

**VIET NAM: BASIC INFRASTRUCTURE FOR INCLUSIVE GROWTH
IN THE NORTH CENTRAL PROVINCES SECTOR PROJECT**

DETAILED ECONOMIC AND FINANCIAL ANALYSIS

- WATER SUPPLY

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I. OVERVIEW OF ANALYTICAL FRAMEWORK

A. Introduction

1. An economic and financial analysis was conducted on a Loc Ha District water supply networks subproject in Ha Tinh province. The subproject was proposed by the Ha Tinh Provincial People's Committee (PPC) and were studied in detail by a project preparatory technical assistance team including a water engineer, a hydrologist and a surveyor. The subproject comprises two adjacent networks with different water sources supplying nine communes: the northern network will draw water from a water treatment plant currently serving Ha Tinh City, via a new booster station in Thạch Hà District, providing up to 2,500 cubic meters (m³) of potable water per day. The southern network includes a water treatment plant with capacity to source 7,000 m³/day from Cu Lay reservoir. The analysis assumes contracts are issued in 2018, and construction starting and finishing within 2019.

2. The Ha Tinh Water Supply Joint Stock Company (HTWSC) will manage both networks. HTWSC 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 is expanding the urban network with total water sales increasing from 8.2 million m³ to 10.5 million m³ in 2015. The expansion involved a D30 billion investment in upgrading mainlines and network coverage.

3. By 2020, the potential customer base is around 4,852 households in the northern network area and 11,488 households in the southern network area. The average households size is 3.62 people in the northern network area and 3.99 people in the southern network area. The analysis assumes that the subproject initially will provide treated water to 80% of potential customer in 2020, or equivalent to 3,882 households in the northern network, and 9,190 households in the southern network. Service coverage percentage will from 80% to 90% by 2030, or equivalently to 4,587 households in the northern network, and 10,985 households in the southern network. Table 1 provides the population and households statistics and forecasts in the two network areas.

Table 1: Communes and Population in the Two Network Areas

District		Population 2016	HH 2016	Population growth (%)	Population 2020	HH 2020	Population 2030	HH 2030
Northern Network								
Thạch Mỹ	Loc Ha	5,005	1,754	0.50	5,111	1,791	5,367	1,881
Mai Phụ	Loc Ha	6,023	1,467	0.50	6,150	1,498	6,459	1,573
Thạch Châu	Loc Ha	6,200	1,541	0.46	6,290	1,563	6,611	1,643
Northern Network Subtotal		17,228	4,762		17,551	4,852	18,437	5,097
Service coverage		0%	0%		80%	80%	90%	90%
Customers		0	0		14,041	3,882	16,593	4,587
Southern Network								
Hồng Lộc	Loc Ha	8,620	2,228	0.70	8,802	2,275	9,504	2,457
Bình Lộc	Loc Ha	5,493	1,393	0.70	5,609	1,422	6,057	1,536
Phù Lưu	Loc Ha	6,800	1,562	0.48	6,898	1,585	7,271	1,670
Ích Hậu	Loc Ha	8,436	2,212	0.50	8,563	2,245	9,046	2,372
Thuan Thien	Can Loc	7,491	1,947	0.44	7,590	1,973	7,966	2,070
Tung Loc	Can Loc	8,245	1,958	0.50	8,369	1,988	8,841	2,100
Southern Network Subtotal		45,085	11,300		45,833	11,488	48,686	12,205
Service coverage		0%	0%		80%	80%	90%	90%

District	Population 2016	HH 2016	Population growth (%)	Population 2020	HH 2020	Population 2030	HH 2030
Customers	0	0		36,666	9,190	43,817	10,985

HH = household.

Source for 2016 household and population data: Ha Tinh Statistical Yearbook, 2015.

4. **Northern Network.** The three communes of northern network do have piped water at present. They are adjacent to communes currently supplied at a low level by the Thach Ha booster station which receives water from the Ha Tinh City water plant. It can deliver around 600 m³/day, servicing (inadequately) around 3,000 households. The Thach Ha booster station will be replaced by a nearby, larger capacity station, to be built under this subproject. The water produced by Ha Tinh City's water plant should be of high quality, and should not need further treatment in the new Thach Ha booster station, although periodic checks on chlorine levels at the end of the network will determine if chlorine levels are adequate

5. The subproject will develop a new water supply system to serve Thach My, Mai Phu and Thach Chau communes situated along the left bank of the Ha Vang river. Assuming (i) a per capita consumption of potable water of 100 m³/day, and given (ii) an average household size of 3.62, and (iii) an initial service coverage of 80%, the northern network will provide around 1,404 m³/day ($4,852 \times 80\% \times 3.62 \times 100$) in 2020, its first operating year, to 3,882 households in the three subproject communes and an additional 10% or 140 m³/day to services, business and other connections. By 2030 it is expected to sell 1,659 m³/day ($5,097 \times 90\% \times 3.62 \times 100$) to 4,587 households, plus 10% or 166 m³/day to other customers (Table 2).

