employ the oxidation ditch process.

The actual project period was 121 months, from January 2010 to January 2020. This was 15% higher than the revised planned project period, and it was concluded that the actual project period slightly exceeded the plan.

Table 4 Planned and actual project periods

	Plan	Revised plan	Actual
Project period	January 2010 – September 2015 (69 months)	January 2010 – July 2018 (103 months)	January 2010 – January 2020 (121 months)
Consulting services (including detailed design)	Jan. 2010 – March 2015	-	January 2010 – March 2020
Tender and Contracts	January 2011 – July 2012	December 2011 – October 2014	May 2014 – December 2015
Construction works	July 2012 – September 2015	October 2014 – July 2018	December 2015 – January 2020

Source: Documents provided by JICA

The tender and contract process began in May 2014, after the M/D was concluded, and was completed in one year and eight months, almost as planned (one year and seven months). Although the tender and contract process had not started in 2014 when the M/D was concluded, the start of the tender and contract process specified in the M/D was undertaken in December 2011, which was prior to the conclusion of the M/D. The reason for this was not identified in the ex-post evaluation.

The construction period was 50 months, which slightly exceeded the original plan (39 months) and revised plan (46 months). One of the reasons was the construction work did not start until April 2016, after the construction contract was signed in December 2015 because the advance payment in Japanese yen by the government of Papua New Guinea was delayed due to the restrictions on foreign currency remittances in Papua New Guinea. The construction work also took longer because the construction period, which was planned to be 900 days (approximately 30 months) at the time of tender, was revised to 1,300 days (approximately 43 months) due to the lack of an annual budget for the government of Papua New Guinea.

The project period of the Technical Assistance Project was nearly as planned. The planned project period was three years—from March 2017 to February 2020—whereas the actual project period was three years and one month—from April 2017 to April 2020.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

For this ODA Loan Project, only the economic internal rate of return (EIRR) was calculated at the time of the appraisal. The EIRR, recalculated at the time of the ex-post evaluation, was lower than that projected at the time of the appraisal. This was because the project cost, as well as operation and maintenance costs, were larger than estimated at the time of the appraisal due to the larger capacity of the sewage treatment plant; moreover, the benefits from tourism revenues and reduction in waterborne diseases were lower than those

estimated at the time of the appraisal.

Table. 5 Economic internal rate of return at the time of appraisal and ex-post evaluation

	At the time of appraisal (2010)	At the time of ex-post evaluation
EIRR	8.4% (Project life: 30 years)	5.9% (Project life: 30 years)
(1) Cost (2) Benefit	(1) Construction cost (excluding taxes), operating and maintenance cost (2) Increase of tourism revenue, reduction of waterborne diseases, increase of fish haul	(1) Construction cost (excluding taxes), operating and maintenance cost, and house connection cost (2) Increase of tourism revenue, reduction of waterborne diseases, increase of fish haul

The actual project cost of the ODA Loan Project exceeded the recalculated project cost at the time of the appraisal by 19%, mainly owing to price hikes as a result of the delay in the start of the project. In addition, the actual project period exceeded the revised project period at the time of the appraisal by 15% because the construction period was extended due to delays in the payment by the Papua New Guinea side. The planned project cost and project period of the Technical Assistance Project were nearly as planned.

In light of the above, both project cost and project period exceeded the plan only slightly; thus, the efficiency of the projects is high.

3.3 Effectiveness and Impacts[4] (Rating: ②)

The ODA Loan Project and the Technical Assistance Project aimed to achieve the same project objectives, as the ODA Loan Project was to develop sewerage facilities in the coastal area of Port Moresby, while the Technical Assistance Project was to enhance the management capacity of Eda Ranu (currently Water PNG), which managed the sewerage facilities. Therefore, the effectiveness and impact of these projects were evaluated in an integrated manner.

The targets at the time of the appraisal were compared to the achievements at the time of ex-post evaluation to evaluate effectiveness and impacts, and the contributions of the Technical Assistance Project were considered to determine the evaluation results.

[4] The impact is also taken into account in determining the effectiveness of the rating.

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operational and Effect Indicators)

The effects expected by the ODA Loan Project were the provision of sewerage services in the coastal area of Port Moresby and the reduction in sewage discharge to coastal waters. Therefore, the volume of sewage treatment, utilization rate of sewerage facilities, and concentration of BOD discharged were selected as operational indicators, while the sewered population and percentage of sewered population were selected as effect indicators. The baseline, target, and actual values of these indicators are listed in Table 6.

Table 6 Planned and Actual Operational Indicators

	Baseline	Target	Actual
	2009	2017	2022
		2 Years After Completion	2 Years After Completion
Volume of sewage treatment (m^3/day)	0	13,100	7,000
Utilization rate of sewerage facilities (%)	-	71.2	38.0
Concentration of BOD discharged (mg/L)	190	20	Smaller than 5

Source: Documents provided by JICA and implementing agencies

The volume of sewage treatment and the utilization rate of sewerage facilitated at the time of the ex-post evaluation were approximately half of the targets, mainly because the number of house connections to the sewerage system did not increase as expected. This was because the residents in the project area avoided the burden of connection fees (minimum fee of 600 kina and material costs) as well as because some residents did not have the necessity to connect to the sewerage system, as they did not even have sufficient water supplies due to non-payment of water charges.

In reaction to this, Water PNG, which manages the sewage treatment plant and the sewer network in Port Moresby at the time of the ex-post evaluation, was planning to launch "House Connection Project" in 2022 by its own budget to connect 1,010 households to the sewerage system in the next few years. Once all 1,010 households were connected, the daily volume of sewage treatment increased by 1,960 m^3 and the utilization rate of sewerage facilities increased from 38% to 49%[5].

The baseline, target, and actual values of the effect indicators, such as the sewered population and the percentage of the sewered population, are shown in Table 7.

