ECONOMIC ANALYSIS

A. Project Rationale

1. The project addresses the failure of (i) the market to adequately provide sanitation services, and (ii) public institutions to deliver such services efficiently and economically.

2. The proposed investments are expected to reduce the incidence of diarrhea and gastroenteritis, dengue, typhoid, and skin diseases, which are among the major sanitation-related illnesses prevalent in the five project cities. The economic impacts of these diseases in terms of health care costs and productivity losses are significant.[1] Incidence of these diseases and pollution of surface and underground water are expected to increase with increasing population and urbanization without proper collection, treatment, and disposal of wastewater.

3. The provision of an off-site sewerage system is part of each city's sanitation strategy and wastewater master plan.

B. Basic Approach and Methodology

4. Economic analyses of the subprojects were carried out in accordance with the Guidelines for the Economic Analysis of Projects of the Asian Development Bank (ADB) and related ADB manuals.[2] The feasibility of the investments was determined by computing the economic internal rates of return (EIRR) and economic net present value, and comparing the EIRR with the assumed 12% economic rate of return. The period of analysis covers 25 years, inclusive of 5–6 years of investment implementation.

5. Economic benefits include (i) health care cost savings from reduced incidence of disease, (ii) productivity savings or avoided loss of income, (iii) avoided costs of septic tank desludging and/or construction, and (iv) averted costs of accessing polluted water for drinking and other domestic uses.

6. Economic costs are derived from financial estimates of investments and operation and maintenance costs net of taxes, duties, and price contingencies; and adjusted using a shadow exchange rate factor of 1.0 and a shadow wage rate factor for unskilled labor of 0.7.[3] For nontradable components, a factor of 1.0 is applied. All costs are expressed at constant October 2012 and valued using domestic price numerarie.

7. Economic analysis was prepared for the base case. Sensitivity tests were carried out to determine the impact of changes in key variables (e.g., investments, operation and maintenance cost, and benefits) on subproject viability. Distribution analysis of benefits is used to determine who gains from the investments and the impact on the poor.

C. Costs and Benefits

8. Economic costs include investments for sewer networks, treatment plants, land, resettlement, consulting services, and project implementation support. They are derived from the financial estimates after adjustments following the described methodology. Economic benefits are estimated using the assumptions described in the following paragraphs.

---

[1] World Bank. 2008. *Economic Impacts of Sanitation in Indonesia*. Washington, DC.
[2] ADB. Year. *Guidelines for the Economic Analysis of Projects.* Manila.
[3] Indonesia Infrastructure Initiative, *Wastewater Investment Master Plans, Final Feasibility Studies: Palembang, Pekanbaru and Cimahi*, 2011.

9. **Cimahi sewerage system.** Health care cost savings estimations are based on the incidence of three major diseases, with rates in 2011 of 207 cases per 100,000 residents for diarrhea and gastroenteritis, 27 for typhoid, and 80 for dengue.[4] Average daily treatment costs are Rp222,000 for diarrhea (for in-patients in government hospitals and clinics; Rp80,000 for out-patients), Rp272,000 for typhoid, and Rp377,000 for dengue. Diseases last an average of 4 days for diarrhea and 6 days for typhoid and dengue. About 58% of patients seek medical treatment in government hospitals and clinics; others seek treatment elsewhere. Morbidity reduction rate over the 25-year period is assumed at 35% based on data from the World Health Organization and from a study conducted by Esrey et. al.[5]

10. Productivity savings or avoided loss of income, as a consequence of reduced morbidity, are estimated based on the proportion of patients who are economically active (45%–53%), duration of sickness, and local minimum wage of Rp53,500 per day.

11. Avoided costs of desludging and constructing septic tanks are based on the costs of constructing a standard 3 cubic meter (m^3) residential septic tank[6] (Rp4.0 million) and desludging (Rp300,000 per service). For commercial septic tanks, cost was assumed at double the rate for domestic connections.[7]

12. Unabated pollution of water sources because of improper wastewater disposal increases the cost of water with avertive behaviors on the part of water users either through the use of more costly water quality improvement technologies, increased treatment, or alternative supplies (e.g., bottled water). Benefit is valued by estimating the total cost of piped and nonpiped water considering consumption rates (122 liters/capita/day (lpcd) for piped water, 98 lpcd for nonpiped), prices (Rp2,750/m^3 for piped, Rp21,200/m^3 economic price for nonpiped), and attribution rate of urban pollution to cost of water (50%).[8]

13. **Jambi sewerage system.** The health benefit analysis focuses on diarrhea (incidence of 266 per 10,000 residents) and dengue (and 21 per 10,000 residents). Treatment cost data from Palembang (city closest to Jambi) of Rp235,000 per day for diarrhea and Rp185,000 for dengue are used in the absence of such data from the city's health department. Duration of sickness is 7 days for diarrhea and 8 days for dengue. Nearly 50% of patients seek medical treatment from government hospitals and clinics.[9] The morbidity reduction rate is assumed at 35%.

14. Estimations of productivity savings assume that (i) 50% of patients are economically active, (ii) a local minimum wage of Rp46,545 per day, (iii) desludging cost of Rp280,000, and (iv) cost of septic tank construction of Rp3.5 million.