Table 2: Northern Network Capacity

	Derivation	2020	2030
Total household in subproject area		4,852	5,097
Percentage served		80%	90%
Household served	Households	3,882	4,587
Person served	Population = 3.62*Household	14,041	16,593
Quantity for domestic consumption	Qd = 100 liter*Population	1,404	1,659
Quantity for public use	Qp = 10%*Qd	140	166
Quantity for average water use			
Per day	Qs = Qd+Qp	1,544	1,825
Per year	Qy = 365*Qs	563,736	666,221
Non-revenue water	NRW = 15%*Qs	154	183
Water use capacity	Qm = Qs+NRW	1,699	2,008
Auxiliary consumption	Qa = 5%*Qm	85	100
Average capacity per day	ADP = Qm+Qa	1,784	2,108
Max capacity per day	MDP = 1.2*ADP	2,141	2,530

ADP = average capacity per day, MDP = maximum daily capacity, NRW = non-revenue water, Qa = Auxiliary consumption, Qd = Domestic Consumption, Qm = Water use capacity, Qp = Public consumption, Qs = Average daily water use, Qy = Average annual water use.

Source: Asian Development Bank estimates.

6. **Southern Network.** The six communes of southern network have no piped water at present. The subproject will build a new plant with a maximum capacity of 7,000 m³/day (Table 3). Assuming (i) a per capita consumption of potable water of 100m³/day, and given (ii) an average household size of 3.99, and (iii) an initial service coverage of 80%, the southern network will provide around 3,667 m³/day ($11,488 \times 80\% \times 3.99 \times 100$) in 2020, its first operating year, to 9,9190 households in the three subproject communes and an additional 10% or 367 m³/day to services, business and other connections. By 2030 it is expected to sell 4,382 m³/day

(12,205*90%*3.99*100) to 10,984 households, plus 10% or 438 m³/day to other customers (Table 2).

Table 3: Southern Network Capacity

		Derivation	2020	2030
Total household in subproject area			11,488	12,205
Percentage served			80%	90%
Household served		Households	9,190	10,984
Person served		Population = Households*3.99	36,666	43,817
Quantity for domestic consumption		Qd = 100 liter*Population	3,667	4,382
Quantity for public use		Qp = 10%*Qd	367	438
Quantity for average water use				
Per day		Qs = Qd+Qp	4,033	4,820
Per year		Qy= 365*Qs	1,472,144	1,759,253
Non-revenue water		NRW = 15%*Qs	403	482
Water use capacity		Qm = Qs+NRW	4,437	5,302
Auxiliary consumption		Qa = 10%*Qm	444	530
Average capacity per day		ADP = Qm+Qa	4,880	5,832
Max capacity per day		MDP = 1.2*ADP	5,856	6,998

ADP = average capacity per day, MDP = maximum daily capacity, NRW =non-revenue water, Qa = Auxiliary consumption, Qd = Domestic Consumption, Qm = Water use capacity, Qp = Public consumption, Qs = Average daily water use, Qy = Average annual water use.

Source: Asian Development Bank estimates.

7. Annual water sales forecasts are derived from the aforementioned parameters. Annual water sales in the northern network will increase from 564,000 m³ in 2020 to 659,000 m³ in 2030, and in the southern network from 1,472,000 m³ in 2020 to 1,741,000 m³ in 2030 (Table 4).

Table 4: Connections and Water Sales Forecasts

		Unit	2020	2022	2024	2026	2028	2030+
Northern Network								
Connected household (A)		#	3,882	4,005	4,132	4,264	4,399	4,539
Other connection (B)		#	388	401	413	426	440	454
Water sales per day (C)		'000 m ³ /day	1.54	1.59	1.64	1.70	1.75	1.81
Water sales per year (D =C*365)		'000 m ³ /year	564	582	600	619	639	659
Southern Network								
Connected household (A)		#	9,190	9,504	9,828	10,163	10,509	10,867
Other connection (B)		#	919	950	983	1,016	1,051	1,087
Water sales per day (C)		'000 m ³ /day	4.03	4.17	4.31	4.46	4.61	4.77
Water sales per year (D =C*365)		'000 m ³ /year	1,472	1,522	1,574	1,628	1,683	1,741

m³ = cubic meter.

Source: Asian Development Bank estimates.

B. Analysis Methodology

8. The economic and financial analysis follows ADB Guidelines for the Economic Analysis of Projects.¹ The major assumptions include the following:

- (i) The analysis is for 25 years between 2019 and 2043, inclusive of 1 year of construction.
- (ii) At year 25 (2043), the residual value of the assets is added back as a benefit.
- (iii) The analysis uses the world price (\$) numeraire. The exchange rate is D22,350 to \$1. All prices are expressed in the 2017 price level.

¹ ADB. 2017. *Guidelines for Economic Analysis of Projects*. Manila.

- (iv) Stakeholder benefits were collected in D and converted to United States \$.
- (v) To convert the items into economic values, taxes and subsidies are first deducted from the gross financial values. Conversion factors are then applied on the local (non-tradable), foreign (tradable), and unskilled labor components of each item.
- (vi) A standard conversion factor (SCF) of 0.95 is applied to all local components, including non-tradables, unskilled labor, and project benefits. For unskilled labor and value of time for beneficiaries, another adjustment is required using a shadow wage rate factor of 0.90.
- (vii) The economic discount rate is 9%.

C. Financial Parameters

9. **Project's capital costs** were developed by the project preparatory technical assistance water engineer in local currency. The financial costs of two networks are \$2.2 million and \$5.9 million (Table 5), of which 82% is local (non-tradable) component. Assuming contracts are issued in 2018, construction will start in 2019 and is expected to complete within that year. The main water distribution system will be constructed concurrently. Costs of meters and connection for the initial customers (80% of households in the network areas) are included in the plant and network construction costs. New installation costs about D2 million per new customer. The analysis assumes that new customers will pay the installation costs.² The financial values are converted to economic values by netting out taxes and applying appropriate conversion factors on the tradable and non-tradable components of each item.

