ECONOMIC AND FINANCIAL ANALYSIS

A. Assumptions and Methodology

1. The economic and financial analysis (EFA) follows ADB Guidelines for the Economic Analysis of Projects.[1] A detailed analysis is presented in the supplementary EFA document.[2] The major assumptions used in the EFA include:

(i) The analysis period is 25 years. The subproject implementation period is 5 years;
(ii) The analysis uses the world price (US$) numeraire. The exchange rate is Viet Nam Dong (VND) 22,350 to $US1. All prices are expressed in 2017 levels;
(iii) Stakeholder benefits, such as savings in the costs of vehicle operation, time, medication, and bottled water, were collected in VND and converted to US$;
(iv) To convert the items into economic values, taxes and subsidies were first deducted from the gross financial values. Conversion factors were then applied on the local (non-tradable), foreign (tradable), and unskilled labor components of each item;
(v) A standard conversion factor (SCF) of 0.95 was applied to all local components, including non-tradables, unskilled labor, and project benefits. For unskilled labor and value of time for beneficiaries, another adjustment was required using a shadow wage rate factor (SWRF) of 0.90.
(vi) The economic discount rate of 9.0 was used%.

B. Output 1: Road Transport Infrastructure Improved

2. The road subprojects will upgrade district road sections in the four north central provinces (NCPs) of Ha Tinh, Nghe An, Quang Binh, and Quang Tri. Feasibility studies were carried out for representative subprojects in Quang Binh, Nghe An, and Quang Tri. Due to provincial budget constraints, currently insufficient maintenance is carried out on all roads in the NCPs. The EFA assumes the status quo will prevail in the without-project scenario, with accelerated rates of road deterioration, increasing vehicle operating costs (VOC) and travel time cost (TTC). With the project, the roads will be upgraded with a double bituminous surface treatment, and will have adequate maintenance.[3]

3. **Traffic categorization**. Three categories of traffic are distinguished in the EFA: normal, generated, and diverted. The normal traffic forecasts are based on October 2016 traffic counts, expected growth in provincial gross domestic product (GDP), income elasticities of traffic demand, and analyses of regional trade and tourism patterns. The GDP of the project provinces grew at 6.5% to 8.1% in 2015, and is assumed to grow at 7.9% to 9.2% between 2017 and 2040. An income elasticity of 0.88 was applied to provincial GDP growth rates to estimate the average traffic growth of 6.8% to 8.1%.[4] Normal traffic is derived by multiplying the growth rates with 2016 traffic counts. Generated traffic is derived as 25 to 50% of the normal traffic rates, depending on vehicle types. With the project, freight will change from being transported by smaller to larger vehicles. Table 1 presents the traffic forecasts.

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[1] ADB. 2017. *Guidelines for Economic Analysis of Projects*. Manila.
[2] Detailed Economic and Financial Analysis: Roads (accessible from the list of linked documents in Appendix 2).
[3] Double bituminous surface treatment has a lower cost-to-output than the alternatives of triple bituminous surface treatment and asphalt cement pavement.
[4] The income elasticity is taken from P. Goodwin, J. Dargay, and M. Hanly. 2004. Elasticity of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review. *Transport Reviews.* 24 (3).

Table 1: Traffic Forecast
(Number of Vehicles per Day[a])