[5] The population per household was assumed to be 7.2 persons based on the 2011 census results. The sewage volume per person per day was assumed to be 0.27 m^3 based on the volume of sewage treatment and the sewered population at the time of the appraisal.

Table 7 Planned and Actual Effect Indicators

	Baseline 2009	Target 2017 2 Years After Completion	Actual 2022 2 Years After Completion
Sewered population (people)	0	48,600	26,000
Percentage of sewered population (%)	27	61	38

Source: Documents provided by JICA and implementing agencies

The sewered population at the time of the ex-post evaluation was estimated to be approximately 26,000 people from the volume of sewage per person per day (0.27 m^3). This means that the achievement level of the target for the sewered population, 48,600 people, was approximately half.

Estimating the population of the project area at the time of the ex-post evaluation as 67,156, assuming that the annual population growth was 2.1% on average since 2011[6], the percentage of sewered population at the time of the ex-post evaluation was 38%. This was much lower than the target of 61%.

The achievements of the effect indicators were rather low, mainly because the number of house connections to the sewerage system in the coastal area did not increase as expected for the reasons mentioned above.

Although the Plan for Environmental Education Activities was prepared for community awareness of house connections to the sewer network, and related activities were implemented through the Technical Assistance Project, the number of new connections after the completion of the Technical Assistance Project was only approximately 10. Therefore, identifying the Technical Assistance Project's additional contributions to improving the utilization rate of sewerage facilities or the percentage of sewered population was not possible.

3.3.1.2 Qualitative Effects (Other Effects)

At the time of the appraisal of the projects, (1) establishment of a sanitary living environment, (2) conservation of the marine environment, (3) improvement in residents' living environment, and (4) industrial development were expected as qualitative effects. However, because (3) improvement in residents' living environment and (4) industrial development were considered as impacts for their nature, they are explained in Section 3.3.2 Impacts.

[6] Source: United Nations, World Population Prospect

(1) Establishment of a sanitary living environment

According to Water PNG, there were almost no sewage overflows in the project area as a result of sewer line installation by the ODA Loan Project; thus, the ODA Loan Project led to improvement in the sanitary living environment of the project area.

Using the maintenance records registered in the sewer network ledger system developed by the Technical Assistance Project, the Sewerage Operation Department of Water PNG identified the locations where sewage overflows occurred frequently, replaced sewer pipes, and improved manholes even outside the project area. As a result, the number of overflows decreased outside the project area, and the Technical Assistance Project also contributed to the improvement of the sanitary living environment in Port Moresby.

(2) Conservation of marine environment

The daily volume of sewage flowing into the sewer network and discharged to the ocean was estimated to be 3,891 m^3 in 2009 from the population in the coastal area, percentage of the sewered population, and sewage volume per person per day in the same year. At the time of the ex-post evaluation, all sewage flowing into the sewer network was treated at the Joyce Bay Sewage Treatment Plant. Therefore, it was confirmed that the water quality of the coastal waters at Port Moresby greatly improved, as shown in Table 8.

Table 8 Water Quality Information Before and After the ODA Loan Project

	2009	2019	Year 2021
E. coli (MPN/100 mL)	23 - 2,400	20	0.0
Ammonia nitrogen (mg/L)	1.4 - 4.2	0.01	0.2
Phosphate (mg/L)	0.21 - 0.69	0.02	0.005

Source: Documents provided by JICA and Water PNG

3.3.2 Impacts

3.3.2.1 Intended Impacts

(1) Quantitative Effects

Improvement in residents' living environment

According to Water PNG, sewage overflows happened 10–12 times every week in the coastal area of Port Moresby before the implementation of the projects, and this reduced to 3–4 times until the time of the ex-post evaluation, suggesting that the residents' living environment improved. In addition, the quality of fish and shellfish consumed by residents also seems to have improved as a result of the improvement in ocean water quality.

In this ex-post evaluation, an interview survey was conducted on the street targeting 150 people in the coastal area of Port Moresby to examine the impacts of the projects on the

residents' living environment. Of the 150 interviewees, 62% were male and 38% were female, 47% were in their 20s and 30s, 44% were in their 40s and 50s, and 9% were over 60.

The survey indicated that 38% of the interviewees had diarrhea in 2021: confirming whether the waterborne disease rate, which was 31% at the time of the appraisal, decreased was not possible[7]. Moreover, it was not possible to confirm a decrease in medical expenses for waterborne diseases either, as most of the interviewees answered to the question on the changes in waterborne medical expenses over the last three years as "almost same[8]."

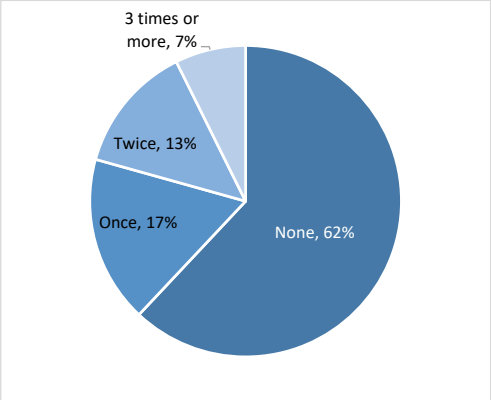

Figure 1 Number of Waterborne Diseases in 2021

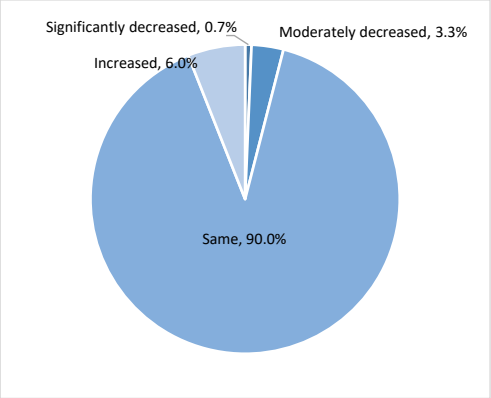

Figure 2 Change in Waterborne Disease Medical Expenses over the Last Three Years

However, as shown in Figure 3, the interviewees living in dwellings connected to the sewerage system answered that they had diarrhea 0.49 times per year on average, while those who were not connected answered that they had diarrhea 0.95 times per year. Similarly, as shown in Figure 4, the proportion of interviewees who had diarrhea within a year among those with sewerage connection was only 27%, while the proportion of those without sewerage connection was 45%. This suggests that an increase in sewerage connections leads to a decrease in the waterborne disease rate. Although the increase in the number of house connections was limited at the time of the ex-post evaluation, it is expected that the waterborne disease rate in Port Moresby will decrease in the future as the number of house connections increases.

