ECONOMIC ANALYSIS

A. Introduction

1. The economic analysis of the proposed investments was undertaken in accordance with the procedures set out in the Asian Development Bank (ADB) guidelines.[1] The Fourth Greater Mekong Subregion Corridor Towns Development Project has two outputs: (i) urban environmental infrastructure improved; and (ii) institutional effectiveness, and policy and planning environment for regional economic connectivity enhanced. The first output is divided into three subprojects: Kampong Cham urban environmental infrastructure improved, Kratie urban environmental infrastructure improved, and Stung Treng urban environmental infrastructure improved. The economic analysis was carried out to determine whether the economic benefits envisioned to be generated by the project are sufficient to cover the cost of the investment in each output in the three towns and the overall project. The economic viability was assessed using least-cost analysis and cost–benefit analysis. The least-cost analysis of alternative options was used to ensure whether options identified and included under the proposed project would represent the least-cost means to meet the proposed project objectives and forecast growth in demand. The cost–benefit analysis compared the with- and without-project scenarios.

B. Project Alternatives and Least-Cost Analysis

2. The least-cost analysis was conducted for the construction investments where alternative engineering options are available. The analysis used the lowest present value of economic costs. Investment and operation and maintenance (O&M) costs were converted into economic costs and compared along with alternative options with appropriate discounted rates per year. The analysis ensured that the three outputs adopted cost-effective engineering design options for wastewater and drainage service (i.e., wastewater treatment process, pipeline network) and solid waste management service (i.e., location, leachate treatment option). Within the least-cost option, the project also considered the impact of climate change, where possible, so it will qualitatively generate more economic value for mitigating flood risks. These features include increasing the height of the drainage channel embankment and landfill cells.

C. Cost–Benefit Analysis

3. The period of analysis covers 25 years from 2019 to 2043. Costs and benefits are quantified at January 2018 constant prices and converted to their economic cost equivalents using shadow prices. Economic costs include (i) capital cost, including safeguard mitigation and monitoring; (ii) costs for consultants; (iii) physical contingencies; and (iv) O&M costs. An exchange rate of KR4,035 = $1 was used. All costs and benefits were valued using the domestic price numeraire. Economic costs were derived from the financial costs by excluding taxes and duties because they represent transfer payments. The prices of tradable components were adjusted to economic prices using a shadow exchange rate factor of 1.1. The non-tradeable components were valued at domestic market prices. The shadow wage rate factors applied were 1.0 for skilled labor and 0.75 for unskilled labor.[2] The economic opportunity cost of capital is assumed at 9%.

---

[1] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila; and ADB. 1998. *Guidelines for the Economic Analysis of Water Supply Projects*. Manila.

[2] The figures were from recently approved projects: ADB. 2016. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant and Technical Assistance Grant for Additional Financing to the Kingdom of Cambodia for the Second Rural Water Supply and Sanitation Sector Project*. Manila; ADB. 2017. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Loan and Grant to the Kingdom of Cambodia for the Provincial Water Supply and Sanitation Project*. Manila.

1. Economic Costs

4. **Wastewater and drainage service**. Kampong Cham, Kratie, and Stung Treng towns have no centralized wastewater collection and treatment system. Wastewater treatment is limited to septic tanks in the more modern houses, hotels, and restaurants, while most households use an unsealed soak pit formed with locally available concrete ring sections. These do not allow for any significant treatment; liquid waste soaks into the ground and solids remain in the pit. The towns have no septage treatment facilities. The existing drainage system collects storm water and wastewater through street drains in the town center and this is discharged into the Mekong River for Kampong Cham and Stung Treng, and the wetlands near the town for Kratie. Kampong Cham and Kratie town centers have annual flood events because of poor storm water drainage and spillover from the Mekong River. Stung Treng has less flooding from the Mekong and Sekong rivers, but the flood occurs some parts due to the five creeks running through the town center.

5. The project will finance a centralized wastewater and drainage system for the three town centers, including a wastewater treatment facility with a design capacity of 7,700 cubic meters per day (m^3/day) for Kampong Cham, 6,950 m^3/day for Kratie, and 4,900 m^3/day for Stung Treng; a combined wastewater and drainage pipeline network of 16.5 kilometers (km) for Kampong Cham, 5.7 km for Kratie, and 16.8 km for Stung Treng; and pump stations and connections for 3,611 households in Kampong Cham, 2,688 households in Kratie, and 2,326 households in Stung Treng. The economic capital costs were estimated at $17.6 million for Kampong Cham, $19.0 million for Kratie, and $14.5 million for Stung Treng. The O&M costs were estimated at 1% of the capital investment.[3]

6. **Solid waste management service**. Kampong Cham, Kratie, and Stung Treng only have an uncontrolled dump site serving each town for municipal solid waste. They have no cell management, no leachate collection and treatment, no formal recycling, no facility for hazardous waste, and no gas collection. The existing landfill sites are located about 28 km from the town for Kampong Cham, 14 km for Kratie, and 6 km for Stung Treng. Private service providers collect and dispose of solid waste in Kampong Cham and Kratie, but their services are irregular with very limited coverage because of lack of a proper contractual agreement, equipment, and operation standards.