	Passenger traffic						Freight traffic			
	Motor-cycle	Personal Car	Pickup	Small Bus	Medium Bus	Heavy Bus	Small Truck	Medium Truck	Heavy Truck	Truck & Trailer
Without Project										
Quang Binh (3 Sections)										
2016 [b]	2,507.7	567.7	0.0	48.0	7.0	0.0	261.3	15.7	4.7	0.0
2020	2,815.7	772.7	0.0	64.9	9.5	0.0	353.6	21.2	5.9	0.0
2030	3,330.7	1,609.1	0.0	123.1	17.5	0.0	686.5	39.1	8.9	0.0
2040	3,243.1	3,320.2	0.0	207.6	25.1	0.0	1,226.7	56.2	11.3	0.0
Nghe An: DR349 Subproject										
2016 [b]	940.1	31.3	0.0	1.7	0.5	0.0	70.0	20.0	5.3	0.0
2020	1,040.0	41.0	0.0	2.2	0.7	0.0	88.6	25.3	6.7	0.0
2030	1,197.1	90.9	0.0	4.3	1.3	0.0	147.5	42.2	11.2	0.0
2040	1,150.9	208.3	0.0	8.4	2.5	0.0	240.3	68.7	18.3	0.0
Quang Tri Gio Linh–Cam Lo Inter-District Road Subproject										
2016 [b]	456.0	56.7	0.0	3.0	0.0	0.0	63.0	0.0	0.0	0.0
2020	503.6	73.9	0.0	3.9	0.0	0.0	81.7	0.0	0.0	0.0
2030	562.1	138.3	0.0	6.7	0.0	0.0	140.5	0.0	0.0	0.0
2040	539.5	328.3	0.0	13.5	0.0	0.0	282.6	0.0	0.0	0.0
With Project										
Quang Binh (3 Sections)										
2016 [b]	2,507.7	567.7	0.0	48.0	7.0	0.0	261.3	15.7	4.7	0.0
2020	2,815.7	772.7	0.0	64.9	9.5	0.0	353.6	21.2	5.9	0.0
2030	4,664.1	2,298.2	0.0	177.6	26.2	0.0	633.4	76.6	37.3	0.9
2040	4,525.1	4,696.3	0.0	296.6	37.6	0.0	1,042.2	128.7	72.3	2.0
Nghe An: DR349 Subproject										
2016 [b]	940.1	31.3	0.0	1.7	0.5	0.0	70.0	20.0	5.3	0.0
2020	1,040.0	41.0	0.0	2.2	0.7	0.0	88.6	25.3	6.7	0.0
2030	1,556.3	118.2	0.0	5.6	1.7	0.0	139.5	42.8	31.3	20.9
2040	1,496.2	270.8	0.0	11.0	3.3	0.0	227.2	69.8	45.2	24.7
Quang Tri Gio Linh–Cam Lo Inter-District Road Subproject										
2016 [b]	456.0	56.7	0.0	3.0	0.0	0.0	63.0	0.0	0.0	0.0
2020	503.6	73.9	0.0	3.9	0.0	0.0	81.7	0.0	0.0	0.0
2030	843.2	207.5	0.0	10.0	0.0	0.0	39.2	19.6	38.2	1.1
2040	809.2	492.4	0.0	20.2	0.0	0.0	78.8	39.4	76.9	2.2

[a] With-project scenario include both normal and generated traffic, but diverted traffic is excluded.
Source: Asian Development Bank estimates.

4. **Subproject Costs** consist of construction, consulting services, a 10% physical contingency, and periodic (in 2031 and 2036) and routine maintenance. The total financial cost is $27.0 million. The financial values are converted to economic values by excluding taxes and applying appropriate conversion factors on the tradable and non-tradable components of each item. Table 2 presents the project costs in financial and economic values.

Table 2: Road Subproject Capital Costs

	Financial Cost	Taxes	Cost net of tax	Composition		Economic Cost[a]		
				non-tradable	tradable	non-tradable	tradable	Total
	('000 $)	(%)	('000 $)	(%)	(%)	('000 $)	('000 $)	('000 $)
Quang Binh 1	3.75	10%	3.41	60%	40%	1.94	1.36	3.31
Quang Binh 2	2.84	10%	2.58	60%	40%	1.47	1.03	2.50
Quang Binh 3	0.94	10%	0.85	60%	40%	0.49	0.34	0.83
Nghe An	5.84	10%	5.31	60%	40%	3.03	2.12	5.15
Quang Tri	13.67	10%	12.42	60%	40%	7.08	4.97	12.05
Total	**27.03**	**10%**	**24.57**	**60%**	**40%**	**14.01**	**9.83**	**23.84**

[a] Derived from financial values by applying a standard conversion factor (SCF) of 0.95 on non-tradable component.
Source: Asian Development Bank estimates.

