ECONOMIC ANALYSIS

A. Introduction and Macroeconomic Context

1. The economic analysis was conducted for the proposed Madhya Pradesh Urban Services Improvement Project in accordance with the guidelines, including Economic Analysis of Projects[1] and Handbook of Economic Analysis of Water Supply Projects,[2] of the Asian Development Bank (ADB). The project comprises three outputs: (i) improved water supply infrastructure in 64 towns and drainage infrastructure in two towns, (ii) sustained operation and maintenance (O&M) for the infrastructure developed under output (i), and (iii) improved institutional effectiveness and strengthened capacity in all project towns. Out of the 64 project towns, one town with a water supply component alone (Sagar)[3] and one town with both water supply and drainage components (Khajuraho)[4] were considered as the sample for the analysis.

2. **Project in sector context**. According to a recent national survey, in the state of Madhya Pradesh, less than 57% of households have access to piped water supply.[5] The state's urban population is about 20 million (according to the 2011 census[6]) and is growing at an annual rate of 2.57%, higher than the national average of 2.45%. An expanding urban population will aggravate the existing gap in the provision of efficient, equitable, and sustainable urban services since the concentrated economic activities in urban areas may attract distressed rural populations into nearby towns. The Government of Madhya Pradesh has a focused urban water supply improvement program, titled Mukhya Mantri Shehari Peyjal Yojana (urban water supply), and, so far, water supply infrastructure improvement works have been taken up in about 99 towns and another 36 towns are said to be in the advance stage of government approval.[7] In line with this, the government of Madhya Pradesh has planned to cover all the towns in the state with domestic and international funding support, including the proposed project.

3. **Project context.** In the process of trying to meet the challenges of a fast-growing state economy, the state government has initiated various urban infrastructure investment initiatives. As a development partner to the government, ADB had successfully implemented the Urban Water Supply and Environmental Improvement in Madhya Pradesh Project in 2011.[8] The proposed project will result in improved and sustainable urban services to 1.8 million people (by 2019) in the state.

4. **The goal.** The project goal of providing sustainable and safe drinking water and drainage is consistent with the state's Twelfth Five-Year Plan, 2012–2017,[9] and is in line with the Government of India's initiatives to improve urban infrastructure.[10]

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[1] ADB, 1997, *Guidelines for Economic Analysis of Projects*, Manila.
[2] ADB, 1999, *Handbook of Economic Analysis of Water Supply Projects*, Manila.
[3] Sagar's population of 274,556 is the largest among the project towns.
[4] Of the two towns with both water supply and drainage components, Khajuraho has the larger population (24,481).
[5] Government of India, Ministry of Statistics and Programme Implementation. 2013. *Drinking Water, Sanitation, Hygiene and Housing Condition in India: National Sample Survey 69th Round.* Delhi.
[6] Government of India. 2011. Series No. 1. Delhi
[7] The government of Madhya Pradesh also received substantial fund support from the Government of India under the Urban Infrastructure Development Scheme in Small and Medium Towns.
[8] ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to India for the Urban Water Supply and Environmental Improvement in Madhya Pradesh Project*. Manila.
[9] "To provide sustainable access to safe potable drinking water to all independent habitations" is one of the objectives of the Twelfth Five-Year Plan, 2012–2017 of the state of Madhya Pradesh.
[10] The Atal Mission for Rejuvenation and Urban Transformation was started in 2015 by the Government of India with thrust areas of water supply, sewerage, and storm water drainage for flood control.

5. **Project rationale**. The government's involvement through the project is sound, as the existing gap in the urban service delivery of adequate water supply and safe sanitation facilities is considerable in the project towns. The project focuses mainly on basic urban services where (i) there is natural monopoly, and (ii) the services provided are public goods.

6. **Analysis of least costs**. Alternative design options were assessed for ensuring cost-effectiveness taking into account capital and O&M costs, sustainability and reliability of supply, and ease of operations. Least-cost analysis in the design stage of water supply components has considered (i) water sources (groundwater and possible surface sources), and (ii) zoning (the distribution network divided into different control zones for better network management). Least-cost analysis in drainage components has been done mainly for (i) optimizing and integrating the existing drainage systems; and (ii) selecting pipe materials.