7. The project will redevelop the existing dump site into a managed landfill with capacity of 900,000 cubic meters (m^3) for Kampong Cham, 433,500 m^3 for Kratie, and 291,000 m^3 for Stung Treng, with drains and leachate collection, all-season site roads, a recycling area, and capping soil storage. Vehicles for collecting, moving, and compacting waste will be provided. The component will also include a public awareness campaign to increase the use of the solid waste collection service. The economic capital costs were estimated at $7.9 million for Kampong Cham, $7.0 million for Kratie, and $7.3 million for Stung Treng. The O&M costs were estimated at 1% of the capital investment.

8. **Town center enhancement**. Kampong Cham, Kratie, and Stung Treng are located on the Mekong River. However, Kratie and Stung Treng have limited and damaged pedestrian walkway and public green space along the riverside to improve drainage in the town center, enhance the livability of local people, and develop more attractive town centers. Kratie and Stung Treng provinces also have unique natural tourism assets with potential for attracting tourists. The project will rehabilitate the pavement of 10,600 square meters (m^2) in Kratie and 5,800 m^2 in Stung Treng,

[3] Based on other projects in Cambodia, Kampong Cham, Kratie, and Stung Treng estimated the O&M (i.e., electricity, fuel, small repairs, water, and workers' wages) for the wastewater treatment facility to be about 1.6%–1.7% of the capital expenditure, 0.3%–0.5% for the pipeline network, and 0.5%–1.0% for the combination of the two components.

and construct curbing and green landscaping. The economic capital costs were estimated at $1.3 million each for Kratie and Stung Treng. The O&M costs were estimated at 1% of the capital investment.

2. Economic Benefits

9. **Wastewater service**. Project benefits include reduced pollution of surface and ground water and wetlands through treated effluent discharge, and improved sanitation and better public health with less waterborne disease occurrence.[4] Disability-adjusted life years (DALYs) were valued using the gross national income (GNI) per capita for 2016 of $3,510 and calibrated to estimate the town level income compared with the national average.[5] The DALY for Cambodia is 33,800 per 100,000 population.[6] About 2.2% of the total DALY is attributed to poor sanitation. DALY savings were applied to the population covered by the wastewater services.

10. **Solid waste management service**. The project's benefits will include: (i) reducing pollution and the associated improvement in public health, (ii) improve nuisance in households and public space, and (iii) improve the overall sanitary condition of the town center—protecting the environment, especially groundwater, from contamination in the landfill site and adjacent areas. Benefits were assumed from the reduction in health risks associated with pollution, measured by savings in DALYs. About 4.7% of the total DALY is attributed to respiratory disease and at least 70% is attributed to toxic smoke inhalation, which can be related to the burning of waste (may contain plastic and other toxic substances).[6] DALY savings were applied to the population covered by the solid waste management services.

11. **Drainage service**. For the drainage component, benefits identified are the avoidance of flood damage and economic losses resulting from the disruption of economic activity during flood events. Based on the household survey (footnote 4), households affected by floods are 33% for Kampong Cham, 35% for Kratie, and 40% for Stung Treng. Estimated flood damage is KR476,000 for Kampong Cham, KR511,000 for Kratie, and KR718,000 for Stung Treng, with a flood duration of 7 days for Kampong Cham, 12 days for Kratie, and 10 days for Stung Treng.[7]

3. Economic Internal Rate of Return and Sensitivity Analysis

12. The base-case economic internal rate of return (EIRR) calculation for the entire project is in Tables 1 and 2. The project is economically viable at a 9.0% discount rate for the urban and social sector project. The EIRRs were computed at 13.6% for the overall project, 15.0% for the Kampong Cham output, 11.9% for the Kratie output, and 14.0% for the Stung Treng output. The estimated benefits of the project were considered conservative because of the additional qualitative benefits that were identified but not included in the analysis, e.g., positive economic

[4] The incidence of waterborne diseases in the project area is 61% for Kampong Cham, and 42% for Kratie and Stung Treng based on the Socio-economic Survey conducted in August 2017 as a part of project preparation.