[7] Many of the survey interviewees who had diarrhea would not have received medical care. Therefore, the percentage of the interviewees having diarrhea identified in the survey would be higher than the "waterborne disease rate" which was compiled from the information provided by medical institutions.
[8] Similarly, this may be due to the fact that the majority of interviewees did not receive medical cares or use medicines even if they had diarrhea.

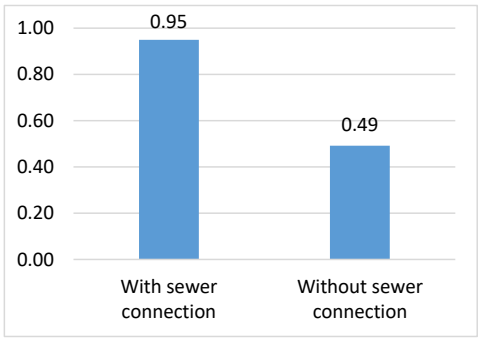

Figure. 3 Number of Waterborne Disease Incidents by Sewer Connection

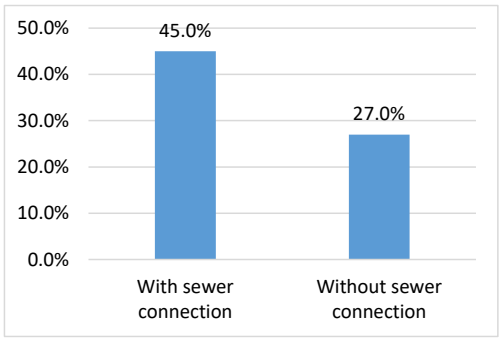

Figure. 4 Percentage of Waterborne Disease Incidence by Sewer Connection

In addition, residents living near the Joyce Bay Sewage Treatment Plant started catching fish and shellfish for their own consumption on the beach as a result of the improvement in the water quality of the ocean. This also indicates that the implementation of the projects led to an improvement in the livelihood of nearby residents.

Industrial development

Ela Beach, located in the coastal area of Port Moresby, started attracting tourists at the time of the ex-post evaluation because sewage is no longer discharged to the ocean as a result of the projects. According to the Investment Promotion Agency and other stakeholders, the number of hotels, restaurants, and apartments increased at Ela Beach, although information on the number of new establishments was not obtained. New manufacturing and food processing plants were built in the vicinity of the Joyce Bay Sewage Treatment Plant, as the odor problem was resolved.

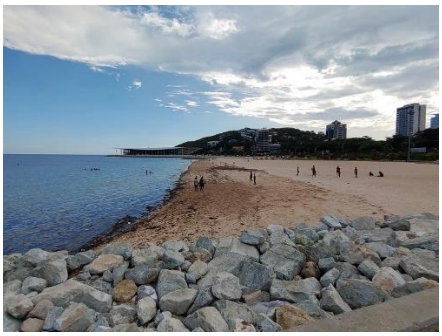

Photo 1 Ela Beach

(2) Qualitative effects

Except for the effects mentioned above, the other qualitative effects of the projects were not identified. Although the environmental education activities implemented with the support of the Technical Assistance Project explained the importance of hand washing and the harmful effects of dumping garbage into manholes on local residents, no visible effects were identified.

3.3.2.2 Other Positive and Negative Impacts

1) Impact on the Natural Environment

For its location in the environmentally sensitive area, the ODA Loan Project was classified as Category A based on the JBIC guidelines for Confirmation of Environmental and Social Consideration (April 2002). The Environmental Impact Assessment Report for the ODA Loan Project was approved in May 2006, and an environmental permit was issued in December 2007. As there were coral reefs in the area where the ocean outfall pipe was planned to be installed, countermeasures were to be taken, for example, by preventing sediment discharge and spreading into the ocean, selecting the lowest impact ocean outfall pipe route, and transplanting corals on the ocean outfall pipe route.

The installation route of the ocean outfall pipe was determined at the location where the impacts on the coral reefs were minimal based on the survey results. In addition, the contractor of the construction works protected and transplanted corals and monitored the settlement of corals for one year after transplantation. The monitoring results were compiled in coral relocation reports, and no particular issues were identified during monitoring.

During the construction of the sewage treatment plant and installation of the ocean outfall pipe, sufficient measures such as the installation of curing sheets for the prevention of sediment spread, were undertaken; thus, no particular issues were identified in sediment discharge and spread.

Furthermore, the environmental permit was renewed by the Conservation and Environment Protection Authority (CEPA) in December 2019 before the sewage treatment plant started operation. Water PNG conducted environmental monitoring based on this permit and submitted monitoring reports to CEPA on a regular basis at the time of the ex-post evaluation. Water PNG operated the sewage treatment plant without any deviation from the monitoring indicators specified in the environmental permit, such as the concentration of BOD discharged.

2) Resettlement and Land Acquisition

In the ODA Loan Project, a project site with an area of approximately 11 ha was acquired, as planned. Kumul Consolidated Holdings evaluated land prices and paid compensation to owners based on the laws in Papua New Guinea and the JBIC Guidelines for Confirmation of Environmental and Social Consideration (April, 2002). Because there were no residents at the project site, no resettlement occurred.