Table 5: Water Subproject Capital Costs

	Financial Cost		Composition		Economic Cost ^a		Total
			Non-tradable	Tradable	Non-tradable	Tradable	
	(D million)	('000 \$)	(%)	(%)	('000 \$)	('000 \$)	('000 \$)
Northern 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
Southern Network							
Construction costs							
Materials	67,024	2,999	80%	20%	2,279	600	2,879
Labor	20,453	915	100%	0%	869	0	869
Equipment	7,943	355	30%	70%	101	249	350
Equipment costs	473	21	0%	100%	0	21	21
Management costs	1,144	51	90%	10%	44	5	49
Consultancy	7,418	332	80%	20%	252	66	319
General costs and training	3,399	152	90%	10%	130	15	145
Contract Management	714	32	100%	0%	30	0	30

² The allocation of installation costs to customers affects the financial analysis but not the economic analysis.

	Financial Cost		Composition		Economic Cost ^a		Total
	(D million)	('000 \$)	Non-tradable	Tradable	Non-tradable	Tradable	
			(%)	(%)	('000 \$)	('000 \$)	
Peripheral electricity costs	318	14	70%	30%	9	4	14
Land compensation	485	22	70%	30%	14	7	21
Tax (10%)	11,959	535	100%	0%	0	0	0
Physical contingency	10,328	462	80%	20%	351	92	444
Total	131,657	5,891	82%	18%	4,081	1,060	5,141

^a Derived from financial values by applying a standard conversion factor of 0.95 on non-tradable component.

Source: Asian Development Bank estimates.

10. **Project's operating costs** is based on the HTWSC's average operating costs between 2015 and 2016, and presented in Table 6. The costs are presented in D, net of tax and in financial terms. They are converted to \$ and in economic terms using the SCF, which is used because the costs items are assumed to be non-tradables.

Table 6: Ha Tinh Water Supply Company Operating Costs

	Financial value		Composition		Economic Value
	D/m ³	\$cents/m ³	Non-Tradable	Tradable	
			(%)	(%)	
Fixed costs					
Labor	439	1.96	100%	0.00	1.86
Operation & maintenance	48	0.22	100%	0.00	0.21
Other	426	1.91	100%	0.00	1.81
Variable costs					
Electricity	580	2.60	100%	0.00	2.96
Chemicals	116	0.52	100%	0.00	0.49
Direct labor	3,313	14.82	100%	0.00	14.08
Operation & maintenance	553	2.47	100%	0.00	2.35
Other	668	2.99	100%	0.00	2.84
Total operating cost	6,143	27.48			26.60
Taxes (4.3% of cost)	262	1.17			0.00

m³ = cubic meter.

^a All cost items are net of taxes.

^b Electricity is heavily subsidized.

Source: Asian Development Bank estimates.

11. **Water Tariff.** Water tariff is regulated by the PPC. Although water tariff regulation ensures water affordability for connected households, it negatively affects HTWSC's financial sustainability. Financial sustainability can be measured by the operating expense ratio (OER) which is a ratio between operating expenses and operating revenue. A ratio greater than parity means operating expense is less than operating revenues, and vice versa if the ratio is less than parity.

12. Between 2013 and 2015, HTWSC's OER deteriorates from 1.07 in 2013 to 1.19 in 2015 due to water tariff freeze. However, the PPC recently agreed to raise tariff to improve the financial sustainability of HTWSC. The new tariff structure is presented in Table 9. The figures are inclusive of value-added taxes (VAT) of 10%. In reality and in the analysis, HTWSC only receives the net of tax amount. The new tariff will help to offset the current operating deficit, but still needs periodic adjustment to prevent decrease in real terms. The analysis assumes a tariff increase of 5% every 3 years from 2021.

Table 7: Ha Tinh Water Supply Company Water Tariff Structure
(inclusive of value-added tax)

User type	D/m ³
Households, residents, rental hostels for students:	
- First 10 m ³ (household/month)	6,500
- 10 m ³ to 20 m ³ (household/month)	8,100
- 20 m ³ to 30 m ³ (household/month)	9,800
- Over 30 m ³ (household/month)	12,200
Schools, kindergartens, hospitals, clinics	9,800
Administrative agencies, business units, armed forces, security	9,800
Production and construction activities	12,200
Business and services	16,300

m³ = cubic meter.

Source: Ha Tinh Province People's Committee, Decision No. 2049/QD-UBND.

13. Affordability of potable water is assessed. Assuming per capita consumption of 100 liters per day, connected households in the northern and southern networks will pay about D795,000 to D988,000 (\$35.6 and \$44.7) each year for potable water, inclusive of VAT. The amounts are about 1.0% and 1.2% of average household incomes and are considered affordable.

Table 8: Water Affordability

	Unit	Northern Network	Southern Network
Average household income (A) ^a	D '000/year	81,900	81,900
Average household size (B)	person/household	3.62	3.99
Average consumption (C = B*100 liter*365) ^b	m ³ /year	132.0	145.6
Average water tariff (D) ^c	Dong/m ³	6,025	6,782
Water expenditure per year (E = C*D)	Dong '000/year	795	988
Water expenditure per month (F = E/12)	Dong '000/month	66	82
Water expenditure as % of income (G = E/A)	%	0.97%	1.21%

m³ = cubic meter

^a The project socio-economic survey report an average household income of D81.9 million. The figure is consistent with information gathered in the focus group discussions.