15. The benefit of avoided costs of accessing polluted water for drinking are estimated using the following assumptions: average consumption rates of 127 lpcd for PDAM Tirta Mayang water and 98 lpcd for nonpiped water, piped water price of Rp2,600/m^3, and economic value of

---

[4] According to Dinas Kesehatan Cimahi City, the figures represent only the cases treated in all puskesmas and government hospital (RS Cibabat) and exclude cases treated in RS Dustira (a military hospital) and two privately owned hospitals.

[5] S. A. Esrey, J. B. Potash J. B. Roberts and C. Shiff. 1990. *Health Benefits from Improvements in Water and Sanitation – Survey and Analysis of Literature on Selected Diseases*. WASH Technical Report No. 66.

[6] *SNI 03-2001, Tata Cara Perencanaan Tangki Septik Dengan Resapan*.

[7] In Denpasar, for example, sewerage fees for small commercial enterprises is 2.25 times that for domestic connections and 5.00 times for medium-sized enterprises (PERDA Provinsi Bali No. 2 Tahun 2011 Tentang Retribusi Jasa Umum).

[8] footnote 1.

[9] SUSENAS 2006 data indicate that 34.6% of urban patients seek treatment in government health centers, 10.1% in public hospitals, 6.5% in private hospitals, and 30.8% in private services/self-treatment.

non-piped water of Rp21,200/m^3. The contribution of domestic sources to water pollution in the city s assumed to be higher than the 39%assessed for the whole province.[10]

16. **Makassar sewerage system.** The health benefit analysis is based on the cost impact of reduced morbidity for diarrhea (278 per 10,000 residents in 2011, typhoid (20), and dengue (1). Treatment costs were Rp222,000 for diarrhea, Rp272,000 for typhoid, and Rp377,500 for dengue. Average duration are 3 days for diarrhea, 10 days for typhoid, and 5 days for dengue. Morbidity reduction rate is assumed at 35%. From 40% to 45% of patients are of working age; the daily minimum wage is Rp54,167.

17. The current cost of constructing a standard septic tank is Rp3.0 million and desludging of domestic septic tank is Rp250,000 per service.[11] Commercial establishments pay the same amount based on the current city regulation.

18. Estimations of avoided costs of drinking and using polluted water are based on consumption rates of 147 lpcd for PDAM Makassar water and 120 lpcd for nonpiped water; price of piped water of Rp2,264/m^3 and economic price of nonpiped water of Rp21,200/m^3. The contribution of domestic sources of pollutants to overall water pollution is 51%.[12]

19. **Palembang sewerage system.** The health benefit analysis is based on diarrhea, typhoid, and dengue. Although cases of diarrhea and typhoid are declining, incidence rates in 2011 of 310 cases per 10,000 residents for diarrhea and 63 for typhoid were the highest among the project cities.[13] The in-patient daily cost of treatment averaged Rp260,000 for diarrhea and Rp235,000 for typhoid. For dengue, the cost was Rp205,000, with an out-patient cost of Rp80,000 per day. Durations of sickness average 5 days for diarrhea, 7 for typhoid, and 8 for dengue. Forty-six percent of patients seek medical care in government hospitals and clinics. The morbidity reduction rate is 35%.

20. From 40% to 45% of patients are of working age; the local daily minimum wage is Rp54,545. The current cost of desludging is Rp188,000 and of constructing a new septic tank Rp5.0 million.

21. The benefit of averted costs of accessing polluted water for drinking and other domestic uses consider the average consumption rates of 167 lpcd for PDAM Tirta Musi water and 92 lpcd for nonpiped water. The price of piped water is Rp2,869/m^3 while the economic value of nonpiped water is assumed at Rp21,200/m^3. Domestic sources of pollution are assumed to contribute 35% to overall water pollution in the city

22. **Pekanbaru sewerage system.** Health benefits are estimated from reductions in the incidence of diarrhea, dengue, and skin diseases. Incidence rates for these diseases in 2011 were 124 per 10,000 residents for diarrhea, 5 for dengue, and 145 for skin diseases. The average daily costs of treatment are assumed at the same rate as for Palembang of Rp260,000 for diarrhea, Rp205,000 for dengue, and Rp185,000 for skin diseases. Diarrhea lasts for 7 days, dengue for 8 days, and skin diseases for 10 days. Only about 24% of patients seek medical treatment in government hospitals and clinics. The morbidity reduction rate is 35%.

23. Productivity savings are based on assumptions that 40%–50% of patients are economically active and the local minimum wage is Rp57,273 per day. Desludging costs Rp247,500 and construction of a new septic tank costs Rp4.0 million.

---

[10] According to the World Bank study of the economic impacts of sanitation (footnote 1), the contributions of various sources to overall water pollution are: domestic – 39%, industry – 49% and agriculture – 11%.

[11] *Local Regulation of Makassar City on Hygiene and Waste Management*, 2011.

[12] In the World Bank study on the economic impacts of sanitation (footnote 1), the contribution of various pollution sources to overall water pollution are domestic 51%, industry 40%, and agriculture 8%.