In addition, as 10 households resided on the construction site of the access road without land ownership, the government of Papua New Guinea completed the payment of compensation and resettlement processes based on an agreement with the residents before the start of the ODA Loan Project. No issues with the residents were identified through

interviews with the implementing agency and residents at the time of the ex-post evaluation.

3) Gender Equality

Although there were no gender related activities in the ODA Loan Project or the Technical Assistance Project, the projects contributed to the improvement in the livelihoods of women, as women in the coastal area started selling shellfish collected from the sea at fish markets as shellfish increased owing to the improvement in the water quality of the ocean after the completion of the projects, according to the National Fisheries Authority of Papua New Guinea.

4) Marginalized People

The residents of several low-income villages in the vicinity of the Joyce Bay Sewage Treatment Plant began to catch fish and shellfish as a result of the improved water quality of coastal waters after project completion. Therefore, the projects led to the improvement in the livelihoods of residents in low-income villages.

5) Social Systems and Norms, Human Well-being, and Human Rights

Through the consulting services of the ODA Loan Project, HIV/AIDS awareness-raising activities for construction workers were organized in collaboration with the Department of Health of Port Moresby. In addition, environmental education activities were conducted targeting the residents living in the vicinity of the Joyce Bay Sewage Treatment Plant under the Technical Assistance Project, wherein the importance of the house connection to the sewerage system and hand washing, as well as the harmful effects of dumping garbage into the sewer network, were emphasized.

However, identifying the extent to which awareness-raising activities led to the prevention of HIV/AIDS infection in Port Moresby at the time of the ex-post evaluation was not possible, as it was not possible to track construction workers. It was also difficult to find residents who received environmental education; thus, identifying the specific impacts of the environmental education activities was not possible. In addition, local residents continued dumping garbage into the sewer network or into the ocean even at the time of the ex-post evaluation, but environmental education activities were not carried out by Water PNG or any governmental institutions.

6) Unintended Positive/Negative Impacts

Except for impacts mentioned above, no other positive or negative impacts were identified.

3.3.2.3 Effectiveness and Impacts of the Technical Assistance Project

(1) Effectiveness of the Technical Assistance Project

The project purpose of the Technical Assistance Project was to enhance the capacity of the sewerage management system in Port Moresby, run by the National Capital District Water and Sewerage Limited (Eda Ranu, currently Water PNG), and the indicators set for the project purpose were as follows:

Indicator 1: The sewerage system is managed based on the administration organization system and division of office work for sewerage system prepared by the project.

Indicator 2: Sewerage facilities are managed in accordance with the plans and manuals prepared for the project.

At the time of planning for the Technical Assistance Project, the Sewerage Operation Department of Eda Ranu operated and managed the existing sewer network in Port Moresby, while the Joyce Bay Sewage Treatment Plant Department, which was to be newly established, was planned to operate and manage the sewerage facilities to be developed by the ODA Loan Project.

The Technical Assistance Project supported the establishment of the Joyce Bay Sewage Treatment Plant Department and made a proposal on the organizational system and division of duties for the Joyce Bay Sewage Treatment Plant Department, the Sewerage Operation Department, and other related departments.

At the time of the ex-post evaluation, it was confirmed that the Joyce Bay Sewage Treatment Plant Department of Water PNG, which merged with Eda Ranu, operated and managed the sewage treatment plant and sewer network developed by the ODA Loan Project, while the Sewerage Operation Department operated and managed the existing sewer network, in collaboration with each other.

However, some Water PNG departments have not yet been given clear mandates after the merger between Eda Ranu and Water PNG in 2020; therefore, some activities such as environmental education and awareness-raising activities, which were prepared with the support of the Technical Assistance Project, were not continued at the time of the ex-post evaluation.

At the time of the ex-post evaluation, utilization of the Sewer Network Maintenance Manual, which was prepared by the Technical Assistance Project, and the Joyce Bay Sewage Treatment Plant and Pumping Stations Operation and Maintenance Manual were confirmed. The “Draft Standard Procedure for House Connections,” which was prepared for the promotion of house connections, was also utilized. Therefore, it can be said that the sewerage facilities were operated and managed based on plans and manuals prepared by the Technical Assistance Project. However, there were some other plans that were not fully utilized, also due to the merger of Eda Ranu with Water PNG mentioned above, such as “Port Moresby Trade Waste Policy and Management Plan” and “Medium to Long Term Business Operation Plan for Sewerage Service in Port Moresby.”

In light of the above, it can be said that the indicators of the project purpose were mostly achieved, and the capacity of the sewerage management system in Port Moresby was enhanced for the most part, as targeted by the project purpose.

(2) Impacts of the Technical Assistance Project

The overall goal of the Technical Assistance Project was "Efforts to improve the level of sanitation and the living environment and to preserve the ocean environment of the coastal area of Port Moresby City are continuously implemented," and its indicators are as follows.

Indicator 1: The situation of sewerage management in Port Moresby is periodically reported.

Indicator 2: Criteria of water quality management is prepared.

Water PNG, which operates and manages the sewerage facilities in Port Moresby, regularly reports its operations to its shareholder, Kumul Consolidated Holdings, and thus Indicator 1 has already been achieved.

At the time of the ex-post evaluation, the bill for the establishment of the National Water and Sanitation Authority was being drafted, which would be responsible for the political aspects of water supply and sewerage in Papua New Guinea. It is expected that Water PNG, as the executing body, reports the water supply and sewerage operational status based on policies and regulations to be developed by the Authority in the future.

Although criteria for water quality management have not been developed at the time of the ex-post evaluation, it is expected that discussions for the development of such criteria are initiated by the National Water and Sanitation Authority mentioned above, once it is established.