^b Based on daily consumption of 100 liter per capita.

^c Inclusive of VAT and based on a progressive tariff structure. The first 10 m³ consumed in a month (or the first 120 m³ in a year) was charged D6,500/m³, and the second 10 m³ is charged D8,100/m³.

D. Project Benefits

14. The analysis initially considered three sources of economic benefits: (i) improvements in health status due to using a clean water supply, reducing the frequency of water-borne disease, the cost of medications and lost due to days off from work, household production, and schooling and travels to health clinics; (ii) costs savings for connected households that currently buy bottled water or install water collection tanks to supplement ground water consumption; (iii) willingness to pay (WTP) for treated water by customers, including domestic households and commercial and public entities. A fourth potential benefit, namely savings in time spent on water collection, was considered. However, during focus group discussions, most households reported to spend collect water at house yard. After connection to the water networks, the potential time savings would be insignificant. Time savings is thus not included in the analysis.

15. The project will provide a clean water supply which improve the health status of connected households, reducing the need for and cost of medicines and loss of productive time from work, household duties and schooling. A socio-economic survey was conducted to estimate

(i) the frequency of water-borne including diarrhea, eye disease, and skin disease; (ii) actual costs such as cost of medication and clinics; (iii) implicit costs due to time lost from productive activities. Summary statistics on the frequency of disease and associated costs are presented in Table 9.

Table 9: Frequency of Water-Borne Disease and Associated Costs

	Financial value	
	D	\$
Northern Network		
Current situation (% of household)		
Redeye incidents	19.6%	19.6%
Diarrhea incidents	1.1%	1.1%
Cost of Medicines (D/incident)		
Redeye incidents	320,870	14.36
Diarrhea incidents	100,000	4.47
Redeye (A)	4.0	4.0
Diarrhea (B)	5.0	5.0
Value of time		
Rural daily wage (Dong/workday) (C)	150,000	6.71
Value of time (as % of wages) (D)	50%	50%
Redeye (E = A*C*D)	300,000	13.4
Diarrhea (F = B*C*D)	375,000	16.8
Southern Network		
Current situation (% of household)		
Redeye incidents	11.0%	11.0%
Diarrhea incidents	2.7%	2.7%
Cost of Medicines (Dong/incident)		
Redeye incidents	225,455	10.09
Diarrhea incidents	500,000	22.37
Redeye (A)	3.5	3.5
Diarrhea (B)	7.0	7.0
Value of time		
Rural daily wage (D/workday) (C)	150,000	6.71
Value of time (as % of wages) (D)	50%	50%
Redeye (E = A*C*D)	262,500	11.7
Diarrhea (F = B*C*D)	525,000	23.5

Source: Asian Development Bank estimates.

16. During focus group discussion, households report to purchase bottled or tanker water in the dry season to supplement consumption. The average volume and expenditure on water purchase is presented in Table 10.

Table 10: Average Household Expenditure on Bottled or Tanker Water
(Financial Values)

	Unit	Northern Network	Southern Network
A. Interviewed household (A)	Households	18	18
B. Bottled Water			
Households purchasing bottled water	Households	3.0	11.0
20 liters bottles purchased	bottle/household/year	104.0	125.0
Cost per 20 liters bottle	D '000 /bottle	15.0	15.0
Cost per household per year	D '000 /household/year	1,560.0	1,875.0
Bottled water cost per year (B1)	D '000 /year	4,680.0	11,250.0
Bottled water consumption (B2)	liter/household/year	6,240.0	15,000.0
C. Tanker water (D300,000 for 5 m³)			

	Unit	Northern Network	Southern Network
Households purchasing tanker water	Households	0.0	6.0
5m ³ tanker water purchased	tank/household/year	0.0	2.0
Cost per 5 m ³ tank (D '000)	D '000 /tank	300.0	300.0
Cost per household per year	D '000 /household/year	0.0	600.0
Tanker water cost per year (B1)	D '000 /year	0.0	3,600.0
Tanker water consumption (B2)	m ³ /household/year	0.0	10,000.0
Average expenditure on water (D1 = (B1+C1)/A)	D '000 /household/year	260	825
Average quantity purchased (D2 = (B2+C2)/A)	liter/household/year	347	1,389

m³ = cubic meter

Source: Asian Development Bank estimates.

17. The imputed cost of a 20-liter bottled water is D750,000/m³ (150,000/20*1,000), and that of a 5 m³ tanker water is D60,000/m³ (300,000/5), which are multiple times the cost of potable water (Table 7). With the project, water purchase of water is assumed to be reduced by 90%. Other savings include reduced need for water collection tanks, installation of underground water pumping system, reduced pumping costs and costs of replacement filters. However, there is insufficient data to allow assessment of these benefits.

18. From the socio-economic survey, the WTP was estimated to be D8,118/m³, or about 110% of the average tariff structure of D7,380 /m³. The WTP figure is consistent with the new tariff structure. From Table 7, water tariff for the first bracket (0-10 m³) is D6,500/m³, while the tariff for the second bracket (11-20 m³) is D8,100/m³. Assuming a per capita consumption of 100 liter/day, and given an average household size of 3.62 people in the northern network area and 3.99 people in the southern network area. The average monthly consumption is 11.0 m³ (3.62*100*30.5/1000) and 12.1 m³ (3.99*100*30.5/1000) respectively. For the households to consume over 10 m³/month and incurs a marginal cost of D8,100/m³, their WTP must at least be D8,100/m³.

