ECONOMIC ANALYSIS

A. Background

1. The urban population in the People's Republic of China (PRC) increased drastically from 170 million in 1978 to 730 million in 2013, and the urbanization rate increased from 17.9% to 53.7%. From 1980 to 1995, the PRC has pursued urbanization with a growth rate 0.53% per year. The urbanization process accelerated in 1995, with an average annual growth of about 1.4% per year. Urbanization still lags behind some countries, however; for example, the average urbanization rate in Europe is 70%. Urbanization is perceived as one of the PRC's main economic driving forces, especially as the country seeks to boost domestic consumption and the rebalance economic activity from investment and exports to demand-driven, service-oriented growth.[1] The National Urbanization Strategy (2014–2020) indicates that the past trend of urban development should be sustained.[2] The urbanization rate should reach 60% by 2020 and 70% by 2030.

2. In 2012, the population of Baicheng Municipality was 2 million, total gross domestic product (GDP) was CNY61.54 billion, and 12.2% GDP growth. In the same year, Baishan Municipality had a population of 1.2 million, total GDP of CNY60.06 billion, and 12.4% GDP growth.[3] Both cities have high urban poverty rates (12.5% in Baishan and 10.2% in Baicheng), well above the Jilin Province average of 6.0%. The population of Baishan City was 480,000 in 2012, and is projected to reach 700,000 by 2020; Baicheng City's population was 330,000 in 2012, and is projected to reach 600,000 in 2020. In Baicheng City, the current urbanization rate of 40% is far below the provincial and PRC averages, which are both around 54%. Given their very rapid growth, both cities face urgent infrastructure needs to facilitate higher productivity and insure their sustainable development and continued growth.

3. The existing urban area of Baicheng City cannot meet its urban development needs. The urban road network is largely incomplete, with missing links and sections. Residential areas located on the western part of the city—the Baicheng Economic Development Zone (BEDZ)—have grown without basic access to central municipal services.[4] Proper development of this area will substantially enhance the city's competitiveness in terms of attracting both foreign and domestic investment, creating employment opportunities, and improving the standard of living of residents. Both project cities lack sound waste collection systems, with small dump sites within the urban area that contaminate surface and ground water, and air quality. There is no systematic waste sorting or retrieval of landfill gases, and minimal effort to reduce, reuse, and recycle municipal solid waste. In Baishan City, the current water supply facility is inadequate to serve the entire city's population and cannot ensure 24-hour water supply services. Moreover, non-revenue water losses are high (up to 65%), resulting in inefficient water use, loss of income, and excessive energy consumption. The proposed project addresses the need for urban road networks and municipal services in Baicheng, the demand for solid waste management in both cities, and the water supply shortfall in Baishan.

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[1] Domestic consumption accounted for 36% of the People's Republic of China's (PRC) gross domestic product in 2011; by comparison, it accounted for 72% in the United States, 65% in the United Kingdom, and 59% in India. The PRC's domestic markets are perceived to have the potential to sustain economic growth even if the global economy continues to stagnate.

[2] State Council of the PRC. 2014. *National Urbanization Strategy, 2014–2020.* Beijing.

[3] The average gross domestic product (GDP) growth of Jilin Province is 12%.

[4] An estimated 25,000 residents are not yet connected to the central wastewater treatment plant, and discharge wastewater to the surrounding environment or use unimproved septic tanks.

B. Methodology and Assumptions

4. Incremental costs and benefits are estimated by comparing with- and without-project scenarios for each subproject and the project as a whole. For all subprojects, the economic analysis was conducted for the project lifespan of 25 years, including the construction period of 5 years. The residual value at the end of the project life is assumed to be zero. All prices and costs are expressed in 2013 prices and in the domestic currency. A discount rate of 12% per annum is assumed. The capital costs are adjusted to eliminate price contingencies, interest during construction, and taxes, [5] while physical contingencies are included. Tradable commodities are valued at border prices at the prevailing exchange rate. Non-tradable commodities are valued by applying a standard conversion factor of 0.987 and the following specific conversion factors: 1.0 for equipment, 1.0 for skilled labor, and 0.67 for unskilled labor.[6]

5. The quantified economic benefits of Baicheng municipal services include mainly traffic-related benefits. However other benefits have been taken in consideration such as (i) increased land values, which serve as a proxy for local economic growth; (ii) increased incremental employment, and underlying labor income; and (iii) benefit from integrated solid waste management activities (see para 11). However, because land value appreciation may include users' willingness to pay (WTP) for reduced travel costs, time savings, and avoided accidents, it may cause double counting, and land value appreciation is therefore not included in the economic internal rate of return (EIRR) calculation. Incremental employment creation and its benefits are often too difficult to quantify, and are likewise not included.