Although some mandates related to the sewerage operations of Water PNG have not yet been clarified because its organizational structure was not finalized after its merger, the project purpose of the Technical Assistance Project was mostly achieved. The overall goal, which was not partly achieved at the time of the ex-post evaluation, is expected to be achieved in the future. Therefore, it can be said that the expected outcomes and impacts were generally achieved as planned.

[Summary of 3.3 Effectiveness and Impacts]

The operational and effect indicators of the ODA Loan Project, such as the volume of sewage treatment, utilization rate of sewerage facilities, sewered population, and percentage of sewered population, were considerably below targets because house connections were limited. However, because sewage, which used to be discharged into the sea, was now treated and the number of sewage overflows in Port Moresby decreased, it can be concluded that qualitative effects such as the establishment of a sanitary living environment and conservation of the marine environment

were realized. In addition, impacts such as the improvement in residents' living environment and industrial development were partly realized.

The Technical Assistance Project targeted the enhancement of the management capacity of Water PNG, which manages water and sewerage operations in Port Moresby, and the effectiveness and impact of the Technical Assistance Project itself are high. In addition, the Technical Assistance Project partly contributed to the improvement in residents' living environment, which was one of the expected impacts of the projects, through the decrease in sewage overflows.

As the effects realized by the implementation of the projects can only be identified to a certain extent compared with the plan, it is concluded that the effectiveness and impact of the project are moderately low.

3.4 Sustainability (Rating: ③)

As the ODA Loan Project was to construct sewerage facilities in the coastal area of Port Moresby, and the Technical Assistance Project was to improve the management capacity of Eda Ranu (currently Water PNG), which was to manage the same sewerage facilities, it can be said that the two projects targeted the realization of the same project outcomes. Therefore, the sustainability of the two projects was evaluated in an integrated manner.

The sustainability of the activities of the Technical Assistance Project, which affected the sustainability of the ODA Loan Project, was reflected in the evaluation of the sustainability of the projects.

3.4.1 Policy and System

The implementing agency of the ODA Loan Project was Kumul Consolidated Holdings. It is an organization renamed from the Independent Public Business Corporation, and its governing law is the Independent Public Business Corporation of Papua New Guinea Act of 2002. Kumul Consolidated Holdings is mandated to manage all government-owned commercial assets except oil and mineral resources.

Water PNG is responsible for the operation and management of the sewerage facilities developed under the ODA Loan Project. The former body of Water PNG was the National Water and Sewerage Board, established under the National Water Supply and Sewerage Act 1982 to be responsible for the management of water supply and sewerage facilities throughout the country. Water PNG was then corporatized in March 2017 by the National Water Supply and Sanitation Act 2016. The shares of Water PNG are wholly owned by Kumul Consolidated Holdings.

Eda Ranu, which was established in 1996 based on National Capital District Water Supply and Sewerage Act and National Capital District Commission Act, used to be responsible for the operation and management of water supply and sewerage facilities in Port Moresby,

while Water PNG were responsible outside Port Moresby. When Eda Ranu merged with Water PNG in 2020, its operations, assets, liabilities, and employees were transferred to Water PNG based on the National Water Supply and Sanitation Act revised in 2020.

Note that the draft legal system for the promotion of house connections, which was drafted by the Technical Assistance Project, had not been approved at the time of the ex-post evaluation. Similarly, the draft Port Moresby Trade Wastewater Policy, which was also prepared by the Technical Assistance Project, had not been approved either because it had not been integrated with the trade wastewater policy of Water PNG.

Although the names of the executing agency of the ODA Loan Project and the operating body of the sewerage facilities changed and the operating body was merged with other body, there were no major issues in policy and system of the Projects, and thus it can be concluded that the validity for the realization of project effects would continue. However, there were some issues in the aspects of policy and system, as the draft legal system and policy related to the operation and management of sewerage facilities, which were prepared with the support of the Technical Assistance Project, were not approved at the time of the ex-post evaluation.

3.4.2 Institutional/Organizational Aspect

Water PNG, which merged with Eda Ranu in 2020, is the body which operates and manages the sewerage facilities developed under the ODA Loan Project.

At the time of the appraisal of the ODA Loan Project and at the time of the planning of the Technical Assistance Project, the sewerage facilities in Port Moresby were operated and managed by Eda Ranu. In Eda Ranu, the Sewerage Operation Department operated and managed the existing sewer network, whereas the Joyce Bay Sewage Treatment Plant Department, which was planned to be newly established, was to operate and manage the sewerage facilities to be developed by the ODA Loan Project. The Technical Assistance Project supported the establishment of the Joyce Bay Sewage Treatment Plant Department. In addition, the Technical Assistance Project made a proposal on the organizational system and division of duties for the Joyce Bay Sewage Treatment Plant Department, the Sewerage Operation Department, and other related departments.

Upon merger, both the Joyce Bay Sewage Treatment Plant Department and the Sewerage Operation Department were transferred from Eda Ranu to Water PNG. At the time of the ex-post evaluation, the Joyce Bay Sewage Treatment Plant Department and the Sewerage Operation Department operated and managed the sewage treatment plant and sewer network developed by the ODA Loan Project and the existing sewer network, respectively, in collaboration with each other.

Although the number of staff members in both departments slightly decreased after the completion of the Technical Assistance Project in 2020, both departments made it possible to operate and manage facilities with fewer staff members by installing surveillance cameras

and replacing existing sewer pipes with their own funds.

Therefore, it can be said that there were no problems due to staff shortages and that there were no issues in the institutional and organizational aspects of the operation and management of the Joyce Bay Sewage Treatment Plant and sewer network.

However, the Administration Department and the Environment & Quality Control Department, which were responsible for environmental education and awareness-raising activities, did not continue the activities because their mandates were not finalized after the merger between Eda Ranu and Water PNG.