19. Note that WTP is based on the utility derived from consumption of potable water which is of better quality than underground or rain water. Since the utility include health benefits of clean water, the WTP in principle already captures part of the health benefits. Therefore, the health benefits discussed in para. 15 was not included in the economic and financial analysis.

20. For analytical purpose, total potable water supply is classified as non-incremental and incremental portion. The former portion will replace or substitute the consumption of bottled or tanker water whose quality is comparable to potable water. When households are connected to the water network, their expenditures on bottled or tanker water will reduce substantially. The benefit of non-incremental water is thus measured by the cost savings in bottled or tanker water purchase. Aside from cost savings, there is no additional utility from consumption of potable water since bottled or tanker water are of comparable quality. As for the incremental portion, it is the additional quantity of potable water (or of comparable quality) households can access after subproject construction. This portion will augment existing water consumption, or replace the consumption of underground water or rain water which is of worse quality. The benefit of the incremental portion is measured by the willingness to pay. Table 11 summarizes the classification of potable water and the associated benefits.

Table 11: Classification of Potable Water and Associated Benefits

Potable Water	Benefit	Measurement
Non-incremental portion	Savings in water purchase	90% of average annual household expenditure on bottled or tanker water purchase (converted to economic value)
Incremental portion	Willingness to pay	D/m ³ - About 110% of initial average tariff - Adjusted by annual real income growth

Source: Asian Development Bank estimates.

21. Annex tables A1 and A2 present the subprojects' economic resource flow over the project life. Individually, the northern network yields an economic internal rate of return (EIRR) of 9.3%, and the southern network, an EIRR of 12.7%.

22. **Financial Analysis.** A financial analysis is undertaken from the perspective of HTWSC. Historically, the average regulated water tariff was 6,356 D/m³, against a sustainable tariff of D9,000 /m³. In other words, HTWSC's water tariff does not recover operating costs. Its OER deteriorated from 1.07 to 1.19 between 2013 and 2015.

23. In August 2017, HTWSC received approval to increase water tariff (Table 9). The tariff will be adjusted periodically following a schedule prepared by the Department of Finance. By 2023, HTWSC's overall OER is expected to reduce to 0.96, assuming no additional management and operational staff are required.

24. Since the water subprojects does not recoup the capital investment, financial internal rate of return is not a meaningful performance metrics. Instead, the financial analysis assesses the OER, expressed as a ratio between operating expenses and operating revenue. The OERs vary across years but average 0.88 for the northern network and 0.97 for the southern network. Both subprojects generate (marginally) sufficient revenue to cover for operating expenses. Annex tables A3 and A4 present the financial cash flow statement of the two networks.

25. **Sensitivity analysis** considers the following scenarios: (i) 10% increase in investment cost; (ii) 10% increase in operating costs; (iii) 10% reduction in new connection; (iv) 10% reduction in project benefits. In all scenarios, the EIRRs are greater than 9% threshold (Table 12). When operating costs increase, the southern networks' average operating expense ratio slightly exceeds parity.

Table 12: Sensitivity Analysis for Water Subprojects

	Average OER	EIRR (%)	ENPV (million \$)	SI (%)	SV
Northern Network Base Case	0.97	9.3%	50.0		
+10% investment cost	0.97	8.4%	-117.5	-0.95	-1.0
+10% operating costs	1.06	8.4%	-98.9	-0.90	-1.1
-10% new connection	0.97	9.0%	2.4	-0.29	-3.5
-10% benefits	0.97	9.1%	10.2	-0.24	-4.2
Southern Network Base Case	0.88	12.7%	1,864.4		
+10% investment cost	0.88	11.6%	1,405.9	-0.88	-1.1
+10% operating costs	0.97	12.0%	1,472.5	-0.61	-1.7
-10% new connection	0.87	12.4%	1,675.7	-0.25	-4.0
-10% benefits	0.88	12.1%	1,563.7	-0.47	-2.2

EIRR = economic internal rate of return, ENPV = economic net present value, OER = operating expense ratio, SI = sensitivity index, SV = switching value.

Source: Asian Development Bank estimates.