7. **Demand analysis.** The state of Madhya Pradesh experienced better than average economic growth, with annual growth of 8.6% against the national average of 7.3% during 2005–2014. Growth of urban populations is also faster than it is nationally, which will aggravate the existing gap in urban service delivery.[11] Of the average water consumption of 74 liters per capita per day (lpcd) in the two sample towns, only 62 lpcd is available from piped water and the balance of 12 lpcd is supplemented from other sources, including tube wells, hand pumps, and dug wells, at higher resource cost rate (ranging between ₹76.9/kiloliter and ₹88.2/kiloliter). The increase of piped water supply up to 100 lpcd—through improving raw water intakes, water treatment plants, and distribution networks—will remove this supply disparity and reduce the cost of water to meet the minimum required demand for the beneficiaries. The identified project towns for drainage intervention have no access to sanitation infrastructure.[12]

8. **Affordability analysis**. The subprojects include water supply and sewerage infrastructure (as part of drainage components) with household connections. It is estimated that the average household expenditure for water supply and sewerage in all income categories in the state will be less than 5% of the total household income (Table 1). This demonstrates the affordability for all income categories to meet their expenditure related to water and sewerage tariffs by considering the generally accepted level of 5% ceiling in India. According to a baseline survey conducted in 2015, households in the sample towns were found to be willing to pay an average of ₹103 per month for water supply; in addition, about 50% of the households were found to be willing to pay additional user charges for improved sewerage facilities.[13] Thus, the proposed combined water and sewerage tariffs for the project towns (₹125.2[14] for slum and ₹250.5[15] for nonslum) do not deviate much from the willingness-to-pay limits for water supply and sewerage derived from the baseline survey.

Table 1: Water and Sewer Charges, Usage, and Average Household Income, 2016

Category	Average Monthly HH Income (₹)	Average Monthly Water Usage (kl)[a]	Average Monthly Water Charge (₹)[b]	Average Monthly Sewer Charge (₹)[c]	% of Water Charge to HH Income	% of Water and Sewer Charge to Household Income
Slum	8,687	15.66	78.3	46.9	0.90	1.44
Nonslum	17,612	15.66	156.6	93.9	0.89	1.42

[11] The urban population in Madhya Pradesh is growing at an annual rate of 2.57%, higher than the national average of 2.45%. By 2026, urbanization in the state is expected to reach 34.8% as compared with 27.0% in 2011.

[12] There is no wastewater collection and sewerage service in the two project towns for drainage intervention.

[13] Baseline survey under project preparatory technical assistance was conducted in 2015 for 11 sample towns representing the project towns.

[14] Monthly water tariff ₹78.3/kl (15.6 kl x ₹5) and monthly sewerage tariff ₹46.9/kl (60% of water tariff).

[15] Monthly water tariff ₹156.6/kl (15.6 kl x ₹10) and monthly sewerage tariff ₹46.9/kl (60% of water tariff).

kl = kiloliter.
Notes:
a. Based on the proposed water supply of 100 liters per capita per day and 5.2 members in a household.
b. Proposed water tariff of ₹10 per kiloliter for nonslum and ₹5 per kiloliter for slum are considered based on past tariffs and discussions with the government of Madhya Pradesh and local governments. The proposed 100 liters per capita per day is assumed for 2016 to arrive at the maximum tariff impacts.
c. More than half (60%) of the water supply charge is considered for the sewerage charge, as practiced in many local bodies in the state.
Source: Project preparatory technical assistance report in 2015

B. Economic Analyses of Sample Subprojects

9. The economic analysis assessed the economic viability in terms of economic internal rate of return and economic net present value using the following assumptions:

(i) All costs are based on 2016 prices and converted at $1 = ₹67.
(ii) The analysis was conducted for 30 years including 5 years of implementation.
(iii) Economic costs (Table 2) of capital works and annual O&M are calculated from the project cost estimates; price contingencies, financial charges, and taxes and duties are excluded from the analysis but physical contingencies are included.
(iv) The economic opportunity cost of capital (EOCC) is assumed at 12% in real terms.
(v) All costs are valued using the domestic price numeraire; tradable inputs are further adjusted by the shadow exchange rate factor of 1.03[16] and unskilled labor costs for the shadow wage rate factor of 0.84.[17]
(vi) Project network and related infrastructure were designed to cater to 30 years demand and water supply capacity and treatment facilities for 15 years (Table 2).

Table 2: Details of Project Costs ($ million)

	Capital Costs		O&M Costs		Project Period	
Town	**Project Costs**	**Economic Costs**	**Project Costs**	**Economic Costs**	**Implementation**	**O&M**
Sagar	45.9	36.2	43.6	34.3	2017–2021	2022–2046
Khajuraho	11.4	9.4	6.3	5.3	(5 years)	(25 years)

O&M = operation and maintenance.
Source: Asian Development Bank.