3.4.3 Technical Aspect

At the time of the appraisal, Eda Ranu, which was to operate and manage the sewerage facilities developed by the ODA Loan Project, did not have any experience in the operation and management of sewage treatment plants with an oxidation ditch process employed for the ODA Loan Project. Therefore, the contractor and consultants provided guidance, including on-the-job training, after completion of the plant. In addition, the sewer network maintenance manual was prepared by the Technical Assistance Project and the training program was organized according to the manual.

When Eda Ranu merged with Water PNG in 2020, the Joyce Bay Sewage Treatment Plant Department, which operated and managed the sewage treatment plant and sewer network developed by the ODA Loan Project, and the Sewerage Operation Department, which operated and managed the existing sewer network in Port Moresby, were both transferred to Water PNG. In addition, many personnel who received technical guidance from the Technical Assistance Project continued working for Water PNG. Therefore, it can be said that Water PNG maintained a sufficient level of technical expertise.

The maintenance of the sewer network and operation and management of the sewage treatment plant and pumping stations were carried out in accordance with the manuals, and the operation and maintenance activities were recorded in logbooks. In addition, because no failures in the facilities that were left unaddressed for a long period of time were identified, there were no technical problems related to operation and maintenance. Furthermore, guidance was provided based on the manuals to the new staff members assigned to the Joyce Bay Sewerage Treatment Plant Department and the Sewerage Operation Department.

In addition, the Business Development and Strategic Planning Department of Water PNG was able to prepare and update its own medium-term investment plan, although the Medium to Long Term Business Operation Plan, which was prepared by the Technical Assistance Project, was not utilized at the time of the ex-post evaluation due to the merger of Eda Ranu with Water PNG. Therefore, Water PNG does not seem to have any issues in terms of the capacity to formulate and update the Medium to Long Term Business Operation Plan.

Environmental education and awareness-raising activities were the responsibility of the Administrative Department and the Environment and Quality Control Department. Because the staff members who received technical guidance from the Technical Assistance Project remained in these departments, neither department would have technical issues. However, as mentioned above, neither department had clear mandates and thus did not carry out any related activities at the time of the ex-post evaluation.

3.4.4 Financial Aspect

The financial status of Eda Ranu up to the merger, which managed the sewage treatment plant developed by the ODA Loan Project and the sewer network in Port Moresby, is shown in Table 9. Eda Ranu did not seem to have any major financial status issues, as its capital adequacy ratio was high despite its low profitability.

In FY2020, the operating income of Eda Ranu increased, mainly because it canceled the outsourcing of water fee collection. However, it recorded loss before an income tax of 41.8 million kina, due to the impairment of account receivables, which amounted to 67.8 million kina, in preparation for the merger with Water PNG. The loss in FY2020 was only temporary, and it achieved a profit before a tax of 17.7 million kina in 2021.

Table 9 Financial status of Eda Ranu

	2018	2019	2020 (15 months)
Revenue	116.8	118.1	150.9
Operating income	34.8	67.1	67.1
Profit / loss before income taxes	-1.4	-41.8	17.7
Total assets	177.4	168.1	-
Total equity	139.4	106.7	-
Capital adequacy ratio	78.6%	63.5%	-

Source: Documents provided by Water PNG
Unit: million kina
Note: The financial result for FY2020 is 15 months, as the fiscal year was adjusted to align with the fiscal year of Water PNG. The figures for FY2020 are not definitive, as audited financial statements were not provided by Water PNG. A balance sheet for FY2020 was not provided.

The financial status of Water PNG is shown below. Note that the financial result for FY2021 is that after the merger with Eda Ranu. Although it incurred a loss in FY2019, it made a profit in both FY2020 and FY2021. As the capital adequacy ratio of Water PNG is also high, it does not seem to have any financial issues.

Table 10 Financial status of Water PNG

	2019	2020	2021
Revenue	106.8	118.0	200.1
Operating income	14.0	30.0	48.5
Profit / loss before income taxes	-5.2	24.9	11.1
Total assets	555.0	583.4	1,080.6
Total equity	321.8	332.7	598.1
Capital adequacy ratio	58.0%	57.0%	55.3%

Source: Documents provided by Kumul Consolidated Holdings
Unit: million kina

Water and sewerage tariff, which the Independent Consumer and Competition Commission (ICCC) authorizes, are supposed to be revised every five years in Papua New Guinea. However, owing to the merger between Eda Ranu and Water PNG, the tariffs were not revised as scheduled in January 2020.

At the time of the ex-post evaluation, Water PNG was discussing the revision of tariffs with the ICCC, and a new tariff structure was expected to be applied from January 2023. Under the new tariff structure, sewerage tariffs are expected to be revised to the level at which Water PNG can recover the operating and managing costs of the Joyce Bay Sewage Treatment Plant and other facilities developed under the ODA Loan Project. Under the new structure, same tariff rates are going to be applied throughout the country after this, although different rates were applied to Port Moresby, under the responsibility of Eda Ranu, and the rest of the country, under the responsibility of Water PNG.

Although Water PNG canceled the outsourcing and started collecting tariffs by itself, there were no issues in the tariff collection rates at the time of the ex-post evaluation. The draft billing system developed by the Technical Assistance Project may have contributed to the enhancement of the tariff collection of Water PNG.

The budget allocated to and executed by the Joyce Bay Sewage Treatment Plant Department is listed in Table 11. There were no maintenance activities that could not be performed owing to budget shortages. In addition, the Joyce Bay Sewage Treatment Plant Department, as well as the Sewerage Operation Department, were able to procure spare pumps that needed to be replaced periodically, and purchased additional equipment and materials, such as vehicles. Therefore, no issues were observed in budget allocation for operations and management.