Table A1: Economic Analysis of Northern Network

Calendar year Project year	Unit	2019 Year 1	2020 Year 2	2021 Year 3	2022 Year 4	2023 Year 5	2024 Year 6	2025 Year 7	2026 Year 8	2027 Year 9	2028 Year 10	2029 Year 11	2030 Year 12
Water supply													
Total network water supply	m ³	0	563,756	572,636	581,656	590,819	600,125	609,578	619,180	628,934	638,841	648,904	659,125
Non-incremental portion	m ³	0	1,346	1,367	1,388	1,410	1,433	1,455	1,478	1,501	1,525	1,549	1,573
Incremental portion	m ³	0	562,410	571,269	580,268	589,408	598,693	608,123	617,702	627,432	637,316	647,355	657,552
Economic Benefits													
Non-incremental benefit													
- Reduction in bottled/tanker water purchase	\$ '000	0	41	41	42	43	43	44	45	45	46	47	48
Incremental benefit													
- WTP for potable water	\$ '000	0	213	228	243	259	276	295	314	335	357	381	407
Total Economic Benefits	\$ '000	0.0	311.6	316.5	321.5	326.6	331.7	337.0	342.3	347.7	353.1	358.7	364.4
Operating Costs													
Fixed costs													
Labor	\$ '000	0.00	10.51	10.84	11.19	11.54	11.91	12.29	12.68	13.08	13.50	13.92	14.37
Operation & Maintenance	\$ '000	0.00	1.16	1.19	1.23	1.27	1.31	1.35	1.40	1.44	1.49	1.53	1.58
Other	\$ '000	0.00	10.21	10.53	10.87	11.21	11.57	11.93	12.31	12.70	13.11	13.52	13.95
Subtotal	\$ '000	0.00	21.88	22.57	23.29	24.03	24.79	25.58	26.39	27.23	28.09	28.98	29.90
Variable costs													
Electricity	\$ '000	0.00	16.68	16.94	17.21	17.48	17.76	18.03	18.32	18.61	18.90	19.20	19.50
Chemicals	\$ '000	0.00	2.78	2.82	2.87	2.91	2.96	3.00	3.05	3.10	3.15	3.20	3.25
Labor	\$ '000	0.00	79.38	80.63	81.90	83.19	84.51	85.84	87.19	88.56	89.96	91.37	92.81
Operation & Maintenance	\$ '000	0.00	13.25	13.46	13.67	13.88	14.10	14.32	14.55	14.78	15.01	15.25	15.49
Other	\$ '000	0.00	16.01	16.27	16.52	16.78	17.05	17.31	17.59	17.86	18.15	18.43	18.72
Subtotal	\$ '000	0.00	128.10	130.12	132.17	134.25	136.36	138.51	140.69	142.91	145.16	147.45	149.77
Total Operating Costs	\$ '000	0.00	\$ '000 152.69	155.46	158.28	161.15	164.09	167.08	170.14	173.25	176.43	179.67	182.88
Tax	\$ '000	0.00	\$ '000 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Cash Flow		0.00	161.66	163.86	166.08	168.32	170.59	172.88	175.19	177.53	179.89	182.28	184.68
Investment Costs													
Capital expenditure	\$ '000	-1,877	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$ '000	0	0	-5	-5	-5	-6	-6	-6	-6	-6	-6	-6
Rehabilitation (2% every 5 years)	\$ '000	0	0	0	0	0	-38	0	0	0	0	-38	0
Investing Cash Flow	\$ '000	-1,877.19	\$ '000 -5.25	-5.34	-5.42	-5.42	-43.05	-5.59	-5.68	-5.77	-5.86	-43.50	-6.05
Net Economic Benefit	\$ '000	-1,877.19	161.66	158.61	160.74	162.90	127.54	167.29	169.51	171.76	174.03	138.78	178.64
EIRR			9.3%										

EIRR = economic internal rate of return, WTP = willingness to pay.

Source: Asian Development Bank estimates.

Table A2: Economic Analysis of Southern Network

Calendar year Project year	Unit	2019 Year 1	2020 Year 2	2021 Year 3	2022 Year 4	2023 Year 5	2024 Year 6	2025 Year 7	2026 Year 8	2027 Year 9	2028 Year 10	2029 Year 11	2030 Year 12
Water supply													
Total network water supply	m ³	0	1,471,922	1,496,801	1,522,101	1,547,828	1,573,990	1,600,595	1,627,649	1,655,160	1,683,137	1,711,586	1,740,516
Non-incremental portion	m ³	0	12,764	12,980	13,199	13,423	13,649	13,880	14,115	14,353	14,596	14,843	15,093
Incremental portion	m ³	0	1,459,158	1,483,821	1,508,901	1,534,406	1,560,341	1,586,715	1,613,534	1,640,807	1,668,541	1,696,743	1,725,422
Economic Benefits													
Non-incremental benefit													
- Reduction in bottled/tanker water purchase	\$ '000	0	305	310	316	321	326	332	338	343	349	355	361
Incremental benefit													
- WTP for potable water	\$ '000	0	554	591	631	674	720	769	821	876	936	999	1,067
Total Economic Benefits	\$ '000	0.0	311.6	0.0	813.7	827.4	841.4	855.6	870.1	884.8	899.8	915.0	930.4
Operating Costs													
Fixed costs													
Labor	\$ '000	0.00	27.44	28.38	29.34	30.34	31.38	32.45	33.55	34.70	35.88	37.10	38.37
Operation & Maintenance	\$ '000	0.00	3.02	3.13	3.23	3.34	3.46	3.58	3.70	3.82	3.95	4.09	4.23
Other	\$ '000	0.00	26.65	27.56	28.50	29.47	30.48	31.51	32.59	33.70	34.85	36.04	37.26
Subtotal	\$ '000	0.00	21.88	22.57	23.29	24.03	24.79	25.58	26.39	27.23	28.09	28.98	29.90
Variable costs													
Electricity	\$ '000	0.00	43.55	44.28	45.03	45.79	46.57	47.35	48.16	48.97	49.80	50.64	51.49
Chemicals	\$ '000	0.00	7.25	7.38	7.50	7.63	7.76	7.89	8.02	8.16	8.29	8.43	8.58
Labor	\$ '000	0.00	207.27	210.77	214.33	217.95	221.64	225.38	229.19	233.07	237.01	241.01	245.09
Operation & Maintenance	\$ '000	0.00	34.59	35.17	35.76	36.37	36.98	37.61	38.24	38.89	39.55	40.22	40.90
Other	\$ '000	0.00	41.81	42.52	43.23	43.97	44.71	45.46	46.23	47.01	47.81	48.62	49.44
Subtotal	\$ '000	0.00	128.10	130.12	132.17	134.25	136.36	138.51	140.69	142.91	145.16	147.45	149.77
Total Operating Costs	\$ '000	0.00	149.98	0.00	149.98	152.69	155.46	158.28	161.15	164.09	167.08	170.14	173.25
Tax	\$ '000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operating Cash Flow		0.00	161.66	0.00	161.66	163.86	166.08	168.32	170.59	172.88	175.19	177.53	179.89
Investment Costs													
Capital expenditure	\$ '000	-5,141	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$ '000	0	0	-13	-14	-14	-14	-14	-15	-15	-15	-15	-16
Rehabilitation (2% every 5 years)	\$ '000	0	0	0	0	0	-103	0	0	0	0	-103	0
Investing Cash Flow	\$ '000	-1,877.19	0.00	-1,877.19	0.00	-5.25	-5.34	-5.42	-43.05	-5.59	-5.68	-5.77	-5.86
Net Economic Benefit	\$ '000	-1,877.19	161.66	-1,877.19	161.66	158.61	160.74	162.90	127.54	167.29	169.51	171.76	174.03
EIRR		9.3%		12.7%									