[5] Government of Cambodia, National Institute of Statistics. 2016. *Cambodia Socio-Economic Survey, 2015*. Phnom Penh. Since provincial and town gross domestic product data are lacking, the average disposable income of Cambodia, Phnom Penh, and other rural areas from the Cambodia socioeconomic survey (2015), i.e., the rate of the whole of Cambodia and other rural areas, to estimate the towns' GNI per capita. The rate of rural GNI is 82% of the national GNI. The assumption is considered conservative considering that (i) Cambodia's rural population is almost 80% of the total population and (ii) economic benefits are generated within the town boundaries.

[6] World Health Organization. 2016. *Global Health Estimates 2015: Disease burden by Cause, Age, Sex, by Country and by Region, 2000–2015*. Geneva. The toxic smoke also includes roadside motor vehicle emissions as well as other point sources such as industries and coal-fired power plants.

[7] Flood damage includes damage to house structure, appliances, vehicles, livestock, and food supplies. Flood events are due to (i) rainwater due to inadequate and clogged (by silt and solid waste) drains; and/or (ii) overflow of the Mekong River. Flood events are more than one per year.

impacts on tourism. The sensitivity analysis, which tested the effects of negative changes in key parameters, revealed that the overall project remains economically viable despite a 10% increase in O&M costs (13.6%), a 10% decrease in benefits (12.4%), a 10% increase in capital cost (12.5%), and a 1-year implementation delay (12.0%). The EIRR declined to 11.8% in the combined scenario of a 10% increase in capital and O&M costs and a 10% decrease in benefits.

Table 1: Summary of the Economic Internal Rate of Return and Sensitivity Analysis

Item	EIRR (%)	NPV ($'000)	Sensitivity Indicator	Switching Value (%)
Subprojects - Base Case				
Kampong Cham subproject	15.0	10,501		
Kratie subproject	11.9	4,868		
Stung Treng subproject	14.0	7,582		
Whole Project				
(i) Base case	13.6	22,951		
(ii) 10% capital cost increase	12.5	18,711	1.8	54%
(iii) 10% O&M cost increase	13.6	22,609	0.1	673%
(iv) 10% benefits decrease	12.4	16,075	(3.0)	-33%
(v) 1-year construction delay	12.0	15,106		
(vi) Combination of (ii), (iii), and (iv)	11.8	14,041		

( ) = negative, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank.

Table 2: Economic Internal Rate of Return for the Project, 2019–2043

($'000)

Year	Benefits						Costs		Net Benefit
	Kampong Cham		Kratie		Stung Treng		Capital Costs	O&M	
	WW-DR	SWM	WW-DR	SWM	WW-DR	SWM			
2019							(2,293)		(2,293)
2020							(13,664)		(13,664)
2021							(13,664)		(13,664)
2022							(18,203)		(18,203)
2023							(20,497)		(20,497)
2024	1,890	1,708	1,109	1,496	1,440	1,326		(683)	8,284
2025	2,031	1,799	1,229	1,576	1,556	1,410		(683)	8,916
2026	2,141	1,893	1,335	1,659	1,650	1,498		(683)	9,493
2027	2,258	1,990	1,448	1,745	1,750	1,591		(683)	10,098
2028	2,380	2,090	1,570	1,836	1,855	1,688		(683)	10,735
2029	2,510	2,193	1,700	1,930	1,967	1,790		(683)	11,405
2030	2,646	2,299	1,839	2,028	2,085	1,896		(683)	12,110
2031	2,790	2,410	1,988	2,136	2,210	2,010		(683)	12,860
2032	2,941	2,525	2,148	2,248	2,342	2,129		(683)	13,650
2033	3,101	2,643	2,318	2,366	2,482	2,254		(683)	14,481
2034	3,269	2,766	2,499	2,489	2,631	2,385		(683)	15,356
2035	3,446	2,892	2,694	2,618	2,787	2,522		(683)	16,276
2036	3,564	3,021	2,846	2,752	2,897	2,666		(683)	17,063
2037	3,685	3,155	3,005	2,892	3,011	2,817		(683)	17,882
2038	3,811	3,293	3,170	3,039	3,129	2,975		(683)	18,734
2039	3,941	3,436	3,343	3,191	3,251	3,140		(683)	19,620
2040	4,075	3,582	3,524	3,350	3,378	3,314		(683)	20,541
2041	4,214	3,733	3,712	3,516	3,510	3,495		(683)	21,498
2042	4,358	3,889	3,909	3,690	3,646	3,685		(683)	22,493
2043	4,506	4,050	4,101	3,871	3,788	3,883		(683)	23,515
								NPV	**22,951**
								EIRR	**13.6%**

( ) = negative, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance, SWM = solid waste management, WW-DR = wastewater and drainage service.
Source: Asian Development Bank.