

## ECONOMIC ANALYSIS

### A. Introduction

1. Maldives recorded an impressive economic growth with an average annual increase of 5.7% during 2010–2016.<sup>1</sup> The World Development Indicators show that the income of Maldives comes primarily from the service sector, i.e., 74% of gross domestic product (GDP) in 2016,<sup>2</sup> mostly concentrated in urban areas. The urban population of Maldives increased from 11.5% in 1968 to 47.5% in 2017, with an average annual growth rate of 2.96%.<sup>3</sup> Though the rapid urbanization has significantly contributed to Maldives' economic growth, environmental challenges have constrained the urban areas from developing into competitive and livable places.

2. The project area suffers from severe environmental pollution and deteriorating livability because of inadequate collection and haphazard disposal of solid waste.<sup>4</sup> Open dumping and burning of garbage at the old dumpsites has particularly caused an environmental and public health hazard posing a daily nuisance to residents and tourists in Malé.

3. The Government of Maldives has requested financing from the Asian Development Bank (ADB) for the Greater Malé Environment Improvement and Waste Management Project to provide disaster and climate-resilient solid waste management (SWM) services in the project area. The project will have the following outputs: (i) improved and climate- and disaster-resilient waste collection, transfer, and disposal systems; (ii) enhanced community-based outer island waste management systems; and (iii) strengthened institutional capacity and public awareness in sustainable waste management.

### B. Project Rationale

4. **Rationale for the government intervention.** The rationale for government involvement is sound as the project focuses on basic urban services including SWM, where the services provided are public goods managed by the government.

5. **Government policy.** The government's major policies on SWM include the following: (i) National Solid Waste Management Policy (2008),<sup>5</sup> (ii) Solid Waste Management Regulations (2013),<sup>6</sup> and (iii) Environmental Protection Agency (2008).<sup>7</sup>

6. **Demand analysis.** The environmental pollution caused by poor waste management has posed a significant threat to public health. The project area severely lacks an organized and environmentally sustainable SWM system for about 400 tons of mixed waste generated per day, mainly due to inadequate waste collection. All these above underlines the demand for the project.

7. **Least cost analysis.** Alternative designs were assessed for cost-effectiveness in the detailed project report, which include (i) options for waste collection suitable for bigger and smaller

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<sup>1</sup> National Bureau of Statistics. Ministry of Finance and Treasury. 2018. *Statistical Yearbook of Maldives, 2018*. Malé.

<sup>2</sup> World Bank. 2017. 'Country Profile - Maldives'. Washington D.C. Available at: [http://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report\\_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=MLD](http://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=MLD)

<sup>3</sup> World Bank. 2018. *Maldives - Urban population 2017*. Washington, DC.

<sup>4</sup> The project area includes the North Ari Atoll, South Atoll, Malé Atoll, and Vaavu Atoll classified as Zone 3. The total population of the project area is 216,000 comprising the capital city of Malé, 35 inhabited islands, and 76 resorts.

<sup>5</sup> Republic of Maldives. Ministry of Environment and Energy. 2008. *National Solid Waste Management Policy*. Malé.

<sup>6</sup> Republic of Maldives. Ministry of Environment and Energy. 2013. *Solid Waste Management Regulations*. Malé.

<sup>7</sup> Republic of Maldives. Ministry of Environment and Energy. 2008. *Environmental Protection Agency*. Malé.

islands, (ii) options for collecting and treating special categories of waste, and (iii) selection of technology for composting and landfill. Based on the comparison study, the project was found to be the most economical for meeting demand in terms of scale, materials, and technology.