EIRR = economic internal rate of return, WTP = willingness to pay.

Source: Asian Development Bank estimates.

Table A3: Financial Analysis of Northern Network

Calendar year Project year	Unit	2019 Year 1	2020 Year 2	2021 Year 3	2022 Year 4	2023 Year 5	2024 Year 6	2025 Year 7	2026 Year 8	2027 Year 9	2028 Year 10	2029 Year 11	2030 Year 12
Revenue													
Tariff													
Tariff increase (real)	%	0%	5%	0%	0%	5%	0%	0%	5%	0%	0%	5%	0%
Average tariff	\$/m ³	0.27	0.27	0.29	0.29	0.29	0.30	0.30	0.30	0.32	0.32	0.32	0.33
Water sales	m ³	0	563,756	572,636	581,656	590,819	600,125	609,578	619,180	628,934	638,841	648,904	659,125
Total Revenue	\$ '000	0.0	153.6	163.8	166.4	169.0	180.3	183.1	186.0	198.4	201.5	204.7	218.3
Operating Costs													
Fixed costs													
Labor	\$ '000	0.00	11.06	11.41	11.78	12.15	12.54	12.93	13.35	13.77	14.21	14.66	15.12
Operation & Maintenance	\$ '000	0.00	1.22	1.26	1.30	1.34	1.38	1.43	1.47	1.52	1.57	1.62	1.67
Other	\$ '000	0.00	10.74	11.09	11.44	11.80	12.18	12.56	12.96	13.37	13.80	14.24	14.69
Subtotal	\$ '000	0.00	23.03	23.76	24.51	25.29	26.09	26.92	27.78	28.66	29.57	30.51	31.48
Variable costs													
Electricity	\$ '000	0.00	14.63	14.86	15.10	15.33	15.57	15.82	16.07	16.32	16.58	16.84	17.11
Chemicals	\$ '000	0.00	2.92	2.97	3.02	3.06	3.11	3.16	3.21	3.26	3.31	3.37	3.42
Labor	\$ '000	0.00	83.56	84.88	86.22	87.57	88.95	90.35	91.78	93.22	94.69	96.18	97.70
Operation & Maintenance	\$ '000	0.00	13.94	14.16	14.39	14.61	14.84	15.08	15.31	15.56	15.80	16.05	16.30
Other	\$ '000	0.00	16.86	17.12	17.39	17.67	17.94	18.23	18.51	18.80	19.10	19.40	19.71
Subtotal	\$ '000	0.00	131.92	133.99	136.11	138.25	140.43	142.64	144.89	147.17	149.49	151.84	154.23
Total Operating Costs	\$ '000	0.00	\$ '000	157.75	160.62	163.54	166.52	169.56	172.66	175.83	179.06	182.35	185.71
Tax	\$ '000	0.00	\$ '000	7.00	7.11	7.22	7.70	7.82	7.95	8.47	8.61	8.74	9.32
Operating Cash Flow		0.00	-7.89	-0.92	-1.31	-1.72	6.06	5.74	5.40	14.09	13.85	13.59	23.27
Investment Costs													
Capital expenditure	\$ '000	-2,151	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$ '000	0.00	0.00	-6.02	-6.11	-6.21	-6.31	-6.41	-6.51	-6.61	-6.71	-6.82	-6.93
Rehabilitation (2% every 5 years)	\$ '000	0.00	0.00	0.00	0.00	0.00	-43.02	0.00	0.00	0.00	0.00	-43.02	0.00
Investing Cash Flow	\$ '000	-2,151.01	\$ '000	-6.02	-6.11	-6.21	-49.33	-6.41	-6.51	-6.61	-6.71	-49.84	-6.93
Net Cash Flow	\$ '000	-2,151.01	-7.89	-6.93	-7.42	-7.93	-43.26	-0.67	-1.11	7.47	7.13	-36.25	16.34
OER			0.97										

OER = Operating expense ratio.

Source: Asian Development Bank estimates.