6. The economic returns are mainly in the form of savings in road-user costs due to the provision of better road facilities. The benefits depend on future transport demand in the area. The feasibility study applied a standard transport model using simulations of the traffic load, using existing data for calibration. By modifying the number of trips generated and attracted by each area, it is possible to simulate changes in average daily traffic intensity for each route, both with and without the project. Two types of benefits are taken into account: benefits resulting from changes in vehicle operating costs (VOCs), and those resulting from user travel time savings.

7. VOC savings allow for differences in roughness, terrain, speed, and congestion, as well as changing vehicle composition for passenger and freight vehicles, and improvements in vehicle performance. VOC savings are a main source of economic benefits. Travel time savings are obtained when road improvements lead to an increase in vehicle speeds, thus reducing the journey times of passengers. The values used per passenger-hour are CNY9.1 for car passengers and CNY2.4 for bus passengers, and 3% for labor productivity growth. Time savings for freight cargos were not quantified because of the lack of reliable data. The operation costs include (i) maintenance, repairs, and spare parts; (ii) tire wear and tear; and (iii) fuel costs. Fuel consumption is calculated as a function of petroleum prices, distances travelled, and travelling speed. Average consumption per kilometer at each speed is estimated using national data.

8. Annual average labor productivity growth of 3% is assumed. In addition to valuing the time savings, this adjustment is applied to the costs of vehicle operators and vehicle maintenance personnel. It is not applied to labor used for road maintenance, which is treated as wholly unskilled with a constant real wage. The significance of labor productivity growth is shown in the model. For

[5] The taxes are assumed to be 25% for income tax, 17% for local value-added tax, and 5% for construction tax.

[6] ADB. 2011. *Report and Recommendation of the President to the Board of Director: Proposed Loan to the People's Republic of China for Hebei Energy Efficiency Improvement and Emission Reduction Project.* Manila; ADB. 2011. *Report and Recommendation of the President to the Board of Director: Proposed Loan to the People's Republic of China for Shandong Energy Efficiency and Emission Reduction Project.* Manila; and ADB. 2010. *Report and Recommendation of the President to the Board of Director: Proposed Loan and Grant to the People's Republic of China for Tianjin Integrated Gasification Combined Cycle Power Plant Project.* Manila.

example, the net present value of value of time (drivers and passengers' time in vehicle) reaches CNY184.4 million for normal traffic from 2019 to 2038. Without labor productivity growth, it drops to CNY122.4 million.

9. Based on the survey, the average ratio of total occupants to drivers is 2.0:1.0 for cars and/or sport utility vehicles, 1.5:1.0 for motorcycles, 1.3:1.0 for all categories of trucks, and 25:1 for buses. It is assumed that all cars, sport utility vehicles and motorcycles passengers (as opposed to drivers) are engaged in leisure activities, as are 40% of bus passengers, and 20% of truck passengers. The value of leisure time is taken as 30% of the value of work time.

10. Health benefits constitute a large part of the quantifiable economic benefits of Baishan water supply management component. Private sector productivity and production capacity in agriculture and industry also depend on the availability of secure, sanitary water. However, these benefits—along with minor benefits such as those that accrue to amenity values, local tourism, and fisheries—are difficult to quantify because of their insignificant scale, possible double counting, and a lack of data. Estimating total economic gain per expenditure approach thus yields overly large variations. In the current analysis, benefits are valued by estimating society's WTP for the benefits, which is based on a social and economic survey.[7]

11. The quantifiable economic benefits of the integrated solid waste management (ISWM) system component and activities consist of the benefits from the sanitation landfill (calculated based on the WTP estimated from the social and economic survey results), and benefits from composting (calculated based on the market price of fertilizer).

C. Least-Cost Analysis

12. The economic least-cost analysis confirms that the engineering options with the lowest financial cost also have the lowest economic cost. For the Baicheng road infrastructure component, the feasibility study compared road pavement materials, and concluded asphalt is the least-cost alternative compared with concrete and low-noise materials. The average incremental economic cost of different materials for the third ring road pavement is in Table 1.