8. **Affordability analysis.** In 2017, poor households in Malé paid about 1.26% of their monthly income toward SWM and this is estimated to increase to 1.27% in 2023 when the operation starts (Table 1), whereas the SWM charge for nonpoor households is estimated to increase from 0.63% in 2017 to 0.64% in 2023. The average household expenditure for SWM was found to be less than the global norm of 2.0% of total household income in all income categories and this underlines the affordability for the project beneficiaries.<sup>8</sup>

**Table 1: Solid Waste Charges, Usage, and Average Household Income**

Item	Existing (2017)	Proposed (2023) <sup>a</sup>
Average monthly household waste generation (kilogram) <sup>b</sup>	114.6	114.6
Monthly solid waste tariff (\$/household) <sup>c</sup>	9.7	11.7
Average monthly household income - Poor categories (\$/month) <sup>d</sup>	769.7	919.1
<b>Solid waste bill as % of income - Poor categories (%)</b>	<b>1.26</b>	<b>1.27</b>
Average monthly household income - Nonpoor categories (\$/month)	1,535.3	1,833.2
<b>Solid waste bill as % of income - Nonpoor categories (%)</b>	<b>0.63</b>	<b>0.64</b>

<sup>a</sup> 2023 is the operation start year for the project.

<sup>b</sup> Adopted from the SWM feasibility report (2017).

<sup>c</sup> Based on WAMCO tariff rate for 2017. Tariff increase of 20% every 5 years is assumed based on the discussion with WAMCO officials and its strategic plan (2016) objectives.

<sup>d</sup> Household income for 2017 is based on the baseline socioeconomic survey (2017). Household income from 2018 to 2023 is updated using the GDP growth rate of 3%.

Sources: (i) Republic of Maldives. Ministry of Environment & Energy. 2017. *'Feasibility Report – Final Version'*, Malé.; (ii) Republic of Maldives. Ministry of Finance and Treasury. 2017. *Statistical Yearbook of Maldives, 2017*. Malé.; and (iii) ADB. 2017. TA-9327 MLD. *'Baseline Socio Economic Survey'*. Manila.

9. **Government capacity.** The government has implemented projects financed by ADB and other external agencies in transport, regional development, and port development, underlining the capacity of the government to manage the project.<sup>9</sup>

10. **Financial sustainability.** The financial sustainability of the project is an identified risk because of the possibility of delays in the required tariff revisions. The government committed the allocation of sufficient funding for operation and maintenance and ADB will also provide capacity building support under the project to mitigate this risk.

## C. Economic Analysis

11. The economic analysis assessed the economic viability of the project in terms of economic internal rate of return and economic net present value in accordance with ADB's Guidelines for the Economic Analysis of Projects.<sup>10</sup>

12. **Economic costs.** The assumptions for estimating economic costs are as follows:  
(i) All costs are in 2018 constant prices and converted at \$1 = Rf15.4.

<sup>8</sup> UN-Habitat research (Habitat 2010) indicates that SWM tariffs should be at 0.7%–2% of family income to be sustainable. Source: User Pays Framework for Island Waste Management Services Final Report, May 2010, prepared by Green Partners as part of the Maldives Environmental Management Project.

<sup>9</sup> ADB-funded projects include (i) Regional Development Project Phase II, (ii) Private Sector Development Project, (iii) Domestic Maritime Transport Project, and (iv) Second Malé Port Project. Projects funded by the World Bank include (i) Maldives Environmental Management Project, (ii) Clean Energy for Climate Mitigation Project, and (iii) Ari Atoll Solid Waste Management Project. JICA funded the Clean Energy Promotion Project in Malé.

<sup>10</sup> ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

- (ii) Projections from July 2018 to June 2038 (including 5 years of implementation and assets created) are assumed to have a 15-year lifespan upon completion.<sup>11</sup>
- (iii) Economic costs of construction and O&M costs are calculated from the financial cost estimates; price contingencies, taxes and duties, and financial charges are excluded, but physical contingencies are included (Table 2).
- (iv) All costs including construction and O&M costs are valued using the domestic price numeraire; tradable inputs are adjusted by the shadow exchange rate factor 1.06;<sup>12</sup> and unskilled labor is adjusted by a conversion factor of 0.87 of the market wage rate to estimate the shadow wage rate.<sup>13</sup>
- (v) The economic opportunity cost of capital is assumed at 9% in real terms.