5. **Subproject Benefits** included in the EFA are: (i) VOC savings for normal and diverted traffic; (ii) TTC savings for normal and diverted traffic; (iii) net change in carbon emission; and (iv) net change in road accidents. The first two benefits accrue to normal and diverted traffic because improved road conditions or reduced travel distance reduces VOC and TTC. The latter two benefits are accrued by reduced travel distance by diverted traffic which would case reductions, while generated traffic would cause increases.

6. For generated traffic, currently travel costs are beyond what road users are willing to incur, consequently trips are not made. With the project, generated traffic will increase the number of trips, but the magnitude of gain is less than that of the existing road users, of the normal category, who attach a higher value to the road use. Hence, for generated traffic, road user benefits were calculated at 50% of normal traffic's cost savings, to account for their lower willingness to pay. Table 3 summarizes the subproject's benefits.

Table 3. Traffic Category and Associated Benefits

Traffic type	Associated Benefits	Associated Costs
Normal	- VOC and TTC savings	
Generated	- VOC and TTC savings (50% of normal traffic)	- Additional emission and accident
Diverted	- VOC and TTC savings (from reduced travel distance)	
	- Emission and accident reduction	

VOC = Vehicle operating costs, TTC = time cost

7. VOC and TTC are estimated using the Highway Development and Management (HDM4) planning tool. VOC and TTC are functions of road conditions which can be summarized by a single metric, the international roughness index (IRI). The IRI differs in the without- and with-project scenarios, resulting in differences in VOCs and TTCs. VOCs and TTCs are first expressed in financial values and are converted to economic values using appropriate conversion factors. The details are documented in the supplementary EFA document (footnote 2). In Viet Nam, road accident frequency is estimated to be 529 cases per million vehicle kilometer (VKM) for injury, and 4.8 cases per million VKM for fatality.[5] At 2016 price levels, the cost of road accidents is $988 per injury and $34,646 per fatality.[6] The amount of carbon emission varies by vehicle type: 162 grams per VKM for small passenger vehicles, 77 grams per person-km for buses, and 150 grams per ton-km for trucks.[7] The social cost of carbon is $36.3 per ton, in 2016 constant prices, increasing by 2% annually. Generated traffic causes more emission and accidents, while diverted traffic reduces both. The EFA computes and monetarizes the net impact using the above mentioned parameters.

8. For Quang Binh, the estimated subproject benefits are for (i) all normal and generated traffic, total savings in VOC and TTC; and (ii) for the diverted traffic, savings in VOC and TTC on the shorter-distanced route via the subproject's Route 1 (R1). The TTC avoided by the diverted traffic was calculated based on (i) the distance by road between Dong Hoi and FLC Joint Stock Company's golf and tourism site via a bypass, which takes 13.6 minutes longer to complete than the distance via the subproject's Route 1; (ii) speed assumption of 40 kilometer (km) per hour on the bypass and 30 km per hour on all the other roads sections; (iii) the value of time (VOT) for FLC guests is $1.75 per hour and for FLC workers is $1 per hour. A VOT survey carried out in

[5] World Bank. 2014. Global Road Safety Facility, the World Bank; Institute for Health Metrics and Evaluation. Transport for Health: The Global Burden of Disease from Motorized Road Transport. Washington, DC.

[6] World Bank. 2005. Project No. 33327 Vietnam Road Safety Project Appraisal Document. Washington, DC.

[7] Government of the United Kingdom, Parliament Publications. 2007. *The Government's Motorcycling Strategy: Government's Response to the House of Commons Transport Committee*. [insert location]; and Government of the United Kingdom website (accessed 2 April 2010). http://directgov.transportdirect.info/Web2/JourneyPlanning/

2016 for the Dau Giay–Phan Thiet Expressway concluded a value of $6 per hour per vehicle.[8] Assuming an average occupancy of 2–3 persons per vehicle, the VOT is slightly above $2 per hour. The HDM4 outputs are based on a work-travel VOT of $2 per hour for cars and $0.9 for motorcycles and buses. FLC guests are holiday makers on leisure time, which they would regard as having a high value. FLC employees commuting between their home and place of work are considered to be engaged in work-related travel.