Table 1: Least-Cost Analysis for Road Pavement Materials
(CNY million)

		Option 1 Asphalt			Option 2 Concrete		
Year	Pavement (m^2)	Capital Cost	O&M	Total Cost	Capital Cost	O&M	Total Cost
1		3.44		3.44	3.28		3.28
2		25.79		25.79	24.60		24.60
3		51.57		51.57	49.20		49.20
4		77.36		77.36	73.80		73.80
5		13.75		13.75	13.12		13.12
6–20	621,720		30.30	30.30		57.90	57.90
NPV (at 12%)	4,234,451	117.30	206.37	323.67	111.91	394.35	335.67
AIEC(CNY/m^3)				76.4			79.3

AIEC = average incremental economic cost, CNY = Chinese yuan, m^3 = cubic meter, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

[7] W. Hanemann. 1985. Some Issues in Continuous and Discrete-response Contingent Valuation Studies. *Northeastern Journal of Agricultural Economics.* 14 (5-13); W. Hanemann et al. 1991. Statistical Efficiency of Double-bounded Dichotomous Choice Contingent Valuation. *American Journal of Agricultural Economics*. 73 (4): pp. 1255–1263; and R. Carson and W. Hanemann. 2006. Contingent Valuation. *Handbook of Environmental Economics*.

13. For the Baishan water supply management component, the least-cost analysis included the watershed transmission pipeline routing, water treatment plant location, and water treatment engineering options. The feasibility study compared two routing plans for the transmission pipelines for Jiangyuan and Hunjiang districts (tables 2 and 3).

Table 2: Least-Cost Choice for Transmission Pipelines for Jiangyuan District

	Option 1				Option 2		
	Diameter, Length	DN800 L=7500 m PN0.6MPa			DN800 L=6868 m PN0.6MPa		
Year	Capacity (million m^3)	Capital Cost	O&M	Total Cost	Capital Cost	O&M	Total Cost
1		29.56		29.56	10.19		10.19
2		29.56		29.56	10.19		10.19
3–20	10.95		1.6	1.6		0.55	0.55
NPV (at 12%)	79.38	49.96	11.57	61.54	17.23	3.99	20.41
AIEC (CNY/m^3)				0.78			0.26

AIEC = average incremental economic cost, CNY = Chinese yuan, DN= diameter nominal, L= length, m^3 = cubic meter, NPV = net present value, MPa= megapascal, O&M = operation and maintenance, PN= nomina pressure.
Note: Capital costs include land acquisition, compensation, and resettlement.
Source: Asian Development Bank estimates.

14. For option 1 in Jiangyuan district and option 2 in Hunjiang district, all transmission pipelines are installed beneath the riverbed, and resulting in substantially higher average incremental economic costs. Thus, options 2 in Jiangyuan district and 1 in Hunjiang district are chosen according to the least-cost principle. The feasibility study considered four options for the location of the treatment plant, including the vicinity of the reservoir, Shangdianzi village, Nanshan waste treatment plant, and Hunjiang district in the Tongjiang bridge area. Ultimately the vicinity of the reservoir area was chosen as the least-cost option.

Table 3: Least-Cost Choice for Transmission Pipelines for Hunjiang District

		Option 1			Option 2		
Transmission Pipelines Diameter, Length, Pressure		DN900 L=19000m PN0.6MPa DN900 L=1500m PN1.0MPa DN900 L=3831 m PN1.6MPa			DN900 L=16750 m PN0.6MPa DN900 L=900 m PN1.0MPa DN900 L=2975 m PN1.6MPa		
Year	Capacity (m^3 million)	Capital Cost	O&M	Total Cost	Capital Cost	O&M	Total Cost
1		49.49		49.49	106.82		106.82
2		49.49		49.49	106.82		106.82
3-20	18.250		2.67	2.67		5.77	5.77
NPV (at 12%)	132	83.64	19.37	103.02	180.53	41.82	213.87
AIEC(CNY/m^3)				0.78			1.6

AIEC = average incremental economic cost, CNY = Chinese yuan, DN= diameter nominal, L= length, m^3 = cubic meter, NPV = net present value, MPa= megapascal, O&M = operation and maintenance, PN= nominal pressure.
Note: Capital costs include land acquisition, compensation, and resettlement.
Source: Asian Development Bank estimates.