**Table 2: Economic Costs and Project Period (\$ million)**

Item	Project Costs		Economic Costs <sup>a</sup>		Project Period	
	Capital	O&M	Capital	O&M	Implementation	O&M
Solid waste management	40.0	123.6	37.7	116.5	July 2018– June 2023	July 2023– June 2038

O&M = operation and maintenance.

<sup>a</sup> Excludes taxes and duties, price contingencies, and financial charges, but includes physical contingencies.

Source: Asian Development Bank estimates.

## D. Project Benefits

13. The project will (i) improve the waste collection and transfer system in Greater Malé and outer islands,<sup>14</sup> (ii) improve dumpsite management and site logistics on Thilafushi Island, and (iii) support project management, design, and supervision consultant, benefiting 307,000 people in 2023. The project is expected to (i) improve the collection and transportation of household and commercial waste, resulting in reduced opportunity costs to the project beneficiaries for waste disposal (i.e., non-incremental benefit); and (ii) increase the processed waste available for sale (i.e., incremental benefit).

14. **Non-incremental benefits.** Non-incremental benefits include savings in (i) costs of household collection and disposal of solid waste, (ii) health expenditure, and (iii) time spent on disposal of solid waste. Under the without-project scenario, the current SWM system is predicted to deteriorate in the future, resulting in increased opportunity costs.<sup>15</sup> The intervention under the project will help Maldives maintain the same level of opportunity costs.<sup>16</sup> The difference between the without- and with-project scenarios is considered the savings in costs of household collection

<sup>11</sup> Existing landfill site and the 15 acres landfill site under reclamation will cover the demand for solid waste management up to 15 years once the proposed project is completed. (Source: Republic of Maldives. 2017. Ministry of Environment & Energy. 'Feasibility Report – Final Version'. Malé.).

<sup>12</sup> Shadow exchange rate factor

Details	2013	2014	2015	2016	Average
Exports (\$ million)	331	301	239	257	282
Imports (\$ million)	1,703	1,961	1,894	2,097	1,914
Customs duties (\$ million)	102	128	152	154	134
Standard conversion factor	0.95	0.95	0.93	0.94	0.94
Shadow exchange rate factor	1.05	1.06	1.07	1.07	1.06

Source: Ministry of Finance and Treasury. 2017. *Statistical Yearbook of Maldives 2017*. Malé

<sup>13</sup> 0.87 (Shadow wage rate factor) was estimated through dividing \$7.0 per day (minimum wage of Maldives) into \$8.07 per day (unskilled labor cost, using practiced labor wage rate paid by contractors to unskilled laborers).

<sup>14</sup> Outer islands are small inhabited islands outside the immediate Greater Malé area.

<sup>15</sup> In the absence detailed data, a 5% annual increase in opportunity cost under 'without project' scenario is assumed based on similar other studies including the SWM Improvement Project in Uzbekistan (RRP UZB 45366).

<sup>16</sup> The opportunity cost at the project operation start year (2023) is assumed to be same based on the proposed tariff during the analysis period, as the proposed project envisages adequate O&M and replacement provisions.

and disposal of solid waste. Similarly, medical expenditure because of diseases related to solid waste pollution in the without-project scenario is assumed to be saved through the intervention of the project. In addition, the time required for the collection and disposal of solid waste under the without-project scenario is considered savings in time.

15. **Incremental benefit.** The project is assumed to increase processed waste that is separated and recycled because of the project intervention.<sup>17</sup> Revenues from the sale of this additional recyclable waste is considered an incremental benefit. In the operation start year (2023), 25.6 tons of household and commercial waste (18.3 tons of composting, 3.0 tons of plastics, 1.2 tons of metals, and 3.1 tons of paper and cardboard) is estimated as the additional daily availability through recycling. In addition, 416.5 tons of recycled building waste and 0.8 tons of recycled damaged vehicles are estimated to be available for sale daily. Considering the unit rates and the projected incremental recyclable waste under different categories during the analysis period (2023–2037),<sup>18</sup> the additional revenue is considered incremental benefit.