9. In Nghe An, additional sources of transport demand include forestry related traffic, and maize feed traffic to Nghia Dan district processors and dairy milk producers. This traffic originates in An Son, Co Cuong, and Tan Ky and would shift from their without-project route via NH7 and NH15 to the improved subproject road and its extension north (Than Son–Tho Son Road) connecting with the Quy Hop district provincial roads and NH48, reducing the total haulage distance by 100 km. Subproject benefit sources were estimated for normal, generated, and the diverted freight traffic comprising for (i) normal and generated traffic, the total savings in VOCs and travel time costs; and (ii) diverted traffic, the VOCs avoided through the 100-km reduced haulage distance. The VOC and time-saving benefits were estimated using HDM-4. For generated traffic, benefits from VOC and time savings were calculated at 50% of cost savings because of their expected lower willingness to pay. For the diverted traffic, an average VOC of $0.67 per VKM was assumed, corresponding to that of a road in fair condition.

10. For Quang Tri, subproject benefits include normal, generated and diverted traffic: (i) savings in VOC and TTC for normal and generated traffic; (ii) diverted traffic's VOC reduction from the use of the improved subproject road instead of the without-project scenario using NH 9–NH 15, or NH 9–NH 1 route. Diverted traffic reduces social costs of carbon emissions and road accidents, but are offset by increase in social costs due to generated traffic.

11. **Economic Analysis.** The overall road subprojects economic internal rate of return (EIRR) is 12.1% for Quang Binh, 14.0% for Nghe An, and 15.1% for Quang Tri. The combined EIRR is 13.7%, and the net present value (NPV) at a 9% discount rate is $9.2 million (Table 4).

Table 4: Economic Analysis for Road Subprojects
(million $)

	Costs			Benefits					Net Benefit
	Capital	Maintenance	Total Cost	VOC Savings	TC Savings	Avoided emission	Avoided accident	Total Benefit	
2018	(9.64)	0.00	(9.64)	0.00	0.00	0.00	0.00	0.00	(9.64)
2019	(12.05)	0.00	(12.05)	0.00	0.00	0.00	0.00	0.00	(12.05)
2020	(2.41)	0.00	(2.41)	0.36	0.00	0.00	0.00	0.36	(2.06)
2025	0.00	(0.09)	(0.09)	2.36	0.68	3.58	0.02	6.64	6.55
2030	0.00	(0.09)	(0.09)	2.50	0.82	0.08	0.00	3.40	3.31
2035	0.00	(0.09)	(0.09)	3.64	1.07	0.05	(0.00)	4.76	4.68
2040	0.00	(0.09)	(0.09)	4.62	1.37	0.07	(0.01)	6.06	5.97
2041	9.04	(0.09)	8.95	4.72	1.43	0.07	(0.01)	6.22	15.17
ENPV (9%)	(19.71)	(4.14)	(23.85)	19.04	5.58	8.34	0.08	33.03	**9.18**
EIRR									**13.7%**

EIRR = economic internal rate of return, ENPV = economic net present value, TTC = time cost, VOC = vehicle operating cost, ( ) = negative.
Source: Asian Development Bank estimates.

12. The sensitivity of subproject viability was assessed through the estimation of switching values at the subproject level, which indicate that the EIRR is robust in terms of changes in both

[8] MVA Systra. 2016. Dau Giay-Phan Thiet Expressway Study.: Draft Traffic Forecasting Report.

the benefits and costs necessary to move the NPV below zero. Table 5 presents the sensitivity analysis for the road subprojects.

Table 5: Sensitivity Analysis for Road Subprojects

	EIRR (%)	ENPV (million $)	SI (%)	SV
Quang Binh Base Case	**12.1%**	**2.09**		
+10% investment cost	10.8%	1.23	-1.10	-0.91
+10% maintenance	11.8%	1.79	-0.28	-3.53
-10% traffic forecast	12.9%	2.65	0.62	1.62
-10% VOC and TTC savings	10.3%	0.77	-1.54	-0.65
Nghe An Base Case	**14.0%**	**2.50**		
+10% investment cost	12.7%	1.92	-0.93	-1.07
+10% maintenance	13.9%	2.36	-0.09	-11.62
-10% generated traffic	13.6%	2.18	-0.29	-3.45
-10% VOC and TTC savings	13.4%	2.07	-0.47	-2.13
Quang Tri Base Case	**15.1%**	**5.20**		
+10% investment cost	13.0%	3.51	-1.36	-0.74
+10% maintenance	14.7%	4.53	-0.28	-3.60
-10% traffic forecast	15.0%	4.88	-0.09	-11.52
-10% VOC and TTC savings	14.1%	3.99	-0.64	-1.55

EIRR = economic internal rate of return, ENPV = economic net present value, SI = sensitivity index, SV = switching value, TTC = travel time cost, VOC = vehicle operating cost.
Source: Asian Development Bank estimates.