Table 11 Budget Executed by Joyce Bay Sewage Treatment Plant Department

	2019	2020	2021
Budget execution	6.0	5.8	5.5

Source: Documents provided by Water PNG
Unit: million kina

The sewerage tariff setting for Port Moresby prepared by the Technical Assistance Project for the enhancement of financial planning capacity for sewerage system was not utilized at the time of the ex-post evaluation because a new tariff structure, which was to be applied throughout the country, was being developed as mentioned above.

Similarly, although the Medium to Long Term Business Operation Plan for Sewerage Service prepared for Eda Ranu by the Technical Assistance Project was used as a reference when Water PNG developed its medium-term plan, the extent to which it contributed to the enhancement of the financial aspect of Water PNG was not clear.

3.4.5 Environmental and Social Aspect

The Joyce Bay Sewage Treatment Plant Department of Water PNG, responsible for the operation and maintenance of the sewerage facilities developed by the ODA Loan Project, operated and managed the sewage treatment plant following the monitoring indicators listed in the environmental permit issued by the CEPA. In addition, Water PNG monitored the water quality of the treated sewage discharged into the sea, carried out sample testing on water quality in the sea on a regular basis, and submitted the monitoring reports to CEPA.

The environmental permit is valid until 2043, and Water PNG is supposed to continue environmental monitoring following the permit; thus, it can be said that the sustainability in the aspects of environmental and social considerations is secured for the future.

3.4.6 Preventive Measures to Risk

Although, the impacts of natural disasters on the proposed sewage treatment plant construction site and the area where the ocean outfall pipe was to be installed were foreseen at the time of the appraisal, no impact of natural disasters or unforeseen risks incurred. Similarly, no factors that could affect sustainability in the realization of project outcomes were identified.

3.4.7 Status of Operation and Maintenance

At the time of the ex-post evaluation, both the sewage treatment plant and pumping station were operated and maintained in accordance with the manuals prepared by the Technical Assistance Project, and no issues were observed in their maintenance status. Using the IT system installed by the ODA Loan Project, the Joyce Bay Sewage Treatment Plant

Department was able to monitor the operational status of the sewage treatment plant and pumping stations on a real-time basis, and the department responded to problems such as garbage clogging within the following day if such problems occurred in pumping stations. In addition, it was also confirmed that necessary materials, such as spare parts were procured by the Water PNG budget.

The sewer pipes were maintained in accordance with the manuals prepared by the Technical Assistance Project, and no issues were identified in their operation and maintenance. Because Water PNG replaced some sewer pipes with larger ones and improved manholes utilizing the maintenance records registered in the sewer network ledger system developed by the Technical Assistance Project, the number of sewage outflows and emergency responses decreased, even outside the project area. As a result, Water PNG was now able to conduct preventive maintenance activities.

Through site visits to the sewage treatment plant and pumping stations conducted during the ex-post evaluation, no issues were identified in the operation and maintenance status.

Regarding policy and system, although the legal backgrounds of the executing agencies were clear, there were minor issues because the legal system for the promotion of house connections and the Trade Wastewater Policy were not approved. However, because Water PNG worked on them, there are good prospects for resolution.

There were no major issues in institutional, organizational, and technical aspects because the departments in charge of operation and maintenance of sewerage facilities continued their duties even after the merger of Eda Ranu with Water PNG, and their personnel were also transferred to Water PNG. However, there were some minor issues because environmental education and awareness-raising activities were not continued due to the mandates of the departments in charge not being finalized. From a financial aspect, there were no issues, as Water PNG had been making profits since the merger, and it had allocated a sufficient budget for operation and maintenance. In addition, environmental and social aspects were monitored following pre-determined indicators, and sufficient preventive measures against risk were taken. In addition, there were no issues in the status of operation and maintenance, as Water PNG operated and maintained sewerage facilities in accordance with the manuals and responded to the abnormalities and emergencies.

Furthermore, it was confirmed that the support provided by the Technical Assistance Project led to improvements in the technical aspects of operation and maintenance and that the proposed collection system developed by the Technical Assistance Project contributed to the improvement in the financial aspect. Thus, it can be said that the Technical Assistance Project contributed to the improvement in the sustainability of the projects.

In light of the above, although some minor issues were observed in the policy, systems, institutional, and organizational aspects, they are expected to be settled. Therefore, the sustainability of the project effects is high.

4. Conclusions, Lessons Learned and Recommendations

4.1 Conclusion

The ODA Loan Project was implemented to provide sewerage services to the coastal area of Port Moresby and to prevent the discharge of contaminated water to the coastal waters by developing sewerage facilities in the area thereby contributing to the improvement in residents' living environment and industrial development through establishing a sanitary living environment and conserving the marine environment. The Technical Assistance Project was also implemented in combination with the ODA Loan Project targeting on improving the management capacity of Eda Ranu that operated and managed sewerage facilities in Port Moresby.

Although the projects were not implemented in coordination with other projects of JICA or other organizations other than JICA, they were highly relevant to the development policies and development needs at the time of the appraisal and ex-post evaluation. Therefore, their relevance and coherence are high. The outputs of the ODA Loan Project were revised based on the M/D concluded in 2014 after the ODA Loan Project was launched. The efficiency of the projects is high because the actual project cost and project period exceeded the planned project cost, which were recalculated in accordance with the revised project outputs, and revised planned project period, only slightly. The qualitative effects of the projects, such as the establishment of a sanitary living environment and conservation of the marine environment, were identified, and impacts, such as improvement in residents' living environment and industrial development, were partly identified. However, because quantitative effects such as the volume of sewage treatment and the utilization rate of sewerage facilities were much lower than the targets, the effectiveness and impact of the projects are moderately low. Although there were some minor issues in the operation and maintenance of the projects in terms of policy and system, as well as institutional and organizational aspect, the sustainability of the projects is high because they were expected to be settled.