**Table 3: Economic Benefits**

Category	Unit Rate	Total Benefits (ENPV, \$ million)
<b>A. Non-Incremental Benefits</b>		
a. Savings in costs of household collection and disposal of solid waste	\$124.0/ton <sup>a</sup>	41.7
b. Savings in avoided health damage	\$1.0/person/yr <sup>b</sup>	2.6
c. Savings in solid waste disposal time	\$79.8/household/yr <sup>c</sup>	29.9
<b>B. Incremental Benefits</b> (incremental revenue from recycled waste)		
a. Household waste	\$82.9/ton <sup>d</sup>	9.9
b. Other waste	\$24.0/ton <sup>e</sup>	21.6

ENPV = economic net present value, yr = year.

<sup>a</sup> By dividing Rf250 (proposed monthly SWM tariff) into 0.1309 tons (monthly household waste quantity disposed), the average monthly household costs for waste disposal is Rf1,910.3/ton (\$124.0/ton). Under the without-project scenario, this household disposal cost is assumed to increase 5% annually and this rate will be maintained without increase under the with-project scenario. The difference is considered savings in the analysis. Source: Republic of Maldives. Ministry of Environment and Energy. 2017. *Feasibility Study for the Integrated SWM in Zone III*. Malé.

<sup>b</sup> \$172.2 (per capita annual health expenditure) x 0.6% (percentage of diseases related to solid waste pollution including parasitic and vector diseases, intestinal nematode infections, and lower respiratory diseases) = \$1.0/person/year in 2017. This health benefit is assumed to increase by 5% annually. Source: (i) ADB. 2017. TA-9327 MLD, 'Baseline Socio-Economic Survey'. Manila., (ii) World Health Organization. 2016. Department of Information, 'Estimated YLD ('000) by cause, sex and WHO Member State'. Washington D.C.; (iii) Chadar SN and Keerti Chadar. 2017. 'Solid Waste Pollution: A Hazard to Environment', *Mini Review Volume 2 Issue 3- July 2017*, Juniper Publishers. Available at: <https://juniperpublishers.com/rapski/pdf/RAPSCI.MS.ID.555586.pdf>.

<sup>c</sup> With 0.38 hours (average daily household savings in waste disposal time) and \$0.6 (time value for unskilled labor during non-working hours), the annual household time savings is estimated at \$79.8/household/year. Source: ADB, 2017, TA MLD 9327, 'Baseline Socio Economic Survey'.

<sup>d</sup> Weighted average of \$90.0/ton for composting, plastic, and metal with 88% share and \$30.0/ton for paper and cardboard with 12% share is \$82.9/ton. Source: Ministry of Environment and Energy. 2017. *Feasibility Study for the Integrated SWM in Zone III*. Malé.

<sup>e</sup> Cost of recycled building waste and damaged vehicles is estimated to be \$24.0/ton. Source: Ministry of Environment and Energy. 2017. *Feasibility Study for the Integrated SWM in Zone III*. Malé.

16. **Economic feasibility results.** The economic analysis shows the project to be economically viable, with the calculated economic internal rate of return exceeding the economic

<sup>17</sup> Composition of household and commercial waste is estimated at organics (60%), paper & cardboard (10%), plastics (10%), metals (4%), and others (16%). The present rates of recyclable waste for composting (20%), sorting of plastics (10%), metals (10%), and paper and cardboards (20%) are assumed to improve to 30%, 20%, 20%, and 30%, respectively, in the operation start year (2023). This will further increase to reach composting (50%), sorting of plastics (40%), metals (40%), and paper and cardboards (50%) in 2037. (Source: Republic of Maldives. Ministry of Environment and Energy. 2017. *Feasibility Study for Integrated SWM for Zone III*. Malé.)