Table A4: Financial Analysis of Southern Network

Calendar year Project year	Unit	2019 Year 1	2020 Year 2	2021 Year 3	2022 Year 4	2023 Year 5	2024 Year 6	2025 Year 7	2026 Year 8	2027 Year 9	2028 Year 10	2029 Year 11	2030 Year 12
Revenue													
Tariff													
Tariff increase (real)	%	0%	5%	0%	0%	5%	0%	0%	5%	0%	0%	5%	0%
Average tariff	\$/m ³	0.30	0.30	0.32	0.32	0.32	0.33	0.33	0.33	0.35	0.35	0.35	0.36
Water sales	m ³	0	1,471,922	1,496,801	1,522,101	1,547,828	1,573,990	1,600,595	1,627,649	1,655,160	1,683,137	1,711,586	1,740,516
Total Revenue	\$ '000	0.0	441.8	471.8	479.8	487.9	520.9	529.7	538.7	575.2	584.9	594.8	635.1
Operating Costs													
Fixed costs													
Labor	\$ '000	0.00	28.89	29.87	30.89	31.94	33.03	34.16	35.32	36.52	37.77	39.06	40.39
Operation & Maintenance	\$ '000	0.00	3.18	3.29	3.40	3.52	3.64	3.76	3.89	4.02	4.16	4.30	4.45
Other	\$ '000	0.00	28.05	29.01	30.00	31.02	32.08	33.17	34.30	35.47	36.68	37.93	39.23
Subtotal	\$ '000	0.00	23.03	23.76	24.51	25.29	26.09	26.92	27.78	28.66	29.57	30.51	31.48
Variable costs													
Electricity	\$ '000	0.00	38.20	38.85	39.50	40.17	40.85	41.54	42.24	42.96	43.68	44.42	45.17
Chemicals	\$ '000	0.00	7.63	7.76	7.90	8.03	8.16	8.30	8.44	8.59	8.73	8.88	9.03
Labor	\$ '000	0.00	218.17	221.86	225.61	229.42	233.30	237.25	241.26	245.33	249.48	253.70	257.99
Operation & Maintenance	\$ '000	0.00	36.41	37.02	37.65	38.28	38.93	39.59	40.26	40.94	41.63	42.33	43.05
Other	\$ '000	0.00	44.01	44.75	45.51	46.28	47.06	47.86	48.67	49.49	50.32	51.18	52.04
Subtotal	\$ '000	0.00	131.92	133.99	136.11	138.25	140.43	142.64	144.89	147.17	149.49	151.84	154.23
Total Operating Costs	\$ '000	0.00	\$ '000	157.75	160.62	163.54	166.52	169.56	172.66	175.83	179.06	182.35	185.71
Tax	\$ '000	0.00	\$ '000	17.62	17.96	18.31	18.67	19.03	19.41	19.79	20.18	20.58	20.99
Operating Cash Flow		0.00	-7.89	-0.92	-1.31	-1.72	6.06	5.74	5.40	14.09	13.85	13.59	23.27
Investment Costs													
Capital expenditure	\$ '000	-5,891	0	0	0	0	0	0	0	0	0	0	0
Connection fee of new customers	\$ '000	0.00	0.00	-15.29	-15.55	-15.81	-16.08	-16.35	-16.63	-16.91	-17.19	-17.48	-17.78
Rehabilitation (2% every 5 years)	\$ '000	0.00	0.00	0.00	0.00	0.00	-117.81	0.00	0.00	0.00	0.00	-117.81	0.00
	\$ '000	-	-	-	-	-	-	-	-	-	-	-	-
Investing Cash Flow	\$ '000	2,151.01	0.00	-6.02	-6.11	-6.21	-49.33	-6.41	-6.51	-6.61	-6.71	-49.84	-6.93
	\$ '000	-	-	-	-	-	-	-	-	-	-	-	-
Net Cash Flow	\$ '000	2,151.01	-7.89	-6.93	-7.42	-7.93	-43.26	-0.67	-1.11	7.47	7.13	-36.25	16.34
OER		0.88											

OER = Operating expense ratio.

Source: Asian Development Bank estimates.

Table A5: Ha Tinh Water Supply Company Financial Data 2015-2016

	Unit	2015 Estimate	2016 Plan	Average
Operating parameters				
- Design capacity	m ³ /day	51,600	58,100	54,850
- Exploitation capacity	m ³ /day	38,100	41,129	39,615
- Raw water volume	1000 m ³	12,316	13,134	12,725
- Clean water volume	1000 m ³	11,899	12,689	12,294
- Water sales	1000 m ³	9,325	10,070	9,697
- Non-revenue water	%	21.6%	20.6%	21.1%
- Customers with piped water	households	55,396	58,436	56,916
- Sales/customer/day	liter	461	472	467
- Average tariff (excluding VAT)	D/m ³	7057	7037	7047
- Average tariff (including VAT)	D/m ³	7763	7741	7752
Expenses				
Variable costs				
- Electricity	D/m ³	574	586	580
- Chemicals	D/m ³	113	118	116
- Direct labor	D/m ³	3118	3507	3313
- R&M	D/m ³	447	658	553
- Other	D/m ³	597	740	668
Total direct costs	D/m ³	4850	5610	5230
Fixed costs				
- Labor	D/m ³	455	422	439
- R&M	D/m ³	50	46	48
- Other	D/m ³	442	410	426
Total fixed costs	D/m ³	948	878	913
Total cost of water supply	D/m ³	5684	6369	6027

R&M = repairs and maintenance, VAT = value-added tax.

Source: Ha Tinh Water Supply Company.