C. Output 2: Productive Infrastructure for Business Development Improved

13. A EFA was conducted on Loc Ha District water supply networks subproject in Ha Tinh province. The subproject comprises two subnetworks supplying nine communes; a northern subnetwork connecting to Cu Lay reservoir and a southern subnetwork connecting to the Ha Tinh municipal water supply. The analysis assumes contracts are issued in 2018, and construction starting and finishing within 2019. Initially, the networks will connect to 80% of the households in beneficiary communes. Service coverage will increase to 90% by 2030.

14. The Ha Tinh Water Supply Joint Stock Company (HTWSC) will manage both networks. It was established in 2015 from a previous public sector entity that was formed in 2012 as part of a World Bank-financed development of the Ha Tinh city water supply. The company has assets of 315 billion VND with debt totaling 145 billion VND. The company is still expanding the urban network with total water sales increasing from 8.2 million to 10.5 million cubic meters (m^3) in 2015. The expansion in 2015 involved a 30 billion VND investment in upgrading mainlines and network coverage that continued into 2016. Non-revenue water levels range between 20% to 23%.

15. **Subproject Costs**. The financial costs of two networks are $8.0 million for the northern and $2.1 million for the southern (Table 6). The financial values are converted to economic values by excluding taxes and applying appropriate conversion factors on the tradable and non-tradable components of each item. The operating cost includes both fixed and variable costs, and are

estimated to be 6,055 VND/m^3. In the analysis, all items are first expressed in financial values and are then converted to economic values using appropriate conversion factors.[9]

Table 6: Water Subproject Capital Costs

	Financial Cost		Composition		Economic Cost[a]		
			Non-tradable	Tradable	Non-tradable	Tradable	Total
	(million VND)	('000 $)	(%)	(%)	('000 $)	('000 $)	('000 $)
Northern Network							
Construction costs							
Materials	90,350	4,043	80%	20%	3,072	809	3,881
Labor	28,556	1,278	100%	0%	1,214	0	1,214
Equipment	10,945	490	30%	70%	140	343	482
Equipment costs	591	26	0%	100%	0	26	26
Management costs	1,581	71	90%	10%	60	7	68
Consultancy	10,286	460	80%	20%	350	92	442
General costs and training	4,774	214	90%	10%	183	21	204
Contract Management	987	44	100%	0%	42	0	42
Peripheral electricity costs	455	20	70%	30%	14	6	20
Land compensation	606	27	70%	30%	18	8	26
Tax (10%)	16,325	730	100%	0%	0	0	0
Physical contingency	14,277	639	80%	20%	485	128	613
Total	**179,732**	**8,042**	**82%**	**18%**	**5,577**	**1,440**	**7,018**
Southern Network							
Construction costs							
Materials	23,326	1,044	80%	20%	793	209	1,002
Labor	8,103	363	100%	0%	344	0	344
Equipment	3,003	134	30%	70%	38	94	132
Equipment costs	118	5	0%	100%	0	5	5
Management costs	437	20	90%	10%	17	2	19
Consultancy	2,868	128	80%	20%	98	26	123
General costs and training	1,374	61	90%	10%	53	6	59
Contract Management	273	12	100%	0%	12	0	12
Peripheral electricity costs	136	6	70%	30%	4	2	6
Land compensation	121	5	70%	30%	4	2	5
Tax (10%)	4,367	195	100%	0%	0	0	0
Physical contingency	3,949	177	80%	20%	134	35	170
Total	**48,075**	**2,151**	**82%**	**18%**	**1,496**	**381**	**1,877**

[a] Derived from financial values by applying a standard conversion factor (SCF) of 0.95 on non-tradable component.
Source: Asian Development Bank estimates.