<sup>18</sup> \$90/ton for metals, plastics, and composting; \$30/ton for paper and cardboards, and \$26/ton for building waste and damaged vehicles, as considered in the Final Feasibility Report, is considered for this analysis.

opportunity cost of capital of 9%. The results of the sensitivity analysis are also satisfactory, except for the scenario combining all risks (Table 4). However, the project is likely to be economically viable even in the worst-case scenario due to unquantifiable benefits not reflected in the analysis such as environmental improvements and reduced cost of health treatments.

**Table 4: Economic Internal Rate of Return and Sensitivity Analysis**

Particulars	EIRR (%)	ENPV (\$ million)	Switching Value (%)
Base case	17.5	34.4	
Construction cost (+20%)	15.4	28.7	120.2
Operation and maintenance cost (+20%)	15.8	26.8	90.3
Benefit (-20%)	13.0	14.2	34.0
Delay in operation by one year	17.2	31.9	
Combined (worst-case scenario)	8.8	(0.7)	

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.

Source: Asian Development Bank estimates.

**Table 5: Cost and Benefit Streams (\$ million)**

Table 5. Cost and Benefit Streams (\$ million)									
Year	Costs			Benefits				Total	Net Benefits
	Construc tion	O&M	Total	Non-incremental		Incremental			
				Savings in costs of solid waste collection and disposal	Savings in health expenditure	Savings in solid waste disposal time	Revenue from recycled waste		
2018	1.2	-	1.2	-	-	-	-	-	(1.2)
2019	8.4	-	8.4	-	-	-	-	-	(8.4)
2020	13.3	-	13.3	-	-	-	-	-	(13.3)
2021	10.0	-	10.0	-	-	-	-	-	(10.0)
2022	4.1	-	4.1	-	-	-	-	-	(4.1)
2023	0.6	3.8	4.4	0.3	0.2	2.3	2.2	5.0	0.6
2024	-	5.7	5.7	1.5	0.3	4.8	4.5	11.2	5.4
2025	-	6.0	6.0	2.5	0.4	5.1	4.6	12.6	6.5
2026	-	6.3	6.3	3.5	0.4	5.2	4.7	13.8	7.4
2027	-	6.7	6.7	4.7	0.4	5.3	4.7	15.1	8.4
2028	-	7.0	7.0	5.9	0.5	5.4	5.8	17.6	10.6
2029	-	7.3	7.3	7.3	0.5	5.5	5.9	19.2	11.8
2030	-	7.7	7.7	8.8	0.5	5.6	6.1	21.0	13.2
2031	-	8.1	8.1	10.4	0.6	5.7	6.2	22.9	14.8
2032	-	8.5	8.5	12.1	0.6	5.8	6.3	24.9	16.4
2033	-	8.9	8.9	14.0	0.7	6.0	7.6	28.3	19.4
2034	-	9.4	9.4	16.1	0.7	6.1	7.8	30.7	21.3
2035	-	9.8	9.8	18.3	0.8	6.2	8.0	33.3	23.5
2036	-	10.3	10.3	20.9	0.8	6.4	8.3	36.4	26.1
2037	-	10.8	10.8	23.8	0.9	6.5	8.5	39.7	28.9
2038	-	5.7	5.7	13.1	0.5	3.3	4.3	21.2	15.5
Total	37.7	122.2	159.9	163.3	8.6	85.2	95.6	352.7	192.8
ENPV	28.6	38.1	66.7	41.7	2.6	27.5	29.4	101.2	34.4
EIRR									17.5%

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance.

Source: Asian Development Bank estimates.

## E. Distribution Analysis

17. A distribution analysis enables the calculation of the poverty impact ratio, i.e., the proportion of project net benefits accruing to the poor. The analysis shows the poverty impact ratio to be 25.8%. Considering that 15.0% of the population lives below the poverty line in Maldives,<sup>19</sup> the project contributes to the poor considerably.

<sup>19</sup> ADB. 2017. *Poverty in Maldives*. Manila. Available at: <https://www.adb.org/countries/maldives/poverty>.