In light of the above, the projects are evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

<u>Improved utilization rate of sewerage facilities by strengthening house connections</u>

The utilization rate of sewerage facilities of the Joyce Bay Sewage Treatment Plant

developed under the ODA Loan Project was only 38%; thus, the number of house connections needs to be increased. Therefore, Water PNG plans to increase the number of connections and the utilization rate of sewerage facilities by waiving connection fees, which are supposed to be covered by users. As an increase in the number of connections would lead to an improvement in the utilization rate of sewerage facilities and the improvement in residents' living environment, this effort should be continued in the future.

However, because the budget of Water PNG is limited, it is recommended that Kumul Consolidated Holdings and the government allocate a budget to Water PNG to increase the number of house connections. In addition, Water PNG should resume publicity and environmental education activities for residents to increase the number of connections.

Integration of trade wastewater policies

At the time of the ex-post evaluation, the trade wastewater policy of Water PNG covering the area outside Port Moresby was already approved, whereas the draft trade wastewater policy prepared for the former Eda Ranu covering Port Moresby was not approved. Therefore, Water PNG, which merged with Eda Ranu, did not have the authority to conduct on-site inspections of business establishments in Port Moresby at the time of the ex-post evaluation and could not prohibit them from discharging sewage exceeding standards into the sewer network.

Therefore, it is recommended that Water PNG consolidate the two trade wastewater policies mentioned above and approve them by its Board of Directors to have the authority to conduct on-site inspections of business establishments in Port Moresby.

Finalization of organizational structure

At the time of the ex-post evaluation, environmental education and awareness-raising activities supported by the Technical Assistance Project had not been implemented because the mandates of departments in charge were not made clear since the completion of the Technical Assistance Project. Environmental education and awareness-raising activities are expected to lead to stable operation and management of the sewage treatment plant by reducing the amount of garbage dumped into the sewer network by residents and sewage exceeding the standard discharged into the sewer network. It is therefore recommended that Water PNG finalizes its organizational structure and mandates of departments, and resumes environmental education and awareness-raising activities.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Consideration of increase in the number of house connections to sewerage system during project planning and implementation

In the projects, the number of house connections did not increase as expected despite the completion of sewerage facilities because users avoided bearing connection fees. As a result, the volume of sewage treatment of the sewage treatment plant and the percentage of sewered population in the project area were smaller than planned; thus, the achievements of the project effects were limited.

Therefore, when developing sewerage facilities, it is recommended to confirm whether any issues related to residents' housing connections to the sewerage system might arise during project planning and implementation. If there is a possibility that such issues related to house connections arise, JICA, the implementing agency and relevant organizations need to discuss solutions to these issues, such as mandatory sewer connections, during project planning and implementation.

Expiration date of environmental permit at time of the appraisal

The environmental permit originally issued for the ODA Loan Project needed to be renewed because it expired in 2013 during project implementation. During this renewal process, the treatment capacity and treatment process of the sewage treatment plant were discussed, and the project period became longer. To avoid major changes in the project scope during implementation, it is recommended that permits and approvals, including environmental permits, cover the periods up to the completion of the project.

5. Non-Score Criteria

5.1 Performance

5.1.1 Objective Perspective

JICA has contributed to the improvement of technical levels of the operation and management of sewerage facilities of Water PNG, in addition to the support provided in the projects, during and after the implementation of the projects, by accepting several Water PNG staff members for subject-specific training programs such as "Sewerage System Maintenance Management" and "Sewerage and Urban Drainage Management."

(end)

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs (1) Sewerage facilities	a) Construction of sewage treatment plant, access road, and ocean outfall - Sewage treatment plant (13,800 m^3/day, oxidation ditch process) - Access road (1.73 km) - Ocean outfall (1.4 km) This component was revised as follows: - Sewage treatment plant (18,400 m^3/day, oxidation ditch process) - Access road (1.5 km) - Ocean outfall (1.6 km) b) Sewer pipe installation - Trunk sewer 17.2 km - Branch sewer 17.7 km This component was revised as follows: - Trunk sewer 13.6 km - Branch sewer 15.6 km c) Construction and rehabilitation of pumping stations - Construction: 8 stations - Rehabilitation: 9 stations This component was revised as follows: - Construction: 4 stations - Rehabilitation: 9 stations d) Construction of sludge drying beds at the Morata Sewage Treatment Plant This component was excluded from the project output.	a) Construction of sewage treatment plant, access road, and ocean outfall - Sewage treatment plant (18,400 m^3/day, oxidation ditch process) - Access road (1.25 km) - Ocean outfall (1.6 km) b) Sewer pipe installation - Trunk sewer 12.4 km - Branch sewer 13.2 km c) Construction and rehabilitation of pumping stations - Construction: 4 stations - Rehabilitation: 9 stations

(2) Consulting Services	- Review of tender documents, tender assistance, and supervision of construction work - Training for Eda Ranu staff members on the operation and maintenance of sewerage facilities - Implementation of environmental monitoring - Support on the implementation of a pilot project on the introduction of flush toilets for inhabitants in water-houses and on the implementation of hygiene and environmental education programs - Support on the implementation of HIV/AIDS prevention programs for workers employed for the ODA Loan project and the surrounding residents	- Review of tender documents, tender assistance, and supervision of construction work - Training for Eda Ranu (currently Water PNG) staff members on the operation and maintenance of sewerage facilities - Implementation of environmental monitoring - Support on the implementation of HIV/AIDS prevention programs for workers employed for the ODA Loan project and the surrounding residents
2. Project Period	January 2010 - September 2015 (69 months)	January 2010 - January 2020 (121 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 3,787 million yen 7,015 million yen (178 million kina) 10,802 million yen 8,261 million yen 1 kina = 39.5 yen (As of January 2010)	 4,774 million yen 9,872 million yen (271 million kina) 14,647 million yen 8,181 million yen 1 kina = 36.4 yen (Average between January 2010 and January 2020)
4. Final Disbursement	March 2020	

(end)