16. **Water tariff**. The subproject's financial performance is largely influenced by the water tariff set by the Provincial People's Committees (PPCs). The PPCs recently raised the HTWSC's water tariff by 15% so that the operating surplus ratio is greater than one.[10] The new tariff offsets operating deficit, but needs periodic adjustment to prevent decrease in real terms. The EFA assumes a tariff increase of 5% in line with the projected increase in incomes in the area every three years from 2021. The executing agency will retain the liability of the ADB loan to the Ministry of Finance and the responsibility for interest and repayment liabilities.

[9] Detailed Economic and Financial Analysis: Water Supply (accessible from the list of linked documents in Appendix 2).

[10] Assuming per capita consumption level of 100 liter per day, connected households will pay $39.3 to $44.2 each year, depending on household size. The amount is about 1.2% of the average household income.

17. **Water Sales**. Table 7 presents the expected number of connections and sales over the project life. The figures are net of non-revenue water loss, estimated to be 15% for both networks.

Table 7: Expected Water Sales

	Unit	2020	2022	2024	2026	2028	2030+
Northern Network							
Connected household	#	9,190	9,504	9,828	10,163	10,509	10,867
Other connection	#	919	950	983	1,016	1,051	1,087
Water sales per day	'000 m^3	4.03	4.17	4.31	4.46	4.61	4.77
Water sales per year	'000 m^3	1,472	1,522	1,574	1,628	1,683	1,741
Southern Network							
Connected household	#	3,882	4,005	4,132	4,264	4,399	4,539
Other connection	#	388	401	413	426	440	454
Water sales per day	'000 m^3	1.54	1.59	1.64	1.70	1.75	1.81
Water sales per year	'000 m^3	564	582	600	619	639	659

Source: Asian Development Bank estimates.

18. **Project Benefits**. An estimate of the willingness to pay was undertaken during the socio-economic survey and confirmed by beneficiary focus group discussions. A simplified approach uses a water tariff at approximately the current willingness to pay, and increases it at the anticipated rate of growth of real incomes (for both financial and economic analyses). This approach ensures affordability with water costing less than 2.5% of household income, below the 5% limit.[11] Other changes in moving from the financial to the economic analysis include (i) exclusion of taxes; (iii) valuation of savings in time for the household consumers valued at 50% of the average rural wage; (iv) improvements in health status due to using a clean water supply, thus reducing expenditure on medicines, travel to doctors, and lost time including time off paid work, household duties, or school are estimated to be 75% allocated to the subprojects.

19. The economic value of water is estimated from the initial tariff less the estimated value of water used for rice production assuming half of the water used during the dry season is sourced from the Cu Lay reservoir. The other half is assumed sourced from the Nghen River. Water supplies will be pumped from Cu Lay reservoir to the water plant. Cu Lay water is used for irrigation—mainly of rice paddies—during the spring and summer dry seasons. The economic opportunity cost of water is estimated based on the potential profit from rice plus the estimated cost of family or hired labor. On this basis, the economic value of water is estimated at VND 1,409/m^3, assuming ex-reservoir water demand for paddy fields is 14,000m^3/hectare. Since there is "excess" water in the Nghen River, no economic value is placed on the river water.

20. **Financial and Sustainability Analysis**. Since the water subproject does not recoup the capital investment, financial internal rate of return (FIRR) is not a meaningful performance metric. Instead, the financial analysis assesses the operating expense ratio (OER), expressed as a ratio between operating expenses and operating revenue. The OERs vary across time but average 0.88 for the northern subnetwork and 0.97 for the southern subnetwork. Both subnetworks generate (marginally) sufficient revenue to cover operating expenses. For HTWSC as an entity, the OER deteriorated from 1.07 in 2013 to 1.19 in 2015. The average water tariff is 6,356 VND/m^3, against a sustainable tariff of 9,000 VND/m^3. HTWSC recently received approval to increase its water tariff. The tariff will be adjusted periodically following a schedule prepared by the Department of Finance. By 2023, the OER is expected to reduce to 0.96, assuming no additional management and operational staff are required.