C. Water Supply Rehabilitation Project – Sagar

10. The subproject is for the rehabilitation of the existing water supply systems including the water source augmentation and district metered area-based supply network in order to achieve 90% coverage (the existing coverage is 69%) and 100 lpcd (the existing piped water supply is 63 lpcd). There will be 333,200 beneficiaries (57,780 households) by 2022. Present water consumption is 73 lpcd, of which 63 lpcd is provided from piped water. Thus, 10 lpcd of water is presently supplemented from other sources. The resource cost spent for 10 lpcd of supplemented water from other sources in the without-project scenario is treated as

[16] Shadow Exchange Rate Factor

Details	**2009–2010**	**2010–2011**	**2011–2012**	**2012–2013**	**2013–2014**
Gov't exports	8,455	11,429	14,660	16,353	18,942
Gov't imports	13,637	16,835	23,455	26,732	27,142
Gov't customs duties	602	976	1,056	1,155	1,231
SCF	0.97	0.97	0.97	0.97	0.97
SERF	1.03	1.03	1.03	1.03	1.03

Gov't = government, SCF = standard conversion factor, SERF = shadow exchange rate factor.
Source: ERD Technical Note Series No. 11, Shadow Exchange Rate for Project Economic Analysis, Feb. 2004.

[17] Shadow wage rate factor = ₹157/day (unskilled labor cost, using practiced labor wage rate paid by contractors to unskilled laborers) / ₹187/day (minimum wages in Madhya Pradesh from April to September 2015).

nonincremental benefit (Table 3). The additional water above the present consumption (73 lpcd) up to 100 lpcd is treated as incremental benefit (Table 3).

Table 3: Economic Benefits (Sagar)

Category	Unit Rate	**Benefits** ($ million)
A. Nonincremental benefits		
i. Savings in resource cost	$0.5/kiloliter/day[a]	12.5
ii. Savings in time to collect water	$0.9/kiloliter/day[b]	24.4
iii. Savings in earning loss during sick days	$18.4/household/year[c]	34.3
iv. Savings in maintenance of storage tank	$52.2/household/year[d]	97.2
B. Incremental benefits		
i. Average unit cost for incremental benefit	$0.10/kiloliter[e]	15.2

kl =kiloliter.

Notes:

a. With 21.2% of replaced water through hand pump at ₹80/kl; 46.9% of replaced water through tube well at ₹5.7/kl; 3.3% of procured water by tankers at ₹200/kl; 0.4% of bottled water at ₹1,200/kl; and 9.1% of water from dug well at ₹7.4/kl, the average cost of procured water is estimated at ₹31.7/kl ($0.5/kl).

b. ₹23.5/day (average daily time value) / 0.4 kl (average daily household water collection) = ₹62.1/kl/day ($0.9/kl/day). (₹23.5/day [average daily time value] = ₹0.9/hour [average daily time savings] x ₹27.5/hour [weighted average of daily wage for women and children] x 50% / 6 hour [average daily working hours].)

c. Average daily household income of ₹617.7 x 8 working days lost because of waterborne diseases x 25% apportioned for water supply component = ₹1,235.5/HH/year ($18.4/HH/year).

d. Average annual maintenance of ₹3,500.0/HH = ₹3,500.0/HH/year ($52.2/HH/year).

e. With ₹103.1 of willingness to pay for a month and the projected household consumption of 15.7 kl/month, the unit rate for incremental water is estimated at ₹6.6/kl ($0.1/kl) for 2015.

Source: Asian Development Bank estimates.

D. Water Supply Rehabilitation and Drainage Infrastructure Improvement - Khajuraho

11. The proposed subproject aims at rehabilitating the existing water supply systems to achieve 90% coverage (the existing coverage is 65%) and 100 lpcd (the existing piped water supply is 46 lpcd). There will be 28,110 beneficiaries (5,796 households) for water supply by 2022. Present water consumption is 87 lpcd, of which 46 lpcd is provided from piped water. Thus, 41 lpcd of water is presently supplemented from other sources. The resource cost spent for 41 lpcd of supplemented water from other sources in the without-project scenario is treated as nonincremental benefit (Table 4). The additional water above the present consumption of 87 lpcd up to 100 lpcd is treated as incremental benefit (Table 4).

12. The proposed subproject also includes components for improvement of sewerage and storm water management systems. The benefits are treated as nonincremental since the coverage will increase to 70% of households by 2022 from the existing coverage of 0%.