[13] The figures do not include cases treated in private hospitals and clinics, and by other health care providers.

24. The benefit of the avoided cost of polluted water is based on consumption rates of 120 lpcd for PDAM Tirta Siak water and 95 lpcd for nonpiped water, and a price of Rp2,452/m^3 for piped water. Domestic sources contribute 9% to water pollution in Riau province. A higher rate of 45% is assumed for the city as no large industrial and agricultural sources of pollution are within the area.

D. Cost–Benefit and Sensitivity Test Results

1. Economic Internal Rate of Return and Economic Net Present Value

25. The results of the base case economic analyses are provided in Table 1.

Table 1: Economic Internal Rate of Return and Economic Net Present Value, Base Case

Indicator	Cimahi	Jambi	Makassar	Palembang	Pekanbaru
ENPV (Rp bln)	17.1	16.9	90.2	10.9	23.2
EIRR (%)	13.7	13.1	15.8	12.6	13.4

EIRR = economic internal rate of return, ENPV = economic net present value

26. Under the "base case" scenario, all proposed investments are economically feasible, with positive NPVs and EIRRs exceeding the minimum threshold of 12%.

2. Sensitivity analysis results

27. Results of the sensitivity analysis are shown in **Table 2.**

Table 2: Sensitivity analysis results, all subprojects

Subproject/Scenario	Change from Base Case (%)	EIRR (%)	ENPV (Rp bln)	Value (%)
Cimahi sewerage system				
Base Case		13.7	17.1	-
Capital investment (1)	+10	12.3	3.0	+12
O&M costs (2)	+10	13.5	15.4	+103
Total benefits (3)	-10	12.0	-0.2	-10
1-Yr delay in benefits		11.7	3.2	-
Combination 1, 2 & 3		10.5	-16.0	-
Jambi sewerage system				
Base Case		13.1	16.9	-
Capital investment (1)	+10	11.6	7.2	+7
O&M costs (2)	+10	13.0	15.6	+131
Total benefits (3)	-10	11.4	-9.9	-6
1-Yr delay in benefits		11.2	-14.1	-
Combination 1, 2 & 3		9.9	-35.3	-
Makassar sewerage system				
Base Case		15.8	90.2	-
Capital investment (1)	+10	14.2	55.8	+23
O&M costs (2)	+10	15.7	88.7	+609
Total benefits (3)	-10	13.9	45.6	-20
1-Yr delay in benefits		13.5	38.7	-
Combination 1, 2 & 3		12.5	9.6	-

Palembang sewerage system						
Base Case			12.6	10.9	-	
Capital investment (1)	+10		11.1	-17.5	+4	
O&M costs (2)		+10	12.5	9.6		+83
Total benefits (3)		-10	10.9	-19.5		-4
1-Yr delay in benefits			10.8	-24.0	-	
Combination 1, 2 & 3			9.5	-49.2	-	
Pekanbaru sewerage system						
Base Case			13.4	23.2	-	
Capital investment (1)	+10		11.8	3.2	+9	
O&M costs (2)		+10	13.3	22.0		+202
Total benefits (3)		-10	11.6	6.3		-8
1-Yr delay in benefits			11.4	-10.4	-	
Combination 1, 2 & 3			10.1	-33.9	-	

EIRR = economic internal rate of return, ENPV = economic net present value

28. The proposed investments for Makassar remain economically feasible under all test cases including a “worse case” scenario combining 10% increases in investments and O&M costs with a 10% reduction in total benefits. In the case of Cimahi, Palembang, Pekanbaru and Jambi subprojects, EIRR remains above or slightly just below the minimum threshold under the first three scenarios. A one-year delay in project benefits and under the “worse case”, EIRR for all four subprojects falls a little short of the benchmark.

E. Other Benefits

29. Some benefits of improved sanitation/wastewater management were not included in the analysis due to lack of local data. These include, among others, (i) health care costs and productivity savings from reduced incidence of other sanitation-related diseases; (ii) value of sludge as a by-product of wastewater treatment process either as in-filling material, soil conditioner or agricultural fertilizer; (iii) increased productivity and value of agriculture/fish catch due to reduced water pollution; (iv) increased value of lands that were previously made unusable or were rendered marginally productive because of pollution; and (v) positive impacts on local tourism and economy.

F. Project Beneficiaries and Distribution of Benefits

30. The subprojects will directly benefit a total of about 70,270 households (population: 352,000) and 12,800 commercial establishments. The number of direct household beneficiaries is estimated to constitute 43% of the projected number of households within the subproject areas after completion of the investments in 2018.

31. In addition to the households and commercial establishments, the cities themselves, through the SDO (PDAM, as the case in Palembang City) as operators of the sewerage facilities, will also benefit from the investments in terms of revenues from service users. Overall, 74% of the benefits will directly accrue to households, 20% to commercial establishments and 6% to SDOs.

32. The poverty impact ratio for the subprojects are Cimahi 16%, Jambi 11%, Makassar 28%, Palembang 18%, and Pekanbaru 10%.