[11] ADB. 2003. *Asian Water Supplies – Reaching the Urban Poor*. Manila.

21. Economic benefits were quantified for improvements in health status due mainly to using a clean water supply, reducing the need for and cost of medicines, travel to clinics, and lost time including time off paid work, household duties, or school. For the northern subnetwork the subsurface water resources are contaminated with naturally occurring heavy metals and are unfit for human or animal use, thus surface water is essential. Costs are estimated, with 75% allocated to the water subproject. Communes currently report the need to purchase water in 20-liter bottles or from bulk tankers in the dry season. It is assumed that when connected to the scheme, the purchase of water will decline by 90%.[12]

22. **Economic Analysis**. Combined, the two subnetworks yield an EIRR of 12.6% (Table 8), or 13.3% and 10.9% individually. The sensitivity analysis indicates the EIRR for the northern network is robust against downside risks (Table 9), while the southern network is more sensitive.

Table 8: Economic Feasibility of the Water Subproject

Calendar year	**2019**	**2020**	**2022**	**2024**	**2026**	**2028**	**2030-43**
Project year	**Yr 1**	**Yr 2**	**Yr 4**	**Yr 6**	**Yr 8**	**Yr 10**	**Yr 12-25**
Economic Benefits							
Reduction in bottled water purchase	0.0	346.0	357.7	369.8	382.3	395.2	408.5
WTP for potable water	0.0	699.2	796.6	907.6	1,034.1	1,178.2	1,342.4
Health benefit	0.0	147.7	152.6	157.7	162.9	168.3	173.9
Total Economic Benefits	**0.0**	**1,192.8**	**1,306.9**	**1,435.0**	**1,579.3**	**1,741.7**	**1,924.9**
Economic Costs							
Operating Costs							
Fixed costs	0.0	57.1	61.1	65.3	69.8	74.7	79.9
Variable costs	0.0	362.5	375.2	388.3	401.9	415.9	430.5
Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Operating Costs	**0.0**	**420**	**436**	**454**	**472**	**491**	**510**
Investment Costs							
Capital expenditure	-7,018.0	0.0	0.0	0.0	0.0	0.0	0.0
New connection	0.0	0.0	-18.9	-19.5	-20.2	-20.9	-21.6
Rehabilitation (2% every 5 years)	0.0	0.0	0.0	-140.4	0.0	0.0	0.0
Residual (in Yr 25)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Investing Cash Flow	**-7,018.0**	**0.0**	**-18.9**	**-159.9**	**-20.2**	**-20.9**	**-21.6**
Net Economic Resource Flow	**-7,018.0**	**773.2**	**851.7**	**821.5**	**1,087.4**	**1,230.2**	**1,393.0**
ENPV at 9% discount rate	**2,447.4**						
EIRR	**12.6%**						

EIRR = economic internal rate of return, ENPV = economic net present value
Source: Asian Development Bank estimates

Table 9: Sensitivity Analysis of the Water Subproject

	Average OER (%)	**EIRR (%)**	**ENPV (million US$)**	**SI (%)**	**SV**
Northern Subnetwork Base Case	**87.8%**	**13.3%**	**2,109.0**		
+10% investment cost	87.8%	12.1%	1,650.6	-0.885	-1.1
+10% operating costs	96.6%	12.5%	1,717.1	-0.585	-1.7
-10% new connection	87.5%	12.9%	1,914.7	-0.243	-4.1
-10% benefits	87.8%	10.5%	724.1	-2.063	-0.5
Southern Subnetwork Base Case	**97.0%**	**10.9%**	**338.4**		
+10% investment cost	97.0%	9.9%	171.0	-0.922	-1.1
+10% operating costs	106.3%	10.1%	189.5	-0.757	-1.3
-10% new connection	96.6%	10.6%	282.5	-0.261	-3.8
-10% benefits	97.0%	7.8%	-210.8	-2.867	-0.3

OER = operating expense ratio, ENPV = economic net present value, EIRR = economic internal rate of return, SI = sensitivity index, SV = switching value
Source: Asian Development Bank estimates.

[12] Other savings include reduced costs in pumping to elevated tanks and the need to buy replacement filters.