D. Economic Return

15. The base case EIRR calculation is in Table 5. At a 12% discount rate, the project is economically viable. For the project as a whole, the net present value is CNY553.9 million and the base case EIRR 16.0%, which exceeds the economic opportunity cost of capital. The component EIRRs are 16.0% for Baicheng municipal services, 16.0% for Baishan water supply management and 15.1% for Baishan ISWM system. The sensitivity analysis shows that the project's economic return is robust in the face of negative impacts such as benefit reduction, cost overruns, and project implementation delays. The results of the sensitivity analysis for the entire project are in Table 5. A summary of the economic evaluation for all subprojects is in Table 6; economic cash flows for the overall project are in Table 7.

Table 4: Economic Internal Rate of Return and Sensitivity Results for the Entire Project

Cases	EIRR	NPV (CNY million)	Switching Values Benefits Reduced	Capital Cost Increase	Delay Year
Base Case	16.0%	553.9	28.0%	26.0%	2
(i) Benefits reduced by 10%	14.7%	363.6			
(ii) Investment cost increased by 10%	14.9%	433.9			
(iii) Delay of 1 year	14.7%	409.9			
(iv) Combination of (i), (ii), and (iii)	12.5%	70.2			

CNY = Chinese yuan, EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank estimates.

Table 5: Summary of the Economic Evaluation for All Subprojects

Components	EIRR	NPV (CNY million)	Benefit Reduction 10%	Capital Cost Increase 10%	O&M Cost Overrun 10%	Delay 1 Year	Combi-nation
Municipal services in Baicheng	16.0%	511.9	14.9%	15.1%	15.6%	14.6%	12.5%
ISWM system in Baishan	15.1%	31.6	12.7%	13.8%	14.2%	13.5%	9.2%
Water supply management in Baishan	16.0%	76.9	14.3%	14.7%	15.8%	14.4%	11.4%

CNY = Chinese yuan, EIRR = economic internal rate of return, ISWM = integrated solid waste management, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

Table 6: Economic Internal Rate of Return for the Entire Project (CNY million)

	Benefits				Costs			
Year	Baicheng Municipal Services	Baishan Water Supply management	Baishan ISWM system	Total	Capital Costs	O&M	Total	Net Benefits
2014	0	0.0	0.0	0.0	212.3	0.0	212.26	(212.26)
2015	0	0.0	0.0	0.0	483.0	0.0	483.04	(483.04)
2016	0	0.0	0.0	0.0	750.5	0.0	750.45	(750.45)
2017	0	0.0	0.0	0.0	332.9	0.0	332.93	(332.93)
2018	0	0.0	0.0	0.0	42.6	0.0	42.56	(42.56)
2019	190.86	66.6	58.0	315.5	0.0	35.1	35.12	280.36
2020	210.49	83.2	58.0	351.8	0.0	35.8	35.85	315.91
2021	232.23	83.2	58.0	373.5	0.0	35.9	35.95	337.55
2022	256.31	83.2	58.0	397.6	0.0	36.1	36.05	361.53
2023	277.58	83.2	58.0	418.8	0.0	50.6	50.59	368.26
2024	300.89	83.2	58.0	442.2	0.0	36.2	36.16	406.00
2025	326.45	83.2	58.0	467.7	0.0	36.3	36.26	431.45
2026	354.51	83.2	58.0	495.8	0.0	36.4	36.38	459.40
2027	385.33	83.2	58.0	526.6	0.0	36.5	36.49	490.10
2028	419.20	83.2	58.0	560.5	0.0	73.2	73.16	487.31
2029	456.47	83.2	58.0	597.7	0.0	36.6	36.61	561.13
2030	497.50	83.2	58.0	638.8	0.0	36.7	36.73	602.03
2031	542.70	83.2	58.0	684.0	0.0	36.9	36.86	647.11
2032	592.55	83.2	58.0	733.8	0.0	37.0	36.99	696.83
2033	647.56	83.2	58.0	788.8	0.0	55.4	55.40	733.42
2034	708.31	83.2	58.0	849.6	0.0	37.1	37.12	812.46
2035	775.46	83.2	58.0	916.7	0.0	37.3	37.26	879.47
2036	849.75	83.2	58.0	991.0	0.0	37.4	37.40	953.62
2037	932.00	83.2	58.0	1073.3	0.0	37.5	37.54	1,035.72
2038	1,015.66	83.2	58.0	1156.9	0.0	37.7	37.69	1,119.23
	NPV at 12%					**166.8**	**1,349.4**	**553.9**
	EIRR							**16.0%**

( ) = negative, CNY = Chinese yuan, EIRR = economic internal rate of return, ISWM = integrated solid waste management, NPV = net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.