Table 4: Economic Benefits (Khajuraho)

Category	Unit Rate	**Benefits** ($ million)
A. Water supply		
i. Nonincremental benefits		
a) Savings in resource cost	$0.5/kl/day[a]	2.6
b) Savings in time to collect water	$0.7/kl/day[b]	4.1
c) Savings in earning loss during sick days	$16.8/household/year[c]	3.1
d) Savings in maintenance of storage tank	$52.2/household/year[d]	9.7
ii. Incremental benefits		
a) Average unit cost for incremental benefit	$0.1/kl[e]	1.2
B. Drainage infrastructure improvement (nonincremental)		
i. Savings in earning loss during sick days	$28.9/household/year[f]	4.4
ii. Savings in annual maintenance of septic tank cost	$30.3/householdyear[g]	4.6
iii. Savings in flood damage maintenance	$29.9/household/year[h]	4.5
iv. Savings in earning loss during flood	$52.8/householdyear[i]	7.9

HH = household, kl = kiloliter.

Notes:

a. With 21.2% of replaced water through hand pump at ₹80/kl; 46.9% of replaced water through tube well at ₹5.70/kl; 3.3% of procured water by tankers at ₹200/kl; 0.4% of bottled water at ₹1,200/kl; and 9.1% of water from dug well at ₹7.4/kl, the average cost of procured water is estimated at ₹31.7/kl ($0.5/kl).
b. By ₹21.4/day (average daily time value) / 0.5 kl (average daily household water collection) = ₹45.2/kl ($0.7/kl). (₹21.4/day [average daily time value] = ₹0.9/hour [average daily time savings] x ₹25/hour [weighted average of daily wage women and children] x 50% / 6 hour [average daily working hours].)
c. Average daily household income of ₹562.2 x 8 working days lost because of waterborne diseases x 25% of apportioned for water supply component = ₹1,124.3/HH/year ($16.8/HH/year).
d. Average annual maintenance of ₹3,500.0/HH = ₹3,500.0/HH/year ($52.2/HH/year).
e. With ₹103.1 of willingness to pay for a month and the projected household consumption of 15.7 kl/month, the unit rate for incremental water is estimated at ₹6.6/kl ($0.1/kl) for 2015.
f. Average daily household income of ₹562.2 x 8 working days lost because of waterborne diseases x 43% apportioned for sewerage = ₹1,933.8/HH/year ($28.9/HH/year).
g. (50% of average of annual maintenance costs of septic tank [₹2,790] + 50% of low-cost sanitation [₹1,274]) = ₹2,031.8/HH/year ($30.3/HH/year), for a household on average.
h. Based on focus group discussions in the 2015 survey and the general inquiry during field visit, an average of ₹2,000 per household per year for flood damage rectification (₹2,000/HH/year [$29.9/HH/year] as economic cost).
i. Six days of annual flooding x ₹590 of average household daily earning = ₹3,540.6/HH/year ($52.8/HH/year).

Source: Asian Development Bank estimates.

E. Economic Feasibility Results

13. The economic analysis shows both subprojects to be economically viable, with calculated economic internal rates of return exceeding the EOCC of 12%. The results of the sensitivity analysis are not satisfactory against (i) capital costs overrun by 20%, (ii) O&M costs overrun by 20%, (iii) benefits decrease by 20%, and (iv) combined worst scenario (Table 5). However, it is expected that the proposed subprojects will secure economic viability even in those cases because of unquantifiable benefits, which are not reflected in the analysis, including improvement of environment quality and increase in land value.

Table 5: Summary of Economic Analysis Results

	Sagar			Khajuraho		
Particulars	**EIRR**	**ENPV** ($ million)	**SWITCHING VALUE**	**EIRR**	**ENPV** ($ million)	**SWITCHING VALUE**
Base case	13.3%	2.7		12.1%	0.1	
Capital cost increase (+20%)	10.9%	(2.5)	10.3%	9.9%	(1.5)	0.9%
O&M cost increase (+20%)	12.7%	1.4	43.6%	11.8%	(0.1)	6.9%
Benefits decrease (–20%)	9.8%	(4.3)	7.7%	9.1%	(1.7)	0.8%
Delay in operation (1 year)	13.3%	2.2		12.0%	0.1	
Combined worst scenario	7.0%	(9.6)		6.7%	(3.5)	

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

Source: Asian Development Bank estimates.

F. Distributional analysis

14. The distributional analysis will lead to calculation of the poverty impacts ratio, i.e., the proportion of project net benefits accruing to the poor. The poverty level is high, with 32% at the state level and 24%–38% for the sample towns. The analysis shows that the poverty impacts ratio for the sample towns was found to be around 35% in Sagar and 46% Khajuraho.

G. Financial Sustainability

15. The lack of sufficient funding for O&M of the assets established under the project is identified as a major risk, as the majority of the project cost (approximately 82.5%) will be given to the project towns through grants. To ensure subproject viability, the commitment of project towns to allocate sufficient funding for O&M will be one of the subproject selection criteria.